Geophysical Research Abstracts
Vol. 15, EGU2013-6847, 2013
EGU General Assembly 2013

Continuous water vapor isotopic composition observations in the sub-tropical North Atlantic (Bermuda)

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We installed an autonomous continuous water vapor isotope monitoring station in Bermuda (Tudor Hill) (32.26 N 64.86 W) in November 2011 with the aim of understanding the processes of the marine atmospheric boundary layer giving rise to the isotope fingerprint in the water vapor. Similarly we installed a station running in parallel on the south coast of Iceland (63.83 N 21.47W) with the aim of studying moisture advection processes between the two stations.

The isotope monitoring station in Bermuda consists of a Picarro Inc. water vapor isotope analyzer together with an autonomous calibration system, which allows for unmanned operation periods of several months. The system automatically performs calibration every 6 hours, which results in high accuracy and precision allowing for analysis of the d-excess in the water vapor.

We present comparison between our observed high-resolution isotopic composition record and nudged simulations using three isotope-enabled atmosphere general circulation models (AGCM), ECHAM5-wiso, LMDZiso and isoGCM. This allows for a direct validation of the isotopic simulation in the AGCM. We find that there is good agreement between the observed and modeled variations in absolute humidity and d18O. This gives us confidence in the models providing a correct representation of the large-scale atmospheric circulation pattern. However, the nudged simulations are not able to reproduce the same observed magnitude of the d-excess variation. We interpret this as a misrepresentation of marine atmosphere boundary layer physical processes.

The continuous monitoring of the water vapor isotopic composition makes it possible to have high resolution observations of the isotope fingerprint for different air masses: we observe d-excess variations from 0 o/oo to 30 o/oo occurring in a few hours as cold fronts pass over the site.

Merlivat and Jouzel [1979] described how the d-excess in the marine atmosphere boundary water vapor should depend on the relative humidity. Despite this assumption being crucial in isotopic modeling this has not been extensively tested until now and never at such a high frequency. Our high-frequency isotope measurements support this assumption albeit with minor caveats.