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PRIMAVERA: High-Resolution Climate Processes: Benefits of locally refined ocean resolution

The AWI-Climate Model (AWI-CM)

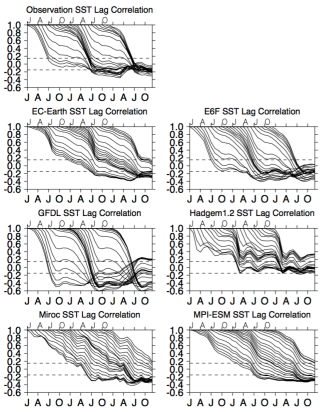
- ECHAM6 (Max Planck Institute) – FESOM (AWI)
- The ocean component FESOM supports *unstructured mesh*
- High resolution possible in dynamically active regions; in other regions such as subtropical regions low resolution to save computing time

Hierarchy of model grids

- Sidorenko et al. (2016), Rackow et al. (2016): Even in coarse REF87K ocean resolution (Fig. 2) and coarse T63 atmospheric resolution our model is as good as state-of-the-art CMIP5 models

***Fig. 1**: Niño 3.4 SST Lagged correlation (persistence) for observation and six models. Each curve is shifted with the starting month (at the top) with the corresponding lead time (x-axis), and the 12 curves have been repeated for clarity. JAJO represents January, April, July and October.*

Figure from Hangyue Li's master thesis



nodes
87,000
127,000
810,000
831,000
1,307,000

- Eddy-resolving in key ocean areas (**1/12°** corresponding to 9-10km) to reduce long-standing biases, specifically the deep (~1000m) biases in the North Atlantic

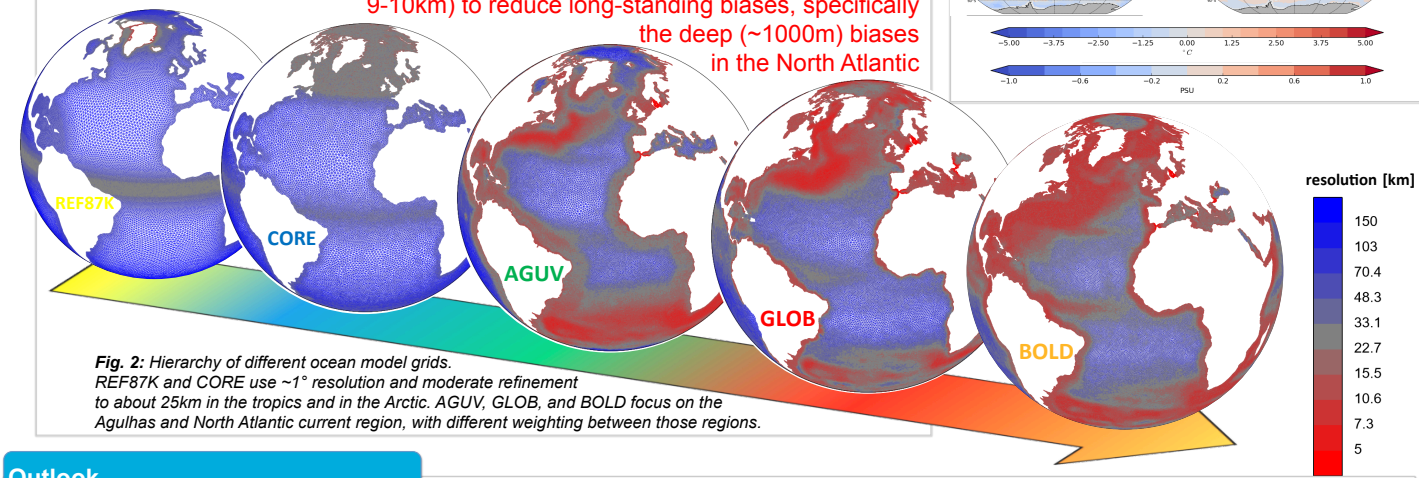


***Fig. 2:** Hierarchy of different ocean model grids. REF87K and CORE use ~1° resolution and moderate refinement to about 25km in the tropics and in the Arctic. AGUV, GLOB, and BOLD focus on the Agulhas and North Atlantic current region, with different weighting between those regions.*

Deep ocean bias reduction

- Improvements with increasing resolution in North Atlantic deep-ocean temperature

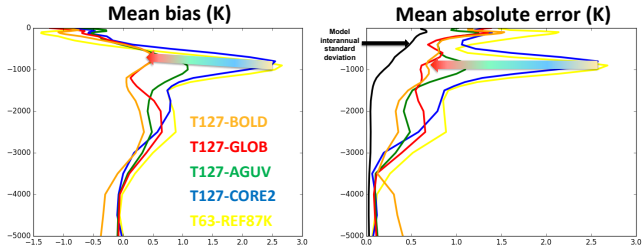
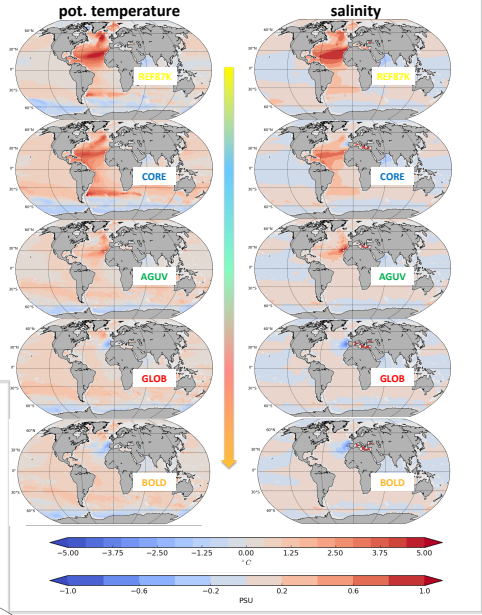


***Fig. 3:** Profiles of potential temperature for years 71—100 of the pre-industrial simulations. Shown is the difference and the mean absolute error to the WOA2005 climatology.*

***Fig. 4:** Difference of **(left)** potential temperature and **(right)** salinity at 1000m to the WOA2005 climatology. The years 91-100 are used. The North Atlantic biases identified in the benchmark version of AWI-CM successively decrease with increasing spatial resolution.*



Outlook

- FESOM2 (finite volume discretisation) is ~3 times faster than FESOM 1.4: test phase
- KPP ocean mixing scheme further improves bias compared to PP scheme (ongoing tests)
- Flagship simulations for PRIMAVERA: On BOLD mesh, T127 atmosphere
- Frontier simulations for PRIMAVERA: 6 Million surface node mesh, T255 atmosphere

Systematic study of mesh resolution planned: very high resolution as reference; local coarsening

References:
- **Sidorenko, D. , Rackow, T. et al. (2015)**: Towards multi-resolution global climate modeling with ECHAM6-FESOM. Part I: model formulation and mean climate. *Clim. Dyn. Vol. 44, Issue 3, pp 757—780 , doi:* 10.1007/s00382-014-2290-6
- **Rackow, T. et al. (2016)**: Towards multi-resolution global climate modeling with ECHAM6-FESOM. Part II: climate variability. *Clim. Dyn., doi:* 10.1007/s00382-016-3192-6

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