Coordinated climate change experiments to be assessed as part of the IPCC AR5

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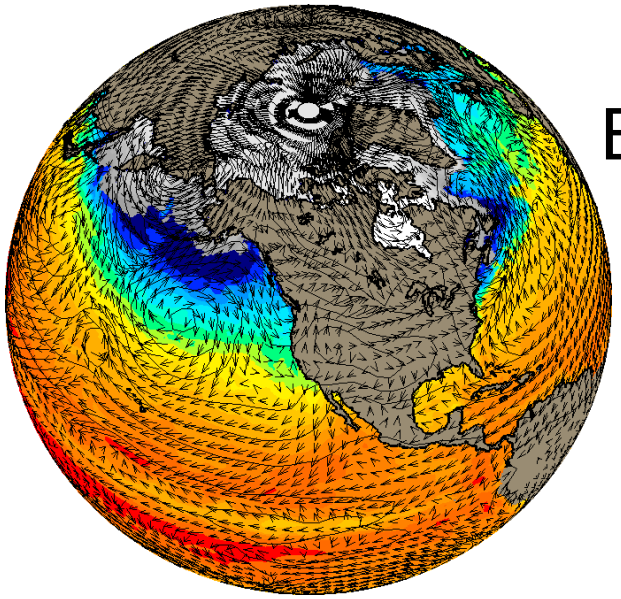


NCAR

Coordinated climate change experiments (formulated by WGCM and AIMES) to be run for assessment in IPCC AR5

Two classes of models to address two time frames and two sets of science questions:

1. Decadal prediction (2005-2030)

higher resolution (~50 km), no carbon cycle, some chemistry and aerosols, single scenario,

science question: *e.g.* regional extremes

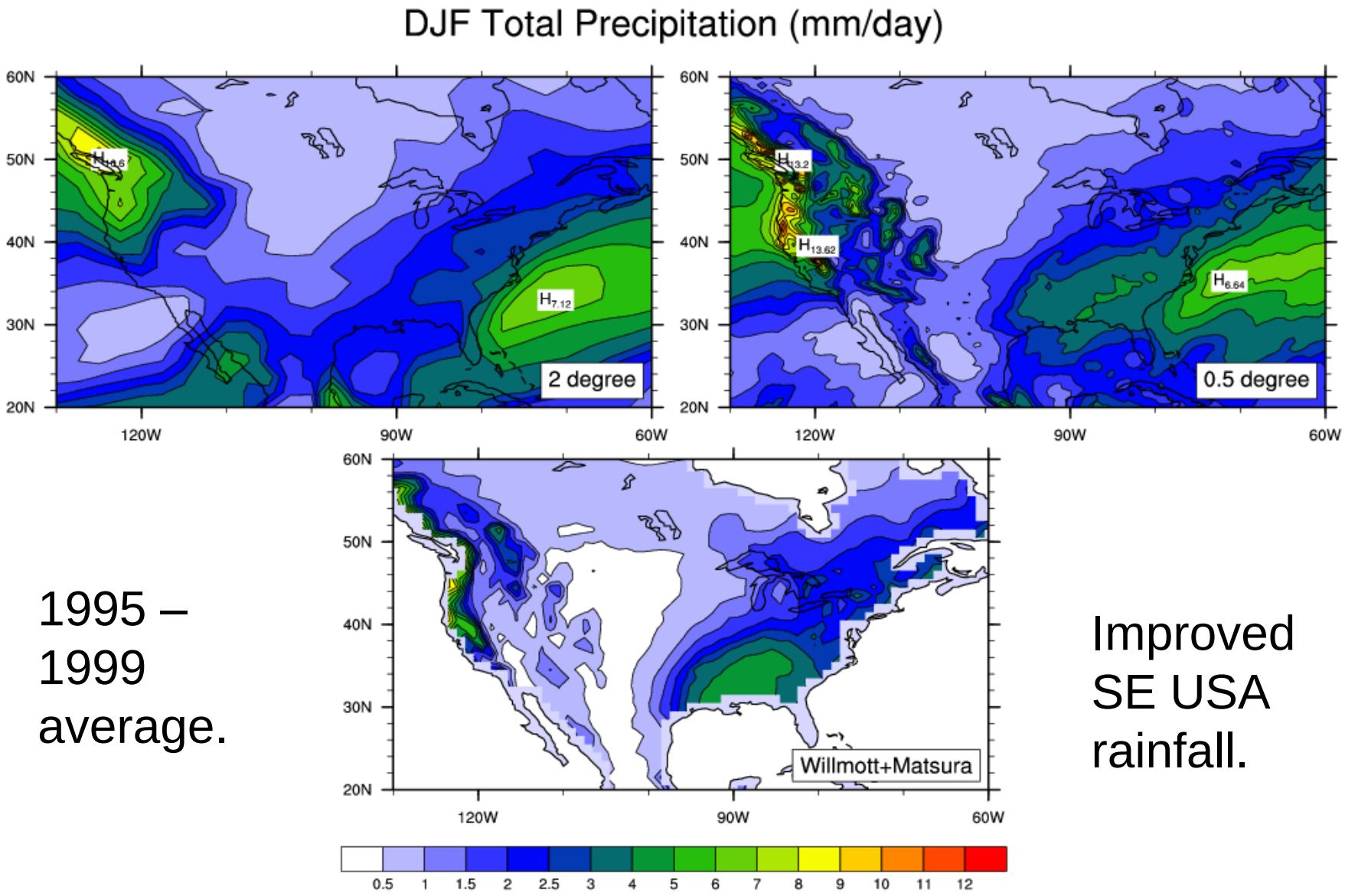
2. Longer term (to 2100 and beyond)

intermediate resolution (~200 km), carbon cycle, specified/ simple chemistry and aerosols, new mitigation scenarios: *"representative concentration pathways" (RCPs)*

science question: *e.g.* feedbacks

(Meehl and Hibbard, 2007; Hibbard et al., 2007)

Developmental version of CCSM3.5 (last 20 years of 20th century)



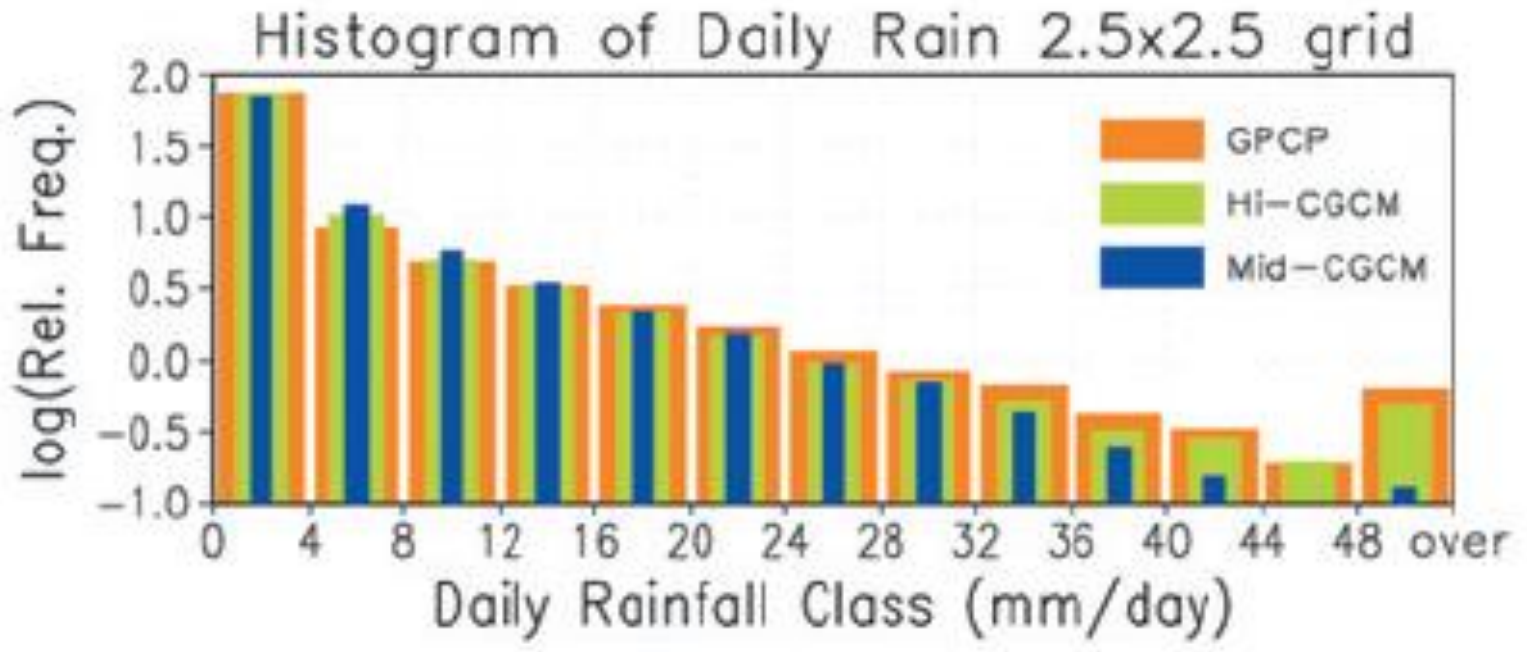
1995 – 1999 average.

Improved SE USA rainfall.

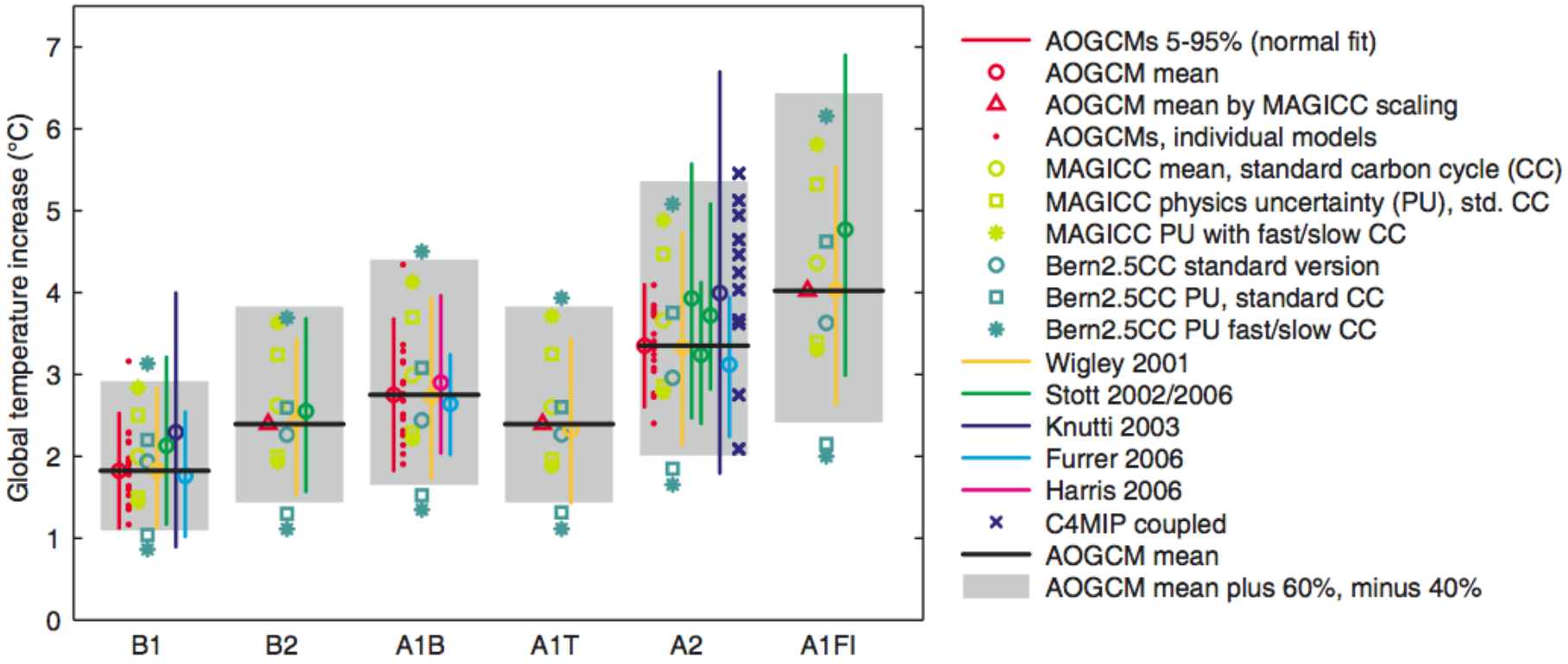
Need higher resolution to simulate extreme precipitation events

Hi-CGCM = T106 (~100 km)

Mid-CGDM = T42 (~240 km)



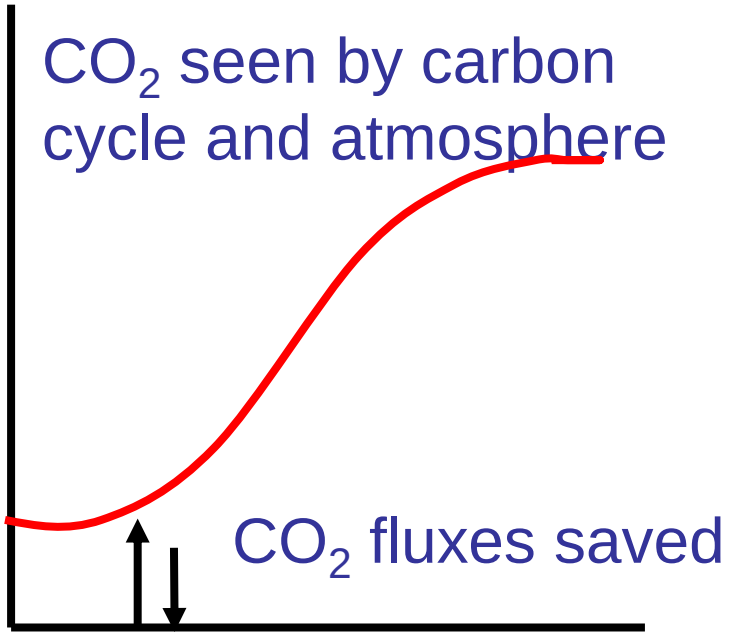
(Kimoto et al., 2005)

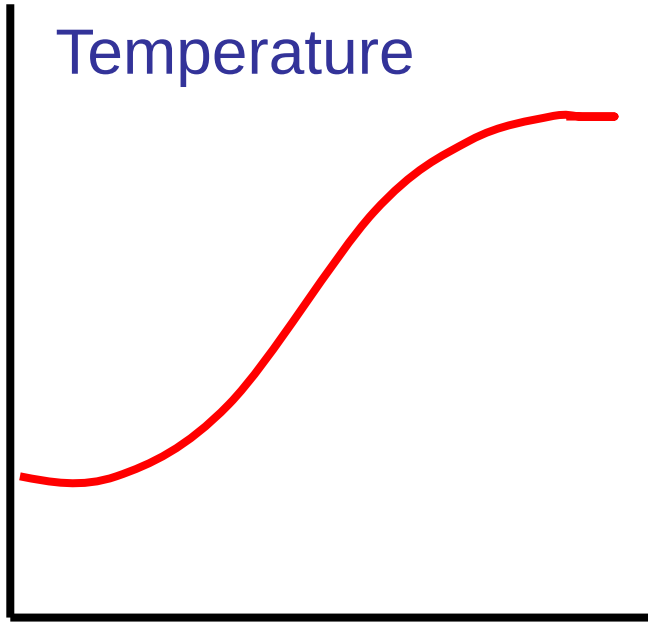


IPCC AR4 Fig. 10.29

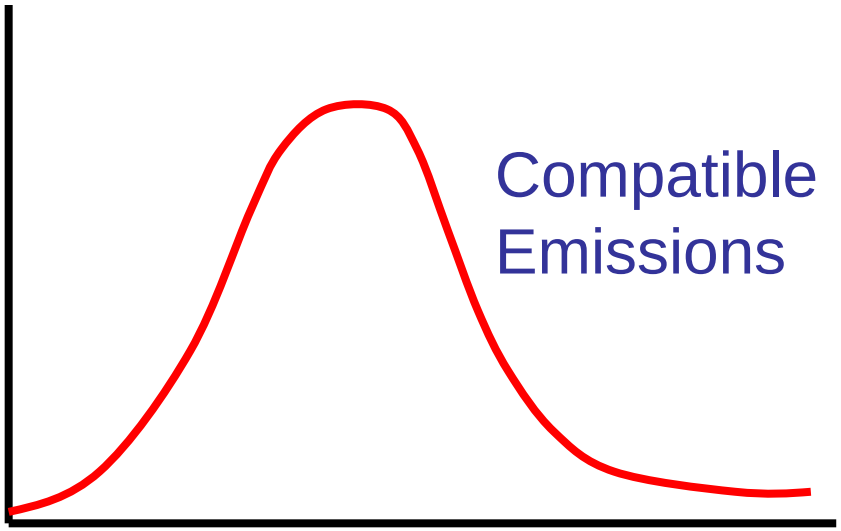
Greater uncertainty towards higher values due in part to uncertainty in the size and nature of the carbon cycle feedback

Expt #1: Diagnose climate and carbon cycle feedbacks





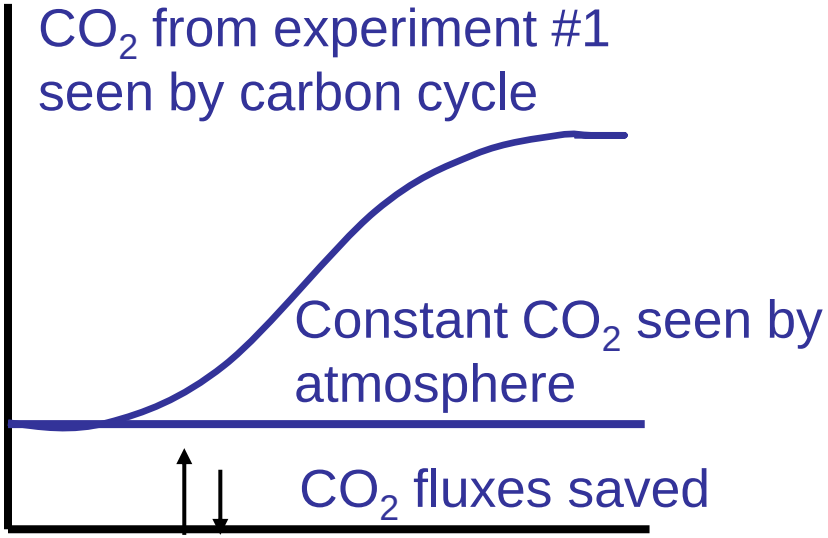
emissions = CO2 flux + CO2 concentrations

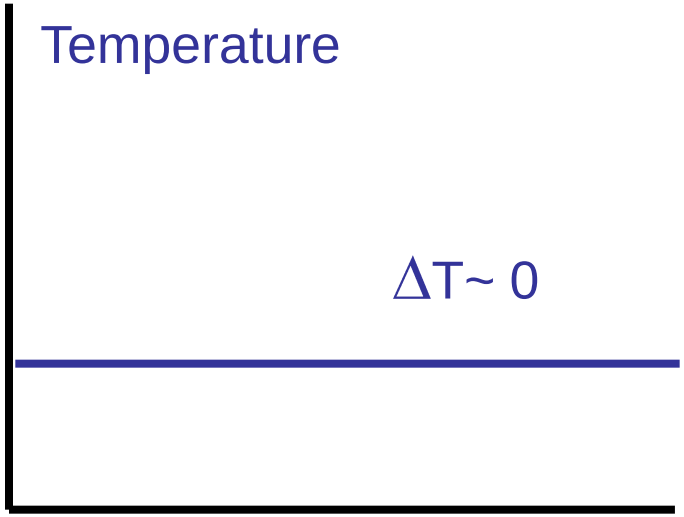


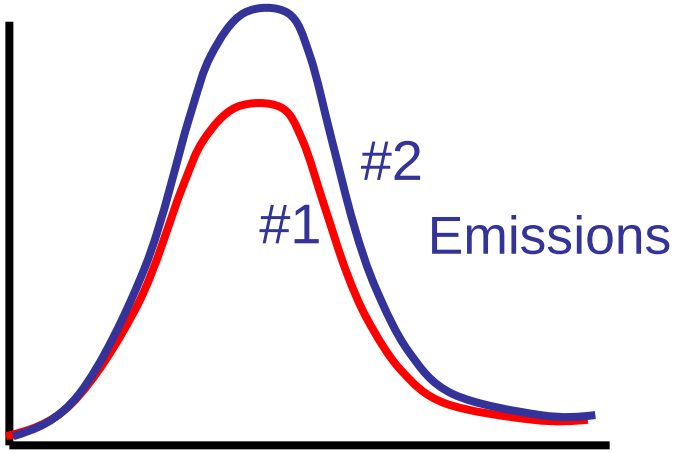
Expt #2: Carbon cycle response with no climate change

Climate change (AOGCM or ESM)

Carbon cycle and compatible emissions (ESM or offline carbon cycle model)



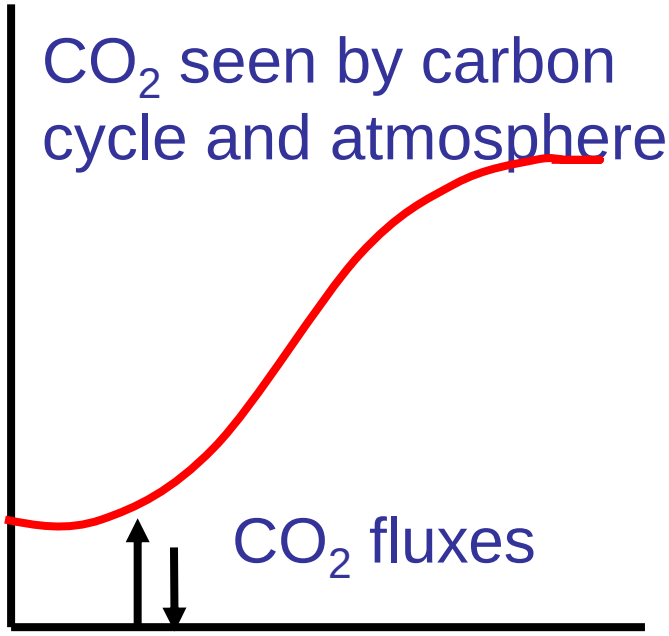


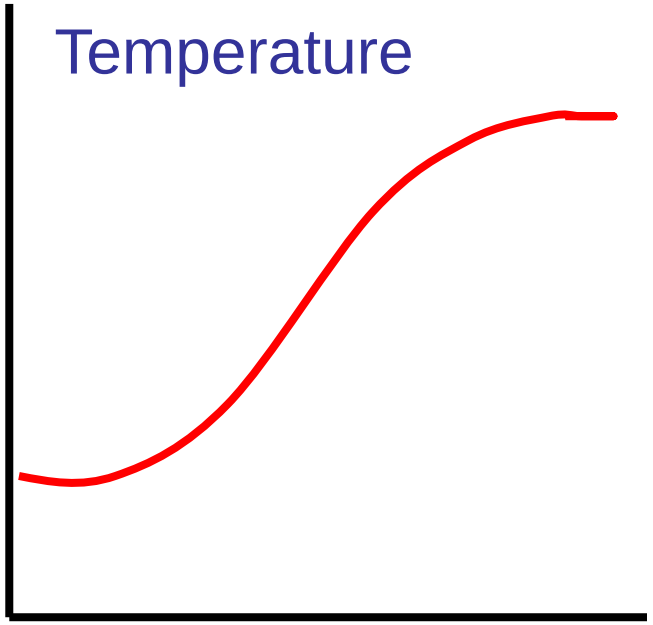


#2 - #1 = effect of climate feedbacks on compatible emissions

Expt #3: Fully coupled ESM climate change projection

Use emissions from RCP scenario, calculate fully coupled climate system response, compare temperature change to experiment 1 to determine size of carbon cycle feedback in terms of climate change





CCWG recommendations:

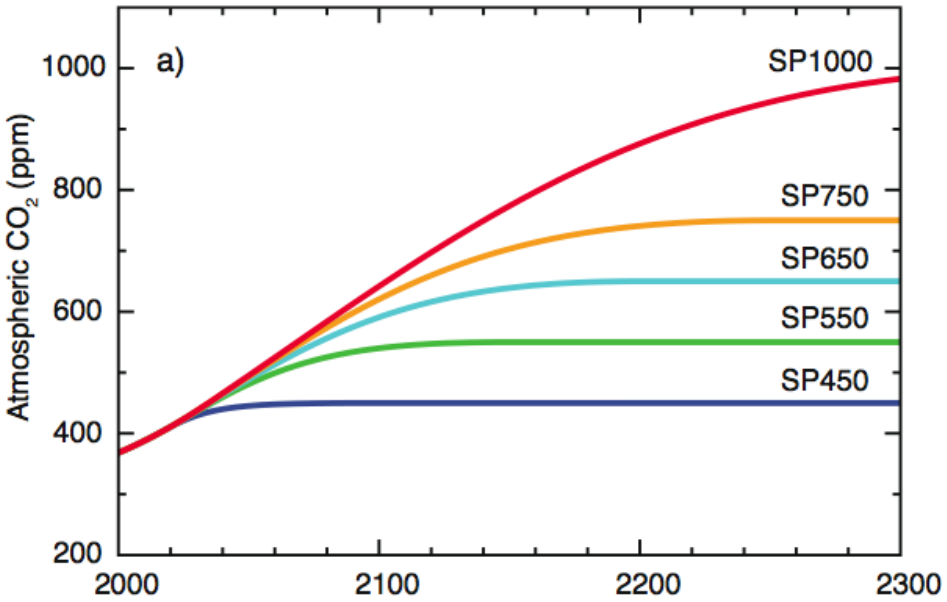
1. 0.5 degree AOGCM version for decadal prediction experiments
2. 2 x 2.5 degree ESM for long term experiments

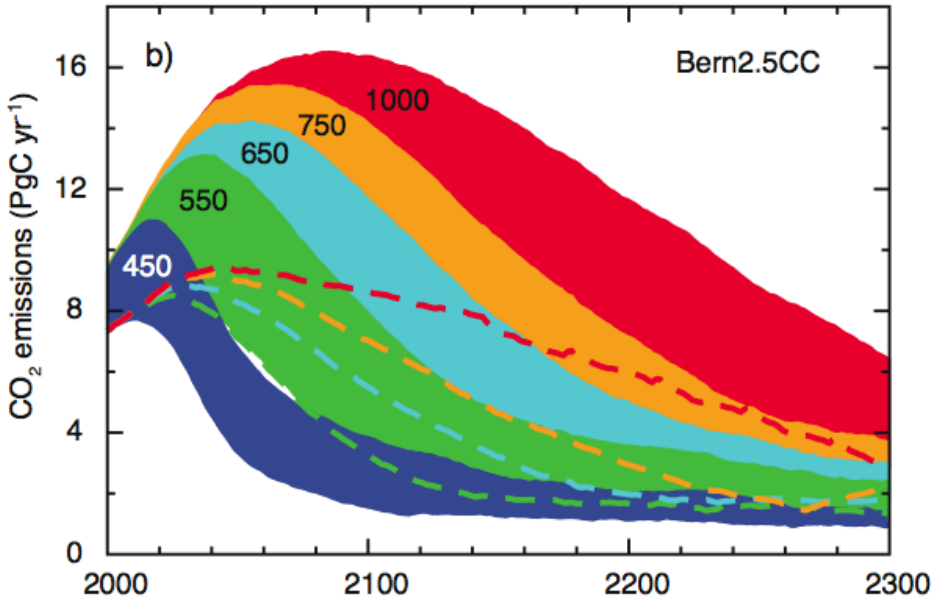
Next: Mitigation/adaptation

New mitigation scenarios run with earth system models will have implicit policy actions to target future levels of climate change

But we can only mitigate part of the problem, and we will have to adapt to the remaining climate change

The challenge: use climate models to quantify time-evolving regional climate changes to which human societies will have to adapt





KAKUSHIN: Global Warming Experiment on the Earth Simulator

(MRI; Kanada et al)

Prediction of ocean and atmosphere by AOGCM

270km-AOGCM

Time slice experiments

20km-AGCM

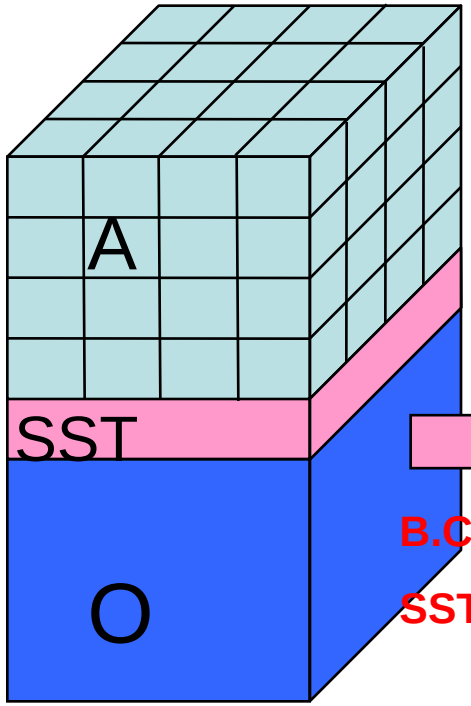
Prediction of regional climate by one-way nested NHM

Prediction of regional climate by one-way nested NHM

Regional Climate Model

5km-NHM

1km-NHM

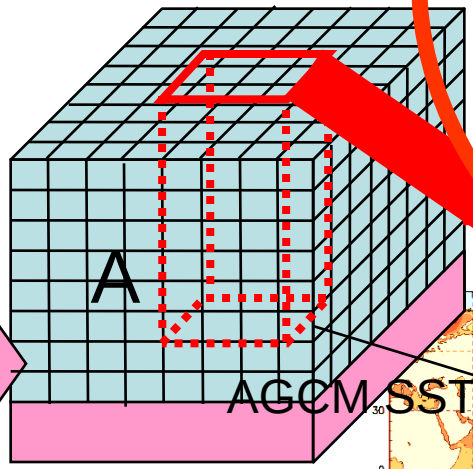


B.C.

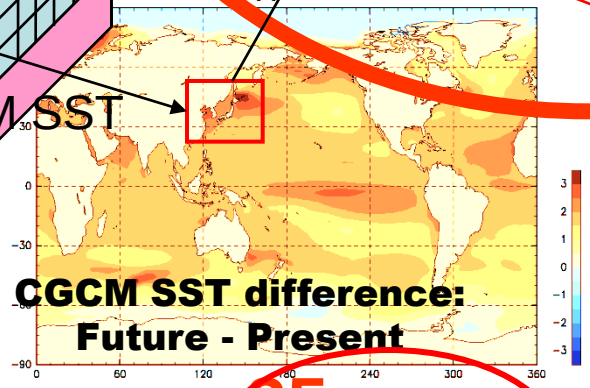
SST

200-50km-OGCM

Nested in the 20km-AGCM



AGCM SST

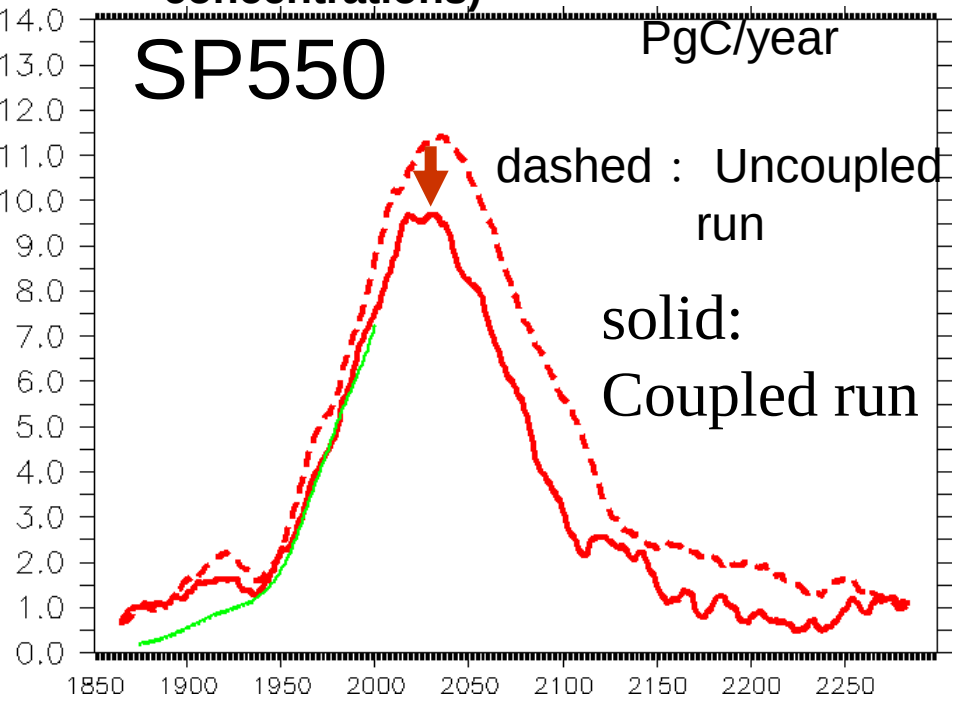


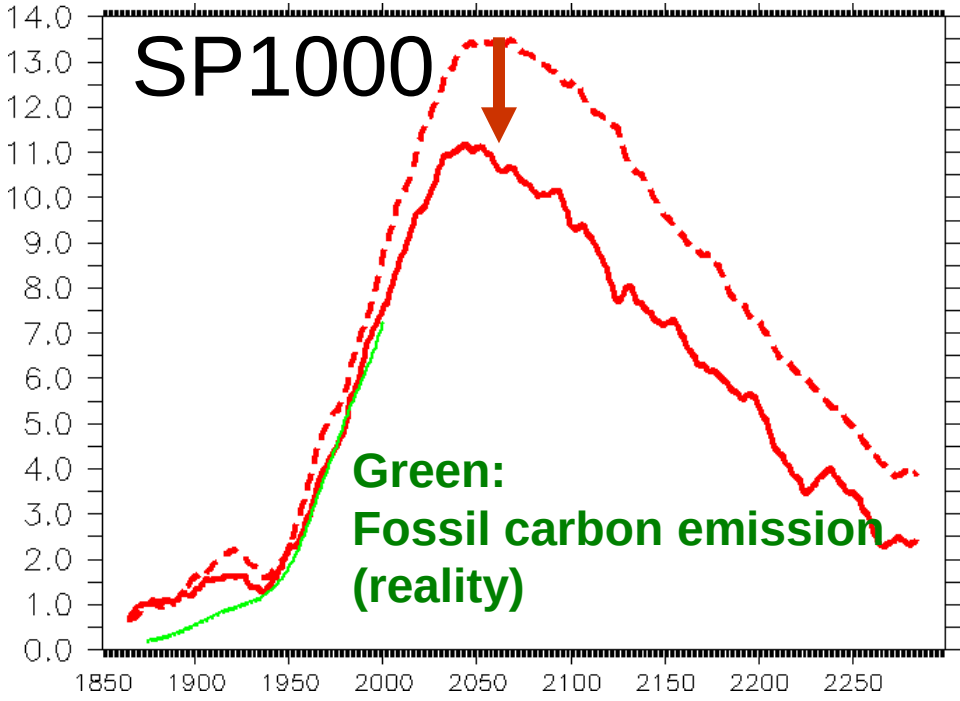
From June to Oct. for each climate.

Permissible Emission = $\frac{d}{dt}$(CO2 in air)
+ Ocean/Land Uptake

"coupled" = climate and carbon cycle respond to increasing concentrations

"uncoupled" = only carbon cycle responds (climate doesn't see increasing concentrations)





Stabilization at SP550 requires a cumulative 24% reduction of permissible emissions due to positive carbon cycle feedback (23% for SP1000)

MIROC integrated earth system model (Kawamiya et al.)