



# Global offline Lake simulations: Evaluation and Impacts on ERA- INTERIM

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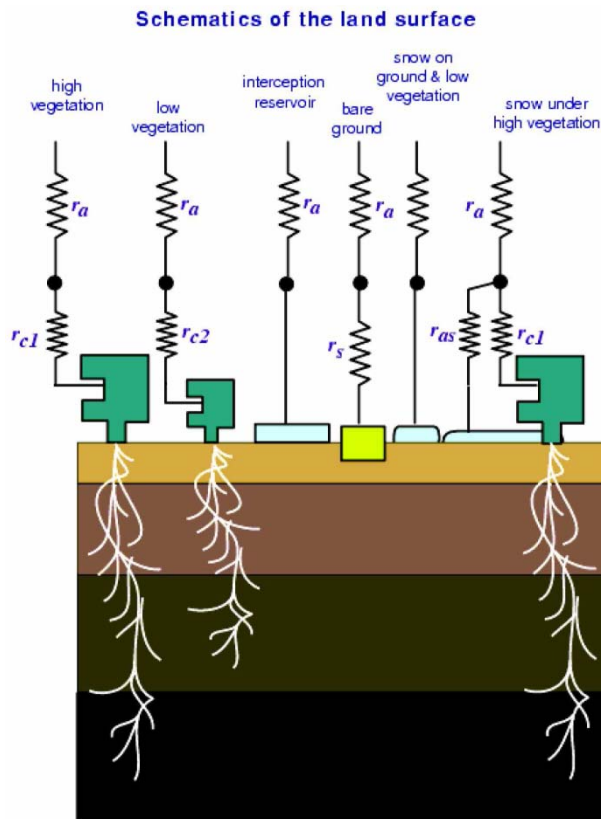
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**Thanks to Dmitrii Mironov**

# Introduction

- Couple the lake model **FLAKE** with the LSM **HTESSSEL** :
  - Representation of both **grid scale** and **sub-grid scale** lakes;
  - Problems / solutions;
- Offline validation:
  - **Global runs** 1989-1998 using **ERA-INTERIM** forcing and resolution
  - **Validation** of grid scale lakes against SSTs (**MODIS-Terra** 2001-2008);
  - Lake depth impact.
- Impact of **representing sub-grid scale** lakes on **surface fluxes**:
  - Mean annual cycle and mean annual cycles differences.

# Coupling FLAKE to HTESSEL



HTESSEL

+

FLAKE

- **New TILE** - allows sub-grid lakes
- **Surface fluxes** (heat moisture and momentum) from HTESSEL routines;
- **No snow** over frozen lakes !
- **No bottom sediments** !
- **Surface characteristics** ( albedo, roughness, emissivity, etc) equal to water or sea ice tiles;

Grid-box surface balances:

- Energy balance – Closed
- Water balance – Open ! **P-E-Runoff  $\neq 0$**

# Global simulations set-up

## •Forcing:

- Near Surface meteorology and radiative fluxes from ERA-INTERIM 1989-1998;
- Spatial resolution Gaussian reduced N128 ( $0.7^{\circ} \times 0.7^{\circ}$ );

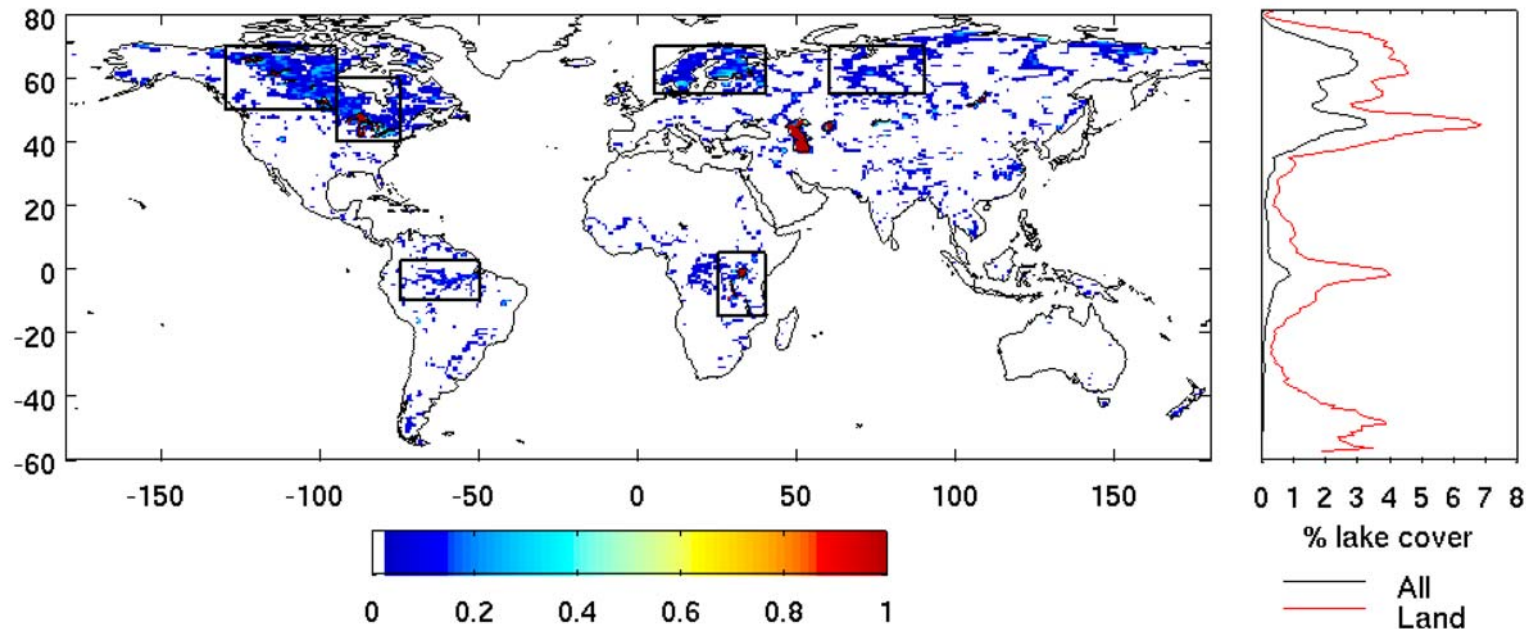
## •Surface/Lake characteristics:

- Surface coverage == ERA-INTERIM (including lake cover);
- Lake depths -> constant = 10, 30 and 50 meters;

## •Initial conditions:

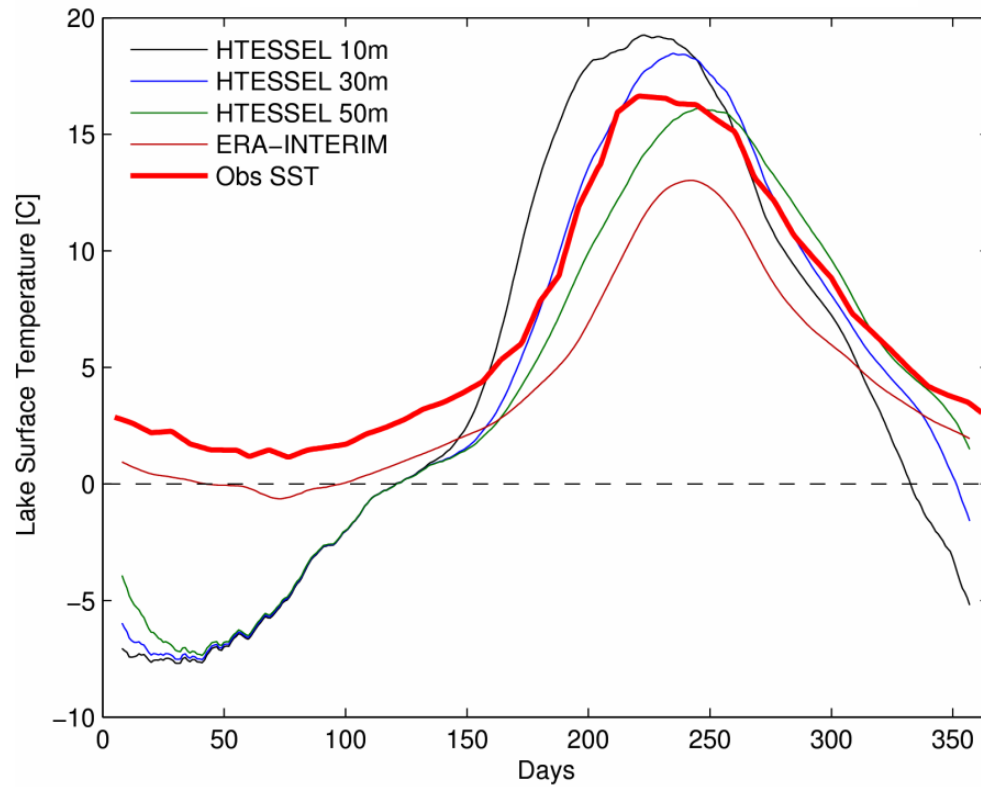
- 4 years spin-up with 1989 forcing

## LAKE COVER



# Lake points validation (High Latitude)

## Lake Superior (16 grid points)



-Late Ice Melting

-Problems late winter beginning spring !

-Depth decreases annual amplitude

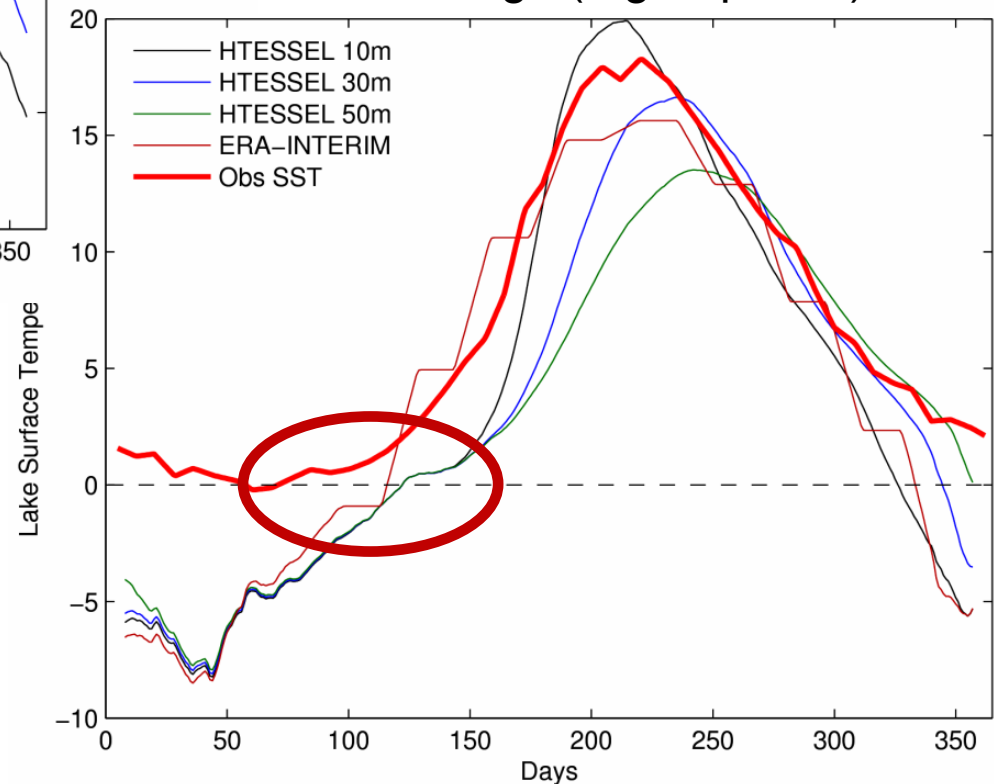
Mean annual cycles:

-SSTs : 2001-2008

-Offline : 1989-1998

SSTs from : <http://oceancolor.gsfc.nasa.gov/>  
Terra Modis SST 11 micron daytime;  
weekly climatology, 4 km

## Lake Ladoga (3 grid-points)



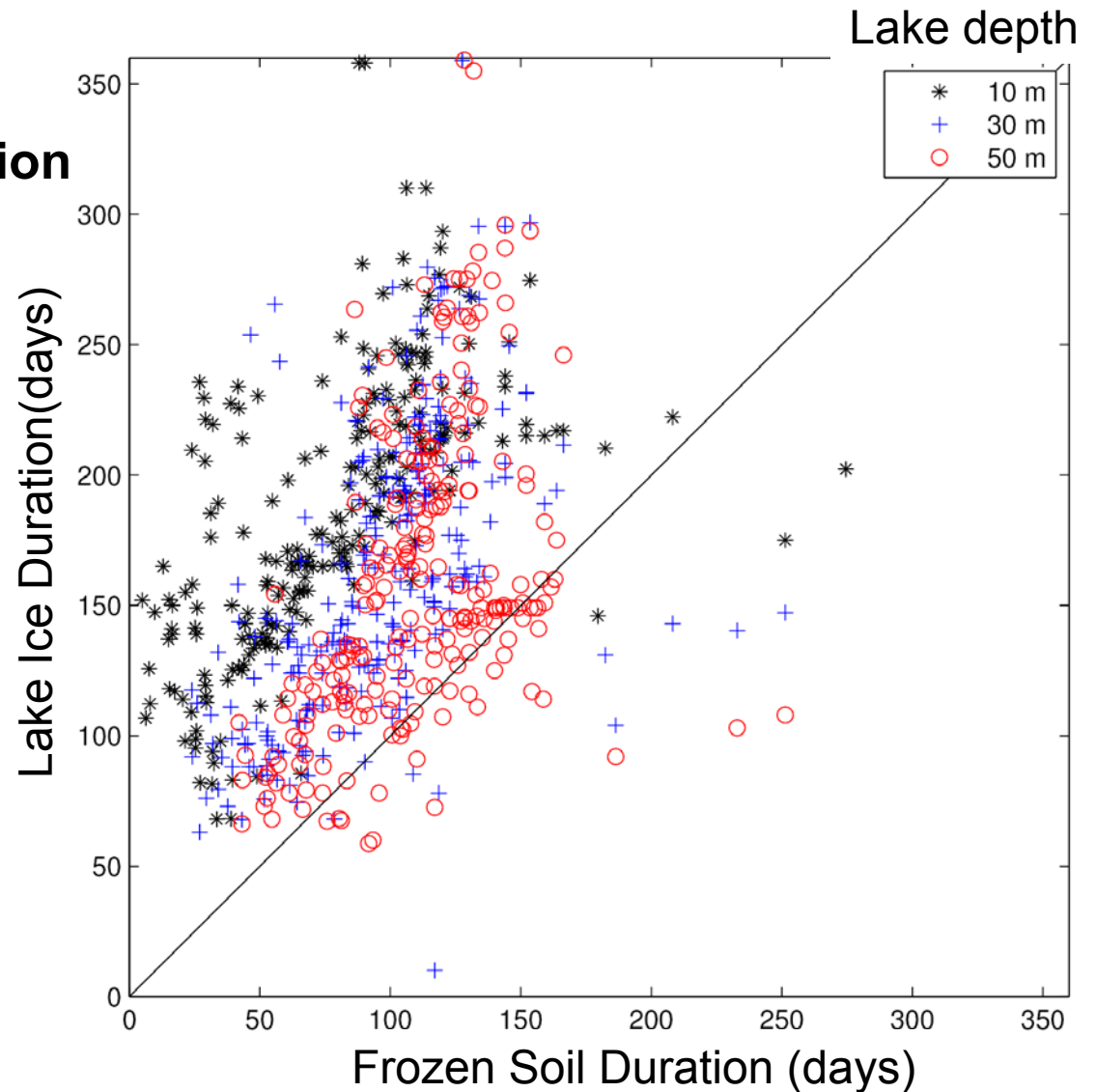
# Lake points validation (High Latitude)

## Sub-grid lake points

### Frozen soil duration vs. Lake Ice Duration (same grid-box)

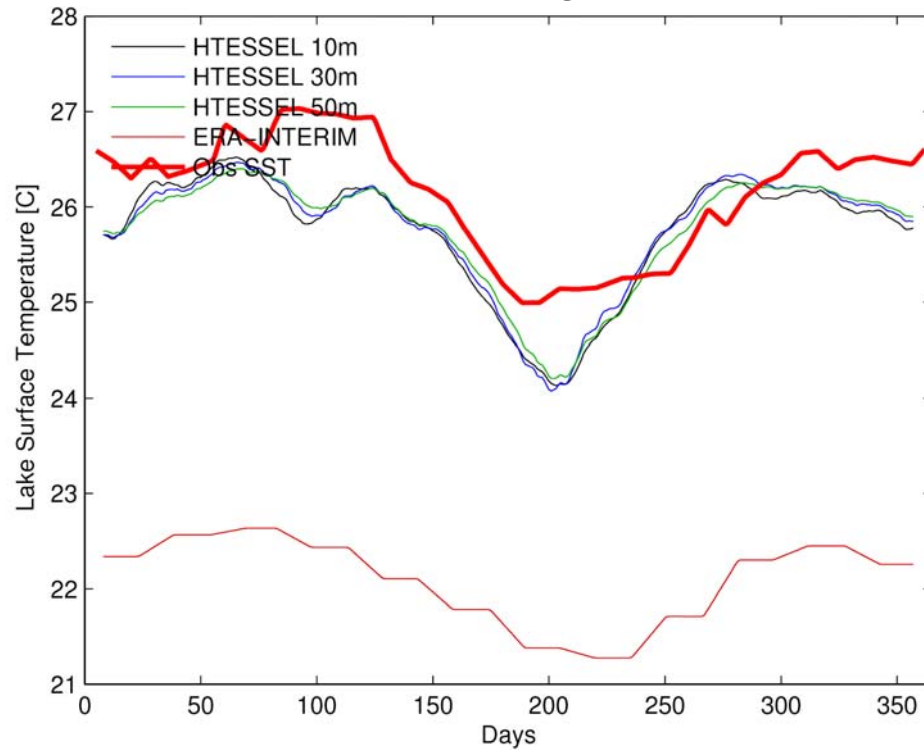
Deeper lakes -> less ice duration

ICE duration > Frozen soil  
- Missing snow over ICE !!



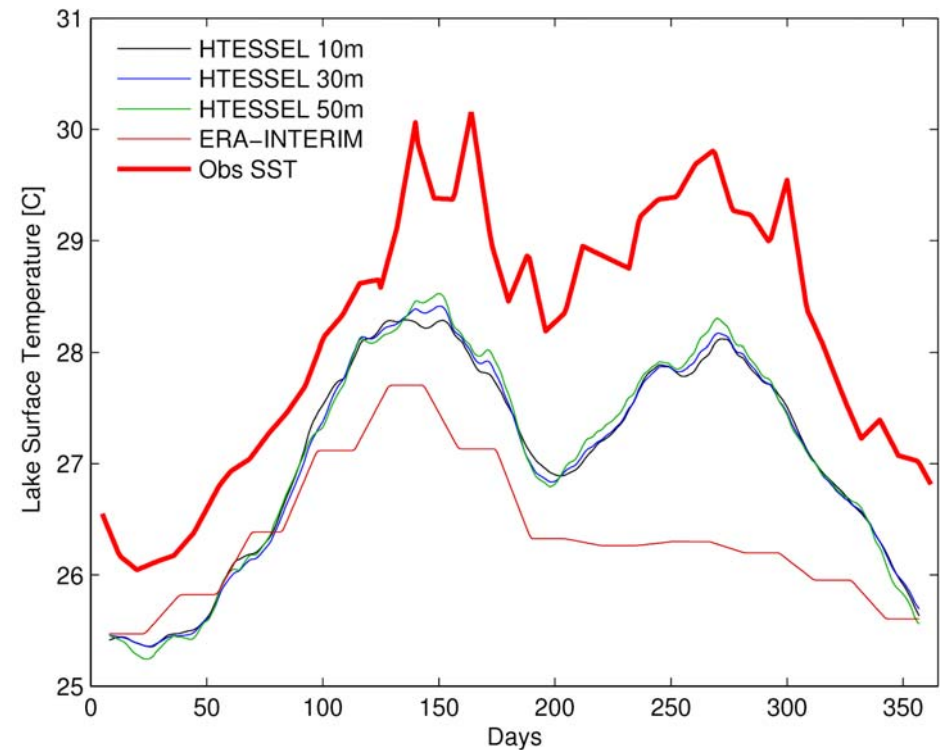
# Lake points validation (Low latitude)

## Lake Victoria (9 grid points)



-Lake depth has a reduced impact on surface temperature

## Lake Nicaragua (2 grid points)



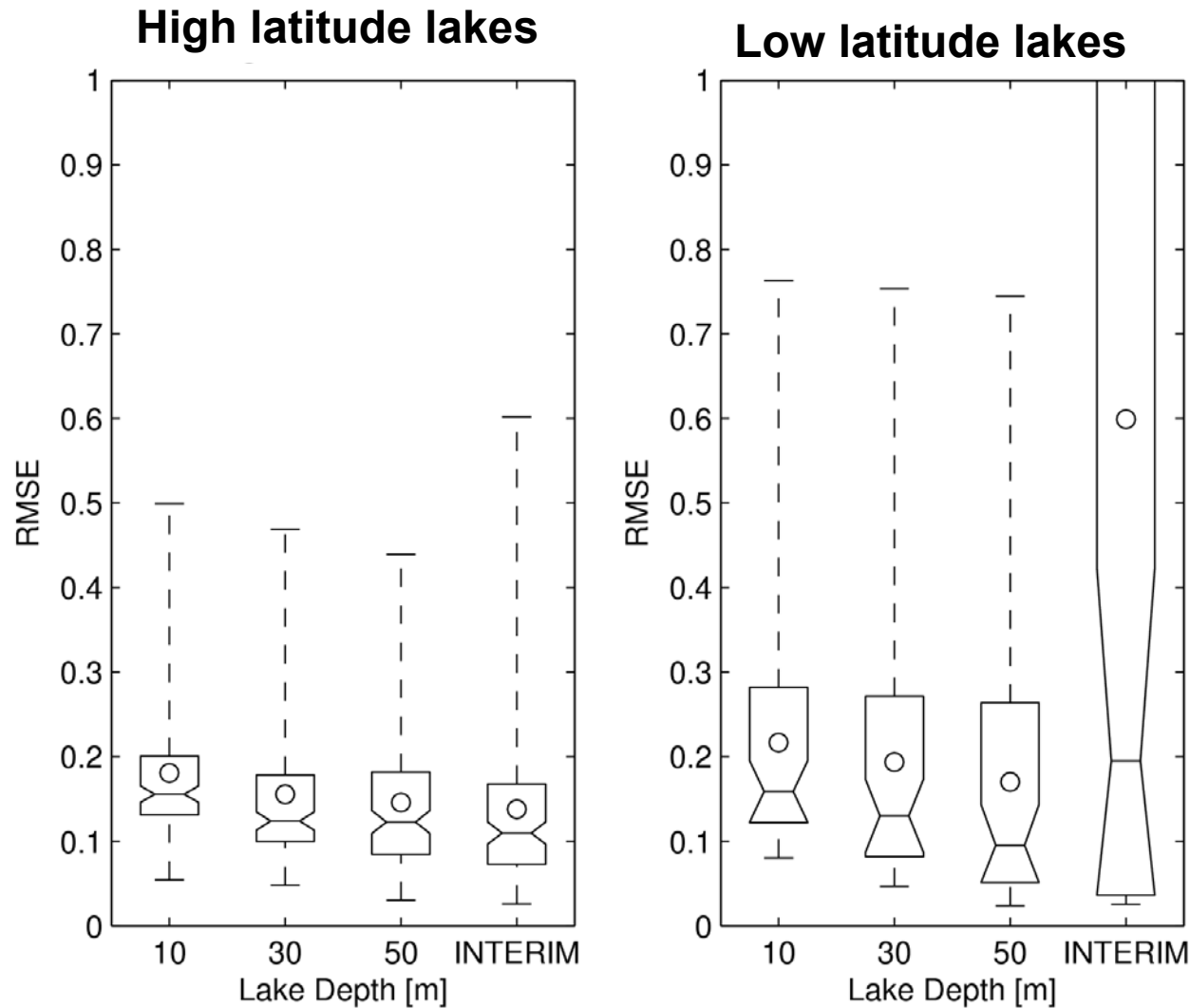
-Systematic under-estimation of surface temperature !

- ERA-INTERIM problems ?

- Lake Optical characteristics ?

# Lake points validation (RMSE)

RMSE normalized by the mean annual amplitude

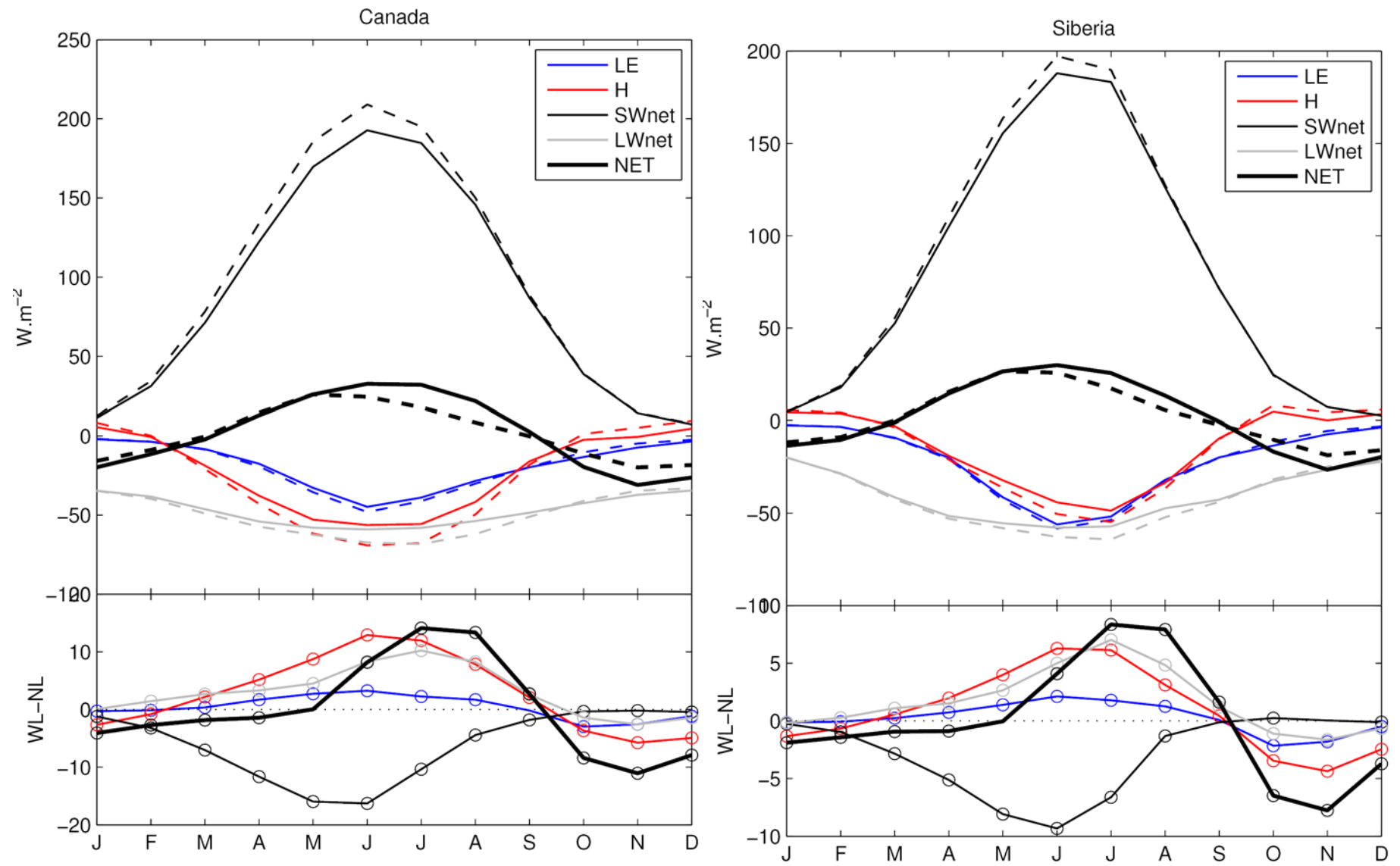


**Deeper lakes ->  
reduction of RMSE**

**Higher RMSE in low  
latitude lakes :  
systematic biases**

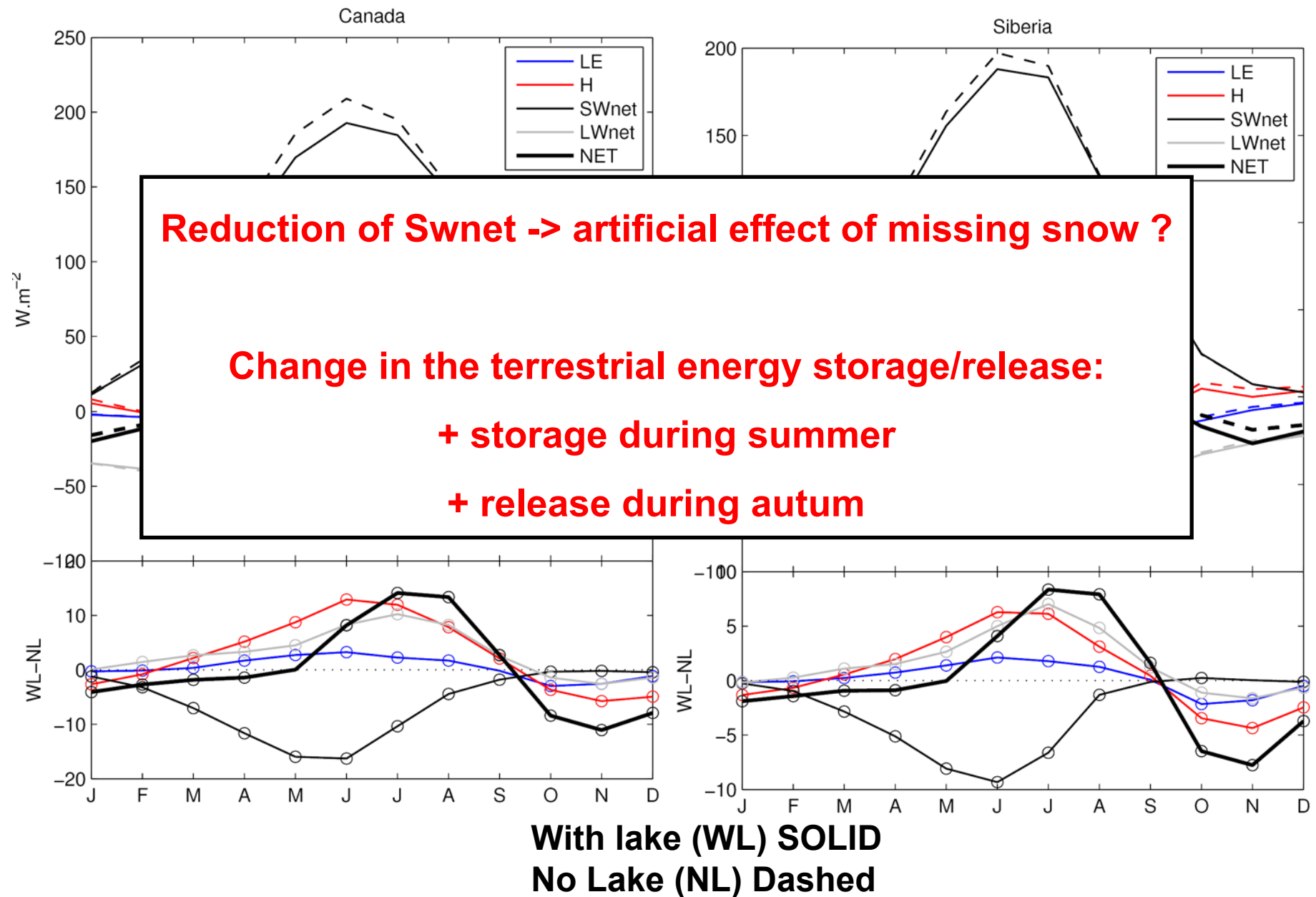


# Sub-grid scale impact: Monthly fluxes (1)

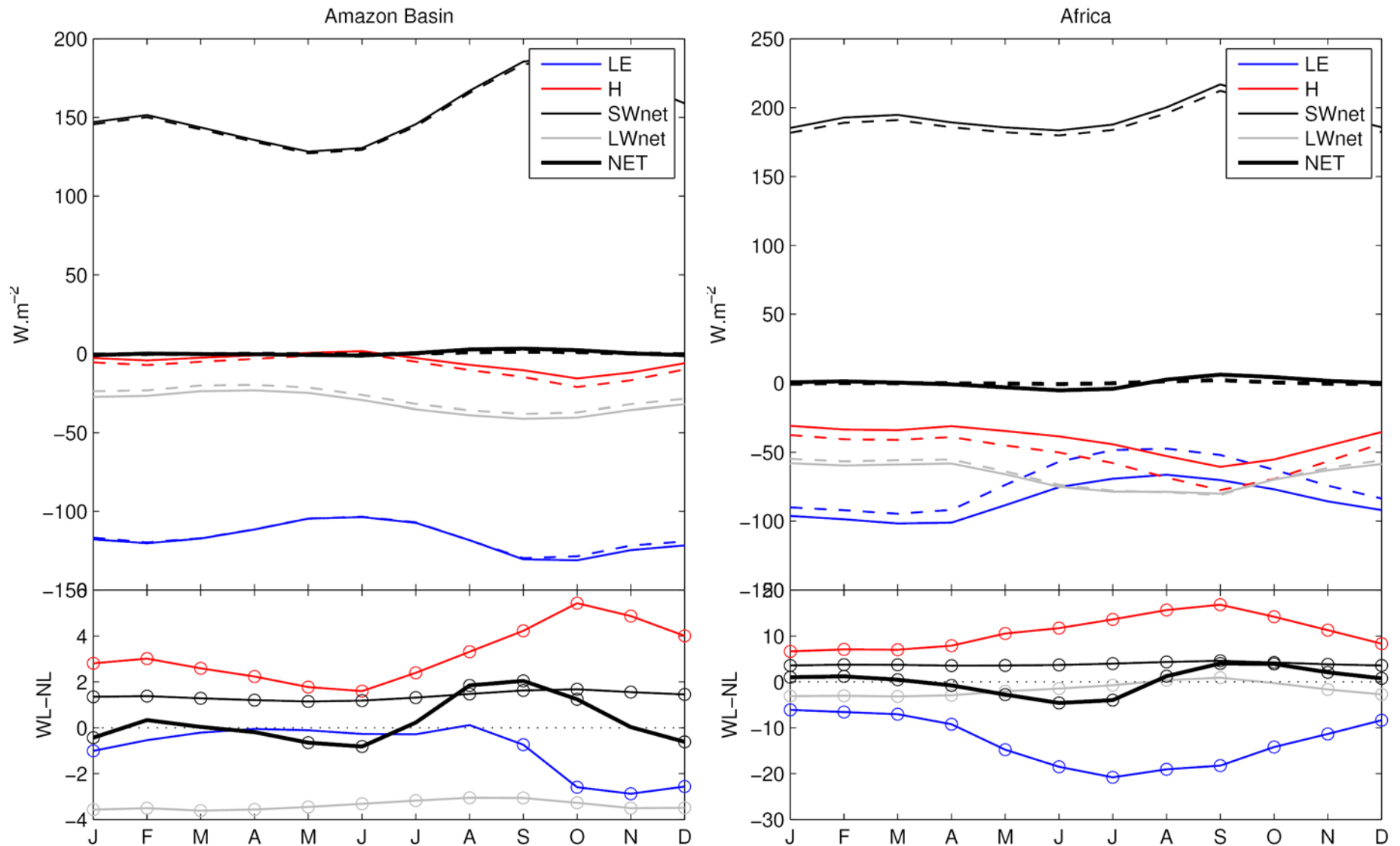


With lake (WL) SOLID  
No Lake (NL) Dashed

# Sub-grid scale impact: Monthly fluxes (1)

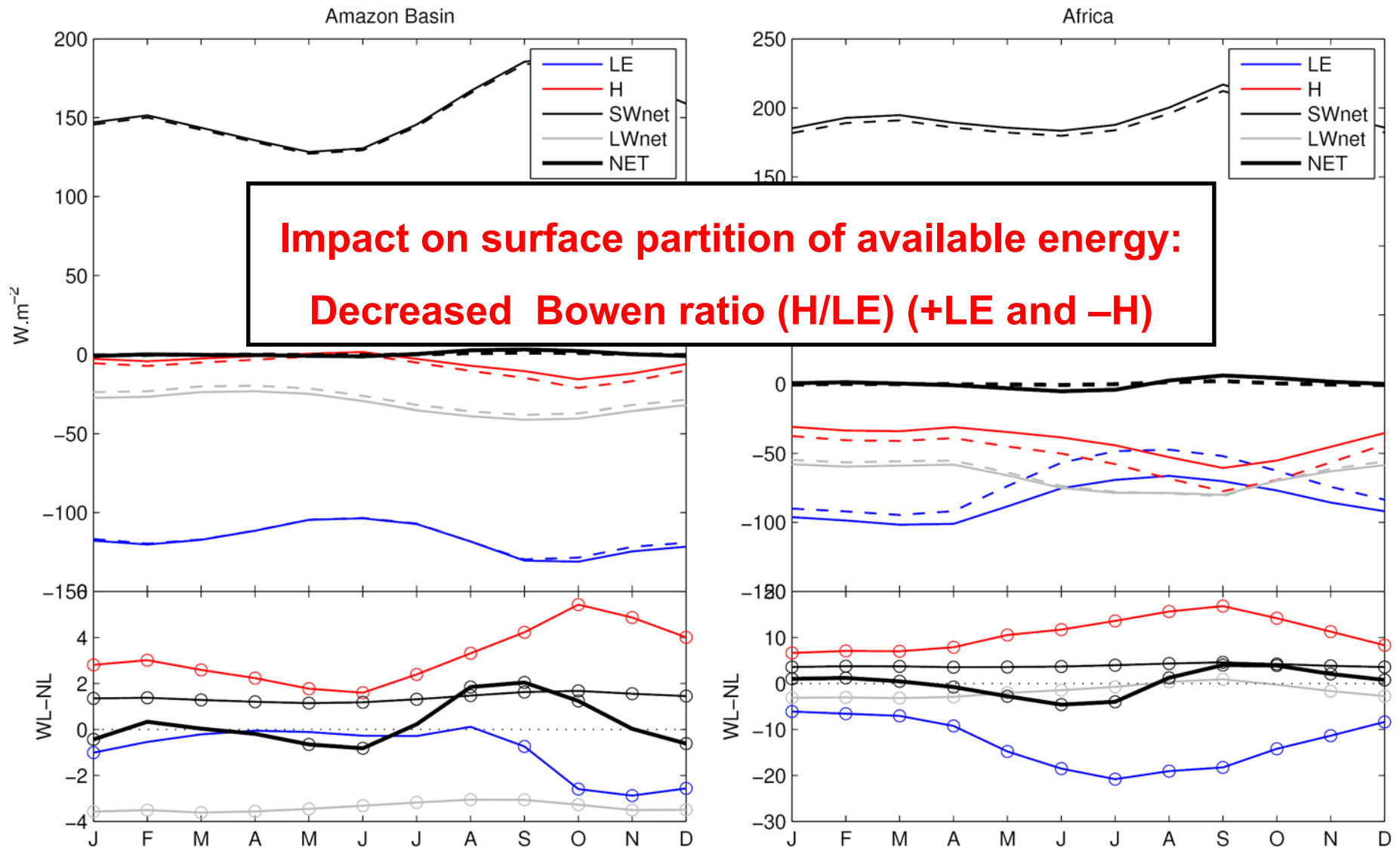


# Sub-grid scale impact: Monthly fluxes (2)



**With lake (WL) SOLID**  
**No Lake (NL) Dashed**

# Sub-grid scale impact: Monthly fluxes (2)



**With lake (WL) SOLID**  
**No Lake (NL) Dashed**

# Sub-grid scale impact: Mean fluxes

Annual mean differences

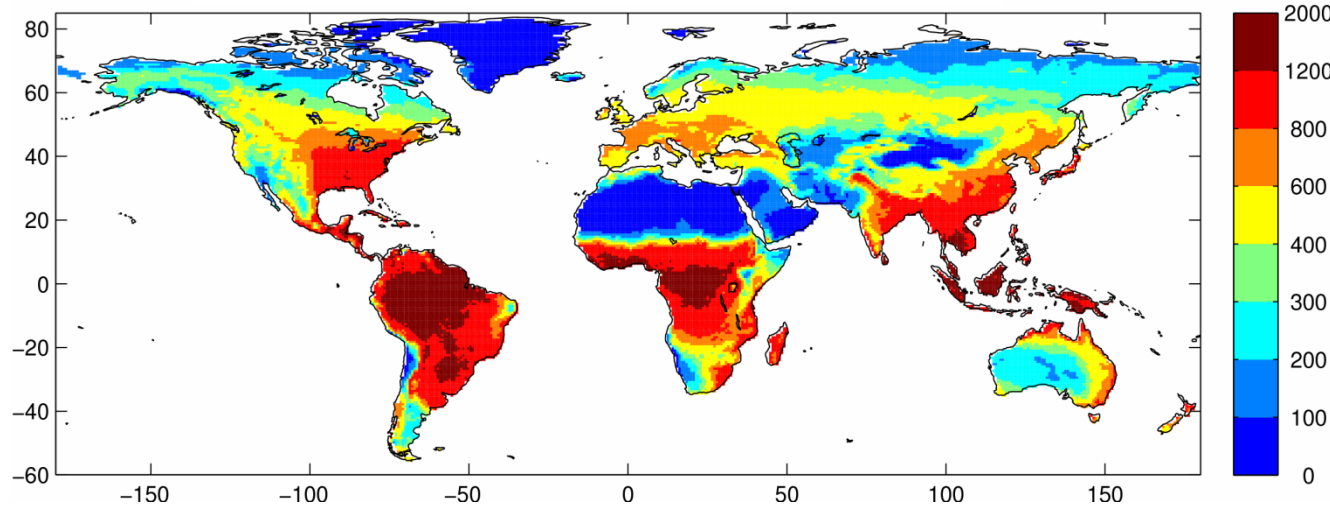
[With lake (30 m)] – [No lake]

Only sub-grid scale grid-points

	S <sub>wnet</sub> W/m <sup>2</sup>	L <sub>wnet</sub> W/m <sup>2</sup>	Sensible	Latent W/2	Evap. mm/y	N° Grid Points 0.05°
Canada	-6.07*	3.00*	2.76*	0.40*	-4.6 / 2 %	309/754 41 %
USA	-4.69*	1.74*	3.75*	-0.73	+9.8 / 2 %	175/482 36 %
Europe	-3.43*	1.87*	1.06*	0.28	-3.0 / 1 %	170/385 44 %
Siberia	-2.87*	1.67*	0.86*	0.25*	-2.8 / 1 %	104/467 22 %
Amazon	1.38*	-3.39*	3.1*	-0.93*	+12 / 1 %	81/629 13 %
Africa	3.85*	-1.67	10.8*	-12.9*	+162 /15 %	74/584 13 %

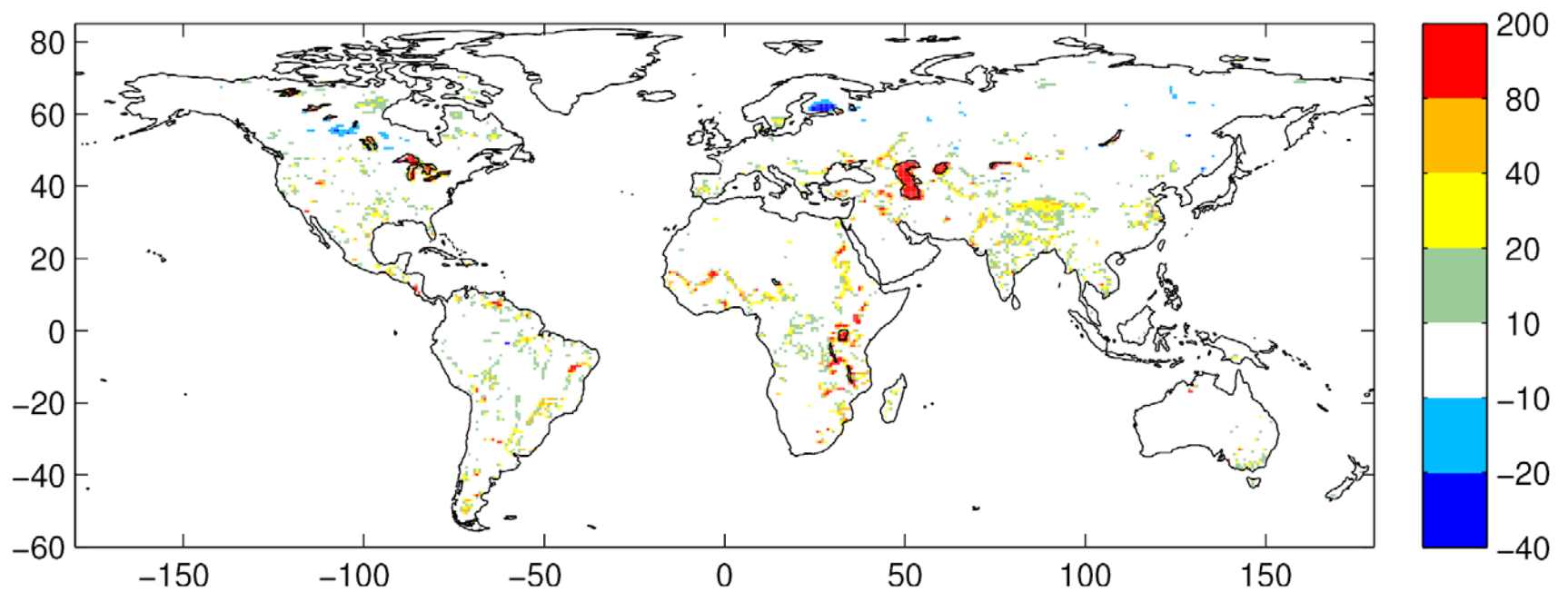
# Global impact on Evaporation

Evap HTESSEL (no lake) [mm/year]



**Colorbar with different spacing!**

Evap WL-NL [mm/year]



# Discussion and Future Work

- **Coupling FLAKE and HTESSSEL:**
  - **Missing Snow** over ICE !!!!!
  - Surface **water balance not closed** !
- **Validation:**
  - **Late Ice melting** in Northern Lakes
  - Systematic **cold biases** in Equatorial Lakes
  - Extension of offline simulation when possible
- **Sub-grid scale lakes impact :**
  - Changes on the **terrestrial energy storage** variation in Northern Areas
  - Changes in **surface partitioning of available energy** (+LE -H) in low latitude Areas.
- **Future work:**
  - Impacts on **coupled simulations** within IFS
  - Near surface **temperature changes ?**
  - Soil moisture **assimilation changes ?**