



Supplement of

Brief communication: Improving lake ice modeling in ORCHIDEE-FLake model using MODIS albedo data

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Contents of this file

Figures S1 to S3 Tables S1 to S4

Captions for Figures S1 to S3 and for Tables S1 to S4

Introduction

These figures and tables provide supplementary information for our paper that is presented in the main text. Figure S1 presents the comparison of simulated and observed lake surface albedo for the five Great Lakes between 2008 and 2018 at a daily time step. Figure S2 complements Figure S1 by showing the simulated relative errors with the old and new model versions for the same period. Figure S3 visualizes the location of the GLRP observations used for the validation of the ice phenology simulated by ORCHIDEE.

Table S1 summarizes the calibrated values of the albedo parameters for water, snow and ice in comparison to prior values. Table S2 presents the RMSEs (modeled vs observed albedos), obtained with the new parameterizations in comparison with the prior model. Table S3 completes Table S2 by giving some the standard deviation, minimum and maximum values and the interquartile ranges of the observed and simulated albedo of the 5 five Great Lakes. Table S4 presents the median values of the time errors (simulated vs observed) for the simulation of the ice-on, ice-off and duration of the lake ice cover.

Figure S1: Lake surface albedo calculated by ORCHIDEE and compared to MODIS albedo observations (Obs) for the five Great Lakes. Prior refers to the standard model, and Post, to the albedo revised one. Interannual mean averages were calculated on the time period (2008-2018).



Figure S2: Absolute errors in surface albedo (simulations vs observations) for the five Great Lakes over the 2008-2018 period. Prior (left panels) refer to the standard model, Post (right panels) refer to the albedo revised one. Color scale depicts the coldest years from dark blue to the warmest ones in dark red. Time series were smoothed with a 15-day moving average.



Figure S3: Location of the GLRP lakes used in the evaluation of the ice phenology modeled by ORCHIDEE-FLake.



Table S1. Lake surface albedo parameters used in ORCHIDEE. Prior values proposed in Bernus and Ottlé, 2022 and new calibrated values (this work) are given for free water, snow and ice cover.

Albedo	Water	Sn	ow	Ice		
		Min	Max	Min	Max	
Prior	0.07	0.77	0.87	0.3	0.5	
Post	0.07	0.50	0.87	0.15	0.5	

Table S2. RMSEs and improvement factors between MODIS albedo and simulations for the Great Lakes calculated over the 2008-2018 period. Prior refers to the standard model, Post to the albedo revised one.

Lake	Erie	Huron	Michigan	Ontario	Superior
Prior Albedo RMSE	0.38	0.32	0.30	0.22	0.54
Post Albedo RMSE	0.17	0.08	0.05	0.06	0.16
Improvement factor	0.55	0.75	0.83	0.73	0.70

Table S3. Standard deviations (Std), minimum (Alb min) and maximum (Alb max) values and interquartile ranges (IQR) of the Great Lakes albedo, observed and simulated with the 2 model versions over the 2008-2018 period. Obs refers to the MODIS albedo observations, Prior refers to the albedo calculated by the standard model and Post by the revised one.

Lake	Erie		Huron		Michigan		Ontario			Superior					
	Obs	Prior	Post												
Std	0.17	0.28	0.15	0.11	0.26	0.07	0.05	0.23	0.04	0.04	0.19	0.04	0.11	0.31	0.09
Alb min	0.02	0.07	0.07	0.01	0.07	0.07	0.01	0.07	0.07	0.01	0.07	0.07	0.01	0.07	0.07
Alb max	0.71	0.81	0.61	0.6	0.87	0.35	0.39	0.83	0.26	0.25	0.83	0.29	0.61	0.87	0.4
IQR	0.04 - 0.21	0.16 - 0.77	0.12 - 0.40	0.03 - 0.11	0.12 - 0.60	0.09 - 0.17	0.02 - 0.07	0.10 - 0.47	0.07 - 0.12	0.02 - 0.05	0.10 - 0.14	0.06 - 0.08	0.02 - 0.06	0.18 - 0.83	0.12 - 0.28

Table S4. Median values of the time errors (in days) simulated by ORCHIDEE-Flake compared to the GLRP observations, for each lake category (shallow, medium and deep) in the simulation of ice-on, ice-off and duration of the lake ice cover, on the 2008-2018 period. Prior refers to the standard model, Post to the albedo revised one.

	lce-on	errors	Ice-off	errors	Duration errors			
Lake category	(in days)		(in d	ays)	(in days)			
	Prior	Post	Prior	Post	Prior	Post		
Shallow	-7.0	-6.0	+14.9	+5.5	+21.2	+8.8		
Medium	-6.6	-1.3	+14.2	+1.8	+20.9	+3		
Deep	+4.8	+3.5	+25.7	+7.7	+23.7	+6.9		

Figure Captions:

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