SWWT comments on Astronet's draft "Science Vision for European Astronomy"

v2, 17 January 2007

I am writing on behalf of the Space Weather Working Team (SWWT) to comment on those parts of a "Science Vision for European Astronomy" that address space weather. The SWWT is a forum open to European experts on space weather. It plays an important role in advising ESA on space weather strategy and acts as a forum for discussion in the European space weather community.

The SWWT welcomes that the Chapter 5.3 of the draft Science Vision includes positive references to space weather. Unfortunately those references present a restricted vision of what space weather is about. The science vision needs significant expansion in this area:

a. Most importantly, we ask that the document recognise that there are major European space weather activities proceeding in parallel with Astronet (see Annex 1). The European space weather community has become much more organised over the last decade, e.g. through the annual European Space Weather Week meetings. ESA has been a major catalyst for this through its support for studies, meetings and networking activities; the EU has also helped by funding a number of space weather projects. The proposed changes might be made by adding a short section on the European space weather scene. This should outline the range of space weather activities in Europe and discuss how Astronet can interact with them.
b. We recognise that Astronet may not wish to cover the full spectrum of space weather effects from the Sun to the crust of the Earth. We ask Astronet to decide how much of this domain they wish to cover and then to work with the wider European space weather community to ensure good scientific coordination at a European level.
c. The document should recognise that prediction is but one goal of space weather studies. Other major goals include environmental specification (what is the likely range of space weather) and post-event analysis (what were the actual space weather conditions); these are important to end users as they allow engineers to design systems to cope with space weather and to learn lessons from space weather problems. Nowcasting (what are the space weather conditions now) is also an important goal as it provides the situational awareness that is valued by operations teams who need to consider space weather effects. Nowcasting is regarded as a very different goal to prediction. The proposed changes might be made by expanding the background in section 5.3.1 to outline the full set of space weather goals.
d. The research areas discussed in the background section should match the breadth of vision captured in the excellent diagram from Lou Lanzerotti (Figure 5.3 of the report). It should include: (i) understanding the solar brightness variations at all wavelengths including in particular the UV that influences the chemical composition of the terrestrial atmosphere, (ii) understanding particle acceleration processes in the solar atmosphere, in planetary radiation belts and in the auroral zones of the magnetised planets, (iii) modelling propagation of coronal mass ejections (and their embedded magnetic fields) from the Sun to the Earth, (iv) understanding and modelling the dynamics of planetary magnetospheres – most importantly gaining a deep understanding of how sub-storms work, and (v) modelling the behaviour of planetary upper atmospheres (neutrals + plasma) and their response to space weather. These areas all require progress in understanding plasma astrophysics - and especially going beyond MHD and using hybrid and kinetic models of plasmas. Progress here can also provide insights applicable to plasma regimes beyond the solar system. For example, the Earth's ionosphere is an exemplar of the collisional plasma regimes found in many astrophysical objects.

e. The section on experiments needs to be extended to cover space weather observations away from the solar atmosphere, e.g. in-situ and remote sensing measurements of the interplanetary medium (plasma and magnetic field), in-situ and remote sensing measurements of conditions in the Earth's magnetosphere, radiation belts and ionosphere. This section would also benefit from a sharper focus on measurement requirements and techniques, e.g. to explicitly state the need for coronagraph measurements. An extensive literature on space weather measurement requirements exists as a result of various ESA-funded studies and should be cited here. The proposed changes might be made by expanding section 5.3.2; the scope of the changes will depend on how much of space weather Astronet wishes to cover as discussed above.

The report rightly makes many statements on the need to make observations of the Sun over periods of time. Examples include:

- in section 5.1, to observe process over a "temporal range from decades to seconds"
- in section 5.2, how does distribution of magnetic flux "change on short and long time scales"
- in section 5.3, "magnetic activity, from short term variations over the 11 year sunspots cycle to long-period variations which modulate the activity cycle maxima,"
- in section 6.4, the need "to monitor the full-disc Solar magnetic and velocity fields on time-scales from minutes to decades"

The SWWT recommends to highlight the requirement for temporal measurements of solar processes by developing a more homogeneous framework for time-scales. A simple way to do this would be a figure that has time as one of its dimensions and shows the range over which each process must be observed. The recommendations for future activities should be reviewed to ensure consistency with the temporal requirements and to be specific about the instruments capabilities required (e.g. wavelengths, spatial resolution, cadence, distribution in space and on ground). We note that the solar measurement requirements with respect to space weather have been extensively explored in ESA-funded studies. We recommend that Astronet consult the outputs of these studies.

The SWWT welcomes the report's strong support for studies of long-term variations in solar activity and its impact on climate. This should be expanded to include long-term trends in space weather, e.g. geomagnetic activity, solar energetic particle events & planetary space environments. On the practical level this shows the importance of research infrastructures to acquire, archive, document and disseminate long-term time-series data. We cannot overstate the importance of good documentation (metadata) as a tool for enabling new science from long-term time series.

The SWWT also welcomes the report's comments on the need to monitor activity on the solar farside. This is increasingly important as a tool to monitor space weather effects relevant to planetary exploration (missions to the planets will experience many space weather events originating from farside solar activity). It is also important to support two-week ahead forecasting of space weather at Earth., e.g. atmospheric drag predictions needed for planning of spacecraft operations in low Earth orbit. We note that the scattering of solar farside UV emissions by the interplanetary medium provides a second method of monitoring farside activity and has been prototyped by the SWAN instrument on SOHO.

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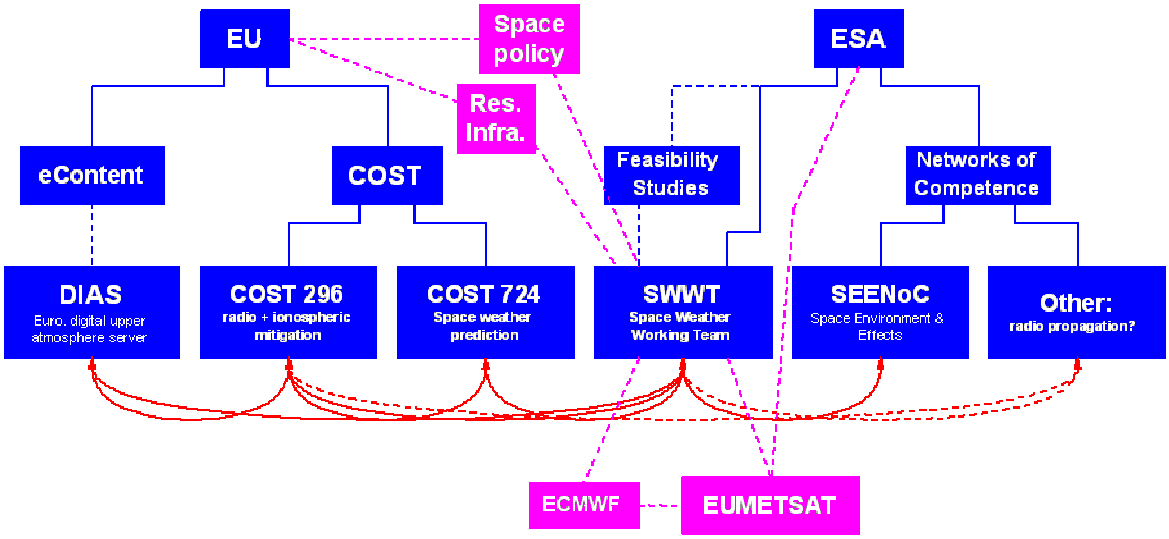
Annex 1. European space weather activities

The figure below outlines the space weather scene in Europe. There are number of groups addressing different aspects of space weather as follows:

a. DIAS – the European digital upper atmosphere server (http://www.iono.noa.gr/DIAS/). It was started with funding from the EU eContent programme.
b. COST 296 – COST action to coordinate studies to mitigate ionospheric effects on radio propagation (http://www.cost296.rl.ac.uk/).
c. COST 724 – COST action to coordinate studies on developing the scientific basis for monitoring, modelling and predicting space weather (http://cost724.obs.ujf-grenoble.fr/).
d. SWWT –This was established by ESA to support their space weather feasibility studies in 2000/1 and is now a forum open to European experts on space weather (http://esa-spaceweather.net/spweather/esa_initiatives/swwt/). It seeks to promote space weather applications and the underpinning science. It advises ESA on space weather strategy and acts as a forum for discussion amongst the European space weather community. It is also developing links with other European bodies including relevant units in the EU Commission and European meteorological organisations.
e. SEENoC – Space Environment Effects Network of Competence. ESA-sponsored network to coordinate member state expertise and activities on the space environment and its effects. Similar ESA networks may be developed for other areas of space weather.



There are strong and effective links between these groups through cross-membership and, most importantly, through attendance at the annual European Space Weather Week. There are also strong links via SWENET, the Space Weather European Network (http://esa-spaceweather.net/swenet/) established by ESA as part of its Pilot Programme for space weather applications. SWENET links together about 25 space weather services across Europe, many of which are embedded in the scientific community.

The space weather community is strong supporter of the International Heliophysical Year (http://ihy2007.org/) and of relevant European activities (http://www.lesia.obspm.fr/IHY/). IHY is an excellent opportunity to raise awareness of the science relevant to space weather and of its societal importance – both as a way to inspire interest in science and as a discipline of practical importance.

Annex 2. Detailed comments

No	Location	Comment
1	Sec 5.3.1 Para 1	Delete “to predict – or at least to recognize – potentially hazardous situations timely enough to enable protective measures”. Space weather requires a good understanding of these physical processes irrespective of whether that knowledge is applied to prediction, environmental specification, post-event analysis or nowcasting.
2	Sec 5.3.1 Para 1	It’s good to highlight the work done by SOHO, but the report should also cite important space weather work done by other missions such as the ACE spacecraft, which has continuously monitored the solar wind and IMF since 1997. While this is a NASA mission, there is European involvement in the payload and the ground segment. European ground stations play a critical role in maintaining 24/7 real-time data availability. This is also an area where Europe has the potential to play a central role in the next generation infrastructure, e.g. through collaboration with China on the KuaFu mission.
3	Sec 5.3.1 Para 1	The penultimate sentence “The main goal of research in this area is the ability to predict energetic events on the Sun” encapsulates the very restricted vision of the present draft. It should be deleted and replaced with text that matches of the breadth of vision captured in Figure 5.3 - as already discussed above