COMODO, Evaluation of numerical methods for Ocean Modeling

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LEGOS, Toulouse

IMUM 2014, Lisbon

The Comodo Project

7 tasks

- Dissipation mechanisms
- Momentum advection schemes
- Time integrators
- Tracers advection-diffusion
- Vertical coordinate systems
- Unstructured mesh methods
- Non hydrostatic

7 labs

- Ifremer, LPO, LEGOS, LEGI, INRIA, SHOM, LOCEAN, LA

6 Models

MARS, NEMO, ROMS, Symphonie, HYCOM, TUGO

1 common tool: pycomodo library (Marc Honnorat INRIA)

The Comodo Project

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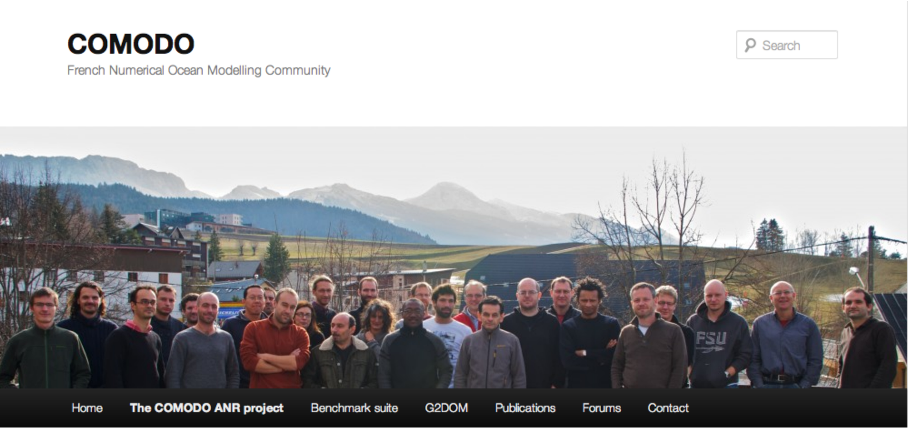


7 Testcases

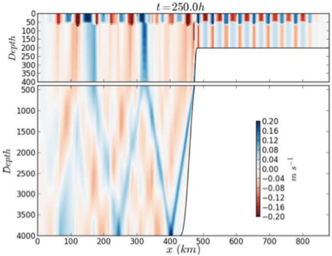
- Baroclinic Vortex
  Momentum scheme and dispersion
- Eddy topography iteraction
  Topographic rectification, PV and enstrophy conservation
- Thacker
  bbl and adiabatic flow along topography
- Upwelling
  bottom flow and vertical coordinates
- Internal Wave
- Lock Exchange
  spurious diapycnal diffusion
- Baroclinic Jet
  Effective model resolution

Internal Wave

Objectives

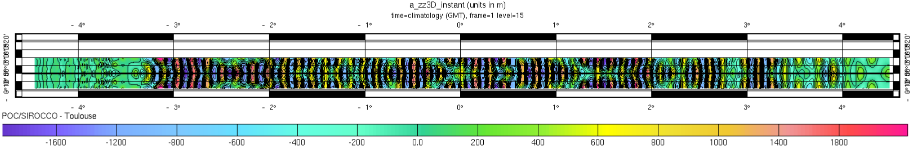
- Validate the pressure gradient calculation,
- Sensitivity of the generation and propagation of IW,
- Investigate the effective resolution in relationship to horizontal and vertical resolution,
- Address the extension toward non-hydrostatic methods,

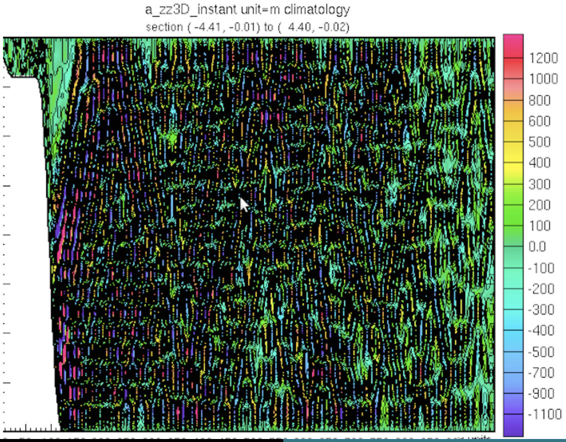
configuration



- Test outgoing OBC for baroclinic fields in hydrostatic and non-hydrostatic dynamics

Internal Wave with Tugo



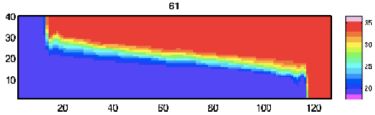


Lock Exchange

Objectives

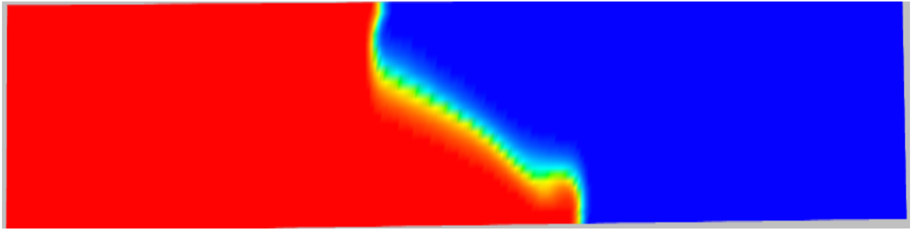
- Quantification of the spurious diapycnal mixing
- Investigate the accuracy of advection schemes
- Impact of numerical choices on numerical solution

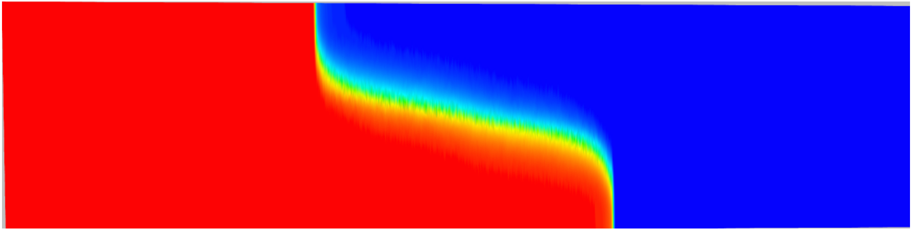
configuration



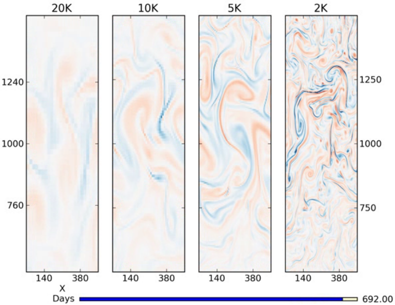
- Setup following Haidvogel and Beckman, Burchard and Rennau 2008
- Diagnostics based on Illicak (OM 2012), RPE , density class and front location

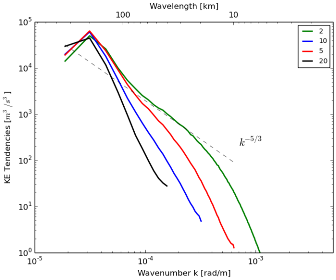
Lock Exchange in Fluidity-ICOM





Baroclinic Jet: Surface Vorticity and KE Spectrum





ROMS NEMO comparison, Surface Vorticity

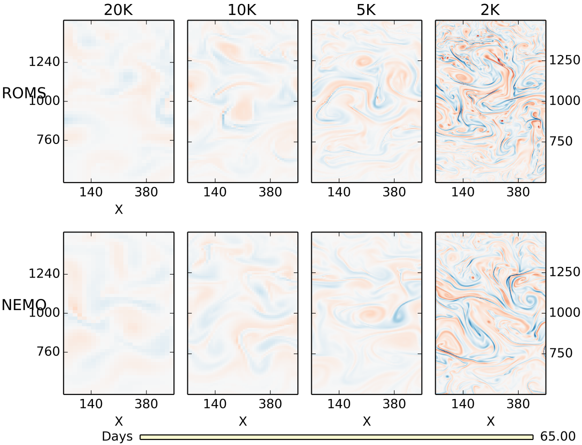


Figure: Colorbar symetric from -0.00015 to 0.00015

Profiles

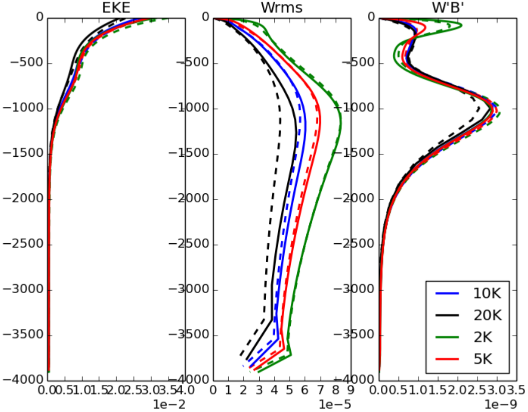


Figure: 20 years average profiles for ROMS (plain line) and NEMO (dashed)

ROMS NEMO comparison: KE spectra

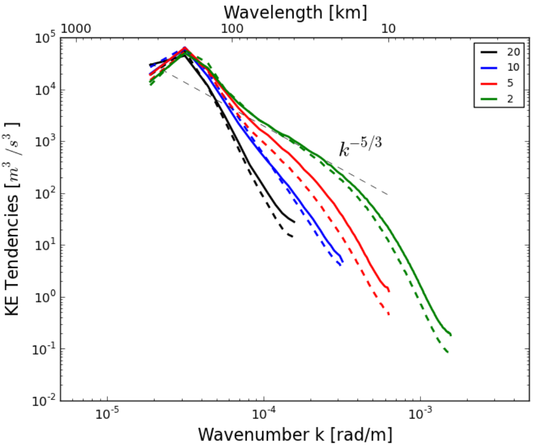


Figure: 20 years average spectra at 10m depth for ROMS (plain line) and NEMO (dashed)

Injection <w′b′> at different resolution

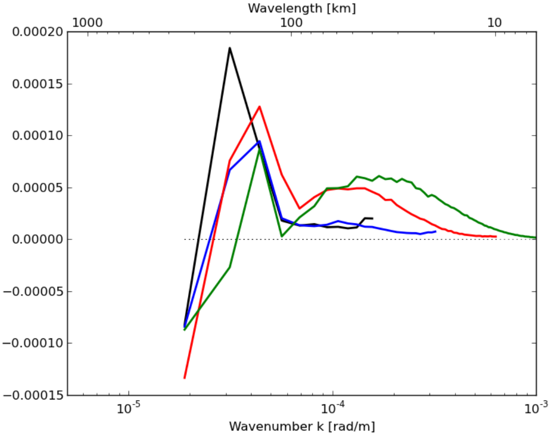
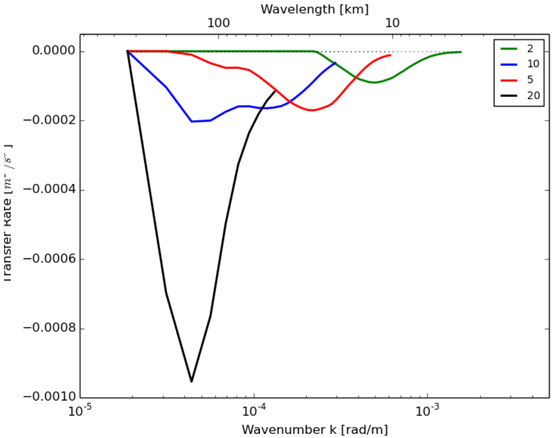


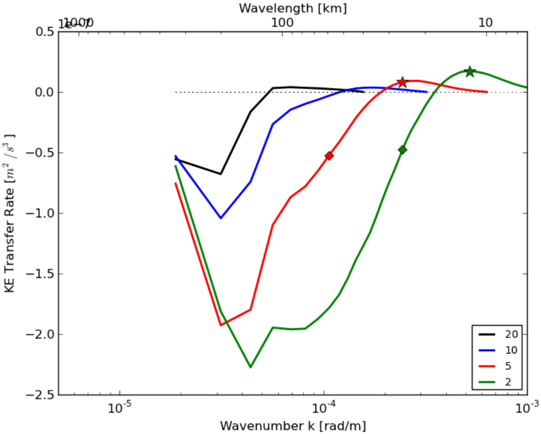
Figure: Injection Spectra at 10m

Diffusion at different resolution



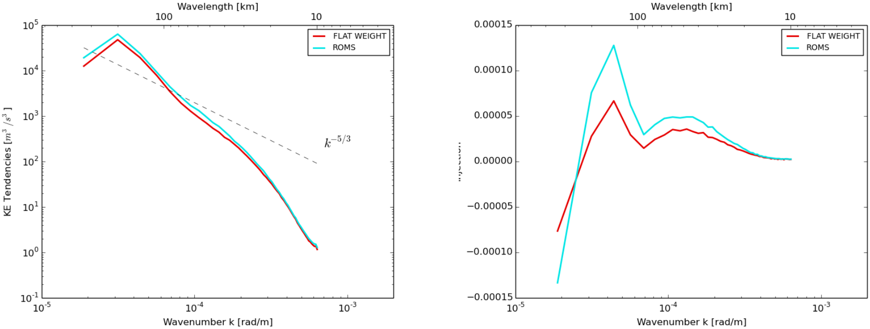
- Amount of dissipation decrease with resolution
- Dissipation range is also reduced towards small scale

Transfert at different resolution



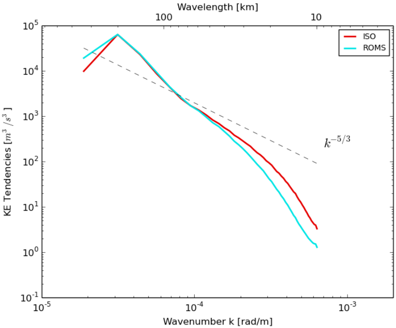
- Direct cascade in the dissipative range

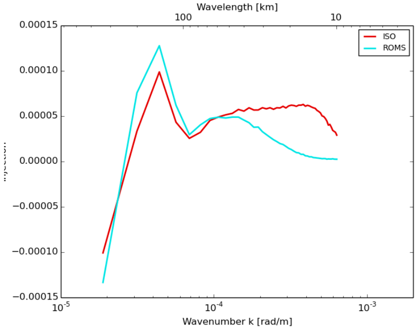
Barotropic/baroclinic coupling filter



- Effect of temporal filter: spectra for 5 Km resolution at 10m
- No effect at small scales

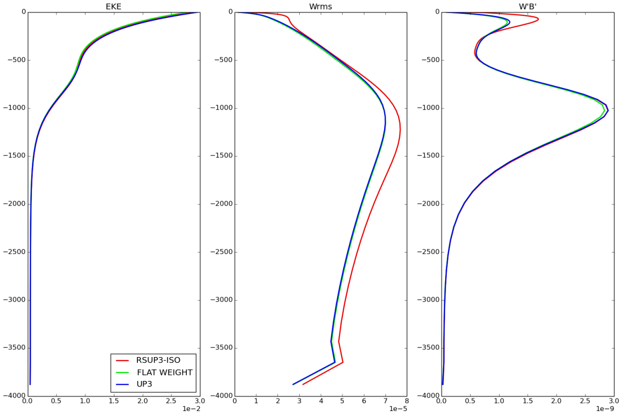
Effect of Diapycnal mixing





- ROMS run with RSUP3-ISO: Rotation of diffusion tensor
- Extension of the injection range at small scales

Profiles at 5km



- Large effect of diapycnal mixing at the surface
- Preserving the stratification allows more APE to be converted

Final word

The baroclinic Jet

- Spectral budget help to identify sources of dissipation
- Difficult to point exactly to the source of differences between model
- Clear/important role of the diffusion of tracer

Other test cases

- Looking for volunteers...
- Which test case can YOU do?