



World Meteorological Organization

Working together in weather, climate and water

Space Weather Services to Build Global Resilience

WMO COORDINATION OF SPACE WEATHER ACTIVITIES

Jérôme Lafeuille (WMO)

UN COPUOS/STSC Workshop

Vienna, 3 February 2015

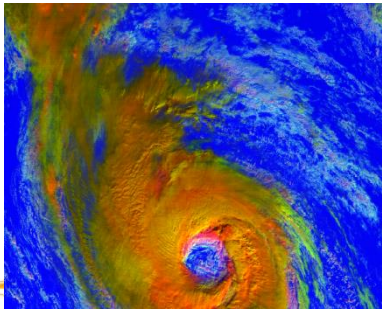
World Meteorological Organization

The specialized United Nations agency for meteorology (**weather** and **climate**), operational **hydrology** and related **geophysical sciences**.

- Space Weather is considered a “related geophysical science”



WMO headquarters, Geneva



COPUOS/STSC Workshop on space weather services to build global resilience

Background for Space Weather and WMO

- WMO Executive Council (2008) noted the potential impact and synergy with meteorological activity
- Inter-programme Coordination Team on Space Weather (2009)
- Congress called for global preparedness to space weather hazards (2011)
- Requirements from ICAO (2012) prompted ICTSW action
- Executive Council (2014) called for 4-year plan
- Four-year plan ready for submission to Congress in May 2015



WMO Inter-Programme Coordination Team on Space Weather



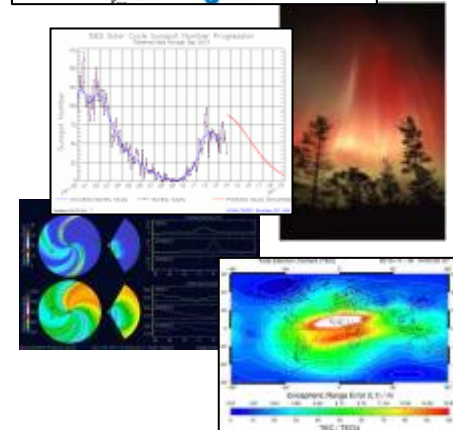
23 out of 185 WMO Member States
7 International Organizations



ICTSW initial focus and development of activities

Demonstrating benefit of coordination for operational SWx services

- Review observation requirements and highlight gaps
- Space Weather Product Portal demonstrating the availability of near-real time products and documenting them
- Reviewed ICAO requirements for SWx services to air navigation
- Data formats, metadata...
- Identified many topics for further work:
 - In-depth review of observation capabilities and needs
 - Operational coordination for extreme events
 - Training
 - Synergy with meteorology and climate applications



WMO Space Weather Product Portal

- Part of the WMO Product Access Guide
- <http://www.wmo-sat.info/product-access-guide/domain/space>
- Promote/demonstrate products approved by ICTSW as:
 - Scientifically sound
 - Operationally available and accessible
 - Documented (metadata) following proposed template
 - Submitted under responsibility of a WMO Member
- Multiple search (by keyword, domain, organization, region..)
- Sub-domains:
 - Ionospheric
 - Geomagnetic
 - Solar & interplanetary
 - Energetic particles





Product Access Guide

Home Simple search Advanced search Themes ▾



Home / Simple Search / Space / Solar and Interplanetary / Solar activity

Domain terms

Imagery

Atmosphere ➤

Land ➤

Ocean ➤

Space ▼

Ionospheric ➤

Geomagnetic ➤

Solar and interplanetary ▼

Solar wind

Solar activity


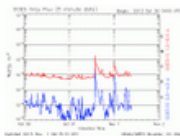

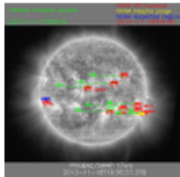
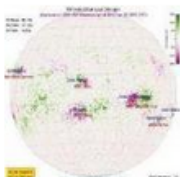
Solar cycle

Energetic Particles ➤

Access to low level data

Solar activity

Product Collections

Preview Image	Organization	Access link	Geographical tag	Domain tag	Theme tag
	NICT	Daily solar flare forecast	Global	Solar activity	Space weather
	NOAA	X-Ray and proton forecast and alerts	Global	Solar activity	Space weather
	BoM	Solar activity summary and forecast	Global	Solar activity	Space weather
	ROB	Solar conditions and 3-day solar flare forecast	Global	Solar activity	Space weather
	RRA/KSWC	Automatic Solar Synoptic Analyzer	Global	Solar activity	Space weather



Product Access Guide

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Search



Home / Simple Search / Space / Energetic Particles

Domain terms

Imagery

Atmosphere ➤

Land ➤

Ocean ➤

Space ▼

Ionospheric ➤

Geomagnetic ➤

Solar and interplanetary ➤

Energetic Particles ▼

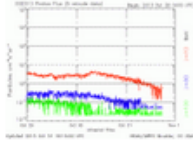
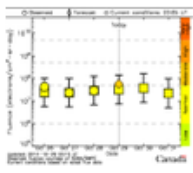

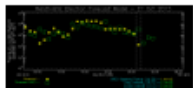
Magnetospheric particles

Solar Energetic particles

Access to low level data

Energetic Particles

Product Collections

Preview Image	Organization	Access link	Geographical tag	Domain tag	Theme tag
	Institute of Applied Geophysics	Proton fluxes from Electro-L	Global	Solar Energetic particles	Space weather
	NOAA	3-day proton forecast and proton alerts	Global	Solar Energetic particles	Space weather
	CSWFC	Electron fluence forecast at GEO orbit	Global	Magnetospheric particles	Space weather
	Institute of Applied Geophysics	Electron and proton fluxes measured by Electro-L	Global	Magnetospheric particles	Space weather
	NOAA	Relativist electron fluence forecast and alerts	Global	Magnetospheric particles	Space weather



Domain terms

Imagery

Atmosphere ➤

Land ➤

Ocean ➤

Space ▼

Ionospheric ▼

HF Communication

Total Electron Content

Ionospheric Irregularities

Geomagnetic ➤

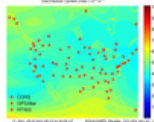
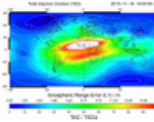
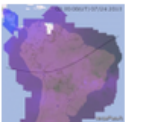
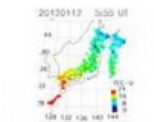
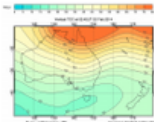
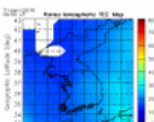
Solar and interplanetary ➤

Energetic Particles ➤

Access to low level data

Total Electron Content

Product Collections

Preview Image	Organization	Access link	Geographical tag	Domain tag	Theme tag
	NOAA	TEC over USA	North America, Central America and the Caribbean (Region IV)	Total Electron Content	Space weather
	DLR	TEC over Europa and global	Global, Europe (Region VI)	Total Electron Content	Space weather
	INPE	TEC over Brazil	South America (Region III)	Total Electron Content	Space weather
	NICT	TEC over Japan	South-West Pacific (Region V)	Total Electron Content	Space weather
	BoM	TEC over Australian region	South-West Pacific (Region V)	Total Electron Content	Space weather
	RRA/KSWC	TEC map over Korean peninsula	Asia (Region II)	Total Electron Content	Space weather

Domain terms

Imagery

Atmosphere >

Land >

Ocean >

Space ♥

Ionospheric >

Geomagnetic ♥

Geomagnetic activity

Auroral activity

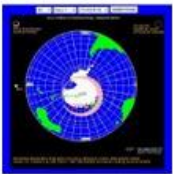

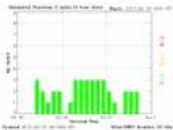
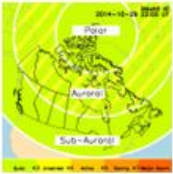



Solar and interplanetary >

Energetic Particles >

Access to low level data

Geomagnetic

Product Collections

Preview Image	Organization	Access link	Geographical tag	Domain tag	Theme tag
	BoM	Auroral Activity in the southern hemisphere	Antarctic, South-West Pacific (Region V)	Auroral activity	Space weather
	FMI	Auroral Activity in Finland	Arctic, Europe (Region VI)	Auroral activity	Space weather
	NOAA	Geomagnetic activity Forecasts and Alerts	Global	Geomagnetic activity	Space weather
	CSWFC	Geomagnetic activity forecast	Arctic, North America, Central America and the Caribbean (Region IV)	Geomagnetic activity	Space weather
	NICT	Daily geomagnetic activity and Dst forecast	Global	Geomagnetic activity	Space weather
	BoM	Planetary A-index time series and GEOSTAT alert	Global	Geomagnetic activity	Space weather
	INTERMAGNET	Global geomagnetic activity maps	Global	Geomagnetic activity	Space weather

PLANS FOR THE NEXT FOUR YEARS AND BEYOND



4-Year Plan for WMO Coordination of Space Weather Activities

Aims to implement the building blocks enabling sustained space weather services

(3.1) SERVICE REQUIREMENTS

- Review user needs
- Feasibility analysis
- Demonstration
- Prioritization

Products & services level

(3.2) BEST PRACTICES for products & services to:

Aviation

GNSS and radiocommunication

Ground infrastructure design & operations (incl. power grids)

Spacecraft design & operations

Disaster risk management

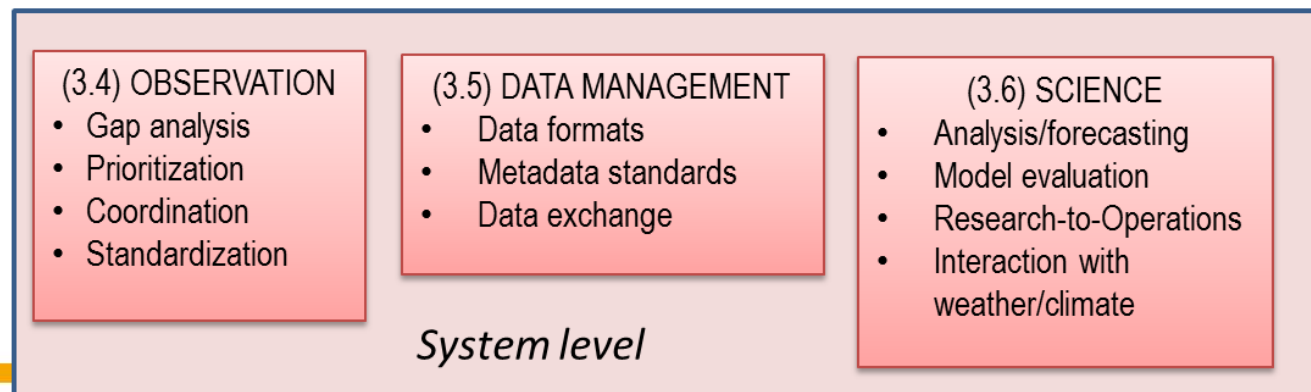
(3.3) TRAINING & CAPACITY BUILDING

- New providers
- New users
- New products



4-Year Plan for WMO Coordination of Space Weather Activities

Aims to implement the building blocks enabling sustained space weather services



4-Year Plan for WMO Coordination of Space Weather Activities

Strategic level

(3.7) COORDINATION, COMMUNICATION AND ADVOCACY

Aims to implement the building blocks enabling sustained space weather services

(3.1) SERVICE REQUIREMENTS

- Review user needs
- Feasibility analysis
- Demonstration
- Prioritization

Products & services level

(3.2) BEST PRACTICES for products & services to:

Aviation

GNSS and radiocommunication

Ground infrastructure design & operations (incl. power grids)

Spacecraft design & operations

Disaster risk management

(3.3) TRAINING & CAPACITY BUILDING

- New providers
- New users
- New products

(3.4) OBSERVATION

- Gap analysis
- Prioritization
- Coordination
- Standardization

(3.5) DATA MANAGEMENT

- Data formats
- Metadata standards
- Data exchange

(3.6) SCIENCE

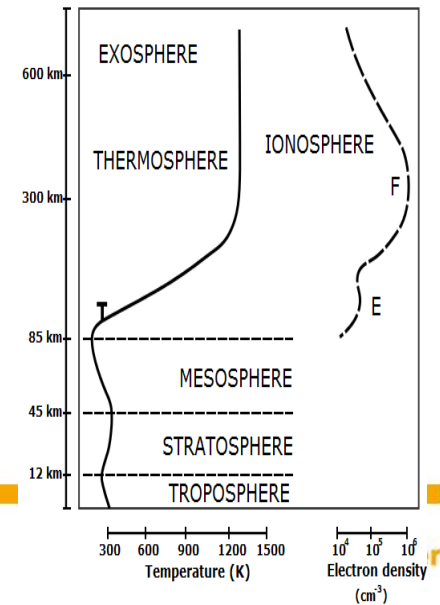
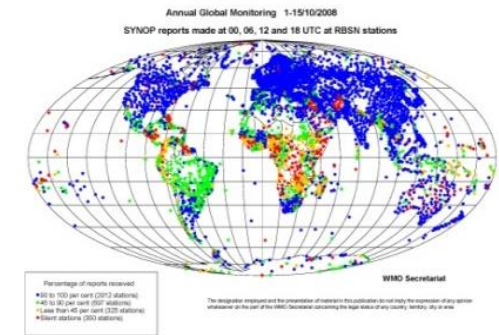
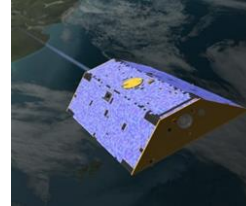
- Analysis/forecasting
- Model evaluation
- Research-to-Operations
- Interaction with weather/climate

System level



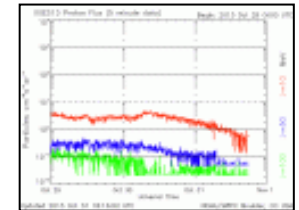
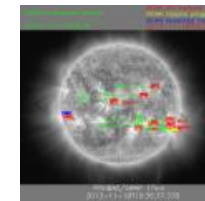
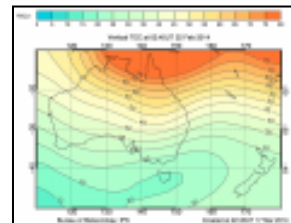
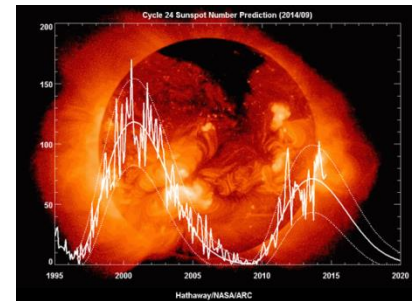
Systems level

- Coordinate observation assets and plans to ensure inter-operability and continuity of space weather observations
- Take advantage of integration of meteorological and space weather observations when relevant
- Support data exchange through WMO Information System data management framework, standards, practices, policy
- Dialogue with meteorological/climate community on modeling and verification



Service level

- Organizing WMO Members to deliver coordinated services responding to ICAO requirements
- Preparing for extreme events in a multi-hazard Disaster Risk Reduction approach (post-Hyogo framework)
- Analyze requirements for other applications including ionospheric disturbances to radiopropagation and GNSS, and design/operations of ground infrastructures (e.g. power grids)
- Training on delivery and user uptake of new services

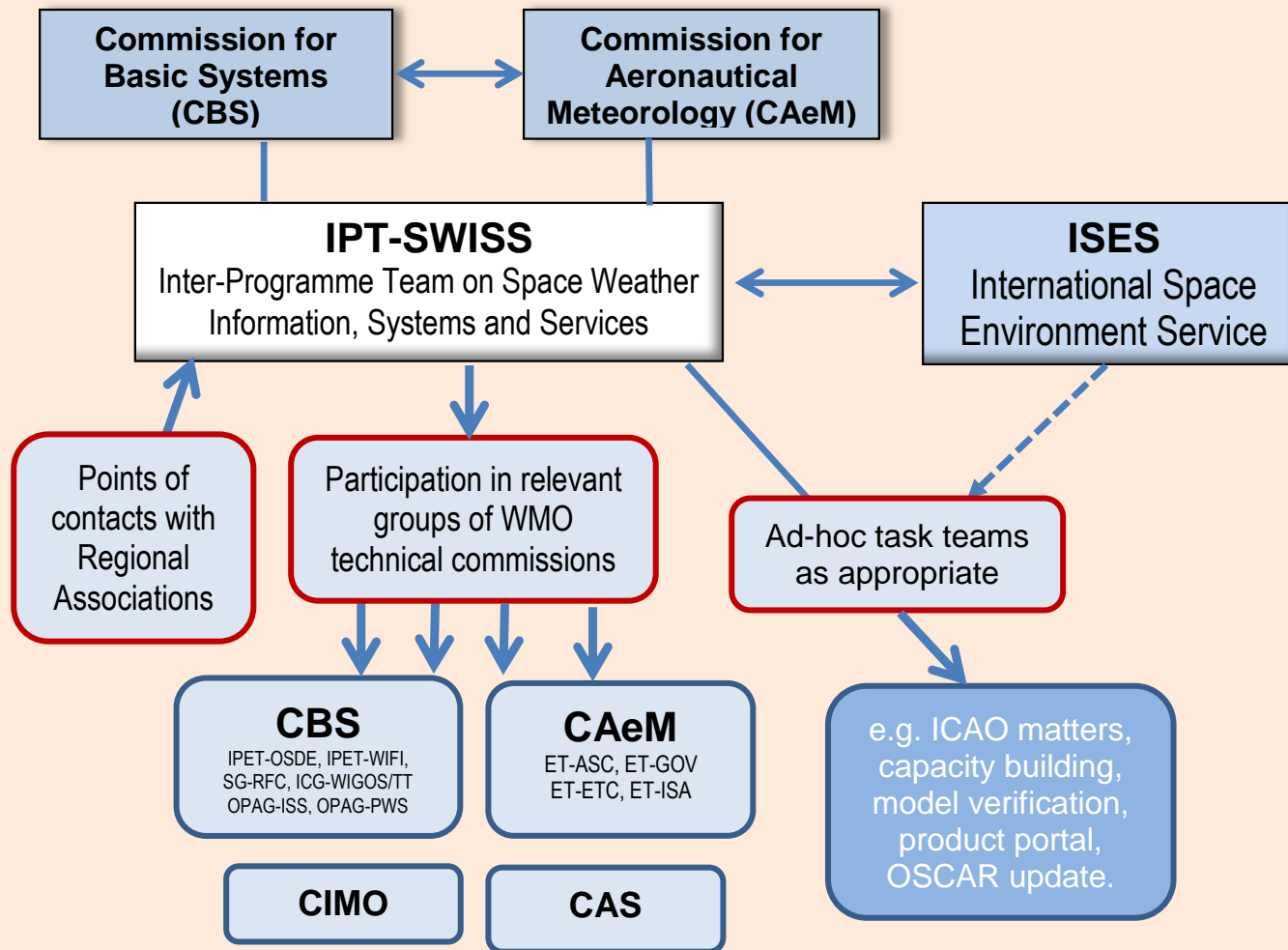


Strategic level

- Build on partnership with SWx service providers (ISES), observation providers (INTERMAGNET, CGMS..), scientific organizations (COSPAR, etc.), capacity building initiatives (ISWI), user organizations (ICAO, ITU..) and overall UN space policy framework (COPUOS)
- Emphasize synergy with core WMO activities
- Capacity building aiming to involve more WMO members
- Focus on achievable, priority objectives for 2016-2019
- Pave the way for a Congress decision in 2019 to engage in sustained activity in 2020 and beyond.



Working structure



WMO-ISES
collaboration
to support
dialogue
among users,
providers, and
partners

Figure 2: Proposed organization of space weather activities.

Conclusions

- It is important for WMO Members (States, represented in WMI) to understand the benefits of coordinating their efforts to enable, improve and deliver space weather services
- A range of high-priority, focused objectives are identified
- International partnership and complementary efforts are essential
- WMO welcomes feedback on this initiative before submission to Congress in May 2015





**World
Meteorological
Organization**

Weather • Climate • Water

Thank you for your attention

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