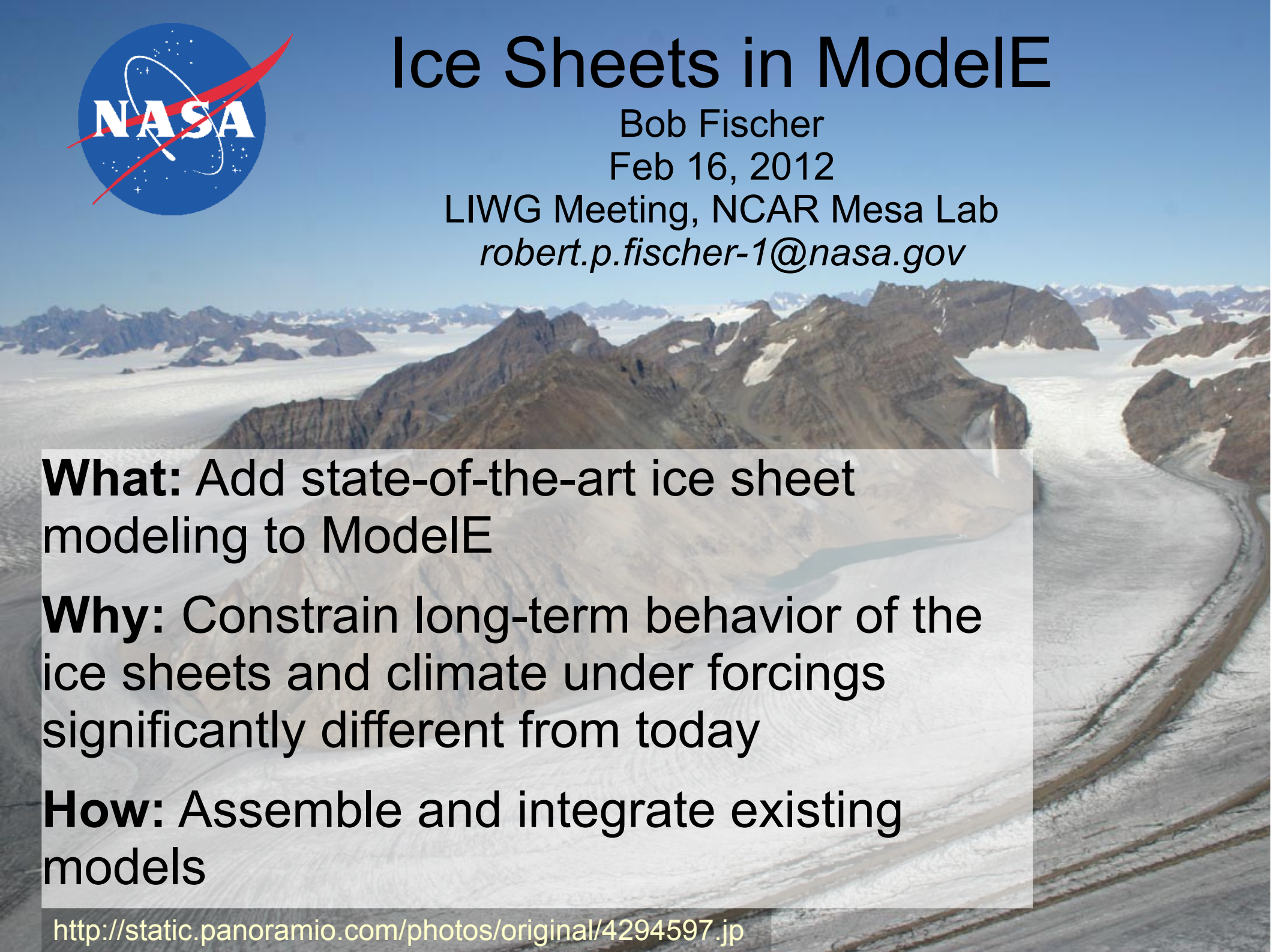

Ice Sheets in ModelE

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Feb 16, 2012
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What: Add state-of-the-art ice sheet modeling to ModelE

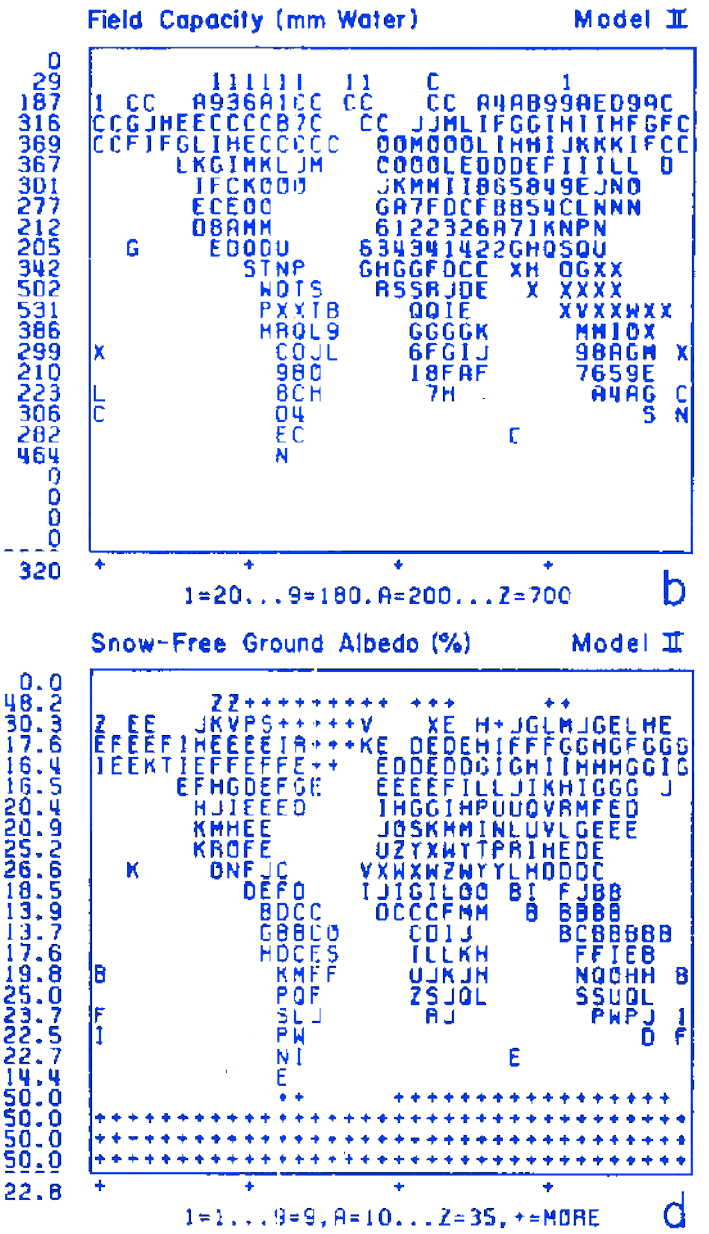
Why: Constrain long-term behavior of the ice sheets and climate under forcings significantly different from today

How: Assemble and integrate existing models

http://static.panoramio.com/photos/original/4294597.jp

Why?

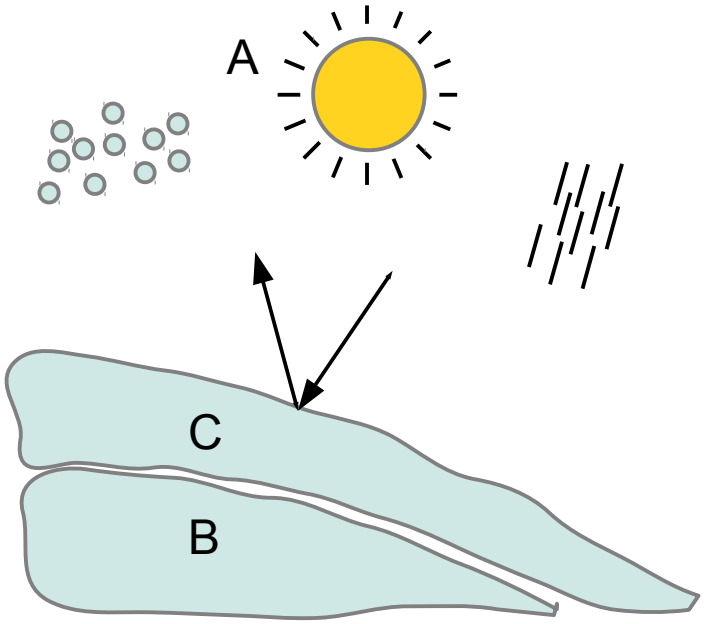
- Ice Needs Updating!
- Use state-of-the-art model components:
  ice dynamics, snow/firn, etc.
  - Replace ice sheet model (1983)
- Two-way coupling with atmosphere and ocean



Hansen et al, 1983

Some Assembly Required

A. ModelE
   Includes SMB
B. Ice Dynamics Model
   Glimmer-CISM
C. Snow/Firn Model
   Albedo
D. Ice Shelves
E. Calving



Challenges

- Snow/Firn Model
- Downscaling
- Height Classes

Snow/Firn Model

Critical for:

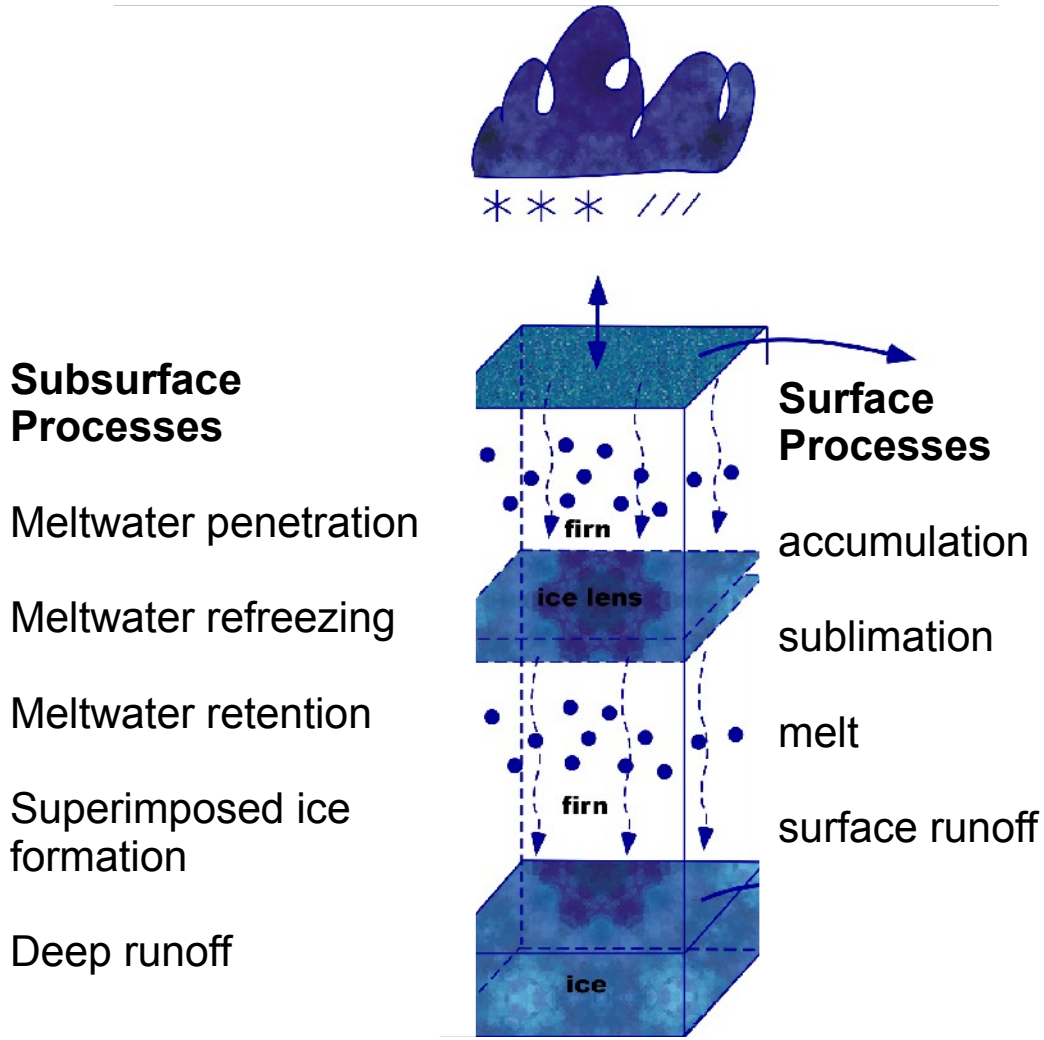
- Albedo feedback (depends on nature of exposed surface)
- Ablation dynamics
- *i.e. getting the melting right!*

Which parts are necessary?

Borrow from:

- RACMO2?
- MAR?
- Stieglitz 1994?

NOTE: Tracers needed!!

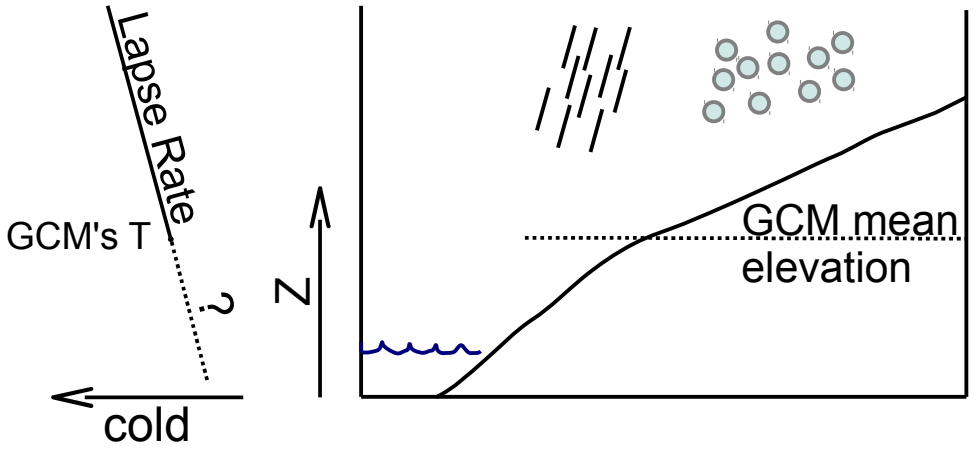


from Ettema et al, 2010

Temperature Downscaling

What Lapse Rate?

- Constant, assume uniform relative humidity (CESM)
- Interpolate from GCM's atmosphere column (Jarosch, 2010)



Downward Extrapolation?

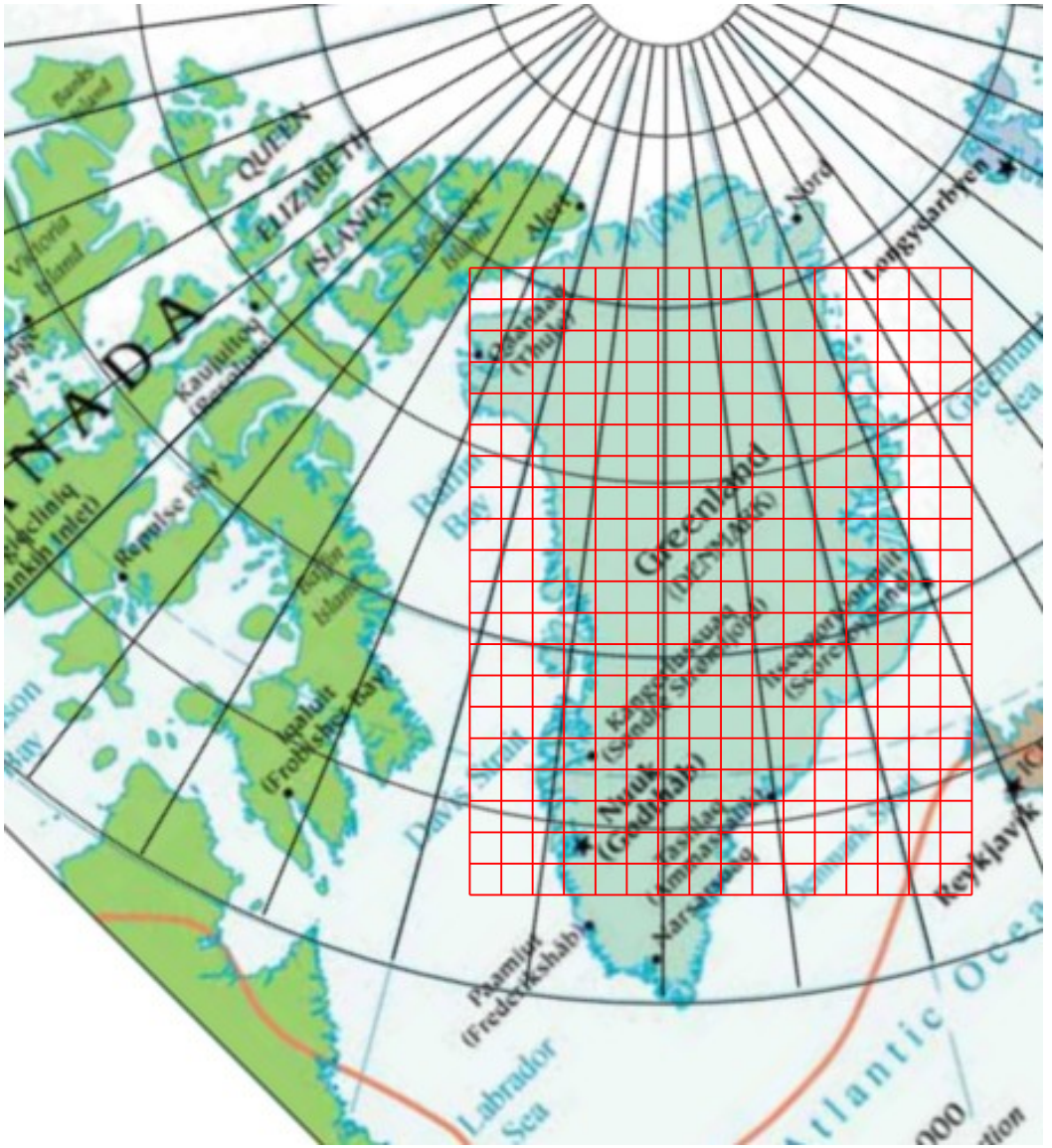
- Extrapolate lapse rate to sea level?
- Correct using low-elevation data from surrounding GCM grid cells?

Will these techniques help SMB with >1 degree GCM grid?

Downscaling

- Pressure/Density
- Temperature
- Precipitation
- Radiative Fluxes (downward IR)
- Specific Humidity

Thompson & Pollard, 1997
Jarosch, 2010

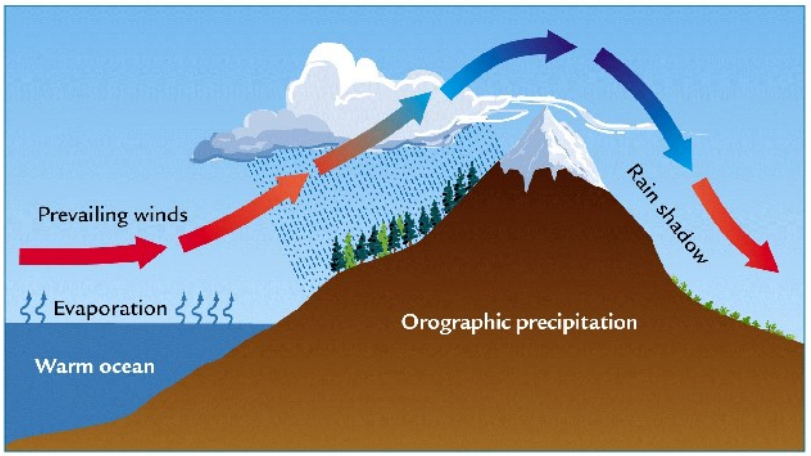


Arctic Region Reference Map with place names from the UT Perry-Castaneda Library

Precipitation Downscaling

Problem:

- High-res topography affects location of precipitation
- Low-res GCM's miss rain shadows
- GCM will overestimate snow in center and underestimate rain on edges of Greenland.



from Dorothy Freidel, Geography 372 notes

Solution:

- Precipitation downscaling based on orographic model
  - Smith & Barstad, 2004
  - Smith, 2003
    (simpler, should work for smooth ice sheet topography)
- GCM must move precipitation between grid cells.
  - Two-way coupling between GCM and downscaler

Height Classes

Theory:

- Assumption: Snow/Ice surfaces of similar elevation are similar.
- Save time every GCM timestep: evaluate model once per height class (in a GCM grid box), not once per cell.
- Fycke 2010, Lipscomb (CISM)

Practice?

- Is assumption true in complex topography?

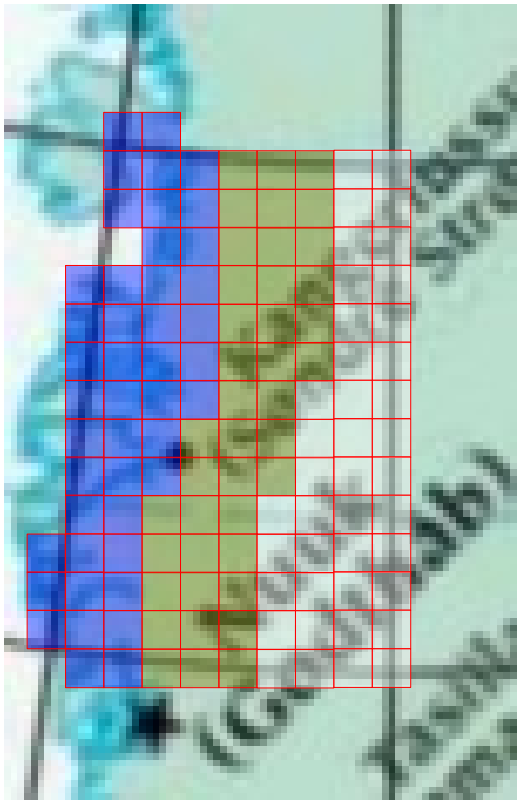


Photo (c) 2006, Elias Castillo. www.trekearth.com

CISM Coupling

- Writing our Own Coupler:
  - Conservative Regridding between Cartesian and Spherical
  - MPI issues, want to use as few gathers as possible.

Final Thoughts

- We *are* Model Shopping.
- Interested in better models, schemes, approaches

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