Microwave Measurements of Middle Atmospheric Water Vapor From Mauna Loa, 1996-2000

GERALD E. NEDOLUHA, RICHARD M. BEVILACQUA, R. MICHAEL GOMEZ, AND BRIAN C. HICKS
Naval Research Laboratory, Code 7227, Washington, D.C. 20375-5320

INTRODUCTION

Measurements have been taken of middle atmospheric water vapor at Mauna Loa, Hawaii (19.5°N, 204.4°E) since March 1996. These measurements are taken at 22 GHz using the Naval Research Laboratory Water Vapor Millimeter-wave Spectrometer (WVMS). Because of the relatively small seasonal variations, combined with the small tropospheric water vapor signal, Mauna Loa is an ideal site for the monitoring of long term changes in middle atmospheric water vapor.

Measurements of water vapor provide important information on several processes in the middle atmosphere. Water vapor is an ideal transport tracer and has been used in numerous studies of atmospheric transport in the middle atmosphere [e.g., *Bevilacqua et al.,* 1990; *Nedoluha et al.,* 1996; *Summers et al.,* 1997]. Water vapor is also the reservoir of odd hydrogen in the middle atmosphere, and is, therefore, important to ozone chemistry. Variations in humidity in the middle atmosphere, therefore, have implications for variations in ozone [*Siskind and Summers,* 1998]. Changes in middle atmospheric water vapor may also impact stratospheric temperatures and thus indirectly affect ozone depletion [*Kirk-Davidoff et al.*, 1999].

WVMS MEASUREMENTS

The WVMS instrument deployed at Mauna Loa is the third such instrument to be deployed. It is essentially identical to the WVMS2 instrument that operated at the Network for the Detection of Stratospheric Change (NDSC) site at Table Mountain, California (34.4°N, 242.3°E) from August 1993 to November 1997. These instruments are both very similar to the WVMS1 instrument that is taking measurements at the NDSC site at Lauder, New Zealand (45.0°S, 169.7°E).

The retrieval of a vertical water vapor profile with ground-based microwave measurements relies upon the change in pressure as a function of altitude. The line width of the spectrum monotonically decreases with altitude because of the dependence on pressure broadening. Thus the resultant signal, which is the sum of the emission from all altitudes, can be deconvolved to retrieve a vertical profile. Details of the measurement technique and instrumentation are given by *Nedoluha et al.* [1995, 1996].

Nedoluha et al. [1999] compared the WVMS3 instrument at Mauna Loa with Halogen Occultation Experiment (HALOE). Once differences in resolution are taken into account, the average difference is <10% at almost all altitudes between 40 and 80 km. The only exception is a small range near 60 km where the average HALOE measurements show an unexpected local minimum in mixing ratio. The differences between the measurements taken at Mauna Loa and Table Mountain in 1996 and 1997 were generally consistent with the latitudinal difference in water vapor measured by HALOE. In particular, the shape of the difference profile between the two WVMS sites was very similar to the shape of the difference profile for the HALOE measurements at these latitudes between 40 and 70 km.

In Figure 1 the mixing ratios retrieved from 40 to 80 km using 500 scan (~1 week) integrations are shown. There is a summer peak in the upper mesospheric mixing ratio consistent with the upward motion of the atmosphere in the Mountain or Lauder [cf. *Nedoluha et al.*, 1997]. There is no sign of the positive trend in water vapor that was observed by the WVMS instruments and by HALOE in the early 1990s [*Nedoluha et al.*, 1998]. There is a suggestion of a very slight negative trend since 1996, a result that is qualitatively consistent with the global variation in stratospheric water vapor observed during this period by HALOE [*Randel et al.*, 1999].

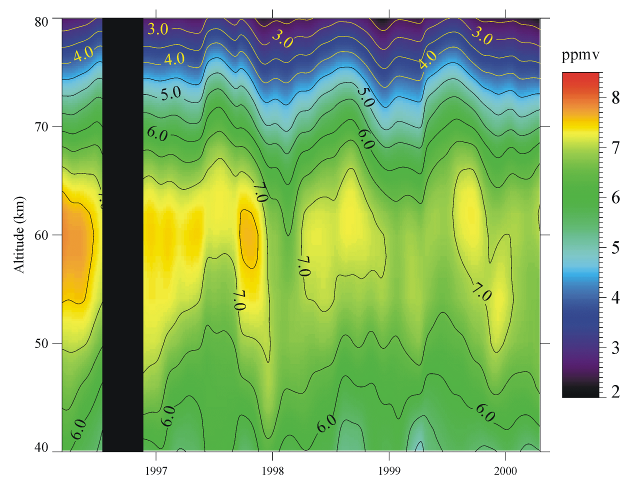

Fig. 1. Weekly integrated spectra of water vapor mixing ratios retrieved from WVMS3 measurements at Mauna Loa. The data are smoothed using a Gaussian filter with a (1/e) width of 25 days.

Acknowledgments. We wish to thank S. McDermid, Rich Cageao, and D. Walsh for their technical assistance with the Mauna Loa radiometer. This project is funded by NASA under the Upper Atmospheric Research Program.

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