CGMS 50y Opening

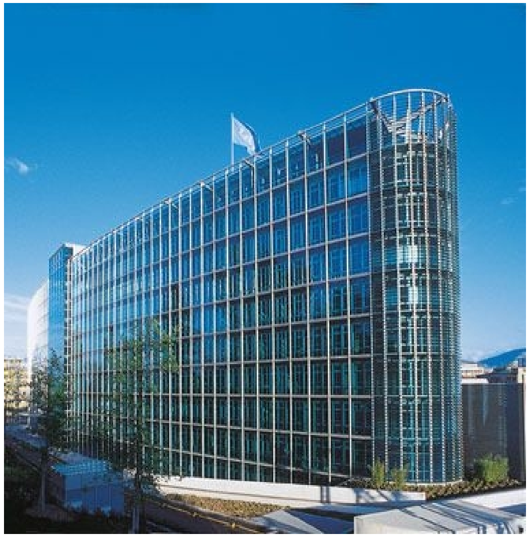
Prof. Petteri Taalas
Secretary-General

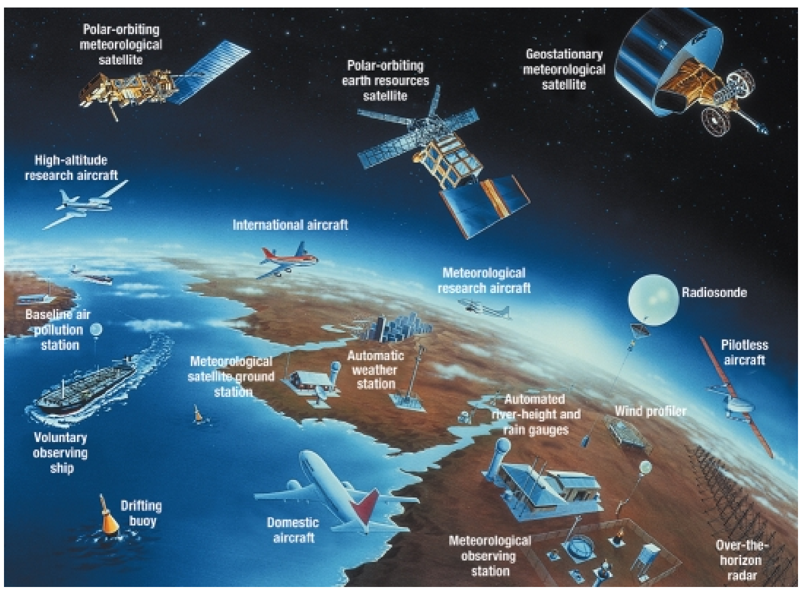
WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

World Meteorological Organization





- UN Specialized Agency on weather, climate & water
- 193 Members, HQ in Geneva
- 2nd oldest UN Agency, 1873-
- Coordinates work of > 300 000 national experts from meteorol-ogical & hydrological services, academia & private sector
- Co-Founder and host agency of IPCC (1st World Climate Conference)
- WMO SG UNSG Guterres' Climate Core Group Member (1/4)

WMO OMM

Biggest risks for global economy 2022-2032

World Economic Forum 2022

Economic | Environmental | Geopolitical | Societal | Technological

1st	Climate action failure	6th	Infectious diseases
2nd	Extreme weather	7th	Human environmental damage
3rd	Biodiversity loss	8th	Natural resource crises
4th	Social cohesion erosion	9th	Debt crises
5th	Livelihood crises	10th	Geoeconomic confrontation

Source: World Economic Forum Global Risks Perception Survey 2021-2022

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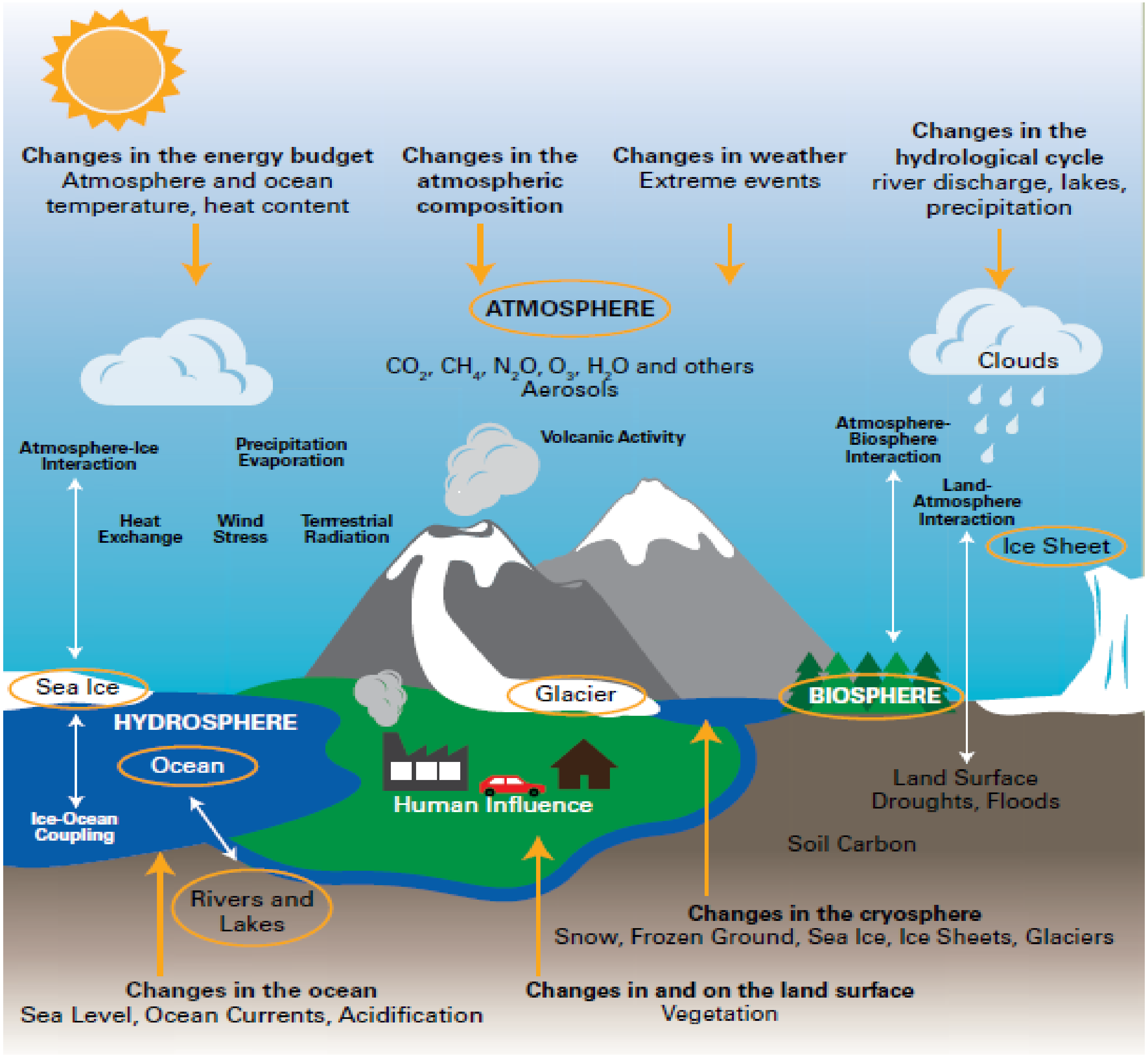
CGMS, 16 Members, 6 Observers

Key contributor of the WMO Integrated Global Observing System's space component, in particular provision of data from the three backbone polar orbiting satellite planes (early morning, mid-morning and afternoon) and the provision of the full geostationary meteorological satellite ring.

Coordination through CGMS together with WMO and the WIGOS Vision has enabled

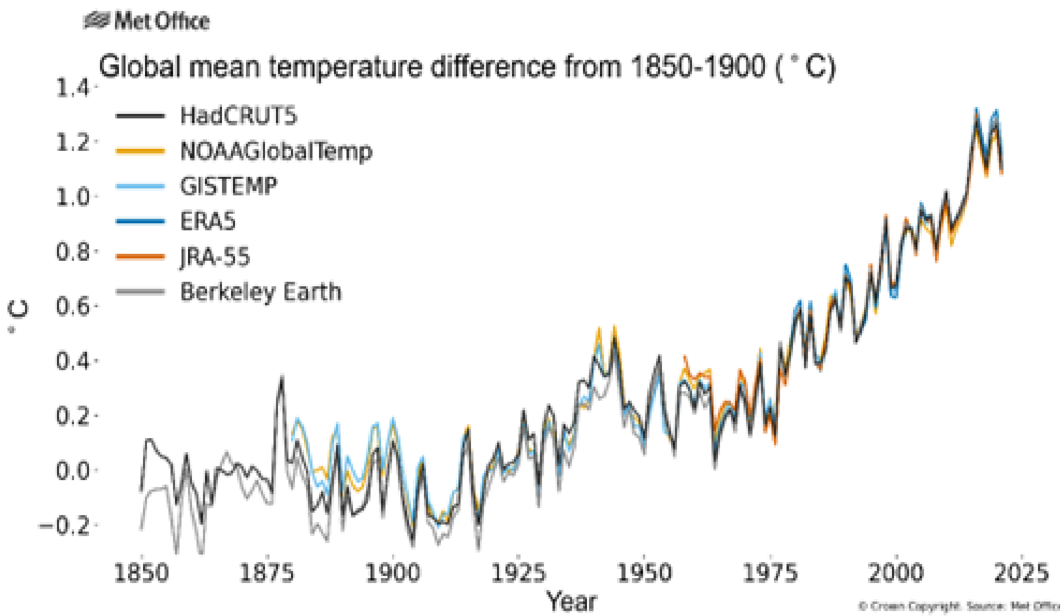
- Provision by EUMETSAT to cover the Indian Ocean Data Coverage (IODC) service
- The contribution of CMA of an early morning satellite
- Coordinated support for the development of future operational critical missions like wind lidar, precipitation radar, sustained high-quality GHG/Carbo monitoring and air quality
- Direct Broadcast network for short timeliness provision of data for global NWP
- Coordinated training activities through VLab (Virtual Laboratory for Training and Education in Satellite Meteorology)
- Provision of NRT data for sustained operational weather forecasting
- Provision of data ad products for climate monitoring, in particular coordination with CEOS through the Joint Working Group on Climate
- Coordination of Radio Frequency matters critical for the space -based component
- Support to operational Space Weather monitoring activities

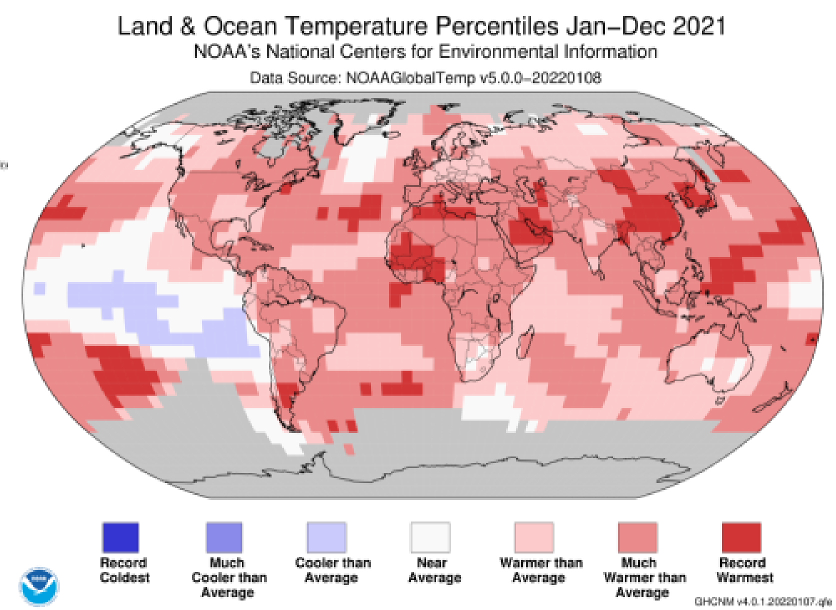
The climate system



WMO

2017-2021 is the warmest period on record





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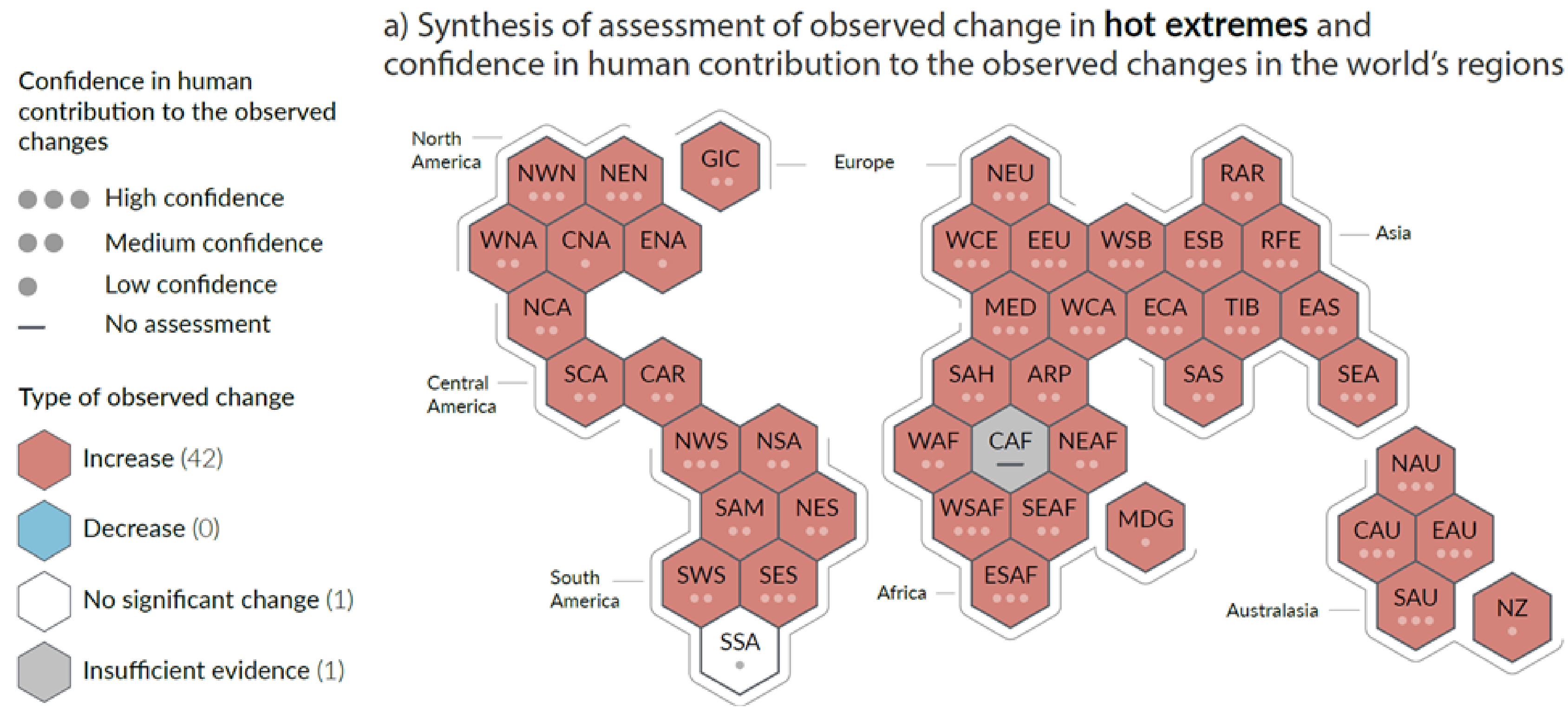
2017-2021 is estimated to be 1.06 °C to 1.26 °C warmer than pre-industrial (1850-1900) levels

We have already seen an increase in the amount of hot extremes (IPCC 6 AR)



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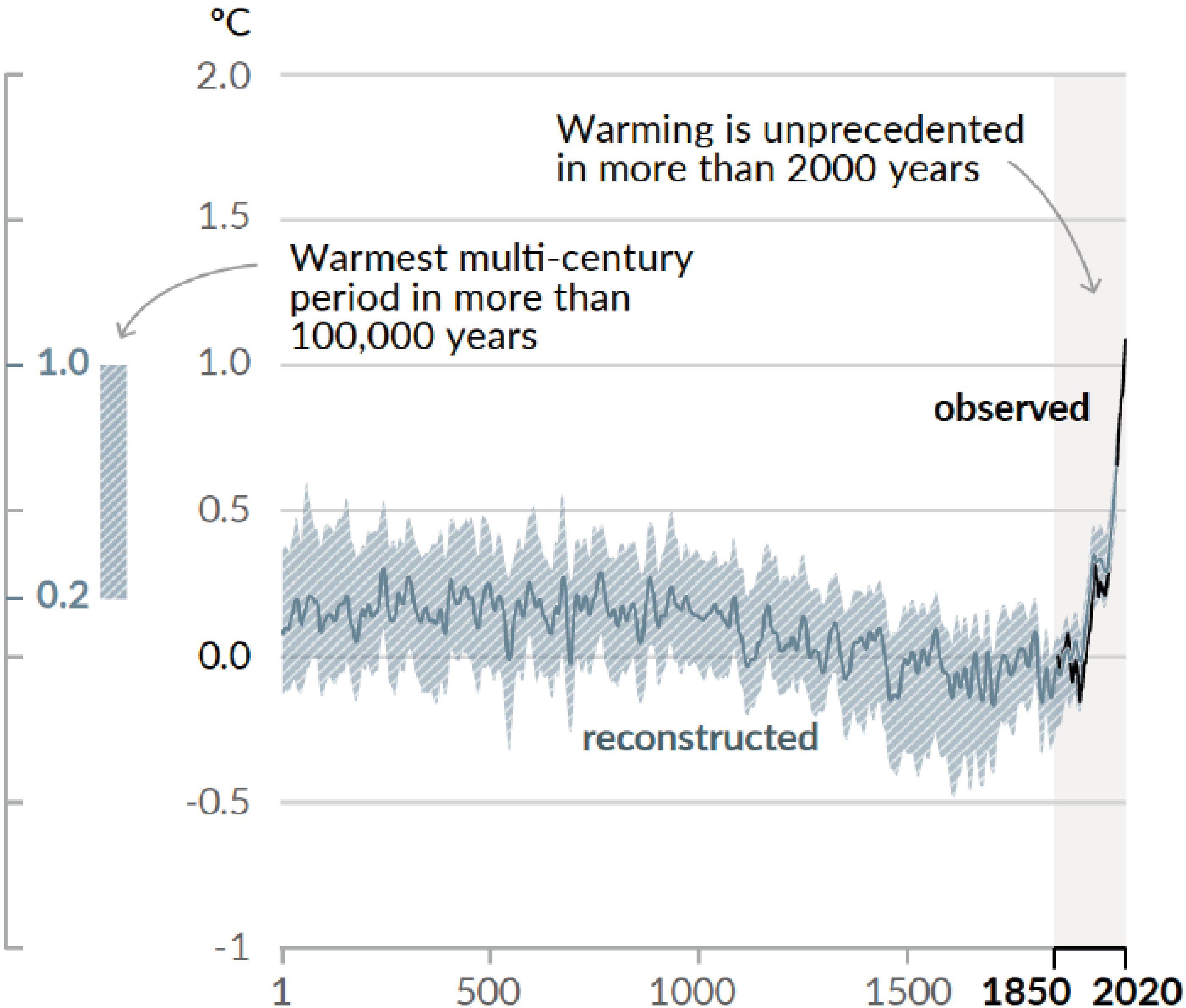
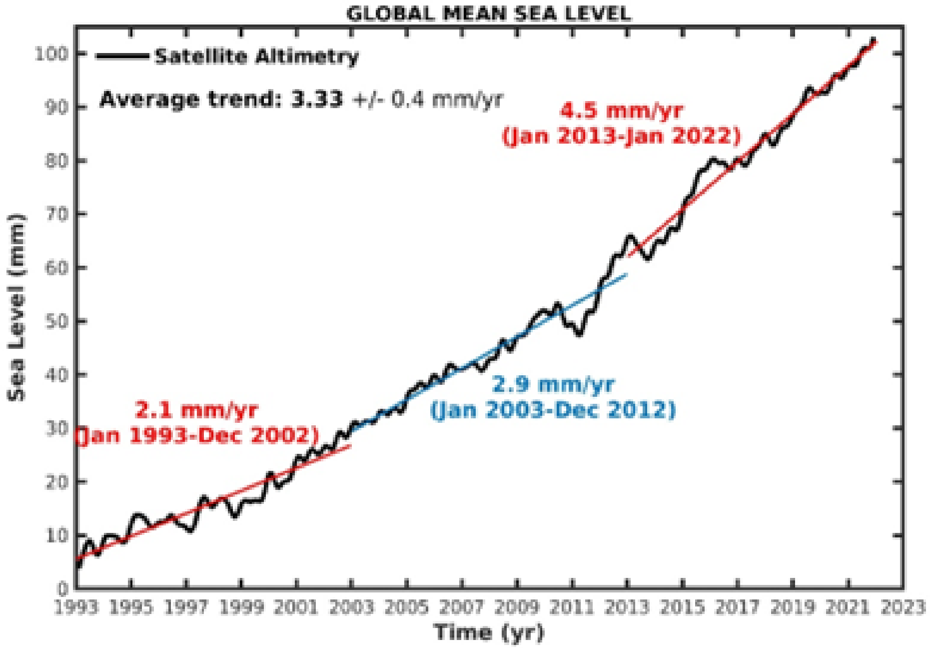
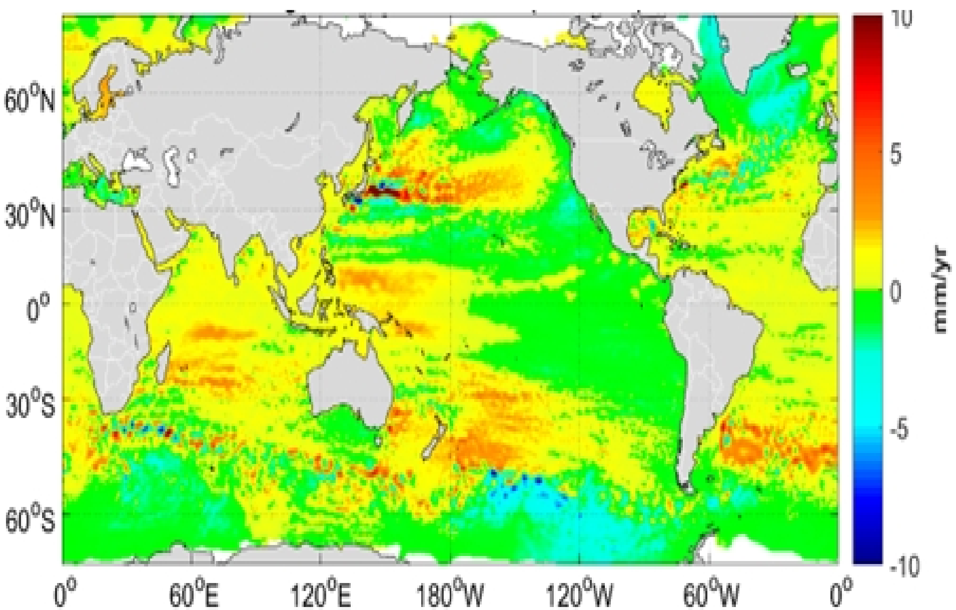
Unusual warming 1900-2020 vs. 0-2020



Global sea level rising at an increasing rate





Regional deviations from post-1993 trend

Sea level rise from ice sheet loss:

Greenland: 0.8 mm/yr
Antarctica: 0.4 mm/yr

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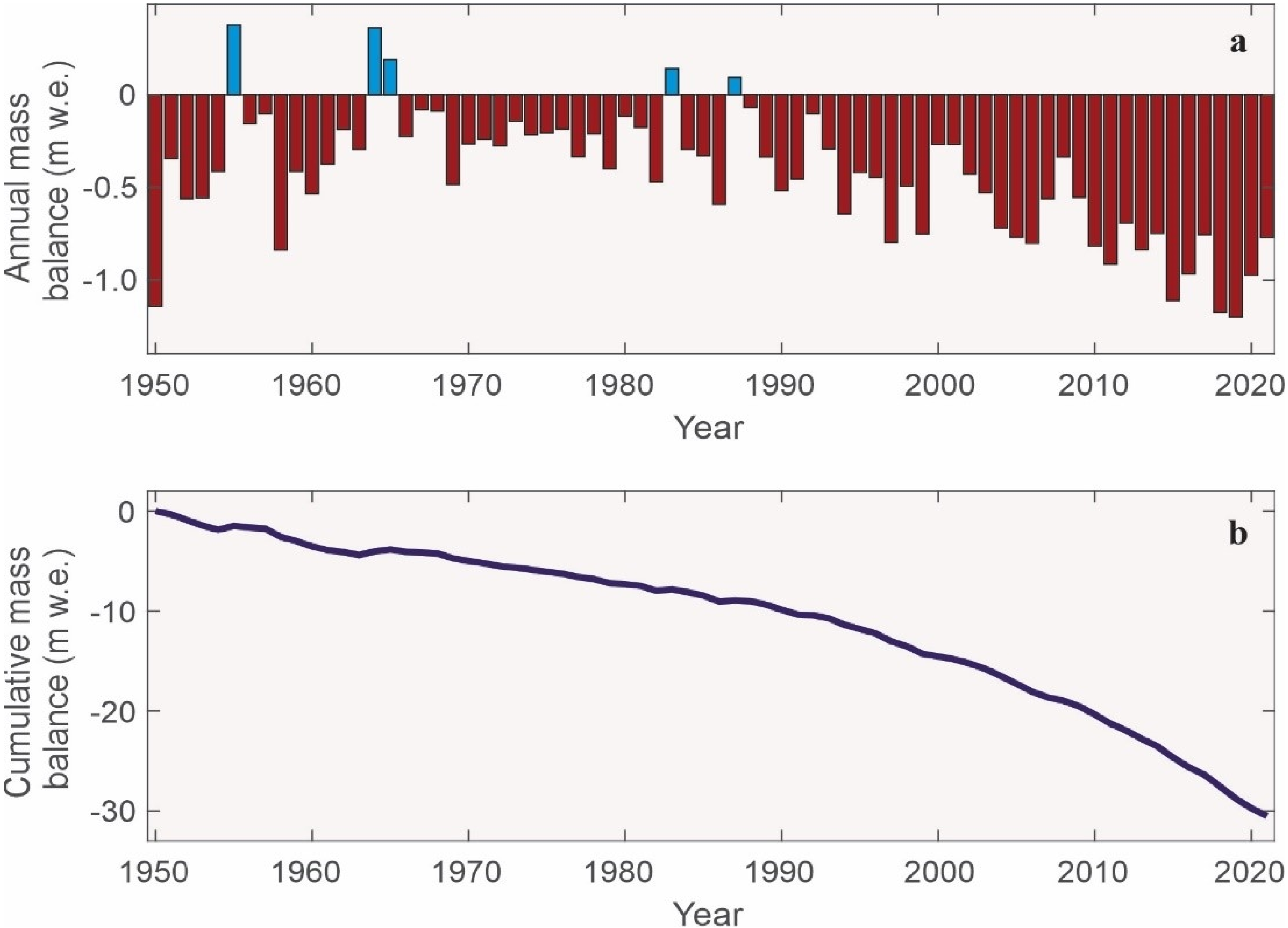
Glacier mass continues to decline



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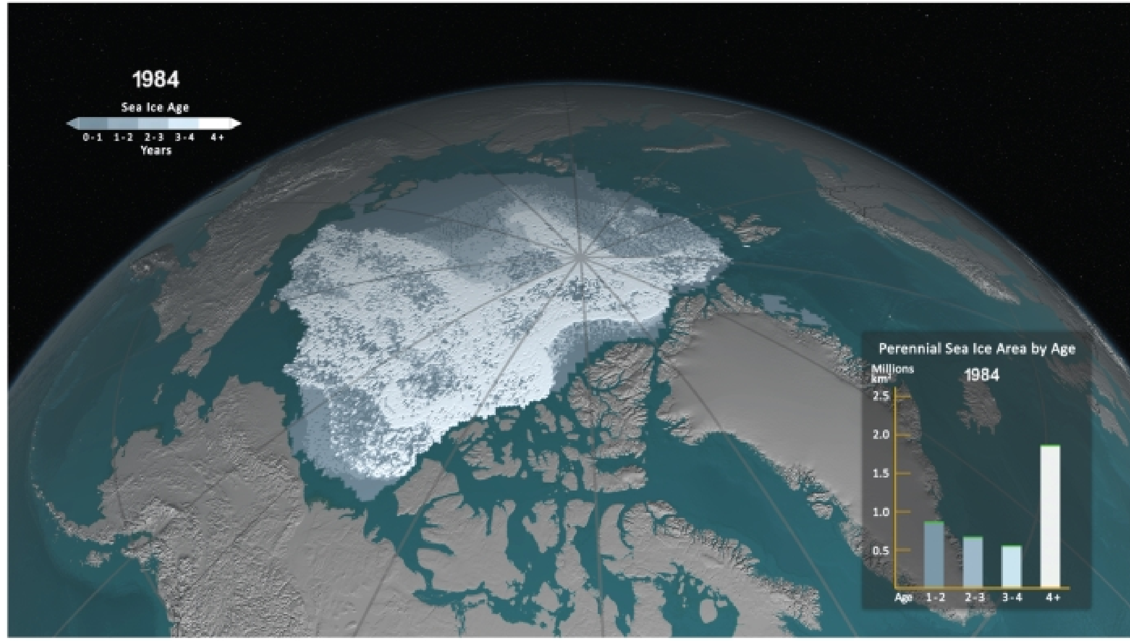
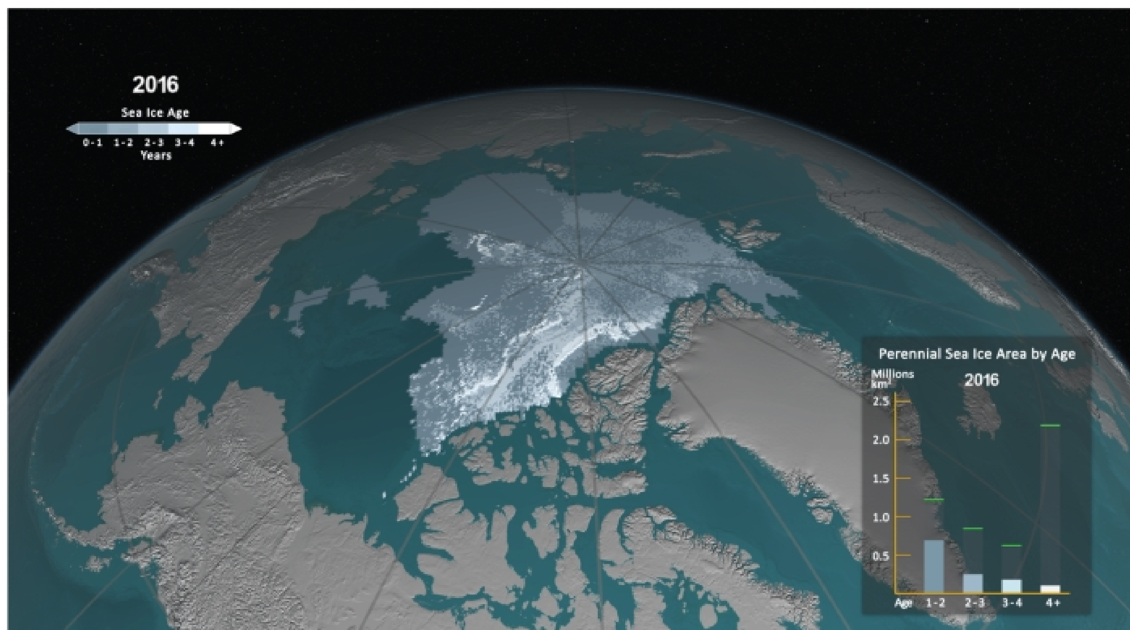
Largest changes in the Arctic

Multi-year ice

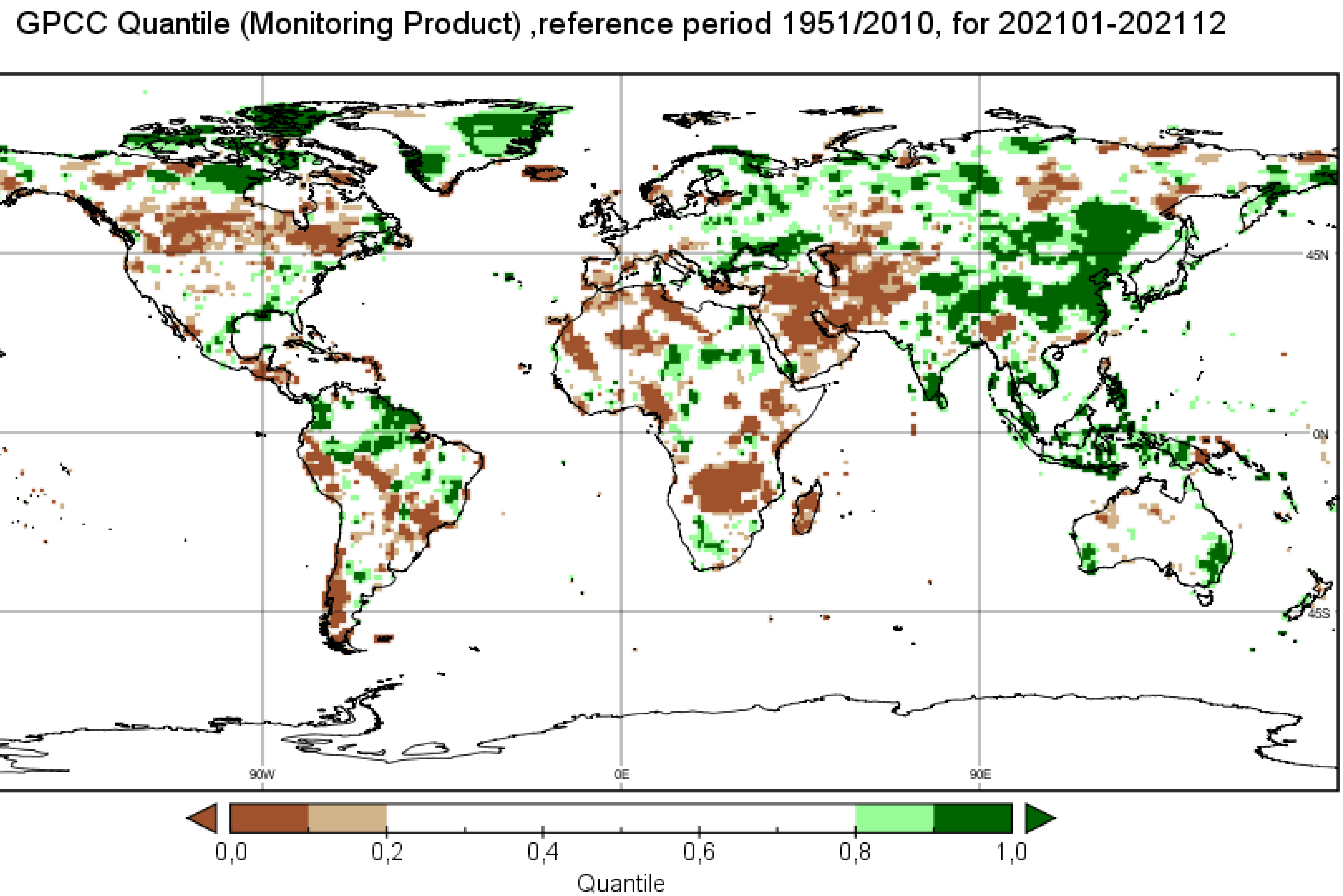
1984



2016



Global precipitation in 2021



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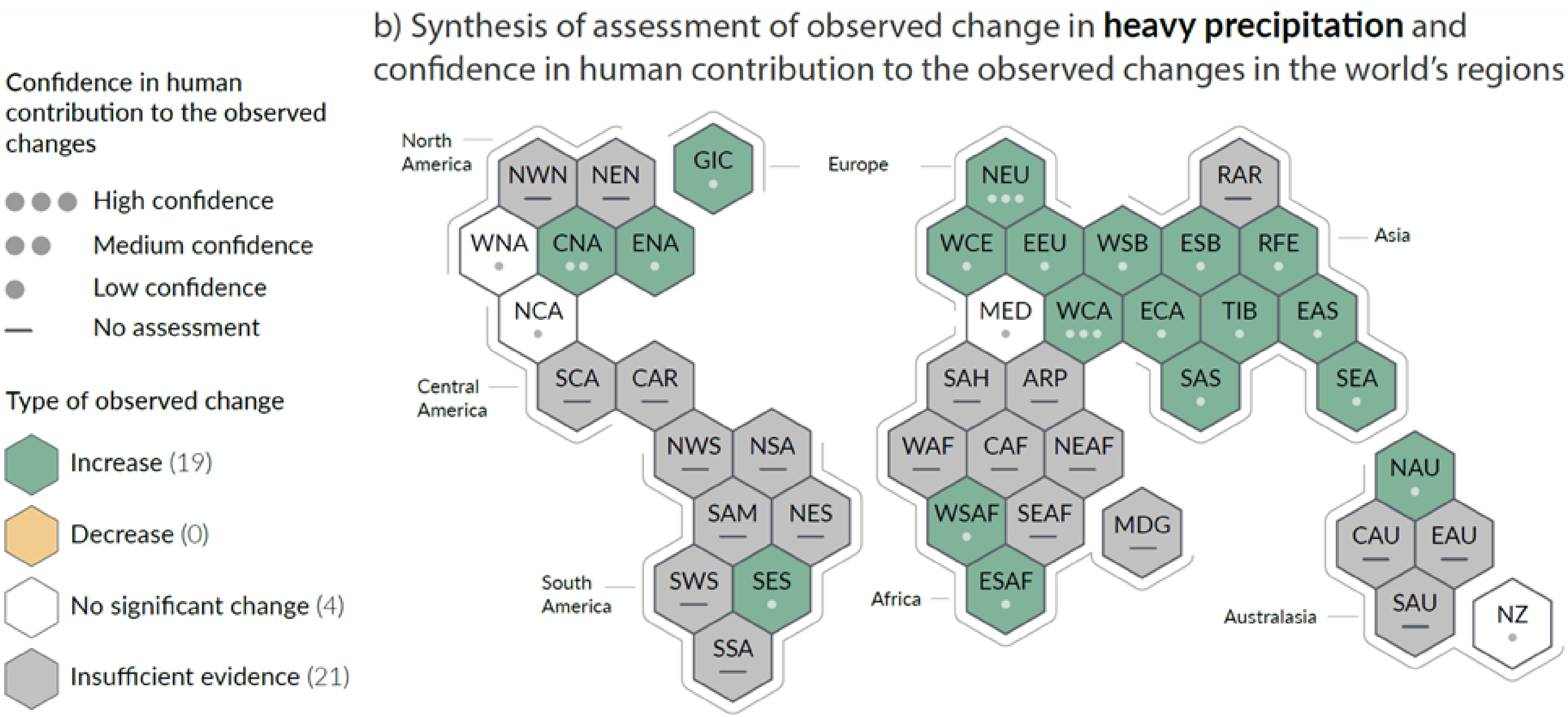
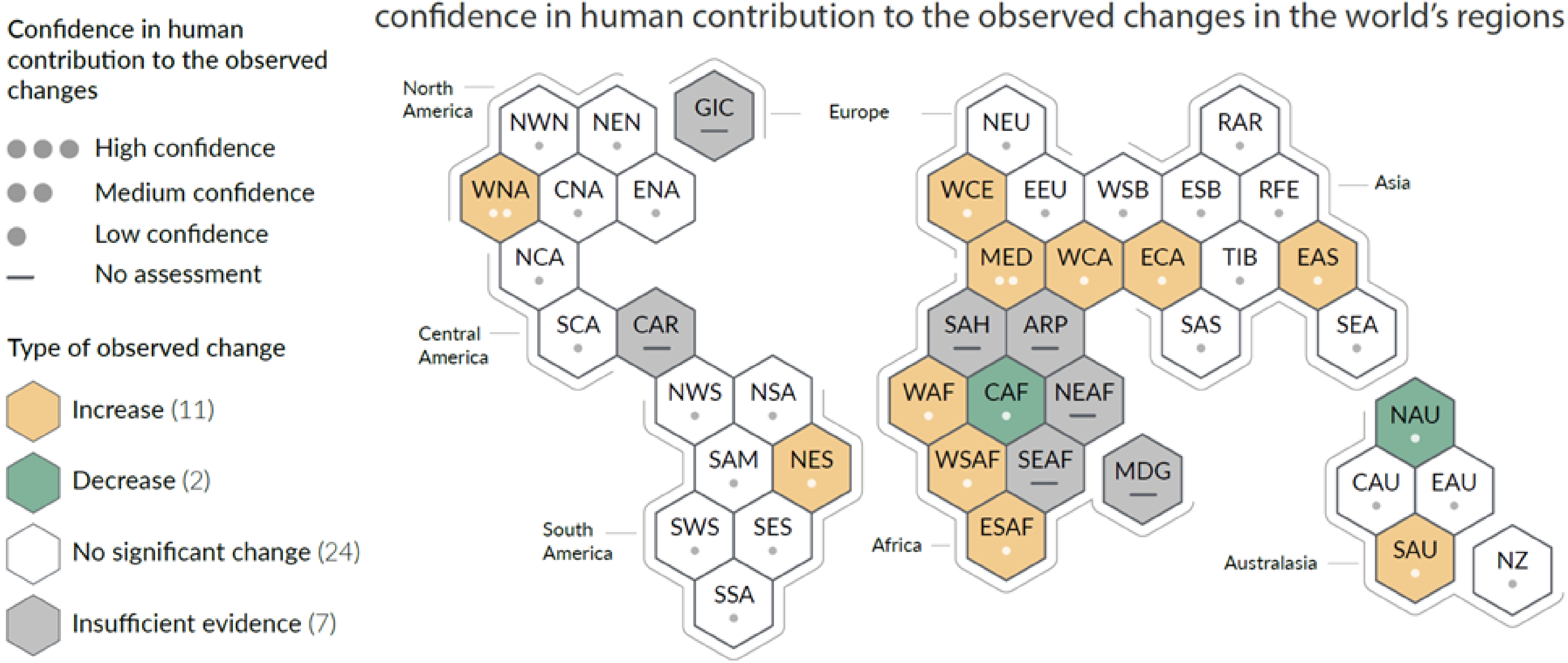
More than half of the planet has been facing increase of heavy precipitation

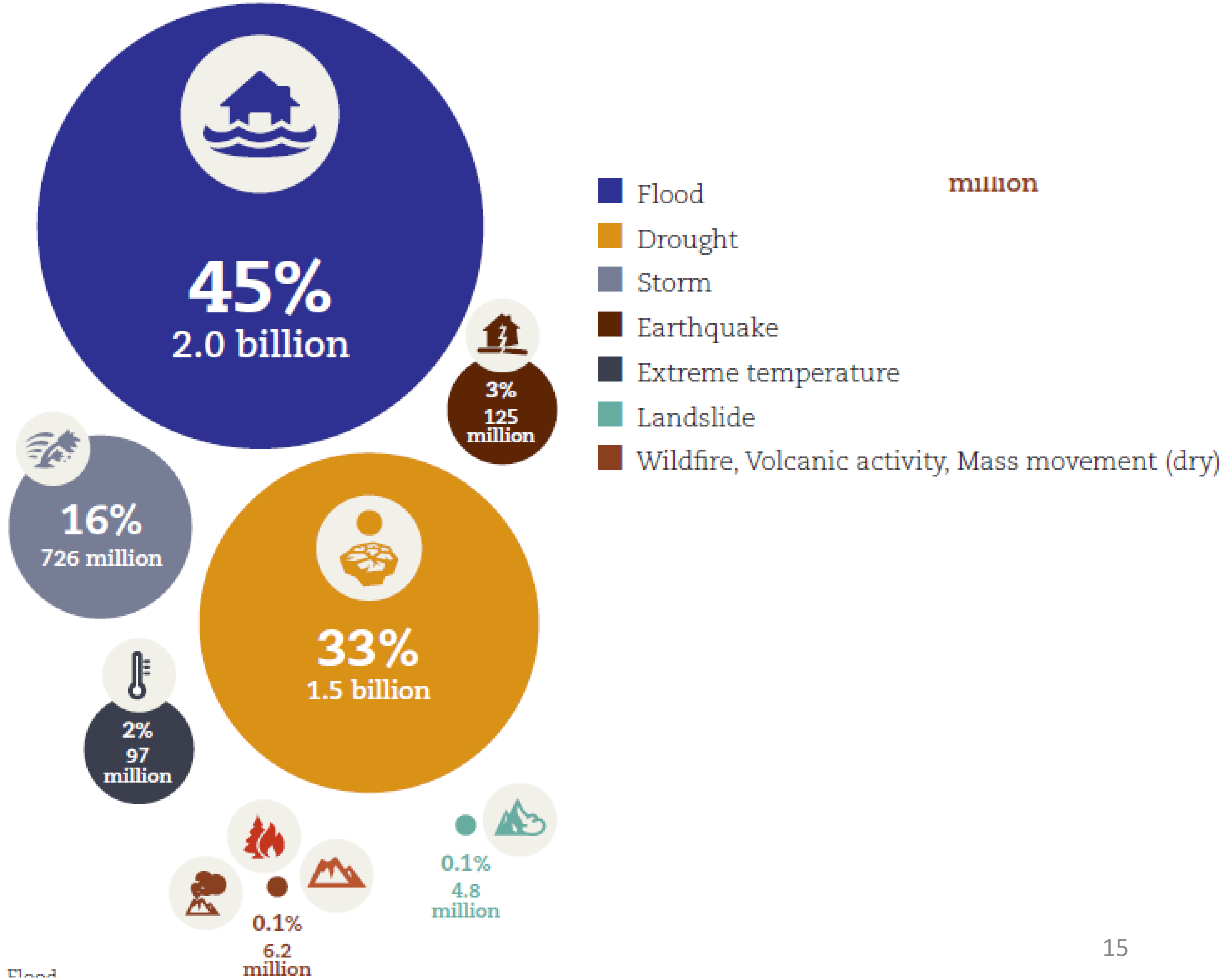


Increase of agricultural drought has been observed in all continents

c) Synthesis of assessment of observed change in **agricultural drought** and confidence in human contribution to the observed changes in the world's regions



~4.5 billion people affected 1998-2017
96% of disasters weather related



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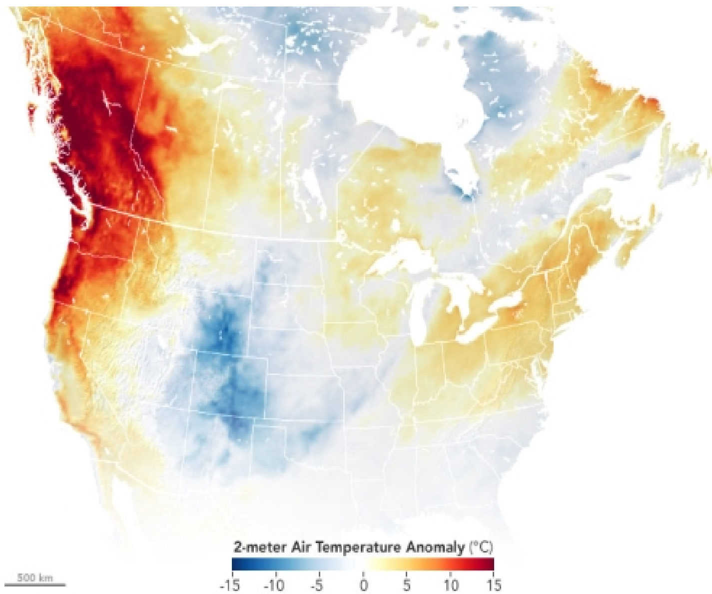
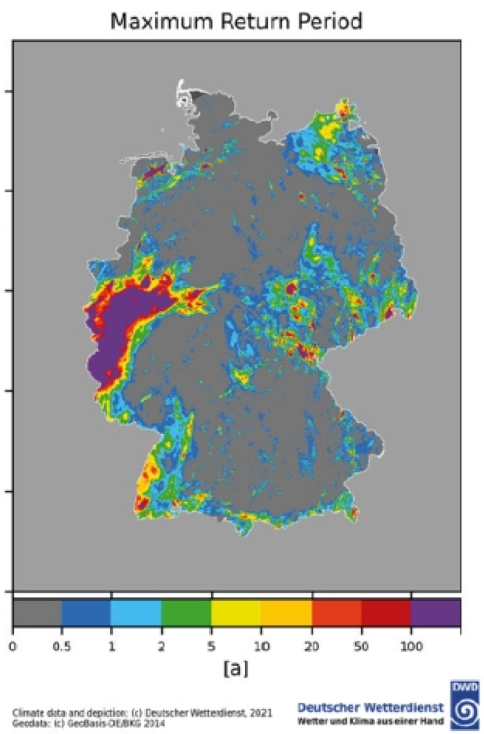
Devastating extreme weather and climate events have been recorded in 2021





A signature of human-caused climate change has been identified in the North American heatwave and west European floods

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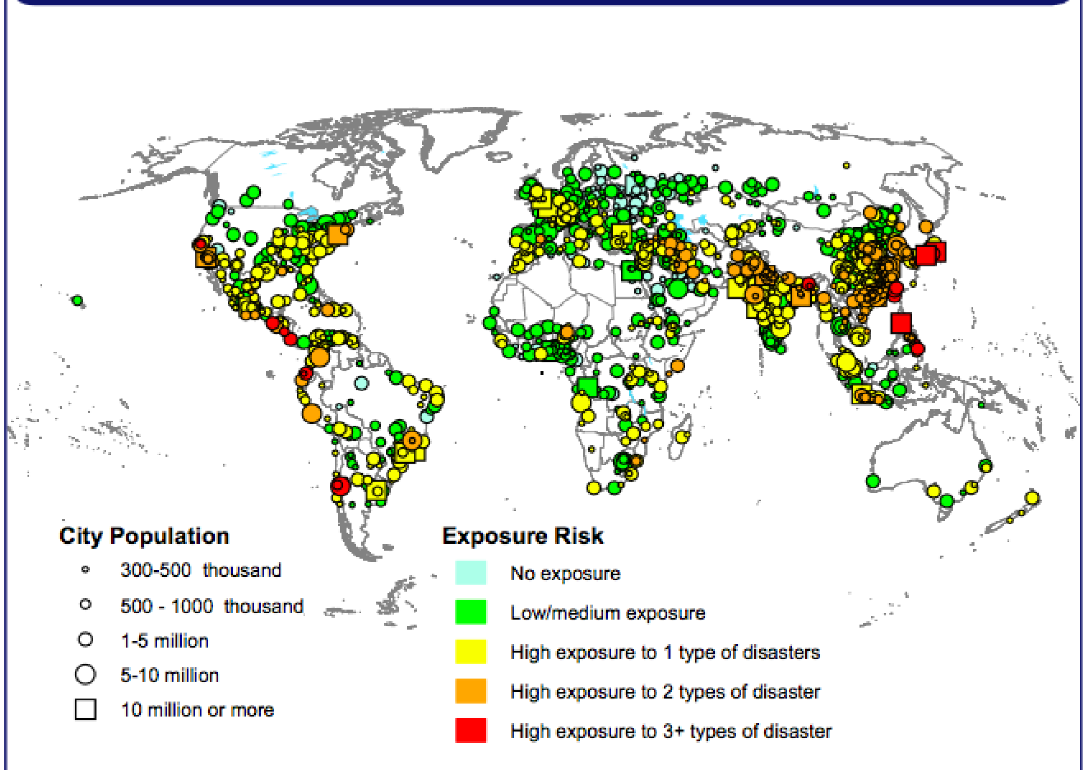
Disaster Risk Reduction

Most cities are vulnerable to at least one type of natural disaster

Cities' risk of exposure to natural disasters

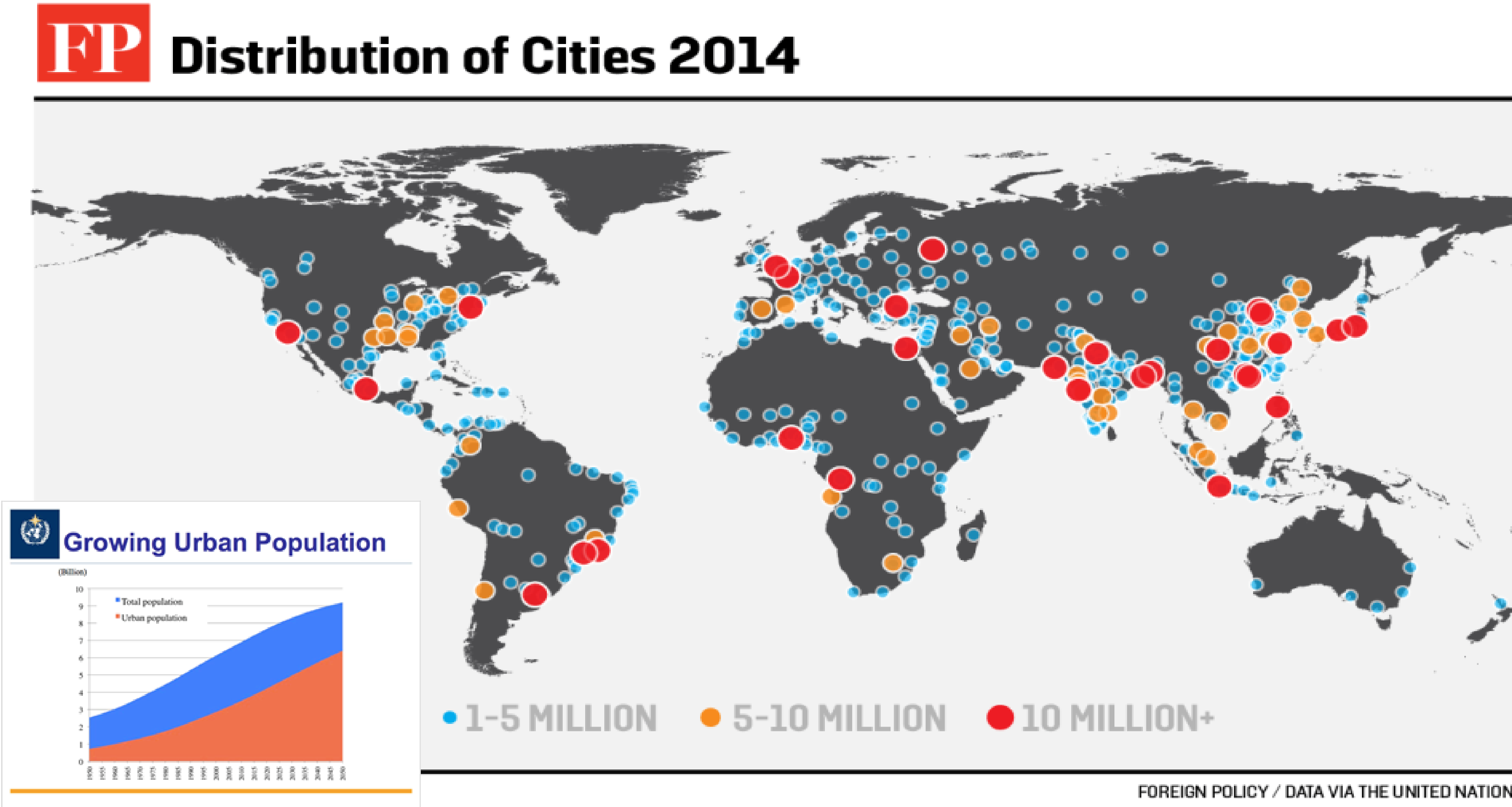


Of the 1,692 cities with at least 300,000 inhabitants in 2014, 944 (56 per cent) were at high risk of exposure to at least one of six types of natural disaster (cyclones, floods, droughts, earthquakes, landslides and volcano eruptions), based on evidence on the occurrence of natural disasters over the late twentieth century.* Taken together, cities facing high risk of exposure to a natural disaster were home to 1.4 billion people in 2014.

Around 15 per cent of cities—most located along coastlines—were at high risk of exposure to two or more types of natural disaster; 27 cities—including the megacities Tokyo, Osaka and Manila—faced high risk of exposure to three or more types of disaster.

* Results summarised here are from a 2015 United Nations technical paper that analysed city population estimates from the 2014 revision of World Urbanization Prospects together with spatial hotspot data on the risks of exposure and vulnerability to natural disasters produced by research institutes at Columbia University and the World Bank. The natural disaster data used in this analysis included historical information on

Extreme weather impact on costal Megacities



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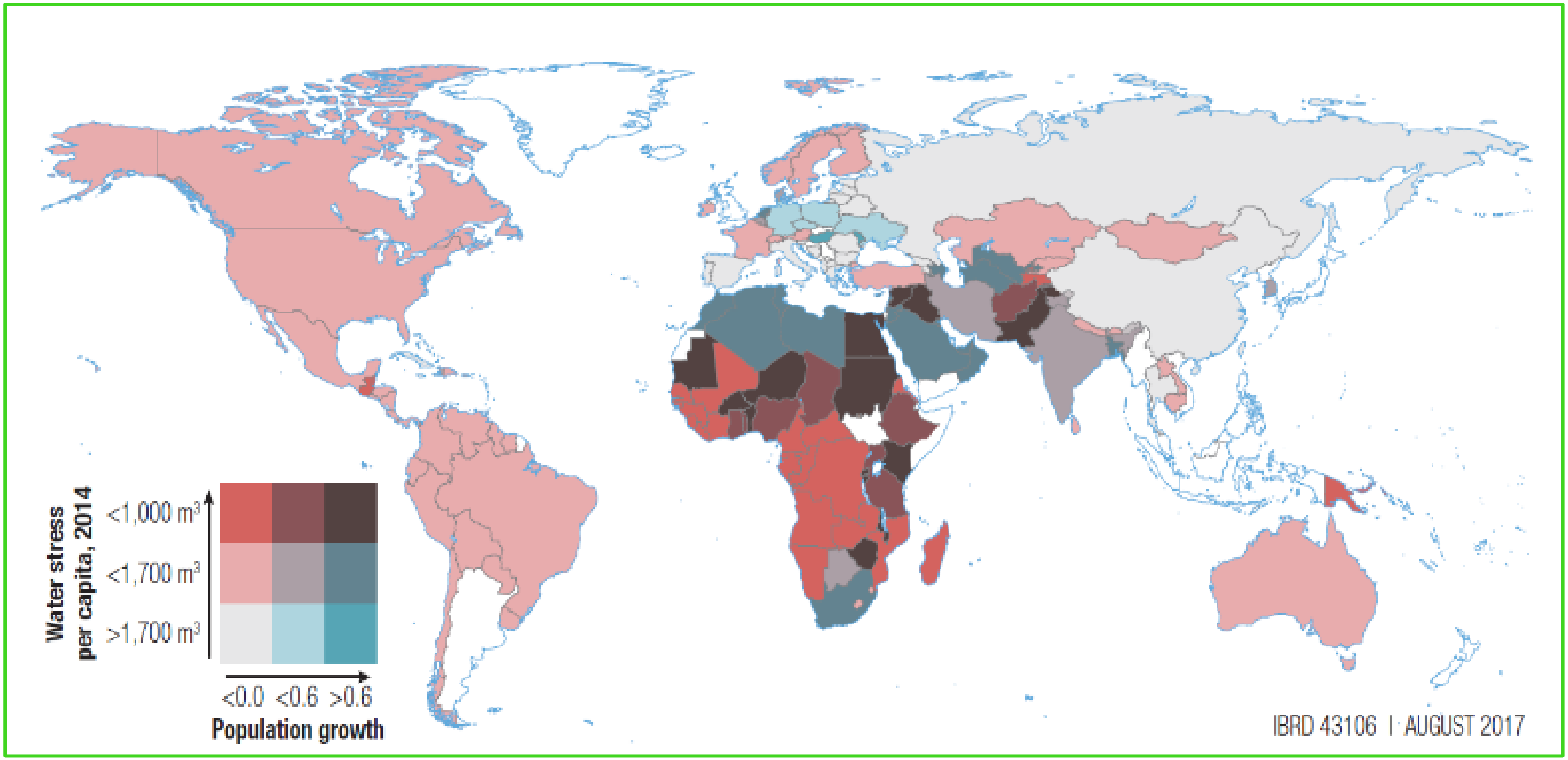
Water availability & population growth 2050



About **4 billion people**, representing nearly two-thirds of the world population, **experience severe water scarcity** during at least **one month of the year**

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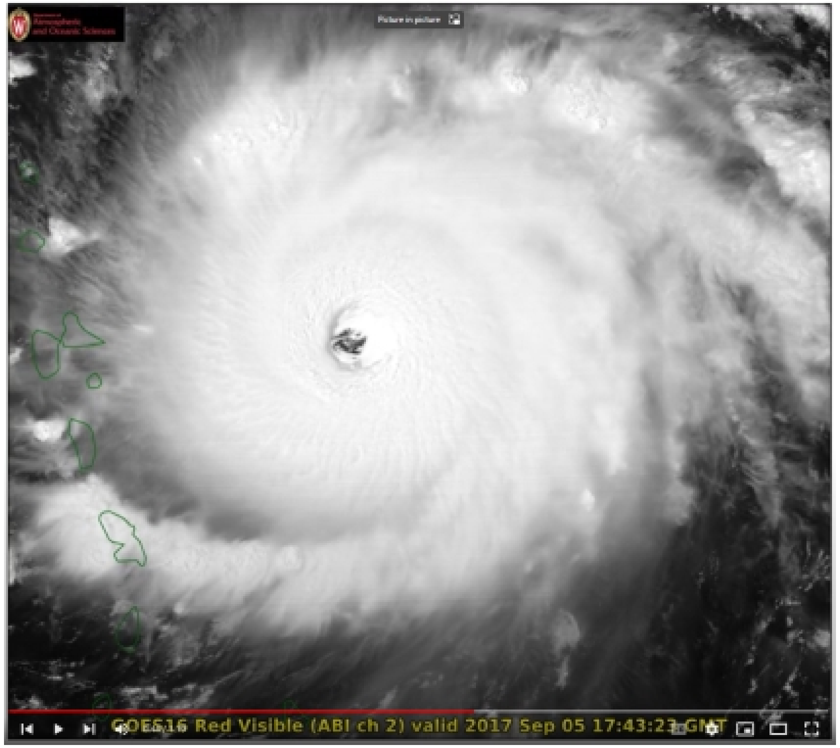
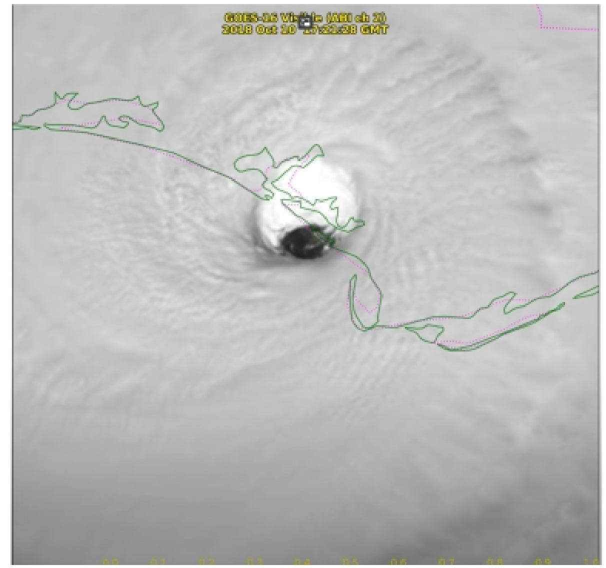
Rapid-scan services

Application – Tropical Cyclones



Irma rapid scan - https://www.youtube.com/watch?v=RRPPAsSpSvg&list=PLnXN3uoWXJ2_1_WssOWqp9k5F8Gll8K5S



Michael rapid scan – Landfall: https://www.youtube.com/watch?v=pCgqmuQnZNo

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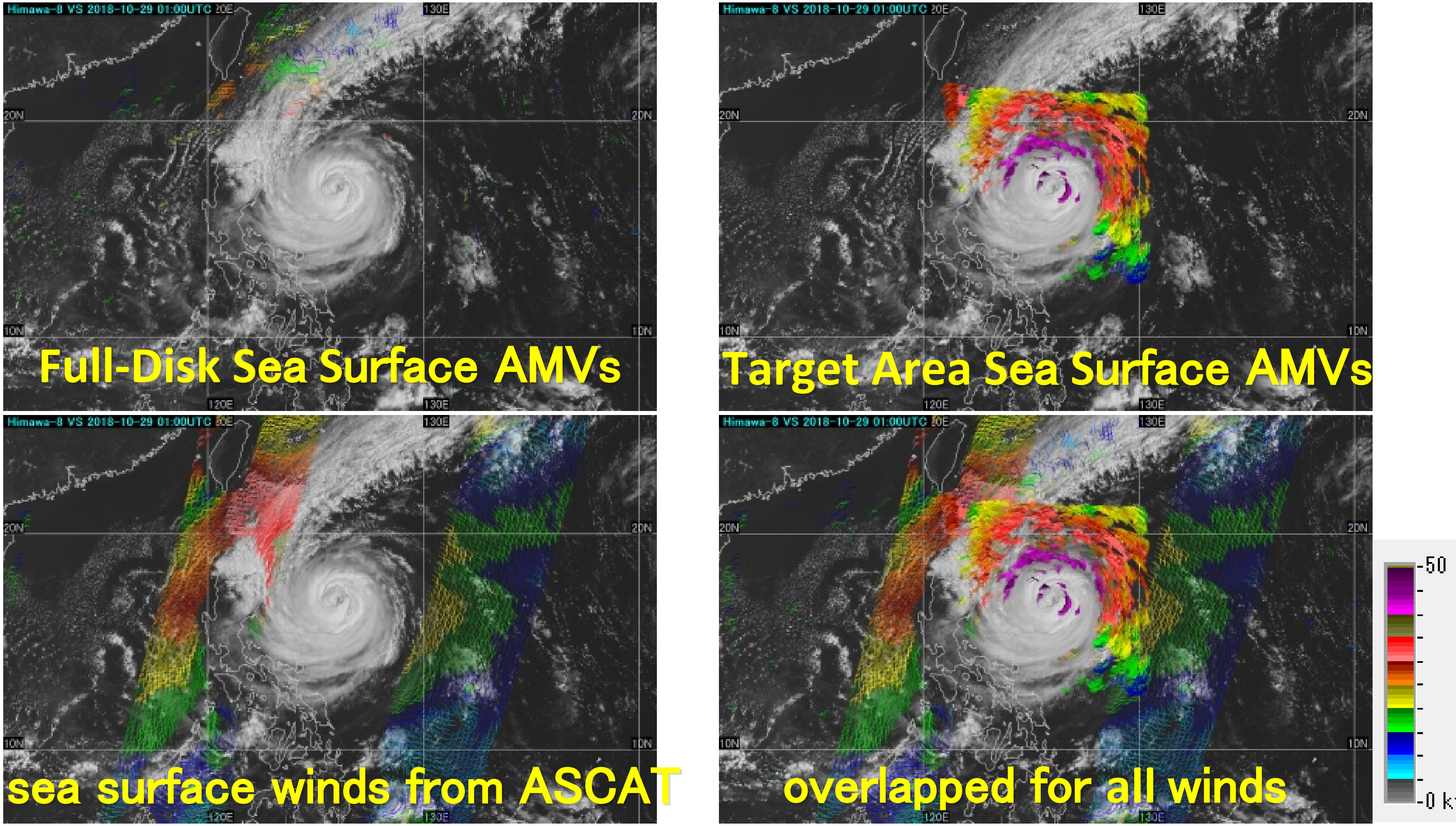
Example of operational use of Sea Surface AMVs



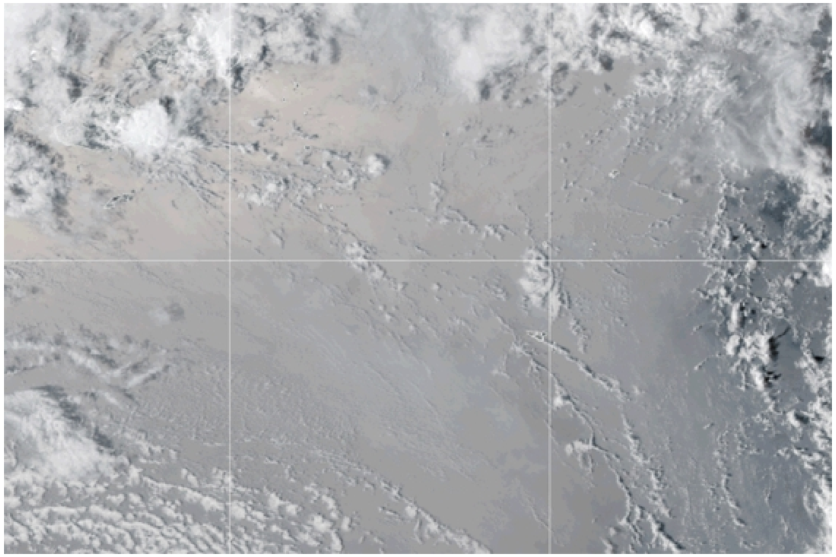
- ASCAT is useful for observing sea surface winds even under dense clouds.
- Sea Surface AMVs estimated from Himawari-8 low-level winds are effective for grasping the wind field in the vicinity of tropical cyclones.
- RSMC Tokyo overlaps Sea Surface AMVs and ASCAT winds when available.

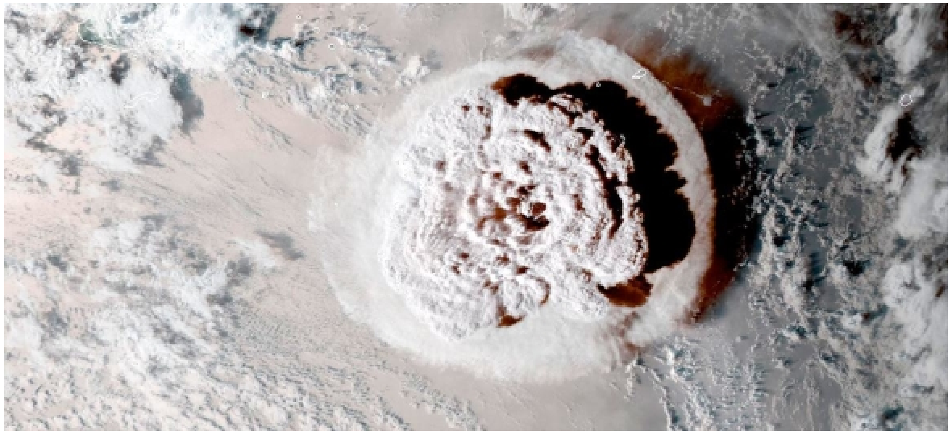
Courtesy RSMC Tokyo

Rapid-scan services

Applications - Volcanic Ash

- Rapid-scan will have significant benefits for monitoring and tracking volcanic ash eruptions. Algorithms used to detect and monitor ash clouds and all cloud classification and tracking algorithms benefit from greater temporal frequency.





The Hunga Tonga–Hunga Ha'apai explosion was captured by several Earth-observing satellites.Credit: Visible Earth/NASA

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Rapid-scan services - Applications - Fires

- Ability to calculate fire spread rates
- Ability to closely monitor a pyro-Cb development
- Significant benefit for fire agencies as it is much cheaper than aircraft reconnaissance, and large fires in remote areas can be more easily monitored.

NASA has shared images of the California Camp Fire as seen from space, Nov 14, 2018

The ESA Copernicus Sentinel-3 satellite saw the massive smoke plumes generated by the fires and spread by winds.
Copernicus Sentinel (2020), processed by ESA

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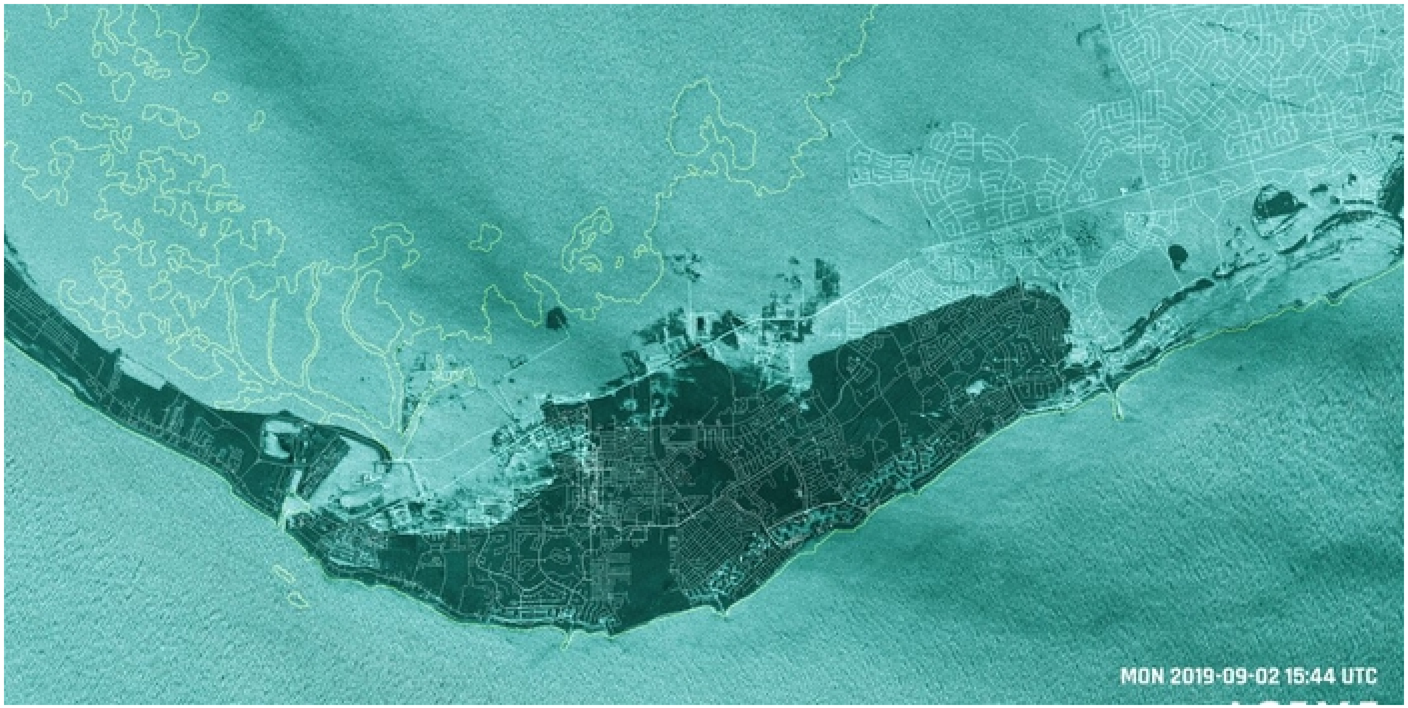
Satellite-derived bathymetric data

Storm surge modelling



- The Bahamian island of Grand Bahama on Monday. The yellow lines indicate where the coastline was before flooding caused by Hurricane Dorian – September 2019. ICEYE
- Hurricane Dorian: Satellite Images Show Extent of Chaos in Bahamas (insider.com)

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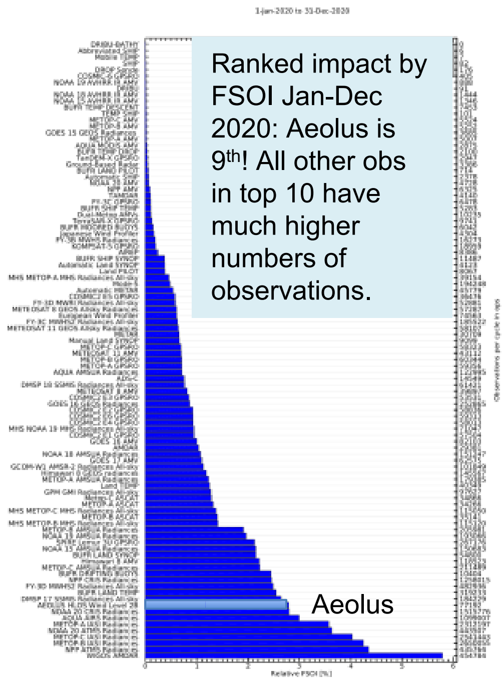
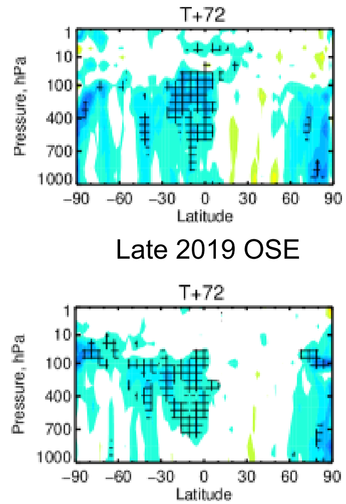
New Exciting Capabilities – e.g wind lidar

Atmosphere: Aeolus

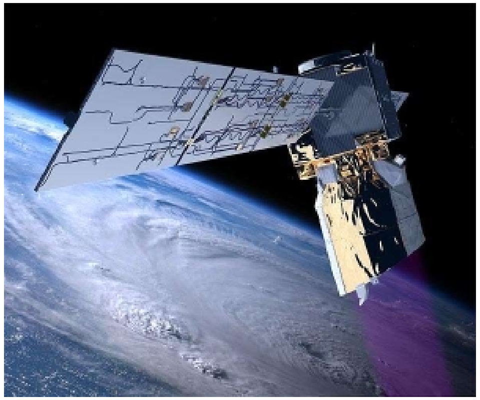
Michael Rennie, Lars Isaksen



Ranked impact by FSOI Jan-Dec 2020: Aeolus is 9th! All other obs in top 10 have much higher numbers of observations.



Aeolus demonstrated value of wind profile data from lidar



aeolus DISC

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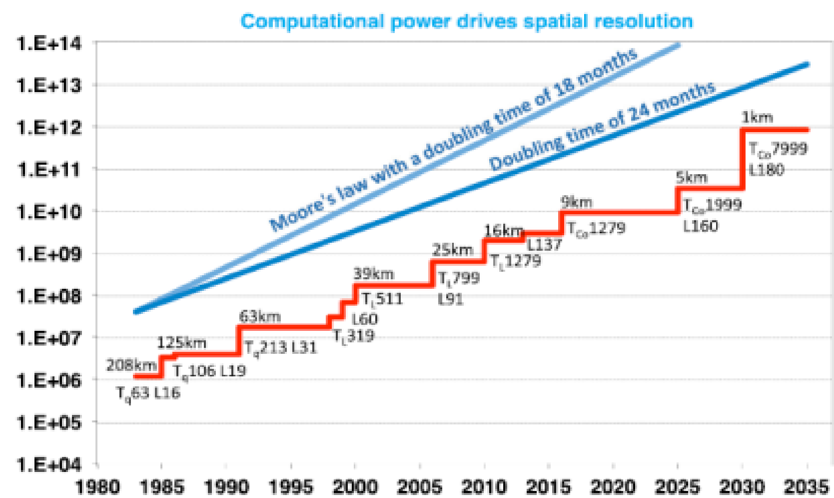
ECMWF

NWP requirements

Trends: By 2040, global NWP resolution will reach 1km(10km at present), regional NWP 100m (1.5km at present), vertical resolution will be 200m (2km at present)

		At present	Future
Polar satellite resolution horizontal and vertical resolution	MWHS	Horizontal resolution:15km, 15 channels	Horizontal resolution: 0.5km, Vertical resolution: 0.2km
	MWTS	Horizontal resolution:50km, 13 channels	Horizontal resolution:0.5km Vertical resolution:0.2km
	MW imager	Horizontal resolution:10km , 10channels	Horizontal resolution:0.5km
	IR sounder	Horizontal resolution:17km, 26 channels	Horizontal resolution:0.5km Vertical resolution:0.2km
GNSS、Lidar & Radar(Precipitation, cloud aerosol temporal resolution	Profiler	16 days revisit	Higher (weekly?)
New Observation	Highly accurate satellite wind field observation		
	Highly accurate satellite atmospheric pressure observation(less than 1hPa at surface)		
	Highly accurate satellite hydrometeor size distribution and profiling		
Stability		5 yrs	15yrs

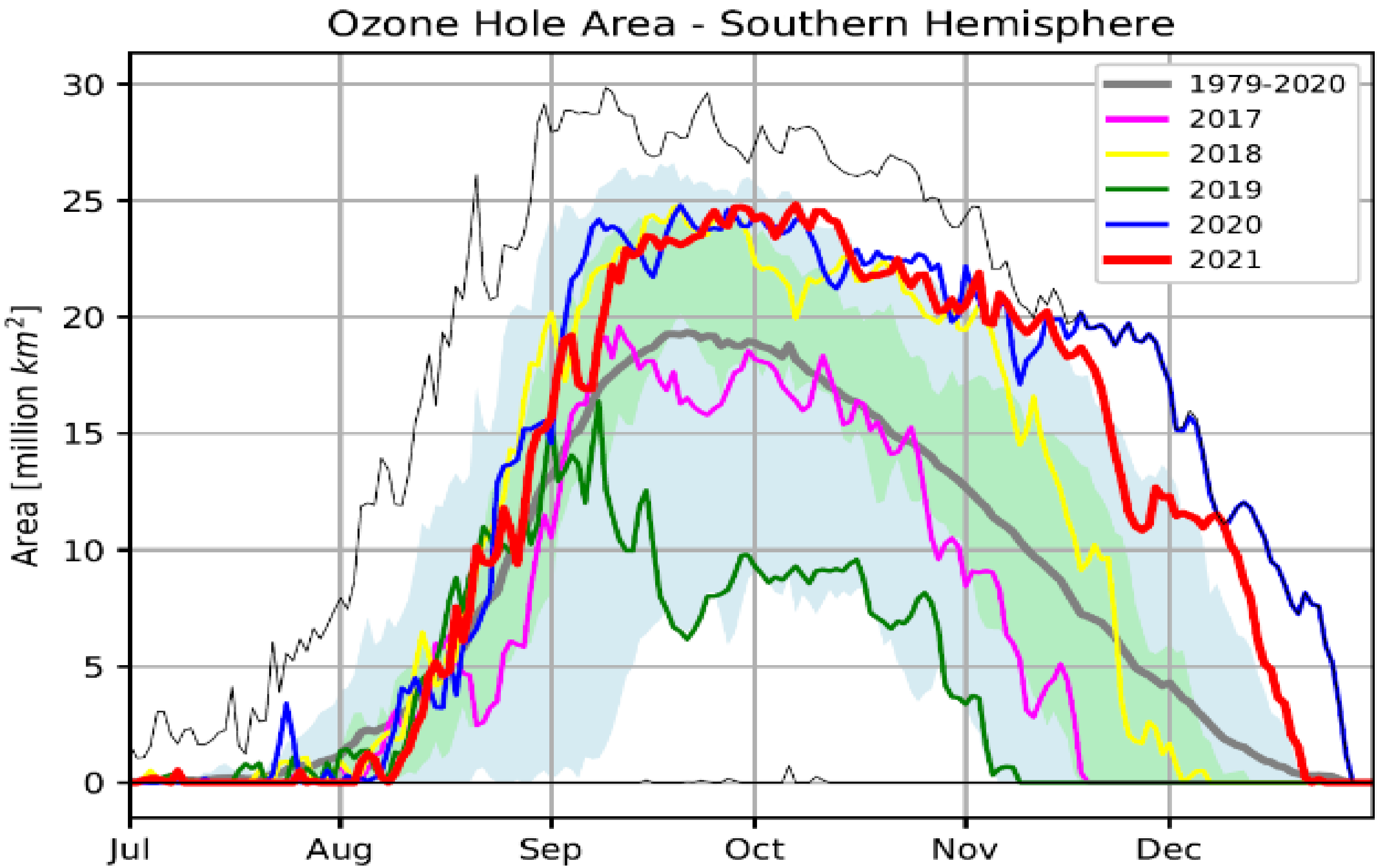
NWP goal of reaching a 1-km horizontal resolution with 180 levels in the mid to late 2030s



Ambitious target configuration for global weather and climate simulations with km-scale horizontal resolution accounting for physical Earth system processes, and with today's computational throughput rate

Horizontal resolution	1 km (globally quasi-uniform)
Vertical resolution	180 levels (surface to ~100 km)
Time resolution	0.5 min
Coupled	Land-surface/ocean/ ocean-waves/sea-ice
Atmosphere	Non-hydrostatic
Precision	Single or mixed precision
Compute rate	1 SYPD (simulated years per wall-clock day)

Strong Antarctic ozone hole 2020 & 2021



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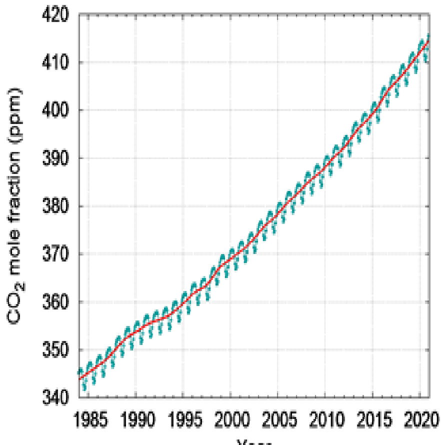
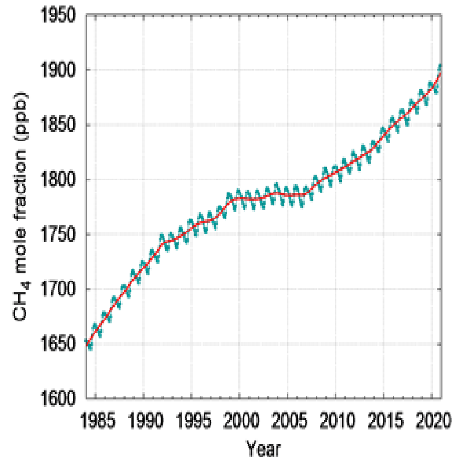
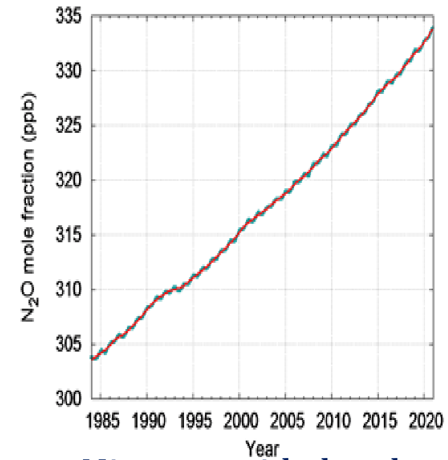
Greenhouse gas concentrations (CO_2, CH_4 and N_2O) continue to rise to new record highs



Carbon dioxide levels **+149%**



Methane levels **+262%**



Nitrous oxide levels **+123%**

of pre-industrial levels (before 1750)

Concentration = Emissions + absorption
Today: Concentration **still increasing**.
Objective: **Co_2 neutral in 2050** in order for concentration to stabilize

=>**Warming** to continue: **today 1.1°C**, likely to reach **1.5°C by 2030**

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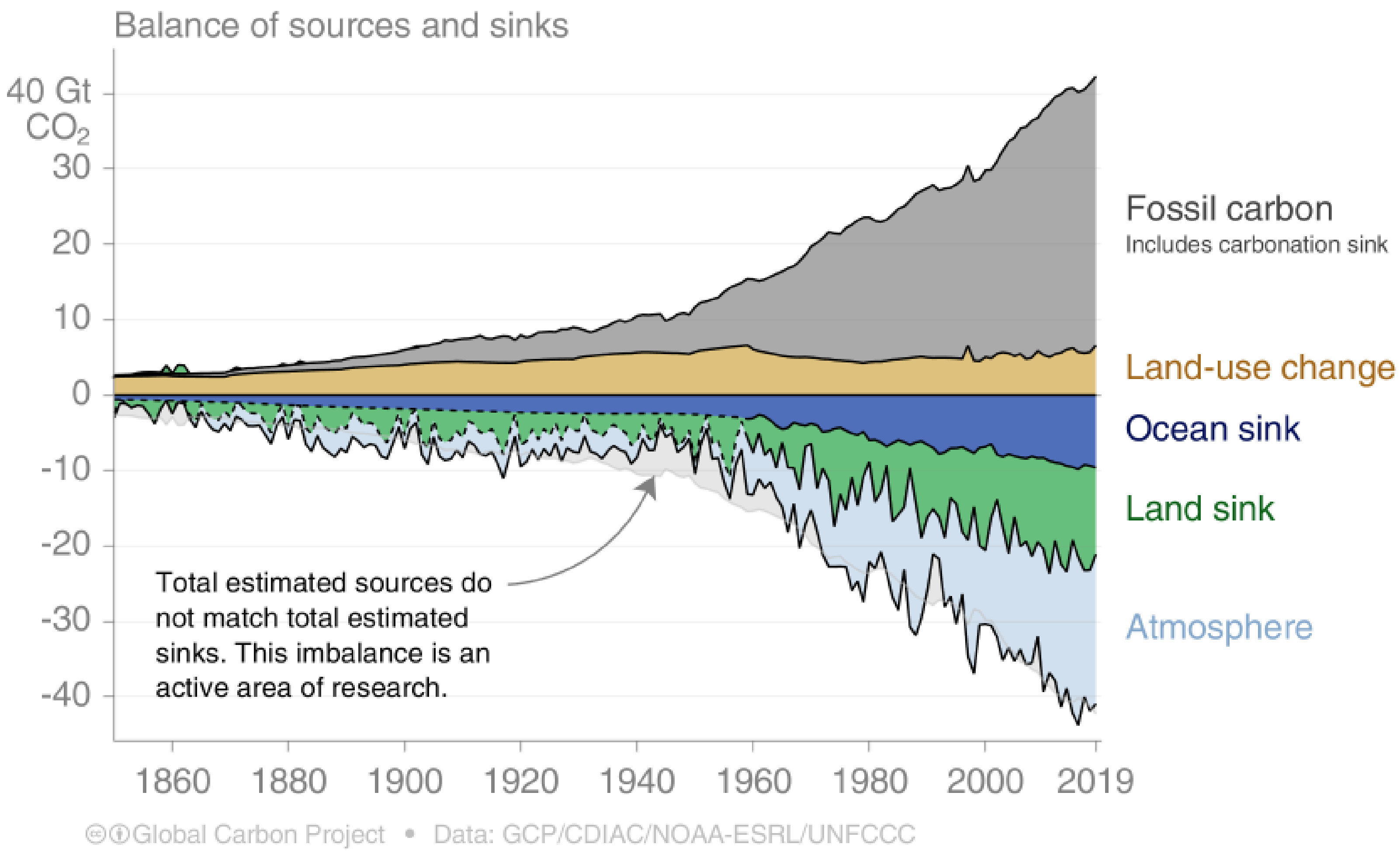
Global carbon budget

Carbon emissions are partitioned among the atmosphere and carbon sinks on land and in the ocean
The "imbalance" between total emissions and total sinks is an active area of research



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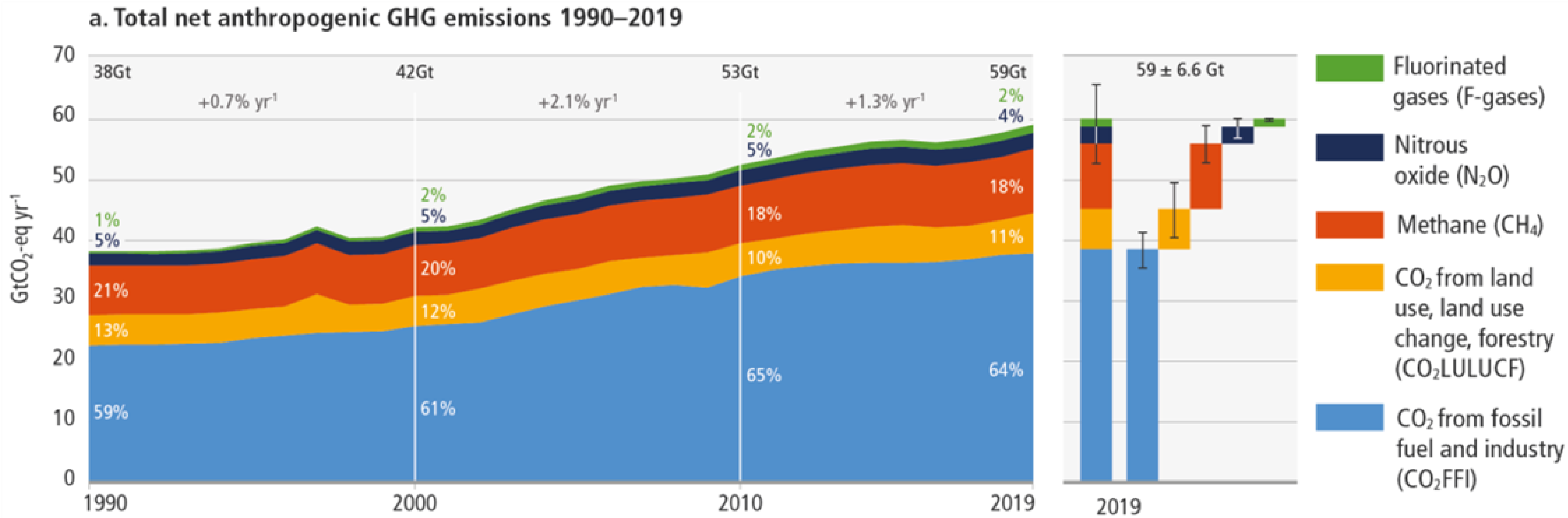
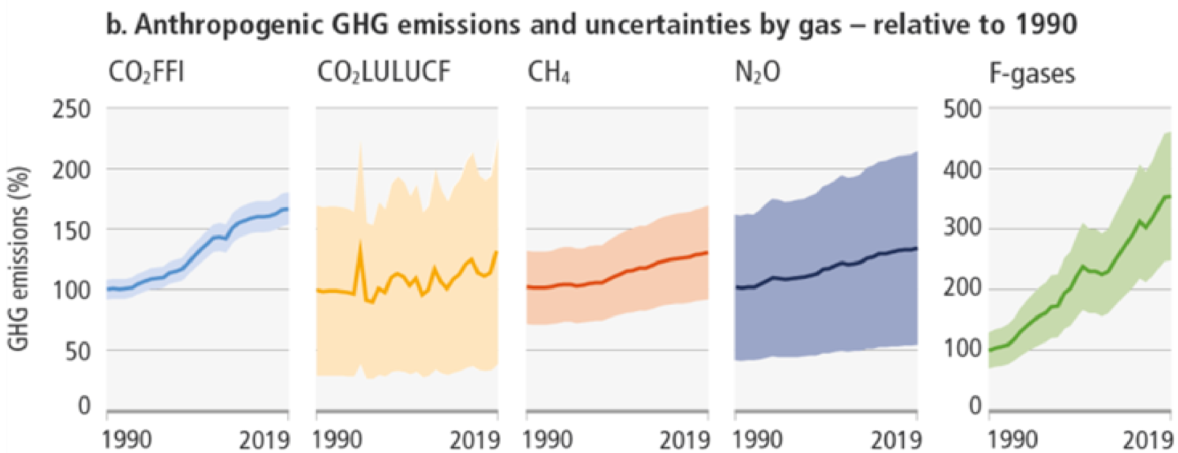
Source: Friedlingstein et al 2020; Global Carbon Budget 2020

Greenhouse gas emissions 1990-2019





	2019 emissions ($GtCO_2$-eq)	1990–2019 increase ($GtCO_2$-eq)	Emissions in 2019, relative to 1990 (%)
CO_2 FFI	38±3	15	167
CO_2 LULUCF	6.6±4.6	1.6	133
CH_4	11±3.2	2.4	129
N_2O	2.7±1.6	0.65	133
F-gases	1.4±0.41	0.97	354
Total	59±6.6	21	154

The solid line indicates central estimate of emissions trends. The shaded area indicates the uncertainty range.

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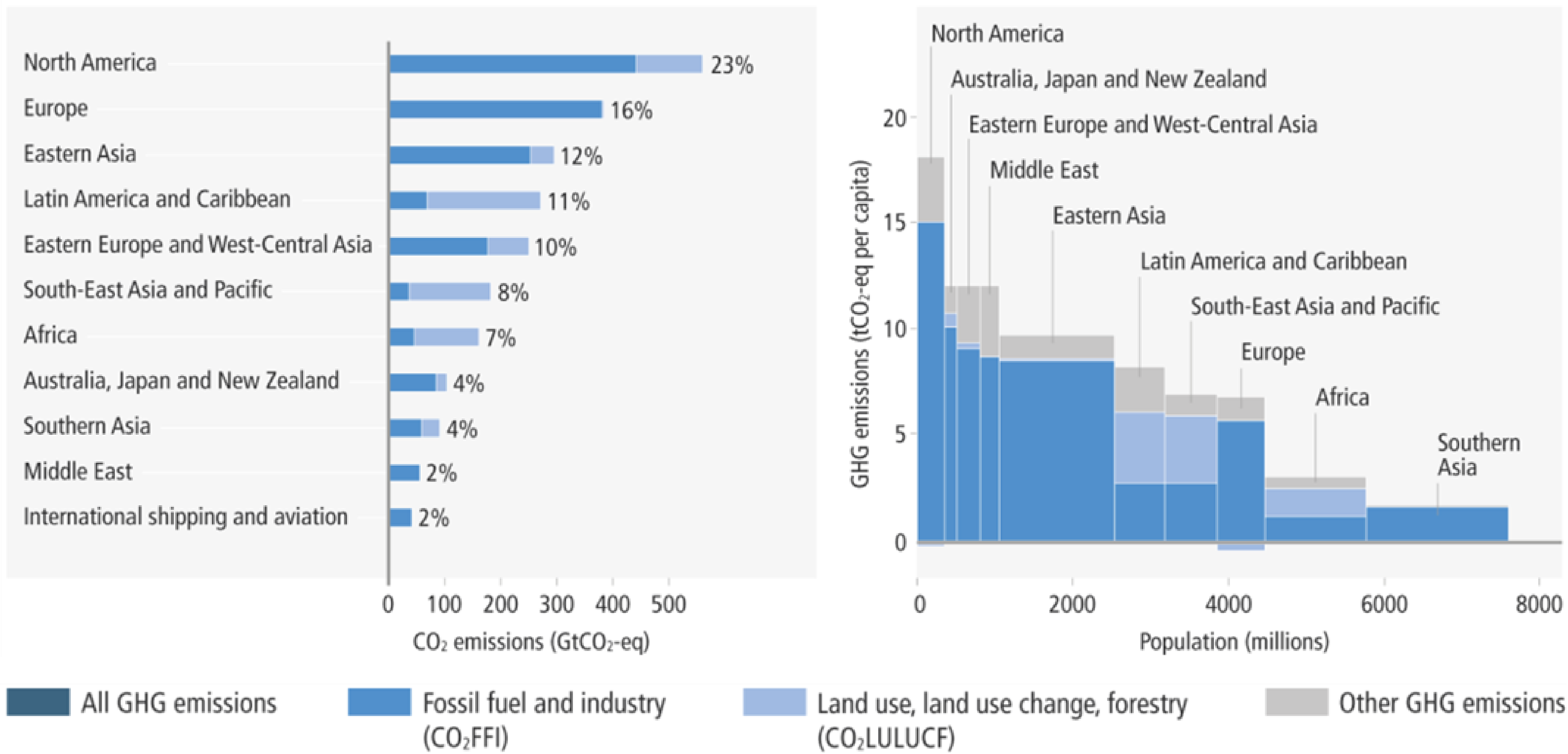
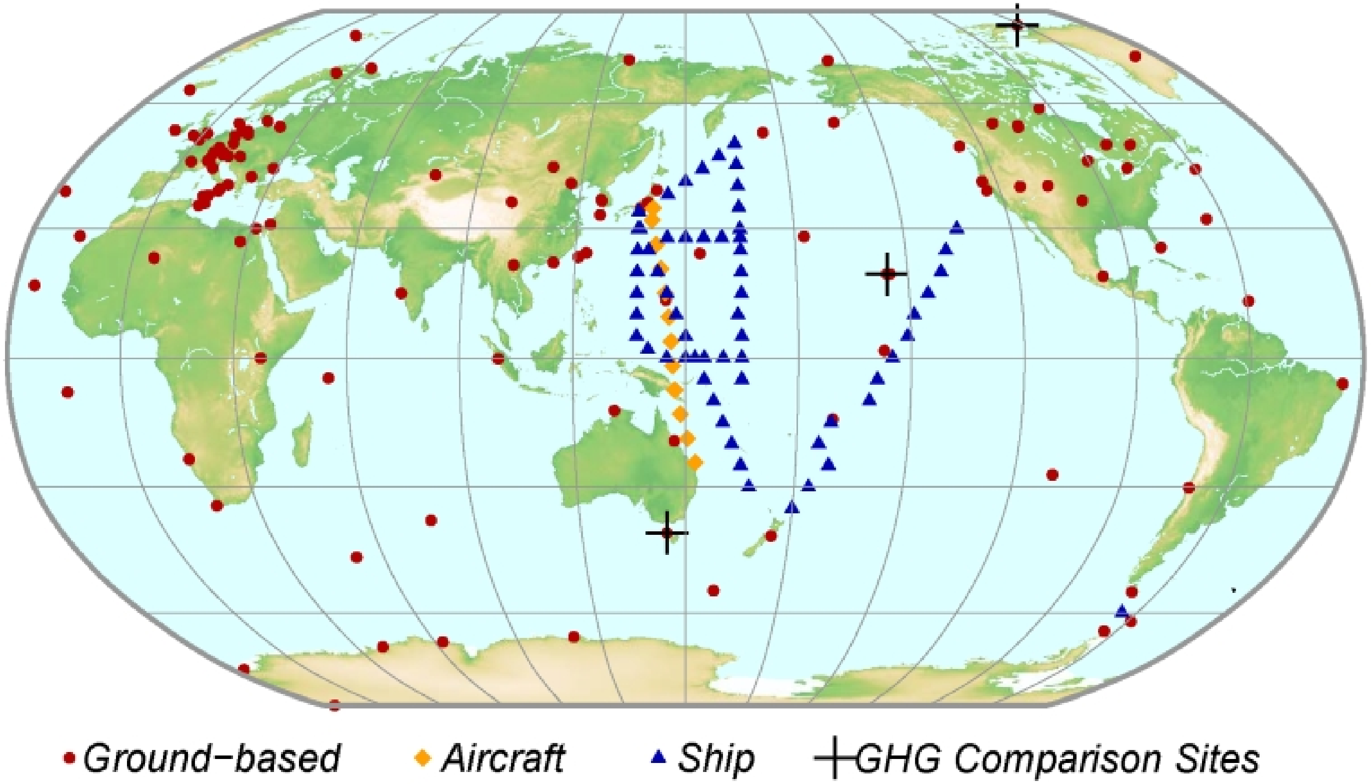
Historical and per capita emissions

b. Historical cumulative CO_2 emissions per region (1850–2019)

c. GHG emissions per capita and for total population, per region (2019)



WMO Greenhouse gas monitoring sites, GAW




Mt. Waliguan, Tibet

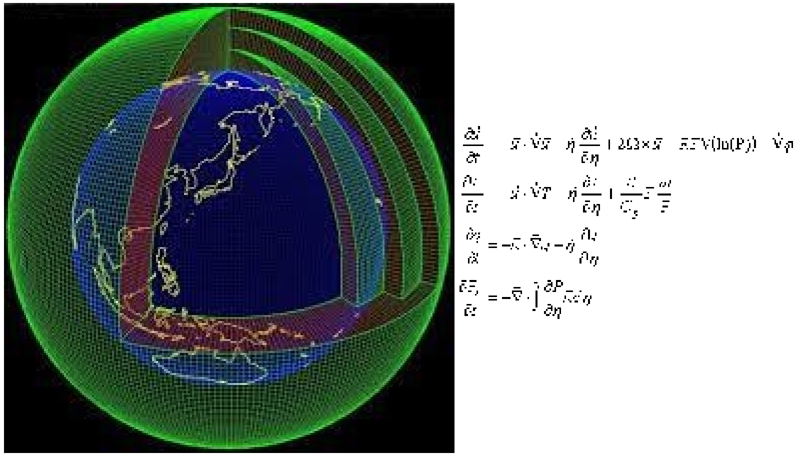

Mt. Kenya


Pallas-Sodankylä, Arctic

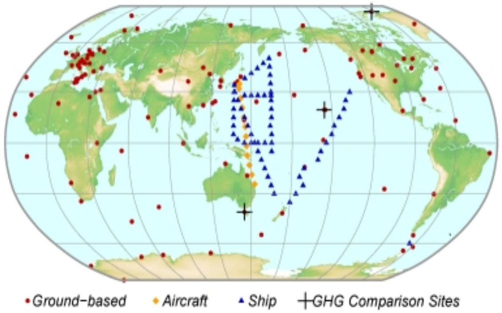
GAW+Satellites+models => Operational greenhouse gas data

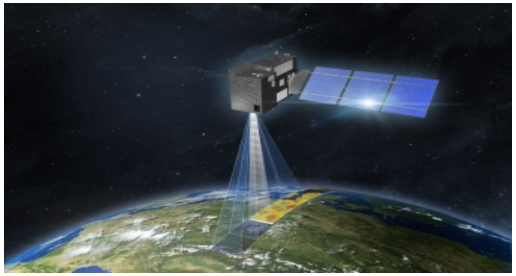
NASA OCO, JAXA Ibuki, CHINA Tansat already exist

+

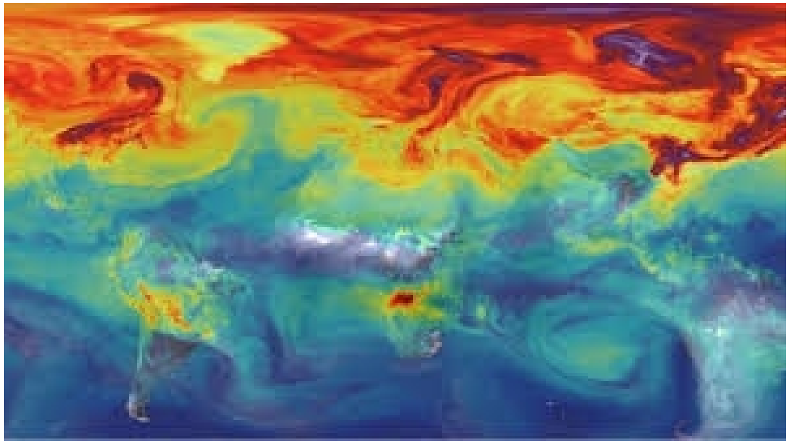


Atmospheric modeling & assimilation





European Copernicus 2025-



Real-time monitoring of CO_2, CH_4 and N_2O

- **Integrated, internationally coordinated global greenhouse gas monitoring system**
- **Better understanding if sources and sinks**
- **Support Paris Agreement implementation**

WMO OMM

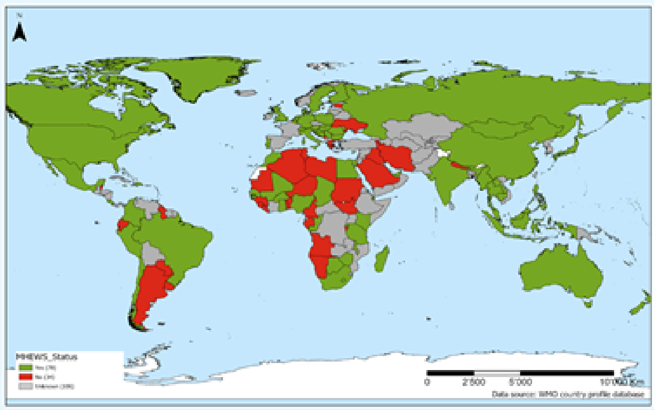
Early warning/climate adaptation initiative for COP-27

"Today I announce the United Nations will spearhead new action to ensure every person on Earth is protected by early warning systems within five years.

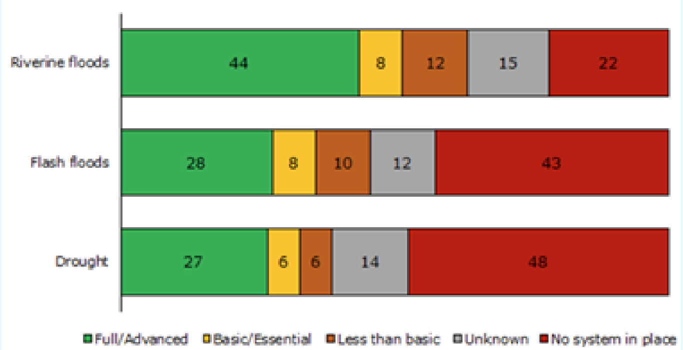
I have asked the World Meteorological Organization to lead this effort and to present an action plan to achieve this goal at the next UN climate conference, later this year in Egypt."

António Guterres, Secretary-General of the United Nations, 23rd March 2022

Global Status of Early Warning System Coverage

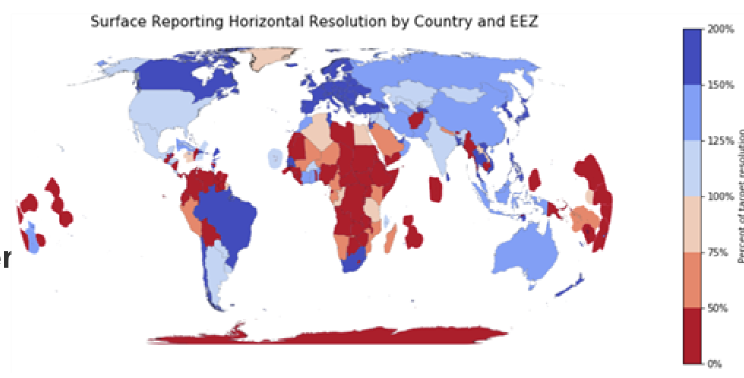


Capacities are particularly lacking for the creation of drought and flash flood warnings, despite these hazards being the deadliest and most costly events, respectively, after storms (1970-2019).



53% of Members have no basic flash flood warning system

54% of Members have no basic drought warning system



1. **Systematic Observation Financing Facility**
2. **Investments in hydrological infrastructures**
3. **Multi-Hazard, Impact-based early warning ser**
4. **Partnerships with WB, GCF, UNDP etc.**

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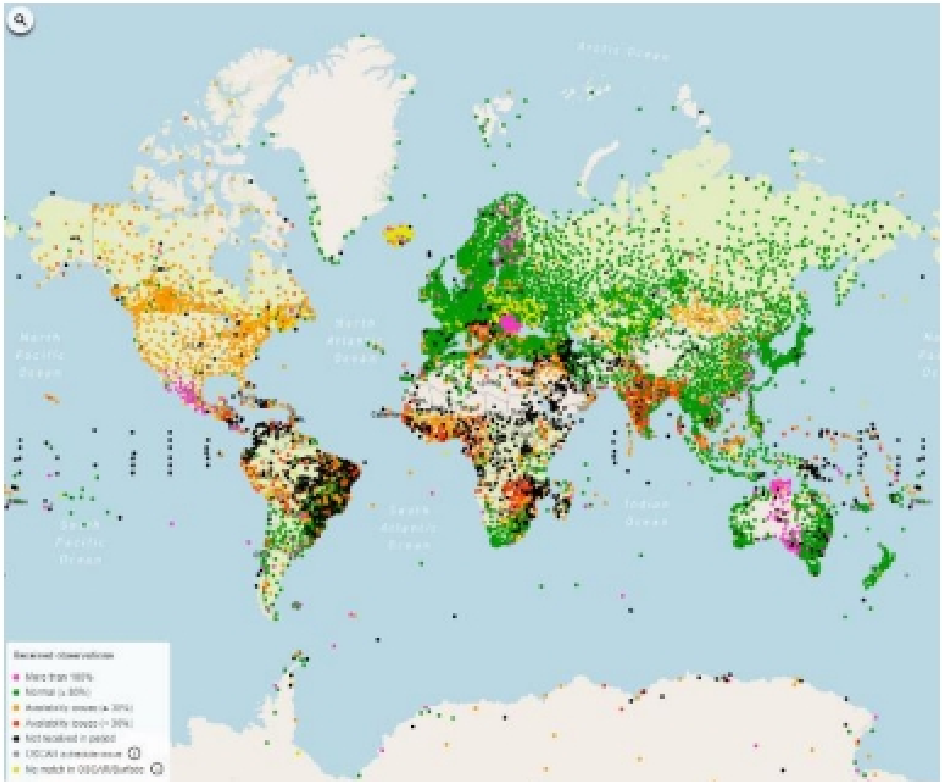
Creation of Systematic Observation Financing Facility



Global surface observations, WDQMS, September 2021
WDQMS, September 2021

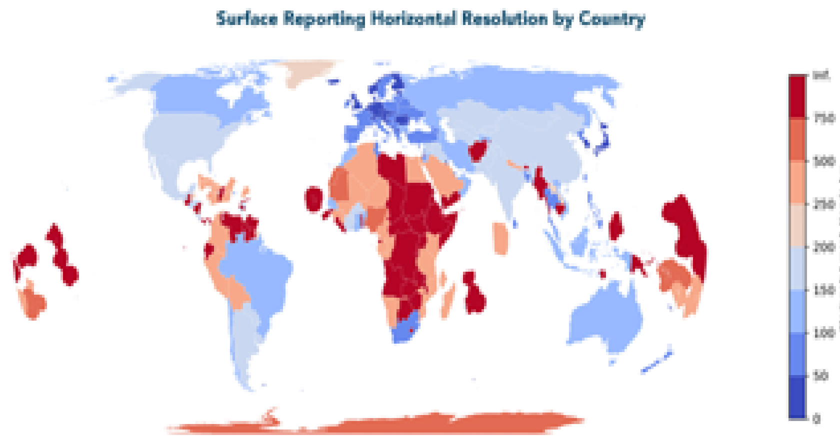


Figure 2 This map shows the horizontal resolution of surface observations in different countries based on stations actively reporting in January 2020. Source: WMO Secretariat.

WMO, UNEP, UNDP & UNMTPF Systematic Observation Financing Facility to enhance the amount of surface and balloon sounding stations in the LDC & SIDS countries. Aim 400 M$ 2022-26 for investments & 250 M$ for maintenance 2023-2032

WMO OMM

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

شكرا لكم

Thank you

Gracias

Merci

Спасибо

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