Improving CAM/CLM Greenland Simulations Using MODIS and ICEsat Data

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Source: Prof. Konrad Steffen, Univ. of Colorado
1. At the edges ice is melt and $T_{skin}$ can be higher than 287K. Simulation is colder than observed in July.

2. Over the central peak parts, simulation is warmer than observations.
Two reasons, at least, responsible for unrealistic $T_{\text{skin}}$ simulation

1. Surface Height

2. Surface albedo
Elevation from ICESat, NASA
Standard deviation of surface height from ICESat Obs.

Abrupt changing surface height
How to assign height in model to represent heterogeneous surface height?
Which should be the surface height $H$ used in model?

Cavity effect (i.e., slope effect)?

Multi-reflection by mountains

Normal surface  mountains
Albedo 0.7-0.8 (color white) is observed over large regions but not simulated ->

**Model albedo is too high!**
Case 3 run minus control run

Case 3: modified atmospheric forcing TBOT and PSRF:

\[ T_{bot\_n} = T_{bot} - \text{lapse} \times dz \]

\[ P_{srf\_n} = P_{srf} \times \left( \frac{T_{bot\_n}}{T_{bot}} \right)^{\frac{g}{R/\text{lapse}}} \]

Here: lapse = 0.006 k/m, g = 9.81 m/s², R = 287.04 J/kg/k, dz = 500 m

Offline CLM3.5

Changing H

Improving T_{skin} or T_g

Monthly mean T_g difference
Model Experiments on Greenland Surface H

Add H by 1000m in CCSM

Sensitivity run – control run

In coupled model, $T_{\text{skin}}$ or $T_g$ is also sensitive to Greenland H
Model Experiments on albedo effect
Replace model albedo with MODIS albedo

Most Greenland has Tg increased (yellow), as MODIS albedo is lower

cavity effect (slope effect) \(\rightarrow\) albedo \(\rightarrow\) \(T_{\text{skin}}\)
Our Thoughts for CLM4

1. Update surface height of Greenland (and Antarctic) using ICESat observations

2. Improve Glacier cover surface albedo

3. Better represent abruptly changing surface height over mountains to reduce surface albedo

we may need to include a term called slop effect?