The oxygen isotope excess $\Delta(^{17}O)$ of marine nitrous oxide

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The small ^{17}O isotope excess $\Delta(^{17}O)$ of atmospheric nitrous oxide (N_2O) of (0.9±0.1) ‰ (vs. VSMOW) is regarded to be mainly a result of chemical in-situ production in the troposphere and the stratosphere. These mechanisms only have a negligible contribution to the global N_2O mass budget, but do significantly affect the ^{17}O excess of atmospheric N_2O because of the high ^{17}O excess of the species involved (NO_y, O_3).

However, Kaiser *et al.* (2004) suggested that the main biological N_2O sources (denitrification, nitrification) can also have an influence on the $\Delta(^{17}O)$ value of atmospheric N_2O. Therefore, soils and ocean should also be considered as a source of the ^{17}O excess in atmospheric N_2O.

We present depth-resolved measurements of the ^{17}O excess in dissolved N_2O from the Atlantic Ocean, the Scotia Sea and the Weddell Sea. In the temperate, subtropical and tropical surface Atlantic Ocean, we observed $\Delta(^{17}O)$ values of up to 1.5 ‰ relative to N_20 in air. Values above the tropospheric mean value of 0.9 ‰ were observed down to 300 m depth. This means that oceanic N_2O from these regions contributes to the atmospheric ^{17}O excess. In polar regions and in the deep Atlantic Ocean, the isotope excess was between 0 and 0.9 ‰. Irrespective of the oceanic net N_2O mass flux, this would lead to a net reduction of the atmospheric ^{17}O excess.

These results show that oceanic N_2O emissions need to be taken into account for tropospheric N_2O isotope budget calculations. However, further measurements in other ocean regions are needed before the net effect of oceanic N_2O on the ^{17}O excess can be established.

A 100% renewable power system in Europe – let the weather decide!

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Todays overall macro energy system based on fossil and nuclear resources will transform into a future system dominantly relying on fluctuating renewable resources. At the moment it is not really clear what will be the best transitional pathway between the current and the future energy system. In this respect it makes sense to think backwards, which means in a first step to get a good functional understanding of fully renewable energy systems and then in a second step bridge from there to todays energy system. Based on state-of-the-art high-resolution meteorological and electrical load data, simple spatio-temporal modelling, time-series analysis and the physics of complex networks, fundamental properties of a fully renewable pan-European power system are determined. Amongst such characteristics are the optimal mix of wind and solar power generation, the optimal combination of storage and balancing, the optimal extension of the transmission network, as well as the optimal ramp down of fossil and nuclear power generation during the transitional phase. These results indicate that the pathways into future energy systems will be driven by an optimal systemic combination of technologies, and that economy and markets have to follow technology

DOI:10.1180/minmag.2013.077.5.7