Couplage LMDZ – Calottes polaires
Projet ISCLIM TRACCS-PC9

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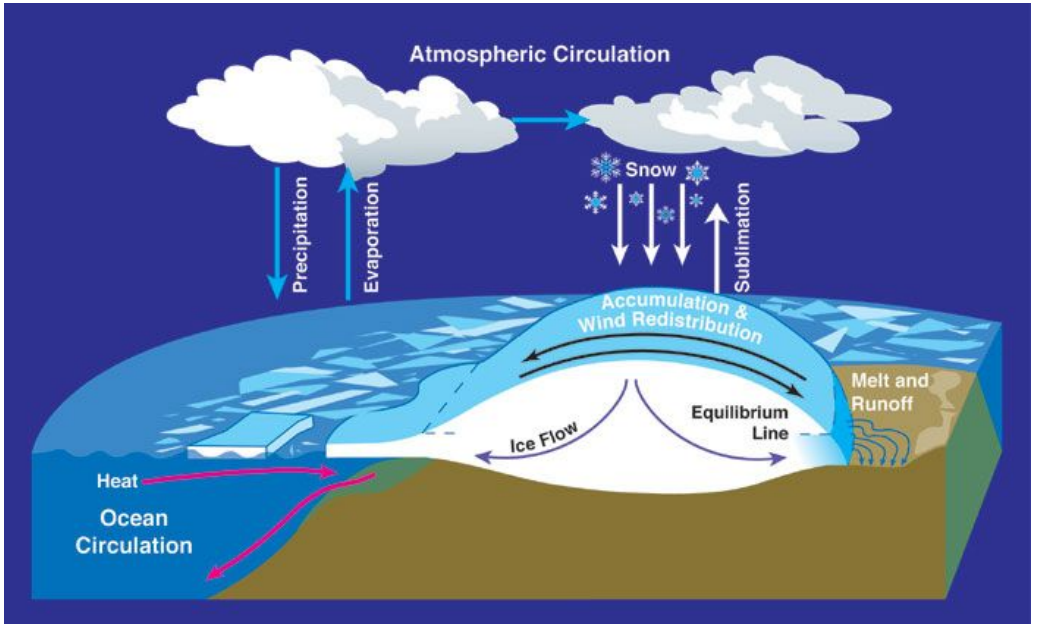
Ice sheets in the climate system

Atmosphere

- precips, sublimation, melt : SMB
- albedo
- surface topography

Ocean

- melt under ice shelves
- runoff, calving



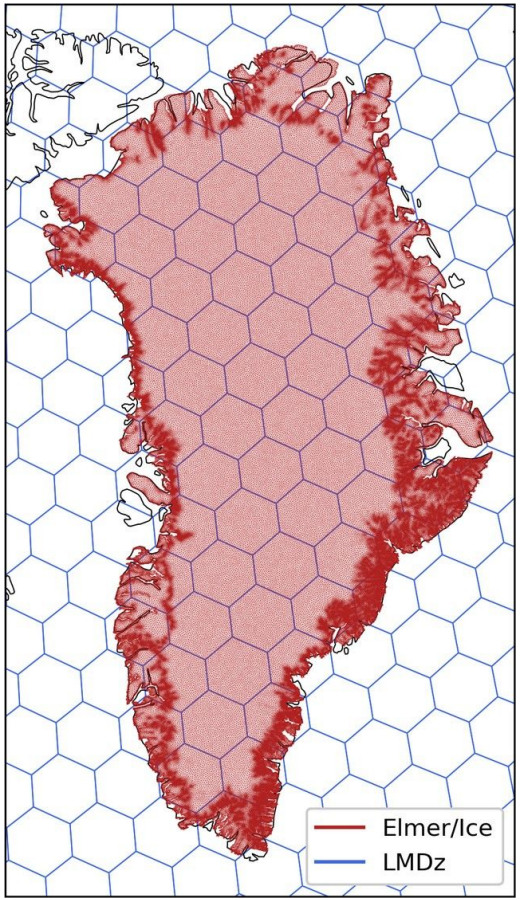
ISM & LMDZ grids

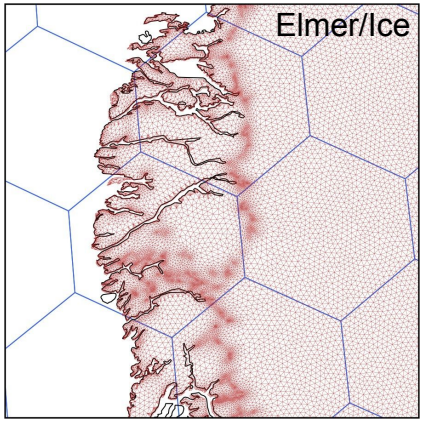
Elmer : unstructured grid with higher resolution where ice flow is fast

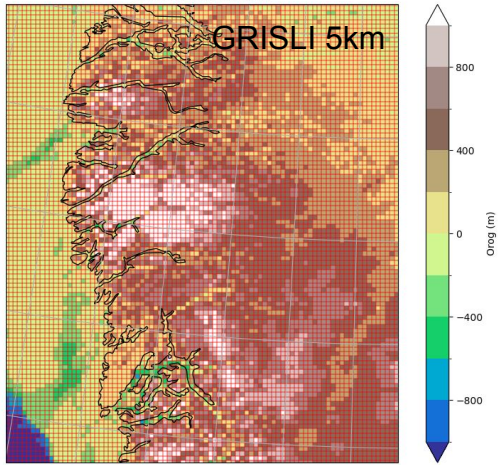
GRISLI : cartesian grid, resolution from 5 to 40 km

Dynamico-LMDZ : icosahedral grid with a much coarser resolution

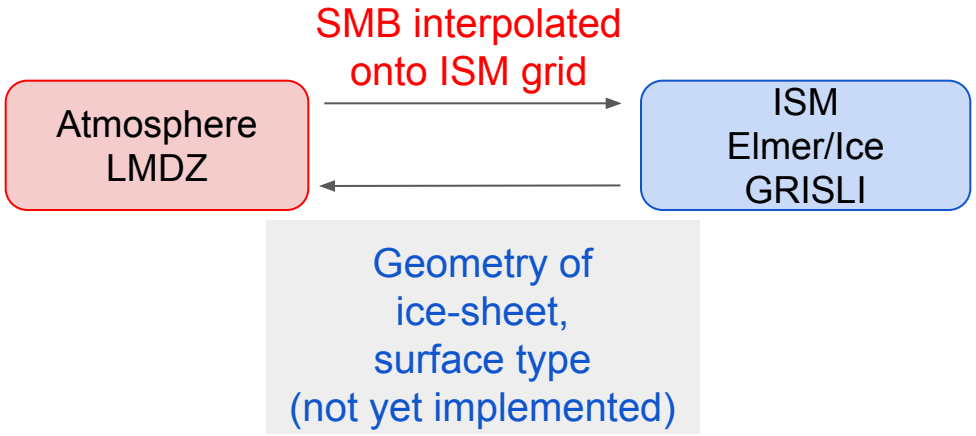
=> Coupling requires downscaling for data coming from LMDZ to ISM







Architecture of the coupling

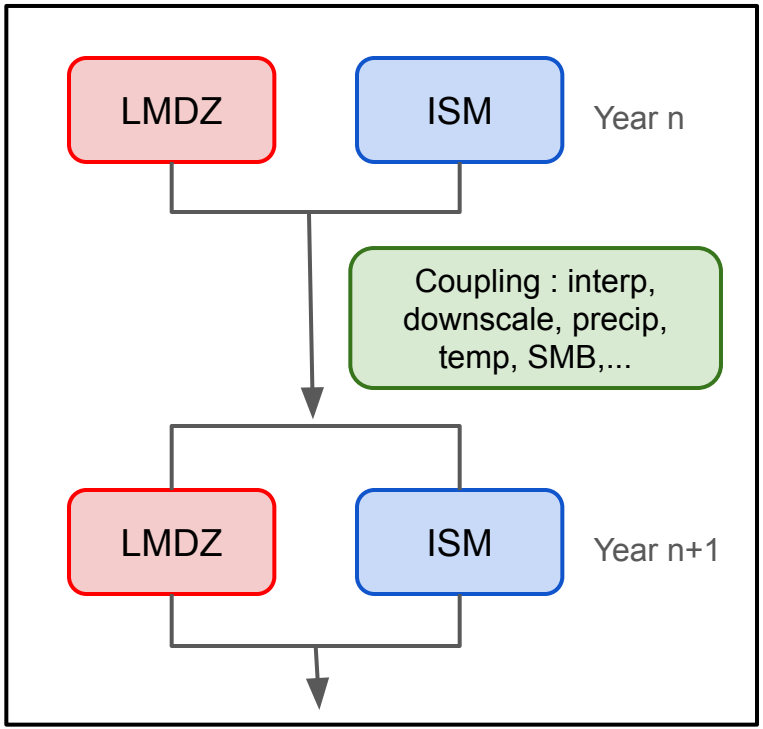


Outils utilisés :

- Interpolation via nco, cdo (bientôt XIOS)
- SMB : PDD (paramétrisation) prog Fortran

Lucas Bastien

Offline coupling once a year



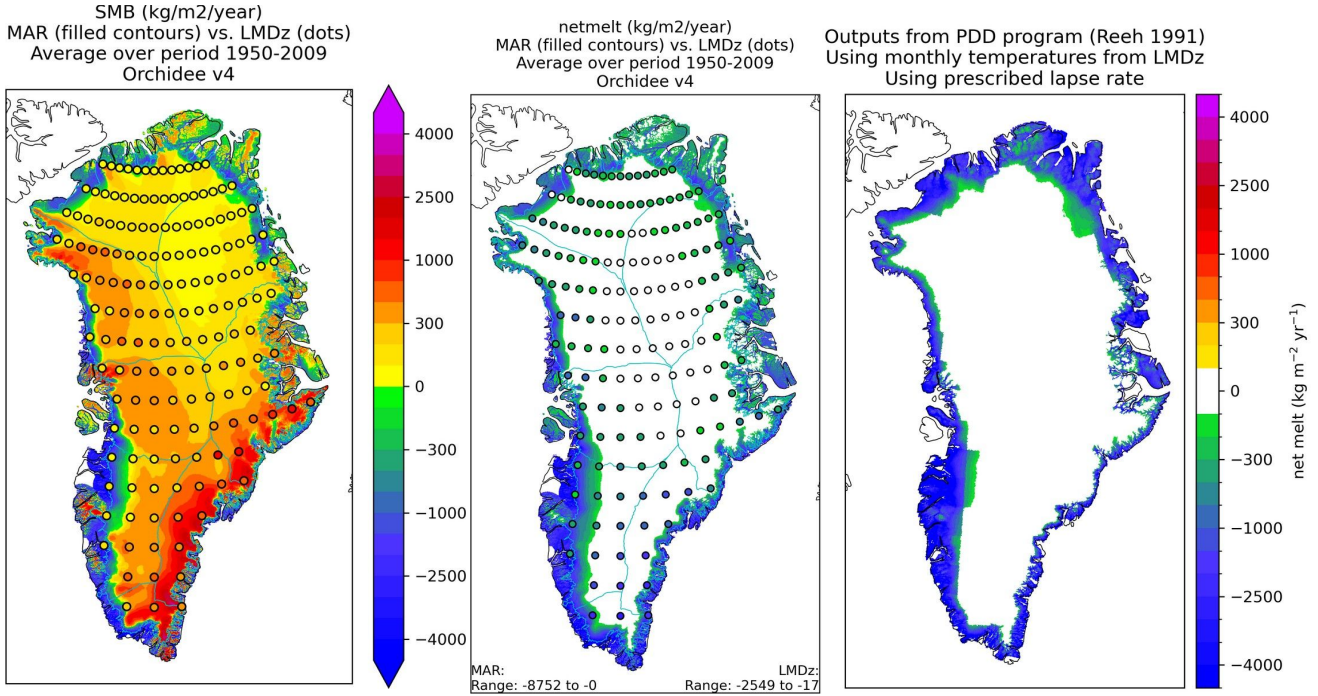
Surface melt and the need of a downscaling scheme

SMB computed by LMDZ : large discrepancies in surface melt rate

Coarse resolution of LMDZ
Very simple snow scheme over ice-sheet : 1 layer, fixed albedos, no refreezing…

PDD scheme improves considerably spatial distribution and magnitude of surface melt

=> Next step : snow & ice melt computed by ORCHIDEEv4



Snow model in ORCHIDEE-ICE : Explicit snow + ice module

Atmosphere / Snow interface : Surface energy balance

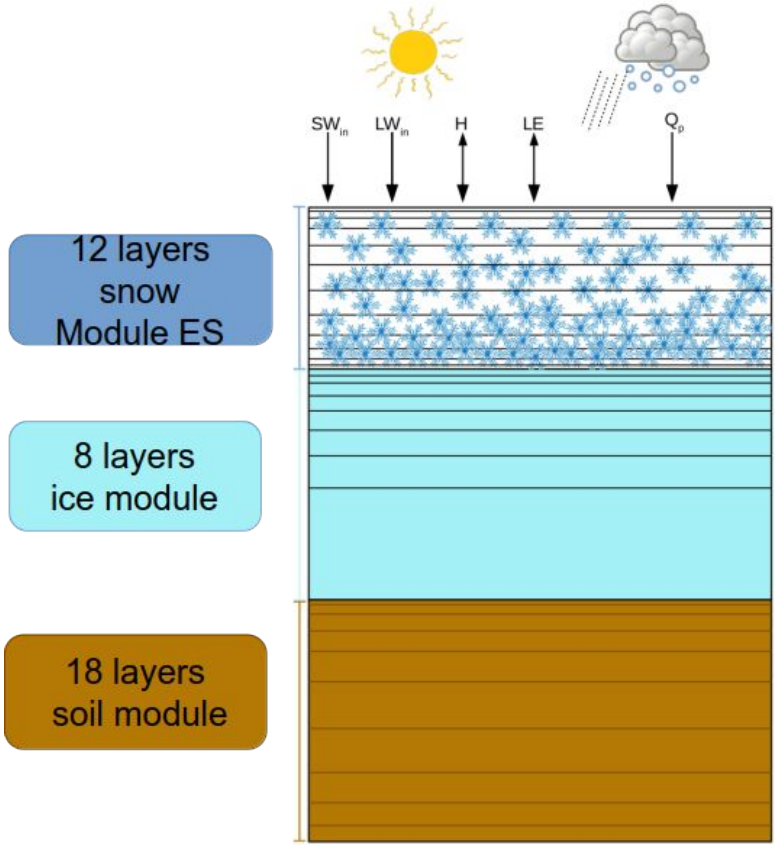
Processes represented in snow :

- snow settling
- snow compaction
- snow aging
- snow melting
- water percolation and refreezing

→ density and albedo changes

Ice module on ice sheet areas allows the computation of heat exchange between snow and ice, and ice melt :

- temperature
- melt
- no refreezing in ice



Modelling snowpack on ice surfaces with the ORCHIDEE land surface model: application to the Greenland ice sheet, The Cryosphere 2024
Sylvie Charbit, Christophe Dumas, Fabienne Maignan, Catherine Ottlé, Nina Raoult, Xavier Fettweis, and Philippe Conesa

Snow in ORCHIDEEv4

- **ORCHIDEE-ICE in the trunk** : flag OK_ICE_SHEET and specific albedo parameters for ice covered surface
- LMDZOR coupling over ice sheet is now operational ! landice_opt = 2 (Josefine Ghattas)
- Philippe Conesa PhD (S. Charbit & C. Agosta): Improving snow representation to better simulate ice sheet mass balance in the IPSL climate model

Next step :
Philippe Conesa PhD
- snow initialisation & evaluation of snow density
- Proper evaluation of ICOLMDZOR with new snow over the two ice-sheets

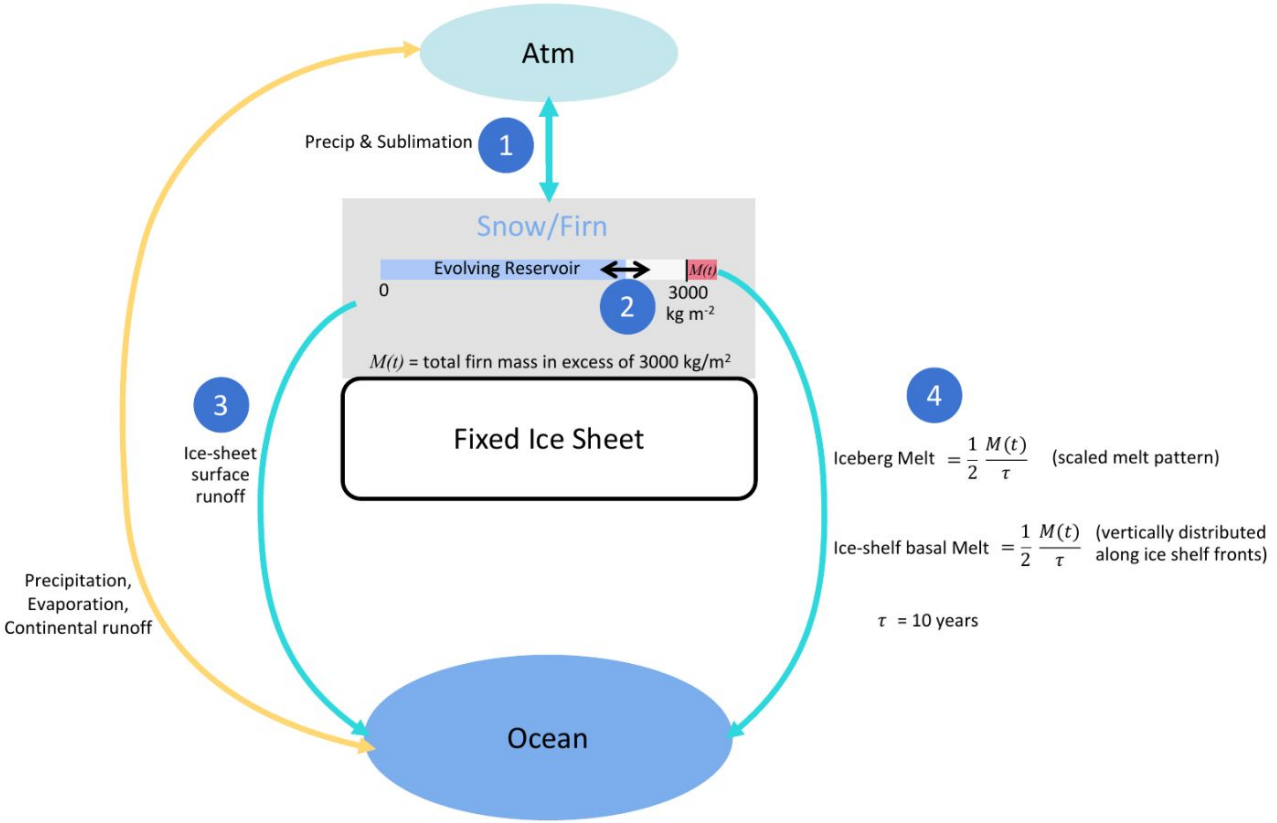
Sujith Krishnakumar Post-Doc TRACCS PC7 (Martin Menegoz, Christophe Dumas)
- Complete the implementation of a spectral snow albedo scheme in the ORCHIDEE surface model, in phase with the LMDZ radiative scheme
- Managing the coupling with the INCA aerosol scheme to simulate the effect of aerosol deposition on the albedo
- Improving the general representation of snow cover in LMDZ-ORCHIDEE with a common approach for ice sheets and continental surfaces, focusing on albedo, topography and vegetation

Pending questions on LMDZ

- LMDZ bias over ice sheets? And their impact on the ice sheet model…
- Consistency between the energy balance calculated on the ice sheet and that calculated by LMDZ
- LMDZ response to changing the topography during a run?
- Water conservation: loss of humidity in LMDZ, conservation over land ice ? (O. Marti)
- How to handle large changes of the topography in the coupled model (sea ↔ land): deglaciation?
- ISMIP7 : simulation with Interactive ice sheet (Greenland & Antarctic)

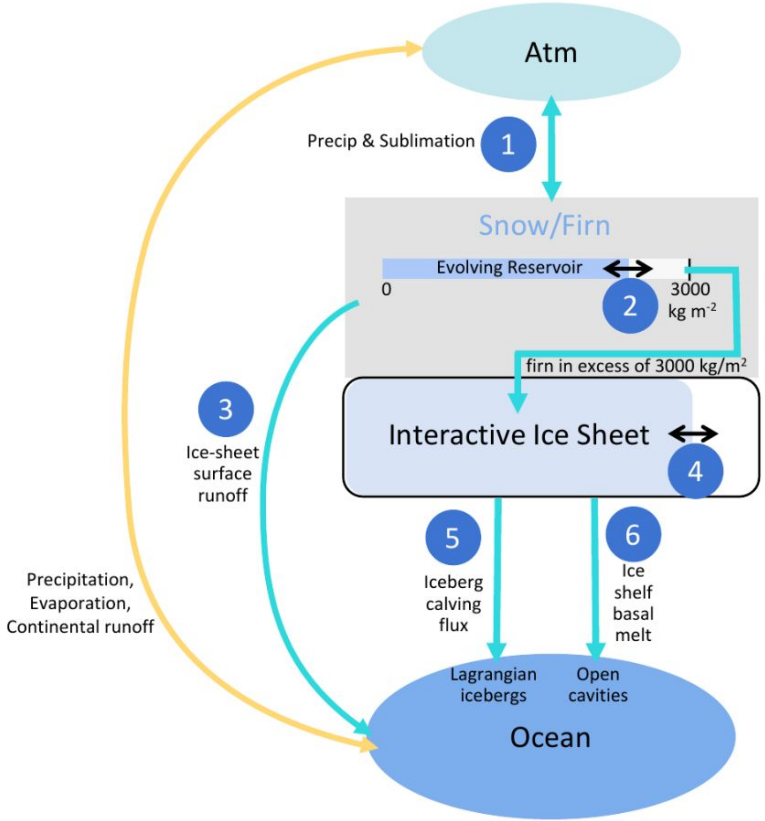
Freshwater mass fluxes in IPSL-CM for all experiments :

1 + 2 + 3 + 4 = 0



Freshwater mass fluxes planned in Elmer/Ice coupled to IPSL-CM (1st version) :

1 + 2 + 3 + 4 + 5 + 6 =0



The firn layer is both in the firn model (thermodynamics) and in the ice-sheet model (dynamics), so when the firn reservoir evolves, the mass changes in both without a mass flux between both.