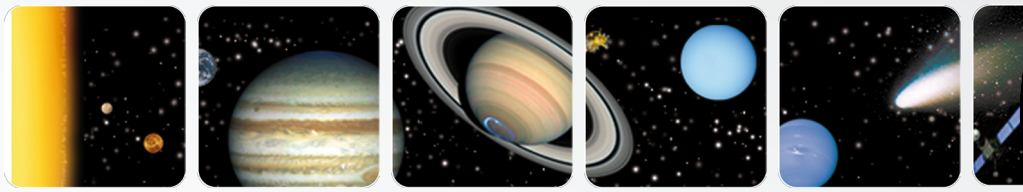
A European Research Infrastructure for Planetary Science



Combination of collaborative project and coordination and support action for integrating activities

PROJECT FINAL REPORT
2009-2012

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EUROPLANET RI AT A GLANCE

Following a four-year Coordination Action supported by the European Union under the Sixth Framework Programme (FP6), the Europlanet Research Infrastructure (RI) project was launched in January 2009 for a duration of four years.

It was an Integrated Infrastructure Initiative (I3), a combination of

- Networking Activities (NA),
- Transnational Access Activities (TNA)
- Joint Research Activities (JRA).

The project was co-funded by the European Union under the Seventh Framework Programme (FP7).

SIXTH FRAMEWORK PROGRAMME
2005 - 2008
2 M€

SEVENTH FRAMEWORK PROGRAMME
2009 - 2012
6 M€

This report summarises the activities and achievements of Europlanet RI.

Project Reference:
FP7-228319

Duration: 48 months
Start Date:
1st January 2009
End Date:
31 December 2012

27 participants
45 laboratories
16 countries

EU Funding:
6 million euros

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EUROPLANET CONSORTIUM

The Europlanet RI consortium is a large and wide-spread consortium. It is made up of 27 participants (contractors) from 16 countries that include13 EU Member States. Many of those comprise several research teams: this means that in practice, 41 research laboratories and space agencies work together within the Europlanet RI consortium.

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01 CNRS	National Centre for Scientific Research	France
08 OBSPARIS	Observatory of Paris	
02 FMI	Finnish Meteorological Institute	Finland
03 INAF	National Institute for Astrophysics	
16 CINECA	CINECA	Italy
22 IRSPS	International Research School of Planetary Sciences	
04 INTA-CAB	National Institute for Aerospace Technology / Astrobiology Centre	Spain
05 IWF-OEAW	Space Research Institute / Austrian Academy of Sciences	Austria
06 KFKI	Institute for Particle and Nuclear Physics	Hungary
07 MPG	Max-Planck-Gesellschaft	
10 TUB	Technical University Berlin	Germany
17 DLR	Institute of Planetary Research	
21 USTUTT	University of Stuttgart	
09 OU	Open University	
11 UCL	University College London	United Kingdom
12 UW-MAPS	Aberystwyth University / Institute of Mathematics and Physics	
14 AO	Armagh Observatory	
13 VUA	Vrije University Amsterdam	The Netherlands
24 JIVE	Joint Institute for VLBI in Europe	
27 UU	Utrecht University	
15 AU-MSL	Aarhus University / Mars Simulation Laboratory	Denmark
18 FFI	Norwegian Defence Research Establishment	Norway
19 IAP	Institute of Atmospherics Physics	Czech Republic
20 IKI-RAS	Space Research Institute / Russian Academy of Sciences	Russia
25 NNSU	Lobachevsky State University of Nizhni Novgorod	
23 ISSI	International Space Science Institute	Switzerland
26 ISARS-NOA	ISARS / National Observatory of Athens	Greece

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How Europlanet was organized

The objective of Europlanet RI was to bring together Europe's leading planetary researchers and laboratories to develop a coherent, focused, collaborative planetary science research programme.

The project was structures around three types of activities:

- **Networking Activities (NA)**
  Fostering a culture of cooperation between planetary scientists, both between project participants and the wider community, throughout Europe.
  - NA1 Observational Infrastructure Networking
  - NA2 Science Networking
  - NA3 Europlanet Outreach Innovation and Media Service
  - NA4 Dissemination

- **TransNational Access (TNA)**
  Providing integrated access to a set of research infrastructures needed for planetary research
  - TNA1 Planetary Field Analogues
  - TNA2 Planetary Simulation Facilities
  - TNA3 Planetary Sample Analysis
  - SA Integrated and Distributed Information Service (IDIS)

- **Joint Research Activities (JRA)**
  Improving the services provided by TNAs and the SA
  - JRA1 Infrastructure Development for Supporting Planetary Missions
  - JRA2 Planetary Facilities and Field Analogues
  - JRA3 European Modelling and Data Analysis Facilities (EMDAF)
  - JRA4 IDIS Preparing the Planetary Virtual Observatory

Management of these activities was overseen by the Project Management Committee composed of the Executive Team and Activities Leaders.

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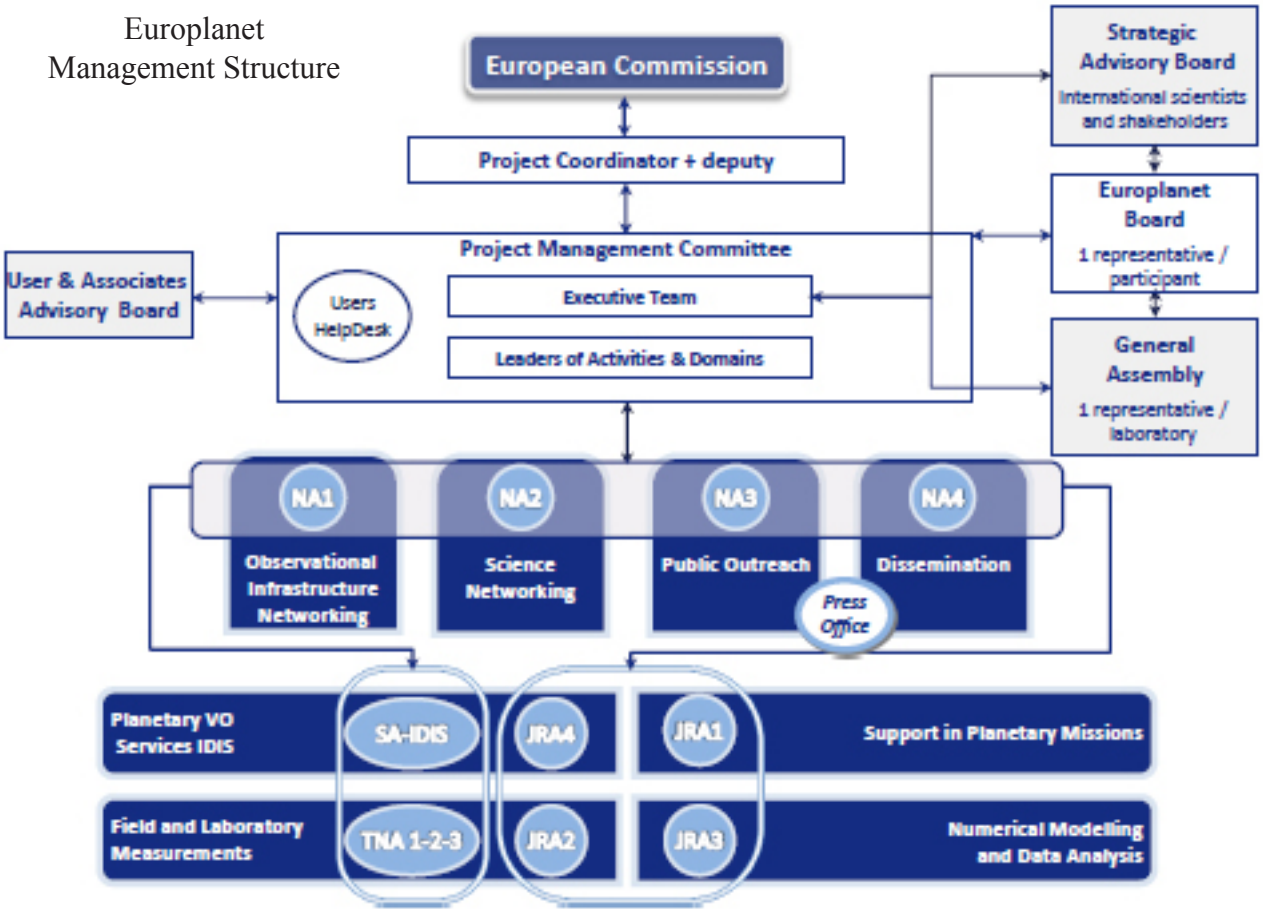
Europlanet
Management Structure



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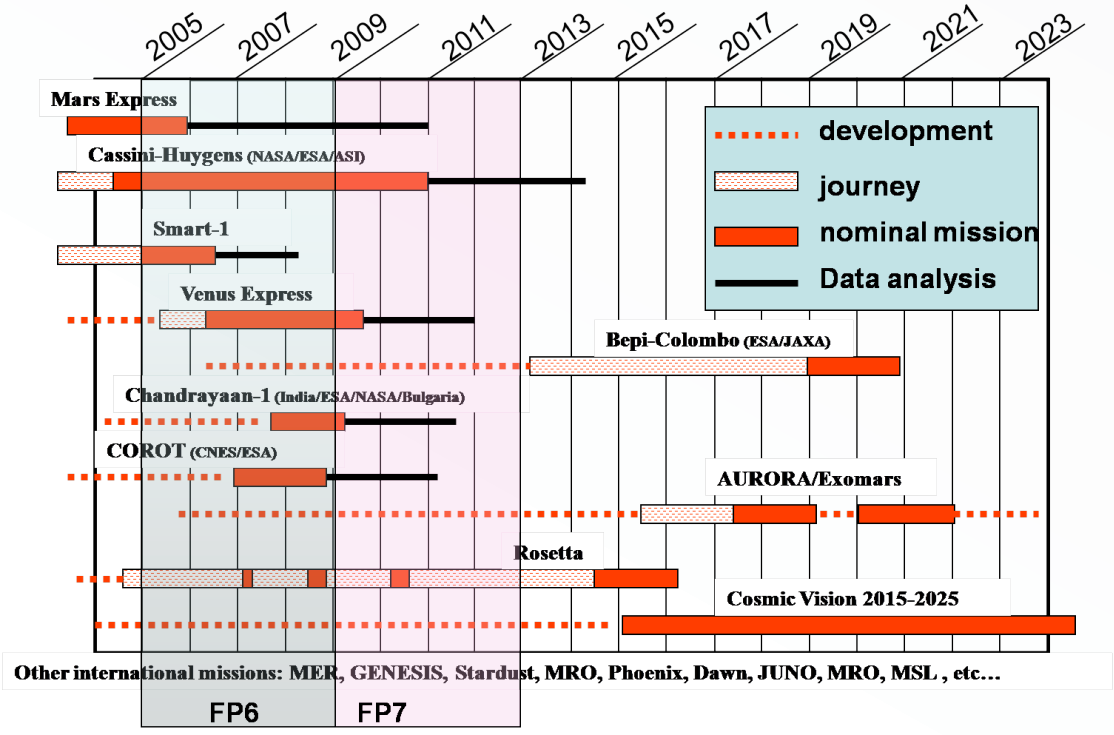
Europlanet RI is Europe's first major research project uniting to unite planetary scientists across Europe from east to west and north to south. With participants from 27 institutes representing 16 countries – including Russia – as project partners, plus hundreds more researchers from more than 40 countries attending the annual European Planetary Science Congress, Europlanet RI has a genuine claim to putting European planetary science on the map. The Europlanet community set out with great hopes for this ambitious €6 million project, which included a suite of four networking activities (NAs), three trans-national access (TNAs) activities, and four joint research activities (JRAs), plus the Integrated Data and Information Service (IDIS). Those hopes have been realised and – in many instances – surpassed.

A key motivation for Europlanet RI was the need to bring together European planetary scientists in a way that would allow them to have a greater impact than the sum of their parts. Europlanet RI's unifying activities have ensure that when space actors– developed and developing – come to look for mission partnership and science leadership, Europe is the place to look. Europlanet RI set out to achieve this at a time of transition in planetary science, as older space missions - Cassini, Mars Express and Venus Express – approached their end and the next generation - Rosetta, ExoMars and the new European Space Agency Jupiter Icy Moon Explorer mission, JUICE - are still to deliver their data.



European Planetary Missions

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The development of EU planetary science must be viewed in the context of a rapidly changing international environment. Alongside the traditional planetary science and space 'powers', China and India have announced - and are achieving - ambitious planetary science and space programmes

It is vital that Europe, with its large knowledge and skills base, remains at the forefront of the planetary science field. To achieve this goal, the EU planetary science community must overcome the current fragmentation of. Europlanet RI has helped accomplished this in two ways:

- by consolidating the integration of the planetary science community, an activity started through Europlanet's FP6 Coordination Action;
- by developing a major distributed European infrastructure to be shared, fed and expanded by all planetary scientists.

Europlanet's management and 12 workpackages, have striven to ensure these goals have been met.

Much of the work of pulling the European planetary science community together has been carried out through its four Networking Activities (NAs). NA1 (Observational Infrastructure Networking) and NA2 (Science Networking) have focused on providing a framework through which the scientific return on Europe's investment can be maximised.
Over the four years of the project, Europlanet organised 25 NA1 workshops that brought astronomers together to strategise and optimise ground-based observational support of space missions. The Austrian Academy of Sciences at Graz hosted more than 70 attendees from 14 countries at the 7th International Workshop on Planetary, Solar and Heliospheric Radio Emissions (2010). Plans to support ESA's Rosetta Mission to orbit and land on Comet 67P/Churyumov-Gerasimenko were discussed at University College London (2012). NA1 has also produced an interactive matrix that enables planetary scientists to link space mission requirements to ground-based facilities that can help them deliver their science goals.
Through NA2, the International Space Science Institute (Bern) partnered with the Finnish Meteorological Institute and the Hungarian Academy of Sciences have provided opportunities for key science issues to be discussed.As a legacy for these meetings, NA2 has published a series of reference and research books. Other workshops were held to support Europlanet's IDIS facility. NA2 also enabled an exchange programme between institutes for Europlanet personnel to develop the infrastructure necessary to put European planetary science on a firm footing.

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Whilst NAs 1 and 2 concentrated on networking within the scientific community, NA3 (Outreach) and NA4 (Dissemination) faced outward to engage Europlanet RI with the wider public, industry and policy makers. NA3's public engagement programme included the development of a Europe-wide network of outreach nodes, responsible for building links between the science community and outreach providers and informal science educators. The European Planetary Media Centre developed media links at a local, national and international level .

NA3 inaugurated a prestigious prize for European planetary science outreach activities, as well as a funding scheme to seedinnovative and dynamic ideas for furthering public engagement in the area. Europlanet's key dissemination platform – the European Planetary Science Congress – organised through NA4 – brought European planetary scientists in their hundreds together with their international peers in an exciting exchange of scientific results and ideas. Its press and outreach activity brought that excitement to European citizens.

Presentation of the 2011 Europlanet Outreach Award to Gernot Grömer of the Austrian Space Forum (OeWF) by Prof Steve Miller. Credit: Europlanet/Lee Pullen

NA4's Technology Foresight workshops have ensured that the aims and objectives of the community could be discussed with those responsible for creating the hardware vital for planetary missions to succeed in the future.

Europlanet RI's Joint Research Activities have developed a range of new infrastructures and tools for the planetary science community. JRA1 provided data, tools, and essential expertise in areas fundamental to the preparation of space missions, their operation and the science data analysis. These included maps of solar system bodies, such as Mars and the moons of Saturn, tools to calculate the dynamics of solar system bodies, and the development of new tracking technologies. JRA1 also trained and supported amateur astronomers, particularly in meteor observations.

Earth Analogues – extreme environments on Earth that resemble those found on other planetary bodies – are an area of increasing scientific interest, providing ground truth to support data from space missions that are characterising planetary bodies including Mars, or Jupiter´s moons, Europa and Ganymede. JRA2 aimed to characterise two new field extreme sites and validate their sutability as Earth Analogues. The JRA2 activity organised several field campaigns to Chott El Jerid (Tunisia) and Popigai crater (Russia) in its campaign to identify further facilities that could be opened to trans-national access.

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Computer modelling and analysis are essential for modern planetary science. JRA3 set out to build an interactive catalogues of models and tools available through the European community, some of which could be run online or on demand, others by arrangement with the relevant programmers. Some were adapted to run on the European high performance facilities located at CINECA in Bologna, Italy. Modelling and analysis are one side of the coin. On the other, is the need to bring together datasets from a variety of space missions and model outputs, developing a holistic view of the Solar System and its component parts. JRA4 has worked to develop data protocols and tools to develop a Virtual Observatory approach for planetary science.

Whilst the JRAs worked to develop new infrastructure for future European planetary research, Trans-National Access (TNA) facilities and Service Activities (SA) provided accessibility of key facilities. Europlanet's central Integrated and Distributed Information Service SA succeeded in its commitments to make available to the community new datasets and services, and to form the basis for a European Planetary Virtual Observatory. All the thematic Nodes into which the SA had been structured became, in their scientific field, a reference portal for the interested community, offering a wide choice of resources that would not have been available without the Europlanet project. All the JRA activities fed into the further development of IDIS, with JRA4 playing a central role in the technological development of the SA itself.

Gorely volcano inside the caldera, Kamchatka Penninsula, during TNA Europlanet field trip. Credit: Agnes Samper

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NA1 Observational Infrastructure Networking

The Europlanet-NA1 Observational Infrastructure Networking activity focused on maximizing the synergies between two key elements of Europe's infrastructure in Planetary Sciences: Ground-based telescopes and space missions. To ensure a permanent and sustainable framework of joint resources and coordination of activities between them, NA1 identified and coordinated two important tasks within Europlanet RI FP7:

- The organization of workshops within key areas of European Planetary Sciences
- The development of an interactive database of ground- and space-based facilities, the so-called 'NA1-Matrix'.

The NA1-Matrix (http://europlanet-na1.oeaw.ac.at/matrix/) provides the user community with interactive links to ground-based instrumentation that is available to European planetary scientists and which have the capability of supporting and complementing space missions. The Matrix is not limited to major observatories, but also includes medium- and small-sized telescopes and instruments that can fulfill niche requirements for the community. Furthermore the database provides information on several space missions, which are interrelated with ground-based observatories via cross-links like science targets and research areas. The target-groups for this online-tool are firstly professionals who are seeking for support of ground-based facilities to space-based observations and secondly amateurs who are willing to support professional research programs. Therefore amateur astronomers have the possibility to include their own telescopes into the Matrix and to state their interest in the participation of coordinated observation campaigns, a crucial point for the self-sustainability of the Matrix beyond 2012. Besides data on general information, scientific contacts, areas of research, or instrumentation of ground- and space-based facilities, the database also provides a visual overview of observatories via its interactive 'Ground-based facilities Map'.

From 2009 until the end of 2012, NA1 organized and supported 25 workshops within key areas of European Planetology. To ensure sustainability and continuity several successful workshop series were established, from which the Exoplanet, Venus Atmosphere, Meteor and Rosetta Workshop Series were notable highlights. The Rosetta Workshop Series will culminate in coordinated observations of Rosetta's encounter with Churyumov-Gerasimenko in 2014. To ensure successful observation campaigns the NA1-Matrix will play a crucial role in identifying professional and amateur facilities interested in and able to support the Rosetta encounter.

Besides workshop series, the 7th International Workshop on Planetary, Solar and Heliospheric Radio Emissions (PRE VII) should be mentioned (http://pre7.oeaw.ac.at/). The Workshop, held in Graz, Austria, September 2010, was the continuation of a long-standing congress series. Over 70 participants from 14 countries made PRE VII one of the outstanding achievement within NA1 and the whole Europlanet RI FP7 Project, culminating in a Proceedings Book (596pp) of the Austrian Academy of Sciences Press in 2011.

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In view of sustainability two further workshops should be noted. These are the NA1 Workshop ‘Europlanet RI towards Sustainability’, and the NA1-IDIS Workshop ‘Europlanet in IDIS’, which both were important steps towards a self-sustaining framework of Planetary Sciences beyond 2012, and for a potential future Europlanet project within Horizon 2020.

Workshop #19 - June 25-29, 2012
European Space Agency, ESTEC, Noordwijk, NL
46th ESLAB Symposium
Formation and Evolution of Moons

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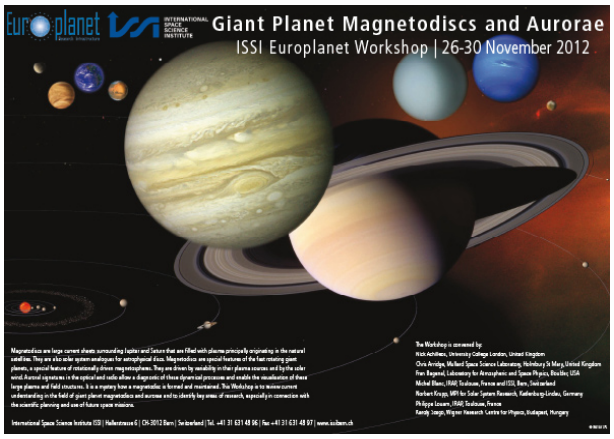
Overall objectives

The basic objective of Europlanet's NA2 activity - to contribute to achieving a well-functioning European Research Area (ERA) in which researchers, scientific knowledge and technology can circulate freely - is of utmost importance. Insufficient cooperation and coordination lead to significant underperformance in the European research system as a whole. As well as increasing cooperation and coordination, the ERA will boost competition, which enables excellence.
It is vital to improve mobility across sectors and countries, attracting top talent to Europe.
Several EU documents have concluded that space exploration in Europe is fragmented.

NA2 aimed to counter the fragmentation of European planetary science and build opportunities that are attractive to the best talents of the world. NA2 also enhanced the ability of European planetary scientists to participate on the global scene with their own agenda-setting projects and ideas. NA2 provided an integrated system of personnel exchanges, workshops and training to improve the scientific impact of the Europlanet Research Infrastructure.
In popular terms the Commission has concluded that there are holes in the fabric of European planetary activity. NA2 has endeavoured to patch these holes.

NA2's scientific working groups have identified key science issues and produced integrated reference books on major science themes.

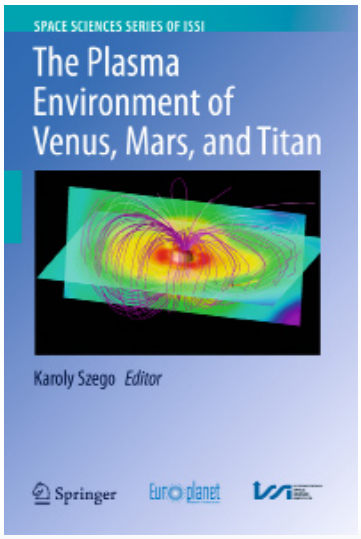


Poster of the Giant Planet workshop

ISSI-Europlanet Working Group

The International Space Science Institute (ISSI) is a participant of Europlanet, however due to its high international standing its name has been included to highlight its role in this activity. Within this framework four workshops were organised, with significant non-European participation, attracting about 30-40 participants.

The workshops themselves last for a week but were followed by around a two-year-long period when the participants continued their collaboration to produce a peer-reviewed scientific book summarising the current highest-level knowledge of the selected scientific topic. In total, about 120-140 people participated in this form of networking.



Cover of an ISSI-Europlanet workshop book

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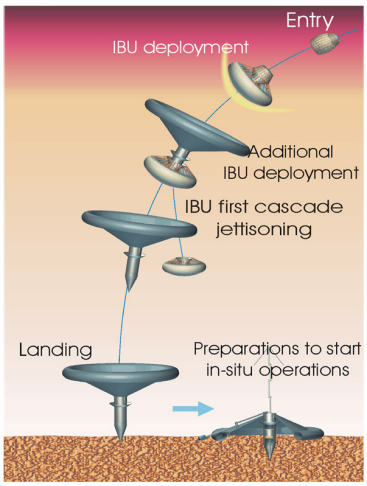
The Alpbach Summer School

The Alpbach Summer School series is organised by the Austrian Research Promotion Agency (FFG), in 2012 Europlanet was also given a role in the organisation work. We proposed the topic for the School, as well as lecturers and jury members, and participated in the Summer School activity. The participants (mostly Ph.D. students or post-docs) were divided into four groups and each group had to work out a space mission to the outer planets. The proposals were assessed in depth by the jury members, including experts from the Europlanet community). About 60 persons participated in this activity.

NA2 WG3 activities



These activities included a total of nine meetings. One group of meetings was focussed on a new type of Mars lander, based on a prototype developed by FMI. The meeting participants assessed the different objectives, the landing plans, technical realisation, risk assessments, etc. About 50 people participated in these workshops.

The second set of workshops were organised in support of the IDIS SA. A Training Workshop was organised in Toulouse, 19-21 September 2011introducing the users to the AMDA (Automated Multi-Dataset Analysis) database for planetary plasma data. During ongoing activities, users formulated different scenarios to test the development of AMDA. We can report that all requirements were met to satisfy users of the AMDA and other IDIS databases.

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NA3 Europlanet Outreach Innovation and Media Service

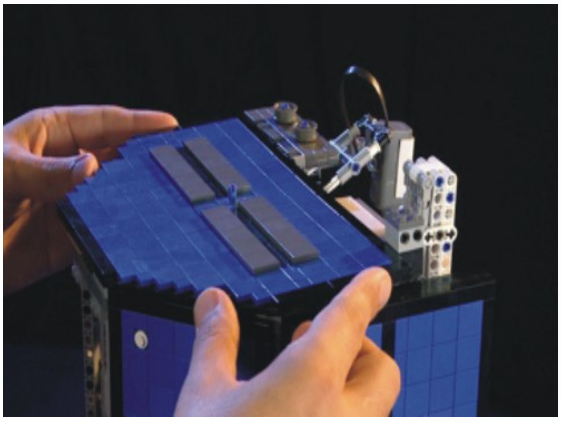
Overall objectives

The Europlanet-NA3 Outreach activity(http://www.europlanet-eu.org/) had three major objectives during the period 2009-2012:

- Support the outreach community in developing innovative projects to engage European citizens with planetary science
- Europeanize planetary science news stories in the media
- Change the culture of the planetary science community towards outreach activities

To support the outreach community, the Outreach Team (T. Fouchet, J.-P. Lebreton, S. Miller, E. Chatzichristou, and A. Heward) launched an annual Europlanet Outreach Funding scheme, designed to kickstart new, innovative projects with a high potential for European-wide engagement with planetary science. Four calls were made with a total budget of 15,000 to 20,000 Euros per round. Each call was oversubscribed by an average factor of six, showing the great interest in this potential source of funding.

Successful applications funded by Europlanet RI included:



- Rosetta's Comet Touchdown (pictured), an educational kit to build a model of the Rosetta lander from LEGO
- The Virtual Space Microscope, an online tool to open up access to samples and thin sections of meteorites and lunar rocks
- A 3D tactile moon for use in planetaria with blind and visually impared people
- VMR, a multiple player game for Android phones simulating a Mars mission
- A project to build meteorological stations in schools to contrast data with that from the Spanish REMS instrument on the Curiosity Mars Rover
- On-line maps of terrestrial planets and major moons of the Solar System in Virtual Globe format
- A series of movies by students following in the steps of 18th century Hungarian scientists observing the Venus transit.

For full details of all funded projects, see the NA3 convened sessions at the European Planetary Science Congress (EPSC) where outreach providers could network, exchange best practices and new ideas for public engagement with planetary science.
To tailor outreach activities to different European countries, and to foster communications between scientists and outreach providers at a local level, we established a network of National Outreach Nodes. This also provided another forum for exchanging and disseminating ideas and best practices at the European scale.

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To highlight European planetary science achievements in the media, we set up the European Planetary Media Centre (EPMC), which has published about 20 press releases each year, especially during EPSC and during Europlanet-sponsored field trips to planetary analogue sites. For special events, e.g. the 2012 transit of Venus, the landing of the Mars Science Laboratory mission, we produced press releases, and films to showcase European involvement and blogs to give more personal insights into the life and work of scientists. The EPMC provided scientists with a distribution channel for press releases about their planetary science results and also offered training for scientists wishing to develop their communication skills, through an intensive 2-day media workshop in 2010 (attended by 16 participants from 7 countries) and during short sessions during EPSC on writing for the media and working with schools (each attended by around 20-30 people).

During the 2009-2012 period, the importance and breadth of Social Media expanded greatly. We explored various channels, focusing mainly on Twitter (@europlanetmedia), and offered social media training to our Outreach Nodes.
Finally, to change the culture of the planetary science community towards outreach activities, we initiated the Europlanet Prize for Public Engagement with Planetary Sciences. Through the four Prizes that have been awarded, we have honoured a broad spectrum of outreach providers, including a specialist organisation excelling in communication (The Austrian Space Forum), scientists that have shown great personal commitment and innovation in engaging with the public on a local and pan-European scale (Jean Lilensten and Yaël Nazé (pictured), and a lay person that has succeeded in putting planetary science high on the political agenda (Jonathan Tate).

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NA4 Dissemination

The key objective of Europlanet RI's NA4 Dissemination activity was to ensure that all our stakeholders were informed and aware of the work of Europlanet and the achievements relevant to them. This work package therefore provided the mechanisms for disseminating the results of Europlanet RI Science Networks, JRAs and TNAs to the whole user community, the wider European Planetary Science community, SMEs and Industry and European policy makers. Specifically this work package provided for:

- An annual meeting, to showcase the work of Europlanet RI, support networking and scientific communication, and develop into the conference of choice for potential industrial partners in the area of space science.
- Technology Foresight workshops, held twice a year to bring together proposers, users and providers of new planetary instrumentation and technology.
- A Press office to ensure efficient communication to the stakeholders outlined above (described more fully in the NA3 report).
- Dissemination to principal stakeholders, including the European Parliament.

Annual meeting

The European Planetary Science Congress (EPSC), which provided the platform for our annual meetings, took place each year: in Potsdam (2009), Rome (2010), Nantes (2011) and Madrid (2012) . Since its inception under FP6, EPSC has achieved global status, and become the major planetary science meeting in Europe. On 2-7 October 2011, we held a joint meeting in La Cité Internationale des Congrès Nantes Métropole, Nantes, France with the Division of Planetary Sciences (DPS) of the American Astronomical Society (AAS). This was the largest planetary astronomy meeting ever held (at least on this planet). The meeting was a huge success with 1535 attendees from 42 countries and over 2000 oral and poster presentations. EPSC is now a sustainable annual meeting that will continue into the foreseeable future.

Technology Foresight workshops

Seven technology foresight workshops were held, mostly co-located with EPSC. The aim was to bring together planetary scientists, instrument builders, and commercial providers of space technology, so as to create roadmaps for the development of the technology needed for future European Planetary exploration.

Topic covered were Robots and Autonomy (Potsdam 2009), Planetary Cartography and Geographic Information Systems (Rome 2010), Detectors (Aberystwyth 2011), In Situ Planetary Instrumentation (Nantes 2011 and Madrid 2012)), Remote sensing of Planets (Madrid 2012) and Design for High Radiation Planetary Environments (Aberystwyth 2012).

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Dissemination to principal stakeholders

As part of its key NA4 Dissemination Activity aim of interacting with European policy makers, Europlanet has been extremely active in contacting Members of the European Parliament. This activity commenced in May 2010, and has resulted in us contacting all 55 members and all 55 substitute members of the Parliament's Industry, Trade, Research and Energy (ITRE) Committee. Some 25 ITRE members have had face-to-face meetings with Europlanet representatives and Ms Britta Thomsen has hosted 2 dinner debates in the Brussels Parliament, with one further held in February 2013. These debates dealt with «Positioning Europe for the New Golden Age of Space Exploration» (February 2, 2011) and «Planetary Science as a Driver for Jobs and Innovation» (May 8, 2012).

The picture shows European Space Agency Director of Science, David Southwood (at lectern), discussing Europe's position in space exploration at the 2011 European Parliamentary Dinner Debate hosted by MEP Britta Thomsen (centre). The debate in 2013, whilst outside of the reporting period for this Research Infrastructure, is «Women in Planetary Research and Exploration». Europlanet has been able to make information available to the Parliamentary Rapporteur on Horizon 2020, including the importance of community self-organisation in the area of space research and development.

Conclusion

Overall, the dissemination of our science to the varied cultures of the 16 Europlanet nations and the representation of their collective achievement has broken new ground. Planetary science makes an ideal focus in this respect, bringing together as it does enormous public interest, major European technology involvements and above all, world class scientific successes. Communicating them, and creating roadmaps for the future, involving all our stakeholders has been one of the outstanding Europlanet RI achievements.

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The TNA programme was core to the aims and ambitions of the Europlanet RI since it both directly engaged with researchers and provided the mechanism for conducting pioneering research within the RI that would produce publishable papers.

Europlanet RI offered the EU planetary science community, for the first time, access to a wide range of facilities from *field sites* (TNA1) to *laboratory apparatus* (TNA2) to *analytical facilities* (TNA3). No such provision had been offered to the EU planetary community before: previously, at best, national access was provided or bilateral collaborations were organised as part of single research projects. Accordingly it was perhaps not surprising that the community took sometime to align itself with the TNA programme since the offer of free (to user) access was a novel concept for a community that expected to have to find travel costs or pay facility fees. The regulations requiring 'transnational' access led to longer than expected time periods for groups to prepare both proposals and visits (the applicants requiring both mentoring in the scheme and information required to prepare a Facility for the user in advance of the visit). The most successful TNAs supported by the RI were therefore those between groups who already have a history of collaboration.

For several of the laboratories involved, this RI was the first time that they had engaged in such an exercise. There was a marked contrast to, for example RIs supporting access to large scale facilities (Synchrotrons, storage rings), and these new participants, who sometimes found that they did not have the large scale administrative support required to efficiently set up initial access. Hence CNRS Nancy, the national French centre for isotope analysis was amongst the most active of the TNA providers since it had both an existing structure for acting as a national laboratory and extensive international partnerships. However, after year one all facilities were able to adhere to agreed procedure, administer TNA visits and complete reports in a satisfactory manner. Several facilities developed methods for extending collaboration commenced under the TNA programme and through exploitation of complementary resources (e.g via the ESF COST STSM programme), allowed TNA visits to be extended allowing further data collection or more often on site data analysis.

Europlanet has supported 77 successful TNAs across its remit with (to date) in excess of 30 publications. Reports of each TNA visit may be found onsite http://www.isa.au.dk/networks/euroPlanet/reports/reports.html. We expect many more publications to appear in 2013 since data recorded during the TNA visits has been reported in preliminary presentations at Europlanet's major conferences (EPSC) in Rome (2010) Nantes (2011) and Madrid (2012), both in formal sessions and in the large poster sessions. The TNA programme also provided a superb opportunity for Europlanet media and outreach activity particularly TNA1 with its blogs of exotic field site activity (from the snows of Svaldbard to the deserts of Tunisia).

SEVENTH FRAMEWORK PROGRAMME

Project supported by the European Community Framework Programme 7 Grant agreement n° 228319

In conclusion we believe that the TNA programme has proved itself to accommodate a particular need amongst the European Planetary Sciences community for transnational access to a wide range of EU facilities and through these visits the conduct of joint research programmes. Indeed arising from this TNA programme several initiatives have developed including; (i) The ESA designated CAFE (Concepts for Activities for Field Exploration) programme to identify and characterise a range of sites that are analogues of planetary environments (ii) The specific call under FP7 EU Space Call (November 2012) for programme entitled 'Life in extreme environments on Earth as prototype of extraterrestrial life', which used many of the field sites developed under the TNA(1) programme and (iii) Field sites and laboratory facilities will be further reviewed as part of the FP7 project on astrobiology road-mapping (AstRoMap) (led by F Gomez the Coordinator of TNA1). Two COST Actions (Chemical Cosmos CM0805 led by N J Mason TNA coordinator and Nano-IBCT MP1002) and a Marie-Curie ITN focussed on astrochemistry (LASSIE) have strongly integrated with Europlanet. Members of the TNA programme have also put in follow-up bids to both COST and Marie Curie Programme for new ITNs in the Fall of 2012 that aim to build upon success of the Europlanet TNA ethos and infrastructure to promote further staff exchanges and collaborative projects.

Mars Test Facility at the Open University. Credit: Open University

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Project supported by the European Community Framework Programme 7 Grant agreement n° 228319

TNA1 Planetary Field Analogues

TNA1 Planetary Field Analogues offered access to well-characterized terrestrial field sites.

In total five natural field facilities were included in TNA 1 to provide realistic mimics of planetary surfaces throughout our Solar System.

- TNA1 A1 - Rio Tinto
  A 100 km long acidic aqueous river environment located in South West Spain
  Access managed from INTA-CAB.
- TNA1 A2 - Chott El Jerid
  A seasonal saline lake in an arid desert environment located in South West Tunisia
  Access managed from INTA-CAB.
- TNA1 A3 - Ny Alesund
  A great diversity of natural icy environments (glacier and permafrost areas) suitable for comparative planetology located in Svalbard (Norway). Access managed from FFI.
- TNA1 A4 - Ibn Battuta
  An arid desert environment with highly variable habitats (bare rock to sand dunes) located near Marrakech (Morocco). Access managed from IRSPS.
- TNA1 A5 - Kamchatka
  A volcanically active region characterised by intense and varied hydrothermal activity located in the Russian Far East. Access managed by IKI-RAS

Access was provided for scientists to perform high quality scientific research, to test instrumentation for space missions under realistic planetary conditions and to undertake comparative planetology research.

As a very brief summary of the activity we describe the last visit to the Rio Tinto field site: Rio Tinto is a unique site in Europe where rock-water-biology interaction produces river water with a pH that averages 2. The very low pH of the water and hydrated mineral precipitation (jarosite, goethite etc.) represents a distinctive geological environment that allows assessment of the relative role of biological and inorganic processes in the production of an environment comparable to that found on the Martian surface by the Mars Environmental Rover, Opportunity.

The site supports a unique ecosystem making it desirable for studying possible habitats for life on other planetary bodies. The river transects a regional mineralized pyrite-rich belt that has been the source of mining since prehistoric times. The pyrite effectively provides the energy for the development of a very particular group of bacteria named chemolithotrophic bacteria. This group of bacteria is able to metabolize pyrite and oxidize the sulphur and ferrous iron parts of the mineral with the production of sulphuric acid and ferric iron like metabolic products. Thus the site provides an excellent example of how life may have evolved in extreme conditions and may provide clues as to the type of bacterial life that may be or have been present on Mars.

SEVENTH FRAMEWORK PROGRAMME

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Rio Tinto expedition in the framework of Europlanet project.

The last expedition to Rio Tinto was to develop a Mars simulation mission. The Austrian Space Forum, under the co-ordination of Dr. Gernot Groemer and partnering institutions conducted a set of field tests. The work was focussed on the Aouda.X spacesuit simulator and astrobiology experiments, the contamination vector analysis as well as the Phileas rover prototype. Geophysical investigations and operational tests brought together a field team and its operation team onsite, a dedicated Mission Control Centre, as well as Remote Science Support team. The expedition considered practicalities of the implementation of the field mission as well as the ability to conduct scientific experimentation under mission conditions.

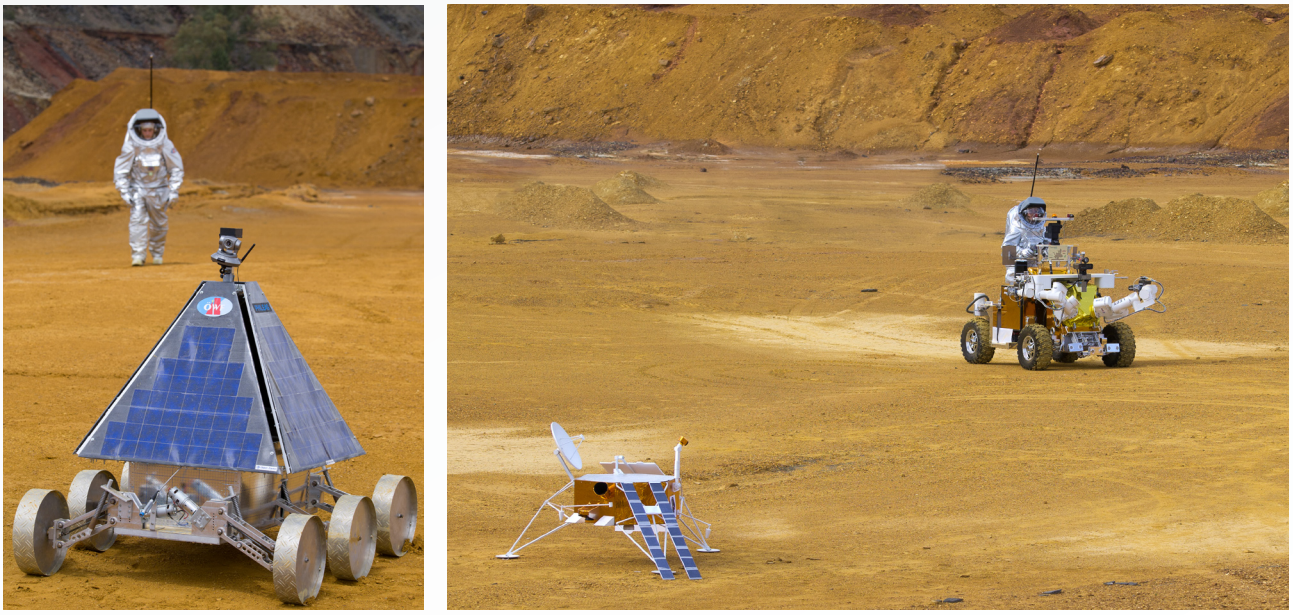

Figure illustrated an astronaut in the Aouda.X suite with the Phileas rover.
Credit: OEWF (Paul Santek), Apr. 2011

Contacts
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Project supported by the European Community
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Grant agreement n° 228319

TNA2 Planetary Simulation Facilities

TNA2 laboratory simulation facilities have successfully provided access to an extremely diverse set of experimentation conditions. These conditions ranged from ultra low vacuum to high pressure atmospheric analogues, ultra cold (approaching absolute zero) to the high temperatures encountered at the surface of Mercury. Moreover, the scale of experimental study provided possibilities ranging from testing full scale instruments (e.g., the large scale wind tunnel at Aarhus and analogue planetary environments at Aberystwyth) to the examination of microscopic chemical and physical consequences of processes occurring under planetary conditions (e.g., Planetary emissivity lab at DLR and the Cosmic Physics & Planetology Laboratory in Naples). The breath of subjects covered by the individual TNA visits is too broad to summarise. Consequently, to provide a "flavour" of the work accomplished, two related TNA projects are briefly discussed. It should, however, be emphasised that peer reviewed publications have and continue to be produced as a direct consequence of visits and many new successful collaborations have been established.

Debris flows under Martian conditions:

A group of researchers led by Gwénël Jouannic from Université Paris-Sud have attempted to solve the debate regarding the origin of linear erosional gullies on sand dunes on Mars (see figure). These geomorphological features, associated with the observation of dark, finger-like features on slopes, have been argued by some as evidence of seasonal fluid flow. The Paris group conducted a series of experiments at The Open University under Martian atmospheric conditions (7 mb CO_2 atmosphere) to simulate debris flows over a frozen material. These experimental produced a far better quantitative understanding of the erosion and, coupled with detailed HiRISE images taken from orbit, led to the conclusion that large amounts of water are required to produce the debris flows that caused the erosion. However, a permafrost table that is seasonally active appears a prerequisite for gully formation. The team concludes that the erosion features are a consequence of temporary warmer periods during high solar irradiation levels in the past.

Mosaic of HiRISE image(s) of gullies on the Russell crater dune. There is evidence of major regressive erosion at the intersection of the main megadune crest and secondary dunes crests. Wider gullies (20 m and more) are located downstream from these major erosive areas. Image credits NASA/JPL/University of Arizona.

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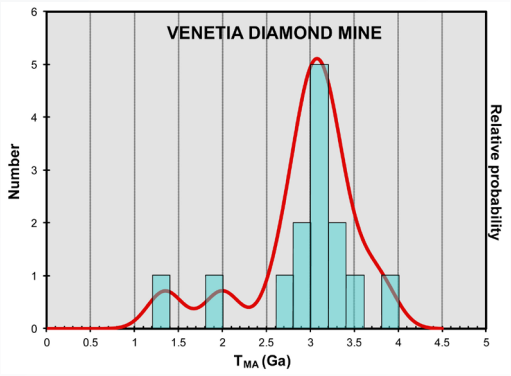
Grant agreement n° 228319

TNA3 facilities provided specialist analysis for an incredibly wide variety of planetary samples, including the determination of the chemical and physical composition of meteorites, samples returned by space missions (lunar rock, cometary dust grains and particles of the solar wind) as well as terrestrial samples used as planetary analogues. The majority of research was carried out on terrestrial samples, focusing on three scientific areas: i) how differentiation processes on Earth lead to the formation of specific geological environments over time, providing a better background to interpret the evolution of other planetary bodies: ii) the study of potential ancient life forms and iii) how different geological materials can be used as proxies of climate change.

As an example of a terrestrial study, a VU University group conducted a Rhenium-Osmium (Re-Os) isotope study (a form of radiometric dating based on the beta decay of the isotope ^{187}Re to ^{187}Os) of the mantle beneath ancient parts of Southern Africa that today comprise the Kalahari Craton. A group of PhD and MSc students led by Gareth Davies studied > 8000 mantle xenoliths (rock fragments that have been enveloped in a larger rock) from locations in southern and northern South Africa and Botswana (Kimberley, Venetia, Orapa and Letlhakane diamond mines) and established they were derived from depths between ~ 50 and 250 km. Based on mineralogical variations it was possible to recognise specific melting and melt addition events in the xenoliths. Data from the Re-Os isotope study at CNRS-CRPG Nancy, under the supervision of Laurie Reisberg, provided model ages that record coherent evidence of major melt depletion at or before 2.9 billion years ago (data for Venetia shown below). This suggests the rapid and extensive formation of continental crust at that time (± 0.2 billion years). For Botswana, this indicates that the younger continental crust that now forms the region was tectonically emplaced at a later date over older crust. Comparable age constraints from all the studies establish that additional major melting events occurred in the mantle at ~ 2.7, 2.0 and 1.5-1.8 billion years associated with respectively stabilisation of the continental crust across all of southern Africa, the Bushveld flood basalt province (2.0 billion years) and accretion of Proterozoic mobile belts around the Kalahari Craton (1.5 to 2.0 billion years). The conclusion of the project is that the mantle beneath the Craton records an integrated signal of the longterm tectono-magmatic evolution of the region.



Contacts
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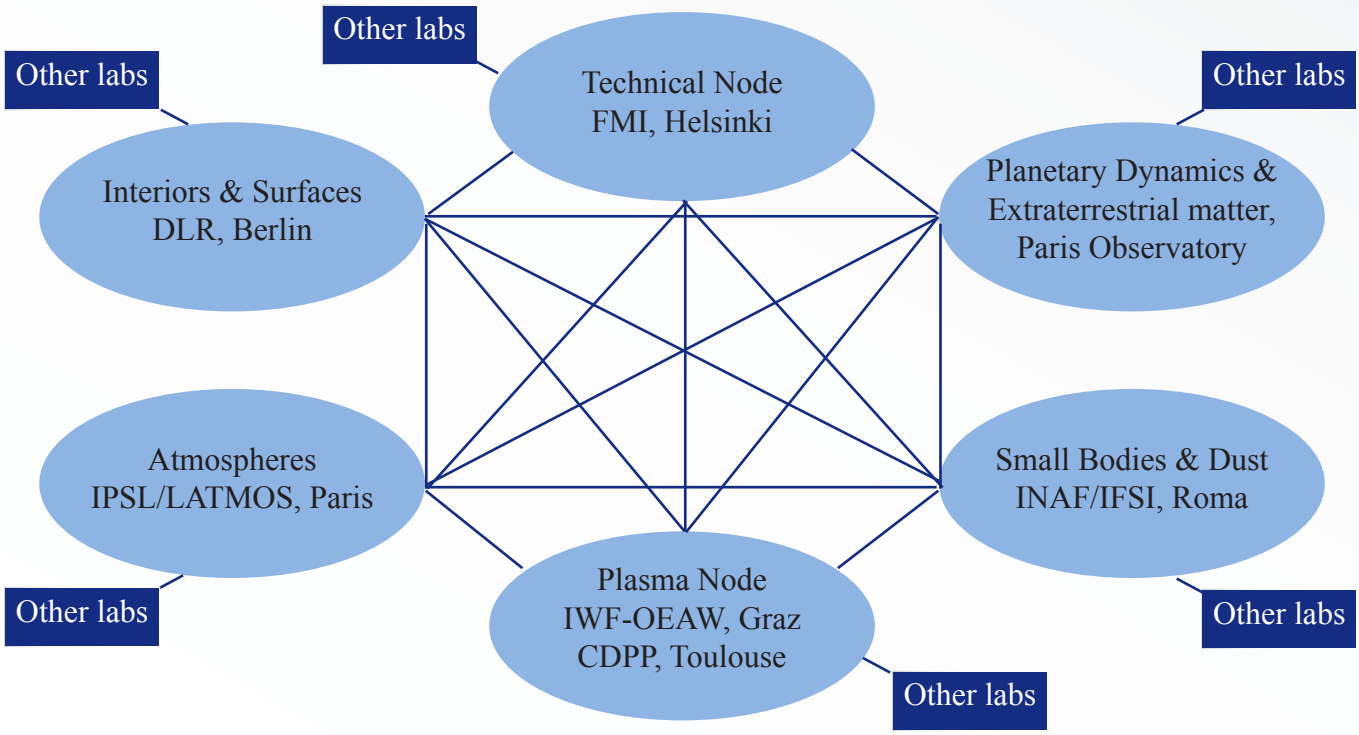
Service Activity - Integrated and Distributed Information Service (SA-IDIS)

The short-term objective of the IDIS Service Activity was to create a structure of thematic Nodes, providing

- easy access to data produced in the different fields of planetary research: space missions, ground based telescopes, laboratory and field facilities, sample collections, and modeling results
- tools to visualize, analyze, manipulate and interpret all types of observational, computational, and laboratory data.

On a longer-term, the objective was to lay the foundation, in close collaboration with the Joint Research Activity 4, of the European Planetary Virtual Observatory.



IDIS SA has succeeded in meeting all its goals. New contents and services, coming both from other Work Packages of the Europlanet RI project and the outside scientific community, were fed constantly into the Nodes. Each of the Nodes became, in its scientific field, a reference portal for the interested community, offering a wide choice of resources that would not have been available without the Europlanet project. At the end of the project IDIS evolved towards the embryo of a Virtual Observatory for planetary sciences. Thanks to the research work performed in JRA4, to which SA IDIS actively participated, this network of Nodes has already began publishing its first datasets following the Virtual Observatory protocol developed by JRA4.

Here are some examples of the activities of the Nodes. They represent only a small part of what each Node actually achieved and made available to the community.

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Screenshot of a typical Technical Node web-page with a list of test facilities including web-links is shown (left)

Similar lists were established for

- data access links to archives, not always already linked to the IDIS Virtual Observatory
- mission and instrument design tools and databases maintained by ESA, NASA and other space agencies
- ground-based observatories supporting planetary missions
- test facilities for space instrument tests
- technical information for data providers interested in making their data publically available via IDIS
- access to information and data generated in the other Europlanet-RI work packages.

All these lists are merged in a “resource list” available at http://www.europlanet-ri.eu/idis/res

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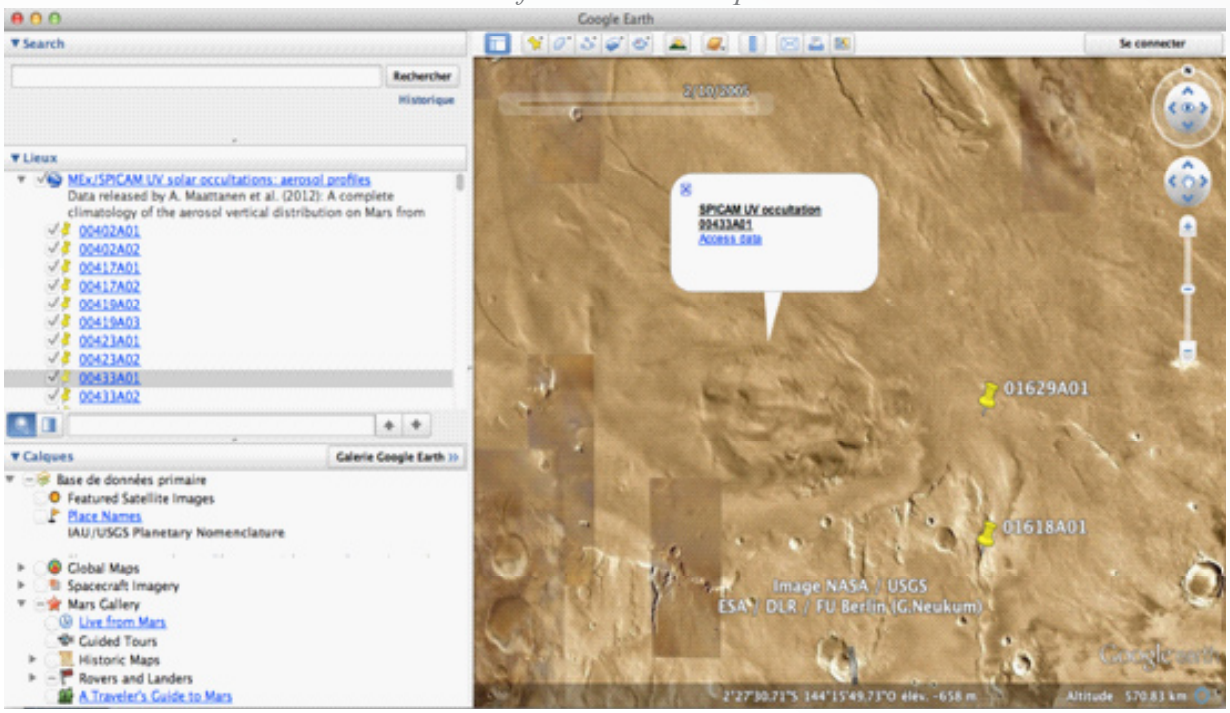
SA IDIS - Planetary Atmospheres Node

CNRS-LATMOS, PARIS

During the 4 years of the project, the IDIS Planetary Atmospheres Node (PAN) has achieved all the targets set for this Node. The great success of recent space experiments relating to this Node has been helpful for the activity. Many scientists from the community have been asked to provide access to their data to the whole community through PAN. This is the non exhaustive list of LATMOS/IPSL/CNRS contribution to IDIS:

- Development of three new science cases related to PAN plus one related to SBD Node
- IVOA tools tested and validated on the PAN data-base, Tomcat, VOSPEC and Aladin
- Integration with Google Mars of Martian aerosol data observed by the SPICAM instrument on Mars
- Science case oriented portals with enhanced functionalities moving towards a virtual observatory: Fondue using IVOA tools, VO-SCAT using NetCDF tools, and ODS using Google Earth /GIS tools, Mars Express using GIS tools
- 2 new planetary workflows based on IVOA tools, the first a search for Asteroids in archived digitalized astronomical plates, and the second a search for exoplanets using radial velocity method from IVOA archived spectra.

Mars Express SPICAM Aerosol Data presented using Google Map / Google Mars and available from IDIS Atmosphere Node.



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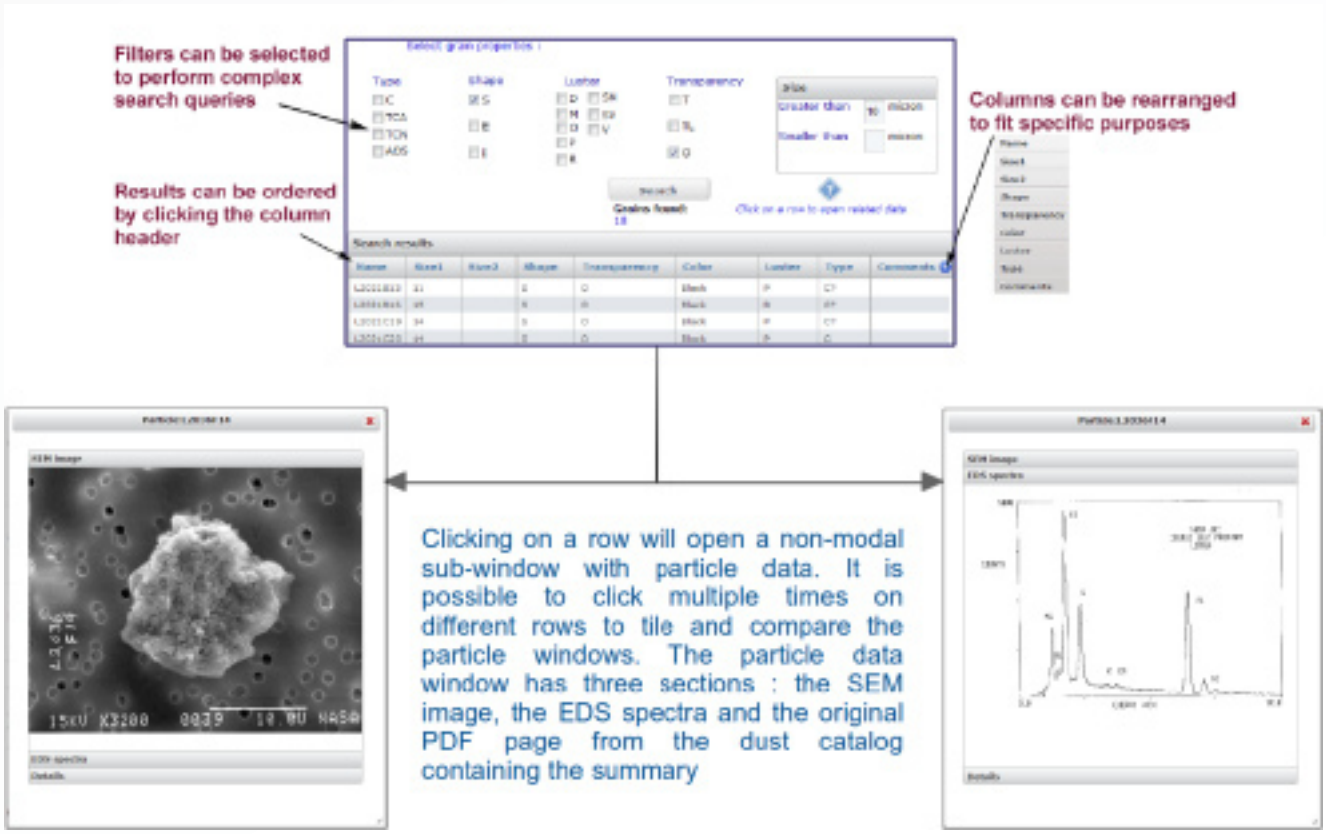
Many resources and services have been made available to the scientific community through the Small Bodies and Dust (SBD) Node portal, hosted by IAPS/INAF in Rome. The resources cover the field of comets, asteroids and interplanetary dust. Services have been implemented offering access to data available only at IAPS, such as the Cosmic Dust Catalog and the Comet Emission Lines data service.

The Cosmic Dust Catalog data service is based on the volumes 15 and 18 of the NASA Cosmic Dust Catalog. NASA's Cosmic Dust catalogs 15 and 18 have been joined to obtain this service, listing 467 (from catalog 15) plus 957 (from Catalog 18) dust grains with their main characteristics, images and X-ray spectra.
The service is currently accessible at the URL:
http://www.iasf-roma.inaf.it:8080/web/sbdn/cosmic-dust-catalog

The Comet Emission Lines data service allows the user to operate a simple query returning wavelengths, species and transitions of the whole set of 33183 emission lines collected within the four imported catalogs and joined together in the comet lines tool database.
The service is available at the URL:
http://www.iasf-roma.inaf.it:8080/web/sbdn/comets-emission-line-search.



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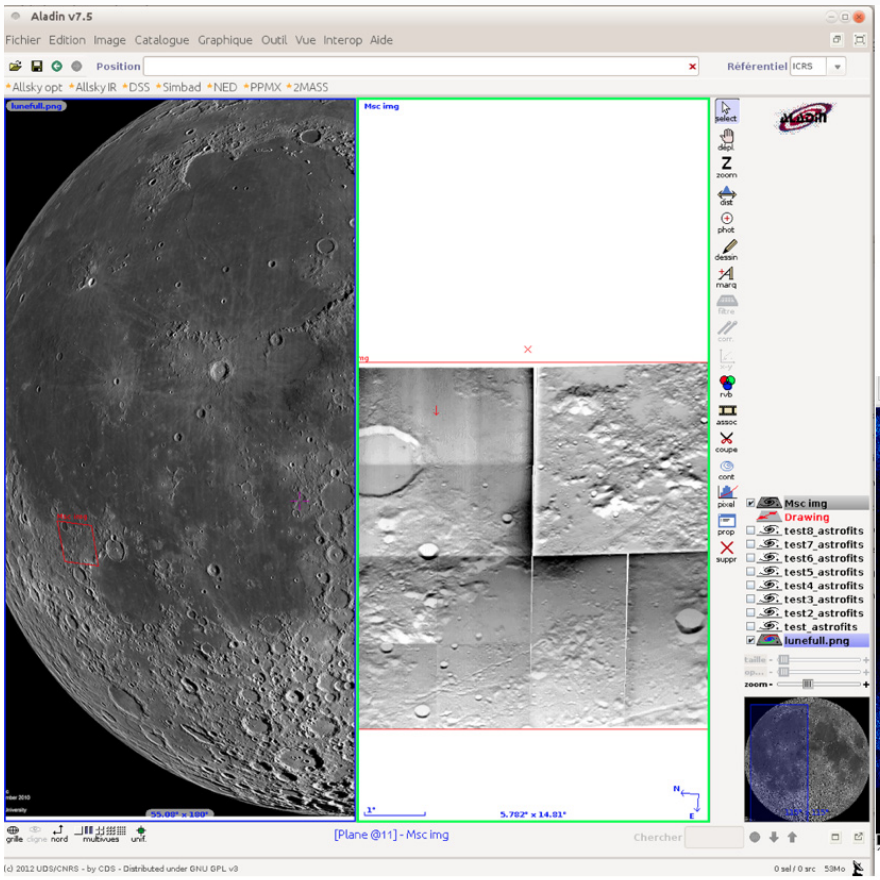
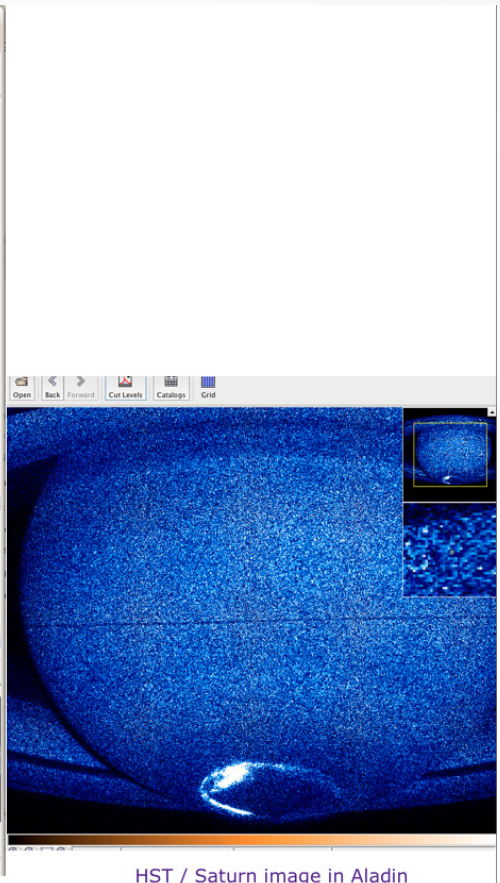
A series of VO compliant data services were set up and made available at the VO-Paris Data Centre. They are based on the EPN-TAP protocol developed in JRA4. All services are declared in a registry and can be queried by a specific client at
http://voparis-europlanet-new.obspm.fr/planetary/data/epn/query/all/.

The services developed in the EPN-RI framework are prototypes for future services to be provided by the community. They include the Encyclopedia of Extrasolar Planets, observational data from CIRS/ Cassini (Titan), HST (Auroral Planetary Imaging and Spectroscopy), historical telescopic images from an older IAU project, and spectral observations of asteroids. All services are accessible through the EPN-TAP client and can be visualized on-line by standard IVOA tools. Basic GIS functions were also implemented to produce image mosaics on-line.



AMIE/Smart-1 image frames & footprint in Aladin



HST / Saturn image in Aladin

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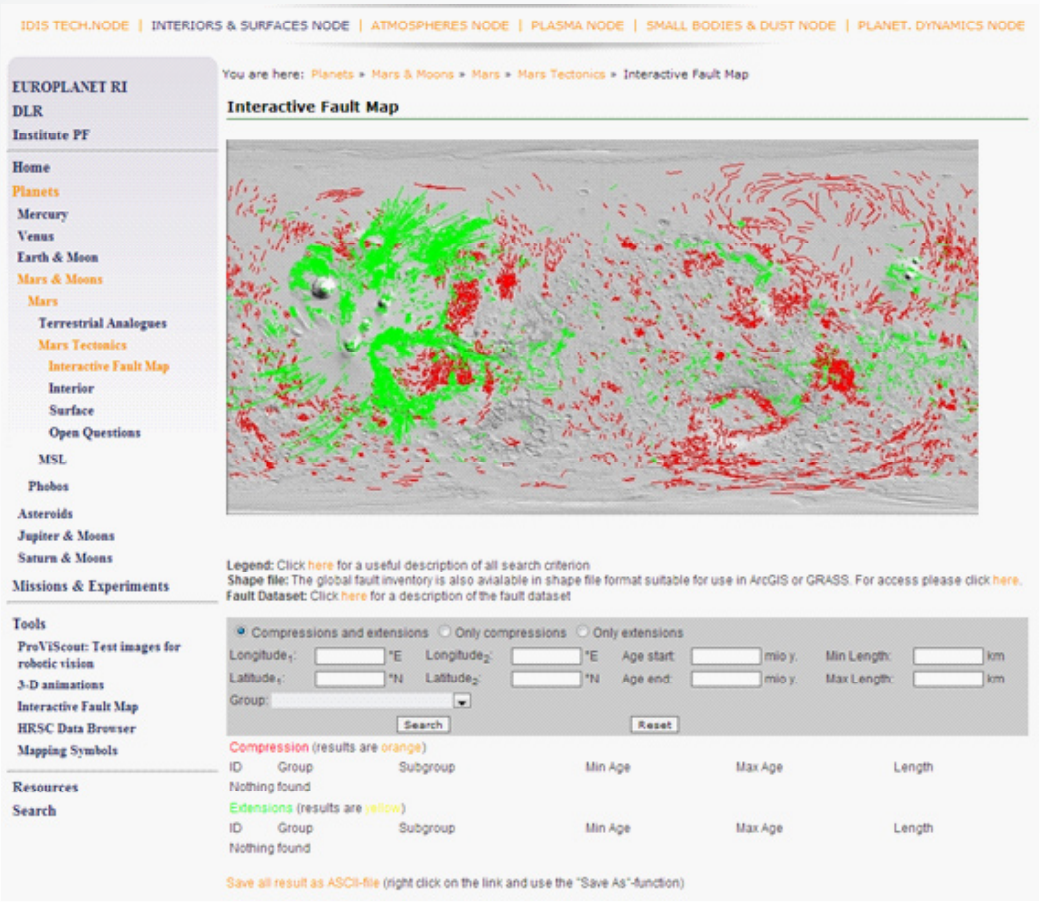
A variety of user-friendly services were made available to the public at the Interiors and Surfaces Node hosted by DLR's Institute of Planetary Research in Berlin. The services cover a wide range of applications, from planetary surfaces maps over tools for planetary mapping to interactive data sets of the Martian surface. Some services provide access to data that are not available anywhere else, e.g., an interactive data base of tectonic faults on Mars, classified by their age and the style of deformation (see screenshot below).



Screenshot of interactive fault map of Mars

Another data set that was particularly useful to the wider community is a series of highly accurate Digital Elevation Models (DEM) that cover the final four candidate landing sites of the Mars Science Laboratory rover, Curiosity. Some services were provided that offer data and information generated in other EU FP-7 projects, thus making use of synergy effects within European science funding.

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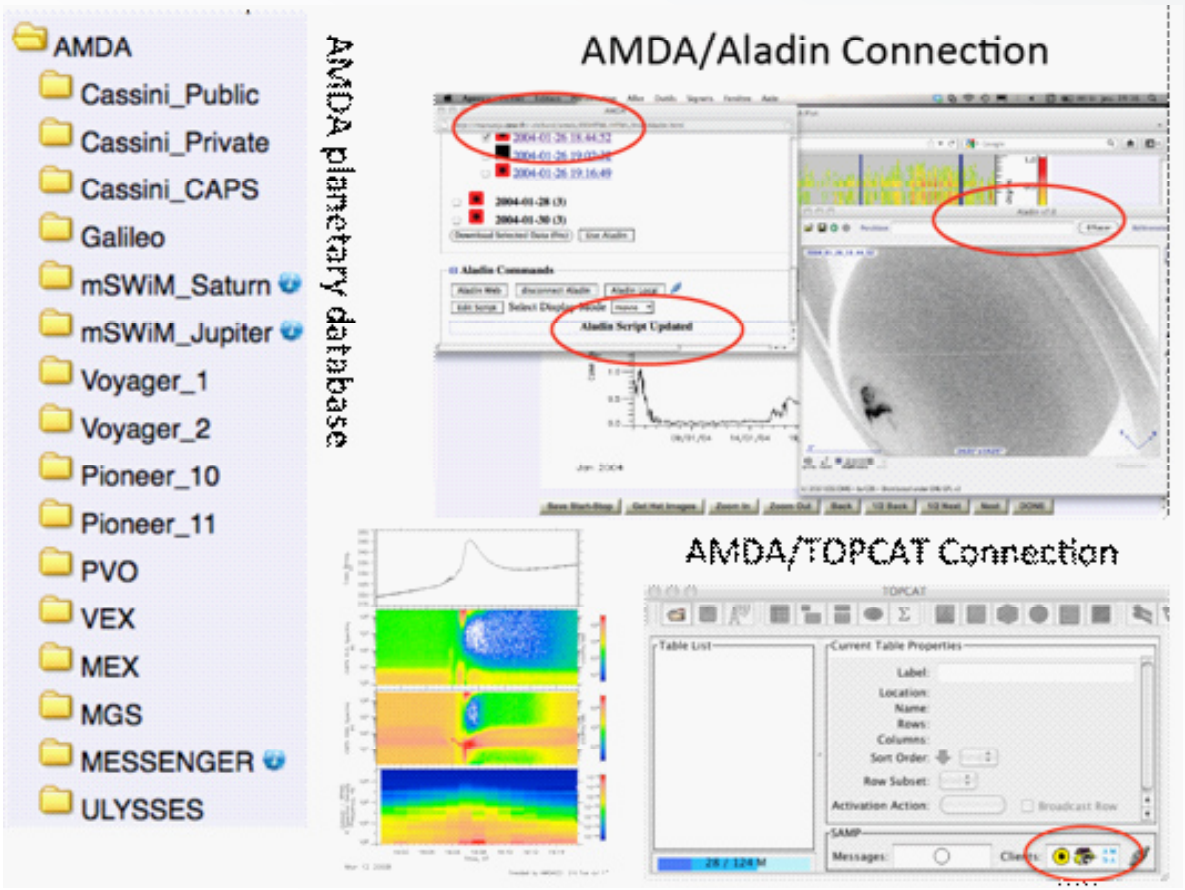
SA IDIS - Planetary Plasma node
CNRS-CDPP, Toulouse & IWF-OEAW, Graz

More than 300 planetary plasma datasets coming from various databases including NASA/PDS, ESA/PSA and various institutes have been added in the CDPP/AMDA (Automated Multi-Dataset Analysis) tool. Our database now covers all planetary environments of the Solar System, with the main emphasis given to missions currently in operation (Cassini at Saturn, VEX at Venus, MEX at Mars) or useful for preparing future ESA-led missions (MESSENGER at Mercury, Galileo at Jupiter).
A training workshop was hosted at IRAP, Toulouse for EuroPlaNet participants to learn how to use the CDPP/AMDA tool.



Our CDPP/AMDA tool has been made SAMP-compatible for VO-interoperability. This enables our tool to be connected to other VO-tools such as Aladin (e.g., visualization of HST observations of auroral emissions of giant planets in correlation with spacecraft measurements around the planets); TOPCAT (e.g., histograms/3D plots, …) or VOStat (statistical data analysis).

Our service is published in a registry and can be queried by a specific client at
http://manunja.cesr.fr/CDPP_EPN_IDIS/WS/searchEngine.php

Project supported by the European Community Framework Programme 7 Grant agreement n° 228319

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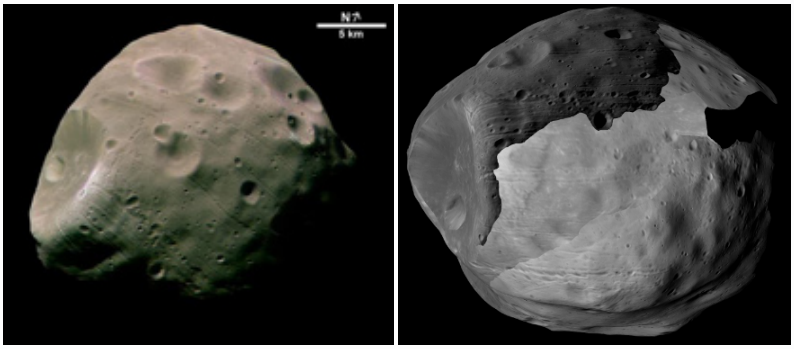
JRA1 Infrastructure Development for Supporting Planetary Missions

The Joint Research infrastructure JRA1 has achieved various tasks with the goal to support European planetary and space missions. The main objectives were to provide data, tools, and essential know-how in the following areas which are fundamental for the preparation of space missions, their operation and the science data analysis.

JRA1 is focused on three main areas:

- Planetary data: with its expertise in geodesy and cartography, the JRA1 team has provided planetary shape-, gravity field-, and rotational models as well as various planetary maps. These data include: an atlas featuring high resolution maps of the Saturnian satellites from the Cassini mission, Digital Terrain Models for the MSL candidate landing sites, a global mosaic and terrain model of the Martian satellite Phobos, lunar terrain models from the Clementine mission, and a rotational model and reference system for Mercury which is relevant for planning of the Bepi Colombo mission.



Phobos observed by the HRSC on Mars Express in August 2004 (color composite, left).

Synthetic view of Phobos computed from sets of HRSC images, taken under different viewing and illumination conditions (right).

- Ephemeris tools: Experts from JRA1 team in planetary dynamics and the development of ephemerides have contributed two specific tools: (1) MIRIADE, a Virtual Observatory compliant ephemeris web service, which is now fully operational; and (2) a prototype version of a tool called “Planetary Scene Viewer”, which can provide synthetic views at planetary constellations, from Earth or from a spacecraft. The tool is based on physical ephemeris data..

- New tracking technologies: JRA1 team members have been involved in the study and application of new spacecraft tracking technologies which allow us to reach unprecedented accuracy in positioning. Spacecraft VLBI and Doppler tracking techniques have been studied and applied to the Venus Express radio data. Novel Laser tracking of spacecraft, e.g., to NASA’s Lunar Reconnaissance Orbiter (LRO), can provide very accurate position information and can also be used to monitor the spacecraft on-board clock. JRA1 team members have participated in LRO Laser ranging campaigns (from Wettzell station) and are involved in the associated data reduction and analysis.

SEVENTH FRAMEWORK PROGRAMME

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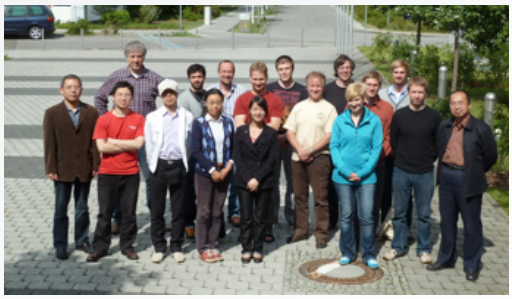
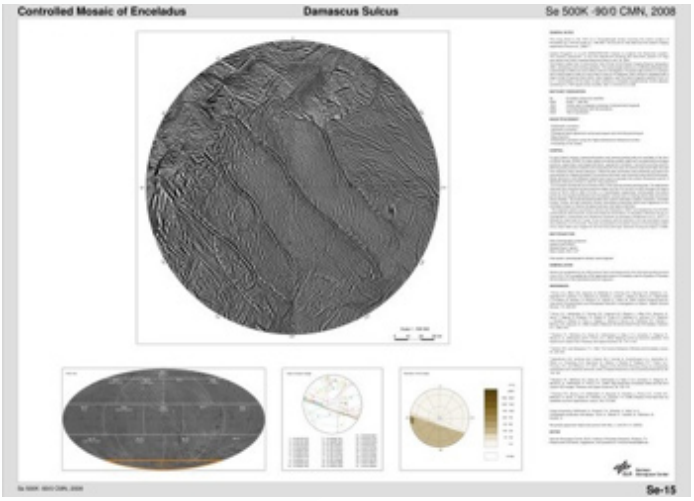
Furthermore, JRA1 has been active in the support and training of amateur astronomers. Specifically, we have worked with amateurs on observations of meteoroid activity. The goal was to empower the amateur community to carry out these observations and make the appropriate data analysis at professional level. First, we developed a low-cost very-low frequency radio wave detector, which was subjected to observation tests. Second, appropriate meteor cameras (SPOSH-type) were supplied. Over the 2009-2012 period, we organized several observation campaigns during meteor showers, in particular in Greece. Software was prepared for studies of meteoroid trajectories and orbits using simultaneous observations from dual stations and triangulation. Several workshops with the amateur community have been also organized to reinforce the collaboration between professionals and amateurs.



During the Europlanet RI program, JRA1 has organized several scientific workshops to establish communications between researchers from Europe and other international teams (e.g., Russia and China) involved in the fields of planetary geodesy and dynamics. These meetings were important steps towards future collaborations.



Map for the South Polar Area (Damascus Sulcus), on Saturn's satellite Enceladus, which was produced from Cassini ISS images.

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Project supported by the European Community Framework Programme 7 Grant agreement n° 228319

JRA2 Planetary Facilities and Field Analogues

Extreme ecosystems with characteristics resembling those found in planetary bodies are defined as Earth Analogues. The EuroPlaNet JRA 2 activity focused on the characterization of two new field analogues and their validation (or not) as Earth analogues. Earth analogues have attracted considerable interest due to recent and upcoming space missions to characterize Mars surface and discover its potential for harbouring life any point in its history. If Mars has been habitable in the past its inhabitants would have been extreme life bacteria forms

The JRA 2 activity organised several field campaigns to the natural field sites of Chott El Jerid (Tunisia) and Popigai crater (Russia).

Chott El Jerid is located near Tozeur in the Kebili region of South-West Tunisia. Centred at 33º42´N 08º24´E, it covers 586 187 hectares. Chott El Jerid is a seasonal lake of endorreic (closed drainage) origin such that for most of the year it has a sun baked, dry surface of deposited sodium chloride salt covering sources of underground water. The vivid red colour is due to high concentrations of ferric iron. Within this extreme arid and saline environment a wide biodiversity exists comprised of photosynthesizers and extreme halophilic bacteria. This environment provides a good analogue for chloride deposits on Mars, such as the layered deposits discovered at the Martian north pole. Underneath the salty crust, there is a high probability of finding a second anerobic ecosystem, completely isolated from the surface and without any interaction with the atmosphere. Ecosystems developing in this type of particular protected environment could, from a habitability and astrobiology point of view, be very interesting.

JRA2 carried out two field trips during the first two years of the Europlanet RI programme to thoroughly characterize the locations at Chott El Jerid.

Popigai is centered at 71°34'N, 111°12'E in central Arctic Siberia. This natural field site has been ascribed as nature conservation object of our planet of significant first value and this area has been designated by UNESCO as World geological Heritage a first-class Site of scientific and general cognitive interest (Paris 1991). JRA2 organised one field campaign to this site.

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We brought back some samples to the laboratory for further analysis.
In summary, our reports following the field trips focused on these areas of study:

- Climate studies: with special emphasis in environmental monitoring stations for space missions testing. The recording of the temperature, wind direction and speed and also solar radiation can help us to understand the real driving forces for water cycle in the area.
- Mineralogy associated with the salty desert and its comparison with salty deposits identified in the Mars surface. The surface material, the salty crust, was mainly composed by halite.
- Microbiology of the area: isolation and characterization of extremophiles with optimal growth on such a harsh dryness conditions form surface samples. But it was also be possible to identify some anaerobic bacteria from samples from sub-surface. Some sulphate reducer's niches and methanogenesis were identified. Samples in the laboratory are under study for farther characterization.
- Sedimentology of these salt deposits environments for Sabkhas model comprehension.
- 3 m deep drilling for sampling for mineralogy and microbiological analysis
- Structure of the first 3 m of the column using sounding electrical techniques

The ultimate objective of the campaigns is the development of a model for the whole systems, which can be developed once we have final experimental results from the laboratory after the analysis of the samples.

Other activity accomplished during 2012 was a special meeting about the definition of "What an Earth analogue is?", organised with specialists in the area. During the whole 2009-2013 period, through inputs from the LF1 European Planetary Session Congress sessions, we worked on the definition of Earth Analogues with a panel of specialists in the area.

Finally, JRA2 activity implemented a webpage on Earth Analogues for making all the data from the field campaigns and meetings available to the public.

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JRA3 European Modelling and Data Analysis Facilities

Observational data analysis and modelling are two major aspects of modern scientific research. Europe has strong expertise in both these areas, but it is insufficiently coordinated. The need to consolidate the European planetary computational community was the primary motivation for the initiation of the JRA3-EMDAF (http://europlanet-jra3.oeaw.ac.at) - the European Modelling and Data Analysis Facility - within the Europlanet Research Infrastructure. JRA3-EMDAF was aimed at the development of a distributed research infrastructure, based on the European computational modelling and data analysis resources, in order to gain and foster the synergies of their coordinated and coherent use for the benefit of the broader European planetary science community. This activity resulted in a generic platform to enhance international cooperation and to provide the conditions under which further development and application of the numerical tools could be achieved. These tools and applications are suitable for planetary computational modeling and analysis of observational data, and the EMDAF platform provides them on a coordinated basis, resulting from close collaboration between scientists and numerical experts, and further encouraging such interactions. JRA3-EMDAF initiated the process of consolidation of several tens of existing European planetary models and data analysis facilities within a flexible, distributed research infrastructure; this platform is also finally linked to the broad scientific community through SA IDIS, as well as via the JRA3-EMDAF Interactive Catalogue of Planetary Models and Data Analysis Tools. Several demonstrators and operational tests of interconnected modelling and multi-disciplinary data analysis services, all in key areas of European Planetary Science, were also prepared during the course of this project.

An essential element of a distributed planetary computational modelling and data analysis infrastructure is an Interactive Catalogue of Planetary Models and Data Analysis Tools (ICPM&DAT, http://europlanet-jra3.oeaw.ac.at/catalogue/) where all the models and data analysis routines, as well as their related computational resources, are presented and described in a topic-oriented fashion. The catalogue enables a registered user to add his/her own modelling and data analysis facilities, and to find resources useful for his/her scientific work. It provides an interface for mining the existing model runs and for requesting new, dedicated modelling and data analysis services, as well as for establishing scientific cooperation with the providers of specific computational resources. One of the integral parts of the JRA3-EMDAF - the Distributed Numerical Modelling Laboratory (DNML) - developed the interfaces to allow scientists to interactively specify inputs for models to be run “on demand”.

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The major goal behind this work is to provide a possibility for modelling groups to carry out coordinated and interconnected simulations of planetary phenomena and objects. At the moment, the DNML environment consists of two main services: firstly, the global circulation model (GCM) of a giant planet atmosphere (developed at UCL) interconnected with a 1-D analytic auroral ionosphere profile (developed at Université de Liège); and secondly, the model of a giant planet magnetodisc (developed at UCL) with inclusion of disc dynamics. Another integral part of the JRA3-EMDAF environment is provided by the Distributed Data Analysis Laboratory (DDAL) activity, aimed at bringing together expert teams in data analysis and their research infrastructures, in order to create a coordinated European interdisciplinary data analysis service for Planetary Science. With the use of modern interactive communication tools, DDAL established a flexible multi-algorithm and multi-disciplinary data analysis service, open for the broad European Planetary Science community. The first demonstration tests of the service were performed in the fields of planetary radio astronomy, space weather and multi-dimensional spectral analysis of electromagnetic fields. The data analysis resources and dedicated tools are made accessible via the ICPM&DAT catalogue.

Finally, with the help of CINECA HPC infrastructure, several codes were selected and further developed, to make them suitable for execution on parallel computing systems in the collaborative context of JRA3-EMDAF. This part of the activity takes into consideration the algorithmic and computational approaches that can gain the most benefit from High Performance Computing. In particular, characteristic features of codes have been discussed with developers during the JRA3-EMDAF Strategic Workshop in Graz (2nd - 3rd June 2011). This has triggered further detailed discussion and follow-up development activities, which have led to the profiling and parallelisation of the codes ExoTim and PicSim (developed at UCL). The updated and HPC- integrated codes are accessible via the ICPM&DAT catalogue.

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JRA4-IDIS
Preparing the Planetary Virtual Observatory

General astrophysical observations collected either from space or ground facilities are feeding large data bases managed by space agencies and ground observatories. For about the last fifteen years the astrophysical community has undertaken a great effort to develop the Virtual Observatory (VO), a new approach to data handling allowing a scientist sitting anywhere in the world and connected to the Web to mine astrophysical databases, to retrieve, handle, and visualize the observations he/she is looking for. The VO is a genuine revolution in our way of doing science. Contributors to the development of the VO are usually coordinated by national VO structures, the latter being coordinated by the International Virtual Observatory Alliance (IVOA). This coordinated contributive approach is a very efficient way to match the expectations of a community.

The main space agencies throughout the world are managing their own archives with specific formats and access protocols. Concerning planetary data the largest and first established of these archives is the NASA Planetary Data System (NASA/PDS) and the second most important is the ESA Planetary Science Archive (ESA/PSA). Accessing and using these archives is not straightforward and the community of space scientists needs tools to easily retrieve and handle data. The first requirement was to allow interoperability of these space data archives : this was the motivation for creating the International Planetary Data Alliance (IPDA). The IPDA gathers representatives of space agencies who define standard protocols to retrieve and access data, and issues recommendations. Beyond this essential step it is necessary to improve and extend these protocols in order to match expectations from the community of users.

IDIS, the Integrated and Distributed Information Service of Europlanet, was created under the FP6 Coordination Action contract of Europlanet which covered period 2005-2008. The initial structure was redesigned in 2007 and Service Activity IDIS of Europlanet RI is its extended successor. The Research Infrastructure contract of Europlanet over period 2009-2012 allowed a widening of the scope of IDIS through Joint Research Activity 4, also named JRA-IDIS to underline it role as the research backyard of Service Activity IDIS. Its aim was to develop the infrastructure and tools necessary to progressively transform IDIS into a Planetary Virtual Observatory.

The first developments of the Astrophysical VO were initiated in several countries at the end of the 90's and the International Virtual Observatory Alliance (IVOA) was created in 2002 in order to coordinate these fast-growing efforts. JRA-IDIS took advantage of the experience and available outputs of the IVOA. Nevertheless, building a planetary VO has proved a challenging task due to the large diversity of observation data in planetary sciences. Imaging and analysis tools of sky views or of spectroscopic data developed for the Astrophysical VO can be used straightforwardly by the Planetary VO. But in situ measurements in space plasmas, in cometary or planetary environments, as well as in situ observations of surfaces of celestial bodies require particular tools and methods which are not within the scope of the Astrophysical VO. These are the specific targets of the Planetary VO that have been initiated by JRA-IDIS.

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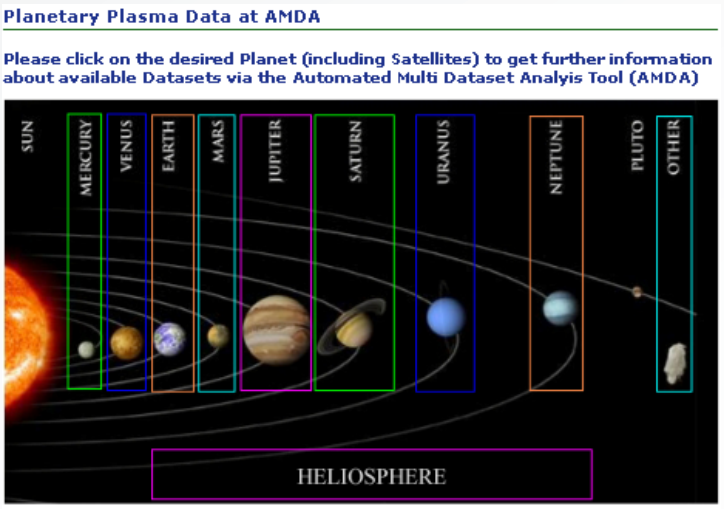
A management task coordinated SA IDIS together with the three technical tasks of JRA IDIS.

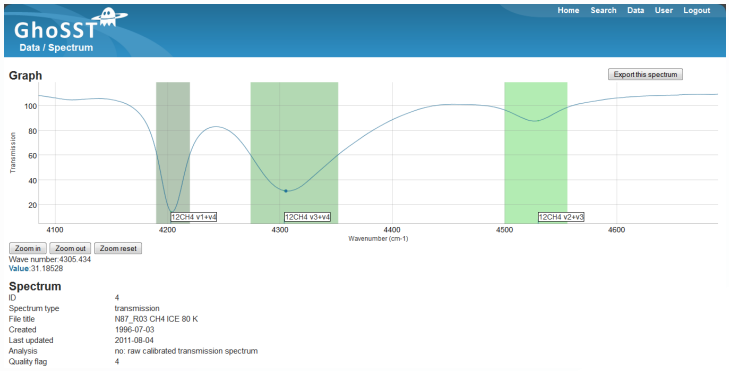
- The first task of JRA IDIS addressed issues concerning the architecture of the virtual observatory, the access layers of the data repositories and their access protocols in order to ensure their interoperability.

- The second task was focused on the creation of new tools to access, process and visualize data specific of the various fields of planetary sciences (surfaces, plasma and atmospheric in situ observations). See webpages at http://voparis-srv.obspm.fr/portal/ and http://cdpp-amda.cesr.fr/ .

- The third task, not to be underestimated, was to promote the creation of new data bases awaited by the community of planetary scientists; JRA-IDIS has thus supported the development of BED, Berlin Emissivity Database and of GhoSST, a database for the spectroscopy of solids and ices (http://ghosst.osug.fr/). Moreover JRA-IDIS has supported new developments of KIDA, a database of chemical kinetics for astrophysics, devoted to the chemistry of planetary atmospheres (http://kida.obs.u-bordeaux1.fr). This third task is directly related to the planetary VO as the newly created databases are VO compliant by construction.



Example of a planetary database providing web services
http://www.idis-plasma.europlanet-ri.eu/



Example of an on-line GhoSST page

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Into the Future

Europlanet is an organisation that has been developed by the planetary science community itself coming together, discussing the key problems that it faced, setting out the goals that need to be reached, and elucidating the strategy for achieving those goals. Community self-organisation is at its heart. Europlanet's success has been due to the fact that the community – the contract partners and planetary scientists outside of the contractors themselves – has been involved at all stages and has bought into the goals, the strategy and the process by which those goals and strategies have been set. Europlanet's achievements have changed the climate for planetary science in Europe to the extent that young researchers in the field cannot imagine a future without it.

The development of the European Union's Horizon 2020 programme offers great opportunities, but key challenges for the future of Europlanet. Among these are:

- The challenge of ensuring that the full potential of planetary science as a driver for jobs and innovation in Europe is realised. There is no doubt that planetary exploration takes industry into new environments that push existing technologies to the limit and demand ingenious solutions, solutions that may well find applicability outside of the planetary science itself. Such developments can benefit our fellow citizens and ensure Europe has a leading edge on the global stage. The future for Europlanet will be to extend its networking, its research and its infrastructure beyond the scientific community into close working partnerships with European industry;

- The challenge of ensuring that European citizens are fully aware of the key role that Europe plays in rolling back the frontiers of our knowledge of our Solar System, and planetary systems beyond our own. Europlanet's outreach and dissemination activities have already demonstrated that Europeans in general, the media, policy makers and industrial players are receptive to the work done by the planetary science community. The future of Europlanet has to be to take this foundation further to ensure that these various publics are fully engaged with, and critically supportive of, Europe's efforts to explore and understand our wider space environment;

- The challenge of ensuring that the European planetary science community overcomes its national and institutional divisions so that it can "punch above its weight" in international forums and conferences, in publishing in the highest impact scientific journals and – critically in the space missions, ground-based observations, and computer modelling and analysis activities that provide the raw materials for our new understanding. The future of Europlanet has to be to open out to the whole European planetary community, to generate an organisation and activities to which they can all belong, in which they can participate, to which they feel committed, and of which they feel genuine ownership.

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The planets come to London - 08-13 September 2013

The European Planetary Science Congress (EPSC) is the major meeting of planetary scientists in Europe and attracts participants from over 30 countries around the world.

EPSC2013 will take place in the UK for the first time and will be hosted by University College London, in the heart of Bloomsbury. Over 800 delegates are expected to register for the meeting, which will include more than 40 scientific sessions and workshops on the latest planetary science research.

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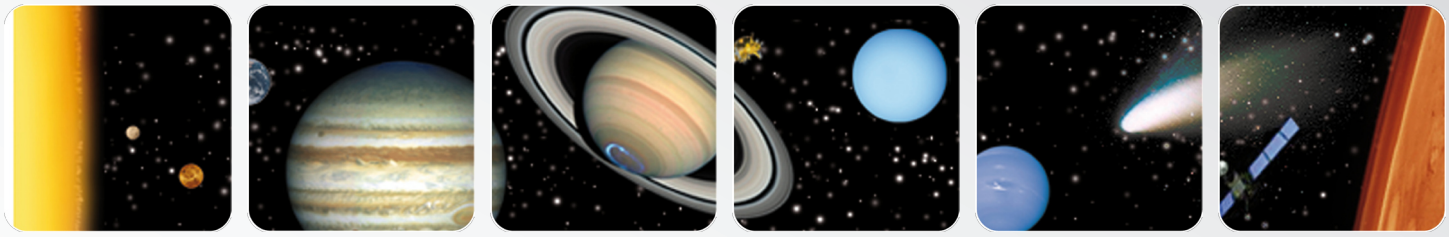

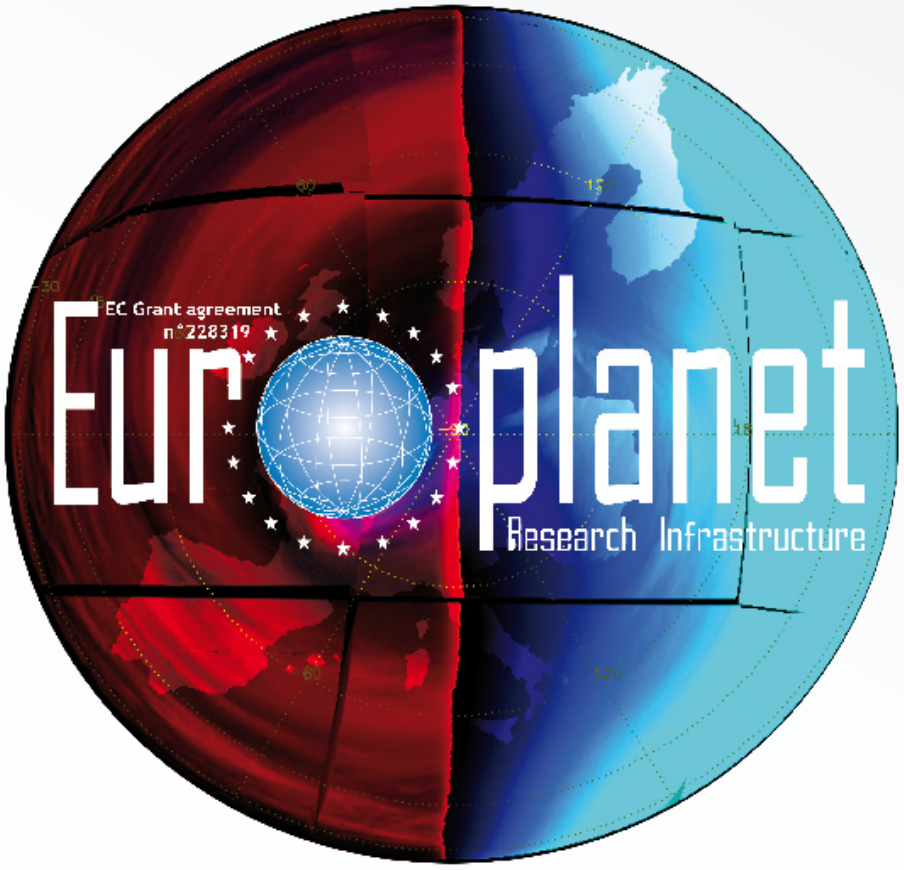

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