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Atmospheric
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Discussions

Interactive comment on "Imaging gravity waves in lower stratospheric AMSU-A radiances, Part 2: validation case study" *by* S. D. Eckermann et al.

S. D. Eckermann et al.

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We thank anonymous reviewer #2 for his/her generous and helpful comments on our manuscript.

To the specific points raised:

General Comment: In this validation study, we have focused in detail on one specific wave event and performed detailed NWP and forward model simulations of it for direct comparison with the AMSU-A radiance data. We just happened to choose as our case a long-wavelength large-amplitude quasi-stationary stratospheric mountain wave at a high northern latitude. Our study could just as easily have searched for and focused upon a long-wavelength large-amplitude nonstationary stratospheric gravity wave forced by deep tropical convection. As long as the gravity wave has sufficiently

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Discussion Paper

long horizontal and vertical wavelengths and sufficiently large amplitude, as defined in the Part 1 forward modeling study of *Eckermann and Wu* (2006), then it should be visible in AMSU-A radiances according to our model.

We have begun to look at AMSU-A radiance structure in the tropics a little. Initial indications are that amplitudes here are weaker. Similar reductions in Microwave Limb Sounder (MLS) radiance variances have been noted by Wu and Waters (1996) in the tropical stratosphere, and were explained, to first order, by weaker mean winds here which refract waves to shorter vertical wavelengths and thus make them harder to resolve with the broad vertical weighting functions of O_2 thermal stratospheric channels (e.g., Alexander, 1998). An additional factor may be the 50-150 km size of the AMSU-A horizontal measurement footprints, which are too broad to resolve some of the short horizontal wavelength gravity waves generated by isolated patches of deep tropical convection (Alexander et al., 2004). A further complicating factor in the tropics might also be higher tropopauses nearer $\sim$100 hPa, which have the potential to yield cloud contamination in the Channel 9 radiances (peaking at $\sim$90 hPa in the nadir), though to date, in the absence of waves, we mostly see tropical variances near nominal NEΔT (noise) limits, suggesting limited structuring of tropical radiances due to cloud contamination.

We hope to study gravity wave-induced AMSU-A radiance perturbations in the tropics more in future work. In revision, we will add a sentence of two on this topic as the reviewer suggests.

Page 2016 lines 3–10: This paper deliberately focuses on just one wave event, in order to fully define its three-dimensional (3D) structure using NWP model simulations, so that we can use that 3D wave structure to perform full 3D forward model calculations, to test and validate the idealized 3D forward model simulations of Eckermann and Wu (2006) concerning the way gravity waves manifest in Channel 9 AMSU-A radiance imagery. Our choice of this one wave should not be taken to imply that we consider this wave either special, or typical, or relating in any way to wave activity observed either

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later in 2003 or from the previous January of 2000. Our choice was motivated only by this wave's large amplitude, long wavelengths, appearance in AMSU-A radiances, and the availability of suborbital data for additional cross-validation.

Our experience is that the characteristics of gravity waves vary significantly from event to event, and thus this one event has little to say about the overall nature of mountain waves over Scandinavia. This is particularly so for gravity wave activity during winter months over Scandinavia, given the well-known interannual variability of the polar winter stratosphere and the dynamical variability of lower atmospheric polar meteorology. For more background on this issue, see Dörnbrack and Leutbecher (2001).

Page 2047 Fig. 8: We have used different color-bar scaling for the upper panels of Figure 8 to make the wave fields from each model simulation visible, so that the reader can see the similar overall horizontal wavelength structure reproduced by each model. However, the middle and lower panels of Figure 8 both profile these wave fields using identical scale ranges and contour intervals to enable cross-comparison of relative amplitude and structure differences. Thus, these middle and lower panels provide wave-field plots with identical scaling, as requested by the reviewer.

Page 2048 Fig. 9: The scale for the topographic elevations is the same pressure height scale in kilometers given on the z axis. Note this is a three-dimensional surface of topographic relief, not a two-dimensional gray-shaded contour plot.

Page 2049 Fig. 10: We cannot be entirely sure what the reviewer means when he/she states (quote) "*although balloon has drifted ... it still lies in the same contour interval at 40–50 hPa*." This statement seems to imply that the reviewer considers the differences in profiling the wind structure along a vertical and oblique ascent trajectory to be a minor effect at best. If so, we would have to disagree. We believe direct inspection of Figure 10 clearly indicates that a balloon ascending purely vertically intercepts different wind contour intervals at different altitudes than the oblique ascent trajectory, and our calculations confirm this.

The reviewer also claims a 10 m s^{-1} systematic offset between the model and radiosonde zonal wind in Figure 10. In fact, on averaging vertically through the full depth of the stratosphere to remove the gravity wave oscillation, none of the three model profiles in Figure 10a show a mean offset from the radiosonde profile of this magnitude. Instead, most of the profile-to-profile differences at any given height arise due to differences in the amplitude and phase of the wave oscillation superimposed upon the mean. Thus, any differences between model and radiosonde curves are mainly gravity wave amplitude and/or phase differences, rather than some large-scale planetary wave effect.

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