Mesospheric water vapor and D/H ratio at the Venus terminator from SOIR/VEx

Arnaud Mahieux$^{1,2,3}$, Ann Carine Vandaele$^1$, Sarah Chamberlain$^1$, Valérie Wilquet$^1$, Séverine Robert$^1$, Arianna Piccialli$^1$, Ian Thomas$^1$, and Loic Trompet$^1$

$^1$IASB - BIRA, Planetary Atmosphere, Brussels, Belgium (arnaud.mahieux@aeronomie.be)
$^2$Fonds National de la Recherche Scientifique, Brussels, Belgium
$^3$The University of Texas at Austin, Austin, Texas, USA

The Solar Occultation in the InfraRed (SOIR) instrument onboard Venus Express sounded the Venus mesosphere and lower thermosphere at the terminator using solar occultation technique between April 2006 and December 2014.

We report on the water vapor vertical distribution above the clouds and geo-temporal variations, observed during the full Venus Express mission. Water vapor profiles are sampled between 80 and 120 km, and calculations of the water vapor volume mixing ratio agrees with those from previous studies. Short term variations over several Earth days dominate the data set, with densities varying by up to a factor 19 over a 24 hr period. Similarly to what was found for other trace gases detected with the SOIR instrument, such as HCl, HF and SO$_2$, no significant spatial or long term trends are observed.

287 water vapor vertical profiles obtained at the Venus terminator between 80 km and 120 km from August 2006 and September 2014 were analyzed for temporal and spatial abundance variations. Standard deviations are significantly smaller than the full range of volume mixing ratio values at all altitudes indicating that the variations are real.

The decrease in volume mixing ratio abundance below 100 km appears to be a common feature of most water vapor volume mixing ratio profiles and agrees with the decrease in water vapor reported in previous studies. Based on a very limited number of spectra, the variability of the water vapor VMR was found to be higher in the lower than in the upper mesosphere of Venus; this is in agreement with our observations as the standard deviation of the SOIR mean profile is the smallest at 100 km and increases with decreasing altitude.

No significant spatial variations or long term temporal variations are observed in the present data set in which short term variability masks all other possible trends. Our observations agree that short term (between 1 and 10 Earth days) variability is dominant.

We also report on simultaneous observations of the water first isotopologue HDO made by SOIR, which occurred 194 times during the whole VEx mission. Similarly to water vapor, we observe a
large variation of HDO with time and space, without any clear time of spatial dependency.

We report on the ratio of the simultaneously measured HDO and H$_2$O profiles, that show a constant ratio of 0.1 ± 0.1 below 100 km, and increase exponentially at higher altitude to reach a value of 1 ± 0.4 at 120 km of altitude. The results are in agreement with previous works below 100 km.