HYCOM code development

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HYCOM NOPP GODAE Meeting

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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

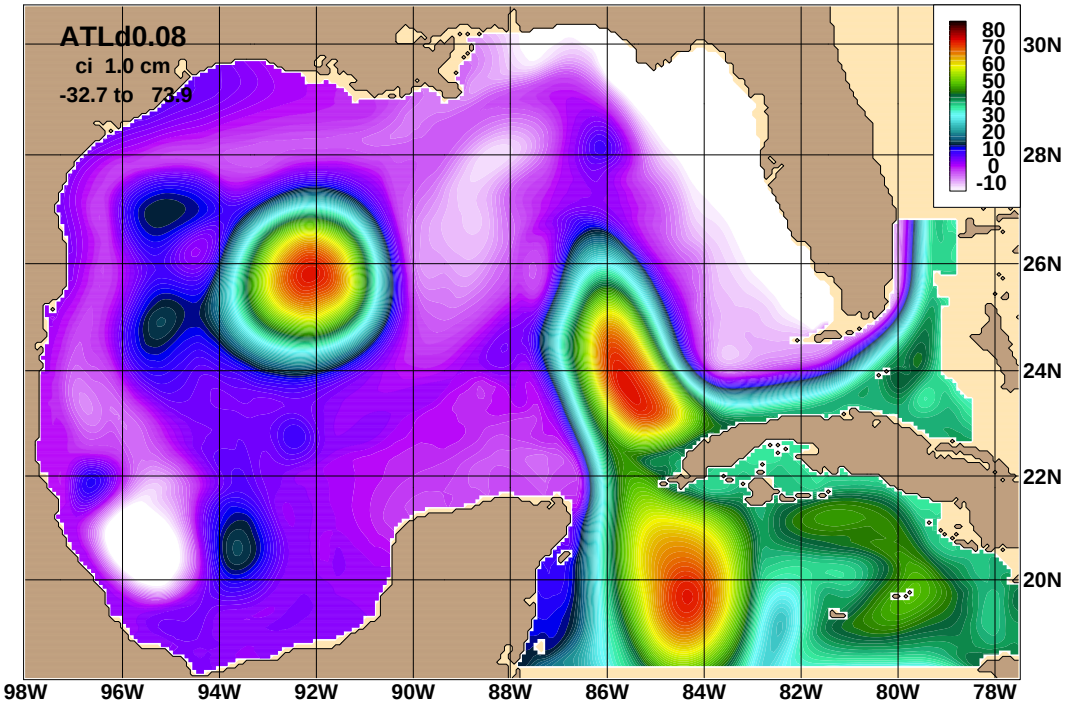
- Most basin-scale cases use a Mercator grid
  - 1-D latitude and longitude axes
  - Handled well by many netCDF packages
- Global HYCOM's Arctic patch grid is curvi-linear
- HYCOM netCDF use the CF-1.0 conventions, which support curvi-linear grids
  - If latitude and longitude are 2-D grids
    - 1-D 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

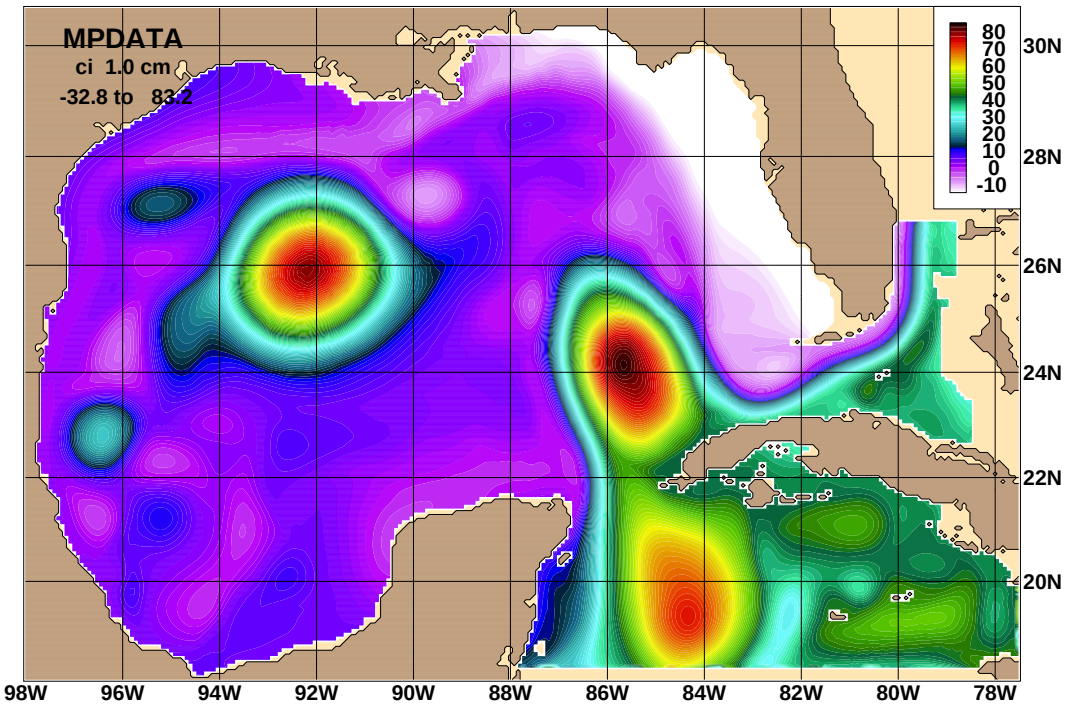
- Same resolution nesting unexpectedly useful
  - No need to rerun large domain
  - Change atmospheric forcing (e.g. use MM5)
  - Change vertical structure
  - Tracer studies (e.g. add biology)
- 1/12°: Gulf of Mexico inside Atlantic
  - Change from 20m to 5m coastline
  - Run for Aug 1999 to equilibrate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

ATLANTIC vs GOM NEST (MPDATA)

sea surf. height Dec 01, 1999 00Z [02.6H]

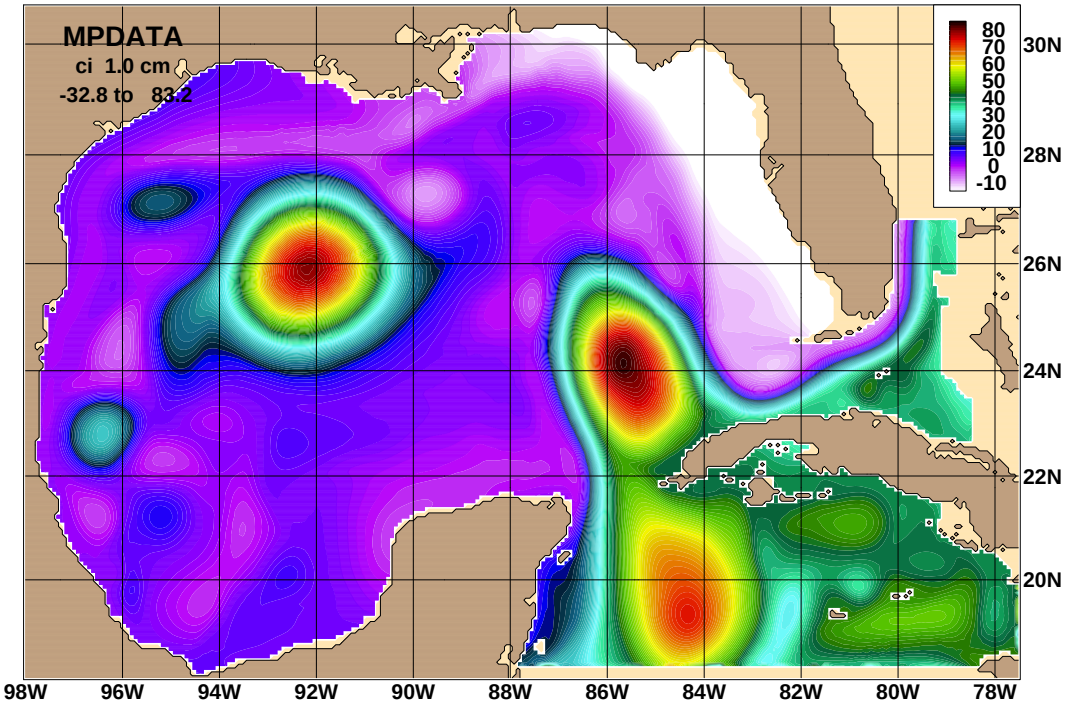


sea surf. height Dec 01, 1999 00Z [02.8H]

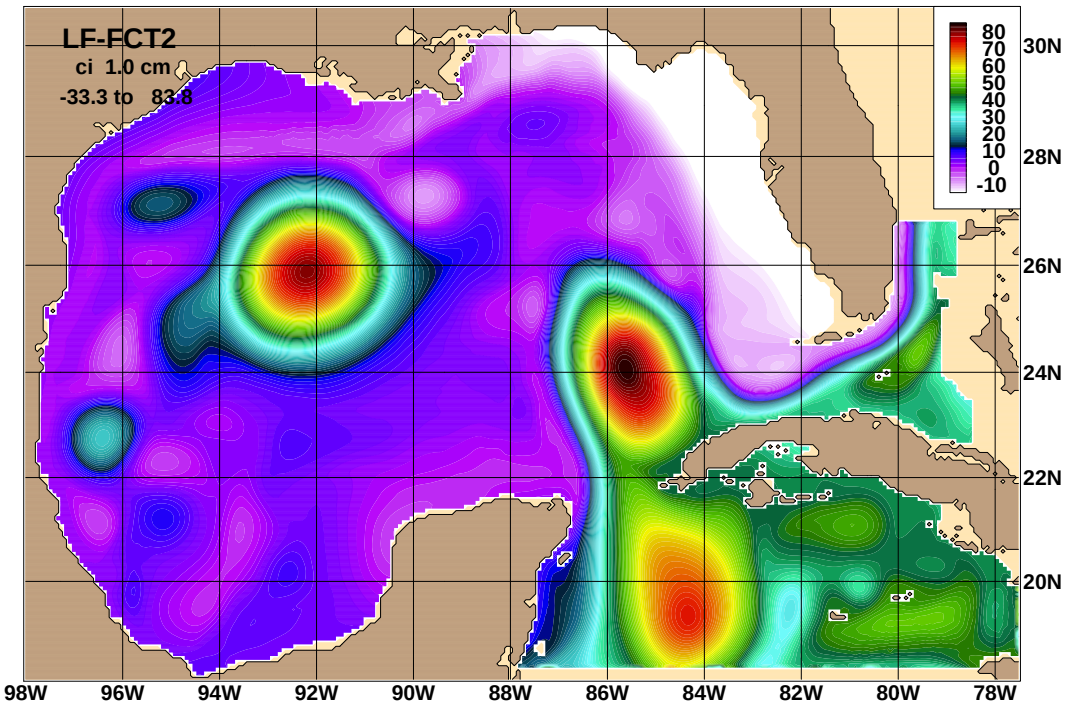


MPDATA VS LEAPFROG-FCT (SSH)

sea surf. height Dec 01, 1999 00Z [02.8H]

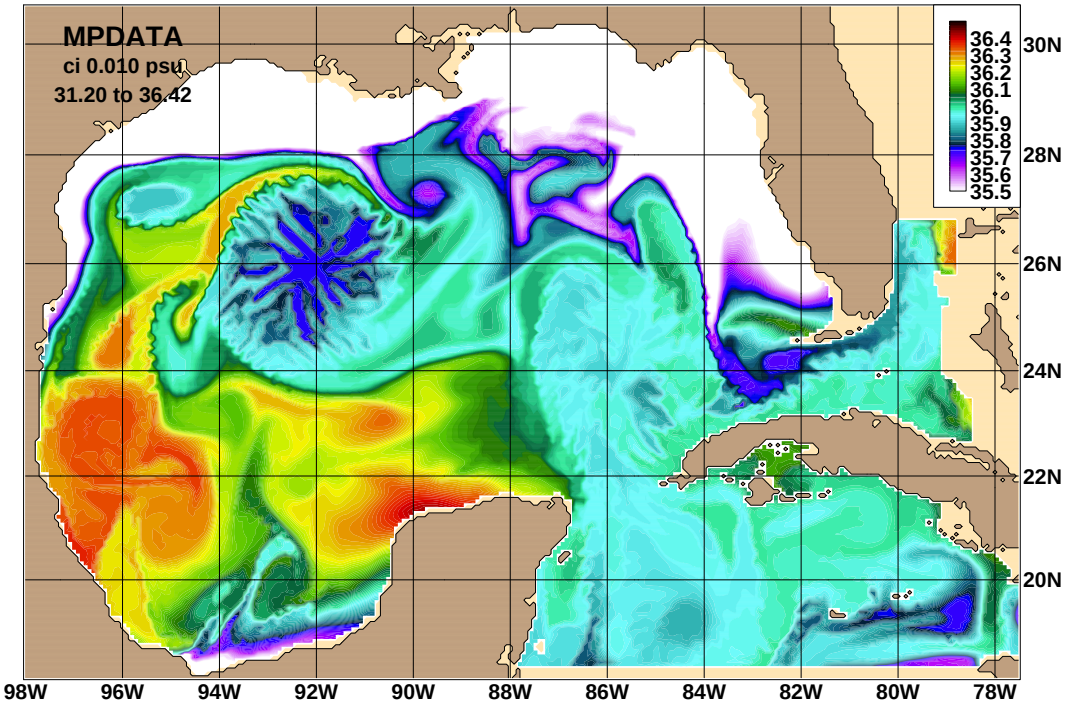


sea surf. height Dec 01, 1999 00Z [03.1H]

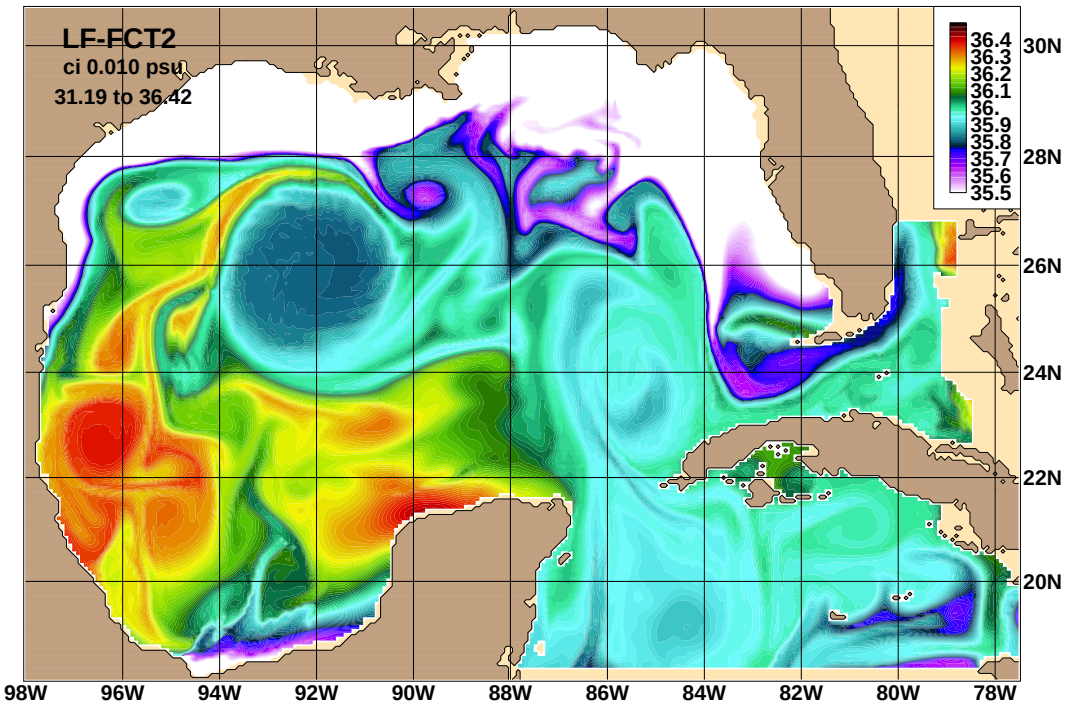


MPDATA VS LEAPFROG-FCT (SSS)

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



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