europlanet Magazine

Issue 6

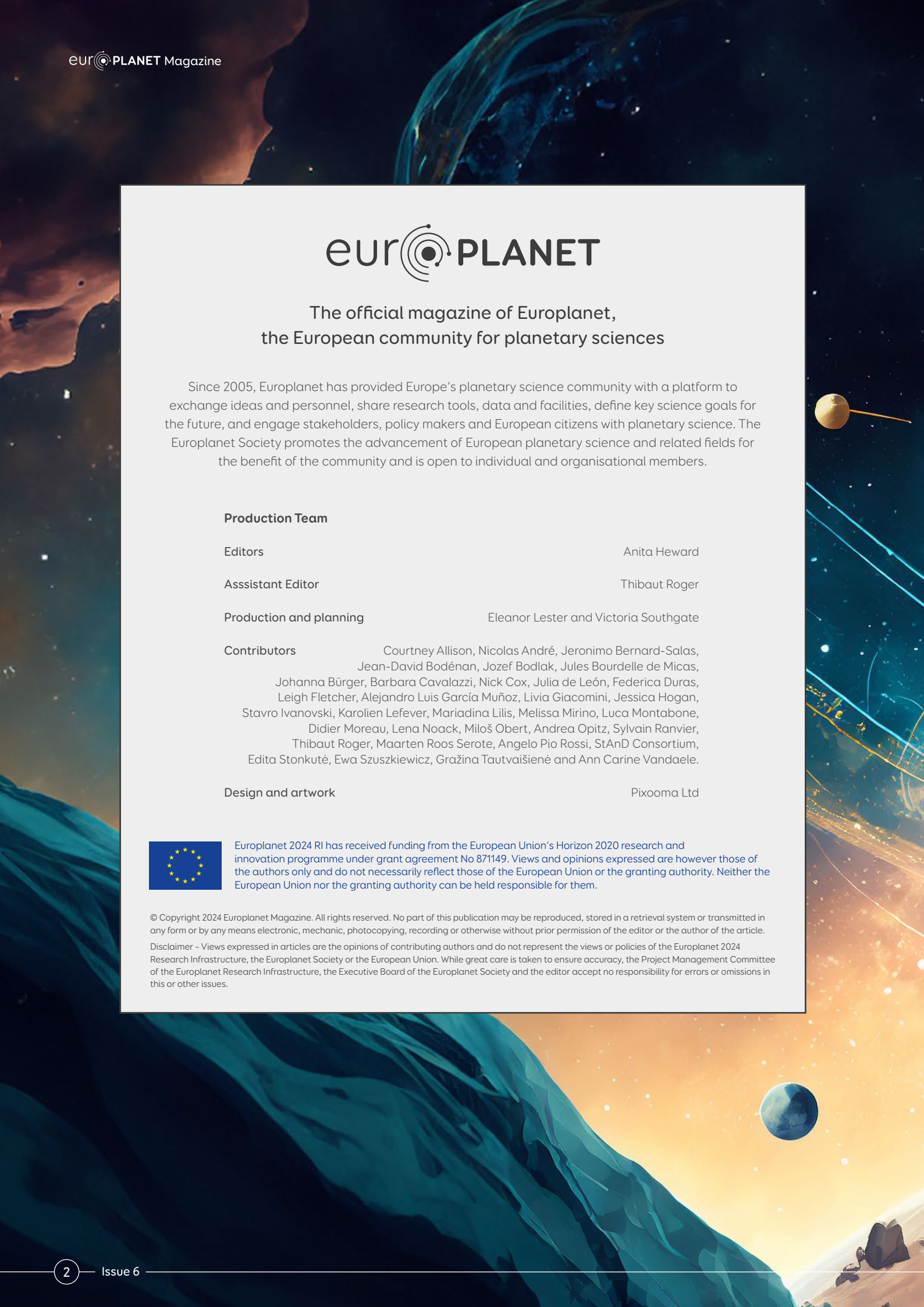
Machine Learning for a Data Driven Era of Planetary Science

ALSO IN THIS ISSUE

- Supporting Astronomy in Ukraine
- Meet the new Europlanet Society Board
- Workshop reports
- Dusting the Moon

ERIM 2023

A new kind of meeting for Europlanet



europlanet

The official magazine of Europlanet, the European community for planetary sciences

Since 2005, Europlanet has provided Europe's planetary science community with a platform to exchange ideas and personnel, share research tools, data and facilities, define key science goals for the future, and engage stakeholders, policy makers and European citizens with planetary science. The Europlanet Society promotes the advancement of European planetary science and related fields for the benefit of the community and is open to individual and organisational members.

Production Team

Editors	Anita Heward
Asssistant Editor	Thibaut Roger
Production and planning	Eleanor Lester and Victoria Southgate
Contributors	Courtney Allison, Nicolas André, Jeronimo Bernard-Salas, Jean-David Bodénan, Jozef Bodlak, Jules Bourdelle de Micas, Johanna Bürger, Barbara Cavalazzi, Nick Cox, Julia de León, Federica Duras, Leigh Fletcher, Alejandro Luis García Muñoz, Livia Giacomini, Jessica Hogan, Stavro Ivanovski, Karolien Lefever, Mariadina Lilis, Melissa Mirino, Luca Montabone, Didier Moreau, Lena Noack, Miloš Obert, Andrea Opitz, Sylvain Ranvier, Thibaut Roger, Maarten Roos Serote, Angelo Pio Rossi, StAnD Consortium, Edita Stonkutė, Ewa Szuszkiewicz, Gražina Tautvaišienė and Ann Carine Vandaele.
Design and artwork	Pixooma Ltd

Europlanet 2024 RI has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the granting authority. Neither the European Union nor the granting authority can be held responsible for them.

© Copyright 2024 Europlanet Magazine. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means electronic, mechanic, photocopying, recording or otherwise without prior permission of the editor or the author of the article.

Disclaimer – Views expressed in articles are the opinions of contributing authors and do not represent the views or policies of the Europlanet 2024 Research Infrastructure, the Europlanet Society or the European Union. While great care is taken to ensure accuracy, the Project Management Committee of the Europlanet Research Infrastructure, the Executive Board of the Europlanet Society and the editor accept no responsibility for errors or omissions in this or other issues.

Take off

The Europlanet Magazine will be three years old this June! Our initial vision for a 24-page publication hugely underestimated the potential content coming from our wonderfully active community. Issue 6 is a bumper-edition of 56 pages that shows the huge range of planetary-related activities in Europe and beyond.

The cover image of this issue is an AI-generated vision prompted by the title of our main feature, which investigates how AI and Machine Learning can contribute to planetary science. Our Commkit column looks at what AI tools mean for outreach and dissemination. We have an update on Europlanet's programme to support colleagues in Ukraine. We report on the outcomes of the Europlanet Research Infrastructure Meeting (ERIM) last June and the ongoing work to make Europlanet sustainable. Our Planetary Perspectives interview introduces the newly-elected members of the Europlanet Society Executive Board. We also have a glimpse behind the scenes of the integration of a space mission with an article on 'The Making of Juice'.

Many thanks to everyone that has contributed and made the Europlanet Magazine a success!

Anita Heward
Editor

Contents

In focus

The last few months has been a time of change and revitalisation in the Europlanet Community. 'In Focus' gives a digest of recent news and events.

Europlanet Society

New Board Members of the Europlanet Society

The results of the elections of the Europlanet Society Executive Board were announced at the Europlanet General Assembly on Friday 10 November 2023.

Eight members of the Board were elected, including Julia de León, Leigh Fletcher, Livia Giacomini, Melissa Mirino and Luca Montabone. Stavro Ivanovski was elected Vice-President, and Edita Stonkutė and Federica Duras will share the role of Secretary.

The current board also includes Ann Carine Vandaele, who takes up the mantle of President following her year as President-Elect (elected 2022), Treasurer Didier Moreau (elected 2021) and Vice President Angelo Pio Rossi (elected 2019 with a one year extended term to ensure that the turn-over of the Board is staggered).

Find out more about the new Board members in this month's Planetary Perspectives (page 15).

Stavro Ivanovski

Edita Stonkutė

Federica Duras

Julia de León

Leigh Fletcher

Livia Giacomini

Melissa Mirino

Luca Montabone

Europlanet Society

Meet the New EPEC Co-Chairs

Melissa Mirino and Jessica (Jessie) Hogan have been elected as the Co-Chairs of the Europlanet Early Career (EPEC) Network.

Melissa is currently starting a second postdoctoral position at the Institute for Space Astrophysics and Planetology (INAF-IAPS) in Rome, where she is supporting the Juno mission and the characterisation of Jupiter's moons. She was previously at the University of Padova, where she worked on the BepiColombo mission and characterising candidate sources of late volcanism on Mercury. She obtained her PhD at the Open University, UK, where she studied ancient river systems on Mars. In 2017 she took part in an internship at ESA's ESTEC facility to work with both radar and spectral data from the North Polar Cap on Mars. She has led the EPEC Communications Working Group since 2020, organising and managing activities such as the 'EPEC Profiles', the '#PlanetaryScience4All video contest' and the EPEC Podcast 'Stairway to Space'. As Co-Chair of EPEC, and a new member of the Europlanet Executive Board, she looks forward to making sure the early career voice is heard in the Society.

Jessica Hogan

Melissa Mirino

Jessie is a PhD candidate in astrobiology at The Open University, UK, working on signatures of organic-salt ice interactions on Enceladus. She graduated with a BSc in Planetary Science with Astronomy from Birkbeck, University of London in 2021. Her interest in astrobiology influenced her to choose a final dissertation on the habitable zone modelling of exoplanets. Following her studies, she secured an internship with ESA in Madrid, Spain, where she studied the icy surface of Enceladus by analysing Cassini data and modelling photometric parameters. Inspired by the astrobiological significance of Enceladus and other icy bodies, she is continuing to build on her existing research with her current PhD. As Co-Chair of EPEC, Jessie looks forward to supporting early careers and improving youth access to education.

Find out more about EPEC: https://bit.ly/EuroplanetEarlyCareers

---

Europlanet Society

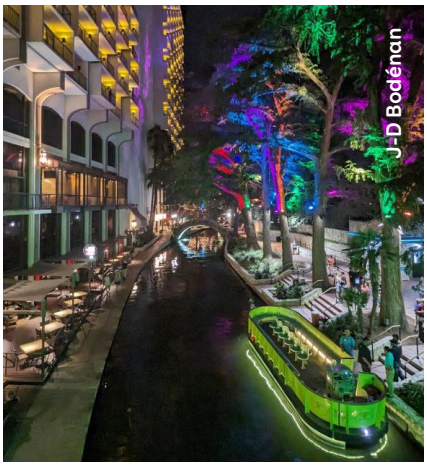
Join the Conversation on Discord!

Join the Europlanet Society Discord server to connect with other members of the Society and keep up to date with community news, events, job opportunities and much more! Download the Discord App to your computer and/or phone and join via the link below. You will receive a welcome message with tips and information on using Discord. The server is designed with a variety of channels to facilitate discussions and interactions, including text channels, discussion forums and voice channels. You can select roles to tailor your experience and access specific channels that match your involvement in the Society, so you can join the conversation on EPEC, Regional Hubs, Outreach, or whichever Europlanet services interest you. You can also join our weekly Friday lunchtime get-togethers on the 'Io' voice channel for informal chat and topical discussions.

Join Europlanet on Discord: membership.europlanet-society.org/discord/

EPSC

DPS-EPSC Joint Meeting 2023



Left: The Europlanet Society team with EPEC volunteers at their joint booths in the exhibition. Right: San Antonio at night.

The 2023 Europlanet Science Congress (EPSC) took place together with the American Astronomical Society's Division for Planetary Sciences (DPS) in San Antonio, Texas, from 1-6 October 2023, in hybrid format. A quarter of the 918 DPS-EPSC 2023 participants were from Europe. The programme was co-organised jointly by DPS and EPSC committee members and included keynote lectures, an Agency Town Hall, and many other events involving both US and European speakers.

The joint meeting offered opportunities to try out some new approaches for EPSC. Oral sessions, which comprised in-person and live online contributions, were organised with back-to-back blocks of talks interspersed by panel discussions with the speakers. The poster hall included large format displays by in-person presenters, as well as smaller-scale printouts of virtual posters, which were also uploaded to the Gathertown platform. The poster hall included a stage for lightning talks by poster presenters, as well as a Gathertown terminal for interactions with virtual participants. Lessons learned through the DPS-EPSC experience with a hybrid meeting will feed into the organisation of future events, starting with EPSC 2024 in Berlin, Germany, and the EPSC-DPS 2025 Joint Meeting in Helsinki, Finland.

EPSC in Berlin and Beyond!

EPSC is the major European meeting on planetary science, regularly attracting 1000-1200 participants from around the world, and is the annual meeting of the Europlanet Society. In 2024, the meeting will be hosted by the Freie Universität Berlin, Germany, 8–13 September 2024. The call for abstracts will run from 21 March to 15 May and registrations will open in the spring: https://www.epsc2024.eu

The Europlanet Society is now looking for hosts for its annual meetings in 2026 and 2027.

EPSC 2026 and 2027 should be hosted in a European city and led by a motivated and capable Local Organising Committee (LOC) with close links to the local planetary science community. The proposed venue should be able to accommodate at least 1200 participants onsite and offer options to allow hybrid access for virtual participation. For more information, see the application pack on the call page.

EUROPLANET SCIENCE CONGRESS

Are you interested in hosting an EPSC meeting in 2026 or 2027?

The call for proposals is now open, with a closing date of 15 May 2024.

https://bit.ly/EPSC2026-2027Call

EPSC

Early Career Activities at EPSC-DPS 2023

Johanna Bürger and Jules Bourdelle de Micas, co-chairs of the EPEC@EPSC Working Group, report on the Europlanet Early Career (EPEC) presence at the DPS-EPSC 2023 joint meeting.

The EPEC@EPSC working group teamed up with the DPS Professional Development Subcommittee to offer several activities for early career researchers at the joint DPS-EPSC 2023 conference. Ahead of the meeting, we organised a mentoring programme for early careers from both Europlanet and DPS. Students who were attending an international conference for the first time were supported by being paired with a more experienced researcher (post-docs or senior researchers).

EPEC's booth in the exhibition was set up alongside that of the Europlanet Society. Throughout the week, participants were able to stop by to find out about the EPEC community and the events we were offering during the conference - and, of course, pick up some goodies. Our booth attracted not only Europlanet early careers, but also DPS participants who discovered EPEC and got to know us during this joint conference.

At the end of the first day, we organised a networking reception for all early careers. It was a great opportunity to meet everyone and mix, especially between DPS and Europlanet, while enjoying a small buffet. Following this reception, we held our traditional workshop focusing on mental health at work. This year, Dr Steve Vance of JPL delivered an insightful presentation on this topic, sharing his point of view on mental health issues. This was followed by an open discussion where participants shared their concerns and thoughts with Dr Vance and people present in the room.

Group picture at the EPEC General Assembly

On Tuesday, the EPEC General Assembly took place, giving participants an introduction to how EPEC is organised, an update on the activities of the past year, and the latest news. This year, we were pleased to announce EPEC's two new co-chairs, Jessie Hogan and Melissa Mirino (see page 5). During the General Assembly, we also initiated a discussion on the future of EPEC and what the community wants from the network.

EPSC wouldn't be EPSC without our famous early career social event! This year, it took place at the outdoor El Camino bar and food truck park. Thanks to the great weather and huge space, it was the perfect setting for early careers to meet each other in a less formal environment, with Mexican-American food and drinks, and the backdrop of a broadcasted American football game.

We were very happy that so many early careers took the opportunity to attend our events, and connect with their fellows and our network during DPS-EPSC 2023. We hope to see everyone again at EPSC 2024. *Bis bald in Berlin!*

Do you want to participate in the organisation of EPEC events for the next EPSC? Get in touch with us (epec.epsc@gmail.com) and we will be happy to include you in our working group.

EPEC volunteers at the EPEC booth

Early career social event at El Camino

Europlanet 2024 RI

GMAP Winter School

The annual Geology and Planetary Mapping Winter School aims to introduce scientists and amateur enthusiasts to geological mapping of other planetary bodies. Now in its fourth edition, the 2024 school ran synchronously (with live sessions) in the week 22-26 January 2024, and asynchronously (allowing participants to work at their own pace) on the Streavent platform until the end of February 2024. The focus of this year's school was geologic mapping aspects of Venus, Icy Satellites and Small Bodies. The programme was largely hands-on, with the inclusion of seminars and time for asynchronous interaction and individual or project mapping work. The school attracted more than 590 registrations from 75 countries around the world.

Each planetary body was introduced, with participants guided through hands-on activities such as the individual completion of a small mapping area. At the end of each day, specific time slots were dedicated to seminars, which provided insights, perspectives, and additional knowledge on related topics. The event was co-funded by the Europlanet 2024 Research Infrastructure (RI) project's GMAP teams at the University of Padova and Constructor University.

All materials and videos from the 2021-2024 editions of the Winter School are freely available at:

https://www.planetarymapping.eu

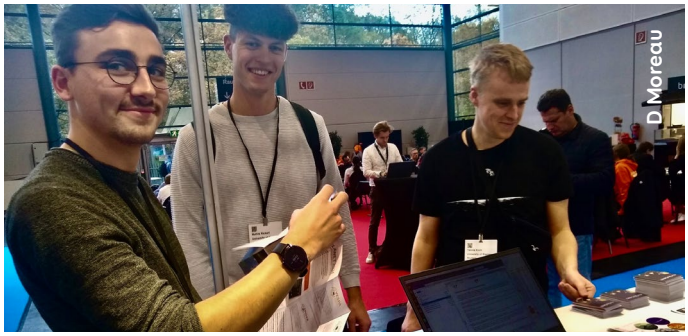
Europlanet Society

Europlanet at Space Tech Expo Europe

Last autumn, the Europlanet Society participated for the first time in Space Tech Expo Europe, which took place in Bremen, Germany, from 14-16 November 2023. Taking part in Europe's largest business-to-business event for the space industry was an opportunity for the Society not only to strengthen its presence on the European space scene but also to highlight its commitment to innovation and technological development in the planetary exploration sector. Space Tech Expo Europe proved an effective platform for the Europlanet Society to showcase its achievements, share knowledge and establish strategic partnerships with other key players in the space industry. During the event, the team organised eleven business-to-business sessions, and gave eighty-one presentations at the stand to share know-how with participants. The Society also took the opportunity to unveil its new sustainability project: the Europlanet Association (see page 55) .

Europlanet's presence at Space Tech Expo Europe was a great success, highlighting the Society's continued commitment to planetary science, exploration, exploitation and space innovation. This participation marks the start of a new era for Europlanet's industry engagement, opening the way to new opportunities, partnerships and achievements in the field of European planetary exploration and beyond.

bit.ly/EuroplanetIndustry



Left: Europlanet Industry team members were joined by local colleagues from the GMAP team at Constructor University in Bremen. Right: Visitors to the Europlanet stand at Space Tech Expo Europe.

Europlanet 2024 RI

European Space Weather Week

More than 600 members of the space weather and space climate community gathered in Toulouse (France) for the European Space Weather Week (ESWW) from 20-24 November 2023. The programme for the annual conference included topics across the spectrum from the Sun to the planets, with a large focus on the Earth. ESWW 2023 also hosted several platforms to exchange knowledge and ideas, besides plenary and parallel scientific sessions, with topical discussion meetings, tutorials, and a dedicated exhibition area.

The Sun Planets Interactions Digital Environment on Request (SPIDER) activity of the Europlanet 2024 RI project contributed during ESWW with a dedicated booth in a busy part of the exhibition. The 1:10 scale model of the JUICE spacecraft attracted many participants and the 3D-printed globes of Jupiter's moons were also a great success. At the booth, the SPIDER team had the opportunity to directly meet the community and tell them about SPIDER's services for modelling planetary environments and solar wind interactions. The team also organised a topical discussion meeting about 'Planetary Space Weather' with more than 40 participants. Feedback, comments, and suggestions from the audience emphasised the need for dedicated models to support future planetary missions beyond BepiColombo and JUICE, in particular missions to the Moon and Mars.

Nicolas André (SPIDER Lead), Andrea Opitz (SPIDER Deputy) and Máté Tomasik (Widening representative) at the Europlanet SPIDER booth.

spider-europlanet.irap.omp.eu

Europlanet 2024 RI

First Europlanet Latin America Workshop

The first Europlanet Latin America Planetary Science Workshop, 'Connecting Earth with other Planets', was held in Buenos Aires from 31 October – 03 November 2023. The workshop was attended by 30 in-person participants, with 30-60 online participants joining at times during the programme. Theoretical and practical training was provided on how Earth-based analogues can be used to understand extraterrestrial environments. Speakers were drawn from universities across Latin America and the Europlanet community, as well as the Argentinian national space agency (CONAE) and the European Space Agency (ESA). The workshop, organised through the Europlanet 2024 RI project, stimulated many discussions and proved a very useful opportunity for networking and connecting local communities. It was followed up by a successful workshop in Bolivia from 6-9 February 2024. eventi.unibo.it/epn24-argentinaworkshop/

Participants at the Europlanet Latin America Workshop

Europlanet Society

Europlanet Committee Funding Scheme Results 2023

In 2023, the Europlanet Society awarded grants to support seven projects proposed by its Regional Hubs, Committees and Working Groups.

Orionids 2023 (€1400)

The Central Europe Hub was awarded funding for the 'Orionids 2023' meteor astronomy camp in Banská Štiavnica, central Slovakia (report on page 47). The programme included a mix of theoretical and practical training on how to observe meteor showers and submit the results in the International Meteor Organization (IMO) database.

Pro-Am occultation campaigns with a portable telescope (€3300)

The Spain-Portugal Hub secured funding for the Sociedad Astronómica Granadina (SAG) to acquire a portable telescope to obtain occultation data of stars. The SAG amateur astronomy group collaborates in dozens of different Pro-Am occultation campaigns, in particular those involving trans-neptunian objects, Jupiter trojans and Near Earth Objects (NEOs).

The new telescope will enable SAG to continue and improve collaborations with professional colleagues and to obtain occultation data of fainter stars.

Careers workshop at French Planetary Science Congress (€4900)

The France Hub has been awarded funding to support a one-day workshop devoted to early career researchers. The event will form part of the French planetary science congress 'ORIGINS - From Planets to Life', which will be held in Nantes in July 2024 conjointly with the French Astrobiology Society (SFE) and National Programme for Planetary Science (PNP). The Europlanet-funded workshop will focus on careers in planetary science, with a programme that includes talks from industry and academia about potential career paths, and practical training on writing CVs and research grants.

https://planetoexobio2024.sciencesconf.org/

EPEC: Early Career Activities at DPS-EPSC 2023 (€900)

EPEC organised events for early career researchers at the joint DPS-EPSC meeting in October 2023 in San Antonio, Texas, including a booth, courses, social events and a mentoring programme (report on page 7).

Terrestrial Analogues for Solar System Studies Conference (€5000)

Co-funding has been awarded through the South East Europe Hub for the Terrestrial Analogues for Solar System Studies Conference in June 2024. The host venue – the Greek island of Milos – is highly relevant to planetary geology, as it has experienced young volcanism and tectonism (as seen on Mars and Pluto), has undergone atmospheric shaping of volcanic deposits, and carving into yardangs (Mars, Titan, Venus, Pluto), and has current hydrothermal and fumarolic activity (Venus, Io, exoplanets). The conference will offer a combination of lectures, science discussions and field trips, as well as dedicated policy and industry discussions.

https://bit.ly/MilosAnaloguesWS

Variable stars and exoplanet research meeting (€3060)

Funding to develop international participation in the Czech Variable Stars Meeting has been awarded through the Central Europe Hub. The meeting has a long history, with the 56th edition planned for 2024. In recent years it has been organised in hybrid format to support international collaboration. The Europlanet funding is helping to broaden the scope of the meeting by advertising the meeting on the European level, providing travel bursaries and supporting translation.

https://bit.ly/55CzVariableStars

BPSC 2024 (€4380)

Europlanet has awarded funding through the Ireland-UK Hub to support early career events at the British Planetary Science Conference (BPSC) 2024, which will be held in Leicester in June. The conference will start with a one-day workshop for early careers on the development of space instrumentation and missions. The main conference will also have an emphasis on careers and equality, diversity and inclusion (EDI) and will include a community consultation day with stakeholders.

https://bpsc2024.le.ac.uk

Outreach

Students as Planetary Defenders

StudenTs As plaNetary Defenders (StAnD) is an ambitious education project to involve school children in the search for asteroids and meteorites.

Launched in November 2023, the 36-month Erasmus+ programme will bring activities and experiments into the classroom that will enable students to follow the journey of these cosmic visitors from the depths of space to our planet. Schools will receive a specially designed kit for micrometeorite hunting, and some schools will even have meteor detection cameras installed, offering the potential of contributing to discoveries of new asteroids and meteorite falls.

Teachers will receive training and support via massive open online courses and summer schools. They will also receive training on how to use robotic telescopes, operate and interpret meteor images acquired by camera systems, and collect and identify micrometeorite samples. StAnD is coordinated by INAF (Italy), with the active participation of COSPAR (France), NUCLIO (Portugal), Ellinogermaniki Agogi (Greece) and FTP-Europlanet (Germany).

For more information and updates on how the project develops, see projectstand.eu

All-sky camera for meteor detection.

Outreach

Blink of a Star

Observations of a Solar System body passing in front of a star (a phenomenon known as an 'occultation') can produce useful data about the object, such as its size, atmosphere, moons or rings, as well as about the occulted stars. On 12 December 2023, Asteroid (319) Leona, occulted Betelgeuse, a very bright star in the Orion constellation.

The extreme brightness of Betelgeuse means that features, such as its precise radius, are difficult to measure because cameras and instruments are quickly saturated. Because the angular diameter of Betelgeuse is very similar to that of Leona, the occultation gave a rare opportunity to study Betelgeuse with unprecedented spatial resolution. The phenomenon was visible with the naked eye in areas that fell under the shadow path of the occultation, which included Andalusia in Spain.

Main picture: The SAG team. Inset: Collage zooming in on Betelgeuse in the Orion constellation.

The Sociedad Astronómica Granadina (SAG), based in northern Andalusia, was awarded a grant by the Europlanet Public Engagement Funding Scheme 2023 for a citizen science project to highlight the event. An outreach campaign engaged the public, schools and amateur astronomers with the science behind occultations and encouraged as many people as possible to record the event using regular cameras and lenses. Submitted lightcurves – precise measurements of the dip in light as Betelgeuse was masked by Leona – are currently being analysed. The results of the citizen science project will complement professional observations of the event and, together, are expected to reveal new information about Betelgeuse that will be published in the next few months. starblink.org

Europlanet Prizes

Europlanet Prize for Public Engagement 2023

The winners of the Europlanet Prize for Public Engagement 2023: Daniela de Paulis (left) and El Mehdi Essaidi (right)

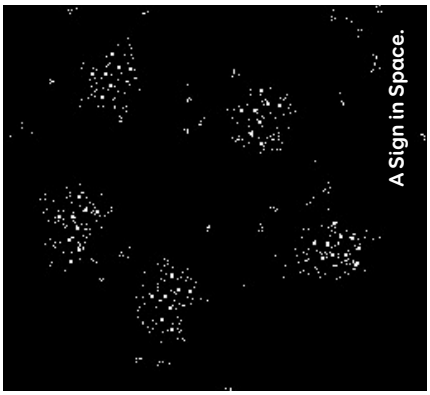
The 2023 Europlanet Prize for Public Engagement has been awarded jointly to the artist, Daniela de Paulis, for her interdisciplinary programmes to bring space and planetary science to international audiences, and the science communicator, El Mehdi Essaidi, for his community-centric work in southern Morocco to share the wonders of our Solar System and the Universe.

Daniela de Paulis is an interdisciplinary artist, whose installations and performances have a strong public engagement component. She has collaborated with astronomers and space scientists for many years and is currently a SETI Institute Artist-in-Residence (SETI AIR). Her latest project, 'A Sign in Space', invited people around the world to help decode a simulated message from an alien civilisation. The message was transmitted from Mars orbit on 24 May 2023 by the European Space Agency (ESA) mission, ExoMars Trace Gas Orbiter, and was received by three radio telescopes on Earth. The project reached people in 174 countries, with over 85,000 people viewing a livestream of the event and almost 5,000 people registering on the online platform Discord. The message was extracted from the raw signal data within less than 10 days; however the process is ongoing as people on Discord are now trying to decode and interpret the message. The design of the project required coordination with ESA, the Italian National Institute for Astrophysics (INAF), the US-based Green Bank Observatory, and the SETI Institute, as well as teams of radio astronomers, planetary scientists, engineers, communicators, artists, poets, philosophers, anthropologists and computer scientists, collaborating over different time zones for more than two years.

El Mehdi Essaidi, from the Asif n Ait Bounouh Association for Culture and Awareness in Ait Bounouh / Tafraoute, works to empower students and enhance science literacy in isolated and underserved communities in southern regions of Morocco. Through programmes that are tailored to the specific cultural contexts and local dialects, including astronomy workshops, hands-on experiments, story-telling, stargazing events, mentorship opportunities, and observational research projects, El Mehdi Essaidi has motivated young individuals to pursue their dreams in the field of astronomy. By engaging both children and adults, he aims to create a ripple effect that spreads scientific curiosity throughout the community, and provide a relatable role model who shares their language and cultural background. With his latest project, 'Asif Stars', he has enabled communities in Morocco to conduct observational research using the Las Cumbres Observatory telescope network.

Both Daniela and El Mehdi have been invited to deliver prize lectures at EPSC 2024 in Berlin.

bit.ly/EuroplanetPrize2023



Binary code received for 'A Sign in Space' was extracted in the form of an image, which is now being used to decode and interpret the message.

Europlanet Prizes

Farinella Prize 2023

Dr Federica Spoto, of the Minor Planet Centre in Cambridge, Massachusetts, USA, and Dr Diego Turrini, of the Turin Astrophysical Observatory (INAF-OATo) in Italy, have been awarded jointly the 2023 Paolo Farinella Prize for their outstanding contributions to the field 'From Superbolides to Meteorites: Physics and Dynamics of Small Planetary Impactors'. The award ceremony took place during the DPS-EPSC Joint Meeting 2023 and was followed by a prize lecture by each of the winners.

The winners of the Farinella Prize 2023, Diego Turrini (left) and Federica Spoto (right).

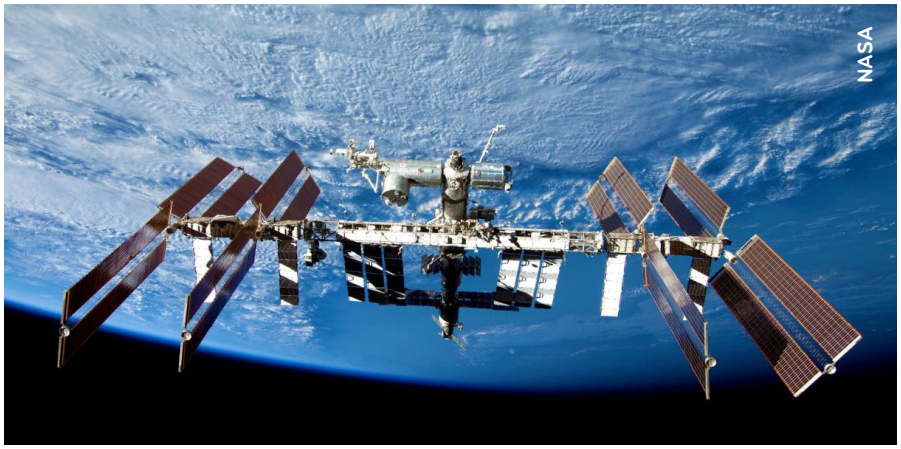
The annual prize was established in 2010 to honour the memory of the Italian scientist Paolo Farinella (1953-2000). Each year, the prize acknowledges an outstanding researcher not older than 47 years (the age of Prof Farinella when he passed away) who has achieved important results in one of Prof Farinella's fields of work. Each edition of the prize focuses on a different research area and, in 2023, the topic was chosen to highlight recent advances in knowledge about small-size Near-Earth Object (NEO) populations. The award is supported by the Europlanet Society and EPSC.

bit.ly/Farinella2023

Central Europe Hub

Polish Experiments to Fly on International Space Station

A call for Polish activities to fly on the International Space Station (ISS) was met with great interest from the scientific community and space private sector in Poland. A total of 66 concepts - an unexpectedly high number - were submitted following the announcement of opportunity by the European Space Agency (ESA) last August. All the proposed ideas complied with ESA's recently adopted Science in Space Environment (SciSpacE) Strategy Roadmap. Following evaluation by ESA and the Polish Space Agency (POLSA), a preliminary list has been released of 18 experiments to be conducted by astronauts on the ISS in 2024-2025. The selected experiments address a wide range of scientific questions and technological solutions, including tests of medications for cancer, trials of mechanisms relevant to space mining, and investigations of sustainable food sources for space exploration.

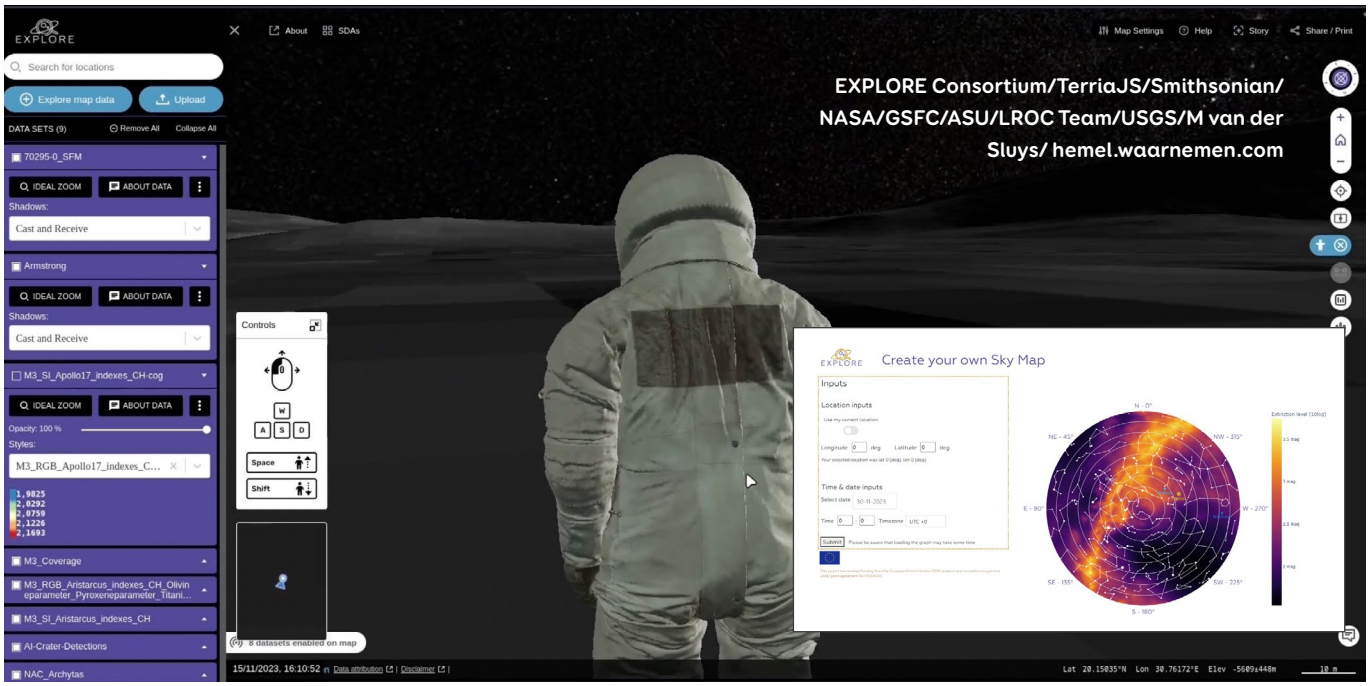


The International Space Station (ISS)

In collaboration with ESA, POLSA has also initiated a competition, 'Direction: Space', for university students and PhD candidates. Both initiatives are connected with the upcoming flight of a Polish astronaut, planned for later this year, on the Axiom-4 mission.

Community

EXPLORE Apps for Lunar, Stellar and Galactic Research



EXPLORE's lunar tools include a 'pedestrian view' for visualising the exploration of the lunar surface. Inset: Sky map showing the concentration of dust in the Milky Way

A new set of tools for planetary scientists and astronomers has been launched that use interactive visual analytics and machine learning to reveal and contrast properties of objects in our galaxy. The EXPLORE Scientific Data Applications are all open-source and are designed to help researchers investigate, annotate and work together on interesting results in a collaborative online environment.

EXPLORE, which has been developed with funding from the European Commission's Horizon 2020 programme, is a close collaborator of the Europlanet 2024 Research Infrastructure (RI) project and a good example of how Europlanet can bring together academic and industrial partners. The lunar applications, L-Explo and L-Hex, allow users to navigate a 3D model of the Moon and upload, display and compare multiple datasets from lunar missions. Zooming in on a location, users can overlay basemaps with contours, visualisations at different wavelengths and spectral information on the mineralogy of the surface. Pre-trained deep learning models help identify craters and map features. A 'pedestrian view' enables users to visualise themselves standing and moving around the lunar surface through digital elevation models.

Tools for stellar research are designed to investigate the properties of stars in the Milky Way observed by the European Space Agency's Gaia mission and in other large databases. S-Disco assigns a weirdness score to spectral data that can help astronomers find unusual stars, or groupings that have similar characteristics, within a population of a million stars. S-Phot compares the brightness of stars at different wavelengths to reveal information on the temperature, age, size and amount of energy stars produce.

G-Arch allows users to estimate chemical and physical parameters of stars by matching Gaia data with theoretical spectra. Finally, G-Tomo enables users to look at dusty objects and the distribution of dust in the Milky Way in one, two or three dimensions. Slicing through the galaxy in any orientation can reveal where dust is densely clumped and where there are windows that offer potential sightlines to objects of interest. Interactive sky maps show how the dust band at the core of the Milky Way passes overhead through the day and night at any given location on Earth. Collectively, these applications can help unravel the composition of our galaxy and how it was built up. All applications, user manuals and video tutorials are now online at: explore-platform.eu

Planetary Perspectives:

Meet the New Europlanet Society Board

This edition of Planetary Perspectives finds out more about interests, backgrounds and ambitions for the Europlanet Society of the members of the Executive Board elected and taking up new roles in November 2023.

How did you get into planetary science?

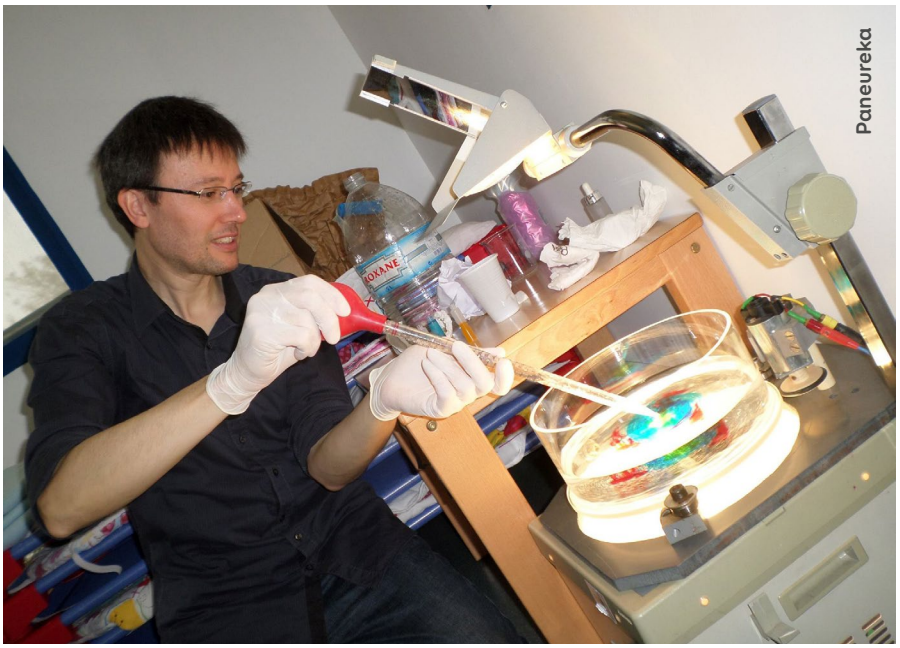
Leigh Fletcher (University of Leicester, UK), Board Member: I was in the right place at the right time for a PhD position working on Cassini data. Actually, I was a Naval Reserve, doing officer training on a small patrol boat (but sometimes getting to sail on aircraft carriers), and almost signed up before being tempted into a science PhD!

Federica Duras (INAF, Italy), Secretary: After my PhD and postdoc in active black holes, I switched to outreach and education and I started dealing with planetary science. It is an extremely interesting topic and its 'closeness', or familiarity, helps to make people fall in love with astronomical science.

Melissa Mirino (University of Padova, Italy), Board Member: I started to collaborate with the Astrophysics Institute INAF-IAPS in Rome when I was an undergraduate and I had to work on my thesis project. At the time, I collaborated with the team who was in charge of interpreting the data from MARSIS, the radar on board the ESA Mars-Express mission. My work was focused on creating a 2D geological model of the deep layers of the North Polar cap of Mars. After that, I fell in love with the topic and, thanks to scholarships and travel grants, I had the opportunity to work and study abroad to dig deeper into other projects related to planetary science.

Julia de León (IAC, Spain), Board Member: Well, this is a funny one. I finished my degree and I started to work as an astronomer at the Optical Ground Station (OGS), a 1-m telescope managed by ESA and located at the Teide Observatory in Tenerife, where I am from. I was detecting and following-up space debris! After a couple of years, I

Society Vice President, Stavro Ivanovski, at the Europlanet Science Congress (EPSC)



Society Board Member, Luca Montabone, simulates the Coriolis effect in a rotating fluid.

started to take advantage of my access to the telescopes and, as I was actually looking at the near-Earth environment, I started observing Near-Earth Asteroids (NEA). I did my thesis on the composition of NEAs... and here I am.

Livia Giacomini (INAF, Italy), Board Member: I remember my first day in a research institute: I was a university student, asking the great Angioletta Coradini about a thesis. She answered that planetary science was the most exciting topic that a young researcher could choose to work on. And, of course, that I needed to be very motivated to become a researcher.

When did you first get involved with Europlanet?

Stavro Ivanovski (INAF-Astronomical Observatory of Trieste, Italy), Vice President: I joined Europlanet in 2017 through the VESPA activity of the Europlanet 2020 Research Infrastructure (RI) project, thanks to the late, much-missed, Maria Teresa Capria. Since 2020, I have acted as the Co-Chair of the Europlanet Science Congress (EPSC) Scientific Organising Committee (SOC). I am serving as the Chair of Italy Regional Hub. Also, whilst chairing the Outreach Working Group in 2020, I was one of the creators of the 'InspiredByOtherWorlds' art contest that invites everybody to submit all kinds of artworks inspired by planetary science. Recently, I've also led the Machine Learning Work Package within the Europlanet 2024 RI project.

Luca Montabone (Paneureka, France), Board Member: I have memories of initially getting involved with EuroPlaNet (around 2005 or so, when it still stood for 'European Planetology Network') when I participated in a meeting in London to discuss a potential future 'Virtual Research Infrastructure'. Subsequently, I attended several EPSCs, with the most vivid memories stemming from the Europlanet Research Infrastructure Meeting (ERIM) last year (report on page 30).

Ann Carine Vandaele (IASB-BIRA), President: I was part of the Europlanet 2020 RI project, which ran from 2015 to 2019, with a very minor contribution. I am a European at

Society Secretary, Federica Duras, at EPSC2022 in Granada, Spain.

heart: I am convinced of the benefits of working together at the European level and of the wealth of expertise and knowledge that exists in Europe. I was in Berlin when the Europlanet Society was created and it seemed natural to engage with the promotion of the Society.

Edita Stonkutė (Vilnius University, Lithuania), Secretary: I have been the coordinator of the Europlanet Mentorship Programme since 2020, but was also a tutor at Europlanet Summer Schools from 2017.

Melissa: I started to get involved with the Europlanet Early Career (EPEC) Network in 2018, after attending the EPEC Annual Week in Lisbon. After that, I became the Co-Chair of the EPEC communication working group. During that time I tried to help the EPEC Network grow by adding and managing new activities such as the 'Raise your Profile' initiative and the #PlanetaryScience4ALL video contest. Currently, I am a Co-Chair of EPEC in general.

What do you most want to see from the Europlanet Society in the next 12 months?

Ann Carine: I hope we can build a strong structure (association, committees, boards, regional hubs) with active and committed people, and be ready to submit proposals or become partners in future projects.

Federica: I hope to see increased engagement through virtual platforms (existing and new), with enhanced accessibility to online resources that will benefit members and strengthen the Europlanet community.

Julia: I think in the next year we need to consolidate our transition to an international non-profit association and, of course, focus on

Society Secretary, Edita Stonkutė, training students at the Europlanet Summer School in Lithuania.

Society Board Member, Melissa Mirino, at the closing ceremony of EPSC2022 in Granada.

Ann Carine Vandaele began her term as President of the Europlanet Society in 2023.

EPSC 2024, which is one of our major events as a society.

Leigh: I want to see optimisation of activities so that we can do more of what we do best, rather than spread ourselves too thin. The EPSC meetings are my top priority, being the premier networking and collaborative meeting for European planetary scientists. We should ensure these continue to serve our community and widen participation, keeping costs manageable, minimising carbon footprints by selecting accessible locations with good public transport, and improving virtual access for those who may be unable to travel.

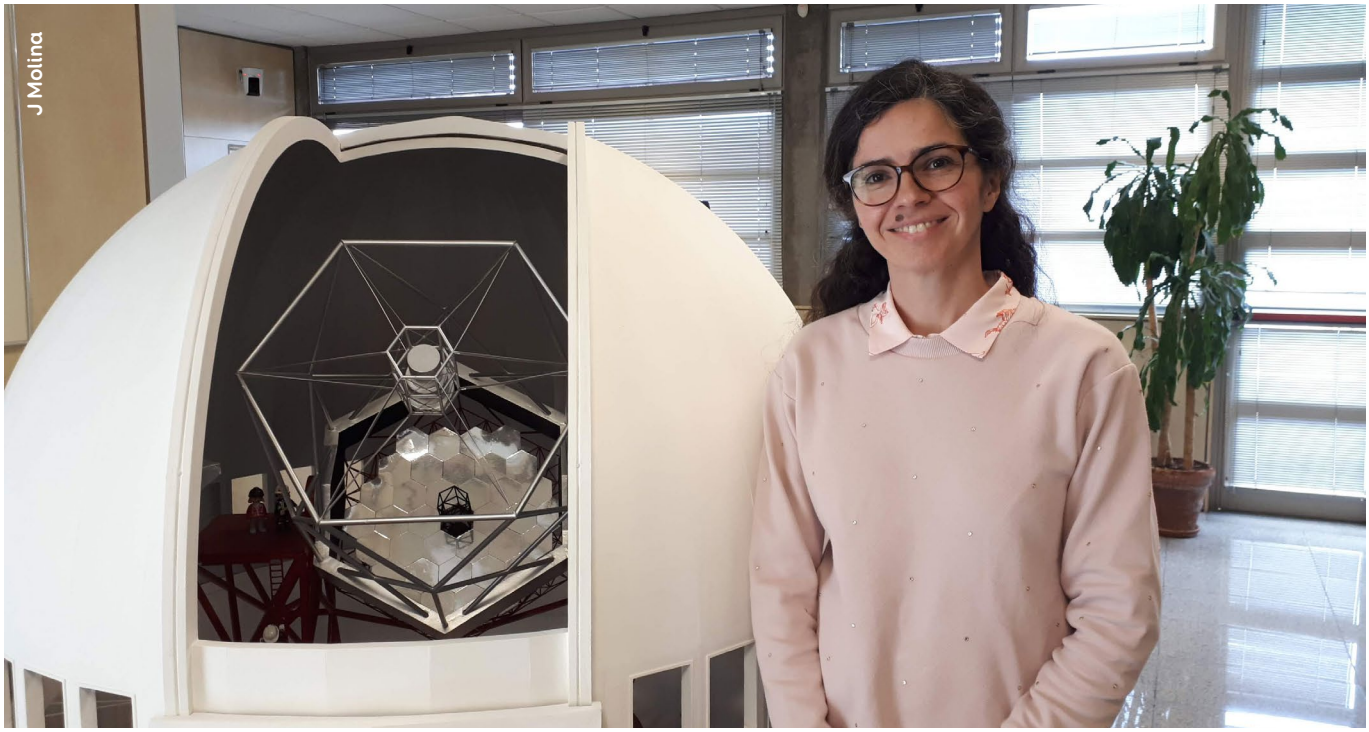
Melissa: Since I am representing the early careers, I hope to see more opportunities and doors open for them. I would like to provide them a clearer guide about how to join EPEC as active participants and how to develop leadership skills by taking care of the activities we already have in place. We should never forget that the future of research and exploration is in the hands of early careers and they should also be motivated to pursue a career in planetary science.

How would you like to see the Europlanet Society develop over the next 5 years?

Edita: I would like to see an even larger, supportive, diverse and inclusive community.

Livia: I would like young students and older researchers to look at Europlanet as the community where they can develop new projects and grow planetary science. I also imagine a Europlanet festival: a very successful week, in which institutes and schools from all around the world organise public events related to the exploration of the Solar System and new worlds.

Luca: I would like to see the Europlanet Society evolve into an entity under which members can initiate pan-European funded projects.



Society Board Member, Julia de León, is a researcher at the Instituto de Astrofísica de Canarias (IAC).

Leigh Fletcher was re-elected as a Board Member of the Europlanet Society in 2023.

Stavro: I would like to see Europlanet as a growing organisation, with a feasible long-term plan for sustainability, breakthrough research, and early career scientist support. My ambition is to see early careers with scientific discoveries owing to their collaborations within Europlanet, and senior researchers able to stand up for European planetary science and establish new lines of research through Europlanet.

Can you share one thing about yourself that may surprise people?

Ann Carine: I practised karate for many years and enjoyed it immensely. Karate requires you to be focused, to show respect to your Sensei and the other students, and be honest with yourself and others. This state of mind should not be limited to the dojo – your whole life should follow these precepts.

Federica: I had a horse (for the one and only time) when I was 6, called Venus. She was so powerful and free, like Venus the planet. I did not choose the name so it's a nice coincidence.

Livia: An asteroid has been named after me, with my nickname: 46644 Lagia.

Stavro: I graduated as an actor with theatre experience. This has helped me to have a strong commitment to public engagement and outreach as well.

Julia: Not sure if this will surprise people, but I love singing and I was the singer in a band. We used to perform in pubs in my home city, doing mostly covers (blues and rock), and we even recorded an album in a studio.

Find out more about the Board Members in this recorded Europlanet Society webinar: https://youtu.be/3vKNdUVW3FA

Society Board Member, Livia Giacomini, gives a training workshop on the 'Planets in a Room' outreach tool

Supporting Astronomy in Ukraine

Gražina Tautvaišienė (Vilnius University, Lithuania), describes how a Europlanet programme is supporting Ukrainian colleagues to continue their research.

Two years on from the Russian invasion, the plight of our colleagues in Ukraine remains a concern for the scientific community. The exhausting war affects both human and economic resources. Scientific work additionally requires a normal psychological environment. However, how can you concentrate on the scientific work if air raid sirens are wailing several times a night and you have to run to a hideout with the elevators not working?

Tired of such a situation, astronomer Leonid Pilyugin, from the Main Astronomical Observatory (MAO) of the National Academy of Sciences of Ukraine (NASU) in Kyiv, turned to me for help. I immediately said that he can come to Vilnius for asylum. He is of the older generation, so the ban on leaving Ukraine did not apply to him. A number of female scientists were also able to leave the dangerous environment and found refuge in the world's scientific centres. But the vast majority of men and women have had to stay and defend, or be ready to defend, their country and care for their loved ones.

The Europlanet 2024 Research Infrastructure (RI) project wanted to support fellow astronomers who remained in Ukraine. After coordinating with the European Commission, we initiated a scheme whereby Ukrainian scientists could leave and continue their research in scientific centres located in safer areas of Ukraine. To date, we have supported 13 visits of 30 days.

Maryna Ishchenko and Gražina Tautvaušienė at the European Astronomical Society Annual Meeting in 2023

Through the Europlanet scheme, we were able to support a young researcher **Maryna Ishchenko** from MAO in Kyiv. She wished to work on investigations of the stellar globular clusters using data provided by the Gaia Space Telescope. She determined orbital parameters for 160 globular clusters and analysed their possible relatively-close approaches to the supermassive black hole located in the centre of the Milky Way. An interesting conclusion was reached that, at a relatively-close distance of 50 parsecs from the galactic centre, we could expect on average about 3–4 globular cluster close passages every billion years. The results were published in the main European astronomy research journal *Astronomy and Astrophysics*.[1]

Maryna was among several Ukrainian scientists who had the opportunity to attend the meeting of

Valerii Shepeliev (left) and Rostislav Vashchishin at the Poltava Gravimetric Observatory.

the European Astronomical Society (EAS) held in 2023 in Krakow. It was very nice to meet her in person.

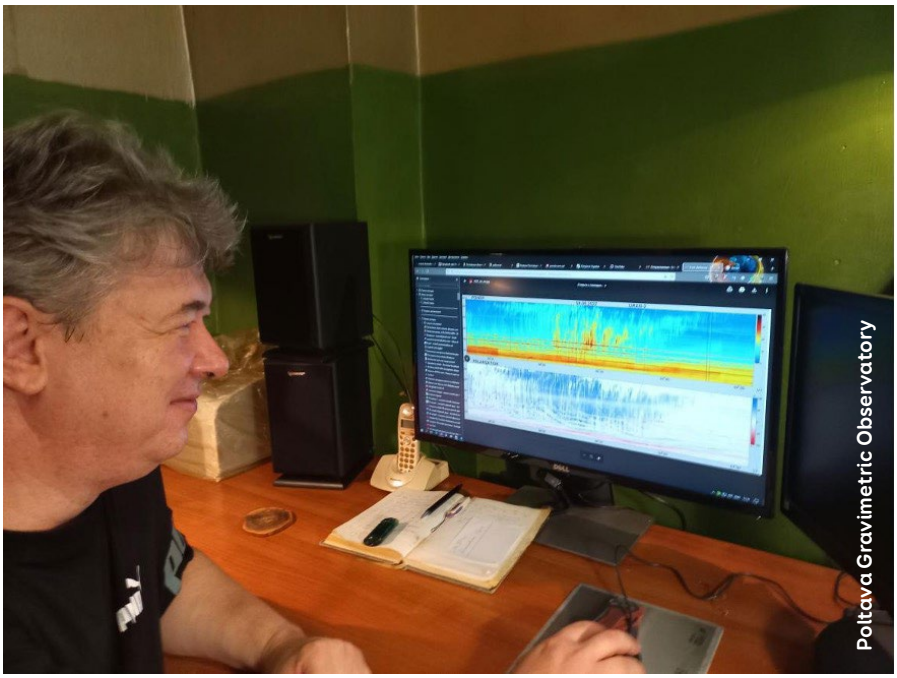
Anna Velichko, a young researcher from the Institute of Astronomy of V. N. Karazin of Kharkiv National University (KhNU), had the opportunity to leave probably one of the most dangerous regions in Ukraine and visit her colleagues at MAO in Kyiv. There she learned new techniques for working with large amounts of data and analysis of stellar kinematics in our Galaxy using the Gaia Space Mission data. As part of the educational programme, she visited the museum of MAO located in the pavilion of the Toepfer Double Long-Focus Astrograph. The observatory has a long and eventful history, dating back to when it was founded in 1944.

Vasyl Shevchenko from the Institute of Astronomy of V. N. Karazin KhNU visited the Astronomical Observatory of Lviv, Ivan Franko National University. There Vasyl continued his work on the creation of the Kharkiv database of absolute magnitudes of asteroids. An article on a comparative analysis of the Kharkiv database with other datasets was prepared and published in *Astronomy and Astrophysics* in October 2022.[2]

In addition, Vasyl lectured online for students of the V.N.Karazin KhNU and discussed with the staff of the Astronomical Observatory of Lviv about further joint scientific and educational work.

Sergey Velichko from the Institute of Astronomy of V.N.Karazin KhNU had an opportunity to collaborate with colleagues at MAO and the Astronomical Observatory of Lviv concerning the identification, and study of sites with anomalous properties of regolith on the lunar surface. He developed a new technique for photometric reduction of high-resolution images obtained with the Lunar Reconnaissance Orbiter Narrow Angle Camera (LRO NAC). The results of LRO NAC image-processing for Irregular Mare Patches were obtained using a new method of geometric and photometric data correction, taking into account local topography at the resolution level of the original frames. A discussion was held on the development and realisation of the new method of mineralogical composition mapping by combining the 'Shkuratov' spectral mixing model with machine learning. The results have now been published in the journal *Planetary and Space Science*.[3,4]

Valerii Shepeliev from the Institute of Radio Astronomy of the National Academy of Sciences of Ukraine (IRA NASU) escaped Kharkiv several times to visit the Poltava Gravimetric Observatory of the S. I. Subbotin Institute of Geophysics of NASU. Valerii is leading the radio interferometric team at IRA NASU, which conducts observations using five radio telescopes from the Ukrainian VLBI URAN network, which also includes the URAN-2 radio telescope in Poltava. The team is studying the fine structure of galactic and extragalactic radio



Vyacheslav Zakharenko, investigating Jupiter's radio storms during the Juno perijove in August 2022.

Andriy Zalizovskyy and Volodymyr Lisachenko in Kharkiv before a long ride to the Regime Geophysical Station in the Transcarpathian region.

sources such as quasars, radio galaxies and supernova remnants. They also conduct interferometer studies of the angular structure of the quiet Sun and manifestations of its sporadic activity using short-baseline interferometers. With the telescopes UTR-2 (the world's largest decametre telescope observing at wavelengths of 10s of metres), URAN-1 in Kharkiv, and URAN-4 in Odesa, they used to observe scintillations (fluctuations in intensity) of radio signals from cosmic sources passing through inhomogeneities of interplanetary plasma, and ionospheric scintillations, which can be used to study the solar wind and its interaction with the Earth's ionosphere. Unfortunately, the main instrument of the URAN network, UTR-2, was located in the combat zone and was occupied by the Russian army in March 2022. After about six months, the Armed Forces of Ukraine liberated the territory of the Radio Astronomy Observatory where UTR-2 is located. However, they found it in a horrible state. Much of the radio and computer equipment has been destroyed or looted, with the Observatory buildings badly damaged or destroyed. During his visits to the Poltava Gravimetric Observatory, Valerii discussed possibilities for the restoration of the instruments, and worked on past results of joint Very Long Baseline Interferometry (VLBI) studies. As a result, a database of observed extragalactic radio sources has been compiled. Data processing for the 3C239 radio galaxy has been completed, and its structure at decametre wavelengths has been established. An extended halo, which is absent at higher frequencies, has been discovered and the synchrotron age of the radio galaxies has been determined. Preliminary results of observations of sporadic decametre radio emission of Jupiter, associated with Io, were discussed, as well as studies of the Earth's ionosphere and the solar wind, which are carried out using the URAN-1 and URAN-4 radio telescopes in an autonomous mode. The research results were presented during the Gamow Conferences in 2022 and 2023, and several scientific papers are in preparation.

Andriy Zalizovskyy together with Evgeny Nakalov, the host at the Regime Geophysical Station, Carpathian branch of S.I. Subbotin Institute of Geophysics of the National Academy of Sciences of Ukraine.

Vyacheslav Zakharenko, Director of the IRA NASU, also visited the Gravimetric Observatory in Poltava where the URAN-2 radio telescope is still operational. After the start of the war, URAN-2 took over 60-70 percent of the programme that was conducted by the damaged UTR-2. Most importantly, URAN-2 took over the ground support programme for the Juno space mission.

Every 43 days, the telescope (along with a large number of other facilities), observes Jupiter's radio emission at the moment of perijove (closest approach to the planet's centre). It is important to compare the faintest components of the radiation between the spacecraft and ground-based telescopes. There is also an ongoing programme studying Jupiter's decametre radiation. Ukrainian astronomers work closely on this with their French colleagues at the Nançay Decameter Array (NDA) and NenuFAR radio telescopes, of which they are co-developers. Vyacheslav's results were presented at the international conference 'Planetary, Solar, and Heliospheric Radio Emissions' in 2022. The results were also published in *Radio Physics and Radio Astronomy* and *The Journal of Physical Studies*.[5,6] During his trip, Vyacheslav not only worked on the URAN-2 data, but also completed the long-term development of the UTR-2 radio telescope radio-frequency interference mitigation programme.

Volodymyr Dorovskyy (IRA NASU) and his colleagues have participated in the ground-based support of the Parker Solar Probe space mission (PSP) since its launch in 2018. Before the war, support consisted of observations with UTR-2 of the solar radio emission during the PSP perihelia. When observations with this telescope became impossible, Volodymyr and his colleagues decided to use the smaller Ukrainian radio telescope, URAN-2. Volodymyr visited the Gravimetric Observatory in Poltava and conducted solar observations during the perihelion #13 in September 2022. The joint analysis of the solar bursts, simultaneously observed by the ground-based and space instruments, will be done as soon as the PSP data are available online.

Andriy Zalizovskyy, Head of Department of Radiophysics of Geospace, together with the junior scientist **Volodymyr Lisachenko**, both from IRA NASU, visited the Regime Geophysical Station (RGS) 'Nyzhne Selyshche', Carpathian branch of S.I. Subbotin Institute of Geophysics of NASU.

Due to a large number of displaced people, it is not always possible to find accommodation. Volodymyr Lisachenko, working during his visit at the Regime Geophysical Station in the Transcarpathian region.

Access to the locally available instrumentation had been lost because of the war. The main task of the trip was to restore the evaluation of provisional K indices (a measure of the severity of geomagnetic storms) in near real time using the geomagnetic data of RGS, located in relatively safe western part of Ukraine, as well as evaluation of the parameters of geomagnetic pulsations. The data, published on the department's website, are the only provisional K indices available in near real time from the territory of Ukraine.

Conclusion

Astronomers in Ukraine, like many other professionals, are facing significant challenges during the war, which has led to infrastructure damage, brain drain, and resource constraints, including funding cuts for scientific research. This hinders the ability of astronomers to conduct experiments, maintain observatories, and engage in international projects. Travel restrictions, safety concerns, and political tensions make it difficult for Ukrainian astronomers to collaborate with colleagues from other countries.

However, despite these challenges, many scientists in Ukraine continue to persevere and contribute to their fields. They rely on international partnerships and support from the global scientific community to mitigate the impact of war on their research. It is important that the international community continues to support them.

References

1. Ishchenko et al, 2023. https://doi.org/10.1051/0004-6361/202245753
2. Shevchenko et al, 2022. https://doi.org/10.1051/0004-6361/202243977
3. Surkov et al, 2024. https://doi.org/10.1016/j.pss.2023.105831
4. Korokhin et al, 2024. https://doi.org/10.1016/j.pss.2024.105870
5. Ryabov et al, 2024. https://doi.org/10.15407/rpra
6. Konovalenko et al, 2024. https://doi.org/10.30970/jps.28.1902

Europlanet 2024 Research Infrastructure project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149.

Machine Learning for a Data Driven Era of Planetary Science

Stavro Ivanovski (INAF-Trieste Astronomical Observatory, Italy), Angelo Pio Rossi (Constructor University, Germany), Jeronimo Bernard-Salas (ACRI-ST, France) and Anita Heward (DFET, UK) look at how Machine Learning (ML) is revolutionising planetary science.

The background image was created using generative AI and the article title as a prompt (for more on the use of AI for image generation see Commkit, page 54).

Traditionally, science starts with a hypothesis. We develop a theory that we test experimentally, producing data; we analyse the data and, hopefully, the process results in new knowledge.

The advent of Machine Learning (ML) has enabled a new approach, known as data-driven science. Using the wealth of data sets and streams available, ML can explore the data to find a pattern or commonality. Out of these initial steps comes a hypothesis that can be tested through data analysis, which again, hopefully, leads to new understanding. Additionally, clustering or fusing datasets can reveal connections or knowledge that are not recognisable in the individual datasets.

Our Solar System contains an exotic range of objects and environments ranging from vast gas giants, like Jupiter and Saturn, to the small rocky and icy bodies of asteroids and comets. Even the planets termed 'terrestrial' are a very mixed assortment that includes the habitable Earth but also the hellishly hot Venus, scorched Mercury and cold, arid Mars.

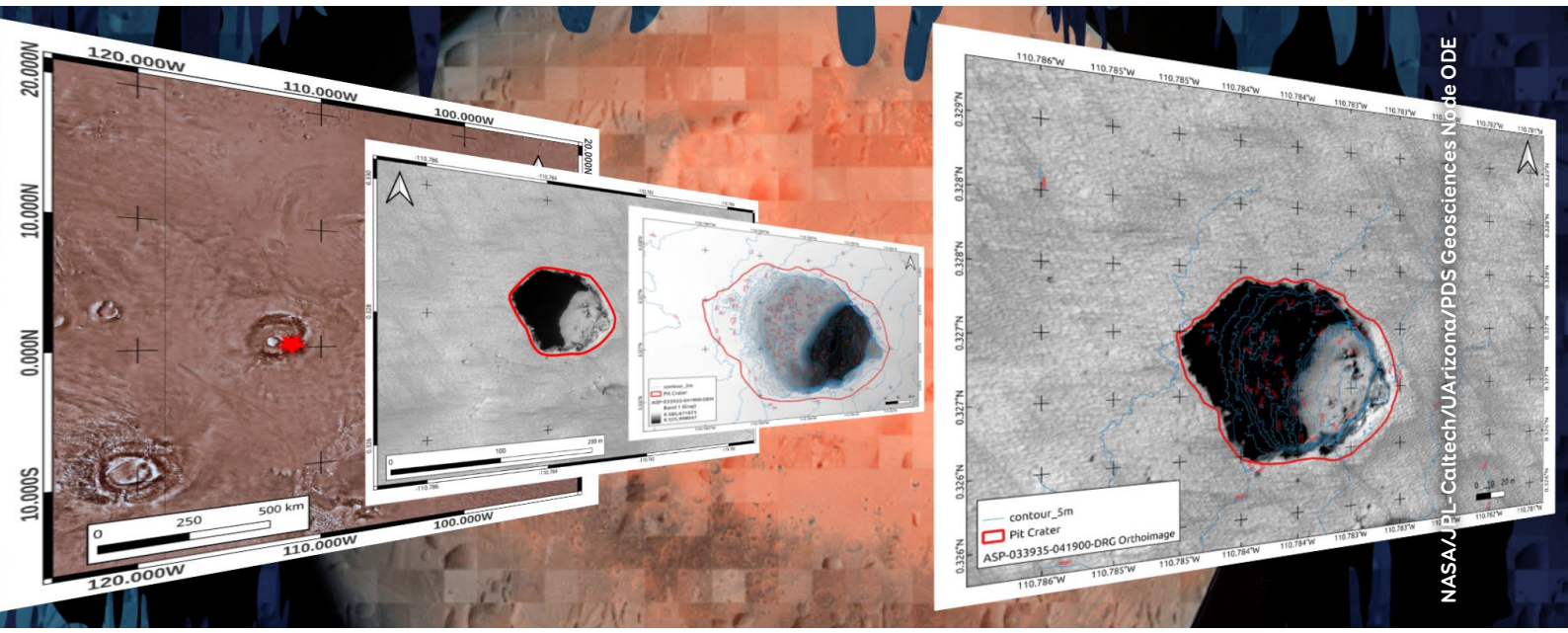
Over the past three decades, our knowledge of planetary systems has extended to those around other stars; these 'exoplanetary' systems have been found to contain many strange objects that are not found in our Solar System, such as lava planets, ocean worlds and 'hot-Jupiters'.

In recent years, planetary science has experienced an exponential growth of the volumes of data available from diverse sources, including space missions, ground-based telescopes, computer modelling, and laboratory and field experiments. To go through and analyse the vast archives of data collected from all these sources, new methods and approaches are required. The introduction of ML tools and algorithms means not only that all the data can be investigated, but that datasets can be combined and mined to find complex correlations, to detect anomalies, faults or missing information, and to maximise the exploitation of data from planetary research to date.

The Europlanet 2024 Research Infrastructure (RI) is a €10 million project, funded by the European Commission's Horizon 2020 programme, that supports the planetary science community. The project's core activities are to provide access to facilities, field sites and data services. However, Europlanet also provides investment through 'Joint Research Activities' that combine the expertise of multiple partners to create the new infrastructure and services needed to carry out world-leading planetary research. Since 2020, the project has developed ML tools to handle complex planetary data more efficiently and provide opportunities to combine and visualise multiple, diverse datasets.

This programme has been further enhanced through a collaboration with a second Horizon 2020 project, EXPLORE, which has developed applications for the exploitation of galactic, stellar and lunar data, and provides a platform for deploying and testing ML tools and services (see page 14).

Europlanet's ML-powered tools are based on scientific cases proposed by the community that address key challenges in planetary research. From these proposals, seven cases were chosen to follow up initially



Example steps from initial detection to semi-final geomorphological map of a pit near Pavonis Mons, Mars.

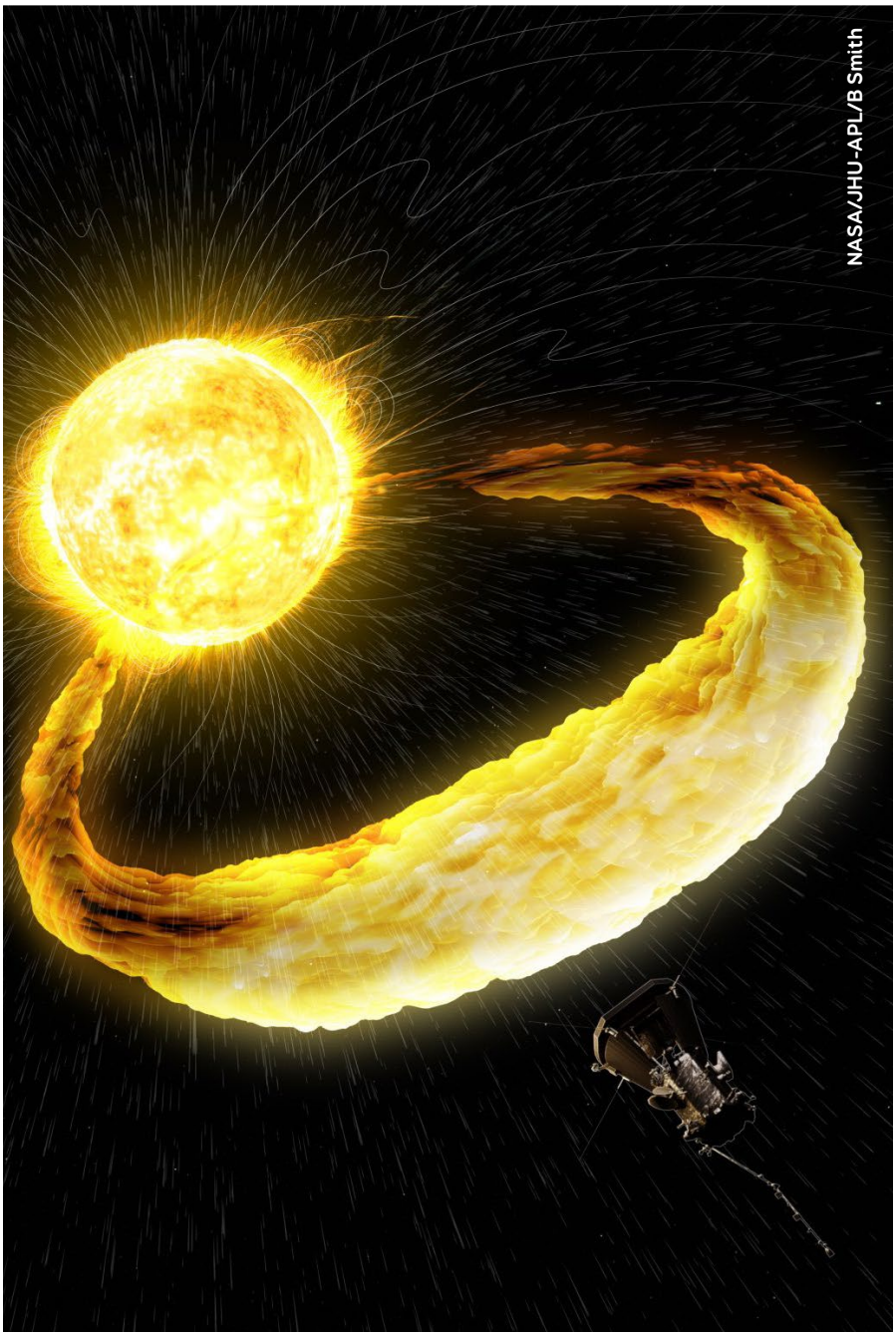
during the project, and further cases have been added over time. All the tools are open-source, ready-to-use and highly customisable, enabling other researchers to freely deploy and adapt them for their own research scenarios.

The ML-powered tools focus on three types of planetary data: time-series data, where data mining can reveal the dynamic evolution of phenomena or time dependent events; imagery, where training algorithms to recognise features can support automated mapping and classification of common characteristics; and spectral data, where characteristics like composition or surface ages can be identified.

Tools for Time-Dependent Phenomena

The Sun emits not only heat and light, but also a stream of electrically charged particles. This 'solar wind' interacts with objects in its path and can potentially strip away planetary atmospheres. Earth, and other planets with a global magnetic field, are largely shielded from the effects of the solar wind. However, solar activity can result in flares, emission of solar energetic particles and eruptions of material, called coronal mass ejections, that can interact with Earth's magnetic environment and, in severe cases, cause serious disruption to power grids, radio networks and satellites.

Europlanet has developed a suite of ML tools to support investigations of the solar wind and its effects on planetary environments over time. One tool supports forecasting the severity of a solar storm based on its magnetic orientation compared to the Earth's magnetic field. A second tool monitors the conditions controlling emissions by high-energy particles trapped in radiation belts. A third tool automatically identifies points in data streams when an orbiting spacecraft crosses over the boundary between a planet's protective magnetic field and the unshielded conditions of the solar wind. Collectively, this deployment of ML enhances our understanding of solar wind interactions and our ability to protect infrastructure both here on Earth and on the surface of, or in orbit around, other planets.



Artist's impression of a solar flare.

Tools for Identifying Hazards and Resources

Every day, about 100 tonnes of rubble or dust from space enters the Earth's atmosphere. Most of this burns up without being seen or reaching the ground. However, larger meteors can cause fireballs that streak across the sky and some fragments can reach the ground as meteorites. Increasingly, camera networks dedicated to fireball tracking are being installed around the world, both to facilitate meteorite recovery for research purposes and to increase our understanding of impacts to support planetary defence initiatives. Europlanet has been working with the professional and amateur meteoritic research

community to develop ML-powered tools that extract information from imagery of fireballs to help determine their characteristics, trajectories and potential origins.

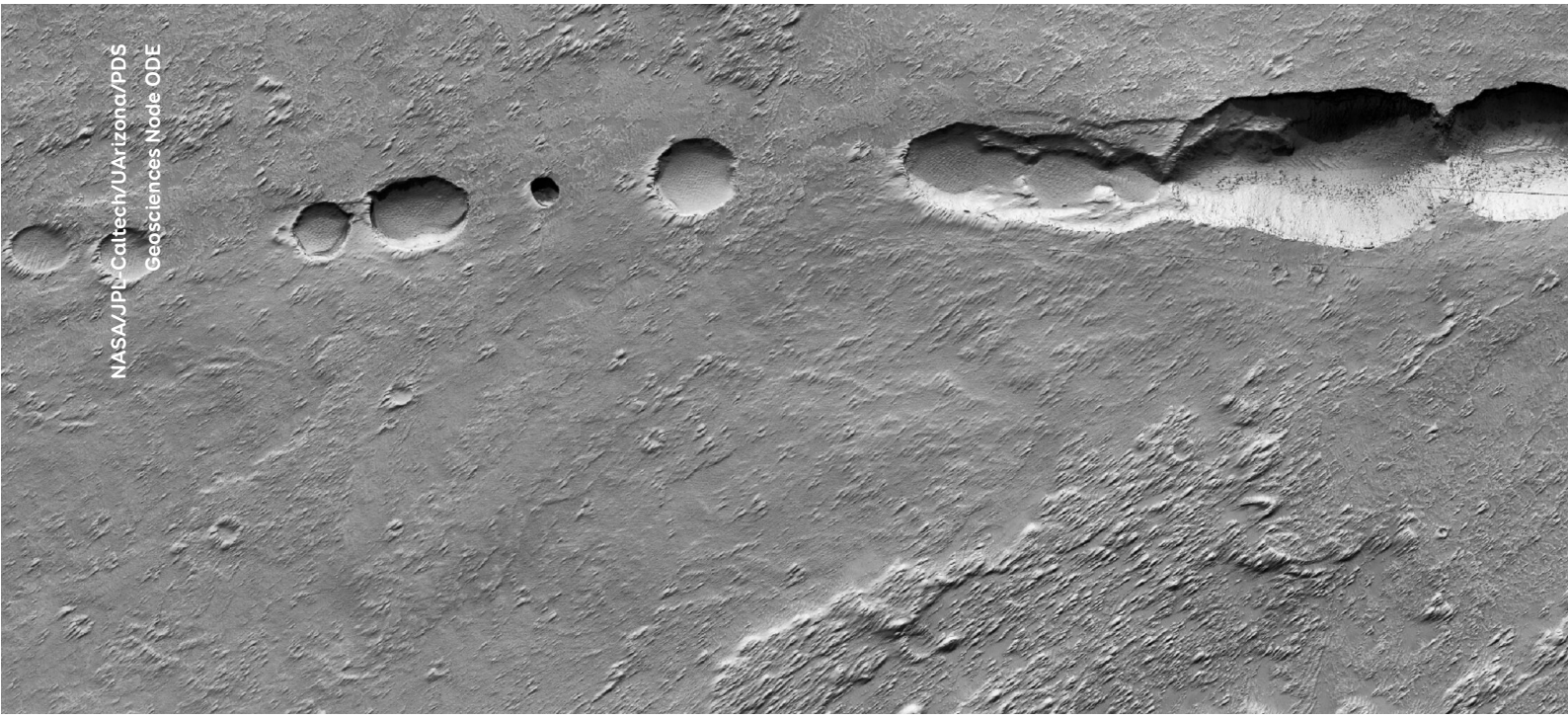
Across the Solar System, images of planetary surfaces exhibit many common features, such as pits, mounds or craters. These features can reveal a wealth of information about the formation, history and potentially useful resources of a planetary body. For example, 'skylights' – sinkholes into subsurface caves – on the Moon or Mars are of interest to geologists studying lava tubes and evidence of ancient volcanic activity; however, skylights are also possible entrances to protected environments where underground habitats could be built for human explorers in the future. Craters can provide a detailed chronological record of the impact history of a planetary surface, potentially going back millions or billions of years, and may also trap water ice that could be used for life support and fuel. With a return of humans to the Moon planned within two-to-three years, and international exploration strategies setting their sights on Mars, detailed and accurate mapping of surface features and resources at high resolution is essential. ML tools created by Europlanet and EXPLORE enable the automatic identification and labelling of skylights, craters, mounds and other surface features. This not only enhances the speed of the mapping process but can also add in layers of information, such as size, depth, composition and other characteristics.

ML-based tools have also been developed to automatically calculate the depth of pits by accurately measuring the associated shadows detected in satellite imagery. These pits will be primary targets for future space exploration and habitability since they are present on most rocky Solar System surfaces and, besides providing shelter from radiation, they have the potential to be entrances to sub-surface cavities which could, in the case of Mars, harbour stable reservoirs of ice water.

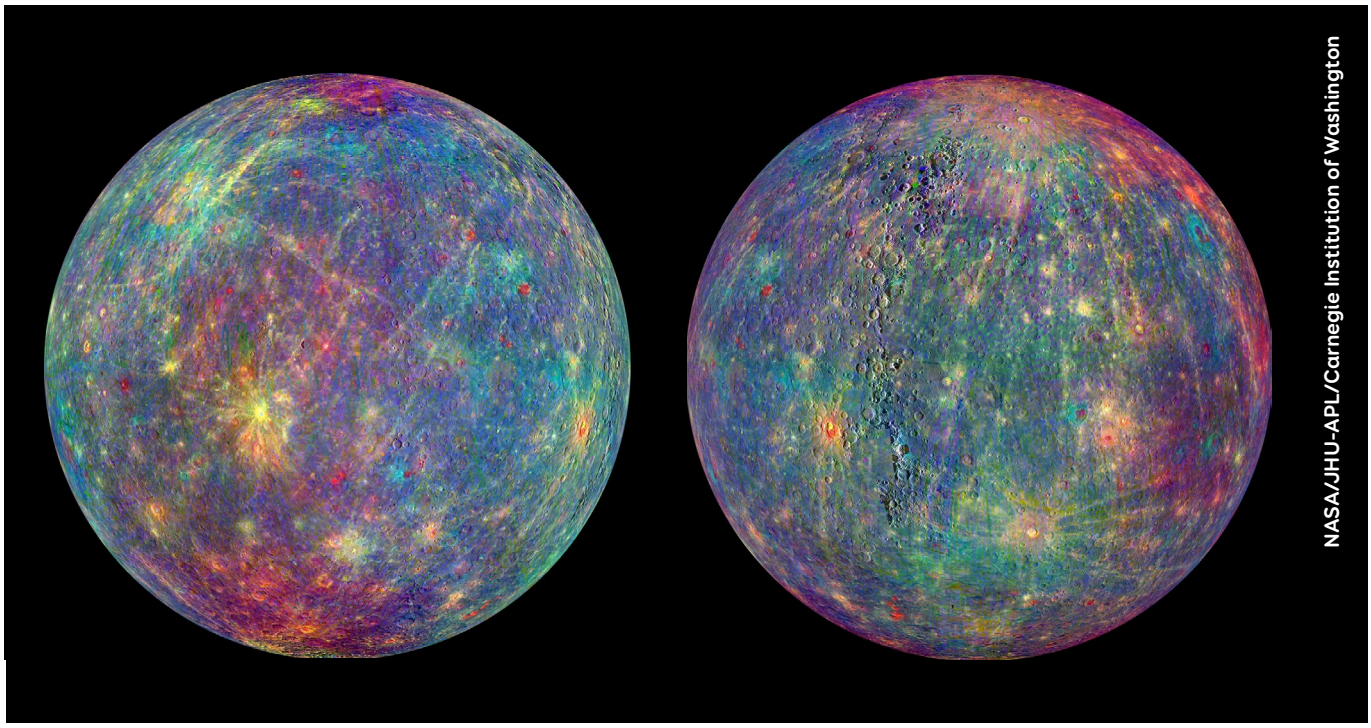
Tools for chemical characterisation

Many planetary missions carry spectrometers to gather information on the mineralogy of planetary surfaces. Minerals reflect certain parts of the electromagnetic spectrum more strongly than others depending on their chemical composition. Remote sensing data, for example detection of igneous rock-forming silicates on the surfaces of various bodies of our Solar System, can help reveal the history of formation of rocky planets such as Mars and natural satellites, such as the Moon.

To support these spectral studies, a Europlanet ML algorithm has been trained with reflectance spectra generated in laboratory experiments at the visible and infrared wavelengths that are key to unlocking surface composition. An additional bespoke tool has been trained for unsupervised classification of infrared observations by NASA's MESSENGER spacecraft, which orbited Mercury between 2011 and 2015. With ESA's BepiColombo



Examples of Martian pit landforms possibly connected to caves.



Spectral measurements by the MESSENGER mission reveal the geology of Mercury's surface.

mission set to arrive at the Solar System's innermost planet in December 2025, this tool is helping BepiColombo's spectrometer team to perform vital groundwork in identifying areas of particular interest and developing workflows for future data analysis.

Impacts to Date

The development phase of Europlanet's ML tools is complete and training and dissemination are underway to support their adoption by the community. The synergistic collaboration between Europlanet and EXPLORE has also demonstrated the EXPLORE platform's usefulness to the planetary community in providing a test environment to deploy ML tools and other applications. The platform fills a previously unidentified gap in supporting the development of applications to the point of maturity needed for deployment on major data hubs, such as the European Science Open Cloud (EOSC) and ESA Datalabs.

Much of the development work for the ML tools has been performed by early career researchers, enabling them to build their skills and experience, as well as their professional profile within the scientific community.

Europlanet's ML tools have been designed for use in a wide variety of applications dealing with scientific databases. The tools are accessible in open-access repositories with documentation, numerical scripts and scientific graphs. The ML repositories are structured so that users can not only find the description of the scientific use cases with the corresponding ML techniques but also the results obtained by applying the given techniques. New users can therefore compare past outcomes of the ML training and apply them to new problems. This approach supports the spirit of independent, standalone best-practice for analysing a scientific problem.

Overall, by developing ML tools tailored to planetary science, Europlanet has cemented collaborations, started to build new user communities and developed services that are already resulting in publications. While the planetary science community could be seen as 'late to the party' in adopting ML, interest now is high. This couldn't be more timely – with flagship missions to Mercury and Jupiter soon adding to the deluge of data streams, the era of data-driven science is only just beginning.

Europlanet ML tools:
https://bit.ly/epn2024ri-ml

EXPLORE:
https://explore-platform.eu

Europlanet 2024 RI's Machine Learning activity is a collaboration between IWF-OEAW, KNOW Center, the University of Passau, ACRI-ST, DLR, INAF, IAP-CAS and Armagh Observatory and Planetarium. The Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149.

The EXPLORE consortium is composed of ACRI-ST, Observatoire de la Cote d'Azur, KNOW Center, Constructor University, the University of Manchester, the Dill Faulkes Educational Trust and adwäisEO, with input from Tel Aviv University. The EXPLORE Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004214

ERIM

ERIM 2023

A New Kind of Europlanet Meeting

Anita Heward (Chair of the ERIM Organising Committee and Europlanet Sustainability Committee) reports on how a meeting in Bratislava has helped to lay the foundations for a sustainable Europlanet.

Networking and collaboration have been at the heart of Europlanet since its foundation in the early 2000s. The success of its research programmes, services, and activities to support the planetary community are all heavily reliant on personal interactions. These are developed and consolidated through access to facilities, expert exchanges, workshops, meetings and joint projects.

Almost 20 years on, we are in the midst of challenging times, with the global pandemic followed by wars, rising living costs and increased political uncertainty in many parts of the world. The importance of a community that can support colleagues at a professional and personal level has never been more evident. However, limitations on face-to-face contact, increased workloads and strains on mental health have all made it difficult to maintain – let alone grow – networks in recent years.

The pandemic came at a critical time in the Europlanet story: the Europlanet Society, founded in 2018, was still in the process of establishing itself and the mechanisms to build its membership. Moreover, a €10 million EU-funded project, the Europlanet 2024 Research Infrastructure (RI), was launched on 1st February 2020 – almost exactly coinciding with the first reported cases of Covid-19 in Europe.

The lockdowns implemented around most of the world in the spring of 2020, and the severe travel restrictions over much of the following two years, meant that the cohesion

of the community started to suffer. In particular, it became an increasing struggle to recruit and maintain motivation for active volunteers for the committees and working groups that run activities, such as the Europlanet Science Congress (EPSC), the EPEC Early Career Network and the Society's Regional Hubs.

In-person activities were able to resume from the spring of 2022, and EPSC took place in Granada, Spain, in September 2022. However, the intensity of catching up on long-delayed face-to-face meetings, and the proliferation of hybrid and online events has, at times, felt overwhelming. Packed schedules have meant that there has not always been time to renew connections properly.

In addition, EPSC 2023 was held as a joint meeting with the American Astronomical Society's Division for Planetary Sciences (DPS) in San Antonio, Texas, USA (page 6), and there was no other major gathering of the European planetary community planned in 2023.

Introducing ERIM

The idea for the Europlanet Research Infrastructure Meeting (ERIM) 2023 arose from the need to reinvigorate the sense of community in European planetary science in the wake of the Covid-19 pandemic.

The hybrid meeting took place from 19-23 June 2023 in Bratislava, Slovakia, and was co-hosted with the 5th edition of the Europlanet Early Careers (EPEC) Annual Week, which is the Europlanet training school for early career scientists who work in the field of planetary science.

ERIM was designed to bring the community together in a relaxed, interactive format that would promote collaboration and discussion on priorities and strategy for the future. The meeting provided an umbrella for other events planned by the Europlanet community, including science workshops, training sessions, the Europlanet Council Meeting and the General Assembly. During the week, participants were also tasked with addressing 10 challenges that face Europlanet's long term plans for sustainability, ranging from redefining membership benefits and structures within the Society to identifying sustainable funding models for services and facility access programmes.

The venue for the meeting was the Hotel Sorea, located on the hillside underneath Bratislava Castle, close to the riverbank of the Danube. The hotel provided all the facilities needed for the meeting, including conference rooms for up to four parallel sessions, a dining room for breakfasts and buffet lunches, outdoor terraces and a large lobby/bar area for networking, as well as accommodation for the majority of the participants.

Organisation of ERIM was a complicated task, as the final programme included 59 workshops and required the input of multiple groups within the Europlanet community.

The Local Organising Committee, led by Comenius University, provided the essential logistical support to ensure the smooth running of the meeting. Significant budgets for workshop organisation were available in the Europlanet 2024 RI project due to underspends on travel in 2020 and 2021. Thus, to attract attendance from a wide audience, no registration fee was set, accommodation costs were pre-paid and travel grants were offered to participants.

ERIM was also an opportunity for Europlanet to develop experience in organising hybrid meetings. Live-streaming of all sessions was

Opposite page: Bratislava, the setting for ERIM 2023. Above: Group photo of the participants in ERIM 2023.

Outgoing President of the Europlanet Society, Nigel Mason, leading discussions at ERIM 2023.

managed by a local contractor, ALEF, with additional support from students at Comenius University. Each room at the venue was equipped with a camera capable of 360 degree rotation, which was primarily focused on the speaker during sessions, but could be directed around the auditorium in case of questions or discussion. Members of the ERIM Committee were tasked with monitoring questions from online participants, whose contributions could be brought into discussions via the main screen in the room.

Recordings of daily streams were edited into individual session videos, and titles and credits were added before the videos were uploaded to YouTube.

A Hybrid Hit

The hybrid event attracted 300 registered participants, with 137 in-person attendees, a further 94 participating in online workshops and 249 active users of the Whova application. A total of 46 countries were represented at the meeting. The programme included interactive sessions on geological mapping, planetary space weather, industry engagement, innovations in outreach tools, and observations of Solar System bodies and exoplanets. ERIM also brought together representatives of astronomy-related research infrastructures to reflect on current challenges and explore future options for developing and sustaining their operations.

The decision to host the meeting in Slovakia stemmed from the high priority placed by Europlanet on promoting collaboration with the planetary science community from European under-represented states, in particular in central and eastern Europe. ERIM proved significantly more successful in attracting these participants than an average EPSC meeting (where they account for less than 10% of registrants), with 29% of attendees coming from target countries including Slovakia, Hungary, Poland and Czechia. The programme included sessions and breakouts led by the Central Europe Hub, with the aim of providing an opportunity for discussion on common challenges and sharing best practice for widening participation in under-represented countries.

A number of social events and excursions were organised during the week. The EPEC Annual Week participants were given the option of participating in Laser Tag or a board game session. All participants were invited to attend a social event at the Parlament Restaurant at the top of the hill by Bratislava Castle on Wednesday night. The LOC also organised an excursion by bus to Comenius University's Astronomical Observatory and daily tours of the University's Electron Induced Fluorescence Laboratory.

Feedback

A feedback form was circulated at the end of the meeting, which gave the option for free text feedback

ERIM participants on the excursion to Comenus University's Astronomical Observatory.

The interactive programme at ERIM gave many opportunities to share views and brainstorm ideas.

on what people liked and didn't like about the meeting, or thought should be done differently.

49 responses were submitted, with 92% giving the meeting a four or five star rating overall. People particularly liked the opportunity to bring the community together for networking, the diversity of topics and the chance to contribute to strategic discussions (see Figure 1). Constructive criticism mostly related to the online platform, session clashes and timing of the meeting and discussions. Overall, the feedback suggested that participants had found ERIM to be an enjoyable experience that provided a timely and effective way for the community to feed into discussions about the future of Europlanet.

As one participant said: "This week was really nice to increase the networking between the community and clarify a lot about how the Society is working. In almost all the sessions I followed, debates were really useful to point out strengths and problems. We have collected lots of information to draft more easily the roadmap."

Roadmap for the Future

The roadmapping activities initiated at ERIM have continued in the intervening months, with several online and hybrid follow-up discussion sessions held during the autumn of 2023. A new Sustainability Committee has now been set up to do the 'heavy lifting' of translating the ideas put forward by the community into a credible operational plan for Europlanet. The aim is to present the sustainability roadmap to the community at EPSC2024 in Berlin. In the meantime, look out for updates and requests for input on the Europlanet website and Discord server.

If you would like to catch up on what happened at ERIM, all recordings are on YouTube: https://bit.ly/ERIMRecordings

Figure 1: Wordcloud of responses by participants on what they liked about ERIM 2023.

ERIM EUROPLANET RESEARCH INFRASTRUCTURE MEETING 2023

If you missed ERIM 2023, here are a selection of reports from some of the workshops and meetings held during the week.

EPEC Annual Week: A Melting Pot of Ideas

James McKevitt (University of Vienna, Austria and UCL, UK) reflects on the outcomes of the Europlanet Early Career event, EPEC Annual Week, held in Bratislava, Slovakia in June 2023.

Group photo of the participants of EPEC Annual Week 2023 in Bratislava.

Nestled in the heart of Europe, Bratislava in Slovakia recently played host to the 5th Europlanet Early Career (EPEC) Annual Week, an event that has rapidly become a cornerstone for early career scientists in European planetary science. Co-hosted with the Europlanet Research Infrastructure Meeting (ERIM) 2023, the gathering marked a significant leap in fostering collaboration and sharing knowledge across the Europlanet Society and shaped the future of the EPEC community.

The Setting and Participation

The historic city of Bratislava, with its blend of modern dynamism and rich cultural heritage, provided a fitting backdrop for an event focused on the future of planetary science. The week saw a healthy mix of 45 participants from across Europe – 23 attending physically at the Hotel Sorea and 22 joining online, leveraging the latest in live-streaming technology to support a seamless hybrid meeting.

Programme Overview

The agenda of EPEC Annual Week was diverse and designed to enrich the careers of the attendees. It spanned a spectrum of activities – from professional development workshops to mental health awareness sessions – reflecting EPEC's holistic approach to career development.

Career Development Sessions: In these sessions, experts from industry and universities talked about their jobs, giving a clear idea of the different types of work you can do in planetary science. They also discussed careers that started in university research and then moved to industry, showing early-career scientists some job paths they maybe weren't aware of. Attendees had the chance to talk to these experts afterwards, which was great for making new contacts and getting advice.

Skill-Building Workshops: These workshops focused on teaching important skills like how to communicate well and write good proposals. Attendees saw examples of successful proposals, and an experienced proposal reviewer

Brainstorming and discussion sessions at EPEC Annual Week 2023 in Bratislava.

explained the essentials points that should be considered when writing a successful proposal. These sessions were interactive, and the communications session enabled the attendees to practice these skills themselves.

Mental Health and Wellbeing: A special session, led by a mental health expert, talked about how to deal with stress and keep a good balance between work and life. Attendees learned how to spot stress early and develop ways to make sure work doesn't take over their life. This was a really important reminder that looking after your mental health is key in a demanding field like science.

Plenary Sessions and Group Activities: These sessions were part of the bigger ERIM programme and helped EPEC attendees learn about the latest research in planetary science. There were talks about the tools from Europlanet that make research easier, with some practical tips on how to use them. It was also a chance for people to discuss collaborative projects in planetary science.

Innovation in Community Building

A central theme of the week was community building, emphasised through various interactive sessions. The event underscored the importance of a supportive network, particularly in a field as dynamic and collaborative as planetary science. Breakout discussion groups played a pivotal role, serving as brainstorming pods for the future of EPEC's working groups.

A key outcome of these discussions was the consensus on the need to restructure EPEC's working groups. The proposed shift towards a more flexible, project-based approach, with clearly defined end points, aims to enhance engagement and effectiveness. This restructuring is seen as crucial for adapting to the evolving demands of the field, the diverse interests of those engaged, and the transient nature of early career members.

The co-hosting with ERIM 2023 was a strategic move that paid off, creating a platform for increased interaction between early career scientists and other sectors of the Europlanet Society, including distinguished scientists from across Europe.

This synergy was evident in the shared sessions, where participants from both events engaged in in-depth dialogues. As an example, EPEC members and Europlanet's Regional Hubs, which provide a localised service to members across the continent, discussed how to establish a clear relationship that reflects what is wanted, and can be provided, on both sides.

Key Takeaways and Future Directions

The 5th EPEC Annual Week in Bratislava was more than just a congregation of young scientists; it was a melting pot of ideas and aspirations. The roadmap that has emerged from the week's collaborative efforts outlines a future where educational resources are expanded, career pathways are diversified, and community engagement is deepened. It emphasises the importance of mental health, the necessity of continuous learning, and the power of a supportive network. These inputs can now be drawn on by the EPEC Committee under the leadership of the new Co-Chairs (see page 5).

As the participants dispersed, along with memories of the picturesque city of Bratislava, they carried with them new connections, fresh perspectives, and a shared vision for the future of planetary science. The 5th EPEC Annual Week was a testament to the vibrant and dynamic nature of the EPEC community – a community that is not only shaping the future of planetary science but also fostering the growth of its next generation of leaders.

Playlist of EPEC Annual Week sessions:
https://bit.ly/EPECAW2023

ERIM

Bridging the Gap Between Policy and Science

The Europlanet Policy Team reports on a workshop that took place as part of the Europlanet Research Infrastructure Meeting (ERIM) 2023 last June.

What is the role of science in policy making? What are the needs of decision makers in order to develop policies based on scientific evidence? What kind of skills are needed for scientists to better engage with policy makers?

The workshop 'Raising Space Research Visibility for Policy Makers', which took place on Wednesday 21 June in Bratislava aimed to address these questions. The programme was designed to look at the interactions in different academic and working levels between scientists and policy makers, and identify challenges and practical skills needed for engaging with policy and decision making.

Eleni Chatzichristou (Europlanet Policy Working Group Chair) set the scene with an overview of the objectives of the session and said a few words about the important role of planetary scientists in informing policy makers about space exploration.

In a recorded talk, Rodrigo da Costa, Director of the European Union Agency for the Space Programme (EUSPA), outlined EUSPA's activities and how it contributes to knowledge-based policy and decision making for the EU Space Programme. Mr da Costa also highlighted the importance of the role of space technology in the context of growing sectors of the European economy, but also the objectives of national and EU policies.

Noel Baker leads discussions during the policy session at ERIM 2023.

Finally, Noel Baker (BIRA-IASB, Belgium), a climate scientist and science policy advocate, gave a practical talk on how to raise the visibility of space and planetary research to policy makers. Dr Baker highlighted the need to amplify the voices of researchers in decision-making, and analysed how research outputs are perceived and utilised by policy makers. She gave practical tips on opportunities to enhance visibility and valorise space research in a policy context. The session finished with a lively discussion on the issues raised by the speakers.

Europlanet Policy: https://bit.ly/EuroplanetPolicy

ERIM

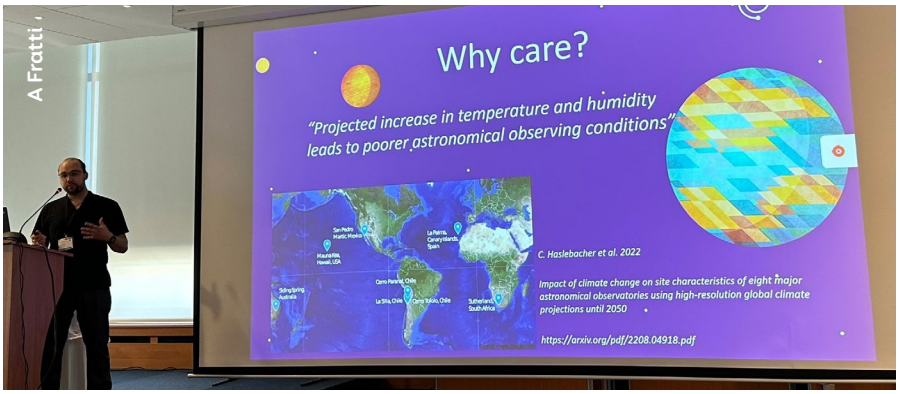
The Ecological Footprint of Astronomy

Thibaut Roger (University of Bern, Switzerland) reports on a session at ERIM to initiate a discussion about the ecological impact of astronomy and planetary research activities.

The main goal of the Europlanet Research Infrastructure Meeting 2023 (ERIM) was to outline the future of the Europlanet Society, which also made it an ideal place for our community to discuss the ecological impact of astronomy-related activities. According to a study published in Nature in 2022, the carbon footprint of astronomical research infrastructures rivals that of some countries.[2]

Exactly how we can make astronomy and astrophysics greener is a complex topic that cannot be solved in a single day or discussion. However, holding an ERIM workshop focused on the ecological footprint of astronomy was a first step for the Europlanet community. The session started with an introductory lecture from Luigi Tibaldo from IRAP (France). It was followed by an open discussion amongst participants, which highlighted the many cultural differences regarding ecological concerns at institute level. For instance, did you know that some countries in Europe give you a salary bonus if you work from home to reduce your ecological impact, while other countries actually do the opposite and apply penalties when you do not work from the office?

Astronomers, in general, are willing to move in the right direction but can often be hampered by administrative complications. Solutions may need measures to be introduced at an institutional and/or international level. Nonetheless, the discussions at ERIM brought hope, as we could see there are several policies recently implemented by institutes to reduce the carbon footprint of our community. Conferences and meetings are another point of leverage, where everyone can actually help by pushing for eco-friendly solutions.



Thibaut Roger sets the scene for the discussion on the ecological footprint of astronomy. [1]

Left: Session participants brainstorm ideas. Right: Remote participant, Luigi Tibaldo, gives the invited talk.

You can watch the session recording and find out more through these links:

https://youtu.be/6gDuNfOftbE

https://astronomersforplanet.earth/

https://labos1point5.org/

https://everydayastronaut.com/rocket-pollution/

1. Haslebacher et al. 2022. https://doi.org/10.1051/0004-6361/202142493

Cantalloube. 2022: https://youtu.be/elpyzqQslgE

2 Knödlseder et al. 2022. https://doi.org/10.1038/s41550-022-01612-3

ERIM

ERIM Goes to Schools

Barbara Cavalazzi gives a lecture on astrobiology as part of 'ERIM Goes to Schools'

In June 2023, during the final week of term, planetary science came to the classrooms of two schools in Bratislava as part of the Europlanet Research Infrastructure Meeting (ERIM). 'ERIM Goes to Schools' offered participating researchers the interesting and enriching experience of engaging with local schools and teachers.

Thibaut Roger (University of Bern, Switzerland) was invited to talk about 'Life in the Universe' to an assembly of secondary school students at the United School of the Holy Family. The lecture – a kick-off event for the school's science fair – was attended by over 100 students. As not all the attendees spoke English, the school organised for one of the teachers to perform a live translation of the talk from English to Slovak. Students learned about the definition of life (or lack thereof), extremophiles, astrobiology and the concept of habitable zones, as well as some lesser-known facts about the exploration of our Solar System and the quest for extraterrestrial life. Thibaut also shared advice on careers in astrophysics and answered numerous questions.

Barbara Cavalazzi (University of Bologna, Italy) gave an immersive lecture to encourage students and aspiring space scientists at the Czech High School to learn more about astrobiology, the origins of life, and space exploration. Questions from both students and teachers highlighted the curiosity of people of all ages to find out what we can learn from tiny molecules, giant planets, single-celled life forms, or galaxies with hundreds of billions of stars. Discussing the endless possibilities of the interdisciplinary field of astrobiology was not only an opportunity for Barbara to share a mutual passion for space with the students, but also a chance for her to get back in touch with her own motivation as a researcher.

Feedback from the schools was very positive, highlighting the importance for students to have the opportunity to speak directly with scientists. 'ERIM Goes to Schools' builds on the successful programme established around the Europlanet Science Congress (EPSC Goes Live to Schools), which has been organised in collaboration with the 'Lecturers Without Borders' association since 2020.

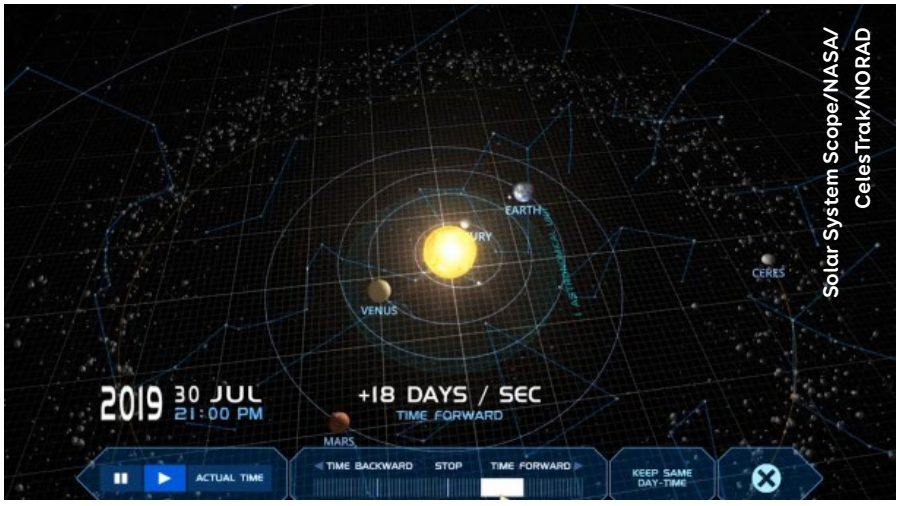
Sign up to participate in 'EPSC2024 Goes Live for Schools' in Berlin in September. https://bit.ly/EPSCLiveSchools2024

Diving into the Heavens: The Solar System Scope Project

Jozef Bodlak (Solar System Scope) tells the story behind an app that takes users on an immersive journey with the aim of bringing the grandeur of space to the fingertips of people around the world.

The story of the 'Solar System Scope' began over a decade ago with the determination of two young siblings, Adrian and Marian Bayer, who were captivated by the wonders of the Universe. They set out to craft a simple app that emulated our Solar System utilising data from NASA. A driving force behind the project was their desire to share their passion and personal fascination with space with others, particularly with the younger generation. Combining their skills and knowledge in programming, graphic design, and physics, they developed their first astronomy app, the 'Solar System Scope', in 2011.

Adrian and Marian perceived the potential of technology to act as a bridge between the scientific communities and a public that can sometimes feel daunted by the intricacies of astronomy. Thus, their vision was to create a platform that was not only accurate and information-rich but also intuitive and accessible to all, irrespective of age or prior knowledge.



Visualisation of celestial configurations based on the user's desired timeframe.

As the project grew, the two siblings rallied around them a team of equally passionate individuals who shared their vision and aided in its realisation. The success and the overwhelmingly positive response to the 'Solar System Scope' have led them to constantly improve the app, add new features, and expand their range of astronomy apps.

They have now set up a company, AuLea Ltd, which specialises in astronomy education, merging education and entertainment to spark a passion for the cosmos. The 'Solar System Scope' has more than 20 million users worldwide, with 310,000 downloads per month from 152 countries.

Unpacking the 'Solar System Scope'

The 'Solar System Scope' aims to meld high-definition graphics, user-

Adrian and Marian, the two siblings captivated by the Universe and its infinite wonders who sparked the project.

VR technology enables users to embark on an immersive journey to explore various points in the cosmos.

centric design, and scientifically precise data to simulate the Universe. Here's a closer look at its features.

- **Interactive 3D Exploration:** Users can seamlessly navigate around planets, moons, asteroids, and other celestial objects, observing them from diverse angles and proximities. This interactivity provides a tactile, immersive experience.
- **Precise Data Integration:** Drawing mainly from NASA and other authoritative space research entities, the 'Solar System Scope' ensures that every celestial depiction, from planetary orbits to relative sizes, is rigorously accurate.
- **Time Manipulation Capabilities:** Users can retrospectively view celestial events, monitor current space phenomena, or even forecast future cosmic occurrences, offering a comprehensive perspective of the Universe's timeline.
- **Virtual Reality (VR) Immersion:** With state-of-the-art graphics and real-time simulations, users are transported into the heart of the cosmos, offering a first-hand journey through space.
- **Multi-language Support:** The tool operates in 19 languages, ensuring its appeal and accessibility to audiences around the world.
- **User-friendly Interface:** The tool's simple interface is designed with both new and seasoned astronomers in mind.
- **Galactic Encyclopaedia Integration:** An integrated space encyclopaedia brings users a Universe of facts, insights and astonishing discoveries about the cosmos.
- **Rendering Technology:** The rendering is capable of producing photorealistic images of celestial entities, complete with intricate textures, luminosity, and atmospheric nuances.

Impact of the 'Solar System Scope'

The 'Solar System Scope' is ideal for anyone who loves looking up at the stars but isn't an expert. They can explore the Universe from home, seeing where stars and planets are right now and what's happening around us in space.

The blend of accurate data representation with user-friendly interfaces has also made it a valuable tool for both professional and amateur astronomers. Universities and research institutions have embraced it as an addition to their resources, further establishing its credibility. However, what pleased the team most was feedback on how the app grabs the attention of children and teenagers. In schools, keeping students interested is tough. Young people are glued to screens in search of fun and information. The 'Solar System Scope' combines both. It provides a hands-on, lively view of our Universe, making complicated ideas about astronomy easy and fun. Teachers can show live space events, making astronomy lessons a lot more exciting. Testimonials from schools, museums and other educational institutions show that the 'Solar System Scope' is effective in getting students excited about space, making them want to learn more and maybe even think about a job in space one day.

John Vilagos, a middle school teacher, told the team: "The 'Solar System Scope' is a useful tool to deploy with a classroom toward children with Special Educational Needs and Disabilities on a variety of levels. The visuals and audio allow for the creation of a highly sensory experience which fosters an exceptionally immersive atmosphere, especially when deployed in a sensory room! In addition to this, the depth of information contained within the software makes it an amazing tool for research projects and really allows students to tap into their special interest."

Benjamin Gondrez, an exhibit technology supervisor in Colorado, US, said, "During the COVID-19 pandemic, the Fort Collins Museum of Discovery searched for ways to continue to

An interactive visualisation showcasing Earth's layers, enabling users to delve into the intricacies of our planet with the aid of a digital space encyclopaedia.

engage our audiences by bringing them virtual discovery through online platforms. When I came across 'Solar System Scope', I knew it would be an amazing tool to do this by taking viewers on a virtual tour of the entire Solar System. I captured the screen output to live stream while narrating the tour. Viewers mentioned how stunning the visuals were and how much fun it was to fly through the Solar System in this interactive way. I hope to continue to utilise 'Solar System Scope' to present space science to museum audiences, as well as to simply have fun flying through and discovering more about our home in space!"

Future Prospects for the 'Solar System Scope'

The 'Solar System Scope' team aims to continually refine and improve existing models, striving for even higher levels of accuracy in representing the intricacies of the cosmos. Users can expect to benefit from more precise portrayals of celestial bodies and their movements.

New languages will be added, and the team aims to strengthen the brand and integrate social responsibility and sustainability.

Recognising the need for hands-on learning experiences, the team intends to roll out additional interactive modules that are tailored for educators. These additions will increase the dynamism and engagement of the tool in classrooms. In particular, the VR facet of the 'Solar System Scope' is earmarked for substantial upgrades. With these advancements, users can anticipate an even more immersive journey through planets, moons, and stars.

Conclusion

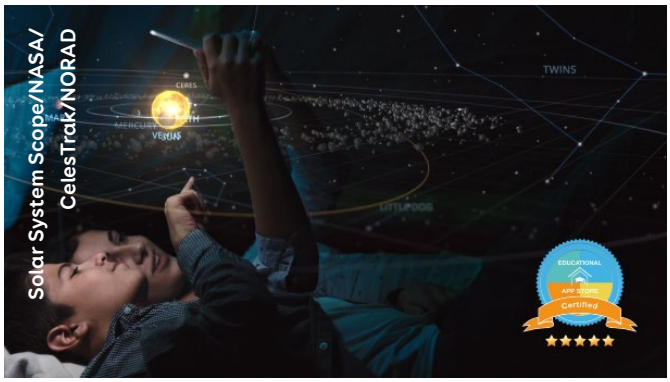
The 'Solar System Scope' project is an example of what is possible when technology meets passion. It brings the vastness of space to the fingertips of everyone, from school children to dedicated amateur astronomers. Tools like the 'Solar System Scope' are invaluable in reminding us of our place in the Universe and inspiring dreams of what's beyond our blue planet.

With distributors and educators around the world, the 'Solar System Scope' offers huge potential for collaboration. The team is reaching out to educational institutions, planetariums, and astronomy enthusiasts, hoping to find partners who will join them on this journey, enhancing the experience for many more. Let's explore the stars together, and in doing so, reshape the future of astronomical education.

https://www.solarsystemscope.com

The Solar System Scope team presented the project in a session on 'How to Transform Your Outreach Activity into a Business' at the Europlanet Research Infrastructure Meeting (ERIM) 2023 in Bratislava. Watch the recording: https://youtu.be/ZW1X9vm2r2g.

The 'Solar System Scope' is an effective tool in teaching about space.



'Solar System Scope' users experience a real-time, three-dimensional representation of our Solar System.

M Roos-Serote

Sunrise over Lake Constance, near the Airbus facility in Friedrichshafen, Germany.

The Making of 'The Making of Juice'

Maarten Roos-Serote (Lightcurve Films, Portugal) shares a unique view behind the scenes of the development of a space mission.

I started my filmmaking career in 2006 with a short promotional video for my first customer - Europlanet.

My second production (2007) was a series of four educational videos about Venus research for the Venus Express mission at ESA. At that moment, the idea took hold in my mind for a documentary film telling the story of the process of putting together a space exploration mission. In the intervening years, I suggested it to people at ESA several times, but found no real interest.

I did, however, in 2010 get a chance to produce a short behind-the-scenes documentary film (sponsored by the Paris Observatory, the French CNRS and the Italian Space Agency) about the VIRTIS instrument, which was flying both on the Rosetta and Venus Express missions.

In late 2019, the Juice Project Scientist, Olivier Witasse, invited me for a coffee at Leiden Central Station. The Juice team at ESA had a wish to create a documentary film about the making of Juice. The industrial phase of the Juice project started in 2015.

The idea for the film would be to follow the second part of the integration activities of the spacecraft right up until lift-off to Jupiter. Though, of course, the science and technology would provide an important backbone for the film, the emphasis would be mostly on the human story behind the project. The aim would be to feature the actual people who were putting the machine together and highlight the incredible collaboration necessary to get the first European mission to Jupiter off the launch pad. Needless to say, I jumped at this opportunity! For me personally, it felt like a circle closing, as my planetary science career had begun in 1991 with the Galileo mission to Jupiter.

Filming started in late February 2020 at ESA/ESTEC in Noordwijk. I interviewed the Juice Project Manager, Giuseppe Sarri, and Olivier Witasse. These were introductory interviews talking about the Juice project in general, the current status and the background. Launch was still foreseen for May 2022 – at that time, the most optimal launch window that would get Juice to Jupiter in about seven years.

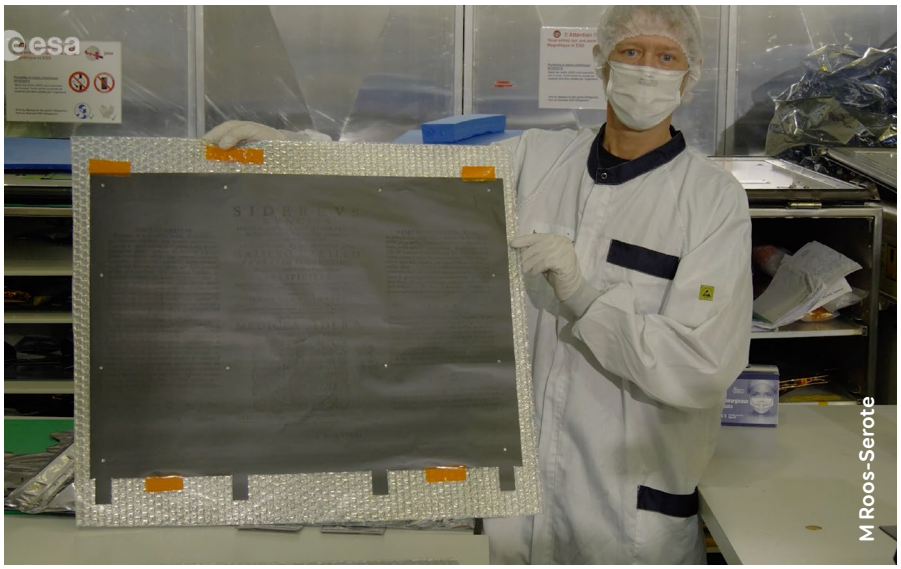
First view of the Juice spacecraft in the clean room at Airbus in Friedrichshafen.

Whilst we were planning the filming activities, we realised that leaving all the materials to simmer until the final film was made, after the launch of Juice, would be a waste. We decided therefore to create and release short 'episodes' highlighting important moments caught on camera. This would also help to get the attention for Juice going on social media and build a fanbase well before launch. The interviews with Giuseppe and Olivier formed the basis for the first short episode, released on 'The Making of Juice' YouTube channel in July 2020.[1]

A moment of stress in the integration of the mission.

A few weeks after the first filming, something happened that no one could have foreseen: the pandemic. It was the start of a difficult time for all of us. In relation to the Juice film project, I could not travel to do any interviews, nor could I visit Airbus, where Juice was being put together. On the other hand, the pandemic added a certain element of drama to the story. During lockdown, I recorded interviews online, some of which made their way into the final film. The Juice teams at Airbus and ESA, the companies across Europe delivering hardware for Juice – as well as the science and engineering teams at the institutions across Europe, the US, Japan and Israel that were to deliver the instruments – creatively found ways to continue their work. After all, the planets did not stop revolving about the Sun, and the best opportunity launch window had not altered by a second.

After the first wave of Covid -19, in the late summer of 2020, I was allowed



Three pages of the 'Sidereus Nuncius' by Galileo are engraved on a layer of Juice's insulation.

to visit Airbus in Friedrichshafen for the first time, for one day. After a late-night arrival, I got up early and left my hotel before sunrise to seek out a nice spot near Lake Constance. I found one, and witnessed the most amazing 'picture postcard' sunrise — some things just cannot be planned!

Later that morning, Hussein Seklawi, the Juice Floor Manager from Airbus, led the way into the clean room where Juice was being integrated. I managed to get my camera rolling just in time to film him pressing the button that opened the large vertical door to reveal Juice. It was my first real-life view of the spacecraft and I was deeply impressed. This shot is used more than once in episodes, the teaser to the final film and of course the final film itself.

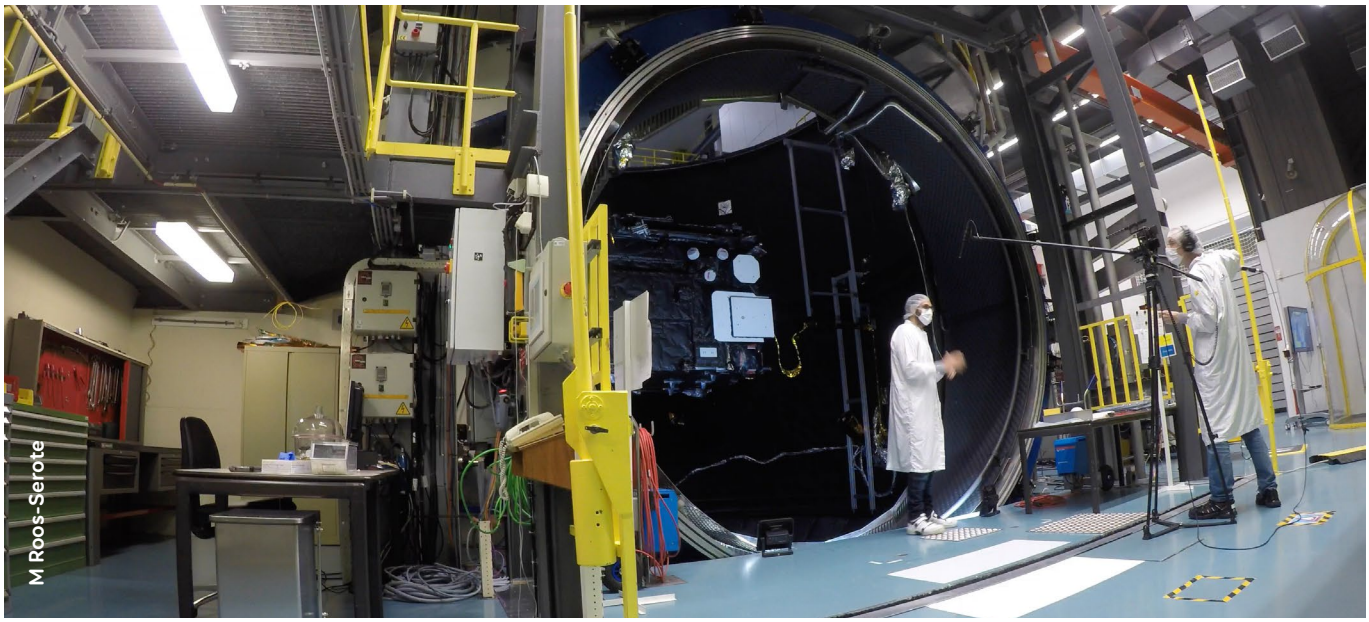
The next spectacular moment was the transport of Juice from Friedrichshafen to ESTEC by road at the end of April 2021. Due to the size of the transport container, the truck was allowed to drive only at night. It took three nights to make the trip. I wanted to record the last leg from the southern border of the Netherlands to ESTEC. My science film colleague, Dan Brinkhuis, was kind enough to lend me his BMW Z4, and Oliver Witasse agreed to participate as my driver, glad of the chance to see the spacecraft transport first hand. In addition to filming on the road, I hired a professional drone team to film from the air. They obtained spectacular shots of the truck crossing over a large bridge in the south of the Netherlands and, finally, of the arrival of Juice in heavy rain at ESTEC at 3:30 in the morning!

Juice stayed at ESTEC for several months for the Thermal Balance Thermal Vacuum test campaign in the Large Space Simulator, during which I got a lot of great footage. Access to ESTEC was relatively easy for me and, by this time, I had become part of the Juice family in a way that people did not mind me being around – in fact they rather ignored me, like a fly on the wall, which led to authentic and natural footage. I even got to record a difficult moment of stress. This was a true gem, from a filmmaker's point of view, with pure human interaction and no direction needed whatsoever.

People from the Juice team at Airbus moved for lengthy periods of time to Noordwijk and its surroundings to work on Juice. This provided me with interesting opportunities to talk about the dynamic and varied lifestyle that is involved with making such a project. After three and a half months at ESTEC, Juice was moved to Toulouse to the Prime Contractor, Airbus, to be finished and shipped to Kourou for launch. This time the transport was done mostly by air. The Juice transport container, weighing some 18 tonnes in total, needed to be carried by an Antonov plane. We drove in one night to the closest airport where the Antonov was allowed to operate, Cologne/Bonn in Germany, and the next morning loaded the container. I was not allowed to film inside the Antonov. In any case, there were no windows in the passenger area and we had slept only one hour that night before, so were ready for a nap!

The work went on in Toulouse to integrate, test and prepare Juice for shipping to Kourou. However,

Manuela Baroni and Juice at Airbus Toulouse



Filming Juice in the Large Space Simulator at ESTEC.

delays partly due to the pandemic postponed the launch date to April 2023. I visited ESOC in Darmstadt to talk with the flight dynamics team, where I learned about the amazing art of designing trajectories and how the planetary scientist, Yves Langevin, had come up with an idea that saved travel time to Jupiter.

The Juice team wanted the mission to carry a tribute to Galileo, who in 1610 published the *Sidereus Nuncius* in which he described his discovery of four moons orbiting Jupiter. The idea was to engrave three pages of the book on a thin sheet of Single Layer Insulation (SLI) and attach that to the exterior of the spacecraft, which is covered in Multi Layer Insulation (MLI). To cover this story, I visited the Observatory of Rome in the autumn of 2022. Lucio Angelo Antonelli, the director of the Observatory, and his team kindly received me and explained details about the history while I filmed a copy of an early edition of the book. The engraved pages were installed on the spacecraft, together with another SLI containing a list of all the people from ESA, Airbus, industry and the science community who had contributed to the mission.

I wanted to film Galileo's telescope as well. I contacted the Galileo Museum in Florence, only to find that I would have to pay 400 Euros for an hour of filming, plus a 1000 Euros security deposit! In the end, I found a very nice cardboard model for 25 Euros, with actual lenses. It was brilliant! My son Marco, a historian who somewhat resembles Galileo in his younger years, played the part of Galileo observing Jupiter.

At the end of 2022, a few months before launch, the first in-person Science Working Team meeting since the outbreak of the pandemic took place in Toulouse. It was the first time that I could meet most of the scientists in one place and interview some of them. This footage resulted in Episode 10, a three-part finale that covered Juice's remote sensing, geoscience and in-situ science instruments.

Finally, the big day arrived. While I could not go to Kourou for the launch, Manuela Baroni from the Juice team filmed behind-the-scenes footage of all the activities there. I instead went to ESOC to witness the launch. A beautiful show was organised at ESOC, where some 200 people gathered. The first launch attempt failed due to weather conditions in Kourou – the disappointment, of course, was great for drama in the film! That evening I met a few of the Juice team members in a bar in Darmstadt. One of them said he could give me access to the Project Support Room to film from there. This is a room behind the Main Control Room. From here people from the mission follow the launch and support the team in the Main Control Room where necessary. This was truly behind the scenes, I think no-one ever filmed in that room! The moment of the launch arrived and it went beautifully. But launch is not all. Almost 50 minutes later, strong tension filled the air when Acquisition of Signal – the first contact between the spacecraft and the ground –did not seem to happen as expected. When it finally did, the relief was enormous – another great moment for the film!

Juice is on its way now and will arrive at Jupiter in July 2031. The film, The Making of Juice, is now available for viewing on the ESA YouTube channel.[2] It gives a unique view of the making of that mission and the people behind it. I am very happy and honoured to have been able to create this film documenting a historical step in European planetary exploration.

1. https://www.youtube.com/channel/UCIK7xrwF0-XVI5IsG9SFKEA

2. https://youtu.be/TOKyzXulb-

Molėtai Magic

Alejandro Luis García Muñoz reports on the Europlanet Summer School 2023 at the Molėtai Astronomical Observatory in Lithuania.

What do you get if you mix a group of strangers in one of the most remote places in Lithuania? For the participants in the Europlanet Summer School 2023, it was an experience that turned a group of people, with a common passion, into a family of cosmos lovers.

During 10 days, from 8-18 August, people with varying levels of astronomical knowledge shared a laugh whilst learning at the Molėtai Observatory – or even taking a dip in the nearby lakes, surrounded by nature. The lectures were designed to be accessible even for beginners (like me). The level gradually increased through the Summer School, ensuring that even the most experienced in the field learned something new, thanks to the efforts made by the speakers to ensure that everyone could enjoy and learn. When the weather allowed, the main star of the event was the night-time observations. The Perseid shower coincided with the Summer School so we were able to become real 'Perseid Hunters'. Thanks to all the friends I made in Lithuania, I can now recognise many constellations in the sky and will remember them with great affection, along with memories of the Summer School. The 'icing on the cake' was a visit to the Lithuanian capital Vilnius. The city welcomed us with its incredibly preserved ancient aesthetics and allowed us to learn more about its rich history and about the whole country.

I have no doubt that every starry night from now on will be a portal to memories of the moments shared on this 'ast(r)onishing' adventure!

Top and above: Participants in the Europlanet Summer School 2023 at the Molėtai Astronomical Observatory.

Orionids Workshop 2023

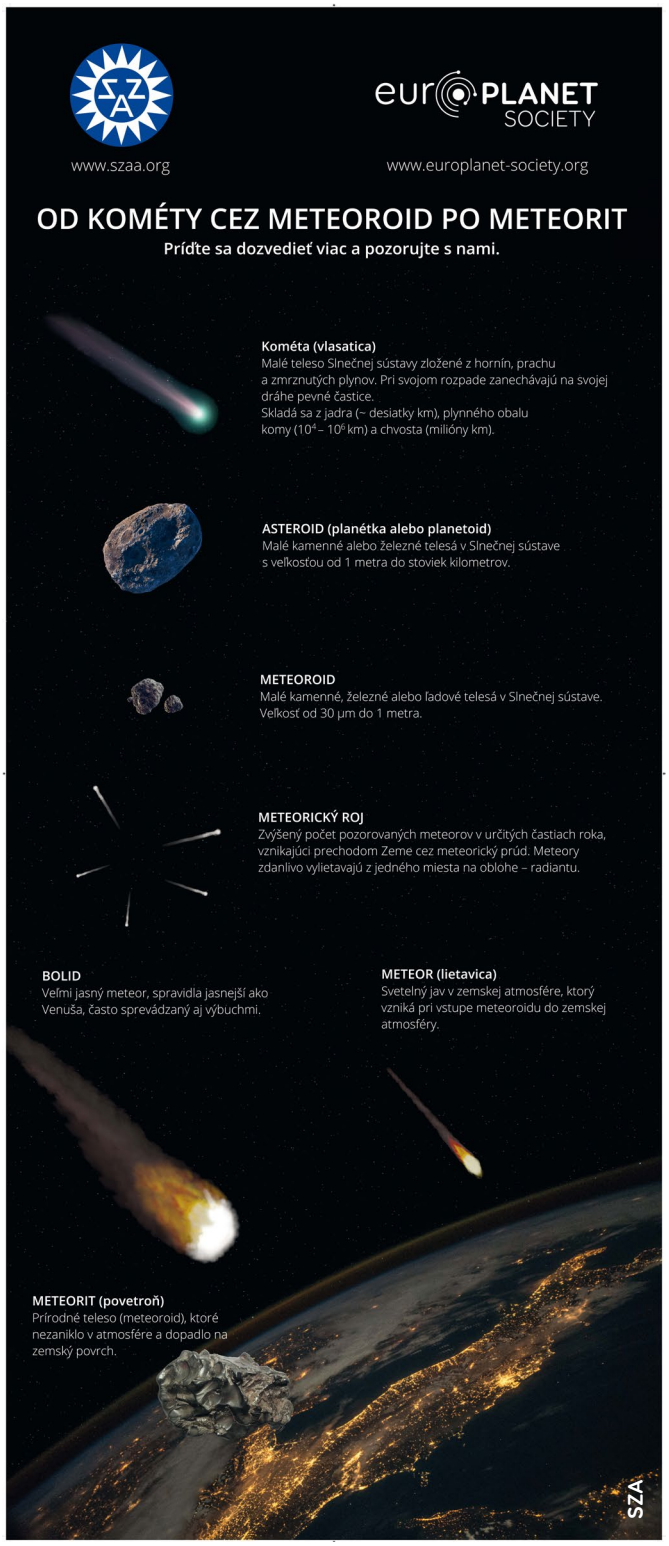
Miloš Obert, Chair of the Slovak Union of Astronomers, reports on a weekend astro-camp on meteor observations.

Visual meteor observing is one of the areas of astronomy where amateur observations are important. This kind of observation has a long tradition in our country, Slovakia, although it has been on the decline recently. The Slovak Union of Astronomers is an institution that brings together professionals and amateurs for the popularisation and development of astronomy in Slovakia. From 20-22 October 2023, we organised the Orionids 2023 workshop for people who are interested in meteor showers, with financial support from our friends at the Europlanet Society.

The week before the workshop, we looked with concern at the weather reports – the forecast indicated freezing conditions with rain and snow flurries for our meeting in Banská Štiavnica (a UNESCO World Heritage site in central Slovakia). Not all aspects of the forecast came true, but it did rain. In fact, despite it being the second half of October, the night temperature was 18 °C, but cloudy.

On Friday, participants and lecturers started to gather at the hut, where I was already waiting with dinner prepared. There was a fire in the fireplace, but the environment was still a little chilly. This was not important, however, because we met in a friendly astronomical atmosphere that warmed us even more than the fire.

According to the workshop programme, we were supposed to move slowly to the meadow and get ready to observe. However, as we would have only been counting raindrops instead of meteors, we began with the alternative programme. Roman Mikušinec started the meeting with a short overview of the basics of meteor observation and introduced us to the terminology. All participants were given handouts that included a brief observers' manual, protocols, International Meteor Organization (IMO) triangles and gnomonic sky-projections to plot the paths of the meteor trails. In his presentation, Jaro Gerboš outlined alternative approaches for recording observations, for example what to do if an observer is alone and is also the recorder. The presentation was enriched with P. Rapavý's stories of past observations, such as how the group travelled to the Khurel Togoot Observatory in Mongolia in 1998



Banner introducing comets, asteroids and meteor showers.

Group photo of the participants in the Orionids 2023 workshop and the banner.

and observed the Leonids at -35 °C, and how the lingering trail of a bright bolide drew a heart across the sky, like a perfect postcard image. Another time, in Spain, when the forecast of the maximum of the Leonids was already almost 100 percent, they experienced a short-term frequency of about 10,000 meteors per hour!

Before we knew it, it was past midnight. After the lectures were over, some of us continued discussions until almost five am.

In the morning, when I got up, some of the participants were already eating breakfast. Over coffee I checked the weather forecast, but the situation for the evening had not improved – in fact, quite the opposite. We were stuck with the alternative programme.

Lectures were continued by Jožko Kováč, who also teaches about meteors at the Post-Secondary School of Astronomy (PSA) in Hurbanova. For some people, who had attended the school, it was a repetition of information; but repetition is never bad, and often represents an opportunity to gain a new perspective.

Participants enjoy the lectures.

After covering lots of theoretical information, we started the practical part of the programme in the warmth of the hut. Jaro Gerboš switched on an old laptop and ran a computer program that simulates meteor swarms. He had prepared a setup simulating two meteor showers and sporadic meteors. We elected someone to act as the recorder and got down to 'observing', complete with darkness, a red headlamp, a radio clock, a log and a pen. The lecturers listened attentively and corrected us ("You're reporting it wrong! Quiet when someone is reporting...") and, after about half an hour, they were satisfied with the course of the observation.

We spent about two hours of pure observation time. A note was added to some of the data because we were not sure if the correct swarm had been identified. But we had the opportunity to evaluate and compare the accuracy of the reported data afterwards with the software recording of the generated data. The sky was still hopelessly overcast and it was raining, so we ended the programme at about one o'clock.

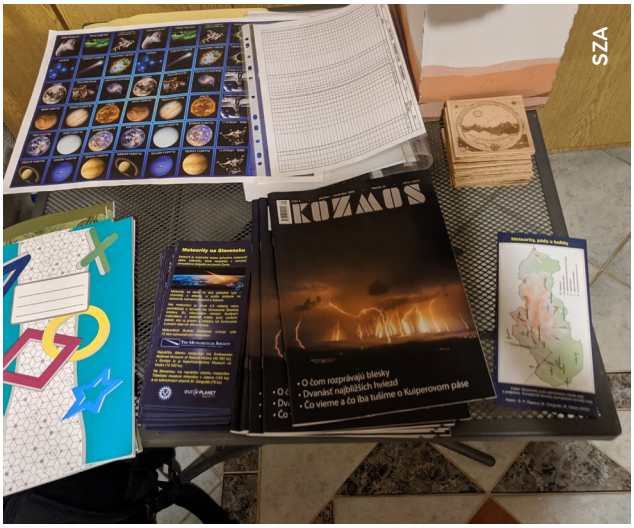
The lecture in full swing.

The last day focused on data evaluation. We looked at how well we had determined the swarm and magnitude of the meteors, to the satisfaction of the lecturers. We evaluated the observations, calculated the frequency and magnitude distribution, and learned how to fill out the IMO's reporting protocol. For group observations, the processing was facilitated by Jaro's 'ImoProt' program, which he developed for these purposes. However, we also practised the manual method and looked at where and how to enter data into the IMO page.

An outcome of the workshop will be the publication of a complete manual for visual observers, in the Slovak language, which will be available in due course on our website. I believe that the participants of the workshop, as well as the lecturers, learned something new and it was certainly an enjoyable and useful time spent with a good team. We were only able to experience a computer projection on this occasion, and the real joy comes from the true experience with 'shooting stars' under a beautiful starry night sky. Everyone agreed that they are looking forward to opportunities for 'real world' observations in the future. Nonetheless, the event was beneficial for community building and international networking, taking the work of the association to another level, for which we thank everyone involved.

IMO: https://www.imo.net

Slovak Astronomical Union: https://www.szaa.org



Participants received workshop materials, a coaster and leaflets about meteorites in Slovakia.

Participants Lubka and Monika admire siderite and pallasite meteorites.

Dusting the Moon

NASA

An artist's rendering of an astronaut working on the lunar surface during a future Artemis mission.

Karolien Lefever and Sylvain Ranvier (BIRA-IASB, Belgium) report on a project that gets to grips with lunar dust in preparation for future exploration missions.

Dust is omnipresent. On Earth, you may find tiny dust particles on surfaces all around your home, and even floating around in the air. Whilst some enjoy watching sparkly flecks illuminated by sunlight, for others, dust can be a real problem, as it contributes to allergies, respiratory problems, and asthma.

Beyond Earth, dust is also found on and around other Solar System objects, such as planet Mars, comets, asteroids, or the Moon. In space, dust can have some very nasty effects.

Several Apollo astronauts returning from the Moon mentioned that the dust that clung to everything, including their spacesuits, and that it made their throats sore and their eyes water. They tried using their hands or a brush to sweep the dust off their spacesuits, but neither method proved very effective.

Lunar dust is made up of tiny, sharp, and abrasive particles of lunar rock that have been crushed by meteorite and micrometeorite impacts. Sharp like glass, but fine like powder, lunar dust can be less than 20 microns in size, making it very damaging in ways that we don't see on Earth. The low gravity of the Moon, one sixth of Earth's, allows tiny particles to stay suspended for longer and penetrate more deeply into astronauts' lungs.

Dust poses a real challenge for future crewed and robotic exploration missions. Apart from potentially compromising astronauts' health by inhalation and irritation of respiratory systems, lunar dust has many other hazardous potential effects, e.g. spacesuit tearing, external vision obscuration, false instrument readings, dust coating and contamination, loss of traction, clogging of mechanisms, abrasion, thermal control problems (overheated radiators) and seal failures.

Dust Charging

Unlike on Earth, the lunar soil (known as regolith) isn't packed down. Dust particles and clouds have been

seen floating several centimetres to metres above the surface, despite the fact that there is no wind or water flowing on the surface to lift them up. Tiny particles can even be transported across vast distances on the Moon. Scientists attribute the dust mobilisation to electrostatic forces. Similar phenomena could take place on other airless bodies such as comets and asteroids.

Although the physical and dynamical processes behind dust lifting and transport are not yet entirely understood, we know that Moon dust may look and behave differently depending on its location on the surface compared to the Sun (the solar zenith angle).

For example, the Sun-facing side (the dayside) is constantly exposed to solar radiation. Irradiation of material on the surface in the UV and X-ray range results in photoemission of electrons (i.e. the release of negatively charged particles). This causes the dust on the dayside to have a slight positive electrical charge, with a potential of about +10V, which means that it clings to everything – like static effects here on Earth.

On the nightside, charged particle interactions tend to induce a negative potential, estimated to lie normally between -100 V and -200 V.

Near the terminator, the region between the shadowed and the sunlit sides, strong electric fields are present because of the fast transition from positive to negative potentials. Medium and small-scale structures such as craters or rocks may even amplify this aspect. This electric field could be the cause of electrostatic levitation and horizontal transport of lunar dust grains, leading to the net deposition of dust from the dark into the sunlit hemisphere.

The DUSTER Project

As space agencies like NASA and ESA are preparing to return to the Moon, international teams of scientists and engineers are thoroughly investigating the physical properties of near-surface lunar dust to assess dust pollution risks and to find ways of efficiently mitigating its dangers. Among them is the DUSTER project team, led by the Royal Belgian Institute for Space Aeronomy (BIRA-IASB), which combines efforts with ONERA, the French Aerospace Lab, Instituto de Astrofísica de Andalucia

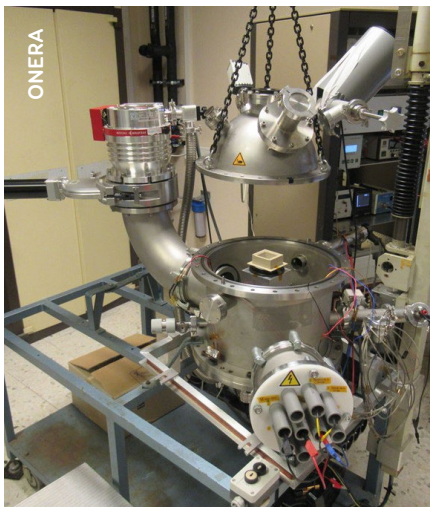
Apollo 17 astronaut, Harrison Schmitt, collecting a soil sample. His spacesuit is coated with dust.

(CSIC-IAA, Spain), and Thales Alenia Space - España (TAS-E, Spain), and is funded by the European Commission's Horizon Europe programme.

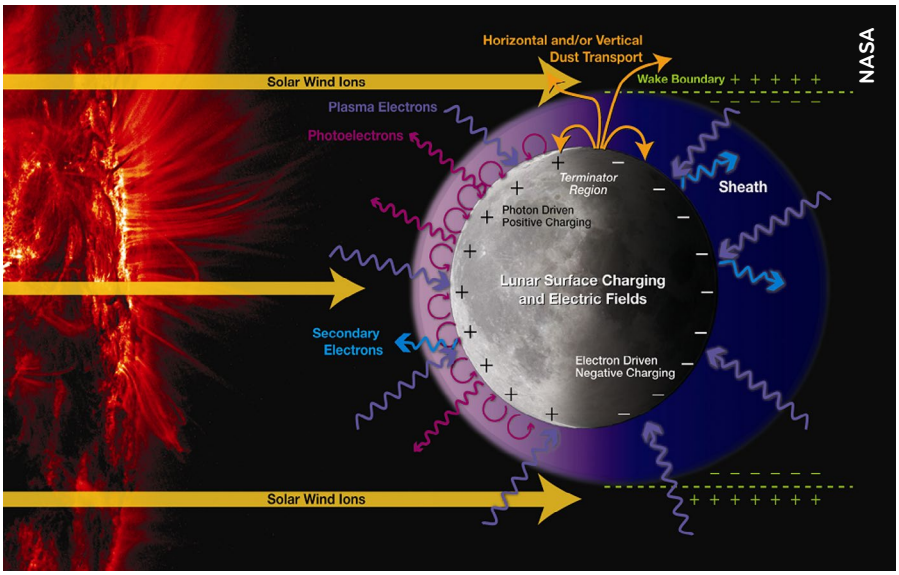
Through laboratory experiments, DUSTER (short for 'Dust Study, Transport, and Electrostatic Removal for Exploration Mission)s' aims to study electrostatic charging and adhesion of dust grains in regolith, which is crucial to understanding dust transport at the surface of airless bodies. The project will develop an engineering model of an instrument able to perform the necessary measurements to investigate those phenomena, in-situ, at the lunar surface. Developing the technology required to electrostatically move the dust grains, in a controlled way, constitutes a first step toward a sensitive surface-cleaning device.

Analogue Tests

To better understand the regolith charging in space environments, the DUSTER team is investigating the charging of lunar dust simulants in the laboratory through both a modelling and experimental approach. Using a dedicated setup in the DROP (Dust Regolith Or Particles) facility at ONERA Toulouse, which mimics lunar environmental conditions as realistically as possible, the team has shown that it is feasible to measure the electric field at the surface of the dust layer, to attract and move charged grains by applying an electric field, to measure the resulting current, and to infer the amount of electric charge carried by the mobilised dust grains. These first results are very encouraging.



The Dust Regolith Or Particles (DROP) chamber at ONERA (Toulouse) is used to carry out the DUSTER laboratory experiments.



Several dust charging phenomena are at play on the Moon.

Prototyping the Instrument

Based on the outcome of the laboratory experiments, a prototype for an in-situ instrument is being designed, manufactured and tested in a controlled environment. The compact DUSTER instrument should allow an in-situ analysis of the mechanical and electrical properties of dust and electrostatic transportation, when installed on a small lunar lander.

The instrument will enable the controlled extraction of dust grains from real regolith exposed to a natural (i.e. uncontrolled) environment. To do so, the instrument will be composed of three sensors: a Langmuir probe (to measure the electron temperature, electron density and electric potential of a plasma) an electric field probe; and a dust collector that consists of a high-voltage electrode coupled to an electrometer.

Results will allow the determination of the electric field needed to attract/collect dust according to the environmental conditions (illumination, plasma density and temperature). This will enable the design of electrostatic dust mitigation devices and dust sample collectors, for a wide range of environments, including the Moon, Mars, comets or asteroids.

https://duster.aeronomie.be

Funded by the European Union

This project has received funding from the European Union's HORIZON Research and Innovation programme under grant agreement No 101082466.

Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the granting authority. Neither the European Union nor the granting authority can be held responsible for them.

Join us

The Europlanet Society promotes planetary sciences in Europe for the benefit of its community.

The Society is open to both individuals and organisations. Launched in 2018, it builds on nearly 20 years of successful Europlanet projects funded by the European Commission. It is the parent organisation of the Europlanet Science Congress (EPSC), the largest annual meeting for planetary sciences in Europe.

Find out more at:
bit.ly/JoinEuroplanet

EUROPLANET

Organisational Memberships

For research organisations, institutions and industrial partners involved in planetary science and related fields.

Benefits:

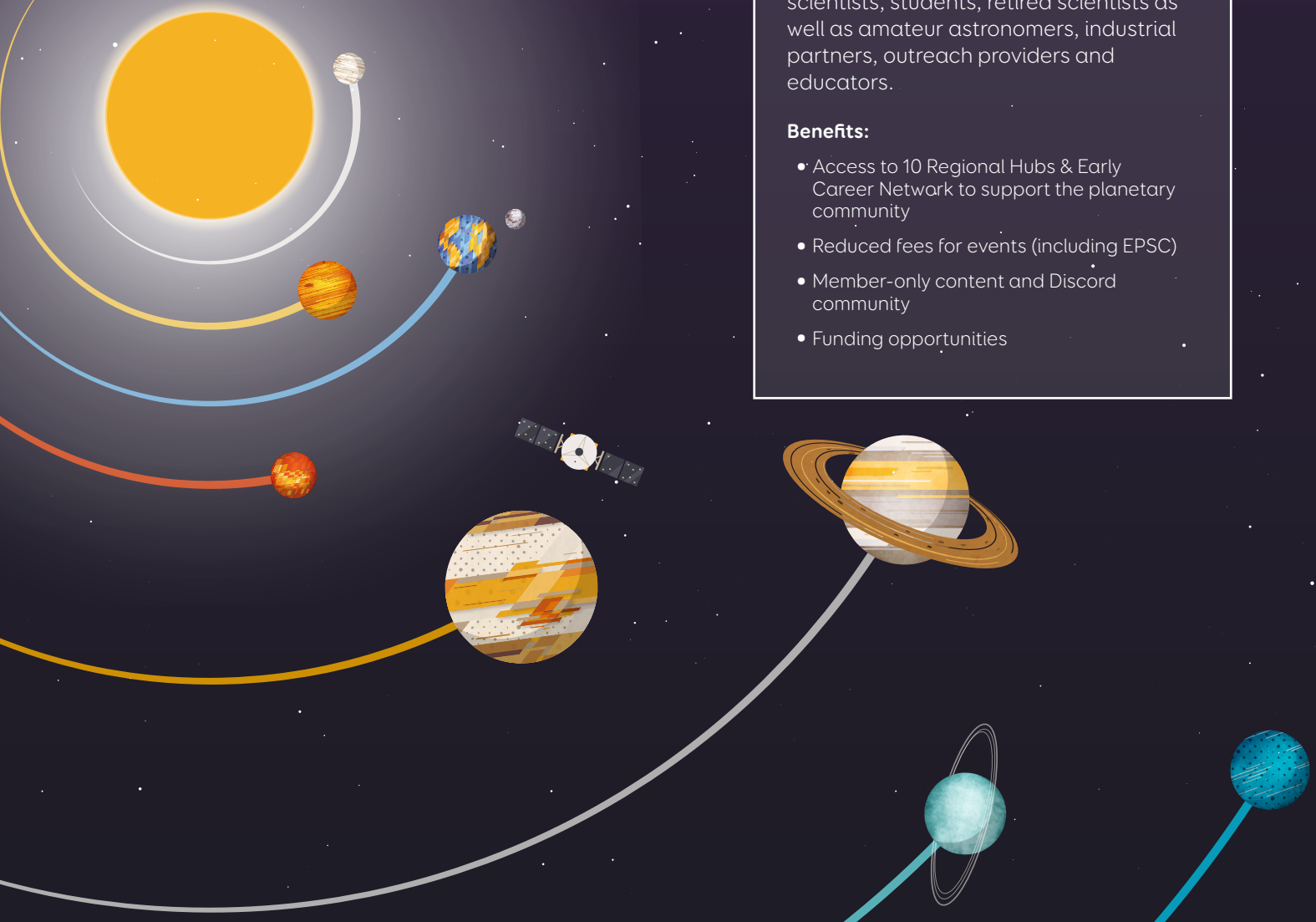
- Representation at the General Assembly
- Reduced fees for events (including EPSC)
- Member-only content
- Packages of individual memberships

Individual Memberships

For active researchers, early career scientists, students, retired scientists as well as amateur astronomers, industrial partners, outreach providers and educators.

Benefits:

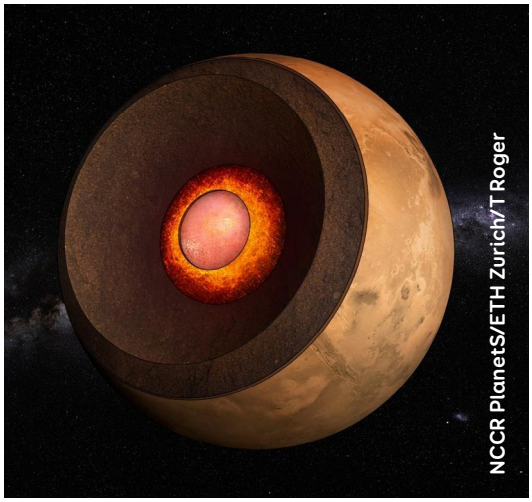
- Access to 10 Regional Hubs & Early Career Network to support the planetary community
- Reduced fees for events (including EPSC)
- Member-only content and Discord community
- Funding opportunities



Commkit

The Dream of AI

Thibaut Roger (University of Bern, Switzerland) examines how AI can be useful for scientific outreach and communication, as well as the limitations.



Top: Adobe Firefly illustration generated by the prompt: "A cut-away view of Mars interior. We see the metallic core surrounded by a thin magma ocean and then the mantle."

Above: My illustration, inspired by the AI-generated example.

This issue of the Europlanet Magazine has delved into the ways that Machine Learning and other Artificial Intelligence (AI) processes can benefit science. But what about science communication and outreach? Can AI help you overcome your artistic or literary challenges to finally grasp your dream of creating magnificent illustrations or flawless prose?

Text Applications

AI struggles with the complexity of scientific or technical language. In my experience, correcting AI-generated content can end up taking much longer than doing the work from scratch, in particular for translations. Recently, a colleague showed me some 'improvements' suggested by ChatGPT for a press release. With the proposed changes, the phrase "a simple process, very complicated to reverse" would have become "a highly complex process"; ChatGPT did not get the point that it was the reversal that is complicated and not the process, which on the contrary is simple. The meaning was changed. Issues can also arise from AI being essentially a dictionary of synonyms. For example, AI is unable to distinguish between "power" and "intensity"; these words can be synonyms in common language, but they are two very distinct scientific notions.

Image Applications

Using AI in communication to generate images and illustrations seems useful (as an example, see this issue's cover), but it also raises important ethical (and legal) concerns. While some AI-powered content generators, such as Adobe Firefly, disclose the composition of their training set, most do not. Concerns about training on copyrighted material actually led EurekAlert!, a major tool for press release publication, to ban any AI-generated content. AI also tends to repeat representation biases, such as diversity biases or common stereotypes (e.g. a scientist = a white man wearing lab coat).

Benefits

At this stage, AI still needs a human to check and correct the results. However, with short and simple texts (e.g. translations of newsletters) it definitely can save you time. Recently, I tried to use AI to generate a cutaway view of Mars showing the planetary interior. While the results were ludicrous, they actually inspired me to create my own illustration with an unconventional cutaway (see above), rather than the traditional 'orange-segment'. Despite its flaws, AI-generated or improved content can serve as a source of inspiration and provide a different take on things.

Planetarily yours,

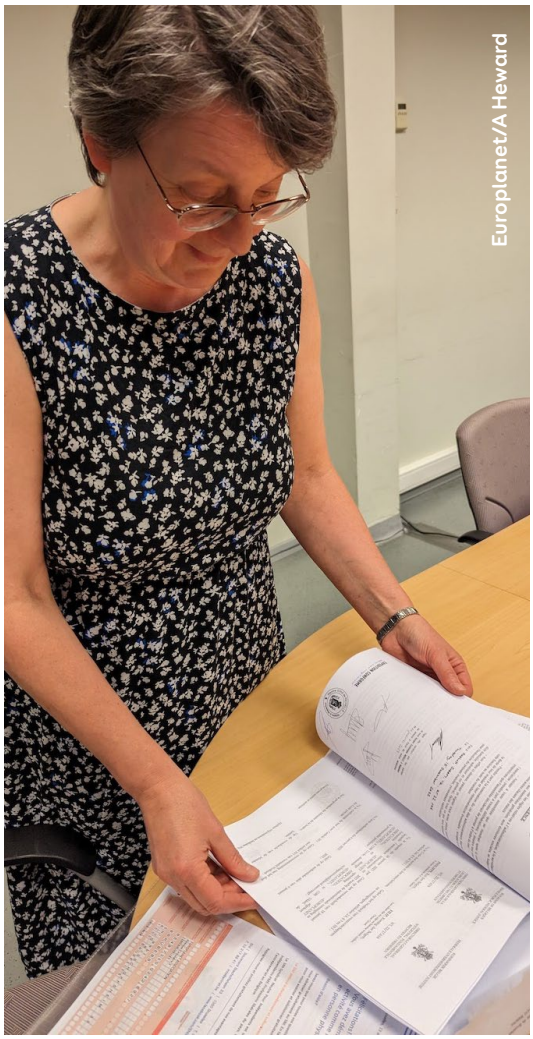
Thibaut

If you have science communication tips and tricks to share, join the conversation on Discord: https://bit.ly/EuroplanetDiscord

The Last Word

Europlanet: A Page Turns

Ann Carine Vandaele, President of the Europlanet Society, reflects on sustainability for Europlanet.



Ann Carine Vandaele with the signed statutes and Royal Decree for the Europlanet AISBL.

A year ago, in February 2023, Europlanet founded an international non-profit association (AISBL) under Belgian law. The objectives of the AISBL are aligned with those of the Europlanet Society, i.e. to promote planetary sciences, for the benefit of the community, by encouraging the creation of new knowledge, promoting education, stimulating innovation, and enhancing accessibility and transparency. The management bodies of the AISBL and the Society are shared to ensure that the AISBL's objectives will always support the Society's activities and strategies.

At the General Assembly in November 2023, the Society's membership endorsed the election results of new Executive Board members (page 4 and 15) and a motion that stated, henceforth, all Society members would also be members of the AISBL. This important step opens up a breadth of new possibilities.

Europlanet now has a legal identity, enabling us to seek funding and to be full partners in projects. This includes, but is not limited to, programmes funded by the European Commission. We are coming to the end of the €10 million Europlanet 2024 Research Infrastructure (RI) project and now have to consider how to sustain the many services that it provides for the wider scientific community.

At the Europlanet Research Infrastructure Meeting (ERIM), we started a major exercise to address sustainability and potential funding models for the different areas of Europlanet activities.

Participants discussed what the benefits of being a member of the Society should be; how our Regional Hubs could best serve the interest of the Society members and our community; how relationships between the Society, industry and policymakers, could be strengthened; how EPEC, the Early Career Network, could help the new generation of planetary researchers find their place and build their own future; and which Europlanet services are critical to the community and should continue to be supported in the future. This week of discussion and brainstorming (reports on pages 30-41) was a fantastic opportunity for everyone to express themselves and describe their vision of what is important to them as members of the Europlanet Society. But the work has not stopped with the end of ERIM. We would like you to take part in the ongoing discussions! To be effective, and to represent the whole community, we need volunteers willing to share their ideas and experiences. Many Regional Hubs and Committees are lacking core members, so contact us, engage actively in our activities, and suggest new ones!

The Europlanet Society is your Society, and I sincerely hope that you will all play an active part in its development.

Join the conversation on Discord: https://bit.ly/EuroplanetDiscord

© Copyright 2024 Europlanet Magazine