



A laboratory study on the diffusion rates of stable isotopes of water in unventilated firn

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Diffusion of stable water isotopes along isotopic gradients, is a process that takes place in snow and firn after deposition. We demonstrate the possibility of experimental study of isotopic diffusion in unventilated snow and firn. A snow stack consisting of 8 layers (4 thin, 4 thick) with different isotopic composition was built in a box under controlled conditions. We present the possibility of using artificial snow as the diffusion medium, instead of crushed or shaved ice, thus approaching better the natural conditions in terms of grain size and shape. The snow stack was left in the box for a total period of 6 months. Three sampling sequences took place during this time interval. Measurement results from the first two sequences with an isotope ratio mass spectrometer revealed an isotopic profile that was smoothed due to a diffusion process along the isotopic gradients that occurred in the stack. Results from the third sequence will soon be available. We also modeled the diffusion process in the box. The results describe the process of diffusion in the snow stack only qualitatively. By using the firn density as a parameter, we fit the results of the model to the measured isotopic profile curves. The result of this procedure is that when we achieve a good fit for the thick layers curves, the model overestimates the diffusion rates for the thin layers. It is not possible to achieve a simultaneous agreement between experimental and modeling results for both thin and thick layers. Parameters of the experimental setup might have been responsible for these results (density and temperature gradients, ventilation). Finally, the parameterization of the diffusivity and tortuosity factors might have been inappropriate for our experiment and therefore they should possibly need reconsideration.