SeaRISE Greenland — On "spin-up" procedures

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Synopsis

- Before we can start making predictions about Greenland's future, we have to get the present state right
- The modeled present state must
  - be devoid of unphysical transients
  - have a physically-based temperature distribution
  - simulate reasonable upper surface elevation and horizontal surface velocities

Question A

Which of the following experiments gets closest to the present state?

- Exp A: no paleo-climate, only present day information
- Exp B: paleo-climate spin-up
- Exp C: combination of A and B, uses paleo-climate information but mass balance is modified to obtain present day geometry at the end of the spin-up run

Question B

What are good metrics to assess the present state?

Model Choices

- we use the *SeaRISE Greenland* data set (http://websrv.cs.umt.edu/isis/index.php/Present_Day_Greenland)
- all parameters related to ice dynamics are the same in all runs

Parallel Ice Sheet Model (PISM)

- is the only *fully parallel* ice sheet model: Greenland runs on grids $\leq$ 5 km and up to 256 processors were performed
- is *polythermal* (**?**): both *temperature* and *liquid water fraction* are simulated
- uses a SSA as sliding law (**?**): avoids propagation of jump discontinuities in the horizontal velocity field and thus unbounded vertical velocities
- the basal mechanical model is based on a *plastic till assumption* (e.g. **?**): produces convincing ice-streams
- is *open source*: get the latest version from www.pism-docs.org

Observed State: Present Day

- surface velocities from **?**

Exp A: Steady-Climate

- 120 ka equilibriation run with fixed, present-day geometry and climate
- 3 consecutive 100 a runs with evolving upper surface

Exp B: Paleo-Climate

- 125 ka equilibriation run on a 10 km grid with fixed, present-day geometry and climate
- 125 ka spinup run with paleo-climate forcing (temperatures and sea level)

Exp C: Paleo-Climate + Correction

- 125 ka equilibriation run on a 10 km grid with fixed, present-day geometry and climate
- 125 ka spinup run with paleo-climate forcing (temperatures and sea level)
- mass balance correction during the last 10 ka of the spinup

Observed State

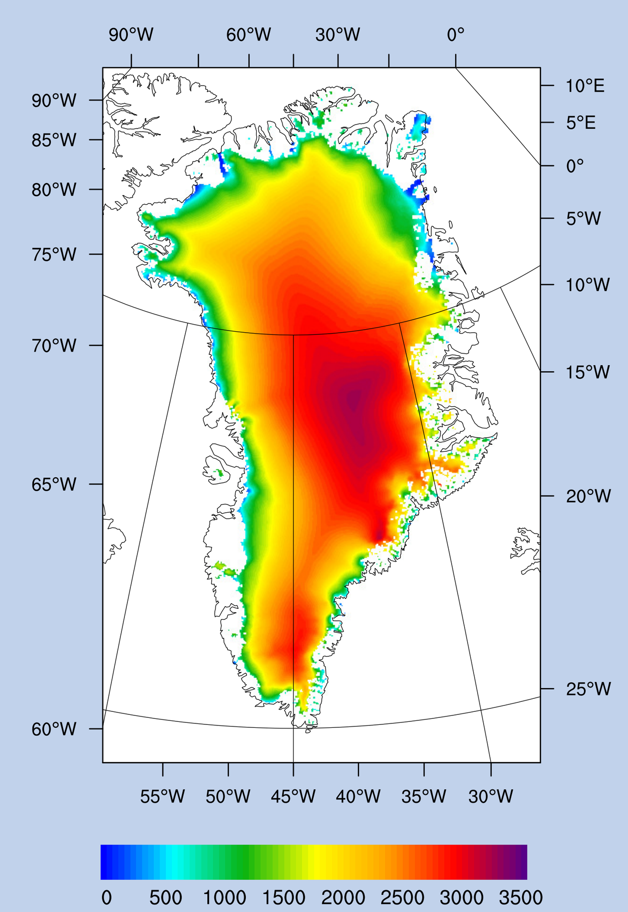


Figure: Observed surface elevation (m a.s.l.)

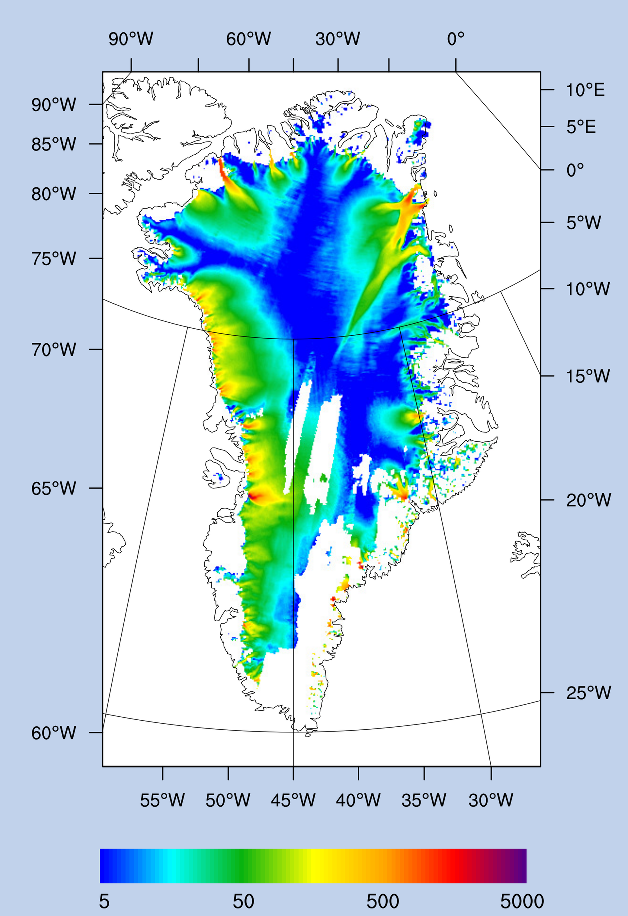


Figure: Observed horizontal surface velocity (m/a).

- volume: 2.91×10^6 km^3

Exp A: Results

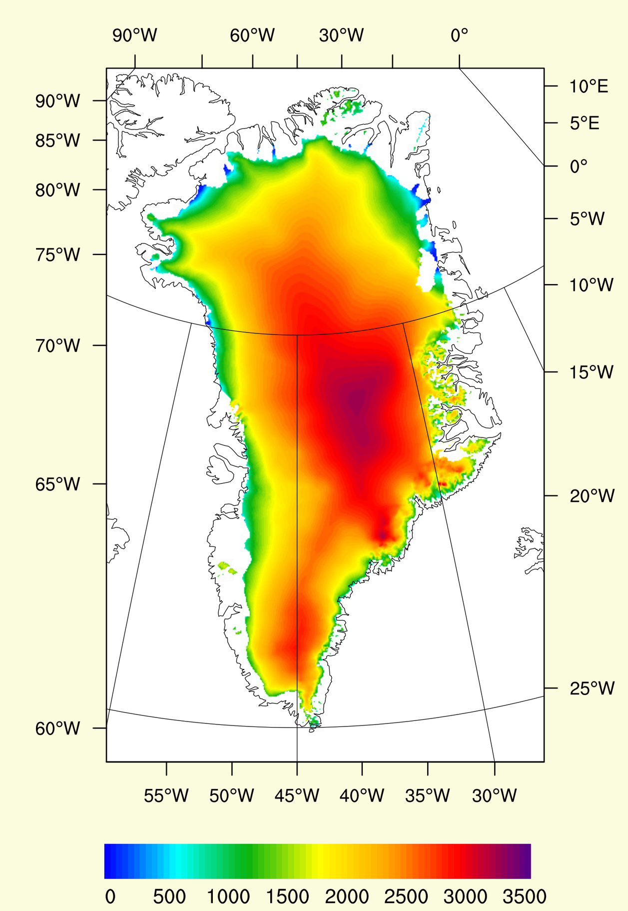


Figure: Modeled surface elevation (m a.s.l.)

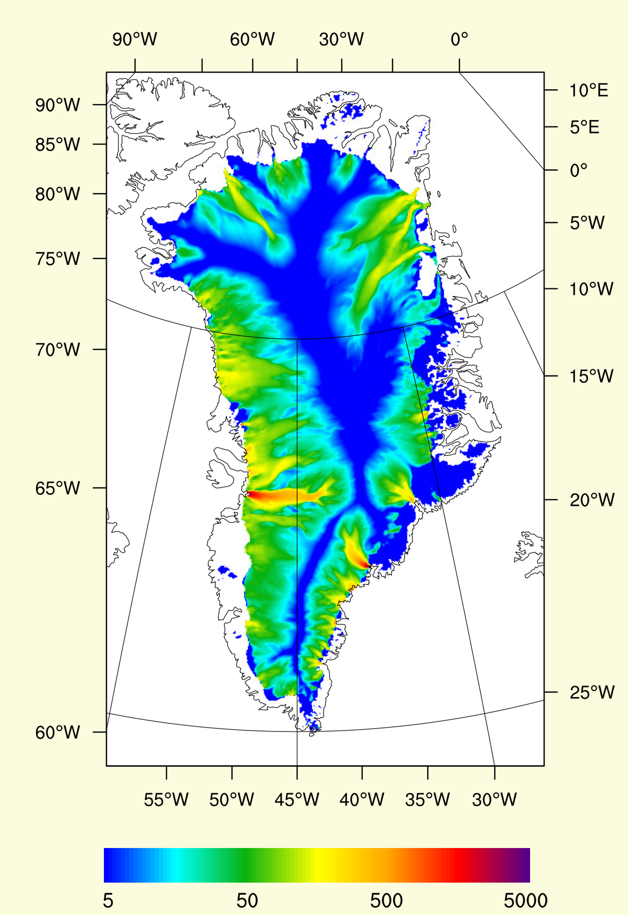


Figure: Modeled horizontal surface velocity (m/a).

- volume: 2.93×10^6 km^3

Exp B: Results

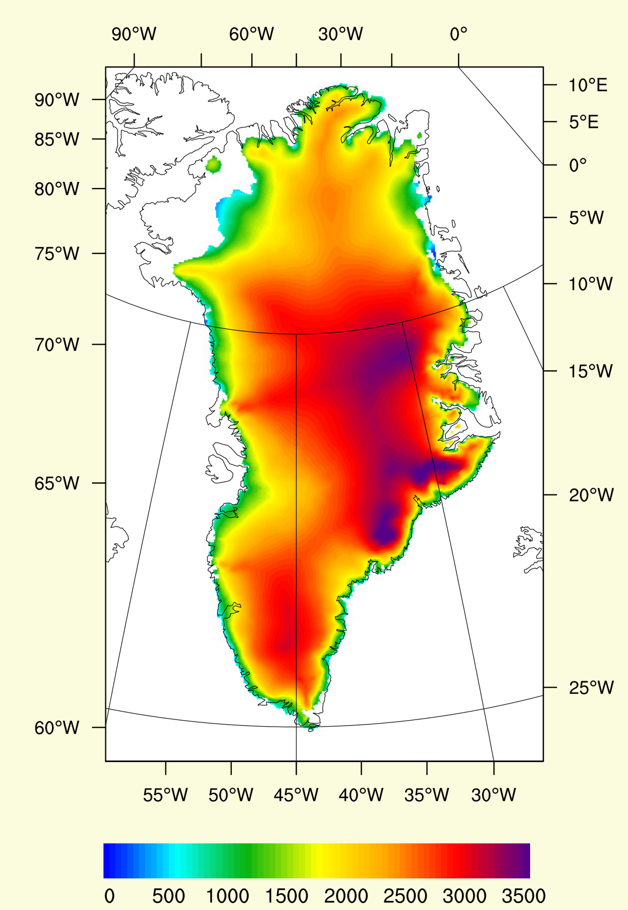


Figure: Modeled surface elevation (m a.s.l.)

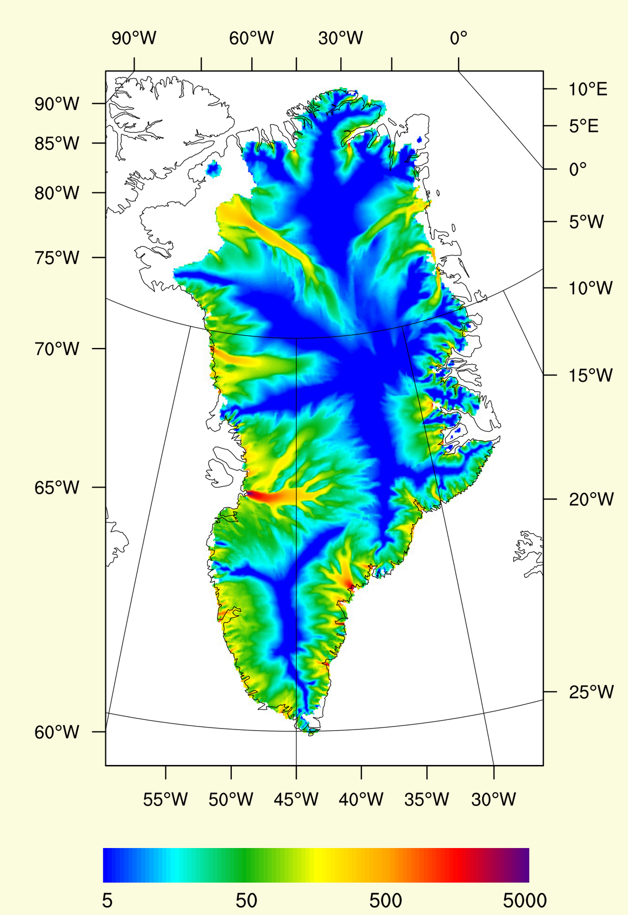


Figure: Modeled horizontal surface velocity (m/a).

- volume: 3.54×10^6 km^3

Exp C: Results

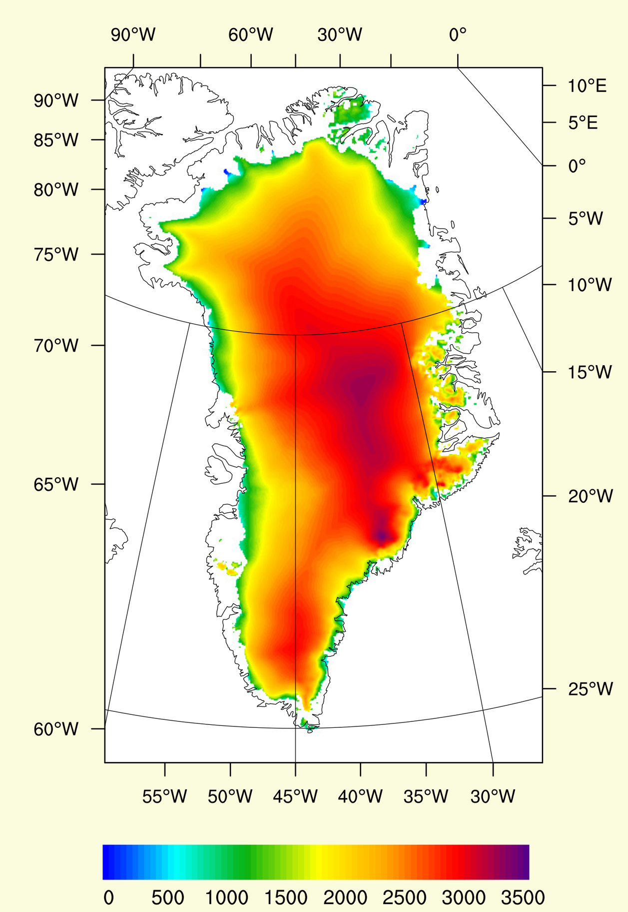


Figure: Modeled surface elevation (m a.s.l.)

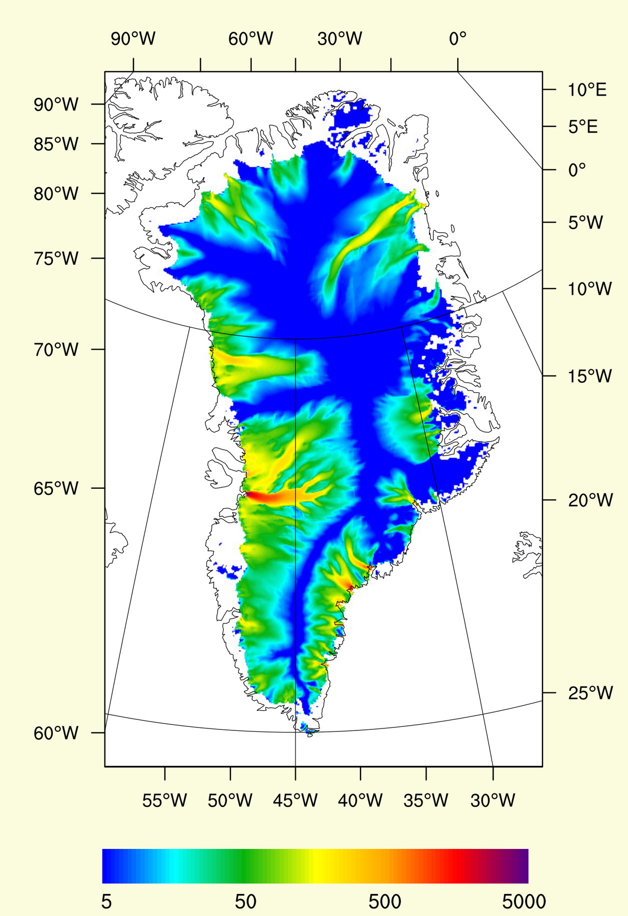


Figure: Modeled horizontal surface velocity (m/a).

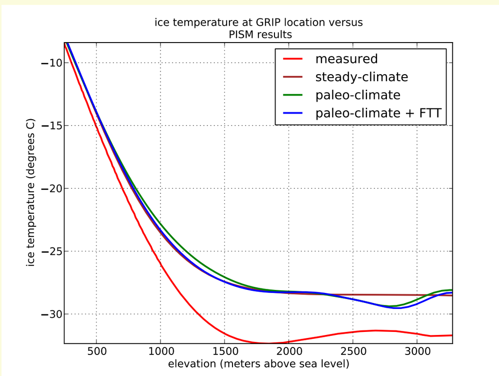
- volume: 3.09×10^6 km^3

Comments On Question A

- Exp A (steady climate) captures fast flow features best
- Exp B (paleo-climate) performs worst
- Upper surface elevation and horizontal surface velocities are not sufficient to assess model performance
- **We still don't know whether we got the present state right or not**

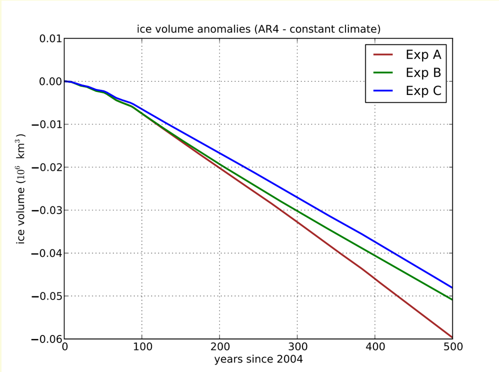
Comments On Question B

- A possible metric: Compare model results with measured temperatures at GRIP



- our modeled ice temperatures are too high
- is this very local result representative for the whole ice sheet?
- is that bulge the paleo signal?
- Another possible metric: Compare simulated age with observed isochrones (future work).

Does It Matter For The Future?



plot on the left shows predicted ice volume anomalies (i.e. AR4 - constant climate)

- all experiments show a similar trend

Conclusions

- Predictions require an accurate representation of the current state
- Surface velocities are an important but not sufficient metric for assessing model performance
- Intitial conditions are extremely important for the short term response

References

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