



PROJECT PERIODIC REPORT

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Table of Main Acronyms

DPS	Division for Planetary Sciences
EPN	Europlanet
EPN2020-RI	Europlanet 2020 Research Infrastructure
EPSC	European Planetary Science Congress
JRA	Joint Research Activities
MoU	Memorandum of Understanding
NA	Networking Activities
PMC	Project Management Committee
PSA	Planetary Science Archive
PSWS	Planetary Space Weather Service
PVOL	Planetary Virtual Observatory and Laboratory
RP2	Second Reporting Period
TA	Transnational Access
TAP	Table access protocol
VA	Virtual Access
VESPA	Virtual European Solar and Planetary Access
WP	Work Package

Project Summary

1. Background

Europlanet emerged from collaborations between European scientists and engineers involved in the Cassini-Huygens mission, with the aim of overcoming fragmentation within the European planetary science community. An initial network developed through a €2 million FP6 Coordination Action developed into a €6 million Research Infrastructure under FP7 that, in turn, evolved into this project. The current Europlanet 2020 Research Infrastructure (EPN2020-RI) is a €10 million Horizon 2020 project that offers a suite of state-of-the-art transnational access, virtual access and networking services to the planetary science community across Europe.

Beyond EU-Funded projects, Europlanet has developed sustainable structures to support the community, including the Europlanet Society (launched in September 2018) and the annual European Planetary Science Congress (EPSC). This report demonstrates the key impacts of the EPN2020-RI during the Second Reporting Period (RP2) from 1 March 2017 – 31 August 2018.

For full details of the background to EPN2020-RI, see the [First Periodic Report](#).

2. Europlanet 2020 Research Infrastructure - Impact to date

EPN2020-RI is an advanced Research Infrastructure and has a considerable reach within the European planetary science community and the international landscape.

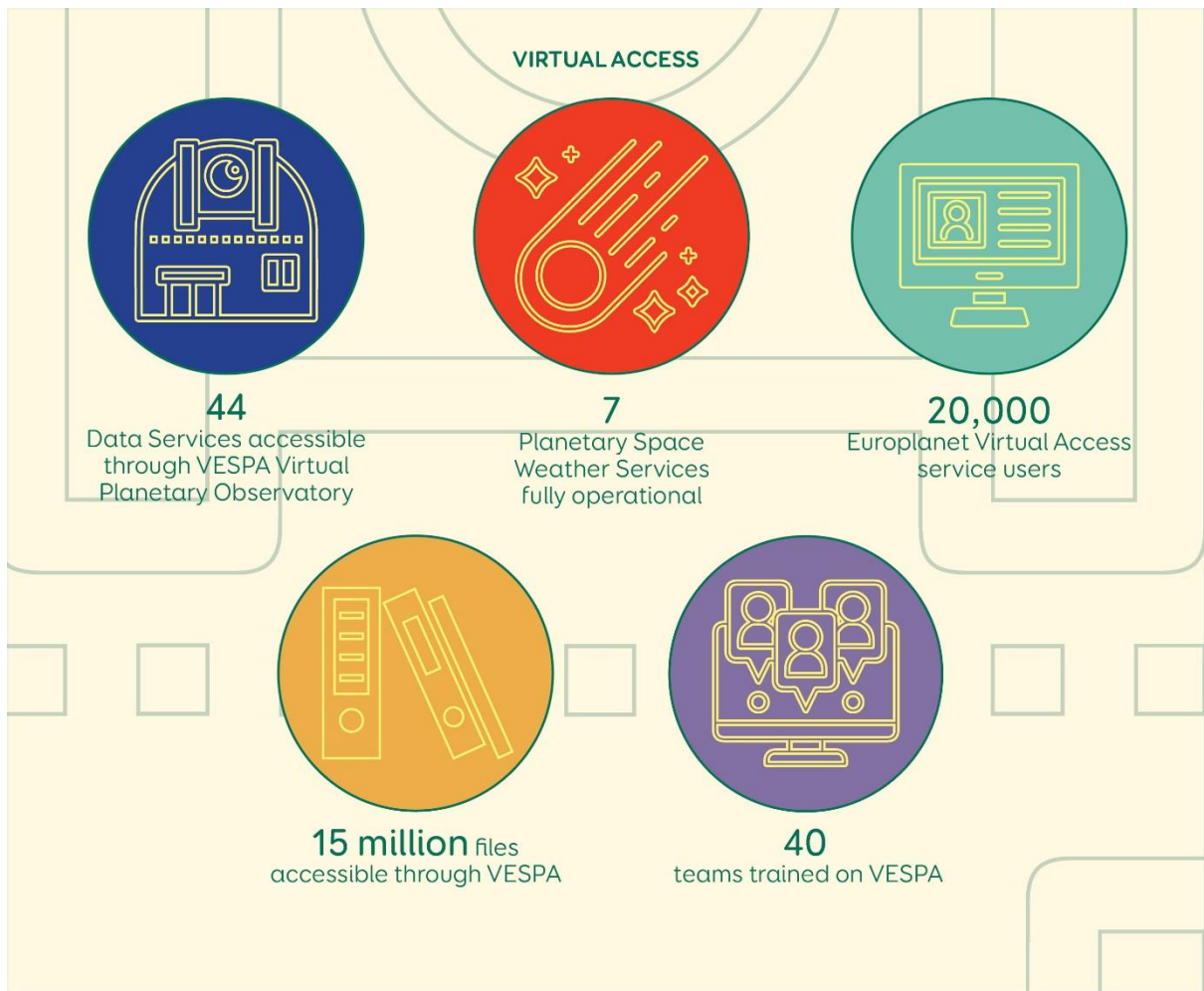


Figure 1: EPN2020-RI Virtual Access in Numbers

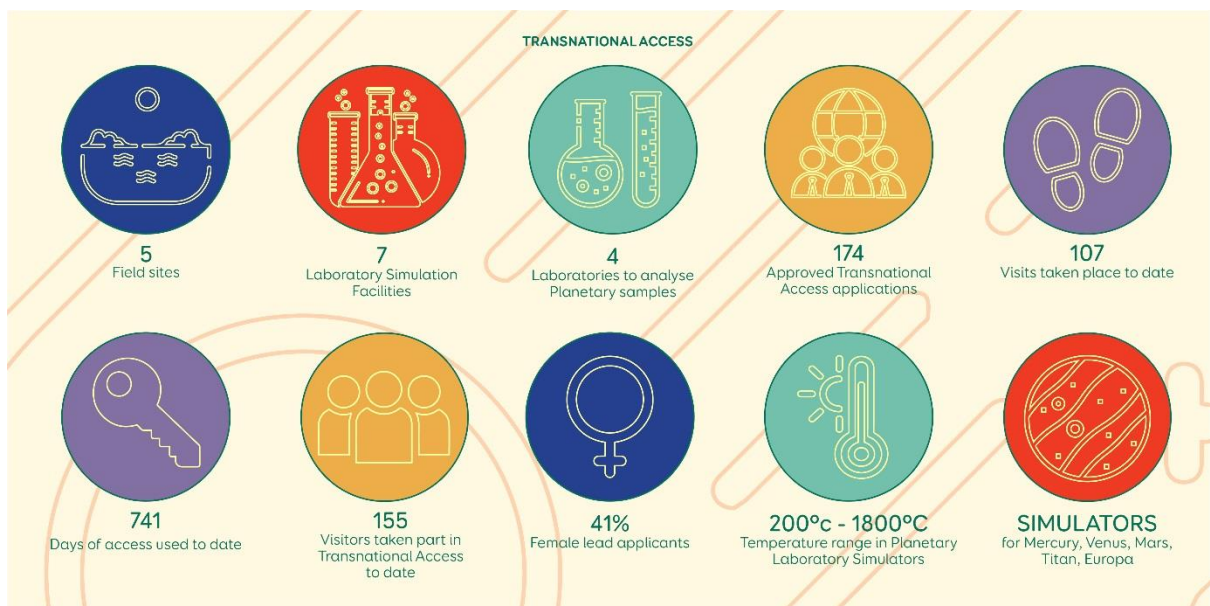


Figure 2: EPN2020-RI Transnational Access in Numbers

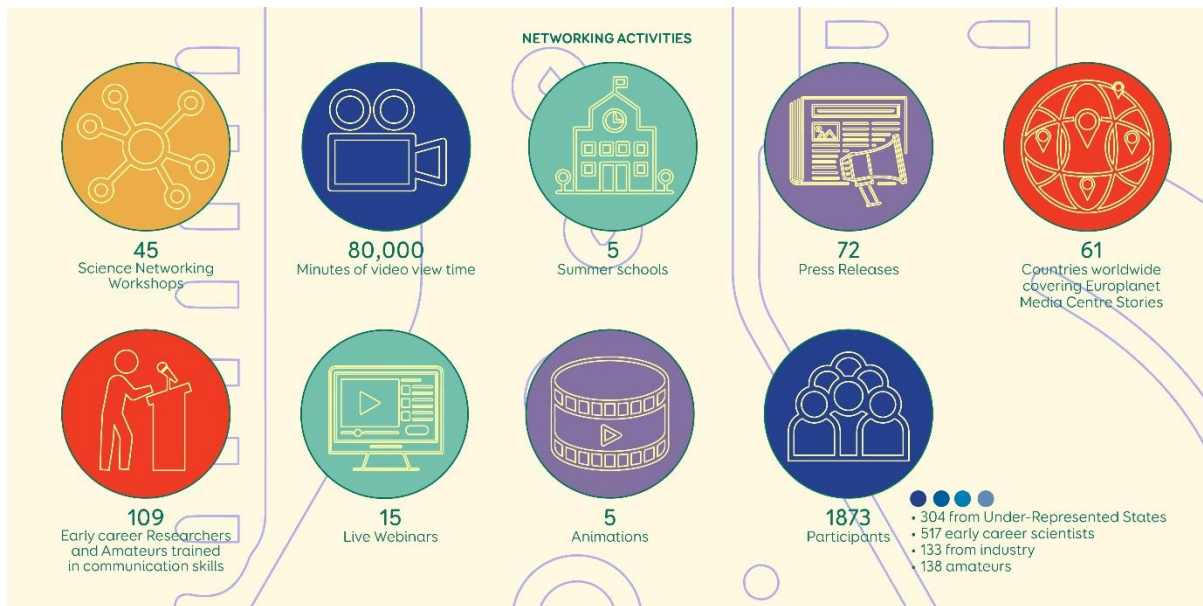


Figure 3: EPN2020-RI Networking Activities in Numbers

EPN2020-RI's third and fourth TA calls were issued during RP2, resulting in 163 applications and 103 approved visits. The final TA call will close on 26th October 2018. Overall, EPN2020-RI thus expects to support more than 200 research projects involving more than 400 researchers (applicants and hosts). This initiative has become a significant resource for the European planetary science community and is resulting in many high quality publications, including in Nature Communications, Icarus and PNAS.

The VA1 [Planetary Space Weather Service](#) (PSWS) portal gives access to an initial presentation of PSWS activities and has already attracted more than 14,000 visitors since its launch. PSWS has also built contacts with ESA and other key stakeholders in the Space weather community including other space weather projects funded by H2020 programmes. Of the 12 services that will ultimately be delivered through VA1-PSWS, nine are operational and development of the remaining three services will be completed by month 40.

The VA2 [VESPA](#) is well on track to exceed its target of enabling access to 50 planetary data services, with 44 services now available, 10 under development or at test level, and further 15 services currently being designed. These services will be enlarged and enhanced throughout EPN2020-RI. ESA has implemented the EPN-TAP (Europlanet Table Access Protocol) within the Planetary Science Archive (PSA), which includes 6 million files from 30 years of planetary science missions in Europe. Five major astronomy / Earth observation data handling tools have been adapted to support planetary science data, and four new ones developed.

EPN2020-RI has made specific efforts to build capacity in the planetary science community through engagement activities aimed at under-represented states, early career researchers, amateur astronomers and industry.

The European Planetary Science Congress (EPSC) 2017 in Riga, Latvia, provided a breakthrough in engaging with researchers, entrepreneurs and policy makers from the Baltic nations. EPN2020-RI bursaries enabled participants from under-represented states, as well as early career researchers and amateurs, to attend the meeting. Inclusiveness networking events, targeted outreach and a series of workshops in under-represented states (including Estonia, Lithuania, Romania and Bulgaria) have also helped to develop active communication channels in northern, central and south-eastern Europe.

EPN2020-RI has provided training workshops and Summer Schools to equip early career researchers with skills to build their career in planetary science. It has also engaged with European amateur astronomers, a community that increasingly provides valuable data for planetary research. The [Planetary Virtual Observatory and Laboratory \(PVOL\)](#) service enables amateurs to make their images available to professional astronomers and provide contextual data of mission observations, such as NASA's Juno mission at Jupiter. 12 reviewed publications have made use of PVOL amateur data since the start of the EPN2020-RI project.

As part of its engagement programme with industry, EPN2020-RI has organised industry-focused workshops and compiled a matrix detailing over 1,000 SMEs with an interest in planetary exploration across the EU Member States.

EPN2020-RI is building a more politically-aware community of researchers and has provided a forum for coordinated feedback into policy consultations. The dinner debate organised by EPN2020-RI in April 2018, attended by 3 MEPs, 3 representatives of MEPs and 5 representatives of the European Commission, was a key opportunity to provide input on Horizon Europe in advance of the debate in the European Parliament on the Multiannual Financial Framework in May 2018.

Europlanet 2020 RI has produced animated videos to engage, inform, educate and entertain young people and members of the public with planetary science and is now translating these into multiple languages. EPN2020-RI collections of planetary educational resources were delivered in RP2 and are available through the IAU [astroEDU](#) portal for educators. EPN2020-RI's monthly webinars provide teachers and students in classrooms across Europe with opportunities to engage directly with planetary researchers and find out about careers in science and engineering.

Press releases on TA and other EPN2020-RI results and meetings have been covered by high profile news outlets around the world, including the BBC, Le Monde, Der Spiegel, the Hindu and the Economist. Footage of the second JRA1 field trip to the Danakil Depression in January 2017 was featured prominently in the first episode of National Geographic's flagship series, "One Strange Rock", was broadcast in March 2018 in 172 countries and 43 languages.

Thus, at the start of its final year, EPN2020-RI is maximising its impact on stakeholders across European Member States.

3. Collaborations with other EU projects

During RP2, EPN2020-RI has continued to build links with related research infrastructures (Opticon, Radionet and Asterics) to discuss wider European collaborations in space and astronomy, and arrangements for longer term sustainability, including options for a formal MOU with the new Europlanet Society.

EPN2020-RI has worked with several projects funded under the Leadership in Enabling and Industrial Technologies (LEIT) Space Programme COMPET calls, including:

- Linking or incorporating tools into EPN2020-RI VESPA and PSWS services from UPWARDS (Understanding Planet Mars With Advanced Remote-sensing Datasets and Synergistic Studies); PLANMAP both providing data tools for exploring Martian surface and geology; MiARD (Multi-instrument analysis of Rosetta data) and SBNF (Small Bodies: Near and Far).

- Building strategic links between EPN2020-RI TA3 programme and EuroCares (European Curation of Astromaterials Returned from Exploration of Space).
- Building strategic links between EPN2020-RI and the PPOSS (Planetary Protection is Outer Solar System) project to develop protocols to prevent contamination between Earth and other bodies in the context of space exploration missions and the NeoShield project for Near-Earth Object impact prevention.
- Collaborating with H2020 Education and outreach programmes such as EUSpaceAwareness and Odyssey.
- Collaborating with H2020 LEIT space technology development projects LUVMI and LUVMI X

Links with recently-funded projects, including ESCAPE successor of Asterics and Our Future, Our Space and SpaceEDU funded under the Space Outreach and Education 2018 call, are already being investigated and will be developed in RP3.

4. Future Plans and Sustainability

Europlanet has moved into a new era with the launch of the [Europlanet Society](#) at EPSC 2018 in Berlin on 20 September 2018. The new Society for individual and institutional members will secure the legacy and exploit the success of EPN2020-RI and act as the parent body of EPSC. The Society will include 10 Regional Hubs that will support Europlanet in building capacity, particularly in under-represented states, and is open to members from European countries and around the world.

The Society's Executive Office will be hosted by the [European Science Foundation](#) (ESF) in Strasbourg. Governance of the Europlanet Society will be overseen by an elected Board, and the Society has established regional hubs, committees to support diversity and early career researchers within the community, as well as working groups on industry, outreach, education and policy.

5. Conclusion

Throughout RP2, EPN2020-RI's TA, VA, JRA and NA programmes have delivered services to the community and responded to feedback to maximise the value and sustainability of activities. Overall, EPN2020-RI has directly supported the research of hundreds of scientists to date through TAs and attracted several thousand online users through its VA programmes. Workshops, meetings and conferences organised through EPN2020-RI have been attended by over 5000 researchers, while many thousands more members of the public have been engaged through EPN2020-RI outreach programmes, and millions worldwide through media coverage of planetary activities related to Europlanet. EPN2020-RI is thus providing the advanced infrastructure that the European planetary sciences community needs to retain its position as a global leader in space exploration.

1. WP1: Management

1.1 Explanation of the work carried out by the beneficiaries and overview of progress

Task 1.1 - Management structure and tools

For details of management structures, please refer to the First Periodic Report.

The [project website](#) has been updated throughout RP2 with news and announcements on EPN2020-RI activities. There have been 7816 new users during RP2 with over 31,000 page views. Public Deliverables can be downloaded from the [website](#)

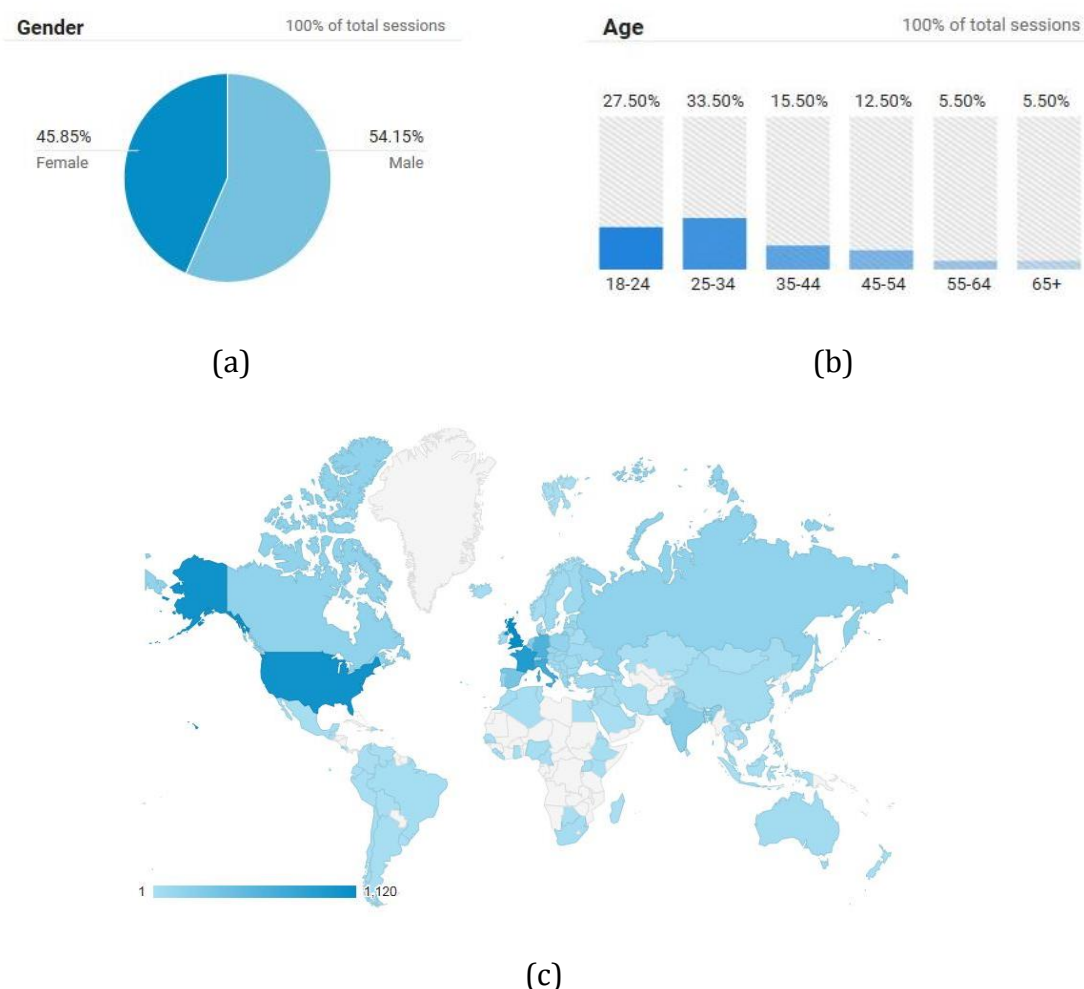


Figure 4-Distribution of users by: (a) gender, (b) age, (c) country for the EPN2020-RI project website during RP2

Task 1.2 - Regular operations of the management structure

1.2.1 Executive board and Project Management Committee

For full details of the Europlanet management structure and personnel, please refer to the [First](#)

[Periodic Report](#). The Project Management Committee (PMC) meets every month, mainly via telecon or on the occasion of major events, and all minutes are kept in the private area of the website. 16 Meetings have taken place during RP2.

1.2.2 Europlanet 2020 RI Council

In RP2, the fourth and fifth Council meetings took place: on 3/05/17 in Windsor (UK) and on 17/9/17 in Riga (Latvia). The sixth and most recent Council meeting took place on 16 September, 2018, at the Technische Universität in Berlin. Minutes of the council meetings can be found in the [private area of the website](#).

1.2.3 The Europlanet General Assembly

The second and third General Assemblies of MoU signatories were held at the Europlanet General Assembly during EPSC 2017 (21st Sept 2017) and EPSC 2018 (on 20th Sept 2018). The latter oversaw the approval of the new Europlanet Society (see 1.5 for details).

Task 1.3 - Reporting

Annual reports from each WP were submitted as deliverables and can all be found [here](#).

Task 1.4 - Call for proposals, evaluation and validation of Transnational Access visits

The competitive call management and scientific assessment of research proposals submitted in response to the TA programme had the following objectives:

- To offer access to well-characterised terrestrial field sites that have been identified as providing the most realistic analogues of surfaces of Mars, Europa, Titan and other bodies to which planetary missions have been sent or are planned;
- To make available laboratory facilities capable of simulating the wide range of environments encountered on planetary bodies;
- To provide a comprehensive capability to determine isotopic and elemental compositions of planetary samples, including analyses at high spatial resolution, high precision and high sensitivity;
- To act as a model of a widely distributed Research Infrastructure;
- To help position Europe at the forefront of planetary science internationally.

In order to contribute to these objectives, the European Science Foundation (ESF) has:

- i) Set up an efficient online platform geared towards applicants to TA, research facilities/analogous site operators and evaluators;
- ii) Identified high-level independent international experts to participate in the Peer Review Panel; and
- iii) Convened the review panel and reported on the outcome of the assessment.

TA Calls in the second reporting period

During RP2, a third call was initiated in January 2017 and closed on 30 March 2017. A fourth call was opened on 31 October 2017 (closed 30 June 2018).

These two competitive calls for TA facilities and analogue sites altogether attracted 173 applications (80 for the third call and 93 for the fourth), of which 166 were eligible (78 for the third call and 88 for the fourth). This shows a regular increase in the number of applications submitted to the TA calls.

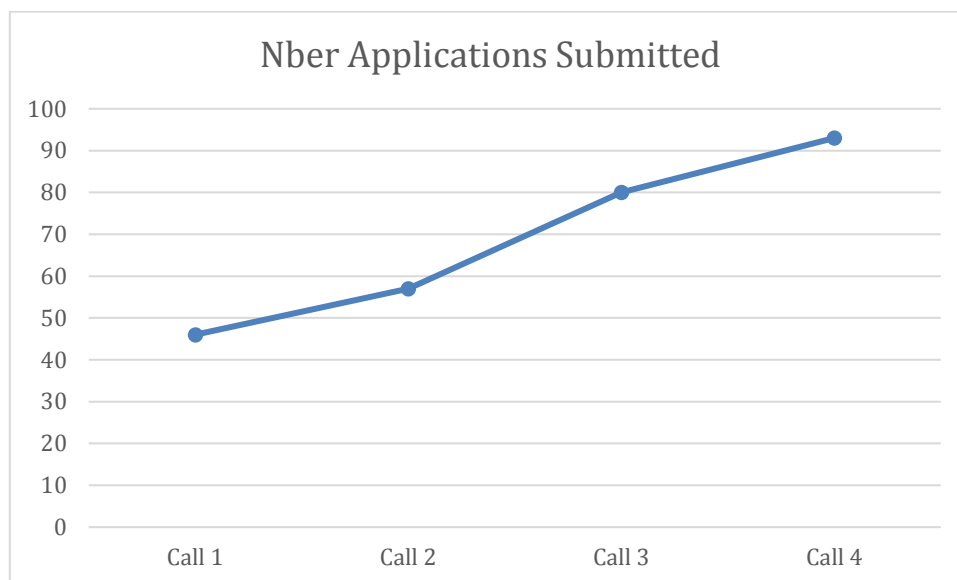


Figure 5- Number of TAs applications received in RP2

During summer 2018, it was decided to have a fifth call starting on 28 September 2018 and to be closed on 26/10/2018.

Table 1 provides a summary of the outputs of the two TA competitive calls open in the second period.

Call Process

Coordination and management of the third and fourth TA calls followed the same procedure as previous calls:

Defining the content of the call text

The call texts were formulated in cooperation between the ESF, the Open University and the TA WPs teams (WP2, 3, 4). These call texts precisely laid down the general conditions of the calls, their objectives, eligibility criteria and timeline. The text of the 3rd and 4th calls were provided in deliverables D1.7 and D1.8. [Eligibility criteria](#), [rules for participation](#), [technical feasibility](#), [evaluation](#) and [reporting requirements](#) all of which can be found on [the project website](#).

Setting-up and maintaining an online call management platform

All TA applications were submitted online, and ESF set up an online platform intended to be used for all the EPN2020-RI TA calls. This online platform has the following functionalities:

- Proposal Submission: the TA applicants have to submit their application online in two steps:

- o Filling in an online form gathering the following information: project title, TA applied for, abstract, scientific discipline, keywords, site(s) selected, visit duration, contact details of the applicants, planned number of participants to the visit.
- o Uploading the .pdf detailing their project, following the provided template.
- Technical feasibility check: once submitted, all applications relevant to a given site or facility are forwarded (anonymously) to its identified operator contact. The operator has to validate the technical feasibility of the proposed work. If they consider that the proposal is not feasible, they have to argue the case and this is then validated by the TA Sub-board, communication with which is managed by the EPN2020-RI Office.
- Online evaluation: Review panel members have access to all applications submitted through the online platform. This platform also provides them with access to the assessment forms for their assigned proposals and to all documents and information relevant to the call.

Setting up a pool of expert reviewers

Based on the description of the field sites, facilities and laboratories, as well as the scope of potential scientific activities to be performed, the ESF identified experts who could potentially serve as reviewers for applications submitted in the frame of the TA calls. This pool of reviewers is to be maintained and complemented for the duration of the project. For reasons of objectivity, no EPN2020-RI beneficiary / active representative (WP or task leader, member of the General Assembly) can be part of this pool of reviewers.

For the third and fourth calls, an average of 115 potential reviewers were identified. Panel members were drawn from this pool of potential reviewers.

Reviewers were eventually invited to join the peer review panels based on their scientific background and the content of the applications submitted. The aim was to have a good match between the disciplinary profiles of the panels and the applications. For each panel, one review panel member was appointed chair of the panel.

Table 1-third and fourth TA calls outcome

	Call 3	Call 4	Total
Call Open	26 Jan. 2017	31 Oct. 2017	
Call Closed	30 March 2017	1 st March 2018	
Total number of applications submitted	80	93	173
Total number of eligible applications submitted	75	88	163
CALL ELEMENTS AND SITE			
TA1: Planetary Field Analogues (PFA)	22	26	48
Ibn Battuta Centre	7	11	
The glacial and volcanically active areas of Iceland	6	5	
Danakil Depression	6	6	
Tirez Lake	3	2	

Rio Tinto Field Site	0	2	
TA2: The Distributed Planetary Simulation Facility (DPSF)	37	41	78
Planetary Environment Facilities at Aarhus University	7	9	
Petrology-Mineralogy Characterisation Facility (PMCF), Mineral and Planetary Sciences Division, Natural History Museum, London, UK.	3	4	
Centre for microbial life detection at Medical University Graz, Austria	7	8	
Planetary Emissivity Laboratory	10	10	
Open University Mars Chamber	4	3	
Cold Surfaces spectroscopy, Institut de Planétologie et Astrophysique de Grenoble (IPAG)	6	5	
High-pressure laboratory at VUA	0	2	
TA3: Distributed Sample Analysis Facility (DSAF)	16	21	37
Radiogenic, non-traditional stable & rare gas isotopes. Le Centre de Recherches Pétrographiques et Géochimiques (CRPG), Nancy, France	6	7	
NanoSIMS 50L Secondary Ion Mass Spectrometer - The Open University	2	3	
Radiogenic & non-traditional stable isotopes: Institute for Planetology (IfP); University of Münster, Münster, Germany	3	3	
Radiogenic and non-traditional stable isotope facility: Geology and geochemistry, Faculty of Earth and Life Sciences, VU University, Amsterdam, NL	4	5	
Stable Isotope Analytical Facilities - The Open University	1	3	
GEOGRAPHICAL DISTRIBUTION (LEAD INVESTIGATORS)			
Austria	0	2	
Belgium	2	4	
Czech Republic	n/a	4	

Denmark	n/a	1
Finland	2	n/a
France	7	10
Germany	8	9
Hungary	n/a	1
Iceland	n/a	1
India	2	1
Ireland	2	1
Israel	1	n/a
Italy	23	21
Netherlands	1	2
Norway	n/a	1
Poland	1	2
Portugal	2	1
Romania	1	n/a
Turkey	n/a	1
Spain	3	3
South Africa	1	1
Switzerland	1	3
Sweden	1	2
United Kingdom	13	12
US	4	4

Scientific assessment and review panel meetings

Two rapporteurs (one lead and one secondary) were assigned to each application; these rapporteurs had the task of providing a set of marks (and comments) for each of the evaluation criteria as follows:

- **Criterion 1** - Innovative nature of the proposal (originality of the research proposed and/or of the methodology to be applied)
- **Criterion 2** - Science and Technology excellence (soundness of concept, and quality of objectives)
- **Criterion 3** - Implementation (quality, effectiveness and feasibility of the methodology and associated work, relevance of the facility/site, strategy for utilisation and publication of the new data)
- **Criterion 4** - Scientific impact (how do the objectives and expected results contribute to advancing the state of the art; relevance for European and/or international planetary scientific community and/or past or future missions)

Each criterion is rated on a 0 to 5 scale with an equal weight (total maximum score 20). The table below provides a guideline illustrating the value and meaning of individual marks.

Table 2- Evaluation Criteria scoring guidelines

Numeric score	Corresponding wording	Definition
5	Excellent	The application successfully addresses all relevant aspects of the criterion in question. Any shortcomings are minor.
4	Very good	The application addresses the criterion very well, although certain improvements are still possible.
3	Good	The application addresses the criterion well, although improvements would be necessary.
2	Fair	While the application broadly addresses the criterion, there are significant weaknesses.
1	Poor	The criterion is addressed in an inadequate manner, or there are serious inherent weaknesses.
0	-	The application ineligible to address the criterion under examination or cannot be judged due to missing or incomplete information.

Once both rapporteurs have provided their preliminary assessment, these reports become available to all panel members. They are requested to read them before the panel meetings.

Review panel meetings were held via web conferencing platform (WebEx) and the ESF staff provided secretariat service to the panel.

Evaluation Structure and process

Unlike for the first two calls, for which only one review panel was set-up, the higher number of applications submitted under calls 3 and 4 required the setting up of three review panels:

- Panel 1: Astrobiology/life
- Panel 2: Mars geology and environment
- Panel 3: Early solar system, planet formation, small bodies

The review panels assessed the applications relevant to their disciplinary coverage, regardless of the call element addressed (TA1 - Planetary Field Analogue Sites, TA2 - Distributed Planetary Simulation Facility, TA3 - Distributed Sample Analysis Facility). As a consequence, applications submitted to a given TA call element were assessed by several panels.

- for each application the lead rapporteur presented the project and his/her assessment
- the secondary rapporteur presented his/her assessment
- the panel discussed the application and agreed on a set of marks

- once all the applications of a given panel were discussed, the panel reviewed the outcome of the evaluation (the ranked list) for a final coherency/consistency check.

In advance of the meeting, panel members prepared a short pre-assessment for each project, these pre-assessments were circulated to all panel member in order to prepare the meeting. They were also used to provide feedback to applicants who approached the programme office for details.

As all panels have different scoring perspectives and approaches (some are harsher than others) and in order to achieve comparability between applications assessed by different panels, the ESF applied a normalisation process that buffers panel scoring behaviour (taking into consideration the scores' averages and standard deviations). The resulting normalised scores were integrated into TA lists and discussed with the panel chairs for validation.

Considering the ranked lists provided as well as programmatic constraints, capacity available and the portfolio of scientific domains supported, the EPN2020-RI programme office then selected the projects to be supported.

- Third call review panel meetings (18, 16 and 24 May 2017). The panels were comprised as follows:
 - Panel 1: six experts (three from the US, one each from United Kingdom, Austria and Canada), five men and one woman.
 - Panel 2: five experts (two from the US, one each from Spain, Sweden and France), four men and one woman.
 - Panel 3: six experts (one each from Belgium, Greece, Finland, Switzerland, United Kingdom and the US), men.

All reviewers provided their pre-assessments by 12 May 2017.

- Fourth call review panel meetings (27 April, 2 and 4 May 2018). Panels were comprised as follows:
 - Panel 1: six experts (one each from Belgium, Germany, Italy, United Kingdom, the US and Spain), four men and two women.
 - Panel 2: seven members (two each from France, Italy and the US, and one from Sweden), five men and one woman.
 - Panel 3: eight members, (two from the US, and one each from Canada, Italy, Morocco, Spain, Switzerland and United Kingdom), six men and two women.

Table 3- Access to TA facilities

Participation number	Organization short name	Infrastructure short name	Installation number	Installation short name	Unit of access	Minimum quantity of access	Access claimed in RP1	Access claimed in RP2	Access approved in calls 3 and 4 (not yet used)	Unallocated Units of cost BEFORE call 5
5	INTA	PFA TA1	1	Rio Tinto	week	6*	1	1	2	2
9	IRSPS	PFA TA1	2	Ibn Battuta	week	20*	6	7	6	1
20	MATIS OHF	PFA TA1	3	Iceland	week	16	1	8	6	1
5	INTA	PFA TA1	4	Tirez Lake	week	8	0	2	2	4
9	IRSPS	PFA TA1	5	Danakil	week	12*	0	6	6	0
5	INTA	PFA TA1	6	Danakil	week	1**	0	0	1	1
11	DLR	DPSF TA2	1	PEL	day	140*	25	37	74	4
25	MUG	DPSF TA2	2	IMRF BioLab	day	150	28	35	80	7
17	AU	DPSF TA2	3	PEF	day	95*	35	33	27	0
4	CNRS	DPSF TA2	4	CSS	day	90	20	23	47	
6	VUA	DPSF TA2	5	HPHT	day	20*	0	0	0	20
1	OU	DPSF TA2	6	LMC	day	150*	70	37	40	10
14	NHM	DPSF TA2	7	PMCF	day	110	25	45	26	14
6	VUA	DAFS TA3	1	GGIF	day	100*	15	10	75	30
4	CNRS	DAFS TA3	2	HNIF	day	20*	0	0	0	0

4	CNRS	DAFS TA3	3	SRIF	day	50*	7	15	0	28
1	OU	DAFS TA3	4	HS50L	day	80	16	30	24	10
1	OU	DAFS TA3	5	LFS	day	15*	0	5	10	0
1	OU	DAFS TA3	6	CSSIA	day	20*	0	0	5	15
21	WWU	DAFS TA3	7	RNTSI	day	100*	20	40	40	0
4	CNRS	DAFS TA3	8	IPF	day	95*	31	40	15	9

- * Changed from RP1
- ** added from RP1

Task 1.5 – Sustainability and Financial Plan

The second sustainability report has been submitted as a deliverable: [D1.14 - Second Sustainability report](#).

Europlanet's sustainability plan has made significant strides during RP2. Following comprehensive discussions and consultations with the community regarding the best mechanism for providing a sustainable structure for Europlanet, the Europlanet General Assembly has approved the formation of a new Europlanet Society. The Europlanet Society promotes the advancement of European planetary science and related fields for the benefit of the community. It is open to individual and institutional members and has the following aims:

- To expand and support a diverse and inclusive planetary community across Europe
- To build the profile of our sector through outreach, education and policy activities
- To underpin the key role Europe plays in planetary science through developing links at a national and international level.

The new Society will secure the legacy and exploit the success of the pan-European collaboration in planetary science engendered by EPN2020-RI. The Society will be hosted by a EPN2020-RI beneficiary, the European Science Foundation, and will develop a 'distributed' structure of 10 Regional Hubs that can support the development of planetary science communities at a regional, national and local level. The Society is open to anyone with a serious interest in planetary science, including researchers, industry, amateur astronomers, educators and outreach providers from European countries and around the world.

The Society was launched at the European Planetary Science Congress (EPSC) 2018, and members will be able to join from early November 2018. Governance of the Europlanet Society will be overseen by an elected Executive Board, with the first elections to be held at the Society's General Assembly in September 2019 at the EPSC-DPS joint meeting in Geneva. The Society has established Regional Hubs Committees, Committees to support Diversity and Early Career researchers within the community. Additional working groups are being established to develop links with industry, amateur astronomers, outreach and education providers and policymakers.

The Europlanet Consortium, which was formed in 2013 and included over 100 organisational members linked through a Memorandum of Understanding (MoU) that agreed cooperation for the mutual benefit of European planetary science, is superseded by institutional membership of the Europlanet Society (the Europlanet Consortium MoU expired in August 2018 and will not be renewed).

Europlanet must also seek, through its members, to secure additional project funding to support its research and related activities. Management and Work Package Boards and the Europlanet Society have already identified relevant forthcoming H2020 (and related pan-European) calls for funding potential bids that complement and support current Europlanet activities. The opportunity to continue to support TA and VA activities in FP9- Horizon Europe (providing a service to EU community that cannot be secured from national funding) will be pursued as part of Europlanet's engagement with FP9 -Horizon Europe.

European Planetary Science Congress

The European Planetary Space Congress (EPSC) is the largest annual planetary science meeting in Europe and hosts the main management meetings for both EPN2020-RI and the Europlanet Consortium. EPSC was launched in 2006 under the EuroPlaNet FP6 project and has developed into a self-sustaining (fee based) conference. The most recent meeting, EPSC 2018 in Berlin, attracted over a thousand participants and was the largest stand-alone planetary science meeting held in Europe to

date. The Europlanet Society has taken over from the Europlanet Consortium as the parent body of EPSC and the EPSC Executive Committee is drawn from its membership. EPN2020-RI currently contributes to EPSC through (1) flat rate subsidies for Early Career Researchers and amateur astronomers to attend and (2) the provision of support for the EPSC press office.

In addition to being the main dissemination platform for EPN2020-RI and venue for its General Assembly and Council meetings, EPSC is an important opportunity to present results and network for other planetary-related projects (ESA mission teams (e.g. Euclid, EnVision) and EU-funded activities (e.g. Euro-Cares, Small Bodies Near and Far, NeoShield).

EPSC will be integral part of the future Europlanet Society (e.g. venue for annual General Assembly, members being eligible for a lower EPSC registration fee).

Task 1.6 - Data management

A second Data Management Plan (DMP) has been submitted as a deliverable: D1.18 - Second Data Management Plan. This deliverable is listed as confidential and can be downloaded from the private area of the website or the EU portal. This will be updated as required in the last Reporting Period.

1.2 Impact

97 reviewed scientific publications and 49 abstracts have arisen to date from the project and can be viewed in the EU portal.

EPN2020 RI places a major emphasis on the importance of impact of the project, both within the planetary science community and on external audiences (see “WP13-NA2 Impact through Outreach and Engagement”). The details contained in this section provide additional support and clarification of the information uploaded into the EU portal and viewable through the tab “Dissemination”.

At the end of this document, Table 24 summarises all dissemination activities (including those which did not charge the project), which, along with the information below, shows the great effort that has been undertaken in terms of time and money (note, all values are in Euros).

Table 4- Summary of dissemination activities and costs per WP

Beneficiary	WP	Description	Cost (Euros)
	WP1 (MGMT)		
<u>OU</u>		Dissemination at conferences, conferences, training events, meetings stakeholders- Nigel Mason	5,214
	WP5 (PSWS)		
<u>CNRS</u>		Presentation, Étendue des collaborations pro-am en planétaire et la structure Europlanet H2020, Semaine de l’Astrophysique et de l’Astronomie Française, Bordeaux, 04-06 July 2018, by N. André	154.05
		Planetary Space Weather and Climate - Science and Services , EPSC 2017, 18/09/2017 Riga, Latvia, by N. André, M. Gangloff, M. Blanc, A. Fedorov, E. Budnik	5,477.64
		Presentations, session Planetary Space Weather Services , Belgium, 27 November 2017, by N. André, M. Gangloff, M. Grande	3,297.69

		Presentation, A Space Weather VOEvent service provided by the CDPP in the frame of Europlanet H2020 PSWS, 15 May 2018, PV2018, Harwell, UK, by M. Gangloff	1,600.31
<u>Wigner</u>		Presentation, Statistical search for solar wind source variation events, EGU 2017, Vienna, 23-28/04/2017, by A. Opitz	2,393.31
		Presentation, Validity and reliability of space weather predictions at Venus, Mars and Comet 67P, EPSC 2017, Riga, 17-22/09/2017 by A. Opitz	3,787.92
		Presentation, Planetary and cometary space weather predictions from observations near and far, ESWW 14, Oostende, 27 November- 01 December 2017, by A. Opitz	1,411.00
		Poster, Effect of solar wind source variation events on planetary plasma environments, 52nd ESLAB conference - Comparative Aeronomy and Plasma Environment of Terrestrial Planets, Noordwijk, Netherlands, 25/11/2015, by A. Opitz	1,743.00
<u>UCL</u>		COSPAR 2018, Solar Windscreens - A service to derive estimates of solar wind speeds from comets' ion tails' by G. Jones	1,900.00
		European Space Weather Week 14, A software tool for finding potential cometary tail crossings: Tailcatcher, Oostende, 27 November- 01 December 2017, by G. Jones	700
		Modelling Magnetodisc Response to Solar Wind Events, EPSC poster, Riga, 17-22 September 2017, by N. Achilleos and P. Guio	1,424.00
		Planetary Modelling Tools and Resources, NA1 workshop, Kalamata, September 2018	913.00
	WP6 (VESPA)		
<u>IAP</u>		Presentation of PSWS results and iPECMAN at ESWW, Nov 2017	566.38
		Participation at VESPA implementation workshop 2017, Apr 2017	781.00
		Participation at VESPA implementation workshop 2017, Apr 2017	816.69
		Presentation of VESPA poster at EPSC 2017, Sept 2017	80.96
		VESPA implementation workshop - travel costs of invited teams, Apr 2018	11,187.59
		Organization of VESPA implementation workshop, Apr 2018	1,327.90
<u>CNRS/IPAG</u>		SSHADE Training IAS, Orsay / 5-7 July 2017	516.35
		SSHADE Training IRAP, Toulouse / 10-11 July 2017	416.34
		SSHADE Training LPGN, Nantes / 18-19 July 2017	812.10
		SSHADE Training, IAS+IGS-PAS, Grenoble / 24-28 July 2017	882.62
		SSHADE Training, AIU Observatory, Jena / 11-13 September 2017	877.16
		SSHADE Training, LATMOS+LISA, Paris / 2-4 May 2018	1,469.69
		VA-T3 implementation workshop (VESPA), Prague / 16-20 April 2018	1,521.42
		6th European Lunar Symposium 2018, Toulouse / 14-16 May 2018 (2 SSHADE user training sessions)	740.92
		SSHADE Training, IAPS, Rome / 5-7 June 2018	2,729.95
		SSHADE Training, IEM+CSFK, Grenoble / 17-19 July 2018	797.89

		2 nd SSHADE database managers meeting, Grenoble / 4-5 December 2017	5,805.52
<u>OEWF</u>		VESPA Implementation Workshop, 27.-31.3.2017, Graz, Austria, support of 5 participants	6,846.36
		M. Scherf, EPSC 2017, Organization Amateur Sessions, Promotion of Europlanet, VESPA hands-on sessions, September 2017	1,195.95
		G. Kargl, OEGAA Assembly, Europlanet presentation, 13.10.2017	56.37
		T. Al-Ubaidi, Europlanet VESPA Implementation Workshop, 16.-20.4.2018, Prague, Czech Republic	1,062.59
		M. Scherf, Europlanet VESPA Implementation Workshop, 16.-20.4.2018, Prague, Czech Republic	575.11
		M. Scherf, Europlanet NA1 Workshop New Views of Jupiter: Pro-Am Collaborations during and beyond the NASA Juno Mission, London, GB, May 11-12, 2018	728.48
		M. Scherf, Promotion of Europlanet, ESLAB Symposium & Europlanet Meeting, Noordwijk, NL & Windsor, GB, 13.5.-19.5.2018	1,392.76
	WP10 (PSWS-JRA)		
<u>CNRS</u>		Presentation, <i>CDPP</i> VO activities including SPASE, International CCMC-LWS Working Meeting, 03 April 2017, by M. Indurain	2,376.19
		Presentation, System architecture enabling runs on request for a Transplanet model of magnetosphere-ionosphere coupling at Earth, Mars, and Jupiter , JpGU, Chiba, 23 May 2017, by A. Goutenoir	2,120.26
	WP12 (NA1)		
<u>OEAW</u>		M. Scherf, EPSC 2017, Organization Amateur Sessions, Promotion of Europlanet, VESPA hands-on sessions, September 2017	1,195.95
		G. Kargl, OEGAA Assembly, Europlanet presentation, 13.10.2017	56.37
		M. Scherf, Europlanet NA1 Workshop New Views of Jupiter: Pro-Am Collaborations during and beyond the NASA Juno Mission, London, GB, May 11-12, 2018	728.48
		M. Scherf, Promotion of Europlanet, ESLAB Symposium & Europlanet Meeting, Noordwijk, NL & Windsor, GB, 13.5.-19.5.2018	1,392.76
<u>UCL</u>		Planetary Modelling Tools and Resources	913
		T. Nikkanen, The 14th International Planetary Probe Workshop (IPPW-14), The Hague, The Netherlands, 12.-16.6.2017	872,98
		A-M. Harri, M. Genzer, <i>H. Haukka</i> , <i>M. Hieta</i> , Europlanet ExoMars Workshop, Saariselkä, Finland, 26.-30.3.2017	1,096.72
		A-M. Harri, M. Genzer, <i>H. Haukka</i> , EPSC 2017, organization of the AM session + exhibition, Riga, Latvia, 17-22.9.2017	1,607.97
<u>CNRS</u>		Organization of a workshop PSWS/NA1-Task1 workshop on Sun's Influence on Planets, <i>IRAP, Toulouse</i> , 09-11/10/2017, by N. André	22,707.03
		Organization of a workshop PSWS/NA1-Task 5 workshop on Tools and Services for Planetary Observations and Image Analysis by Amateurs, <i>Pic du Midi, France</i> , 17-19/07/2018, by N. André	11,822.84
		Organization of Planetary Exploration 2061 workshop, Lausanne, Switzerland, 23-25 April 2018, by M. Blanc	1,143.42
<u>Aber</u>		ASIME, Luxemburg 16-17 th April 2018	1,338.45

		European Astrobiology Campus Early Career Scientist Workshop, Tartu, Estonia 6-11 th August 2018	12,646.28
	WP13 (NA2)		
<u>IASA</u>		Participation to EPSC:	1,557.85
		Participation to Workshop:	1,228.64
		Outreach Workshop Athens:	2,889.67
<u>LU</u>		equipment for production of outreach content	480
<u>Leiden University</u>		Participation to conference: M.Fitzgerald(astroEDU editor in chief) Vienna, Austria Aug-18 IAU General Assembly, meeting and presentation about IAU astroEDU and Europlanet collections	700
		P. Russo delivery of training workshops at Europlanet 2017 Summer School (24 July 2017) and Europlanet 2018 Summer School (06 August 2018), Moletai Astronomical Observatory, Lithuania.	1,134
		J. Rivero Gonzales, Participation in Europlanet Policy Meeting, 27 February 2017	78.5
<u>ObsParis</u>		Travel:	1,775
		2017 Europlanet Prize for Public Engagement with Planetary Science:	4,000
		2017 Europlanet Public Engagement Funding Scheme:	17,000
		2018 Europlanet Prize for Public Engagement with Planetary Science:	4,000
		2018 Europlanet Public Engagement Funding Scheme:	15,000
<u>Science Office</u>		travel to conferences, meetings, workshops	12,918
		Other goods and services like subscriptions to media and social media services, catering, printing costs and video production	7,635
<u>Vilnius University</u>		Travel grants for Summer School 2018 participants from other countries	4814.49
		Summer School 2017 costs (catering)	5476.33
		Summer School 2018 costs (catering)	6217
		Travel Summer School 2017 (Vilnius-Moletai Observatory)	552.93
		Travel Summer School 2018 (Vilnius-Moletai Observatory)	1058.34

2. Deviations from Annex 1

2.1 Amendments

Two amendments have been launched (in July and October 2017) and approved (in October and December 2017) during RP2. The main objective of Amendment #2 was to re-distribute resources

from and among TAs, whilst the main objective of Amendment #3 was to add Beneficiary #35, LMSU. Detailed information and justification letters can be found in the archived processes in the EU portal.

2.2.2 Additional proposed changes

This section lists those changes that have not yet been approved for RP3. They will all be included in a next amendment.

OU – Under WP1 add 6 PMs (no change in requested contribution).

VUA- The importance of the work undertaken within JRA 3 (WP9) was emphasised by the involvement of two industrial partners. After the initial success of the work with 10^{13} Ohm high resistance amplifiers, ThermoFisher (one of the largest international mass spectrometer manufacturers) contributed equipment with a commercial value of > € 60k (including BTW). The consequence of the donation is that a significant amount of expenditure on equipment and consumables were not required, saving part of the JRA budget. At the same time more money would be required to cover the management costs for the role of TA officer covered by Prof Gareth Davies which that will be re-allocated elsewhere in the project. A transfer of 2PMs and a budget of Euros 26K from WP9-other direct to WP1-personnel within VUA's budget is therefore proposed (no change of total required contribution).

IAP – Under WP6, add 8 PM and transfer 21,918 EUR from Other costs to Personnel (the total budget allocated to IAP does not change).

The description of two WP11 deliverables (due by 31/12/2018) needs to be updated, as the current one is misleading (i.e. implying a major contribution from ESA). We therefore propose the following change in title:

- D11.10 “VO-GIS interface + Adaptation” to be replaced with “VO-GIS interface and potential application to space data archives”
- D11.11 “workflow studies + application” to be replaced with “Workflow studies: application to the Magnetospheres science theme, new data services and support to ESA/JUICE mission planning. To be postponed to 31/01/2019

Based on the take up for facilities we will require reallocation between TA facilities funds. Exact numbers will be known after the disclosure of results from the 5th TA call.

Some reallocation of money within NA1.

3. Financial reports

Table 5 below details the maximum grant awarded and the requested contribution in RP2 (for months 19 to 36 of the project)

Table 5- Costs under RP2 for each beneficiary

Number	Beneficiary	Maximum Grant amount	Approved RP1	Requested RP2	% Available funds for RP3
1 **	OU	€1,353,008.67	€ 406,925.58	€ 483,324.48	34%
2	OBSPARIS	€ 933,500.00	€ 371,449.15	€ 487,936.18	8%
3 *	UCL	€ 345,632.99	€ 81,454.55	€ 78,073.89 plus requested Adjustment €7,647.66	52%
4	CNRS	€ 1,517,285.25	€ 791,487.96	€ 609,608.61	8%
5 **	INTA	€ 382,693.32	€ 110,538.95	€ 132,734.17	36%
6 **	VUA	€ 321,647.27	€ 70,818.56	€155,085.89 plus requested Adjustment €59,393.99	11%
7	SO	€ 476,335.00	€ 208,597.50	€ 139,126.86	27%
8	OEAW	€ 486,500.00	€ 154,718.28	€ 141,221.25 plus requested Adjustment €5,000	38%
9 **	IRSPS	€ 509,810.00	€ 185,307.32	€ 208,994.51	23%
10*	FMI	€ 365,000.00	€ 85,698.44	€ 106,237.78 plus requested Adjustment € - 3,977.74	49%
11 **	DLR	€ 321,215.00	€ 135,153.66	€ 68,020.33	37%
12 *	ABER	€ 241,300.00	€ 84,496.74	€ 42,065.09	48%
13 *	MPG	€ 263,750.00	€ 35,680.80	€ 126,030.01	39%
14 **	NHM	€ 204,350.00	€ 65,038.78	€ 52,655.86	42%
15	JacobsUni	€ 267,500.00	€ 110,244.05	€ 91,199.10	25%
16	INAF	€ 225,750.00	€ 56,603.75	€ 112,914.49	25%
17	AU	€ 227,125.00	€ 143,883.06	€ 59,696.10	10%

18 *	Wigner RCP	€ 195,000.00	€ 28,836.29	83,074.38	43%
19	IAP	€ 176,250.00	€ 44,421.14	€ 74,724.40	32%
20 **	MATIS OHF	€ 147,226.00	€ 9,291.62	€ 65,876.32	49%
21 **	WWU	€ 100,945.00	€ 19,327.98	€ 35,533.99	46%
22	ESF	€ 139,012.50	€ 54,335.60	€ 38,982.58	33%
23	GFI INFORMATIQ UE SA	€ 113,750.00	€ 113,750.00	0	0%
25 **	MUG	€ 130,125.00	€ 27,949.74	€ 32,333.49	54%
26	IASB – BIRA	€ 85,000.00	€ 15,996.81	€ 32,237.06	43%
27	LU	€ 49,900.00	€ 23,100.84	€ 600.11	53%
28	UPV/EHU	€ 93,000.00	€ 53,191.49	€ 36,117.04	4%
29	IGS PAS	€ 61,750.00	€ 36,195.40	€ 25,497.05	0%
30	VU	€ 61,000.00	€ 17,116.10	€ 37,725.44	10%
31	IASA	€ 50,000.00	€ 14,134.96	€ 16,470.19	39%
32	U LEIDEN	€ 50,000.00	€ 35,023.25	€ 9,067.96	12%
33	SRC PAS	€ 50,000.00	€ 21,347.10	€ 16,407.86	24%
34	ISSI				
35	LMSU				
TOTAL		€9,945,361.00			
24	CORIOLYS budget reallocated to CNRS as the beneficiary was terminated	0.00 €			

* These beneficiaries have significant NA costs for meetings which will be focussed on final year on funding will be reallocated within the Work Package.

** Outstanding TA visits will reduce underspent and money will be reallocated to those who are more successful.

2. WP2 - TA 1: Planetary Field Analogues (PFA)

EPN2020-RI provides Transnational Access to five of the most realistic terrestrial analogues of the surface and near-surface geological-geomorphological environments of Mars, Europa and Titan: Rio Tinto and Lake Tirez (Spain), Ibn Battuta (Morocco), the Danakil depression (Ethiopia) and cold and hot environments in Iceland. For full details of the analogue sites, please refer to the [first periodic report](#).

1.1 Explanation of the work carried out by the beneficiaries and overview of progress

EPN2020-RI issued a third and fourth TA call during RP2, and 21 visits led by researchers (14 male and 7 female) from 10 countries took place to TA1 Planetary Field Analogues.

Full details of the individual calls can be found at the [EPN2020-RI website](#), along with the reports submitted and approved at the completion of each TA1 visit. While it is not possible to include details from all 21 TA1 visits in this summary report, we include a case study from each of the field sites, which together give an overview of the range of research carried out. For details of presentations and publications of results, see section 1.3. Impact.

Task 2.1-Rio Tinto (INTA)

One team (male lead applicant from USA) carried out research work in Rio Tinto during RP2.

Table 6- Visits to the Rio Tinto TA site during the reporting period

Proposal number	Access Site	Visit	Proposer	Project Title
16-EPN-016	Rio Tinto	5-13 May 17	Pablo Sobron, SETI Institute, USA	MASTER: Mars Analog Spectroscopic Technology for Exobiology Research

TA1 Rio Tinto Case Study

Project: 16-EPN-016 - MASTER: Mars Analog Spectroscopic Technology for Exobiology Research

Applicant: Pablo Sobron, SETI Institute, USA

Date of visit: 5-13 May 2017

The MASTER project focuses on research for Mars using Rio Tinto, a well-established Mars-analogue site. The mineralogy and hydrochemistry make Rio Tinto a unique analogue for sulphate formation and habitability investigations in extreme conditions. The main goals of MASTER were to 1) Foster a better understanding of how to seek, identify, and characterise habitats and biosignatures that may exist, or have existed, on Mars; and 2) Field test two technology elements that will support science investigations on the upcoming ExoMars and Mars2020 missions.

The team conducted field work in three sites near Peña de Hierro, the source of Rio Tinto. They used both visible-near infrared reflectance spectroscopy (VNIR) and laser Raman spectroscopy (LRS) instruments to investigate a total of 15 locations featuring a combination of sulphate-rich evaporation products and iron-rich precipitates from acidic stream waters (pH = 2.4). The results show that the combined use of VNIR and LRS is widely justified for achieving unique mineral identification of iron-bearing oxides and sulphates in natural samples from acidic Mars analogue sites, and likely in samples from Mars surface and surface. They concluded that the synergies between these two techniques should be explored in the context of the science objectives of future Mars missions, e.g., ESA's ExoMars 2020 rover mission and NASA's Mars 2020, through assessing their potential to characterise additional types of minerals relevant to Mars exploration.

Task 2.2-Ibn Battuta Centre (IRSPS)

Five teams (one female/four male lead applicants from four countries (Germany, Italy, UK, USA)) carried out research work in Ibn Battuta during RP2.

Table 7: Visits to the Ibn Battuta TA site during the reporting period.

Proposal number	Access Site	Visit	Proposer	Project Title
15-EPN-024	Ibn Battuta	13-27 Jul 17	Gabriele Franzese, University of Naples & INAF, Italy	Dust Devil survey in the Moroccan desert as analogue of Martian observations
15-EPN-032	Ibn Battuta	13-27 Jul 17	Simone Silvestro, INAF Osservatorio Astronomico di Capodimonte, Italy	Aeolian bedform dynamics on Earth and Mars. A terrestrial analogue approach
17-EPN3-043	Ibn Battuta	13-23 Jun 18	Dennis Reiss, Westfälische Wilhelms-Universität, Germany	Relationships Between Pressure Drop Magnitudes And Vertical Speeds In Dust Devils: Towards A Better Quantification Of Dust Fluxes On Mars And Earth
17-EPN3-044	Ibn Battuta	13-23 Jun 18	Jan Raack, The Open University, UK	In Situ Sampling And Diurnal Monitoring Of Active Dust Devils
17-EPN3-038	Ibn Battuta	Jul 18	Micaela Glamoclija, Rutgers University – Newark, USA	Moroccan Early Animal Record From Precambrian - Cambrian Transient Environments And Its Relevance For Life Detection On Mars

TA1 Ibn Battuta Case Study

Project: 17-EPN3-044 - In Situ Sampling And Diurnal Monitoring Of Active Dust Devils

Applicant: Jan Raack, The Open University, UK

Date of visit: 13-23 June 2018



Figure 6: Jan Raack sampling dust devils in Morocco. Credit: J. Raack

Dust devils are vertical convective vortices which occur on Earth and Mars. Although they have been observed on both planetary bodies for several decades, in situ sampling of dust devils is rare: very few publications deal with in situ grain size characterisation of dust devils and the grain size distribution data are limited to heights of up to 4 m. Such studies are significant for understanding the climatic and environmental impact of dust devils on Earth by extrapolation on Mars. On Earth, dust particles smaller than $\sim 25 \mu\text{m}$ in diameter can stay in suspension in the atmosphere, which makes up around 60-75% of the number of lifted particles. This quantity of lifted aerosols has an influence on the terrestrial climate and is an important consideration for human health, weather, and biogeochemistry. On Mars, particles smaller than $\sim 20 \mu\text{m}$ can go into suspension but, due to the high Martian surface

dust cover, the amount of lifted particles will be generally higher, potentially exerting a large influence on the Martian climate. It is estimated that large dust devils may contribute over 50% of the total dust in the Martian atmosphere.

During a field campaign in 2016 in the same region (Meteorological Signatures of Vertical Convective Vortices, 15-EPN-046), dust devil sampling methods were tested and six dust devils were sampled at heights up to 5 m. In-situ sampling is vital for understanding the internal structure (vertical grain size distribution), the relative particle loads of dust devils, and the erosional capacity of the sand skirt at the base of the dust devil (first couple of cm).

This follow-up project analysed the diurnal occurrence of dust devils in the study region. Recent modelling studies suggest that dust devil activity may be higher during morning hours than previously thought, as local winds may have more influence upon the timing of dust devil formation than previously considered. This project therefore included full-day surveys of dust devil activity within the designated study area, taking particular interest in the level of dust devil activity through early to mid-morning hours, which may have previously been excluded from some dust devil surveys due to expectations that activity during this period would be low.

To give a detailed and complete picture of dust devils and their influence on the climate, this study was carried out concurrently with a second proposal (Relationships Between Pressure Drop Magnitudes And Vertical Speeds In Dust Devils: Towards A Better Quantification Of Dust Fluxes On Mars And Earth, 17-EPN3-043) which collected intensive meteorological data and sampled dust at a height of 2 m. The resulting datasets enabled (a) calculations of the dust flux of dust devils, (b) estimations of daily dust lifting in the study region and beyond (dust flux measurements in combination with diurnal survey), and (c) a wider meteorological context for the observed levels of dust devil activity.

Task 2.3- The glacial and volcanically active areas of Iceland, Iceland (MATIS)

During the reporting period, eight visits (three female/five male lead applicants from five countries (Finland, France, Germany, Spain, UK)) to the Icelandic TA site were conducted (Table 8). In addition, four proposals for access were approved during the reporting period that are planned for the final period of the grant (Table 9).

Table 8: Visits to the Icelandic TA site during the reporting period.

Proposal number	Access Site	Visit	Proposer	Project Title
15-EPN-006	Iceland	04-13 Jul 17	Thorsten Stoeck, TU Kaiserslautern, Germany	Complex eukaryote life in Mars analogue field sites on Iceland environmental (meta)genomics approaches in astrobiology
15-EPN-028	Iceland	28 Jul – 03 Sep 17	Andreas Türcke, University of Bremen, Germany	Microbes at mineral interfaces in subseafloor young volcanic rocks
16-EPN2-064	Iceland	23-31 Oct 17	Olga Prieto-Ballesteros, Centro de Astrobiología, Spain	Analog studies on salt minerals assemblages for support of the MEDA instrument of the future Mars 2020 NASA mission
17-EPN3-004	Iceland	17-24 Apr 18	Daniel Carrizo, Centro de Astrobiología, Spain	Searching for molecular evidences of life in extreme environments by exploiting molecular (geolipids) and isotopic forensic tools.
17-EPN3-009	Iceland	30 Jul- 09 Aug 17	Arola Moreras Marti, St. Andrews University, U.K.	Lithotrophic microbial communities and biosignatures in geothermal environments at Kverkfjöll: an analogue for Mars life
17-EPN3-020	Iceland	23–31 Aug 17	Anu Hynninen, University of Helsinki, Finland	Microbial colonization and weathering of terrestrial basalts

17-EPN3-076	Iceland	01-13 Jul 18	Mourad Harir, Helmholtz-Zentrum München, Germany	Resolving chemical complexity of hot springs dissolved organic matter (DOM) from different geothermal areas in Iceland
18-EPN4-028	Iceland	12- 19 Aug 18	Benjamin Rondeau, University of Nantes, France	Effect of the temperature of amorphous silica deposition on its spectroscopic signature

Table 9: Proposals granted to the Icelandic TA site during the reporting period that have not yet been carried out.

Proposal Number	Planned visit	Proposer	Proposal Title
17-EPN3-052	Spring 2019	Giacomo Colombatti, University of Padova, Italy	MILaCE : Mars Investigations and Landing Cameras Experiment
18-EPN4-002	Spring 2019	Thorsten Stoeck, TU Kaiserslautern, Germany	Extremophile microbial eukaryotes in Mars-analogue field sites
18-EPN4-036	5-11 Sep 18	Pablo Sobron, Centro de Astrobiología, Spain	IceSTAR – Iceland Sample Tracing and Return
18-EPN4-059	12-16 Sep 18	Tina Santl-Temkiv, Aarhus University, Denmark	Microbial colonization of analogue terrestrial surfaces by depositing airborne microorganisms

TA1 Iceland Case study

Project: 16-EPN2-064 - Analogue studies on salt minerals assemblages for support of the MEDA instrument of the future Mars 2020 NASA mission

Applicant: Olga Prieto-Ballesteros, Centro de Astrobiología, Spain

Date of visit: 23-31 October 2017

The Mars Environmental Dynamics Analyzer (MEDA) instrument is the meteorological sensor package of the NASA Mars 2020 mission. MEDA will characterise the weather and dust environment of Mars and will help to infer Martian potential habitability by studying the interaction between atmosphere and substrate. The Iceland analogue site was used in this project to produce unique and valuable data for the European science and technology teams of MEDA, by characterizing the mineral changes due to substrate-atmosphere interaction and thermal properties of hydrothermal mineral assemblages. Two main geothermal areas and some small geothermal patches were chosen for sampling because of the presence of iron-rich basalts and extensive sulphate and phyllosilicates-rich deposits from basalt weathering, but also according to the acid-sulphate alteration and oxidation conditions of the hydrothermal fluids. 31 samples were taken and additional, in-situ measurements were made using (among other instruments) a portable RAMAN spectrometer with similar characteristics to Mars 2020's SuperCam.

Task 2.4 Lake Tirez (INTA)

Two Transnational Access visits by two external teams (two female lead applicants from two countries (UK, India)) to Tirez Lake took place during this reporting period.

Table 10: Visits to the Lake Tirez TA site during the reporting period.

Proposal number	Access site	Date	Proposer	Project Title
17-EPN3-040	Tirez Lake	20-25 Nov 2017 (5 days)	Nisha K Ramkissoon, The Open University, UK	A microbiological investigation examining Europa's potential as a habitable environment
17-EPN3-030	Tirez Lake	9-13 Apr 18 (3 days)	Rebecca Thombre, S.P.Pune University, India.	Extremophiles from Tirez and Peña Hueca: Implications for exploring habitability of Mars and Europa

TA1 Lake Tirez Case study

Project: 17-EPN3-030 - Extremophiles from Tirez and Peña Hueca: Implications for exploring habitability of Mars and Europa

Applicant: Dr Rebecca Thombre, Department of Biotechnology, at the Modern College of Arts, Science and Commerce in Shivajinagar, Pune, India

Date of visit: 9-13 April 2018



Figure 7: Rebecca Thombre collecting samples during TA1 visit to Lake Tirez, April 2018. Credit: F Gomez

The main objective of this project was to isolate extremophiles that could survive in conditions similar to briny water on Jupiter’s Moon, Europa, and chloride deposits found in the Southern highlands of Mars. The Laguna de Peña Hueca is part of the Lake Tirez system in La Mancha, with a maximum depth of 40 cm, and is characterised by bright pink coloured water with a thick layer of pink salt crust. Underlying the crust is a typical green “mat”, below which is a black anoxic layer. The applicants collected samples and rocks from the lagoon and analysed physical characteristics and genetic sequence of isolated microorganisms. They found that the lagoon’s pink colour derives from the red cells of a sub-genus of the salt-loving algae *Dunaliella*. This extremophilic algal strain from Laguna de Peña Hueca has been named *Dunaliella salina* EP-1 (Europlanet -1) after EPN-2020-RI.

Task 2.5-Danakil Depression, Ethiopia (IRSPS)

During RP2 five teams (One female/four male lead applicants from five countries (Belgium, Poland, Portugal, UK, USA)) participated in the Danakil Field Campaign.

Table 11: Visits to the Danakil TA site during the reporting period.

Proposal Number	Access Site	Visit	Proposer	Title
17-EPN3-046	Danakil	20-27 Jan 2018	Ralph Lorenz, Johns Hopkins University, USA	Ground-Truth for Remote Sensing of vast Dallol salt flats as Planetary Analogues
17-EPN3-034	Danakil	20-27 Jan 2018	Daniel Mège, Space Research Centre, Poland	Geomorphologic assemblages and shallow plumbing system of the Dallol hydrothermal site: Implications for interpretation of the upcoming Mars exploration mission data
17-EPN3-039	Danakil	20-27 Jan 2018	Hugo Moors, SCK•CEN, Belgium	Dallol, in the Danakil depression: a model region to study if life can be present in one of the most extreme places on Earth.

17-EPN3-073	Danakil	20-27 Jan 2018	Karen Olsson-Francis, The Open University, UK	The limits of life: Characterisation of the active microbial community within the saline, acidic, hot springs of the Dallol volcano, Danakil Depression, Ethiopia
17-EPN3-037	Danakil	20-27 Jan 2018	David Alegre Vaz, University of Coimbra, Portugal	The geometry and morphometry of normal fault scarps on the Afar Depression: constrains on the paleoclimatic evolution of Mars

TA 1 Danakil Depression Case study

Project: 17-EPN3-034 - Geomorphologic assemblages and shallow plumbing system of the Dallol hydrothermal site: Implications for interpretation of the upcoming Mars exploration mission data

Applicant: Daniel Mège, Space Research Centre, Poland

Date of visit: 20-27 Jan 2018



Figure 8: Daniel Mège and Barbara Cavalazzi during TA1 visit to Danakil, January 2018. Credit: A. Pritz/Europlanet

Several hydrothermal sites in the Danakil depression were visited by the Polish team, some of them previously undocumented along the western border of the Afar rift and south of the Dallol dome. The association between the magmatic systems and evaporites, and the likelihood that microorganisms live in this type of extreme environment, make this area a unique site for studying potential analogues of Martian rift zones. Detailed geomorphological observations were carried out, documenting the diverse impact of hydrothermal fluid upflows on micro-scale geomorphology of the depression. Soil, salt and water samples were collected for analysis of bacterial life below the surface and their associated liquid environment. Connections were established with microbiologists also participating to the campaign and sampling hydrothermal fluids of various compositions, temperature and pH, making it possible to obtain an integrated biological-geological understanding of this very special planetary environment. Enough data were collected to be prepared for the next step of the project, a magnetic prospecting survey aiming at locating magmatic intrusions in the ≥ 1 km of evaporitic sediments of the Danakil rift.

1.2 Impact

The TA visits completed to date have resulted in multiple presentations at conferences, workshops and seminars (please refer to Table 24), including at the Lunar and Planetary Science Conference 2018, the International Ocean Discovery Program (IODP)-International Continental Scientific Drilling Program (ICDP) Colloquium 2018, the Yearly Meeting of the Stockholm University Astrobiology Centre, the 4th Colloquium of Finnish Geosciences. At EPSC 2017, two out of four abstracts and at EPSC 2018, eight out of 18 abstracts presented in the special LF1 “Earth Analogues” sessions featured projects enabled through TA1. Many more presentations are scheduled for the final year of the project.

The first peer-reviewed papers on TA1 results are being published, including Qu et al, *Acta Protozoologica* (in press), which relates to the TA1 visit 15-EPN-006 (Complex eukaryote life in Mars analogue field site) that took place in RP1. This TA visit has also led to two follow-up projects: High-throughput sequencing and transcriptomics studies of Icelandic samples for the MExEM (Mars EXposed Extremophiles Mixtures) experiment, funded by the German Federal Ministry for Education and Research (BMBF); and a further project (Extremophile microbial eukaryotes in Mars-analogue field sites, 18-EPN4-002) approved by EPN2020-RI under the fourth TA call. The team behind Project 15-EPN-028 (Microbes at mineral interfaces in subseafloor young volcanic rocks) has submitted a proposal for a follow-up study to the International Continental Scientific Drilling Program (ICDP) in August 2018.

The TA1 visit to Lake Tirez in April 2018 (Response Of Extremophiles From Tirez Lake To Space Related Stress: Implications For Exploring Habitability, 17-EPN3-030) led to the discovery of a sub-genus of the *Dunaliella* algal strain, *Dunaliella salina* EP-1. The cells of *Dunaliella* algae are used in many countries for the industrial production of carotenoids, β -carotene, glycerol, bioactives, biofuel and antioxidants. Follow up studies will explore the biotechnological potential of *Dunaliella salina* EP-1. The discovery and other results from the field trip were presented at EPSC 2018 and featured in a press release that resulted in worldwide coverage.

Several publications are planned on the TA1 visits to Danakil Depression in January 2018. A Europlanet press release describing the 5 projects undertaken was issued in April 2018, and at least two follow-up releases on results from this trip (focusing on 17-EPN3-034 and 17-EPN3-039) are planned. A press release on a visit to Ibn Battuta that took place in the first reporting period (15-EPN-046) and presented at EPSC 2017 was issued in September 2017, leading to international coverage in the media (see Table 24). The co-lead scientist, Jan Raack also took part in a Europlanet webinar in October 2017, [‘Chasing the devil – what do dust devils on Earth tell us about Mars?’](#).

A [photograph](#) taken by Hugo Moors and Mieke De Craen during the 17-EPN3-039 visit to Dallol was a winner in Nature’s 2018 #ScientistAtWork photo contest.

Dr Barbara Cavalazzi took part in a live Europlanet webinar with teachers and schools [‘Tales of Geology and Education in Ethiopia’](#) in April 2017 to discuss her participation in TA1 and engagement activities with teachers and schools in Ethiopia. She has developed a multimedia show that puts Danakil into a planetary context, ‘History of the Earth in Colours’, and has delivered this at the Laboratorio di San Filippo Neri during an event organised by the Fondazione del Monte di Bologna and the Ravenna con Mismaonda.

The research teams visiting Danakil in January 2017 were accompanied by a journalist, Amanda Sperber, a photojournalist, Alex Pritz, and an artist, Samantha Tisoni. The press release in April 2017

featured images taken by Pritz, and Sperber and Pritz have now submitted a feature for publication in the next issue of the *Virginian Quarterly Review* at the time of writing.

Tistoni collaborated with Barbara Cavalazzi to create a photographic exhibition, 'PhysisArt – Photography of Danakil Exhibition', which toured Bologna, Modena, Chieti and Pescara during RP2 from October 2017-March 2018. Cavalazzi gave a series of talks to accompany launch events for the exhibition at each venue.

Two researchers from under-represented states (Poland, Portugal) visited TA1 sites during the reporting period. Efforts have been made to improve communication networks with researchers in these communities (see WP12) and we hope to see a slight increase in these numbers in the final call, which closes in October 2018.

A full list of dissemination activities can be found in Table 24.

3. WP3 - TA 2: Distributed Planetary Simulation Facility - DPSF

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

The main goal of TA2 (Distributed Planetary Simulation Facility – DPSF) is to give European and international scientist access to seven world-leading laboratory facilities to study materials under planetary analogue conditions for Mercury, Venus, Mars, the Moon, near-Earth asteroids, comets and the icy moons of the outer planets, as well as access to life detection techniques to study terrestrial extremophiles. For full details of facilities, please refer to the [First Periodic Report](#).

EPN2020-RI issued a third and fourth TA call during RP2, and 24 visits led by researchers (12 male and 12 female) from 10 countries took place to TA 2 DPSF laboratories. The seven TA host institutions have all contributed to publicising TA calls at international conferences and through dedicated planetary science and geochemical e-mail forums.

Full details of the individual calls completed can be found at the Europlanet2020 RI [website](#) along with reports submitted and approved at the completion of each TA2 visit.

While it is not possible to include details from all 24 TA2 visits in this summary report, we include a case study from each of the facilities, which gives an overview of the range of research carried out. For details of presentations and publications of results, see section 1.3. Impact.

Task 3.1- Planetary Emissivity Laboratory (PEL), Institute for Planetary Research, DLR, Berlin, Germany
There were seven visits (five female/two male lead applicants from three countries (France, Italy, UK)) during RP2.

Table 12: Visits to the PEL facility at DLR during RP2

Proposal number	Access site	Date of visit	Name of visitors	Project Title
17-EPN3-053	PEL	4-10 Oct 2017 (5 days)	Giulia Alemanno, Università del Salento, Italy	Emissivity and reflectance measurements of particulate mixtures for the interpretation of planetary remote sensing data
17-EPN3-047	PEL	6-17 Nov 2017 (10 days)	Paola Comodi (Max Fastelli), University of Perugia, Italy	New insight on the surface on the icy planets
17-EPN3-082	PEL	4-8 Sep 2017 (5 days)	Fabrizio Dirri, IAPS- INAF, Italy	Emissivity investigation of Ceres surface analogue materials and application to Thermal IR telescopic observations
17-EPN3-006	PEL	7-8 Dec 2017(2 days)	Liseth Gavilan, Université de Versailles, France	Infrared properties of Titan aerosols by using tholins powders and thin films produced in a plasma simulating Titan's atmosphere
17-EPN3-061	PEL	26 Feb-02 Mar 2018 (5 days)	Kerri Donaldson Hanna (Neil Bowles), University of Oxford	Spectral characterization of a suite of well-characterised bulk lunar soils from the ultraviolet to the far infrared
17-EPN3-023	PEL	18-23 Feb 2018 (5 days)	Jacopo Nava, Università di Padova, Italy	Mineralogical composition of the asteroid Ceres derived from the comparison between Antarctic-weathered and laboratory-weathered meteorites spectra, micrometeorites spectra and the NASA-Dawn space mission data
17-EPN3-050	PEL	23 Apr-23 May 2018 (5 days)	Giovanna Serventi (Cristian Carli), University of Parma, Italy	Sample characterization under hermean conditions

TA 2 Planetary Emissivity Laboratory Case Study

Project: 17-EPN3-047 - New insight on the surface on the icy planets

Applicant: Paola Comodi, University of Perugia, Italy

Date of visit: 6-17 November 2017

Icy planets, in particular Jupiter's moon Europa, have attracted scientific attention due to the likely presence of oceans under the crust which may potentially support life. NASA plan of a new mission to Europa will increase our knowledge of the surface composition. The *nonice* components of Europa's materials represents a question up to now not completely solved. Preliminary data indicate sulphate hydrates are especially important on hydrous worlds and are expected to be important extra-terrestrial salts. Currently a good database of their spectral features is lacking. The creation of a library of possible *nonice* spectra is fundamental to interpret the remote data.

During experiments at Planetary Spectroscopy Laboratory, emissivity and reflectance spectra of a relevant group of minerals were collected at different temperatures to investigate the role of chemical substitutions (cations as well anions) and of the amount of water molecules in spectral features. In particular, the samples investigated were subdivided in the following sub groups:

- a) Alkaline-earth alkaline sulphates: Thenardite Na_2SO_4 , Arcanite K_2SO_4 , Barite BaSO_4 , Gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$,
- b) Magnesium sulphates with different water contents: Kieserite $\text{MgSO}_4 \cdot (\text{H}_2\text{O})$, Pentahydrate $\text{MgSO}_4 \cdot 5(\text{H}_2\text{O})$, Epsomite $\text{MgSO}_4 \cdot 7(\text{H}_2\text{O})$
- c) Chlorides: Halite NaCl , Silvite KCl

- d) Mixed (chloride and sulphates) salts: Bloedite $\text{Na}_2\text{Mg}(\text{SO}_4)_2 \cdot 4(\text{H}_2\text{O})$, Loweite $\text{Na}_{12}\text{Mg}_7(\text{SO}_4)_{13} \cdot 15(\text{H}_2\text{O})$, Kainite $\text{MgSO}_4 \cdot \text{KCl} \cdot 3(\text{H}_2\text{O})$, Carnallite $\text{KMgCl}_3 \cdot 6(\text{H}_2\text{O})$, Polyalite $\text{K}_2\text{Ca}_2\text{Mg}(\text{SO}_4)_4 \cdot 2(\text{H}_2\text{O})$.

Four sets of measurements were collected:

- Emissivity in a purging environment at different Temperature up to 130 °C
- Emissivity under vacuum at temperature between 200 and 500 °C
- Reflectance in a vacuum environment at room temperature
- Reflectance in a vacuum environment with the samples frozen at -80 °C

Reflectance measurements were collected on the same set of samples, both on the fresh and recoiled after heating samples, for a total of about 30 samples.

Emissivity measurements were taken using two identical Bruker Vertex 80V FTIR spectrometers, with a nitrogen-cooled MCT detector and potassium bromide (KBr) beamsplitter, connected to an emissivity chamber: one for moderate temperature (from room temperature up to 130 °C under purging conditions) and one for high temperature measurement (from 180 °C to about 500° C in vacuum). Figure 9 shows the spectral measurements taken for the sample thenardite (Na_2SO_4).

A freezer device operating at -80 °C was used to bring the samples down to that temperature and a special apparatus (containing N_2 liquid) was used to maintain the specimens at -80 °C during the spectral measurements. All samples were recovered after the heating and freezing cycle measurements and will be characterised from a chemical and structural point of view by using electron microprobe and X-ray diffraction.

The final aim of the project will be to improve the spectral library of possible non-ice materials and to associate the structural and chemical changes to selected bands in the emissivity and reflectance spectra. Moreover, the spectral evolution studied in a wide temperature range, from -80 °C to about 500°C shows the temperature dependence gradient for different spectral bands. These data will help to extract more detailed information from remote data and suggest which areas and which data should have higher priority for remote investigations in future space missions.

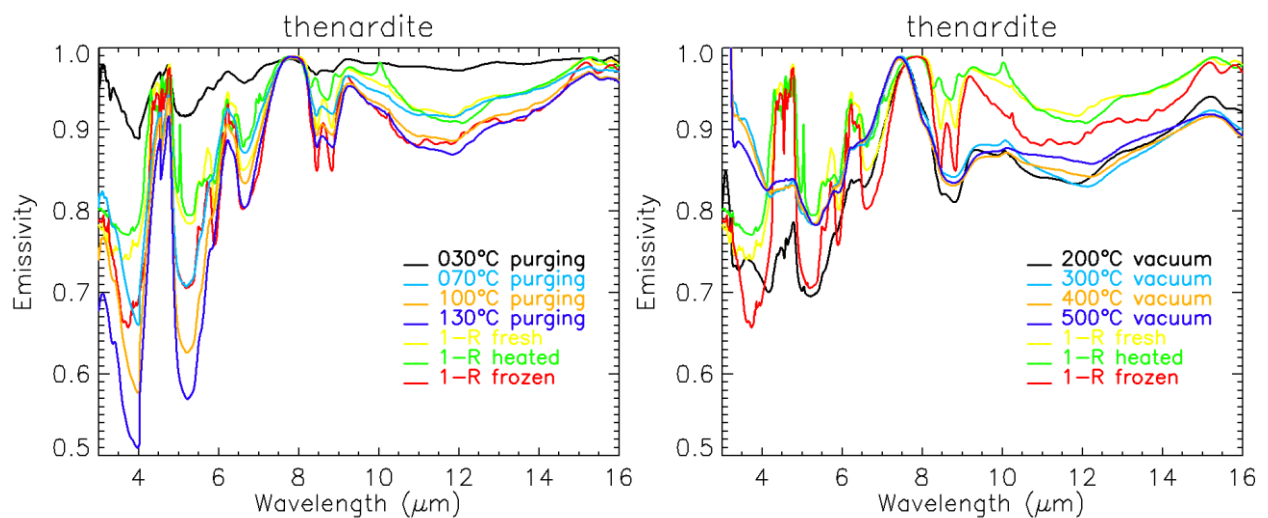


Figure 9. Spectral measurements on the thenardite sample

Task 3.2- Interactive Microbiome Research Facility (IMRF) Medical University Graz (MUG), Centre for Medical Research (ZMF), Graz, Austria.

There were six visits (four female/two male lead applicants, four countries (Finland, Germany, Italy and the under-represented state Romania)) including one from an under-represented state.

Table 13: Visits to the IMRF facility at MUG at DLR during RP2

Proposal number	Access site	Date of visit	Name of visitors	Project Title
16-EPN2-021	MUG/IMRF	6 Dec 2017 – 13 Mar 18 (10 days)	Nikea Ulrich (Ralf Möller), DLR, Germany	Microbial diversity in the vicinity of the Concordia research station on the high Antarctic plateau: studying spatiotemporal dynamics of indigenous and human-associated microorganisms (Short title “IceBacs”)
17-EPN3-067	MUG/IMRF	11-15 Sep 2017 (5 days)	Rahela Carpa, Babes-Bolyai University, Romania	Microbiota and their microenvironment in mud volcanoes from Hasag and Boz, Romania
17-EPN3-026	MUG/IMRF	19-23 Feb 2018 (5 days)	Martina Cappelletti (Daniele Ghezzi), University of Bologna, Italy	In-depth microbial composition analysis of speleothems from the quartz-sandstone cave Imawari Yeuta in Auyan Tepui (Venezuela)
17-EPN3-021	MUG/IMRF	19-23 Feb 2018 (5 days)	Ilenia D’Angeli (Stefan Leuko), DLR, Germany	Sulphur as a key for life? The microbial potential of sulphuric caves in Italy and the implications for extant or extinct life on Mars
17-EPN3-018	MUG/IMRF	5-17 Nov 2017 (10 days)	Cyprien Verseux, University of Rome Tor Vergata, Italy	Microbiome evolution during the HI-SEAS IV mission and impact on human space travel
17-EPN3-031	MUG/IMRF	24-27 Apr 2018 (3 days, 7 to follow in Oct 2018)	Jenni Hultman, University of Helsinki Finland	Microbial diversity and selection of key members for single cell sequencing from arctic soils

TA 2 Interactive Microbiome Research Facility Case study

Project: 17-EPN3-018 - Microbiome dynamics during the HI-SEAS IV mission and impact on human space travel

Applicant: Dr Cyprien Verseux, University of Rome Tor Vergata

Date of visit: 5-17 November 2017

The main objective of the reported project was to advance our knowledge on the evolution of microbial communities associated with crewed missions in isolated and confined environments, notably long-term space missions. Pathogens and technophiles may pose a threat to space crews and mission objectives and dynamic changes of the microbiome must be considered when designing planetary protection strategies.

This project took advantage of the HI-SEAS IV mission, which took place in 2015-2016. HI-SEAS IV gathered for a year six people selected for their astronaut-like features, in an 11-meter-in-diameter dome located on the barren slopes of the Mauna-Loa volcano in Hawaii, USA, primarily for NASA BHP research. The crew was isolated and confined, and hygiene practices were strictly maintained.

The Project Leader, who was one of the crewmembers, collected surface samples on ground and furniture surfaces, and on the crewmembers’ front torso skin. Those samples were taken every other week from September 18th, 2015 to August 26th, 2016, and an extra series of skin wipe samples was taken one week after the mission. In brief, the habitat/furniture surface samples were taken with swabs at four different locations: i) external surface of the toilet bowl, ii) wooden table surface in an individual compartment, iii) plastic table surface in the common area, and iv) gap between two pieces

of furniture in the kitchen, where dust tends to accumulate. The skin surface (front torso) samples were taken by each crewmember on themselves, following written instructions. The samples were then analysed at the Center for microbial life detection at MUG, Austria, using NGS-based amplicon sequencing.

Samples from the built environment were very similar to each other over the whole sampling period, while samples from the crew showed some events of very high dissimilarity, mostly due to an archaeal lineage. Indeed, surprising abundances (up to 80%) of the archaeon *Methanobrevibacter* were found in some wipe samples. Metadata predictions with Forest Classifiers worked very well for different sampling categories with an overall accuracy of 97%, while predictions of different time points were less accurate.

Further work is ongoing to obtain a deep understanding of the microbiome's nature and dynamics throughout the HI-SEAS IV mission.

Task 3.3- Planetary Environment Facilities (PEF) at Aarhus University, Denmark

Four visits to the Planetary Environment Facilities (one female/three male lead applicants, four countries (Italy, Spain, UK, USA)) at Aarhus took place during RP2.

Table 14: Visits to PEF facility at Aarhus during RP2

Proposal number	Access site	Date of visit	Name of visitors	Project Title
17-EPN3-005	PEF /AU	11 Dec 2017- 15 Jan 2018 (5 days)	John McClean, Robin Vinther Nielsen, Imperial College, UK	Investigation into the long-term effects of dust loading on atmospheric in-situ resource utilisation on Mars
15-EPN-009	PEF /AU	13-15 Mar 2018 (3 days)	Fernando del Campo Deustua, Bahillo Mugarza, SENER Ingeniería y Sistemas, S.A, Spain	ExoMars rover solar array mechanism dust test
17-EPN3-072	PEF /AU	2-6 Apr 2018 (5 days)	Anya Portyankina, <u>Zurine Yoldi</u> , Clemence Herny, University of Colorado in Boulder, USA	Variety Of CO2 Ice Crystals And Their Creation And Metamorphism In The Martian Polar Regions
15-EPN-031	PEF /AU	9-13 Apr 2018 (5 days)	Fabio Cozzolino, <u>Cesare Molfese</u> , <u>INAF Osservatorio Astronomico di Capodimonte</u> , Italy	Measurements and tests of a Martian Dust Analyser in Martian relevant environmental conditions

TA 2 Planetary Environment Facility Case Study

Project: 17-EPN3-072 - Variety Of CO₂ Ice Crystals And Their Creation And Metamorphism In The Martian Polar Regions

Applicant: Anya Portyankina, Zurine Yoldi, Clemence Herny

Date of visit: 2-6 April 2018

Vast seasonal ice caps of CO₂ form every fall on the Martian poles and sublime every spring. In order to understand the physics of this process, simulations at the Aarhus Planetary Environment Facility were carried out. Important new observations of the various phases and properties of CO₂ ice were made and how they evolve. This will help in analysing remote-sensing data of CO₂-covered surfaces on Mars.

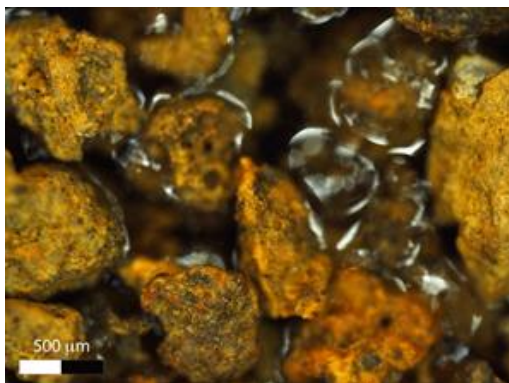


Figure 10- Microscope images.(left) CO₂ ice depositing as transparent slab ice and beginning to immerse sand under Martian conditions and (right) shows as yet un-researched crystal forms created at even lower temperatures and pressures

Task 3.4- Cold Surfaces spectroscopy, Institut de Planétologie et Astrophysique de Grenoble (IPAG) Grenoble France

There were three visits (two female/one male lead applicants, two countries (Italy, Switzerland) to the Cold Surfaces Spectroscopy facility during RP2.

Table 15: Visits to IPAG facility in Grenoble during RP2.

Proposal number	Access site	Date of visit	Name of visitors	Project Title
17-EPN3-042	CSS/IPAG	30 Jan-2 May 2018 (5 days)	Assimo Maris, Camilla Calabrese, University of Bologna, Italy	Spectroscopic Investigation Of Terrestrial Analogues Of Mars By Simulating Different Environmental Conditions
17-EPN3-054	CSS/IPAG	23-27 Apr 2018 (5 days)	Federico Tosi, Simone de Angelis, Cristian Carli, INAF-IAPS, Italy	Characterization Of Na-Sulphates At Cold Planetary Conditions
17-EPN3-057	CSS/IPAG	11-22 Jun 2018 (8 days)	Zuriñe Yoldi, Romain Cerubini, Antoine Pommerol, University of Bern, Switzerland	Measurement Of The Infrared Reflectance Spectra Of Icy Solar System Analogue Material

TA 2 Cold Surfaces Spectroscopy Facility Case study

Project: 17-EPN3-054 - Characterization of Na-carbonates at Cold Planetary Conditions

Applicant: Federico Tosi, INAF-IAPS, Italy

Date of visit: 23-27 April 2018

The proposal carried out a series of laboratory measurements of the visible-near infrared spectra of sodium carbonates with different levels of hydration, in three different grain sizes and in a wide range of temperatures (93-279 K), representative of real planetary surfaces. These measurements are key to correctly interpreting data acquired by spectrometers carried onboard ongoing and future interplanetary space missions at various planetary bodies, particularly Ceres (Dawn), Mars (ExoMars 2018, Mars 2020), and the Jovian icy satellites (JUICE, Europa Multiple-Flyby Mission).

The SHINE spectro-gonio radiometer coupled to the CarboN-IR cryogenic cell was used to allow reflectance measurements at temperatures as low as 93 K on large samples of powdered Na-sulphates, sieved to 3 separate grain size ranges (36-50, 75-100 and 125-150 μm).

Nine samples and two references were measured at eleven temperatures over the 93-279 K range.

Each experiment took one full day (+ night). In total, 110 spectra covering the 0.8-4.2 μm range were recorded. Six of them are plotted in Figure 11. The temperature-dependent laboratory spectra recorded during this TA2 visit have been compared with Dawn-VIR spectra of 29 Ceres and with Galileo-NIMS spectra of Europa. In particular, the data allowed confirmation of the identification of Natrite in Cerealia Facula, the brightest feature found in the crater Occator of Ceres (Figure 12), and to constrain the temperature of this anhydrous sulphate.

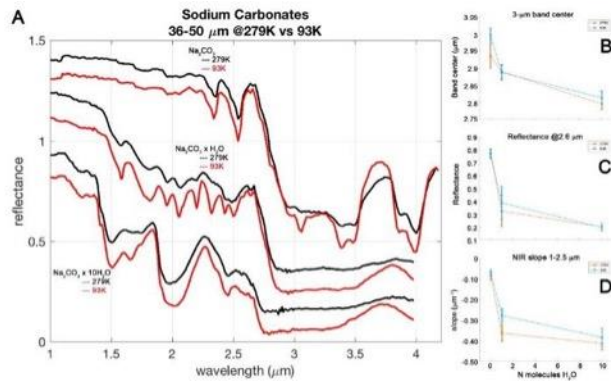


Figure 11-A spectra acquired for three species for 26-50 μm grain size, at 279 K (black) and 93 K (red). Spectra of Na_2CO_3 and $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ shifted in reflectance by 0.2 and 0.1 for clarity respectively.

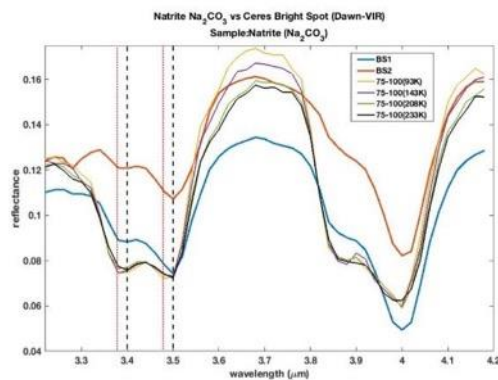


Figure 12- Spectra of Natrite sample with 75-100 μm grain size at 4 temperatures compared to two spectra of Ceres Bright Spot. VIR data have been resampled on the same set of wavelengths

Task 3.5- High-Pressure, High-Temperature Laboratory (HPHTL), Geology and Geochemistry, VU University Amsterdam.

The facility had no visitors in this reporting period.

Task 3.6- Large Mars Chamber Facility (LMCF), Open University, Milton Keynes, United Kingdom

There were two visits (two female lead applicants, from two countries (France and Ireland)) to the Large Mars Chamber Facility during RP2.

Table 16: Visits to the Large Mars Chamber Facility, Open University, UK during RP2

Proposal number	Access site	Date of visit	Name of visitors	Project Title
17-EPN3-069	Large Mars Chamber, OU	5-16 Feb 2018 (5 days)	Lauren McKeown, Trinity College Dublin, Ireland	An Investigation Of The Role Of CO ₂ Sublimation And Levitation As A Geomorphic Agent Under Martian Conditions
17-EPN3-078	Large Mars Chamber, OU	2-13 Apr 2018 (3 days)	Sabrina Carpy, Marion Masse, Nantes University, France	Emergence Of Exotic Ripples Formed Under A Tenuous Atmosphere: Exploration Of Their Size And Dynamic behaviour

TA 2 Large Mars Chamber Facility Case Study

Project: 17-EPN3-069 - An Investigation Of The Role Of CO₂ Sublimation And Levitation As A Geomorphic Agent Under Martian Conditions

Applicant: Lauren McKeown, Trinity College Dublin, Ireland

Date of visit: 5-16 February 2018

The Martian atmosphere is composed predominantly of carbon dioxide which is deposited in the form of ice, frost and snow each winter. The spring sublimation of this seasonal ice deposit is now widely recognised as a cardinal agent of landscape modification in the present day. A variety of sublimation hypotheses have been offered for the formation of these features. Previous experiments indicated that pressurised sublimating carbon dioxide gas beneath a CO₂ ice overburden can form a variety of furrow networks and that a stationary sublimating CO₂ ice block can erode pits and surrounding levees on level beds of grain sizes ranging from 4-212 micrometres. However, the efficacy of these individual geomorphic mechanisms has never been investigated under Martian atmospheric pressure, which is three orders of magnitude lower than ambient Earth pressure and hence would significantly affect sublimation rate and sediment transport. Additionally, the patterns resulting from a central vent within the ice have never been investigated, which may produce radial and even dendritic radial morphologies similar in pattern to the spider-like “araneiform” terrain on Mars.

This visit performed a suite of experiments at the Open University Mars Simulation Laboratory which were designed to investigate the efficacy of CO₂ block sublimation in the context of pit and furrow formation under Martian conditions. To investigate radial furrow formation, Guyson Honite glass spheres were poured into a 60 x 40 x 40 cm glass tank positioned in the Mars Chamber and were levelled and smoothed. A CO₂ block was drilled at its centre to create a hole using a drill bit measuring either 3 mm or 5 mm. The chamber was depressurised and when ambient pressure reached 6 mbar, the block was gently lowered onto the surface using a pulley. Initial data show excellent agreement with the numerical model of CO₂ block sublimation and levitation indicating CO₂ block sublimation and levitation may be responsible for linear gully pit formation on Mars. Additionally, for the first time, radial furrow formation analogous in morphology to the enigmatic araneiform terrain of the Martian south polar cryptic region were observed. These were formed by cryoventing in a similar manner to that suggested for the araneiform terrain and furrows on Martian dunes, where subsurface gas and material was transported above the ice in a plume.

Task 3.7- Petrology-Mineralogy Characterisation Facility (PMCF), Mineral and Planetary Sciences Division, Natural History Museum, London, UK

There were two visits (two male lead applicants, from two countries (France and Germany)) to the Large Mars Chamber Facility during RP2.

Table 17: Visits to the Petrology-Mineralogy Characterisation Facility, Natural History Museum, UK, during RP2.

Proposal number	Access site	Date of visit	Name of visitors	Project Title
17-EPN3-033	PMCF /NHM	13-19 Sep 2017 (5 days)	Keyron Hickman-Lewis, Université d'Orléans, France	High-Resolution Correlative Microscopy Of Biogenic And Abiotic Carbonaceous Matter In Archaean Chert
17-EPN3-079	PMCF /NHM	5-19 Dec (10 days)	Christopher Hamann, Museum für Naturkunde, Germany	Element Fractionation During Vapour Condensation In Nature And Experiment: Implications For High-Tem

TA 2 Petrology-Mineralogy Characterisation Facility Case Study

Project: 17-EPN3-033: High-Resolution Correlative Microscopy of Biogenic and Abiotic Carbonaceous Matter in Archaean Cherts

Applicant: Keyron Hickman-Lewis, Université d'Orléans, France

Date: 13-19 September 2017

This research visit to the X-Ray Diffraction (XRD) laboratory and Computed Tomography (CT) laboratory at the Natural History Museum, London, sought to:

- Investigate morphology and context of the earliest traces of life on Earth from the early Archaean (>3 billion years ago) of South America and Western Australia.
- Analyse the mineralogical and elemental associations of surficial colonies commonly associated with biofilms in order to constrain substrate relations.
- Assess the potential of these biosignatures to be preserved and detected during the search for life on Mars, particularly emphasising the ExoMars2020 mission.

High resolution CT scans conducted on material from the Barberton greenstone belt of South Africa and the East Pilbara terrane of Western Australia permitted the assessment and refinement of 3-D biogenicity criteria for a range of biogenic and sedimentary samples. This research also supports the utility of CT scanning when applied to the Precambrian fossil record. Further detailed XRD measurements, specifically targeting clay mineralogy, enabled better understanding of how microbes are governed by their substrates, and the way in which morphologies and ecosystem diversity are controlled by geosphere bio-availability.

The research carried out during this highly successful visit greatly extends our understanding of ancient microbial biomes in the Archaean and will contribute towards a number of publications.

1.2 Impact

TA2 visits have resulted in many presentations at workshops, conferences and seminars, including Lunar and Planetary Science Conference, EPSC 2017, EPSC 2018 and EGU. The session LFI2 "The distributed planetary simulation and sample analysis facilities" at EPSC has showcased research enabled through the first three calls of TA2, including six oral presentations and four posters at EPSC 2017. A special session dedicated to presentations of work performed in TA2 program of EPN2020 RI was held at EPSC 2018 in Berlin, including six oral presentations and 11 posters.

Lauren McKeown who visited the Large Mars Chamber Facility at the Open University in February 2018 (An investigation of the role of CO₂ sublimation and levitation as a geomorphic agent under Martian conditions, 17-EPN3-069) was awarded the Planetary Science Institute's Pierazzo International Student Travel Award to present at the Lunar and Planetary Science Conference in Houston, Texas. Her result is the first observation of its kind and two manuscripts are currently being prepared on the results from these experiments for submission to high-impact journals.

Results from several projects have now been published in high-impact peer-reviewed journals, e.g.

- Results from the TA2 visit by Susan Conway to the Large Mars Chamber Facility (Grain saltation induced by boiling of metastable water, 16-EPN2-050) in early 2017 were published in Nature Communications in October 2017 (Raack et al, 2017). Europlanet and the Open University issued a joint press release, which received international media coverage (see Table 24).
- Results from the TA2 visit by Petra Schwendner to the Interactive Microbiome Research Facility in Graz in August 2016 (MICHAMolecular – bacterial and archaeal inventory, 15-EPN-044) were published in the open access journal, Microbiome, in October 2017. The journal and Europlanet NA2 issued a joint press release, which was also well covered by the media worldwide.
- Results from the TA2 visit to the Planetary Environment Facility at Aarhus by Jörn Sesterhenn (Experimental analysis of high-speed free jets at low Reynolds number, 15-EPN-005) has been published in the Journal of Aerosol Science ([Alois et al, 2017](#)).
- Results from the TA2 visit to Cold Surfaces Spectroscopy Facility by Federico Tosi in April 2018 have been accepted for publication in the January 2019 issue of Icarus ([De Angelis et al, 2019](#)).

In addition to generating media coverage through press releases, TA2 has worked with NA2 to find additional ways to engage with the public and schools e.g. Jacqueline Campbell wrote a blog post ([Mixing a recipe for Mars in the ice-lab](#)) for the Europlanet Outreach website in June 2018 about her visit to the Cold Surfaces Spectroscopy Facility at IPAG, Grenoble, and Jörn Helbert has taken part in a [live webinar](#) with teachers and schools to discuss research at the Planetary Emissivity Laboratory in January 2018.

Only one visit to a TA2 facility was made by a researcher from an under-represented state (Romania) during the reporting period. Efforts have been made to improve communication networks with researchers in these communities (see WP12) and we hope to see a slight increase in these numbers in the final call, which closes in October 2018.

For full details of publications, see the project Portal and for other dissemination and media coverage, see Table 24.

4. WP4 - TA 3: Distributed Sample Analysis Facility (DSAF)

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

The main goal of TA 3 (WP4), The Distributed Sample Analysis Facility (DSAF), is to provide European and a limited number of international users with access to four centres of excellence for isotope geochemical analysis and the broad range of instrumentation required to quantify the complex (bio)geochemical cycles that control the formation and evolution of planetary bodies. DSAF provide the comprehensive capability to determine:

- isotopic and elemental analyses at high spatial resolution, down to ~3 nm,
- high precision (down to 5 ppm)
- high sensitivity (sub ng sample sizes).

For full details of the TA2 facilities offered, see the [First Periodic Report](#).

EPN2020-RI issued a third and fourth TA call during RP2, and 21 visits led by researchers (16 male and 5 female) from nine countries took place to TA 3 DSAF laboratories. The four TA hosts institutions have all contributed to publicising TA calls at international conferences and through dedicated planetary science and geochemical e-mail forums.

Full details of the individual calls completed can be found at the Europlanet2020 RI [website](#) along with reports submitted and approved at the completion of each TA3 visit. While it is not possible to include details from all 21 TA2 visits in this summary report, we include a case study from each of the field sites, which give an overview of the range of research carried out. For details of presentations and publications of results, see section 1.3. Impact.

Detailed description of work

Task 4.1- Radiogenic and Non-Traditional Stable Isotope Facility: Geology and geochemistry, Faculty of Earth and Life Sciences, VU University, Amsterdam, NL: (GGIF)

Three teams (three male lead applicants from three countries (France, Germany, UK) visited the Geology and Geochemistry GGIF at VU Amsterdam during RP2.

Table 18: Visits to GGIF at VUA during RP2.

Proposal number	Access site	Dates of visit	Name of visitors	Project Title
16-EPN2-009	GGIF/VUA	17-30 Sep 2017 (12 days)	Jason Harvey, University of Leeds, UK	Analogues of the mantles of rocky solar system planets: Petrogenetic processes in lithospheric sulphides
17-EPN3-015	GGIF/VUA	3-16 Dec 2017 (10 days)	Francois Benny, Université Lille 1, France	Undercool - Understanding Deep Exchange Ratio Of Carbon In The Southern Ocean During The Last Deglaciation
17-EPN3-065	GGIF/VUA	15-31 May 2018 (8 days)	Felix Genske, Westfälische Wilhelms-Universität Münster	Unravelling the Composition Of Terrestrial Planet's Interior Using High- precision Isotope Analysis

TA 3 Interactive GGIF Case study

Project No: 16-EPN2-009 - Analogues of the mantles of rocky solar system planets: Petrogenetic processes in lithospheric sulphides

Applicant: Jason Harvey, University of Leeds, UK.

Date: 17-30 September 2017

The uranium-thorium-lead (U-Th-Pb) isotope system has three parent-daughter decay systems with different half-lives and hence is a very powerful tool to understand the early formation and subsequent differentiation of planetary bodies. Lead isotope ratios of terrestrial magmas are relatively radiogenic (produced through radioactive decay) compared to the lead isotope ratios derived from primordial chondritic material. This relationship is termed the “first lead paradox” – the observation that a reservoir of unradiogenic lead in the Earth has yet to be somewhere within the Earth’s interior. One possible explanation could lie in base-metal sulphides that reside within Earth’s mantle.

Lead’s strong affinity for sulphur means that base-metal sulphides likely represent a major repository

for lead in planetary interiors, yet the precise analysis of lead isotopic compositions of 50 to 500 μm diameter sulphide grains recovered from the mantle of planetary bodies has previously been hampered by the difficulty in processing samples of lead in the picogram to nanogram range. Recent development of a low blank $^{207}\text{Pb}/^{204}\text{Pb}$ double spike technique and use of a Triton *Plus* thermal ionisation mass spectrometer (TIMS) equipped with a 10^{13} Ohm amplifier to measure the low abundance ^{204}Pb isotope at the Vrije Universiteit now allows lead isotope analyses of minute peridotite-hosted sulphide grains. This project therefore aimed to assess if the analysis of individual sulphides was possible.

This study reports the lead isotope composition and lead elemental abundance of 20 base-metal sulphides recovered from a single harzburgite xenolith from Kilbourne Hole, New Mexico, USA. In addition to partial oxidation to Fe-oxy-hydroxides, many of the sulphides had also subsequently interacted with a siliceous melt / fluid, obscuring their primary mineralogy and textures still further (Figure 13). As such, these sulphides were considered to be as challenging a target material as could reasonably be expected for meteorite-hosted sulphides. Sulphide masses ranged from 17 to 171 micrograms, yielding 0.14-7.45 nanograms of lead. Blank measurements were consistent at 65 picograms of lead, meaning that in the two smallest samples up to 45% of the measured lead came from making the measurement itself. However, the mean blank contribution in the remaining samples was only 11%. Lead isotope ratios obtained were ubiquitously radiogenic, plotting to the right of the 4.57 billion year “geochron” (age of the Earth). The results suggest that, in this harzburgite sample at least, despite a wide range of lead abundances being retained in mantle base-metal sulphides, sulphides from the sub-continental lithospheric mantle are unlikely to be a significant source of unradiogenic lead and thus do not represent a solution to the first lead paradox (Figure 14).

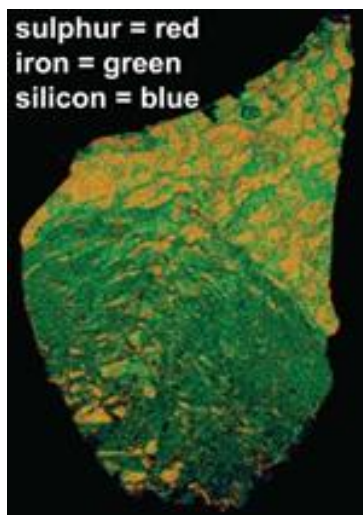


Figure 13-False colour overlay of iron, sulphur and silicon distribution in a typical altered sub-continental lithospheric mantle sulphide from Kilbourne Hole, NM. Orange areas depict relatively fresh sulphide, green areas are iron oxy-hydroxides and turquoise areas have been infiltrated by a silicon-rich melt / fluid. Field of view 300 x 500 microns

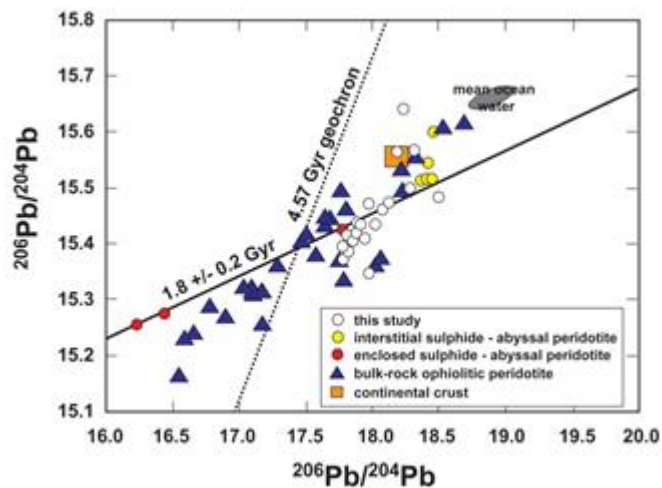


Figure 14-Lead isotope compositions of the samples from this study. Analytical uncertainty smaller than symbol size. Unlike some sulphides recovered from oceanic peridotites, the samples from this study all yielded unradiogenic lead compositions

Task 4.2- Radiogenic, non-traditional stable & rare gas isotopes. Le Centre de Recherches Pétrographiques et Géochimiques (CRPG-CNRS), Nancy, France.

Seven visits (seven male lead applicants from four countries (Germany, Netherlands, UK, USA)) took place during RP2, four to the Ion Probe Facility (IPF) and three to the Stable and Radiogenic Isotope Facility (SRIF).

Table 19: Visits to DFAS facility at CRPG, Nancy, France during RP2.

Proposal number	Access site	Dates of visit	Name of visitors	Project Title
15-EPN-030	IPF/CNRS	7-12 Aug 2017 (5 days)	Joshua West, University of Southern California, USA	Hydrogen Isotope Composition of Clays from the Andes-Amazon System: Calibrating a Proxy of Planetary Environments and Tracking Weathering and Soil Erosion on Earth
15-EPN-040	SRIF/CNRS	21 Jan-9 Feb 2018 (10 days)	Pieter Vroon, Kirsten van Zuilen, VU Amsterdam, Netherlands	Germanium isotope variations in the 3.5 Ga old Buck Reef Chert
16-EPN2-017	IPF/CNRS	16-24 Jan 2018 (9 days note issue with instrument breakdown- 2 visits)	Andrea Giuliani, Montgarri Oliver, VU Amsterdam, Netherlands & Macquarie University, Australia	Carbon isotope evolution of the deep Earth from coupled C-O isotope SIMS measurement of carbonates in kimberlites
16-EPN2-033	SRIF/CNRS	6-10 Mar 2017 (5 days)	Timothy Gregory, Luu Tu-Han, University of Bristol, UK	Carbon Solubility In Reduced Silicate Melts: Implications For The Differentiation Of Mercury
16-EPN2-066	IPF/CNRS	10-18 Oct 2017 (8 days)	George Jacobs, The Open University, UK	Investigating the chronology of clast formation and disruption in martian meteorite Northwest Africa 7034
17-EPN3-011	IPF/CNRS	17-23 Dec 2017 (5 days)	Dominik Hezel, Jens Barosch, University of Cologne, Germany	O-Isotope and Rare Earth element study of an unusual compound object, consisting of a barred olivine chondrule inside a magmatic, Ca,Al-rich object in a highly primitive H-chondrite
17-EPN3-074	SRIF/CNRS	15-20 Jan 2018 (5 days)	Sami Nabhan, Friedrich-Schiller-University Jena, Germany	Tracing Metabolic Pathways Of Archean Microbial Communities

TA 3 CRPG-CNRS Case study

Project: 17-EPN3-074 - Tracing Metabolic Pathways Of Archean Microbial Communities.

Applicant: Sami Nabhan, Friedrich-Schiller-University Jena, Germany

Date of visit: 15-20 January 2018

This [project](#) investigated the metabolic processes used by microbial communities in the early Archaean (~3.2 billion years ago) on Earth. The Moodies Group is a well-preserved Archaean shoreline system in the Barberton Greenstone Belt, South Africa (Figure 15). The excellent preservation of Moodies Group rocks enables investigation of a number of Archaean habitats e.g. microbially populated tidal plains, soils and shallow-water banded iron formations (BIFs) that formed in anoxic, CO₂ rich environments possibly very similar to those of early Mars. The complex behaviour of sulphur phases in the Archaean, due to the lack of an ozone shield, can help understand the sulphur cycle on Mars which also lacks an efficient UV shield. The Moodies Group contains up to 1000 m of strata with fossilized microbial mats of excellent morphological preservation. However, metamorphic alteration of the remaining carbonaceous matter has been to a degree that does not allow the extraction of biomarkers to determine former microbial pathways. Variations of stable isotope ratios, including sulphur, provide an alternative method of tracking such pathways.

Primary sulfates and especially gypsum are exceptional in the Archaean rock record. The terrestrial environment in which they formed is more sensitive to changes than that of the otherwise marine sulfates of this age. Therefore, the Moodies nodules open a unique possibility to study the evolution of sulphur based microbial pathways.

Multiple sulphur isotopic compositions were determined on six pyrite and three barite samples from the Moodies Group using the Stable and Radiogenic Isotope Facility at the Centre de Recherches Pétrographiques et Géochimiques.

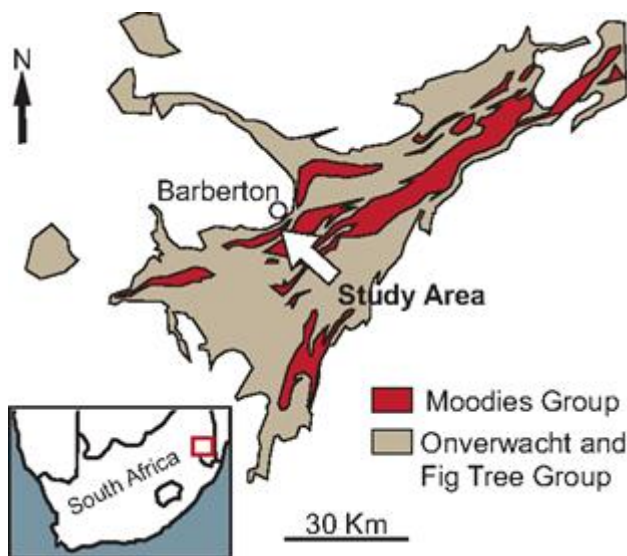


Figure 15 - Location of the Moodies Group within the Barberton Greenstone Belt, South Africa. Modified from Bontognali et al. (2013).



Figure 16- Polished banded ironstone rock from Moodies Formation. A) Chert layer; B) laminated magnetite and haematite. C) Siliciclastic layer. Modified from Bontognali et al. (2013).

The measured mass dependent fractionation between sulphate and sulphide of up to 34 parts per thousand is similarly high as in modern environment and clearly caused by microbial sulphate reduction while variations in the $\delta^{34}\text{S}$ (standard measurement of $^{34}\text{S}:^{32}\text{S}$ sulphur isotopes) composition and the recorded mass independent fractionation ($\Delta^{33}\text{S}$) of the sulphate inclusions are clearly caused by microbial sulphur oxidation (MSO) which is in part photosynthetic. Therefore, the Moodies paleosols record one of the oldest microbial communities known to date. The consequences of MSO on the S- isotopic composition of the Moodies sulfate may thus explain the steady $\Delta^{33}\text{S}$ increase of Paleoarchean sulphates over a period of around 330 million years. This indicates that MSO was an

active microbial pathway since the formation of the oldest known sulfate deposits (around 3.55 billion years old).

Moodies nodules are a good analogue to nodules observed in the Sheepbed mudstone of the Yellowknife Bay formation in Gale crater on Mars. Sheepbed and Moodies nodules both formed at a similar time (~3.3-3.2 Ga) under similar conditions on planets that then resembled each other more than they do today. The involvement of a sulphur based microbial community in the formation of the Moodies nodules strengthen the case for an ancient habitable environment during the deposition of the Sheepbed mudstone and the subsequent formation of the Sheepbed nodules.

Task 4.3- Radiogenic & stable isotopes. Open University, Milton Keynes, United Kingdom

There have been seven visits (three female, four male lead applicants from six countries (Belgium, Italy,) to the NanoSIMS 50L- Laser Fluorination System (LFS)- Compound Specific Stable Isotope Analysis (SIA) during RP2.

Table 20: Visits to NanoSims 50L facility at OU during RP2.

Proposal number	Access site	Dates of visit	Name of visitors	Project Title
15-EPN-001	HS50L/OU	4-8 Jul 2017 (5 days)	Barbara Cavalazzi, Emanuele Enrico, Università di Bologna, Italy	NanoSIMS Measurements of Carbon rich areas in Archchaen Cherts
15-EPN-035	HS50L/OU	3-6 Apr 2017 (4 days)	Steven Goderis, Bastien Soens, Vrije Universiteit Brussel, Belgium	Determination of the origin of (micro)meteorites from the Antarctic Sør Rondane Mountains using laser fluorination IRMS
15-EPN-045	HS50L/OU	24-28 Apr 2017 (5 days)	Sylvain Petitgirard, Ingrid Blanchard, University of Bayreuth, Germany	Partitioning of W and Mo at high pressure during terrestrial accretion
16-EPN2-032	HS50L/OU	6-10 Nov 2017 (5 days)	Nicola Potts and Stefie Potts & S Luginbuehl, VU Amsterdam, Netherlands	Investigating Cl isotope fractionation during magmatic degassing of lunar melts
16-EPN2-043	HS50L/OU	3-7 Sep 2017 (5 days)	Ioannis Baziotis, Agricultural University of Athens, Greece	Characterization of the primary melt inclusions and phosphates in martian meteorite Tissint and lunar meteorite NWA 773: implications for understanding the history of volatiles in planetary interiors
16-EPN2-059	HS50L/OU	22-26 May 2017 (4 days)	Fernando Tornos, Centro de Astrobiología (CSIC-INTA), Spain	Unusual sulphur isotope fractionation as tracer of microbial activity
17-EPN3-017	HS50L/OU	21-25 May 2018 (5 days)	Ingrid Blanchard, Eleanor Jennings, University of Bayreuth, Germany	Fate of Carbon During Earth's Core Formation

TA 3 NanoSims 50L Case study

Project: 17-EPN3-017 - Fate Of Carbon During Earth's Core Formation.

Applicants: Ingrid Blanchard & Eleanor Jennings, University of Bayreuth, Germany

Date of visit: 21-25 May 2018

Carbon is an element of great importance in the Earth, because it is intimately linked to the presence of life at the surface, and, as a light element, it may contribute to the density deficit of the Earth's iron-rich core. Carbon is siderophile (easily forms alloys with iron) at low pressures and temperatures. Based on this behaviour, it should be stored mainly in the Earth's core. Nevertheless, we still observe the existence of carbon at the surface, stored in crustal rocks and associated with the presence of life, and in the mantle, as shown by the exhumation of diamonds. The presence of carbon in the crust and mantle could be the result of the arrival of carbon during late accretion, after the process of core formation ceased, or because of how carbon was distributed between metallic liquid and silicate melt (metal–silicate partitioning) at the conditions of core formation where there were very high temperatures and pressures (e.g. $P > 40$ GPa and $T > 3500$ K). Previous studies reported metal–silicate partitioning of carbon based on experiments using large volume presses up to 8 GPa and 2200 °C (Li et al., 2016).

This study used a diamond anvil cell to perform the first laser-heated experiments to determine carbon partitioning between liquid metal and silicate at the extreme conditions of Earth's core–mantle differentiation. The team performed six successful metal–silicate partitioning experiments between 41 and 71 GPa and 3500 and 4100 K. They recovered their samples using the Focused Ion Beam technique and welded a 2–3 μm thick slice of each sample onto a Transmission Electron Microscope (TEM) grid (Figure 17). Major elements were analysed by electron microprobe, whereas the concentrations of carbon in the silicate were analysed by nanoSIMS at the Open University. The two phases (metal and silicate) are extremely small (each are less than 10 microns). The team was able to measure the abundance of carbon in the silicate and in the metallic phase of the six samples. This required careful synthesis of standards containing various amount of carbon using a piston-cylinder apparatus. They thus have obtained metal–silicate partitioning results for carbon at pressure and temperature conditions relevant to planetary core formation. Results will be integrated into state-of-the-art core formation models (Rubie et al., 2015, 2016) in order to determine carbon concentrations in the core and bulk silicate Earth (BSE) at the end of accretion.

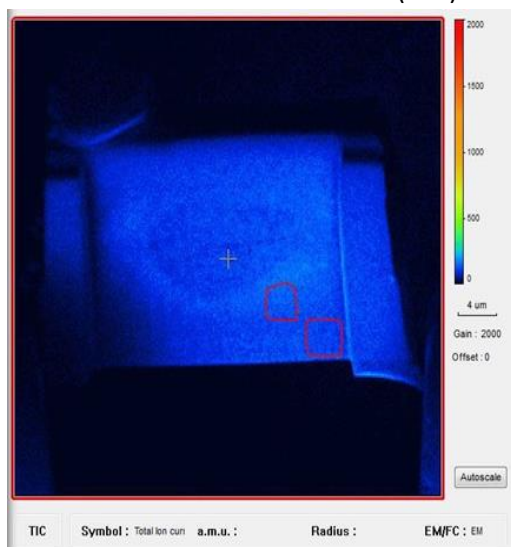


Figure 17- total ion image of a FIB slice from one of the diamond anvil experiments. Inner dark region shows position of molten metal region, surrounded by lighter melted and equilibrated silicate region with the outer mid blue region showing un-equilibrated silicate material. The two red squares show the position of analyses of equilibrated (upper left) and un-equilibrated (lower right) silicate. The sample is gold coated in order to facilitate charge dissipation during analyses, and therefore only very subtle differences are apparent in this imaging mode. Note scale is bar is 4 μm .

Task 4.4- Radiogenic & non-traditional stable isotopes: Institute for Planetology; University of Münster, Münster, Germany

Four visits (two female/two male lead applicants from four countries (France, Germany, UK, USA)) to the Radiogenic & Non-Traditional Stable Isotopes (RNTSI) facility took place during RP2.

Table 21: Visits to Radiogenic & Non-traditional Stable Isotopes Facility at WWM during RP2.

Proposal number	Access provider short name	Actual days visited	Name of visitors	Project Title
16-EPN2-034	RNTSI /WWM	2-11 Aug 2017 (10 days)	Francois Tissot, Massachusetts Institute of Technology, USA	Investigating early Solar System chronology
17-EPN3-007	RNTSI /WWM	22 Jan- 2 Feb 2018 (10 days)	Sebastian Tappe, University of Johannesburg/ WWU Muenster, Germany	Tungsten isotopic compositions of kimberlites generated atop the African LLSVP
17-EPN3-012	RNTSI /WWM	26 Feb- 9 Mar 2018 (8 days)	Christa Gopel, IPGP, Sorbonne, Paris Cité, Université Paris Dider, France	Comparing the ages obtained by ^{182}Hf - ^{182}W and ^{53}Mn - ^{53}Cr chronology in ordinary chondrites
17-EPN3-036	RNTSI /WWM	20-31 Aug 2018 (10 days)	Natasha Almeida, Natural History Museum, UK	Hf-W measurements of Barwell 'Pebbles': Dating early differentiation in the Solar System

TA3 Radiogenic & Non-traditional Stable Isotopes Facility case study

Project: 17-EPN3-036 - Hf-W measurements of Barwell 'Pebbles': Dating early differentiation in the Solar System

Applicant: Natasha Vasiliki Almeida, Natural History Museum, UK

Date: 20-31 August 2018

In a follow up to a visit made under the first TA call (15-EPN-042), this project investigated igneous-textured inclusions in ordinary chondrites to constrain early differentiation, timing of thermal metamorphism, and implications for impact history and mixing in the early Solar System (Figure 18). Characterising such inclusions allows determination of their origin and relationship to the bulk meteorite, i.e. whether they formed on the chondrite parent body, formed in a similar way to chondrules, resulted from impact melting, or are fragments of an achondritic projectile. The earliest formed material in chondrites are calcium–aluminium-rich inclusions (CAI) dated at 4.567 billion years. The chondrules are thought to have formed within 2-3 million years of the CAI.

Samples of the inclusions were separated from the Barwell meteorite and three other ordinary chondrites, previously identified at the Natural History Museum, London. Hafnium-tungsten (Hf-W) compositions were determined on seven inclusions, ranging in mass from 102 mg to 219 mg using a Neptune Plus Multicollector-Inductively Coupled Plasma Mass Spectrometer (MC-ICP-MS). The Hf-W isotope system is used to provide insight into the mechanisms of planetary accretion, specifically the timing of metal-silicate separation. Hafnium (the parent) and tungsten (the daughter) are both notably refractory elements and should occur in chondritic proportions ($\text{Hf}/\text{W} \sim 1.1$) in undifferentiated early Solar System material (Kleine et al., 2004). If the proto-parent body (or bodies) of the inclusions was

differentiated prior to their ejection, they would be expected to exhibit radiogenic ^{182}W excesses, as the silicate portion of the parent body would have had a higher-than-chondritic Hf/W due to fractionation during differentiation.



Figure 18- Photograph of the Barwell Meteorite containing large dark basaltic silicate inclusions (black arrow) and smaller chondrules.

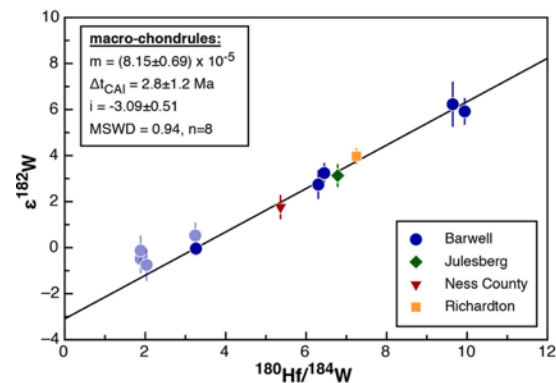


Figure 19- Hf-W isochron diagram of the ordinary meteorites.

One Barwell inclusion showed a low concentration of Hf, resulting in a negative two-stage model age, similar to two Barwell inclusions studied during a previous visit. Although no meaningful age can be calculated for these samples, the results indicate a complex formation that will be further explored by other techniques. The six other inclusions have super-chondritic Hf/W ratios and display radiogenic ^{182}W excesses. The model ages for these inclusions ranges from 2.0 to 2.7 million years after CAIs. Importantly, these inclusions define a bulk rock Hf-W isochron that more accurately dates the timing of their formation at 2.8 ± 1.2 million years after the CAI (Figure 19).

The results indicate that most of these inclusions formed contemporaneously with chondrules. This combined with the similarities in Hf, W and Rare Earth Elements (REE) concentrations suggests a genetic link between chondrules and inclusions and has important implications for the early accretion in the Solar System.

1.2 Impact

The combined infrastructure available within DSAF includes a past investment of $\sim \text{€}40 \text{ M}$ (excluding buildings) mainly sourced from national funding agencies. DSAF therefore contains large national facilities with a reputation for multi-disciplinary research and hence the capability to support a wide range of research topics related to habitability and the fundamental processes that led to the formation of the planetary bodies in the Solar System (e.g., accretion & differentiation processes), as well as the atmospheric and hydrological process at planetary surfaces. JRA 3 introduced new capabilities for improved sample handling techniques (minimally destructive) and the analysis of smaller sample size. These new capabilities became fully available for access in late 2017. This resulted in a major increase in the number of TA applications in the third and fourth call.

The TA visits during RP2 have resulted in many presentations at workshops, conferences and seminars including the 48 and 49th Lunar and Planetary Science Conference in Houston in March 2017 & 2018, the European Geoscience Union General Assembly in Vienna in April 2017 & 2018, and the Geochemical Society Goldschmidt meeting in Paris and Barcelona August 2017 & 2018 and the quadrennial International Kimberlite Conference (Botswana, October 2017), (see Table 24 for full

details). A special session dedicated to presentations of work performed in TA3 program of EPN2020 RI was held at EPSC 2018 in Berlin. Publications are also now being produced and accepted in high impact journals e.g. results from the visit by Janosch Schirmack (16-EPN2-047) to the Stable and Radiogenic Isotope Facility at CRPG-CNRS, Nancy, have been published in the Proceedings of the National Academy of Sciences of the United States of America (PNAS) ([Schulze-Makuch et al, 2018](#)). Nine applications for TA3 have been approved in the fourth TA call, and we expect to see several papers published during the final reporting period.

See Table 24 for full details of dissemination for TA3.

2. Deviations from Annex 1

As a consequence of the demand requested by the community (regularly approved by the peer review process), during RP2 the length of TA applications has generally been longer than expected. With Amendment #2 we therefore envisaged that we will be offering less but longer TA visits, thus with a lower number of users. The total amount of time provided remained however unchanged from what we originally predicted. Some re-distribution of resources between the facilities will be warranted after a review of the final TA3 call has been conducted, as some facilities have proved more in demand and/ or more successful in passing the peer review process.

5. WP5- VA1: PSWS (Planetary Space Weather Service)

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

“Planetary Space Weather Services” (PSWS) offers five ‘toolkits’ to assist in planning for space missions: a general planetary space weather toolkit; toolkits for Mars, comets and the outer planets; and an event-diary for at predicting and detecting planetary events like meteor showers and impacts. 12 PSWS tools are distributed over four different service domains (A. Prediction, B. Detection, C. Modelling, D. Alerts) and accessed through the [PSWS portal](#). PSWS will deliver all tools by Project Month 40. For full details of the PSWS services, see the [First Periodic Report](#).

Task 5.1 Coordination (CNRS, ABER, WIGNER)

For details of the management team and structure, see the [First Periodic Report](#). The PSWS coordination team held a [Coordination Meeting](#) at EPSC 2017 in Riga to prepare the PSWS VA facility for presentation to the user community.

Task 5.2 Implementation (UCL, ABER, CNRS, SRC PAS, GFI Informatique)

A2. Extensions of the CDPP Propagation Tool (CNRS, GFI Informatique)

The GFI Informatique (GFI) has extended the Propagation Tool available from the Centre de Données de Physique des Plasmas (CDPP) for applications to comets, giant planet auroral emissions, and catalogues of solar wind disturbances. They are providing new plug-ins including selection of the comets as targets, visualization of their trajectories, projection onto solar maps, projection onto J-maps, and estimates of solar wind disturbance arrival times; they will enable the user to use catalogue of solar wind disturbances to identify those that have impacted the planetary environments.

Status (final): Service operational at <http://propagationtool.cdpp.eu>

Task 5.3 Detection (UPV/EHU, UCL, ABER)

A4. Cometary tail crossings - Tailcatcher (UCL)

Mullard Space Science Laboratory (MSSL) within UCL is developing and posting online a software to enable users to predict comet ion tail crossings by any interplanetary spacecraft including future missions like Solar Orbiter. Tail crossings cannot simply be searched for by looking for times when comets pass between the Sun and spacecraft. The ion tails are carried with the solar wind, and it takes a finite amount of time for the ions to travel from the comet to the detecting instruments. Tail crossings are dependent on the solar wind flow direction, which is not always directly away from the Sun, and on the speed of the solar wind carrying the tail to the spacecraft.

Status: Development started with preliminary [website](#) online.

Future plans: Service to be made operational at <https://www.ucl.ac.uk/mssl/planetary-science/tailcatcher> for PSWS VA1 WP5 before PM 40.

B1. Lunar impacts - ALFIE (ABER)

Aberystwyth University (ABER) is upgrading and converting its [lunar impact software](#) and posting it online in order to enable users to detect visible flashes in lunar amateur or professional images.

Status: Preliminary software available on demand, ongoing developments to develop a GUI

Future plans: Service to be made operational for PSWS VA1 WP5 before PM 40.

B2. Giant planet fireballs – DeTeCt3.1 (UPV/EHU)

The Universidad del Pais Vasco (UPV/EHU) has upgraded and converted its giant planet fireball detection software and posted it online to enable users to detect visible fireballs in giant planet amateur or professional images. This work is done in collaboration with the amateur community, led by Marc Delcroix, Toulouse, France. A software tool will be disseminated through a network of amateur astronomers who will analyse thousands of hours of video observations of Jupiter to detect fireball impacts in Jupiter.

Status (final): Service operational for PSWS VA1 WP5 at:

http://pvol2.ehu.eus/psws/jovian_impacts/

B3. Cometary image analysis software – Solar Windsocks (UCL)

MSSL is upgrading and converting its cometary image analysis software and post it online, with the aim of also providing it as an interactive suite. The software will be readily accessible to any users (professional or amateur) who work with comet images and wish to obtain an estimate for the solar wind speed at the comet from their observations.

Status: Development ongoing, preliminary [website online](#)

Future plans: Service to be made operational at https://www.ucl.ac.uk/mssl/planetary-science/Solar_Windsocks for PSWS VA1 WP5 before PM 40.

Task 5.4 Liaisons (CNRS, SRC PAS)

SRC PAS is illustrating how other programmes can benefit from PSWS outputs by implementing PSWS Alerts in the Polish SSA project HelgeoSSA, which is monitoring Earth's ionosphere and magnetosphere for civilian GPS and radio users:

(<http://helgeossa.cbk.waw.pl/helgeossa/MAIN.html>).

Status: SRC PAS participated in the VESPA implementation workshop, March 27-31 <https://voparis-confluence.obspm.fr/display/VES/VESPA+implementation+workshop+2017> in Graz in order to discuss the setup of a comet server and the content of VOevents related to their own alert service.

Future plans: Alert service to be made operational for PSWS VA1 WP5 before PM 40.

1.2 Impact

The [PSWS portal website](#) has had 14674 visitors between the start of the EPN2020RI project and 30 July 2018. Analytics are being applied to all PSWS tools as they come online. VA1 PSWS plans to announce all operational services to the wider community in December 2018 by PM40 through various newsletters (e.g., SPA, Planetary Exploration Newsletters) and expect the number of users to grow significantly. So far, the Propagation Tool, Heliopropa, Transplanet and DeTeCt3.1 services have been extensively used since they are operational over a longer time period. The number of users for PSWS services varies at the moment between tens (e.g., Transplanet, Magnetodisc) to several hundred (Heliopropa, Propagation Tool, DeTeCt3.1).

VA1 PSWS has been presented at several meetings and workshops, including the Community Coordinated Modeling Center (CCMC) Living With A Star (LWS) Workshop 2017 at Cape Canaveral, EPSC 2017 in Riga, EPSC 2018 in Berlin, and European Space Weather Week 2017 in Oostende.

A topical issue in Journal of Space Weather and Space Climate was agreed with the editor, Jean Lilensten (IPAG/CNRS), following PSWS-related sessions at EPSC 2017 and European Space Weather Week 2017. Guest Editors for the issue will be Nicolas André (CNRS), Andrea Optiz (WIGNER), Romain Maggiolo (BIRA, Belgique), Caitriona Jackman (University of Southampton), Manuel Grande (ABER). A call for papers was issued in January 2018, inviting contributions on methods and tools for prediction or detection of planetary space weather, validation of methods and tools against remarkable solar or meteor events, space weather effects on planetary environments and spacecraft, radiation modelling and effects at planets and spacecraft and modelling of planetary environments and their response to solar disturbances. The deadline for manuscript submission was 15 September 2018.

VA1 in collaboration with NA1 has organised two PSWS workshops during RP2 on:

- [The Sun's influence on planets](#), Toulouse, 9-11 October 2017, attended by 24 participants.
- [Tools and Services for Planetary Observations and Image Analysis by Amateurs](#) organized at Pic du Midi, France, 17-19 July 2018, attended by 16 participants.

The [1D MHD Solar Wind Prediction Tool - Heliopropa](#) service has been proposed and accepted by ESA for inclusion in the ESA SSA programme (Period-E extension, Heliospheric European Science Center). Development work is starting in September 2018. In addition, VA1 PSWS has also contributed through ISSI Beijing to the organization of the [Space Science School](#), "Study Space Weather Effects from the Sun to the Ground", 10-19 October, Sanya, China.

2. Deviations from Annex 1

The following milestone has not yet been reached: M37 PSWS Re-release review, PM 33. It will be reached by PM 40, as some of the services were not able to be fully implemented by PM 33.

2.1 Tasks

Andrea Optiz (WIGNER) is now contributing to Task 5.1 as PSWS VA1 Deputy Lead.

2.2 Use of resources

PSWS VA1 WP5 Person-Months for the time period 01/03/2017-31/08/2018 are summarized and compared to the original proposal covering the time period 01/03/2017-31/08/2018 in the Table below:

Work package number	WP5	Start Date or Starting Event				
Participant number	3	4	12	23	28	33
Short name of participant	UCL	CNRS	ABER	GFI Informatique	UPV/EHU	SRC PAS
Person-month per participant (planned):	0 (1)	0 (3)	0 (12)	0 (6)	0 (2)	0 (12)
Person-month per participant (done):						13,775

3. Update of the data management plan

The PSWS Data Management Plan has been delivered on February 2016. PSWS are compliant where possible with the VESPA Data Management Plan. PSWS datasets and services are accessible and usable through VESPA tools (EPN-TAP, SAMP, VOEvent) as summarized below.

PSWS Services	Type of developments	Use of EPN-TAP	Use of SAMP	Use of VOEvent
Heliopropa	Website+Database+Alerts	yes	Yes	yes
Propagation Tool	Software+Database+Alerts	yes	Yes	no
Meteor showers	Website+Alerts	no	No	yes
Tailcatcher	Software+Alerts	no	No	yes
ALFIE	Software+Database+Alerts	yes	Yes	yes
DeTeCt31.	Software+Database+Alerts	yes	Yes	yes
Solar Windsocks	Software+Database	yes	Yes	no
Transplanet	Runs on request+Database	yes	Yes	no
Radmaree	Runs on request+Database	yes	Yes	no
Magnetodisc	Runs on request+Database	yes	yes	no
Jupiter's thermosphere	Runs on request+Database	yes	yes	no
Alerts	Database+Alerts	yes	no	yes

4. Update of the plan for exploitation and dissemination of result

Dedicated 'Planetary Space Weather Services' sessions at the Joint EPSC-DPS 2019 Meeting in Geneva, and at the 16th European Space Weather Week will be proposed in order to disseminate activities to

scientific users as well as space agencies and industries. A second topical issue in Space Weather and Space Climate-journal will be proposed to publish user manual and science cases for the PSWS services not published in the first issue. A NA1-Task 2 PSWS workshop on Modelling of planetary environments will be organized in 2019 by IRAP, Toulouse, France in order to present PSWS services in particular to space agencies and industries.

The opening of all services will be announced through various newsletters including the [Planetary Exploration Newsletter](#) (PEN).

6. WP6 - VA2: VESPA (Virtual European Solar and Planetary Access)

1.1 Explanation of the work carried out by the beneficiaries and overview of progress

WP6 VA2 “Virtual European Solar and Planetary Access” (VESPA) is a Solar System and Planetary Sciences Virtual Observatory (VO) that:

- provides a web-based portal giving access to remotely distributed data resources using online forms with scientific parameters;
- incorporates a series of standards and interoperable tools that enable users to share data transparently and visualise planetary datasets, derived from different instruments, missions and models, simultaneously, to create a multi-dimensional view of the “planetscapes” under study.

Task 6.1– Coordination

For details of management structure and procedures, see the [First Periodic Report](#). Complete documentation of VA activity is maintained and available on the VESPA public wiki (<https://voparis-confluence.obspm.fr/>); a summarized and more user-friendly version can be reached on the web site (<http://www.europlanet-vespa.eu/>)

Task 6.2- Internal services

The VESPA Virtual Access facility currently has 44 online services as listed in Table 22 below. During RP2 12 new services were open, including the large Planetary Science archive of ESA, and planetary data from the Hubble Space Telescope. A first service provided by another EPN2020-RI WP was installed (Transplanet from PSWS). Older services benefited from regular technical upgrades; some major upgrades involving extra content were also performed. Evolving services/living archives are updated on a weekly or monthly basis, or after release campaigns (AMDA, PVOL...). The complete roadmap for data services, including those from external calls, is maintained on the VESPA wiki: <https://voparis-confluence.obspm.fr/display/VES/EPN-TAP+Services>

In addition, 13 databases of solid spectroscopy are now accessible online in the SSHADE infrastructure, and are being populated – the roadmap is here: <https://wiki.sshade.eu/ssshade/databases>

Table 22-EPN-TAP data services publicly accessible through the VESPA interface and other TAP clients, as of 31/8/2018. External services are highlighted in blue in the 1st column, major updates by (up) in the 2nd column.

#	New / upgraded in RP2	Origin	Name / # of entries
1		IAA/CSIC & ObsParis	abs cs - Data for numerical modeling of planetary atmospheres 13 results
2		CNRS/IRAP	AMDA - CDPD AMDA DataBase 985834 results
3	up	ObsParis	APIS - Auroral Planetary Imaging and Spectroscopy 34871 results
4		ObsParis	BASECOM - The Nancav Cometary Database 15611 results
5	X	ObsParis	BASS2000 - solar survey archive 276689 results
6		ObsParis	BDIP - Base de Données d'Images Planétaires 16906 results
7		IASB-BIRA	BIRA-IASB TAP - Profiles from SPICAV-SOIR/VEx 2672 results
8		CNRS/IRAP	CLIMSO - CLIMSO coronagraphs at Pic du Midi de Bigorre 325448 results
9	up	JacobsUni	CRISM - CRISM data from Earth Server 20722 results
10	up	ObsParis	DvnAstVO - Asteroid orbital database and ephemerides 18353 results
11	up	ObsParis	ExoPlanet - Extrasolar Planets Encyclopaedia 3812 results
12		ObsParis	HFC1AR - Heliophysics Feature Catalog active regions 948627 results
13		ObsParis	HFC1T3 - Heliophysics Feature Catalog type 3 radio bursts 90845 results
14	x	Tohoku & ObsParis	Hisaki - Hisaki Planetary Database 3562 results
15	x	ObsParis & CADC	HST planeto - Planetary data from the Hubble Space Telescope 42647 results
16		Tohoku & ObsParis	litate - litate HF data 3307 results
17		ObsParis	IKS - IR spectroscopy of comet Halley 206 results
18	up	CNRS/IRAP	ILLU67P - Illumination maps of 67P 189000 results
19		IWF	IMPEX EPN20 - IMPEX Simulation Data 1277 results
20		Tohoku & ObsParis	IPRT - IPRT/AMATERAS data 1410 results
21	X	SRC/PAS & ObsParis	lofar jupiter - Jupiter obs. by LOFAR 595 results
22	X	JacobsUni	M3 - Moon Mineralogy Mapper 584 results
23		ObsParis	M4AST - M4AST - Modeling for Asteroids 6414 results
24		JacobsUni	Mars Craters - Martian Impact Craters 384344 results
25	up	LMD & ObsParis	MCD - EPN-TAP access to the Mars Climate Database 3897543 results
26	X	UCL	MDISC - UCL Magnetodisc Model for Jupiter and Saturn 22 results
27		Heidelberg & ObsParis	MPC - Minor Planet Center - Asteroid Orbital Data 781575 results
28		ObsParis	NDA Obs. Database - Nancav Decameter Array observation database 27030 results
29	up	IAPS	ndcs - NASA dust catalogue 3315 results
30	X	IAS-PSUP	omega cubes - L3 Omega Cubes from PSUP 7038 results

31	X	IAS-PSUP	omega maps – Mineralogic maps of Mars from Omega 8 results
32	X	ObsParis	pds speclib - PDS spectral library 2260 results
33		ObsParis	Planets - Main characteristics of solar system planets 8 results
34	X	ESA/ESAC	PSA - ESA Planetary Science Archive 6141347 results
35		UPV/EHU	PVOL 36550 results
36		ObsParis	RadioJOVE - RadioJOVE Data Archive 12 results
37	X	ObsParis	spectro planets - Spectra of planets and satellites 136 results
38	ud	CNRS/LATMOS	SPICAM - SPICAM Mars Atmospheric Vertical Distribution 2302 results
39		ObsParis	Titan - Vertical Profiles in Titan Middle Atmosphere 1430 results
40		ObsParis	TNOsarecool - TNOs are Cool 592 results
41	X	CNRS/IRAP	Transplanet - Magnetosphere Ionosphere coupling simulation runs 346 results
42		JacobsUni	USGS WMS - USGS WMS 55 results
43		IWF	VExMag EPN20 - Venus-Express Magnetometer Data 2278 results
44		ObsParis	VEx - VIRTIS Venus Express nominal mission (demo) 15682 results

Tools using these services are in preparation and progress is reported in WP11 JRA5.

Task 6.3- Enlarging VO contents

An annual call to the community for the inclusion of new services into the VESPA VA is made with the goal of not only increasing the content of the Planetary Science VO but also transferring the VO knowledge to teams, allowing them to develop their services in accord with the infrastructure of the VESPA VA. The second and third VESPA calls for data services took place during RP2. In call #2 (2017), 4 teams were selected but one couldn't attend at the last minute; the workshop was organized by [IWF in Graz](#). One selected service was an assessment for Cassini data at JPL – although the implementation was successful, public data distribution was not retained a priority at JPL. In call #3 (2018), 4 teams were selected for 7 different data services (3 of which are now open, the others being finalized); the workshop was organised [in Prague by IAP](#). The two workshops were open to VESPA participants to work on their projects and some non-VESPA teams also attended, including ESA and SRC/PAS (Warsaw); several existing services were also updated with new content. Both workshops were very efficient and reinforced the community of data providers.



Figure 20- VESPA implementation workshop, Graz 2017 -



Figure 21- VESPA implementation workshop, Prague 2018

Task 6.4- Linking to the amateur community

The amateur community provides valuable data for the planetary science community. These skilled enthusiasts now have access to high-quality equipment, and are able to produce standardised data that complement those generated by professional observatories, filling in gaps in coverage that inevitably result from the competitive scheduling of large telescopes that have to cover the whole spectrum of astronomy and cosmology. For the first time VESPA will provide a forum for incorporating such data into a portal accessible to the wider research community. The initial setup of the RadioJOVE service (with limited data) completed during RP1 has been discussed further with US contributors in spring 2018 to clarify data description requirements. The pre-existing PVOL service, upgraded during RP1, now hosts new amateur data at an increasing rate; VO access was added during RP2, so it now provides powerful search functions to high-quality amateur images. A prototype service in Graz (in collaboration with NA1) allows for amateurs to upload description of their facility and equipment. Regular Amateur Workshops are organized (some with NA1) to engage with the amateur community, to demonstrate the tools developed, and to present plans for future services. Results are also presented in professional conferences, i.e. at DPS 2017 (Provo, Utah, Oct 2017 - International Outer Planets Watch).

Task 6.5- Training

An extensive training programme has been organised by the VESPA team for users and for existing and potential service providers. Nine 3-day meetings to train and support the SSHADE data providers have been hosted during RP2, as well as a first user training session during the 6th European Lunar Symposium in Toulouse, 14-16 May 2018 (35 attendees). Independently, VESPA tutorials for users were held during EGU 2017 and 2018 in Vienna and EPSC 2017 in Riga. VESPA also contributed with demonstrations on the PDS/IPDA booth at COSPAR, Pasadena (July 2018). The Planetary Mapping workshop in Roscoff (see WG11) focused on data access through VESPA and VO-GIS connections.

Task 6.6- Dissemination and sustainability

More than 49 presentations and posters directly related to VESPA were given in conferences during RP2; special sessions dedicated to data distribution systems in Planetary Science have been organized at the EPSC, AGU, JpGU and COSPAR conferences by VESPA contributors. Seven VESPA-related papers were published in a Special issue of Planetary Space Sciences co-edited by a VESPA contributor, two other ones are in press in PSS and Adv Space Sc, and three papers are currently under review for a Special Issue of Earth & Space Science following the VESPA Planetary Mapping Workshop (Roscoff, April 2017) and the LPI Planetary Data Workshop #3 (Flagstaff, June 2017). Several documentations on VESPA standards and practices have also been prepared.

VESPA activities and developments are also advertised on platforms involved in Planetary Science and cartography, including with on-line demos: e.g. <http://openplanetary.org> (mostly professionals with a nerd attitude), <https://cesiumjs.org>, <https://planetcarto.wordpress.com> (both oriented towards modern mapping techniques), etc. VESPA has contributed to and supported the OpenPlanetary Data Cafe session at EPSC 2017.

VESPA has engaged with many stakeholders whose long-term engagement is necessary for sustainability of the VESPA portal. This includes discussions with the IVOA (International Virtual Observatory Alliance) and IPDA (International Planetary Data Alliance, i.e.: space agencies). VESPA representatives are chairing the new Solar System IG and the Registry WG of IVOA. VESPA has developed a strong links with policy makers in France (ASOV, SF2A; the Astronomy Data Centre at Paris Observatory is chaired by a VESPA representative) and worked with the several PDS nodes (plamas, rings, and small bodies in particular). VESPA has also developed a close collaboration with the U.S. Geological Survey (USGS) about Geographic Information Systems (GIS).

1.2 Impact

Five VESPA-related papers from the PSS Special Issue (Jan 2018) are listed among the most downloaded PSS articles (June 2018). The VESPA paper itself has now more than 250 reads on ResearchGate.

The impact of VESPA VA Facility is threefold:

1.2.1- Impact on Planetary Science data archives

The main goal of VESPA VA is to increase the accessibility and standardisation of planetary data. The ultimate goal is to provide some 50 data services by the end of the program and there are already 44 EPN-TAP services open, plus ~15 more being designed / at test level (see Table 22).

VESPA implements data services which can be accessed through a single portal allowing planetary

data to be searched for easily, thanks to uniform data description and to the preparation of several query interfaces developed in the JRA. In addition to the main portal, VESPA has also developed several ways to access EPN-TAP services, either from VO tools or from the command line, for VO-challenged users.

New EPN-TAP data services are implemented through several strategies:

- Direct implementation by VESPA participants; this encompasses recent and historical archives, sometimes related to previous EU programs, or containing derived data related to publications.
- Research team contributions, selected through annual calls (Graz 2017 and Prague 2018 during RP2). In many situations, this relates to archives produced by a local experiment, or extensive derivations of observational datasets.
- Services from the amateur community. Two such services have been identified from the start based on content quality and potential impact: PVOL and RadioJOVE.
- Direct collaborations with large institutes or consortia. This aspect is most relevant for ESA, who have implemented EPN-TAP access on the PSA (6 million files, 30 years of Planetary Science missions in Europe). Interfacing EPN-TAP with PDS4 archives is still an important goal for the coming years, and this is being worked in collaboration with several PDS Nodes. Regular contacts with the Tohoku University resulted in the installation of 3 data services in Japan (radio observations of Jupiter and the Sun, space-borne UV observations of planets). Contacts with the Canadian Astronomy Data Centre (CADDC) led to the installation of the HST planetary archive in Paris. Other contacts exist through IPDA (e.g., with Japanese and Indian space agencies, JAXA and ISRO) or conferences forums (e.g., Chinese space agency CAS/NAOC at AOGS 2016).

1.2.2- Impact on Science applications

Easy access to data archives and reference (lab) data will improve data interpretation. An expected outcome is to speed up the analysis of space borne observations, either archived or on-going.

- An example application is the update of the Martian craters database (supported by VO tools developed at GEOPS) with direct application to dating of terrains. A publication has been submitted.
- VESPA provides easy access to the Mars Climate Database, which will support interpretation of Mars atmospheric observations and has potentially a big impact on current missions, including ExoMars.
- SSHADE has a similarly large potential for surface research, by providing uniform access to experimental spectroscopy of minerals, ices, organics and cosmomaterials (see Task 11.3 in WP11). In addition, SSHADE has the ambition and the potential to become a central coordination place for scientists working in this field.
- The possibility to query the whole PSA at once will enforce the cross-analysis of related data, i.e. imaging and spectroscopic observations on the same body, or in a region of a body. The additional availability of HST planetary data in VESPA makes such comparisons even more powerful.

1.2.3- Impact on participative science & involvement of the amateur community

The two preselected services (PVOL and RadioJOVE) have been implemented and are expected to foster professional-amateur collaboration and exploit the use of high-quality amateur observations by the science community. PVOL, covering the field of planetary imaging, is entirely operational and accepts new submissions; 12 reviewed publications have made use of PVOL amateur data since 2015.

RadioJOVE, covering radio monitoring of Jupiter, is installed and currently includes a limited dataset for test purposes. It is expected to reach full potential during year 4.

In addition, the multiresolution planetary maps computed for Aladin are considered for use by the Stellarium software in the near future.

Some VESPA beneficiaries (UPV/EHU & IWF in particular) participate to amateur-professional meetings on a regular basis, including those organised by NA1. VESPA is also very active on <http://openplanetary.org/> and other media open to enthusiast amateurs, including our own slack: <https://vespa-eqn.slack.com/>

1.3 Statistics

Accesses are monitored in several ways: data services are monitored by AWStats (<https://www.awstats.org>), which is installed on all VESPA data servers; the portal and other web sites are monitored by Matomo (formerly Piwik) (<https://matomo.org>). Data accesses through VO tools and alternative interfaces cannot be monitored independently. A difficulty is to filter housekeeping accesses from science-related ones. In the plots below, internal and technical accesses have been filtered as much as possible.

Figure 22 provides access statistics to the main web sites during the first three years of the programme. The first services were publicly advertised in September 2016, but were already available outside VESPA. The average number of visits to the VESPA portal (Figure 22b) approaches 300 / month, while the number of views oscillates from 500 to 1500. Peaks in the web site plot (Figure 22a) correspond to the implementation workshops (April) and EPSC conferences (Sept or Oct). Most accesses are from the participating countries and the US. Altogether, ~15% of accesses are from North America, and another ~10% from Asia. The number of visits to the wiki site (Figure 22c), which is more technical, probably provides an estimate of the activity from potential data providers (~ 300 unique visits / month).

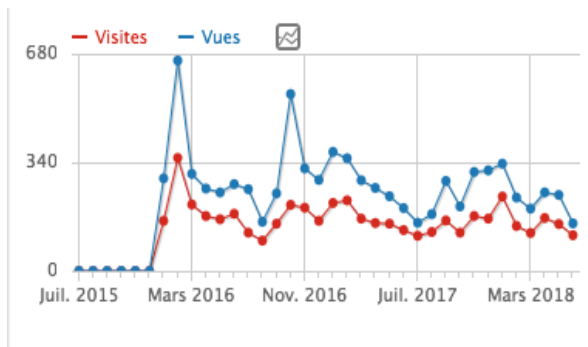
The analysis of accesses to the main server in ObsParis during period 2 suggests that ~ 50% of the requests now originate from the VESPA portal (main search interface), the rest being issued from ESA, NASA, JAXA, AMDA in Toulouse (~10% each, with large monthly variations) from alternative TAP clients (TAPhandle portal in Strasbourg, TOPCAT, EPN-TAP clients in CASSIS and 3Dview, etc). The VESPA portal itself (~ 4000 accesses during this period, Figure 22d) is mainly attended by French users (~ 40%) followed by users in the US (~ 12%), Italy, UK, Japan, then other EU countries.

It must be stressed that these figures represent only a fraction of data services attendance, in particular because the largest services also have non-VO access through a dedicated web site. For instance, the Exoplanets service alone has 30,000 to 40,000 visits / month and is the worldwide reference in its domain.

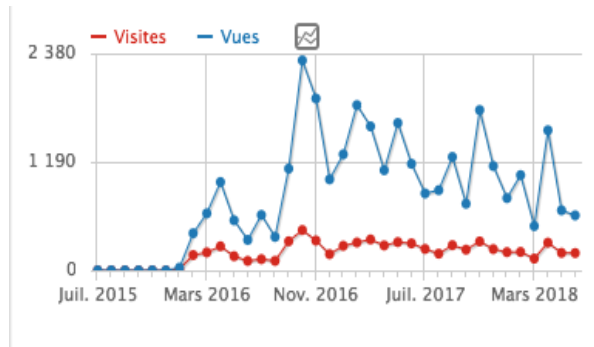
Statistics for SSHADE started on 1st February 2018. External visits already average to 120/month after removal of an estimated 40% bias due to data providers (mostly in France where most training and tutorials occurred). About 70% of accesses are currently from EU, 15% from North America, and 12% from Asia.

At this point the absolute figures are becoming more reliable but are still incomplete and mostly inform on the evolution of VO accesses. However, VESPA has apparently found an audience that is slowly growing with the number of services available, in particular in connection with space agencies. A challenge in the coming years will be to increase the weight of the more flexible VO access, relative to manual operations on the web sites. For this reason, VESPA is now developing very light access

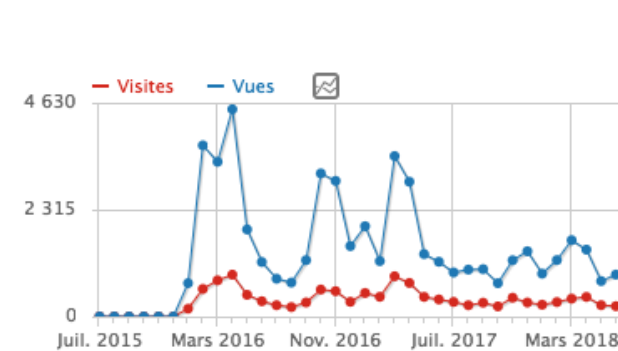
procedures (based on python scripts) for use in pipelines.



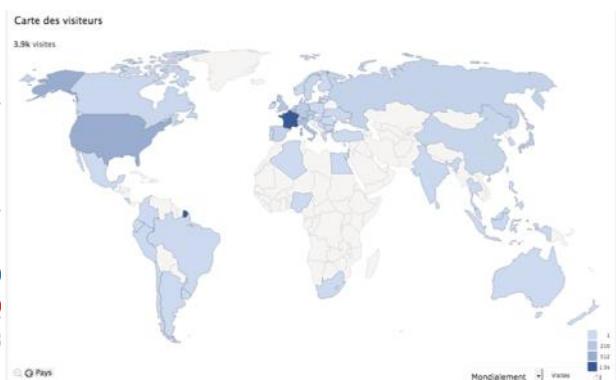
a: Monthly external accesses to public VESPA web site during the first three years



b: Monthly external accesses to the VESPA portal during the first three years



c: Monthly accesses to VESPA wiki / Confluence during the first three years



d: Origin of accesses to the VESPA portal during the second period (April 2017-Aug 2018)

Figure 22- evolution of VO accesses

Review board

1) An external review board has been setup for VESPA at the beginning of the programme. For more details please refer to the submitted [First Periodic report](#).

2) Formal reviews of services are performed automatically whenever possible:

- A monitoring system has been installed during year 2, based on the Nagios software. This sends messages to data providers when a service remains in error for more than several hours.
- An EPN-TAP service validator has been developed and updated during the first two years. It is used to test the outputs of new data services during the setup phase.
- The most efficient way is in fact a manual review performed by the VESPA coordination at the time of implementation, prior to service opening. Additional checks are performed annually to follow the evolution of the protocol and tools.
- Although EPN-TAP data services are declared in the IVOA registry and are visible from most VO tools, the VESPA portal uses additional filtering to control content quality – only certified services are

reachable from there.

3. Update of the data management plan

The VESPA Data Management Plan issued during RP1 (VESPA-003-PL v1.0, dated 14/2/2016) was updated during RP2 (**VESPA-022-PL v2.0, dated 24/8/2017**). It focuses on science data and codes produced in EPN2020-RI. Data services are public, although a proprietary period can apply. Software related to creation or update of data services is accessible in the VESPA Github. Service access information is stored in IVOA registries.

All of the data providers commit to maintain their services for at least 3 years beyond the end of RI. Metadata from the services may be mirrored in the Observatory of Paris and other places in the future for extra backup purposes. Publications related to VESPA activity are available from open repositories (e. g. ArXiv or conference sites).

7. WP 7 - JRA1: Characterisation Lake Tirez and Danakil planetary field analogues

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

The main objective of JRA1 was to prepare two new field analogues, Tirez Lake (Spain) and the Danakil depression (Ethiopia), for TA1 activity in the final two year of the project. Fieldwork was needed to fully characterise the geo-microbiological environment and to determine the feed-back mechanisms between the regional geology, soils, climate and biology and how these mechanisms vary throughout the year. This information was integrated to create a working model of the system as the last objective. RP2 focused on the biodiversity description and genome analyses of the samples.

For details of coordination (Task 7.1) campaigns and sampling procedures, see the [First Periodic Report](#).

Task 7.2: Characterisation of PFA 1 - Tirez Lake (INTA; IRSPS)

Some results from the characterisation of Tirez Lake include:

- **Physico-chemical characterization**

Physico-chemical analysis of sediment cores of Tirez Lake sampled at different depths showed higher sulphide concentrations at 0-10 cm depth. The occurrence and distribution of sulphide along the profile reflects the presence of sulphate-reducing bacteria (SRB) in the hypersaline sediment. The sulphate-reducing prokaryotes (SRP) activity, which was inferred by the concentration of hydrogen sulphide, coincided with the presence of a black deposit of iron sulphide below the surface of the sediment. The sulphate increased with the depth and the concentration ranged from 102 mM, up to a ~300 mM, the latter detected at 10-15 cm. These values are located below the highest concentration zone of sulphide. The entire profile was anoxic (without oxygen). The redox potential and oxygen increased slightly in the deeper zones (15-20 cm in depth). The redox conditions of the majority of the sediments were in the range of -300 and -200 mV, which was enough to allow the presence of sulphate-reducing and Microbial Translocation (MT) processes. The lowest redox potential values were reached at 0-10 cm in depth. The ammonium concentration fluctuated between 1-6 μM . Likewise, the

highest ammonia concentration (4-6 μM) was observed at 10-15 cm in depth. The proportion of chloride to sulfate fluctuated between 0.1 and 0.3, which reflected the inland, saline nature of the system. A dual aerobic vs. anaerobic ecosystem was identified in the surface and subsurface of Lake Tírez.

- **Anaerobic diversity in the hypersaline sediment**

JRA1 applied Denaturing Gradient Gel Electrophoresis (DGGE) and phylogenetic analyses to identify genetically and unambiguously microbial samples from Tírez Lake.

Several phylotypes were characterised but analyses revealed a low diversity of sulphate-reducing prokaryotes (SRP), sulphur-oxidizing prokaryotes (SOP) and Methanogenic Archaea (MA), which agrees with the fact that the diversity of the three domains of life decreases in extreme hypersaline communities. Nevertheless, Tírez, as in other hypersaline environments, supports the presence of low energetic anaerobic metabolisms such as the extreme halophiles fermenters from the Halanerobiales group, which ferment organic compounds to produce volatile fatty acids (VFA), such as acetate and H_2 .

- **Microbial diversity in Tírez Lake**

Analyses of samples indicated genera phylotypes that had not previously been reported in this kind of inland saline environments, although they have been reported in other environments that have been more extensively studied (e.g. seawater sediments and soda lakes)

Task 7.3: Characterisation of PFA 2 - Danakil Depression (Ethiopia) (IRSPS; INTA-CAB)

Some results from the characterisation of the Danakil Depression include:

- **Atmospheric measurements**

Weather conditions in the area were found to be very restrictive since the temperature is very high and rain precipitation is low. Air temperature, velocity and direction were very stable at different days.

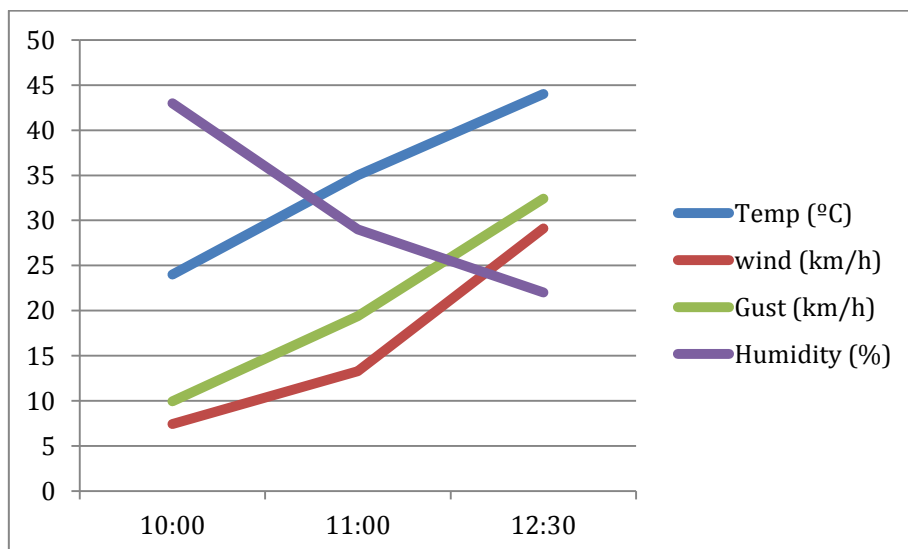


Figure 23- Graphic representation of several days means values of temperature of humidity, air temperature, wind velocity and gust intensity during the second JRA1 campaign to Danakil in January 2017.

- **Physico-chemical parameters of the extreme environment**

Physico-chemical parameters of the water samples were found to be very extreme, with pH values of 0.5 and 1. Temperature of water at one of the sampling areas (D8) water was measured at 86°C, which means that the possible natural bacteria population in this ecosystem would be thermophile.

- **Microbial diversity**

Samples from Dallol were carried out to the laboratory for further analyses. Initial analysis indicated that, in spite of the very extreme conditions microbial life is present at Dallol. Further analyses are necessary in order to identify the microbial diversity. Results will be published in scientific journals.

1.2 Impact

Both the Lake Tírez and Danakil Depression sites were validated as Earth analogues and delivered to TA1 for external users visits in time for the third TA Call. The two sites make a significant extension to the range of planetary analogue facilities offered through the TA1 programme and are of particular value for the community with the upcoming focus for international planetary exploration missions on Mars and moons of the giant outer planets.

The saline environments at Lake Tírez provide potential new constraints for astrobiology studies in the context of Mars and Europa. Tírez lake is also an ideal environment for testing new techniques, protocols and instrumentation for future space missions to examine potential habitability of salty environments.

The rare nature of Danakil and its adjacent areas will provide a natural and complex analogue for extreme planetary environments linked to (transient) lakes and hydrothermal vents, the latter representing analogues of Venus, Io, Ganymede and other satellites where water is pumped to the surface in tectonically active settings. Sulphate deposits in the region also appear to have direct analogues to sulphate deposits on Mars. This site will also allow researchers to study acidophiles under very low pH conditions and desiccation processes probably related with salt deposition and stromatolites formation.

Two teams visited Lake Tírez and five teams visited the Danakil site during RP2 (see WP3 for details and results).

The second JRA1 field trip to the Danakil Depression was featured in the National Geographic series, One Strange Rock, which premiered globally on National Geographic in March 2018 in 172 countries and 43 languages (see WP13).

4.2.1 Unforeseen subcontracting

During the field study of Tírez several analyses were needed, requiring resources outside Centro de Astrobiología (CAB-INTA). In particular, in order to characterise the biodiversity of Tírez lake, a partial sequencing of 16/18 S rDNA was needed and done through SIDI (an external service of the Autònoma University). Similarly, some analysis was needed of rock samples from the last external users visit to Tírez, so the analysis of the composition and mineralogy of some samples was done through the X-ray diffraction service at SIDI (Autònoma University).

8. WP8: JRA2 - Implementation of New Spectroscopic and Simulator capabilities

1.1 Explanation of the work carried out by the beneficiaries and overview of progress

The main objective of JRA2 was to improve experimental capabilities relevant to the planning and implementation phases of forthcoming missions to Mercury, Mars, asteroids and the icy moons of Jupiter. This WP has:

- Introduced new high-speed imaging techniques, air cooling system and a UV LED solar simulator to the Aarhus University Planetary Simulator Facility to enable the quantitative study of planetary dust and sand transport processes.
- Extended the spectral coverage offered in TA2 (DLR and CNRS-IPAG) and provided capabilities for measurements under extreme conditions pertinent to planetary surfaces and for measurements small and rare samples.

Task 8.1: Coordination (DLR; AU; IPAG)

For details of JRA2 Coordination (Task 8.1), see the [first periodic report](#).

Task 8.2: New capabilities for Aarhus Planetary Environment Facility

The aim of JRA2 Task 8.2 was to design, install and test three large-scale technological improvements into the Aarhus Planetary Environment Facility (APEF):

- a Particle Image Velocimetry (PIV) system, comprising a high speed camera and laser sheet systems
- an air cooling system
- an LED based (far) UV solar simulator.

All these improvements were completed by the end of RP1. For details, see the [First Periodic Report](#) and the Commissioning Report for Aarhus Planetary Environment Facility: http://www.europlanet-2020-ri.eu/sites/open.ac.uk.europlanet/files/ePN2020ri_d8.1.pdf

Task 8.3: Expansion of spectral range for high temperature measurements (DLR, LESIA, University Padua)

The goal of EPN2020-RI JRA2 Task 8.3 was to extend the spectral coverage for high temperature measurements down to 0.7 μm at the Planetary Spectroscopy Laboratory (PSL) at DLR. This extension offers the community – for the first time – access to spectra obtained in emission, covering the spectral range from 0.7 to 1.2 μm (and beyond) and obtained at typical Venus surface temperatures of 460°C. These improvements were all completed in RP1. For full details, see the [First Periodic Report](#) and the Commissioning Report for High Temperature Measurements: http://www.europlanet-2020-ri.eu/sites/open.ac.uk.europlanet/files/ePN2020ri_d8.2.pdf

Task 8.4: Development of a micro spectro-gonio radiometer for small and dark materials at low temperatures

The objective of Task 8.4 was to further expand the spectral range of a new spectro-gonio radiometer called SHADOWS with a radical new design. This will allow far greater sensitivity and the capability to analyse small (sub-centimetre) sample sizes at low temperatures, i.e. samples from space such as meteorites, analogues of cometary and asteroid material and interplanetary dust particles.

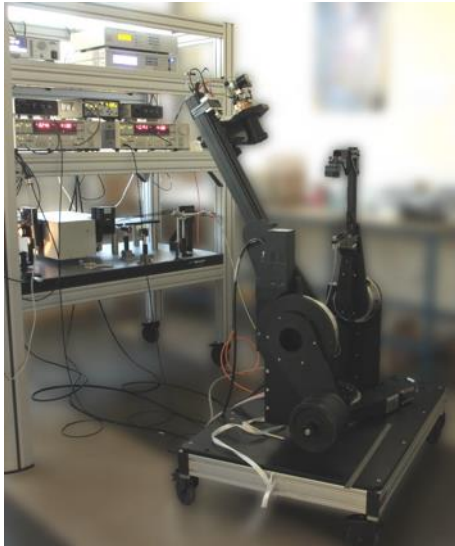


Figure 24- Picture of the SHADOWS instrument, showing all instrumentation and goniometer parts

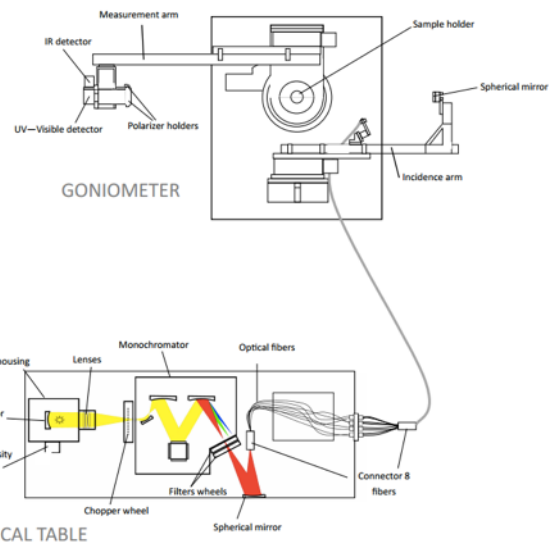


Figure 25- Complete instrument scheme showing the optical table where the monochromatic light is generated and the goniometer acquiring the spectra (see Fig.16).

The majority of this task was completed in RP1. In RP2, the following activities were carried out:

- **Optimising the spectral range extension (completed Month 19)**

The question of the NIR-IR spectral range involves a trade-off between the scientific objectives only achievable at high wavelengths (typically in the 3.5-5 μ m range), the S/N of the measurements over the remaining range, and the cost and complexity of the system. Diminishing the maximum wavelength reduces the thermal infrared contribution in the background signal and thus the noise of the detector with, as a result, an increase of the S/N over the remaining spectral NIR range of the detector. Cutting the wavelength range below about 4.3 μ m would have very significant impact on the science that could be achieved, in particular limitations on the study of minerals, water in minerals and organics and that of the organics themselves. For these reasons, the widest spectral range possible was selected, i.e., up to at least 4.8 μ m (as for the current goniometer) or reaching 5 μ m with still good S/N using a miniature cryocooled detector.

- **Selection of challenging samples (Completed Month 23)**

Several discussions and meetings occurred in Grenoble, Paris, Wroclaw and Krakow with the members of the expert's consortium (SRC-PAS; INAF; CNRS-IAS) to define the set of challenging samples (mostly very dark or precious) and reference samples (well characterised) to be delivered to IPAG for the testing of the prototype, calibration and validation of the final instrument. To test the performances of the instrument over and beyond its expected range of operation, and illustrate the quality of the spectra in terms of spectral range and resolution, each member of the expert team (CNRS - IPAG, IGS-PAS, CNRS-IAS, IAPS) selected a set of typical and challenging samples. The samples were presented a partner meeting held in Grenoble in July 2017. A subset of a dozen of the most interesting of them were chosen to test the instrument, including:

Natural samples:

- Calcite (CaCO₃)
- Basalts (from Udokan and Ogade)
- Lava (San Bartolo, Montiferru/Bonarcado)
- Chondrite meteorite (type CM)

- Irradiated Allende meteorite (with 40 keV He⁺ and Ar⁺ ions)
- Clays: Ca-SCa-3 and TMA-SCa-3 (Clay Mineral Database)
- Limestone (Mt Ernici)

Artificial samples:

- Dark Spectralon© 5% calibrated reference (LabSphere™)
- Metal Velvet© (Acktar™)
- Spectral Black© (Acktar™)
- VANTABLACK© aligned carbon nanotubes (VBS1004)
- Aeroglaze© paint Z306 & Z307

Conclusions on delivery (Month 24)

The whole expected performances of the system in terms of spectral range, illumination/observation geometries, Signal-to-Noise and photometric accuracy were met in the nominal conditions and in several cases exceeded expectations (S/N in the NIR, lowest detectable reflectance). In particular the main improvements relative to the current SHINE spectro-gonio radiometer are:

- Minimum measurable reflectance: < 0.0003 (target was: < 0.01, SHINE: > 0.2 or much longer time below)
- Gain in S/N by a factor: > 60 in visible, > 250 in NIR (target was: > 25, relative to SHINE)
- Minimum volume of sample: < 1 mm³ (target was: < a few mm³, SHINE: > 0.5 cm³)
- Control/acquisition software: much improved versatility of the modes of acquisition, parameter choices and results display

Absolute photometric accuracy is met down to 1% reflectance. For lower reflectance of the surface a proper calibration of some non-linearity and offset will be needed.

Given the very high S/N ratio in the nominal conditions (up to 10000 and > 200 over the 400-4200 nm range) even for samples with albedo as low as 5-10% it will be possible to optimize the measurement parameters in some wavelength ranges, depending on the spectral properties of the sample, in order to reduce by a large factor (> 3, up to 10) the acquisition time and thus further increase the number of wavelengths or geometries that can be measured within one day for a spectral BRDF 4D-cube.

The whole SHADOWS instrument, tested and calibrated in its nominal operating mode, was delivered in Month 24. For full details, see the Commissioning report for Development of micro spectro-gonio radiometer:

http://www.europlanet-2020-ri.eu/sites/open.ac.uk.europlanet/files/ePN2020ri_d8.3.pdf

1.2 Impact

The expanded capabilities offered in years 3 & 4 of EPN2020-RI will allow more quantitative interpretations of planetary mission observations through better-calibrated analogue experiments and measurements made at more pertinent conditions. The upgraded capabilities of have been presented at several meetings and workshops, including LPSC 2017, EPSC 2017 and EPSC 2018.

The new capabilities at the Aarhus Planetary Environment Facility will enhance our understanding of physical parameters and processes controlling the Martian surface and atmosphere and dust-sand transport, as well as providing capabilities which will be relevant to other planetary bodies and comparative planetology, volcanology and Earth's upper atmosphere. This has already been demonstrated by TA visits (e.g. 15-EPN-003 that investigated gas-particle and particle-particle interactions in volcanic eruptions occurring on Earth and in non-terrestrial environments). For industrial testing (e.g. Mars missions and meteorology sensors) these new capabilities are already in urgent demand by users.

The development of a collection of a spectral library for rocks and minerals under Venus conditions at the DLR Planetary Emissivity Laboratory will be key in understanding and modelling differences in emissivity between ambient and Venus conditions, potentially enabling calibration transfer between datasets. With the ESA EnVision mission among the ESA M5 candidates and at least 3 Venus-related proposals in the NASA New Frontiers selection, the impact of these measurements will be extremely high. A [press release](#) on the upgrades to the PEL facility was issued in collaboration with NA2 in February 2018 (for details of coverage, see Table 24).

The new micro Spectro-Gonio Radiometer will allow far greater sensitivity and the capability to analyse analogue comet/asteroid materials or samples from space that are mostly very dark or precious. Details of the SHADOWS micro spectro-gonio radiometer are publicized through the Cold Surfaces Spectroscopy web site (<https://cold-spectro.sshade.eu/micro-spectro-gonio-radiometer/>).

All three facilities have had successful proposals under the fourth TA Call. The publications of completed studies will lead to peer reviewed publications that will be linked to articles in the popular press.

2. Update of the plan for exploitation and dissemination of results

All aspects of the project were completed in the prescribed 24 months. The newly developed capabilities were available for the fourth TA call, as planned and all new capabilities will be used in selected proposals. We envisage improvement to all three facilities will continue to be developed beyond the end of the EPN2020-RI project, based on the feedback from the first users with Europlanet. Hence the end of the RI will not represent the end of the development work. The new facilities developed in the JRA and made available to TA applicants are expected to be used mainly by planetary scientists in an academic context. However, the two spectroscopic and the environmental chambers offer major improvements that are expected to be utilised by industry involved in planetary missions.

9. WP9 - JRA3: Optimal planetary sample handling, investigation and analysis

The principle objectives of JRA 3 were to improve capabilities for the optimal handling and characterisation of material from sample return missions and extra-terrestrial material such as meteorites. JRA3 had three overarching aims:

- to determine to what extent samples can be characterised using no preparation at all (e.g. using computed tomography, scanning electron microscopy, electron microprobe etc);
- develop novel preparation techniques that lower sample loss;
- make key developments in mass spectrometry to optimise isotopic analysis of small samples.

Task 9.1: Coordination

For details of coordination and personnel, please refer to the [First Periodic Report](#). JRA 3 successfully achieved most of its objectives in RP1, as detailed in the First Periodic Report.

Task 9.2: Development of analysis of pristine samples; no sample preparation (lead Sara Russell: NHM; All JRA Team) and

Task 9.3: Development of sample preparation for analytical geochemistry with minimal mass loss (leads Sara Russell (NHM) and Gareth Davies (VUA); JRA Team: Albert Galy, Etienne Deloule, Laurie Reisberg (CRPG); Ian Franchi (OU))

Tasks 9.2 and 9.3 are intimately linked and in some cases involve iterative approaches to optimise the minimal amount of material used. To avoid repetition, the two tasks are dealt with together. NHM led the development of sample characterisation and analysis utilising no or minimal sample preparation but the JRA included input from all four partners. 3D image data from Computed Tomography (CT) scanning were evaluated using primitive chondritic meteorites, comparing outputs from the laboratory CT scanner at NHM with information gained from synchrotron CT scanning at the SPring-8 facility in Japan. 3D data were also compared with 2D data acquired from electron microscope analyses. In parallel, a study of Energy Dispersive X-Ray (EDX) element maps used scanning electron microscopy (SEM) on conventionally polished and carbon coated samples and quantitatively compared the data with that acquired on unprepared chips.

The improved capabilities of the JRA work have been offered in the third TA call during RP2. An example of the type of sample characterisation is shown below for the Barwell Meteorite (Figure 26), which was subsequently sampled and analysed for W-Hf isotopes (see WP4-TA3 Case Study).

An additional approach was successfully developed by the VU team. An Electron Microprobe technique has been formulated that requires no sample preparation other than carbon coating. Samples are aligned with surfaces perpendicular to the electron beam. Advice on how to validate data quality have also been developed.

Task 9.4: Validation of analytical methodologies for the use of 10^{13} Ohm resistors in state-of-the-art analytical instrumentation (VUA; CNRS-CRPG; OU; ThermoFisher; CAMECA)

The VU, OU and CRPG evaluated the performance of newly developed high Ohmic resistors to conduct isotopic analysis of smaller samples.

In RP1, the precision achieved represented a significant improvement (around a factor of 2) over conventional 10^{11} Ohm amplifiers and offers the ability to avoid the use of secondary electron multipliers that are prone to drift. The collaboration between Europlanet partners and industry has continued in RP2 and led to additional improvements in precision. The improved capability has been offered and used in TA calls.

Different measurement scenarios were evaluated in detail by the OU NanoSIMS team. The very high precision sought in this work is a requirement for exploring most planetary types of processes, especially those at high temperature, where the magnitude of isotopic effects are usually very small. Hence it must be stated that although significant improvements were delivered within the timescale of the JRA, continued collaboration with industrial partners is expected to lead to on-going improvements in analytical precision for the next 3-5 years.

High resistance amplifiers (10^{13} Ohm) have been applied to TIMS at both VUA and CRPG and Multi-Collector Induced Coupled Plasma Mass Spectrometry (MC-ICPMS). The first TA application to use the high resistance amplifiers was approved and carried out as part of the second TA call, ahead of schedule (16-EPN2-009: Analogues of the mantles of rocky solar system planets: Petrogenetic processes in lithospheric sulphides). Data generated were presented at the recent the Goldschmidt conference 2017 and will be the basis of a manuscript that is in preparation.

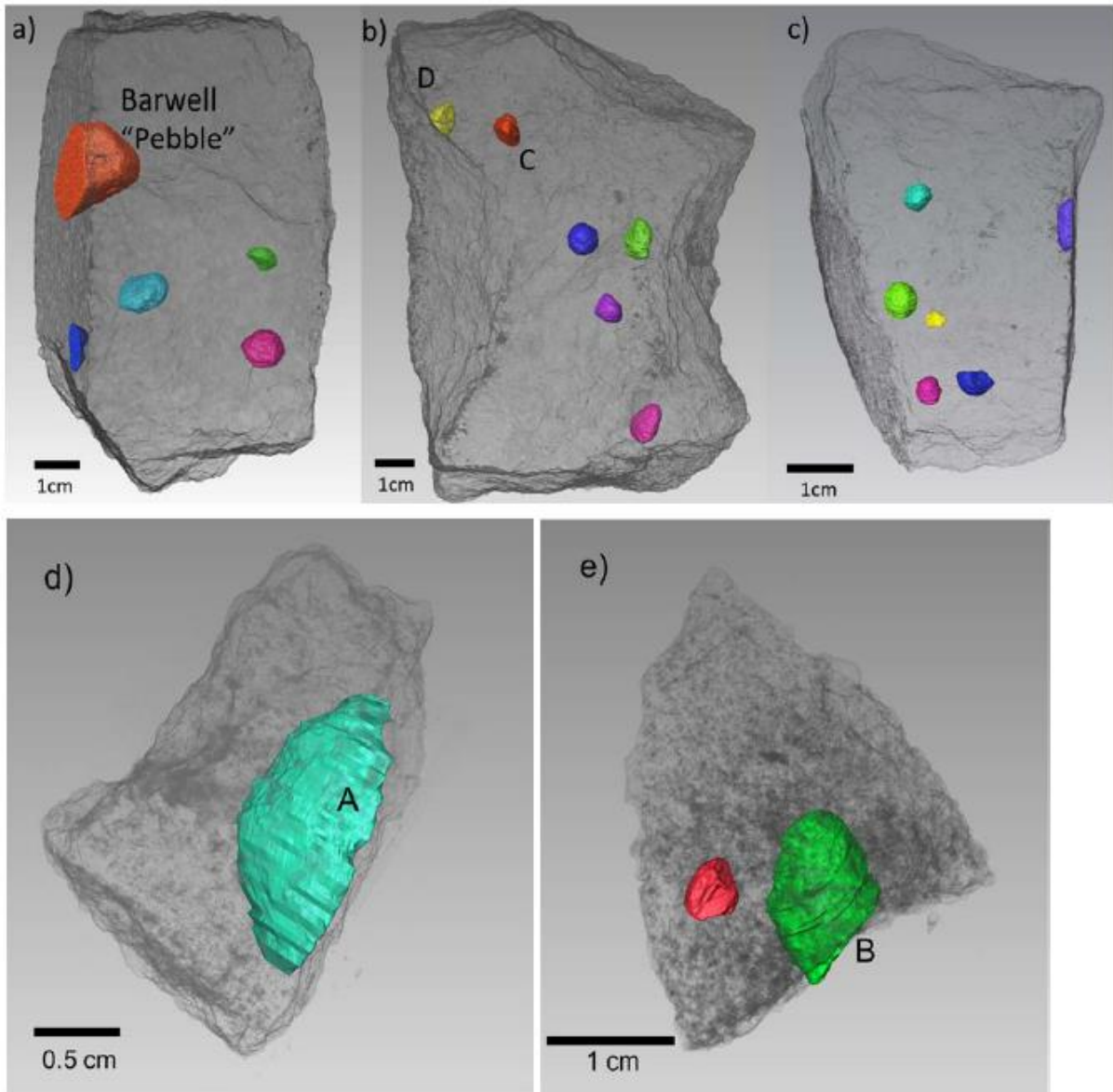


Figure 26- Visualisations of X-ray computed tomography data of segmented inclusion in: (a) BM.1966,59, The 'Pebble' sample, 232.7 g; (b) BM.1966,59, 441 g – which was later subsampled and inclusions C and D were extracted; (c) BM.1966,58b, 203 g; (d) BM.1986, M68, 2.286 g – from which inclusion A was extracted; (e) BM.1986, M68, 9.961 g – from which inclusion B was extracted.

Applications to use the improved capabilities were made by the community in TA call 3 and 4 but not approved by the peer review process.

1.2 Impact

Improved methodologies and analytical capabilities were delivered to TA2 and TA 3 facilities and offered in subsequent TA calls. There have been at least 8 TA applications from the community to make use of the improved capabilities (not all approved by the peer review process).

We envisage improvement to the SIMS and NanoSIMS methodologies will continue to be developed beyond the end of the EPN-2020-RI project, within currently running non-disclosure agreements. Hence the end of the RI will not represent the end of the development work.

The importance of the work undertaken within JRA 3 was emphasised by the involvement of two industrial partners. After the initial success of the work with 10^{13} Ohm high resistance amplifiers, ThermoFisher (one of the largest international mass spectrometer manufacturers) contributed equipment with a commercial value of > € 60k (including BTW). The consequence of the donation is that a significant amount of expenditure on equipment and consumables were not required, saving part of the JRA budget that will be re-allocated elsewhere in the project.

There were several presentations at workshops, conferences and seminars before the end of the JRA, and there have been many subsequent contributions e.g. the JAXA Hayabusa Symposium 2016, the 48th Lunar and Planetary Science Conference in Houston in March 2017, the European Geoscience Union General Assembly in Vienna in April 2017, and the Geochemical Society's Goldschmidt meeting in Paris, August 2017. A second paper applying techniques developed through JRA2 was published during RP2 in a high impact journal (Koornneef et al., 2017) and reported analysis of small mineral inclusions extracted from diamonds and initially analysed without sample preparation. The publication also reported isotopic data (D9.3) highlighting the potential for synergy through combining the different techniques developed within the JRA. The publication was the subject of a press release (see WP13 for details) and the lead researcher participated in a live Europlanet Webinar with schools and teachers.

Additional publications applying the technique to single melt inclusions in olivine grains have been accepted in a high impact journal and will be published in the near future (Geochemical Perspectives Letters). The success of the development work is being disseminated to the planetary science community through presentations at international meetings, with an emphasis on promoting the new capabilities within the TA. The turnaround times of submission to publication are typically 6-9 months, thus the significant impact from peer reviewed publications is expected to expand over the next 2-3 years (see online portal for details of publications to date).

Perhaps the most gratifying aspects of the success of the development work has been the direct impact on applications outside the direct field of Planetary Science. The application of the new techniques to the study of diamonds for example has had major press coverage (Table 24) and led to several presentations at conferences (e.g. EGU, Goldschmidt 2017/2018 and the quadrennial International Kimberlite Conference in Botswana, October 2017).

There has also been direct impact outside the traditional disciplines that use analytical scientific methods. The ability to analyse smaller samples has already led to new developments in art (e.g. a posters on new applications of isotopic analysis of small quantities of oil paint were presented at TechNart Bilbao, May 2017 and Gordon Conference, Scientific Methods in Cultural Heritage Research, Barcelona July 2018) and archaeology (e.g. an application for the provenance of jade artefacts in the context of changing archaeological trading networks will be presented at the 27th Congress of the International Association for Caribbean Archaeology in St Croix, July 2017 the European archaeological association meeting in August/September in Maastricht, 2017). See Table 24 for full details. Dr Joanna Ostapkowicz (Research Associate in Caribbean Archaeology, School of Archaeology, University of Oxford) has obtained a grant from the Arts & Humanities Research Council of the UK ~ 0.4M Euro to work with Professor Davies' team at the VUA to apply micro-analytical techniques to museum quality artefacts to determine their place of origin (provenance). Initial results were presented at the annual meeting of the society of American archaeologists in Washington, April 2018.

Overall the activities outlined above and in Table 24 suggest that the JRA will leave a major mark and a firm legacy felt more broadly than in Planetary Science. This conclusion is supported by the fact that

two studies concerning climate change were published at the end of 2016 that made use of the newly developed techniques (Aarons et al., 2016, Earth and Planetary Science Letters, Chemical Geology). Although not directly attributed to EPN2020-RI funding, these proof of concept studies appeared in journals with high impact and stress that the JRA developments may have applications in scientific fields far wider than initially anticipated.

2. Update of the plan for exploitation and dissemination of results

The high number of presentations made associated with the initial development work of the JRA and the publications in high impact journals has already made significant impact with dissemination of the results to the popular press. A similar strategy will be followed as the new capabilities are used by future TA users. In particular the analysis of meteorite material is expected to have a major impact within planetary science. The spin-offs of the work outside the discipline is already evident, with projects funded to study museum grade archaeological artefacts and collaborations with climate scientists and art historians. Potential applications in forensic science are also being explored with the Netherlands Forensic Institute, recognised internationally as one of the leading forensic institutes.

10. WP10- JRA4: PSWS (Planetary Space Weather Service)

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

The Planetary Space Weather Services (PSWS) aims to extend the concept of space weather to other planets in our Solar System and in particular, to spacecraft that voyage through it. The overall objectives of JRA4 are to review, test, improve, and adapt methods and tools available to make prototype planetary event and space weather services operational in Europe at the end of the programme. For full details of services, see the [First Periodic Report](#).

The JRA3 has developed 12 services distributed over 4 different service domains – A. Prediction, B. Detection, C. Modelling, D. Alerts. These are sub-divided as follows:

- A1. 1D MHD Solar Wind Prediction Tool – HELIOPROPA (Task 10.2)
- A2. Propagation Tool
- A3. Meteor showers (Task 10.3)
- A4. Cometary tail crossings – TAILCATCHER
- B1. Lunar impacts - ALFIE
- B2. Giant planet fireballs – DeTeCt3.1
- B3. Cometary tails – SOLAR WINDSOCKS
- C1. Earth, Mars, Venus, Jupiter Magneto/Ionosphere coupling- TRANSPLANET (Task 10.2)
- C2. Mars radiation environment – RADMAREE (Task 10.4)
- C3. Giant planet magnetodiscs – MAGNETODISC (Task 10.2)
- C4. Jupiter’s thermosphere (Task 10.2)
- D. Alerts (Task 10.5)

Task 10.1 Coordination (CNRS, UCL, ABER)

Nicholas Achilleos (UCL) now also contributes to Task 10.1 as PSWS JRA4 Deputy Lead. For further details of WP10 Management structure and personnel, see the [First Periodic Report](#). Several coordination meetings have taken place during RP2:

- Task 1 Coordination meeting at EPSC in Riga (ABER, CNRS), 19 September 2017
- Task 2 meeting on the C3. MAGNETODISC and C4. Jupiter's thermosphere service in Toulouse (CNRS, UCL), 18 April 2018
- Task 3 and Task 4 meeting during the NA1-Task 1-PSWS workshop on Sun's influence on planets, Toulouse (CNRS, WIGNER, IAP) 10 October 2017
- Task 4 meeting on the RADMAREE service in Noordwijk (ABER, CNRS), 28 February 2018
- Task 5 Coordination and Liaisons meeting at ESWW in Oostende (ABER, CNRS, WIGNER), 27 November 2017
- Task 5 VO event definition, Riga, 10 October 2017 (CNRS, OBSPARIS)
- Task 5 VO event definition, Prague, 30 March 2017 (CNRS, OBSPARIS, SRC PAS)

Task 10.2 Adapting available tools and methods for planetary space weather (UCL, CNRS)

Several PSWS tools have been successfully launched in WP5-VA1: PSWS (Planetary Space Weather Services). Below we will discuss progress on the tools as they are developed for the VA.

A1. 1D MHD Solar Wind Prediction Tool – HELIOPROPA (CNRS)

The Centre de Données de Physique des Plasmas (CDPP) within the Institut de Recherche en Astrophysique et Planétologie (IRAP/CNRS) provide real time and archive access to propagated solar wind parameters at various planetary bodies (Mercury, Venus, Mars, Jupiter, Saturn, comets,...) and spacecraft (Rosetta, Juno, Maven,...) using a 1D magnetohydrodynamic (MHD) code available through the CDPP/AMDA tool (<http://amda.cdpp.eu>) initially developed by Chihiro Tao (Tao et al., 2005).

Status: Service fully operational through a dedicated web-tool at <http://heliopropa.irap.omp.eu> for PSWS VA1 WP5. Reference manuscript describing the service submitted to the Planetary Space Weather topical issue of the Journal of Space Weather and Space Climate (SWSC).

Future plans: Linkages of HELIOPROPA with the C3. Giant planet magnetodiscs – MAGNETODISC (UCL, CNRS) and C4. Jupiter's thermosphere (UCL) being developed; Linkages of HELIOPROPA with catalogues from the FP7-HELICATS (<https://www.helcats-fp7.eu/>) project being developed; Inclusion of the HELIOPROPA service into the ESA Space Situation Awareness Space Weather (Period-E extension, Heliospheric European Science Center) being developed, starting in September 2018.

C1. Earth, Mars, Venus, Jupiter Magneto/Ionosphere coupling – TRANSPLANET (CNRS)

CDPP within IRAP/CNRS provide an online version of the hybrid-fluid TRANSPLANET ionospheric model (Marchaudon and Blelly, 2015) that will enable users to make runs on request for Venus, Earth, Mars, and Jupiter.

Status (final): Service fully operational through a dedicated web-tool at <http://transplanet.irap.omp.eu> for PSWS VA1 WP5. Reference manuscript describing the service submitted to Planetary and Space Sciences.

C3. Giant planet magnetodiscs – MAGNETODISC (UCL)

UCL with the help of CNRS provide a parametric magnetodisc model for Jupiter and Saturn and their space environments.

Status: Service fully operational through a dedicated web-tool at <http://magnetodisc.irap.omp.eu> for PSWS VA1 WP5. Reference manuscript describing the service submitted to the Planetary Space

Weather topical issue of the Journal of Space Weather and Space Climate (SWSC).

Future plans: Linkages of MAGNETODISC with HELIOPROPA in order to take into account realistic, rapid solar wind compressions, based on time-dependent predictions of dynamic pressure from predictions of the solar wind parameters at Jupiter or Saturn orbit.

C4. Jupiter's thermosphere (UCL)

UCL is adapting the 2D thermospheric models available for Jupiter and its space environment in order to take into account realistic, rapid solar wind compressions, based on time-dependent predictions of dynamic pressure from the HELIOPROPA service and/or observations of the solar wind at Jupiter orbit. The service is directly included within HELIOPROPA.

Status: Development started in the HELIOPROPA service in order to include model outputs based on time-dependent predictions of dynamic pressure from predictions of the solar wind parameters at Jupiter orbit.

Task 10.3 Enabling planetary event prediction/ensuring reliability of services (Wigner, OBSPARIS)

A3. Meteor showers (OBSPARIS)

OBSPARIS is linking ephemeris of Solar System objects to predictable meteor showers that impact terrestrial planet surfaces or giant planet atmospheres.

Status: Prototyped service available internally and tested.

Future plans: Service of meteor showers ephemeris to be run automatically and made operational by OBSPARIS. In addition, WIGNER has tested space weather connections in the Solar System in order to assess and quantify the reliability of some of the services developed (A1. 1D MHD Solar Wind Prediction Tool – HELIOPROPA and A2. Propagation Tool) developed by CNRS and GFI Informatique. Test results have been submitted to the Planetary Space Weather topical issue of the Journal of Space Weather and Space Climate (SWSC).

Task 10.4 Testing space weather connections in the Solar System (IAP, DLR, ABER, Wigner RCP)

IAP and Wigner RCP coordinated their approach for validating the existing space weather models and tools. Due to the continuous data coverage at L1, IAP is testing the propagation of ICMEs between Mercury and L1 with the A1. 1D MHD Solar Wind Prediction Tool – HELIOPROPA and A2. Propagation Tool developed by CNRS and GFI Informatique. Test results have been submitted to the Planetary Space Weather topical issue of the Journal of Space Weather and Space Climate (SWSC).

C2. Mars Radiation Environment – RADMAREE (ABER, DLR, CNRS)

ABER together with the Institute of Aerospace Medicine (DLR Cologne) and support from CNRS developed a Mars radiation surface environment model, using modelled average conditions synthesised into look-up tables parameterized to variable solar wind conditions at Mars by Jingnan Guo (Guo et al., 2015).

Status: Service fully operational through a dedicated web-tool at <http://radmaree.irap.omp.eu> for PSWS VA1 WP5. Reference manuscript describing the service submitted to the Planetary Space Weather topical issue of the Journal of Space Weather and Space Climate (SWSC).

Task 10.5 Alert Service (OBSPARIS, UCL, CNRS, SRC PAS)

D: Alerts (OBSPARIS, SRC PAS, CNRS)

OBSPARIS together with UCL, IRAP/CNRS, and PAS/SRC are creating an Alert service linked to the planetary meteor shower and planetary space weather predictions based on the use of VOEvent (White et al., 2006). This service is developed in order to facilitate discovery or make predictions within the PSWS user community, in order to watch or warn against specific events. The ultimate objective is to set up dedicated observation campaigns, distribute contextual information for science data analysis, and enable safety operations of planet-orbiting spacecraft against the risks of impacts from meteors or solar wind disturbances.

Status: Service operational for planetary space weather predictions through a dedicated web-tool at CNRS at <http://alerts-psws.irap.omp.eu> for PSWS VA1 WP5. Interfaces for user subscription for giant planet fireball, lunar impacts, and cometary tail event operational at CNRS at <http://alerts-psws.irap.omp.eu> for PSWS VA1 WP5. Reference manuscript describing the service submitted to the Planetary Space Weather topical issue of the Journal of Space Weather and Space Climate (SWSC). VOEvent and Comet server deployed at partner institutes (OBSPARIS, SRC PAS).

Future plans: VOEvent Alert contents to be defined and implemented at OBSPARIS and SRC PAS; Interfaces for user subscription to be developed and made operational at OBSPARIS and SRC PAS.

1.2 Impact

All tools are on track to be delivered to VA1 by Project Month 40. For details of impact for users of PSWS, see VA1 WP5 report.

2. Update of the plan for exploitation and dissemination of result

See PSWS VA1 WP5 report.

3. Update of the data management plan

See PSWS VA1 WP5 report.

4. Deviations from Annex 1

4.1 Tasks

Nicholas Achilleos (UCL) now also contributes to Task 10.1 as PSWS JRA4 Deputy Lead without any impact on PSWS resources.

4.2 Use of resources

PSWS JRA4 WP10 Person-Months for the time period 01/03/2017-31/08/2018 are summarized and compared to the original proposal covering the time period 01/03/2017-31/08/2018 in the Table below:

Work package number	WP10	Start Date or Starting Event	Month 2
Work package title	JRA4 : PSWS (Planetary space Weather Service)		

Participant number	2	3	4	18	11	12	19	33
Short name of participant	OBSParis	UCL	CNRS	Wigner RCP	DLR	ABER	IAP	SRC PAS
Person-month per participant (planned):	8	5	12	14	3	7	12	2

11. WP11 - JRA5: VESPA (Virtual European Solar and Planetary Access)

1.1 Explanation of the work carried out by the beneficiaries and overview of progress

The objective of WP11 JRA5 is to develop the infrastructure underlying VA2 VESPA, including data servers, access protocols, exchange standards, and tools to visualize and analyse the data.



Figure 27- short-term roadmap for the VESPA system. Colors indicate the main origin of the developments: orange = IVOA, blue = VESPA, light green = PDS / SPICE / IPDA, silver = OGC / GIS-related. Bold arrows are connections already implemented, thin ones are under study or limited in scope.

Task 11.1- Coordination

For details of management structure and coordination procedures for JRA5, see the [First Periodic Report](#).

Task 11.2- Tools and Interfaces

The EPN-TAP v2 access protocol has been slightly modified during RP2 but proves to be robust; extra thematic extensions have been defined to support data services in new fields, e.g. sample description and laboratory setups to support SSHADe and other spectroscopy services. The data service installation procedure in a Virtual Machine is now very mature and many options are documented in updated tutorials; an even easier procedure based on Docker is being finalized. All new services developed in a DaCHS server use the EPN-TAP mixin, which makes installation and maintenance much easier. Previous issues with the registration procedure have been solved in collaboration with Harvard Univ., which maintains the IVOA registry. The main portal is being redesigned to integrate results from various data services; alternative and lighter access modes have been developed, e.g. via specific

libraries in VO tools, and also via python, IDL, or shell scripts, and web services. These are adapted to pipeline processing and workflows.

Several attempts at running simulation codes on line were made, but most of them were evaluated too demanding to be helpful. The most promising system is based on the datalink protocol; it is used to retrieve ephemerides for HST observations, and to connect observed atmospheric profiles of Mars from SPICAM to simulations using several scenarios from the Mars Climate Database at LMD. This will expand during year 4 in a Workflow activity. Several services of events (either observed or predicted) are also being implemented, in particular as an outcome of PSWS activities.

The CASSIS spectral tool has been updated (v5, July 2017, CNRS/IRAP) in particular to support spectra in reflected light and 2D/dynamic spectra. MATISSE has been updated (v1.5, May 2018, ASI+IAPS) with new functions for spectra and aerodynamic coefficients; a SAMP interface has been added to receive spectral cubes and tables from other tools, and support of the new geofits convention has been added. Aladin has been hugely updated to support planetary surfaces (v10, Feb 2018, CNRS/CDS), see Task 11.4. A SAMP plug-in was also added in the open source software ImageJ (ObsParis); this both brings image processing functions to the VO, and adds support for many image formats (currently in test).

The preparation of an observatory list is in collaboration with NA1 (see WP12 Task 12.5.1 Preparation and discussions on future extensions of the ground-based observatories database). Actions during RP2 were to collect existing lists and cross-correlate their contents (including space missions); develop a script to merge these lists; prototype an implementation with the resolver engine Quareo (used for the Solar System objects name resolver at IMCCE/ObsParis). When ready, the resulting list will also be implemented as a searchable EPN-TAP service, and the NA1-Matrix of ground-based facilities will be used as a public input interface to add new amateur facilities.

Task 11.3- Solid Spectroscopy Hosting Architecture of Databases and Expertise – SSHADE

SSHADE is a sub-network of 21 European contributors from 10 different countries. It extends the GhoSST (Grenoble astrophysics and planetology Solid Spectroscopy Thermodynamics) infrastructure defined in FP7 programs Europlanet-RI and VAMDC (2009-12) to a large set of contributors in the field of solid spectroscopy, including the major ones in Europe. Implementation in the JRA has been done during RP2, followed by a phase of data ingestion, documentation and validation in VESPA-VA, to ensure consistency and data quality. The resulting service will not only help improve the spectral databases of ices, minerals, organics, and cosmomaterials, but will also make the state-of-the-art laboratory data readily available as references to interpret observations of planets and small bodies, in particular from spacecraft.

The SSHADE databases will eventually cover: laboratory, field, airborne, as well as simulated and theoretical spectral data (spectra and various product types, e.g., transmission, absorbance, absorption coefficient, optical constants, band lists) for many different types of solids: ices, snows and molecular solids, minerals, rocks, inorganic solids, natural and synthetic organic and carbonaceous matters, meteorites and other cosmo-materials such as extra-terrestrial samples, with a wide range of measurement techniques: transmission, bidirectional reflection, Raman, fluorescence, XANES from X-rays to millimetre wavelengths. SSHADE will also host all data collected during the Transnational Access (TA) program of EPN2020-RI to the 'Cold Surfaces Spectroscopy Facility' @ IPAG.

WP11-JRA5 (CNRS/IPAG) has developed SSHADE by creating a multi-database structure complete with the development of data import tools, search/visualisation/export interfaces for users and data providers, and templates and various conversion tools. The SSDM Data Model describes the data and metadata and defines units, files, bibliography, doi on datasets, etc. Following the prototype delivered

during RP1, the service has been completed and delivered in open access in January 2018 (<https://www.sshade.eu>). A prototype VO access is also being developed to access its content from the VESPA portal, and is approaching finalization; it is derived from 3 other data services related to laboratory spectroscopy (2 at DLR + the PDS spectral library adapted in ObsParis).

Task 11.4- Planetary surfaces

This activity focuses on developing a bridge between Geographic Information Systems (GIS, much used by planetary geologists) and the VO, which are traditionally disconnected and use very different protocols.

A first step was to identify tools of interest and work on their I/O interfaces. QGIS, a free, open source application, was provided with new plug-ins to handle connections with the main portal and VO tools (Jacobs Univ). This makes it possible to setup VO data services providing links as standard GIS requests (WMS, WCS, etc), and to open files in usual GIS formats (georeferenced images in GeoTIFF). A web service also makes it possible to browse GeoTIFF spectral cubes from the VESPA portal, and to send individual spectra e.g. to CASSIS. In addition, the astronomy fits format has been enlarged and its use rationalized to support planetary images and coordinate frames (CNRS/GEOPS, in collaboration with USGS); this geofits convention has been implemented in the standard GDAL format library, making it possible to convert fits files and ingest them in GIS applications. In consequence, the major GIS and astronomy formats, including geo-localisation, can now be read by dedicated software from either world.

The new Planetary Cesium Viewer web application (CNRS/GEOPS) has been publicly open (<http://134.158.75.177/viewer/Apps/PlanetaryCesiumViewer/index.html>) and the code is available on Github. It has been used during a collaborative effort to upgrade the reference Mars crater database, soon to be published.

The Aladin VO tool (originally a “Sky atlas”) has been upgraded to support planetary images and object catalogues, and to allow search for intersections of complex footprints (CNRS/CDS). A selection of 45 planetary maps from USGS has been converted to multiresolution format (HiPS) and is available in the Aladin data tree, to plot maps quickly using adaptive resolution; the maps are distributed in CDS (Strasbourg), Observatory of Paris, and Canadian Astronomy Data Centre (Victoria). This method also provides a dramatically efficient way to navigate large panoramic images, e. g. from Martian landers.

The VESPA mapping app project has been started in 2018 with the objective to discover georeferenced planetary data from the VESPA VO (Jacobs Uni). This is intended both for students and the general public. A global workflow has been identified and a general design has been drafted.

Organisation of data acquired during a field trip (ESA PANGAEA-X 2017 campaign for astronauts training) was started to assess the distribution of data from TA1. Georeferenced drone images and sample descriptions are stored on Zenodo (Jacobs Uni).

A planetary mapping workshop was held on 19-21 April 2017 in Roscoff, France (<https://epn-vespa.github.io/mapping2017/>), with some support from NA1 (CNRS/GEOPS and Jacobs Uni). It gathered 30 people in-situ + 8 remote, and was so productive that a second edition is being studied. Attendees from ESA, ASI, JPL, and USGS were present together with academics from Europe. Programme and presentations are available here:

<https://voparis-confluence.obspm.fr/display/VES/VESPA+Mapping+2017>

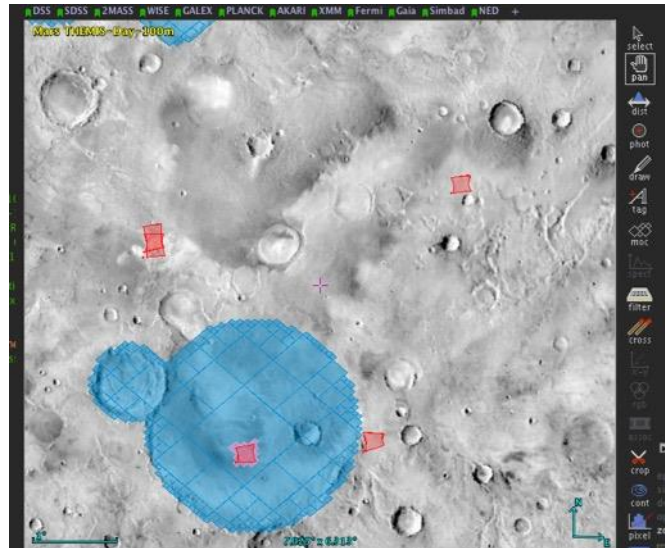


Figure 28- CRISM spectral cubes and Mars largest craters over-plotted on Mars THEMIS mosaic in Aladin. Footprints processing allows the selection of cubes located inside craters.



Figure 29- The VESPA planetary mapping workshop, Roscoff 2017.

Task 11.5- Magnetospheres

The Russian LMSU team, successfully integrated during year 3, contributes to this science theme in particular with new data services.

The iPECMAN on-line tool has been released in Sept 2017 (IAP/Prague). It is aimed at multi-dimensional measurements of planetary electromagnetic fields, e.g., with support for polarization analysis. A SAMP interface has been added later to retrieve data from the portal and connect to Autoplot. I/O files are in CDF format: <http://ipeccman.ufa.cas.cz/>

The das2 protocol from Iowa Univ. has been installed on several test services to retrieve long time series with adaptive time resolution (ObsParis). The association of EPN-TAP for search, das2 to serve the data and Autoplot to visualize them proves to be very efficient. Although the original application is to radio measurements, any time series could benefit from this infrastructure in the future, including monitoring of space experiments. Prototypes are installed at Nançay, CNES/CDPP, Iowa U. (MARSIS atm data), and JAXA/Tohoku Uni (Kaguya /NPW).

The MASER python library has been enlarged to include CDPP, Nançay, Juno-Ground-Radio support, Cassini, RadioJove data services. Methods to load files with various formats are being implemented (ObsParis): <https://github.com/epn-vespa/JUNO-Ground-Radio>

A NA1 workshop was held in IRAP/CNRS on The Sun's influence on planets (October 09-11, Toulouse). Discussions about EPN-TAP and Hisaki/VLA datasets (<http://planetaryspaceweather-europlanet.irap.omp.eu/workshops.html>)

Task 11.6- Small Bodies

The Miriade ephemeris system has been updated to produce extra outputs (IMCCE/ObsParis): <http://vo.imcce.fr/webservices/miriade/>. The development is twofold:

1) The positional ephemeris method of Miriade now provides apparent magnitudes in many filters, based on a database of spectral classes of asteroids and colour indices in various photometric bands built from multiple sources (PDS, literature).

2) The physical ephemeris method of Miriade now provides 3D visualization of selected small bodies. Existing shape models and spin solutions are collected from the PDS Small Bodies Node and from the DAMIT database from Charles University, Prague. New models included in DAMIT are ingested in Miriade on a regular basis, so that newly available data are readily accessible. The interface can now produce realistic 3D views of the requested targets. This takes into account the magnitudes of the targets, background stars, and even potential background Solar System objects. The system is publicly open but possible improvements are being studied. Physical ephemerides are connected to the HST planetary data service via datalink. Another function called ViSiON has also been developed on Miriade to help plan observations of planetary objects from arbitrary locations (publication in press).

The DynAstVO engine now produces Spice kernels that provide the computed trajectory of Near Earth Asteroids (IMCCE/ObsParis). Those are distributed in the data service.

MATISSE has been updated as mentioned in Task 11.2 (ASI & IAPS). For memory, a specificity of this tool is the 3D visualization of the data on a shape model, which is particularly relevant for small bodies. The tool is available at <http://tools.asdc.asi.it/matisse.jsp>

Task 11.7 – Atmospheres

A VESPA Atmosphere-oriented workshop ("Sharing Planetary modelling run results in VESPA") was held on 27-29 Nov 2017 in Brussels, Belgium. The focus was on running on-line simulations and

comparing with observational data. A first solution (EPN-Ping protocol) was discussed. Some of the functions are now fulfilled by the use of datalink in data services, e.g. in SPICAM service calling simulations in the Mars Climate Database (LATMOS/CNRS with LMD/CNRS). The meeting gathered 23 persons, see here:

<https://voparis-confluence.obspm.fr/display/VES/VESPA+Simulations+meeting%2C+2017>

A more powerful solution for radiative transfer codes is now being sought, in particular for the ASIMUT service and NOMAD data in Brussels (IASB-BIRA).



Figure 30- The VESPA simulation workshop, Brussels 2017.

Task 11.8 – Exoplanets

In addition to the regular updates of the web site, VO access to the Encyclopaedia of extrasolar planets has been upgraded during RP2, with added content. A command line API has been setup based on python VO routines, to bypass the interfaces for workflow processing (ObsParis).

An interface to submit new data and corrections to the existing database is being designed. This will evolve into an open, collaborative system during year 4, with review of submissions handled by the service team, as an extension of the current helpdesk.

1.2 Impact

VESPA has been in pole position for several years in the field of Planetary Science VO, and is in practice defining the standards in this field through intense contributions to various consortia:

- IVOA: the new Solar System Interest Group started its activities in May 2017, chaired by B. Cecconi. VESPA project manager at ObsParis (P. Le Sidaner) is the new vice-chair of the Registry WG. Extra contributions are provided to WG semantics, applications, etc, and some EPN-TAP concepts are now used by the IVOA (UCDs, parameters for time series and events, etc). Major tools developed in the IVOA framework have been upgraded to support Planetary Science data, and strong collaborations are expanding beyond VESPA (e.g., ESA, Bristol Uni, Heidelberg Uni, CADC in Canada, ASTERICS programme...).
- IPDA: participation to steering committee (B. Cecconi) and Technical Expert Group (P. Le Sidaner, S. Erard). EPN-TAP is being assessed as a new IPDA standard. Connections between PDS4 and EPN-TAP

dictionaries are studied to set up bridges between the two protocols.

- IAU: VESPA has issued requests for description systems (coordinate frames, object nomenclature, observatory list, etc). The fits extension for planetary surfaces will be submitted to the IAU commission in charge of the fits format.

The VESPA JRA also has had a major impact through dedicated sessions in science conferences and through cross-discipline events such as the Planetary Mapping workshop held in Roscoff (partly NA1-funded), 19-21 April 2017, focused on the VO-GIS connection; or the Atmosphere modelling workshop in Brussels, 27-29 Nov 2017, focused on launching simulation codes on-line.

The large success of VESPA has led to an enhanced visibility of Planetary Science within the VO and also at the national scale: one of us (S. Erard) has become the head of the whole VO service at Paris Observatory, including Astronomy. Besides, the VESPA portal and local services are now certified by INSU as a national observation service (ANO5), ensuring sustainability of the core infrastructure of VESPA in the long term.

For a full list of activities refer to Table 24.

2. Update of the plan for exploitation and dissemination of results

Dissemination of VESPA JRA products is being performed through submission of VESPA standards for validation by international consortia. This activity was enforced during RP2 with IPDA (our EPN-TAP access protocol is a case study at IPDA) and IVOA (proposed extensions of various existing standards to handle Planetary Science data, in particular reference frames and field descriptors). This activity becomes more and more important with the start of the new Solar System Interest Group in the IVOA, chaired by one of us (B. Cecconi).

3. Update of the data management plan

See WP6.

12 WP12: NA1: Innovation through Science Networking

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

NA1 'Innovation through Science Networking' provides the framework to enable EPN2020-RI to build overall capacity in European planetary science and a stronger, bigger community of researchers and industry related to the field. As an advanced infrastructure, a key objective for EPN2020-RI is widening participation; thus, a main objective of NA1 is to integrate scientists from under-represented states (URS) into EPN2020-RI activities and the wider Europlanet Community, as well as to build links with industry. For full details of objectives, see the [First Periodic Report](#).

Task 12.1- Coordination (FMI; Wigner RCP)

For details of the management structure of NA1, please refer to the [First Periodic Report](#).

WP 12.1 organized four internal NA1 face-to-face meetings and several teleconferences to plan the NA1 operations and to communicate among the Task leaders. Minutes of the face-to-face meetings are available via NA1 intranet webpage for task leaders and others who have access to the intranet. The inputs from telecons are reported as part of NA1 monthly reports. The times and places for the face-to-face meetings were:

- 24.4.2017, Vienna, Austria
- 28.8.-31.8.2017, Budapest, Hungary
- 11.4.2018, Vienna, Austria
- 11.9.-12.9.2018, Budapest, Hungary

Task 12.2- Scientific Working Groups (MPS, CNRS, UCL)

WP12.2 brings together sections of the European planetary science community, including researchers, amateur associations, commercial and industrial organisations, to work on current planetary topics. Eight workshops were organised during RP2:

- **Comets Formation**, Sofia, Bulgaria*, 19-23 June 2017, 53 participants. This workshop, one of the main post-Rosetta scientific forums in 2017, was organised by the Institute for Space Astrophysics and Planetology (IAPS), National Institute for Astrophysics (INAF), Italy and the Institute of Astronomy and National Astronomical Observatory (IANAO), Bulgarian Academy of Sciences (BAS). The workshop gathered together cometary science researchers with experts in planetary formation to discuss cometary nuclei formation in the context of Rosetta results through 22 invited talks and 15 contributed talks.
- **5th CHEOPS science workshop**, Seggau, Austria, 24-26 July 2017, 89 participants. The 5th CHEOPS CHaracterizing ExOPlanet Satellite (CHEOPS) Science Workshop brought together 89 participants (10 from URS, one from industry and eight from outside the EU) 18 months before the launch of the ESA's first mission dedicated to search for transits. The programme consisted of 47 talks and 21 poster presentations. Workshop website: <http://geco.oeaw.ac.at/cheops-workshop-05.html>
- **Early history of planetary systems and habitable planets**, Tartu, Estonia* 8-10 August 2017, 54 participants. This conference was organized by the European Astrobiology Campus in cooperation with the COST Action TD1308 "Origins and Evolution of Life on Earth and in the Universe", the Nordic Network of Astrobiology, Astrobiology Graduates in Europe (AbGradE) and Tartu University.
The program included nine sessions with nine invited speakers, including seven early career researchers. Participants came from 21 countries, including Chile, Zambia, Canada and the US.
- **Geosciences for understanding habitability in the solar systems**, Azores, Portugal*, 25-30 September 2017, 68 participants. This conference dealt with fundamental issues of planetary habitability, i.e. the environmental conditions capable of sustaining life, and how interactions between the interior of a planet or a moon and its atmosphere and surface affect the habitability of the celestial body.
- **Sun's influence on planets**, Toulouse, France, 9-10 October 2017, 24 participants. The workshop addressed planetary space weather and space climate in the context of space missions including STEREO, MEX, VEX, MESSENGER, Galileo, Cassini, Rosetta, MAVEN, Exomars, BepiColombo, and JUICE. New tools and methods developed by PSWS were discussed. A topical issue devoted to planetary space weather in the Journal of Space Weather and Space Climate was announced following the workshop.
- **VESPA simulations**, Brussels, Belgium, 27-29 November 2017, 25 participants. The VESPA simulation workshop covered different aspects related to including atmospheric data, simulations, and related tools within VESPA. In particular (new) atmospheric inputs for the

VO, data from models (GCM), tools needed to view/compare data, on-line call to radiative codes have been discussed. During the workshop the VESPA tool was demonstrated and used to compare different model runs

- **Kuiper belt objects**, Coimbra, Portugal*, 26-30 March 2018, 109 participants. Results presented in contributed and poster papers at this international scientific workshop dedicated to the Trans-neptunian Solar System (held after a break of seven years) have been submitted for a special issue on the Kuiper Belt to be published by the scientific journal *Icarus* in 2018. The invited papers will serve as framework for a textbook issue on the Transneptunian Region to be published in 2019 by Elsevier publishers. A follow-on meeting is planned in about 3 years in Taiwan.
- **Planetary atmospheric erosion**, Murighiol, Romania*, 11-15 June 2018, 35 participants. The workshop consisted of a combination of 35 science presentations and open discussion. Among the key science issues discussed were the roles of planetary magnetic fields and atmospheric composition for erosion processes and protection of planetary atmospheres. New techniques and new mission proposals from Japan, China, USA and Europe were presented.

*Workshop held in under-represented country.

Task 12.3- Knowledge consolidation and strategic planning (ISSI, Wigner RCP)

At ISSI, the workshop programs and speakers are defined by a group of highly qualified experts serving as conveners (5-6 scientists). The convener meeting (2 days at ISSI) is organized 6-9 months before the workshop. All the conveners are fully supported with travel and living costs while in Bern. The Workshops of a week duration can be attended by 40-45 invited scientists and experts. The results of the Workshops are published as refereed papers in issues of *Space Science Reviews* and in parallel as volumes of the *Space Science Series of ISSI (SSSI)*.

During RP2 the following conveners' meetings and workshops were held:

- **Workshop 1 - The Role of Sample Return Missions in the Exploration of the Inner Solar System**

The conveners' meeting of the first ISSI-Europlanet workshop on "*The Role of Sample Return Missions in the Exploration of the Inner Solar System*" was held on 3-4 July 2017. The conveners attending the meeting in Bern were:

- Mahesh Anand, The Open University, Milton Keynes, United Kingdom
- Michel Blanc, ISSI, Switzerland
- Yangting Lin, Chinese Academy of Sciences, Beijing, China
- Kuljeet Kaur Marhas, Physical Research Laboratory, Ahmedabad, India
- Sara Russell, Natural History Museum, London, United Kingdom
- Shogo Tachibana, Hokkaido University, Sapporo, Japan
- Meenakshi Wadhwa, Arizona State University, Tempe AZ, USA

The actual workshop was held during the week of 5-9 February 2018, with 47 participants, 3 of which from under-represented countries, and 17 from non-European countries.

The workshop had the following objectives:

- 1) Review major outstanding science questions in Planetary Sciences that can only be answered via Sample Return missions.
- 2) Identify specific target body(ies) for answering specific science question(s).

- 3) Evaluate technological readiness for individual mission concepts against their science return.
- 4) Engage with sample curation communities across Europe to prepare for future sample return missions

The workshop followed the format of a discussion meeting and the presentations were grouped under three main themes:

- a. Initial conditions and workings of the Solar System
- b. Planetary habitats
- c. Sample curation

Based on the discussions of the workshop, Springer Editorial will publish a peer-reviewed “ISSI book” (Space Science Series of ISSI). Tentative publication time for the book is May 2019. The papers will be published online at the end of December 2018.

- **Workshop 2 - Reading terrestrial planet evolution (Venus, Earth, Mars, Titan) in isotopes and noble gases measurements**

The conveners’ meeting of the second ISSI-EP workshop on “*Reading terrestrial planet evolution (Venus, Earth, Mars, Titan) in isotopes and noble gases measurements*” was held on 24-25 October, 2017. The conveners attending the meeting in Bern were:

- Michel Blanc, ISSI Beijing, Beijing, China
- Helmut Lammer, Austrian Academy of Sciences, Graz, Austria
- Bernard Marty, CRPG, Vandoeuvre les Nancy, France
- Aubrey Zerkle, University of St. Andrews, St. Andrews, United Kingdom

The actual workshop will be held during RP3, in the week of 22-26 October, 2018.

- **Workshop 3 - Comparative study of the atmospheres of planets and exoplanets**

The conveners’ meeting of the third ISSI-EP workshop on “*Comparative study of the atmospheres of planets and exoplanets*” was on December 21st – 22nd, 2017. The conveners attending the meeting in Bern were:

- Michel Blanc, ISSI, Bern, Switzerland
- François Forget, Université Paris 6, Paris, France
- Kevin Heng, University of Bern, Bern, Switzerland
- Takeshi Imamura, The University of Tokyo, Kashiwa, Chiba, Japan
- Oleg Korablev, Russian Academy of Sciences, Moscow, Russia
- Helmut Lammer, Austrian Academy of Sciences, Graz, Austria

The actual workshop will be held during RP3, in the week of 12-16 November 2018.

This task also focused on engagement of scientists and industrial representatives from under-represented countries. As results from RP1 showed that TA calls were more successful in targeting participants from inclusiveness states than the NA1 exchange programs, the main focus during this period was on building links with researchers. The procedure for advertising workshops was changed from using established mailing lists to promoting activities through known, targeted contacts.

Task 12.4- Innovation and Foresight Working Groups (ABER, FMI)

NA1-Task 4 Workshop organisation

Europlanet 2020 NA1-Task 4 has organised or co-organised 5 workshops as follows:

- **Towards a lunar village, Riga, Latvia***, 17-22 September 2017. The interactive MoonVillage [Technology Foresight workshop](#) at EPSC 2017 included invited and contributed talks, a panel discussion and interactive posters with a short oral introduction. Topics covered included:
 - Technology for precursor missions, instruments and investigations for landers, rovers, sample return, human cis-lunar activities and human lunar surface sorties.
 - Technology preparation for the International Lunar Decade: databases, instruments, missions, terrestrial field campaigns and support studies.
 - International Lunar Exploration Working Group (ILEWG) and Global Exploration technology roadmaps towards a global robotic/human Moon village.
 - Strategic knowledge gaps, and key technology goals relevant to Lunar global exploration.
 - Technology preparation for the Moon Village with the goal of a sustainable human and robotic presence on the lunar surface as an ensemble where multiple users can carry out multiple activities.
 - Technology goals for the Moon Village to support planetary science, life sciences, astronomy, fundamental research, resources utilisation, human spaceflight, peaceful cooperation, economical development, inspiration, training and capacity building.
- **EPSC2017 Show & Tell workshop:** This pilot session explored interest and value in setting up a regular showcase platform at EPSC aimed at fostering industry/SME-planetary links. ~40 people attended in total, including 7 speakers (EPN2020-RI industry officer, 3 industry representatives, 3 research representatives). The format included informal talks and interaction from the audience. Following the success of the session, a follow-up was planned for EPSC 2018 in Berlin. <https://meetingorganizer.copernicus.org/EPSC2017/session/26082>
- **Space weather and radiation science**, Oostende, Belgium, 28 Nov -1 Dec 2017
- **Asteroid mining 2 (ASIME2)**, Luxembourg, 16-17 April 2018. http://geophy.uni.lu/users/tonie.vandam/asime-2018/Abstract_book.pdf
 - <https://asime.uni.lu>
 - Sponsorship of two attendees to the meeting. The meeting focused on the asteroid composition theme following on from the previous meeting in 2016. The programme featured discussion on presentations on spectroscopic observations from the ground, laboratory measurements, and space missions.
- **Microsatellites in planetary and atmospheric research**, Tartu, Estonia*, 6-11 August 2018
 - Sponsorship of the workshop.
 - The course consisted of lectures by leading scientists, planning of micro/nanosatellite project in small groups in addition to open discussion. Participants had the opportunity to display their research in a poster session. The event was aimed at graduate students and early career scientists.
 - <http://www.nordicastrobiology.net/Tartu2018/>
 - The workshop was held in an under represented country, Estonia, with a total of 50 participants, of which 18 were from inclusiveness states, and 35 early career scientists.

*Workshop held in under-represented country.

Task 12.5- Coordination of ground based observations (OEAW, VU)

12.5.1 Preparation and discussions on future extensions of the ground-based observatories database

The extension of the so-called NA1-Matrix (see <http://iwf.oeaw.ac.at/matrix/>) started in project year 2 and proceeded in project year 3 in cooperation with WP6 VA2 VESPA. After a test phase, the NA1-Matrix will go online in project year 4. A merge script has been developed in cooperation with VESPA to join different available lists of observatories (e.g. NAIF, AAS, IAU-MPF, NSSDC facility lists, NA1-Matrix), which will be used as an observatory name resolver for the VESPA interface. The main

developments in project year 3 have been

- An image upload option for amateurs into the NA1-Matrix, which will make their data available via the VESPA interface.
- Changes of and additions to the NA1-Matrix user-interface to allow for image upload
- EPN-TAP services for amateur data and a list of observatories (not yet available online). The respective RD uses a newly implemented web service with the latest version of the matrix-server for the export of observatory data.
- The merge script for the list of observatories.

12.5.2 Workshop organisation

During EPN2020-RI RP2, NA1-Task 5 organised and held 8 workshops, of which 5 were amateur training workshops or summer schools:

- **NA1 Workshop “Pic du Midi T1M planets observation campaigns”**, Observatoire du Pic du Midi, France, 09-12 June 2017. Five participants took part, including four amateur astronomers and one participant from an inclusiveness country. The website (<http://pic-net.org>) hosts the announcement, agenda, participants, and outcomes of the workshop. Observations are available via the observatory database PVOL2 (<http://pvol2.ehu.eus>), which is also available via the Virtual Observatory of VESPA. The coverage on media and internet was high, due to the excellent quality of the images produced during the workshop: Sky & Telescope, the French journal “Le Monde” and many astronomical blogs (Dan Fisher’s and many others) published short articles about the outcome of the first Pic-Net workshop. One Saturn image made the Astronomy Picture of the Day on June 17, 2017. A follow-up press release was issued by NA2 (see WP13/ Table 24 for coverage). A detailed report of the workshop can be found at <http://tinyurl.com/picnet-report>.
- **“Europlanet Summer School 2017: Space missions: ground-based observations and science communication”**, Molėtai Astronomical Observatory, Molėtai, Lithuania*, 18-28 July 2017. The Summer School was attended by 21 participants, including early career researchers and amateur astronomers, of whom 11 came from inclusiveness countries. The workshop website (<http://mao.tfai.vu.lt/europlanet2017>) hosted the announcement, agenda, participant details, as well as a poster for dissemination. The summer school, which was co-organized by NA1-Task 5 and NA2, combined observations of variable stars and exoplanets with science communication training. A press release prepared by the participants as part of the media training was published by a Lithuanian news site: <http://tinyurl.com/school2017pr>; a short report and evaluation from participants can be found at <https://www.europlanet-eu.org/europlanet-summer-schools-2017-reports>.
- **NA1 Workshop on New Views of Jupiter: Pro-Am Collaborations during and beyond the NASA Juno Mission**, Royal Astronomical Society, London, UK, 10-11 May 2018. The workshop aimed to promote collaboration between citizen scientists, amateur astronomers and professional space scientists in studies of the atmosphere of Jupiter in support of the ongoing NASA Juno mission. Additional goals were the improvement of future ground-based observations of the planets from amateur astronomers. An important part of the workshop was also dedicated to the contribution of citizen scientists in processing JunoCam observations and how their contribution has improved the analysis of JunoCam data. The

workshop was accompanied by a press release and very well covered on traditional and social media (see dissemination).

- **NA1 Didymos Observer Workshop**, Prague, Czech Republic*, 19-21 June 2018. Key topics of the workshop were the recent progress in observations, modelling and interpretation of the Didymos binary asteroid system and plans for its future study. AIDA (joint ESA-NASA mission) will be the first space experiment to demonstrate asteroid impact hazard mitigation by using a kinetic impactor to deflect an asteroid. Remote (mostly Earth-based) observations of Didymos are an important part of the mission. The two main goals are to pre-characterise of the target binary asteroid (necessary for designing and planning the spacecraft mission) and to measure the change in the secondary orbital period caused by the impactor. Participants at the workshop discussed plans for observations and subsequent analyses and modelling of the binary system in 2019-2021 as well as in 2022-2023. They specified aims and tasks of the observations using various instruments and prepared an internal document with a detailed plan for observations in the upcoming apparition of Didymos in 2019. Further details on this can be found in the workshop report.
- **NA1 Workshop in Geology and Geophysics of the Solar System**, Valjevo, Serbia*, 24 June-1 July 2018. A total of 20 participants received a waived registration fee thanks to the support of EPN2020-RI. The workshop was designed to cover a wide range of topics related to the formation, structure and dynamics of the Solar System. The workshop targeted students and young researchers of various backgrounds and of different levels of experience in the fields of planetary sciences and space exploration. The workshop was attended by 43 participants, of which 24 were PhD students, 13 masters students and six undergraduate students. Feedback from the participants is being prepared. Preliminary feedback suggests that the workshop was extremely useful for the students, both in terms of meeting peers and mentors and broadening their knowledge of planetary science.
- **PSWS/NA1 Workshop on Tools and Services for Planetary Observations and Image Analysis by Amateurs'**, Pic du Midi, France, 17-19 July 2018. The workshop aimed to present PSWS tools and services to the amateur community and apply them to images obtained by amateurs. Dedicated observation campaigns were prepared, as well as discussions held on improvements to current PSWS services and how amateurs can contribute to EPN2020-RI and future programmes. Some observations at Pic du Midi were obtained during the workshop and the planetary images will be submitted to the PVOL database after processing and analysis.
- **Europlanet Summer School 2018 on Space missions: Ground-based Observations and Science Communication**, Molėtai Astronomical Observatory, Molėtai, Lithuania*, 1-10 August 2018. The aim of the course was to give participants a thorough, multidisciplinary introduction into space missions and the ground-based observations required by space missions before and after launch, as well as an introduction to science communication. More general subjects about specific space missions (TESS, JWST, PLATO...), planetary systems, habitability of planets, photometric and spectroscopic techniques were presented. Parts of the summer school were hands-on sessions using the Molėtai Astronomical Observatory telescopes (CCD photometry and high-resolution spectroscopy). In addition, the course gave participants the

opportunity to develop comprehensive theoretical and practical skills in science communication and engaging with a range of lay audiences, including the public, media, policy makers, schools and educators.

- **Europlanet/IAU Summer School Basics of Astrobiology**, Vienna, Austria, 17-18 August 2018. The summer school was part of the IAU General Assembly 2018 in Vienna and was organized at the Observatory of the University of Vienna. The school was associated with the IAU Symposium 345 “ORIGINS: From the Protosun to the First Steps of Life” and covered the basics of astrobiology, from the formation of stars and planetary systems to the early conditions of life on planets, including atmospheres and planetary interiors, and the formation and early evolution of life itself.

*Workshop held in under-represented country.

12.5.3 Alpbach Summer School

Since 2017 NA1 Tasks 5 and 2 have collaborated to support students from under-represented countries to participate in the famous ESA Summer School in Alpbach, Tyrol, Austria (17-27 July 2017 and 17-26 July 2018).

In 2017, 12 students from these states applied for the newly available Europlanet funding and 8 were finally chosen to participate. In 2018, NA1 received a total of 39 applications from students from under-represented countries, of which – due to limited budget – 8 were again finally chosen. External budget was made available nationally so that an extra four students from these states could participate, bringing the total to 12 (out of 64).

The high number of applications from under-represented countries in 2018 illustrates not only the real need of funding for students from these countries, but also the effectiveness of this approach in integrating under-represented countries into the European community. The knowledge transfer of such summer schools back into the under-represented countries is a great example of sustainable support by EPN2020-RI.

12.5.4 Workshop evaluation

Throughout RP2, feedback on workshops has been gathered from participants based on an evaluation form developed during RP1. The statistics clearly show an increase of awareness and knowledge about EPN2020-RI by the participants as the figure below illustrates.

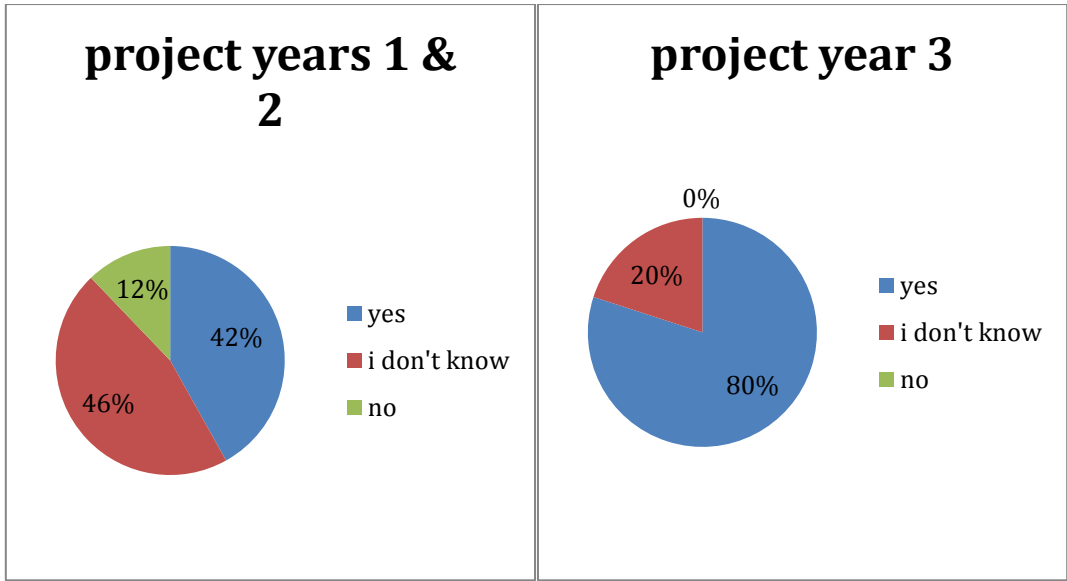


Figure 31- Workshop Feedback 1: I am aware of the aims and goals of the EU-project Europlanet 2020 and what it can offer to me.

Some further statistics for the first 3 project years are presented below.

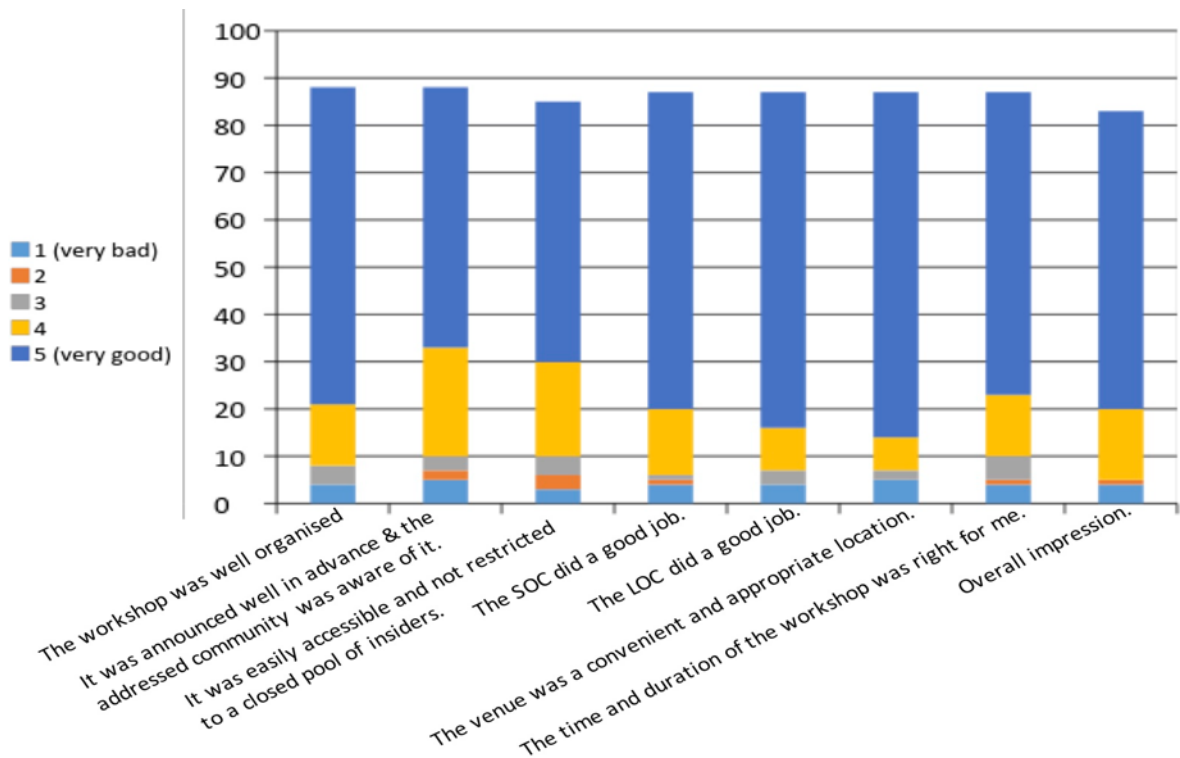


Figure 32- Workshop Feedback 2: Overall workshop impressions.

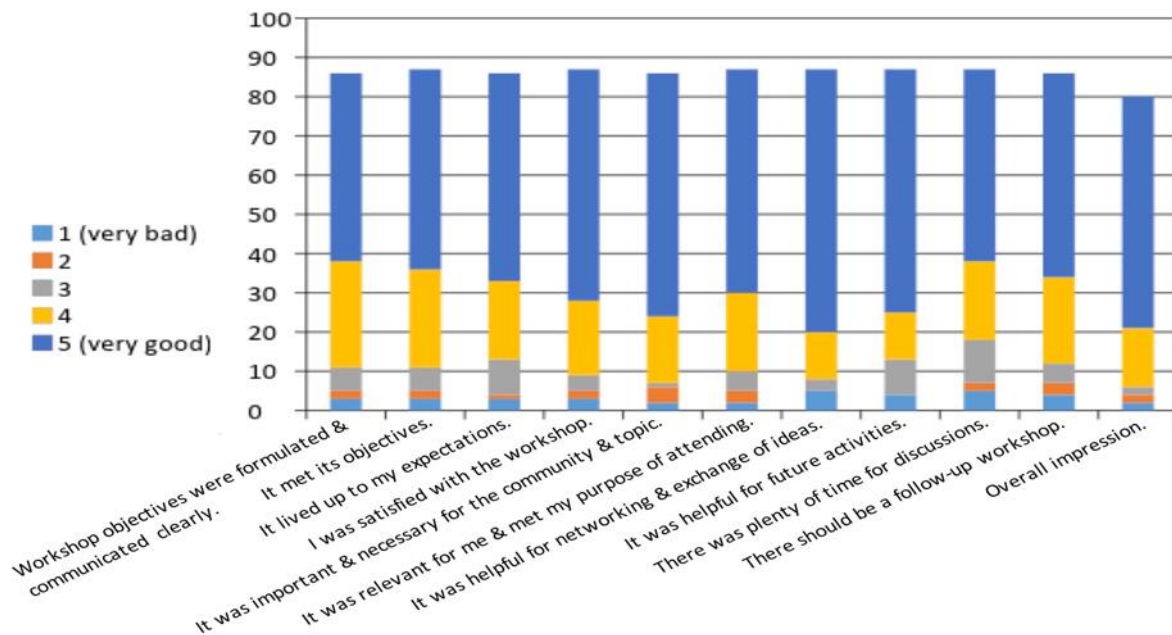


Figure 33- Workshop Feedback 3: Workshop content.

12.5.5 Amateur Sessions at EPSC

Within RP2 NA1-Task 5 established very good connections with the amateur community in Europe. Several discussions led to the idea of supporting amateurs to participate in EPSC 2017 in Riga (16 attendees in total), Latvia to present their impressive contributions to planetary science and to develop collaborations with professional scientists in Europe. NA1 bursaries for amateurs to attend EPSC 2017 led to a record 16 amateur presentations over two sessions:

- Amateur collaborations in small bodies, terrestrial, giant and exoplanets professional studies, EPSC 2017, Riga, Latvia.
- Juno Ground-Based Support from Amateurs, EPSC 2017, Riga, Latvia

Even more presentations were expected at EPSC 2018 in Berlin, thanks to NA1-Task 5 support. One big session was finally held covering different topics of pro-am collaborations, i.e.:

- Professional-Amateur collaborations in small bodies, terrestrial, giant, exo planets studies and Juno Ground-Based Support

Within this session 9 talks and 8 posters were presented, making EPSC 2018 with a total of 17 amateur presentations once again to the by now most successful EPSC in view of amateur collaboration. Several different amateurs additionally attended the conference to discuss and prepare their collaboration with professional scientists.

Task 12.6- Exchange program (FMI)

The objective of the Expert Exchange Programme (Task 6) is to support the activities of EPN2020-RI with experts and scientific exchange whenever it is needed. During RP2, a special call was opened with the aim of promoting links between journalists/science communicators and members of the planetary science community. It was also decided to support early-career scientists' participation to the workshops arranged by Europlanet through the exchange programme. The following calls were issued during RP2:

Special call for grants for participation in IPPW-14 workshop, June 12-16, 2017 (application deadline 31 March 2017). Selected applications:

- **David Gaudin**, IRAP, France
- **Timo Nikkanen**, FMI, Finland
- **Fabrizio Dirri**, IAPS-INAF, Italy
- **Pauli Laine**, University of Jyväskylä, Finland (withdrawn)
- **Isil Sakraker**, DLR, Germany
- **George Vekinis**, Institute of Nanoscience and Nanotechnology, Greece
- **Amalia Marinou**, Institute of Nanoscience and Nanotechnology Greece

Call 4 for visit to take place between 1 June-30 November 2017 (application deadline 14 June 2017). Selected applications:

- **Alena Zdravkovic**, from Faculty of Mining and Geology, Serbia, to Open University, UK: "Meteorite thin-section preparation and Virtual Microscope images acquisition"
- **Maria Hieta**, from Finnish Meteorological Institute, Finland, to University of Michigan, USA: "Comparative humidity measurements in low-pressure carbon dioxide"
- **Jingnan Guo**, from University of Kiel, Germany, to Aberystwyth University, UK: "Implementation of the Martian part of the Europlanet Planetary Space Weather Service VI".

Special call for journalists/science communicators for visits to take place between 15 August 2017 – 15 February 2018 (application deadline of 31 August 2018). Selected applications:

- **Lidia Pokrzycka**, from Maria Curie-Skłodowska University, Poland, to IASA, Greece. "Media relations and planetary science community. Practical activities."
- **Lukasz Lamza**, from Tygodnik Powszechny magazine, Poland, to University College London/Open University, UK. "A universe of planets".
- **Anastasia Kokori**, from Dublin City University, Ireland, to University College London Observatory, UK. "Astronomy outreach and public engagement with Space missions"

All the visits listed in the Calls above took place and the reports have been received (no report was requested from the participants of IPPW-14).

Continuously open call with period of visit until 30 April 2019 (applications will be accepted until 31 December 2018). This call covers standard and journalist/science communicator visits, as well as early-career scientists' participation to workshops arranged by EPN2020-RI. Up to the end of RP2, 10 applications have been received and 8 selected:

- **Kitti Berényi**, from Geodetic and Geophysical Institute, Hungary, to Institute of Atmospheric Physics, Czech Republic. Visit the ionospheric research group of Institute of Atmospheric Physics, participation at the Solar variability and coupling effects in the Earth's atmosphere workshop
- **Veronika Barta**, from Geodetic and Geophysical Institute, Hungary to Institute of Atmospheric Physics, Czech Republic. Visit the ionospheric research group of Institute of Atmospheric Physics, participation at the Solar variability and coupling effects in the Earth's atmosphere workshop
- **Caitriona Jackman**, from University of Southampton, UK, to LESIA, Observatoire de Paris, France. Collaboration on radio data set collation and novel algorithm development

- **Willi Exner**, from TU Braunschweig, Germany, to LESIA, Observatoire de Paris, France. First workshop of the SHOTS group (Mercury simulations).
- **Sarah Osama**, from Alexandria University, Egypt, to University of Bologna, Italy. Attending the short course 'Geomicrobiology of extreme acidic environments: Fundamentals and applications in astrobiology'.
- **Pierre Le Sidaner**, from Observatoire de Paris, France to IRAP, France. Upgrade of voevent production and research environment.
- **Keyron Hickman-Lewis**, from CNRS, France to University of Bologna, Italy. Early Earth surface environments
- **Willi Exner**, from TU Braunschweig to IRF, Kiruna. Second workshop of the SHOTS group (Mercury simulations).

From the 21 selected applications of RP2, 12 were from women (57% of the applications), 7 involved an under-represented country (33%), and 2 involved a country outside Europe (10%).

1.2 Impact

1.2.1 Inclusiveness

Having a wider, less homogeneous scientific community will boost competition and scientific results. Expanding participation in planetary science by countries in Eastern Europe can also increase cost effectiveness. Thus, during RP2, efforts have focused on engaging members of the community in under-represented states. EPSC 2017 in Riga, Latvia was a very good occasion to further raise awareness of Europlanet and build links with researchers and industry representatives in the Baltics. EPN2020-RI offered limited funds for the travel costs of inclusiveness participants (see WP1 for details) and the resulting contacts developed have had a significant impact on the ratio of received answers and the number of people contacted effectively. A lunch debate at EPSC 2017 for inclusiveness participants enabled discussions on how Europlanet could facilitate integration with under-represented states. A further workshop on inclusiveness will be held in Budapest just after the end of RP2 in September 2018.

NA1's 2-part work-plan developing links in under-represented states has involved 1) getting in touch with a wide network of scientists to draw their attention to the Europlanet programme and 2) holding discussions, brainstorming with these people, identifying their needs and working out how they can be helped in a sustainable way. Step 1 has proved a particular challenge, as securing the attention of a community in any given country really only works when there is an established contact that can act as a bridge. With a person known by both parties, Europlanet's objectives are taken more seriously, and chances of a successful contact are higher. Thus, in line with the EPN2020-RI GDPR policy, NA1 has re-defined its channels for contacting the community and focused on making direct contacts.

The meeting on "Planetary atmospheric erosion" in Murighiol, Romania on 11th-15th June 2018 was a test-case for the new procedures. Prior to the meeting, the conveners made contact with multiple agencies and key people from under-represented states and mobilised Europlanet contact points from these countries to spread the word. As expected, there was a strong representation from the Institute of Space Science (ISS) in Romania, since this group is directly involved in one of the ESA mission proposals within this field. For the other states, the response was somewhat mixed and there are still a few countries where NA1 has not yet been able to establish an effective contact point. The Europlanet Inclusiveness Forum in Budapest in September 2018 offers an opportunity to address this, and the Europlanet Society's new network of Regional Hubs will offer a further mechanism to build effective links with under-represented states.

1.2.2 Dissemination

Opportunities within EPN2020-RI for the community have been promoted via the Europlanet newsletter and via meetings and workshops.

In addition to engaging with scientific communities, NA1 activities have engaged with wider audiences, including the public, schools, amateur astronomers, the media and policy makers. The workshop on “Comet Formation” in Bulgaria included a public outreach event in Sofia on 20th June 2017 that was attended by members of the public, students and representatives of the Ministry of Education and Science including talks and table discussions. The Bulgarian official journal of science “Az Buki” published an article about the workshop:

<http://www.azbuki.bg/en/editions/azbuki/archive2017/newspaper26201>

The workshop on “The Early History of Planetary Systems and Habitable Planets” in Tartu/Estonia drew the attention of nationwide TV and radio networks. Kanal 2 – Reporter, the most watched TV news broadcast, included a short news story about the conference and an interview was given to the daily news program of Radio Kuku.

On October 13, 2017, the talk “Europlanet - Potential für die österreichische Amateurastronomie” [Europlanet – its potential for the Austrian amateur astronomy] was held at the general Assembly of the Austrian Society for Astronomy and Astrophysics (OeGAA) in Vienna, Austria.

The Juno workshop in May 2018 trended on Twitter in Great Britain with the #RASJuno hashtag and was subject of a Europlanet press release. BBC covered this workshop with several interviews of participants in its TV program “Sky at Night”. Furthermore “Astronomy & Geophysics” issued a dedicated article on the Juno WS (<https://britastro.org/node/14397>).

The proceedings book of *Planetary Radio Emissions VIII*, funded by NA1-Task 5 in RP2, was published in December 2017, (*Proceedings of the 8th International Workshop on Planetary, Solar and Heliospheric Radio Emissions*, Eds. Fischer, G., G. Mann, M. Panchenko, P. Zarka, Austrian Academy of Sciences Press, Vienna, 2017).

1.2.3 Workshop attendance

At the end of RP2, 1873 participants have taken part in NA1 workshops, including 304 from the under-represented countries (16.2% of all participants), 517 early career scientist (27.6% of all participants), 133 participants from industry (7.4% of all participants), and 138 amateurs (7.4% of all participants). 270 participants were from outside the EU (14.4% of all participants).

Table 23- Statistical data on the NA1 impact.

Year	from	to	Workshop Title	City	Country	UR S	Total number of participants	Number of participants of under-represented countries	Number of early career scientists	Participants from Industry	Amateur Participants	Participants from outside Europe
2015	24.11.	25	NA1 Kickoff	Göttingen	Germany	no	15	2	0	0	0	0
2016	21.4.		NA1 progress meeting 1	Vienna	Austria	no	7	1	0	0	0	0
2016	31.8.	1.	NA1 progress meeting 2	Helsinki	Finland	no	11	0	1	0	0	0
2016	7.6.	9.	Mars 3D	Dorking	UK	no	23	5	23	1	0	4
2016	1.12.	3.	Ethiopia (Danakil Depression in	Bologna	Italy	no	20	0	2	2	2	2

			Planetary Science)									
2016	12.9.	13	ISSI forum 1: Solar system exploration	Bern	Switzerland	no	45	1	4	5	0	11
2016	21.1.		Eurospace meeting	Paris	France	no	12	0	5	0	0	0
2016	26.4.	28	Eurospace meeting	Lausanne	Switzerland	no	85	0	0	80	0	0
2016	21.9.	22	Asteroid mining	Luxembourg	Luxembourg	yes	79	13	19	21	1	16
2016	24.10.	27	IWIPM-3	Pasadena	USA	no	250					
2016	14.11.	18	Space weather and radiation design (in conjunction with PSWS).	Oostende	Belgium	no	12	20	3	3	0	1
2016	11.5.	13	Ground-based observations in support of the JUNO mission to Jupiter	Nice	France	no	33	4	0	0	22	5
2016	20.6.	22	Rosetta ground-based observations	Seggau	Austria	no	40	0	8	0	2	14
2016	2.8.	12	Exoplanets	Moletai	Lithuania	yes	45	31	17	0	13	0
2016	25.10.	27	Planetary Radio Emissions VIII	Seggau	Austria	no	50	5	13	0	0	18
2017	24.4.		NA1 progress meeting 3	Vienna	Austria	no	8	1	0	0	0	0
2017	2.5.		NA1 progress meeting 4	Windsor	United Kingdom	no	6	0	0	0	0	0
2017	28.8.	31	NA1 progress meeting 5	Budapest	Hungary	yes	14	7	1	0	0	0
2017	20.3.	24	Dynamics of planetary systems (Alexander von Humboldt Symposium)	Bad Gastein Salzburg	Austria	no	50	12	10	2	3	6
2017	26.3.	30	Exomars Atmospheric Science and Missions Workshop	Saariselkä	Finland	no	22	1	3	0	0	2
2017	19.4.	21	Planetary Mapping through Virtual Observatory	Roscoff	France	no	30	0	9	2	0	2
2017	19.6.	23	Comets Formation	Sofia	Bulgaria	yes	53	6	5	0	0	4
2017	24.7.	26	5th CHEOPS science workshop	Seggau	Austria	no	89	10	17	1	0	8
2017	8.8.	10	Early history of planetary systems and habitable planets	Tartu	Estonia	yes	54	26	37	2	12	20
2017	25.9.	30	Geosciences for understanding habitability in the solar	Azores	Portugal	yes	68	25	18	0	0	3

			system									
2017	9.10.	11	Sun's influence on planets	Toulouse	France	no	24	3	3	0	0	4
2017	27.11.	29	Vespa simulations	Brussels	Belgium	no	25	0	0	0	0	0
2017	17.9.	22	Towards a lunar village	Riga	Latvia	yes	60	20	20	5	0	5
2017	28.11.	1.	Space weather and radiation design	Oostende	Belgium	no	25	5	5	5	0	2
2017	9.6.	12	Pic du Midi T1M Planets Observation Campaigns Workshops	Toulouse	France	no	7	1	0	0	5	0
2017	18.7.	27	Alpbach Summer School: Dust in the Solar system	Alpbach	Austria	no	60	8	60	0	0	0
2017	18.7.	28	Europlanet Summer School 2017	Moletai	Lithuania	yes	32	15	10	0	8	2
2017	17.9.	22	AM1/AM2 Amateur Sessions at EPSC 2017.	Riga	Latvia	yes	15	1	1	0	11	2
2018	11.4.		NA1 progress meeting 6	Vienna	Austria	no	8	1	0	0	0	0
2018	26.3.	30	Kuiper belt objects	Coimbra	Portugal	yes	109	8	50	0	0	59
2018	11.6.	15	Planetary atmospheric erosion	Murighiol	Romania	yes	35	8	5	2	0	10
2018	5.2.	9.	ISSI workshop 1: Role of Sample Return Missions in the Exploration of the Inner Solar System	Bern	Switzerland	no	47	3		0	0	17
2018	16.4.	17	Asteroid mining 2	Luxembourg	Luxembourg	yes	90					
2018	13.8.	18	Microsatellites in planetary and atmospheric research	Tartu	Estonia	yes	50	18	35	0	0	2
2018	19.6.	21	Didymos Observer Workshop	Prague	Czech Republic	yes	29	6	6	0	1	9
2018	24.6.	1.	Geology and geophysics of the solar system bodies	Valjevo	Serbia	yes	43	17	43	0	0	20
2018	17.7.	19	Tools and Services for Planetary Observations and Image Analysis by Amateurs	Toulouse	France	no	16	1	1	0	12	0
2018	19.7.	26	Alpbach Summer School: Sample return from small solar system bodies	Alpbach	Austria	no	62	12	62	0	0	0

2018	31.7.	10	Europlanet Summer School 2018	Moletai	Lithuania	yes	33	15	4	0	13	1
2018	17.8.	18	Basics of Astrobiology Summer school	Vienna	Austria	no	66	14	53	0	0	15

13. WP 13 – NA2: Impact through Outreach and Engagement

1.1 Explanation of the work carried out by the beneficiaries and Overview of the progress

NA2 ensures that the work of EPN2020-RI and the community it supports is known, understood and used by the widest possible community of stakeholders, and that inputs from external communities are taken into account by the project.

Task 13.1- Coordination

For details of NA2 Management, see the [First Periodic Report](#).

During RP2, significant effort was made in ensuring that EPN2020-RI outreach activities comply with the General Data Protection Regulations (GDPR), which came into force on 25th May. A new privacy policy was published for the outreach newsletter mailing list and website, and a new footer for press releases has been added with clear details for unsubscribing from the list. GDPR compliant checkboxes are now a standard part of all NA2 activity registration forms to ensure that there is a clear record of consent for future contacts.

Task 13.2- Outreach Services and Community Support

Sub-task 1.2.2.1. Outreach Services (U Leiden, SO, UCL)

One of the highlights of this Task in over the reporting period has been the development of the Europlanet [Evaluation Toolkit](#). The kit, which has been developed by Dr Karen Bultitude and Dr Jen DeWitt of UCL, includes 14 tools (plus a number of alternative variations) to enable the organisers of outreach activities to evaluate the impact and outcomes for participants. The tools are intended to provide advice and resources that can be simply and easily integrated into normal outreach and education activities. The toolkit was piloted at the Europlanet Best Practice Workshop in Athens and Summer School in Lithuania. The toolkit was piloted at the Europlanet Best Practice Workshop in Athens on 2-3 July and Summer School in Lithuania from 1-10 August.

With so much information available on the Internet, it can be hard for educators and outreach providers to judge the quality of educational resources and find reliable activities quickly. The IAU's [astroEDU](#) peer-review method is similar to publishing a scientific paper and allows the authors to improve educational resources according to the comments received from the reviewers (consisting of one educator and one scientist). During RP2, EPN2020-RI has delivered six collections for the [astroEDU platform](#) (D 13.5 astroEDU collections. Due Project Month 24):

1. The Planets & their Moons (new)

Activity collection by Europlanet: The Solar System, in which we live, consists of our Sun as its central star, eight planets with their moons and several dwarf planets. Explore the planets and moons of our Solar System and discover the amazing distances and scales in our neighbourhood. Visit the collection [here](#).

2. Children's Planetary Maps (new)

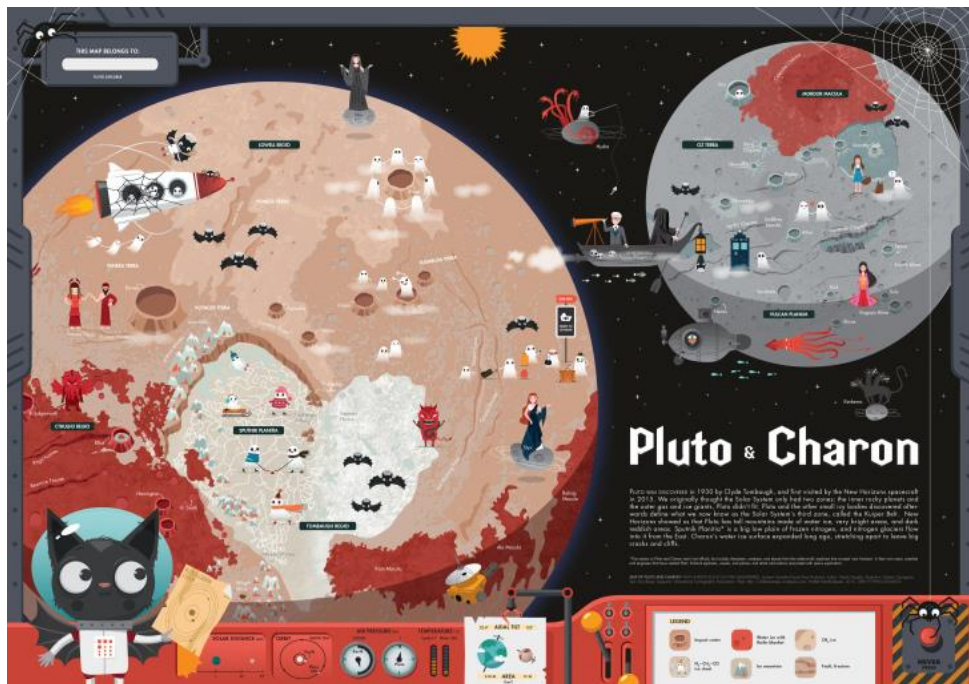


Figure 34 Example Children's Planetary Maps used in the Europlanet astroEDU collection

Activity collection by Europlanet: Using the maps of planets and moons specifically designed for children, students will have an insight to the geography, environmental conditions, astrobiological potential and exploration opportunities of Pluto, Charon, Titan, Io, Moon, Mars and Venus (N.B. The Children's Maps were originally developed through funding from FP7 Europlanet Outreach Funding Scheme in 2012). Visit the collection [here](#).

3. Asteroids, Comets and Meteors (new)

Activity collection by Europlanet: Discover the differences between asteroids, comets and meteors. Learn how to track an asteroid, count craters on Earth and build your own asteroid in this collection of activities. Visit the collection [here](#).

4. Moon (updated)

The Moon is the Earth's only natural satellite and the fifth largest moon in the Solar System. It was formed 4.6 billion years ago. The Moon is in synchronous rotation with Earth meaning the same side is always facing the Earth. Observe and explore Earth's companion through this collection. Developed with support from Europlanet. Visit the collection [here](#).

5. Exploring the Earth (updated)

Earth is the only planet in our solar system known to harbour life. It is the third planet from the Sun and the fifth-largest of the eight planets in the Solar System. Roughly 71 percent of Earth's surface is covered by water, most of it in the oceans. Explore and learn more about our home planet. Developed with support from Europlanet. . Visit the collection [here](#).

6. Sun (updated)

The Sun is the star at the centre of our solar system and is the largest object - about 109 times the diameter of Earth. It contains more than 99.8% of the total mass of the Solar System. Through this collection you can explore and observe the behaviour and characteristics of the Sun. Developed with support from Europlanet. Visit the collection [here](#).

Following the delivery of six collections of educational resources for the [astroEDU platform](#) (D 13.5 astroEDU collections. Delivered Month 24), Europlanet has highlighted these activities and other high quality educational activities to be used in and out of the classroom through a "Planetary Resource of the Week" feature on Facebook and Twitter.

1.2.2.2. Subtask: Meetings (U Athens, VU)

In 2017, it was decided to combine efforts and resources between the WP13 *Meetings* and *Training* subtasks, as well as the NA1 Task 12.5: *Coordination of ground based observations*, to jointly hold a Europlanet Summer School 2017 at the [Moletai Observatory](#) in Lithuania from 18-28th July. The Summer School was organised by Dr Grazina Tautvaisiene of the University of Vilnius.



Figure 35 Students and tutors at the Europlanet Summer School in Moletai, Lithuania. Credit: T. Heenatigala

The Summer School included a brainstorming session on best practice in outreach on Tuesday 25th July, attended by 21 people (11 female, 10 male), including amateur astronomers, outreach professionals and young researchers, with participants from Azerbaijan, Colombia, Croatia, France, Germany, Greece, Italy, Lithuania, Portugal, Romania, Spain, Ukraine and UK. The attendees split into four groups to brainstorm projects, strategies and/or key issues for (1) the visibility of planetary science; (2) the relevance of astronomy to citizens' lives; (3) addressing topical issues and controversies; and (4) widening participation to engage different communities with planetary science. A short report and a summary of evaluation of the Summer School can be found [here](#).



Figure 36 Students and tutors at the Europlanet Outreach Workshop in Athens. Credit: S. Koufos

A workshop, “Touching the Planets, Evaluating Excellence” was organised at the Kostis Palamatis Building at the National and Kapodistrian University of Athens.

- 18 people attended from Greece and Cyprus (11 male, 8 female), including amateur astronomers, outreach professionals and young researchers. Participants shared best practice of running outreach activities and gained hands-on experience of using the Europlanet [Evaluation Toolkit](#)
- An [evaluation report](#) of the workshop can be found online.

Sessions on “Making the case for European astronomy and space science: public and political engagement” were held at the European Week of Astronomy and Space Science (EWASS) in 2017 and 2018, co-organised by EPN2020-RI, the Royal Astronomical Society (RAS), the European Astronomical Society and the European Space Agency:

- For the 2017 session, abstracts were submitted for 13 oral presentations and 2 posters by outreach, communication and policy professionals, including invited speakers from the European Space Agency (ESA) and the Science and Technology Facilities Council (STFC).
- The session was allocated two 1.5 hour time blocks, each including 30 minutes discussion on the topic.
- A review of the session was published in the February issue of the RAS magazine, Astronomy & Geophysics, which reaches more than 3000 astronomers worldwide.
- The 2018 session featured a panel including MEP Clare Moody, Nathalie Meusy of the European Space Agency and Terry O’Connor of the Science and Technology Facilities Council. For details of the session and to download the presentations, see: <http://www.europlanet-eu.org/making-the-case-for-astronomy-engaging-with-policy-makers/>

Four sessions in the Outreach Education and Policy programme stream at EPSC 2017 in Riga included 29 oral presentations and 11 posters:

- [OEP1](#): Policy & Sociocultural Aspects of Planetary exploration/Networking of European planetary science communities/Citizen Science with Big Data
- [OEP2](#): Education, capacity building and training with Planetary Research
- [OEP3](#): Planetary science and exploration outreach through Arts

- [OEP4](#): International lunar decade - towards a self-sustaining space economy

Additionally, a breakfast event was held at EPSC 2017 to discuss the needs of the outreach community in developing the evaluation toolkit.

1.2.2.3. Subtask: Training (U Leiden, UCL, SO)

As stated above, it was decided to pool resources and focus the training at the Europlanet Summer School. Following the success of this course, a similar programme was offered for the 2018 Summer School.



Figure 37: Students at the Europlanet Summer School 2018 use the “Physical Ranking Scale” to show how much experience they have with doing outreach, from none (left) to a lot (right).

The summer school aims to equip young researchers and amateur astronomers with skills in observational astronomy and in science communication. The modules included:

- Basics of Science Communication and introduction to Evaluation Toolkit
- Writing for the Media
- Engaging with Schools
- Engaging with the Public
- Social Media Communications

Practical exercises included:

- Using the “Three words” evaluation tool to gather information on students’ reasons for doing outreach
- Drafting a press release
- Making a sixty-second video or a social media story.
- Mind-mapping a public engagement activity on the theme of ‘Planetary sciences and climate change’.
- Developing an inquiry-based learning activity for educators.

The 2017 Summer School had 21 participants (11 female, 10 male) from 13 countries (Azerbaijan, Colombia, Croatia, France, Germany, Greece, Italy, Lithuania, Portugal, Romania, Spain, Ukraine and UK), comprising mainly young scientists (post-doctoral researchers, PhD students, Masters students and undergraduates) but also amateur astronomers.

The 2018 workshop had 21 participants (12 female, 9 male) from 9 countries (Finland, Greece, Italy, Lithuania, Romania, Spain, Ukraine, UK and USA), comprising young scientists (post-doctoral researchers, PhD students, Masters students and undergraduates) studying astronomy and other disciplines (software engineering, mechanical engineering, museum studies), amateur astronomers and teachers.

In 2017, a [press release](#) written by students about the summer school was published on the Lithuanian news site [alkas.lt](#). In 2018, a press release written by students about the summer school was published on the University of Vilnius [website](#).

A photo diary by Andrius Zigmantus, one of the participants from Lithuania, can be found [here](#). A short report and links to presentations from the 2017 Summer School and a summary of evaluation responses by the students can be found [here](#). A full evaluation report on the 2018 workshop can be found [here](#).

NA2 has also supported teacher training workshops at the Academy of Education of the Vytautas Magnus University in Vilnius, Lithuania and at EPSC 2017 in Riga. NA2 also supported outreach training modules during the Europlanet Early Careers (EPEC) meeting in Strasbourg on Tuesday 12 June.

1.2.2.4 Sub-task Europlanet Prize and Funding Scheme

During RP2, Dr Regis Courtin took over management of this task from Dr Thierry Fouchet, both affiliated with the Beneficiary ObsParis.

The Europlanet Prize for Public Engagement 2017 was awarded to the team behind the exhibition, “Comets – The Rosetta Mission: Journey to the Origins of the Solar System”, at the Museum für Naturkunde, Berlin and the Europlanet Prize for Public Engagement 2018 was awarded to Dr Amara Graps for raising the profile of planetary science in the Baltic region. Press releases were issued to announce the prize winners.



Figure 38: Europlanet Prize Winner 2018, Dr Amara Graps. Credit: Anrijs Pozarskis

There were 2 nominations for the prize (from the UK and Latvia) in 2018 and 3 (from UK and Germany) in 2017. There were 17 applications for the funding scheme in 2017 (France, Greece, Ireland, Italy, Netherlands, Slovenia, Spain, Sweden and UK) and 4 applications for the funding scheme in 2018 (Greece, Ireland, Spain, and UK). The reasons for the low number of applications in 2018 are not entirely clear, but additional steps will be taken by the Outreach Jury to promote the 2019 round of both the Prize (for which nominations were also down) and the funding scheme.

In the 2017 Funding Scheme round, 7000 Euros were awarded to the National and Kapodistrian University of Athens / Department of Physics for 'Planets in Your Hands', a project to construct models of planetary surfaces in square frames, giving a visual and tangible representation of a wide range of environments in our Solar System and 10,000 Euros were awarded to SpaceFrog Design for 'OpenPlanetaryMap', a mapping and social platform for space enthusiasts and students, planetary researchers and mappers, educators and story tellers. In addition, [Speak Science](#) was awarded an additional 7,500 Euros (having been awarded 7,500 Euros in 2016 to develop an affordable, self-build version of a 'Science on a Sphere' display system) having submitted [this progress report](#) and demonstrated a working prototype at EPSC 2017 in Riga.

In the 2018 Funding round, 7,500 Euros were awarded to the Connacht Schools Planetary Radio Telescope Network to install 8 radio telescopes in rural secondary schools in Ireland.

Task 13.3- Dissemination to Stakeholders

1.2.3.1. Sub-task: European Planetary Media Centre (SO)

Europlanet's Social Media Manager, Thilina Heenatigala stepped down at the end of RP2 and will be replaced in RP3 by Sara Mynott.



Figure 39: Media interview with Latvian Finance Minister during EPSC 2017

A major activity for the Europlanet Media Centre is to provide press office support for EPSC. The European Planetary Science Congress 2017 attracted 808 participants from 40 countries and more than 20 representatives of the media, including from AFP, DPA, Physics World, Nature Astronomy, Nature Geophysics, Forschung aktuell DLF, Tähdet ja avaruus, Zparks.lv, www.teadus.ee, Latvijas Avīze, Diena, Berlingske Media, Latvijas Radio, Ilustrētā Zinātne and some freelance journalists. The EPSC Press Office issued two media invitations, two details of press briefings and eight press releases on science presented at the meeting were issued, as well as a press release to announce the winner of the Farinella Prize 2017.

LMT, who sponsored EPSC provided media support through the Deep White PR Agency. Details of the Latvian coverage can be found in the [monitoring report](#) compiled by Deep White.

The press release on [Devilish source of dust in atmosphere of Earth and Mars](#) featured a research trip funded through the EPN2020-RI TA1 programme. The press release on [What do we need to know to mine an asteroid?](#) covered a White Paper resulting from Asteroid Science Intersections

with In-Space Mine Engineering (ASIME) 2016 conference, which was supported through the EPN2020-RI NA1 workshop programme.

Two press briefings were held during EPSC and were webcast to provide access for journalists worldwide [Pushing the Boundaries of Planetary Exploration](#) (19th September and [Cassini/Comet Siding Spring encounter with Mars](#) (21st September). Additional press releases and web stories during the reporting period of the project have covered activities of EPN2020-RI, including:

- TA1 ([Extreme environment of Danakil Depression sheds light on Mars, Titan and nuclear waste](#))
- TA2 ([Monitoring microbes to keep Marsonauts healthy, Levitation key to long-debated mystery of how recent and present-day martian landscapes form](#))
- JRA2 ([Creating a hotspot for understanding Venus – the Planetary Spectroscopy Laboratory](#))
- NA1 ([Ground-breaking ground-based images of planets obtained by Pic-Net Pro-Am team](#)), ([“New views of Jupiter” showcases swirling clouds on giant planet](#))
- NA2 ([Europlanet Prize for Public Engagement 2018 awarded to Amara Graps](#)).

The press release on the JRA1 Europlanet field trip to the Danakil Depression in April 2016 led to several ongoing contacts with journalists that were interested in covering the follow-up field trip in January 2017. A TV crew from Nutopia Ltd accompanied the Europlanet JRA1 team to film for the National Geographic series, [One Strange Rock](#), which is produced by Darren Aronofsky and narrated by Will Smith. This footage was featured in the first episode of the series, broadcast around the world in March 2018, and specifically mentioned in several of the series reviews (e.g. [Telegraph](#), [Inverse](#), [Entertainment Weekly](#), [Forbes](#), [Science News](#)).

For details of coverage of the press releases, see a more detailed spreadsheet [here](#).

1.2.3.2. Sub-task Online and Social Media (SO)

The website has had more than doubled its average monthly users during RP2, with high profile press releases, social media campaigns and more regular content updates helping to increase visitor numbers to the site. There have been 86 posts on the Europlanet Outreach website during RP2, including 25 press releases, 8 guest posts from researchers in the community, 16 reports on meetings, workshops and other activities, and 37 announcements.

Audience Overview



Figure 40: Google Analytics for the Europlanet Outreach Website during the reporting period

Europlanet maintains a social media presence on [Facebook](#), [Twitter](#), [Instagram](#), [Flickr](#) and [YouTube](#). Information is posted on a regular basis (usually daily, but more frequently during events e.g. EPSC or Europlanet workshops). Europlanet’s social media following has continued to grow steadily during RP2 (see Figure 41). Europlanet’s YouTube channel has 166 subscribers and 29,388 views.

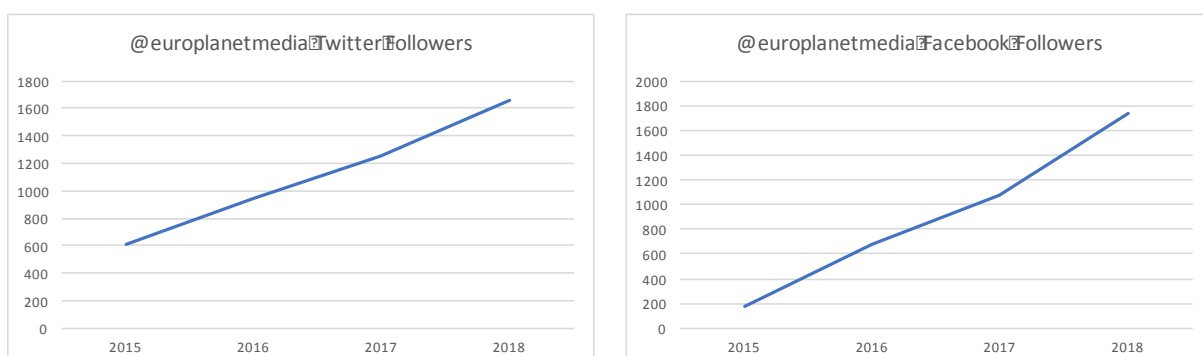


Figure 41: Rise in @europlanetmedia followers on social media since start of EPN2020-RI project

The hashtag #EPSC 2017 was promoted from the spring of 2017. During the week of the meeting, #EPSC2017 was a trending topic in Riga and Latvia and had more than 7 million impressions and a 2.3 million reach on Twitter.



3,610
POSTS

805
USERS

2,300,956
REACH

7,056,899
IMPRESSIONS

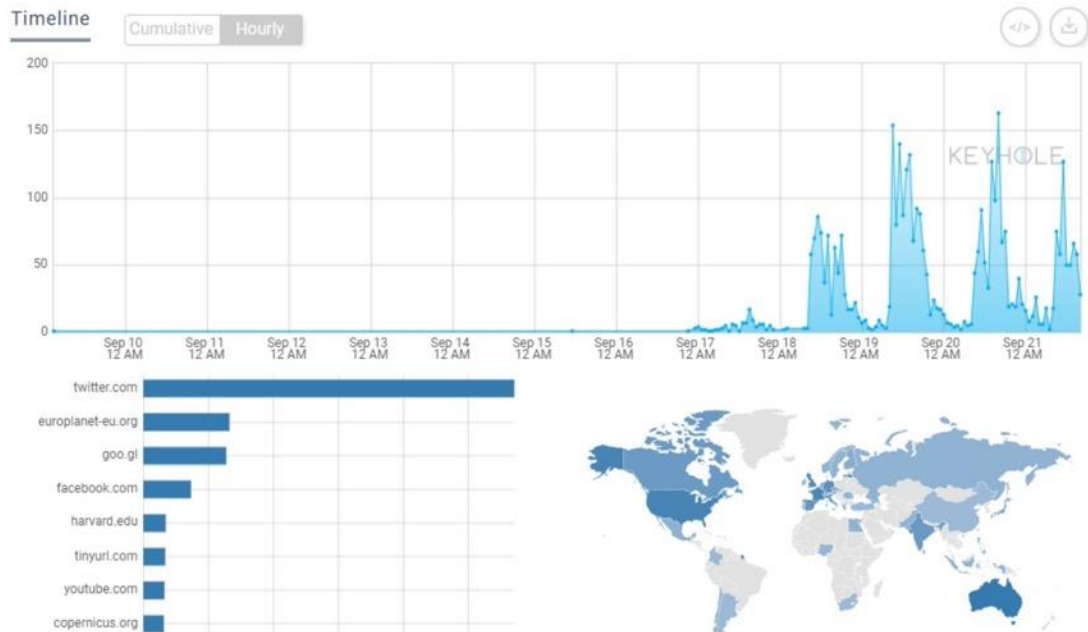


Figure 42: #EPSC2017 trended on social media during the meeting in Riga

Since April 2017, Europlanet webinars have been managed by Nuclio, based in Portugal, and have included live participation from schools in Europe and around the world. Europlanet held ten webinars during RP2:

- May 2017 – [“Exploration of Saturn's Icy Moons as Possible Habitats”, with Dr Athena Coustenis](#)
- July 2017 – [“Inspired by Cosmic Space”, with Dr Eleni Chatzichristou](#) (live stream of public lecture at Europlanet Summer School 2017)
- September 2017 – [“Cassini-Huygens and The Lord of the Rings”](#) with Dr Sheila Kanani (female, British). Audience: 4 classrooms live, 31 individual viewers live, 62 views on YouTube.
- October 2017 – [“Chasing the devil – what do dust devils on Earth tell us about Mars”](#) with Dr Jan Raack (male, Dutch). Audience: 4 classrooms live, 39 individual viewers live, 40 views on YouTube.
- November 2017 - [“Impact cratering – the most important geological process in our Solar System”](#) with Dr Anna Losiak (female, Polish). Audience: 9 classrooms live, 50 individual viewers live, 151 views on YouTube.
- December 2017 – [“Diamonds – Precious time capsules from the deep Earth”](#) with Dr Janne Koornneef (female, Dutch). Audience: 0 classrooms (school holidays), 16 individual viewers live, 78 views on YouTube
- January 2018 - [“Creating a hotspot for understanding Venus – the Planetary Emissivity Laboratory”](#) with Dr Joern Helbert. Audience: broadcast live but not recorded due to technical issues. Viewing figures not available.
- March 2018 – [“Back to the Moon”](#) with James Carpenter (Male, British). Audience: 4 classrooms live, 41 individual viewers live, 16 views on YouTube.

- April 2018 – “[Exploring Mars on Earth](#)” with Joao Lousada (Male, Portuguese). Audience: 2 classrooms live, 51 individual viewers live, 25 views on YouTube.
- June 2018 – “[Hayabusa2 Mission to the Asteroids](#)” with Dr Elizabeth Tasker (female, British). Audience 5 classrooms live, 62 individual viewers live, 73 views on YouTube.

EPN2020-RI celebrated the significant milestone of the end of the Cassini mission with a series of blog posts and webinars with members of the EPN2020-RI community, an official statement of congratulations from Europlanet that highlighted the role that Cassini-Huygens had played in the formation of Europlanet, and posts on social media.

See [Appendix 1](#) for a full report on social media.

1.2.3.3. Sub-task Policy-makers and Industry (SO, INAF)

During RP2, Europlanet organised a dinner debate in the European Parliament on 24th April 2018 on the topic: “Planetary exploration inspiring European innovation”. The dinner debate was hosted by Marian-Jean Marinescu MEP and was attended by Clare Moody MEP, Flavio Zanonato MEP, 3 representatives of Members of the European Parliament, 5 representatives of the European Commission, as well as representatives of the European space industry and the European planetary science community. A total of 30 guests participated in the dinner debate. Presentations were made by Mr Marinescu MEP, Prof Nigel Mason (Coordinator of Europlanet), Prof Lena Noack (Freie Universität Berlin), Kartik Kumar (Austrian Space Forum, analogue astronaut, Co-founder & CEO satsearch.co) and Dr Marcell Tessenyi (EPN-2020-RI Industry Officer, CEO Blue Skies Space Ltd). The discussion focused on recommendations for Framework 9, as well as proposals of themes for future Widespread and calls. EPN2020-RI distributed updated briefing sheets about the project and [the impact of EU funding on planetary science](#), as well as a briefing sheet from the ASD-Eurospace Exploration Working Group on [Key Messages to Europlanet on Planetary Exploration: Inspiring European Innovation](#). Details of the topic and photos of the event can be found here: <http://www.europlanet-eu.org/dinner-debate-planetary-exploration-inspiring-european-innovation/>



Figure 43: MEP Marian-Jean Marinescu at the Dinner Debate

EPN2020-RI provided [input to the Multiannual Financial Framework](#) public consultation on EU funds in the area of investment, research & innovation, SMEs and single market, as well as encouraging EPN2020-RI beneficiaries, associates and Europlanet Consortium members to provide organisational

and individual input. It has also continued with its programme of one-to-one briefings with MEPs, including several meetings with Mr Marinescu, who hosted the dinner debate, and his office staff, and Ms Moody, who continues to be a key supporter of Europlanet.

EPN2020-RI has also attended a number of space policy conferences and events, including the 10th Annual Conference on European Space Policy on 23-24 January 2018 in Brussels, an event “Which future for space research in Europe after 2020?” hosted at the Representation of the Free State of Bavaria to the European Union, in Brussels in November 2017 and the [UK Space Conference](#) in Manchester in June 2017.

Task 13.4 - Development of Outreach and Educational Tools

1.2.4.1. Sub-task. Planetary Video Shorts (SO)

During RP2, EPN2020-RI released two popular-science animated videos ([Astrobiology: Life in the Universe](#) and [Space Detectives: The Case of the Rocks from Space](#)) as part of a series with the aim of widening engagement with planetary science amongst Europe’s citizens. The language and visual style for the videos were chosen to be appealing to audiences that normally would not engage in this kind of content. The themes chosen for the videos relate to topical areas in planetary science and align with research supported through EPN2020-RI.

The videos are available on YouTube, Vimeo and Facebook on both Europlanet’s and Science Office’s channels and have been promoted through Facebook, Twitter and Instagram. Mass media use of the videos and supporting graphics has increased the audiences reached. The videos have also been promoted through partner networks (e.g. the Space Group of the Ecsite network of science centres, museums and planetaria).

Scientific oversight was provided by Dr Barbara Cavalazzi of the University of Bologna and Dr Felipe Gomez of CAB-INTA for the Astrobiology script and by Prof Gareth Davies of VU Amsterdam for the Space Detectives script.

A Christmas/seasonal giveaway of four posters was run as a campaign on social media to further promote the videos, along with a [teaser](#), [trailer](#) and posters (example below).



Figure 44: Four posters were given away to promote the Astrobiology video

EPN2020-RI’s “Astrobiology” video will be featured as part of an exhibition by [S\[Cube\]](#), which creates annual touring exhibits that are displayed at venues around the Ile-de-France and wider France. The exhibits are typically visited by 7,000 people. The second video in the series, “[Jupiter and Its Icy Moons](#)” was shortlisted for the European Science TV and New Media Festival and Awards 2017/18.

An additional video, using footage from the four animations, has been created to promote the EPN2020-RI project overall.

1.2.4.2. Sub-task Planetary Analogue and Comparative Planetology Outreach and Educational Tools (LU, INTA)



Figure 45 Planet P.I. in field tests during the TA1 field trip to the Danakil Depression

The “Planet P.I. project” is based around two of Europlanet’s core science themes, planetary analogues and comparative planetology, and is intended for use in formal and informal settings. “Planet P.I.” challenges students to compare climate data on Earth with data from the Rover Environmental Monitoring Station (REMS) instrument on the Curiosity Rover, which has been exploring the Gale Crater on Mars since August 2012.

Projects have been designed to allow for different levels of engagement by schools or groups and at different age ranges:

- Older students (13-18) can build their own climate sensors based on the Raspberry Pi single board computer. A suite of sensors has been identified and issued to a group of experienced teachers for piloting. Students can use the kit to collect their own data and compare it with data collected using the same sensors by scientists during planetary analogue field trips supported through Europlanet's JRA/TA programme.
- School groups that do not want to build the kit but still participate in the project can access archive data online and process this to complete investigations.
- A project has also been developed for younger students (9-13 years) to compare online data from REMS and data from weather stations around the world.

The projects are linked to key topics in school curricula (e.g. ideal gas equation, climate, seasons, position of planets within the solar system, conditions for life etc).

Pilot versions of the Planet P.I. Raspberry Pi kit have been issued to teachers in Spain, the UK and Latvia. The projects will be refined and publicised to a wider audience in Year 4 of the project.

Task 13.6- Access to Dissemination events

Can be found online [here](#).

1.2 Impact

1.2.1 Evaluation and measuring impact

The Europlanet Evaluation Toolkit developed during RP2 provides tools to enable the collection of basic and more complex information about the outcomes of outreach activities. We believe the Toolkit is a unique, valuable and much-needed resource that will have a significant usage within the Europlanet project, the planetary science community and beyond for many years to come.

1.2.2 Diversity and Inclusion - engaging European citizens across the EU



Figure 46- Students and tutors at the Europlanet Summer School 2018 in Moletai, Lithuania. Credit: Andrius Zigmantas

Diversity has been an increasing area of concern and focus for EPN2020-RI outreach during the reporting period. A Europlanet Diversity Working Group was set up following a diversity networking session convened at EPSC 2017. This Working Group aims to champion issues relating to diversity within the Europlanet community, including EPN2020-RI outreach activities. It also became a standing community of the Europlanet Society launched in September 2018.

NA2 has carried out an audit of the gender balance of all its outputs to date. During the reporting period, 50% of guests on Europlanet's webinars were female, 32% of the talks streamed during EPSC 2017 had a female presenter (29% of abstracts at EPSC 2017 had female first authors), and 34% of researchers quoted or mentioned in the main text of press releases issued by the Europlanet Media Centre were female. However, only one of nine researchers participating in press briefings at EPSC 2017 was female (11%). Attempts were made to ensure a better balance of participants in press conferences at EPSC 2018, although it should be noted that the EPSC Press Office has only partial control of those included (e.g. NASA and ESA approved the line-ups for the Cassini briefing, which was all-male) and some female participants were invited but were unable to attend and handed over to male colleagues.

EPN2020-RI's outreach activities have placed a particular emphasis on engagement with countries that are currently under-represented in the European planetary science community (Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Republic of Macedonia, Romania, Serbia, Poland, Slovakia, Slovenia, Africa (all); Armenia, Azerbaijan,

Georgia, Kazakhstan, Moldavia, Tajikistan, Uzbekistan, Ukraine). Priority is given to holding Europlanet's science communication training and best practice workshops in these under-represented states to assist in building and supporting outreach communities related to planetary science.

Over half of the participants at the Europlanet Summer School in 2017 and 2018, at the Moletai Observatory in Lithuania, were from under-represented countries (Greece, Lithuania, Romania and Ukraine) and participants at the Europlanet Best Practice Meeting, "Touching the Planets, Evaluating Excellence" were from Greece and Cyprus. The workshops in this reporting period bring the total of researchers, amateur astronomers and outreach professionals trained by Europlanet-2020-RI in science communication skills since the project started to 109, including 66 from under-represented states, 59 female and 50 male participants.

In September 2017, EPN2020-RI organised outreach sessions, meetings and training workshops associated with the European Planetary Science Congress (EPSC) 2017 in Riga, Latvia.

An exhibition on the Solar System created for EPSC 2017 in Riga was visited by 600 local school children during the meeting and has since been visited by 10,000 Latvian children at the Zinoo Science Centre in Cesis.

An outcome of a brainstorming session at the first Europlanet Outreach Innovation Day in Athens (held in July 2016) was the identification of a need to provide opportunities for both scientists and journalists to learn about their respective priorities and requirements in order to foster better communication. In 2017, EPN2020-RI issued a special call for journalists, science communicators and lecturers in journalism to participate in an expert exchange programme to visit EPN2020-RI facilities and find out more about activities and spend time with researchers. Three of these visits took place in RP2, all featuring participants from under-represented states (see WP12 for details).

1.2.3 Dissemination of results

The results of Europlanet's activities have been successfully disseminated through the Europlanet Media Centre and Europlanet's social media channels. EPN2020-RI has issued 25 press releases related to its activities in the reporting period (including EPSC 2017), and has also assisted partner institutions to reach a wider audience by translating their press releases into English and by posting on the Europlanet website and on the AlphaGalileo media service. Europlanet activities have been covered by many of the world's leading and most trusted media outlets around the world, including the The Economist, The Financial Times, News Week, AFP, DPA, UPI, ANI, EuropaPress, Agenția Națională de Presă AGERPRES, Yahoo! News, MSN, IFL Science, The Sunday Times, The Daily Mail, the Sun, CBC News, The Times of India, The Hindu, ABC.es, Media INAF, Zeit Online, Der Standard, Deutschlandfunk Forschung aktuell, ORF.at, Híradó, Focus, Popular Mechanics, Gizmodo, Inverse, Space.com, Tähdet ja avaruus, Sky at Night Magazine, Astronomy Magazine, Sciences et Avenir, Urania, Air&Space Magazine, Physics World.

One of the highlights was the coverage of EPN2020-RI's second JRA1 field trip to the Danakil Depression in the National Geographic series, One Strange Rock, which premiered globally on National Geographic in March 2018 in 172 countries and 43 languages.



Figure 47: Screenshot of *One Strange Rock*

The Danakil site continues to receive a great deal of interest from journalists worldwide, with recent enquires from the Polish magazine “Wiedza i Życie” (article yet to be published) and from the Swedish newspaper “Expressen” about the possibilities for accompanying the next field trip. A feature by a journalist, Amanda Sperber, and photographer, Alex Pritz, who accompanied the JRA1 field trip to Danakil in January 2018, is due for publication in the *Virginian Quarterly Review* in the autumn of 2018.

1.2.4 Inspiration and education

Throughout RP2, NA2 has continued to develop its [webinar](#) programme with a focus on schools and teachers. The webinars are hosted by the Nuclio Foundation in Portugal, which is a recognised European leader in training teachers in the use of new technologies and the promotion of real research in classroom. In term time, this has meant that at least 4 classes have participated in each webinar. After the webinars, teachers are sent the guests’ presentation slides so that they can follow up in lessons after the event or replay the videos on YouTube.

Europlanet has run social media campaigns to promote the activities in the astroEDU collections that it has delivered in this reporting period, and continues to offer support for researchers in engaging with schools, via training sessions (e.g. at the Europlanet Summer School 2018 in Lithuania) and for teachers to use planetary science in the classroom (e.g. through astroEDU collections and teacher training workshops in the Baltics).

Since Europlanet’s first field trip to the Danakil Depression in April 2016, opportunities have arisen for NA2 to collaborate with Barbara Cavalazzi at the University of Bologna and colleagues at the University of Mekele in Ethiopia on outreach activities (see WP3 for details).

1.2.5 Engaging with Policy Makers and Industry

During this reporting period, Europlanet 2020 RI focused on ensuring that the community had

opportunities to feed into discussions on Framework 9, Horizon Europe. The highlight of this was a Dinner Debate held on 24th April 2018, just before the Framework 9 debates in the European Parliament in May 2018. The dinner debate was hosted by MEP Marian-Jean Marinescu, who is a very active member of the Sky & Space Intergroup and ITRE Committee, as well as being a driving force behind the STEPP JTI signed in November 2017 by Eurospace and the European Commission.



Figure 48: Kartik Kumar presenting at the dinner debate in the European Parliament in April 2018

The industry database created by the Europlanet Industry Officer, Dr Marcell Tessenyi (Blue Skies Space Ltd (BSSL), has been updated throughout the reporting period and will ultimately include around 1200 space upstream companies in 27 European countries. In the next 12 months, steps will be taken to ensure that the information is GDPR compliant and to develop an interface to make this database accessible to the Europlanet community.

Table 24- List of all dissemination activities

WP	Type of activity	Title	Date	Place	Type of audience	Size of audience	Countries addressed
WP01	Communication Campaign	Emission France culture / La Méthode scientifique.	09/05/2017	France	Scientific Community	n/a	France
WP01	Participation to a conference	Palais de la Découverte : Planétarium, conference, 350 ans of the Paris Observatory.	17/06/2017	Paris	Scientific Community	100	France
WP01	Participation to an Event other than a Conference or a Workshop	Participation at the Panel « Presenting Europe's new vision for space exploration » au ESA pavilion, Paris Air and Space show 2017: http://www.esa.int/About_Us/Exhibitions/Le_Bourget_2017/ESA_at_the_Paris_Air_and_Space_Show_19_25_June_-_Programme_of_events	20/06/2017	Paris	Scientific Community	n/a	France
WP01	Participation to a conference	Conference at Congress « 350 ans de l'Observatoire », Palais de Versailles, Grand Auditorium : « les mondes habitables dans le système solaire externe ».	22/06/2017	Paris	Scientific Community	100	France
WP01	Participation to a conference	Conference and animation at the « Nuit des Etoiles », Montrouge, France.	29/07/2017	France	Scientific Community	100	France
WP01	Participation to an Event other than a Conference or a Workshop	Participation at the event at l'Hôtel de Ville de Paris : « Cosmos sur Scène, télescopes sur Seine ».	01/09/2017	Paris	Scientific Community	n/a	France
WP01	Stakeholder meeting	UK Europlanet community meeting	17/01/2018	UK	Scientific Community	12	United Kingdom
WP01	Stakeholder meeting	Meeting with COST Our Astrochemical History management	02/02/2018	Paris	Scientific Community	11	International
WP01	Participation to a conference	The icy moons of gas giants as possible habitats. Univ. St Andrews Physics Colloquium	06/04/2018	Scotland, UK	Scientific Community	100	International
WP01	Participation to a conference	Possible habitats in the solar system. <u>Keynote lecture.</u>	12/04/2018	Athens	Scientific Community	500	International
WP01	Participation to a conference	The icy moons of the gas giants as possible habitats. CosmoCaixa Foundation Invited Public Lecture	09/05/2018	Spain	Scientific Community	100	International

WP01	Participation to a conference	Les mondes habitables dans le système solaire externe. Bureau des Longitudes Invited Conference of the Ecole Normale Supérieure. .	16/05/2018	Paris	Scientific Community	100	International
WP01	Participation to a conference	Conference/event at the Château de Vincennes : « Fête le Savoir ».	26/05/2018	France	Scientific Community	100	France
WP01	Participation to a conference	The icy moons of the outer solar system as potential habitats. Invited conference, TU Delft	04/07/2018	Delft	Scientific Community	100	International
WP01	Participation to a conference	Panel on International Coordination of Space Exploration Activities (PEX.1). invited talk on "The European Space Sciences Committee On International Coordination For Space Exploration". 42nd COSPAR Scientific Assembly, Pasadena, US, 15-21 July.	17/07/2018	Pasadena	Scientific Community	n/a	USA
WP01	Participation to a conference	Seasonal evolution of organic chemistry in Titan's stratosphere from Cassini/CIRS. <i>Titan Through Time IV</i> . GSFC, Greenbelt, MD, 3-5 April.	03-05/04/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	Habitability potential of icy moons around giant planets and future exploration. <i>AOGS 15th Annual Meeting</i> , Honolulu, HI, USA, 4-8 June.	04-08/06/2018	Honolulu USA	Scientific Community	100	USA
WP01	Participation to a conference	Evolution of Titan's atmosphere near the poles during the Cassini Solstice mission. <i>AOGS 15th Annual Meeting</i> , Honolulu, HI, USA, 4-8 June.	04-08/06/2018	Honolulu USA	Scientific Community	100	USA
WP01	Participation to a conference	Assessing the geology of the Galilean Moons for future missions. <i>AOGS 15th Annual Meeting</i> , Honolulu, HI, USA, 4-8 June.	04-08/06/2018	Honolulu USA	Scientific Community	100	USA
WP01	Participation to a conference	Seasonal evolution of Titan's stratosphere near the poles during the Cassini Solstice mission. <i>EGU General Assembly</i> , Vienna, 8-13 April.	08-13/04/2018	Vienna, Austria	Scientific Community	1000	International
WP01	Participation to a conference	The Spectral Nature of Titan's Major Geomorphological Units. <i>EGU General Assembly</i> , Vienna, 8-13 April.	08-13/04/2018	Vienna, Austria	Scientific Community	1000	International
WP01	Participation to a conference	EU-Japan Plasma meeting	11-13/07/2018	York,UK	Scientific Community	50	International
WP01	Training School	Europlanet Early Career Network	11-15/06/2018	Strasbourg	Scientific Community	50	International

WP01	Participation to a conference	What Does Titan's Atmosphere Look Like Near The Poles At The End Of The Cassini Mission? <i>AGU Fall Meeting</i> , New Orleans, USA. 11-15 Dec.	11-15/12/2017	New Orleans	Scientific Community	100	USA
WP01	Participation to an Event other than a Conference or a Workshop	Invited to the « Space Policy for EU Integration – 60th anniversary of the Rome Treaties high-level event » : https://www.sme4space.org/space-policy-for-eu-integration-60th-anniversary-of-the-rome-treaties/	14-15/06/2017	Rome	Scientific Community	n/a	Italy
WP01	Participation to a conference	EANA European Astrobiology Association	14-17/08/2017	Aarhus, Denmark	Scientific Community	125	International
WP01	Participation to a conference	RSC meeting on Astrochemistry	15-16/01/2018	UK	Scientific Community	55	United Kingdom
WP01	Participation to an Event other than a Conference or a Workshop	Member of the Conclave EU Space policy, Windsor, UK.	15-17/03/2017	UK	Scientific Community	50	United Kingdom
WP01	Participation to an Event other than a Conference or a Workshop	Future of Space exploration	15-17/03/2017	Windsor, UK	Scientific Community	9	International
WP01	Participation to a conference	Atmospheric studies by space mission sin the Solar System and Beyond. <i>42nd COSPAR Scientific Assembly</i>	15-21/07/2018	USA	Scientific Community	500	International
WP01	Participation to a conference	Titan's atmosphere evolution during the Cassini mission and comparison with the Voyager data. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA
WP01	Participation to a conference	The Spectral Nature of Titan's Major Geomorphological Units: Their spectral and morphological nature. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA
WP01	Participation to a conference	Insights on the formation of raised rims around Titan's polar basins from Cassini near-IR and microwave observations. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA

WP01	Participation to a conference	The Saturn PRobe Interior and aTmosphere Explorer (SPRITE) Entry Probe Mission Concept. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA
WP01	Participation to a conference	JUICE: A European Mission to Jupiter and its Icy Moons. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA
WP01	Participation to a conference	Current and future exploration of the habitability potential of icy moons around giant planets. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA
WP01	Participation to a conference	Exploration of icy moons around giant planets: astrobiological aspects. <i>42nd COSPAR Scientific Assembly</i> , Pasadena, US, 15-21 July.	15-21/07/2018	Pasadena	Scientific Community	100	USA
WP01	Organisation of a Conference	EPSC 2017	15-22/09/2017	Riga	Scientific Community	808	International
WP01	Stakeholder meeting	Visit to Debrecen as future TA partner	16-19/07/2018	Debrecen, Hungary	Scientific Community	50	Hungary
WP01	Participation to a conference	The seasonal evolution of organic chemistry in Titan's stratosphere from CASSINI/CIRS. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	Exo-Planetary High-Temperature Hydrocarbons by Emission and Absorption Spectroscopy (the e-PYTHEAS project). <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	Exploration of Jupiter's atmosphere and magnetosphere with the European Jupiter Icy Moons Explorer (JUICE). <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	Transit spectroscopy of a temperate Jupiter. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	The spectral nature of various Titan surface units: implications on the composition. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	Modeling of methane absorption in Titan's atmosphere using ab initio TheoReTS database spectra predictions. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	n/a	International

WP01	Participation to a conference	Titan's Stratospheric Water Vapor profile from Cassini CIRS far-infrared Spectra. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	100	International
WP01	Participation to a conference	Constraining the composition and geological history of the main types of terrains found in the equatorial belt of Titan. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	100	International
WP01	Participation to a conference	The New Frontiers Saturn PRobe Interior and aTmosphere Explorer (SPRITE) Mission Proposal. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	100	International
WP01	Participation to a conference	The Hera Saturn Entry Probe Mission: a Proposal in Response to the ESA M5 Call. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept.	17-22/09/2017	Riga	Scientific Community	100	International
WP01	Participation to a conference	Scientific rationale and concepts for in situ probe exploration of Uranus and Neptune. <i>EPSC 2017</i> , Riga, Latvia, 17-22 Sept. P12B-02	17-22/09/2017	Riga	Scientific Community	100	International
WP01	Participation to a conference	JUICE: A European mission to explore the emergence of habitable worlds around gas giants. <i>EPSC 2017</i>	18-22/09/2017	Riga	Scientific Community	n/a	International
WP01	Participation to a conference	Meeting with COST Origins	19-23/03/2018	Bertinoro, Italy	Scientific Community	70	International
WP01	Participation to a conference	Radiative Transfer Modelling in Titan's Atmosphere Using Cassini/VIMS data. <i>LPSC 2017</i> , The Woodlands, TX, USA, 20-24 March.	20-24/03/2017	USA	Scientific Community	n/a	USA
WP01	Participation to a conference	Exploration of icy moons as habitats. XXXth General Assembly of the International Astronomical Union, Vienna, Austria, 20-31 Aug.	20-31/11/2018	Vienna, Austria	Scientific Community	150	International
WP01	Seminar	Space Plasmas - Europlanet Planetary Space Weather Service	2-3/03/20-17	Dublin,Ireland	Scientific Community	35	Ireland
WP01	Participation to a conference	Cassini's Ring Grazing and Grand Finale Orbits: Topping Off an Awesome Mission. 19th EGU General Assembly	23-28/04/2017	Vienna, Austria	Scientific Community	15000	international
WP01	Participation to a conference	Insights on Titan's atmospheric properties evolution with Cassini. <i>IAPSO-IAMAS-IAGA Genral Assembly, Good hope for Earth Sciences</i> , Cape Town, South Africa, 24 Aug-1 Sept.	24/08-01/09/2017	Cape Town	Scientific Community	n/a	South Africa

WP01	Participation to a conference	Titan's mid-latitude geology using Cassini/VIMS analysis and atmospheric contributions. <i>IAPSO-IAMAS-IAGA Genral Assembly, Good hope for Earth Sciences, Cape Town, South Africa, 24 Aug-1 Sept..</i>	24/08-01/09/2017	Cape Town	Scientific Community	n/a	South Africa
WP01	Workshop	VAMDC Annual meeting	24-25/05/2018	Paris	Scientific Community	30	International
WP01	Participation to a Workshop	Europlanet Workshop	24-26/05/2017	Bratislava,	Scientific Community	38	International
WP01	Participation to a conference	A look toward the surface: Radiative Transfer Modelling in Titan's Atmosphere Using Cassini/VIMS data. <i>EGU General Assembly, Vienna, 24-28 April.</i>	24-28/04/2017	Vienna, Austria	Scientific Community	15000	International
WP01	Participation to a conference	The Hera Saturn Entry Probe Mission: a Proposal in Response to the ESA M5 Call. <i>EGU General Assembly, Vienna, 24-28 April.</i>	24-28/04/2017	Vienna, Austria	Scientific Community	15000	International
WP01	Participation to a conference	Explorer of Enceladus and Titan (E ² T): Investigating Ocean Worlds' Evolution and Habitability in the Saturn System. <i>EGU General Assembly, Vienna, 24-28 April.</i>	24-28/04/2017	Vienna, Austria	Scientific Community	15000	International
WP01	Participation to a conference	Complex organic chemistry in Titan's stratosphere near the poles from Cassini/CIRS. <i>EGU General Assembly, Vienna, 24-28 April.</i>	24-28/04/2017	Vienna, Austria	Scientific Community	15000	International
WP01	Participation to a conference	The spectral nature of Titan's mid-latitude region. <i>EGU General Assembly, Vienna, 24-28 April.</i>	24-28/04/2017	Vienna, Austria	Scientific Community	1500	International
WP01	Participation to a conference	Astrochemistry and planetary science in India workshop and tour	25/10-5/11/2017	India	Scientific Community	200	Mainly Indian
WP01	Participation to a conference	The National Academy of Sciences Space Studies Board Space Science Week: invited talk in CAPS: « The COSPAR Planetary Protection Panel ».	27-29/05/2018	Washington DC	Scientific Community	n/a	International
WP01	Participation to a conference	The National Academy of Sciences Space Studies Board Space Science Week: Plenary Conference: « The European Space Programme ».	28-30/05/2017	Washington DC	Scientific Community	1000	International
WP01	Participation to a conference	UK Space Conference	29-31/05/2017	Manchester, Uk	Scientific Community	400	United Kingdom

WP01	Participation to a conference	CEPAS conference	3-6/09/2017	Prague	Scientific Community	45	International
WP01	Participation to a conference	COST Origins of Life meeting	3-7/04/2017	Warsaw, Poland	Scientific Community	95	International
WP01	Participation to a conference	Habitability potential of icy moons around giant planets and the JUICE mission'. ESLAB 51st Symposium on « extreme habitable worlds ». ESTEC	4-8/12/2017	Noordwijk, The Netherlands	Scientific Community	500	International
WP01	Participation to a conference	Microsatellites	6-10/08/2018	Tartu, Estonia	Scientific Community	60	International
WP01	Training School	ESF Astrobiology elective	8-11/05/2018	Strasbourg	Scientific Community	20	International
WP01	Participation to a conference	The Cassini-Huygens mission at Titan. <i>EGU General Assembly</i> , Union Symposium on the Cassini-Huygens mission	8-13/04/2018	Vienna, Austria	Scientific Community	100	International
WP01	Participation to a conference	Exploration for planetary atmospheres and search for habitable conditions with Horizon 2000. <u>Invited talk</u> . Symposium in honor of R. Bonnet "Space Science Horizon 2000, A retrospective View". ESTEC, Noordwijk	8-9/02/2018	Noordwijk, The Netherlands	Scientific Community	500	International
WP01	Participation to a conference	RSC Faraday meeting on Astrochemistry	11-13/04/2017	Warwick, UK	Scientific Community	70	International
WP01	Participation to a conference	EWAS	3-6/03/2018	Manchester, UK	Scientific Community	300	International
WP02	Participation to a conference	EPSC 2017 + organisation of sessions LF1	18/09/2017	Riga	Scientific Community	40	International
WP03	Participation to a Conference	IPPW 2018	10-15/06/2018	Boulder USA	Scientific Community	300	International
WP03	Participation to a Conference	EPSC 2017 + organisation of sessions LF2, SWM1.9	17-22/09/2017	Riga	Scientific Community	900	International
WP03	Participation to a Conference	LPSC 2018	19-23/03/2018	Houston USA	Scientific Community	2000	International
WP03	Participation to a Conference	Participation to a Conference	23-28/04/2018	St Louis, USA	Scientific Community	300	International

WP03	Participation to a Conference	International Symposium on Thermophysical Properties	25-30/06/2018	Boulder USA	Scientific Community	3000	International
WP03	Participation to a Conference	AOGS 2018	3-8/06/2018	Honolulu USA	Scientific Community	1800	International
WP03/ WP08	Participation to a Conference	Innovations at a European Planetary Simulation Facility, EPSC 2017	19/09/2017	Riga	Scientific Community	800	International
WP03/ WP08	Participation to a Conference	SHADOWS: spectro-goniometer for bidirectional reflectance studies of dark meteorites and terrestrial analogues, EPSC 2017	19/09/2017	Riga	Scientific Community	800	International
WP03/ WP08	Participation to a Conference	Planetary Sample Analysis Laboratory at DLR, Mars Sample Return Conference 2018	27/04/2018	Berlin, Germany	Scientific Community	500	International
WP04	Participation to a conference	"Journée des doctorants de l'IREPSE	11/07/2017	Lille	Scientific Community	50	France
WP04	Participation to a Conference	EGU 2017 + organisation of sessions GMPV2.3	27/04/2017	Vienna, Austria	Scientific Community	15000	International
WP04	Participation to a Conference	11th International Kimberlite Conference	22/09/2017	Berlin, Germany	Scientific Community	500	International
WP04	Participation to a Conference	EGU 2018	09/04/2018	Vienna, Austria	Scientific Community	15000	International
WP05	Participation to a Conference	Semaine de la société française de l'astronomie et de l'astrophysique	03-06/07/2018	Bordeaux, France	Scientific Community	300	France
WP05	Participation to a Conference	EGU 2018	08-13/04/2018	Vienna, Austria	Scientific Community	1000	International
WP05	Participation to a Workshop	NA1 workshop ('Cometary observations and derivation of Solar Wind properties')	09-11/10/2017	Toulouse	Scientific Community	30	International
WP05	Participation to a Conference	52nd ESLAB conference - Comparative Aeronomy and Plasma Environment of Terrestrial Planets	14-18/05/2018	Noordwijk, Netherlands	Scientific Community	200	International
WP05	Participation to a Conference	COSPAR 2018 ('Solar Winds – A service to derive estimates of solar wind speeds from comets' ion tails')	14-22/07/2018	Pasadena	Scientific Community	n/a	International
WP05	Participation to a Conference	COSPAR 2018 ('')	14-22/07/2018	Pasadena	Scientific Community	n/a	International

WP05	Participation to a Conference	PV 2018	15-17/05/2018	Harwell, UK	Scientific Community	100	International
WP05	Participation to a Conference	EPSC 2017	17-22/09/2017	Riga	Scientific Community	900	International
WP05	Participation to a Conference	European Space Weather Week 14	27-30/11/2017	Ostende, Belgium	Scientific Community	300	International
WP05	Participation to a Conference	European Space Weather Week ('A software tool for finding potential cometary tail crossings: Tailcatcher')	27-30/11/2017	Ostende, Belgium	Scientific Community	40	International
WP05	Participation to an Event other than a Conference or a Workshop	Girl's Day - Women with Space Career: Andrea Opitz - talk: "Discovery of the secrets of the Solar System"	26/04/2018	Budapest, Hungary	General Public	1000	Hungary
WP05	Participation to a workshop	Planetary Modelling Tools and Resources NA1 workshop	09/2018	Kalamata, Greece	Scientific Community	12	International
WP05	Participation to a Conference	52nd ESLAB conference - Comparative Aeronomy and Plasma Environment of Terrestrial Planets	14-18/05/2018	Noordwijk, Netherlands	Scientific Community	200	International
WP05	Participation to a Conference	EGU 2017	23-27/04/2017	Vienna, Austria	Scientific Community	1000	International
WP05	Participation to a Conference	European Space Weather Week ('Estimating solar wind speeds from comet ion tail images: Solar Windsocks')	27-30/11/2017	Ostende, Belgium	Scientific Community	40	International
WP05/ WP06	Participation to a Conference	AGU meeting ('Trapped Particle Motion In Magnetodisc Fields' http://adsabs.harvard.edu/abs/2017AGUFMSM33C2668G)	01/12/2017	New Orleans	Scientific Community	20000	International
WP05/ WP06	Participation to a Workshop	Cassini MAPS workshop ('Mapping Saturn's Night Side Plasma Sheet Using Cassini's Proximal Orbits')	16-18/04/2018	Toulouse	Scientific Community	40	International
WP06	Training	Training session at EGU 2017	25/04/2017	Vienna, Austria	Scientific Community	15	International
WP06	Participation to a Conference	JpGU 2017 + organisation of session M-GI27	01/05/2017	Tokyo, Japan	Scientific Community	n/a	International
WP06	Training	Training session at EPSC 2017	21/09/2017	Riga	Scientific Community	17	International

WP06	Organisation of a Conference	ESEP day 2017 (« Bases de Données et Observatoires Virtuels »)	23/11/2017	Meudon, France	Scientific Community	60	France
WP06	Training	Training session at EGU 2018	12/04/2018	Vienna, Austria	Scientific Community	15	International
WP06	Participation to a Conference	JpGU 2018 + organisation of session M-GI23	01/06/2018	Tokyo, Japan	Scientific Community	n/a	International
WP06	Participation to a Conference	AOGS 2018	01/06/2018	Honolulu USA	Scientific Community	n/a	International
WP06	Participation to a Workshop	NA1 workshop: The Sun's influence on planets	09-11/10/2017	Toulouse	Scientific Community	n/a	International
WP06	Participation to a Conference	EGU 2018	09-13/04/2018	Vienna, Austria	Scientific Community	1000	International
WP06	Participation to a Conference	AGU 2017 + organisation of session IN11C	11-15/12/2017	New Orleans, USA	Scientific Community	n/a	International
WP06	Participation to a Workshop	IPDA steering committee meeting (space agencies)	12-14/07/2018	Pasadena	Scientific Community	25	International
WP06	Participation to a Conference	European Lunar Symposium	14-16/05/2018	Toulouse	Scientific Community	150	International
WP06	Training	SSHADE databases user tutorial at 6th European Lunar Symposium	14-16/05/2018	Toulouse	Scientific Community	35	International
WP06	Participation to a Workshop	IVOA Interop Meeting	14-19/05/2017	Shanghai, China	Scientific Community	100	International
WP06	Participation to a Conference	COSPAR + organisation of session 5.2	14-22/7/2018	Pasadena	Scientific Community	1500	International
WP06	Participation to a Conference	PV 2018	15-17/05/2018	Harwell, UK	Scientific Community	200	International
WP06	Organisation of a Workshop	VESPA implementation workshop #4	16-20/04/2018	Prague	Scientific Community	20	International
WP06	Participation to a Conference	EPSC 2017 + organisation of sessions MT8, SMW1.3, SMW1.9	17-22/09/2017	Riga	Scientific Community	900	International
WP06	Participation to a Conference	EPSC2017 (presentation of iPECMAN and PSWS results)	17-22/09/2017	Riga	Scientific Community	n/a	International

WP06	Participation to a Conference	LDSE 2017	19-22/09/2017	Beijing, China	Scientific Community	n/a	International
WP06	Participation to a Conference	EGU 2017	22-28/04/2017	Vienna, Austria	Scientific Community	1000	International
WP06	Participation to a Conference	EGU 2017 + organisation of session SC1.8	23-28/04/2017	Vienna, Austria	Scientific Community	n/a	International
WP06	Participation to a Conference	PSIDA 2018	24-26/04/2018	St Louis, USA	Scientific Community	80	International
WP06	Participation to a Workshop	MHD Simulations in Astrophysics and Space Plasma workshop	2-6/07/2018	Chiang Mai, Thailand	Scientific Community	30	mainly Thailand, Nepal, India.
WP06	Participation to a Workshop	IVOA Interop Meeting	27/05-01/06/2018	Victoria, Canada	Scientific Community	100	International
WP06	Participation to a Workshop	IVOA Interop Meeting	27-29/10/2017	Santiago, Chile	Scientific Community	80	International
WP06	Participation to a Conference	European Space Weather Week (presentation of iPECMAN and PSWS results)	27-30/11/2017	Ostende, Belgium	Scientific Community	40	International
WP06	Organisation of a Workshop	VESPA implementation workshop #3	27-31/03/2017	Graz, Austria	Scientific Community	20	International
WP06	Participation to a Conference	IAA Planetary Defense Conference	5-19/05/2017	Tokyo, Japan	Scientific Community	n/a	International
WP06	Participation to a Workshop	IPDA steering committee meeting (space agencies)	5-7/07/2017	Berlin	Scientific Community	25	International
WP06	Participation to a Conference	XIV Congresso Nazionale di Scienze Planetarie	5-9/02/2018	Bormio, Italia	Scientific Community	n/a	Italy
WP06	Training	SSHADE data provider tutorials	9 x 2-day sessions	various	Scientific Community	90	Europe
WP06	Participation to a Conference	EGU 2018 + organisation of session SC1.12	9-13/04/2018	Vienna, Austria	Scientific Community	n/a	International

WP07	Participation to an Event other than a Conference or a Workshop	La Storia della Terra a colori	16/03/2017	LabOratorio di San Filippo Neri, Bologna, Italy	Scientific Community	40	International
WP09	Participation to an Event other than a Conference or a Workshop	Goldschmidt Paris 2017	13-18/08/2017	Paris	Scientific Community	1000	International
WP10	Participation to a Workshop	International CCMC-LWS Working Meeting	03-07/04/2017	Cape Canaveral, USA	Scientific Community	300	International
WP10	Participation to a Conference	JpGU 2017	20-25/05/2017	Chiba, Japan	Scientific Community	1000	International
WP10	Website	http://planetaryspaceweather-europlanet.irap.omp.eu/	RP2	Online	Scientific Community	n/a	International
WP10	Website	http://transplanet.irap.omp.eu/	RP2	Online	Scientific Community	n/a	International
WP10	Website	http://magnetodisc.irap.omp.eu/	RP2	Online	Scientific Community	n/a	International
WP10	Website	http://alerts-psws.irap.omp.eu/	RP2	Online	Scientific Community	n/a	International
WP10	Website	http://radmaree.irap.omp.eu/	RP2	Online	Scientific Community	n/a	International
WP11	Organisation of a Workshop	VESPA workshop: Aladin and planetary surfaces	02/06/2017	Paris	Scientific Community	10	France
WP11	Organisation of a Workshop	VESPA workshop: Planetary Mapping and Virtual Observatory	19-21/04/2017	Roscoff, France	Scientific Community	30	International
WP11	Organisation of a Workshop	VESPA workshop: Sharing Planetary modelling run results in VESPA	27-29/11/2017	Brussels	Scientific Community	20	International
WP12	Non-peer-reviewed publication	ExoMars Atmospheric Science and Missions Workshop Abstracts, FMI Reports 2017:5, ISBN 978-952-336-028-0	01/05/2017	n/a	Scientific Community	n/a	International

WP12	Participation to an Event other than a Conference or a Workshop	Europlanet - Potential für die österreichische Amateurastronomie, General Assembly of the Austrian Society for Astronomy and Astrophysics (OeGAA)	13/10/2017	Vienna, Austria	Scientific Community	n/a	Austria
WP12	Non-peer-reviewed publication	Proceedings of the 8th International Workshop on Planetary, Solar and Heliospheric Radio Emissions, Eds. Fischer, G., G. Mann, M. Panchenko, P. Zarka , Austrian Academy of Sciences Press, Vienna, 2017.	01/12/2017	Vienna, Austria	Scientific Community	n/a	International
WP12	Organisation of a workshop	PSWS/NA1 workshop on Sun's influence on planets	09-11/10/2017	Toulouse	Scientific Community	30	International
WP12	Participation to a Conference	IPPW-14	12-16/06/2017	Hague, The Netherlands	Scientific Community	300	International
WP12	Organisation of a workshop	PSWS/NA1 workshop on Tools for Amateurs	17-19/07/2018	Pic du Midi, France	Scientific Community	20	International
WP12	Participation to a Conference	EPSC 2017, organization of the AM session + exhibition	17-22/09/2017	Riga	Scientific Community	900	International
WP12	Participation to a Conference	Europlanet 2020: Fostering the collaboration between professional scientists and amateur astronomers, EPSC 2017	17-22/09/2017	Riga	Scientific Community	900	International
WP12	Organisation of a workshop	Planetary Exploration 2061 workshop	23-25/04/2018	Lausanne, Switzerland	Scientific Community	50	International
WP12	Organisation of a Workshop	Europlanet ExoMars Workshop	26-30/03/2017	Saariselkä, Finland	Scientific Community	15	International
WP12	Non-peer-reviewed publication	Comet Formation workshop news article, Az Buki, https://azbuki.bg/en/	n/a	Sofia, Bulgaria	Scientific Community	n/a	Bulgaria
WP13	Organisation of a Workshop	Best Practice workshop at Europlanet Summer School 2017	25/07/2017	Moletai Astronomical Observatory, Lithuania	Scientific Community/ Other (Amateur Astronomers/ Educators)	21	International

WP13	Organisation of a Workshop	Evaluation Brainstorming, Community event at EPSC 2017	21/09/2017	Riga	Scientific Community/Other (Amateur Astronomers/Educators/Outreach Professionals)	15	International
WP13	Participation to a Conference	Concepts for Mars Sample Return Public Outreach, Mars Sample Return Conference 2018	27/04/2018	Berlin, Germany	Scientific Community	500	International
WP13	Organisation of a Workshop	Touching the Planets, Evaluating Excellence' Best Practice Workshop	2-3/07/2018	Kostas Palamas Building, University of Athens, Greece	Scientific Community/Other (Amateur Astronomers/Educators)	18	Greece/Cyprus
WP13	Website	Europlanet Outreach Website	RP2	www.europlanet-eu.org	Scientific Community/General Public/Media/Other (Educators/Outreach Professionals)	20578	International
WP13	Press release	European Planetary Science Congress 2017 – 1st Media Announcement	12/06/2017	Online	Scientific Community (Higher Education, Research)/General Public/Media, Other (Educators/Outreach Professionals)	5000	International

WP13	Press release	"Comets – The Rosetta Mission" Exhibition Curation Team Awarded Europlanet Prize 2017	28/06/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Ground-breaking ground-based images of planets obtained by Pic-Net Pro-Am team	20/07/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	European Planetary Science Congress 2017: 2nd Media Announcement	10/08/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International

WP13	Press release	Final media announcement and details of press briefings at European Planetary Science Congress 2017	15/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Studies of 'Crater Capital' in the Baltics show impactful history	18/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Devilish source of dust in atmosphere of Earth and Mars	18/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International

WP13	Press release	Watch live streaming of sessions and press briefings at EPSC 2017	18/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	2017 Farinella Prize Awarded to Simone Marchi	18/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Size matters in the detection of exoplanet atmospheres	19/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International

WP13	Press release	Nanosat fleet proposed for voyage to 300 asteroids	19/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	What do we need to know to mine an asteroid?	19/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	EPSC 2017 Press Briefings Live Stream	20/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International

WP13	Participation to a Conference	Impact Through Outreach and Education with Europlanet 2020-RI	21/09/2017	Riga	Scientific Community, Other (Outreach Professionals, Educators, Amateur Astronomers, Policy Makers)	40	International
WP13	Participation to a Conference	Policy Activities in Europlanet 2020 RI	21/09/2017	Riga	Scientific Community, Other (Outreach Professionals, Educators, Amateur Astronomers, Policy Makers)	40	International
WP13	Participation to a Conference	Public Engagement in Planetary Science through Europlanet Social Media	21/09/2017	Riga	Scientific Community, Other (Outreach Professionals, Educators, Amateur Astronomers, Policy Makers)	40	International
WP13	Press release	Diamonds show Earth still capable of 'superhot' surprises	21/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Ou	5000	International

					treach Professionals)		
WP13	Press release	Solar eruption 'photobombed' Mars encounter with Comet Siding Spring	21/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Ou treach Professionals)	5000	International
WP13	Press release	'Crash Scene Investigation' reveals resting place of SMART-1 impact	22/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Ou treach Professionals)	5000	International
WP13	Press release	Lava tubes: the hidden sites for future human habitats on the Moon and Mars	23/09/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other	5000	International

					(Educators/Outreach Professionals)		
WP13	Press release	Monitoring microbes to keep Marsonauts healthy	04/10/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Levitation key to long-debated mystery of how recent and present-day martian landscapes form	27/10/2017	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Creating a hotspot for understanding Venus – the Planetary Spectroscopy Laboratory	07/02/2018	Online	Scientific Community (Higher Education, Research), General Public, Media, Other	5000	International

					(Educators/Outreach Professionals)		
WP13	Press release	Europlanet at EGU	09/04/2018	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	Extreme environment of Danakil Depression sheds light on Mars, Titan and nuclear waste	18/04/2018	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	"New views of Jupiter" showcases swirling clouds on giant planet	10/05/2018	Online	Scientific Community (Higher Education, Research), General Public, Media, Other	5000	International

					(Educators/Outreach Professionals)		
WP13	Press release	Europlanet Prize for Public Engagement 2018 awarded to Amara Graps	27/06/2018	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Press release	European Planetary Science Congress (EPSC) 2018, 16-21 September, TU Berlin – 1st Media Announcement	26/07/2018	Online	Scientific Community (Higher Education, Research), General Public, Media, Other (Educators/Outreach Professionals)	5000	International
WP13	Participation to a Conference	Presentation on "Europlanet 2020 RI - planetary science, public engagement and policy", Making the Case for Astronomy, Special Session, European Week of Astronomy and Space Science (EWASS) 2017	28-29/06/2017	Prague	Scientific Community, Other (Outreach Professionals, Policy Makers)	40	International

Table 25 - Resources used to provide access to Research Infrastructures

Beneficiary Short Name	Beneficiary Number	WP2	WP3	WP4	WP5	WP6
		TA1	TA2	TA3	PSWS VA	VESPA VA
OBSParis	2					22.45
UCL	3					4.21
CNRS	4		2.5		7.7	25.49
UGA	4		0.32		0.44	2.77
UPS	4				0.37	0.16
INTA	5	0.01				
OEAW	8					0.75
DLR	11				0.30	
ABER	12				2.09	
JACOBS	15					129
INAF	16					6.27
IAP	19					4.2
IASB BIRA	26					1.49
UPV/EHU	28				6.2	1.72
IGS PAS	29					10
SRC PAS	33				11.25	