Climate change results from the CMIP5 experiments and science context for future plans of the CCWG

Climate Change Working Group co-chairs:
Gerald A. Meehl, Warren Washington,
Karl Taylor

Results from CMIP5 simulations with CCSM4 and CESM1/CAM5

Science questions related to planned simulations:

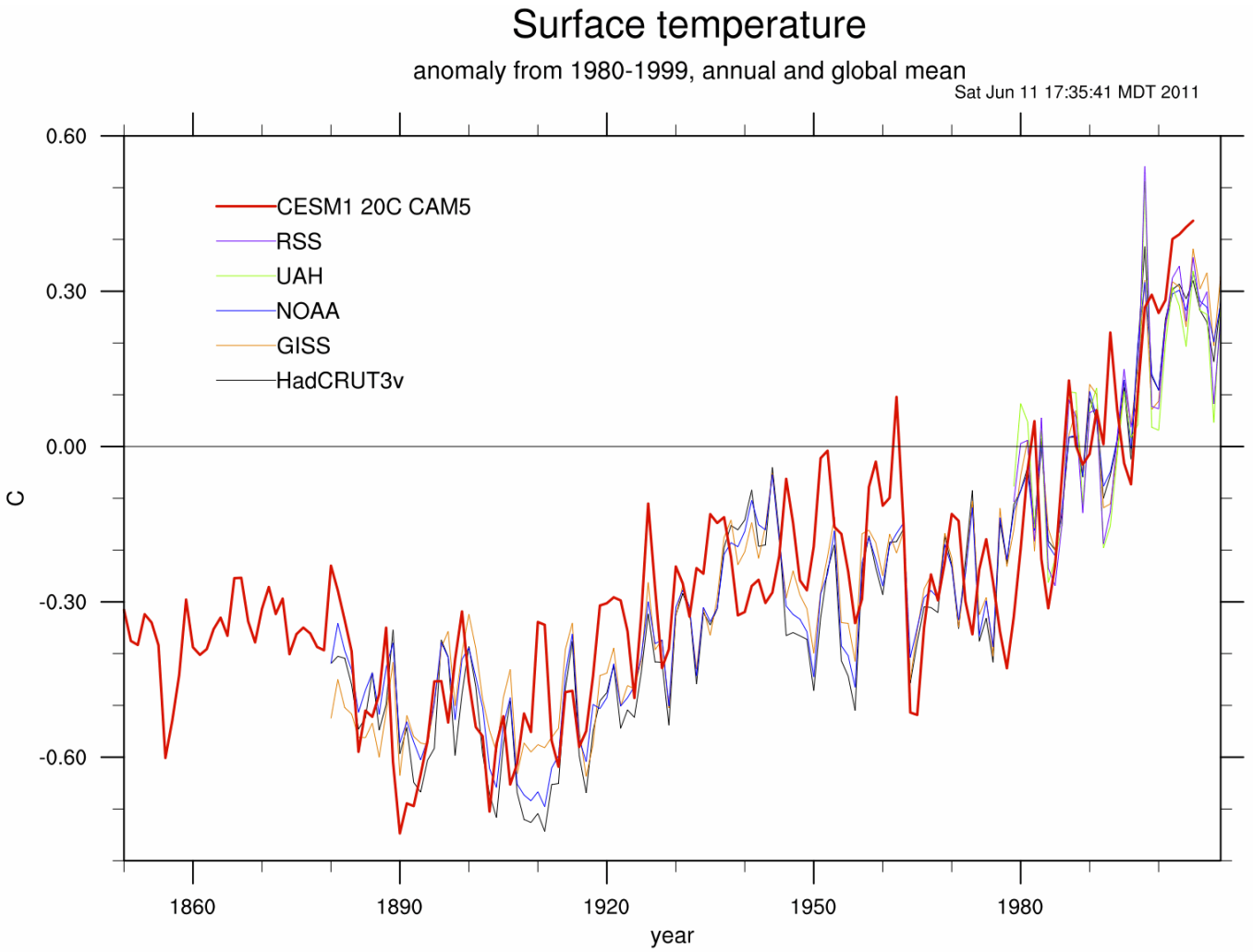
High resolution: What will be the future number and intensity of hurricanes? How will future regional precipitation extremes change?

Decadal prediction: What will be the time evolution of regional climate over the next few decades?

Geo-engineering: What are the effects on the climate system, intended and unintended, of either solar management or sulfate injection?

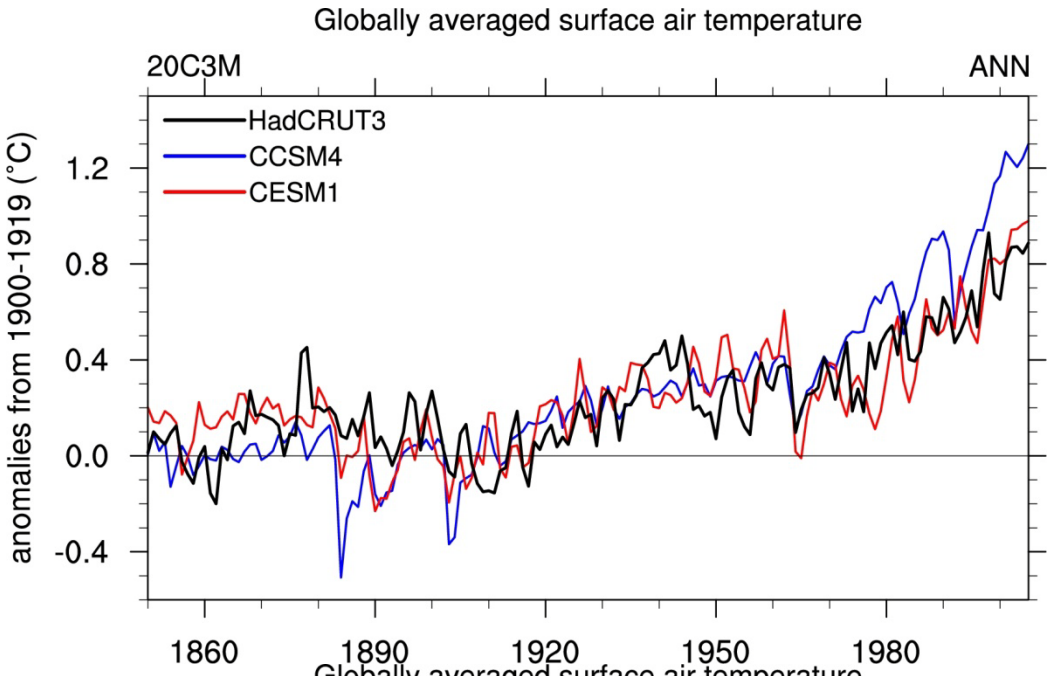
Biogeochemistry (with BGCWG): What is the size and nature of carbon cycle feedback?

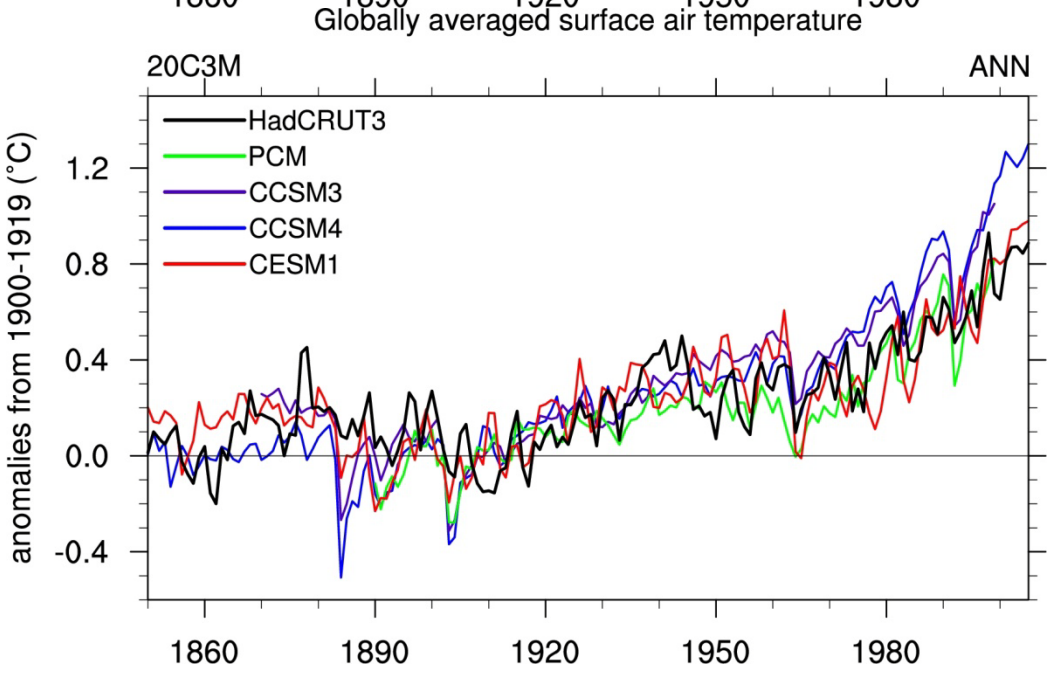
Sea level rise (with LIWG): How much and how fast will sea level rise?



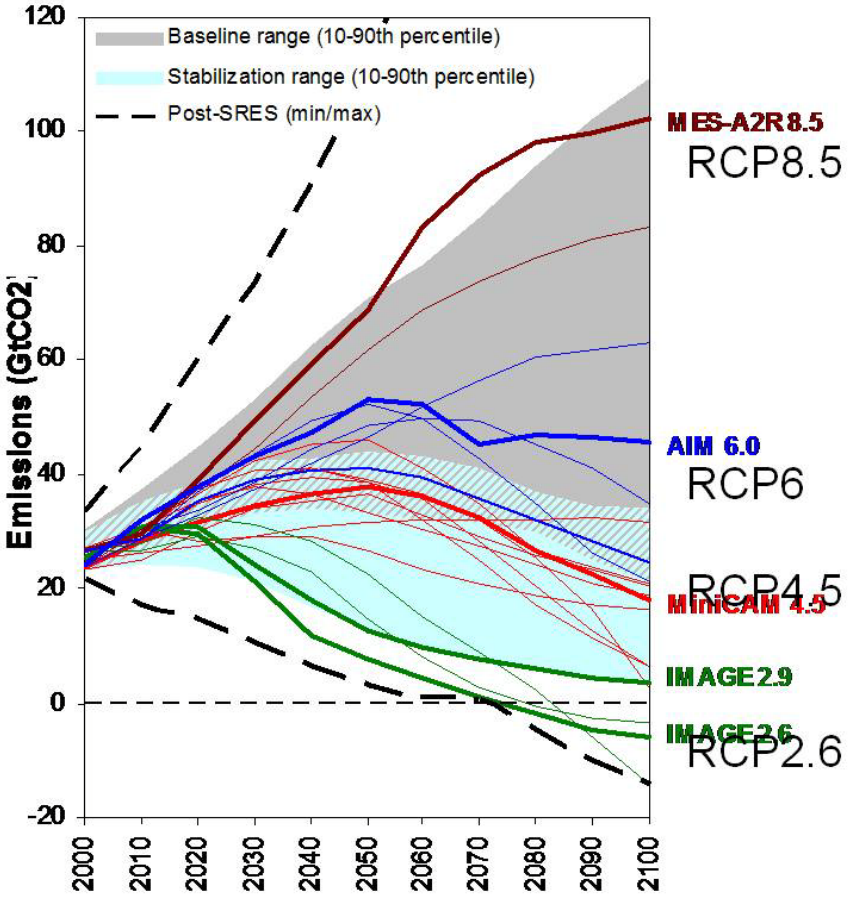
CESM1-CAM5 1-degree * FV with CN on and prognostic aerosols - Control done, some 20th-century runs done - Another 20th planned, RCPs planned *

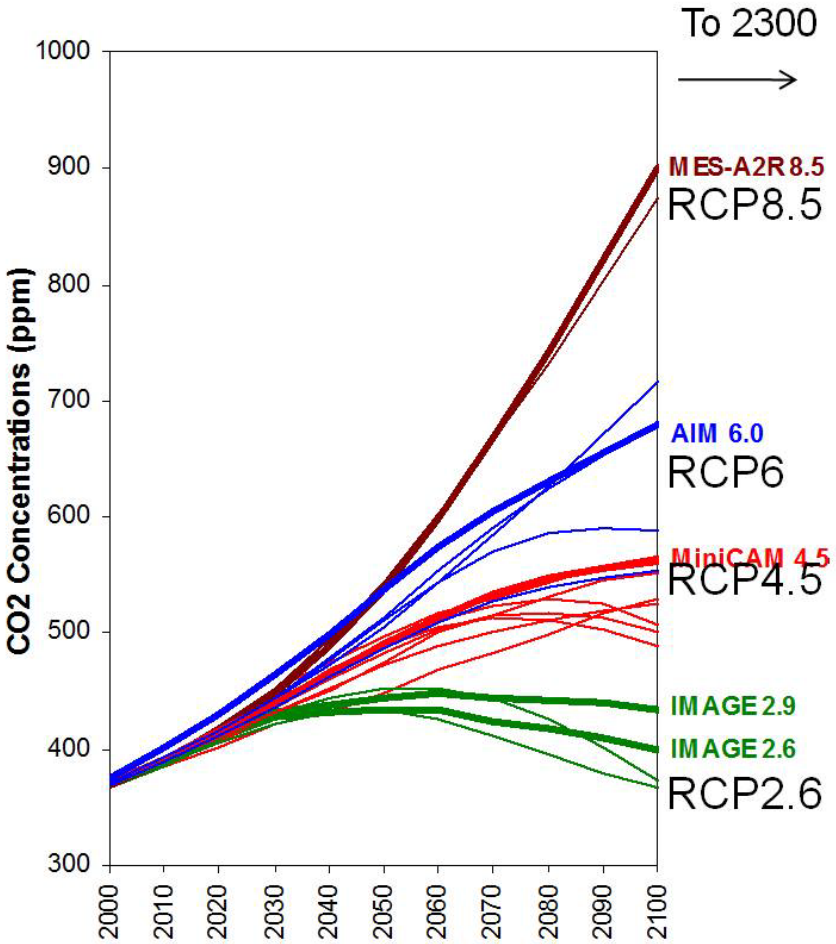
CCSM4 1-degree single forcing runs for 20th and RCPs; black carbon sensitivity experiments


Globally averaged surface air temperature
20C3M
ANN
HadCRUT3
CCSM4
CESM1
anomalies from 1900-1919 (°C)
1.2
0.8
0.4
0.0
-0.4
1860
1890
1920
1950
1980

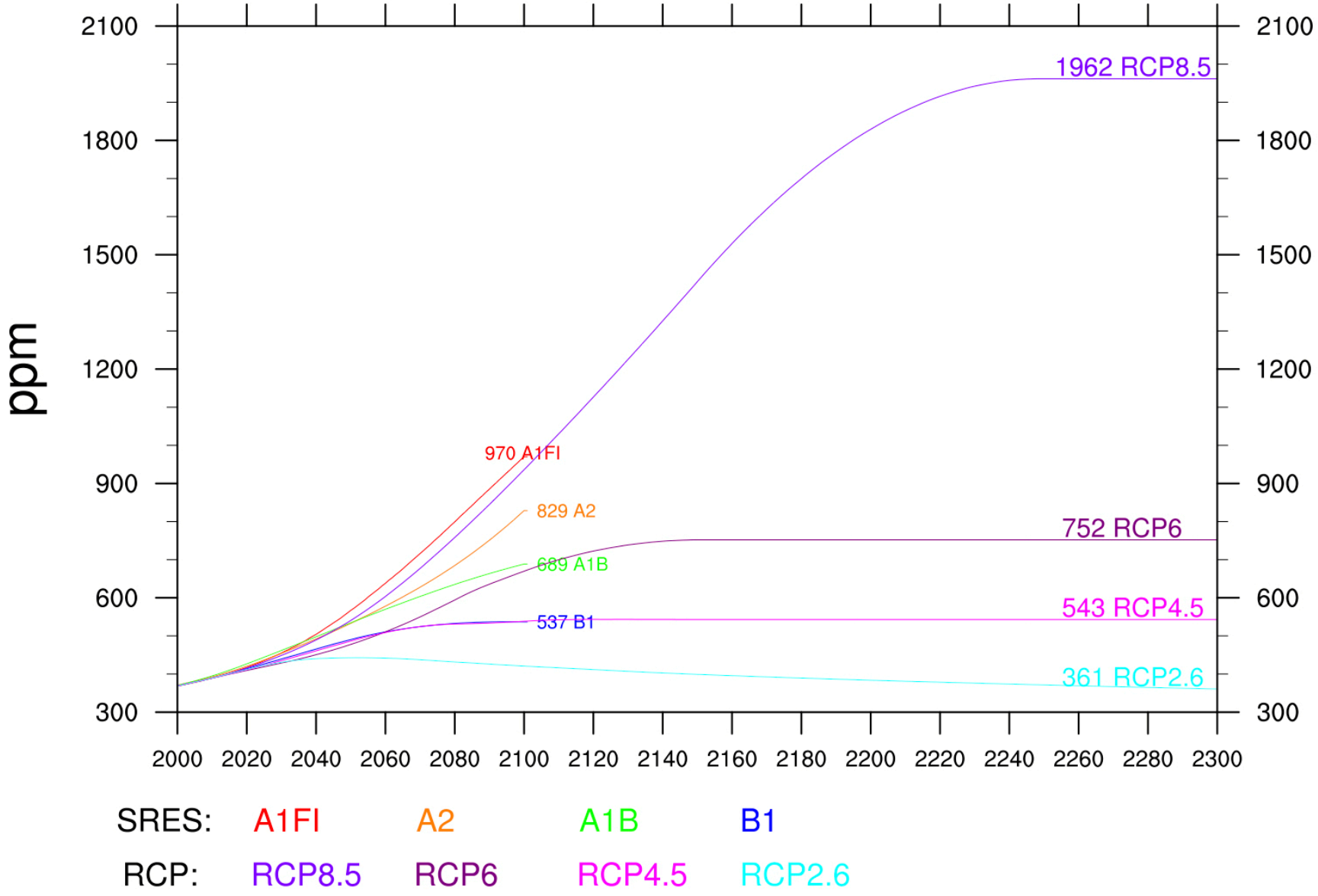

Globally averaged surface air temperature
20C3M
ANN
HadCRUT3
PCM
CCSM3
CCSM4
CESM1
anomalies from 1900-1919 (°C)
1.2
0.8
0.4
0.0
-0.4
1860
1890
1920
1950
1980

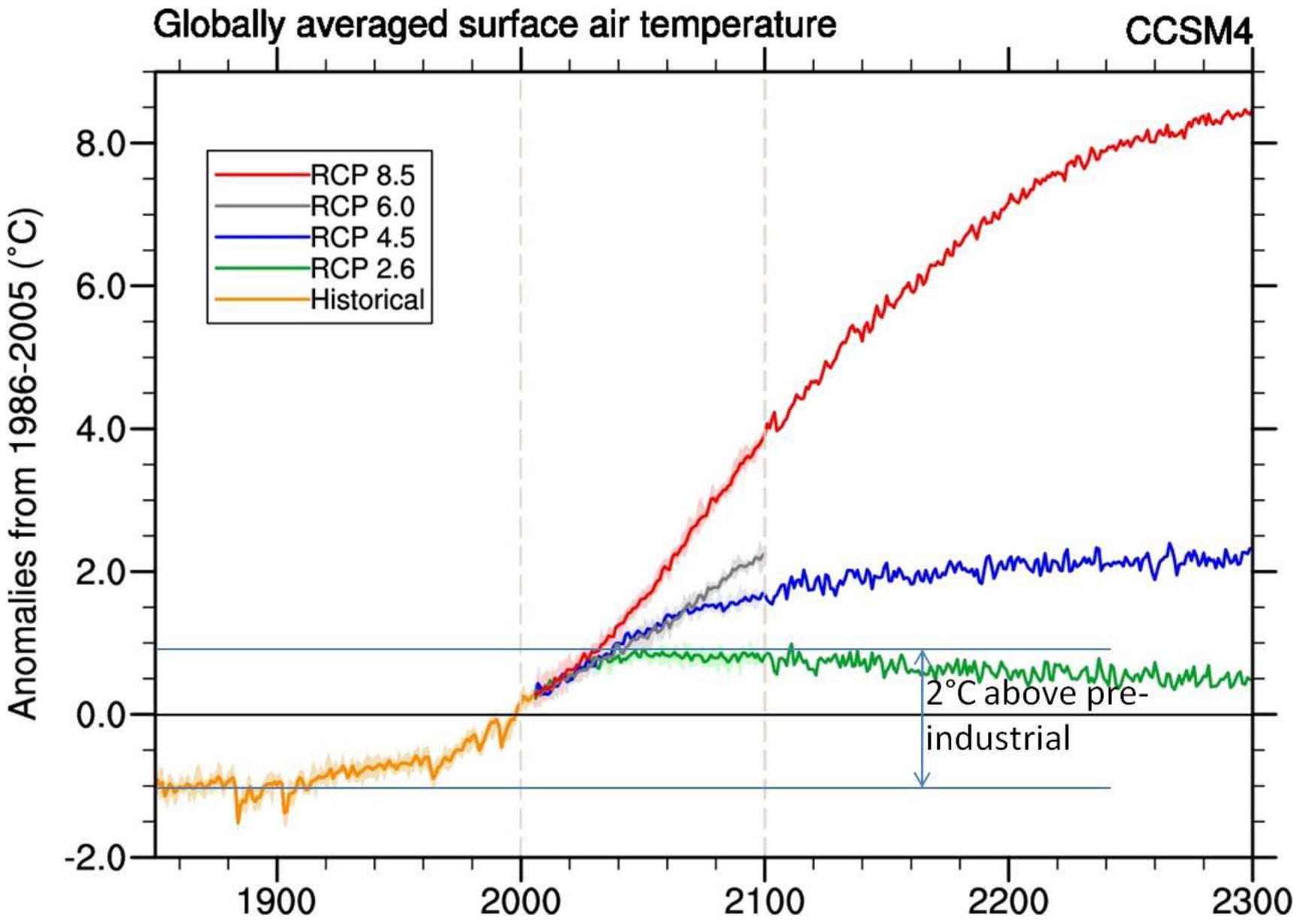
Representative Concentration Pathways (RCPs)

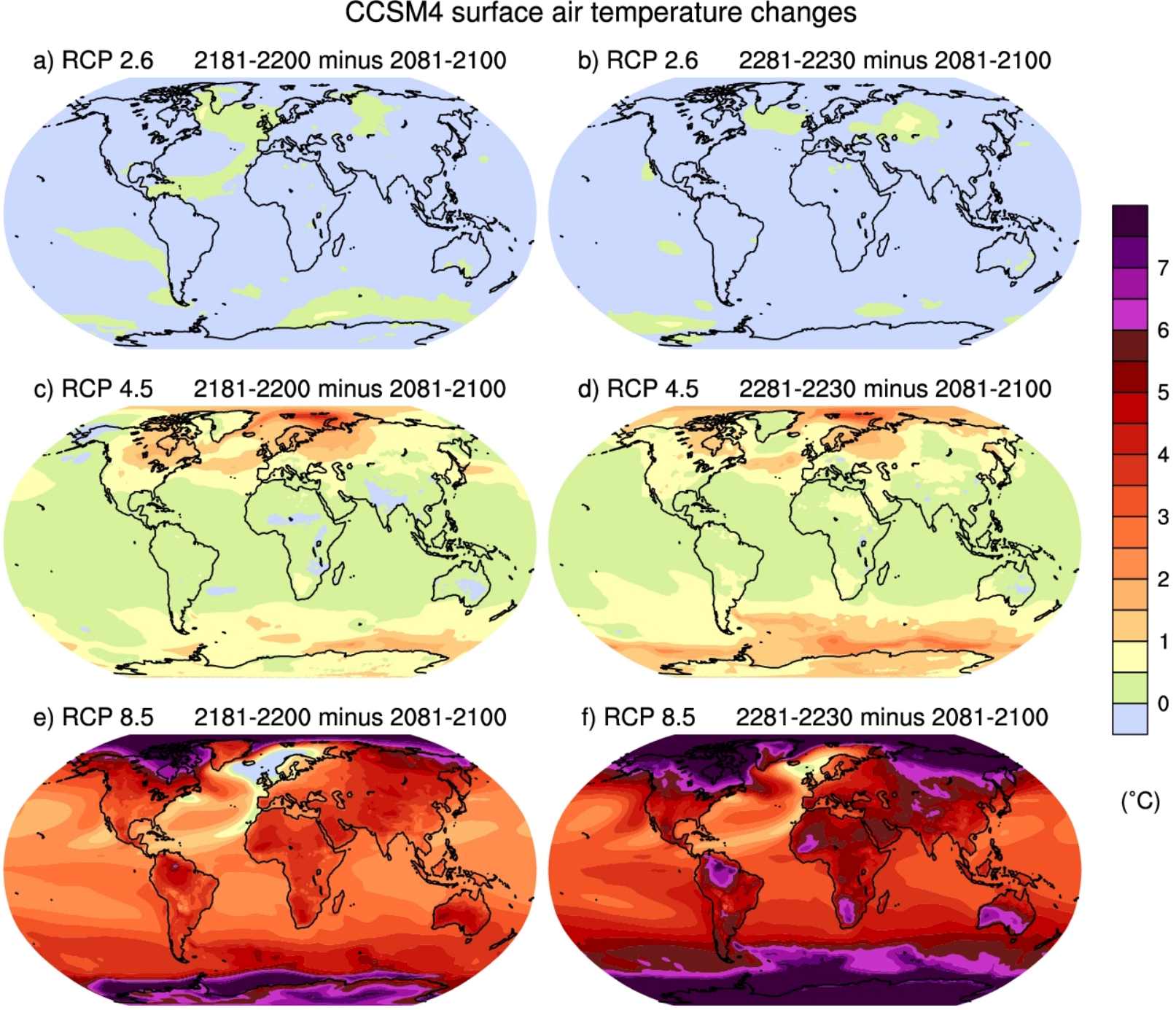




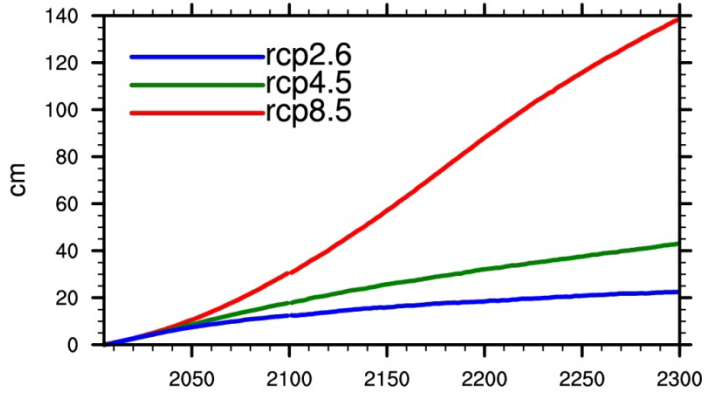
CO_2 concentrations



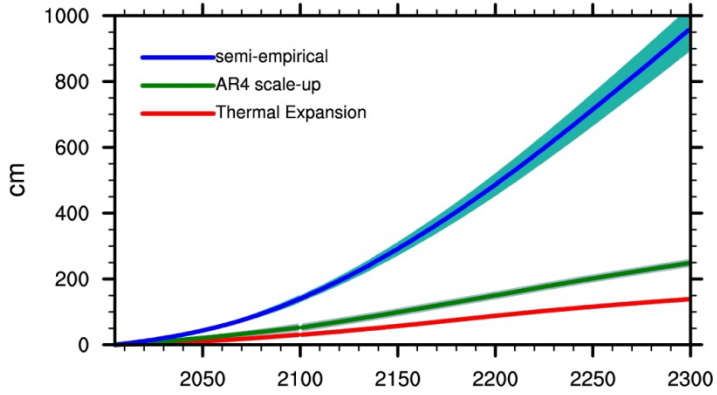

Globally averaged surface air temperature
CCSM4
RCP 8.5
RCP 6.0
RCP 4.5
RCP 2.6
Historical
Anomalies from 1986-2005 (°C)
8.0
6.0
4.0
2.0
0.0
-2.0
1900
2000
2100
2200
2300
2°C above pre-
industrial


CCSM4 surface air temperature changes
a) RCP 2.6 2181-2200 minus 2081-2100
b) RCP 2.6 2281-2230 minus 2081-2100
c) RCP 4.5 2181-2200 minus 2081-2100
d) RCP 4.5 2281-2230 minus 2081-2100
e) RCP 8.5 2181-2200 minus 2081-2100
f) RCP 8.5 2281-2230 minus 2081-2100
7
6
5
4
3
2
1
0
(°C)

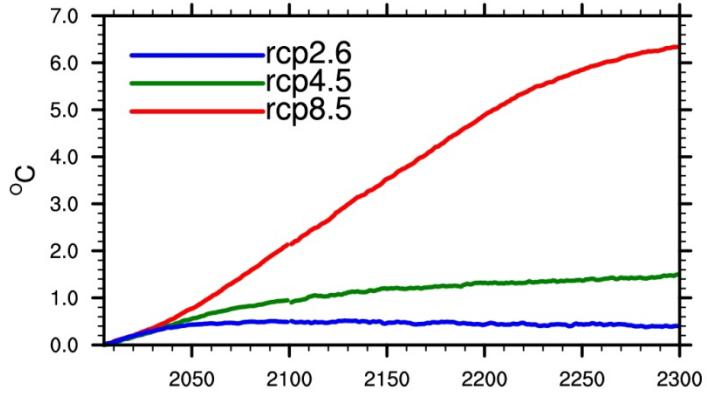
Global Sea Level Anomaly due to thermal expansion



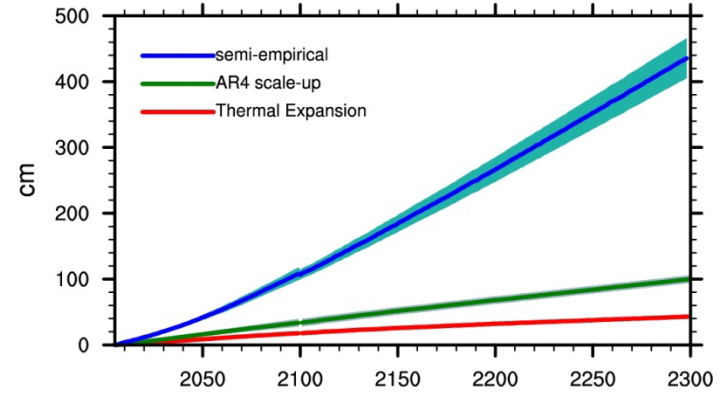
Global Sea Level Anomaly (rcp8.5)



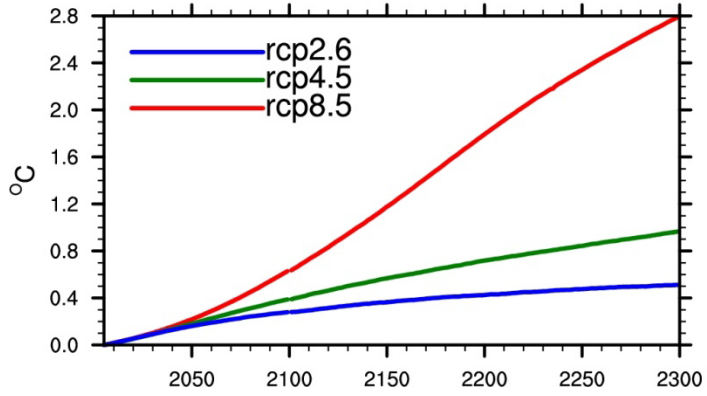
Upper 300 m ocean temperature anomaly



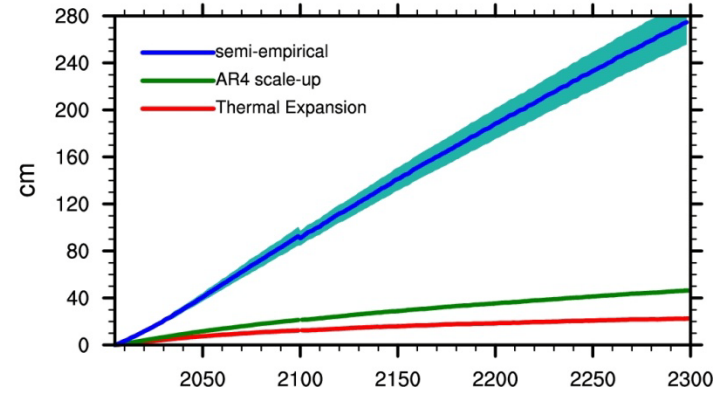
Global Sea Level Anomaly (rcp4.5)

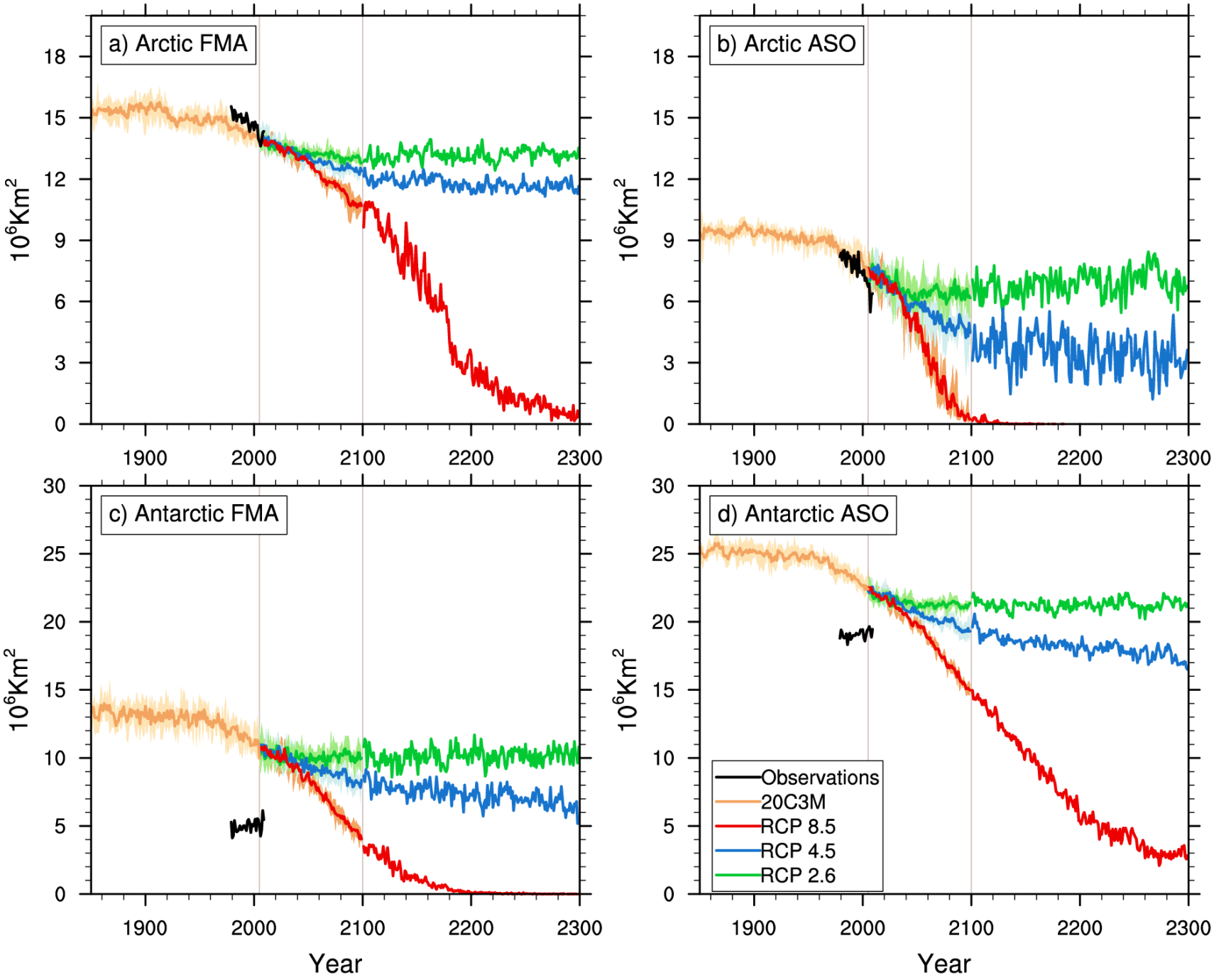


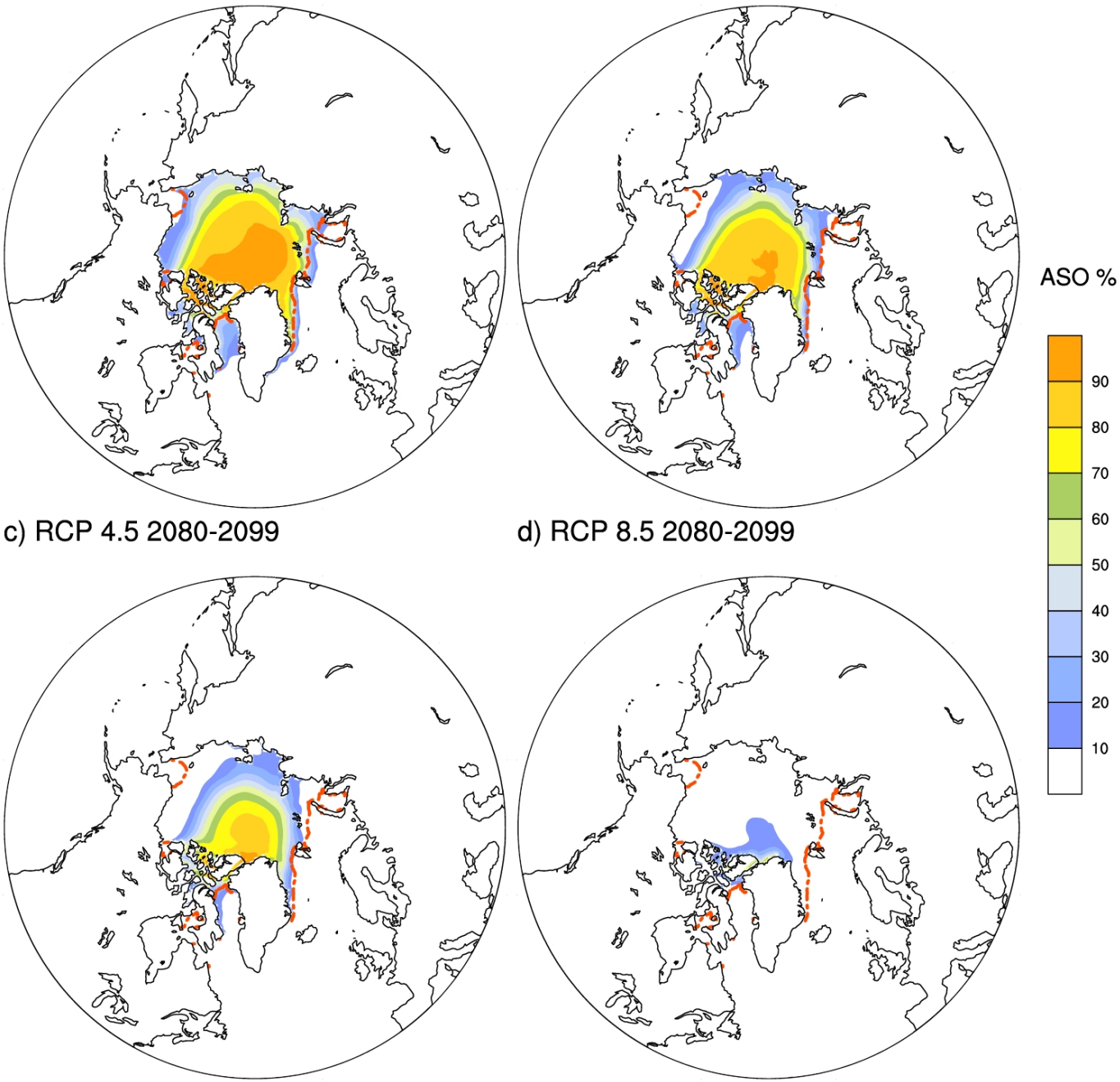
Upper 3 km ocean temperature anomaly



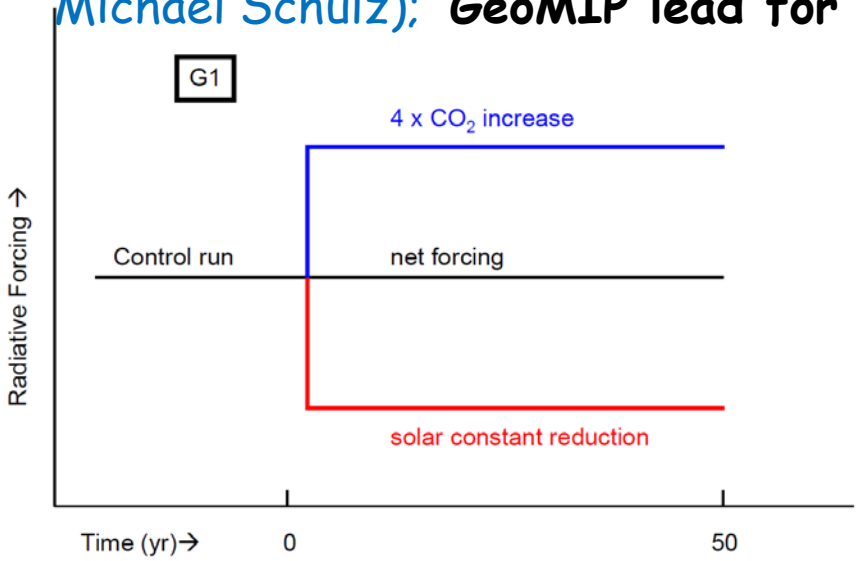
Global Sea Level Anomaly (rcp2.6)

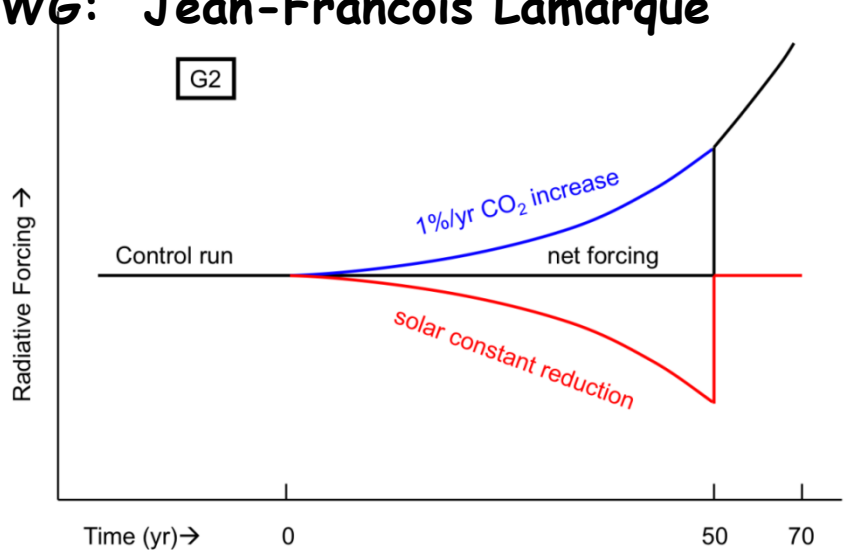


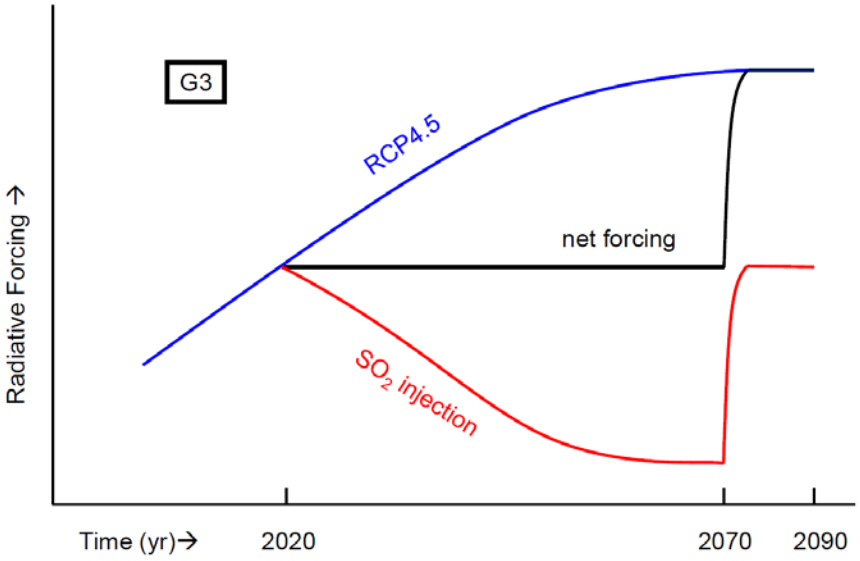

a) Arctic FMA
b) Arctic ASO
c) Antarctic FMA
d) Antarctic ASO
$10^6 Km^2$
Year
1900
2000
2100
2200
2300
Observations
20C3M
RCP 8.5
RCP 4.5
RCP 2.6

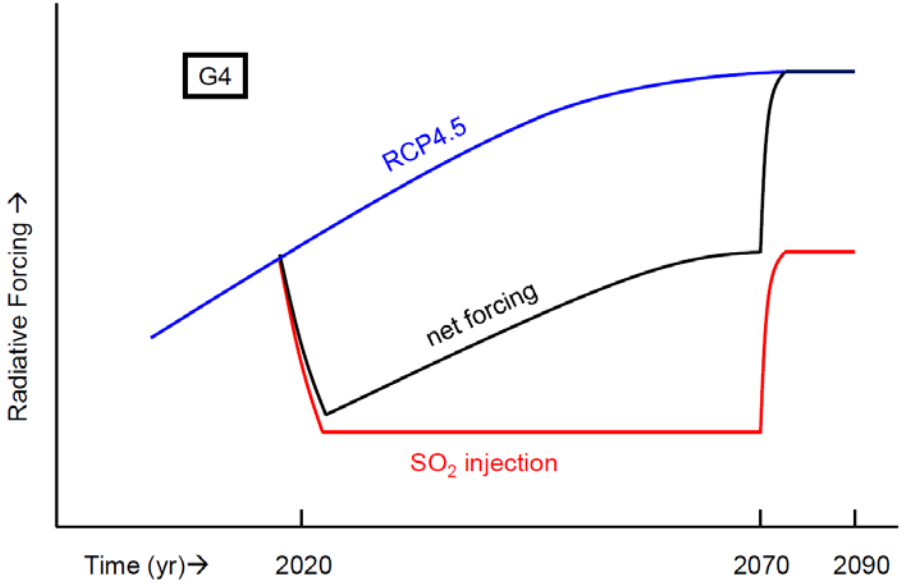

a) 20C3M 1986-2005
b) RCP 2.6 2080-2099
c) RCP 4.5 2080-2099
d) RCP 8.5 2080-2099
ASO %
90
80
70
60
50
40
30
20
10

The Geoengineering Model Intercomparison Project, GeoMIP, a WGCM-endorsed community coordinated experiment (Ben Kravitz, Alan Robock, Olivier Boucher, Hauke Schmidt, Karl Taylor, Georgiy Stenchikov, Michael Schulz); **GeoMIP lead for CCWG: Jean-Francois Lamarque**



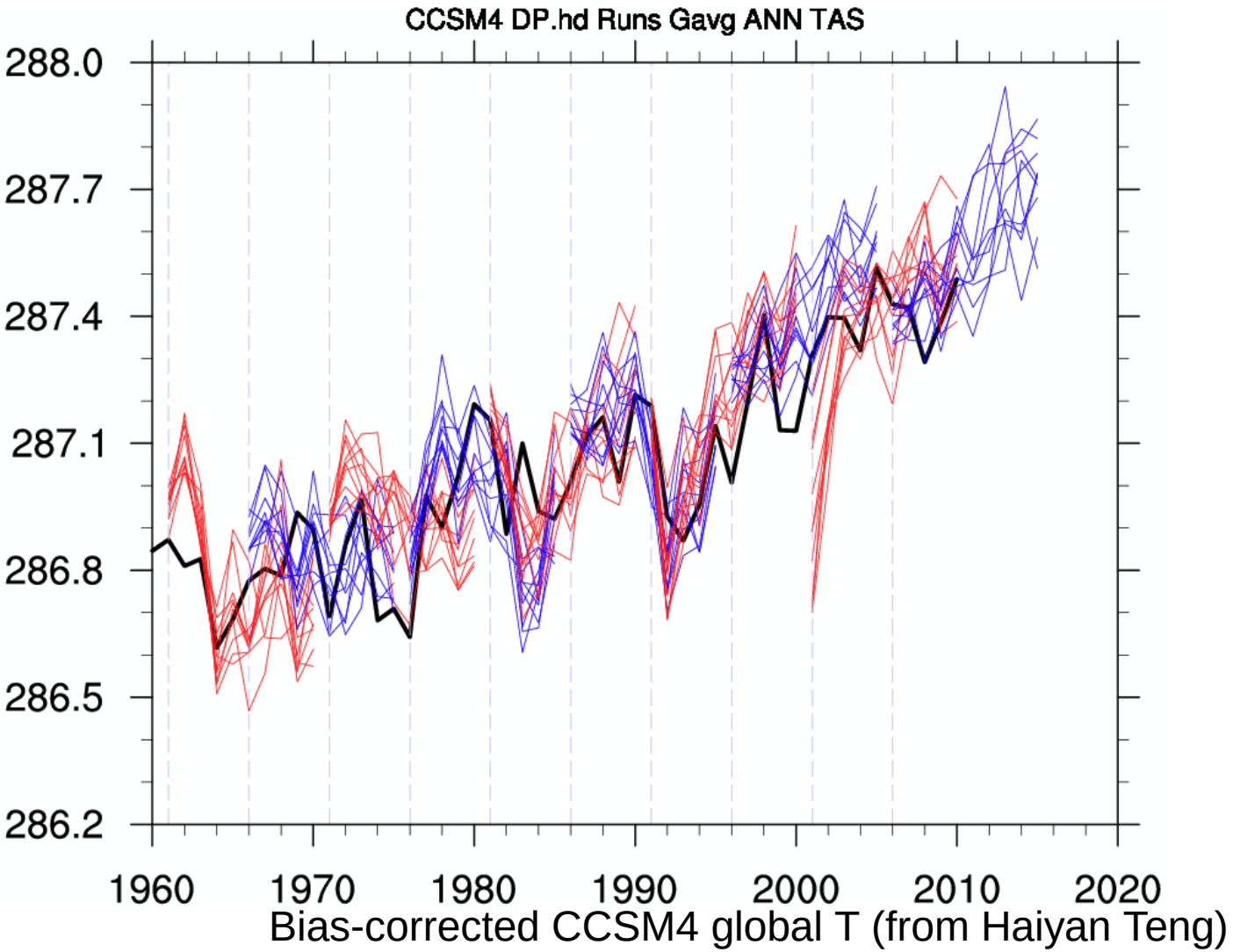






Decadal prediction

(perform hindcasts to compute bias corrections; find ways to put error bars on predictions)



Bias-corrected CCSM4 global T (from Haiyan Teng)

Decadal prediction using two initialization schemes: hindcast and DART

Hindcast initialized CMIP5 runs completed; DART initialized runs in progress

CMIP5 suite of runs nearly complete with CCSM4; model data posted on ESG and next week to CMIP5

CMIP5 runs have begun with CESM1/CAM5

½ degree coupled CCSM4 control run is in progress, to be followed by 20th century and RCP runs

High resolution time slice experiments have begun

GeoMIP runs are in progress

Decadal prediction CMIP5 suite completed with hindcast initialization technique; bias-corrected surface temperature and SLP calculations completed, and some bias-corrected ocean fields

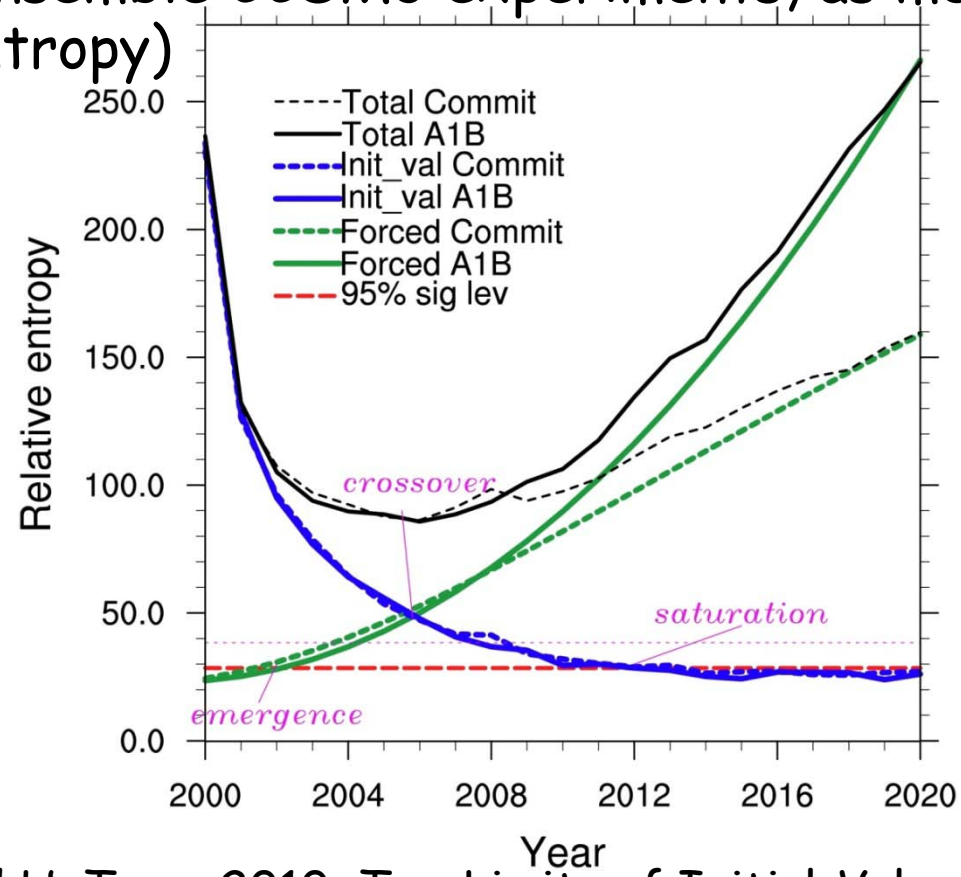
Decadal prediction CMIP5 suite with DART initialization in progress

BGC CMIP5 runs in progress

Coupled ice sheet runs in the next year

An example of a science question from decadal prediction: How fast does initial condition skill diminish, and skill from external forcing become more dominant?

One preliminary indication is about 5 years for global upper ocean (300m) heat content (from an analysis of 40-member ensemble CCSM3 experiments, as measured by relative entropy)



Branstator, G., and H. Teng, 2010: Two Limits of Initial-Value Decadal Predictability in a CGCM. J. Climate, 23, doi: 10.1175/2010JCLI3678.1

High resolution experiments

CAM4 time-slice experiments * T341 by Oak Ridge on Jaguar * 1/4-degree FV by NCAR on Jaguar * 1/4-degree HOMME by Sandia on Intrepid

CCSM4 1/2-degree control * This is running now on Jaguar * Planning initially for 20th-century and at least one RCP

CAM5 1/4-degree time-slice experiments * Prescribed aerosols * HOMME on Jaguar or Intrepid * Computer time from ALCC proposal

HOMME 1/8-degree time-slice * Short scoping runs, 1-5 years * CAM4 * By Sandia on Intrepid this year or next

CESM-CAM5 1/4-degree * Control, 20th century, and one or more RCPs * 1-degree ocean and sea ice * HOMME * Prognostic aerosols* Some computer time from ALCC proposal * Put more in INCITE under high-res subproject * Blue Waters allocation