

Isotopic signatures of production and uptake of H₂ by soil

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Molecular hydrogen (H₂) is the second most abundant reduced trace gas in the atmosphere, but its biogeochemical cycle is not well understood. Our study focuses on the soil production and uptake of H₂ and the associated isotope effects. Air samples from a grass field and a forest site in the Netherlands were collected using soil chambers. The H₂ mole fraction and deuterium content were measured in the laboratory to determine the isotopic fractionation factor during H₂ soil uptake (α_{soil}) and the isotopic signature of H₂ that is simultaneously emitted from the soil (δD_{soil}). The results show that uptake and emission of H₂ occurred simultaneously at all sampling sites, with strongest emission at the grassland sites where clover (N₂ fixing legume) was present. Considering all the net-uptake experiments, an overall fractionation factor for deposition of $\alpha_{\text{soil,true}} = 0.945 \pm 0.004$ (95% CI) was obtained. When the data are evaluated with a model of simultaneous production and uptake, the isotopic composition of H₂ that is emitted at the grassland site is calculated as $\delta D_{\text{soil,true}} = (-530 \pm 38) \text{‰}$. This is less deuterium-depleted than what is expected from isotope equilibrium between H₂O and H₂.