

PICES XV (2006) in Yokohama

**Overview of present state and future
projection of North Pacific climate
simulated by CCSR/NIES/FRCGC
coupled models**

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Japan K-1 Project Team

Research consortium of

- Center for Climate System Research (CCSR), the University of Tokyo
- National Institute for Environmental Studies (NIES)
- Frontier Research Center for Global Change (FRCGC)

has contributed to the IPCC AR4

Two models of different resolution

→ What does resolution matter in climate projection? (with a focus on the North Pacific)

Coupled GCM

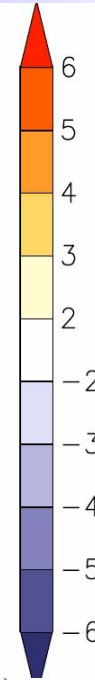
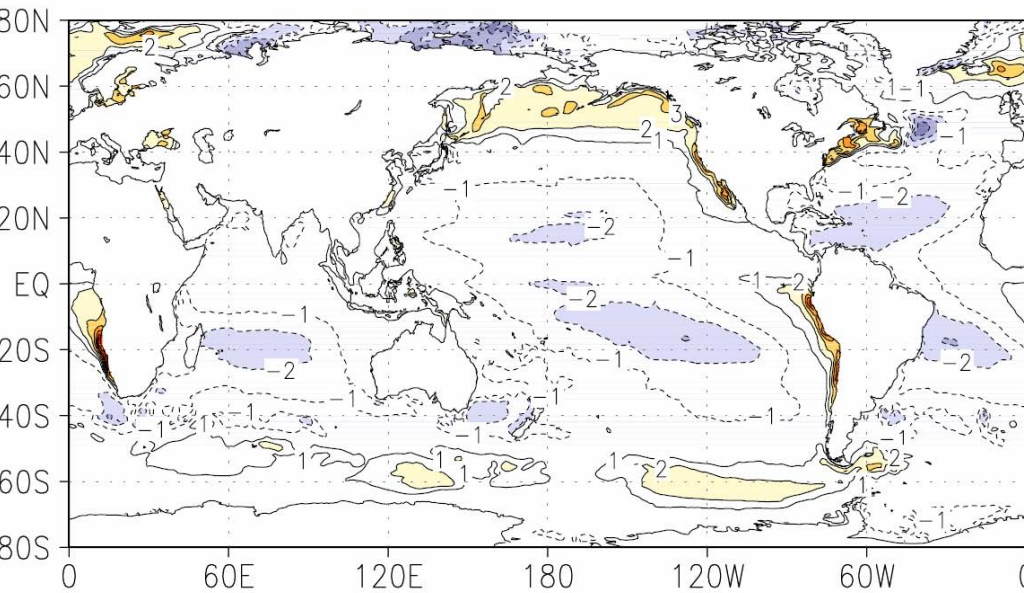
MIROC (Model for Interdisciplinary Research On Climate) version 3.2

	High	Medium
Atmosphere: CCSR/ NIES/FRCGC AGCM 5.7	T106 ($\sim 1.1^\circ$) 56 levels	T42 ($\sim 2.8^\circ$) 20 levels
Ocean: CCSR Ocean Component Model 3.4	$\sim 0.28^\circ \times 0.19^\circ$ 47 levels	$\sim 1.4^\circ \times 0.5^\circ - 1.4^\circ$ 43 levels
Land: MATSIRO	$\sim 0.56^\circ$	$\sim 2.8^\circ$
River: TRIP	0.5°	$\sim 2.8^\circ$
Sea ice: dynamic (EVP)- thermodynamic (0-layer)	same as ocean	same as ocean

Coupled GCM

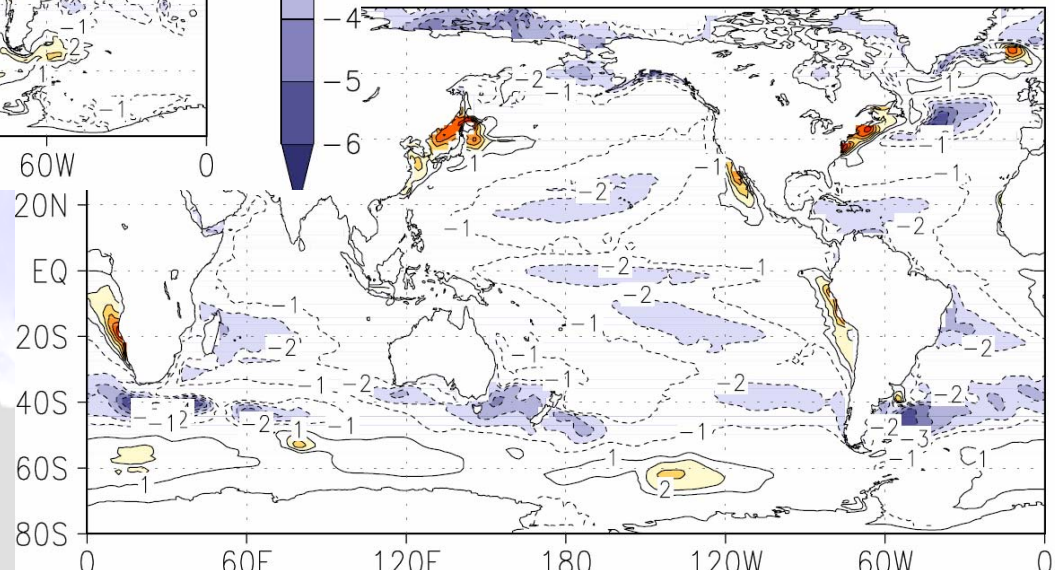
Biases in annual-mean SST of the control (pre-industrial condition) runs

Hi-CGCM - Obs.



Medium-resolution

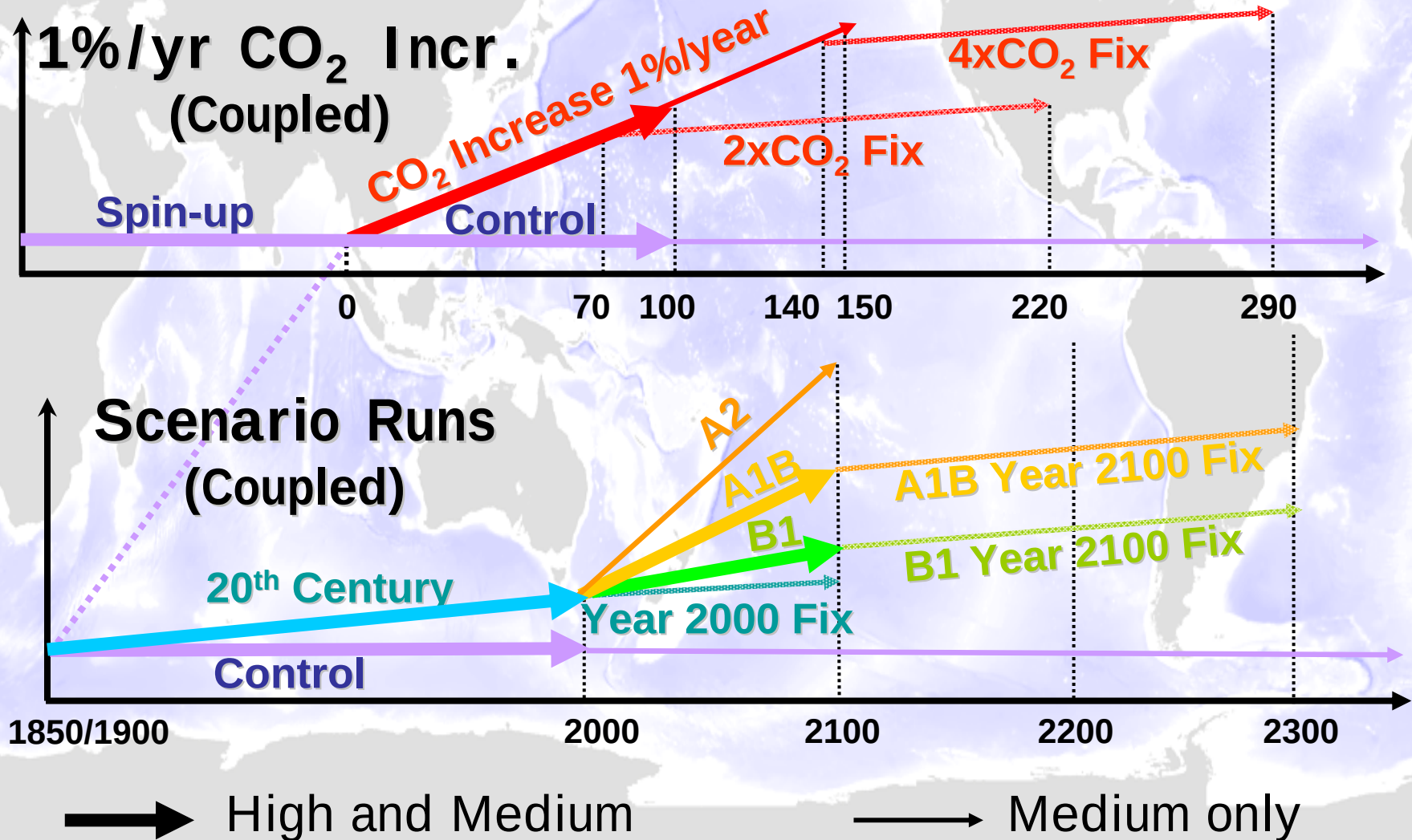
Mid-CGCM - Obs.



High-resolution

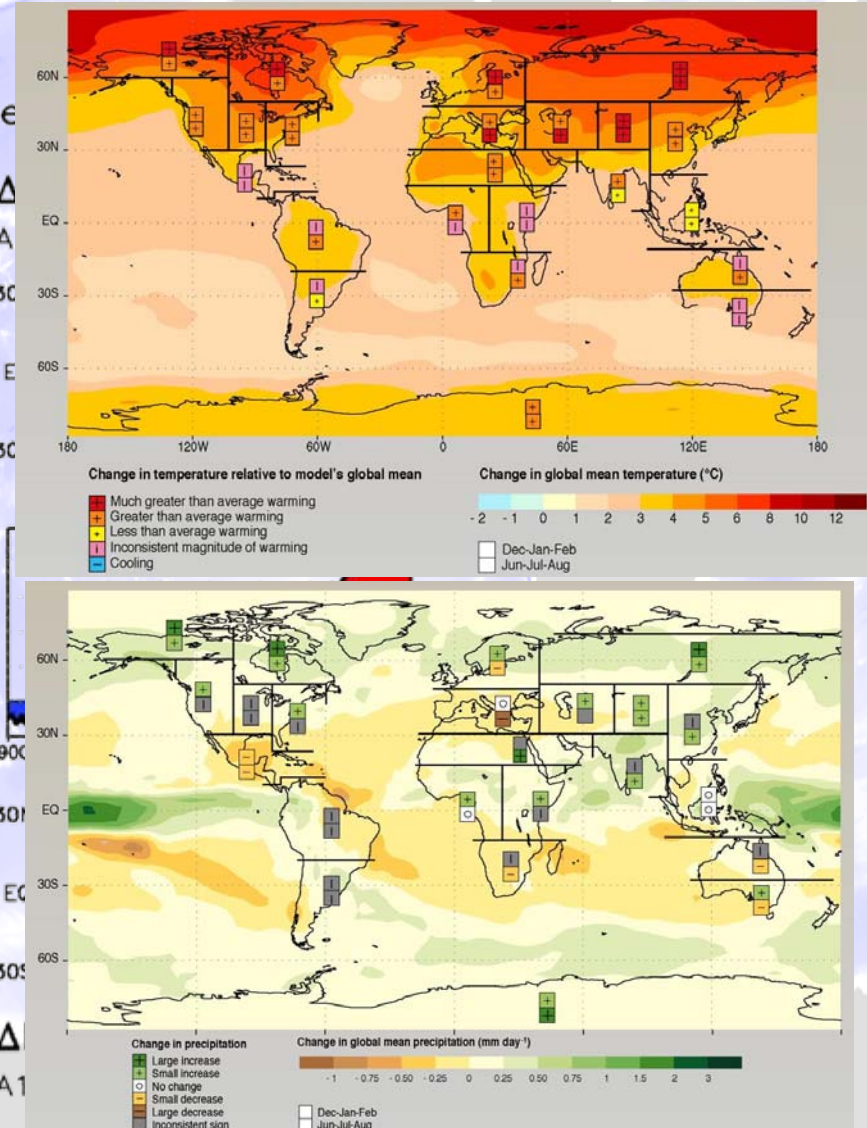
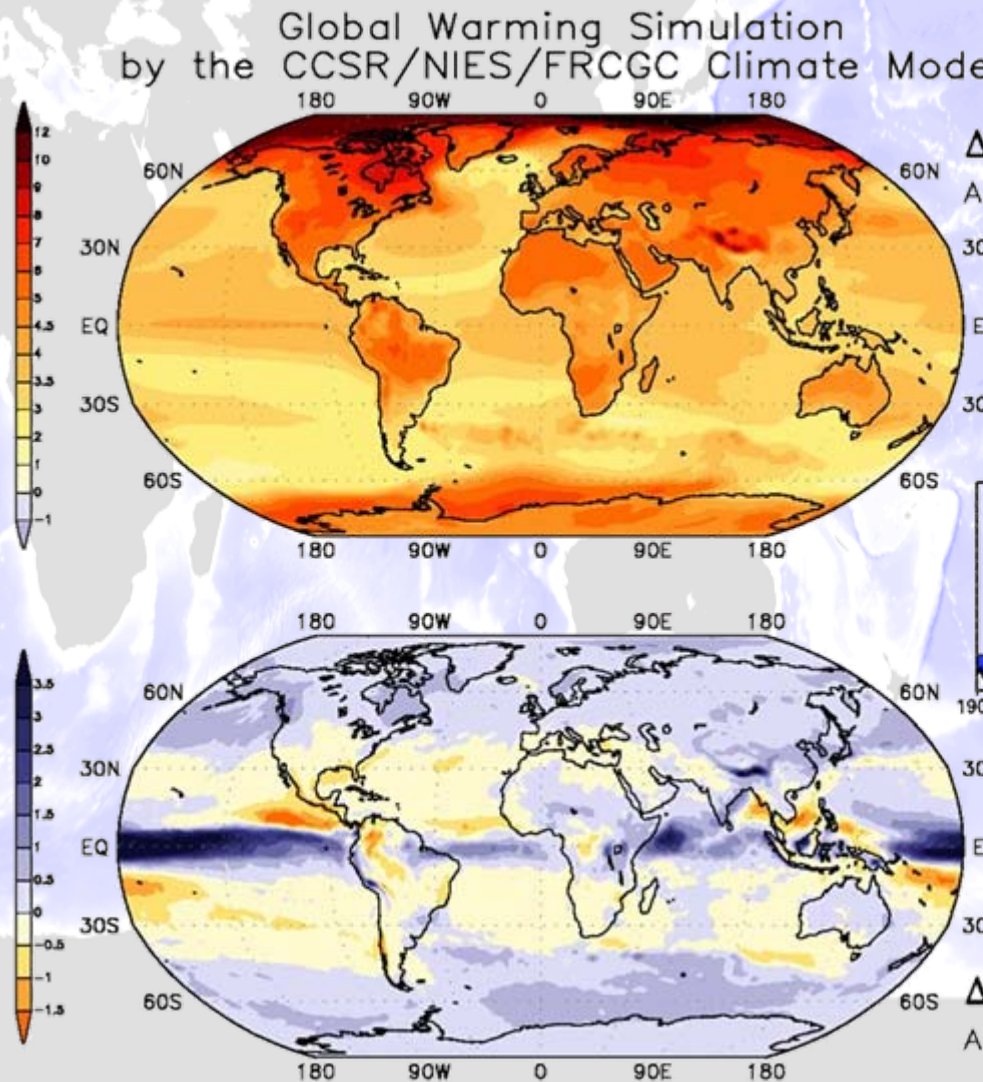
Experiments

Runs for IPCC AR4 and CMIP Coordinated Ex.



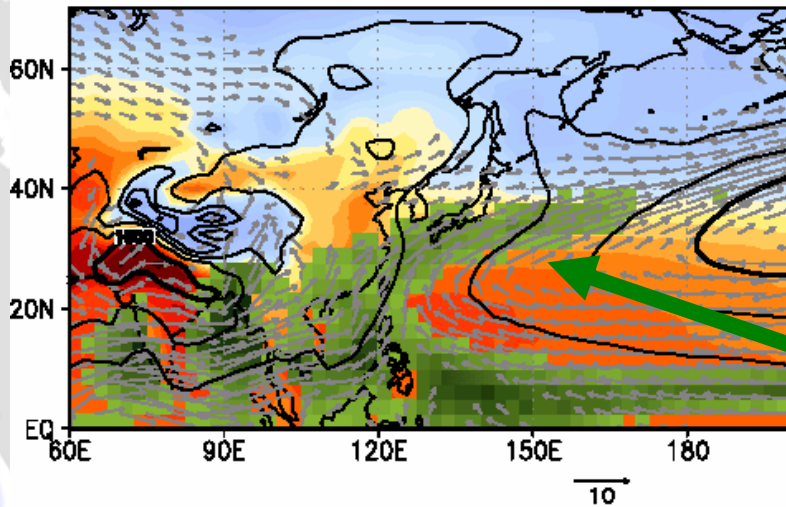
Large-scale feature of global warming

SAT and rain: (2071-2100 of A1B) - (1971-2000)



What does resolution matter?

T2/SLP/V850 1xCO2 Obs. Jun



**SAT/SLP/V850
June (control)**

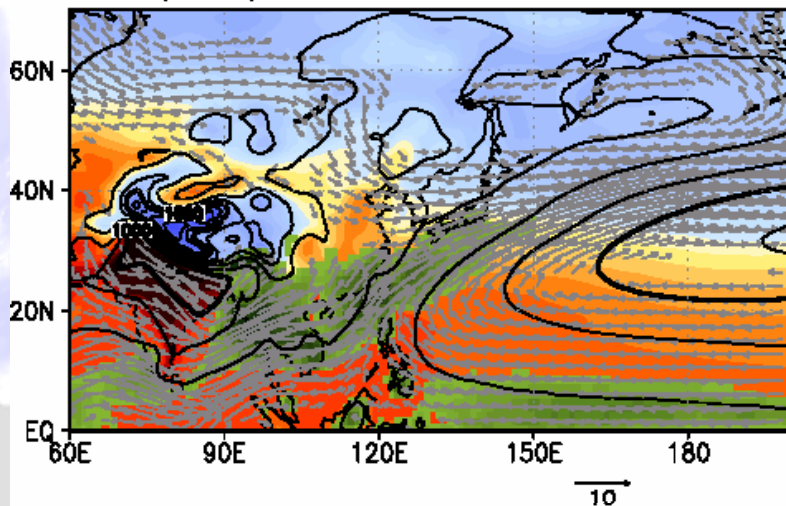
Obs.

High-res.

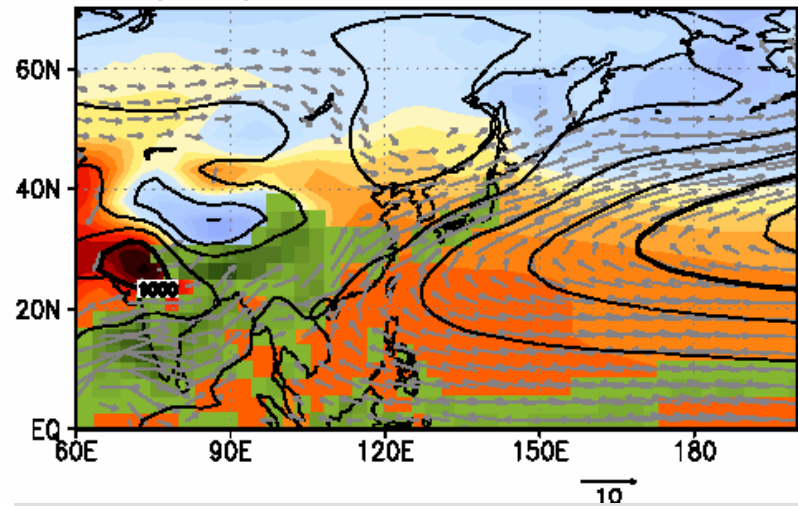
Med-res.

Baiu/Meiyu front

T2/SLP/V850 1xCO2 Hi-CGCM Jun

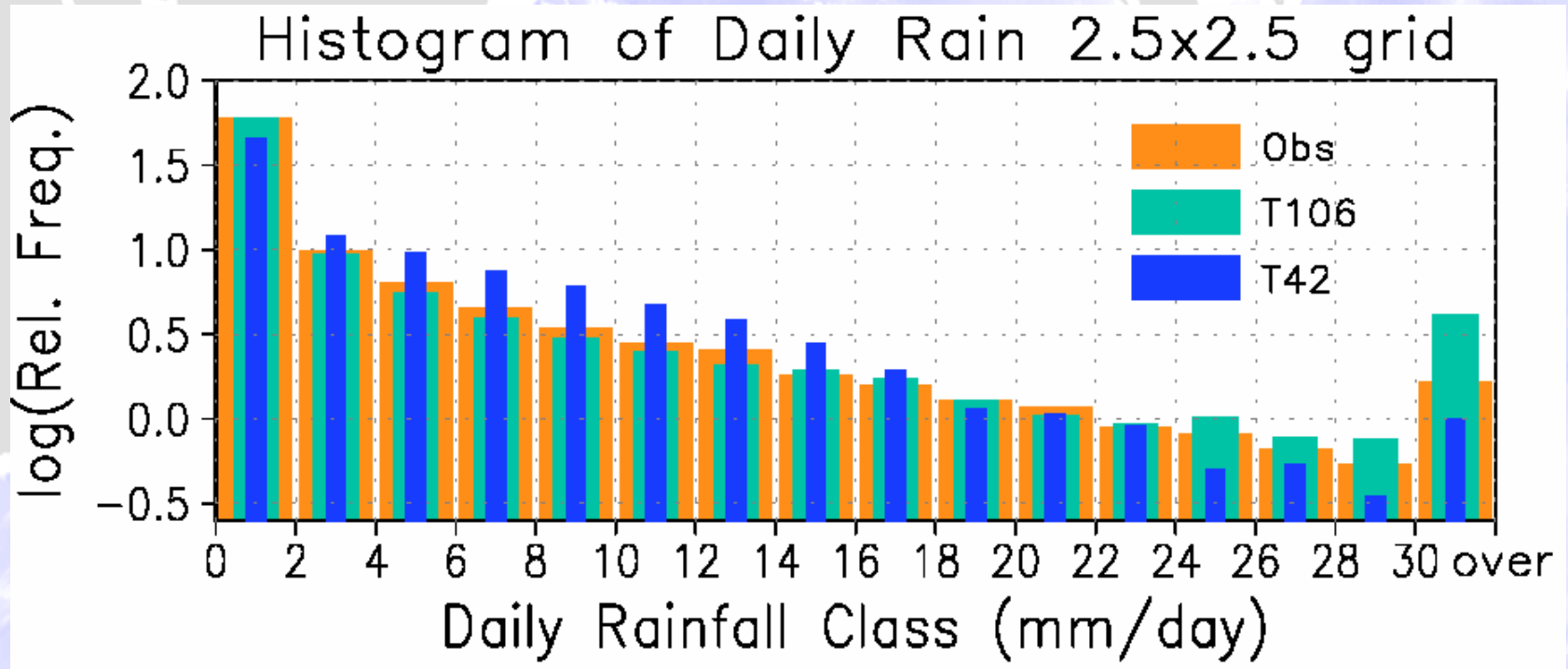


T2/SLP/V850 1xCO2 Mid-CGCM Jun



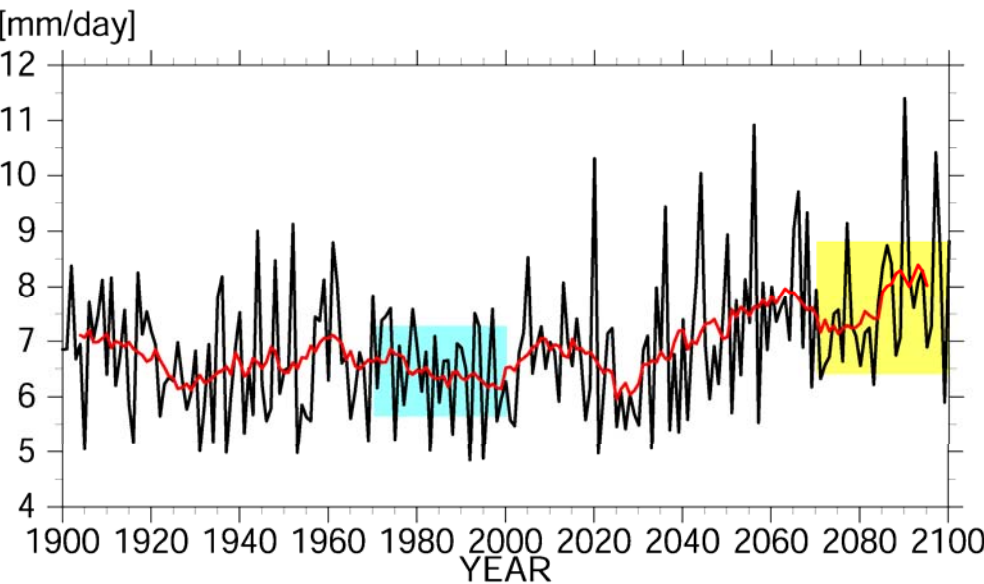
What does resolution matter?

Daily rainfall frequency over Japan
(120E-140E, 30N-40N)



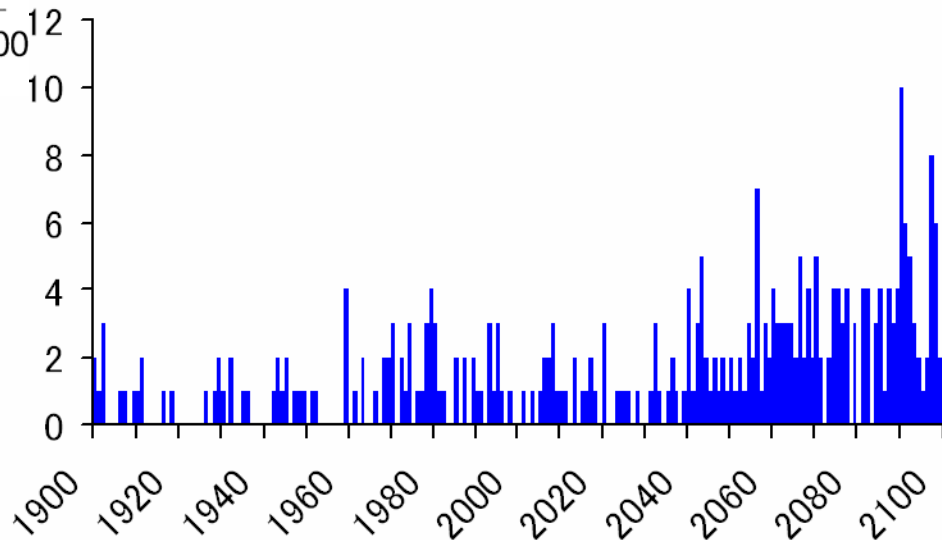
What does resolution matter?

Change of rainfall over Japan by high-res. model



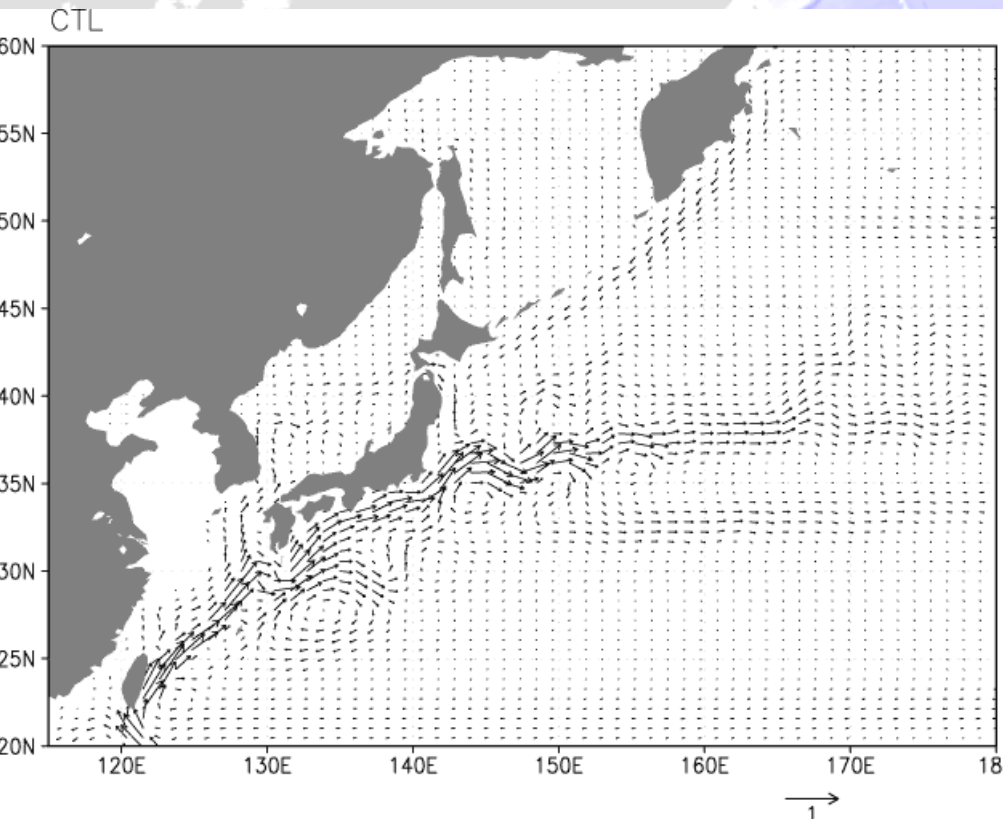
Summertime mean
rainfall

Number of days of
heavy (> 100 mm/day)
rainfall



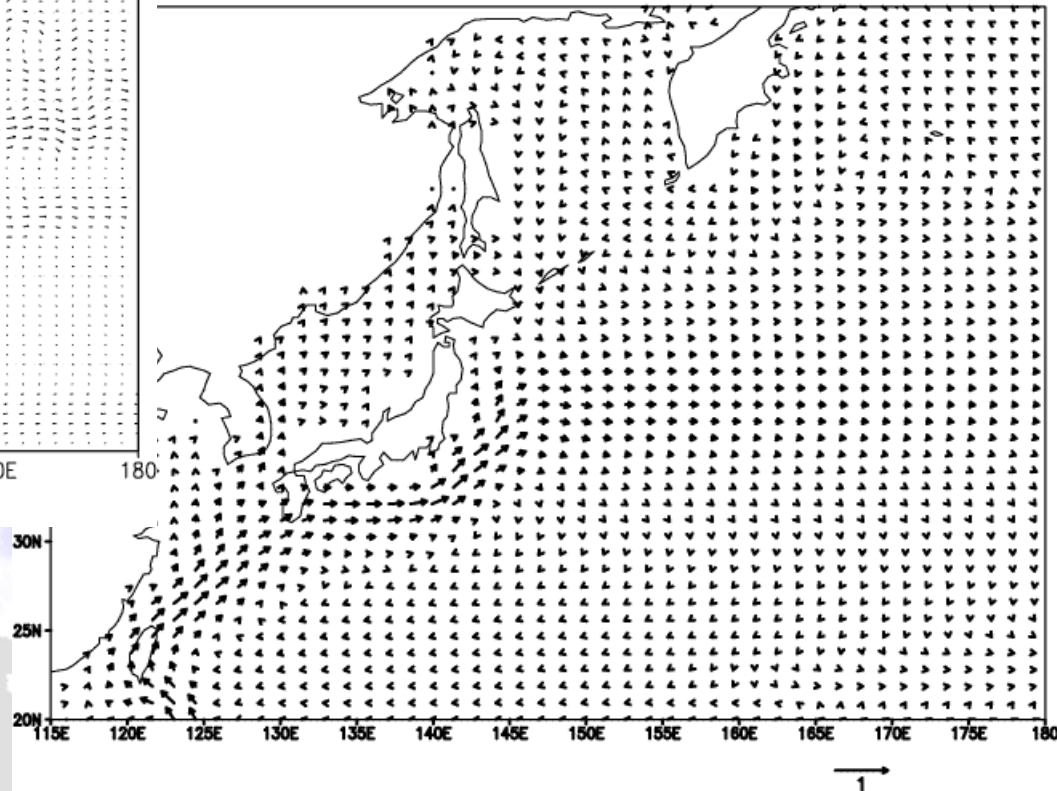
What does resolution matter?

Annual-mean 100 m velocity



Medium-resolution

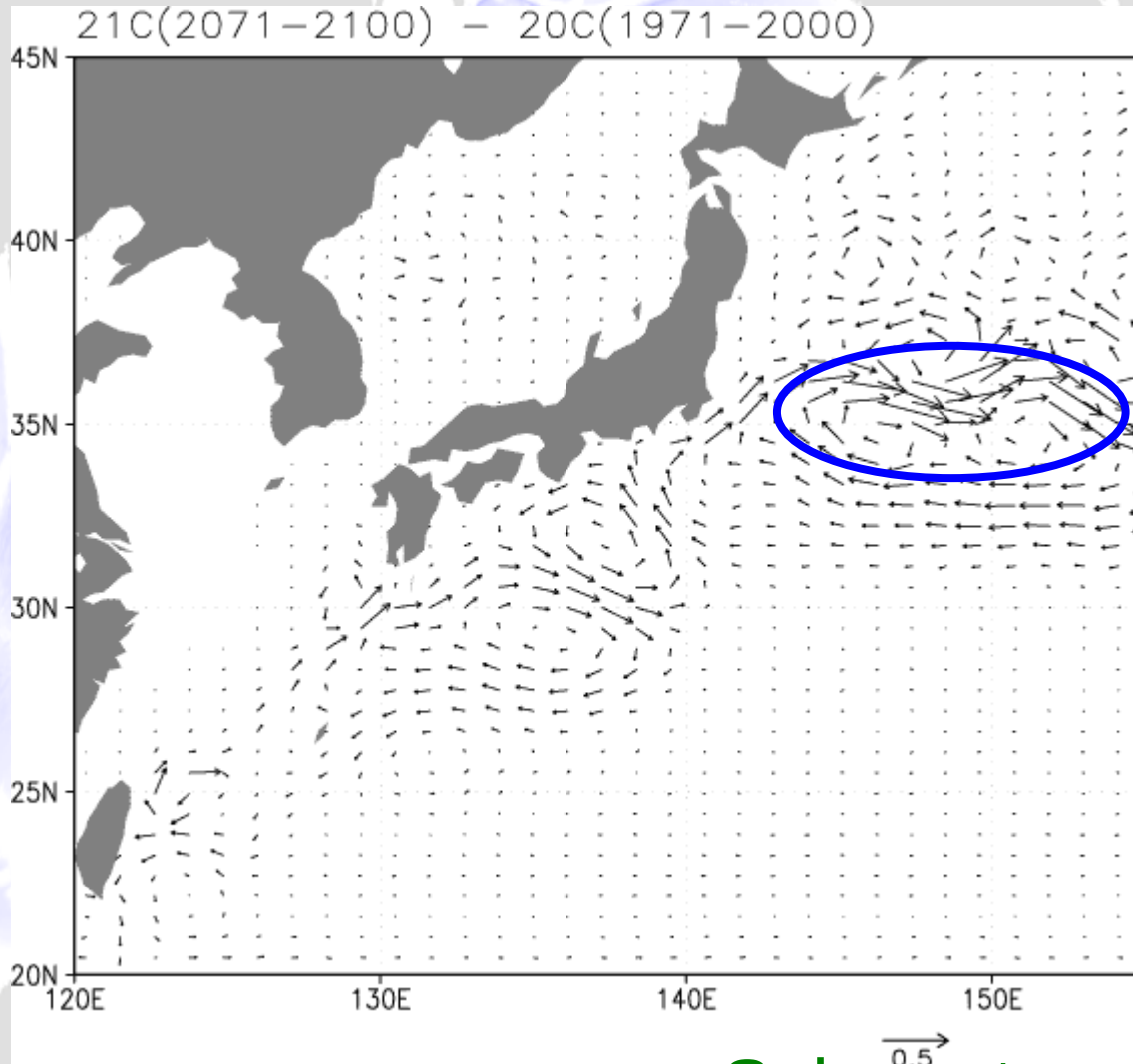
Annual-mean surface currents: Medium-res. CONTROL



High-resolution

What does resolution matter?

Kuroshio: (2071-2100 of A1B) – (1971-2000)

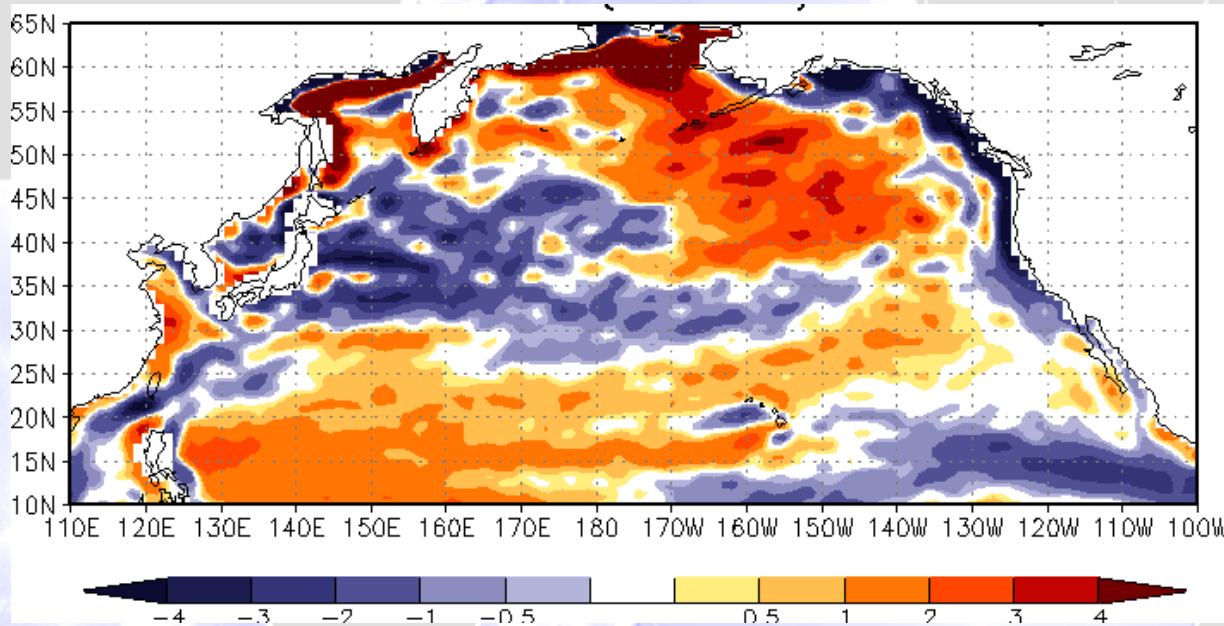


+30 cm/s

Sakamoto et al. (2005)

What does resolution matter?

Curl τ change: (2071-2100 of A1B) – (1971-2000)

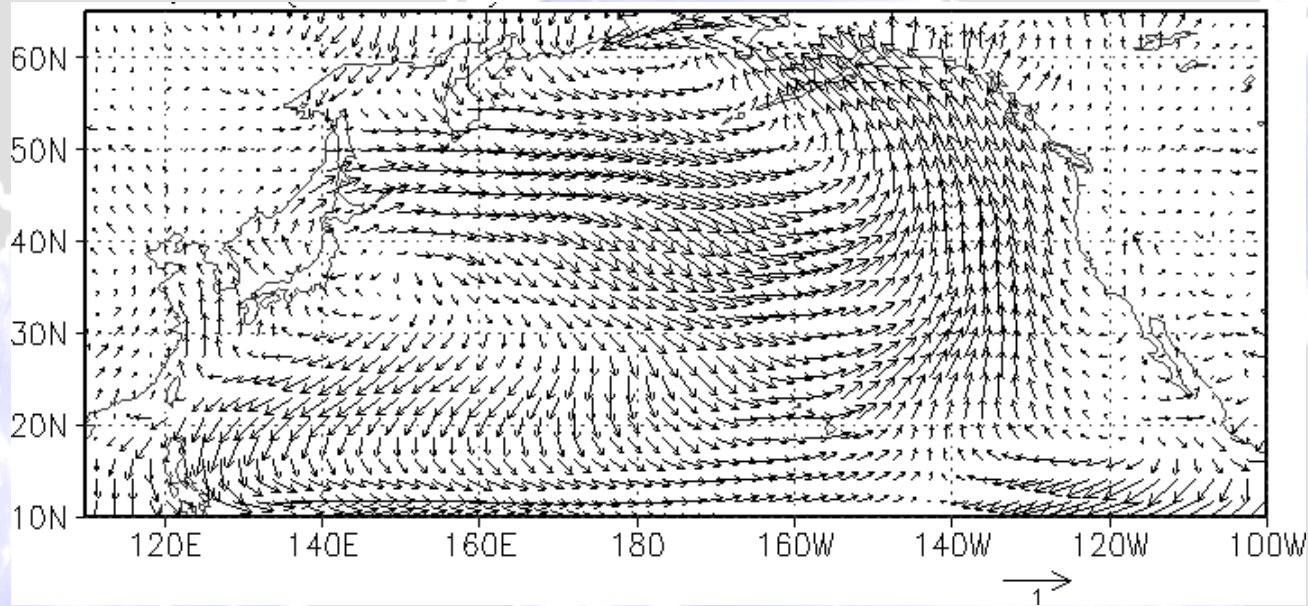


- Acceleration of the Kuroshio accounted for by Sverdrup transport ~5 Sv
- Actual acceleration ~30 Sv

Sakamoto et al. (2005)

What does resolution matter?

Wind change: (2071-2100 of A1B) – (1971-2000)



- Weakened trades
 - Intensified Aleutian Low
- ... El Nino-like response (Many models project El Nino-like SST rise under global warming)

Sakamoto et al. (2005)

What does resolution matter?

Coupled effect of resolution dependence?

- Higher resolution AGCM → better atmosphere (Baiu/Meiyu front, tropical cyclone, ...)
- Higher resolution OGCM → better ocean (Kuroshio, eddy and variability, ...)
- Does atmospheric (oceanic) resolution affect ocean (atmosphere)?
- Is there any air-sea feedback affecting resolution dependence?

What is improved by resolution? How and why?

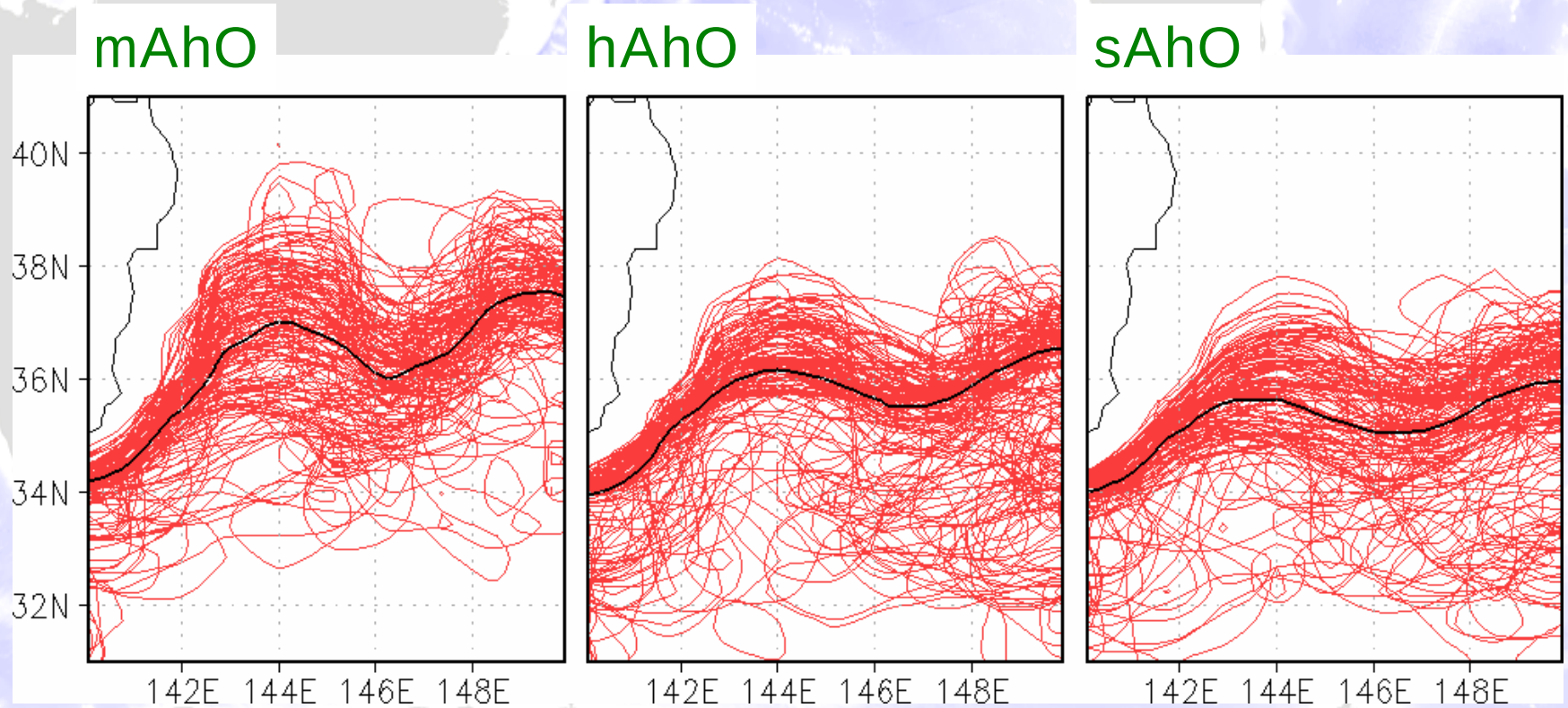
Cross-bred models

Control climate simulations by models with different combinations of resolution

- T106(1°) AGCM + 1/4°x1/6° OGCM
high-AGCM high-OGCM → hAhO
- T42(3°) AGCM + 1° OGCM
medium-AGCM medium-OGCM → mAmO
- T106 AGCM + 1° OGCM
high-AGCM medium-OGCM → hAmO
- T42 AGCM + 1/4°x1/6° OGCM
medium-AGCM high-OGCM → mAhO
- T213(0.5°) AGCM + 1/4°x1/6° OGCM
super-high-AGCM high-OGCM → sAhO

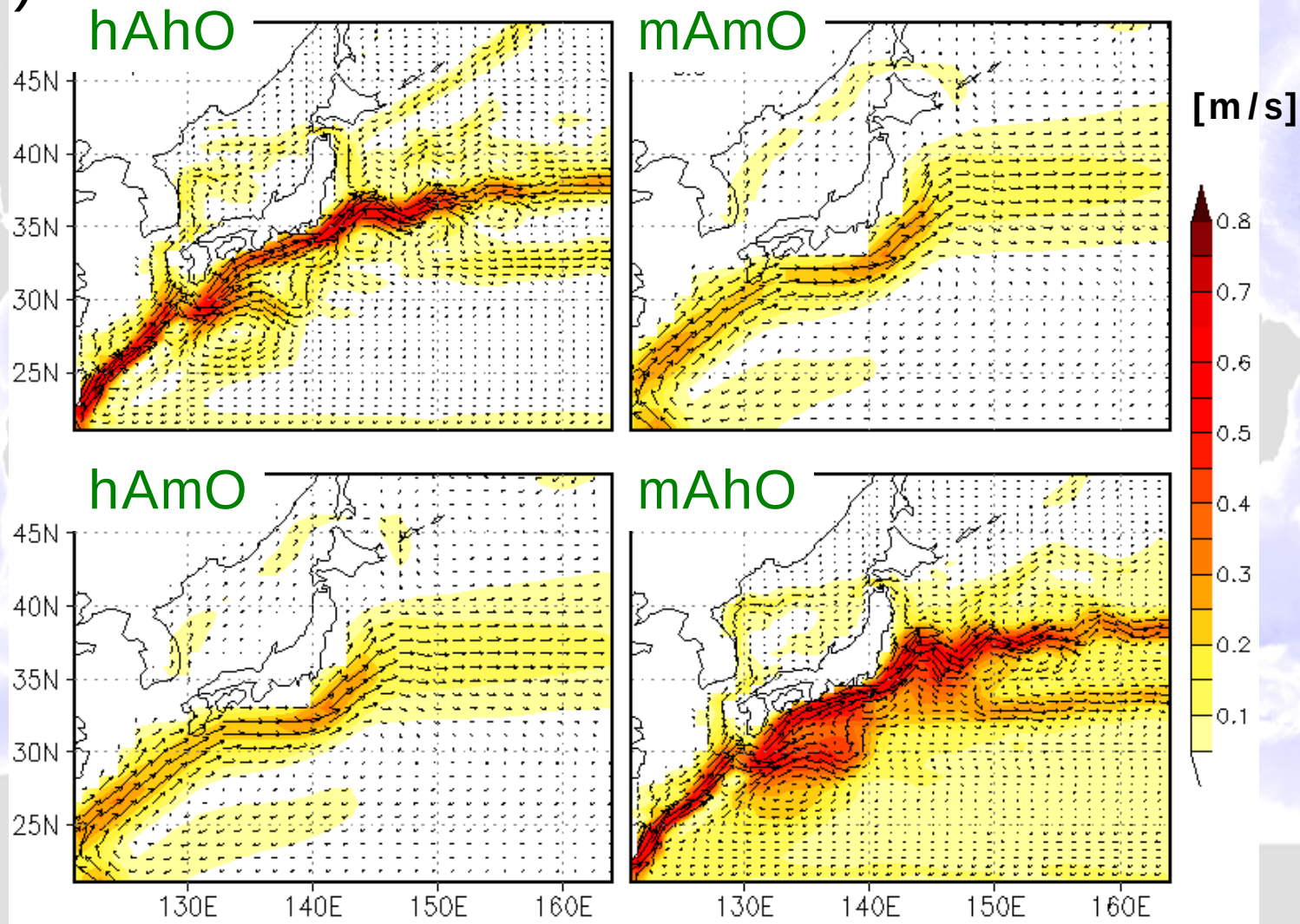
Cross-bred models

Kuroshio axis for high-OGCM cases
(16°C contours at 200 m depth)



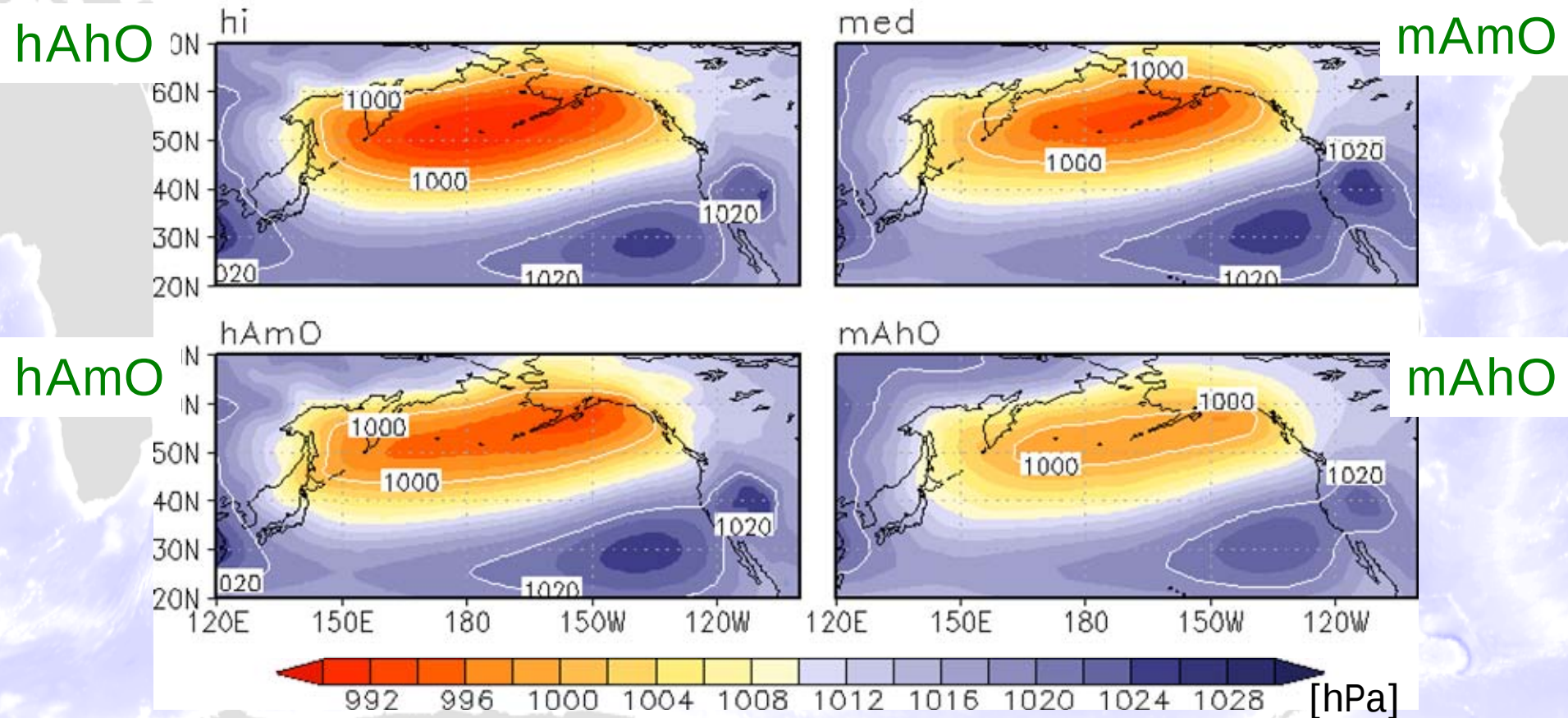
Cross-bred models

Atmospheric resolution and the Oyashio (subpolar gyre)



Cross-bred models

Wintertime sea level pressure



Stronger Aleutian Low $\leftarrow ? \rightarrow$ Stronger Oyashio

Summary

- Question: What is improved by resolution in climate simulations and projections?
How and Why?
- Running models of various combination of atmospheric and oceanic resolution
... Ongoing work