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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A global climatology of the mesospheric sodium layer from GOMOS data during the 2002–2008 period" *by* D. Fussen et al.

Anonymous Referee #2

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This paper describes the use of 7 years of stellar occultation measurements by the GOMOS instrument to measure the density of the atomic Na layer in the upper mesosphere. The retrieved profiles compare satisfactorily with a climatology of the Na layer measured by a lidar at Colorado State (39 degrees N). The authors then go on to smooth the data using an expression containing annual, semi-annual and latitudinal terms, from which their climatology is derived.

The first referee has raised some detailed questions regarding the measurement of very narrow absorption features compared with the resolution of the GOMOS instrument, and the particular problem of Fraunhofer structure in the stellar emission. These are valid points which require a response. The scale of the problem can be seen from the fact that the "effective" absorption cross section which is employed in the retrieval,

2.2e-14 cm2, is 500 times smaller than the cross section of the D2 line of Na at its peak. I am confused by one aspect of the fitting procedure: is the D2/D1 ratio fitted in some way? It is first mentioned when discussing Fig. 6, where it seems to be quite variable.

Nevertheless, the analysis procedure seems to work, and so I wish to comment on the results. The authors acknowledge that the Na layer is highly variable, but they have to average so many spectra to get a usable signal-to-noise that much of this (interesting) variability is lost. For instance, we are told that GOMOS makes measurements during night AND day (though there is a scattered light problem), but there is NO discussion of the diurnal variability of the layer. Are all the data presented in the paper diurnal averages? Also, what about the local time of the measurements? Tides play a very important role in this part of the atmosphere. For instance, the OSIRIS study of Fan et al. (ACP) showed a very large tidal effect on the Na layer at low latitudes.

Another time-varying factor that is not mentioned at all in the paper is the solar cycle. This causes well known changes to the minor species (O3, O, H etc.) and temperature, all of which affect Na chemistry. For instance, the lower panel of Fig. 10 in the paper shows a decrease in O3 towards solar minimum. The authors compare an average 7-year data-set with a 2-year data-set from OSIRIS, and lidar data which was taken for a decade ending 4 years before the GOMOS data begins! Discussion of solar cycle effects is a serious omission.

The smoothing function (eqn.8) averages 7 years of data to produce a single latitude/month variation. Comparison of the top and bottom panels in Fig. 9 raises some questions. How was the -80 to -90 box smoothed, when there are hardly any measurements? Simiarly, at high northern latitudes the data is sparse, but the smoothing seems to have produced averages that don't match the observations of more than 7e9 cm-2.

At the bottom of p. 6104 is a statement that Na absorption is still detectable when

PMCs are present, and that this calls into question whether the ice clouds nucleate on meteoric material. There are two points here. First, PMCs are very narrow layers with limited spatial extent. How can the authors be sure that they are observing Na and PMCs in the same air mass, not simply averaging along very long slant columns? The second point is that once PMCs have nucleated, meteoric ablation continues. So the observed removal of Na, Fe and K on ice clouds means that the rate of uptake must be faster than replenishment from ablation. The uptake coefficients have been measured in the lab, and lidar measurements of clouds and metals simultaneously have confirmed that the removal takes place - for all three metals. The authors should cite some of the papers involved.

This last point is also important in the discussion on page 6109 and 6111. Gardner et al. (JGR 2005) showed that removal on PMCs is required to model the summertime Fe and Na layers over South Pole. Furthermore, they have shown that convergence and descent of upper mesospheric air in the Antarctic polar vortex is essential to explain - using a model including vertical transport from a 2D GCM (so the statement on page 6111, line 23 is incorrect) - the wintertime Na and Fe layers.

The discussion on page 6108 about the correlation between O3 and Na is incomplete. O3 oxidizes Na, so at first glance an anti-correlation might be expected. Clearly, meridional transport is an important factor, but the situation is quite complex. Why plot the O3 column between 80 and 100 km? Why not the O3 concentration at the peak of the Na layer?

Minor points:

p. 6098, line 21. Meteorites are stones found on the ground. Meteoroids are particles entering the atmosphere.

p. 6099, line 16. Substitute "In brief, ..." for "Shortly"

p. 6101, line 18. split into

p. 6105, line 2. does not exist

Figure 8 - please put tick marks on to show the beginning and end of each month

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 6097, 2010.