The Southeast Coastal Climate Network presents

The Science behind Global Warming

Featuring Dr. Greg Carbone
University of South Carolina

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Global Climate Change

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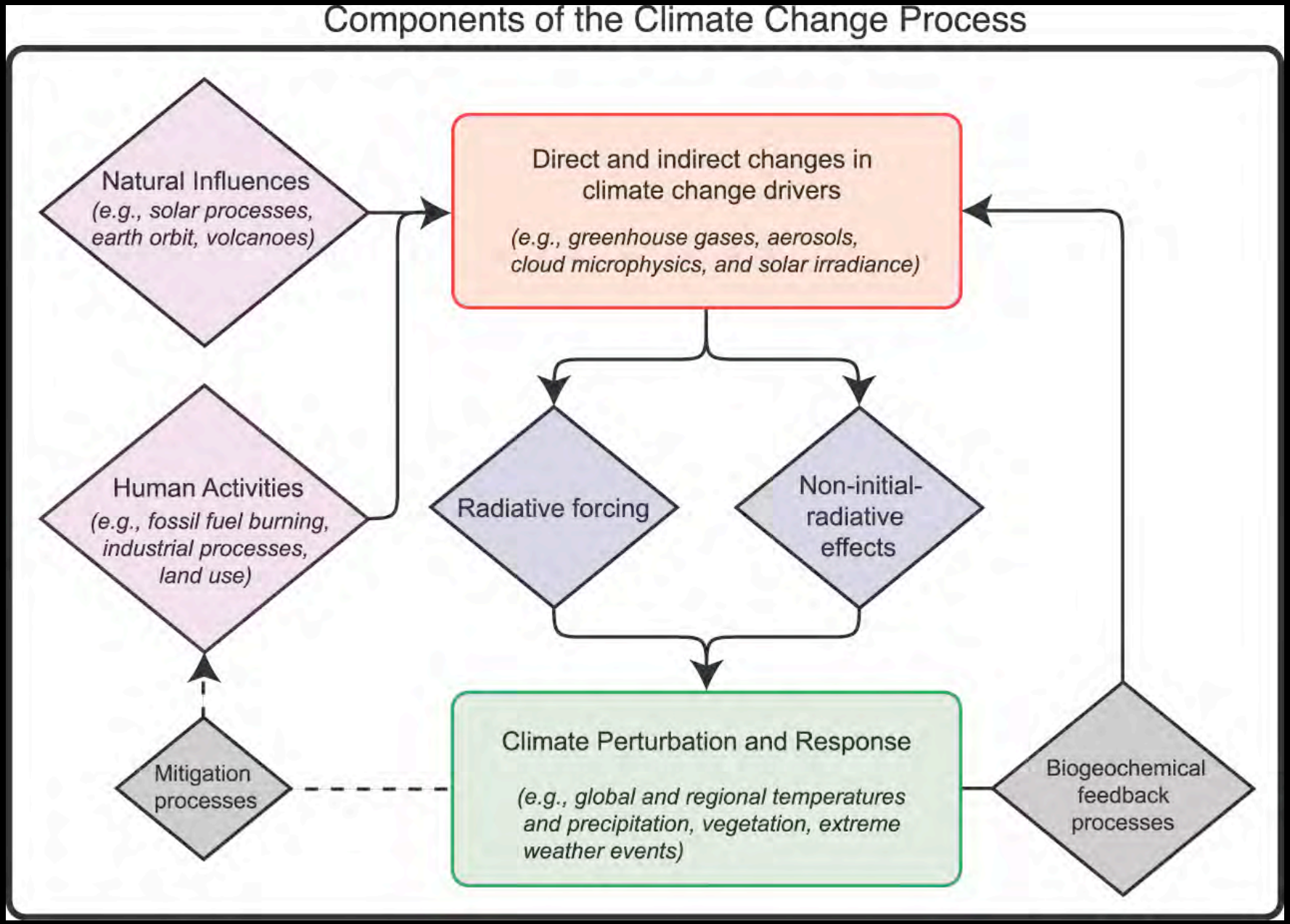
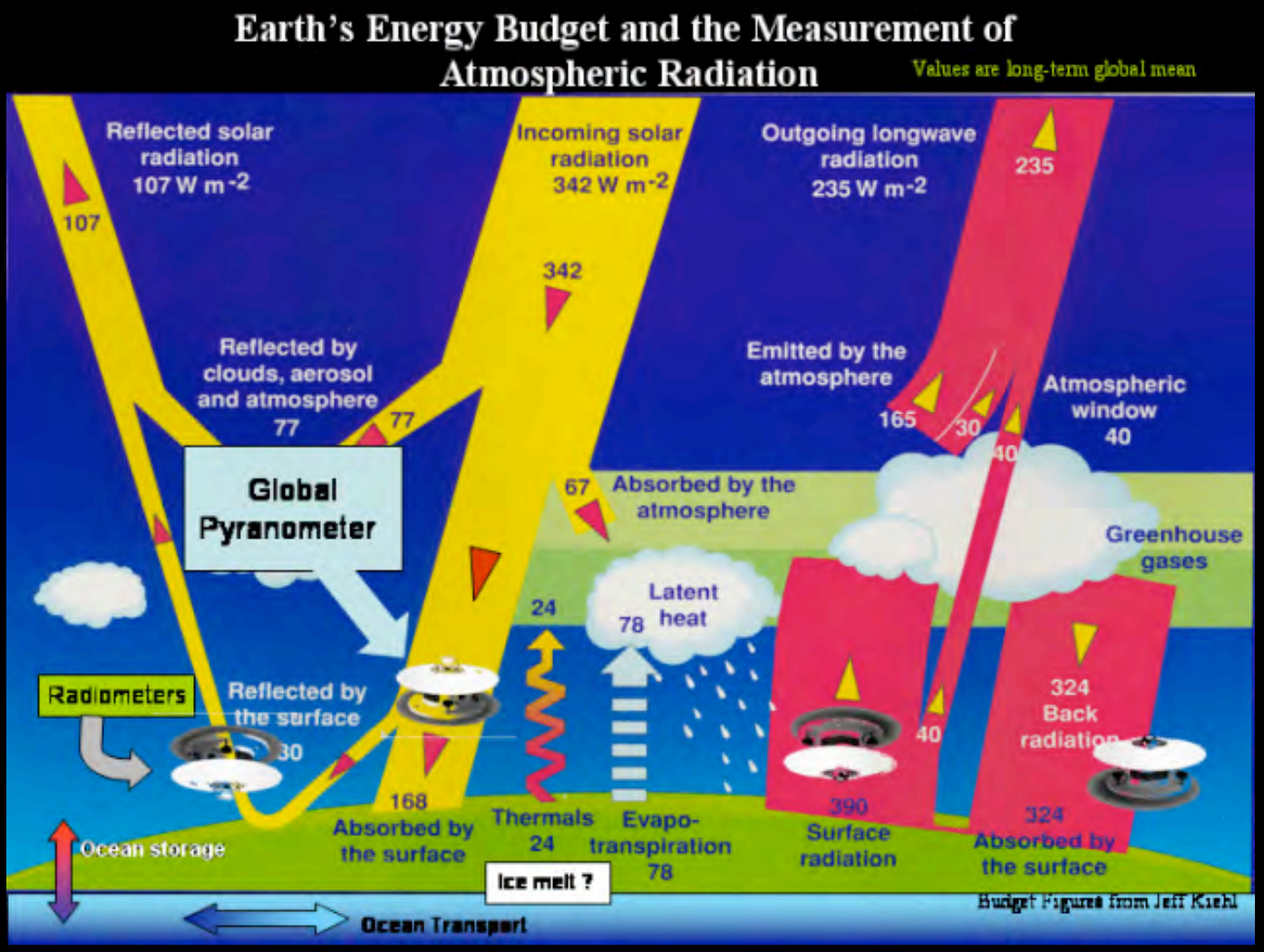
Webinar, 19 March 2009

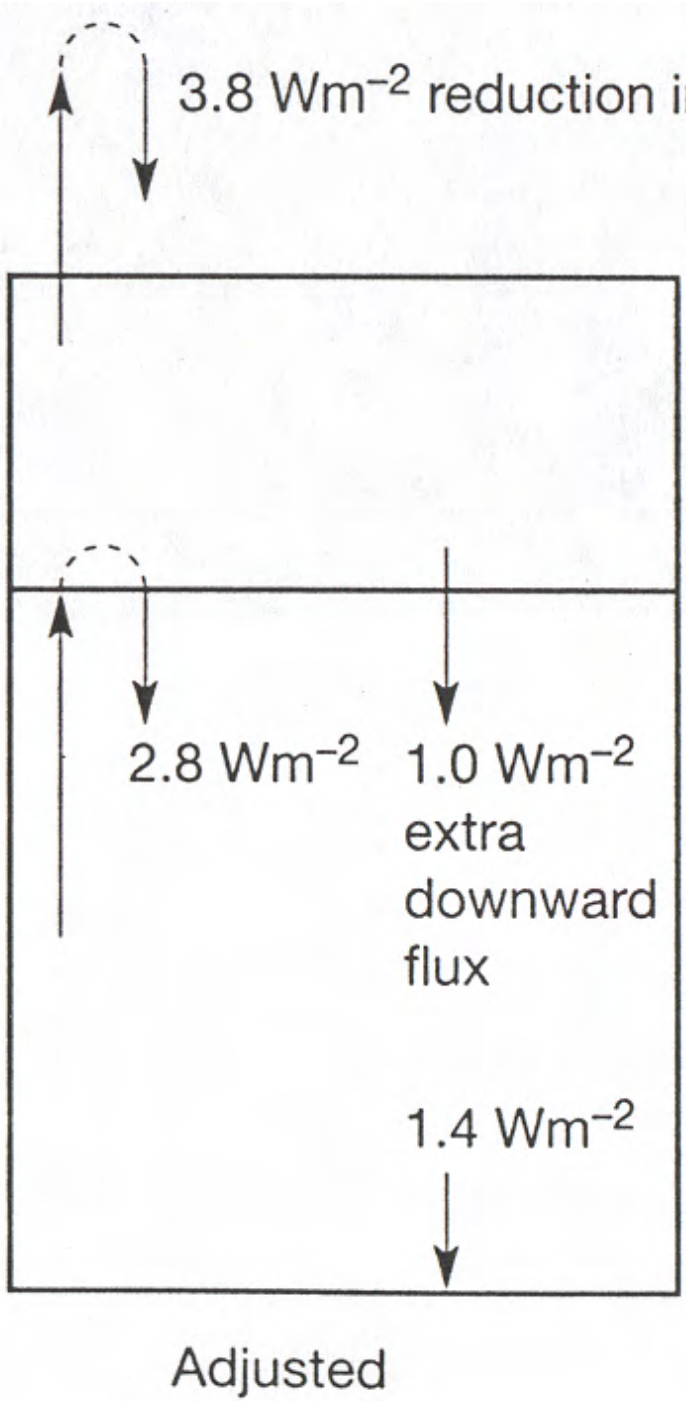

Components of the Climate Change Process
Natural Influences
(e.g., solar processes, earth orbit, volcanoes)
Direct and indirect changes in climate change drivers
(e.g., greenhouse gases, aerosols, cloud microphysics, and solar irradiance)
Human Activities
(e.g., fossil fuel burning, industrial processes, land use)
Radiative forcing
Non-initial-radiative effects
Mitigation processes
Climate Perturbation and Response
(e.g., global and regional temperatures and precipitation, vegetation, extreme weather events)
Biogeochemical feedback processes

IPCC, 2007



Kiehl and Trenberth, 1997

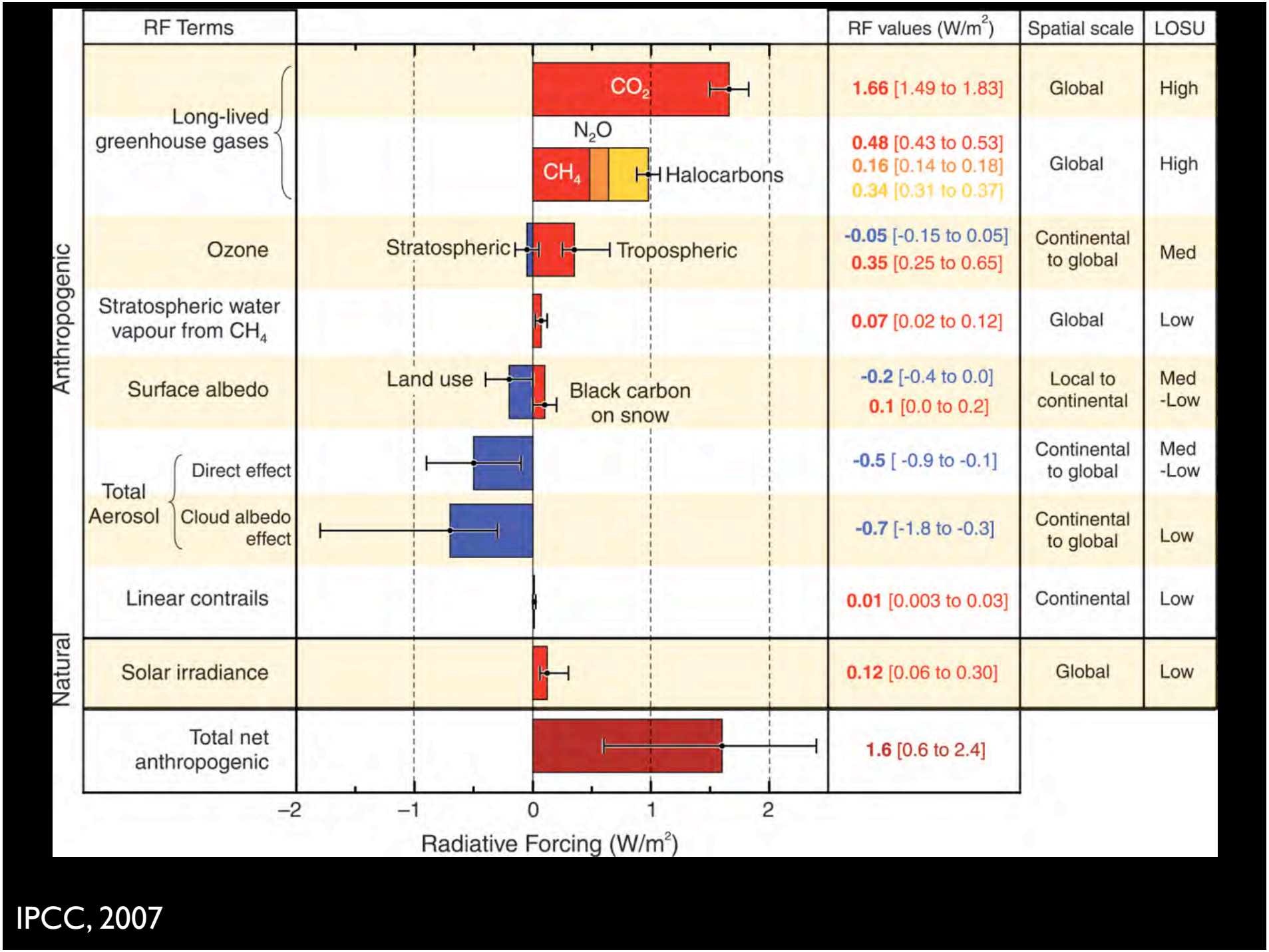
absorbed solar radiation = emitted infrared radiation to space



If IR lost to space decreases:
temperature increases
IR increases

New balance at higher resulting temperature

Radiative Damping: how quickly is new energy balance achieved?


RF Terms
RF values (W/m²)
Spatial scale
LOSU
Anthropogenic
Natural
Long-lived greenhouse gases
CO2
N2O
CH4
Halocarbons
1.66 [1.49 to 1.83]
Global
High
0.48 [0.43 to 0.53]
0.16 [0.14 to 0.18]
0.34 [0.31 to 0.37]
Global
High
Ozone
Stratospheric
Tropospheric
-0.05 [-0.15 to 0.05]
0.35 [0.25 to 0.65]
Continental to global
Med
Stratospheric water vapour from CH4
0.07 [0.02 to 0.12]
Global
Low
Surface albedo
Land use
Black carbon on snow
-0.2 [-0.4 to 0.0]
0.1 [0.0 to 0.2]
Local to continental
Med -Low
Total Aerosol
Direct effect
-0.5 [-0.9 to -0.1]
Continental to global
Med -Low
Cloud albedo effect
-0.7 [-1.8 to -0.3]
Continental to global
Low
Linear contrails
0.01 [0.003 to 0.03]
Continental
Low
Solar irradiance
0.12 [0.06 to 0.30]
Global
Low
Total net anthropogenic
1.6 [0.6 to 2.4]
–2
–1
0
1
2
Radiative Forcing (W/m²)

IPCC, 2007

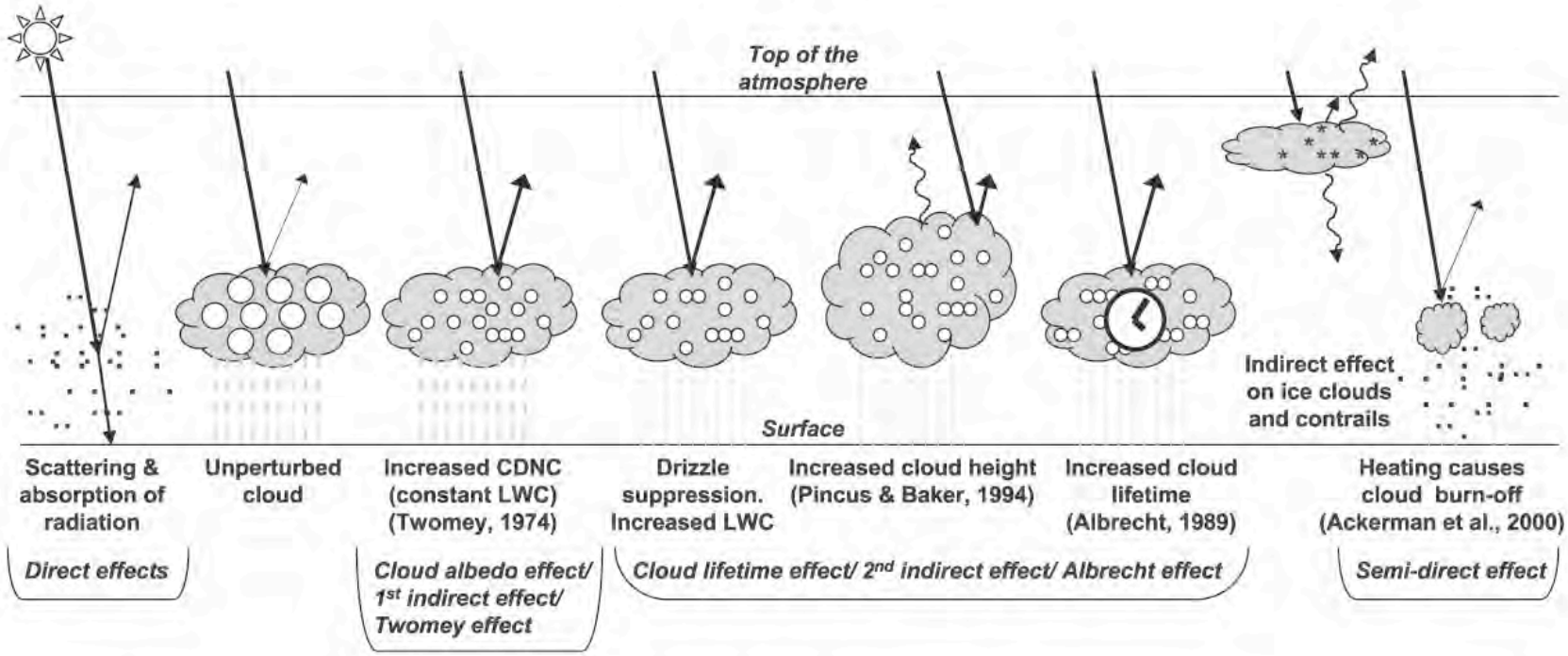


Figure 2-10, IPCC Working Group I Report , 2007

$$\lambda = 4\left(5.67x10^{-8}Wm^{-2}K^{-4}\right)(255K)^3 = 3.76Wm^{-2}K^{-1}$$

CO_2 doubling: 3.5-4.0 Wm^{-2}

$$\frac{\Delta R}{\lambda} = \frac{\sim 3.75Wm^{-2}}{3.76Wm^{-2}K^{-1}} \approx 1K$$

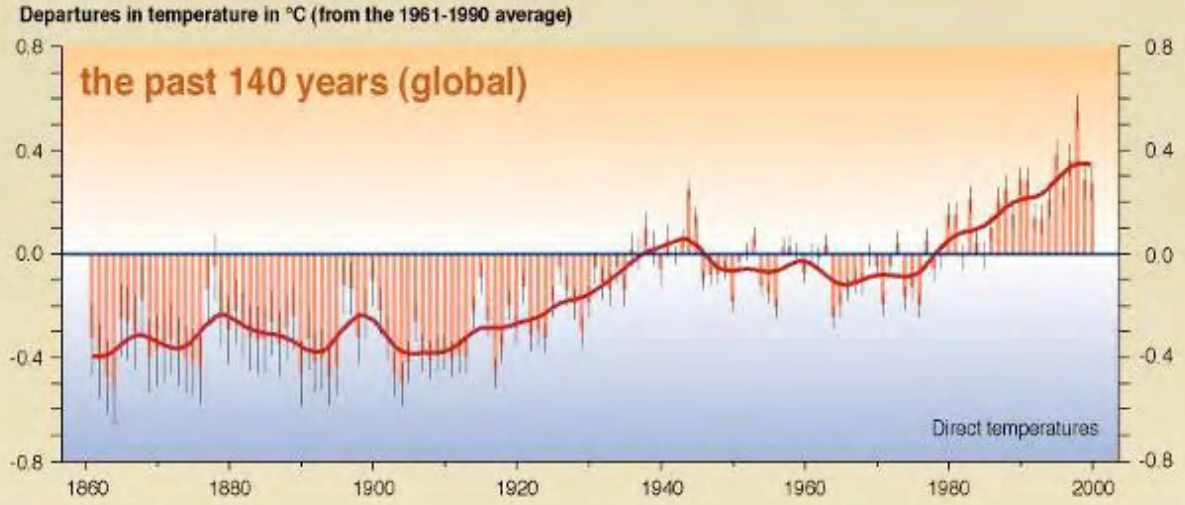
Water vapor:

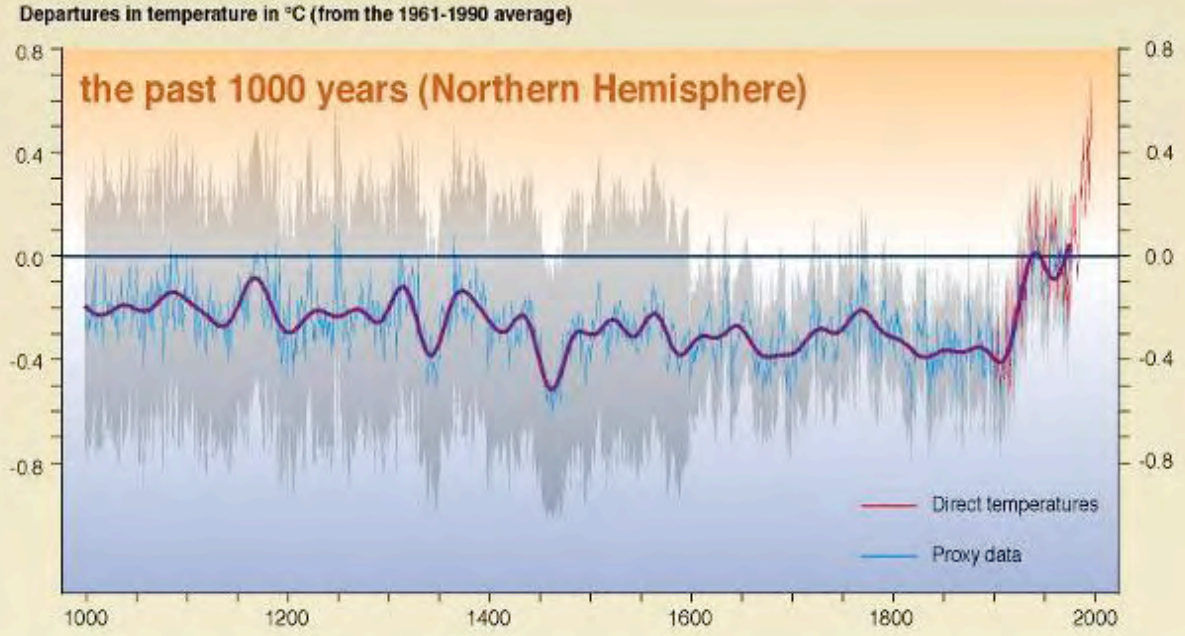
$$\frac{\Delta R}{\lambda} = \frac{\sim 3.75Wm^{-2}}{(3.76-1.7)Wm^{-2}K^{-1}} \approx 1.83K$$

Water vapor and ice:

$$\frac{\Delta R}{\lambda} = \frac{\sim 3.75Wm^{-2}}{(3.76-1.7-0.6)Wm^{-2}K^{-1}} \approx 2.58K$$

Variations of the Earth's surface temperature for...



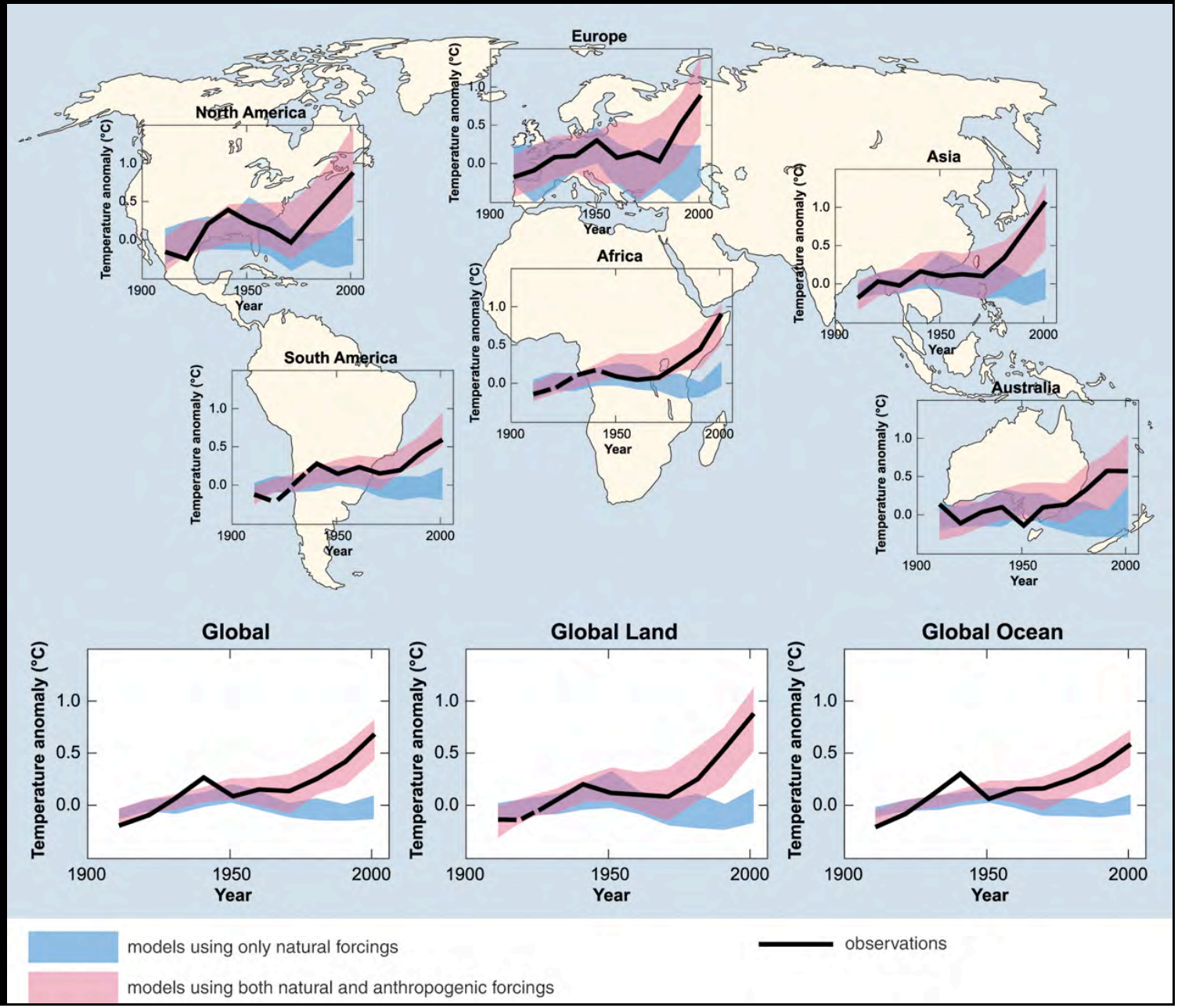


SYR - FIGU

IPCC

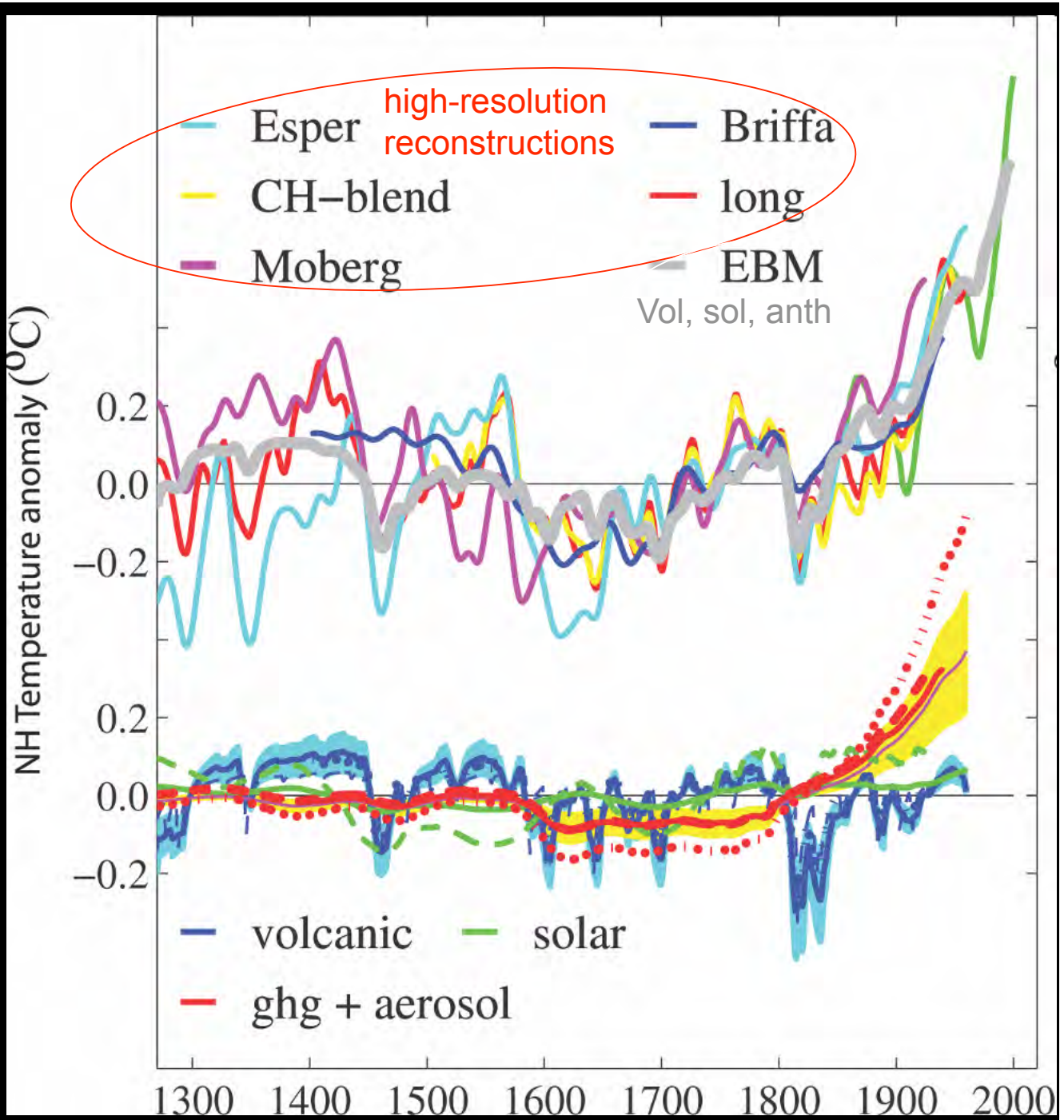
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Do the climate models get it right?



IPCC, 2007

Capturing climate variability in the past 1000 years



IPCC Fig. 9-5

Delays in response to policies

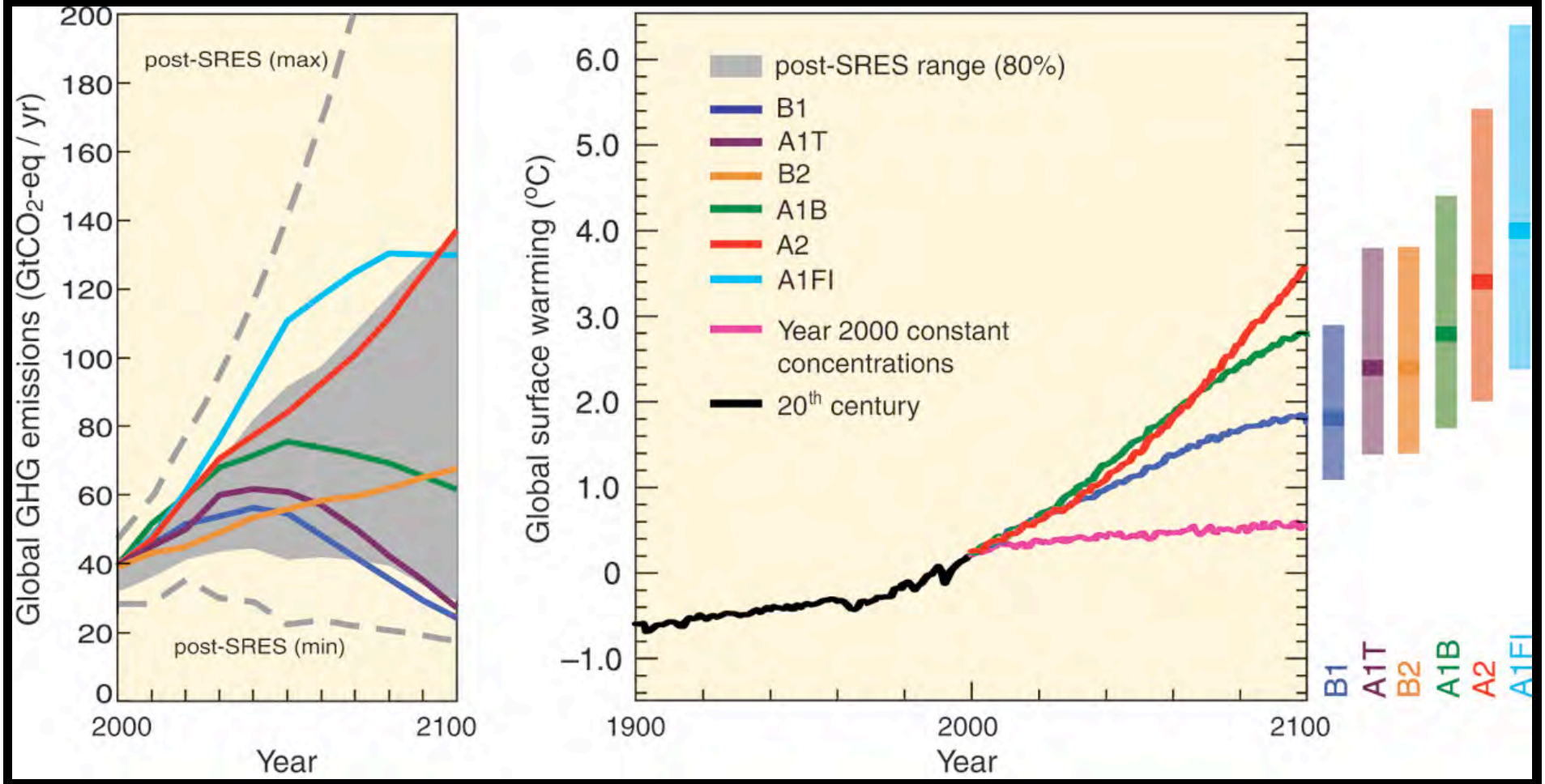


Figure 5, IPCC Summary for Policy Makers, 2007

The range of projected temperature change

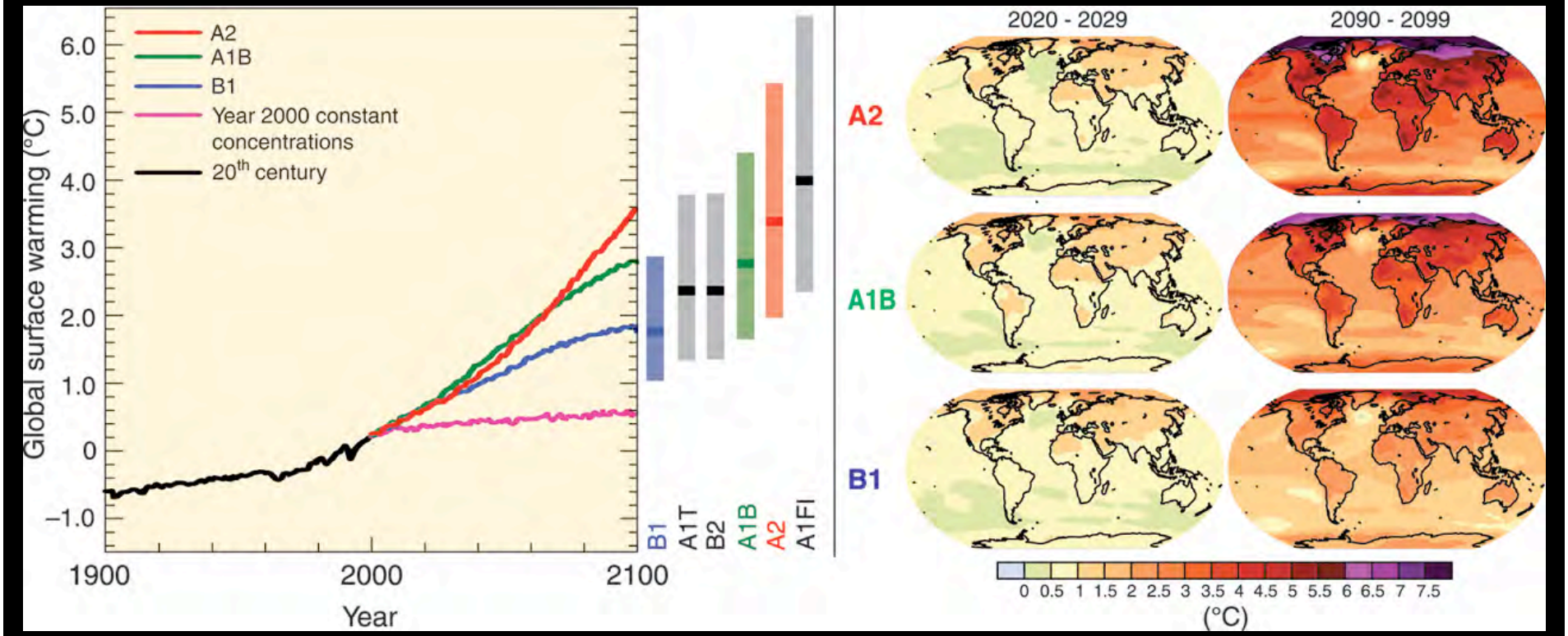
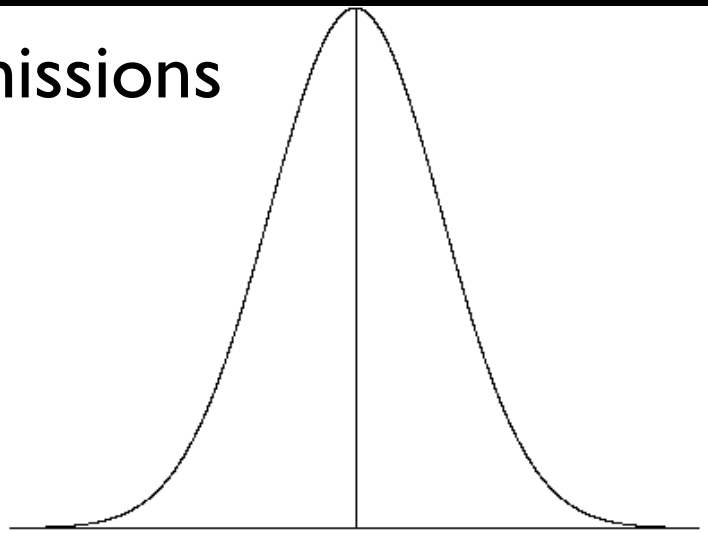


Figure 3-2, IPCC Synthesis Report, 2007

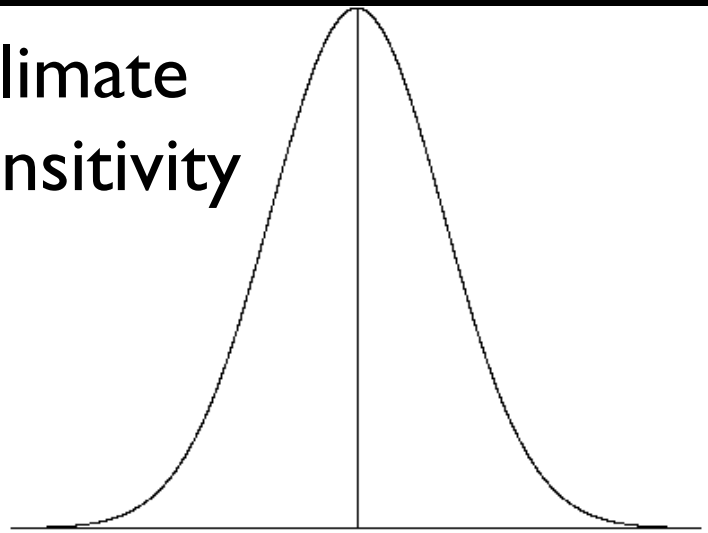
Key Uncertainties

emissions

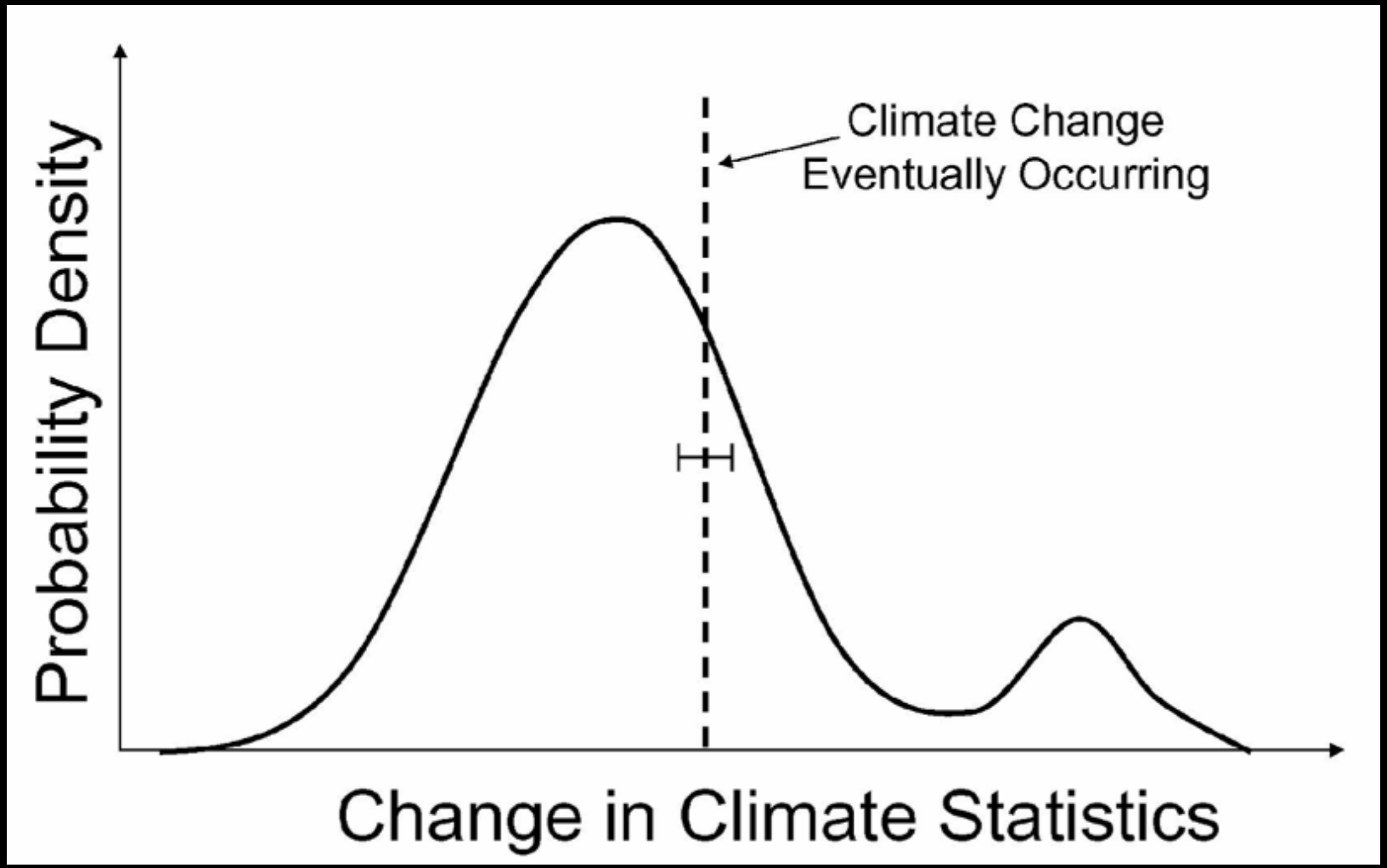


low high

climate sensitivity

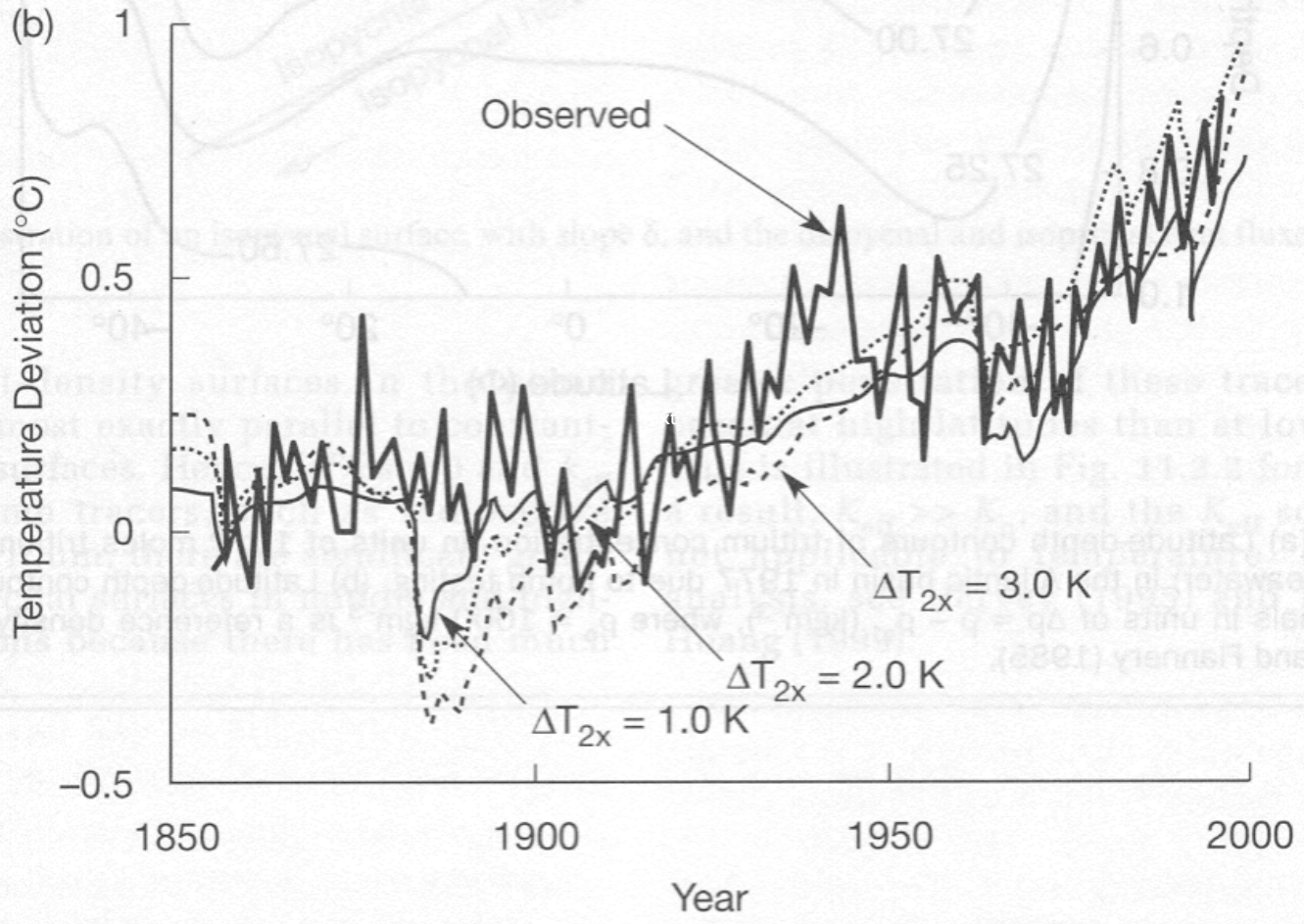


2.6°C



Giorgi. 2005 *Climatic Change*

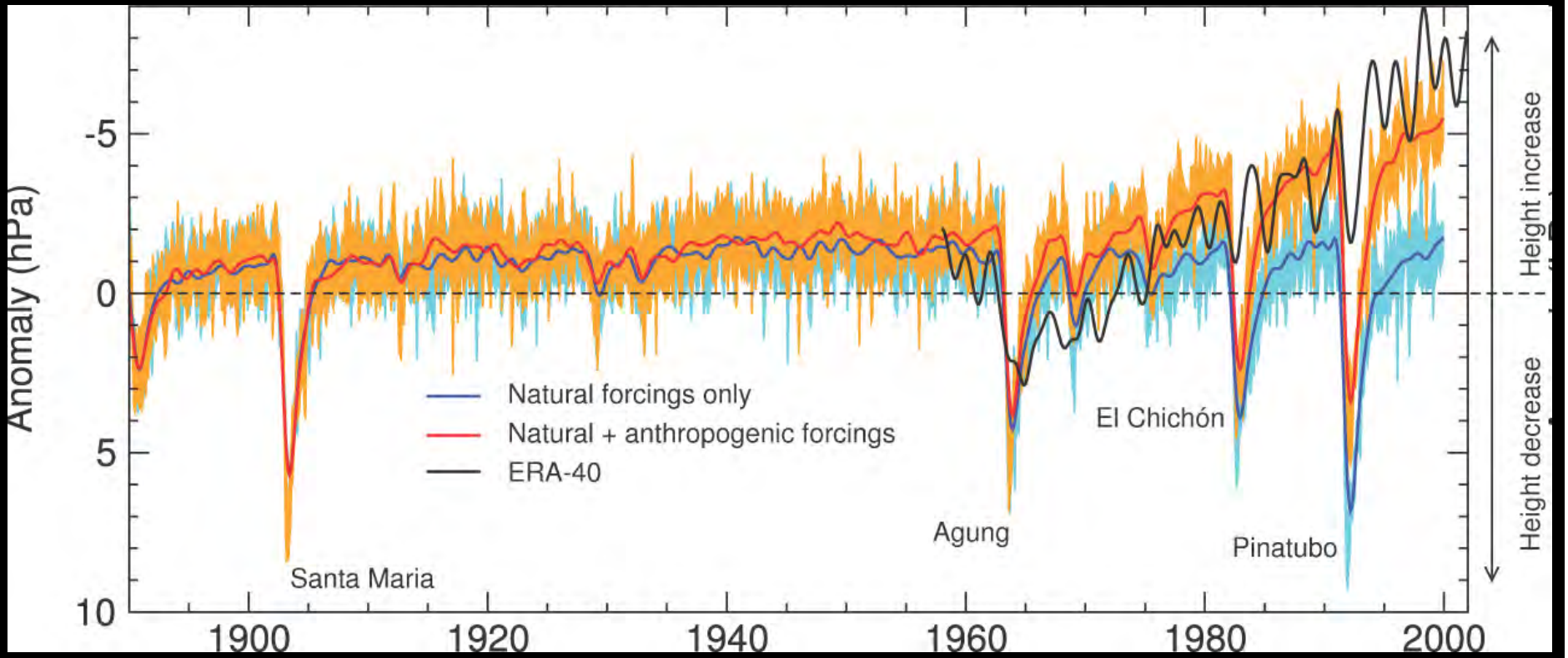
Large climate sensitivity → large aerosol cooling needed
greater warming diff. between NH & SH



Harvey, 2000

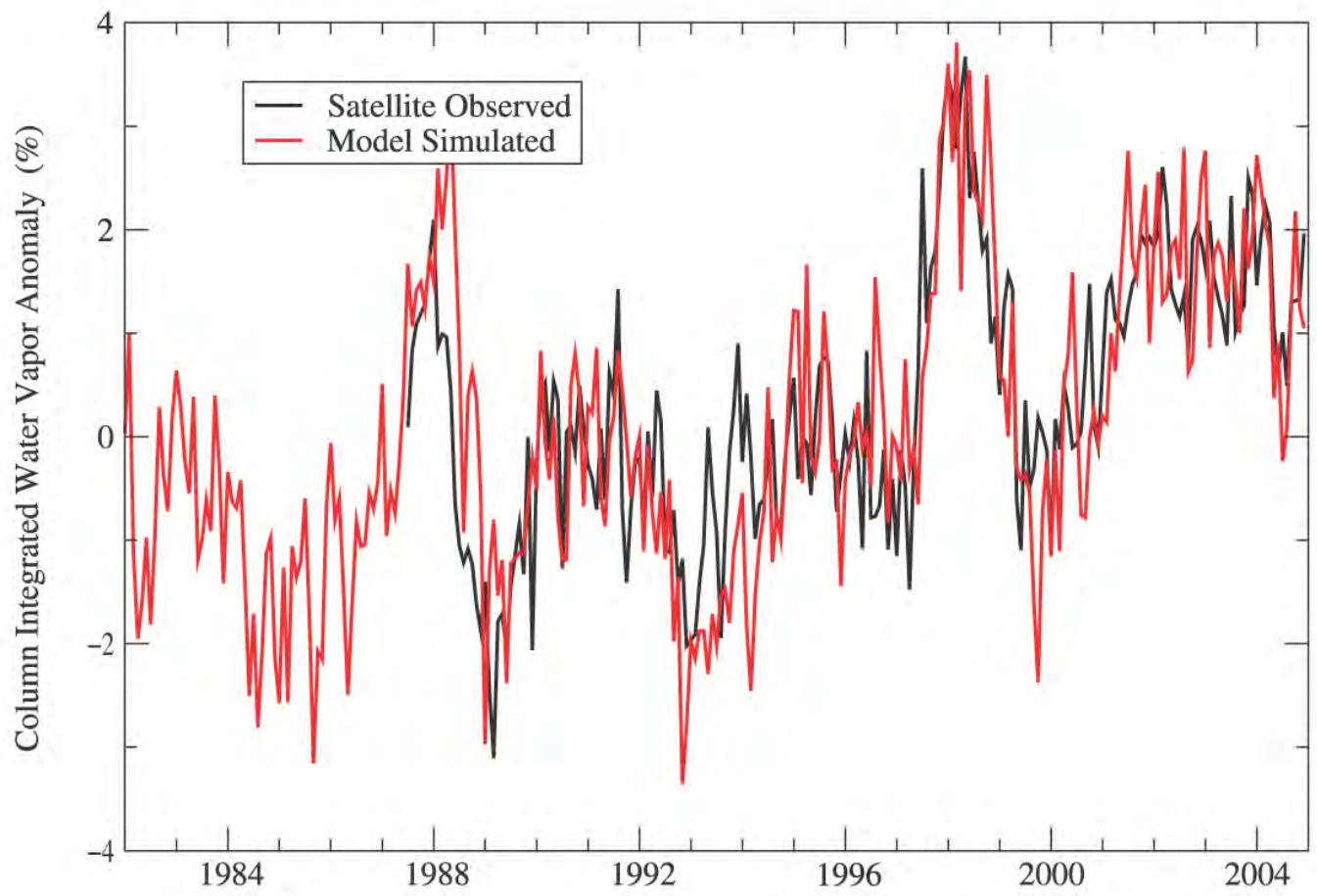
Fig. 11.19 Simulated variation in global mean surface air temperature from 1850 to 2000, and comparison with observations (to 1997), for the GHG, solar, and volcanic forcings given in Fig. 11.16, and using climate sensitivities of 1.0 K, 2.0 K, and 3.0 K for a CO_2 doubling. Results are given for (a) no aerosol cooling, and (b) aerosol coolings reaching 20%, 40%, and 60% of the 1990 GHG forcing by 1990 for climate sensitivities of 1.0 K, 2.0 K, and 3.0 K, respectively.

Tropopause height



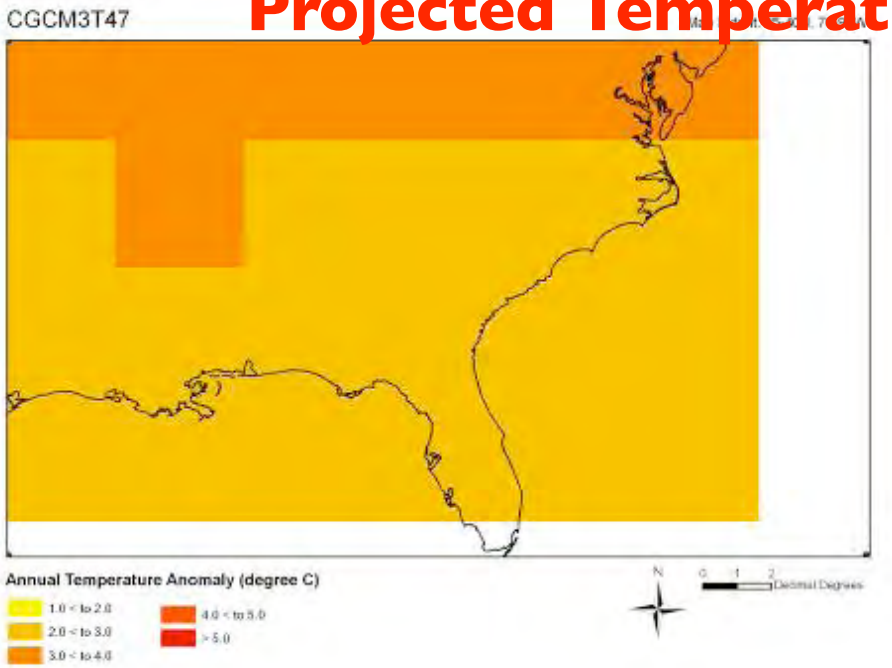
IPCC Fig. 9-4

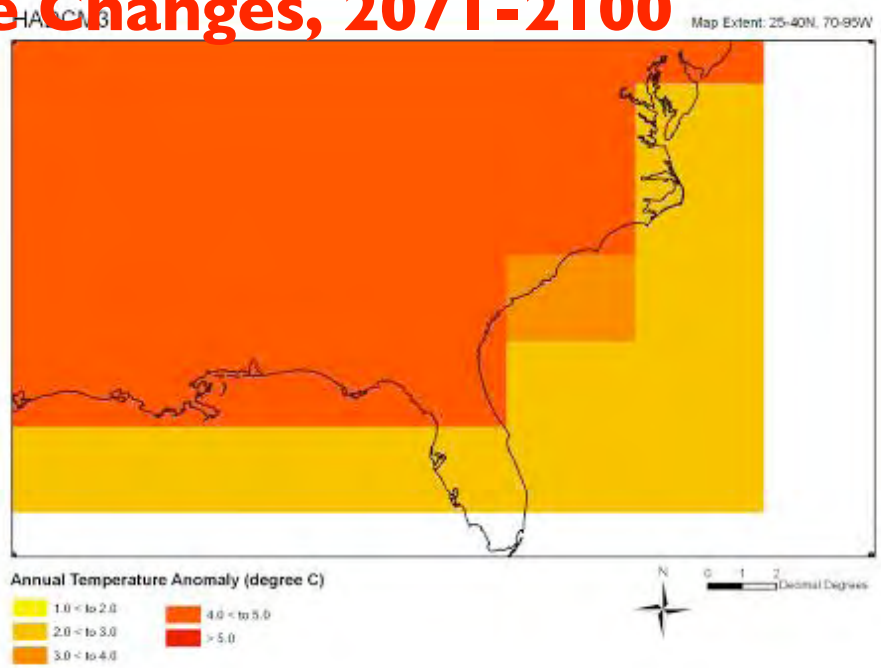
Column-integrated water vapor (SSMI vs. GFDL w/ obs. SSTs)

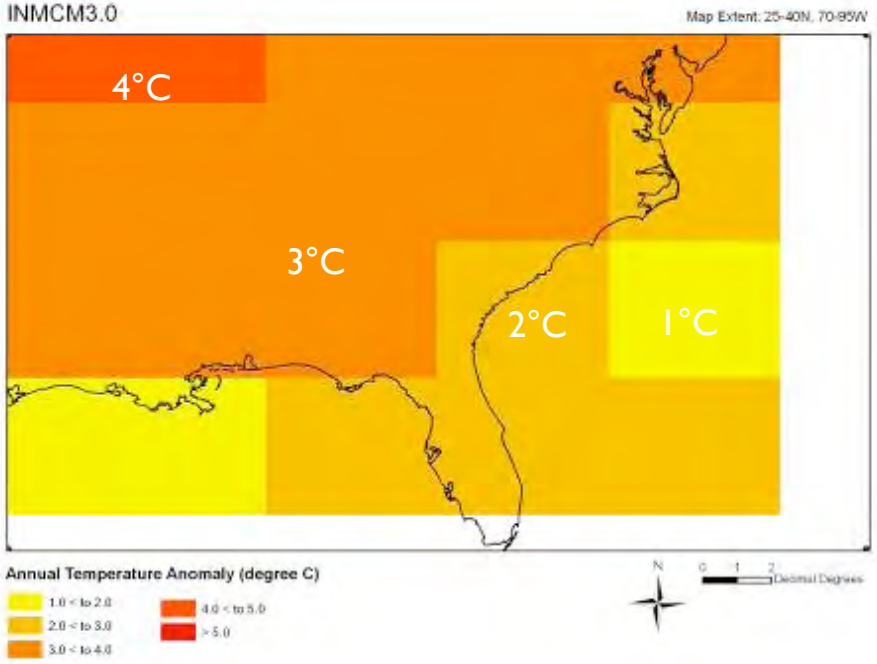


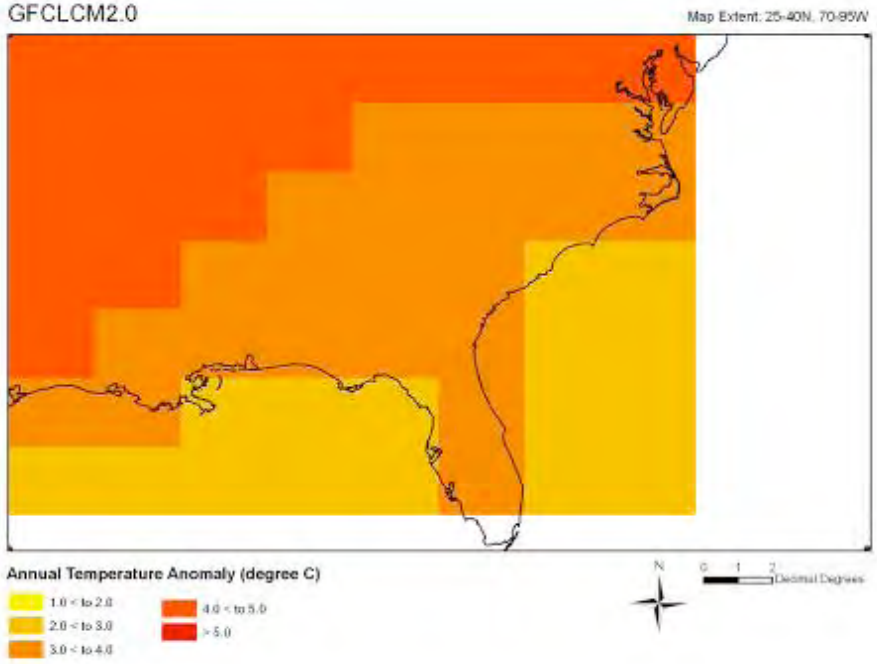
IPCC Fig. 9-17

Projected Temperature Changes, 2071-2100

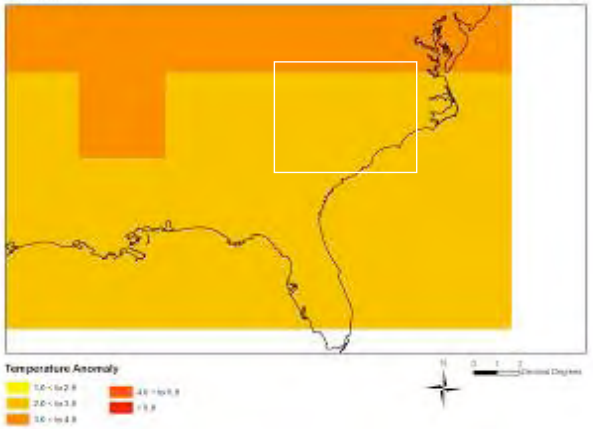




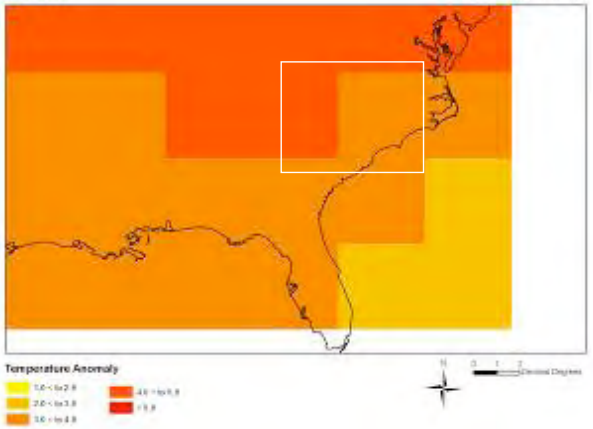




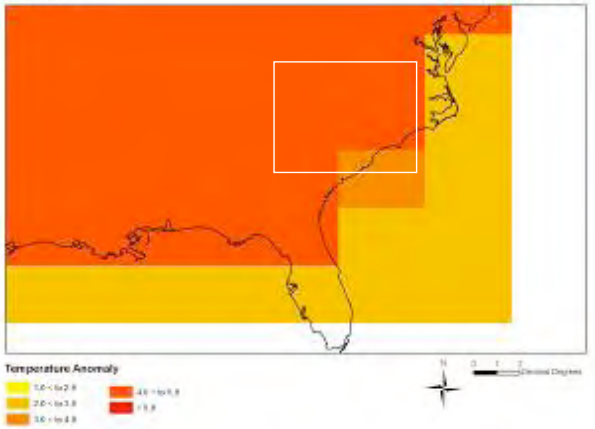
CGCM3T47



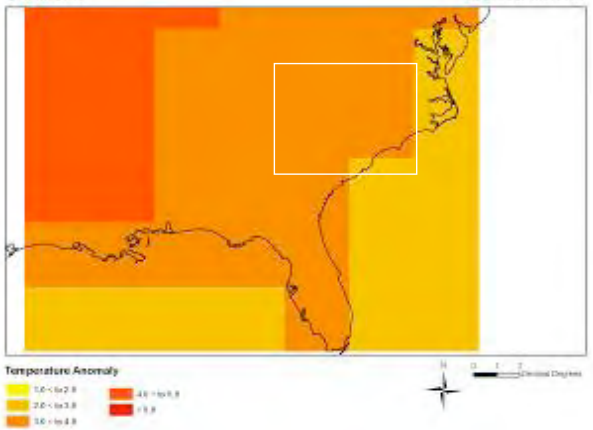
ECHO-G



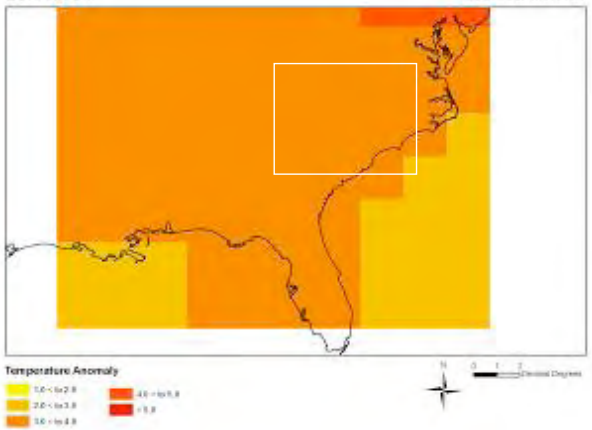
HADCM3



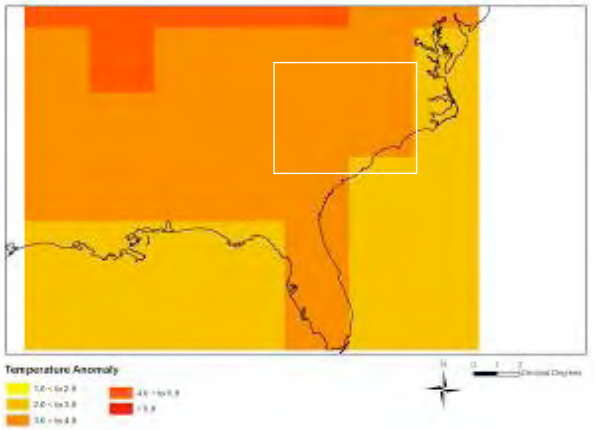
CNRMCM3



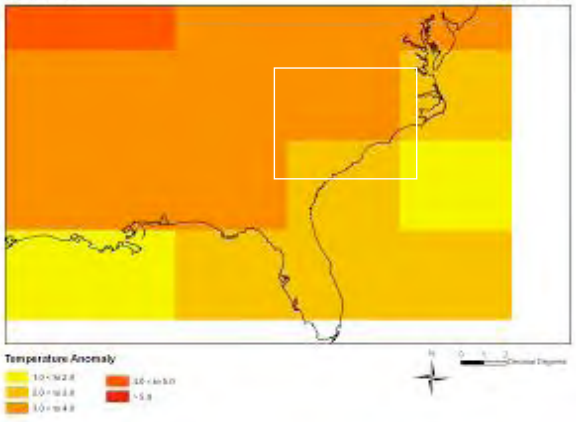
ECHAM5OM



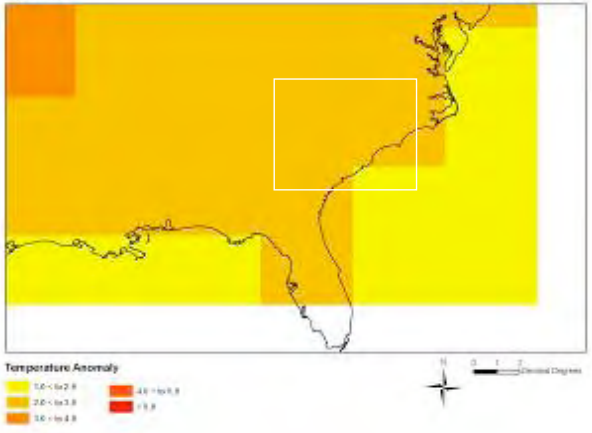
BCM2.0



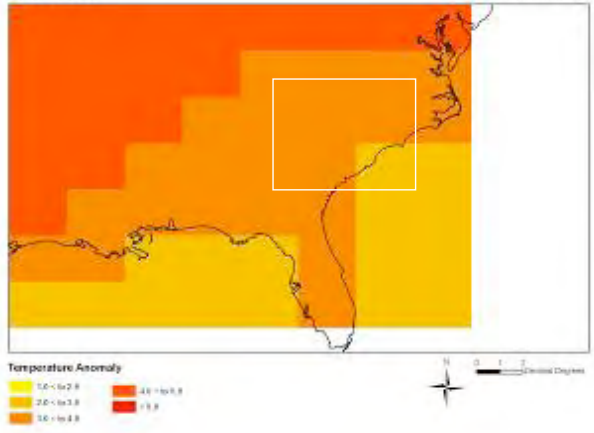
INMCM3.0



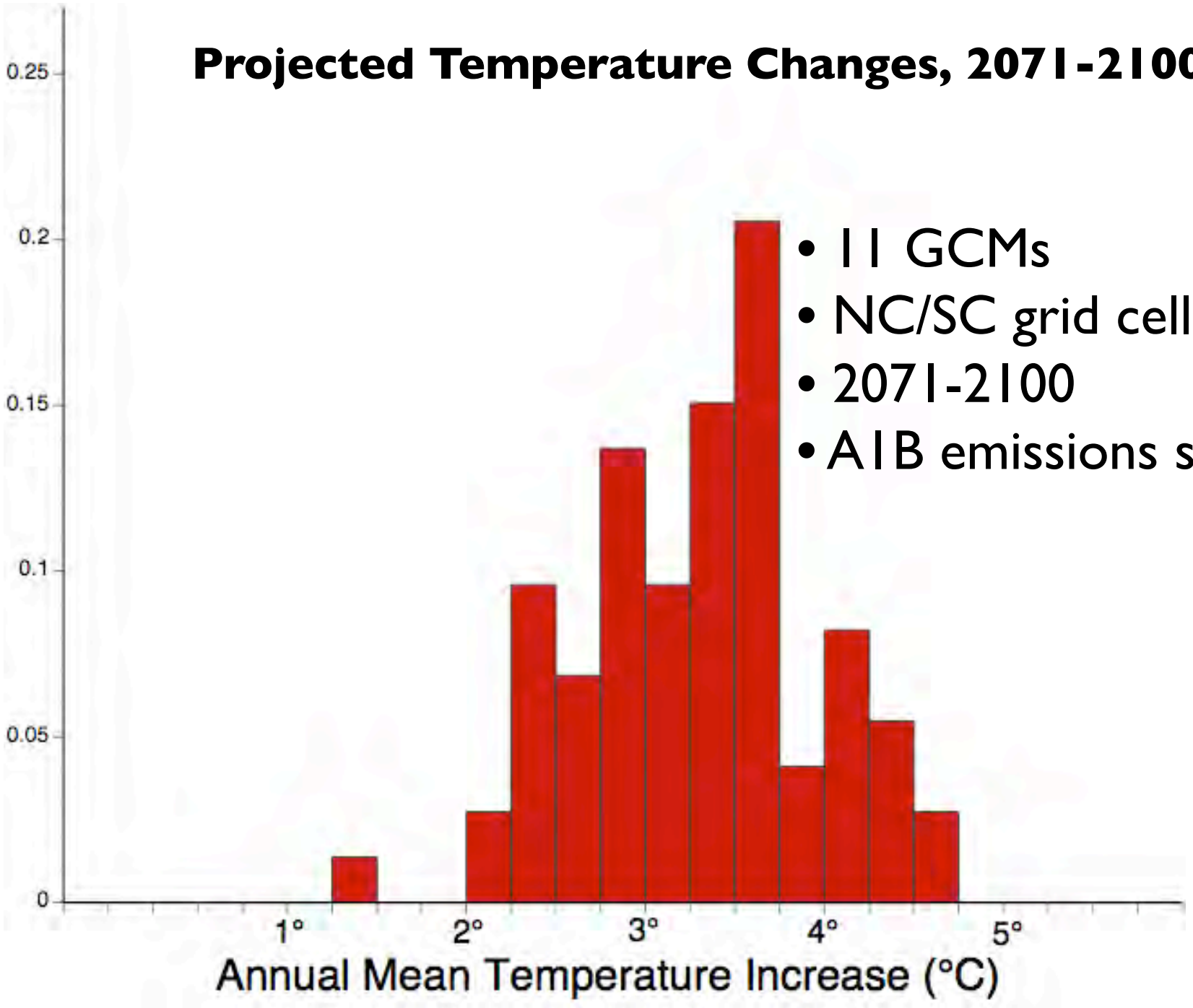
GISSAOM



GFDLCM2.0



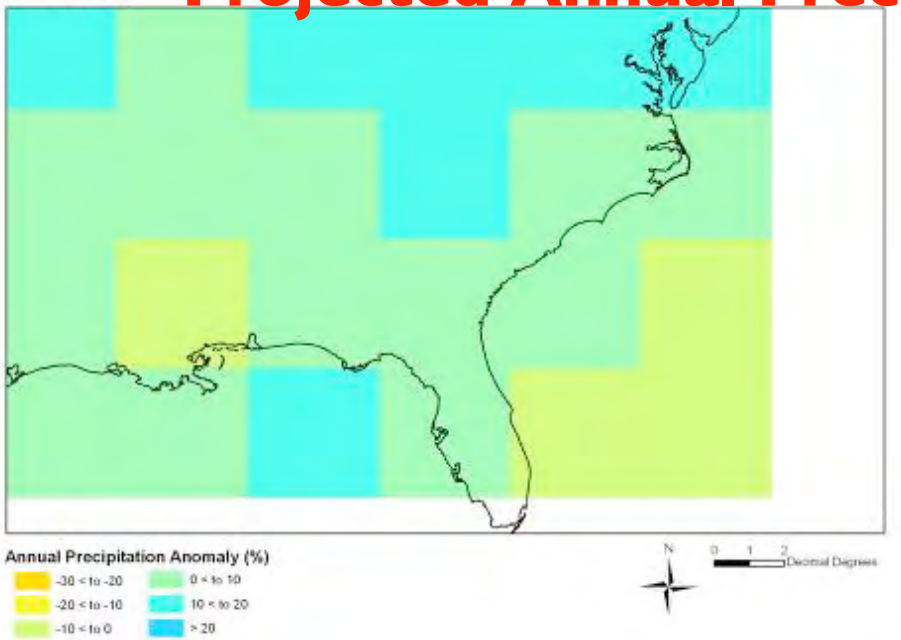
Projected Temperature Changes, 2071-2100

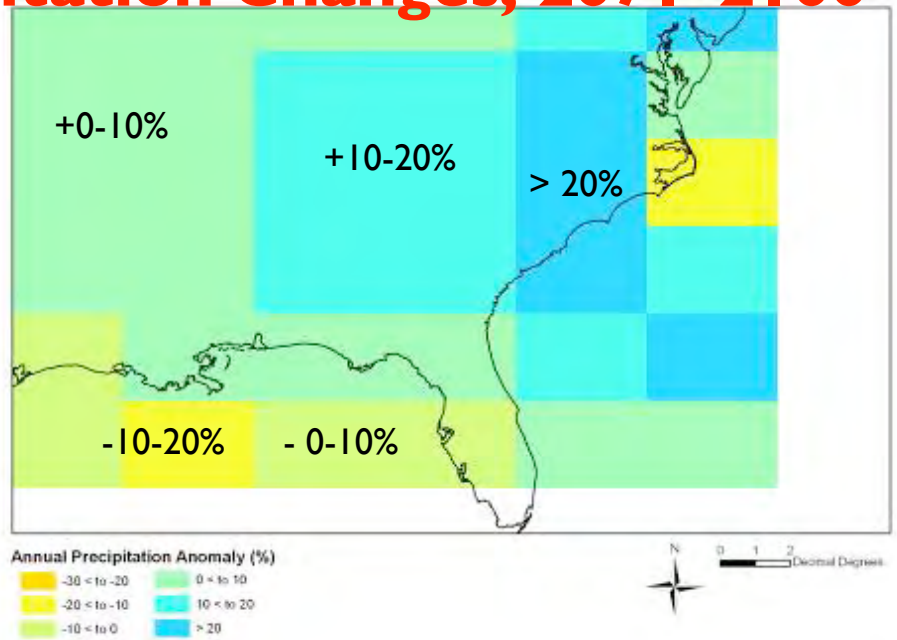


- 11 GCMs
- NC/SC grid cells
- 2071-2100
- A1B emissions scenario

Projected Annual Precipitation Changes, 2071-2100

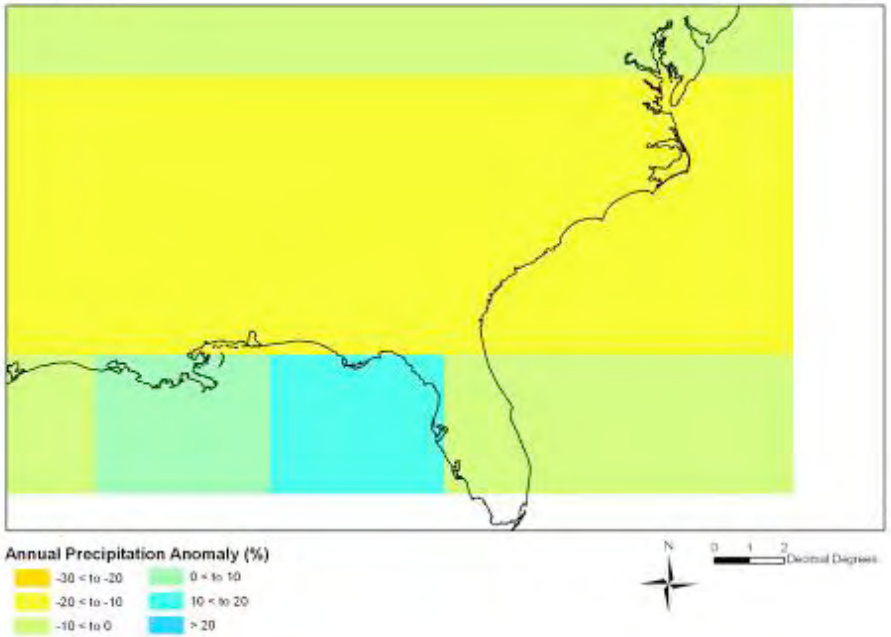
CGCM3T47





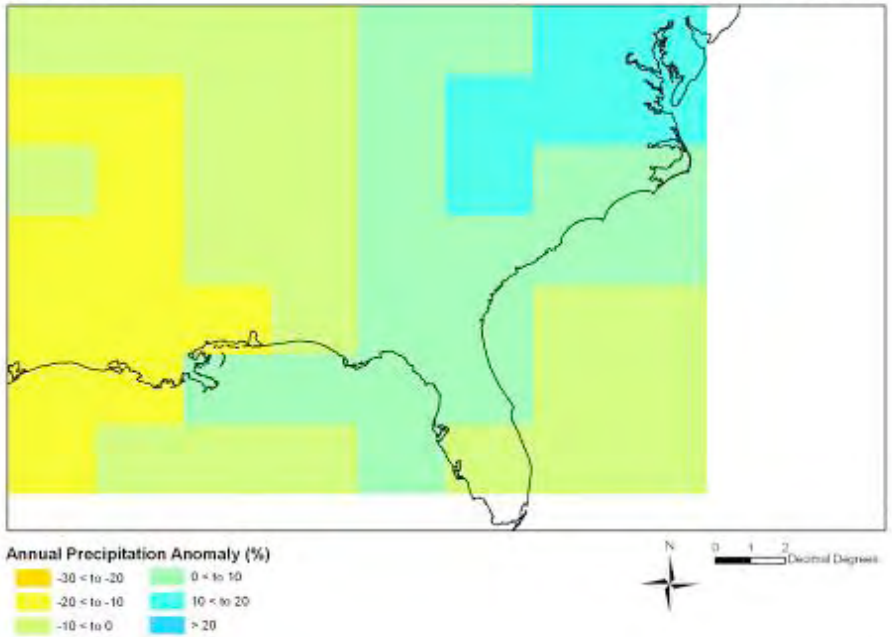
INMCM3.0

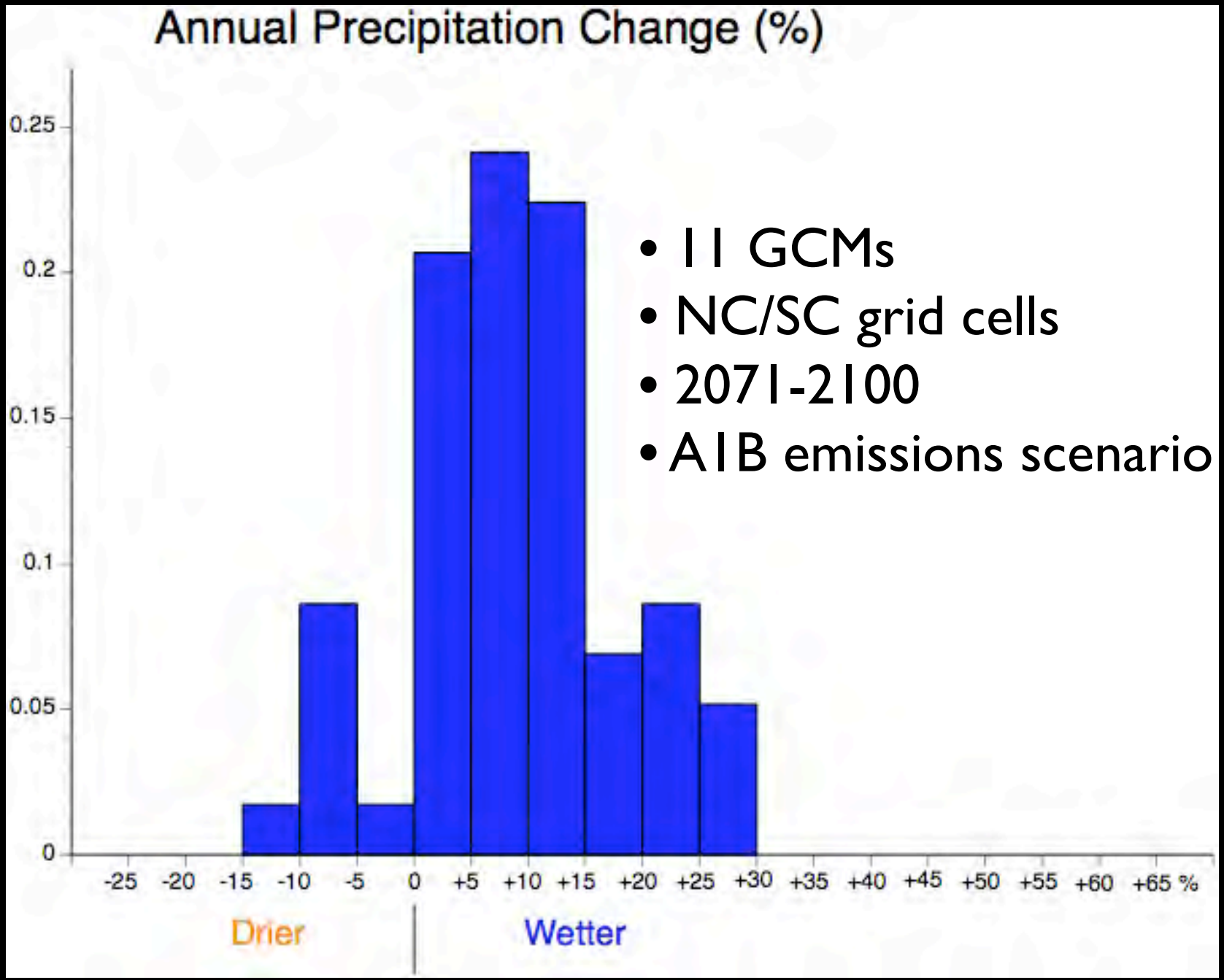
Map Extent: 25-40N, 70-95W



GFCLCM2.0

Map Extent: 25-40N, 70-95W





- 11 GCMs
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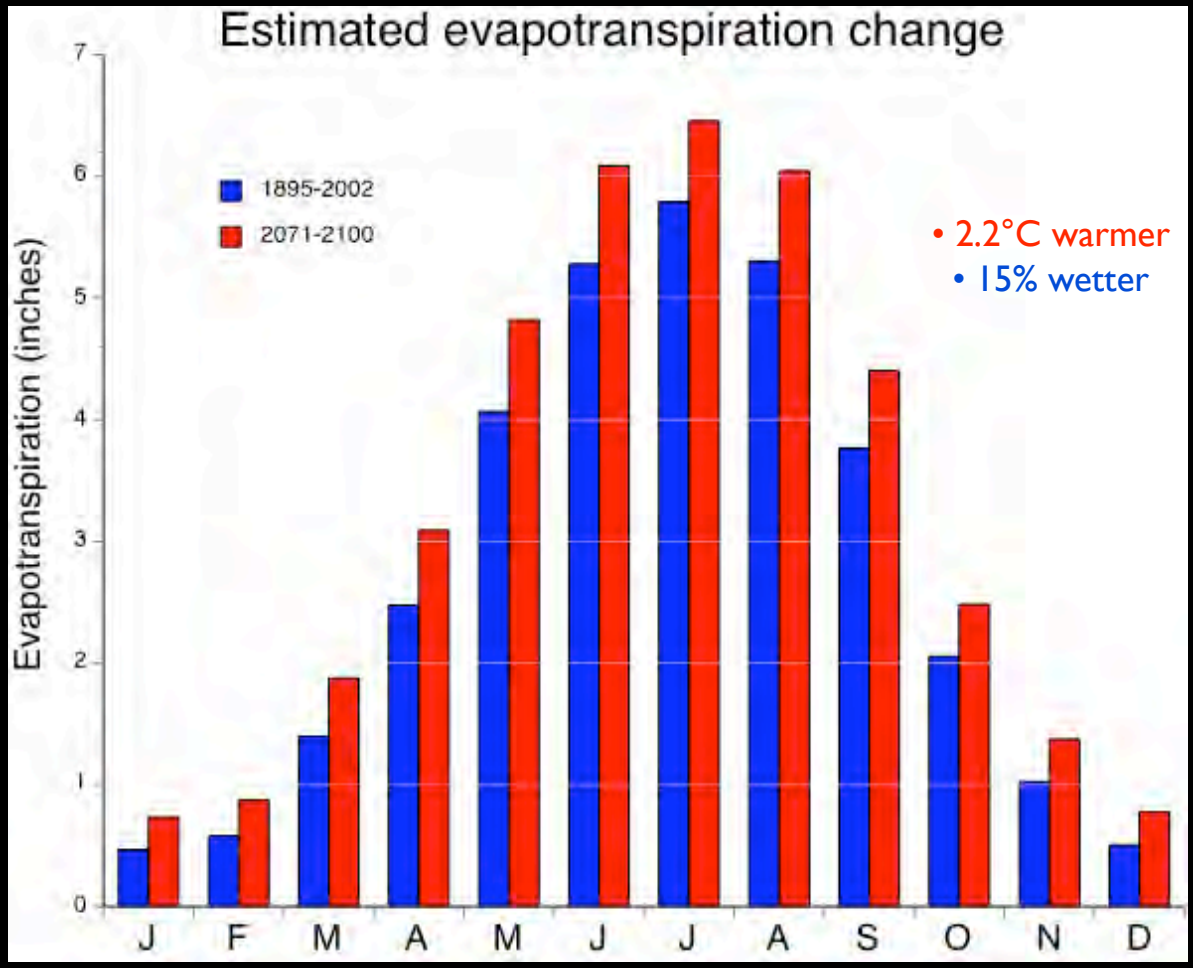
Estimated evapotranspiration change
Evapotranspiration (inches)
0
1
2
3
4
5
6
7
1895-2002
2071-2100
J
F
M
A
M
J
J
A
S
O
N
D
• 2.2°C warmer
• 15% wetter

The Southeast Coastal Climate Network is dedicated to fostering regional leadership in mitigating and adapting to the challenge of global warming.

The Network promotes protection of the Southeast's uniquely vulnerable coastal resources by increasing local, state, and national awareness of the threats and opportunities posed by global warming.

Interested in joining? Email Toni Reale at toni@cleanenergy.org