Overview of SSA PP 2012 - SWE Achievements and plans for the next Period

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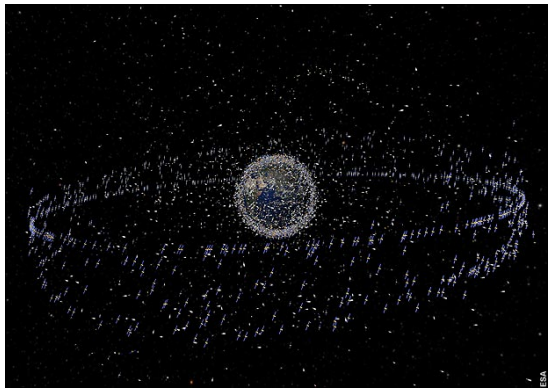
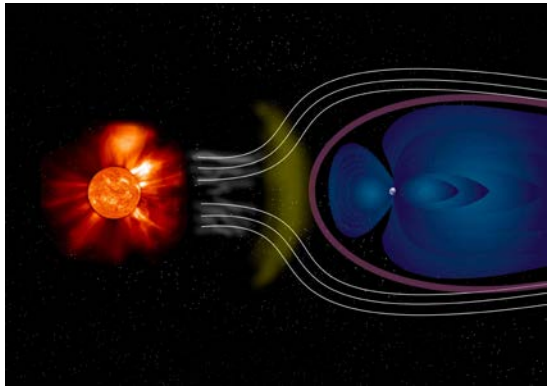
PURPOSE OF THE SSA PROGRAMME

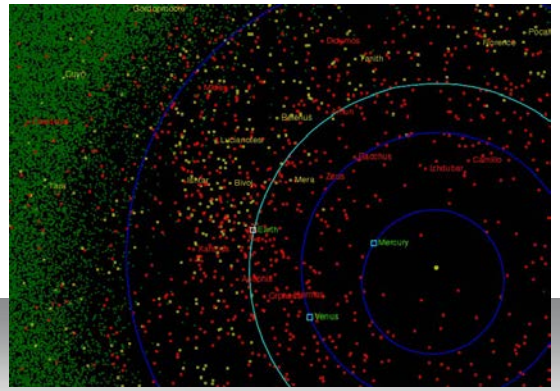
"The objective of the Space Situational Awareness (SSA) programme is to support the **European independent utilisation** of, and **access to, space** for research or services, through the **provision of timely and quality data**, information, services and knowledge regarding the **space environment**,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

- **ESA Ministerial Council November 2008**

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)

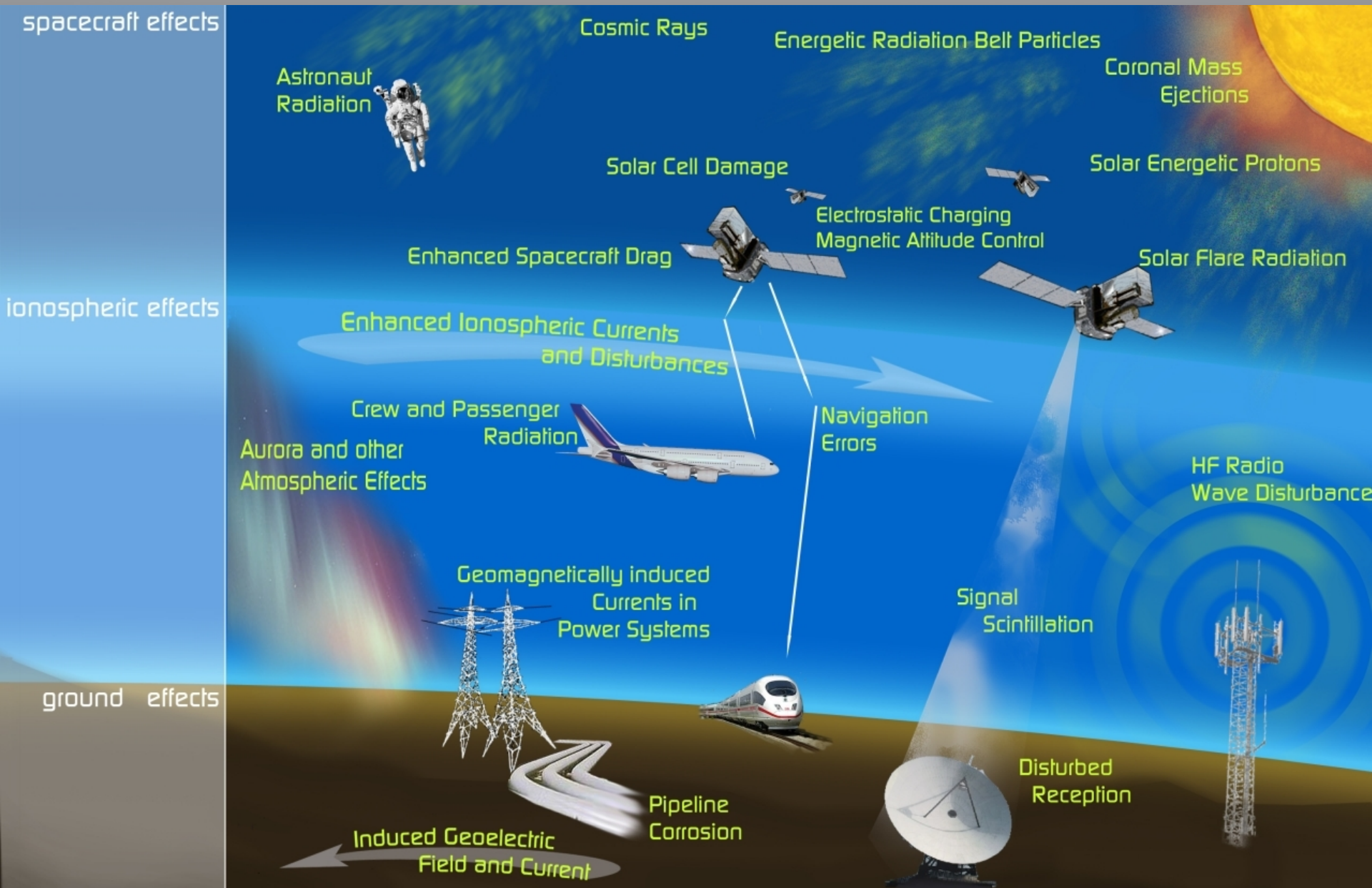
- Detection and forecasting of Space Weather and its effects
- Monitoring of the sun, solar wind, magnetosphere, radiation belts, ionosphere and disturbances in the geomagnetic field
- Provide SWE effect related services for designers, operators and users of spaceborne and ground based infrastructures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

SSA Space Weather Segment

Space Weather Impacts on Infrastructure



SSA PP Objectives

- The Space Weather SSA component shall acquire process and distribute all relevant data to provide reliable, continuous and non-dependent services to the European users.
- The following activities will be undertaken during the SSA Preparatory Programme (2009 – 2011) in the area of Space Weather:
  - Consolidation of the requirements related to the Space Weather activities in Europe.
  - Establishment of agreements and designs for implementation of Space Weather auxiliary payloads on already planned ESA/European partner spacecraft.
  - Analysis and evaluation of existing assets and competencies in the area of Space Weather
  - Definition and enhancement of the services provided using the existing prototype European Space Weather Networks.
  - Architectural design of the required ground components, as well as spacecraft payloads and platforms (e.g. through the Concurrent Design Facility at ESTEC)

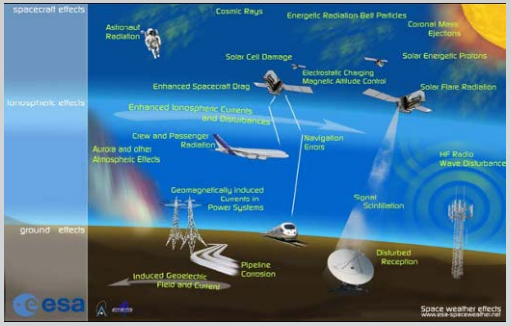
Achievements: Customer Requirements

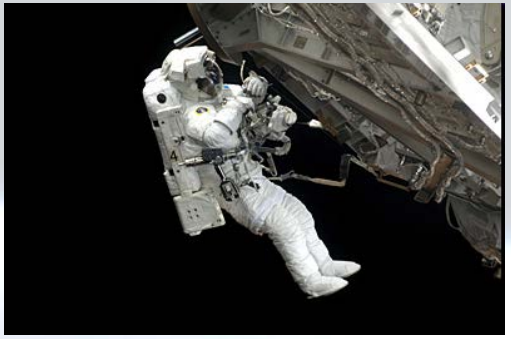
- SSA Space Weather Customer Requirements Document (CRD)
  - Requirements defined together with the SSA User Representation Group (URG)
  - First issue in November 2009
  - Updated in 2011 based on SN-I, CO-I and SSA SRR (with the support of the SSA URG and SWWT Steering Board)
- CRD is the baseline document defining
  - Objectives of the SSA SWE Segment
  - End users split into user domains
  - SSA SWE Services for each user domain
  - Basic requirements for each service: input data, products, timeliness and accuracy
- CRD has been the starting point for defining SWE Segment system requirements:
  - SSA SWE System Requirements Document
  - SSA SWE Product Requirements Document

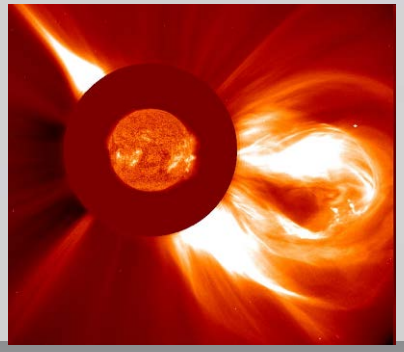
SSA Space Weather Segment
Objectives

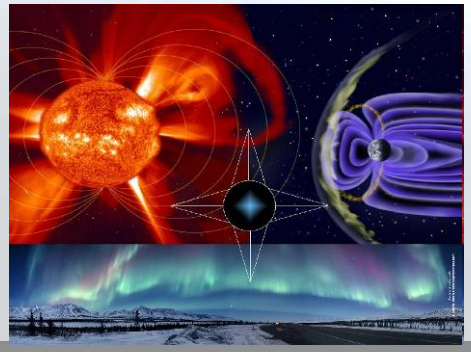
Detection and forecasting of the Space Weather events and the effects it has on European space assets and ground based infrastructure:

- 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)

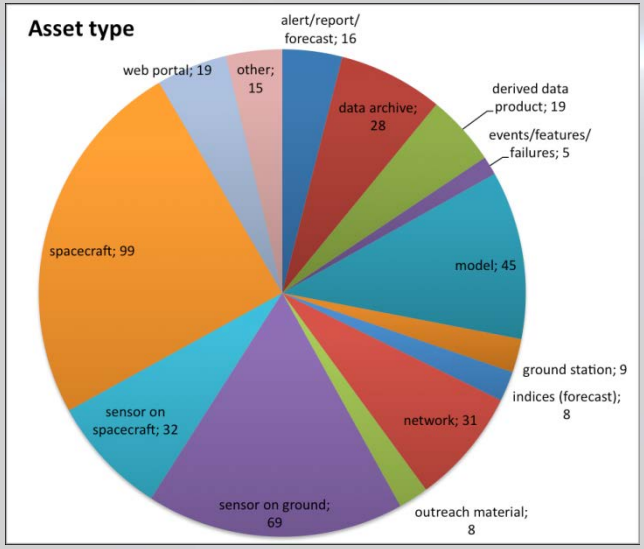
Achievements: SN-I Activity

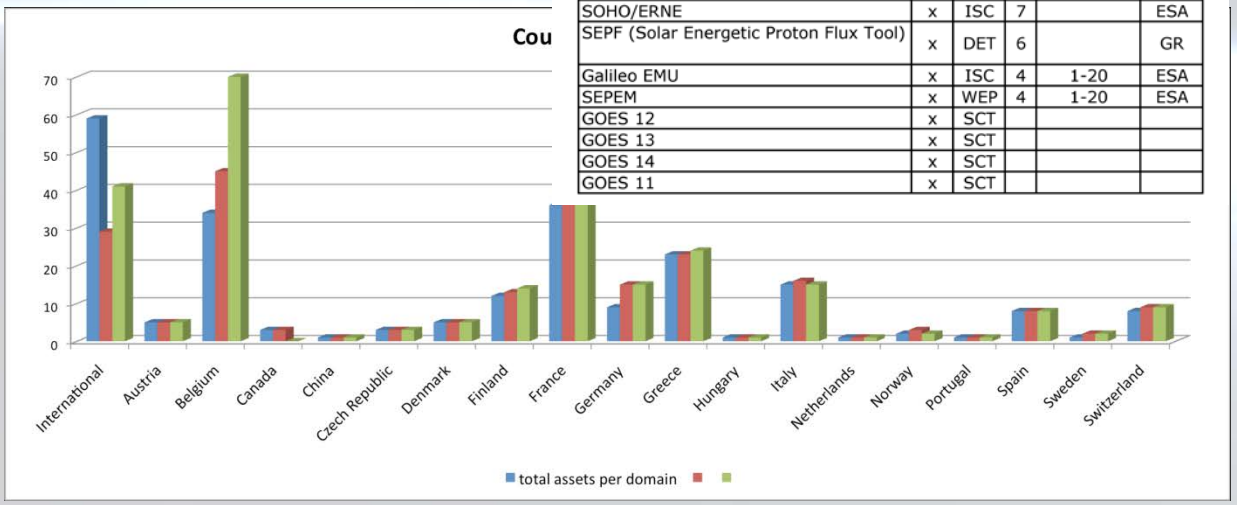
- Space Weather Segment Precursor Services - Part-1: Definition and Service Consolidation
- Consortium: RHEA System S.A., ROB, BIRA, Spacebel S.A., DLR, etamax GmbHm, DH Consulting, TGO, SAS NV, Solenix, GMV, University of Graz, AIT
- Objectives:
  - to investigate the suitability of existing assets to provide SSA SWE services and identify gaps in existing assets to provide services;
  - to elaborate a development plan for the space weather services;
  - to re-deploy an initial set of precursor services based on existing operational applications and data sources and provide access to them through a common service portal;
  - to develop relevant service mock-up's for the purpose of service concept assessment.

SN-I: European space weather assets

- Updated database of European SWE assets
- Currently about 250 European assets
- Assessment and linking to the SWE services
- Maturity of all assets and linking to SSA-SWE services
- Database to be enhanced and kept up-to-date (e.g. sharing data with COST ES0803)

Estimate of radiation effects in sensitive electronics	SWE-CRD-LAU-1617-PRD	Service category: CAT-2			
Fulfilled by existing assets?	no	Asset details			
		asset type	maturity level	users in 2010	owner country
SPENVIS GEANT4-based models	x	MOD	8		ESA
SPENVIS space environment models: orbital version	x	MOD	8		ESA
QinetiQ-Merlin	x	ISC	7	1-20	GB
Magnetocosmics	x	MOD	7		CH
SOLPENCO	x	MOD	7	1-20	ES
Radiation Environment Monitor (REM) on STRV-1B and MIR	x	ISC	7	1-20	ESA
SOHO/ERNE	x	ISC	7		ESA
SEPF (Solar Energetic Proton Flux Tool)	x	DET	6		GR
Galileo EMU	x	ISC	4	1-20	ESA
SEPEM	x	WEP	4	1-20	ESA
GOES 12	x	SCT			
GOES 13	x	SCT			
GOES 14	x	SCT			
GOES 11	x	SCT			



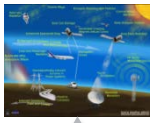


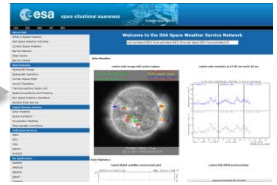
SN-I: SWE service development roadmaps

- Development roadmaps for all SSA-SWE services as seen by SN-I consortium
- Based on SWE asset database and the SN-I consortium assessment
- Services categorised: Cat-1, Cat-2, Cat-3
- Reflecting the requirements in SWE CRD:
  - Applicability of CRs on each service
  - Asset maturity and suitability to each service
  - Identification of gaps in the available assets
  - Development needs for existing assets
- These roadmaps and gap analysis are already in use and will be utilised in the planning of the coming SSA-SWE activities

SN-I: First SWE precursor services

SSA SWE Users





SWE Data Centre
Redu, Belgium

SWE Service Coordination Centre, BIRA, Belgium

SWE Expert Service Centre
Solar Weather

Coordinator:
ROB, Belgium
Austria: Kanzelhöhe

SWE Expert Service Centre
Ionospheric Weather

Coordinator:
DLR, Germany

SWE Expert Service Centre
Space Radiation

Coordinator:
BIRA, Belgium
Austria: AIT

SWE Expert Service Centre
Geomagnetic Conditions

Coordinator:
TGO, Norway

SN-I: Assessment of the service concepts and user feedback

- Assessment of all SSA-SWE services with end users
- Workshop was held in ROB on 13 June 2012
- Results will be presented in the SN-I final documents

Achievements: SN-II

- SN-II: Implementation design study for piggy-backing space weather instruments
- Consortium: Astrium GmbH, University of Göttingen, SAS N.V.
- Objectives:
  - Assess the observation requirements based on SWE CRD
  - Identify European instruments needed to satisfy these requirements
  - Identify Hosted Payload (HP) flight opportunities for these instruments
  - Perform an implementation design study on the HP instruments
  - Identify the needs for dedicated SWE missions

SN-II: Observation requirements

Appendix 1 Space based observation requirements derived from SSA SWE CRD

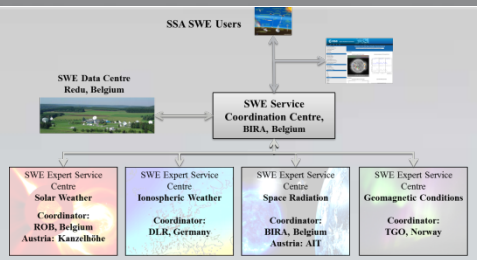
No.	CRD Specifications (according to SSA-SWE-SYS-CRD-1001r4iO_SSA and update of October 4, 2010)	Identified SWE observables or derived SWE parameters, revised by IET, SAT, SN-II Study Team Dec 1, 2010	Examples of SWE Effects	Identified instrument type	Reference to SoW baseline instrument set	Identified Orbit requirements, preferences and alternatives and orientation for SWE observable and instrument	CRD priority ranking
1a	SCD-1512, SCO-1549, 1554, 1555, 1558,1560, 1567, 1569, 1584, NSO-1749, SCH-1592, SCH-1599, 1603, LAU-1614, 1623, NSO-1751, 1752, 1753, GEN-1704, 1705, 1713	>1 MeV proton energy spectrum, upper bound 5 MeV, directional resolution of ~20 deg, for 2 pi, 30 sec measurement cadence	Solar cell and surface degradation	**Geo-space and interplanetary high energy proton radiation monitors**	High energy particle spectrometer	above 600 km, any direction In L1 required spatial resolution shall be 2 pi towards the Sun.	high
1b		>5 MeV proton energy spectrum, upper bound ~70 MeV, directional resolution of ~20 deg for 2 pi, 30 sec measurement cadence	NIEL and dose			(GTO, GEO for trapped protons (MEO, HEO, polar LEO) GEO, L1 for solar particles (MEO, HEO, polar LEO)) any directed	high
1c		>30 MeV proton energy spectrum, upper bound ~400 MeV, directional resolution of ~20 deg for 2 pi, 30 sec measurement cadence	SEEs				high
2	SCD-1513, 1549, SCO-1570, LAU-1614 (to 300 MeV), 1629,NSO-1749	>1 MeV ion energy spectrum, upper range 1 GeV, high importance of E>10 MeV range, omni-directional coverage, 30 sec measurement cadence	Dose, NIEL, SEEs	**Geo-space and interplanetary high energy ion radiation monitors**		above 600 km, any direction In L1 required spatial resolution shall be 2 pi towards the Sun.	high

SSA Space Weather Segment
SN-II: Instrument mission pairing

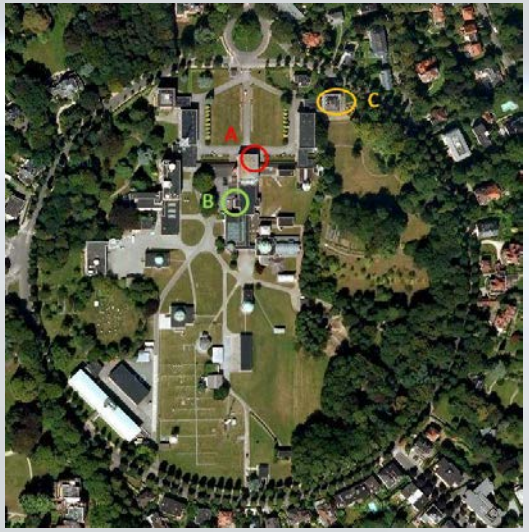
Table legend:
x (green) - accommodation possible
o (yellow) - might be possible/ difficulties are expected
- (light red) - not possible (e.g. EMC and magnetometer)

											Low Energy Particle			Medium + High Energy							Imagers				
Mission Priority	Mission	Institution	Orbit	Inclination	Orbit Altitude	Instruments	Pointing Dir.	Power Margin	Mass Margin	Launch Year / Design Life	Langmuir Probe	Ionosph. + Magnetosph. Plasma Anal.	Solar Wind Plasma Anal.	Univ. M&H Energy Part. Detectors	M&H Energy Part. Det. for MEO	M&H Energy Part. Det. for L1	Dust Detectors	Surface Charging Detectors	GNSS Receivers	Magnetometers	Sun Oriented Imagers	Earth Oriented Imagers	Imagers for Observation of Sun-Earth Line	Radiometers + Spectrometers	Accelerometer
	LEO Low Earth Orbit, < 2000 km																								
deleted	Premier (Explorer 7)	ESA	SSO		834	-	Earth	tbd	tbd	2016	x	x	-	x	-	-	x	o	x	o	-	-	-	o	-
112	COSMIC2	NSPO		72/ 24	800	2 x 6 satellites: GPS radio occultation	Earth	small	small	2014 to 2017/10	-	-	-	x	-	-	o	o	x	x	-	-	-	o	-
106	Jason-CS	Eumetsat		66	1300	radar altimeter package	Earth	tbd	tbd	2017	-	-	-	x	-	-	-	o	x	-	-	-	-	o	-
deleted	Biomass (Explorer 7)	ESA	SSO		641	-	Earth	55	92.6	2019/5	o	o	-	x	-	-	o	o	x	-	-	-	-	o	-
deleted	CarbonSat (Explorer 8)	ESA	SSO	98.6	800	-	Earth/Sunglint	tbd	tbd	2019/5	x	x	-	x	-	-	x	o	x	x	-	-	-	o	-
deleted	FLEX (Explorer 8)	ESA	PEO		-	-	Earth	tbd	tbd	2016	x	x	-	x	-	-	x	o	x	x	-	-	-	o	-
deleted	CoReH2O (Explorer 7)	ESA	SSO	98.0	652	-	Earth(-35)	104	200+	2018/5	o	o	-	x	-	-	o	o	x	-	-	-	-	o	-
110	Meteor-MP N3	Roscosmos	SSO	98.77	832		Earth	tbd	tbd	2016/5	x	x	-	x	-	-	x	o	x	x	-	-	-	o	-
103	Iridium NEXT	Commercial	Polar	86.4	780	4 main missions in addition to Iridium communication P/L: radar altimeter for sea level measurements; radiometry (earth's radiation); multispectral imaging;GPS radio occultation	Earth	50a, 200p	50	2015	o	o	-	x	-	-	o	o	-	-	-	-	-	o	-
111	FY-3 02 (Fengyun-3)	CMA/NRSCC	SSO	98.75	836	Meteorological: 3-D temperature, moisture, clouds; 6 satellites in total, 3 missions: IR & microwave sounder; ozon measurement & imager - IR & microwave	Earth	tbd	tbd		x	x	-	x	-	-	x	o	x	x	-	-	-	o	-
101	MOS A (MSG)	Eumetsat	SSO	98.7	817	imagers, spectrometer, interferometer, GNSS, all for UV/VIS/NIR/SWIR	Earth	60	84	2019/15	x	x	-	x	-	-	x	o	RO	x	-	-	-	o	-
102	MOS B (MSG)	Eumetsat	SSO	98.7	817	relay system, space environment monitor, GNSS, imager microwave, scatterometer	Earth	60	84	2019/15	o	o	-	SEM-N	-	-	o	o	RO	-	-	-	-	o	-
deleted	Sentinel-3	Eumetsat	SSO	98.5	801	-	Earth	tbd	tbd	2014/7	x	x	-	x	-	-	x	o	x	x	-	-	-	o	-
deleted	MetOp-C	Eumetsat	SSO	98.0	825	-	Earth	15 W	35 kg	2016/5	o	o	-	x	-	-	o	o	x	-	-	-	-	o	-
107	CSG 1	ASI	SSO	97.8	620	x-band SAR	+/-34deg off Nadir'	<35	20	2015/7	o	o	-	x	-	-	o	o	x	-	-	-	-	o	-
108	CSG 2	ASI	SSO	97.8	620	x-band SAR	+/-34deg off Nadir'	<35	20	2016/7	o	o	-	x	-	-	o	o	x	-	-	-	-	o	-
109	JPSS-2	NOAA	SSO	98.7	824	ATMS (Advanced Technology Microwave Sounder); CERES (Clouds and Earth's Radiant Energy System); CrIS (Cross-Track Infrared Sounder); OMPS (Ozone Mapping and Profiler Suite); VIIRS (Visible/Infrared Imager/Radiometer Suite)	Earth	tbd	tbd	2019/7	x	x	-	x	-	-	x	o	x	x	-	-	-	o	-
113	Merlin	DLR	SSO	polar	500-650	Methan LIDAR (Light Detecting and Ranging, active, using a laser)	Earth	tbd	tbd	2016/3	x	x	-	x	-	-	o	o	x	x	-	-	-	o	-
	MEO Medium Earth Orbit, < 36,000 km																								
201	Galileo FOC	EC	MEO		23.222		Earth	tbd	tbd		o	o	o	o	EMU	-	o	o	-	-	-	x	-	-	-
	GTO Geostationary Transfer Orbit, < 36,000 km																								
	HEO 1 Molnija Orbits, < 80,000 km																								
deleted	Sentinel-5 Precursor	Eumetsat	HEO			Ultraviolet Visible Near-Infrared Shortwave (UVNS) spectrometer & 2 imagers (IR & multi-channel)	Earth	tbd	tbd	2014	o	o	x	o	x	-	o	o	-	-	-	o	-	-	-
	HEO 2 Highly Elliptical Orbit, < 400,000 km																								
	GEO Geostationary Orbit, at ~36, 000 km																								
408	FY-4 M (Fengyun-4)	CMA/NRSCC	GEO		36000	geo-stationary meteorological satellite	Earth	tbd	tbd	2018/5	o	o	-	x	o	-	o	x	-	-	o	-	-	o	-
404	Heinrich Hertz	DLR	GEO		35800		Earth	tbd	22.5 kg	2016/5	o	o	-	x	o	-	o	o	-	-	o	-	-	o	-
401	EDRS-C	ESA	GEO		35800		Earth	1280	120	2015	o	o	-	x	o	-	o	o	-	-	o	-	-	o	-
405	Intelsat	Intelsat	GEO		35786		Earth	750	to 300	/15	o	o	-	x	o	-	o	o	-	-	o	-	-	o	-
406	GK-2A	KARI	GEO		36000	EMC?	Earth	1808 W	37.7 kg	2018/7	o	o	-	x	o	-	o	x	-	-	o	-	-	o	-
407	GK-2B	KARI	GEO		36000	EMC?	Earth	1808 W	37.7 kg	2019/7	o	o	-	x	o	-	o	x	-	-	o	-	-	o	-
402	MTG-I	Eumetsat	GEO		35800		Earth	>5	21	2017/10+	o	o	-	NGRM	o	-	o	x	-	-	o	-	-	o	-
403	MTG-S	Eumetsat	GEO		35800		Earth	tbd	tbd	2019/10+	o	o	-	NGRM	o	-	o	x	-	-	o	-	-	o	-
	L1 Lissajous Orbits, 1.5 million km R < 800,000 km around solar vector																								
deleted	DSCOVR	NASA	L1		1.5M km		Earth	tbd	tbd	2014/2	o	-	x	o	o	x	-	-	-	x	x	-	-	x	-
	L2 Lissajous Orbits, 1.5 million km R < 800,000 km around solar vector																								
601	Euclid	ESA	L2		1.5M km		Sun+/-30	15	<5	2018/5	o	-	o	x	-	o	-	-	-	-	o	-	-	o	-
602	Plato	ESA	L2		1.5M km		Deep Space	<80	100	2018/6	o	-	o	x	-	o	-	-	-	-	o	-	-	o	-
	L4, L5 150 million km, no halo orbit																								

SSA Space Weather Segment
Achievements: SN-IV

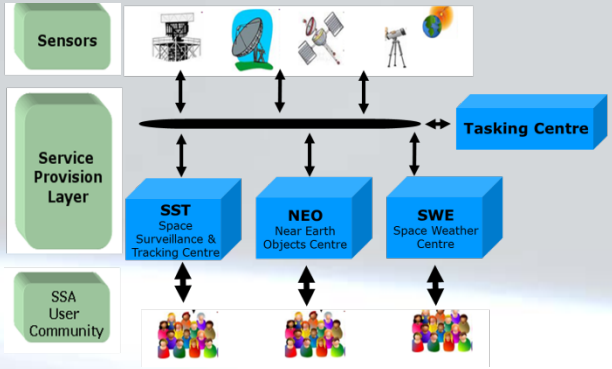


- SN-IV: Space Weather Precursor Services Operations
- Consortium: BIRA, ROB, SAS N.V., Spacebel S.A.
- Objectives:
  - Establishment of the SSCC (SWE Service Coordination Centre)
  - SWE service network monitoring handover from SN-I
  - Daily operation of the SWE Service Coordination Centre (SSCC)
- Core activity was started in April 2012 and will last 18 months
- Handover from SN-I is being almost over
- SN-IV activity includes also new services focusing on ionospheric weather, solar weather, and neutron monitor data
- Contracts for the new services are under negotiations



Other activities in progress in SSA PP

- CO-II Architectural Design
  - To establish a consolidated architecture for the civilian SSA
  - To establish a justified programmatic dossier, i.e. for project management, development, deployment, operation and utilisation approach
- DC-II WP5
  - Establishment of the 2nd generation SWE service portal
- DC-IV
  - New SWE services federated into the SSA system
- SN-VI
  - Additional SWE services for the SSA system
  - Can address development aspects more than SN-I and SN-IV
  - Size of the activity: 500 k€
  - ITT out soon
- In pareallel technology developments for new SWE instruments, data processing, simulation, etc. in GSTP and GSP programms



SSA Space Weather Segment
SSA Programme Period 2 (2013 – 2016)

- Objectives for the SSA-SWE Segment:
  - Networking of available national and European SWE assets (sensors, data centres, service centres, service coordination, user support)
  - Continuation of the Proba-2 operations and exploitation
  - Implementation of the first flight opportunities for hosted payload SWE instruments and planning for the future HP missions
  - Exploitation of SWE instruments, as well as data and service centres
  - Study (phase A) of a mission to ensure availability of solar wind, IMF and coronagraph data from L1
  - Studies of mission concepts for enhanced SWE monitoring and forecasting with sensors away from the Sun-Earth line (for example in L4 or L5)
  - Continuation of the preparation of SWE additional services
  - SSA-SWE technologies development
- Joint participation to the Chinese KuaFu mission together with ESA Science programme under consideration
  => replacement for ACE and SOHO for solar wind and coronagraph observations

European SSA System