ACME
Accelerated Climate Modeling for Energy

Radiation in ACME

To explore issues ACME is facing associated with radiation, and possible improvements

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ACME meeting, Summer 2017 (Bolger Center)

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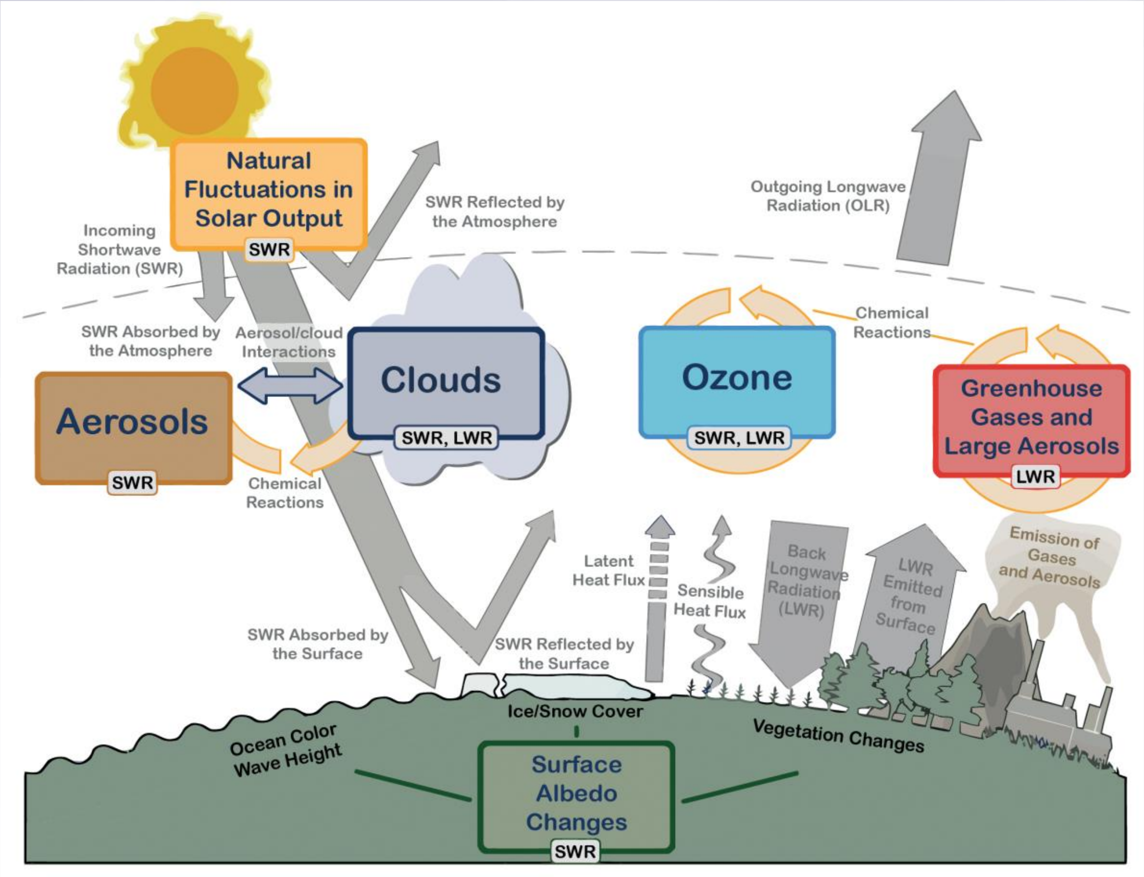
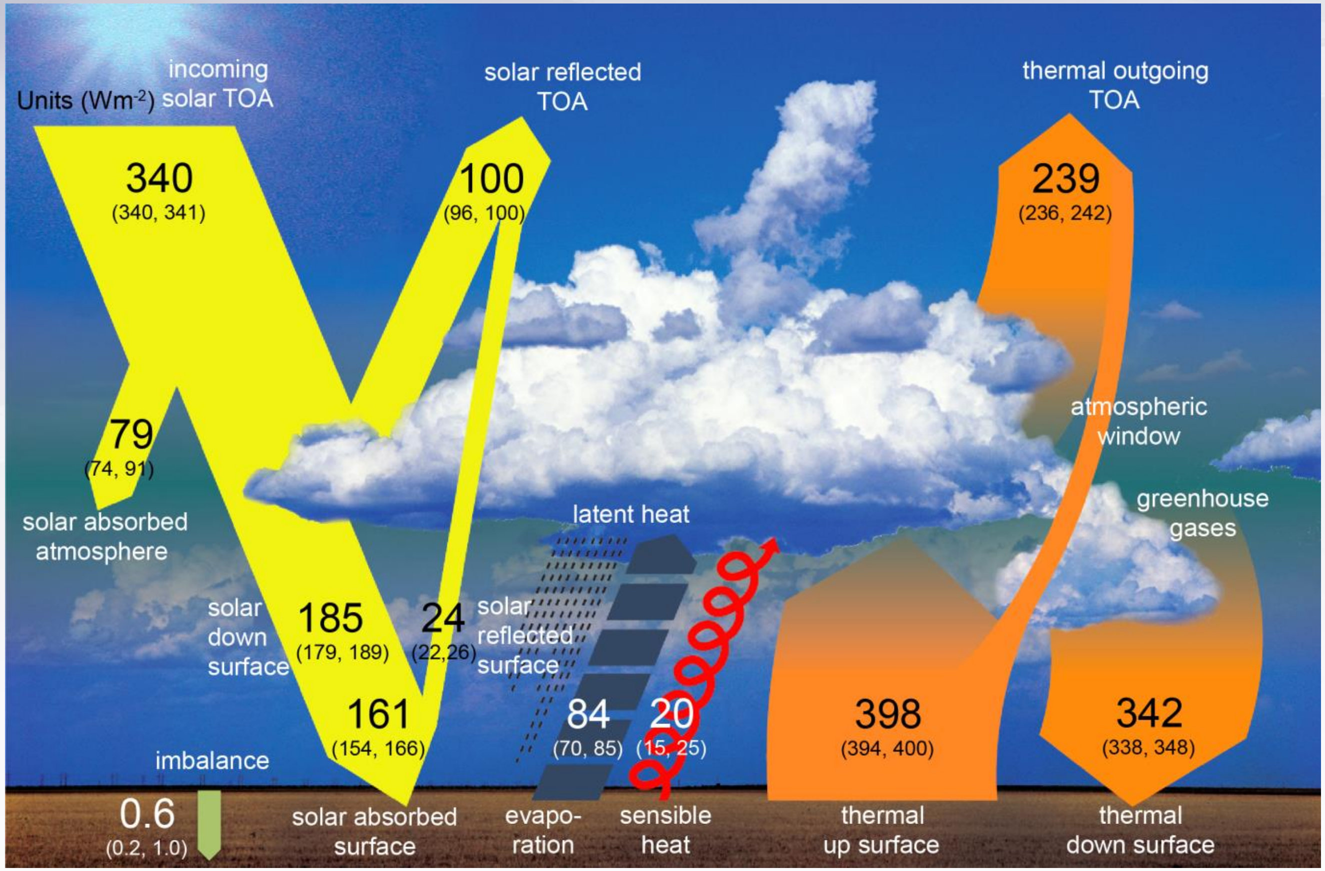
U.S. DEPARTMENT OF ENERGY

Radiation affects Atm, Land, Ocn, Ice



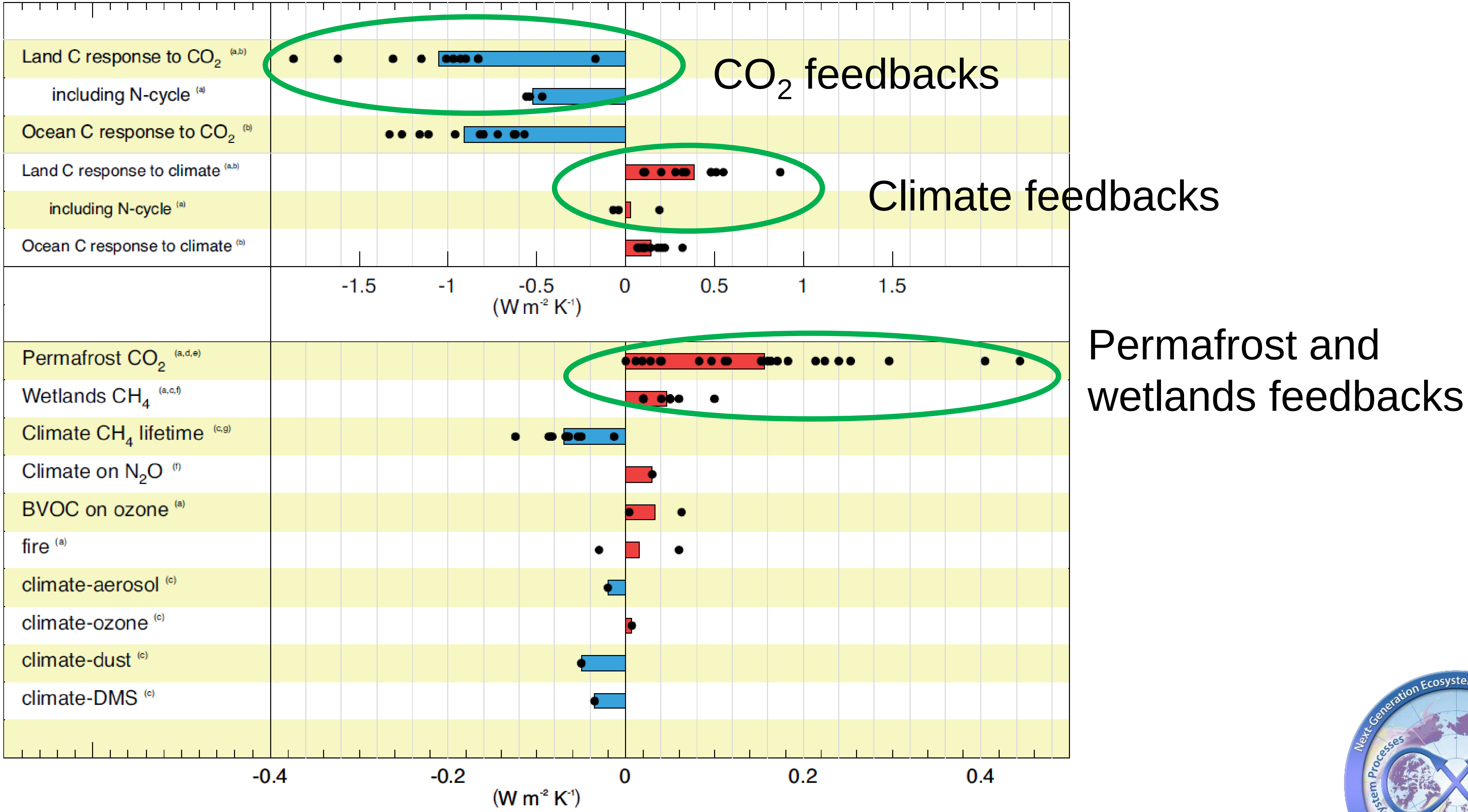
Radiation is still uncertain



Key points:

High-resolution surface radiation, temperature, precipitation, humidity, winds are likely to be important drivers of surface processes, especially in the Arctic.

Topography and microtopography controls on surface radiation budgets have large potential impacts in permafrost landscapes (next slide).



(Fig 6.20, IPCC AR5, WG I, 2013)

What does "high-resolution ESM gridcell" mean for the Arctic?

1° Climate model | ¼° Climate model | 1 km Observation-based

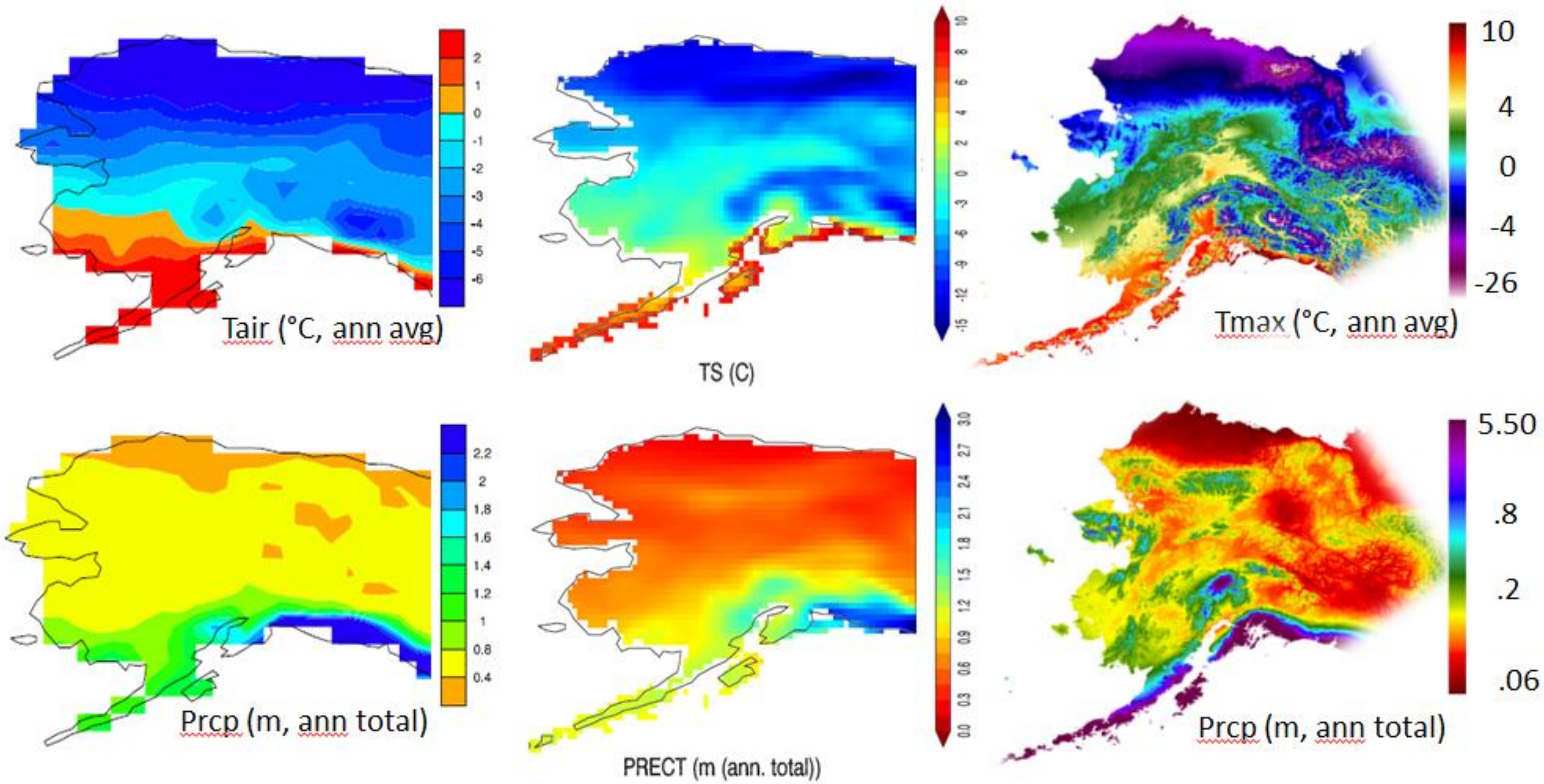
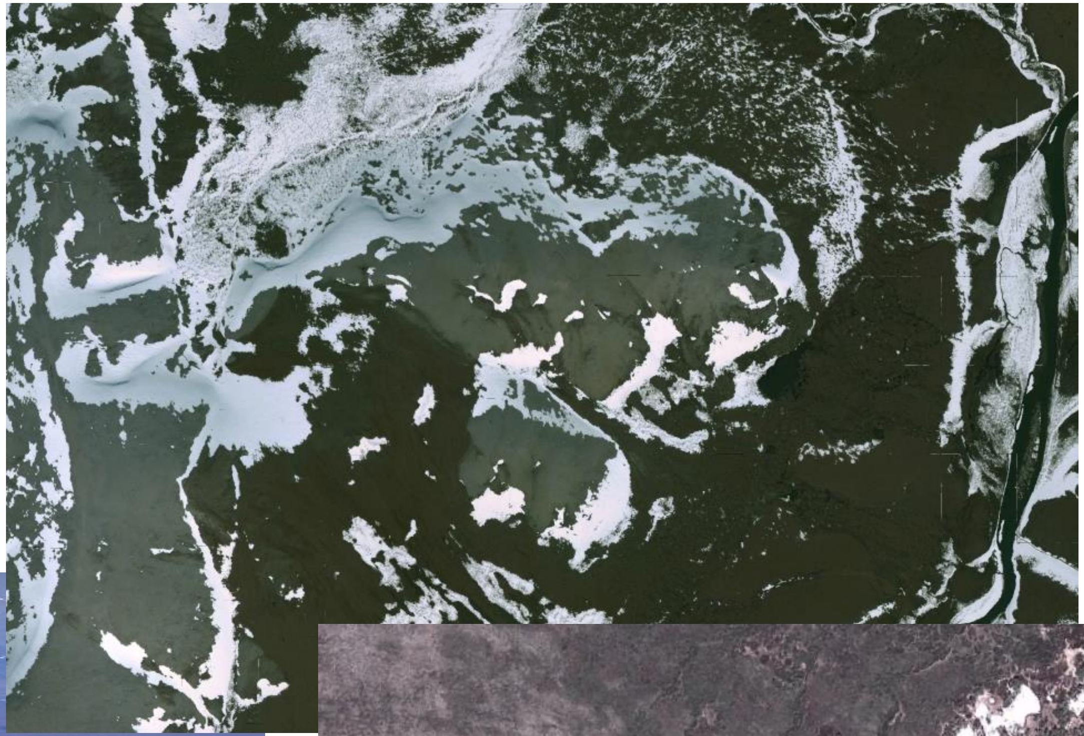
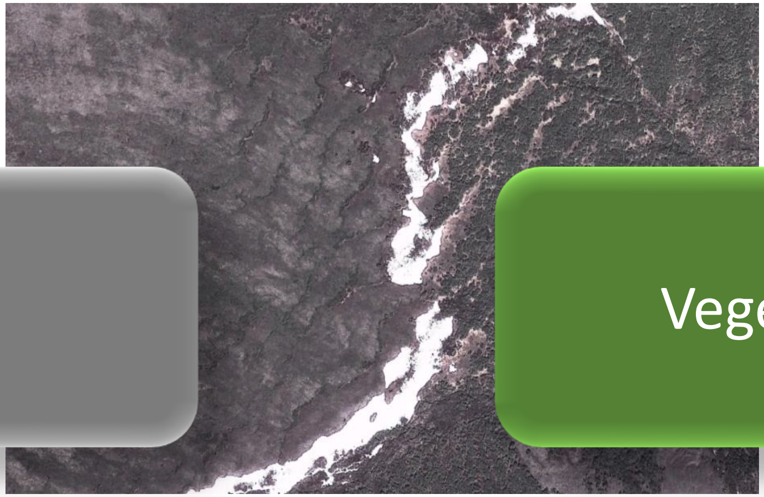


Image credits: Jiafu Mao, Salil Mahajan, Michele Thornton

Observations illustrate interactions among terrain, vegetation distribution, and snow. Surface radiation plays an important role in these interactions.



Snow



Vegetation

Terrain and Microtopography

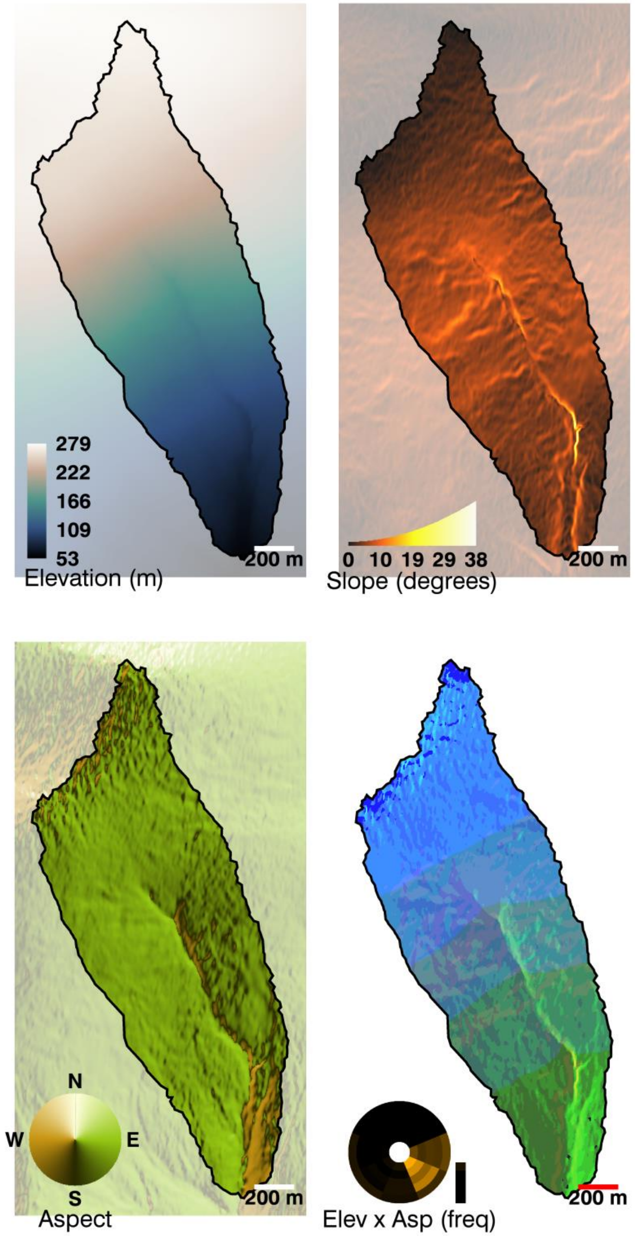
Surface Hydrology

Soil Biogeochemistry

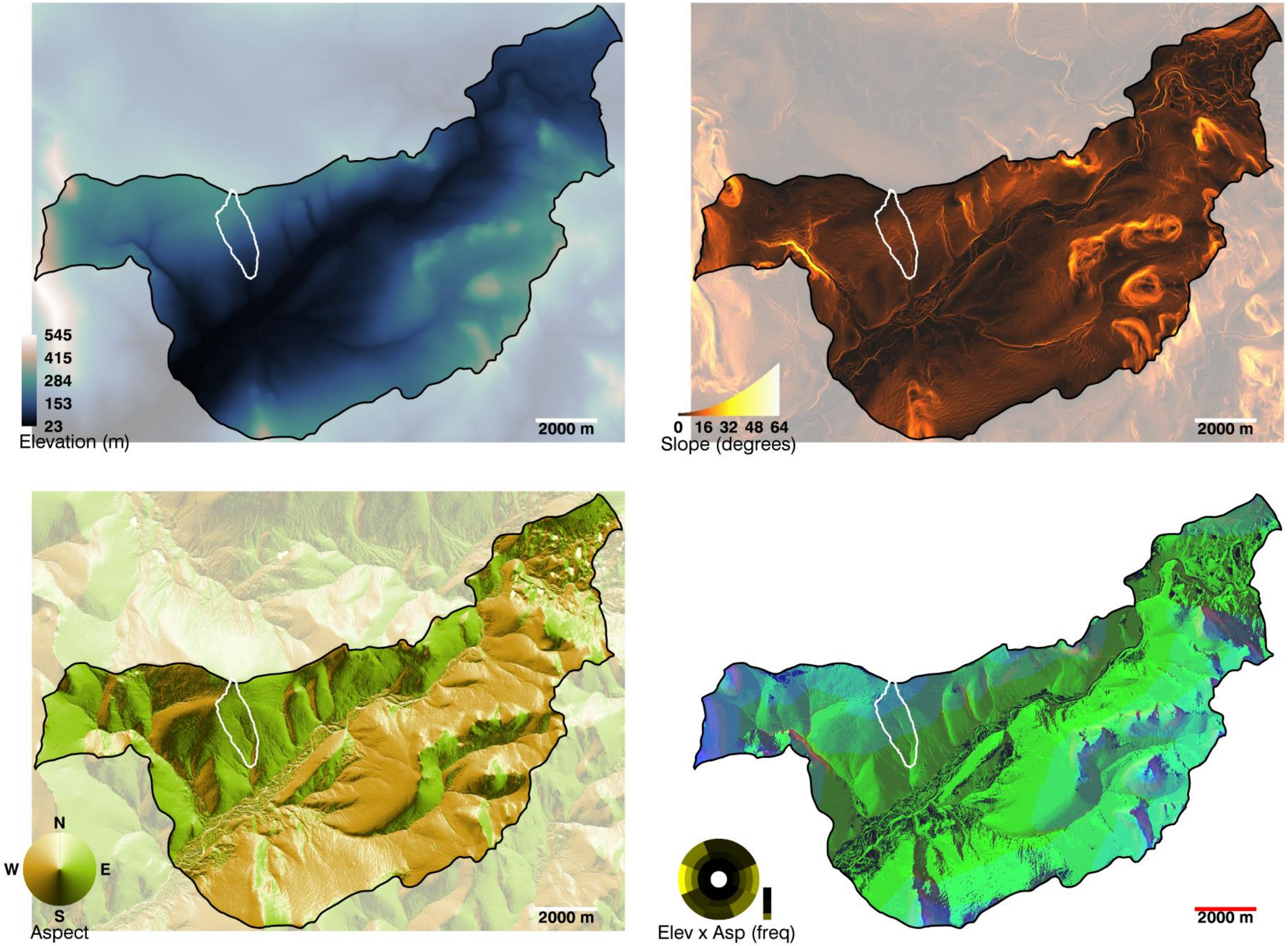
Subsurface Thermal-Hydrology

Detailed studies in several Arctic tundra watersheds on Alaska’s Seward Peninsula (NGEE-Arctic)

Teller watershed: 2.3 km^2



HUC-12 containing the Teller watershed: 140 km^2



Impact of surface heterogeneities on land surface fluxes and states in simulations using an uncoupled, hyper-resolution land surface model

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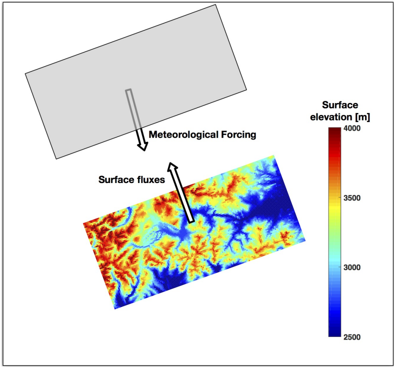
June 2, 2017

Research objectives

Local surface topographic features (e.g. slope, aspect), as well as, non-local topographic features (e.g. terrain shading, sky view factor), impacts total amount of solar radiation reaching the Earth's surface. Yet, the ACME land model assumes a flat Earth with an unobstructed view of sky.

1. How does surface heterogeneities due to soils, vegetation cover, and topography impact coarse-scale surface fluxes and states?
2. What is the relative impact of various sources of surface heterogeneities on coase-scale surface fluxes and states?



Methodology

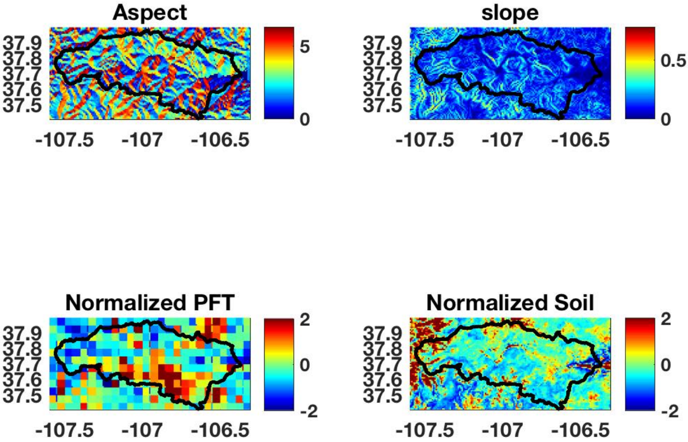
- Sources of heterogeneities
  1. Soils (POLARIS30)
  2. PFT (MODIS)
  3. Surface elevation (GTOP30)
- ALM is modified to account for effects of topography (slope and aspect) on downwelling solar radiation
- Surface dataset created at 1km horizontal resolution
- Each watershed was driven by 1×1 CRUC forcing dataset
- Simulation length was 20-years
- Surface dataset contained 100% naturally vegetated land
- Watersheds
  1. Rio Grand headwaters watershed, CO
  2. Snake headwater watershed, Wyoming

Methodology (continued)

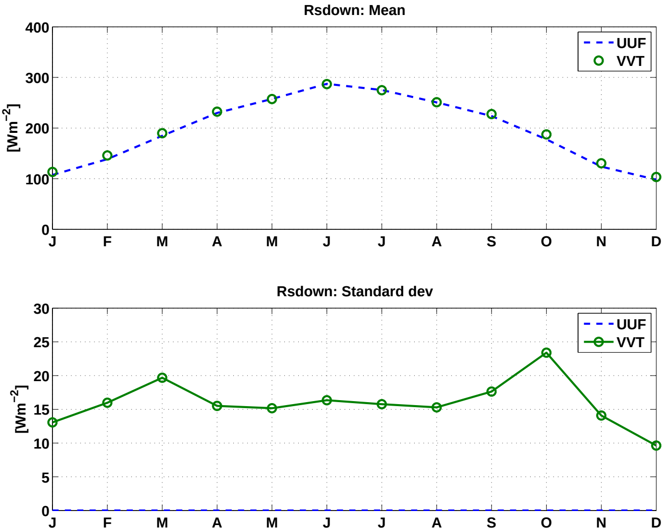
- Following set of ALM simulations were performed:

Code	Soil	PFT	Surface elevation
UUF	Uniform	Uniform	Flat
VUF	Variable	Uniform	Flat
UVF	Uniform	Variable	Flat
VVF	Variable	Uariable	Flat
UUT	Uniform	Uniform	Topography
VUT	Vniform	Uniform	Topography
UVT	Uariable	Variable	Topography
VVT	Variable	Variable	Topography

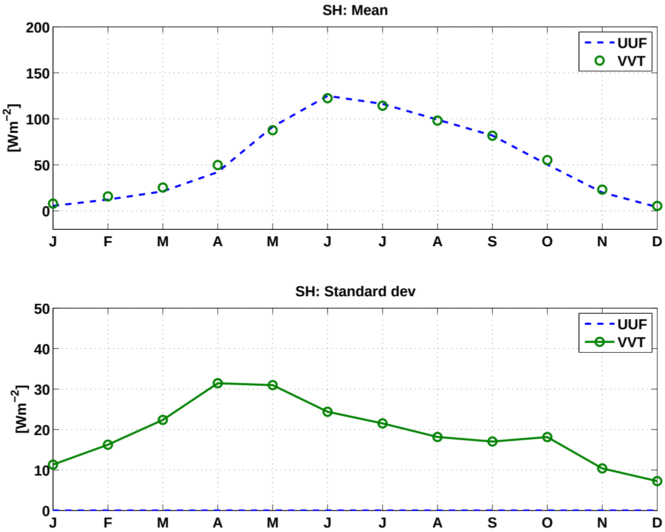
Rio Grande Headwaters



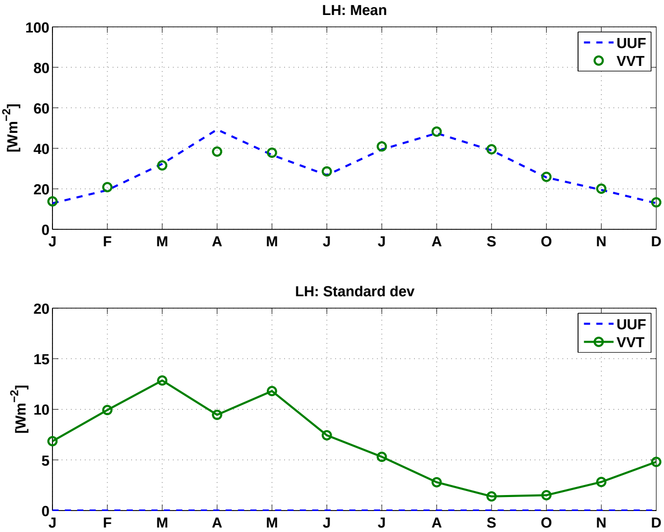
Rio Grande Headwaters: Monthly $R^{\downarrow}_{shortwave}$



Rio Grande Headwaters: Monthly sensible heat flux



Rio Grande Headwaters: Monthly latent heat flux



Conclusion

- Surface heterogeneities have negligible impact on domain average fluxes and states.
- Surface heterogeneities lead to spatial variability in simulated fluxes and states.

Conclusion

- Sub-gridscale Land heterogeneity will affect climate response.
- Correlated land-use with snow affects the mean response.