

Vertical coordinate modification and accommodation of ice-shelves

reported by

Matthew Hecht, LANL

Why modify vertical coordinate?

- From the CESM2 Ocean Model Requirements document, we must accommodate:
 - Natural boundary condition on freshwater and tracers
 - Small vertical scale structures in upper ocean
 - Floating sea ice
 - Floating ice shelves

http://www.cesm.ucar.edu/working_groups/Ocean/agendas/pop2.requirements.pdf

Why modify vertical coordinate?

- From the CESM2 Ocean Model Requirements document, we must accommodate:
 - Natural boundary condition on freshwater and tracers
 - Small vertical scale structures in upper ocean
 - Floating sea ice ← Workshop in Boulder next week on sea ice/ocn coupling; RACM workshop last month in Monterey
 - Floating ice shelves

http://www.cesm.ucar.edu/working_groups/Ocean/agendas/pop2.requirements.pdf

Ocean Mod requirements for CESM.2 set at Dec. meeting, posted online:

Navigation: CESM Administration Working Groups Models Events News Publications Projects

Community Earth System Model

CESM OCEAN MODEL WORKING GROUP

Support of specific science objectives of the CESM and maintaining a state-of-the-art ocean component for the CESM as well as conducting related, but curiosity-driven, research leading to new contributions to the CESM community are the primary goals of the OMWG. The former goals ensure that our working group, through CESM, fully contributes to science. The latter is absolutely necessary to keep the CESM at the leading edge of ocean climate models. This, of course, requires a continuous high level of effort and support. Information on the new ocean model component of the CESM can be found at <http://www.cesm.ucar.edu/models/cesm1.0/pop2/>.

Upcoming Meetings

Ocean Model Working Group Meeting

14 - 15 December, 2011, NCAR, Boulder, CO [[agenda + presentations](#)] [[POP2 Requirements](#)] [[participants](#)]

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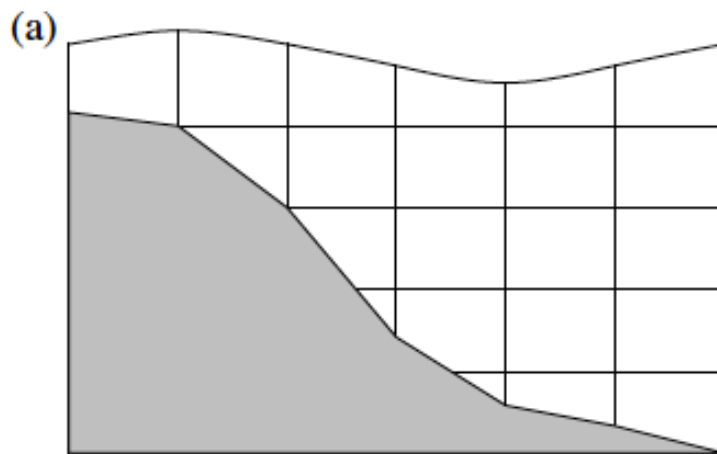
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 14 - 15 December, 2011, NCAR, Boulder, CO [agenda + presentations] **[POP2 Requirements]** [participants]

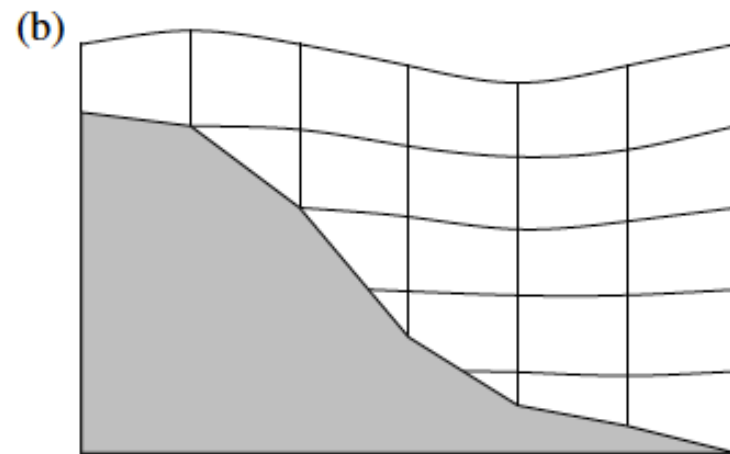
Time stepping to accommodate frequent coupling (preceding presentation) is the other development that came out of these req's

z-star: allow all levels to respond in a proportional way to external mode

A. Adcroft, J.-M. Campin / Ocean Modelling 7 (2004) 269–284



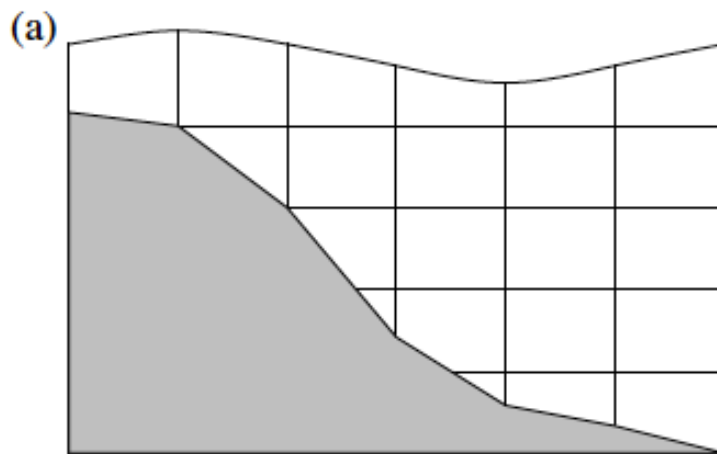
How POP does it now



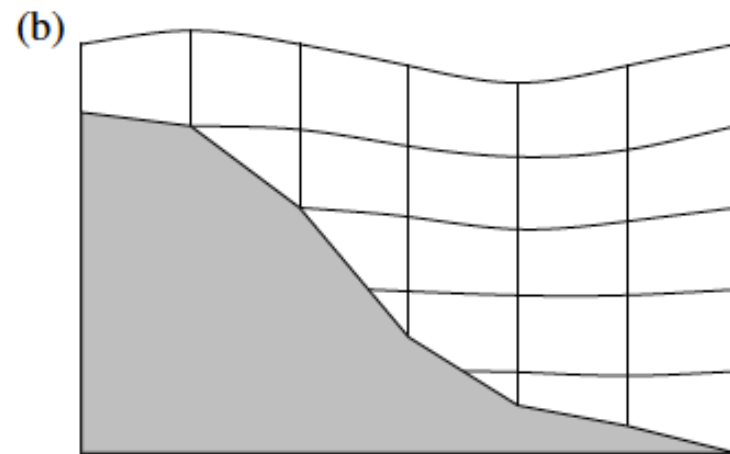
Z-star

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A. Adcroft, J.-M. Campin / Ocean Modelling 7 (2004) 269–284



How POP does it now




Z-star

As per MITGCM, MOM, NEMO

Modification of vertical coordinate is underway:

- Start from CESM version cesm1_1_beta08
- Design document, based on requirements
 - as per **Mark's** MPAS z-star/z-tilde design document
- **Phil** modified code for stand-alone use
- Propagate 3-D DZ(t), as **Wilbert** did in HyPOP
- Add thickness variable, as per HyPOP
 - Test in diagnostic mode

Modification of vertical coordinate is underway:

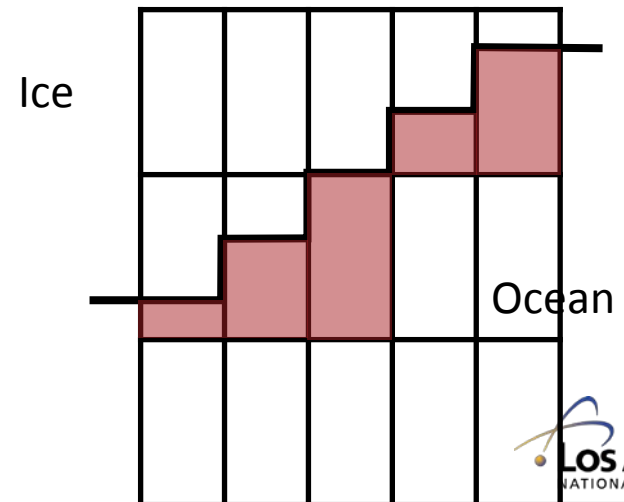
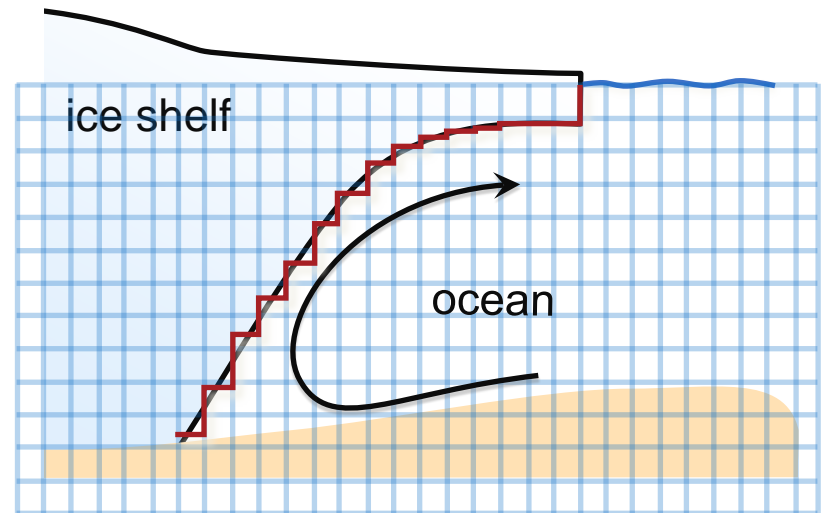
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 - Test in diagnostic mode  now

Ice sheet/ocean coupling also involves the vertical coordinate

- Just as we use partial bottom cells to better resolve the bottom slope, can use partial top cells to resolve the ice sheet/ocn interface
- Simpler than the Immersed Boundary Method
 - IBM still an attractive option... for later.
 - **Xylar** has partial top cells working, now.
 - Currently in a separate code branch. Will merge, once z-star has been implemented and vetted.

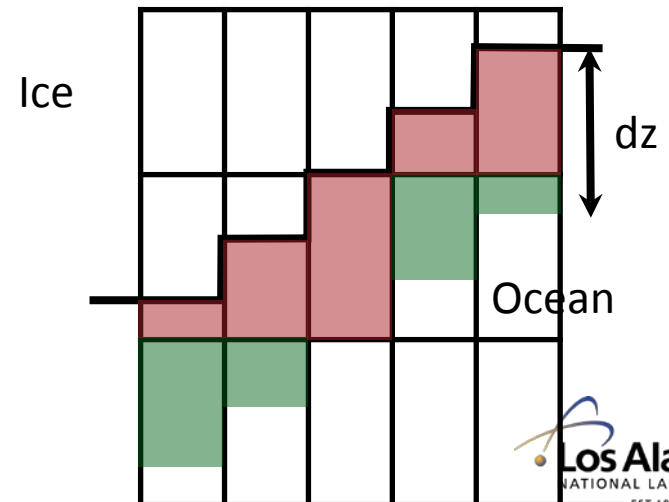
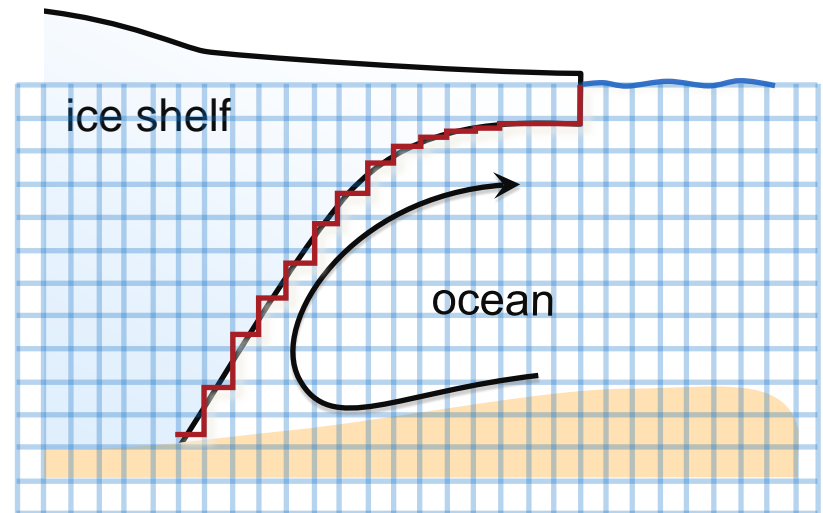
Ice-sheet/Ocean interface in POP

- See Asay-Davis talk in LIWG on Thursday for more details
- Modified version of POP: POP2X includes ocean cavities under ice shelves
- Ice/ocean boundary defined by **partial-top cells** (analogous to partial-bottom cells)
- Based on Losch 2008: static ice shelves in MITgcm



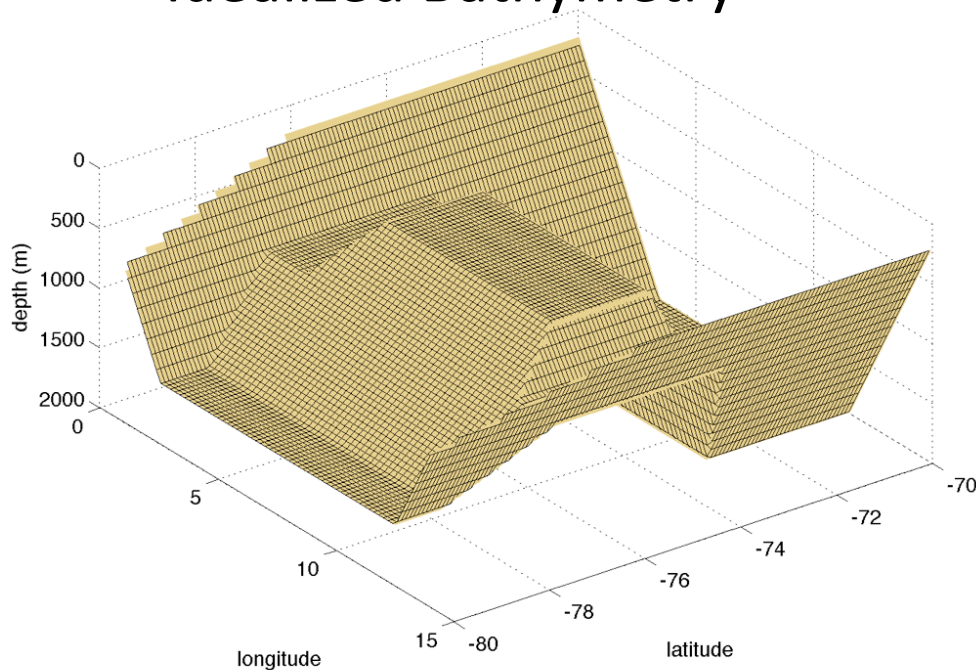
Partial Cells Method

- Following Losch 2008, “boundary layer” below partial top cells:
- Salt/heat from melting/freezing mixes into both **partial cell** and **next cell below** (reduces noise at expense of extra mixing)
- “boundary layer” does not resolve true boundary layer physics

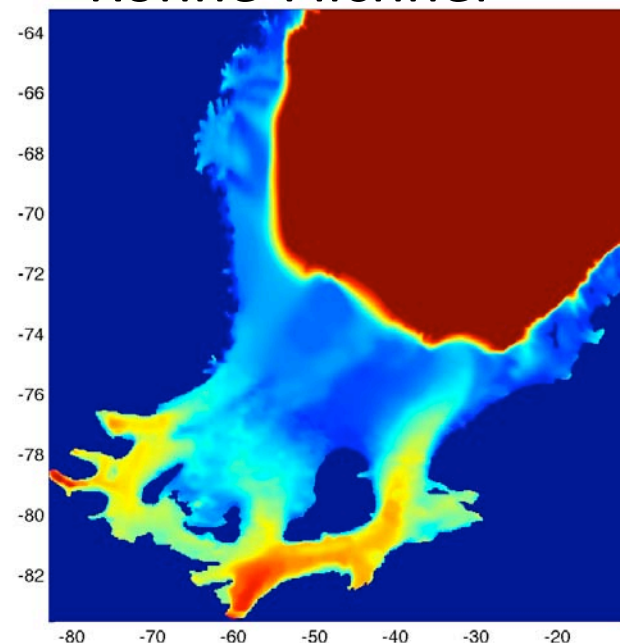


Sim. with Idealized Geometry

Idealized Bathymetry



Ronne-Filchner



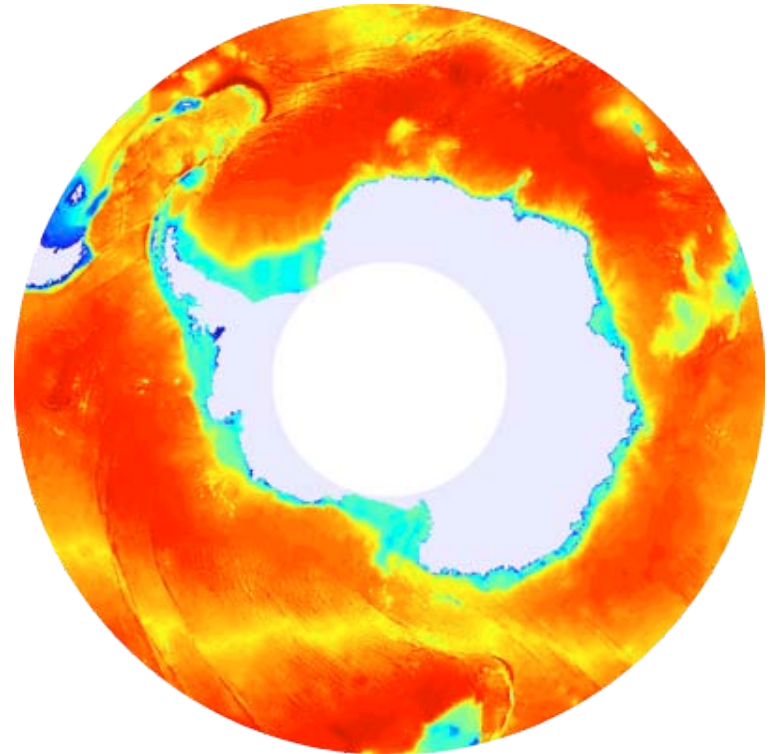
- Expt. 6 from Grosfeld et al. 1997
- Bathymetry mimics Ronne-Filchner: troughs; deepens to the south; northern basin (Weddell Sea)

Closed box (not periodic in either direction)

In progress: sim. of Southern Ocean (no ice shelves yet)

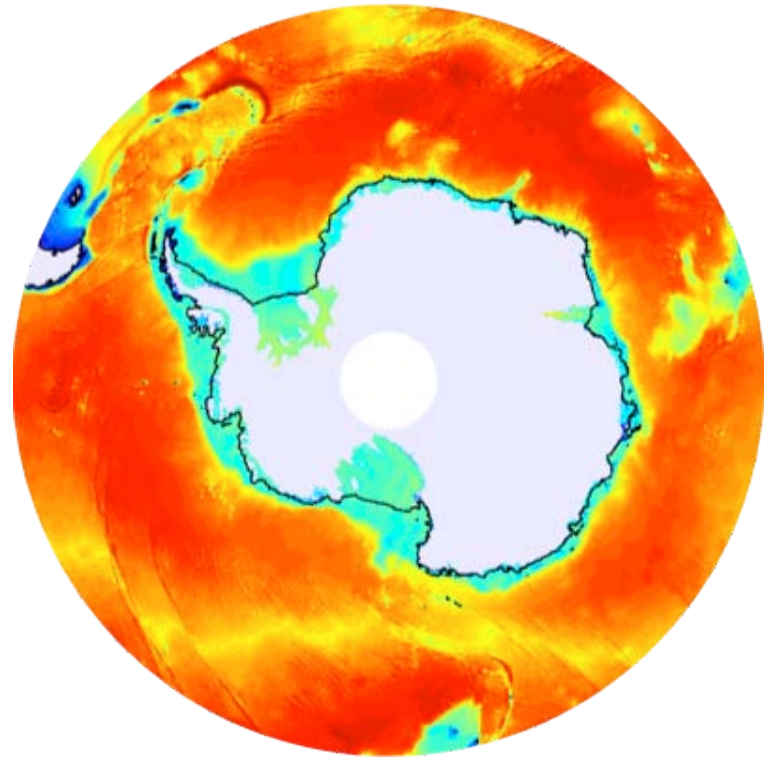
- Existing POP grid: No cavities under ice shelves

Mathew Maltrud
has set this up

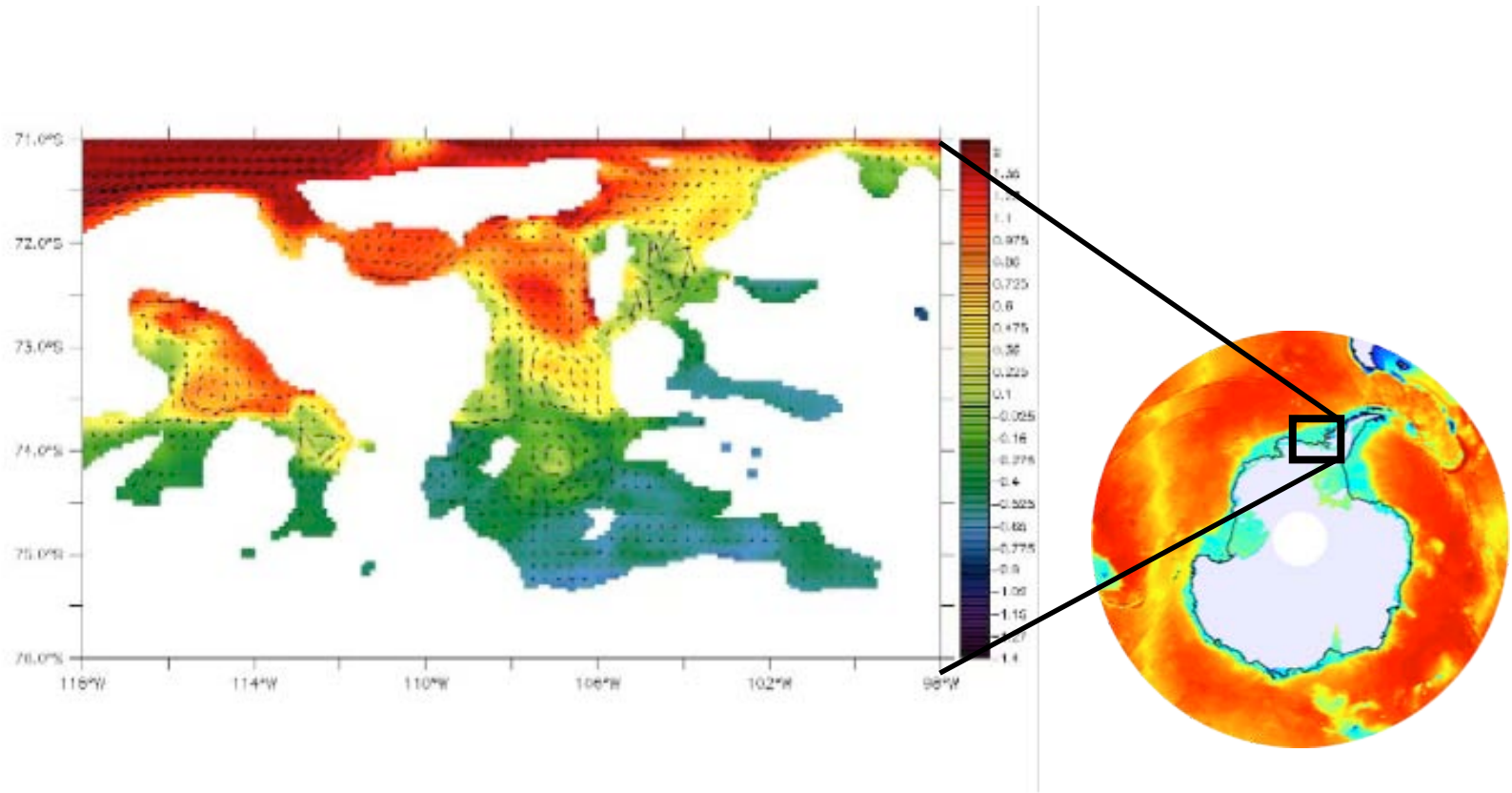


In progress: sim. of Southern Ocean (no ice shelves yet)

- Existing POP grid: No cavities under ice shelves
- New POP grid: Ice shelves replace by open ocean
- Bathymetry from RTOPO-1 data set (Timmermann et al. 2010)



In progress: sim. of Southern Ocean (no ice shelves yet)



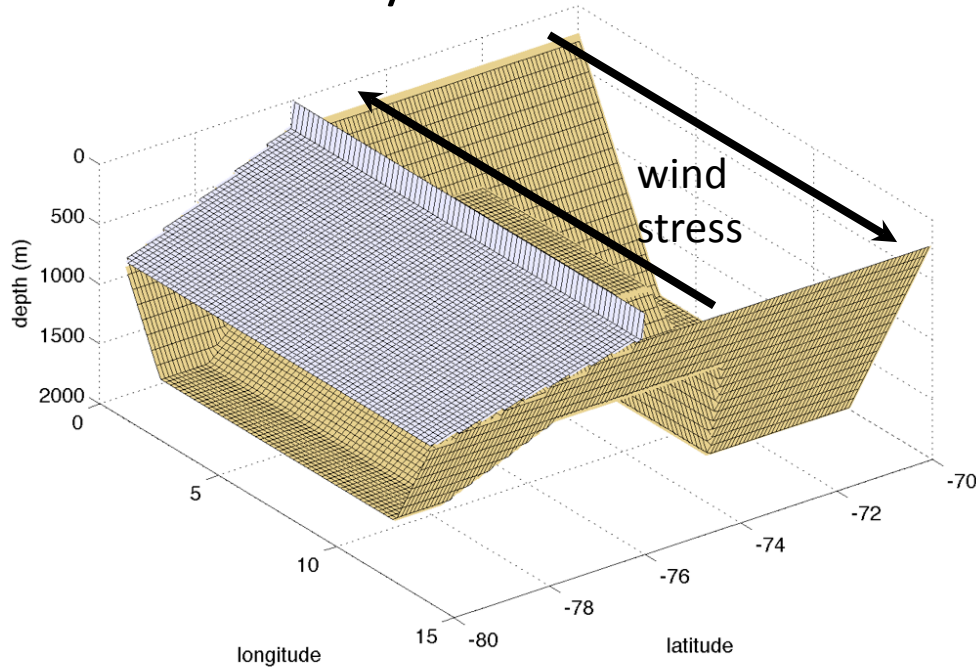
Model temperature and velocity vectors in the Amundsen Sea
at 579 m depth after 2 years.

Summary

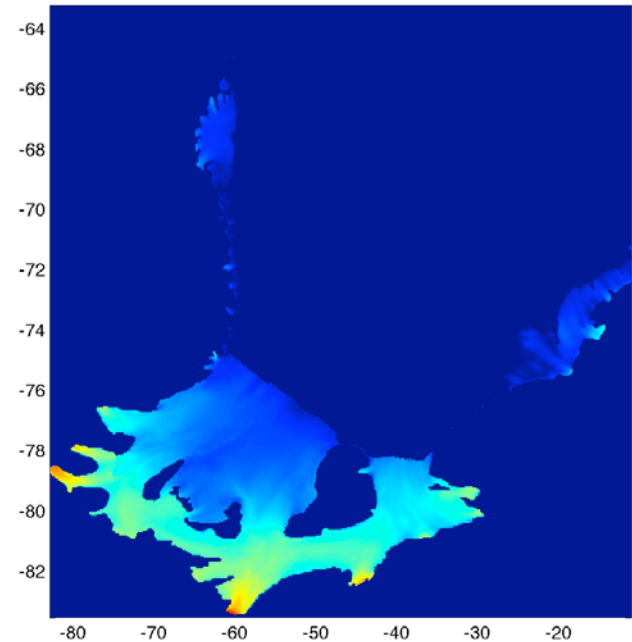
- Conservative Robert filter implemented, being evaluated -- as Mathew Maltrud explained
- Partial top cell approach to ice sheet/ocean coupling also implemented, going through evaluation – to be presented to Land Ice Group (Thurs)
- Implementation of z-star vertical coordinate underway

Sim. with Idealized Geometry

Idealized Ice/ocean interface



Ronne-Filchner



- Linearly sloped ice shelf covers southern 40% of domain
- Open ocean:
 - zonal wind stress

melting/freezing by simplified sea-ice model

Sim. with Idealized Geometry

Expt. 6 from Grosfeld et al. 1997

