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Interactive comment on “A long-term comparison of wind and tide measurements in the upper mesosphere recorded with an imaging Doppler interferometer and SuperDARN radar at Halley, Antarctica” by R. E. Hibbins and M. J. Jarvis

Anonymous Referee #2

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General comments

This paper compares wind estimates for an altitude of 90–95 km made using two instruments that have operated at Halley Bay in Antarctica since 1996. Parameters derived from these wind estimates (mean winds, tidal amplitudes and phases) are also analysed. Care is taken to ensure the consistency of the comparison and advanced regression analysis techniques are used. However, it becomes apparent that the agreement between the two wind estimates is often very poor. This limits the utility of such a study unless some significant insight into the cause of the disagreement can be presented.

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Comments suggesting reasons for the disagreement are scattered throughout the paper but the focus remains on presenting comparisons. The paper would be greatly improved if the cause of the disagreement between the instruments became more of a focus.

Specific comments

As figures 3, 4 and 5 show, the correlation between the measurements made by the two radars is often very poor. But surprisingly (and possibly instructively) there are some parameters for which the correlation is better than others. It is argued that the differences in the correlations of the hourly data and the tides are due to different gravity wave fields being present in the two (separated) radar sampling volumes. But this does not explain the difference in the correlation for the mean winds and the two tides. Nor is the variation of the correlation through the year explained in this context. (Perhaps the gravity wave field differences at the two sampling values vary through the year?) The meaning of the word 'sensitive' in the context of P6574 L8, P6578 L17 and P6585 L13 needs to be expanded (at least). Alternately a model to explain the observations more fully should be developed. (A suggested model has been included below for discussion.)

The authors should make a clear note about the separation between the sampling volumes of the two instruments when the data properties are presented so that the reader can interpret the observed differences with this in mind.

Aspects of the measurement technique that draw the SuperDARN meteor radar results into question (i.e. the influence of meteor detections in the back lobe of the radar) should be noted when the data technique is presented along with arguments that suggest the data is still worth considering.

The description of the mean and tide fitting technique should be expanded (P6577 L21 on). Something like "SVD was used to fit a wind field described by two horizontal components to the spatial distribution of radial velocities". This will help the reader to

interpret the effect of radial velocity estimates from the back lobe.

In describing the assumed meteor echo height (or prior to that point), the frequency at which meteors are being detected should be included.

There could be more comparison of the mean winds and tides with results from other studies. Two papers already included in the reference list are candidates for this. Baumgaertner et al., (2006) contains results for the same latitude that could be included in many of the papers diagrams. Murphy et al., (2006) also contains tidal amplitudes.

Given the poor quality of the correlations and the resultant doubt about the quality of the data, it is questionable whether the section on long-term trends contributes much to the field in its present form. With better knowledge of the causes of the poor correlations, it may be possible to apply data rejection schemes that strengthen the long-term trend analysis.

A model for the current observations

It may be possible to explain the observations presented in this study using the following model: Each of the radars can be thought of having data acquisition attributes similar to the following (but to differing degrees and with differing temporal structures).

1) the individual wind determinations have a large statistical error associated with them. This error is of a magnitude larger than or similar to the tidal and gravity wave velocity perturbation amplitudes present at the observing height;

2) the quality of the data varies through the day. It is of reasonable quality for much of half of the day, but of such a quality that statistical errors dominate for the rest of the day.

Thus the signal measured by each of the radars is the sum of 'noise' with the above characteristics and the underlying signal due to the gravity wave field, tides and the mean wind. The hourly average values potentially have some of the gravity wave vari-

ance removed by the averaging process. But at times of the day when few data points are available, the minimum number per hour will be present and much of the gravity wave variance will persist.

If the noise were not present, the measured signal would consist of part day snapshots of the underlying mean wind, tide and gravity wave field. When the data quality is poor, it is equivalent to there being no data. When it is good, there are data. This situation is equivalent to the product between the wind field signal and a periodic data availability function.

If this model is considered in the frequency domain, the spectrum of the measurements will consist of the sum of

3) high frequency noise (strongest between the nyquist frequency and approximately one cycle per hour); and

4) the convolution of the true spectrum of the tide and the Fourier transform of the data availability function. This convolution process has the potential to alias the spectrum such that resultant tidal amplitudes will be affected by mean wind and/or the other tide. It is the components of this changed spectrum that are extracted by the fitting process.

This model can explain the poor correlations between the hourly wind values (because they have large statistical errors), the poor quality of the mean winds and diurnal tides, particularly when the diurnal tides are large (because the aliasing will be worst for the poorly sampled diurnal tide and this will affect mean wind estimates) and the better quality of the semidiurnal tide estimates (because the aliasing is not as bad for the semidiurnal tide; it is still present though and can degrade the estimate).

The differing temporal characteristics to which the radars demonstrate the above properties act against the success of the present study. As noted by the authors, independent studies have shown that the two radar techniques have their merits. But correlating the hourly averages in conditions where the radar's optimal times of operation have

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limited overlap will yield low correlation coefficients because one or the other will act to degrade the correlation. These same temporal differences in data quality will cause different levels of frequency aliasing. The effect on the fitted winds and tides will differ and lead to a poor correlation between the resulting parameters.

Notes on the model:

Re 1) The scatter of the daily averages presented in Figure 7 is large. That of the hourly or individual values would likely be larger.

Re 2) This is supported by the images of Figure 2.

Technical corrections

P6577 L9 Insert “southern” before “spring”

P6578 L16 onwards - As noted above, the poor correlation cannot be attributed to different gravity wave fields alone.

P6579 L9 Suggest replace ‘Though’ with ‘However’ and add an ‘s’ to ‘cover’ in the next line.

P6581 L16 Suggest start new sentence at ‘A similar’

P6581 L27 The January zonal component also differs.

P6582 L14 on. The text from ‘linear regression’ onwards should be given a new sentence (or two).

P6585 L22 Does ‘meteor winds’ refer to mean winds or tidal amplitudes?

P6586 L17 Change ‘This’ to ‘The present’

P6587 L10 Insert ‘approximately’ before ‘co-located’

Legends describing each line in Figures 4, 5, 6 and 9 would be desirable.

Fig 6a caption Delete ‘equivalent’ in L2 and insert ‘for equivalent sampling volumes’

before 'generated' in L3.

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