Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Impact Factor 4.865
ISI indexed
ARCHIVED IN PORTICO

Atmos. Chem. Phys., 3, 651-663, 2003
www.atmos-chem-phys.net/3/651/2003/
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A fast H_2O total column density product from GOME – Validation with in-situ aircraft measurements

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Abstract. Atmospheric water vapour is the most important greenhouse gas which is responsible for about 2/3 of the natural greenhouse effect, therefore changes in atmospheric water vapour in a changing climate (the water vapour feedback) is subject to intense debate. H_2O is also involved in many important reaction cycles of atmospheric chemistry, e.g. in the production of the OH radical. Thus, long time series of global H_2O data are highly required. Since 1995 the Global Ozone Monitoring Experiment (GOME) continuously observes atmospheric trace gases. In particular it has been demonstrated that GOME as a nadir looking UV/vis-instrument is sensitive to many tropospheric trace gases. Here we present a new, fast H_2O algorithm for the retrieval of vertical column densities from GOME measurements. In contrast to existing H_2O retrieval algorithms it does not depend on additional information like e.g. the climatic zone, aerosol content or ground albedo. It includes an internal cloud-, aerosol-, and albedo correction which is based on simultaneous observations of the oxygen dimer O_4. From sensitivity studies using atmospheric radiative modelling we conclude that our H_2O retrieval overestimates the true atmospheric H_2O vertical column density (VCD) by about 4% for clear sky observations in the tropics and sub-tropics, while it can lead to an underestimation of up to -18% in polar regions. For measurements over (partly) cloud covered ground pixels, however, the true atmospheric H_2O VCD might be in general systematically underestimated. We compared the GOME H_2O VCDs to ECMWF model data over one whole GOME orbit (extending from the Arctic to the Antarctic) including also totally cloud covered measurements. The correlation of the GOME observations and the model data yield the following results: a slope of 0.96 (r^2 = 0.86) and an average bias of 5%. Even for measurements with large cloud fractions between 50% and 100% an average underestimation of only -18% was found. This high accuracy of our GOME H_2O data is also confirmed by the excellent agreement with in-situ aircraft measurements during the MINOS campaign in Greece in summer 2001 (slope of 0.97 (r^2 = 0.86), and an average bias of only 0.2%). Our H_2O algorithm can be directly adapted to the nadir observations of SCIAMACHY (SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY) which was launched on ENVISAT in March 2002. Near real time H_2O column data from GOME and SCIAMACHY might be of great value for meteorological weather forecast.

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Final Revised Paper (PDF, 4006 KB) Discussion Paper (ACPD)

Citation: Wagner, T., Heland, J., Zöger, M., and Platt, U.: A fast H_2O total column density product from GOME – Validation with in-situ aircraft measurements, Atmos. Chem. Phys., 3, 651-663, 2003. Bibtex EndNote Reference Manager