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STRATEGIC PLAN FOR SPACE WEATHER

Proposed WMO Strategy for Space Weather: Towards a Space Weather Watch Programme

(Provided by the WMO Secretariat)

Summary and Purpose of Document

This document suggests some elements for the definition of a "Space Weather Watch" proposal, as a basis of discussion of the WMO strategy for Space Weather.

APPENDIX

Draft outline of a Space Weather Watch Proposal

DISCUSSION

1. BACKGROUND

1.1. Past CBS, Executive Council and Congress decisions

WMO started to pay attention to Space Weather in 2007 in response to a request from several members of the International Space Environment Service (ISES) communicated by the Director of ISES.

The potential benefits of involving WMO in international coordination of space weather operational services¹ were analyzed in a report published in 2008. On this basis, the WMO Executive Council (EC-60) recognized the importance of space weather as it affects core meteorological infrastructure such as meteorological satellites and telecommunications; it also noted the potential synergy that could develop through integration of relevant observations, data, products and services with meteorological observations, data, products and services. The EC therefore requested the Commission for Basic Systems (CBS) and the Commission for Aeronautical Meteorology (CAeM) *“to develop plans for WMO activities in Space Weather, identifying objectives, activities, resources, deliverables and expected outcomes, in close cooperation with ISES and relevant bodies of COPUOS, ICAO, IMO and ITU. The Council further invited the two Technical Commissions to submit proposals to the Council, in advance of next Congress, for appropriate inclusion into the future WMO Strategic Plan with respect to formal WMO involvement in Space Weather.”*

The Terms of Reference of the Inter-Programme Coordination Team on Space Weather (ICTSW) were approved by the CBS in 2009, and the team was established and initiated its activities in 2010 under the auspices of both CBS and the Commission for Aeronautical Meteorology (CAeM).

In 2011, a further step was accomplished when the sixteenth WMO Congress recognized space weather coordination as one of the activities of the WMO Space Programme². Only a limited funding was allocated to this activity with the expectation that most of the resources would be provided by Members on a voluntary basis, including for instance the secondment of staff. The Congress encouraged Members to provide extrabudgetary financial and staff resources to support space weather coordination activity, given the severe impact of Space Weather on observation and telecommunication infrastructure and on aviation safety, as well as the potential synergy between Space Weather warnings and meteorological service delivery. Congress noted that a coordinated effort by Members was needed to address the observing and service requirements to protect against the global hazards of Space Weather. Congress further *“invited the WMO Space Programme, in coordination with the Inter-programme Coordination Team on Space Weather and with the support of the relevant technical commissions, to develop near-term and far-term action plans, including education and training, and work with the WMO Regional Associations to implement a coordinated strategy for Space Weather.”*³

1.2. ICTSW status and perspective

The ICTSW now involves 21 out of the WMO Member countries and several international organizations. Its remarkable achievements demonstrate the value that can be added in the WMO framework in the area of space weather. However, a real breakthrough in terms of services to the society is more likely to happen with broader and more active engagement of WMO Members, supported by Secretariat resources. This would require defining a programme, guided by a shared vision, with an agreed strategy and roadmap.

¹ [The potential role of WMO in Space Weather, WMO, SP-5, TD-1482, 2008](#)

² [WMO Space Programme description.](#)

³ [Report from the 16th WMO Congress, 16 May-3 June 2011, WMO N° 1077](#)

2. SPACE WEATHER WATCH PROPOSAL

The purpose of this paper is thus to initiate the development of what could be named a WMO “Space Weather Watch” proposal in response to the request from the WMO Congress. The terms “Space Weather Watch” refer to the “World Weather Watch” (the historical programme of WMO which organized the Global Observation System, the Global Telecommunications System, and the Global Data Processing and Forecasting System to support weather forecasting worldwide), it also refers to the “Global Atmospheric Watch” (which deals with atmospheric composition including atmospheric chemistry and aerosols), and to the recently proposed “Global Cryosphere Watch” (which focuses on snow and ice on the sea and on ground, including high latitudes and high mountain ranges and glaciers).

A tentative outline of a Space Weather Watch proposal is proposed in Appendix as a basis for discussion.

It is underlined that ICTSW was invited by the Congress to develop long-term action plans. Therefore, its proposals should not be limited by the initial Terms of Reference of ICTSW, but could outline long-term activities and recommended organisational structure beyond the ICTSW itself.

3. CONCLUSION AND WAY FORWARD

The elements suggested in this document should be discussed in the light of the reports on national and international strategic plans for space weather and actions should be taken to develop a proposal along these lines, or as agreed otherwise, with a view to submit an intermediate report to the Executive Council in May 2014, and a final report to the WMO Congress in May 2015.

DRAFT OUTLINE OF A PROPOSAL FOR A SPACE WEATHER WATCH

1. HOW DOES SPACE WEATHER RELATE TO THE MANDATE OF WMO ?

1.1 Space weather definition

Space Weather encompasses the conditions and processes occurring in space, including on the sun, in the magnetosphere, ionosphere and thermosphere, which have the potential to affect the near-Earth environment. (?)

1.2 Past Congress and EC decisions

EC-60 (June 2008)

Cg-16 (May 2011)

1.3 Understanding the environment up to a new frontier

WMO coordinates the activities of its Members to monitor, record, understand, model, and forecast the weather, the climate, and hydrological resources, to support applications providing essential socio-economic benefits.

The Sun and the outer space are beyond its initial scope of activity.

However understanding the weather and climate processes have led WMO, in the past, to progressively expand the lower boundaries of its activity in order to properly take into account the carbon, water, and energy cycles in the weather and climate models: increased attention was paid to the ocean (in partnership with UNESCO/IOC) with coupled ocean-atmosphere models, and then to the land surface with coupling with the biosphere (including joint projects with the FAO), and more recently the cryosphere.

There has been also increasing interest in extending the upper boundary, in order to take into account: atmospheric composition and radiative processes in the high stratosphere and mesosphere. The top of NWP models is now around the mesopause (0.01 hPa), which suggests future coupling of neutral atmosphere and ionosphere models. Furthermore, a number of potential interactions between space weather and the neutral atmosphere need to be further investigated and evaluated, such as the impact of ionospheric ionization on atmospheric chemistry and upper atmosphere heating, the possible effect of galactic cosmic rays on condensation nuclei, the impact of solar activity fluctuations on the overall atmosphere radiative forcing. Therefore, whether for operational or scientific research purposes, it may be appropriate for WMO to look at a "new frontier" above the neutral atmosphere..

1.4 Integration of systems and services

There is scope for more integration of:

- observations (given e.g. the number of space environment and solar monitors on meteorological satellites);*
- data (taking advantage of the WIS);*
- products and services (in particular considering the expectations of aviation community)*
- communication to the users(e.g. multi-hazard approach of Disaster Risk Reduction)*

1.5 Societal needs requiring international coordination

With increased vulnerability to space weather, several international bodies have made a call for a global framework to coordinate space weather activities. For example, COPUOS

through its Working Group on Long-Term Sustainability of Outer Space activities, COSPAR, in developing its roadmap for space weather, and various conferences expressed similar conclusions.

It is a matter of global optimization of the efforts, leveraging the benefit of existing initiatives to a truly global level, ensuring interoperability, fostering research-to-operations transition.

1.6 A role for WMO

No other organization is currently providing global coordination of operational space weather services.

Through the initial activities of ICTSW in close cooperation with ISES, WMO has demonstrated the relevance of its involvement and the possible benefits to be expected.

Focusing on operational services, building on the legacy of ISES and strengthened by its longstanding partnership with UN organizations such as ICAO and ITU, and with CGMS, WMO provides a framework where its Members can join their efforts to advance space weather observations, products and services and leverage the benefits to the global scale..

2. SPACE WEATHER WATCH PRELIMINARY CONCEPT

2.1 Vision of the Space Weather Watch

Global Framework for Space Weather Services...to understand and model the processes involved, to enable forecasting, warning and assessments, in support of safety and economic development.

More specifically:

- coordinating ground and space-based observations of key space weather phenomena and their precursors*
- developing best practices for observing, recording, analyzing, forecasting, warning, and communicating the resulting information to the users*
- training and building capacity, promoting transition from research to operations, and subsequent user uptake*
- ensuring a science-based, authoritative voice on space weather situation*

2.2 User needs

Aviation

Spacecraft design and launch operations

Telecommunications

Electrical and other ground-based networks

Satellite positioning services and applications

2.3 Activities and deliverables

- User requirements (consultation and analysis) => maintaining requirements of key user groups for products and services,*
- Observation (observation requirements, high-level network design, coordinated specifications, integration and standardization)*
- Data exchange (dissemination, storage, stewardship, long-term preservation, data representation)*
- Product generation (standardization, best practices, validation, operational maturity)*

- *Climatological analysis and assessments*
- *Forecasting and warning*
- *Capacity building and training*
- *Evaluation and strategic planning*

2.4 Information sources

- *Ground-based networks (magnetometers, ionosondes, telescopes, radars, neutron monitors ...)*
- *Space-based observation in L1, L4/L5, GEO, LEO*
- *Models*
- *Scientific community*

2.5 Scientific and technical challenges

- *Inadequate temporal and spatial sampling of the Sun-Earth environment*
- *Lack of knowledge on essential processes occurring on the Sun and in the interaction of the solar wind with the magnetosphere*
- *Limited predictability of space weather events given the very short lead time between observation of precursors and the event itself.*

2.6 Guiding principles

- *Fostering interoperability, integration where appropriate, and standardization*
- *Long-term sustainability*
- *Science-based*
- *Leverage national/regional initiatives and programmes*
- *Open availability of the information*
- *Strengthening capabilities*

2.7 Mapping with WMO Expected Results and strategic goals

- *Integration of observing and information systems*
- *Science and technological developments*
- *Disaster Risk Reduction*
- *Service delivery*
- *Capacity building*
- *Good governance*
- *Partnership*

3. ORGANIZATION AND RESOURCES

3.1 Governance

Under umbrella of CBS, with links to CAeM, CIMO, CAS

Establishment of a new “Open Programme Area Group for Space Weather Watch”

Expert Teams to deal with:

Observation planning

Products and services

Outreach and Training

Applied Research and modelling

Transition from ICTSW to the proposed structure

3.2 Main players (and roles)

National centres of excellence in space weather (not necessarily a meteorological service) including the ISES regional warning centres

National Met Services

Regional/global centres to be defined with specified functions and service level agreements

Regional programmes e.g. the ESA SSA

3.3 Key partnerships

ISES

CGMS

ICAO, ITU as key user organizations

COSPAR and ICSU

Regional organizations

3.4 Secretariat support

Space Programme Office (at least one permanent person plus other on a project basis)

Contribution of Research department, Aeronautical Meteorology Division

3.5 Financial resources

Budget resources

Voluntary contributions of Members (Trust fund, seconded staff)

In kind support from other organizations

4. IMPLEMENTATION ROADMAP

4.1 ICTSW achievements

4.2 Pilot projects

4.3 Incremental implementation of key services

4.4 Communication

4.5 Risk analysis

5. CONCLUSION

Expected benefits

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