Comments on the AMTD manuscript entitled "Observation of the exhaust plume from the space shuttle main engine using the Microwave Limb Sounder" by Hugh C. Pumphrey, Alyn Lambert and Nathaniel J. Livesey

The present paper describes the detection of water vapour exhaust plume released from Space Shuttle main engines based on Aura/MLS observations of the 183 GHz water vapour emission line. The manuscript is interestingly written and I recommend it for publication after addressing some comments which are listed below in chronological order of their occurrence.

- page 3972

- line 15: "...mesopause regions of the..." - It's more a philosophical thing. Do we have one mesopause region or several?

- lines 15 - 16: "...up to 7 ppmv: enough to condense..." - 7 ppmv is a much too high concentration here. At the altitudes where the formation of ice particles starts you will definitely not find 7 ppmv. See for example Hervig et al. (JASTP 2009). Somehow one might also get the feeling that the concentration statement is related to the sentence in line 14 and 15 about H_2O being a important constituent in the upper mesosphere and mesopause region. In the polar summer you might have up to 7 ppmv at 75 km, even more in the redistribution peak caused by the sublimating ice particles when they encounter warmer temperatures around 80 km. But in the rest of the named region the water vapour concentrations are definitely smaller than 7 ppmv.

- line 23: "...down from the lower thermosphere..." - The dry air is brought down within the polar vortex which ends somewhere in the altitude range between 80 km and 90 km. This is still in the mesosphere. Above measurements indicate actually an upwelling in the polar winter within a higher located circulation cell. See Lossow et al. (JGR 2009).

- line 24: "...near the mesopause response strongly to the 11-year solar cycle" - Of course I agree with that, but using Remsberg et al. (JGR 2009) to validate that statement is rather a bad choice. The analysis by those authors is based on UARS/HALOE in the latitude range between 45°S and 45°N up to an altitude of about 80 km. This I would not even consider as upper mesosphere given a stratopause altitude of 50 km and a mesopause altitude of 100 km. Maybe Sonnemann and Grygalashvyly (JASTP 2004) might a better choice, even though this model work. To my knowledge nobody has so far addressed the solar cycle signal in water vapour close to the mesopause based on measurements.

- page 3973

  - line 7: "...is a direct result of the increase in CO_2 and/or CH_4..." - First of all it is worth to point out that CO_2 is the main cooling agent in the NLC area, likewise methane the main source of H_2O in the middle atmosphere. Still I think some caution or a more thorough discussion is required at this point. Of course cooler conditions and more water vapour favour the formation of any cloud type. With respect to NLC, model simulations with doubled CO_2 concentrations showed little or even positive temperature changes due to dynamical adjustments in response to the initial cooling by CO_2 (see for example Schmidt et al., JC 2006 or Fomichev et al., JC 2007). Lübken et al. (JGR 2009) presented a model study which was able to reproduce the observed NLC trends, however CO_2, O_3 and CH_4 were kept constant. On the other they were nudging ECMWF data up to the middle stratosphere into the model run, so some trend information might have slipped through.

  - lines 27 - 28: This sentence is misleading as it implies that for example an imager or an solar occultation type of instrument could not observe the water vapour plume.

- page 3974

  - line 9: MAF and MAF appears to be an MLS thing, at least I have not heard of something like that from any other satellite instrument. Maybe it is more convenient for the reader just to consider the "limb scan" as a whole and individual "tangent altitudes" where spectra taken. This is a more familiar vocabulary.

  - line 13: Looking at figure 2 I get the impression that the scan at tangent altitude separation is even better than 3 km, which is good!

  - line 15: I gather that the FOV is 8 km wide, but what is it in the vertical?

- page 3977

  - lines 2 - 5: The plume detections in polar summer need more discussion. Typically one would expect low water vapour concentrations at the tangent heights considered here as those are in the region where ice particles form and consume the ambient water vapour. So the influx from below should not a play role. Between 90 km and 95 km the vertical wind direction changes sign in the polar summer lower thermosphere. Above downwelling conditions prevail accompanied by a meridional circulation from the winter to the summer pole. This circulation cell could bring the water vapour deposited by the Space Shuttles off the US east coast towards polar latitudes where the air masses descend. So this sounds reasonable to me. However looking at figure 5 these plume detections appear to be a consistent polar summer phenomenon,

occurring even before or long after some Space Shuttle launches. Could that be due other space traffic? Is it any idea to add the Ariane and Proton launches to figure 5 as well?

- lines 15 - 17: "...conclude that SABER has a better sensitivity" - One important argument to consider here is that SABER scans to much higher altitudes than MLS does. This makes it easier to detect plumes from the Ariane or Proton spacecrafts that ascend more steeply and release the water vapour in not such a confined altitude region as the Space Shuttles do.