

How Tibetan Plateau Affects the Global Meridional Overturning Circulation?

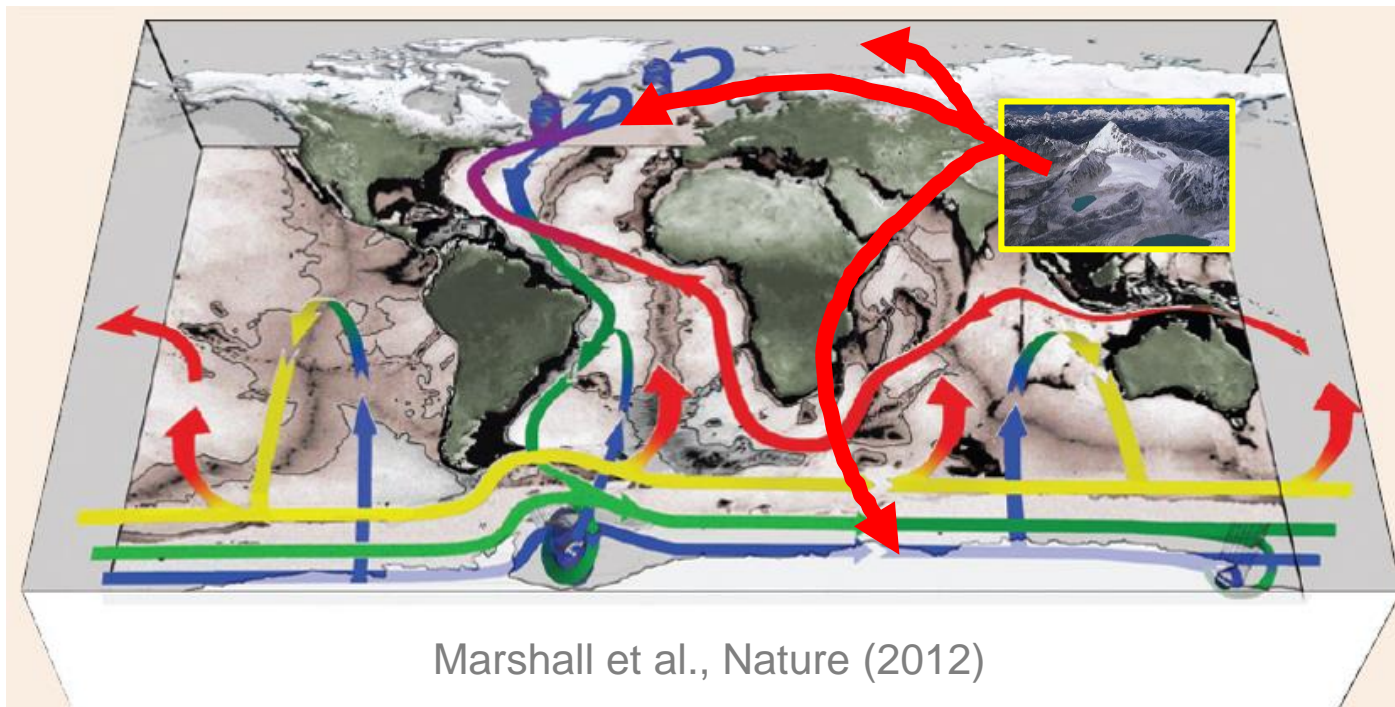
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School of Physics, Peking University
Email: hjyang@pku.edu.cn



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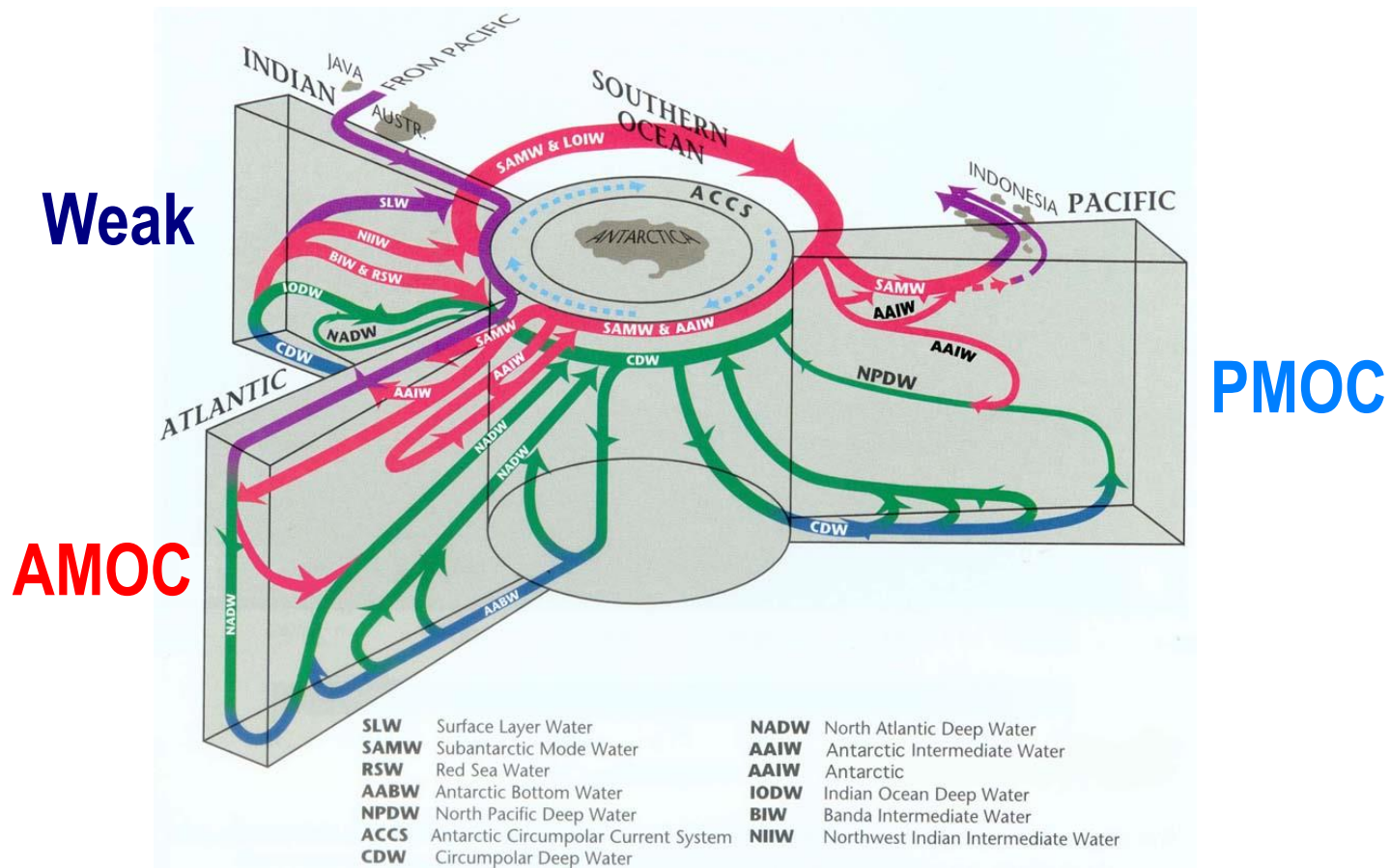
TP: A *Global* Perspective

How and to what extent?



Global Meridional Overturning Circulation

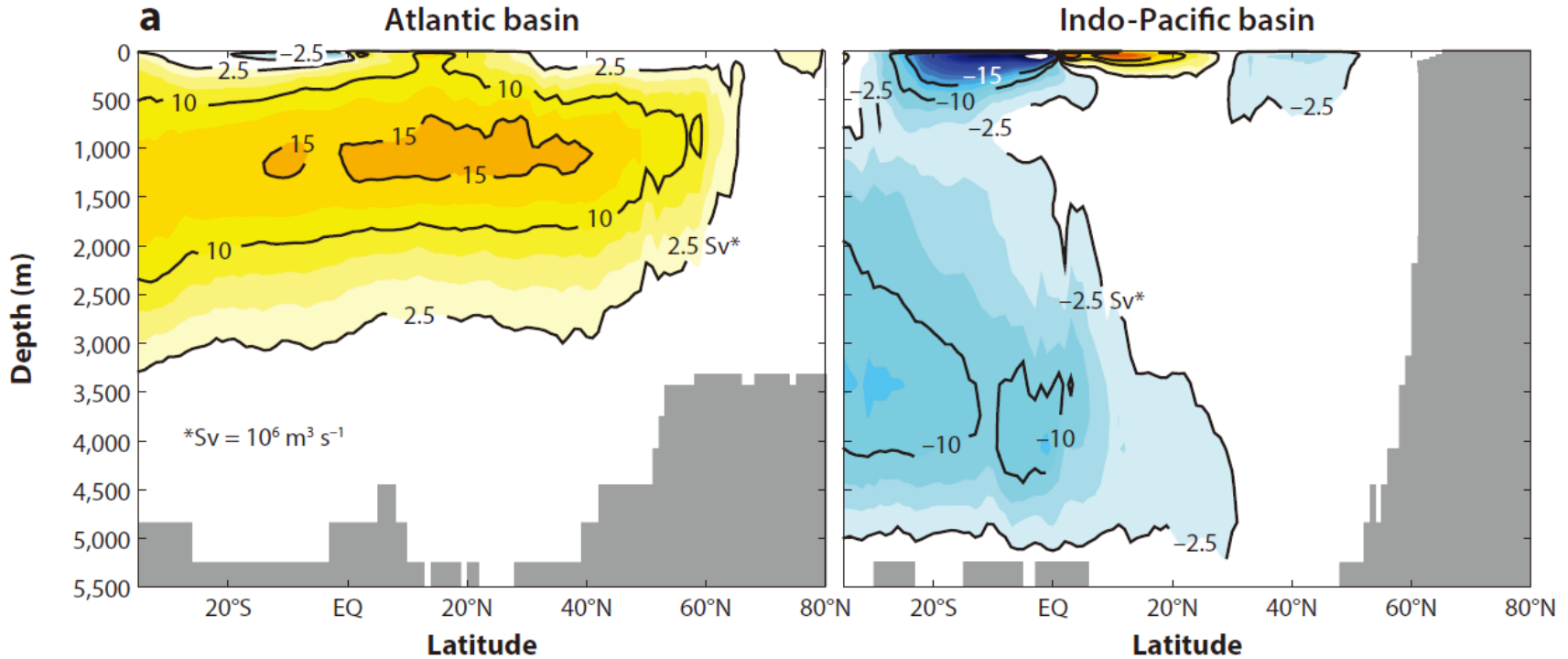
Energy and Freshwater Balance



Schmitz (1997) Overturning circulation: Southern Ocean View

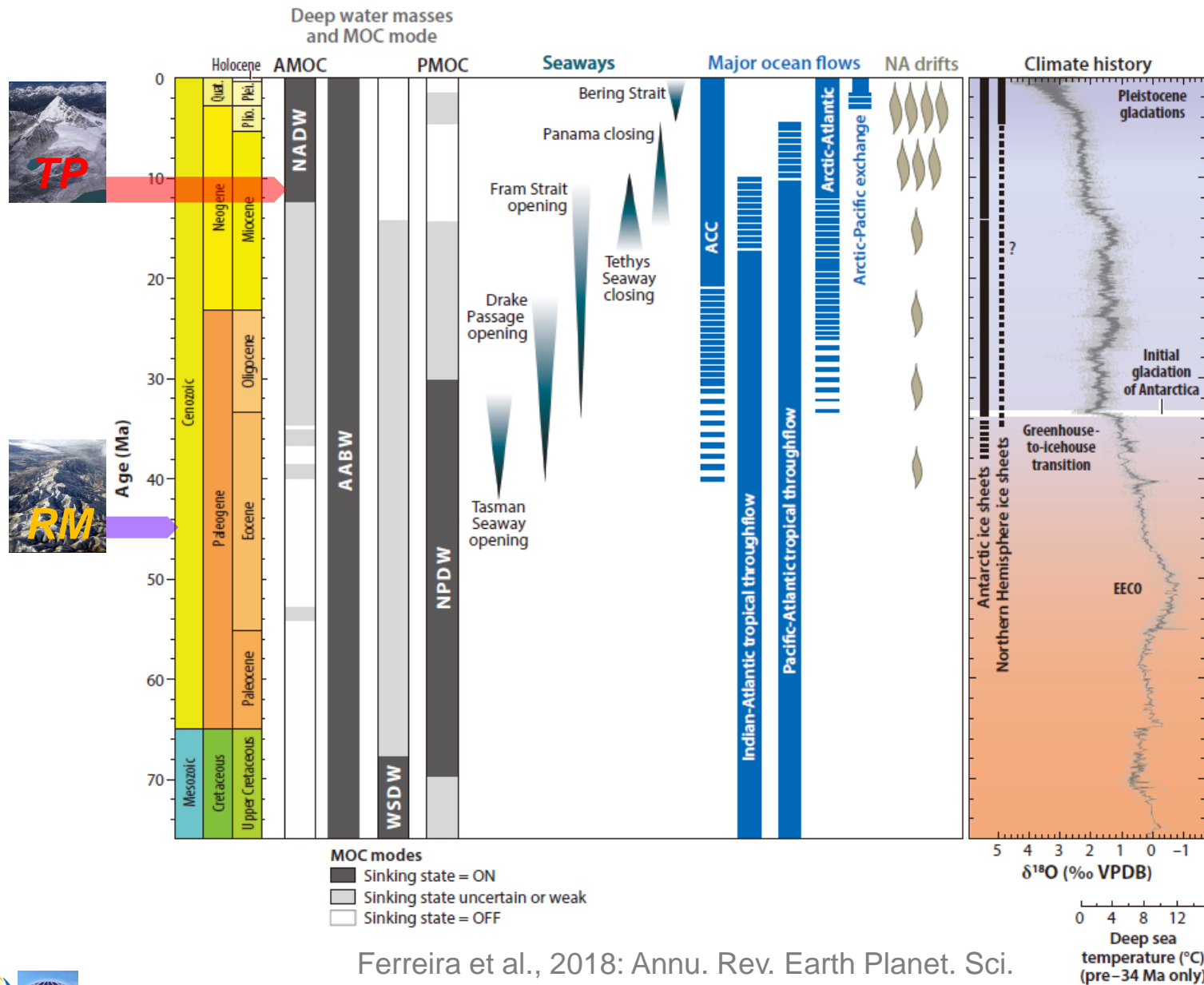
Strong AMOC

Weak PMOC



Ferreira et al., 2018: Annu. Rev. Earth Planet. Sci.

Geological History of *GMOC*

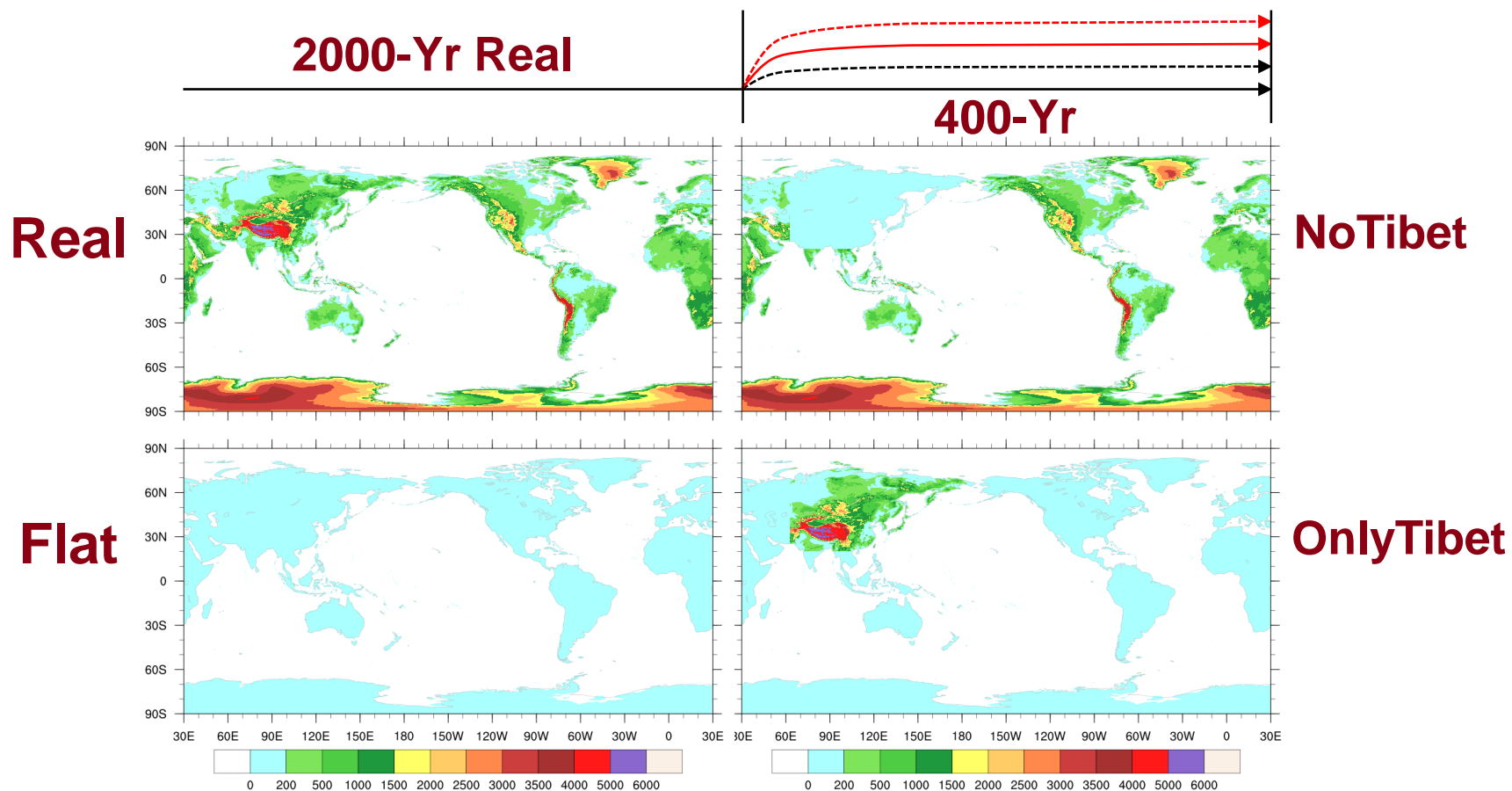


Ferreira et al., 2018: Annu. Rev. Earth Planet. Sci.

气候变化历史与机理：重建-模拟-数据挖掘研讨会，2019.08.27，兰州

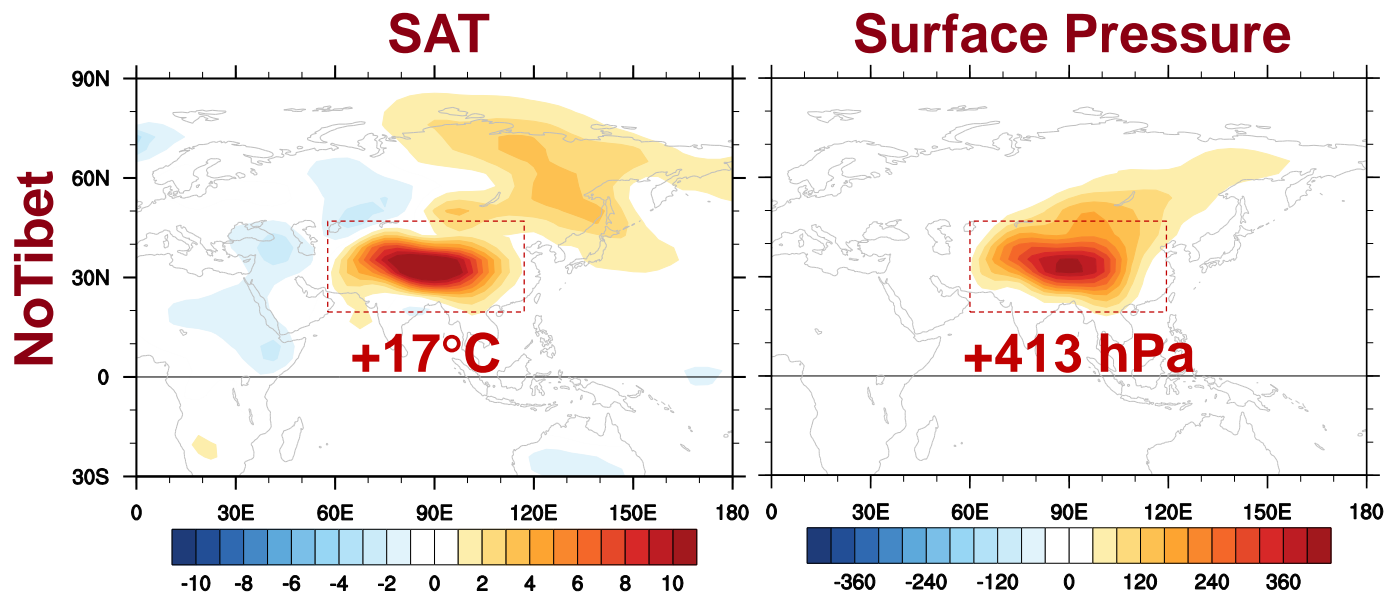


Coupled Earth System Model



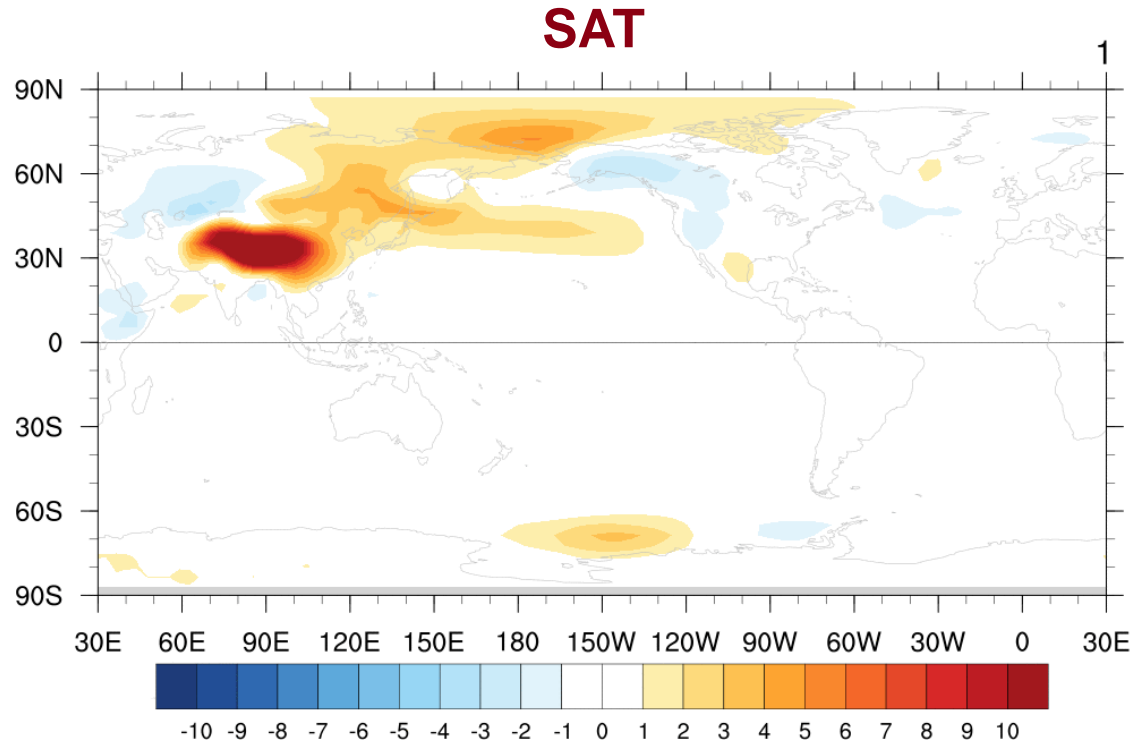
NCAR CESM1.0: CAM5 / POP2 / CLM4 / CICE4 / Glimmer-CISM

TP Forcing: *Thermal* and *Dynamical*



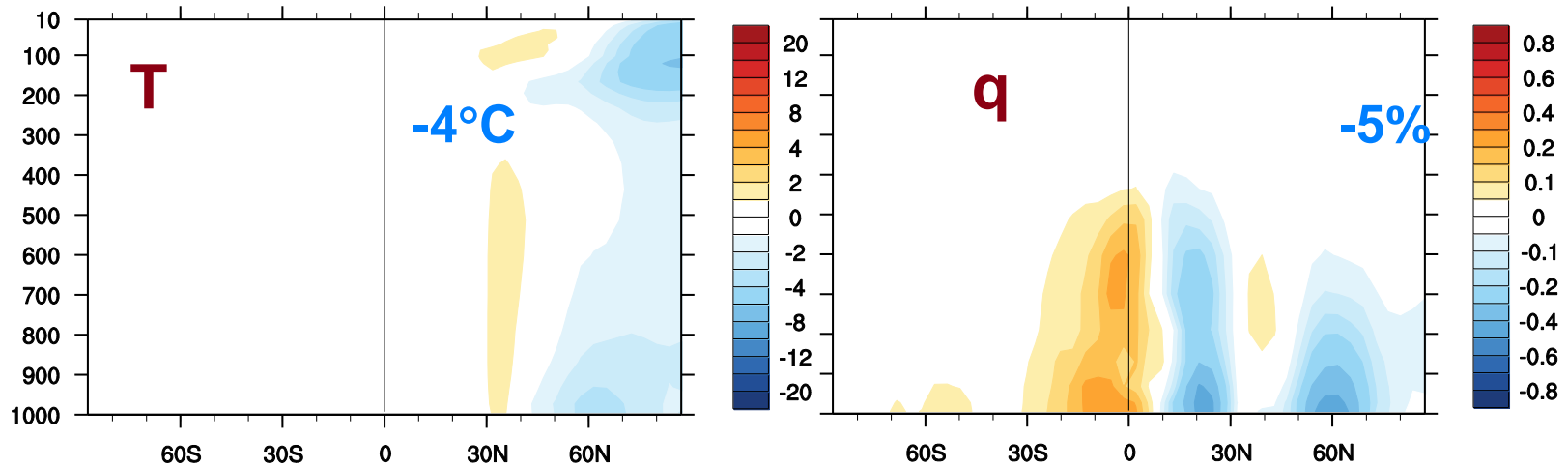
Lapse Rate $T \sim 4 \text{ km} \times 7 \sim 28^\circ\text{C}$

SAT Evolution w/o TP



Atmosphere T and Moisture

NoTibet



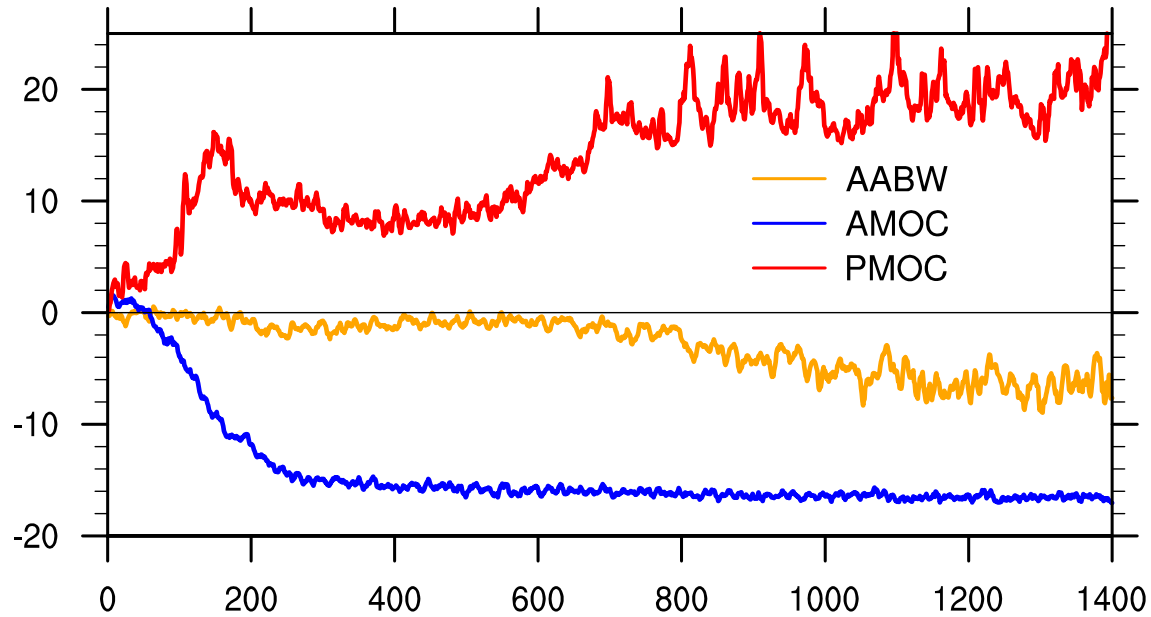
Cold and Dry without TP

Preliminary Results

		NoTibet	OnlyTibet
Atmos	TOA (PW)	+0.2	-0.04
	Air T (°C)	-4.0	+6.0
	SAT (°C)	-18.0	+19.0
	Air q (%)	-5.0	+10.0
	HC (%)	+13	-20
Ocean	SST (°C)	-8.0	+10.0
	SSS (psu)	-4.0	+6.0
	SSD (kg/m ³)	-3.0	+4.0

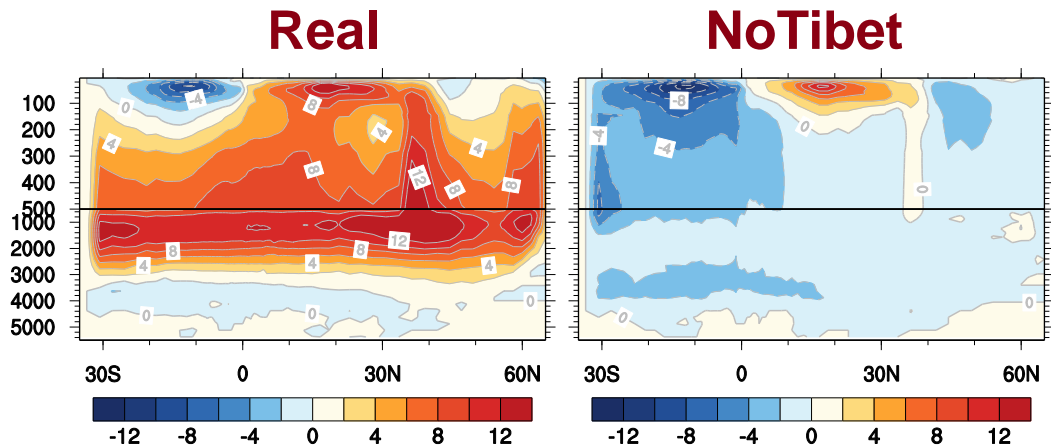
0 → 1 : Critical in Shaping Global Climate!

GMOC Index

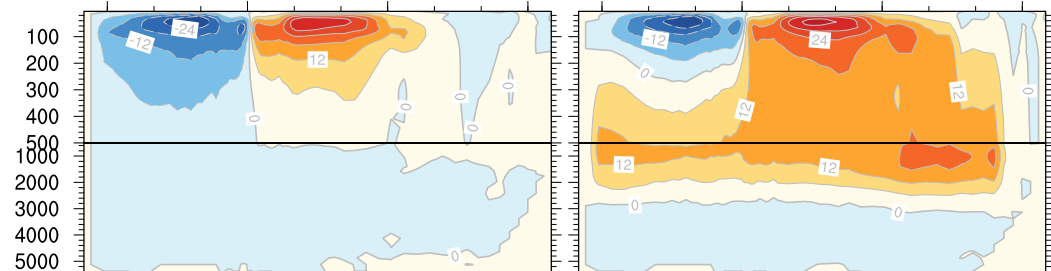


Global MOC

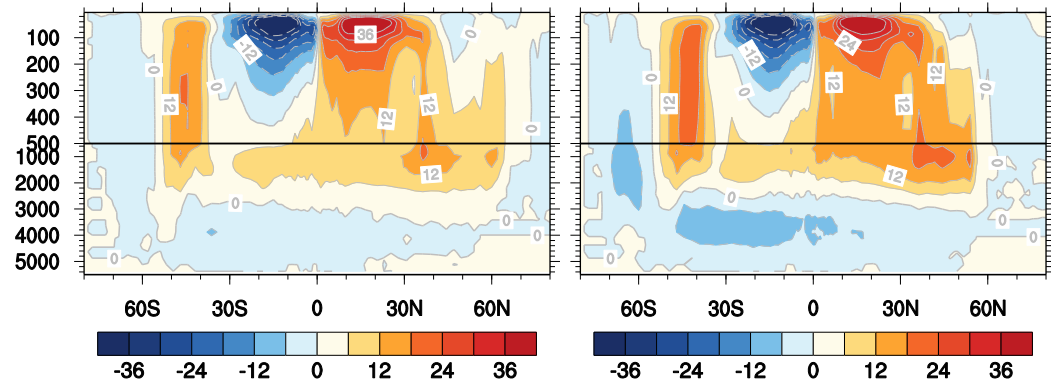
AMOC



PMOC

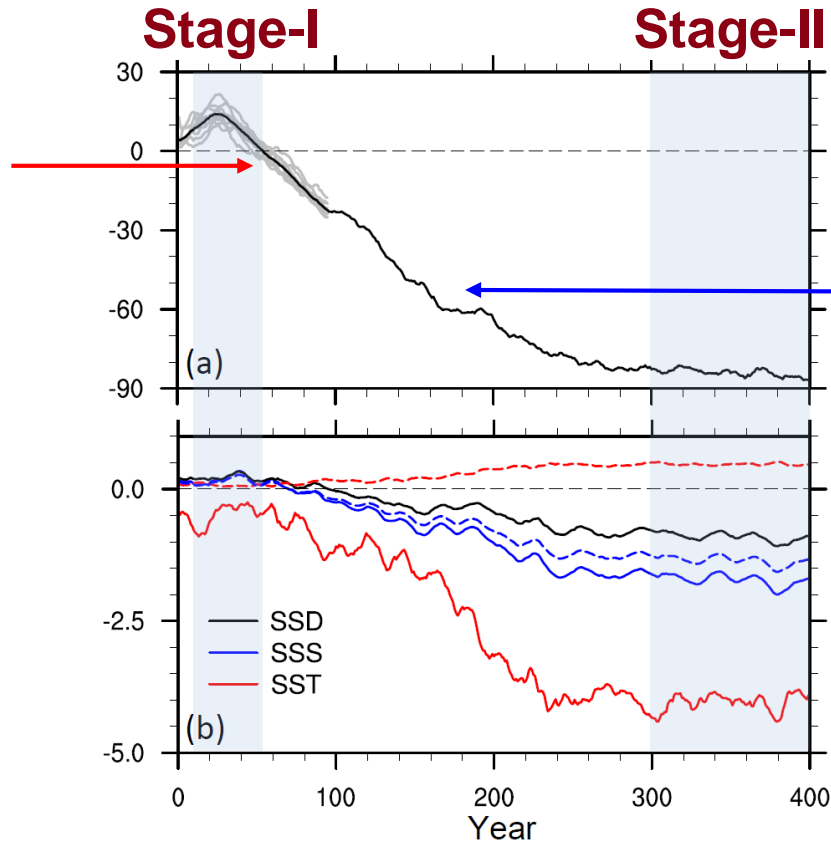


GMOC



AMOC Evolution w/o TP

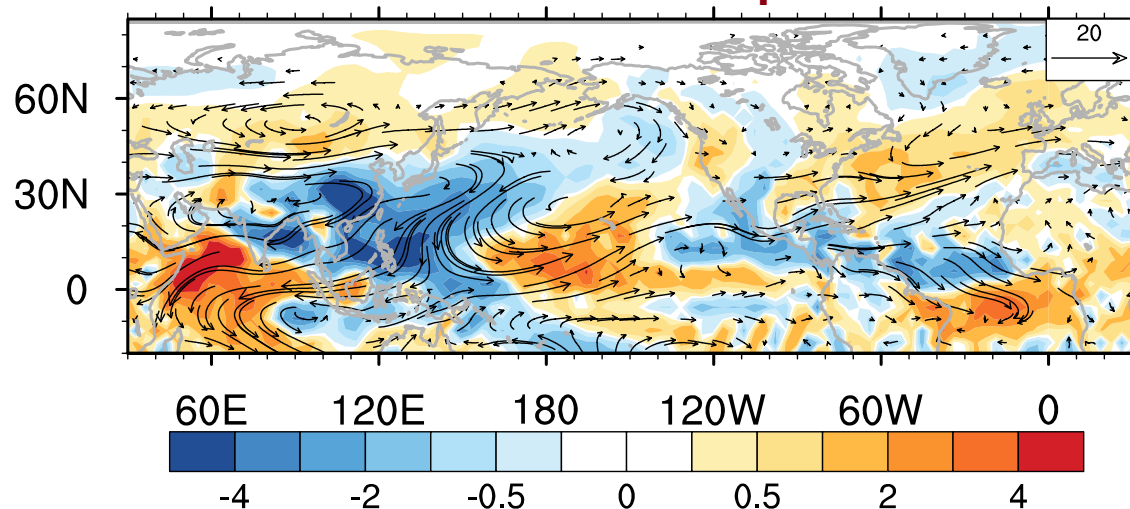
**Atmosphere
Dynamics**



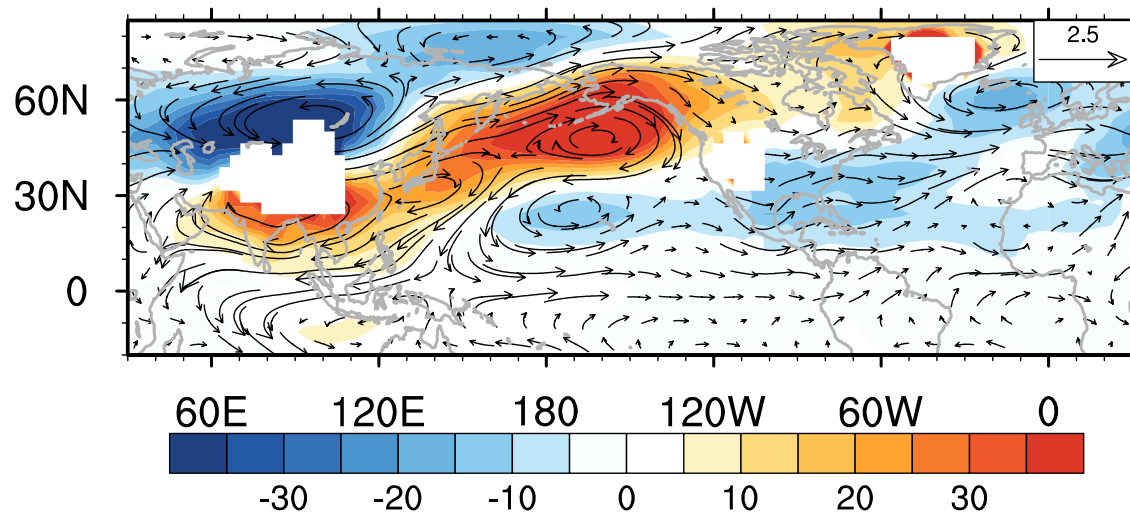
**Sea-ice &
Ocean
Dynamics**

Teleconnection: From *TP* to *Atlantic*

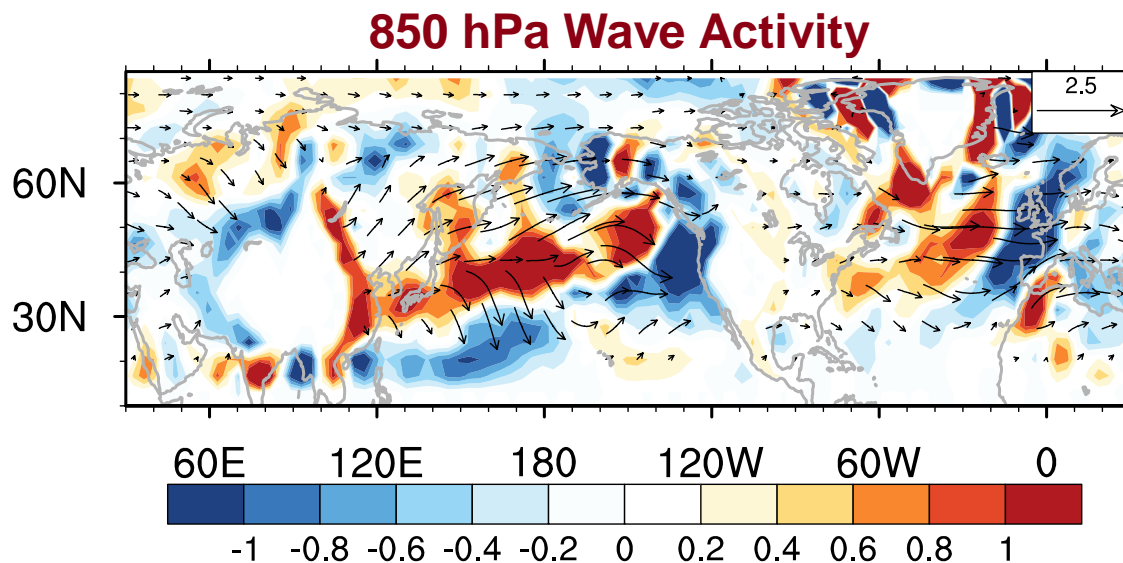
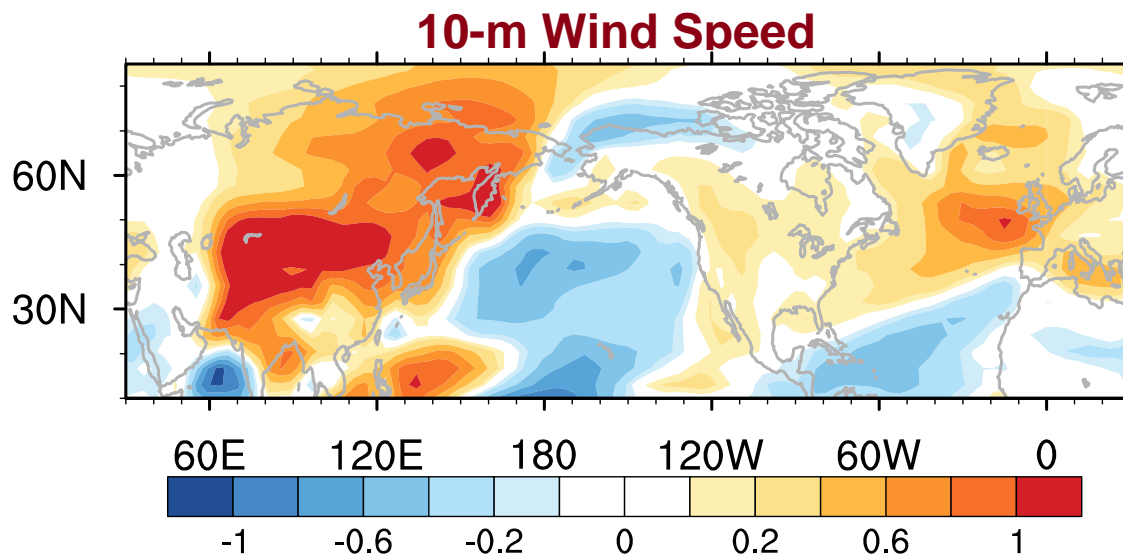
Moisture Transport



850 hPa GH and Wind



Teleconnection: From *TP* to *Atlantic*

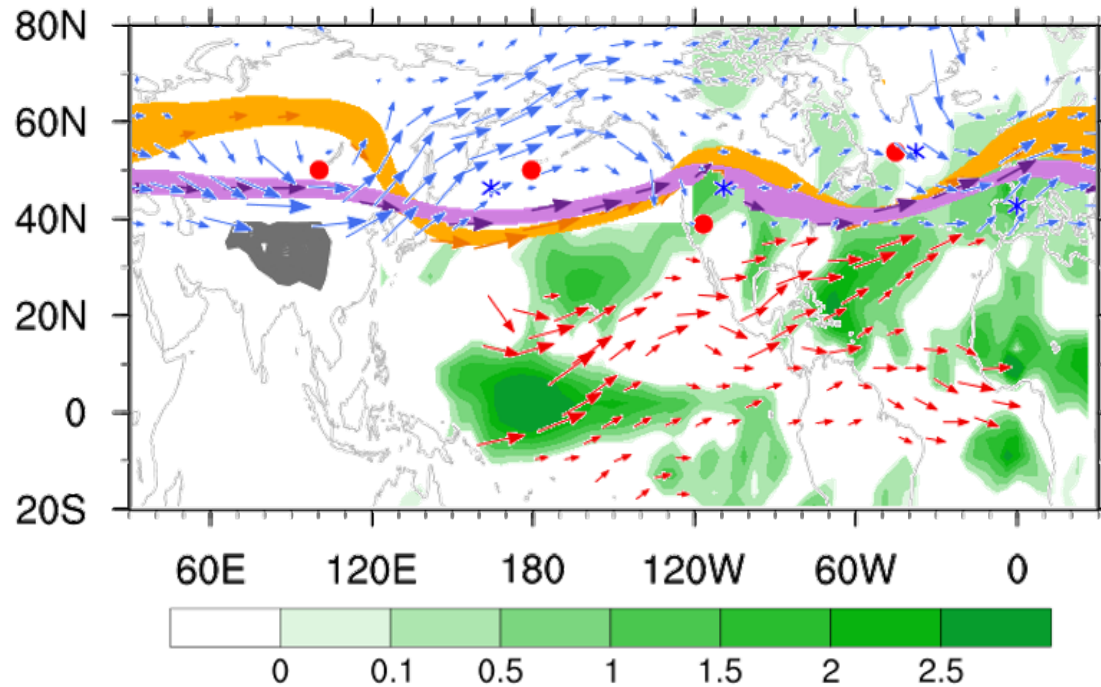


Alan Plumb, JAS, 1985
Takaya & Nakamura,
JAS, 1998



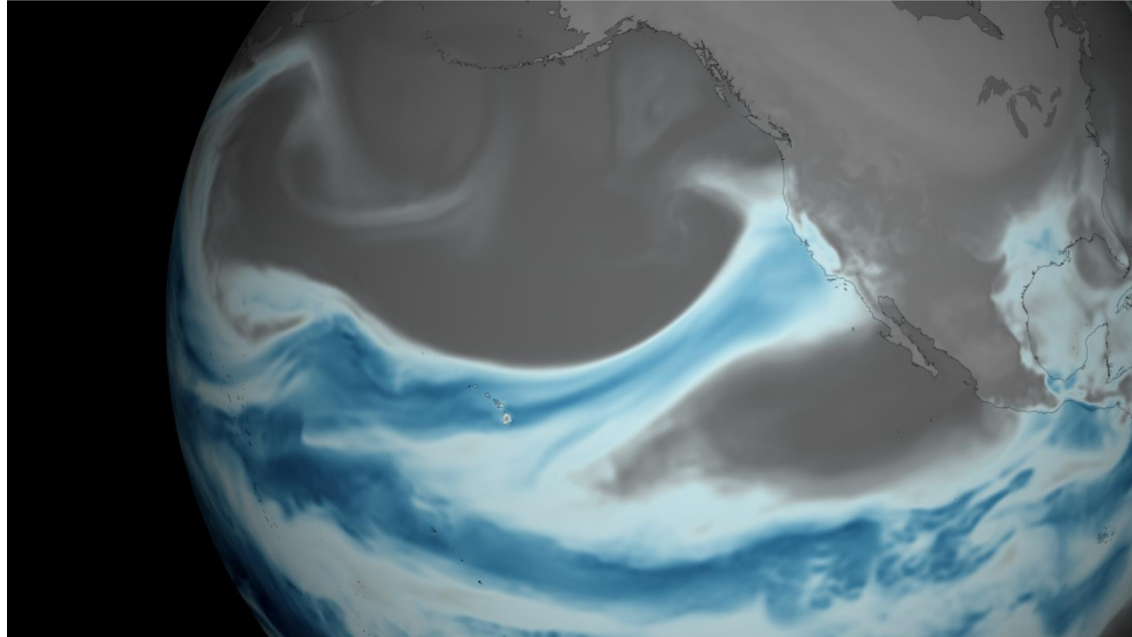
From *TP* to *AMOC*: Atmosphere Dynamics

Stationary Waves with Tibetan Plateau



Atmosphere River

Precipitable water forecast for mid-day, April 6, 2018



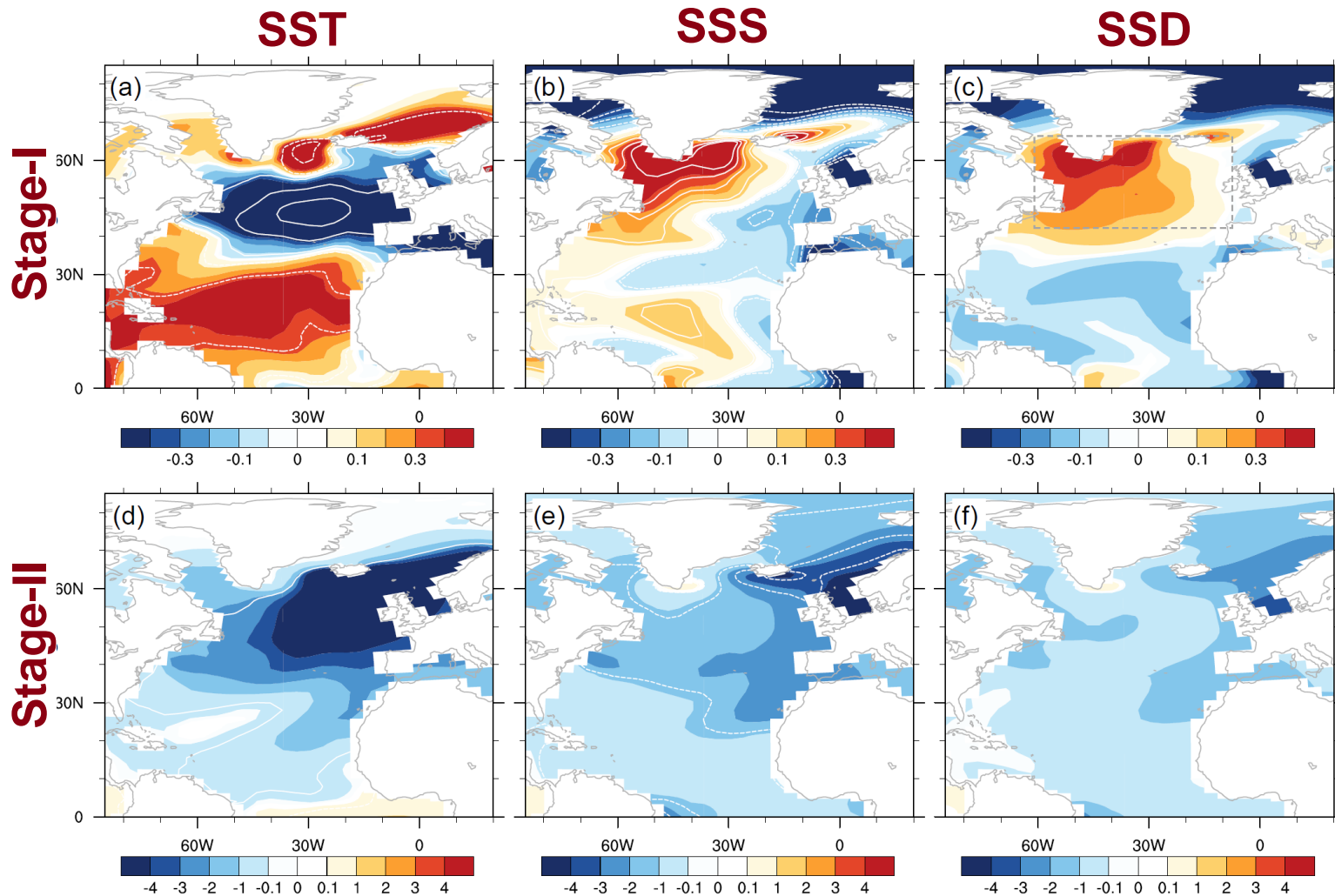
Apr 6, 2018, 11am (PDT)
model run on
Apr 5, 2018, 11pm (PDT)

Precipitable Water (mm)

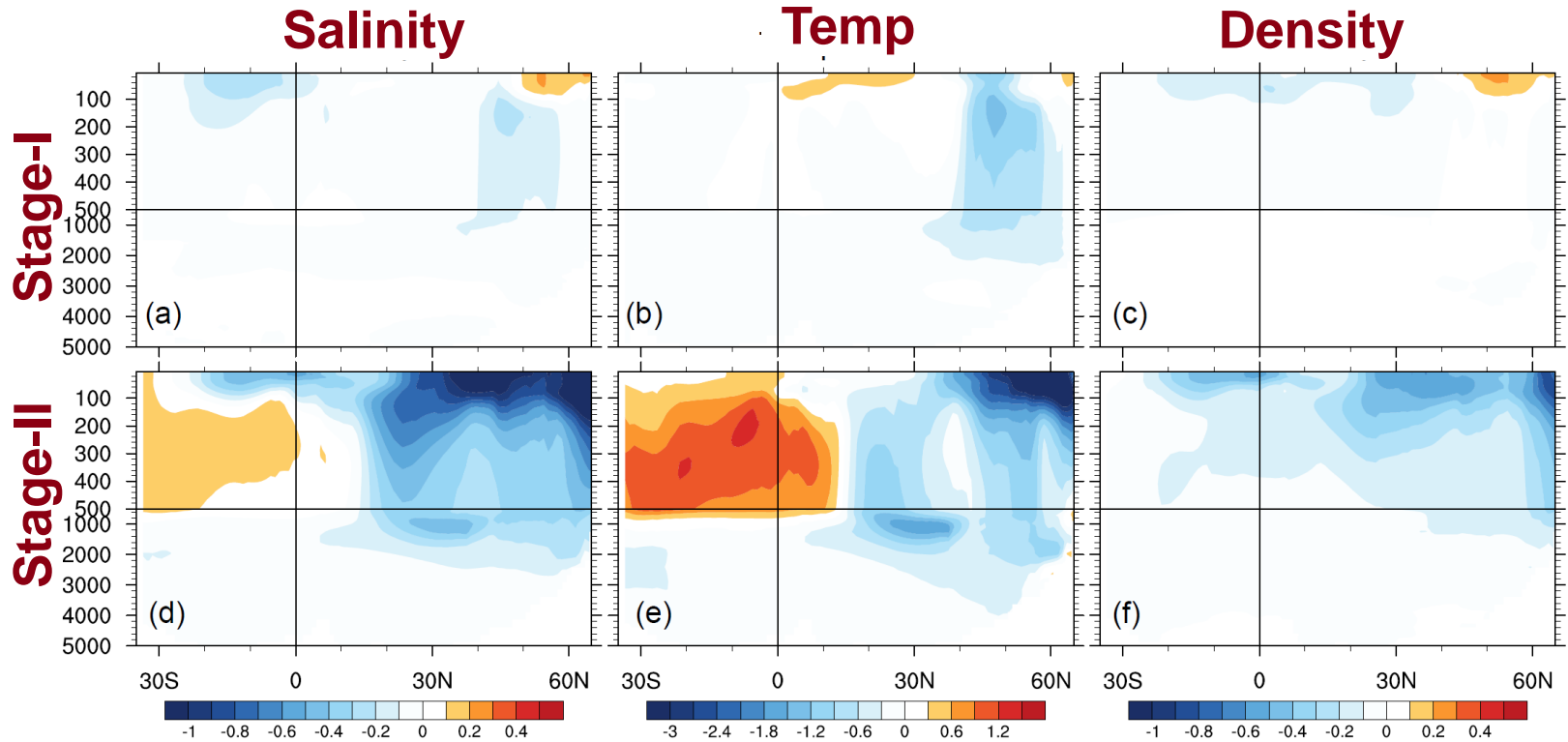


NOAA Climate.gov
Data: NESDIS

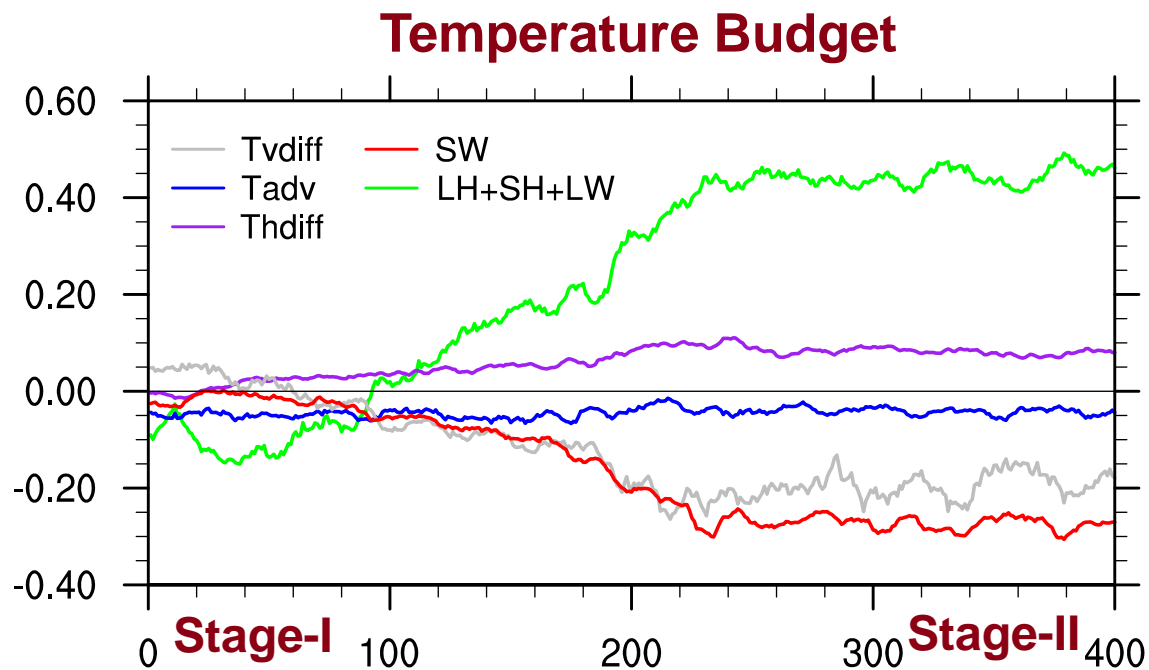
Ocean Change



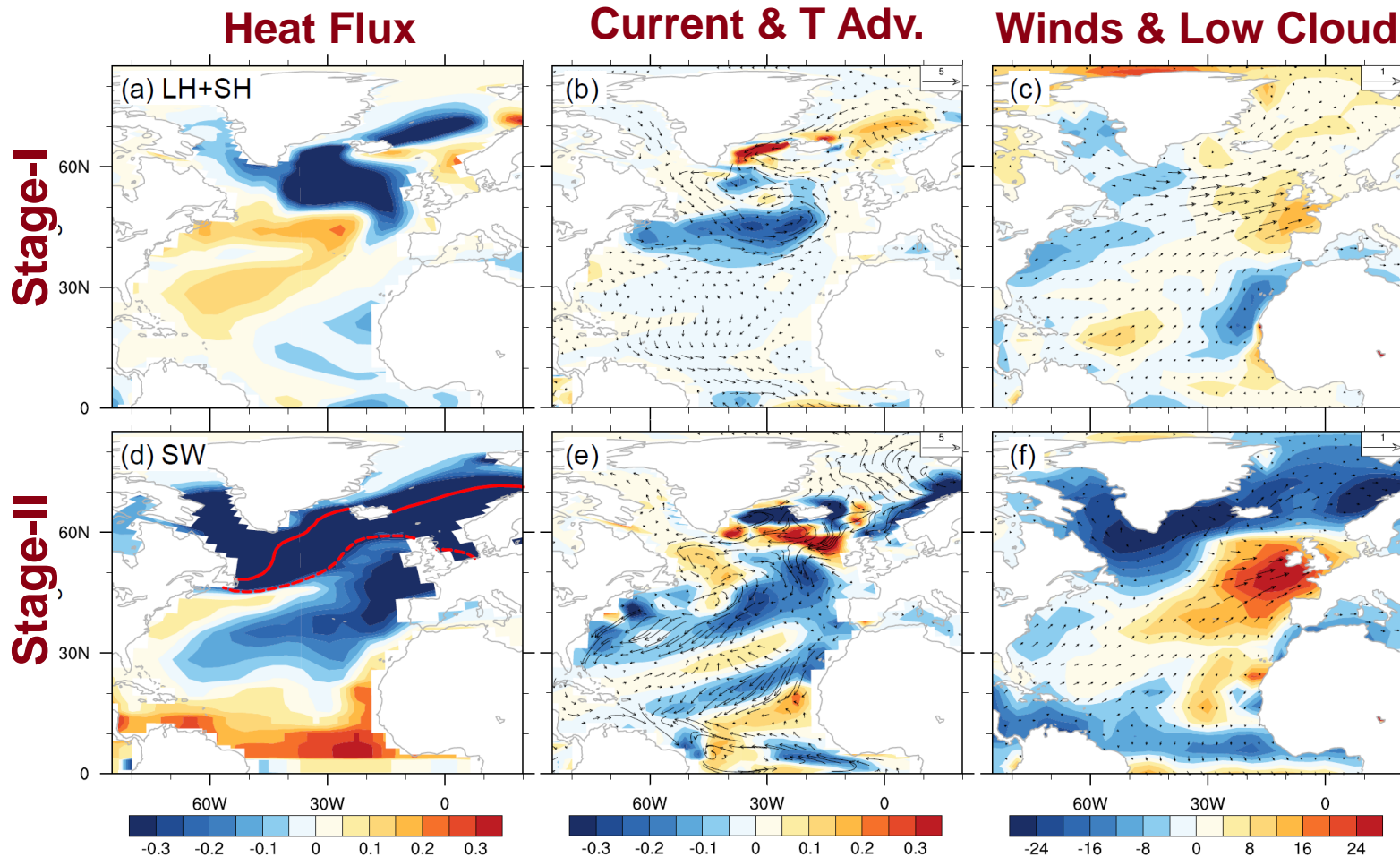
Ocean Change



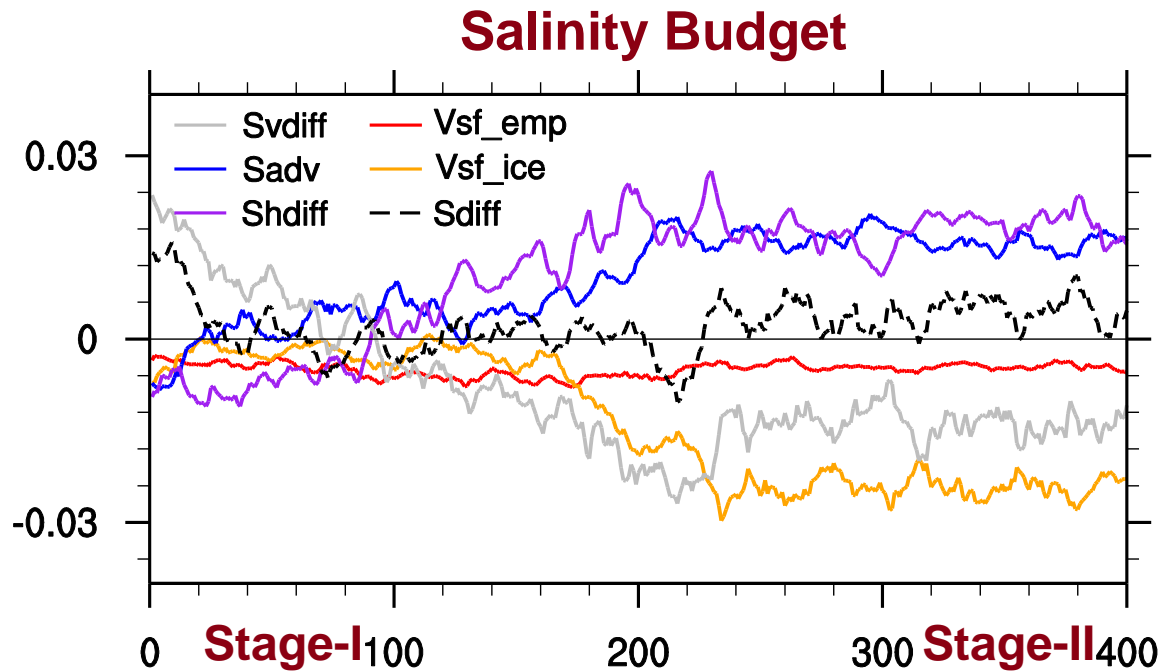
Mechanism for *Temp* Change



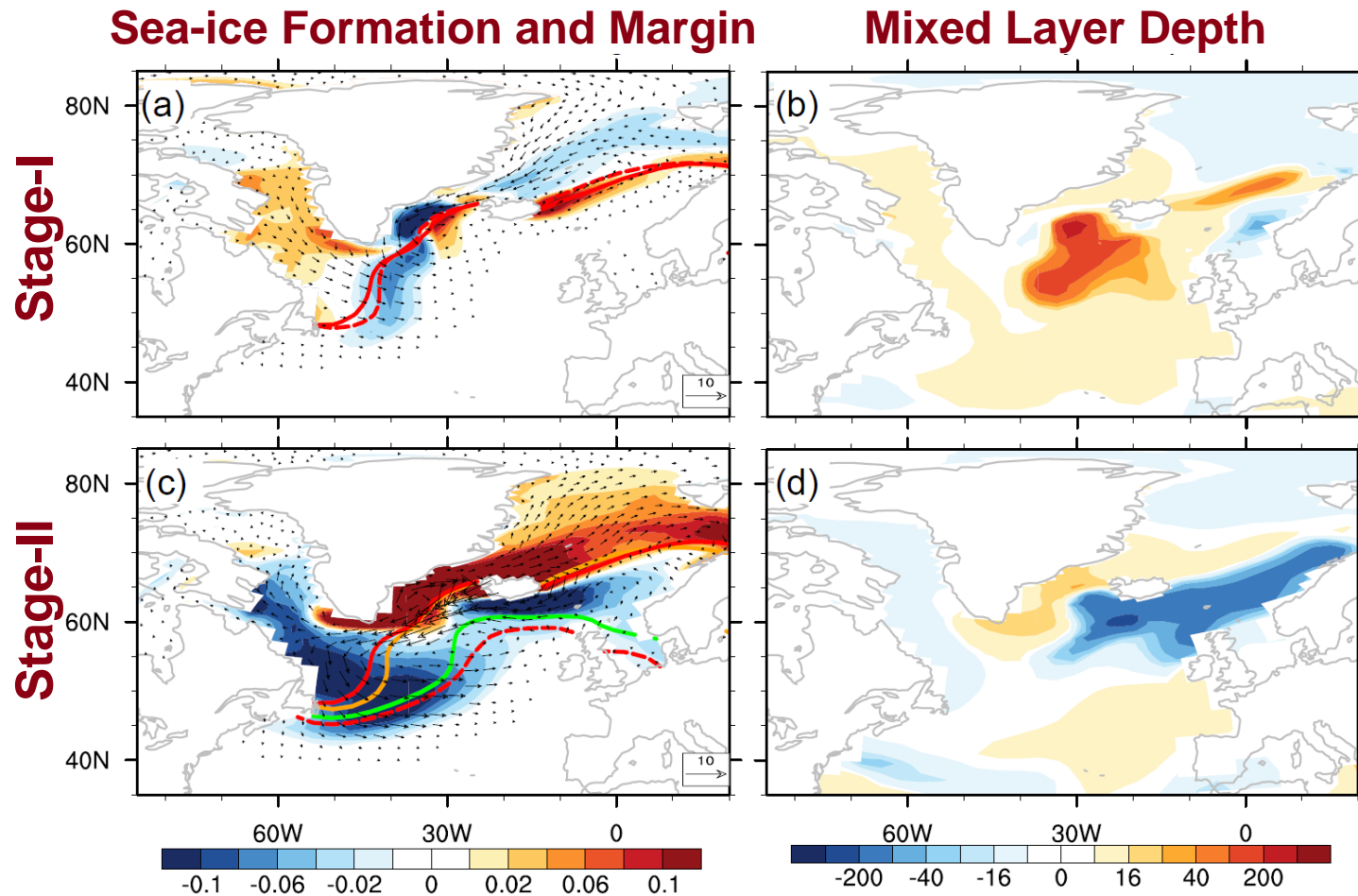
Mechanism for *Temp* Change



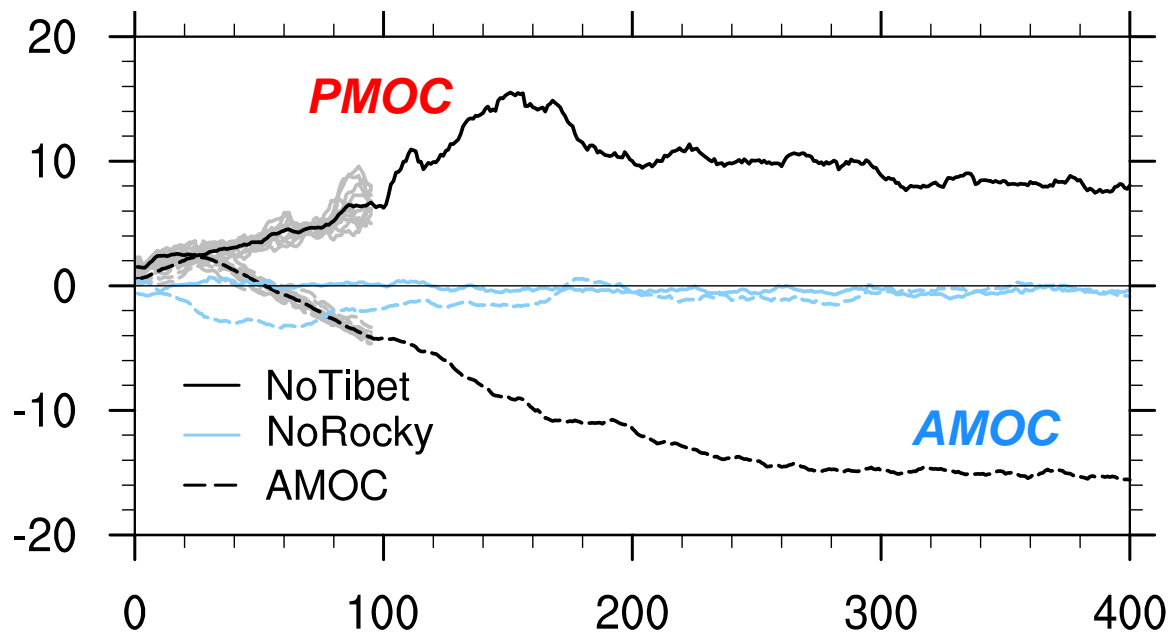
Mechanism for *Salinity* Change



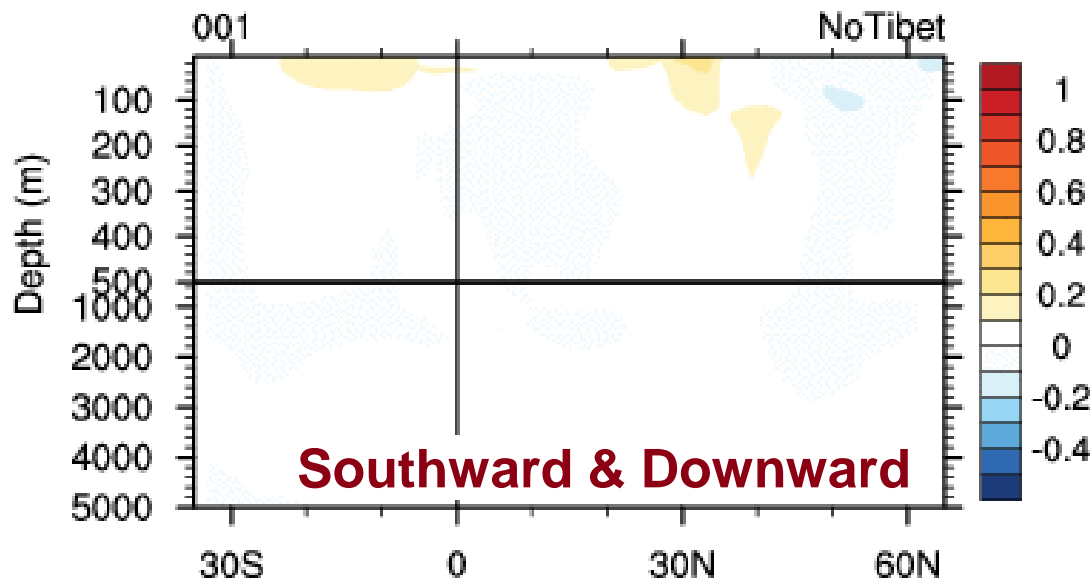
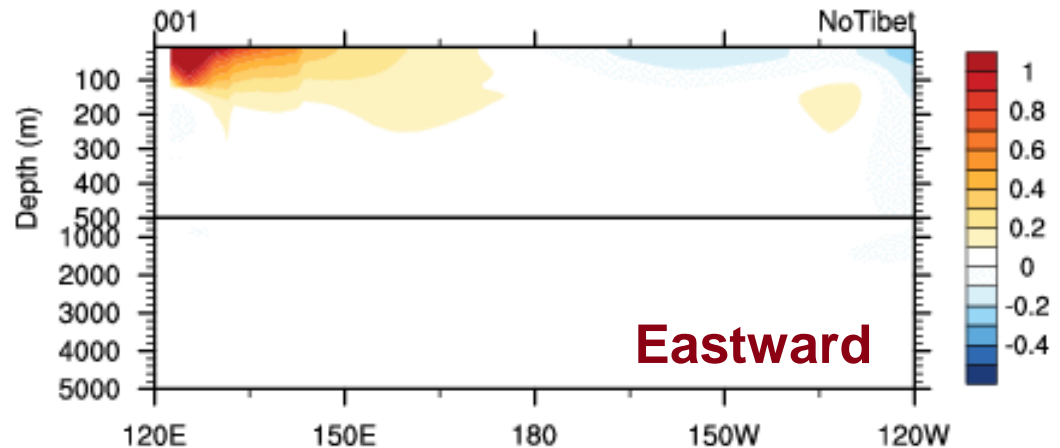
Mechanism for *Salinity* Change



AMOC vs. PMOC

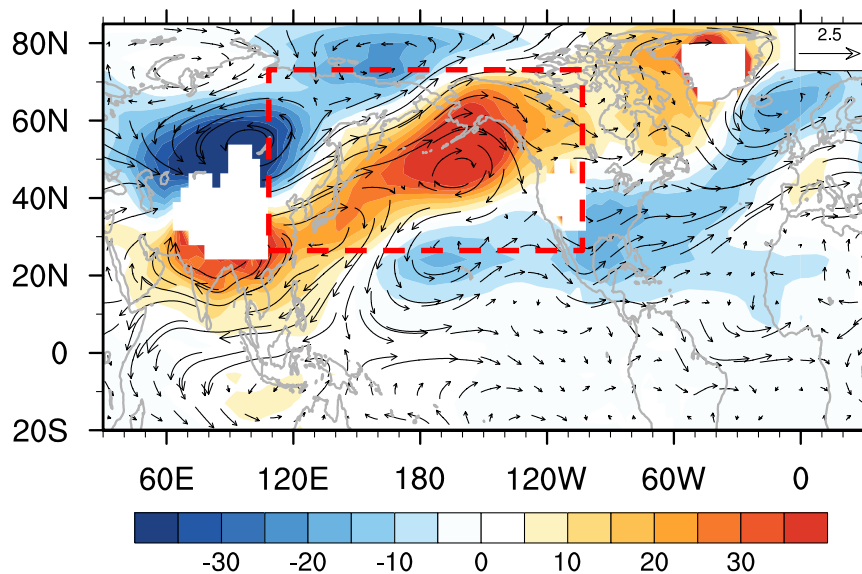


PMOC: *Salinity* Mechanism

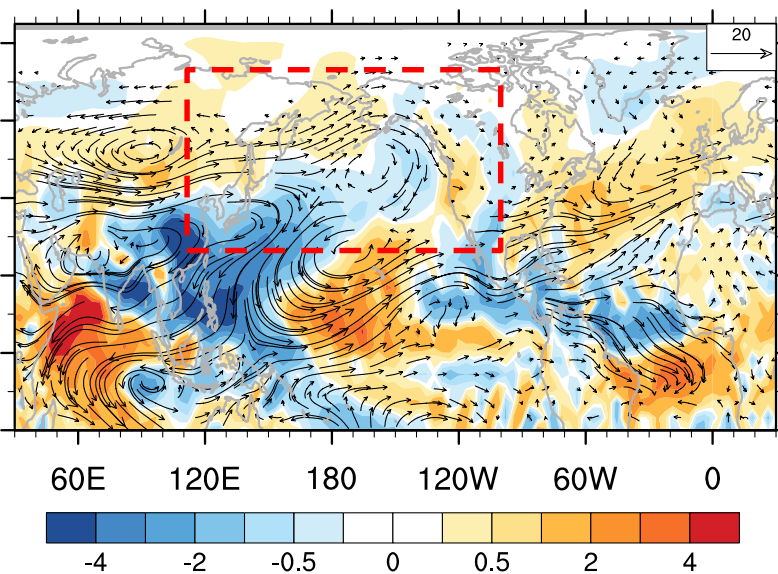


Atmospheric Changes

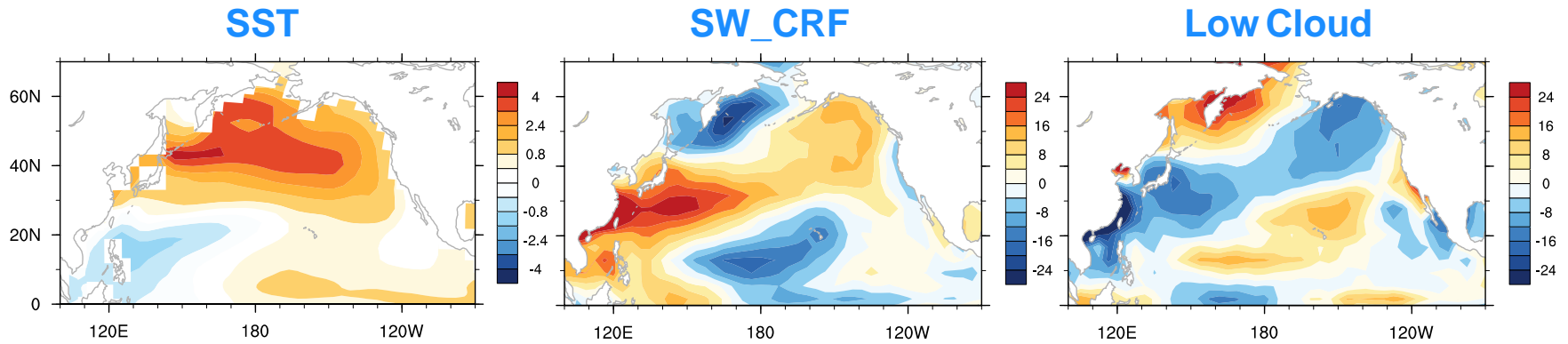
850 hPa GH and Winds



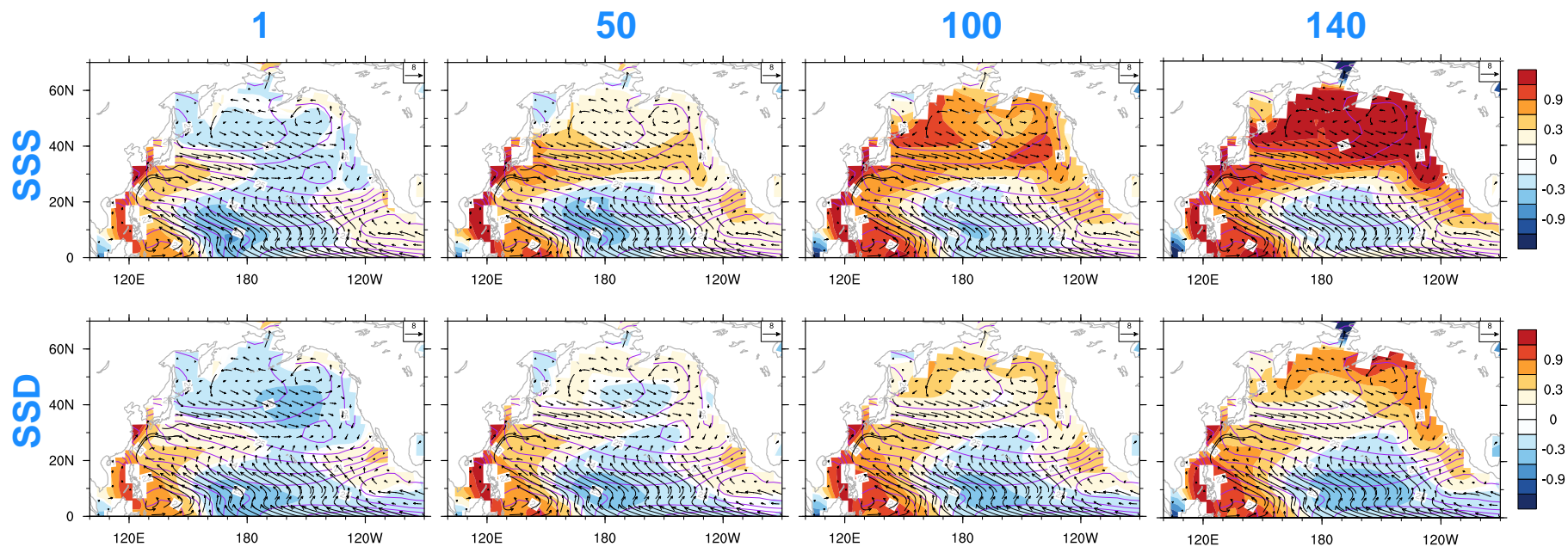
Moisture transport and divergence



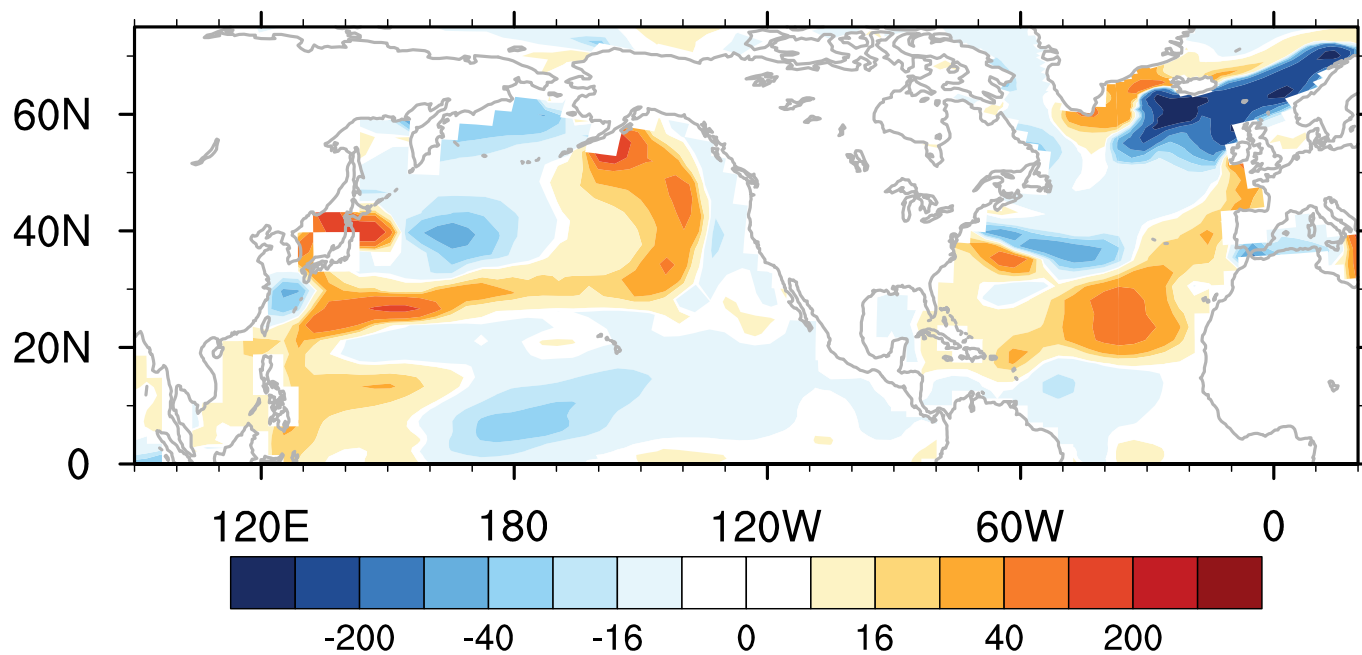
SST Change



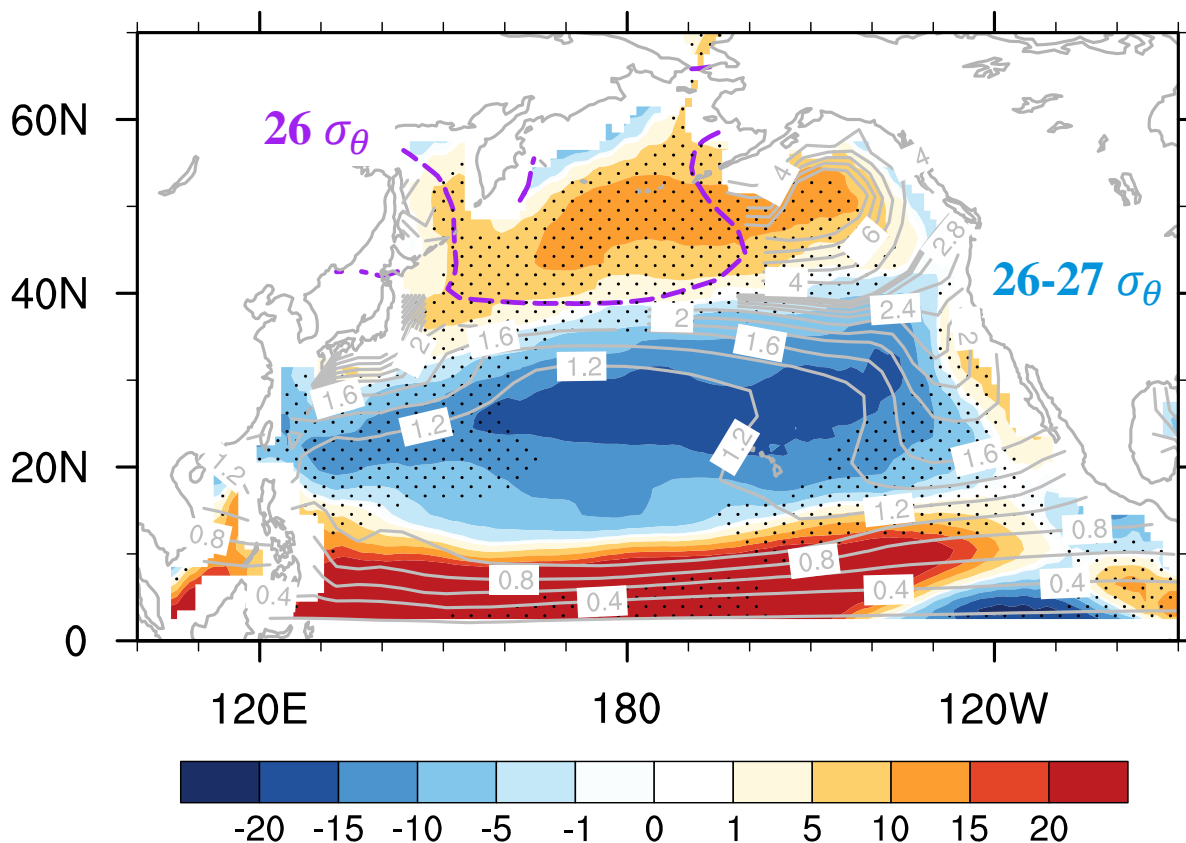
Surface Salinity and Density Changes



Mixed Layer Depth Change



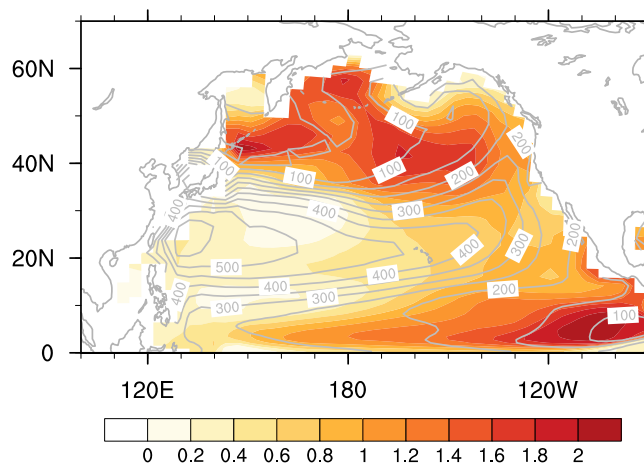
Ekman Pumping and PV



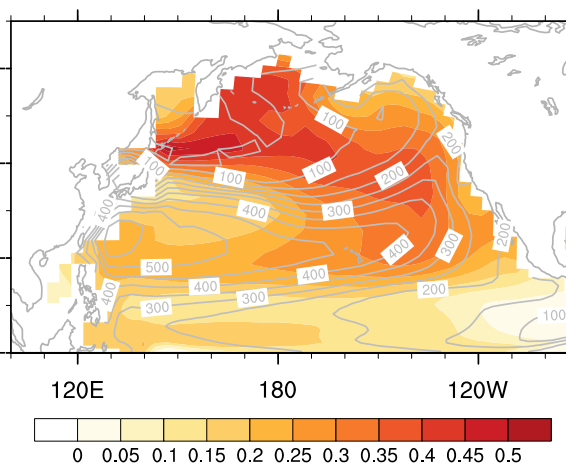
Black Dots: Enhanced Ekman Downwelling

RMS of *Temp*, *Salinity* and *Thickness*

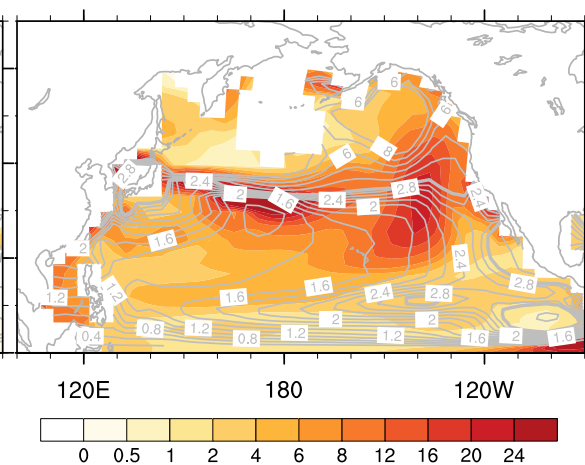
26.6 RMS(T)



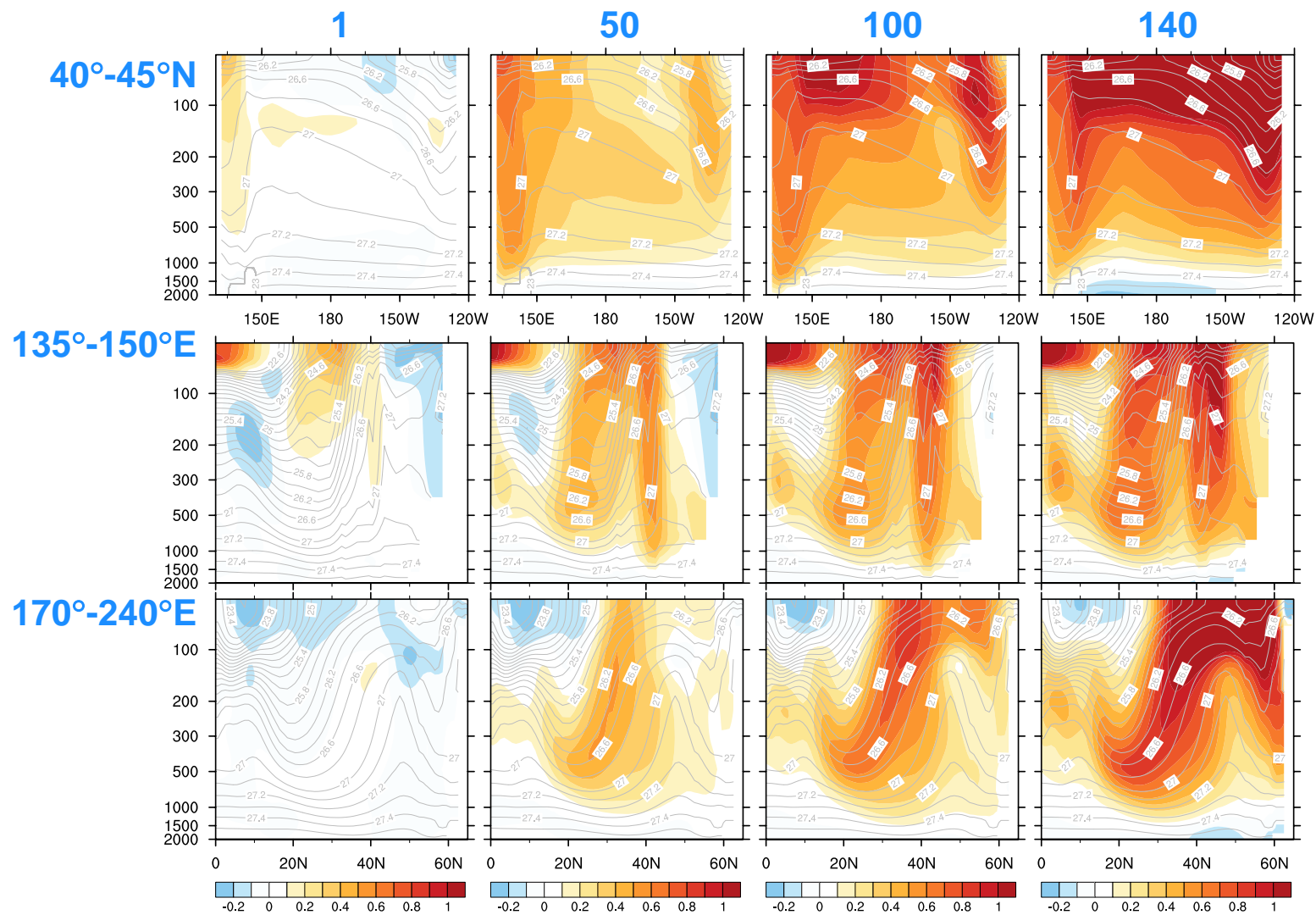
26.6 RMS(S)



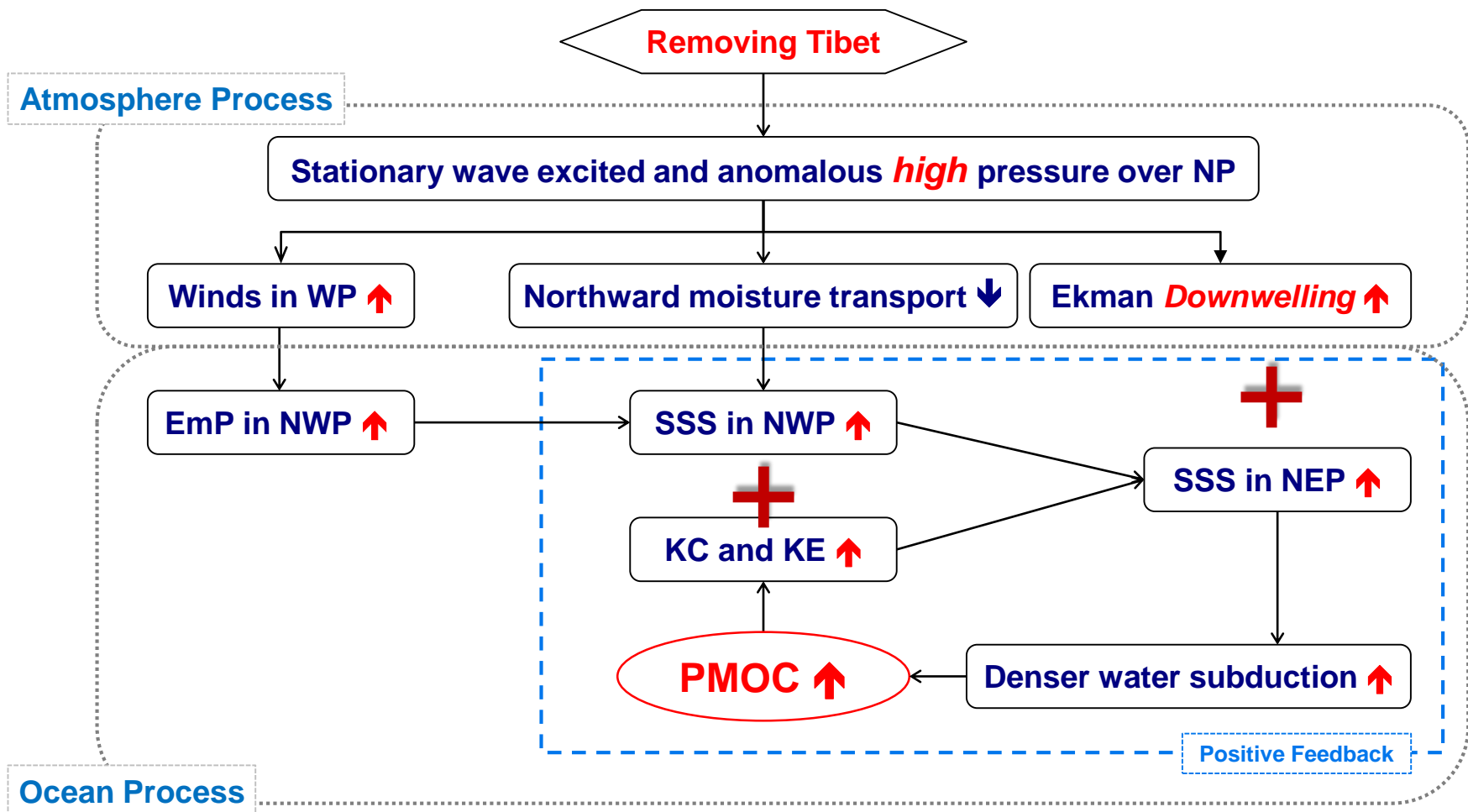
26.2-26.6 RMS(dH)



Salinity Subduction

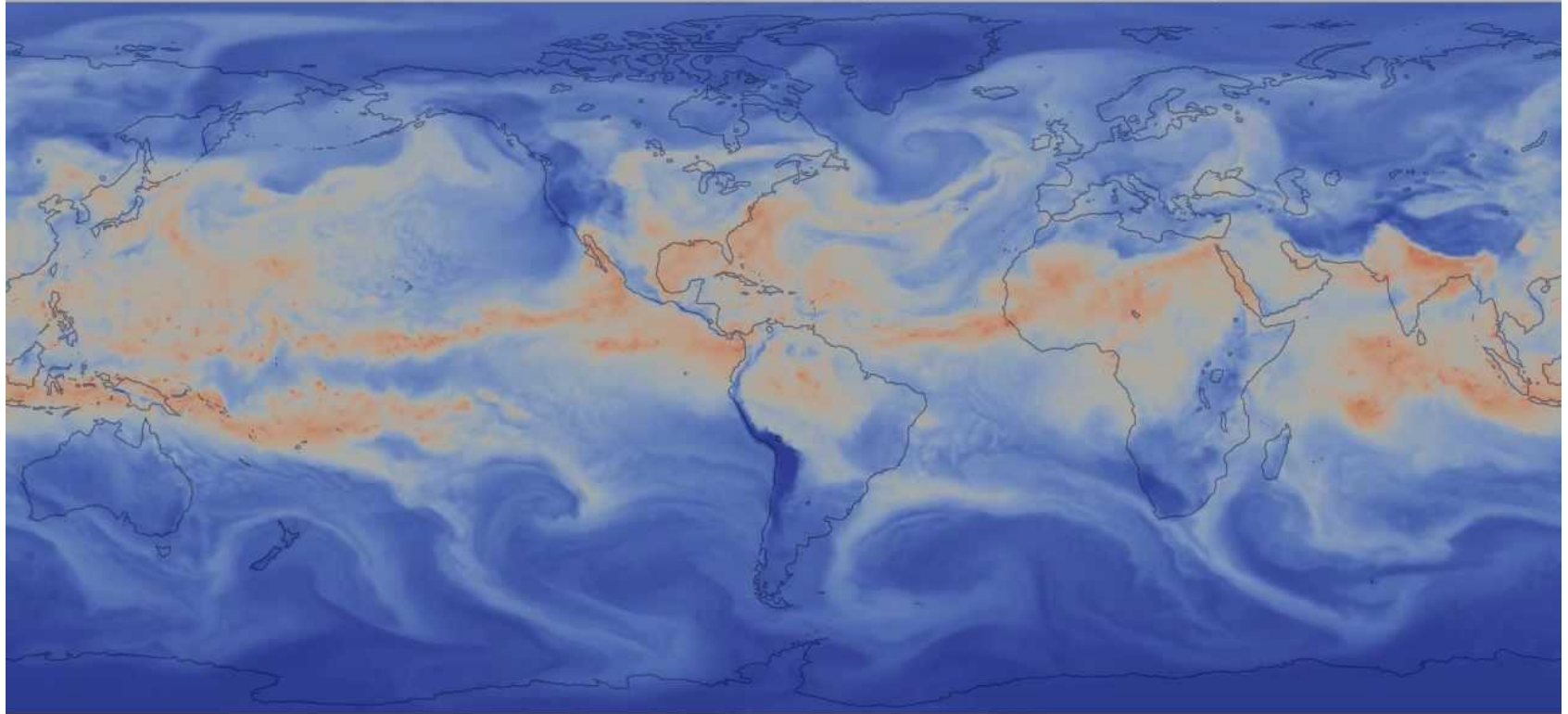


Mechanism



Atmosphere River

NSF/DOE Community Atmosphere Model (CAM5)

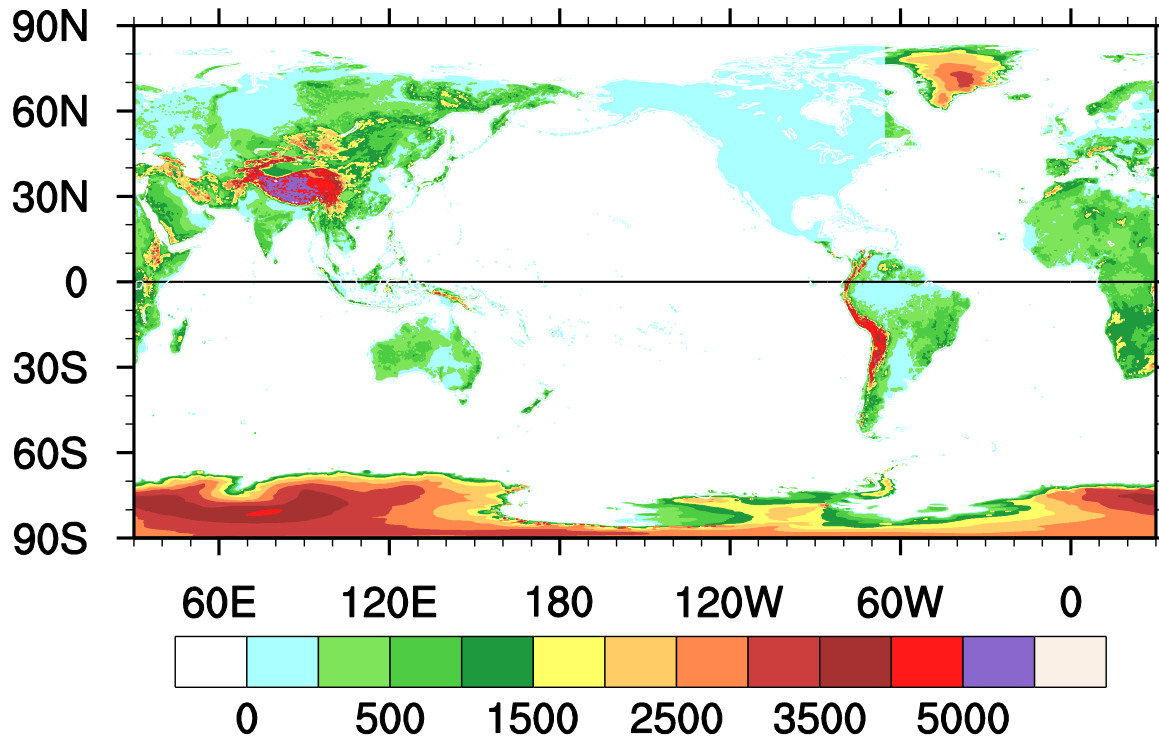


Aug 19 18:00

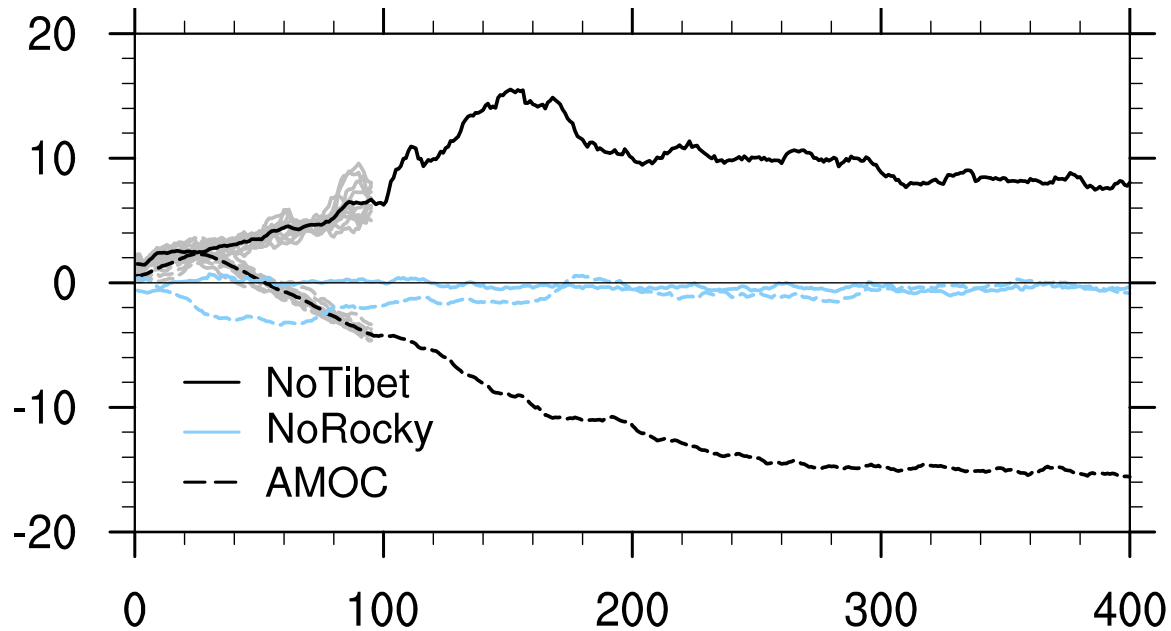
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Computing Facility

Argonne
NATIONAL LABORATORY
Sandia
National
Laboratories

Role of *Rocky* Mountain?



Rocky Mountain: No Role?



Summary

0 → **1** : Critical to **AMOC**, **PMOC**,

Energy and moisture transport

in / between SH and NH

1 → **∞**



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谢谢