

Notes on GIGATL6 tests

September 7, 2022

1 Kinetic Energy

Problem is that GIGATL simulations have low EKE and mean currents in the Gulf Stream region (see Fig. 1) compared to previous generation of simulations (RATLBIG). The question is why!

Differences between RATLBIG and GIGATL6 include:

| | RATLBIG | GIGATL6 |
|------------------|---|------------------------------|
| vertical mixing | KPP | GLS |
| bottom drag | LIMIT_BSTRESS | BSTRESS_FAST |
| | | PSOURCE_NCFILE |
| | | CROCO_QH |
| Surface forcings | Monthly clim. | hourly CFSR with online BULK |
| Winds | daily clim wind stress | hourly CFSR with online BULK |
| Current feedback | | SMFLUX_CFB |
| BRY | SODA clim | SODA inter. |
| Topo | atlbigrd SRTM30 masked Hudson Bay | gigatl6 grd SRTM30 plus |
| θ_s | 7 | 5 |

- Hypothesis 1: Is it a problem with the recent version of CROCO? Rerunning RATLBIG with the latest CROCO (2021) gives qualitatively the same results (Fig. 2).

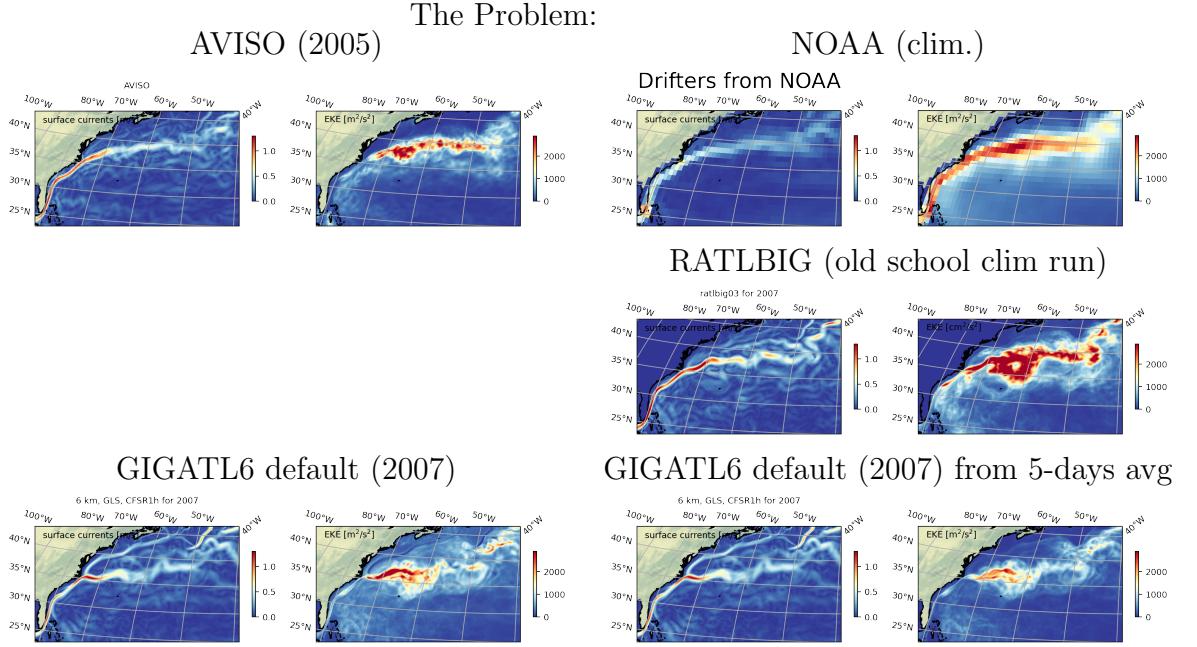


Figure 1: Problem with default GIGATL6

- Hypothesis 2: KPP versus GLS? No differences for GIGATL with KPP or GLS (Fig. 3).
- Hypothesis 3: Wind forcing and current feedback? A little bit more EKE when turning off CFB but does not explain all differences. (Fig. 4). Changing the wind frequency also do not change significantly the result.
- Hypothesis 4: Other differences in the numerical options (BSTRESS_FAST, PSOURCE, CROCO_QH)? (Fig. 5).
- Hypothesis 5: Differences due to interannual BRY (instead of climatological) and vertical grid? Only small differences for RATLBIG (Fig. 6).
- Hypothesis 6: Differences due to topography and mask? The main difference in the mask is the presence of Hudson bay. It seems to make a big difference for EKE, mean currents, as well as SST and SSS anomalies (Fig. 7).
- Answer: The difference with/without Hudson Bay is in fact due to a problem with the SODAINI and BRY that were used to force GIGATL runs (soda version 2.2.4). In this earlier version, there was no data in this area before 2012, such that data used to generate BRY/INI were extrapolated from re-

code: old versus new

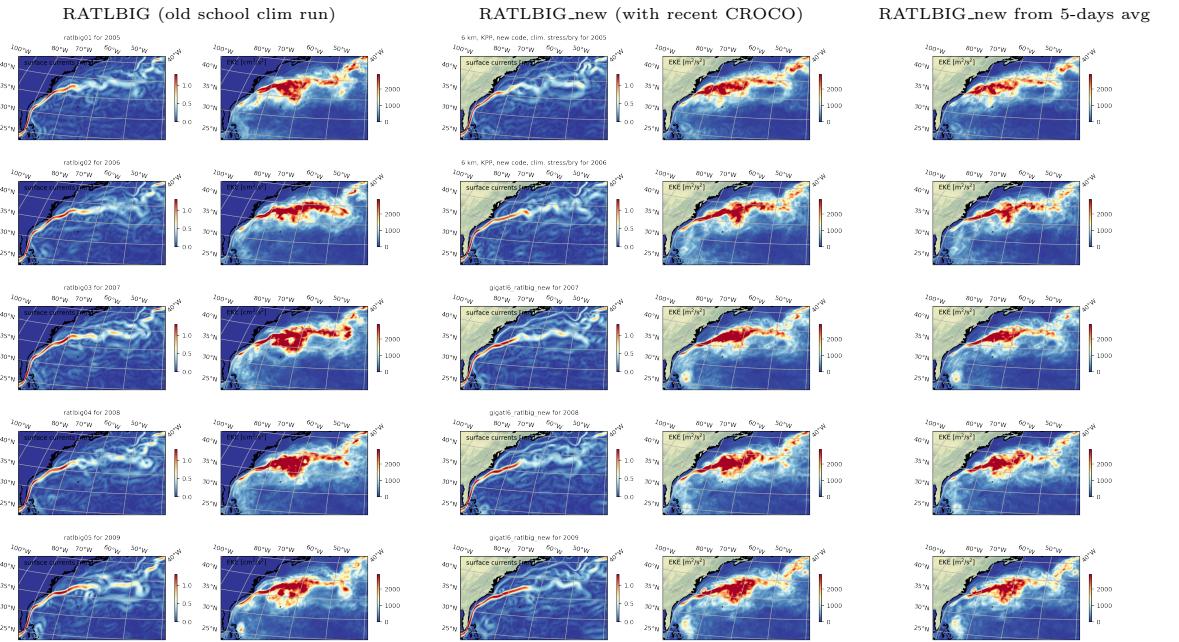


Figure 2: Old code (left) versus new code (right) for RATLBIG. Also note that RATLBIG EKE is computed from 12 hours snapshots, compared to online averages or 5-day averages for RATLBIG_new.

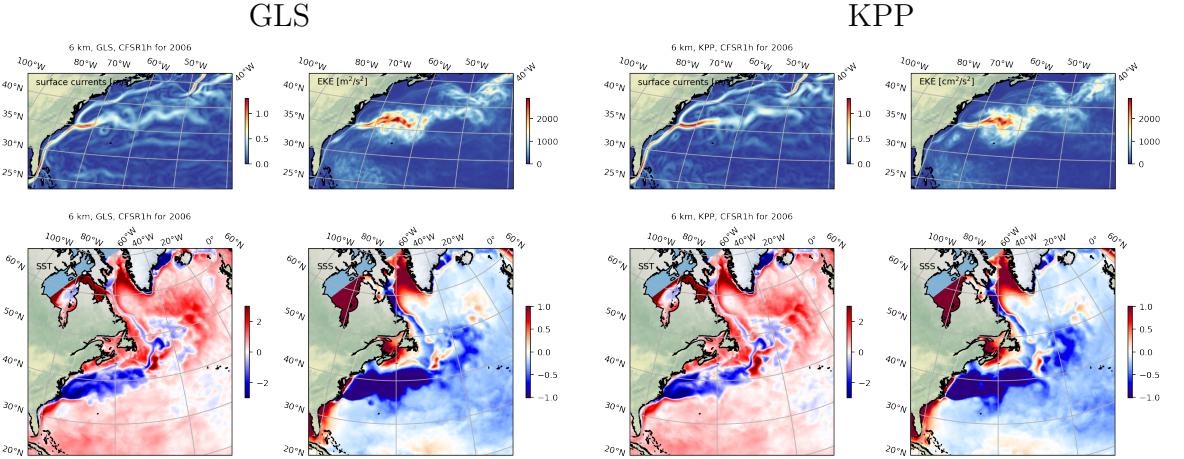


Figure 3: GIGATL6 (from 5 days avg) with GLS or KPP

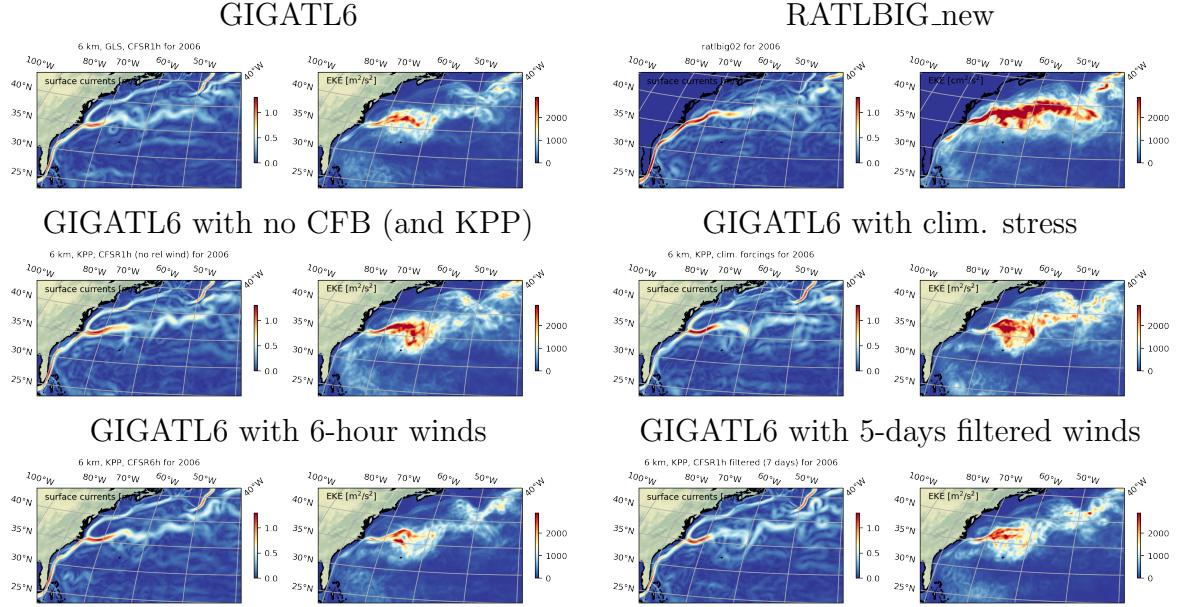


Figure 4: GIGATL6 (from 5 days avg) with different wind forcings

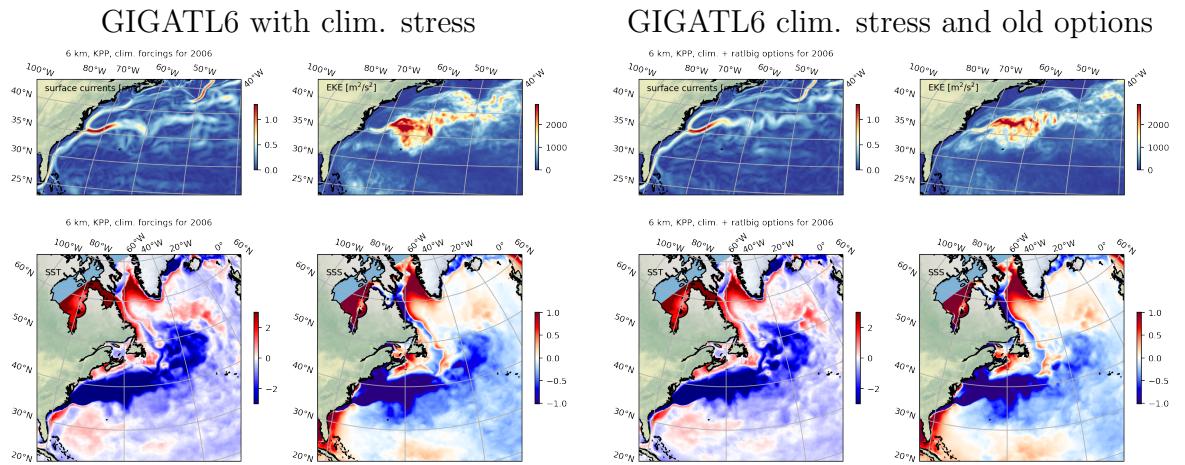
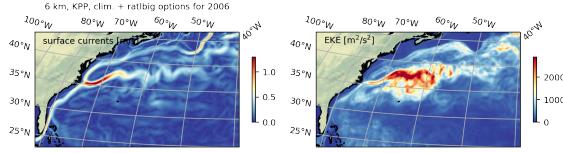
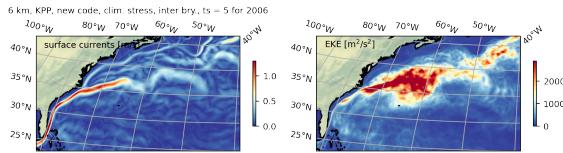


Figure 5: GIGATL6 (from 5 days avg) with daily wind stress using new (left) or old options (right).

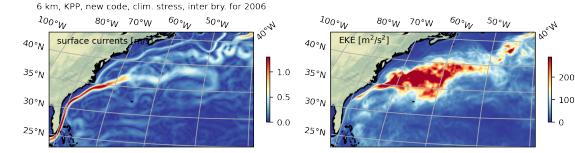
GIGATL6 clim. stress and old options



RATLBIG with inter. bry and $\theta_s = 5$



RATLBIG with inter. bry



RATLBIG with inter. bry, $\theta_s = 5$, and online bulk

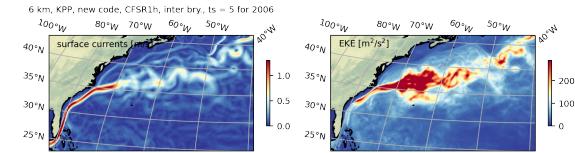


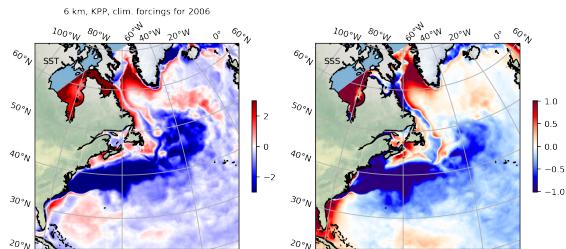
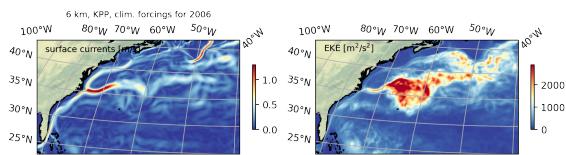
Figure 6: GIGATL6 with daily wind stress and old options (a) compared with RATLBIG with interannual BRY, interannual BRY and $\theta_s = 5$, and online BULK.

mote locations, leading to too warm and salty water in this area, leading to significant biases in the gyres and stabilizing the Gulf Stream. Rerunning the original GIGATL with a more recent SODA version (3.4.2) has the same effect than removing Hudson Bay (Fig. 9).

Various tests are summarized on Figures 10 and 11 .

Additional sensitivity tests with a different value for surface salinity restoring ($dSdt=10$ days instead of 30 days), and a different value of bottom roughness (with $Zob = 1e-3$ m instead of $1e-2$ m) are also shown in Fig. 10.

GIGATL6 clim. stress, new options



same with no Hudson Bay

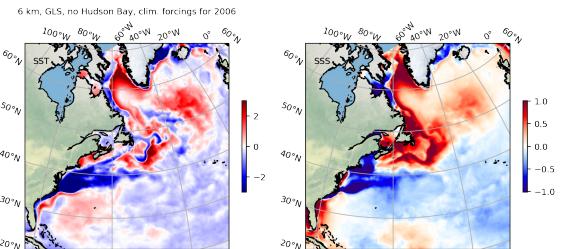
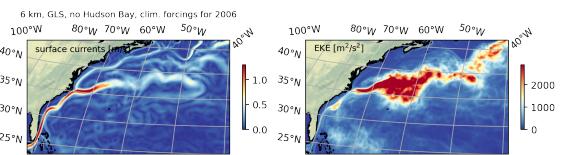
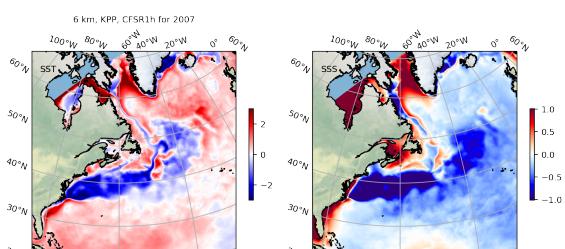
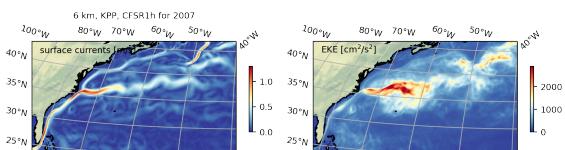
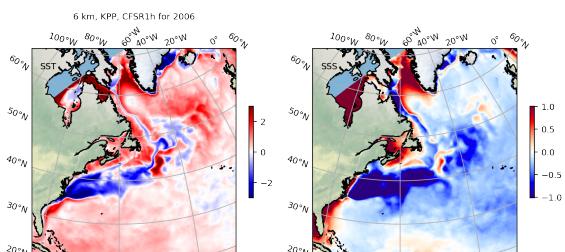
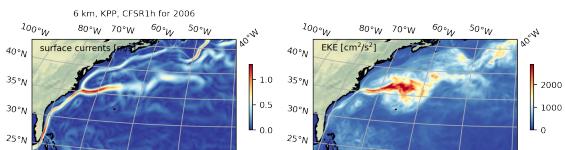
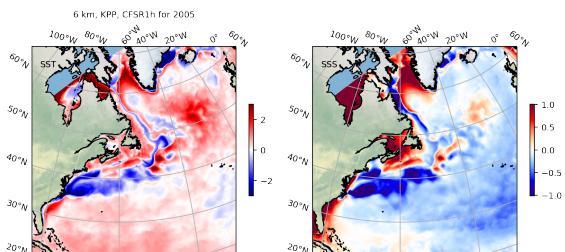
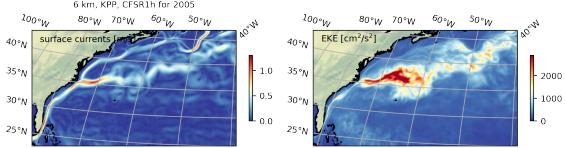


Figure 7: GIGATL6 with daily wind stress with or without Hudson Bay.

GIGATL with



or without Hudson Bay

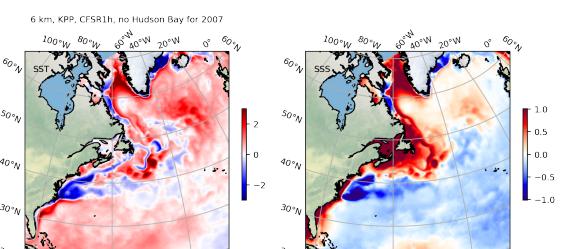
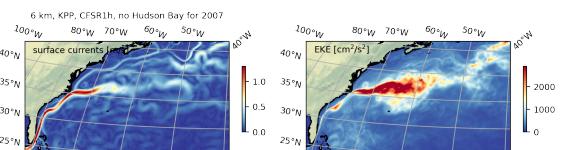
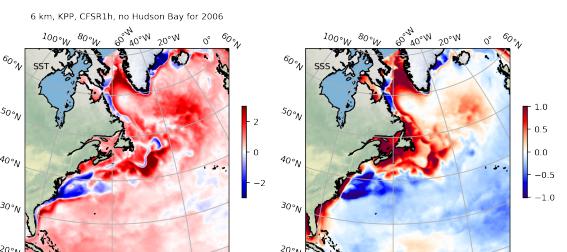
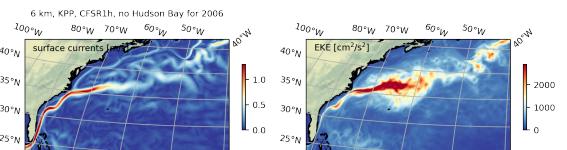
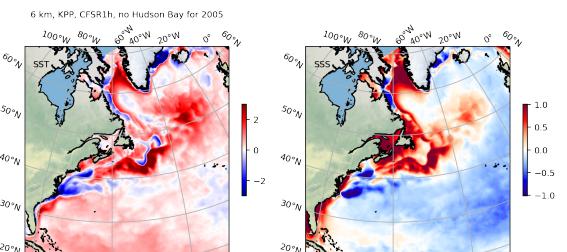
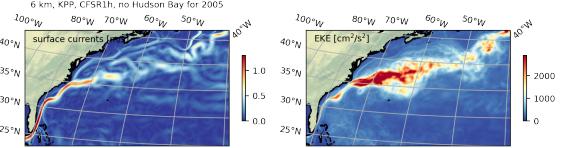
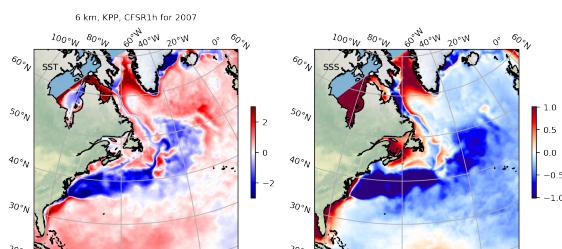
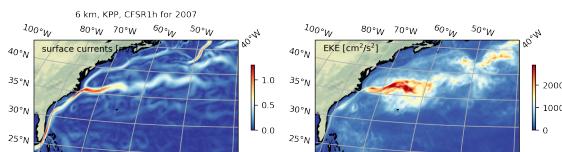
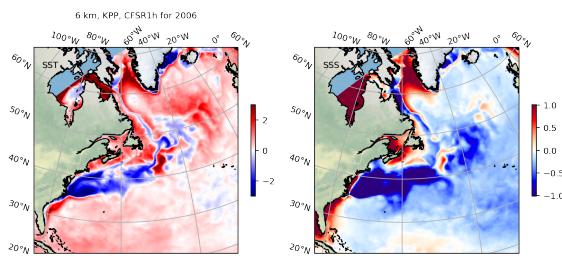
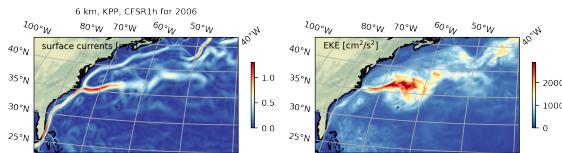
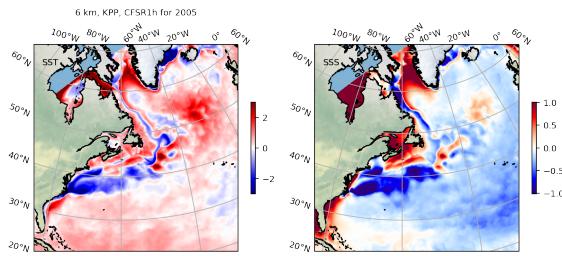
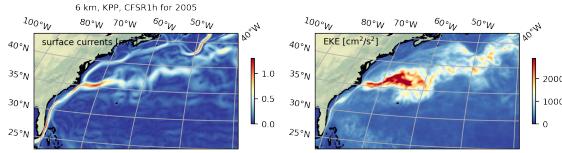


Figure 8: GIGATL6 with hourly CFSR with or without Hudson Bay.

GIGATL with soda 224



soda 342

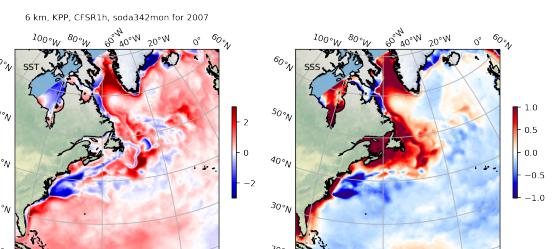
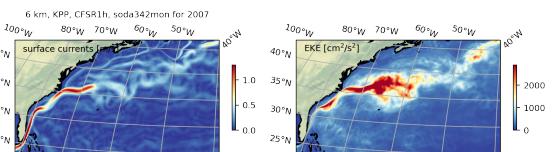
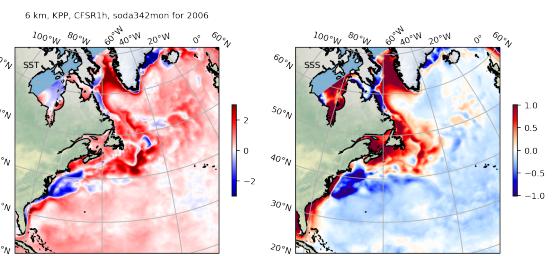
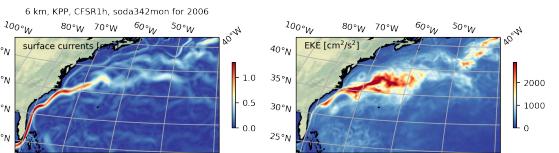
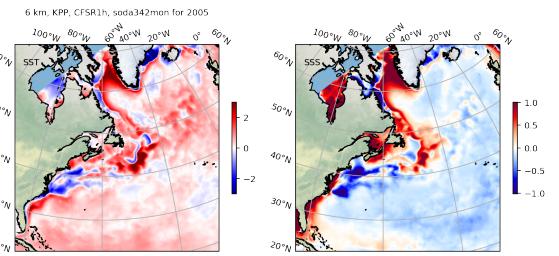
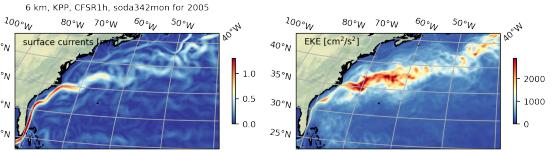


Figure 9: GIGATL6 (with KPP) with soda 2.2.4 (left) or soda 3.4.2. (right)

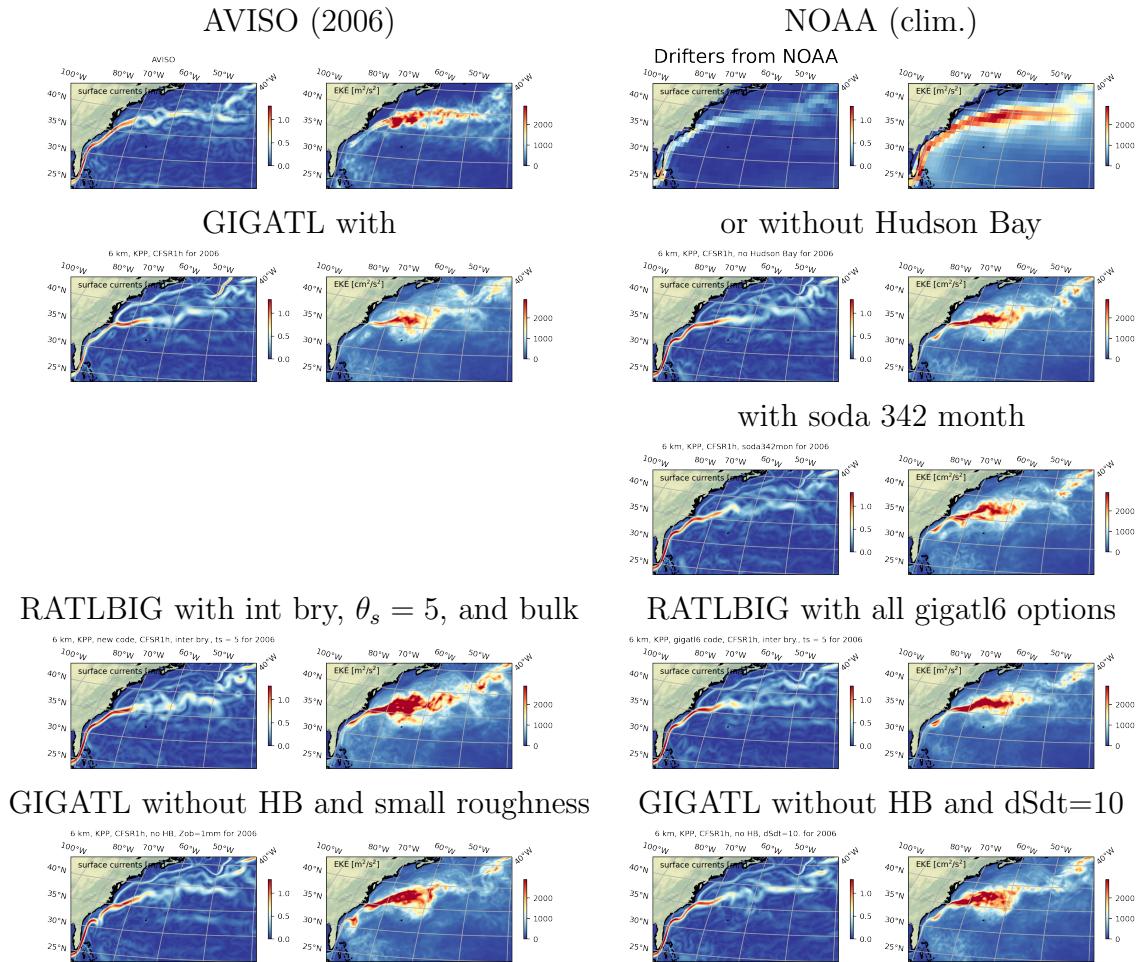


Figure 10: MKE and EKE from various datasets.

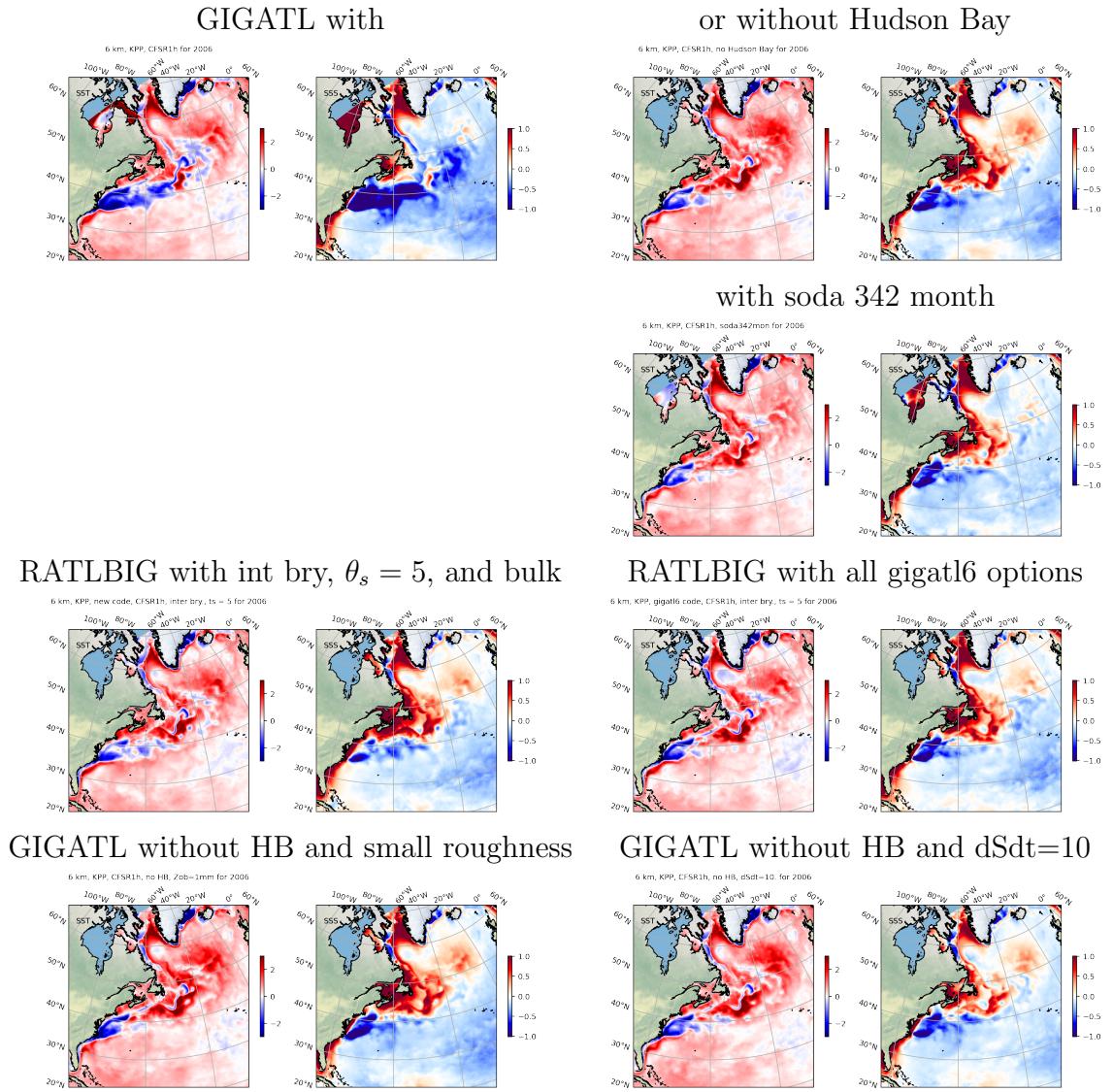


Figure 11: .