Biases in the Pacific Ocean in the CCSM

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- Diagnostic analysis of biases in the North Pacific: what we saw.
- Some possible implications
- A wish list for future analysis

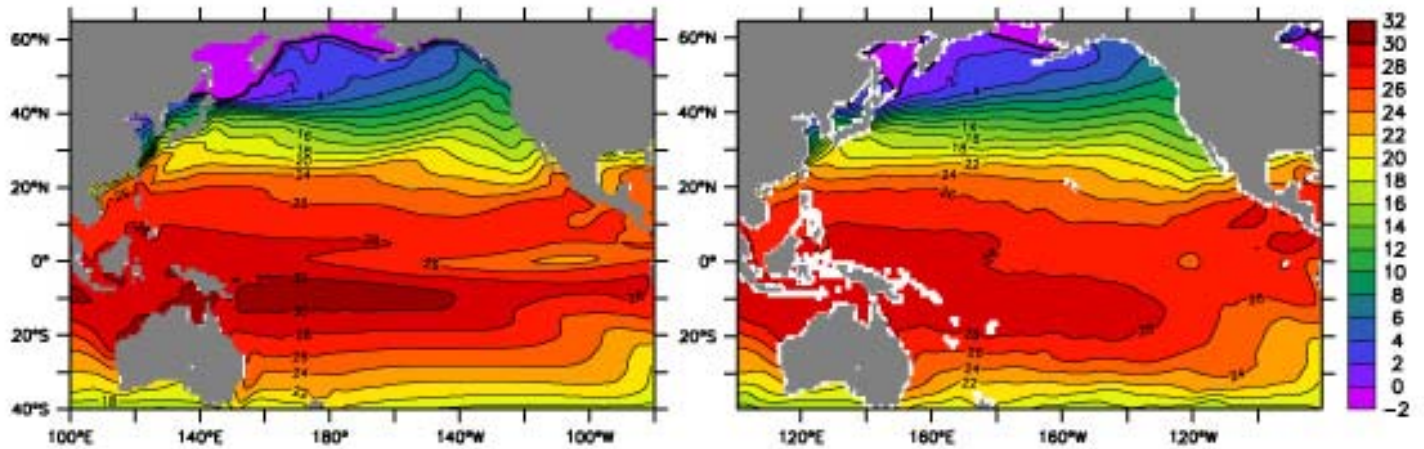
- Model run used CCSM3 009, T85 atmosphere, 1 degree ocean, years 300-599. Monthly surface values and annually averaged subsurface.

Pacific March SST and SSS

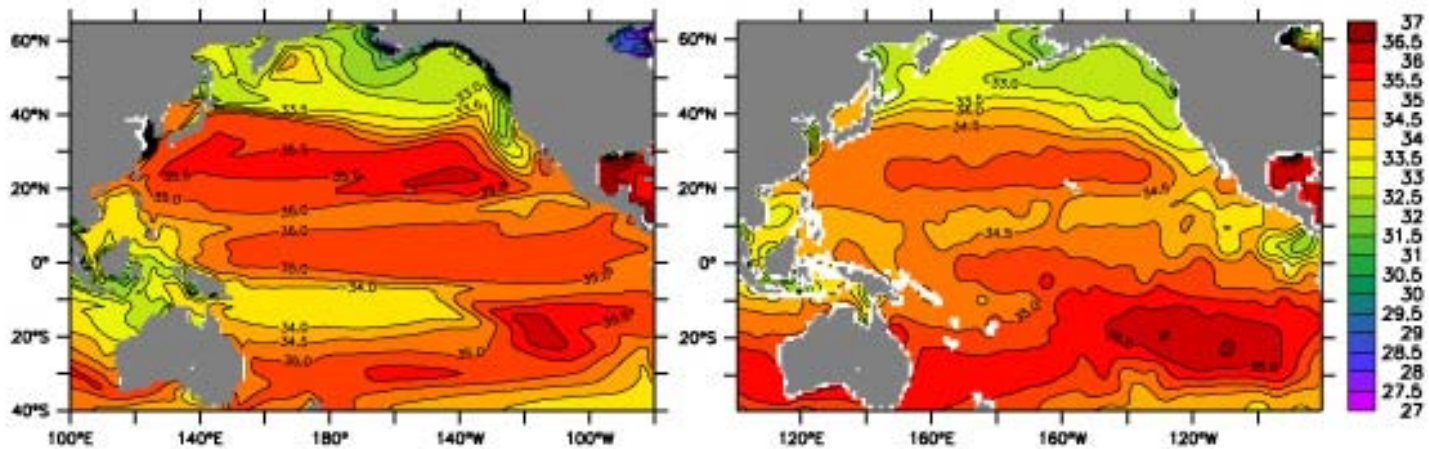
Model

WOA

SST



SSS



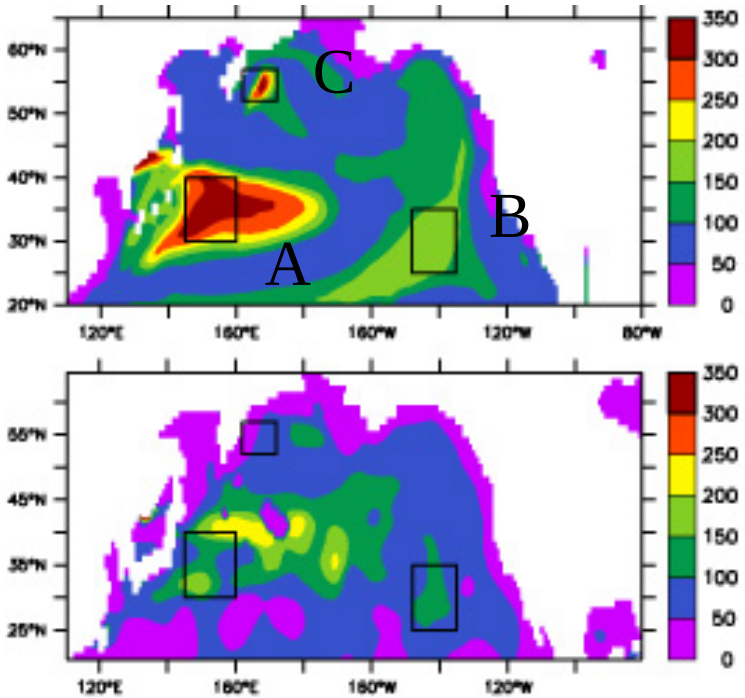
Mixed-layer depth

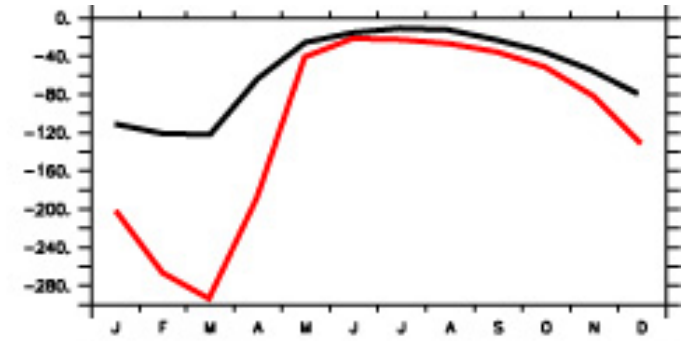
March MLD

MLD spatial average

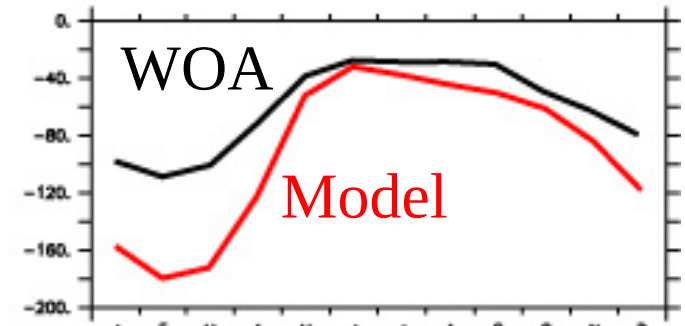
Model

WOA

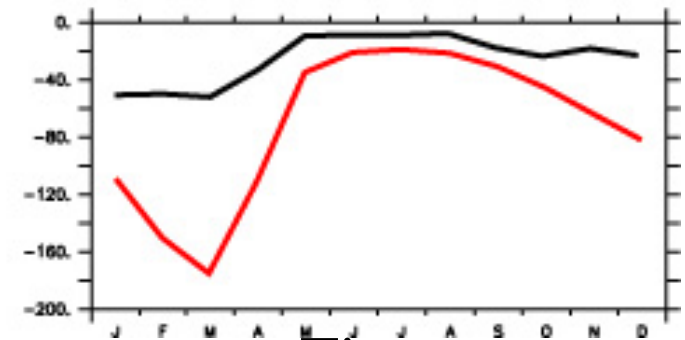




Box A



Box B



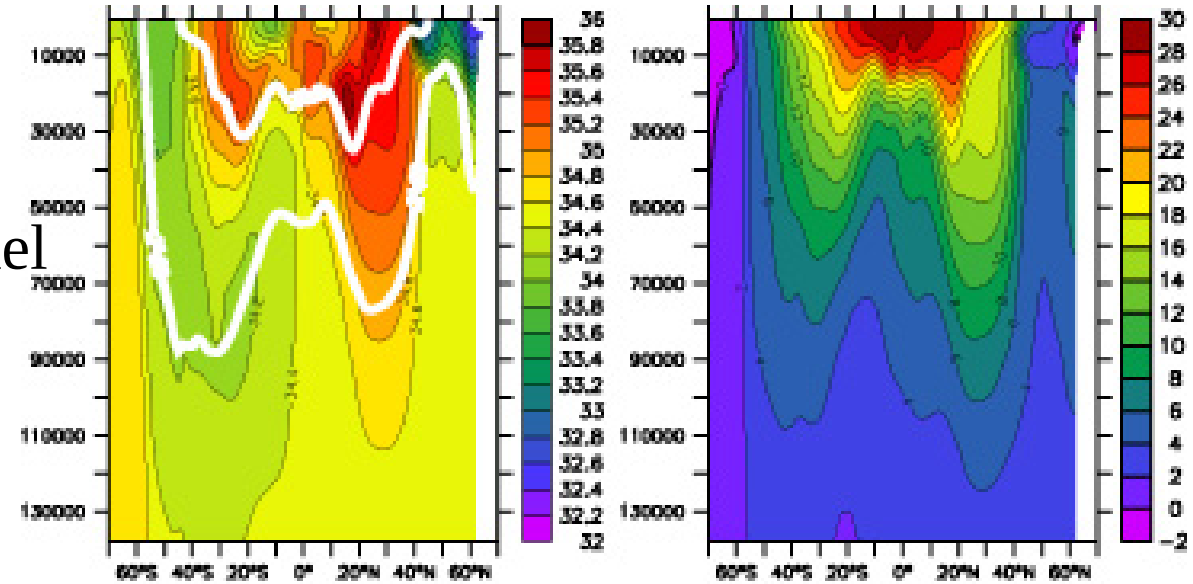
Box C

Time

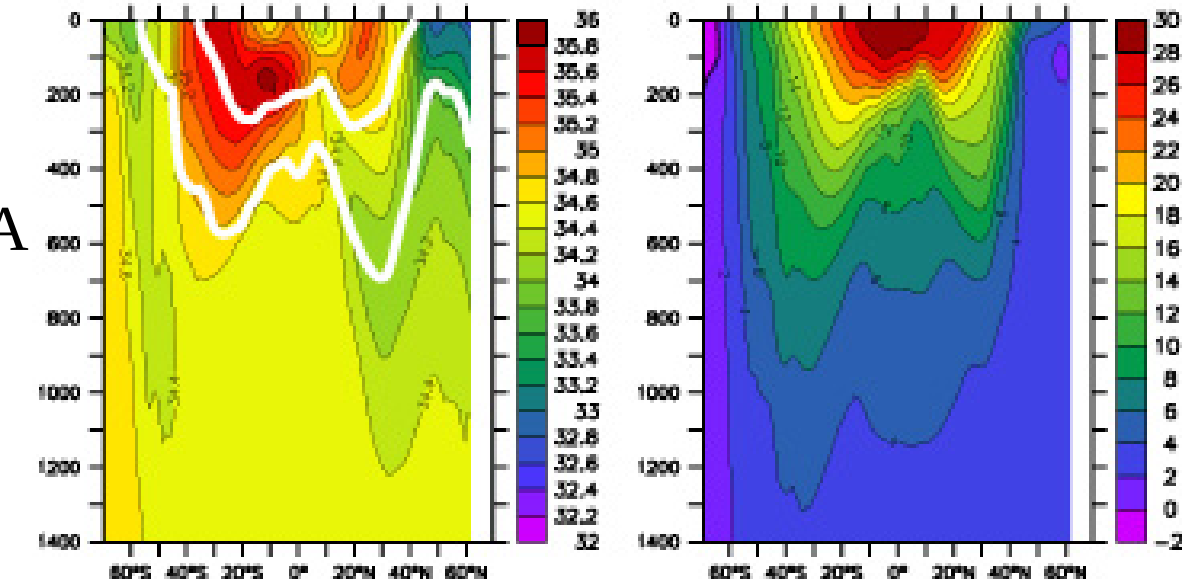
Salinity

Temperature

Model



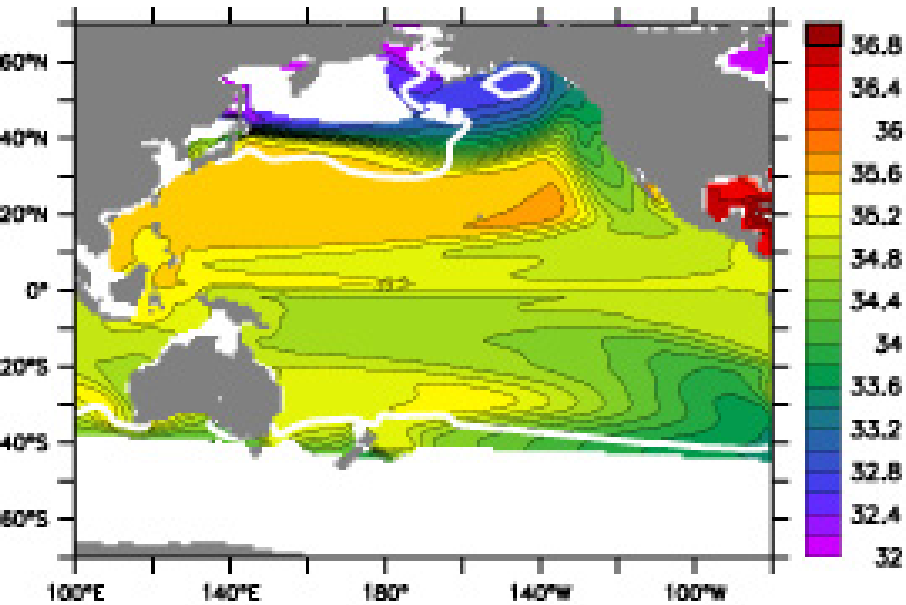
WOA



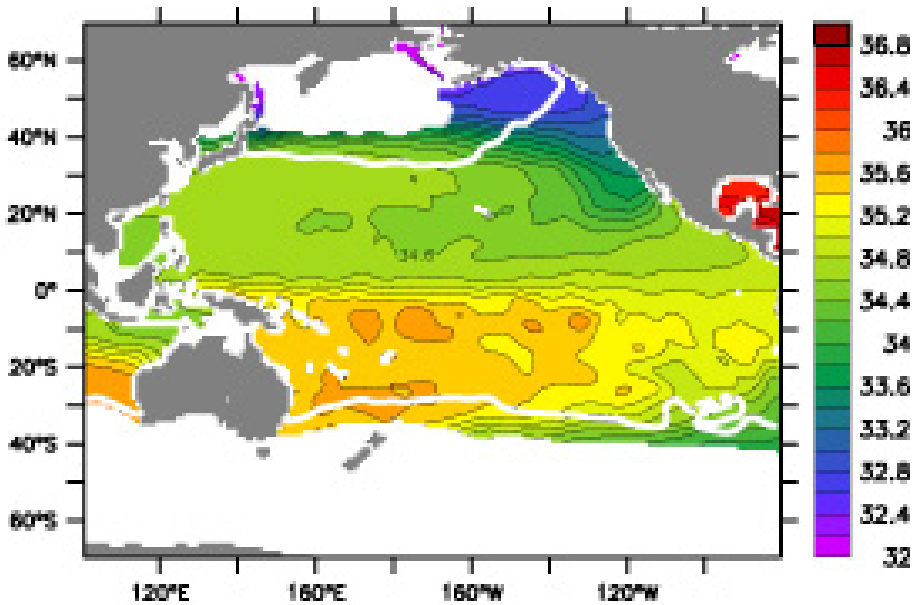
Sections in central Pacific

Salinity in thermocline

Model sigma 25.8

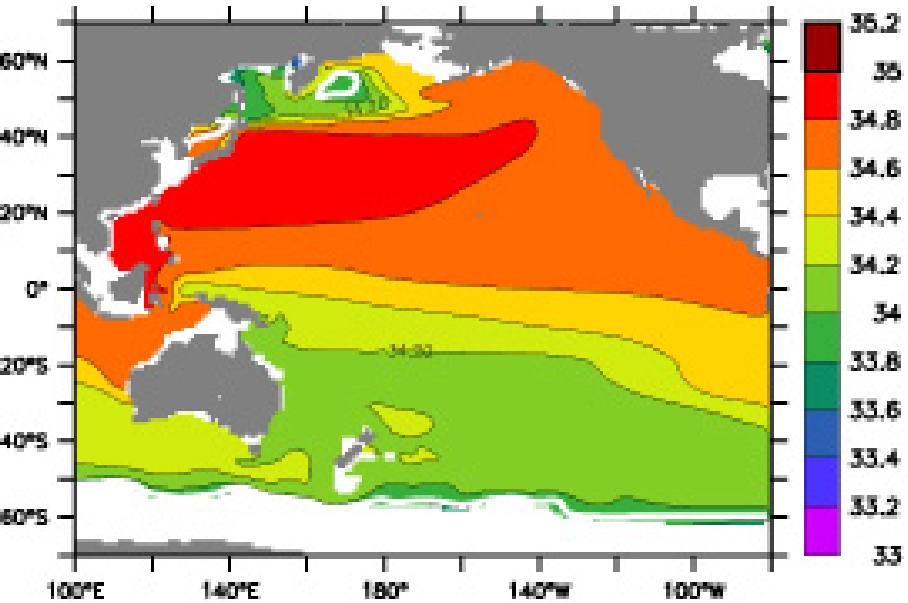


WOA sigma 25.6

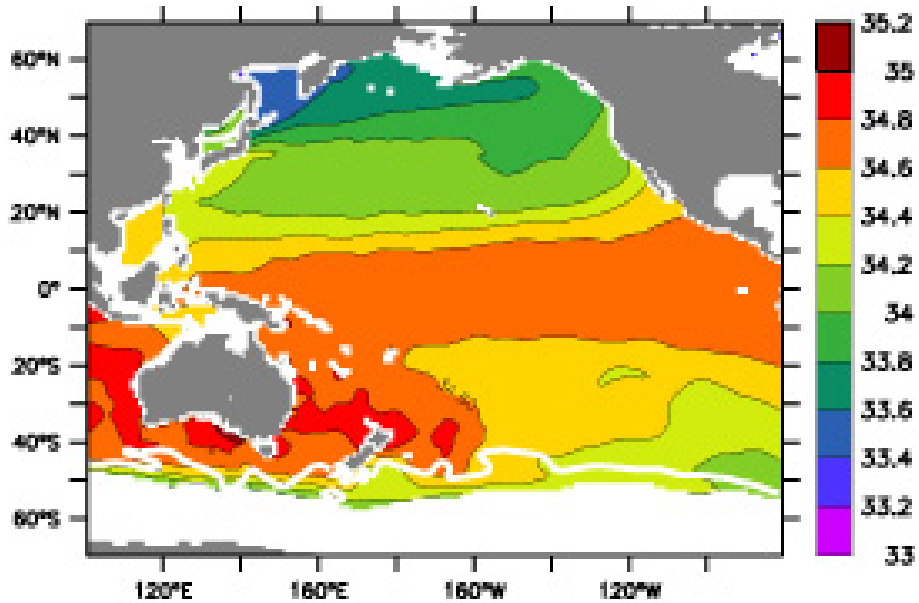


Salinity in NPIW

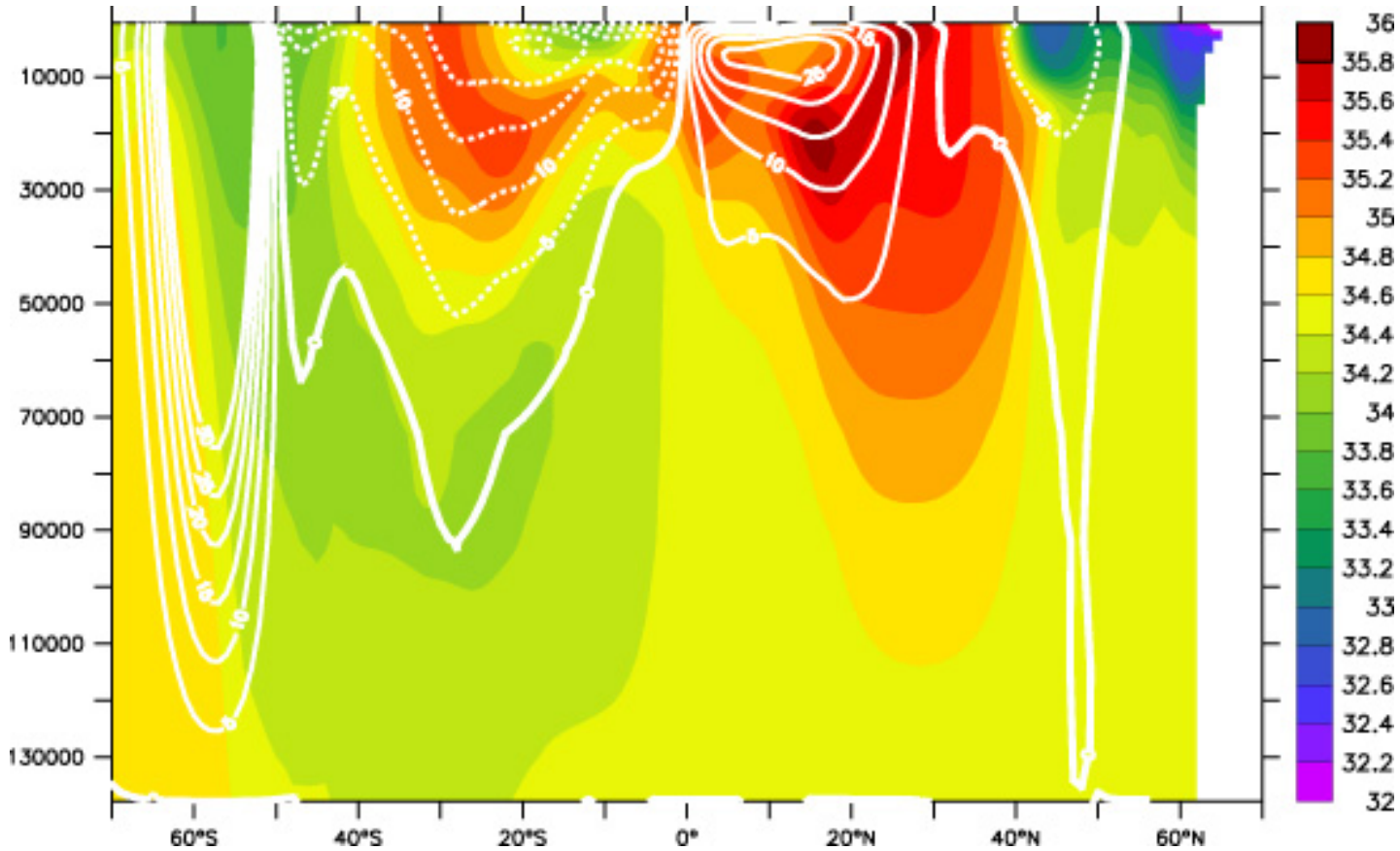
Model sigma 27



WOA sigma 26.8

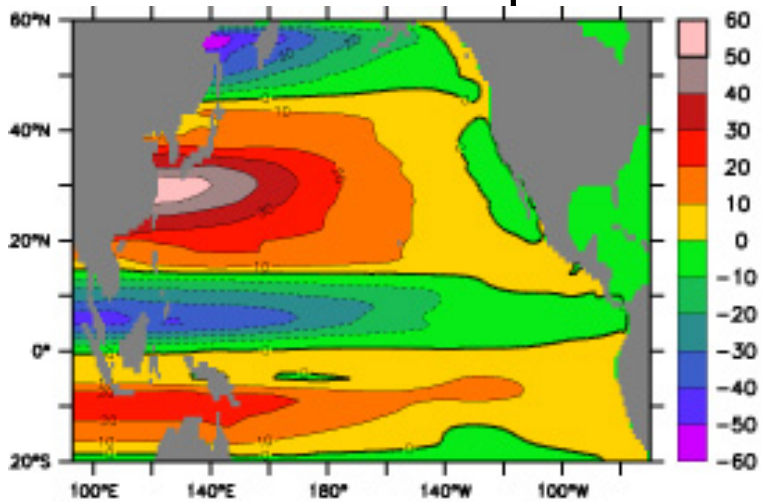


MOC

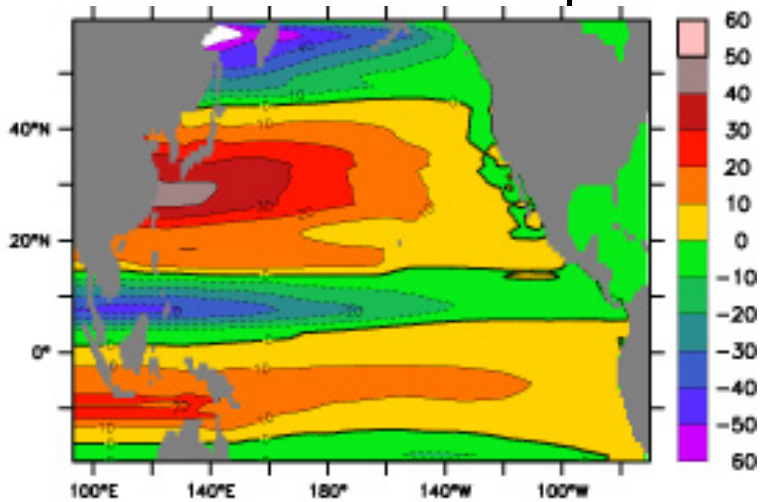

10000
30000
50000
70000
90000
110000
130000
60°S
40°S
20°S
0°
20°N
40°N
60°N
36
35.8
35.6
35.4
35.2
35
34.8
34.6
34.4
34.2
34
33.8
33.6
33.4
33.2
33
32.8
32.6
32.4
32.2
32

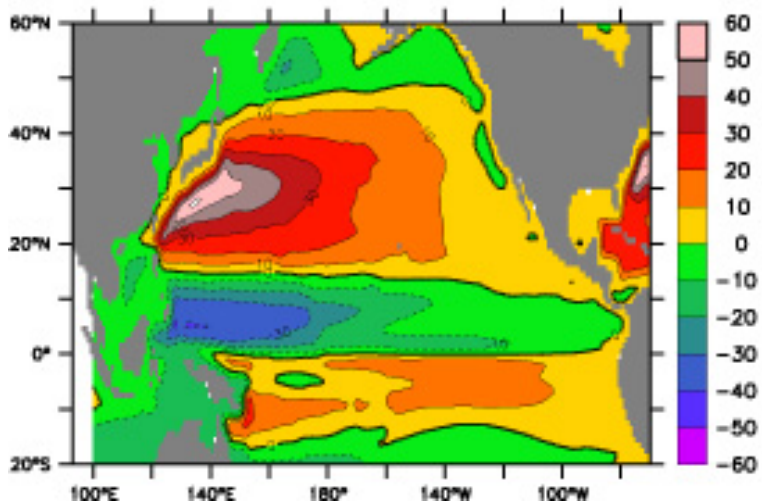
Sverdrup circulation

Model Sverdrup

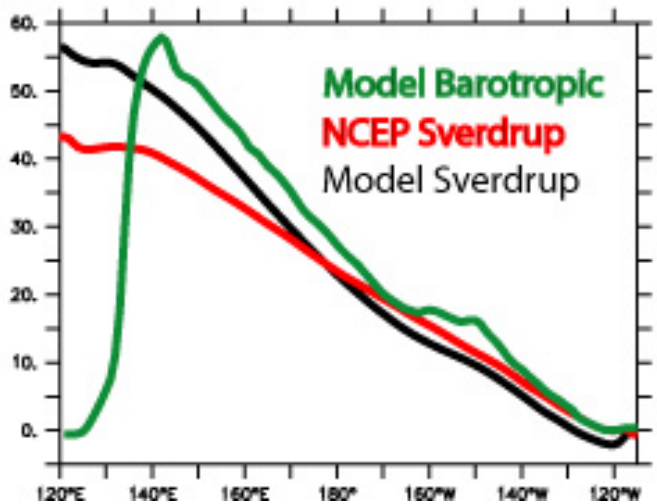


NCEP Sverdrup



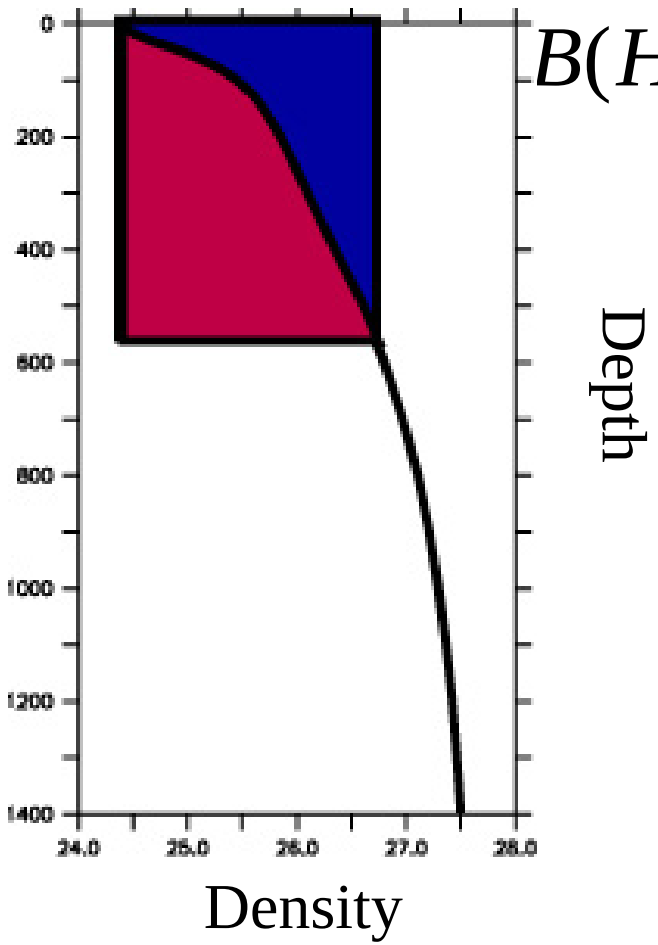


Model barotropic SF



Zonally integrated transport

Definition of buoyancy barrier



$$B(H) = \int_{z=-H}^{z=0} \left[\sigma(T,S,z) - \sigma(T,S,-H)\right] dz$$

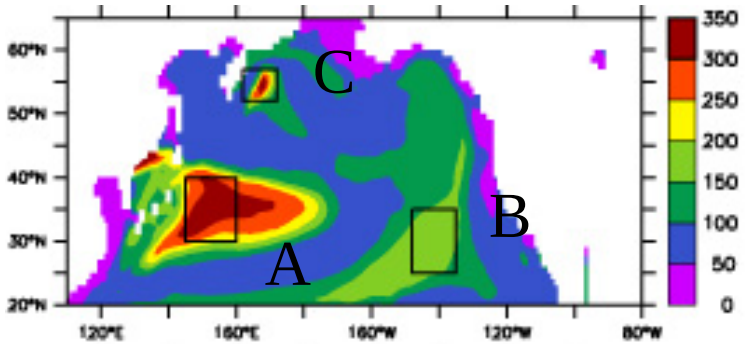
The buoyancy barrier is the integrated buoyancy loss required to mix the fluid to depth H. It has units of kg/m2. This can be converted to Joules/m2.

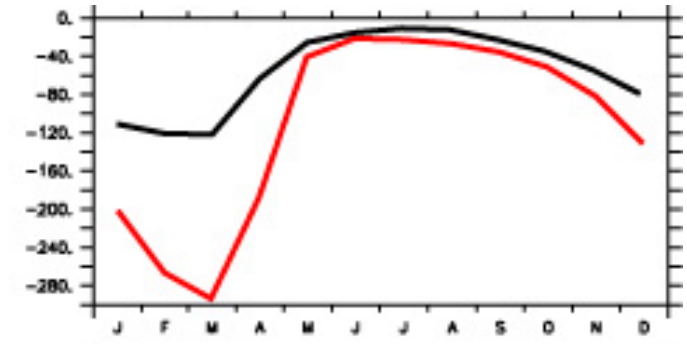
Mixed-layer depth

MLD

MLD spatial average

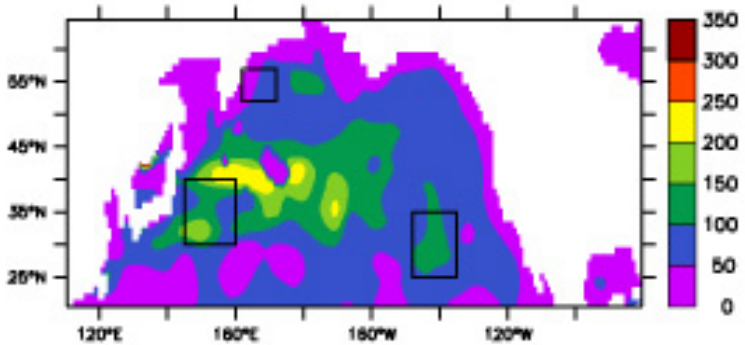
Model

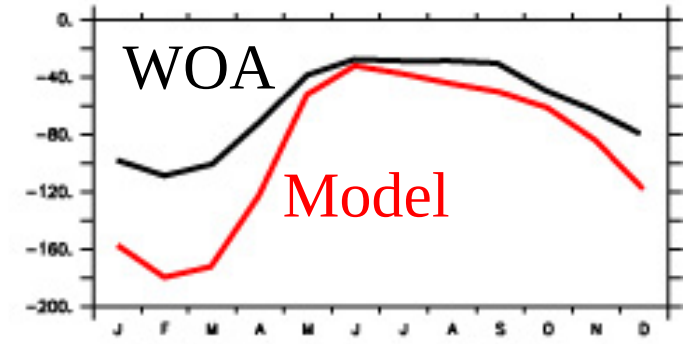




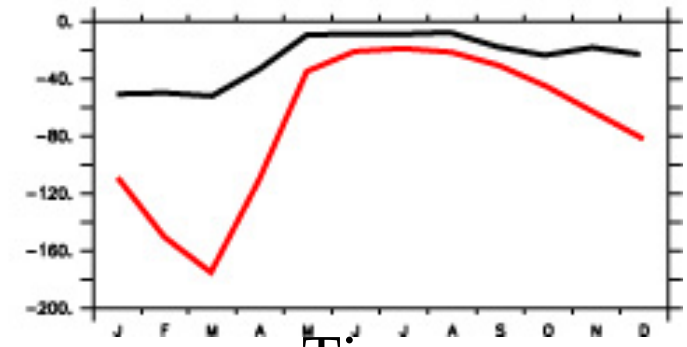
Box A

WOA





Box B



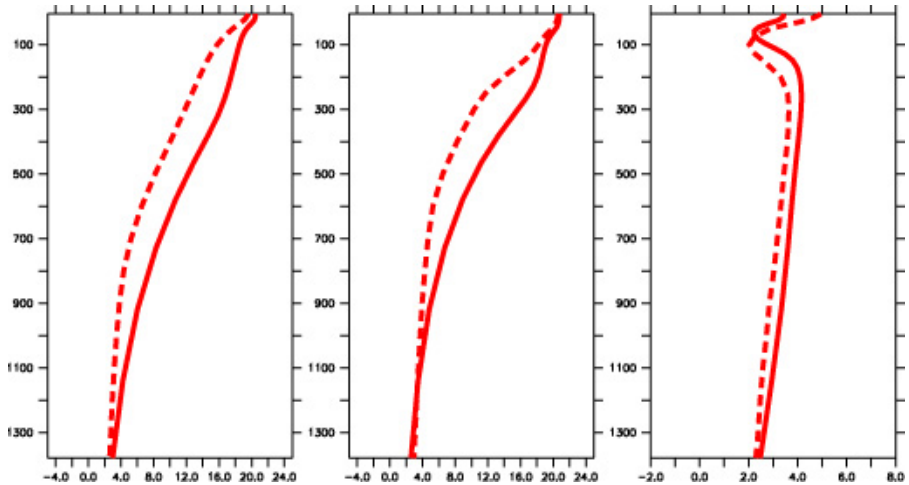
Box C

Time

Box A
W.subtropics

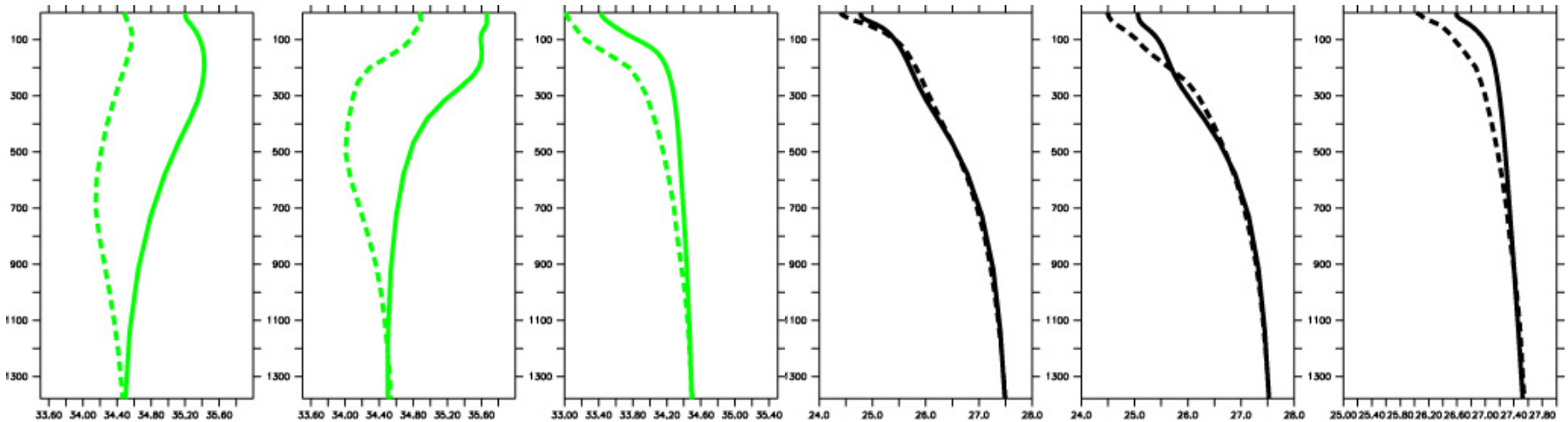
Box B
E subtropics

Box C
Subpolar



Temperature

Density T and S in the 3 regions. Solid model, dashed WOA.

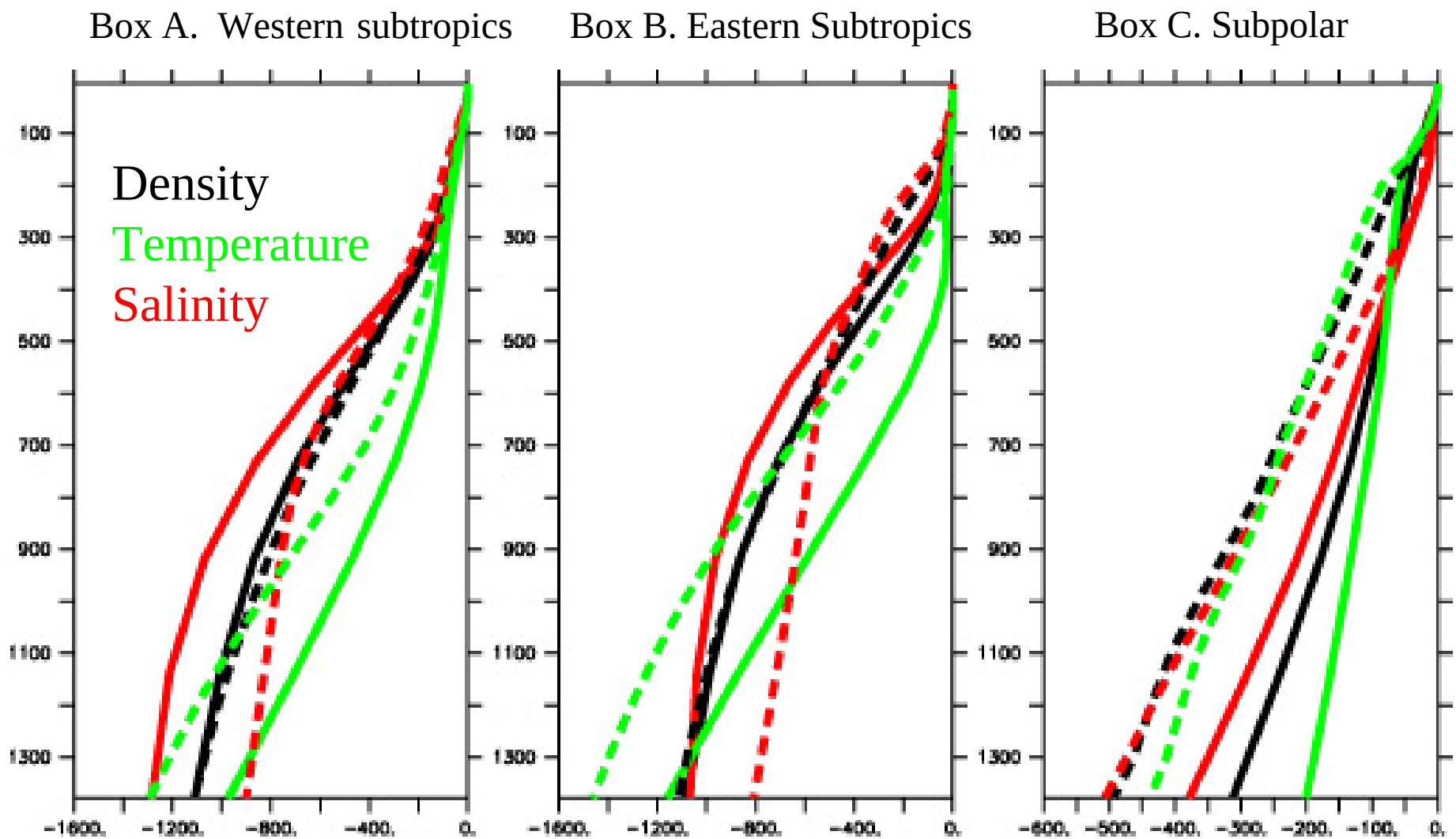


Salinity

Density

Buoyancy barrier

Solid model, dashed WOA



Conclusions

- The North Pacific ocean is too salty
- NPIW is created at too great a density and in the open NP. It does not penetrate into the subtropics. AAIW dominates the water masses below the thermocline.
- The subtropical gyre is too salty and too strong. Central mode water dominates the thermocline structure. The NP water entering the tropical thermocline is too salty, SP too fresh.
- The errors in ocean structure are owing to both buoyancy forcing errors (E-P) and wind forcing.

Possible consequences

- Coupled mid-latitude response may be in error (too strong?)
- Properties advected to tropics by subtropical cell are incorrect.
- Heat and carbon uptake in subpolar North Pacific may be underestimated.

Wish List

- Initial adjustment of coupled model to determine source of salinity biases.
- Salt budget in boxed regions in POP and coupled model.
- POP forcing fields (E-P and Q and wind)
- Force POP with stress of coupled model, but buoyancy forcing from observations or visa versa.
- Some subsurface monthly data from coupled model.