MOM6 ice shelf pan-An parameters meeting

10 Oct 2025

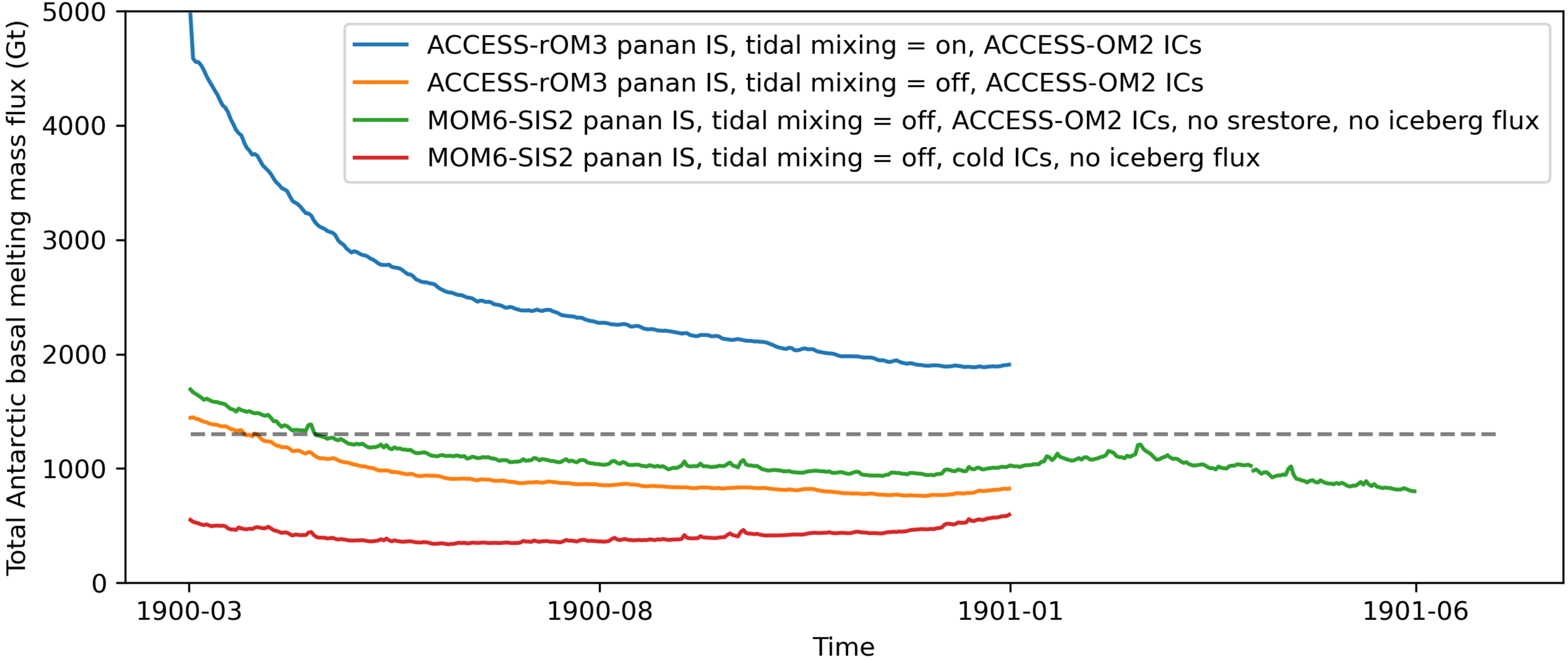
Where we are at

- 4 x 1 year simulation, two with ACCESS-OM3 and two with MOM6-SIS2
- Expensive: 240kSU/year
- Known frazil bug in all experiments that prevents refreezing.

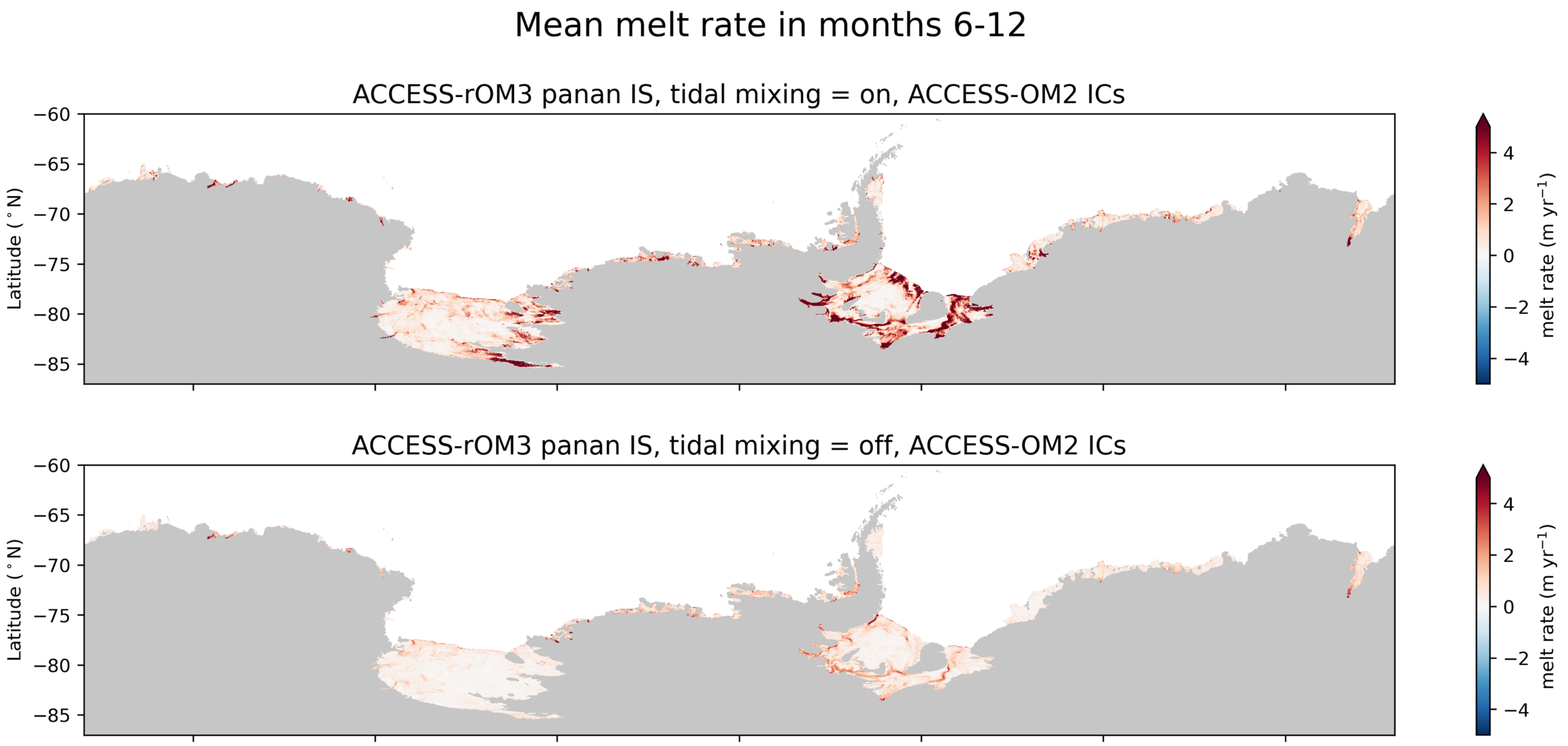
Expts:

1. ACCESS-OM3, with ACCESS-OM2 restart ICs, tides contribute to melt param (melts too much)
2. ACCESS-OM3, with ACCESS-OM2 restart ICs, tides do not contribute to melt param (melts too little)
3. MOM6-SIS2, with ACCESS-OM2 restart ICs, tides do not contribute to melt param (melts too little)
4. MOM6-SIS2, with COLD Ics (0.1deg above freezing), tides do not contribute to melt param (melts too little)

Meeting comment: Looking pretty good!

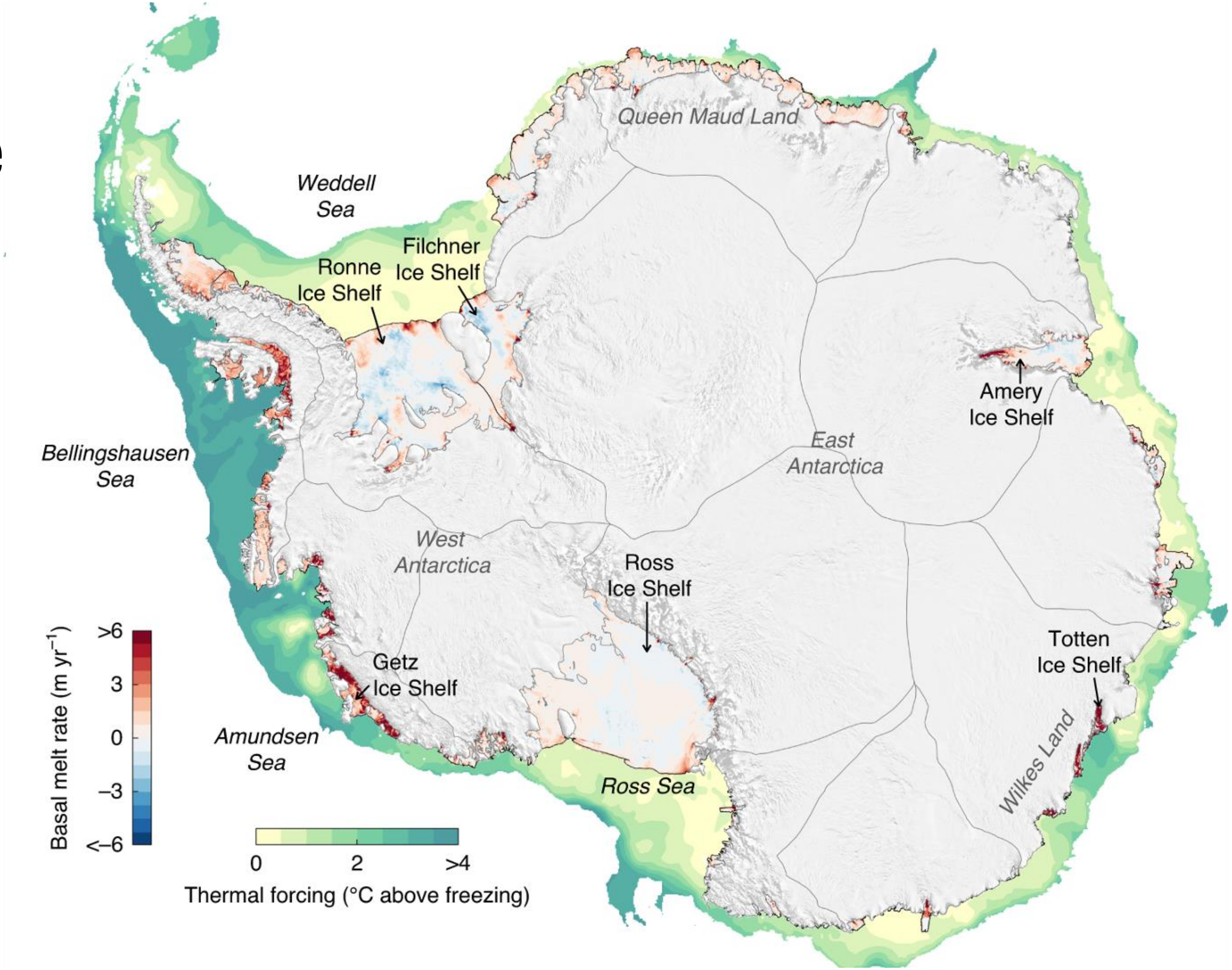


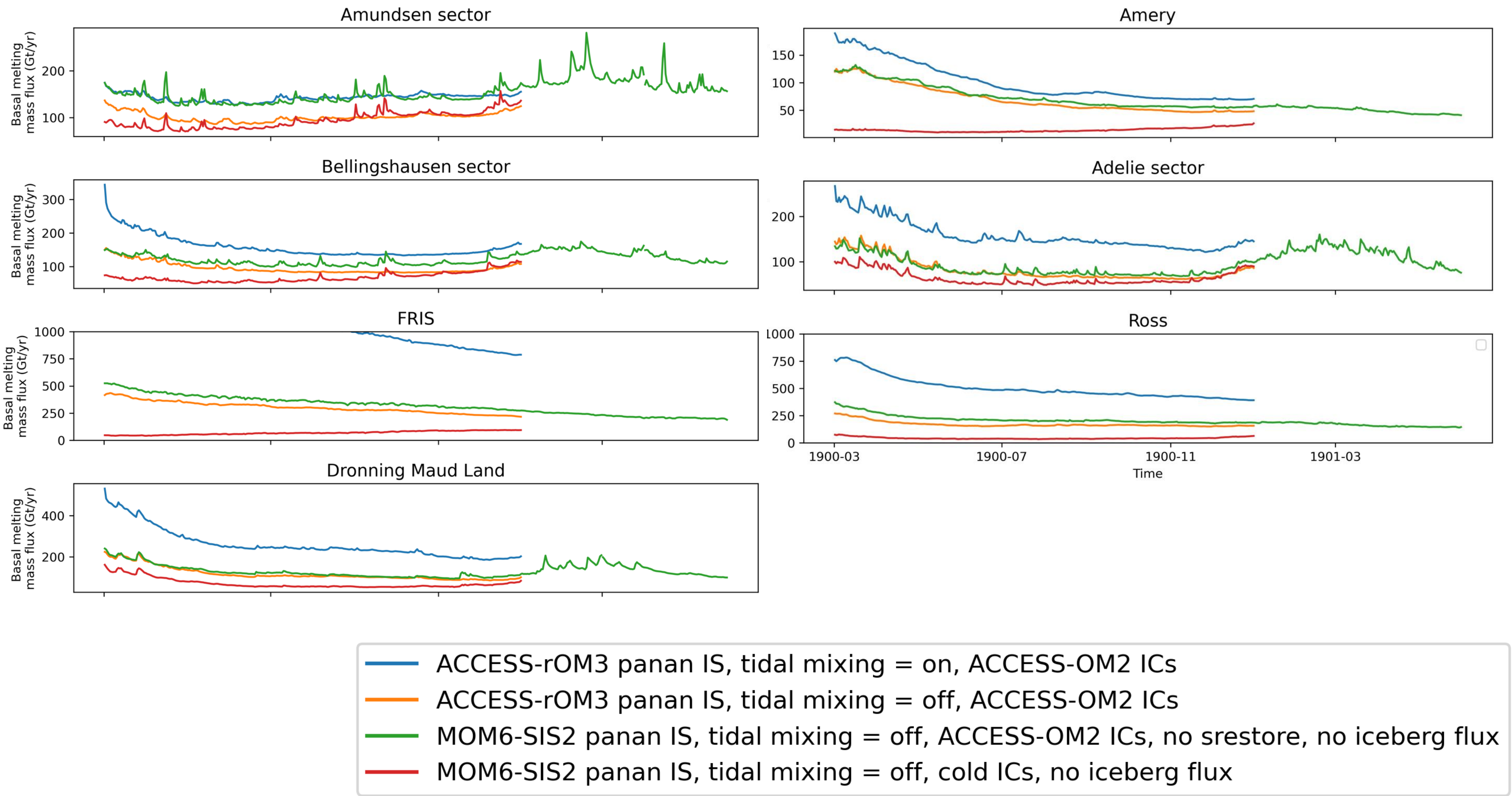
Meeting comment: RISE models generally less than Rignot 1300Gt/yr value



Mean melt rate in months 6-12
ACCESS-rOM3 panan IS, tidal mixing = on, ACCESS-OM2 ICs
−60
−65
−70
−75
−80
−85
Latitude (° N)
4
2
0
−2
−4
melt rate (m yr^{-1})
ACCESS-rOM3 panan IS, tidal mixing = off, ACCESS-OM2 ICs
−60
−65
−70
−75
−80
−85
Latitude (° N)
4
2
0
−2
−4
melt rate (m yr^{-1})

Adusumilli et al. 2020 figure



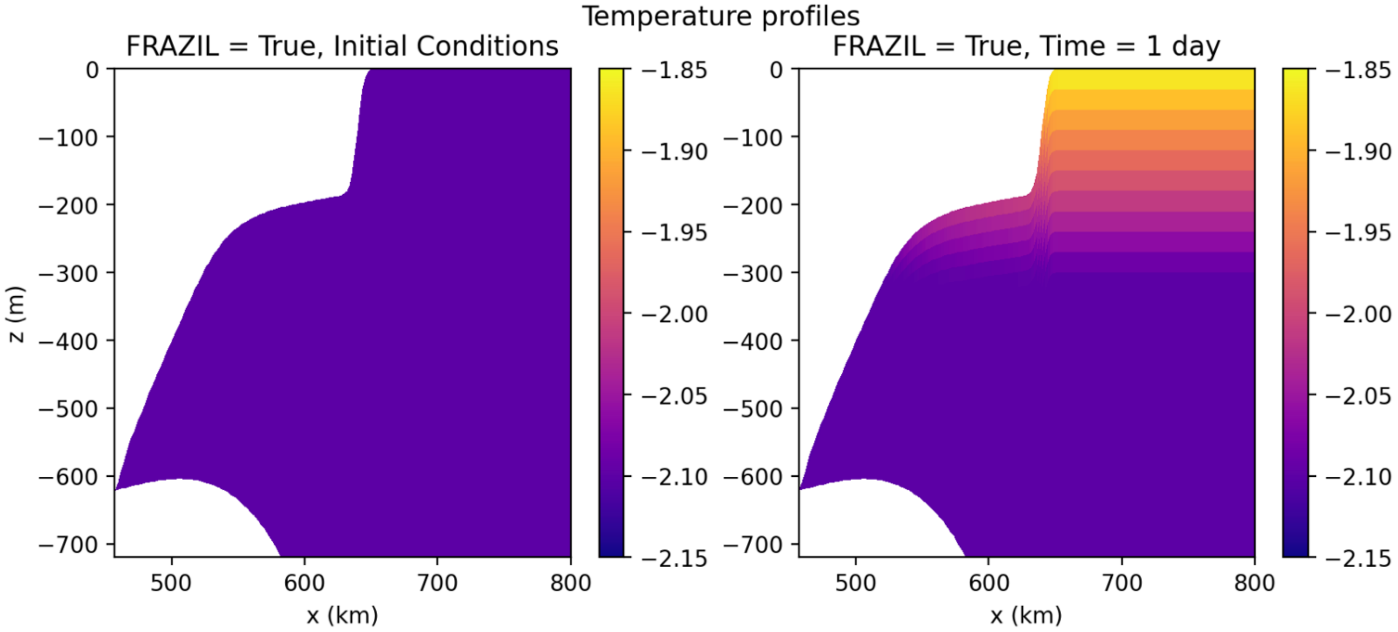

Amundsen sector
Amery
Bellingshausen sector
Adelie sector
FRIS
Ross
Dronning Maud Land
Basal melting mass flux (Gt/yr)
Time
1900-03
1900-07
1900-11
1901-03
ACCESS-rOM3 panan IS, tidal mixing = on, ACCESS-OM2 ICs
ACCESS-rOM3 panan IS, tidal mixing = off, ACCESS-OM2 ICs
MOM6-SIS2 panan IS, tidal mixing = off, ACCESS-OM2 ICs, no srestore, no iceberg flux
MOM6-SIS2 panan IS, tidal mixing = off, cold ICs, no iceberg flux

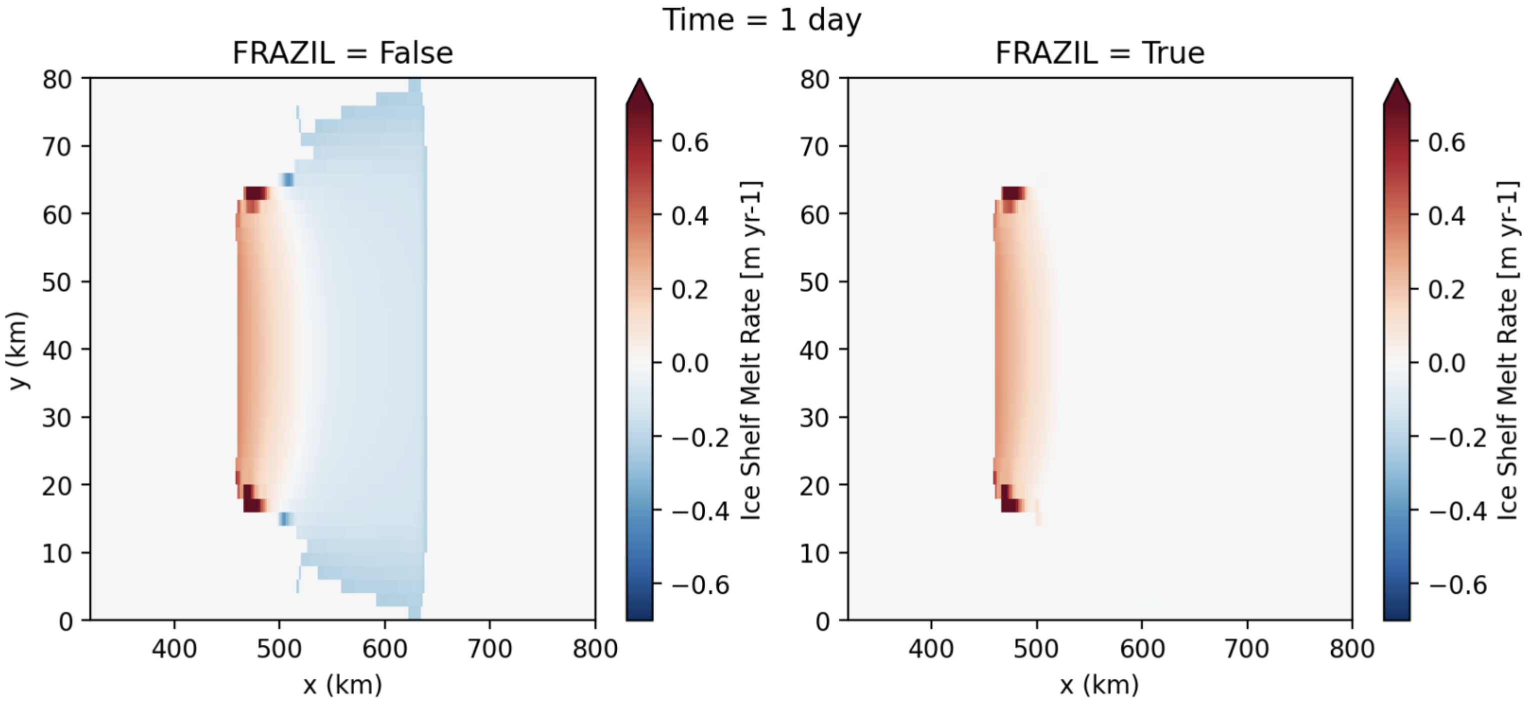
- "Frazil" formulation (currently not conserving heat, code changes required https://github.com/claireyung/mom6-panAn-iceshelf-tools/issues/43)
- Internal tide dissipation, bottom boundary tide mixing? https://github.com/claireyung/mom6-panAn-iceshelf-tools/issues/42 (requires change to input file at least, and more verification)
- Melt parameterisation minimum friction velocity (for both numerical and physical reasons)
- Prescribed additional friction velocity for tidal velocities (constant, spatially varying based on Jourdain 2019 – reqs same file as internal tide dissipation https://github.com/claireyung/mom6-panAn-iceshelf-tools/issues/42)
- Drag coefficient
- Transfer coefficients/melt parameterisation choice
- Sampling of far-field conditions/vertical spread of FW in melt parameterisation? (noting spread beyond the first layer would require code changes as currently it would also affect open ocean)
- Initial conditions
- Goals to compare with (models, satellite/in situ melt obs, ocean obs), and what we accept to be good enough, given expense of model and limited time
- Checking conservation/budget closure, and calling for help if anyone has done that yet in OM3/knows what the diagnostics should be
- Age tracer in cavity (thoughts, opinions – currently it is set to zero at ice shelf-ocean boundary layer too)
- Horizontally spreading iceberg flux https://github.com/ACCESS-NRI/access-om3-configs/issues/728

Frazil/IOU heat scheme

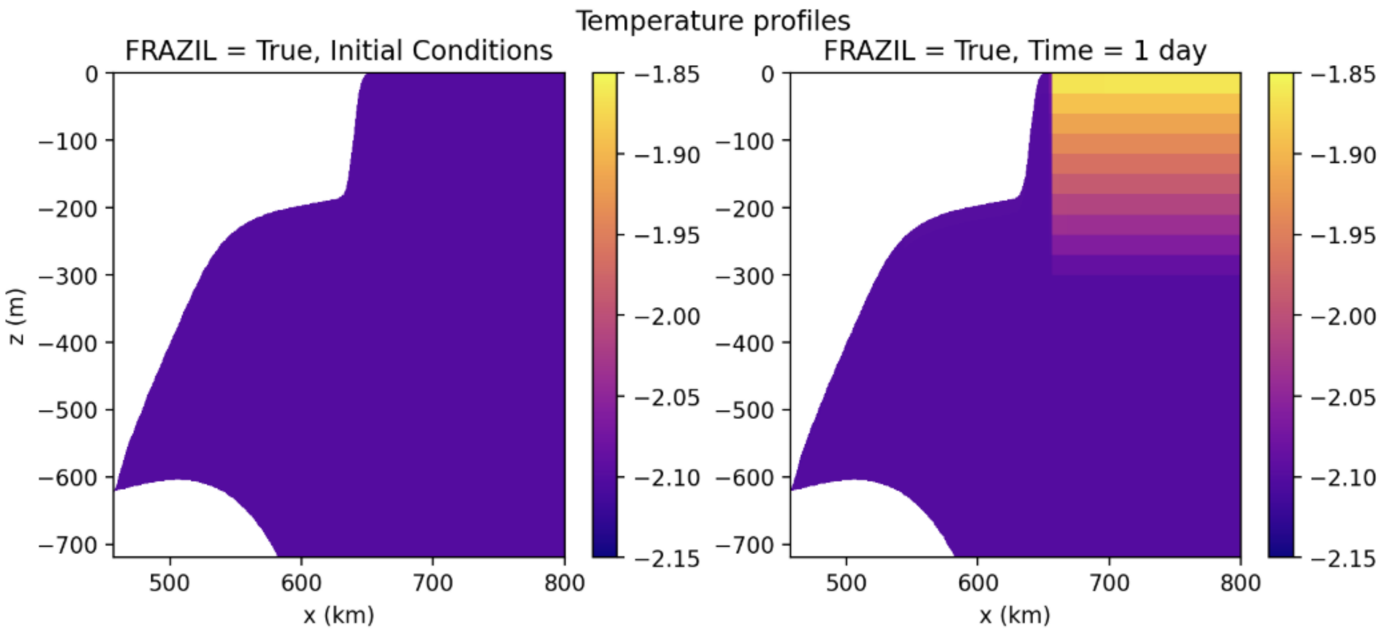
- Not conserving heat, hence why no refreezing in my simulations
- Fix not straightforward
- Thank you Andrew and Dave for discussion! https://github.com/claireyung/mom6-panAn-iceshelf-tools/issues/43

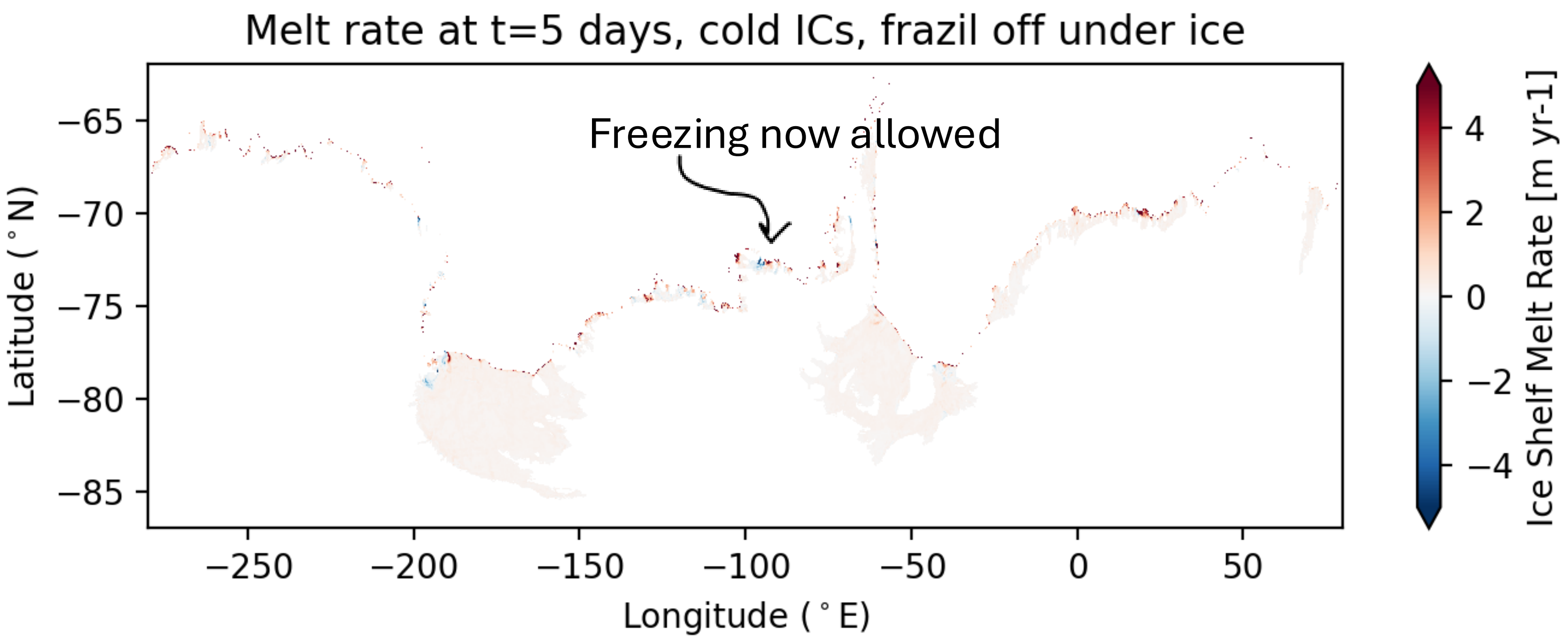
Current issue:





Potential fix 1: turn frazil off under ice shelves





Meeting comment: run this for longer

Potential fix 2: deal with IOU heat

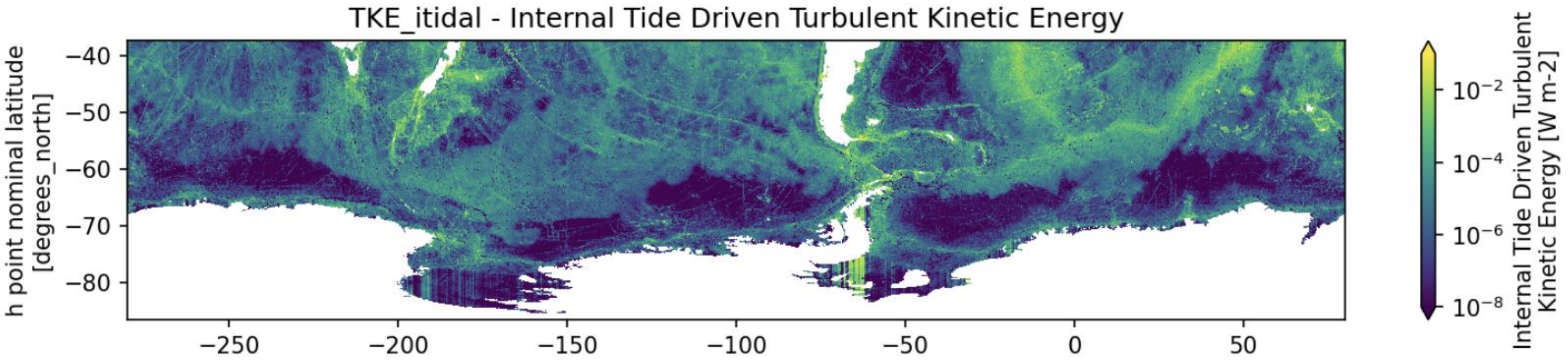
- As an effective temperature in the thermal driving of the melt parameterisation?
  - But, different process. What boundary layer thickness? And can make it appear to be not conserving at any given time, because of heat storage in the leftover frazil term if not all used up in one timestep
- As an extra freeze flux *after* 3eqn parameterisation?
  - More like sea ice approach. Requires engineering…. Frazil heat content J/m^2, whereas other fluxes are W/m^2….
- Let top cell get supercooled, i.e. don't let IOU heat pass through it, has a negative temp, freezing is direct from melt parameterisation.
  - What if top cell vanished? Not a problem right now, but maybe later.
  - Same issue as #1 with regard to process

Meeting comment: or, do frazil fluxes/brine rejection LOCALLY in each cell (the most physically correct)

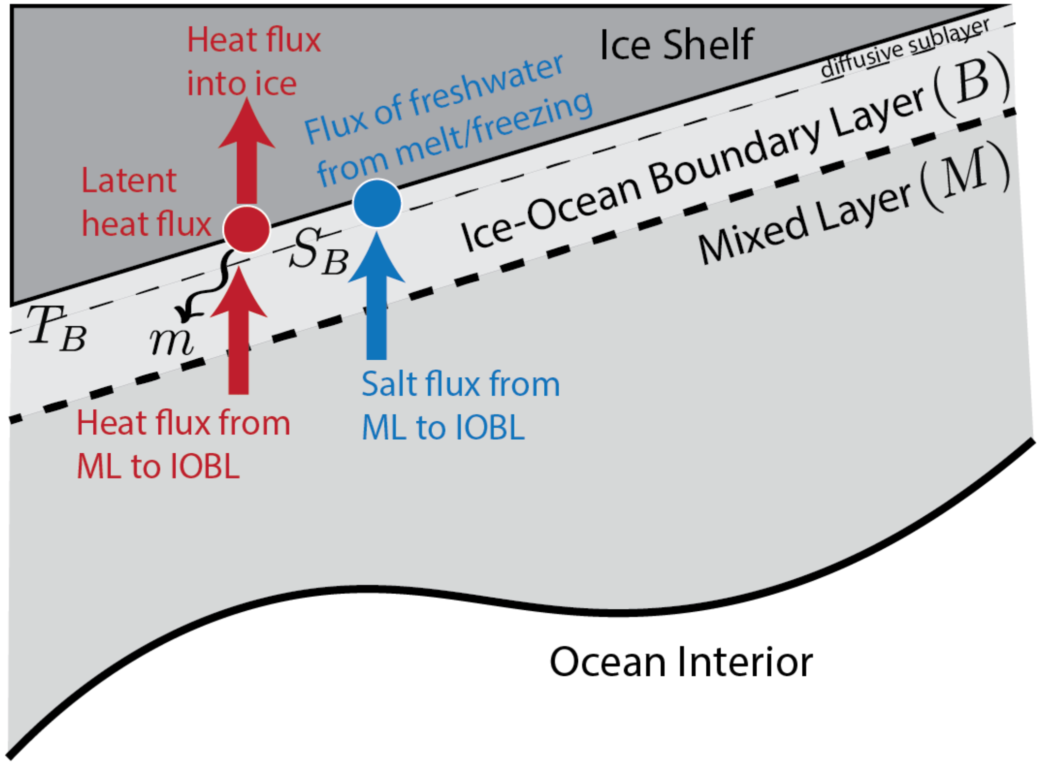
Internal tide dissipation

- Requires file change to avoid internal tide dissipation south of critical latitude, minor effect so NOT the reason why melt rates were high
  - Solution: set bathymetry roughness to zero south of 74S

Meeting comment: agreed



3-eqn melt parameterisation



$$\rho_I L m = \rho_I c_{p,I} \kappa \left.\frac{dT}{dz}\right|_b + \rho_w c_{p,w} (T_w - T_b) \gamma_T$$

$$\rho_I L m = \rho_w c_{p,w} (S_w - S_b) \gamma_S$$

$$T_b = \lambda_1 + \lambda_2 S_b + \lambda_3 p$$

Usually:

$$\gamma_T = \Gamma_T u_*, \gamma_S = \Gamma_S u_*$$

Choices for Γ_T, Γ_S:

- Constant: Jenkins et al. 2010 or tuned
- Variable: Holland and Jenkins 1999 with McPhee 1981 η_* parameter, or StratFeedback

Choices for u_*:

$$u_* = \max\left(c_d^{\frac{1}{2}} \sqrt{U_w^2 + U_t^2}, \quad u_{*,min} \right)$$

Melt parameterisation

Transfer coefficients

- $\gamma_T = \Gamma_T u_*, \gamma_S = \Gamma_S u_*$
- Choices for Γ_T, Γ_S:
  - Constant: Jenkins et al. 2010 or tuned
  - Variable: Holland and Jenkins 1999 with McPhee 1981 η_* parameter, or StratFeedback
- StratFeedback will decrease West Antarctic melt and increase FRIS, exacerbating our current bias....

Meeting comment: We haven’t run long enough to establish a bias

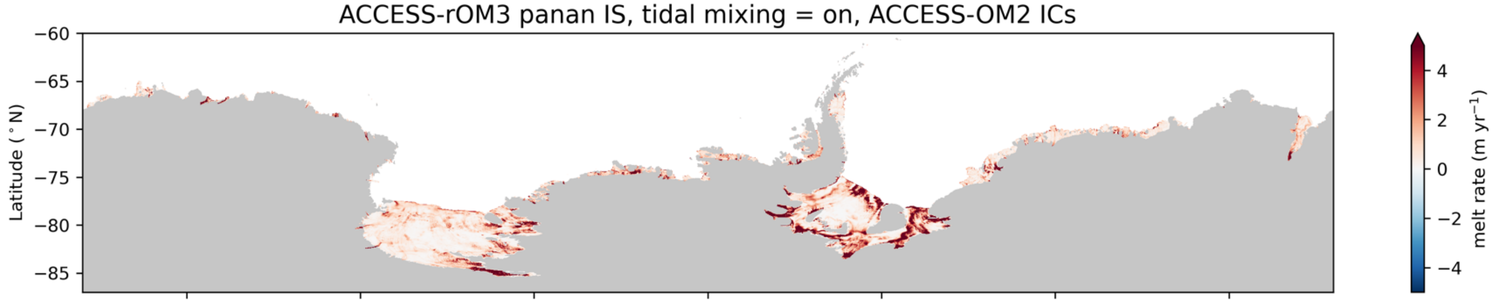
Melt parameterisation

Choices for u_*:

$$u_* = \max\left(c_d^{\frac{1}{2}} \sqrt{U_w^2 + U_t^2}, \qquad u_{*,min} \right)$$

Tidal velocity

- Jourdain et al. 2019 suggest a relationship of $U_t = \ 0.66\ U_{amp}$ where U_{amp} is the barotropic tidal amplitude from e.g. TPXO
- Inadvertently already tested this, but with too big an amplitude
  ($U_t = \ U_{amp}$) (could add scaling factor to code) Meeting comment: sounds good
- Probably makes Filchner-Ronne and Ross melt too much relative to Amundsen, but maybe compounded by frazil issue
- Alternative – choose a constant U_t.



Melt parameterisation

Choices for u_*:

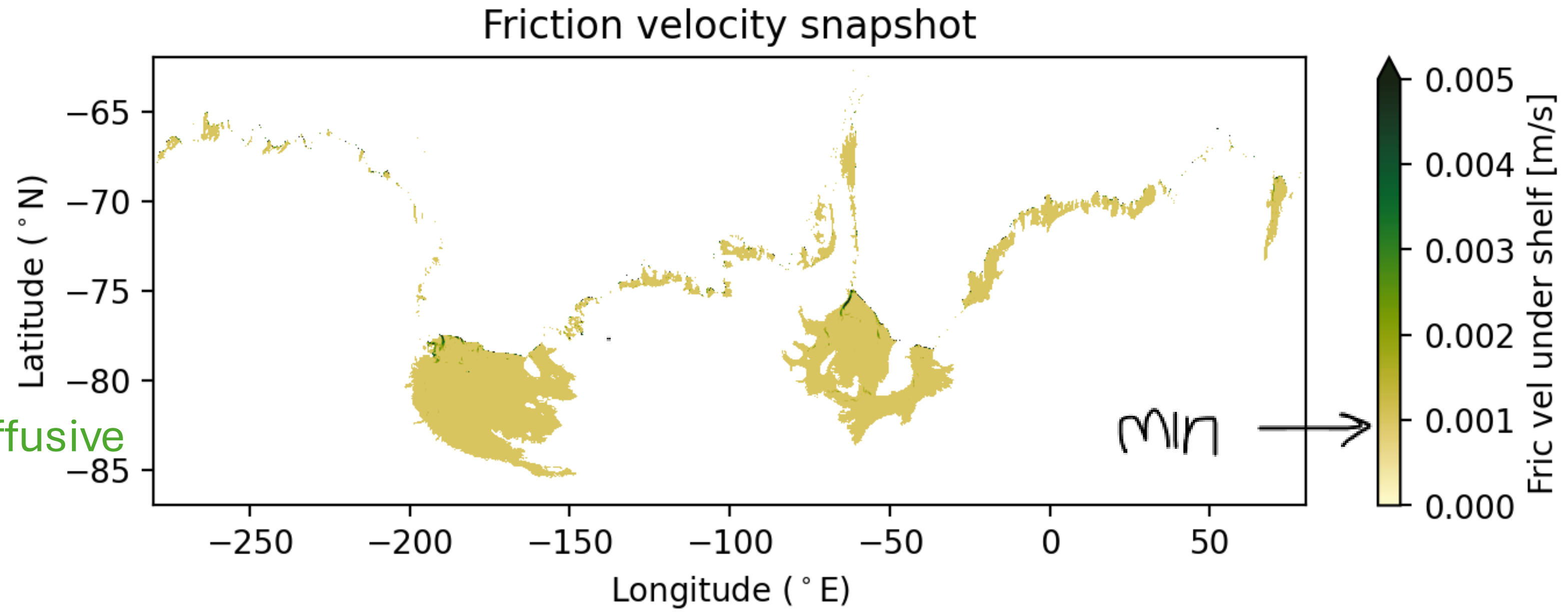
$$u_* = \max\left(c_d^{\frac{1}{2}} \sqrt{U_w^2 + U_t^2}, \quad u_{*,min} \right)$$

Minimum friction velocity

- Currently it is 0.001m/s, too big since that is bigger than resolved velocities almost everywhere.
- Can't be zero for numerical reasons, might expect a lower limit of due to diffusive-convective melt anyway.
- Gwyther 2016: 2E-5m/s, Jourdain 2019: 6E-4m/s

Meeting comment: compare to U_tC_d component

Gwyther calc from HJ99+M81 based on ROMS vertical grid thickness as diffusive lengthscale



Melt parameterisation

Choices for u_*:

$$u_* = \max\left(c_d^{\frac{1}{2}}\sqrt{U_w^2 + U_t^2}, \qquad u_{*,min}\right)$$

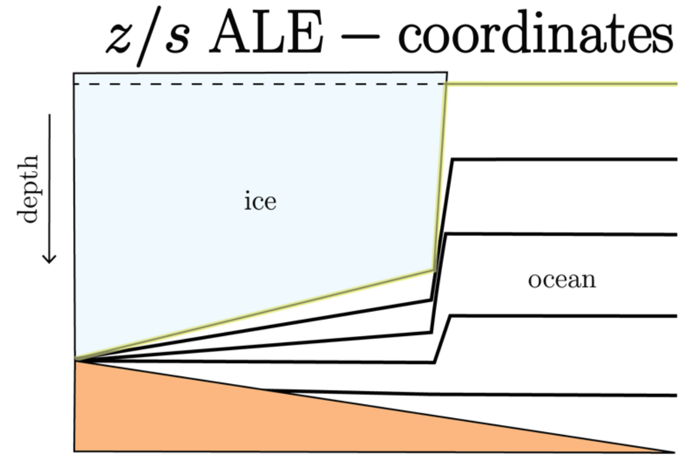
Drag coefficient

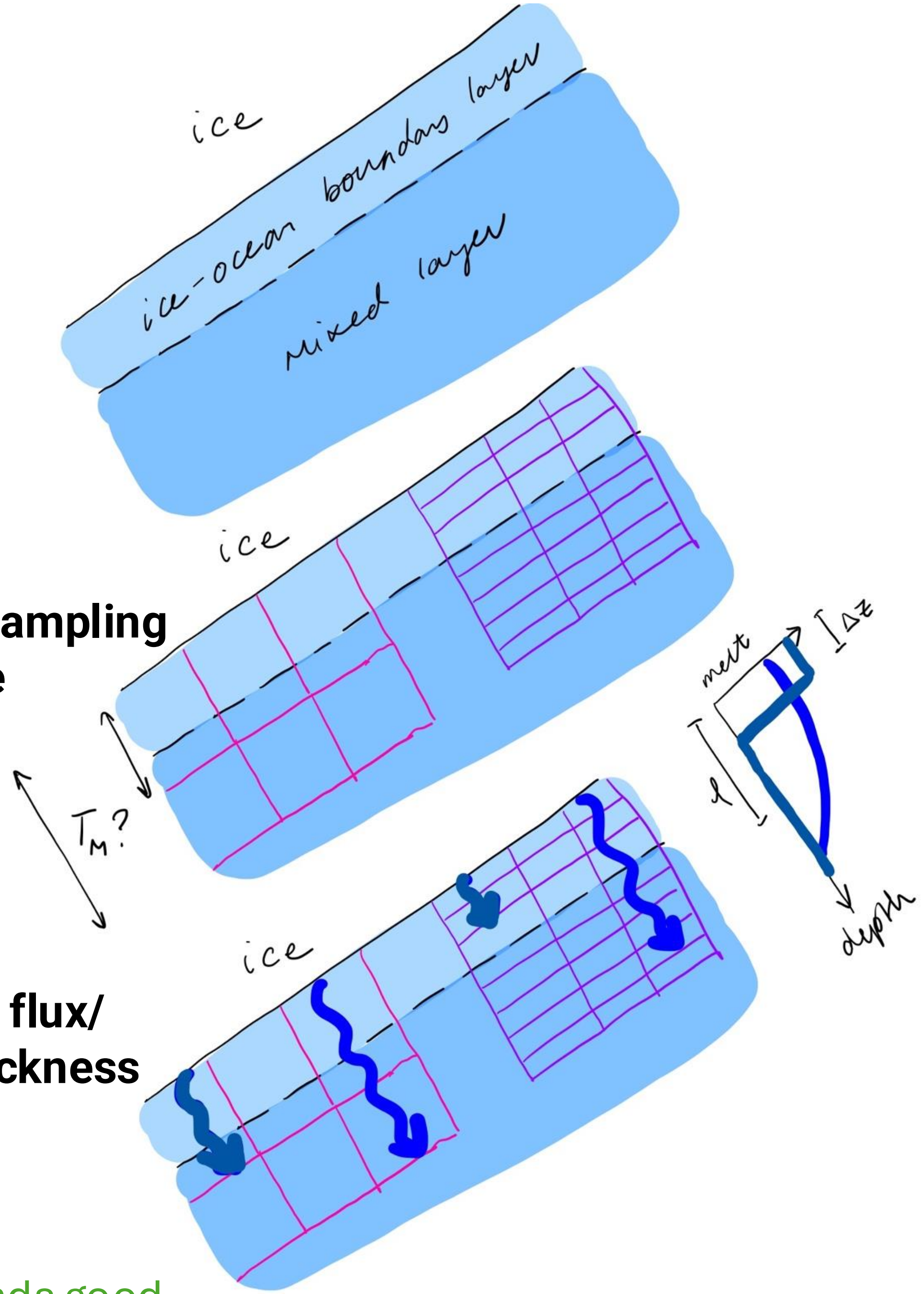
- Currently it is 0.0015 (HJ99 value)
- Tuning??
- Also affects drag law.

Meeting comment: start with this

Vertical coord related parameterisation choices

- Sampling of Td, velocities etc
- Distance over which fluxes are distributed
- In ALE mode, can be over a fixed distance, or just in top layer (by choosing a small distance)



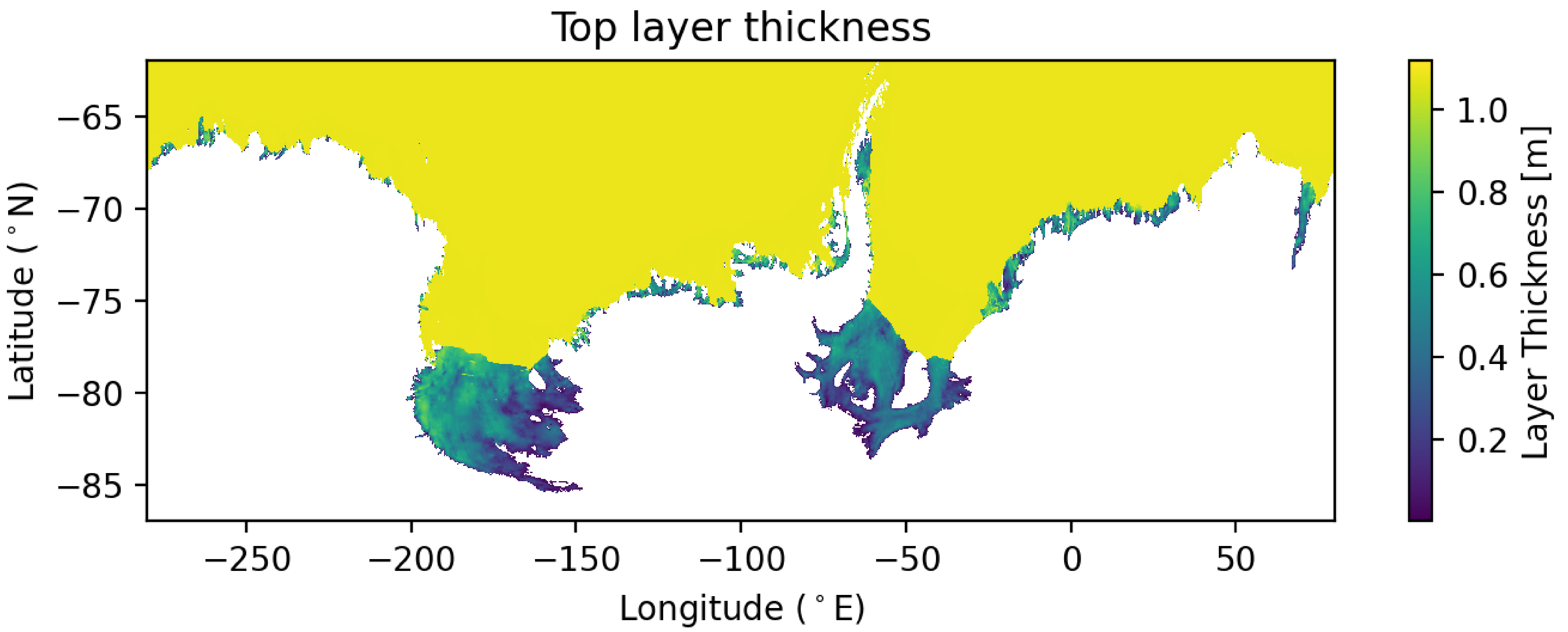


Tracer sampling distance

Meltwater flux/ mixing thickness

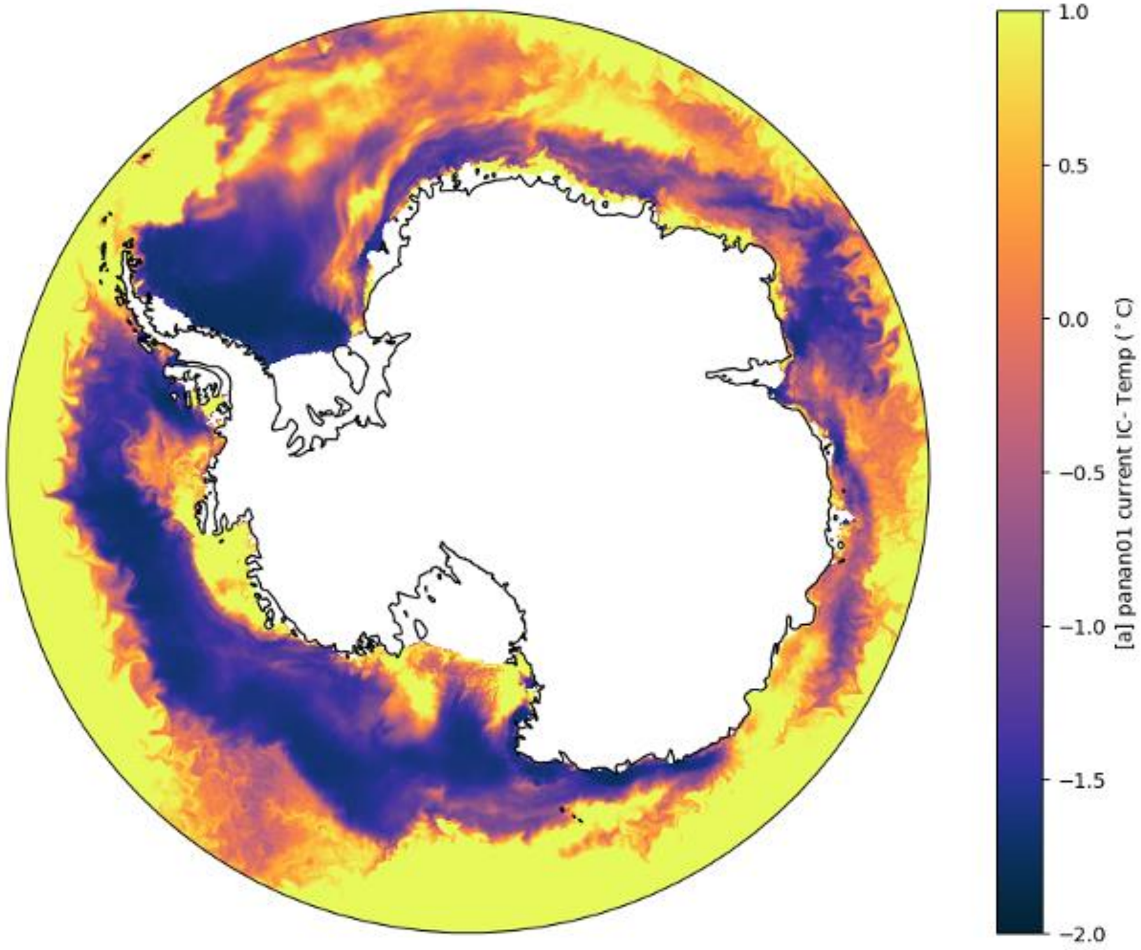
Meeting comment: sounds good

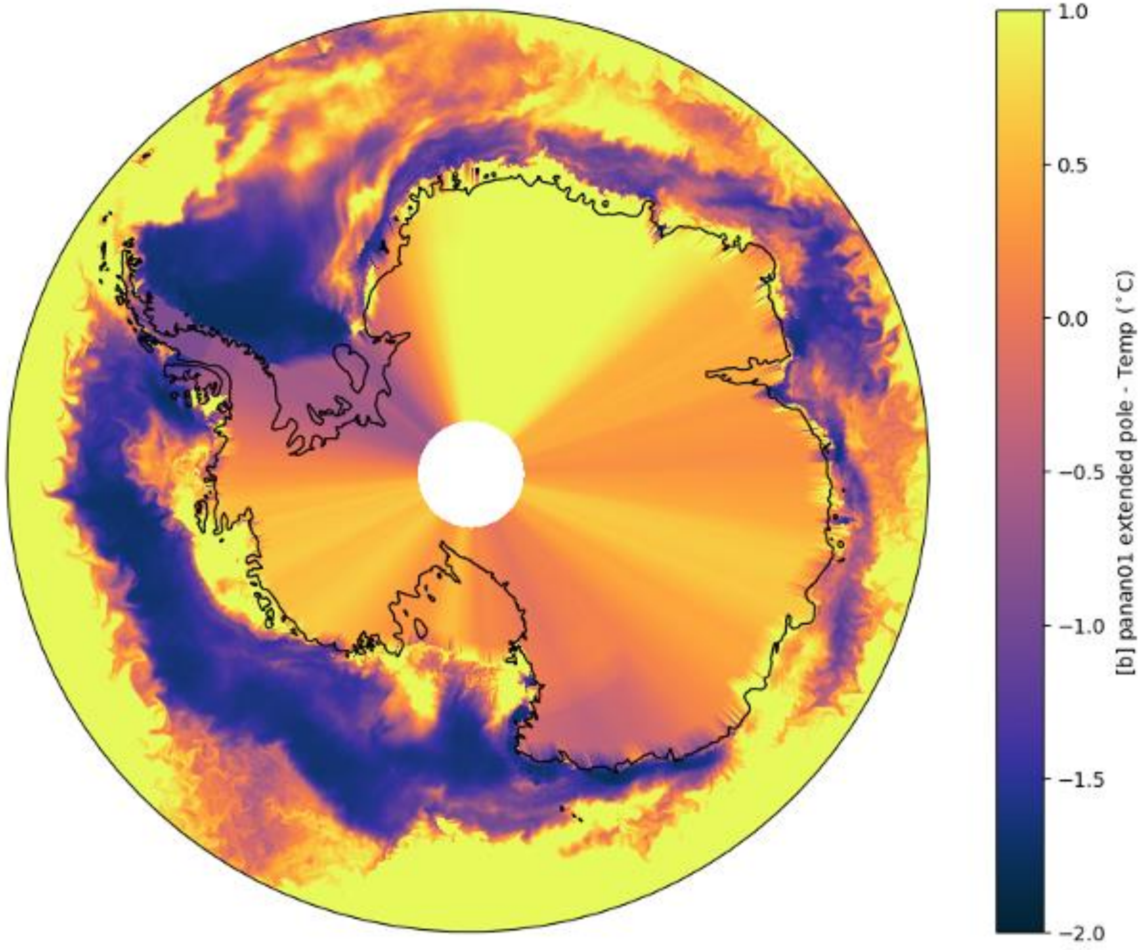
Plot of top layer thickness



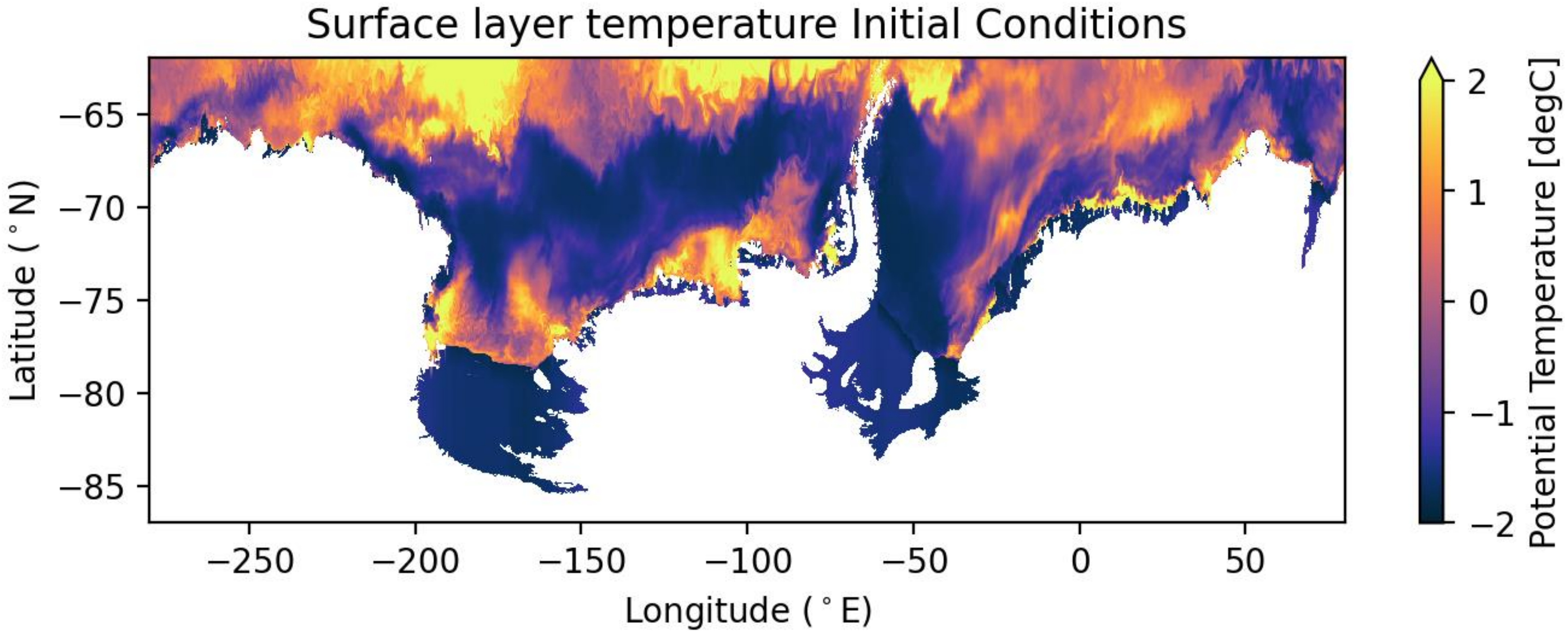
Meeting comment: skipped these slides because of time and also clearly just need to spin up more

Initial conditions – extrapolate from ACCESS-OM2-01 + smoothed (method by Wilton)

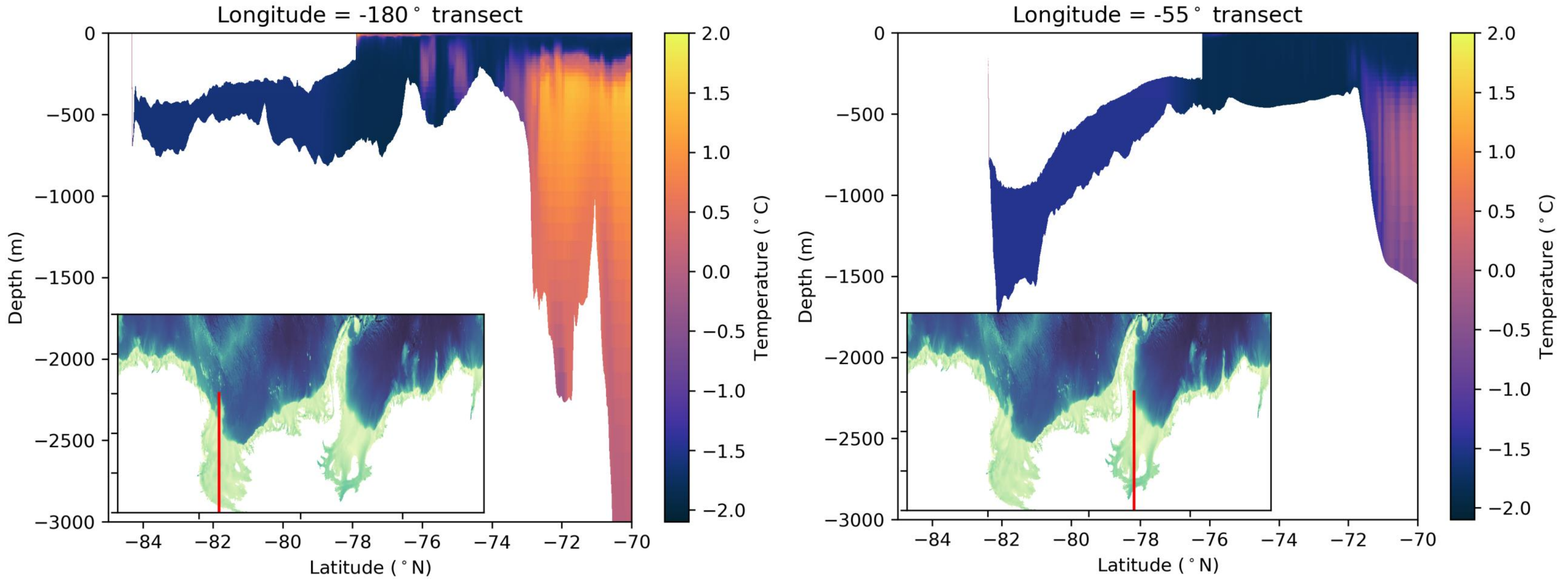




Initial conditions surface temperature

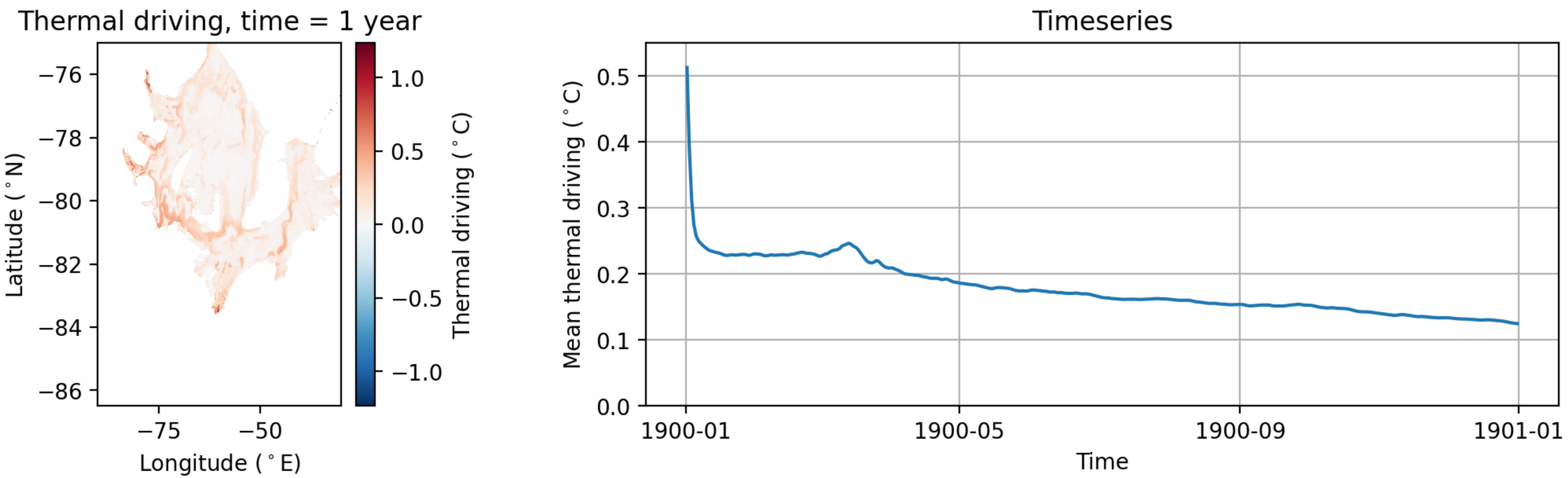


Initial conditions - transects



- Order of filling – first vertically, then horizontally (with zonal smoothing)

Thermal driving in FRIS



- Starts too warm, definitely trending down so may reach ok value…

Meeting comment: skipped this slide

Goals to compare with

- (models, satellite/in situ melt obs, ocean obs), and what we accept to be good enough, given expense of model and limited time

- Adusumilli 2020?
- Ocean conditions on shelf? Ocean conditions in cavities?
- Other models?

Meeting comment: do if easy

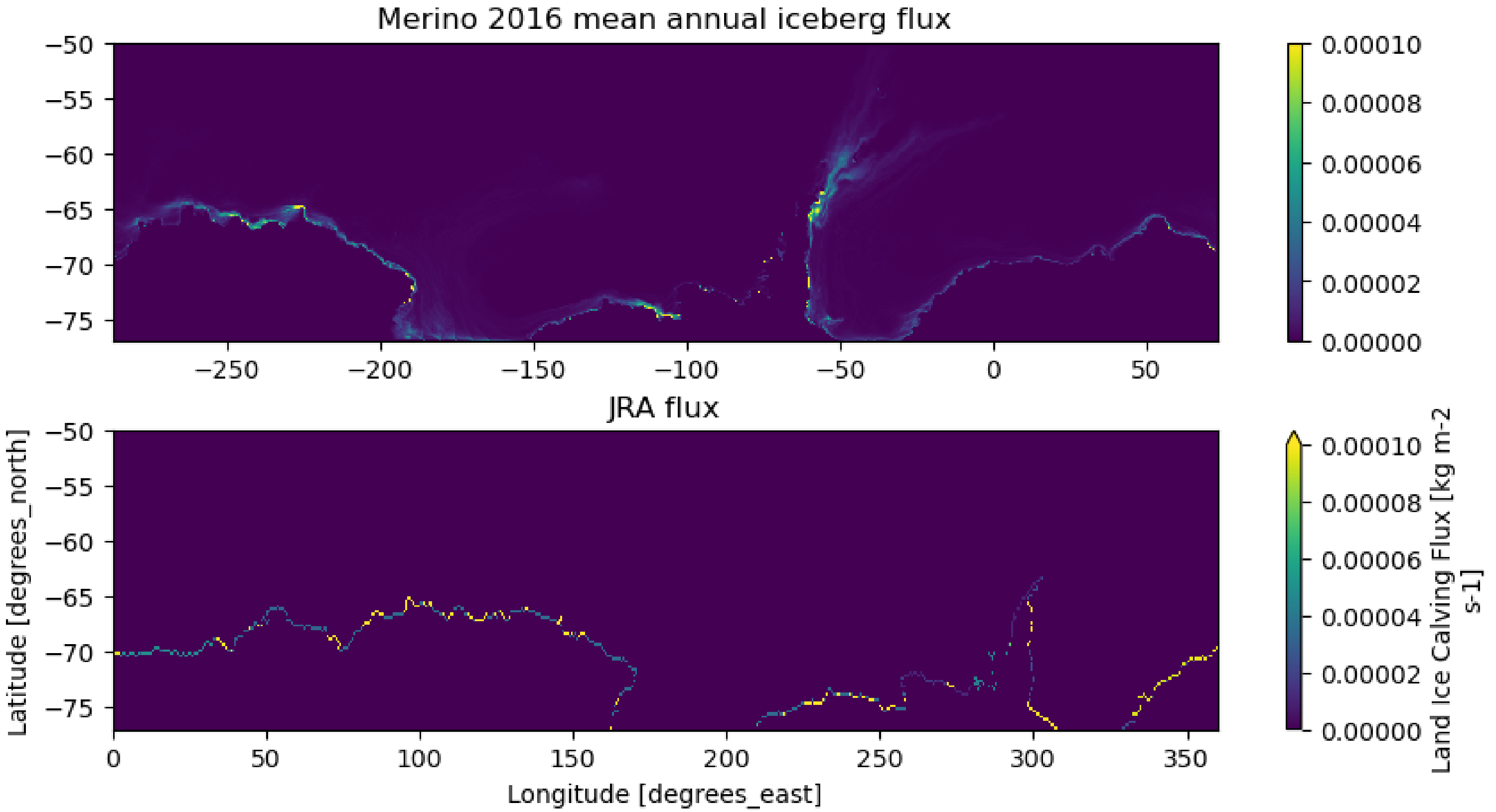
Age tracer in cavity

- thoughts, opinions – currently it is set to zero at ice shelf-ocean boundary layer as well as real ocean surface
- is that okay, or would that affect our AABW/SWMT age tracer interpretations?

Meeting comment: skip

Horizontally spreading iceberg flux

- https://github.com/ACCESS-NRI/access-om3-configs/issues/728



- Feasible but not yet implemented.
- Maybe just at coast is okay?

Meeting comment: Thanks Fabio for offering to work on this!

Checking conservation/budget closure

- calling for help if anyone has done that yet in OM3/knows what the diagnostics should be
- (let’s avoid finding another heat conservation violation after doing a long run ☺)

https://mom6-analysiscookbook.readthedocs.io/en/latest/notebooks/Closing_tracer_budgets.html