Extreme deuterium enrichment in stratospheric hydrogen and the global atmospheric budget of H-2

Rahn T, Eiler JM, Boering KA, Wennberg PO, McCarthy MC, Tyler S, Schauffler S, Donnelly S, Atlas E

NATURE
424 (6951): 918-921 AUG 21 2003

Abstract:
Molecular hydrogen (H-2) is the second most abundant trace gas in the atmosphere after methane(1) (CH4). In the troposphere, the D/H ratio of H-2 is enriched by 120parts per thousand relative to the world's oceans(2-4). This cannot be explained by the sources of H-2 for which the D/H ratio has been measured to date (for example, fossil fuels and biomass burning)(5,6). But the isotopic composition of H-2 from its single largest source-the photochemical oxidation of methane-has yet to be determined. Here we show that the D/H ratio of stratospheric H-2 develops enrichments greater than 440parts per thousand, the most extreme D/H enrichment observed in a terrestrial material. We estimate the D/H ratio of H-2 produced from CH4 in the stratosphere, where production is isolated from the influences of non-photochemical sources and sinks, showing that the chain of reactions producing H-2 from CH4 concentrates D in the product H-2. This enrichment, which we estimate is similar on a global average in the troposphere, contributes substantially to the D/H ratio of tropospheric H-2.

KeyWords Plus:
LIQUEFIED PETROLEUM GAS, MOLECULAR-HYDROGEN, ISOTOPIC COMPOSITION, RATE COEFFICIENTS, AIR-QUALITY, TROPOSPHERE, METEORITES, TRITIUM, LEAKAGE, CARBON

Addresses:
Rahn T, Los Alamos Natl Lab, EES-6,MS-D462, Los Alamos, NM 87545 USA
CALTECH, Div Engn & Appl Sci, Pasadena, CA 91125 USA
Univ Calif Berkeley, Dept Chem, Berkeley, CA 94720 USA
Univ Calif Berkeley, Dept Earth & Planetary Sci, Berkeley, CA 94720 USA
Univ Calif Irvine, Earth Syst Sci Dept, Irvine, CA 92697 USA
Natl Ctr Atmospher Res, Boulder, CO 80307 USA
CALTECH, Div Geol & Planetary Sci, Pasadena, CA 91125 USA

Publisher:
NATURE PUBLISHING GROUP, MACMILLAN BUILDING, 4 CRINAN ST, LONDON N1 9XW, ENGLAND

IDS Number:
713EH

ISSN:
0028-0836