Impact of European Union Funding on Planetary Science

Overview

- Planetary science covers the study of our solar system and those around other stars.
- It is an interdisciplinary field of research that covers physics, chemistry, astronomy and geophysics, robotic and human exploration of other planets, as well as the search for extraterrestrial life.
- Comparative planetology research, such as climate modelling, can help improve our understanding of the Earth, its history, evolution and the risks that it faces from space, such as geomagnetic storms or asteroid impacts.
- Europe has world-leading facilities and the largest international community of planetary scientists, comprising over 800 tenured academics and around 4000 early career researchers spread in more than 200 research groups/institutions.
- Since 2005, the European Commission has supported the European planetary science community with over 40 million Euros funding, including 18 million Euros for the Europlanet project to integrate planetary science across the European Research Area.

Support for the underpinning scientific community is distributed among ESA’s national members and institutions, each with their own funding and support regimes. Europe’s planetary science community is at least as large as its US counterpart, with more than 800 tenured academics and around 3000-4000 young researchers spread across over 20 countries and around 200 research institutes. The European planetary science community is, therefore, much more fragmented and it is sometimes difficult for the community to carry out coordinated activities. Funding from EU Framework programmes for Europlanet has allowed the planetary science community across Europe to develop self-organized programmes, in order to complement and support the activities of ESA from the bottom up.

Background

The Europlanet project was founded to support scientists and engineers working across Europe on planetary-related research and development, and to maximise the scientific return from investment in international planetary missions. The European Commission has funded Europlanet through successive framework programmes, including 2 million Euros under FP6, 6 million Euros under FP7 and 9.97 million Euros under Horizon 2020. In addition, a range projects focused on specific areas of planetary science (e.g. Near Earth Objects, Venus, Mars, astrobiology) have received total funding of more than 20 million Euros to date through targeted calls by DG Research and Innovation and DG Internal Market, Industry, Entrepreneurship and SMEs (formerly DG Enterprise) under FP6, FP7 and Horizon 2020 (Table 1).

The European Space Agency (ESA)’s annual budget for science and robotic exploration, which covers solar system science as well as astronomy and fundamental science, is over 650 million Euros (around one fifth of the corresponding NASA budget). However, while NASA and other national space agencies have the responsibility both of developing missions and supporting the scientific communities involved, the remit of ESA is restricted to building and operating space missions.
Community cohesion

Investment by the European Commission in the Europlanet project between 2005-2012 has enabled two significant and sustainable outcomes for the long term cohesion of the European planetary community: the formation of a community organisation, linked by a Memorandum of Understanding (MoU), and the establishment of an annual conference of international stature on planetary science.

The Europlanet Community organisation was established in 2013 with the aim of creating a sustainable, active community for decades to come. To date, more than 75 research institutions and signatories have agreed to cooperate on an informal and mutually beneficial basis through the terms of the MoU. The MoU was renewed in 2015 and Europlanet has set a goal of signing up at least 180 institutional members – 90% of the planetary science institutions in the European Research Area – by the end of the decade.

Identifying science goals and priorities

European funding from Framework 6, Framework 7 and Horizon 2020 has provided the planetary science community with a forum to meet, debate and define science goals and priorities for planetary science and future missions. Europlanet has organised more than 20 specialist working group meetings, attended by 400 of the world’s leading planetary scientists. A series of eight workshops organised in association with the International Space Science Institute (ISSI) in Bern have resulted in the publication of reference books on key planetary science topics, including giant planets and the plasma environments of Venus, Mars and Titan.

The decision by the Committee on Space Research (COSPAR) and NASA that Jupiter’s icy moon, Ganymede, only required Category II planetary protection was in part influenced by contributions the authors of the reference book on satellites of the outer solar system, which resulted from one such Europlanet/ISSI workshop. This categorisation has reduced the potential cost of ESA’s JUICE mission to Ganymede by several million Euros due to the less stringent precautions necessary for protecting a Category II site from terrestrial contamination.

Europlanet has also given a platform for the community to make public statements on priorities at an international level (e.g. Europe should take leading role in curation and analysis of samples returned by missions) and at a national level (e.g. Scientists sign declaration in support of German Lunar Mission). The forum provided by EPSC has also been used for community consultations on international strategy (e.g. on the US Planetary Science Decadal Survey).

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**Table 1.** Planetary science related projects that have received EU funding under Framework Programmes 6, 7 and Horizon 2020.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Topic</th>
<th>Framework</th>
<th>Funding (M€)</th>
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<tbody>
<tr>
<td>EuroPlaNet³</td>
<td>European Planetary Network</td>
<td>FP6</td>
<td>2</td>
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<tr>
<td>Europlanet RI²</td>
<td>Europlanet Research Infrastructure</td>
<td>FP7</td>
<td>6</td>
</tr>
<tr>
<td>NeoShield²</td>
<td>Near Earth Objects</td>
<td>FP7</td>
<td>5.8</td>
</tr>
<tr>
<td>ProVISg²</td>
<td>Planetary Robotics Vision Ground Processing</td>
<td>FP7</td>
<td>3.5</td>
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<tr>
<td>PROVIScout⁴</td>
<td>Planetary Robotics Vision Scout</td>
<td>FP7</td>
<td>1.9</td>
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<tr>
<td>EuroVenus⁴</td>
<td>European Unified Research on Observations of Venus using coordinated Space and Earth-based facilities</td>
<td>FP7</td>
<td>2.2</td>
</tr>
<tr>
<td>AstRoMap⁴</td>
<td>Astrobiology Road Mapping</td>
<td>FP7</td>
<td>0.5</td>
</tr>
<tr>
<td>Europlanet 2020 RI³</td>
<td>Europlanet 2020 Research Infrastructure</td>
<td>Horizon 2020</td>
<td>10</td>
</tr>
<tr>
<td>EuroCARES⁴</td>
<td>European Curation of Astromaterials Returned from the Exploration of Space</td>
<td>Horizon 2020</td>
<td>2</td>
</tr>
<tr>
<td>Upwards⁴</td>
<td>Understanding Planet Mars with Advanced Remote-sensing Datasets and Synergistic Studies</td>
<td>Horizon 2020</td>
<td>2</td>
</tr>
<tr>
<td>NeoShield-2⁵</td>
<td>A Global Approach to Near Earth Object Impact Threat Mitigation</td>
<td>Horizon 2020</td>
<td>4.2</td>
</tr>
<tr>
<td>MIARD⁵</td>
<td>Multi-Instrument Analysis of Rosetta Data</td>
<td>Horizon 2020</td>
<td>2</td>
</tr>
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Transnational access and development of new facilities and tools

Places on Earth that have the same geological, physical or extreme environments found on other planets, such as Mars or the icy moons of Jupiter and Saturn, are vital test-grounds in preparing for future missions and in understanding where life might be found in the solar system. With EC funding from FP7 and Horizon 2020, Europlanet has enabled scientists across the EU to access Mars-like deserts in Spain and Morocco, and icy ecosystems in the Arctic circle, in order to test rovers and other instrumentation, or study life that has evolved under extreme conditions of temperature, salinity, acidity or aridity.

Europlanet scientists have already prepared a new analogue field site for study at Chott El Jerid in Tunisia: underneath the salty crust of this seasonal lake, which shares many conditions with areas found near the Martian poles, Europlanet scientists discovered an anerobic ecosystem, completely isolated from the surface and without any interaction with the atmosphere. The development of an ecosystem in this protected environment provides insights into the potential for life evolving on Mars. Through Horizon 2020 funding, Europlanet is preparing two further analogues for Mars and Europa (in Ethiopia and Spain respectively) in support of ESA’s flagship ExoMars mission to the Red Planet and the JUICE mission to Jupiter and its icy moons, Ganymede and Europa. Through Europlanet, access to these unique sites will be offered to researchers for the first time.

Europlanet also provides access to laboratory facilities capable of simulating a wide range of environments without natural analogues on Earth, such as the scorched, radiation-intense orbit of Mercury, dust storms on Mars or the frigid surface of comet Churyumov-Gerasimenko. These facilities allow researchers to carry out laboratory experiments to help understand results coming from the ongoing Rosetta mission, as well as to support upcoming missions, such as the BepiColombo mission to Mercury, or JUICE.

Through Europlanet’s FP7 funding, over 400 researchers were given the opportunity to access state-of-the-art facilities across EU borders. In Horizon 2020, this provision should enable a further 600 visits for researchers by 2019.

In addition, Horizon 2020 funding is assisting European scientists to prepare for some of the most ambitious missions planned in the next decades – to collect samples from extraterrestrial bodies, such as Mars, comets, asteroids or the Moon, and return them to Earth for analysis. This investment, through the EURO-CARES and Europlanet projects will define procedures for handling, studying and storing these rare samples, and will ensure that Europe is the world leader in curation of extraterrestrial material.

Understanding and protecting our planet

Venus is Earth’s closest sibling, but our ‘twin planet’ has ended up with a radically different climate: hostile with baking temperatures thanks to a runaway greenhouse effect. The emerging field of comparative planetology is helping us to understand how and why similar planets evolve in such different ways, and can assist in developing climate models for our own planet. The EuroVenus project is building on the legacy of ESA’s Venus Express mission to strengthen Europe’s position at the forefront of Venus research, as well as comparative planetology.

In recent years, increasing attention has been given to hazardous solar activity that could inflict severe damage to our infrastructure. The European Union has funded over 40 million worth of space weather-related research to date. Horizon 2020 funding is allowing the planetary science community to extend space weather research to other planetary bodies, with the practical application of ensuring that missions throughout the Solar System are protected in the same way as Earth-orbiting and ground-based facilities. Space weather tools and models for Mars, Mercury, comets and the outer planets, will support future missions such as ExoMars, Bepi-Colombo and JUICE. However, these tools will also lead to more
effective predictions and alert services for solar storms here on Earth, which will help prevent disruption to power and communication networks.

Near-Earth Objects (NEOs) represent potentially catastrophic threats to our planet. EU funding through FP7 and Horizon 2020 for the NEOShield and NEOShield-2 projects have provided access to technologies and characterisation for hazardous NEOs, preparing for their deflection and expanding our knowledge of the science behind them. With support from Horizon 2020, Europlanet is developing more accurate prediction and detection tools for meteor showers and impacts.

Equipping an emerging science community for the future

Europlanet has equipped young scientists with the skills to engage a variety of audiences with their research, including the public, schools, the media and policy makers. The project runs an active programme of communication workshops, as well as short, practical seminars during meetings such as EPSC. EU funding has supported intensive summer schools for early stage researchers, challenging them to develop concepts (e.g. a mission to the outer planets) under the guidance of leading international researchers. The EU also supports young researchers through the Marie Curie scheme and European Research Council (ERC) fellowships.

In addition, EU funding has trained and supported amateur astronomers, particularly in meteor observations. Through a Europlanet workshop, this funding instigated the development of a worldwide network of amateurs to support the Rosetta mission with near-continuous observations of comet 67P/Churyumov-Gerasimenko during the entire active period of its orbit. This model of professional-amateur astronomer collaboration is now being replicated in support of other missions.

In Horizon 2020, a prime objective for Europlanet is to integrate researchers and institutions from the EU’s Inclusiveness States into the established community, strengthening links with professional – and amateur – astronomers at a personal, national and regional level. As a practical example, the Europlanet community provided support and documentation to Latvian researchers and industry in building a case to join the European Space Agency, which they presented to the national parliament in January 2015.

Bringing industry and academia together

Europlanet has organised seven technology foresight workshops to date, with the aim of bringing together planetary scientists, instrument builders, and commercial providers of space technology, to create roadmaps for the development of the technology needed for future European planetary exploration. Challenges identified and addressed include robotics and autonomy, planetary cartography and Geographic Information Systems (GIS), detectors, in-situ and remote-sensing planetary instrumentation, and design for high radiation planetary environments. Europlanet 2020 RI will organise a further eight workshops and is working with a number of high-tech SME partners to develop new facilities for the planetary community. The project will also support industry-academia personnel exchanges to improve the scientific and innovation impact of the infrastructure, and is proactively developing links with industry through partnerships with Eurospace, the trade association of European space industries, and NEREUS, the network of European regions using space technology.

ERC funding has enabled academic researchers and industrial partners, led by Surrey Satellite Technology Ltd, to investigate a new model for developing astronomy missions using off-the-shelf technology. The first mission under development is Twinkle, which will study atmospheres of planets orbiting distant stars.

Maximising science return

Europlanet project activities have resulted in well over 250 publications to date. EU funding has also supported Europlanet in maximising science return through the development of synergies between the different components of planetary science, namely: space exploration, ground-based observations, laboratory and field experiments, numerical modelling, and technology. One successful product has been an interactive matrix to enable planetary scientists to link space mission requirements with ground-based facilities that can help them deliver their science goals. The matrix integrates more than 235 facilities, and is maintained and used three years beyond the end of Europlanet’s FP7 funding.
Gender equality and diversity

EU funding has supported the organisation of networking events for women during the annual EPSC, as well as a dinner debate in the European Parliament on gender balance within the planetary science community. Europlanet will provide a platform for the on-going discussion of gender issues and diversity in the planetary science community. To date, there has been no formal study on the demographics of the European planetary science community. Thus, in 2016, Europlanet is planning to survey its membership to provide a baseline for future studies.

Inspiring the next generation

Almost three-quarters of Europeans think that including subjects linked to space activities in educational materials would encourage students to choose careers in science, technology, engineering and mathematics. EU funding is creating repositories of the best space-related teaching resources and activities, as reviewed by teachers, and ensuring that those resources are adapted and translated to make them available in classrooms across Europe. The Horizon 2020-funded Space Awareness project works closely with the European Space Agency and collaborates with extensive European networks of schools and science museums to engage teachers, educators, students, and the general public across Europe with space research and planetary exploration. To understand more about what factors influence scientists and engineers in choosing a career in STEM, Europlanet is currently surveying its community to find out about members’ backgrounds, education and career paths.

Priorities for ensuring competitiveness of European planetary science in the future:

1. Making European academia and industry the first choice for collaboration with emerging space powers, such as China, India and Brazil - all of which have ambitious plans for future lunar missions.

2. Developing science and technology readiness for future planetary missions. Current COMPET and PROTEC calls are focused on exploiting data from past mission and accelerating the development of technologies to reach mature Technology Readiness Levels (TRL). Given the long timeframes and complexity of developing ambitious interplanetary missions, such as JUICE or BepiColombo, the planetary science community sees a clear need for research and development of data, instrumentation and tools at the conceptual stage (early TRL).

3. Exploiting EU expertise in non-EU missions (eg New Horizons and JUNO). European science and technology has contributed to the success of these missions and it is vital to ensure that this knowledge is transferred and integrated back into the wider European community.

4. Developing inclusiveness capacity and community cohesion, particularly for countries with early-stage space programmes, ESA Cooperating States and and EU Inclusiveness Member States.

5. Developing a trained workforce with the technical, academic and entrepreneurial skills needed for a next generation EU space industry.
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