SWWT Plenary Meeting Agenda – 15:30UT-17:00UT – Wednesday 06 November 2024 at ESWW2024 (Auditório), Coimbra, Portugal.

Meeting started at 15:32UT.

1. ESA SWWT Status and News in 2024 – Mario M. Bisi (5 Minutes).
   - Mario welcomed everyone, briefly updated the audience on the recent activities throughout 2024 including the new Terms of Reference having been agreed and noted the website changes that are happening now.
     - See: https://swe.ssa.esa.int/swwt
   - The slides will be provided for the full background on the ESA SWWT website.
   - Approximately 150 in the room and 16 on Zoom at the start of the meeting – some variations throughout the meeting.

2. Space Weather Within the ESA Space Safety Programme: Progress and Planning – Jussi Luntama (30 Minutes).
   - The slides will be provided for the full background on the ESA SWWT website.
   - Jussi noted that there will be no numbers in his slides today as the budgets have not been finalised, but there is a good direction of budgets getting agreed across the ESA Member States that sign up for the Space Safety Programme.
   - The process for preparing the proposal for the Member States is still being finalised, so it is not too late to include some additional items and/or changes. Please talk to Jussi ASAP!
   - Jussi gave a short overview of the importance of the ESA Space Weather Office and also the differences between such a programme and the science programme areas.
   - ESA is a development agency with a commitment to transition capabilities into an operational framework. There are ongoing discussions regarding a future space weather operational governance framework (including a TDM tomorrow – Thursday – at ESWW2024).
   - Various avenues will be continued going into Period 3 of the Space Safety Programme (S2P).
   - Downloading data from spacecraft is one of the noted bottlenecks for providing timely space-weather services.
   - The ESA S2P is also developing hosted payloads in addition to the Cornerstone Missions and Core Programme.
     - The next period will look into what needs to be continued under the D3S (distributed hosted payloads) part of the Programme.
       - Discussion with KASA (South Korea) and possible planned Mission to the Sun-Earth L4.
       - The SWING D3S Mission is expected to launch in 2026 with a complementary second mission to launch in 2027.
       - This second mission will be started sometime in early 2025.
       - Other Missions and opportunities were also discussed from the slides.
   - The ESA Vigil situation is quite solid at the moment with Mission and Payload contracts having been signed now, along with the agreements with NOAA and NASA for the USA instruments.
     - CCOR-3 from NOAA.
     - JEDI from NASA.

    - ESA still needs additional Ministerial support, so please ensure you keep pressing on the decision makers to make them aware that the final hurdle is close, but not yet there on the funding.
    - There is hope to have additional collaboration with South Korea colleagues.
- ESA Vigil Workshop at the end of ESWW2024 – please register (08 November 2024).
- EU Space Programme and Horizon Europe Space-Weather activities being entrusted to ESA is still ongoing and some projects are underway now.
    - ITT releases expected early in 2025.
    - There will be an ITT for the Initial Operational EU Space Weather Service expected in February 2025.
- Question from the audience regarding the interface with the SWFO L1?
    - There is an agreement with NOAA on data exchange from the L1 Mission. At the time of ESA Vigil, it will likely be NOAA SWFO Next 1 – and transitioning into Next 2.
        - ESA and NOAA are working on data-exchange agreements now for those future missions.

3. The SWE Service Network Next Steps and Development Outlook – Alexi Glover (20 Minutes).
    - The slides will be provided for the full background on the ESA SWWT website.
    - Alexi gave an initial overview of the ESW Space Weather Services and the Network.
        - There are statistics on the slides showing the recent performance characteristics.
    - There is a central help desk that are supported by first and second line support arrangement including a wide range of experts supporting those accessing the services when there are any problems or when clarifications are needed.
    - New events/activities/training influence the usage statistics of the services.
        - Several more-severe events in 2024 have shown this.
    - There are, now, more than 300 individual products provided via the ESA SWE Portal structured into 29 pre-operational services across the entire space-weather domain.
    - Highlights of the May 2024 Events and noted the parallel session on these events that is ongoing Wednesday-Friday at ESWW2024.
        - Several examples of SWE Service output were shown on the slides from the May 2024 Events.
    - Alexi covered several of the services, their improvements, and some of their activities in some detail.
        - This included expected upcoming ITTs also.
            - There are expected budget numbers included on the slides.
    - Additional developments include arctic capability developments also.
    - Looking towards Period 3 there is an expectation of substantial development following on from the Network review last year into this year, and the next stage of the SWE Network to start to develop.
        - Not all the users are space-weather experts and so they need help in understanding some of the products in the ESA SWE Portal.
        - Increased interoperability will be a key focus going forward as well as strengthening the R2O(2R) processes.
        - improved service component deployment anticipated throughout 2025 as projects mature.
    - ESA Space Weather Office (in conjunction with the ESA Educational Office) has recently initiated a Space Weather Training course for Masters/PhD students delivered by experts within ESA and more-widely across the Space-Weather Community.

    - A third edition of this course will come soon on 24-28th March 2025!
    - Lectures are complimented by tutorials and training in the use of tools available via the ESA SWE Portal.
    - Students are also able to visit key facilities including the SpacePole and SSCC premises.
    - See the penultimate slide for further information.

4. ESA Technology Programme Update – Piers Jiggens (10 Minutes).
    - The slides will be provided for the full background on the ESA SWWT website.
    - Piers explained his role in the Technology, Engineering and Quality Directorate (TEC) of ESA and gave an overview of Technology Programmes within ESA and how these connect to ESA's Space Safety Programme that Jussi and Alexi spoke about.
    - The ESA Technology Programmes are far and wide across many ESA directorates.
    - See https://technology.esa.int/ for more information on generic technology developments.
        - For those that want to know more about Technology Readiness Levels (TRLs) – please see: https://drive.google.com/file/d/1OtKReiQRhptt4BRzDKwzT4BJOt02cWg5/view?usp=sharing for information specific to ESA and how ESA views TRLs for the technology developments.
    - Different programmes cover areas crossing from TRL 1 through to TRL 8.
    - Piers highlighted some activities raising TRL levels of various instruments over the last ~12 months.
        - PROBA-3 is expected to launch early next month as a formation-flying coronagraph and space-weather technology demonstration Mission.
    - There are also modelling and data-exploitation activities, not just space-instrument developments.
    - Piers reminded everyone that the ESA Science L4 Mission is the "Large" Mission from the Science directorate of ESA that will go to Saturn; it's different from the KASA Space-Weather Mission to the Sun-Earth L4 that's under initial developments.
    - There are various activities planned to be released in 2025 which may be of interest to this audience and these are listed on the penultimate slide.
        - All ITTs can be found on: https://esastar-publication-ext.sso.esa.int/ - please check regularly for updates.
    - Piers' contact details are on the final slide – including the subscription information for the Space Weather Euro News (SWEN) Newsletters – around 28 years old now.
    - Question from the audience around technology development internationally, e.g. between the USA and Europe?
        - Examples such as payloads on ESA Vigil were mentioned, but lower-level technology development collaborations don't seem to happen?
            - Normally, all the programmes are only for ESA member states and are completed as such within the relevant TRL-raising programme.
            - Never really thought of programmes that would truly develop something between agencies.
                - Piers will l think more on this. Unsure how this could work.
                - Jussi clarified that this is about actually developing technology together and some of the ESA Vigil activities might achieve this between ESA and NASA (*e.g.* for JEDI).
        - It's a bold idea and Jussi and Piers will talk on this going forward.
    - Question from online about how ESA activities link/merge with E-SWAN.

    - It is likely that some developments and discussion will be ongoing and will start to build as time goes on.
        - Jussi mentioned that ESA work closely with E-SWAN and the EU and, as Jean Lilensten had said, that these make up the three legs of Europe.
    - Expectations and opportunities for the future discussions – especially as Governance across Space Weather in Europe is discussed and developed going forward. Alexi noted that an E-SWAN perspective has been solicited for the Thursday TDM addressing Operational Governance.

5. WICCT Updates – Mamoru Ishii (15 Minutes).
    - The slides will be provided for the full background on the ESA SWWT website.
    - WICCT = WMO-ISES-COSPAR Coordination Team.
    - Ishii-san introduced the concept and background/drivers behind WICCT.
    - Ishii-san briefly explained the background from UN COPUOS Expert Group on Space Weather (EGSW) recommendations being made via the UN STSC.
    - The three organisations are different in terms of their Space-Weather remits/interested, but with overlap sufficient to work together effectively and complementarily.
        - Ishii-san described more of the background to WICCT, some of the key points are given on the slides.
    - As a joint ventures, the International Space Weather Coordination Forum was established and first met on 17 November 2023.
        - Further activities have been ongoing and this will include one or more joint projects.
            - These are often referred to as WICCT Pilot Projects.
    - There are now four representatives from each of the three organisation involved in WICCT with Suzy Bingham (Met Office/WMO) who acts as the Secretary.
    - The first project will involve Ionosondes; further details can be found on the slides, or you can reach out to Ishii-san for further information.
        - Establishing a true international organisation for ionosondes and also for real-time data sharing and archiving.
        - The ionosonde project will start imminently.
            - Key people are needed to take part.
                - This is of wider importance for ground-based network coordination and cooperation in general.

6. Update on the ESA SWWT Topical Working Groups – Sean Bruinsma and Mario M. Bisi (10 Minutes).
    - The slides will be provided for the full background on the ESA SWWT website.
    - Mario provided a brief of where we are with the ESA SWWT TWGs including the various vacancies.
        - The remit of the TWGs has changed since the update to the Terms of Reference.
        - Please get in touch with Mario and/or Alexi if you're interested in taking part in one or more TWGs and/or want to start your own.
    - Mario noted the need for closer working/collaboration with other international space weather endeavours such as COSPAR ISWAT and WICCT.
        - There is a COSPAR ISWAT Meeting 10-14 February 2025 in Cape Canaveral, FL, USA – early-bird registration is TODAY!
        - Sean reminded everyone that this is about doing work, it's not a conference!
    - Sean described the COSPAR ISWAT G2A as an example of how the international collaboration activities within the COSPAR ISWAT initiative work out.

- Please come to Florida, think on how TWGs and ISWAT Teams/Clusters can benefit from each other – no extra effort – but increase in outputs and impacts from the work.
- Links to the Updates COSPAR Space-Weather Roadmap activities.
- Further information is on the slides.
- Mario reminded everyone that we can only get more benefits working with the synergies together…

7. Close (16:58UT).
   - End.

Meeting closed at 16:58UT.

ESA Space Weather Working Team Plenary Meeting – 06/11/2024

Welcome everyone!

SWWT Plenary Meeting 44:
06/11/2023, 15:00UT to 17:00UT, Coimbra, Portugal

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2. Space Weather Within the ESA Space Safety Programme: Progress and Planning – Jussi Luntama (30 Minutes).
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5. WICCT Updates – Mamoru Ishii (15 Minutes).
6. Update on the ESA SWWT Topical Working Groups – Sean Bruinsma and Mario M. Bisi (10 Minutes).
7. Close.

1. ESA SWWT Status and News in 2024

Mario M. Bisi, ESA SWWT Chair

ESA SWWT Status and News in 2024 (1)

- The ESA Space Weather Working Team (SWWT) is a forum to both space weather experts and users of space weather information.
- The ESA SWWT investigates space weather applications' requirements, space weather services, and the underpinning research and development.
  - It advises ESA, particularly the Space Weather Office within the Space Safety Programme, on strategies and activities related to space weather.
- The ESA SWWT will seek to recommend strategic priorities for space weather operational services and underpinning research.
  - These recommendations may for example build on ongoing community initiatives and roadmaps.
  - The SWWT will also highlight associated data requirements including availability and timeliness needs.
- ESA SWWT membership is open to representatives of any European university, institute, company, or international organisation currently undertaking space weather related activities or affected by space weather.
  - Can also include Canadian experts, following Canada's status as an ESA Associate member.

ESA SWWT Status and News in 2024 (2)

- The ESA SWWT will promote activities aiming towards the development of European operational space weather capabilities.
  - These will include promoting the coordination of developments at European, national and industry levels.
  - Activities to be addressed can include, but are not limited to, national and international coordination issues, service and measurement infrastructure development, research into the underpinning science along with activities to raise awareness of space weather within existing and new user communities.
  - With these aims, the ESA SWWT seeks to identify and discuss avenues of potential collaboration and/or synergies among European and national entities, as well as with other international structures and organisations.

ESA SWWT Status and News in 2024 (3)

- The current members of the SB:
  - Mario Bisi (UK) (Chair)
  - Peter Beck (Austria)
  - Anna Belehaki (Greece)
  - Volker Bothmer (Germany)
  - Sean Bruinsma (France)
  - Ioannis Daglis (Greece)
  - Peter Gallagher (Ireland)
  - Mike Hapgood (UK)
  - Martin Kriegel (Germany)
  - Susan McKenna-Lawlor (Ireland)
  - Mauro Messerotti (Italy)
  - Minna Palmroth (Finland)
  - Stefaan Poedts (Belgium)
  - Guenter Reitz (Germany)
  - Christian Kintziger (Belgium)
  - Margit Haberreiter (Switzerland)
  - Larisa Trichtchenko (Canada)
  - Ronald Van der Linden (Belgium)
  - Susanne Vennerstrom (Denmark)
  - Peter Wintolf (Sweden)
  - Alexi Glover [Vice-Chair and *Ex-Officio*] (ESA)
  - Juha-Pekka (Jussi) Luntama [*Ex-Officio*] (ESA)

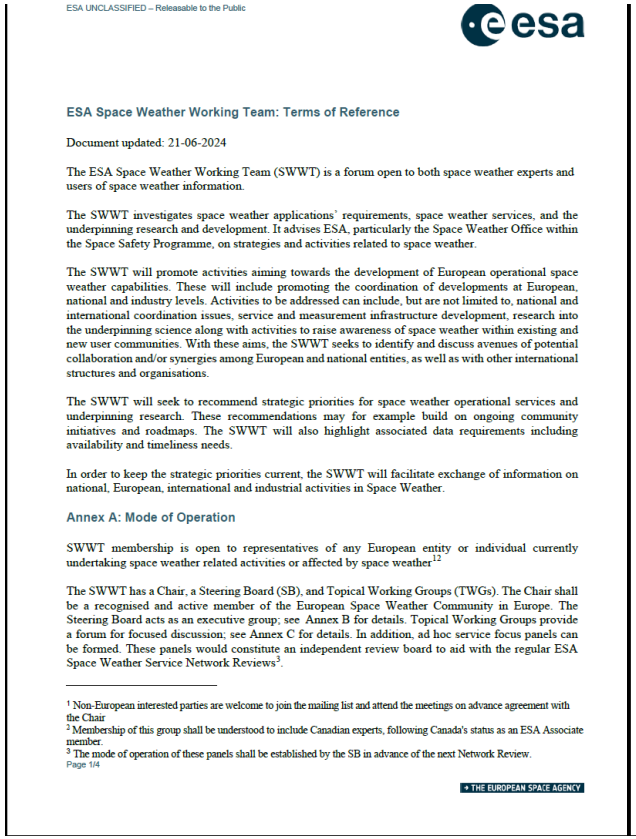
ESA SWWT Status and News in 2024 (4)

- The ESA SWWT Terms of Reference have now been fully update and ratified by the Community.
- Updates and documentation is being updated on the ESA SWWT webpages…
  - Please see: https://swe.ssa.esa.int/swwt for details - updates are in the process of being made this month.

- Any questions, please come find me and ask during the rest of this week…

ESA SWWT Status and News in 2024 (5)

- The ESA SWWT Terms of Reference can be found here:
  - https://swe.ssa.esa.int/documents/d/guest/space-weather-working-team-tor-2024-21-june-2024



ESA Space Weather Working Team: Terms of Reference

Document updated: 21-06-2024

The ESA Space Weather Working Team (SWWT) is a forum open to both space weather experts and users of space weather information.

The SWWT investigates space weather applications' requirements, space weather services, and the underpinning research and development. It advises ESA, particularly the Space Weather Office within the Space Safety Programme, on strategies and activities related to space weather.

The SWWT will promote activities aiming towards the development of European operational space weather capabilities. These will include promoting the coordination of developments at European, national and industry levels. Activities to be addressed can include, but are not limited to, national and international coordination issues, service and measurement infrastructure development, research into the underpinning science along with activities to raise awareness of space weather within existing and new user communities. With these aims, the SWWT seeks to identify and discuss avenues of potential collaboration and/or synergies among European and national entities, as well as with other international structures and organisations.

The SWWT will seek to recommend strategic priorities for space weather operational services and underpinning research. These recommendations may for example build on ongoing community initiatives and roadmaps. The SWWT will also highlight associated data requirements including availability and timeliness needs.

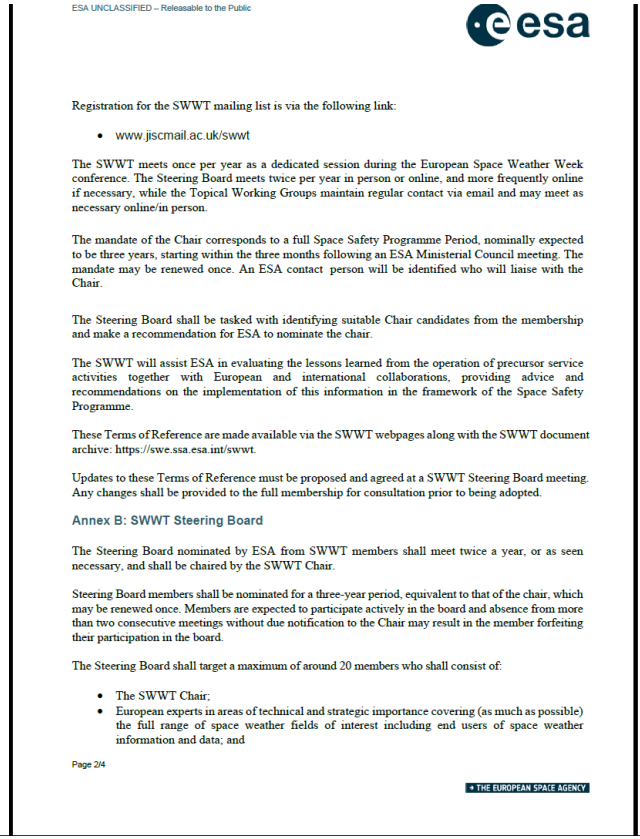
In order to keep the strategic priorities current, the SWWT will facilitate exchange of information on national, European, international and industrial activities in Space Weather.

Annex A: Mode of Operation

SWWT membership is open to representatives of any European entity or individual currently undertaking space weather related activities or affected by space weather[1][2]

The SWWT has a Chair, a Steering Board (SB), and Topical Working Groups (TWGs). The Chair shall be a recognised and active member of the European Space Weather Community in Europe. The Steering Board acts as an executive group; see Annex B for details. Topical Working Groups provide a forum for focused discussion; see Annex C for details. In addition, ad hoc service focus panels can be formed. These panels would constitute an independent review board to aid with the regular ESA Space Weather Service Network Reviews[3].

[1] Non-European interested parties are welcome to join the mailing list and attend the meetings on advance agreement with the Chair
[2] Membership of this group shall be understood to include Canadian experts, following Canada's status as an ESA Associate member.
[3] The mode of operation of these panels shall be established by the SB in advance of the next Network Review.



Registration for the SWWT mailing list is via the following link:

- www.jiscmail.ac.uk/swwt

The SWWT meets once per year as a dedicated session during the European Space Weather Week conference. The Steering Board meets twice per year in person or online, and more frequently online if necessary, while the Topical Working Groups maintain regular contact via email and may meet as necessary online/in person.

The mandate of the Chair corresponds to a full Space Safety Programme Period, nominally expected to be three years, starting within the three months following an ESA Ministerial Council meeting. The mandate may be renewed once. An ESA contact person will be identified who will liaise with the Chair.

The Steering Board shall be tasked with identifying suitable Chair candidates from the membership and make a recommendation for ESA to nominate the chair.

The SWWT will assist ESA in evaluating the lessons learned from the operation of precursor service activities together with European and international collaborations, providing advice and recommendations on the implementation of this information in the framework of the Space Safety Programme.

These Terms of Reference are made available via the SWWT webpages along with the SWWT document archive: https://swe.ssa.esa.int/swwt.

Updates to these Terms of Reference must be proposed and agreed at a SWWT Steering Board meeting. Any changes shall be provided to the full membership for consultation prior to being adopted.

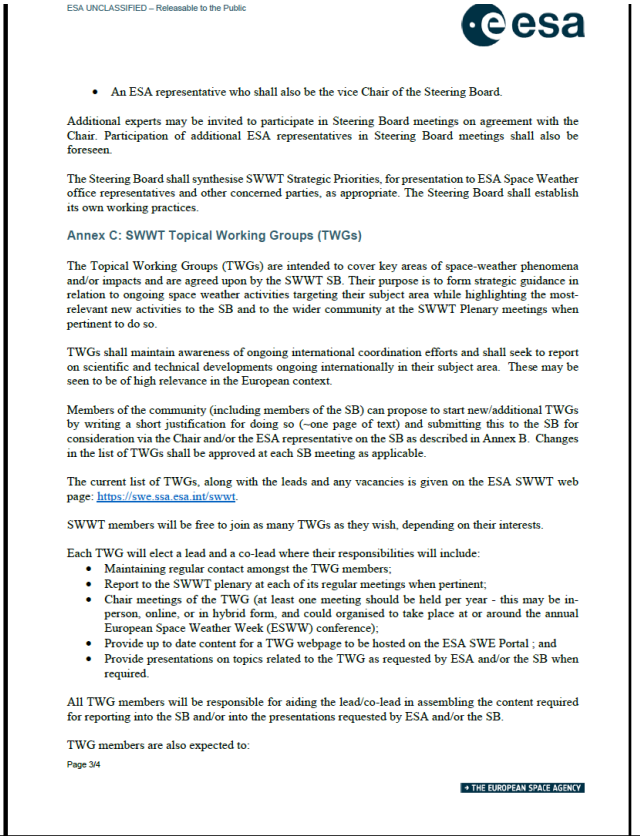
Annex B: SWWT Steering Board

The Steering Board nominated by ESA from SWWT members shall meet twice a year, or as seen necessary, and shall be chaired by the SWWT Chair.

Steering Board members shall be nominated for a three-year period, equivalent to that of the chair, which may be renewed once. Members are expected to participate actively in the board and absence from more than two consecutive meetings without due notification to the Chair may result in the member forfeiting their participation in the board.

The Steering Board shall target a maximum of around 20 members who shall consist of:

- The SWWT Chair;
- European experts in areas of technical and strategic importance covering (as much as possible) the full range of space weather fields of interest including end users of space weather information and data; and



- An ESA representative who shall also be the vice Chair of the Steering Board.

Additional experts may be invited to participate in Steering Board meetings on agreement with the Chair. Participation of additional ESA representatives in Steering Board meetings shall also be foreseen.

The Steering Board shall synthesise SWWT Strategic Priorities, for presentation to ESA Space Weather office representatives and other concerned parties, as appropriate. The Steering Board shall establish its own working practices.

Annex C: SWWT Topical Working Groups (TWGs)

The Topical Working Groups (TWGs) are intended to cover key areas of space-weather phenomena and/or impacts and are agreed upon by the SWWT SB. Their purpose is to form strategic guidance in relation to ongoing space weather activities targeting their subject area while highlighting the most-relevant new activities to the SB and to the wider community at the SWWT Plenary meetings when pertinent to do so.

TWGs shall maintain awareness of ongoing international coordination efforts and shall seek to report on scientific and technical developments ongoing internationally in their subject area. These may be seen to be of high relevance in the European context.

Members of the community (including members of the SB) can propose to start new/additional TWGs by writing a short justification for doing so (~one page of text) and submitting this to the SB for consideration via the Chair and/or the ESA representative on the SB as described in Annex B. Changes in the list of TWGs shall be approved at each SB meeting as applicable.

The current list of TWGs, along with the leads and any vacancies is given on the ESA SWWT web page: https://swe.ssa.esa.int/swwt.

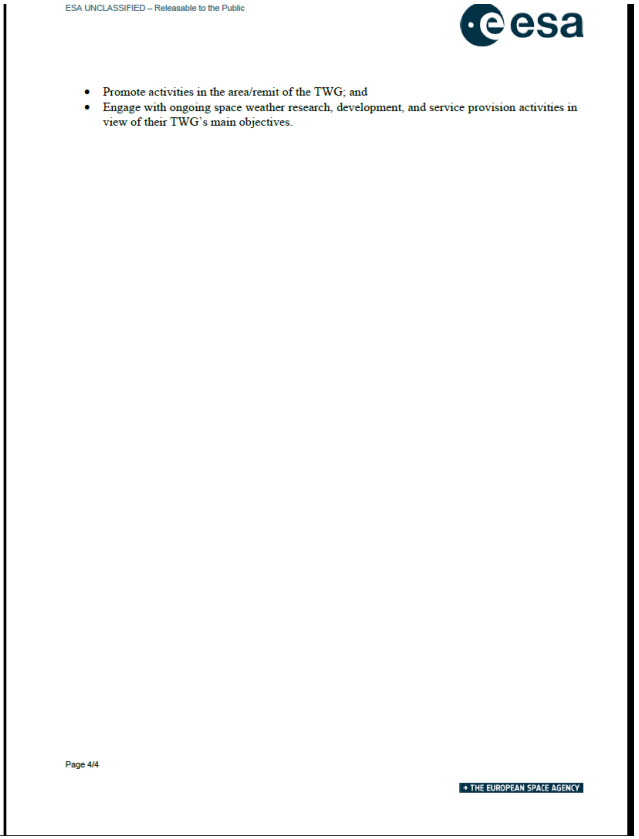
SWWT members will be free to join as many TWGs as they wish, depending on their interests.

Each TWG will elect a lead and a co-lead where their responsibilities will include:

- Maintaining regular contact amongst the TWG members;
- Report to the SWWT plenary at each of its regular meetings when pertinent;
- Chair meetings of the TWG (at least one meeting should be held per year - this may be in-person, online, or in hybrid form, and could organised to take place at or around the annual European Space Weather Week (ESWW) conference);
- Provide up to date content for a TWG webpage to be hosted on the ESA SWE Portal ; and
- Provide presentations on topics related to the TWG as requested by ESA and/or the SB when required.

All TWG members will be responsible for aiding the lead/co-lead in assembling the content required for reporting into the SB and/or into the presentations requested by ESA and/or the SB.

TWG members are also expected to:



- Promote activities in the area/remit of the TWG; and
- Engage with ongoing space weather research, development, and service provision activities in view of their TWG's main objectives.

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Preparation for Space Weather activities in S2P Period 3

Juha-Pekka Luntama, Alexi Glover
Space Weather Office
European Space Agency

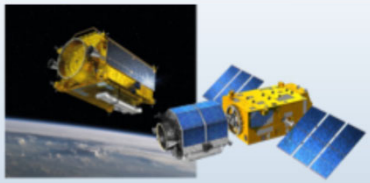
2024 European Space Weather Week
06/11/2024

Space Safety Programme Structure in P3

Cornerstone activity areas

PLANETARY DEFENCE (RAMSES)

SPACE WEATHER (VIGIL)



ADRIOS (CS-1, RISE, ENCORE)

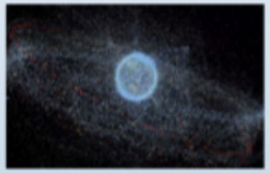
Cosmic activity area

DEVELOP SPACE WEATHER SERVICES

SPACE WEATHER SENSORS

PREDICT ASTEROID IMPACTS

TECHNOLOGIES FOR A GROWING SPACE TRAFFIC



TOWARDS A CLEAN AND ZERO DEBRIS FUTURE

COMPETITIVENESS

Space Weather Objective in S2P

Aiming to protect Europe from space weather hazards by advancing our abilities to forecast space weather activity and to take necessary measure to mitigate their impact on critical infrastructure in outer space and on Earth.

Space Weather Activities in S2P - Overview

Space Safety Programme works to **improve our Space Weather forecasting capabilities** and **to transition mature service elements into an operational framework under a clear governance scheme**, including through:

a. An **enhanced space weather monitoring system** providing data for more accurate Space Weather now- and forecasts as well as improved monitoring of space weather impacts.

b. Services tailored to European user needs providing timely, accurate and actionable information for all user domains, with a clear maintenance and enhancement plan.

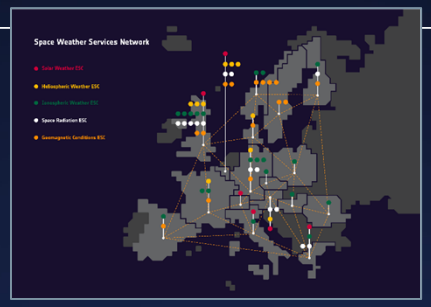
c. A **tested and exercised early warning system** enabling prompt responses based on actionable information.

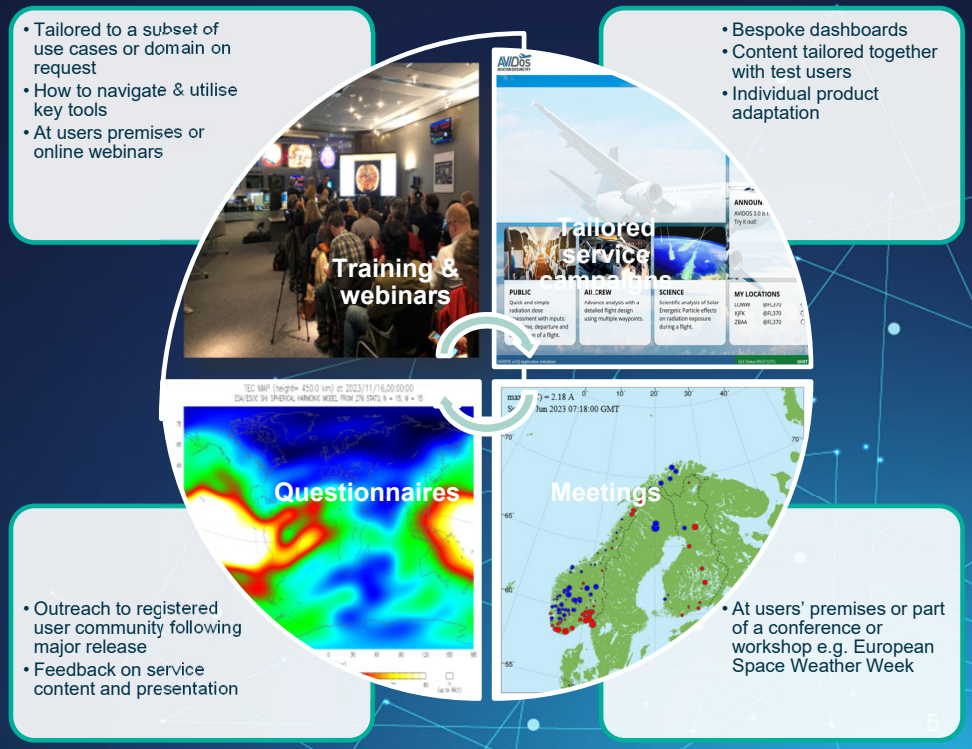
d. A **Space Weather Service Network** supporting **research and development** (R&D) => **R2O(2R)**

e. End-to-end space weather data utilisation and simulation **system**.

Space Weather in S2P Period 3: Space Weather Service Network

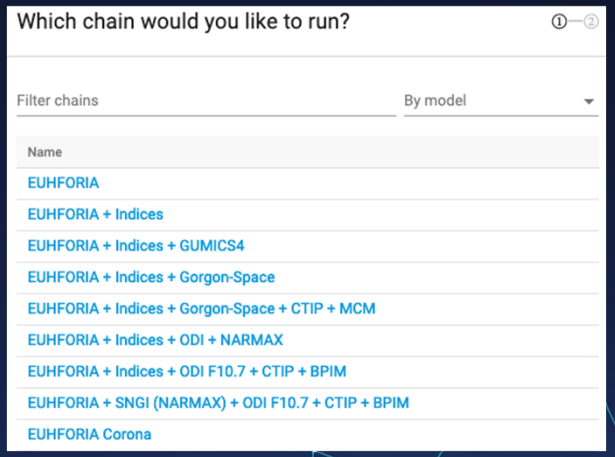
- Provision of increasingly mature pre-operational services
- Preparation of transition of mature services to operational framework
- Further development of R2O(2R) capability with coordinated performance assessment campaigns, validation and verification
- Evolution of the Service Portal based on SWE Service Network Review recommendations
- Development of new and improved user-focussed products and toolkits

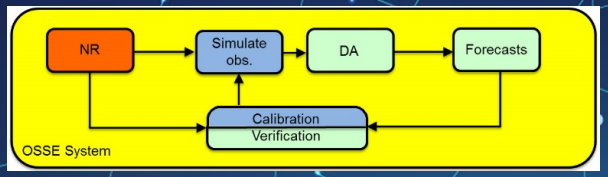


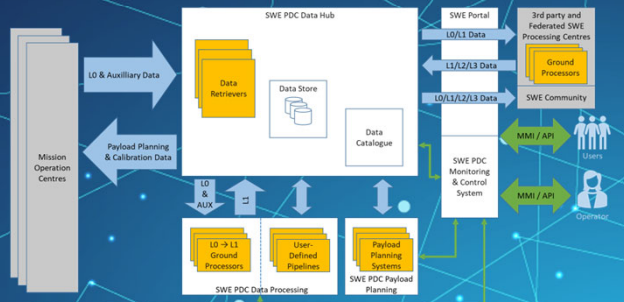


Space Weather in S2P Period 3: Core Space Weather

- Enhancement of **end-to-end space weather modelling** capability: **Virtual Space Weather Modelling Centre (VSWMC)**
- Enhancement of European space weather models to
  - ➢ **utilise data** from coming space weather missions
  - ➢ taking advantage of **scientific progress** in **space physics**, **deep learning** and **artificial intelligence** towards operational readiness => **R2O(2R)**
- Investigation of utilising **onboard data processing** including deep learning techniques
- Execution of **Observation System Simulation Experiments** (OSSE) and **Observation System Experiments** (OSE)
- Operation and evolution of **Space Weather Payload Data Centre (PDC)** and **Data HUB**



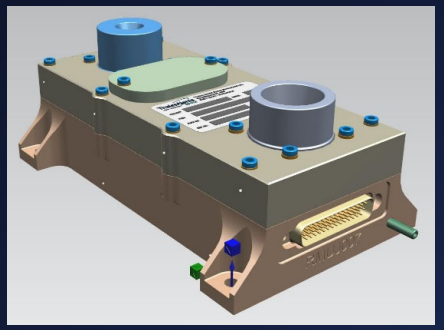




Space Weather in S2P Period 3: Hosted Payloads (D3S)

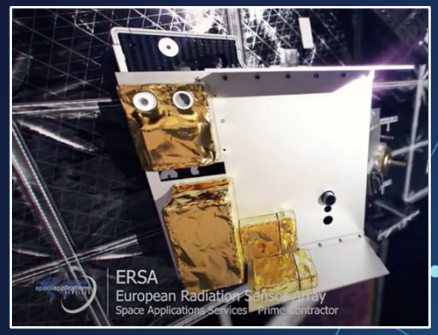
Implemented missions:

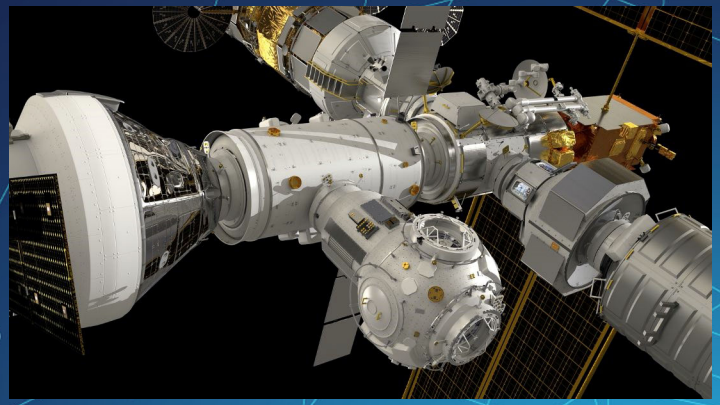
- SOSMAG/GK2A
- NGRM/EDRS-C
- ICARE-NG/HOTBIRD
- MiniRMU/Lunar Pathfinder (launch 2025)
- ERSA/Lunar Gateway (launch 2026/2027)
- Collaboration with EUMETSAT for radiation monitors onboard Sentinel-6, MTG, Metop-SG



Proposed new missions:

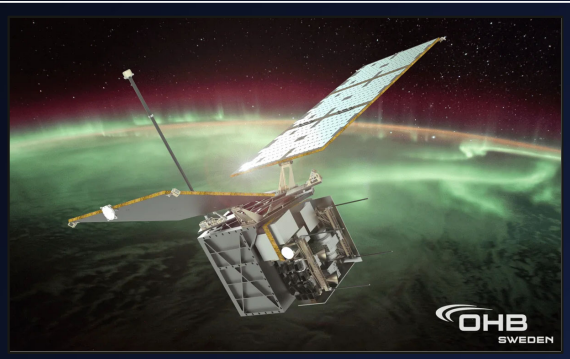
- Procurement of high TRL instruments for HP missions
- IOD of novel instruments
- SOSMAG-2 (collaboration with KMA GK5 mission)
- Collaboration with KASA for the L4 mission





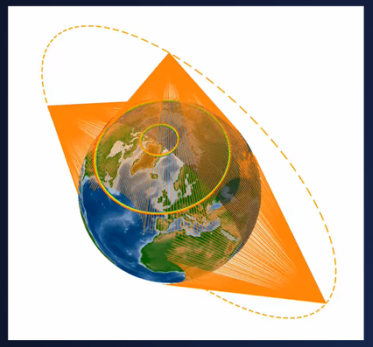
Space Weather in S2P Period 3: Aurora (D3S)

Mission concept
- Circular Medium Earth Orbit ~6500 km
- 1 satellite (Aurora-D)
- 4 satellites (Aurora-C)



Mission Duration
- Aurora-D: 1 year (+ potential extension)
- Aurora-C: 3 years

Launch dates:
- Aurora-D: 2029
- Aurora-C: 2032+



Payload
- Auroral Optical Spectral Imager (AOSI)
- Auroral Far UV Imager (AUI)
- Radiation Monitor and Magnetometer (RadMag)

Imagery of Auroral Oval

- Refreshed image every 20-30min
- SSD 30km at nadir, 100km at edge
- "wide" FoV

Optical Imaging:
- Intensities of multiple lines between 350-750nm

Far UV Imaging:
- 2 spectral bands within Oxygen lines or LBH-L and LBH-S

In-Situ Measurements

Radiation monitors: (3 directions TBC)
- proton flux (3.5 – 400 MeV, 11 channels)
- electron flux (0.3 – 5 MeV, 6 channels)
- Heavy ions particle count

Fluxgate magnetometer:
- Magnetic field vector (<10 nT accuracy)

Space Weather in S2P Period 3: Nanosatellites (D3S)

Mission objectives:

- Data on space environment and effects in LEO
- Demonstrate "new space" and commercialisation approach with mission/data-as-a-service
  => Industry responsible for implementation, mission operation & Level 1 data processing
  => ESA an anchor customer

Baseline measurements of 1st mission: SWING

- High energy Proton and Electron flux
- Solar X-ray spectrum
- 3D electron density in the ionosphere
- Ionospheric Radio Occultation

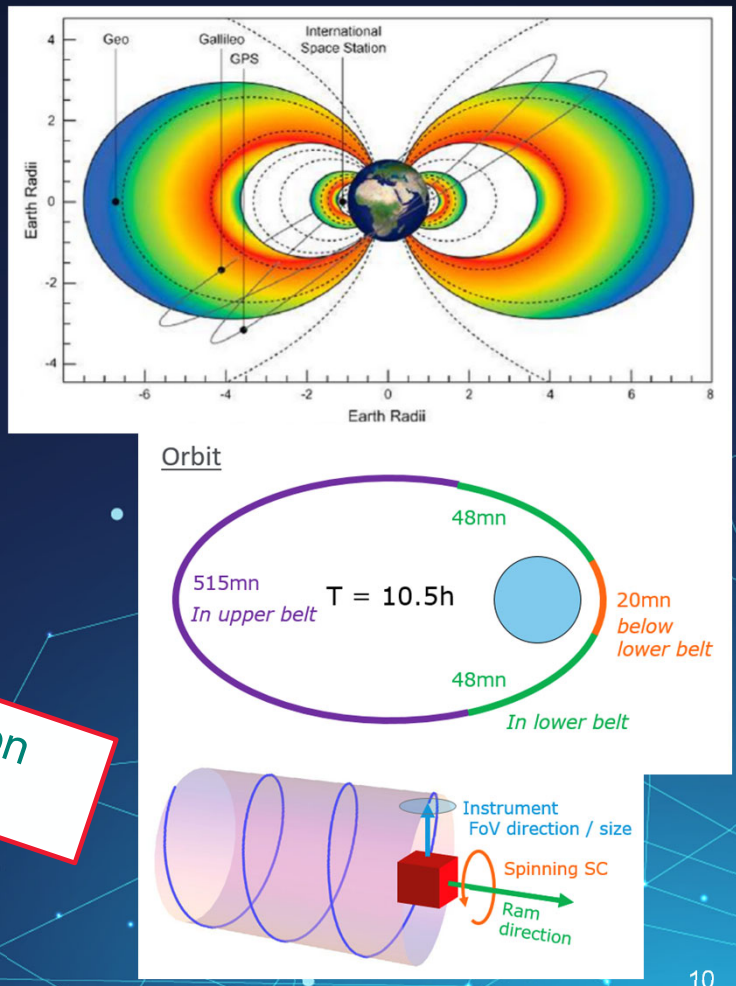
Status:

- Phase A/B/C/D/E1 started
- **Launch target: 2026**
- 2nd complementary nanosat mission in preparation => launch **2027**

Space Weather in S2P Period 3: SWORD (D3S)

Mission:

- GTO like orbit, inclination between 0-15 degree
- 2 satellites separated by half-orbit
- Slow rotation to sample pitch-angle distribution
- Low latency <60 minutes (goal of <5 minutes)
- High availability (>90%)
- Lifetime 2 (3) years – to be regularly replenished

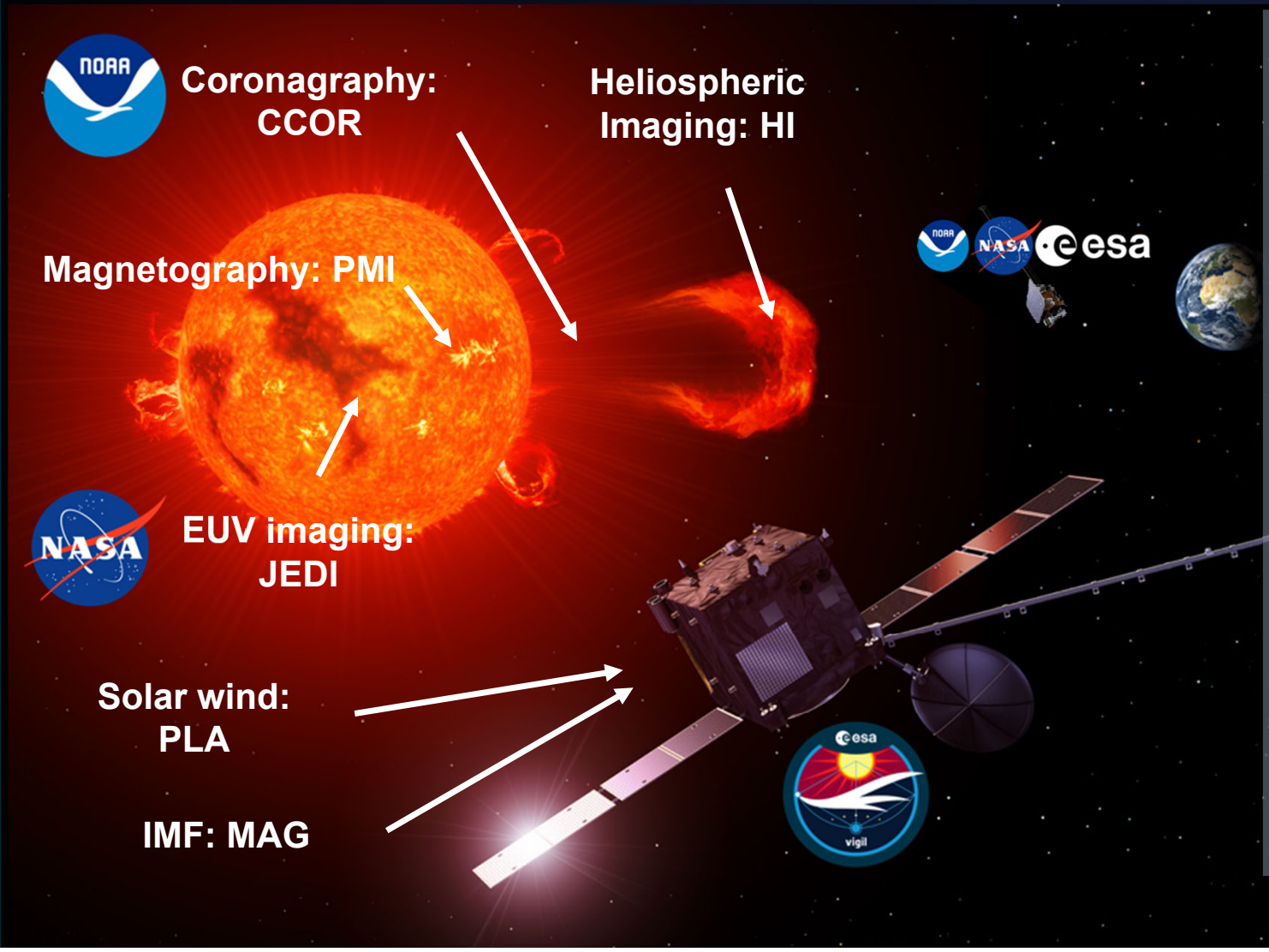


Payloads:

- High energy radiation monitor
- Medium energy particle instrument
- Magnetometer
- Plasma monitor (optional)
- Langmuir Probes (optional)

Dedicated talk in SWR3.2 on Thursday at 15:00

Space Weather in S2P Period 3: Vigil

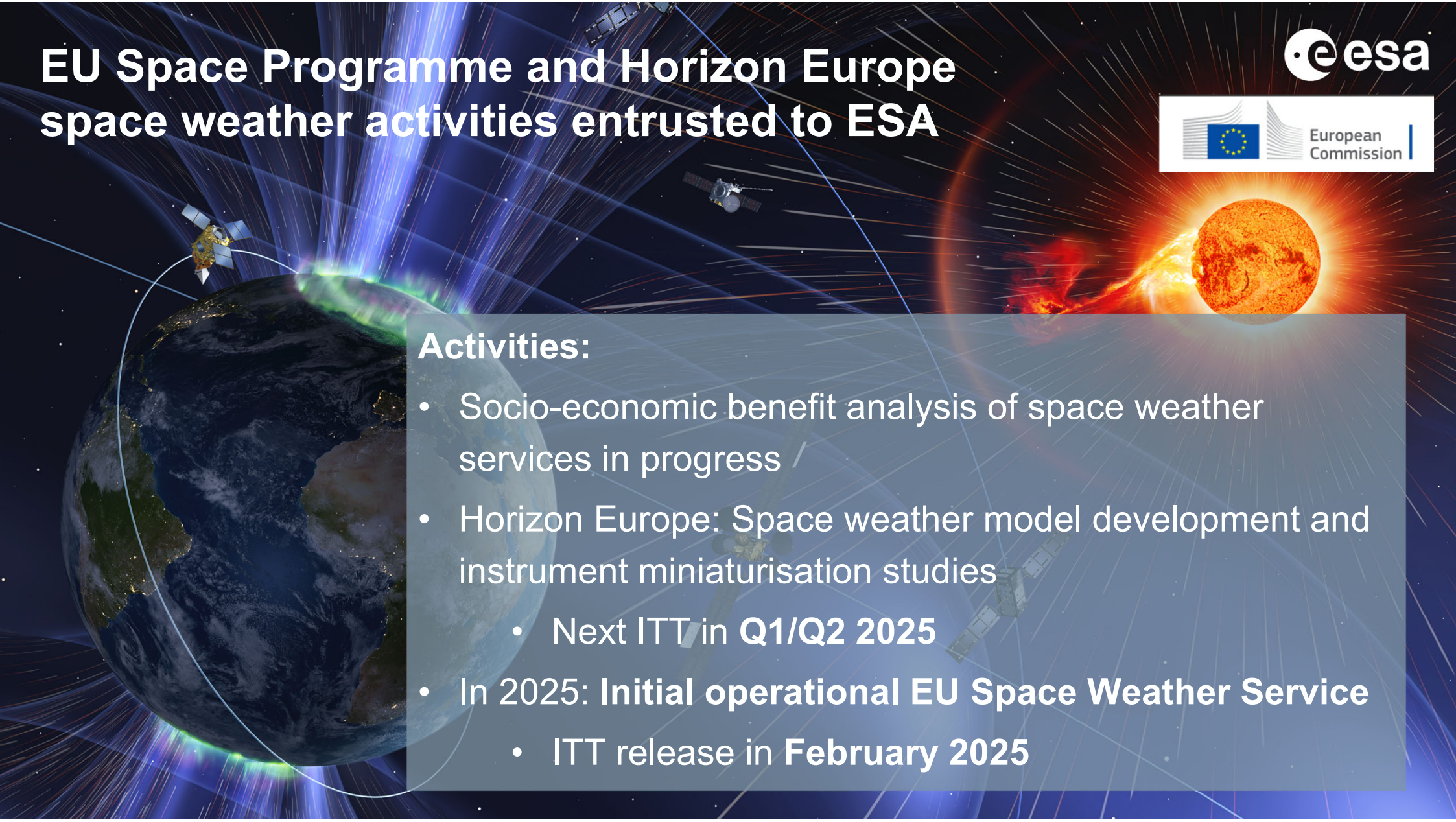


- Launch: **2031**
- Phase B2/C/D/E1 contract signed with Airbus
- All baseline instrument developments contracted
- CCOR-3 agreement with NOAA
- NASA EUV imager confirmed: **JEDI (J**oint **E**UV coronal **D**iagnostic **I**nvestigation**)**
- ESA MS support still needed in CM25!

Vigil Workshop on Friday, 8th November 14:30 – 18:00!

- Detailed agenda and registration through ESWW Satellite Events page: https://esww2024.org/programme/satellite-events/

EU Space Programme and Horizon Europe space weather activities entrusted to ESA



Activities:

- Socio-economic benefit analysis of space weather services in progress
- Horizon Europe: Space weather model development and instrument miniaturisation studies
  - Next ITT in **Q1/Q2 2025**
- In 2025: **Initial operational EU Space Weather Service**
  - ITT release in **February 2025**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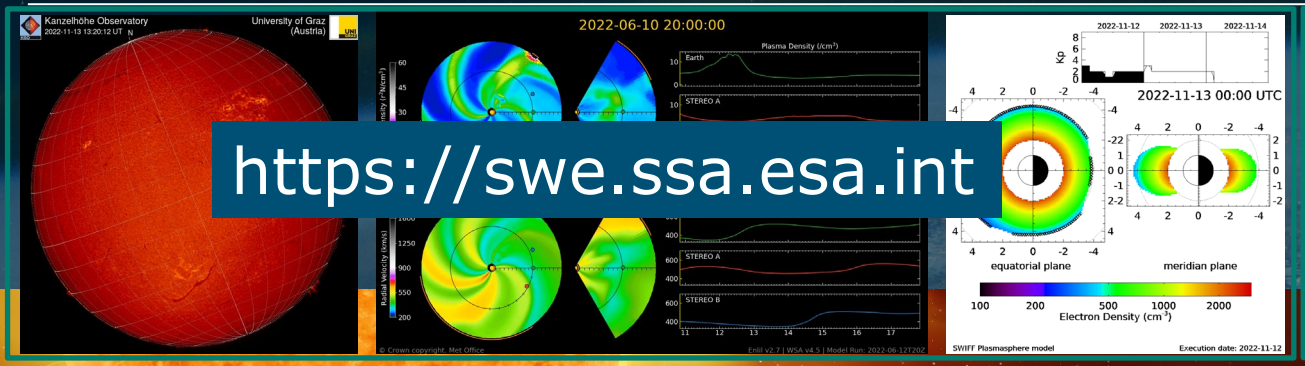
ESA SWE Service Network Next Steps and Development Outlook

Alexi Glover*, Jussi Luntama & OPS-SW Team

Space Weather Office, Space Safety Programme Office ESA/ESOC, Darmstadt, Germany

*&ESA HQ, Paris

ESA Space Weather Service Network



https://swe.ssa.esa.int

Service Network Provides:

- 29 services built on >300 data products & tools
- 95% availability & office hours helpdesk support
- Full Sun-Earth chain, coupled modelling
- Timely user tailored notifications & alerting

Who uses the services?

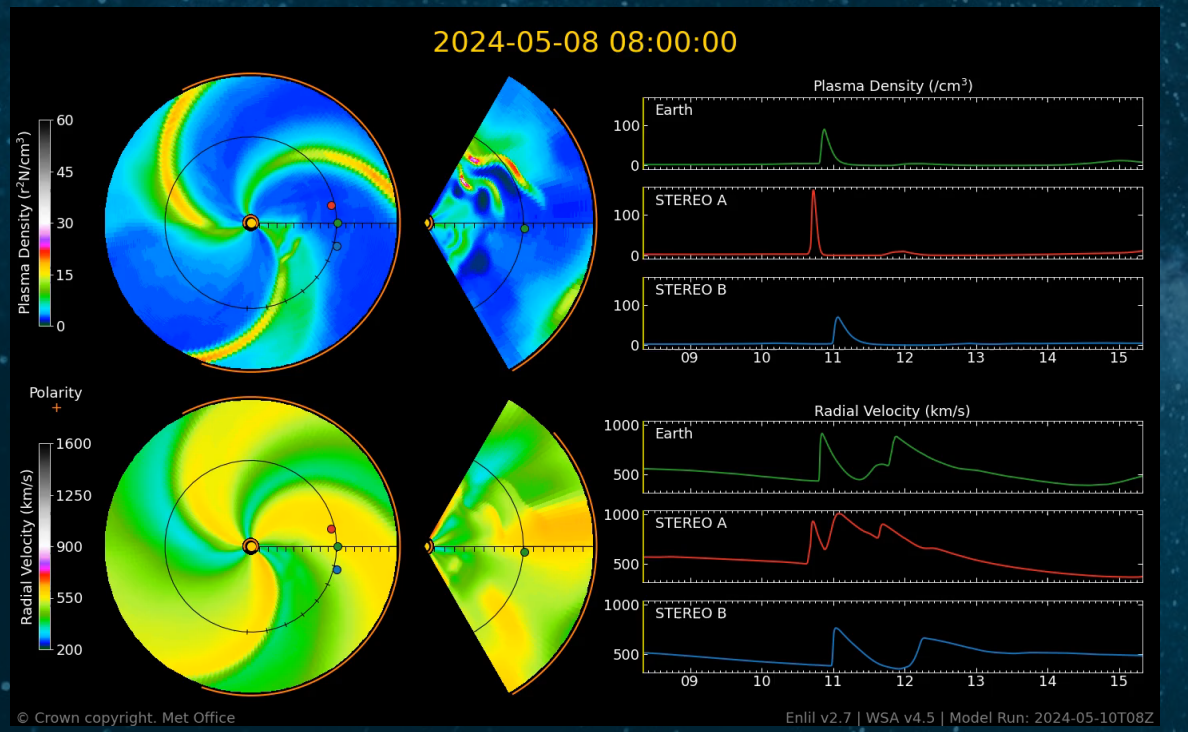
- >5000 registered users
- >2M hits on portal monthly
- All affected sectors, plus national & regional agencies

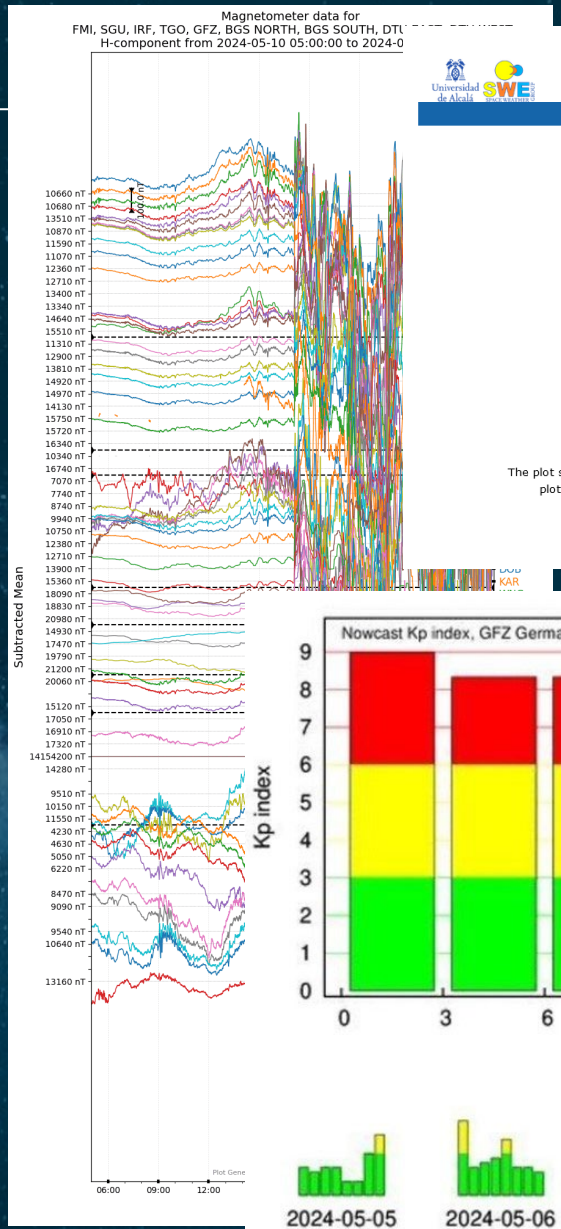
Who participates?

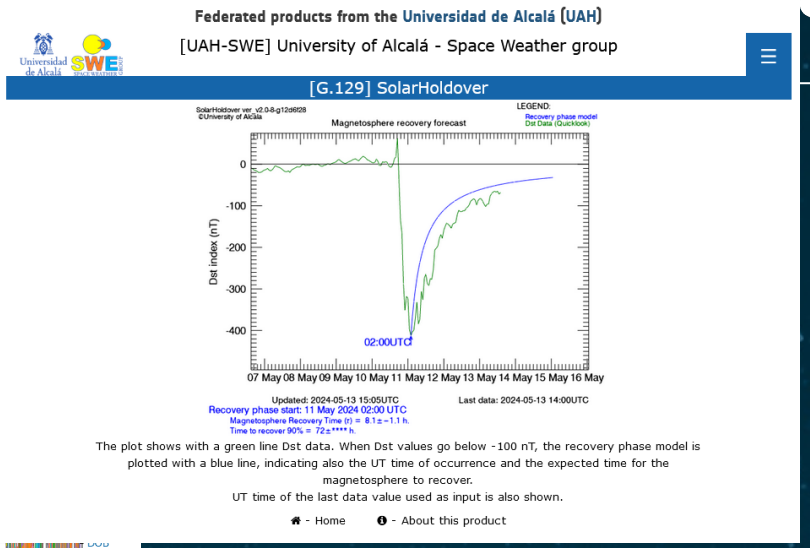
- >50 institutes, industry, academic groups
- Building on & strengthening European assets & expertise

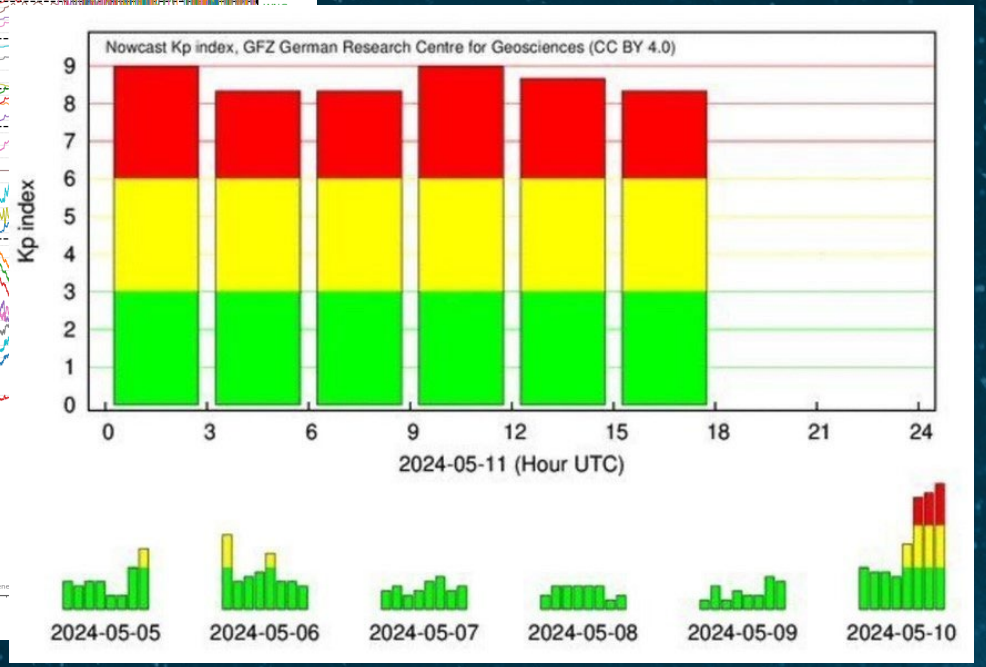
Space Weather in May 2024

- 25 >M5 class flares between 3-14th May including 14 X-Class
- Multiple CME onsets 8-9th May
- First arrivals on 10th May triggered Kp9 event





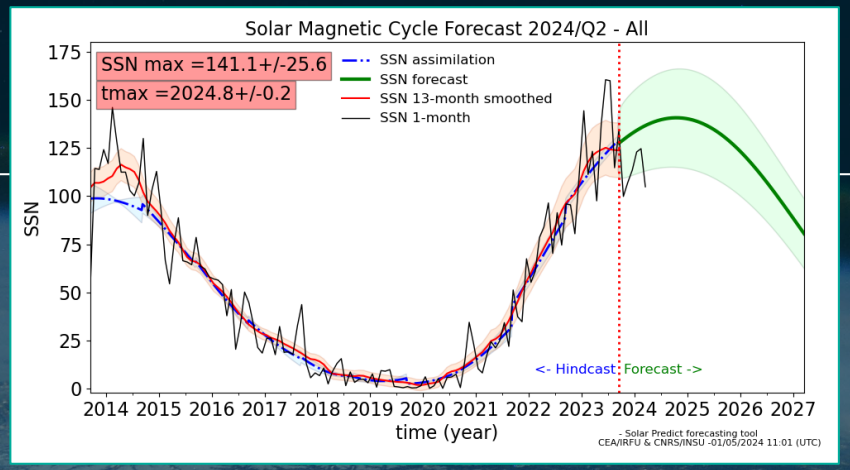


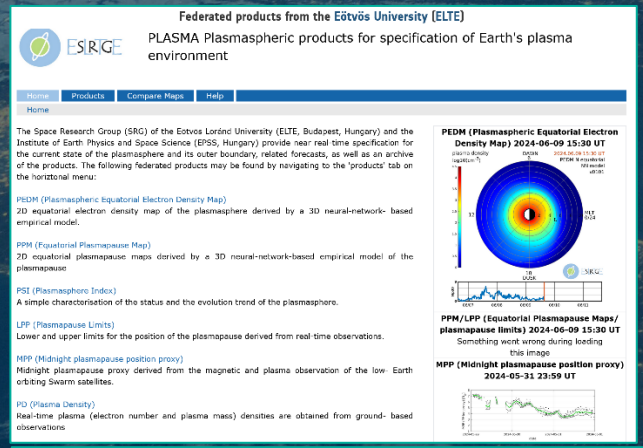


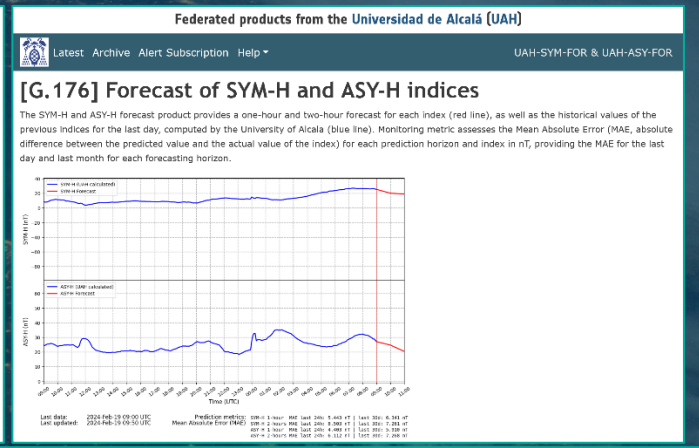
Service Enhancements

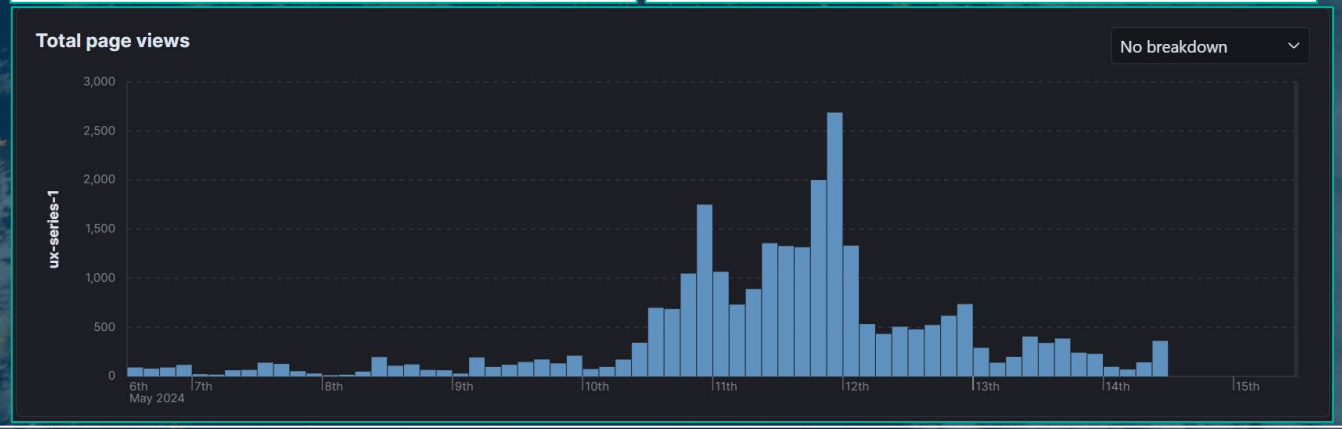
- SWE portal releases 3.9.0 – 3.11.0
  - New and updated products from the Expert Service Centres including solar cycle forecasting
  - SWE Products for Southern Europe Phase 1 (P3-SWE-XXXVII) [Lead: UAH]
  - P3-SWE-LII Plasmaspheric products for Space Weather Services [Lead: SSE ltd]
  - New data from ICARE-NG instruments accessible via SWE Data Browser & API

- Excellent performance during events of May 2024
  - Peak in page hits and new registered users
  - user feedback collection ongoing









Upcoming Developments – S2P Period 2

- Currently preparing Evolutionary Maintenance (S2-SW-05) and pre-operational extension through 2025 with SWESNET project team

- S1-SW-19 Virtual Space Weather Modelling Centre (ITT open)
- S1-SW-21 Space Weather Impact on GNSS Performance

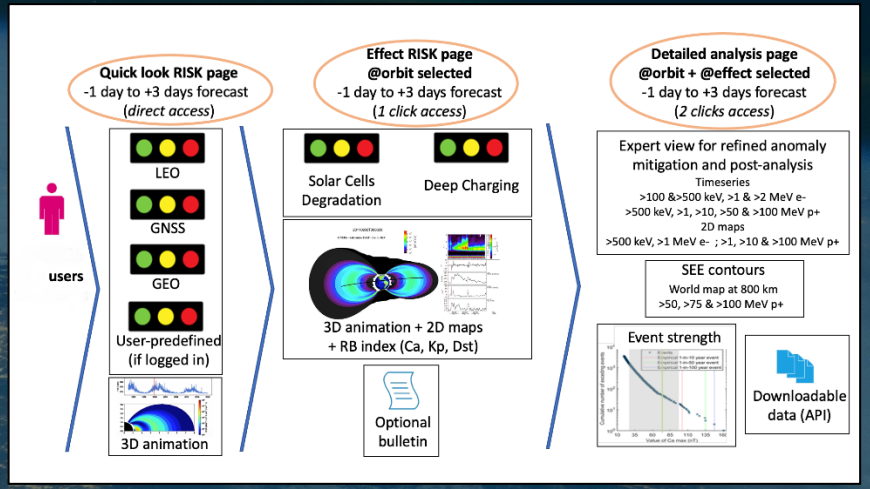
- Expected 2025 (total budget 3,610kEuro):
  - S2-SW-06.A Virtual Space Weather Modelling Centre
  - S2-SW-06.B Space Environment Characterisation, Nowcast and Forecast
  - S2-SW-06.C Space Weather Capability Development for Ionospheric and Geomagnetic Conditions
  - S2-SW-06.D Solar and Heliospheric Weather Toolkit Development
  - S2-SW-06.E Advanced Validation for the SWE Service Network

- Plus new and improved service component deployment anticipated throughout 2025 as projects mature including but not limited to ISPA (lead: Univ Oslo), BIGG (Lead Univ Bergen), 3D-Ionospheric Modelling (Univ Birmingham)…

SWE Service Network Review – Towards S2P P3

A significant SWE portal evolution

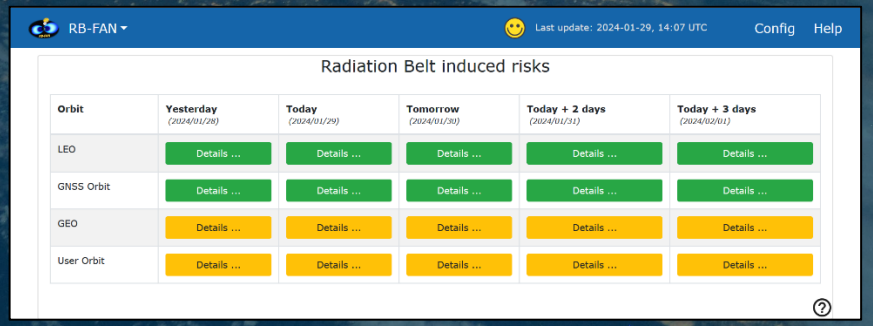
- Layered approach portal-wide catering for different levels of user expertise
- Leverage data system improvements supporting API data access



Strengthening the network's R2O Processes

- Continued focus on end user engagement and feedback
- Build upon a wealth of well validated and reliable data products to develop new, focussed user tailored capabilities.
- Increased emphases on coordinated performance assessment activities
  - Further extend validation and inter-comparison studies to ensure key products meet user criteria
  - Effectively capture the uncertainties in the information provided to the users
- Increased involvement of end users in the assessment of service maturity

Example layered approach implemented by RB-FAN project team [Lead: ONERA]



https://swe.ssa.esa.int/onera-rb-fan-federated

Space Weather Training Course – Third Edition!

- One week residential course targeting Master/PhD students organised by SWE Office together with ESA Academy team, ESEC-Galaxia, Belgium 24-28th March 2025
- Lectures delivered by internationally recognised experts
  - Fundamentals of space weather science through modelling, forecasting, different application areas and socio-economic impacts
- Hands-on tutorials using the SWE portal and key tools
- Group project to design a space weather service concept
- Tours of the operations centre at ESEC-Redu with introduction to PROBA mission operations and visit to Space Pole in Brussels including the SSCC premises

THANK YOU

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European Space Agency

European Space Agency Technology Programmes

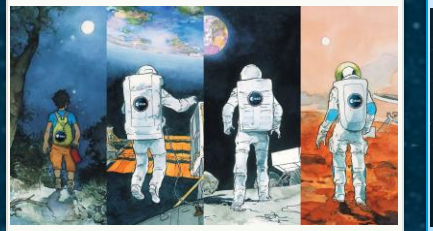
Space Weather Working Team (SWWT)

Piers Jiggens

2024-11-06

ESA's Technology Programmes

Human & Robotic Exploration



ExPeRT (Exploration Preparation, Research and Technology)

Navigation

NAVISP (Navigation Innovation and Support Program)

Science

CTP (Core Technology Programme)

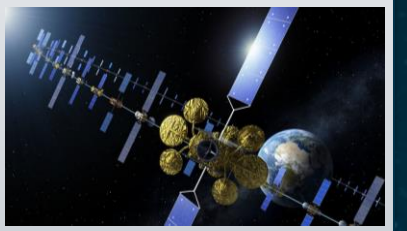
Space Transportation

FLPP (Future Space Transportation Ecosystem Programme)

Earth Observation

FutureEO (Future Earth Observation programme)

Telecomms



ARTES (Advanced Research in Telecommunications Systems)

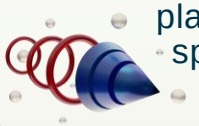
Technology (Generic) - https://technology.esa.int/ Programmes address different stages of development/maturity, measured by Technology Readiness Level (TRL) scale and each aims at increasing the TRL.

Open Space Innovation Platform (OSIP)

Open channels including **Discovery element** and Co-funded research https://ideas.esa.int

Technology Development Element (TDE)

Testing feasibility of prospective technologies allowing to plan and define future space missions and activities.

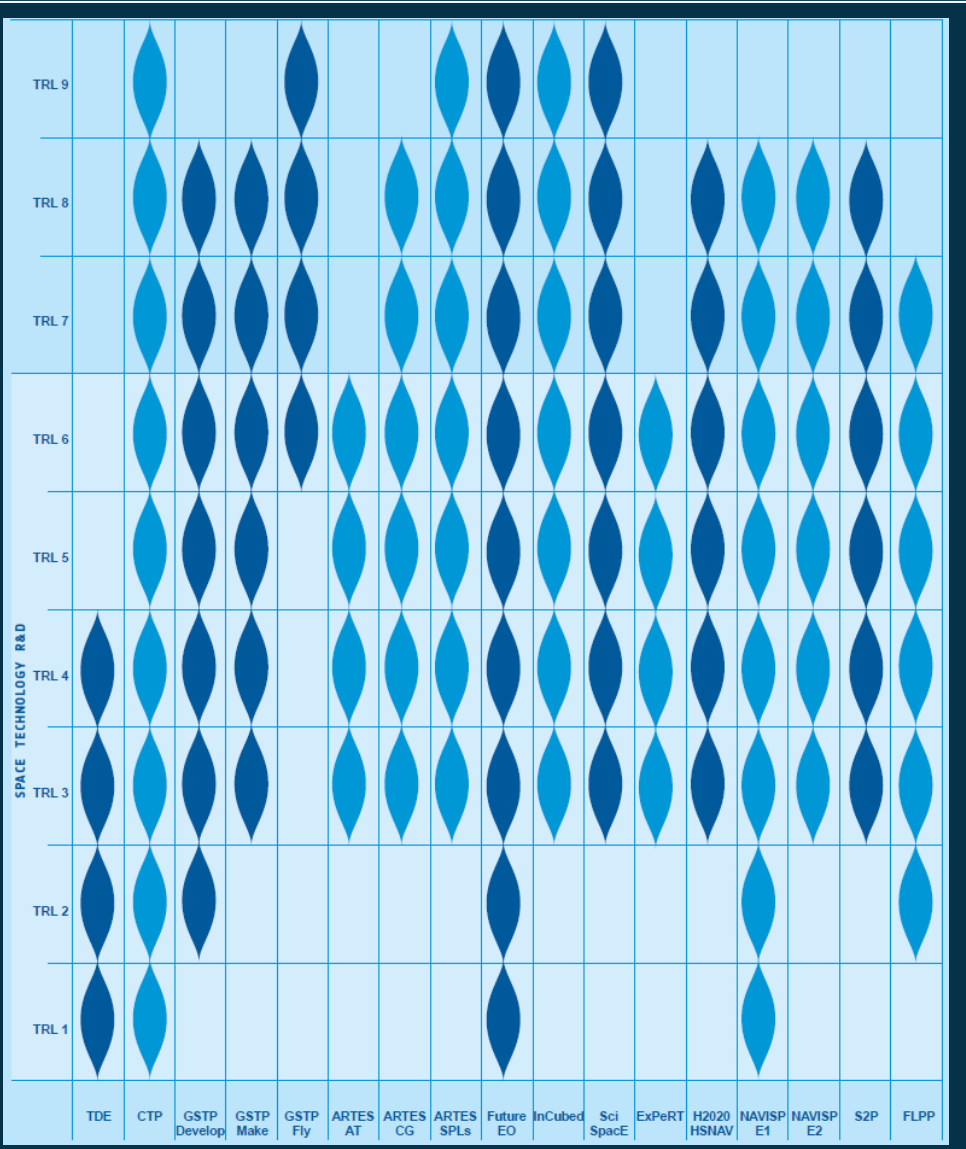


General Support Technology Programme (GSTP)

Evolves proven innovations into fully tested hardware ready for adoption by future missions.

Mapping of TRL to Technology Programmes

Technology Readiness Level	Milestone achieved for the element
TRL 1 Basic principle observed and reported	Potential applications are identified following basic observations but element concept not yet formulated.
TRL 2 Technology concept and/or application formulated	Formulation of potential applications and preliminary element concept. No proof of concept yet.
TRL 3 Analytical and experimental critical function and/or characteristic proof-of-concept	Element concept is elaborated and expected performance is demonstrated through analytical models supported by experimental data/characteristics.
TRL 4 Component and/or breadboard functional verification in laboratory environment	Element functional performance is demonstrated by breadboard testing in laboratory environment.
TRL 5 Component and/or breadboard critical function verification in a relevant environment	Critical functions of the element are identified and the associated relevant environment is defined. Breadboards not full-scale are built for verifying the performance through testing in the relevant environment, subject to scaling effects.
TRL 6 Model demonstrating the critical functions of the element in a relevant environment	Critical functions of the element are verified, performance is demonstrated in the relevant environment and representative model(s) in form, fit and function.
TRL 7 Model demonstrating the element performance for the operational environment	Performance is demonstrated for the operational environment, on the ground or if necessary in space. A representative model, fully reflecting all aspects of the flight model design, is built and tested with adequate margins for demonstrating the performance in the operational environment.
TRL 8 Actual system completed and accepted for flight ("flight qualified")	Flight model is qualified and integrated in the final system ready for flight.
TRL 9 Actual system "flight proven" through successful mission operations	Technology is mature. The element is successfully in service for the assigned mission in the actual operational environment.

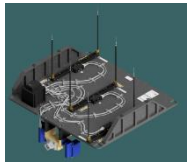
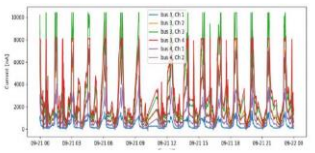
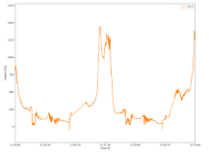


In-Situ Instrumentation

GSTP TDE PRODEX | Science S2P | Human and Robotic Expl.

Multi-Needle Langmuir Probe (M-NLP)

NORSAT-1 2017 — UiO : Department of Physics, University of Oslo
ISS/Bartolomeo 2023
~5kHz plasma density sampling

Service-Oriented Spacecraft Magnetometer (SOSMAG)

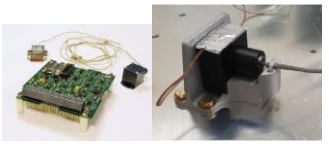
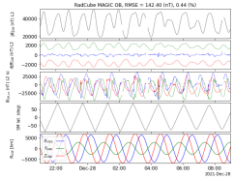
Magson GmbH

2x fluxgate magnetometer + AMR
GEO-KOMPSAT-2A 2018
Able to operate on 'dirty' spacecraft

MAGnetometer from Imperial College (MAGIC)

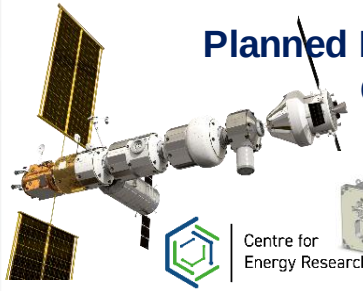
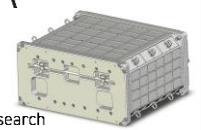
Compact Anisotropic Magneto-Resistive (AMR) magnetometer flying on RadCube but also planned for Gateway/ERSA

Imperial College London

Gateway Radiation Payloads

Planned Launch: Q4 2025

Centre for Energy Research

Internal Dosimeter Array

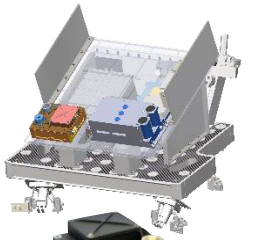
Developed by Centre for Energy Research, Hungary

spaceapplications SERVICES



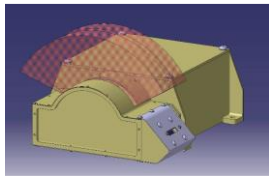
European Radiation Sensor Array

Developed by Space Applications, Belgium





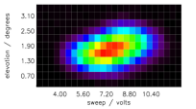
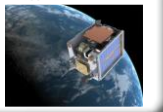
HOPE-M (Plasma Monitor)




Bessel box analyser breadboard
GEO environment: UCL
30eV to 30keV; 11° x 60° FoV

(ChaPS) Charged Particle Spectrometer

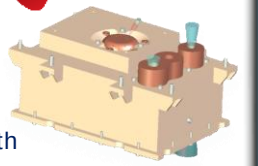
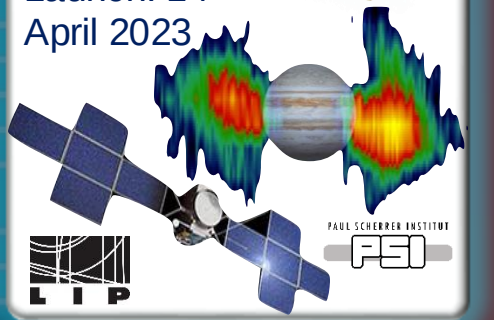
TechDemoSat (UK IOD) 2014,
e⁻ and ions in LEO and auroral

Rad-hard electron Monitor (RADEM)

JUICE
Mission to Jupiter System
Launch: 14th April 2023

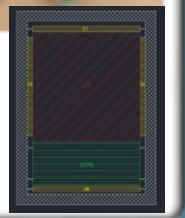
efacec

PAUL SCHERRER INSTITUT PSI
LIP

Other Radiation Monitors



ideas Integrated Detector Electronics AS

3DEES

UNIVERSITY OF SURREY HEPI

3DEES PROBA-3 2024

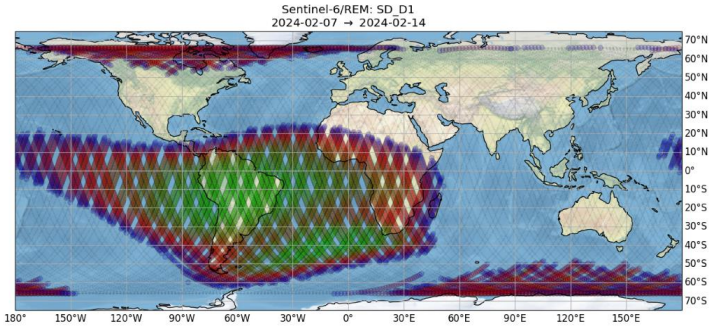
NORM ASBM 2024

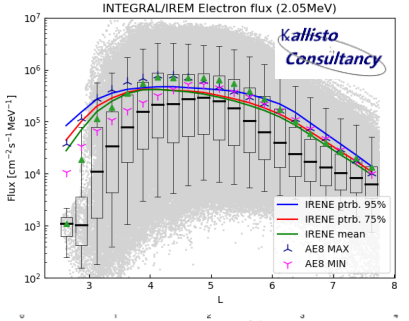
REDWIRE | UCLouvain | BIRA-IASB

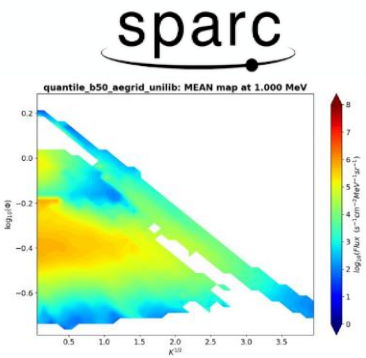
Specification Modelling and Data Exploitation

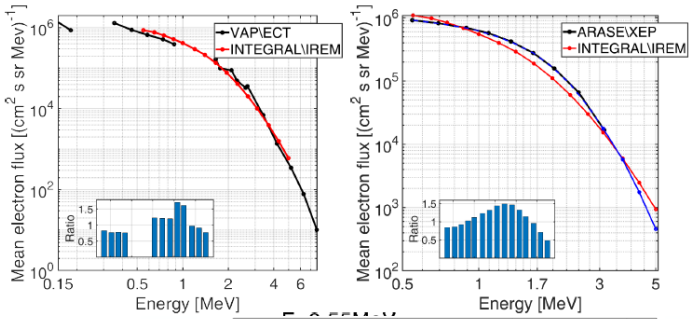
TDE
CTP
ARTES

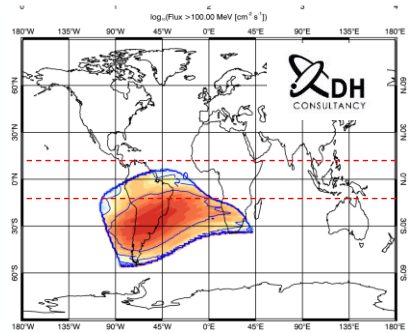
- Radiation and Plasma Environments (also microparticle and ATOX) for mission specifications and requirements - requires modelling expertise.
- Notable Projects this year include:
  - GloRaB – Global Radiation Belt Prototype for LEO Constellations
  - VERSE - eVent-based Electron belt Radiation Storm Environments modelling
  - FIRESPELL - uniFied InteRplanEtary and Solar Particle Event modeLLing

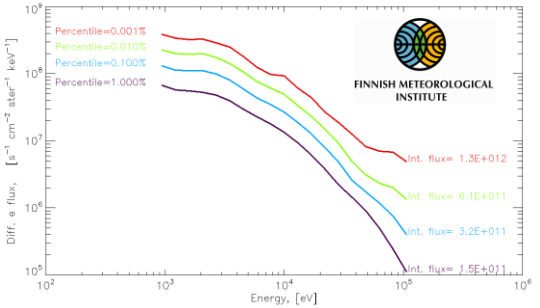


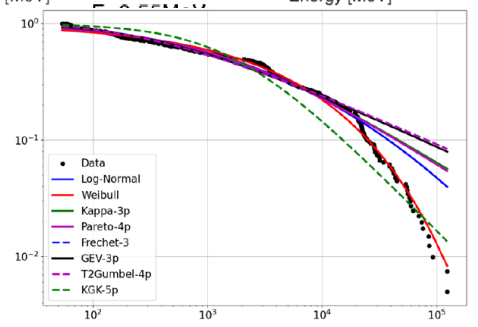








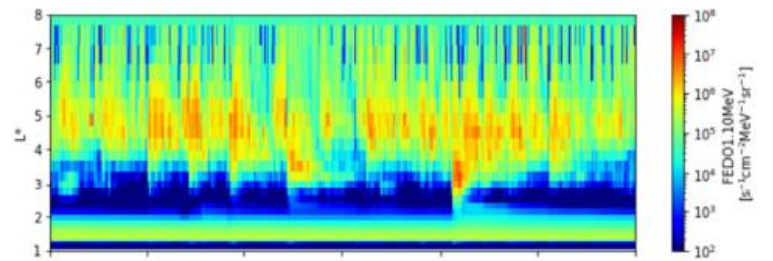


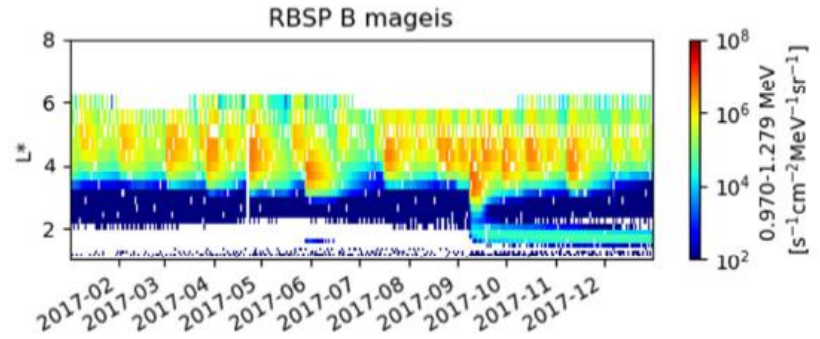


ONERA
THE FRENCH AEROSPACE LAB

BIRA·IASB

UCLouvain





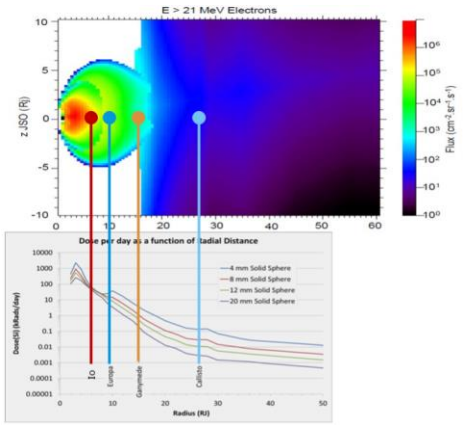
Planetary Environments in the Solar System

TDE

Jupiter (JORE²M² + JCAT)

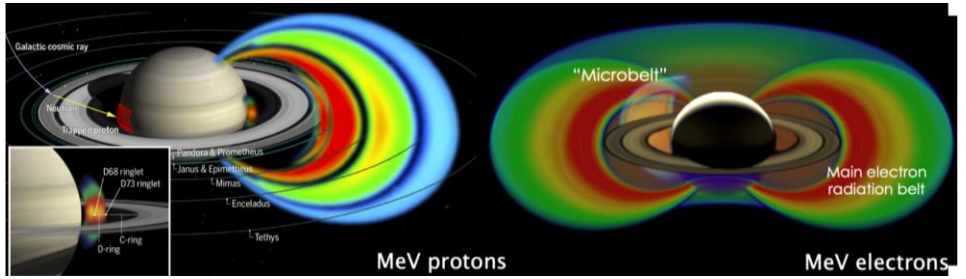
QinetiQ ONERA THE FRENCH AEROSPACE LAB

- Jovian Radiation Environment and Effects Models and Mitigation (JORE²M²)
- JUICE Charging Analysis Tools (JCAT)
- Developed radiation and plasma models for the Jovian system to be used in mission environment specification and feasibility



Saturn and Beyond (TRAPPED)

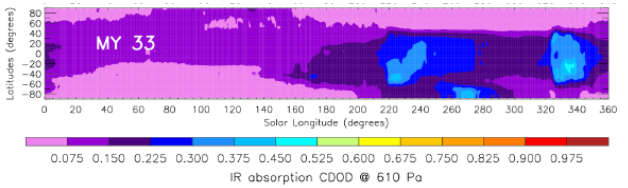
- Testbed for Radiation and Plasma Planetary Environments
- Development of a modelling framework for radiation and plasma in other gas giant magnetospheres
- Focus on Kronian system for future mission definition

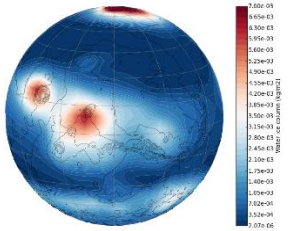


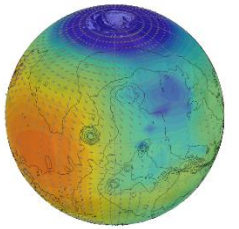
Mars Climate Database (MCD)

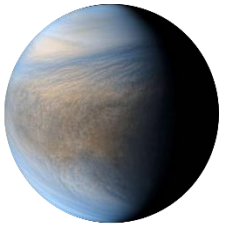
LMD

- MCDv6.1 provides realistic and reliable models of the Martian climatological system.
- Covers altitudes from surface to exosphere, providing atmospheric temperature, wind, pressure, composition, dust content…
- Used widely for mission EDL (Entry-Decent-Landing), mission design, data analysis and modelling work (incl. dust storms)



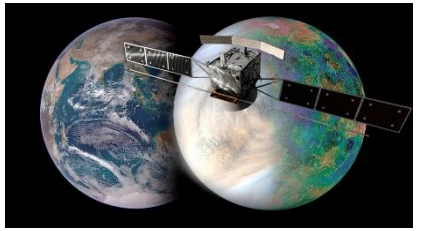






Venus Climate Database (VCD)

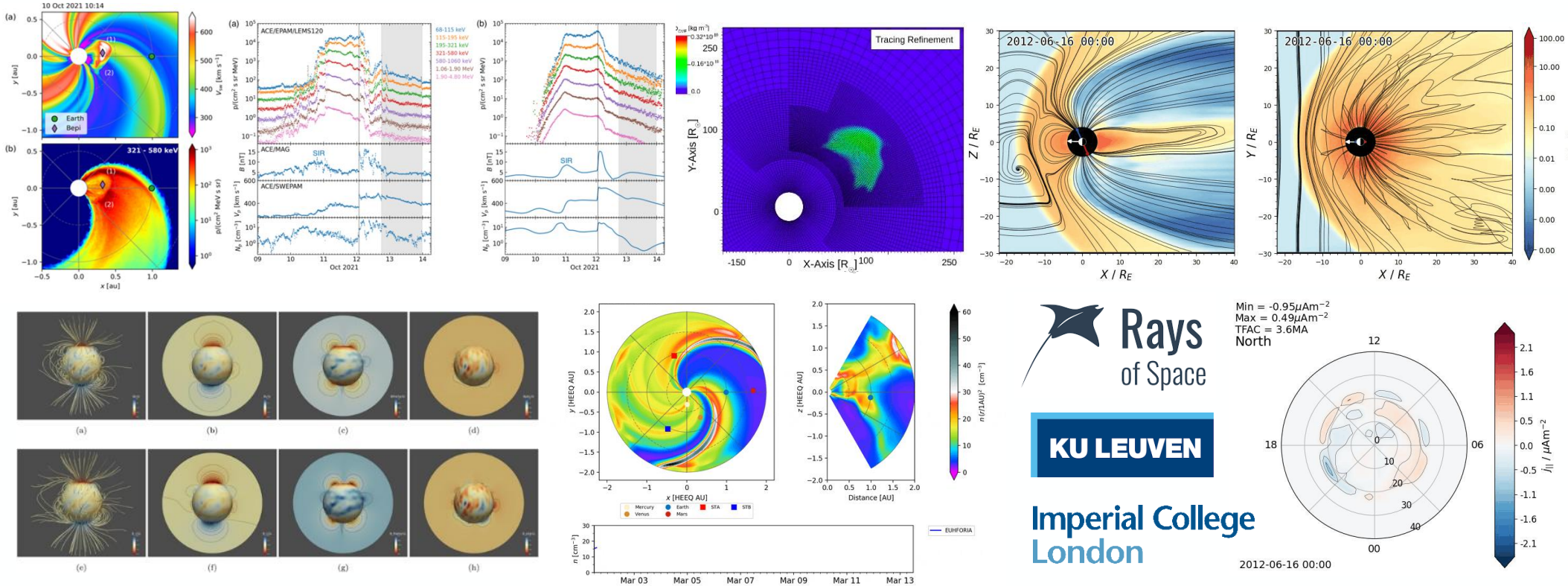
- VCDv2.3 meets similar objectives as the MCD but for Venus
- Focus on modelling density variability and associated uncertainties
- Current reference for EnVision mission design (e.g. aerobraking) and planning

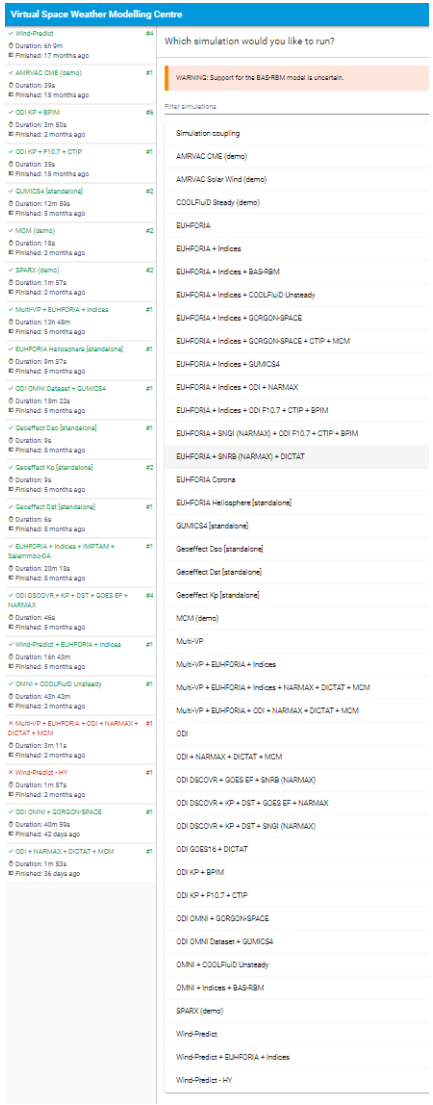


Space Weather Modelling

GSTP
S2P
PRODEX

- Main development (in coordination with S2P Space Weather Office) is the Virtual Space Weather Modelling Centre (VSWMC) which incorporates models across the following domains: Solar corona, solar wind, CMEs, solar particle radiation, radiation belts, magnetospheric plasma, plasmasphere, ionosphere interactions, thermosphere





- There are various tie-ins to this in terms of TDE, GSTP and OPS-SW activities

Example TDE Activities in the planning for 2025

Prog. Ref.	Title	Budget (kEUR)
T704-802EP	End-to-end modelling of the Radiation Hardness Assurance Process	400
T704-803EP	High-performance Monte Carlo radiation transport and effects modelling methods	300
T804-801EP	Novel Techniques for radiation storm forecasting	300
T804-803EP	PRISE (Particle Radiation Instrument and Spectrometer for Europe)	300

Where to go to see all the ESA ITTs

All ITTs can be found on ESA-Star:

https://esastar-publication-ext.sso.esa.int/

Subscribe to the SWEN (Space Weather Euro News)

swen@esa.int

Any questions you can contact me:

piers.jiggens@esa.int

Pathways to Improving International Coordination in Space Weather

WMO-ISES-COSPAR Coordination Team (WICCT)

SWWT, European Space Weather Week – 6 Nov., 2024

WMO-ISES-COSPAR Coordination

- Letter from UN Office of Outer Space Affairs (**UNOOSA)** dated on **July 1, 2022** by request of the Committee on the Peaceful Uses of Outer Space (**UNCOPUOS**) and its Scientific and Technical Subcommittee (STSC).

- COSPAR, ISES and WMO are invited to lead efforts to improve the global coordination of space weather activities in consultation and collaboration with other relevant actors and international organizations.

WMO

COSPAR
COMMITTEE ON SPACE RESEARCH

ISES
International Space Environment Service

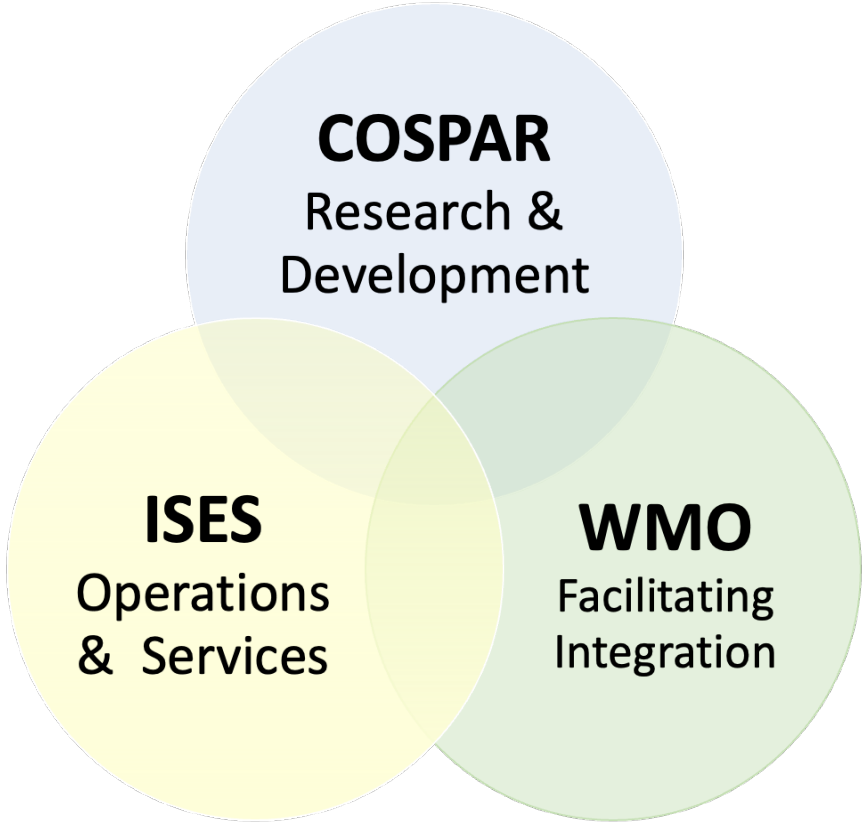
Brainstorming meeting in Coimbra, Sep 30 – Oct 1, 2022 (after ISWAT 2022)

- **Moderator:** Ian Mann on behalf of UNCOPUOS (remote participation)
- **Facilitator:** Suzy Bingham, WMO/UK MetOffice
- **Venue:** Observatório Geofísico e Astronómico da Universidade de Coimbra (OGA)
- **Participants:**
  - COSPAR: Masha Kuznetsova (Chair of PSW) and Hermann Opgenoorth (Vice-Chair of PSW)
  - ISES: Jesse Andries (Director) and Mamoru Ishii (Deputy Director)
  - WMO: Kenneth Holmlund (H/SSU) and Kirsti Kauristie (co-chair of ET-SWX)

Come together with open hearts and open minds

The Coimbra Declaration

- **Agreed on core expertises of the three organizations**
- Agreed to define collaboratively the overarching activities in the overlapping areas
- **Established WMO-ISES-COSPAR Coordination Team (WICCT).** Meet in person (at least every 6 months) + virtually
- Agreed to establish cross-memberships in the organizations' working groups
- Agreed to orgnise a **Space Weather International Coordination Forum** to bring together representatives from major organisations and activities in space weather.

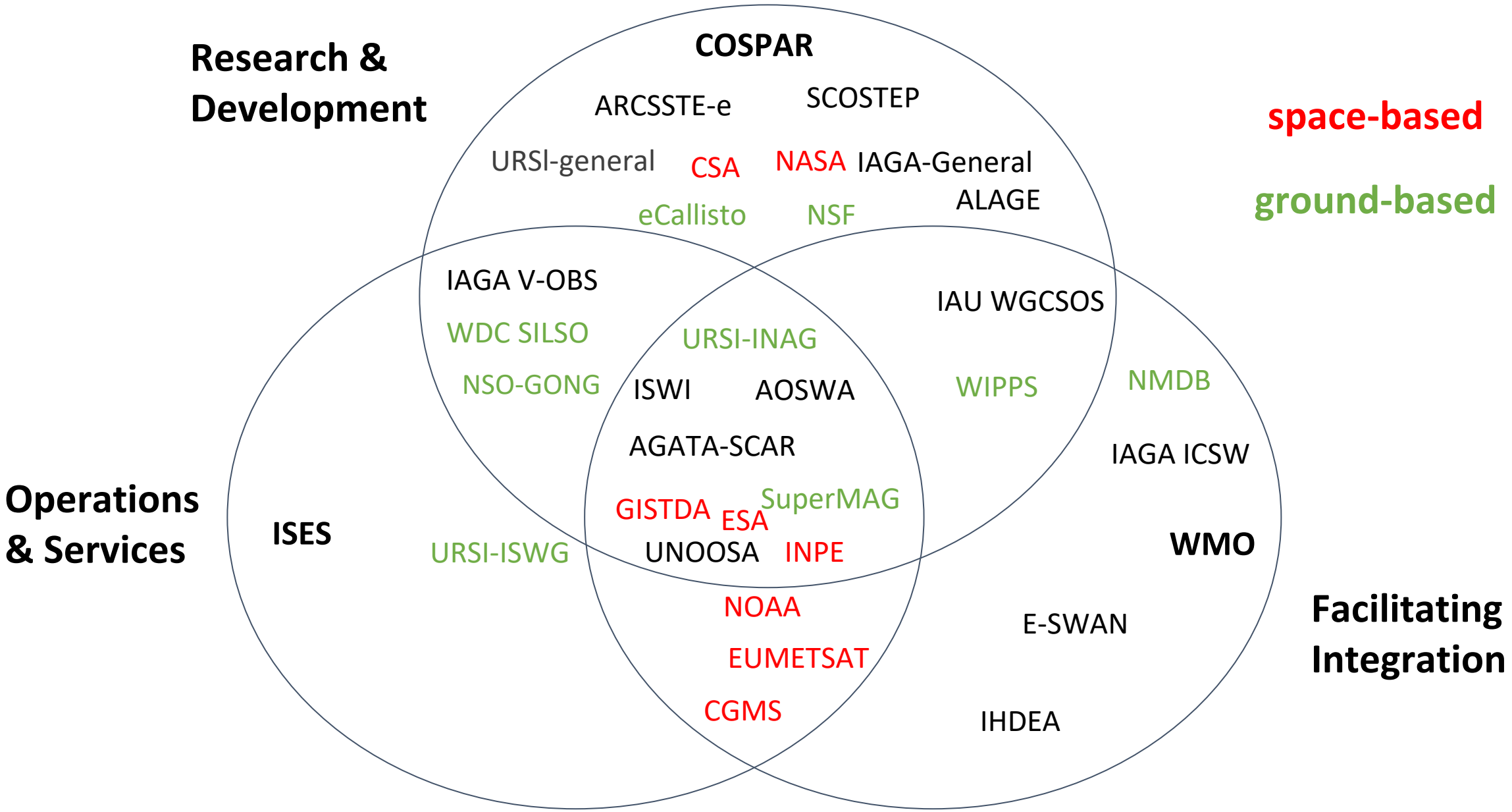


Space Weather International Coordination Forum
(Nov 17 2023, Geneva)

Anticipated outcomes include:

- An outline of the international space weather landscape identifying **primary expertise of each organization** represented in the Forum
- Initial Discussion about the coordination in;
  - Space Based Observation
  - Ground Based Observation
  - User Engagements
- Plans for interfacing with organizations representing major user groups
- Approach to alignments with national strategic planning activities and funding programs
- Plans for join projects to demonstrate the value of collaboration and coordination

Primary area of organisations' expertise



Schedule - ESWW2024 | OPS2 session plan - ESWW2024 | ISWCF | iswat-cospar.org

iswat-cospar.org/iswc-forum

Bookmarks | NICT Internal Services | 宇宙天気ユーザー協... | 科研費電子申請シス... | ポータル | ホーム | 宇宙天気予... | NICT 電磁波研究所... | ビデオ会議、クラウド電...

Keywords

International Space Weather Coordination Forum

ISWC Forum Home | Meetings | Statements | Coordination Themes | Projects | FAQs | Participating Organizations | Login

Now, ISWCF Webpage is on public!
https://www.iswat-cospar.org/iswc-forum

The Inte nd recognize the benefit d cooperation. The For ies.

This ISW andscape. Coordination Themes are areas where coordination can be improved. Projects are activities towards addressing the Themes. Information on Participating Organizations is provided to help identify and establish partnerships between relevant entities to work on projects.

This website's content management system enables representatives from organizations to update this website. Each organization has a dedicated webpage, linked from the Participating Organizations webpage, which can include links to organizational webpages. Each joint project will have a dedicated webpage, anticipated to be regularly updated by project coordinators.

WMO-ISES-COSPAR Coordination Team (WICCT) is coordinating efforts for the Forum. If any organization is interested in joining the Forum or for any other queries, please contact **WICCT members** (wicct@googlegroups.com).

For questions related to accounts on this website, please contact maria.m.kuznetsova AT nasa.gov or annemichelle.m.mendoza AT nasa.gov.

Candidates of Pilot Projects

User Engagements

- Essential Space Environment Quantities (ESEQs)
- Collaborative development of generic displays for major user groups
- International user-group community participation analogous to the ICAO activity.
- Overarching space weather portal for forecast/operational services (for users).e.g. Centralized directory.

Establishment of framework for severe space weather events

- Global Space Weather Warning System
- Extreme space weather event thresholds/categorization
- Simulated exercise for testing/improving response to global super-extreme events
- Collect information on socio-economic benefit studies - such as sharing and comparing processes, best practices, risk assessment protocols, etc - across the space weather community.

Coordination among observations, models and forecasts

- Coordination of similar instruments in ground-based networks (ionosondes, neutron monitors, magnetometers, ...)
- Standards - many possible projects, for example (1) identify meta-data for a relevant domain, e.g. ionosondes (2) establish coordinate reference system (CRS) and transformation standards for space weather, equivalent to terrestrial weather's PROJ. Going beyond "see Hapgood [1992]".
- FAIR common information architecture - many possible projects, for example (1) sharing and discoverability of ionosonde data (e.g. through WIS2.0), (2) showcasing interoperability between two platforms (e.g. SPASE, WIS)
- Coordinated validation and inter-comparison of models, forecasts and/or end-user products. This can involve workshops, real-time scoreboards and other community tools,…
- Coordinated efforts to enable access to space weather impact information including anomaly databases, GIC data, etc

Capacity building

- Training for early career researchers. Building on work by COSPAR Panel on Capacity Building and existing agreement between COSPAR-WMO; lecturers have included some ISES representatives.
- Capabilities Building / Training
- Competency based training frameworks for space weather forecasters.

Others

- ACitizen science project
- Standardized naming of large space weather events

One of the low hanging fruits… Ionosonde

- Coordination of ground-based observation
  - Establishing international representative organization for ionosonde observations
- Sharing data (in real time)
  - Sharing real time ionogram and ionospheric model results in ICAO/SWXCCG/subteam8
  - Data Exchanging Experiments in WMO/ET-SWx with WIS2.0 including the exchanging format

SWWT Plenary Meeting 44:
06/11/2023, 15:00UT to 17:00UT, Coimbra, Portugal

1. ESA SWWT Status and News in 2024 – Mario M. Bisi (5 Minutes).
2. Space Weather Within the ESA Space Safety Programme: Progress and Planning – Jussi Luntama (30 Minutes).
3. The SWE Service Network Next Steps and Development Outlook – Alexi Glover (20 Minutes).
4. ESA Technology Programme Update – Piers Jiggens (10 Minutes).
5. WICCT Updates – Mamoru Ishii (15 Minutes).
6. **Update on the ESA SWWT Topical Working Groups – Sean Bruinsma and Mario M. Bisi (10 Minutes).**
7. Close.

6. Update on the ESA SWWT Topical Working Groups

Sean Bruinsma and Mario M. Bisi

ESA SWWT TWGs (current status – as of today!)

- Drivers of Space Weather (*e.g.* solar, S-T, including future missions and instrumentation)
  - Subgroup: Solar Storms (Solar Flares, CMEs, SEP events), spokesperson: Olga Malandraki
- Ground Effects (GIC, prospecting, tourism), spokesperson: Vacant
- Atmospheric Effects (incl. drag), spokesperson: Sean Bruinsma
- Ionospheric Effects, spokesperson: Vacant
- Spacecraft, Launcher and Aircraft Environments, spokesperson: Guenther Reitz
- Education, Outreach and Emerging Markets, spokesperson: Vacant; co-spokesperson G. Cessateur
- Space Weather Forecast, spokesperson: Vacant, co-spokesperson: Shaun Bloomfield
- Radio for Space Weather: Mauro Messerotti and Mario Bisi

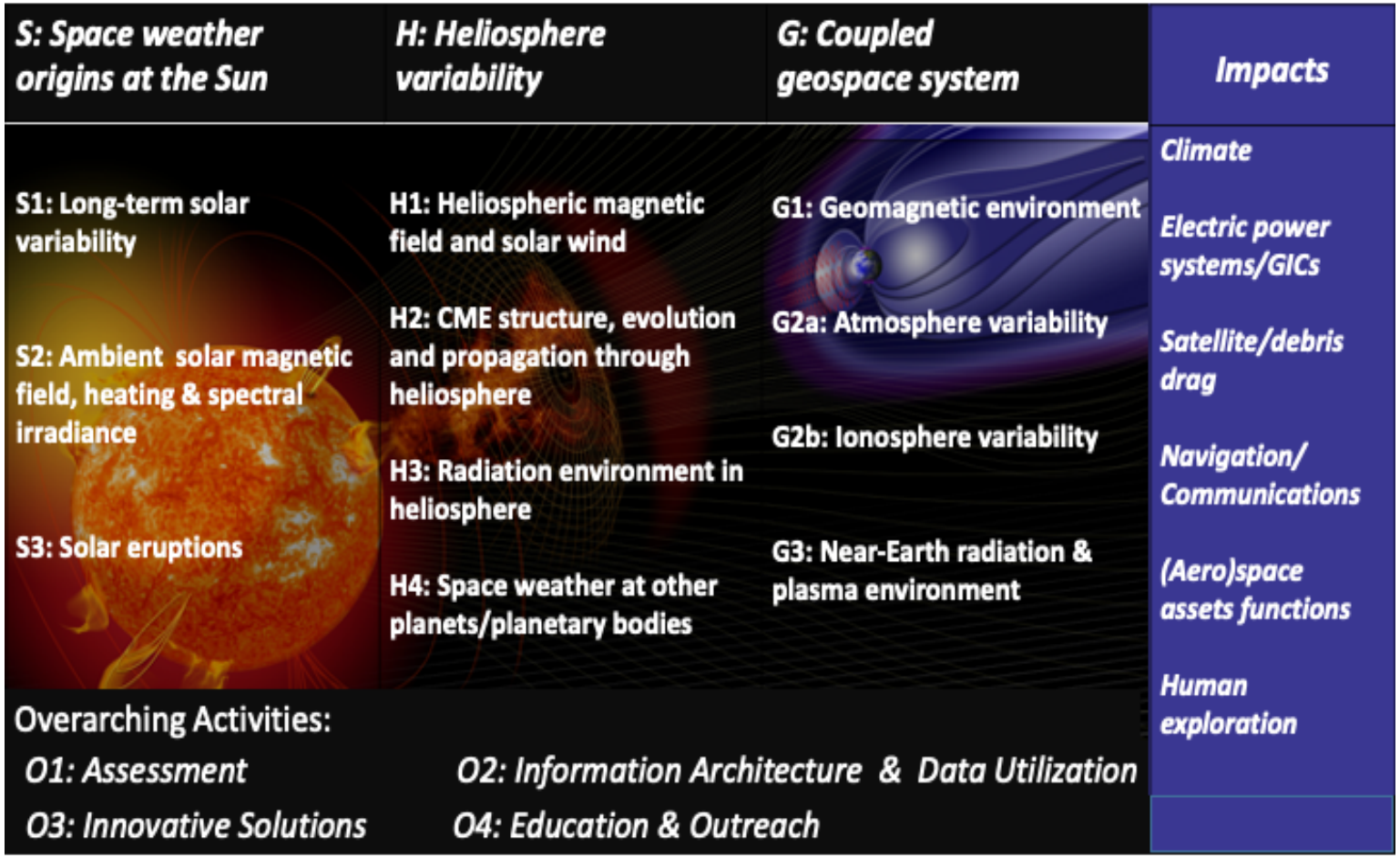
A Potential Way Forward: Better Interaction with the COSPAR ISWAT Initiative and WICCT…

- COSPAR ISWAT was designed as a bottom-up, global community involved in key science/impacts challenges around space weather and space climate.
- Updating of the COSPAR PSW Roadmap as a community-driven activity.
  - Topical Issue II is nearing completion with most papers already available online…
- COSPAR PSW wants to provide a future "Living Space Weather Roadmap".
- Many of the SWWT TWG members are involved in COSPAR ISWAT Teams/activities – *working together reduces workload and increases impact!*
- COSPAR ISWAT is leading the way on the scientific side of space weather (and opportunities for space climate also).
- COSPAR ISWAT includes overarching activities, educational, and outreach activities as well as data storage and archive pathways and pathways to critical space-weather impacts…
- WICCT are driving forward international collaboration and pilot projects…

International Space Weather Action Teams

COSPAR ISWAT

Platform for self-organized open collaborations addressing challenges across the field of space weather



https://iswat-cospar.org

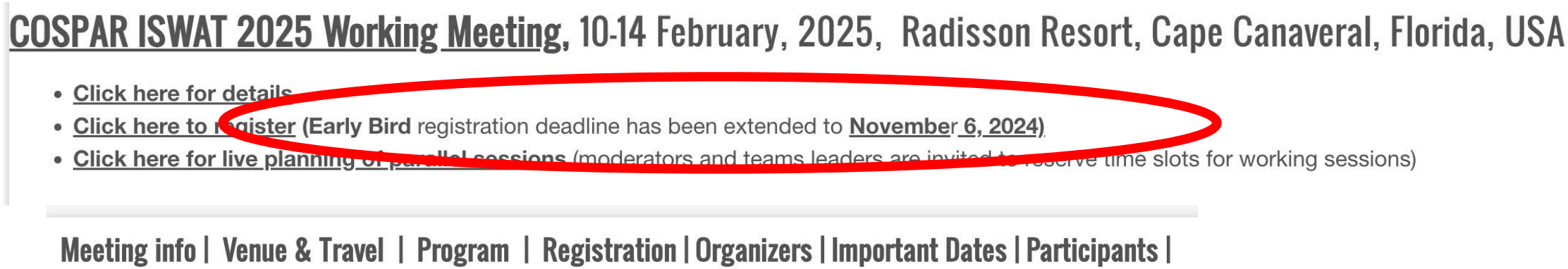
Action Teams *(building blocks of ISWAT)* are organised into ***ISWAT Clusters*** by domains, phenomena, impact, or overarching activity.

Status: 62 Action Teams, 15 Clusters, **595+ active members**, 50+ countries, 350+ affiliations.

Working Meetings:
2020 (Florida, USA)
2022 (Coimbra, Portugal)
Mini-ISWAT@ESWW2023
Mini-ISWAT@ESWW2024
Feb 10 – 14, 2025 (Florida, USA)

- ISWAT is an effort multiplier. Maximise return on investments by national/regional programs

https://iswat-cospar.org/



- Discuss **Roadmap recommendations** and set targets for Action Teams to address
- Expand on-going community-wide research projects, Define new community-wide endeavors and jump-start new campaigns
- Review approaches to source-to-impact pathways (**Sun2Geo**, **Sun2Impact** predictions)
- Define new overarching activities
- Establish new teams, plan new actions and collaborations to address new targets and priorities.
- Discuss **implementation of open science in** modeling and other in ISWAT activities
- Discuss approaches to **global coordination in space weather in partnership with WMO and ISES**

ESA SWWT Further Information…

- Please see: https://swe.ssa.esa.int/swwt for details and the full Terms of Reference (updated 11 June 2024) – updates on the website are in the process of being made this month…

- Any questions, please come find me and/or Alexi and ask us during the rest of this week…

- Thanks for attending today!

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7. **Close – Thank you again for attending!**