

World Meteorological Organization

Working together in weather, climate and water

The WMO Inter-Programme Coordination Team on Space Weather (ICTSW)

Update for the SWWT splinter session

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World Meteorological Organization

The specialized UN agency for weather, climate, operational hydrology and related geophysical sciences.

High-level goal to support:

- Protection of life and property
- Economic and social welfare
- Environment and natural resources
- Capacity building in less advanced countries

Founded in 1950, WMO has 189 Members (States and territories)

- ➤ Fosters international cooperation and information exchange
- Coordinates global observation, telecommunications, analysis, warning



WMO Motivations and Goals of Space Weather activities

- WMO's 60-year experience (processes, tools) in global coordination
 - can help Space Weather to move from Research to Operations
- Meteorological satellites are affected by Space Weather and contribute to space weather observation
- Impact on global aviation and other services
 - WMO coordinating meteorological/environmental services to ICAO
 - Synergy with meteorological service delivery, Multi-hazard approach
- Space Weather-climate linkage
 - Potential for integrated modeling
- ➤ Decision made in 2008 to support international coordination of operational Space Weather observation, products and services, in particular to protect against global Space Weather hazards.



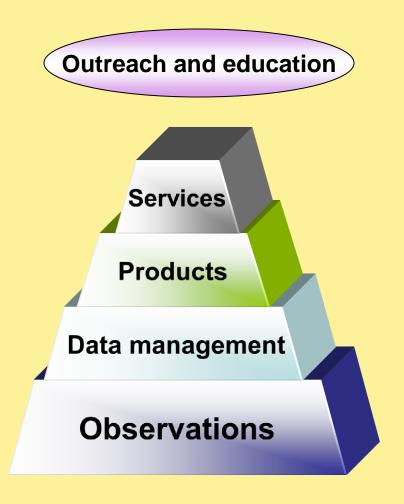
Inter-Programme Coordination Team on Space Weather (ICTSW)

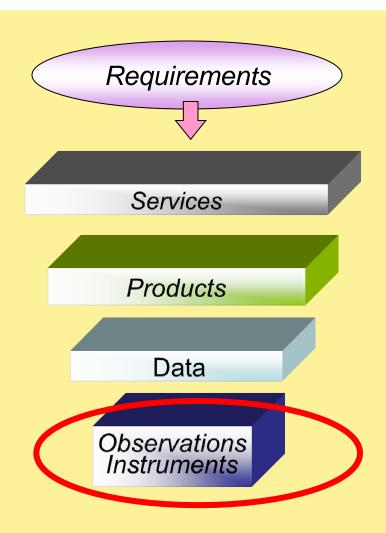
- Currently 13 countries
 - Australia, Belgium, Brazil, Canada, China,
 Colombia, Ethiopia, Finland, Japan, Rep.
 Korea, Russian Federation, United Kingdom,
 USA
- 6 international organizations
 - ESA, ISES
 - ICAO, ITU, OOSA, WMO
- Co-chairs
 - Terrance Onsager (USA) designated by Commission for Basic Systems
 - Xiaoxin Zhang (China) designated by Commission for Aeronautical Meteorology

- Phil Wilkinson
- Ronald Van der Linden
- René Warnant
- Hisao Takahashi
- Larisa Trichtchenko
- Wang Jingsong
- Zhang Xiaoxin
- Alain Hilgers
- Kirsti Kauristie
- Raoul Romero
- David Boteler
- Sergio Buonomo
- Ken Murata
- Hans Haubold
- Seok-Hee Bae
- Daeyun Shin
- Vyachesloav Burov
- David Jackson
- Joe Davila
- Jim Head
- Terry Onsager
- Jerome Lafeuille



ICTSW activities and user requirements







Observations

- http://www.wmo-sat.info/db/
- **Inventory & evaluation of capabilities** (on going)
- **Advocacy on gaps and priorities** (starting)



Space Weather Variables defined for the Rolling Review of Observing Requirements

- Cosmic ray neutron flux density
- Electron flux density energy spectrum
- Heavy ion flux density energy & mass spectrum
- Proton flux density energy spectrum
- foEs
- foF2
- h'F
- hmF2
- Spread F (h'P)
- Ionospheric plasma velocity
- Ionospheric Radio Absorption
- Ionospheric Scintillation (S4 and Sigma Phi)
- Ionospheric Total Electron Content (TEC)
- Interplanetary magnetic field
- Vector magnetic field

- Solar Call-K image
- Solar EUV image
- Solar H-alpha image
- Solar magnetic field
- Solar radio emission
- Solar white light image
- Solar wind density
- Solar wind temperature
- Solar wind velocity
- Solar X-ray image
- Wide-angle solar corona image
- Solar EUV flux
- Solar X-ray flux
- Heliospheric image





Satellites with Space Weather instruments

Dedicated scienti	fic sat	Operational meteoro	ological	Other w. GNSS RO receiver			
SOHO	1995-2012	FY-2 series	1997-2019	SAC-C	2000-2012		
ACE	1997-2012	NOAA-15-19	1998-2014	СНАМР	2000-2010		
TRACE	1998-2010	GOES-11-15	2000-2020	COSMIC-1,2	2006-2022		
ORSTED	1999-2012	DMSP-F16-20	2006-2020	TerraSAR-X	2007-2022		
CLUSTER	2000-2012	Metop-A,B,C	2006-2021	Oceansat-2	2009-		
TIMED	2001-2014	FY-3 series	2008-2024	Tandem-X	2010-2015		
STEREO (x2)	2006-2012	Meteor-M1,2,2.1/2	2009-2020	Megha-Tropiques	2011-		
HINODE	2006-2012	Electro-L-1,2,3	2011-2022	SAC-D	2011-		
THEMIS (x5)	2007-2012	Arctica	2014-2019	GRACE-1,2	2002-2012		
SDO	2010-2015	GOES-R-S-T-U	2015-2033	KOMPSAT-5	2012-2017		
CASSIOPE	2012-2016	FY-4 series	2015-2035				
SWARM	2012-2016	Electro M-1,2	2016-2024				
MMS	2014-2019	Meteor-MP-1,3	2017-2023				

Gap Analysis of Observing Capabilities

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	SEM-N	DWSS-2	05;30															X	X	X	X	ľ
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	SEM+	DMSP-F17	05035	X	X	X	Х	X	X													
	EiS	HINODE	06,400	X	X	Х	X	Х														ĺ
	SOT	HINODE	06д00	X	X	Х	X	Х														ĺ
	XRT	HINODE	06д00	X	X	Х	X	Х														
	TRACE	TRACE	06д00	X	X	X																ĺ
	PREMOS	PICARD	06д00			X	X	Х	Х	Х	Х											
	SODISM	PICARD	06д00			X	Х	Х	Х	Х	Х	,				-						
	SOVAP	PICARD	06д00		<u> </u>	X	X	Х	Х	X	Х					$\overline{}$						
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	AOPOD	KOMPSAT-5	06д00				Х	Х	Х	-		X	7									ĺ
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	GMSC	METEOR-M N1	09g10		X	Х	х	Х	Х	Х												ĺ
	GMSC	METEOR-M N2	09;30					Х	Х	Х	Х	Х	X									ĺ
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	GRAS	METOP-A	09p30	Х	X	Х	Х	Х														
	SEM/2	METOP-A	09[30	Х	X	Х	Х	Х														
	GRAS	METOP-B	09:030					Х	Х	Х	Х	Х	Х									
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Extracted from Dossier Vol.3



Current ICTSW activities

Outreach and education

Products

Services

Data

Observations

- Data management in WMO Information System
 - Metadata, possible product registration in WIS
- Observation requirements (on line database)
- Inventory & evaluation of capabilities (on going)
- Advocacy on gaps and priorities (starting)



Associating metadata to products

- Primary goal is to inform users
 - enable discovery and usage of the data/products
- Harmonization of metadata across product providers
- Align with international standards
- WMO core metadata profile based on ISO19115
- Would make the products searchable in WIS (WMO) and GEO catalogues worldwide
- Metadata being developed for a first set of products



Proposed product metadata template (1/2)

ISO19115 label	Explanation	Example					
fileidentifier Unique Code		urn:x-wmo.md:gov.noaa.swpc::XXXXXX					
citation	Product name	HF Radio Disturbance Product - 2011					
abstract	Product Description	2-D plot showing current location and intensity of degradation of High Frequency radio communication, updated every minute. Information is provided for all latitudes and within specific frequency bands. At low latitudes, the radio communication degradation is due to solar x-rays. At high latitudes, the degradation is due to solar energetic particles.					
	Target users	Product users include emergency managers, aviation, and maritime communication					
contact Point of Contact name and address		SWPC customer support, SWPC.CustomerSupport@noaa.gov					
dateStamp	Date of Metadata Record	4-Nov-11					
Keywords	Product Category	Space weather, Ionospheric Storms, Radio Communication					
,	Other keywords (product type, area,)	2-D plot, solar, x-ray,					



Proposed product metadata template (2/2)

geographicboundingbox	Area Covered (on Earth)	Global			
GeographicDescription	Geographic description	Earth's globe			
Online Resource	Product Location	www.swpc.noaa.gov/drap/index.html			
Responsible party	Originating Center	NOAA/SWPC, Boulder, USA			
Temporal element	Start-end of data series				
Format	Format	Graphical display and text output			
DigitalTransferOptions	Near-real-time dissemination				
	Data source	GOES satellite X-ray flux, 0.1-0.8 nm.			
Lineage	Product generation process and validation information	Empirical relationship between solar x-ray flux and ionospheric D-Region ionization. www.swpc.noaa.gov/drap/dregion_absor ption_documentation.html			
	quality indicator				
	status (Demo, Operational)	Operational			
Use Limitation	Usage constraints				
SpatialResolution	Spatial Resolution	4 degrees latitude x 2 degrees longitude			
MaintenanceAndUpdat eFrequency	Updating Cycle	1 minute			



Current ICTSW activities

Outreach and education



- WMO Congress, CGMS, EU, AMS, COPUOS,
 - web (under development)
 - training modules (planned)
- Services to global aviation
 - Review of ICAO service specifications
- Web portal for products
 - Product harmonization
- Data management in WMO Information System
 - Metadata, possible product registration in WIS
- Observation requirements (on line database)
- Inventory & evaluation of capabilities (on going)
- Advocacy on gaps and priorities (starting)



Expectations

- Leveraging the technical coordination effort initiated by ISES
- Engaging more parties in observation
- More interoperability and product harmonization
- Quality-controlled, operational services to global aviation and other major users
- Greater awareness of decision makers and general public on Space Weather information
- Organizing responsibilities for consistent and efficient alert chain (e.g. WMO hurricane centres or Volcanic Ash Advisory Centres)



Thank you

• WMO Space Programme:

www.wmo.int/sat