U.S. Modeling Contributions to the IPCC Fourth Assessment Report (AR4)

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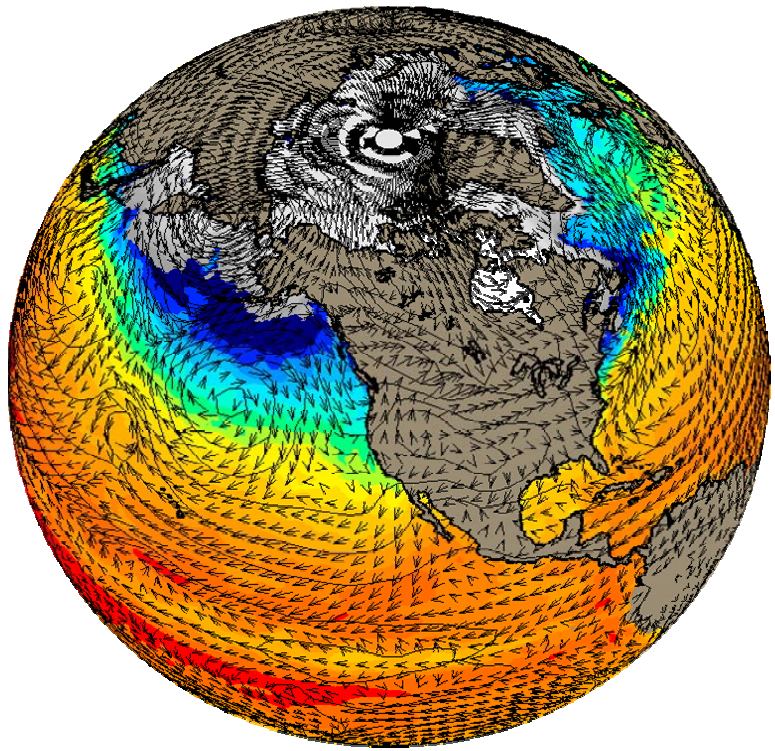


The IPCC AR4 has motivated the formulation of the largest international global coupled climate model experiment and multi-model analysis effort ever attempted, and is being coordinated by the WCRP/CLIVAR Working Group on Coupled Models (WGCM) Climate Simulation Panel

Seventeen modeling groups from 10 countries around the world are participating with 23 models; considerable resources have been devoted to this project;

PCMDI has taken on the considerable task of collecting, archiving and making available the model data; ~27 TeraBytes of model data archived so far

Three global coupled climate modeling groups from the U.S. have made major contributions to the AR4:
1) Running the extensive set of model experiments with multi-member ensembles

2) Publishing scientific results from the experiments

GFDL (NOAA)

GISS (NASA)

NCAR-CCSM (NSF-DOE)

The Climate Model Evaluation Project (CMEP) has also supported analyses of the U.S. model data for IPCC

Participating AOGCMs (23 models from 17 institutions in 10 countries)

Data Availability Summary (as of 12 July 2005)

shaded area indicates that at least some but not necessarily all fields are available for data type indicated

time-independent land surface
monthly-mean atmosphere
daily-mean atmosphere
3-hourly atmosphere
time-independent ocean
monthly-mean ocean
Extreme Indices
Forcing
ISCCP Simulator

		Picntrl	PDcntrl	20C3M	Commit	SRESA2	SRESA1B	SRESB1	1%to2x	1%to4x	Slab cntl	2xCO2	AMIP
	BCC-CM1, China												
	BCCR-BCM2.0, Norway												
X	CCSM3, USA												
	CGCM3.1(T47), Canada												
	CGCM3.1(T63), Canada												
	CNRM-CM3, France												
	CSIRO-Mk3.0, Australia												
	ECHAM5/MPI-OM, Germany												
	ECHO-G, Germany/Korea												
	FGOALS-g1.0, China												
X	GFDL-CM2.0, USA												
X	GFDL-CM2.1, USA												
X	GISS-AOM, USA												
X	GISS-EH, USA												
X	GISS-ER, USA												
	INM-CM3.0, Russia												
	IPSL-CM4, France												
	MIROC3.2(hires), Japan												
	MIROC3.2(medres), Japan												
	MRI-CGCM2.3.2, Japan												
X	PCM, USA												
	UKMO-HadCM3, UK												
	UKMO-HadGEM1, UK												

Ensemble members

Monthly Mean Atmosphere Data Availability **(as of 12 July 2005)**

1 realization multiple realizations

	PIcntrl	PDcntrl	20C3M	Commit	SRESA2	SRESA1B	SRESB1	1%to2x	1%to4x	Slabcntl	2xCO2	AMIP
BCC-CM1, China		2	4		2		2	1	1			4
BCCR-BCM2.0, Norway	1		1		1		1					
X CCSM3, USA	2	1	9	5	5	7	8	1	1	1	1	1
CGCM3.1(T47), Canada	1		5	1	2	4	4	1	1	1	1	
CGCM3.1(T63), Canada	1		1			1	1	1		1	1	
CNRM-CM3, France	1		1	1	1	1	1	1	1			1
CSIRO-Mk3.0, Australia	2		3	1	1	1	1	1		1	1	
ECHAM5/MPI-OM, Germany	1		3	3	3	3	3	3	1	1	1	
ECHO-G, Germany/Korea	1	1	5	4	3	2	3	1	1			
FGOALS-g1.0, China	3		3	3		3	3	3				
X GFDL-CM2.0, USA	1		3	1	1	1	1	1	1			
X GFDL-CM2.1, USA	1		3	1	1	1	1	1	1			
X GISS-AOM, USA	2		2			2	2					
X GISS-EH, USA	1		5			4		1				
X GISS-ER, USA	1		9	1	1	5	1	1	1	1	1	4
INM-CM3.0, Russia	1		1	1	1	1	1	1	1	1	1	1
IPSL-CM4, France	1	1	2	1	1	1	1	1	1			6
MIROC3.2(hires), Japan	1		1			1	1	1		1	1	1
MIROC3.2(medres), Japan	1		3	1	3	3	3	3	3	1	1	3
MRI-CGCM2.3.2, Japan	1	1	5	1	5	5	5	1	1	1	1	1
X PCM, USA	1	1	4	3	4	4	4	5	1			1
UKMO-HadCM3, UK	2		2	1	1	1	1	1				
UKMO-HadGEM1, UK	1		1		1	1		1		1	1	1

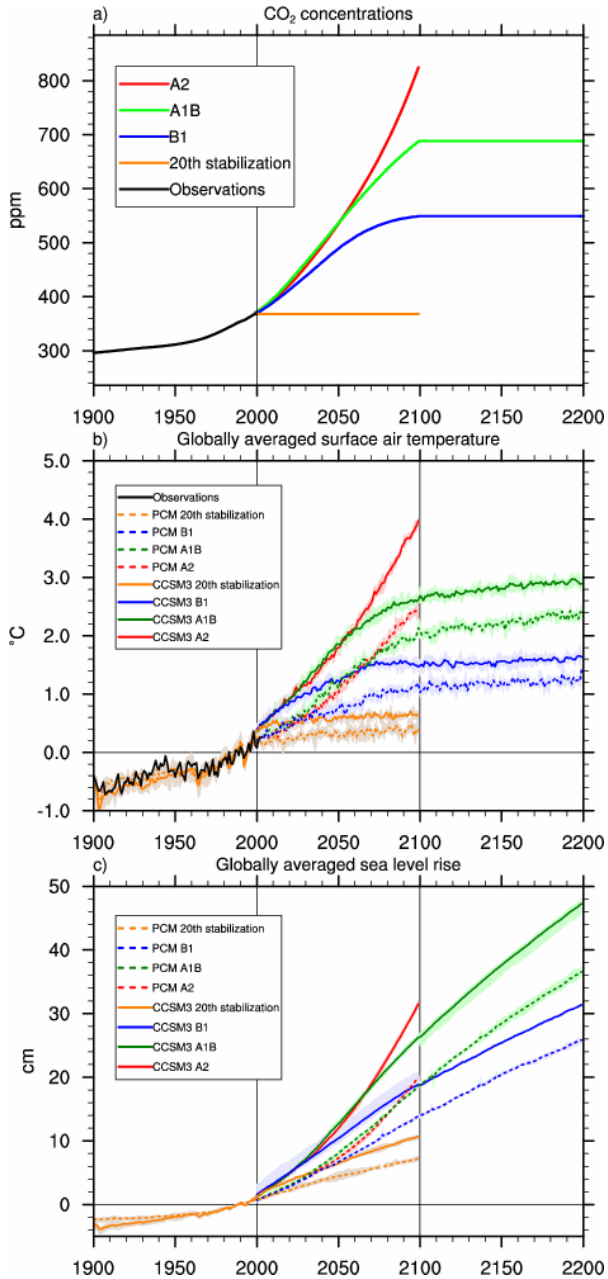
a shaded box indicates that at least some, but not necessarily all, fields of this type are available

Climate change commitment in the NCAR CCSM3 and PCM

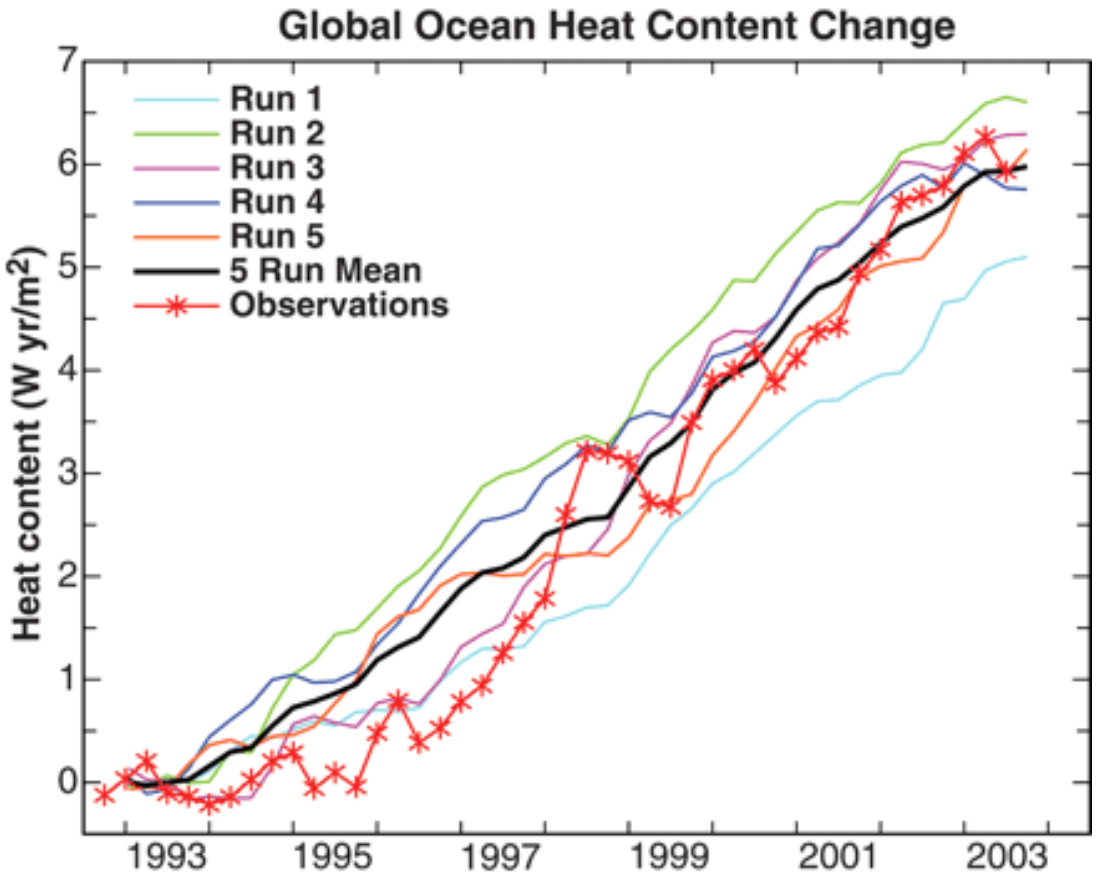
At any point in time, we are committed to additional warming and sea level rise from the radiative forcing already in the system.

Warming stabilizes after several decades, but sea level from thermal expansion continues to rise for centuries.

(Meehl et al., 2005: How much more warming and sea level rise? *Science*, **307**, 1769—1772)

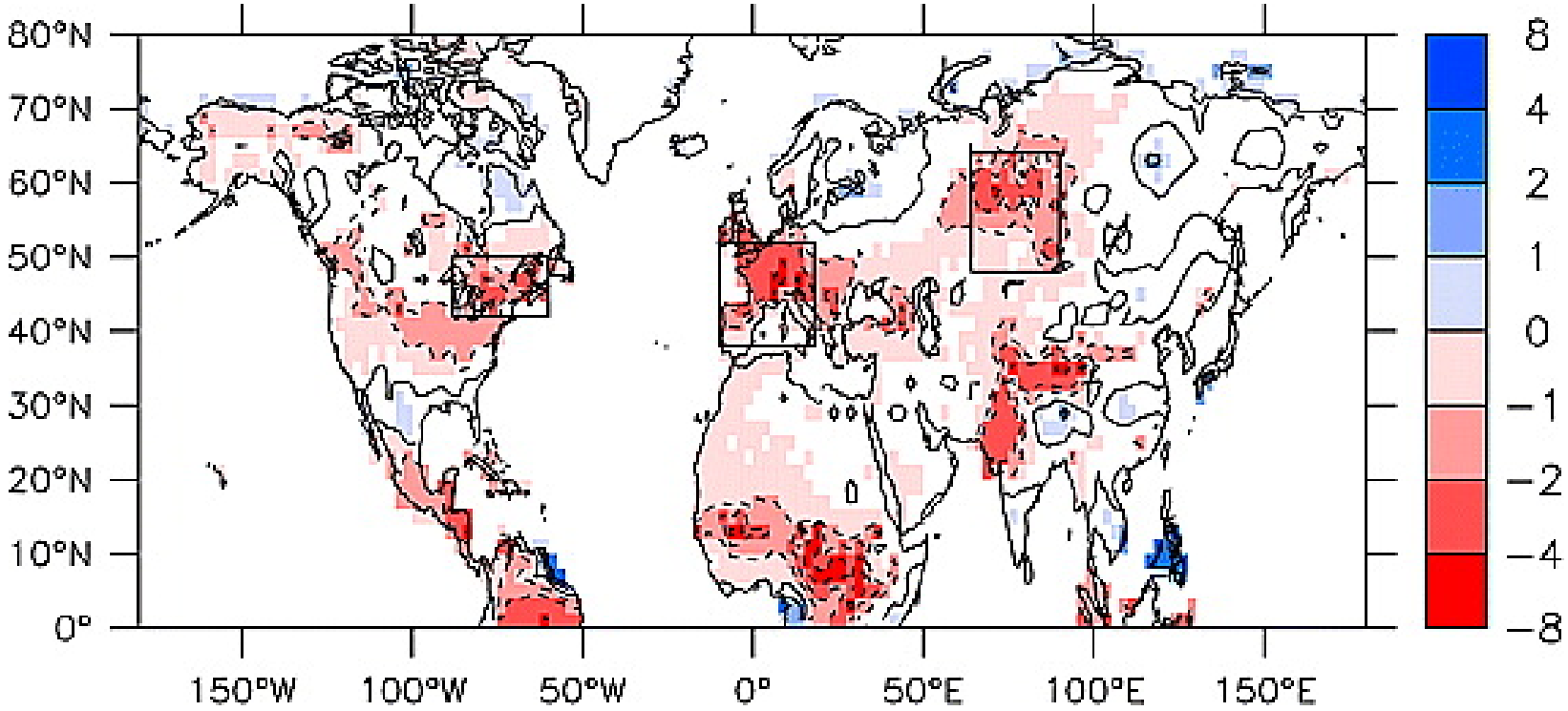


Ocean Heat Uptake in GISS model

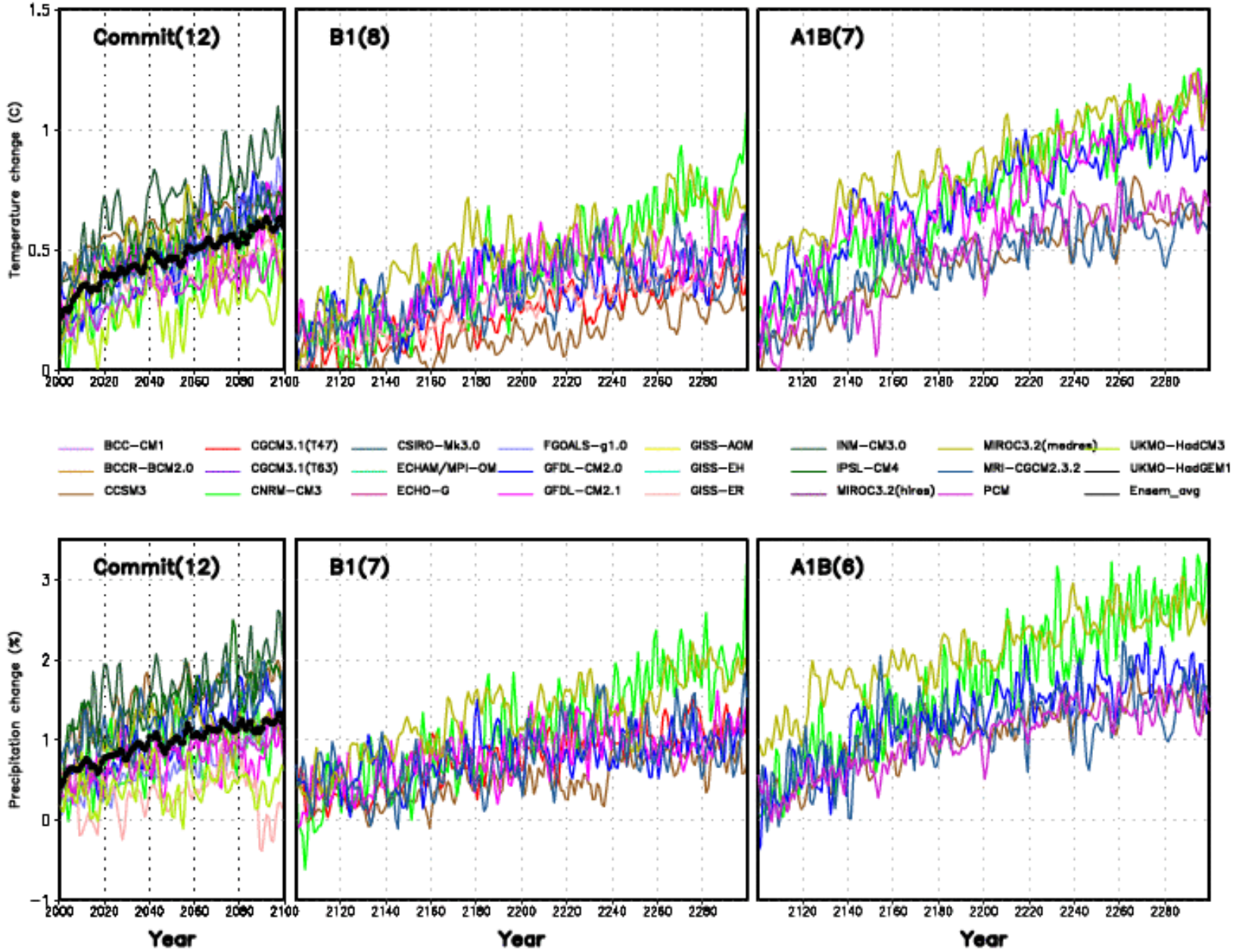


(Hansen, J. and co-authors, 2005: Earth's Energy Imbalance: Confirmation and Implications. *Science*, **308**: 1431-1435)

Summer Drying in GFDL model

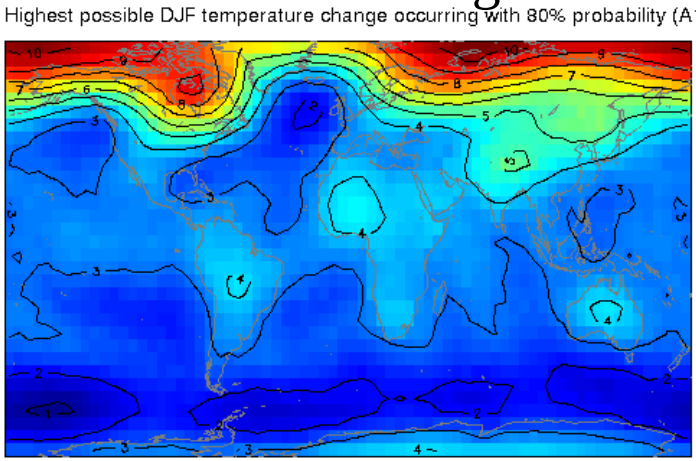


(Findell, K. L., and T. L. Delworth, 2005: A modeling study of dynamic and thermodynamic mechanisms for summer drying in response to global warming. *Geophysical Research Letters*, **32**, L16702, doi: 10.1029/2005GL023414.)

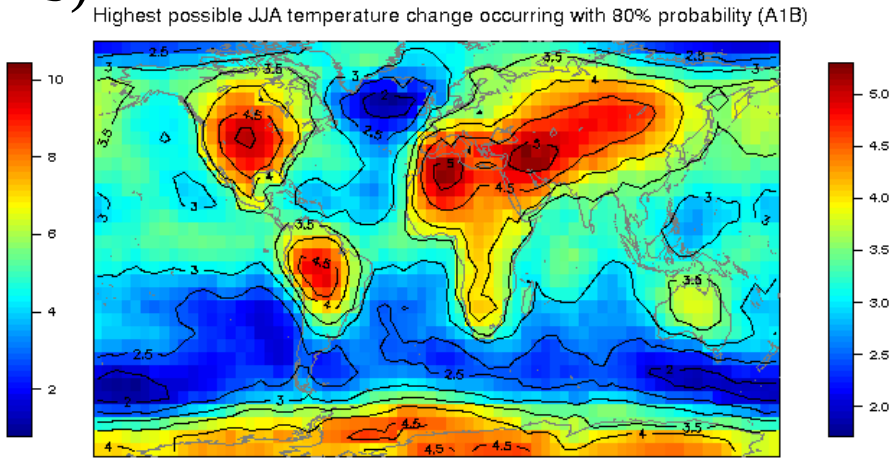

Commit(12)
B1(8)
A1B(7)
Temperature change (C)
1.5
1
0.5
0
2000
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260
2280
BCC−CM1
BCCR−BCM2.0
CCSM3
CGCM3.1(T47)
CGCM3.1(T63)
CNRM−CM3
CSIRO−Mk3.0
ECHAM/MPI−OM
ECHO−G
FGOALS−g1.0
GFDL−CM2.0
GFDL−CM2.1
GISS−AOM
GISS−EH
GISS−ER
INM−CM3.0
IPSL−CM4
MIROC3.2(hires)
MIROC3.2(medres)
MRI−CGCM2.3.2
PCM
UKMO−HadCM3
UKMO−HadGEM1
Ensem_avg
Commit(12)
B1(7)
A1B(6)
Precipitation change (%)
3
2
1
0
−1
Year
Year
Year

21 AOGCMs, 2080-99 compared to 1980-99, SRES A1B, common 5° lat-lon grid

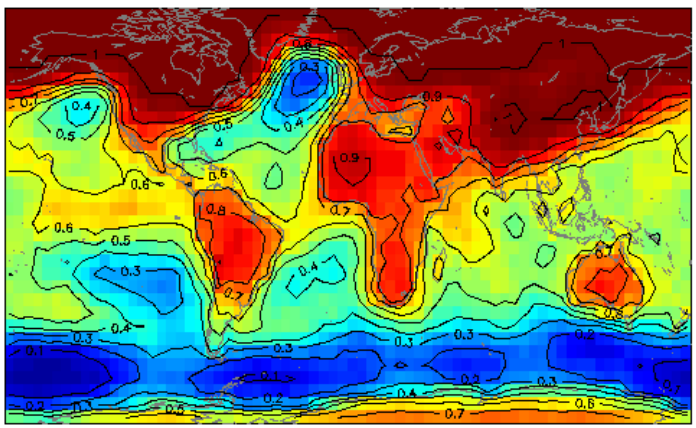
a)



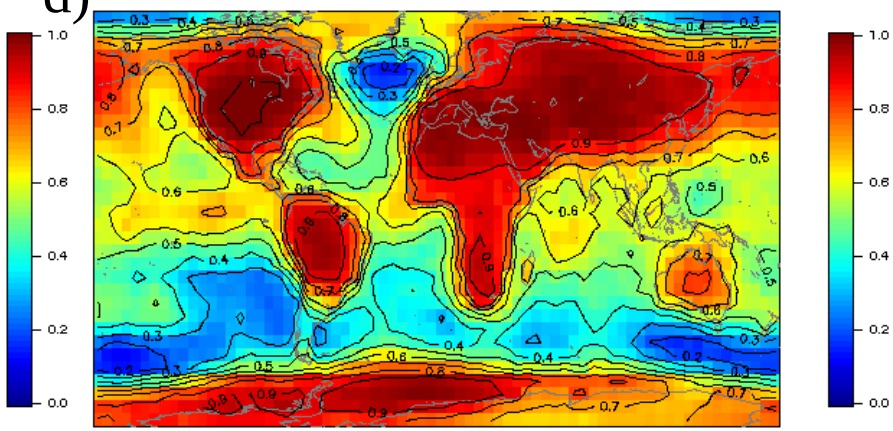
b)



c)



d)



(Furrer et al., 2005)

Results from analyses of the multi-model dataset were presented by 125 scientists at a workshop convened by US CLIVAR and hosted by IPRC (Univ. of Hawaii) March 1-4, 2005, and are feeding directly into the AR4 assessment process

Over 200 papers have been submitted to peer-reviewed journals with results from multi-model analyses for assessment in the IPCC AR4

This is more than double the most optimistic estimate for participation

To date, there are over 400 analysis projects registered at PCMDI, with about three more being added each week

U.S. CLIVAR Climate Model Evaluation Project (CMEP)

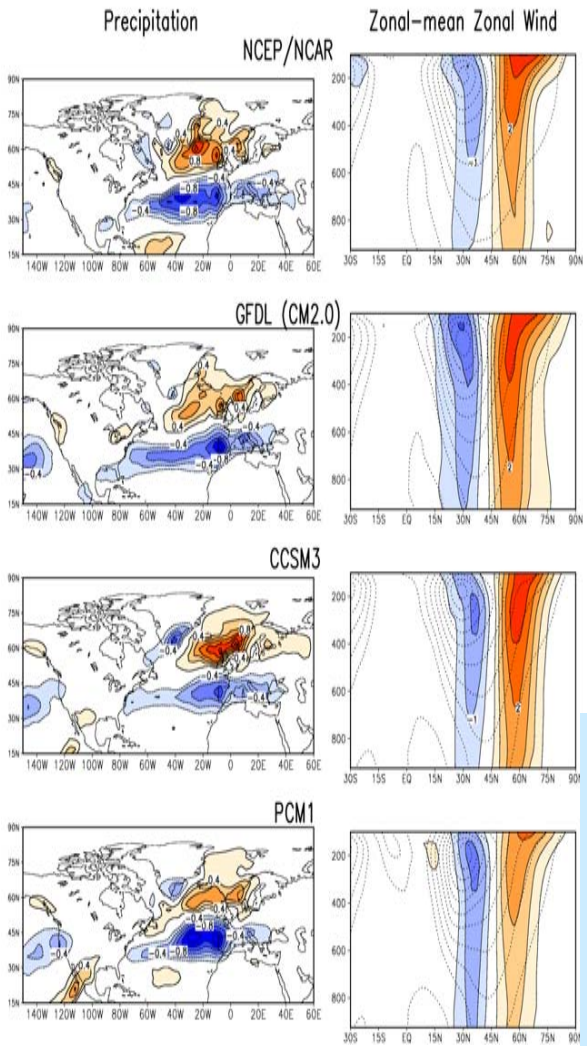
- US CLIVAR recommended that NSF, NOAA, NASA, and DOE have a program to evaluate US coupled climate model simulations of 19th and 20th century
- 61 proposals submitted - 19 funded
- List of awards and abstract found at: www.usclivar.org/science.html

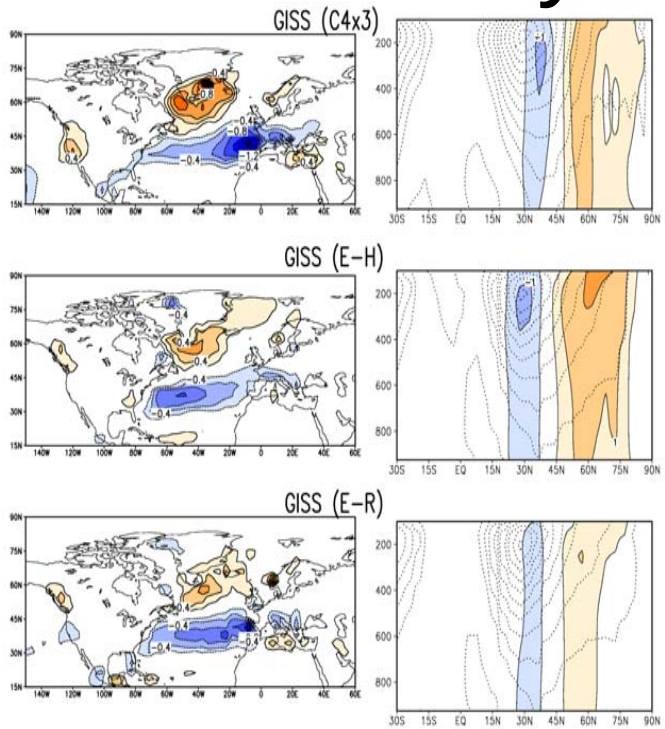
- CMEP IPCC AR4 Workshop hosted by the International Pacific Research Center (IPRC) at the Univ. of Hawaii…about 150 participants

CMEP results: NAO Variability

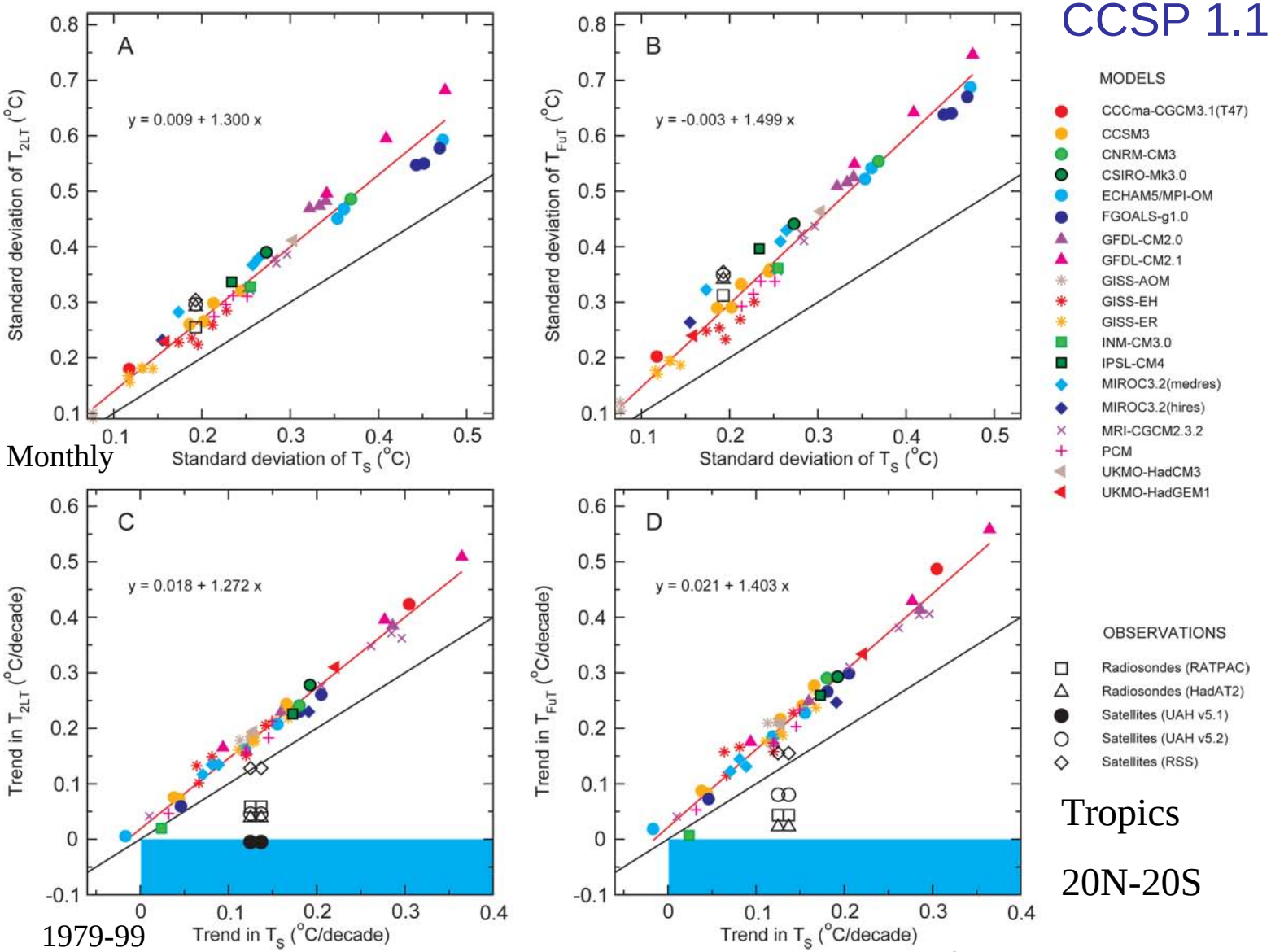
(S. Nigam)

CMEP Results





- NAO variability is tracked using the leading EOF of 850mb heights in the Atlantic sector
- Models are able to generate the salient features of the NAO pattern. The observed pattern exhibits no Pacific connections, but the GFDL pattern does. The southern cell is eastward shifted in CCSM3
- Robust surface temperature signals are produced over northeastern North America and northern Europe and Asia in all models. Distribution of the warming signal over US is more varied, though
- Precipitation anomalies over the Atlantic, reflecting meridional stormtrack displacement, are generally well captured in all models. Positive rainfall anomalies are placed a bit too eastward in CCSM3 and a bit too westward in the GISS C4x3 model.
- NAO related zonal-mean zonal wind anomalies, having a dipole structure in the midlatitudes, are realistically modeled in the GFDL, CCSM3 and PCM runs; they serve to broaden the jet in all cases; connections to the lower stratosphere are also well modeled (Nigam)



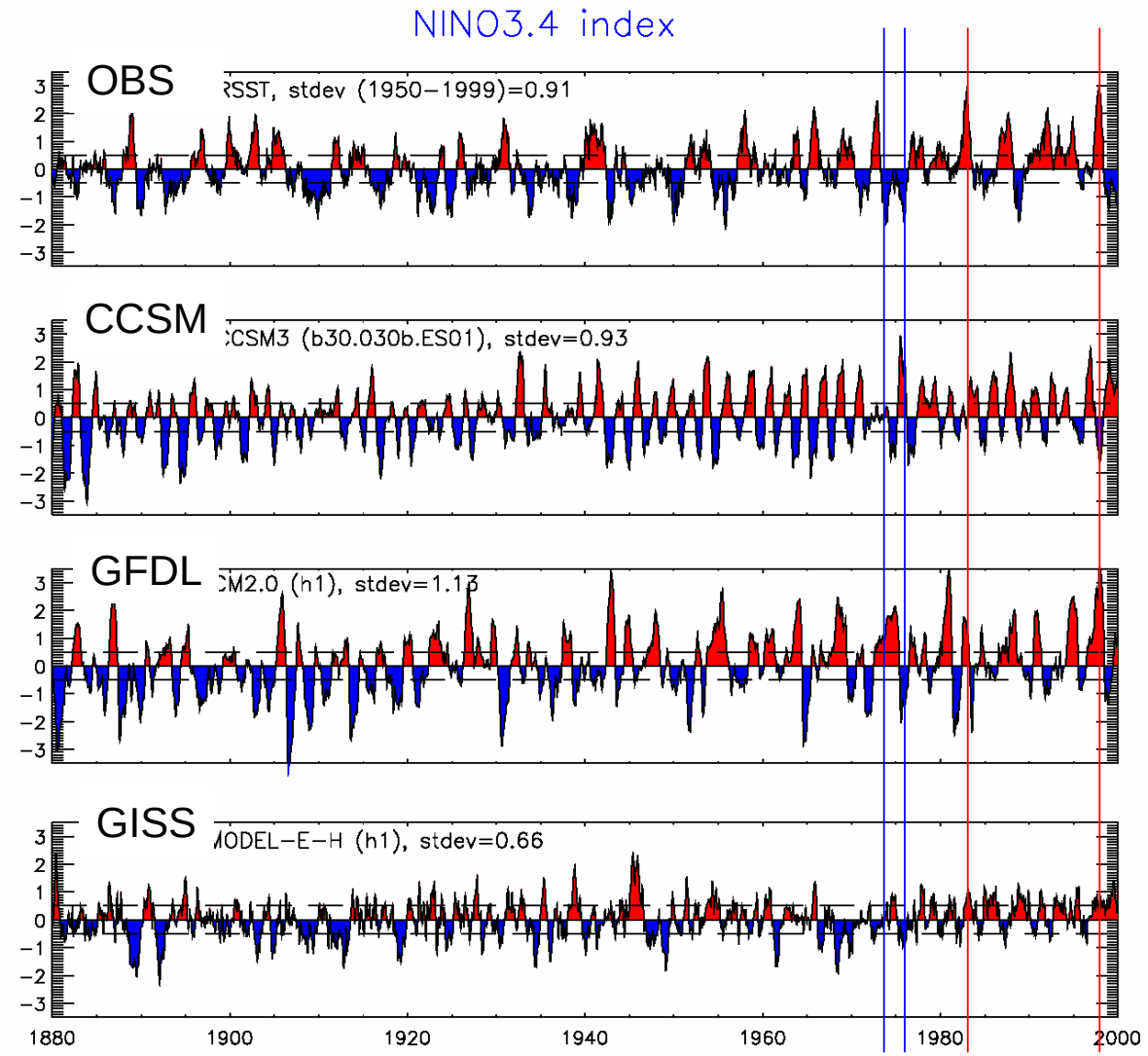
(Santer et al., 2005, Science) obs and 49 realizations from 19 AOGCMs

Conclusions

1. The U.S. modeling centers (GFDL, GISS, and NCAR-CCSM) have all made significant contributions in terms of running the model experiments and analyzing results from their models for publication and assessment in the AR4
2. PCMDI has taken on the formidable task of collecting, archiving and making available the multi-model data; 27 terabytes archived, over 400 registered analysts, more than 200 papers submitted
3. CMEP has provided funding for 19 U.S. projects to analyze the output from the U.S. models
4. The model data have been used and will continue to be used in support of the CCSP reports and further CMEP analyses (recommended by US CLIVAR)

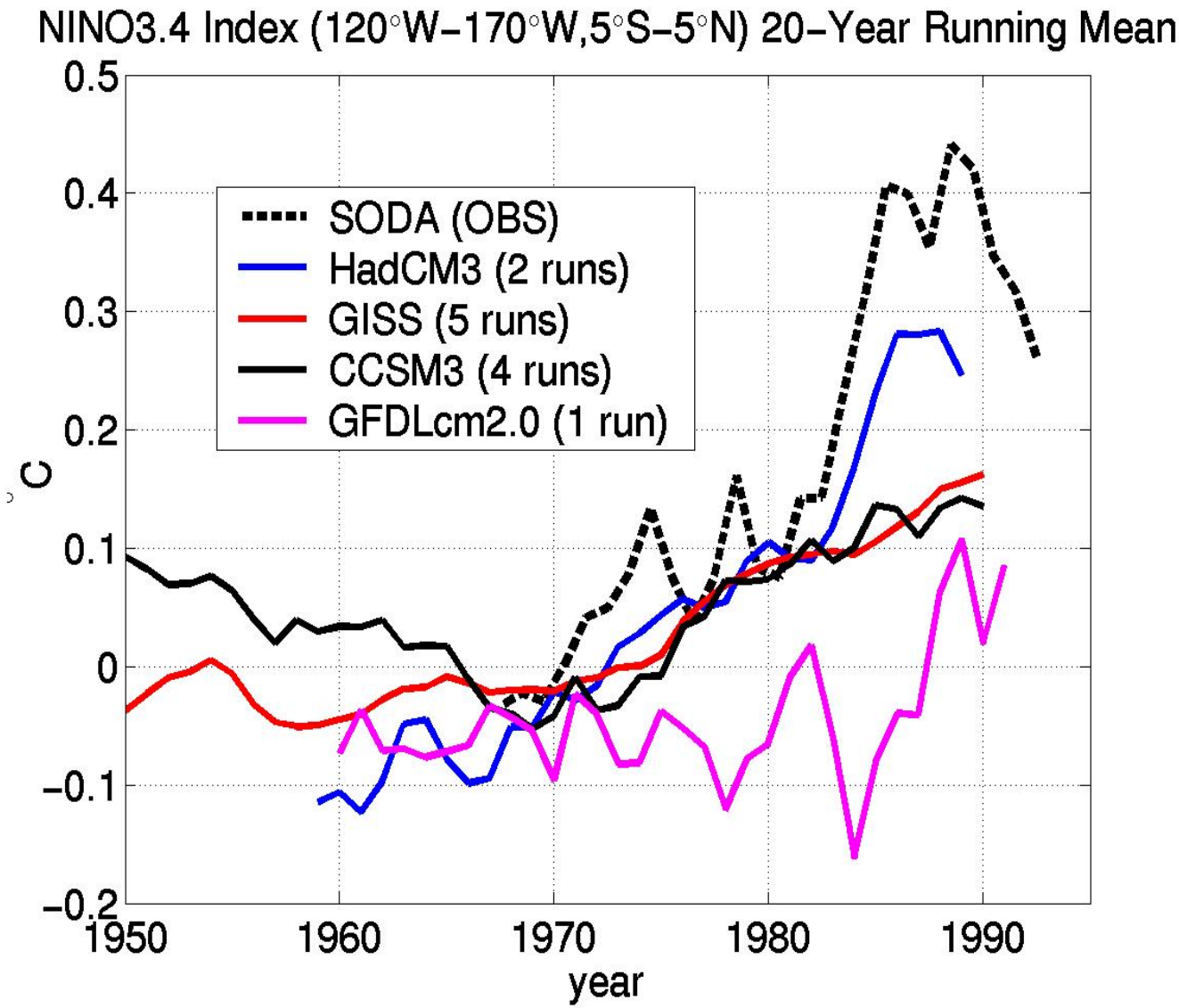
IPCC AR4 ENSO Events

CMEP Results



A. Solomon

A.Capotondi

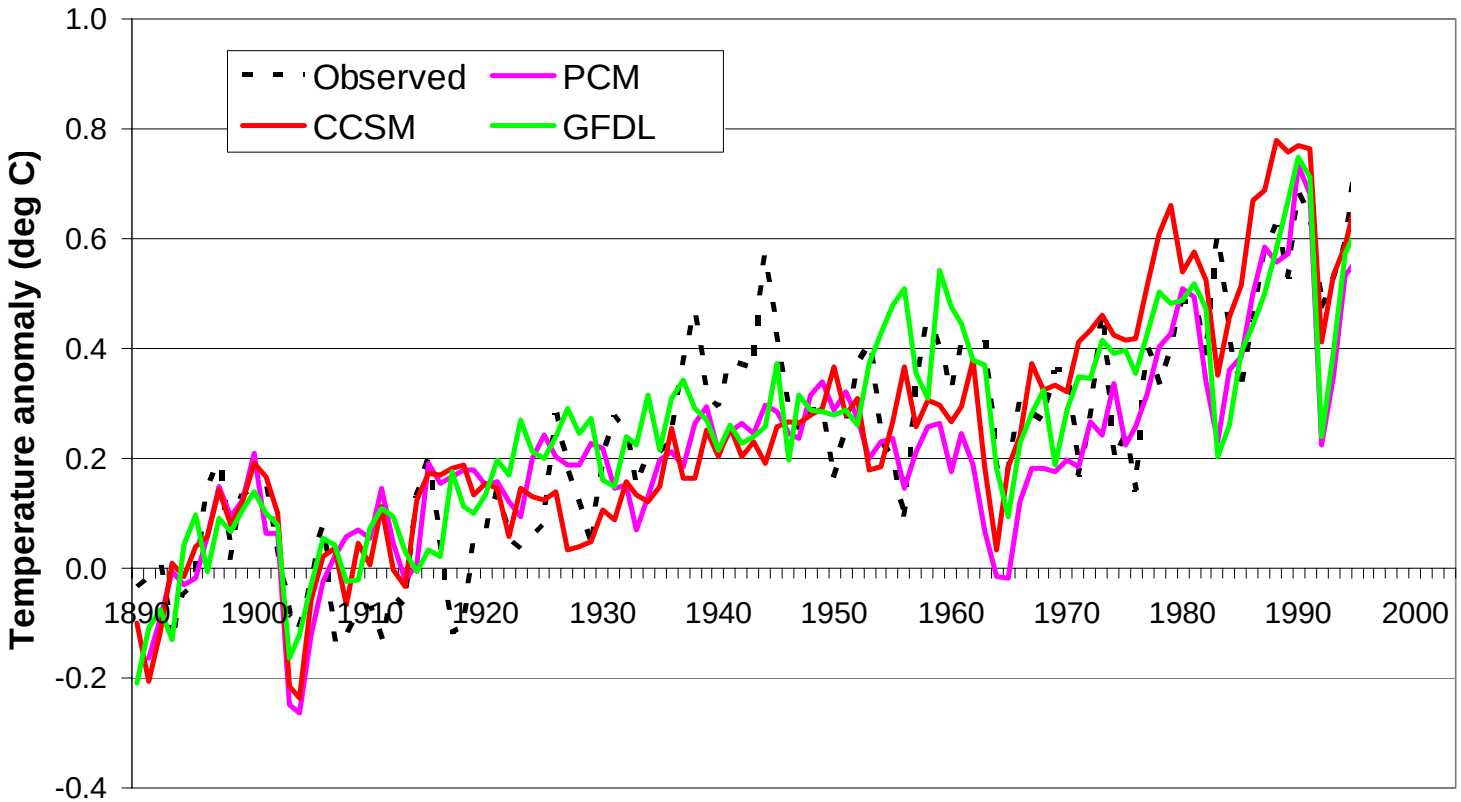

NINO3.4 Index (120°W–170°W,5°S–5°N) 20–Year Running Mean
SODA (OBS)
HadCM3 (2 runs)
GISS (5 runs)
CCSM3 (4 runs)
GFDLcm2.0 (1 run)
°C
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
1950
1960
1970
1980
1990
year

Simple Indices of Climate Variability and Change

(D. Karoly)

Global mean surface air temperature

CMEP Results



There is very good agreement between the time variations of observed global-mean temperature and the ensemble-mean from the model simulations that included all forcings; increasing greenhouse gases and sulphate aerosols, as well as major volcanic eruptions and changes in total solar irradiance. The modeled cooling after volcanic eruptions appears to be too large.