

## ***Interactive comment on “Satellite measurements of the global mesospheric sodium layer” by Z. Y. Fan et al.***

**Z. Y. Fan et al.**

Received and published: 18 July 2007

We thank the referees for their positive response to the paper, and their useful comments. We have revised the paper to take these into account. Our responses to each referee are listed below. The referee’s comments are shown in single quotation marks. Where we indicate changes that have been made in the revised paper, double quotation marks are used.

Referee #1:

1. ‘The full width at half maximum (FWHM) of the Na layer is smaller in September than in March at all latitudes (Figure 4), but the total column density in Fig. 1 does not show this pattern.’

We thank the referee (and Referee #3) for pointing this out. In fact, the version of Figure

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

4 that was included in the ACPD submission was an incorrect one, which did not match the discussion on page 5421. We apologise for causing the resulting confusion to the referees.

'I suggest that Fig. 4 also gives the distribution of the peak density.'

This is a very sensible suggestion, which we have incorporated into the correct version of Figure 4 as a new middle panel. We have now added the following discussion on page 5421, line 29: "A comparison of the FWHM and peak density in the top and middle panels of Figure 4, respectively, shows that these parameters are not strongly correlated (as might have been expected). For example, the highest peak densities occur at the autumn equinox above 40o in both hemispheres, when the layer is actually quite narrow. Moreover, the Na layer tends to be broad at low latitudes (below 40o) with a relatively small peak density."

'And in Fig. 5, the zonally-averaged Na layer in March is also given...'

We prefer not to add a further set of three panels with the March data to Fig. 5 because the results in March are pretty similar to those in September. Instead, we now state this in the revised paper, and emphasise that the strong diurnal variation occurs at the equinoxes, with the following sentences on page 5422, line 18: "A similarly significant diurnal variation at low latitudes is seen at the March equinox. In contrast, this diurnal variation becomes much smaller at the solstice (the morning column density is ~ 85% of that in the evening)."

2. 'The discussions on the modulation of the Na layer by tide'

The referee is correct that because of the constant local times at 0600 and 1800 LT of the observations, we should only be able to see the effects of the diurnal, as opposed to the semi-diurnal, tide. We have added the following on page 5422, line 15: "The most likely explanation for the strong diurnal variation seen at the equinoxes is the effect of the diurnal tide (note that because the satellite measurements are made at local times

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

that are 12 hours apart, the effect of the semi-diurnal tide would be hard to observe).”

The diurnal tide clearly dominates the diurnal changes in the Na layer shown in Fig. 5. The vertical winds plotted in Fig. 6 from the GSWM model include the combination of the diurnal and semi-diurnal tide in September; however, the diurnal tide is predicted by the model to dominate around 90 km, in accord with the effect on the Na layer. We have added the following sentence on page 5422, line 18: “Although both the diurnal and semi-diurnal tide are included in the GSWM, it is clear from Figure 6 that the diurnal tide dominates around 90 km.”

We have then added the following sentences at the end of this section (page 5423, line 17), to point out that the reverse of the tidal phase at higher latitudes is also apparent in the Na layer: “Finally, Figure 5 shows that at mid- to high latitudes ( $\sim 25^{\circ}$  -  $70^{\circ}$ ), the smaller diurnal variation of the Na layer is actually reversed from the tropics i.e. the density below 90 km is higher at 0600 LT compared with 1800 LT. This is consistent with the vertical tidal wind direction also reversing in phase between the tropics and latitudes greater than about  $20^{\circ}$ , as shown in Figure 6.”

The colour bar of figure 1 should indeed be  $\text{cm}^{-2}$ , and this is corrected in the revised version of the paper.

Clemesha (referee #2)

1. P5417 L(ine)26: The referee is correct to point out that the winter maximum at  $23^{\circ}$ S lasts for several months, as it does at South Pole. We have therefore changed this sentence to “The maximum Na layer density usually occurs in October-November in the northern hemisphere (NH), and from May to August in the southern hemisphere (SH)”

2. P5422: This is a good point about comparing the lidar measurements at  $23^{\circ}$ S with the satellite measurements. We have addressed this by first pointing out that the really significant diurnal variation at the equinox actually occurs only between  $10^{\circ}$ N and

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

15oS (Figure 5, lowest panel), and then added the following sentences at the end of the paragraph: “It is interesting to compare the diurnal variation at 23oS in the Odin data (Figure 4, lowest panel) with lidar measurements made in Brazil at this latitude. These measurements show a predominantly semi-diurnal variation with maxima at 0600 and 1800 LT (Clemesha et al., 1982). However, these lidar observations were restricted to winter, whereas the satellite measurements exhibit the relatively modest diurnal variation at 23oS during spring and autumn, and in fact show essentially no diurnal variation at the summer solstice (January).”

3. P5422 L20: Probably the most likely reason for the removal of Na below 90 km is the depletion of atomic O, which has been observed to occur at low latitudes around the equinox by the UARS satellite (as discussed on p. 5422). We agree with the referee that the phenomenon needs to be modelled properly, but this is a whole study in itself. Here we have only indicated some of the likely effects of the vertical tide, which could contribute to the depletion of the underside of the Na layer. We have added the following sentence on p. 5422: “However, these tidal effects are quite complex and a detailed chemical-dynamical model is required to understand this very interesting phenomenon properly.”

Minor points

4. P5424 L4: Changed to “Figure 8 compares month-to-month variation of  $\tilde{E}$ ” 5. P5425 L14: Changed to “the first extensive set of observations of the Na layer in the equatorial region”. 6. P5419 L11: This sentence has now been corrected to read “during winter there is strong downward transport caused by the convergence of the meridional wind at the winter pole”.

Referee #3

Minor comments

‘I do not see the increase of FWHM by more than a factor of 2 from summer to winter.’

Interactive  
Comment

The new version of Figure 4 shows that the FWHM does indeed increase by  $\sim 2$  at high latitudes, slightly less at mid-latitudes. We apologise to the referee that the incorrect version of this figure was included in the original ACPD submission (see reply to Referee #1).

'Another interesting information – the latitudinal variation of FWHM vanishes in September/October and is very small in March/April –'

The correct version of Figure 4 does not show an absence of variation in the FWHM - again we apologise for supplying an incorrect version of the Figure.

Technical comments

p 5422, line 3: corrected

p. 5422 line 18. This is a good point which we missed. We have now included the following sentence in the revised paper on page 5422, line 23: "Interestingly, the vertical wind maximum is slightly asymmetric to the south (peaking at  $\sim 50$ S), and this may correspond to the asymmetry in the Na diurnal variation which also peaks south of the equator (Figure 5, lowest panel)."

The references have now been corrected.

p. 5433, Fig. 4. The correct version of Figure 4 has the same numbers of profiles in each grid box as Figure 1.

---

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 5413, 2007.

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)