Geophysical Research Abstracts
Vol. 17, EGU2015-7090, 2015
EGU General Assembly 2015

Constraints on the δ2H diffusion rate in firn from field measurements at Summit, Greenland

Harro A.J. Meijer (1), Gerko (L.G.) van der Wel (1,2), Henk A. Been (1), Roderik S.W. van de Wal (3), and Paul (C.J.P.P) Smeets (3)

(1) University of Groningen, Energy and Sustainability Research Institute Groningen, Centre for Isotope Research, Groningen, Netherlands (h.a.j.meijer@rug.nl), (2) University of Bern, Institute of Climate and Environmental Physics, Bern, Switzerland (vanderwel@climate.unibe.ch), (3) University of Utrecht, Institute for Marine and Atmospheric Research Utrecht, Utrecht, Netherlands (R.vandeWal@phys.uu.nl)

Diffusion smears out, and can eventually wash away, spatial gradients (such as seasonal cycles) in the stable isotope signals in snow and firn after deposition. The diffusion process is governed by the continuous evaporation and condensation of ice particles into and from the air channels. As this diffusion process influences the isotope signals that are eventually conserved in ice cores, quantitative knowledge of the process is necessary.

We performed detailed 2H isotope diffusion measurements in the upper 3 meters of firn at Summit, Greenland. Using a small snow gun, a thin snow layer was formed from 2H-enriched water over a 6 x 6 m2 area. We followed the diffusion process, quantified as the increase of the δ2H diffusion length, over a four years period, by retrieving the layer once per year. Each year we drilled 2-3 firn cores, sliced them into 1 cm layers and measured the δ2H-signal of these layers.

Our experimental findings show the gradual increase of the diffusion length to close to 4 cm after four years. This is much smaller than the result based on the commonly used model by Johnsen at al (2000), which yields more than 6 cm. We have studied the possible causes for this discrepancy, and conclude that the poor constraint of the tortuosity partly explains the discrepancy. But more important, it is likely that isotopic inhomogeneity exists within the ice grains in the firn, which slows down the diffusion process. This effect has not been considered in the model.

Reference: S. Johnsen, K. Clausen, K. Cuffey, K. Hoffmann, J. Schwander, T. Creyts. Diffusion of stable isotopes in polar firn and ice: The isotope effect in firn diffusion. Physics of ice core Records (T. Hondoh, editor) Hokkaido University Press 2000.