

# Earth System Approach to Weather, Climate, Water and Environment

## a new WMO agenda

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*World Meteorological Organization (WMO)*



**WMO OMM**

World Meteorological Organization

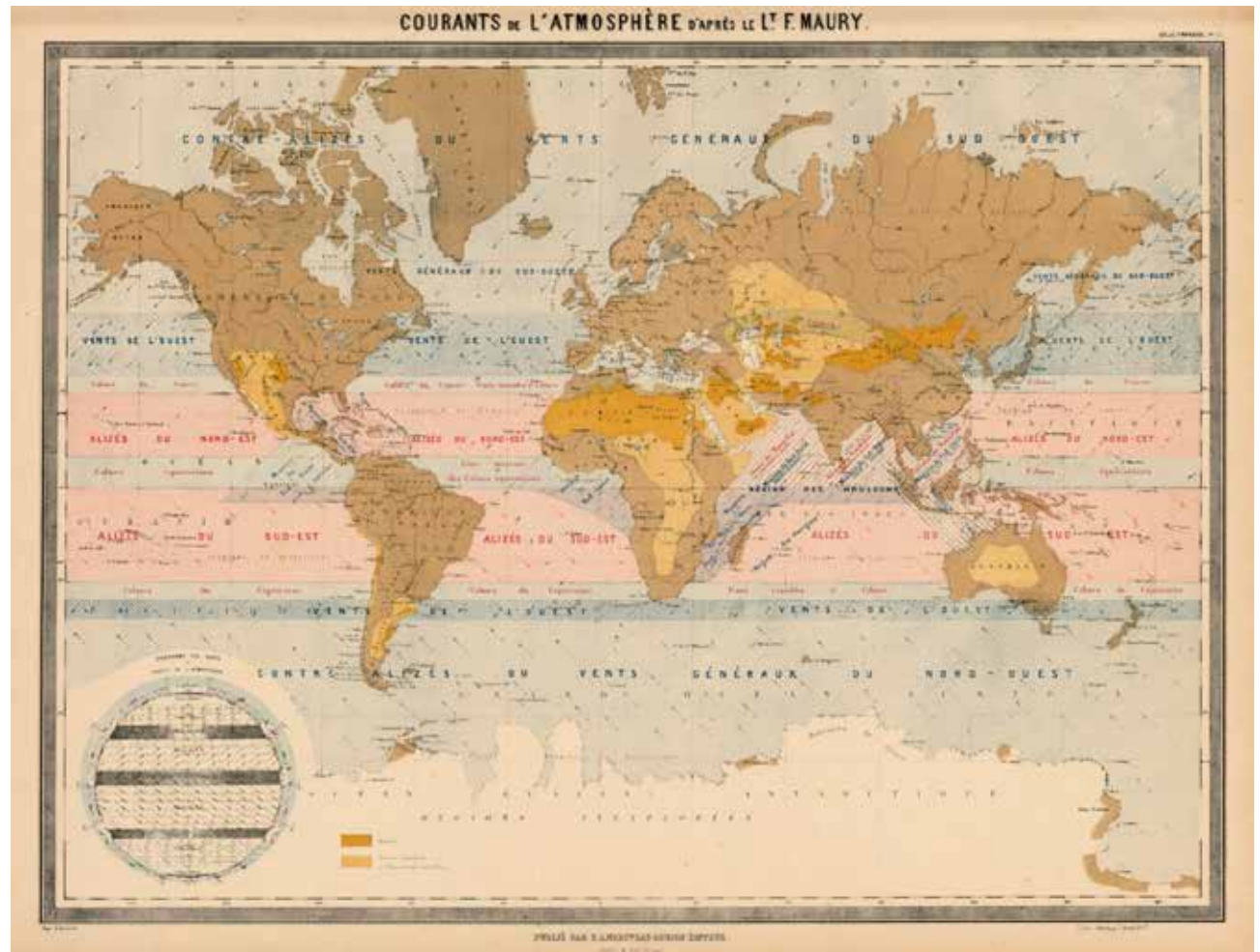
Organisation météorologique mondiale

WEATHER CLIMATE WATER  
TEMPS CLIMAT EAU

# Standard meteorological logs for ships at sea



Ship barometer  
ca. 1840



Atmospheric circulation after Maury (ca. 1860)



**First International  
Meteorological  
Congress  
(Vienna, 1873)**

***The 1947 Convention: from IMO to WMO...***

**Conference  
of IMO Directors  
(Washington D.C., 1947)**



**WMO OMM**

Weather • Climate • Water



# WMO@2018 and its Members

**WMO has 195 Members (countries) and coordinates the activities of all the National Meteorological and Hydrological Services (NMHSs) of the planet because weather, climate and water know no national or political boundaries.**



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Weather • Climate • Water

# 2015: A Landmark Year.

## How should WMO respond?



- Over 190 countries signed up to reduce emissions, with the target to stay within a 2°C world.
- 15-year agreement for the substantial reduction of disaster risk and losses in lives, livelihoods and health.
- 2030 agenda with 17 goals to end poverty and hunger, improve health and education, making cities more sustainable, combating climate change, and protecting oceans and forests.

**Understanding and Quantifying Weather, Climate and Environmental Risks are at the Core of these Actions**

# A little Preamble...

## Where do we stand today?

**“United in Science”, UNSG Climate Summit, New York, Sep 2019  
WMO 2019 Provisional Statement on the State of the Global Climate,  
COP25, Madrid, Dec 2019**



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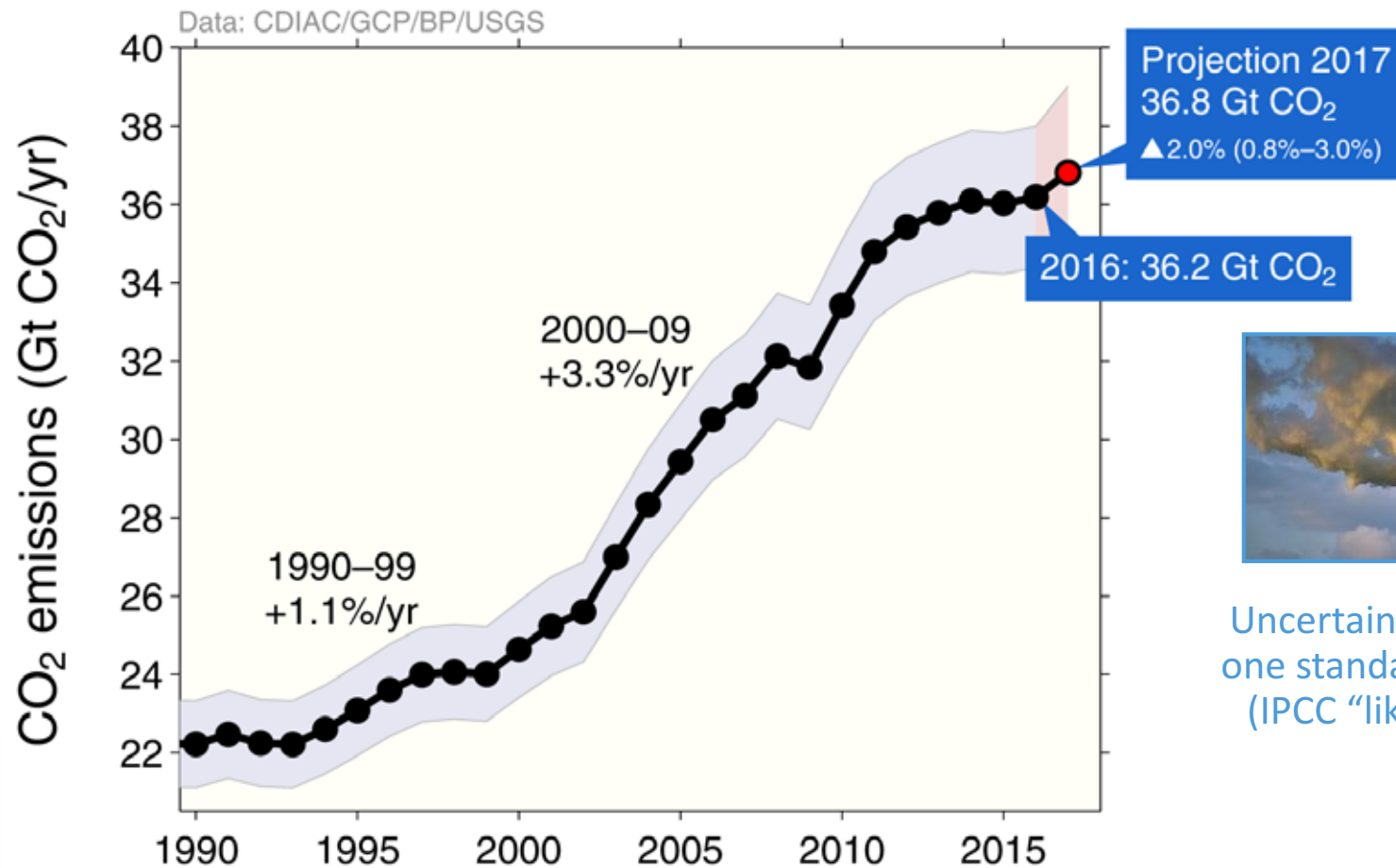
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# Emissions from fossil fuel use and industry

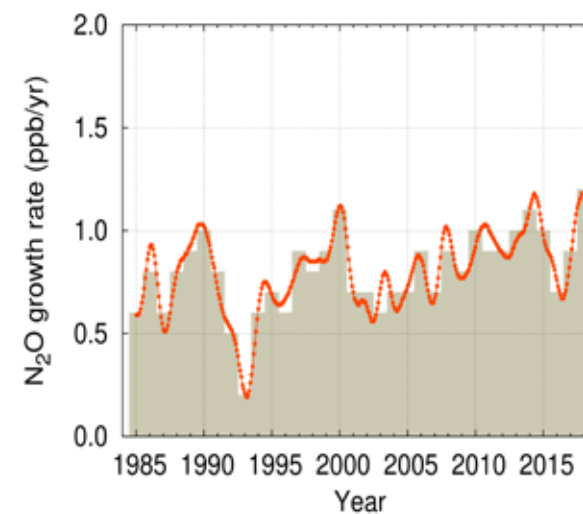
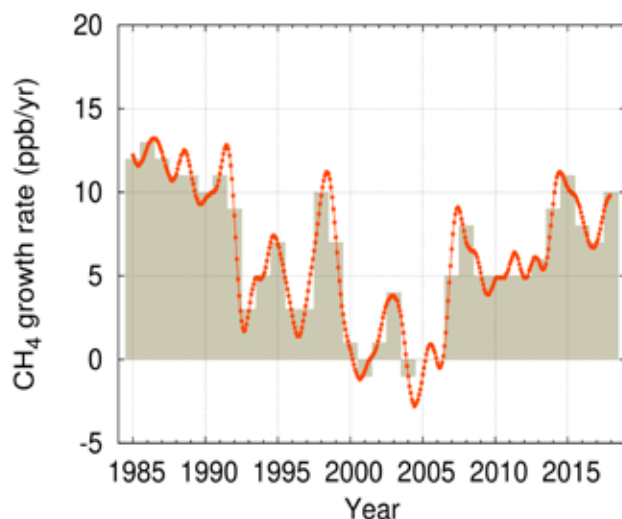
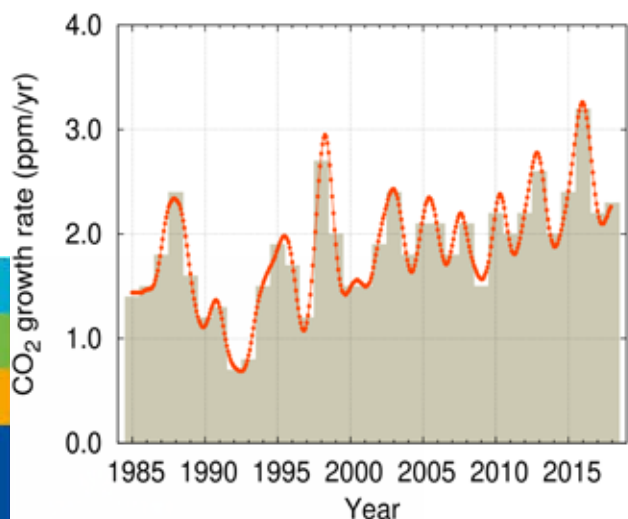
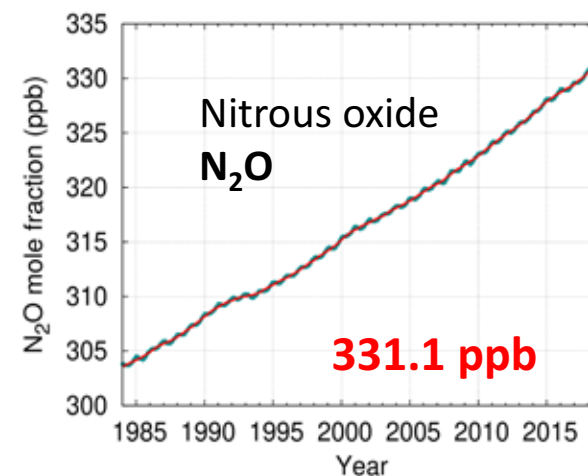
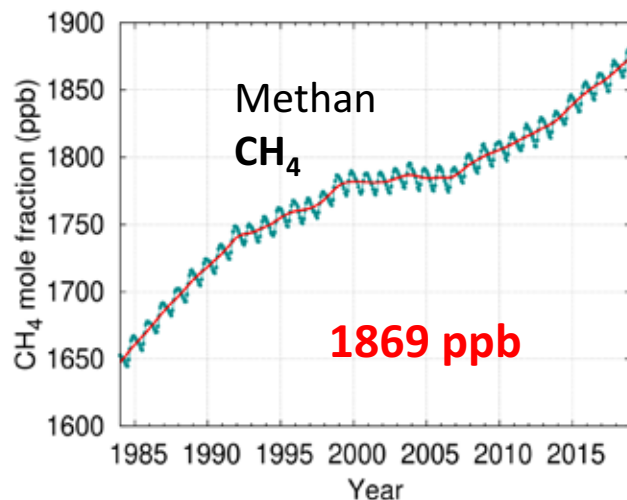
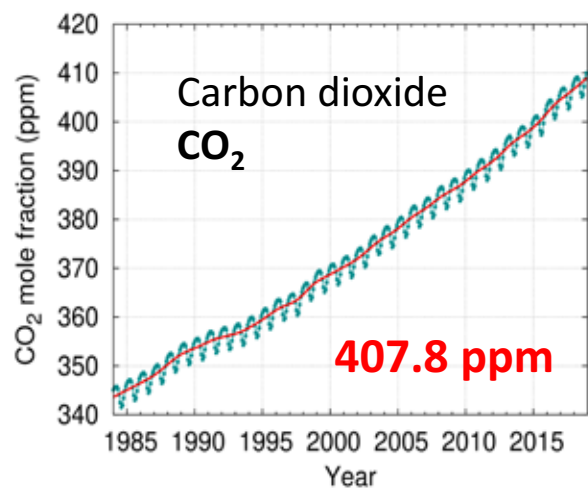
Global emissions from fossil fuel and industry:  $36.2 \pm 2$  GtCO<sub>2</sub> in 2016, 62% over 1990

- Projection for 2017:  $36.8 \pm 2$  GtCO<sub>2</sub>, 2.0% higher than 2016



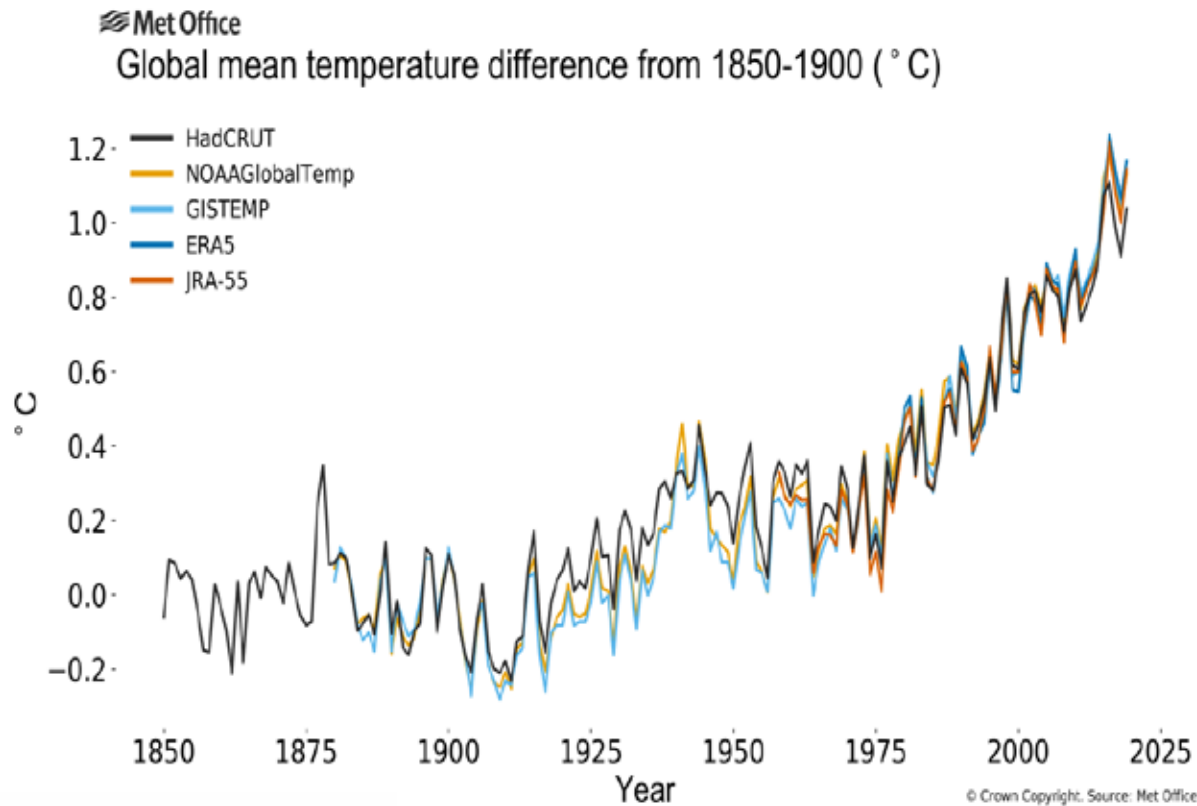
Uncertainty is  $\pm 5\%$  for one standard deviation (IPCC “likely” range)

# Greenhouse gas concentration reached new highs





# 2019 global temperature: + 1.1°C increase (Reference 1850-1900)



❖ Past 5 years are ranked top warmest years

2016 1

2019 2,3

2017 3

2015 4

2018 5

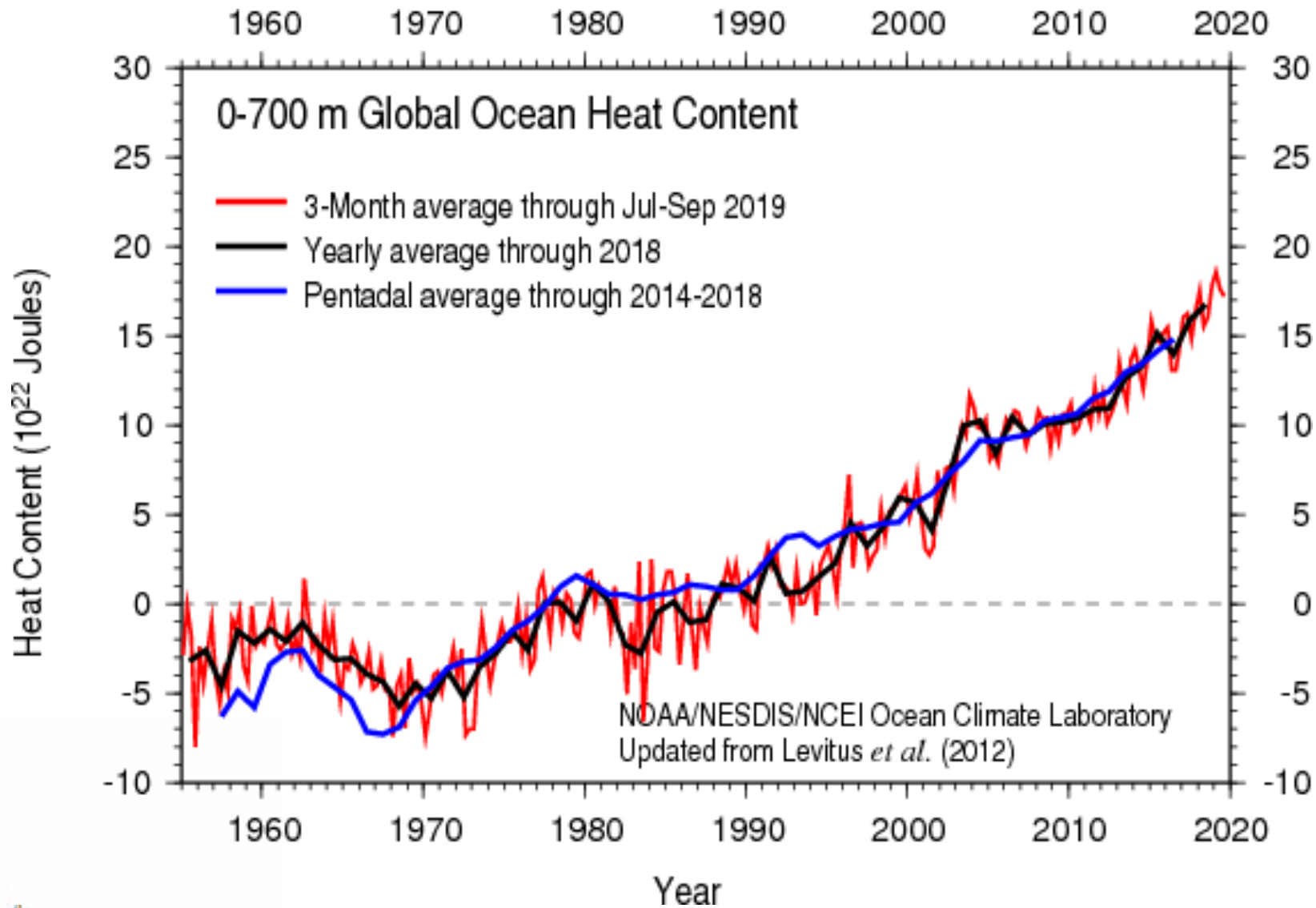
❖ 2015-2019

warmest 5 year period

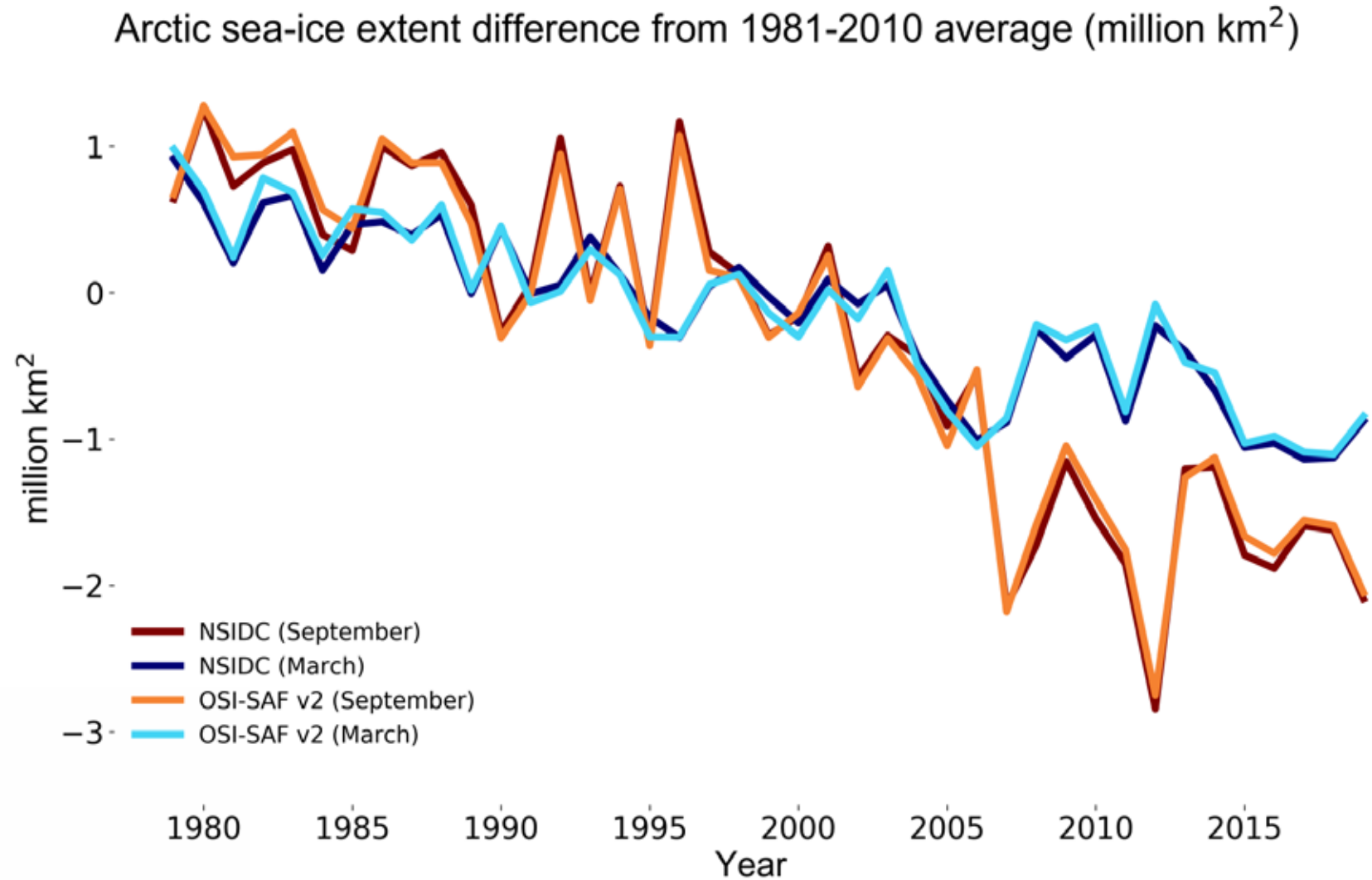
❖ 2010-2019

warmest 10 year period

# Ocean heat content on record

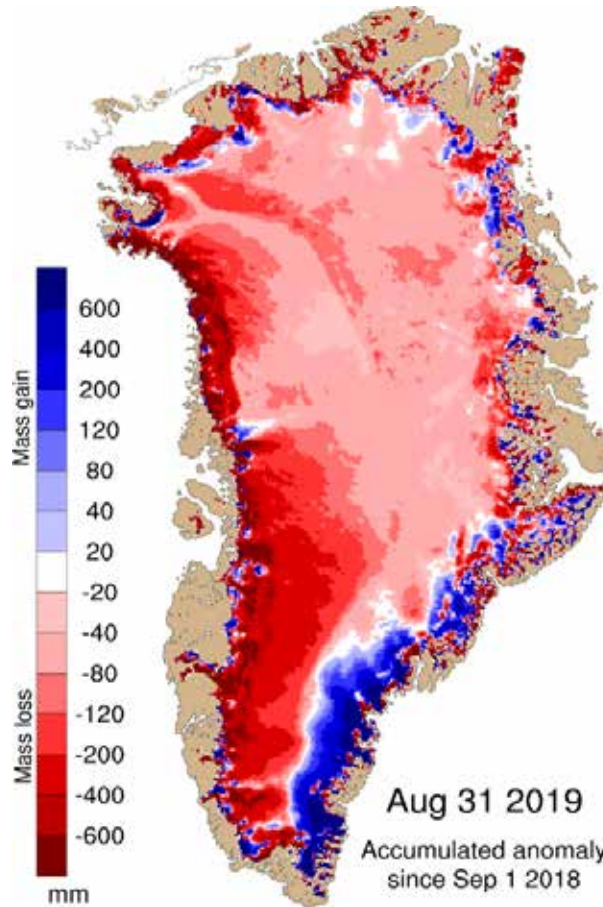
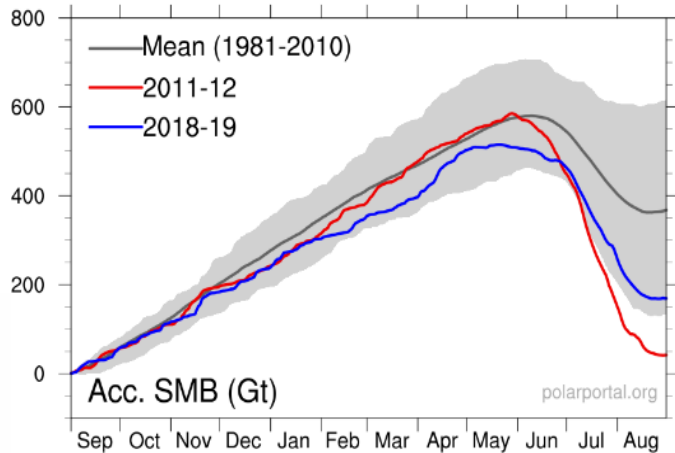
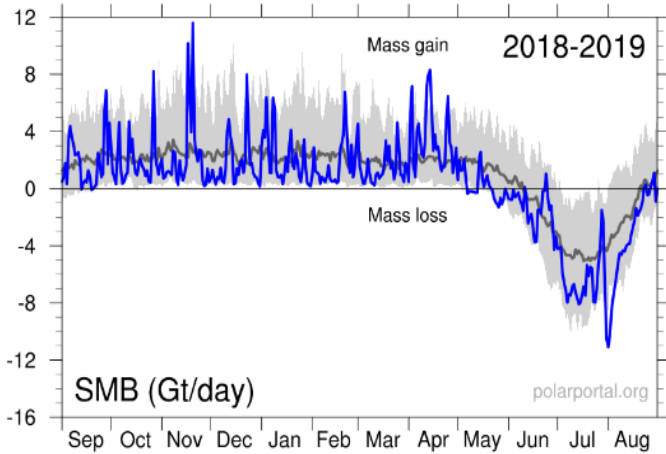


# Arctic sea ice continues long term decline



# Greenland ice Mass Balance decreasing

## **329 Gigatonnes net ice loss 2018/2019**

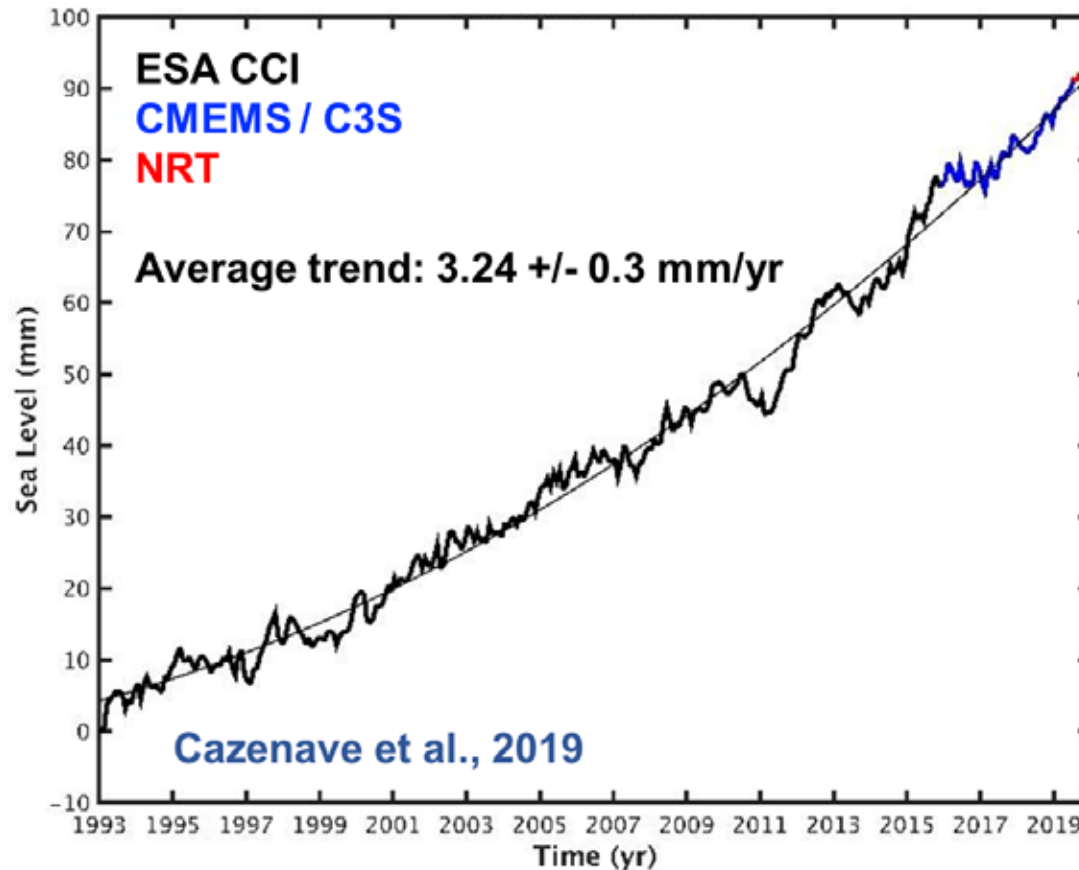


- Average of 260 Gt of ice per year over the period 2002-2016
- Maximum loss occurred in 2011/2012: 458 Gt



# 2019: Global mean sea level rise *Has accelerated*

Global Mean Sea Level



4.8 mm/yr since 2010

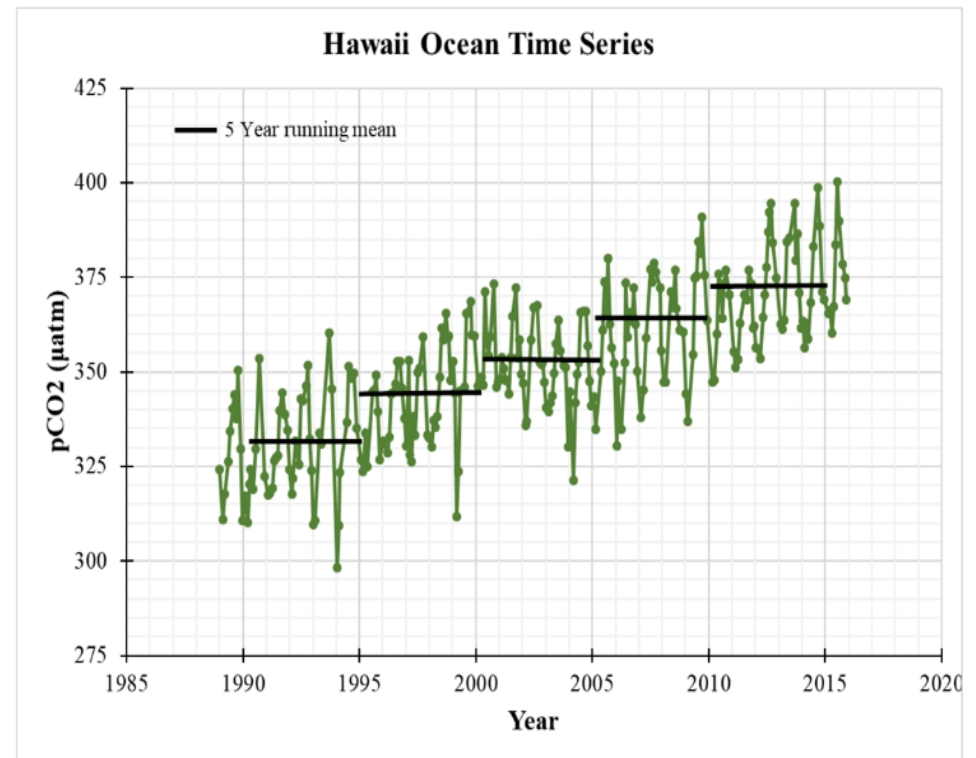
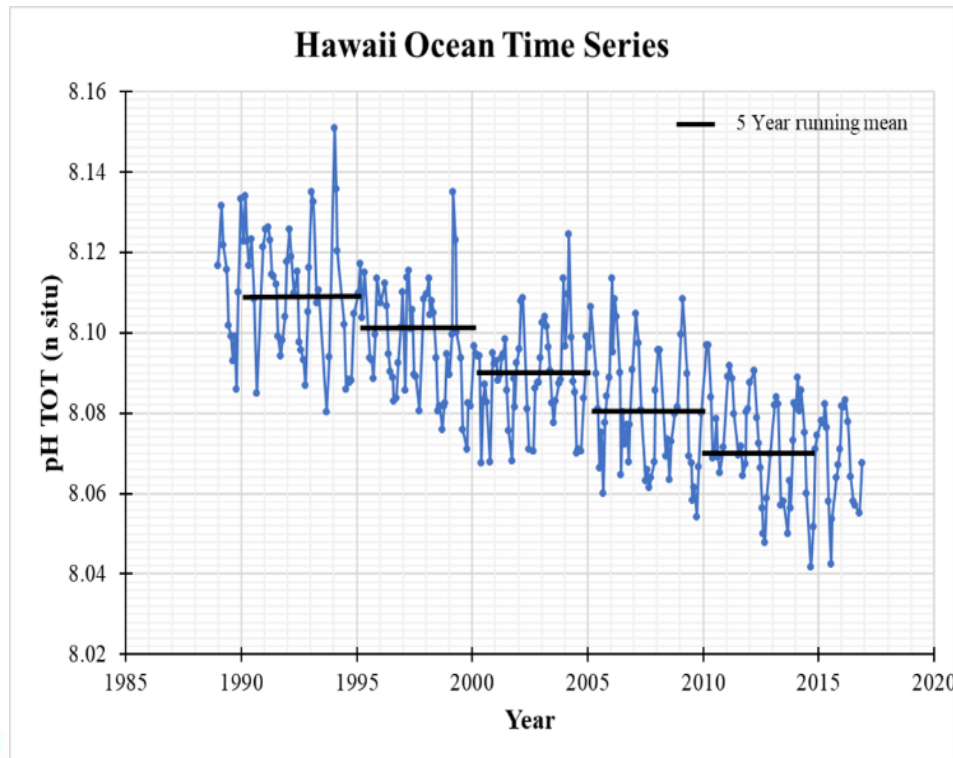
3.7 mm/yr since 2005

3.25 mm/yr since 1993



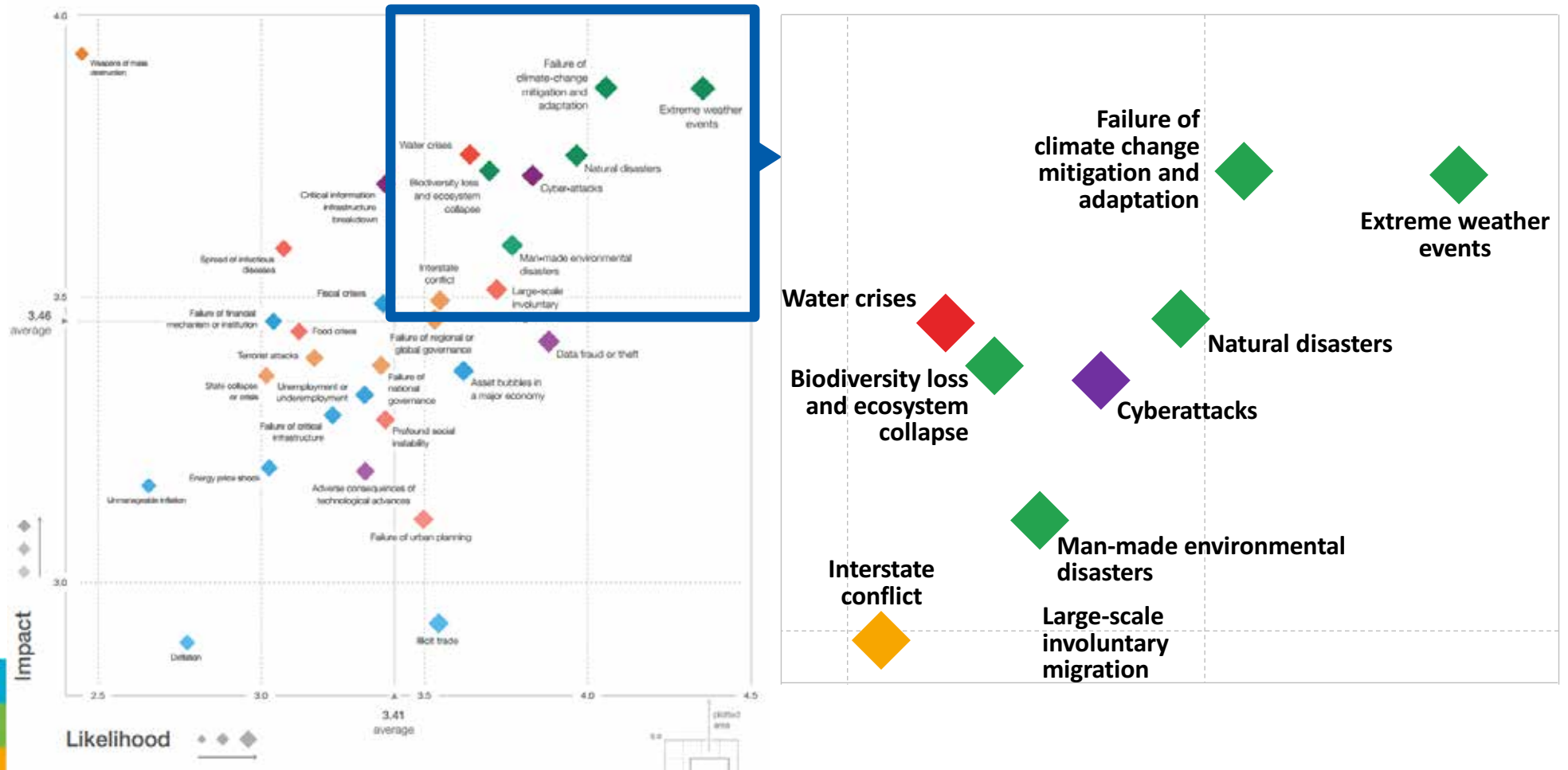
# Ocean Acidification

**+ 26%** since the beginning of the industrial revolution



Long-term observations from the open ocean at the Hawaii Ocean Time Series site show a decrease in pH and an increase in pCO<sub>2</sub> over the last 30 years. Source: Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), NOAA Pacific Marine Environmental Laboratory (NOAA PMEL), International Atomic Energy Agency Ocean Acidification International Coordination Centre (IAEA OA-ICC).

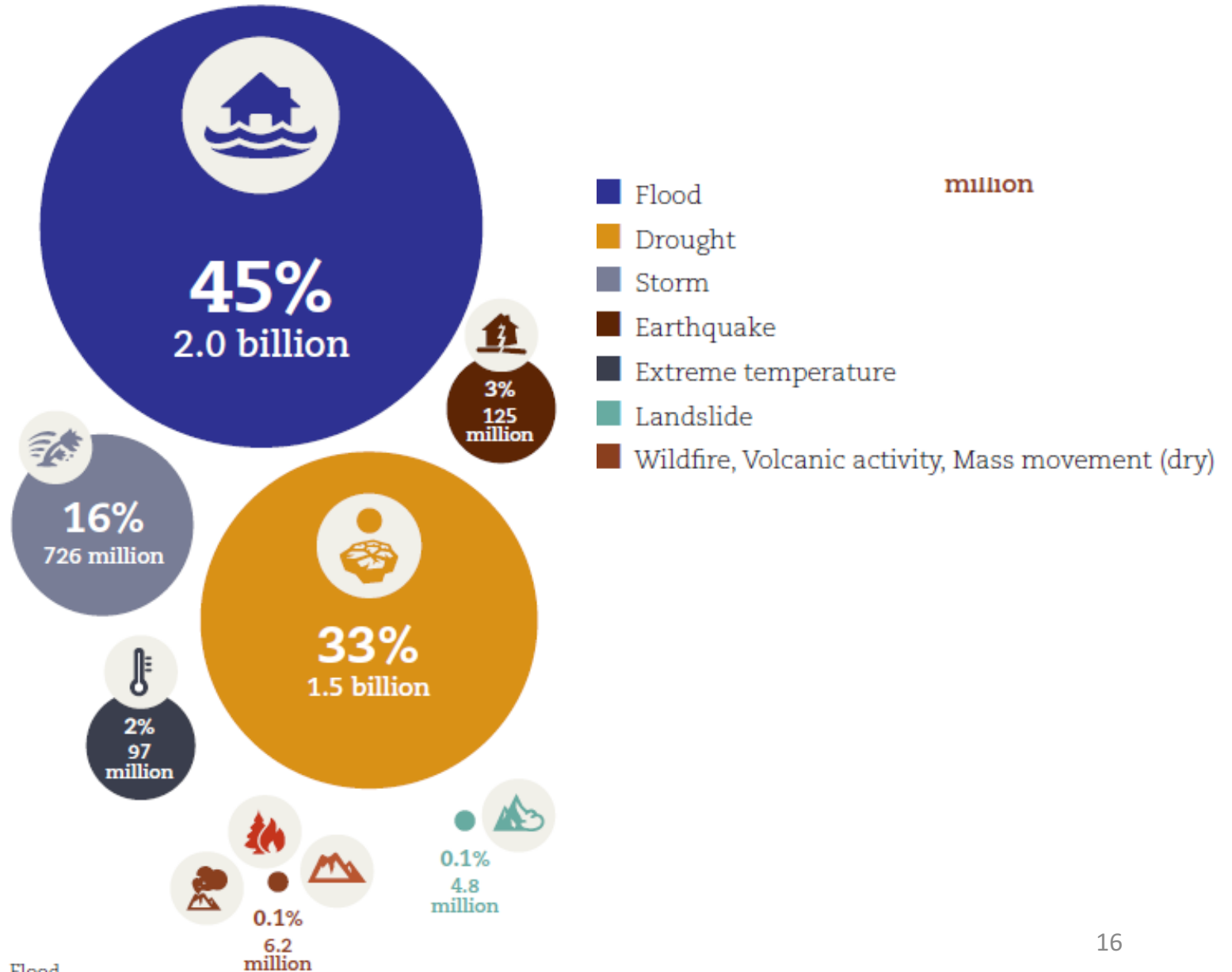
# Biggest risks for world economy 2019



World Economic Forum Global Risks Landscape 2019

# ~4.5 billion people affected 1998-2017

## 96 % weather and climate (?) related





# The (Climate) Science Requirements are Changing...

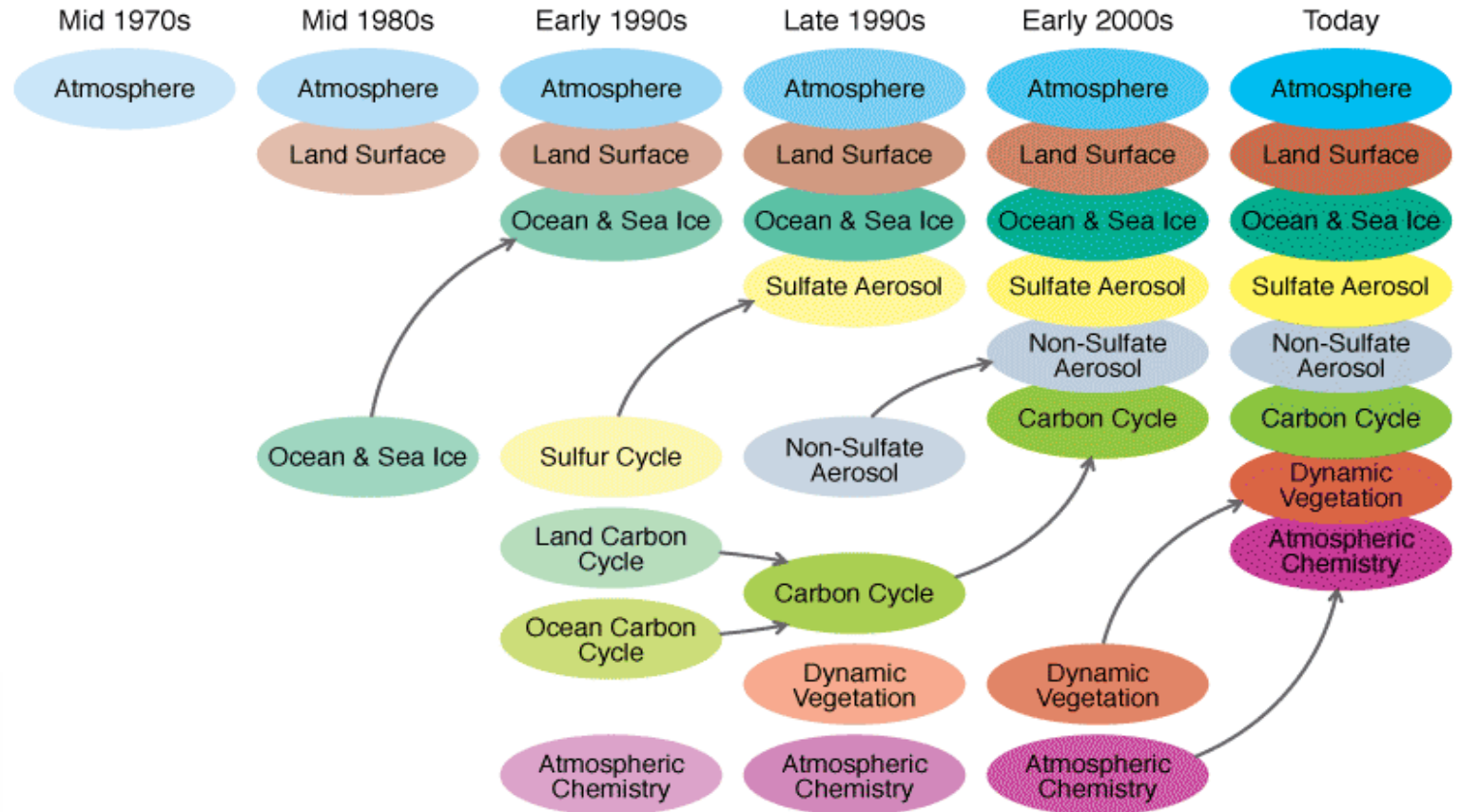


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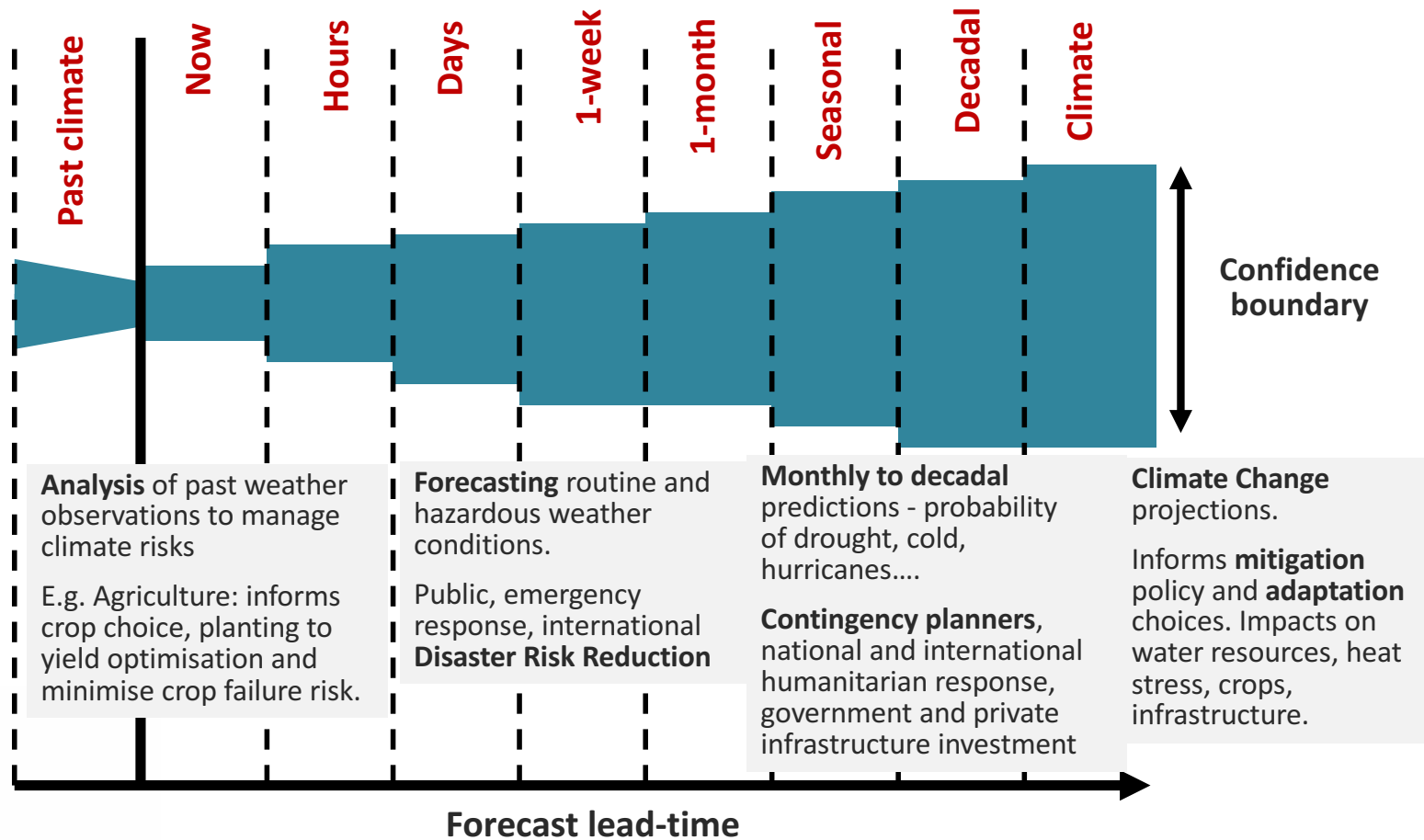


# There is no logical scientific argument for separating the physical climate system from full Earth system science

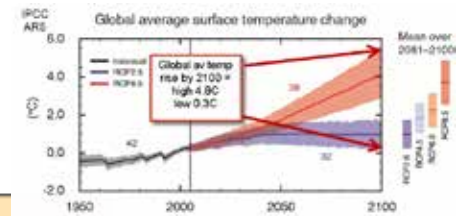
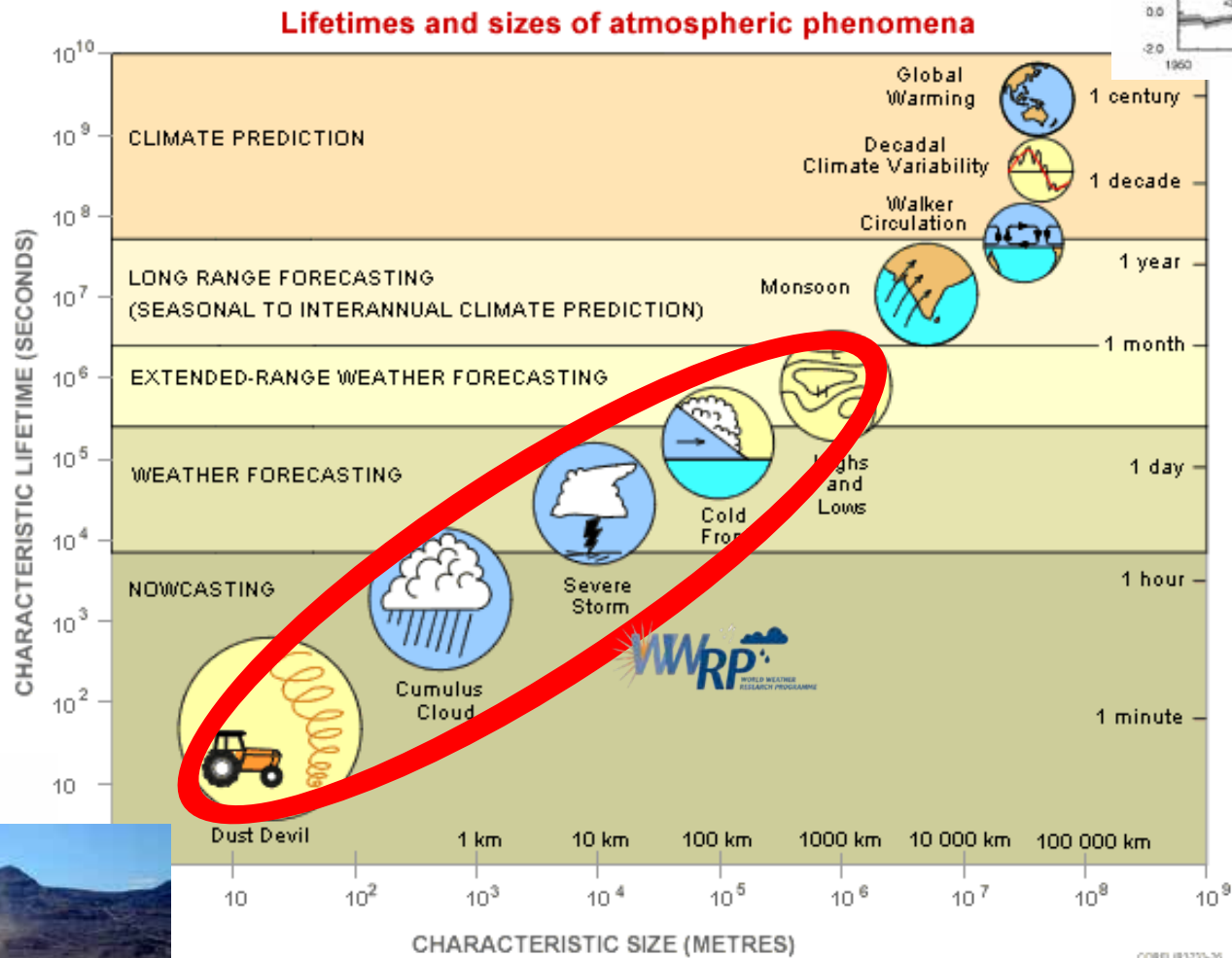
Evolution of Climate Models to Earth System Models



# New Tools in the Toolbox: Seamless Prediction Across Timescales



# Weather and Climate Research

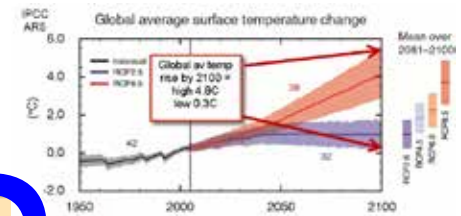
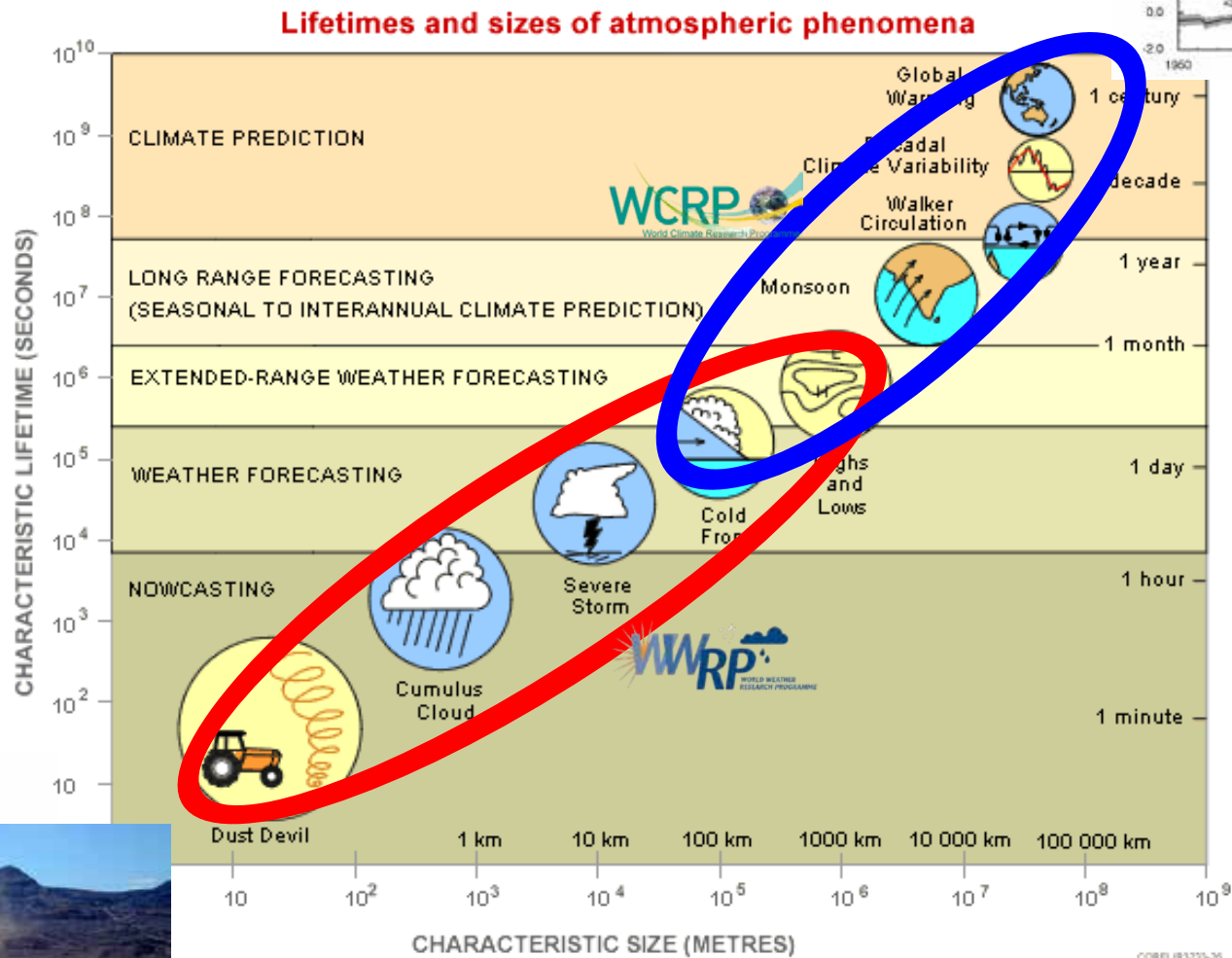


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# Weather and Climate Research



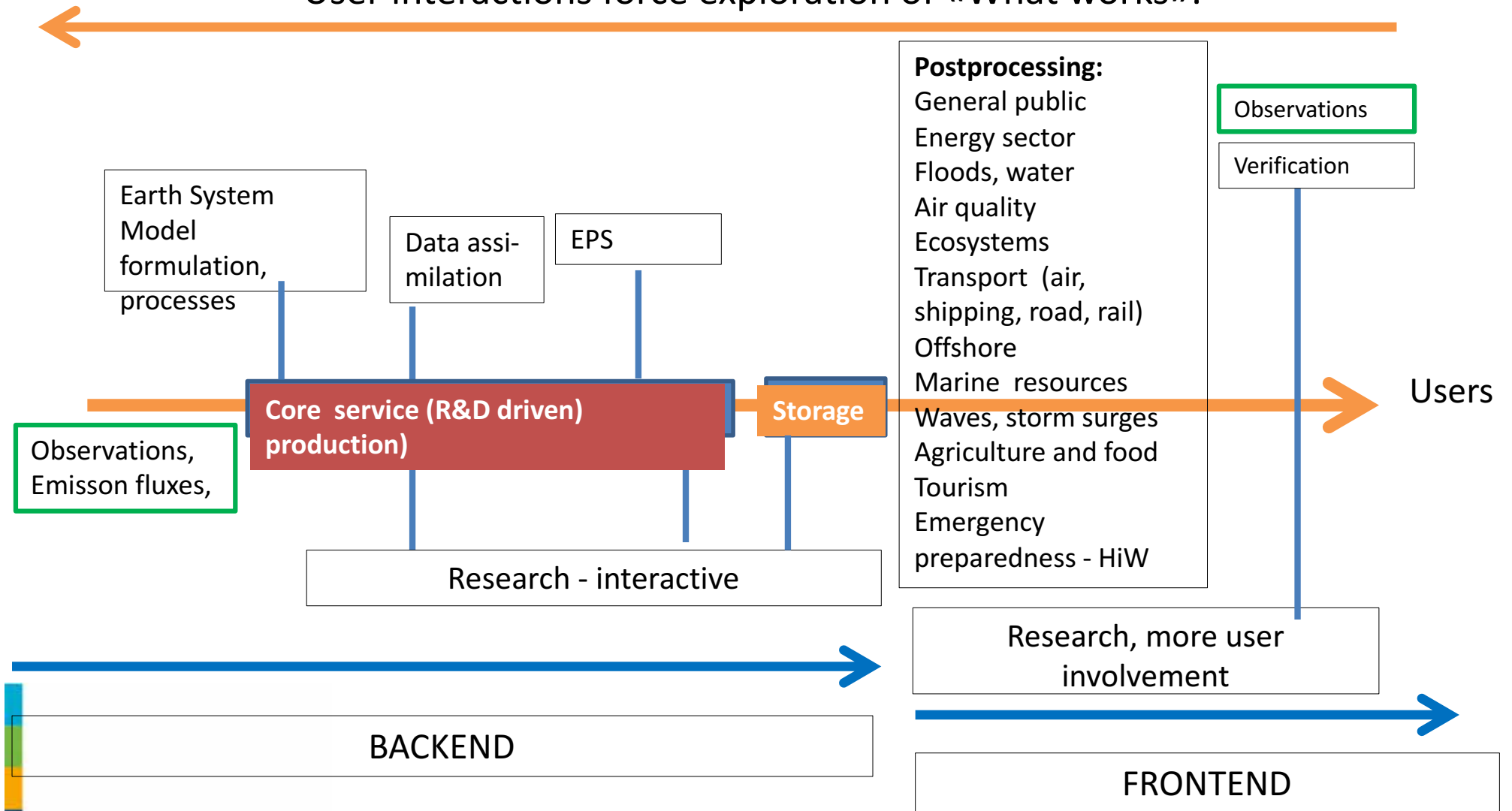
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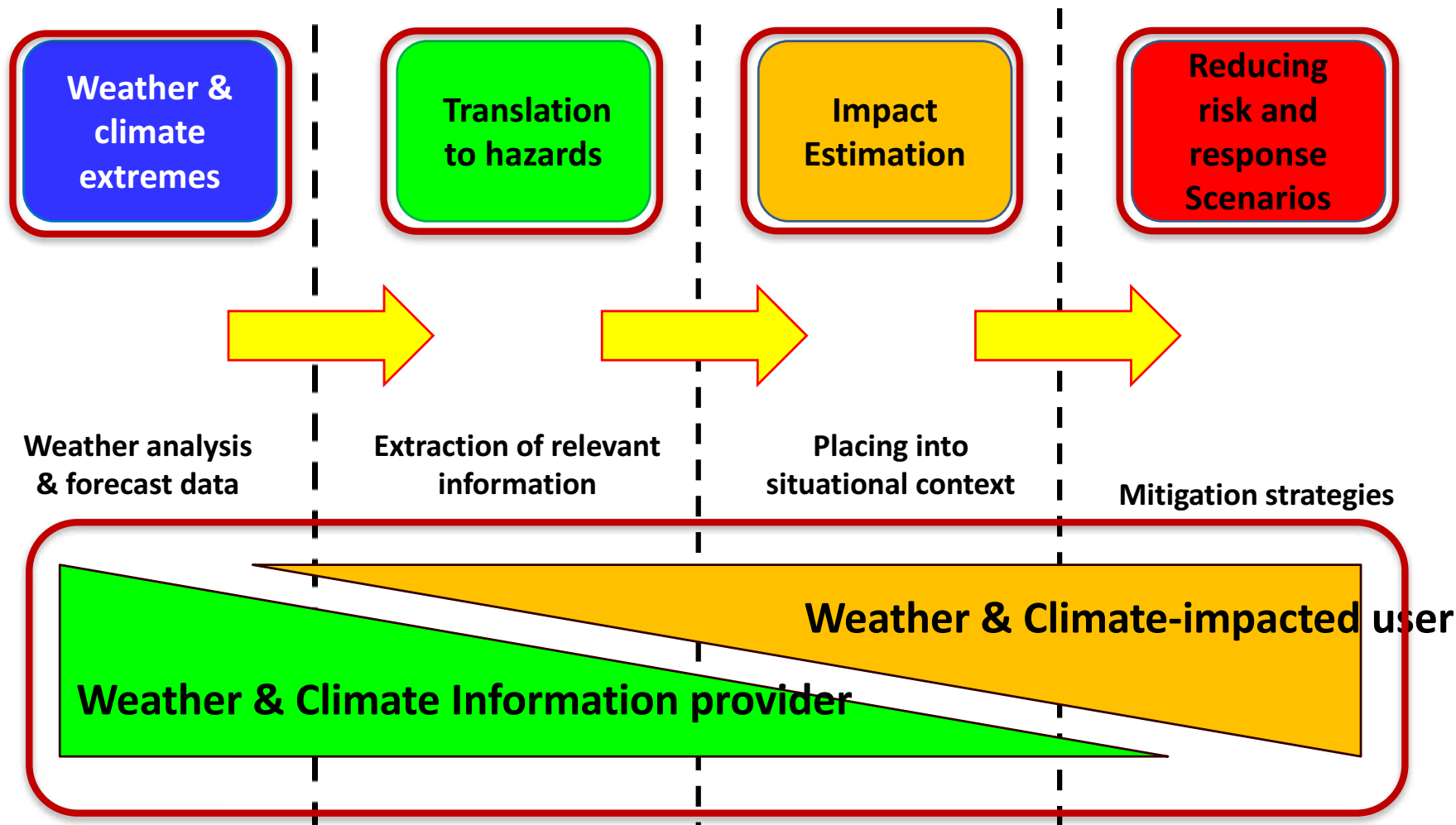
# Seamless across Weather-climate-water-ocean-ice-environment

Science for services – Quality, relevance and impact

User interactions force exploration of «What works»:



# Seamless towards impacts



**Co-Design of Information Outputs with Stakeholder Communities**



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# ... a new challenge – how will our (near) future (climate & wether) models look like?



- Why do we need *ExtremeEarth*?
- What is the scientific reasoning behind *ExtremeEarth*?
- What are the key technologies for realizing *ExtremeEarth*?
- How will *ExtremeEarth* produce socio-economic impact?
- What is the *ExtremeEarth* partnership?

[www.extremearth.eu](http://www.extremearth.eu)

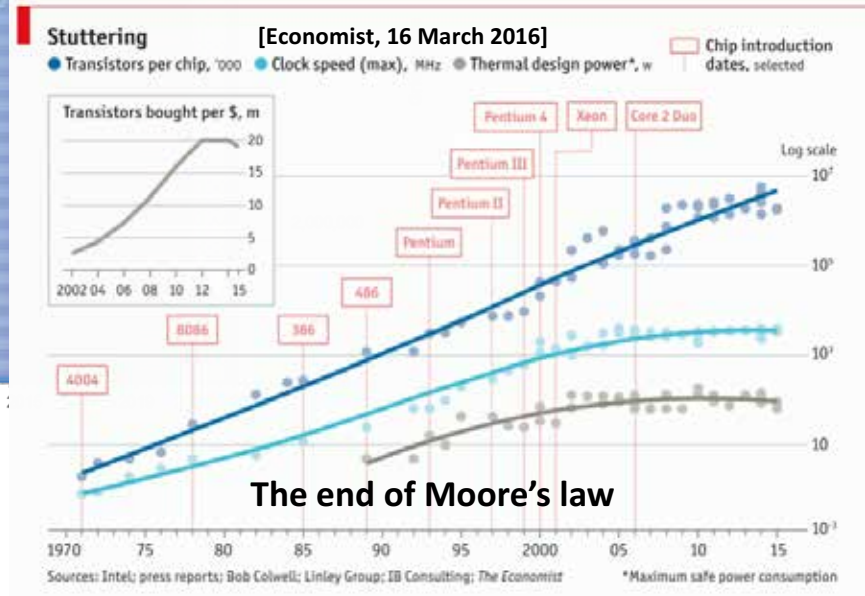
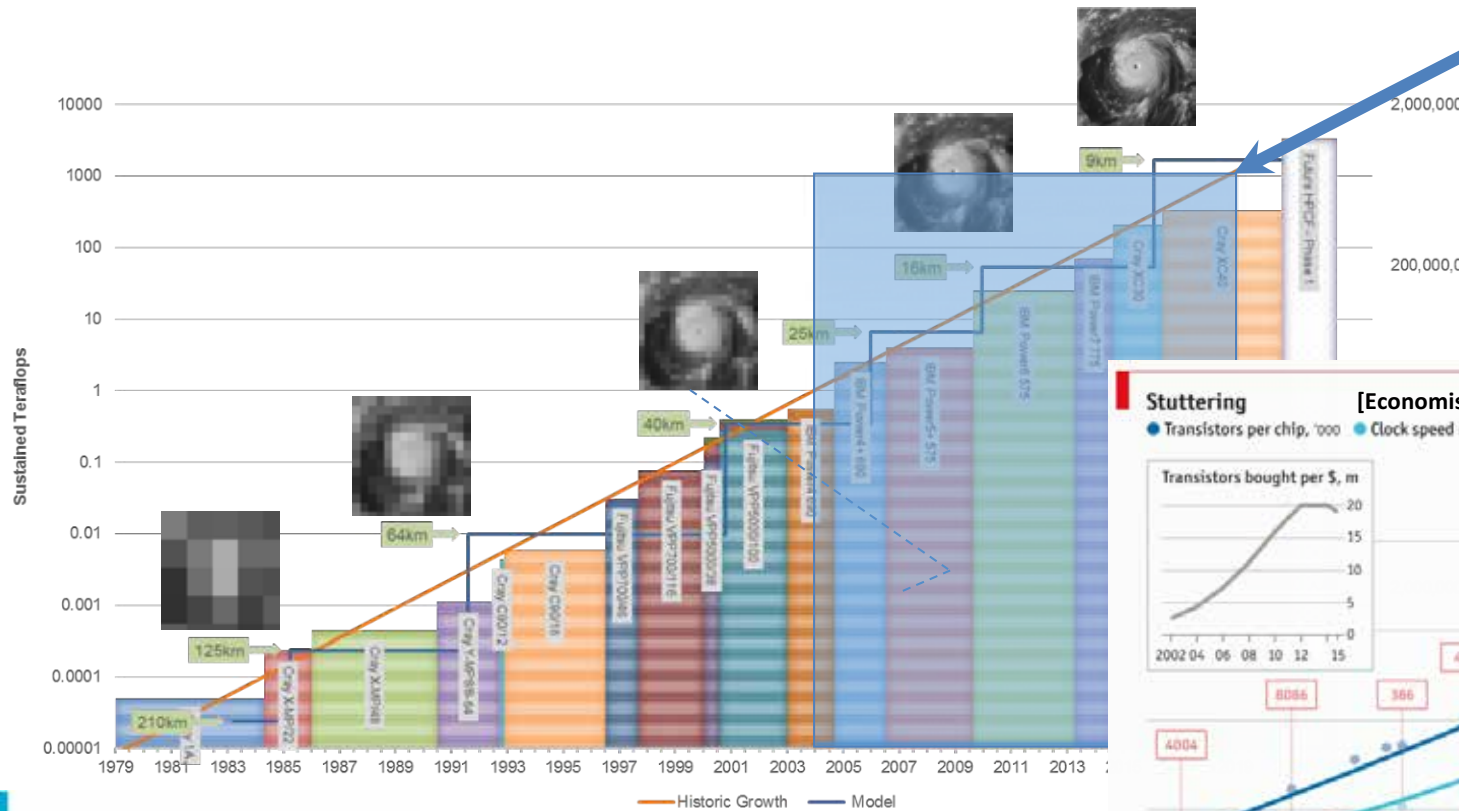


# What does x1000 mean?

**In the past:**  
 x1000 = 15 years =  $10^{15}$  scale  
 = 2 M€ electric power / year

**In the future:**  
 x1000 = ?? years =  $10^{18}$  scale  
 = ?? M€ electric power / year

**Codes are only 5% efficient!**





# 2019: Climate science at a crossroads?



A key role for the future, with the challenge even bigger than  
in 1980:

**WORLD CLIMATE RESEARCH PROGRAMME**  
**WCRP**



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# WMO is taking up the challenge...

..and keeps fully committed to supporting and assisting WCRP in a close collaboration with IOC and ISC



1873



2050

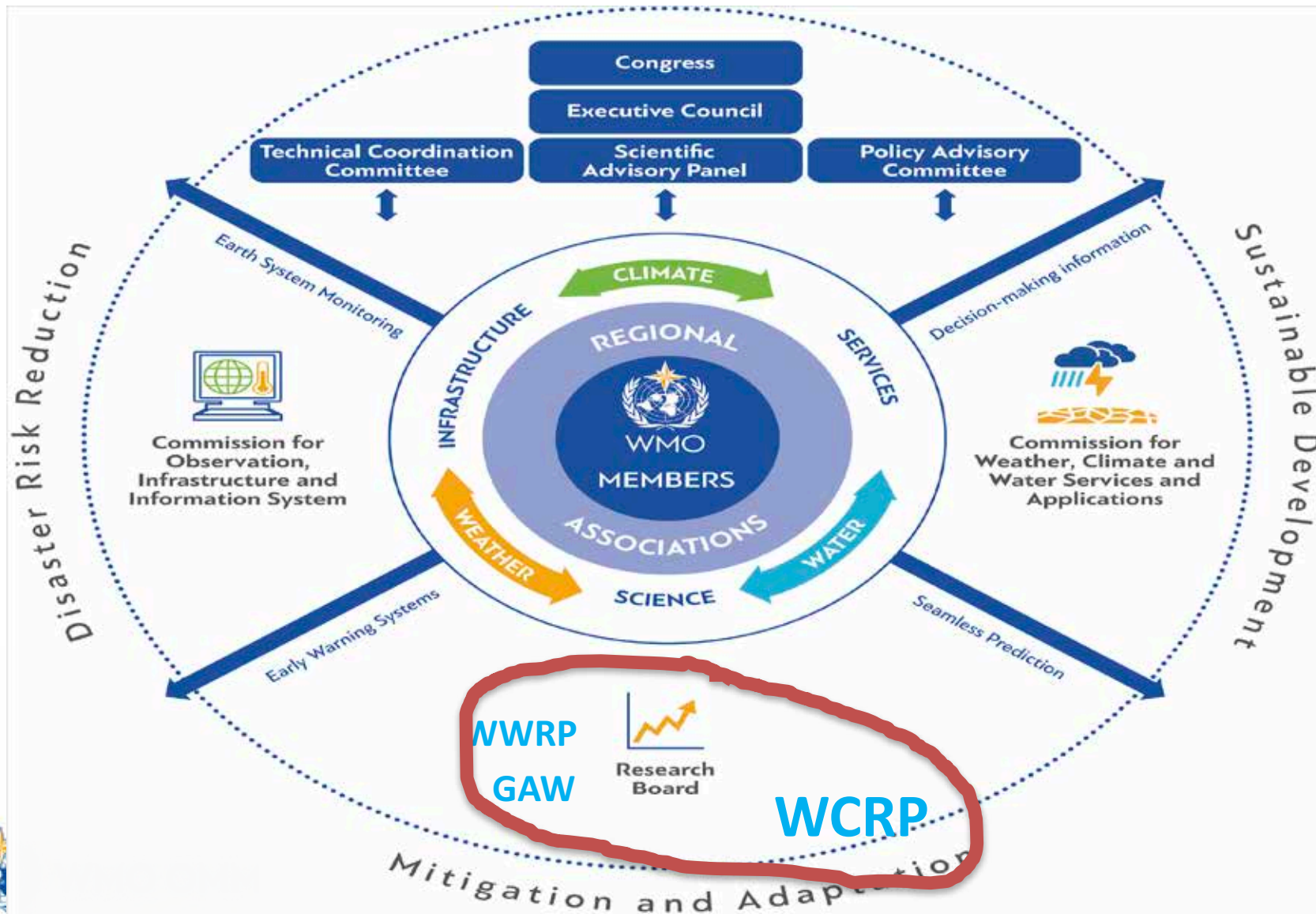
## WMO for the 21<sup>st</sup> Century



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# Future WMO: Integrated seamless Earth-system science and science for services approach



# ENHANCED COLLABORATION WITH PARTNERS



Joint bodies  
Working arrangements  
Programmes/Projects

More interaction and collaboration with partners from all relevant areas, e.g.:



GREEN CLIMATE FUND



ICAO



Food and Agriculture Organization of the United Nations



World Health Organization



World Food Programme



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IOC

Thank you  
Merci

**And Happy 40<sup>th</sup> Birthday WCRP!**



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