Atmos. Chem. Phys. Discuss., 9, C10949–C10955, 2010
www.atmos-chem-phys-discuss.net/9/C10949/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Study on the impact of sudden stratosphere warming in the upper mesosphere-lower thermosphere regions using satellite and HF radar measurements" *by* N. Mbatha et al.

N. Mbatha et al.

nmbatha@hmo.ac.za

Received and published: 18 February 2010

The authors thank the Referee's comments and his/her useful comments and suggestions.

Major comments:

1. How does this work fundamentally differ from the work of Dowdy et al. [2004]? That is, it seems that the physical observations being presented herein (i.e., the occurrence and timing of the mesospheric wind reversals, the observations of planetary

wave signatures, etc.) are the same as those reported in Dowdy et al. [2004]. The only difference is that herein the authors have used a single HF radar as opposed to the 3-MF radars used in Dowdy et al. [2004]. I would request that the authors specifically identify how this work is fundamentally different than this previous study.

Reply: Towards the end of our introduction section, we have discussed the difference between the two studies. Interestingly, our study and results from the SANAE HF (meteor) SuperDARN radar observations together with NCEP reanalyses, compliments Dowdy et al., [2004] work, where they used MF radar (operating at 1.94 to 2.4 MHz) from three different stations and UKMO. We have extended our work by utilising the SANAE HF radar (8 to 20 MHz) and SABER/TIMED satellite temperature data to assess the dynamics of the MLT in terms wave activity. Added to it, the presented results conclude the capability of SANAE HF radar to study the influence of warming at MLT region. We described in the introduction and the paper is motivated on this context.

2. In Figure 3 the averaged 2003-2006 winds need to have their corresponding daily sample variance associated with each daily mean value included. Though the 2002 wind reversal can be seen, it is unclear if this reversal is unique and outside the climatological variance (i.e., the variance of the 2003-2006 periods).

Reply: As per suggestion from the referee, we have introduced the standard deviations in the figure and are discussed in the text.

3. The authors should discuss these results in light of the two Baldwin and Dunkerton papers listed above. This reviewer feels that this topic of downward coupling mechanisms has not been adequately explored in the literature.

Reply: We have discussed the downward coupling mechanisms in our conclusion and introduction, and referenced the suggested Baldwin and Dunkerton plus Lee et al., [2009].

4. pg 23061, line 22-23: Regarding the increase in stratospheric temperatures, please

reference why this is an “uncommon increase”. What is the rate of increase?

Reply: Basically, we were discussing the referenced Baldwin et al., [2003] study where they found a sudden rise in temperature at Southern Polar region during September 2002 in comparison to the past years from 1979. The above findings are similar to our reported result on SABER temperature. Based on SABER temperature profile, the rate of increase is found to be 5 K /day. Now, the corresponding sentences are rewritten.

5. pg 23061, line 28+: Regarding the detection of mesospheric inversion layers, please reference MIL literature [e.g., Meriwether, J. W., and A. J. Gerrard, Mesosphere inversion layers and stratosphere temperature enhancements, Rev. Geophys., 42, RG3003,doi:10.1029/2003RG000133, 2004.]. In addition, this result is very interesting unto itself, as it shows the MIL formation in the absence of the polar vortex system at high latitudes. That is, it is often thought that the lack of MIL observations at high latitudes is due to the removal of planetary wave activity due to the refraction of such waves off the polar vortex. Once the polar vortex is disrupted, the signature of MIL activity at high latitudes in winter is very interesting!

Reply: We have referenced the work by Meriwether, and Gerrard in our discussion . Since this issue is very important, our future plan is to investigate the relation between the SSW and MIL formation (more interestingly due to adiabatic cooling and lapse rate).

6. Please provide more details on how the power spectra of Figure 5 were computed. Was the 28-day window a Hamming or Hanning-type window? What are the confidence levels of the observed spectra? What are the units on the color bar? Please add more “tick marks” to the x-axis so that the reader can better see the values on various days (e.g., the data at day 262). Also, what is the spectral resolution of the figure? How did the authors get such high spectral resolution of periods between 14-days and 28-days with a Fourier analysis using only a 28-day data window?

Reply: Under section 3, we have explained more details of the how the power spectra

of figure 5 were computed. We have also changed the figure into normalised Fourier power spectra which is given by σ2/N, where N is the number of data points and σ2 is the variance of the time series. Using this normalization, white noise would have an expectation value of 1 at all frequencies. This is well explained in section 4 of Torrence and Compo, [1998]. We have applied Hamming window while calculating the power spectra. The 95% confidence levels using a chi-square test, assuming white noise as background spectrum [Torrence and Compo, 1998] is calculated and plotted now. Furthermore, we have plotted the FFT spectra illustrating the 14-, 10- and 5- day waves including the 95% confidence level (See. Fig.6 in the revised manuscript). In all these figures, we have added more tick marks, as suggested. We have restricted our discussion only up to 14 days and the corresponding spectral resolution is 0.0357 cycles per day.

7. Just because one sees 14-day periodicities doesn’t mean that planetary waves are being observed. These periodicities could be the natural mode of oscillation of the polar vortex system. I think the authors need to provide such caveats.

Reply: We agree with the referee that sometimes one can detect periodicities that are in neutral mode of oscillation of polar vortex system. But, in our present study, we certain from the past findings that the observed periodicity might be associated with planetary wave activity.

Minor comments: 1. Throughout the text, the common usage of commas is “. . .item 1, item 2, and item 3. . .” For example, on pg 23055, line 11 the list would read: “. . . significant changes before, during, and after the occurrence. . .”. That is, there is a comma missing after the word “during”. This missing commas is missing in 3-4 other locations in the text.

Reply: we have corrected the usage of commas as per referee suggestion.

2. Throughout the text: I recommend that the authors refrain using the word “proved” and instead use the words such as “showed”, “demonstrated”, etc. [e.g., pg 23055 line

25; pg 23057, line 12; etc.]

Reply: We have changed appropriately as suggested by the referee.

3. pg 23053, line 2: suggest “The occurrence of a sudden. . .”

Reply: Changed the sentence as per referee suggestion

4. pg 23053, line 5: Why is the “degree” symbol of 2 different sizes on the location of SANAE?

Reply: We made the degree symbols to be the same size. We apologize, it was a typo graphical error. 5. pg 23053, line 11: suggest: “. . .at the MLT shows reversal approximately 7 days. . ."

Reply: Changed the sentence as per referee suggestion.

6. pg 23053, line 22: suggest: “. . .event the 60 o S winds at 10 hPa reversed on the . . .”

Reply: Changed the sentence as per referee suggestion

7. pg 23054, lines 28+: Please verify the statement of how Labitzke and Nanjokat [2000] defined a minor warming. I was under the impression it was ONLY below 10 hPa, not “at any stratospheric level”.

Reply: We have looked at the statement by Labitzke and Nanjokat [2000] and we then changed into “at any stratospheric level” to “ below 10 hPa”.

8. pg 23055, line 13: suggest “. . . occurrence of a SSW. . .”

Reply: Changed the sentence as per referee suggestion

9. pg 23057, line 8: suggest “. . . and the pulse sequence is . . .”

Reply: Changed the sentence as per referee suggestion.

10. pg 23058, line 1: What is “overage?” Please define.

Reply: We sorry for the type mistake, it is average.

11. pg 23058, line 15: Why are the details of the NCEP data being given here when they were presented in Figure 1, some pages previous? Shouldn’t this information be associated with Figure 1?

Reply: In our revised manuscript we have discussed the details of NCEP in section 2 only.

12. pg 23059, lines 1-9: Please denote the actual days you are referring to in this data presentation. That is, what specific days where westward winds observed?

Reply: Now, we noted the actual reversal period in the revised manuscript as per referee suggestion.

13. pg 23059, line 10: suggest “. . . and persisted for a few days before. . .”

Reply: We changed the sentence as per referee suggestion.

14. pg 23060, line 4: The beginning of this sentence is awkward. I suggest: “As discussed in Matsuno [1971], Andrews et al. [1987], Dowdy et al. [2004, etc., the dynamical mechanisms. . .”

Reply: We changed the sentence as per referee suggestion.

15. pg 23062, line 27: suggest “. . . took place in a few days. . .”

Reply: We changed the sentence as per referee suggestion.

16. pg 23062, line 27: “thermosphere”? I think the authors mean mesopause or MLT.

Reply: We changed thermosphere to MLT.

Figure 1: Does this figure really have to be in color? Also, the caption should indicate the figure shows “zonal mean” values.

Reply: The figure is replotted into black and white as per referee suggestion.

Figure 2: The quality of this plot is rather poor. The authors should increase the figure resolution, and convert the x-axis values to “day-of-year” as opposed to “Hour of Month”, which really doesn’t make a lot of sense.

Reply: We changed the figure as per referee suggestion.

Figure 3: The daily variance of the average 2003-2006 zonal and meridional data needs to be indicated on this plot so that the reader can better asses when the 2002 winds are indeed outside the realm of “typical” variability.

Reply: We have included the daily variability of 2003-2006 as per referee suggestion.

Figure 4: Please include the daily variability of the mean zonal winds. Also, the last comma is not necessary.

Reply: We have tried to incorporate the daily variability in the figure, but, it is too clumsy. Now, we mentioned in the text the magnitude variability. The last comma is removed

Figure 6: Please consider plotting this data in a contour plot instead of the current plot. It is very difficult to see the temperature changes and to distinguish individual days.

Reply: We have plotted the figure as per referee suggestion.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 23051, 2009.