

**ESA Space Weather Study****ALCATEL LPCE consortium****WP5200 Report : New structures****Recommendation for the co-ordination of  
a European Space Weather Programme**

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**ESA Space Weather Study /ALCATEL LPCE consortium****WP5200 Report : New structures****Recommendation for the co-ordination of a European Space Weather Programme****I. INTRODUCTION**

As emphasised in most presentations of Space Weather in the last years, Space Weather is a part of our environment in the same sense as traditional weather. Weather is defined as the state of the atmosphere. Space Weather is the state of geospace where human activities are developed. In both cases, basic research as well as application require co-ordination between several activities and entities or agencies. The aim of the present note is :

- to identify the activities to co-ordinate in order to set up a European Space Weather Programme,
- to point out entities and/or agencies to involve,
- to suggest actions to be taken to define European structures.

In order to fix guidelines the consortium has thought about an ideal structure based on a co-ordination between sub-structures, each of which being in charge of one European space Programme element. The main organisation is sketched in the WP 3110 document. A connection to other International Space Weather Centres is proposed via a World Space Weather Organisation. Now, a thorough analysis is needed to identify the critical points and the stakes for each participating entity. Waiting for the constitution of a Committee gathering all stakeholders in the relevant European entities, at this stage one may only define principles or, at most, pre-operational European structures.

The plan of the report is as follows :

Section 2 is devoted to the presentation of the present situation and to the description of the constraints adopted by the consortium to define a European structure.

In section 3, the main outputs of previous WPs are used to define six European Space Weather Programme elements :

- Space observations,
- Ground-based observations,
- Space Weather data Centres,
- Space Weather services,
- Modelling,
- Education and User assistance.

Section 4 deals with the European entities which are (or could be) involved in these Programme elements, and which could take in charge some of them : fully or partially. They are :

- ESA,
- European Union and European Commission,
- EUMETSAT,
- Scientific Unions
- National space agencies
- National institutes.

Finally, provisional conclusions are given in section 5.

## II      CONTEXT

### II.1 The present situation

As already noted, the objectives of a Space Weather Programme are very similar to those of a Weather (or meteorology) Programme. Then, it might be inviting to copy structures adopted for meteorology. Now, even if an entity like EUMESAT may be involved in Space Weather, or at least may be considered as a model for Space Weather, it is not obvious that the structures must be similar. The history is not the same. No comparison is possible between the political and economical weights of the National Meteorological Services and of the Space Weather data Centres and services presently active in Europe.

Presently Space Weather activities have been initiated without reference to the meteorology model. In what follows we will briefly recalled :

- The US National Space Weather Programme,
- Space Weather initiatives taken in other countries, particularly in Europe.

A summary of the activities in each Space Weather element is given in Table 1.

#### *II.1.1 US Space Weather Programme*

The US Space Weather model is more appealing. It is linked to meteorology because the Office of the Federal Co-ordinator for Meteorology (OFCM), which orchestrates multi-agency co-ordination, was the good place to gather governmental agencies (NSF, NASA, NOAA and the DOD) and so to host the National Space Weather Programme Council (NSWPC) and the Committee for Space Weather (CSW). In the implementation plan of the National Space Weather Programme (2<sup>nd</sup> edition, July 2000) five elements are considered :

- At a first level : Research, Observations, Models, Education,
- At a second level : Forecast and Specification Services.

The Research Programme is based on the need to understand the fundamental physical processes, to define observations to be made, and to aid the development of operational models. NSF, NASA, NOAA and the Department of Defence are supporting research Programmes. The Living With a Star (LWS) Programme is co-ordinated with other NSWPC activities through NASA membership on the CSW and by CSW member's participation in LWS planning.

The observation Programmes builds on existing observational capabilities and determines the value of current data and new data needs. The initial focus is on better coverage of data-void or data-sparse regions, and on the deployment of systems that provide data with appropriate accuracy, resolution and timeliness. Versatility is included in order to take evolutions into account. Space observations include operational data and research-oriented data sources provided by satellites constructed and operated by different agencies. Ground-based data are mainly provided by scientific instruments.

Modelling aims to specify and predict the space environment. It is conducted in three steps : (i) development by research groups, (ii) tests and further development in the Community Co-ordinated Modelling Centre (CCMC), based at the Goddard Space flight Centre, Greenbelt, Maryland, (iii) transition into operational capability via the Rapid Prototyping Centres (RPCs) based at the Boulder Space Environment Centre (SEC).

The Education Programme is based on the hypothesis that educated public and commercial sector can make better use of space environment forecasting services and that training is necessary for all persons involved in the Space Weather Programme. So, education activities (conferences, workshops, training) are directed to : science education (raising awareness), space scientists, operations personnel and Space Weather customers.

As emphasised in the implementation plan, Forecast and Specification Services are the predominant drivers for the Space Weather Programme. Accuracy, reliability, and timeliness are expected to become comparable



to that of conventional weather forecasting. The two “operational arms” are : (i) the Boulder Space Environment Centre (SEC), dedicated to civil customers, (ii) the USAF 50<sup>th</sup> Weather Squadron, dedicated to defence. At both Centres, Space Weather is approached in much the same way as forecasting tropospheric weather.

The US participates in international exchange of data and forecasts for the space environment through the Environment Space Environment Service (ISES) described below.

### ***II.1.2 Other Space Weather initiatives***

Presently, there is no equivalent to the US National Space Weather Programme. Several countries or/and international organisations are involved in works related to one or several elements of a Space Weather Programme. But they don't cover all of them or/and they don't have reached the same level of co-ordination. However, a co-ordinated structure is initiated by end 2001 in Europe via a proposal for a new COST action on Space Weather. A non-exhaustive list of SW activities in Europe is given in the proceeding of the workshop on Space Weather (11-13 November 1998, ESTEC, Noordwijk, The Netherlands, WPP-1555, 1998)

Space observations in support of Space Weather are mainly performed by research-oriented satellites such as SOHO (ESA/NASA) and YOHKOH (Japan). However, the mode of operation being tailored to research programmes, there are frequent discontinuities in the measured and transmitted data. Furthermore, the resolution is often not appropriate. For technical research, several agencies (ESA included), embark operational instruments on non-dedicated satellites. But, except for short time periods where US environmental satellites like CCRES are in orbit, environmental data are missing. As a matter of fact, available data bases are discontinuous, inhomogeneous (calibration problem), and incomplete (missing parameters).

Although strong efforts are made for multinational collaborations and co-ordination, most ground-based instruments are still funded by national academies or institutes, with the consequence : that the quality of the data is inhomogeneous, that the continuity is not guaranteed, and that, for most observations a 24-hour coverage is a very difficult challenge. Due to the geographic locations, countries are specialised in some type of measurements. This is the case for Australia, Canada, China, India, Japan, Russia, .. and the Scandinavian countries.

The acquisition, storage and distribution of space and ground data has been strongly developed in recent years. Presently, there are nearly 200 Web sites around the world. A few of them belong to the World Data Centre (WDC) system of the International Council of Scientific Union (ICSU). Nine WDC are in Europe. Data are also accessible from the Regional Warning Centres described below.

Regional Warning Centres (RWC) are labelled by the Environment Space Environment Service (ISES). ISES is a service of the Federations of Astronomical and Geophysical Data Analysis Service (FAG) under the auspices of International Scientific Unions represented at ICSU. It facilitates near-real-time international monitoring and prediction of the space environment by : the rapid exchange of space environment information, the standardisation of the methodology for observations and data reduction, the uniform publication of observations and statistics, and the application of standardised space environment products and services to assist users. Three RWC plus an associate RWC are present in Europe.

Several countries have integrated Programmes where observations and Space Weather services are closely linked. This is the case for Austria, Canada, Japan, and Sweden. Furthermore, for strategic reasons, several countries have their own data and service Centres. This is particularly the case for the transmissions and ionospheric systems in Europe. However, for that problem, collaborations exist via an existing action in the European COST Programme.

Modelling may be research-oriented or user-oriented. From the view point of research-oriented modelling, one can break the Space Weather system up into several regions of the Solar system (solar corona, solar wind, magnetosphere, ..). But, for the use in Space Weather services, once the corresponding models have been developed, it remains to integrate all the elements and to make the system operational. For the

European countries, regional models with various level of sophistication have been developed by research groups funded by national or/and European organisations (see WP 2100 by Lathuillere, Lilensten and Menvielle). But, no co-ordinated plan of development exists for regional as well as for integrated models. Furthermore, there is no specialised Centre, like in USA, to develop large-scale integrated models and to make them operational. User-oriented modelling have been developed at the Lund University which is now the Regional Warning Centre in Sweden.

Outreach actions are currently organised in many countries. In Europe, ESA and EU (via the fifth framework Programme) use to fund such a type of actions. Actions directed to the users are also taken. Each year, a meetings dedicated to the GIC (Geomagnetic Induced Currents) users is organised in the Scandinavian countries. ESA already invited users to 2 workshops and has a third workshop in December 2001. National meetings took place in UK and France in 2001. However, a strategic plan is missing to better identify demands from the public as well as for the commercial users, then to answer these demands.

## **II.2 Hypotheses on the constitution of a European Space Weather Programme**

### ***II.2.1 Hypotheses on the elements***

The Space Weather elements considered by the consortium are slightly different from the one of the US National Space Weather Programme.

According to the AO issued by ESA, an independent Research element has not been included. Basic scientific research is obviously needed to improve our fundamental understanding of physical processes by which : coronal mass ejections occur, storms are triggered and develop, electrons and ions are accelerated, irregularities in electron density are produced within the ionosphere and above, etc. But the science Programme is defined independently of the Space Weather Programme. Missions to be launched in the context of Space Weather are supposed to be operational or pre-operational, and so proposed to ESA as an optional Programme. However, bridges are identified in the present study.

Distinction is made between Space and Ground-based observations. The Space observation element include : (i) inter-agency and international co-operations, (ii) design, development of instruments and/or platforms, launch, operations, and delivery of raw data. The ground-based observations elements include : (i) improvement of the existing networks, (ii) design, realisation and implementation of new instruments, operations and delivery of raw data.

Distinction is also made between Space Data Centres and Space Weather Services. The two functions are different. Space Data Centres are linked do data providers. They are supposed to use same standards of formatting and archiving. Space Weather services are linked to users. They may offer different services from one to the other.

Modelling is restricted to modelling of the Space-Weather system. Although part of the developments may be in common, it does not include modelling used to test space instruments at ground and modelling to predict effects on the electronics and on biological systems.

A specific Space weather element is devoted to formation of the public, of the students, of the operations personnel, and of the users. It must also facilitate relationships with the users

### ***II.2.2 Hypotheses on the structures***

According to the rapid evolution of our knowledge of Space Weather system and of effects of solar storms on the modern technology and on the day life, it is of prime importance to have open structures for the European Space Weather Programme. This has consequences : for the management structure, for the participation to a Space Weather element, and for co-operations with all Space Weather stakeholders.

As regards to the management, it seems essential to have a structure which gather all involved European entities with a possibility that new entities be involved and that the sharing of responsibilities at a given time be modified when needed.

For participation of groups or Centres to a Space Weather element, it is suggested that one may take advantage of the existing structures (World Data Centres, Regional Warning Centres, Associate Regional Warning Centres, ...) without being stuck by them. Which means that AO must be send for activities funded by the Space Weather Programme and that, if the membership of the applicants to an international organization is regarded as a positive element, labels may be given to groups or Centres which don't belong to any international organization.

A particular case is the constitution of new Centres funded by the Space Weather Programme. In general, networks structures seem more adapted for European countries than dedicated structures. But, when technical constraints impose to gather competencies in a given place, it is essential to open bridges to independent labelled Centres.

To ensure maximum benefit, formal and informal mechanisms have to be found to promote effective cooperation with the European Research Community, the European user community, and Space Weather Programmes run outside Europe, in particularly in US. The objective to have some kind of autonomy as regards to Space Weather, does not prevent to avoid duplication of efforts and to promote resource sharing.

<b>SW Elements</b>	<b>US national SW program</b>	<b>Europe : the existing</b>
<b>Search</b>	Solar/Earth interaction studies <b>LWS</b>	Solar/Earth interaction studies
<b>Observations</b>	Research-oriented satellites Operational satellite(s) networks of ground-based instruments	Research-oriented satellites networks of ground-based instruments
<b>Models</b>	Research models Operational models <b>CCMC</b> (Goddard) <b>RPC</b> (SEC)	Research models Operational models
<b>Education</b>	Conferences SW meetings Space SW week events Training courses (DOD, SEC)	Conferences SW meetings
<b>Forecast and specification service</b>	WDC Solar-Terrestrial Physics (SEC) + other data centers RWC, SEC USAF 50 <sup>th</sup> Weather Squadron Internal services Commercial companies	WDC Geomagnetism, Denmark WDC Geomagnetism, Scotland WDC Solar-Terrestrial Physics, England WDC Sunspot Index, Brussels, Belgium + other data centers RWC , Belgium RWC, Poland RWC, Sweden ARWC, France Internal services Commercial companies

**Table 1: Space Weather elements, present status**

ARWC, Associate Regional Warning Center  
CCMC, Community Co-ordinated Modeling Center  
LWS, Living With a Star  
RPC, Rapid Prototyping Center

RWC, Regional Warning Center  
SEC, Space Environment Centre  
WDC, World Data Center

### III. FUNCTIONS TO BE ACHIEVED IN EACH SPACE WEATHER ELEMENT

Functions to be achieved for each element of a European Space Weather Programme have been examined in the previous WPs. A brief review is presented here. The main outcomes are summarized in Table 2.

#### III.1 Space Observations

The space segment proposed for a European Space Weather Programme has been defined after discussions with all consortium members and after the issue of « a first iteration » (WP 4400, by T. Dudok de Wit). It is fully described in the report written by Andrew Coates, Norma Crosby and Bob Bentley, WP 2000 – 2300). System architecture and element design are given WP 2400 by O. Pansart document. The main elements of the space segment consist in :

- a solar observer,
- an upstream monitor at L1,
- a set of radiation belt mappers,
- a set of ionospheric mappers, including an auroral imager,
- hitch-hikers

The way these elements may be used to satisfy the user requirements is described by B. Huet (WP 5100) via three scenarios taking into account of the complementarity with observations made by ground-based measurements : (i) a full scale scenario, where all requests are fulfilled, (ii) a medium scale scenario, where part of the objectives are fulfilled only, (iii) a low scale scenario where a minimum of objectives may be reached only.

It has to be noted that the radiation belt and ionospheric mappers defined by the consortium, from user requirements, have basically same equipments as the Living With a Star radiation belt and ionospheric mappers defined by the US Geospace Mission Definition Team from scientific objectives linked to Space Weather. Furthermore, compromises are possible to have the same orbits. Common interests on equipments and satellite platforms may also be found for the other elements of space segment.

Differences between research-oriented missions and application missions are mainly related to :

- continuity and duration of measurement for monitoring and post analysis (although the constraint be less severe for model developments),
- 24 h coverage,
- real time access to measured data for monitoring,
- operability of ground segments (telemetry reception and data handling) and links to data Centres for any applications.

Provided cautions be taken, for several elements of the space segment the same satellite may be considered as a research-oriented satellite or a Space Weather operational satellite. As a consequence, collaborations around Solar/Earth satellites must be looked for : at the European level, or at the international level, for instance with the LWS programme.

Functions to be associated with the Space Observation element are :

- define and take in charge the European Space Weather Space Observation element,
- promote and follow co-operation with research and user communities,
- promote and follow inter-agency and international co-operation.

### III.2 Ground-Based Observations

A report on ground based instruments of potential use for space Weather has been presented by M.Pick, C. Lathuillere and J. Liliensten (WP 3120). The most relevant equipments have been selected. They are :

(a) existing equipments

- for all scenarios described in the B. Huet document : 10.7 cms flux monitor, Neutron and muon detectors, Magnetometer networks, the SuperDARN HF coherent radars network, ionosondes and positional receivers,
- for low scale scenario only : full disk magnetograph, H $\alpha$  network.

Except for 10.7 cms flux monitor, improvements are needed to make the measurements operational. For radio receivers (radio spectrograph and radio imager) new networks must be set up with three sites in three longitudinal ranges.

(b) new equipments

- for all scenarios described in the B. Huet document : a Broad band radio spectrograph (40 MHz – 20 GHz), a Multifrequency radio imager (in the band : 70 MHz – 1 GHz).

Functions to be associated with the Ground-Based Observation element are :

- define and take in charge European Space Weather ground-based instruments (i.e. new instruments)
- improve existing networks of ground-based measurements,
- coordinate cooperation with Centres out of Europe.

### III.3 Data Centres

Information on the existing Data Centres are given in the H. Lundstedt (WP 3110) document. Presently, there are nearly 200 Web sites around the world. A few of them belong to the World Data Centre (WDC) system of the International Council of Scientific Union (ICSU). Nine of them are in Europe. Data are also accessible from the Regional Warning Centres (see III.4). Scientific Data Centres for which there is presently no interest to produce data dedicated to Space Weather are not included.

Pending questions are upon :

- adequacy of the existing data bases (including Boulder) to the user needs (extreme and average values, inputs to prediction models, use for post-analysis, ...),
- constitution of a European network of labelled Data Centres (AO must be issued to allow the existing data centres to be labelled but also to new ones to apply; the status of a labelled Data Centre being to be defined)
- creation of a main Data Centre (i.e. of a European Space Weather data Centre) to take care of technical evolutions, to make sure that the labelled Centres are at the standard level, and to valorise scientific data bases,

Functions to be associated with the Data Centres element are :

- establish a policy for the labelled Data Centres and the European Space Weather data Centre, then take in charge the control and evaluation tasks,
- coordinate collaborations with data Centres out of Europe.

### III.4 Space Weather Forecast Centres

Space Weather Forecast Centres presently available are described in the H. Lundstedt (WP 3110) document. They may be under the responsibility of governmental organizations as well as commercial companies. Most services run by governmental organizations are Regional Warning Centres (RWC) associated with the International Space Environment Service (ISES). In Europe, there are :

- three governmental Regional Warning Centres (RWC) affiliated to ISES (Brussels – Belgique, Warszawa – Poland, Lund – Sweden),
- one other governmental organization (British Geological Survey – UK),
- one associate RWC (CLS – France),
- and several services belonging to governmental organizations or companies (British power distribution company, CNES, ESOC)

Pending questions are upon :

- adequacy of the existing services to the user needs (warning, forecast, nowcast, post-analysis),
- constitution of a European network of labelled SW Forecast Centres (AO must be issued to allow the existing Centres to be labelled but also to new ones to apply; the status of a labelled SW Forecast Centre being to be defined)
- creation of a main European Space Weather Forecast Centre, to provide generic forecasts, to take care of technical evolutions (in particular for modelling), to make sure that the labelled Centres are at the standard level, etc.

Functions to be associated with the Forecast Centres elements are :

- establish a policy for the labelled Forecast Centres and the European Space Weather Forecast Centre, then take in charge the control and evaluation tasks,
- co-ordinate with Modelling services development process for operational models
- co-ordinate collaborations with services out of Europe.

### **III.5 Modelling Services**

A report on a future modelling Programme has been written in WP 3230 by Cargill et al.. The main ideas are:

- development of specific models (i.e. specific to components of Space Weather systems) must continue to take place with the research groups where the models reside,
- development of large-scale integrated computational models must be located at an institution, or consortium thereof, in the ESA countries,
- provided there is some co-ordination from the ESA Programme, commencement of the development of the integration of models between different regions of geospace may take place within the research groups.

It has been implicitly assumed that the modelling of the consequences of the Space Weather effects on the astronauts, air crews, airplane passengers, electronic components, satellite orbits, communication, etc. had to be taken into consideration by the users (satellite designers, satellite operators, space agencies, defence, civil aviation, ground-based systems, insurance ..). However, as for the modelling of the Space Weather system, a European co-ordination is needed.

Functions to be associated with the Modelling element are :

- define and follow the constitution of one or several Centres for large scale integrated modelling,
- label groups and Centres working on regional modelling
- establish a development Programme
- coordinate with Space Weather services development process for operational models
- coordinate collaborations with services out of Europe.

### III.6 Education and User Assistance

Education is essential for public, students, scientists and operations personnel and Space Weather customers. But assistance to identify Space Weather effects and to take the proper actions is also needed. Analysis of requirements made by R. Horne (WP 1100, 1300, 1400) and A. Shaw (WP 1200) show :

- in the one hand, that users have severe requirements about : continuous coverage, continuous access, reliable data, back-up redundancy, reliable predictions, understandable predictions, etc ...but,
- in the other hand, that user knowledge of Space Weather effects happens to be very poor, that the expertise one company may have at a given time is easily lost a few years after, that businesses are not aware of the true cost of Space Weather in their operations, etc. In other words, assistance is essential.

Functions to be associated with Education and user element are :

- promote demonstrative modelling and prototyping,
- support users for defining true requirements and make cost-benefit analysis,
- run an education Programme directed to : commercial users, research community, school and universities, general public, news media, ...

<b>SW Element</b>	<b>Improvement of the existing</b>	<b>New Implementations</b>
Space Observations	Hitch- hikers	ESW space segment (preferentially in the context of International collaborations)
Ground – Based Observations	Equipments Networks	Radio and optic instruments (at 3 different longitudes for radio, 6 for optics)
SW Data Centres	Labelled Data Centres	One ESW Data Centre
SW Forecast Centres	Labelled Forecast Centres	One ESW Forecast Centre
Modelling	Developments in research labs, Co-ordination	One ESW Centre for large scale integrated modelling
Education & User Assistance	Demonstrative modelling and prototyping, Experts for each Space Weather element	

**Table 2 : Summary of the proposals**

*Summary of actions to be taken for implementing a European Space Weather Programme. The main points consist in : a space segment, new ground-based instruments, labelled Centres , and European Space Weather Centres. The status of labelled Centres and of European Space Weather (ESW) Centres have to be defined.*

#### **IV. EUROPEAN ENTITIES AND AGENCIES THAT MIGHT BE INVOLVED**

At the present stage ESA is the only European body which is clearly involved in Space Weather activities. The EU has shown signs of interest via the Framework Programme including some initiatives (GALILEO and GMES). EUMETSAT also could be a driver. Other entities, not contacted yet might contribute to a European Space Weather Programme. National agencies and institutes which support activities related to one or several Space Weather elements must also be involved. Of prime importance for effective progress in Space Weather goals is the co-ordination with the customer community.

Indications on strategic elements to be discussed in the future are summarised in Table 3.

##### **IV.1 The European Space Agency,**

ESA is clearly the driver and should continue to play that role. It is already involved in operational Space Weather activities (radiation monitoring instruments). It is a data Centre and it has a forecasting activity (orbitography). It funds modelling development and supports outreach Programmes. It has issued the Announcement (A03533, 11/06/1999) for the current study on Space Weather and follows and controls the advancements of the studies.

##### ***IV.1.1 ESA role and possible actions***

ESA directorates which are involved or might be involved are :

- the Directorate of Strategy & External Relations (D/SER), which has to deal with the Member States and the European Union;
- the Directorate of Technical & Operational Support (D/TOS), and specifically the Space Environment & Effects Analysis Section (TOS-EMA) which is in charge of the present study;
- the Directorate of the Scientific Programme (D/SCI), which has an obvious interest for research about Solar- Earth interactions, but not for operational missions; in addition, the scientific Programme, based on Horizon 2000 concept, is the main part of the mandatory activity and funding for ESA members (according to their national gross product);
- other directorates like Directorate of Application Programmes (D/APP), Directorate of Earth & Environment Monitoring from space (D/EEM) might have an interest in the future.

One obvious difficulty is the harmonisation of the mandatory Science Programme (for all the Member States) and other optional Programmes (which supposes several States agree on the level of resource). However, assuming an operational Programme is set up, in Europe or elsewhere, Science may probably collaborate via some instruments. This point has probably to be investigated if collaborations with the US LWS Programme is found desirable.

Apart co-ordination with the Science Programme, ESA may :

- trigger the interest for Space Weather via the present study, and other public actions, like Conferences or Workshops, (eg the ESA workshop on Space Weather, ESTEC, 1998),
- introduce the Space Weather concept in some Council at the ministerial level, via a new optional Programme (for several reasons, this was not possible for the Edinburgh council of November 2001 (see annexes) but Space Weather is mentioned in the General Budget),
- initiate a co-operation of all entities among Europe involved in SW, including non ESA member States (EU members, Eastern Europe States, Canada) in order to develop some pre-operational organisation.

Common actions of ESA with EU are presented below.



#### ***IV.1. 2 The ESA Ministerial Council (Edinburgh, 15/11/2001)***

This important political and strategic meeting coincides with the time of completion of the present study, so it was difficult to anticipate on its conclusions in the present report. It was originally envisaged to push the subject Space Weather to be on the agenda. Although not possible, many concerns were expressed in relationship with the council meeting :

- the ESF/ESSC, acting as representatives of the scientific community, after hearing the consortium members, expressed to the JSSAG a very positive statement : “to support the launch of a European Space Weather initiative; a decision to begin a modest study Programme is recommended”
- the industrial community, via EUROSPACE, did not expressed formally any statement, however, after hearing the consortium members, they decided to push the subject in their internal working groups, in order to propose for the next future new technological and industrial developments based on Space Weather.

Generally speaking, the Edimburgh meeting strongly insisted on many aspects related top the Space Weather and to other projects like GMES and GALILEO : “*Space serving European citizens*”.

*With Europe's evolving geopolitical role and the increasing recognition of space as a strategic instrument for carrying out its policies and improving the overall quality of life for European citizens, ESA is seeking to pursue its goals in closer co-operation with the European Union. This ESA Council meeting at ministerial level will be instrumental in implementing policies that will lend direction to and consolidate the evolution of the public space sector and in confirming the mandate given to ESA to develop further towards becoming the space agency for the European Union. The meeting will also be taking decisions on specific activities that will create knowledge, provide services for the benefit of the people, and secure Europe's position in space so that it can make the fullest possible use of its potential over the long term.*

#### **IV.2 The European Union**

Inside the European Union (EU), the European Commission (EC) with all its Directorate-General's (DG) holds the executive role. It has undertaken and managed the recurrent Framework Programme (FP) for research and technological development. The current FP5 (1998-2002) incorporates some Programme lines and “initiatives” indirectly related to space activity, like GALILEO or GMES.

The future FP6 (2002-2006) is not yet fully approved, it is supposed to enter in force by end 2002. Many new concepts are introduced or reinforced like the European Research Area (ERA) which intends to develop the European Union's policy in the field of research and technological development and thereby contribute to the international competitiveness of European industry. It will include 7 “Specific Programmes”, one of them being “Aeronautic and space” with an expected funding of 1 Billion Euros. It will insist on the Integrated projects (IP) and the Networks of excellence (NOE).

The DG Research is presently the main one to be open to Space Weather activities. Further on, other DG's may have an interest for Space Weather, e.g. the DG Energy-Transport, the DG Environment, the DG Information Society (via Transeuropean networks). In addition the DG Research is in charge of the 7 Joint Research Centres (JRC), among them is the Institute for Environment and Sustainability (IES) in Ispra (Italy).

The DG Research may probably support actions related to Space Weather activities provided they are presented in behalf of users and they concern research or, at most, pre-operational activities. An exception for operational action seems possible by sake of continuity of service. Information may be passed via the Space Co-ordination Group (SCG). Joint structures EC/ESA may have an important role in the elaboration of a European Space Weather Programme.

### **IV.3 The ESA / EU co-operations**

#### ***IV.3.1 The joint ESA / EU entities : JSSAG, Task Force***

The Joint Space Strategy Advisory Group (JSSAG) aims at providing an ESA/EC structure for consultation with the Member States about missions given to the task force, notably on future development and implementation of the European Strategy for Space. When appropriate, JSSAG may also formulate opinions and recommendations about proposals made by the Joint Task Force. The JSSAG is composed of national representatives. It may invite representatives from the European Economic Area (EEA) and experts from relevant organisations, eg the ESF/ESSC which deliver inputs from the science community, and the EUROSPACE association of European industrials acting in space business.

The joint ESA/EC Task Force is a new way for the two Executives to work jointly without affecting existing responsibilities and decision-making mechanisms. The field of activity of the Task Force will encompass all areas of common interest between ESA and the Commission. It will include :

- Investigate how space can be used to better implement Community policies;
- Monitor progress on the two priority areas relevant to EU policies, i.e. GALILEO and GMES,
- Propose an EC/ESA framework enabling notably ESA to act as implementing agency with respect to the EU policy for space;

A “Science” Working Group has been set up very recently, it would be probably a good place for ESA and EU to examine Space Weather issues.

#### ***IV.3.2 Joint ESA / EU Programmes : Galileo, GMES***

GALILEO (Global Satellite Navigation Services for Europe) is the first system of navigation and positioning by satellite designed for civil purposes. This EU project supported by ESA, aims to launch a series of satellites, in orbit at around 20000 km, monitored by a network of ground control stations, in order to provide world cover. This will ensure by 2008 precision, reliability and safety in place of the American (GPS) and the Russian (GLONASS) current systems. GALILEO is part of the FP5, “Competitive and sustainable Growth” Programme, key action 2 (Sustainable mobility and intermodality).

GMES (Global Monitoring for Environment and Security) was launched in 1998 by the European Commission and a group of space agencies, and is a dedicated effort to put knowledge-supporting technologies (Earth observation and information technologies) at the service of better environmental management and security. The GMES long-term objective is to put into place a distributed information system leading to the efficient provision of environmental data, information and knowledge, contributing to the sustainable management and security of our common territory and of the global environment. Europe has a collective role to play in the management of the environment, and GMES is a facilitating capability aimed at defining and delivering operational systems to answer users’ specific problems.

As a reference to Space Weather, GALILEO and GMES show the way that new European Programme may follow from science development to pre-operational then operational activities. In addition, GMES could be a candidate for hosting a Space Weather activity, due to the common features about the data collection from Earth’s environment and the use to trigger alarms.

### **IV.4 EUMETSAT**

This is an intergovernmental organisation created through an international convention agreed by 17 European Member States. It inherited the Meteosat satellite Programme from the ESA. EUMETSAT has the capacity and obligation to provide operational services for Europe concerned with the long-term monitoring of the Earth, oceans and atmosphere. Its primary objective is to establish, maintain and exploit European systems of operational meteorological satellites.

For several observers, EUMETSAT is a model to be followed for the Space Weather Programme. It was initiated from user demands. It applies to the climate broadcast (usual Weather). It was taken in charge by

ESA till the Programme was mature enough. It has capacity to design, develop, operate and process dedicated spacecraft and instruments. It has an original organisation based on Satellite Application Facilities (SAF) specialised Centres which could be compared to the EU Centres of excellence. For other observers, this is not so obvious. What can be considered as a legitimate constraint for meteorology could be viewed as an unnecessary rigidity for Space Weather. Further analyses are needed to see how such an organisation may answer to the Space Weather requirements and how it may react to the expected evolutions of the activities in time.

Recently, EUMETSAT opened its activities to oceanography and altimetry by taking in charge the JASON satellite, then the chart of the organisation had to be updated accordingly. This suggests EUMETSAT could be interested by Space Weather effects, at least on the aircraft operations and on the availability and accuracy of GPS-based navigation. But this has to be discussed with the EUMETSAT officers.

#### **IV.5 National entities and Programmes**

A condition for the success of a European Space Weather Programme is to concentrate efforts of all potential partners. In that respect, co-operation with national space agencies and other national institutions is essential. Although this is not developed here, member states have also to be consulted for the implementation of new instruments or/and Centres, which generates a supplementary degree of complexity.

Several European countries fund both the ESA mandatory Programme and national Programmes. This allows them:

- first, to work in specific domains which are of less interest for the majority of the member states, and
- second, to get a unique expertise in those domains.

Whatever the context (ESA optional Programme, pure national Programme, multi-lateral agreements with other space agencies : inside or outside Europe) European national space agencies which have activities in the domain of Space Weather must have a proper place in the organisation of a European Space Weather Programme.

The same situation is encountered for the observations from ground-based instruments, for data Centres, and for Space Weather services. Even if a co-ordination is made via international scientific unions, most of the practical support (equipment, operation, man-power) is provided by national institutions. As a consequence, services are not at the same level, and any attempt to insure continuity of good quality measurements, 24 hour coverage, real time access to data and to services, etc. is a difficult challenge.

Actions have probably to be taken at two levels :

- support to existing national instruments and/or national Centres,
- implementation of new instruments and/or Centres.

In both cases agreements with national institutions must be found. However, it seems difficult to have representative of all national institutions in a management structure of a European Space Weather Programme. The only way to have a good cooperation in that domain is probably to involve European scientific organizations.

The case of the modelling activities is slightly different. Interactions with research groups don't require agreements with National Institutions. However, National institutions must be involved if a European modelling Centre is created.

#### **IV.6 Coordination with the user community**

Of prime importance for effective progress in Space Weather goals is to establish a good interface with Space Weather customers. However, such a task is not easy. The user community is very heterogeneous. One may consider that it consists in the addition of independent communities working in specific domains. The only organised community is the one who is affected by effects of GICs (Geomagnetically Induced Current)

for which workshop are regularly organised in Scandinavian countries. For the others, except when there is a pressure from the public or from the staffs (aircraft crew members), strong efforts must be made to gather commercial customers and industries around well identified types of Space Weather problems. The difficulty has been already pointed out in the implementation plan of the US Space Weather National Programme, where it is noted : *"Identifying the requirements of the satellite industry has been difficult due to the highly competitive nature of the industry, the complexity associated with insurance coverage, and the legal aspects of satellite communications"*. The organisation of workshops such as the ESA one is obviously important to help the users to have a better appraisal of the stakes. But, there is probably actions to take to define, in each area of interest, what could be considered as a pre-competitive studies.

In the mean time, one cannot expect clear recommendations from the users to construct a European Space Weather Programme. But one must make sure that experts, accepted by the user communities, be present at each level of management of the Programme.

<b>EU SW Element</b>	<b>ESA Involvement</b>	<b>EU Involvement</b>	<b>EUMETSAT Involvement</b>	<b>National Institutions</b>
<b>Space Observations</b>	Optional Program  Mandatory program ( <i>Instrumental contribution to other programs ?</i> )	To be investigated ( <i>research or pre-operational</i> )	To be investigated ( <i>e.g. for effects at the troposphere – stratosphere level ?</i> )	To be investigated
<b>Ground-based Measurements</b>	To be investigated ( <i>Pre-operational measurements</i> )	To be investigated ( <i>research or pre-operational</i> )		Supplementary support to be examined
<b>SW Data Centres</b>	To be investigated ( <i>Pre-operational Centres</i> )	To be investigated ( <i>for continuity of services</i> )		Supplementary support to be examined
<b>SW Forecast Centres</b>	To be investigated ( <i>Pre-operational Centres</i> )	To be investigated ( <i>for continuity of services</i> )		Supplementary support to be examined
<b>Modelling</b>	Expected support ( <i>pre-operational or operational</i> )	To be investigated ( <i>research or pre-operational</i> )	To be investigated	Supplementary support to be examined
<b>Education &amp; User Assistance</b>	Expected support	Expected support	To be investigated	Supplementary support to be examined

**Table 3 : Indications on strategic elements to be discussed in the future.**

## **V. STRUCTURES AND RECOMMENDATIONS**

### **V.I. Management Structures**

At the present stage, the only proposals which may be discussed are skeleton of structures. Three levels of management are considered here :

- a European Space Weather Board (or Council),
- a Technical Committee,
- Topical Committees.

Iterations are needed between the three levels to get an agreement about missions and composition. What is described below could be considered as a first iteration. For the sake of convenience, one starts from the bottom level.

#### **V.I.1 Board (or Council)**

The Board (or Council) is a multi-entity group designed to provide oversight and direction to the Programme. It establishes policy, share responsibilities between the participating entities, and has the responsibility of financial resources. He examines proposals made the Technical Committee and give guidelines.

The Board members are nominated by the participating European entities.

#### **V.I.2 Technical Committee**

The Technical Committee is the executive structure of the European Space Weather Programme. Its mission is both to analyse and prioritise the proposals made by the Topical Committees according to guidelines fixed by the Board (or Council), and to give guidelines to the Topical Committees.

The Committee members are nominated by the Board (or council). The best way is probably to add to the chairmen of the topical committees representatives of entities and organizations which provide financial supports to the European Space Weather Programme.

#### **V.I.3 Topical Committees**

A Topical Committee is designed to propose a development Programme for a specific Space Weather element, then to follow the application of the decisions taken by the Technical Committee. In a first step it will have to make a careful analysis of what can be done to improve the existing and what requires new commitments (see table 2). Status for the “labelled Centres” and the “new Centres” are supposed to be discussed and defined at upper levels.

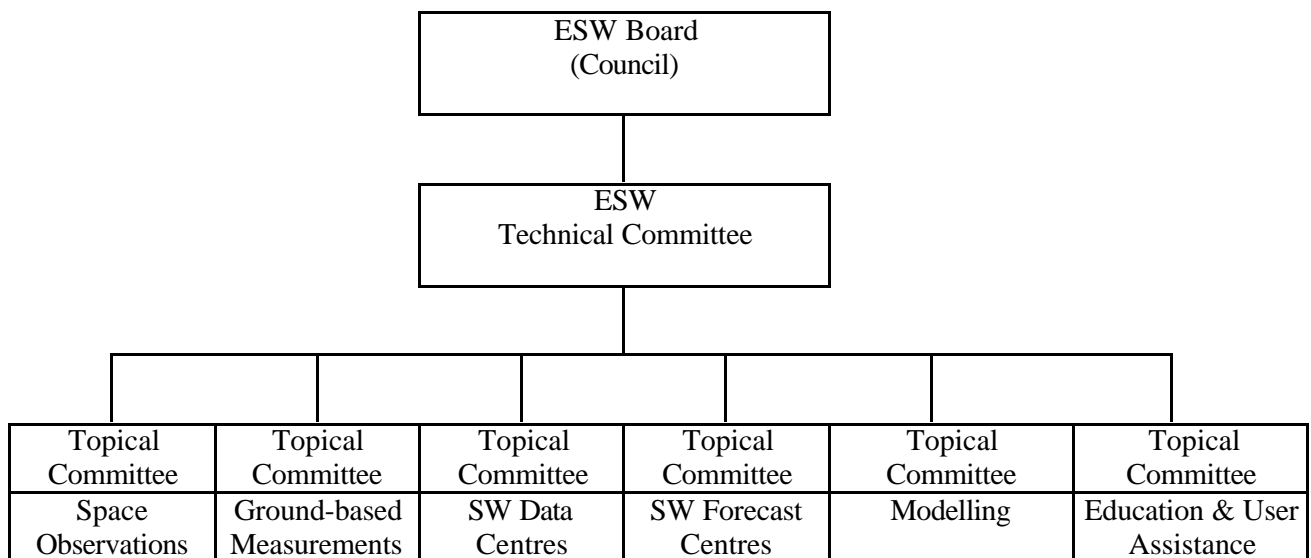
The Committee members are nominated by the Technical Committee under the basis of their expertise and/or their membership to European entities or organisations involved in the topic.

As six topical entities were identified (see enclosed Figure 1) it may be convenient to merge several topical Committees. However one must make sure that with 7 to 10 members (the maximum number to make efficient work) one has the competent expertise to examine all the points listed in section III.

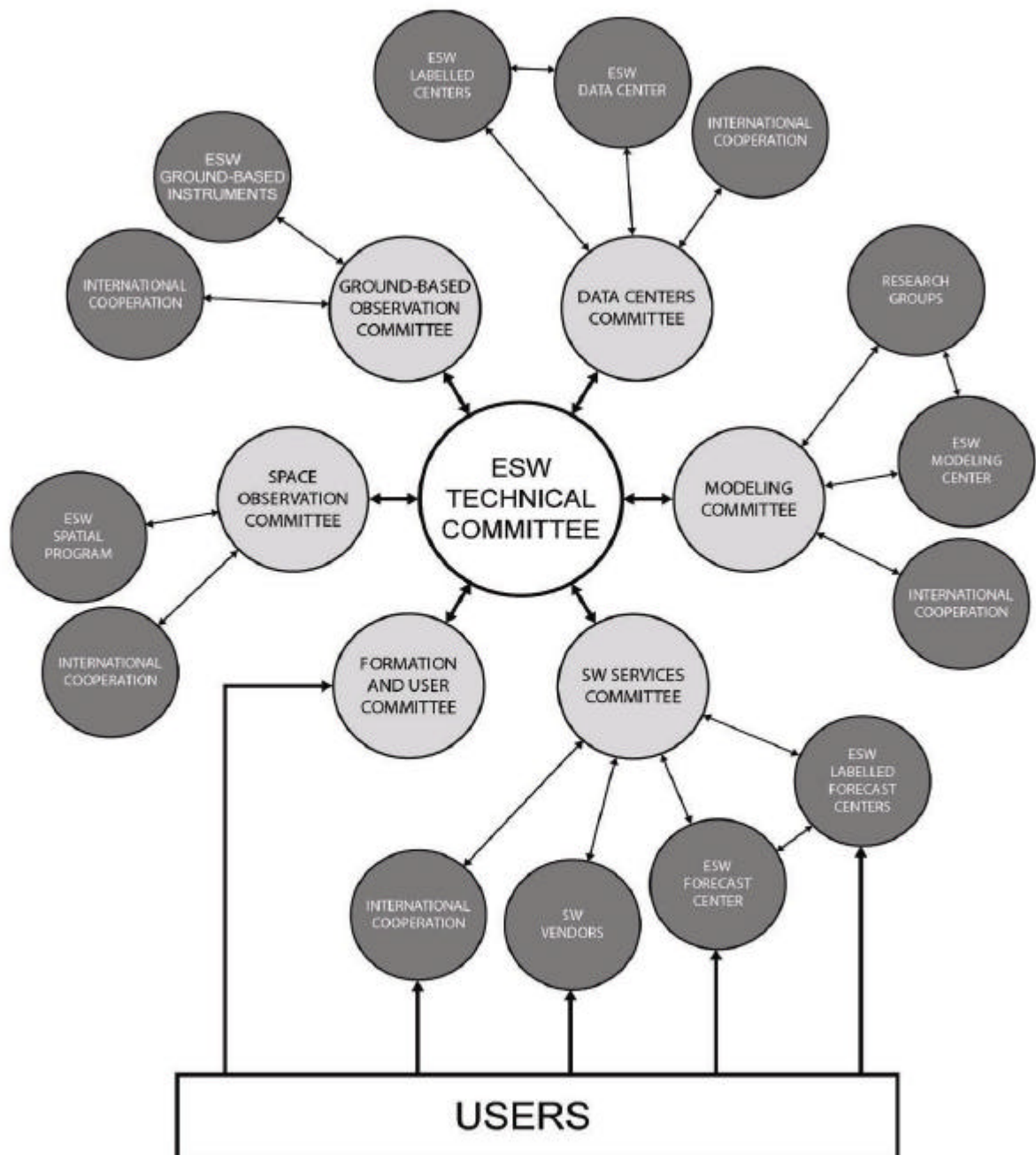
## V.2 Recommendations

The consortium makes the following recommendations to ESA :

- (1) Initiate a European Space Weather Board (or Council), i.e. a multi-entity group, for instance via the joint ESA/EU structures, to give policy and guidelines, particularly as regards to the degree of collaboration to encourage (for instance with projects in preparation in the Living With a Star Programme), and to the status which may be given to labelled Centres and to European Space Weather Centres.
- (2) Set up a Technical Committee in order to synthesise and prioritise the proposals, then to prepare a first implementation plan.
- (3) Set up Topical Committees in order to examine in details the proposals made by the two consortiums, particularly as regards to the improvement of the existing and to new implementations (see Table 2); the members may be selected from the Consortiums and from the SWWT.



**Figure 1 : Recommended structure for a European Space Weather organisation**



*Figure 2 : Conceptual view of a European Space Weather organisation*

## VI. ANNEXES

### Annex : Acronyms

ARWC	Associate Regional Warning Center	
CCMC	Community Co-ordinated Modelling Centre	NASA
COST	European Cooperation in the field of Scientific & Technical Research	UE
CSW	Committee for Space Weather	USA
D/APP	Directorate of Application Programmes	ESA
D/EEM	Directorate of Earth & Environment Monitoring from Space	ESA
D/SCI	Directorate of the Scientific Programme	ESA
D/SER	Directorate of Strategy & External Relations	ESA
D/TOS	Directorate of Technical & Operational Support	ESA
DG	Directorate-General	EC
DOD	Department of Defence	USA
EC	European Commission	EU
EEA	European Economic Area	
ERA	European Research Area	EU
ESF	European Science Foundation	
ESOC	European Space Operations Centre	ESA, Darmstadt
ESRIN	European Space Agency's Research centre	ESA, Frascati
ESSC	European Space Science Committee	ESF
ESTEC	European Space research Technological Centre	ESA, Noordwijk
ESW	European Space Weather technical committee	
EU	European Union	
FAG	Federations of Astronomical & Geophysical (Data Analysis Service)	
GIC	Geomagnetically Induced Current	
GMES	Global Monitoring for Environment and Security	
ICSU	International Council of Scientific Union	
IES	Institute for Environment and Sustainability	JRC, Ispra
ISES	International Space Environment Service (network )	ICSU
JRC	Joint Research Centre	EU
JSAG	Joint Space Strategy Advisory Group	EU, ESA
LPCE	Laboratoire de Physique et de Chimie de l'Environnement	Orléans
LWS	Living With a Star	NASA
NASA	National Aeronautics and Space Administration	USA
NOAA	National Oceanic and Atmospheric Administration	USA
NSF	National Science Foundation	USA
NSWPC	National Space Weather Programme Council	USA
OFCM	Office of the Federal Co-ordinator for Meteorology	USA
RPC	Rapid Prototyping Centres	SEC
RWC	Regional Warning Centre	ISES, URSI
SAF	Satellite Application Facilities	Eumetsat
SCG	Space Coordination Group	EU
SEC	Space Environment Centre	NOAA, Boulder
SW	Space Weather	
SWWT	Space Weather Working Team	ESA
TOS	Technical & Operational Support	ESTEC
TOS-EMA	Space Environment & Effects Analysis Section	ESA TOS
USAF	US Air Force	USA
WDC	World Data Centre	
WMO	World Meteorological Organisation	
WP	Work Package	



**Annex : Reference documents**

- Proceeding of the workshop on Space Weather (11-13 November 1998, ESTEC, Noordwijk, The Netherlands, WPP-1555, 1998) A non-exhaustive list of Space Weather activities in Europe is given.
- Implementation plan of the National Space Weather Programme (2<sup>nd</sup> edition, July 2000).
- ESS008, March 8, 2001, Terms of reference of the joint space strategy advisory group (JSSAG)
- ESS006-final, 21.II.2001, ESA/EC Task Force, Terms of reference.
- Future of Europe in Space Research, ESF recommendations to Ministers of ESA member States (position paper), European Science Foundation / European Space Science Committee, October 2001.
- EUMETSAT Satellite Application Facilities an example for the Space Weather service segment ? Information note prepared for the ESA Space Weather Working Team by Werner Verschueren OSTC, Section Space Research and Applications, Belgium, March 2001

**Annex : The joint space strategy advisory group (JSSAG)**

*[Ref : ESS008, March 8, 2001, Terms of reference of the joint space strategy advisory group ]*

The elaboration of the common European Strategy for Space (COM(2000)597 and ESA/C(2000)67 rev 1) by the Commission and ESA and its endorsement by both EU and ESA Councils have been achieved thanks to a consensus on the major issues at stake among the Member States of both institutions. This consensus has in turn been achieved through repeated joint consultations with the Member States. The Joint Space Strategy Advisory Group (JSSAG) aims at building on this experience and at providing a joint ESA/EC structure for consultation with the Member States in view of the work of the Joint Task Force, with the following Terms of Reference:

1. The Joint Space Strategy Advisory Group (JSSAG), as described in ESS006, assists the Commission and ESA and advises and accompanies the work of the Joint Task Force on all issues related to Space, notably on the further development and implementation of the European Strategy for Space. The JSSAG may also, where appropriate, take the initiative to formulate opinions and recommendations on proposals from the Joint Task Force.
2. The JSSAG is composed of two representatives from competent bodies per each EU and ESA Member State.
3. Representatives for the European security and defence policy are invited in compliance with the EU Council Resolution to participate to the work of the JSSAG.
4. Representatives from the competent bodies in the Member States of the European Economic Area (EEA) are invited to participate to the work of the JSSAG.
5. The Commission and ESA may decide, when appropriate, to invite experts and representatives from other relevant European organisations to the JSSAG.
6. The JSSAG is convened and co-chaired by the Commission and ESA. The secretariat is assured by the Joint Task Force Secretariat.

## **Annex : The ESA/EC Task Force**

*[Ref : ESS006-final, 21.II.2001, ESA/EC Task Force, Terms of reference]*

### **1. Background of the Task Force**

Following the proposals on a European Strategy for Space, ESA and the Commission are developing practical arrangements for working together on the further development and implementation of this strategy. The pursuit of common projects has been achieved so far through ad hoc arrangements with multiple settings of co-ordination at several layers between and inside the two organisations. More permanent arrangements between the EU and ESA need to be established for a sustainable implementation of the common European Strategy for Space.

In view of this, the ESA Executive and the Commission have announced they would set up a joint Task Force, which will reflect on a possible unified setting for Member States to review the strategy and its implementation, elaborate proposals for framework arrangements for the management of joint projects and outline a coherent approach with respect to third countries.

The Task Force will bring together the parts of each organisation involved or interested in the co-operation between the two organisations. It will be a place of cross-fertilisation and stimulation, providing an alert function. It will use resources in both organisations on the basis of a mandate provided by the Commission and the ESA Director General, without direct effect on existing hierarchical structures.

This Task Force is a new way for the two Executives to work jointly without affecting existing responsibilities and decision-making mechanisms.

### **2. Tasks of the ESA/EC Task Force**

A high-level Task Force will be set up by end 2000/beginning 2001 for a period of one year. It will monitor and carry forward the European strategy for space jointly prepared by the Commission and ESA and supported by the respective EU and ESA Council Resolutions (16.XI.2000). It is expected to make proposals for the configuration and terms of references of a permanent joint structure and its relationship with the Member States by the end of 2001.

The field of activity of the Task Force will encompass all areas of common interest between ESA and the Commission. In line with the thrust of the proposed strategy, but without exercising any management responsibility, the Task Force will in particular:

Make joint proposals for the continuing development of the European space strategy and its implementation;  
Examine horizontal issues related to the implementation of the strategy such as international co-operation, industrial activities, RTD, dual-use, SMEs, etc, aspects;

- Investigate how space can be used to better implement Community policies;
- Monitor progress on the two priority areas relevant to EU policies, i.e. GALILEO and GMES, and address specific issues relating to these priorities;
- Consult and discuss its findings with the different stakeholders, in particular Member States, and formulate proposals to the ESA Director General and the Commission as appropriate to the relevant decision-making agenda;
- Propose an EC/ESA framework enabling notably ESA to act as implementing agency with respect to the EU policy for space;
- Produce, before the end of 2001, a joint report on the implementation of the strategy, the way to carry it further and the definition of the scheme to be put in place after the Task force has expired.
- The Task Force will start its activities in January 2001 according to a work plan upon which the advice of the Member States of ESA and the EU will be sought.

### **3. Consultations of the Task Force with the Member States**

The joint document on the European Strategy for Space has been achieved through a broad consensus on the main issues at stake. These issues have been established through repeated consultations with Member States, which have been an important element in the consensus building process. The interaction of the Task Force with the Member States is considered key to achieve the objectives within the targeted timeframe.

Building on the experience in consultations with the Member States for the elaboration of the joint document, it is planned to succeed the Space Advisory Group with a joint ESA/EC advisory structure i.e. the Joint Space Strategy Advisory Group.

The JSSAG will gather the Member States of ESA and the Union into a single body to advise and accompany the work of the Task Force (cf. Chart 1). The JSSAG will meet on invitation by the co-Chairpersons of the Task Force. Where appropriate, JSSAG can take the initiative to formulate opinions and recommendations on proposals from the Task Force.

#### 4. Organisation and Structure

The Task Force will be composed of staff from the ESA Executive and the Commission services. Drawing on existing resources of the two organisations, it will keep the number of full-time dedicated staff required for its needs to a minimum. The Task Force is envisaged to function with two layers (cf. Chart 2).

One layer is constituted by “designated members” formally appointed by the respective organisations. It will involve Directors of ESA and the Commission, representing the range of common interest between the two organisations, e.g. ESA Directorates in charge of strategy, industrial matters and technology, applications, launchers, science and manned spaceflight; Directorates General of the Commission in charge of Enterprise, Environment, Information Society, Research, Transport, Trade, External relations, etc. (a first estimate would lead to a total of about thirteen designated members). Legal, financial, and institutional matters will be addressed on an ad-hoc basis.

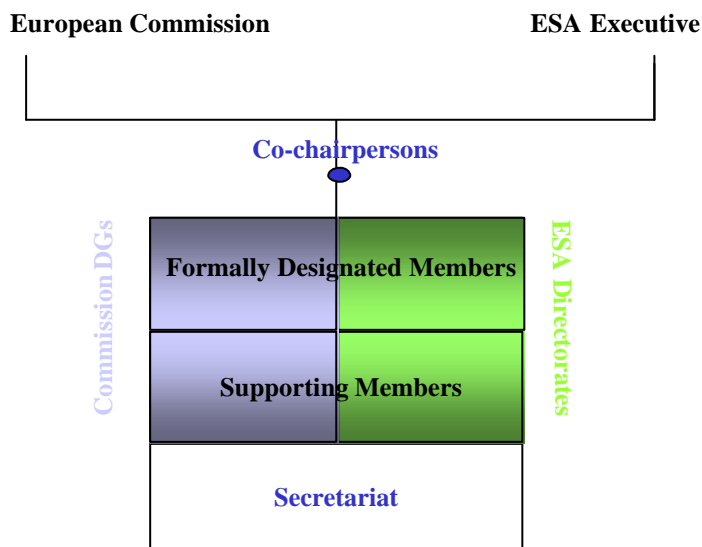
The other layer is the more operational level and is constituted by “supporting members” who are assigned by the designated members to carry out tasks decided upon by the Task Force. The number of people involved in the second level is shaped according to the tasks assigned to it.

Finally, a Secretariat composed of dedicated staff from both organisations will support the work of the Task Force and its co-Chairpersons in organising its external and internal activities.

The co-Chairpersons of the Task Force will animate the Task Force for ensuring that all above tasks are properly implemented. They will be selected from the designated members and appointed jointly by the Commissioner responsible for Space and the Director General of ESA and act under their joint responsibility. They will convene the meetings with the JSSAG with the Member States.

### CHART 1

#### TASK FORCE : INTERNAL SETTING



**Annex : ESF/ESCC position on ESA Ministerial Council, Edinburgh**

*[Ref : Future of Europe in Space Research, ESF recommendations to Ministers of ESA member States (position paper), European Science Foundation / European Space Science Committee, October 2001]*

Space weather issues are of global relevance. While it appears necessary to develop an independent European capability in this area, the proposal for a European effort in space weather should thus be seen as ultimately motivated by the wish to make a strong contribution to the global goal. There are still many important topics which lack detailed scientific understanding before accurate predictions become possible, and many open questions about the Sun and Earth's environment whose investigation will help to advance space weather prediction. However the understanding of the basic physical processes involved in the creation of a space weather service, and the knowledge of the most critical parameters to be monitored and of the respective measuring techniques, are sufficiently far advanced that the time appears to be ripe for a first practical step.

The ESSC-ESF supports the launch of a European space weather initiative; a decision to begin a modest study Programme is recommended.

The establishment of a space weather service is not a scientific subject by itself; its relevance to science is the increasing concern over space weather effects. An assessment has to be made of related economic issues, and the distinction between the initiative and the ESA science Programme needs to be clearly and simply described, as is the case with the Aurora Programme. There is an obvious need to identify the economic case by, e.g. engaging the EC to support this initiative through the initiation of a discussion at the level of the ESA/EC Task Force and of the JSSAG. At a later stage it will be necessary to consider the eventual operational execution of the space weather Programme by industry and/or EUMETSAT.

**Annex : Programmes proposed the ESA Ministerial Council, Edinburgh 14/15 November 2001**

*[Ref : ESA Information Note N° 10-2001, 7 November 2001, Programmes proposed for adoption at the ESA Council Meeting at Ministerial Level, Edinburgh 14/15 November 2001]*

On 14 and 15 November, the ministers responsible for space activities in the fifteen ESA member states and Canada gather in Edinburgh to set the course for Europe's space Programmes over the period ahead. They will be invited to endorse the next stages of a series of ongoing Programmes and to commit to the start of new Programmes that will keep Europe at the forefront of space activities.

With Europe's evolving geopolitical role and the increasing recognition of space as a strategic instrument for carrying out its policies and improving the overall quality of life for European citizens, ESA is seeking to pursue its goals in closer cooperation with the European Union.

This ESA Council meeting at ministerial level will be instrumental in implementing policies that will lend direction to and consolidate the evolution of the public space sector and in confirming the mandate given to ESA to develop further towards becoming the space agency for the European Union. The meeting will also be taking decisions on specific activities that will create knowledge, provide services for the benefit of the people, and secure Europe's position in space so that it can make the fullest possible use of its potential over the long term.

Political objectives and plans for the future of the European space sector will be set out in a resolution entitled "Space serving European citizens".

[...]

The General Budget covers corporate and administrative costs, technical activities such as the basic General Studies and Technological Research Programmes, plus Earthnet and Education (funding of fellowships, etc.). The General Studies Programme prepares new science missions for possible selection, prepares the case for approval and funding of new optional projects/Programmes and supports the evolution of ESA by analysing and testing new work methodologies. Other subjects covered within General Studies include Space Weather applications, Near Earth Objects hazard prevention, the Grid (the future development of the World Wide Web) and advanced networking, and a number of very advanced technological assessments.

The Technological Research Programme (TRP) enables future space missions by assessing the potential of prospective technologies, demonstrates technological feasibility of future ESA missions and harmonises future developments with national agencies. The Technology Transfer Programme (TTP) promotes and disseminates developed space technologies throughout the European community, with the aims of adapting them as necessary and integrating them into the market economy.

[...]

The Science Programme is the backbone of ESA's Programmes. It is a "maker of knowledge", performing an essential role in a knowledge-based society. Its very successful missions have made ESA the leader or co-leader with NASA in most areas of space science research.

An overall budget increase is needed in the coming years to ensure that Science can remain a European flag-carrier in a competitive global environment, contribute to Europe's knowledge-based society, and perform its strategic role as a source of information.

[...]

Earth Observation from space contributes to Earth Science as well as to operational applications such as Environmental Monitoring and Management of Natural Resources. Earth Science provides key contributions to improved understanding of the Planet Earth and its complex processes. Earth Observation application missions provide unique and cost-effective support to decision-making processes in a wide variety of areas.

The ministers will be asked for decisions on two Earth Observation Programmes:

- the second period of the Earth Observation Envelope Programme (EOEP-2) covering the time frame 2003-2007;
- the first slice of the Earth Watch Programme, with missions to be started between 2002 and 2006.

The start of an Earth Watch Programme in parallel with EOEP was endorsed by Council in 1998 and responds to a top priority for Europe, the initiative on Global Monitoring for Environment and Security, GMES, identified in the European Strategy for Space approved by the EU and ESA Ministerial Councils in November 2000. The Earth Watch initiative will broaden the range of EO application missions developed through ESA in partnership with member states, user organisations and industry.

[...]

The Galileo Programme is a joint initiative of the European Commission and ESA. It is intended to deploy a full constellation of navigation satellites by the end of 2008. The Programme was initiated in the autumn of 1999 and, once operational, will give Europe sovereignty in safety-critical applications and telematic infrastructure with superior technical and operational capabilities compared with the American GPS and the Russian Glonass systems.

## **Annex : Space serving European citizens, after ESA Ministerial Council, Edinburgh**

*[Ref : ESA 2001 Press Release N° 65-2001 15 November 2001, Space serving European citizens]*

The ministers responsible for space affairs in the countries that make up the European Space Agency - its fifteen member states and Canada - today concluded a two-day meeting in Edinburgh of the Agency's ruling Council by endorsing the next stages in a series of ongoing Programmes and committing to new initiatives that will help keep Europe at the forefront of space science and technology, Earth monitoring from space, telecommunications, satellite navigation, launchers, human spaceflight and planetary exploration.

In particular ESA and its member states made significant progress on shaping a range of future- oriented Programmes, with major decisions aimed at enhancing Europe's role in the space sector.

The Agency signalled its strong commitment to closer cooperation with the European Union. A first Resolution highlighting the importance of a balanced, ambitious space Programme serving Europe's citizens was adopted unanimously.

The members agreed on a Declaration embodying financial commitments for the development of Galileo, Europe's satellite navigation system. ESA now looks forward with confidence to EU transport ministers' approval of their contribution to Galileo at their December meeting. Galileo is a major component of Europe's transport policy and will be deployed in partnership with the business sector. It will offer a wide range of independent navigation services for commercial and private users and promises to generate new commercial services in areas such as road vehicle navigation and air traffic control.

Further collaboration with the European Union will focus on the Global Monitoring for Environment and Security (GMES) Programme, which will address such issues as global change, natural and man-made hazards, environmental trends and monitoring of treaty commitments. Earth observation is today an essential resource for surveillance of the environment and the management of natural resources. GMES and a number of other Earth observation projects were approved as the first elements in a series of applications missions under the Agency's Earth Watch initiative.

[...]

ESA and the European Commission : towards closer ties Europe now needs to exploit the strategic potential of space systems more effectively to further its scientific, economic, social and political objectives. The ministers acknowledged this in Edinburgh by renewing and expanding ESA's mandate to establish closer ties with the European Union.

The process of wedding the public policy objectives of the European Union and the capabilities of the European Space Agency got underway some years ago. ESA is increasingly committed to closer cooperation with the European Union to further its aim of putting space at the service of European citizens and also to focus attention on space at the highest political level in Europe. Pursuing these goals ESA and the EU are now engaged in the development and implementation of a truly European space policy. The foundations of that policy were laid in November last year, when the ESA and EU Councils endorsed a joint document on a European Strategy for Space.

Outstanding space Programmes are only possible with a strong technology base, the key to the competitiveness of European industry in world markets. The ministers sought therefore to underline the importance of deriving maximum benefit from technology, with measures to encourage technology transfer and spin-off.

## **Annex : Eumetsat**

*[Ref : EUMETSAT Satellite Application Facilities, an example for the Space Weather service segment ? Information note prepared for the ESA Space Weather Working Team by Werner Verschueren OSTC, Section Space Research and Applications, Belgium, March 2001 ]*

### **1. Definition**

EUMETSAT is a European intergovernmental organisation for the exploitation of meteorological satellites. It operates the present geostationary METEOSAT satellites, their future successor the Meteosat Second Generation satellite (MSG), and the future polar orbiting METOP satellite, the latter one in the framework of the EUMETSAT Polar System (EPS) Programme.

After preprocessing of the satellite data, they enter into the Applications Ground Segment of EUMETSAT. This segment consists of two parts: a centralised processing facility located at the EUMETSAT headquarters in Darmstadt that generates standard meteorological products and makes them available to users all over the world. And secondly a number (presently 7) of Satellite Application Facilities (SAFs) which are specialised centres that perform decentralised processing of satellite data and that generate specialised thematic derived products, including application software. Also data from non-EUMETSAT satellites may be used to help accomplishing these tasks (multi-mission approach). The SAFs also perform research and development activities.

The products generated by the SAF's are used for operational meteorology and for research.

### **2. Implementation**

The concept of the SAFs was agreed upon at the EUMETSAT Council of November 1992. Between 1993–1996, the scientific themes to be addressed by a first generation of SAF's were worked out by a STG Task Force in response to a Call for Ideas and the implementation of the SAF concept was defined. The potential need for any (new) SAF is established by Council agreement on a relevant SAF theme. EUMETSAT/Council decides upon matters of policy and funding. One SAF Network Manager coordinates the entire SAF network. The 7 presently existing SAFs started their activities in the period 1997-1999. Each SAF consist of a consortium of institutes from the EUMETSAT member states, one of which acts as host institute (mostly National Meteorological Services).

Each SAF goes through a development phase of 5 years. The development phase is initiated and implemented through a dedicated Cooperation Agreement between EUMETSAT and the host institute, based on a Detailed Proposal of the scientific development by the consortium which priorly has to be approved by Council. The host institute is responsible for the management of the complete SAF project, while a Steering Group, chaired by the host institute and composed of the consortium, EUMETSAT and delegate bodies representatives, monitors and directs the progress of the work undertaken in accordance with a concrete SAF Science and Project Plan. STG, AFG and Council perform regular reviews of the progress based on formal reporting.

At the end of its development phase, each SAF will present a Preliminary Operations Proposal (POP) and, after feedback from Council, a Detailed Operations Proposal (DOP), describing all proposed operational services, continuing research and development activities, and their technical and cost implications. It will cover a 5 year period, to be extended by incremental decisions every five years. The SAF operations leading entity can be different from the initial host institute.

Council's formal approval of the DOP is based on value for money and affordability of the proposed services, while specific implementation options taken (central or distributed operations, ...) are based on cost efficiency, risk assessment and synergy with other EUMETSAT services. After approval of the DOP, a cooperation agreement with the SAF operations leading entity is signed, initiating its operational phase.

Two SAF Operations Managers, one designated by the operations leading entity and one by EUMETSAT are responsible for the overall management of the operations. A Steering Group, co-chaired by the operations leading entity and EUMETSAT and composed of the consortium, EUMETSAT and delegate bodies representatives, monitors and directs the progress, the quality and the relevance of the work undertaken in accordance with an Operational Interface Control Document (OICD) and a set of Joint Operations Procedures (JOP). STG, AFG and Council perform regular reviews of the progress based on formal reporting.

### 3. Product and service development

The SAF services belong to three main types:

- development and distribution of software packages to users for local operational applications or local off line data processing in the user's environment;
- off-line product services;
- real-time product services.

SAF product development is in principle limited to level 2.

All products are distributed and archived using the centralised standard EUMETSAT data distribution and archiving chain. EUMETSAT has ownership of all SAF products, intellectual property and proprietary technical data, including software. The EUMETSAT Data Policy for SAF deliverables is in compliance with the general principles of the EUMETSAT Data Policy, as e.g. applicable for MSG and EPS data.

### 4. Cost and Funding

The Cooperation Agreement between each SAF and EUMETSAT contains a detailed financial budget based on the activities developed during each of the 5 years of the development phase for each participating institute. The rule is that EUMETSAT pays up to a maximum of 50% of these institute costs (up to a maximum of 2 MEUR at 1996 e.c. per SAF), and that the remaining must be financed by national means from the country in which the participating institute is based (additional to the total yearly EUMETSAT contribution of that country). Visiting scientists costs are paid entirely by EUMETSAT up to 300 KEUR per SAF.

EUMETSAT financing comes from the General Budget (for visiting scientists) and from the budget of the Programme most related to each of the SAF activities. For the operational phase, no funding is currently budgeted yet but it is expected in the short and medium term to come from approved Programme envelopes; on the longer term, optional Programmes could be considered.

EUMETSAT will pay up to 75 % of the total operational costs, the rest must come from national means. Visiting scientists will be paid entirely from the EUMETSAT General Budget. Funding will also be available for continuing research and development as part of the DOP.

## 5. Relevance for the Space Weather Programme

The use of the SAF concept rapidly becomes popular among other recently planned earth observation space activities, such as the European Commission GMES initiative, the Earth Watch 'GMES Services' element, and the ENVISAT Processing and Archiving Centres: they propose the use of a network of Centres of Excellence for multi-mission high-level thematic product and services generation.

Although there is no a-priori reason against using the 'Earth Weather' SAF concept for a Space Weather Programme, there are, however, a number of contextual differences which raise questions that first have to be carefully addressed:

- There is no equivalent (yet) in Space Weather of the UN related World Meteorological Organisation (WMO) who coordinates 'earth weather' activities on a world-wide scale and who has a strong moral impact on policy makers.
- There is no equivalent (yet) of EUMETSAT in Space Weather; this means that the complete central service segment structure (called 'European Space Weather Operations Centre' in the stroman proposal) still has to be set up, including a data policy. Note that EUMETSAT originated from a similar central facility operated by ESA in the end seventies beginning eighties. So the exercise has been done already (and successfully !).
- There is no equivalent (yet) of the National Meteorological Services (NMS) in Space Weather. The NMS have established and govern EUMETSAT and the SAF's, they are the sole responsables for data distribution and sales in their country and they are the main providers of forecasts. Appropriate equivalent organisations in SW still have to be found.
- For EUMETSAT and the SAFs, raw data inflow is guaranteed since coming primarily from own satellites and ground observing stations. For Space Weather, operations will, at least initially, be based to a large extent on third party data sources, which will limit the operationality of many products and services.
- Meteorological modelling in Europe has been pushed forward enormously by the existence of ECMWF (European Centre for Medium-range Weather Forecasts, in Reading, UK). No such thing exists for Space Weather, yet.
- Meteorological services are mainly oriented to public free use, though with commercial activities growing rapidly. Space Weather is faced from the beginning with a fair share of commercial possibilities, and this should be reflected in the data policy. Is it appropriate for Space Weather that the central facility has all the data rights and the sole distribution authority ? Can the Centres of Excellence organise commercial activities on their own account ?
- Since no central service facility exists yet for Space Weather, one has to decide from scratch on which type of products should be produced where. The SAFs produce specialised level 2 products, while the central EUMETSAT facility produces standard level 2 products. Is this appropriate for Space Weather ? Or do we produce all level 2 products centrally, and higher level 4 products in the Centres of Excellence, as is proposed for ESA Earth Watch and ENVISAT ?
- Regarding financing of such Centres of Excellence, can we expect national or private co-funding next to ESA funding, taking into account the novelty of the subject ?
- The importance of reliable meteorological forecasts is well established since decades. One of the additional tasks of the Space Weather Centres of Excellence will have to be to contribute to awareness of this subject in their countries.