ESA Space Situational Awareness Programme
Space Weather Segment

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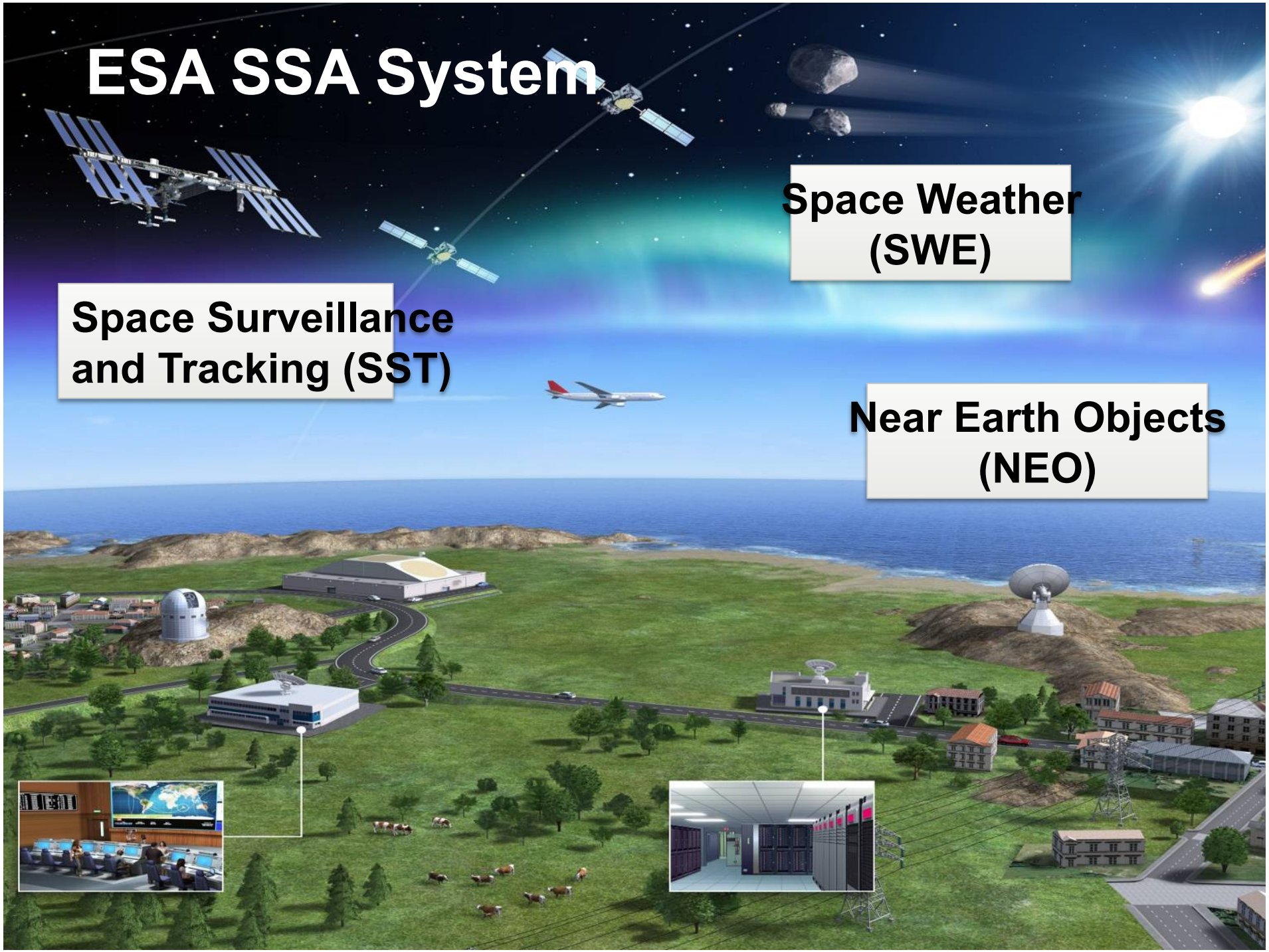
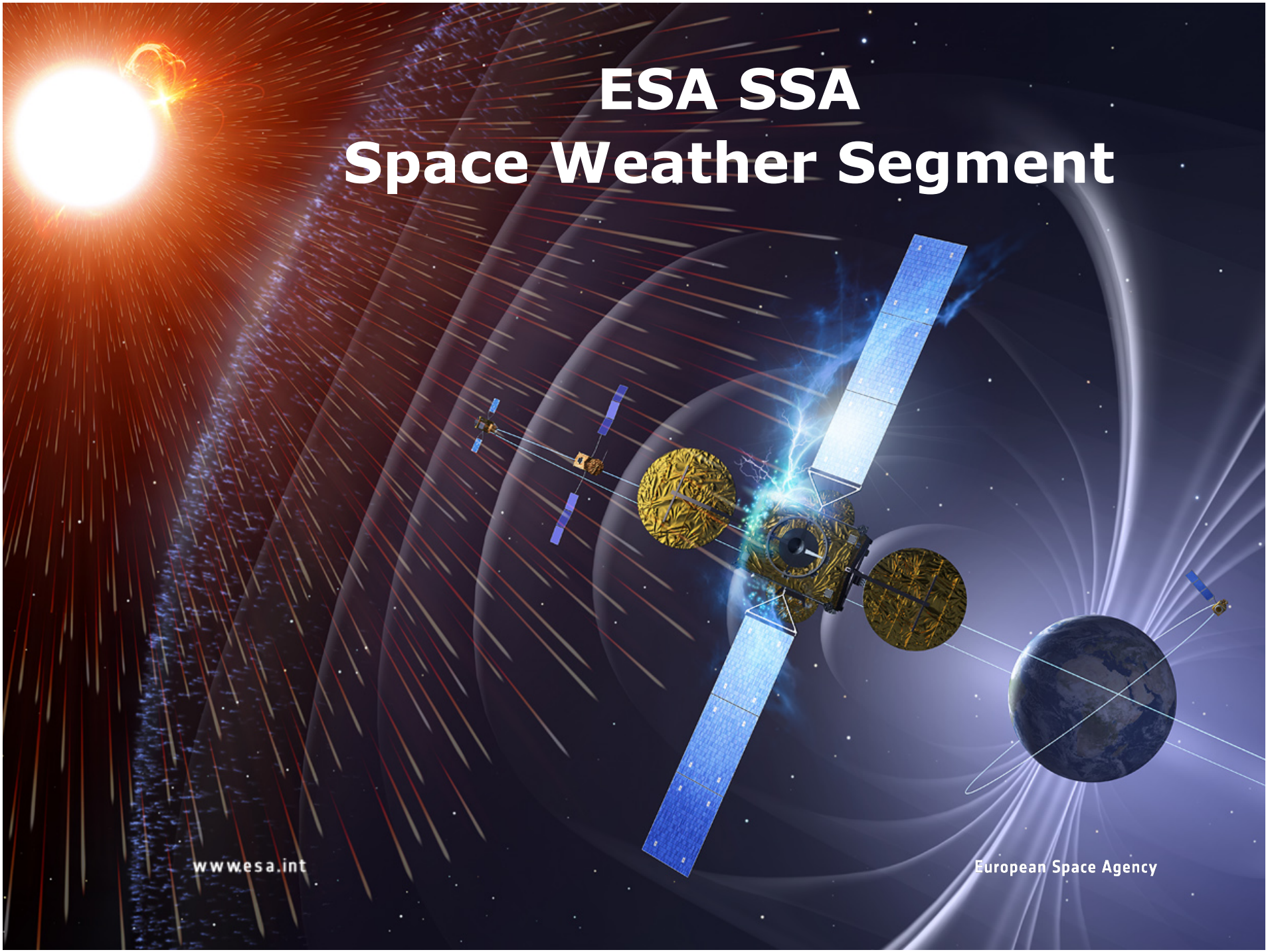
PURPOSE OF THE SSA PROGRAMME

"The objective of the Space Situational Awareness (SSA) programme is to support the **European independent utilisation** of, and **access to, space** for research or services, through the **provision of timely and quality data**, information, services and knowledge regarding the **space environment**, the **threats** and the sustainable exploitation of the outer space **surrounding our planet Earth."**

- **ESA Ministerial Council November 2008**


ESA SSA System
Space Weather (SWE)
Space Surveillance and Tracking (SST)
Near Earth Objects (NEO)

ESA SSA
Space Weather Segment



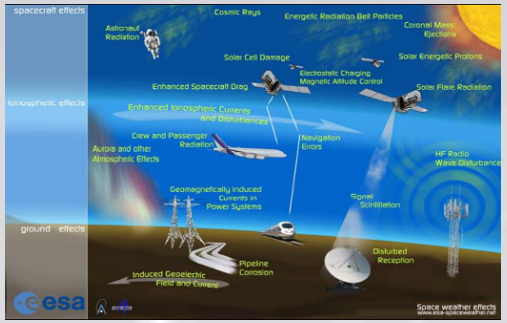
www.esa.int

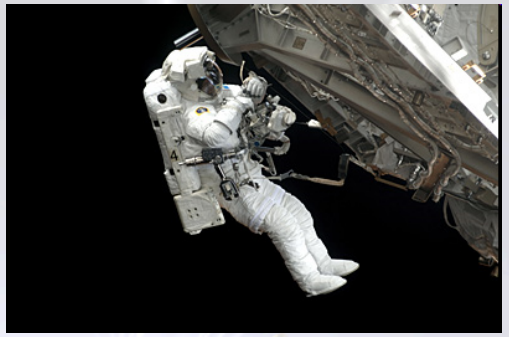
European Space Agency

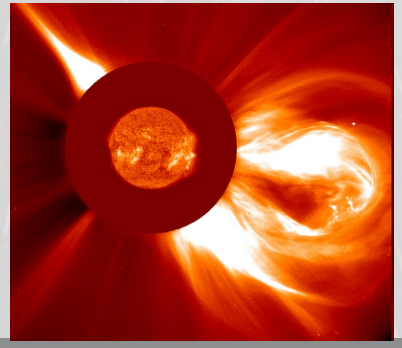
Objectives for SSA-SWE services

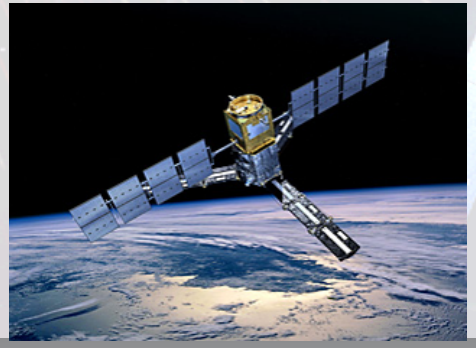
Detection and forecasting of the Space Weather events and the effects it has on European space assets and ground based infrastructure:

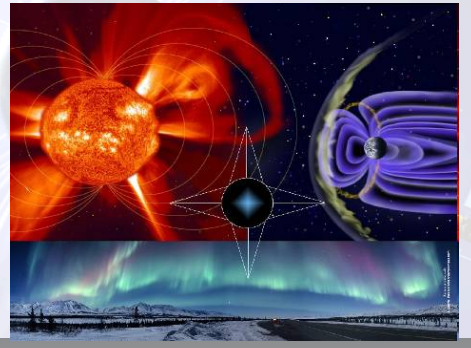
- Comprehensive knowledge, understanding and maintained awareness of the natural space environment
- Detection and forecasting of SWE and its effects
- Detection and understanding of interferences due to SWE
- Prediction and/or detection of permanent or temporary disruption of mission and/or service capabilities
- Provision of predicted local spacecraft and launcher radiation, plasma and electromagnetic environment data











images: (ESA & NASA)

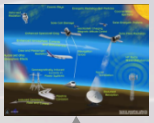
Examples of SSA User Requirements

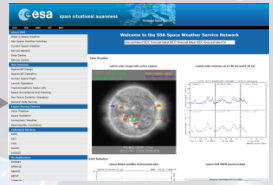
User Domain & context	Example Requirements
Spacecraft designers defining environment specification for a mission pre-launch	Statistical info per orbit as function of time & location for: ionising radiation, plasma, microparticles, atmosphere
Spacecraft operators requiring real-time environmental conditions, forecasts and short-term anomaly analysis	forecast effects per s/c per orbit as function of time and location: single event effects, radiation dose, charge build-up…
Human spaceflight mission operators requiring dosimetry and solar activity forecast	Environment reconstruction at a given time and location to allow the accurate evaluation of doses received
Communications and navigation system operators and users make use of ionospheric specification and forecast	Near real-time and forecast over 7 day TEC global and regional maps
Ground systems operators monitoring local geomagnetic disturbances, making use of monitoring and forecast data	Tailored information on geomagnetically induced currents throughout the power system including plotting local E-field and GIC by substation

SSA Space Weather Segment

SSA/SWE Precursor System in 2013

SSA-SWE Users





SSA-SWE Service Portal: swe.ssa.esa.int

SWE Data Centre Redu, Belgium

SWE Service Coordination Centre, Space Pole, Belgium

SWE Expert Service Centres

Solar Weather	Ionospheric Weather	Space Radiation	Geomagnetic Conditions	Heliospheric Weather
ROB, Belgium (coord.) Uni. Graz, Austria	DLR, Germany (coord.) NMA, Norway NOA, Greece CLS, France	BIRA, Belgium (coord.) AIT, Austria UOA, Greece	TGO, Norway (coord.) FMI, Finland	TBD

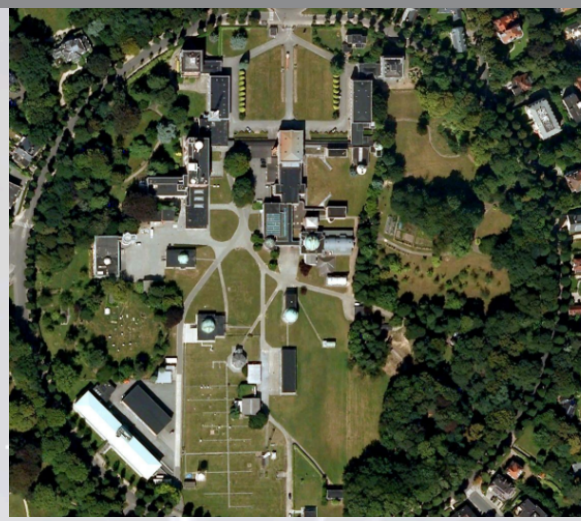
SSA SWE Coordination Centre

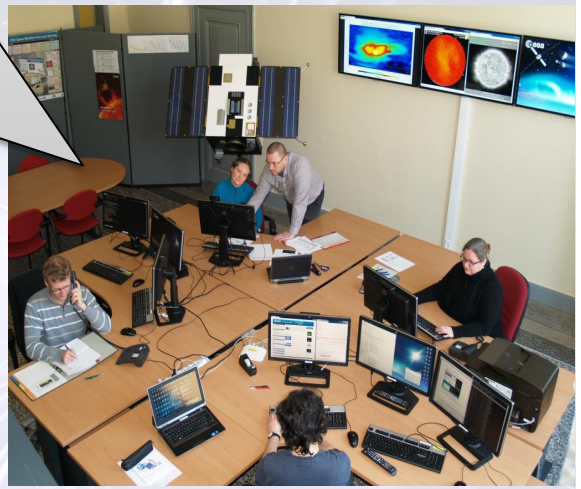
- SSA Space Weather Coordination Centre (SSCC) was established by the SSA Programme
- Ina
- SSC
  info
  use
- SSA
  curr
  => Support currently provided during normal working hours + dedicated campaigns
- SWE services available from: http://swe.ssa.esa.int

SSA SWE Coordination Centre

Space Pole
Avenue Circulaire, 3 - Ringlaan
1180 Uccle - Ukkel (Brussels)
BELGIUM

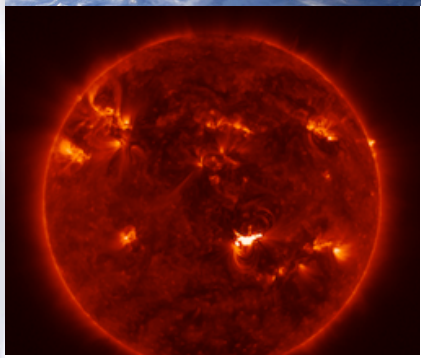
Tel: +32-2-7903-913
Email: helpdesk.swe@ssa.esa.int

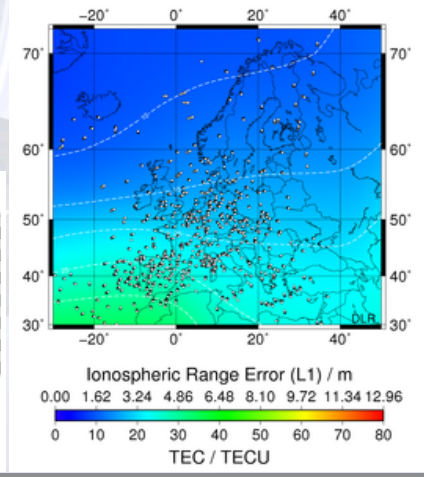


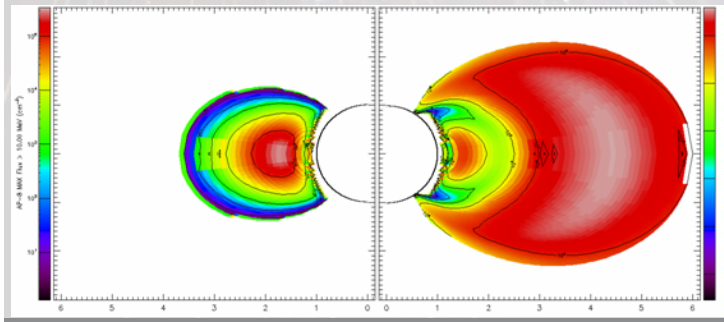


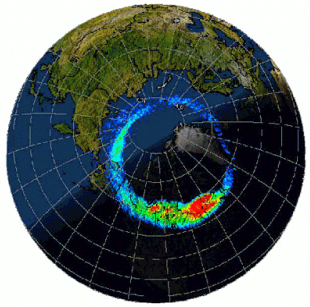
Expert Service Centres (ESCs)

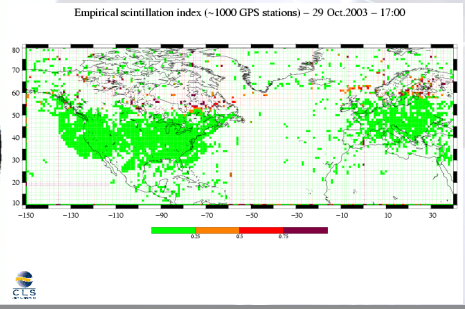
- ESCs are internationally distributed centres of expertise focussed on a specific SWE domain
- Four ESCs established by 2013:
  - Solar Weather: Expertise on solar drivers of the space weather
  - Space Radiation: Expertise on radiation environment in space and for aviation
  - Ionospheric Weather: Expertise on the ionized upper layers of the atmosphere
  - Geomagnetic Environment: expertise on variations in the Earth's magnetic field
- A new ESC will be started in 2014: Heliospheric weather





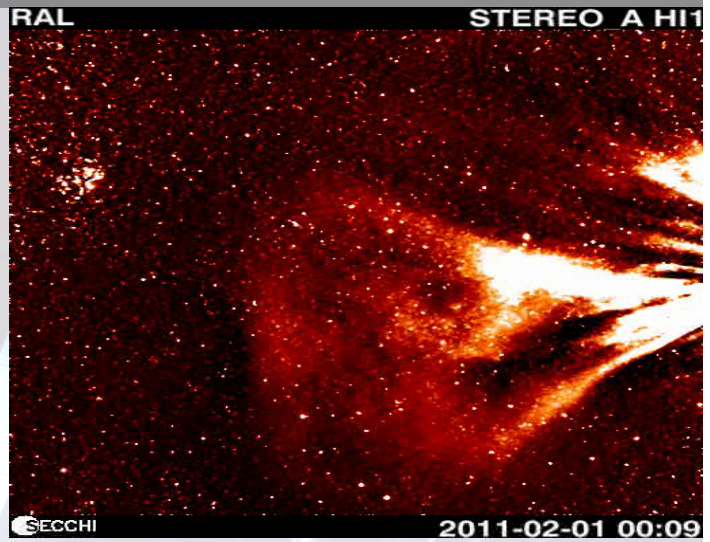


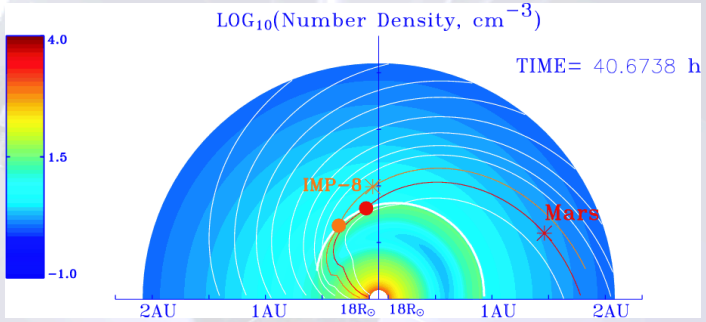




Heliospheric Weather ESC
(development starting in 2014)

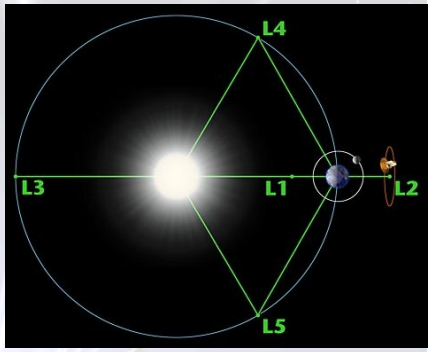
- Focus on magnetospheric response to solar wind disturbances
  - Multi-point remote sensing of heliospheric phenomena
  - Physical modelling of solar wind/CME initiation and evolution, Interaction solar wind/IP CMEs
  - SEP event modelling
  - Nowcast & forecast techniques to be prototyped and tested
- Tasks include space weather at other locations of interest within the heliosphere
- Heliospheric and Solar Weather ESC outputs form key inputs to the ESC network

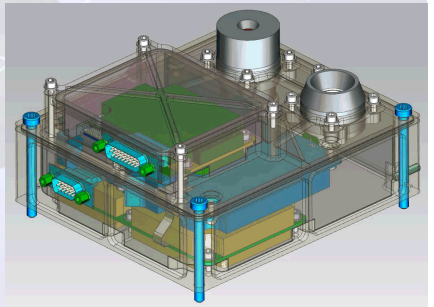




SSA SWE Space Segment Development

- Objective is to ensure data availability and continuity for the ESA SSA system and collaboration partners
- SSA Period 2 includes activities for
  - Operation of the PROBA-2 spacecraft
  - SWE instruments as Hosted Payload (HP) for GEO, MEO and LEO missions
    - NGRM mission on-board EDRS-C under implementation
    - Other HP missions to GEO and LEO under investigation
    - Phase C/D developments of new SWE instruments for HP missions (e.g. magnetometer, EUV imager, …)
  - Phase A/B1 study of an operational L1 mission + Phase 0 study of a L4/L5 mission
  - Prototyping of a compact wide angle coronagraph in ESA GSTP
  - Phase A/B studies on new space based SWE instruments





SSA SWE technology development

- Technology Plan for the SSA Programme produced in 2013
- Includes space and ground segment technologies
- G/S technology developments include
  - Ground based observation systems
  - Data networking, transfer and processing and ingestion
  - Standardisation of instruments and intercalibration
  - Development of physics based and empirical modelling
  - Virtual, distributed data, modelling and service systems
- Virtual Space Weather Modelling Centre (VSWMC): https://esa-vswmc.eu/
  - First European end-to-end modelling effort
  - Protype under development in ESA GSTP
  - Development to be continued within the SSA Programme in 2014

  => International modelling challenge?

G/S challenge: Moving from science to applications to services

User Engagement

- First publication/demonstration of feasibility
  - Comparison with user needs &/or existing services
- Initial implementation of model/algorithm based on existing facilities/data
- Validation/verification
  - Does it work under all conditions and how accurately?
- Tailoring interface and outputs to meet user requirements
  - Focussed development: products, availability and means of delivery
- Implementation in operational environment
  - Model versioning and possible re-coding to comply with IT architecture
  - Service availability guarantee requiring underpinning SLAs

Investigation of performance measures: Metrics

- Critical for understanding how well applications and services are addressing user needs
- Metrics studies are an important part of transitioning a research model into operations.
- Operational models/applications require automated monitoring in order to build up a picture of their performance over time
- SSA P2 objective is to define and apply metrics to new SWE precursor services
- Some metrics related activities are well established, particularly in US e.g. GEM prediction challenge and CCMC metrics studies.
- Prospective for future international cooperation and standardisation of the approach to validation activities: work towards a recognised international benchmark for key models
- A potential approach: Coordination action within e.g. COSPAR framework, with support of existing key players?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THANK YOU
For more information:
swe.ssa.esa.int
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