Roughness, reflectance, and thermal conduction on a scoured snow surface

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Snow in a climate model

Radiative and sensible heat flux

Mass transport

Latent heat

\( \alpha, k, z_* \)
Depositional bedforms → time → Erosional bedforms

Higher wind speeds

- Barchan dune, Antarctica
  - Kobayashi 1979

Young sastrugi, Colorado
- Kochanski 2017

Low wind speeds

- Ripples, Alaska
  - Filhol & Sturm 2015

- Sastrugi, South Pole
  - Bill McAtee 2008

- Lanceolate sastrugi, CO
  - Bill McAtee 2008

- Sastrugi, Colorado
Snow surfaces take 24-48 hours to stabilize
Properties of a sastrugi-covered surface
Flat snow cover provides more effective insulation

Increasing the variance of snow thickness makes it a less effective insulator

\[ \frac{\Delta T}{\Delta T_{\text{flat}}} \geq \sqrt{1 - a^2} \]
Melt ponds form between sea ice
Sastrugi modify the bidirectional reflectance of snow
Surface roughness and aerodynamic roughness

The roughness of aerodynamic surfaces increases by as much as two orders of magnitude across sastrugi

Vignon et al, 2016
Conclusions

- Flat, unsheltered snow surfaces are not stable under winds >5m/s
- Snow surfaces evolve continuously for 1-2 days after each storm
- The most common snow surface type is a sastrugi field, which
  - Provides less insulation than flat snow
  - Has a lower albedo (2-4%)
  - Reflects sunlight anisotropically
  - Has asymmetric roughness and reflectivity.

Questions?

Thank you: Robert Anderson, Greg Tucker, Clea Bertholet
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