Improving CAM/CLM Greenland Simulations Using MODIS and ICEsat Data

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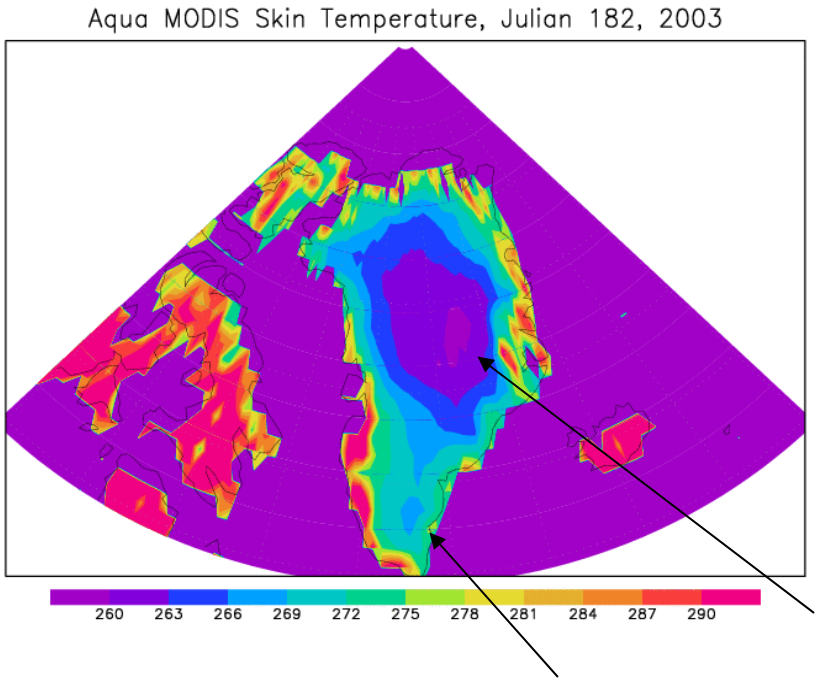
Source: Roger Braithwaite, University of Manchester (UK)

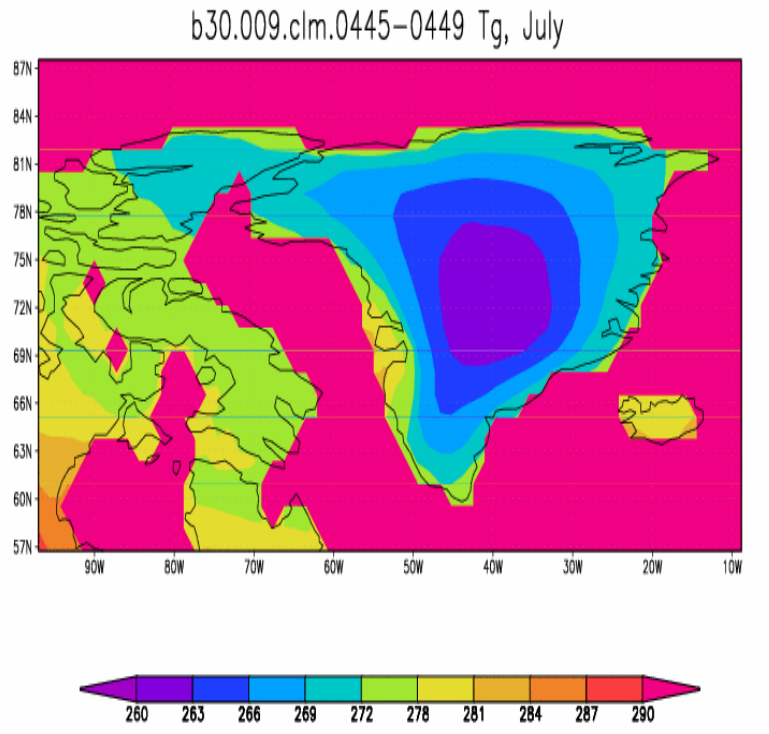
Source: Prof. Konrad Steffen,Univ. of Colorado

Land Surface Skin Temperature

MODIS Obs. July



CCSM Simulation



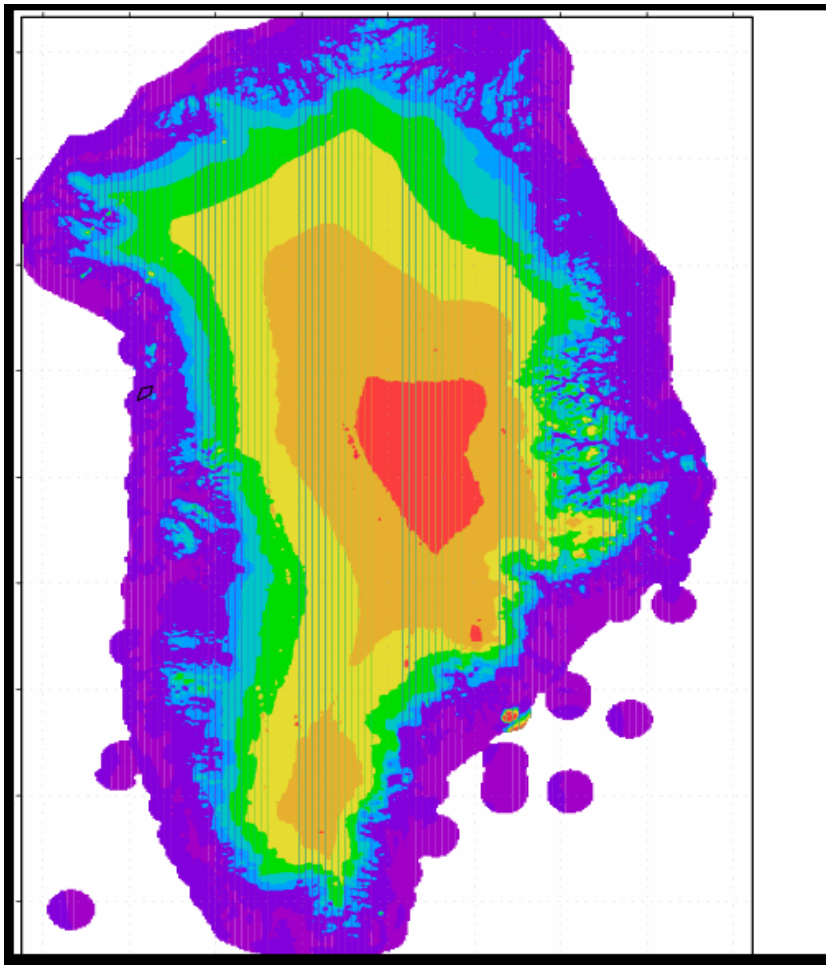
1. <u>At the edges</u> ice is melt and T_{skin} can be higher than 287K.
   simulation is <u>colder</u> than observed in July
2. Over the central peak parts, simulation is warmer than observations

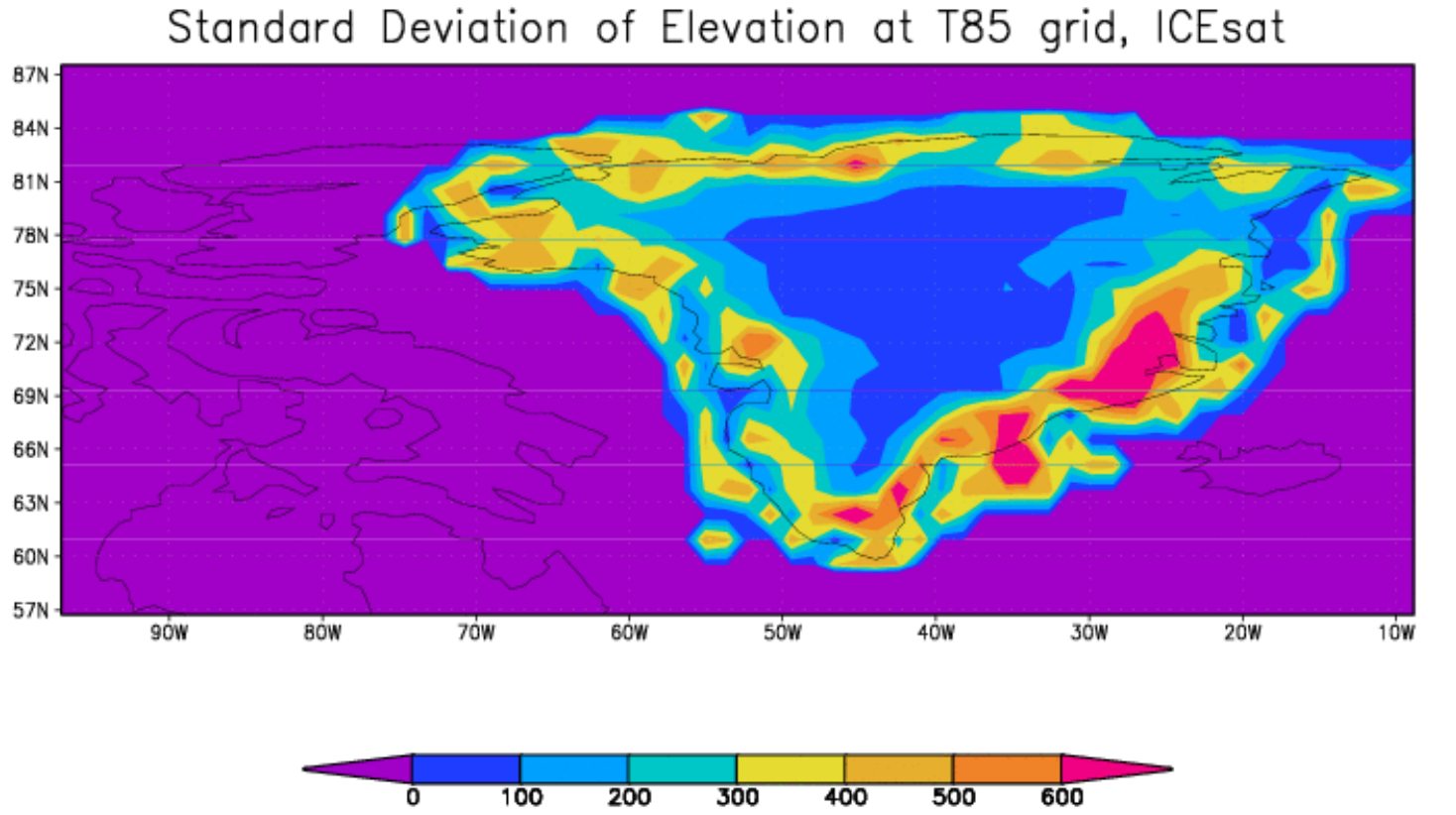
Two reasons, at least, responsible for unrealistic T_{skin} simulation

1. Surface Height

2. Surface albedo

Elevation from ICESat, NASA

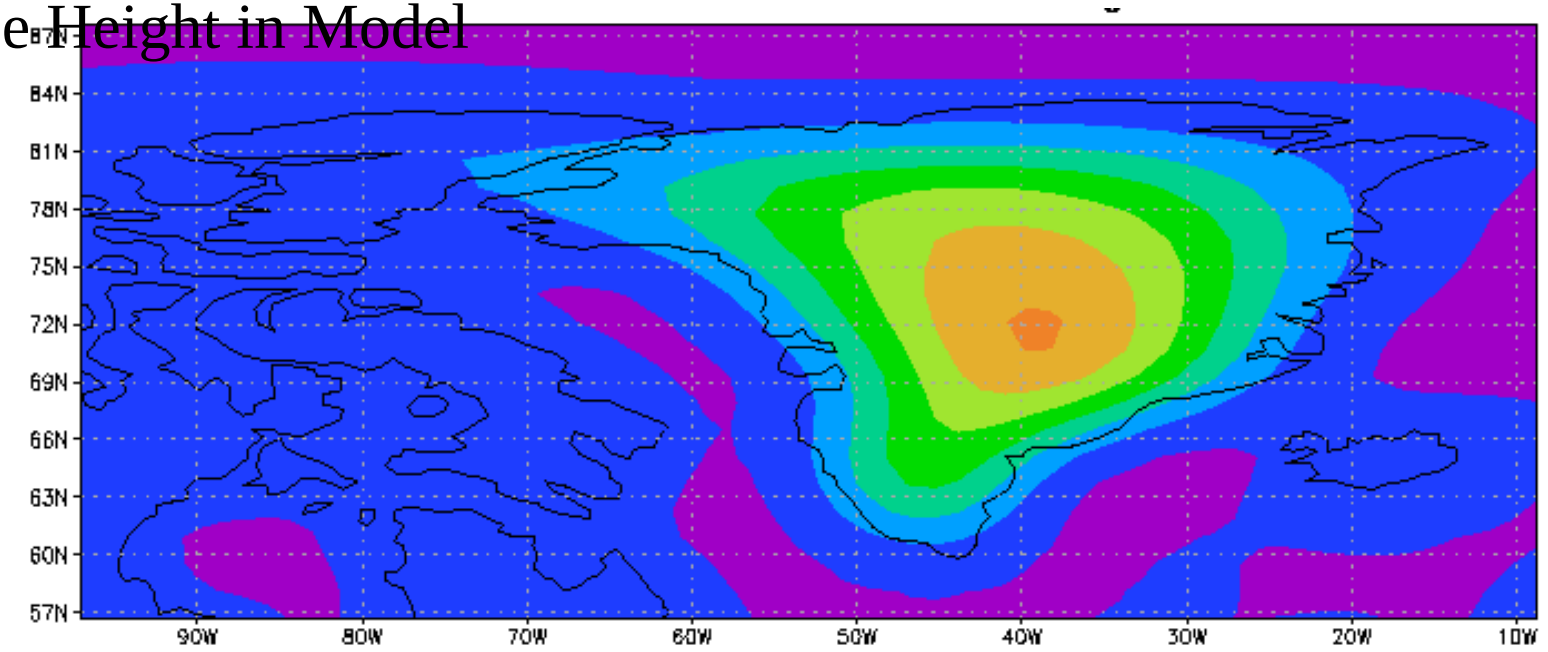




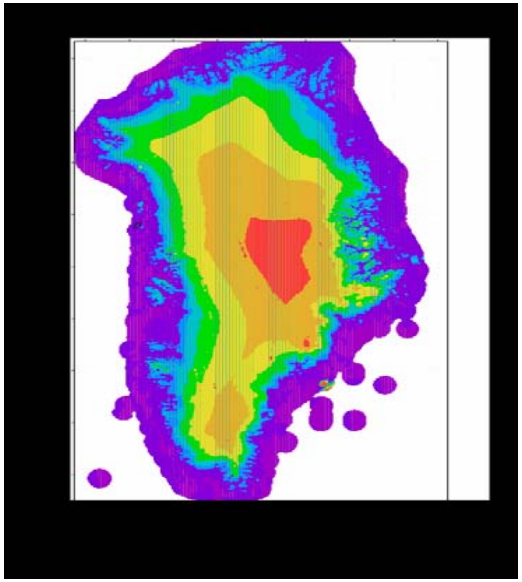
Standard deviation of surface height from ICEsat Obs.

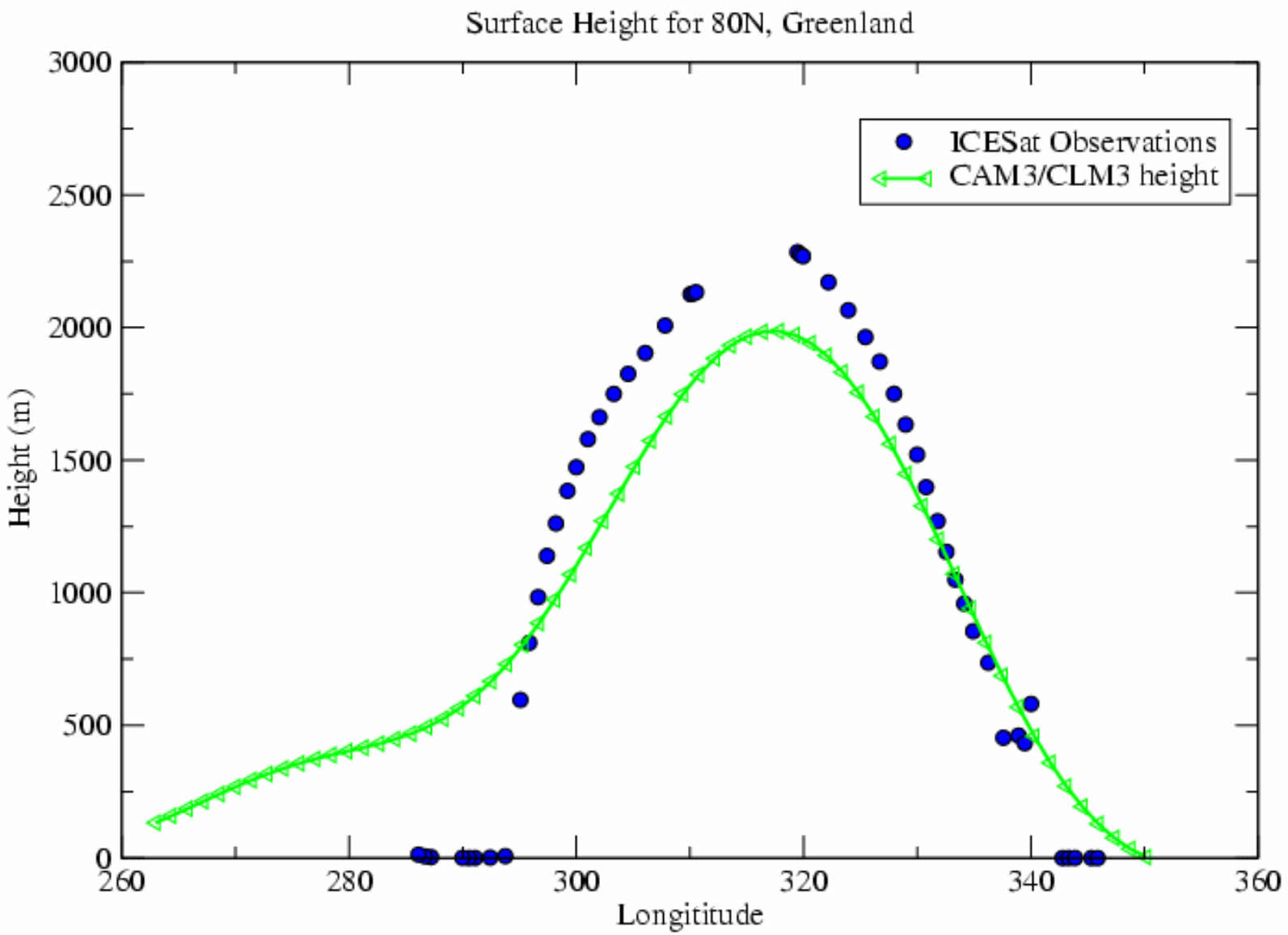
Abrupt changing surface height

Surface Height in Model

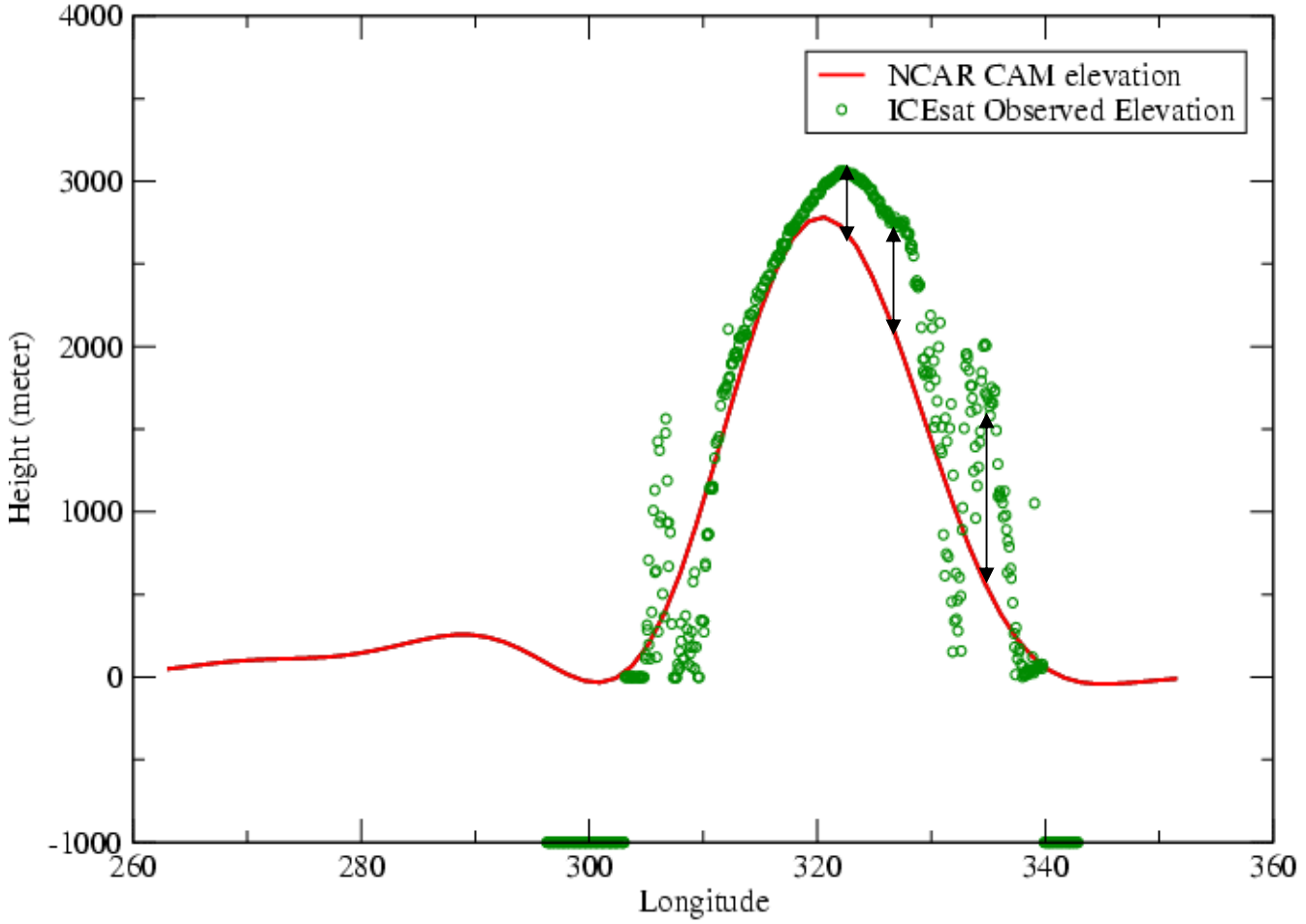


ICEsat

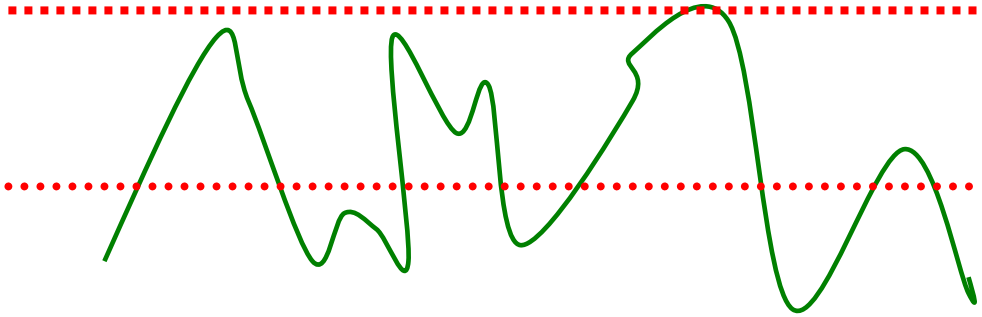



Surface Height for 80N, Greenland
ICESat Observations
CAM3/CLM3 height
Height (m)
Longitude
3000
2500
2000
1500
1000
500
0
260
280
300
320
340
360

70°N, across Greenland

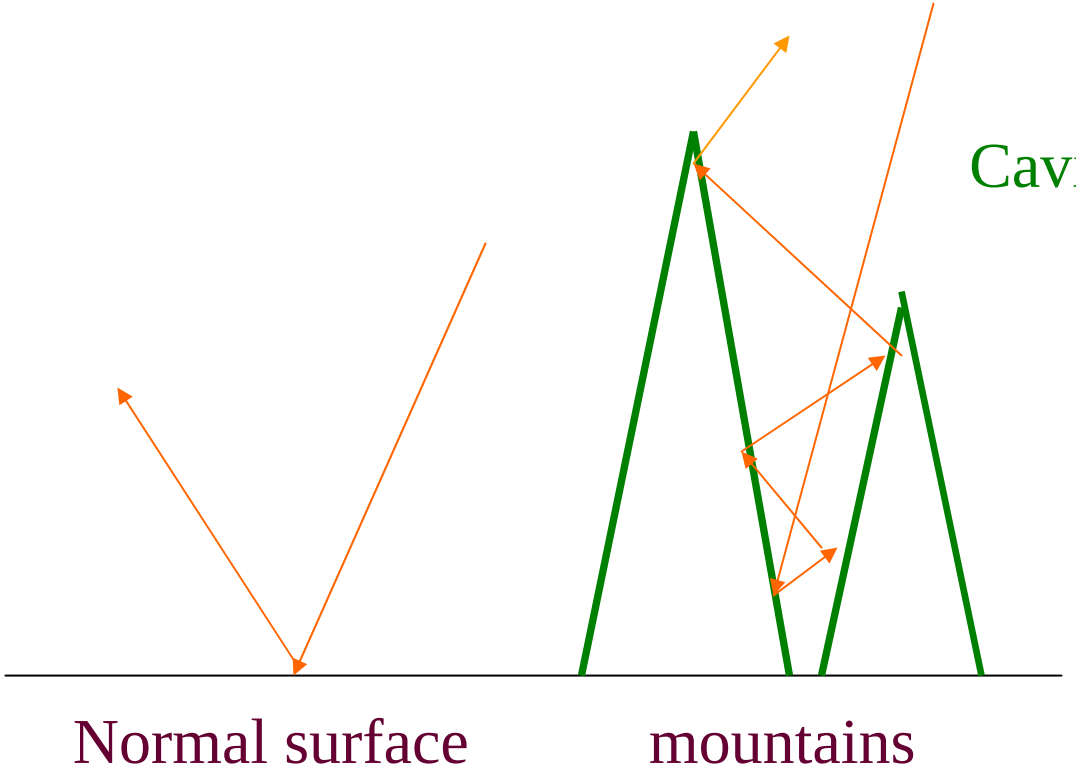


How to assign height in model to represent heterogeneous surface height?



Which should be the surface height H used in model?

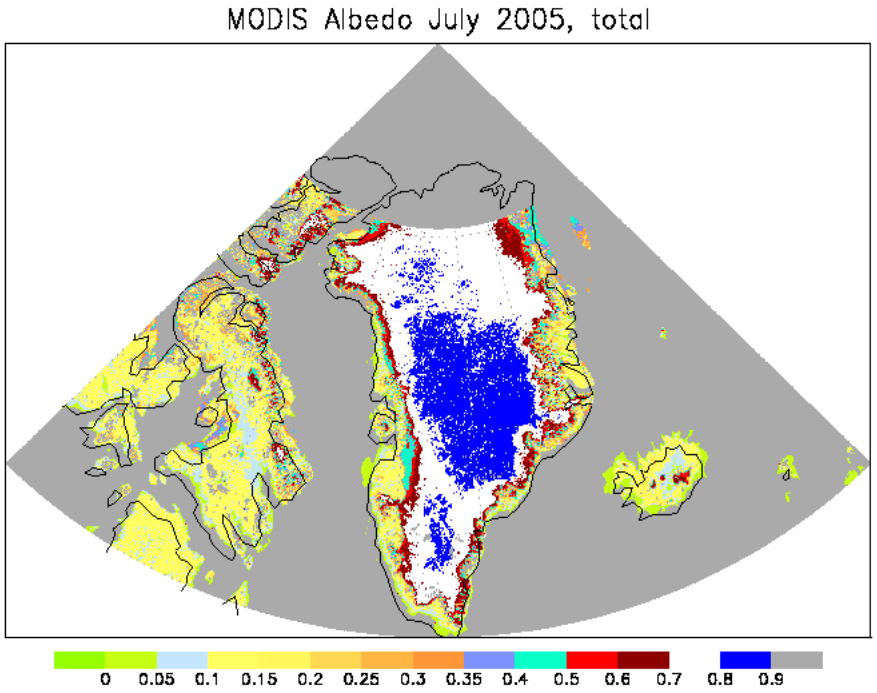
Cavity effect (i.e., slope effect)?



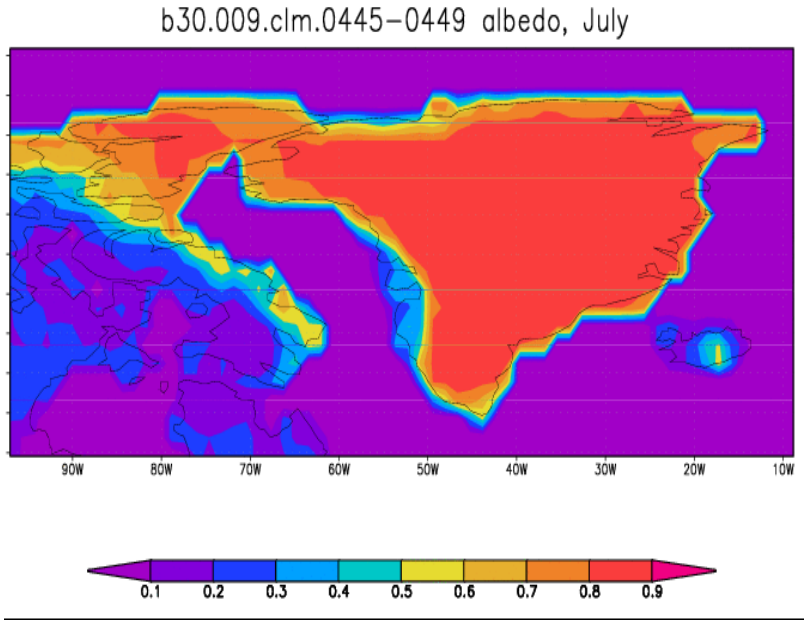
Multi-reflection by mountains

Surface Albedo

MODIS Obs.



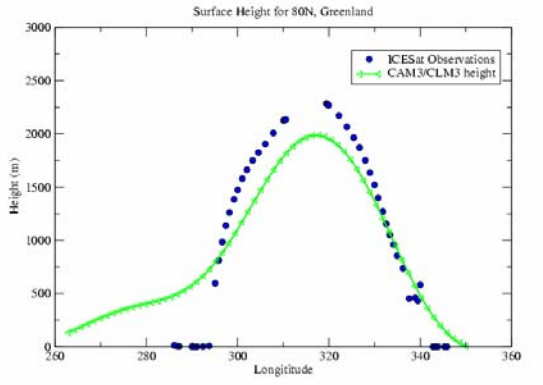
CCSM Simulations



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

Model albedo is too high!

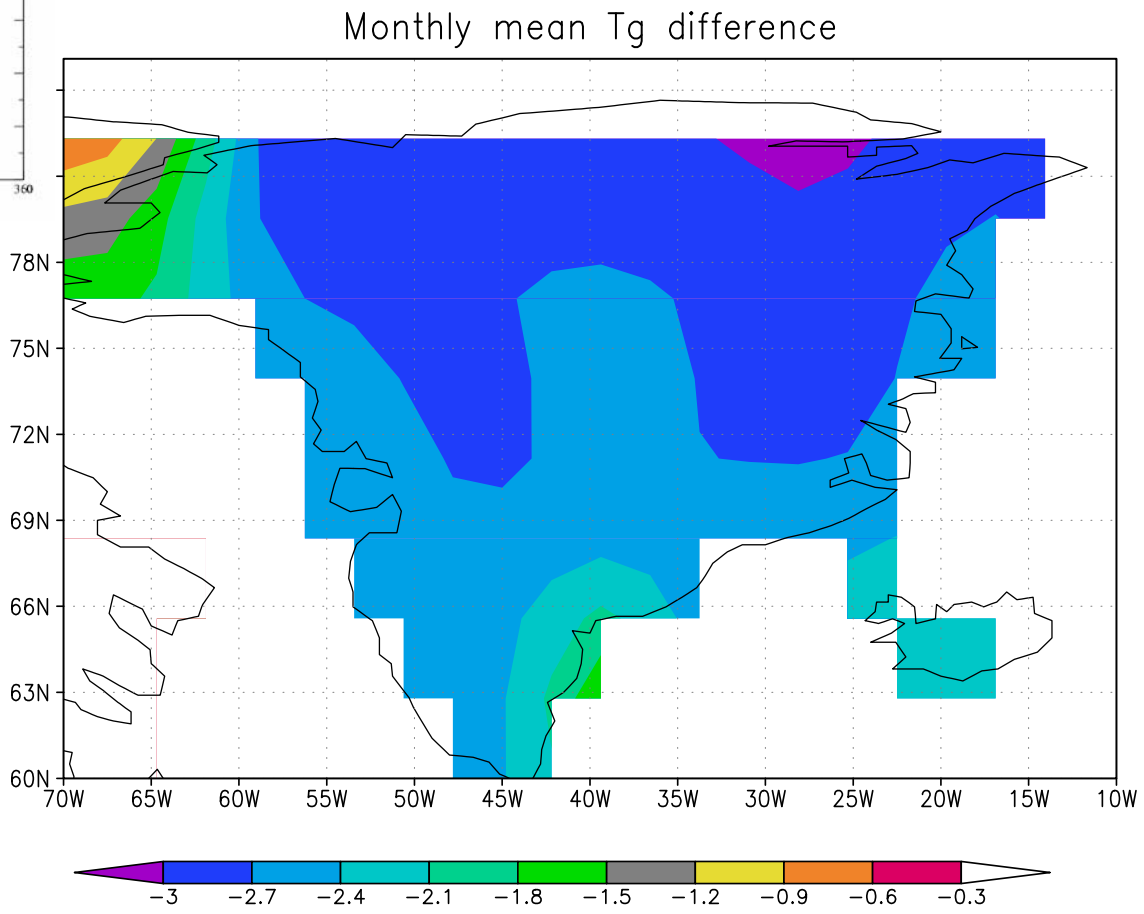
Offline CLM3.5



Changing H

↓

Improving T_{skin} or T_g



Case 3 run minus control run

Case 3: modified atmospheric forcing TBOT and PSRF: Tbot_n=Tbot-lapse*dz

Psrf_n=Psrf*(Tbot_n/Tbot)**(g/R/lapse)

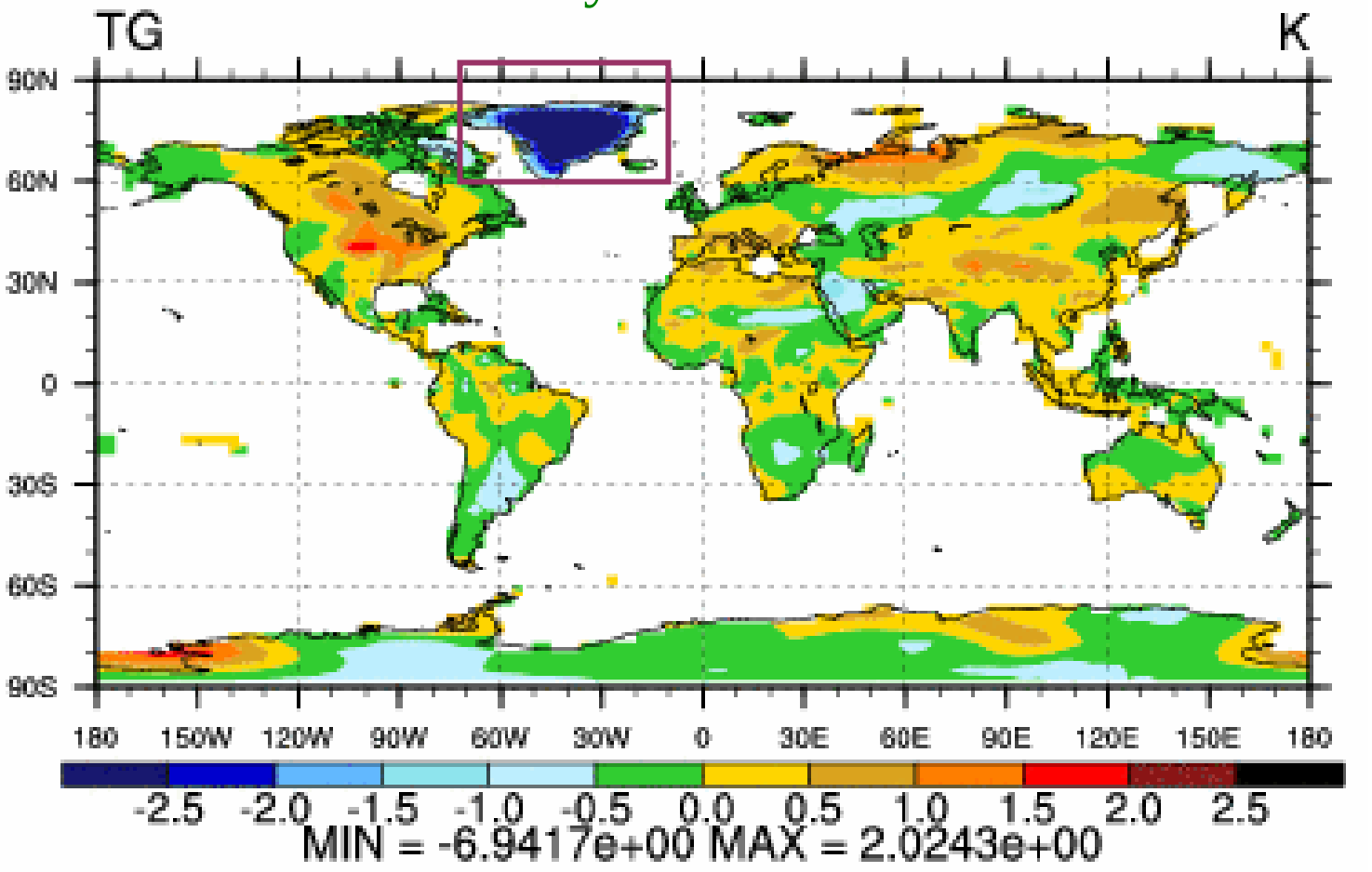
Here: lapse =0.006k/m, g=9.81m/s2, R=287.04J/kg/k, dz=500m

Model Experiments on Greenland Surface H

CCSM

Add H by 1000m in CCSM

Sensitivity run – control run

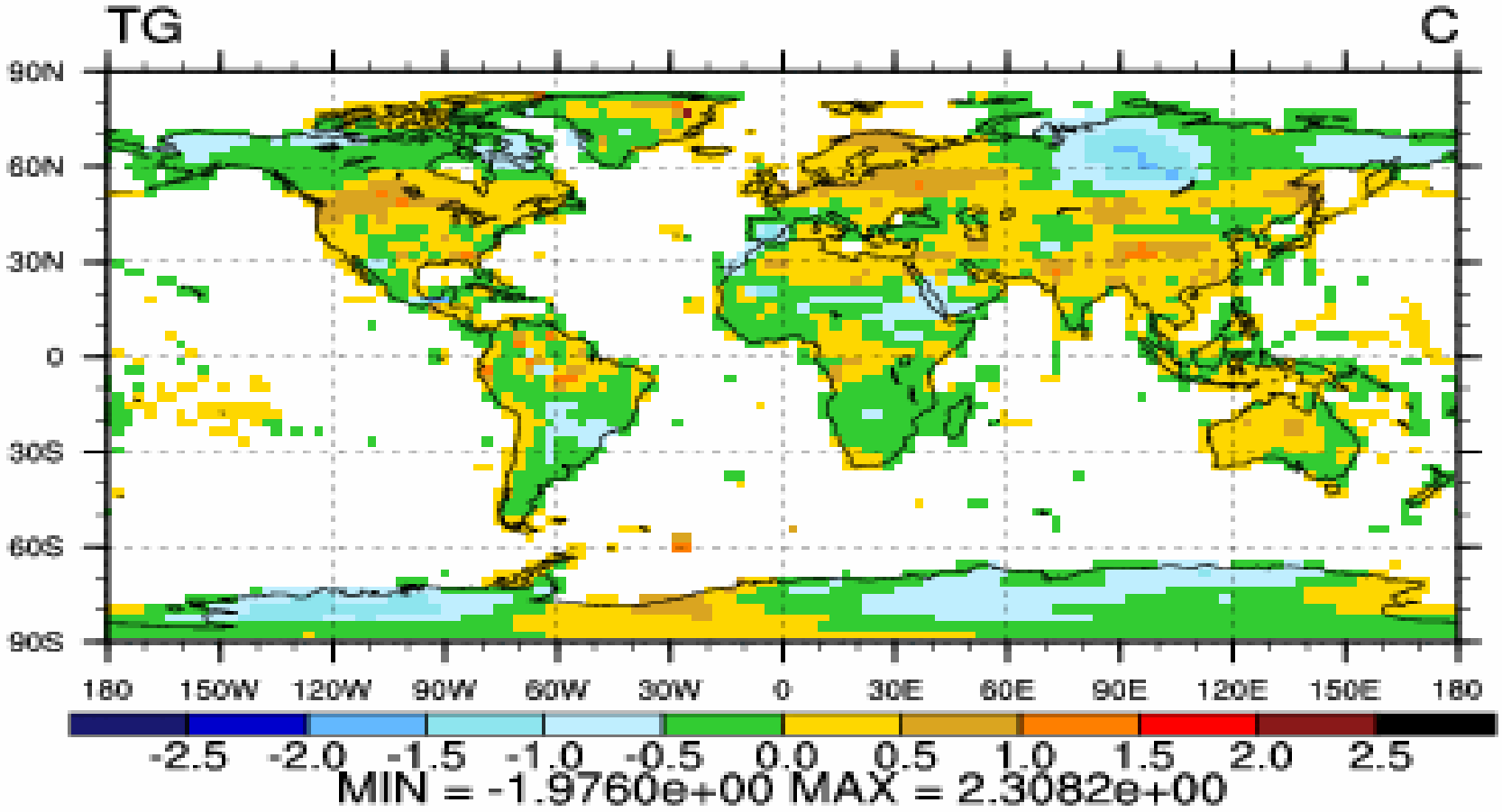


In coupled model, T_{skin} or T_g is also sensitive to Greenland H

Model Experiments on albedo effect

CCSM

Replace model albedo with MODIS albedo



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

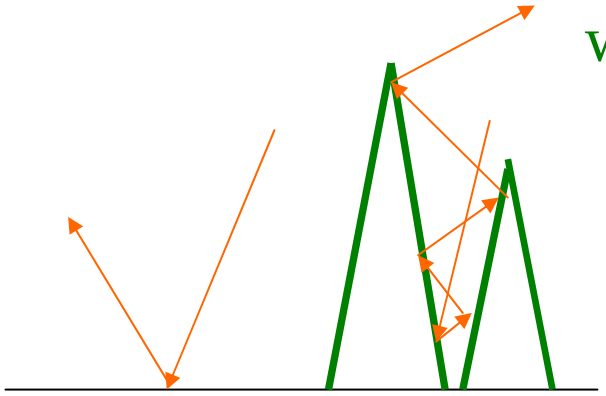
cavity effect (slope effect) ->albedo ↓ -> T_{skin} ↑

Our Thoughts for CLM4

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

2. Improve Galcier 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**?