Sensitivity experiments with HYCOM-CICE during the CORE-II project

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Experimental setup

REF : HYCOM-CICE forced with CORE-II Atmospheric forcing from 1948 to 2007 (1st Cycle)
- Initialization from rest with Levitus PHC2.1
- Normalization of the salt flux at the surface
- Bulk Formulation : Large and Yeager
- Thermobaric corrections
- Sigma-2 vertical coordinates
- SSS-relaxation: 4 year/50m everywhere except Southern Ocean at 6 months/50m

No Tbaric : REF + No thermobaric corrections
Kara : REF + Kara bulk formulation
Sigma-1: REF + sigma-1 + 4 year/50m SSS relaxaltion everywhere
SO Weak Relax : REF + 4 year/50m SSS relaxation everywhere

Bulk formulation comparison: Kara vs. Large and Yeager

- Kara's SST 0.1ºC warmer than REF leading to higher increase of the global temperature (Fig. 1).
- Warmer and saltier bias in North Polar Gyre than REF but ~ same density bias (Fig. 4).
- Stronger wind-stress in North Atlantic and slightly stronger heat loss over the Labrador Sea in Kara than in REF (Fig. 3).
- Deeper Mixed Layer Depth (between 2000-2400 m) in Kara in Labrador Sea (Fig. 5).
- Stronger AMOC at 26.5ºN and 41.5ºN in Kara (14 Sv in Kara vs. 12 Sv in REF at 26.5ºN) (Fig. 6).

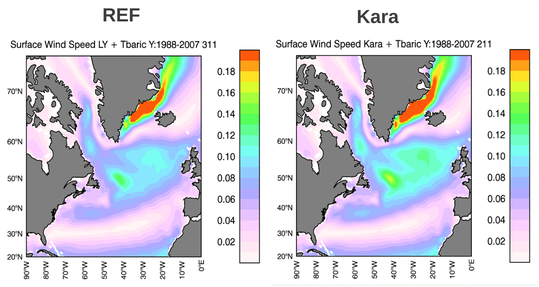

Fig. 3: Surface wind-stress in North Atlantic average over 1988-2007 (N/m²).

Thermobaricity comparison: No Tbaric vs. Tbaric

- Decrease of global temperature in No Tbaric (Fig. 1).
- Warmer and saltier bias in North Polar Gyre in No Tbaric than in REF but ~ same density bias (Fig. 4).
- Stronger heat loss over the Labrador Sea in No Tbaric (Fig. 2).
- Deeper Mixed Layer Depth (between 2400-3000 m) in No Tbaric in Labrador Sea than in REF (Fig.5).
- Stronger AMOC at 26.5ºN and 41.5ºN in No Tbaric (18 Sv in No Tbaric vs. 12 Sv in REF at 26.5ºN) (Fig. 6).
- Less ice in Southern Ocean with No Tbaric (ice cover maintained by a 6 months/50m SSS relaxation) (Fig. 7).
- Stronger Drake passage transport in No Tbaric than in REF (Fig. 8).

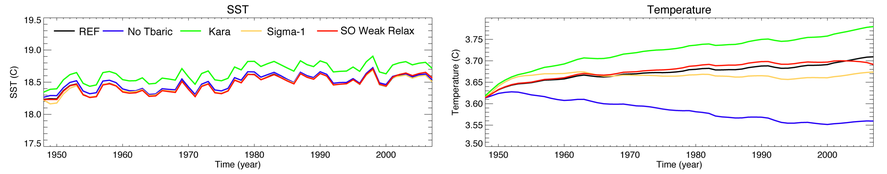

Fig. 1: (left) Sea surface temperature, (right) global temperature.

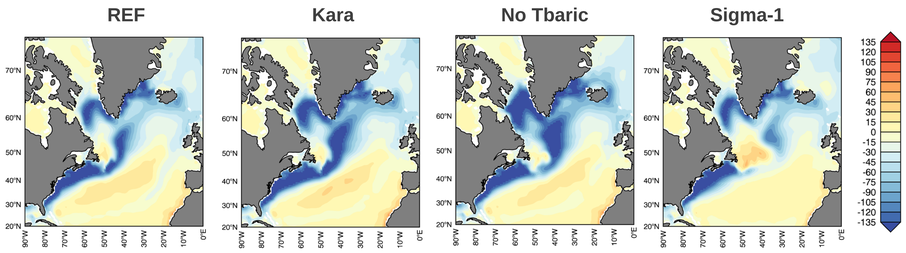

Fig. 2: Surface heat flux in North Atlantic average over 1988-2007 (W/m²).

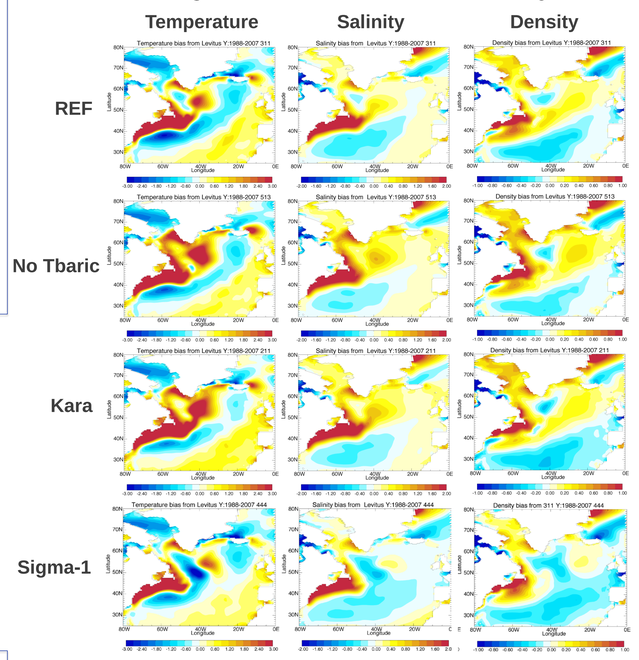

Fig. 4: (left) Surface temperature bias from Levitus, (middle) surface salinity bias, (right) surface density bias, averaged over 1988-2007.

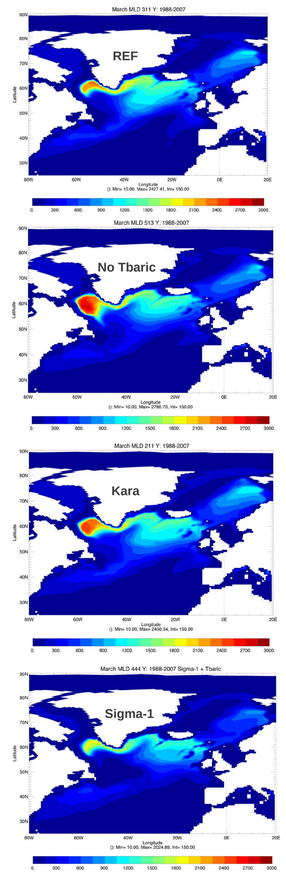

Fig. 5: March mixed layer depth averaged over 1988-2007.

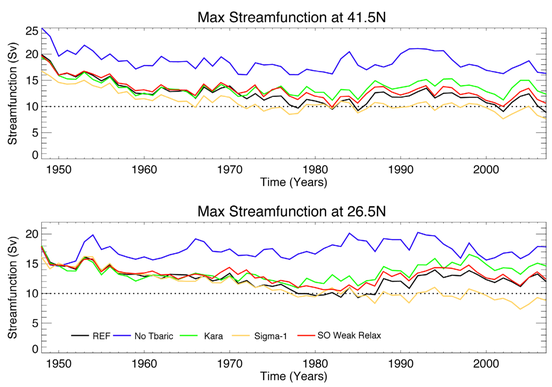

Fig. 6: Maximum streamfunction (top) at 41.5ºN, (bottom) at 26.5ºN.

Vertical coordinate comparison: sigma-1 vs. sigma-2

- Lower increase of global temperature in sigma-1 (Fig. 1).
- Cooler and fresher bias in North Polar Gyre in sigma-1 than REF leading to fresher density bias (Fig. 4).
- Lower heat loss in Labrador Sea in sigma-1 than in REF (Fig. 2).
- Lower Mixed Layer Depth (between 1500-1800 m) in Labrador Sea in sigma-1 than in REF (Fig. 5).
- Lower AMOC at 26.5ºN and 41.5ºN in sigma-1 (9 Sv in sigma-1 vs. 12 Sv in REF at 26.5ºN) (Fig. 6).
- More ice in the Weddell Sea in sigma-1 (despite a weaker SSS relaxation) (Fig. 7).

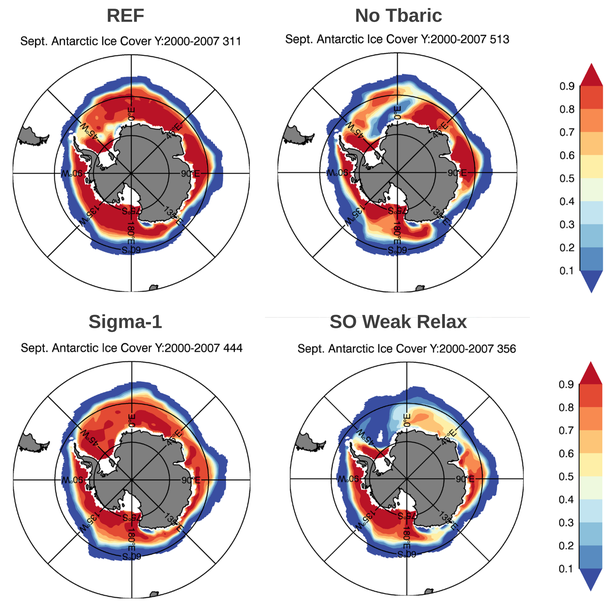

Fig. 7: Ice cover extent in September averaged over 2000-2007.

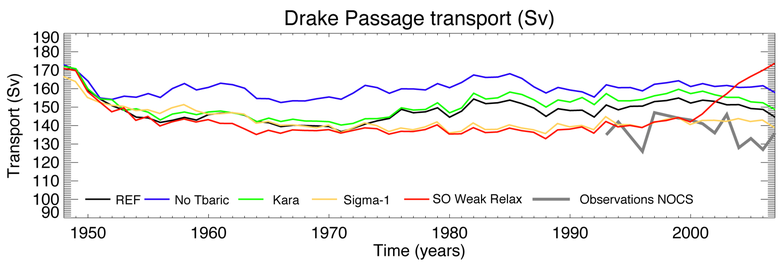

Fig. 8: Evolution of the Drake Passage transport.

SSS relaxation over the Southern Ocean: Weak Relax vs Strong Relax

- Loss of half of the ice in the Southern Ocean in the last 10 years in SO Weak Relax (Fig. 7).
- Drastic increase of the Drake passage transport following the loss of the ice in SO Weak Relax (175 Sv in SO Weak Relax vs. 145 Sv in REF) (Fig. 8).