

SPACE WEATHER OBSERVATION CAPABILITIES
Space-based instrument draft categorization and evaluation

(Submitted by J. Lafeuille, WMO Secretariat)

This document introduces the inventory of space-based instruments and the assessment of the variables that these instruments have the potential to measure, as recorded in the Observing System Capability Analysis and Review tool (OSCAR).

A tentative categorization has been developed for space weather instruments. The 267 space weather instruments recorded in OSCAR have been distributed into 120 different classes grouped in five broad instrument types:

- Solar processes monitors (46 classes),
- Solar wind and cosmic ray radiation monitors (17 classes),
- Magnetosphere/ionosphere sounders (27 classes),
- Aurora imagers (7 classes),
- Platform environment monitors (24 classes).

The classes were defined based on instrument design characteristics and expected performances for the required variables. Therefore, it should be possible to map each class of instruments with the main variables that these instruments can measure. Reciprocally, for a given variable, such a mapping should allow to determine which instruments are the most relevant, which is a starting point for a gap analysis. A tentative mapping of instruments to variables has been performed for all the 120 classes, and is submitted to ICTSW for review.

In addition, the Space Weather capabilities that are deemed relevant to the WMO Vision of global observing systems have been tentatively identified.

ACTION PROPOSED

The ICTSW is invited :

- to review in OSCAR the draft identification of measured variables, and the corresponding ranking, for each instrument class;
- to select the most relevant instrument classes to be taken into account as space weather capabilities within WMO global observing systems.

DISCUSSION

1. INTRODUCTION

1.1 OSCAR

In order to support the planning, evaluation, and gap analysis of future observing capabilities following the Rolling Requirements Review process, WMO is maintaining the Observing System Capability Analysis and Review tool (OSCAR), which is available on line (www.wmo.int/oscar). OSCAR includes three components:

- *OSCAR/Requirements* is a repository of the observation requirements defined by representative expert groups of various application areas. The requirements of the “Space Weather” area (<http://www.wmo-sat.info/oscar/applicationareas/view/25>) are maintained by ICTSW.
- *OSCAR/Satellite capabilities* contains an inventory of space-based instruments, satellites and programmes of relevance for WMO activities. It currently contains references of more than 800 instruments, including 267 instruments for space weather, the other being designed mainly for atmosphere, ocean or land observation. In addition to the inventory, OSCAR contains an assessment of the potential relevance of each instrument for measuring given variables.
- *OSCAR/Surface capabilities* is still under construction. Similarly, it will contain an inventory and evaluation of the surface-based observation capabilities.

1.2 Past actions

At the third meeting of ICTSW¹ on 12-14 November 2012, the following action was agreed: “Alain Hilgers to lead a review of the Space Weather space-based capabilities recorded in OSCAR, including the assignment of missions into homogeneous classes of performance and the list of variables for which these classes are relevant. “(Action 3.3). A. Hilgers provided a first set of comments in May 2013, which were taken into account by the Secretariat, however the comprehensive and systematic review and assessment could not take place as expected.

In order to move forward, the Secretariat undertook this task with the help of a consultant. A new classification of instruments was proposed, based on the detailed capabilities of the various instruments to measure specific space weather variables and phenomena. As no feedback was received, a revised classification of space weather instruments was implemented in OSCAR, thus enabling the whole ICTSW team to access this information in a more user friendly way and provide feedback at the fourth ICTSW meeting.

1.3 Scope of the document

This document describes the new instrument categorization and evaluation.

This is submitted to the ICTSW for review and finalization. During the face-to-face ICTSW-4 meeting it will be possible to define changes using OSCAR off-line in an interactive way.

¹ http://www.wmo.int/pages/prog/sat/documents/ICTSW-3_Final-Report.pdf

2. SPACE WEATHER INSTRUMENT CATEGORIZATION

2.1 Instrument types and classes

The *Satellite capabilities* module of OSCAR contains references of 267 instruments dedicated to space weather observations from space. These instruments have been analyzed and distributed into 120 different classes, based on their design characteristics and their nominal performances, and grouped in five broad instrument types:

- Solar processes monitors (46 classes),
- Solar wind and cosmic ray radiation monitors (17 classes),
- Magnetosphere/ionosphere sounders (27 classes),
- Aurora imagers (7 classes),
- Platform environment monitors (24 classes).

In addition, 37 instruments that are not dedicated to space weather are providing observations of relevance to space weather. They belong to the following types:

- GNSS radio-occultation receivers (6 classes),
- Radar altimeters (2 classes),
- Solar Irradiance monitors (3 classes).

The space weather instruments are listed under types 22 to 26 in the list of instrument types: <http://www.wmo-sat.info/oscar/instrumenttypes>.

2.2 Instrument relevance for particular variables

For each class the variables that the instruments have the potential to measure can be determined, based on the common characteristics of the instruments of that class. As a result, with every instrument description, OSCAR displays a “tentative evaluation of measurements” i.e. a list of variables that can typically be measured with comparable instruments; it also indicates the degree of relevance (Primary, High, Medium, Useful, Marginal). Such a mapping of instruments with variables has been implemented first to Earth Observation instruments and yields meaningful results. A tentative mapping was recently developed for the new space weather instrument classes (For example, <http://www.wmo-sat.info/oscar/instruments/view/847> displays a list of variables potentially measured by SECCHI/HI-1 or comparable instruments.)

This exercise is however complicated by the high diversity, the experimental nature, and the lack of technical details currently recorded in OSCAR for many of the Space Weather instruments. As a starting point, the ranking is simplified (the relevance is often rated “high” for the variables that the instruments are designed to measure, and lower for the side-products). A significant tuning is still necessary.

It is underlined that the variables initially listed for Space Weather are defined in a rather general way in comparison with the fine granularity of the instrument classification. For example, “Aurora” does not specify the spectral band (SWIR, NIR, VIS, UV), “Density/temperature/velocity of solar wind plasma” combine different particles. Therefore, in order to exploit the full information potential of OSCAR a more detailed typology of variables has been introduced to complement the initial list.

2.3 Gap analysis

The mapping of instruments to variables can be used reciprocally to determine which instruments are potentially relevant for measuring a given variable. In the *Satellite*

capabilities module of OSCAR, when entering the name of a variable in the quick-search window, or when selecting one of these variables measured by a specific instrument, OSCAR displays a list and a timeline of potentially relevant missions and instruments. For instance, in selecting “proton flux density” we reach the gap analysis page for proton flux density: <http://www.wmo-sat.info/oscar/gapanalyses?view=220>.

As this information does not take into account the actual status of the data, possible in-orbit failure or degradation, calibration issues, or data availability issues, the timeline provided by OSCAR is not a comprehensive gap analysis, but rather a first screening to be used as a starting point to perform a gap analysis.

Selecting « Satellite capabilities »

Quick search window

Instrument: IRIS (IRIS)

Instrument details

Acronym	IRIS (IRIS)		
Full name	Interface Region Imaging Spectrograph		
Type of Instrument	22. Solar processes monitor		
Purpose	To obtain UV spectra and images with high resolution in space and time focused on the chromosphere and the transition region of the Sun		
Short description	UV imaging spectrometer. Two bands: 1) Far UV, 1332-1358 Å and 1390-1406 Å, both with 40 mÅ resolution; and 2) Near UV, 2785-2835 Å with 80 mÅ resolution. Time resolution 1 s.		
Background	Consolidated technology		
Scanning Technique	Sun pointing, CCD array of 1024x1024 pixels covering a field of view of 170 arcsec addressable within the Sun disk		
Resolution	120 km at Sun surface		
Coverage / Cycle	Full Sun disk		
Mass	Power	Data Rate	0.7 Mbps

Providing Agency: [NASA](#)

Utilization Period: 2013-06-28 to ≥2015

Last update: 2013-10-13

Detailed characteristics

List of potentially relevant variables

Satellites this instrument is flying on

Note: a red tag indicates satellites no longer operational, a green tag indicates operational satellites, a blue tag indicates future satellites

- [Interface Region Imaging Spectrograph](#) (NASA)
- [IRIS](#) (2013 - 2015)

Contribution to Space Capabilities

The instrument contributes to the following Capabilities, as identified in the "Vision for the GOS in 2025" and the Implementation Plan for the Evolution of Global Observing Systems:

→ [Space Weather: solar activity, solar wind and deep space monitoring](#)

Tentative Evaluation of Measurements

The following list indicates which measurements can **typically** be retrieved from this category of instrument. To see a full Gap Analysis by Variable, click on the respective variable.

Note: table can be sorted by clicking on the column headers.

Variable	Relevance for measuring this Variable	Operational Limitations	Processing maturity
Solar UV flux energy spectrum image	2-High	Referring to the Photosphere	Consolidated methodology
Solar UV flux energy spectrum	3-Medium	Referring to the Photosphere	Consolidated methodology

Figure 1: Example of an OSCAR Instrument View displaying a brief description of the instrument, the satellite(s) carrying it, and a list of variables that this class of instrument has the potential to measure.

2.4 Capability review

The concept of “Capability review” in OSCAR refers to the comparison between, on one hand, current and planned instruments and, on the other hand, the target capabilities identified by WMO.

As concerns space weather, these target capabilities are currently recorded under two headings:

- “Solar activity, solar wind and deep space monitoring “ (<http://www.wmo-sat.info/oscar/observingmissions/view/36>) and
- “Ionosphere and magnetosphere monitoring” (<http://www.wmo-sat.info/oscar/observingmissions/view/37>)

A tentative mapping of the instrument classes with these capabilities has been entered but requires further review. This should be done in consistency with the Statement of Guidance for Space Weather observation (<http://www.wmo.int/pages/prog/www/OSY/SOG/SoG-SW.doc>).

3. CONCLUSION: PROPOSED ACTION

A new classification of instruments, and a tentative assessment of the potential relevance of instruments for particular variables are submitted to ICTSW to be reviewed and tuned as appropriate. They are available on line.

The recommended way to navigate in the OSCAR/Space capabilities module is to:

- Select the “Space capabilities” page: <http://www.wmo-sat.info/oscar/spacecapabilities>
- Type the beginning of the name of an instrument, a satellite or a variable (or a character string contained in the name) in the “Quick-search” window on the top right of the screen.
- Select the appropriate item in the drop-down list that will show up.

It is stressed that the mapping of instruments to variables is based only on the design and definition of the instrument. It does not take into account the actual status of the data it provides, the possible in-orbit failure or degradation, calibration issues, or data availability issues.

ICTSW is invited to:

- Review and provide feedback on the list of potentially measured variables associated to each instrument class;
 - Where appropriate, introduce a ranking among the performances of the instruments for the variables they can measure;
 - In addition, with reference to the observations required for operational purpose, as described in the Statement of Guidance for space weather observation, the ICTSW may wish to advise on what classes of instruments should be flagged in OSCAR as part of the target capabilities for either “Solar activity, solar wind and deep space monitoring“ (<http://www.wmo-sat.info/oscar/observingmissions/view/36>) or “Ionosphere and magnetosphere monitoring” (<http://www.wmo-sat.info/oscar/observingmissions/view/37>)
-