



# Consultation on Horizon Europe
*October 2019*

# European Space Sciences Committee Contribution

**CONTACT**

European Space Sciences Committee Secretariat

European Science Foundation

1 quai Lezay-Marnésia, BP 90015

67080 Strasbourg cedex, France

essc@esf.org

+33 (0)388 767 100

**14 October 2019**

# *Table of Contents*

## Introduction

The European Space Sciences Committee (ESSC – www.essc.esf.org) was established in 1974, first as the European Provisional Advisory Committee for Space Research, and then as an independent committee under the then newly-created European Science Foundation (ESF – www.esf.org). ESSC has for main objective to give European space scientists an independent voice in the space sciences arena.

The ESSC scope covers the whole spectrum of space sciences, from microgravity research to space physics, and from planetary sciences to astronomy and Earth sciences. ESSC has a unique position in Europe providing independent scientific advice on space sciences matters to the European Space Agency (ESA), the European Commission (EC), national space agencies, and other stakeholders and has become the reference body in Europe on space sciences matters.

Over the past years, the ESSC has regularly contributed to consultations and events targeted to better defining and optimising the European Union's role and ambitions in the space sector in general and in space sciences in particular. This document and its recommendations is following in the line of previous contributions provided by ESSC, which can be found on http://www.essc.esf.org/studies-and-publications/.

The space sector offers several key solutions to challenges that our modern society is facing. Fundamental space research delivers answers to the most important questions of mankind: what sort of environment do we live in? Why do we live here? How did the universe and our (and other) solar system(s) develop and how will it (they) evolve? Additionally, fundamental science brings surprises. It is not straightforward to plan exactly how it will benefit society, but experience shows that it always does. For example, the development of the theory of general relativity by Albert Einstein in 1915, which 80 years later enabled the performance of GPS systems, is today a key component in services routinely delivered and used by citizens.

Space activities such as telecommunication and navigation, operational Earth observation services and security, space engineering and space technology are deeply rooted in the lifestyle of European citizens. In return, European societies and economic welfare are increasingly dependent on these services and activities. This intertwining of space activities with our technology-driven societies and economies can also be transposed to research performed in space. Space sciences cover an extremely wide range of sciences and have relevance and impact on many scientific disciplines: health research (i.e. ageing, immunity, stress related responses and cardiovascular diseases), life and environmental sciences, physical and material sciences, to name a few in addition to astronomy and planetary science.

Looking downstream, numerous space-based investigations have direct relevance for technology development (e.g. telemedicine, biomedical research, material engineering, energy production, communications, information technology, robotics, sensors and automation). Acknowledging and catalysing the role of space sciences on European citizens would strengthen the links between research and application. It would also facilitate socioeconomic uptake and appropriation of investigations performed in and from space.

Support to space sciences represents only a marginal share of the Horizon 2020 programme in general and a rather modest share of its 'Space' Work Programmes. However, through the Horizon 2020 programme, between 2014 and 2020, the European Union has supported many excellent space sciences initiatives. Projects supported by the European commission allow to structure the community, to identify research priorities and to generate knowledge from mission data. For example, the Europlanet 2020 Research Infrastructure project, supported at the level of €10 Million for the period 2015-2019, has allowed for more than 350 research teams to access research facilities and planetary analogue sites. This project also allows providing access to online datasets and opportunities to network the European planetary science community. The European Commission regularly allocated funding to Europlanet projects since 2005, and again in the new call for the 2020-2024 period. This

support permits the development and strengthening of a robust scientific community that is now coming under the umbrella of the recently created Europlanet Society, which has the potential to grow into a successful European counterpart to the US Division of Planetary Sciences of the American Astronomical Society.

Additionally, Horizon 2020 provided, among others, a better understanding of the reasons behind cometary activity (MIARD project that studied data from the Rosetta mission) and new accurate maps of dark matter (DEDALE project). Space hardware and space technology development were also supported by Horizon 2020 through projects such as HYPROGEO (research into a hybrid satellite propulsion engine) or DEMOCRITOS (large spacecraft and their propulsion).

The Horizon Europe programme has thus the opportunity to build on the experience gained in Horizon 2020 and its predecessor programmes. Horizon Europe support to space sciences has to be ambitious and stable. It should also be intra-connected (coordination between the various component relevant to space) and inter-connected to other non-EU programmes in Europe and beyond.

## The European Research Landscape

### *Horizon Europe as a tool to strengthen space sciences and technology on the European scene*

Involving different States, national research organisations and/or space agencies, European institutions and international organisations, the European space sciences landscape is indeed complex. Although very significant progress has been made in the past decade, there is still a need for improved coherence between the science strategies of all European space players.

Although with relatively modest level of dedicated support, the Horizon 2020 programme provides the means to generate outstanding space sciences knowledge and results and helps structuring the communities across borders. Horizon Europe should capitalise on these successes and allow for an increased support for space sciences at least to the level of increase of the full programme.

A coherent vision for European space sciences and technology should include both—and in a balanced way—a bottom-up approach and top-down strategic plans with dedicated budgets. It is important to stress that fundamental and curiosity-driven research should be included in these strategic areas, to ensure optimal long-term scientific developments without immediate short-term technological applications. It is also important to stress that support to space sciences should be continuous and coordinated to generate impact.

Such an approach has been adopted to some extent within the Horizon 2020 programme's Strategic Research Clusters (SRCs) and should be continued in Horizon Europe, e.g. through the development of virtual institutes for domains of strategic relevance and/or that would most benefit from increased European coordination. Building up critical masses, these initiatives would strengthen the European space research landscape and demonstrate flexibility and adaptability.

As science progresses and tackles more and more difficult and increasingly complex problems, it is vital to follow a 'System Approach' to answer scientific questions, i.e. to study interactions within the solar system (as for example the sun-planets interactions) as coupled processes, looking at all available data, not just from one instrument on one satellite. This is particularly true in areas where there are multiple, complimentary assets available to the communities, both in space and on ground (free-flying and Earth-based observatories). An integrated approach between ground and space research on selected topics across the full space sciences arena has high potential for progress and increased benefits to the European citizens as a whole.

Beyond the perimeter of Horizon Europe, the ESSC is a long-standing supporter of an improved coordination between the European Commission and the European Space Agency activities and

investment in space sciences. The positions and recommendations presented in this document can also be approached in the light of coordination between ESA and EC programmes.

In this context, the ESSC expresses support for the future vision and extensive commitment demonstrated by ESA Director General in his proposal on "*A United Europe in Space*", which was adopted by ESA Member States on 25 October 2018, following the ESA Intermediate Ministerial Meeting (IMM18) held in Madrid. This far-sighted (2019-2028) long-term plan aims to identify the *"…substantial evolution expected to occur in the various fields of space activity and the different role that players and stakeholders, and primarily the Agency's activities and programmes will be called upon to play in the coming years*". The ESSC also witnesses with satisfaction the notable progress that was achieved in improving coordination between ESA and the European Union institutions. The ESA Member States adopted a resolution on 25 October 2018, giving mandate to the ESA Director General to establish appropriate relations between ESA and the European Union.

Beyond Europe, the international space sciences landscape is evolving at a rapid pace, new capacities are appearing, and scientific and technological milestones are being completed in non-European countries. Besides USA and Russia, this is particularly the case in Japan, China and India and Europe is in a unique position to exploit partnerships with all space powers. While cooperation between scientists is overall successful and progresses at a fast pace internationally, several collaborative projects are still hindered by a lack of willingness or capacity to reach agreements at a sufficiently high level in space agencies (and/or overlaying governmental bodies), for political and/or export regulation reasons. An improved European coordination mechanism could also allow for the emergence of a European anchor for international cooperation.

***RECOMMENDATION:*** Horizon Europe should initiate new large-scale and long-term topical areas within the Space element of the programme. It should be focussed on key scientific and societal challenges and feature improved coordination between the various relevant actors, which could be defined and implemented through the principles of a reinforced EU-ESA relation. Similarly, stronger links between national (space) agencies and Horizon Europe would be beneficial.

***RECOMMENDATION:*** The scientific community should be involved in the definition of Horizon Europe's space-related work programmes as early as possible in order to maximise its scientific return.

***RECOMMENDATION:*** Horizon Europe should give strong consideration to Member States research organisations, national agencies and the European Space Agency and to the most appropriate way to optimise interactions and coordination. Although primarily developed by the European Union's institutions, the space element of Horizon Europe should be developed in agreement with key European stakeholders and result in a more efficient implementation of aspects of common interest. Beyond Europe, Horizon Europe should also consider how to allow for a more robust European position in the international cooperation context, with the aim to promote common development and partnerships at the international level, for areas of common interest and in particular for scientific programmes.

### *Complementing national and European space programmes: upstream and downstream support*

In line with an improved coordination between ESA and EU on space activities, the added value of the EU funding for space is not to substitute for, or overlap, with what ESA and national space agencies are doing already. EU investment should facilitate and support scientific teams working on space sciences and exploration upstream (community support) and downstream (data exploitation), which

are not funded—or only marginally—by national funders or by the European Space Agency. In this context, the ESSC welcomes the wording introduced in the early outline of the *Strategic Research and Innovation Agenda for EU-funded Space research supporting competitiveness (SRIA).*

**Upstream community support**

Bringing an experiment, a payload or a mission to the stage it can be proposed for funding requires significant upstream effort from the teams involved. There is a significant effort that is needed in order to mobilise the community (or even create it) and allow for novel ideas to take root, be initially examined and mature enough from the technological and scientific point of view to be proposed as a project or mission to the respective funding agency. The role of engaging industrial partners at an early stage could also be shared between national space agencies and the EU programmes.

Coordination and Support Actions (CSA) or other networking and community building initiatives should be an integral part of the Work Programmes in order to ensure that scientific teams and communities consolidate behind low TRL concepts which are then brought to a higher level via more appropriate Research and Innovation actions.

**Downstream community support**

In most European countries, the scientific community is faced with a major challenge when mission or experiments come to an end: although a large amount of data is produced and remains to be analysed and exploited to produce new knowledge and advance science, funding to support teams and networks are discontinued and somewhat limited. The Horizon 2020 Space Work Programme topic "*Scientific Data Exploitation"* opens every other year and is intended to address this issue, and therefore increase the scientific return of public investment in space missions. Horizon Europe should allow for the continued scientific exploitation of mission and experiment data, possibly in partnership with national space agencies and funding organisations.

***RECOMMENDATION:*** Horizon Europe presents a unique opportunity to strengthen the European efforts in space sciences by complementing investment made by space agencies and member states on missions and instruments, either upstream (early development work for potential future science missions and instrument) or downstream (exploitation of mission and science data). This opportunity should be exploited throughout the Horizon Europe programme on a regular (annual calls) and substantial (with level of support allowing the development of a critical mass) manner. This support should be based on scientific excellence only (fully bottom-up), and attention could be given to co-funding mechanisms and programmatic approach with national funding organisation (e.g. through partnerships also with industry).

## *Big Data*

In all domains of science, current and future space assets produce or are predicted to produce a very large amounts of data. The request for the establishment of infrastructure for data analysis and archiving is a consistent appeal from the scientific community. There is a large amount of space missions and ground-based observations acquired by European scientists and agencies that would gain in productivity if they were organised in a coherent way, shared via public databases and properly archived and analysed in a more coordinated way. Also, facilities related to space sciences exist in many European countries, these facilities should be made available for scientists, students and schools in a broader scope, including didactical packages in STEM education. Virtual observatories (e.g. Europlanet VESPA – Virtual European Solar and Planetary Access) are concrete examples of the

benefits that modern coordinated data facilities and software can have for the European scientific community. These infrastructures allow to network, pool and make available data, algorithms and computing power from different sources and located in different data centres.

The full spectrum of space sciences communities in Europe would largely benefit from such coherent organisation which would further increase their competitiveness at an international level and appeal for educational systems. The main aim of such an endeavour would be to improve framework conditions, workforce and infrastructure for space data preservation and exploitation, including the development of archives and tools for accessing, processing (including regular re-processing) and dissemination. It would also allow integrating the use of space data in the context of the European e-infrastructures for e-science, including big data and modelling.

Ideally, European space research would benefit from the development of robust cloud services that would go beyond simply making data available and would aim at providing tools for analysis and visualisation. Space data e-infrastructure should support R&D actions either focused in specific scientific domains, merging space data with knowledge and data developed on the ground, or aimed at linking and associating data from different domains to pursue cross-disciplinary scientific goals as well as policy and socio-economic goals that go much beyond scientific interest.

Currently operating space missions like GAIA produce a huge amount of data that need dedicated and original system for its archiving and exploitation. This will be true as well for the Euclid mission in a close future. More specifically, the Copernicus programme offers unique datasets with high temporal resolution that require a new paradigm in data processing. Bringing the process to the data offers many advantages over bringing the data to the process, particularly in efficient data exploitation. The aim of such an approach would be to develop processing systems, e.g. based on cloud computing, that enable data processing that do not require the download and storage of huge amounts of data on the users' facilities. Bringing the process to the data would allow for improved efficiency in data processing, distribution and interpretation, greater uptake of Copernicus data, standardisation in products, algorithms, validation and reliability. The ESA TEP is an example of an external initiative that has proved to be successful.

***RECOMMENDATION:*** Horizon Europe should encourage and mobilise assistance to research infrastructures supporting activities that produce large amounts of data and that require high computing capacity to exploit them. As to (scientific) data, the European Commission should also support enhanced and unified networking, pooling and sharing of data and facilities and encourage revisiting existing data with new paradigms and algorithms for data interpretation, presentation and combination. In this context, the European Open Science Cloud (EOSC) is considered as a very positive development.

### *Reaching a clear view of Horizon Europe Support to space activities*

As it has been (and still is) the case in Horizon 2020, the support to space activities (science, technology development and support to innovation and industry) is scattered around many different schemes and tools. For example, space sciences are supported not only through the SPACE Work Programme of the Leadership in Enabling and Industrial Technologies (LEIT) programme; it is also supported through e.g. the European Research Council instruments, the Research Infrastructure programme, the Climate programme or the Marie Skłodowska-Curie actions.

Information on the various space-related projects and initiatives should be centralised and made available in order to support the development of new partnerships and synergies in an efficient way. This would also allow to define precisely the investment in space research and technology development made by the European Commission through the Horizon Europe programme. The information available in CORDIS certainly represent a valuable first step in this direction.

***RECOMMENDATION:*** Horizon Europe should develop an information hub gathering all information on the available counters existing on space-related matters. This information should be circulated to all European stakeholders, in particular the scientific community and the national research organisations and space agencies.

## *European Talents*

**Maintaining knowledge**

Space missions require a long lead-time of development before launch. This is often followed by a similarly long phase of data exploitation, starting once the mission is in operation and continuing after its end. Together, these efforts can span decades, or the entire careers of researchers and engineers. In addition, missions will often include phases which require less support (e.g., the cruise phases of BepiColombo or JUICE, but also launch delays, etc.) but pose a substantial risk to the missions because knowledgeable personnel may be forced to leave the project. This sometimes results in a loss of competence and know-how in the teams involved, as well as in a higher level of uncertainty in the optimised operational and data exploitation phases. In this context, the use of ground-based equipment and facilities (e.g. telescopes, in-situ environmental stations, simulated microgravity) is a very valuable way to maintain knowledge and know-how.

Also related to this, programmatic planning may lead some discipline to be less engaged in active missions or investigation for potentially very long time periods. One can find such an example with the uncertainty raised by the de-commissioning of the International Space Station sometime in the second half of the 2020s. Although schemes are being developed at national level to ensure some level of continuity for life and physical sciences in space, there is currently no integrated European plan to maintain the level of excellence built up in Europe.

***RECOMMENDATION:*** Horizon Europe should allow for the development of mechanisms to permit maintaining knowledge, competencies and know-how in areas where the European scientific community excels at the international level. These mechanisms could be implemented by and/or in concertation with Member States' institutions and should integrate fully the use of relevant ground-based facilities and infrastructures.

**Inspiration for the younger generations**

Space has been an inspiration for young people ever since the beginning of the space era. The recent planetary science highlights (in particular NASA and ESA's Cassini-Huygens mission, ESA's Rosetta mission, GAIA and Lisa Pathfinder, and most recently ExoMars 2016 following in the footsteps of the highly productive Mars Express and Venus Express spacecrafts) have drawn huge public attention, including from the younger generation. European astronauts catch the interest and imagination of millions European citizens (the French astronaut Thomas Pesquet has more than 740.000 followers on Twitter). Space sciences and space exploration are one of the very few disciplines able to draw such level of interest and enthusiasm, and to spur entire careers.

Additionally, students and Post-Docs who worked on a space mission learn how to manage a complex project, how to cope with diverse technical requirements, and gain expertise in working within various disciplines of science and engineering. This constitutes an excellent preparation for future involvement in, or interactions with, the industry. Indeed, space graduates tend to choose to pursue their career in the industry sector, not only in large space companies but also increasingly in small SMEs or start-up companies.

Considering the current decrease of graduates in engineering, mathematics and physics in Europe, the European Union should use the interest raised by space activities as a tool to channel and build capacities in graduate STEM education and inspire young students to follow such a career, with specific attention to gender and minority groups.

Considering direct support to young researchers, ERC has created specific programmes for young researchers in the area of microgravity research. This interesting opportunity is however allocated to a few individuals only. EC should develop and implement space-science and space technology-related programmes for young researchers, PhD students, and Post-Docs in the form of networks or institutional fellowships, which could benefit a larger scientific community.

***RECOMMENDATION:*** Horizon Europe should acknowledge the high level of public interest stimulated by space activities (and in particular space exploration) and work towards turning this interest into improved recruitment in STEM high-school and graduate studies as well as improve general STEM literacy of the European citizens. The creation of specific coordinated programmes and actions for children, pupils, and young researchers in the field of space research is highly recommended in view of the large shortage of STEM graduates. Furthermore, space sciences projects to be funded by the Horizon Europe programme should dedicate some of their grants to outreach and education activities.

### *The Need for an Empowered Advisory Body for Space*

There is a basic need to provide Horizon Europe with a completely independent advisory body that would advise the Member States delegates and EC executives in the implementation of the Space programme. This is particularly relevant if the programme is not supported by a dedicated programme advisory committee, but even then, in accordance with the use of ad hoc senior committees in ESA, an external expert body could be required to ensure transparency and efficiency.

Given the increased importance of the EU in space matters, a trend projected to increase in the next decades, it is essential that the EU receives authoritative independent advice on scientific and technological matters beyond the only Horizon Europe—and successor—programmes. This could come from a body that can articulate and organise the needs of the wider space community, in a fully transparent way, and independently from national, EU or ESA considerations. It is also necessary to resist the unnecessary fragmentation and duplication of efforts at European level, to carry out regular surveys to assess the status and perspectives of European space activities, and to establish roadmaps and strategic plans that are widely accepted by the community.

Such a body could express the collective voice and vision of the broader European space community, on current and future space research matters. At international level, it could promote synergies between programmes and organisations, by identifying potential opportunities for shared development. Such a body could also offer a ‘systemic view’ to space research as it would draw its members from the large European pool of established researchers (and not only space scientists) that are vital, active and expert members of the scientific fields at hand.

Examples of such bodies abroad are the Space Studies Board and the Aeronautics and Space Engineering Board of the U.S. National Academy of Sciences, Engineering, and Medicine. In Europe, the European Space Sciences Committee of the European Science Foundation already provides independent scientific advice and recommendations and has a recognised role in the EU scientific community, as well as a large stakeholder network.

***RECOMMENDATION:*** The European Union should equip itself with an independent advisory body, empowered to advise the EU (the European Commission and the European Parliament) and other European and national institutions on space matters. This body should be tasked by EU institutions, ESA and the member states and its structure and mandate should encompass the whole scope of space sciences and technology, from a pan-European and international perspective.

## Topical Issues of Relevance for Horizon Europe

### *Health Research and Life Sciences*

Many data show analogies between spaceflight and clinical conditions, for example for patients with osteoporosis, autoimmune problems or nutritional defects. Despite restricted resources on the International Space Station in the past years, the last decades have pushed the European life science in space research to a high level of excellence. A strong ground-based analogue research (bedrest, isolation and irradiation studies) has complemented and contributed to this success.

As an example, the investigations performed in space have applications for the benefit of patients on Earth. Musculoskeletal research for spaceflight is fully relevant to the study of age-related osteoporosis and sarcopenia on Earth and therefore has direct potential for the wellbeing of an ageing population. Similarly, research performed in space on the cardiovascular or immune systems as well as on neurophysiology, nutrition, radiation biology or habitat management allow addressing health challenges, some of which being triggered by our modern lifestyle.

Furthermore, understanding why some of the crew members are affected by space flights more severely than others leads to studying the genetic susceptibility to certain physiological changes. These investigations require the analysis of the underlying molecular and cellular processes with model systems of different complexity and are a concrete example of how space research can support the development of personalised therapy strategies and individualised prevention programmes.

***RECOMMENDATION:*** Horizon Europe should provide a framework to facilitate engaging space life science into translational research in order to fully reap the benefits that these disciplines have to offer to the European population in terms of health and medical research.

### *Material and Physical Sciences*

The European physical and material science in space has reached a high level of excellence in the last decades. The availability of short-time microgravity environments (sounding rockets, parabolic flights, drop towers) allowed to prepare the ISS experiments in efficient conditions and contributed to this success. In some cases, the available time of these additional facilities was sufficient to obtain important results. Top class scientists became involved, leading to European leadership in the field.

The investigations include fundamental physics (atomic clocks, quantum communication in space, quantum tests of principles, plasmas) as well as astrophysics and atmospheric physics. Other investigations deal with fluid physics, combustion and heat transfer (including boiling), which not only allowed to improve fundamental knowledge but also gave important information for the operation of spacecraft: for instance, the 'piston' effect allowing temperature equalisation in space was discovered during ISS experiments (it was believed before that temperature gradients would not disappear in microgravity environments due to the lack of convection). Because of the absence of convection, measurements of the Soret effect (coupling of temperature and concentration gradients) are highly facilitated by microgravity. Oil industry readily took advantage of this opportunity. Considerable additional knowledge was obtained in material science including soft materials (foams, granular media including complex plasmas, colloidal glasses) which also benefited to industry. For instance, the ways

by which unwanted foams can be destroyed in microgravity environments was clarified recently. Results of material science research in space have contributed to improved competitiveness of European industry.

Besides the direct gain of know-how from microgravity experiments, the necessity to miniaturise scientific setups from table top to small rack-based systems (like in quantum physics where large optical benches can be realised on a chip) and the need to ensure safety in manned space flight is an important technology driver for institutes and industry involved in design and manufacturing leading to new possibilities and applications on Earth.

It is therefore clear that space research not only provides fundamental knowledge increasing our understanding of the way in which our world has evolved and will evolve in the future. It contributes to a better understanding of physical phenomena on Earth and is very valuable to industry. It will also provide key knowledge for the operation of spacecraft and for future space exploration.

***RECOMMENDATION:*** Horizon Europe should provide a framework to facilitate engaging space physical and materials science into innovation and application mechanisms in order to fully realise the benefits that these disciplines offer to European citizens.

## *Cal/Val for Earth Observation*

The global downstream market for satellite Earth Observation (EO) data was worth $28.3 billion[1] in 2017 and growing and there is an Increasing need for reliable, fit-for-purpose information, available on-demand, derived from a multitude of data sources and sensing technologies.

Data sets for applications (e.g. climate change, food security, pollution monitoring) all require the user to have some quantitative level of confidence in the data/derived information. In this context, whilst significant effort is made to ensure that satellite sensors are well-calibrated, characterised, and traceable before launch, the violence of launch and the harsh environment of space impacts on sensor performance. Therefore, missions rely on well-characterised measurements from a range of geographically and environmentally representative locations.

Calibration and validation (Cal/Val) can, in principle, be obtained from a mix of aircraft, UAV, balloon and ground-based measurement techniques (remote or direct). The European Space Agency has, in the past few years, initiated a number of projects with that purpose, in a number of products such as surface temperature, ocean colour, altimetry, SAR, greenhouse gases, and vegetation. Similarly, the EU has in parallel supported a number of projects to develop strategies and methods to the same end including GAIA-CLIM, QA4ECV, Fiduceo and METEOC.

These projects have advanced significantly the state of the art and the principles and methods that should be followed; however sustainable long-term comprehensive Cal/Val has yet to be achieved. As Copernicus evolves, it is timely to take decisions on a clear ownership of Cal/Val at a European level.

Earth Observation is rapidly evolving with the emergence of new actors and new technologies including innovative constellations of Cube- and Nano-satellites. The opening of new markets and opportunities is increasing the urgency for optimised Cal/Val and improved trustable quality assurance mechanisms.

Similarly, constructing accurate long-term climate records places increasing demands on the accuracies needed, and research to meet the uncertainty and decadal stability requirements for many

[1] Source : https://londoneconomics.co.uk/wp-content/uploads/2018/07/LE-IUK-Value-of-EO-to-UK-Government-FINAL-forWeb.pdf

parameters This is urgently needed and should be carried out in a coordinated manner to minimise duplication of effort.

The ESSC has addressed these issues in detail through a study entitled "*Towards a European Cal/Val Service for Earth Observation"*. The study report provides a review of the current Cal/Val landscape and needs at European level. The report will be published by the end of 2019.

***RECOMMENDATION:*** Europe should take the leadership role in creating a European coordinating entity for satellite product calibration and validation. This would benefit all Copernicus services including the climate service, providing a public good and ensuring there are no barriers to trade in EO data and products. The Horizon Europe programme should contribute to the development of such entity.

### *Space Weather*

Over the last decades there has been an ever-increasing international awareness of risks to modern society from adverse and potentially harmful—and in extreme cases even disastrous—space weather events. Many individual countries and even international organisations like the United Nations (UN) have begun to increase their activities in preparing for and mitigating effects of adverse space weather.

As in the rest of the world, there is also in Europe an urgent need for coordination of Space Weather efforts in individual countries as well as in and among European organisations such as the European Space Agency and the European Union. This coordination should not only improve our ability to meet space weather risks, but also enable Europe to contribute to on-going global space weather efforts. While space weather is a global threat which needs a global response it also requires tailored regional and trans-regional responses that require coordination at all levels.

European States should regularly assess their exposure to Space Weather risks and coordinate and combine their studies at regional and European level to cover the interdependency of technological infrastructures. This requires close cooperation between decision makers, Space Weather scientists, service providers, and end-users.

We find that the presently ongoing Space Weather efforts in Europe are to a large degree uncoordinated and also mostly unsustainable. This is probably at least partially due to the fragmentation of funding responsibilities in Europe. Apart from the ESA and the EU, individual states and many different agencies also fund space weather activities.

The EU had scattered Space Weather calls under its framework programmes, reoccurring every other or sometimes even only every third year. The funding offered in each call is sub-critical to develop sustainable science and service activities and did not match the European needs. Many of these calls were aimed primarily at the prototyping of services with relatively little regard for the scientific foundations, which are required for such services to become reliable. Most of the work required for the scientific underpinning of Space Weather, especially the science and data exploitation activities, fall into the general EU-calls, where they compete with basic science.

Additional funding provided by individual European states is fragmented, localised, un-coordinated. Private sector (recently emerging) funding is often too directed and topically far too narrow to satisfy Space Weather needs.

Europe is, of course, not alone in its recognition of the importance of Space Weather science and services. European agencies and researchers have long recognised the importance of international coordination of scientific efforts, information exchange on space weather events and their mitigation, national, regional and over-regional risk analysis and assessment of user needs.

***RECCOMENDATION:*** ESSC recommends that a dedicated Europe-wide coordination of Space Weather activities is established. This could be done in a similar manner to how the COPERNICUS programme deals with Earth Observations. This coordination should be supported by dedicated funding for research with the aim of covering both the scientific foundations of Space Weather as well as the development of Space Weather services for society.

## European Space Sciences Committee – Membership

| | | | | | |
|---|---|---|---|---|---|
| ***Chair*** | | | | | |
| Dr. | **Athena** | **Coustenis** | Observatoire de Paris-Meudon, PSL | Meudon | France |
| ***Members*** | | | | | |
| Prof. | **Conny** | **Aerts** | Katholieke Universiteit Leuven | Leuven | Belgium |
| Dr. | **Nabila** | **Aghanim** | IAS-CNRS | Paris | France |
| Dr. | **Mahesh** | **Anand** | The Open University | Milton Keynes | United Kingdom |
| Dr. | **Sarah** | **Baatout** | Belgian Nuclear Research Centre (SCK-CEN) | Mol | Belgium |
| Dr. | **Antonella** | **Barucci** | Observatoire de Paris-Meudon, PSL | Meudon | France |
| Prof. | **Alexander** | **Choukèr** | Hospital of the Ludwig-Maximilian University | Munich | Germany |
| Dr. | **Helen** | **Fraser** | The Open University | Milton Keynes | United Kingdom |
| Dr. | **Marc** | **Heppener** | Consultant | | France |
| Prof. | **Maarten** | **Krol** | University of Wageningen | Wageningen | Netherlands |
| Dr. | **Dominique** | **Langevin** | Université de Paris-Sud | Orsay | France |
| Dr. | **Luisa M.** | **Lara Lopez** | Instituto de Astrofisica de Andalucia -CSIC | Granada | Spain |
| Dr. | **Rosemary** | **Morrow** | LEGOS-OMP | Toulouse | France |
| Prof. | **Hermann** | **Opgenoorth** | Swedish Institute of Space Physics | Uppsala | Sweden |
| Mr. | **Gerhard** | **Paar** | JOANNEUM RESEARCH | Graz | Austria |
| Dr. | **Anne** | **Pavy Le Traon** | University Hospital of Toulouse | Toulouse | France |
| Prof. | **Michael** | **Perryman** | North University College | Dublin | United Kingdom |
| Prof. | **Roberto** | **Piazza** | Milano Politecnico | Milano | Italy |
| Prof. | **Manolis** | **Plionis** | National Observatory of Athens | Athens | Greece |
| Prof. | **Juri** | **Poutanen** | Tuorla Observatory, University of Turku | Turku | Finland |
| Dr. | **Peter** | **Preu** | DLR | Rheinbreitbach | Germany |
| Dr. | **Sindy** | **Sterckx** | VITO | Mol | Belgium |
| Dr. | **Hubertus** | **Thomas** | DLR | Oberpfaffenhofen | Germany |
| Prof. | **Alexander** | **Tielens** | Leiden University | Leiden | Netherlands |
| Prof. | **Stephane** | **Udry** | Université de Genève | Geneva | Switzerland |
| Dr. | **Pepijn** | **Veefkind** | Royal Netherlands Meteorological Institute | De Bilt | Netherlands |
| Prof. | **Robert** | **Wimmer-Schweingruber** | Institut fuer Experimentelle und Angewandte Physik, University of Kiel | Kiel | Germany |