Climate Change

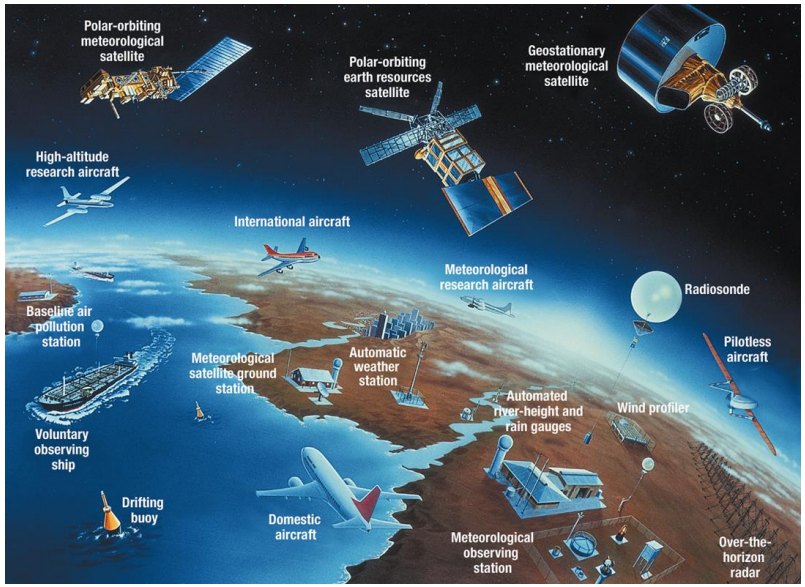
Prof. Petteri Taalas
Secretary-General

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale

World Meteorological Organization



- UN Specialized Agency on weather, climate & water
- 191 Members, HQ in Geneva
- 2nd oldest UN Agency, 1873-
- Coordinates work of ~200 000 national experts from meteorological & hydrological services and academia
- Co-Founder and host agency of IPCC (1st World Climate Conference)
- Co-Founder of UNFCCC (2nd World Climate Conference)

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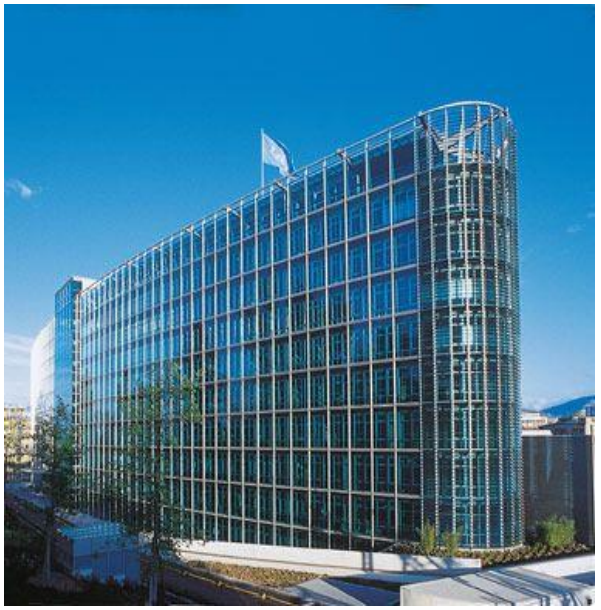
WMO Mission/key activities



1. World climate
2. Weather, disasters & safety
3. Oceans and water resources
4. Data & technology
5. Strengthening of the national service capabilities
6. Atmospheric research
7. Efficient governance

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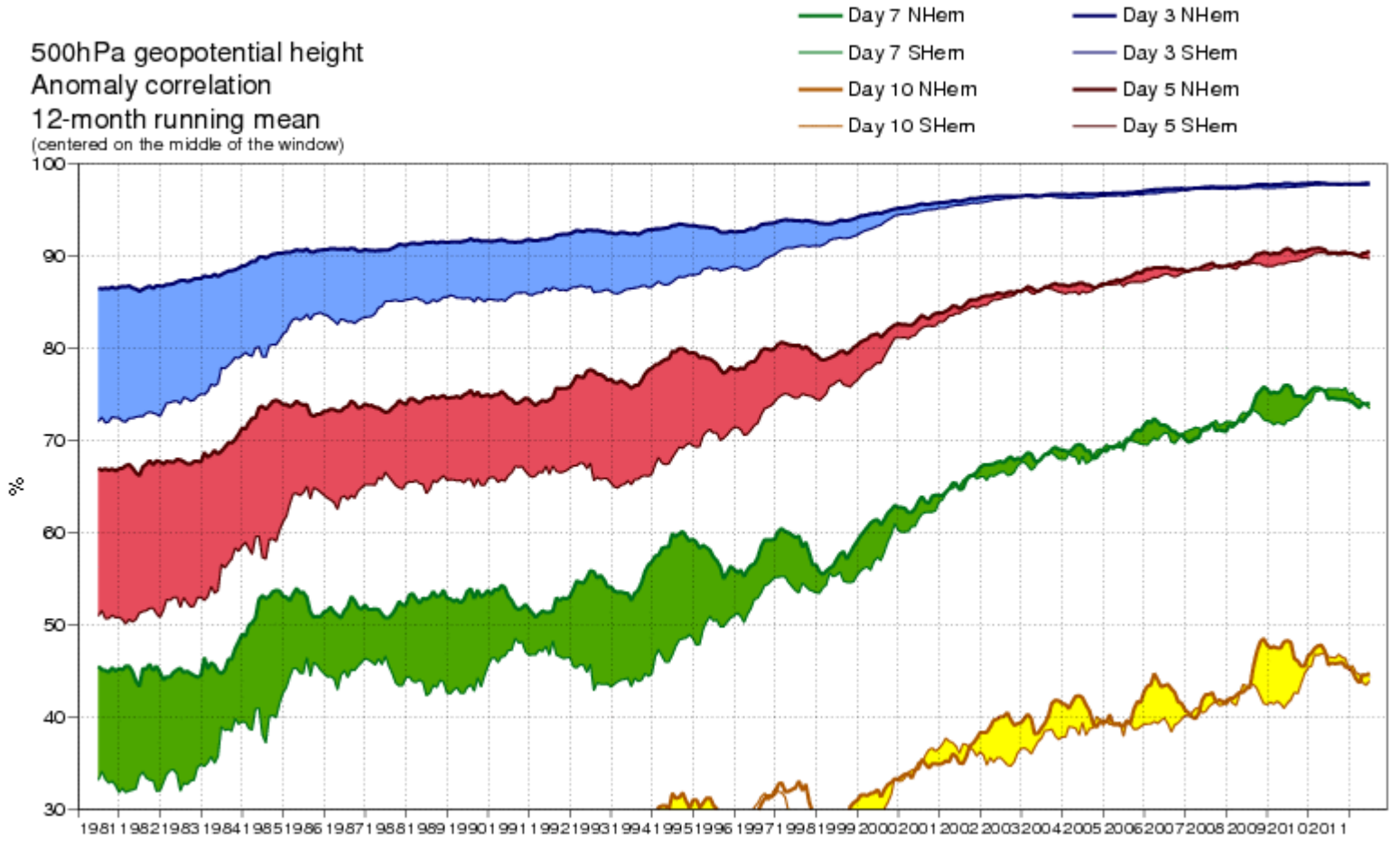
Improved weather forecasts



Improvements in anomaly correlation of 500 hPa height forecasts of the European Centre for Medium-Range Weather Forecasts (ECMWF) for the northern and southern hemispheres linked to the increase in satellite observations and skill of numerical models

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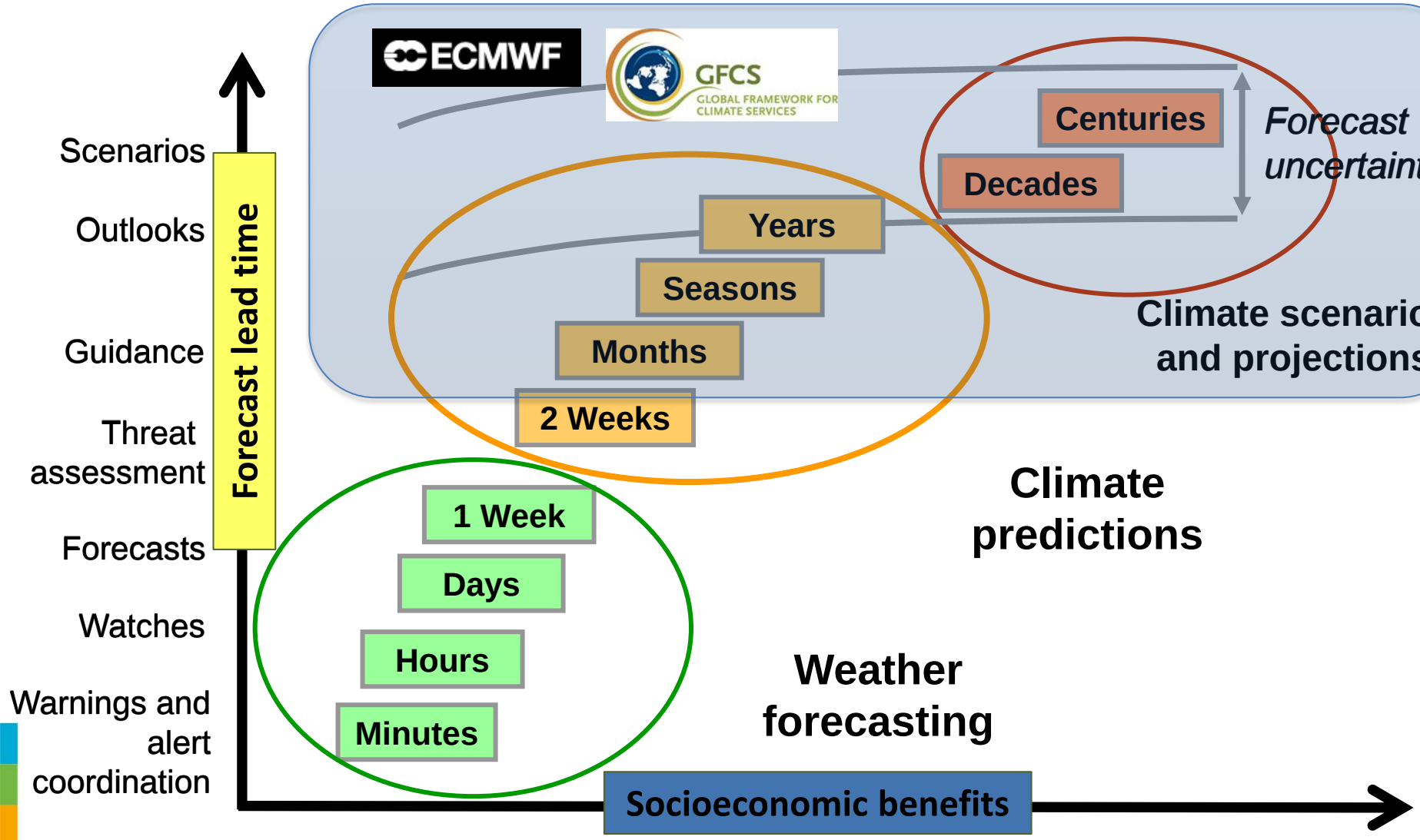
Weather to climate: a seamless framework



Adapted from NOAA 2011

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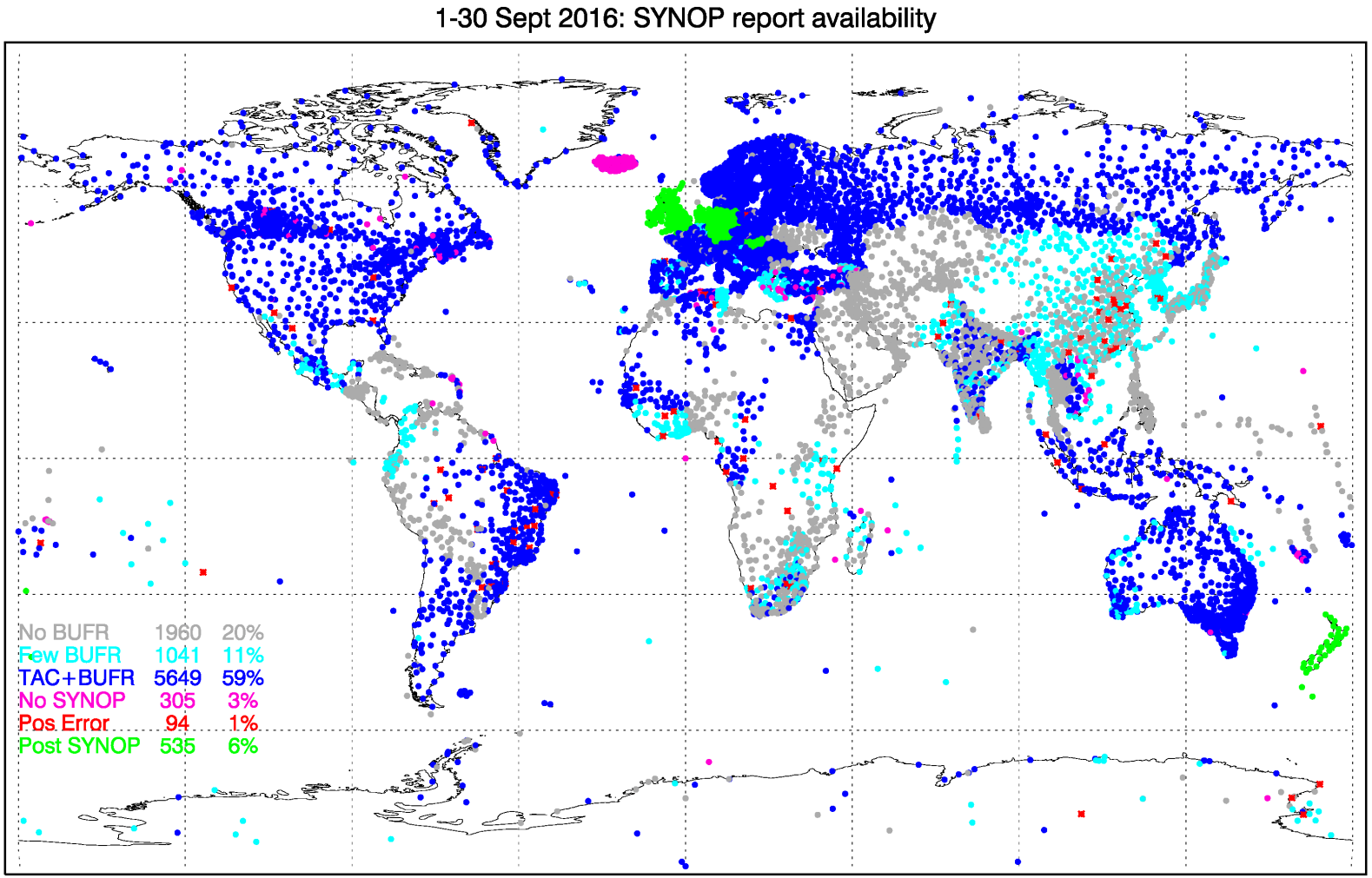
Functioning surface observing stations in 2016



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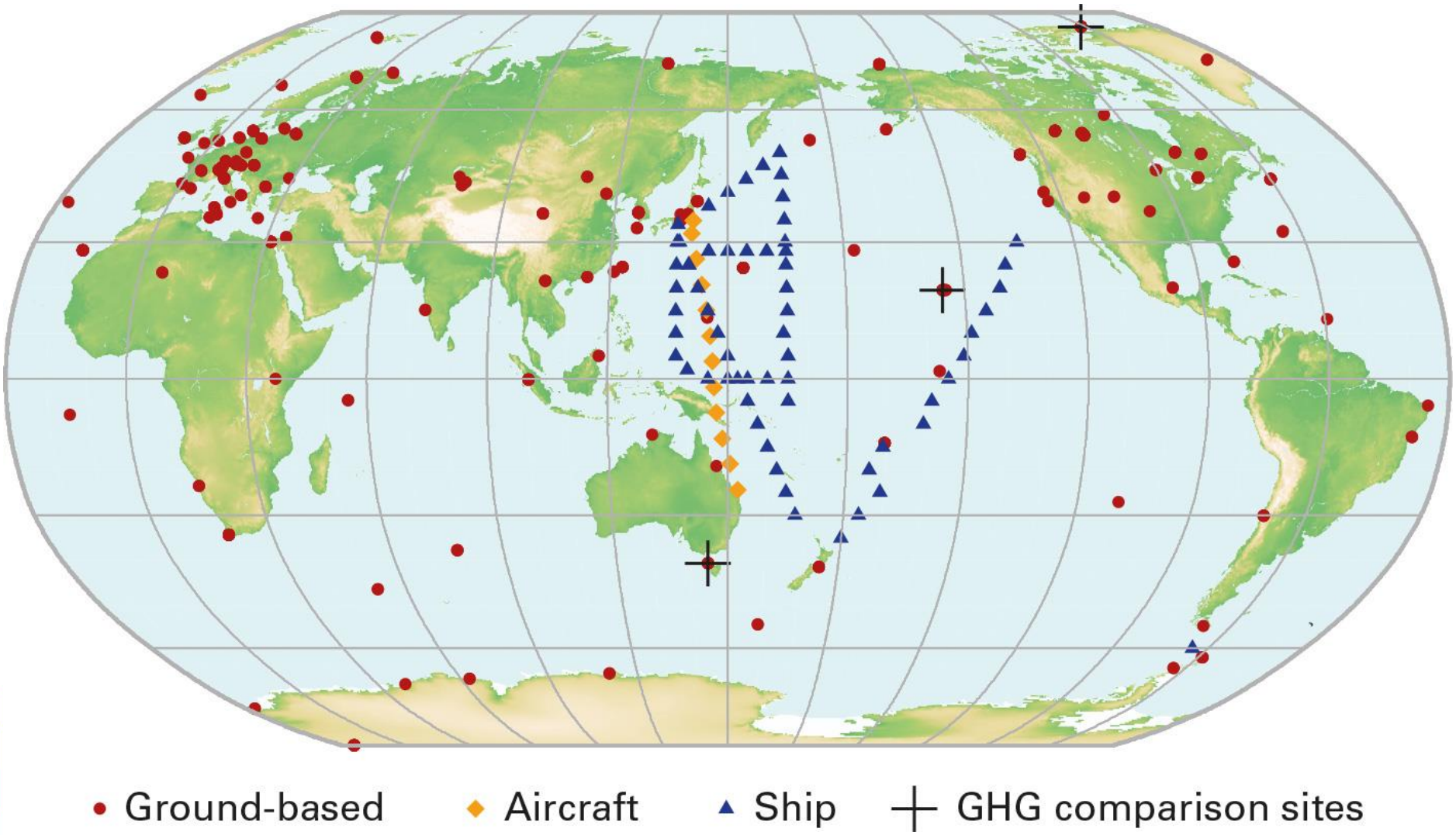
Global greenhouse gas monitoring



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CO_2, CH_4 & N_2O 1984-2016

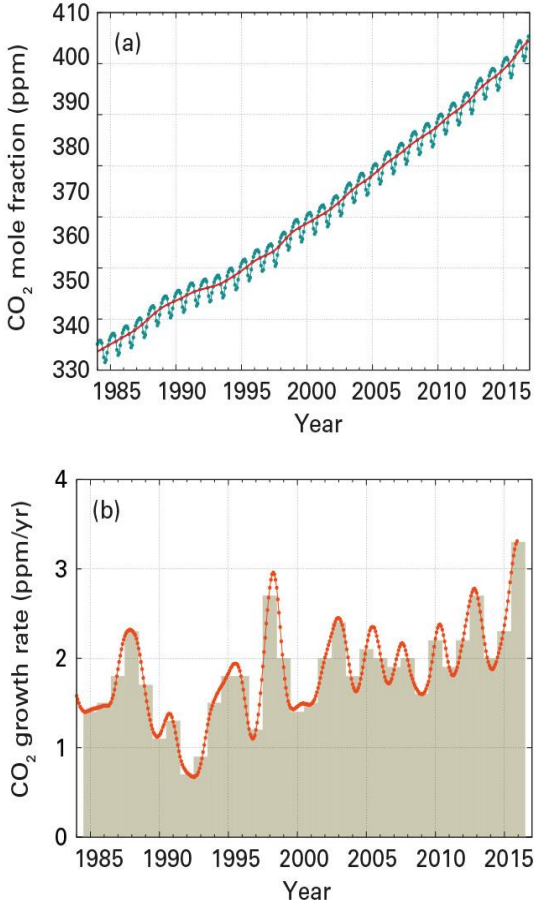

Figure 3. Globally averaged CO_2 mole fraction (a) and its growth rate (b) from 1984 to 2016.

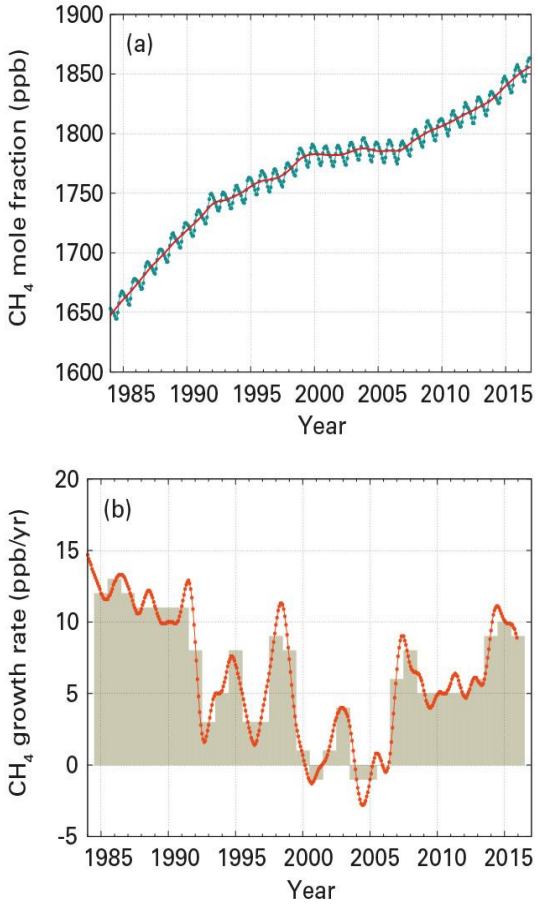

Figure 4. Globally averaged CH_4 mole fraction (a) and its growth rate (b) from 1984 to 2016.

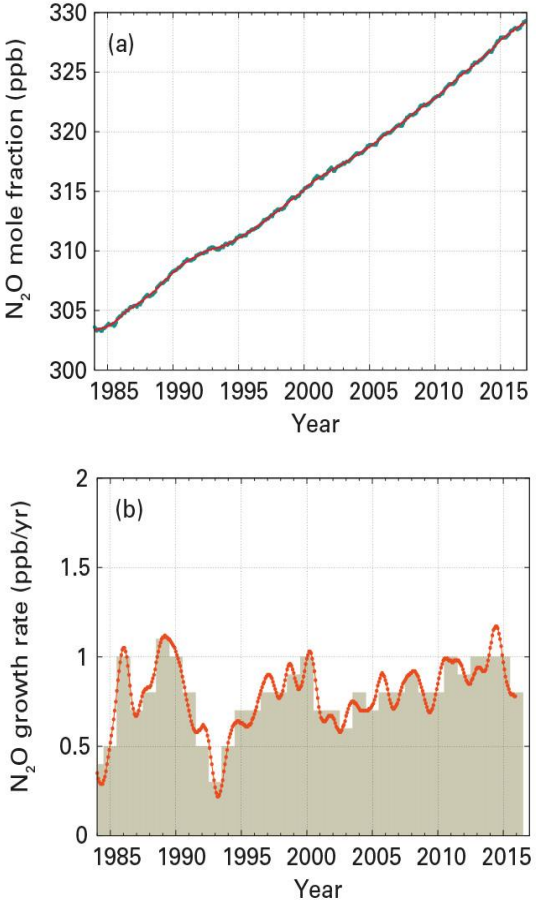

Figure 5. Globally averaged N_2O mole fraction (a) and its growth rate (b) from 1984 to 2016.

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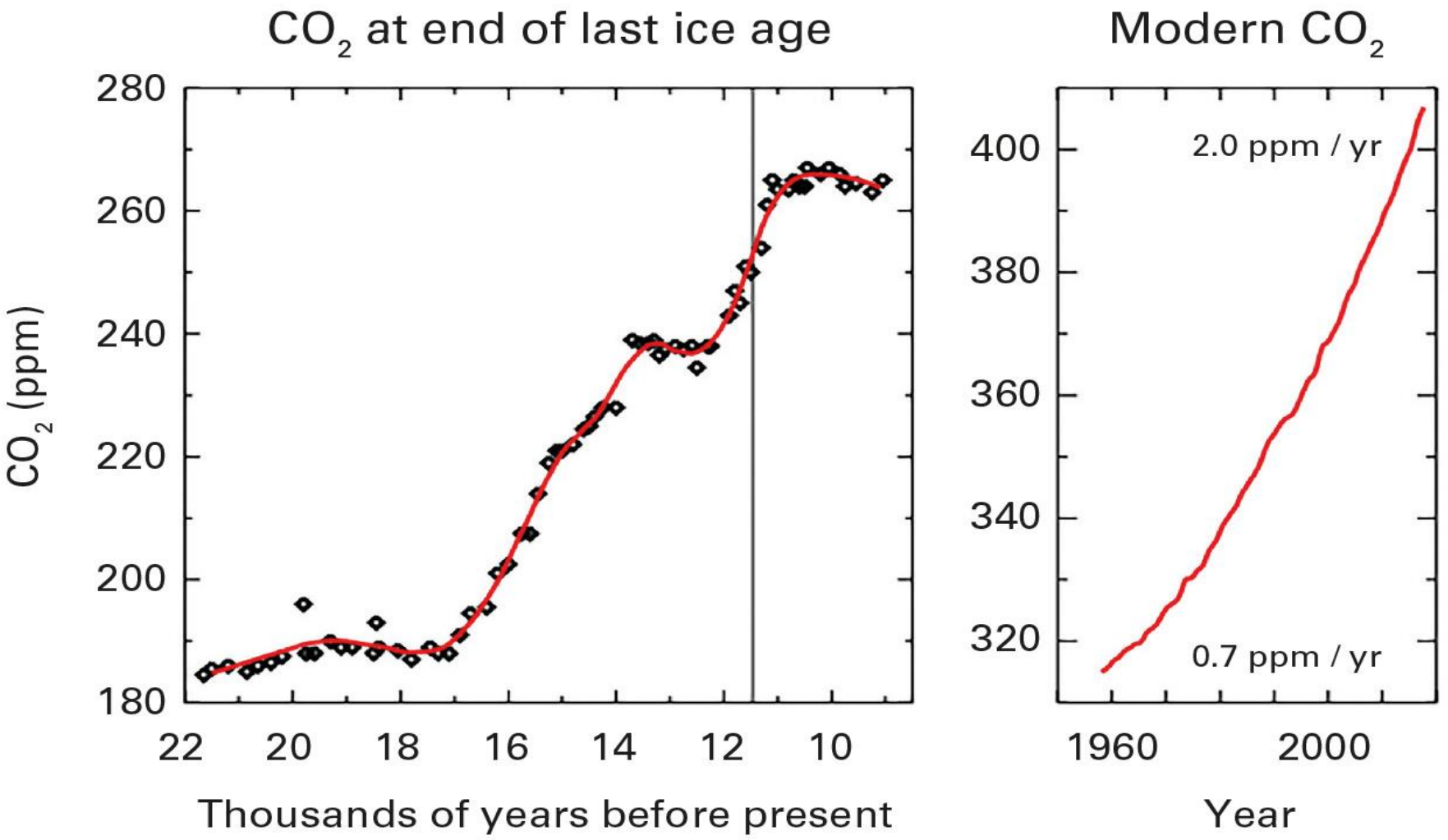
Historical and recent CO_2 variability



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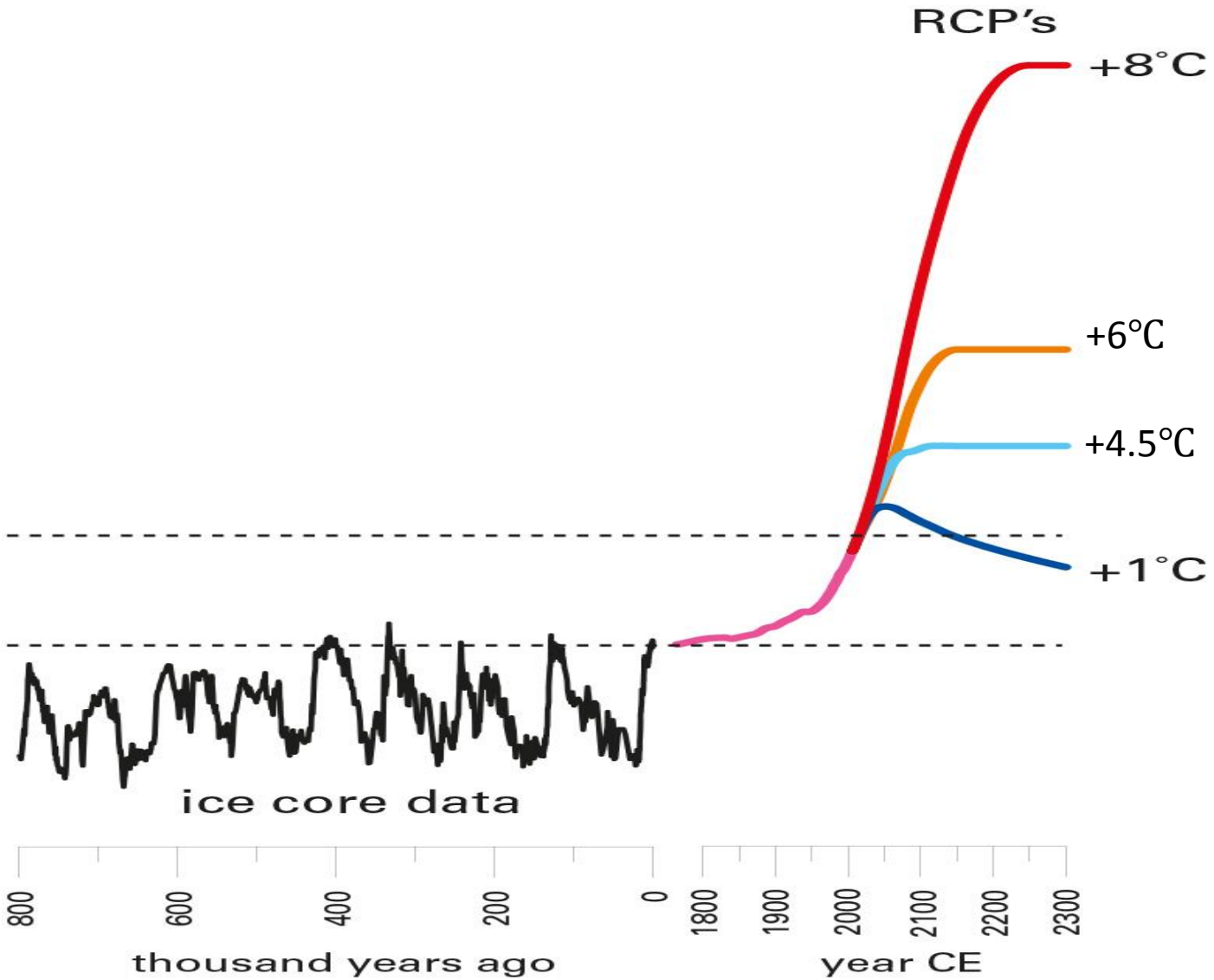
WMO GREENHOUSE GAS BULLETIN

The State of Greenhouse Gases in the Atmosphere
Based on Global Observations through 2016

Scale of CO_2 concentrations 800 000 BC-2300 AD



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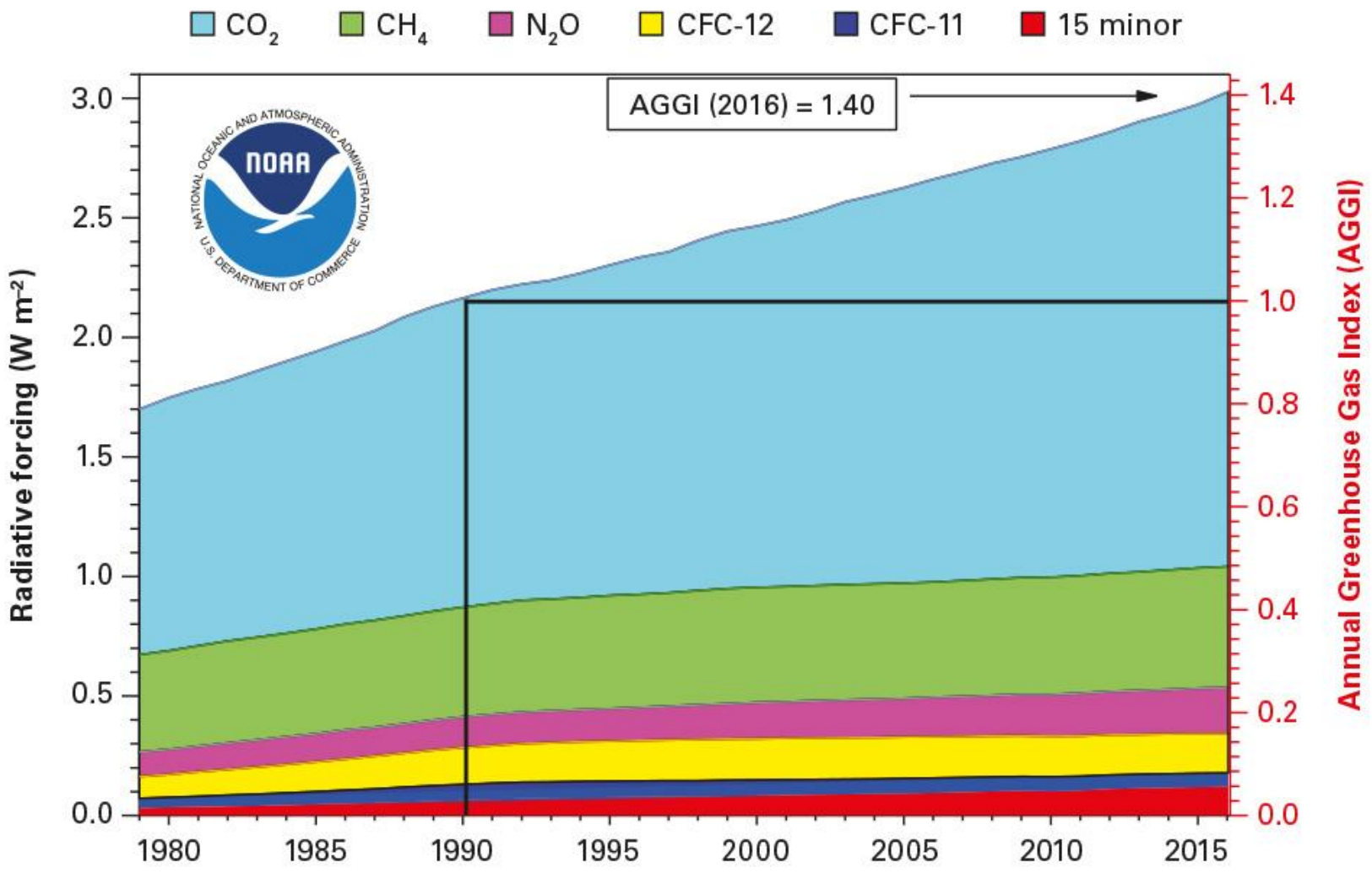
Radiative forcing of greenhouse gases 1979-2016



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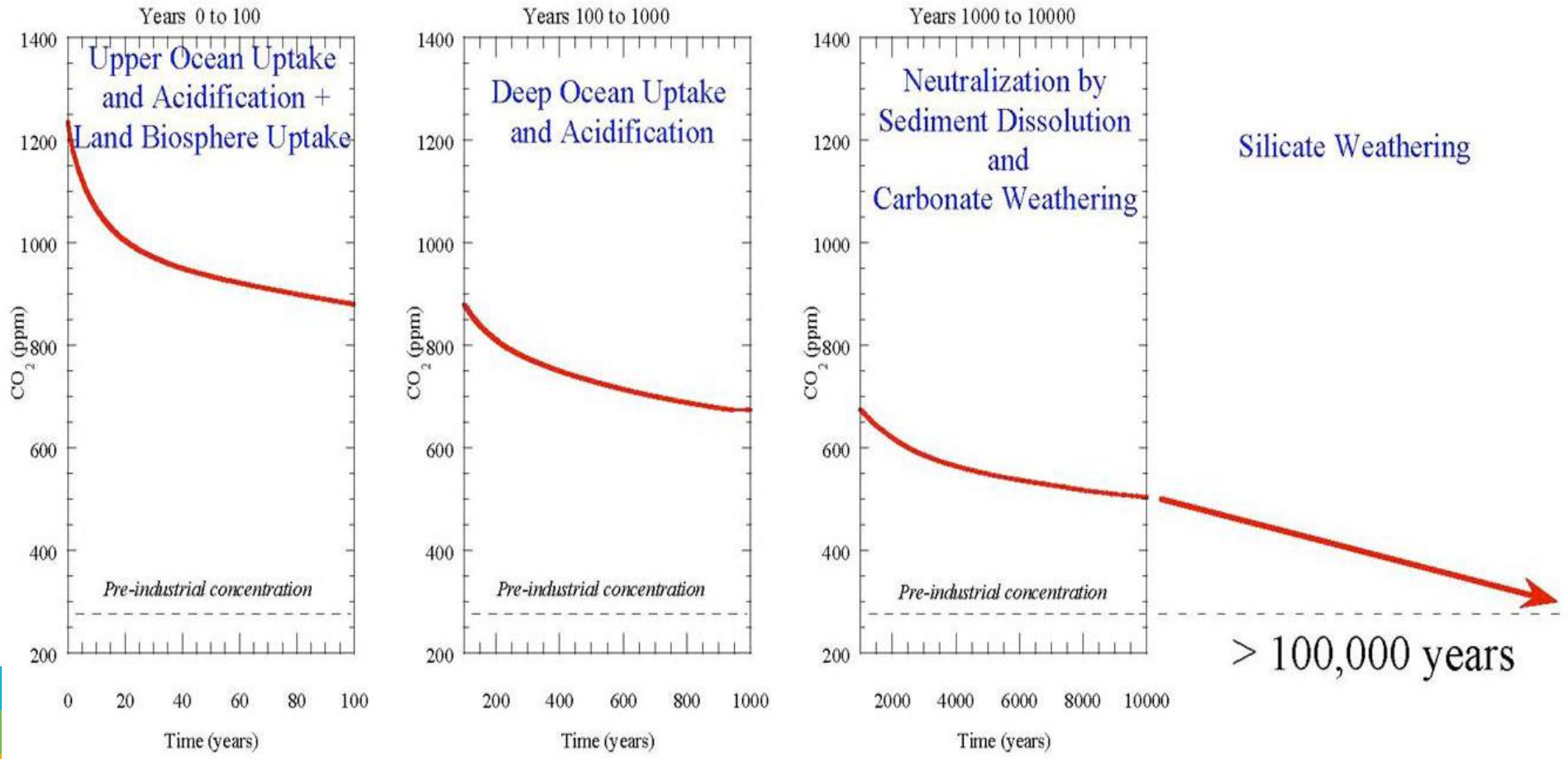
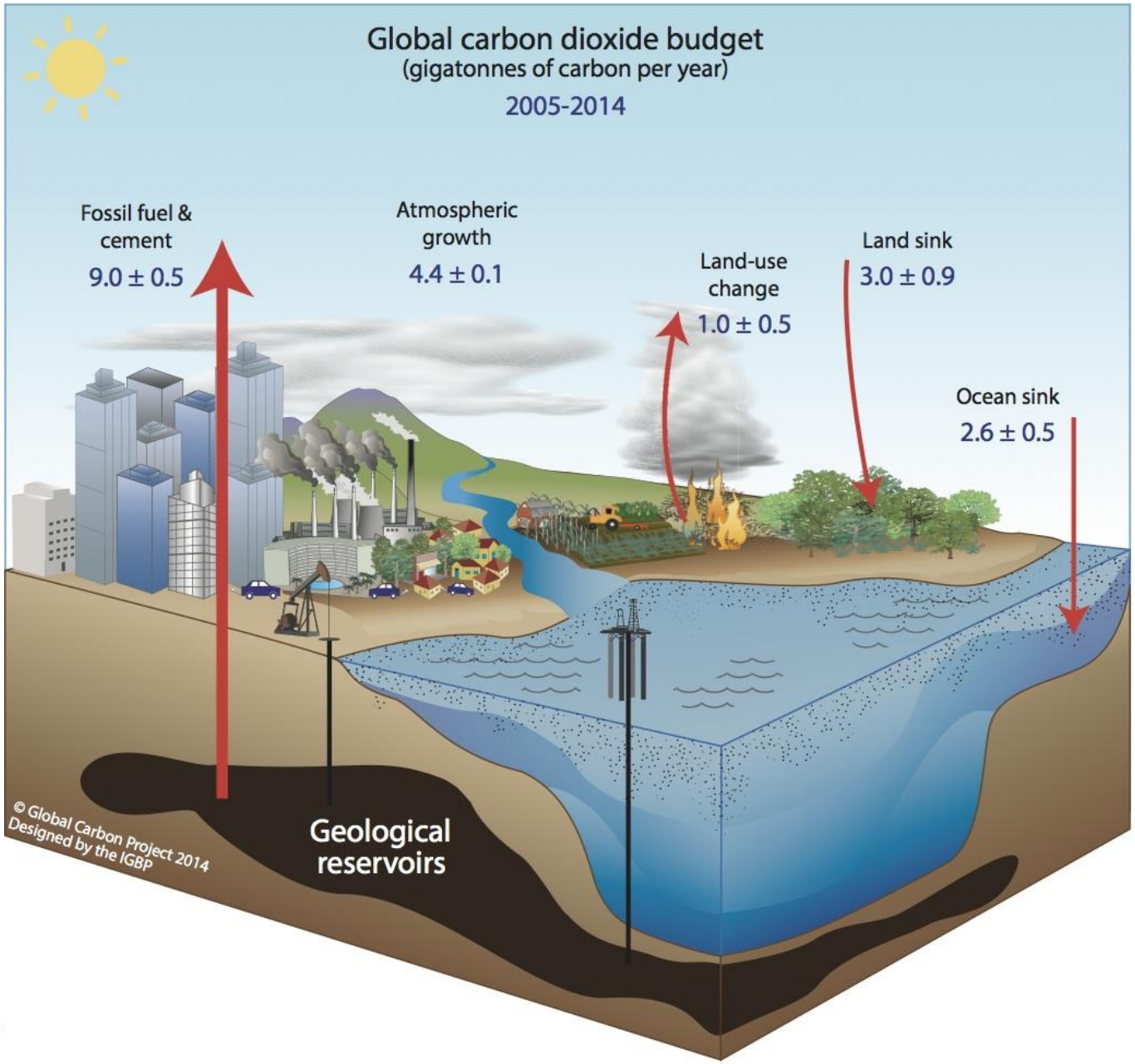
How long time the return of CO_2 to ”normal” takes?



Carbon budget



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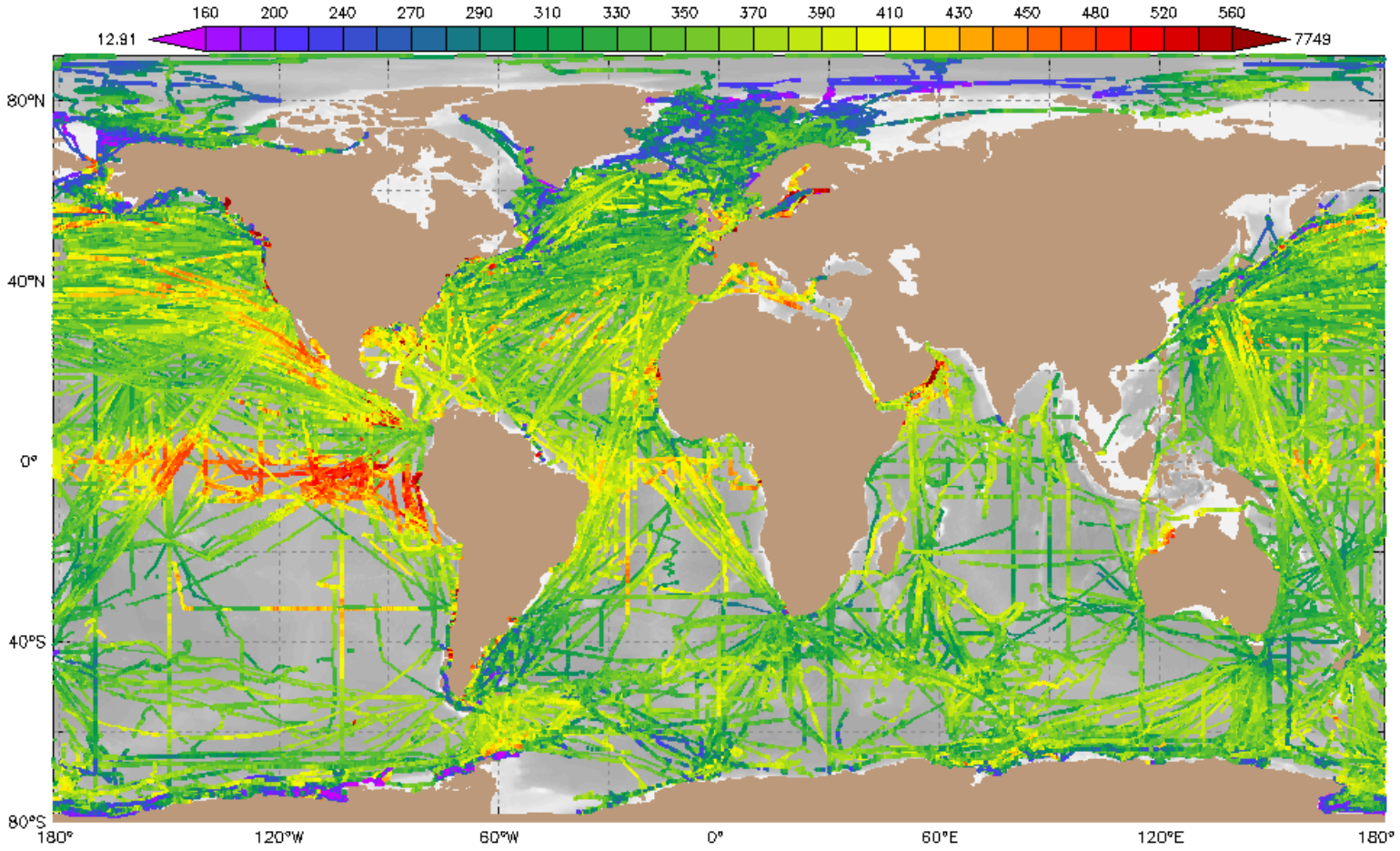
Ocean Acidification



Ocean acidification is a global problem that threatens marine organisms, ecosystems, services and resources and that has potentially considerable ecological and socio-economic consequences (food security, livelihood of fishing communities)

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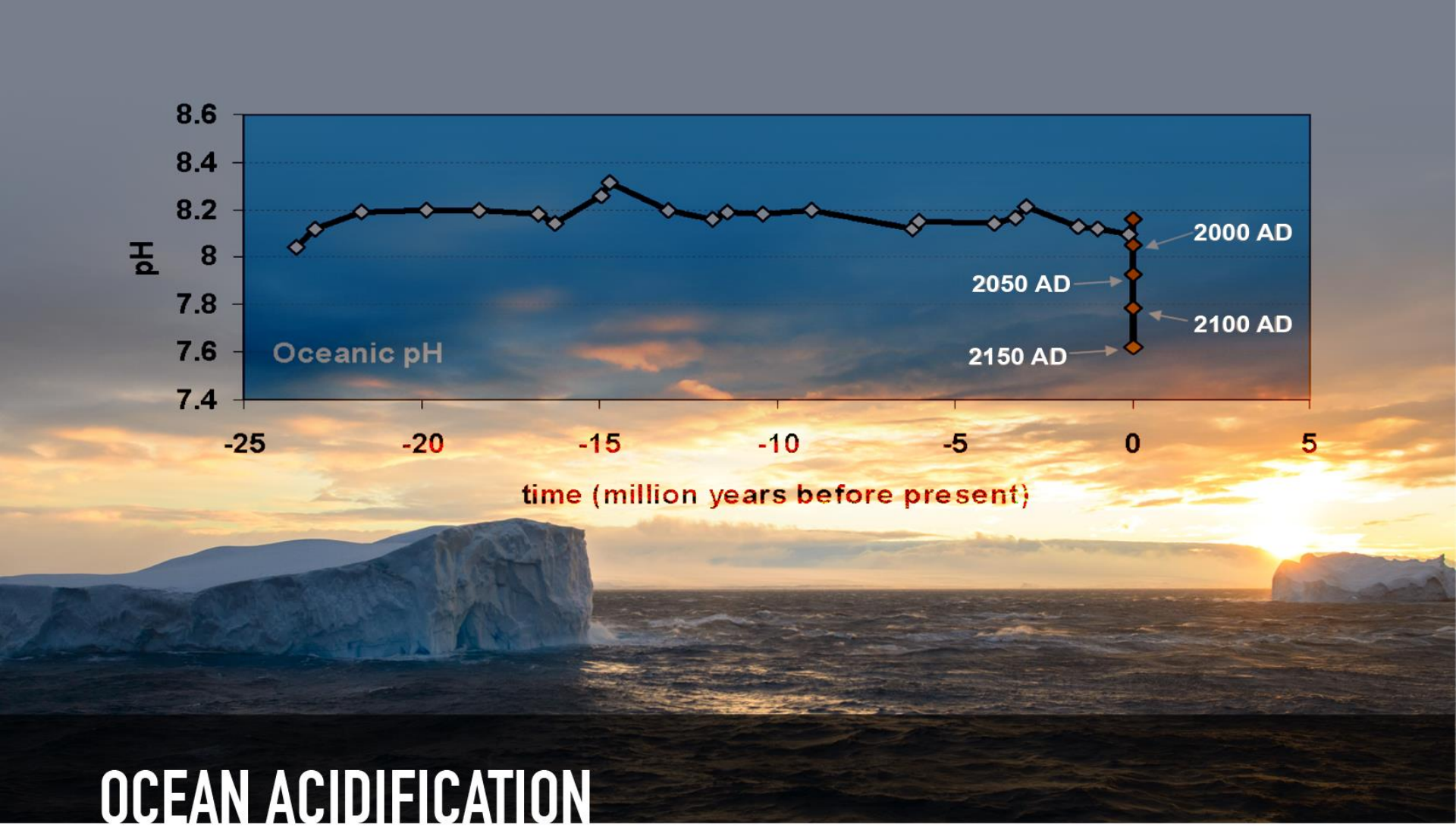
DATA SET: SOCAT v4 Data Collection
VARIABLE: fCO2 recommended (µatm)
01-Jan-1957 00:00 to 31-Dec-2016 00:00



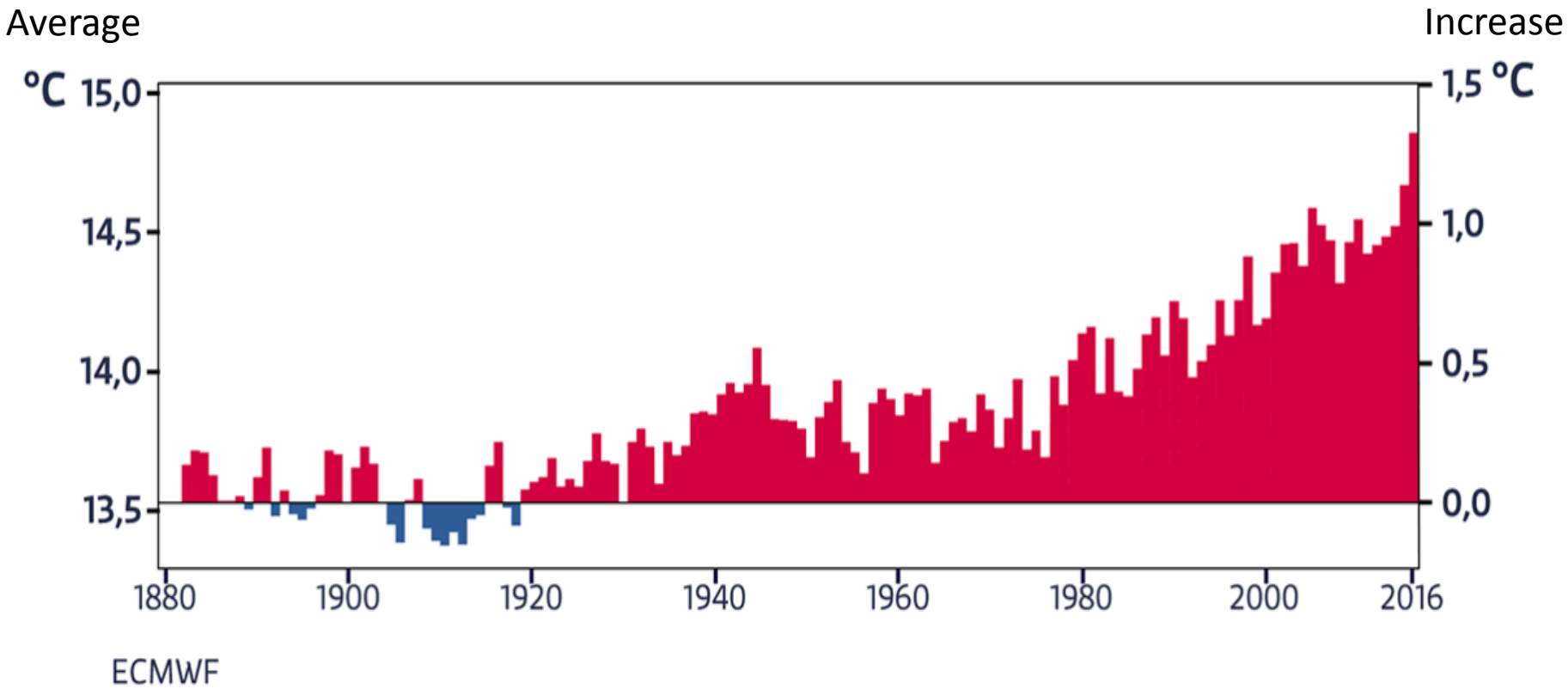
OCEAN ACIDIFICATION

Current levels of acidification unmatched in last 25 million years.

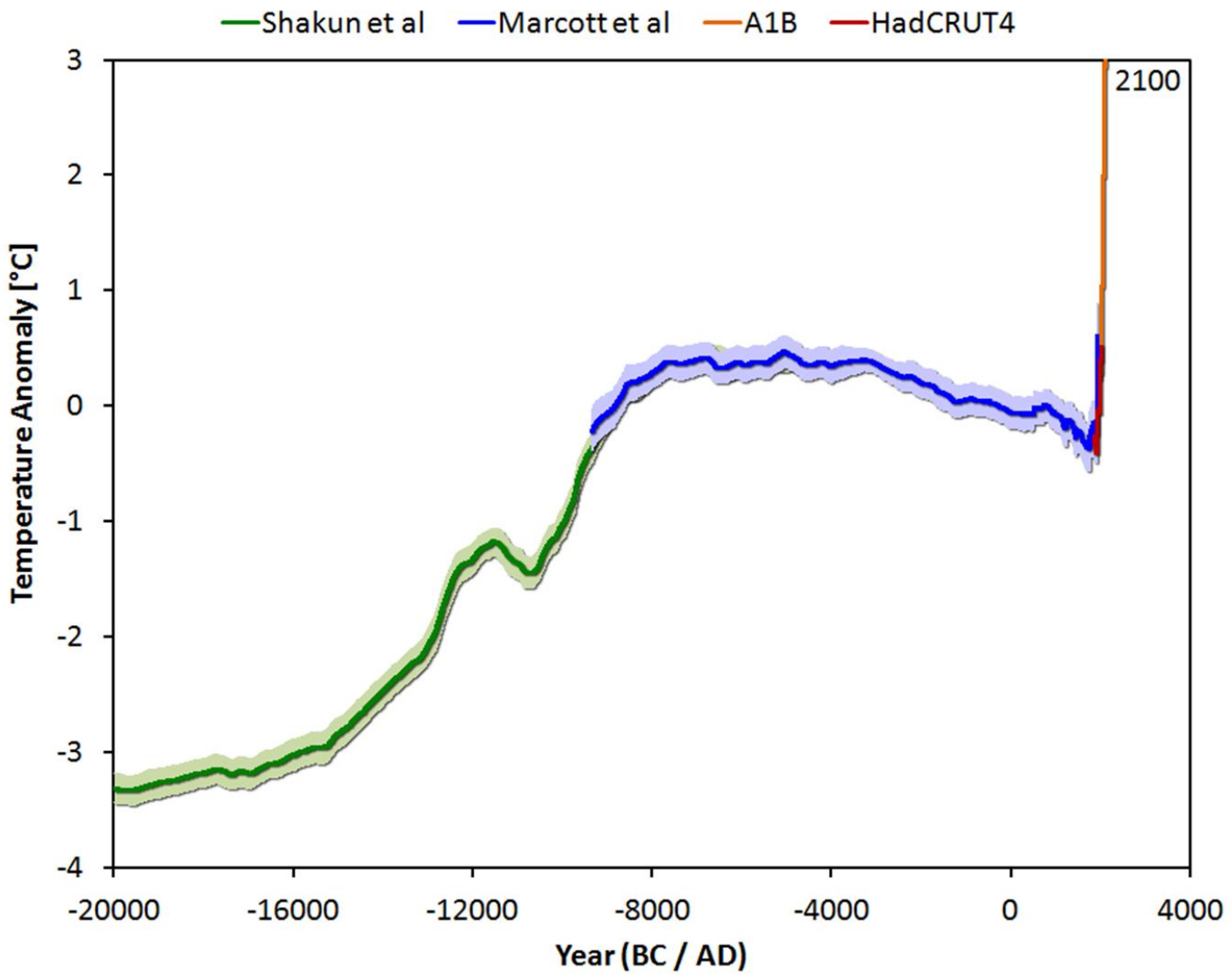
Direct evidence of human impact on climate and oceans.

Courtesy of NASA, Avoiding Dangerous Climate Change (Turley et al 2006)

Global temperature 1880-2016



Temperature 20 000 BC - 2100 AD



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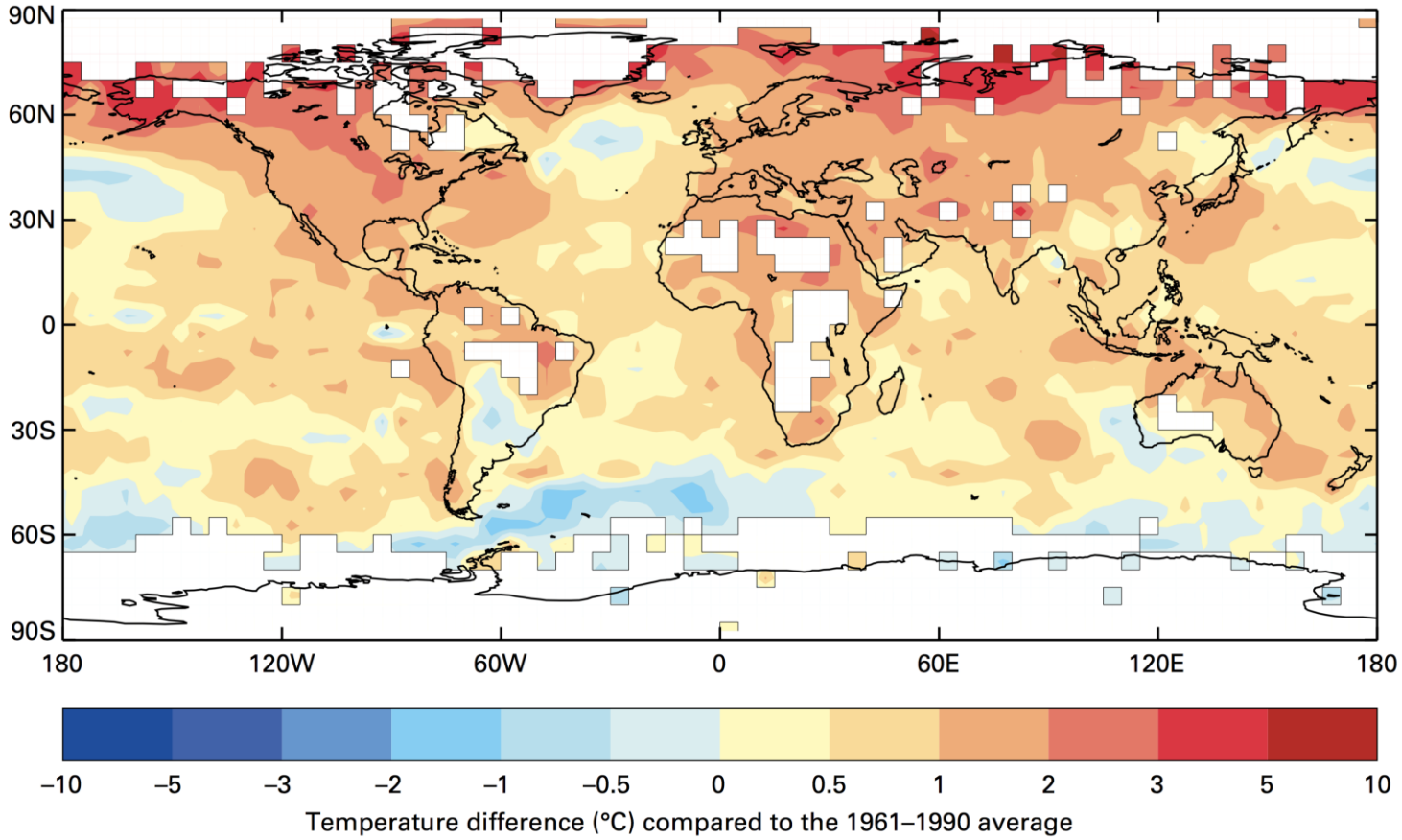
The Arctic matters globally



- The Arctic is heating twice as rapidly as the rest of the world: melting of glaciers, shrinking sea ice and snow cover.
- The impact of this is felt in other parts of the globe: rising sea levels and changing weather and climate patterns.

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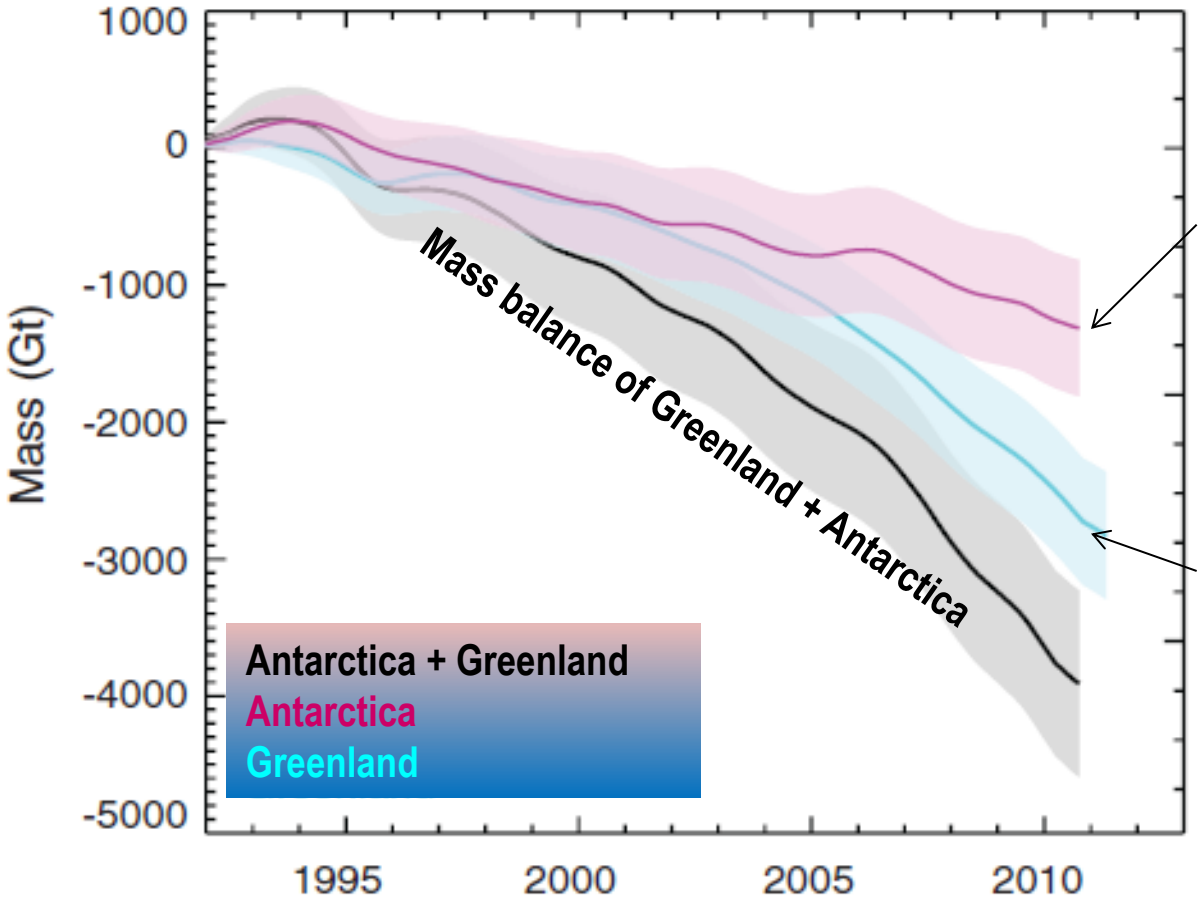
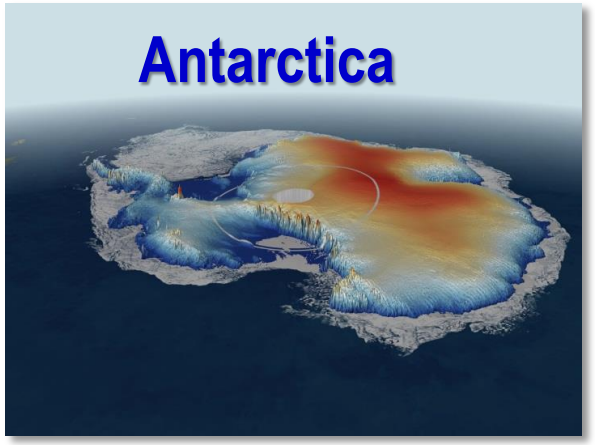
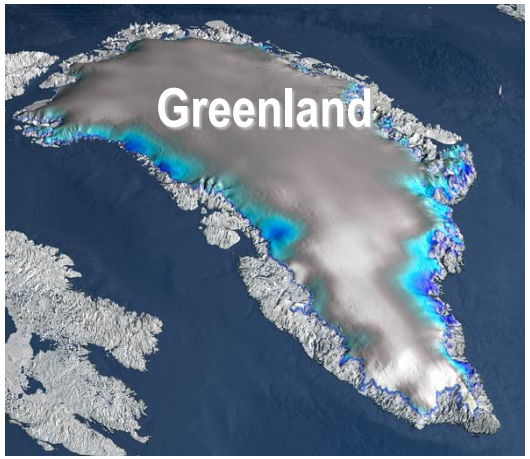
Ice mass loss from Greenland and Antarctica measured by space techniques since 1990 (in Gt)

→ mass loss acceleration since early 2000s

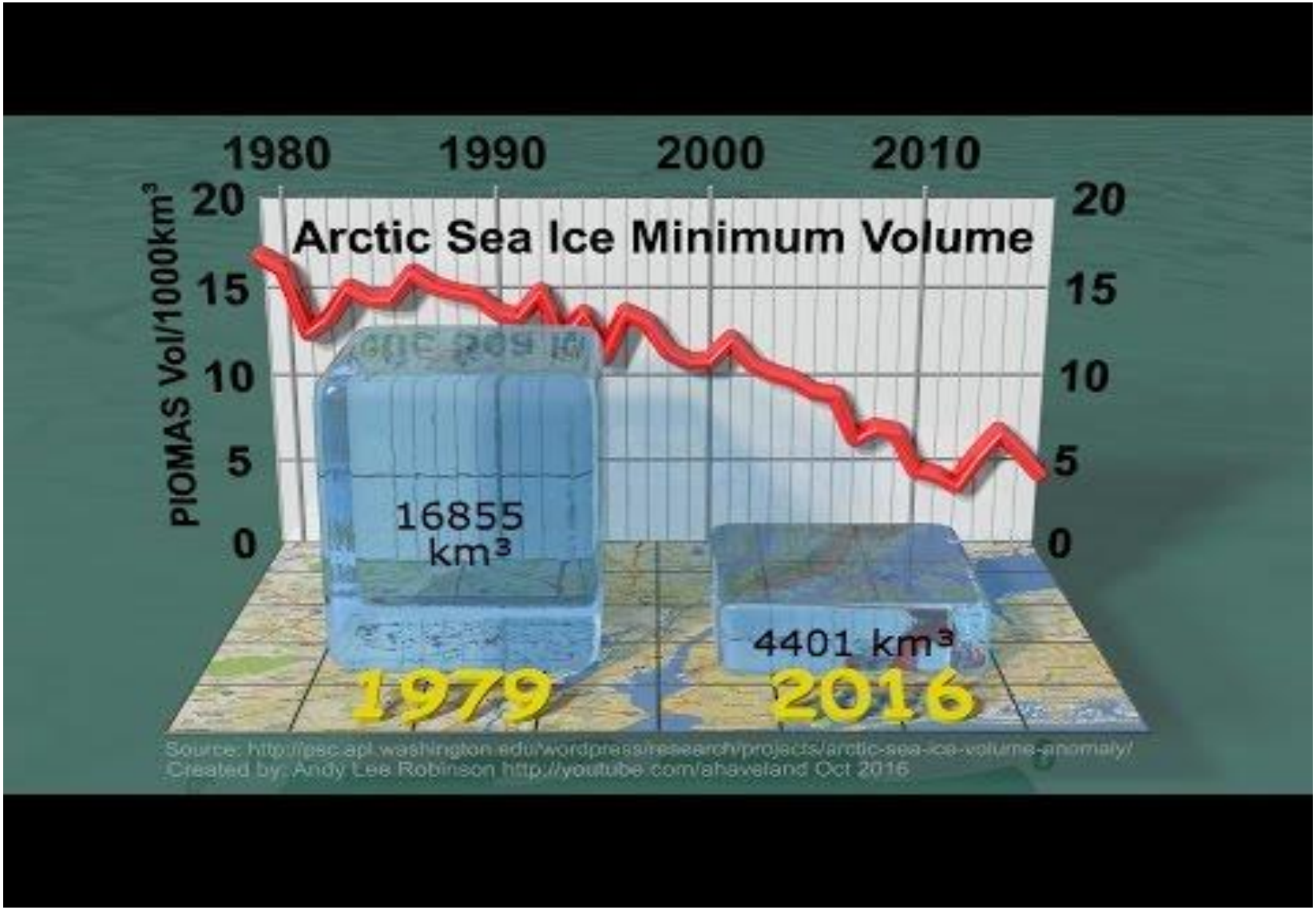




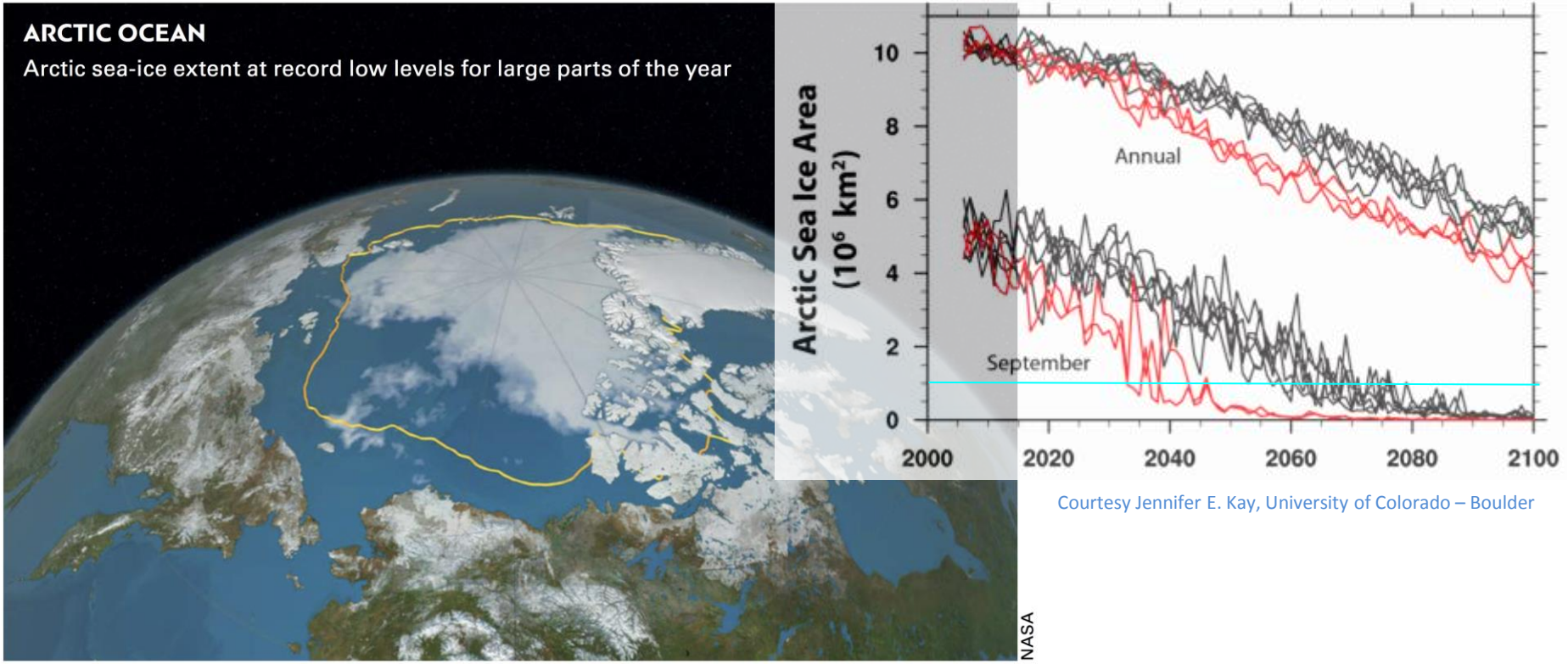


Shepherd et al., 2012
IPCC AR5

Arctic sea ice volume 1979-2016: -74 %



An Arctic Ocean free of ice



Courtesy Jennifer E. Kay, University of Colorado – Boulder

- 2016 ties with 2007 for second lowest Arctic sea ice minimum
- September predicted to be ice-free in Arctic between 2040 and 2070

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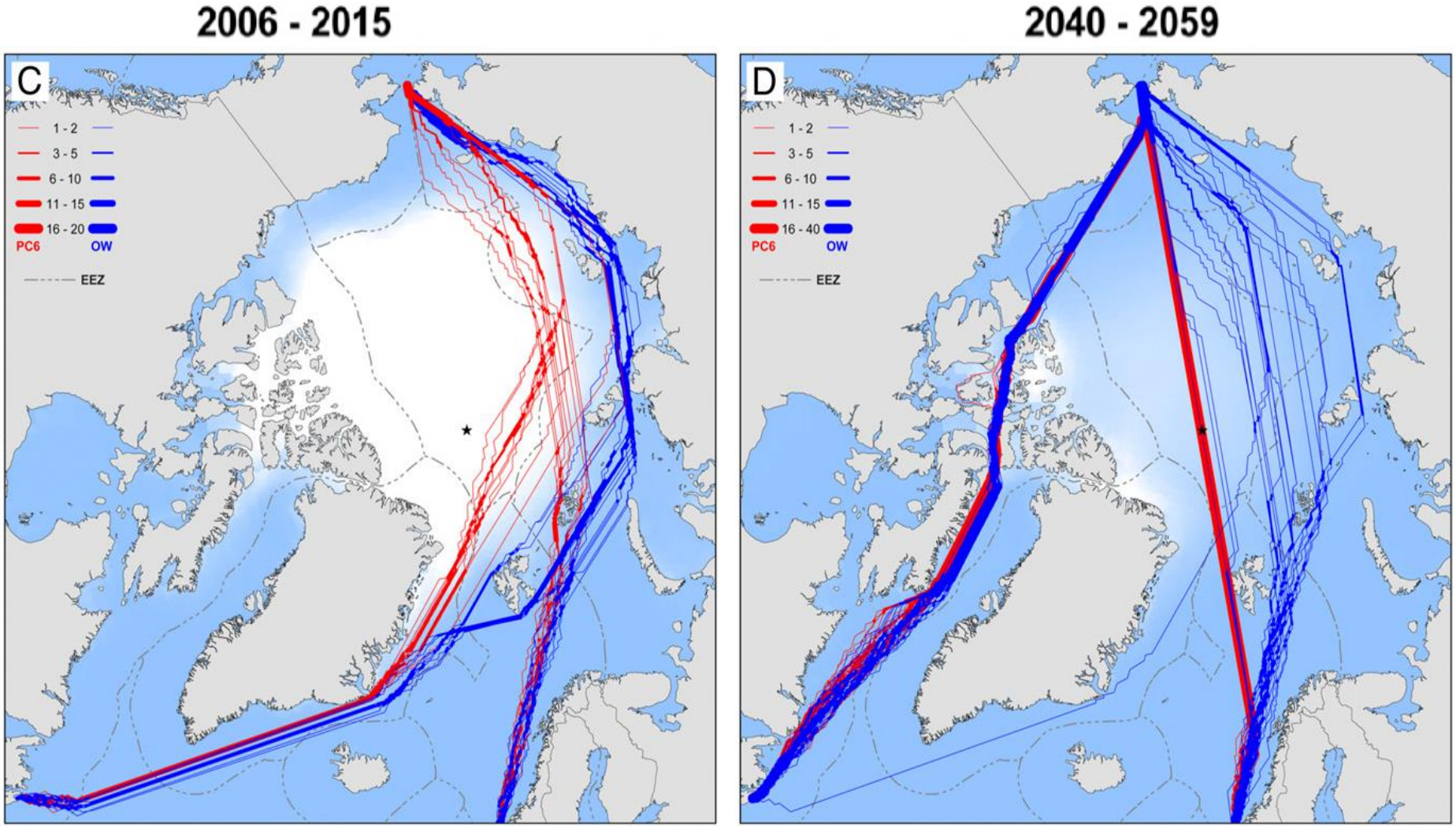
ARCTIC SEA ROUTES IN SEPTEMBER 2006-2059

RED=ICE STRENGHTENED VESSEL, BLUE=NOT



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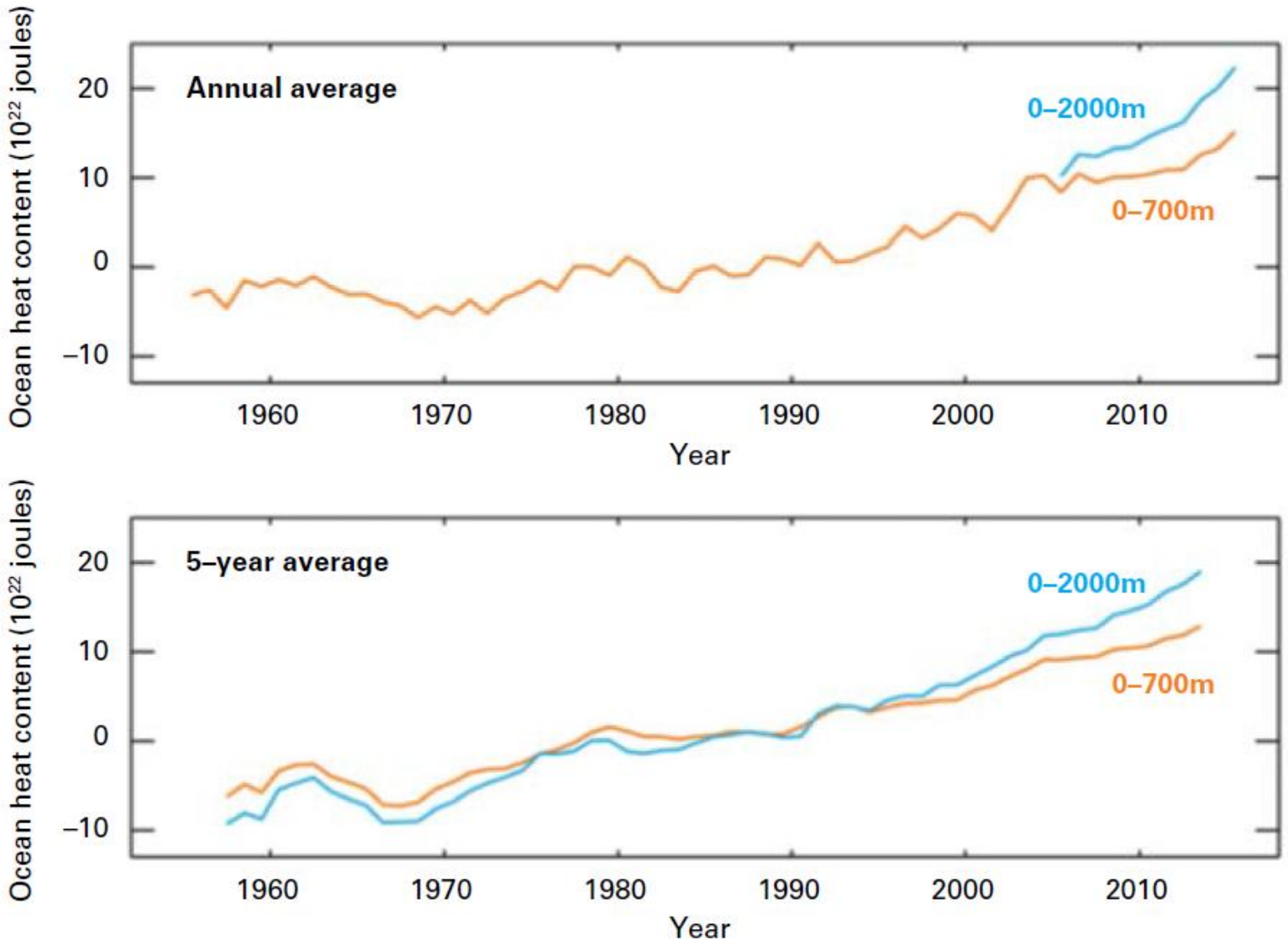
Ocean heat content



Source: Data from NOAA/NESDIS/NODC Ocean Climate Laboratory, United States, updated from Levitus et al. (2012)

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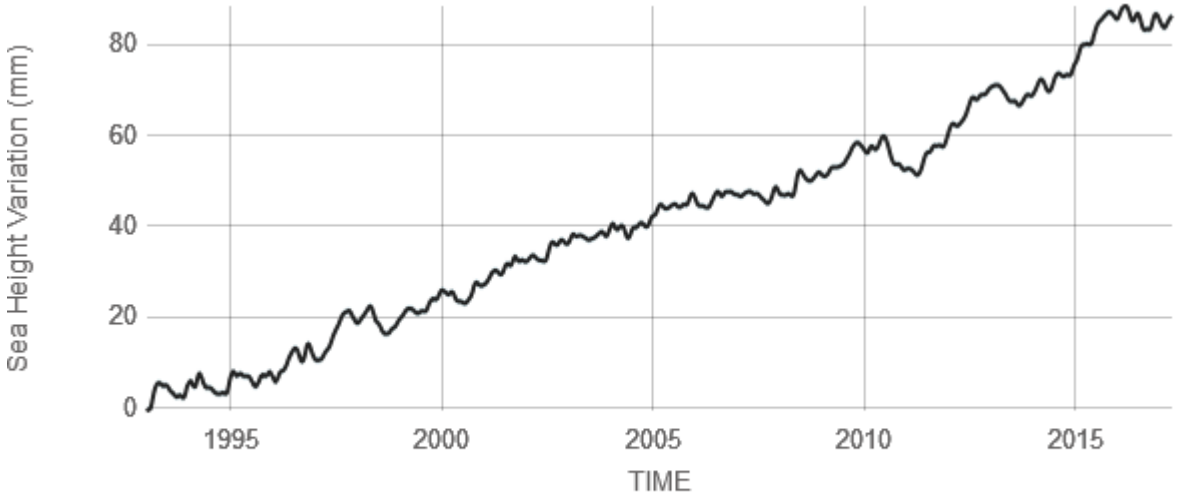
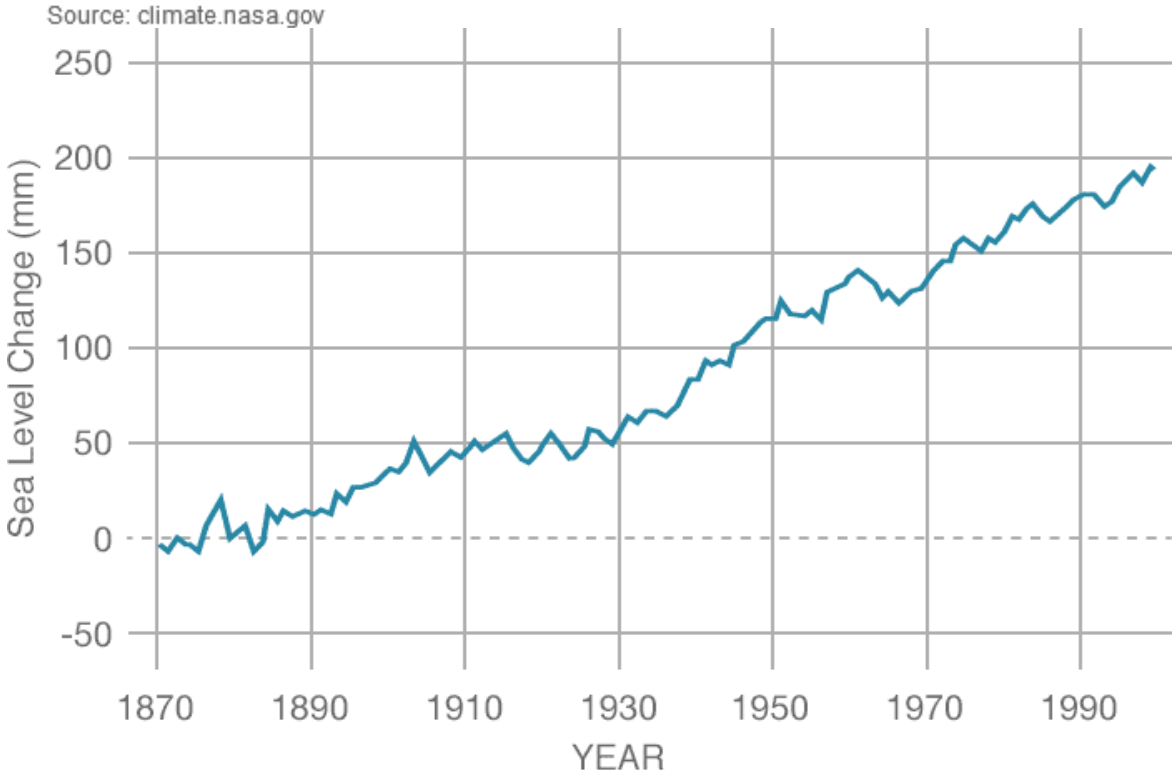
Global sea level rise: + 26 cm 1870-2017

NASA-EUMETSAT Satellites (1993-present)



Tide gauges (1870-2000)



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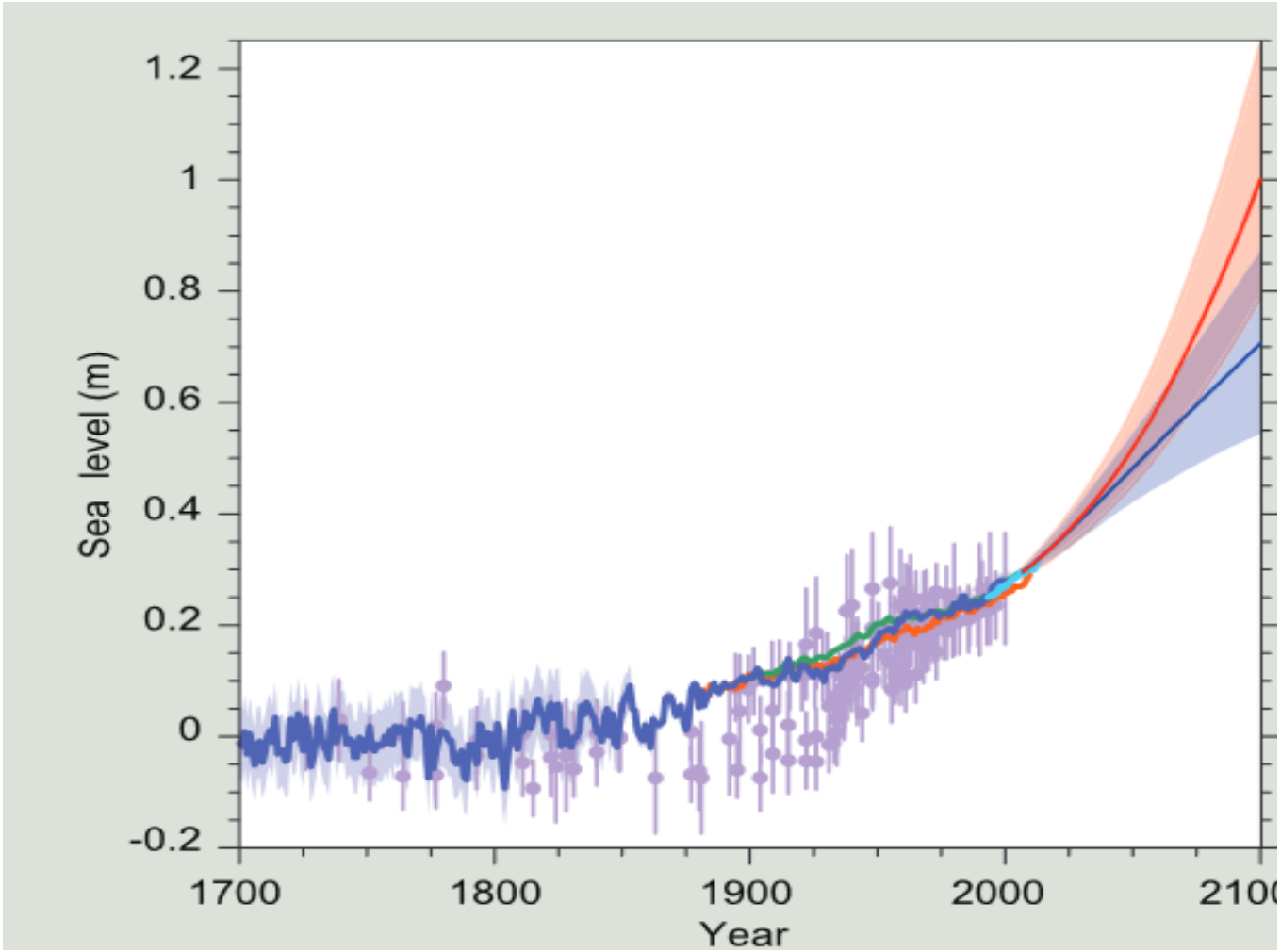
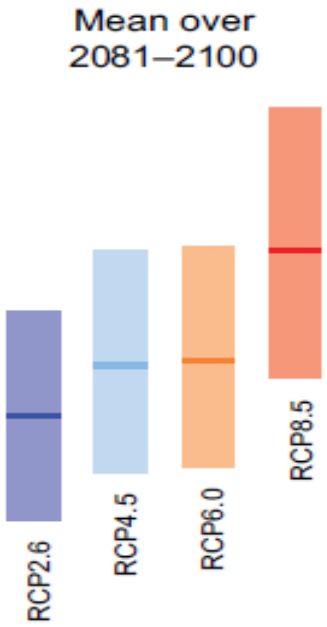
Seal level rise (1700 – 2100)





Source: IPCC 2014

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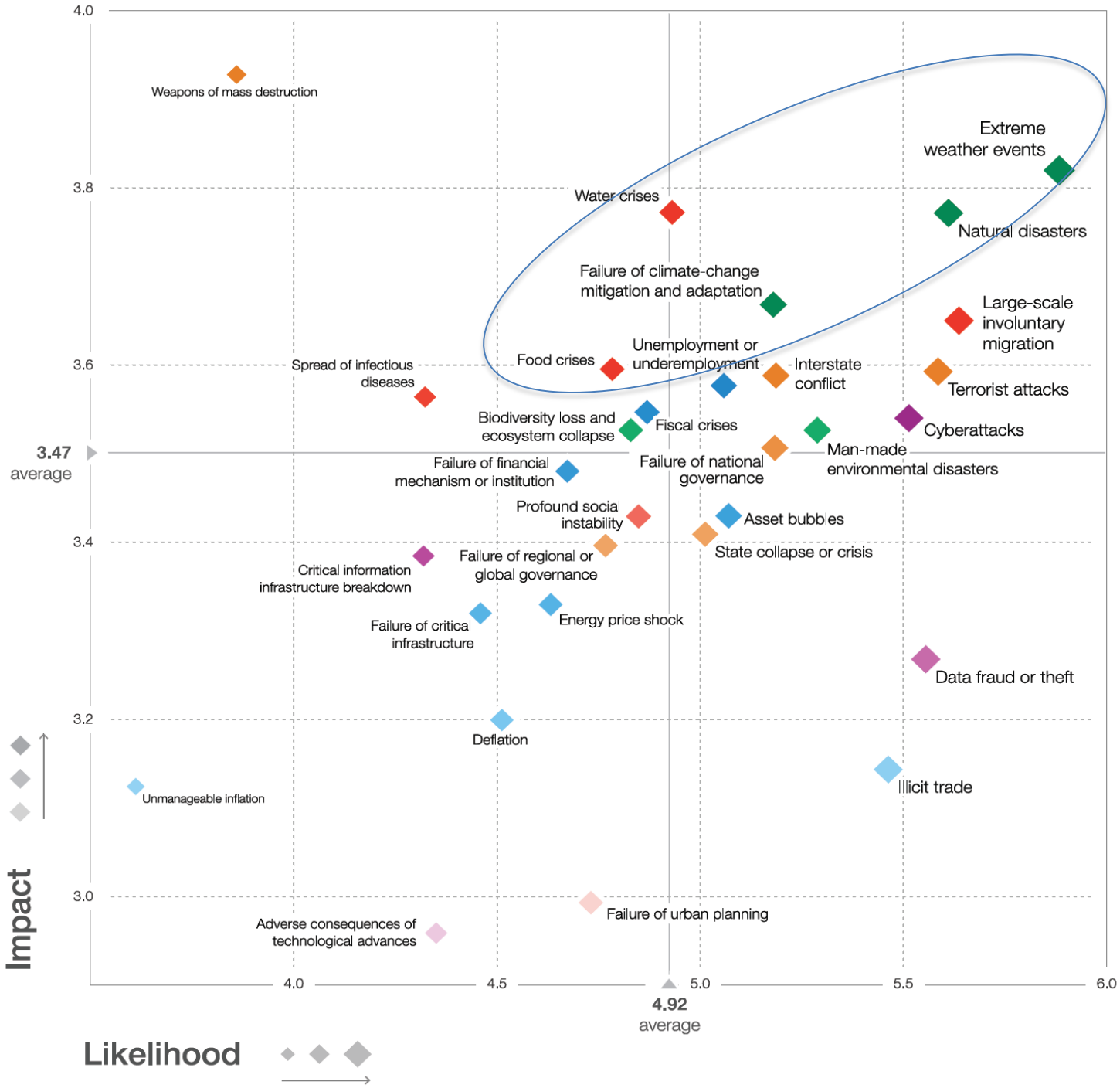
Global risks landscape 2017

World Economic Forum



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Hurricanes break records

Hurricanes Irma and Harvey - first time two Category 4 storms made landfall in USA in the same year.

Irma: 300 km/h winds for 37 hours – longest on record at that intensity

Irma: Three consecutive days as category 5 hurricane – longest on satellite record

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Hurricane Harvey

Unprecedented rainfall caused catastrophic flooding in Texas

Rainfall totals in some places of more than 1 meter

Fuelled by unusually warm waters (about 2°C above average) in western Gulf of Mexico

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Climate Change and Tropical Cyclones

Climate change likely made rainfall rates associated with Harvey more intense

Tropical atmosphere holds more water vapor (about 7% more water vapor per degree Celsius sea surface temperature increase).

Higher water vapor content leads to higher rainfall rates in hurricanes.

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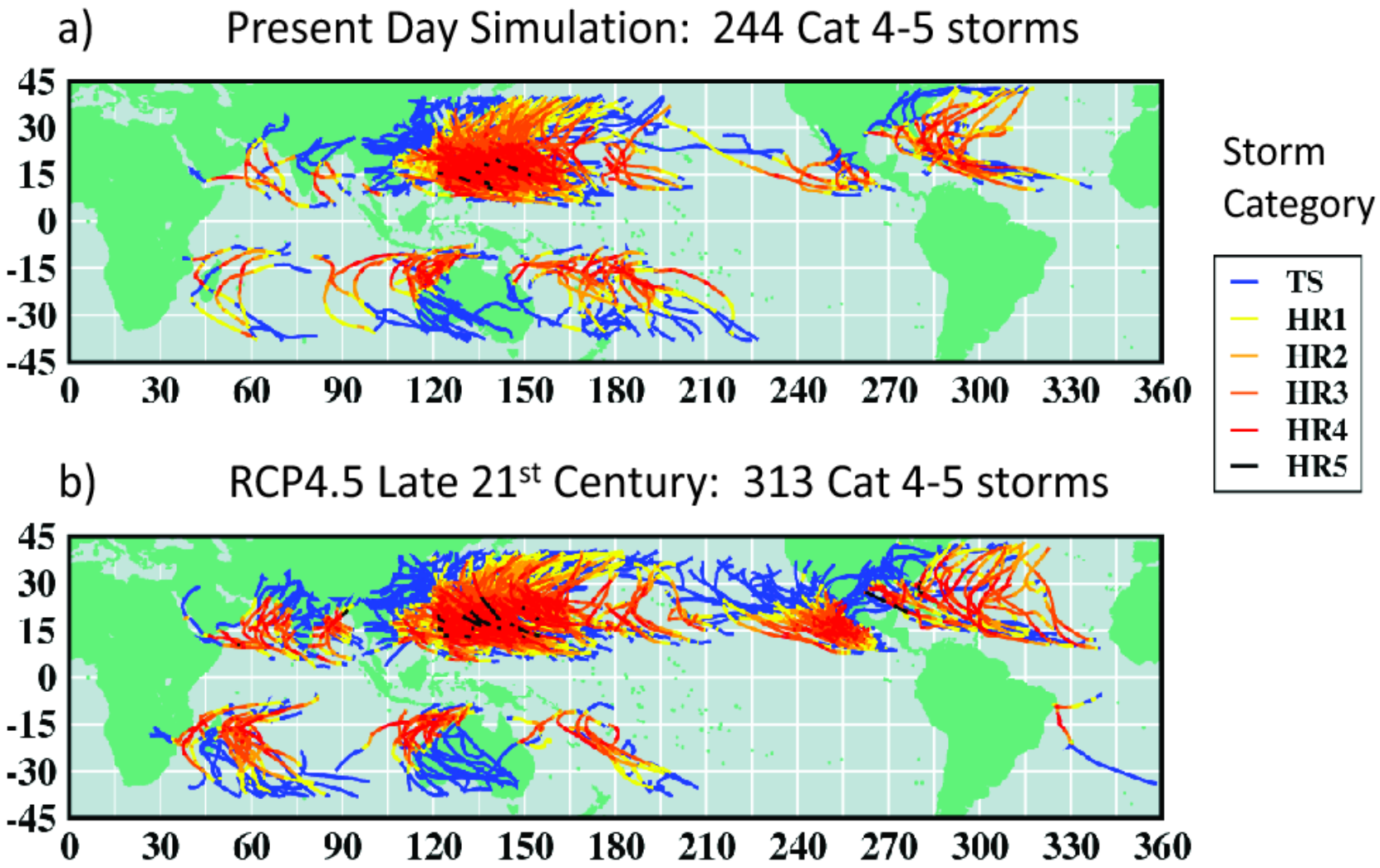
Tropical storms today and in 3 C warmed climate



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2017: high temperatures and many extremes

Jan-August 2017 second hottest year to date on record

Exceptional global warmth has lasted since mid-2015

Many heat temperature records broken

Extreme rainfall events and flooding

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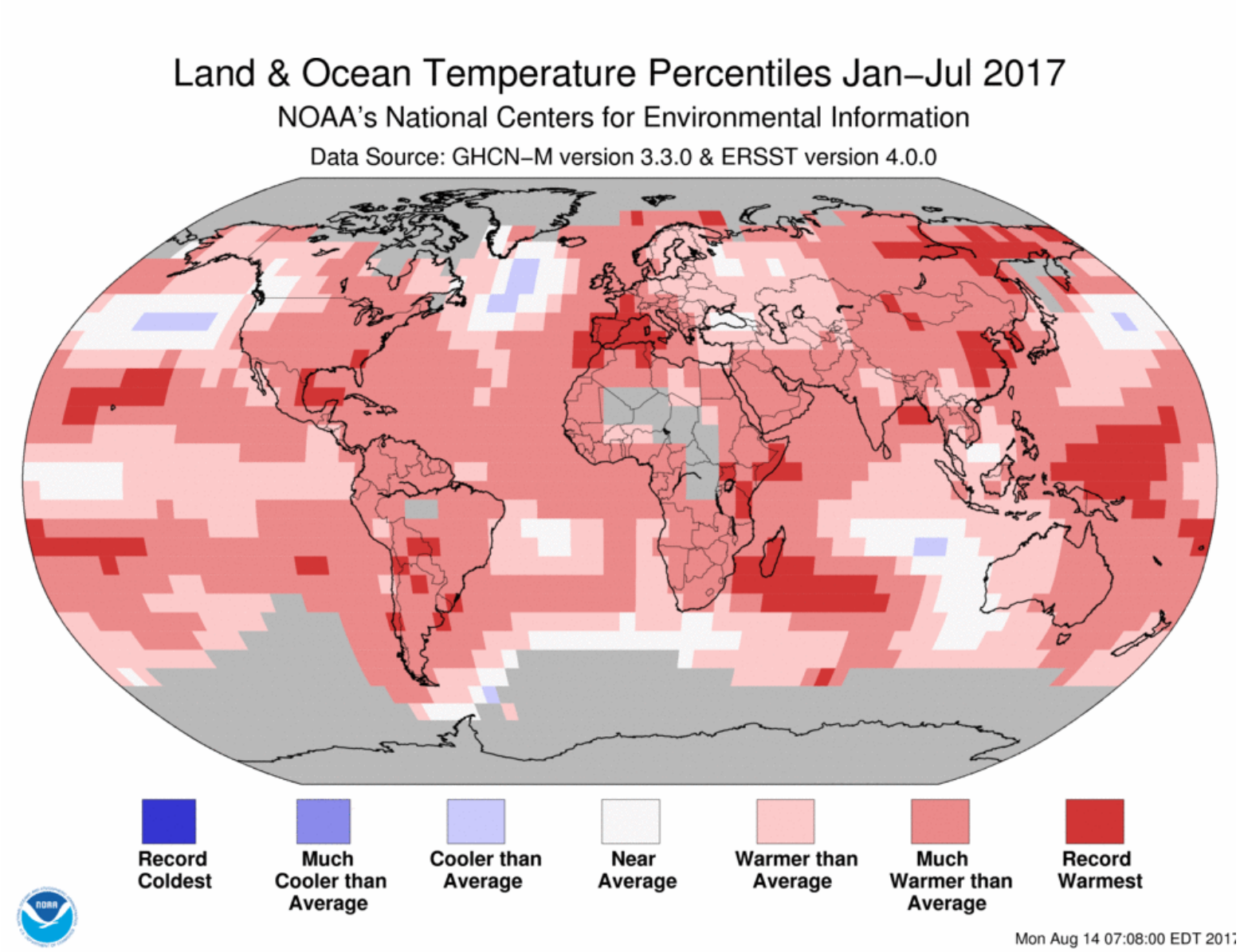
Global temperature anomalies



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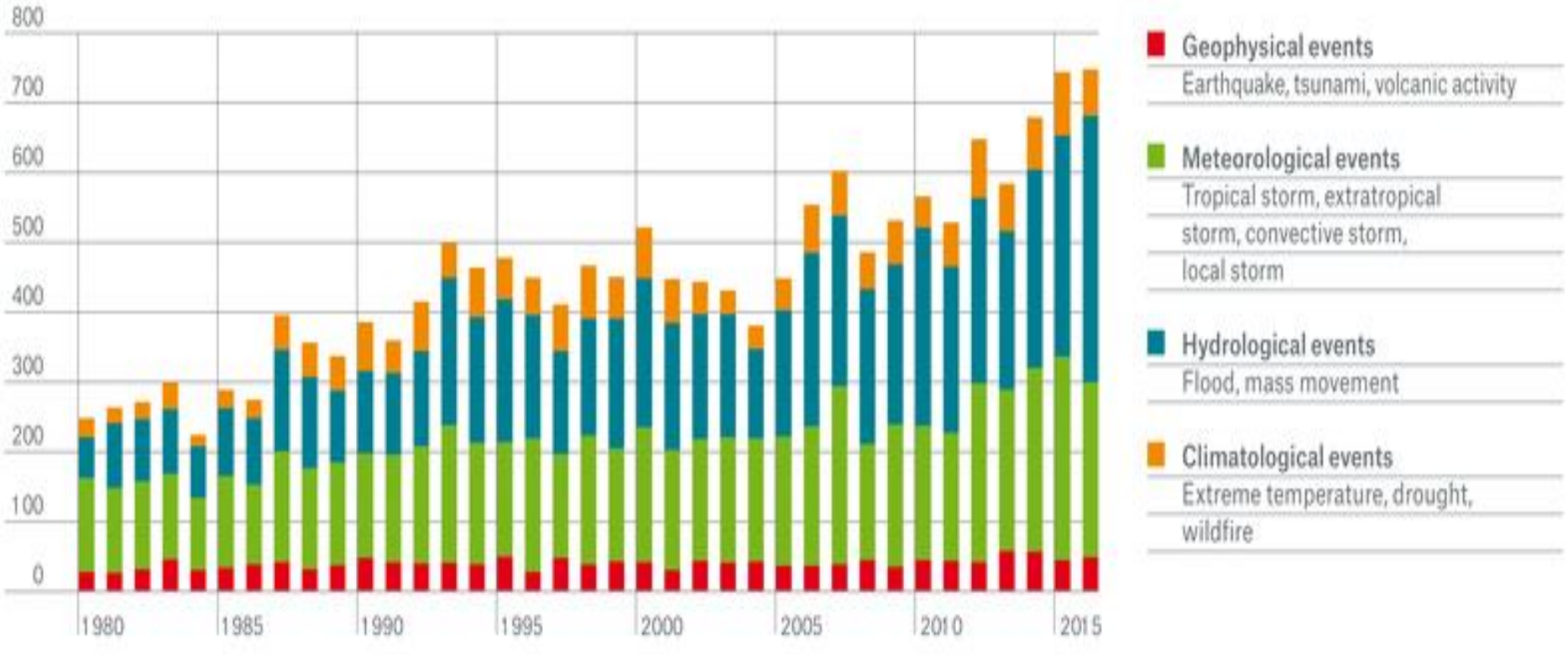
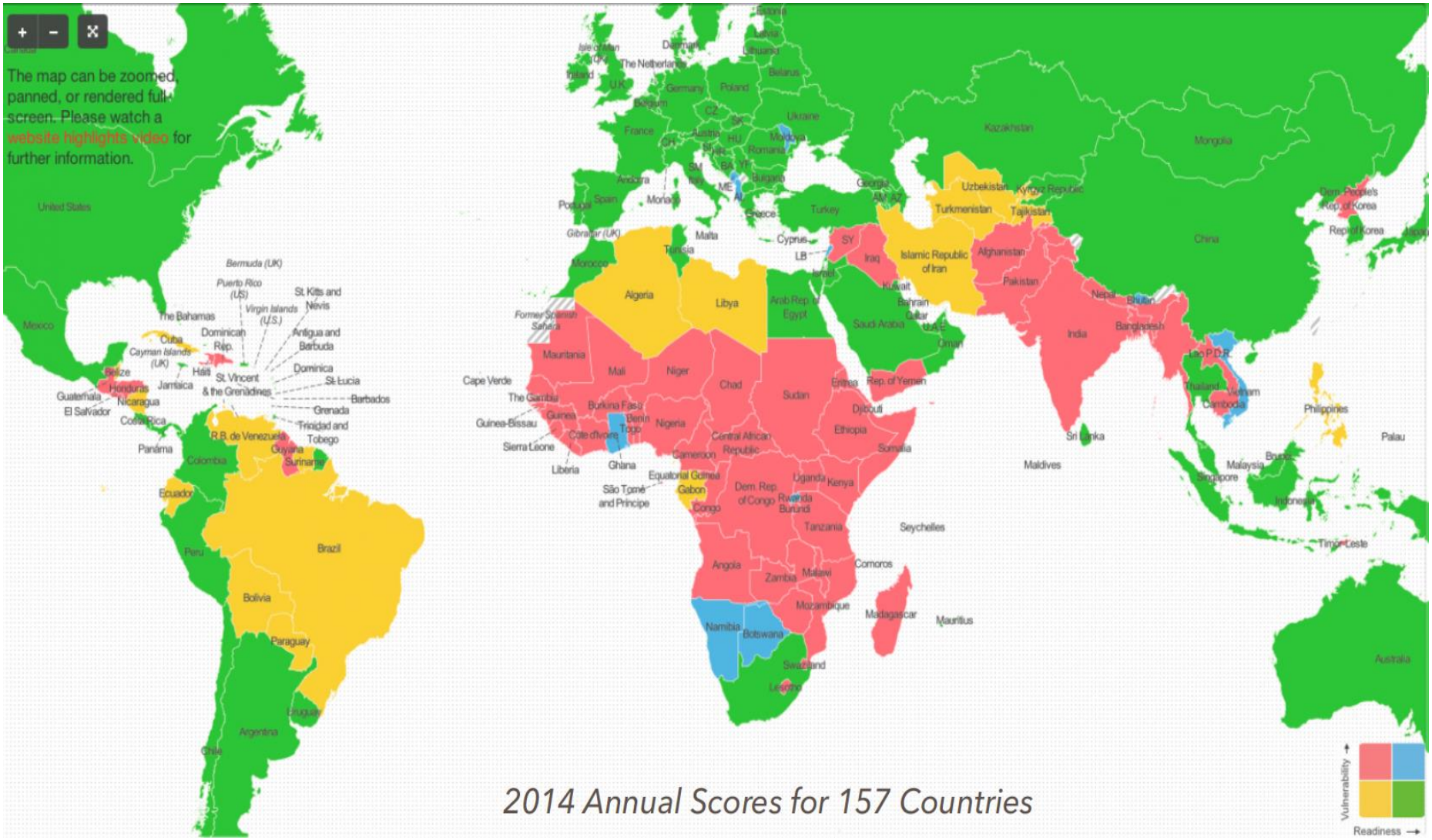
Growing number of weather related disasters 1980-2016

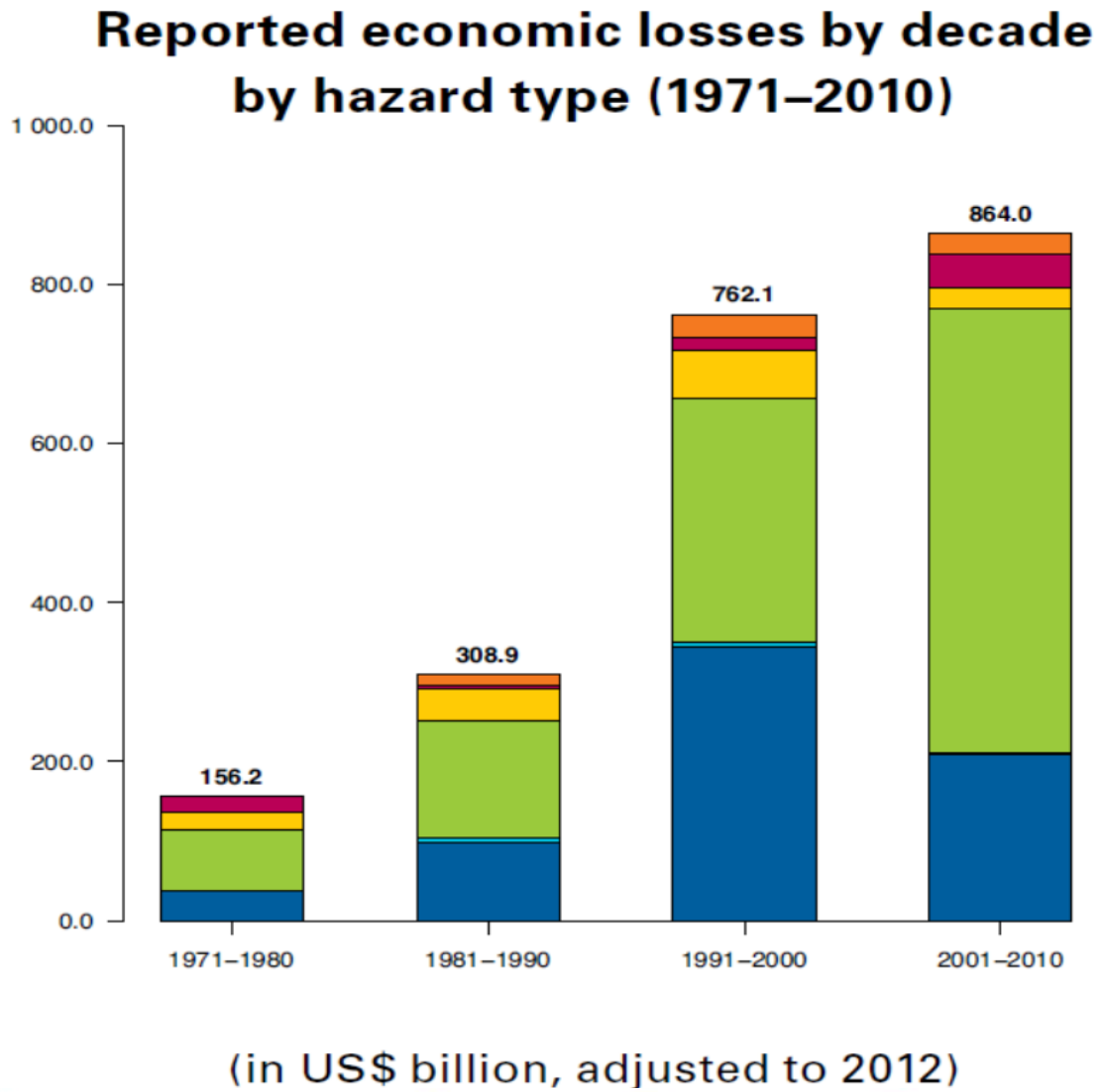


Global adaptation index



Univ. Notre Dame

Economic lossess also growing



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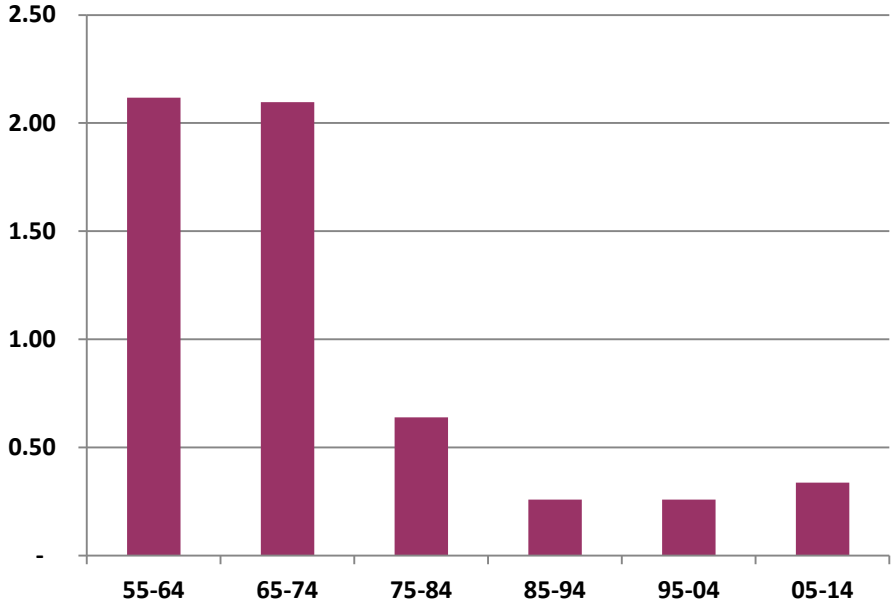
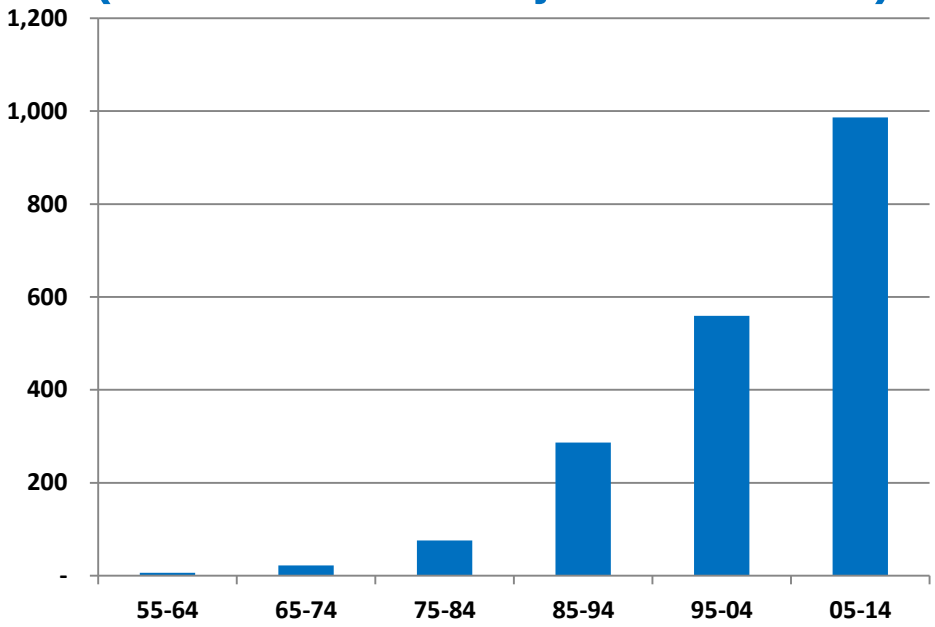
Impacts of hydrometeorological and climatological hazards (1955–2014)

Human losses by decade (millions)



Economic losses by decade (billions of US$ adjusted to 2013)



Reduction of the number of victims thanks to greater effectiveness of early warning systems and prevention measures

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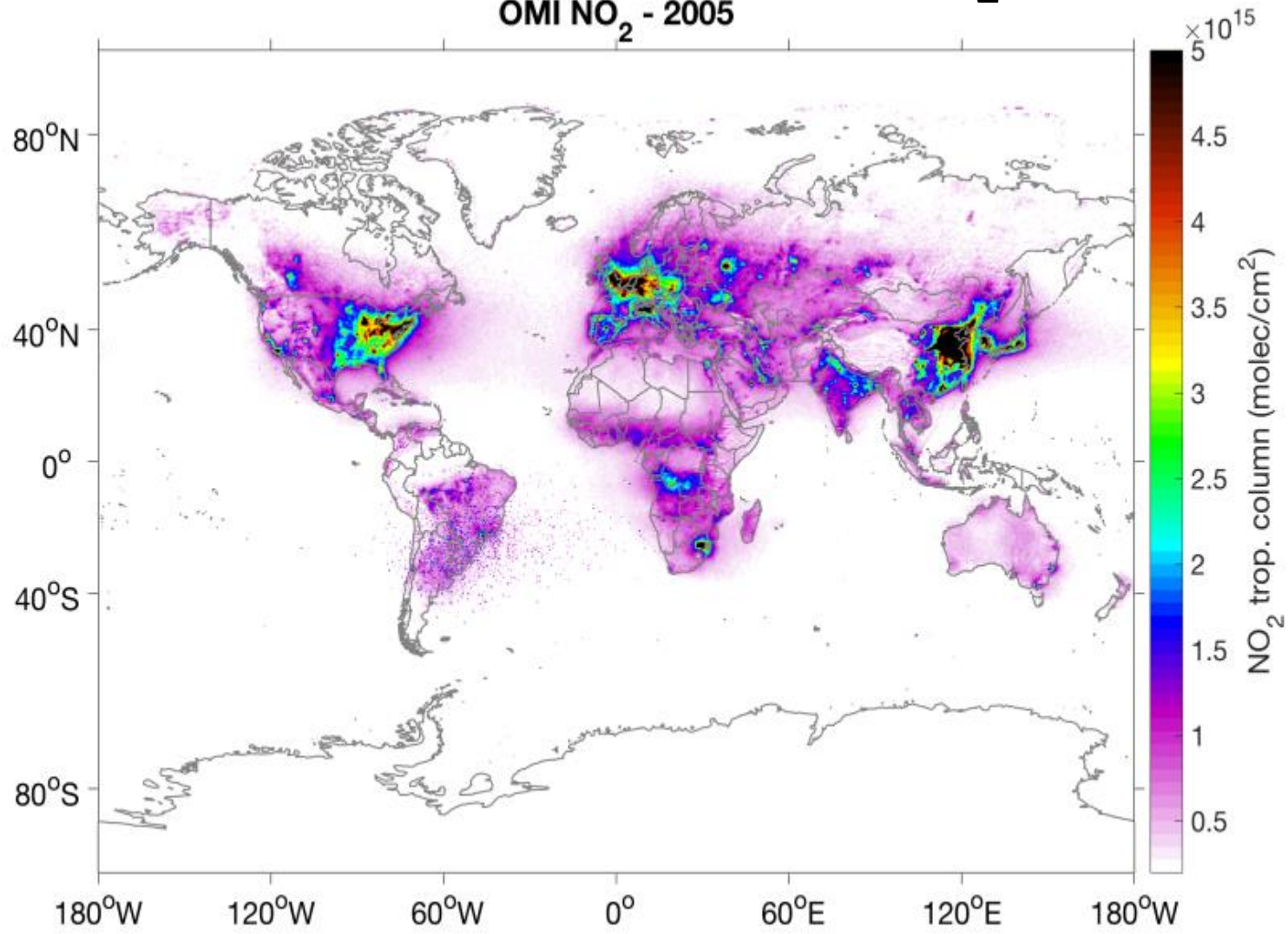
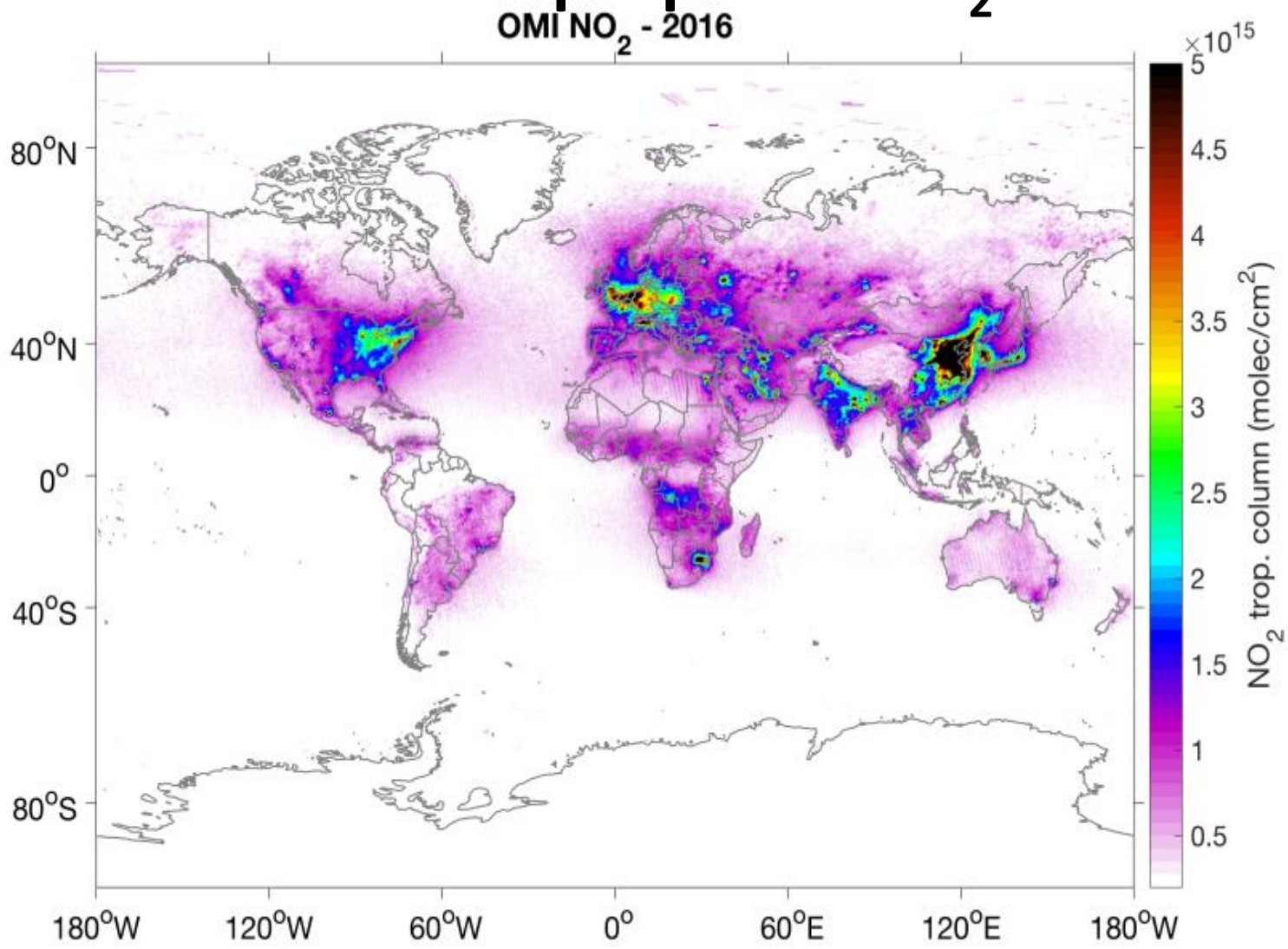
OMI tropospheric NO_2



Picture: Iolanda Ialongo, Finnish Meteorological Institute

- NO_2 is a short-lived polluting gas, produced from fossil fuel combustion.
- Pollution decreased in USA and Europe as result of air protection policies, while increased in India and Middle-East because of the increasing industrial activities.
- In China polluting emissions started also decreasing a couple of years ago as consequence of new environmental policies.

OMI tropospheric NO_2



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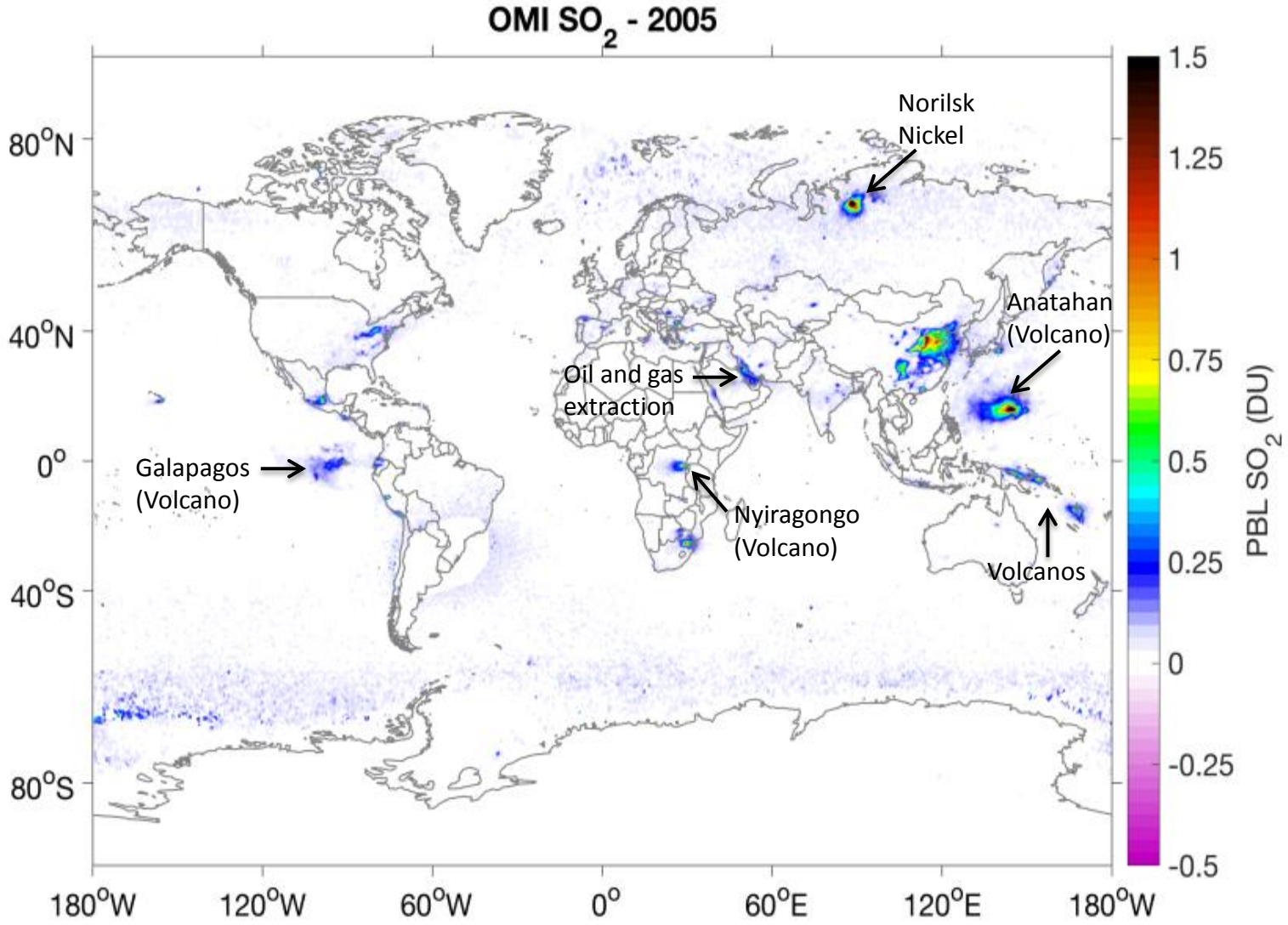
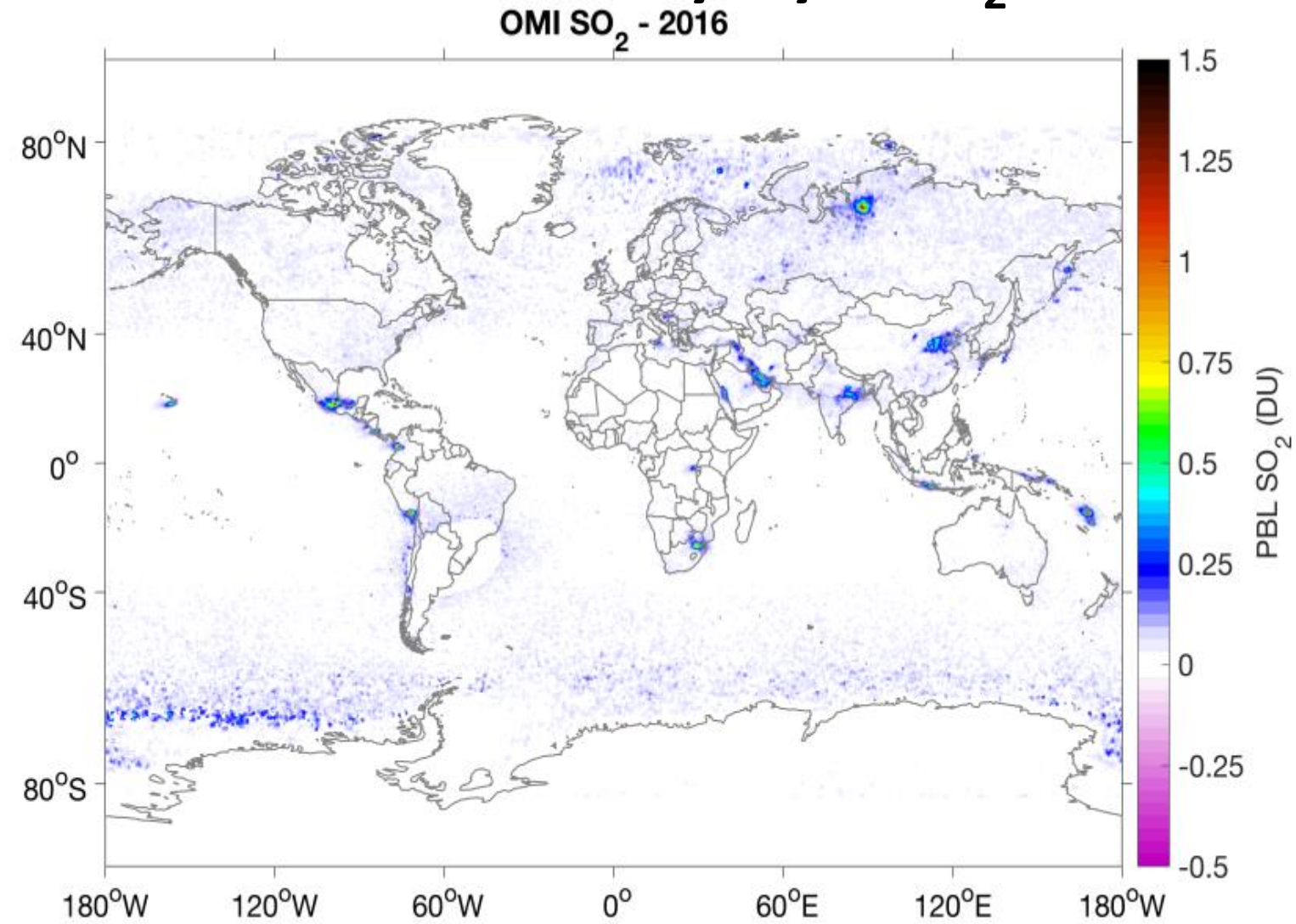
OMI boundary layer SO_2



- SO_2 is a short-lived gas, produced by both anthropogenic (power plants, smelters, oil and gas extraction) and natural (volcanoes) sources.
- Anthropogenic SO_2 emissions also decreased as result of new environmental policies in USA, Europe and China, while increased in India.

Picture: Anu-Maija Sundström, Iolanda Ialongo, Finnish Meteorological Institute

OMI boundary layer SO_2



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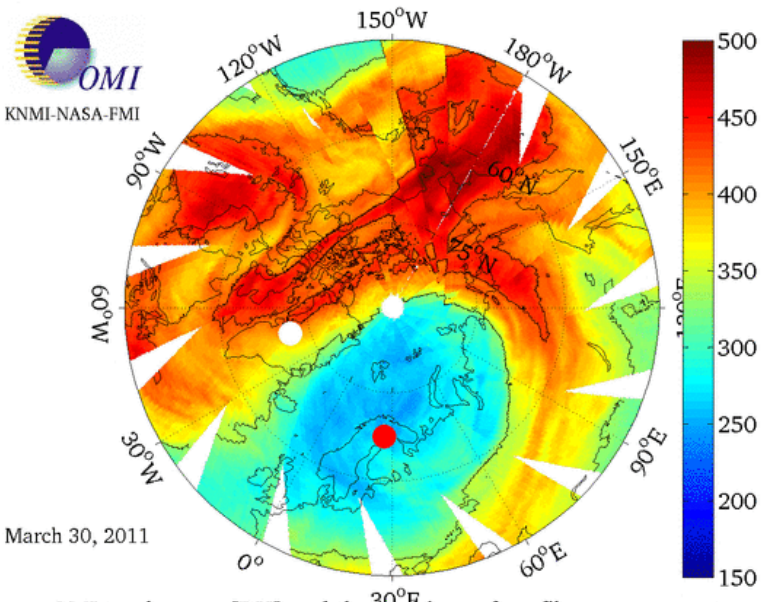
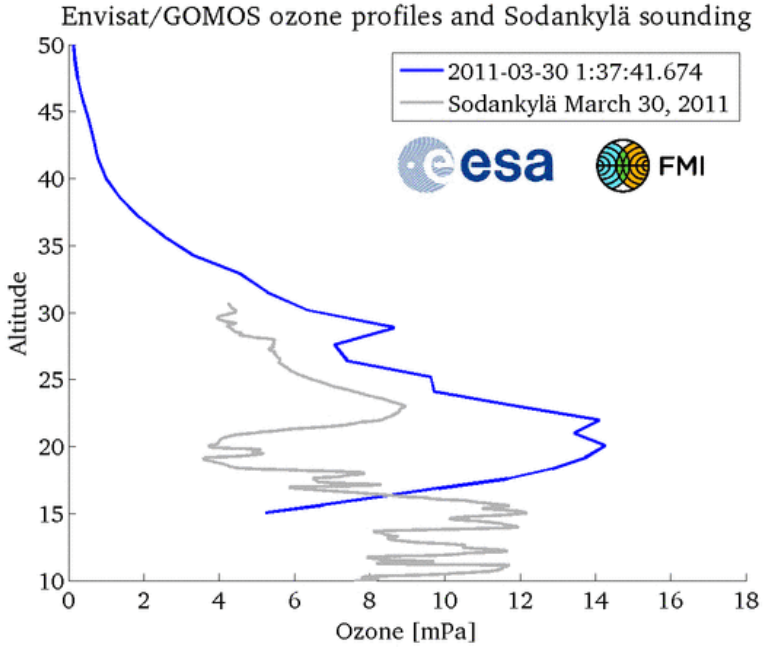
Picture: Anu-Maija Sundström, Iolanda Ialongo, Finnish Meteorological Institute

“Ozone hole”

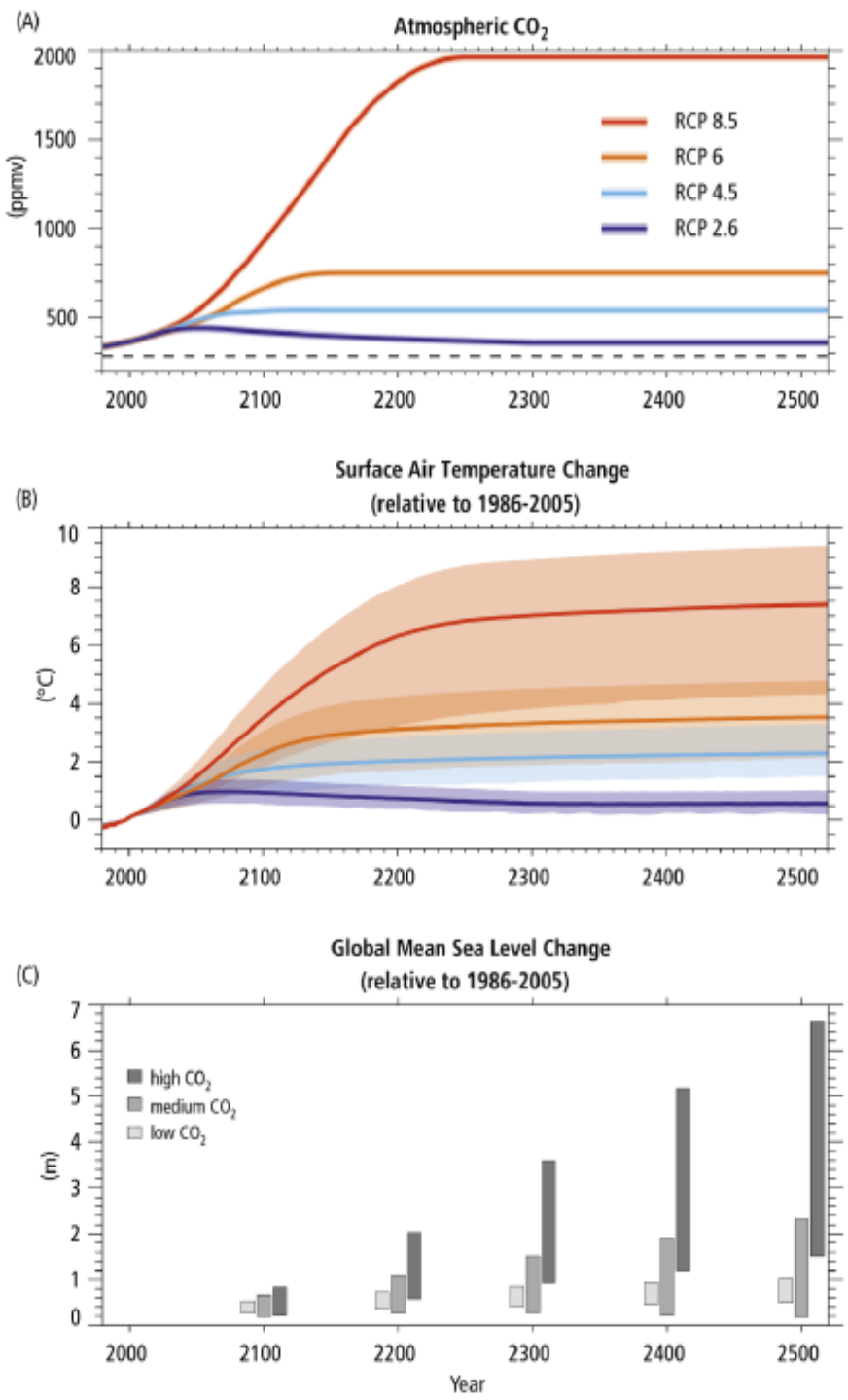
- Discovery of ozone hole in the Antarctic and Arctic and the chemistry/meteorology behind it => Nobel Price 1995 for Crutzen, Molina & Rowland



OMI total ozone [DU] and the positions of profile measurements



2000-2500? Various emission pathways:



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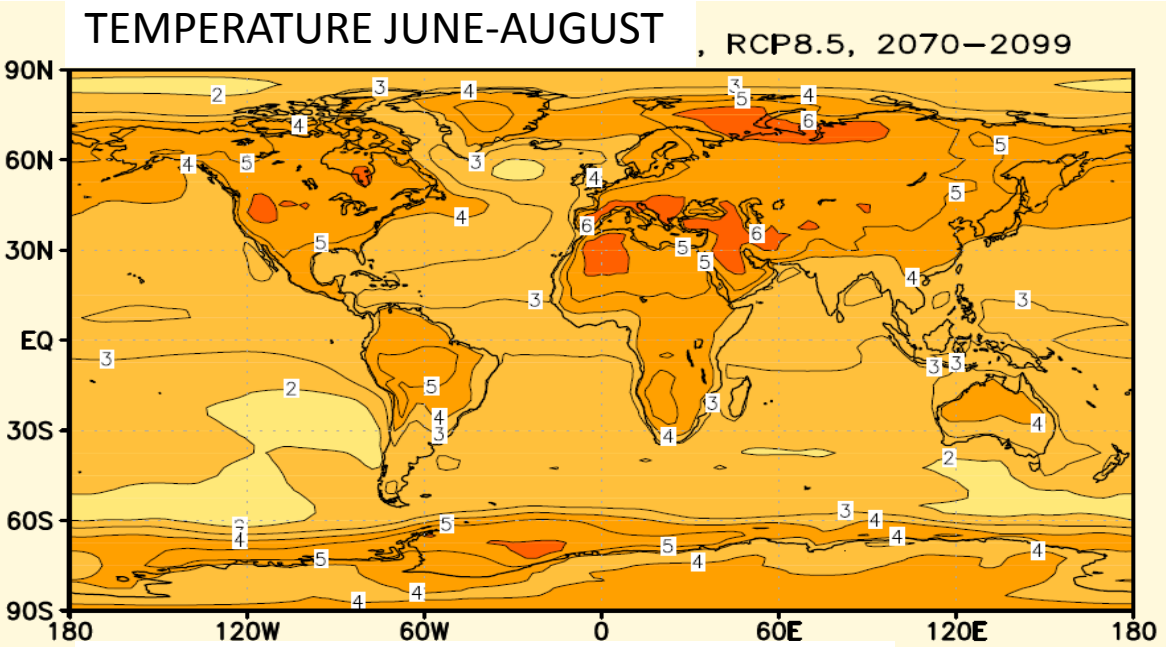
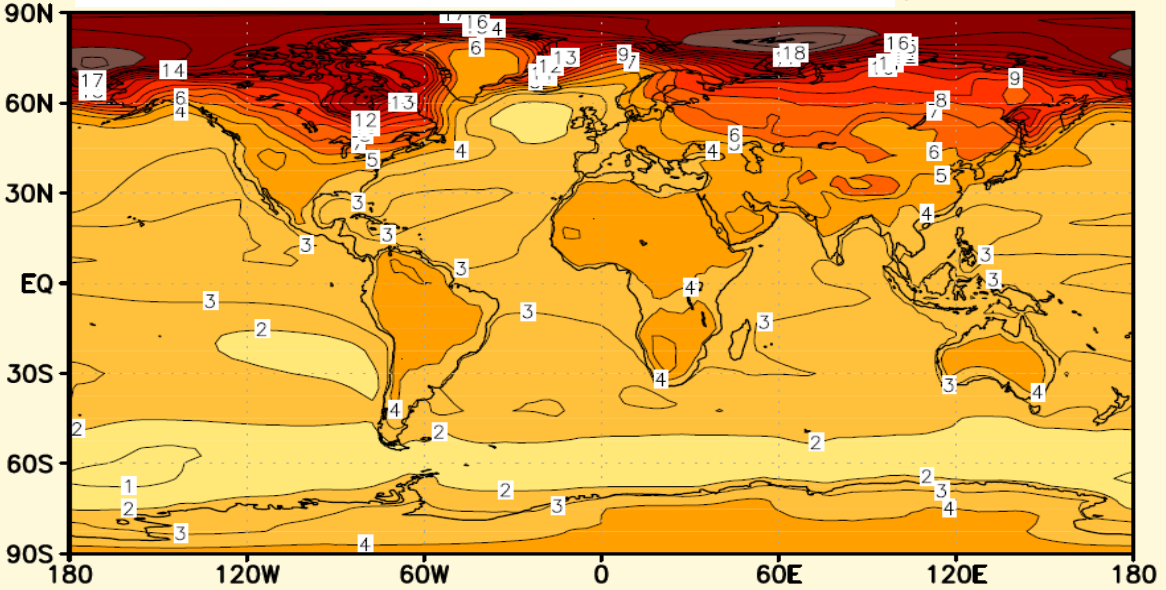
TEMPERATURE CHANGE =>2070-99, RCP 8.5

TEMPERATURE JUNE-AUGUST



TEMPERATURE DECEMBER-FEBRUARY



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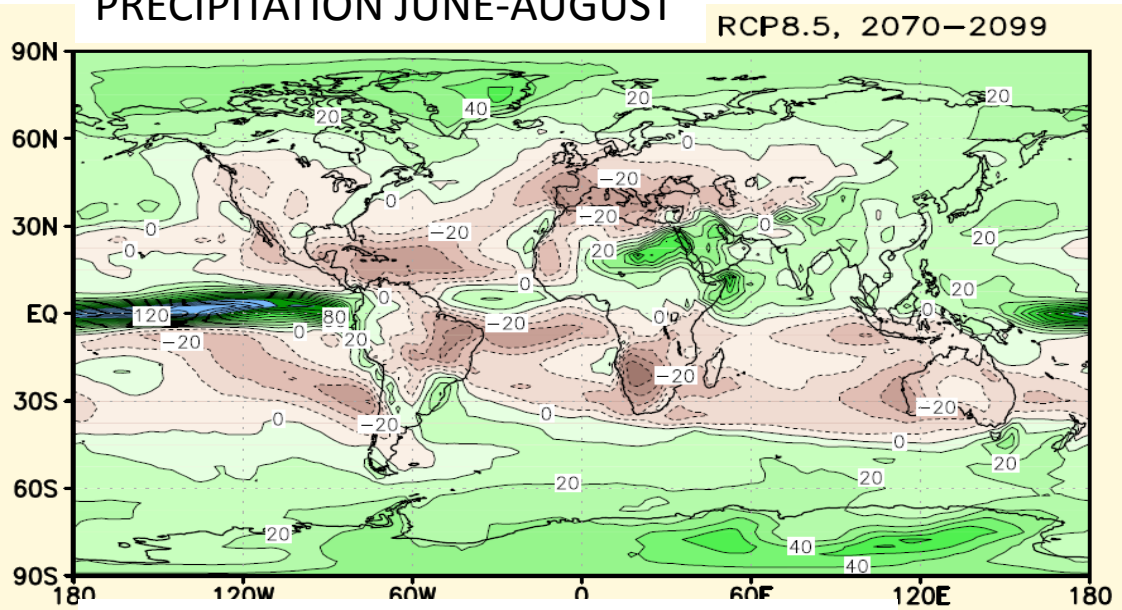
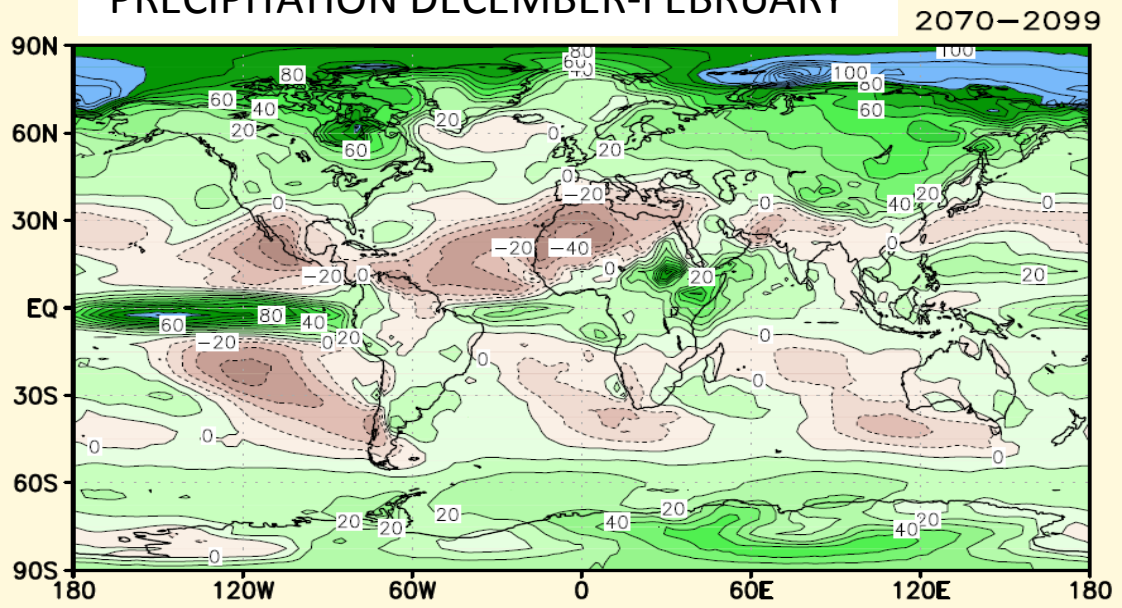
PRECIPITATION CHANGE =>2070-99, RCP 8.5

PRECIPITATION JUNE-AUGUST



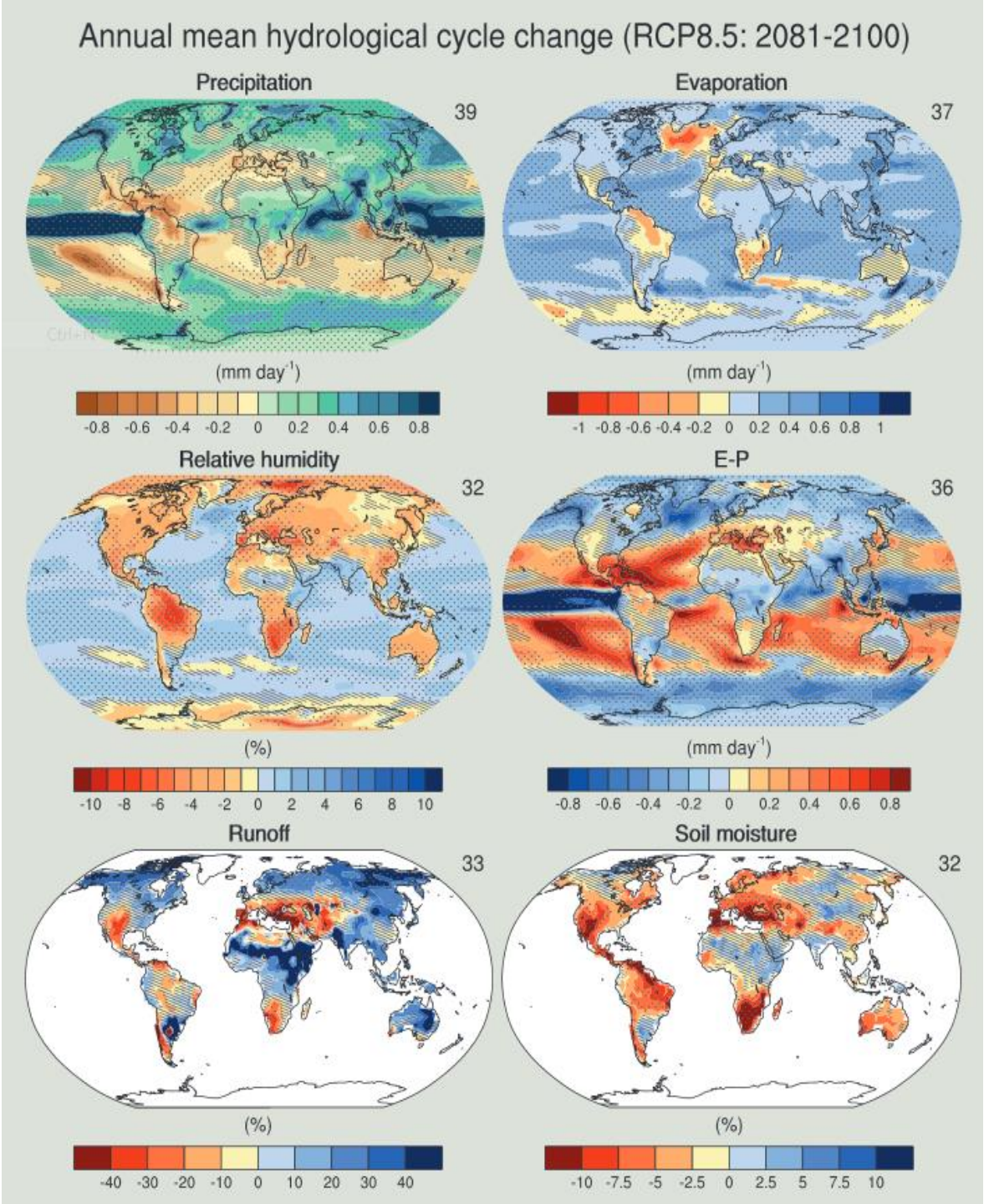
PRECIPITATION DECEMBER-FEBRUARY



WMO

NO EMISSION CUTS

NOW => 2081-2100



WMO OMM

UNFCCC plenary, Paris, 4pm on December 12th 2015

- Excellent agreement, success depends on (speedy) implementation
- 1.5 ◦C very soon, also 2 ◦C

WMO OMM

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
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