Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19733

Ultra-sensitive Water Isotope Spectrometer for Atmospheric Measurements on-board a Passenger Airplane

MARKUS MILTNER[1,2,3], TIM STOLTMANN[2], KÉVIN JAULIN[2], DANIELE ROMANINI[1], HARALD BÖNISCH[3], ANDREAS ZAHN[3] AND ERIK KERSTEL[1]

[1]LIPHY
[2]AP2E
[3]IMK-ASF (KIT)

Presenting Author: markus.miltner@univ-grenoble-alpes.fr

Water is arguably the most important molecule in Earth's atmosphere. It plays a dominant role in the global redistribution of energy by tropospheric transport of latent heat. Water vapor is also the most important greenhouse gas and, in the form of clouds, water represents the major uncertainty in today's climate models. The reason for this uncertainty is the complexity of the feedback processes in which water is involved. A promising candidate to help disentangle and quantify these processes is the isotopic composition of water, since all involved processes are isotope-dependent. The isotope ratios D/H and $^{18}O/^{16}O$ enable identification of different moist air masses and the following of their mixing. They also reflect their evaporation and condensation history. Due to the lack of instrumentation that is capable of detecting the isotope changes in the cold and thus increasingly dry free atmosphere and the lack of an instrument carrier (an aircraft) that regularly samples the atmosphere, practically no in-situ data on water isotope ratios are available. The new CARIBIC H2O ISotope Analyzer (CHISA) will help fill this gap. This IR spectrometer is based on the Optical Feedback Cavity Enhanced Absorption Spectroscopy method that has already proven its capacity to make similar measurements [1]. To facilitate the data interpretation, we will make two measurements in parallel: the isotopic composition of the total water and the isotopic composition of the vapor phase only. To assure regular sampling, we use passenger aircraft within the framework of IAGOS CARIBIC. CARIBIC converts a freight container into a flying high-tech chemical laboratory measuring over 100 atmospheric parameters. This container will be installed on a Lufthansa A350 passenger airplane for several consecutive long-haul flights once every month. We present the laboratory performance of the new spectrometer, notably its response time, precision, and stability.

[1] R. Q. IANNONE, D. ROMANINI, O. CATTANI, H. A. J. MEIJER, and E. KERSTEL, «Water Isotope Ratio (d2H and d18O) Measurements in Atmospheric Moisture Using an Optical Feedback Cavity Enhanced Absorption Laser Spectrometer», Journal of Geophysical Research 115 (D10): 1–12 (2010)