

T85 and T341 Fully-Coupled CESM Simulations: Climatology Comparisons and Present-Day Transient Initialization Strategy.

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Overall Goal

Evaluate the veracity of both T341/0.1° and T85/1° CESM pre-industrial simulations by comparing them with:

- Observations, especially those of vertical ocean structure.
- Existing coupled simulations at comparable resolutions i.e. standard resolution CCSM4 and Atlas 0.25°/0.1° CCSM4.

Overview

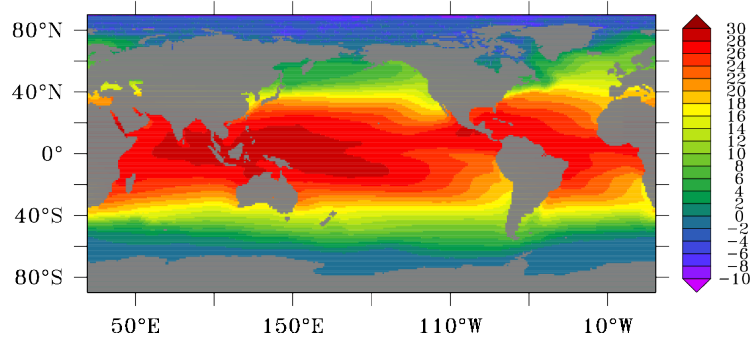
1. Compare Atlas CCSM4 simulation (0.25° CAM3.5 (FV)/CLM, 0.1° POP/CICE, McClean et al. 2011) and T341/0.1° CESM.
2. Global veracity of T341/0.1° CESM: particularly using Argo monthly climatologies (Holte and Talley, 2010; Roemmich and Gilson, 2008)
3. Comparisons of T341/0.1° and T85/1° CESM in regions where eddies are important.
4. Compare T85/1° (CAM4) and CCSM4 (CAM4 FV/1°): different dycores.
5. Initialization Strategy for fine resolution CESM present day transients. Test with T85/1°.

T85/1° Fully-Coupled CESM

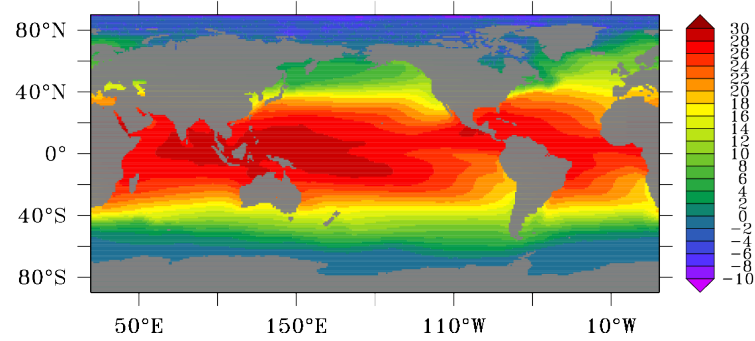
- T85 Eulerian Spectral dycore
- CAM4 physics
- Otherwise as in CSSM4 (Gent et al. 2011)
- Ocean initialization: PHC2
- Ice initialization: spun-up ice state from coupled climate simulation (standard release)
- Land initialization: CCSM4

SST from Hadley PI climatology, T341 for years 34-43 (LHS), and Atlas for years 13-19 (RHS)

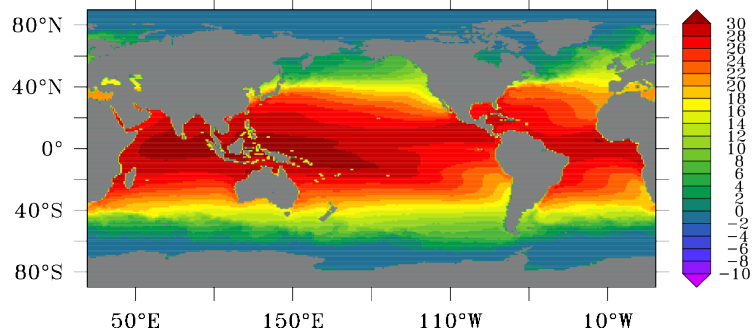
(a) SST (degC): Hadley clm



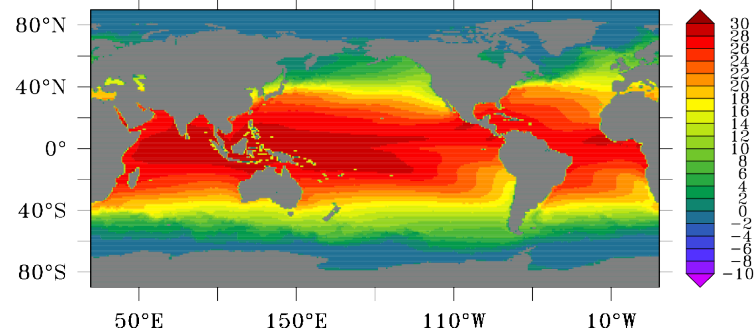
(d) SST (degC): Hadley clm



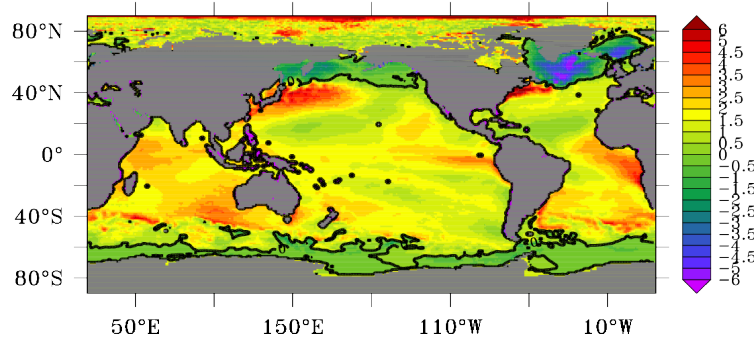
(b) SST (degC): T341 B1850 YY034-043 mean



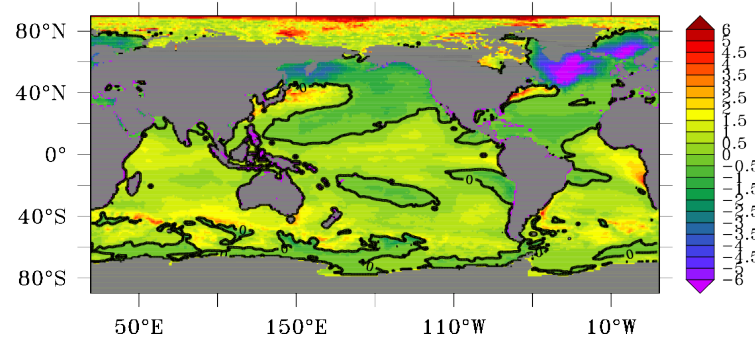
(e) SST (degC): T403 B1850 YY0013-0019 mean



(c) DIFF (degC): (T341 - OBS)

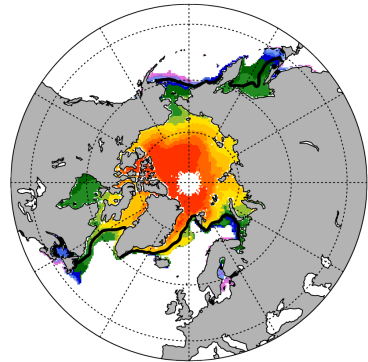


(f) DIFF (degC): (T403 - OBS)

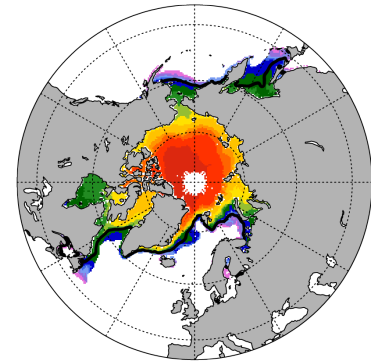


Annual Ice concentration (%) from Atlas (LHS) and T341 (RHS) and SSM/I

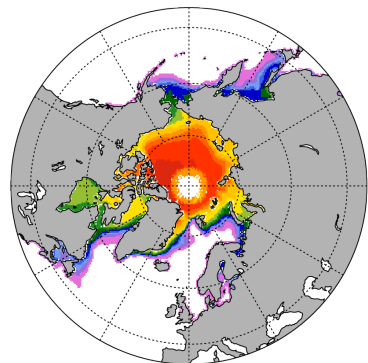
T403 B1850 ice area (aggregated) %



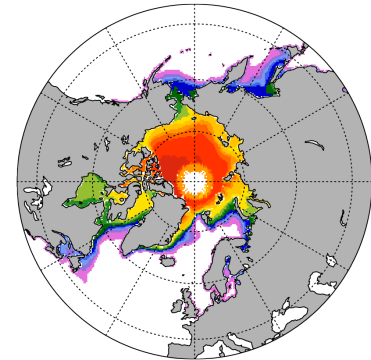
T341 B1850 ice area (aggregated) %



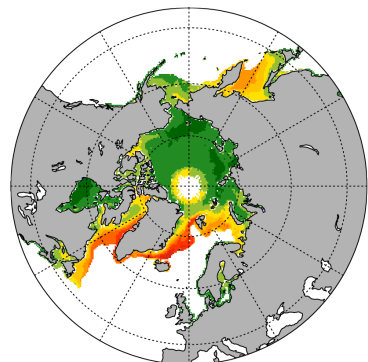
SSM/I ice area (aggregated) %



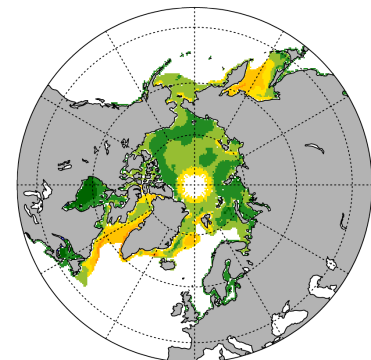
SSM/I ice area (aggregated) %

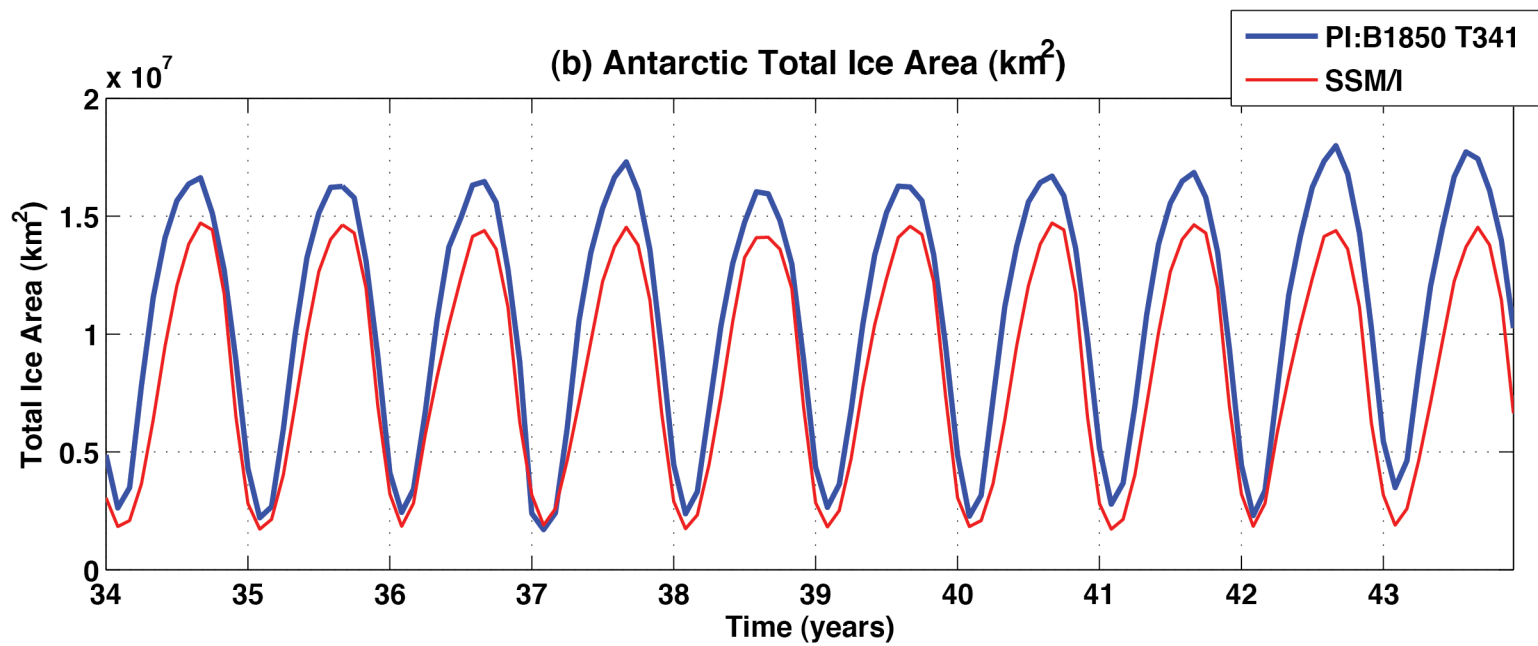
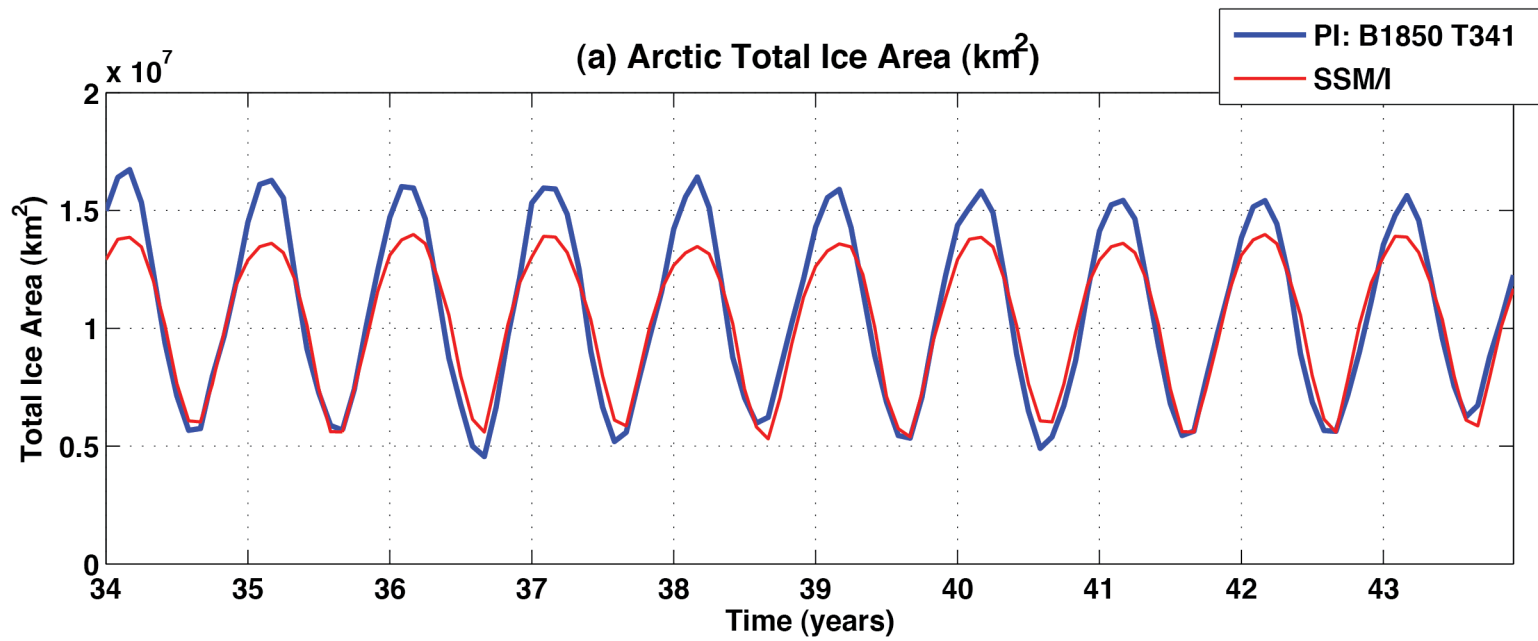


T403 B1850 - SSM/I ice area %

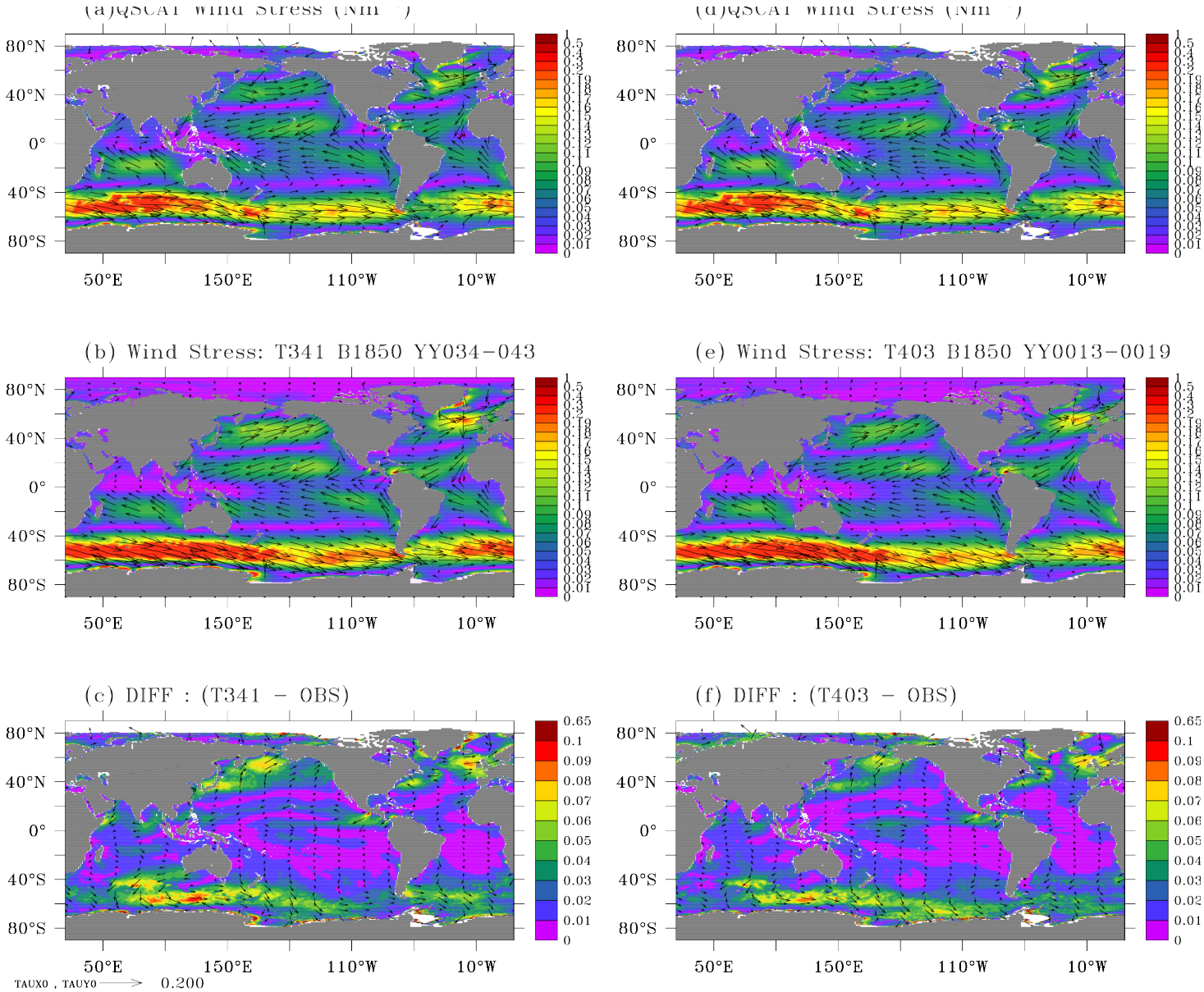


T341 B1850 - SSM/I ice area %

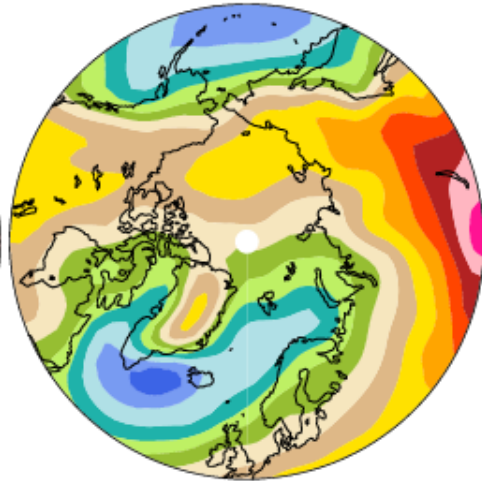




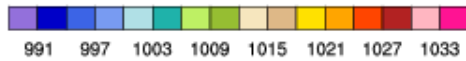
Annual Wind Stresses Vectors and Their Magnitudes from QuikSCAT and T341 for Years 34-43 (LHS) and Atlas years 13-19 (RHS)



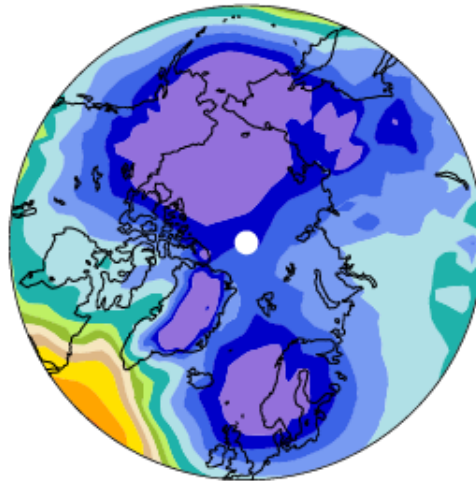
NCEP Reanalysis



MEAN= 1012.59 Min= 994.30 Max= 1033.93

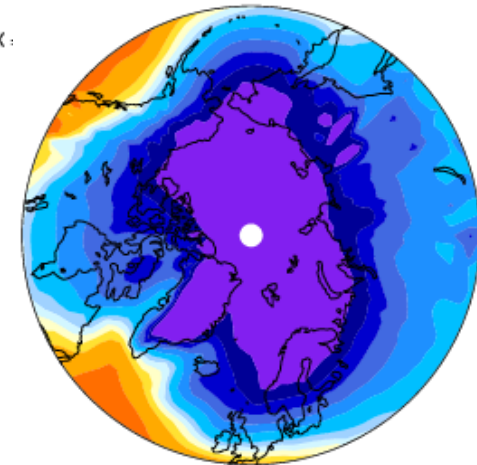
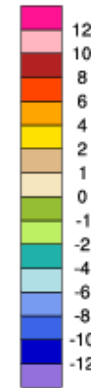


T341-NCEP

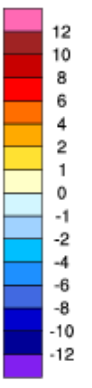


Atlas-NCEP

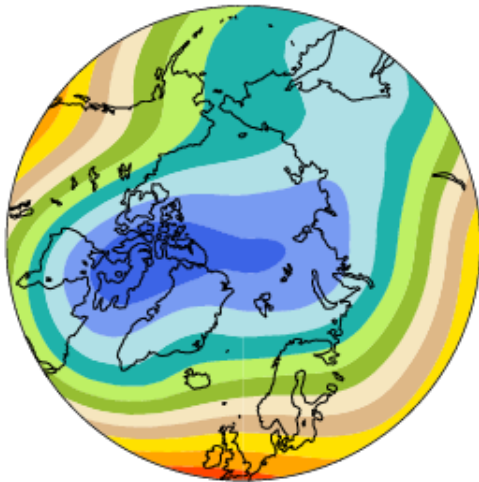
MIN = -18.36 MAX :



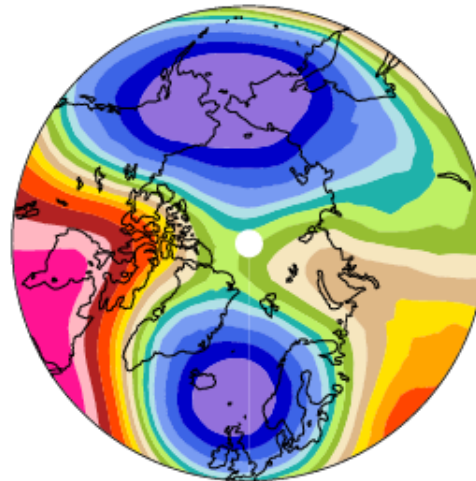
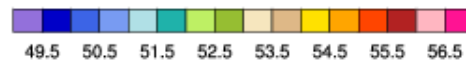
MIN = -23.61 MAX



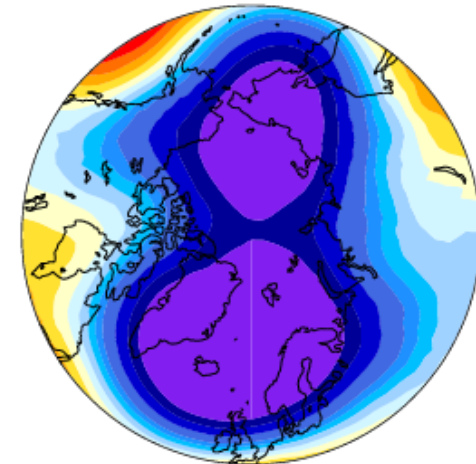
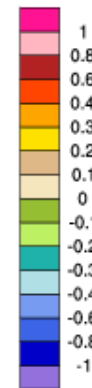
DJF Sea-level Pressure (millibars)



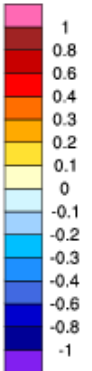
MEAN= 52.12 Min= 50.15 Max= 55.30



MIN = -1.34 MAX



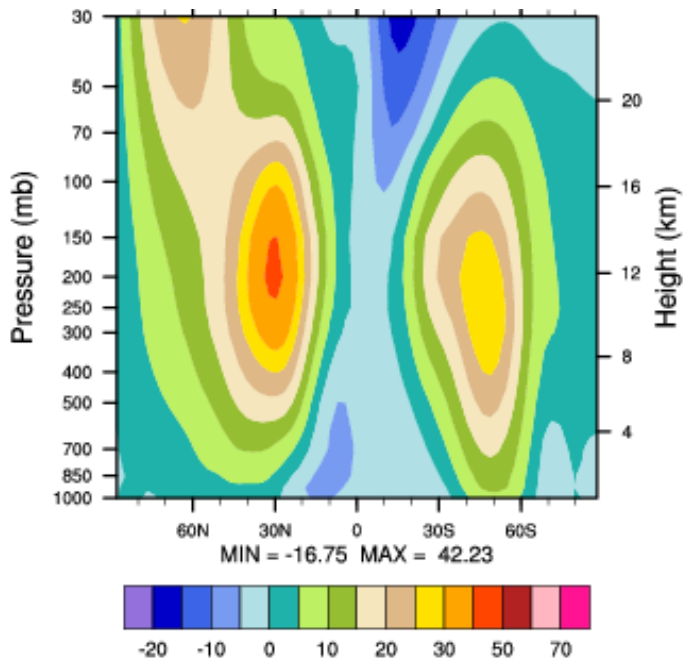
MIN = -2.10 MAX =



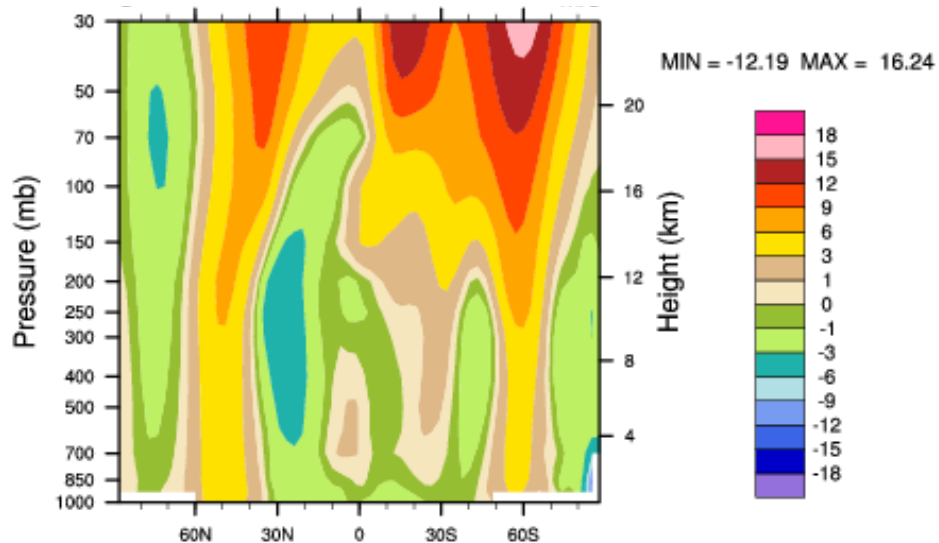
DJF 500 mb heights (10^2 m)

Excessive polar vortex contraction and deepening much reduced

DJF Zonal Wind (m/s)

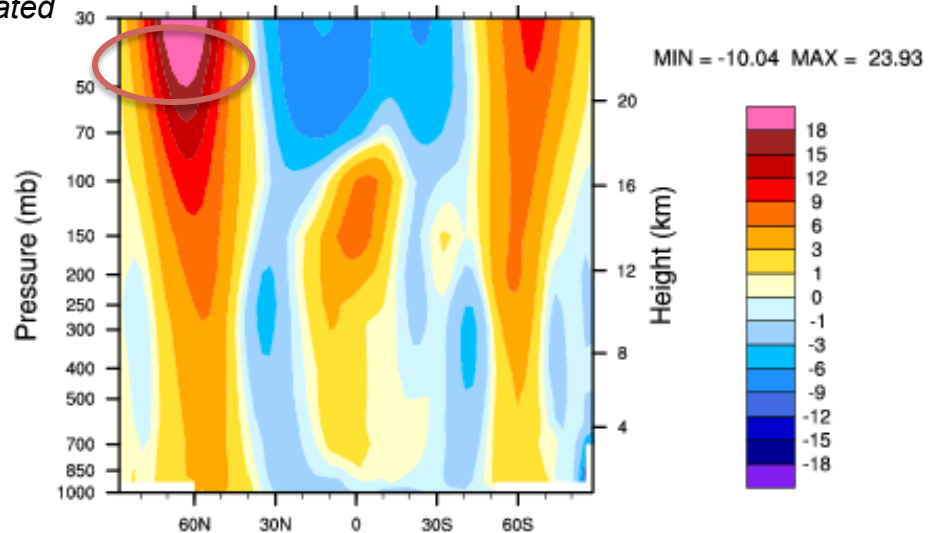


NCEP Reanalysis



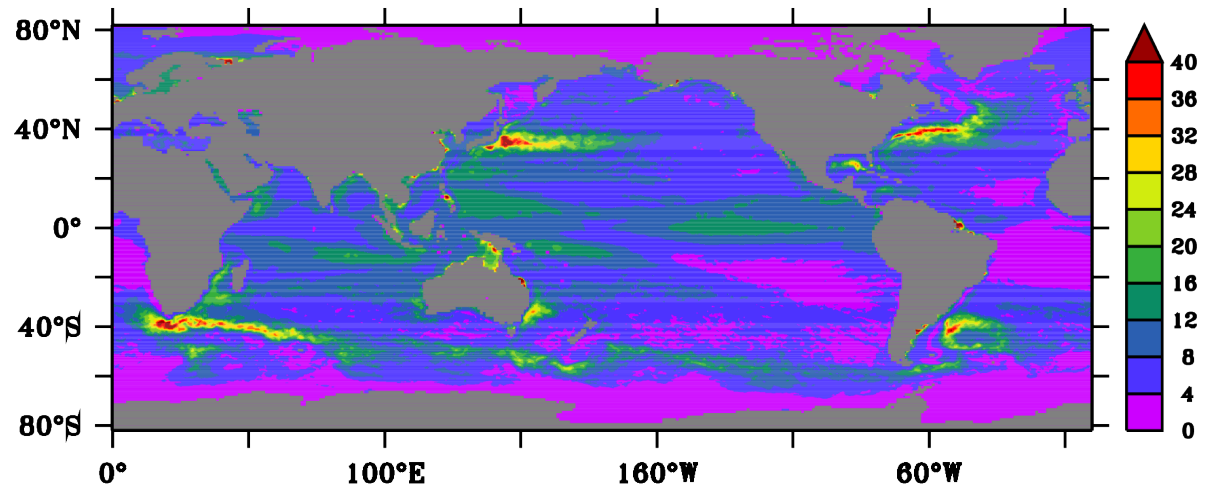
T341-NCEP

*Overly strong
polar night jet
eliminated*

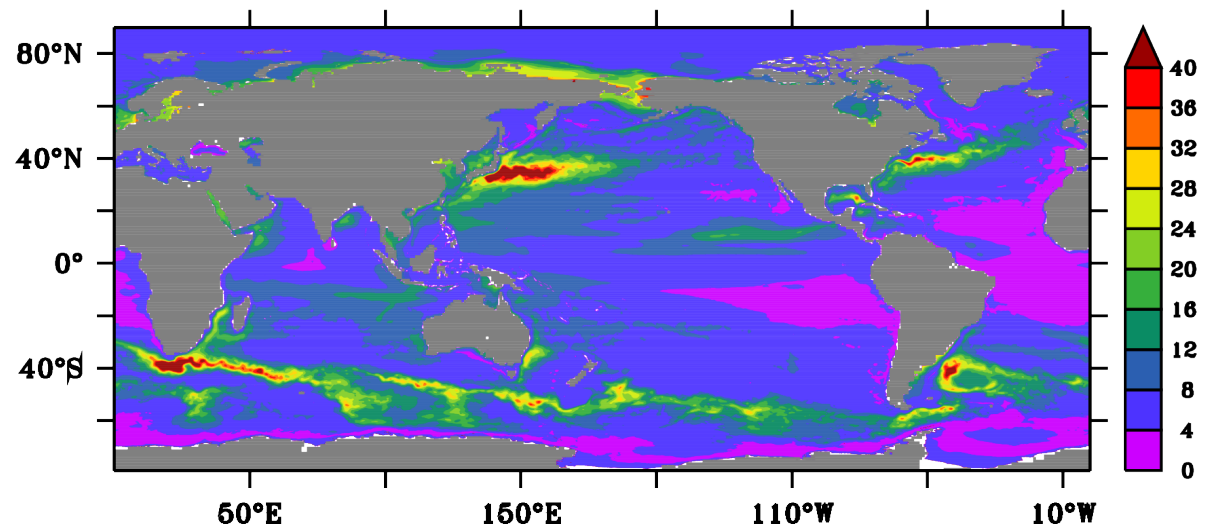


Atlas-NCEP

RMS SSHA (CM) from AVISO (upper) and 7-daily SSHA from T341 (lower)



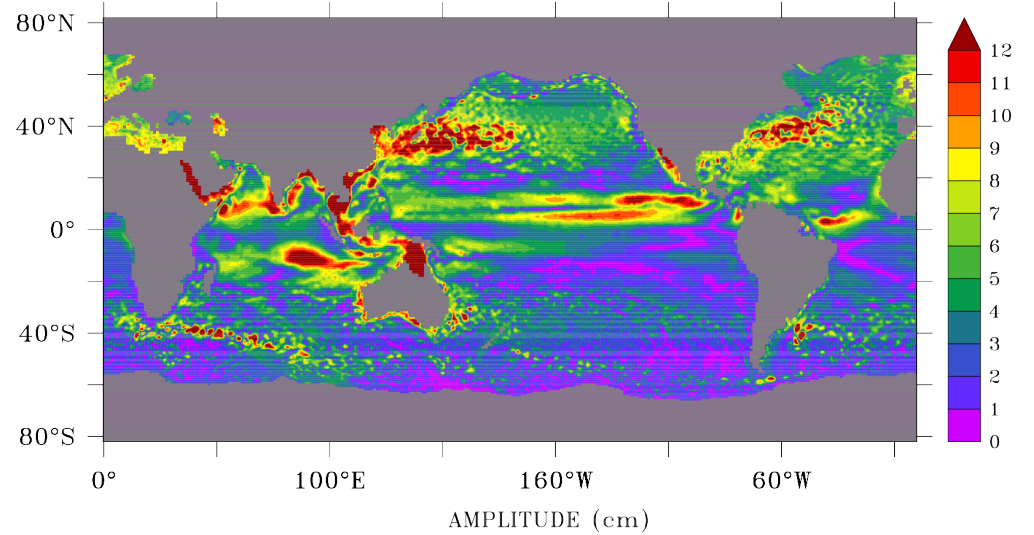
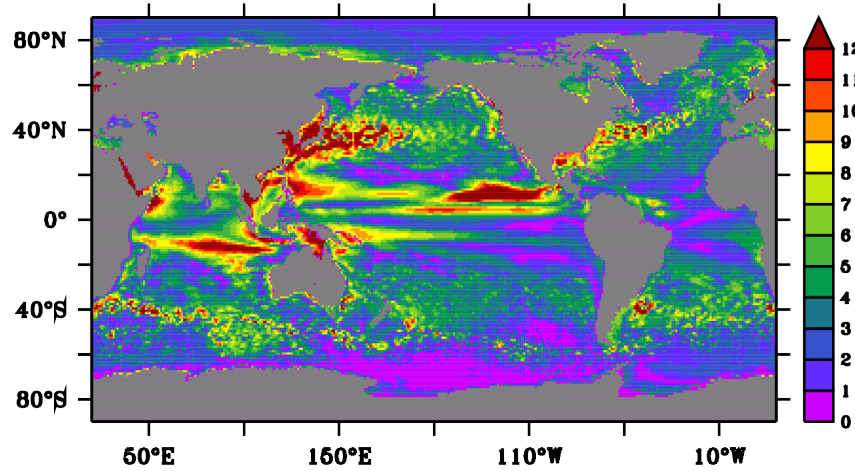
(b) B1850 T341 RMS SSH (cm)



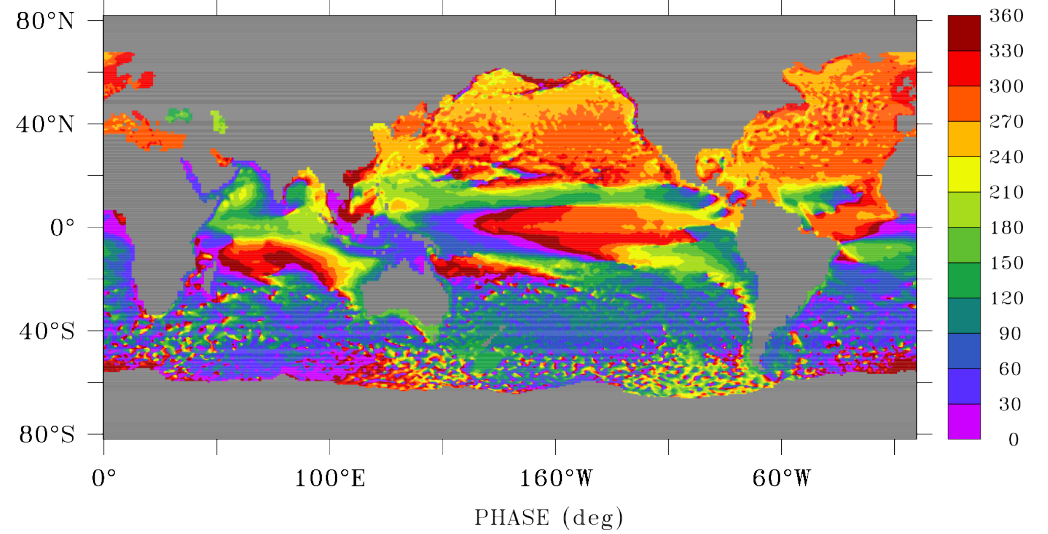
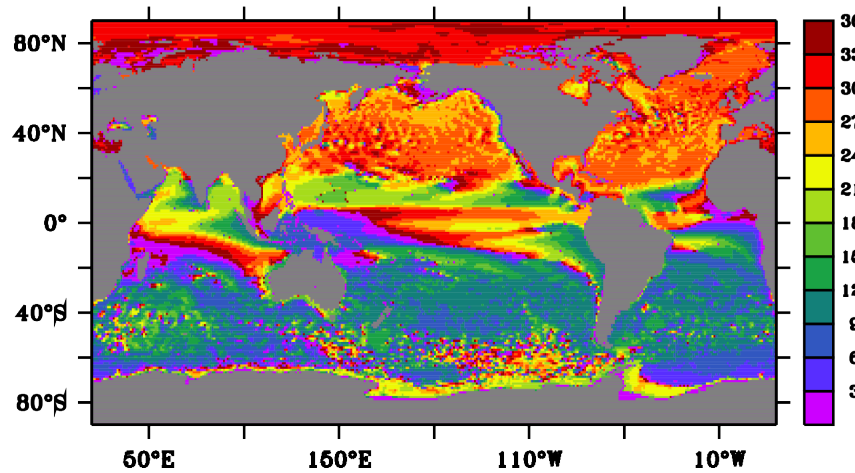
Annual Cycle

Altimetry

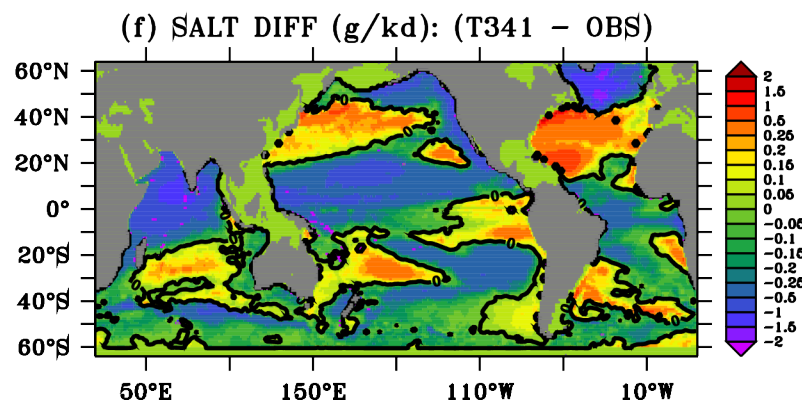
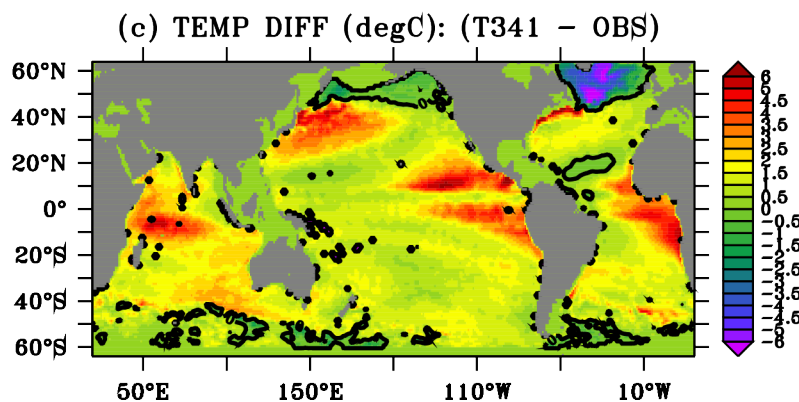
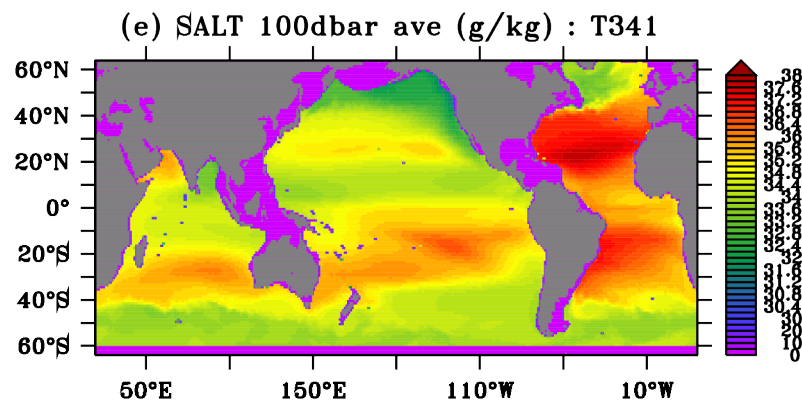
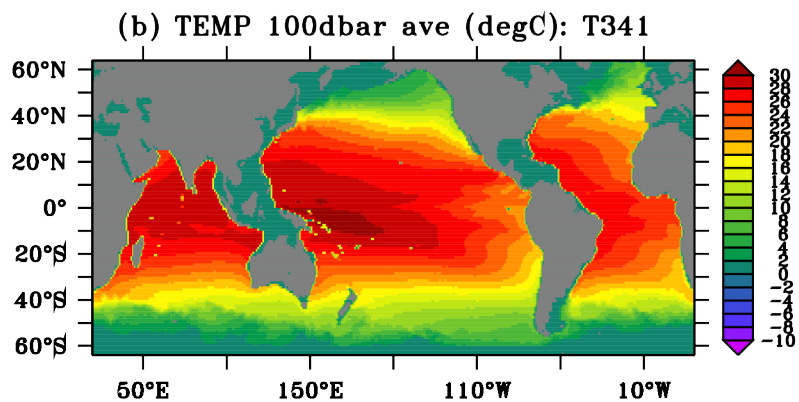
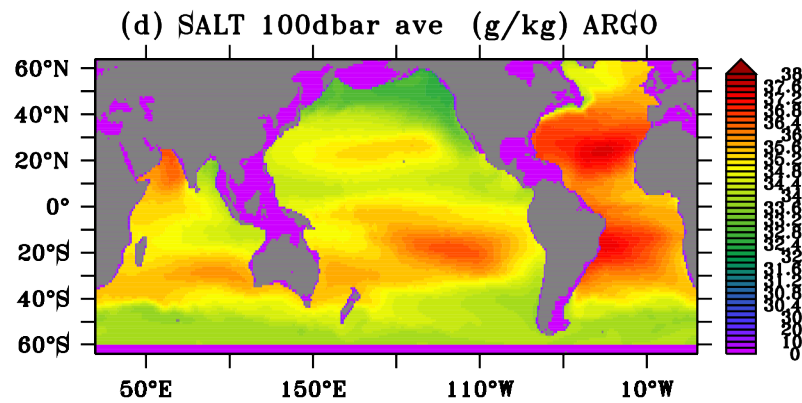
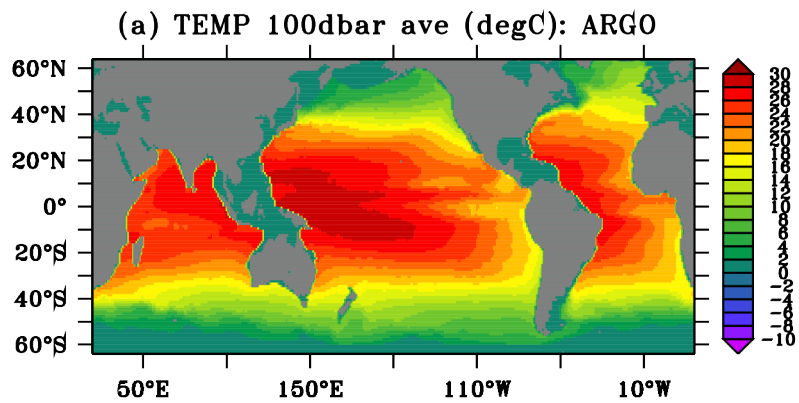
SSH ann amp (cm) B1850 T341



SSH ann phase (degree) B1850 T341

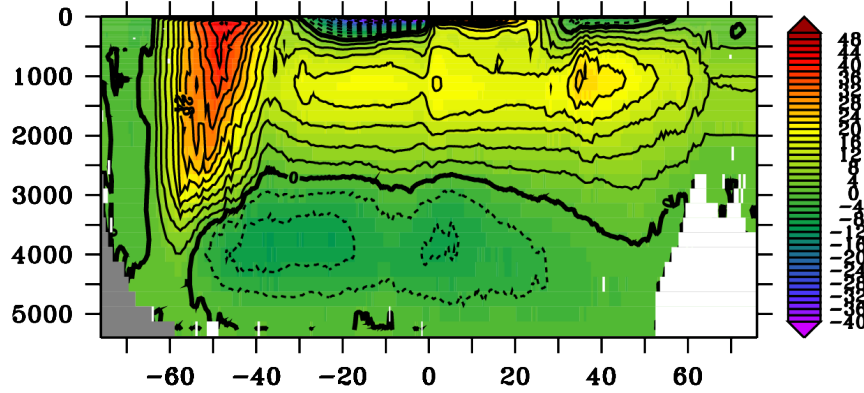


Temperature and Salinity averaged over top 10-100 dbar, Argo: 2004-2008

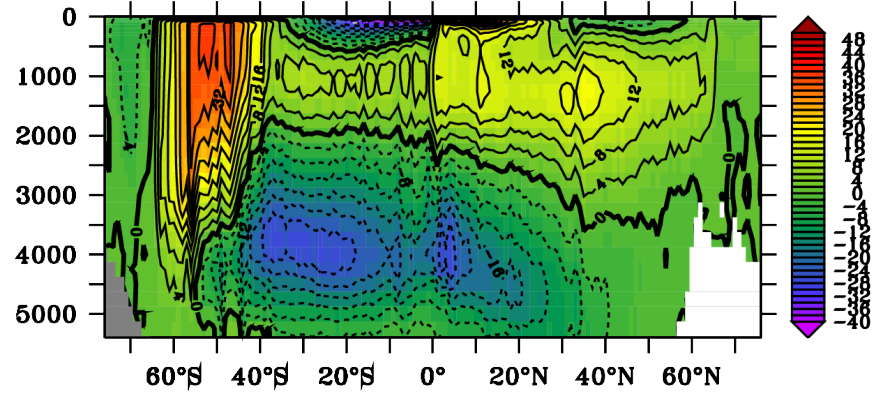


Meridional Overturning Circulation for T85 (LHS) and T341 (RHS)

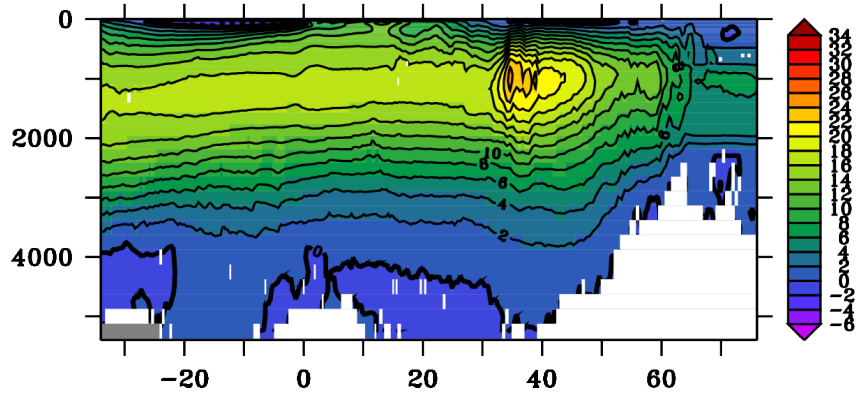
(a) T85 B1850: GL. MOC (Sv) YY0034-0043



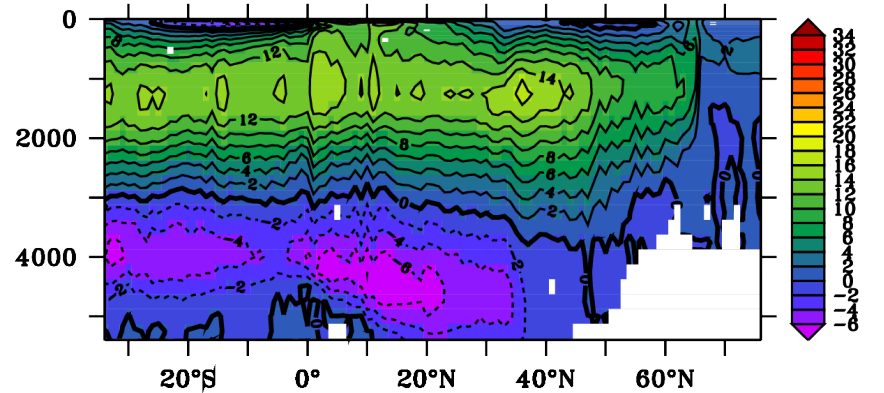
(b) T341 B1850: GL. MOC (Sv) YY0034-0043



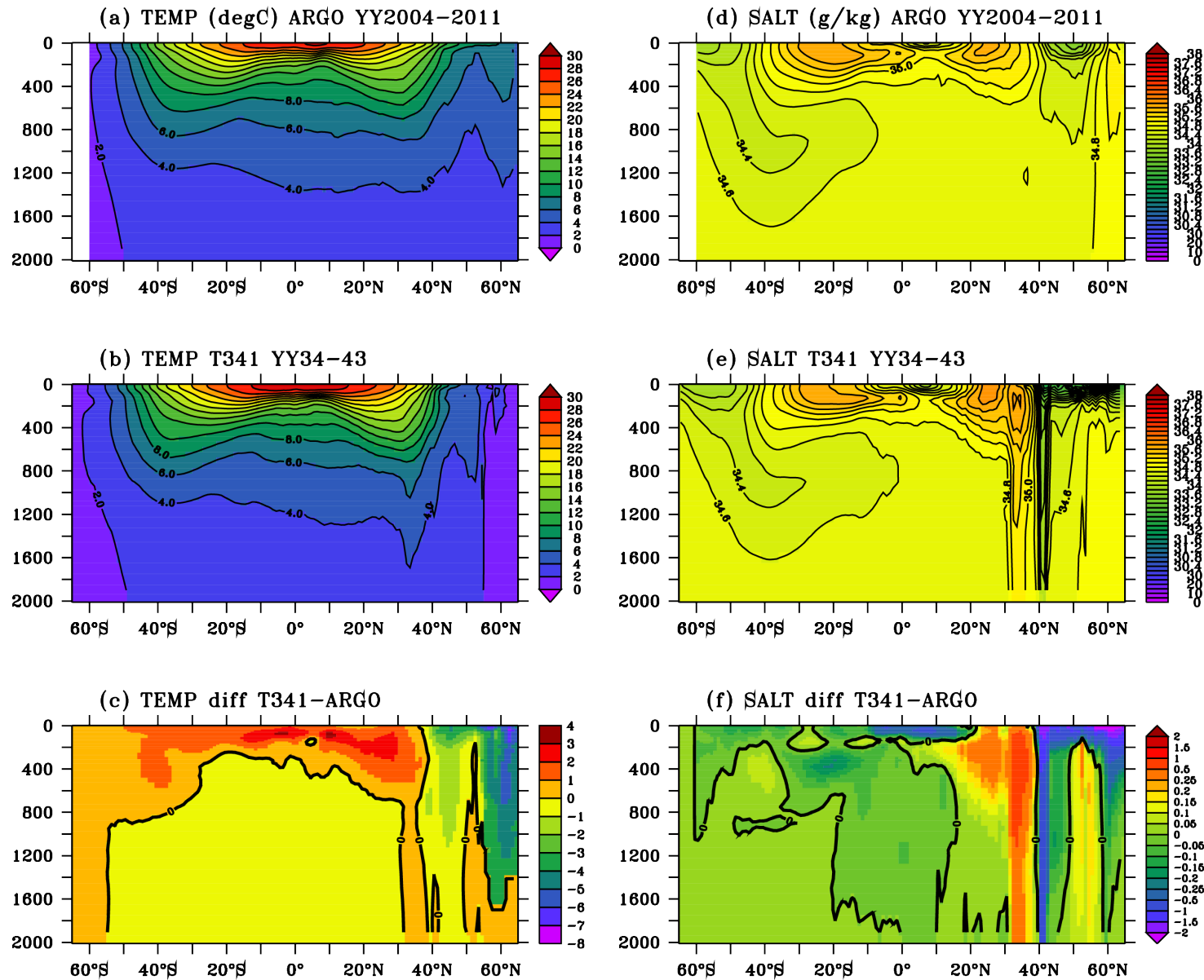
(c) T85 B1850: ATL. MOC (Sv) YY0034-0043



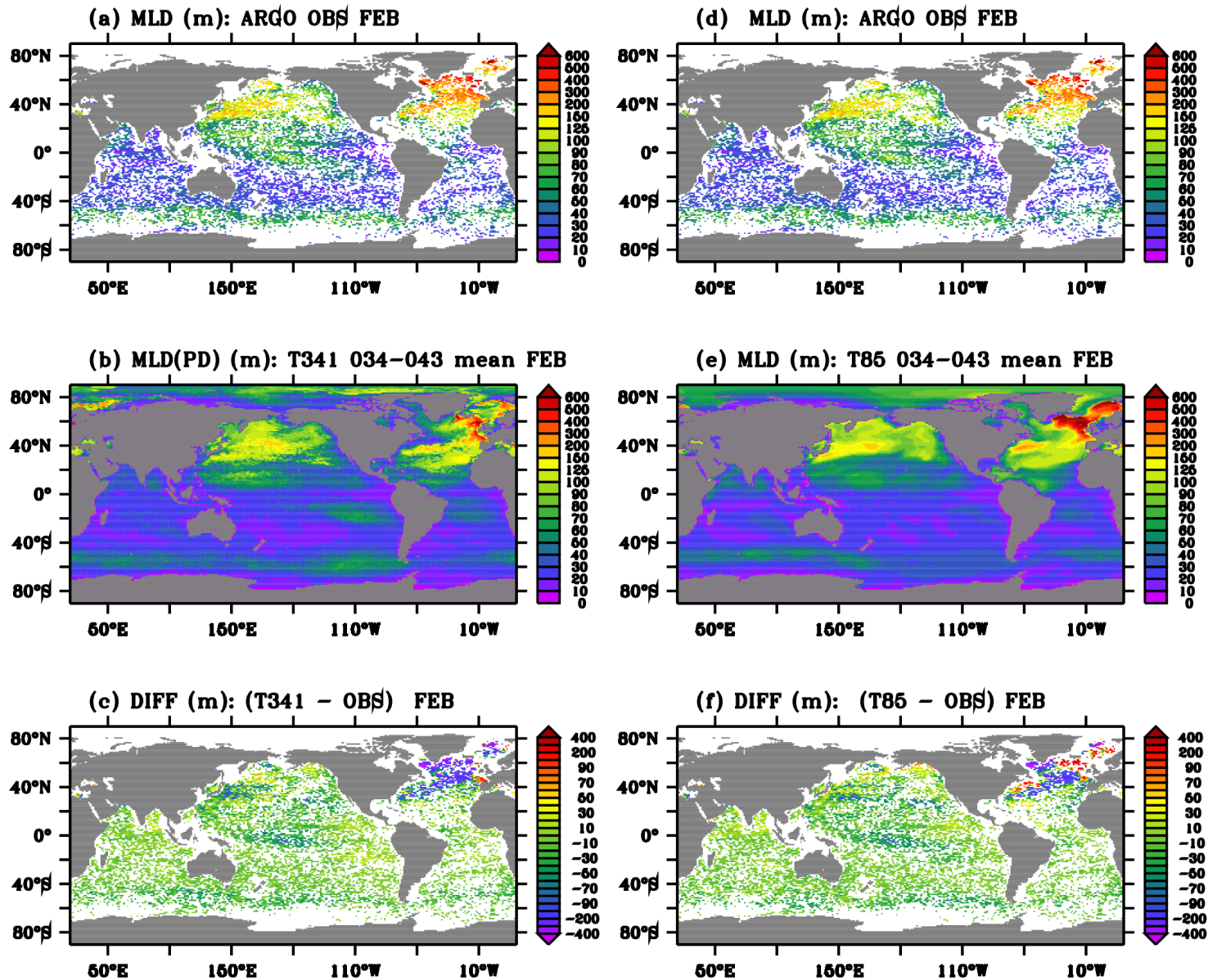
(d) T341 B1850: ATL. MOC (Sv) YY0034-0043



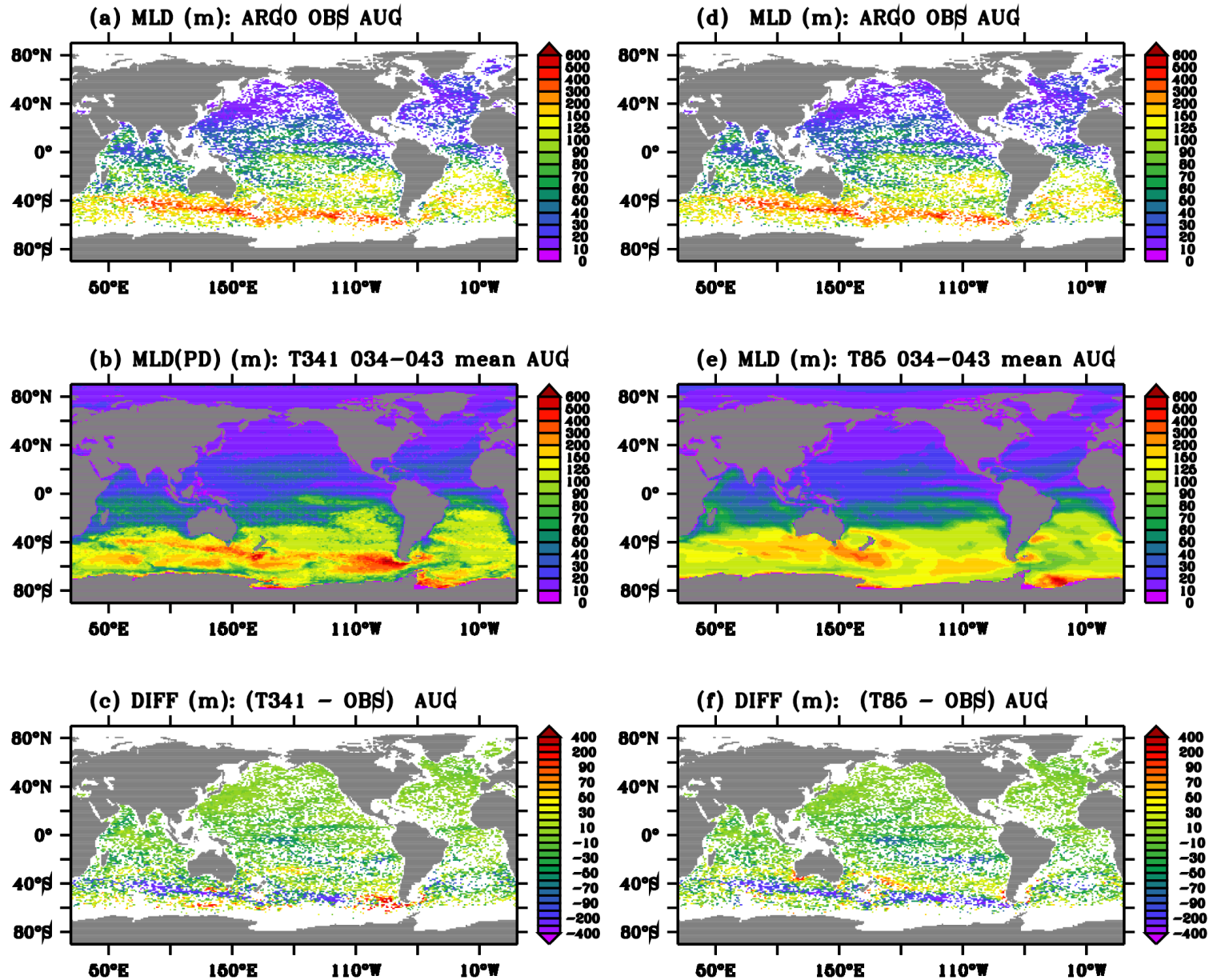
Zonally-Averaged Temperature and Salinity in top 2000 m



Mixed Layer Depth: Density threshold of 0.03 kg/m^3 , following de Boyer Montégut et al., 2004.

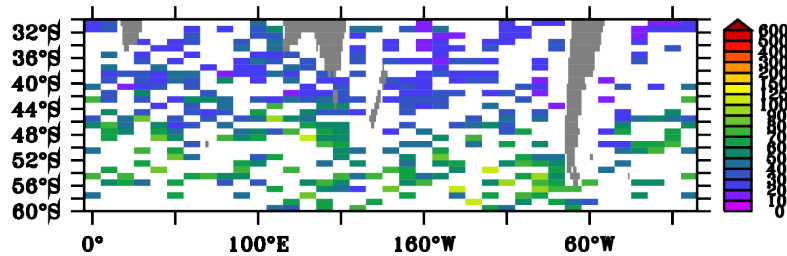


Mixed Layer Depth: Density threshold of 0.03 kg/m^3 , following de Boyer Montégut et al., 2004.

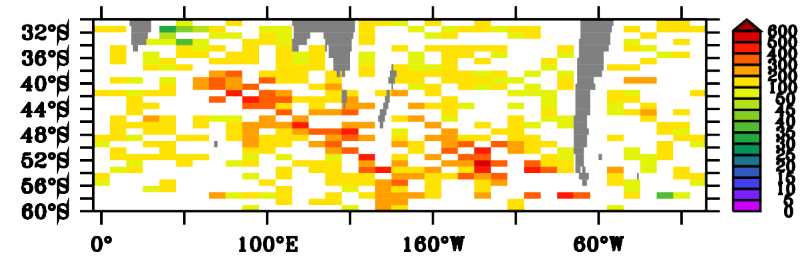


Southern Ocean Mixed Layer Depths from ARGO and T341 February and August climatologies.

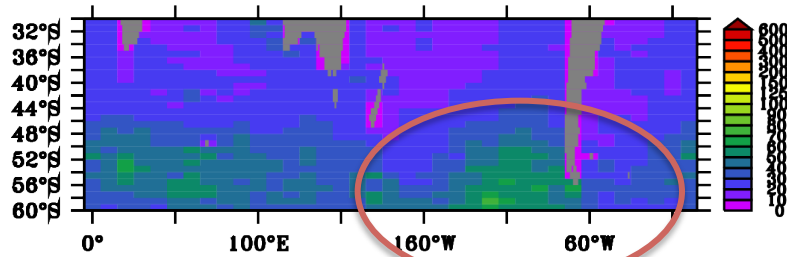
(a) MLD (m): ARGO OBS FEB



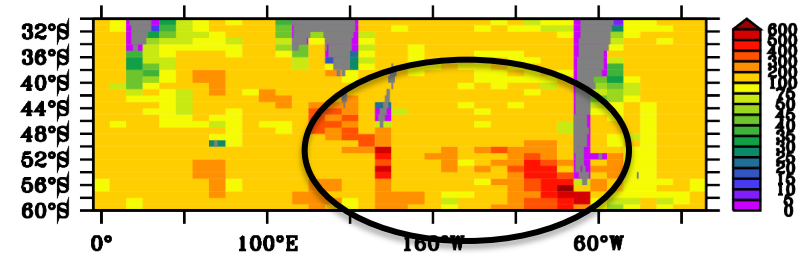
(d) MLD (m): ARGO OBS AUG



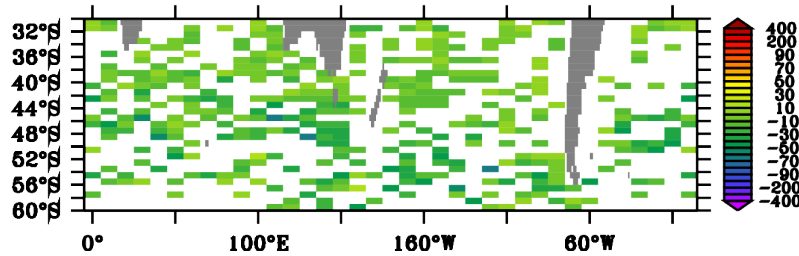
(b) MLD (m): T341 034-043 mean FEB



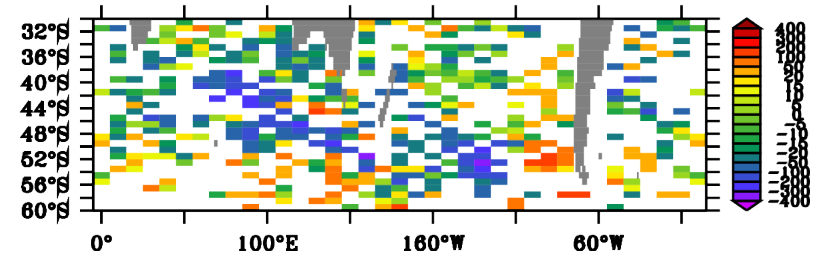
(e) MLD (m): T341 034-043 mean AUG



(c) DIFF (m): (T341 - OBS) FEB

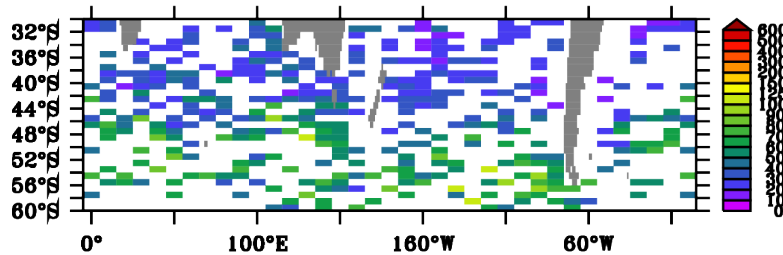


(f) DIFF (m): (T341 - OBS) AUG

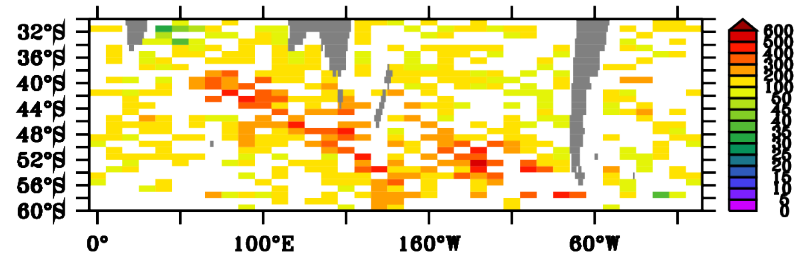


Southern Ocean Mixed Layer Depths from ARGO and T85 February and August Climatologies

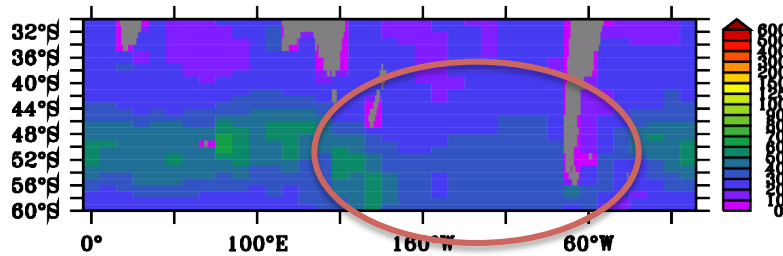
(a) MLD (m): ARGO OBS FEB



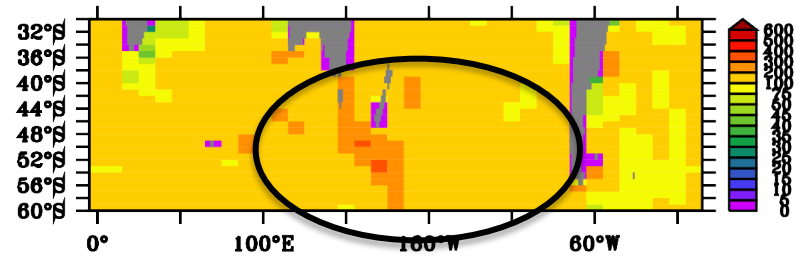
(d) MLD (m): ARGO OBS AUG



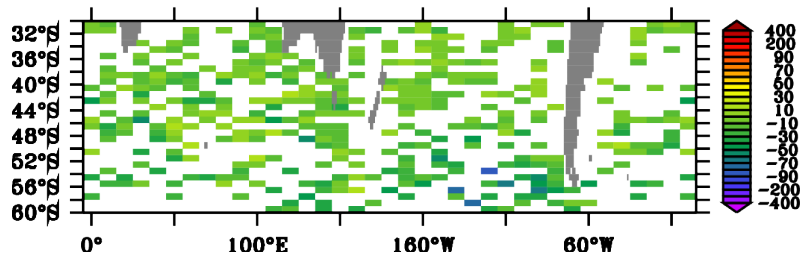
(b) MLD (m): T85 034-043 mean FEB



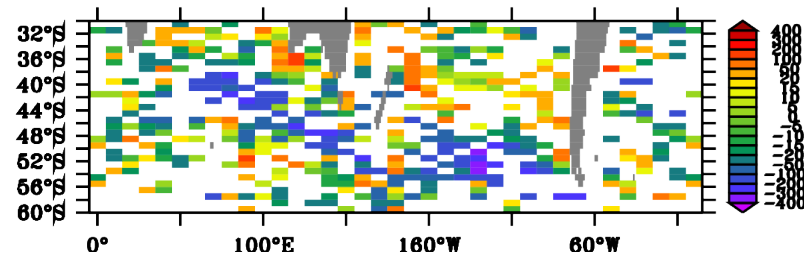
(e) MLD (m): T85 034-043 mean AUG



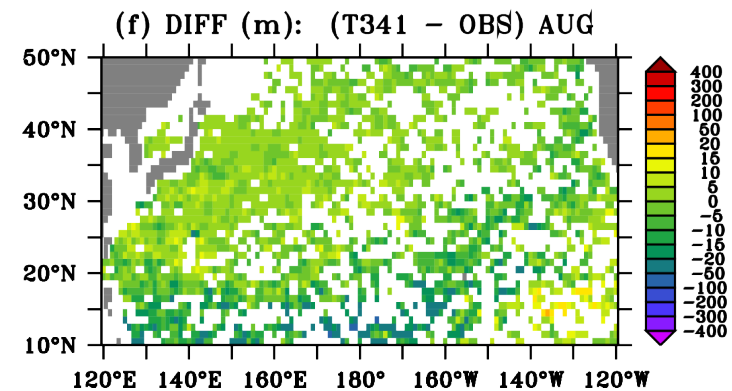
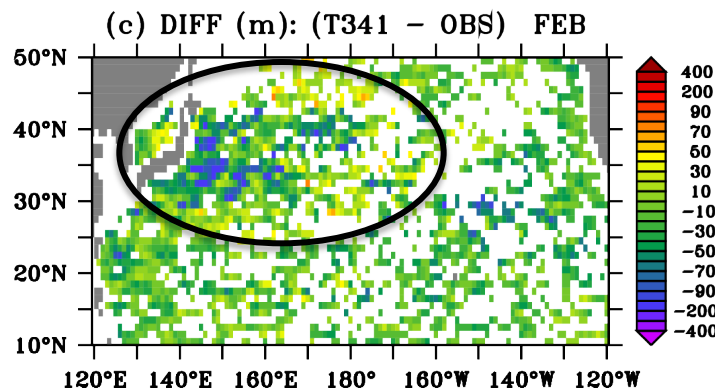
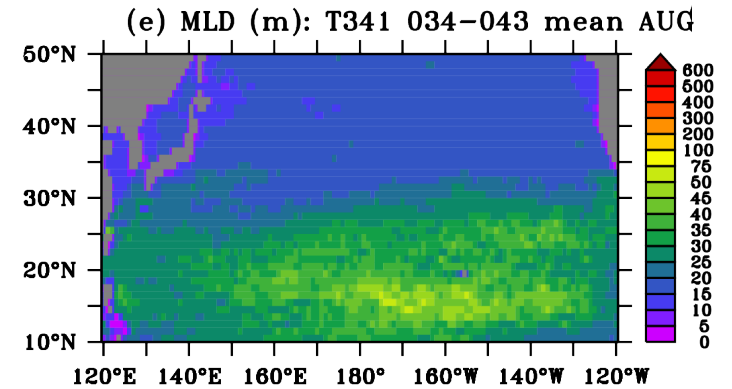
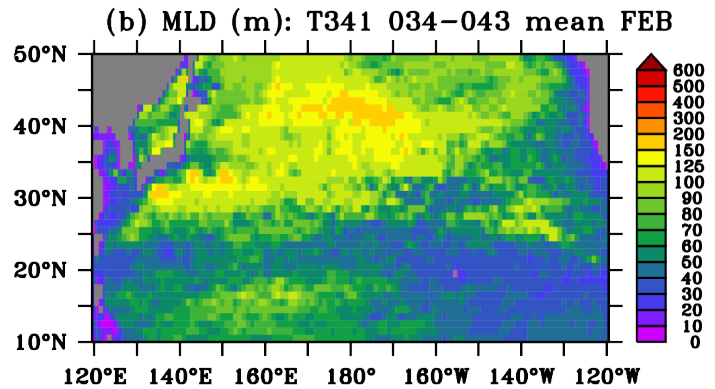
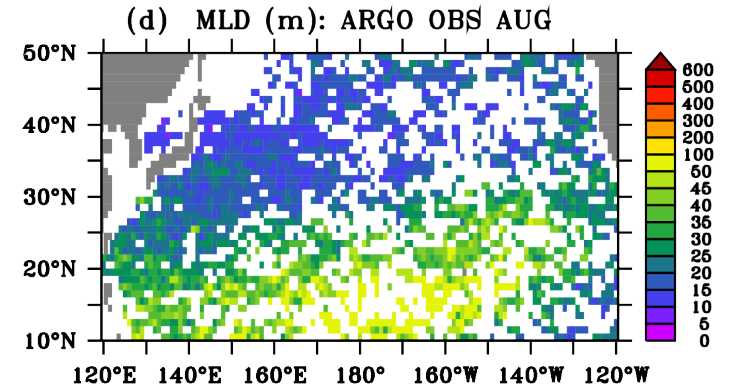
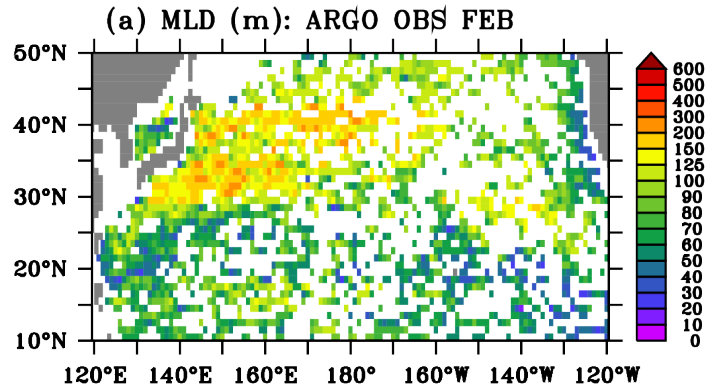
(c) DIFF (m): (T85 - OBS) FEB



(f) DIFF (m): (T85 - OBS) AUG

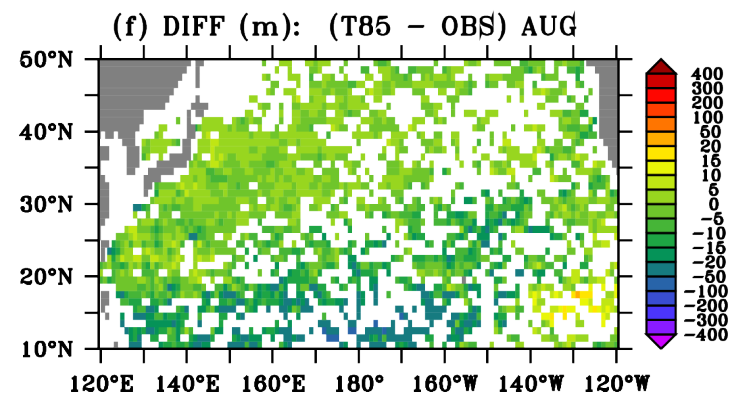
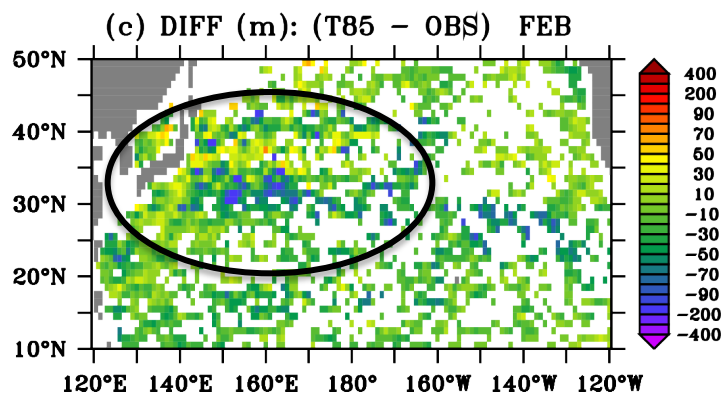
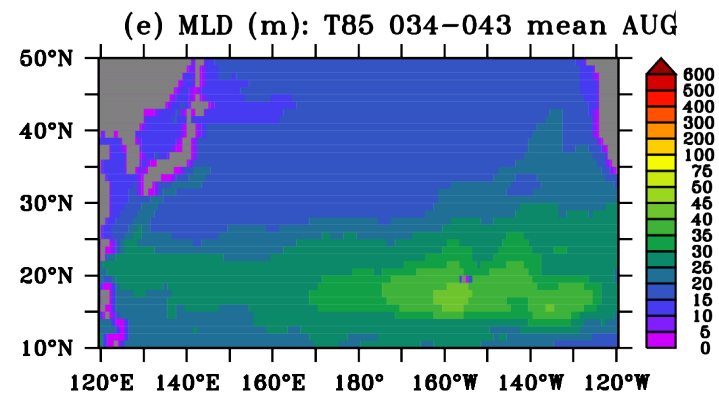
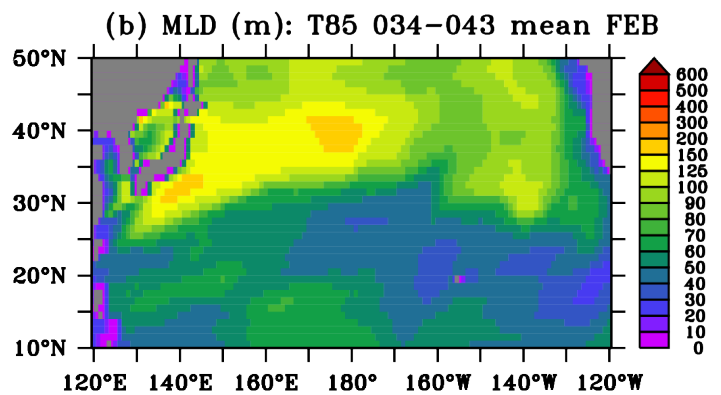
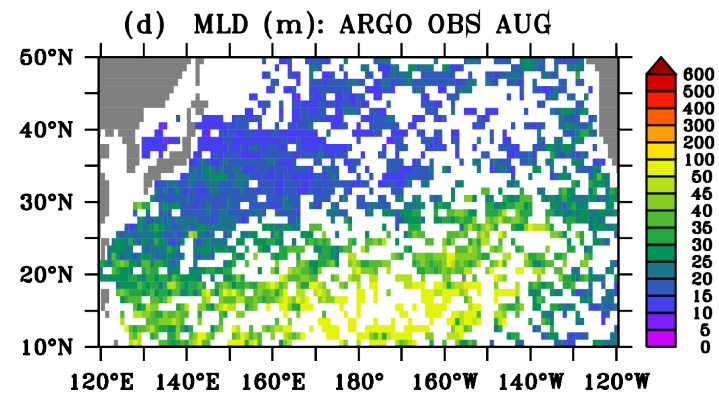
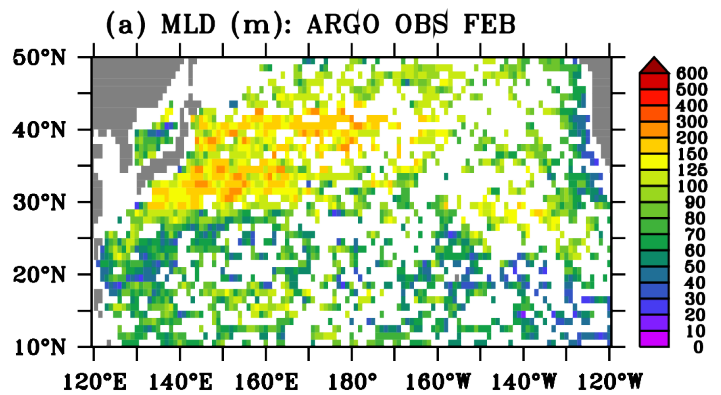


North Pacific Mixed Layer Depths from ARGO and T341 February and August climatologies



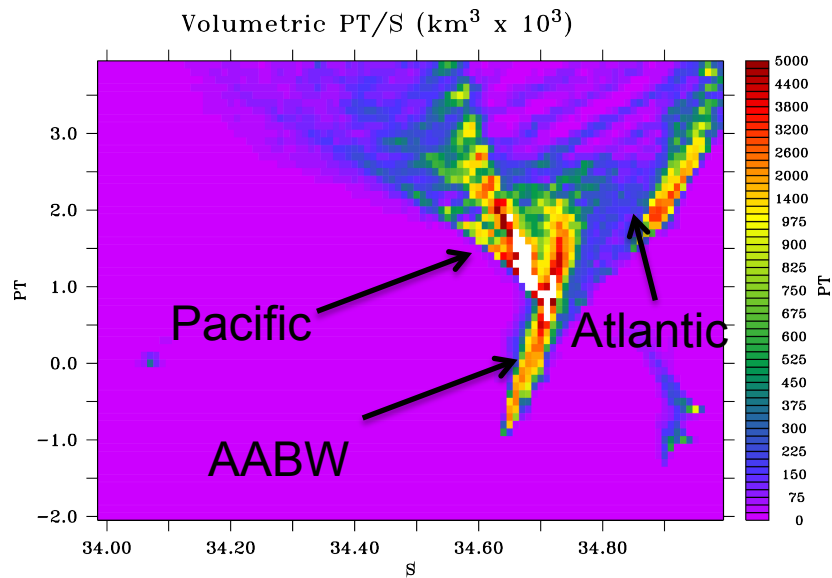
Shallow
model
MLDS

North Pacific Mixed Layer Depths from ARGO and T85 February and August climatologies

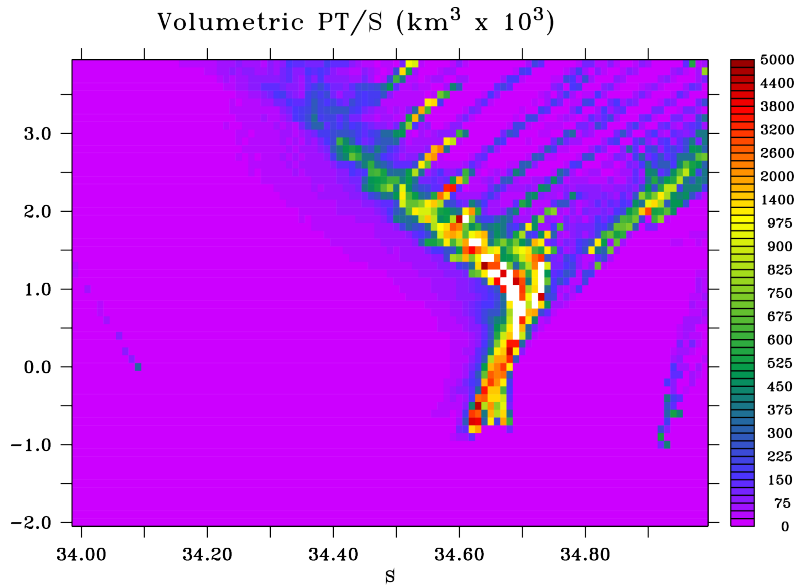


Worthington Volumetric Temperature-Salinity Census

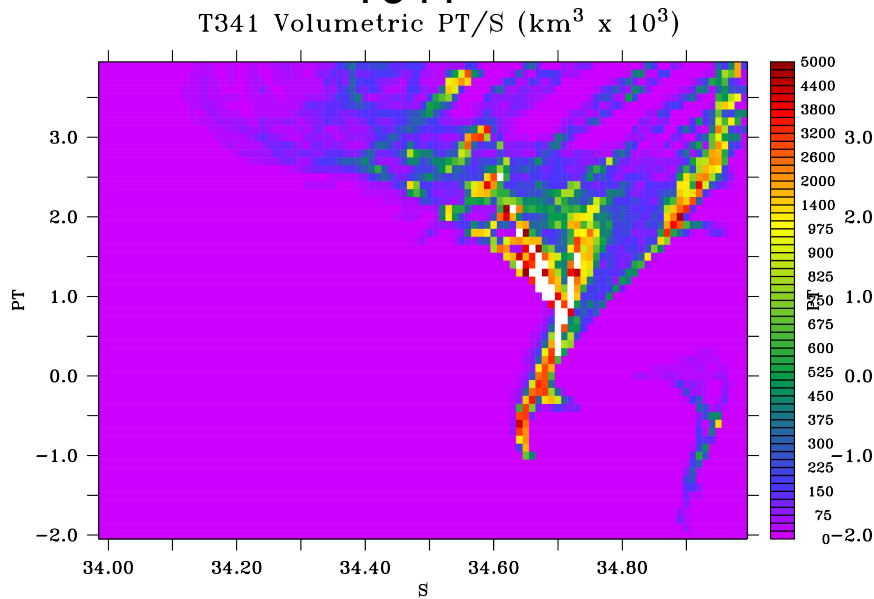
PHC2



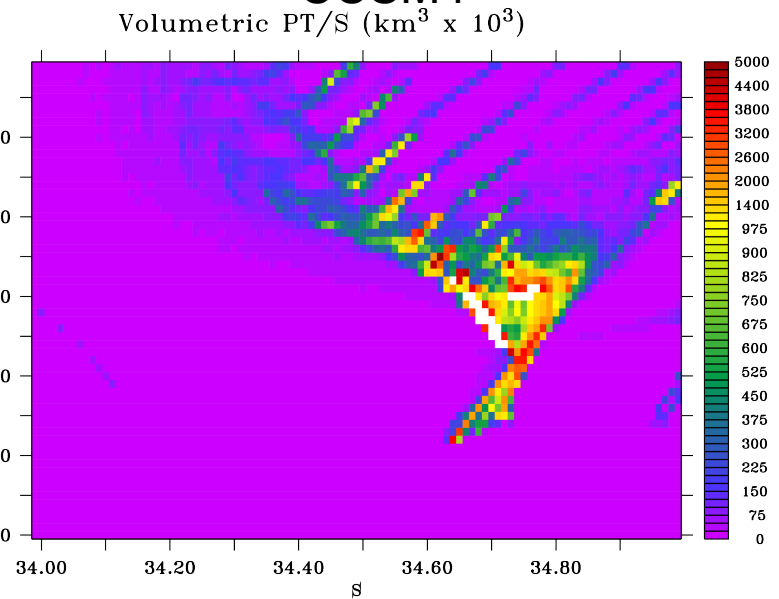
T85



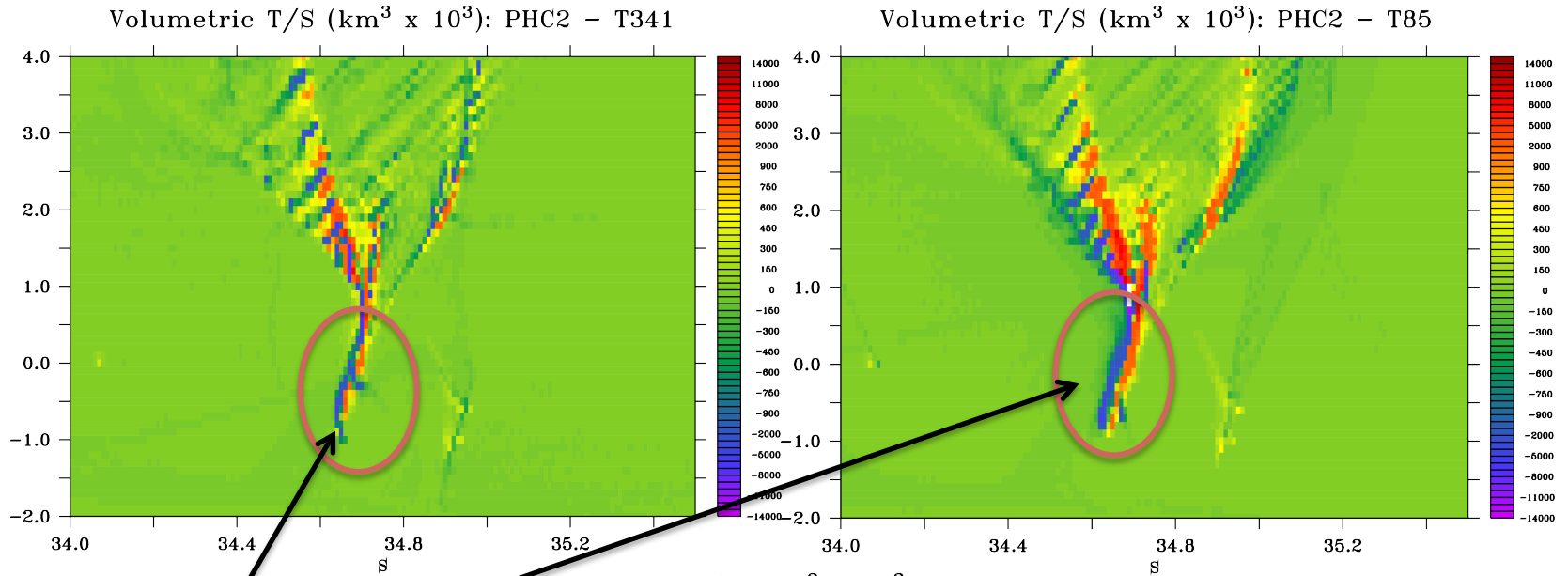
T341



CCSM4

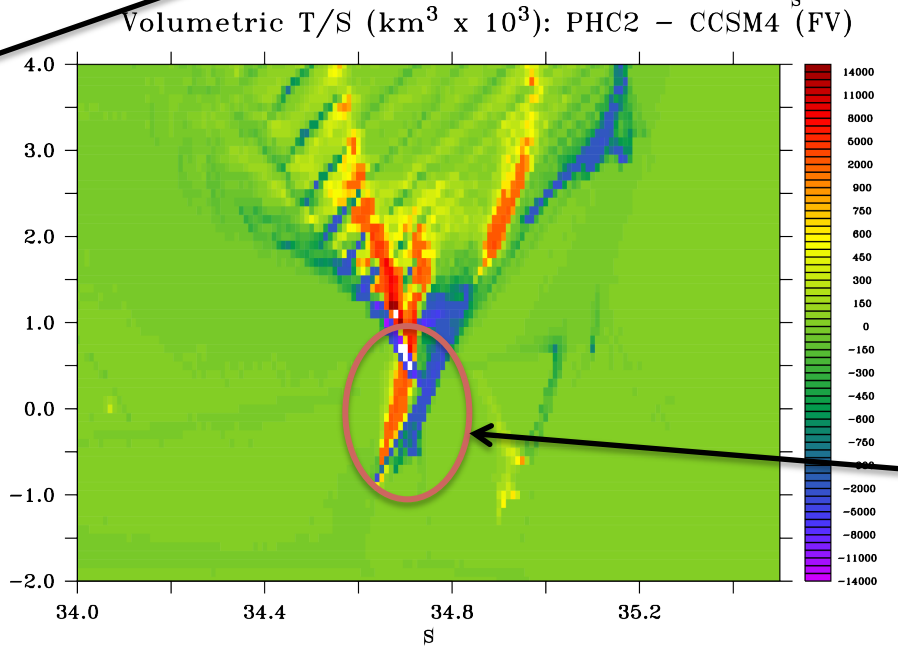


Volumetric Temperature-Salinity Census: Observations - Model



Modest
Freshening

T341 for yrs
34-43



T85 and
CCSM4 for
yrs 176-200

Excessive ice
formation
producing higher
salinity AABW

Conclusions and On-Going Work

- Anomalous strengthening & deepening of the winter-time NH polar vortex not as severe in T341 as Atlas, nor is it getting worse.
- T341 upper ocean generally shows a warm bias in mid-latitudes & tropics.
- Mixed layer depths in T341 more realistic in SO and KE relative to T85.
- AABW better represented in T85 and T341 relative to CCSM4.
- More study is required to determine sources of the T341 biases especially in salinity.
- Evaluate T85 transients.