Contribution of lakes in the ORCHIDEE land surface model

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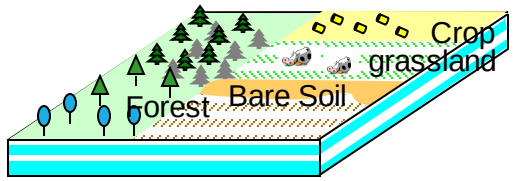
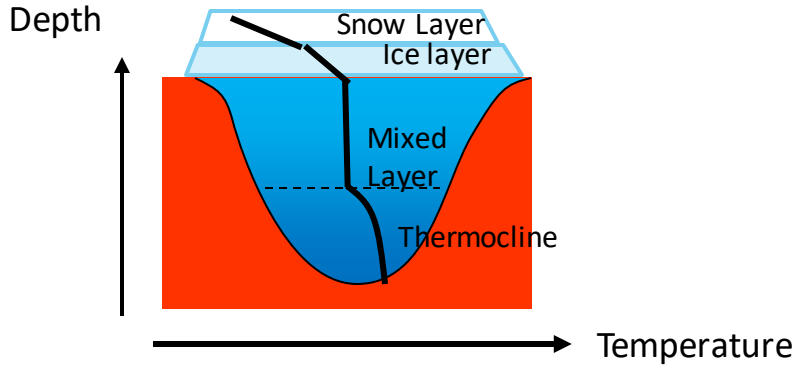
Coupling overview

ORCHIDEE: Land Surface Model resolving the land surface heat budget (one equation with parameters represent the plant function type (PFT) in a tile).



<u>New version</u>: The water inland corresponding to lakes has its own fraction (before it was associated with the bare soil). Flake resolves its heat budget

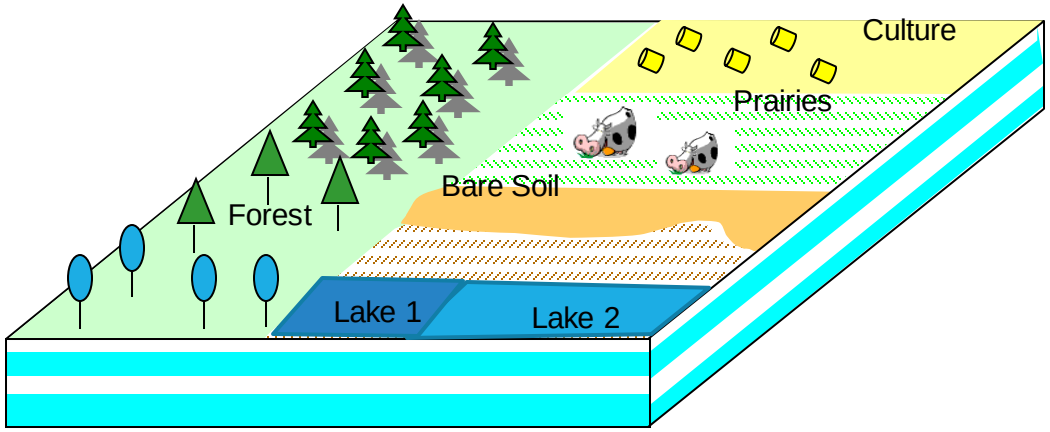
Flake [1]: Fresh lake model resolving the lake heat budget



[1] Mironov, D. V., 2008: Parameterization of lakes in numerical weather prediction. Description of a lake model. COSMOS technical report, N11, Deutscher Wetterdienst, Offenbach am Main, Germany, 41pp

Coupling overview (II)

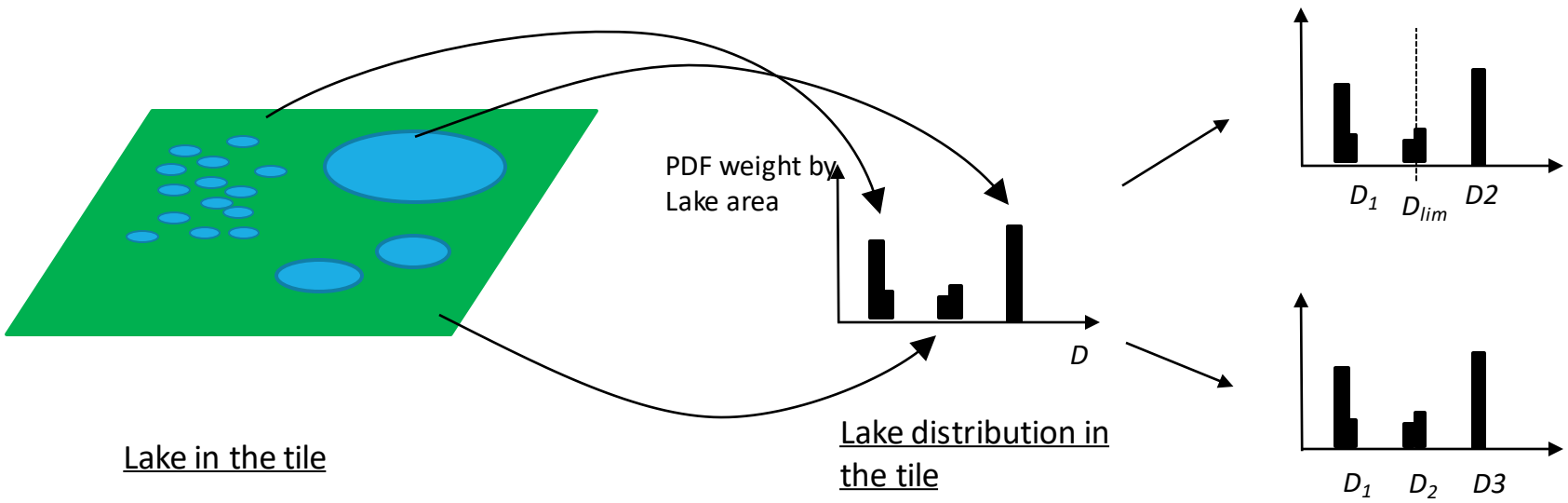
- The Heat budget for the standard PFT are simulated by ORCHIDEE standard.
- We define severeal generic lakes (See the following slide for definition).
  Flake resolves one heat budget equation per generic lake.



Flake setting

Main FLake parameters: Depth, Ligth extinction coefficient, Fetch, Albedo
The Depth *D* and Ligth extinction coefficient C_{ext} are the most influent [2]
How to set them ?

- Take a constant for Cext (not global database available for C_{ext})
- Build generic lake (for each tile) to set the depth. We can use two methods:



1/ Choose a limit depth D_{lim}. The first generic lake represents all lakes with *D* inferior to D_{lim}. *Its depth D_1 is the mean depth of all lake corresponding and its fraction their sum.*

The second one represents all the lake with D superior to Dlim

2/ The main peak of the distribution corresponds to a generic lake with the corresponding depth. The high of the peak determinates the fraction. (**Result not shown here**)

[2] Bernus, A, Ottle C. Raoult N., 2020: Variance based sensitivity analysis of Flake model for global land surface modeling, Journal of Geophysical Research (In review)

Validation I: simulation and satellite product presentation

Simulation

Duration: 10 years of spinup + 10 year simulation (2000-2009)

Atmospheric forcing: WFDEI_CRU

Time step simulation: 30min

Spatial resolution: 0.5°

Lake fraction calculation from Hydrolake[3]

Satellite product for validation:

Database: ARClake[4]

Instruments: ATSR1-2 et AATSR on ENVISAT

Observation Period: 1991-2010

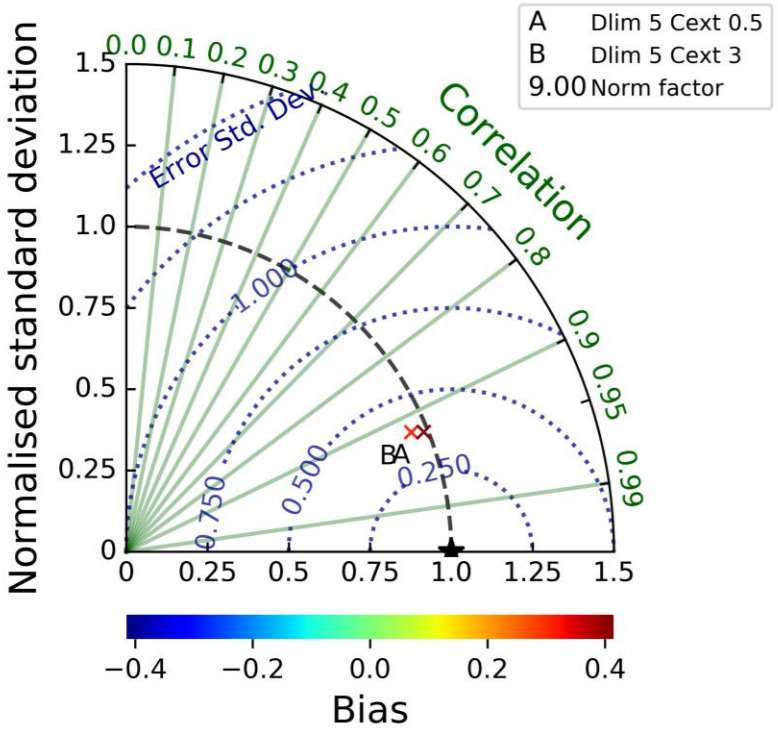
Number of observed lakes: 263

The observed variable: Lake Surface Temperature when the lake is not frozen.

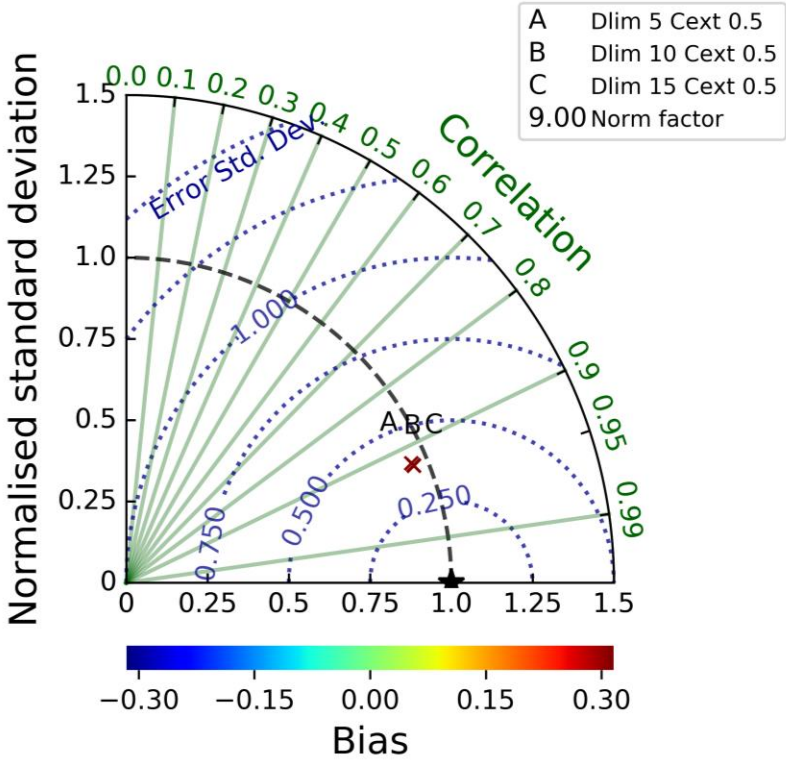
[3] Messager, M.L., Lehner, B., Grill, G., Nedeva, I., Schmitt, O. (2016): Estimating the volume and age of water stored in global lakes using a geo-statistical approach. Nature Communications: 13603. doi: 10.1038/ncomms13603

[4] MacCallum, S. N. and Merchant, C. J. 2013. ARC-Lake v2.0,1991-2011 [Dataset]. University of Edinburgh, School of GeoSciences/European Space Agency. Online at: http://hdl.handle.net/10283/88

Validation on surface temperature



This Taylor diagramm shows the normalised RMSE of the two simulations with D_{lim} =5m and C_{ext} = 0.5 for A and C_{ext}=3 for B. 56 lakes was selected. Their surface temperature time series was concatenated before to compare it to the observation. The configuration A shows a RMSE a little bit smaller C_{ext} egal to 0.5 (corresponding to a clear lake) fit better the observations for the selected lakes.



The Taylor diagram shows here the impact of D_{lim} . The observed surface temperature is .compared to the generic lake corresponding to the real lake depth. All the configurations almost give the same statistics.

Comparaison ORCHIDEE with and without lakes

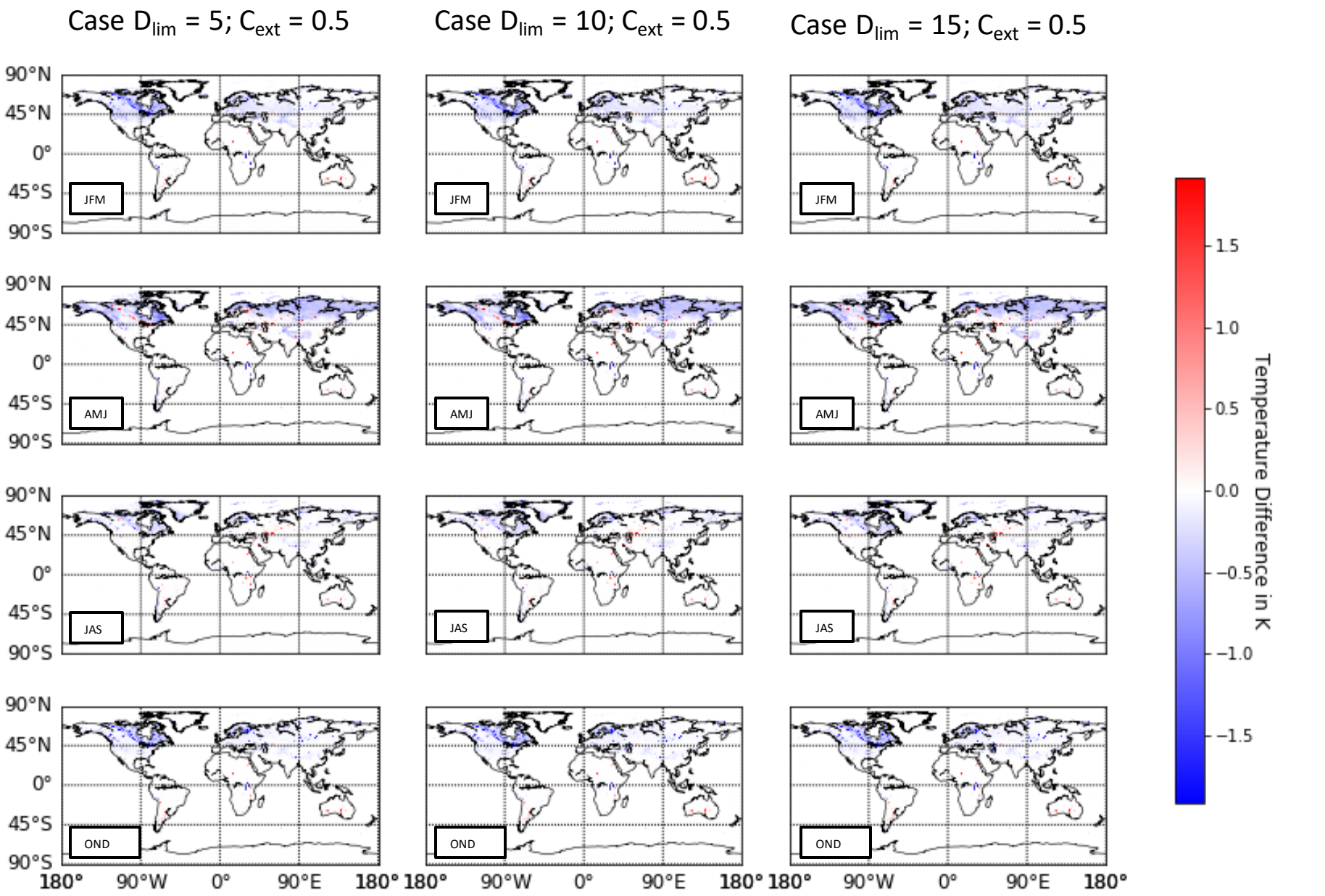
Seasonal mean differences (on the ten years of simulation) between ORCHIDEE without FLake and ORCHIDEE with FLake .

Each line correspond to a seasonality

Each column to an experience.

These differences can go up to 4K.

Change the D_{lim} have a relatively small impact.



Conclusion/Perspective

- The parameter D_{lim} has small impact on the surface temperature calculated on the ORCHIDEE tile.

Perspectives:

- Spatialize the C_{ext} parameter

- Make the validation of the second method to set up the lake depth in a ORCHIDEE tile.

Thanks you