The WMO Integrated Global Observing Systems and the value of satellite data

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WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

Diversity of Earth-Observing Satellite Systems

	1960s	1970s	1980s	1990s	2000s	2010s
U.S.	16	26	14	14	20	35
ESA and/or EUMETSAT	0	1	3	7	11	14
Japan	0	1	4	4	6	8
Korea	0	0	0	1	2	6
India	0	0	4	13	10	13
China	0	0	1	3	11	46
France	0	0	1	3	4	7
Russia*	0	2	4	3	3	15
Germany	0	0	0	0	2	1
Algeria	0	0	0	0	1	3
Turkey	0	0	0	0	1	3
Brazil	0	0	0	1	2	0
Total	16	30	31	49	73	151+

* Russia launched a large number of short-lived satellites in the 1960s that are not included in this table.
+ In the 2010s an additional 18 countries launched 33 satellites not included in the table.

NUMBERS OF MAJOR ENVIRONMENTAL SATELLITES (RESEARCH AND OPERATIONAL) AND THEIR COUNTRIES/AGENCIES OF ORIGIN, LAUNCHED DURING EACH DECADE. SATELLITES WITH GEO SYNCHRONOUS, SUN SYNCHRONOUS, AND IN GEOSTATIONARY AND L1 ORBITS WERE SELECTED. SOURCE AND CREDIT: WORLD METEOROLOGICAL ORGANIZATION (WMO) OBSERVING SYSTEMS CAPABILITY ANALYSIS AND REVIEW (WMO, 2019) WEBSITE (HTTPS://WWW.WMO-SAT.INFO/OSCAR/SATELLITES). MAINLY PUBLIC-SECTOR OWNED SATELLITES WERE INCLUDED IN THESE STATISTICS.

TIROS-I – First weather satellite image (April 1960)

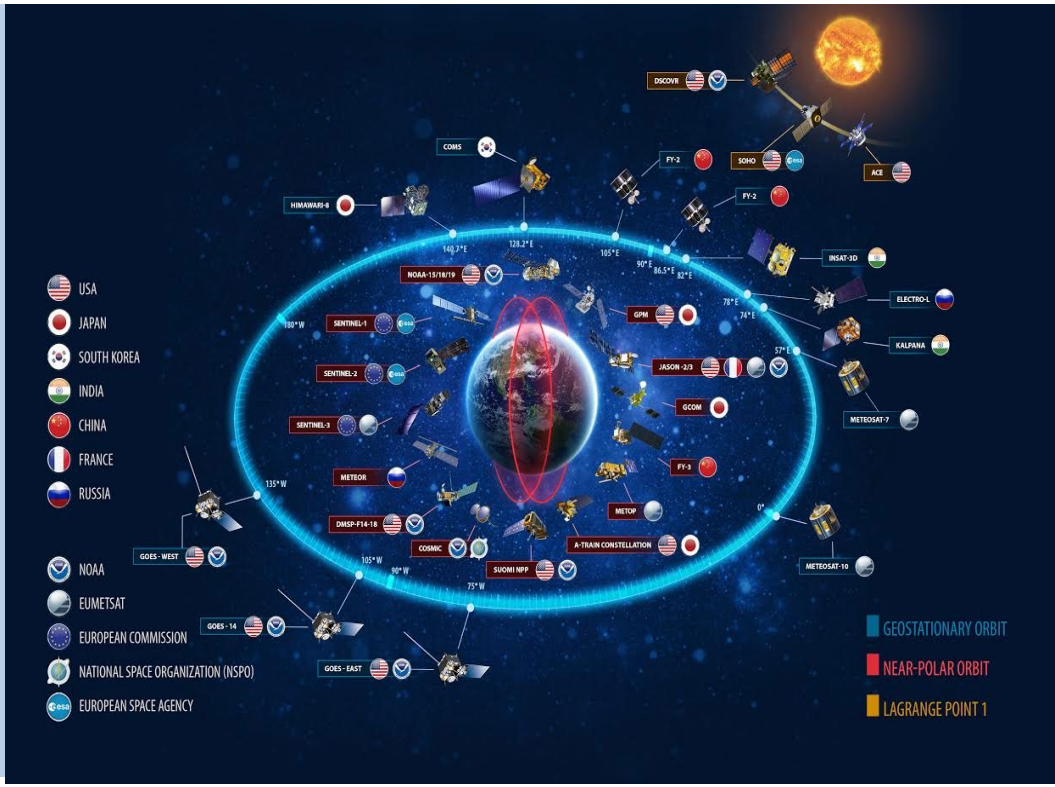
A clear increase in diversity and number of public-sector Earth-observing satellites in last 2 decades

Trends in Global Earth Observation Systems

(Toward the Ability to Comprehensively sense the environment all the time, everywhere)

GOS Trends and Driving Factors:

- New and Emerging Actors in Global Observing System
- New & enhanced Sensors (higher resolutions, higher SNR, etc.)
- New technology (smallsats, cubesats..)
- Emergence of potential new Payload hosting platforms (commercial, Near-Space platforms, rideshare, etc.)
- Increase in volume and diversity of data
- Commercialization of satellite data and new business models
- Spectrum challenges in the MW
- Risk due to Space Debris
- New sensing Technology : Hyperspectral MW, Wind Lidar, Polarimetric RO, Reflectometry, etc



Space agencies are making long-term plans. Similar to the Earth System model (ESM) approach (on the modeling and requirements side), the EOSC design and evolution is approached in a similar comprehensive, coordinated fashion (on the Observation side).

Coordination Group for Meteorological Satellites

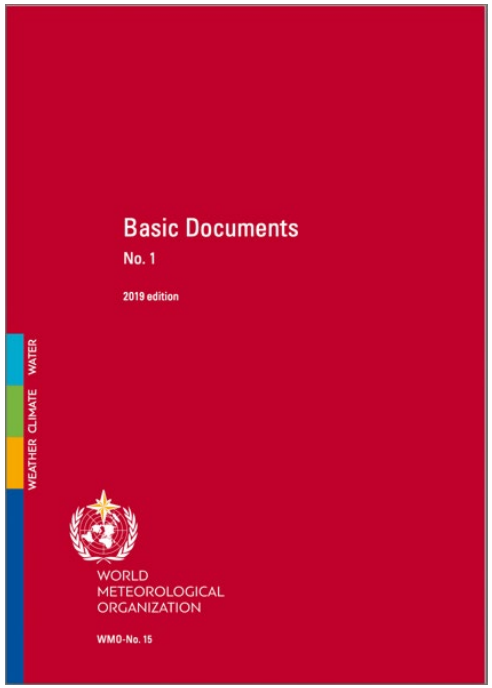
See http://cgms-info.org

Committee on Earth Observation Satellites

See http://ceos.org

INTERNATIONAL DATA EXCHANGE

is a major purpose of WMO, WMO Convention, Art. 2b:



(a) To facilitate worldwide cooperation in the establishment of networks of stations for the making of **meteorological observations** as well as hydrological and other geophysical observations related to meteorology, and to promote the establishment and maintenance of centres charged with the provision of meteorological and related services;

(b) To promote the establishment and maintenance of systems for the **rapid exchange of meteorological and related information**;

(c) To promote **standardization of meteorological and related observations** and to ensure the uniform publication of observations and statistics;

(d) To further the **application** of meteorology to aviation, shipping, water problems, agriculture and other human activities;

(e) To promote activities in **operational hydrology** and to further close cooperation between Meteorological and Hydrological Services; and

(f) To encourage **research and training** in meteorology and, as appropriate, in related fields and to assist in coordinating the international aspects of such research and training.

Until last month this was governed by the Data policies for weather, climate and hydrology (res. 40, 60 and 25)

WMO Extraordinary Congress in 20221 approved: A new UNIFIED POLICY FOR THE INTERNATIONAL EXCHANGE OF EARTH SYSTEM DATA

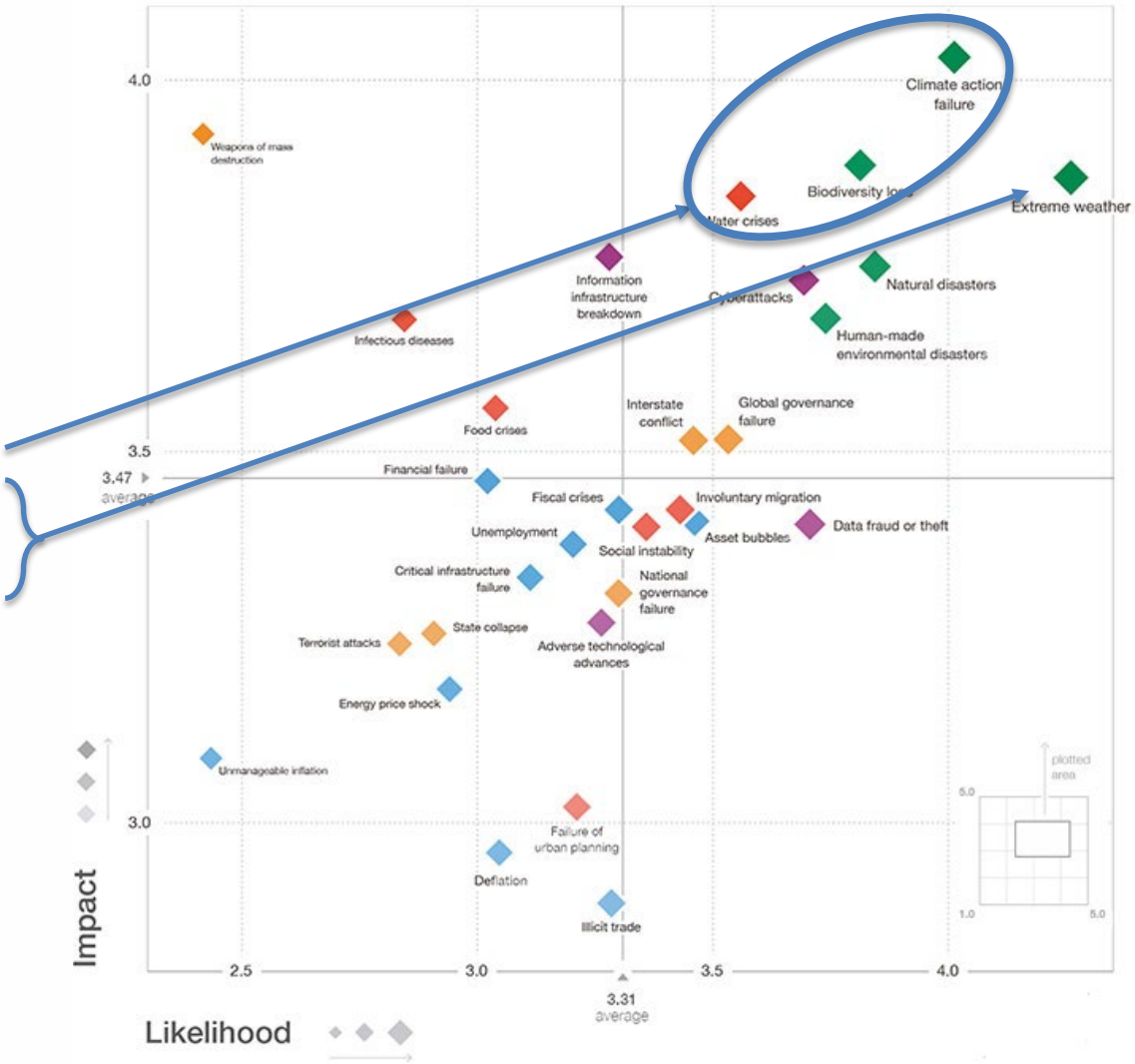
- **Adopts** the following policy on the international exchange of Earth system data:
- *As a fundamental principle of WMO and in consonance with the expanding requirements for its scientific and technical expertise, **WMO commits itself to broadening and enhancing the free and unrestricted international exchange of Earth system data;*** (including prediction models data exchanges);
- Single, overarching data policy resolution;
- Emphasis on the Earth System: Observations, Monitoring, Prediction and Services
  1. Covers all WMO Earth system data: weather, climate, hydrology, ...
  2. Two main categories of data:
  - *Core* (*shall* be exchanged);
  - *Recommended;* (*should* be exchanged);
  3. Specifics on *core* and *recommended* data referred to Technical Regulations, primarily Manuals on WIGOS, GDPFS;
  4. "*Free and unrestricted*" exchange (term defined directly in the Resolution, literal interpretation);
  5. Addressed to Members, but covers exchange of data between all partners, inclucing private sector, academia, etc

Global Risk Landscape 2020

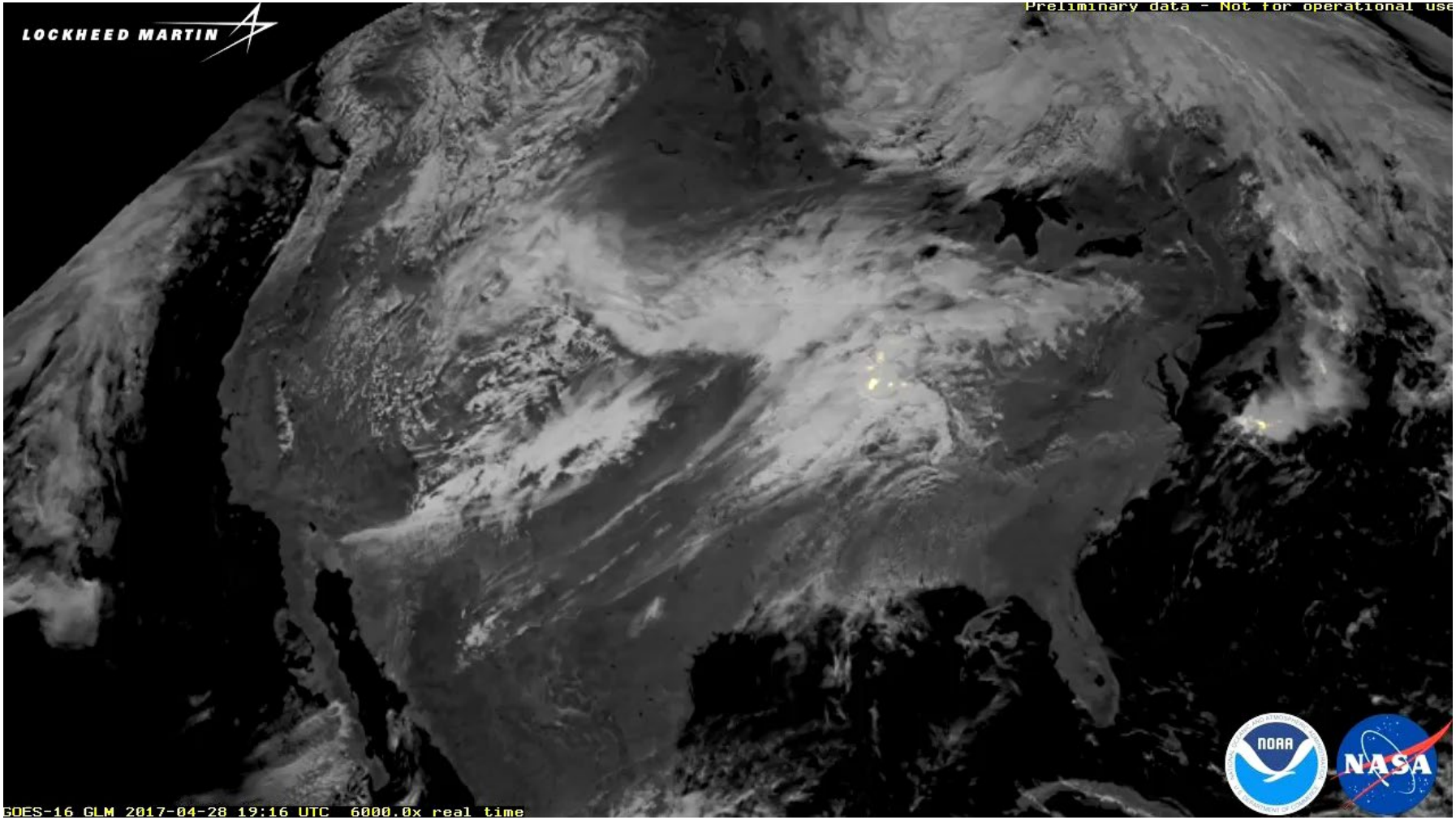
Key Challenges:

1. **Earth System modelling and global NWP (supports most WMO application areas)**
2. **GHG/Climate Monitoring (also consider Paris Agreement)**
3. **Monitoring Extreme Weather Events**
4. **Air Quality Monitoring**

But there is more….

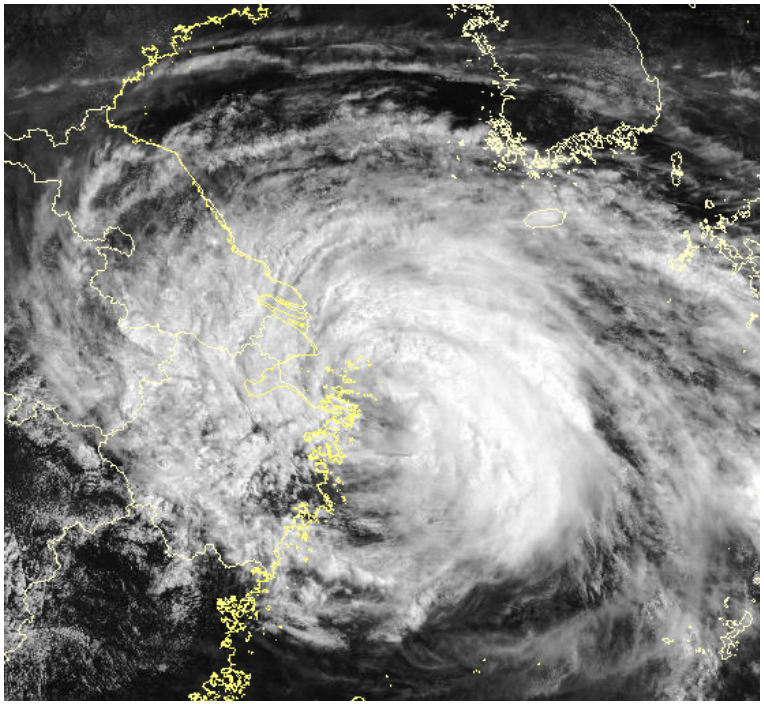


GOES-16 lightning observations and imagery
Can be used as a proxy for ground-based radar in remote areas!

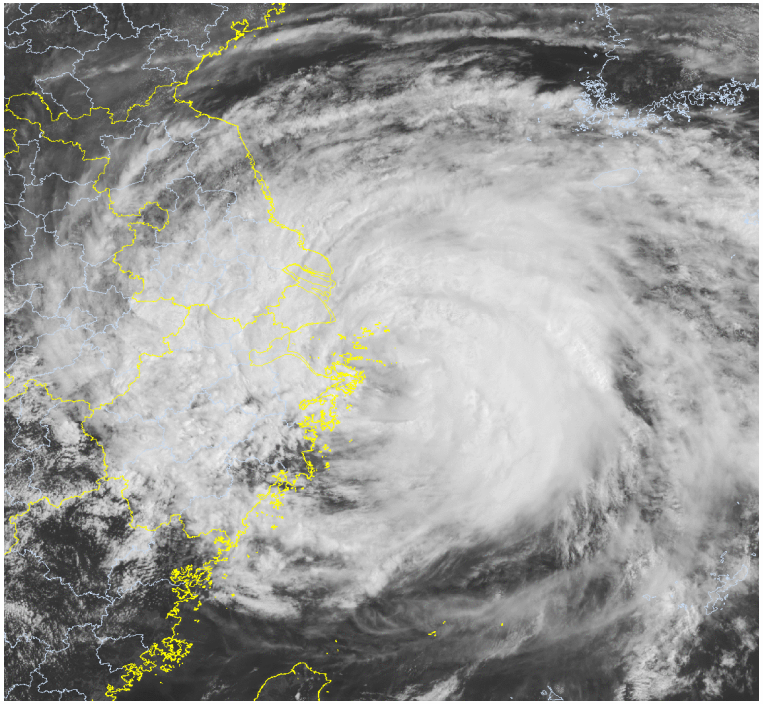


FY- 4 satellites monitor Typhoon In-Fa

FY-4A spatial resolution: 5mins

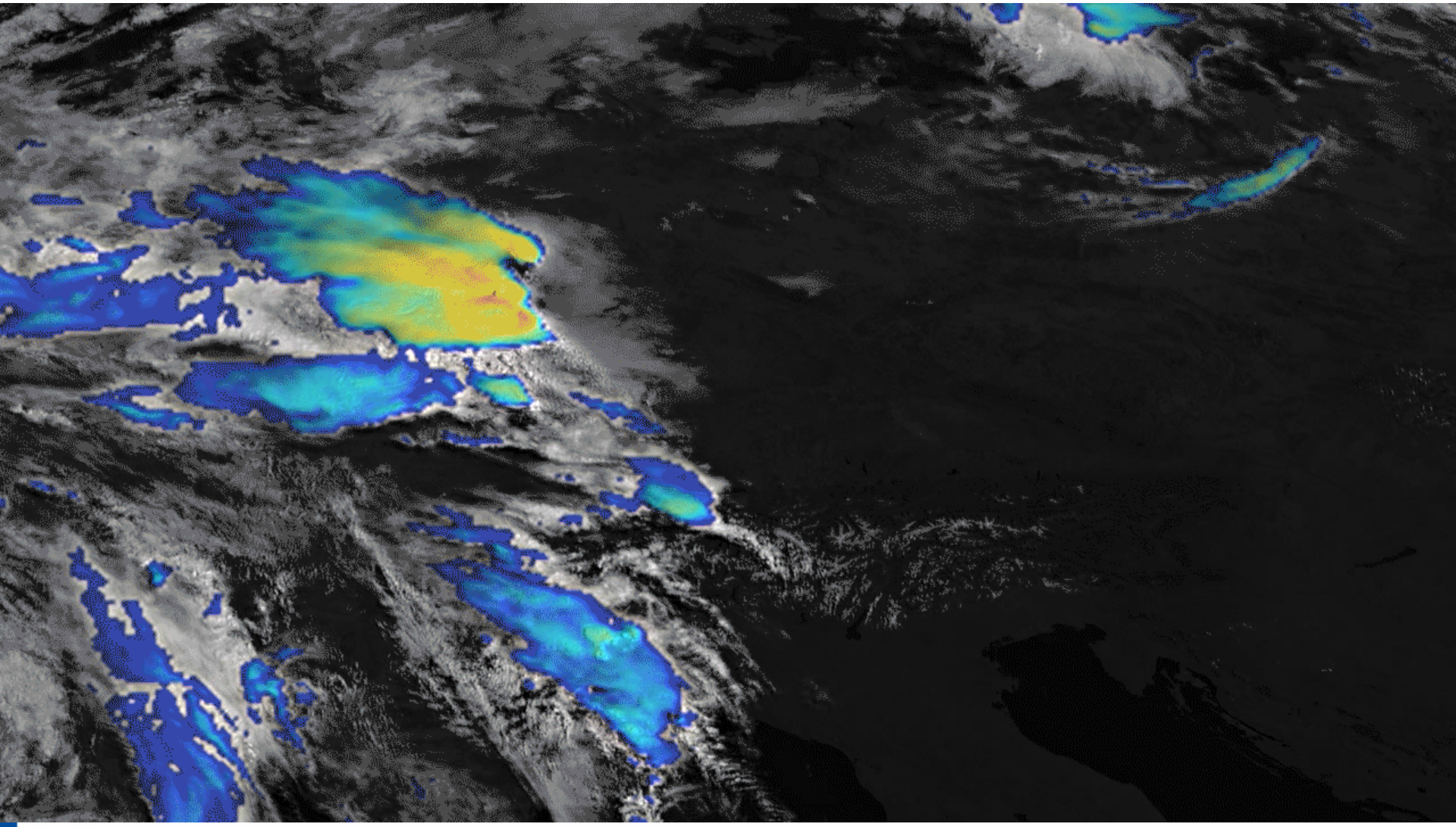


FY-4B spatial resolution: 1min



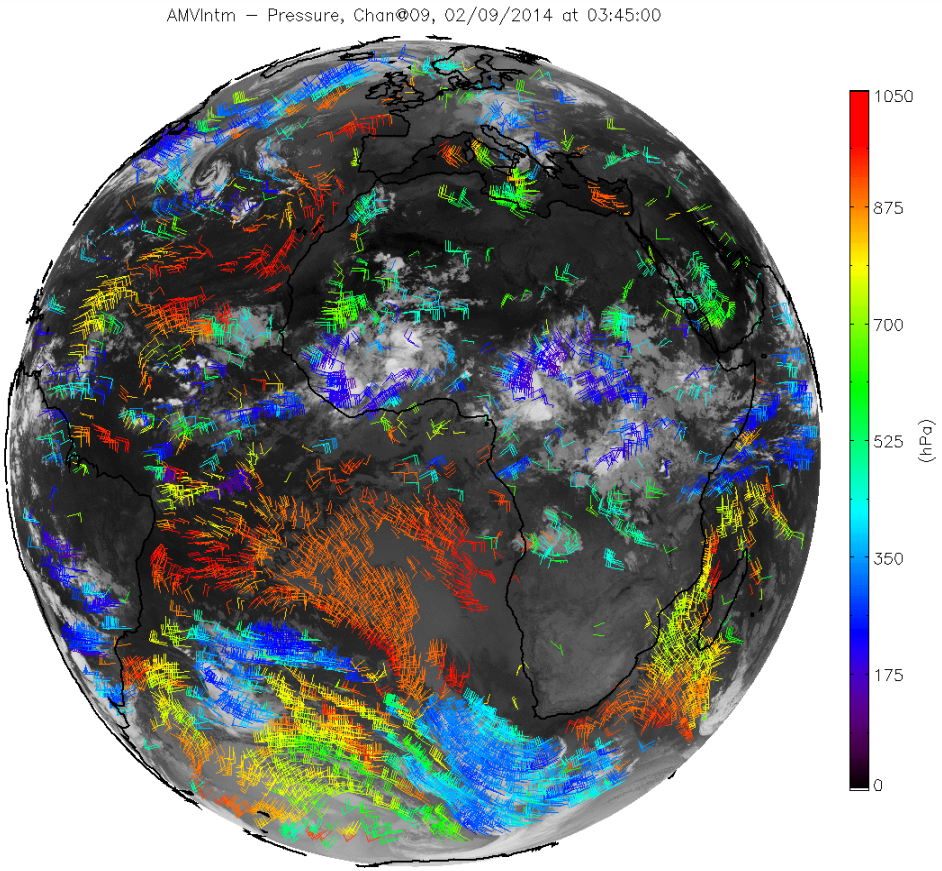
2021.07.25

Nowcasting of severe weather: Thunderstorm

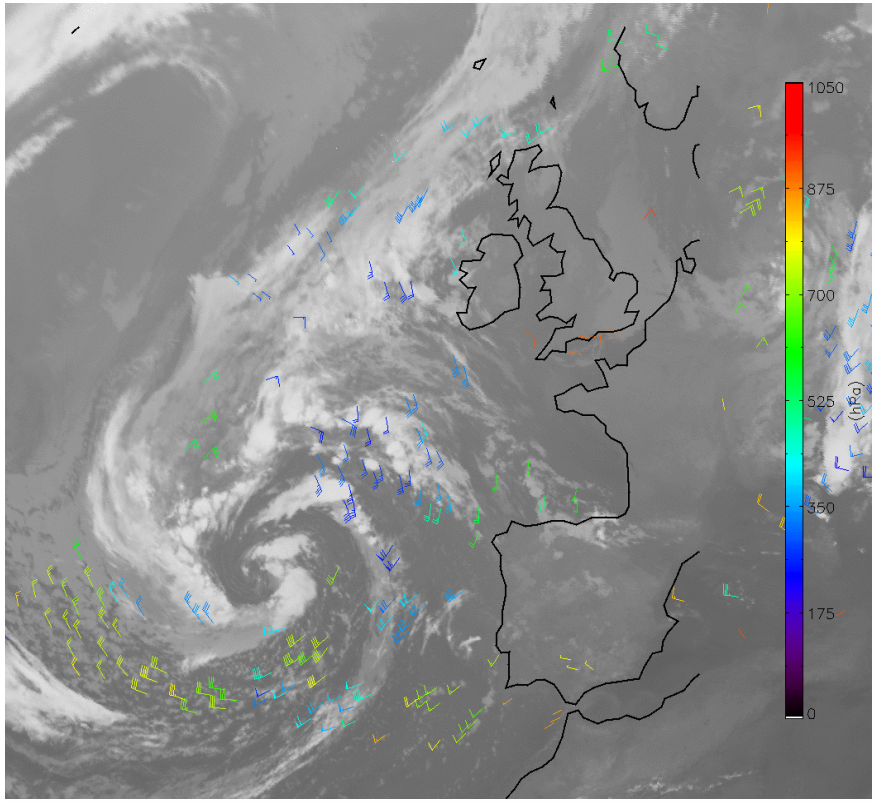


MSG – AMVs Examples

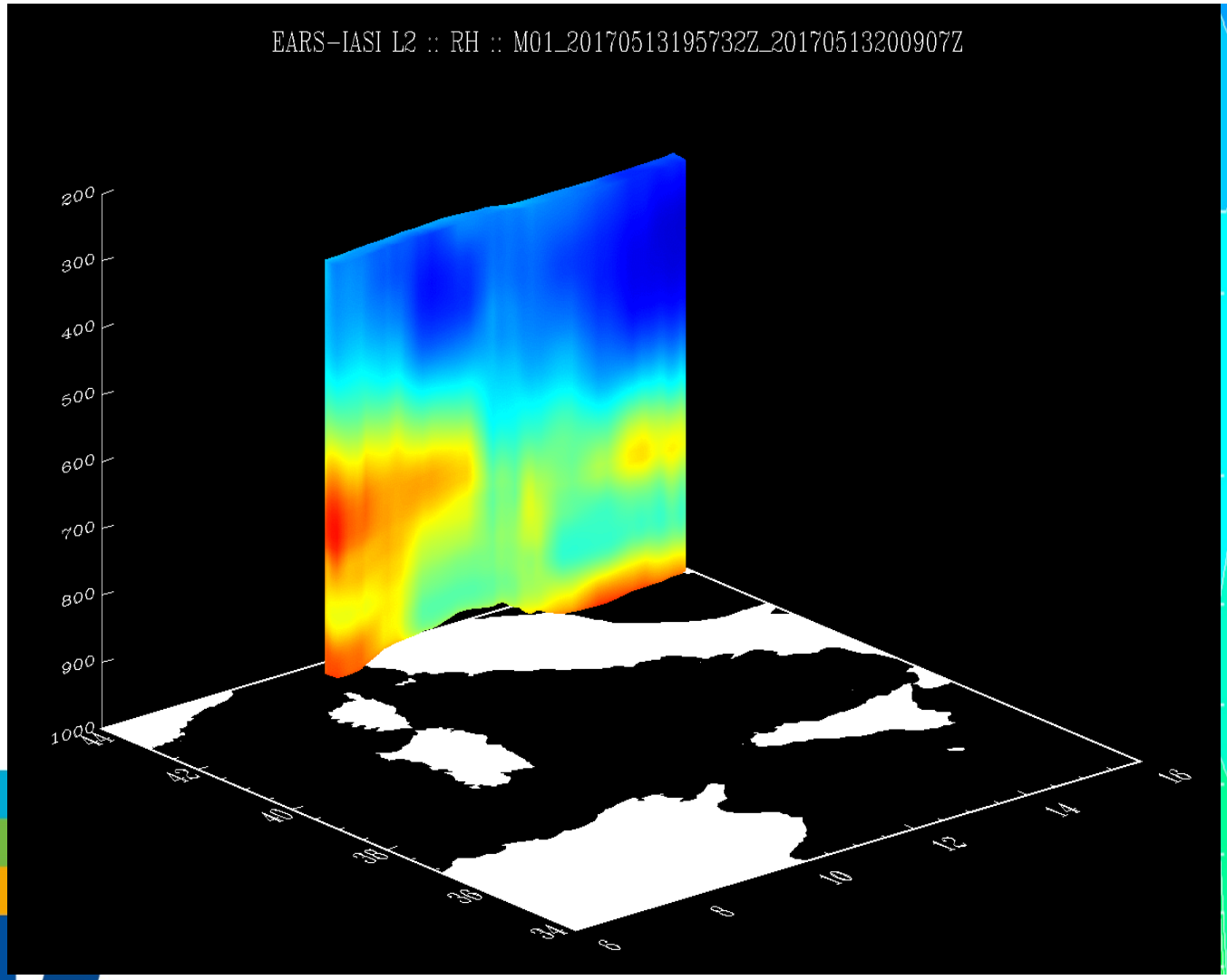
FES, 02/09/2014, 20:45 – 03/09/2014, 19:45



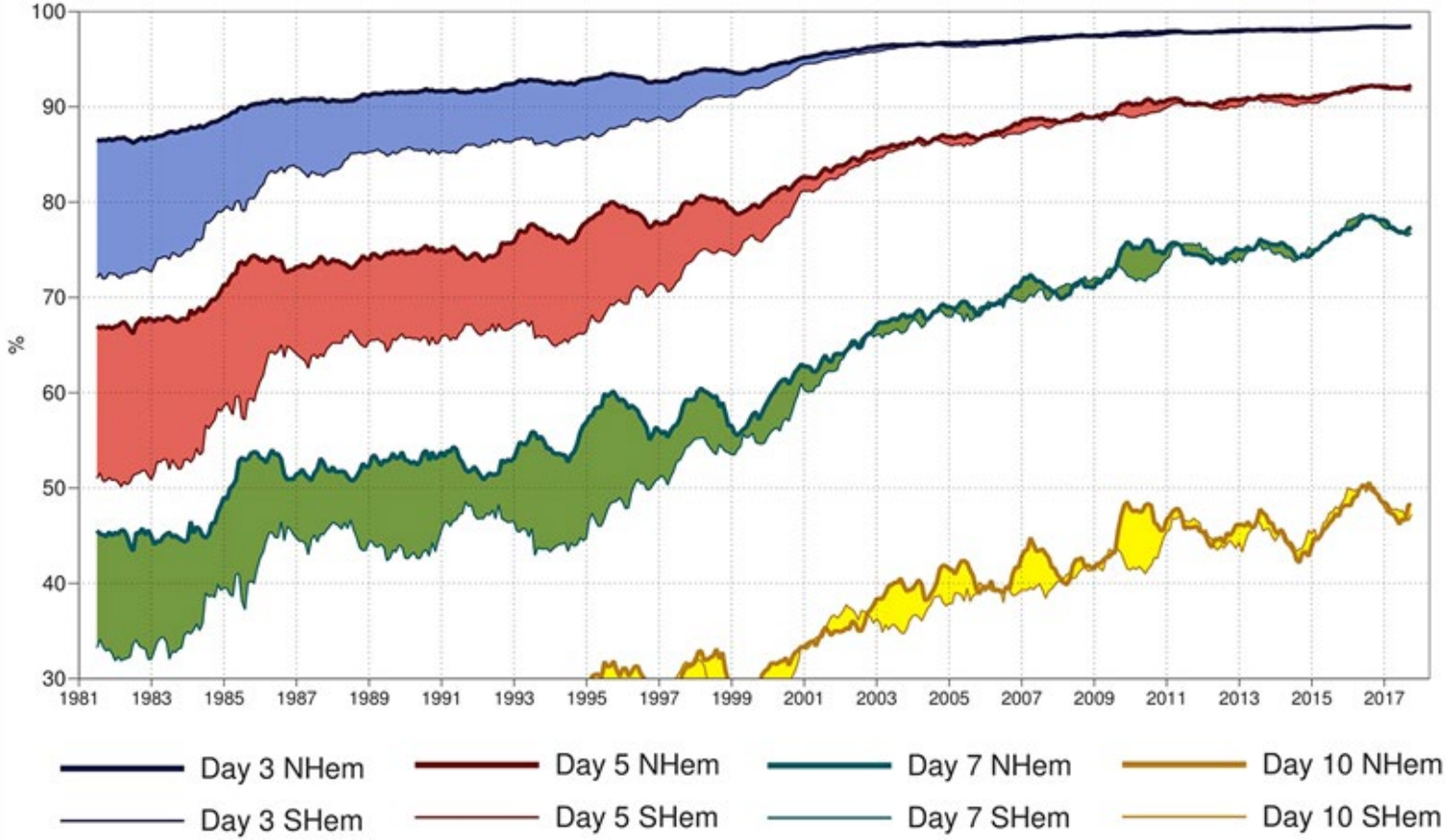
RSS, 11/09/2014, 6:30 – 12/09/2014, 5:30

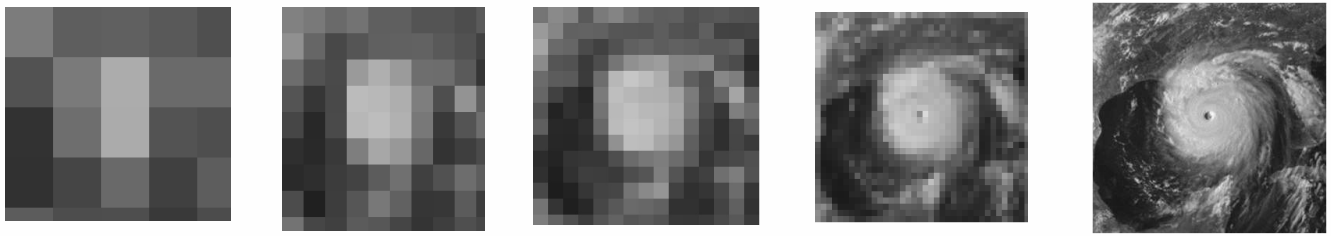


Atmospheric profiling using hyperspectral infrared and microwave



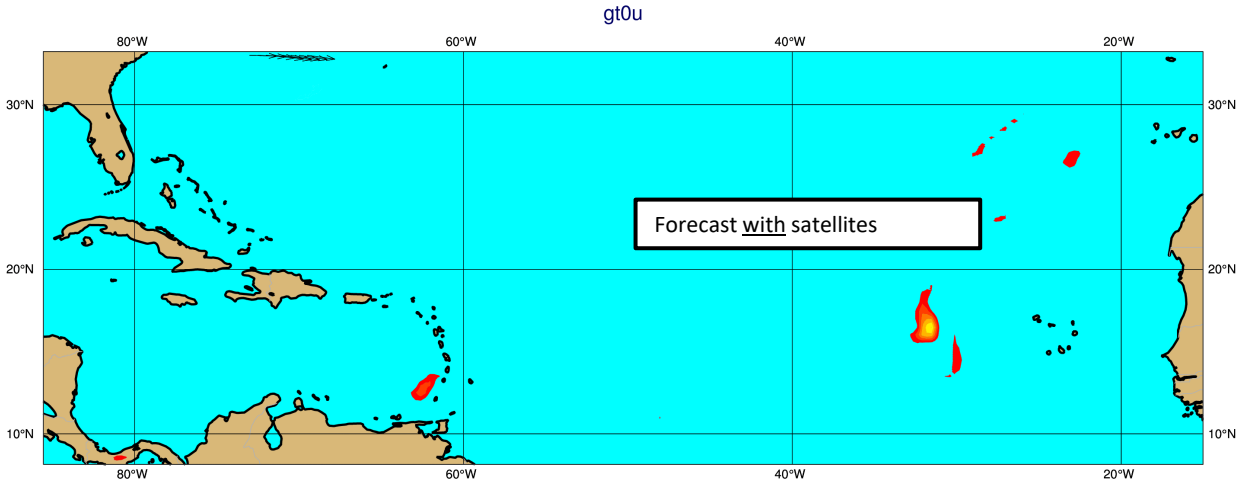
WMO Community has produced great returns to the global society



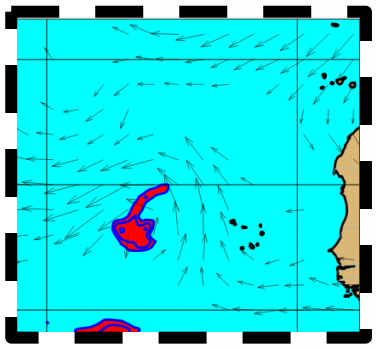


~210km ~63km ~39 km ~16km ~8-10km

IRMA - up to 8 day forecast

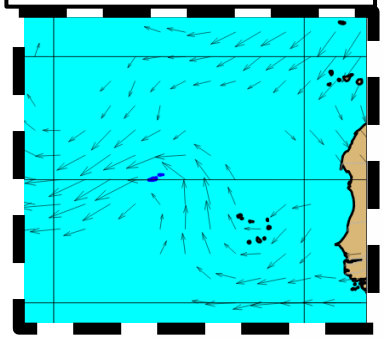


700hPa initial conditions with satellites



Red shading humidity > 95%

700hPa initial conditions without satellites



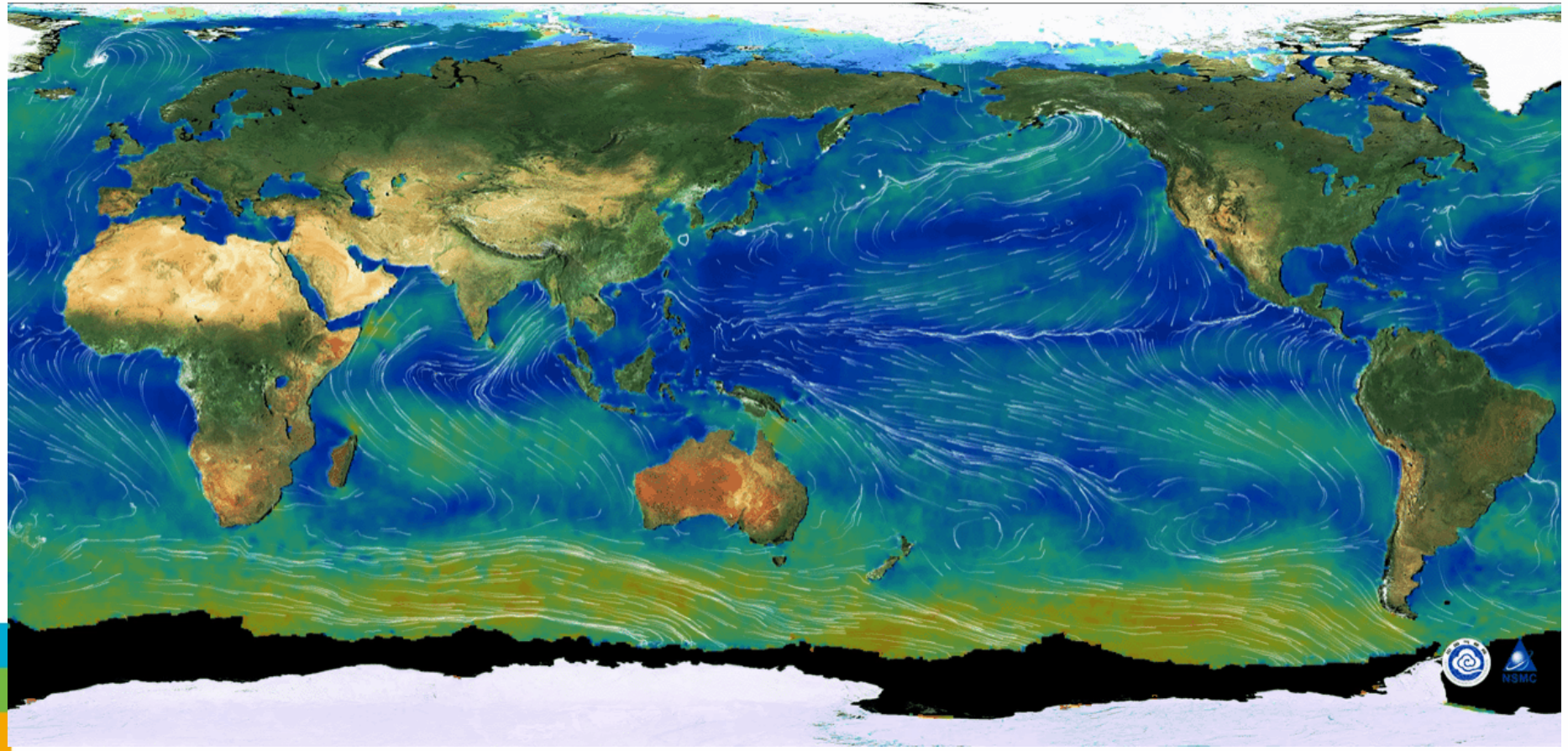
ECMWF

WMO OMM

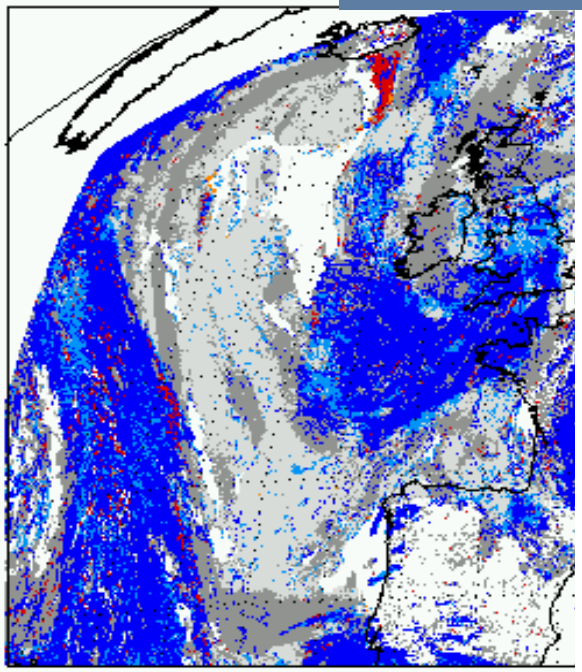
FY -3E successfully launched 5 July 2021

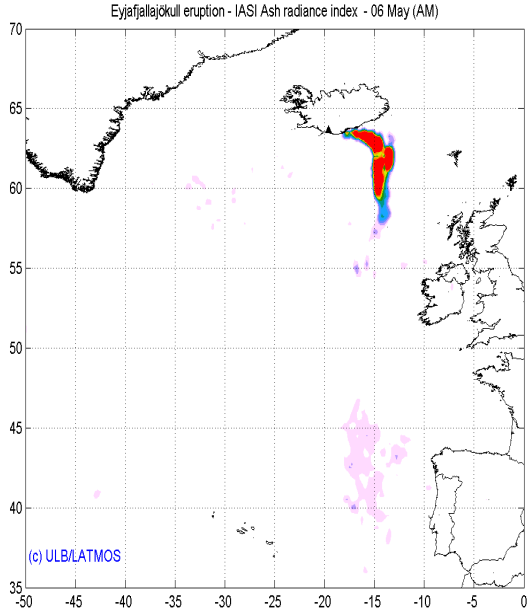
It fills a critical need for early morning observations

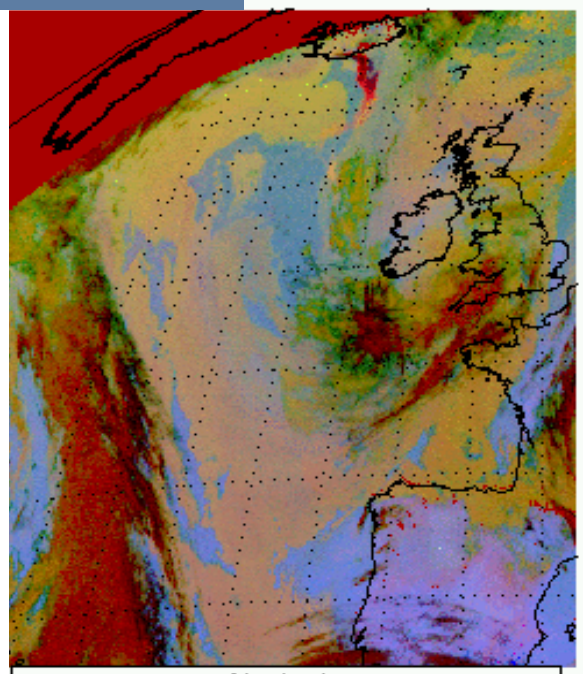
Monthly Wind from WindRAD/FY-3E (Sept., 2021)

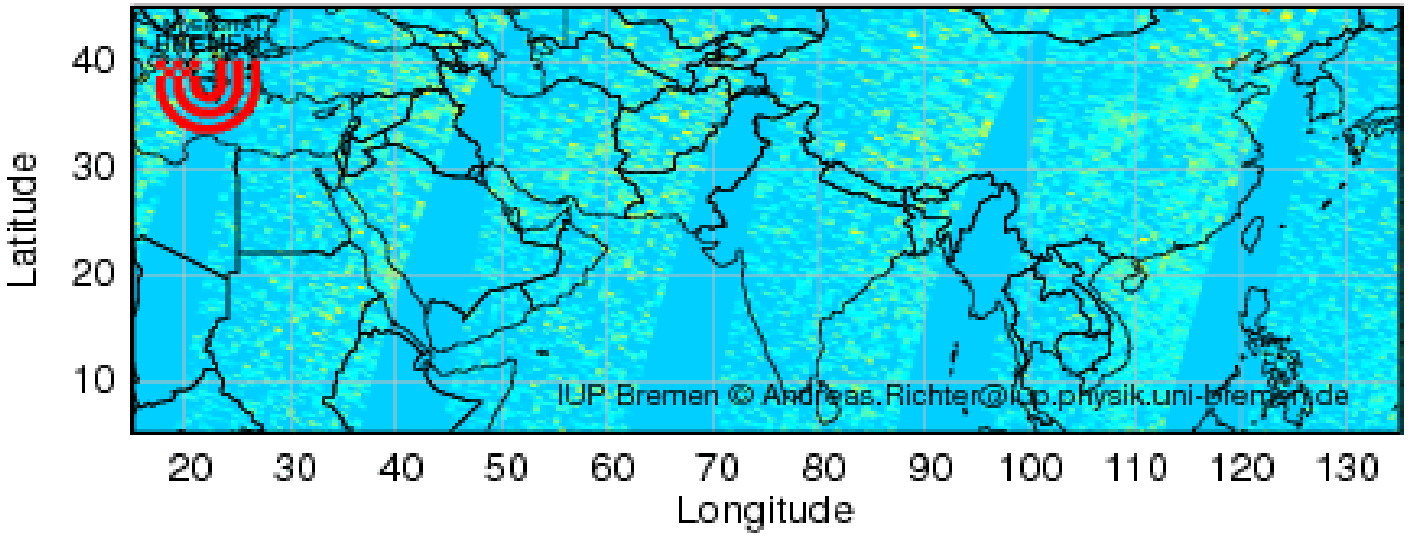


Aviation: Volcanic Ash

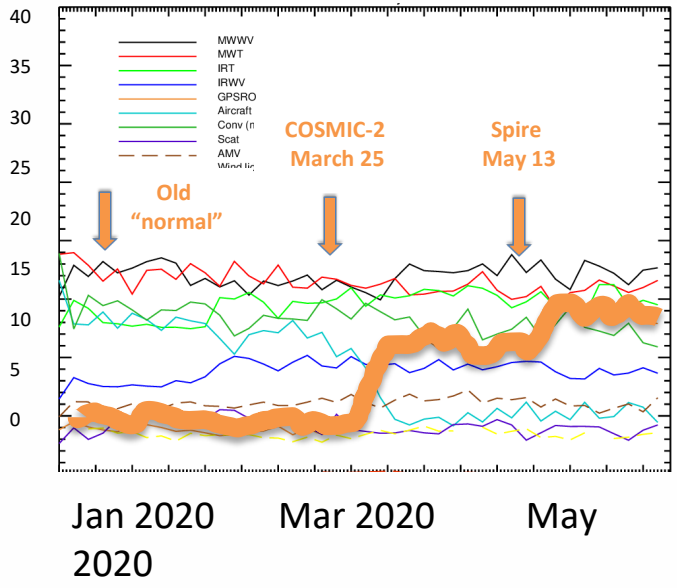


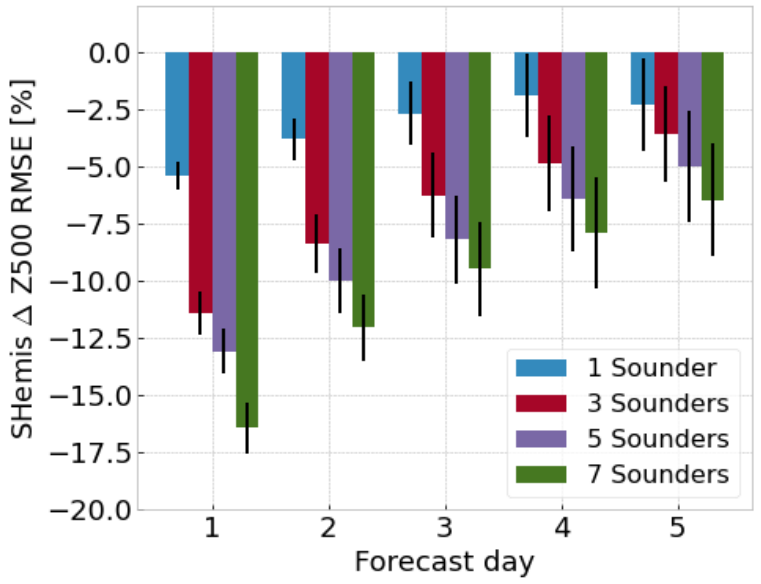






Commercial data providers are emerging:
Radio-occultation data for atmosüpheric profiling
- e.g. Spire and GeoOptics
SAR for monitoring ice and cryosphere
e.g. ICEYE
Microwave sounding and precipitation using small sats next





COSMIC-2 and Spire obs in 2020 confirm need for more GNSS data

Duncan (2020) demonstrated value of MW data from additional LEO orbits

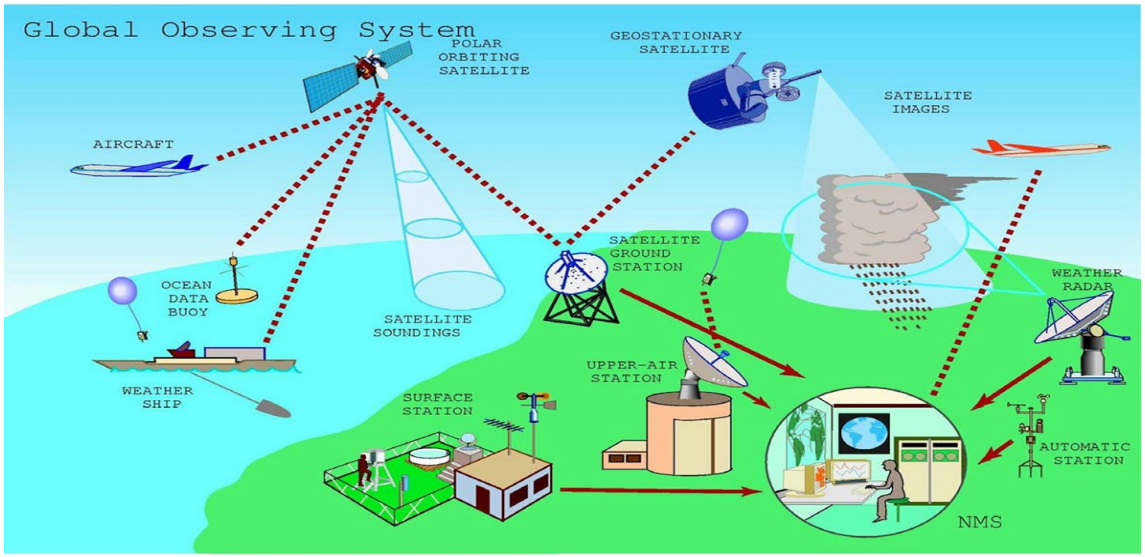
Additional RO from commercial providers available to compensate for loss of aircraft observations during COVID-19 in summer 2020

Frequency Protection

ITU (Res 673, Geneva 2012) Observes

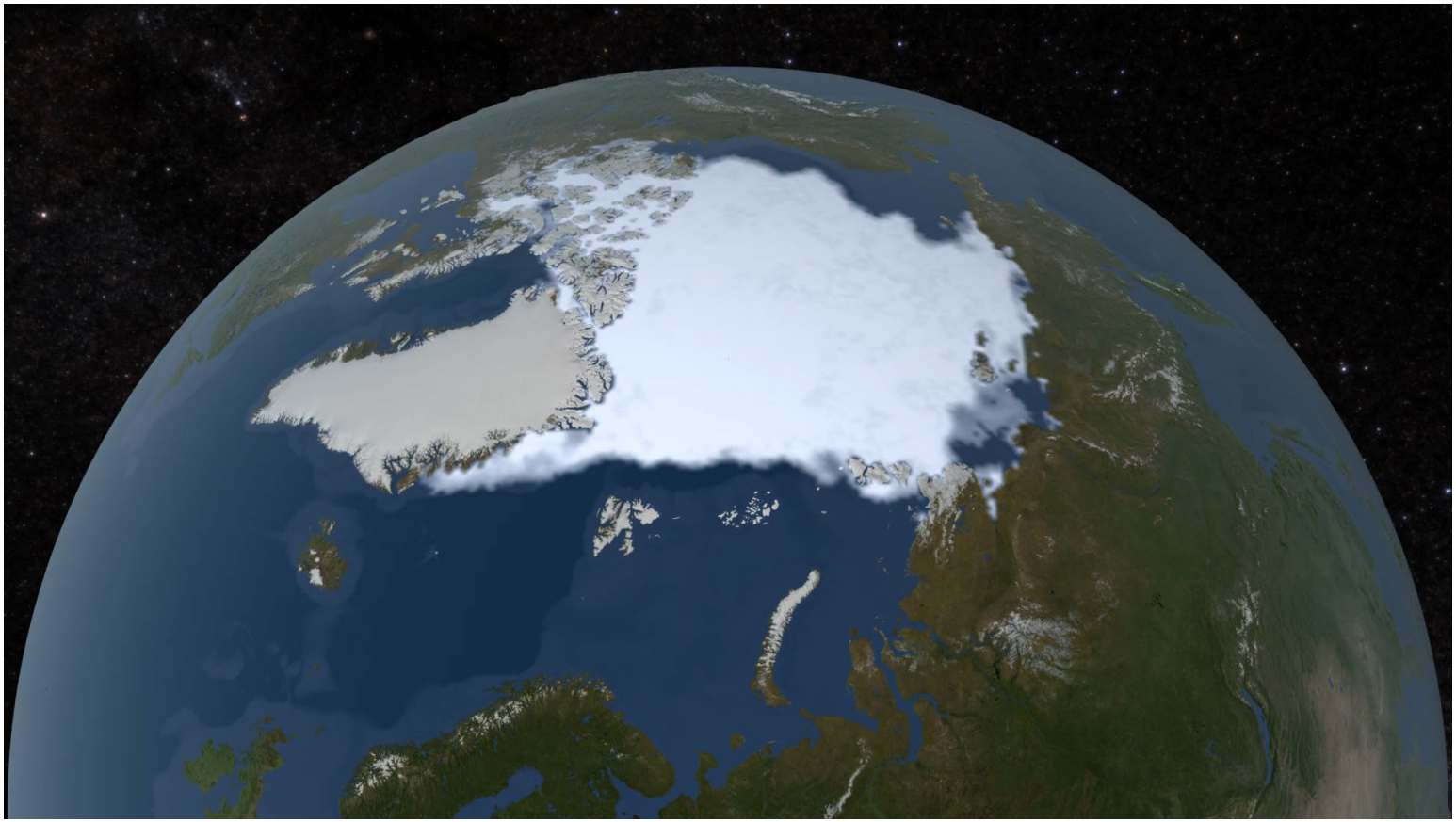
- Earth observation data are essential for monitoring and predicting climate changes, for disaster prediction, monitoring and mitigation, for increasing the understanding, modelling and verification of all aspects of climate change, and for related policymaking;
- Many observations are performed over the entire world which require spectrum-related issues to be considered on a worldwide basis;
- Earth observations are performed for the benefit of the whole international community and the data are generally made available at no cost;

WMO will present its position on the World Radiocommunication Conference 2023 (WRC-23) agenda

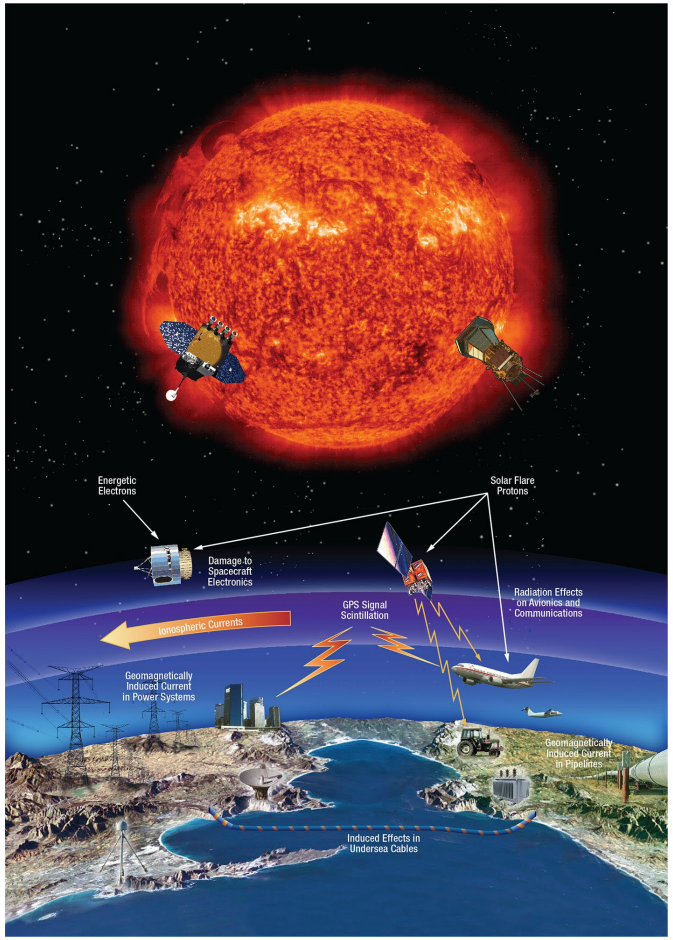


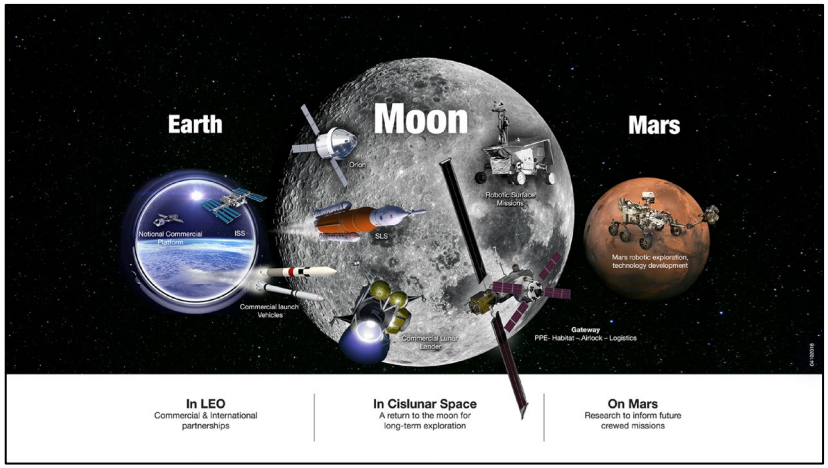
Arctic sea ice extent – Courtesy NASA

https://climate.nasa.gov/climate_resources/155/video-annual-arctic-sea-ice-minimum-1979-2018-with-area-graph/



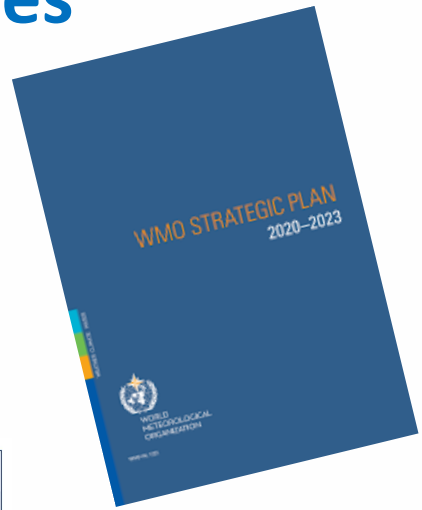
Last but not least: WMO and Space Weather





See https://community.wmo.int/activity-areas/wmo-space-programme-wsp/space-weather-introduction

WMO Space Programme Activities



Data Exchange:

- International data exchange is a major purpose of WMO
- Embracing an Earth systems approach => **New Data Policy is required**
- **New Data Policy** to be presented for approval to extraordinary Congress in 2021 (autumn (TBC))
- Mandatory/Recommended satellite data for global NWP being defined
- Associated updates to WMO Regulatory material

User Support

- Support to the WMO Regional Associations => Satellite Data Requirements
- Training – VLAB, SATURN
- Data Access: WIS, GEONETCast, DBNet
- OSCAR
- Surveys

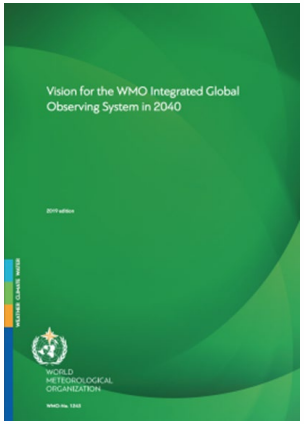
Space Agency Support

- Custodian of User requirements
- Rolling Review of Requirements => OSCAR
- WIGOS2040 Vision*
  - => Space Agencies commitment through CGMS baseline
- GSICS with CGMS

Support to WMO Programmes

- GCOS, GAW, DRR,
- Example flood monitoring

***WMO Integrated Global Observing System Vision 2040**
https://community.wmo.int/vision2040



Supported by

- WMO (Joint) Expert Teams: SSU, EOSDE, RFC, SWx (TBC) and others
- Initiatives: PSTG, GSICS, SCOPE-CM, SCOPE-NWC, SWCEM
- Satellite Coordinator

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TEMPS CLIMAT EAU

Thank you!
Merci!

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