

# Antarctic ice sheet coupling within the Norwegian Earth System Model: advances and challenges

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- Overall goals;

- Preliminary results from fully coupled tests

- What we can (should) improve;

- Next steps towards CMIP7 and ISMIP7;

# Ice sheet coupling in NorESM2...





#### ...and in NorESM2.5 and onwards





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#### First NorESM2.5 tests coupled to GrIS and AIS

• SMB melt patterns over Greenland fairly similar to RACMO2.4;



RACMO2.4 (van Dalum et al. 2024)

#### First NorESM2.5 tests coupled to GrIS and AIS

• Antarctica: no melt (except for tip of AP), coarse precipitation patterns (no dowscaling)





# Ocean-ice sheet coupling in Antarctica

• Multi-level ocean temperature and salinity remapped from BLOM to CISM (far field!);





BLOM grid (no cavities)





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### Ocean-ice sheet coupling in Antarctica

- Multi-level ocean temperature and salinity remapped from BLOM to CISM (far field!);
- Far-field, multi-level ocean fields extrapolated in ice shelf cavities to calculate thermal forcing;
- Ocean thermal forcing used to calculate **ocean melting under ice shelves** (2-eqs. parametrization);

$$\underline{B_m(z_b)} = \frac{\rho_o c_{po} \gamma_t F_m \cdot (T_o(z_b) - T_f(z_b))^2}{L_i \rho_i}; \quad T_f(z_b) = 0.0939 - 0.057 \cdot S(z_b) + 7.64 \cdot 10^{-4} \cdot z_b$$

$$= T_f(z_b)$$

$$T_f(z_b)$$

$$T_o(z_b)$$

$$= ISMIP6-type \text{ parametrization used for Antarctica;}}$$

$$= Will \text{ need something different for Greenland;}$$

## Sub-shelf melting in Antarctica: first NorESM2.5 tests



Ocean thermal forcing Surface



200 m depth



400 m depth







#### What can (should) be improved: ocean extrapolation



• Extrapolation algorithm: ocean cell at given level taking values of nearest cell (accounting for sills);



• Ok (sort of) in narrow cavities or fjord with little lateral circulation – striped pattern in large shelves;



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- Ok (sort of) in narrow cavities or fjord with little lateral circulation striped pattern in large shelves;
- Improvements in sub-shelf melt pattern after including <u>Gaussian smoothing</u> in the algorithm;
- We will also explore more advanced methods to calculate sub-shelf melting (PICO, LADDIE, MELTNET...)
- Attempt to inject meltwater from cavities at depth, not surface layers!

Example of LADDIE offline run, forced with NorESM ocean data

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