

Power of Earth Observation Satellite Services

Global Space Connectivity and Sustainability Event

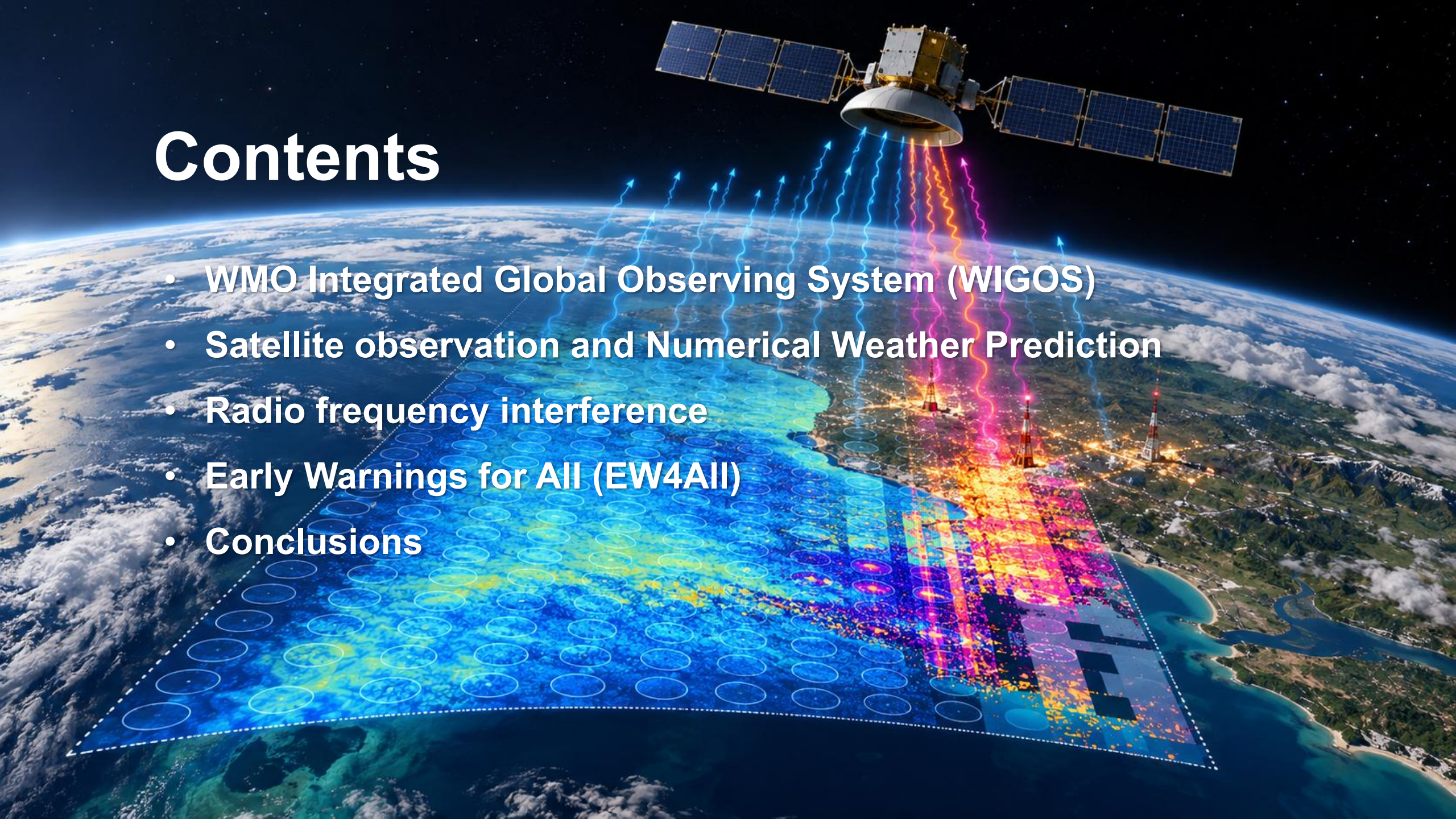
Dr Anthony Rea, Senior Director, Earth System Data and Prediction, WMO
14 Oct 2026, Riyadh



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Contents

- WMO Integrated Global Observing System (WIGOS)
- Satellite observation and Numerical Weather Prediction
- Radio frequency interference
- Early Warnings for All (EW4All)
- Conclusions



Global weather observing systems



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Drivers for the future evolution of WIGOS - WIGOS Vision 2050

Two forces are shaping the WIGOS Vision 2050 — a technology push and a user-demand pull

Technology push

New capabilities and opportunities

- AI and digital twins
- Non-traditional observations — IoT, UAVs, citizen science
- Space 2.0 / 3.0 — CubeSats, SmallSats, easier access to space
- Higher-performing sensors — quantum sensing, lidar, hyperspectral microwave
- Commercial sector, philanthropies and new space-faring nations

User-demand pull

Evolving observational needs

- Societies and economies ever more reliant on accurate environmental information
- Demand for higher-resolution, higher-refresh, higher-quality forecasts
- Highly localized, specialized forecasts — e.g. urban
- Diverse observations across the whole Earth system
- Applications beyond life & property — economy and decision-support

Implication for WIGOS: a coordinated “**system of systems**” integrating Earth- and space-based sources — maintaining quality, trust, sustainability and resilience, with governance across sectors and speed in the EO→action value chain. **No single observing system will achieve this alone.**

Observations are at the core of what we do

A global observing system, operating around the clock



16 000

surface stations

hourly observations worldwide



1 300

upper-air stations

two balloon flights per day



~100

instruments in global NWP

assimilated, from ~30 satellites



10+ / 130+

global / regional centres

for data processing & forecasting

What they enable

Global NWP

Numerical Weather Prediction is driven by the assimilation of satellite data — the single largest source of forecast skill.

Climate monitoring

Tracking 55 Essential Climate Variables to detect change and underpin adaptation.

Disaster awareness

High-resolution, high-frequency data for situational awareness of fast-moving hazards.

Satellite observation are the most essential for Numerical Weather Prediction (NWP)

A global service layer for weather, climate, water and environmental intelligence

~100

satellite instruments assimilated in global numerical weather prediction

~30

satellites contributing operational observations to global NWP

600M

satellite measurements per day in the WMO observing system

24/7

continuous global observing and service delivery

What these observations enable



Weather forecasting

Better initial conditions and more accurate forecasts



Early warnings

Detection and monitoring of fast-moving hazards



Climate monitoring

Long-term records for trends, adaptation and risk

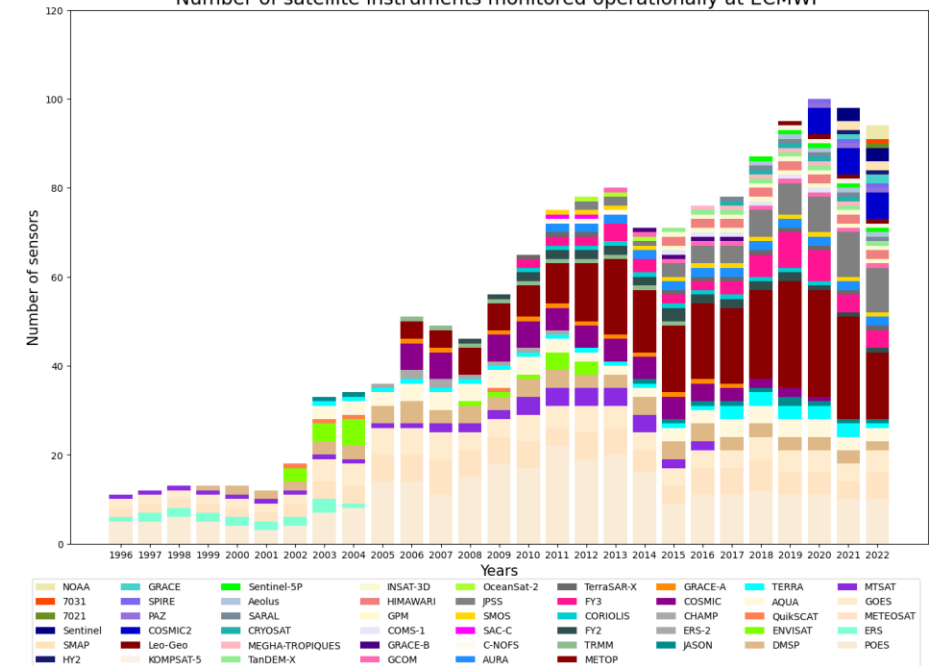


Economic decisions

Agriculture, energy, aviation, maritime and infrastructure

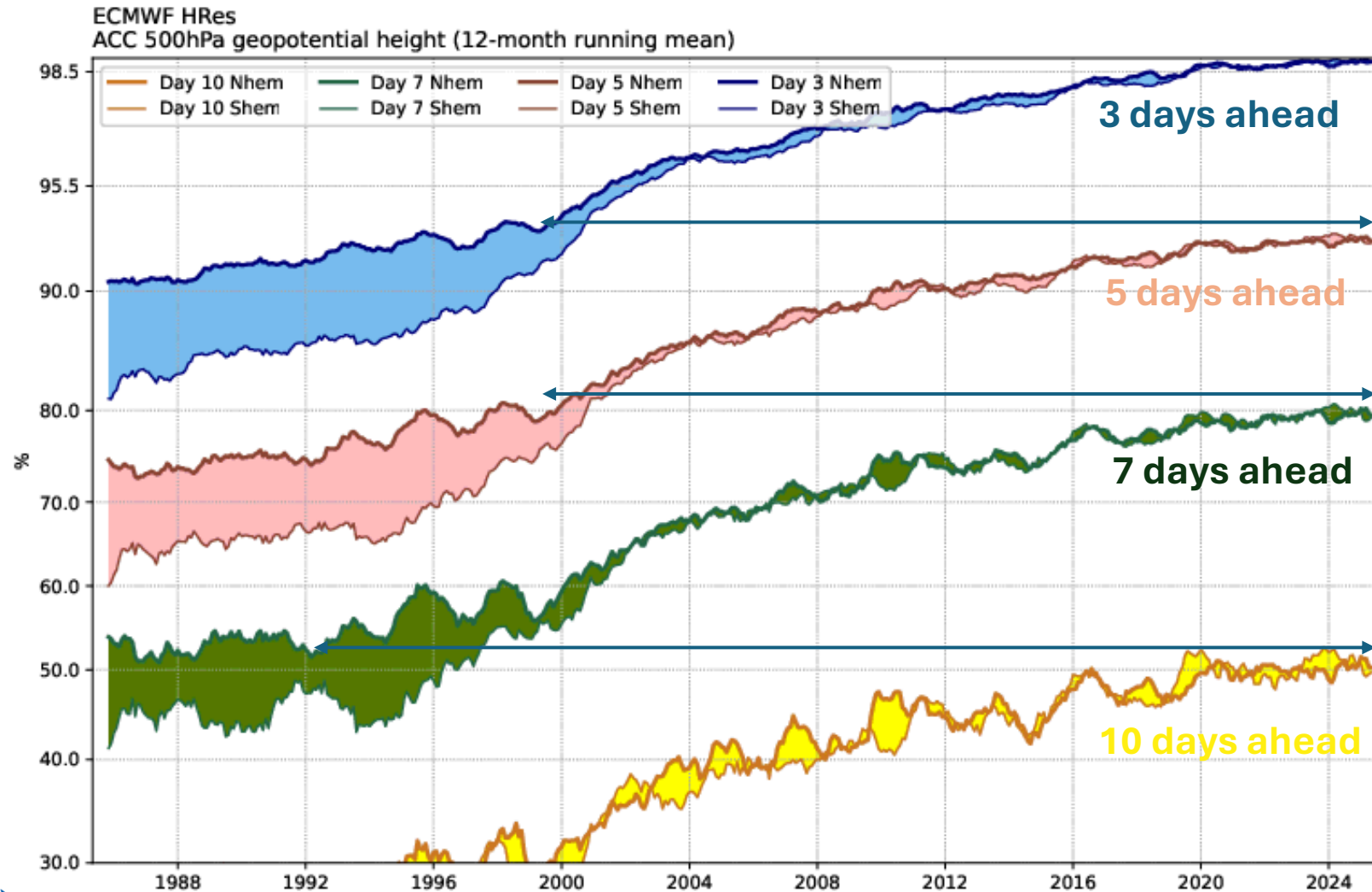
A growing constellation

Number of satellite instruments monitored operationally at ECMWF



Reliance on satellite data: NWP skill in the satellite era

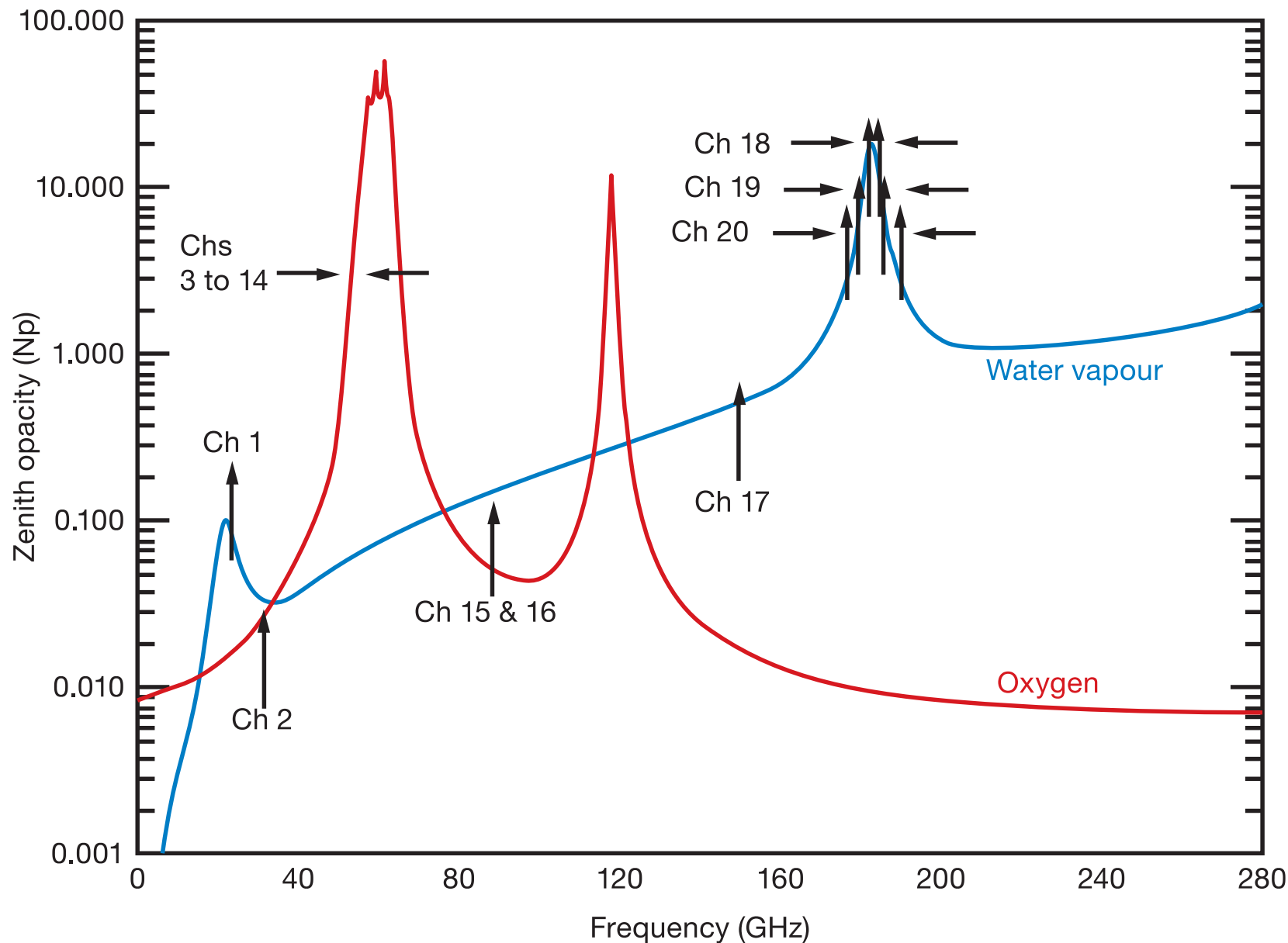
Two lines denote skill in northern and southern hemispheres respectively: proxies for well and poorly observed with in situ data



Headline: 1 day per decade skill improvement

Before satellite era: very low skill in southern hemisphere

1999: AMSU-A and MHS
2006: GNSS RO

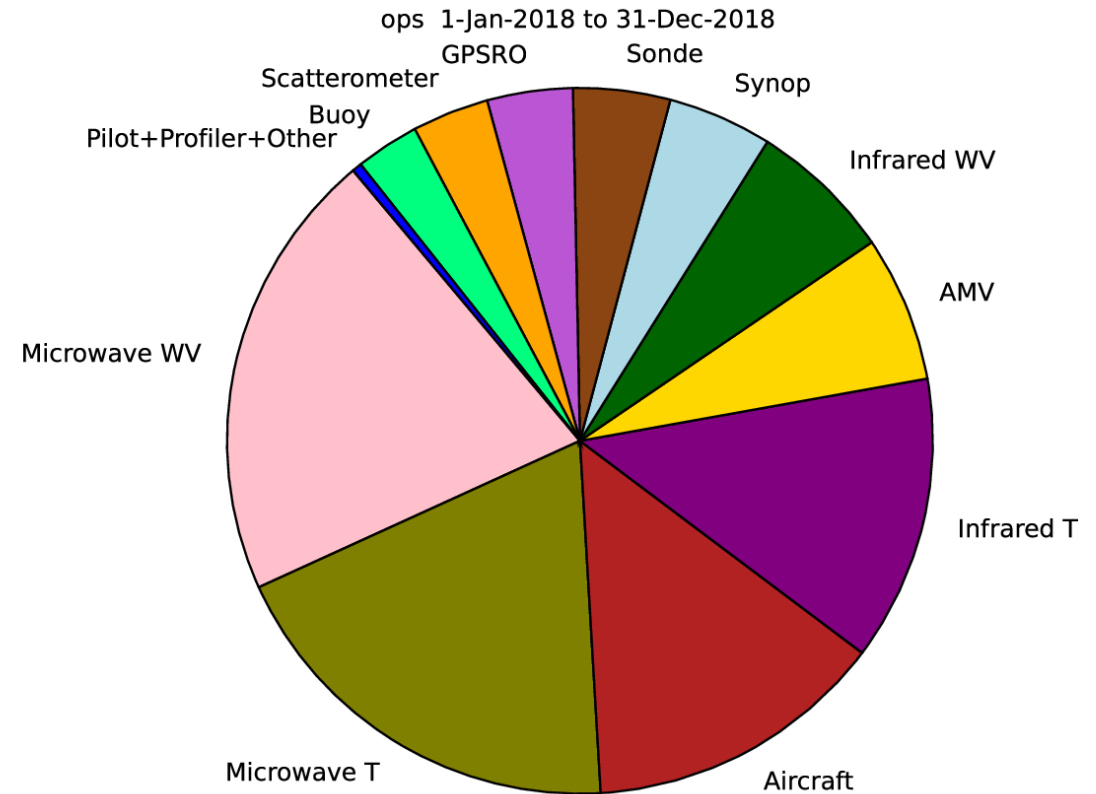


Atmospheric opacity in the frequency range 0–280 GHz. The chart shows frequencies used by the channels of the Advanced Microwave Sounding Unit (AMSU-A, channels 1-15, AMSU-B channels 16-20), one of the most important instruments used in NWP. It has been continuously operated since 1998 on a series of operational satellites run by NOAA and EUMETSAT. Today there are also a range of new-generation instruments that measure microwave radiances, such as China's MWTS-2 and MWHS-2, Russia's MTVZA-GY and the USA's ATMS, amongst many others. (Source: S. J. English et al., 1994, Q.J.R. Meteorol. Soc., doi:10.1002/qj.49712051706.)

Microwave (radio frequency spectrum) observations are critical to NWP

And which data matters most

- **Microwave radiances lead** — the single most important satellite system for NWP
- **~50% of short-range skill** from microwave (~40% passive + ~10% active)
- **Continuity is critical** — it depends on protected radio-frequency spectrum



Relative impact on short-range forecast skill

RFI and satellite observations in the news

The Washington Post
Democracy Dies in Darkness

CAPITAL WEATHER GANG

Head of NOAA says 5G deployment could set weather forecasts back 40 years. The wireless industry denies it.

Government agencies are at an impasse on how to proceed.

 By [Jason Samenow](#)

May 23, 2019 at 10:16 a.m. EDT

- For the passive instruments detecting natural energy from Earth, noise is the target signal

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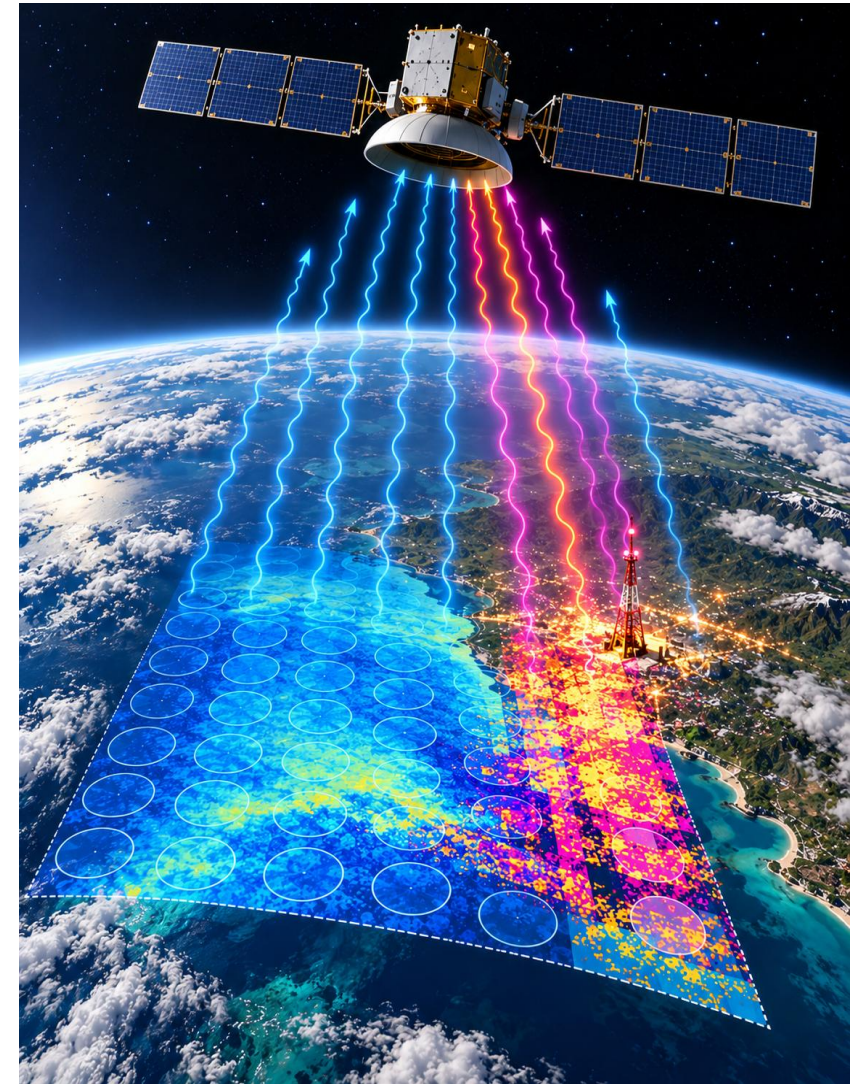
Satellite constellations could interfere with meteorological spectrum

by Debra Werner January 23, 2023

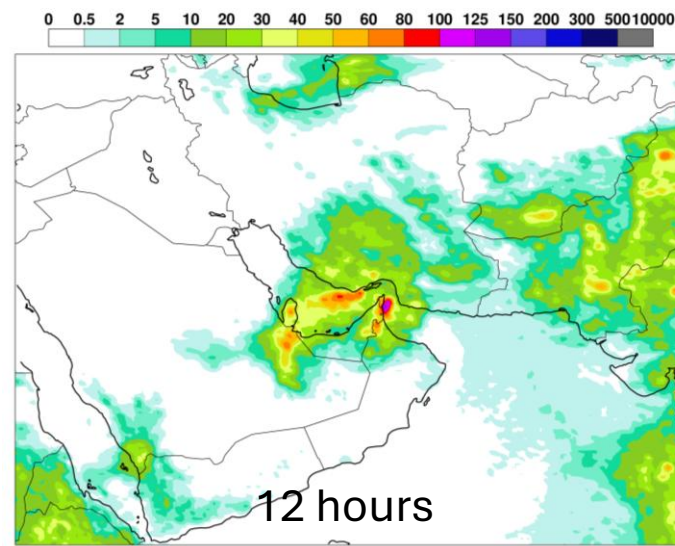
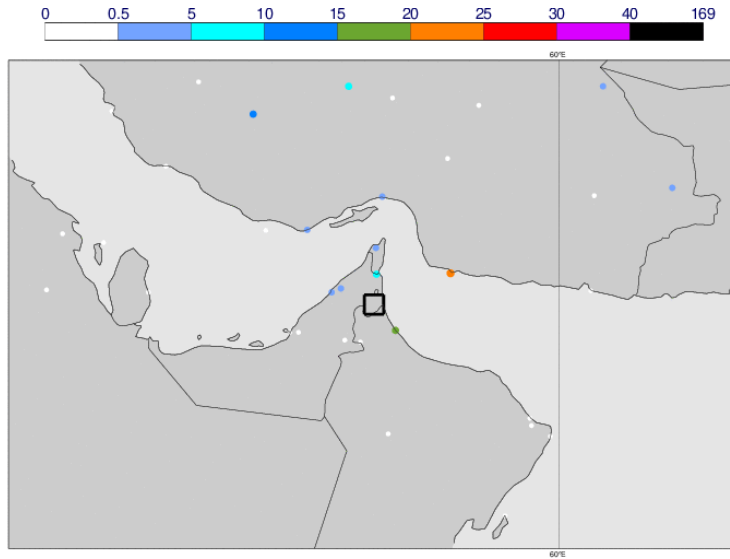
Potential impact of WRC-27 on remote sensing

Agenda Item (AI)	Threat vs Opportunity	EO bands
1.1 (ESIM)	Threat	50.2-50.4 GHz
1.2 (small antennas FSS)	Threat	13.25-13.75 GHz
1.3 (FSS uplinks)	Threat	52.6-59.3 GHz
1.4 (BSS and FSS)	Threat	17.2-17.3 GHz
1.7 (mobile networks)	Threat	X-band uplinks X-band downlinks Adjacent bands wrt AI 1.19
1.8 (radars)	Threat	Sensors above 226 GHz
1.12 (IoT links)	Threat	1.4-1.427 GHz S-band uplinks
1.13 (Direct-to-device)	Threat	1.4-1.427 GHz S-band uplinks & downlinks
1.18 (EO protection)	Opportunity	Sensors above 86 GHz
1.19 (SST)	Opportunity	4.2-4.4 GHz 8.4-8.5 GHz

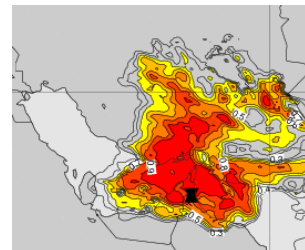
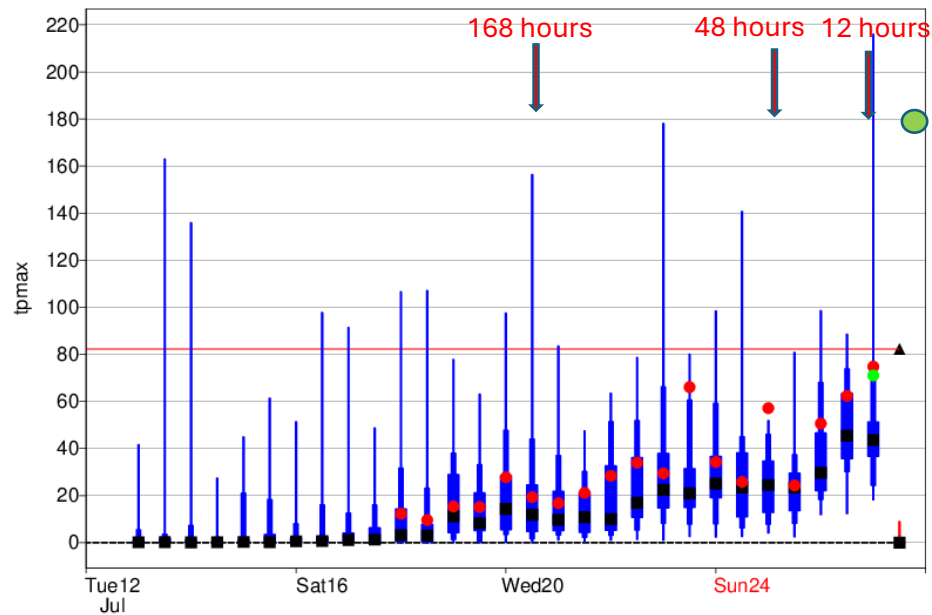
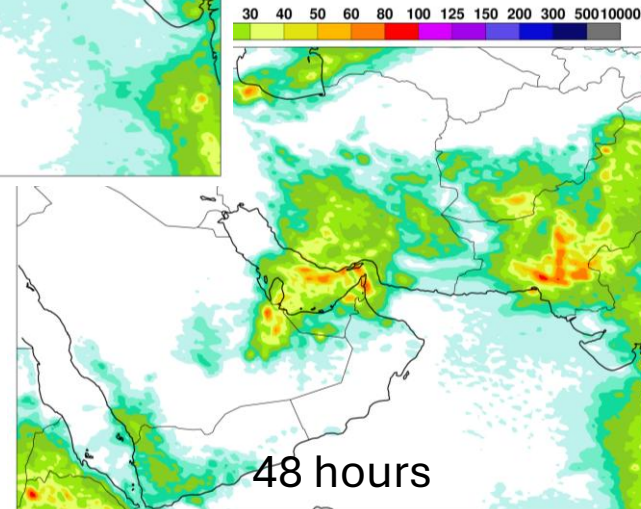


Fujairah, UAE 27-28 July 2022 Severe rainfall event

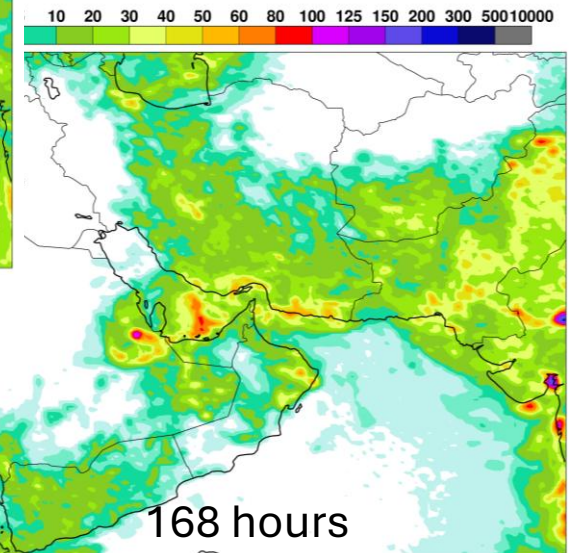
On 27 July parts of United Arab Emirates was hit by torrential rainfall, causing 7 fatalities. Fujairah measured 169 mm in 24 hours.



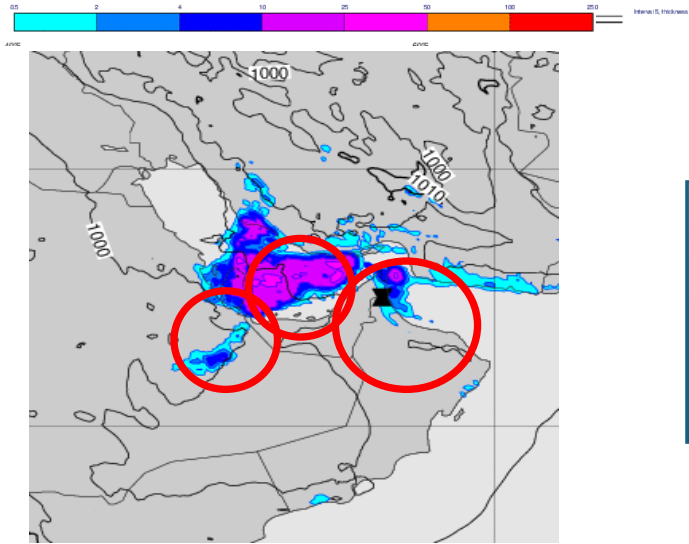
How different would this and similar forecasts have been if we could not use observations dependent on spectrum allocated to meteorology?



ECMWF Extreme Forecast Index shows this event was exceptionally rare

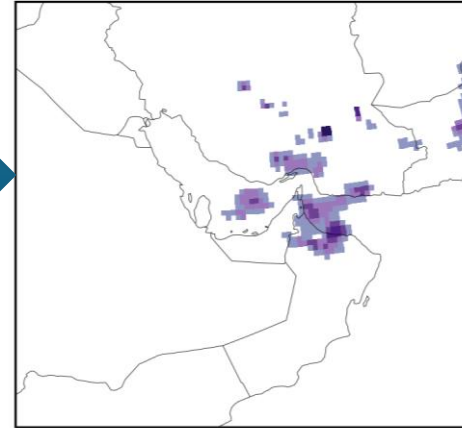


What if we did not have microwave observations?



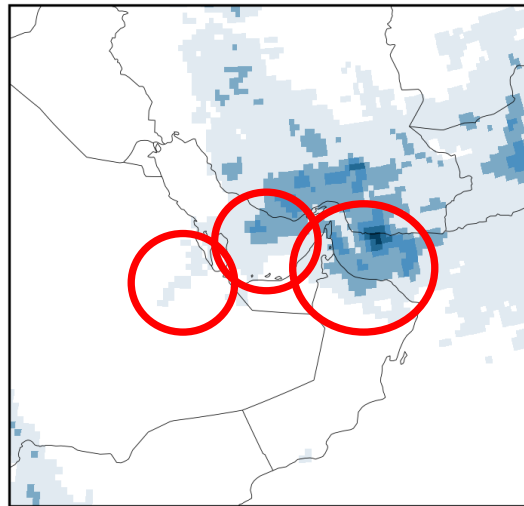
This shows where
this event was
extreme compared
to normal extremes

c. Extreme Rain Multiplier from
26-28 July 2022

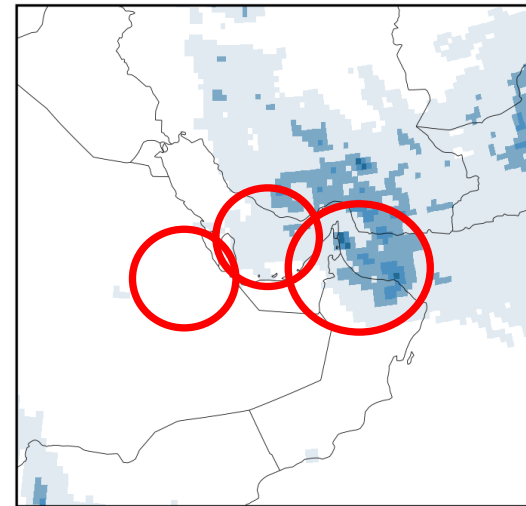


This
shows the
difference

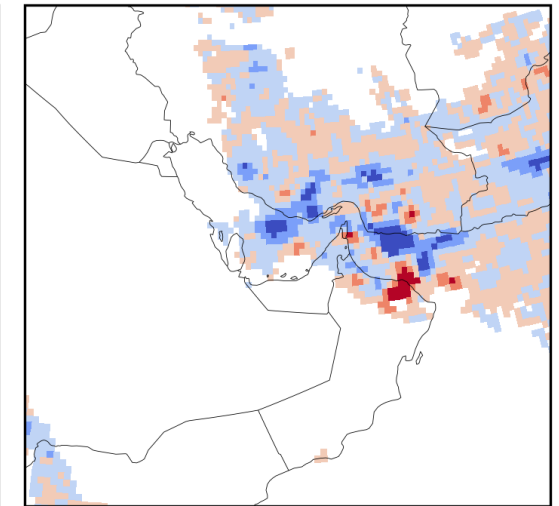
a. Control run



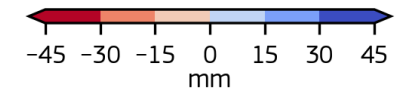
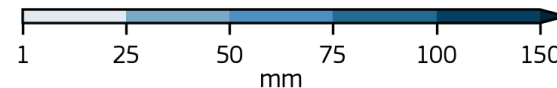
b. Denial run



c. Difference



This shows that the 72
hour forecast with and
without observations
using EESS bands



Early Warnings for All is a groundbreaking initiative that aims to protect everyone everywhere by 2027



- Part of the UN Secretary-General's **Acceleration Agenda**
- Aligns with the priorities of the **Paris Agreement**
- Supports key provisions of the **Sendai Framework for Disaster Risk Reduction**, particularly **Target G** on availability and accessibility of multi-hazard early warning systems
- Contributes directly to the UN's **Sustainable Development Goals** (SDGs), on poverty, hunger, health, water, clean energy, climate action and sustainable cities.

Early Warnings for All (EW4All)



A groundbreaking UN initiative to protect **everyone on Earth** with multi-hazard early warning systems by **2027**.

A global mandate

- **UN Secretary-General's call (2022)** — the Acceleration Agenda
- **Aligned with the Paris Agreement**
- **Sendai Framework, Target G** — access to multi-hazard early warnings
- **Advances the UN SDGs** — poverty, health, water, climate action

A UN-wide partnership

- **Co-led by WMO and UNDRR** with ITU and IFRC as pillar leads
- **Delivered nationally** by NMHSs, disaster agencies, civil society and youth
- **Support must grow** — implementation varies widely between countries

Four pillars — WMO leads Pillar 2

1 Disaster risk knowledge

Lead: **UNDRR**

Collect data and undertake risk assessments

2 Observations & forecasting

Lead: **WMO**

Detect, monitor and forecast hazards; generate warnings

4 Preparedness & response

Lead: **IFRC**

Build national and community response capabilities

3 Warning dissemination

Lead: **ITU**

Communicate risk information and early warnings

Conclusions

- **Earth observations are the foundation of early warnings** — and of the whole weather, climate and water value chain
- Forecast skill has improved dramatically, driven above all by satellite data; **sustaining the observing system is essential**
- **RFI is a big risk** and challenge especially for the passive satellite instruments detecting natural energy from Earth, noise is the target signal
- WMO through WIGOS Vision 2050 sets the course; **coordination with CGMS, CEOS and partners** makes it possible
- **Early Warnings for All depends on a globally coordinated system**, delivered nationally through NMHSs

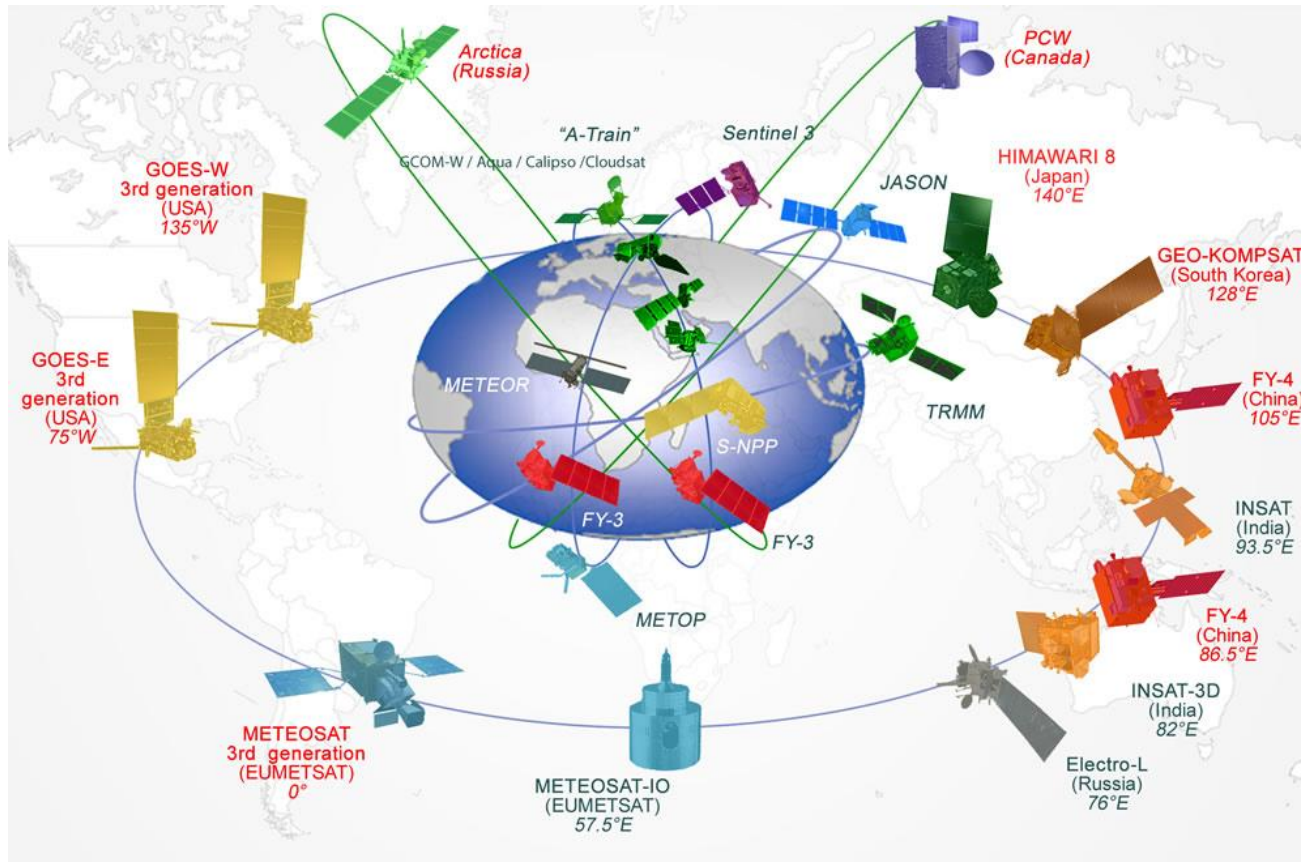
Thank you.



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Global coordination of the space-based system



- **WMO works with CGMS and CEOS** and many partners to coordinate the space-based system
- **A complete ring of GEO satellites** shared between the US, Europe and Asia
- **A succession of LEO orbits** shared between the US, Europe and China