Geophysical Research Abstracts, Vol. 9, 00816, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-00816

Predicting the isotopic ratio of western European Precipitation using an isotope trajectory model

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Spatial and seasonal variations of isotopic ratios in precipitation across Western Europe are well documented. Locations of moisture uptake, transport pathways, condensation temperatures, and surface temperatures at source region and precipitation location all influence the water isotope cycle. Isotope cycle modelling has been included in Global Circulation Models (GCMs) in order to model all of the controlling factors. However, the relative importance of each of these processes remains unclear due to the difficulties in decoupling these processes in GCMs.

A combination of a Lagrangian Particle Dispersion Model and an extended Rayleigh distillation theory model allows the effects of different atmospheric processes on isotopic fractionation to be investigated. This method has previously been used to model precipitation in Antarctica and Greenland with excellent results. However, there are added complications involved when modelling rainfall rather than snowfall, such as isotopic re-equilibration between falling raindrops and the surrounding water vapour. Lower latitude locations also experience more evaporation and re-evaporation along the path of a moist air parcel, increasing opportunities for fractionation.

These models have been used to predict the hydrogen and oxygen isotope ratios of rainfall in the U.K and Ireland. The model results have been compared with measured isotopic data from daily rainfall samples in order to test how the modelled processes interact. A case study is presented which incorporates observed data collected throughout November 2005 at stations in Norwich, Birmingham and Dublin, together with the corresponding temporal model predictions at these localities.