WGOMD Workshop on High Resolution Ocean Climate Modeling
Session 2: Ongoing work – State-of-the-Art Simulations
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Current efforts of ocean-climate modeling using high-resolution ocean models in JMA/MRI

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1. Very brief summary of high-resolution simulations at JMA/MRI

Three model configurations, all based on the nominal 1-degree model used for CMIP5/COREs (MRI.COM)

I. Nesting 10 km resolution two regional models (subtropical North Atlantic and Pacific Ocean) for the Global Ocean

- An optional oceanic component for CMIP6
- Technique may be applicable to other regions that need high-resolution

II. Hierarchically nesting 10 km and 2 km models in the western North Pacific Ocean

- Downscaling toward Japan (designed as an operational system)
- Submesoscale processes in 2km model are also of scientific interest

III. 10 km resolution global ocean model

- Oceanic component for post CMIP6 (currently forced by COREs)
  (Our intention is to "skip" the 20 km resolution)

2. To what scientific questions are our high-resolution simulations applied?

General

- Impacts of mid-latitude Jets and Fronts on reproducibility of modeled climate
- Impacts of well resolved passage flow/transport (Indonesia, Florida, etc.) on regional/global climate
- Role of mesoscale eddies on energetics and quasi-steady balance of the global ocean

Regional (around Japan / North Pacific Ocean)

- Long-term variation of the Kuroshio path bimodality south of Japan
  … Is it affected by large-scale climate variability?
- Mechanism of formation and variability of Jets and Fronts in the Kuroshio/Oyashio extension region in the western North Pacific

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3. The main challenges we see to progress in high-resolution modeling

Improvement in the representation of marginal seas and boundary regions

- Level of requirement on realism is getting high
- Additional processes in the coastal region: Explicit inclusion of tides and/or appropriate parameterization for tidal mixing on the shelf seas will be necessary

Appropriate choices of SGS mixing parameterization, advection schemes (tracer and momentum), and forcing methods

- Our current choice: Prather SOM scheme for tracer advection, Arakawa Jacobian (B-grid), bi-harmonic Smagorinsky-like viscosity, GLS turbulence closure, parameterization of background vertical mixing due to breaking of internal waves / tides
- Sensitivity to the choice of “relative” or “absolute” wind for surface stress

Technical issues: Optimization of algorisms and data transfer between MPI processes, robust nesting method, etc.

4. A list of the questions we would like discussed during the meeting

- Do features of the modeled climate modified in general manners when the oceanic fronts and eddies are resolved?
  - We are particularly interested in the impacts of mid-latitude jets, fronts, and western boundary currents on overall representation of climate
  - Do we really need to increase the resolution globally?
- What is the most appropriate horizontal viscosity parameterizations for realistic high resolution models?
  - Should mesoscale / sub-mesoscale eddy resolving models take different approach?
  - Side boundary conditions (slip/no-slip)
  - Drag effect of wind stress on mesoscale eddies may be comparable to that of horizontal viscosity parameterizations
- How do sub-mesoscale processes affect the climate system?
  - Is it enough to parameterize them in the mesoscale eddy resolving ocean models?
  - Or should we eventually step into "sub-mesoscale resolving global model" in the near future?