

ORCHIDAS in 2-D

Calibrating ORCHIDEE albedo parameters over the whole of the Greenland

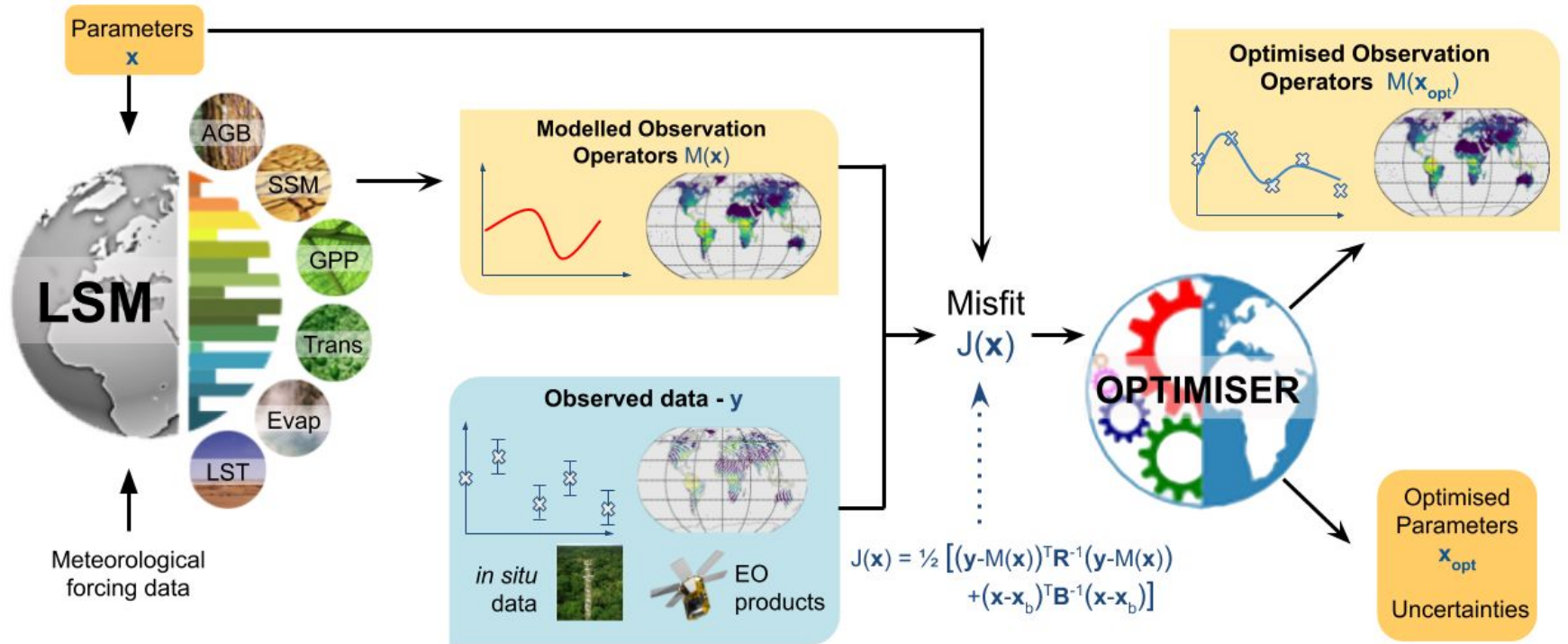
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Overview

- **Goal:** finding one set of parameters for the whole of Greenland
 - Challenges:
 - Large area with different behaviours at the edges and the middle
 - Gradual warming over the last decade
- **Approach:** Perform a calibration/validation study using ORCHIDAS - the ORCHIDEE data assimilation system



ORCHIDAS
DATA ASSIMILATION SYSTEMS



DATA ASSIMILATION SYSTEM: parameter optimisation

Principles of Data Assimilation

The diagram illustrates the cost function $J(\mathbf{x})$ used in data assimilation. The equation is $J(\mathbf{x}) = \frac{1}{2}(\mathbf{y} - M(\mathbf{x}))^T \mathbf{R}^{-1}(\mathbf{y} - M(\mathbf{x})) + \frac{1}{2}(\mathbf{x} - \mathbf{x}_b)^T \mathbf{B}^{-1}(\mathbf{x} - \mathbf{x}_b)$. Annotations include: 'Vector of parameters' pointing to \mathbf{x} ; 'Observations e.g. MODIS albedo' pointing to \mathbf{y} ; 'Model output given the set of parameters \mathbf{x} e.g. modelled albedo' pointing to $M(\mathbf{x})$; 'Mismatch between the observations and the model' pointing to $(\mathbf{y} - M(\mathbf{x}))$; 'Error covariance matrix' pointing to \mathbf{R}^{-1} ; '“Background” parameters i.e. default parameter values' pointing to \mathbf{x}_b ; and 'Mismatch between the parameters tested and their values' pointing to $(\mathbf{x} - \mathbf{x}_b)$.

Vector of parameters

Observations
e.g. MODIS albedo

Model output given the
set of parameters \mathbf{x}
e.g. modelled albedo

Mismatch between
the observations
and the model

Error covariance
matrix

“Background” parameters
i.e. default parameter
values

Mismatch between
the parameters tested
and their values

$$J(\mathbf{x}) = \frac{1}{2}(\mathbf{y} - M(\mathbf{x}))^T \mathbf{R}^{-1}(\mathbf{y} - M(\mathbf{x})) + \frac{1}{2}(\mathbf{x} - \mathbf{x}_b)^T \mathbf{B}^{-1}(\mathbf{x} - \mathbf{x}_b)$$

The parameters (x)

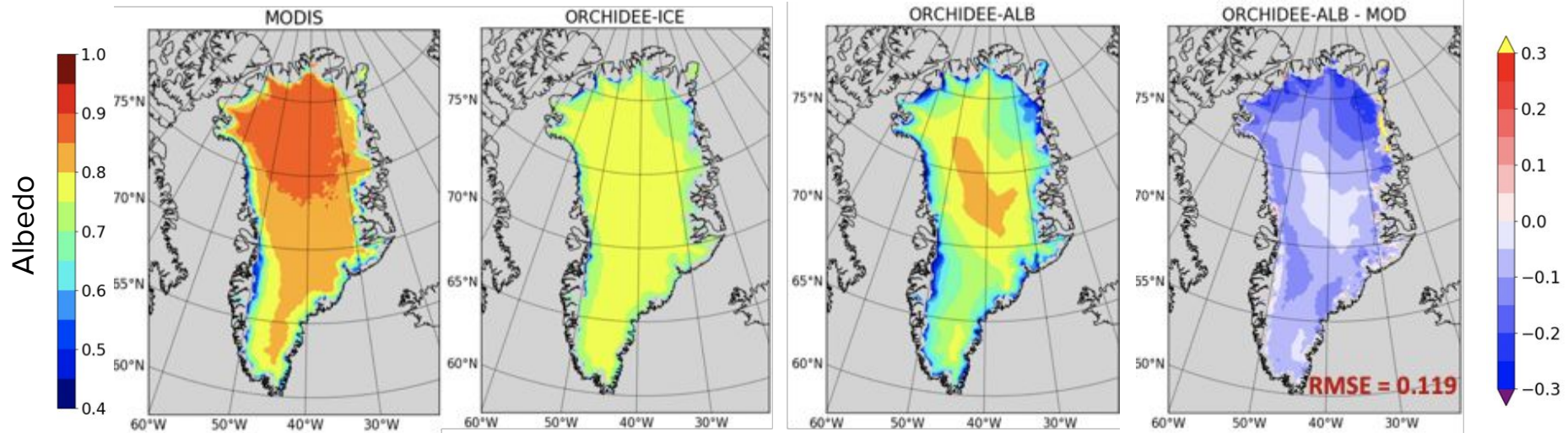
Parameters already extensively tuned

	Prior (x_b)	Min	Max
SNOWA_AGED_VIS*	0.525	0.50	0.70
SNOWA_DEC_VIS*	0.349	0.10	0.40
SNOW_TRANS_NOBIO	1	0.2	2
TCST_SNOWA_NOBIO	2	1	10
OMG1	2.5	1	7
OMG2	4	0.5	4
MAX_SNOW_AGE	50	40	60
ALB_ICE [†]	0.4	0.3	0.5

*parameters are PFT specific therefore optimising the PFT1 (bare soil) parameter. Also there sum must be less than or equal to 1

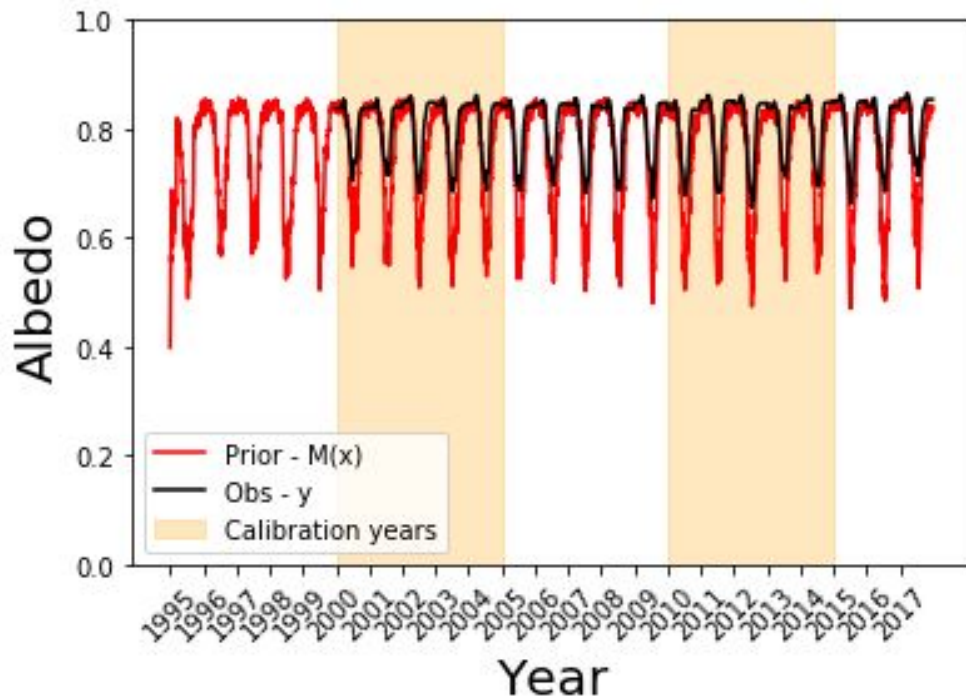
[†]this parameter takes two values which are both equal.

The observations, model and difference: y , $M(x)$, $(y - M(x))$



Summer Albedo (averaged over time 2000-2017)

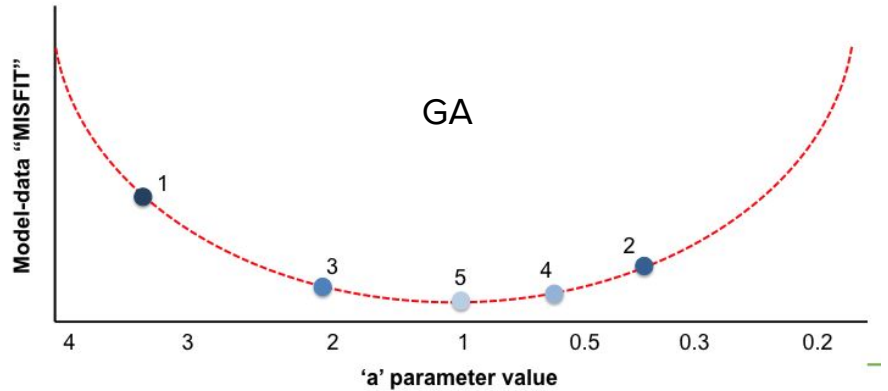
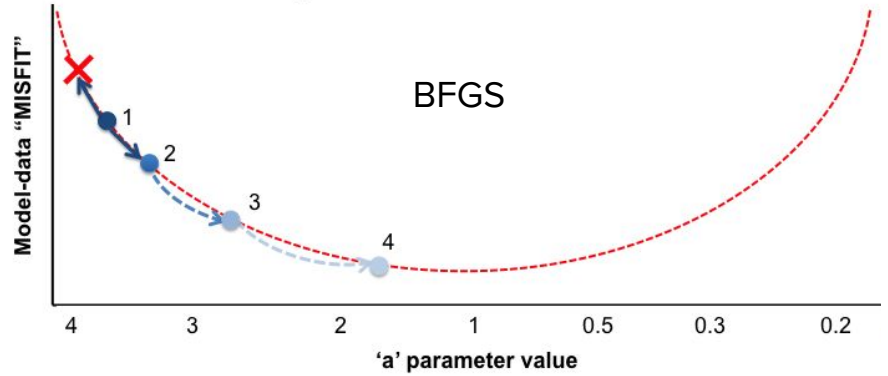
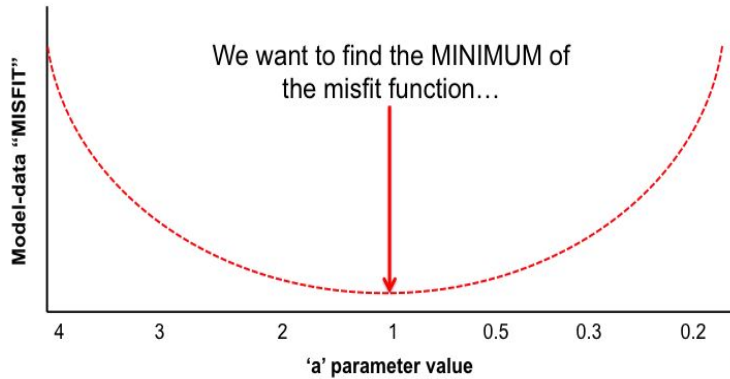
The model and observations - y , $M(x)$



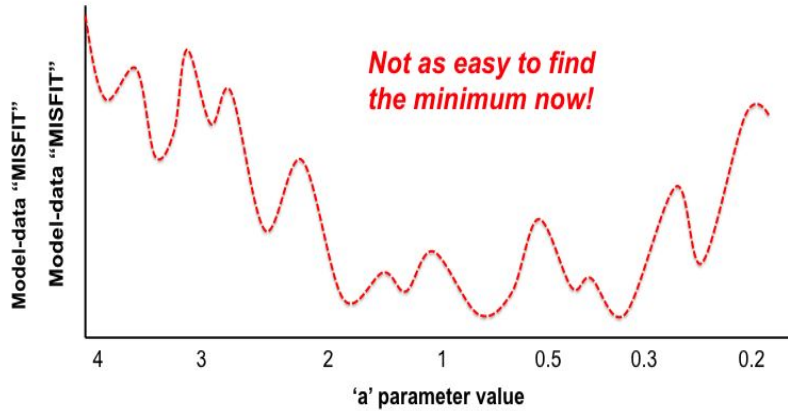
Averaged over space

- ❖ “Prior” run is the run before calibration
- ❖ Needs years to “spinup”
- ❖ Want to keep years for validation

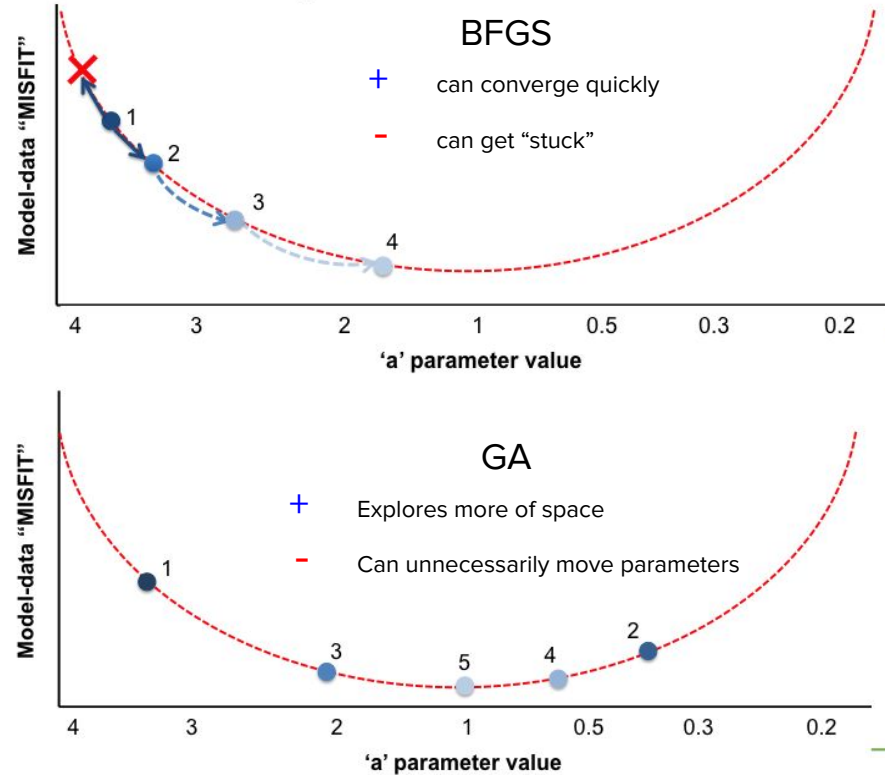
Two algorithms



Two algorithms

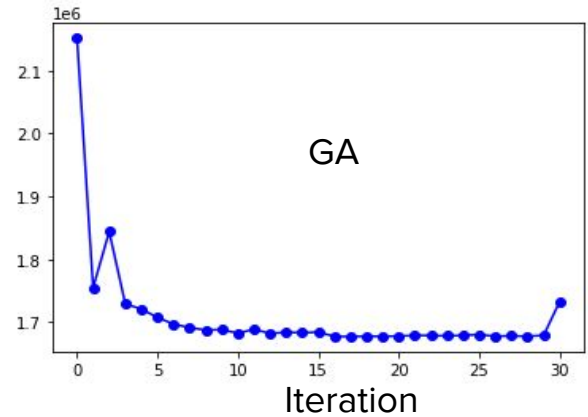
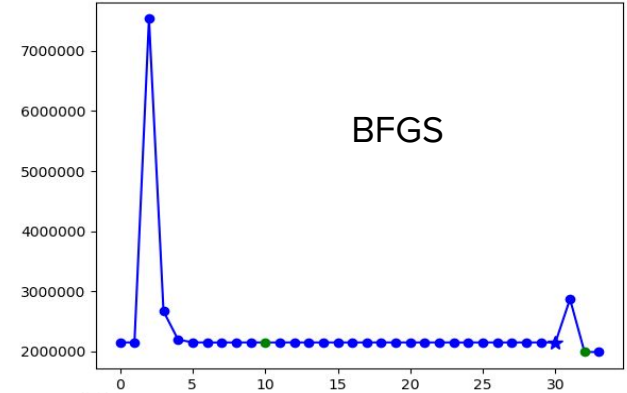


Showing only one dimension of a multi-dimensional space!

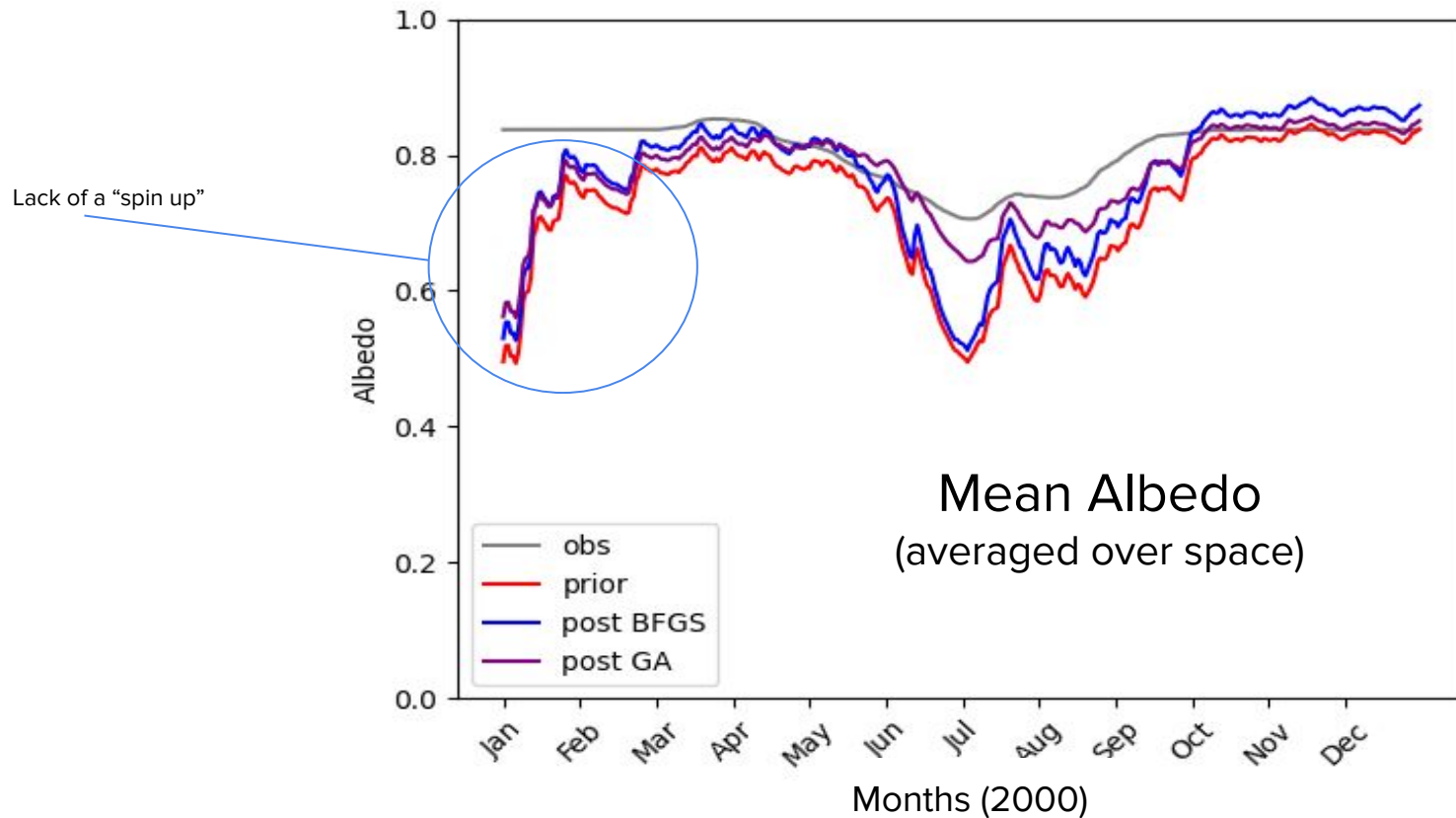


Preliminary optimisation over 2000

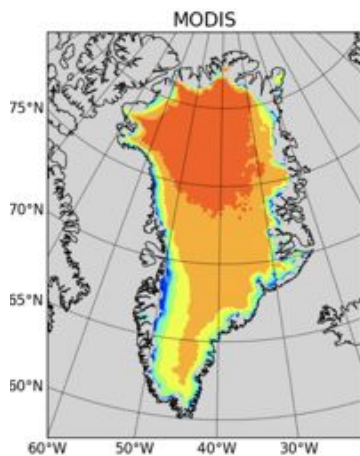
Parameter	Prior	Min	Max	Post (BFGS)	Post (GA)
SNOWA_AGED_VIS	0.525	0.5	0.7	↓0.5158	↑0.6283
SNOWA_DEC_VIS	0.349	0.1	0.4	↑0.3604	↓0.2498
SNOW_TRANS_NOBIO	1	0.2	2	↓0.7064	↑1.877
TCST_SNOWA_NOBIO	2	1	10	↓1.634	↑5.202
OMG1	2.4	1	7	↓1.95	↓1.346
OMG2	4	0.5	4	↓2.715	↓3.713
MAX_SNOW_AGE	50	40	60	↓46.33	↑54.97
ALB_ICE	0.4	0.3	0.5	↑0.4367	↑0.4978
COST	2152000			1993000 (0.9261)	1677000 (0.7795)



Results (time-series)

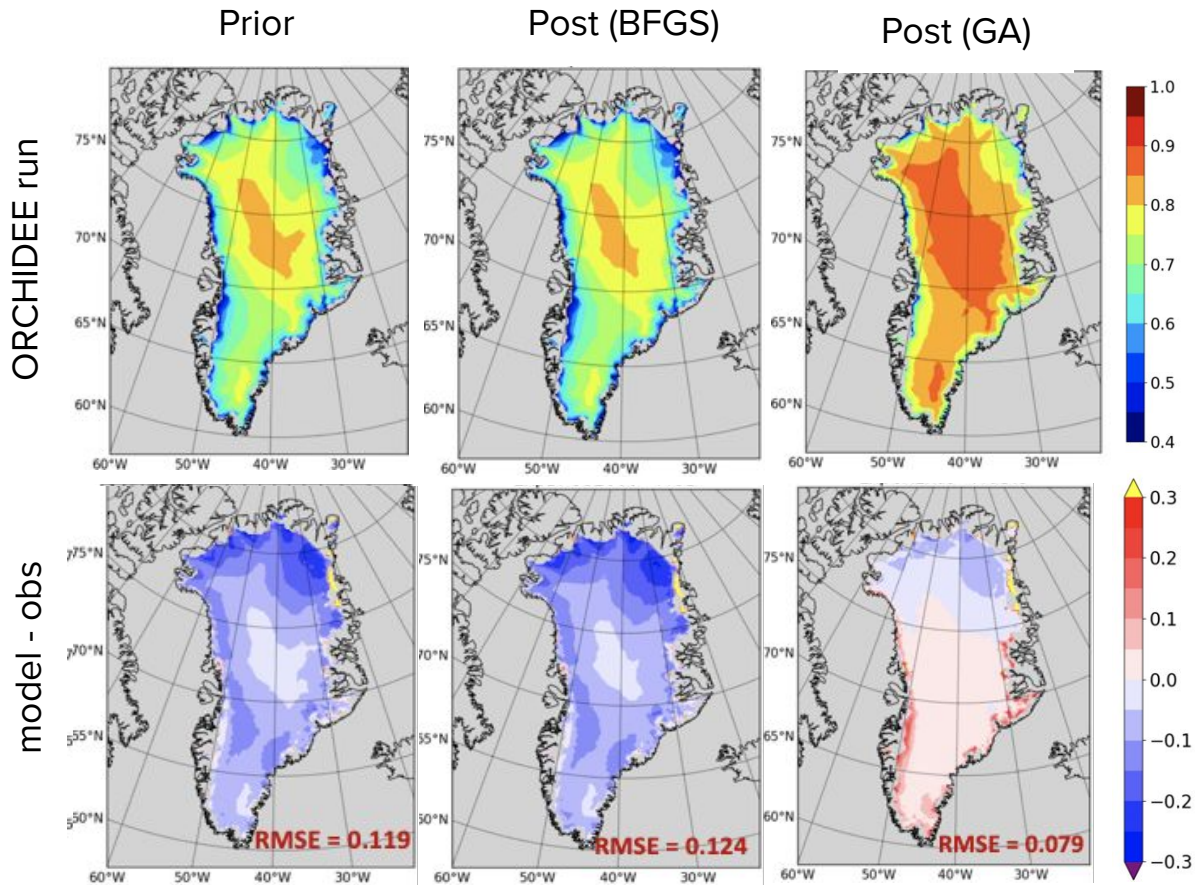


Results (2-D)



Observations

Summer Albedo
(averaged over time 2000-2017)



Perspectives

Further calibrations over the:

- Whole of greenland for multiple years
- Whole of greenland with extra weights on edge points
- PROMICE in situ sites
- Summer only?
- Other data streams?

Thank you. Any questions?

<https://orchidas.lsce.ipsl.fr/>