Cascading decrease of the surface snow SSA at Kohnen Station, DML, Antarctica

Introduction
The grain size of the surface snow is the key parameter of albedo in interior Antarctica, as impurity content is very small. The snow surface at the end of austral winter is characterized by very small grains. The small snow grains consist of broken precipitation particles and partially sublimated or mechanically fractured older ice particles. The albedo is consequently very high. The size of snow grains can be determined quite accurately by measuring its specific surface area (SSA). The specific surface area (SSA) is defined as the free surface area of the ice matrix $S$ per unit ice mass $m$ $SSA = \frac{S}{m}$ (Legueneux et al. 2002, Domine et al. 2006, Gallet et al. 2011): $SSA = \frac{S}{V} \cdot \frac{V}{\rho_{ice} \cdot \rho_{eff}}$ (1)

(with the density of ice $\rho_{ice} = 917$ kg m$^{-3}$ at 0°C and the radius of the effective or equivalent sphere $\rho_{eff}$).

The SSA as a material property used for albedo estimates typically shows an annual cycle. During the summer it decreases due to grain coarsening caused by snow metamorphism. A recently published study of Picard et al. 2012 showed that the grain size increase in DML during the summer is noticeably high. But until now there are no field studies available investigating the sensitivity of SSA measurements

SSA measurements
The SSA measurements were taken on a daily basis during a field campaign in austral summer 2012/2013 at Kohnen Station (75°00'S, 00°04'O at 3892m a.s.l.) in Dronning Maud Land (DML).

The whole setup was build up in a tent to be protected against weather and radiation influences and disturbances. The sampling site was about 500 m SE of the main station. The location could be reached during all weather conditions. The transect had a length of 50 m across the main wind direction. Every 2 m a sample was taken (daily profile shift).

Results

Discussion & Conclusion

• The surface snow SSA decreased about 46% over the measurement period during the austral summer 2012/2013 at Kohnen Station. This corresponds to a decrease in broadband albedo of about 5% in less than 7 weeks. The snow surface layer in DML is affected by a variety of processes including wind driven redistribution, precipitation or surface hoar formation.

• We found that the SSA was not reducing smoothly but showed a cascading decrease: Alternating temperature gradient metamorphism (ATGM) plays an important role for SSA decrease over the summer. Its effect is interrupted by precipitation events (occurring as ‘cascades’ in the mean SSA).

• Even small amounts of precipitation during the summer period can affect the decrease of SSA, respectively the albedo, in the DML region on the East Antarctic Plateau.

• The peaks in the daily mean SSA correspond to precipitation and surface hoar formation events during the austral summer (supporting the findings from Picard et al. 2012).

• But: Redistribution caused by wind drives the decrease of the mean SSA so that the precipitation effect in DML vanishes after 3-5 days.