



Session on
THE NOAA Space Weather Scales Tables

Chair: M. Messerotti

This plenary session was devoted to an in-depth analysis of the tables set up by NOAA to categorize the geoeffectivity level of, respectively, geomagnetic storms, solar radiation storms and radio blackouts according to the severity of the observed effects and based on thresholding the relevant physical observables.

The session was organized in short presentations by the specialists of the working groups, expert in each topic addressed by the tables, followed by an open discussion with the audience.

The main goals were the answers to the following questions:

- What is the level of usability of NOAA tables?
- Are they adequate to cope with any observable situation all over the world or a localization is needed?
- Is the granularity of the categories adequate?
- Can the thresholding be based on additional/different observables?
- Is any additional table needed to consider other Space Weather effects?

Frank Jansen, Leader of WG 4, acted as secretary of the session and this report is based on his notes, complemented by the presentations (see appendix) by M. Messerotti, Leader of WG 1, Rami Vainio, Chairman of WG 2, and Jürgen Waterman, Leader of WG 3, and by the open discussion with the audience.

The schedule of the session was as follows:

- General introduction (Chairman)
- The NOAA Scale for Solar Radiation Storms (R. Vainio)
- Open discussion
- The NOAA Scale for Geomagnetic Storms (J. Watermann)
- Open discussion
- Conclusions (Chairman)

M. Messerotti presented, by means of a set of concept maps, a general analysis of the NOAA Tables based on a paper by B. Poppe (NOAA SEC), which describes the rationale and the process that led to the construction of the tables for the needs of both the operators and the general public. He emphasized the set of possible issues to be discussed and questions to be given an answer as an outcome of the revision process:

- Inadequacy due to
 - A single physical parameter
 - Insufficient granularity in the set of categories
 - Redundant granularity in the set of categories
 - Bad scaling of the categories
 - Incomplete climatological assessment
 - Redundant climatological assessment



- Incompleteness of the set of tables
 - Need of additional scales tables
 - E.g. RADIO JAMMING to express the level of radio noise
 - E.g. IONOSPHERIC TURBULENCE to express the scintillation state

R. Vainio commented on the NOAA Tables about Solar Radiation Storms by considering the granularity, the geographical localization according to the possible dependence of effects intensity on geographical location, the thresholding of the used observable and the need of additional ones, the level of usability. He concluded that:

- There is no need for a different granularity
- The geographical localization may be an issue
- The used observable (>10 MeV proton flux) is not ideal e.g. for anything at low L and/or below thick shields and e.g. dose estimates
- Alternative/additional observables to be considered are the >100 MeV proton flux and the proton fluence per event as a function of E
- The solar radiation storm severity may be less useful for predicting effects at low L and/or under thick shielding, aircrew/passengers alerts, dose-related degradation estimates
- COST Action 724 would be able to analyze the range of validity in more detail and to propose better indices based on such an analysis.

J. Watermann commented on the NOAA Tables about Geomagnetic Storms by focusing on the used observable i.e. the Kp index and its adequacy as a descriptor of the phenomenology and by considering other analogs like intensity scales in seismology (Mercalli, Omori) and magnitude scales (Richter, moment magnitude), and the Saffir-Simpson scale which categorizes hurricanes based on wind speed and potential damages. Based on the statistics on the Kp index he stressed that for categories G4 and G5 (severe and extreme storms) in the “late morning sector” major problems on power systems can occasionally occur whereas in the “noon sector” will almost never occur. He concluded that:

- The Kp index is not an optimal storm index to begin with. Dst is better.
- The effect of a geomagnetic storm on technological systems depends on
 - the location
 - the local time
 - the configuration and parameters of pipeline networks and power line systems.
- Phenomenological descriptor tables are rarely used (if ever).
- There is no need for an effort to discuss in depth and possibly revise the NOAA geomagnetic storm tables.
- Storm categories based on the Dst index should be considered.

M. Messerotti showed briefly the NOAA Tables about Radio Blackouts, but with no comments as this topic is relevant to COST Action 296 and the invited speaker was Lily Cander, who could not attend the meeting.



The following issues emerged during the open discussion:

- Recommendations to NOAA and to ESA can be the outcome of this work. Eventually new tables and/or scales or new scale parameters can be prepared by the next MCM meeting. (J. Liliensten)
- The definition of specific keywords about Space Weather-related topics were solicited from COST Action 724 by the Virtual Observatory community to properly index and manage the relevant data. CA 724 is committed to provide such inputs. (J. Liliensten)
- Additional scales are to be considered for satellite navigation (Galileo) and aviation (airlines). (R. Vainio, F. Jansen)
- A warning about the proper use of the orientation concept for power lines was raised. (R. Pirjola)
- To get the highest impact for the general public, it is recommended a localization of any tables in the respective national languages. (M. Messerotti)
- The main role of such descriptive tables is in the framework of an alerting system, such as the one to be activated in ESA/SWENET, which will issue scale-based alerts by e-mail. (D. Heynderickx)
- A ground level effect scale might be investigated on. (S. Dachev)
- Peter Beck might be involved in the definition of a scale table for aviation. (F. Jansen)
- The development of a ULF index is currently under consideration in the space science community. If such an index materializes it has the potential to become a useful classification parameter for Space Weather-related effects in the magnetosphere-ionosphere system. (F. Jansen, J. Watermann)
- A scale table for the ionosphere scintillation/turbulence is to be considered for navigation and radio communications. (M. Messerotti, I. Stanisławska)
- A scale table related to the effects on the thermosphere is worthwhile considering. (J. Liliensten)



Executive summary

Two out of three NOAA Space Weather Scale Tables (S-Solar Radiation Storm and G-Geomagnetic Storm ones) were considered in detail with respect to usability, intrinsic characteristics and climatological assessments.

For the S-scale table, the >100 MeV proton flux and the proton fluence per event as a function of E are recommended for consideration.

For the G-scale table, the Dst index is recommended for consideration.

Additional scales for e.g. ground-level effects and the ionosphere state should be investigated.

Action Items

- Exploration of a GLE scale table. (S. Dachev)
- Involvement of CA 296 for an scale table on the ionosphere state. (I. Stanislawska)
- Exploration of a scale table relevant to the thermosphere. (J. Liliensten)
- Exploration of a scale table relevant to aviation. (P. Beck, F. Jansen)
- Preparation of a list of SpW-related keywords. (WG 4 upon the inputs from all WGs)
- Reporting about the outcomes at the next MCM meeting to decide about the possible evolution of the review process.