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The overwhelming role of soils in the global atmospheric hydrogen cycle

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Abstract. The removal of molecular hydrogen (H_2) from the atmosphere is dominated by the uptake in soils. Notwithstanding, estimates of the magnitude of this important process on a global scale are highly uncertain. The CARIBIC aircraft observations of the seasonal variations of H_2 and its D/H isotopic ratio in the Northern Hemisphere allow an independent, better constrained estimate. We derive that 82% of the annual turnover of tropospheric H_2 is due to soil uptake, equaling 88 (±11)Tg a^{-1}, of which the Northern Hemisphere alone accounts for 62 (±10)Tg a^{-1}. Our calculations further show that tropospheric H_2 has a lifetime of only 1.4 (±0.2) years – significantly shorter than the recent estimate of ~2 years – which is expected to decrease in the future. In addition, our independent top-down approach, confined by the global and hemispheric sinks of H_2, indicates 64 (±12)Tg a^{-1} emissions from various sources of volatile organic compounds by photochemical oxidation in the atmosphere. This estimate is as much as up to 60% larger than the previous estimates. This large airborne production of H_2 helps to explain the fairly homogeneous distribution of H_2 in the troposphere.

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