

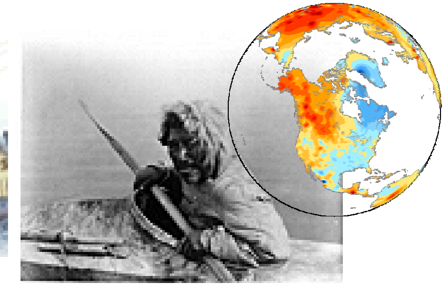

EVALUATION OF IPCC AR4 COUPLED CLIMATE MODEL SIMULATIONS

A First Look at the Simulations over the Arctic and North Pacific During 20^{th} Century

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Experiment Design Specification – Part I

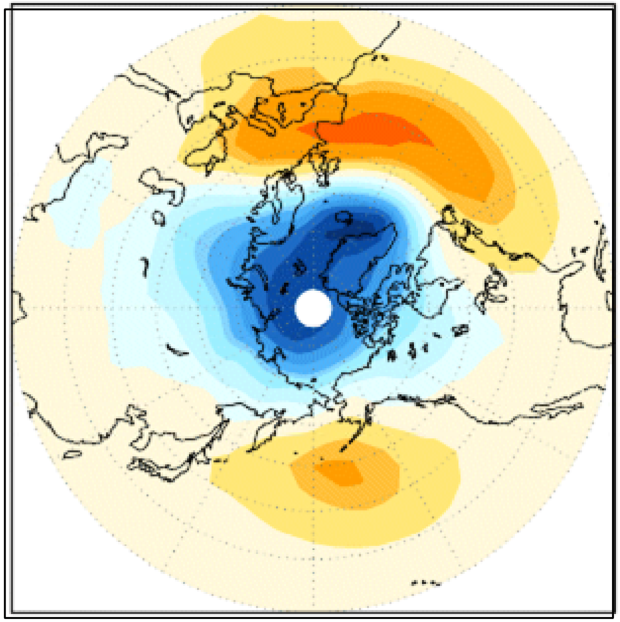
	Experiment Name	Monthly Data and Yearly Data (Extreme Indices) (submit for each member of ensemble)	Daily Data (temperature and precipitation data should be submitted for each member of ensemble, but all other fields should be submitted for only a single ensemble member)	3-Hourly Data (submit for a single ensemble member)	Notes
1	pre-industrial control experiment	> 100 years (~500 years)	40 years that can best be compared to years 1961-2000 (i.e., through the end of year 2000) of the 20C3M expt.	last year of reported daily data (i.e., corresponding to year 2000 of the 20C3M expt.)	control for experiments 3-7 and for some models also the control for experiments 8-9. There will be no anthropogenic or natural forcing in this control. The control experiment should be long enough to extend to the furthest point in time reached by the end of the perturbation experiments (which presumably branch from it). Thus the control should allow us to subtract any residual, unforced drift from all perturbation simulations.
2	present-day control experiment	> 100 years (~300 years)	last 20 years	last year	for most models this experiment is not needed, but for some it is the control for experiments 8-9. There will be no natural forcing and anthropogenic influences will be set at present-day level. The control experiment should be long enough to extend to the furthest point in time reached by the end of the perturbation experiments (which branch from it). Thus the control should allow us to subtract any residual, unforced drift from the perturbation simulations.
3	climate of the 20th Century experiment (20C3M)	~1850 - present	1961 - 2000 (i.e., through the end of year 2000)	1991-2000 (i.e., through the end of year 2000)	should initialize from a point early enough in the pre-industrial control run to ensure that the end of all the perturbed runs branching from the end of this 20C3M run end before the end of the control. This will enable us to subtract any residual drift in the control from all runs that will be compared to it.
4	committed climate change experiment	present - 2100	2046-2065, 2081 - 2100	2050, 2100	should take the end of the 20C3M run as its initial condition.
5	SRES A2 experiment	present - 2100	2046 - 2065, 2081 - 2100	2050, 2100	should take the end of the 20C3M run as its initial condition.
6	720 ppm stabilization experiment (SRES A1B)	present - 2300 (present - 2200)	2046 - 2065, 2081-2100, 2181-2200, 2281-2300	2050, 2100, 2150, 2200, 2300	Impose SRES A1B conditions and initialize with conditions from the end of the 20C3M simulation and run to 2100, after which hold concentrations fixed and continue run to 2200. One member of the ensemble should be extended for an additional 100 years (to 2300), continuing to hold concentrations fixed.

Experiment Design Specification – Part II

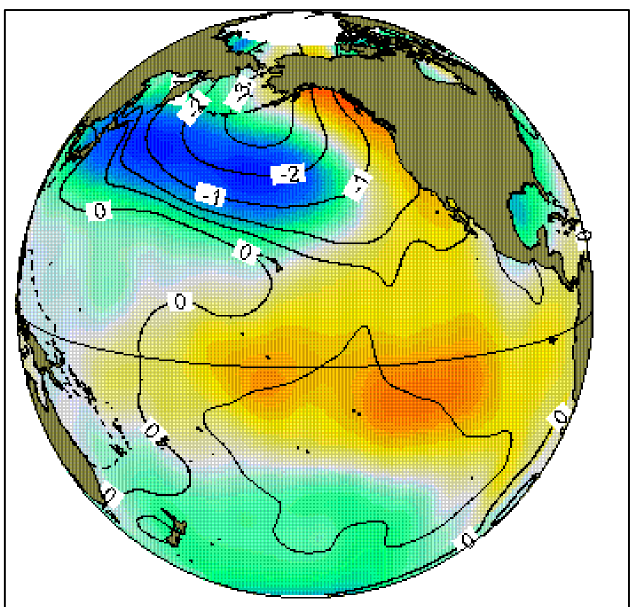
	Experiment Name	Monthly Data and Yearly Data (Extreme Indices) (submit for each member of ensemble)	Daily Data (temperature and precipitation data should be submitted for each member of ensemble, but all other fields should be submitted for only a single ensemble member)	3-Hourly Data (submit for a single ensemble member)	Notes
7	550 ppm stabilization experiment (SRES B1)	present - 2300 (present - 2200)	2046 - 2065, 2081-2100, 2181-2200, 2281-2300	2050, 2100, 2150, 2200, 2300	Impose SRES B1 conditions and initialize with conditions from the end of the 20C3M simulation and run to 2100, after which hold concentrations fixed and continue run to 2200. One member of the ensemble should be extended for an additional 100 years (to 2300), continuing to hold concentrations fixed.
8	1%/year CO2 increase experiment (to doubling)	~70 years to doubling + an additional 150 years	20 years centered on time of doubling + last 20 years	at doubling and 150 years after doubling	Hold CO2 fixed after reaching doubled concentration. This run should be initialized from a point either within a present-day control run or a pre-industrial control run. Make sure that the initial time is early enough in the control run to subtract out any residual (unforced) drift that might occur over the 220 years of this experiment.
9	1%/year CO2 increase experiment (to quadrupling)	~140 years to quadrupling + an additional 150 years	20 years centered on time of quadrupling + last 20 years	at quadrupling and 150 years after quadrupling	Hold CO2 fixed after reaching quadrupled concentration. This run should be initialized from a point either within a pre-industrial control run or a present-day control run. Make sure that the initial time is early enough in the control run to subtract out any residual (unforced) drift that might occur over the 290 years of this experiment.
10	slab ocean control experiment	~100 years??	last 20 years	last year	slab ocean control for experiment 11. Be sure to run long enough to reach a true equilibrium state and to produce stable statistics (at least 20 years beyond equilibrium).
11	2xCO2 equilibrium experiment	~100 years??	last 20 years	last year	slab ocean experiment with an instantaneous doubling. There is interest in the transient response to the instantaneous doubling, so please report all years and be sure to run long enough to reach a true equilibrium state and to produce stable statistics (at least 20 years beyond equilibrium).
12	AMIP simulation	1979 - present	all years	2000	atmospheric component should be identical to that used in the above experiments

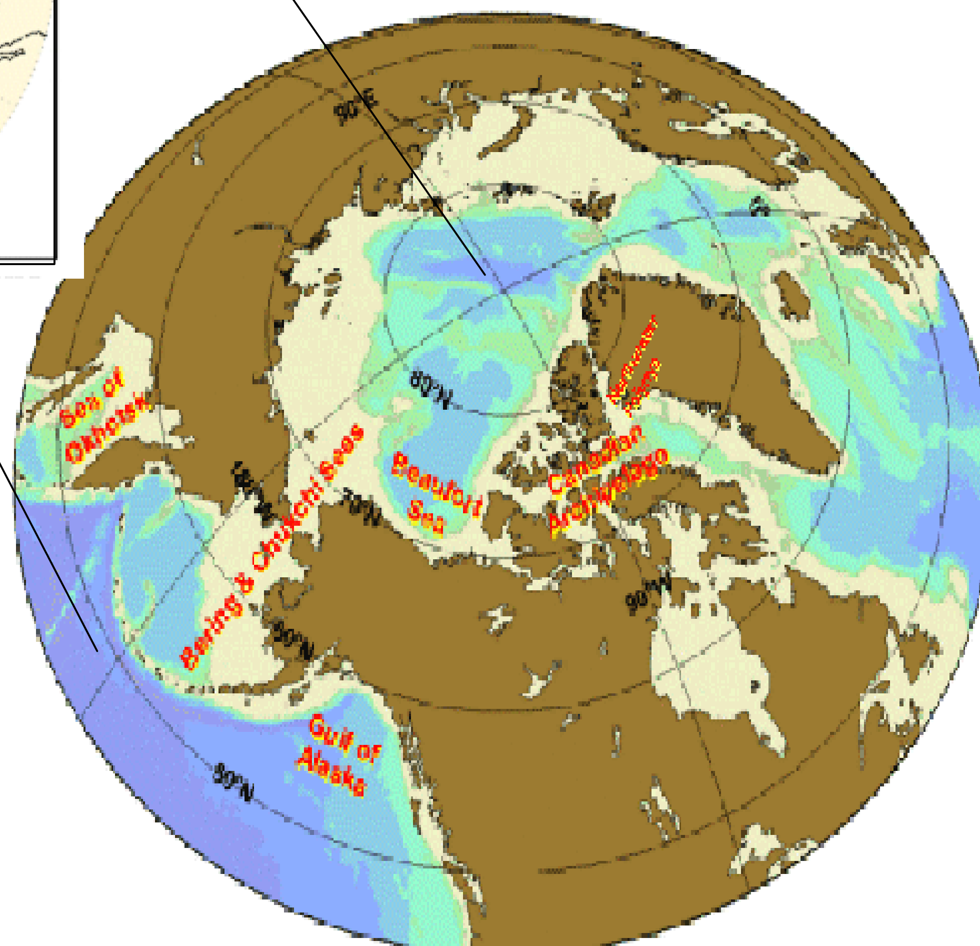
AREA OF INTERESTS

Arctic

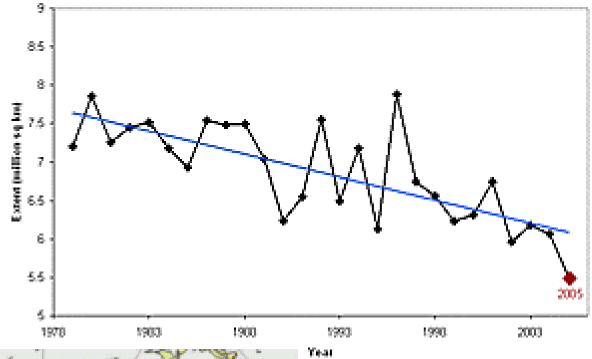


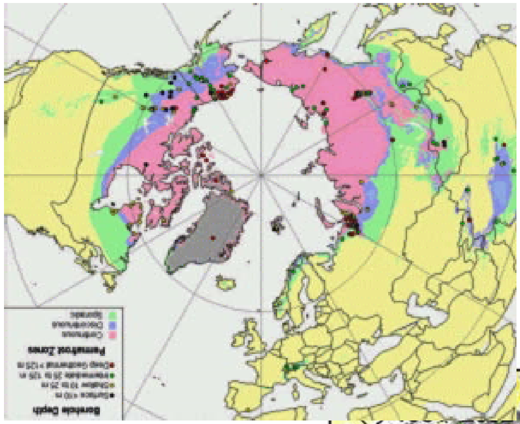
North Pacific



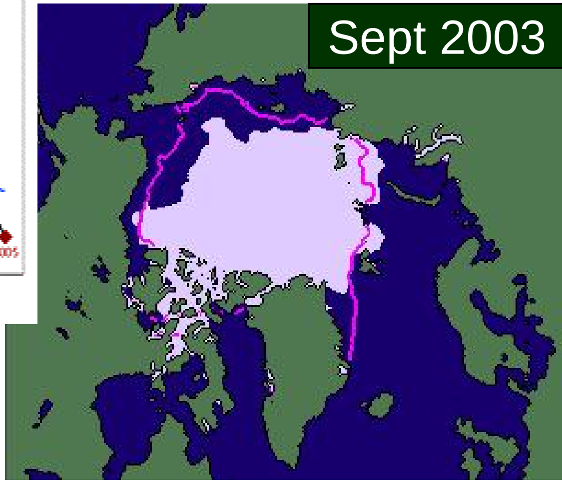


Persistent Multivariate Arctic Changes



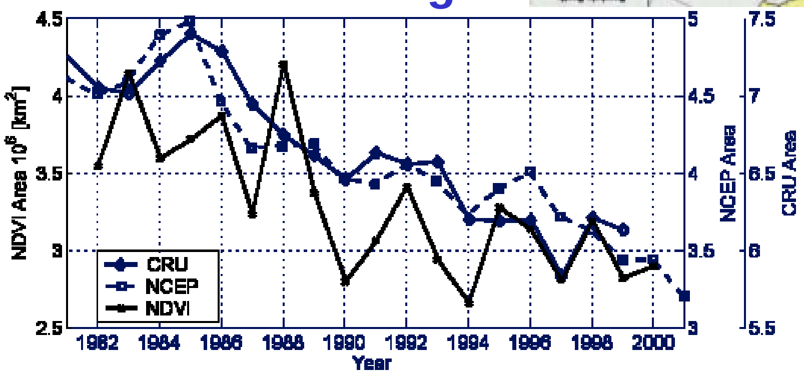


Sea Ice

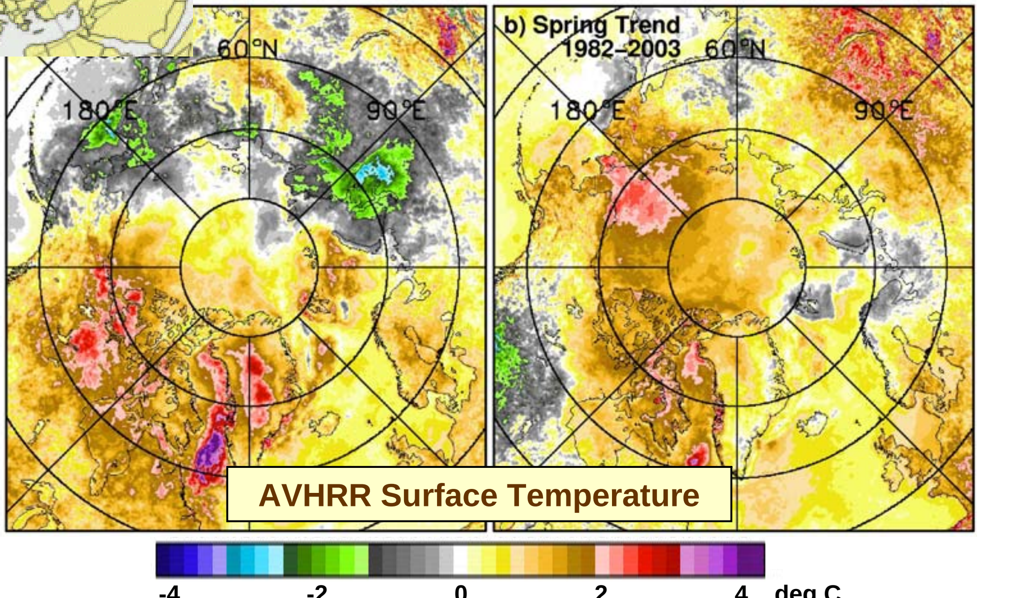


From NSIDC

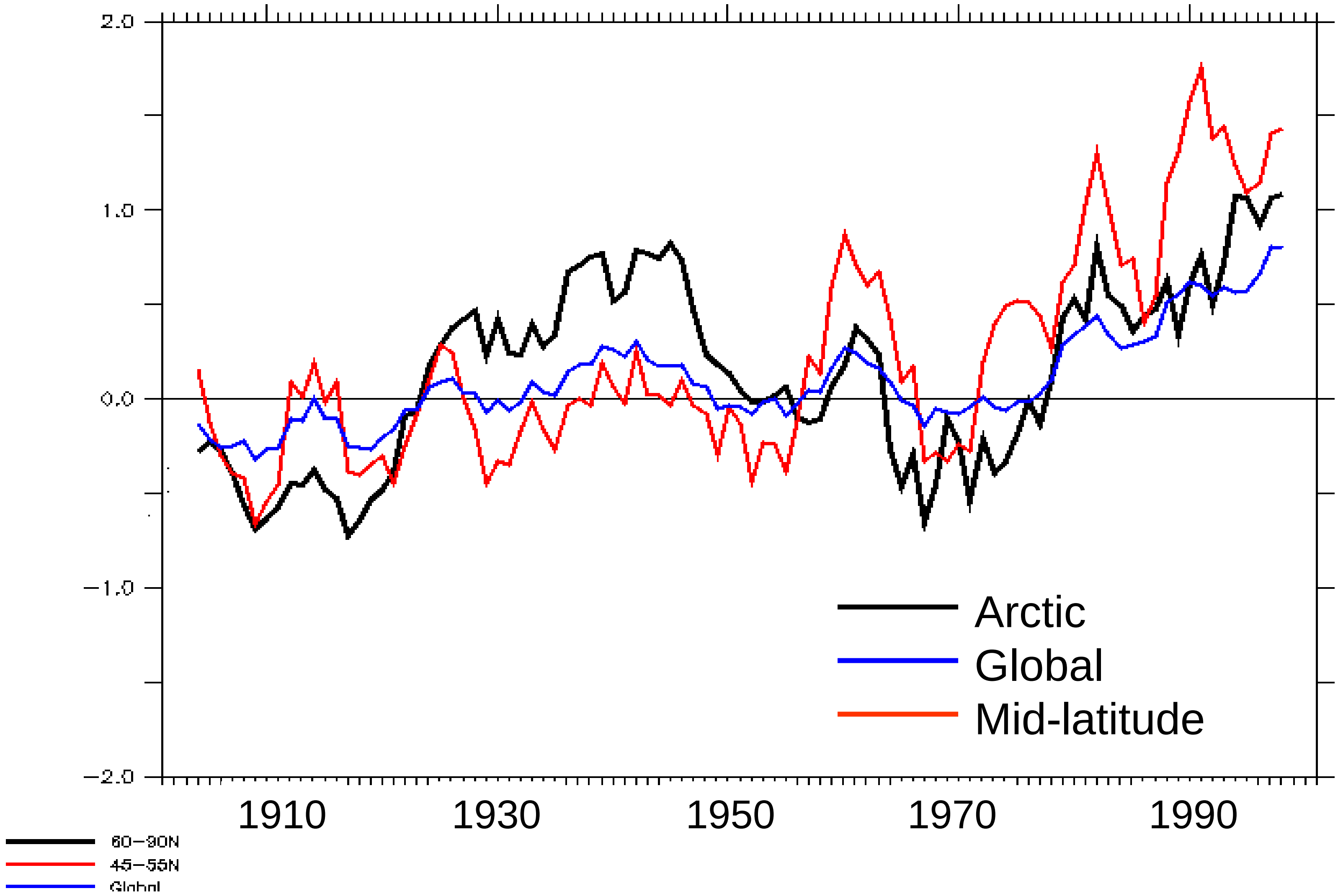
Tundra Decreasing



Overland and Wang 2005
Wang and Overland 2004

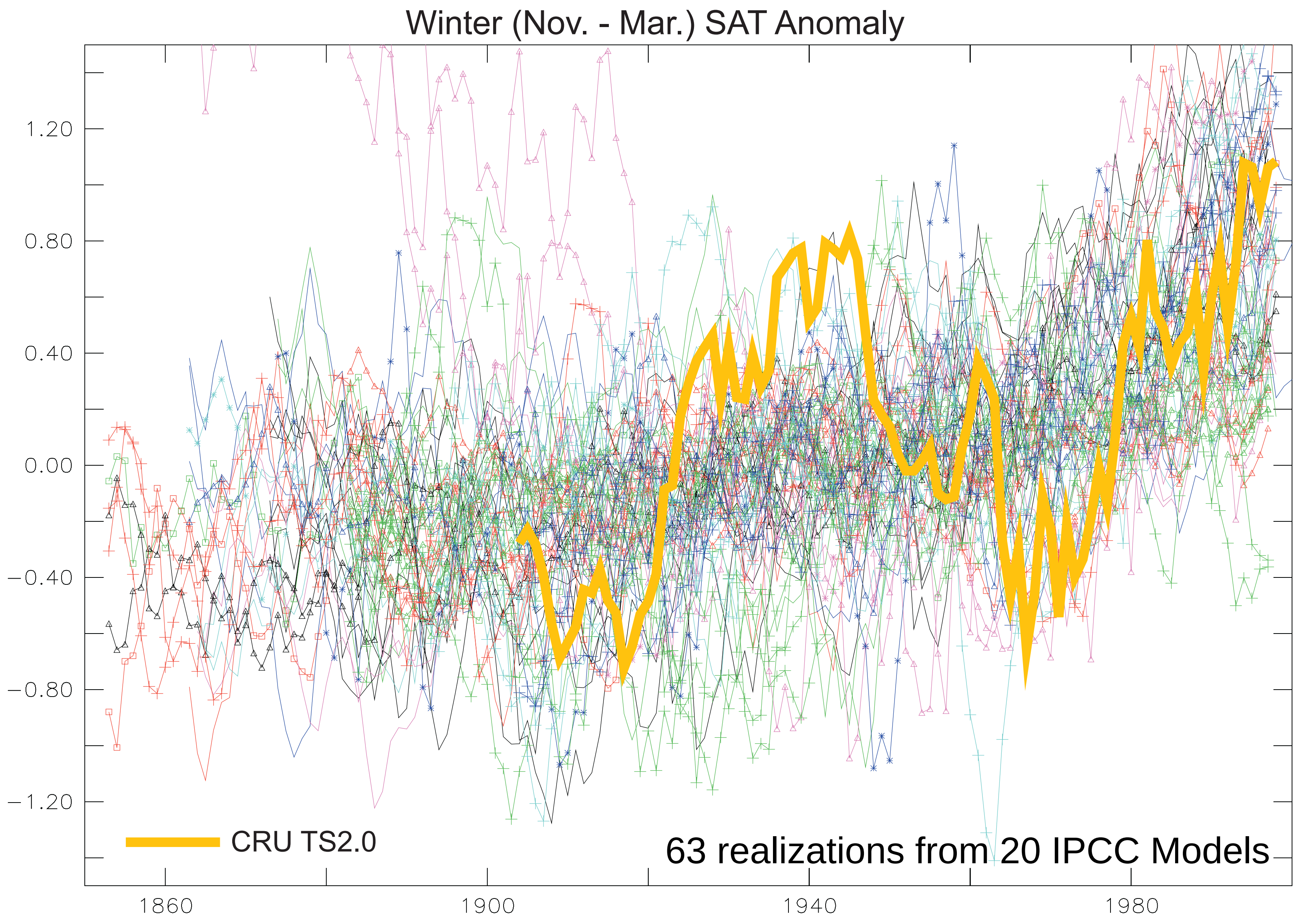


20th Century Zonal Mean Land Surface Air Temperature Anomalies (Nov. – Mar.)



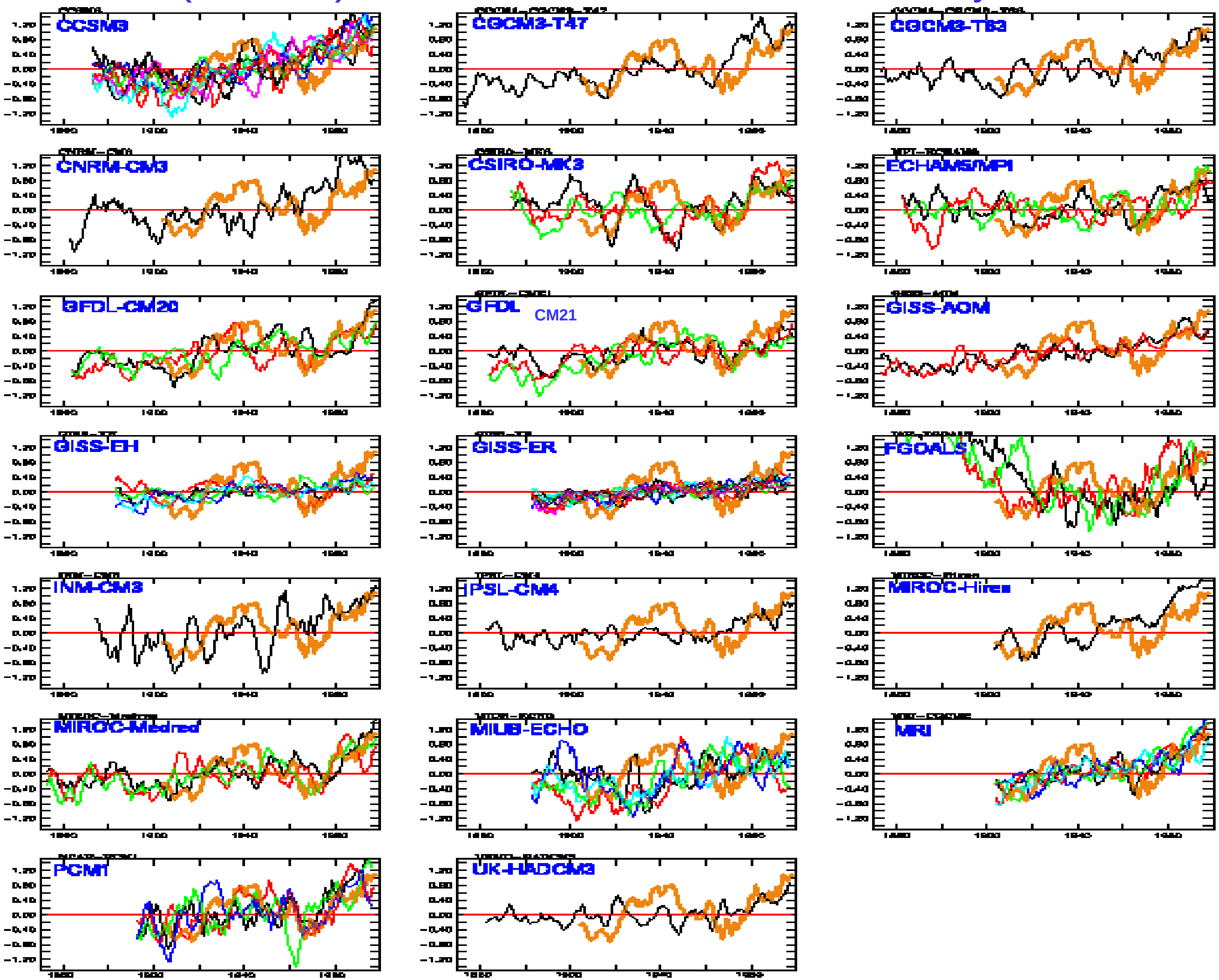
Model and Ensemble Runs Analyzed

	IPCC I.D.	Country	Atmosphere Resolution	Ocean Resolution	Simulation Length	# of Realizations	Control Runs (yrs)	Natural Forcing in 20C3M
1	**CCSM3**	**USA**	T85L26	(0.3-1.0°)x1.0° L40	1/1870 –12/1999	**8**	230, 500	Yes
2	**CGCM3.1 (T47)**	**Canada**	T47L31	1.9° x1.9° L29	1/1850 – 12/2000	**1**	500	No
3	**CGCM3.1 (T63)**	**Canada**	T63L31	1.4° x0.9° L29	1/1850 – 12/2000	**1**	349	No
4	**CNRM-CM3**	**France**	T42L45	182x152L31	1/1860 –12/1999	**1**	390	No
5	**CSIRO-Mk3.0**	**Australia**	T63L18	1.875° x0.925° L31	1/1871 – 12/2000	**3**	380, 80	No
6	**ECHAM5/ MPI-OM**	**Germany**	T63L31	1.5° x1.5° L40	1/1860 –12/2050[1]	**3**	332	No
7	**FGOALS-g1.0**	**China**	T42L26	1° x1° xL30	1/1850 –12/1999	**3**	150x3	No
8	**GFDL-CM2.0**	**USA**	2.5° x2.0° L24	1° x1° L50	1/1861 –12/2000	**3**	500	Yes
9	**GFDL-CM2.1**	**USA**	2.5° x2.0° L24	1° x1° L50	1/1861 – 12/2000	**3**	100x5	Yes
10	**GISS-AOM**	**USA**	T42L20	1.4° x1.4° L43	1/1850 –12/2000	**2**	251x2	Yes[4]
11	**GISS-EH**	**USA**	5° x4° L20	2° x2° *cos(lat) L16	1/1880 –12/1999	**5**	400	Yes
12	**GISS-ER**	**USA**	5° x4° L13	5° x4° L13	1/1880 –12/2003	**9**	500	Yes
13	**INM-CM3.0**	**Russia**	5° x5° L21	2° x2.5° L33	1/1871 –12/2000	**1**	130, 200	Yes
14	**IPSL-CM4**	**France**	3.75° x2.5° L19	(1° -2°)x2° L19	1/1860 – 12/2000	**1**	230	No
15	**MIROC3.2 (hires)**	**Japan**	T106 L56	0.28125° x0.1875° L47	1/1900 –12/2000	**1**	101	Yes
16	**MIROC3.2 (medres)**	**Japan**	T42 L20	(0.5° -1.4°)x1.4° L44	1/1850 –12/2000	**3**	500	Yes
17	**MIUB-ECHO**	**Germany**	T30L19	T42L20	1/1889 – 12/1999	**5**	341	Yes
18	**MRI-CGCM2.3.2**	**Japan**	T42 L30	(0.5° -2. 5°)x2° L23	1/1901 –12/2000[2]	**5**	350	Yes
19	**PCM**	**USA**	T42L18	(0.5-0.7°)x0.7° L32	1/1890 –12/1999	**4**	350	Yes
20	**UKMO-HadCM3**	**UK**	3.7° 5x2.5° L15	1.25° x1.25° L20	1/1860 –12/1999	**1[3]**	341	No
	Sum				**1901-1999**	**63**		

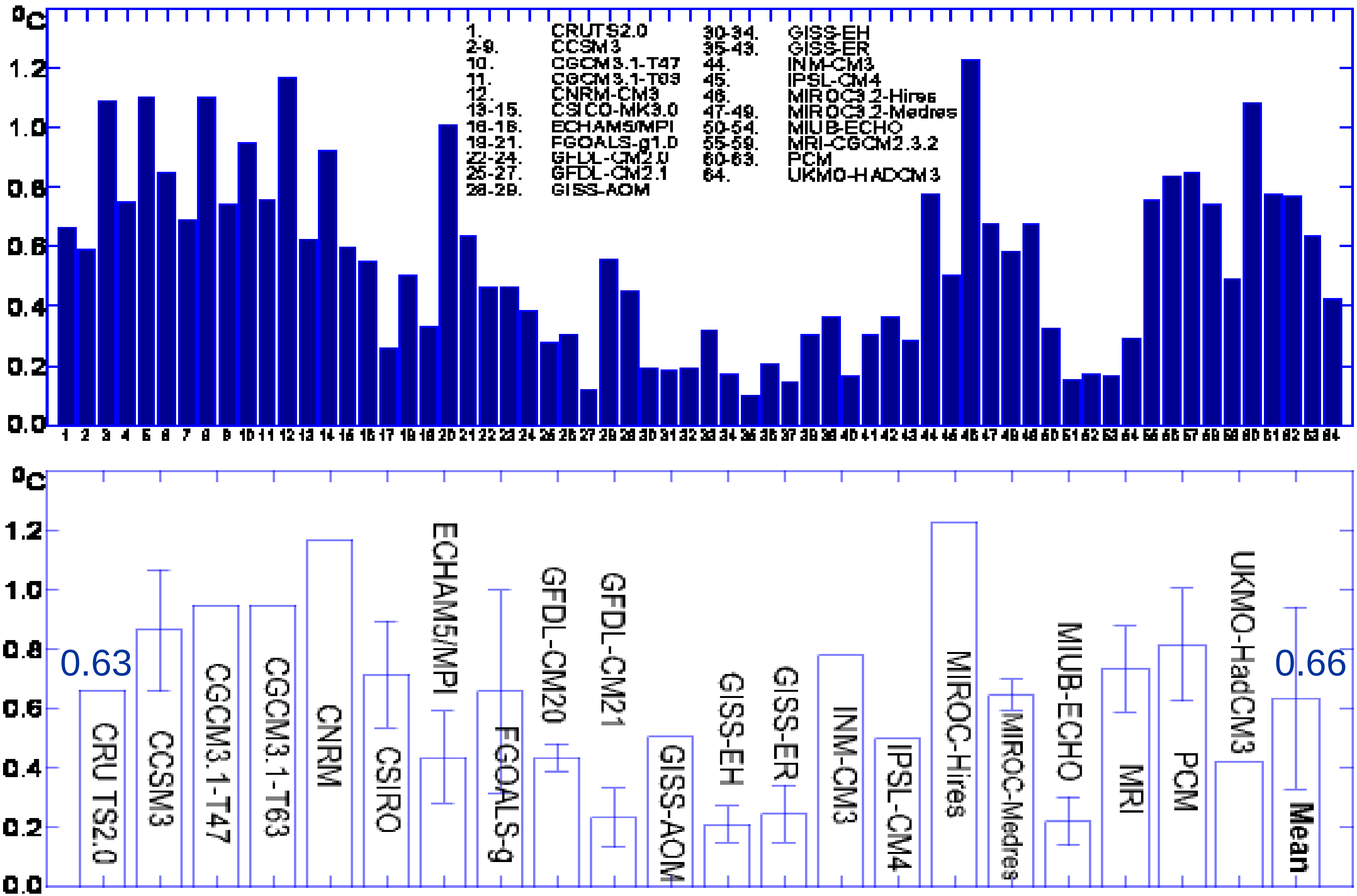


Winter (Nov. - Mar.) SAT Anomaly
1.20
0.80
0.40
0.00
−0.40
−0.80
−1.20
1860
1900
1940
1980
CRU TS2.0
63 realizations from 20 IPCC Models

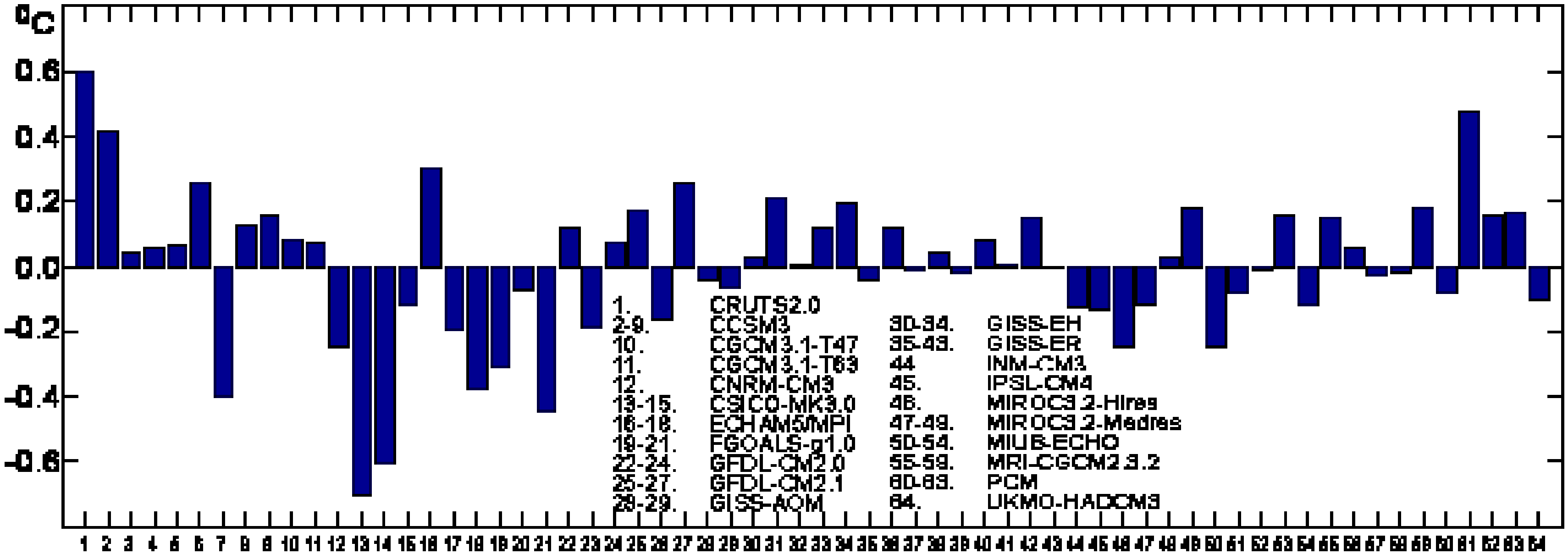
Arctic (60-90^{o}N) Winter SAT Anomalies Simulated by Models

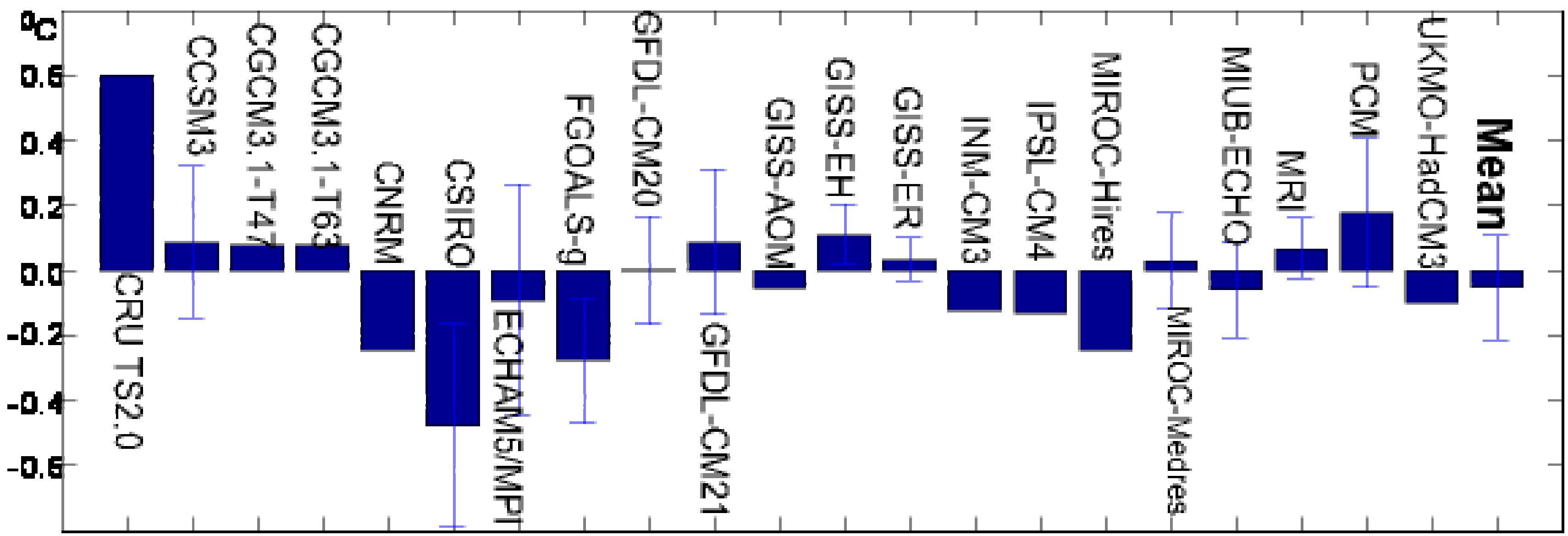


Decadal Mean of Win5m SAT for 1979-99 period



Decadal Mean of Win5m SAT for 1939-49 period

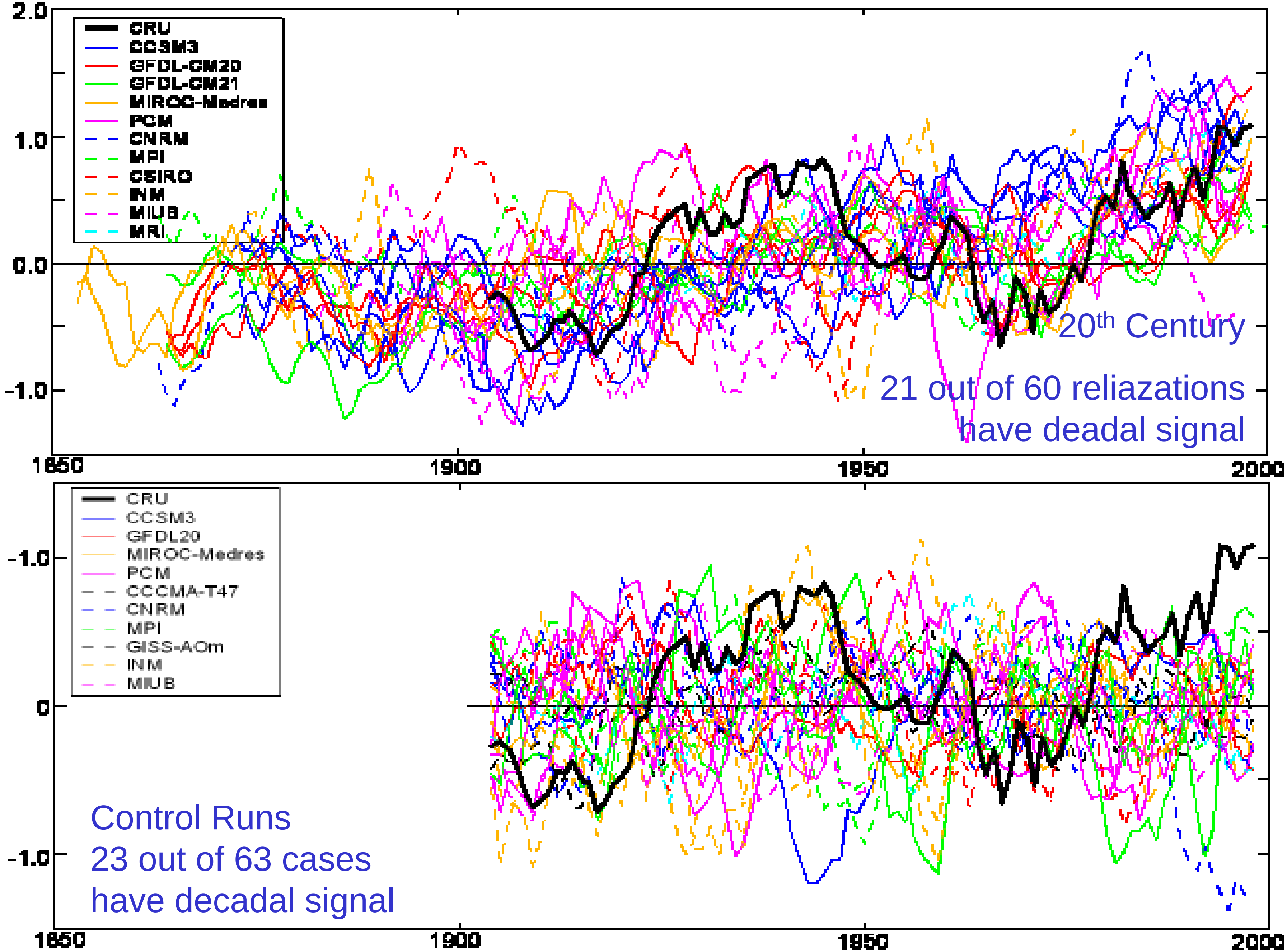




THE CRITERION

A Success Simulation of mid-century Warm Anomaly is

The maximum of the 5-yr averaged winter SAT anomalies in a given period (1920-60) is greater then 2/3 of the observed maximum, (0.55 ^{o}C) based on CRU TS2.0

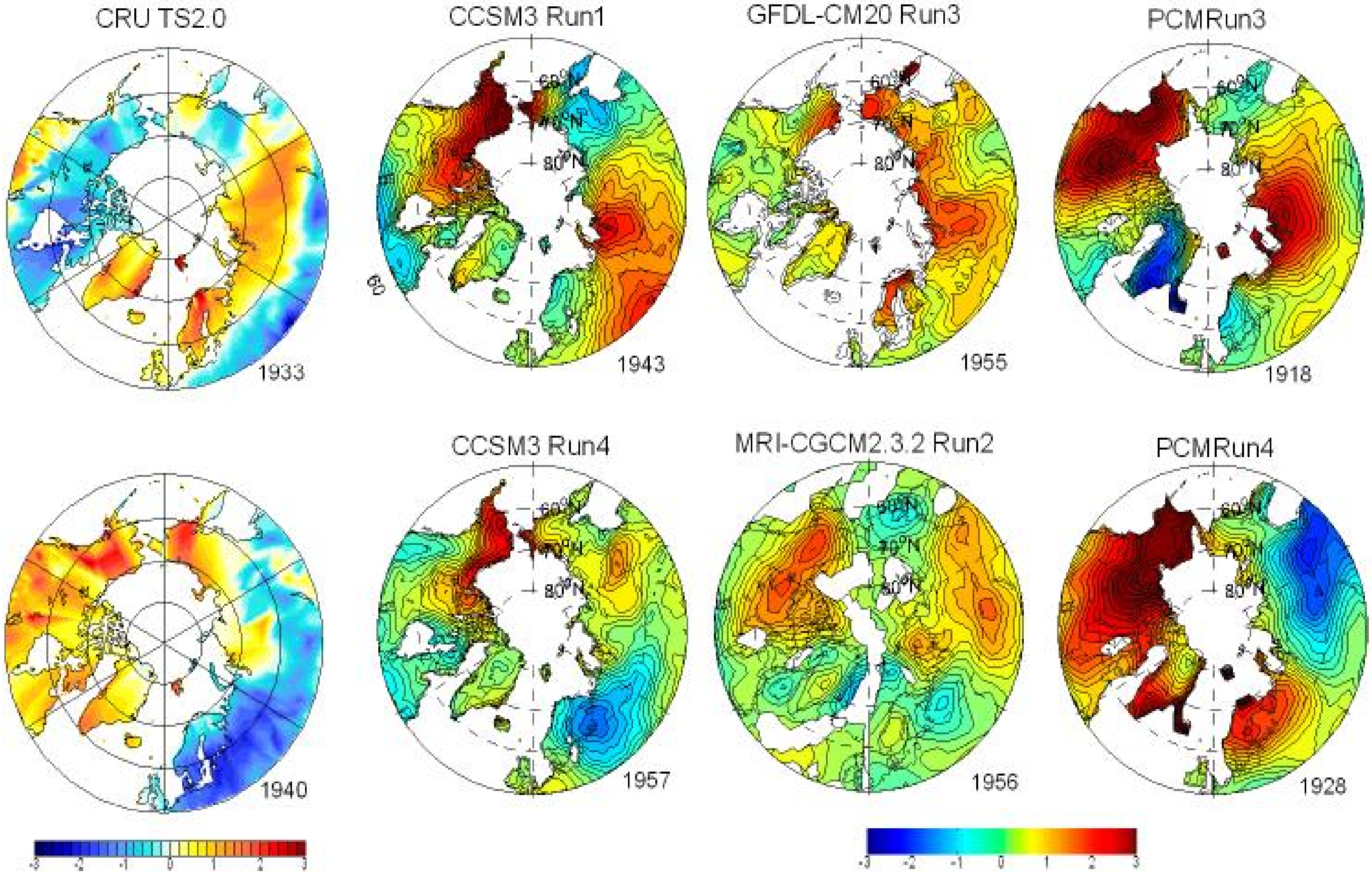


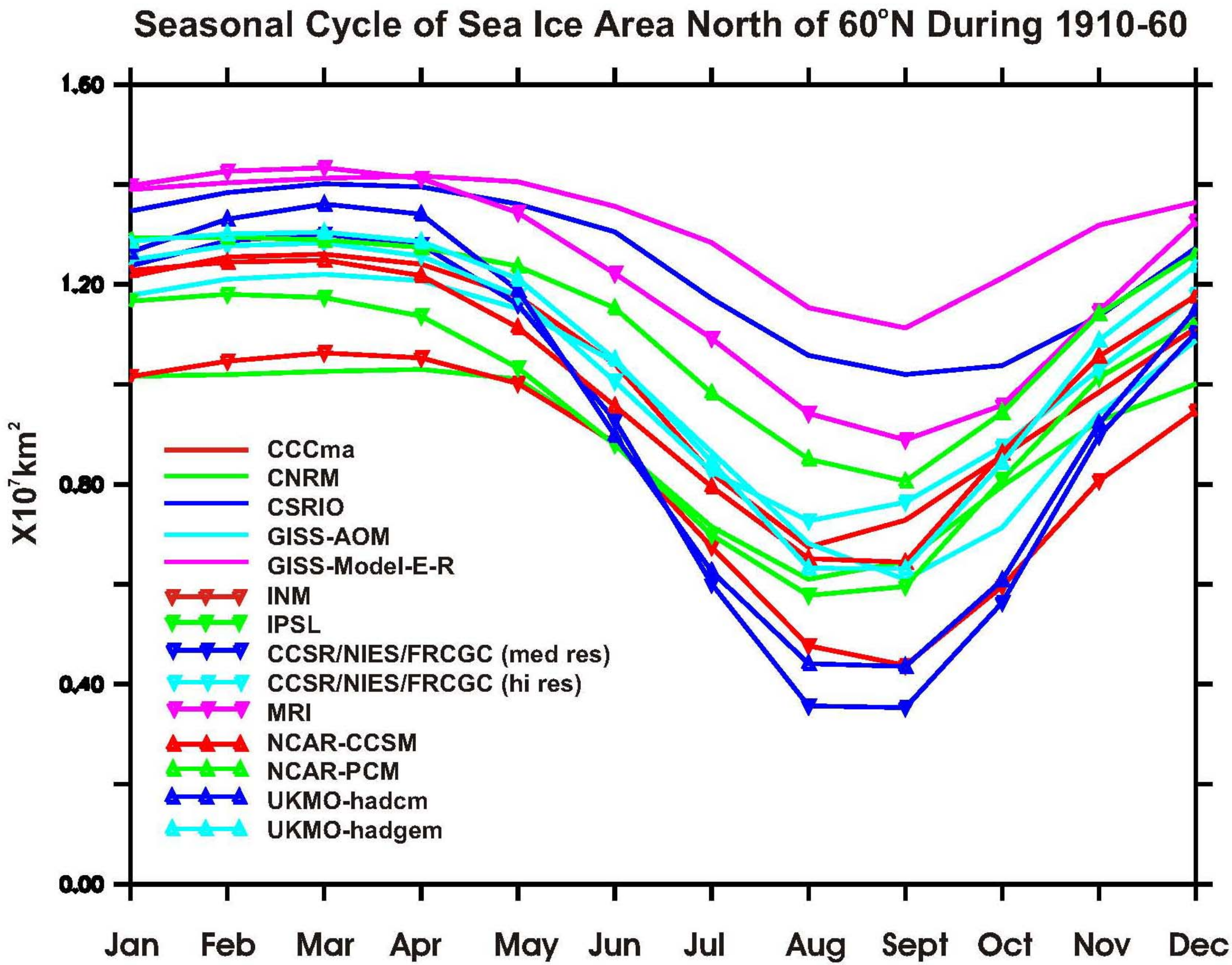
2.0
1.0
0.0
-1.0
CRU
CCSM3
GFDL-CM20
GFDL-CM21
MIROC-Medres
PCM
CNRM
MPI
CSIRO
INM
MIUB
MRI
20th Century
21 out of 60 reliazations
have deadal signal
1850
1900
1950
2000
-1.0
0
-1.0
CRU
CCSM3
GFDL20
MIROC-Medres
PCM
CCCMA-T47
CNRM
MPI
GISS-AOm
INM
MIUB
Control Runs
23 out of 63 cases
have decadal signal
1850
1900
1950
2000

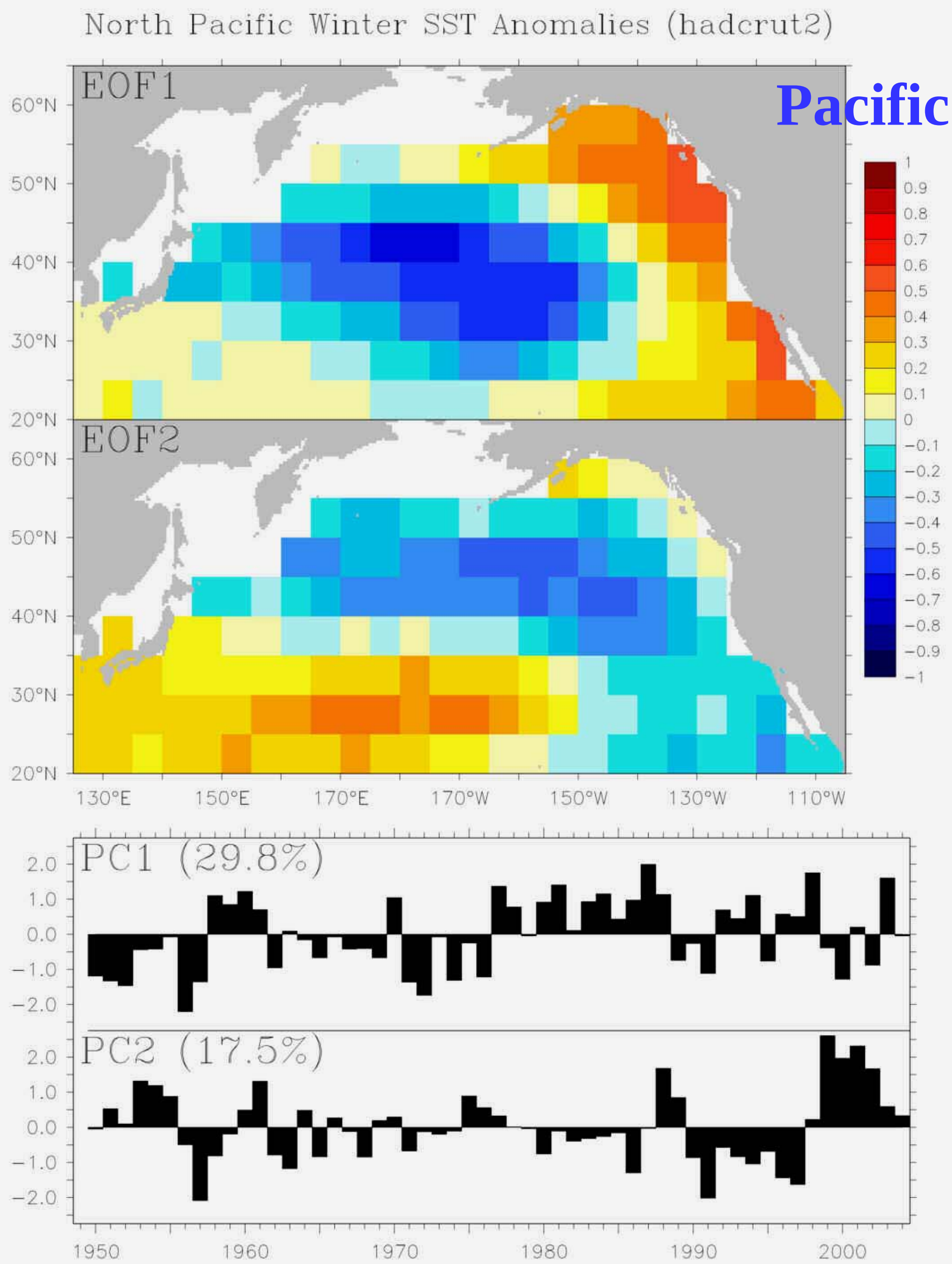
Statistics Of Model Runs Producing Mid-century Winter LSAT Warm Anomaly

Model	# of 20C3M runs	½ CRU	2/3 CRU	# of Control runs	½ CRU	2/3 CRU	Success Ratio of the model
CCSM3	8	6	4	2	2	1	5/10
CGCM3.1 (T47)	1	0	0	5	4	3	3/6
CGCM3.1 (T63)	1	0	0	3	2	0	0/4
CNRM-CM3	1	1	1	3	3	3	4/4
CSIRO-MK3	3	3	1	3	3	0	1/6
ECHAM5/MPI	3	3	1	3	3	2	3/6
FGOALS-g1.0	3	3*	2*	3	3*	3*	0/6
GFDL-CM20	3	3	3	5	3	1	4/8
GFDL-CM21	3	2	2	5	3	0	2/8
GISS-AOM	2	0	0	2	1	1	1/4
GISS-EH	5	2	0	4	2	0	0/9
GISS-ER	9	0	0	5	0	0	0/14
INM-CM3	1	1	1	3	3	3	4/4
IPSL-CM4	1	0	0	2	1	0	0/3
MIROC3.2 (hires)	1	1	0	1	0	0	0/2
MIROC3.2(medres)	3	3	2	5	5	4	6/8
MIUB-ECHO	5	2	2	3	2	2	4/8
MRI-CGCM2.3.2	5	4	1	3	2	0	1/8
PCM	4	4	3	3	3	3	6/7
UKMO-HADCM3	1	1	0	3	1	0	0/4
Total Ensemble Runs	60*	32	21	63*	39	23	34%

Regional Response




Seasonal Cycle of Sea Ice Area North of 60°N During 1910-60
1.60
1.20
0.80
0.40
0.00
X10^7km^2
CCCma
CNRM
CSRIO
GISS-AOM
GISS-Model-E-R
INM
IPSL
CCSR/NIES/FRCGC (med res)
CCSR/NIES/FRCGC (hi res)
MRI
NCAR-CCSM
NCAR-PCM
UKMO-hadcm
UKMO-hadgem
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec



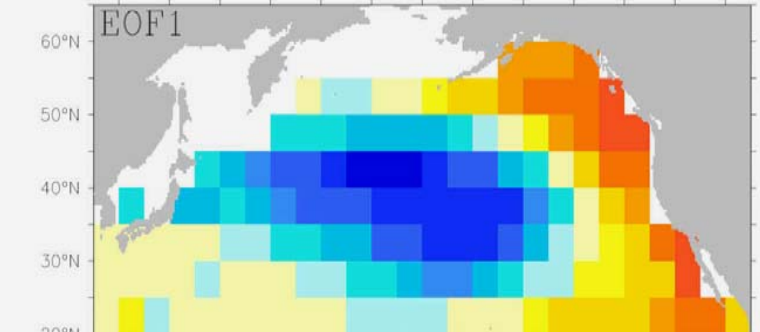
Pacific Decadal Oscillation

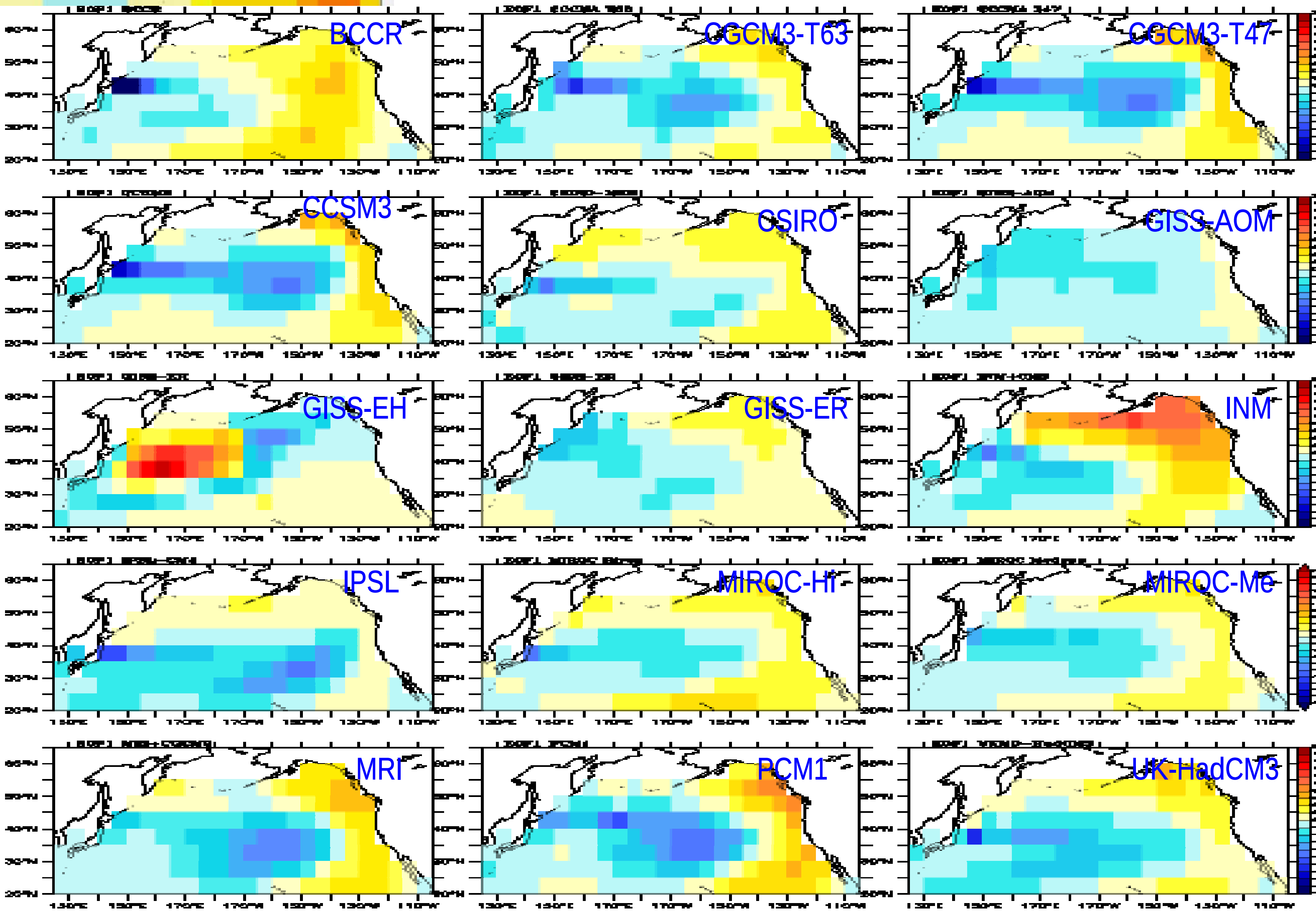
(PDO)

Victoria Pattern

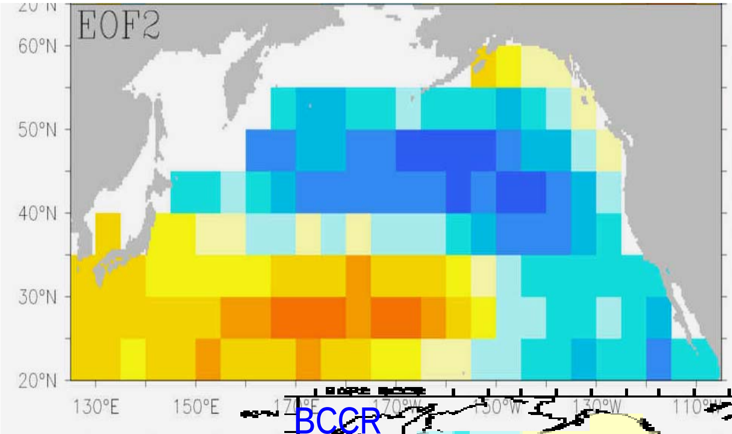
Bond et al. 2003

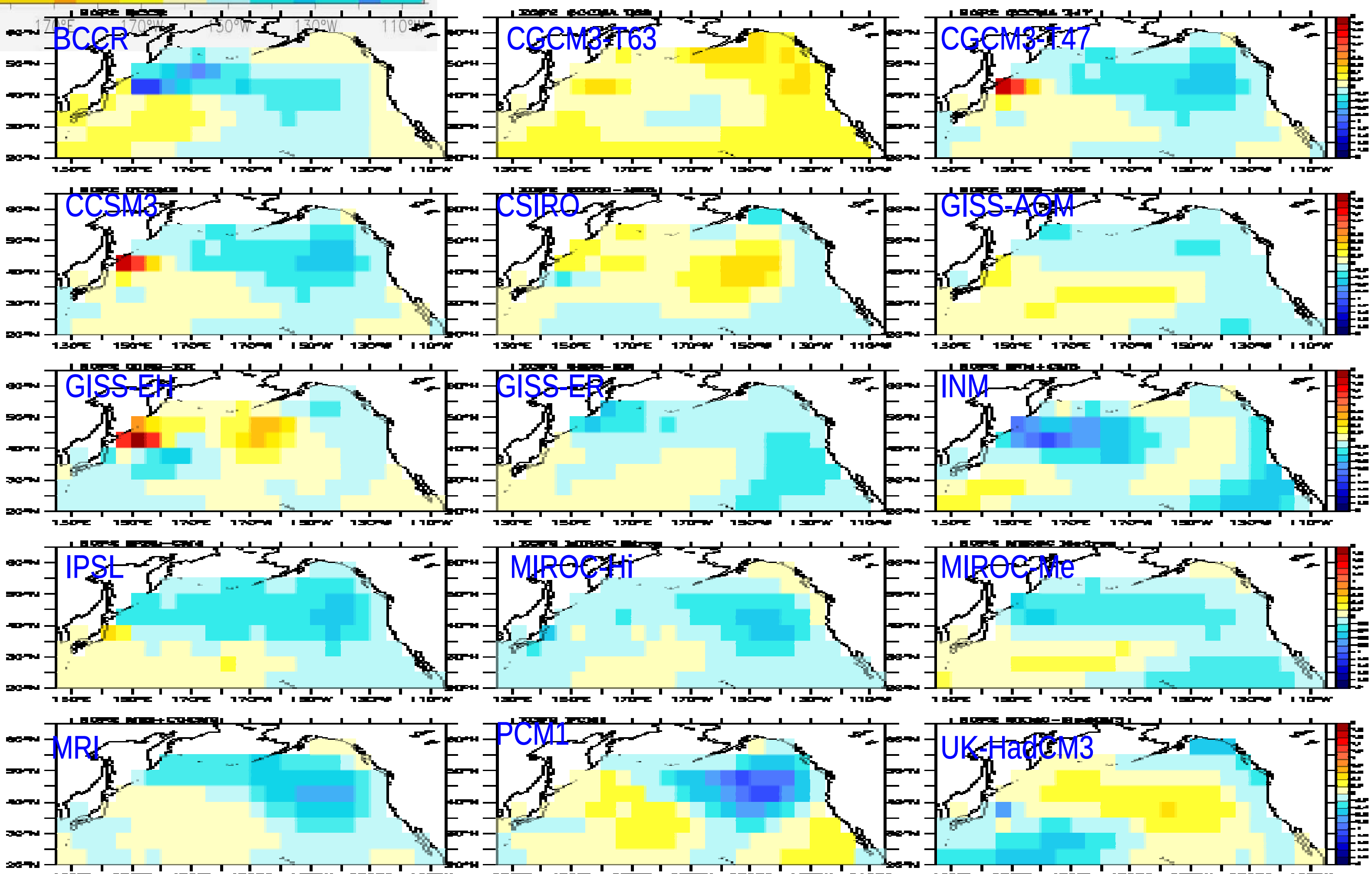
Pacific Decadal Oscillation (PDO) – Leading Mode of N.Pacific SSTA



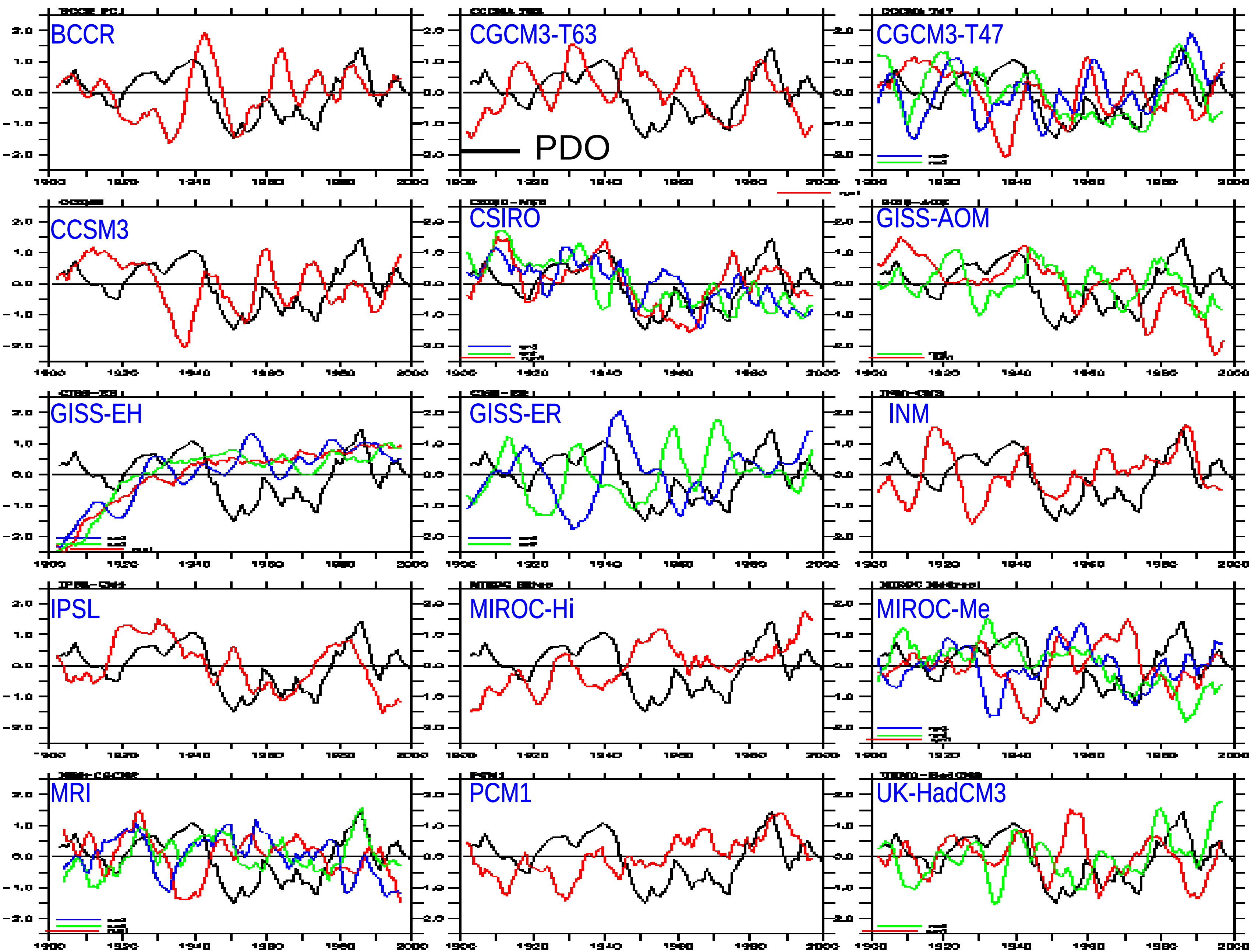


Victoria Pattern – The 2nd mode of N. Pacific SSTA





PC Series of Leading EOF from Model 20C3M Simulations



SUMMARY

- The IPCC AR4 models are better than those from IPCC Third Assessment
- Most of the 20 IPCC models show recent warming and 34 % show 1930s type natural decadal variability in the Arctic.
- 10 out of 15 models produce reasonable spatial pattern of both the First and Second EOFs of Pacific SSTA.
- Most of the models have more inter-annual variability than interdecadal variability in their PDO.

Available Variables for Atmosphere and Ocean Archived at PCMDI

Output Frequency	Spatial Dimension	Number	of variables
		Atmosphere	Ocean
Monthly	2D	44	15
	3D	9	6
	1D		1
Daily	2D	14	
	3D	4	
3-hourly	2D	9	