Provisional State of the Global Climate 2022

The global climate system is complex.

In order to unpack such complexity, the WMO State of the Global Climate uses **seven Climate Indicators** to describe the changing climate—providing a broad view of the climate at a global scale. They are used to monitor the domains most relevant to climate change, including the composition of the atmosphere, the energy changes that arise from the accumulation of greenhouse gases and other factors, as well as the responses of land, oceans and ice. The following site aims to provide an overview of the annually produced State of the Climate report.

Please note that this site represents the Provisional State of the Climate 2022, the full report is expected to be launched early 2023. For many indicators, 2022 data is not yet available. Estimates and 2021 data is provided where this is the case.

Greenhouse Gases

The atmospheric concentrations of greenhouse gases reflect *a balance* between emissions from human activities, sources and sinks. Increasing levels of greenhouse gases in the atmosphere due to human activities are a **major driver of climate change.**

Real-time data indicate that global greenhouse gas emissions continued to increase in 2022.

The Big 3

Carbon dioxide (CO_2) is the most important greenhouse gas, and its atmospheric concentration is measured by parts per million (ppm). **Methane (CH_4)** and **nitrous oxide (N_2O)** are also extraordinarily important for the global climate and are measured by parts per billion (ppb). In 2021...

Carbon dioxide: 415.7ppm ± 0.2 = **149% of pre-industrial levels.**

Methane: 1908±2 ppb = **262% of pre-industrial levels.**

Nitrous oxide: 334.5±0.1 ppb = **124% of pre-industrial levels.**

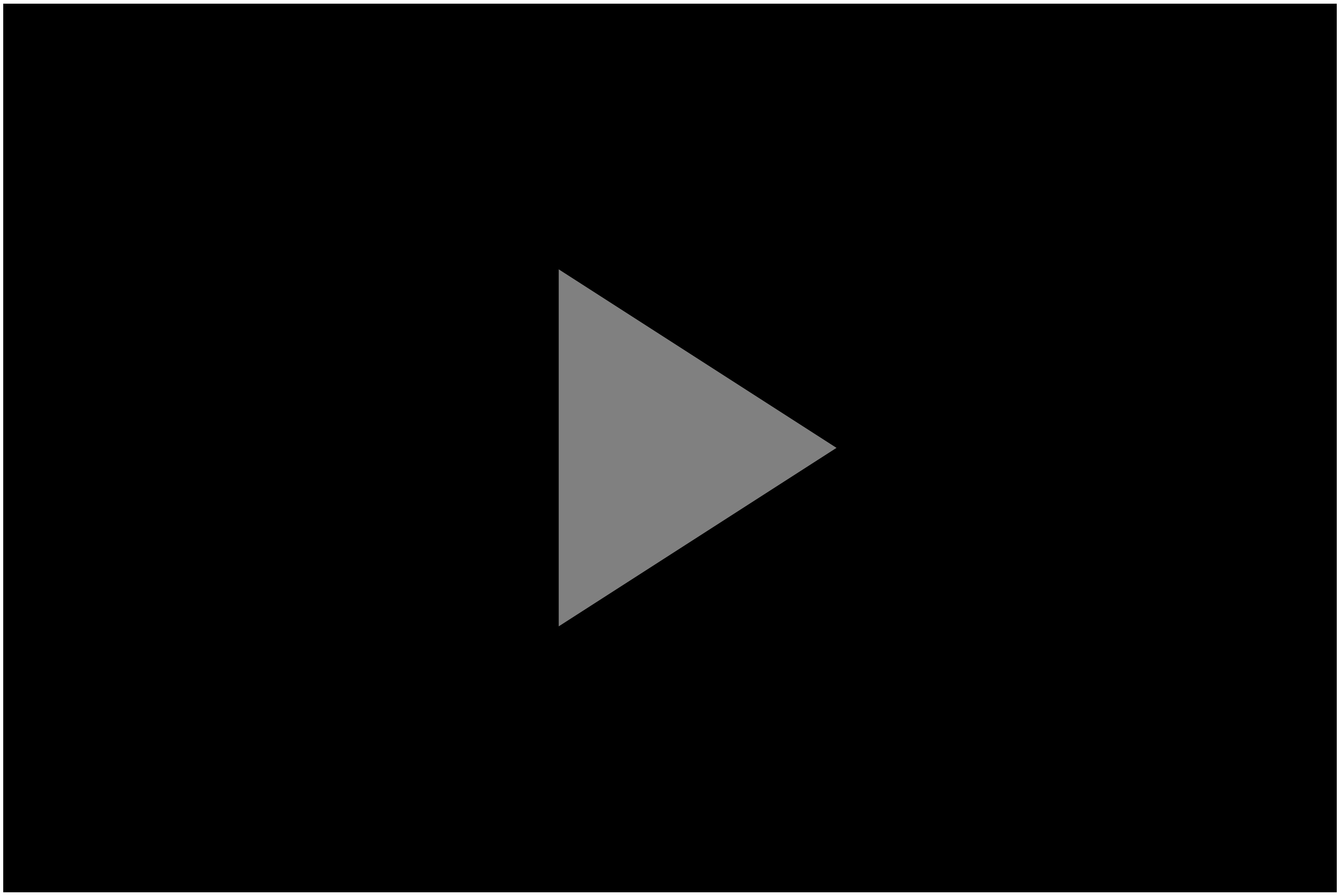
Methane

Methane (CH_4) is a powerful greenhouse gas, **25 times more potent than carbon dioxide** at trapping heat in the atmosphere.

The annual increase of methane was 18 ppb from 2020 to 2021. **This is the largest increase on record.** Its causes are still being investigated.

Methane emissions come from both human and natural sources. Of the natural sources of methane, wetlands are one of the biggest contributors.

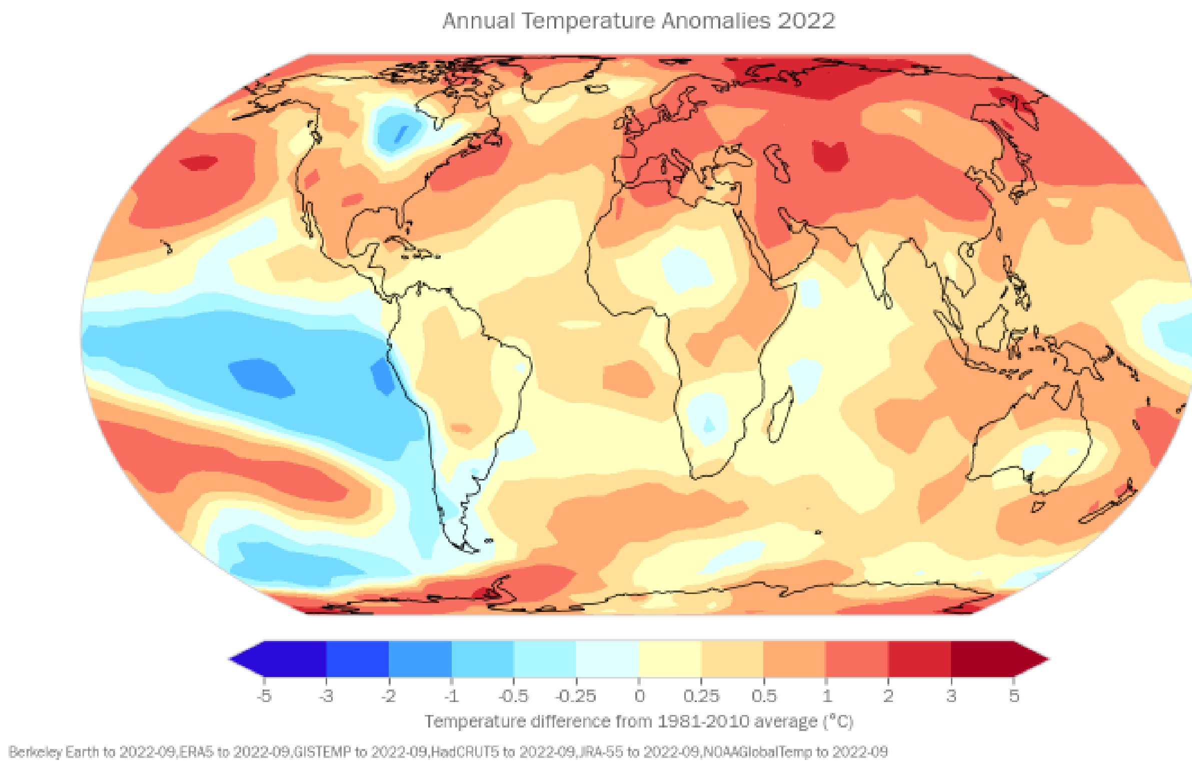
Therefore, there is a need to **improve observations in areas like tropical wetlands to better understand changes in greenhouse gases and to better support efficient mitigation strategies**.



Why do greenhouse gases matter?

Global Mean Surface Temperature

As greenhouse gas concentrations rise, so does global mean surface temperature (GMST). GMST is measured using a combination of air temperature over land, and sea surface temperature in ocean areas, typically expressed as an anomaly from a baseline period.



From January-September 2022, GMST was **1.15 ± 0.13 °C** warmer than the pre-industrial baseline (1850-1900).

Despite La Niña conditions keeping global temperature low for the second consecutive year, **2022 is still likely to be 5th or 6th warmest year on record**.

The last 8 years are likely to be the 8 warmest years on record.

Why does global temperature change from one year to the next?

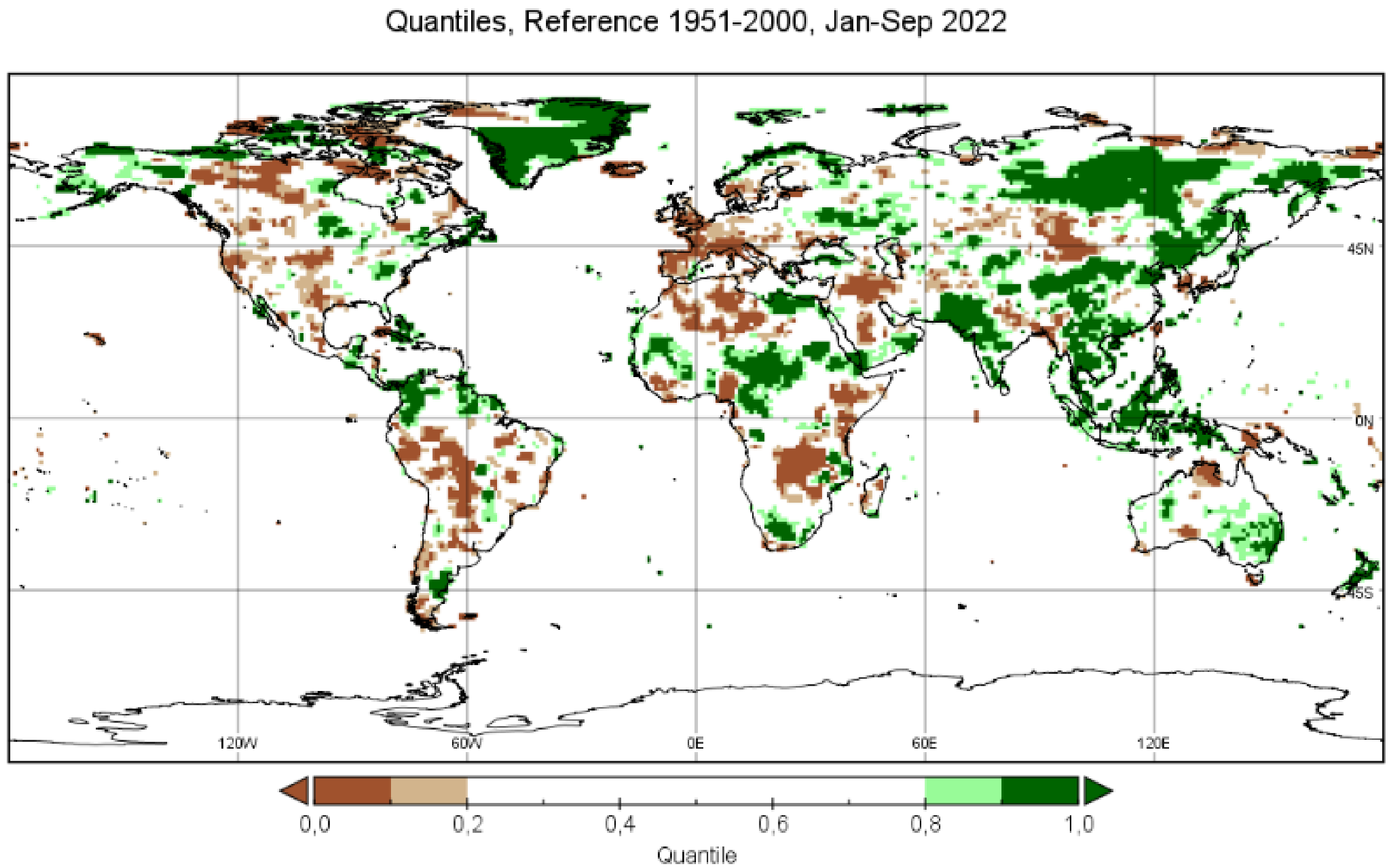
Play the interactive video to find out.

Now, test your knowledge!

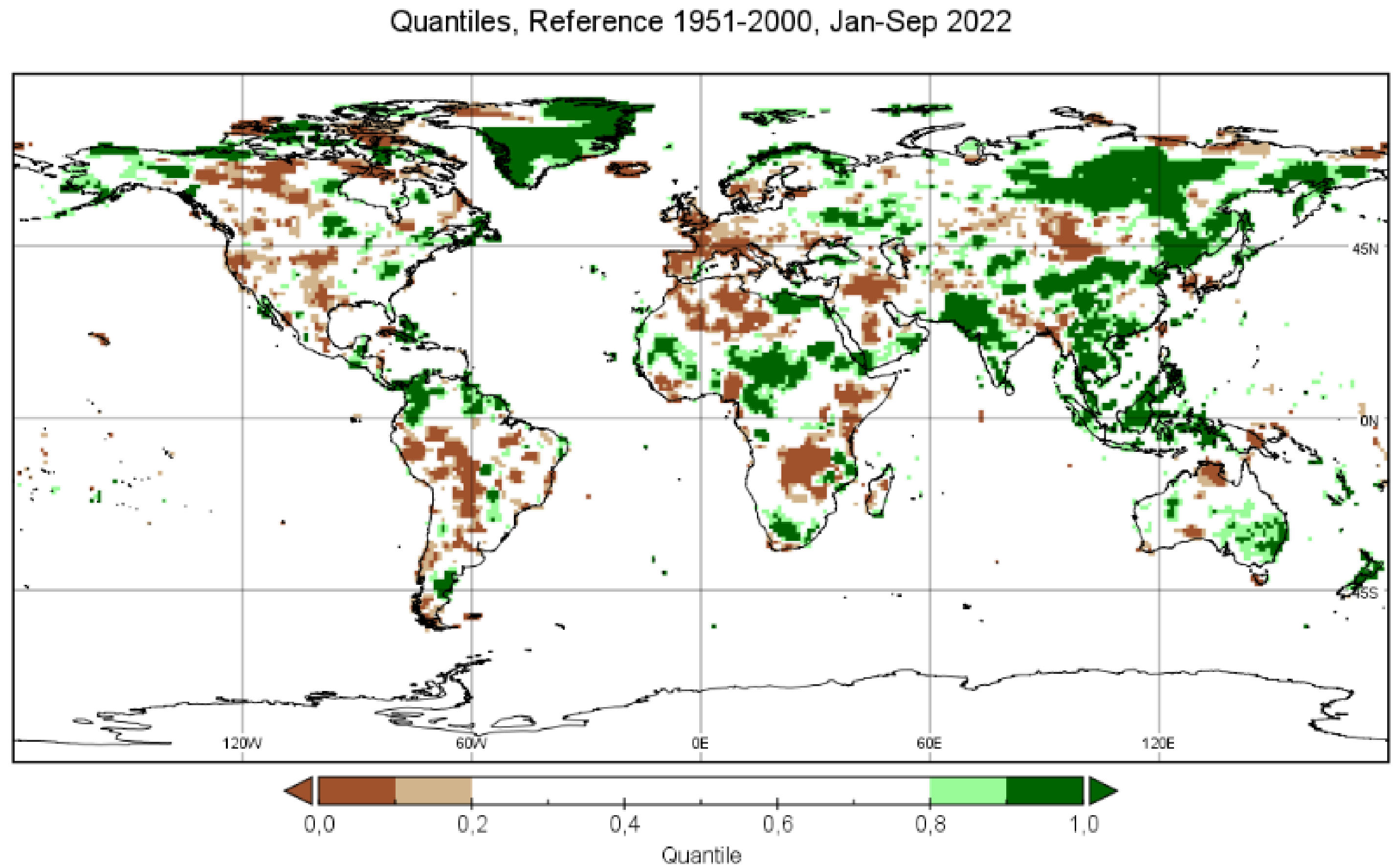
Use the temperature graph from the interactive video on the previous slide to help you answer the question.

Precipitation

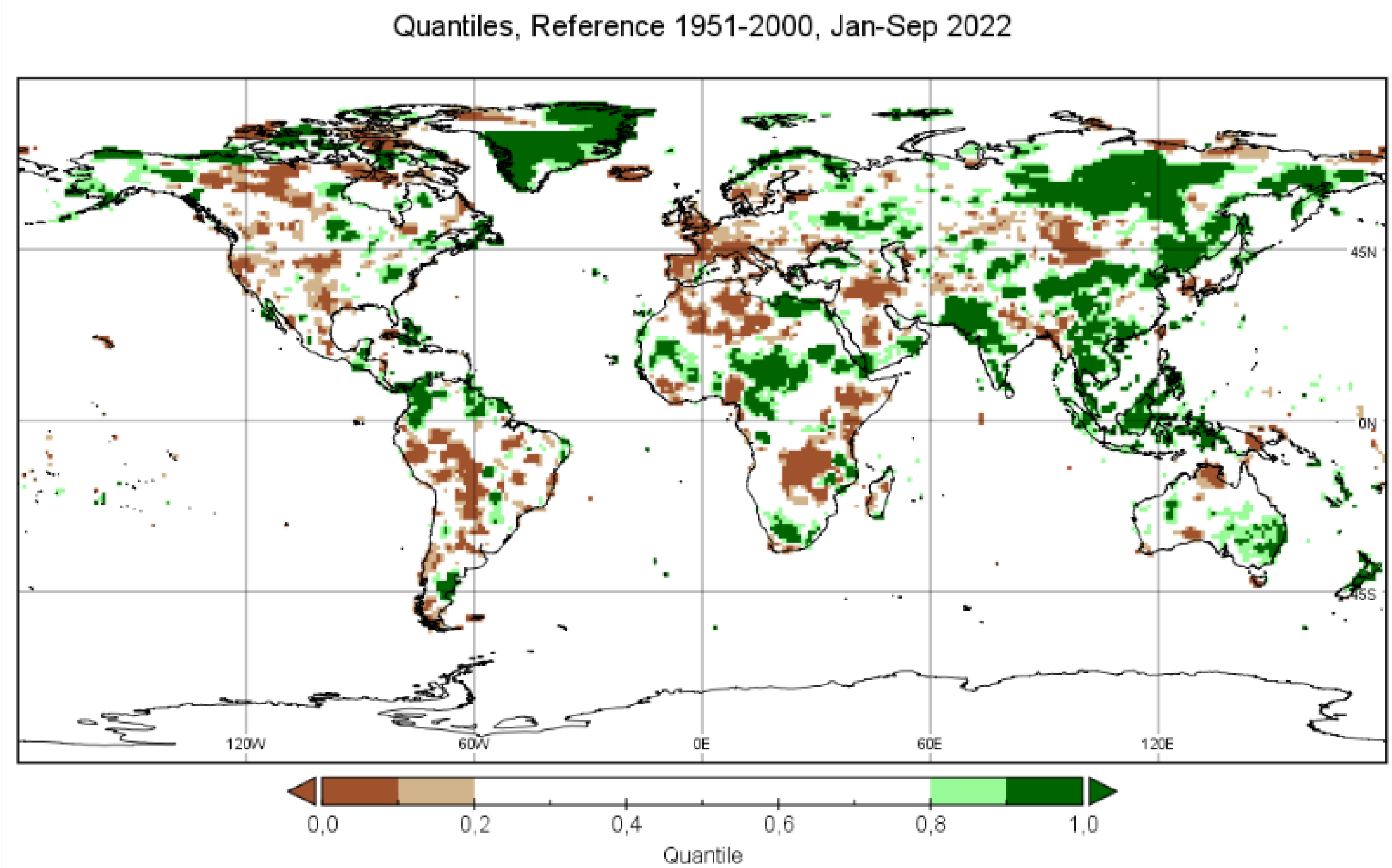
Compared to temperature, precipitation is characterized by higher spatial and temporal variability.



In 2022, large areas with **above normal precipitation** included large parts of Asia, the Maritime Continent, Australia, New Zealand, areas of northern South America, the Caribbean, west Africa, Sudan, coastal areas extending from western Libya to Egypt, and the southern Arabian Peninsula.



Meanwhile, regions with **rainfall deficit** included Europe, Central Asia, Northern Australia, Eastern Africa, most of North Africa, central and southern South America, and central and western North America.



What was precipitation like where you live?

Precipitation Extremes

The majority of the Indian Subcontinent received high precipitation totals and the monsoon extended farther westward then usual towards Pakistan, where there was **extensive flooding**.

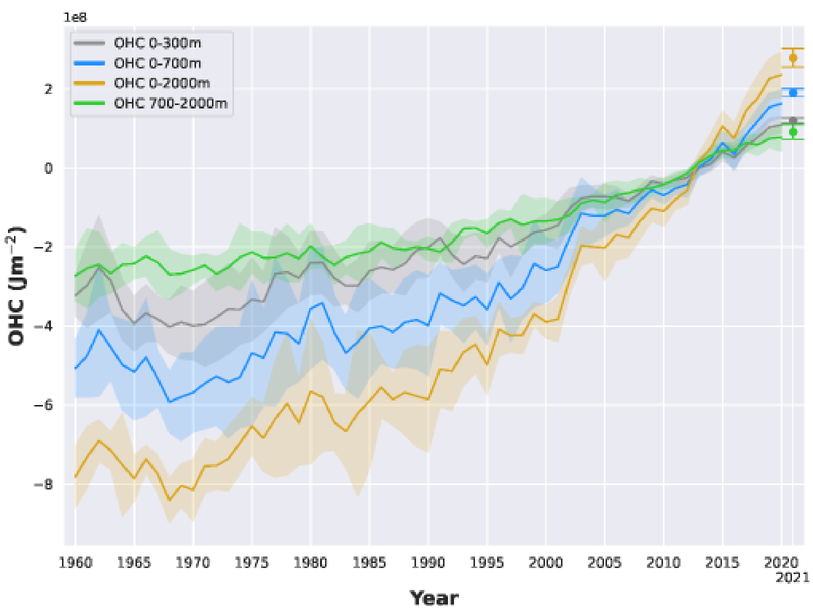
Ocean Heat Content

Around **90% of the excess energy** that accumulates in the earth system due to increasing concentrations of greenhouse gases, **goes into the ocean.**

Ocean Heat Content (OHC) is a measure of this heat accumulation in the Earth system. It is measured at various ocean depths, up to 2000m deep.

All data sets agree that ocean warming rates show a particularly **strong increase in the past two decades**.

The ocean continued to warm in 2021 *(the latest year for which data is available).*

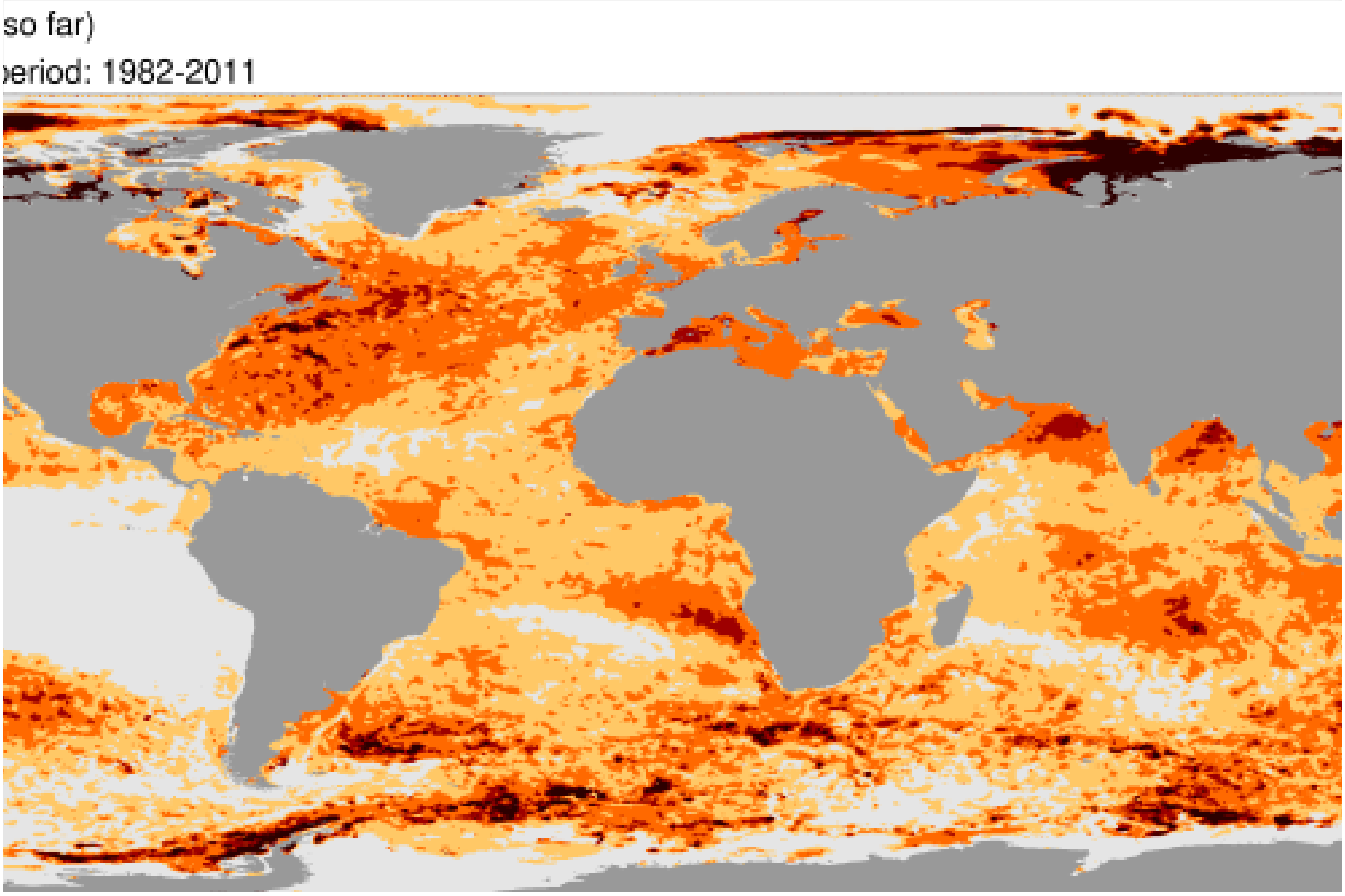


It is expected that the ocean will continue to warm well into the future – **a change which is irreversible on centennial to millennial time scales.**

Why does ocean warming matter?

Coral bleaching

Corals are extremely sensitive to temperature changes. Their health is vital as they create entire ecosystems, serve as source of food for millions, protect coastlines from storms and erosion and serve as a source of tourism.



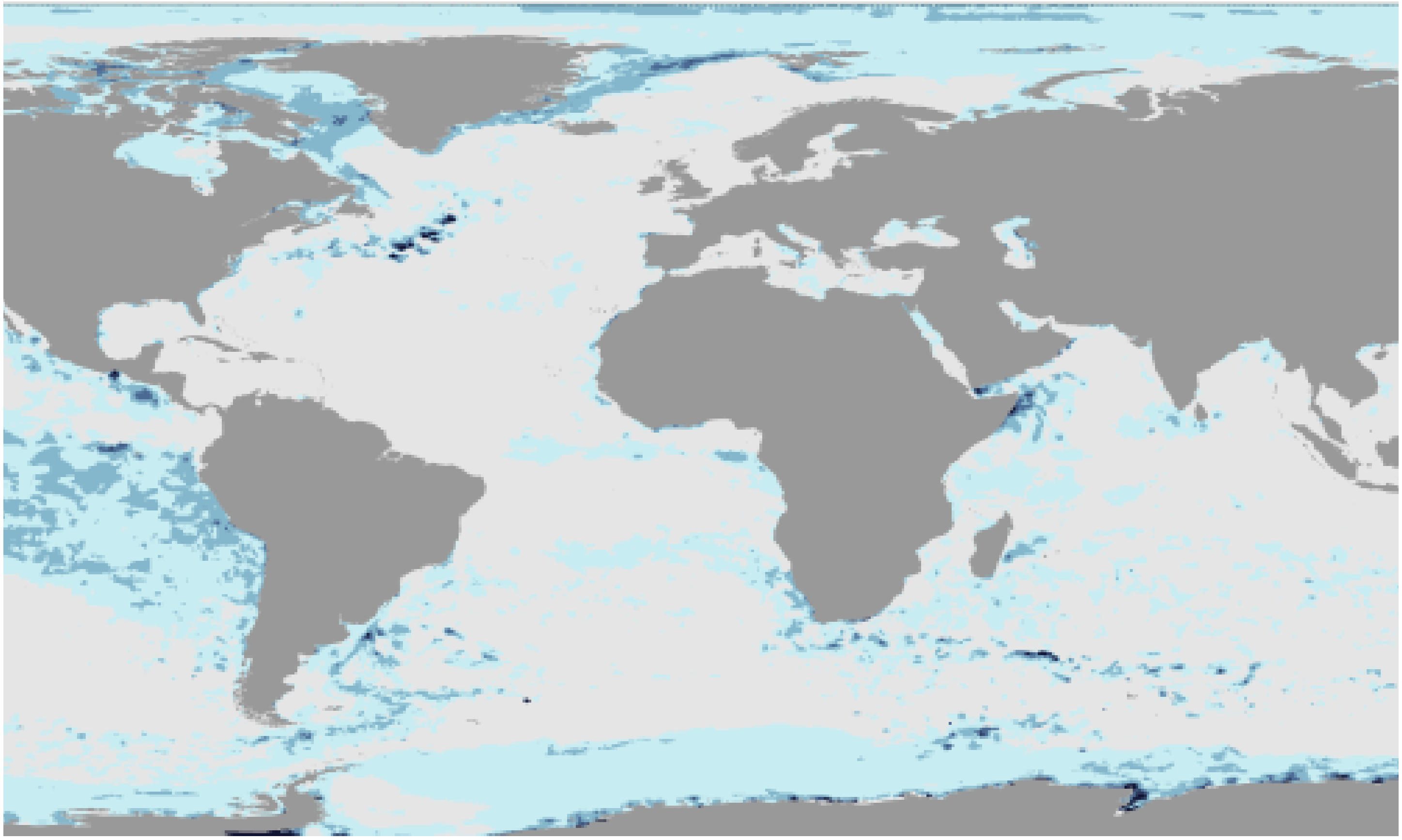
Marine Heatwaves (MHW)

Overall, 55% of the ocean surface experienced at least one MHW during 2022 – the lowest annual coverage since 2012 (57%).

In the Arctic, the Laptev and Beaufort Seas experienced severe and extreme MHWs.

Click on the map to expand.

so far)
period: 1982-2011



Marine Cold Waves

In contrast, 22% of the ocean surface experienced at least one MCW during 2022, much less than the 1985 record (63%).

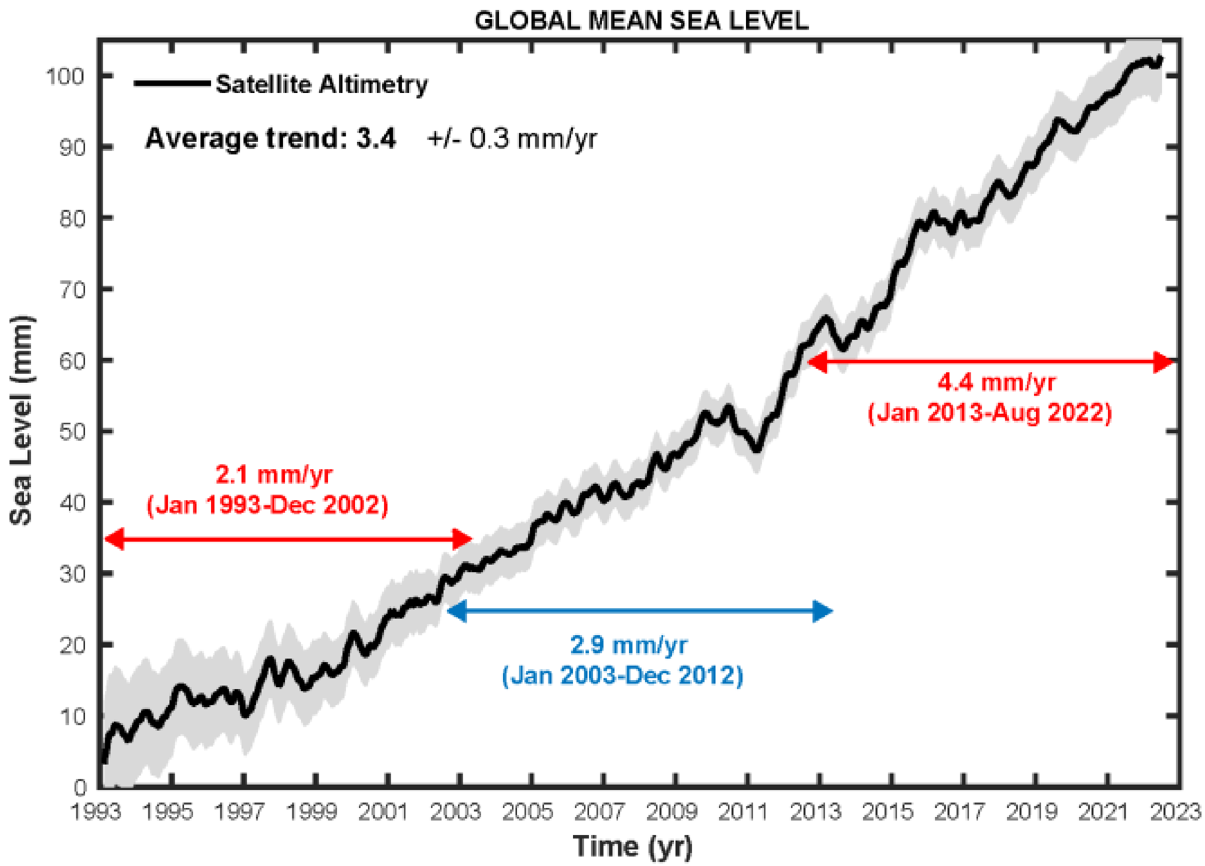
The ongoing La Niña mean that the **equatorial Pacific is one of the few ocean regions to see wide-spread coverage of strong MCS in 2022.**

Click on the map to expand.

Sea Level Rise

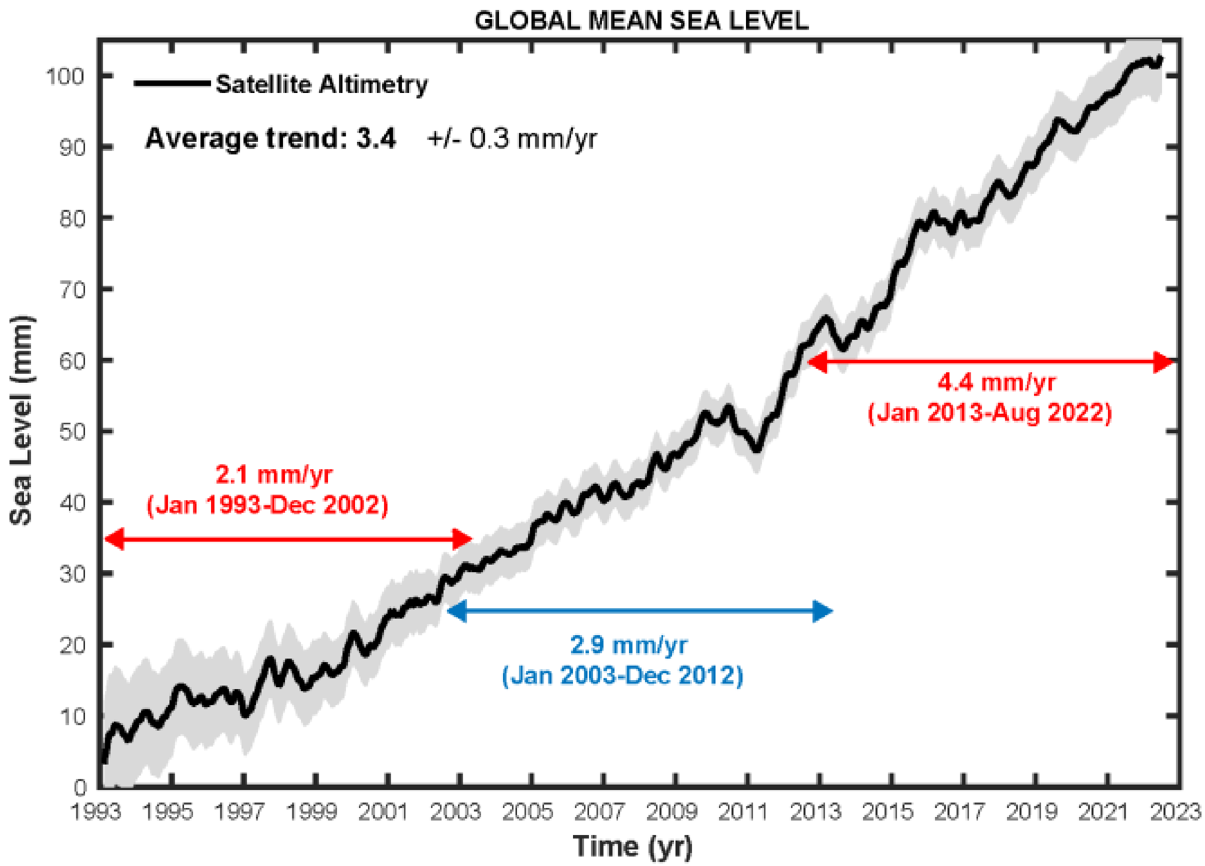
As water warms, it expands. Therefore, rising ocean temperatures are a key contributor to rising sea levels around the globe.

Sea Level Rise



In 2022, global mean sea level (GMSL) continued to rise.

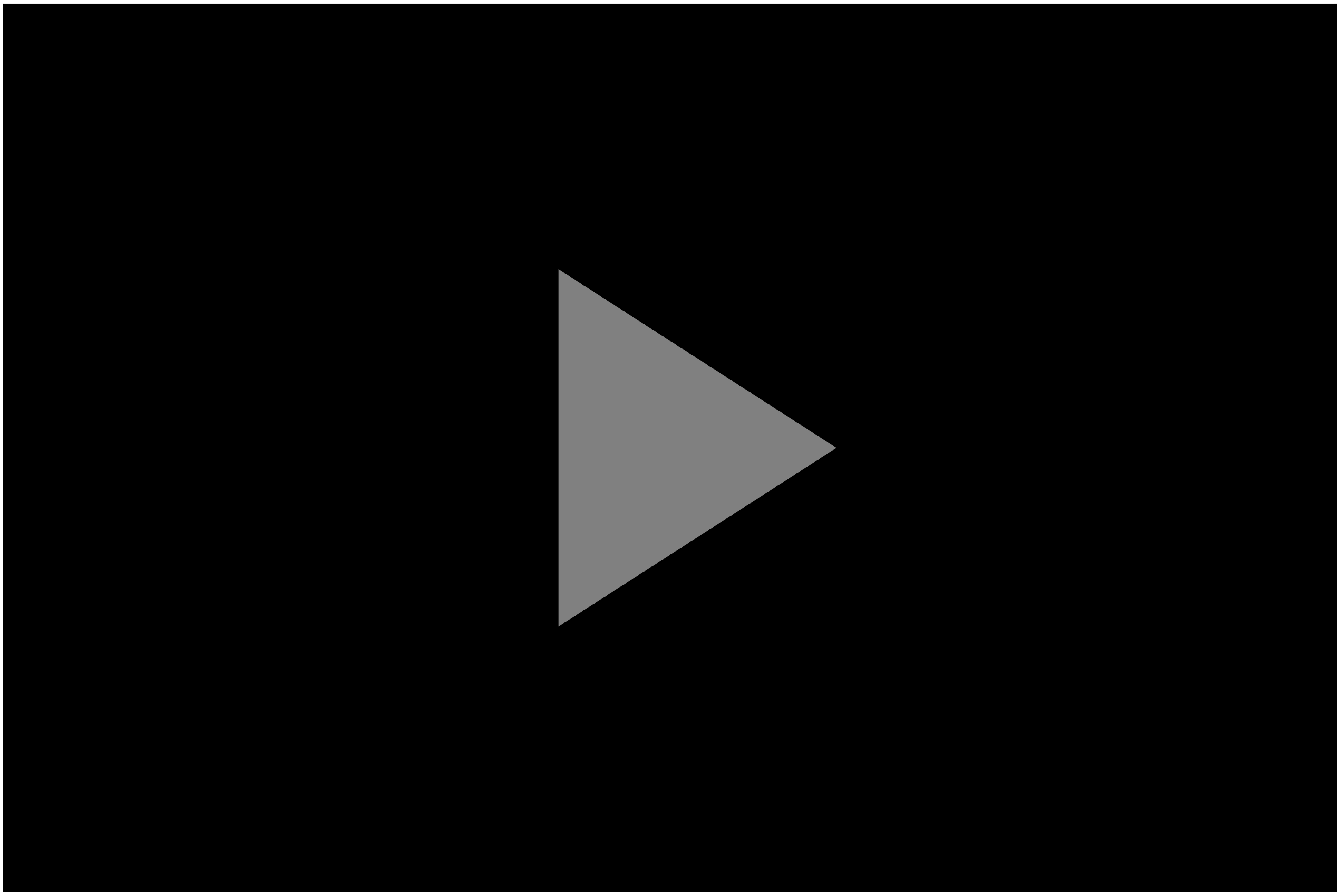
However, sea level does not rise equally everywhere: regional patterns of sea level change are dominated by local changes in ocean heat content and salinity.



Sea level has risen around 10 mm since January 2020.

While this may not sound significant, it is nearly 10% of rise since 1993 in less than 2 years, despite the ongoing La Niña.

Check your understanding!



What's the big deal?

Ocean Acidification

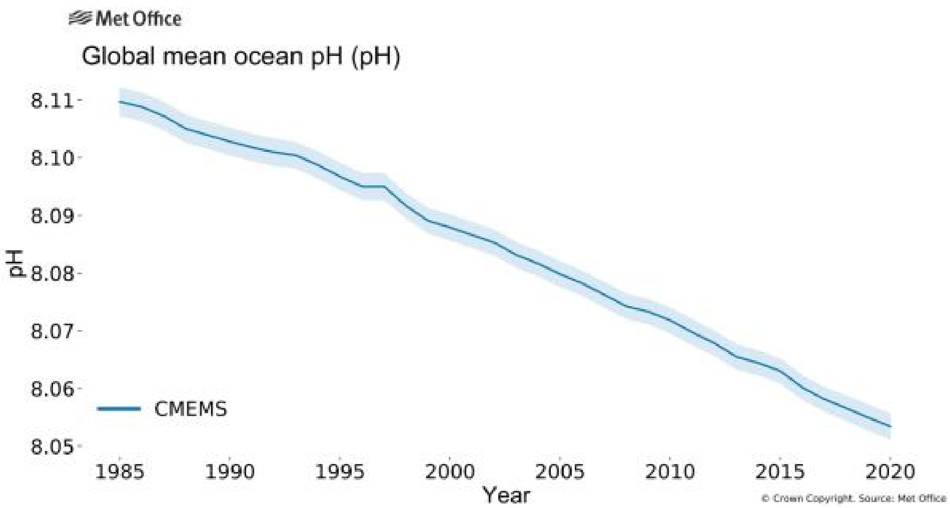
One impact of rising CO2 concentration is **ocean acidification.**

The ocean absorbs around **23%** of the annual emissions of anthropogenic CO2 to the atmosphere, helping to alleviate the impacts of climate change but at **a high ecological cost to the ocean.**

CO2 reacts with seawater and increases its acidity. **It endangers organisms and ecosystem services, including food security**, by endangering fisheries and aquaculture. It also affects coastal protection by **weakening coral reefs, which shield the coastline, and encourage tourism.**

As the pH of the ocean decreases, meaning that it's acidity increases, its capacity to absorb CO_2 from the atmosphere also **declines.**

Global mean ocean pH has been steadily declining at rates not seen for at least the past 26,000 years:



Global mean surface pH from E.U. Copernicus Marine Service Information (blue) covering the period 1985-2020. The shaded area indicates the estimated uncertainty in each estimate. Data from Copernicus Marine Environment Monitoring Service. Source: Met Office, United Kingdom.

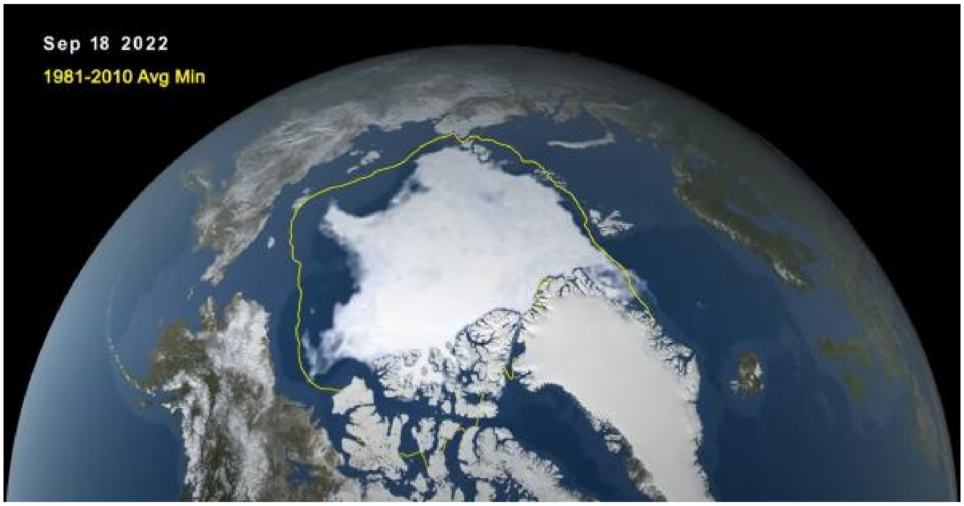
Sea Ice Extent

Sea ice extent **measures areas covered by an ice concentration greater than 15%.**

It serves as a useful indicator of climate change particularly given how quickly change occurs in the Arctic and how widespread the repercussions of its cover can be.

Arctic Sea Ice

Arctic sea-ice extent was below the long-term average for most of the year. The September extent was **1.54 million km^2 below the long-term mean extent**, making it tied for the 11th lowest monthly minimum ice extent in the satellite record.



Minimum sea ice extent compared to the long-term average (1981-2010) in the Arctic on September 18, 2022.

Explore the levels of maximum and minimum sea ice extent values in the Arctic from 1979-2022. *Source: EUMETSAT OSI SAF v2p1 and National Snow and Ice Data Center (NSICD) v3.*

Antarctic Sea Ice

Antarctic sea-ice extent dropped to 1.92 million km2 on February 25 2022, the **lowest level on record** and almost 1 million km^2 below the long-term (1981-2010) mean.

The total extent of Antarctic sea ice continued to be below average up to October 2022 -- it was even record low at times in June and July.

Explore the levels of maximum and minimum sea ice extent values in the Antarctic from 1979-2022.
Source: EUMETSAT OSI SAF v2p1 and National Snow and Ice Data Center (NSICD) v3.

Greenland Ice Sheet

The Greenland Ice Sheet ended with a negative total mass balance for the **26th year in a row.**

September 2022 broke several records. Summit Station, the highest point in Greenland had its warmest September on record and experienced melting for the first time. Heavy rain fell on the ice sheet, another first for September.

Glacier Mass Balance

Glaciers, including ice sheets, are distributed across the planet, with concentrations in the high mountain ranges of Asia, and North and South America. As providers of ecosystem services and freshwater supply to millions around the world, **glacial loss has significant and direct impacts on both the global climate and sustainable development.**

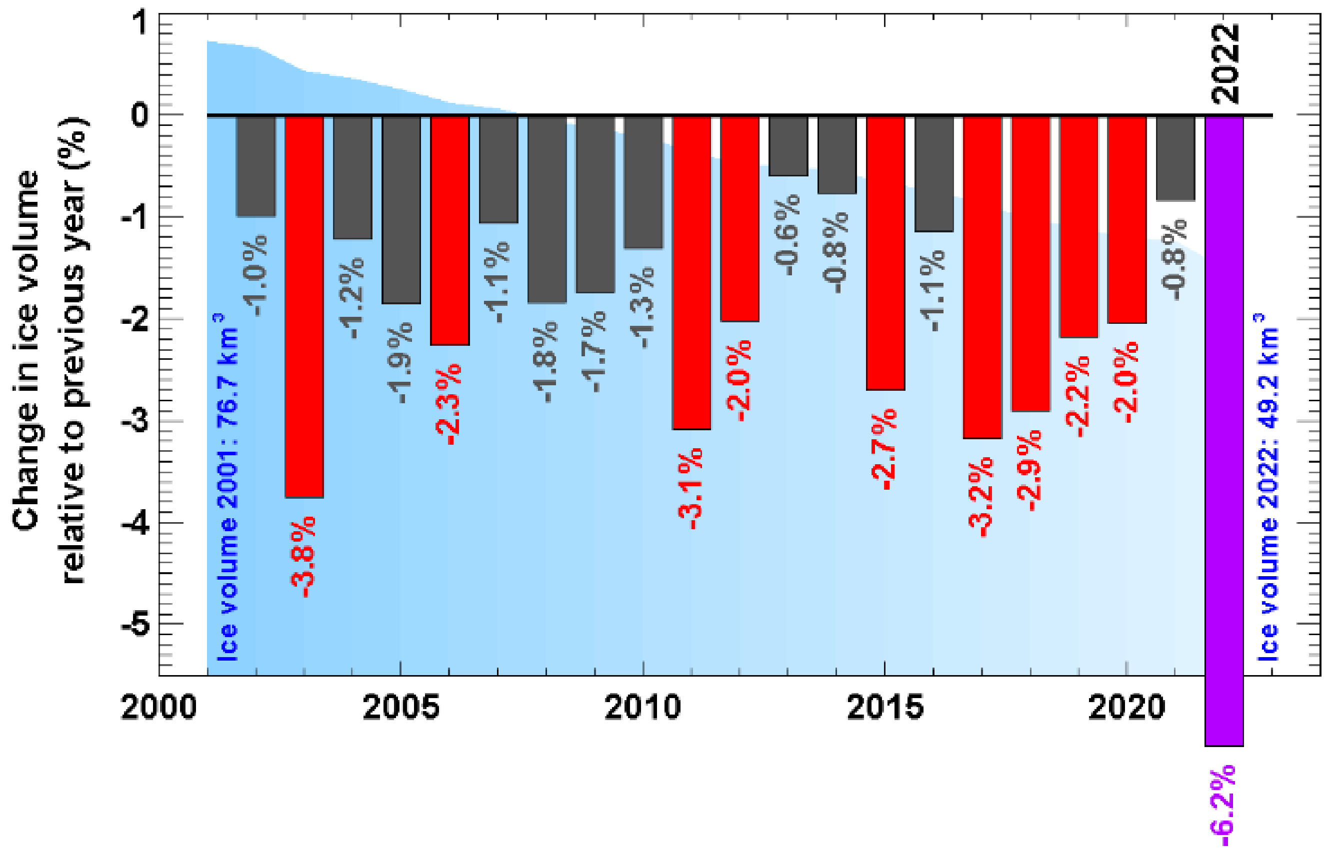
Swipe to see how fast glaciers are shrinking worldwide:

Stein Glacier in 2006 (left) and 2015 (right)

From 2020-2021, the glaciers with long-term observations experienced an average mass balance of **–0.77 m water equivalent (m w.e.)**.

This is a smaller loss than the average for the last decade but still **more than the average for the period 1991-2020.**

Preliminary results for 2022 are only available for a few selected regions at this time, as field observations are recently completed and need to be evaluated.



Exceptional Glacier Mass Loss in Swiss Alps

In the European Alps, records of glacier mass loss were shattered in 2022.

Mass losses were far beyond normal. In Switzerland **6% of the glacier ice volume was lost** between 2021 and 2022. There are three reasons for this extreme glacier melt.

1. Very little winter snow meant that the ice was unprotected in early summer.
2. Saharan dust blew over the Alps darkening the snow surface, making ice melt faster.
3. Long and persistent heat waves between May and early September 2022 led to massive ice loss.

For the first time in history, no snow outlasted the summer season even at the very highest measurement sites and

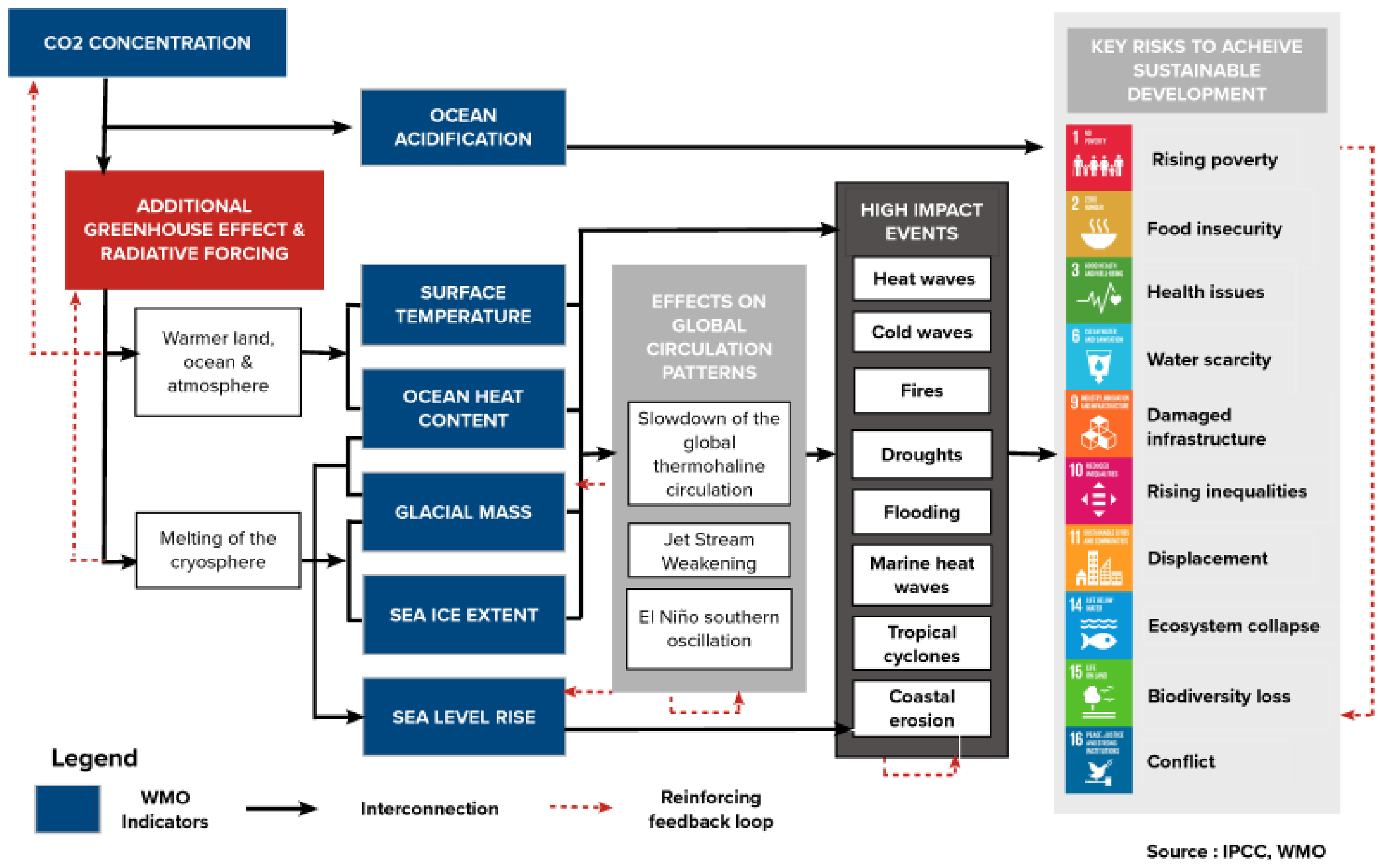
thus no accumulation of fresh ice occurred.

Extreme Events

Rising global temperatures have contributed to more frequent and severe extreme weather events around the world, including cold and heat waves, floods, droughts, wildfires and storms.

Provisional Extreme Events 2022

Risks & Impacts



Impacts on Sustainable Development

Rising atmospheric CO2 concentrations lead to cascading effects via six of the other key climate indicators that perpetuate warming and contribute to high impact events, **risking the achievement of the Sustainable Development Goals (SDGs)**.

Food Security

As of 2021, 2.3 billion people faced food insecurity, corresponding to 9.8% of the global population. Rising undernourishment has been exacerbated by the compounded effects of COVID-19 on health, food security, incomes, and equality, as well as of protracted conflicts and violence.

Swipe to see a few key climate drivers of food security until September 2022.

Heatwaves in India & Pakistan

The pre-monsoon period was exceptionally hot in India and Pakistan.

The heat caused a decline in crop yields. This, combined with the banning of wheat exports and restrictions on rice exports in India, are threatening the international food markets and posing risks to countries already affected by shortages of staple foods.

Flooding in Pakistan

The flooding in Pakistan led to the spread of water-borne diseases with the greatest impacts among the most vulnerable and food-insecure regions of southern and central Pakistan. As it could take months for the water to recede, the threat of waterborne diseases and food inaccessibility are expected to rise.

Drought in Horn of Africa

Under the effects of the drought and other shocks, an estimated **18.4-19.3 million people have faced acute food insecurity before June 2022**. 75% of the total refugee population have been affected by major cuts in food assistance.

Displacement

Extreme weather events and conditions have had major and diverse impacts on population displacement and on the vulnerability of people already displaced throughout the year. From Afghanistan to Central America, droughts, flooding and other extreme weather events are hitting those least equipped to recover and adapt.

Swipe to see a few key climate drivers of human mobility until September 2022.

Floods

Preliminary satellite data indicated that 75 000 square kilometres, about 9% of Pakistan's area, was inundated at some stage during August. Some 33 million people were affected, and 7.9 million people were displaced, with nearly 600 000 living in relief sites.

Floods

Floods also triggered 663 000 displacements in the Indian state of Assam.

Floods

In Bangladesh, the worst floods in 20 years have affected some 7.2 million people with 481 000 displacements recorded. In Cox's Bazar, heavy rains affected nearly 60 000 refugees and triggered secondary displacement. Emergency shelter assistance was provided to over 15 000 affected families.

Floods

More than 190 000 people who lost or fled their homes during Tropical Storm Ana in January remained displaced inside Malawi in April.

Two months after the storm had displaced over 20 000 IDP households in Mozambique, 736 000 people were affected by Tropical Cyclone Gombe in Nampula and Zambezia provinces, while over 129 000 people were internally displaced.

Droughts

Over 1.1 million people have been internally displaced in Somalia as a consequence of the drought by September 2022. Fleeing a complex mix of conflict and drought, over 16 000 Somali refugees arrived in Dollo Ado, Ethiopia and another 10 000 in Kenya until June 2022.

Such situations highlight the **importance of disaster preparedness and risk management**, but also for supporting solutions to displacement that are sustainable and **supporting the resilience of people who might otherwise see their living conditions progressively eroded through repeated disasters and displacement**.

Ecosystems

Ecosystems – including terrestrial, freshwater, coastal and marine ecosystems – and the services they provide, are affected by the changing climate and some are more vulnerable than others.

Ecosystems are degrading at an unprecedented rate, limiting their ability to support human well-being and harming their adaptive capacity to build resilience.

Mountain Ecosystems

Mountain ecosystems – the water towers of the world – are vulnerable and can be profoundly affected by climate change due to their low capacity to adapt. **This may affect the 1.9 million people living in mountain areas**.

Climate change may exacerbate water stress, especially in areas of decreased precipitation and where groundwater is already being depleted, affecting agricultural production, arable land, and the more than 2 billion people who are already experiencing water stress.

Biodiversity Loss & Extinction

Substantial changes in species' abundance and distribution may in turn affect the interactions between species. Climate change also exacerbates other threats to biodiversity.

The number of species projected to go extinct increases dramatically as global temperatures rise – and is 30% higher at 2 °C warming than at 1.5 °C warming.

Arctic Ecosystems

Climate change is triggering the disintegration of the Greenland and Antarctic ice sheets and increasing the chances of the Arctic Ocean being ice-free in the summer, further disrupting ocean circulation and Arctic ecosystem.

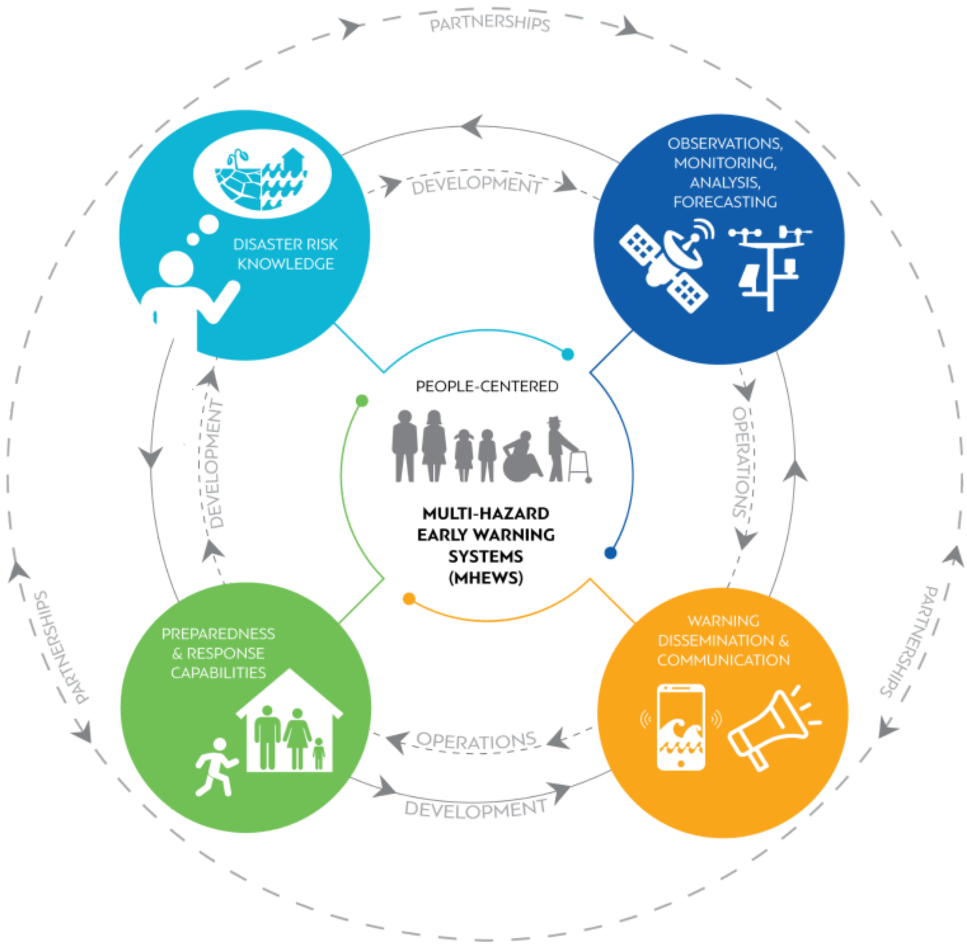
Coastal & Marine Ecoystems

Rising temperatures heighten the risk of irreversible loss of marine and coastal ecosystems, including seagrass meadows and kelp forest.

Coral reefs are especially vulnerable to climate change. They are projected to lose between 70 and 90% of their former coverage area at 1.5 °C of warming and over 99% at 2 °C.

What can we do?

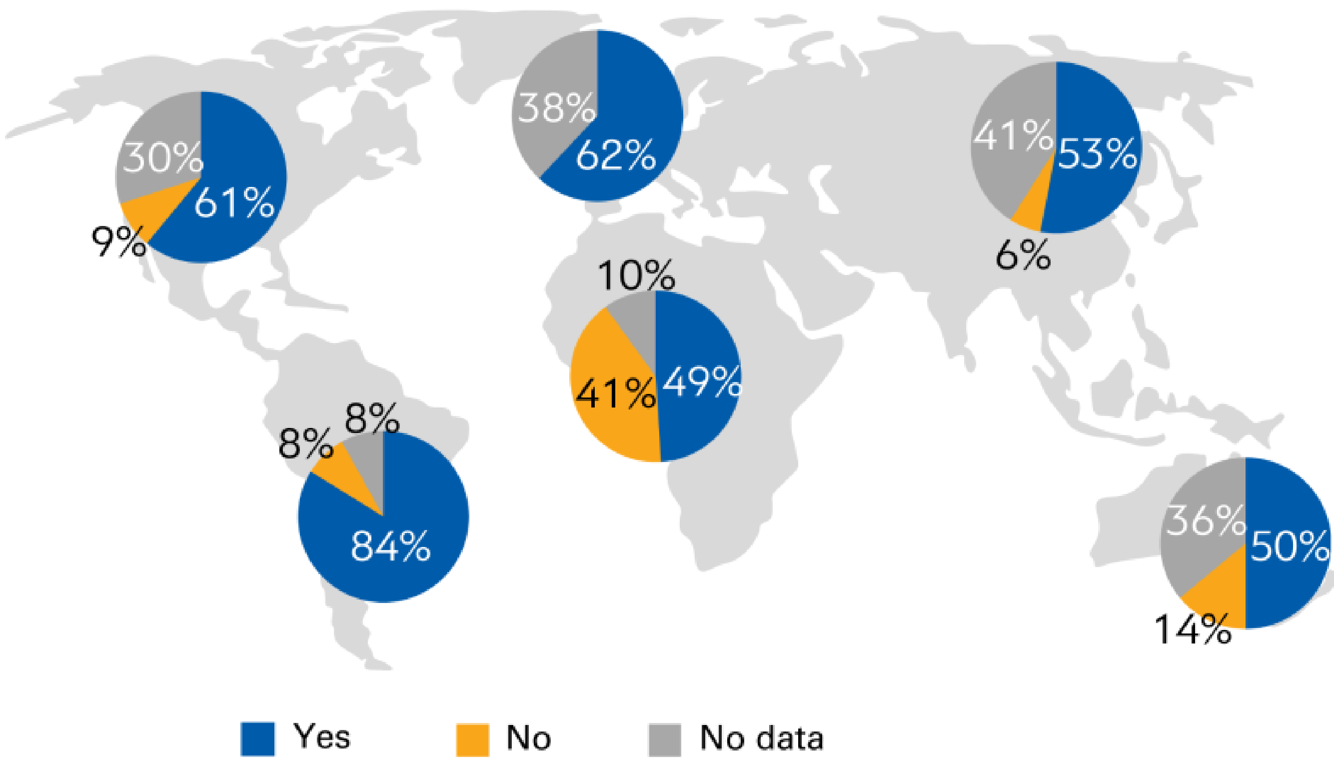
The climate is changing in unprecedented ways, but there are still many options to alliviate the impacts, through both mitigation and adaptation.



Adaptation

As extreme weather events become more frequent and intense, **predictions must go beyond what the weather will *be* to include what the weather will *do*.**

Early Warning Systems allow people to know hazardous weather is on its way, and informs how governments, communities and individuals can act to minimize the impending impacts.



However, **one-third of the world's people**, mainly in least developed countries and small island developing states, **are still not covered by early warning systems.**

In Africa, it is even worse: 60% of people lack coverage.

To face this challenge, UN Secretary-General António Guterres has tasked the World Meteorological Organization to lead the effort to **ensure every person on Earth is protected by early warning systems within five years.**

Find out more here.

Mitigation

However, even if adaptation is improved, the climate will continue to change unless the underlying drivers are addressed.

According to the IPCC, **without immediate and deep emissions reductions** across all sectors and regions, **it will be impossible to keep warming below 1.5° C.**

Fortunately, there are ways for everyone to take their part.

How could your sector work toward limiting emissions?

IPCC Mitigation of Climate Change

Time for one last quiz!

Your feedback is important to us and helps us improve.

WMO uses datasets developed and maintained by the United States National Oceanic and Atmospheric Administration, NASA's Goddard Institute for Space Studies, and the United Kingdom's Met Office Hadley Centre and the University of East Anglia's Climatic Research Unit in the United Kingdom.

It also uses reanalysis datasets from the European Centre for Medium Range Weather Forecasts and its Copernicus Climate Change Service, and the Japan Meteorological Agency. This method combines millions of meteorological and marine observations, including from satellites, with models to produce a complete reanalysis of the atmosphere. The combination of observations with models makes it possible to estimate temperatures at any time and in *any place across the globe, even in data-sparse areas such as the polar regions.*

Internationally recognized datasets are used for all other key climate indicators. Full details are available in the State of the Global Climate report.

Videos	NASA, UNEP, WMO
Data Visualization	Claire Ransom, Nirina Ravalitera