Emerging Risks: Climate Change

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hwind SCIENTIFIC

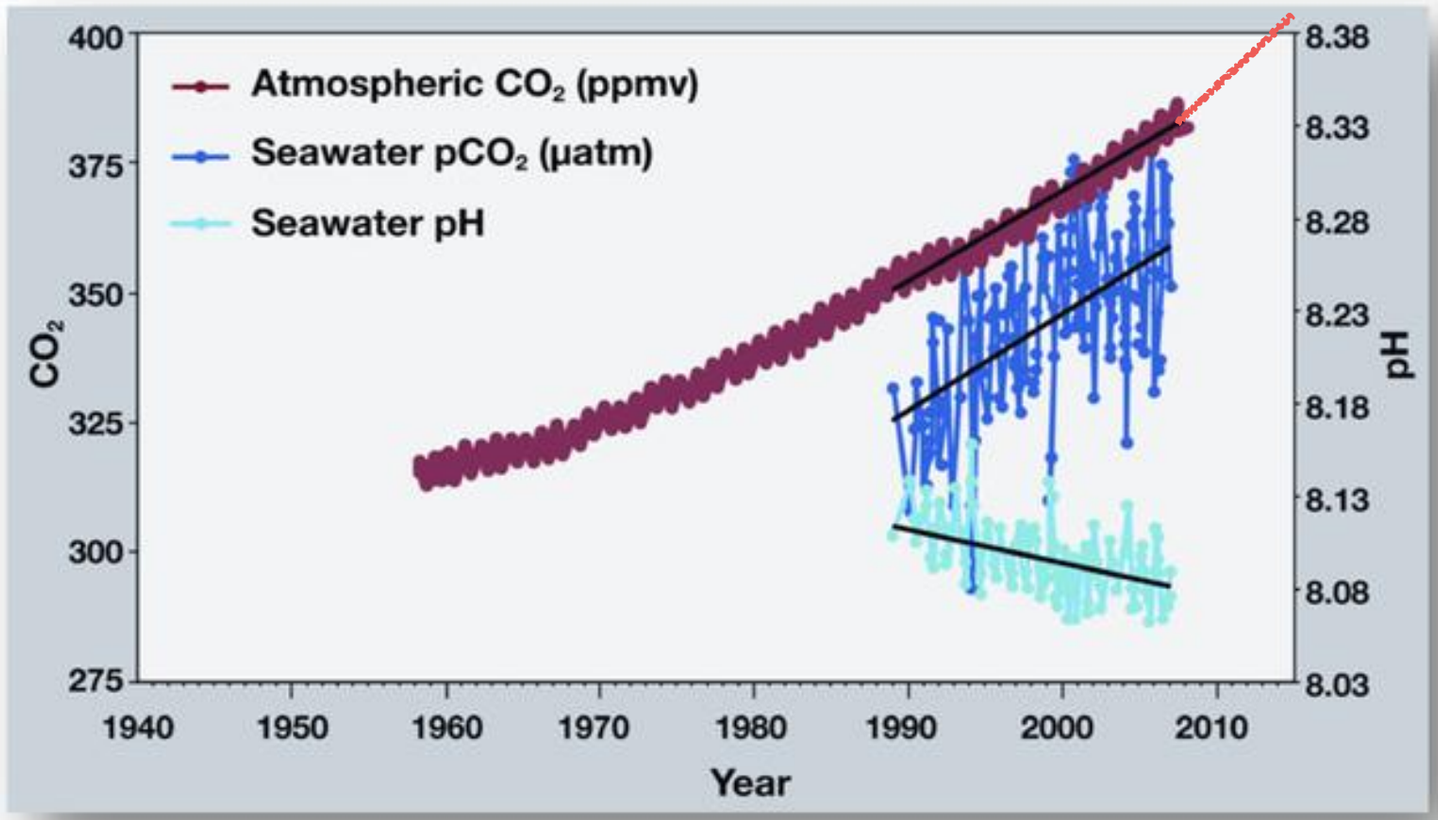
Understand | Prepare | Respond | Recover

- Emerging Risks: Climate change
  - CO_2 and IPCC Scenarios
  - Warming
  - Sea-level Rise
  - Tropical Cyclone activity

CO_2 increase 1958-2008

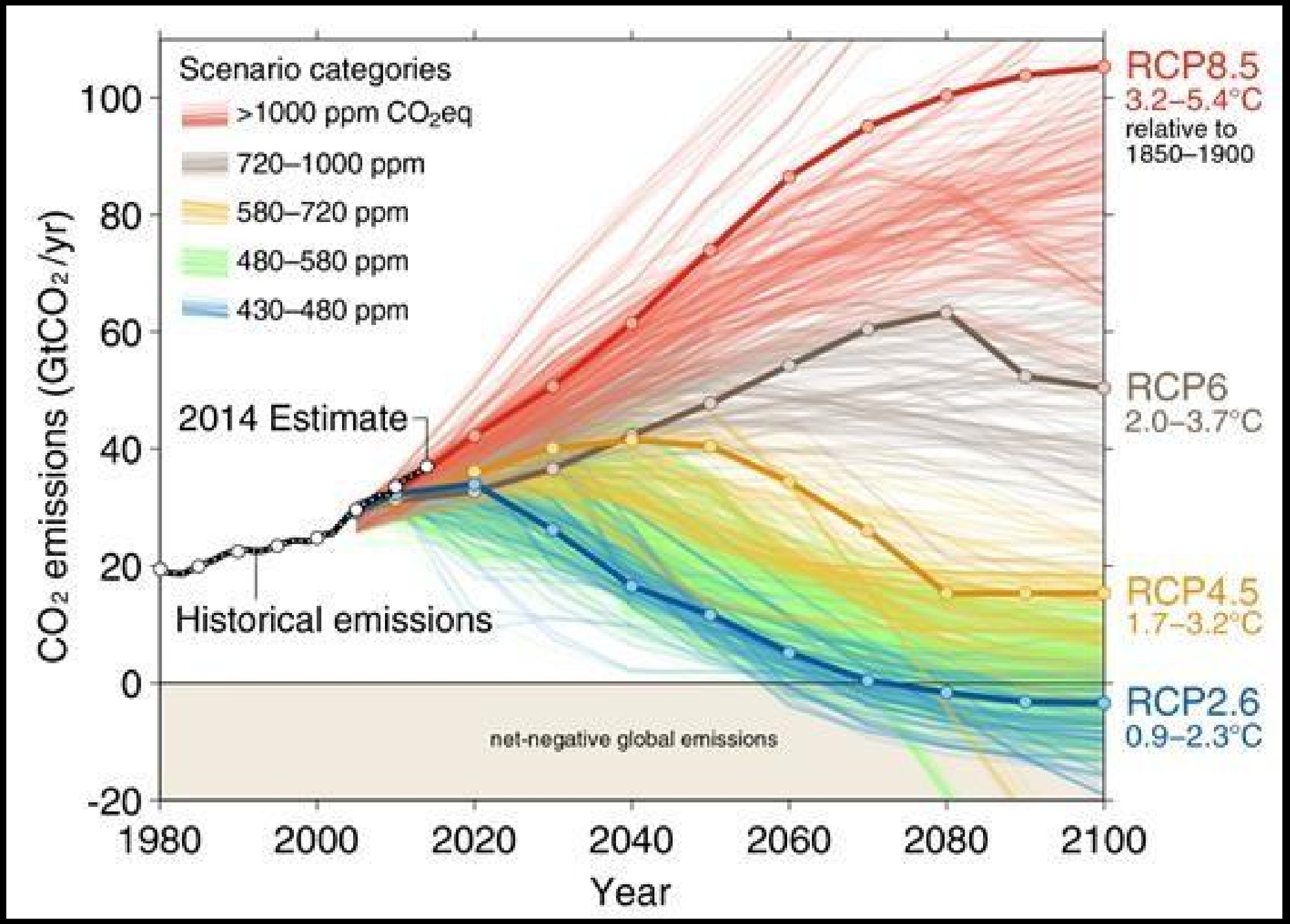
2014 over 400 ppm

Atmosphere > heat
Ocean > Acid
> Heat



IPCC Scenarios

2014 is following a 3-5C global mean increase



Global Land and Ocean Temperature Anomalies, August

1880-2014 Trend
+0.06°C/Decade

Temperature Anomalies

Anomaly (°C)

Anomaly (°F)

0

1

0

-1

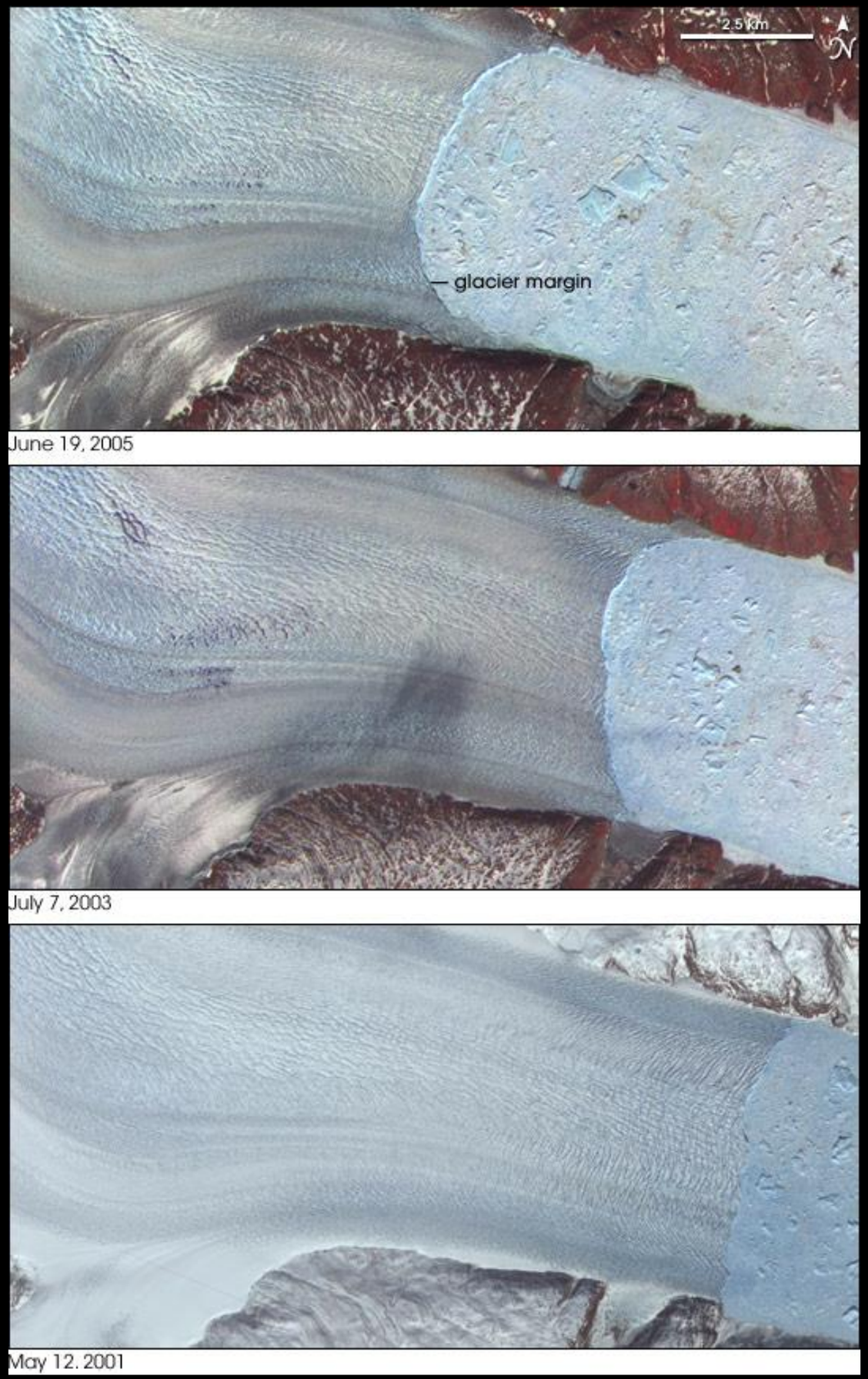
1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

Sea Level Rise

Thermal expansion of warmer oceans (HC)

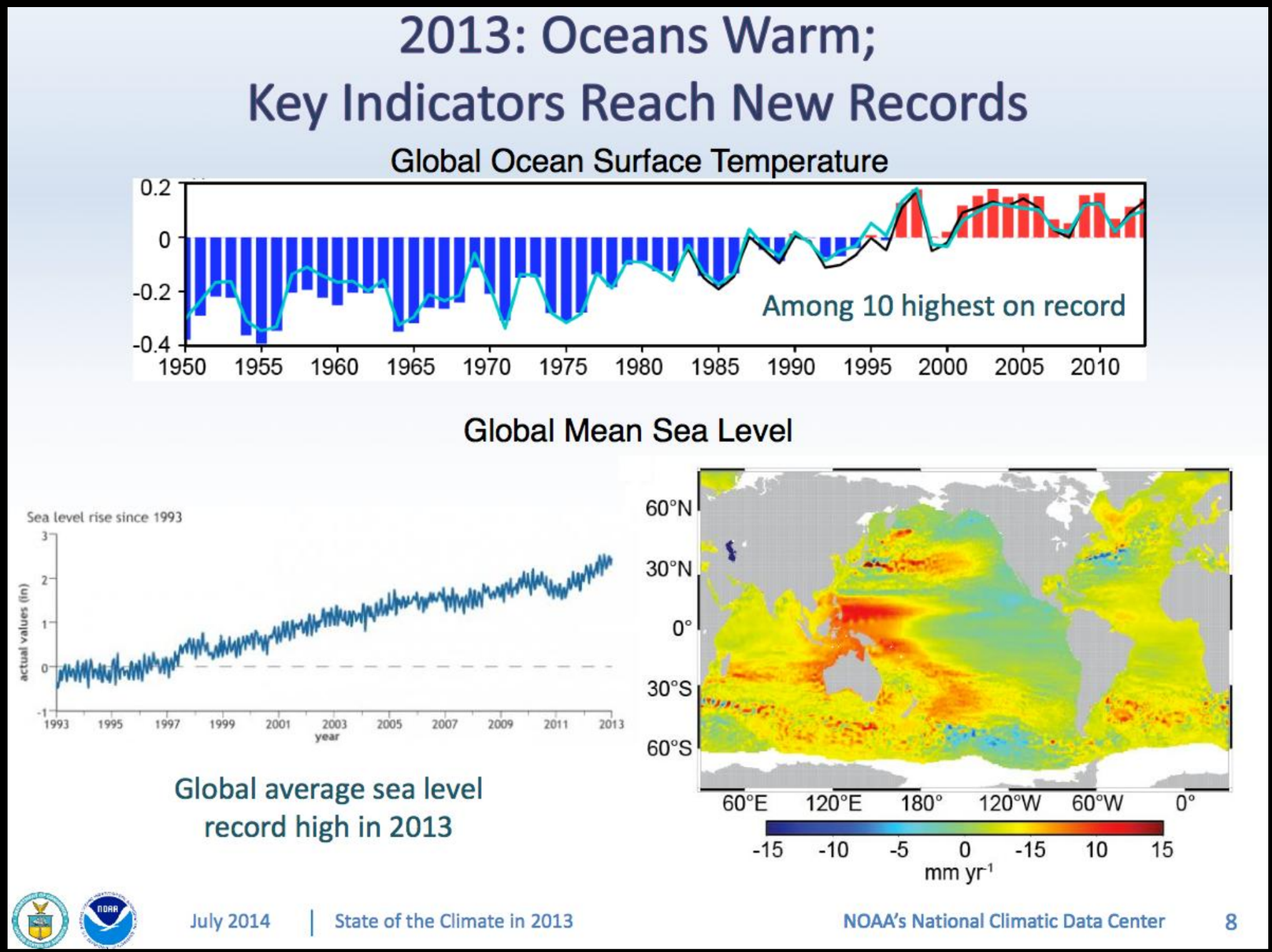
Glacier Melt (MC)
Ice sheet calving

Less water storage on land



Helheim Glacier, Greenland (NASA)

Ocean Temperatures and Sea Level



SST for 2013 among 10 warmest on record.

North Pacific record warm for 2013.

Mean sea level rise 2013, on pace with 3.2 ± 0.4 mm per year past two decades

High confidence in projections of thermal expansion

Good observational estimates

Consistency of historical simulations with observations

Better understanding of the Earth energy budget

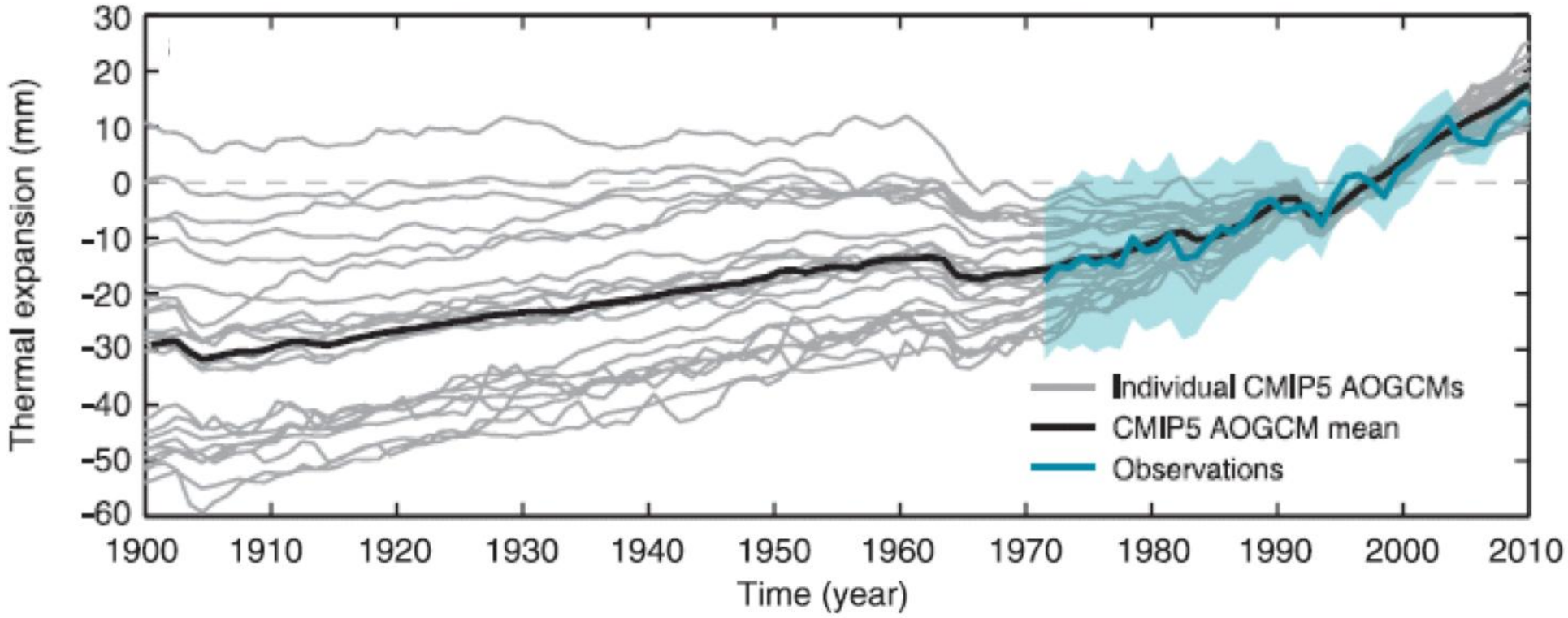
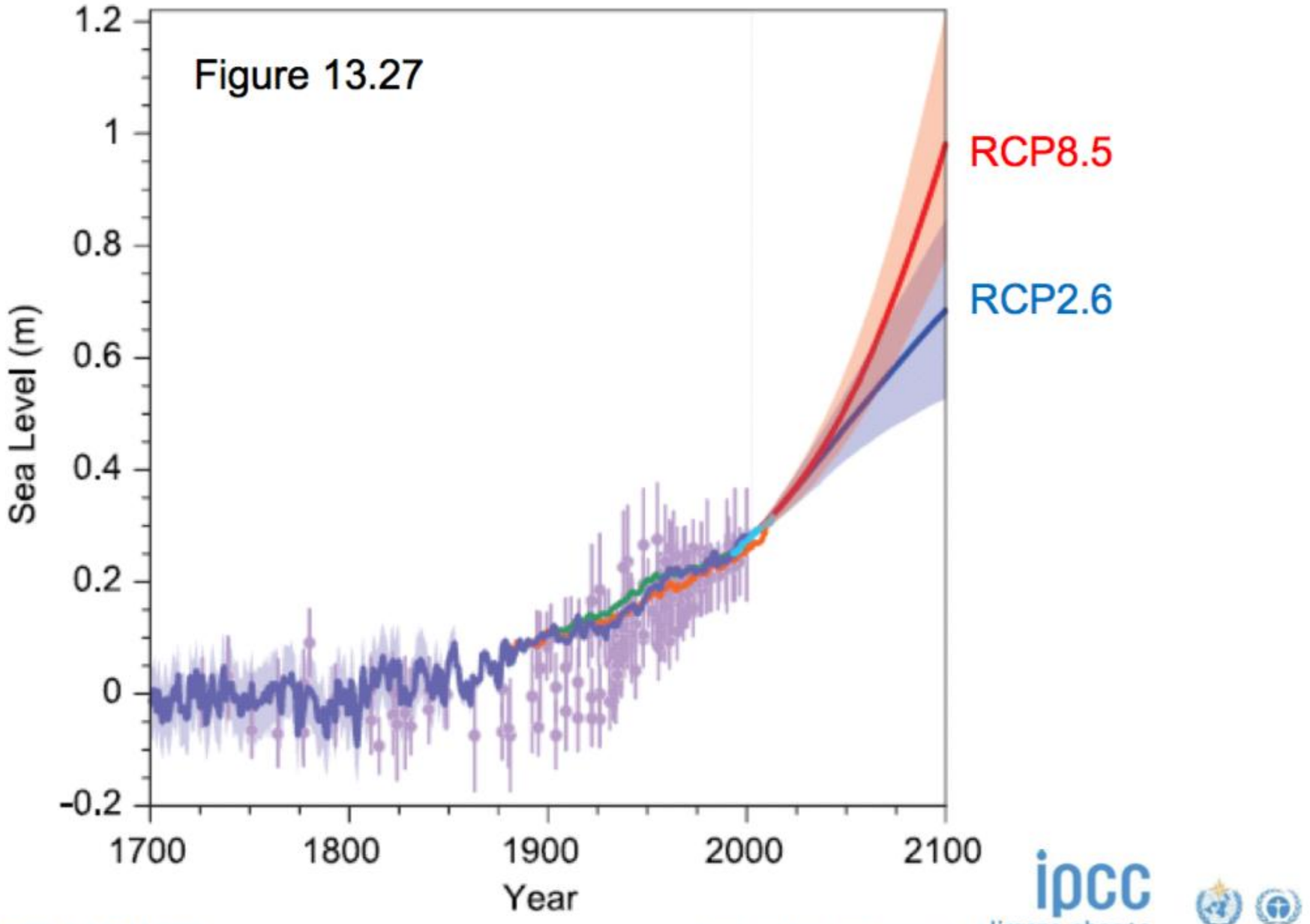


Fig 13.4a, change relative to 1986-2005

Very likely that the 21st-century mean rate of GMSLR will exceed that of 1971-2010 under all RCPs.



From J. Gregory, IPCC AR5 WG1, 2013

Regional sea level rise by the end of the 21st century

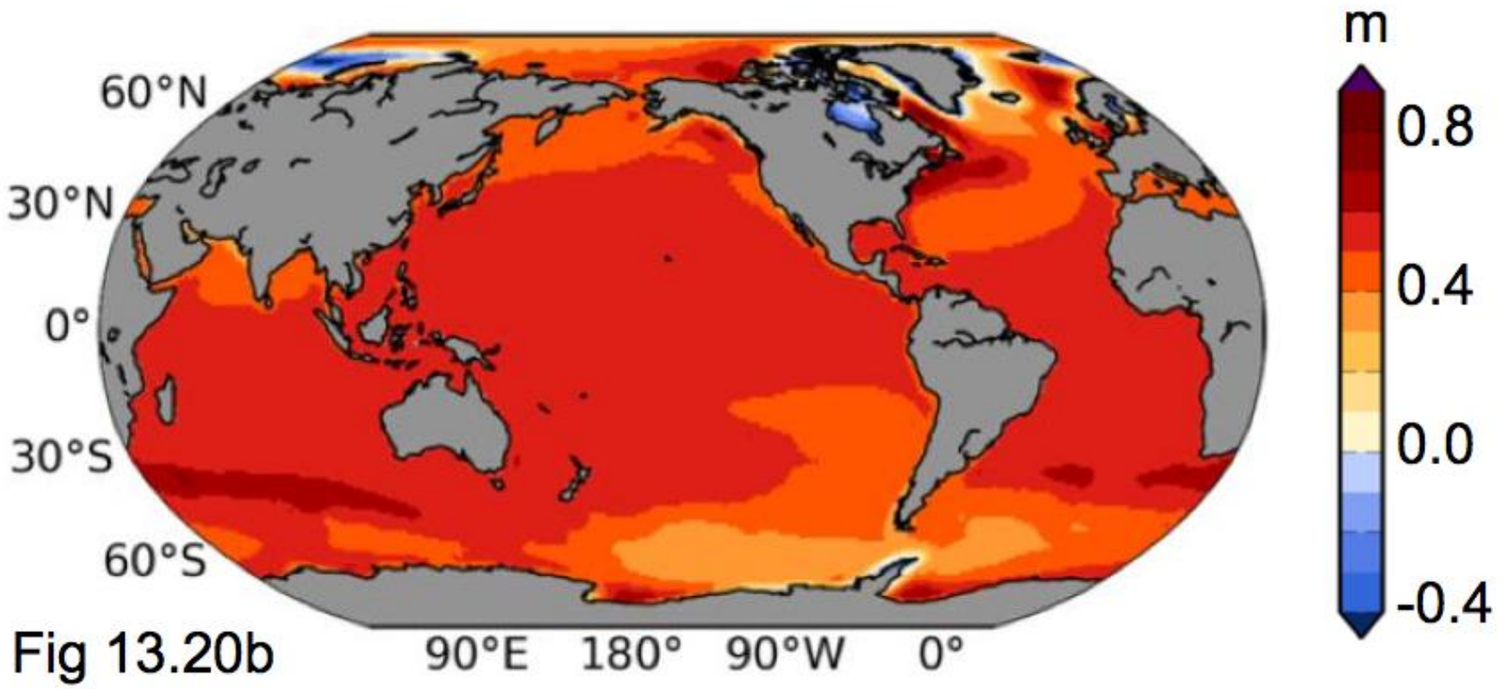


Fig 13.20b

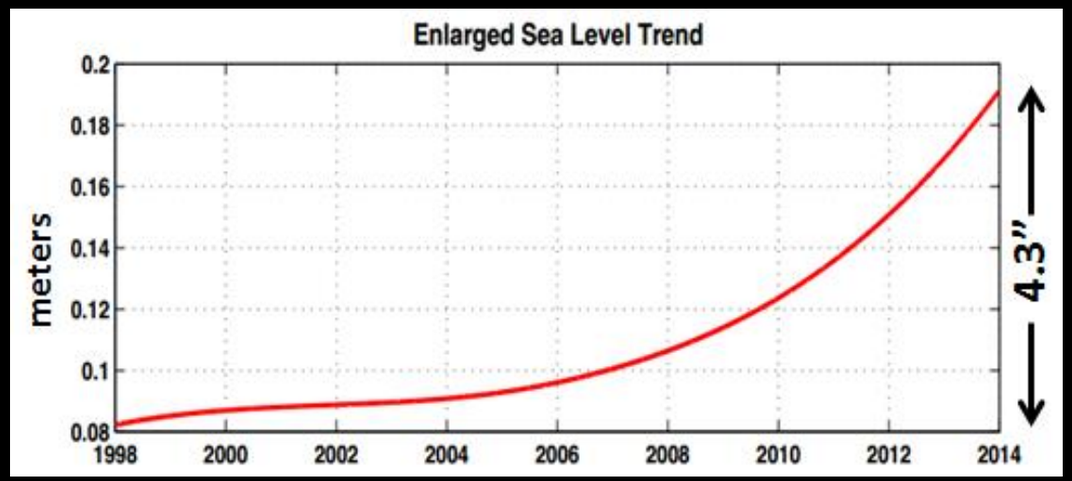
It is *very likely* that sea level will rise in more than about 95% of the ocean area.

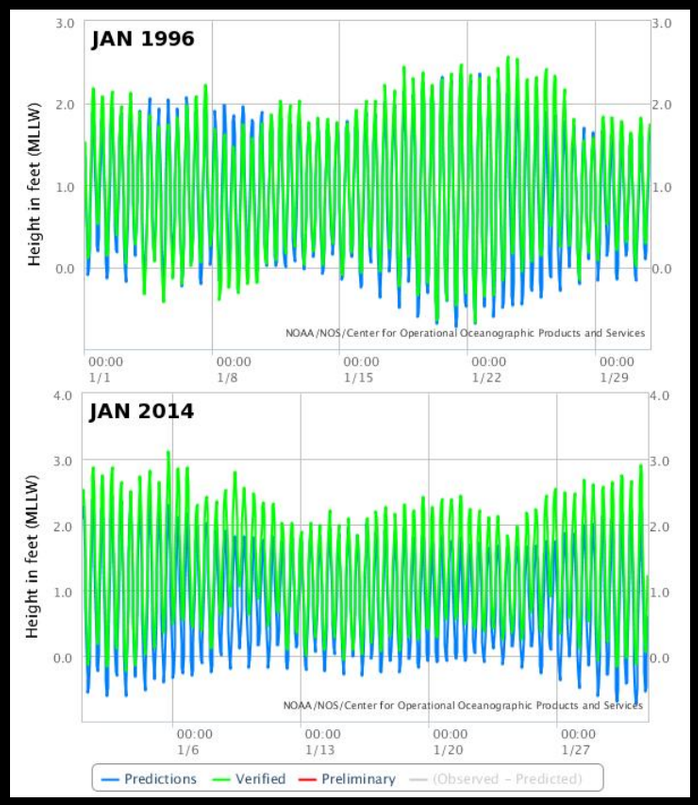
About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change.

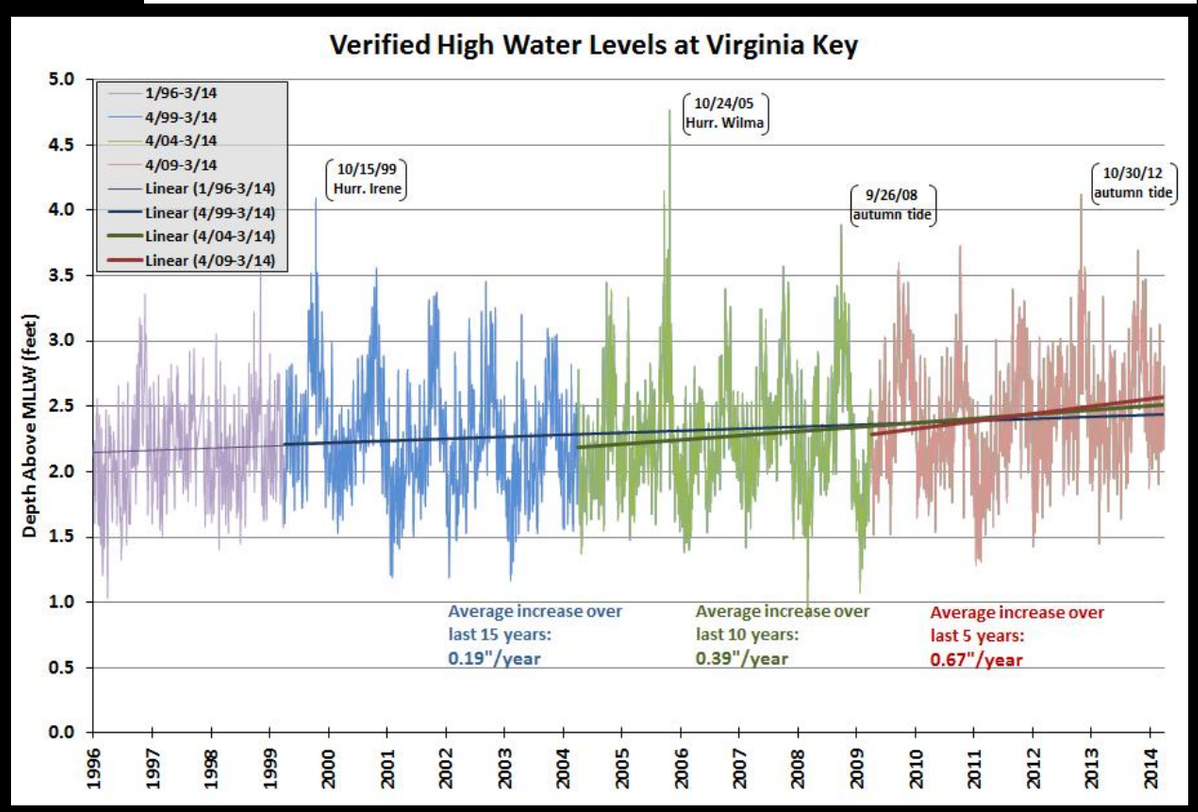
From J. Gregory, IPCC AR5 WG1, 2013

Miami

3-12 in increase by 2034







Venetian Causeway: Eric Blake, NHC (B. McNoldy RSMAS blog)
http://www.rsmas.miami.edu/blog/2014/10/03/sea-level-rise-in-miami/

Global Tropical Cyclones in a warmer climate

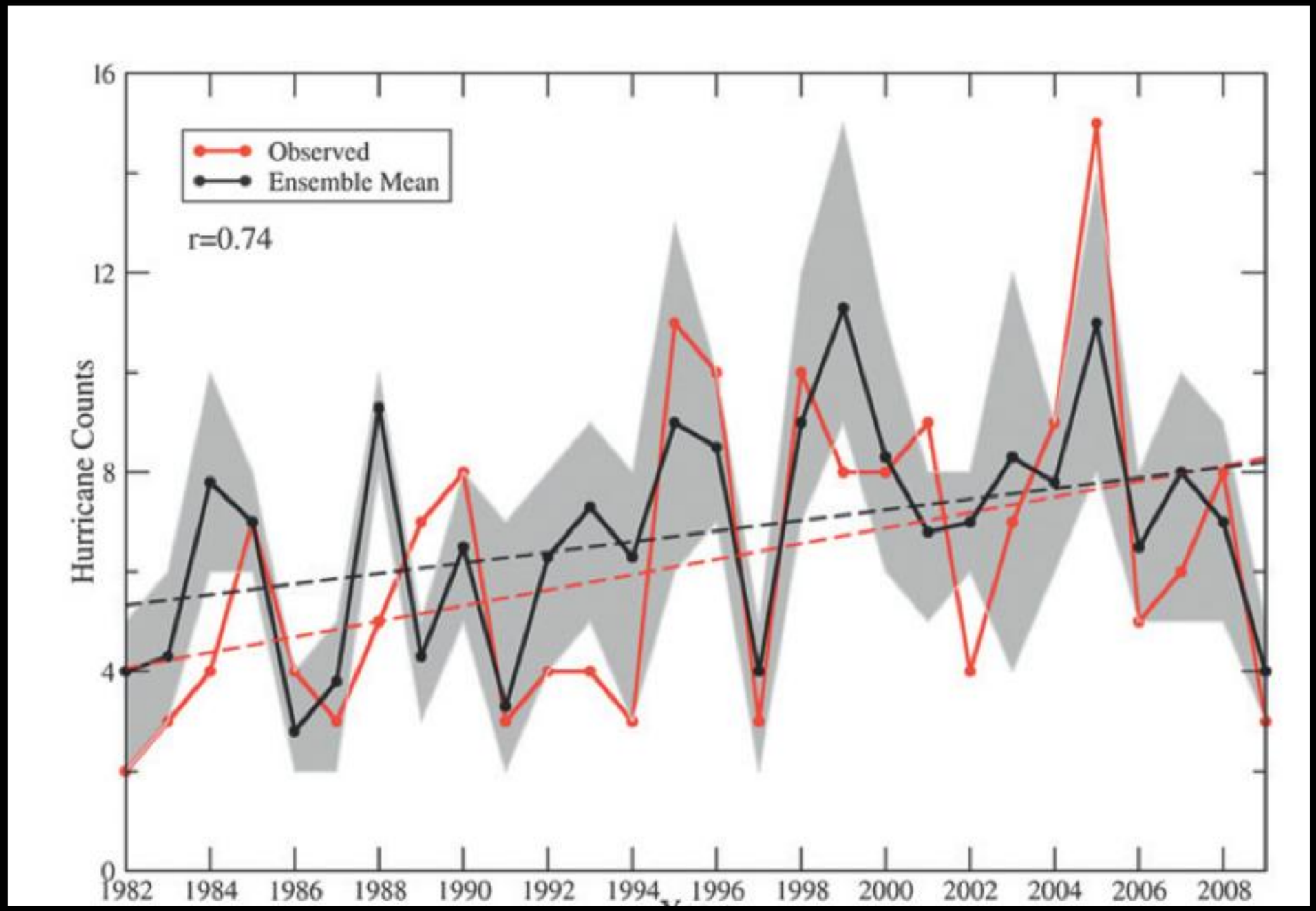
Lower frequencies

Slightly higher intensities

Some indication of larger storms, more precipitation

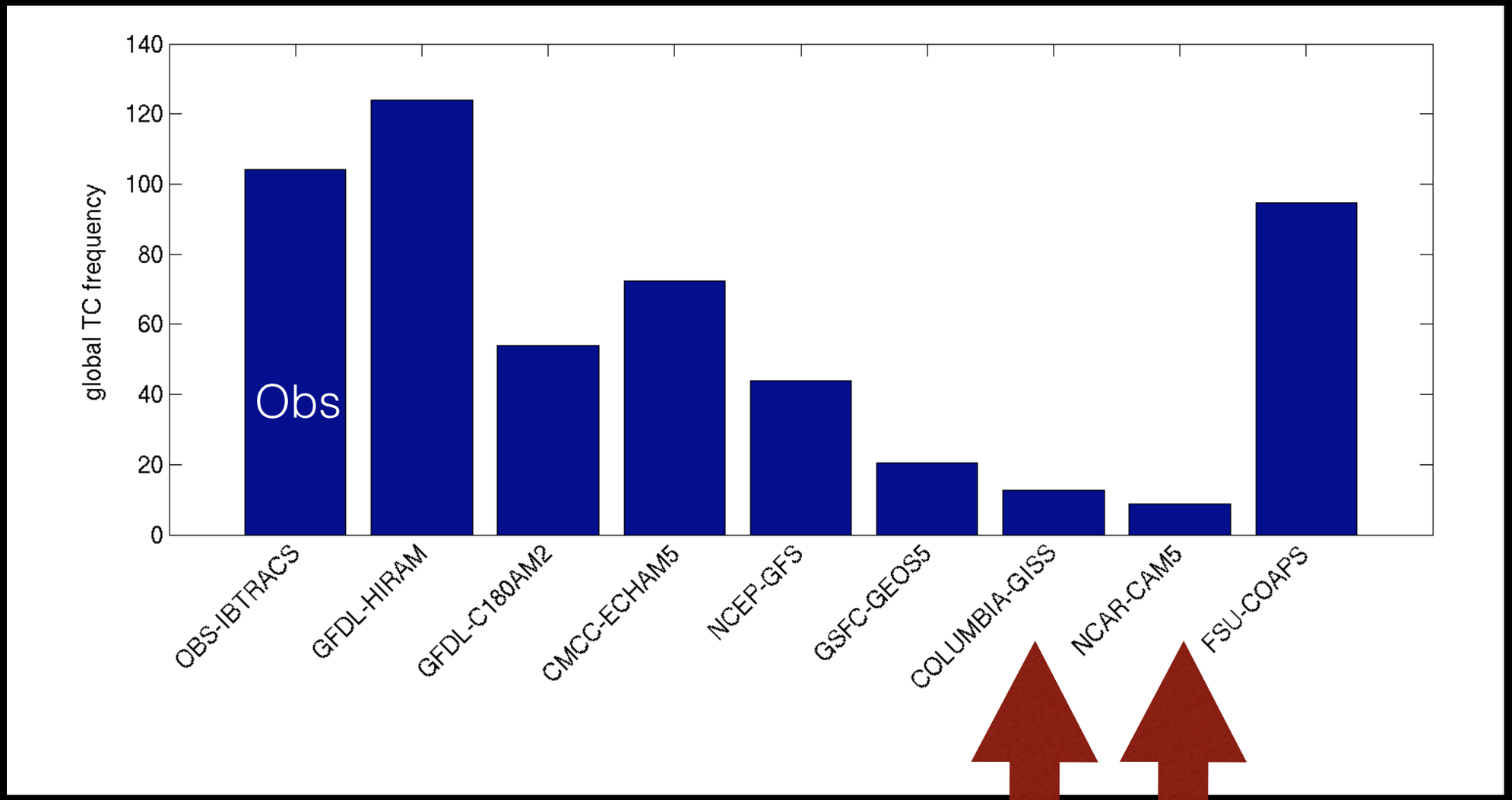
Lots of variability from one ocean to the next

Global models can predict TC frequencies given SSTs



FSU Global Model LaRow, 2013 Monthly Weather Review

Model Predicted Global Annual Frequency

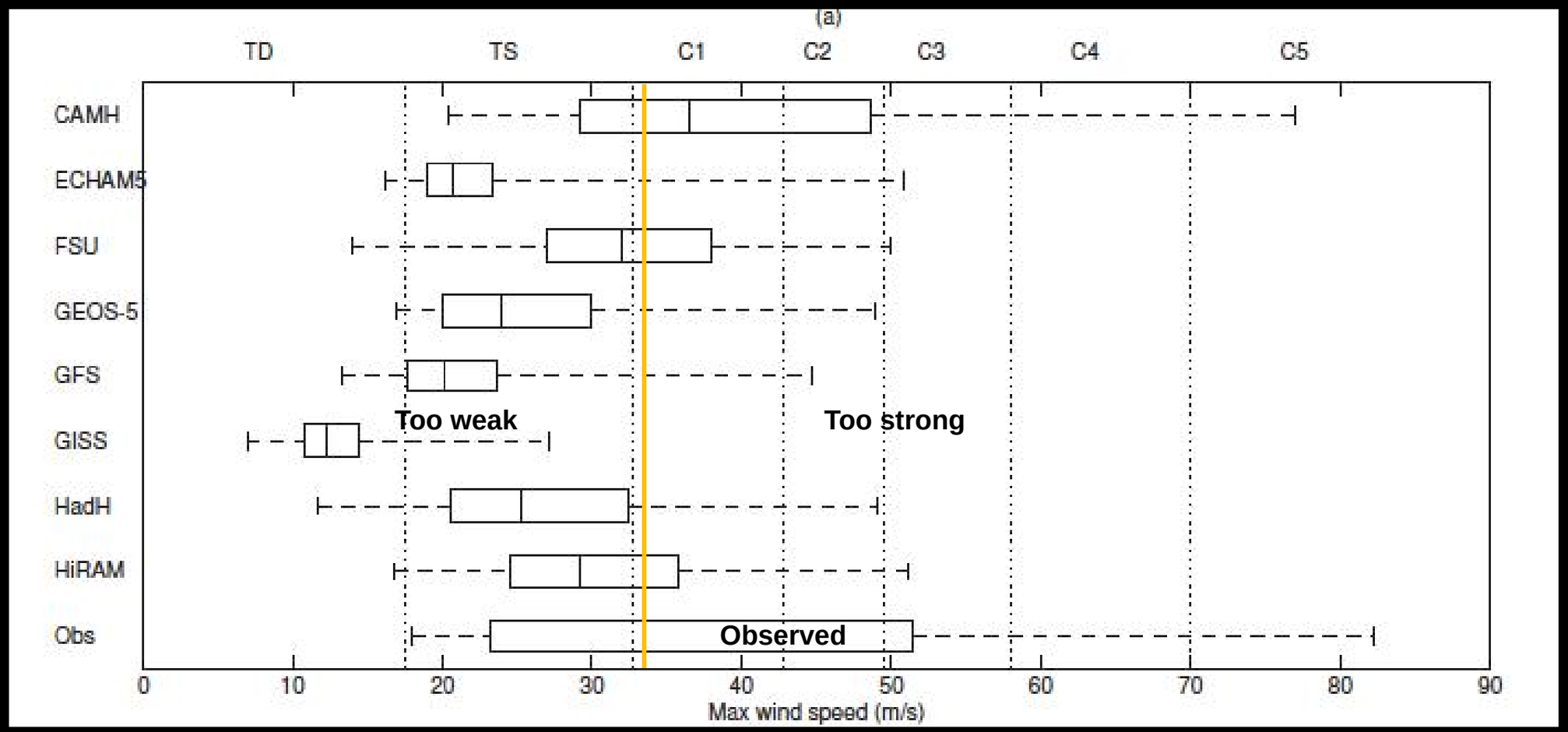


Global TC frequency from control simulation
present day CO2 and climatological SSTs

too few for
reliable stats.

Clivar Working Group

Distribution of Max Intensity in models and observations for with present day CO2 and climatological SSTs



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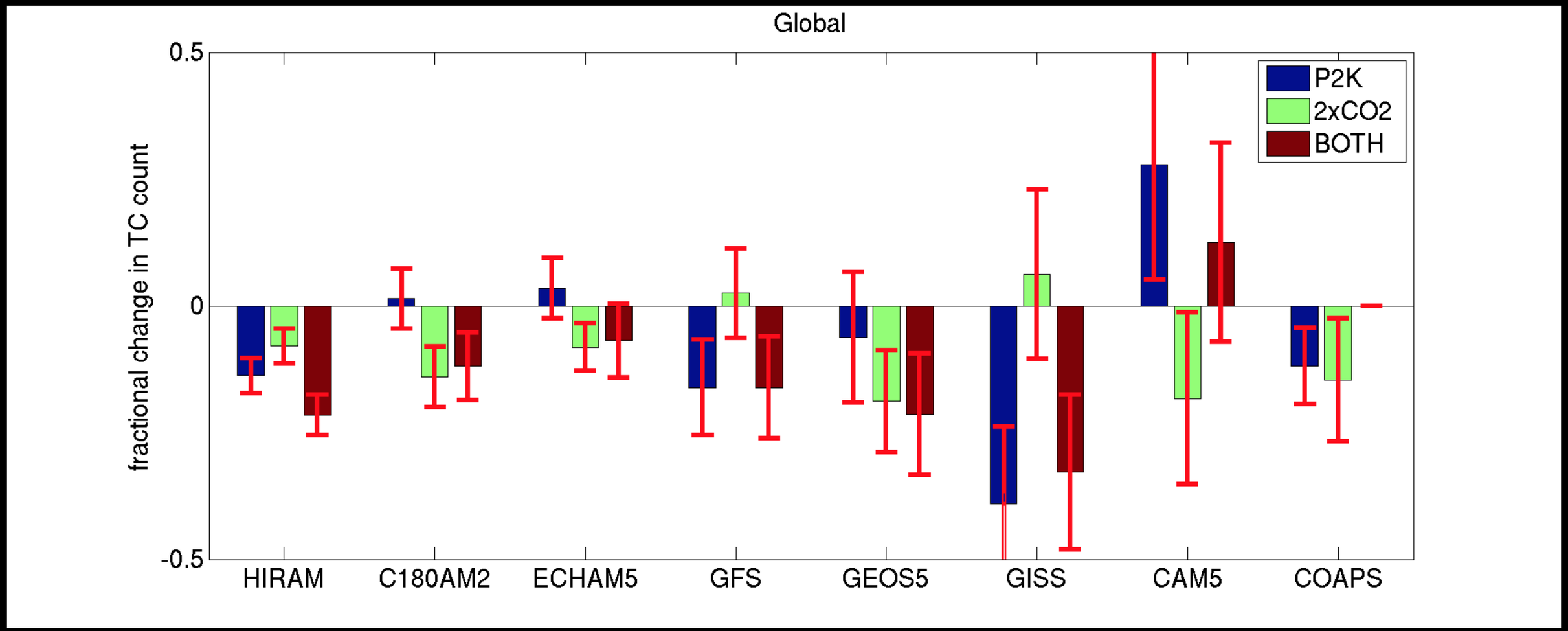
Response of global TC frequency to 2C warmer, Double CO_2



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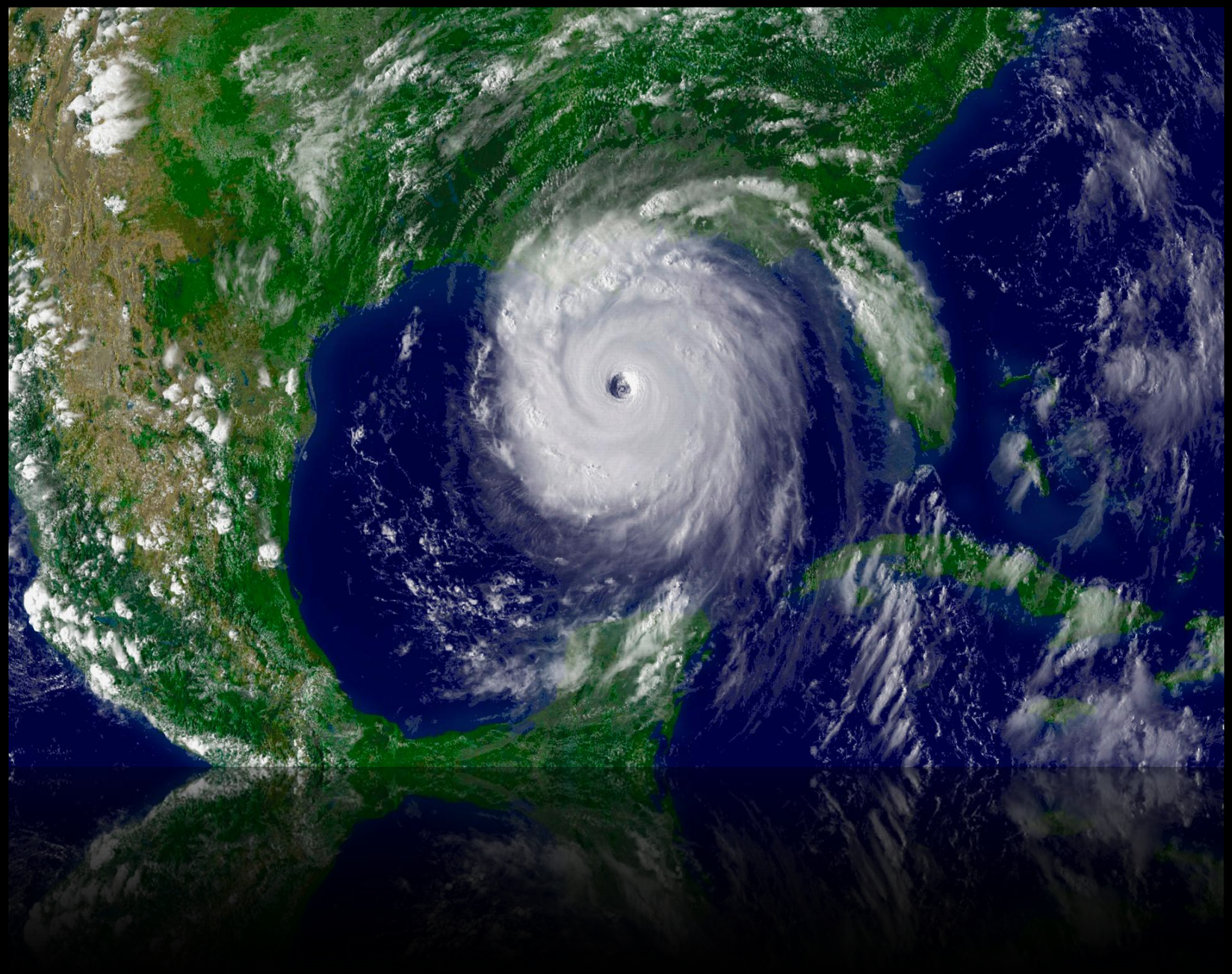
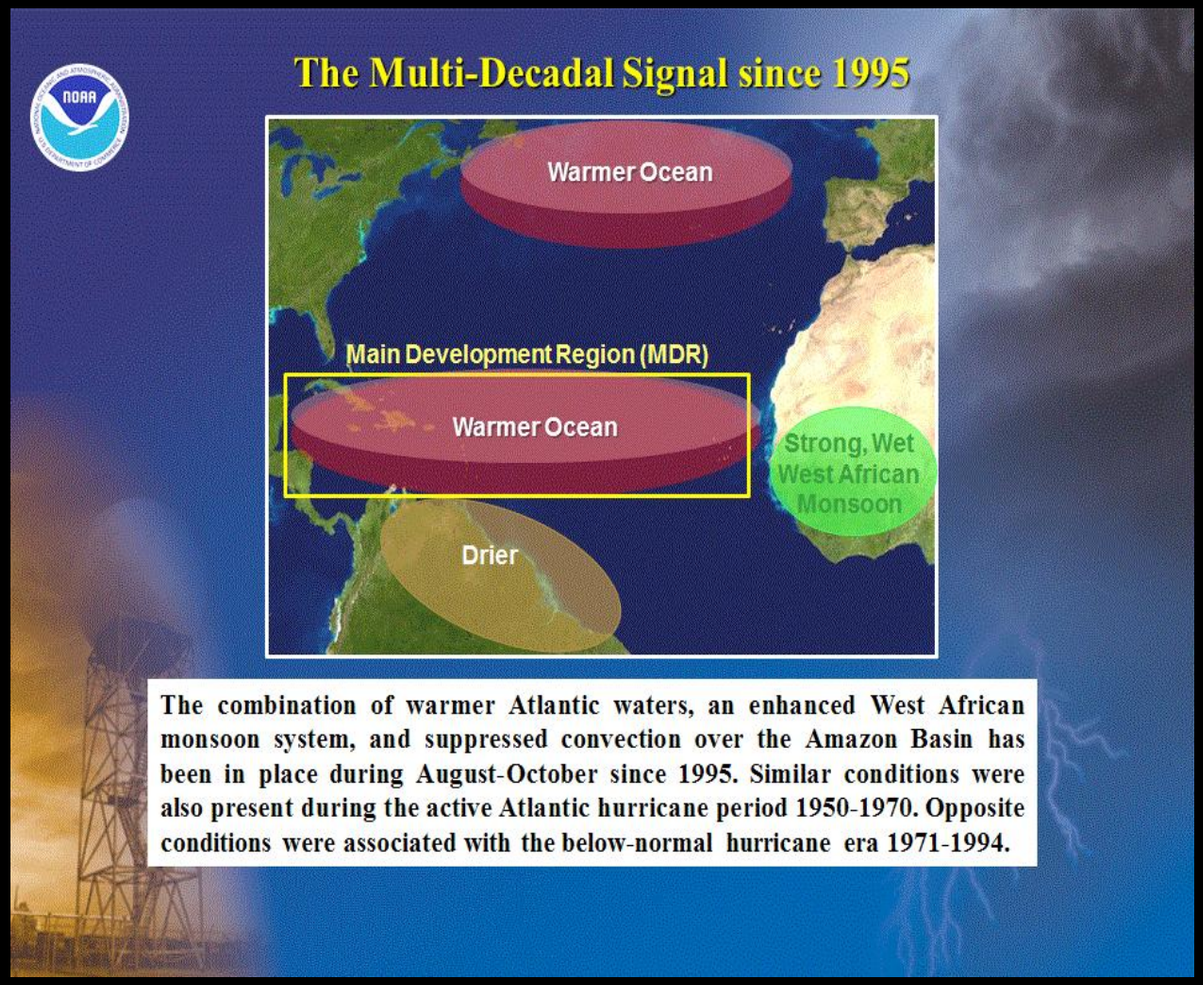
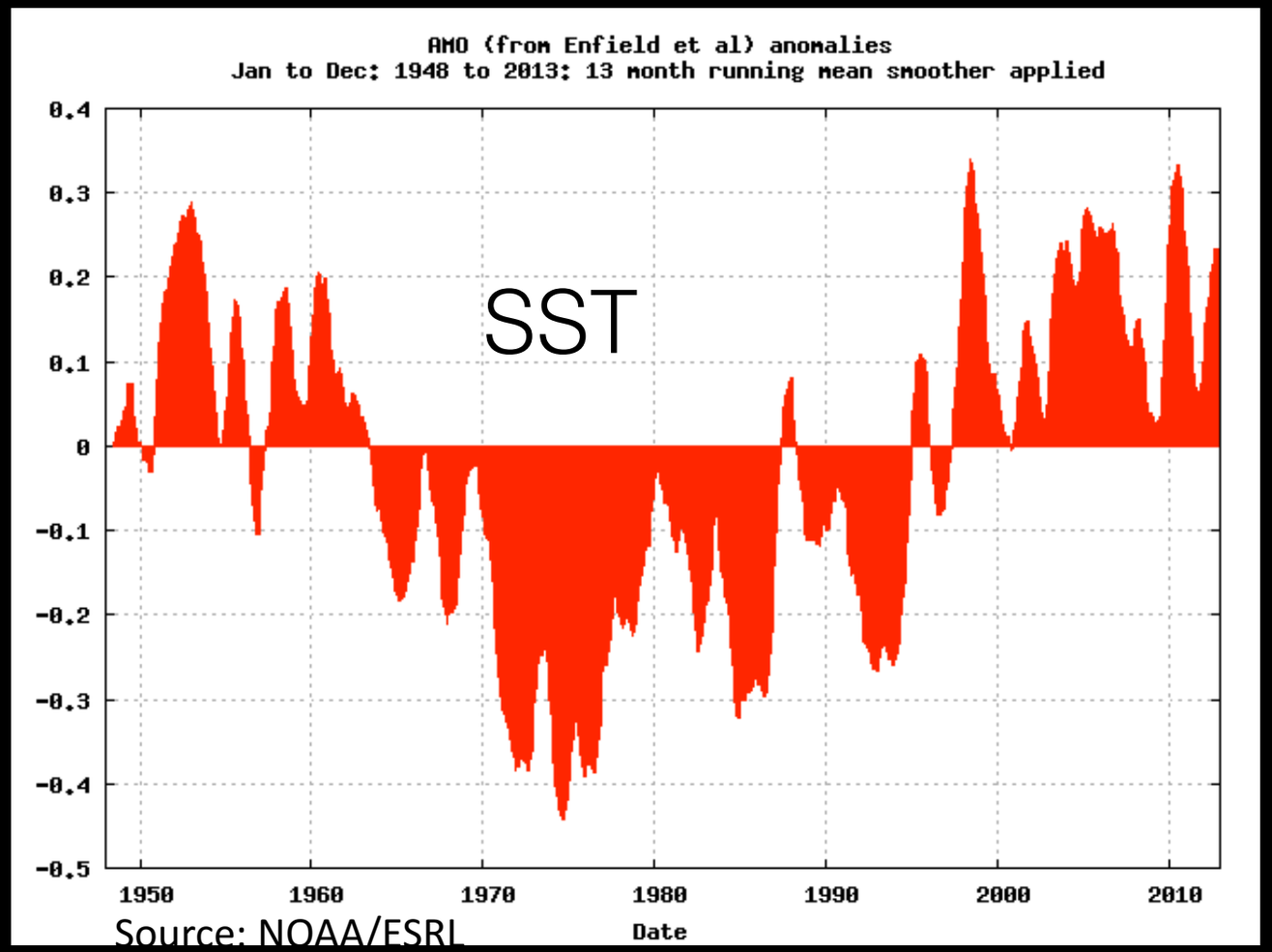
What about Atlantic Hurricanes?



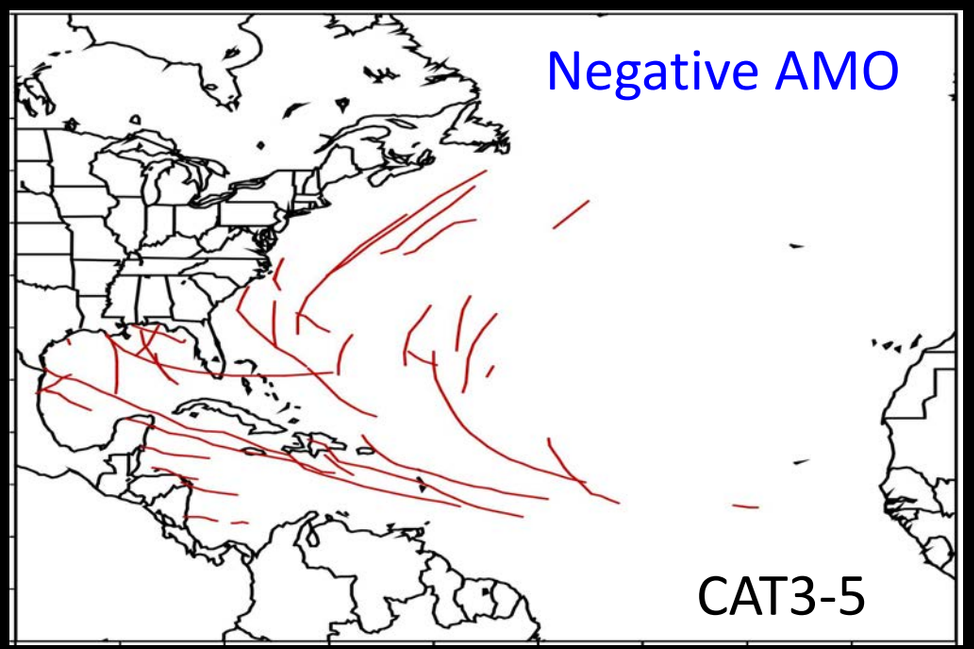
Atlantic Multidecadal Oscillation (40-70 year oscillation in SSTs)





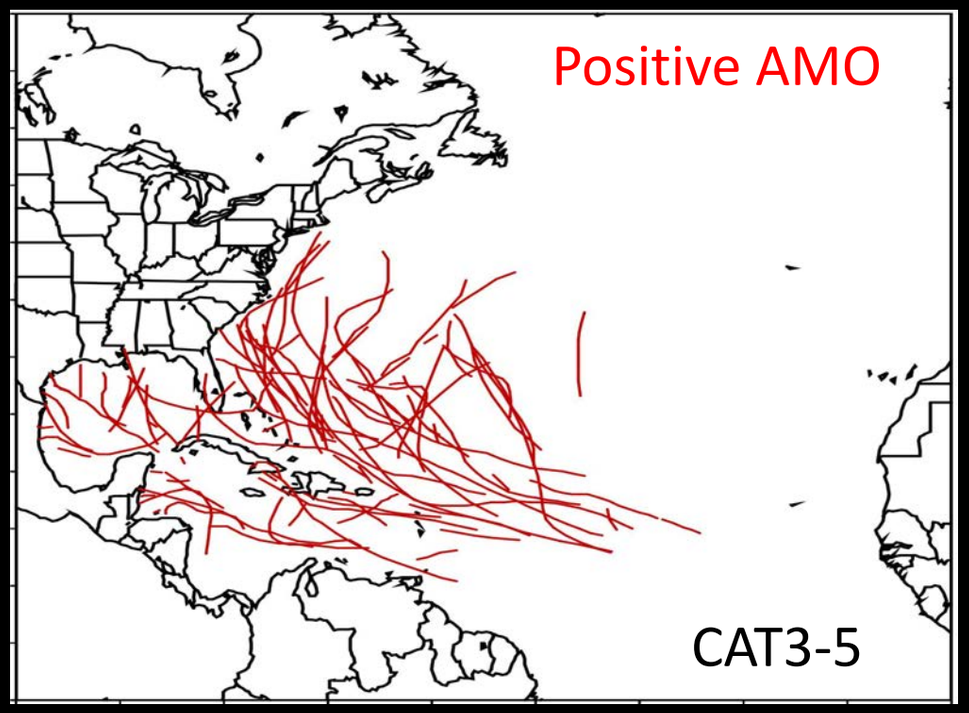
Source: NOAA/ESRL

Atlantic Multidecadal Oscillation (AMO) (Observations)



Negative AMO Phase Impacts

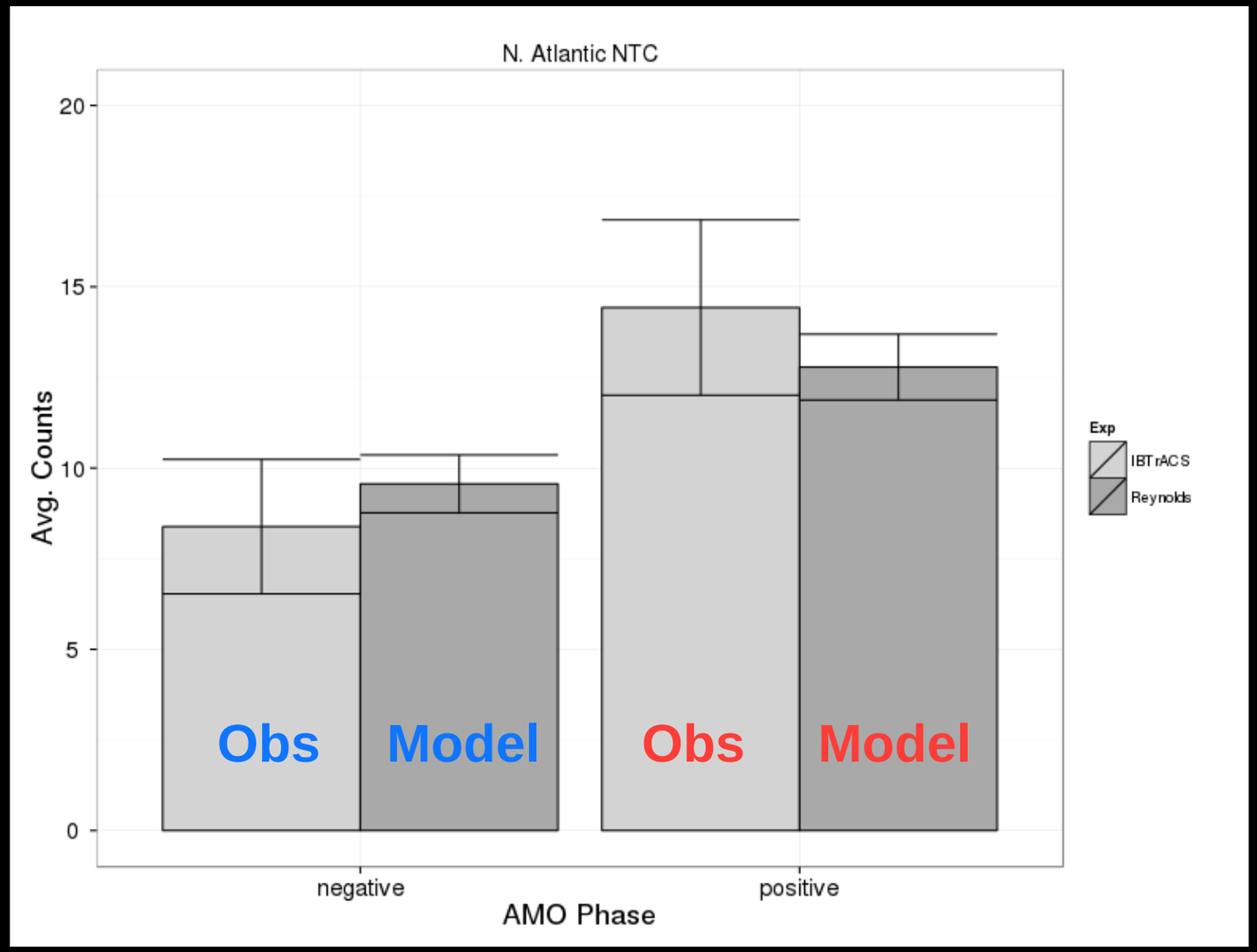
1. 1971-1994 ⟶ 25 years of AMO cool phase
2. 15 major hurricanes (surface winds > 111mph)
3. Decrease US landfalling hurricanes



Positive AMO Phase Impacts

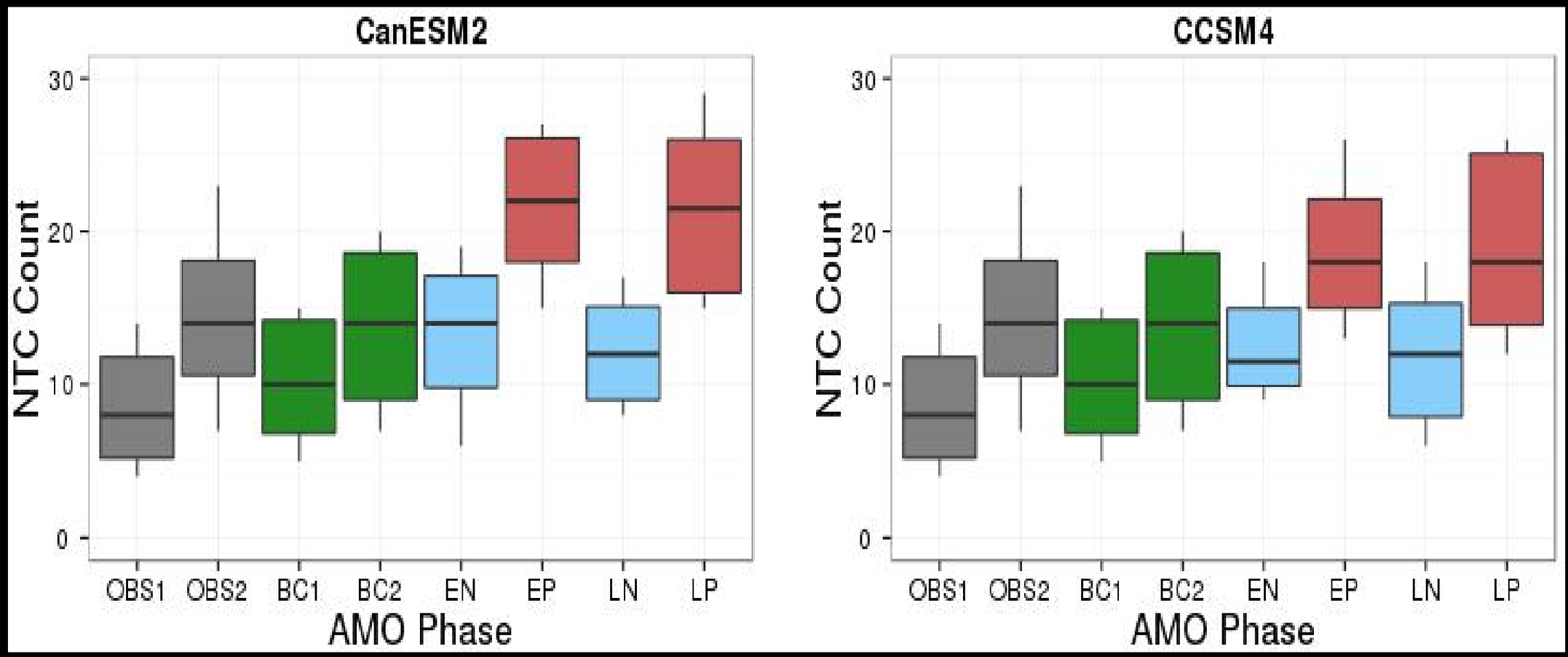
1. 1953-1970 & 1995-2000 ⟶ 25 years of AMO warm phase
2. 33 major hurricanes (surface winds > 111mph)
3. Increase US landfalling hurricanes

FSU Model TC Counts



LaRow, et al., 2014 Journal of Climate

FSU Model and Future NTC Projections

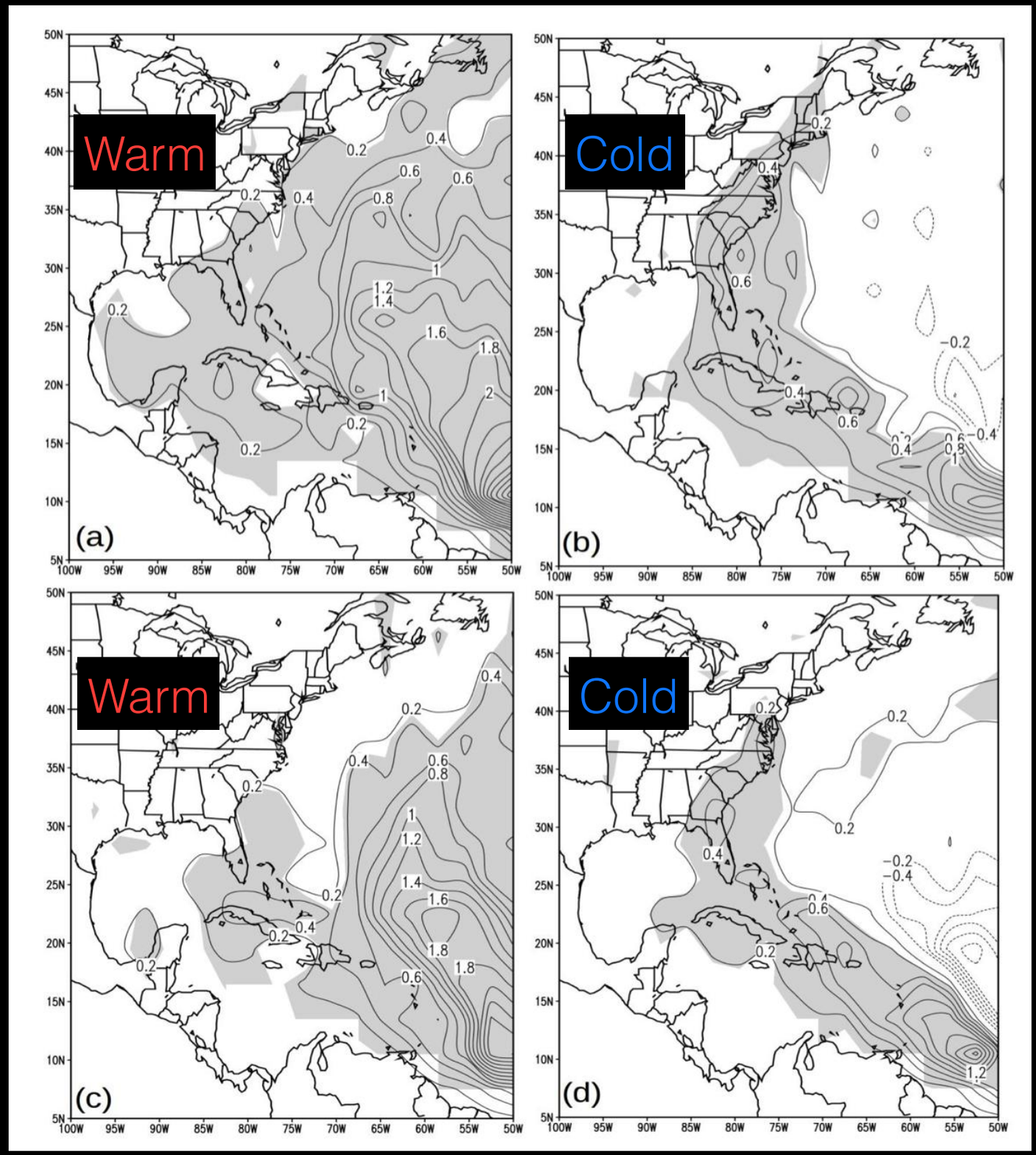


Even under a cold AMO, 21st century TCs have counts similar to the current active period of 1995-2012, under warm AMO, counts are even higher and intensities ~5% stinger

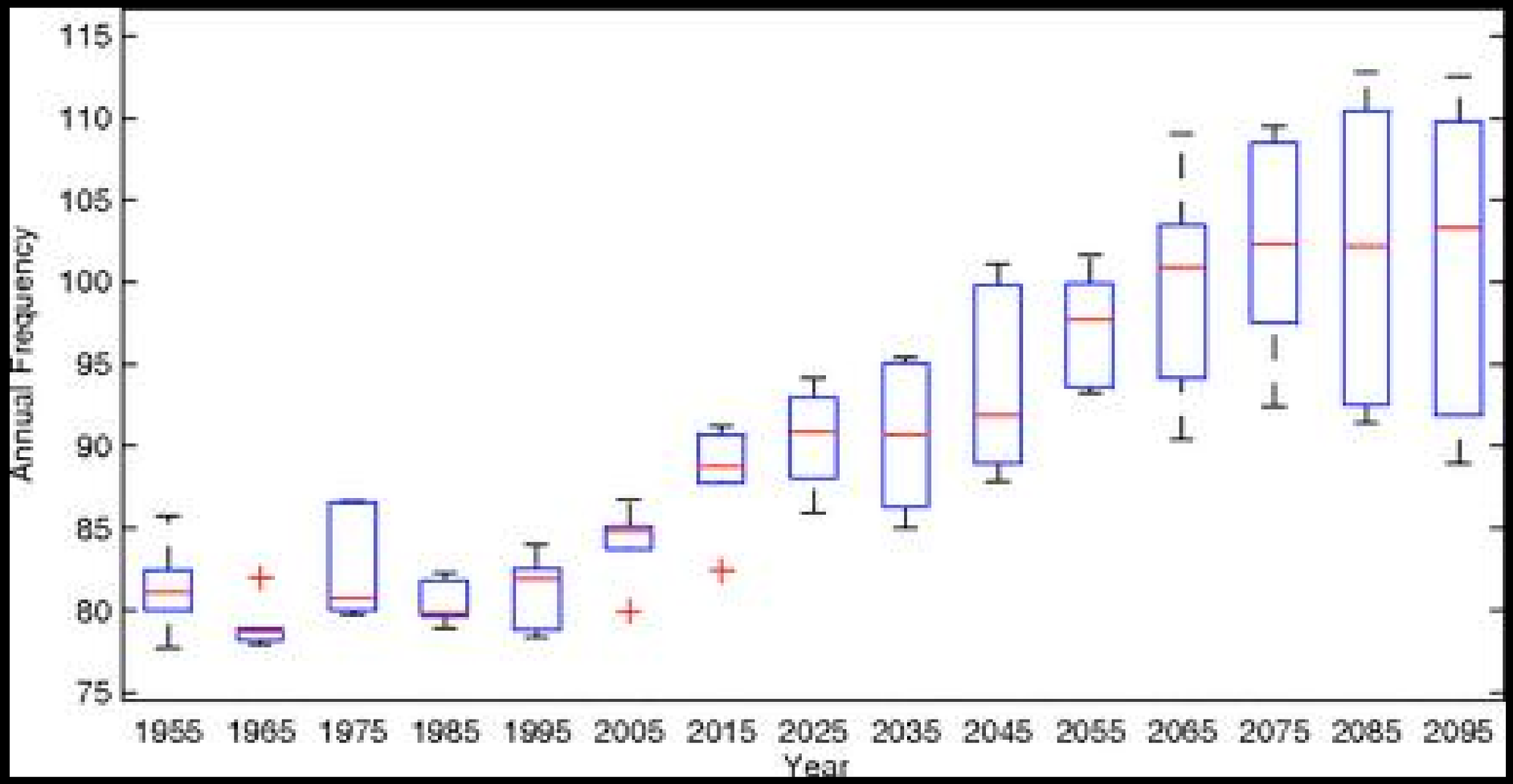
LaRow, T. E., L. Stefanova and C. Seitz, 2014: Dynamical Simulations of North Atlantic Tropical Cyclone Activity using Observed Low Frequency SST Oscillation Imposed on CMIP5 Model RCP4.5 SST Projections (accepted *J. Climate*).

Model Projected AMO signal to 21st Century

- Compared to 1982-2009 mean
  - Warm phase: More storms but further offshore
  - Cold Phase: Fewer storms but more landfalls
  - 5-7% increase in Winds
  - 13% increase in Precip



LaRow, et al., 2014 Journal of Climate



Global TC counts under the historical (1950-2005)
and RCP 8.5 scenario using a downscaling method
on results of six climate models
Emanuel 2013 PNAS

Emanuel's Downscaling suggests increased TC activity 2006-2100

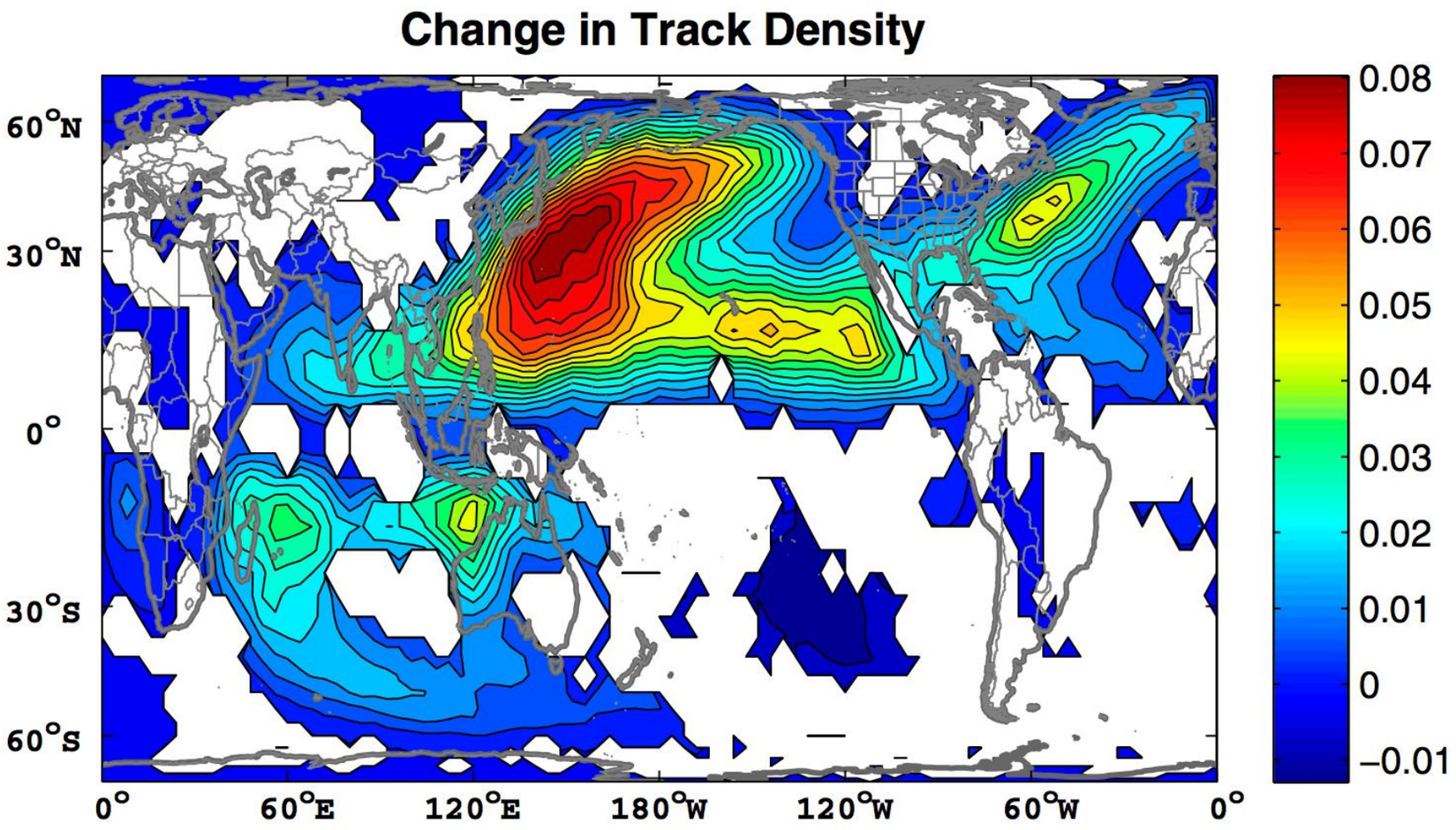


Fig. 2. Change in track density, measured in number of events per 4° × 4° grid box per year, averaged over the six models. The change is the average over the period 2006–2100 minus the average over 1950–2005. The white regions are where fewer than five of the six models agree on the sign of the change.

Conclusions

- **Sea Level Rise**
  - Models reproduce thermal expansion well
  - Glaciers and ice shelves a challenge
  - Most certain projection of climate change
- **Tropical Cyclones and Climate change**
  - Models can reproduce history well
  - Still differences on TCs in a warmer climate
  - Some indication of more activity in Atlantic

Thanks!

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