

# European Space Weather Activities within ESA

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**TIEMS Oslo Conference**  
**22 – 24 October 2012**  
on  
**Space Weather and Challenges**  
**for Modern Society**

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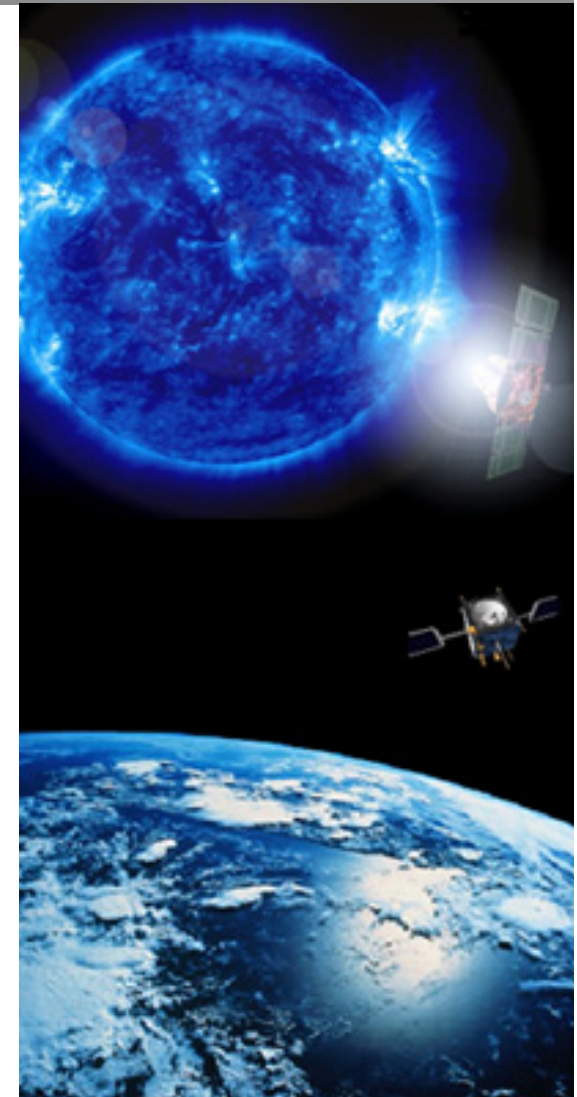
European Space Agency



# ESA Space Weather Activities

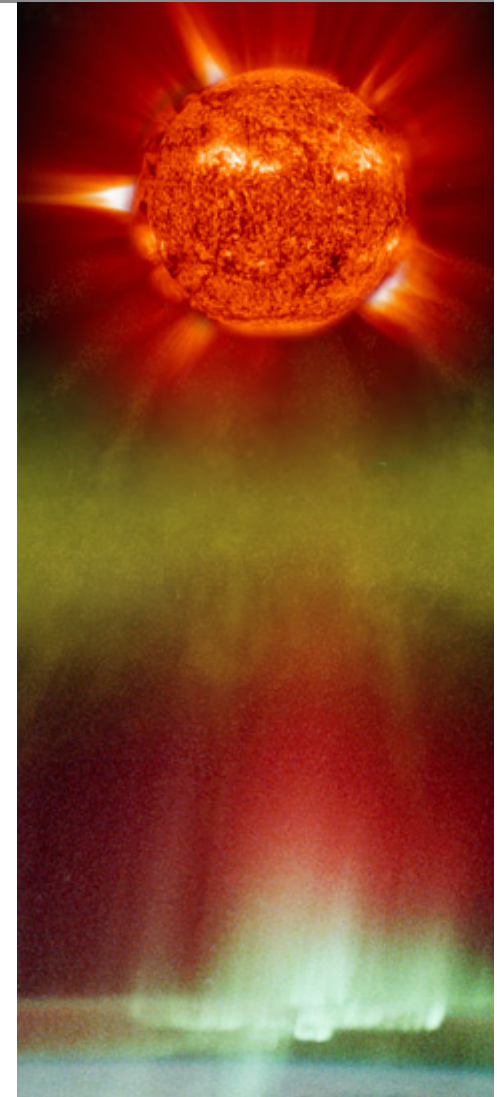


- ESA has been actively working on space weather projects for over 15 years:
  - 1998: ESA Workshop of Space Weather
  - 2004: First European Space Weather Week
  - 2003 - 2005: Space Weather Applications Pilot Project
  - 2009: SSA Preparatory Programme
  - 2012: 9<sup>th</sup> European Space Weather Week
- Space weather activities are carried out within several programmes:
  - SSA (Space Situational Awareness)
  - GSTP (General Support Technology Programme)
  - GSP (General Studies Programme)
  - TRP (Technology Research Programme)

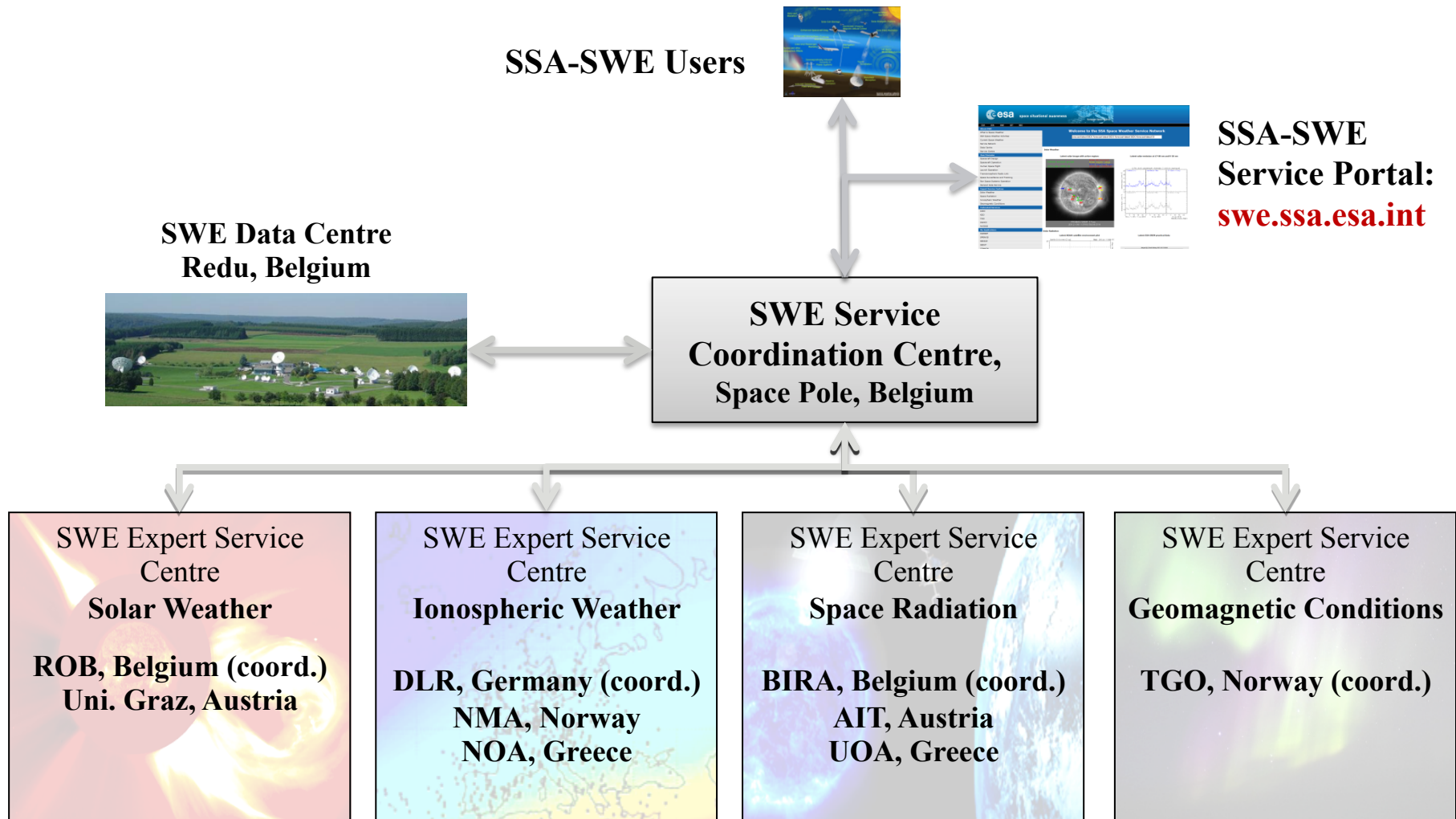




- Development of the SSA-SWE services is based on utilisation of European space weather assets and expertise
  - ⇒ ESA is coordinating the system development and establishing a framework to network European assets
  - ⇒ Services will be provided by European centres forming Expert Service Centres (ESCs)
  - ⇒ Federated SSA-SWE Services
- ESA will establish agreements with
  - ESCs for service provision
  - Asset owners (ground based and space borne assets) for access to the SWE data
- ESA will continue the development of the SSA-SWE space segment to ensure availability of the space weather data



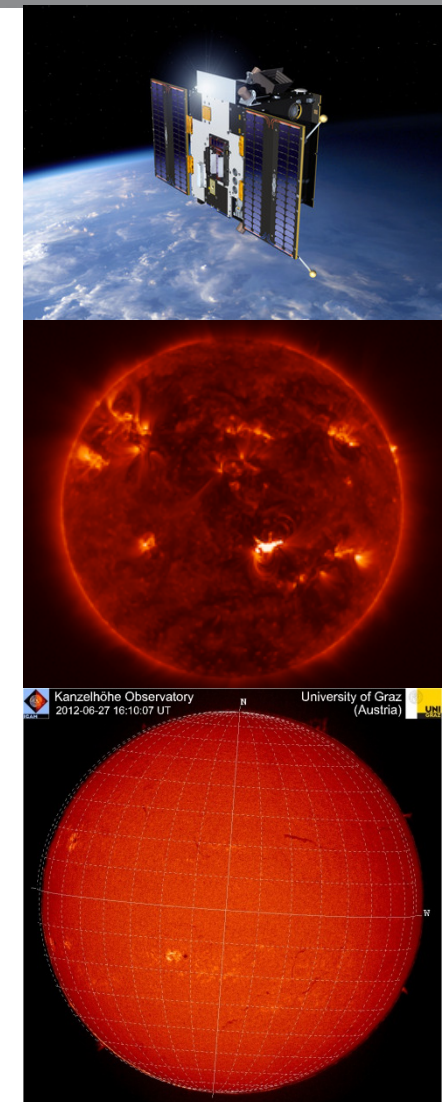
# SSA-SWE Precursor Service System in 2012



## SSA-SWE Segment *ESC: Solar Weather*



- Solar Weather ESC centralises the expertise on solar drivers of the space weather
- The expertise offered by the ESC includes
  - Long term solar cycle prediction
  - Solar flare monitoring and statistical prediction
  - Coronal Mass Ejection (CME) monitoring and geo-impact prediction
  - Coronal hole monitoring and geo-impact prediction
- Provides a large number of federated SSA-SWE services:
  - solar event alerts (automatic and forecaster triggered)
  - Solar weather predictions and forecasts
  - Latest and archived solar data
  - solar indexes
- Coordinator: **Royal Observatory of Belgium, Belgium**
- Participants: **University of Graz, Austria**

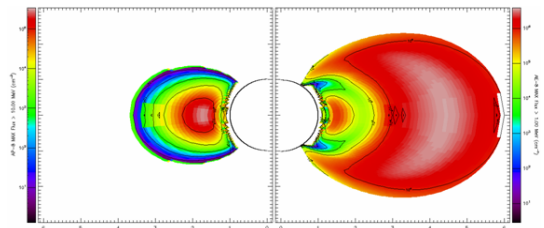


## SSA-SWE Segment

# ESC: Space Radiation Environment



- Centralises the expertise on radiation environment in space and in aircraft flight altitudes
- End user support includes
  - Solar Energetic Particle (SEP) events: potentially harmful for manned spaceflight and airline crews/passengers on polar flight
  - Trapped radiation particles: harmful for spacecraft electronics, electrical systems and solar cells
  - Cosmic rays: harmful for spacecraft electronics and cause for background radiation dose for aircraft crew/passengers
- Applications made available to end users:
  - SPENVIS (SPace ENVironment Information System)
  - AVIDOS (AVIation DOSimetry)
- Coordinator: **Belgian Institute of Space Aeronomie, Belgium**
- Participants: **Austrian Institute of Technology, Austria**

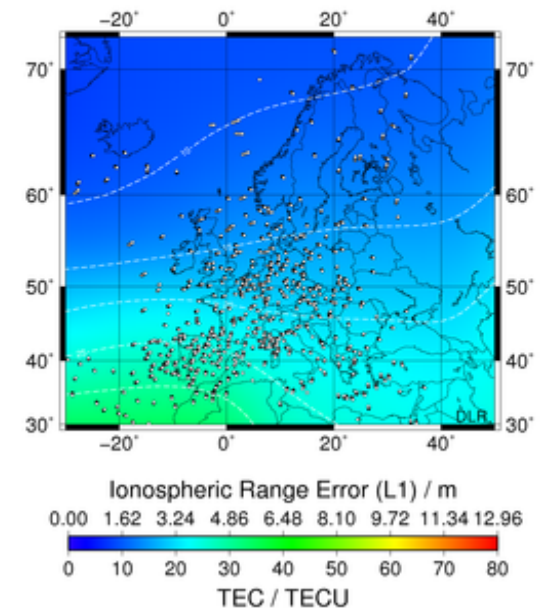




## SSA-SWE Segment *ESC: Ionospheric Weather*



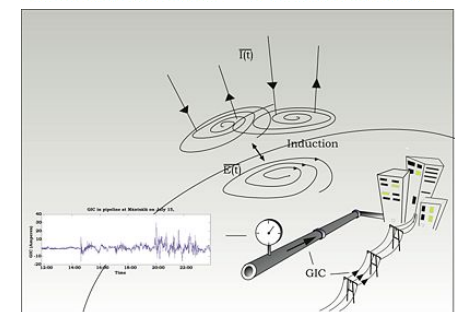
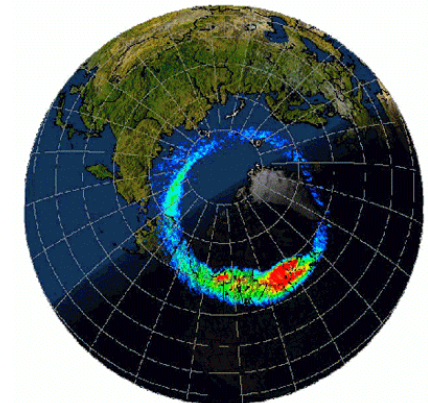
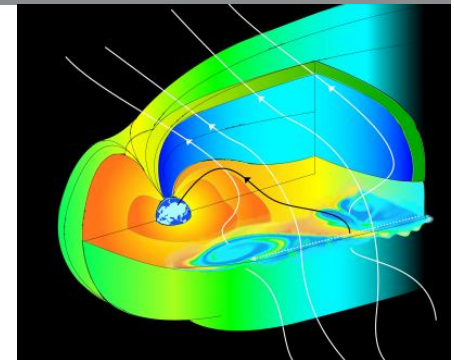
- Ionospheric Weather ESC centralises the expertise on the ionized upper layers of the atmosphere
- Disturbances in the ionosphere impact satellite telecommunication, navigation and VHF/UHF radio communication
- Federated services offered by the Ionospheric Weather ESC include:
  - Regional and global maps and forecasts of Total Electron Content (TEC)
  - Ionospheric disturbance information and alerts
  - Ionospheric scintillation information
  - 2D electron density in the plasmasphere
- Coordinator: **Deutschen Zentrums für Luft- und Raumfahrt, Germany**



## SSA-SWE Segment *ESC: Geomagnetic Conditions*



- Geomagnetic conditions ESC centralises expertise on variations in the Earth's magnetic field
- Geomagnetic storms can cause problems in traditional navigation systems, Geomagnetically Induced Currents (GIC) in power systems and pipelines and are related to ionospheric disturbances
- The end users of the Geomagnetic Conditions ESC services include:
  - Power grid and pipeline operators
  - Resource exploration and exploitation industry
  - Geomagnetic surveying companies
  - Auroral tourism sector
  - Other ESCs requiring geomagnetic data
- Coordinator: **Tromsø Geophysical Observatory, Norway**

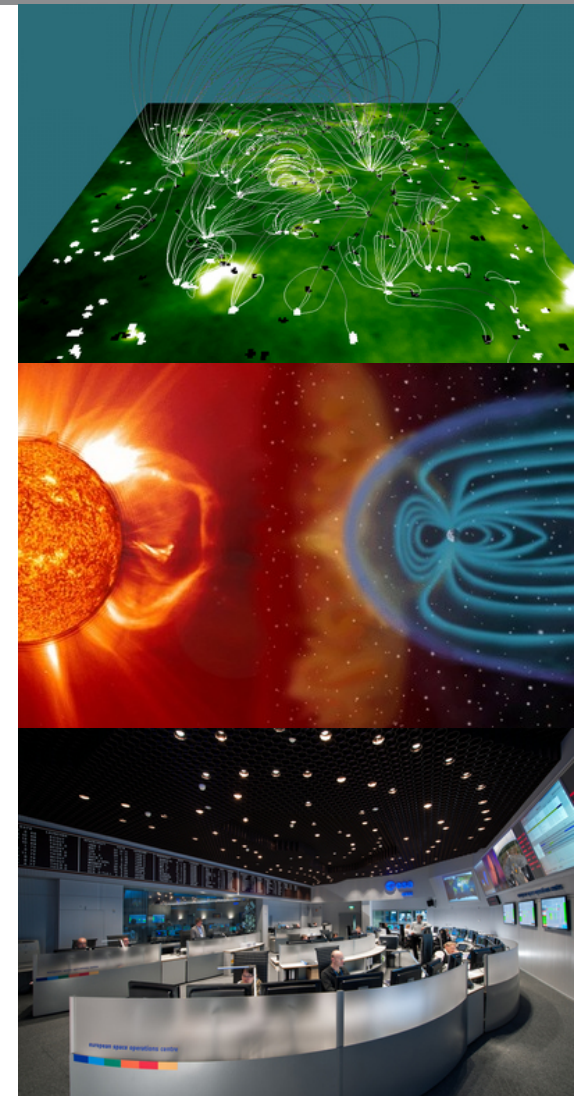




## SSA-SWE Segment *ESC Concept Evolution*



- Existing ESCs have been established focusing on physical domains of space weather
- New participants to the existing ESCs are expected already during SSA PP to establish more services to the users
- Additional ESCs are foreseen during SSA Period 2
- Interplanetary environment modeling is one potential new ESC topic
- Development of the ESC concept and the federation of the SSA-SWE services will be continued throughout the Programme
- ESCs and the participating entities are the core of the SSA-SWE service provision system

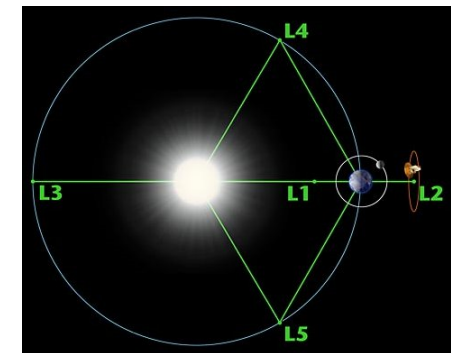
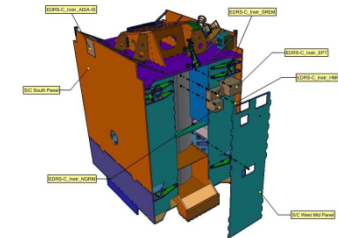


# SSA Space Weather Segment

## SSA-SWE Space Segment Development



- SSA-SWE services depend critically on space borne observations
- SSA Period 2 proposal includes activities for
  - SWE instruments as Hosted Payload for GEO, MEO and LEO missions
    - Radiation environment, s/c charging, solar x-ray, micro-particles, magnetic field and plasma measurements
    - Phase C/D development for selected instruments either as part of the SSA Programme or in national activities
  - System studies for enhanced SWE monitoring from L4/L5 points with a heliospheric imager mission
  - Exploitation of data from existing and already planned SWE missions including e.g. Proba-2, GIOVE A and B, Galileo FOC, MTG,...
  - Phase A/B/C/D development of a miniaturized wide angle coronagraph
  - Phase A/B studies on new space based SWE instruments



# Space Weather in ESA Technology Programmes



Instrument	Programme	Status
Energetic Particle Telescope (EPT): Ph C/D	GSTP4/ <b>Proba-V</b>	Running (QinetiQ Space/ UCL, B)
EUV Solar Imager for Operations (ESIO): Ph A/B	GSTP5-Elt3	Running (CSL, B)
Next Generation Radiation Monitor (NGRM): Ph A/B/C/D	GSTP5-Elt2	Running (RUAG, CH)
High-Fidelity 3-D Energetic Electron Spectrometer: Ph A/B	GSTP5-Elt3	Running (UCL/CSR, B)
Service oriented spacecraft magnetometer set (SOSMAG)	GSTP5-Elt3	2 Running (Magson, D, IWF, A)
Particle Trajectory Analyzer: Ph A/B	GSTP5-Elt3	Running (Etamax, D)
Next Generation Micro Debris and Meteoroid Analyzer Prototype	GSTP5-Elt3	Not subscribed (Phase A/B in progress)
Compact X-ray Solar Monitor for Operations (CXSMO)	GSTP5-Elt3	Not subscribed
Prototype Compact Wide Angle Coronagraph for SSA	GSTP5-Elt3	Not submitted to IPC
3-D solar wind plasma monitor	GSTP5-Elt3	Not submitted to IPC



# Space Weather in ESA Technology Programmes



Instrument	Programme	Status
High Performance Distributed Solar Imaging and Processing Prototype	GSTP5-Elt3	Under negotiation
Next Generation Space Environment Information System	GSTP5-Elt3	Running (BIRA, B)
Virtual Space Weather Modelling Centre – Phase 1	GSTP5-Elt3	Running (KU Leuven, B)
H-alpha Solar Telescope Network prototype for Applications (HASTENet)	GSTP5-Elt3	Not subscribed
Distributed Environmental Data-Driven Analysis System	GSTP5-Elt3	Not submitted to IPC
Detection of micro-particle impacts on spacecraft via their plasma effects	GSP	Under evaluation
Interplanetary and Planetary Radiation Model for Human Space Flight	GSP	Running (DHC, B)

## *Other Activities in Europe and beyond*



- ESA is actively participating SWE activities in international frameworks
  - COSPAR Panel on Space Weather
  - UN OOSA Expert group C of the Long Term Sustainability Working Group
  - ISWI
  - WMO
  - ISES
  - ILWS
- ESA is also following closely EC FP7 space weather related projects  
=> utilisation of the results in the SSA Programme



# European SSA System



**Thank you!**