Progress in full coupling between ice sheets and climate in CESM

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- Overview of ice-sheet/climate coupling in real world
- New coupling links in model
- Ongoing work and future plans
What do we mean by ice-sheet/climate coupling?

_Climate passes:_
- Surface mass balance (SMB)
- Boundary temperatures
- Sub-shelf melt/freeze rates

_Ice sheet passes:_
- Elevation
- Ice sheet extent
- Solid ice discharge (icebergs)
- Sub-shelf geometry
Climate passes:

- **Boundary temperature**

- **Surface accumulation**

- **Surface melt/sublimation**
  - Lipscomb et al., 2013; Vizcaino et al., 2013 & 2014;
  - Fyke et al., 2014, Fyke et al., in review.

- **Sub-shelf melting**
  - (/freeze-on)

Need for Antarctica!
Ice sheet takes climate-derived forcing and moves
Ice sheet passes: solid ice discharge (calving)

Freshwater addition
Heat extraction
Ice sheet passes: solid ice discharge (calving)

- Solid ice routing replaces snow-capping scheme over ice sheets
- Could fix excess frazil ice growth due to artificial concentration of +/- winter POP fluxes of moisture/heat
Ice sheet passes: elevation changes

NASA/Bamber et al., 2013
Ice sheet passes: elevation changes

- Script-based approach regenerates global CAM topography at every coupled model resubmission point (~1 year)
- Time series trends from 100-year transient simulation bracketed by snapshot simulations -> coupling appears successful

Surface temp

Total cloud

Precip rate

Near-surface wind
Ice sheet passes: ice extent changes

retreat

in-situ inception
dynamic advance
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if (constant_snowpack and time>time_{snow\_persistence\_max })
then is\_icesheet = .true.

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Two-way coupled model for “primarily grounded” ice sheet complete
Ongoing work and future plans

- 2-way coupling nominally complete (SIA CISM 1, 1 degree CLM4.5, 1 degree CAM 5 FV, POP2, CICE4)
- Description in in-prep GMD-style manuscript
- Stress-testing of coupled model:
  - Development of partially-coupled configurations
  - Development of asynchronous coupling
  - Fixing “coupled-only” bugs and issues
- Validating 2-way coupled model
- Continuing development (e.g. CISM2, firn, multiple ice sheet instances, improved downscaling, explicit icebergs, coupled model tuning...)

Thanks