

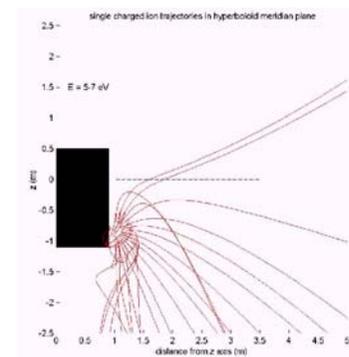
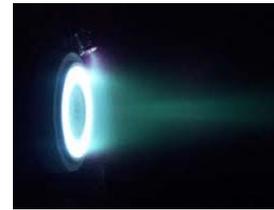
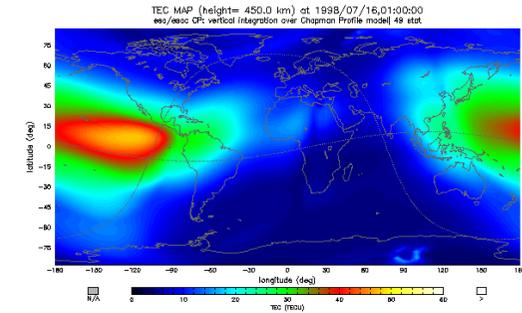
ESA Space Situational Awareness services related to spacecraft charging

A. Hilgers, D. Rodgers, and J.-P. Luntama

- Needs
- Today's approach
- Future: ESA Space Situational Awareness programme

Charged particle interactions with space systems

- Instrumental:
 - Detection of particles and fields
 - Remote sensing
 - Propulsion
- Detrimental:
 - Contamination and interferences
 - Electrostatic discharges
 - Radiation effects



How to address them

- Orbit optimisation
- Protection
- Space weather monitoring and feed-back of information into operational processes

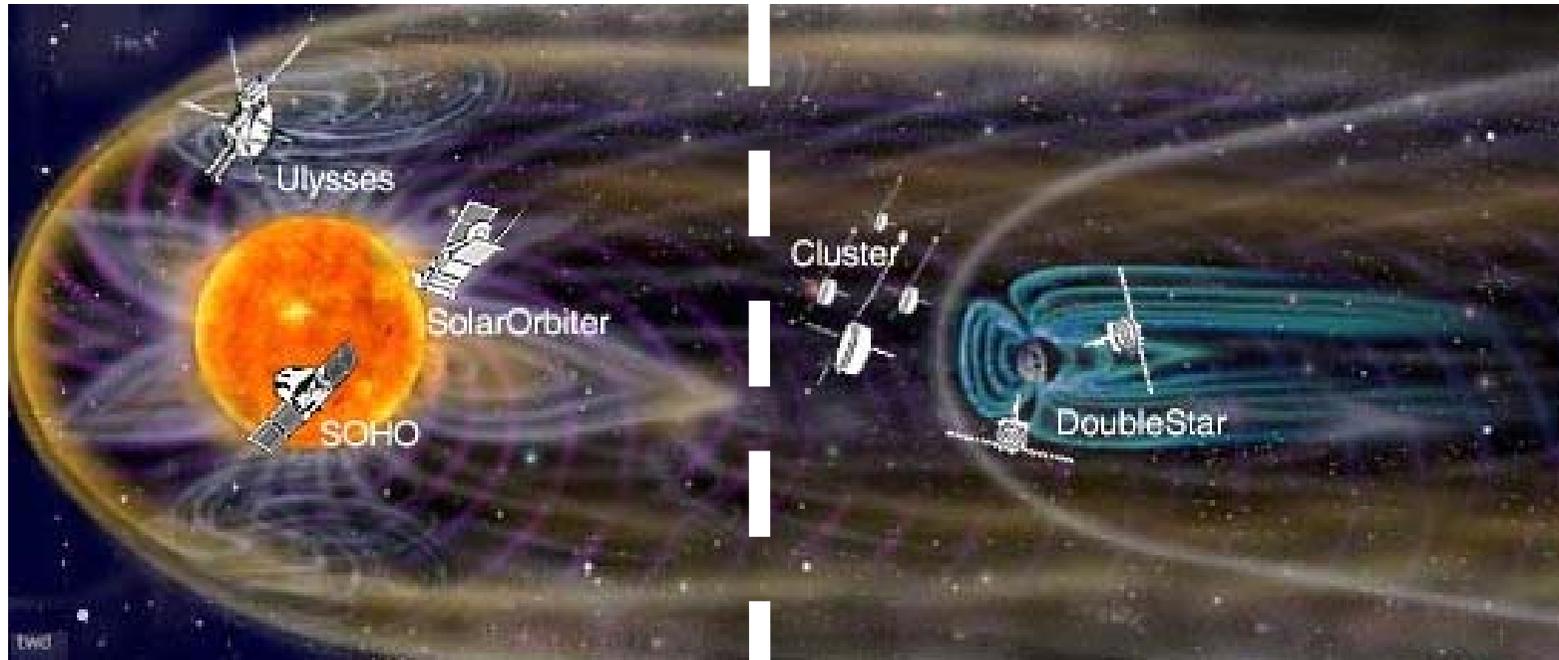
Needs

Service needs	End users
Statistical specification of the space plasma environment or of effects	Development Operation planning
Real-time information on environment or on effects	Operators
Reconstruction of the state of the plasma environment for event analysis	Development Operators
Forecast of the plasma environment	Operators

Today's approach

- Seek data from various sources e.g. (science programme)
- Use adhoc monitors in support to missions.
- Develop and operate models that are often r&d prototypes.

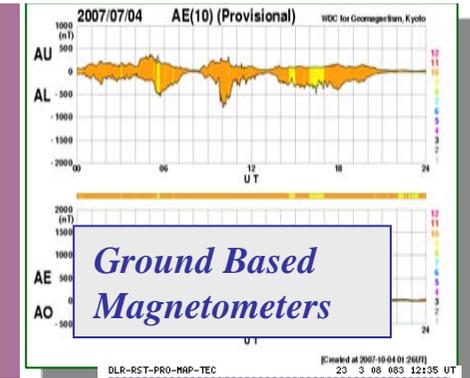
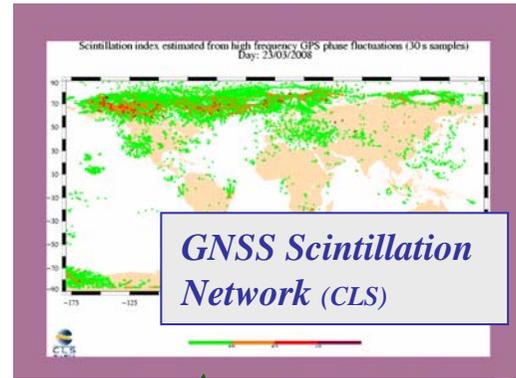
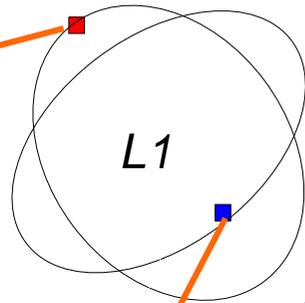
Data from solar-terrestrial missions



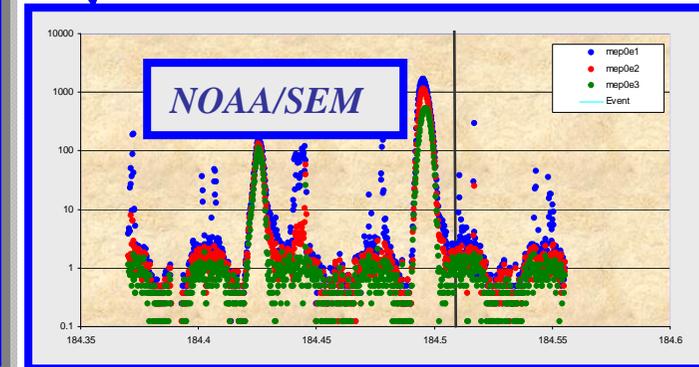
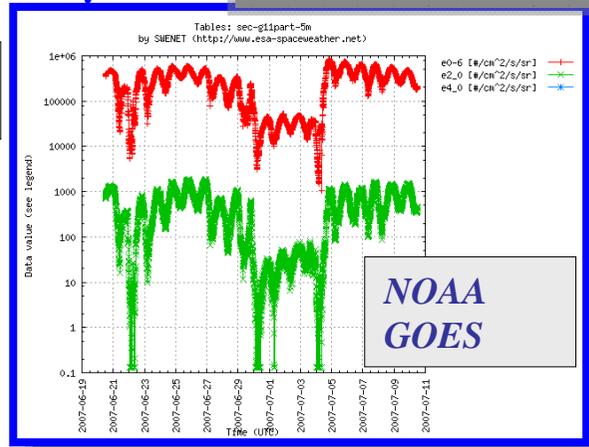
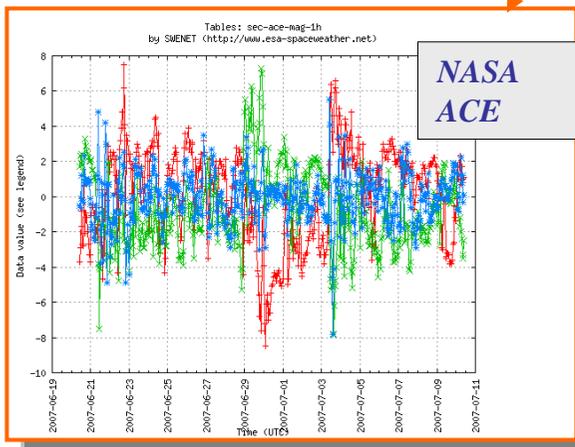
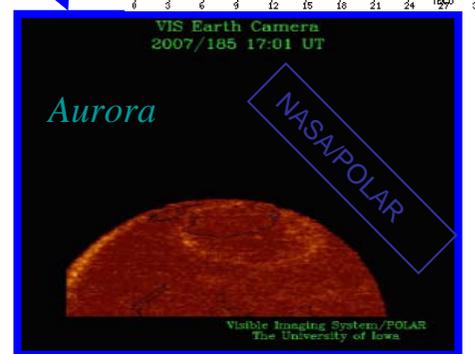
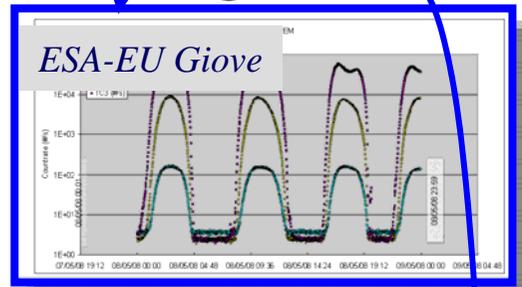
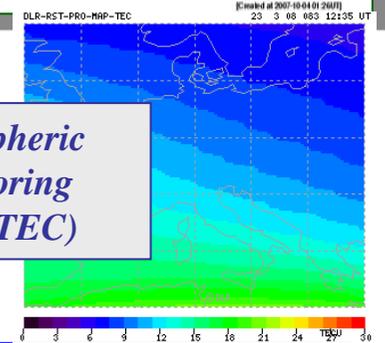
- Ulysses: out of the ecliptic solar observation
- SOHO: solar monitoring
- Cluster: magnetospheric dynamics
- Double star: magnetospheric dynamics
- To come: SWARM : low altitude magnetosphere; Solar orbiter; etc...



Examples of SWE available Resources

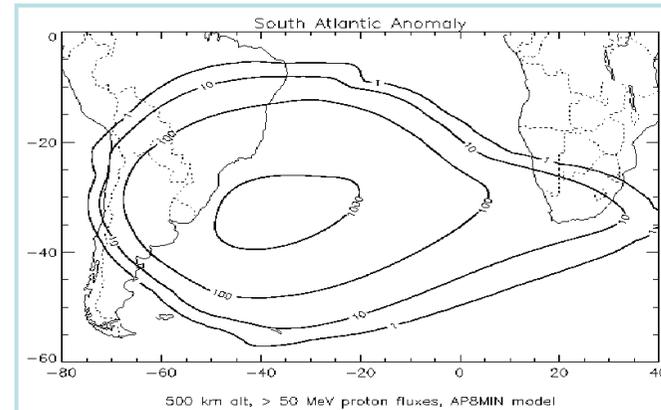


Ionospheric monitoring (GPS TEC)



TR&D programme on space weather effects - 1

- Models of environments and effects for specifications and analysis

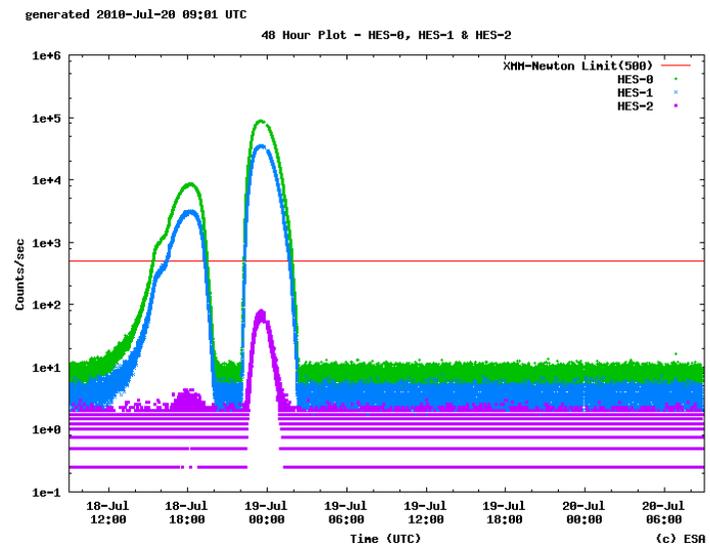


- Space environment monitors to support operations

- Effects experiments



- Technology sat



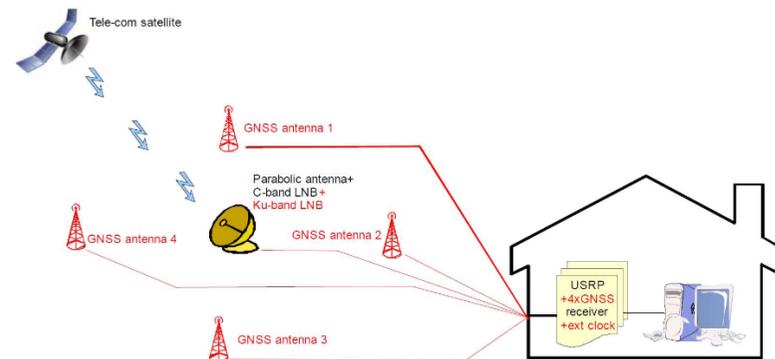
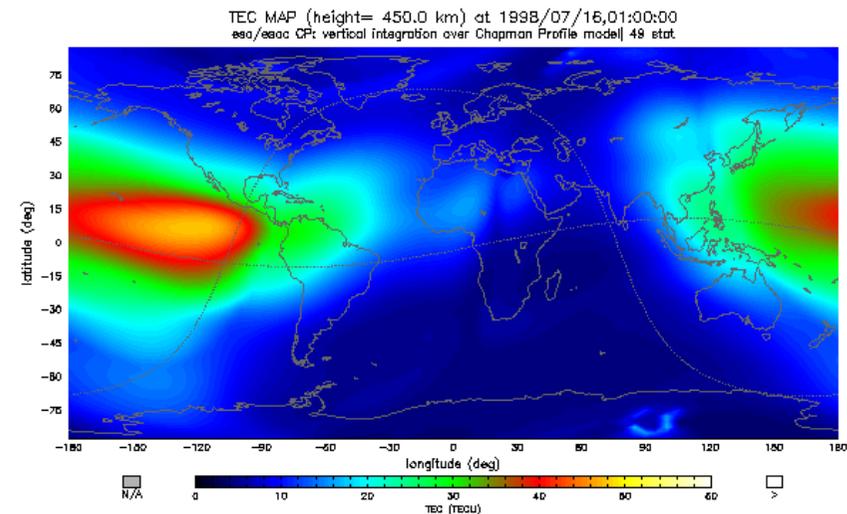
SSA/1/ah

SCTC 2010
ABQ, USA, 20-24 Sept 2010



TR&D programme on space weather effects - 2

- Models of environments and effects for specifications and analysis
- Space environment monitors to support mission operations
- Effects experiments



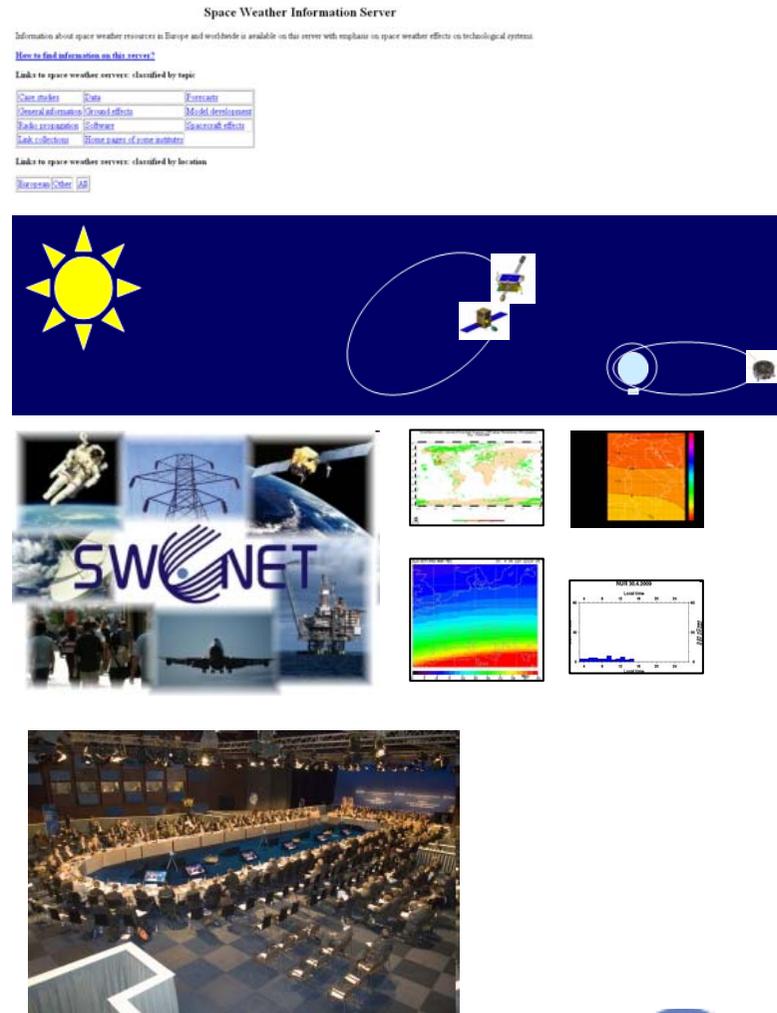
NOAA Space Weather Prediction Centre



- Full operational capability 24h/24h 7Day/7Day
- Continuity of space elements (GOES/SEM, POES, SEM)
- Testing new space elements: ACE solar wind monitoring
- Modelling programme

ESA application programmes: space weather programme

- 1998: review of assets and capabilities
- 2000: review of requirements for a programme: customer requirements, system requirements, architecture study
- 2002: cost benefit analysis of a federative approach to space weather service provision
- 2008: adoption of a Space Situational Awareness (SSA) programme with a space weather element besides a survey and tracking element and a NEO element.



SSA programme

- Objective: to set-up an independent European SSA system in a 10 year-time scale and transfer it to an operator.
- Application domains:
 - Survey and tracking
 - (Imaging)
 - Space weather
 - Near Earth objects
- Phases:
 - Preparatory programme + TR&D: 2009-2011
 - Development phase: 2012-2019
- Participating countries:
Austria, Belgium, *Finland*, France, Germany, Greece, Italy, *Luxembourg*, Norway, Portugal, Spain, Switzerland, UK.

SSA Programme Tasks

2009 – 2011: Preparatory Programme

- Requirements analysis
 - User requirements
 - Governance Definition
 - Data Policy
- Architecture
- Precursor Services
- Federation
- Pilot Data Centres
- Radar Breadboard
- Other TR&D from ESA relevant R&D

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SSA SPACE WEATHER SEGMENT ACTIVITIES

User Domains and Services

1. Spacecraft designers

- Environment specification and post event analysis

2. Spacecraft operators

- In orbit environment and effects monitoring/forecasting, post event analysis, mission analysis

3. Human space flights

- In flight and cumulative crew radiation exposure, increased crew radiation exposure risk

4. Launch operators

- In flight monitoring, estimates and forecasts of radiation effects in electronics, atmospheric density forecasts

5. Transionospheric radio link users

- Near real-time and forecast TEC maps, scintillation maps, ionospheric disturbances monitoring

6. Survey and tracking

- Atmospheric estimates, geomagnetic and solar indices archives and forecast for drag calculation

7. Data services

- Space weather data archive, event based alarms, integrated space weather model platform,

8. Non Space Systems Operators

- Power systems and pipeline operators, airlines, resource exploitation system operators, auroral tourism sector



SSA SPACE WEATHER SEGMENT ACTIVITIES

Precursor Services

- More than 30 services identified.
- SN-1 contract: preliminary service segment work – to begin soon.
 - Review of existing applications and assessment of maturity:
 - Cat-1: existing quasi-operational application
 - Cat-2: all building block exist in non-operational environment
 - Cat-3: critical building block is missing
 - A subset of existing applications and services to be re-deployed in Redu (B) in 2010.
 - ESA owned applications to be part of these precursor services:
 - Space Environment Data System (SEDAT)
 - European Impact Detector Database (EDID)
 - Space Environment Information System (SPENVIS)
 - Standard Radiation Environment Monitors (SREM)
 - Space Weather European Service Network (SWENET) portal
 - Space Environment System for Operations (SEISOP)
 - Ionospheric Monitoring Facility (IONMON)
 - Service assessment based on re-deployed or federated applications, prototypes or mock-up's.
 - More precursor services to be developed under future contracts (SN-4)

SSA SPACE WEATHER SEGMENT ACTIVITIES

Measurement Infrastructure

System requirement and architecture study to be performed under Co-1 contract – started.

Re-use of existing (ground based and space based) Member States assets will be considered in priority – start soon.

Meanwhile preparatory work for piggy-backing on planned platforms is to be performed under SN-2 contract – started.

Platforms include ESA, MS and other (international, commercial, ...).

Baseline list of SWE Instrument types to be addressed in SN-2:

- X/EUV imager
- X-ray flux monitor
- UV flux monitor
- Wide Angle Coronagraph
- 3D Magnetometer
- Solar wind plasma monitor
- Plasma spectrometer and
- (Langmuir) density probe.
- Medium energy particle detector
- Compact Radiation Monitor
- High energy particle spectrometer
- GNSS dual frequency receiver in radio-occultation mode
- Micro-particle detector

Conclusions

- SSA PP is preparing for a full blown operational European space weather application system.
- As a first step SSA PP is transitioning relevant assets (including research models and instruments concepts based on science mission heritage) into operational elements.
- Many aspects need to be defined and an appropriate architecture found:
 - query handling
 - data system
 - measurement infrastructure
 - service provision