ESA Space Weather STUDY

Alcatel Consortium

SPACE Weather Parameters

WP 2100

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The entire Solar-Terrestrial system can be described as, and understood in terms of a succession of subsystems that exchange material and energy: the Sun atmosphere, the interplanetary medium, the magnetosphere, and finally the ionosphere-thermosphere system.

First stage : Model study

<u>Goals :</u>

- Synthesis of present modelling capabilities (Europe / world) of the whole Sun-Earth system
- Classification of space-weather operational models (versus research models)
- Look for lacks
- List of used input parameters and outputs

<u>Classification :</u>

- Empirical models : characterise the relations between relevant parameters from available observations
- Physics-based models : describe a given sub-system
- Technological models : estimate specified effects of our environment on a given 'system'.

	Number of models	Number of pre-operational or operational models (including empirical)
SUN	17	?
INTERPLANETARY MEDIUM	11	?
MAGNETOSPHERE	14	5
IONOSPHERE – THERMOSPHERE	17	8
CONVECTION ELECTRIC FIELD AND AURORAL PRECIPITATION	7	7
EUV – UV	5	4
METEOROIDS AND SPACE DEBRIS	11	11

Note : For sun and interplanetary medium, most of the models are research ones. The physics is not yet sufficiently understood to have proper operational models

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1) The large variability of the Solar Terrestrial system limits the efficiency of empirical models while progress in Space Weather requires the development of models that rely on basic physical principles controlling the behaviour of the Sun Earth interaction. **Achieving the development of such quantitative physics-based models is one of the main challenge for Space Weather issues**, and more generally for Solar terrestrial Physics.

2) Space Weather aims at routinely producing forecasts of relevant parameters. Before the development of operational versions of physics-based models, this will be achieved by means of hybrid models involving simultaneously physics based codes, artificial intelligence based codes, and empirical models. Such a hybrid approach is at present, and is likely to remain for a long time the most promising way of development of operational models. **More developments and improvements of empirical models remain therefore mandatory**.

3) These developments imply **routine availability of relevant direct measurements or scientifically agreed proxies**. **Homogeneous and long enough data series are necessary to assess the models.** The **development of new indices is mandatory** and has already been initiated in the scientific community.

Second stage : Input parameters

	Observed quantities	From ground	From space
SUN	6	3	6
INTERPLANETARY MEDIUM	6	2	5
MAGNETOSPHERE	3	0	3
IONOSPHERE – THERMOSPHERE	5	2	4
CONVECTION ELECTRIC FIELD AURORAL PRECIPITATION	Themselves	1	3
EUV – UV	Themselves	0	1
METEOROIDS AND SPACE DEBRIS	Themselves	2	2

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1) Ground observations are often complementary to space observations

2) Most of the required measurements cannot be accomplished from ground

A space weather program cannot be fully accomplished from ground

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Other studies of the WP

1) The indices

Used to summarise quantities, to provide a relevant synthetic information.
Involved in the description of the solar-terrestrial system and in its interactions

6 studied for the solar activity
6 families studied to monitor magnetic activity

Do remain basic data in Space Weather. Impossible to bypass for long term studies

In order to keep long records (past and future) of geophysical evolution, **any Space Weather program should recommend to continue the monitoring of the main indices**.

2) Space weather versus climatology :

Geophysical and historical records show that mankind already experienced several climatic or meteorological changes. Several phenomena contribute to these changes. Some may be related to space weather :

- Impact of the solar constant and solar energy
- Impact of the cosmic rays
- Impact of the greenhouse gazes

Any Space Weather program should keep open relationships with weather and climate programs.