The Future Climate of the North Pacific - from IPCC AR4 Model Projection

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Previous study shows that

being able to constrain future climate model projections with information from climate characteristics we have already observed, helps us better quantify possible future climate changes.

Simulation Specification – Part I

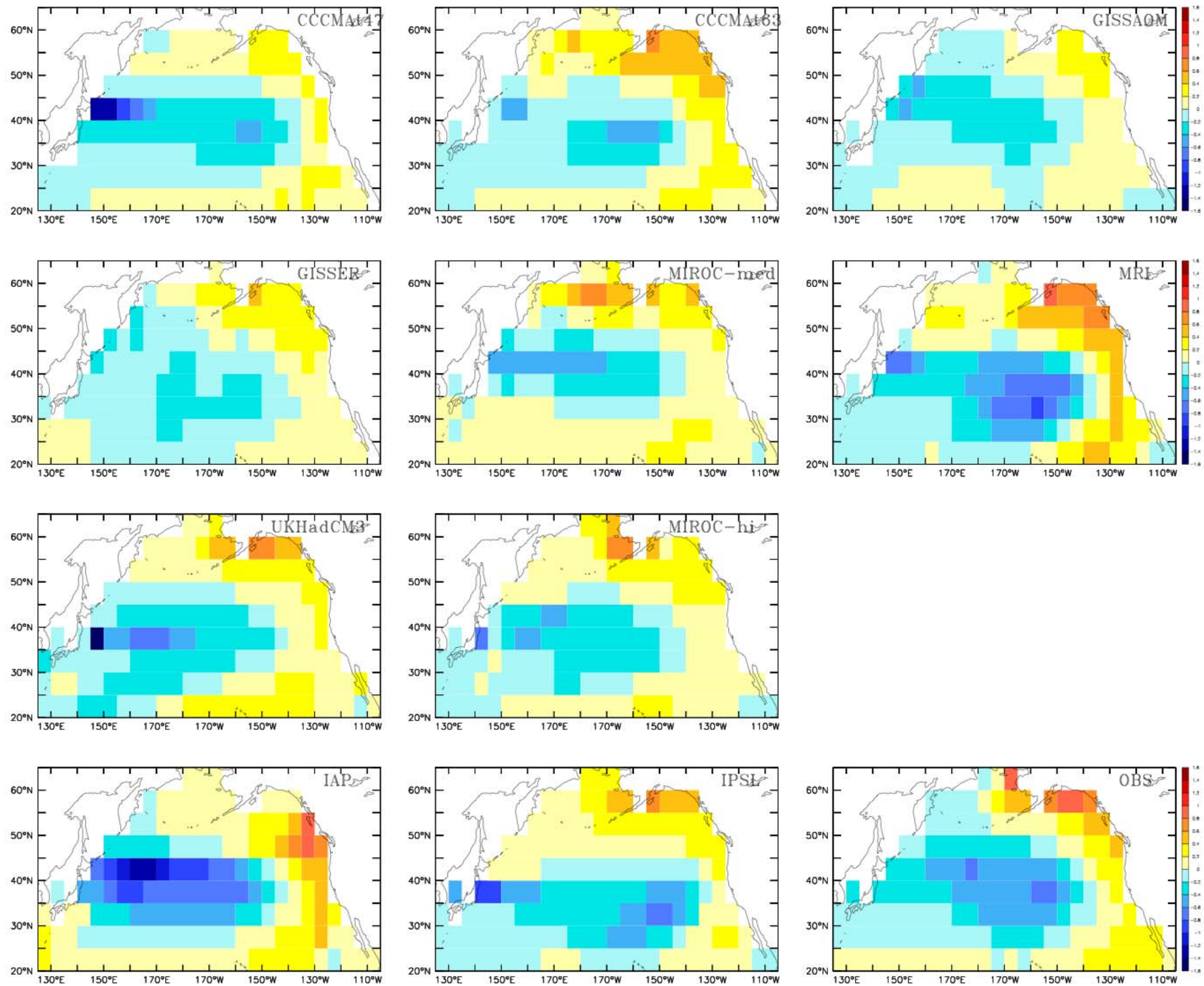
for IPCC 4th Accessment Report (AR4)

	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.
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.

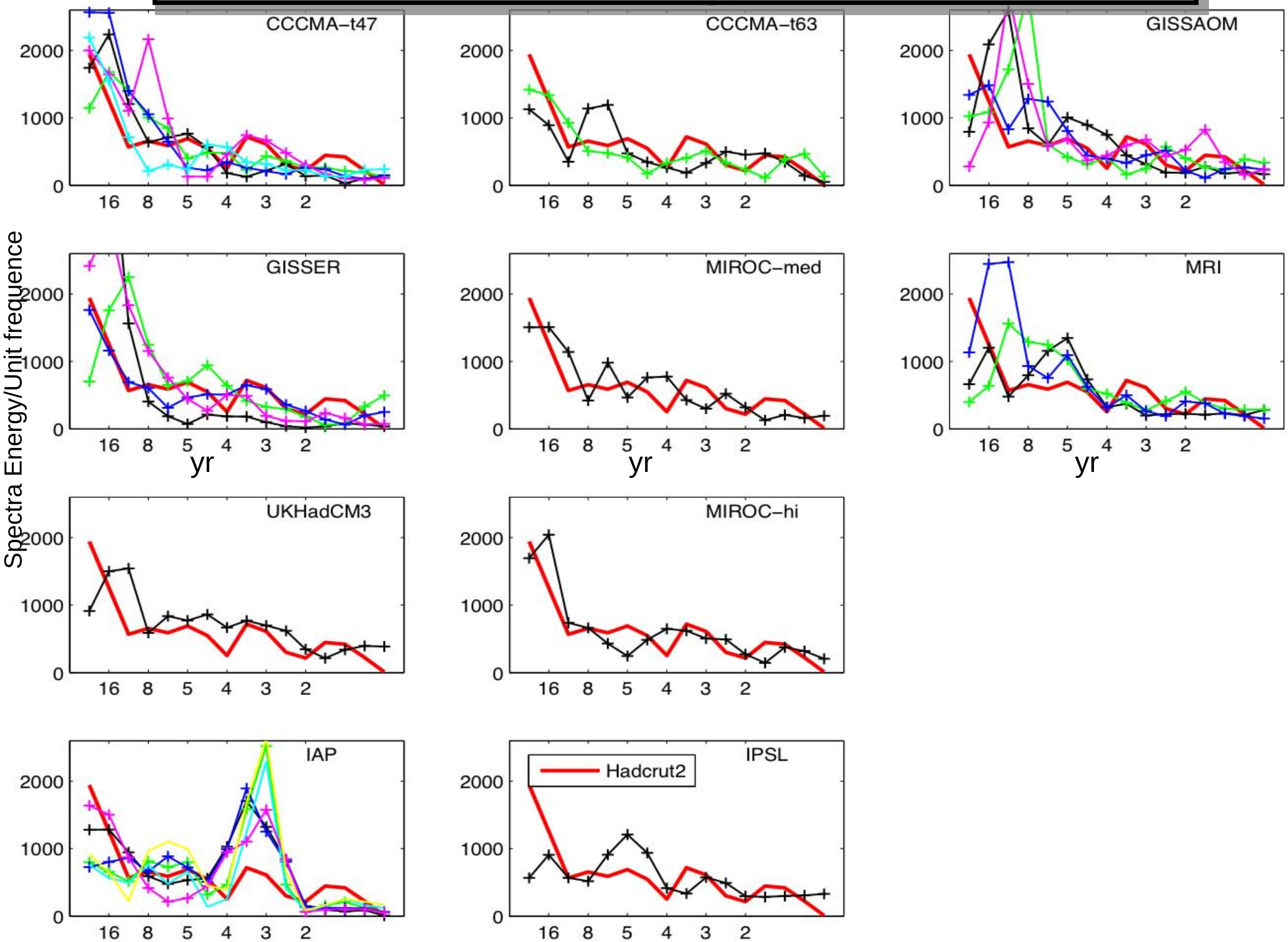
Models Contributed to IPCC AR4

	IPCC I.D.	Country	Atmosphere Resolution	Ocean Resolution	# of Control runs	# of 20c3m runs	# of A1B runs
1	BCCR-BCM2.0	Norway	T63L31	(0.5-1.5°) x 1.5°L35	2	1	1
2	CCSM3	USA	T85L26	(0.3-1.0°) x 1.0°L40		1	1
3	CGCM3.1(T47)	Canada	T47L31	1.9° x 1.9°L29	2	5	5
4	CGCM3.1 (T63)	Canada	T63L31	1.4° x 0.9°L29	1	1	1
5	CNRM-CM3	France	T42L45	182x152L31	3	1*	1
6	CSIRO-Mk3.0	Australia	T63L18	1.875° x 0.925° L31	3	3	1
7	ECHAM5/ MPI-OM	Germany	T63L31	1.5°x1.5°L40			
8	FGOALS-g1.0 (IAP)	China	T42L26	1°x1°xL30	9	3	3
9	GFDL-CM2.0	USA	2.5°x2.0° L24	1°x1°L50	5	3	1
10	GFDL-CM2.1	USA	2.5°x2.0° L24	1°x1°L50	5	5	1
11	GISS-AOM	USA	T42L20	1.4°x1.4°L43	2	2	2
12	GISS-EH	USA	5°x4°L20	2°x2° *cos(lat) L16	4	5	3
13	GISS-ER	USA	5°x4°L13	5°x4°L33	1	9	5
14	INM-CM3.0	Russia	5°x5°L21	2°x2.5°L33	2	1	1
15	IPSL-CM4	France	3.75°x2.5° L19	2°x1°L31	3	1	1
16	MIROC3.2(hires)	Japan	T106 L56	0.28°x0.188° L47	1	1	1
17	MIROC3.2(medres)	Japan	T42 L20	(0.5°-1.4°)x1.4° L44	3	3	3
18	ECHO-G (MIUB)	Germany/Korea	T30L19	T42L20	1	3	3
19	MRI-CGCM2.3.2	Japan	T42 L30	(0.5°-2. 5°) x 2° L23	3	5	5
20	PCM	USA	T42L18	(0.5-0.7°) x 0.7° L32		1	
21	UKMO-HadCM3	UK	3.7°5x2.5° L15	1.25°x1.25° L20	2+1*	1	1
22	UKMO-HadGem1	UK	1.25°x1.875°L38	(0.33-1.0°) x 1.0° L40	1+2*	2	1*
	Sum					55	40

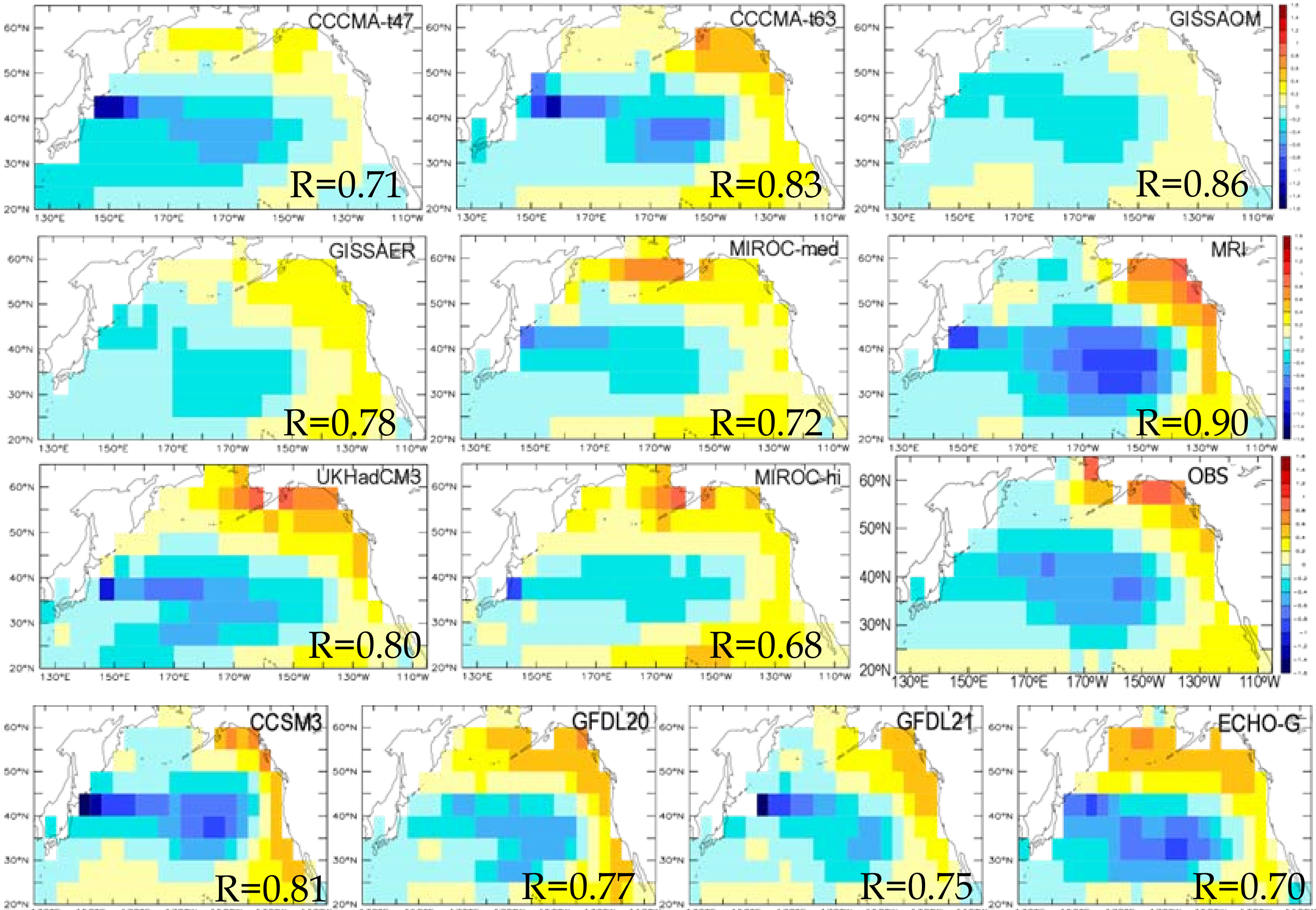
EOF1 of SST from control runs (PIcntrl)



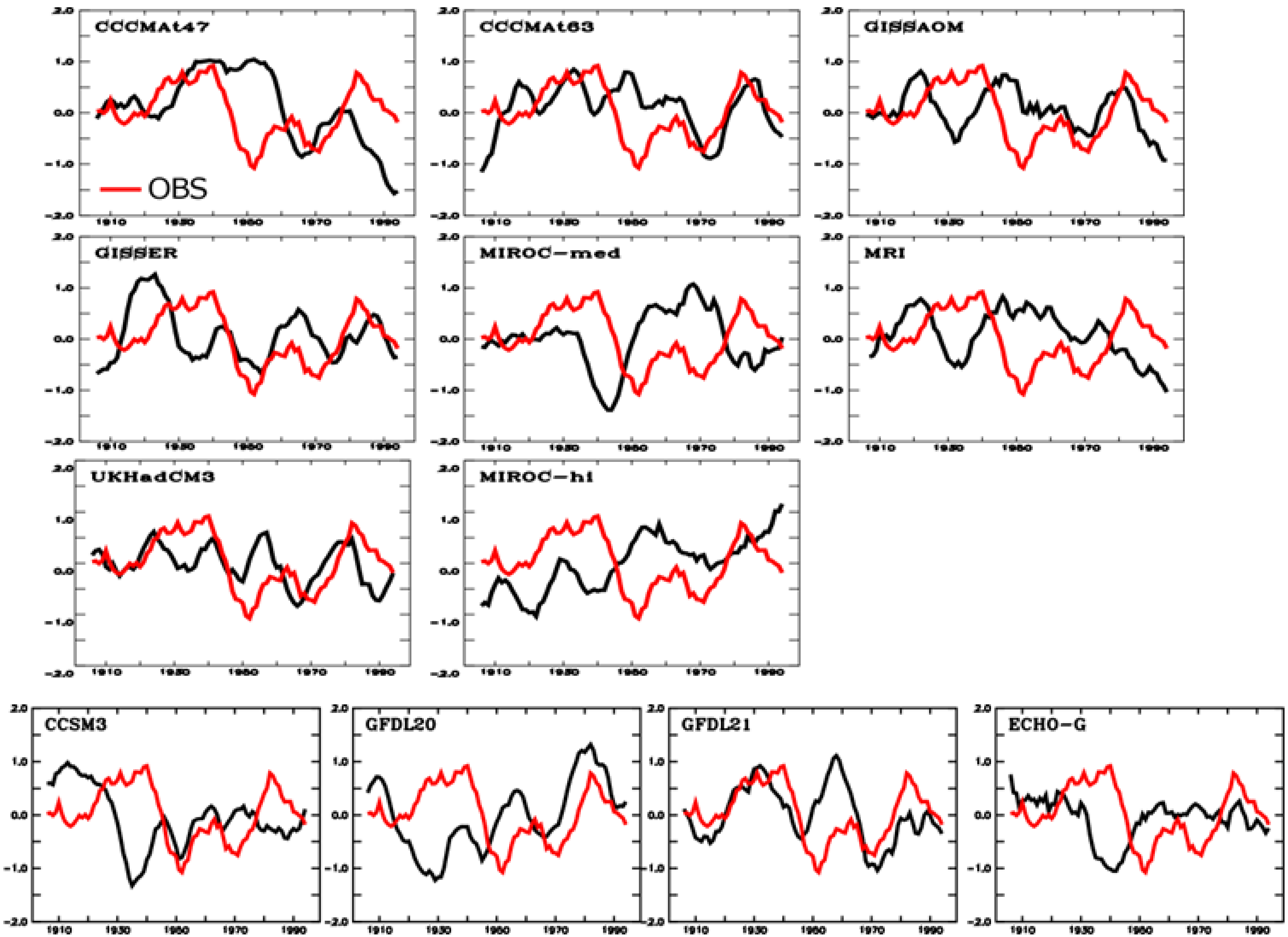
Power Spectrum Analysis of PC1



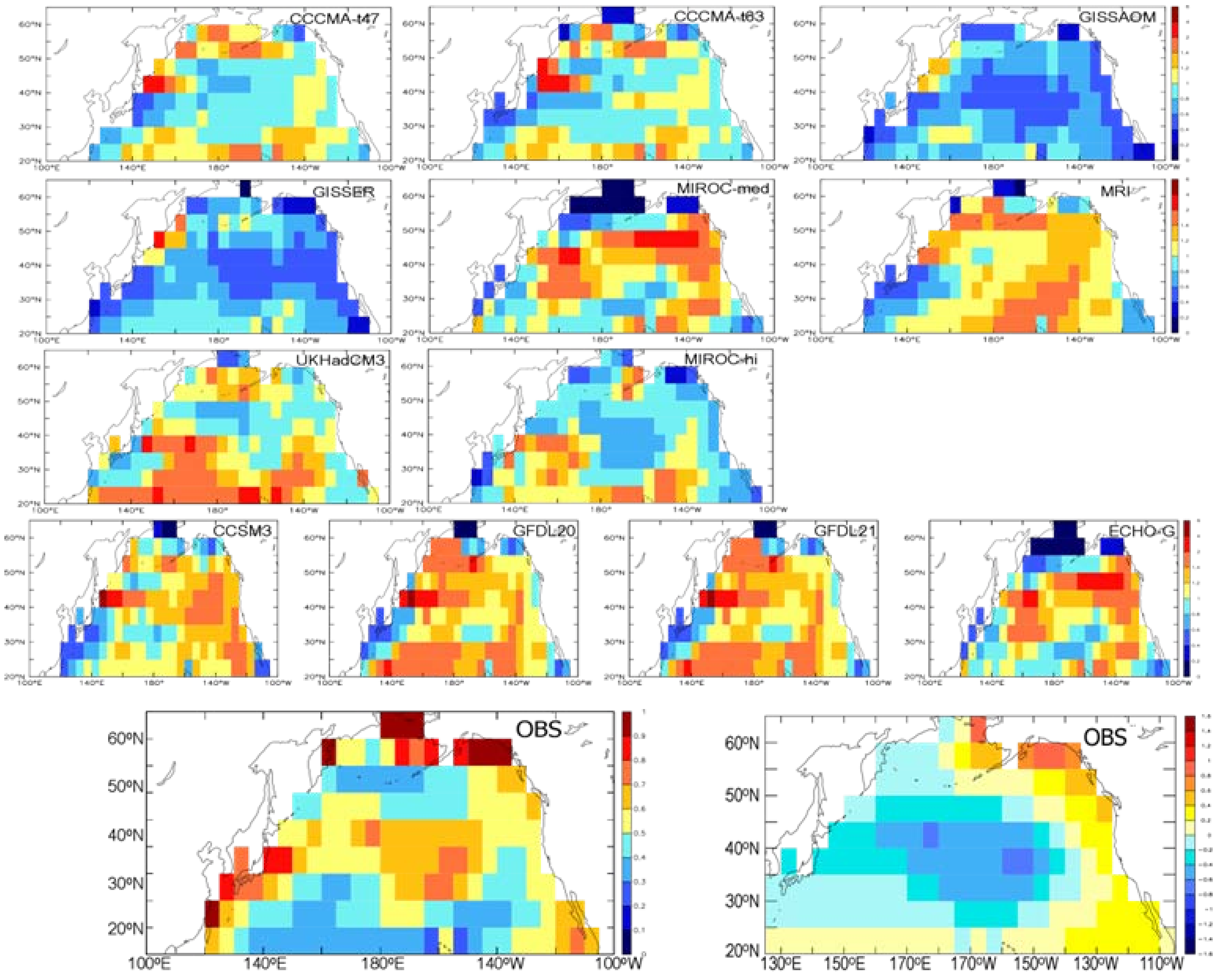
EOF1 of SST from 20C3M Simulations



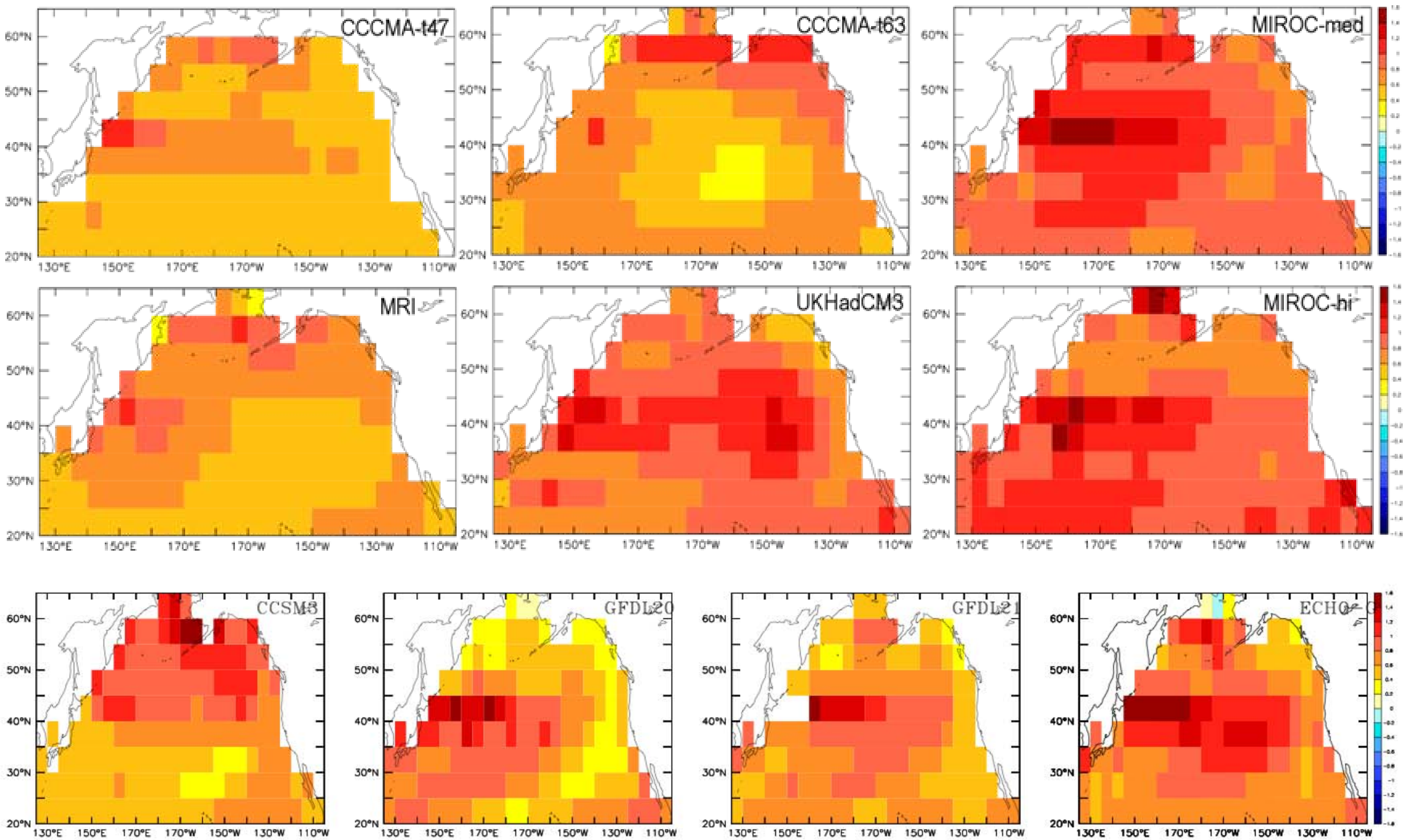
PC1 of SST from 20C3M Simulations



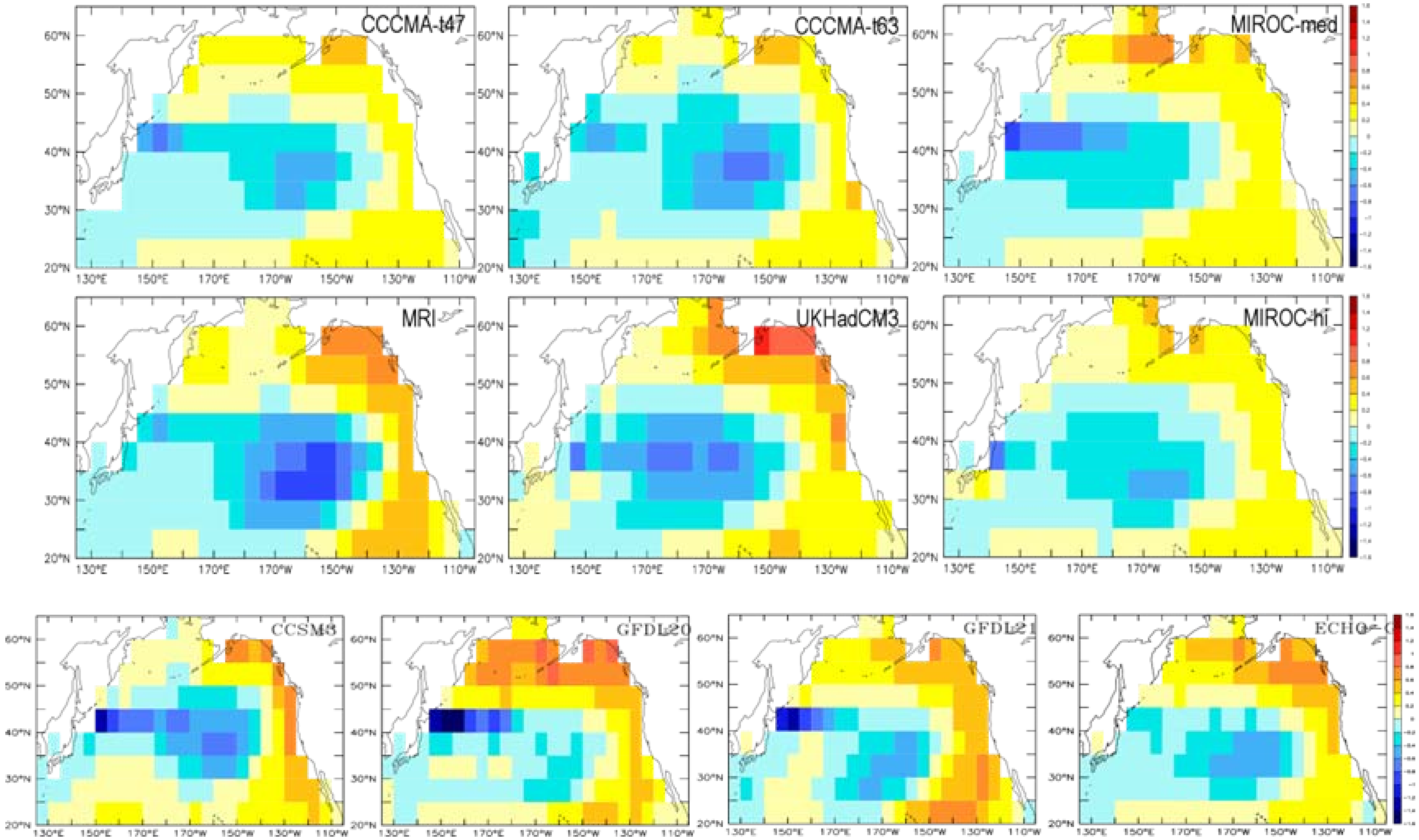
Ratio of Variance from 20c3m run to Observed



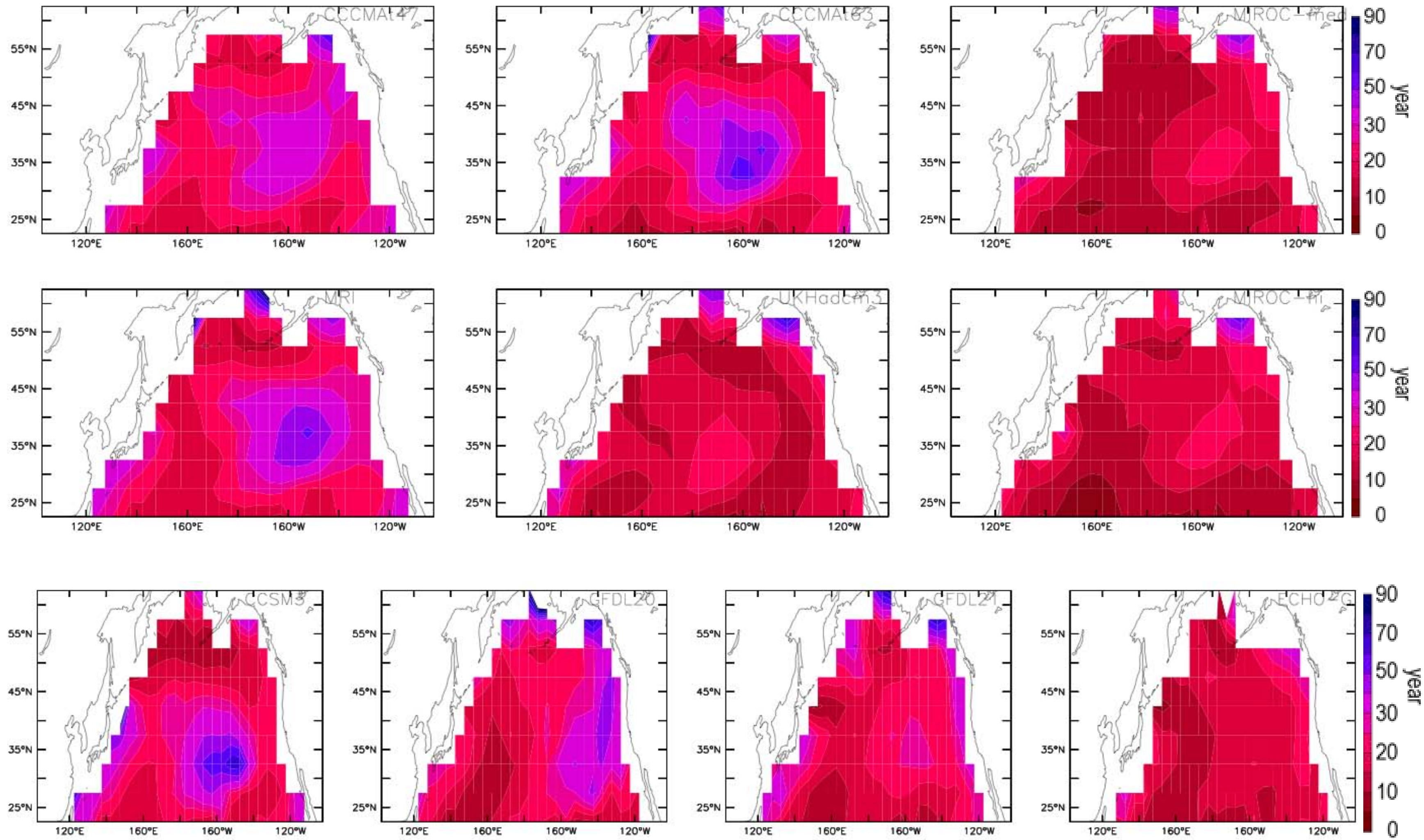
EOF1 of SST for 2001-2099 in A1B



EOF2 of SST for 2001-2099 in A1B



Natural Variability vs Trend:
The time when trend overpasses the natural variability



Natural Variability vs Trend:

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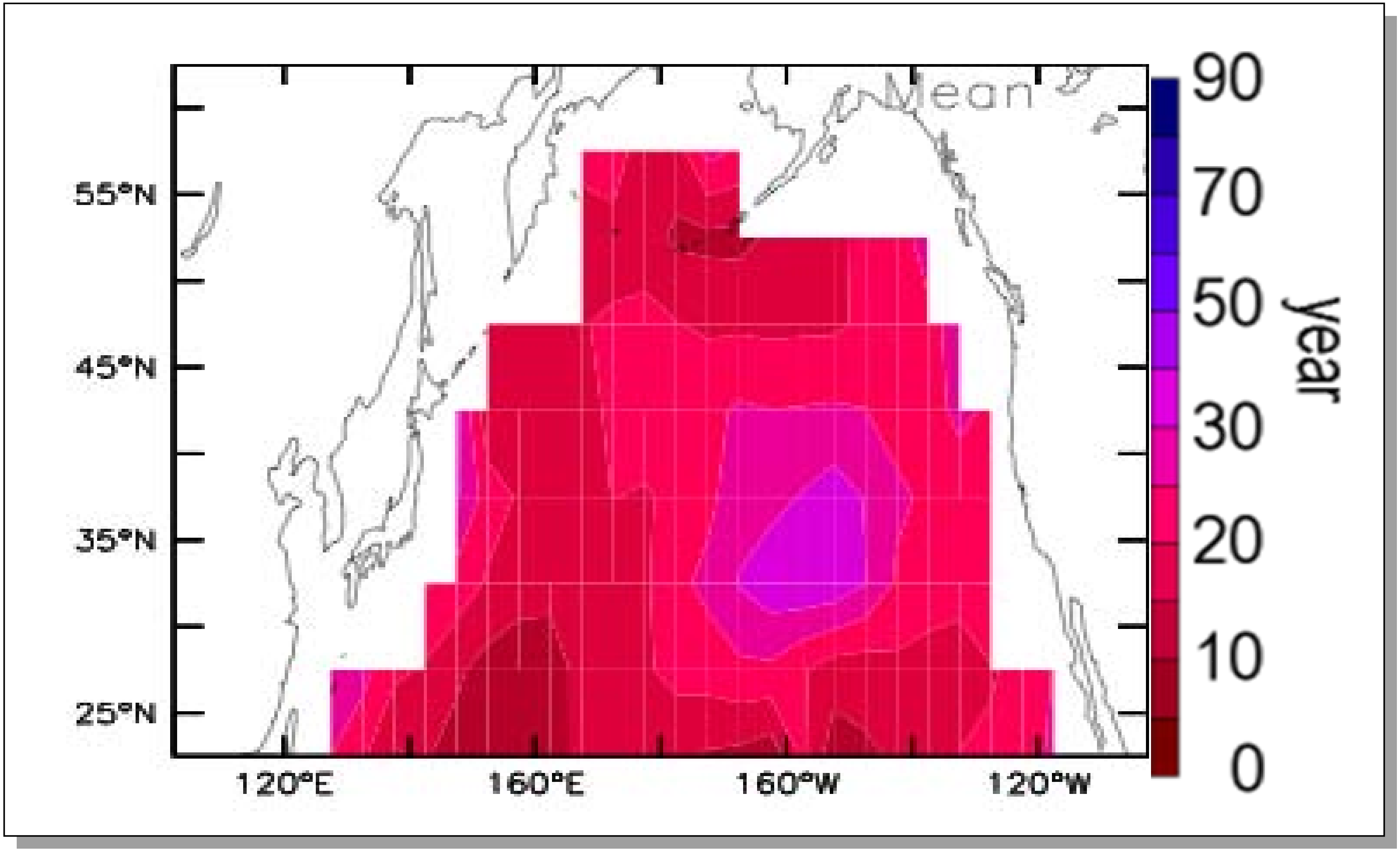
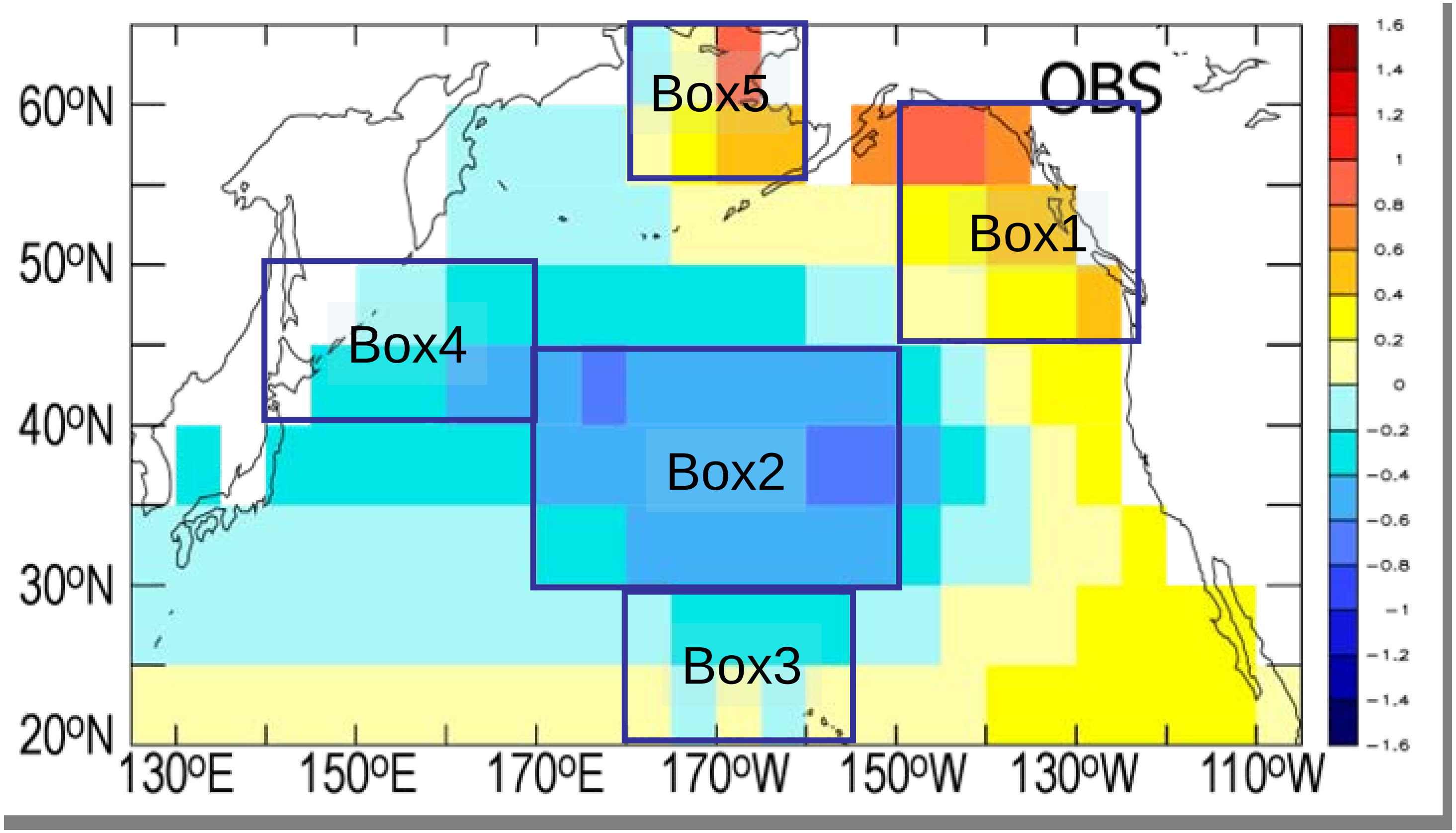
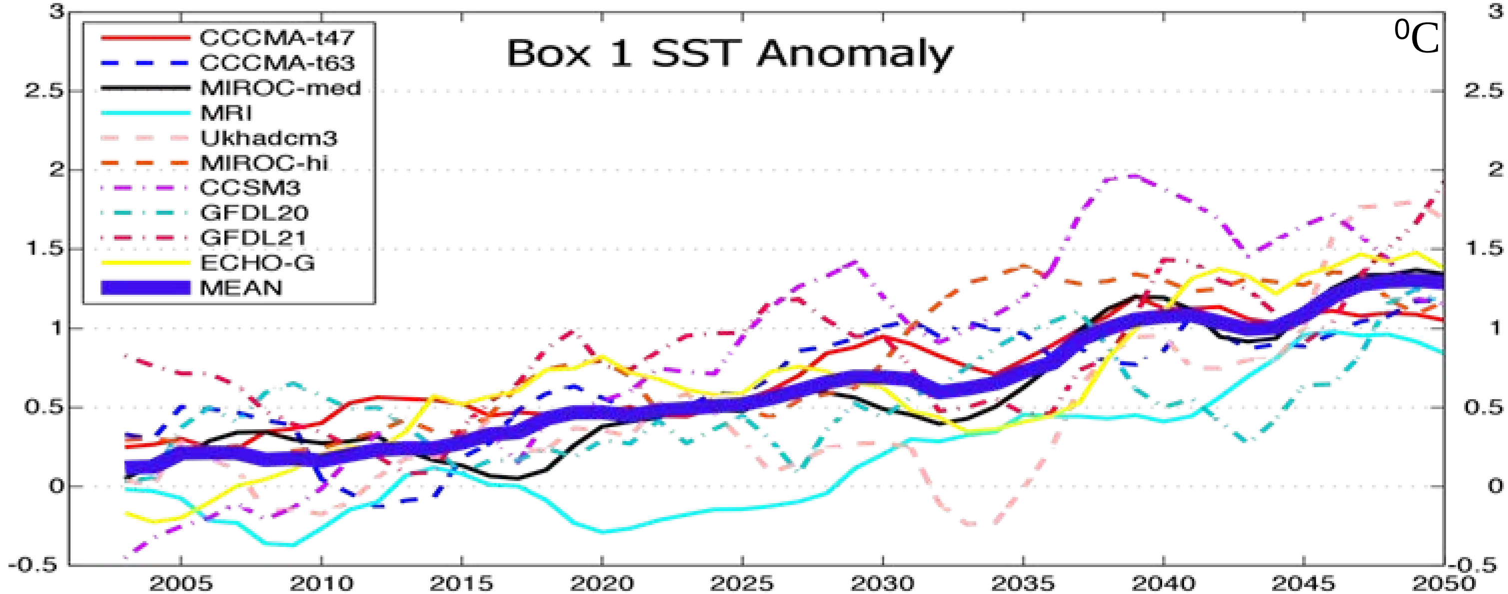
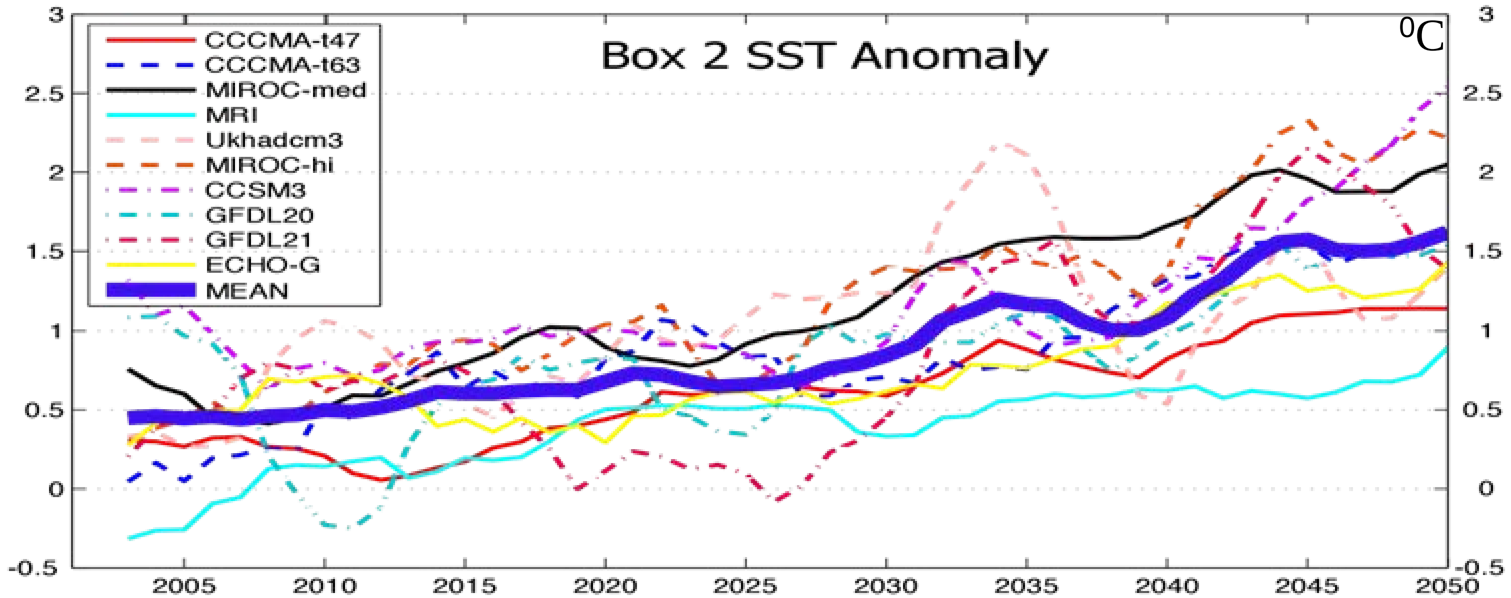


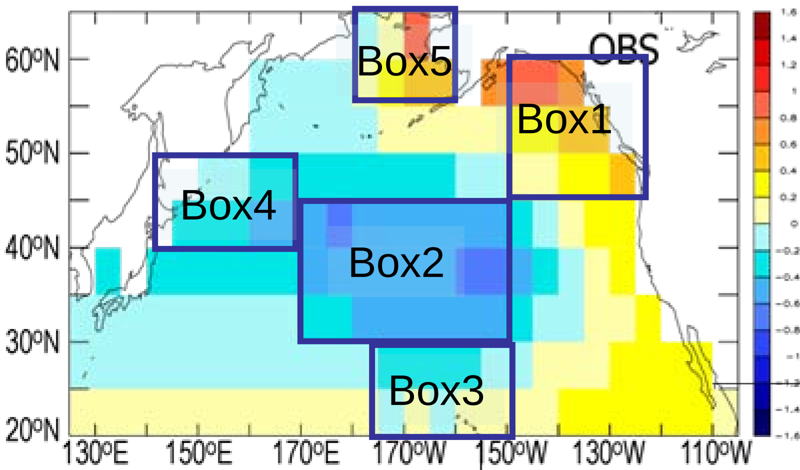


OBS
Box1
Box2
Box3
Box4
Box5
60oN
50oN
40oN
30oN
20oN
130oE
150oE
170oE
170oW
150oW
130oW
110oW
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4
−1.6

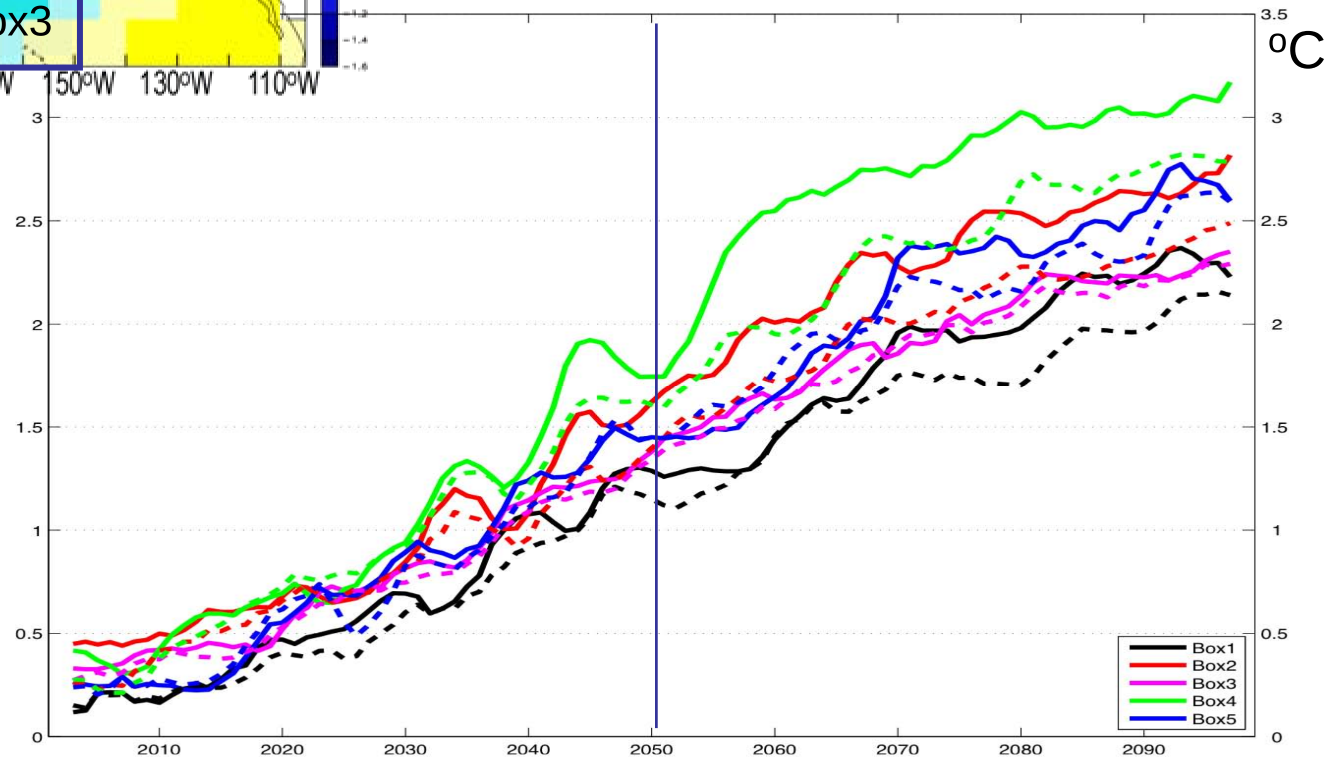
Projected SST Anomaly Relative to 1980-99 Mean Under A1B Scenario



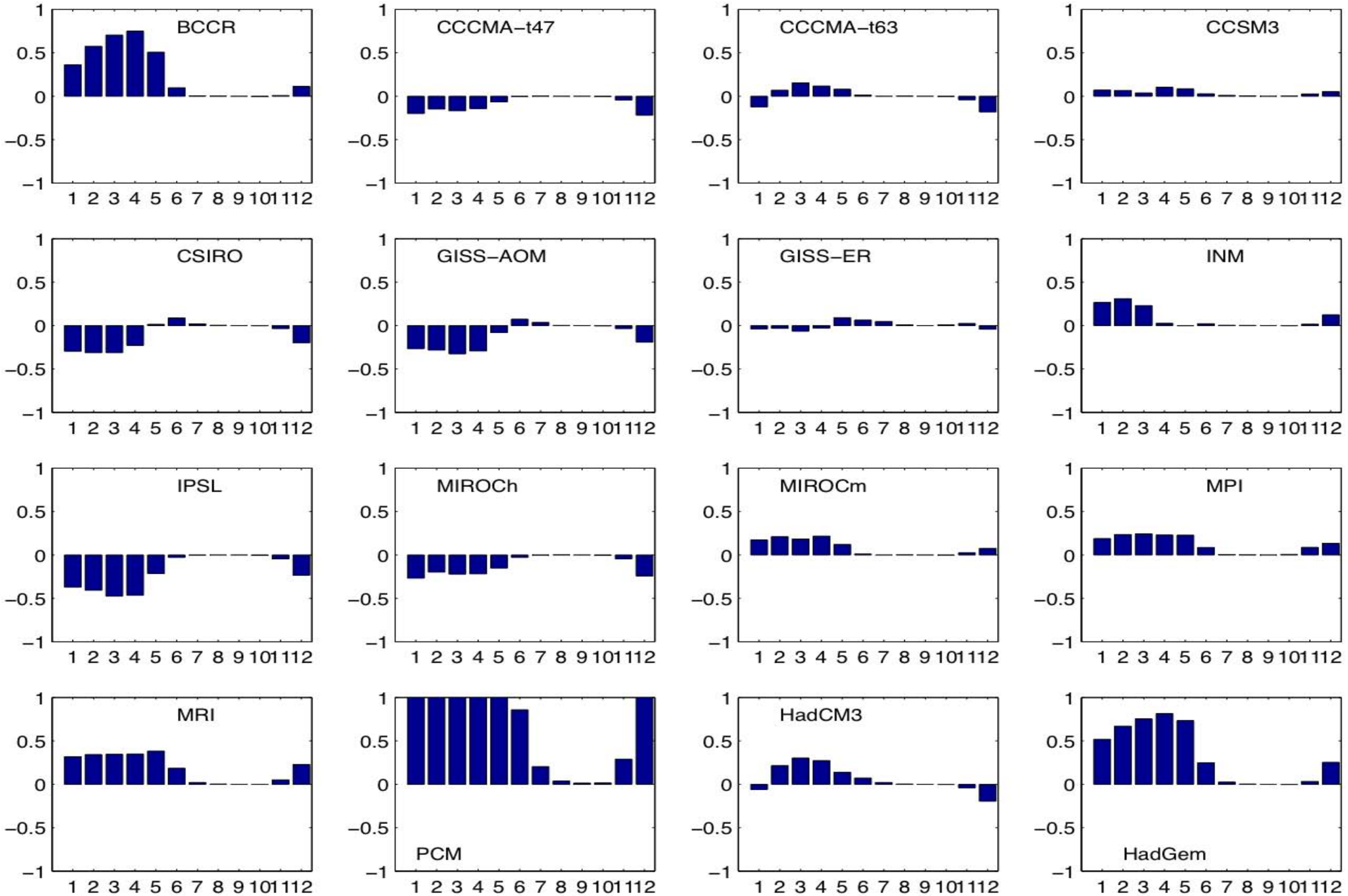




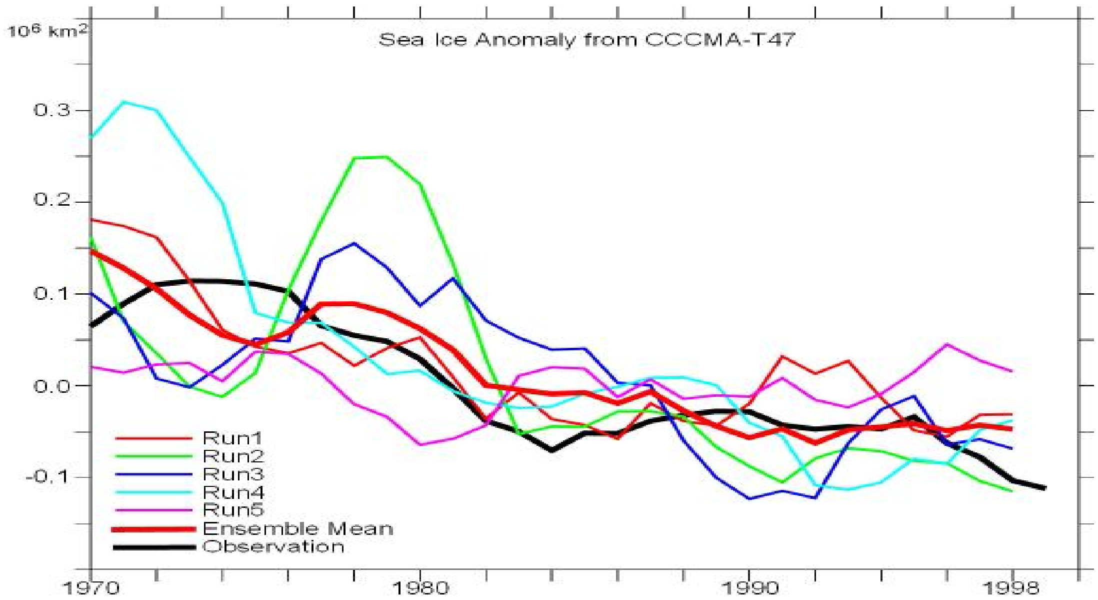
Projected
SST ANOMALY
relative to 1980-99 mean
under A1B scenario

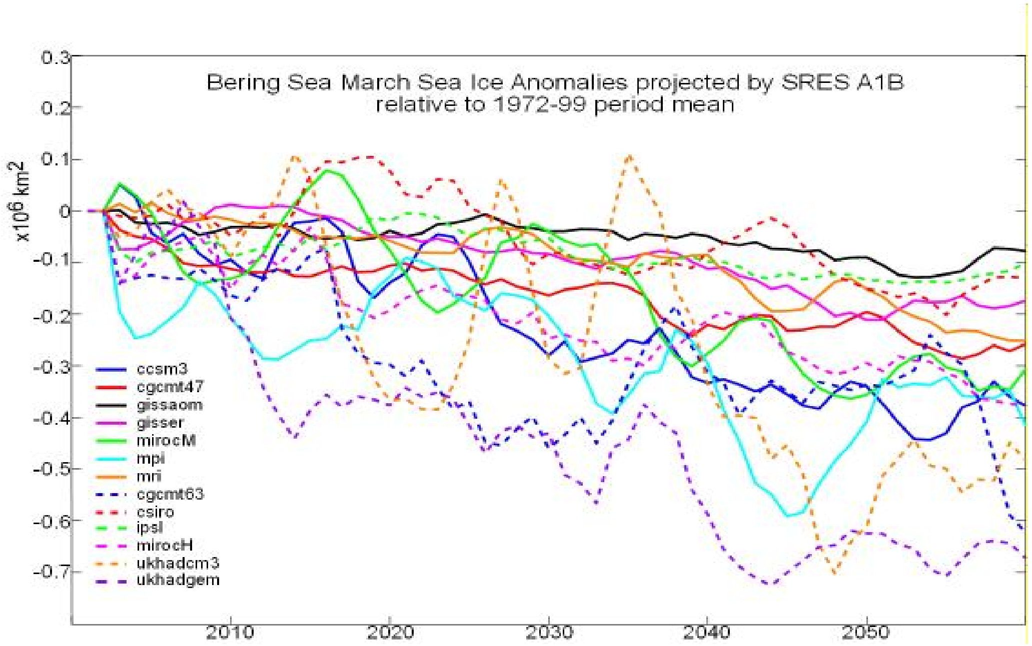


Difference in Bering Sea Ice Area Compared with OBS

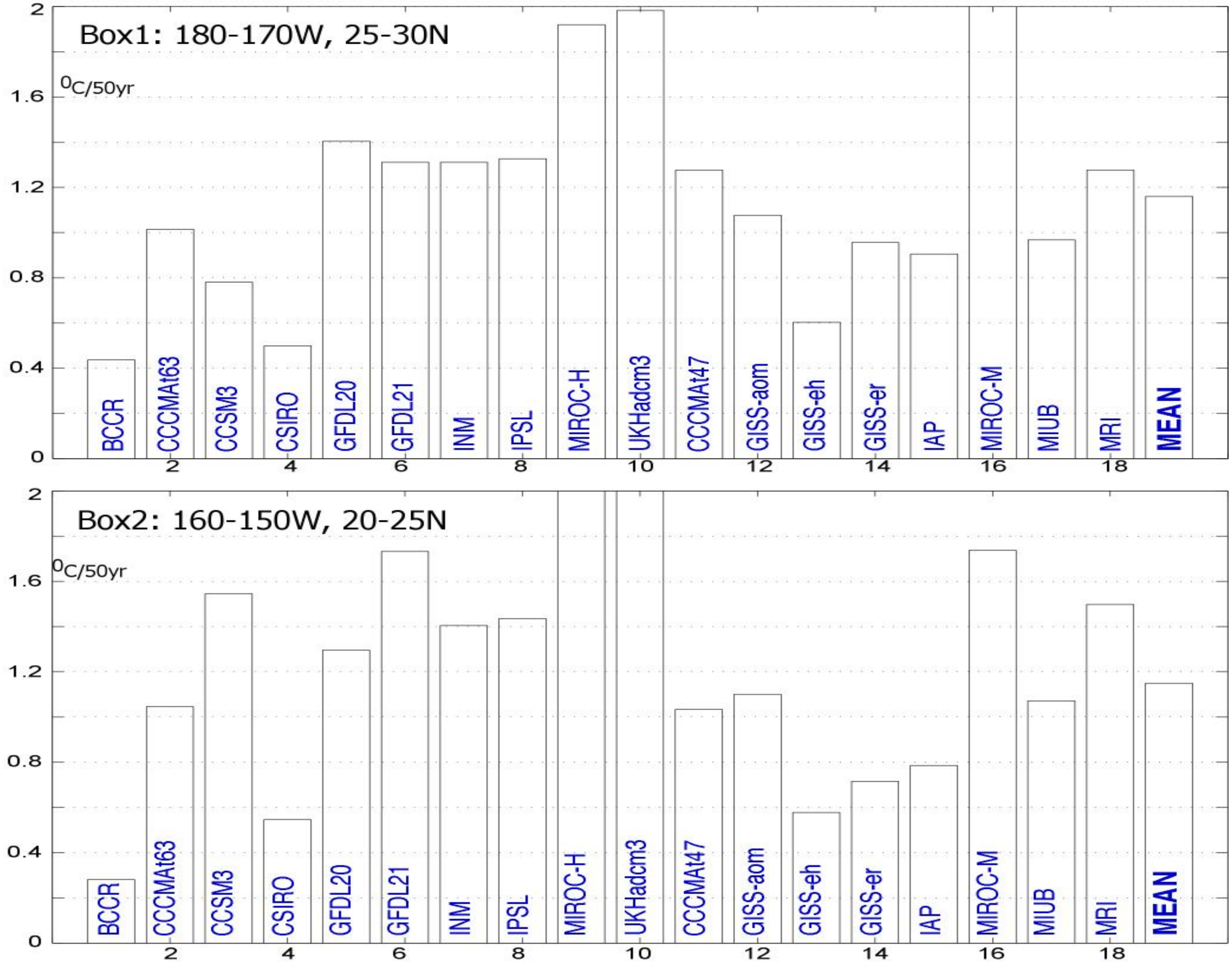


Bering Sea Ice Projection Under A1B scenario

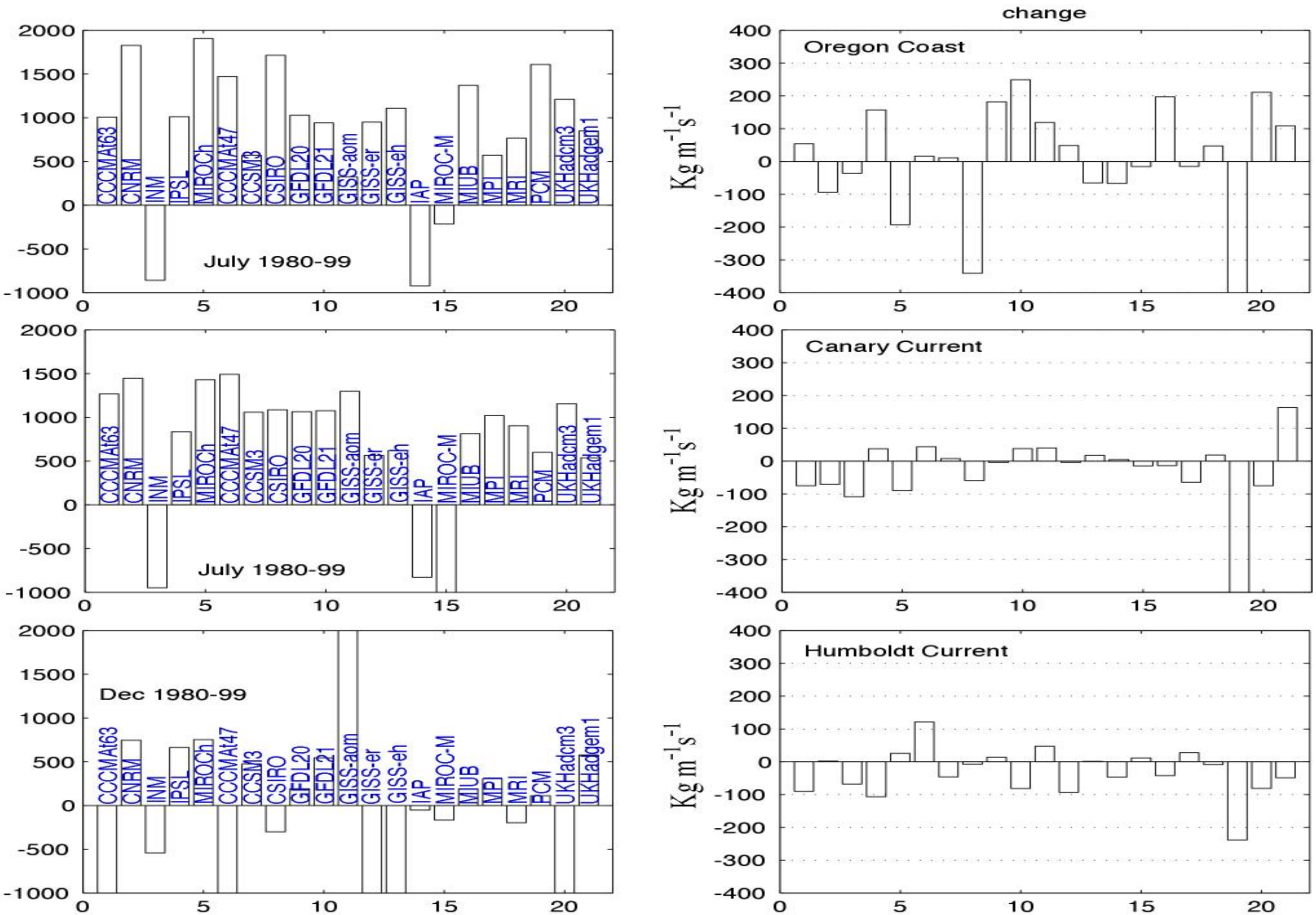




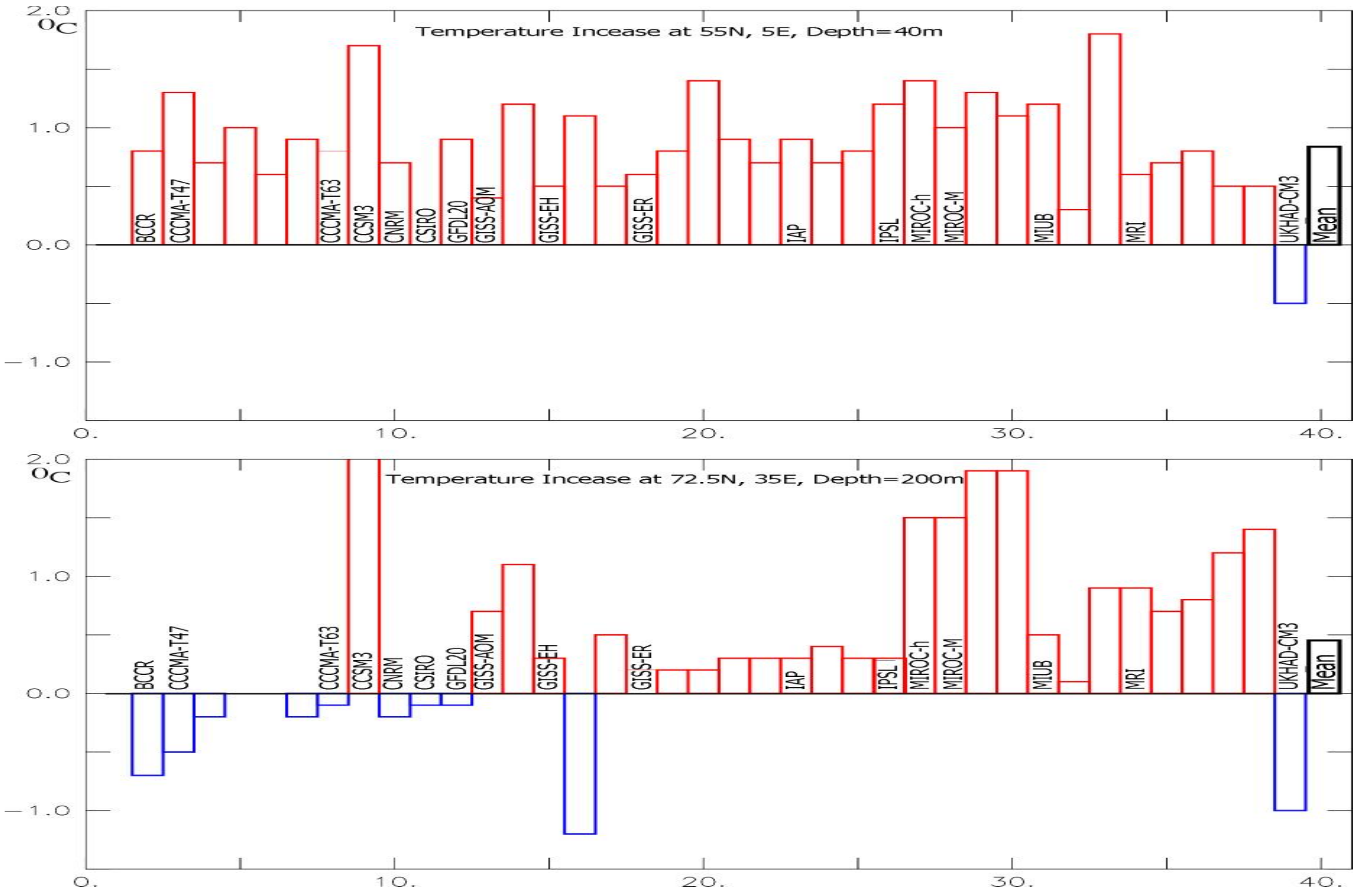
PROJECTED SST CHANGE IN 50 YEARS AVERAGED OVER SELECTED BOXES



Decadal Mean Upwelling Indices and Projected changes in 2030-39



BOTTOM WATER TEMPERATURE CHANGE AT SELECTED LOCATIONS



SUMMARY

- 10 out of 18 models are able to capture the major mode of the North Pacific SST variability.
- 21st Century showing rather spatially uniform warming trend (upto 0.5°C/decade in some area).
- In about 40-50 years the warming due to trend will surpass the natural variability over most of the North Pacific.
- Impacts from warming will be different than from PDO