A new blowing snow scheme for CLM

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Introduction

Importance of blowing snow

- Displacement of particles: local SMB
- Sublimation of particles
- Blue ice and albedo feedback

Image courtesy of Jan Lenaerts
Introduction

Two parts:

Observations: ceilometer at PE station

- An New Algorithm to Detect Blowing Snow from Ceilometers in East Antarctica
  - Session Block, A Seehorn
  - 20.06.2018, 11:00 – 12:30
  - TE-3e - Remote sensing of polar regions

Modelling: implementation of a blowing snow scheme

- A Long-term Hindcast Simulation with COSMO-CLM² over Antarctica
  - Session Block, A Studio
  - 21.06.2018, 14:00 – 15:30
  - AC-3a - High-Latitude Boundary Layers and Model Evaluation

Gossart et al., 2017; Souverijns et al., 2018
Material and methods

- **NM**: frequencies (2012 – 2013 - 2014)
- **D47**: frequencies + transport (2010-2011)
- **D17**: frequencies + transport (2013-2014)
- **TD**: frequencies + transport (2009)
Material and methods

Adaptations to the model to improve the snow pack

- Back porting changes from CLM5.0 to 4.5 (van Kampenhout et al., 2017)
- Density dependence on temperature and wind (van Kampenhout et al., 2017)
- Grain size dependent on wind speed and air temperature (van Kampenhout et al., 2017)
- Runoff/top snow temperature/albedo bug
Material and methods

Simple bulk model (Déry and Yau, 1999)

- Friction velocity ($u_*$) dependent on horizontal wind speed
- Blowing snow threshold based on air temperature
Material and methods

Simple bulk model (Déry and Yau, 1999)

- Friction velocity \( u_* \) dependent on horizontal wind speed only → dependence on snow density and other mobility parameters (Gallée 2001)

\[
\begin{align*}
    u_* &= u*_{t0} \exp \left( \frac{n}{1-n} + \frac{n_0}{1-n_0} \right) \\
    \text{Snow density / ice density} & \quad \text{Porosity of fresh snow (300 kg/m}^3) \\
    \text{Mobility of snow particles (dendricity and sphericity = 0.5) + drag coefficient for momentum (0.002)}
\end{align*}
\]
Material and methods

Simple bulk model (Déry and Yau, 1999)
– Blowing snow threshold based on air temperature only
Material and methods

Simple bulk model (Déry and Yau, 1999)
– Blowing snow threshold based on air temperature only

Wind speed >

\[ A \times t^2m + B \times \text{snow density} \]
Material and methods

Simple bulk model (Déry and Yau, 1999)

- Transport calculation as flux (kg/m^2.s)
- A * wind speed B
Material and methods

D47

D17

TD
Material and methods
Material and methods

![Graphs showing the relationship between wind speed and transport for different datasets (D47, D17, TD, and all). The graphs compare observations with model predictions.](image)
Future work

1) Blowing snow sublimation
2) Add the routine in the coupled COSMO-CLM² model
3) Simulate blue ice