



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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WMO Space Programme,  
Geneva



# 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

Outreach and education

Services

Products

Data management

Observations

Requirements

Services

Products

Data

Observations  
Instruments



WMO OMM



Overview: *Space Weather*

Description			
Corresponding Institution	WMO-ISES	Contact Person	Terry Onsager

Variables measured in this Application Area

[Cosmic ray neutron flux density](#), [Electron flux density energy spectrum](#), [Solar EUV flux](#), [foEs](#), [foF2](#), [hF](#), [Heavy ion flux density energy and mass spectrum](#), [Heliospheric image](#), [hmF2](#), [Interplanetary magnetic field](#), [Ionospheric plasma velocity](#), [Ionospheric Radio Absorption](#), [Ionospheric Scintillation \(S4 and Sigma Phi\)](#), [Ionospheric Total Electron Content \(TEC\)](#), [Proton flux density energy spectrum](#), [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](#), [Spread F \(h'P\)](#), [Vector magnetic field](#), [Wide-angle solar corona image](#), [Solar X-ray flux](#)

REQUIREMENTS DEFINED FOR *SPACE WEATHER* (40)

Show/Hide Details

Id	Variable	Layer	Uncertainty Goal	Uncertainty Thresh	HR Goal	HR Thresh	VR Goal	VR Thresh	OC Goal	OC Thresh	Avail Goal	Avail Thresh
<a href="#">576</a>	<a href="#">Cosmic ray neutron flux density</a>	Surf-Earth	5 (%)	25 (%)	1000 km	5000 km	N/A	N/A	60 sec	10 min	5 min	30 min
<a href="#">577</a>	<a href="#">Electron flux density energy spectrum</a>	Geo	5 %	25 %	45 degrees	180 degrees	N/A	N/A	60 sec	10 min	60 sec	100 min

Outrea

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Observations

- Observation requirements database <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

<i>Dedicated scientific sat</i>		<i>Operational meteorological</i>		<i>Other w. GNSS RO receiver</i>	
SOHO	1995-2012	FY-2 series	1997-2019	SAC-C	2000-2012
ACE	1997-2012	NOAA-15-19	1998-2014	CHAMP	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

MISSION	SATELLITE	ECLIPSE	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SEM	FY-1D	03,00	X	X	X	X														
SEM/2	NOAA-15	04,05	X	X	X	X														
SEM-N	DWSS-1	05,00												X	X	X	X	X	X	
SEM-N	DWSS-2	05,00															X	X	X	X
SEM+	DMSP-S19	05,00					X	X	X	X	X	X	X							
SEM+	DMSP-F17	05,05	X	X	X	X	X	X												
EIS	Hinode	06,00	X	X	X	X	X													
SOT	Hinode	06,00	X	X	X	X	X													
XRT	Hinode	06,00	X	X	X	X	X													
TRACE	TRACE	06,00	X	X	X															
PREMOS	PICARD	06,00			X	X	X	X	X	X										
SODISM	PICARD	06,00			X	X	X	X	X	X										
SOVAP	PICARD	06,00			X	X	X	X	X	X										
SOVAGR.	ADITYA-1	06,00					X	X	X	X										
AOPOD	KOMPSAT-3	06,00				X	X	X	X	X										
IGOR	PAZ (SEOSAR)	06,00						X	X	X										
IGOR	TERRASAR-X	06,00	X	X	X	X	X													
IGOR	TERRASAR-X2	06,00					X	X	X	X	X	X								
IGOR	TANDEM-X	06,00					X	X	X	X	X									
ROSA	SAC-D	06,00					X	X	X	X	X									
SEM+	DMSP-F16	06,00	X	X	X	X														
SEM/2	NOAA-16	07,00	X	X	X	X														
SEM+	DMSP-S20	07,00							X	X	X	X	X	X	X					
SEM+	DMSP-F18	08,10		X	X	X	X	X	X											
SEM/2	NOAA-17	08,15	X	X	X	X														
GMSC	METEOR-M N1	09,10		X	X	X	X	X	X											
GMSC	METEOR-M N2	09,30					X	X	X	X	X									
RADIOMET.	METEOR-M N3	TBD							X	X	X	X	X	X						
RADIOMET	METEOR-MP	09,30									X	X	X	X	X	X	X	X	X	X
GGAK-M	METEOR-MP	09,30									X	X	X	X	X	X				
GRAS	METOP-A	09,30	X	X	X	X	X													
SEM/2	METOP-A	09,30	X	X	X	X	X													
GRAS	METOP-B	09,30					X	X	X	X	X	X								
SEM/2	METOP-B	09,30					X	X	X	X	X	X								
GRAS	METOP-C	09,30							X	X	X	X	X	X	X					
BO	FPS-SG-A1	09,30													X	X	X	X	X	X

DRAFT

Extracted from Dossier Vol.3

# Current ICTSW activities

Outreach and education

Services

Products

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

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- 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
<b>fileidentifier</b>	<b>Unique Code</b>	urn:x-wmo.md:gov.noaa.swpc::XXXXXX
<b>citation</b>	<b>Product name</b>	HF Radio Disturbance Product - 2011
<b>abstract</b>	<b>Product Description</b>	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.
	<b>Target users</b>	Product users include emergency managers, aviation, and maritime communication
<b>contact</b>	<b>Point of Contact name and address</b>	SWPC customer support, SWPC.CustomerSupport@noaa.gov
<b>dateStamp</b>	<b>Date of Metadata Record</b>	4-Nov-11
<b>Keywords</b>	<b>Product Category</b>	Space weather, Ionospheric Storms, Radio Communication
	<b>Other keywords</b> <i>(product type, area, ...)</i>	2-D plot, solar, x-ray,



# Proposed product metadata template (2/2)

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

# Current ICTSW activities

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Services

Products

Data

Observations

- **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

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- 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](http://www.wmo.int/sat)