



NCODA Implementation with re-layerization

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GULF OF MEXICO MODEL CONFIGURATION:

- Horizontal grid: $1/12^\circ$ (258 x 175 grid points, ca. 7 km spacing on average)
- 18°N to 31°N
- 20 vertical hybrid layers with the top layer at its minimum thickness of 3m
- Bathymetry: 5m coastline
- KPP mixed layer scheme
- Surface forcing from FNMOC/NOGAPS
- Monthly river runoff
- Nested Boundary:
relaxation to the $1/12^\circ$ Atlantic HYCOM T and S, U and V along open boundary, (no assimilation in these experiments)



Building an interface with re-layerization (1) :

NOCDA is assimilating observed data into a model with conventional pressure-like vertical coordinates.

HYCOM simulation is done with hybrid vertical coordinate, which varies both spatially and temporally.

⇒ **Need to build a coordinate transforming interface between the two systems**

The strategy is to communicate through existing two HYCOM standard files

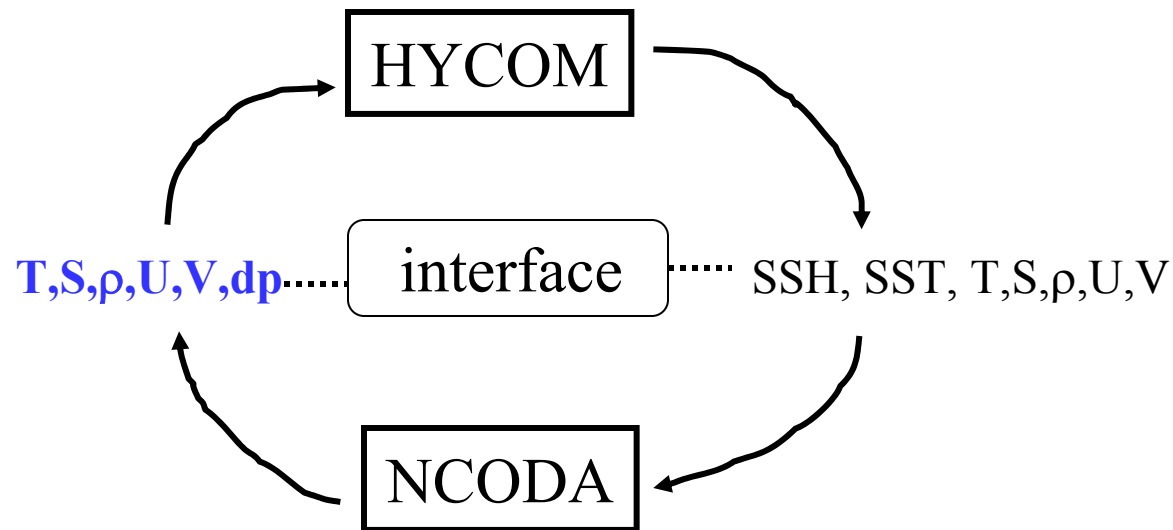
- a) SSH and SST from an archive file

- b) temperature, salinity, baroclinic velocities and **layer thickness** from a restart file

*T & S change → density change → layer displacements
⇒ layer thickness should be updated with new density information

Building an interface with re-layerization (2) :

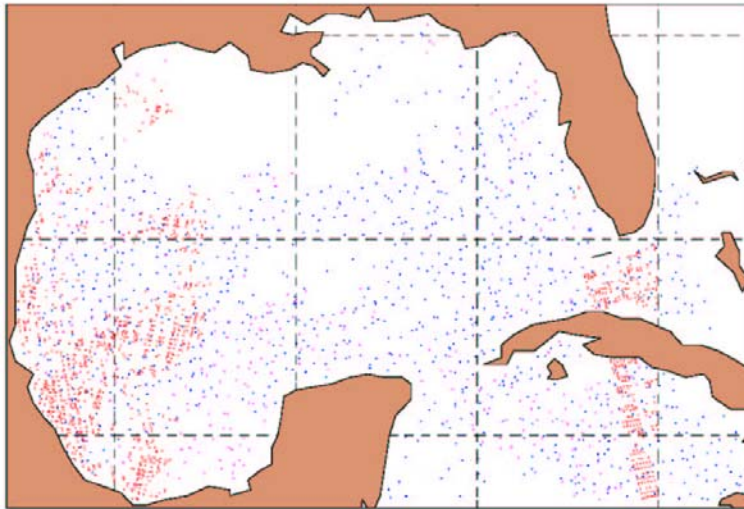
1. Interpolate HYCOM variables onto z-levels to be used as the first guess in NCODA
2. Get observation-based corrections of variables from the NCODA analysis
3. Put the new variables back into HYCOM layers (re-layerization)



Experiment of daily updating with NCODA analysis

Aug 11, 1999 (the first update cycle)

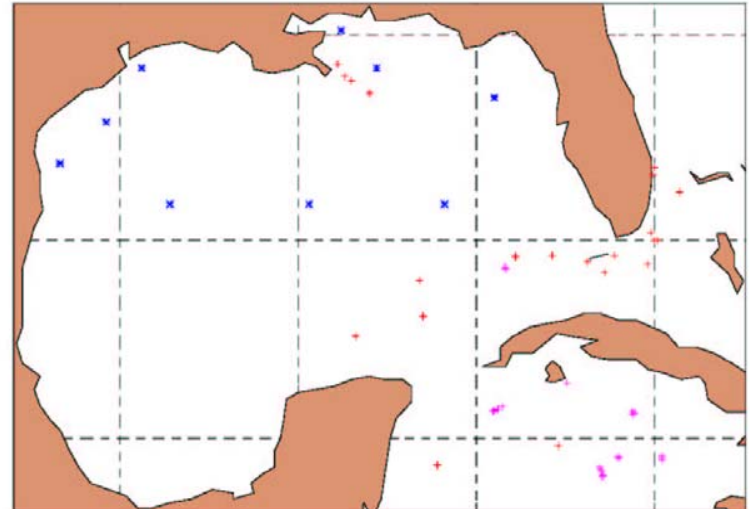
Satellite SST



AVHRR GAC GOES AVHRR LAC

AC Day GAC Night GAC Rlx Day GOES Day GOES Night LAC Day LAC Ni

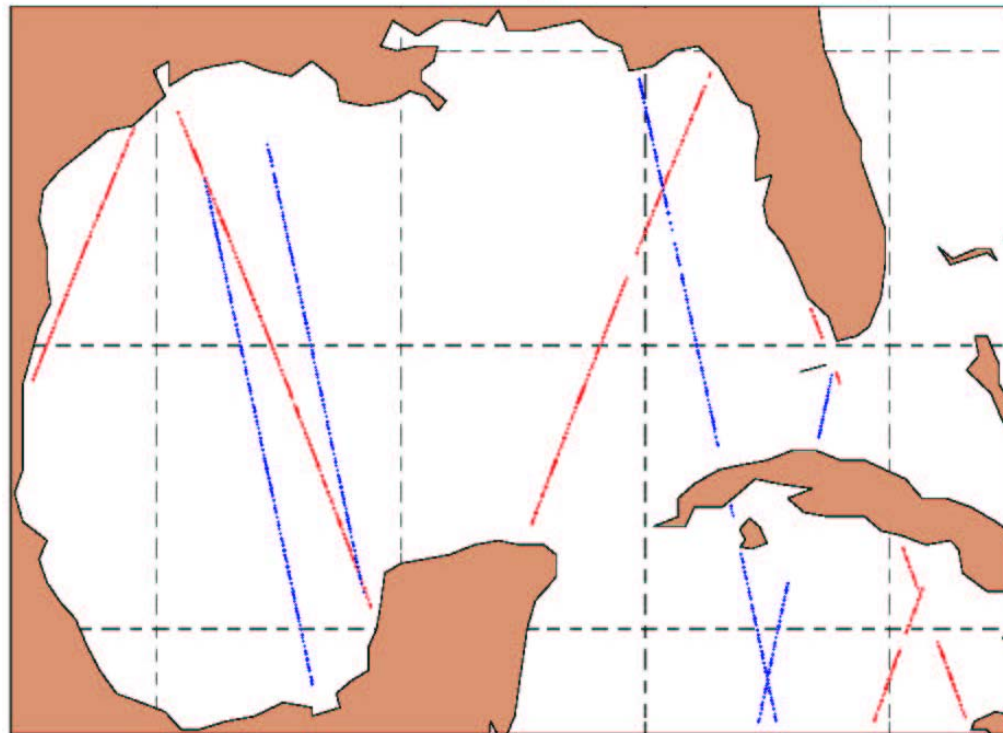
In Situ SST



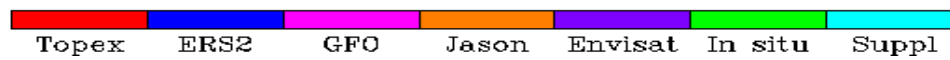
SHIP BUOY

Stc Ship Fixed Buoy Drft Buoy Sea Ice SST Climate CMAN SST Analyzed SST

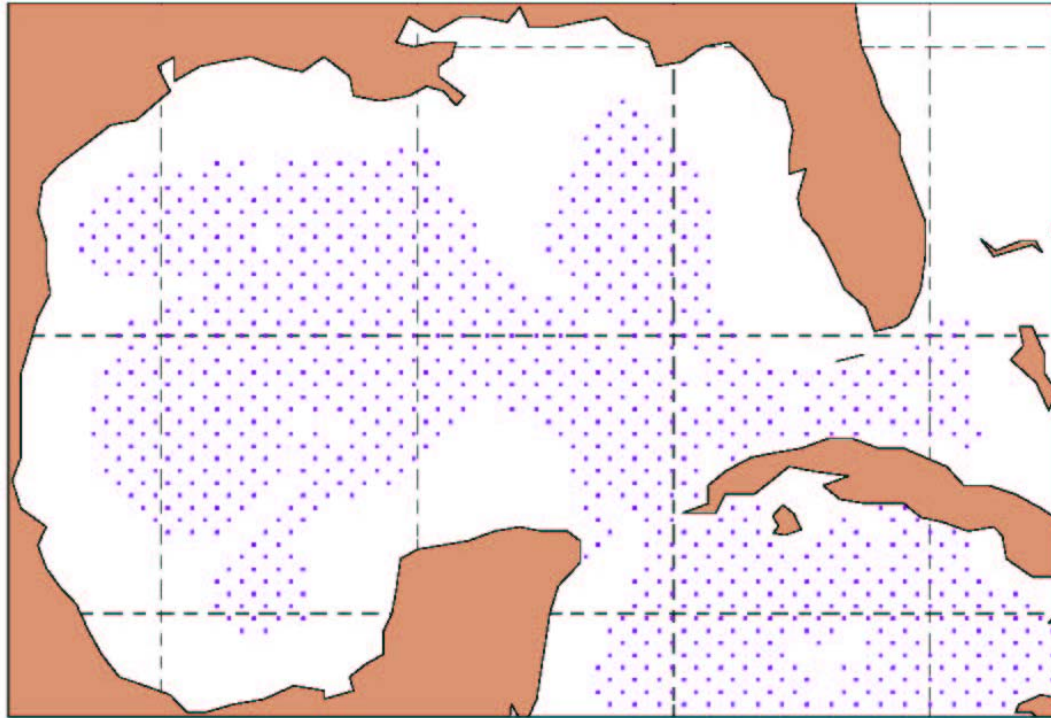
Satellite altimetry Aug 11, 1999



Topex ERS2

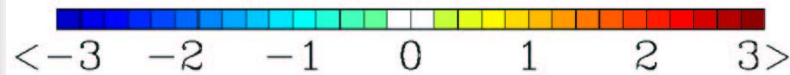
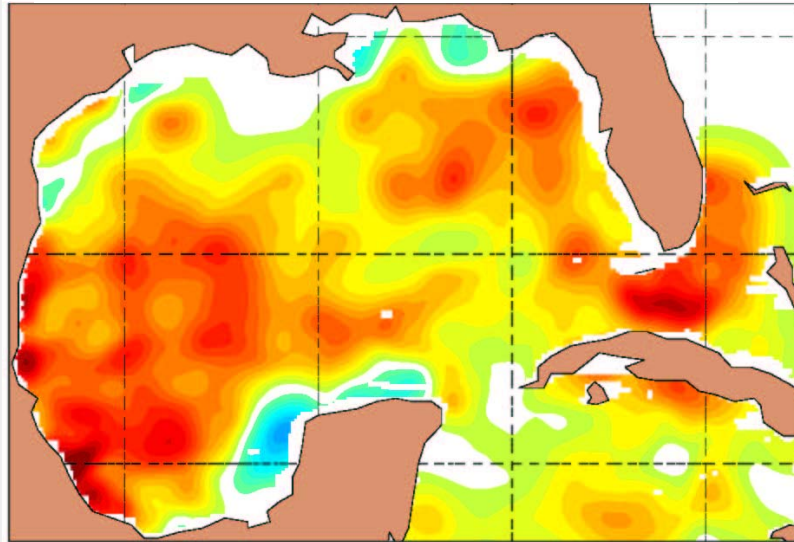


Profile Observations Aug 11 1999

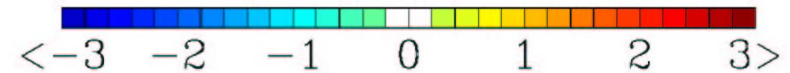
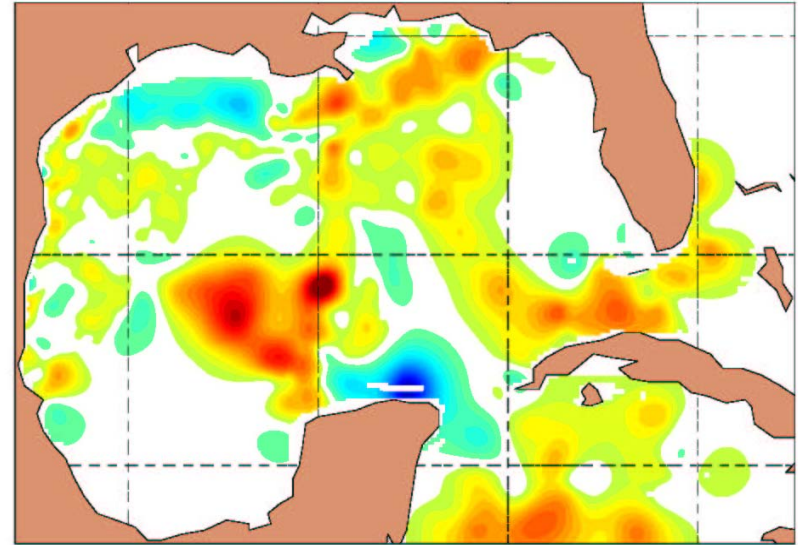


SST Analyzed Increment ($^{\circ}\text{C}$)

Aug 11, 1999
(after the first update cycle)

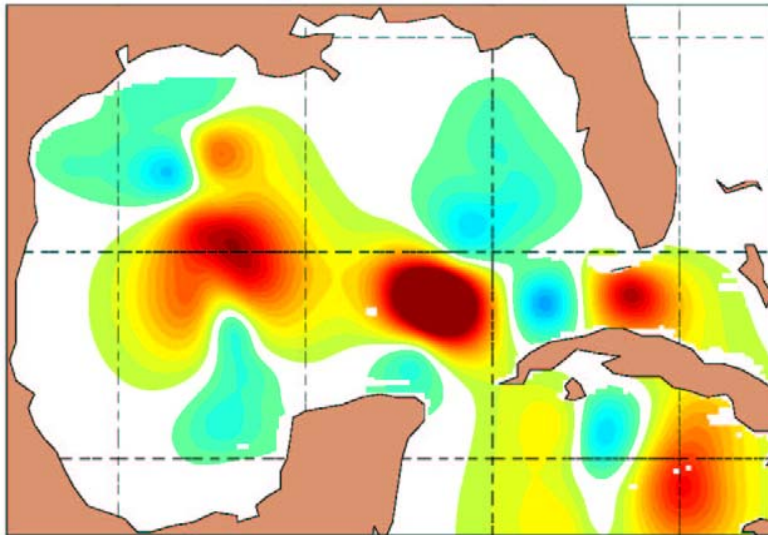


Aug 20, 1999
(after the 10th update cycle)

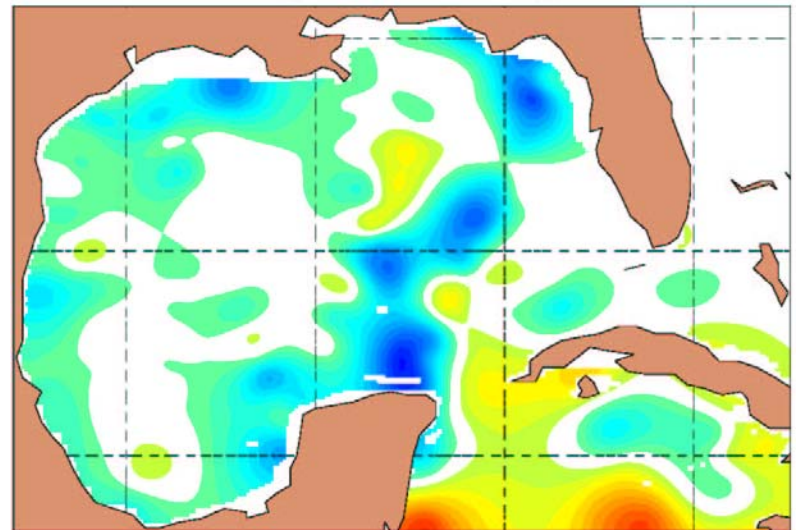


SSH Analyzed Increment (m)

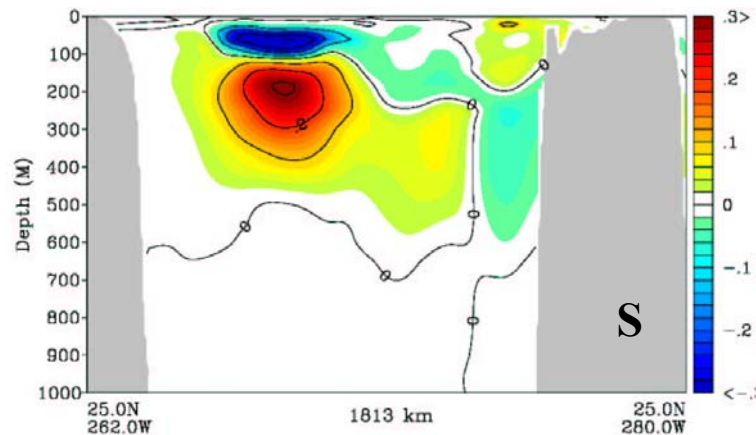
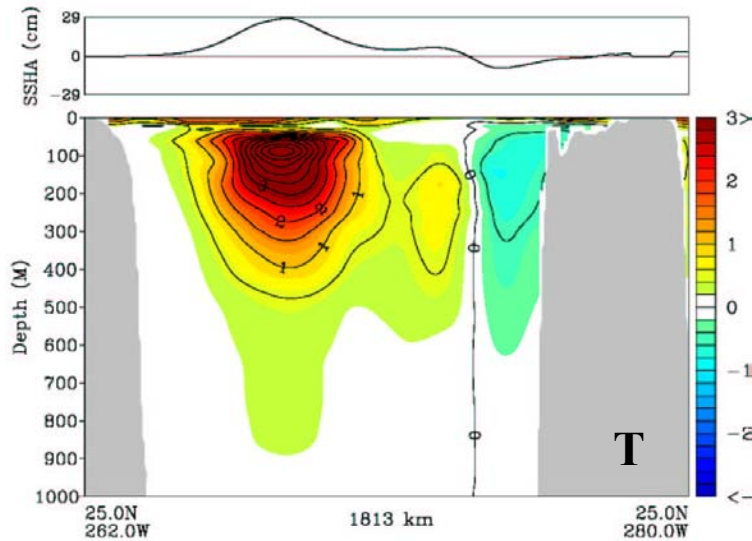
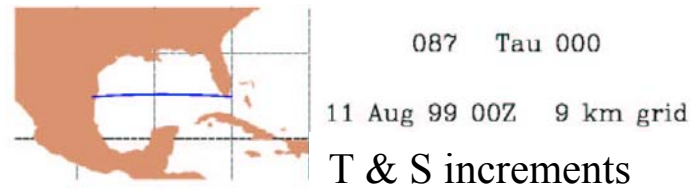
Aug 11, 1999
(after the first update cycle)



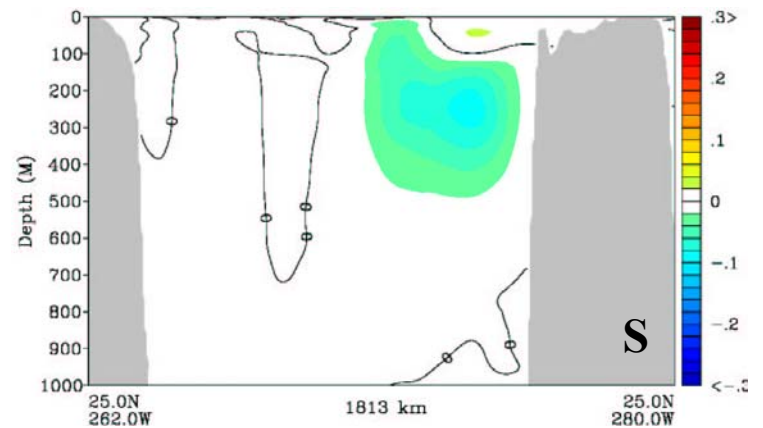
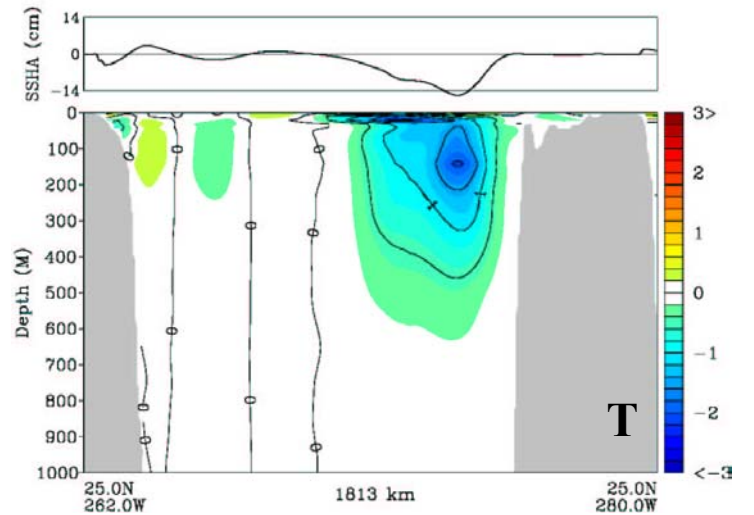
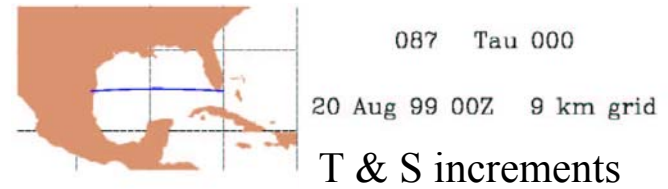
Aug 20, 1999
(after the 10th update cycle)



after the first update cycle



after the 10th update cycle

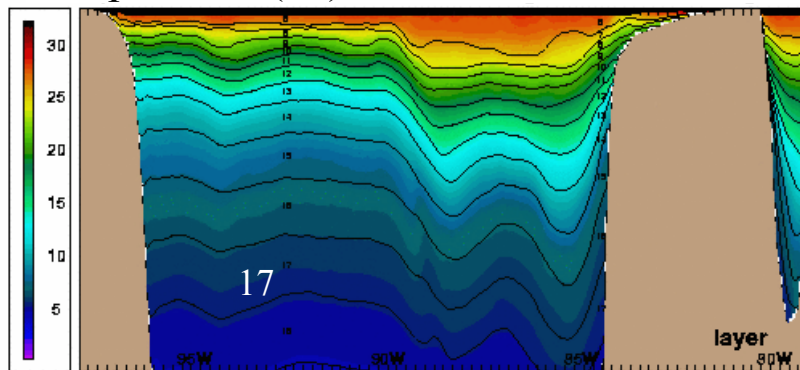


Checking the changes of layer interfaces

Aug 11, 1999 (after the first update cycle)

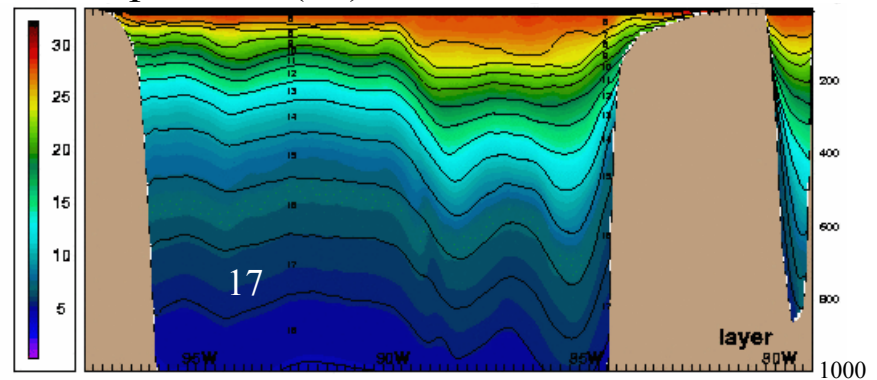
Daily updating

Temperature ($^{\circ}\text{C}$)

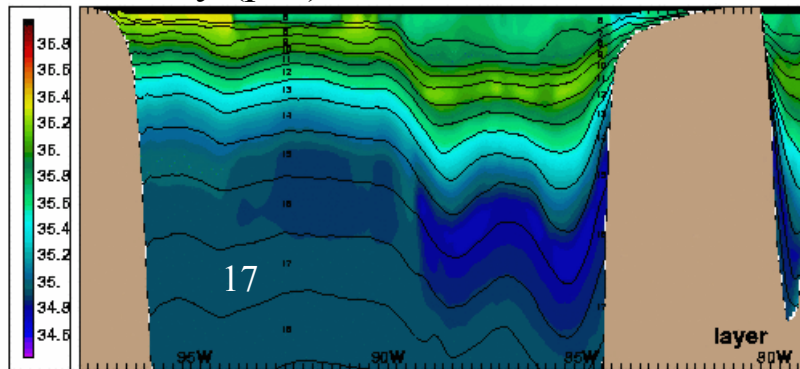


No data assimilation

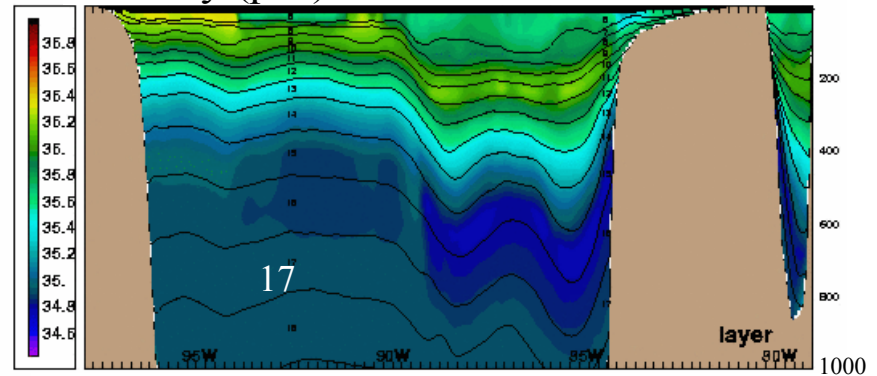
Temperature ($^{\circ}\text{C}$)



Salinity (psu)



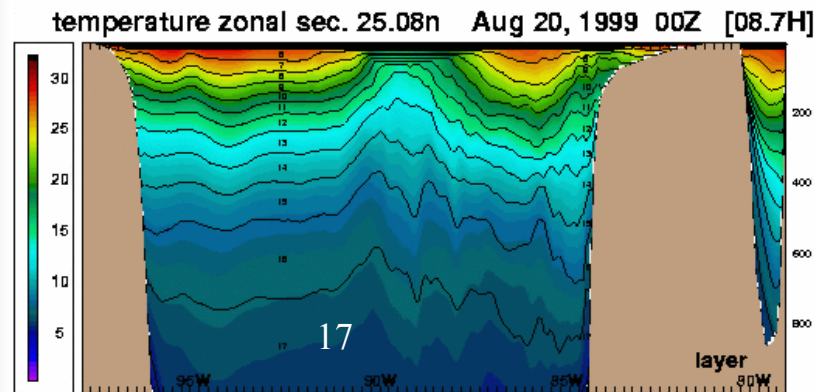
Salinity (psu)



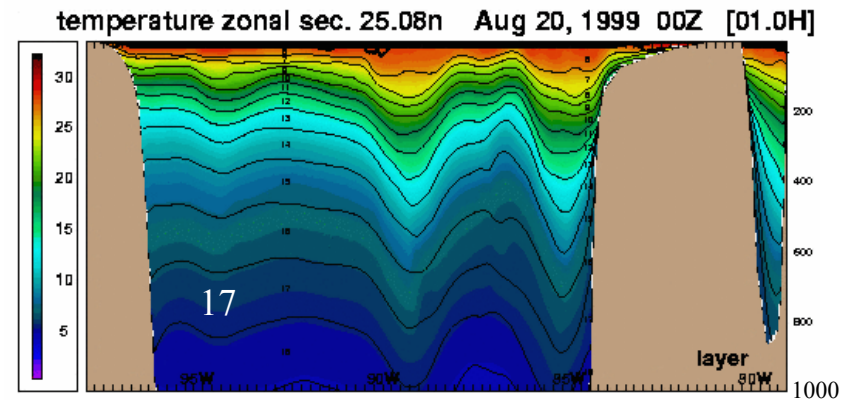
Lines are the layer interfaces

Aug 20, 1999 (after the 10th update cycle)

Daily updating



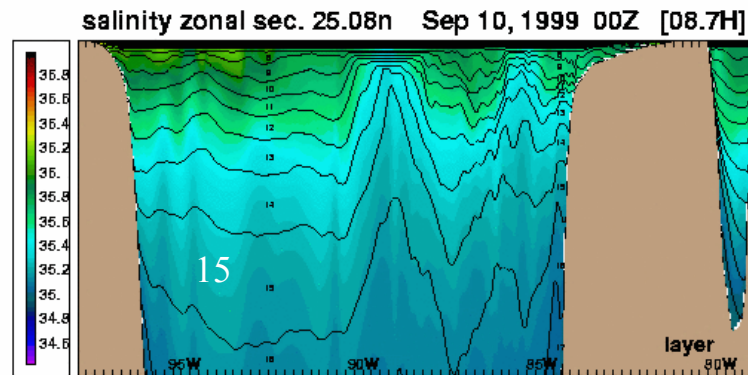
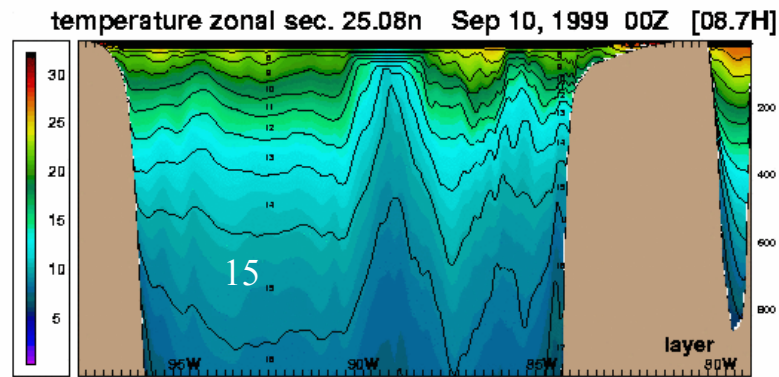
No data assimilation



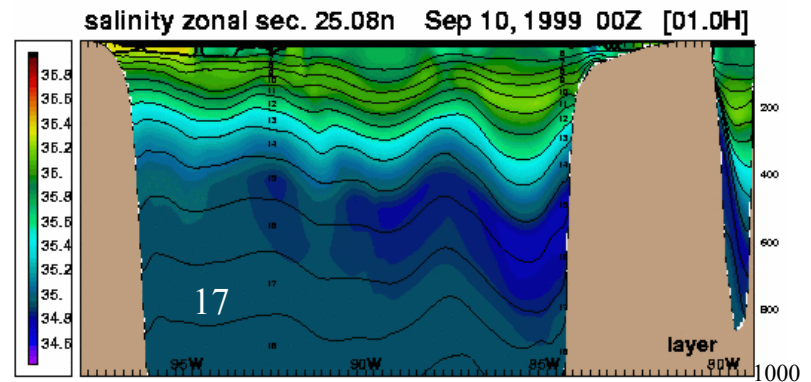
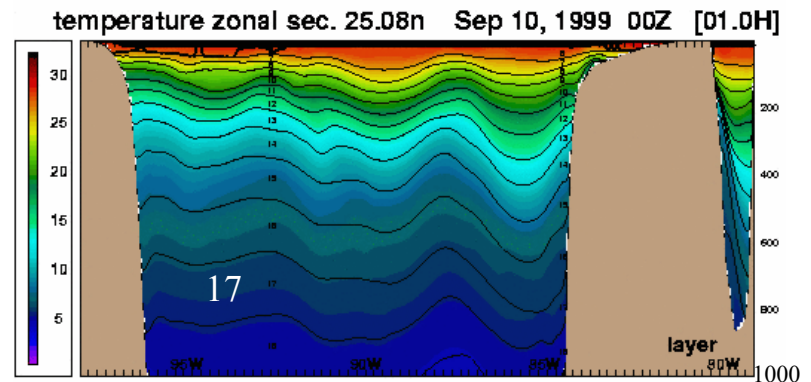
Lines are the layer interfaces 12

Sep 10, 1999 (after the 31st update cycle)

Daily updating



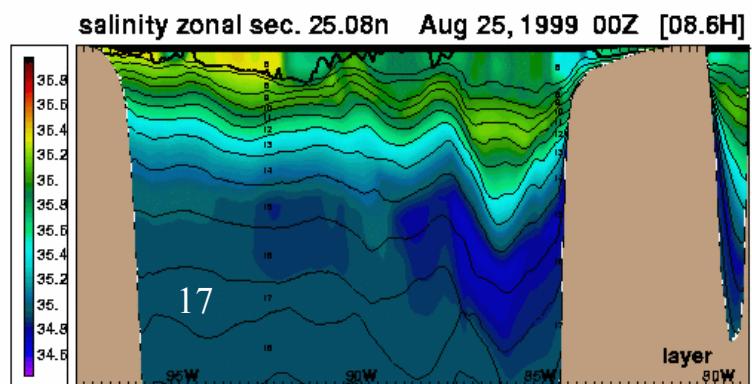
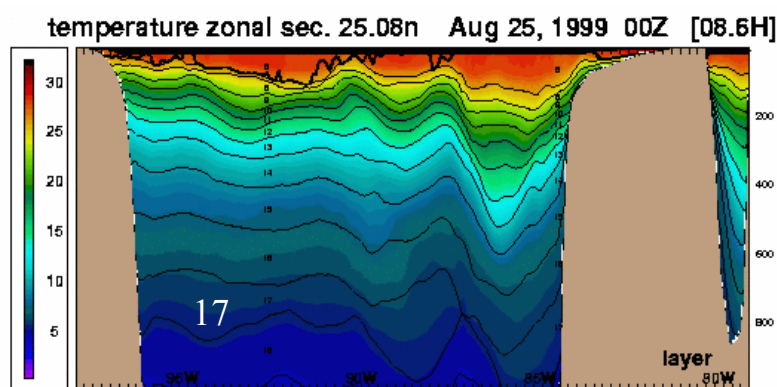
No data assimilation



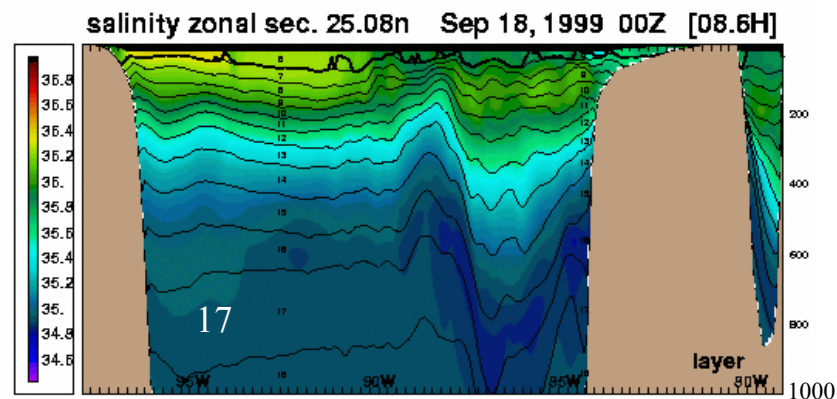
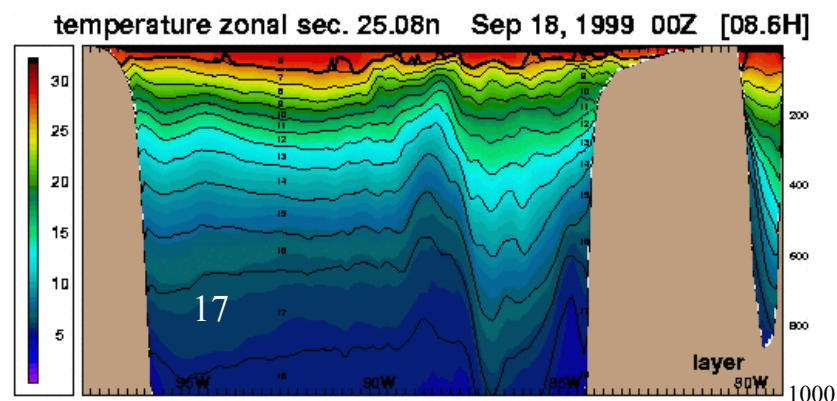
Lines are the layer interfaces

Weekly updating (restart from Aug 18, 1999)

Aug 25, 1999
(after the first update cycle)



Sep 18, 1999
(between 4 and 5 update cycles)

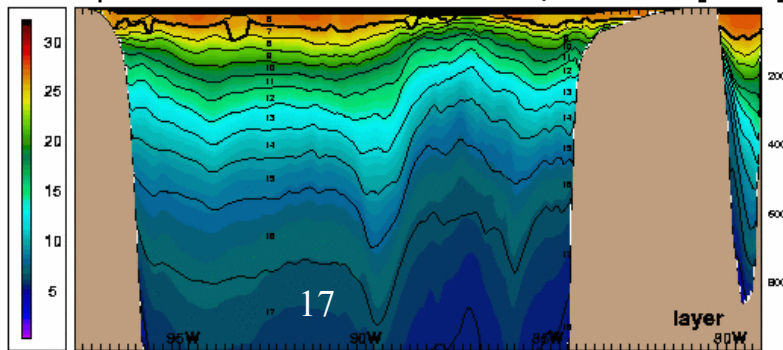


Lines are the layer interfaces

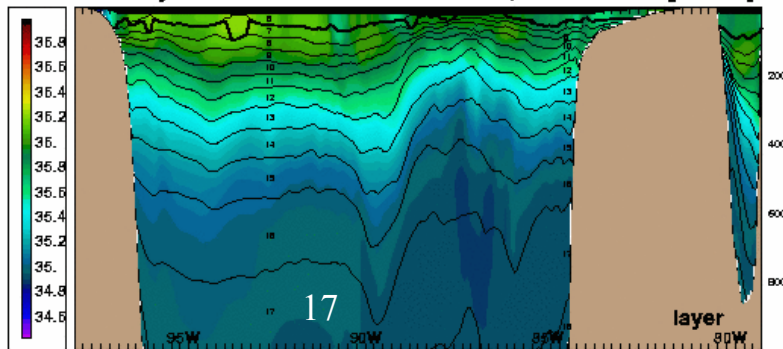
Weekly updating (restart from Aug 18, 1999)

Oct 27, 1999
(after 10 update cycle)

temperature zonal sec. 25.08n Oct 27, 1999 00Z [08.6H]

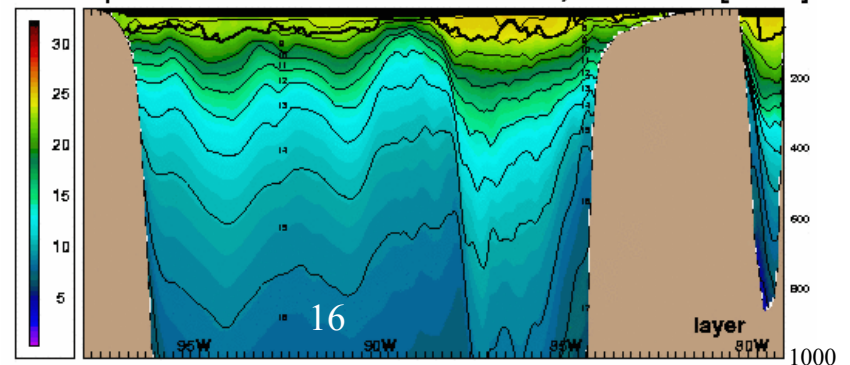


salinity zonal sec. 25.08n Oct 27, 1999 00Z [08.6H]

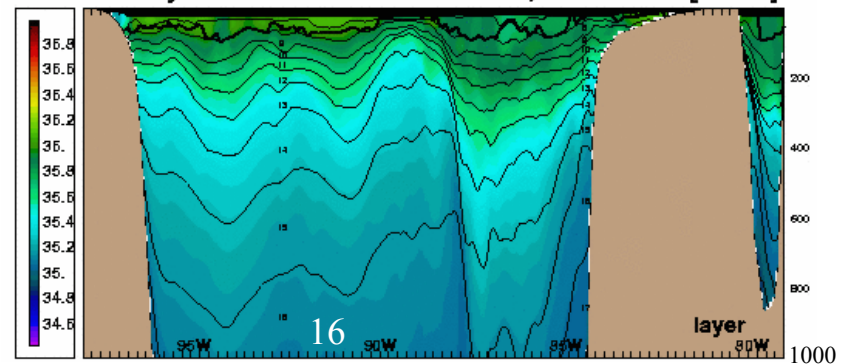


Mar 22, 2000
(after 31 update cycle)

temperature zonal sec. 25.08n Mar 22, 2000 00Z [08.6H]



salinity zonal sec. 25.08n Mar 22, 2000 00Z [08.6H]



Lines are the layer interfaces



A simple experiment:

to see what happens

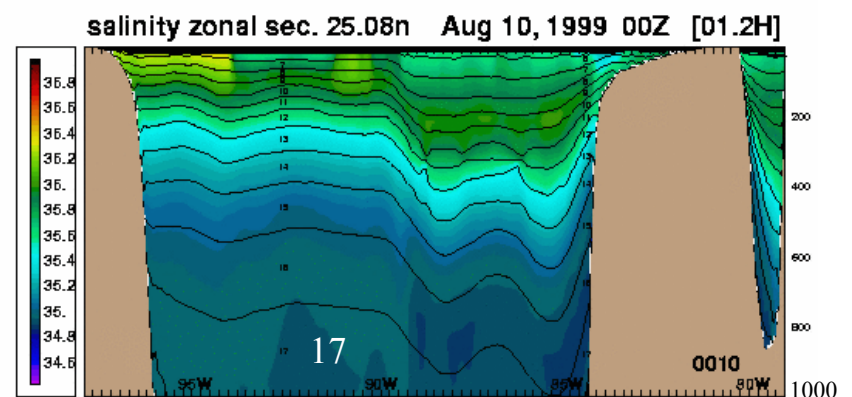
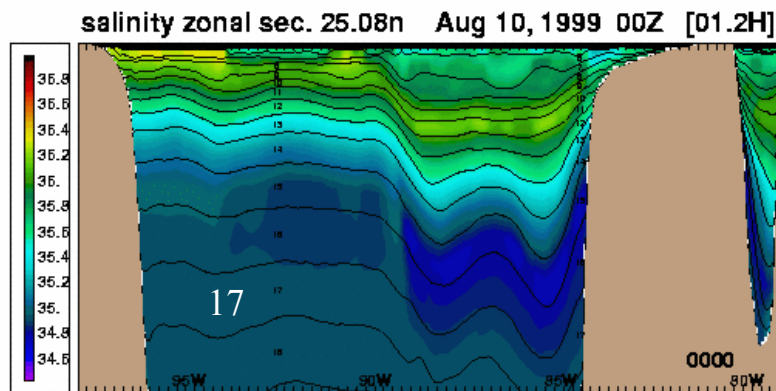
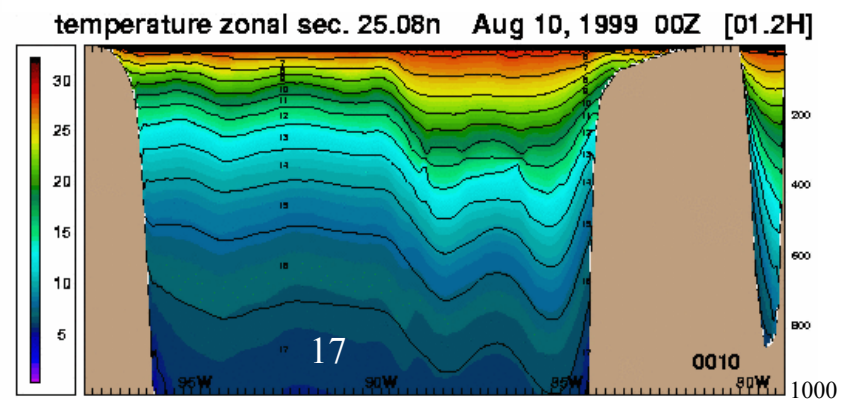
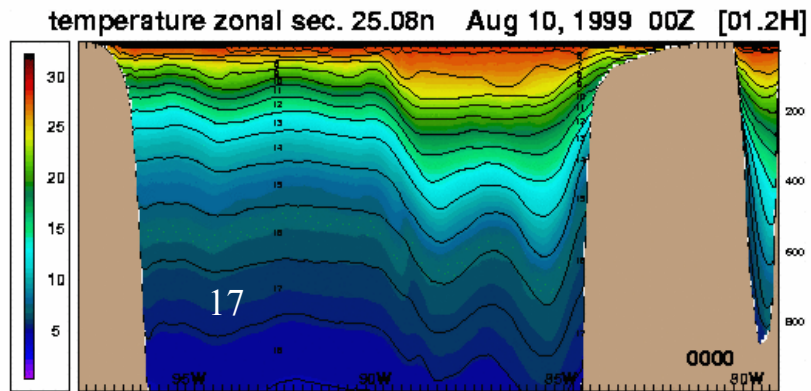
when there are no data that might change the model's state

⇒ The model running and data corrections were skipped,
focusing on transforming back and forth between
HYCOM layers and z-levels.

Because the dynamics are not changed,
ideally nothing should happen.

Initial condition

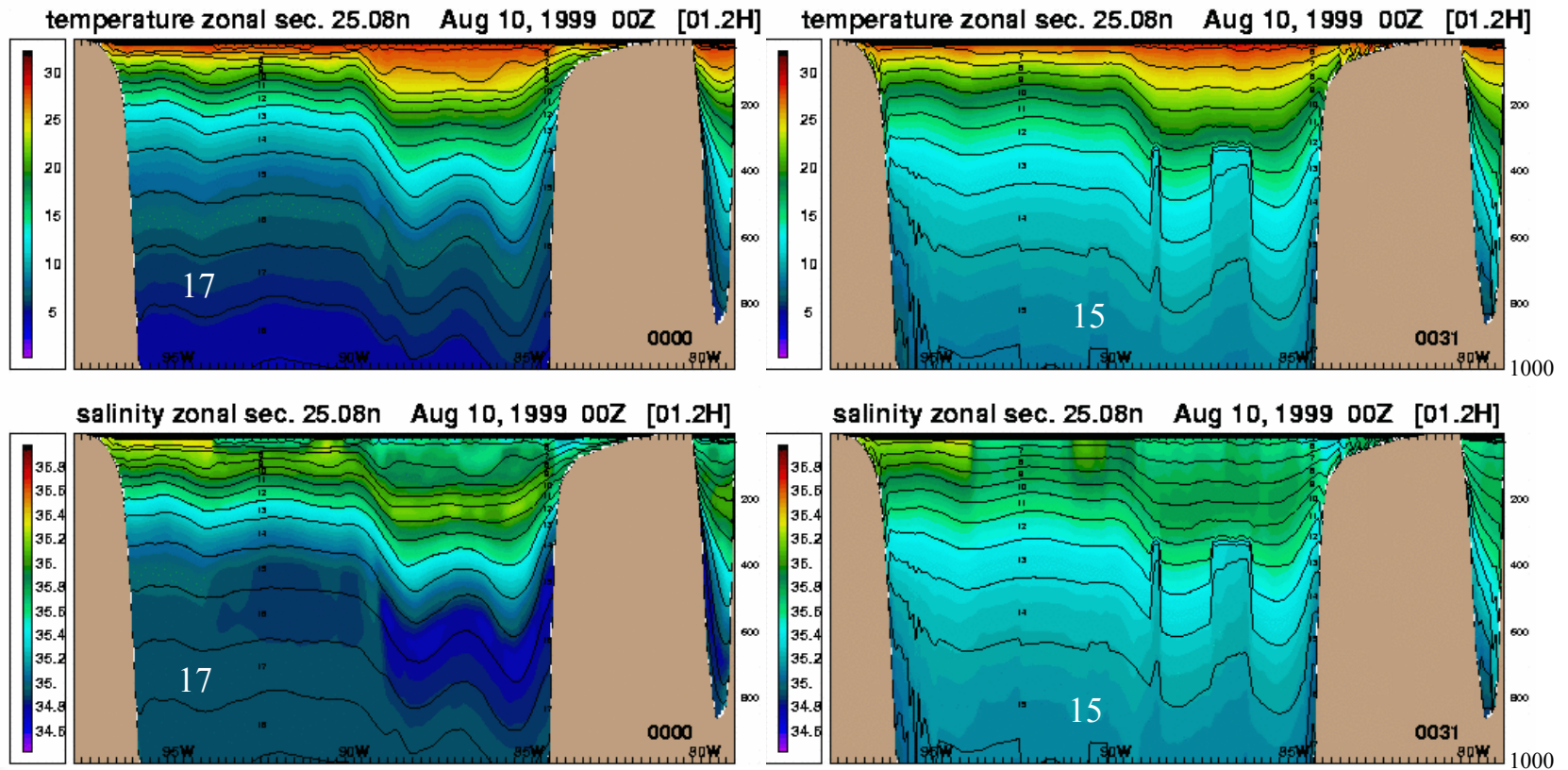
After 10 times transforming



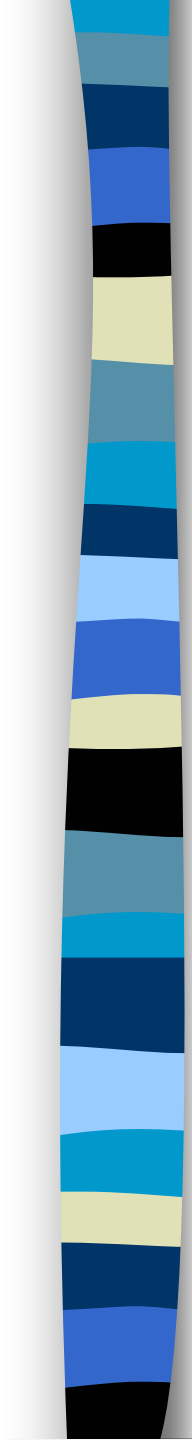
Lines are the layer interfaces 17

Initial condition

After 31 times transforming



Lines are the layer interfaces 18



Transforming back and forth repeatedly is highly diffusive and weakening the stratification at each time.

This vertical diffusion introduced by interpolation could be counteracted with the assimilated data if there are enough profiles providing information about the ocean's stratification.

However, there are very few such profiles available in the Gulf of Mexico.

Current & Future works

The vertical diffusion caused by interpolation can be avoided if the NCODA analysis is computed in HYCOM's native coordinates.
=> we come to conclude that it is time **to convert the NCODA codes to work directly with HYCOM's layers.**

Jim provided NCODA codes.

Tasks to be done :

- compile NCODA codes on a linux machine.
- understand NCODA structure.
- locate which codes to be modified.
- how to handle vertical coordinate.
- observed data to be layerized before MVOI.
- choose test datasets and test domain.

