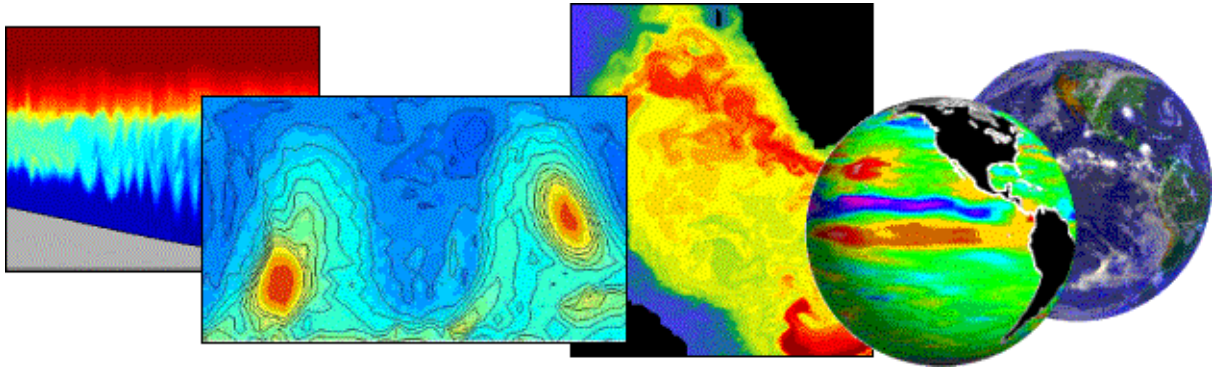
Model development

MITgcm



ECCO-2 Meeting, Caltech, Nov 2009

News

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About MITgcm
The MITgcm (MIT General Circulation Model) is a numerical model designed for study of the atmosphere, ocean, and climate. Its non-hydrostatic formulation enables it to simulate fluid phenomena over a wide range of scales; its adjoint capability enables it to be applied to parameter and state estimation problems. By employing fluid isomorphisms, one hydrodynamical kernel can be used to simulate flow in both the atmosphere and ocean.
You are welcome to download and use MITgcm.
Papers charting the development of MITgcm can be found here
Latest News and Features
Planet-in-a-Bottle
Oct 31st, 2009
Planet-in-a-Bottle
story by Helen Hill
Here we look at work by Sai Ravela, John Marshall, Chris Hill, Andrew Wong and Scott Stransky in which they use MITgcm to provide the virtual analogue for a fluid lab experiment in the physical laboratory, as part of an effort to demonstrate how to achieve real-time model-data synthesis, using measurements from

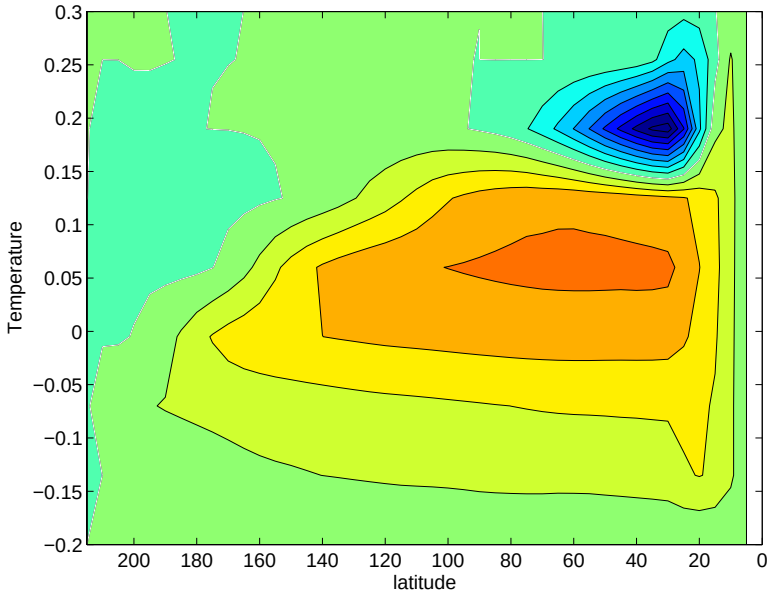
MITgcm development

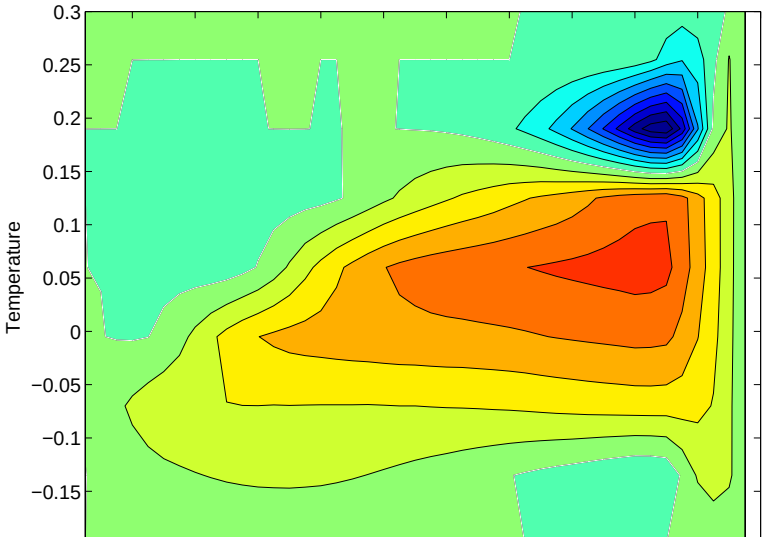
- New development
  - tracer long time-step (*pkg/longstep*) (Oliver J.)
  - lagrangian floats (*pkg/flt*)
  - isothermal / isopycnal transport diagnostics (*pkg/layers*) (Ryan A., David F.)
  - setting topology within pkg/exch2:
    more flexible, e.g.: sub-set of facets, regular domain;
    easy to use (independent of tiling) and to modify (*data.exch2*)
  - Multi-threaded IO and EXCH (using shared buffers)
    work on local array ; speed-up (less read/write);
    regression tests using MPI + multi-threaded
- Improvement - Validation
- Future

MITgcm development

- New development
- Improvement - Validation
  - sea-ice dynamics and adjoint (Martin L., Patrick H.):
    LSR sub-timestep, metric-terms ...
  - vertical mixing:
    - KPP (double diffusion term)
    - Gaspar etal 1990 (*pkg/ggl90*)
  - Eddy-mixed layer parameterization (Ferrari & Mc Williams, 2007)
    Mixed Layer restratification (Baylor Fox-Kemper)
  - Atmospheric dynamical core tests (Jablonowski etal, 2008)
    15 tests, x2 resolutions (cs-32 & cs-96) to compare with 10 other GCMs
  - Adiabatic advection scheme in eddy resolving model
  - Planetary atmospheres
- Future

Eddy resolving chanel *(David F.)*



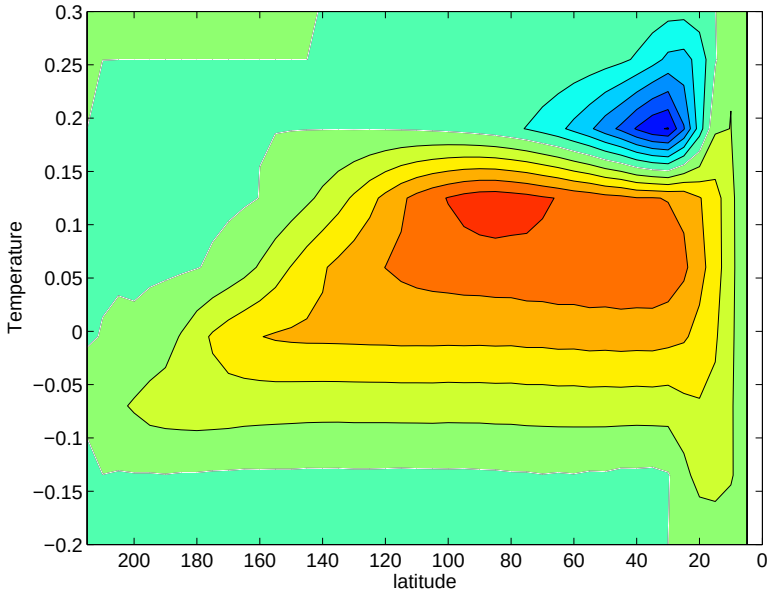


Residual mean circulation in θ coordinate

a) Centered with small diffusion

b) Super-Bee flux-limiter

c) Prather



MITgcm development

- New development
- Improvement - Validation
  - sea-ice dynamics and adjoint
  - vertical mixing
  - Eddy-mixed layer parameterization
  - Atmospheric dynamical core tests
  - Adiabatic advection scheme in eddy resolving model
  - Planetary atmospheres:
    Mars: Angela Zalucha etal, JAS, in press 2009.
    Jupiter: Yohai Kaspia etal, Icarus, 202, 525-542, 2009.
    and : Yuan Lian and A. Showman, Icarus, 194, 597-615, 2008.
    Hot Jupiters: A. Showman etal, ApJ, 699, 564-584, 2009.
- Future

MITgcm development

- New development
- Improvement - Validation
- Future (and in progress)
  - 2 way nesting
    (Gianmaria Sannino etal, Ocean Modelling, 30, 56-72, 2009)
  - Multi-scale application (embedded model)
  - High-end atmospheric model
  - Coupling with MITgcm ocean
  - High-Res ocean set-up (Chris H.)

Superparamerization applied to deep convection

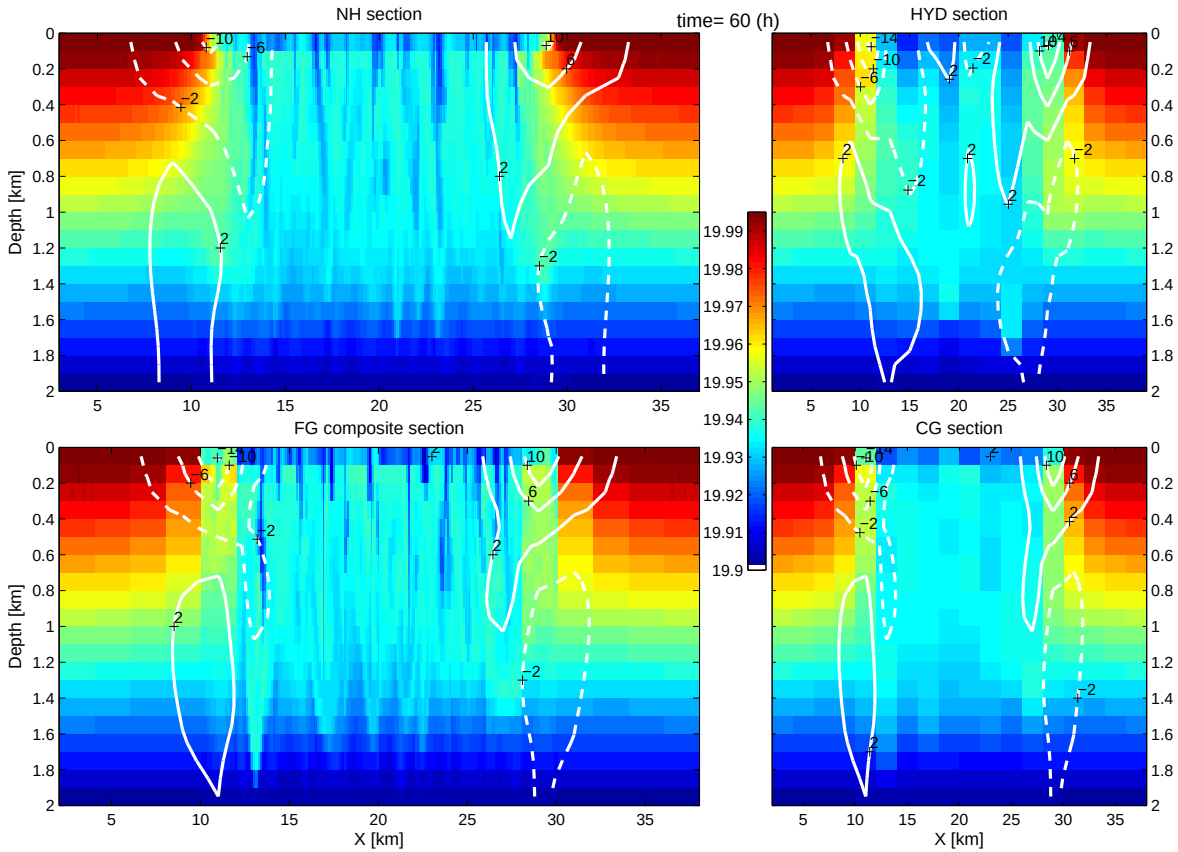
Concept: Explicitly resolve sub-grid scale processes in each column of a largescale, coarse resolution model.

- Needs scale separation
- No need for parameterization: small scale processes are explicitly simulated
- Cost: much cheaper than fine scale resolving model over the full 3D domain

Deep Convection test case: compare 3 set-up

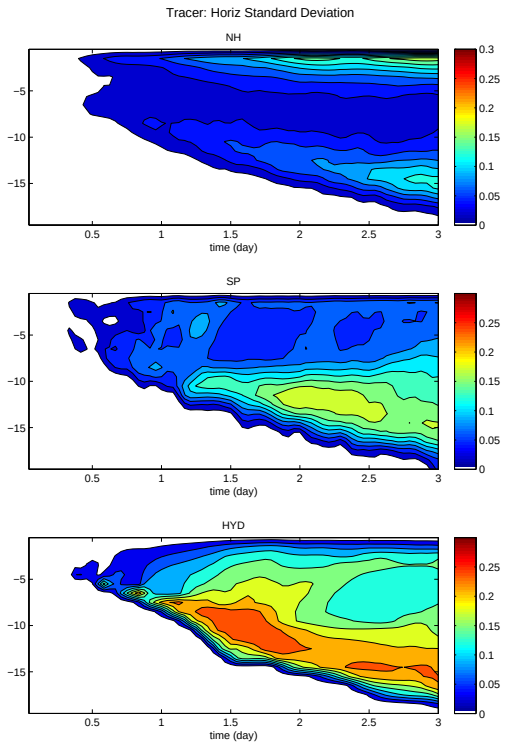
- 3D High resolution nonhydrostatic model
- 2D nonhydrostatic plume model embeded in each column of a coarse hydrostatic model
- Coarse hydrostatic model with convective adjustment

Superparamerization applied to deep convection



Temperature in one vertical radial section after 60h:
Top left: Fine 3D nonhydrostatic; Top right: Coarse hydrostatic;
Bottom left: composite of all 2D plume models along this section;
Bottom right: same but averaged on the coarse grid.

Evolution of tracer horizontal standard deviation inside the convective region:
Top: Fine 3D nonhydrostatic
Middle: Coarse + 2D plumes
Bottom: Coarse hydrostatic



MITgcm development

- New development
- Improvement - Validation
- Future (and in progress)
  - 2 way nesting
  - Multi-scale application (embedded model)
  - High-end atmospheric model
    NCAR (CAM) physics with MITgcm dynamical core ?
  - σ_p and hybrid σ - p coordinate
  - Coupling with MITgcm ocean
  - High-Res ocean set-up (Chris H.)
  - covariant / contravariant horizontal coordinates (non orthogonal grids)

end