Geophysical Research Abstracts
Vol. 16, EGU2014-9530, 2014
EGU General Assembly 2014

The ability of isotope enabled Global Circulation Models to simulate observed water vapor isotopic composition above the Greenland Ice Sheet

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We have measured continuously for three summer seasons (2010-2012) the isotopic composition of the water vapor on top of the Greenland Ice Sheet as part of the NEEM deep ice core-drilling project (77.45 N 51.06 W, 2484 m a.s.l). The purpose of this campaign has been to improve our understanding of the climatic factors controlling the ice core isotope signal, which can then be used to reconstruct the past climate.

To achieve such an understanding general circulation models provide a valuable tool. It is therefore crucial to test the ability of the models to simulate the present day hydrological cycle and its isotopic counterparts. We therefore compare the observed water vapor isotopic composition with model outputs from three isotope-enabled general circulation models (LMDZiso, isoGSM, ECHAM-wiso). We are thereby able to benchmark the models and address effect of model resolution, effect of transport, effect of isotope parameterization, and representation of significant source region contributions.

We find for all models that simulated isotopic value δD are significantly biased towards too enriched values. This isotopic bias is partly explained by a bias in the simulated air temperature. We furthermore find that the simulated amplitude in d-excess variations is $\sim$50% smaller than observed and that the simulated average summer level is $\sim$10‰ lower than in observations.

The bias in the simulated δD and d-excess water vapor is similar to the already-documented bias in the simulated δD and d-excess of Greenland ice core records. This suggests that if we improve the simulation of the water vapor isotopic composition we might also improve the simulation of the ice core isotope record.