Geophysical Research Abstracts
Vol. 17, EGU2015-13497, 2015
EGU General Assembly 2015

Simulating the budget and distribution of $\Delta^{17}O$ in CO_2 with a global atmosphere-biosphere model

Wouter Peters (1,2), Linda Schneider (1), Magdalena E.G. Hofmann (3), Ivar van der Velde (1), and Thomas Röckmann (3)

(1) Wageningen University, Dept. of Meteorology and Air Quality, Netherlands (wouter.peters@wur.nl), (2) University of Groningen, Center for Isotope Research, The Netherlands, (3) University of Utrecht, Institute for Marine and Atmospheric Research, The Netherlands

The isotope ratios of ^{16}O, ^{17}O and ^{18}O in CO_2 are referred to as the triple-oxygen isotope composition of CO_2, and have long held promise to better understand terrestrial carbon cycling. However, measurement precision as well as an incomplete understanding of fractionation during equilibrium exchange and diffusion of CO_2 have been a challenge, especially for the estimation of gross primary production (GPP) and respiration from measured $\delta^{17}O$ and $\delta^{18}O$ isotope ratios in CO_2. The excess-^{17}O in CO_2 ($\Delta^{17}O$), defined as the deviation of the $\delta^{17}O$ and $\delta^{18}O$ ratios from an expected mass-dependent fractionation line, is in principle easier to interpret as many processes that simultaneously affect $\delta^{17}O$ and $\delta^{18}O$ are not reflected in $\Delta^{17}O$. Two global box model simulations suggest that atmospheric $\Delta^{17}O$ is therefore mostly determined by transport of relatively $\delta^{17}O$ enriched CO_2 from the stratosphere, and its equilibration in leaf-water back to an excess of close to zero, following diffusion as part of photosynthetic CO_2 uptake by vegetation. This makes $\Delta^{17}O$ an interesting tracer for photosynthesis at the global scale, and the first decadal time series have recently been published that indeed suggest strong GPP-driven variations in atmospheric $\Delta^{17}O$. In this study, we expand the modeling of $\Delta^{17}O$ beyond the current two global box model results published by explicitly simulating the global atmospheric $\Delta^{17}O$ distribution over a five year period. We specifically are interested whether regional gradients in $\Delta^{17}O$ in areas with large GPP such as Amazonia leave an imprint on $\Delta^{17}O$ that can be measured with the rapidly improving measurement precision (10-40 permeg currently). Therefore, we used the SIBCASA biosphere model at 1x1 degrees globally to simulate hourly fluxes of $\Delta^{17}O$ into and out of C3 and C4 vegetation as well as soils. These fluxes were then fed into the TM5 atmospheric transport model at 6x4 degrees horizontal resolution to simulate the hourly spatial gradients in $\Delta^{17}O$ all over the globe. Our results suggest that there are indeed strong regional signatures of biospheric uptake in atmospheric $\Delta^{17}O$ that could be measured at the current precision. These signals are formed by the seasonal GPP of the biosphere as well as by the seasonal transport of stratospheric $\Delta^{17}O$, in addition to spatial gradients in areas with high GPP. We will explain our modeling capacity, demonstrate these signatures, and make a first attempt to compare our model to observed $\Delta^{17}O$ in this presentation.