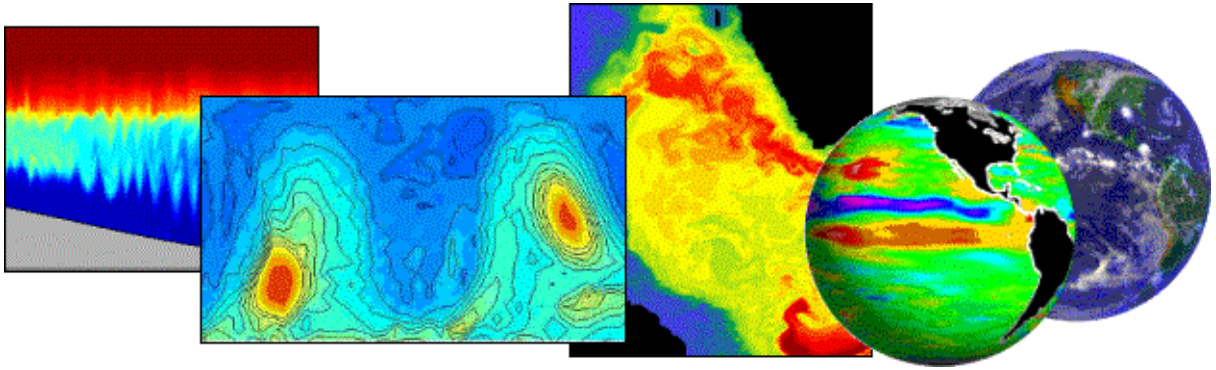
Model development

MITgcm



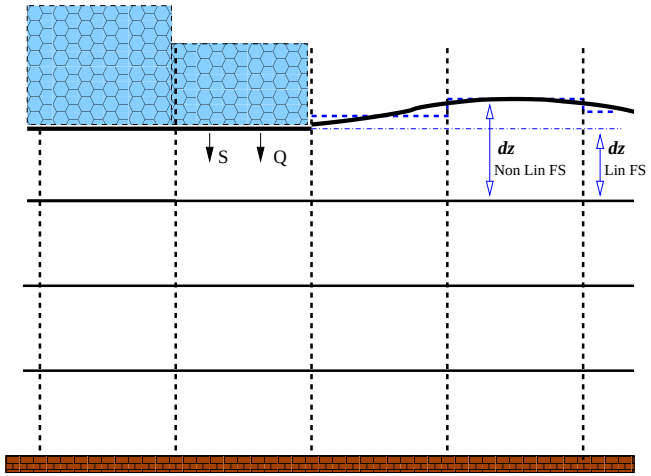
ECCO-2 Meeting, MIT, Sep 2008

MITgcm development

- Ice
  - sea-ice dynamics (Martin Losch *etal*, paper in preparation)
  - adjoint (sea-)ice modelling (Patrick H.)
  - z^* & sea-ice loading (Campin *etal*, OM, 2008)
  - sea-ice enthalpy advection
  - sea-ice salinity (Dimitris M.)
  - ice-shelf cavities (Martin Losch, JGR, 2008).
  - salt-plume parameterization (An Nguyen)
- Ocean
- Coupling
- software

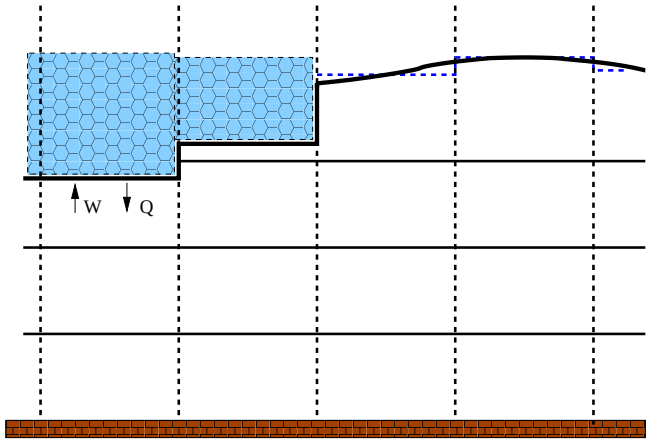
z* & Sea-Ice Loading

Salt Flux formulation (Linear or Non-Linear FS)

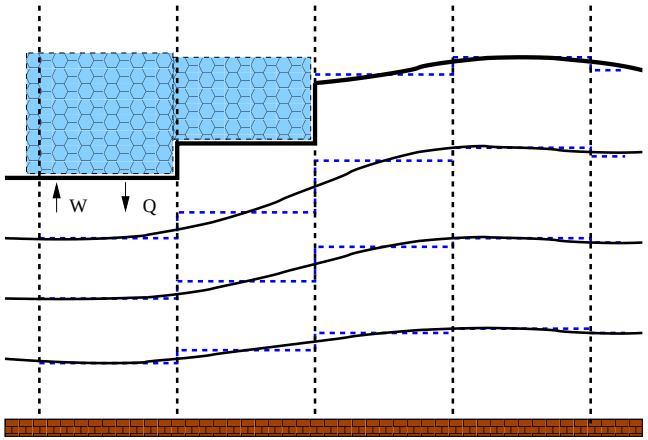


Real Fresh Water formulation (Non-Linear FS)

z-coord.



z*-coord.



MITgcm development

- Ice
  - sea-ice dynamics (Martin Losch *etal*, paper in preparation)
  - adjoint (sea-)ice modelling (Patrick H.)
  - z* & sea-ice loading (Campin *etal*, OM, 2008)
  - **sea-ice enthalpy advection** (Ice-Dynamics + Winton Thermo)
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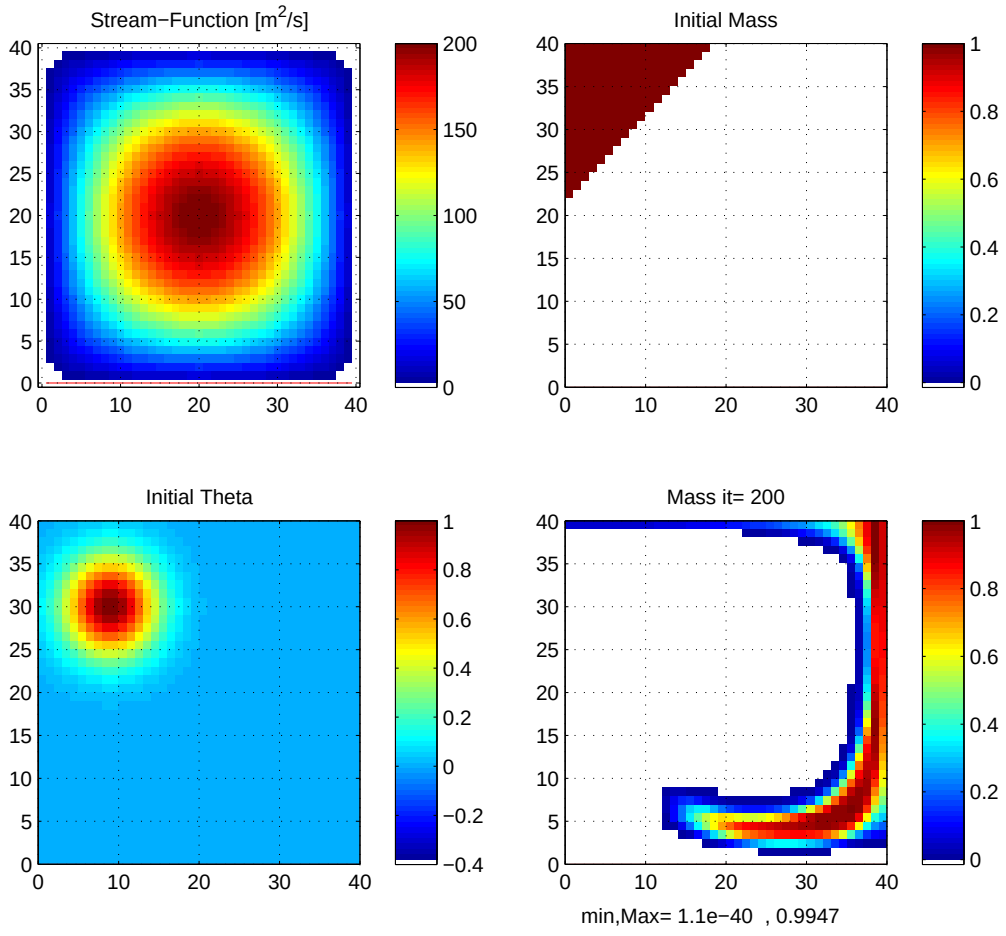
Sea-Ice Enthalpy advection



Sea-ice advection:

- Discontinuous field
- positive

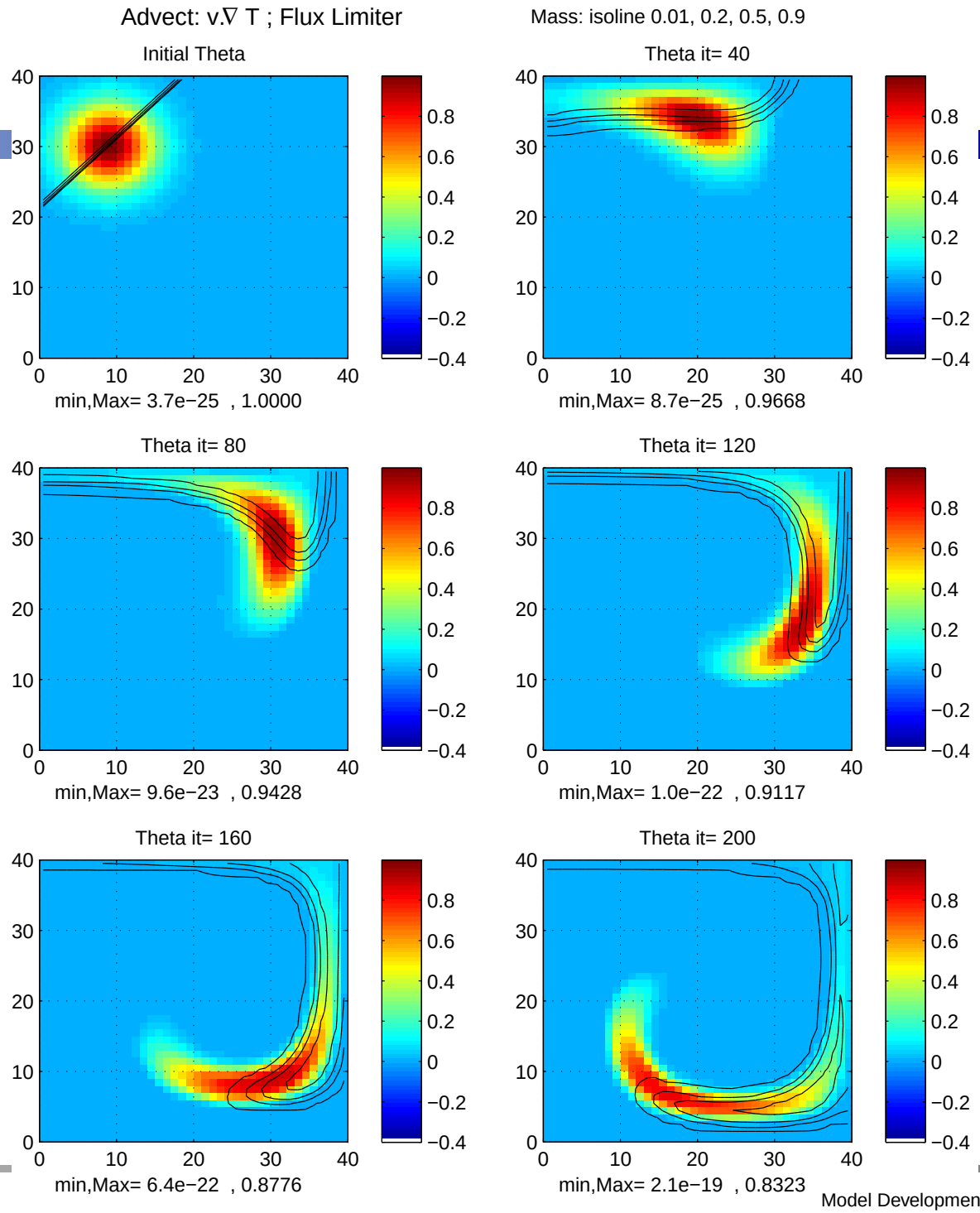
$\Rightarrow$ Non-Linear Adv. Scheme

Temperature/Enthalpy Advection ?

test (1)

advect Mass & Temp., same adv.Scheme for both: (Super-bee limiter).

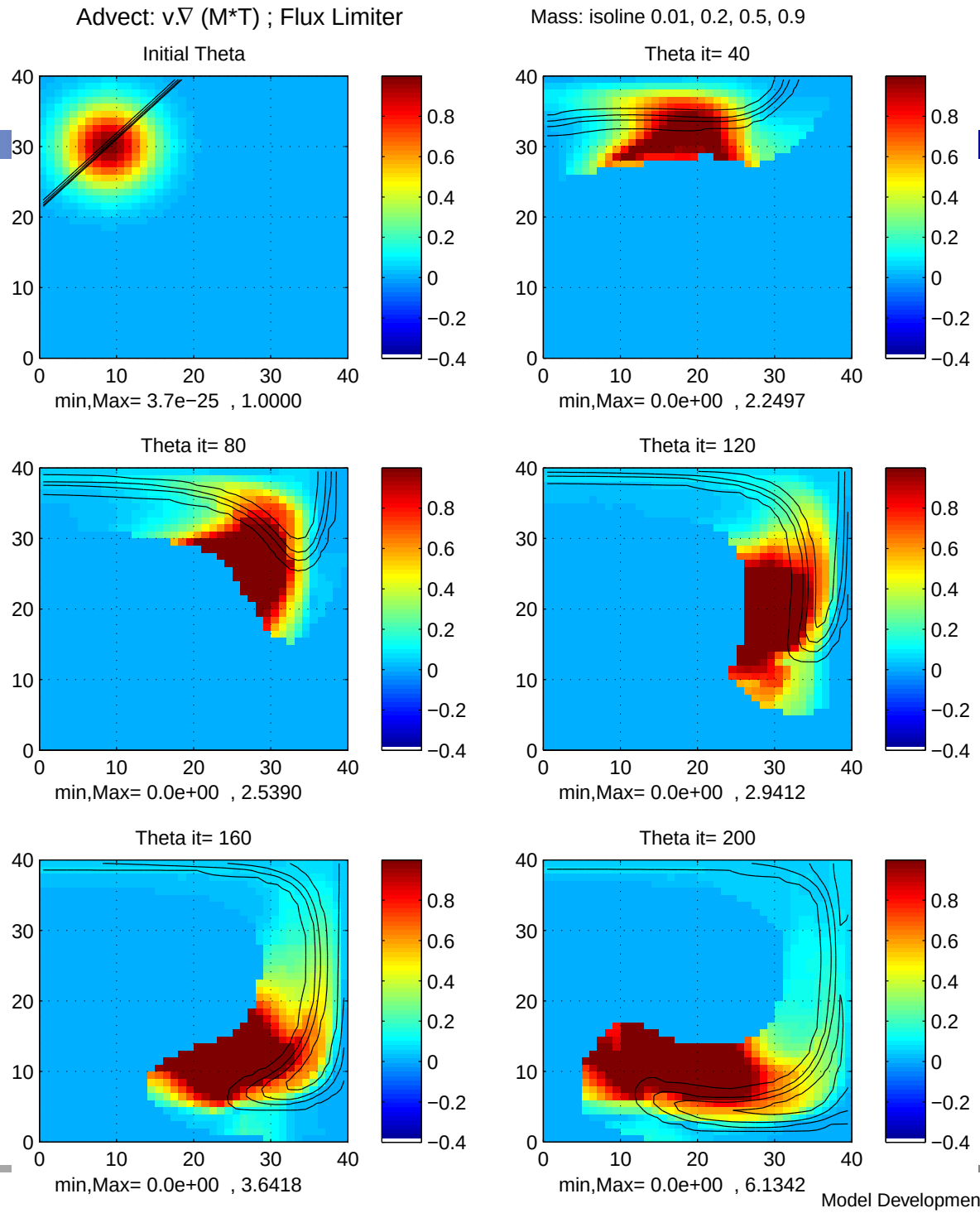
$G_T = \mathbf{v} \cdot \nabla T$



test (2)

advect mass & Heat Content

$$G_{mT} = \mathbf{v} \cdot \nabla(mT)$$

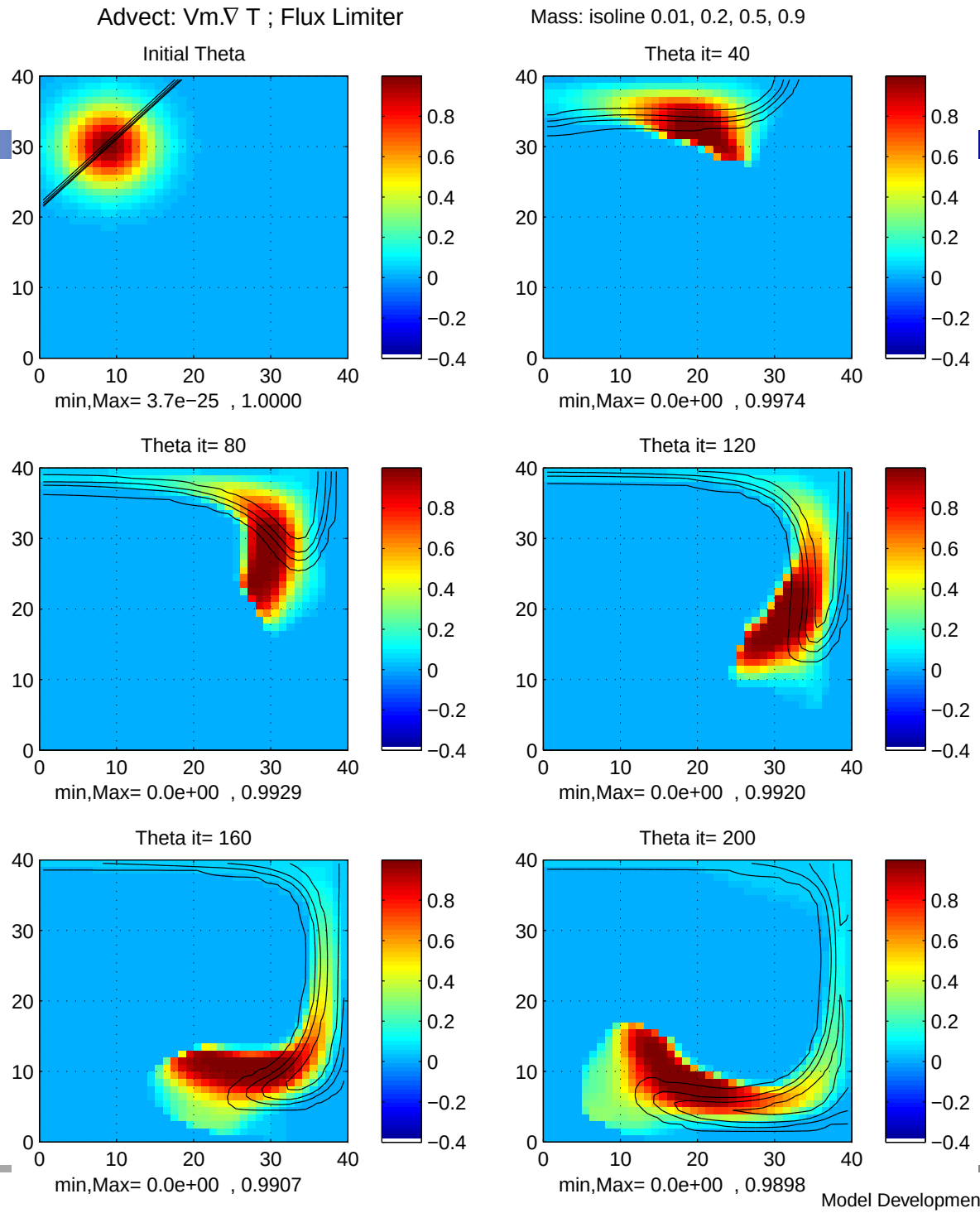


test (3)

a) advect mass

b) use mass flux to Adv. Temp.

$$G_{mT} = \mathbf{V}m \cdot \nabla T$$



test (4)

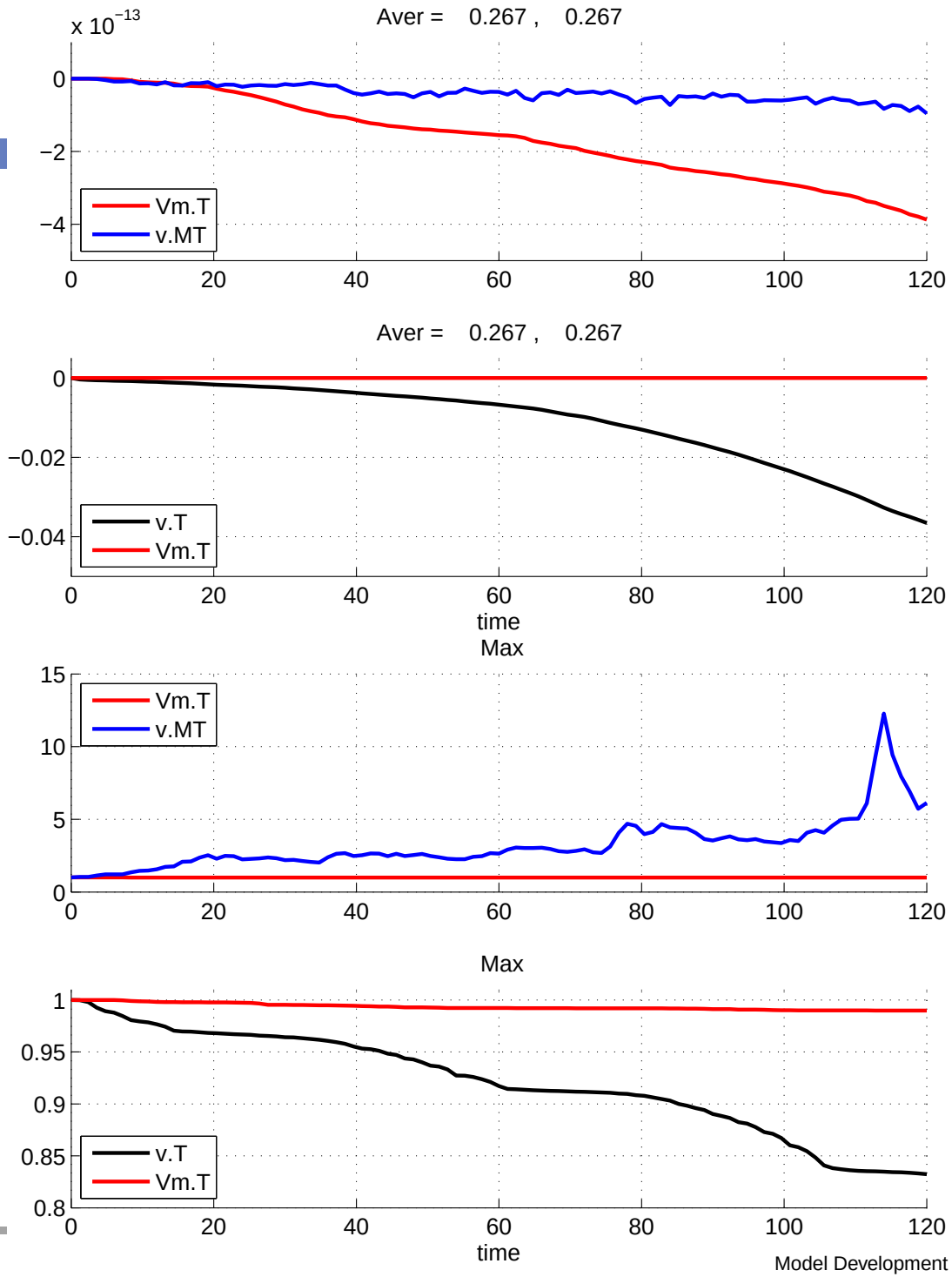
Average Temperature (conservation)

$G_T = \mathbf{v} \cdot \nabla T$ (black)

$G_{mT} = \mathbf{v} \cdot \nabla (mT)$ (blue)

$G_{mT} = \mathbf{V}m \cdot \nabla T$ (red)

Maximum Temperature



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MITgcm development

- Ice
- Ocean
  - Grids, coordinates and remapping (Alistair A.)
  - Positive Redi scheme with (many) biogeo tracers (Oliver J.)
  - Density-driven downsloping flow
  - Eddy-mixed layer parameterization (Ferrari & Mc Williams, 2007)
    Mixed Layer restratification (Baylor Fox-Kemper)
  - Tides
  - Momentum advection
  - 3-D mass flux input (extension of 2-D real fresh water flux)
    deep estuary ; ground-water run-off ; supercooled water freezing
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downsloping flow parameterization

density driven downsloping flow

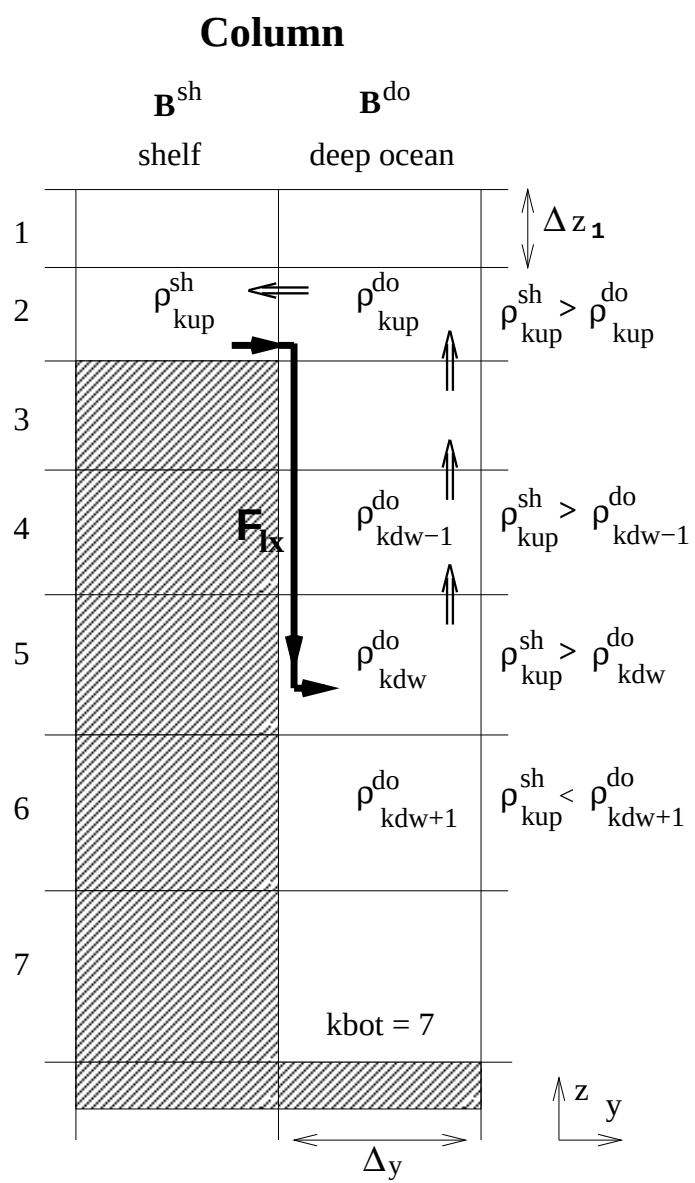
- observed
- constrained by (mostly) unresolved

topographic ridges/canyons/sills

- influences water masses

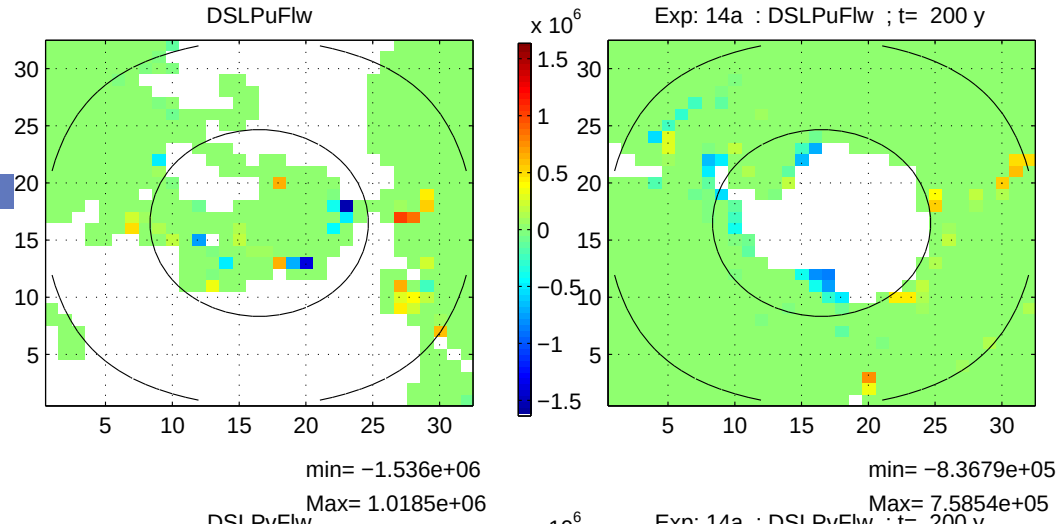
$\Rightarrow$ parameterization of its effects

(Campin & Goosse, Tellus, 1999)

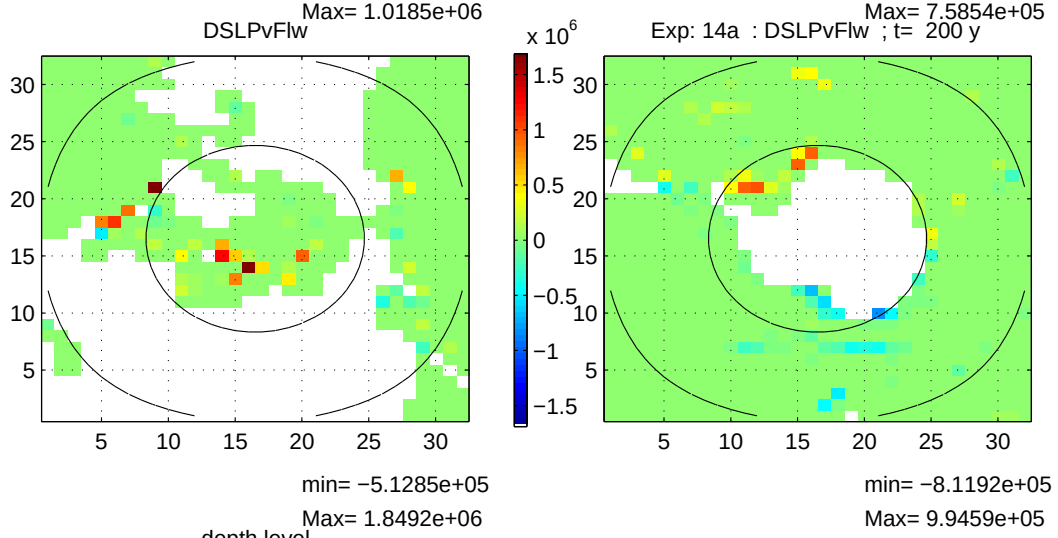


Coarse resolution test

U-transport

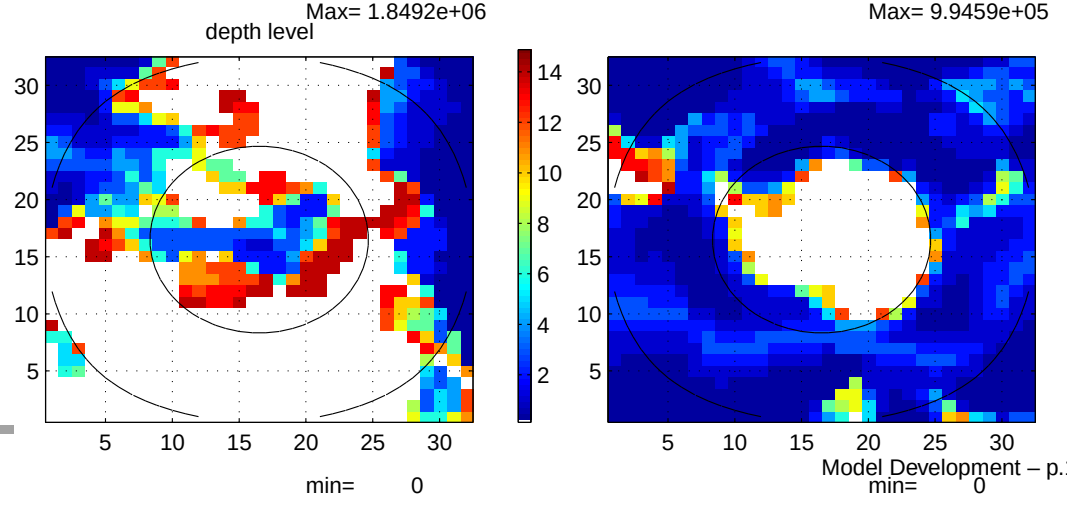


V-transport



Global CS-32, 15 levels,
sea-ice with dynamics,
CORE forcing, no restoring,
200 yrs run,
last 50yrs average

bottom level



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Tides

- Tidal residual circulation
- Non-linear process/scheme (e.g. quadratic bottom friction)
- Energetics:
  significant input $\Rightarrow$ more realistic dissipation
- Constrain dissipation using tidal observation
- Continental shelf $\leftrightarrow$ open ocean
  biochemistry, productivity, sedimentation ...
- Sea-ice dynamics
- Advantage of z^* coordinate

MITgcm development

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Momentum Advection

- Vorticity term (vector invariant)
  - Enstrophy conserving scheme
  - Energy conserving scheme
  - 4th Order scheme
  - Energy and enstrophy conserving scheme (Sadourny)
- Vertical momentum advection and topography
- Momentum conserving formulation (flux-form)

  improved momentum conservation prevents noise to develop near

  a bathymetry step (used by Maxim N.)

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MITgcm development

- Ice
- Ocean
- Coupling
  - AIM (Speedy), Thermodynamic sea-ice, + Biochemistry (David F.)
  - Geos-5 (Chris H.)
  - 2-D Atmosphere (Jeff Scott)
  - improved EBM (cheapAML pkg, Nicolas G., FSU)
  - super-parameterization (embedded-plume) (Chris H.)
- software

MITgcm development

- Ice
- Ocean
- Coupling
- software
  - diagnostics: periodic averaging (e.g., mean seasonal/diurnal cycle), regional statistics.
  - "clever pickup"
  - exact restart: daily tested
  - exch2 (cleaned up, tested AD)
  - (slow) move to F90
  - user friendly MITgcm interface (Constantinos E.)

MITgcm development

Plans:

- Coupling with atmospheric Model (Goddard - Geos-5)
- Nesting ; embedded model (with ESMF)
- Global eddying adjoint
- Ecosystem modelling

end