HYCOM code development

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HYCOM NOPP GODAE Meeting

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### HYCOM code development

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<table>
<thead>
<tr>
<th>a. REPORT</th>
<th>b. ABSTRACT</th>
<th>c. THIS PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>unclassified</td>
<td>unclassified</td>
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</tr>
</tbody>
</table>

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12

#### 19a. NAME OF RESPONSIBLE PERSON
HYCOM 2.2 (I)

- First public release of HYCOM 2.2
  - Scheduled for December, 2004
- Maintain all features of HYCOM 2.1
  - Orthogonal curvilinear grids
  - Can emulate Z or Sigma or Sigma-Z models
  - Explicit support for 1-D and 2-D domains
  - KPP or Kraus-Turner or
    Mellor-Yamada 2.5 or Price-Weller-Pinkel
  - Rivers as bogused surface precipitation
  - Multiple tracers
  - Off-line one-way nesting
  - Scalability via OpenMP or MPI or both
    * Bit-for-bit multi-cpu reproducibility
- New diagnostics within HYCOM
  - Time-averaged fields (in archive files)
  - Drifters
HYCOM 2.2 (II)

- Alternative scalar advection techniques
  - Donor Cell, FCT (2nd and 4th order), MPDATA
- Vertical coordinate changes
  - Vertical remapping uses PLM for fixed coordinate layers
  - Thin deep iso-pycnal layers
  - Spatially varying iso-pycnal layer target densities
  - Stability from locally referenced potential density
- Atmospheric forcing changes
  - Option to input ustar fields
  - Option to relax to observed SST fields
  - Improved COARE 3.0 bulk exchange coefficients
  - Black-body correction to longwave flux
- Mixed layer changes
  - GISS mixed layer model
  - KPP bottom boundary layer
  - KPP tuning
  - Latitudinally dependent background diffusion
HYCOM 2.2 (III)

- Improved support for rivers
  - Still bogused surface precipitation
  - Better control of low salinity profiles
  - Option for mass (vs salinity) flux

- Nesting no longer requires co-located grids
  - General archive to archive horizontal interpolation

- Hybrid to fixed vertical grid remapper
  - Allows fixed-coordinate nests inside hybrid coordinate outer domains
    - HYCOM to (fixed-grid) HYCOM
    - HYCOM to NCOM

- Diagnostic fields to netCDF and other file formats
  - All x-y “hycomproc” fields
    - Layer space
    - Velocity interpolated to the p-grid
  - All 3-D archive fields interpolated to z-space
    - On p-grid, or
    - Sampled along arbitrary tracks
  - Forcing input fields
HYCOM CURVI-LINEAR GRIDS and NetCDF

- Most basin-scale cases use a Mercator grid
  - 1-D latitude and longitude axes
  - Handled well by many netCDF packages
- Global HYCOM’s Arctic patch grid is curvi-linear
- HYCOM netCDF use the CF-1.0 conventions, which support curvi-linear grids
  - If latitude and longitude are 2-D grids
    * 1-D axes are array indexes
    * Longitude and latitude arrays are also in the file and identified as alternative coordinates
- Most netCDF packages are not CF-1.0 aware
  - Can plot in “logical” (array) space
  - Interpolate to a 1-D latitude and longitude grid off-line
    * General archive to archive horizontal interpolation
- Archive to archive remapper can also be used for standard (non-native) grids
  - Mersea grid is uniform 1/8°
GoM NESTED TEST DOMAIN

• Same resolution nesting unexpectedly useful
  ○ No need to rerun large domain
  ○ Change atmospheric forcing (e.g. use MM5)
  ○ Change vertical structure
  ○ Tracer studies (e.g. add biology)
• 1/12°: Gulf of Mexico inside Atlantic
  ○ Change from 20m to 5m coastline
  ○ Run for Aug 1999 to equilibrate
  ○ Run Sep-Nov as standard test case
• Used to test advection schemes
MPDATA VS LEAPFROG-FCT (SSS)

layer=01  salinity  Dec 01, 1999  00Z  [02.8H]

MPDATA
cl 0.010 psu
31.20 to 36.42

LF-FCT2
cl 0.010 psu
31.19 to 36.42

layer=01  salinity  Dec 01, 1999  00Z  [03.1H]
CANDIDATE FEATURES FOR HYCOM 2.3

- Stable-code vs new features
  - Released code-base has to be tested and stable
  - New features can be a significant improvement
  - Will add interim releases to web page
    - * Features may be removed in next released code
- Fully region-independent
  - Compile once, run on any region and any number of processors
  - Needed for full ESMF compliance
- Improve split-explicit time scheme
- Tidal forcing
- Diurnal heat flux cycle
- Equation of state that is quadratic in salinity
- Even better support for rivers
- Wind drag coefficient based on model SST
- Initial support for ESMF
HYCOM AND ESMF

- Earth System Modeling Framework
  http://www.esmf.ucar.edu/
  - Superstructure couples components
    - Air/Ocean/Ice/Land
    - Asynchronous I/O component
      - Not yet available via ESMF
  - Infrastructure provides data structures and utilities for building scalable models
- Add a superstructure “cap” to HYCOM
  - Simplifies coupled systems
    - HYCOM coupled to LANL CICE sea-ice
    - Convert atmospheric field processing and the energy-loan ice model into ESMF components
      - Use ESMF for I/O
- This initial ESMF support will probably be optional
- ESMF may be required to run HYCOM at some point
  - Harder to get started with HYCOM
  - Will provide many new capabilities
HYCOM AND HOME

- Hybrid Ocean Modeling Environment (HOME)
  - Not one model, but an environment
  - Unify existing isopycnal/hybrid ocean models into a single code base
  - Still an unfunded proposal
- There will be a migration path from HYCOM to HOME
  - Re-implement HYCOM in HOME
  - HYCOM with ESMF will simplify the migration
- HOME “best practices” studies may find better alternatives to HYCOM algorithms
  - Exact mass conservation
  - Better free surface formulation
  - Improved time stepping
- Some of these may be back ported to HYCOM
- At some point “HYCOM in HOME” will become the only supported HYCOM
  - Might be very different to HYCOM 2.X
  - Might not even be called HYCOM