



Ocean, atmosphere and climate change: What do we know about?

Vanessa Cardin

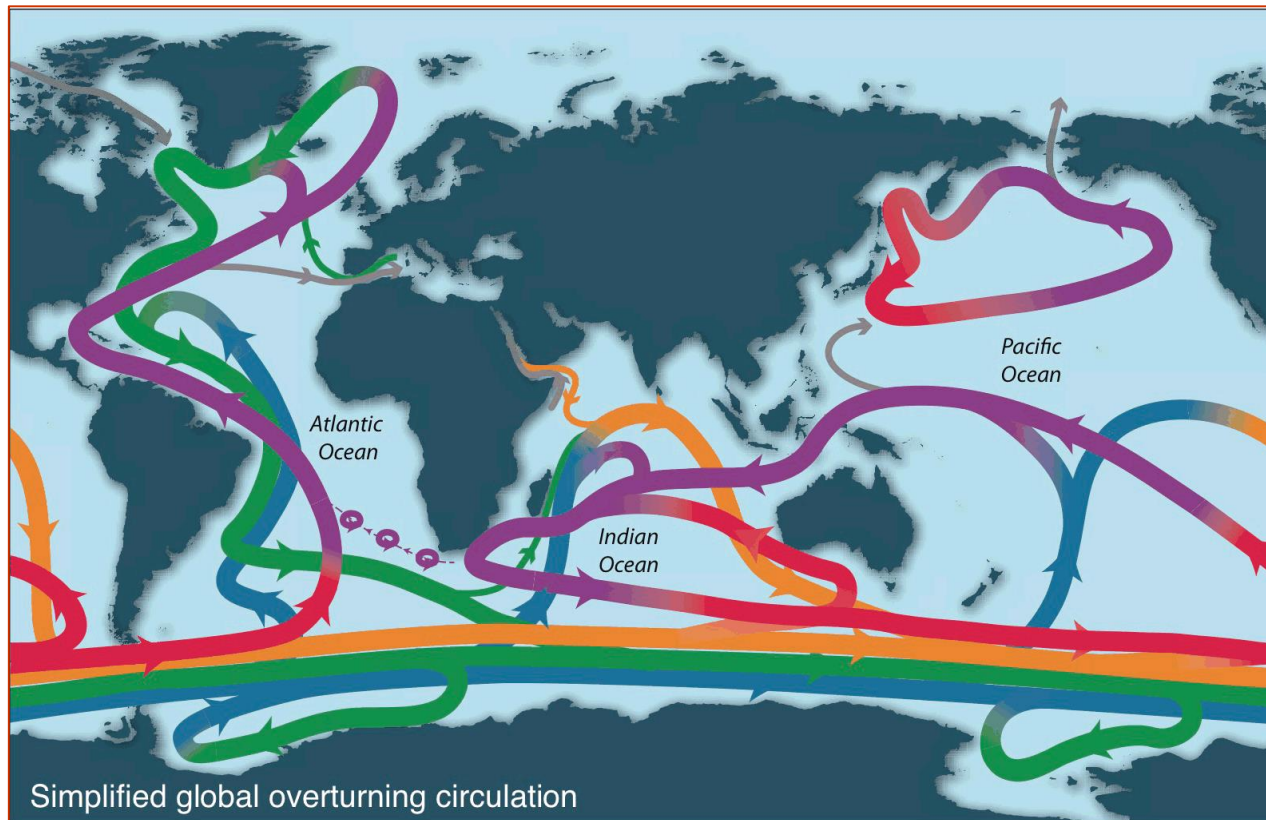
ROLE OF THE OCEAN IN THE EARTH ENVIRONMENT

- Great heat reservoir
- An efficient regulator of greenhouse gases
- The largest food resource for the humanity

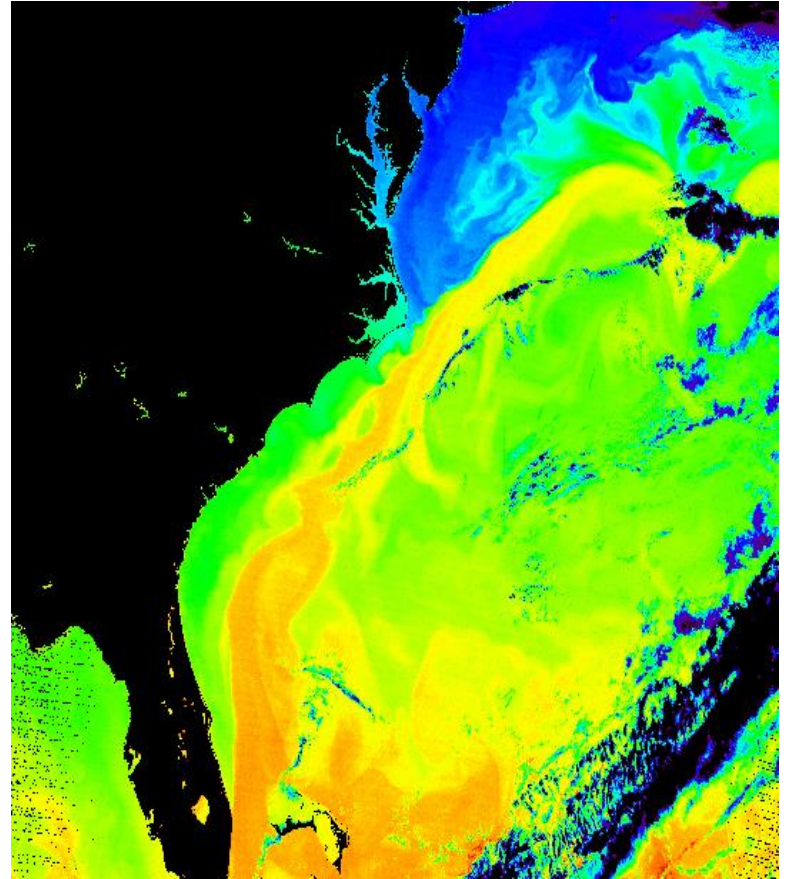
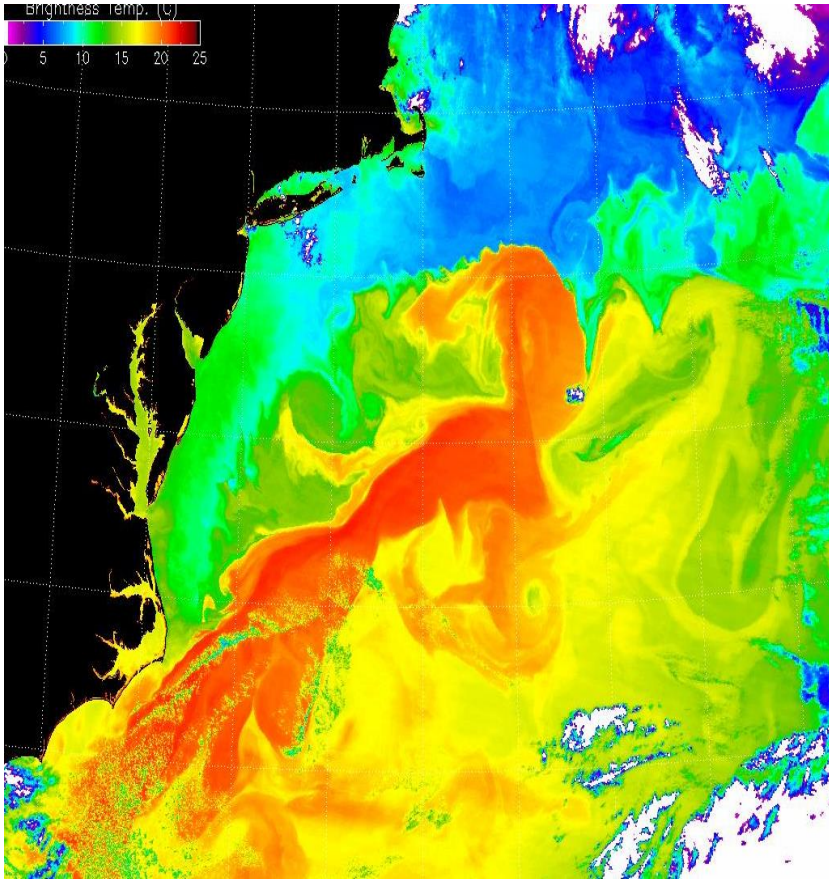
GLOBAL OVERTURNING CIRCULATION

The thermal balance is in equilibrium, but this is not necessarily true for any single area

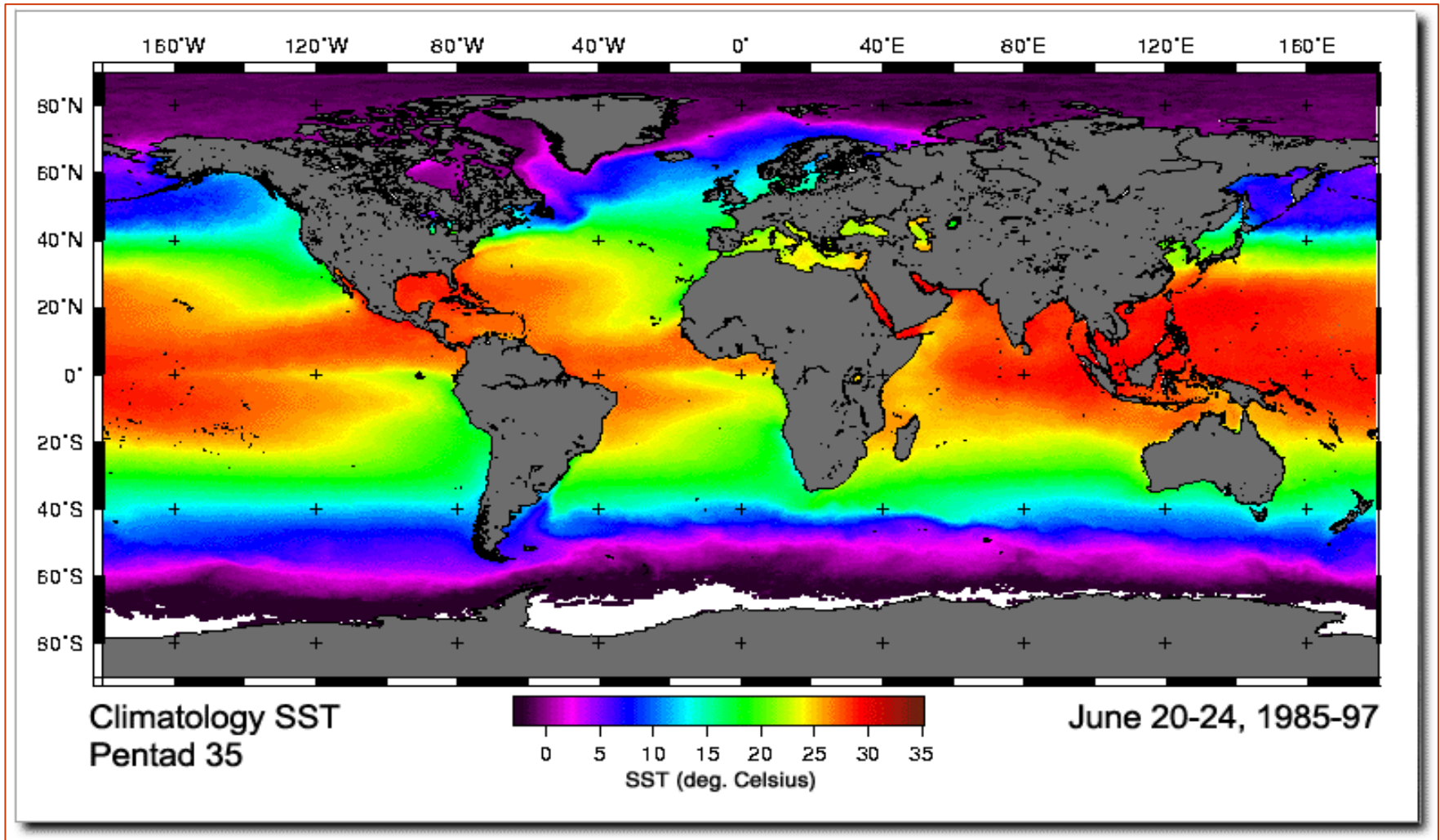
Why there is no a continuous increase of temperature at the Equator and a steady temperature decrease at poles?



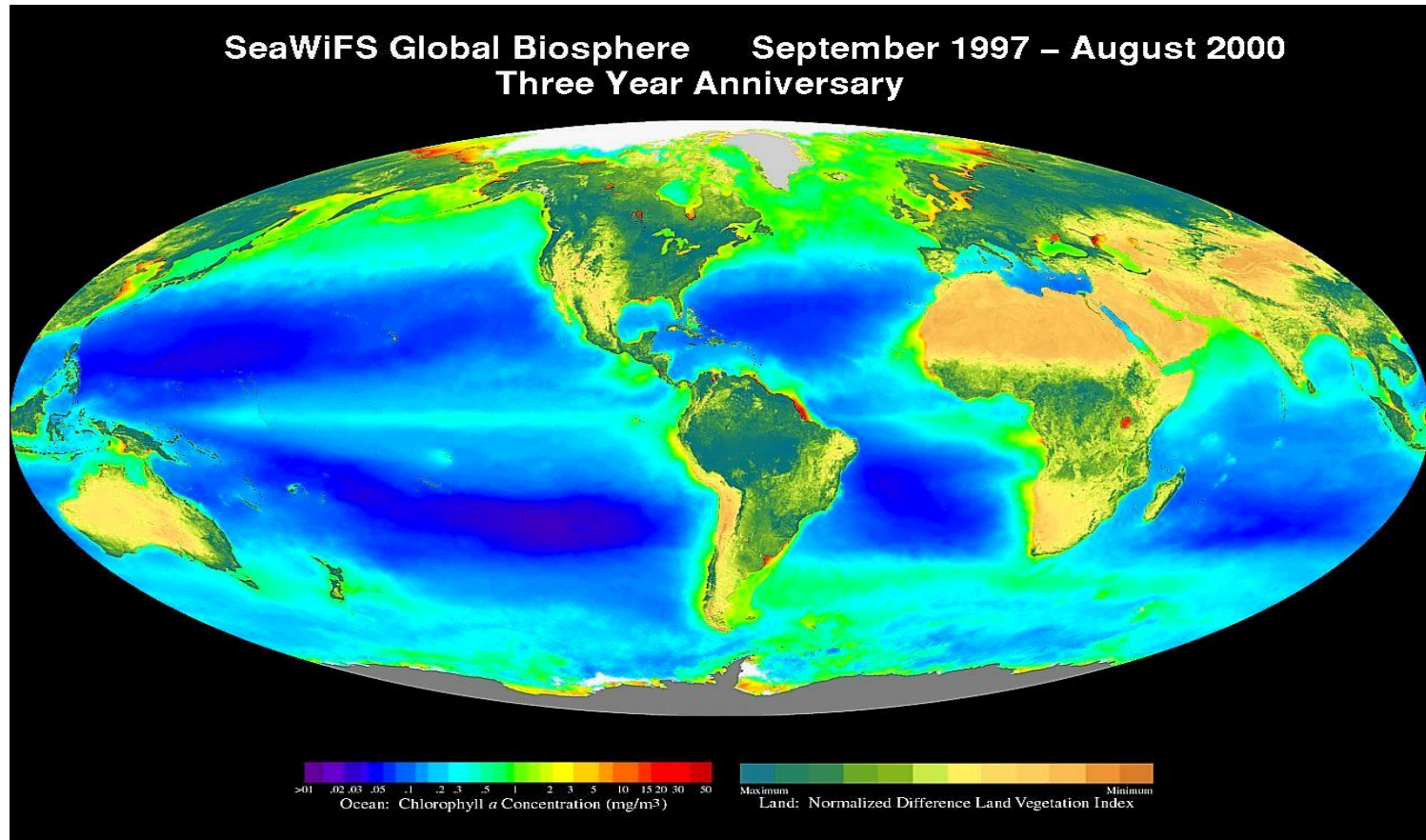
NORTHWARD HEAT TRANSPORT: The Gulf Stream



SEA SURFACE TEMPERATURE



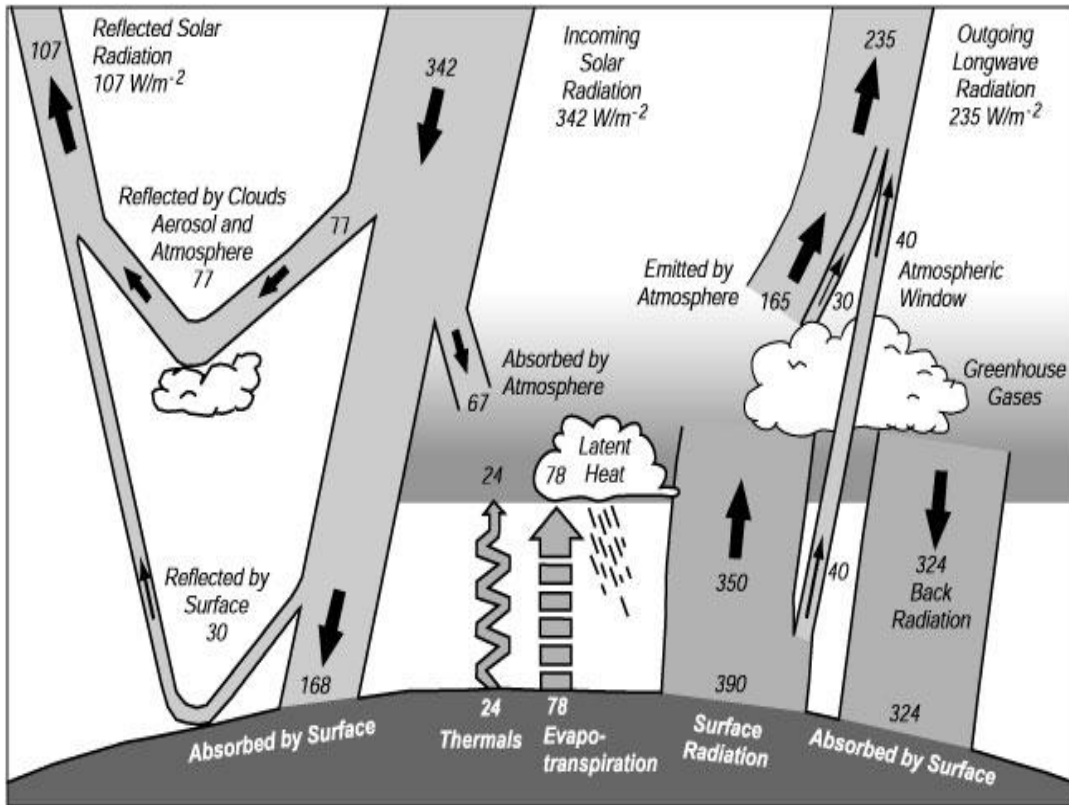
SURFACE CHLOROPHYLL-A DISTRIBUTION



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EARTH HEAT BALANCE



$$Q_T = Q_R + Q_B + Q_L + Q_S$$

Q_R = incoming heat short wave radiation

Incident + reflecting radiation

Q_B = net heat long wave radiation (from the sea)

Turbulent Fluxes

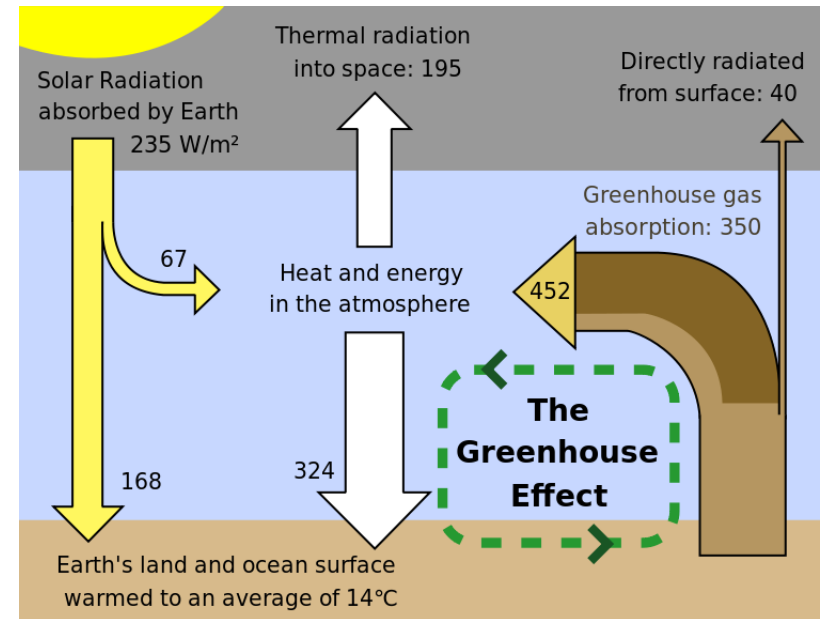
Q_L = Latent Heat

Q_S = Sensible Heat

From Houghton et al., (1996: 58)

THE GREENHOUSE EFFECT

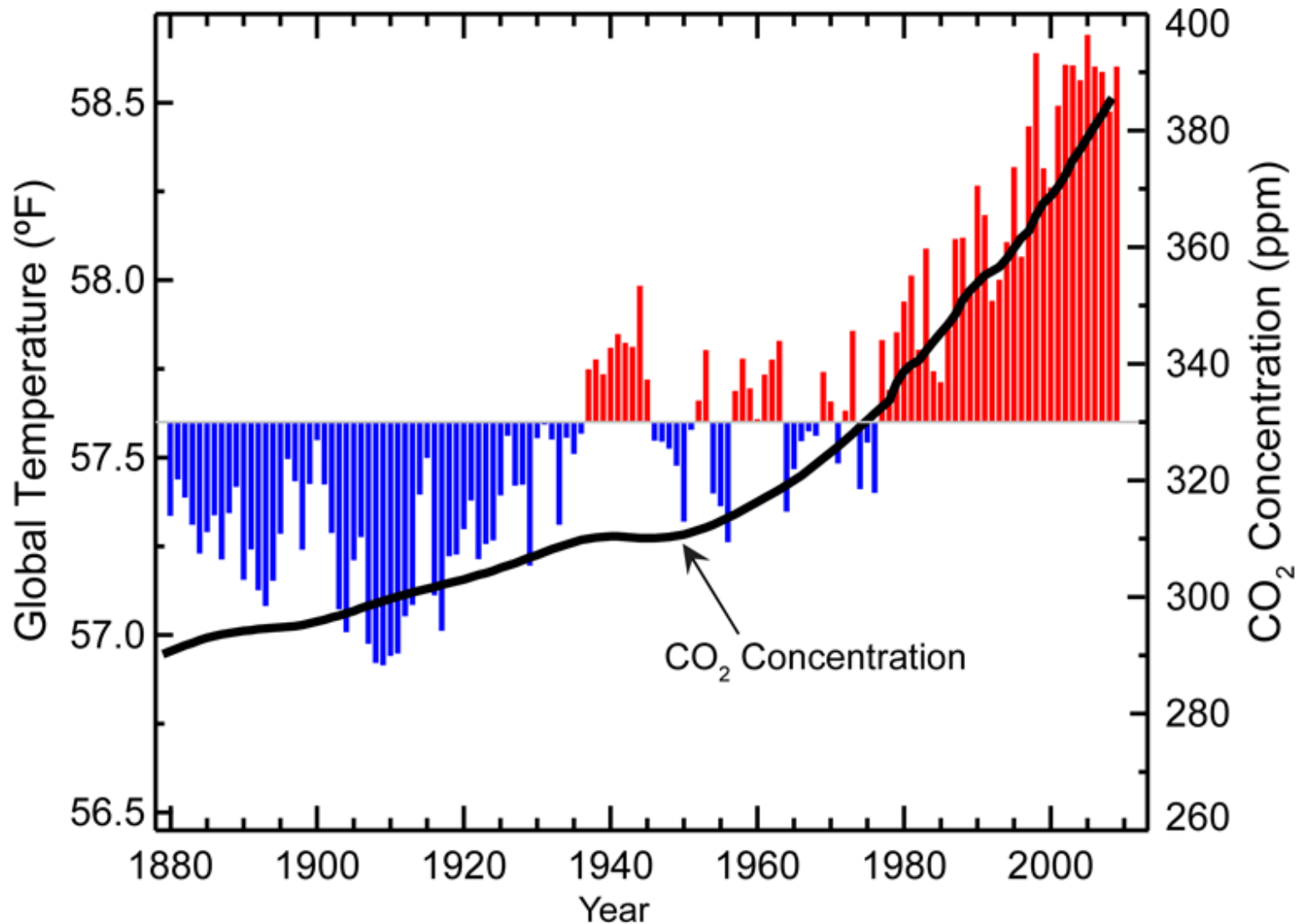
- The greenhouse effect increases the temperature of the Earth by trapping heat in our atmosphere.
- The greenhouse effect is a major factor in keeping the Earth warm because it keeps some of the planet's heat that would otherwise escape from the atmosphere out to space.



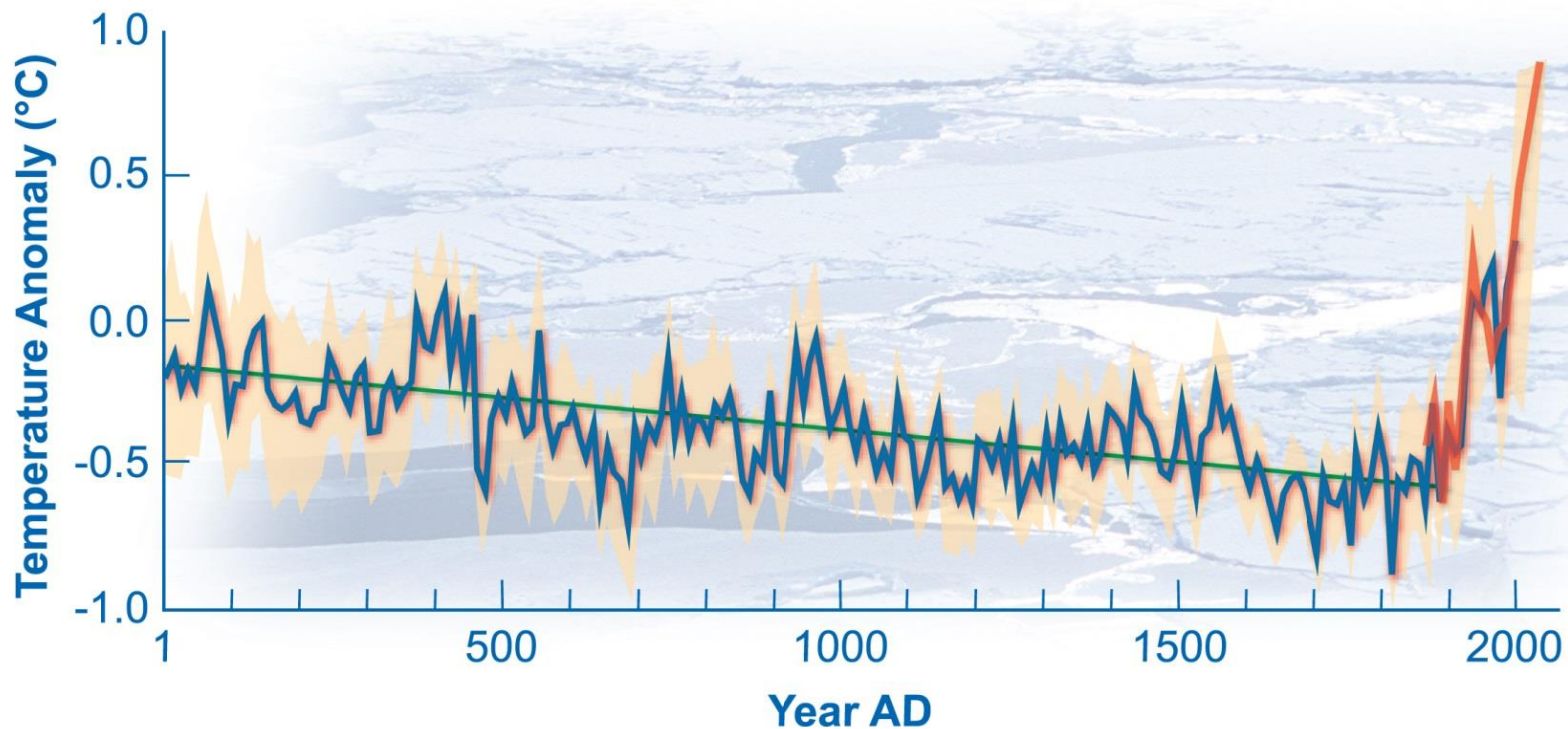
Robert A. Rohde (Dragons flight at English Wikipedia)

One of the greenhouse gases which are exchanged with the atmosphere is the carbon dioxide (CO_2) which although being present in a small percentage (0.04%) plays a very important role.

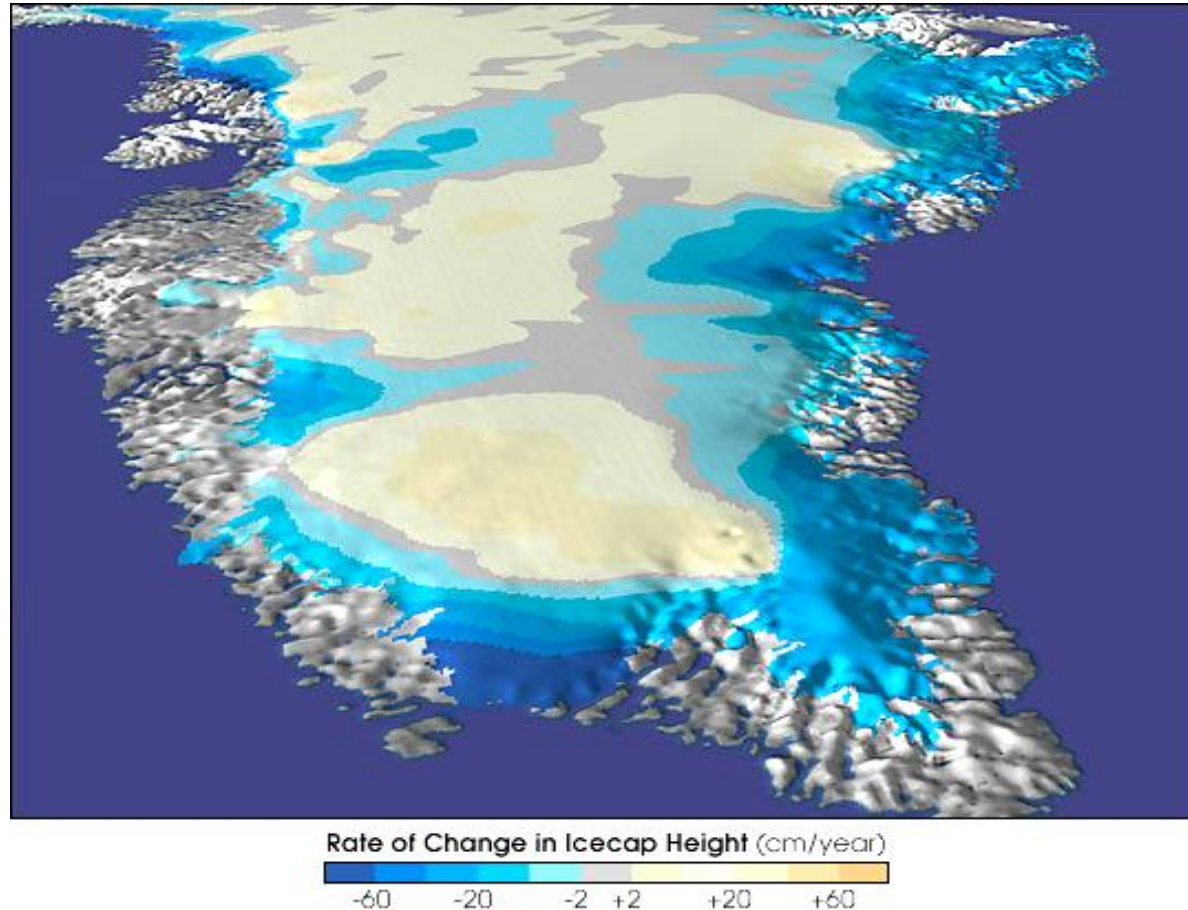
GLOBAL TEMPERATURE AND CARBON DIOXIDE



WORLD OCEAN TEMPERATURE VARIATIONS IN THE LAST 2000 YEARS

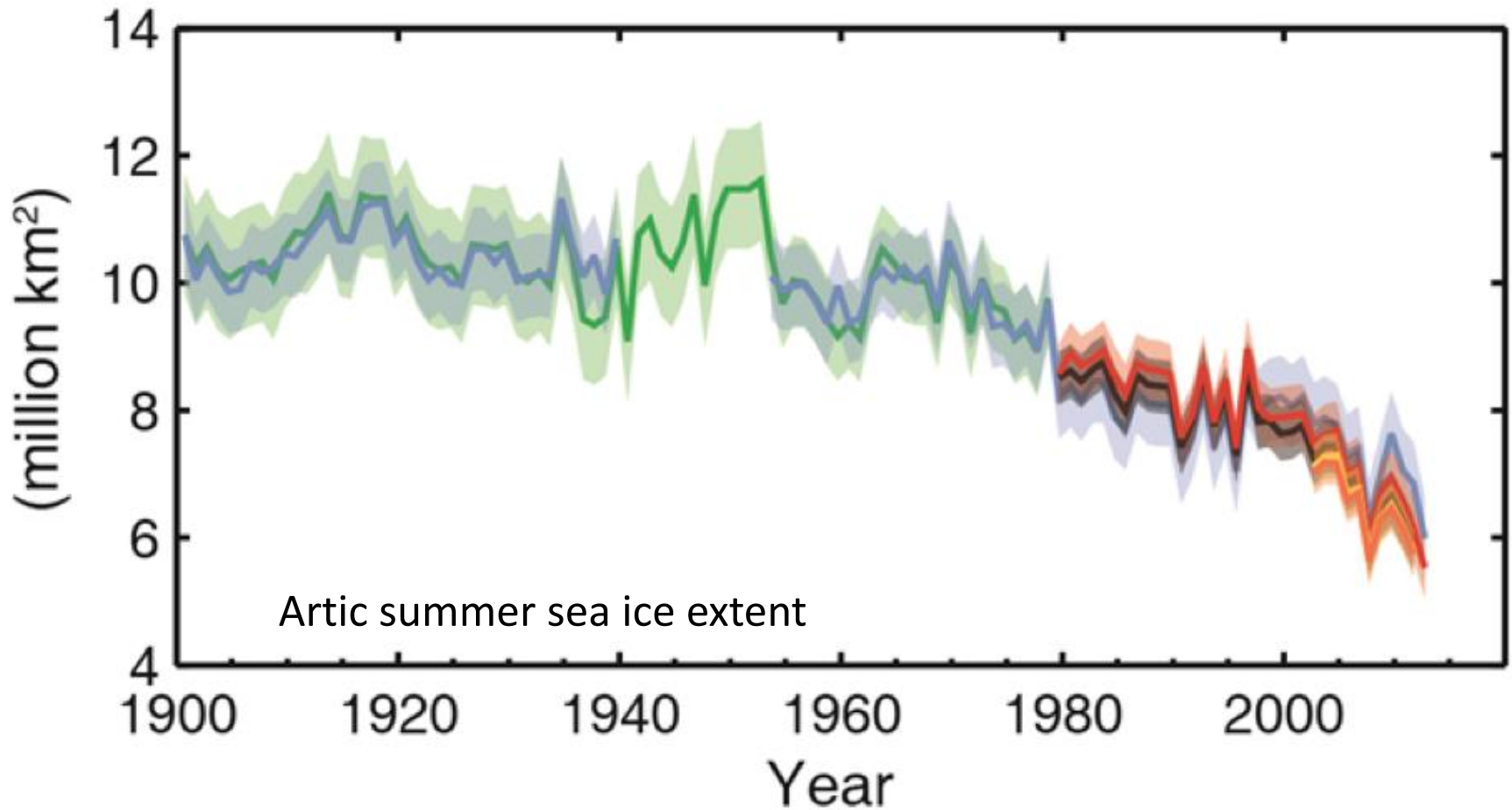


VARIATION OF THE THICKNESS OF THE ICE IN THE AREA OF GREENLAND

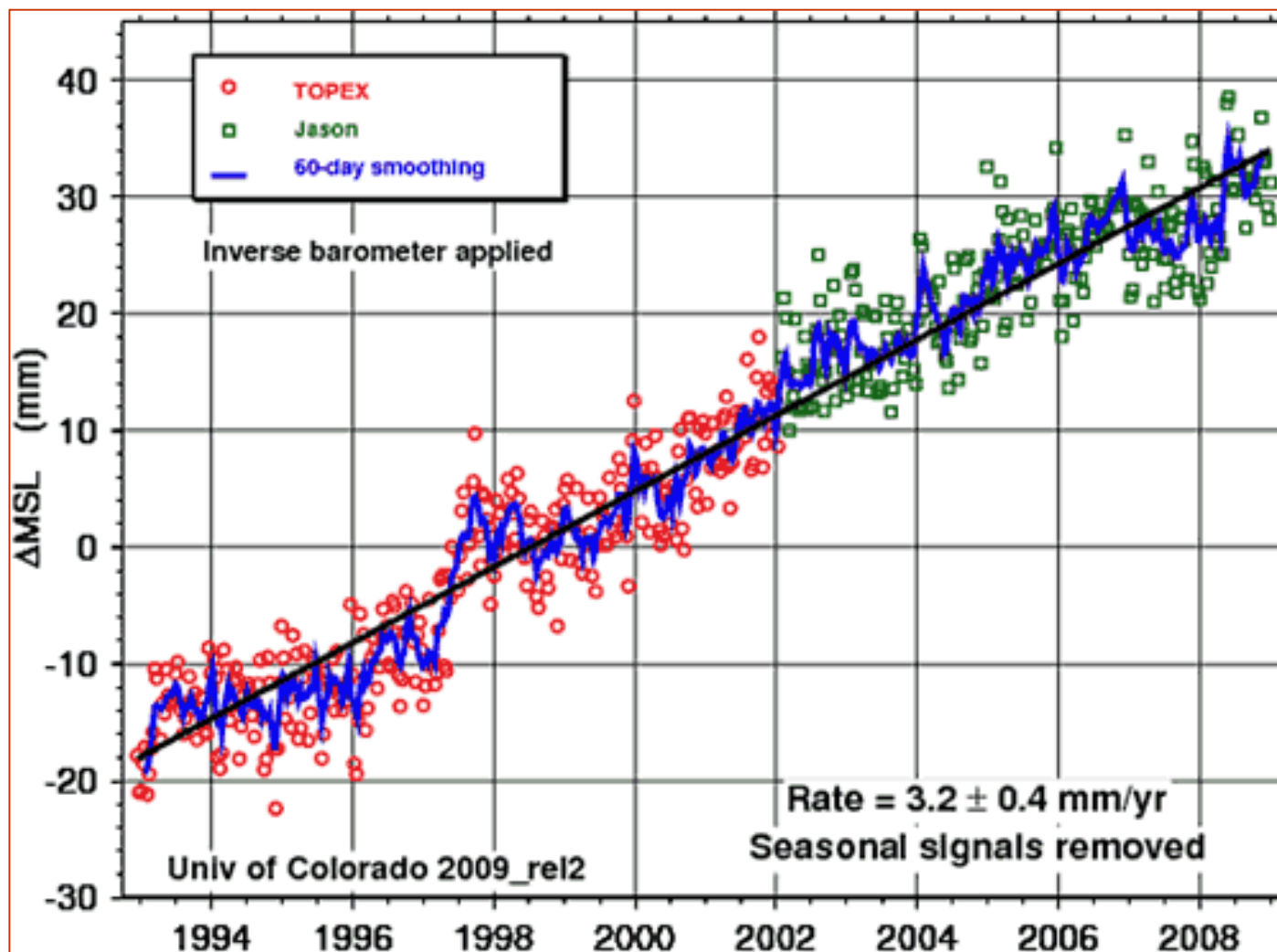


*Numbers and color scales refer to variations in cm per year.

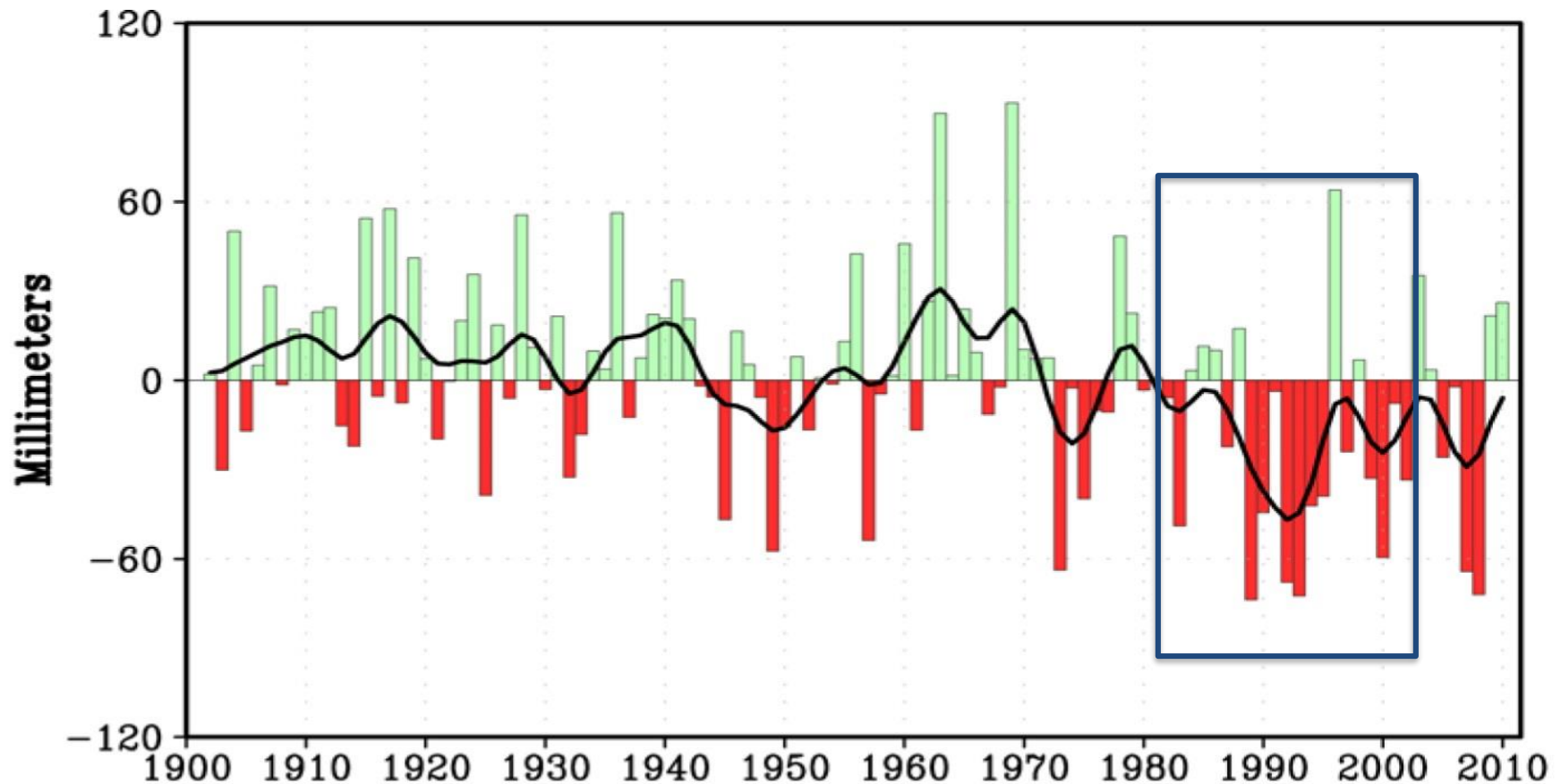
SPATIAL EXTENSION OF THE ARTIC GLACIERS



SEA LEVEL VARIATIONS OF THE WORLD OCEAN

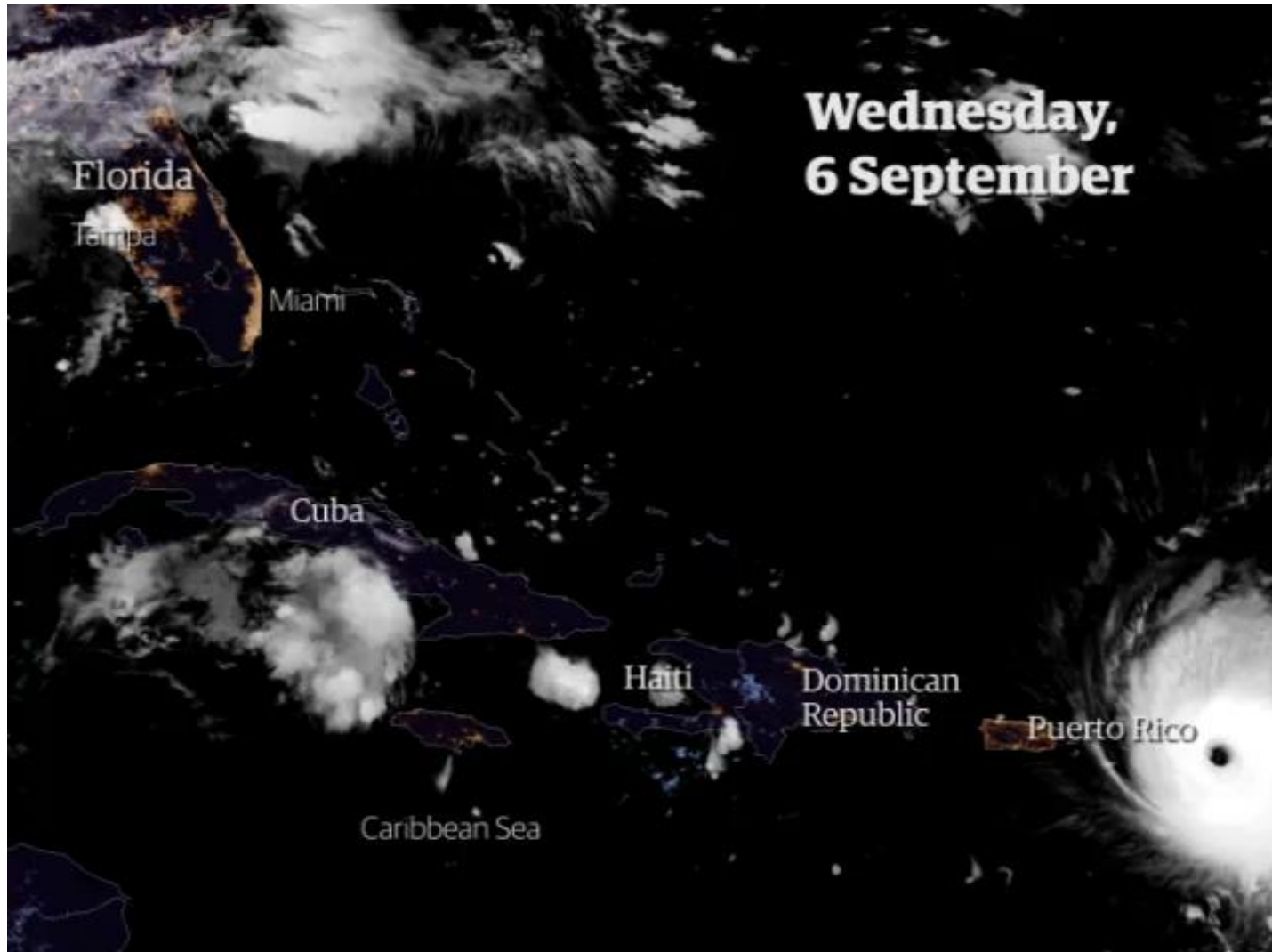


WINTER DROUGHTS



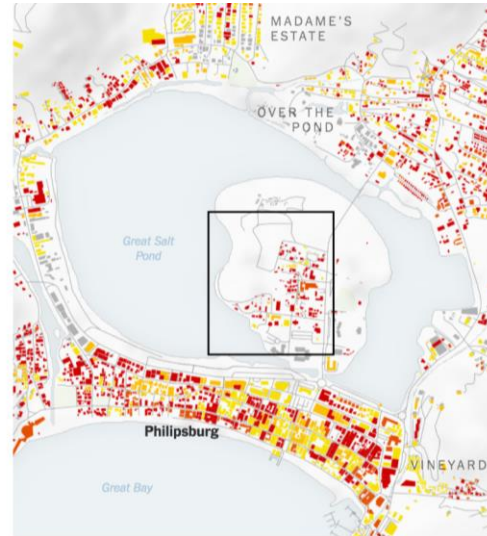
- More frequent in the recent years
- Twelve driest winters
- Responsibility of human activities

HURRICANE IRMA – SEPTEMBER 2017



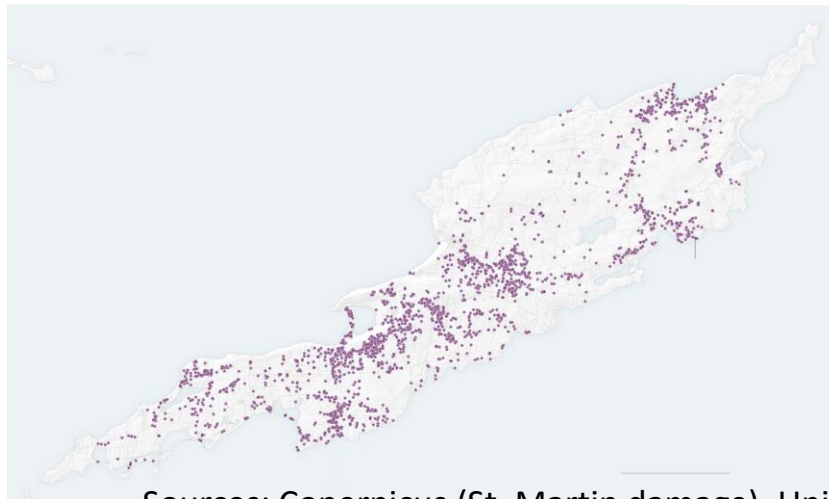
HURRICANE IRMA – SEPTEMBER 2017

ST. MARTEEN



Satellite image taken on Sept. 14 by DigitalGlobe.

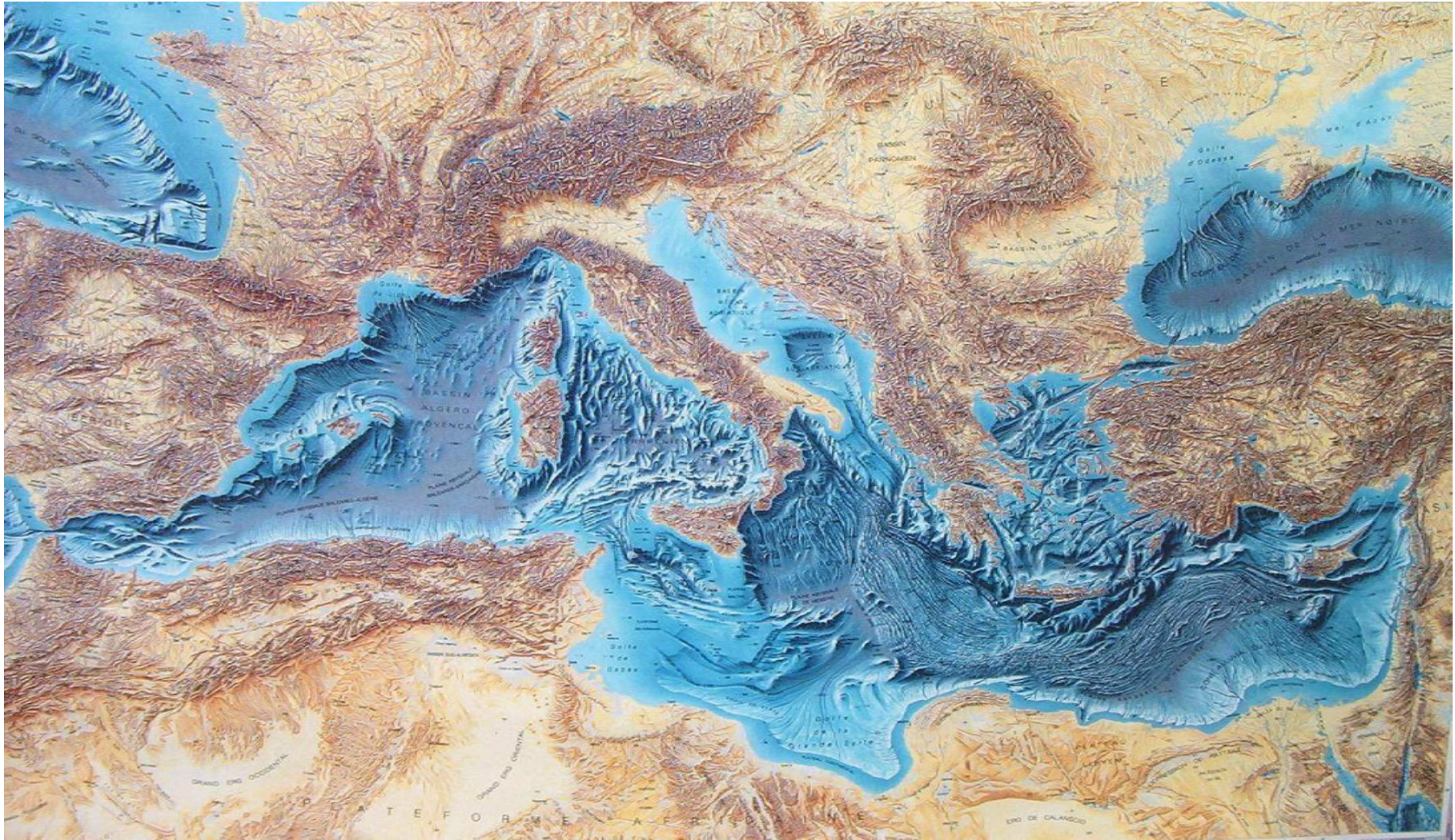
DAMAGE ■ Destroyed ■ Heavy ■ Moderate ■ Light ■ None or unknown



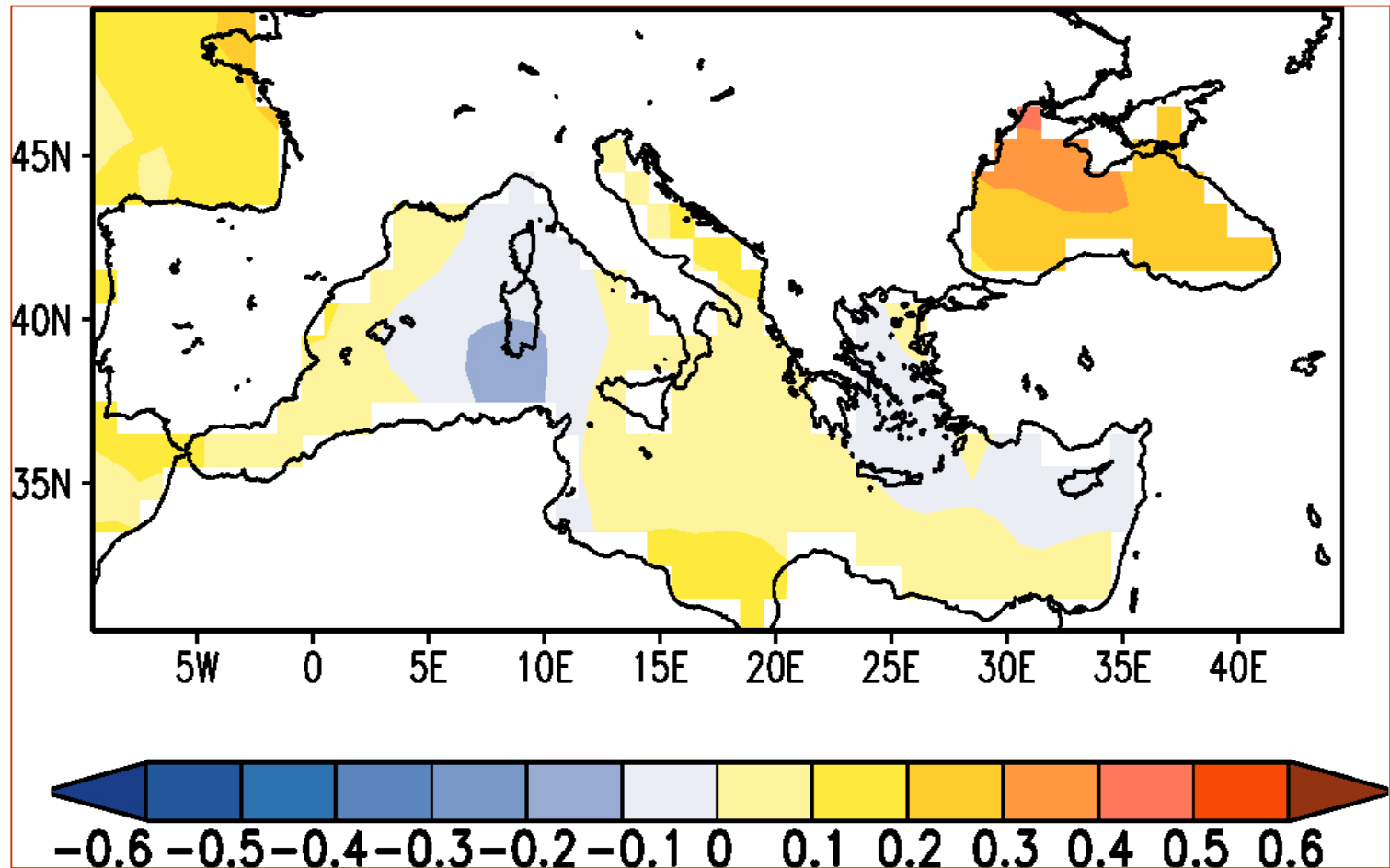
ANGUILLE

Sources: Copernicus (St. Martin damage), United Nations Institute for Training and Research (Anguilla and Barbuda damage),

Mediterranean bathymetry

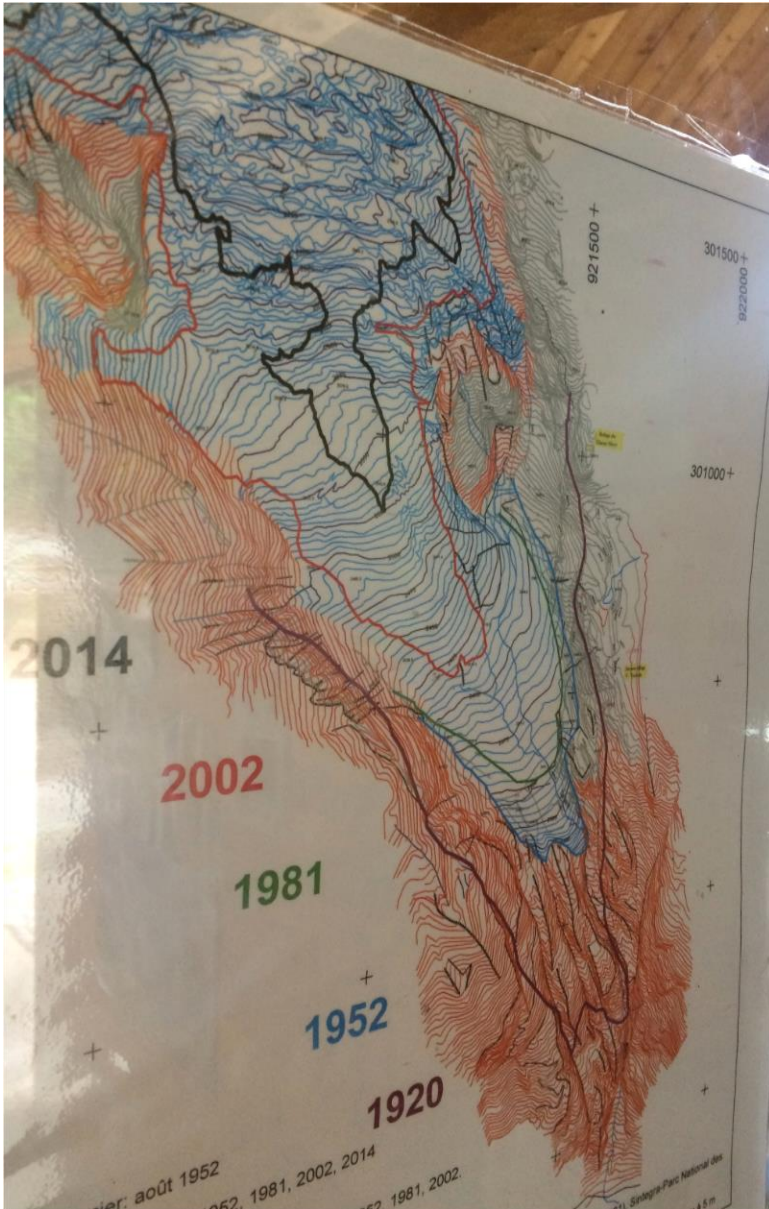


Summer sea surface temperature rate of increase in the period 1950 -1999

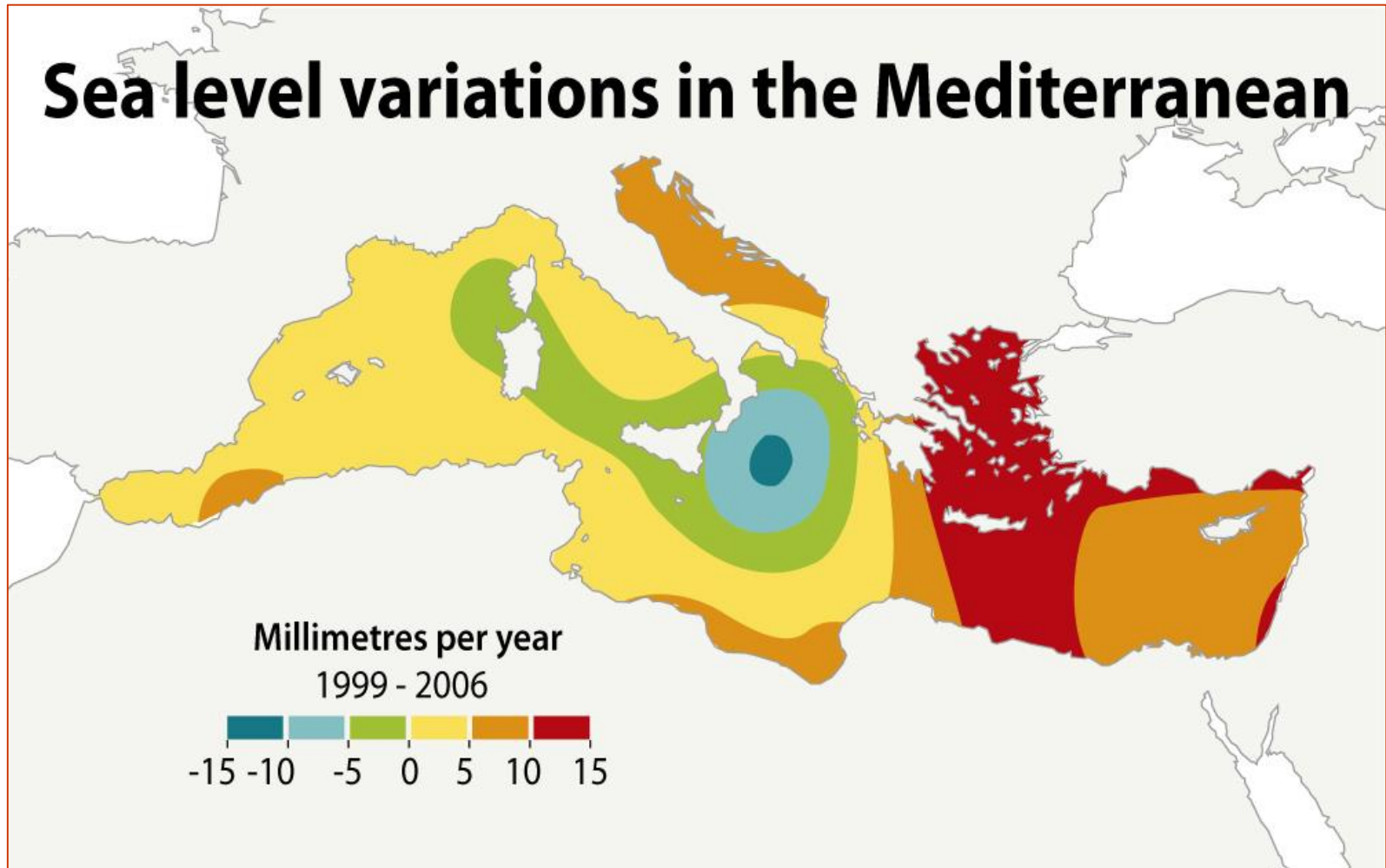


GLACIER BLANC

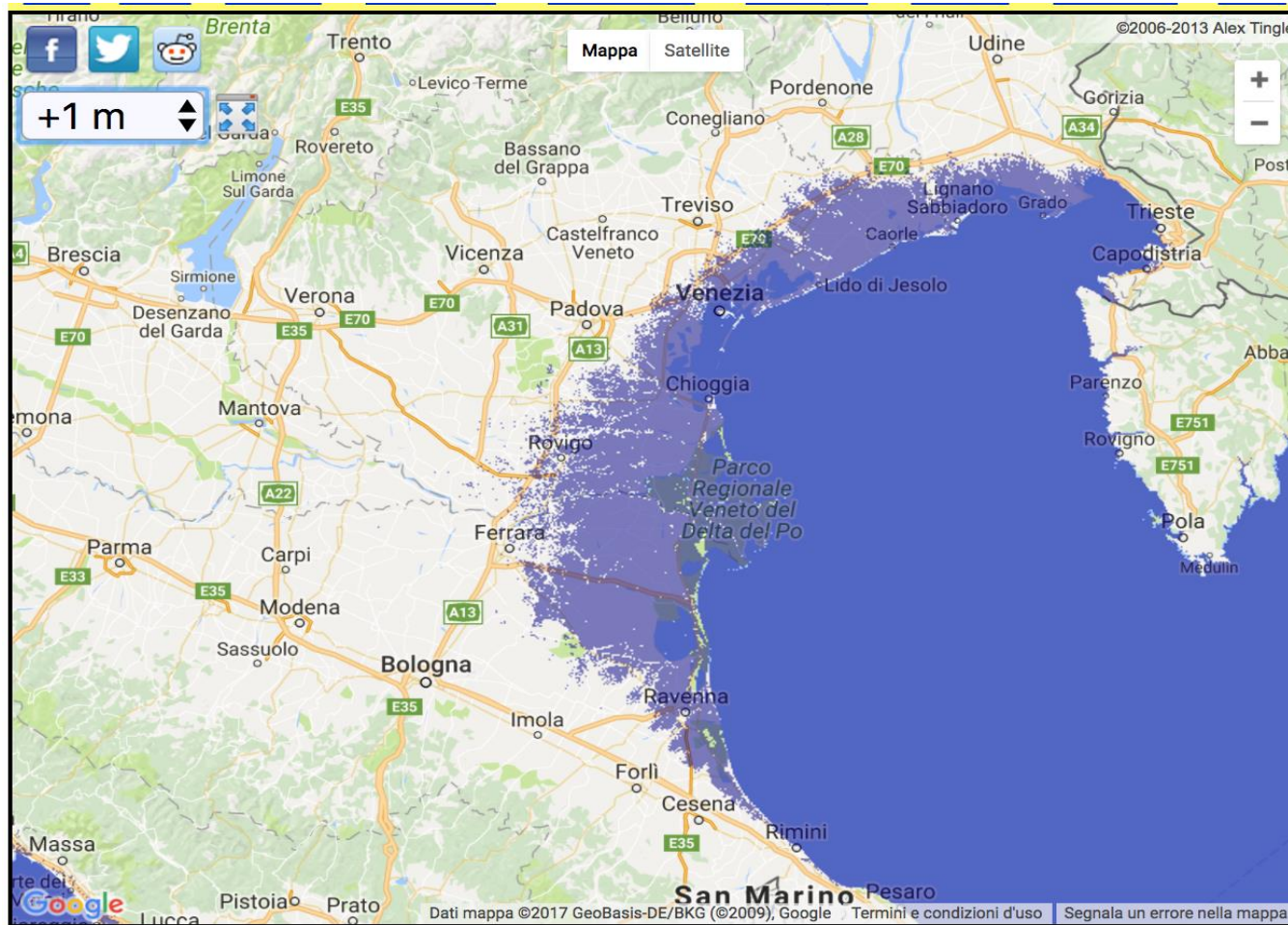
- 1970-80 decade
Equilibrium period
 - Mass balance
between winter and
summer
- 2002 onwards it has lost
nearly 10m in thickness



Sea level variations in the Mediterranean



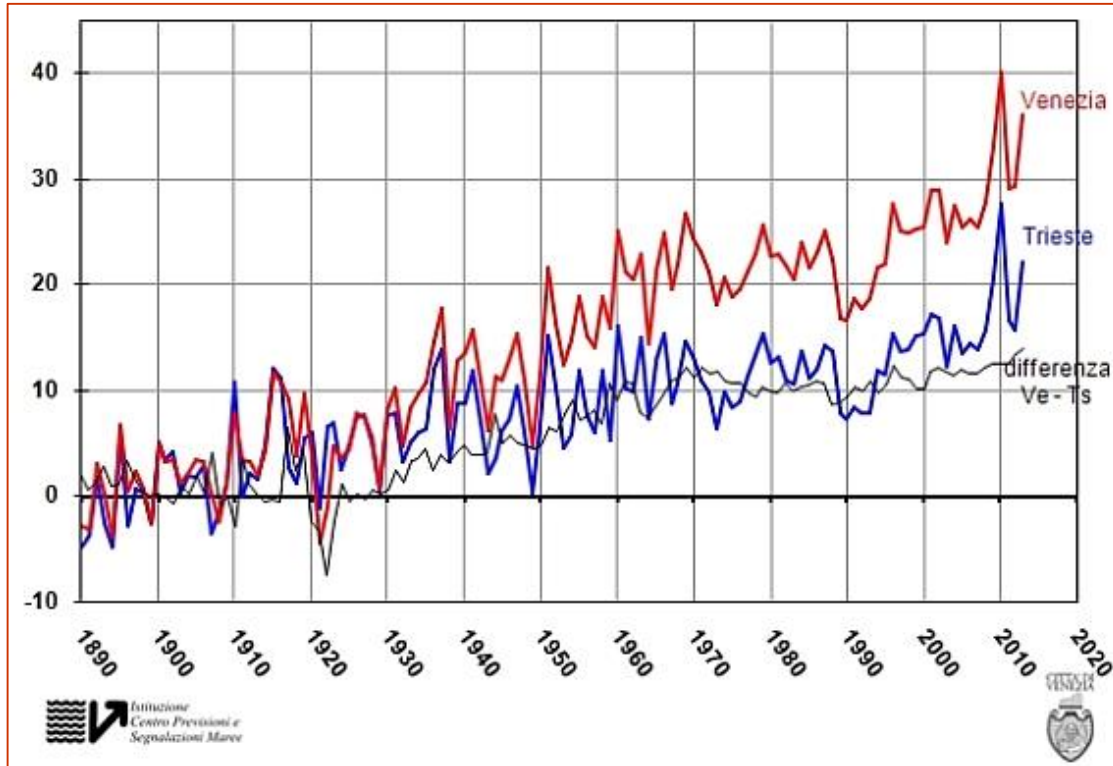
SEA LEVEL INCREASE IN VENICE



The map above shows areas of Venice, Italy that would be flooded at various stages of sea level rise.

Source: Climate Central.org.

Sea Level Rise



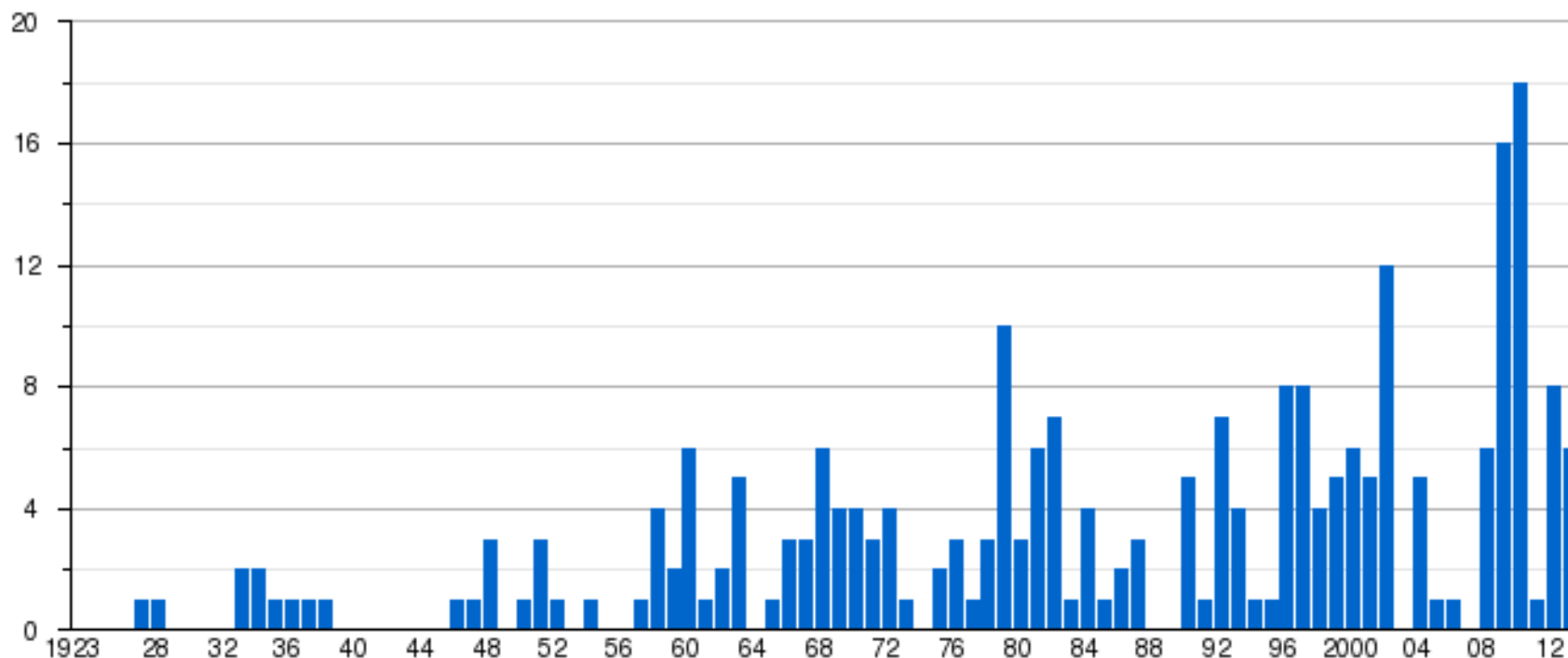
Comparison
between Trieste
and Venice

➤ Global sea level rise

➤ Subsidence ➡

Industrial purposes

Annual frequencies of the flooding events in the Venice Lagoon $\geq 110\text{cm}$



Estimation for the period between 1923 and 2013

Font: Centro Previsioni e Segnalazioni Maree

HOW TO PREVENT OR MITIGATE THE EFFECTS?



Barriers

CONCLUSIONS

CLIMATE CHANGE MANIFESTS IN:

- LONG TERM TRENDS OF TEMPERATURE INCREASE BOTH IN THE ATMOSPHERE AND IN THE OCEAN ASSOCIATED TO THIS:
 - GLACIARS MELTING AND OCEAN VOLUME INCREASE RISULTING IN THE SEA LEVEL RISE
 - DROUGHT AND FLOODING EVENTS,
- EXTREME EVENTS ARE MORE PRONOUNCE AND FREQUENT (HURRICANE, TORNADOS ETC)

THANKS FOR YOUR ATTENTION!

QUESTIONS?