Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009

The GFDL Modular Ocean Model (MOM)

Presented by

Stephen Griffies

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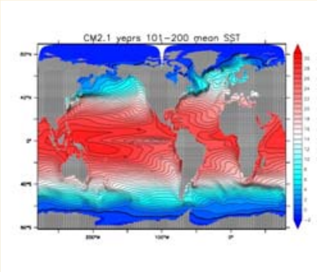
Characteristics of MOM

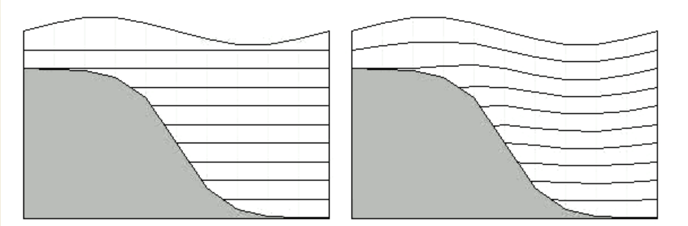
- **Hydrostatic primitive equation ocean code:**
  - Primarily for ocean climate science
  - Growing regional and coastal applications
  - With mass conserving (non-Boussinesq) formulation
  - A community code freely available under GNU public license
- **The world's primary community ocean code:**
  - There are ~500 registered users of MOM4
  - Hundreds (thousands) of people use (used) earlier MOMs
- **GFDL's role in the MOM Project:**
  - Intellectual vision for evolution; software; documentation
  - Coordination of contributions from broad range of collaborators

Key NOAA Applications of MOM4

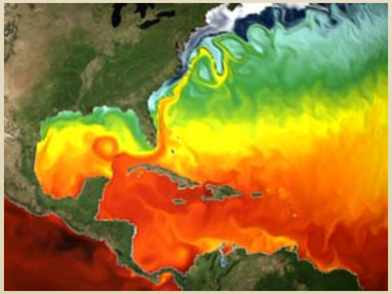
- AR4 Climate Models CM2.0/CM2.1



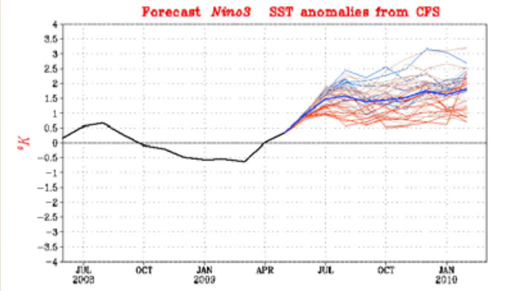
- AR5 Climate/Earth System Models CM2M/ESM2M



- AR5 Decadal Variability/Prediction CM2.1/CM2.4



- NCEP Climate Forecast System v2

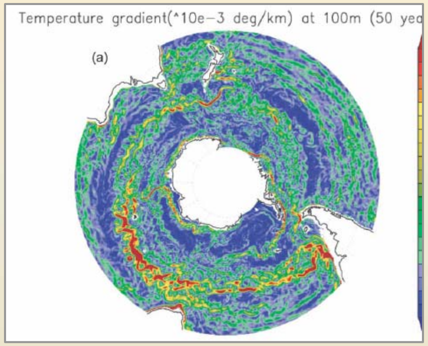


Evolution of CM2.1 to CM2M

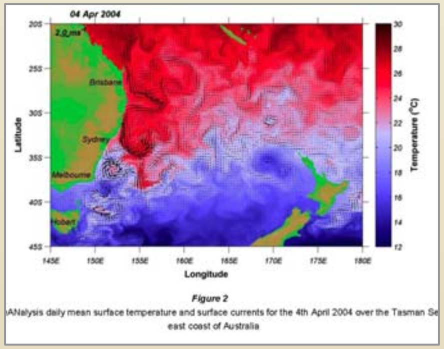
CM2.1	CM2M	Problem addressed
Geopotential coordinate	Z* vertical coordinate	Eliminate vanishing top cell
Sweby tracer advection	Piecewise parabolic	Reduce spurious mixing and maintain stronger gradients
Bryan-Lewis vertical tracer diffusivity	Simmons et al.(2004) tidal mixing	Employ energetic based scheme with more physical basis
Neutral physics matching to mixed layer ala Treguier et al. (1997)	Ferrari et al. (2008) matching of streamfunction to boundary layer	Smooth the interaction between GM and surface boundary layer
Laplacian horizontal viscosity as per NCAR	Biharmonic plus laplacian	Reduce by ~10 the number of free parameters; enhance boundary currents; include TIWs to reduce cold tongue bias; ITF improve
No submesoscale closure	Fox-Kemper et al. (2008) scheme	Include restratification effects from upper ocean submesoscale eddies to reduce overly deep mixed layers
Morel and Antoine (1994) shortwave penetration	Manizza et al. (2005) shortwave penetration	Allow use of fully prognostic chlorophyll

Selected non-NOAA MOM Applications

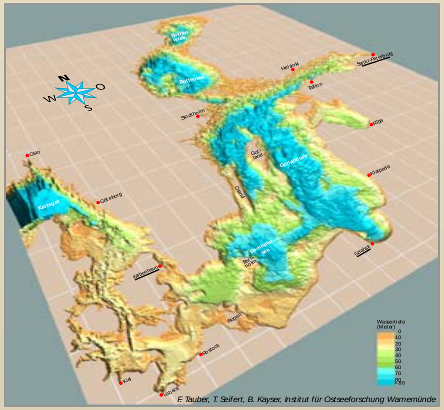
- 1/10° ocean on Japanese Earth Simulator



- Operational coastal ocean forecasting (weekly forecasts) for Australia



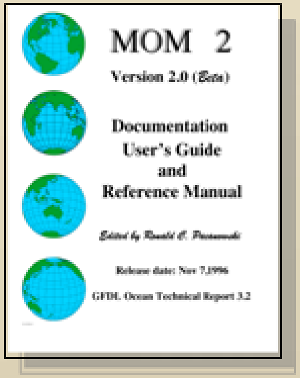
- Coastal process and ecosystem modeling of Baltic



Why is MOM Successful?

- **Well understood and trusted solutions of high integrity**
  - extensive documentation
  - invaluable repository of research experience
  - GFDL commitment and sanction
- **Easy to use for many applications**
  - new configurations readily developed
  - numerous test cases from idealized to global coupled climate
  - multiple state-of-science methods and parameterizations
  - extensive user community extending over multiple generations

518 pages



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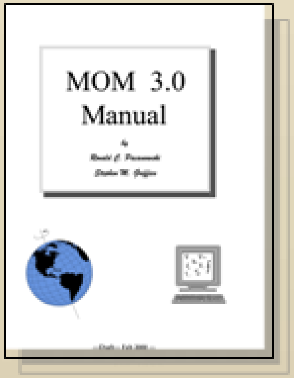

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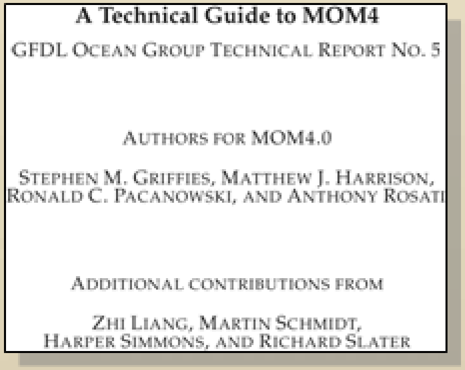

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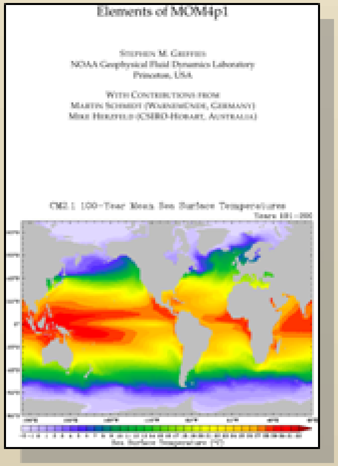

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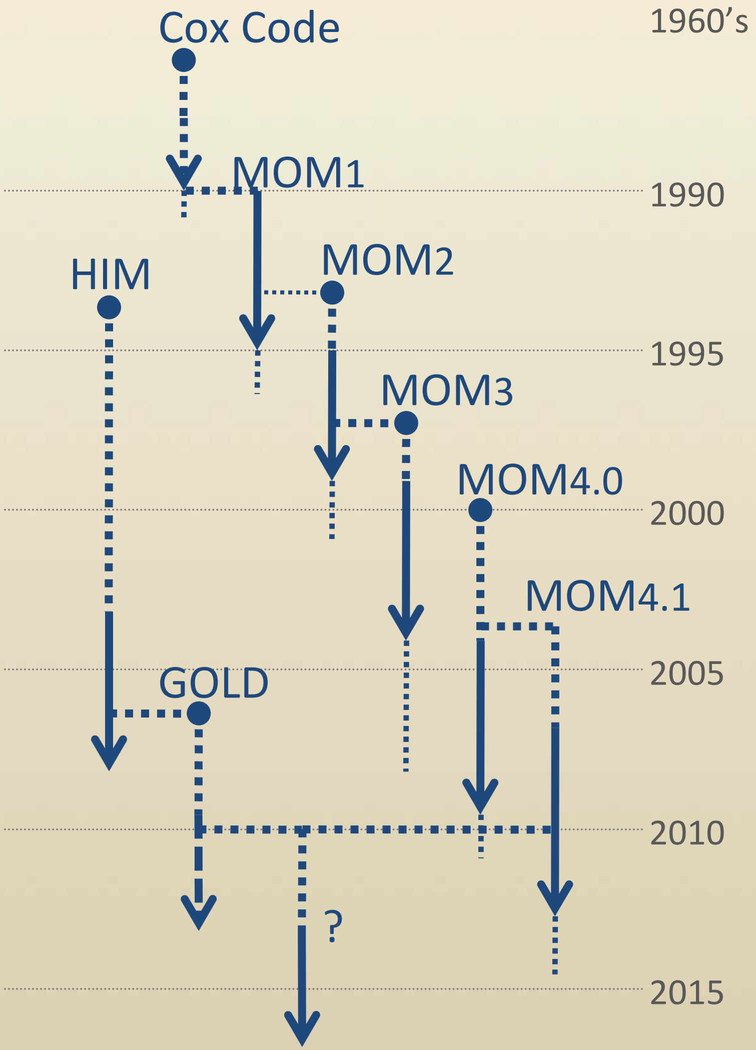
Evolution of MOM

- **Selected updates to MOM4p1 through AR5 cycle (2013)**
  - Most recent code release June2009 (including CM2.1 coupled model)
- **Merger of key MOM4 features into unified GFDL ocean code**
  - Reduce spurious numerical mixing
  - Incorporate physically based closures
  - Use very accurate transport schemes
  - Generalize the numerics, physics, analysis, and documentation
  - Examine the "vertical coordinate problem" for key applications



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