A new albedo parameterization for the Antarctic ice sheet

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The challenge

In coastal Antarctica, the energy budget of the snowpack is dominated by **solar radiation**. How much solar radiation is absorbed depends on the albedo of the snow surface. Albedo is involved in a **strong positive feedback**: when snow melts, albedo drops, causing more radiation to be available for **melting**.

It is thought that **ponding of meltwater** has led to the break-up of the Larsen A (1995) and B (2002, see images) ice shelves. Also, meltwater extent is measured by satellites and used as a **climate change indicator**.

If you want to simulate meltwater production realistically (and indeed the entire surface energy budget), the key is to have the parameterization of albedo right. The challenge is to implement a good parameterization of albedo in our regional climate model RACMO2.1

The solution

Apart from solar elevation and cloudiness, albedo is determined mainly by the **size of the snow grains**. A computation of the evolution of snow grain size was implemented in RACMO2.1, based on Flanner and Zender (2006). It takes into account

(1) dry snow metamorphism

(2) wet snow metamorphism

(3) fresh snowfall

(4) refreezing of meltwater,

processes that each influence snow grain size. Figure 2 demonstrates the evolution of snow grain size in an Antarctic summer season, for three very different locations. Figure 3 shows the evolution of snow grain size during one summer on the entire Antarctic continent.

Lastly, formulas by Gardner and Sharp (2010) are used to **translate** snow grain size, solar elevation and cloud cover to snow albedo.

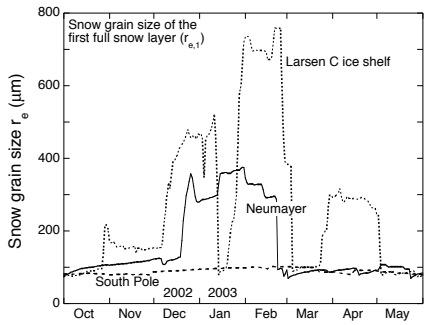


Figure 2 *(above): Snow grain size in an Antarctic summer at the Larsen C ice shelf (Antarctic Peninsula), Neumayer (coastal East Antarctica), and South Pole (Antarctic plateau).*

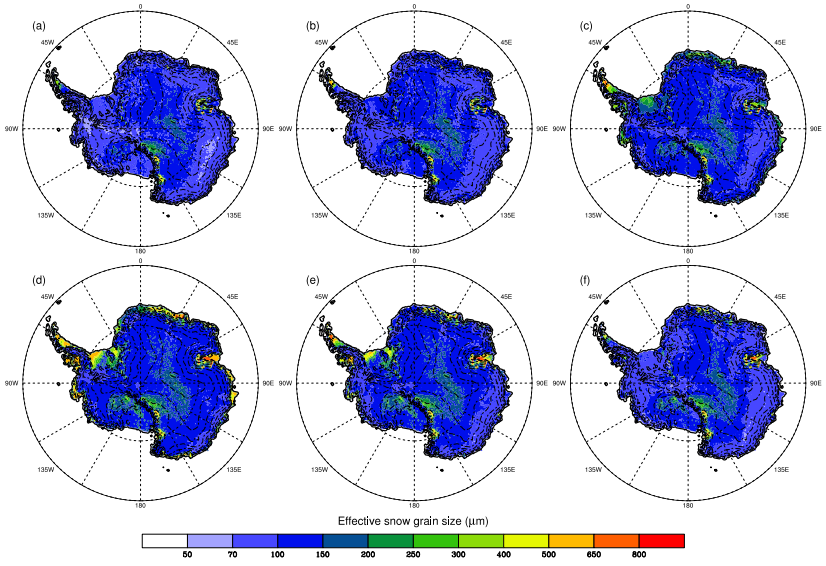
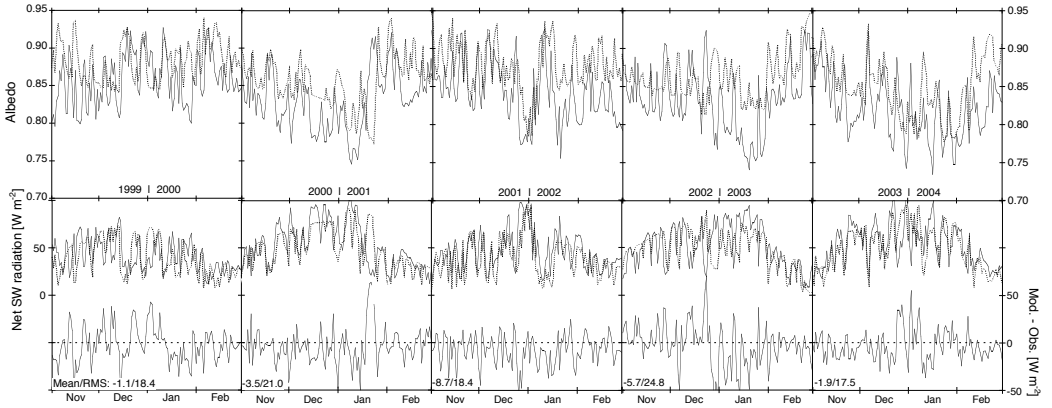


Figure 3 *(right): Snow grain size in an Antarctic summer over the entire continent. (a) October, (b) November, (c) December, (d) January, (e) February, (f) March.*

Validation

The computed albedo is validated against observed albedo at Neumayer, a site with **high-quality solar radiation measurements**. The agreement between RACMO2.1 (dashed lines in figure 4 to the right) and observations (solid lines) is very good. Over a summer season, net shortwave radiation is underestimated by 2.7 W m-2. The **seasonal cycle**, the **variability** due to cloud cover, and the **feedback** between albedo and melt are well represented.



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