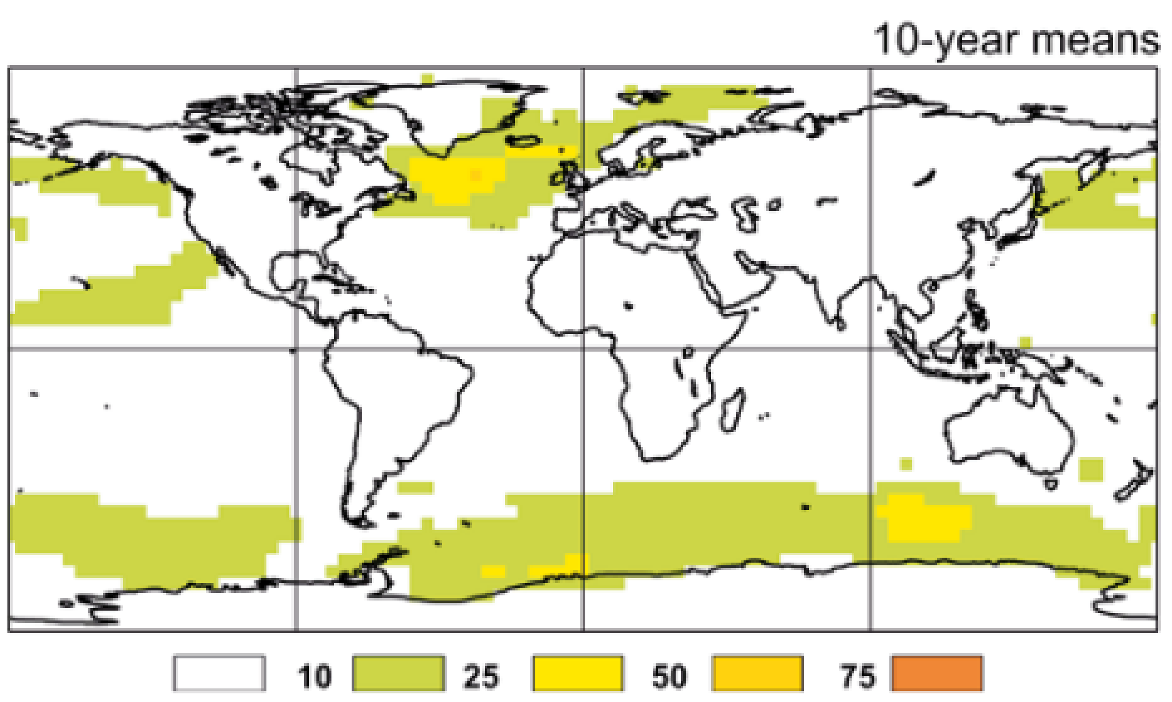
# A regional Southern Ocean configuration for investigating polar decadal predictability

TECLIM
Université catholique de Louvain
Belgium

**Charles Pelletier**, Hugues Goosse, François Klein
charles.pelletier@uclouvain.be

The Southern Ocean (SO) plays a key role in global ocean heat uptake and circulation. In recent years, the polar climate has rapidly evolved in a non-predicted way, which considerably uplifts challenges and constraints on mid and long term global climate predictions. While previous studies have shown that polar regions could withhold predictability on 1 – 10y time scales, further investigations are required for fully understanding the processes accounting to it. We aim at assessing decadal predictability in the Southern Ocean by using a five-component coupled configuration.

## Motivations




*Boer et et. (2004)*

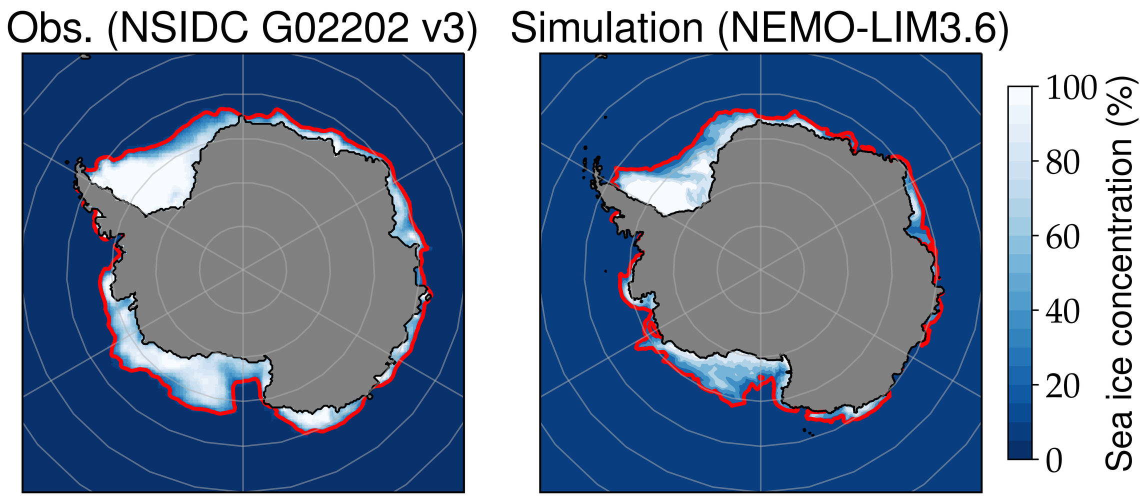
*Geographical distribution of the potential predictability fraction for the SST on the 10-year time scale*

- Polar regions potentially holds significant **predictability** on seasonal to decadal timescales.
- Possibly due to **slower climate components** (e.g., ice sheets) and their interactions with the ocean and atmosphere.
- GCMs typically run at **too coarse resolutions**, and do not include **comprehensive enough coupling mechanisms**.
- In these areas, **measurement-induced constraints** on model are **sparse**.

**Establishing cutting-edge coupled configurations is necessary for gaining insight on polar predictability.**

## Ocean & sea ice model: NEMO-LIM 3.6

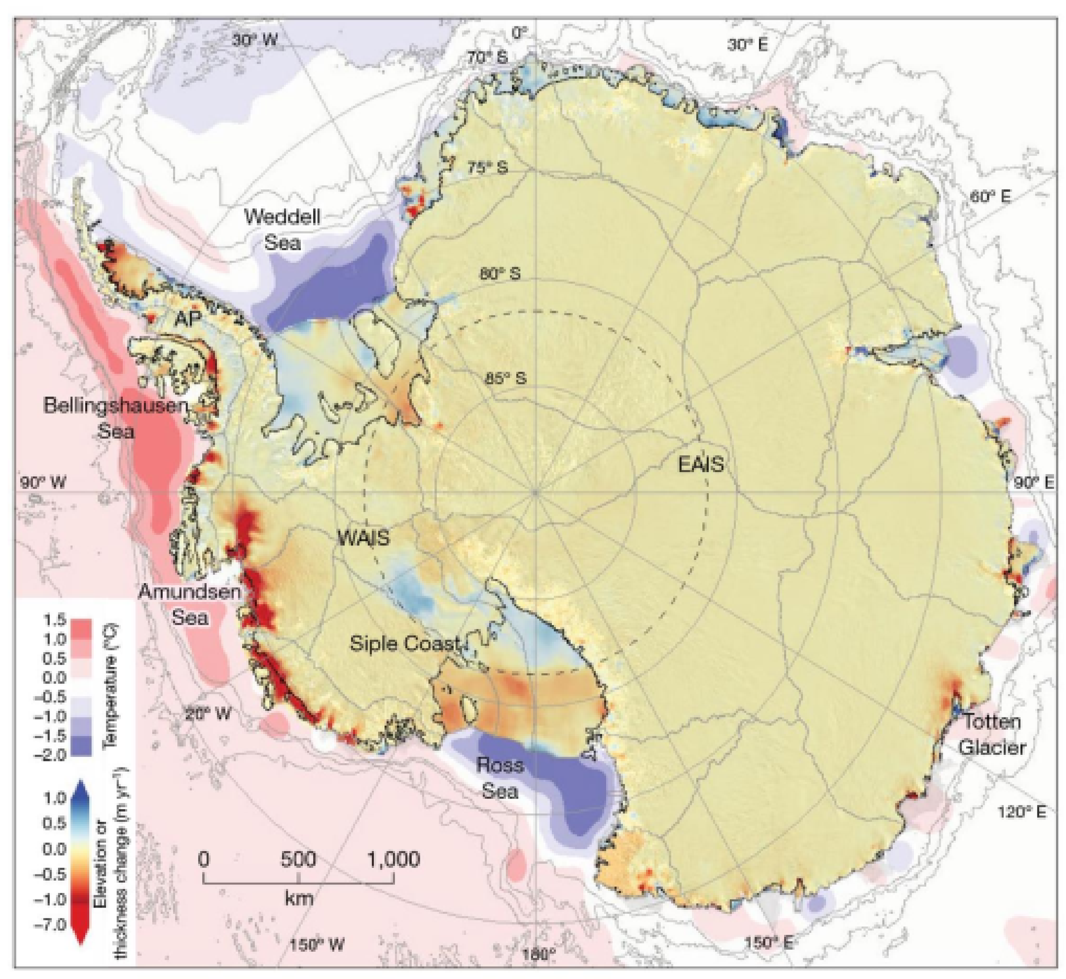
- **Energy and mass conservative** numerical schemes.
- Sub-grid-scale sea ice thickness **distribution** and **salinity processes**.
- Custom ice parameterizations for **melt ponds** and **blowing snow**.
- Large **community**.




*Observations and simulated sea ice concentrations and extents in autumn (March 2000).*

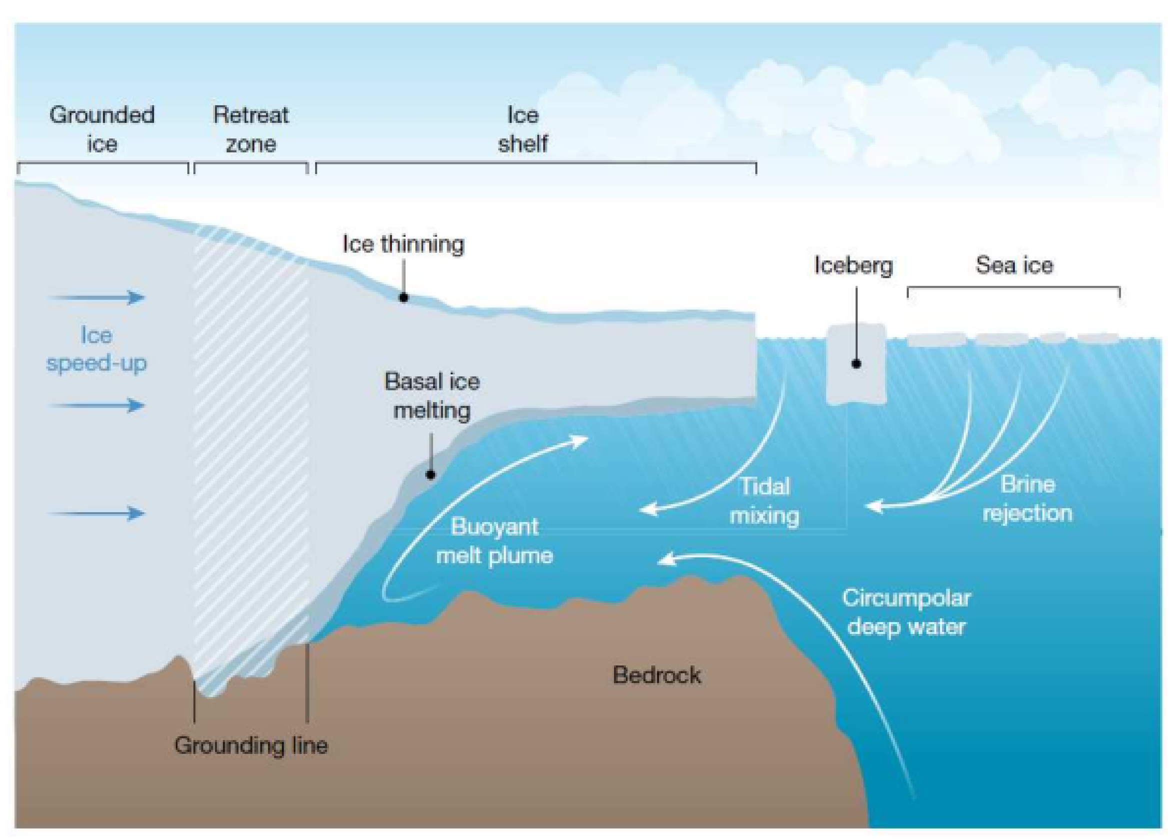
## Marine ice shelf representation

Marine ice sheet (MIS) melting is a major **freshwater source** in the SO.




*Shepherd et al. (2018)*

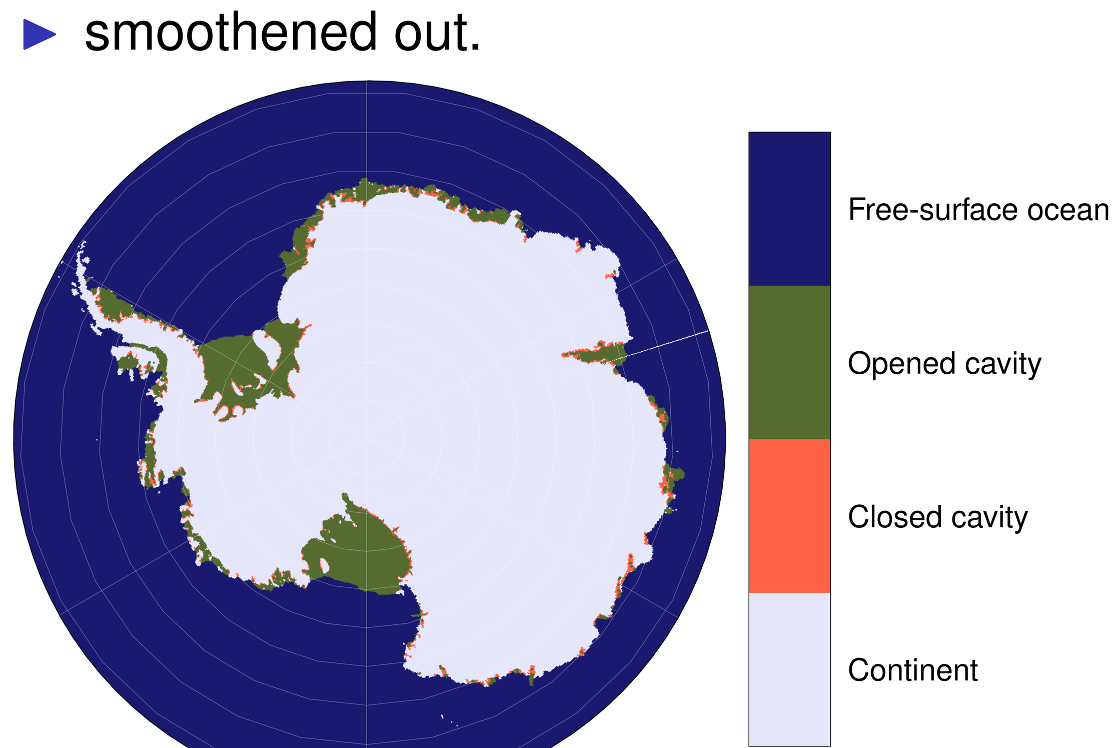
**Warm circumpolar water upwelling** towards the Antarctic continental shelf provokes it. Relevant dynamical coupling is better achieved by **representing the ocean ice shelf cavities**.




Shepherd et al. (2018)

Depending on the grid, bathymetry and ice shelf draft, ice shelf cavities can be:

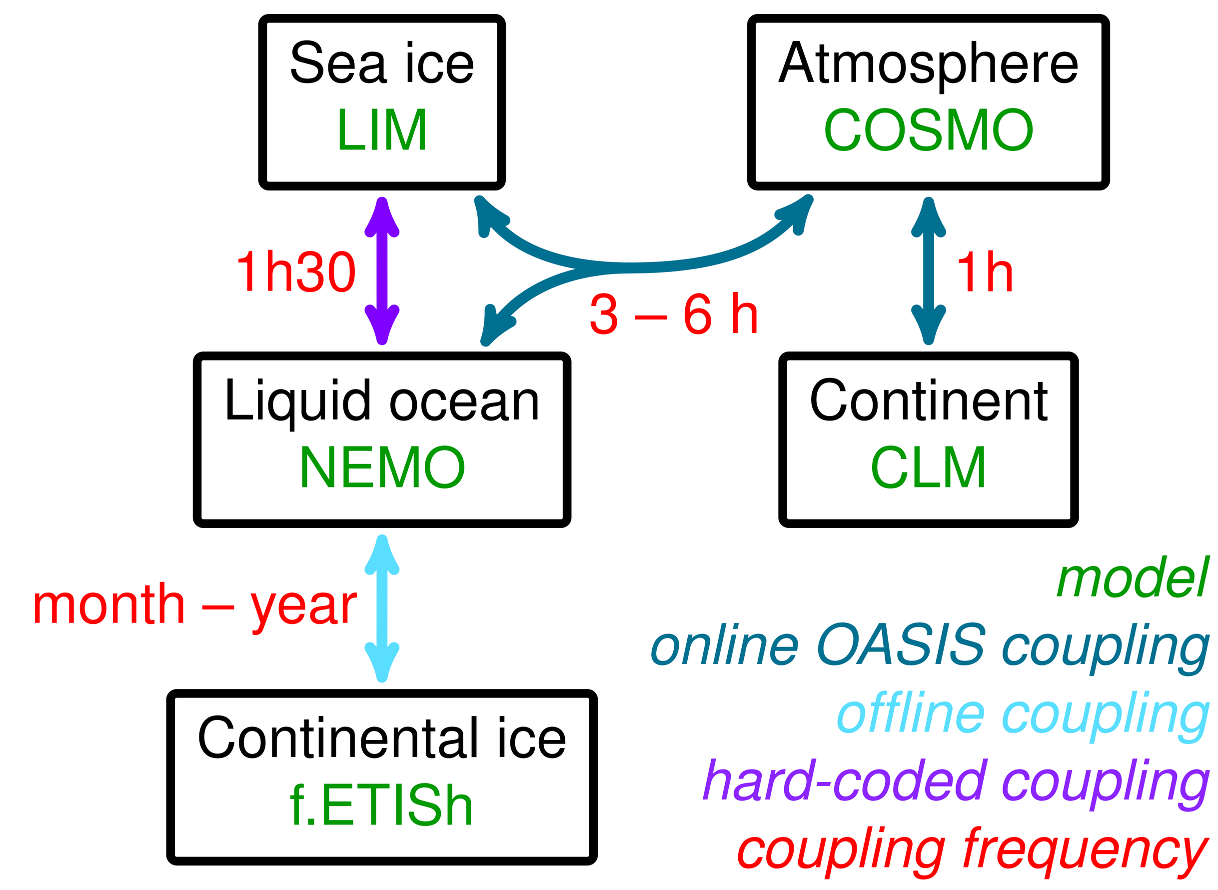
- **opened** to ocean circulation;
- **closed** to ocean circulation, but **injecting freshwater** (at varying, non-zero depths);
- smoothened out.




*Ice shelf cavities as seen by our configuration*

## Coupling implementation

Five subcomponents, four coupling mechanisms.




**COSMO ↔ NEMO-LIM3.6**

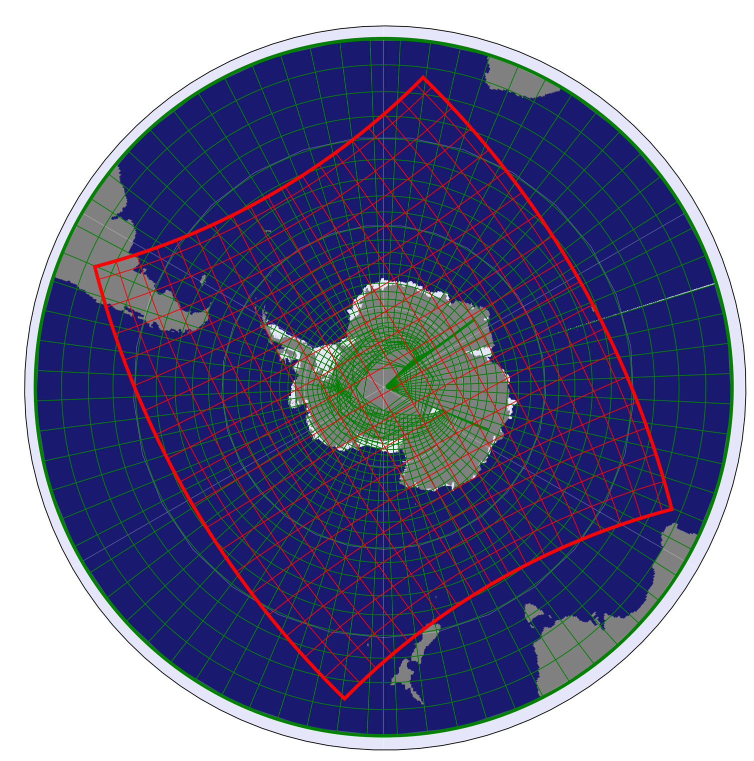
- **COSMO** computes air-sea turbulent fluxes (TKE surface-layer scheme).
- COSMO computing **real-time fluxes**; NEMO receiving 3 – 6h **delayed** ones.
- Flux **tile distribution** over land, ocean and sea ice categories.

**NEMO-LIM3.6 ↔ f.ETISH**

- NEMO sends f.ETISh **bottom temperature & salinity**.
- Still undetermined: who computes the **MIS melt rate** (realism vs. NEMO stability)?

## Ocean configuration specifications

- eORCA025 grid (1/4°, 75 levels) cut at 30° S ;
- 15min time step;
- $z^*$-ISF coordinate;
- TEOS10 equation of state;
- WOA18 based climatology;
- GLORYS2V4 reanalyses on lateral boundaries;
- BedMachine2 & ETOPO1 bathymetry.



*COSMO and NEMO grids (resp. red and green, boundaries in bold); 1 out of 20 cells represented.*

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