ESA SSA Services Helping to Mitigate the Risks of Space Weather Events

Jordanas Técnicas Sobre "Clima Espacial"
Madrid, 23 – 24 Marzo 2011

Juha-Pekka Luntama

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**

INTRODUCTION
AIMS OF THE SSA PROGRAMME

- Independent utilisation of Space
  - Space assets are critical assets
- Guarantee access to Space
  - Diplomatic,
  - Political
  - Regulatory
  - Technical
- Serve EU “Lisbon Objectives”
  - New Applications
  - New Jobs
  - New Markets

INTRODUCTION
CUSTOMERS FOR SSA SERVICES

- European Governments
  - EU
  - National
  - Regional
- European Space Agencies
  - ESA, EUMETSAT
  - National
- Spacecraft Operators
  - Commercial
  - Academic
  - Governmental
- Space Insurance
- Space Industry
- Energy
  - Surveying
  - Electrical Grid
  - Power Supply
- Network Operations
- Telecommunications
- Air Traffic Control
- Search and Rescue Entities
- United Nations
- Defence
- Civil Protection

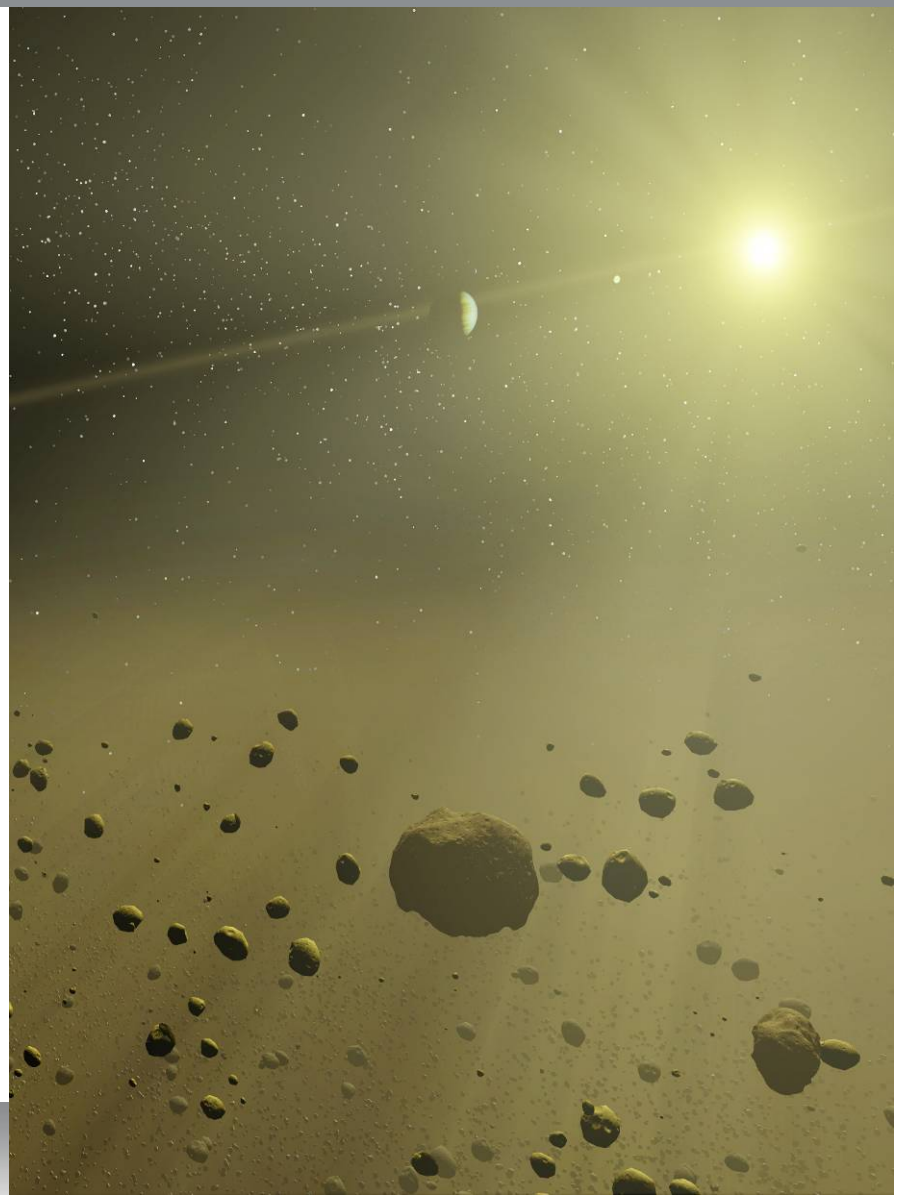
INTRODUCTION
CURRENT OBJECTIVES

2009 – 2012

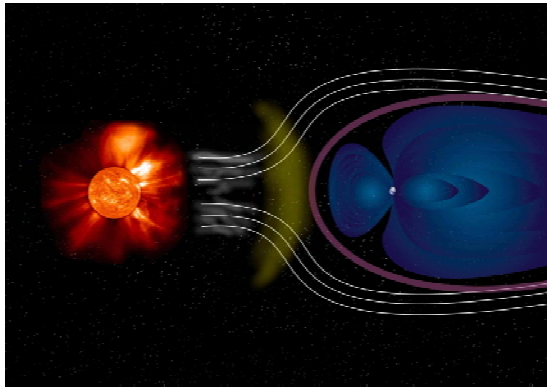
- **Preparatory Programme**
  - Governance Definition
  - Data Policy
  - Architecture
  - Federation
  - Precursor Services
  - Radar Breadboard
  - Pilot Data Centres

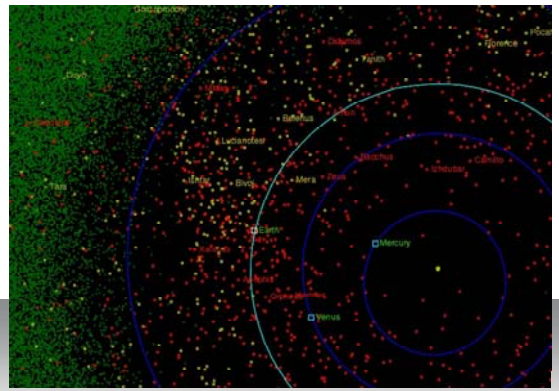
2013 – 2020

- **Development / Operational Phase**
  - Development of essential components
  - SSA Exploitation



INTRODUCTION
SSA PROGRAMME SEGMENTS





Space Surveillance and Tracking (SST)

- Maintain catalogue of man-made objects in Earth Orbit
- Detection, tracking, correlation and characterisation of all objects above a given size threshold for a given orbit region
- Covers LEO, MEO and GEO
- Prediction and warning of collisions and re-entry events
- Detection of on-orbit explosions, collisions and manoeuvres

Space Weather (SWE)

- Detection and forecasting of Space Weather and its effects
- Monitoring of the sun, solar wind, magnetosphere, radiation belts, ionosphere and disturbances in the geomagnetic field
- Provide SWE effect related services for designers, operators and users of spaceborne and ground based infrastructures
- Statistical monitoring of micro particles of natural or human origin

Near Earth Objects (NEOs)

- Solar system objects with orbits bringing them into close proximity with the Earth
- Includes a few thousand Near Earth Asteroids, Near Earth Comets, solar orbiting spacecraft and larger meteoroids
- Determination of the orbit state and physical parameters
- Identification and ranking of NEO collision risk with the Earth

INTRODUCTION
European SSA System

ESA SSA SPACE WEATHER (SWE) Services

Image Credit: Keith Vanderline / NS

SPACE WEATHER
Space Weather Risks

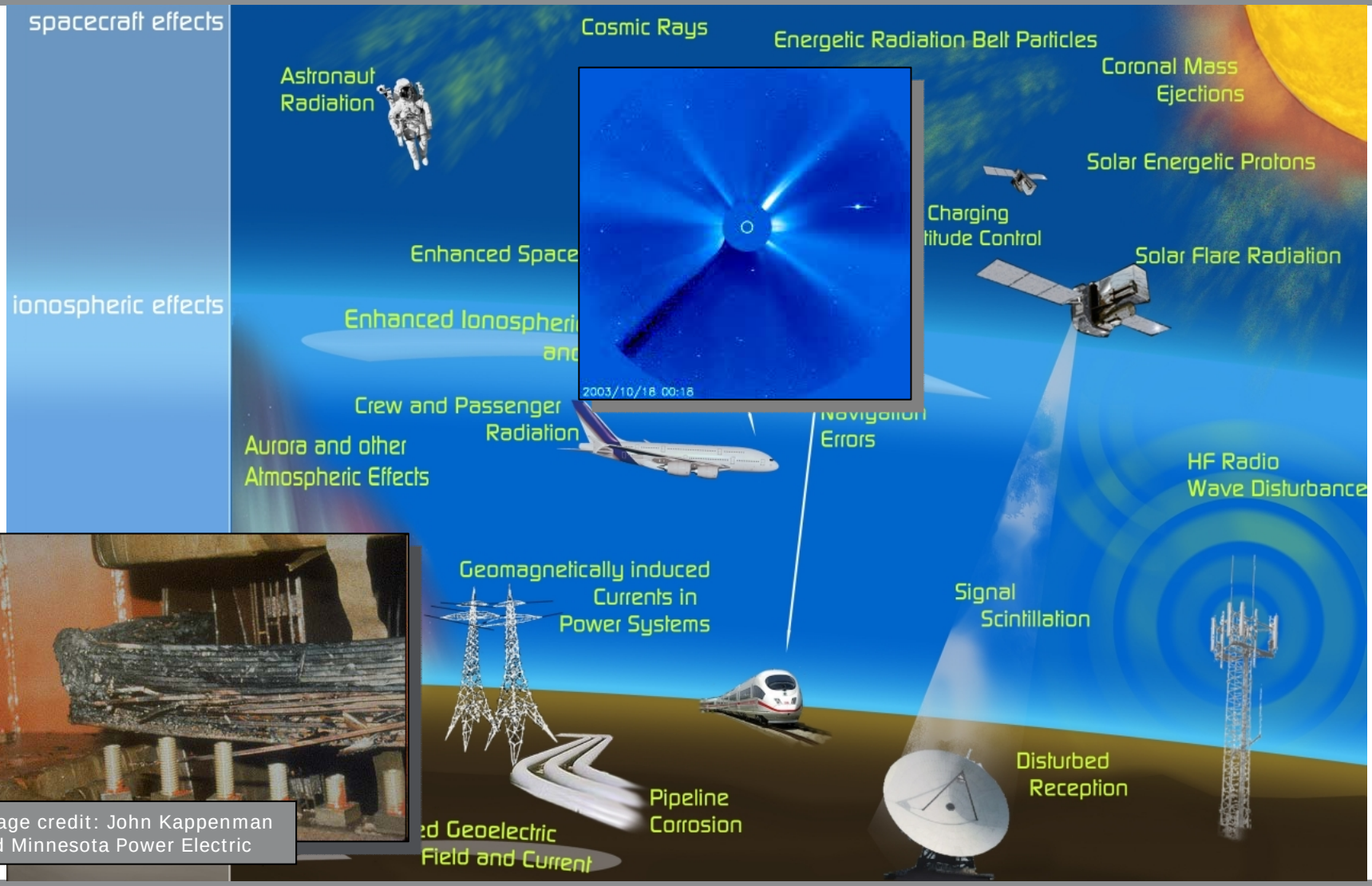
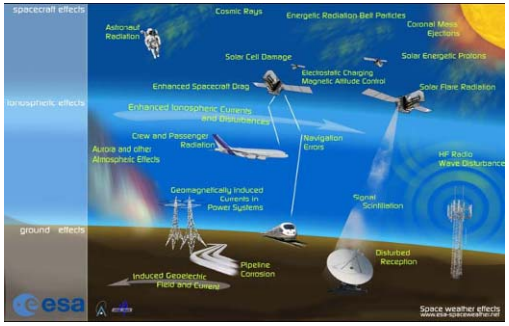


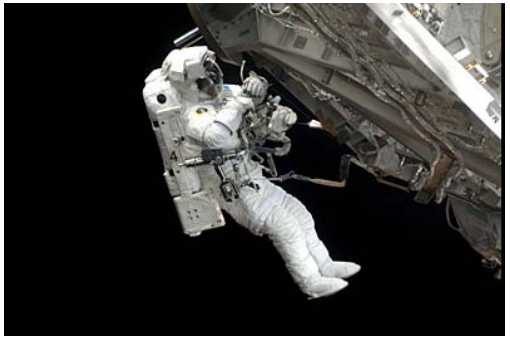
Image credit: John Kappenman and Minnesota Power Electric

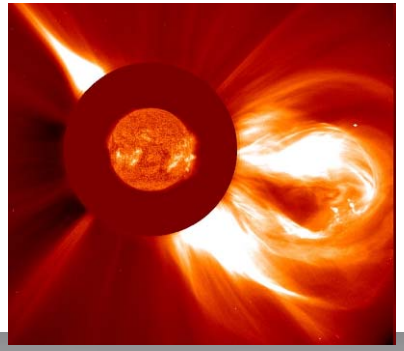
SPACE WEATHER
ESA SSA SWE Objectives

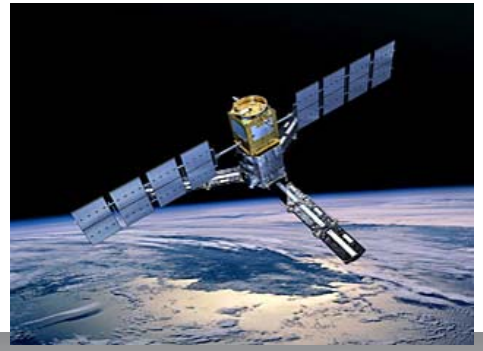
Detection and forecasting of the Space Weather events and the effects it has on European space assets and ground based infrastructure:

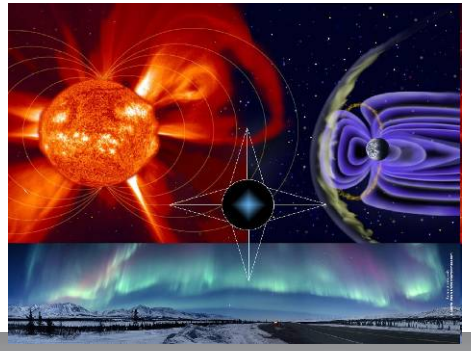
- Comprehensive knowledge, understanding and maintained awareness of the natural space environment
- Detection and forecasting of SWE and its effects
- Detection and understanding of interferences due to SWE
- prediction and/or detection of permanent or temporary disruption of mission and/or service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











images: (ESA & NASA)

SPACE WEATHER
User Domains and Planned Services

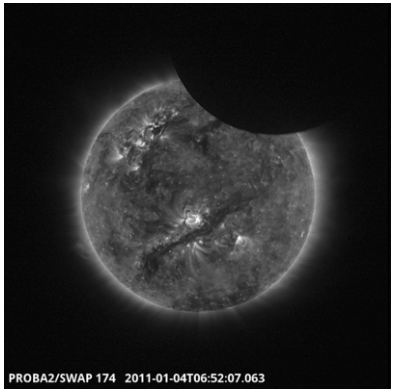
1. Spacecraft designers
    - Environment specification and post event analysis
2. Spacecraft operators
    - In orbit environment and effects monitoring/forecasting, post event analysis, mission analysis
3. Human space flights
    - In flight and cumulative crew radiation exposure, increased crew radiation exposure risk
4. Launch operators
    - In flight monitoring, estimates and forecasts of radiation effects in electronics, atmospheric density forecasts
5. Transionospheric radio link users
    - 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
8. Non Space Systems Operators
    - Power systems and pipeline operators, airlines, resource exploitation system operators, auroral tourism sector

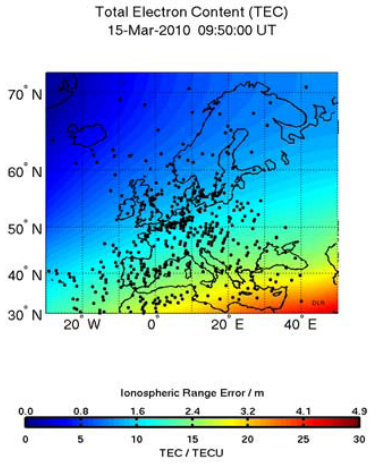
SPACE WEATHER
Initial Precursor Services I

- A subset of percursor services will be made available through the SSA system in 2011
- First four Expert Service Centres (ESC) are established:
  - Solar Weather (coordinator: ROB)
  - Space Radiation (coordinator: BIRA-IASB)
  - Ionospheric Weather (coordinator: DLR)
  - Geomagnetic Conditions (coordinator: TGO)
- A large number of federated services:
  - SIDC: SIDC ursigram, sunspot index, forecasts of the Sunspot Index, GPS relevant ionospheric and geomagnetic conditions, CACtus CME detection: daily detection and catalog, NEMO EUV wave detection: catalog only, provisional aa index, monthly activity bulletin, GOES X-ray flare alert CACtus halo CME detection alert, disturbed geomagnetic conditions alert, all quiet alert, Presto, Proba-2 data, SDO data redistribution, ...
  - BIRA-IASB: SPENVIS
  - DLR: Access to the services from the SWACI system
  - TGO: Expertise and services on geomagnetism
  - AIT: Background radiation doses for flight routes

PRESTO FROM SIDC - RWC BELGIUM Mon Jan 17 2011, 123

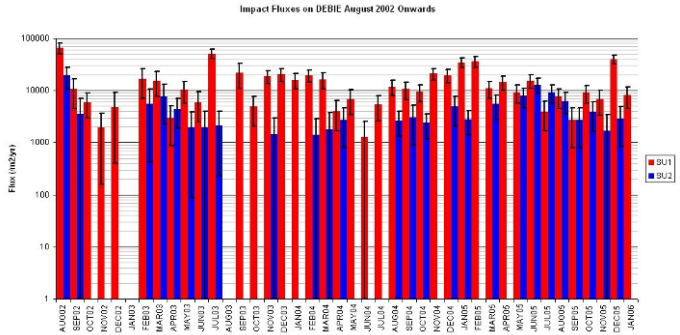
The fast solar wind speed escaping from the extension of the southern coronal hole, might arrive today. According to the solar wind parameters recorded by STEREO B, we expect the solar w to rise up to 500 km/s. Active conditions are possible, unsettled conditions are more likely. Other conditions are quiet.

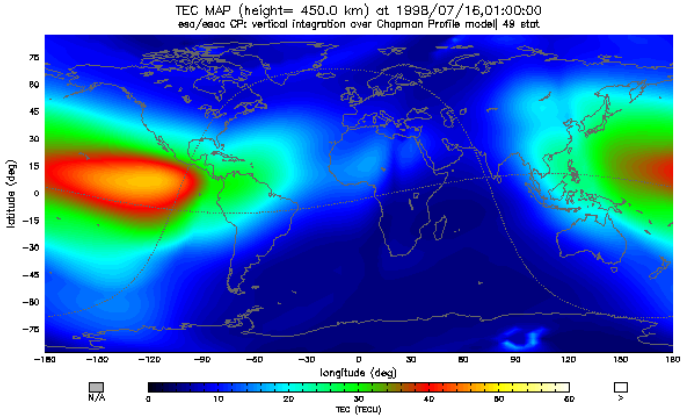


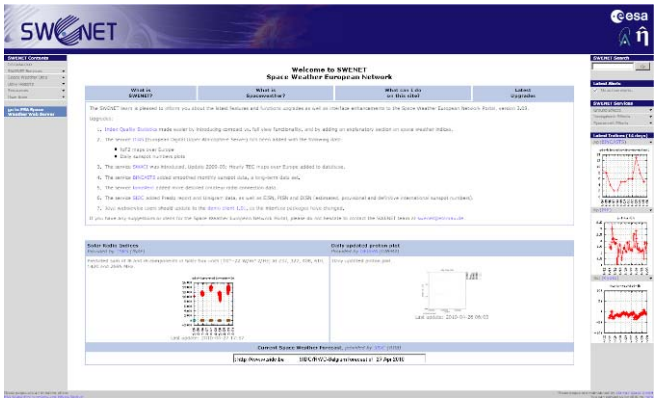


SPACE WEATHER
Initial Precursor Services II

- The applications developed by ESA will be part of the 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)
- All services will be available to the users through the SSA web portal







Space Weather

Service Example: solar flare on 15 Feb 2011

:Issued: 2011 Feb 15 1526 UTC
:Product: documentation at http://www.sidc.be/products/meu
#---#
DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the
(RWC Belgium)
#---#
SIDC URSIGRAM 10215

:Issued: 2011 Feb 16 1130 UTC
:Product: documentation at http://www.sidc.be/products/cactus

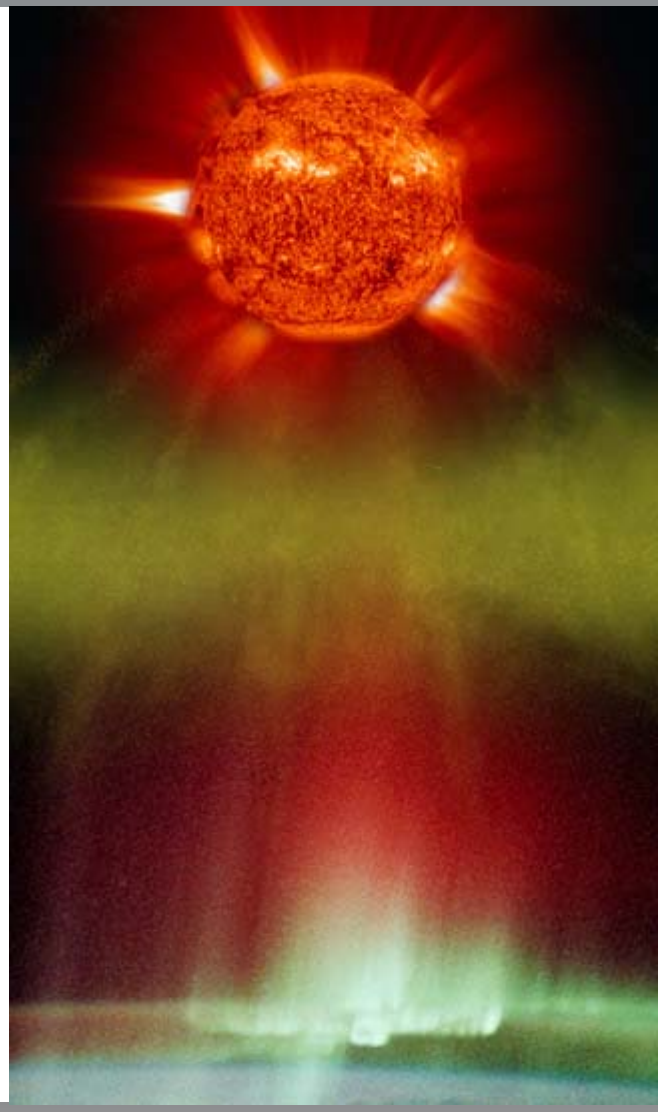
PRESTO FROM SIDC - RWC BELGIUM Wed Feb 16 2011, 1337 UT

Solar activity continues to be high from NOAA AR 1158 with two M flares (M1.0 flare peaking at 01:39 UT and M1.0 at 07:44 UT), plus several C-flares. This region is still growing and has potential for more M and probably X class flares. An eruption occurred in AR 1161 (around 02:00 UT) that lead to a CME directed towards the north which is not expected to arrive to the Earth. Geomagnetic conditions are quiet but are expected to be disturbed later tonight or tomorrow, by the arrival of the CMEs (3) that erupted in the previous three days. Since the last CME was faster than the previous two, they will most likely interact in interplanetary space and it is extremely difficult to give a good prediction of the geomagnetic consequences, but storms are expected.

didn't reach critical levels. More active conditions, with possible storm periods, are expected tomorrow and the day after, due to the three CMEs which have been directed towards the Eath in the last three days.

Space Weather
Conclusions I

- Space weather can cause significant risks on secure and safe operation of the critical European space and ground based infrastructure and related services
- Potential effects of Space Weather include:
  - degradation of spacecraft communications, performance, reliability, and lifetime
  - risks to human health in manned space missions
  - damage to aircraft electronics
  - radiation doses to air passengers and crew
  - damage and disruption to power distribution networks and pipelines
  - degradation of ground based VHF/UHF radio communications



Space Weather
Conclusions II

- Space Situational Awareness (SSA) Preparatory Programme (PP) is an ESA programme that was started in 2009
- Objective of the programme is to support the European independent utilisation of and access to space research or services
- Space Weather (SWE) segment of the SSA PP is starting the establishment of services addressing a wide variety of space weather user domains
- The initial precursor services established in 2011 and 2012 based on existing expertice and assets in Europe
- All services will be made available through the ESA SSA web portal


esa
GRACIAS
http://www.esa.int/esaMI/SSA/index.html
European Space Agency