Data assimilation in RTOFS

Carlos Lozano
MMAB/EMC/NCEP
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SST

- **Data:** AVHRR, GOES and in situ
  - GOES bias is removed

- **Algorithm:**
  - Two 2DVAR analyses: one for yesterday and one for today
  - Time interpolated temperature is nudge while integrating from yesterday to today
  - Nudge is a pseudo heat flux source/sink at the model top layer
SSH

- Data: JASON and GFO
  - AVISO is not operational

- Algorithm: 2DVAR SSH, and 1D covariance in the vertical.
  SSH = MDT + SSHA with MDT from Rio (2005).
Results from operations as well as parallel runs give higher estimates of net transport for the section Florida to Bahamas as compared to the daily cable data. The parallel run has a similar variability to the operations but better estimates of mean transport.
Low Frequency Boundary Conditions

Internal Mode:

a) **Extrapolation of velocity fluxes for advection and momentum**

b) **Relaxation of Mass Fields T, S and P (interface thickness) in the buffer zones**

\[
\begin{align*}
T^k_{t+1} &= T^k_t + \Delta t \mu (\theta^k_t - T^k_t) \\
S^k_{t+1} &= S^k_t + \Delta t \mu (\theta^k_t - S^k_t) \\
P^k_{t+1} &= P^k_t + \Delta t \mu (\theta^k_t - P^k_t)
\end{align*}
\]

where \( \theta \) represents a slowly varying estimate (here, climatology), \( k \) is the layer and \( \mu^{-1} \) is the relaxation time scale.

The width of buffer zones and values of \( \mu^{-1} \) are defined a priori.
Low Frequency Boundary Conditions

External Mode:

**Normal transports and elevations determined from T,S climatology and Mean Dynamic Topography using:**

a) Thermal wind relations
b) Absolute geostrophic velocity determined by either
   i) assuming a level of no motion, or
   ii) constrained by the slope of mean sea surface elevation, MDT, from Maximenko, Niiler, McWilliams (GJR,2005).

   c) The mean of mean sea level is taken from MDT.
Low Frequency Boundary Conditions

Data assimilation modulates directly the low frequency mass field and sea surface height:

a) SST: mixed layer
b) SSH: water column and SSH
c) CTD: water column and SSH

But; there is no feedback...
Large scale

- Large scales $O(>500\text{km})$ are well resolved by observations.
- Internal dynamics at the mesoscale is influenced/modulated by the ambient potential vorticity.
- Are we introducing the large scales correctly in the assimilation?
Three simulations (from Jan 1 to March 31 2007)
- Central: No assimilation (*)
- With SST assimilation
- With SST & SSH assimilation

Model parameters and forcing nearly identical to those used in operations
Remark

The large scale estimates derived from the model and from the combination of model and data assimilation require improvements in some geographical areas (of practical interest).

- Model
- Data
- Data assimilation