Community Earth System Model (CESM)* plans for CMIP5

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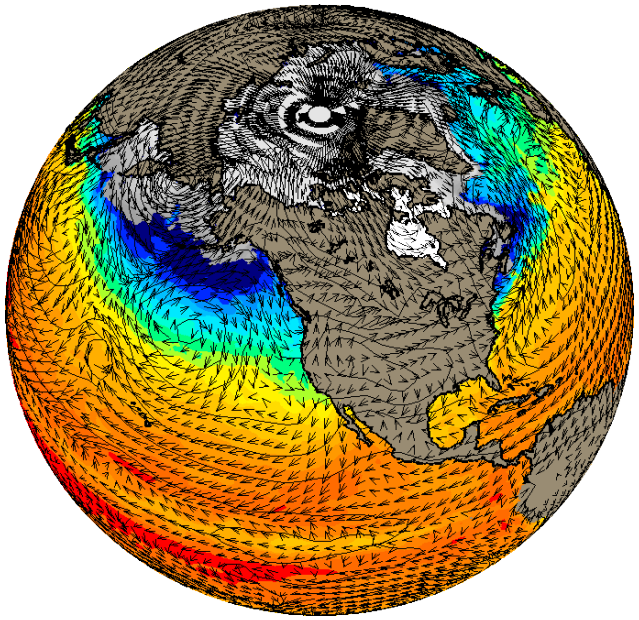
NCAR



*formerly Community Climate System Model (CCSM), as of 2010 CESM, still a distributed modeling effort centered at NCAR but with close contributions from university, DOE, and other government lab scientists

Model versions with future climate change simulations

CCSM4, 1 degree atmosphere, (full suite of CMIP5 simulations complete, including paleo, CFMIP, carbon cycle feedback; most available on ESG, a few via PCMDI, but delays in converting to CMIP5 format)

CCSM4, 2 degree atmosphere, 20th century and single member RCP simulations (limited number of simulations, not likely to be available in CMIP5 format)

CCSM4, 0.5 degree atmosphere, pre-industrial control, single member 20th century and RCP8.5; decadal prediction experiments (nearly completed 200 year control run; next: 20th century and RCP single members)

CESM1 (WACCM), high-top model, 2 degree atmosphere, stratospheric dynamics, ozone chemistry (pre-industrial control, 20th century and RCP4.5 to 2050 completed)

CESM1 (CAM5); new 1 degree atmospheric model, other components as in CCSM4; (pre-industrial control, three 20th century all-forcings runs completed; next: RCP 21st century simulations, at least one ensemble member from each)

CESM1 (BGC): CMIP5 carbon cycle feedback experiments completed, 20th and 21st century RCP8.5 (completed, awaiting conversion to CMIP5 format)

HOMME 0.25°, T341 CCSM4, 0.25° CCSM4: atmosphere-only time slice experiments (20 yrs end of 20th century; 20 yrs end of 21st century) (in development)

CESM1 (Glimmer-CISM), land ice model included, 20th century, RCP4.5, RCP8.5 (in prep)

GEOMIP

3 ensemble members of G1 and G2 completed with CCSM4; separate G3 (called G3solar) in which the solar constant is adjusted instead of aerosols with CCSM4;
now doing additional runs of G3solar to look at chemistry impacts;
Also some WACCM simulations with prognostic chemistry in progress

CMIP5 Decadal prediction experiments

Multi-ensemble member sets of CMIP5 decadal hindcast and prediction experiments with two initialization schemes:

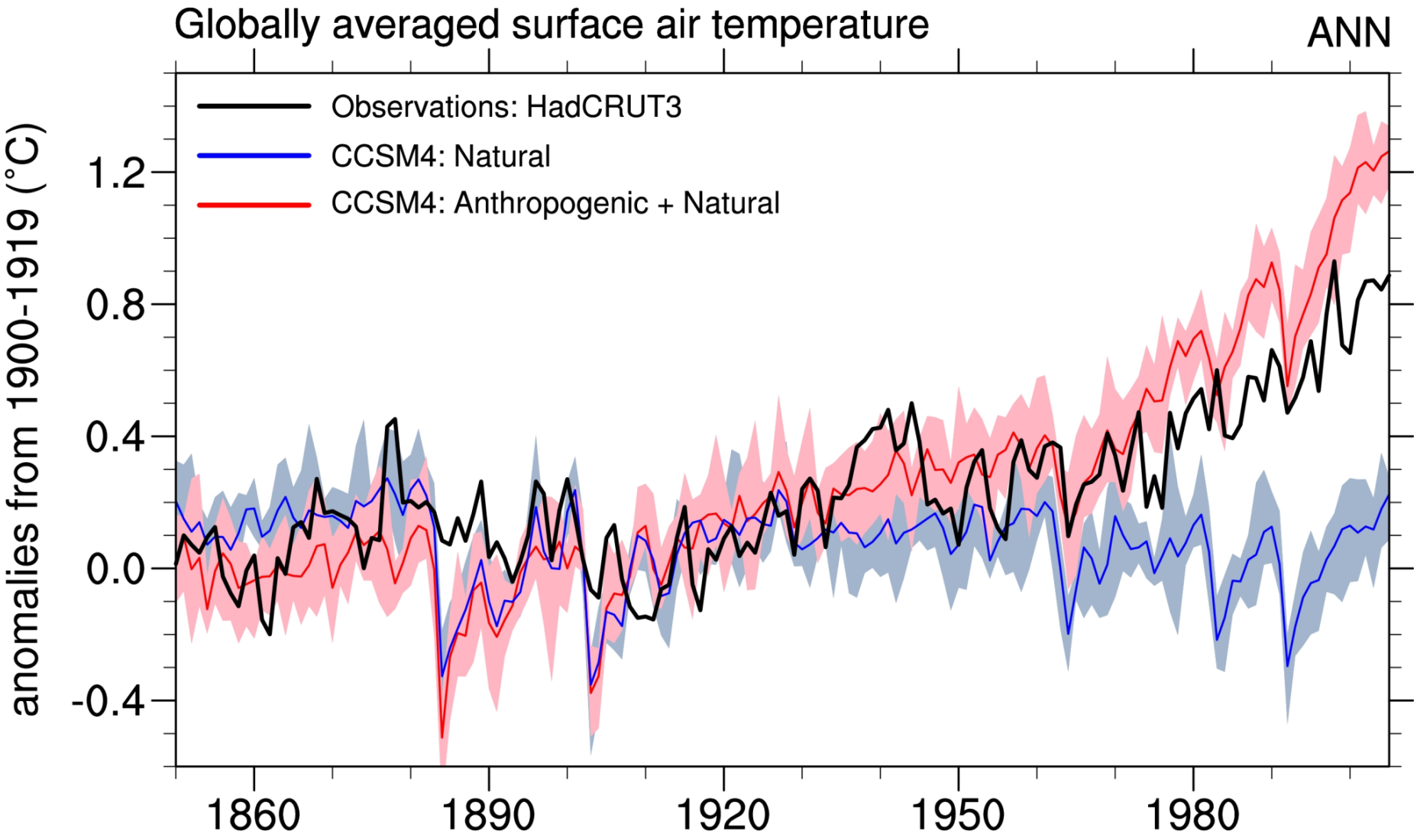
1. Ocean-Ice Hindcast (CORE) (full set completed with 10 member ensembles with initial states every 5 years from 1960, and the 2000s; paper describing initial results submitted last week; awaiting conversion to CMIP5 format)

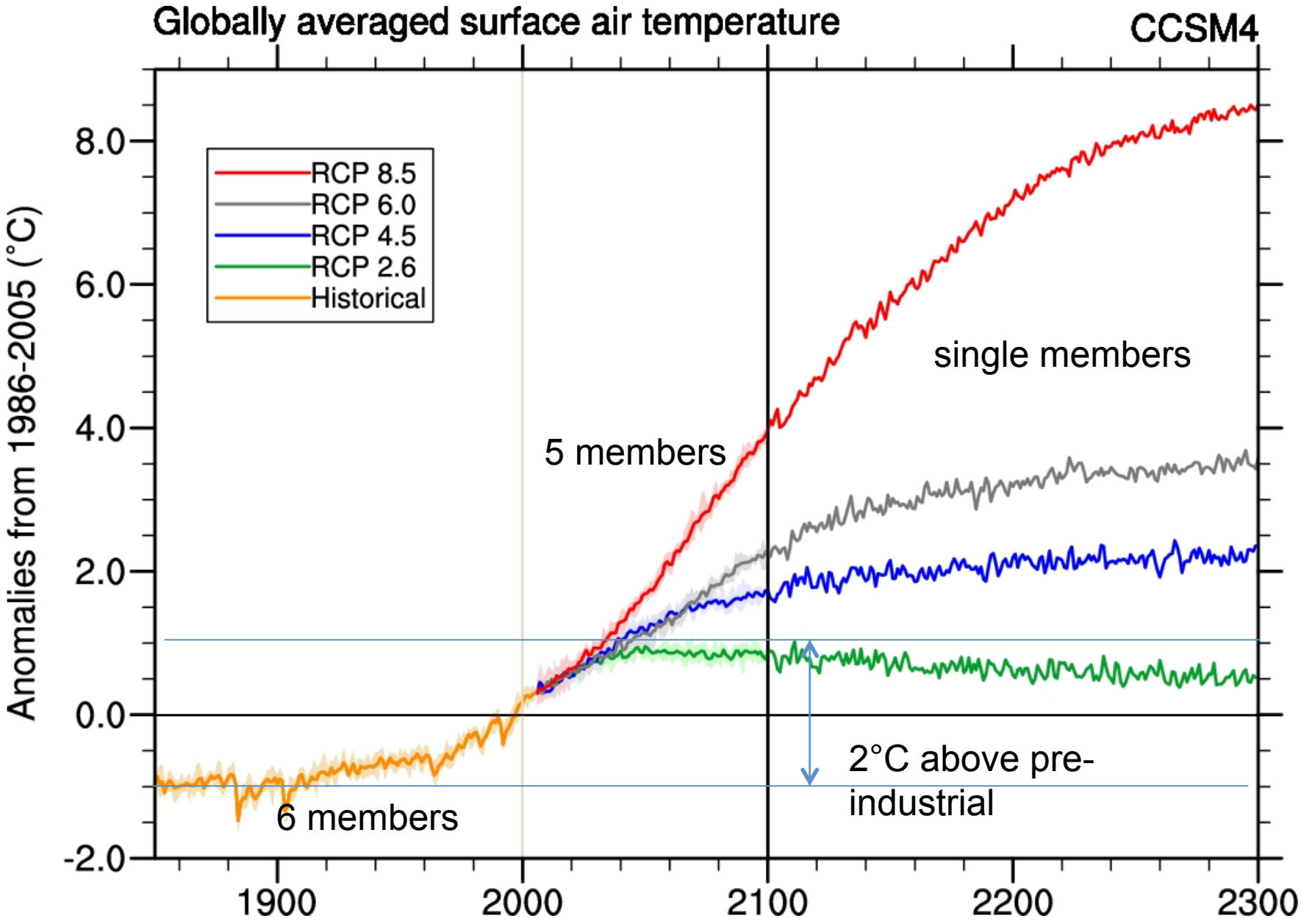
2. DART weakly coupled scheme (ocean data assimilation weakly coupled to atmosphere data assimilation) (several initial states completed: the 2000s, 1990, 1980, full set of initial states every 5 years planned)

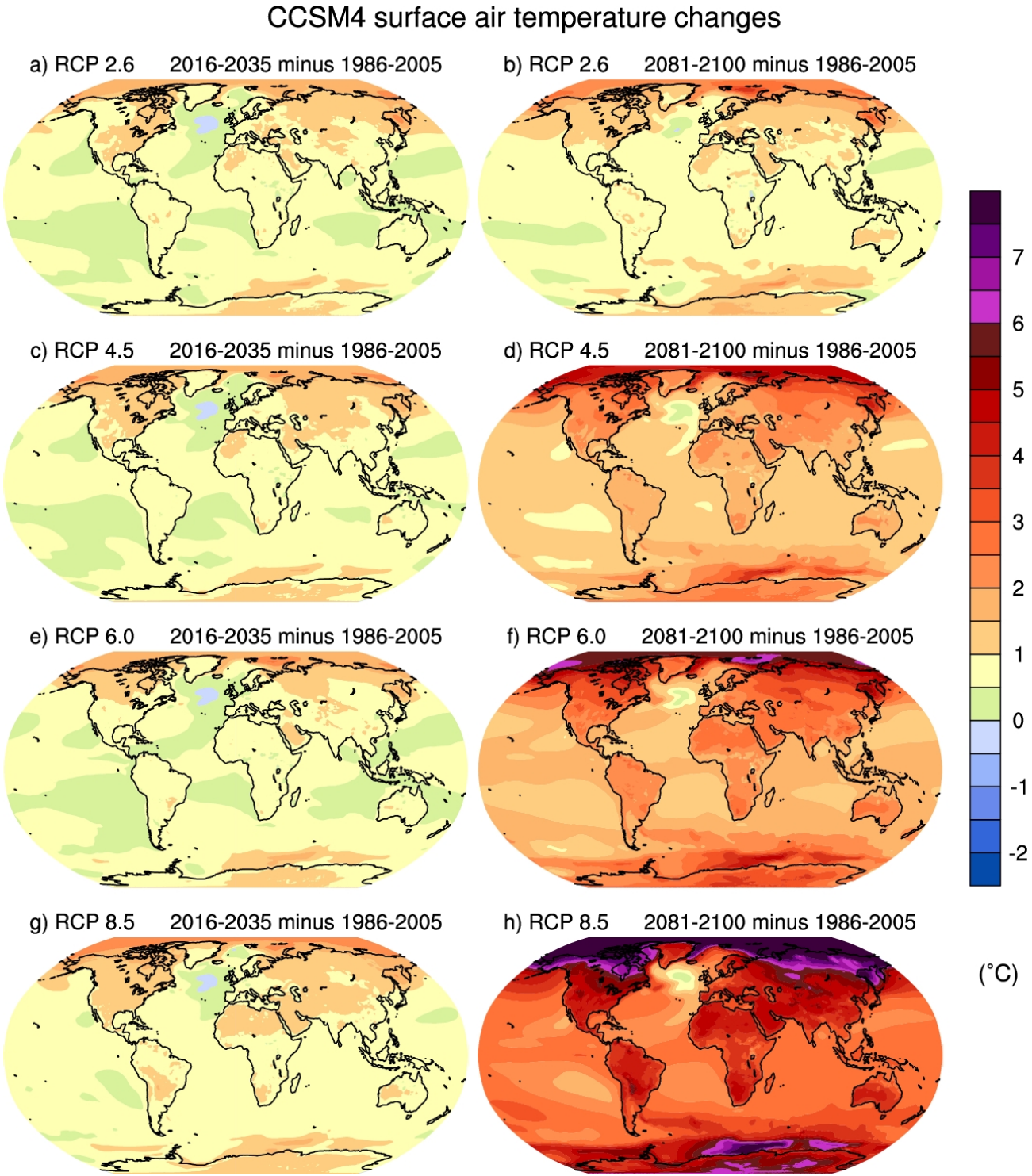
Equilibrium climate sensitivity

PCM: 2.1°C
CCSM3: 2.7°C

CCSM4: 3.2°C
CESM1 CAM5: 4.2°C


Globally averaged surface air temperature
ANN
Observations: HadCRUT3
CCSM4: Natural
CCSM4: Anthropogenic + Natural
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
CCSM4
Anomalies from 1986-2005 (°C)
8.0
6.0
4.0
2.0
0.0
-2.0
1900
2000
2100
2200
2300
RCP 8.5
RCP 6.0
RCP 4.5
RCP 2.6
Historical
single members
5 members
6 members
2°C above pre-industrial



Warming in the near-term (2016-2035, left column) is similar no matter what scenario is followed —near term climate change is an adaptation problem

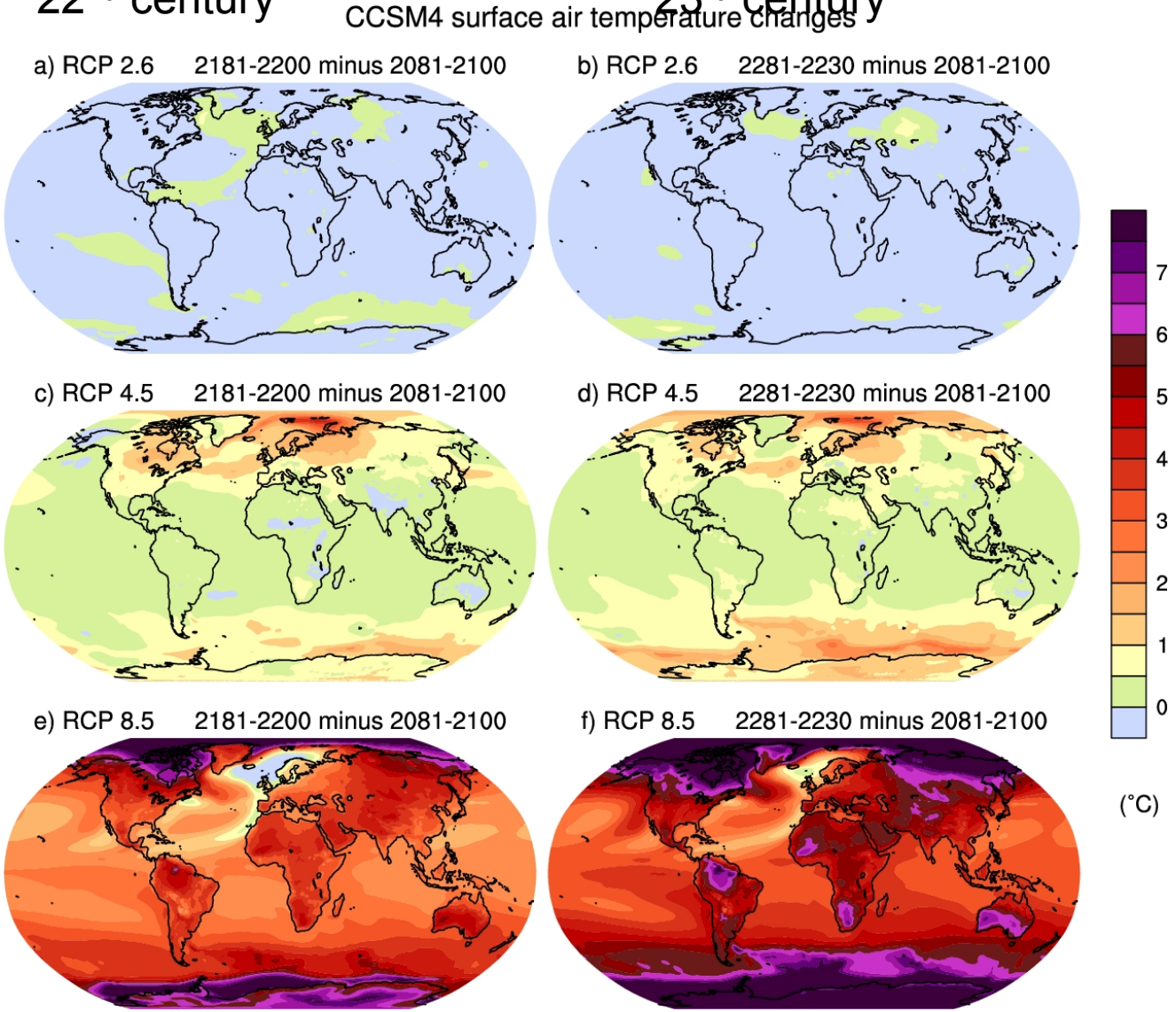
Magnitude of the warming later in the century (2081-2100, right column) depends a lot on what scenario is followed —the mitigation path we follow makes a big difference after mid-century

Climate change doesn't stop at 2100

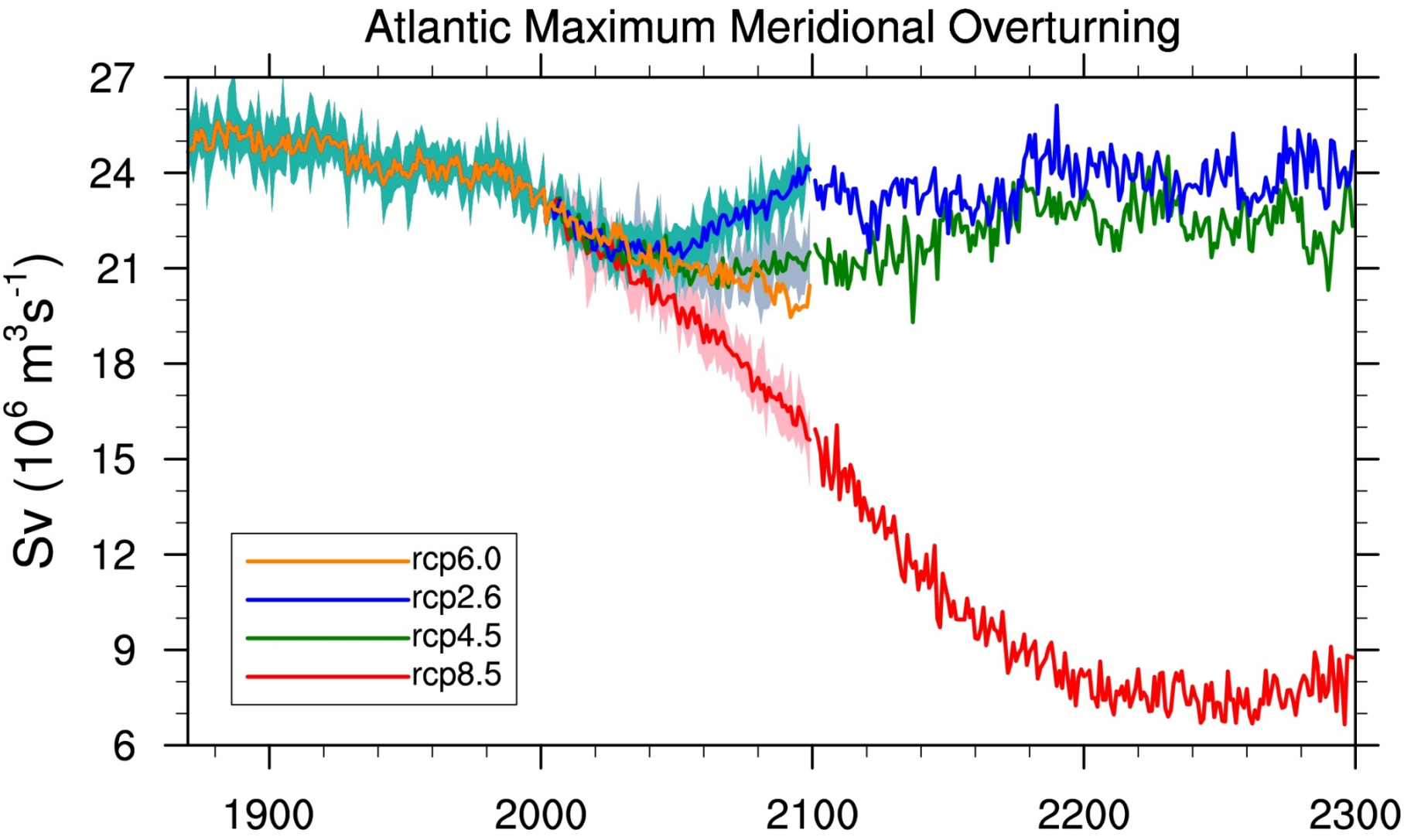
Aggressive mitigation in RCP2.6 produces **cooling after 2100** (top) but little mitigation in RCP8.5 results in **onging large warming** to 2300 (bottom)

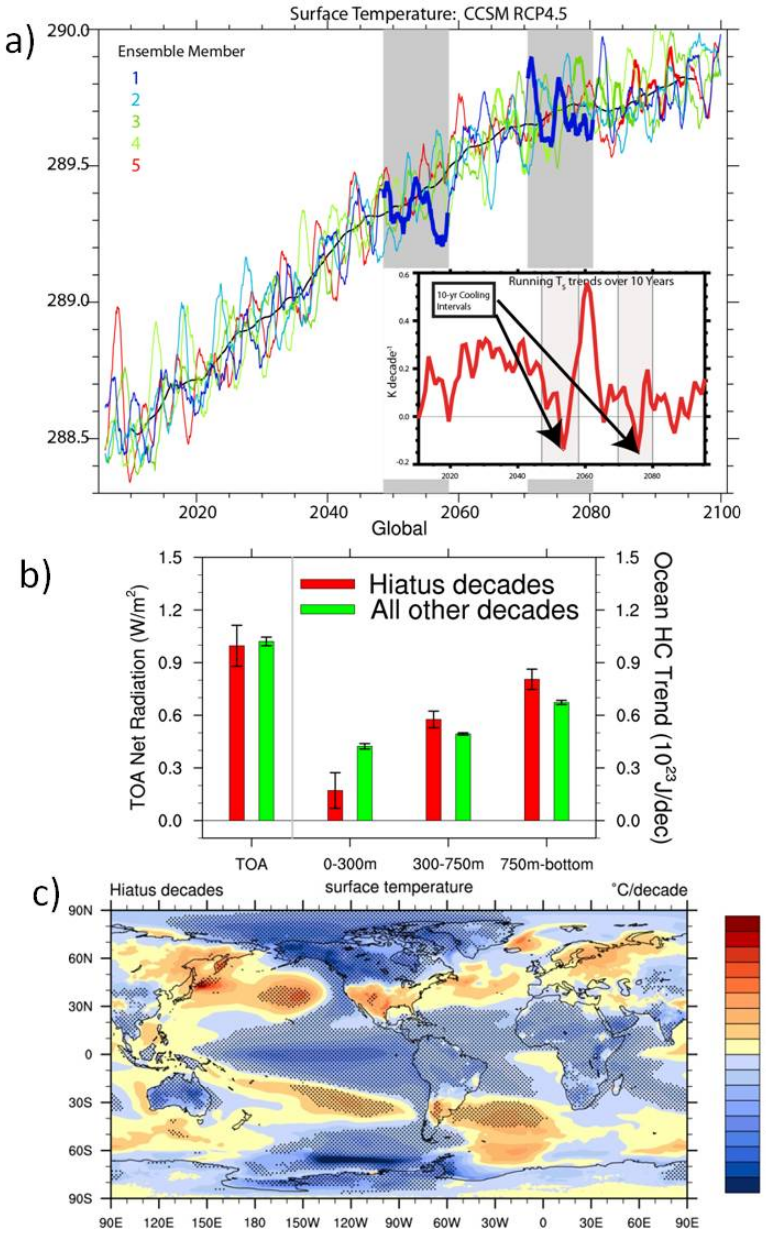
22nd century

23rd century



The point of no return: mitigation restores the “conveyor belt” circulation in the North Atlantic, but with little mitigation the conveyor belt shuts down





Diagnosis of CMIP5 RCP4.5 simulations with CCSM4

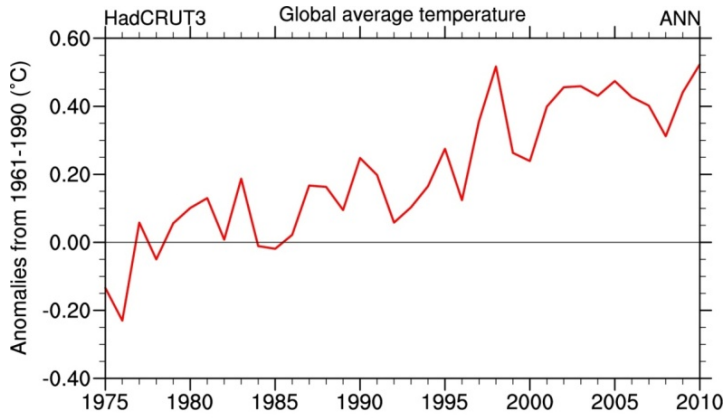
Q: **Where heat goes when the surface temperature trend is flat for a decade or so?**

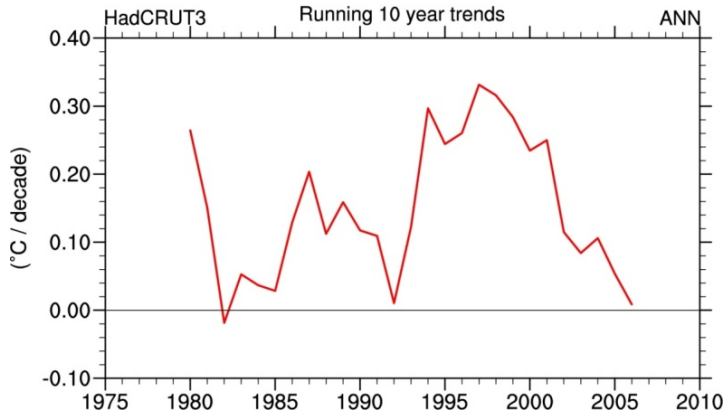
A: The deep ocean

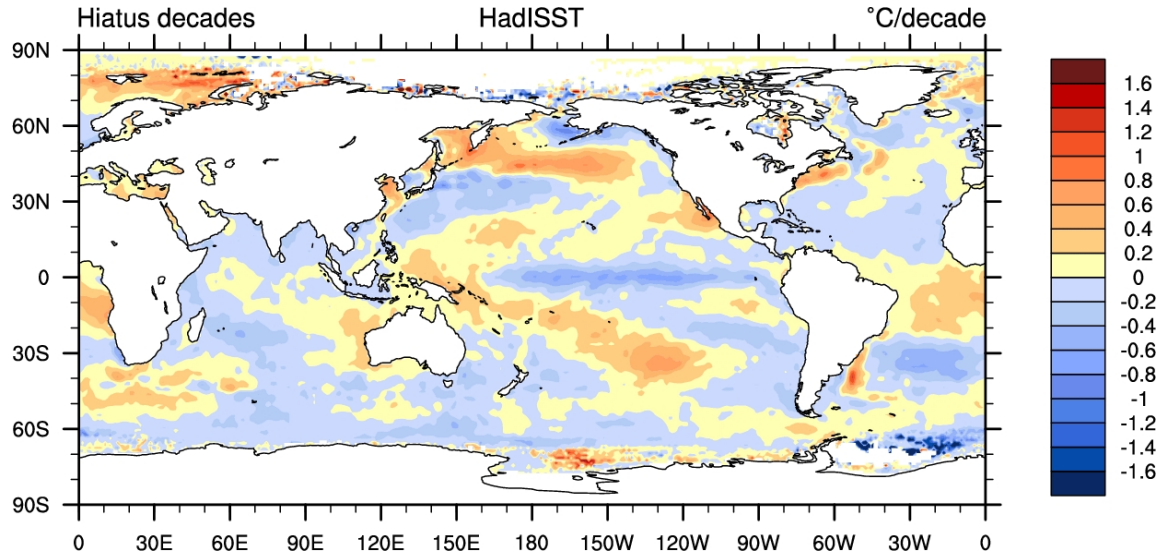
With a La Niña-like SST pattern, increased heat convergence in the subtropical oceans, weakened MOC and Antarctic Bottom Water formation

A hiatus period is a relatively common climate phenomenon, and a hiatus period is consistent with our physical picture of how the climate system works, and does not invalidate our basic understanding of greenhouse-gas-induced warming or the models used to simulate such warming.

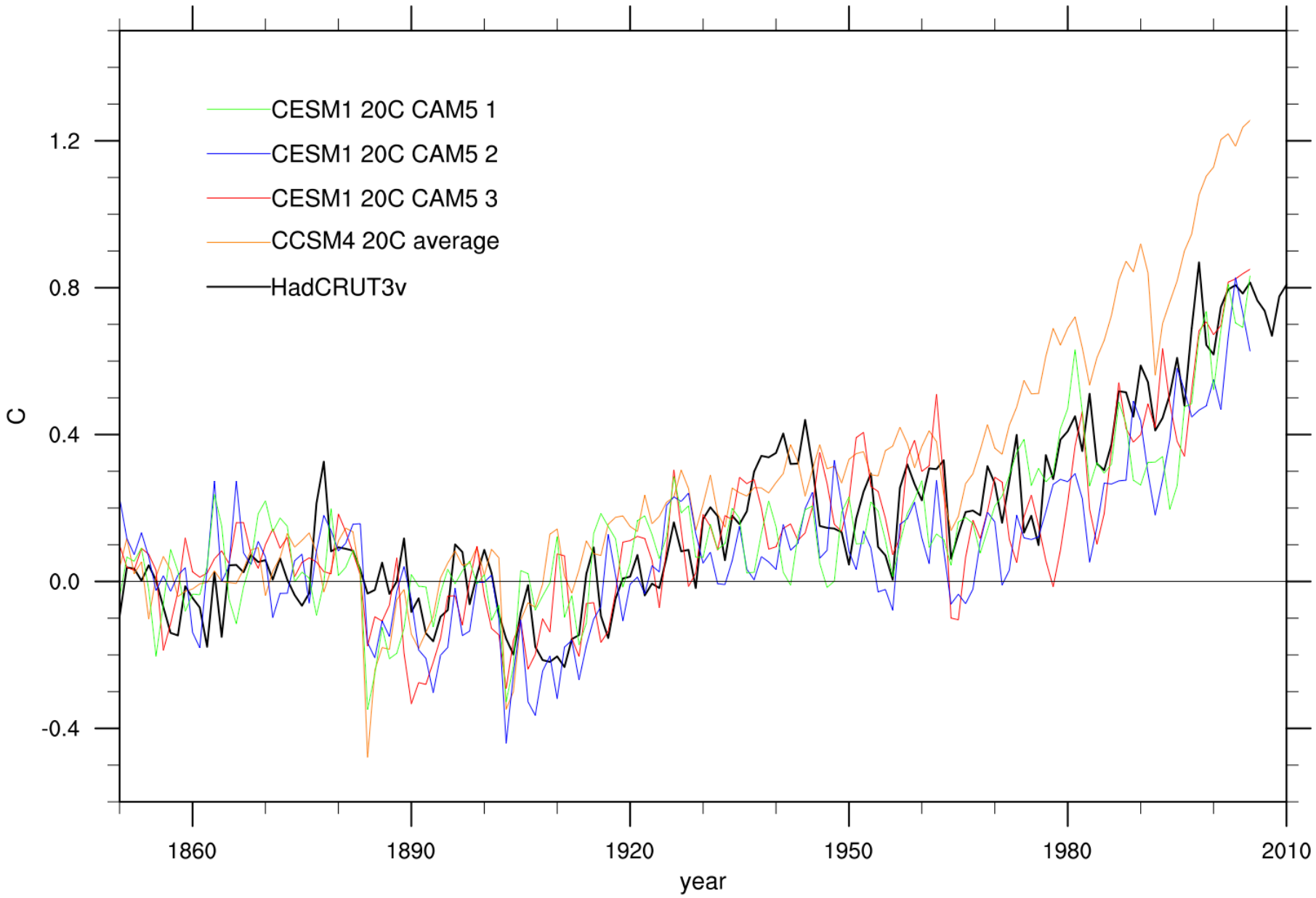
(Meehl, G.A., J.M. Arblaster, J. Fasullo, A. Hu, and K.E. Trenberth, 2011: Model-based evidence of deep ocean heat uptake during surface temperature hiatus periods. *Nature Climate Change,* doi:10.1038/NCLIMATE1229)







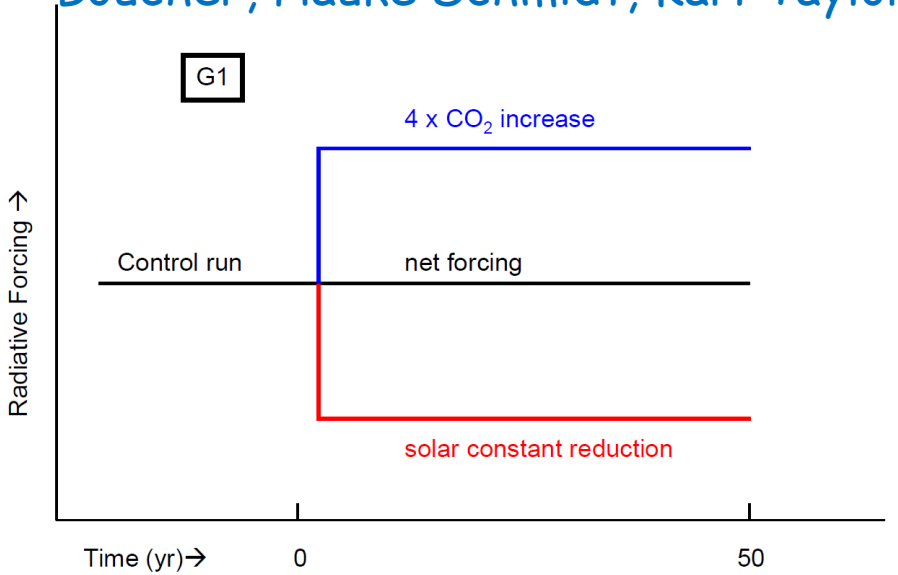
The most recent three hiatus periods in observations show a La Niña-like sea surface temperature trend pattern similar to the model simulations, indicating the model may be capturing similar processes to those in the observed system to produce hiatus periods

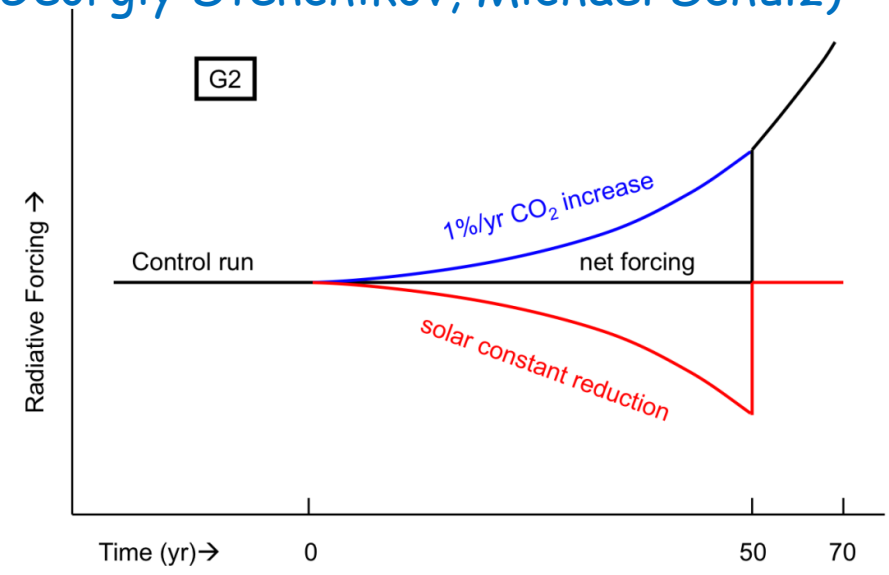

Surface temperature
anomaly from 1850-1899, annual and global mean
Fri Oct 21 07:36:46 MDT 2011
CESM1 20C CAM5 1
CESM1 20C CAM5 2
CESM1 20C CAM5 3
CCSM4 20C average
HadCRUT3v
C
1.2
0.8
0.4
0.0
-0.4
1860
1890
1920
1950
1980
2010
year

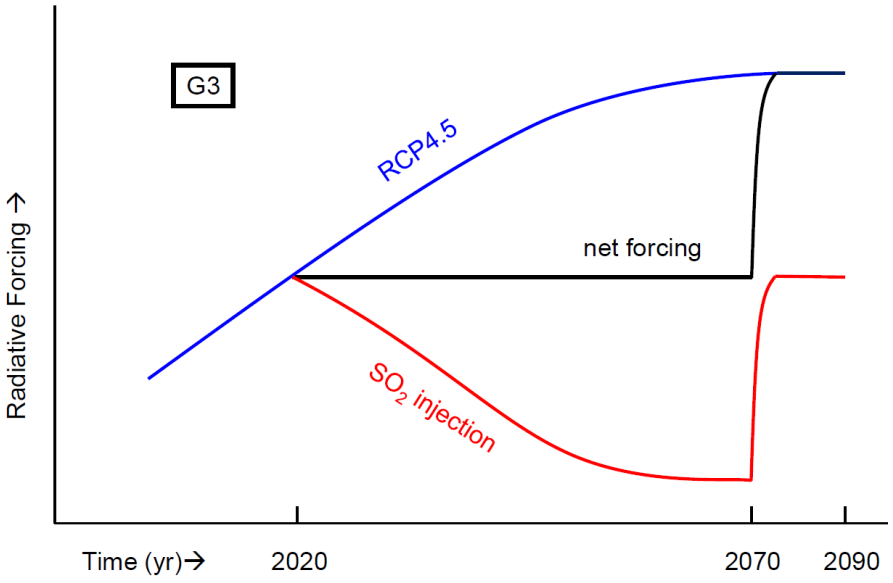
CCSM4 CMIP5 experiments completed, but two stage process of data translation, first to ESG and then to CMIP5, has caused delays

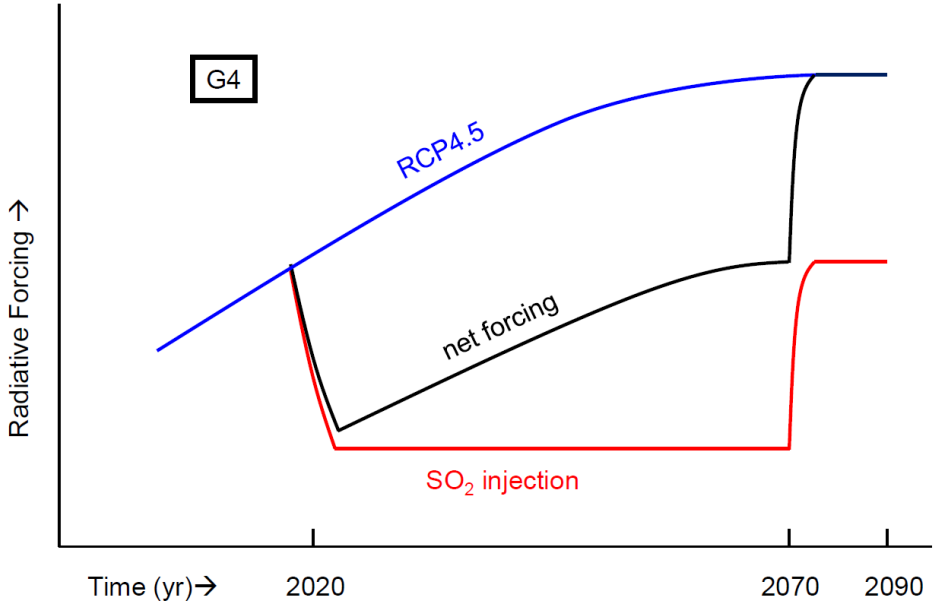
CESM1/CAM5: new model now being run, will have at least some CMIP5 experiments completed by end of 2011

The Geoengineering Model Intercomparison Project, GeoMIP, a CMIP Coordinated Experiment (Ben Kravitz, Alan Robock, Olivier Boucher, Hauke Schmidt, Karl Taylor, Georgiy Stenchikov, Michael Schulz)









Representative Concentration Pathways (RCPs)