WMO Update

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

COP-27 initiatives
Status of climate
Water and energy reports

Prof. Petteri Taalas
Secretary-General

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

Key initiatives of WMO

1. **Early warnings for all**: only half of 193 Members have proper early warning services in place. Therefore the impacts of weather extremes are more damaging (human lifes & economy) than in advanced countries. Need to invest 1.5 B$ 2022-27 in basic observing systems, EWS capacity building & water resource monitoring/services.

2. **New way of monitoring of CO2, CH4 & N2O cycles in the real atmosphere**. The current way of following of emissions and sinks may be erroneous. There is and opportunity to create a system, where ground-based & satellite data and modelling tools are used for following of the greenhouse gases behavior in real atmosphere.

3. **International high resolution climate modelling centre**. The current calculations of future climate by 2100 is based on 20-30 km horizontal resolution climate models, which is not enough for proper simulation of weather extremes, changes in rainfall patterns or melting glaciers, like Antarctica. There is a need to create a centre with largest possible supercomputing resources and 100 leading experts to improve the situation ("CERN of climate science").

Early Warnings for All

The UN Global Early Warning Initiative for the Implementation of Climate Adaptation

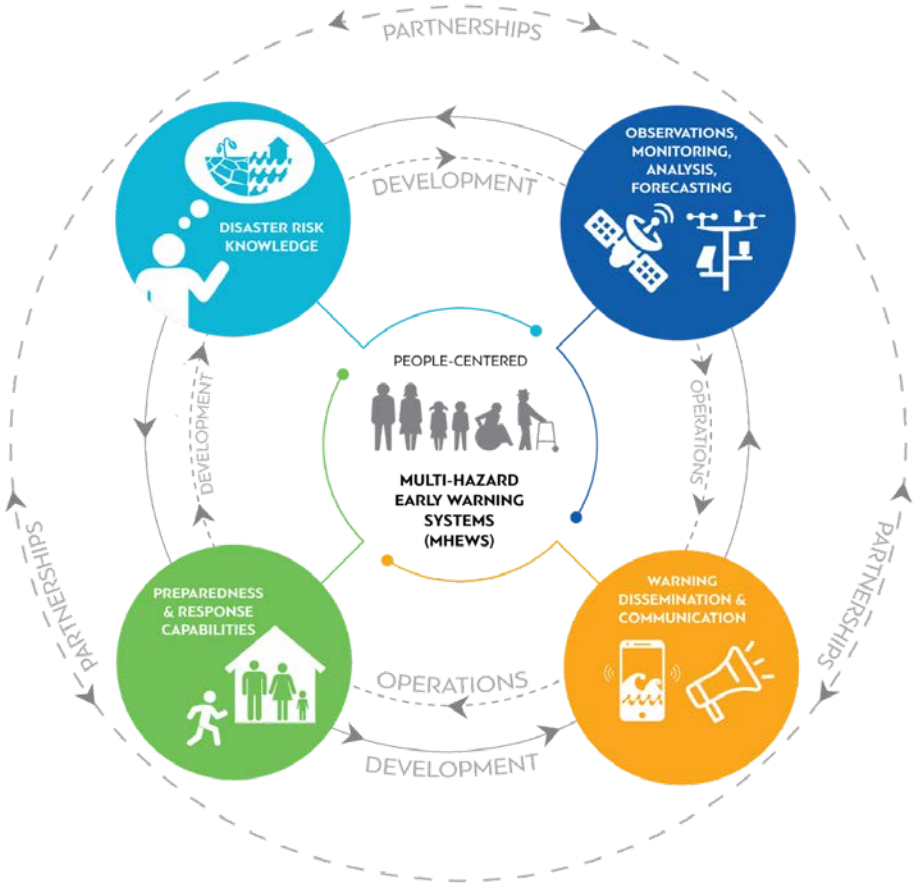
> Today I announce the United Nations will spearhead new action to ensure every person on Earth is protected by early warning systems within five years. I have asked the World Meteorological Organization to lead this effort and to present an action plan at the next UN climate conference, later this year in Egypt.
>
> UN Secretary-General Antonio Guterres on World Meteorological Day 23 March 2022

WMO OMM

Multi-Hazard Early Warning Systems (MHEWS)

A MHEWS is an integrated system which allows people to know that hazardous weather is on its way, and informs how governments, communities and individuals can act to minimize impacts. MHEWS should be people-centered to empower those threatened by hazards to act in sufficient time and in an appropriate manner, and they build on partnerships within and across relevant sectors.

1. Disaster risk knowledge
2. Observations, monitoring, analysis, forecasting
3. Warning dissemination and communication
4. Preparedness and response capabilities



WMO OMM

Disaster risk knowledge

Systematically collect data and undertake risk assessments

- Are the hazards and the vulnerabilities well known by the communities?
- What are the patterns and trends in these factors?
- Are risk maps and data widely available?

Detection, observations, monitoring, analysis and forecasting of hazards

Develop hazard monitoring and early warning services

- Are the right parameters being monitored?
- Is there a sound scientific basis for making forecasts?
- Can accurate and timely warnings be generated?

Preparedness and response capabilities

Build national and community response capabilities

- Are response plans up to date and tested?
- Are local capacities and knowledge made use of?
- Are people preapred and ready to react to warnings?

Warning dissemination and communication

Communicate risk information and early warnings

- Do warnings reach all of those at risk?
- Are the risks and warnings understood?
- Is the warning information clear and usable?

The state of MHEWS globally

- An enhanced data collection campaign (the ***WMO Performance Monitoring System***) conducted since March 2022 shows that significant MHEWS gaps remain globally
- A **composite Early Warning Index** will be developed with Members and key partners in the months ahead. This index will better demonstrate changes in the global status of early warnings and early action going forward and highlight areas where urgent action is required.

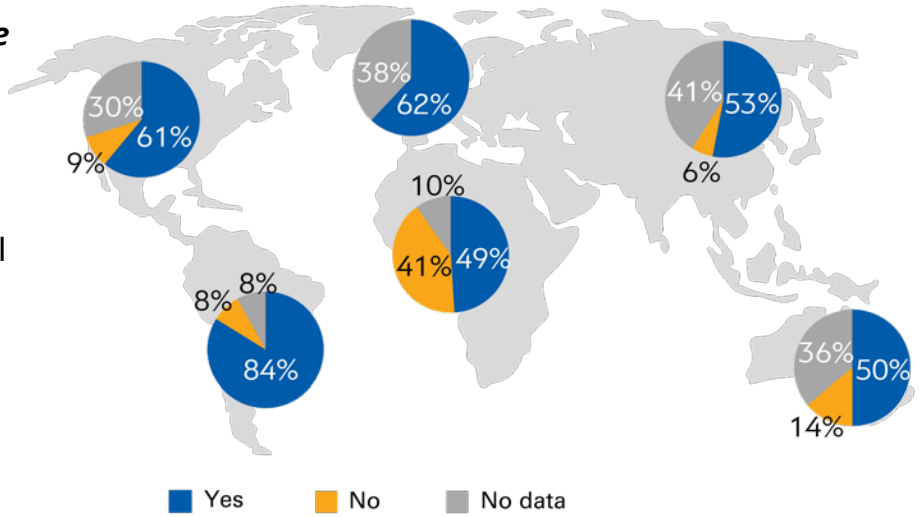
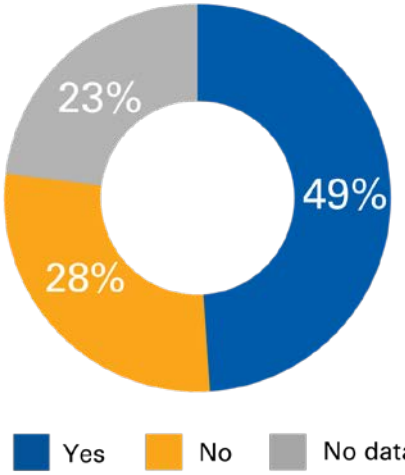
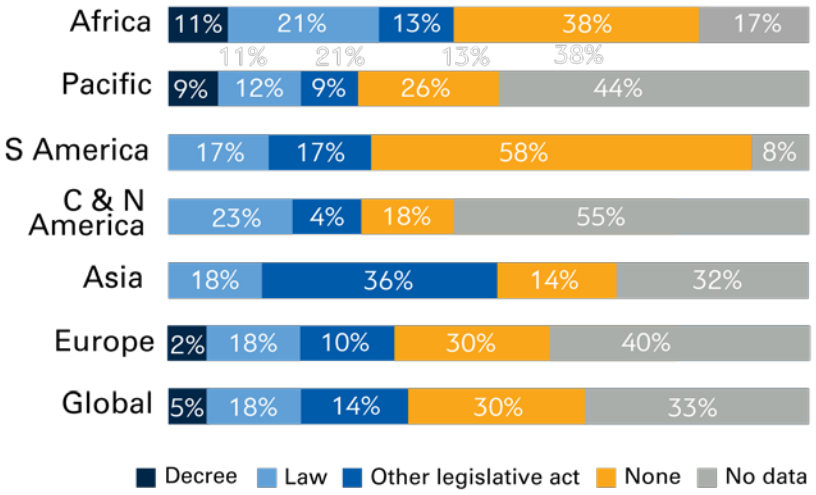


Figure 4: Percentage of countries reporting to have Standard Alerting Procedures (SAPs)



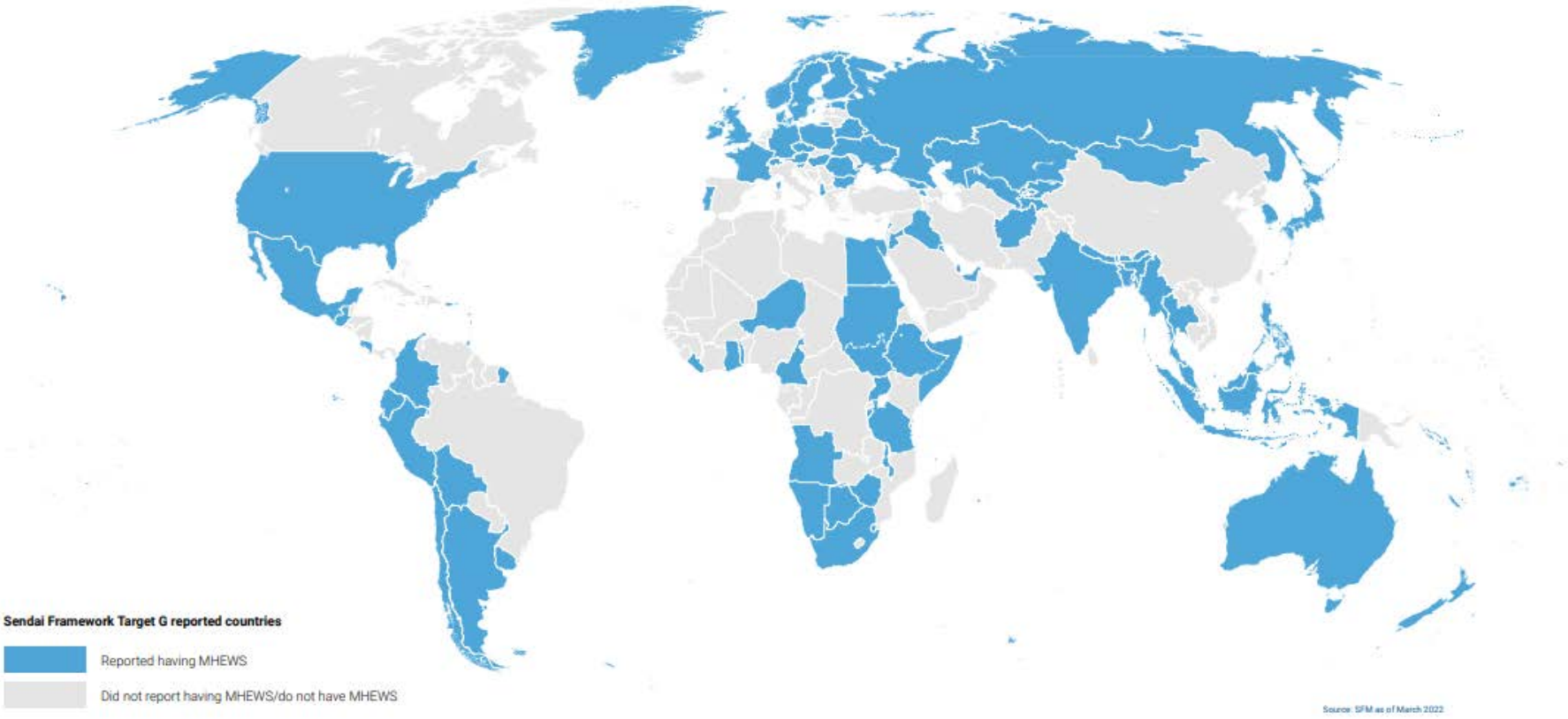
Percentage of WMO Members reporting to have MHEWS



Percentage of Members reporting to have legislation on MHEWS

WMO OMM

The state of MHEWS globally



UNITED NATIONS Geospatial

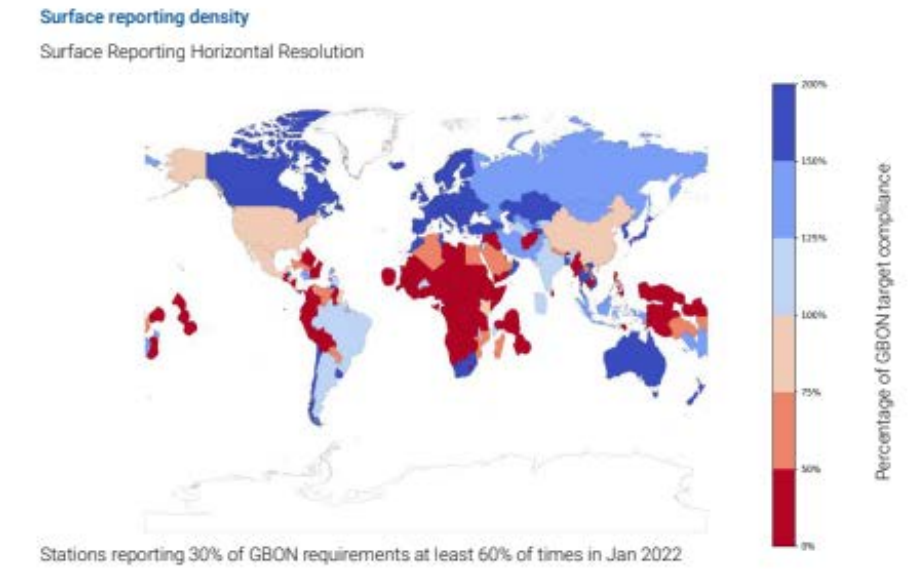
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations

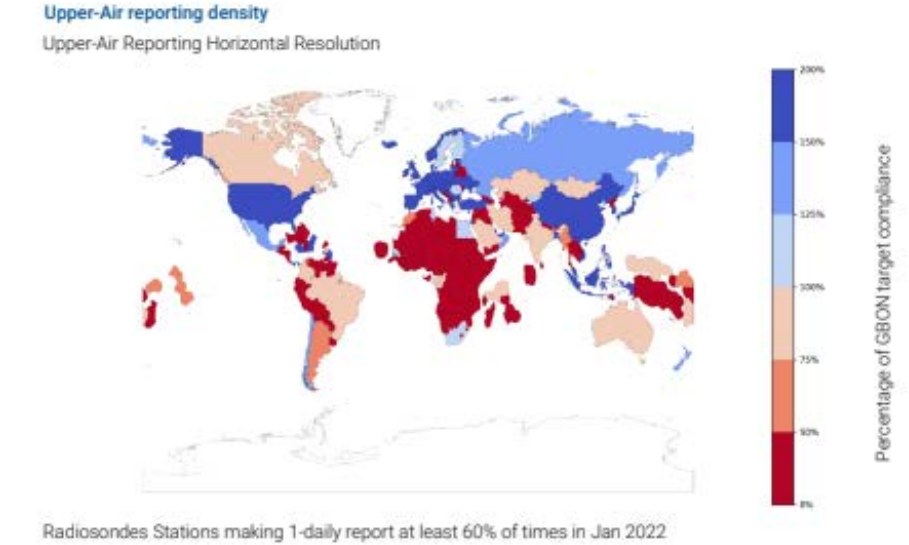
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

WMO OMM

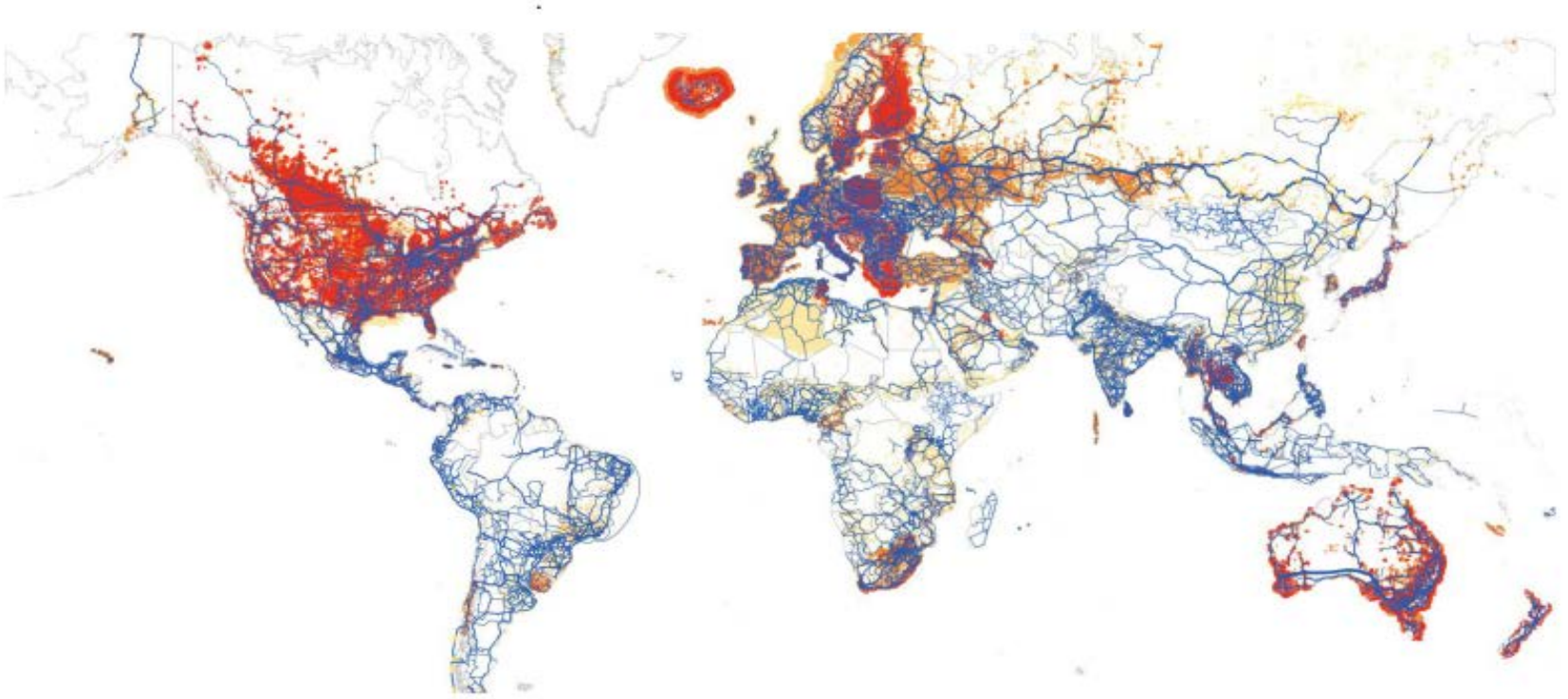
The state ground-based and sounding stations





WMO OMM

Networks and mobile coverage



LEGEND

2G Mobile Coverage	Strong signal	Variable signal
3G Mobile Coverage	Strong signal	Variable signal
4G Mobile Coverage	Strong signal	Variable signal
5G Mobile Coverage	Strong signal	Variable signal

Figure 2.10: Global networks and mobile coverage.

Map and data source: International Telecommunication Union (ITU) ITU - Map

Disclaimer: The boundaries and names shown and the designations used on the map do not imply official endorsement or acceptance by the United Nations.

WMO OMM

Water & Climate Leaders – Call for Action

To be presented at COP27

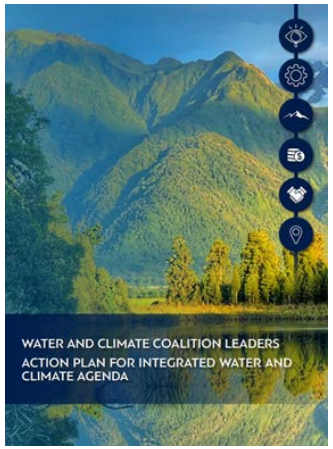
Water Day on 14 November

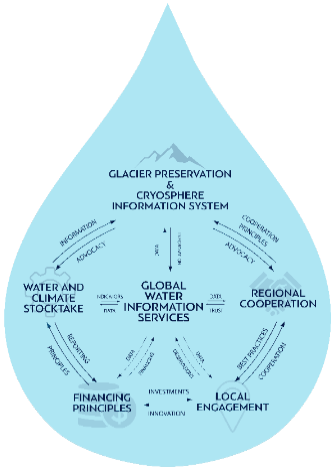
- **An integrated water and climate approach**—Recognizing the role of water for informed decision-making in climate change mitigation and adaptation action.

- **International support to improve water data and information for a climate ready world**—Working together to operationalise a Global Water Information System that provides status, assessment, and outlook for smart climate and water-related decisions.

- **Partners to join us in the implementation**—Support solutions for sound decision making: a water and climate stocktake, a cryosphere information mechanism, a new financing rationale, local engagement, and river basin cooperation.

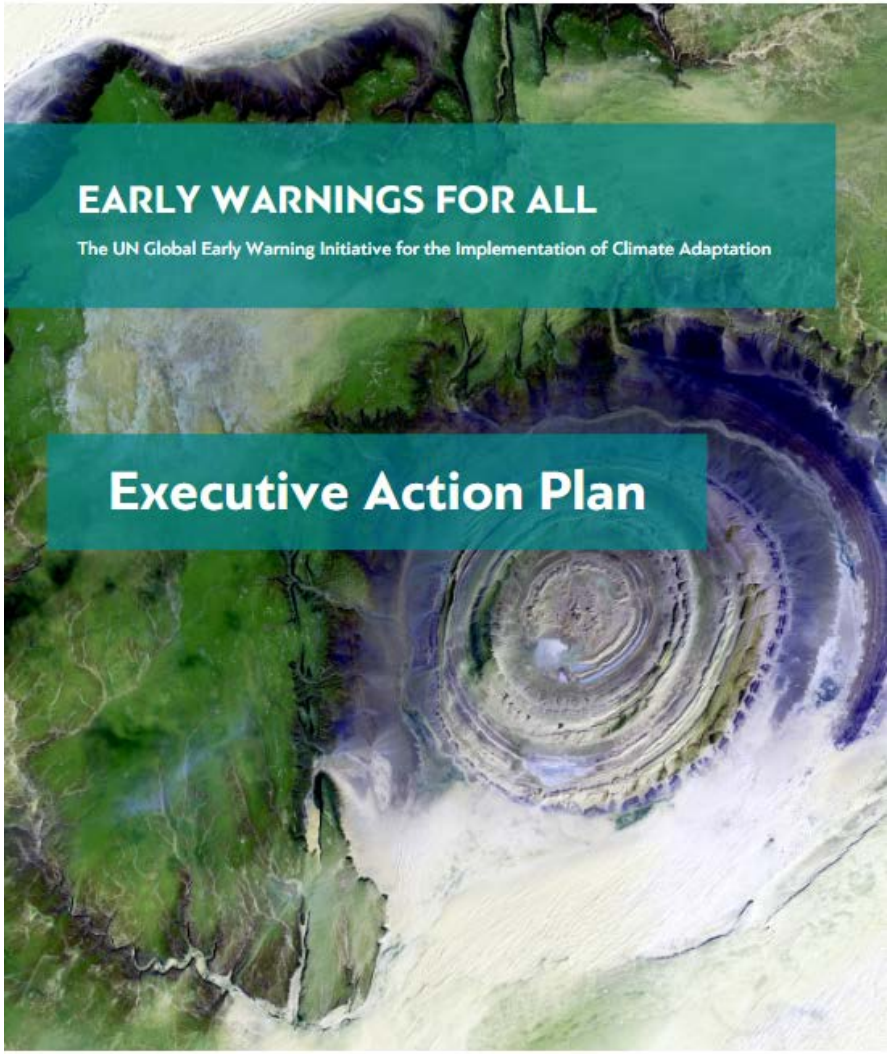
- **Recognizing the need to protect glaciers**—Understanding the role of glaciers as one of the most critical sources of freshwater and uniting forces in preserving these resources through an International Year of Glacier Preservation 2025.





https://www.water-climate-coalition.org/leaders/

WMO OMM



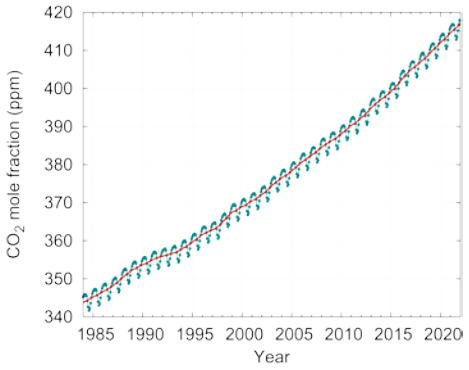
WORLD METEOROLOGICAL ORGANIZATION

COP27 SHARM EL-SHEIKH EGYPT 2022

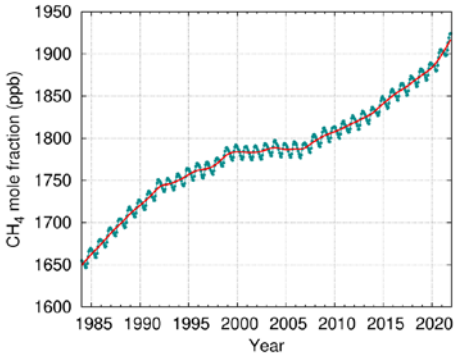
WMO OMM

WEATHER CLIMATE WATER

Main greenhouse gases (CO_2, CH_4, N_2O)

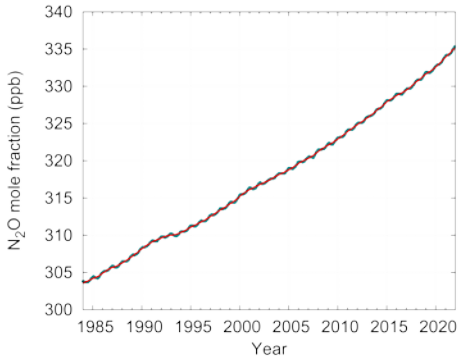


Carbon dioxide levels +149%

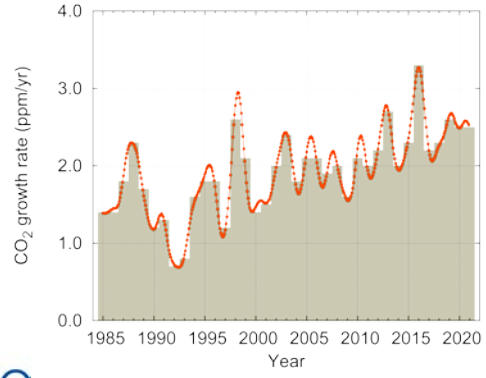


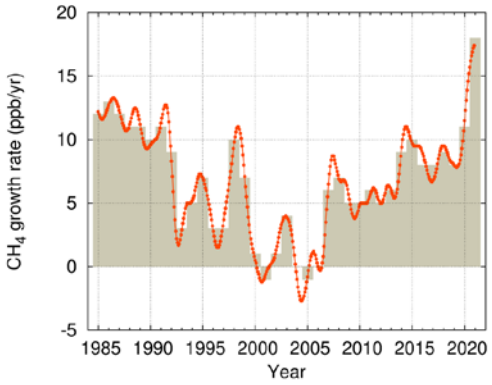
Methane levels +262%

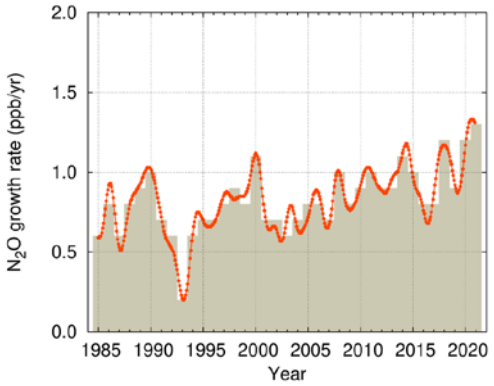
of pre-industrial levels (before 1750)



Nitrous oxide levels +124%



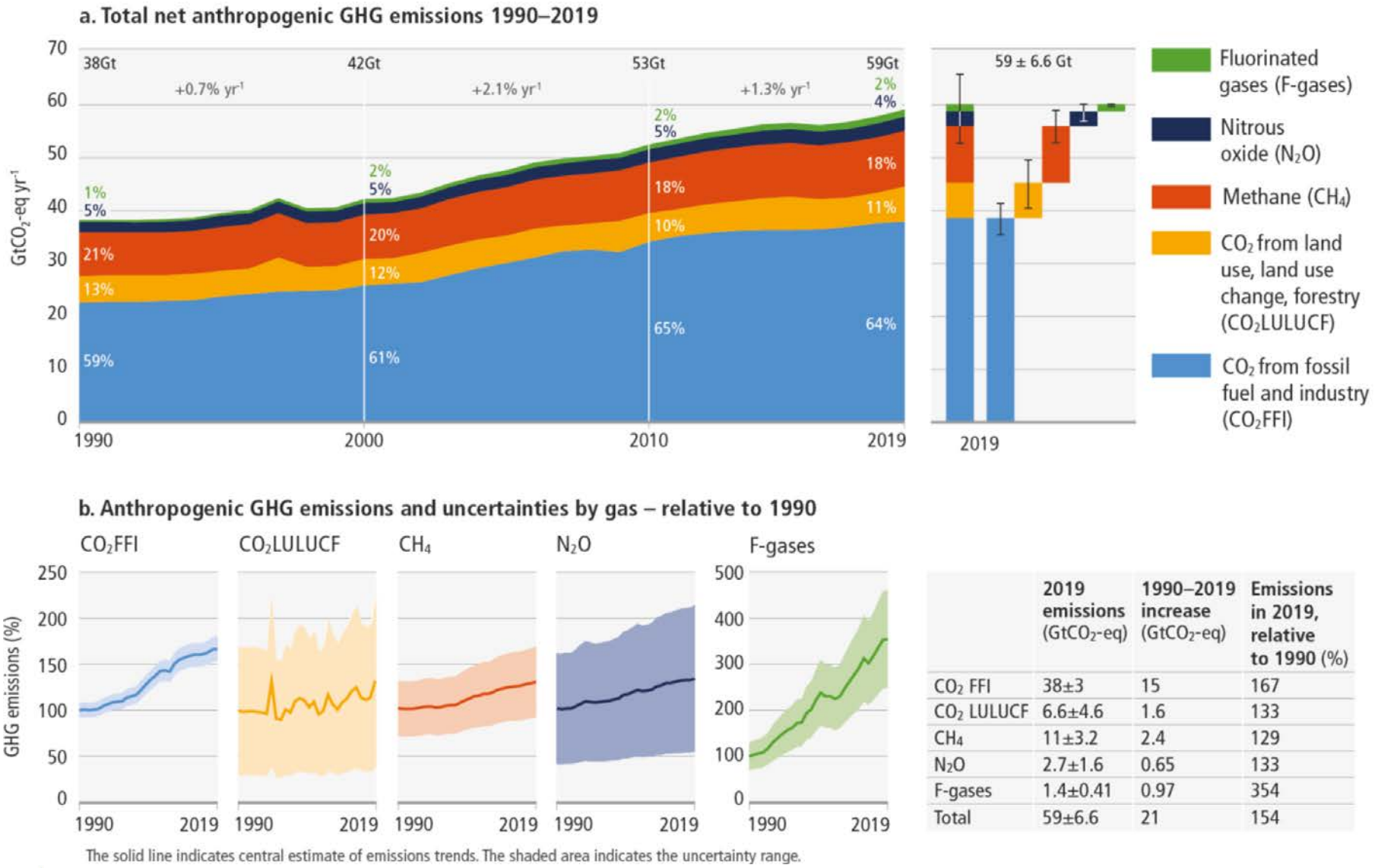




WMO

WMO OMM

Greenhouse gas emissions 1990-2019

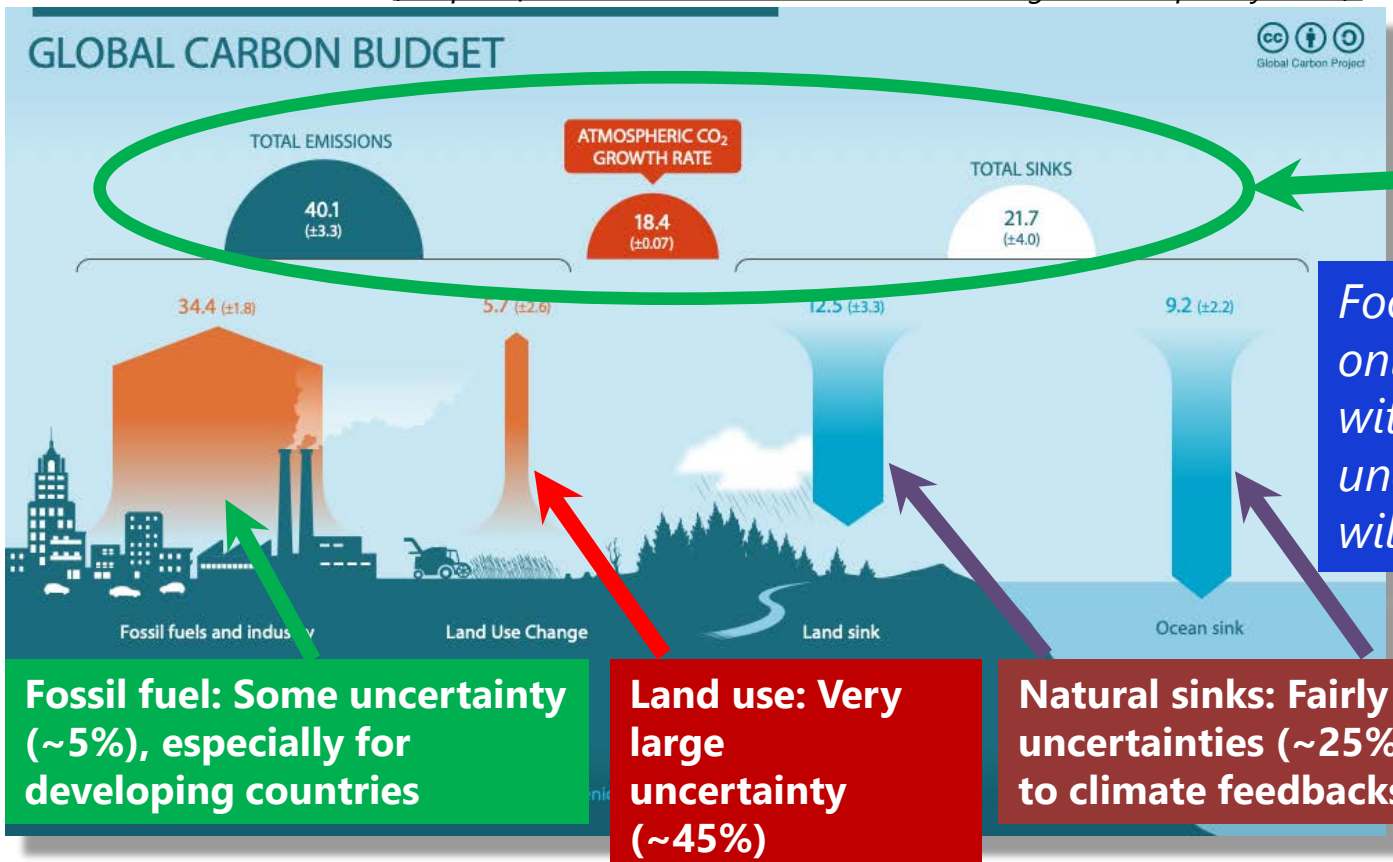


	2019 emissions ($GtCO_2$-eq)	1990–2019 increase ($GtCO_2$-eq)	Emissions in 2019, relative to 1990 (%)
CO_2 FFI	38±3	15	167
CO_2 LULUCF	6.6±4.6	1.6	133
CH_4	11±3.2	2.4	129
N_2O	2.7±1.6	0.65	133
F-gases	1.4±0.41	0.97	354
Total	59±6.6	21	154

WMO OMM

How well do we understand the CO_2 budget ?

(Graphic from Canadell, WMO GHG Monitoring Workshop, May 2022);



Top level global budget is well understood

Focusing our efforts only on the areas with low uncertainties (green) will not work!

Fossil fuel: Some uncertainty (~5%), especially for developing countries

Land use: Very large uncertainty (~45%)

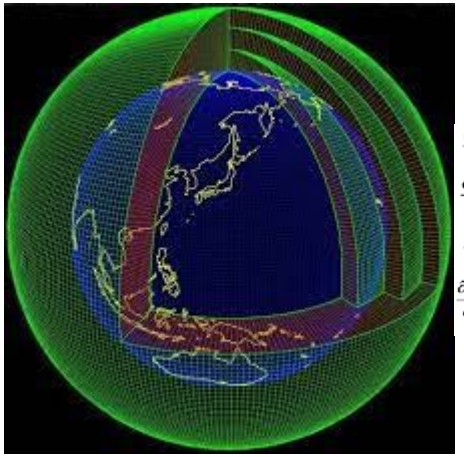
Natural sinks: Fairly large uncertainties (~25%); subject to climate feedbacks

WMO OMM

GAW+Satellites+models => Operational greenhouse gas data

NASA OCO, JAXA Ibuki, CHINA Tansat already exist

+



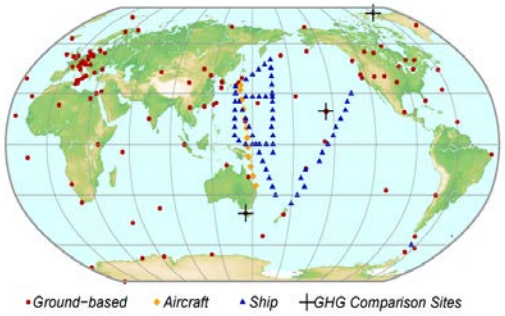
$$\frac{\partial \vec{u}}{\partial t} = -\vec{u}\cdot\vec{\nabla}\vec{u} - \dot{\eta}\frac{\partial \vec{u}}{\partial \eta} + 2\vec{\Omega}\times\vec{u} - RT\vec{\nabla}(\ln(P)) - \vec{\nabla}\phi$$

$$\frac{\partial T}{\partial t} = -\vec{u}\cdot\vec{\nabla}T - \dot{\eta}\frac{\partial T}{\partial \eta} + \frac{R}{C_p}T\frac{\omega}{P}$$

$$\frac{\partial q}{\partial t} = -\vec{u}\cdot\vec{\nabla}q - \dot{\eta}\frac{\partial q}{\partial \eta}$$

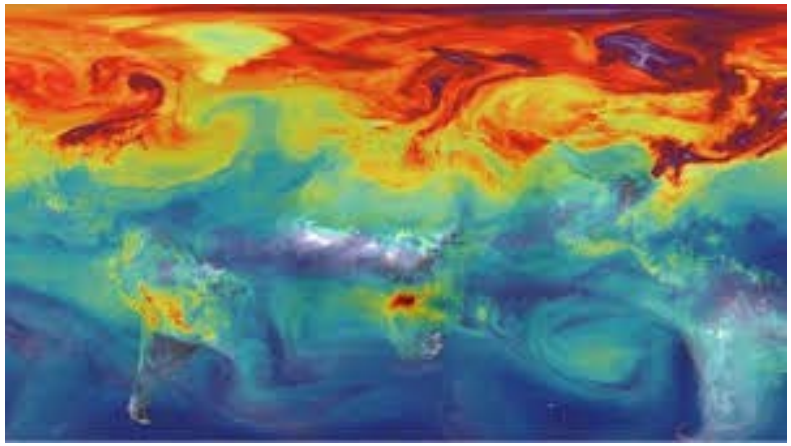
$$\frac{\partial P_s}{\partial t} = -\vec{\nabla}\cdot\int_0^1 \frac{\partial P}{\partial \eta}\vec{u}\,d\eta$$

Atmospheric modeling & assimilation



European Copernicus 2025-

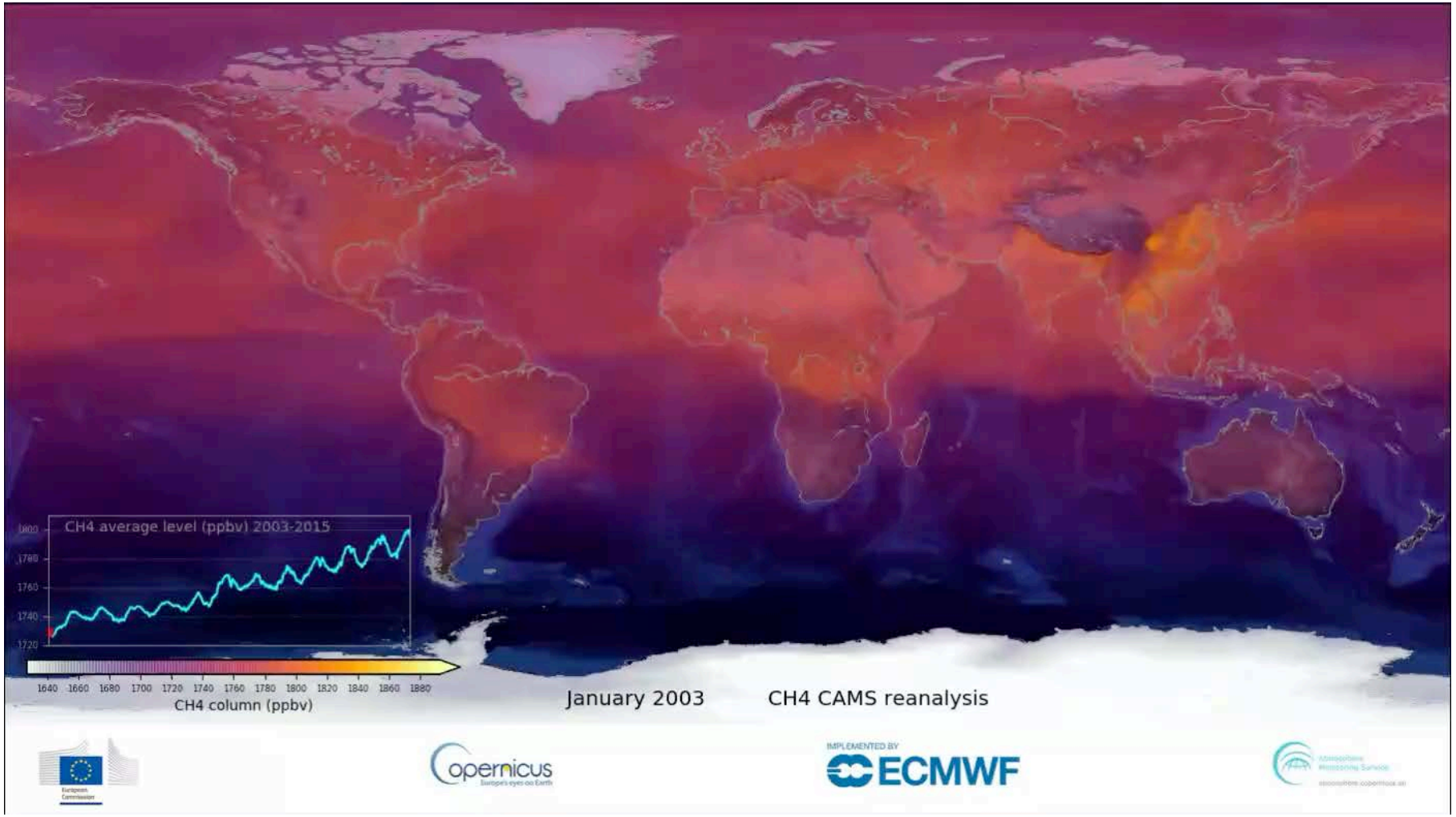
- **Integrated, internationally coordinated global greenhouse gas monitoring system**
- **Better understanding if sources and sinks**
- **Support Paris Agreement implementation**



Real-time monitoring of CO_2, CH_4 and N_2O

WMO OMM

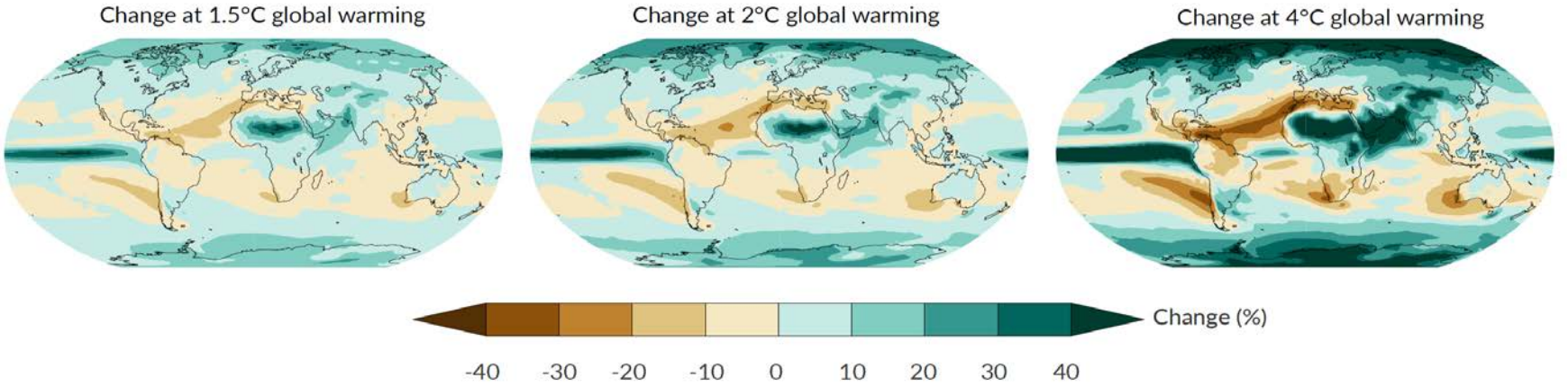
Can we improve our understanding of GHG cycles? CH_4 example



Rainfall & soil moisture versus future warming

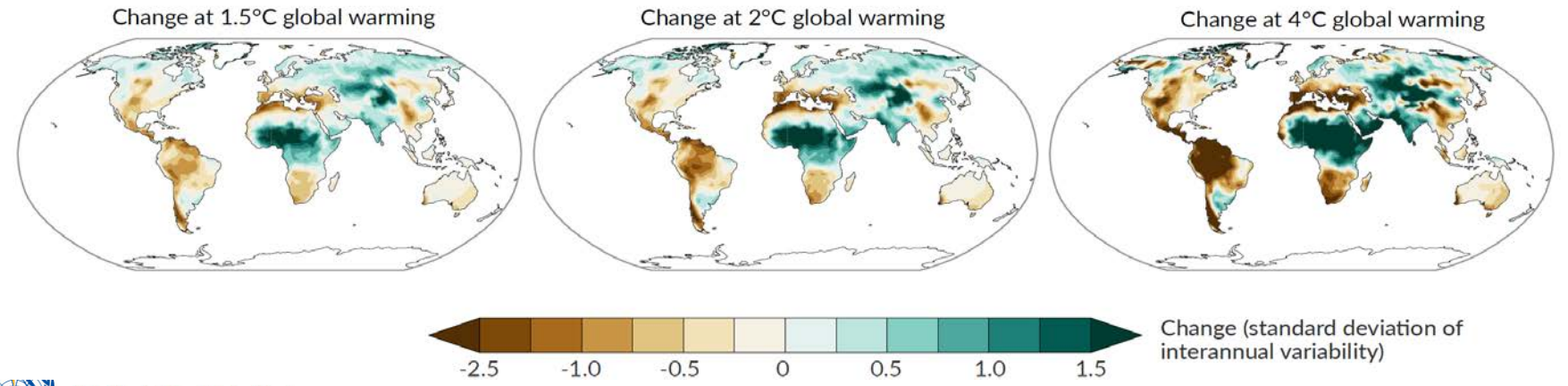
c) Annual mean precipitation change (%)
relative to 1850-1900 at three global warming levels

Precipitation increases over high latitudes, tropical oceans and parts of the monsoon regions but decreases over parts of the subtropics.



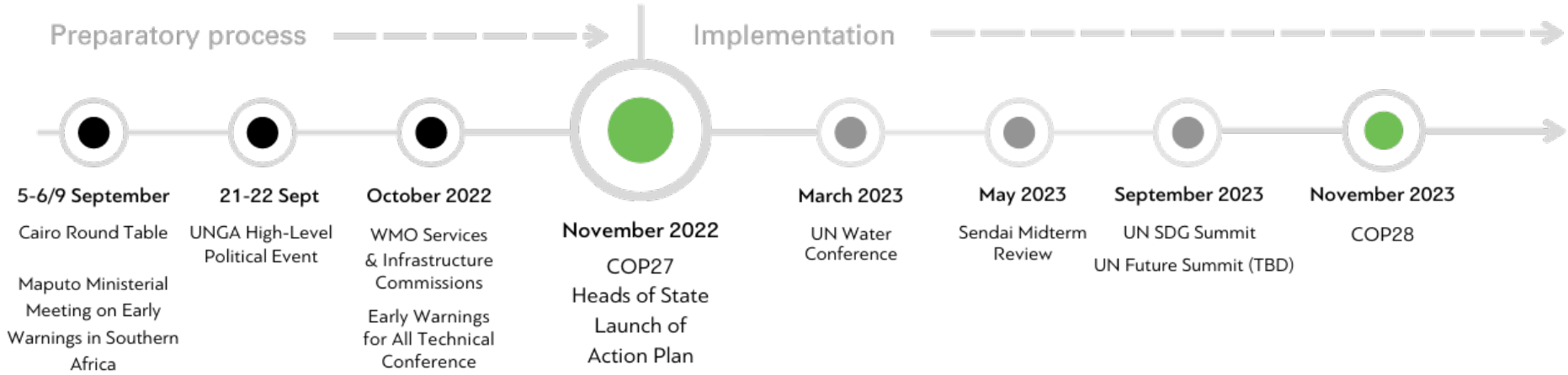
d) Annual mean soil moisture change (sd)
(standard deviation of interannual variability) relative to 1850-1900 at three global warming levels

Across warming levels changes in soil moisture largely follow changes in precipitation but also show some differences due to the influence of evapotranspiration.



WMO OMM

Milestones to COP27 and beyond

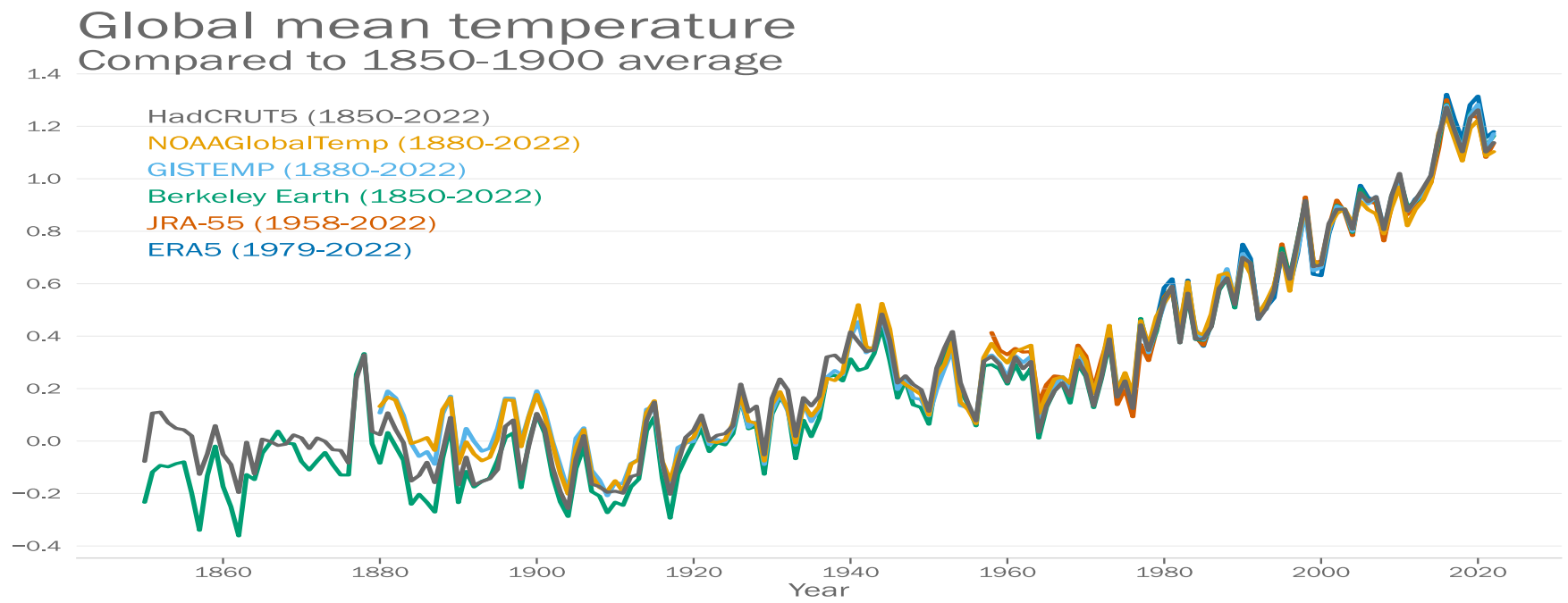


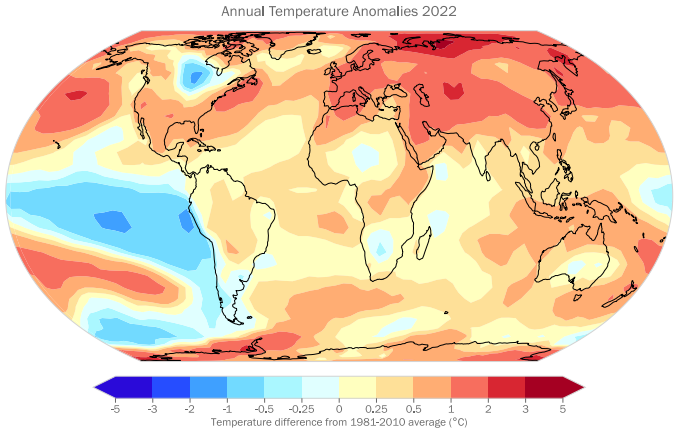
COP27
SHARM EL-SHEIKH
EGYPT 2022

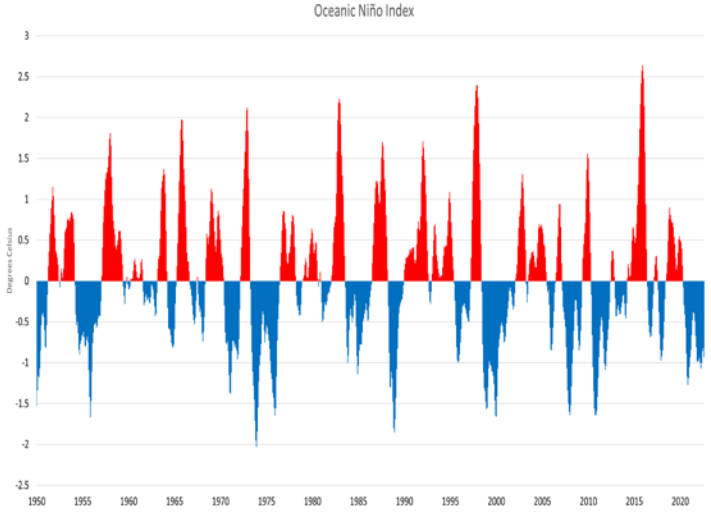
WMO OMM

WMO OMM

Global temperature & ENSO

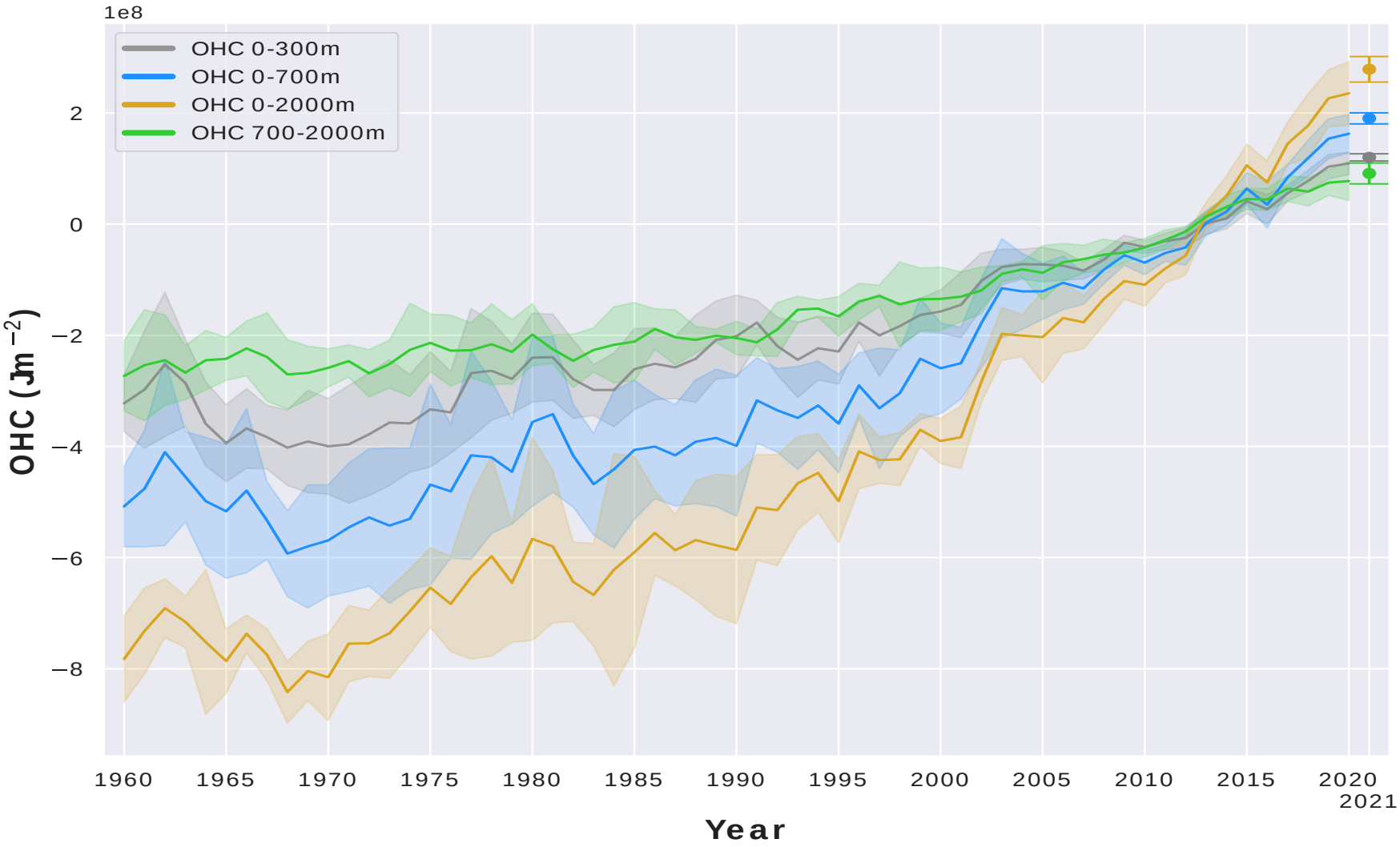






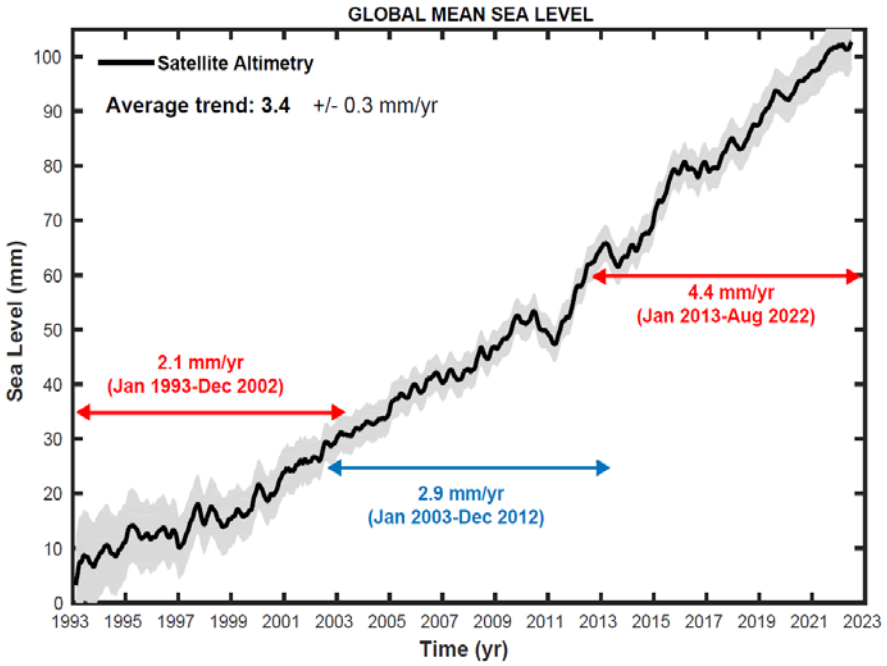
WMO OMM

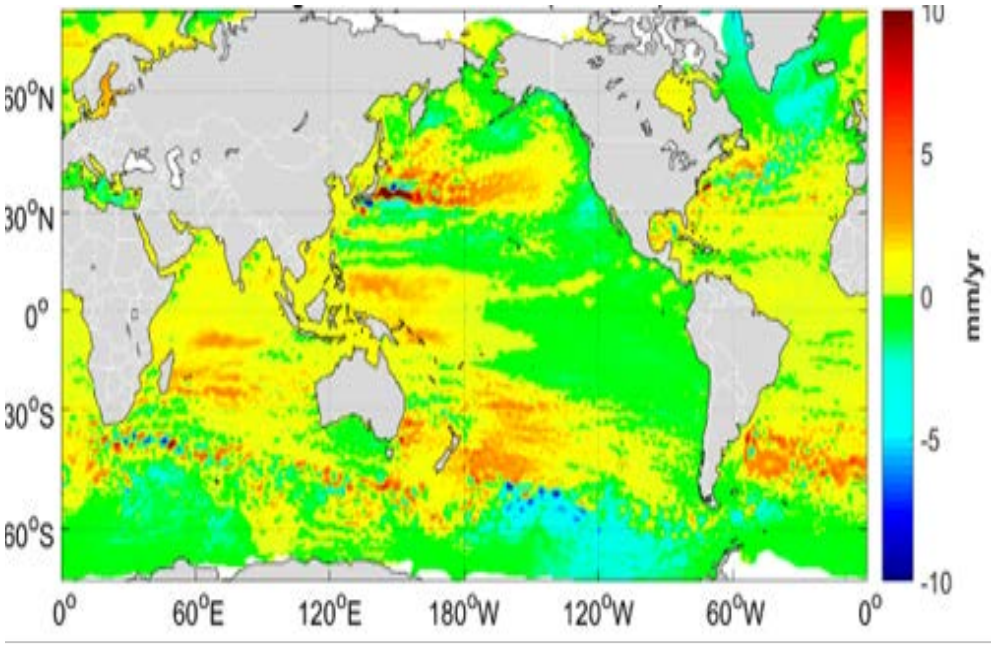
Ocean heat content at record high levels



WMO OMM

Global sea level rising at an increasing rate





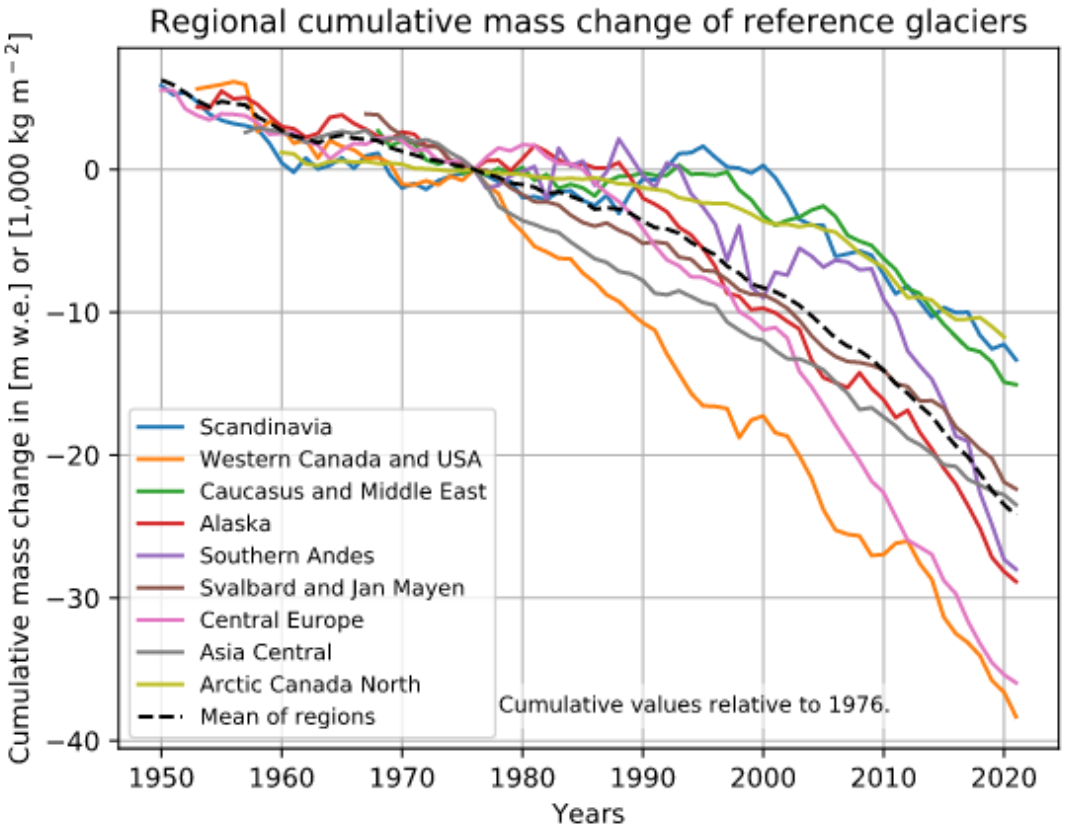
Regional deviations from post-1993 trend

Sea level rise from ice sheet loss:

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

WMO OMM

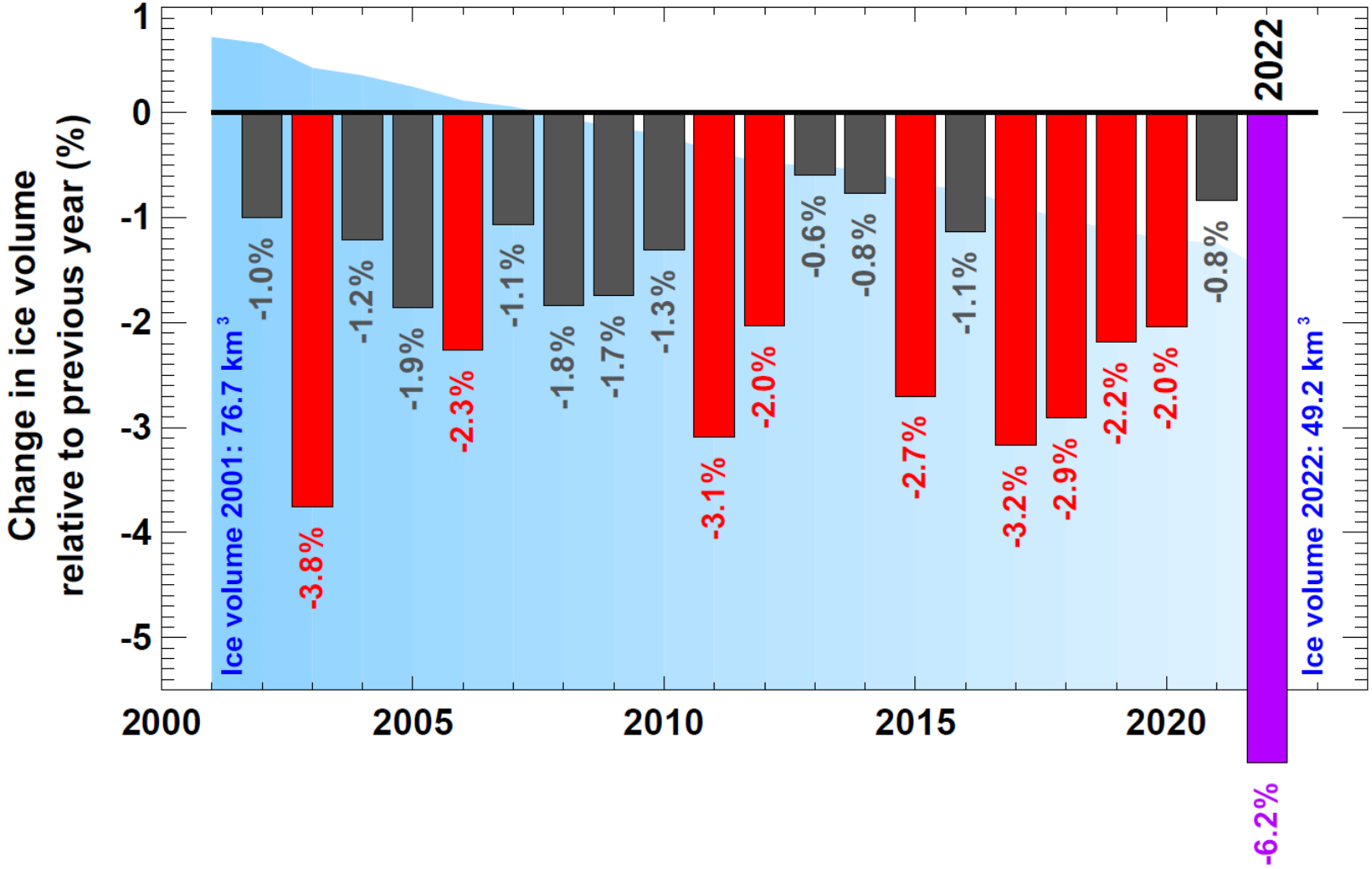
Cryosphere Water Resources



Source: World Glacier Monitoring Services, Global Glacier State, accessed 26 Sept 2022

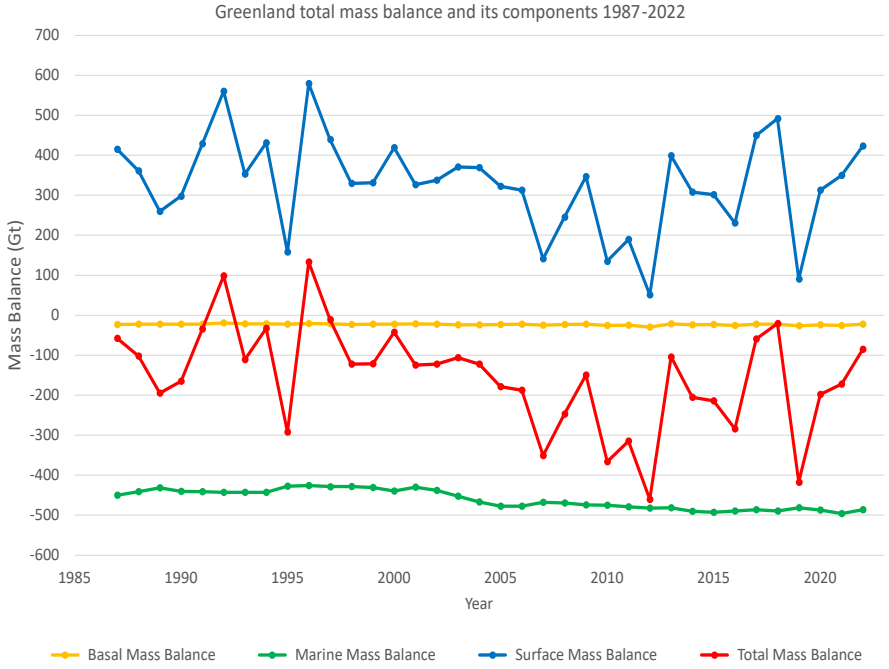
WMO OMM

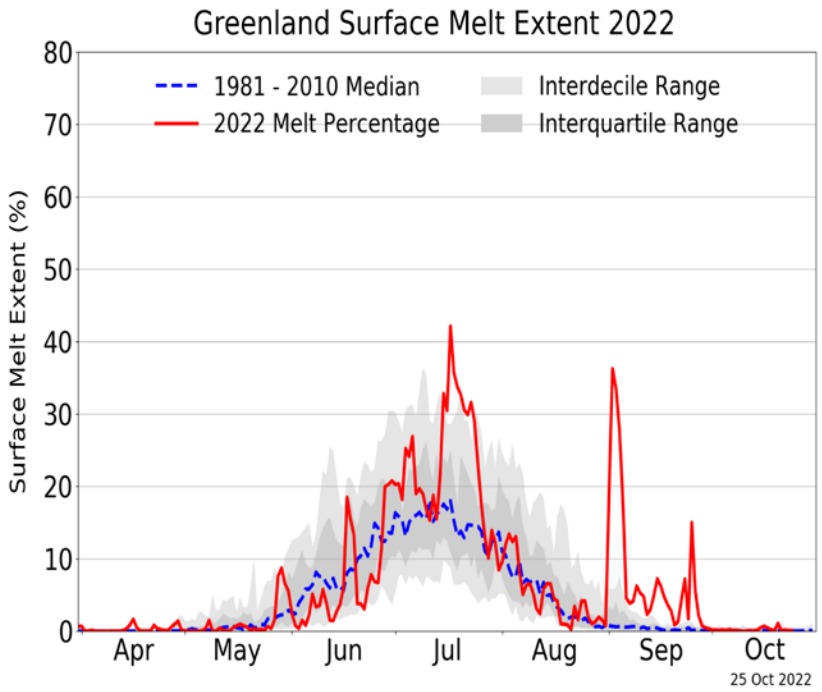
Swiss glacier retreat



WMO OMM

Greenland glacier melt 1987-2022

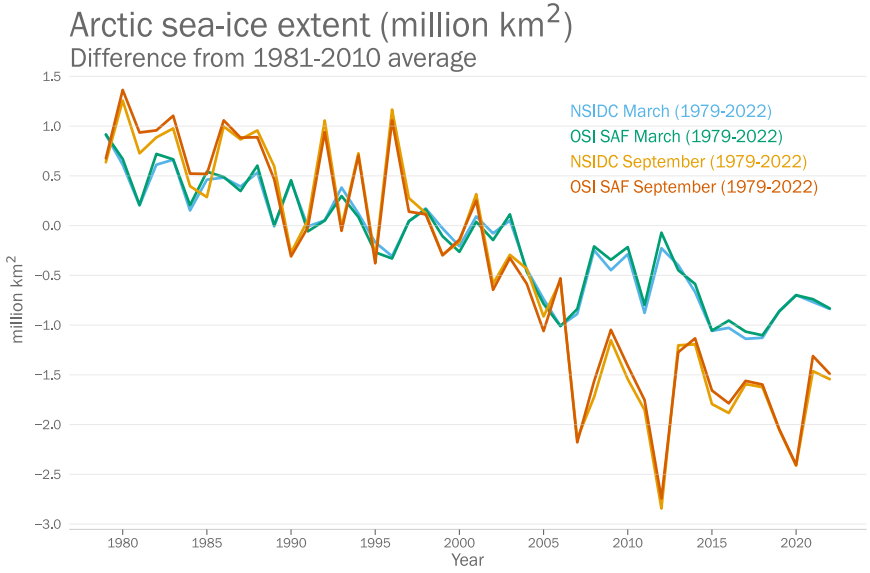


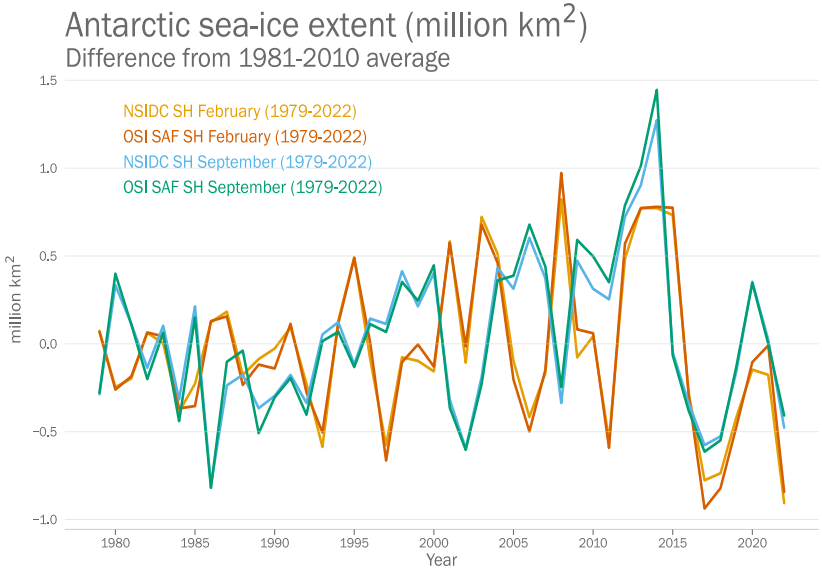


NSIDC / Thomas Mote, University of Georgia

WMO OMM

Arctic and Antarctic sea ice coverage

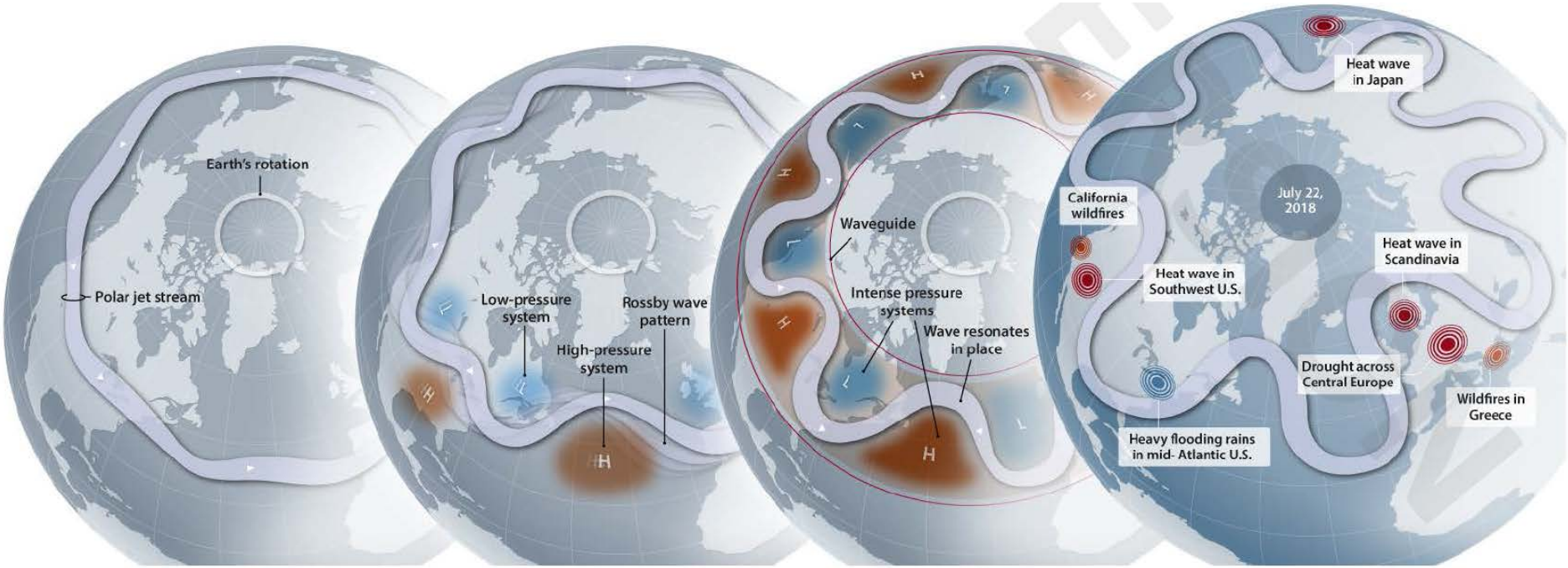




WMO OMM

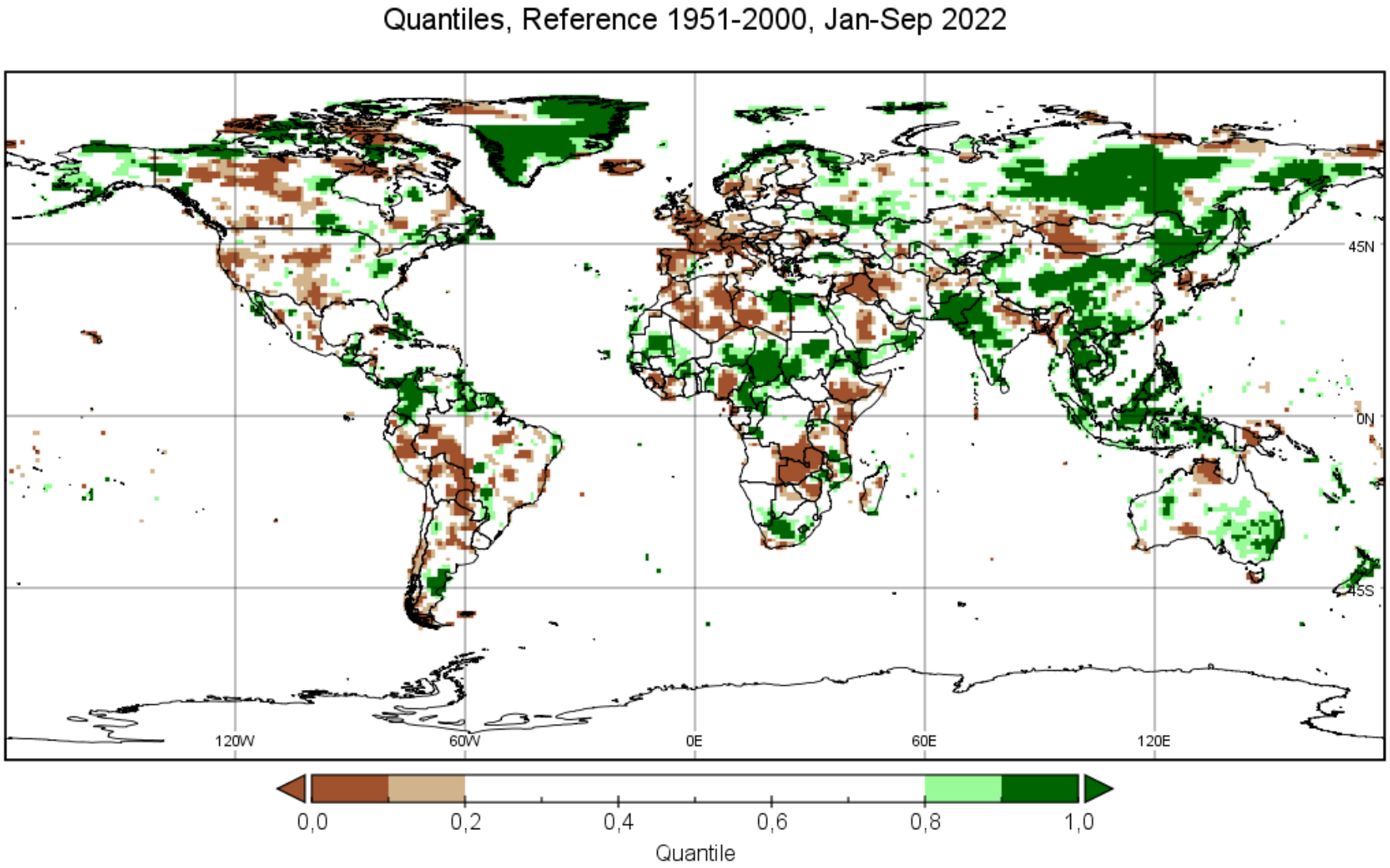
What happens in the Arctic doesn't stay there

More stagnant weather patterns?: Heat waves/drought, cold spells & flooding risks



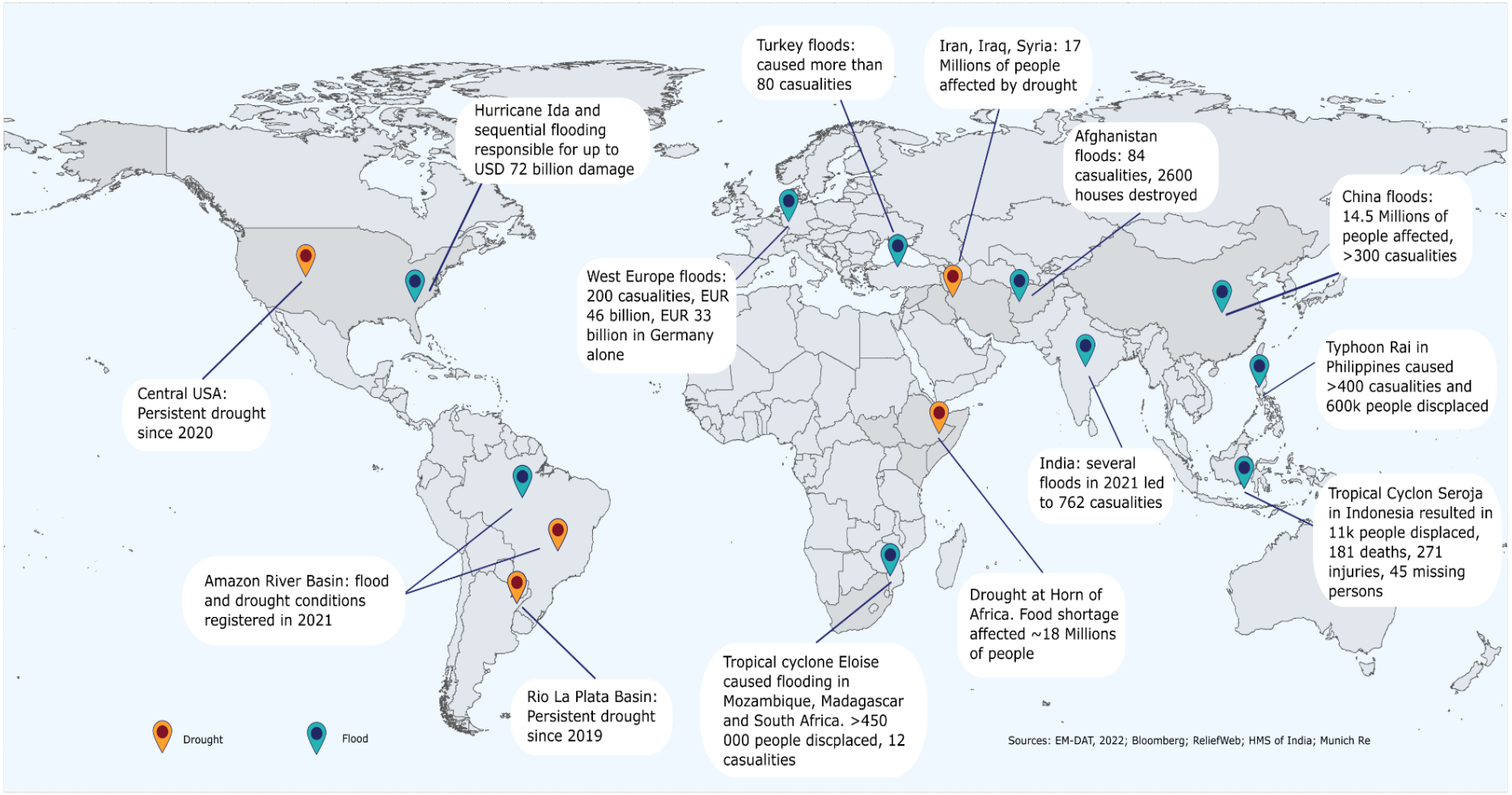
WMO OMM

Rainfall anomalies 2022



WMO OMM

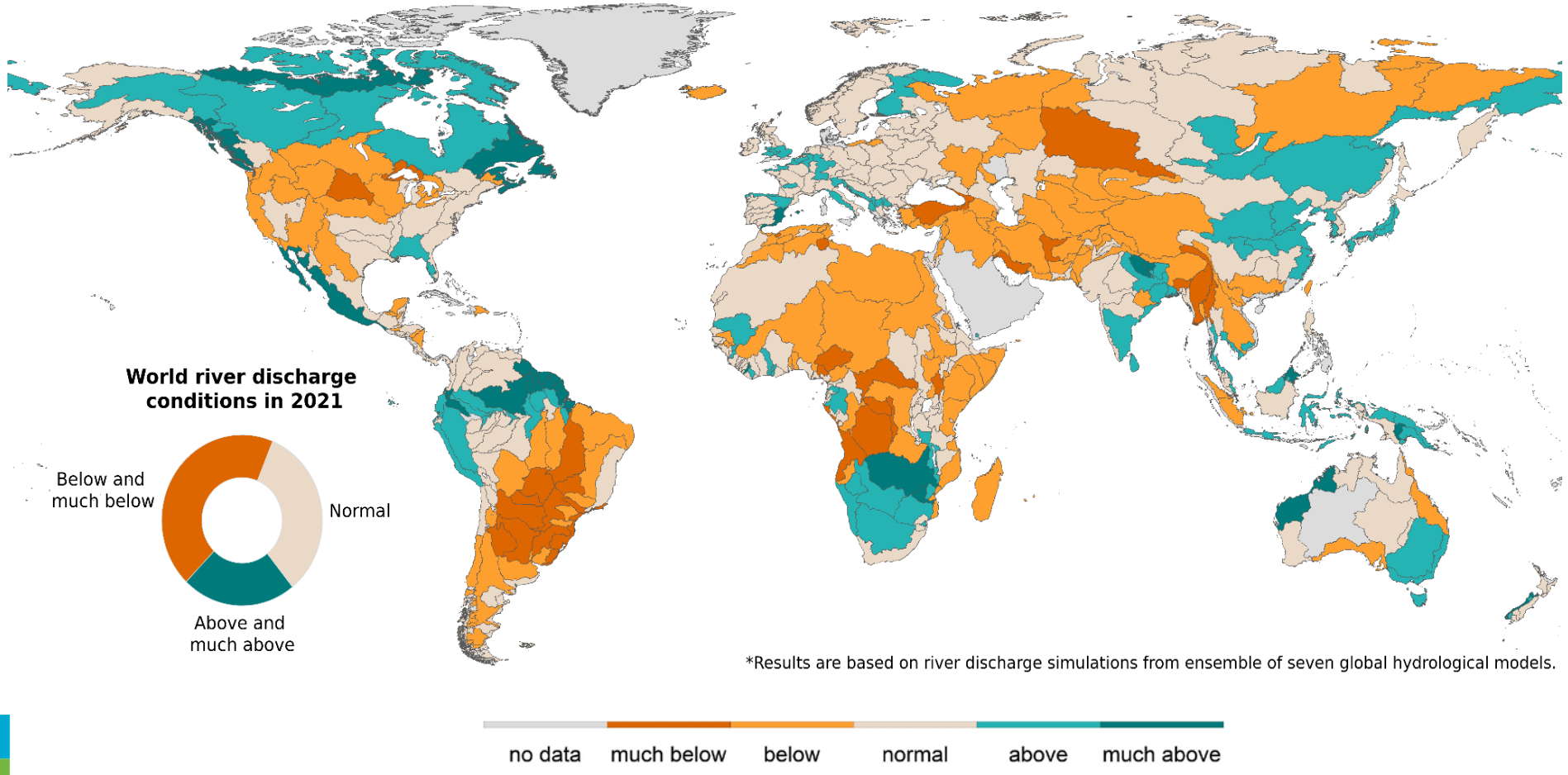
High Impact Water Events 2021



Information on the events was collected from EM-DAT

WMO OMM

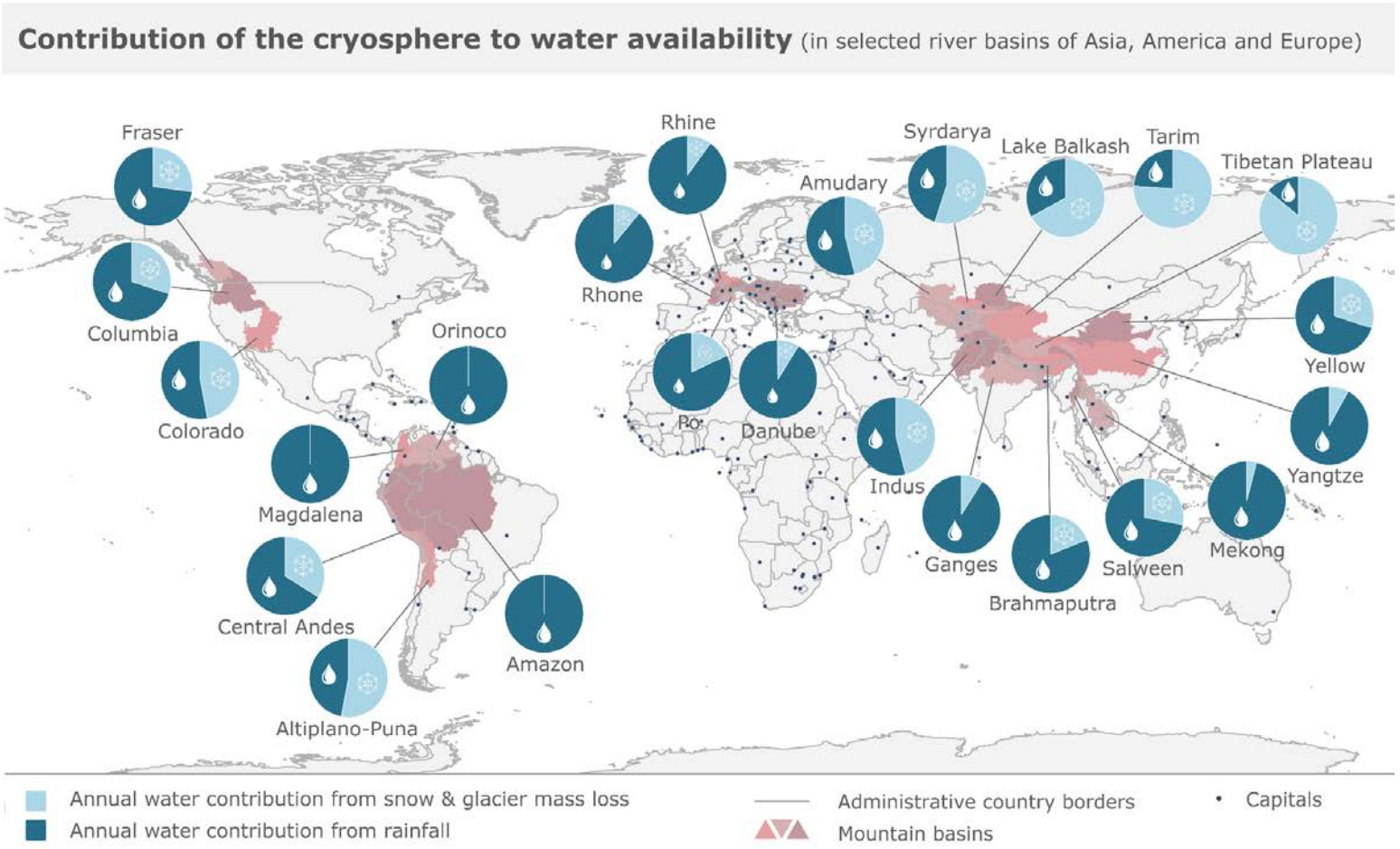
Streamflow 2021



Streamflow in 2021 w.r.t. the hydrological normal for 515 basins
(calculated based on 30 years historic data)

WMO OMM

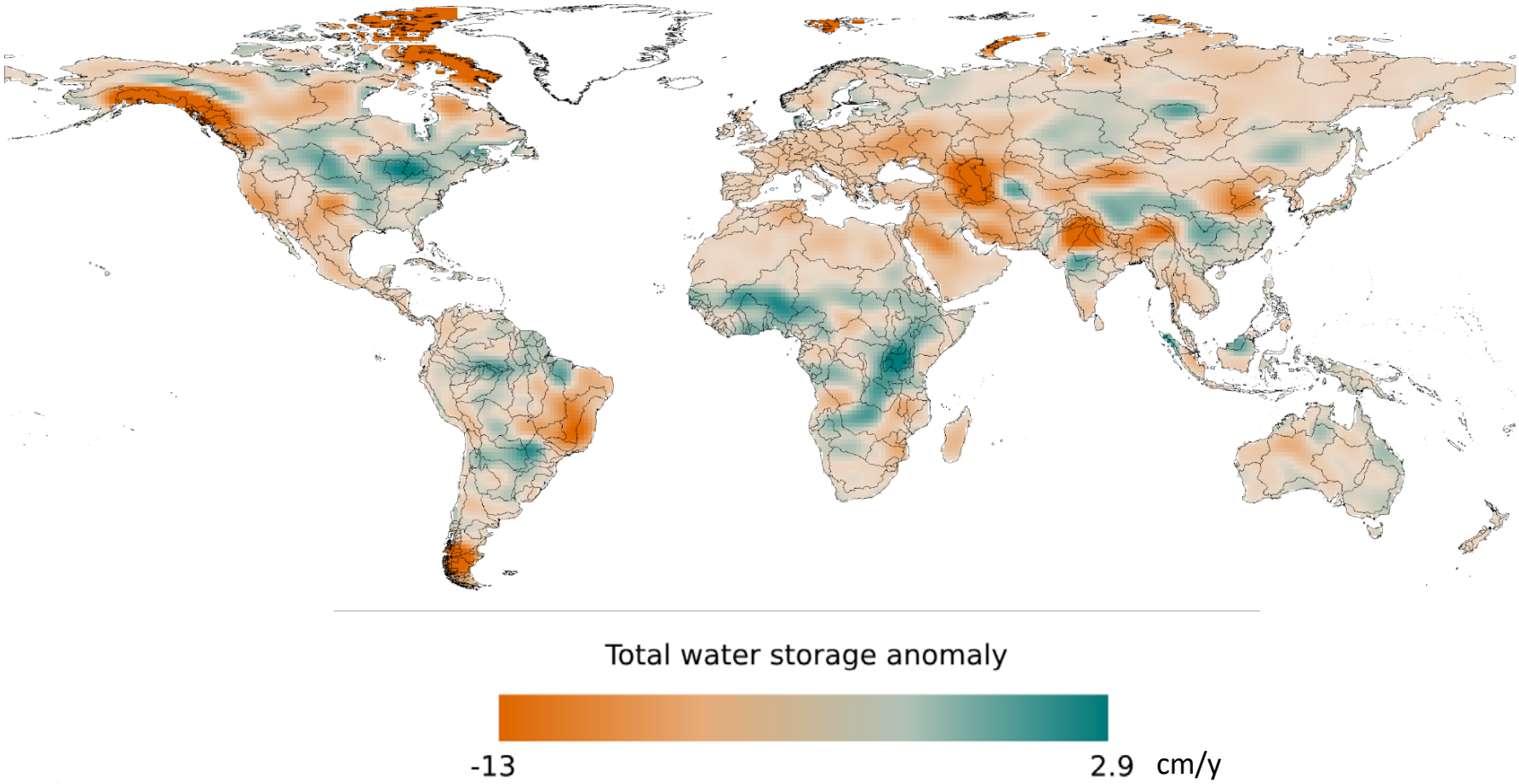
Cryosphere Water Resources



Data in "Towards mountains without permanent snow and ice" by Huss et al., 2017 (Table 2 - period: from 1998 to 2012).

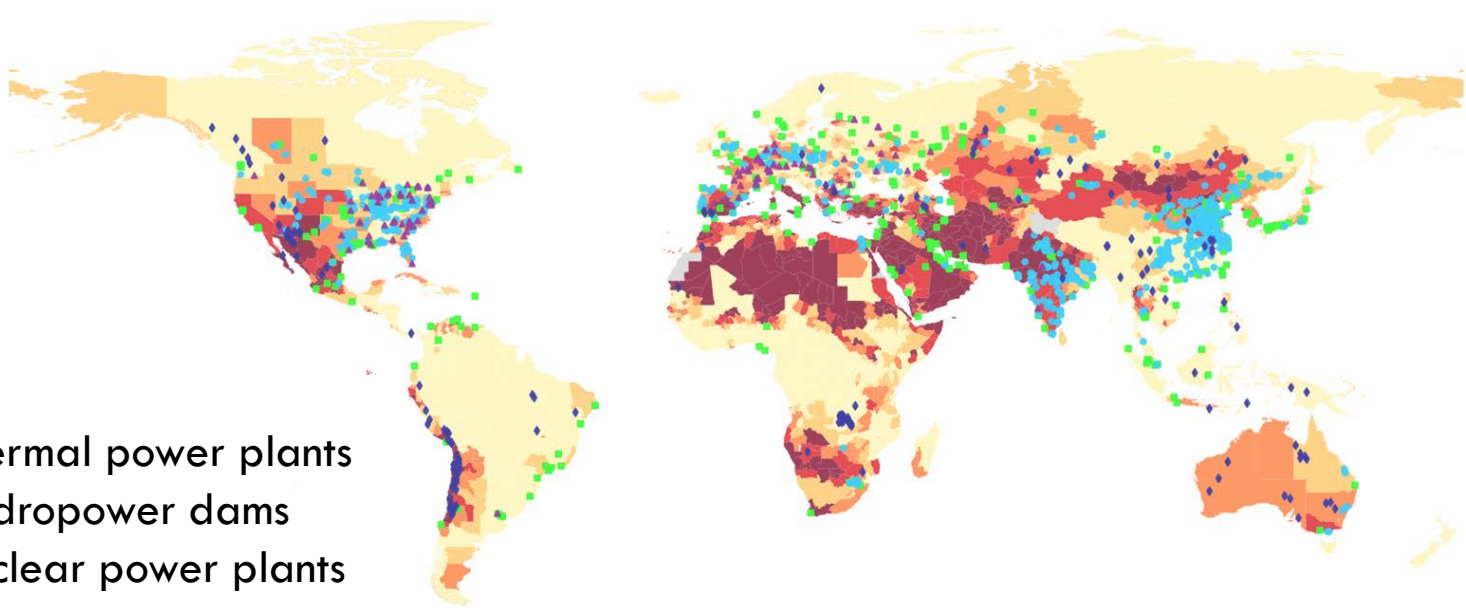
WMO OMM

Total Water Storage Trends 2002-2021



WMO OMM

Climate change is a challenge for energy



33% of thermal power plants
26% of hydropower dams
15% of nuclear power plants

located in **high water stress areas**

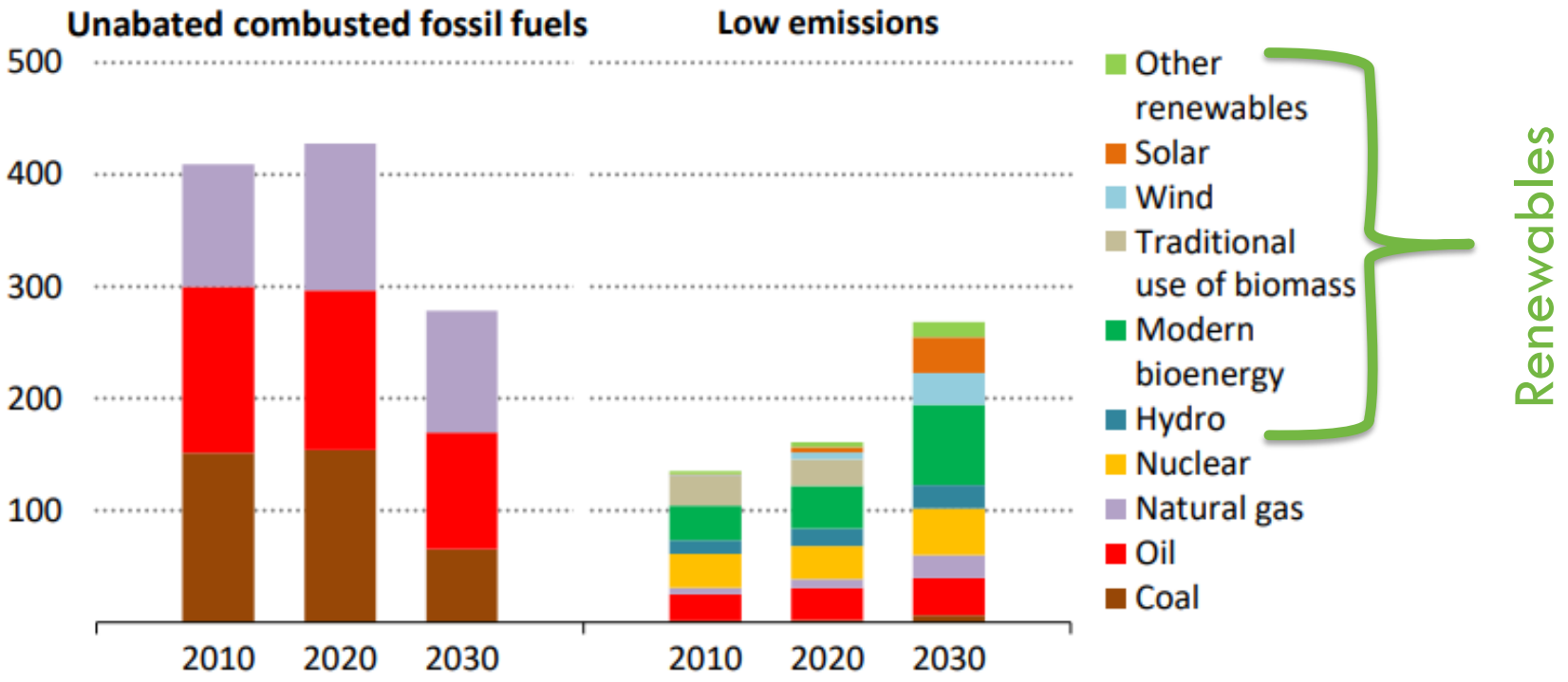
Low (< 10%) Low-medium (10-20%) Medium-high (20-40%) High (40-80%) Extremely high (> 80%)
Thermal power plants Nuclear power plants Refineries Copper mines

(IEA, IAEA)

WMO OMM

Energy transition for climate mitigation

Supply from low emissions sources needs to **double by 2030**

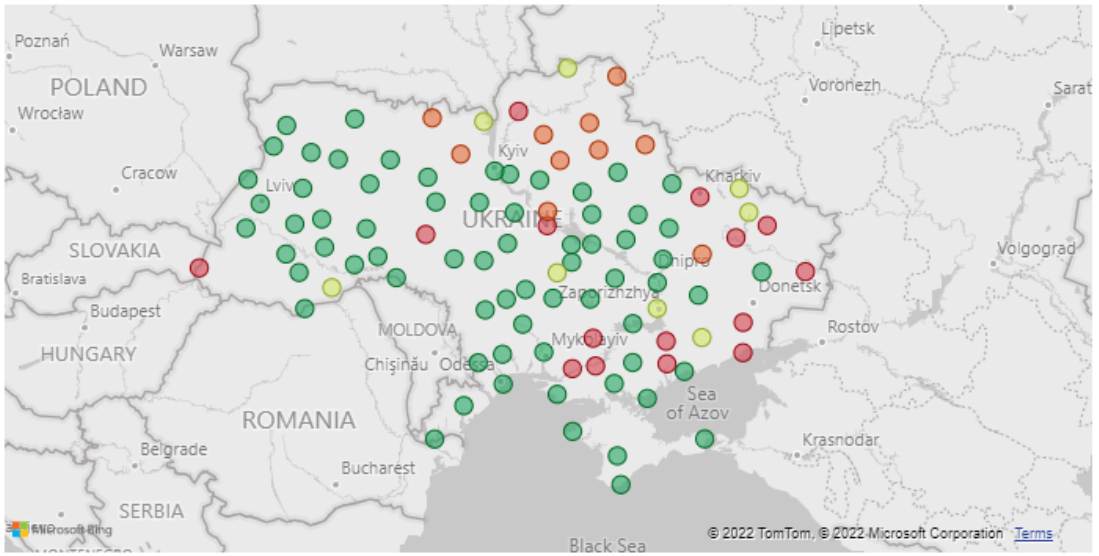


(IEA)

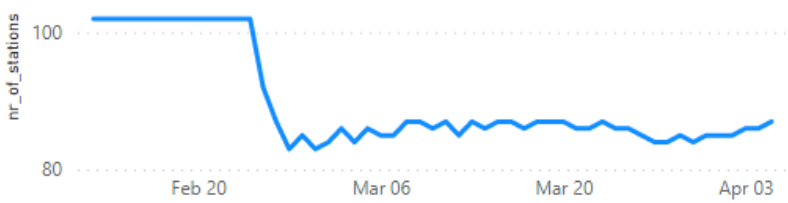
Meteorological station reporting to WMO in Ukraine
20% reduction since Pre-Conflict

Date	Nr received	Nr of stations
4/5/2022	628	87
4/4/2022	634	86
4/3/2022	628	86
4/2/2022	622	85
4/1/2022	622	85
3/31/2022	618	85
3/30/2022	611	84
3/29/2022	604	85
3/28/2022	606	84
3/27/2022	618	84
3/26/2022	616	85
3/25/2022	616	86
3/24/2022	627	86
3/23/2022	628	87
3/22/2022	623	86
3/21/2022	624	86
3/20/2022	614	87
3/18/2022	625	87
3/17/2022	610	86
3/16/2022	614	87

UKR stations: percentage of observations, w.r.t. daily avg. before 23-Feb-22

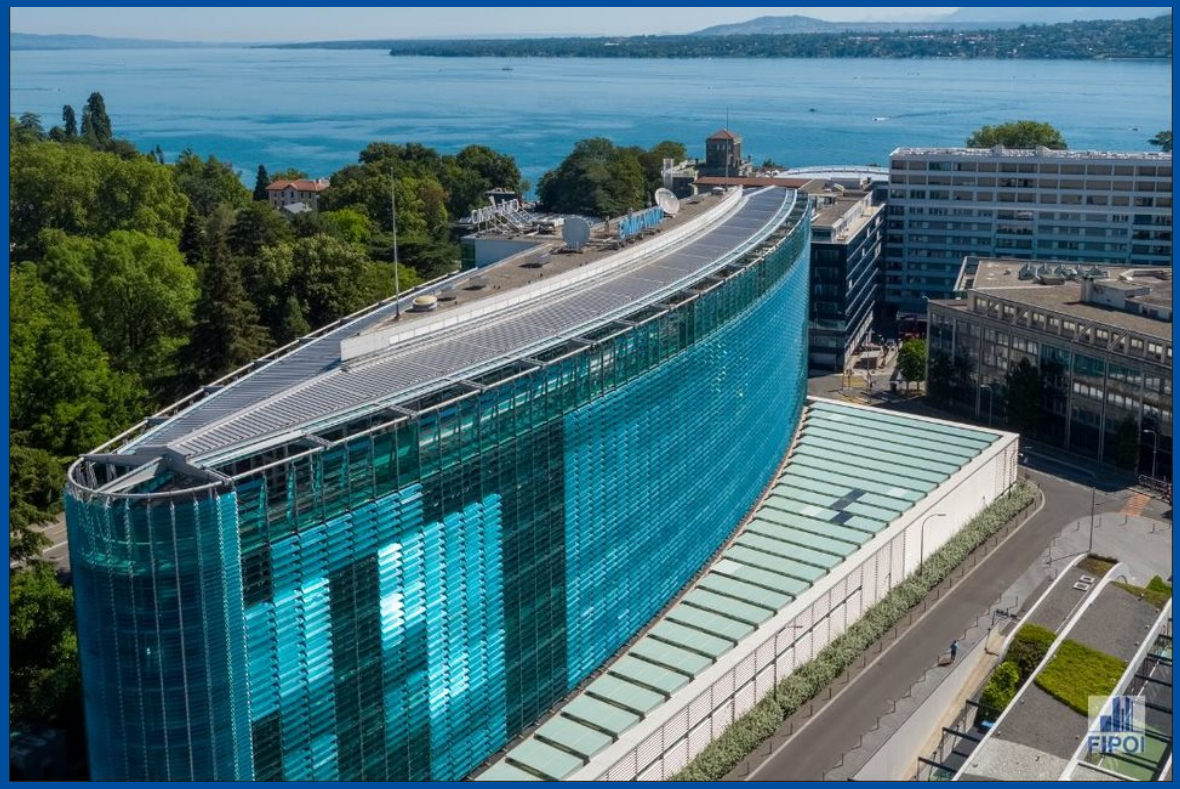


UKR: stations with >=1 observations (pressure)



UKR: total daily received observations (pressure)

WMO OMM



شكرا لكم

Thank you

Gracias

Merci

Спасибо

谢谢

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale