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UPDATE ON SPACE WEATHER INFORMATION RECORDED IN OSCAR/SPACE

The WMO OSCAR/Space database (see https://www.wmo-sat.info/oscar/spacecapabilities) includes a considerable amount of information on space weather satellites and instruments. Approximately 50 satellites and 350 instruments are described, covering missions launched and planed for the time period between approximately 1990 and 2030, including instruments on dedicated satellites or hosted on Earth observation satellites, including operational missions. In addition, a total of 64 geophysical variables are included in the database.

This working paper describes how space weather information is managed in OSCAR/Space: in the Programme Pages, the Satellite Pages, the Instrument Pages, and in the Gap Analyses by Variable and by Mission.

It also acknowledges some current limitations and considerations for future improvements.

Action proposed: SWCG to take note of the space weather information presently recorded in OSCAR/Space and to continue providing to WMO the required information on space weather satellites and their instruments to maintain the OSCAR/Space database up to date with correct data.

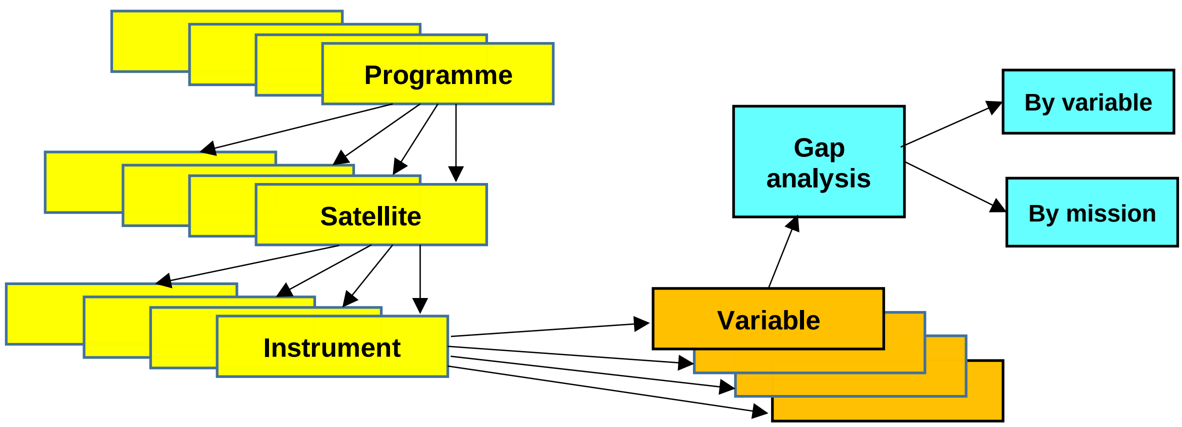
UPDATE ON SPACE WEATHER INFORMATION RECORDED IN OSCAR/SPACE

1. Introduction

The Observing Systems Capability Analysis and Review Tool (OSCAR, see https://www.wmo-sat.info/oscar/spacecapabilities) draws its origin from a CEOS initiative carried out in 1996-1997 for a "*Database on User requirements and Space capabilities*". The implementation was taken over by the WMO Space Programme Office. The collected information started to be issued in electronic form as a *Dossier on the Space-based Global Observing System*, published from 2004 to 2012, updated initially yearly, thereafter quarterly. Since Autumn 2012 the Dossier was replaced by the version-1 of an on-line database (OSCAR). In the Database, the information on Programmes, Satellites and Instruments is also utilised to provide an evaluation of the retrievable geophysical variables. In the current version-2, active since Autumn 2016, the evaluation is performed by means of an *expert system* that process the main instrument characteristics ("Properties") on the basis of the main features of the retrieval algorithm ("Rules").

The Database includes the data from all meteorological satellites and probably all EO satellites at large since TIROS-I (1st April 1960), current and planned till about 2040. Space weather satellites have been entered later, starting from 2013, and the current list includes most satellites since 1990 and some earlier, current and planned till about 2030. The total number of described satellites is ~770 (~50 dedicated to Space weather, ~720 for EO, but often hosting also SW instruments). The number of described instruments is ~1000 (~650 for EO, ~350 for Space Weather, including several hosted on EO satellites).

The following figure shows the OSCAR architecture and the information hierarchy:



It is acknowledged that, because of the late addition of the Space weather subject, the EO and SW sections do not have the same level of maturity. The architecture has been developed for EO data handling, and it is not optimal for SW data handling:

- For EO, the basic observation is essentially only one: electromagnetic. radiation emitted or reflected by the target; the required measurement consists of several geophysical variables indirectly derived by means of retrieval models, that may be rather complex.
- For SW, the required measurement directly consists of the observed quantity: several types of energetic particles, of electromagnetic. atomic or nuclear radiations, of fields. The *expert system* currently running in OSCAR, when applied to SW measurement, is too simplistic, in so far there is no algorithm linking the required geophysical variable to the basic observation.

It is possible to define several SW geophysical variables as a more complex quantity, for instance involving information complementary to the basic observed quantity (e.g., directional information, temporal structure, …). This could be included in the expert system if the User community provides the definition and a description of an appropriate retrieval algorithm.

2. Space weather satellites within OSCAR

According to the information hierarchy in OSCAR, the first step consists of the description of a Programme (series of satellites or single satellite). In the case of SW, most Programmes are based on a single satellite. The list of Satellites described in OSCAR is at page https://www.wmo-sat.info/oscar/satellites. In the satellite descriptive page, the carried instruments are recorded. The instrument descriptive page enables to understand whether the instrument is relevant for space weather. The current list of satellites relevant for space weather is shown in the following tables, including their launch dates (actual or planned) and end-of-life dates (actual or expected):

Space weather satellites at L_1 or in the ecliptic orbit or in solar orbit or in Highly elliptical Earth Orbit crossing the Magnetosphere											
Lagrange libration point L_1			Ecliptic orbit			Solar orbit			Cross-magnetosphere orbit		
ACE	1997	≥2026	STEREO (2 sats)	2006	≥2020	Parker Solar Probe	2018	≥2025	CASSIOPE	2013	≥2020
Aditya-1	≥2020	≥2025				Solar Orbiter	2020	≥2030	CLUSTER (4 sats)	2000	≥2020
DSCOVR	2015	≥2020							ERG	2016	≥2020
SOHO	1995	≥2019							GEOTAIL	1992	≥2020
SWFO-L1	≥2024	≥2029							IBEX	2008	≥2020
WIND	1994	≥2020							IMAGE	2000	2005
									MMS (4 sats)	2015	≥2020
									Polar	1996	2008
									STSat-2C	2013	2014
									THEMIS (5 sats)	2007	≥2020
									VAP (2 sat)	2012	2019

Space weather satellites in LEO or Molniya or geosynchronous orbits								
ACRIMSat	1999	2013	MATS	≥2020	≥2025	STPSat-1, STPSat-3	2007	≥2020
C/NOFS	2008	2015	Ørsted	1999	2014	STSat-1, STSat-3	2003	≥2020
CHAMP	2000	2010	Picard	2010	2014	SWARM (3 sats)	2013	≥2020
Coronas-F, Coronas I	1994	2005	PROBA-2	2009	≥2020	TIMED	2001	≥2020
Coronas-Photon	2009	2009	RHESSI	2002	2018	TRACE	1998	2010
CRRES	1990	1991	SAMPEX	1992	2012	TWINS (2 sats)	2006	≥2020
CSIM	2018	≥2023	SDO	2010	≥2020	UARS	1991	2005
ICON	2019	≥2024	SMM	1980	1989	XMM-Newton	1999	≥2020
Ionosphere (4 sats)	≥2021	≥2025	Solar-A (Yohkoh)	1991	2001	Zond	≥2025	≥2028
IRIS	2013	≥2020	Solar-B (Hinode)	2006	≥2020			
ISS TSIS-1, TSIS-2	2017	≥2025	SORCE	2003	2020			

Non-SW-dedicated satellites hosting Space weather instruments, in LEO or GEO or Molniya orbits								
Arctica-M N1, N2, N3, N4. N5	≥2020	≥2030	Galileo	2011	≥2031	Meteor-MP N1, N2	≥2025	≥2033
Coriolis	2003	≥2020	GEO-KOMPSAT-2A	2018	≥2029	Meteor-P 2, 3, 4, 5, 6	1976	1983
COSMIC-1 (6 sats)	2006	≥2020	GOES 1 to 15, SMS-1, SMS-2	1974	≥2020	Metop-A, Metop-B	2008	≥2024
COSMIC-2 (6 sats)	2019	≥2026	GOES 16 / 17 / T / U	2016	≥2036	Nimbus-3, Nimbus-4	1969	1980
DMSP F01 to F19	1976	≥2020	Himawari 1, 2, 3, 4	1977	2000	PROBA-1, PROBA-V	2001	≥2020
Electro-GOMS	1994	2000	Himawari-8, Himawari-9	2014	≥2031	Resurs-DK, Resurs-P2	2006	≥2020
Electro-L N1, N2, N3, N4, N5	2011	≥2032	IRS-P3	1996	2004	SAC-B, SAC-C, SAC-D	1996	2015
Electro-M N1, N2, N3	≥2025	≥2039	ISS ASIM	2018	≥2021	SES-14	2018	≥2020
FORMOSAT-1	1999	2004	ITOS-1, NOAA 1, 2, 3, 4, 5	1970	1979	SICH-2	2011	2012
FORMOSAT-5	2017	≥2022	JASON-2, JASON-3	2008	≥2021	SPOT-4	1998	2013
FY-1 A, B, C, D,	1988	2012	KOMPSAT-1	1999	2008	TIROS-7	1963	1968
FY-2 A, B, C, D, E, F, G, H	1997	≥2022	Meteor-2 N1 to N21	1975	1995	TIROS-N, NOAA 6 to 19	1979	≥2019
FY-3 A, B, C, D, E, F, G, H	2008	≥2029	Meteor-3 N1, N2, N3, N4. N5, N6	1985	1996			
FY-4 A, B, C, D, E, F, G	2016	≥2040	Meteor-3M, N1, N2, N2-2 to N2-6	2001	≥2029			

In the Programme Page, the following features are recorded:

- programme nature (single satellite, series of satellites, satellites launched in cluster, …)
- responsible agencies and their roles (for development, for operations, …)
- main platform features (stabilisation, design lifetime, …)
- replacement policy (for satellite series)
- orbit type (sun-synchronous, drifting, GEO, Molniya, cross-Magnetosphere, solar, L_1, …)
- data circulation architecture
- list of satellites under the Programme (with hyperlinks).

For each satellite, there is a Satellite Page, that records:

- a description table in plain language, that records:
  - mission (main and, in case, substantial or significant contribution)
  - sizing information (mass, power, …)
  - data access information
  - detailed orbital information
  - mission status (planned, after-launch commissioning, operational, possible anomalies, …)
  - launch date (actual or planned) and End-of-Life date (actual or expected);
- the list of embarked instruments (with hyperlinks);
- by activating an option, a table opens that, for each instrument of the list, provides information on whether it is fully operational or degraded or inactive.

3. Space weather instruments within OSCAR

Moving to an Instrument Page, a descriptive table is found, changing with four different types:

- Solar activity monitor
- Space radiometer or spectrometer
- Energetic particle spectrometer
- Field or radio wave sensor.

For solar activity monitoring instruments, the following is recorded:

- viewing: Sun pointing, whole solar disc and/or corona (possibly by occultation);
- radiation range: Gamma-ray, X-ray, EUV (with possible Fe IX, FE XII, Fe XV, He II lines), H Lyman-alpha line, UV, Ca II-K line, VIS (with possible Doppler and polarisation features, and possibly H-alpha line), Radiowave;
- for each range, the minimum and maximum wavelengths, whether it is sampled by a number of channels (radiometer) or by spectrometry of a specified spectral resolution;
- whether the observation is spatially integrated or an image of a specified resolution; and the temporal sampling; for coronagraphs, possibly internally or externally occulted, the minimum and maximum distance of the observed corona from the solar centre.

For space radiometers or spectrometers, the following is recorded:

- viewing: interplanetary space, aurora, Earth's limb, Earth's surface;
- radiation range: Gamma-ray, X-ray, EUV, H Lyman-alpha line, UV, VIS, NIR, SWIR, Radiowave;
- for each range, the minimum and maximum wavelengths, whether it is sampled by several channels (radiometer) or by spectrometry of a specified spectral resolution;

- whether the observation is spatially integrated or an image of a specified resolution; and the temporal sampling.

For energetic particle spectrometers, the following is reported:

- viewing: Sun pointing, interplanetary space, in-situ platform environment, multiple view by flying on a satellite cluster crossing the magnetosphere;
- particles: electrons, protons, alpha-particles, solar wind density/temperature/velocity (inferred from e-, p and α), heavy ions, cosmic rays (including neutrons), Energetic Neutral Atoms (ENA);
- for each particle, the minimum and maximum energy, whether the measurement regards the flux or the energy spectrum (for heavy ions, energy and mass spectrum);
- the particle flux direction and aperture solid angle, the temporal sampling rate.

For Field or radiowave sensors, the following is recorded:

- viewing: interplanetary space, Earth's limb, in-situ platform environment, multiple view by flying on a satellite cluster crossing the magnetosphere;
- fields: magnetic field (vector or scalar), electric field, magnetic and/or electric field oscillations, ionospheric plasma density and velocity (inferred from field oscillations or other), radiowaves, scintillations, Total Electron Content, platform electrostatic charge, radiation dose at the platform;
- for each field, the dynamic range and the resolution or sensitivity;
- the temporal sampling rate; certain special sensing features such as, for instance, exploitation of active radio waves.

It is important to note that, in general, the description of space weather instruments available from the sources used to be consulted by the OSCAR compilers does not include all these elements. Often, the descriptions are biased towards the scientific aspects or, on the opposite, detailed mechanical features.

Since in most cases the instruments embarked on space weather satellites are provided by scientific institutes, it is likely that the best instrument descriptions are published in specialised literature, not commonly available to the OSCAR compilers.

4. Space weather geophysical variables within OSCAR

The geophysical variables required to be measured for Space weather were initially (2012) identified by the OSCAR compilers essentially by inspecting what Space weather satellites use to measure, with the aid of a few experts. With time, several requirements have been added. These are listed in OSCAR in the section Observation Requirements (see https://www.wmo-sat.info/oscar/observingrequirements).

After filtering to select those relevant to Space weather, currently 79 variables are listed. Not all of them can be measured from space, and a few others are redundant, differing for minute details.

The final list includes 64 variables analysed in the OSCAR section Space-based Capabilities ("OSCAR/Space"), tabled according to three themes:

Geophysical variables handled in OSCAR/Space		
Solar monitoring	Solar velocity fields	Proton differential directional flux
Solar gamma-ray flux spectrum	Gamma-ray flux	Alpha particles integral directional flux
Solar X-ray flux	Gamma-ray flux spectrum	Alpha particles differential directional flux
Solar X-ray flux spectrum	X-ray flux	Heavy ion flux energy and mass spectrum
Solar X-ray image	X-ray flux spectrum	Heavy ion angular flux energy and mass spectrum
Solar EUV flux	X-ray sky image	Cosmic ray neutron flux spectrum
Solar EUV flux spectrum	EUV flux	Energetic Neutral Atom (ENA)
Solar EUV image	EUV flux spectrum	Solar wind density
Solar Lyman-alpha flux	EUV sky image	Solar wind temperature
Solar Lyman-alpha image	UV flux	Solar wind velocity
Solar UV flux	UV flux spectrum	Interplanetary magnetic field
Solar UV flux spectrum	UV sky image	Electrostatic charge
Solar UV image	VIS flux	Radiation Dose Rate
Solar Ca II-K image	VIS flux spectrum	
Solar VIS flux	VIS sky image	**Ionospheric disturbances**
Solar VIS flux spectrum	NIR/SWIR flux	Aurora
Solar VIS image	Radio-waves	Electric field
Solar white light image	Heliospheric image	Electron density
Solar H-alpha image		Ionospheric plasma density
Solar radio flux spectrum	**Energetic particles and solar wind**	Ionospheric plasma velocity
Solar coronagraphic image	Electron integral directional flux	Ionospheric radio absorption
Solar electric field	Electron differential directional flux	Ionospheric scintillation
Solar magnetic field	Proton integral directional flux	Ionospheric Vertical Total Electron Content (VTEC)

In OSCAR/Space, the variables possible to retrieve from an instrument are identified by means of an expert system that relates the variable to the main instrument characteristics ("Properties") by applying certain "Rules" significant of the retrieval algorithm. For EO variables these Rules may be rather complex because of the indirect nature of remote sensing. For SW the Rules are very straightforward because of the direct observing mode. The problem is with the need to associate a quality rate to the identified retrieved measurement. For EO, that basically measures a single physical quantity (electromagnetic radiation), the variety of the specific instrument Properties and of the retrieval algorithms provide high discrimination possibilities for quality rating. For SW, the measured physical quantity already nearly coincides with the variable, and there are not many other features to be exploited for quality rating.

The current rating criteria adopted in OSCAR/Space for SW variables represent a best effort. A clear limitation consists in the lack of account for geometrical directional features because of 1) difficult understanding of how to compare the effect on quality rating; and, most important, 2) poor or missing information on these features in the consulted sources.

The list of variables (with quality rating) potentially retrievable from each instrument is recorded in the instrument page, in the table Tentative Evaluation of Measurements. In the table, information is also provided on possible operational limitations; and there are explanations on the driving elements for variable identification and rating.

The figure below shows an example of list of instruments carried by a Space weather satellite (SOHO) and the lists of variables retrievable from two of its instruments (LASCO and UVCS):

List of instruments on SOHO

(frame from https://www.wmo-sat.info/oscar/satellites/view/458)

Acronym	Full name
SUMER	Solar UV Measurement of Emitted Radiation
CDS	Coronal Diagnostic Spectrometer
EIT	Extreme UV Imaging Telescope
UVCS	UV Coronagraph and Spectrometer
LASCO	Large Angle and Spectrometric Coronagraph
SWAN	Solar Wind Anisotropies
CELIAS	Charge, Element, Isotope Analysis
COSTEP	Suprathermal & Energetic Particle Analyzer
ERNE	Energetic and Relativistic Nuclei and Electron experiment
GOLF	Global Oscillations at Low Frequencies
VIRGO	Variability of Solar Irradiance
MDI	Michelson Doppler Imager
SEM	Solar EUV monitor

List of variables from LASCO

(frame from https://www.wmo-sat.info/oscar/instruments/view/715)

Variable	Relevance for measuring this variable	Operational limitations	Explanation
Solar coronagraphic image	2 - very high	No specific limitation.	VIS (400-700 nm), observed with occultation
Solar VIS flux spectrum	3 - high	No specific limitation.	Coarse spectral resolution, moderate dynamic range, corona view included
Solar H-alpha image	5 - marginal	Limited to the solar corona.	H-alpha line at 656.3 nm (deep Red), solar disc occulted

List of variables from UVCS

(frame from https://www.wmo-sat.info/oscar/instruments/view/714)

Variable	Relevance for measuring this variable	Operational limitations	Explanation
Solar coronagraphic image	1 - primary	No specific limitation.	H-Ly-alpha at 121.6 nm (EUV/UV boundary), observed with occultation
Solar EUV flux spectrum	3 - high	Limited to the solar corona.	Coarse spectral resolution EUV, solar disc occulted
Solar Lyman-alpha flux	3 - high	Limited to the solar corona.	H-Ly-alpha at 121.6 nm (EUV/UV boundary), solar disc occulted

5. Gap analysis of Space weather geophysical variables

OSCAR/Space includes a section, Gap analyses, that plots the time availability of SW space-based measurements by variable or by mission.

The *Gap analysis by variable* displays the time bar chart of all the instruments processed in OSCAR/Space relevant for measuring the variable. The example shown in the figure below refers to the variable *Solar coronagraphic image*. The timeframe, that in the figure is cut to 2014-2030, can be shifted from 1980 (CP, Coronograph/Polarimeter, on SMM, Solar Maximum Mission) to 2036 (CCOR, Compact COROnagraph, planned for GOES-U). It is reminded that, currently, OSCAR/Space handles 64 SW variables.

Gap analysis for the variable *Solar coronagraphic image* (from https://www.wmo-sat.info/oscar/gapanalyses?variable=178)

Instrument	NRT?	Relevance	Satellite	Orbit	14	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	20
UVCS		1 - primary	SOHO		X	X	X	X	X	X											
CCOR		2 - very high	SWFO-L1												X	X	X	X	X	X	
LASCO		2 - very high	SOHO		X	X	X	X	X	X											
VELC		2 - very high	Aditya-1								X	X	X	X	X	X					
CDS		3 - high	SOHO		X	X	X	X	X	X											
EIT		3 - high	SOHO		X	X	X	X	X	X											
CCOR		2 - very high	GOES-U	75°W												X	X	X	X	X	X
RESPEKT		3 - high	Zond	TBD												X	X	X	X		
SOLIST		3 - high	Zond	TBD												X	X	X	X		
STEK		4 - fair	Zond	TBD												X	X	X	X		
SECCHI/COR-1		2 - very high	STEREO (2 sats)	23.44 °	X	X	X	X	X	X											
SECCHI/COR-2		2 - very high	STEREO (2 sats)	23.44 °	X	X	X	X	X	X											
SECCHI/EUVI		3 - high	STEREO (2 sats)	23.44 °	X	X	X	X	X	X											
METIS		1 - primary	Solar Orbiter	25 °							X	X	X	X	X	X	X	X	X	X	X
SPICE		3 - high	Solar Orbiter	25 °							X	X	X	X	X	X	X	X	X	X	X
SoloHI		4 - fair	Solar Orbiter	25 °							X	X	X	X	X	X	X	X	X	X	X
CP		2 - very high	SMM	28.5 °																	
TEREK-C		3 - high	Coronas-I	82.5 °																	
TEREK-C		3 - high	Coronas-F	82.5 °																	
TESIS		3 - high	Coronas-Photon	82.5 °																	
XRT		3 - high	Solar-B (Hinode)	06:00 asc	X	X	X	X	X	X											
EIS		3 - high	Solar-B (Hinode)	06:00 asc	X	X	X	X	X	X											
SWAP		3 - high	PROBA-2	06:00 asc	X	X	X	X	X	X											

In the time bar chart, the instruments are rated (up to 5 steps with different colours), but the rating criteria are different from those used in the list of variables associated to the instruments. The criteria change from variable to variable. In the case of the variable in example, Solar coronagraphic image, the rating is as shown below.

	Rating criteria for variable *Solar coronagraphic image*
	Each instrument is assigned with an up-to-5-step rating, evaluated as a blend of several elements. For this particular Variable, the rating is driven by: • the observation mechanism (occultation coronagraph or disk + corona) • the observed radiation band. RATING CRITERIA:
1	• Occultation coronagraph, observing X-ray and/or EUV or the Lyman-alpha line
2	• Occultation coronagraph, observing UV and/or the CA-II-K line and/or VIS and/or the H-alpha line
3	• Disk + corona viewed, observing X-ray and/or EUV
4	• Disk + corona viewed, observing UV and/or VIS
5	• -

An example of *Gap analysis by mission* is shown below. It refers to the mission *Energetic particles monitoring*, and the displayed frame is limited to satellites in the L_1 orbit.

Gap analysis for the mission *Energetic particles monitoring* (from https://www.wmo-sat.info/oscar/gapanalyses?mission=30) **limited to L_1**

Instrument	NRT?	Sorting	Satellite	Orbit	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EPACT		1	WIND		X	X	X	X	X	X											
EPAM		1	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
ERNE		1	SOHO		X	X	X	X	X	X											
PAPA		1	Aditya-1								X	X	X	X	X	X					
SWE		1	WIND		X	X	X	X	X	X											
COSTEP		1	SOHO		X	X	X	X	X	X											
SWEPAM		1	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
SWIS/SWIPS		1	SWFO-L1												X	X	X	X	X	X	
PLASMA		1	WIND		X	X	X	X	X	X											
ASPEX		2	Aditya-1								X	X	X	X	X	X					
CELIAS		2	SOHO		X	X	X	X	X	X											
CRIS (ACE)		2	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
SIS		2	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
SMS		2	WIND		X	X	X	X	X	X											
SWICS		2	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
SEPICA		3	ACE																		
SWIMS		3	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
ULEIS		3	ACE		X	X	X	X	X	X	X	X	X	X	X	X	X				
SWIS/STIS		4	SWFO-L1												X	X	X	X	X	X	

Four missions are currently defined in OSCAR/Space: *Solar activity monitoring*, *Heliospheric radiation monitoring*, *Energetic particles monitoring* and *Field and wave monitoring*. The rating criteria are different from those adopted for the Gap analysis by variable and changing from one mission to another. Those applicable to the example above are as follows:

Rating criteria for the mission *Energetic particles monitoring*	
	For this particular capability, instrument performance is considered to be driven by • the measured energetic particle • the number of energetic particles measured by the instrument. RATING CRITERIA:
1	• Instruments measuring electrons and possibly protons, alpha-particles, ions, cosmic-rays and ENA
2	• Instruments measuring protons and possibly alpha-particles, ions, cosmic-rays and ENA
3	• Instruments measuring alpha-particles and possibly ions, cosmic-rays and ENA
4	• Instruments measuring ions and possibly cosmic-rays and ENA; OR cosmic-rays and possibly ENA; OR cosmic-rays
5	• Instruments measuring ENA

6. Status and perspective developments of OSCAR for Space weather

The description of the situation of Space weather information in OSCAR leads to the following comments and discussion points:

- in spite of the late inclusion of the SW subject in OSCAR, there is already plenty of recorded information on programmes, satellites (~50 dedicated) and instruments (~350) flown on either dedicated satellites or hosted on other satellites (especially important those part of series of operational meteorological satellites);
- new satellites and instruments will certainly be uploaded as they become available. In addition, it is possible to add selected historical satellites provided that the proposing institute supplies sufficiently detailed information (or references) on the carried instrumentation;
- the variables so far processed in OSCAR/Space (64) could be extended, provided that the variables to be added are clearly described, with the indication of the basic quantities to be observed. It is acknowledged that, currently, the *expert system* used to identify the retrievable variables and rate the quality of the retrieved measurement is very simplistic;
- it should be realised that it is not easy to improve the performance of the *expert system* by including consideration of, for instance, viewing geometry and directional information. In addition to the difficulty of representing this into a retrieval algorithm, there is a general lack or lack of clarity of this information in the ordinarily available instrument descriptions;
- a very critical point in the current status of the SW information in OSCAR/Space is the poor cooperation of the responsible agencies in updating the information on the status of satellites and instruments. There are satellites launched over 20 years ago, carrying over 10 instruments, that, in the absence of updated information, are carried forward in the Gap analyses as fully functional, whereas several instruments could be degraded or no longer active, and the satellite itself decommissioned. This uncertainty undermines the credibility of the Gap analyses.

To conclude, the OSCAR/Space information on Space weather (current and to continue to be updated following new launches) is believed to be rather useful as it is.

Improvements possible within the constraints of the current architecture can be made, but certain substantial improvements require assistance and cooperation from the expert groups. One critical cooperation item is the updating of the status of satellites and instruments.