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A modified density model of the Venus atmosphere at 130-200 km altitude

Håkan Svedhem (1), Ingo Mueller-Wodarg (2), Pascal Rosenblatt (3), and Emmanuel Grotheer (1)

(1) ESA/ESTEC, Noordwijk, Netherlands (H.Svedhem@esa.int, +31 71 56-54697), (2) Imperial College, London, UK, (3) Royal Observatory of Belgium, Brussels, Belgium

Until recently the only information on the structure of the polar upper atmosphere of Venus available has been based on the reference atmosphere models such as the VTS3 or VIRA models. These models extrapolate the values from low latitudes to high latitudes by using equivalent solar zenith angles. New measurements by Venus Express show that such extrapolations not always give correct results and that there is a permanent overestimate of the density at high latitudes.

These new results have been reached by using two different but related techniques, both using an atmospheric drag effect on the spacecraft. By reducing the pericentre altitude the total mass density in the altitude range 150-200km can be measured in situ by monitoring the orbital decay caused by the drag on the spacecraft by the atmosphere via direct tracking of the Doppler signal on the telecommunication link. Such measurements have been performed with Venus Express several times during the last years as part of the Venus Express Atmospheric Drag Experiment (VExADE). The results indicate a large variability within only a few days and have led to questions if these variations are real or within the uncertainty of the measurements. A completely different and independent measurement is given by monitoring the torque asserted by the atmosphere on the spacecraft. This is done by monitoring the momentum accumulated in the reaction wheels during the pericenter pass and at the same time considering all other perturbing forces. This requires the spacecraft to fly in an asymmetric configuration with respect to the center of gravity, center of drag and the velocity vector. This technique has proven very sensitive, in particular if the geometric asymmetry is large, and offers an additional method of measuring atmospheric densities in-situ that previously had not been explored with the Venus Express spacecraft. Similar measurements have been done in the past by Magellan at Venus and by Cassini at Titan. Between 2009 and 2013 several campaigns, with altitudes going as low as 165 km, were held. The highest density measured was 1.3 10-11kg/m3 which is significantly less than earlier models predict. The results largely confirm the density measurements by the VExADE drag measurements and add to the confidence in the results from these measurements. By using these drag and torque results and assuming a hydrostatic diffusive equilibrium atmosphere a new model has been constructed.