Le climat au Groenland et en Arctique dans le modèle de l'IPSL

-

quelques résultats et réflexions

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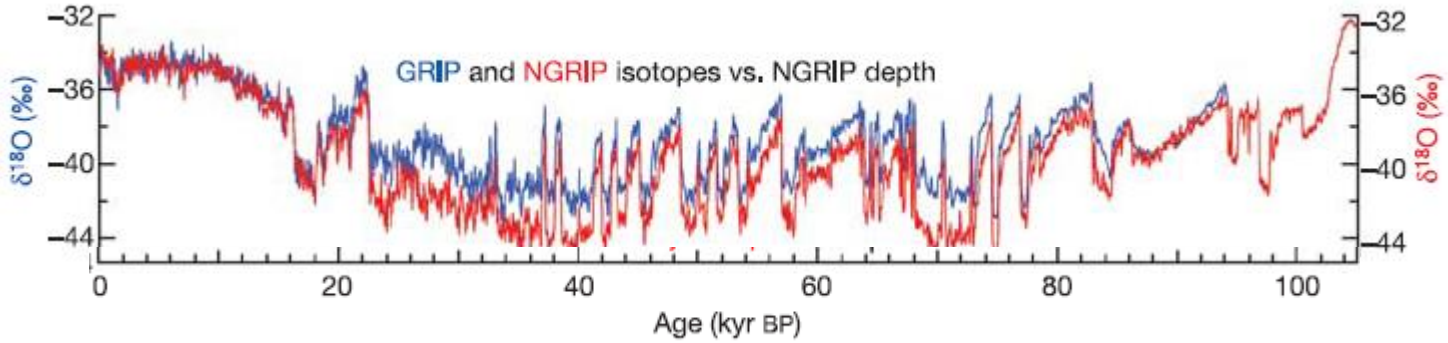
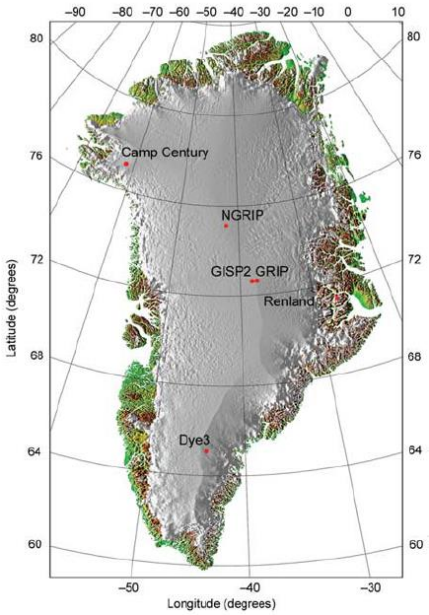
Motivations (1)

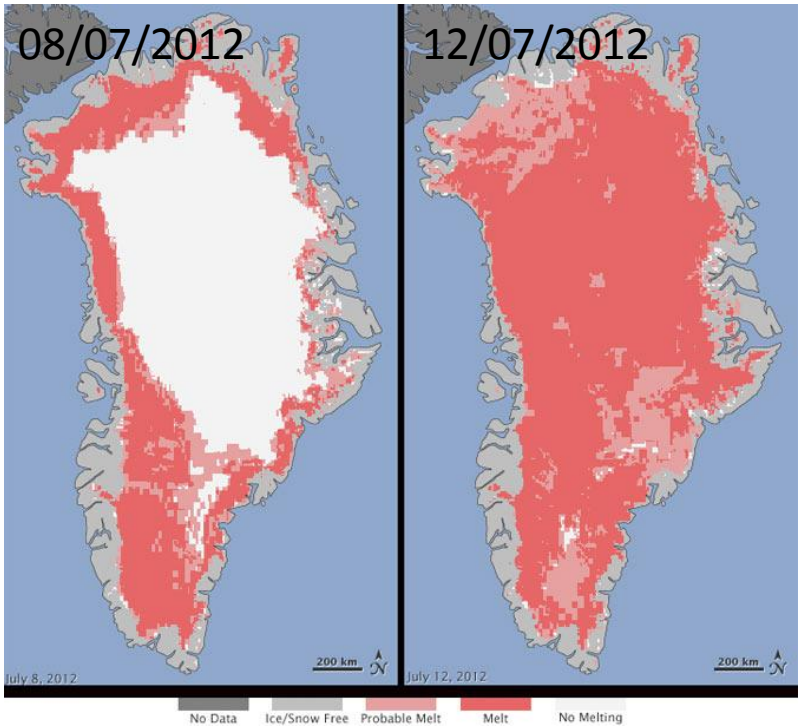




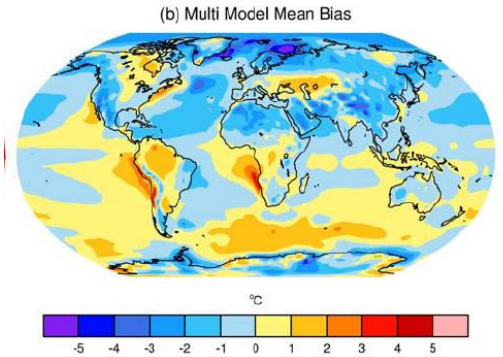
1. Etude des variations climatiques sur le Groenland, lien avec les enregistrements paléoclimatiques provenant de cette calotte

2. Compréhension de l'évolution récente du bilan de masse de la calotte groenlandaise

3. Impacts de l'évolution de la calotte groenlandaise sur l'atmosphère et l'océan



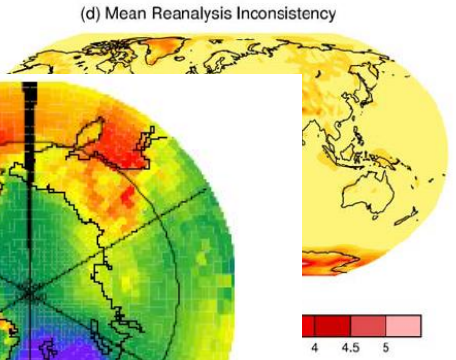
Biais d'IPSL_CM5: température



CM5A-LR

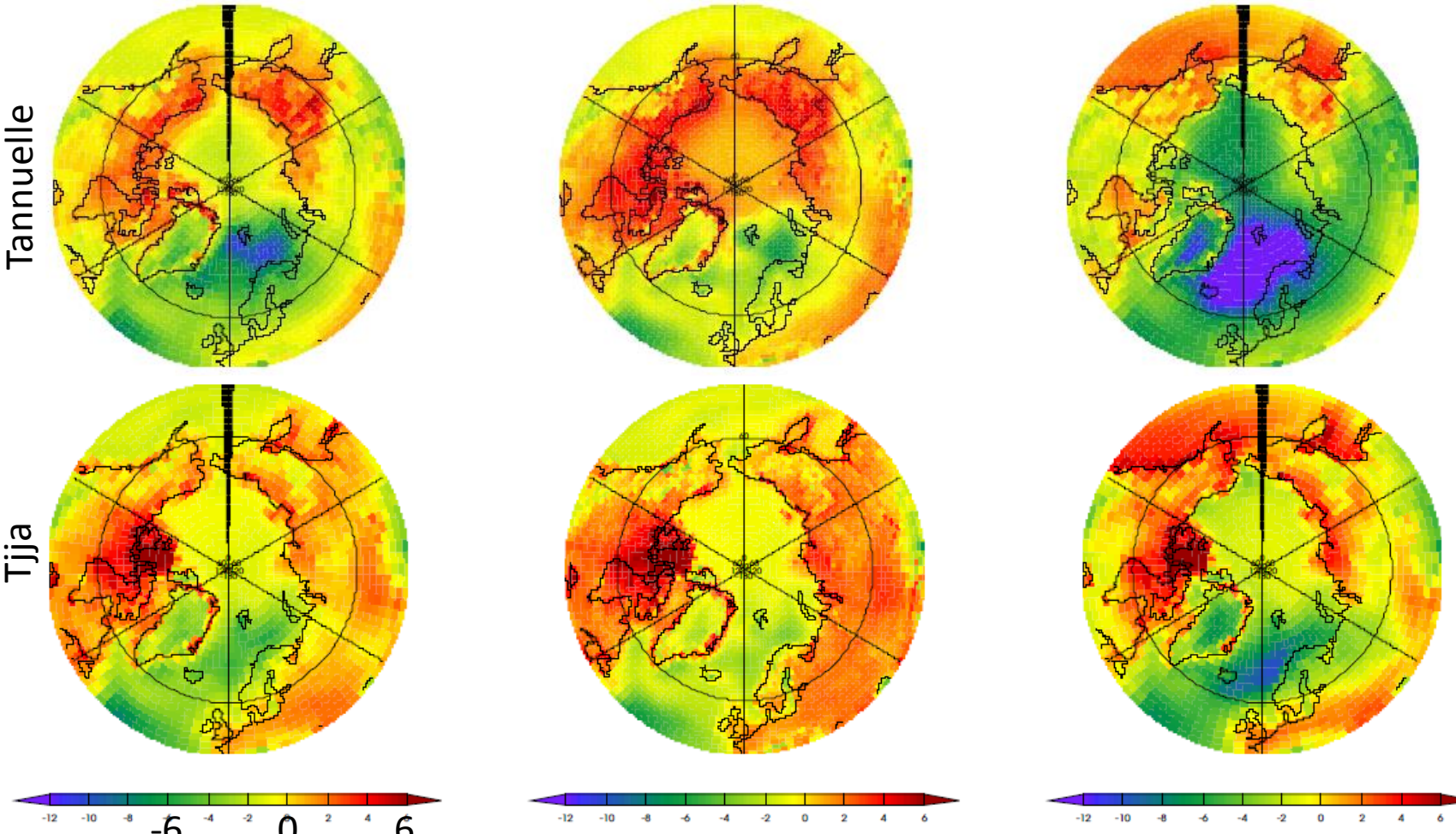
CM5A-MR

CM5B-LR



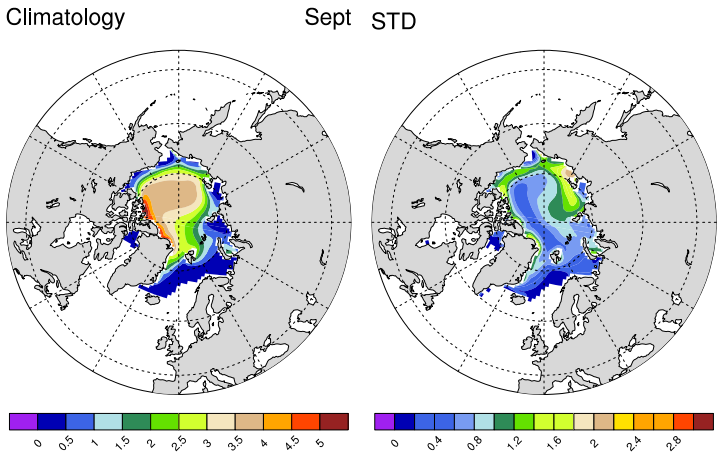
Tannuelle

Tjja

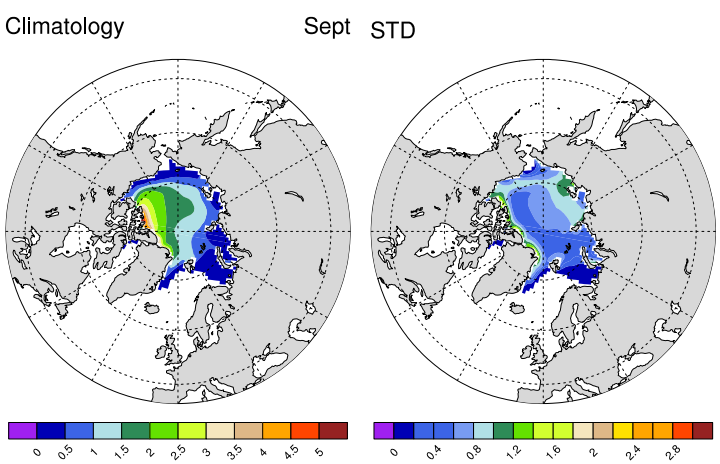


Banquise: épaisseur estivale

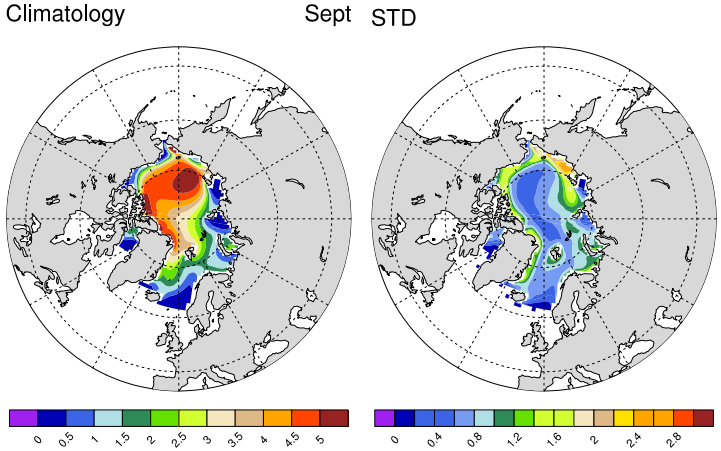
IPSL-CM5A-LR

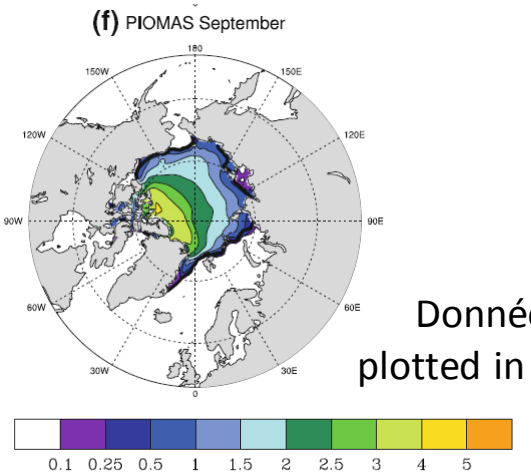


IPSL-CM5A-MR



IPSL-CM5B





Données PIOMAS, as plotted in Voldoire et al, 2013

Futur: LIM2→ LIM3… à suivre…

Quelles améliorations?

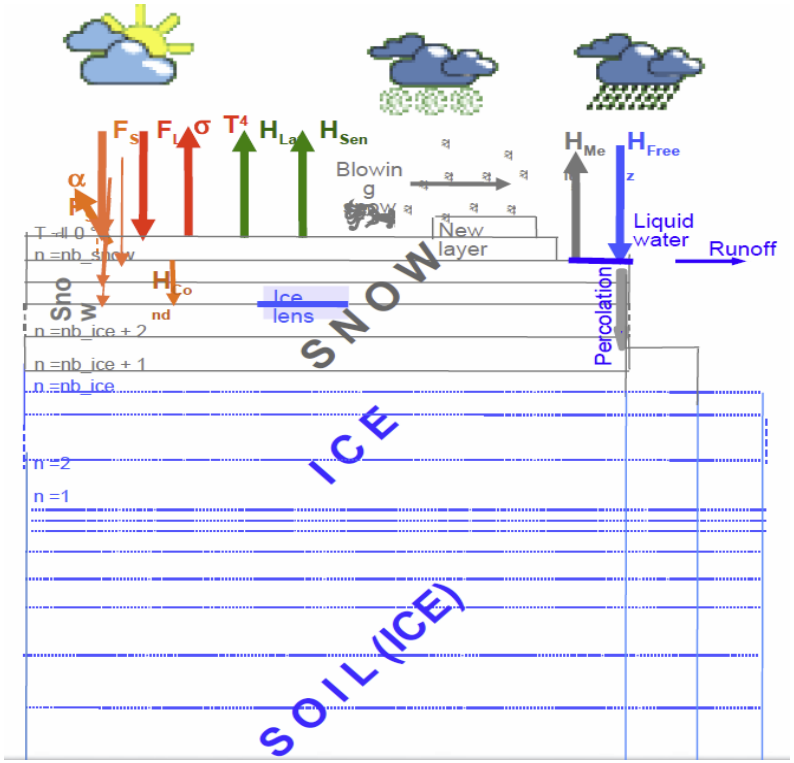
- Modèles de neige:
  - sur la calotte groenlandaise, implémentation dans LMDZOR: H.-J. Punge, H. Gallée, G. Krinner, M. Kageyama
  - sur les continents non englacés, implémentation dans ORCHIDEE : T. Wang, C. Ottlé, G. Krinner)
- Gel du sol
  - Implémentation dans ORCHIDEE : I. Gouttevin, G. Krinner
- Modèles de banquise:
  - LIM2→ LIM3

Exemple: modèle de neige sur les calottes glaciaires

Inclusion du modèle de neige du modèle régional MAR dans le modèle LMDZ (Punge et al, 2012)

SISVAT: used in the Belgian atmospheric regional model MAR *(e.g. Fettweiss et al., 2005, 2007, 2011)*

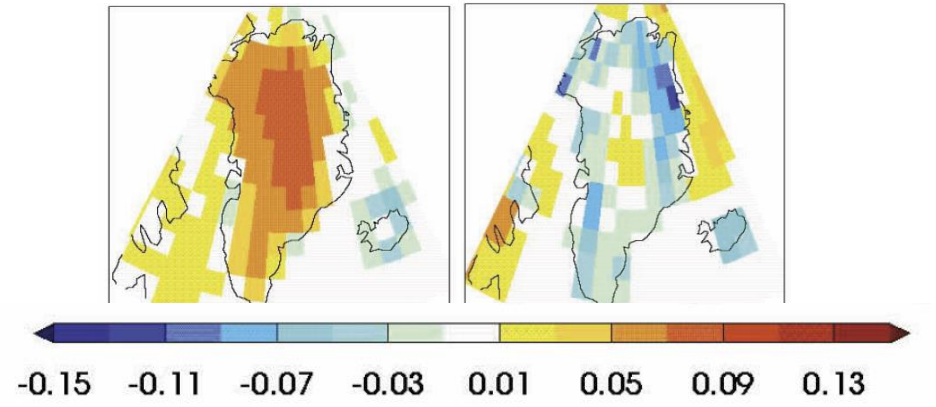
Based on the snow model CROCUS *(Brun et al., 1989, 1992)* :



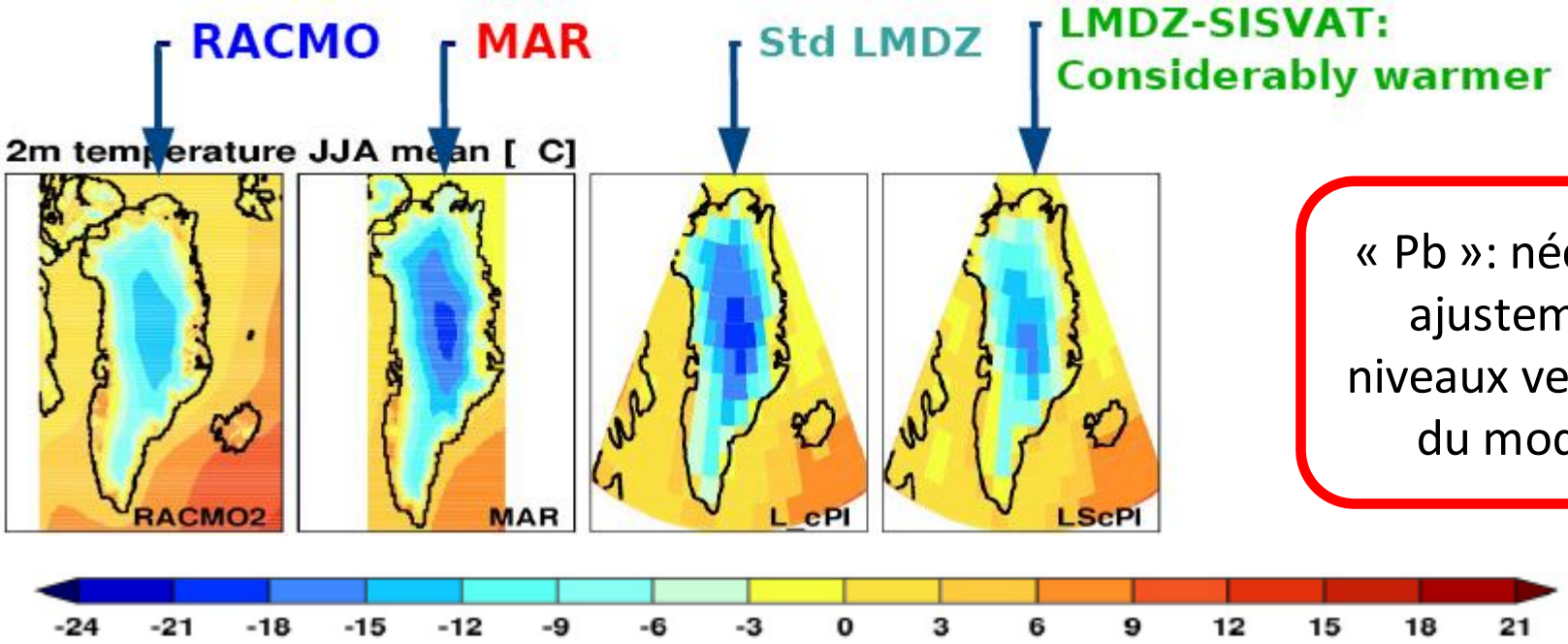
- **1D multi-layer model (up to 35 layers in this study) → stratification of the snowpack**
- **Energy and mass balance of the snowpack**
- **Account for snow metamorphism *(semi-empirical laws to describe the evolution of size and type of snow grains as a function of environnmental conditions)***
- **Refreezing**
- **Percolation**
- **Variable albedo, 3 wavelength bands**

Impact sur l'albédo de surface et la température d'été

Surface albedo anomaly
(LMDZ-SISVAT – LMDZ std)



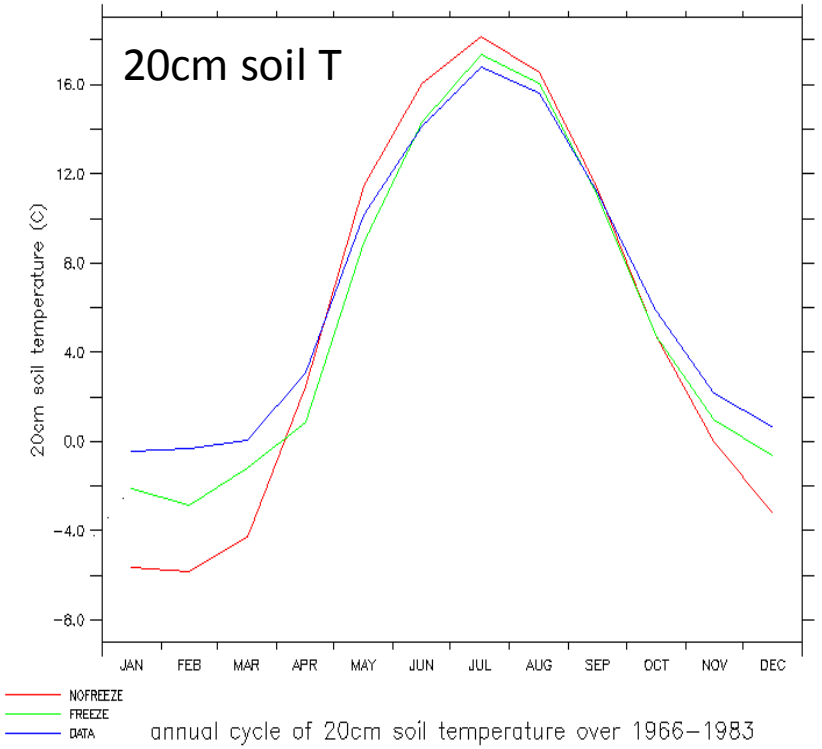
In winter : higher albedo values due to fresh snow
In summer : lower albedo (except at high altitude) due to melting and snow transformation

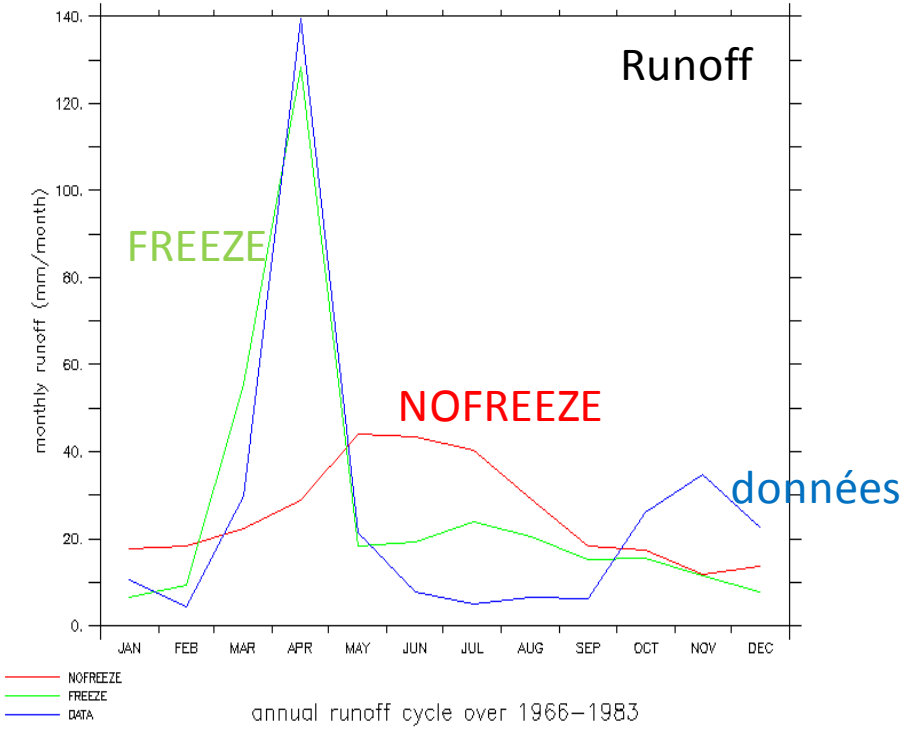


« Pb »: nécessite ajustement niveaux verticaux du modèle

Pergélisol – gel du sol

- Impact du gel du sol sur le runoff, Isabelle Gouttevin, G. Krinner, LGGE

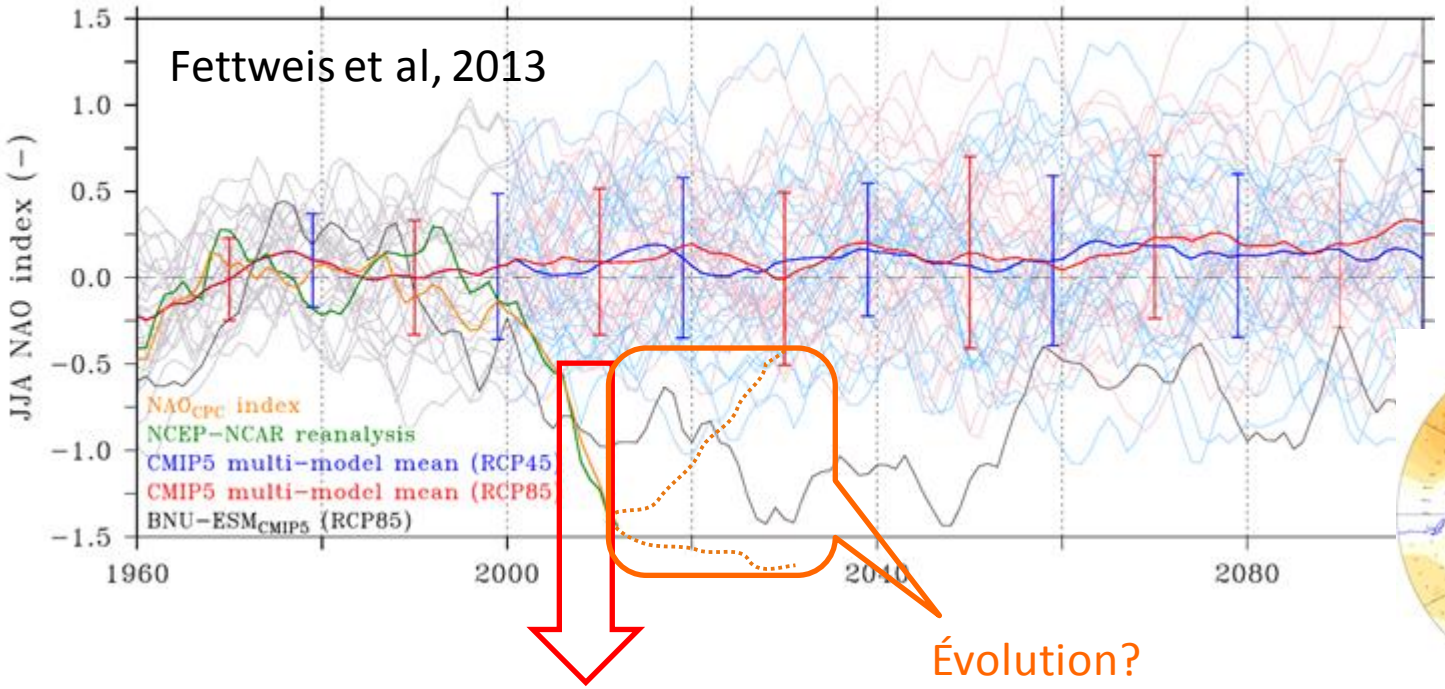




*Mean annual cycle of soil temperature at 20 cm (a) and of overland flow (b) simulated at **Valdai** (Russia) over 18 yrs. Atmospheric forcing and field data were provided in the framework of the PILPS 2d experiment (Schlosser et al., 1997). Red and green curves respectively refer to the model without and with the soil freezing scheme; the blue curve represents the data.*

Processus de climats froids, mais pas seulement…

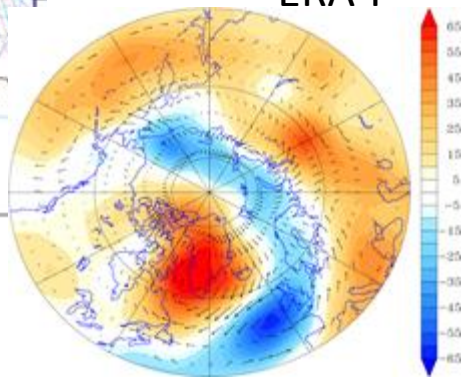
- 2012, année de record de fonte au Groenland, marquée par une NAO d'été très négative



Évolution?

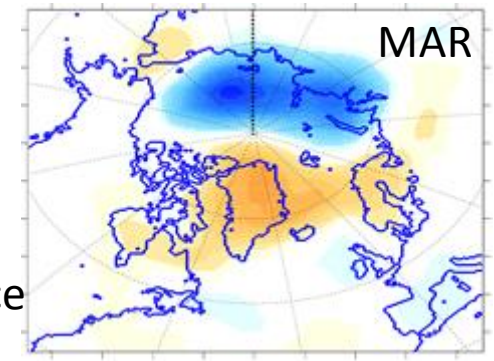
Variabilité naturelle?
Problèmes dans les GCM?

ERA-I



2012 – clim 1980-1999

MAR



MAR forcé par ERA-I/ SST/sea-ice

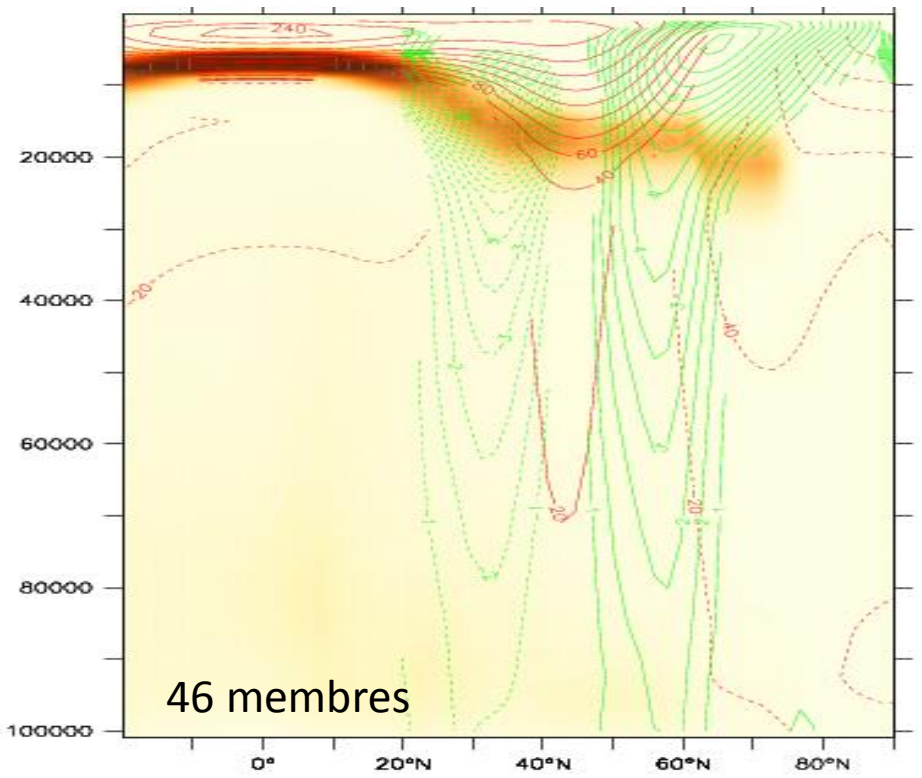
→ Besoin d'une « bonne » représentation de l'AO/NAO
→ Influences circulation/surface/strato?
→ Grande échelle vs Groenland

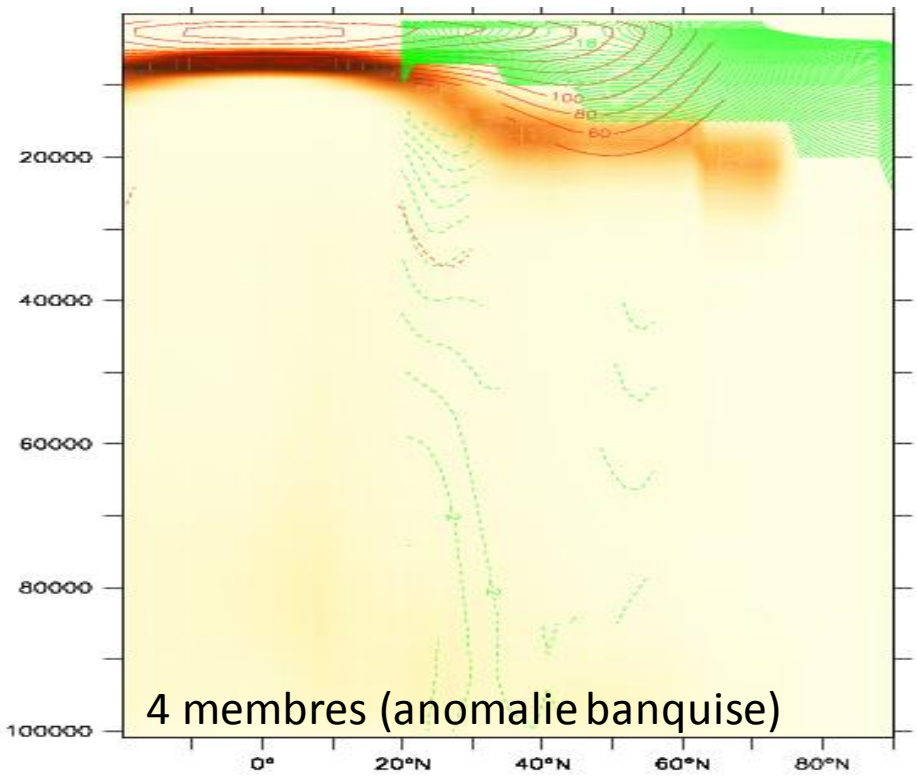
Fall-Winter 1991-1992, after Pinatubo eruption

↑Lower stratospheric pole–to–equator temperature gradient

↑ Polar Vortex

Courtesy Myriam Khodri





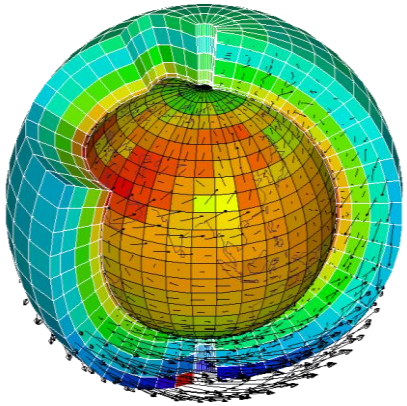
Altitude-latitude plot of ensemble-mean anomalies for the fall-winter 1991-1992

AOD (brown shading), geopotential height (red contours) and zonal winds (green contours).

Améliorations possibles: meilleure résolution de la strato
Etude du rôle des conditions de surface vs. strato-tropo
→ diagnostics développés au LOCEAN, pour étude impacts volcans, solaire, variabilité Atl N/Arctique

Rétroaction de la calotte glaciaire groenlandaise sur le système climatique: premier couplage

IPSL Earth System



Every day →

← Every day

← Every year

OASIS
Interpolation
- Temperature
- Precipitation
- Fresh water flux
- Topography
- Fresh water flux from calving

Every day →

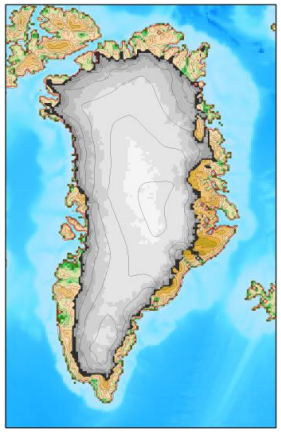
← Every day
Ablation

Mass Balance
Computed daily
- Accumulation
- Ablation
- Temperature

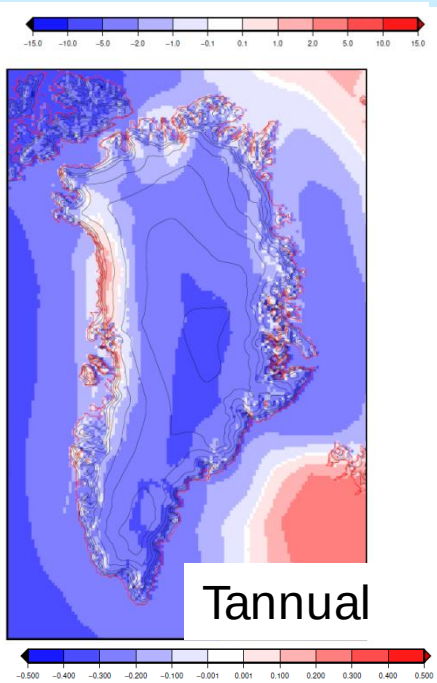
Annual Forcing ↓

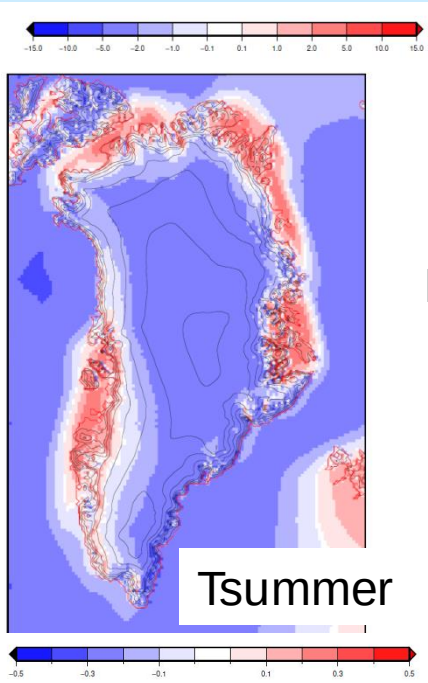
Every year →

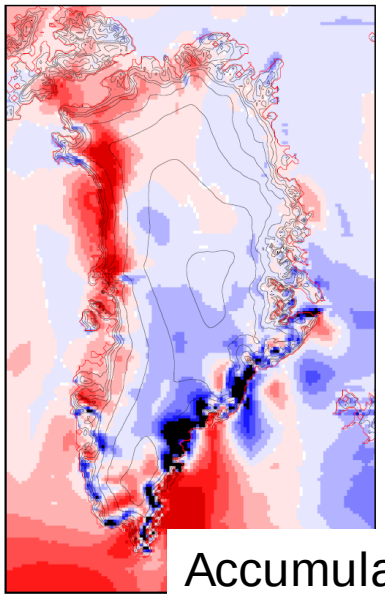
GRISLI (LGGE)

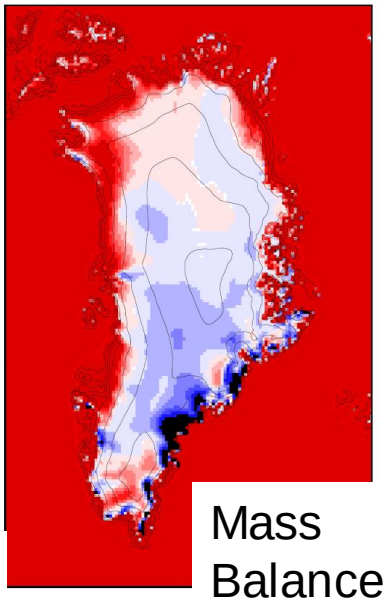


IPSL model climate bias

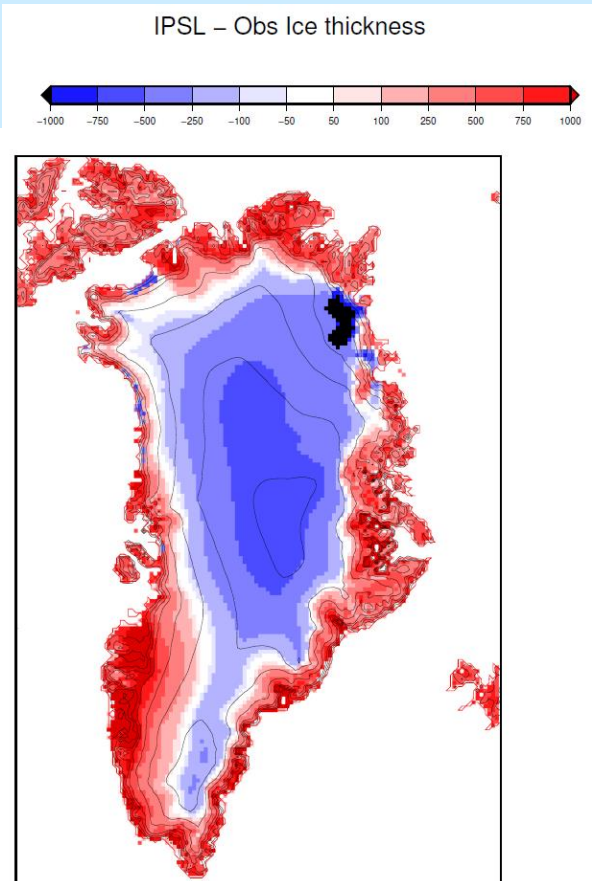








Equilibrium simulation under pre-industrial climate



Some biases (e.g. higher central ice-sheet) **not** due to local climate model bias
→ Need to « adjust » ice-sheet model too

Pb: lack of sensitivity to climate warming
Need to improve coupling method
Need to improve representation of snow at ice surface

Conclusions, perspectives

- Un intérêt fort sur le climat Arctique en général + lien avec circulation océanique et AO/NAO …
- + processus de climat froid (pergélisol, neige, nuages polaires) → collaborations LGGE
- Aspects couplage cycle du carbone: LGGE, IPSL
- Couplage IPSL-GRISLI…

- investissement dans le développement de LMDZ avec plus de niveaux verticaux (meilleure résolution de la couche d'inversion et des processus de surface pour le calcul du bilan de masse), modèle de neige
- Métriques/diagnostics à développer

Merci!