

Coupling LMDZ and ORCHIDEE over ice sheets: work in progress and prospects

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S. Charbit, C. Agosta, C. Amory, F. Cheruy

ORCHIDEE DEV meeting on snow processes modeling

Tuesday 26 September 2-4pm

Two-part presentation :

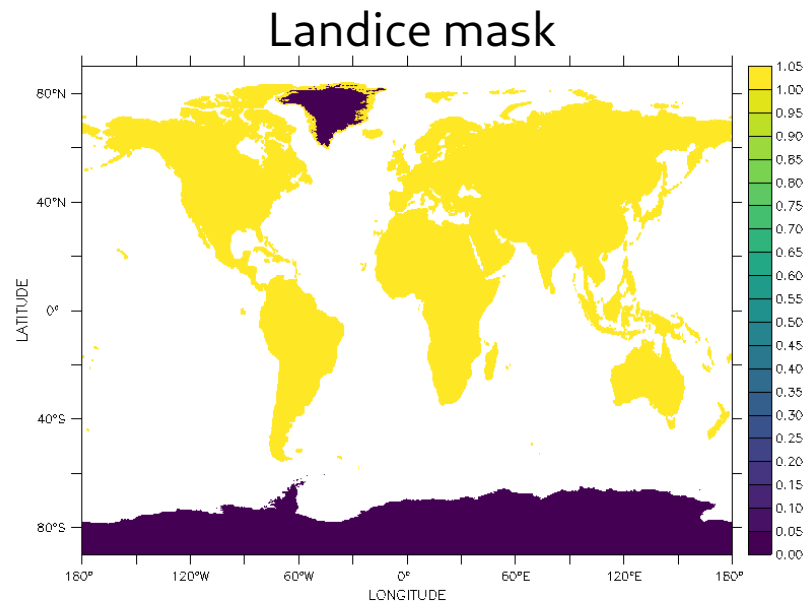
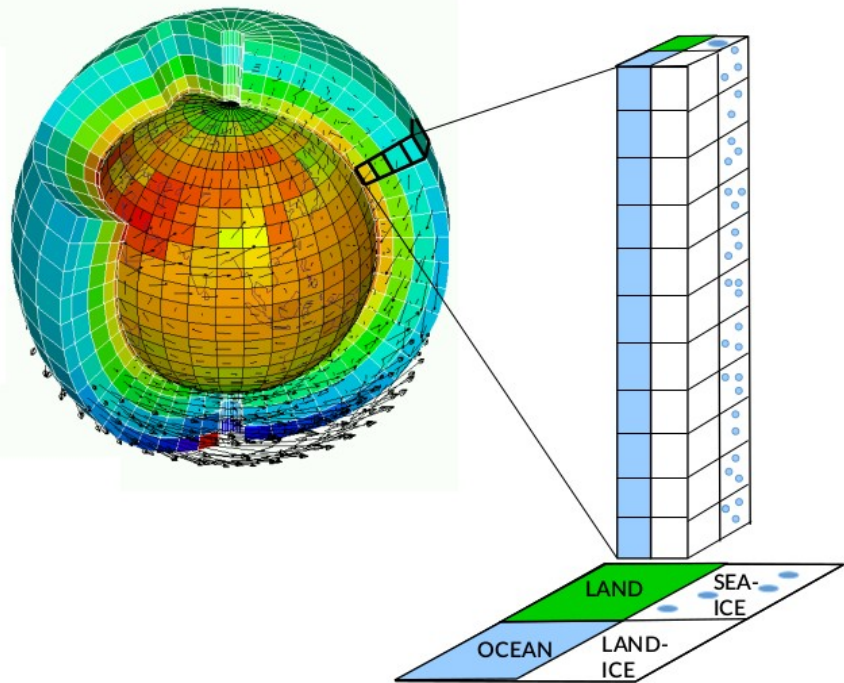
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2. Switching from a 3- to 12-layer snow over lands (excluding ice sheets!) → which impacts on LMDZOR simulations ?

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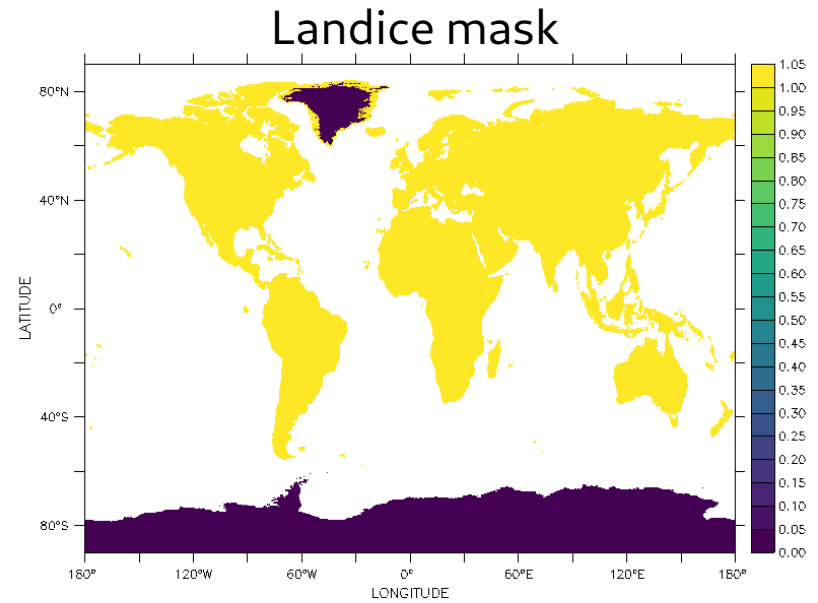
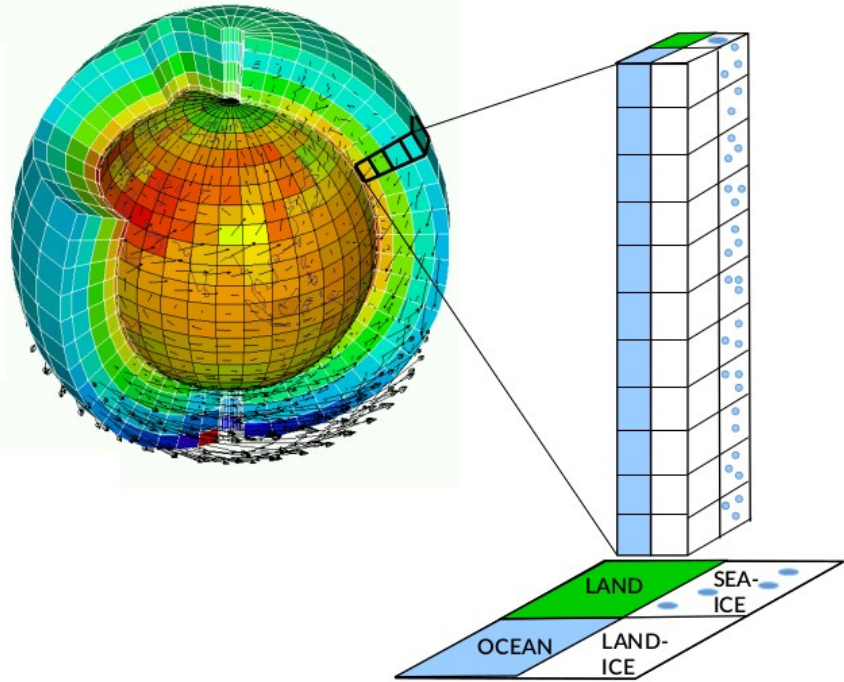
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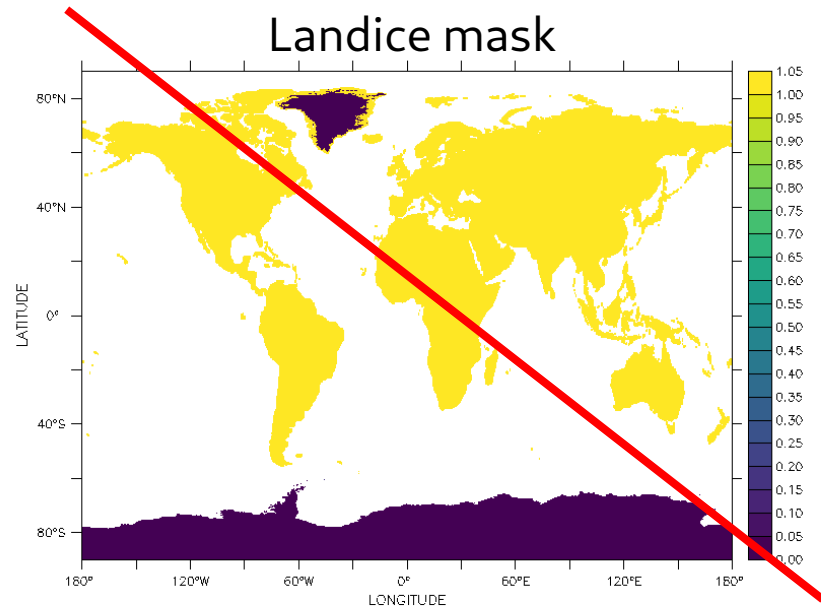
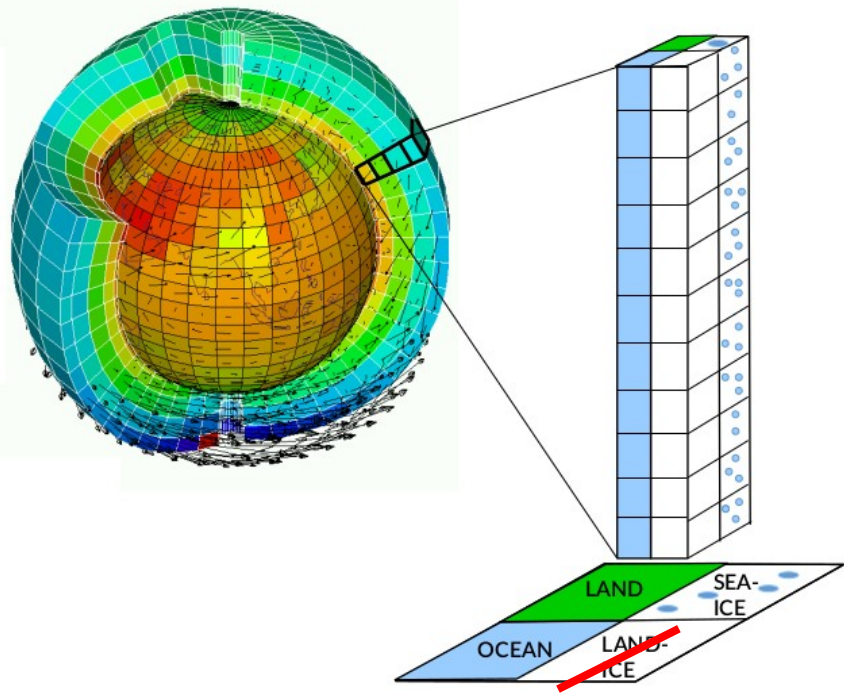


Coarse snow physics

- Fixed z_0 , $z_{0m}=z_{0h}=1\text{mm}$
- Fixed albedos $alb_1=0.96$ (vis), $alb_2=0.68$ (nir)
- Heat transfer through 11 vertical layers, constant thermal inertia
- Direct « excess water » transfer to ocean is $SnowMass > 3000 \text{ kg/m}^2$ ($\sim 10\text{m}$)
- Bulk snow melting when $T_s > 0^\circ\text{C}$ (no refreezing)



Aim : benefit from the recent 'ice sheet oriented' developments in Orchidee



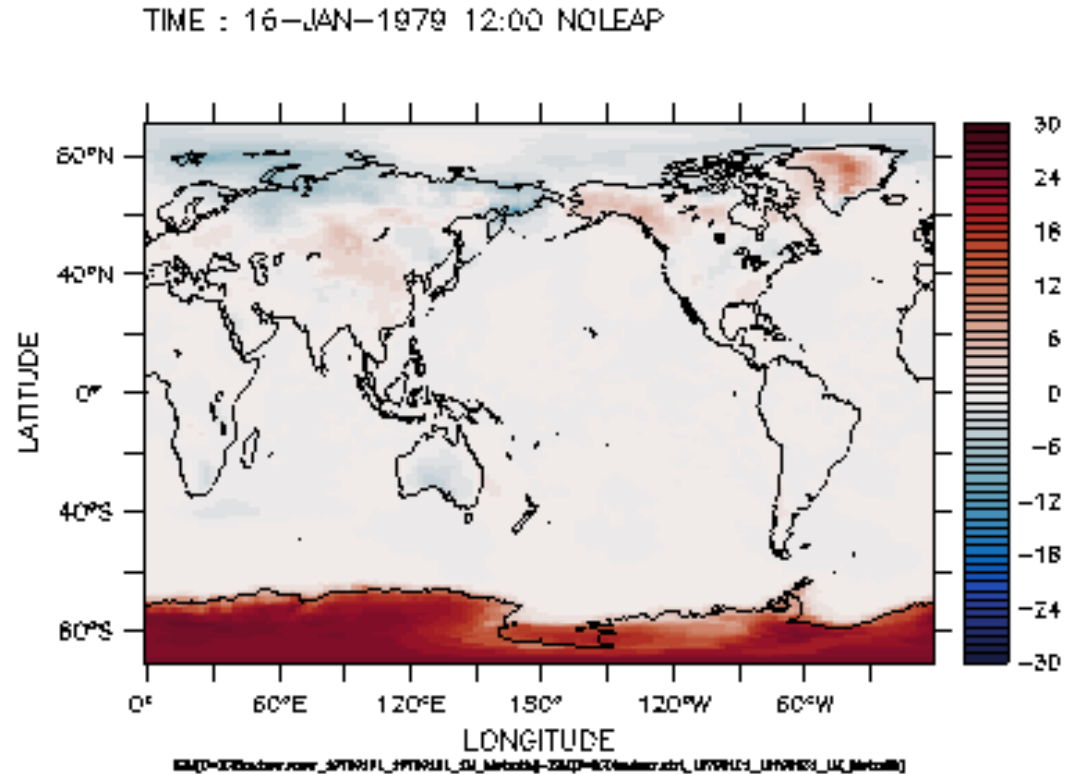
Aim : benefit from the recent 'ice sheet oriented' developments in Orchidee

→ 3 subsurfaces in LMDZ

→ Flag landice_opt=2

→ work on LMDZ-Orchidee interface (attention paid to the runoff_lic terms for fully coupled IPSL-CM)

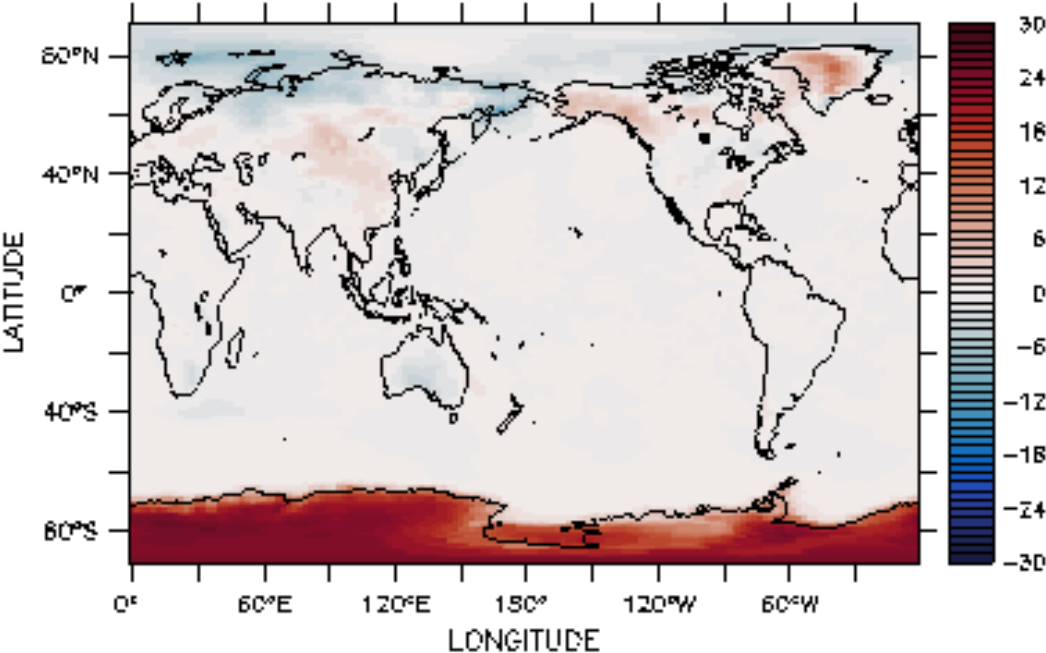
It works ! 10y of simulation with LMDZOR-Orchideetrunk +OK_ICE_SHEET=y
→ 1 month of simulation with ICOLMDZOR



Surface temperature TEST - CTRL

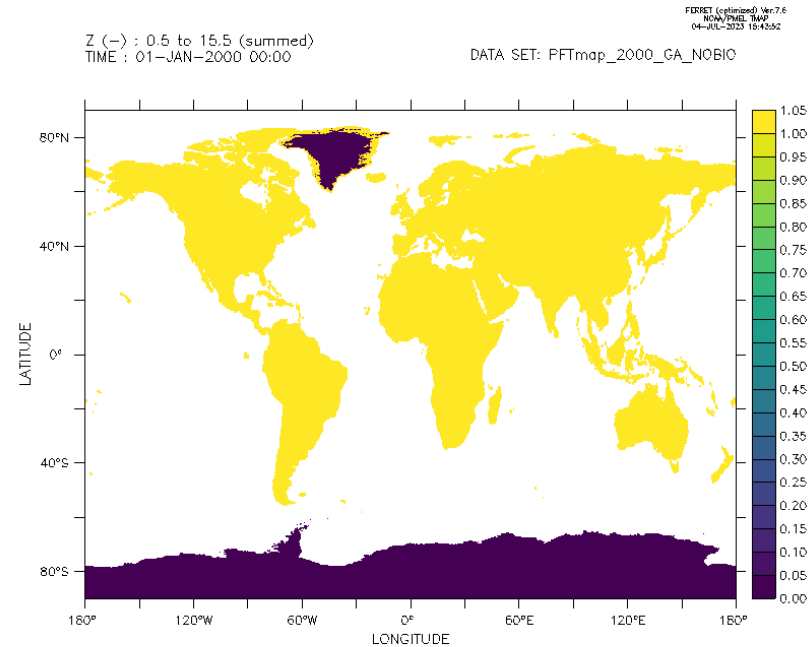
Reason : Bare soil (no ice, no snow) over Antarctica !!!!
because PFT map does not encompass the Antarctic

TIME : 16-JAN-1979 12:00 NOLEAP



Surface temperature TEST - CTRL

Set-up of a PFT map with nobio over Greenland and Antarctica (as OK_ICE_SHEET activates new snow param over nobio surfaces)



→ had to fix a bug when reading a PFT map with nobio

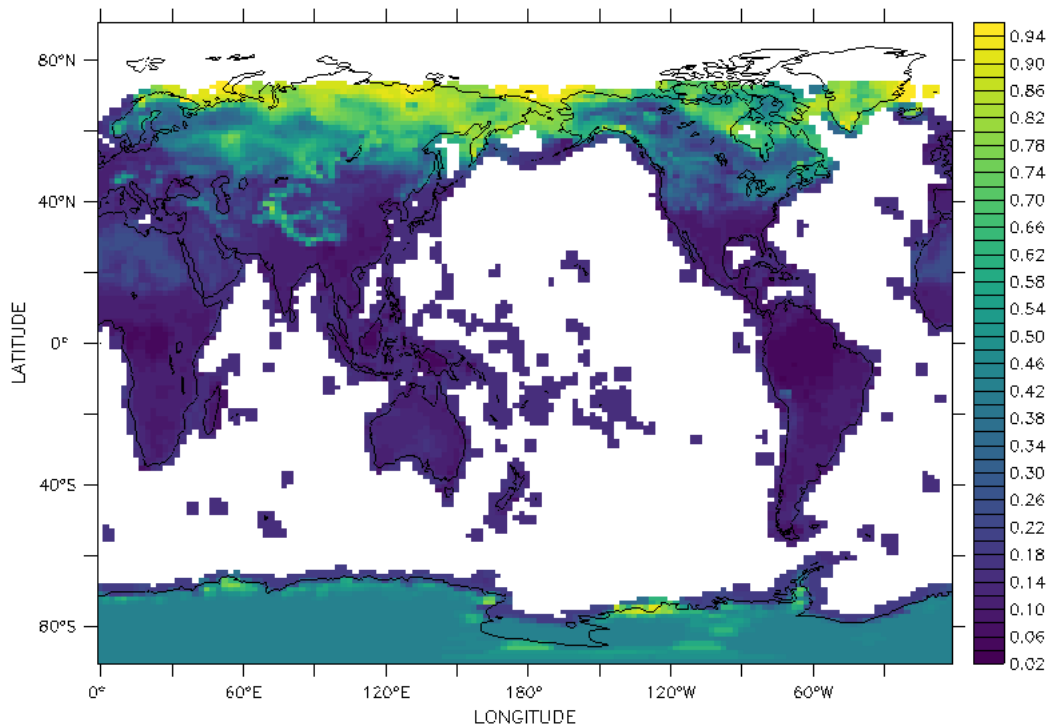
YES it works (one month simulation with ICOLMDZOR) but still 15K bias over Antarctica ...

→ Because no snow initially over the Antarctic (albedo of pure ice)

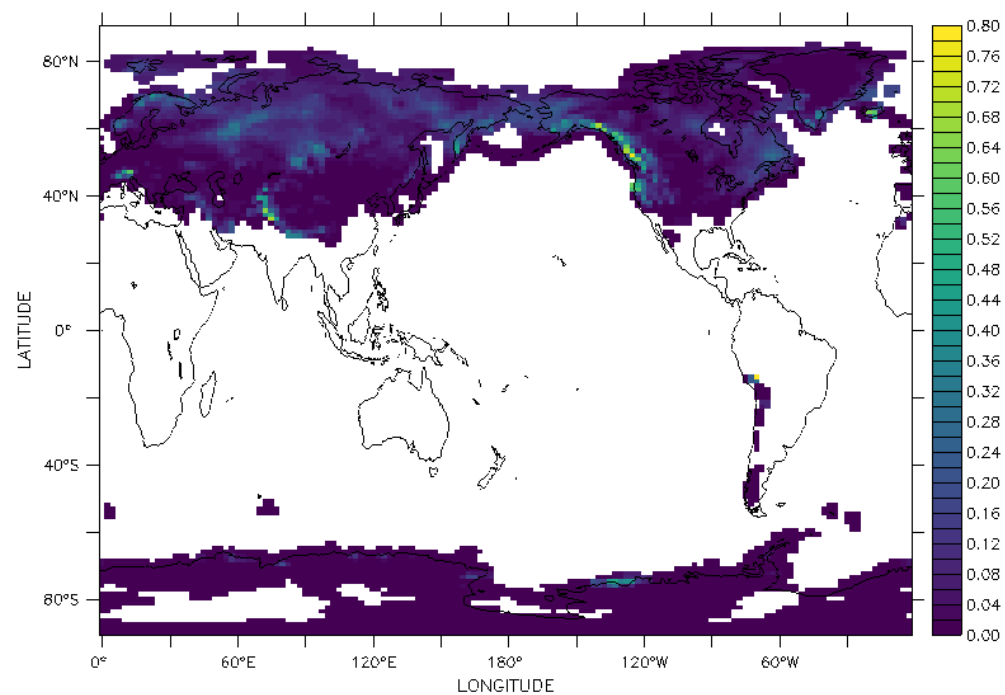
→ Work on initialisation of snowpack over ice sheets (Christophe, Cécile)

DATA SET:
_19790131_1M_schiba_history

Created by xios



Albedo visible (1)



Snow thickness

Conclusions and prospects for the first part:

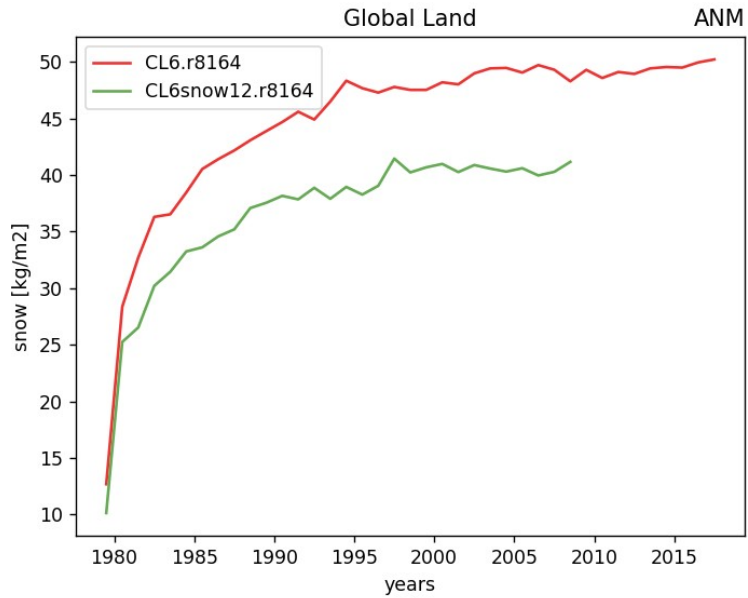
- LMDZ-Orchidee coupling over ice sheet is now operational !
- Need to work on snow initialisation (in progress)
- Proper evaluation of ICOLMDZOR with new snow over the two ice-sheets
→ New PhD (Philippe Conesa) starting in January 2024
- Check water conservation (starting with a IPSL-CM fully coupled simulation ?)
- Plugging a blowing-snow parameterisation in development in ICOLMDZ (erosion depends on snow surface properties)

Two-part presentation :

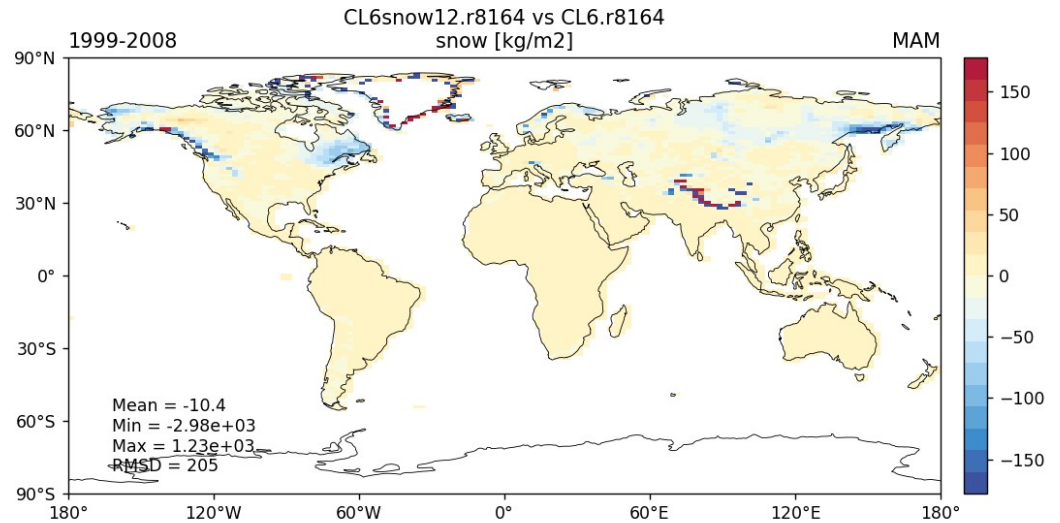
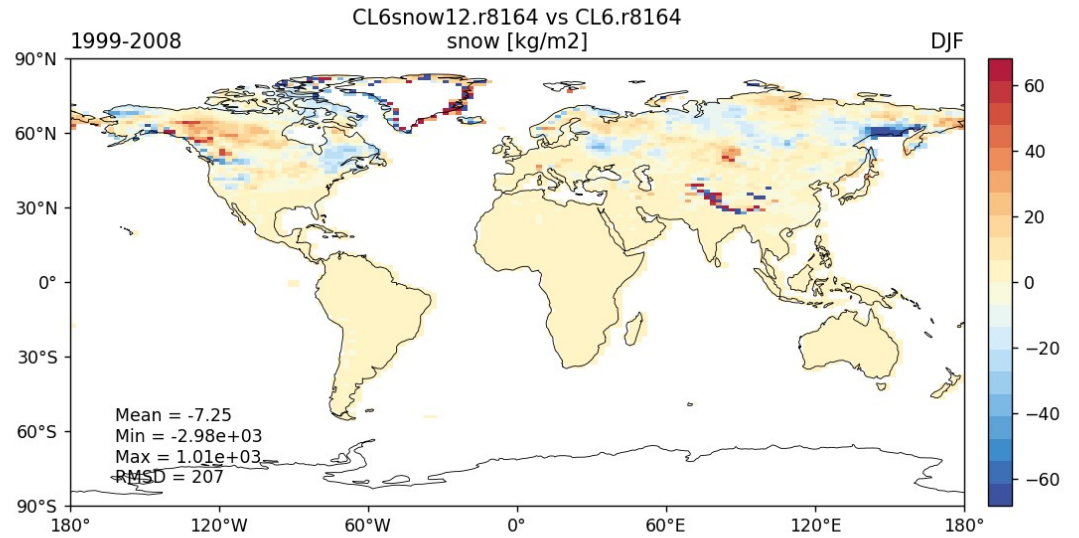
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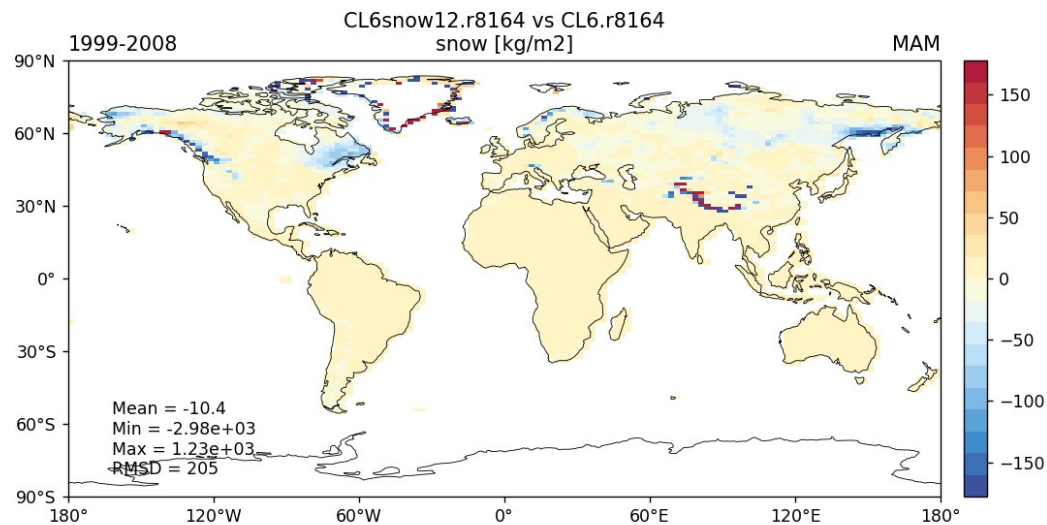
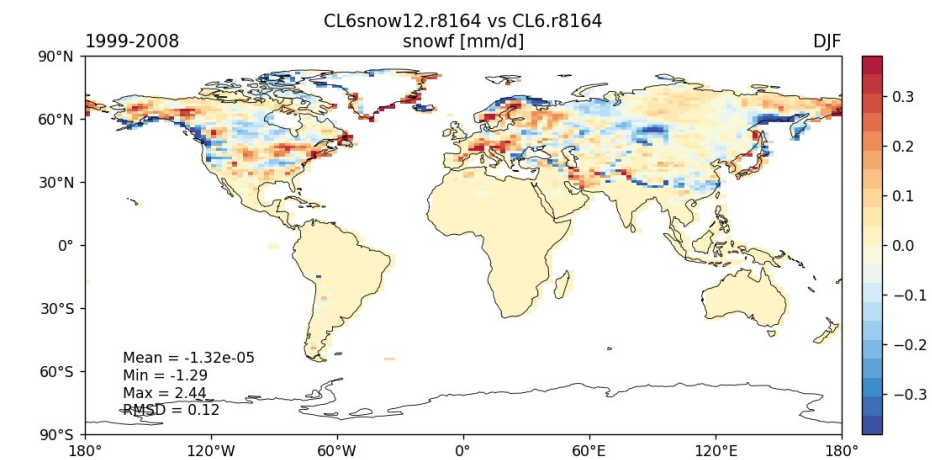
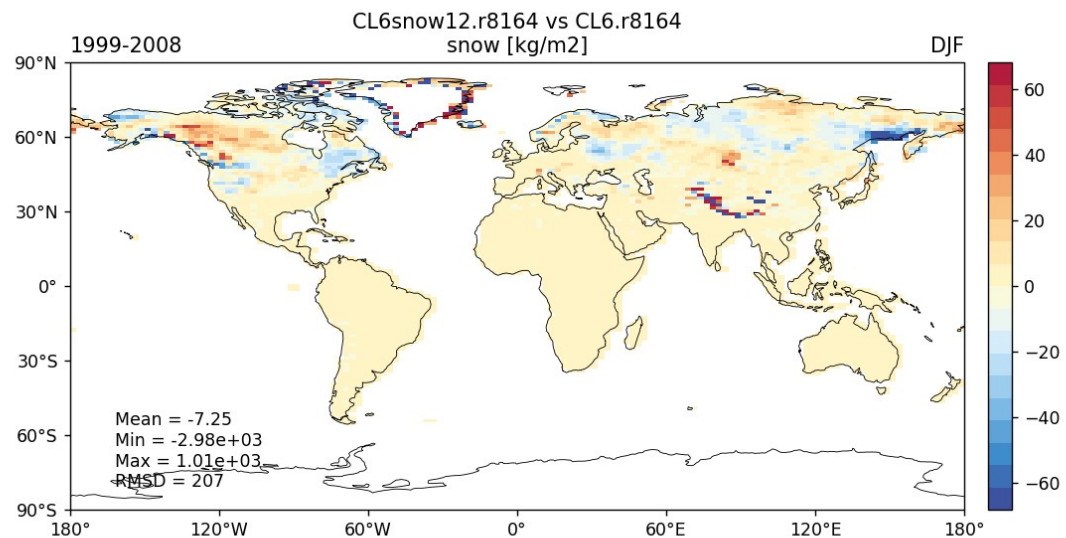
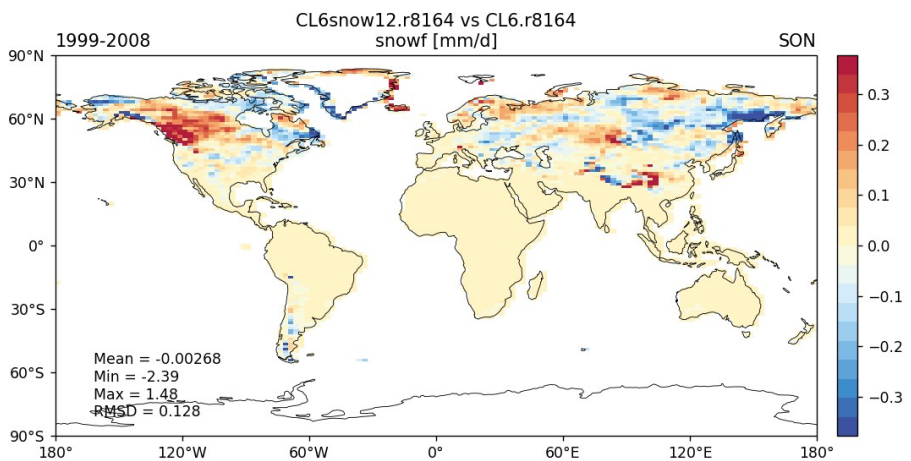
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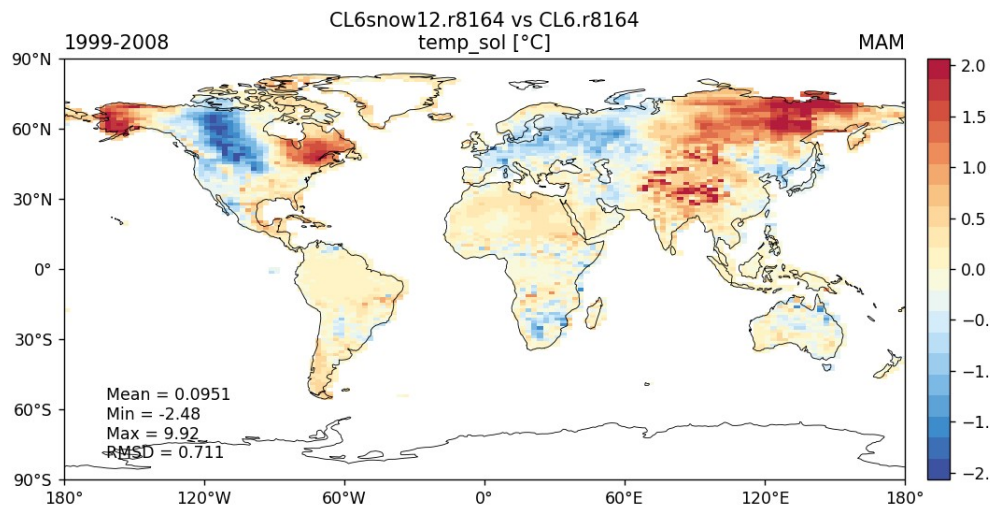
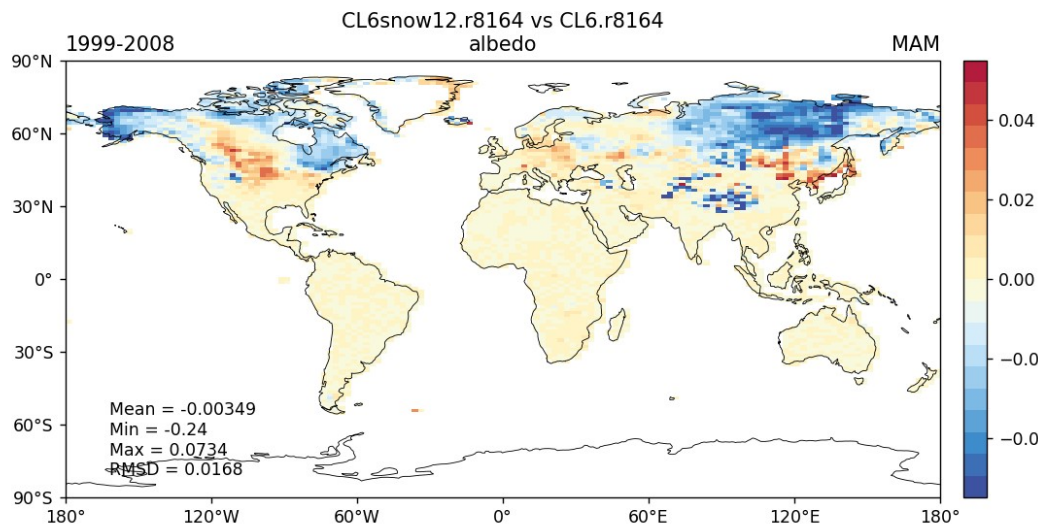
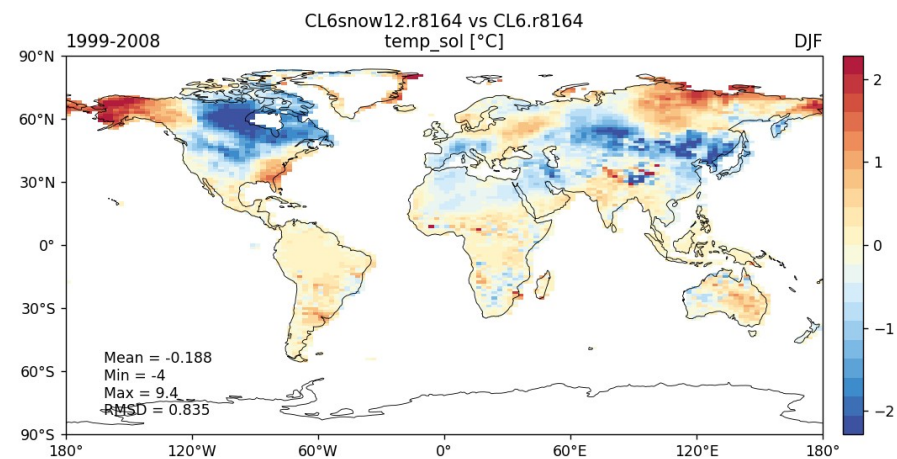
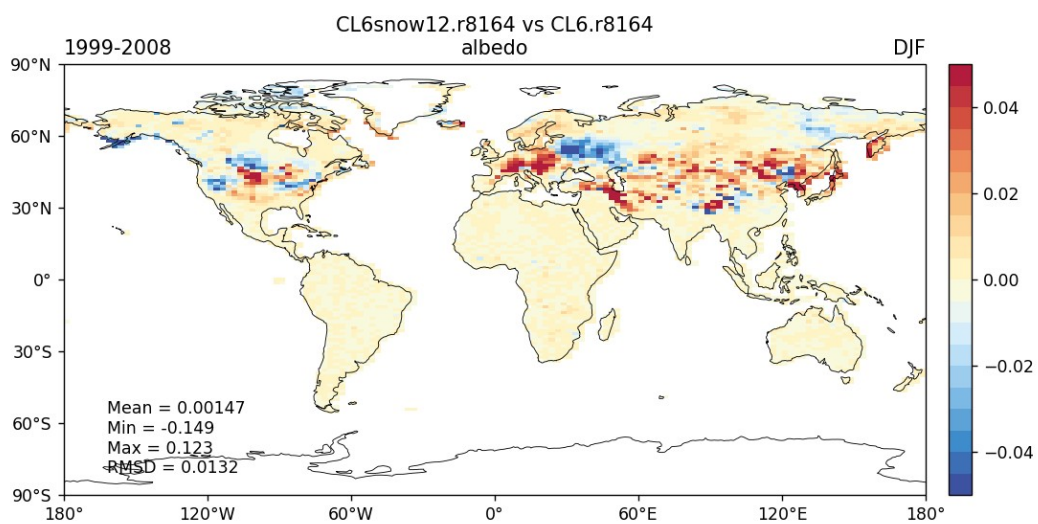
- As a reminder, the ice-sheet oriented developments of the snow parameterisation implies (but not necessarily) increasing the number of snow layers.
- Currently 12 layers are used (instead of 3 commonly in Orchidee)
- number of snow layers is a fixed parameter for all continents
- regardless of the specific changes in parameterisations, does the increase in number of snow layers have significant climate impacts
- LMDZOR simulations, CMIP6 configuration. One single change : number of snow layers (from 3 to 12)

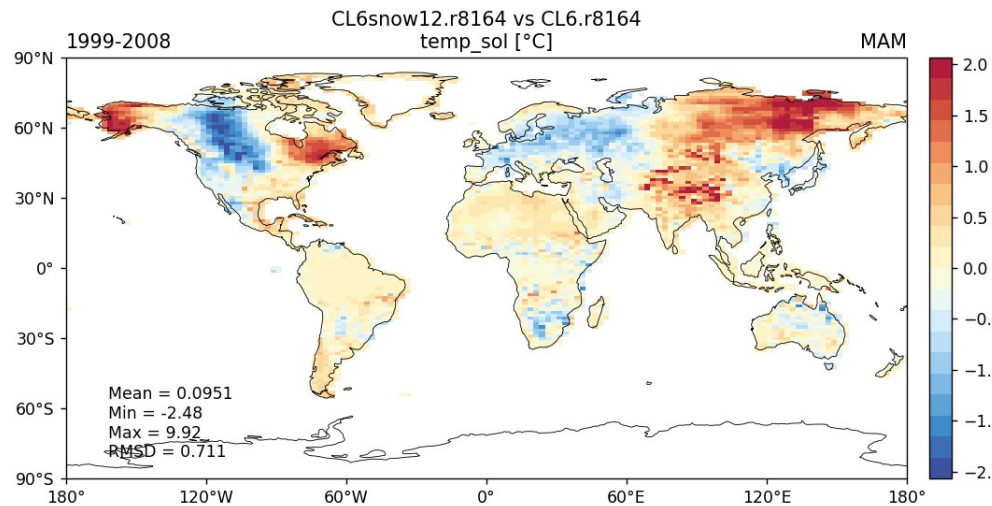
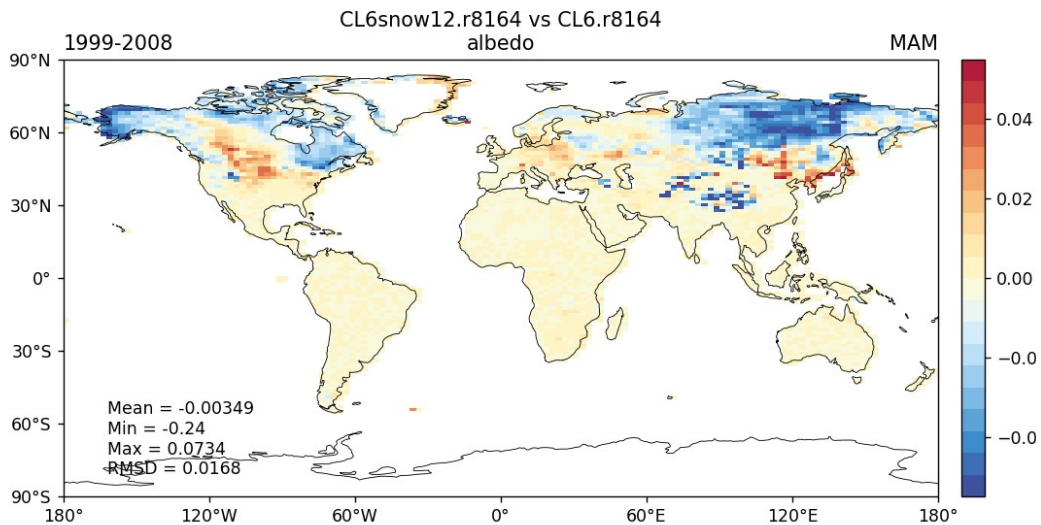
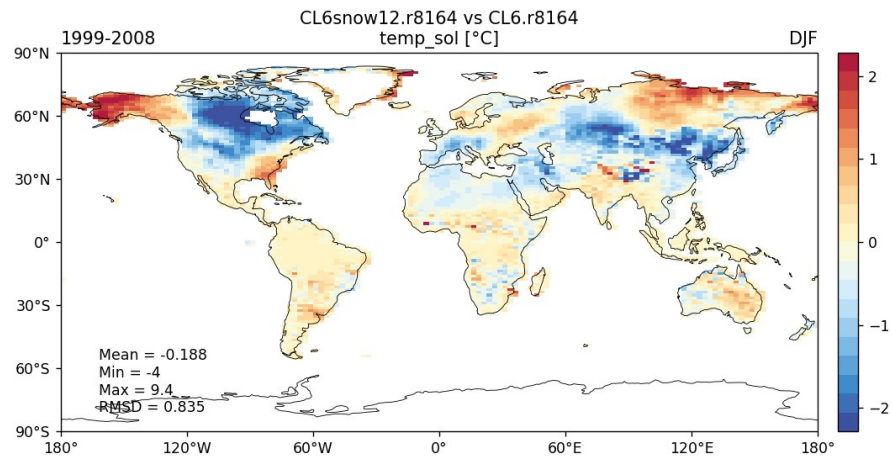
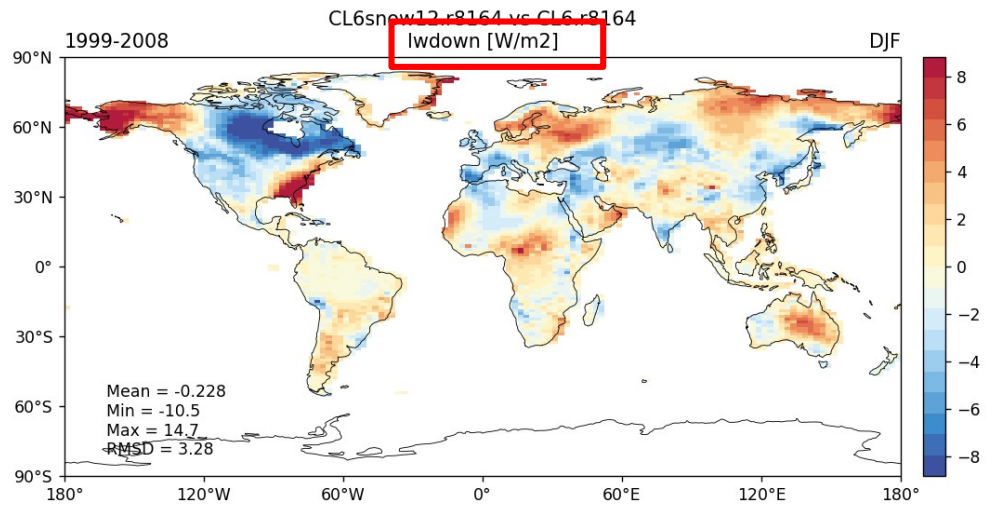


→ less snow in East Russia, Quebec, north-Alaska
 → substantial very local differences in Himalaya





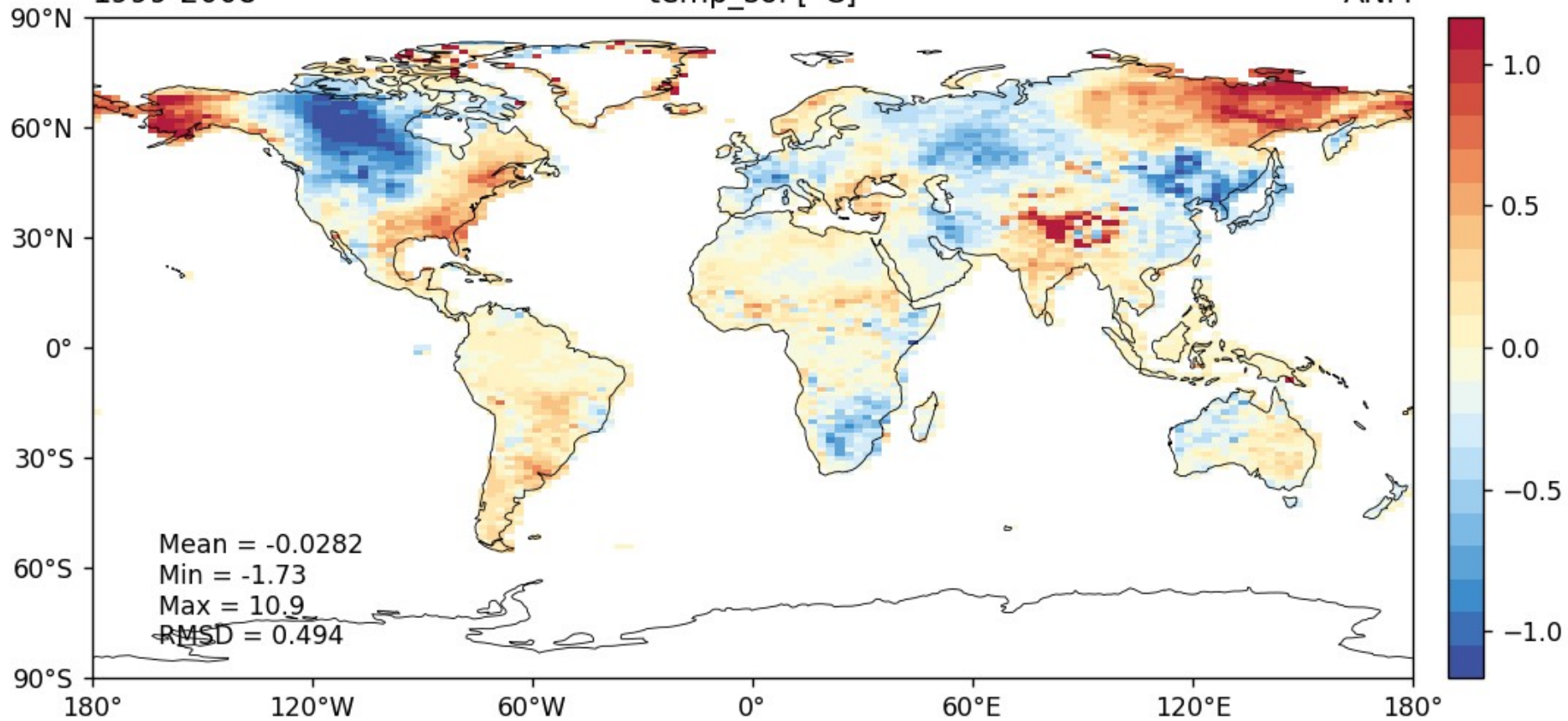




CL6snow12.r8164 vs CL6.r8164
temp_sol [°C]

1999-2008

ANM



Conclusions and prospects for the second part:

- Switching from a 3 to 12-layer snow pack with no retuning lead to local Ts differences of max 1K in annual mean.
Snow (through albedo) seems to explain differences mostly in MAM season
→ **overall weak consequences (at least at the continental scale)**
→ **we live in the same world**
- Local snow amount differences quite well correlated with differences in snowfall → variability signal ?
- Melt differences and effects on soil moisture not investigated in details yet

Melt seems more efficient (more rapid) with 12 layers

Differences in total and surface soil moisture in boreal North America and Asia are comprised between 1 and 5 % (higher with 12-layer snow)

Key messages from the informal « groupe neige »

5 works in progress

→ new snow with 'ice sheet options' + 12-layers (Sylvie + Christophe)

→ snow cover fraction = $f(\text{topo})$ (Mickaël + Martin)

→ Spectral snow albedo param + dependency on dust deposition
(Martin+ Sujith)

→ snow cover fraction depending on PFT type (Catherine + students).

→ blowing snow param in ICOLMDZ (Etienne, Charles, Cécile)

6 years of post-doc for snow-related developments in TRACCS PC7

Priorities that have been identified:

→ check the sensitivity to 12-layer snowpack over lands

→ code Mickaël's parameterisation in the trunk (activation with a flag)

→ Ice and snow initialisation over ice sheets