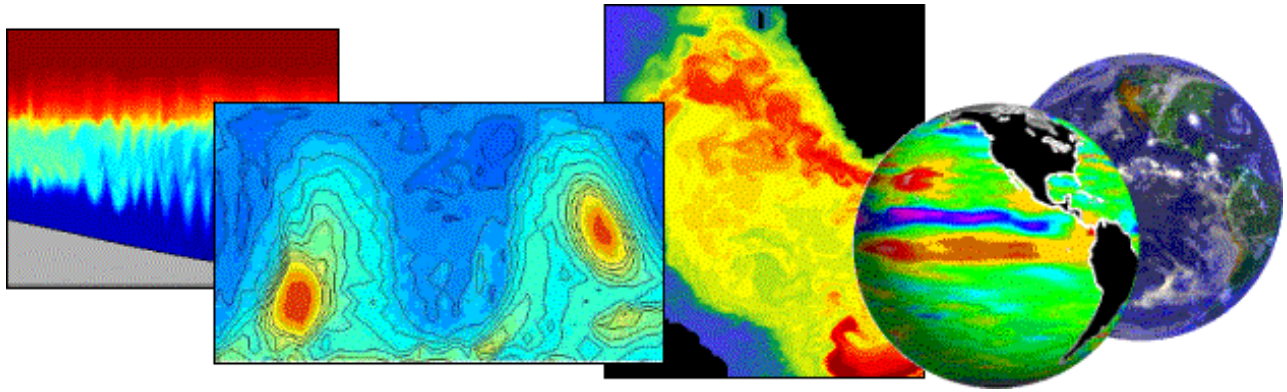
ECCO Projects Meeting

# MITgcm model development



Austin, TX Oct 29, 2018

MITgcm development

1. The move to GitHub (review)
2. Code development

- Coupling with GEOS (Udi, Dimitris)
- Earth Machine project, now: CliMa (Chris)
- Wetting and Drying with dynamical ice-shelf
- Two way nesting
- Other

# MITgcm in GitHub

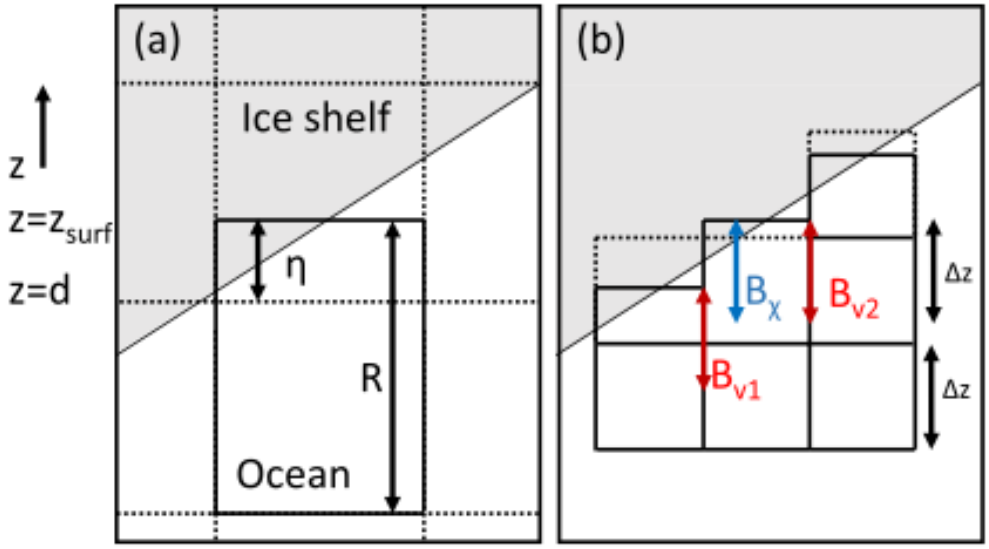
- main code moved in January (conversion from cvs to Git: Oliver Jahn)
- contribution/changes through pull-request (PR)
  - works well for limited addition/changes (95 merged PRs)
  - anyone can view any PR content and review it
  - a bit slower but code quality improves
- documentation in main MITgcm repository
  - conversion from latex to Sphinx (Jeff Scott) completed (except tutorials)
  - improved "getting started" section (Jeff)
  - old "How-to" document: merged into & improved
  - releases are on "zenodo.org" with a doi
- Contrib content:
  - "verification_other" repository added in same project (MITgcm)
  - other parts ?

# GitHub (cont)

- GitHub does not fix everything
  - no automatic documentation writer
  - large input files
- pull-request review process
  - permission to merge PR
    (currently: christophernhill, edoddridge, jahn, jm-c & jrscott)
  - code standard / PR requirement
- "travis" testing
  - cover only few experiments
  - no TAF license
- how to improve documentation
- how to replace "MITgcm_contrib"
  - individual/private GitHub projects
  - MITgcm_contrib project ? (currently empty)

## Wetting and Drying

- coupling with dynamical ice-shelf: published
  James Jordan *etal*, JGR, 2017 → "vertical" remeshing
  Dan Goldgerg *etal*, Ocean Modelling, 2018
  → with "horizontal" spreading and grounding line migration
- using pkg/streamice & pkg/shelfice
- non-linear free-surface in z coordinate
- vertical remeshing: clean and smooth transition when adding or removing 1 grid-cell (allows hFac > 1). → PR# 124



## Wetting and Drying (cont)

- "pCellMix" (increased vertical mixing and viscosity when grid-cell become very thin) could help
- horizontal spreading: more difficult with implicit free-surface
  - keep thin layer of resting water under grounded ice-shelf
  - porous flux implementation
  - use implicit bottom drag and ice-shelf drag
- not fully applicable to tidal excursion

## Two way nesting

- started by Louis-Philippe Nadeau + contribution from Carl Gladish and now Feras Habbal.
- different from Gianmaria Sannino implementation (no coupler)
- preliminary version in bitbucket
- exchanges between the 2 model work
- missing some parts (different time-steps, odd resolution ratio ...)
- tracer conservation

# Other development

- pkg/diagnostics for AD variables (Tim).
- Improved Leith scheme: QG Leith (Baylor F.K.)
  → getting in repository: PR # 96
- pkg/seaice
  - ITD code testing & cleaning ; ridging (Martin)
  - parameter default set to "good" (recommended) value (Martin)
  - preventing seaice to form or spread in some area
    e.g., thin ice-shelf in model top level
    also GEOS dry grid-cell
    → easy to do with proper mask (hEffM)
- spectral 3-D solver for LES with simple geometry & uniform resolution (Chris)
- no horizontal smoothing in ggl90 ?

Thanks !

## Implicit bottom friction:

useful with small partial-cell at the bottom or large bottom friction

$$u^{n+1} = \mathbf{U}^{-1}\mathbf{L}^{-1}\left(u^n + \Delta t G_u^{n+1/2}\right) - \frac{g\Delta t}{\Delta x}\mathbf{U}^{-1}\mathbf{L}^{-1}(\delta^i \eta^{n+1})$$

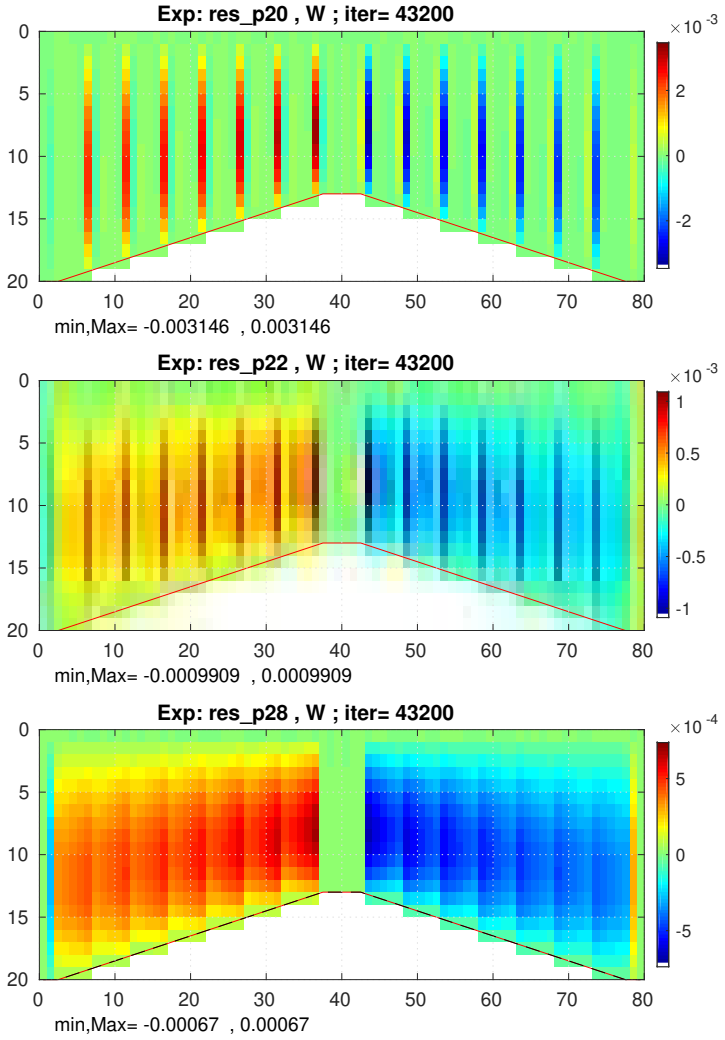
## Accounting for partial cell in vertical viscous and diffusive flux

- bottom stress (no-slip BC) with hFac ($bottomVisc\_pCell$ =T):
  $-viscAr_k\, u_k/(drF_k/2) \quad / hFac_k$
- hFac in interior viscous flux ($interViscAr\_pCell$ =T)
  $viscAr_k\,(u_k - u_{k-1})/drC_k \quad / \overline{hFac}^k$
- hFac in interior diffusive flux ($interDiffKr\_pCell$ =T)
  $diffKr_k\,(T_k - T_{k-1})/drC_k \quad / \overline{hFac}^k$

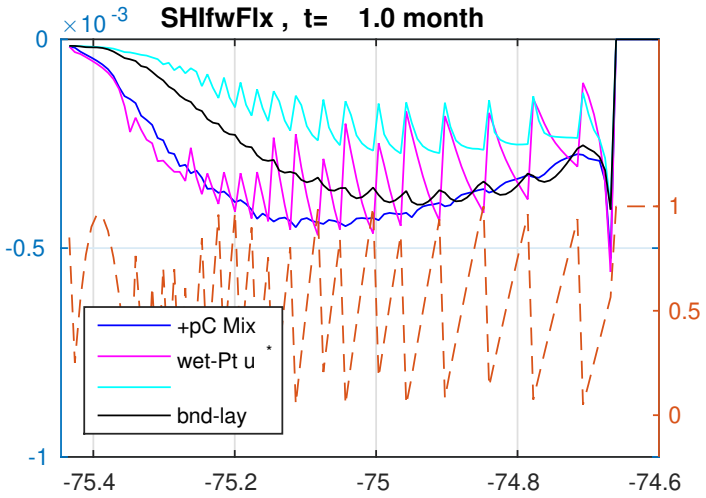
## Increasing viscosity and diffusion near bottom

- numerical "trick" for too thin bottom cell (small $hFac$)
- ensure a smooth evolution as $hFac$ get smaller
- increase near bottom interior viscosity and diffusivity by:
  $recip\_hFac^n$ $(n = pCellMix\_select)$
- also available for too thin surface grid cell

# pCellMix test:




2-D flow over a sill, linear dynamics with quadratic bottom drag




Melting rate in 2-D shelfice set-up with or without: SHELFICEboundaryLayer, Wet-Point $U^*$, pCell-Mix.