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What controls atmospheric particle sizes over the Greenland ice sheet?

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Insoluble particle concentrations and their size distributions are routinely measured in polar ice cores to reconstruct past atmospheric dust loads and often interpreted in terms of changes in atmospheric transport. However the transfer of mineral dust particles from the atmosphere to the ice is not well understood, especially regarding the preserved particle size distributions (PSDs).

Here we present an extension to a conceptual deposition model for aerosols based on precipitation scavenging and gravitational settling including the size distribution of the particles. The extended model can be used to study the effect of different atmospheric PSDs and changes in accumulation rate on the persevered particle concentration and their size distribution. It can also be applied to reconstruct past atmospheric dust conditions using accumulation rate reconstructions and measured PSDs.

We apply the model to previously published size distribution data from North GRIP (Greenland) to investigate the influence of the changing deposition regime during the fast transitions between stadial and interstadial conditions during the last glacial. For these transitions reconstructed accumulation rates show changes by a factor of two with low accumulation rates during cold and high accumulation rates during warm periods .

In general the transfer to the ice core shifts the particle size distributions towards larger particles. This effect is more pronounced for lower accumulation sites where dry deposition dominates. For sites with accumulation rates comparable to NGRIP variability in the accumulation rate has a small influence on the PSDs in the ice. However for low accumulation sites, such as in central Antarctica, changes in accumulation rate can have a large impact on the preserved PSDs.