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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Temperature climatology and trend estimates in the UTLS region as observed over a southern subtropical site, Durban, South Africa" *by* H. Bencherif et al.

**H. Bencherif et al.**

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Referee comments are divided into 5:

comment 1: "The SAWS undertook twice daily radiosonde launches, one in the early morning and one in the early afternoon, from Durban, South Africa during the period of the current study. The authors state that they chose to use only the afternoon data to limit any tidal biases. However, I think an inclusion of the morning data could enhance the current analysis. Namely, how do atmospheric tides affect the diurnal cycle of temperature at different altitudes? Is there a trend in the morning data as well, and if so, how does it compare to the afternoon data?"

answer 1:

As suggested by Referee # 1, we have investigated temperature trends by taking into account early-morning and afternoon datasets separately. A new figure (Fig.5) has been added. This figure shows the resulting linear trend profiles as derived from the morning and afternoon datasets. Also superimposed on the figure are the differences between the morning and the afternoon trends.

We also would like to take the opportunity here to underline that we initially used morning data, not afternoon data as stated on p.1304/line23 and p.1310/line2 in the original manuscript. This has been corrected accordingly in the revised manuscript.

From Fig.5 one can see that the morning and the afternoon trends have globally the same shape. However, the cooling rate obtained with the afternoon data is more significant in the UTLS, reaching its maximum value in the lower stratosphere (-1.88 K/decade, at 50 hPa).

Besides, the absolute differences between morning and afternoon trends are almost constant in the troposphere (including at the tropopause, i.e., 100hPa), and are increasing in the stratosphere. One possible explanation for the obtained trend differences may be associated to ozone (O3) changes in the stratosphere. Indeed, stratospheric O3 is photo-chemically active, and its evolution has been observed to present a negative trend (-6%), (WMO, 2002). Moreover, atmospheric tides are global-scale oscillations that are primarily induced by the diurnal variation of solar radiation absorption, mainly by water vapour (H2O) in the troposphere (˜1/3) and O3 in the stratosphere (˜2/3) (Strobel, 1978). Any change in H2O and/or O3 concentrations may induce a change of the tidal structures. Indeed, using a 3-D dynamics-chemistry-transport model, Morel et al. examined the sensitivity of the tidal amplitudes to decadal changes of the thermal source distributions, notably changes in O3 and H2O distributions; and found that the largest changes occur at tropical and subtropical latitudes.

Yet, despite their weak amplitudes in the stratosphere (less than 1K), and because of



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the way they are generated, tidal variations seem to affect the trend of temperature diurnal cycle at different heights and emphasize the stratospheric cooling as shown on Fig.5.

The following references have been added to the References list:

- Morel, B., P. Keckhut, H. Bencherif, A. Hauchecorne, G. Mégie, and S. Baldy, Investigation of the tidal variability in a 3-Ddynamics- chemistry- transport model of the middle atmosphere, Journal of Atmospheric and Solar-Terrestrial Physics, 66, 251-265, 2004

- Strobel, D.F., Parameterization of the atmospheric heating rate from 15 to 120 km due to O2 and O3 absorption of solar radiation, J. Geophys. Res., 83, 6225-6230, 1978

- WMO, Scientific assessment of ozone depletion: 2002, Global Ozone Res. and Monit. Proj., Rep. 47, 2002

Comment 2: "The authors explored the temperature climatology and trends over one site. While the conclusions are interesting, I fear that they lack a great deal of meaning without analyzing a more geographically comprehensive dataset. Are additional temporally comparable data over Africa available? If so, analyzing these data would more fully support any conclusions that are ultimately drawn."

answer 2:

Trend analysis requires the use of long time-series of observational data. Collection and qualification of the required datasets are important and demanding. Unfortunately, due to the relatively brief lapse of time granted by the ACP revision procedure, we have not been able to undertake a comprehensive trend analysis based on a larger number of datasets obtained over comparable subtropical sites.

However, we managed to analyse the daily morning data from one additional South-African subtropical site, Upington, for the JAN.1980 - MAR.1999 period. Durban (29.9°S, 30.9°E) and Upington (28.5°S, 21.3°E) temperature trend values are shown on Fig.4.a (modified).

It can be seen from Fig.4.a that both sites show nearly similar trends, notably in the stratosphere. The highest cooling rate over Upington is obtained in the lower stratosphere (-1.12ś0.40 K/decade) at the same pressure level as for Durban (70 hPa).

In the troposphere, unlike the Durban trend values (slightly negative: -0.10 K/decade), those estimated for Upington are almost equal to zero (-0.02 K/decade). This small discrepancy in the troposphere could be related to the site locations and indeed to the associated tropospheric regimes. Durban is a coastal site, while Upington is a continental one.

comment 3: "The individual radiosondes that are launched from a particular site during different seasons over many years could be separated spatially by hundreds of kilometers by the time they reach the UTLS. As a result, any analysis of temperature in the UTLS from multiple radiosondes over a particular site is not necessarily representative of that particular location. Again, the addition of additional launch sites would make this less of an issue, as a greater geographical region is intentionally covered and spatial differences are investigated. In the absence of a more comprehensive dataset, was any analysis of the spatial variability of the data performed to account for the potential heterogeneity?"

answer 3: Same as comment 2.

comment 4: "On page 1304, section 2, line 24, the manuscript states that all unrealistic data were removed. Could the authors specify what type of statistical process was used to remove the spurious data?"

answer 4:

A spurious temperature record is identified in the data file by the value 999. However, one can find spurious temperature data which are different of 999. In order to compute the monthly time-series, these values are removed by applying on daily time-series (per pressure level) a qualification routine. The latter permits to examine every temperature sample. A temperature value is rejected by the qualification test if it is 1.4 times greater or less than the 5-nearby-point mean value.

comment 5: "The post Pinatubo data from June 1991 - December 1995 were removed from the dataset. However, these data appear to remain in the plots given in Figures 1 and 4b. Is this correct?"

answer 5:

Yes, Fig.1 and Fig.4.b show the post Pinatubo data, even though they have been removed from the dataset for the trend analyses.

Technical Corrections:

- The sentence at p.1306 and line 7 “ The SAO has its maximum amplitude at 200-hPa ... ” has been changed as follows: “ The SAO has its maximum amplitude at 250-hPa ... ”

- The sentence at p.1310 and lines 16-19 “ The former is dominant ... whereas the SAO has its maximum amplitude at 200-hPa, ... ” has been changed as follows: “ The former is dominant ... whereas the SAO has its maximum amplitude at 250-hPa, ... ”

- In the sentence at p.1307 and lines 10-11, the word “a” has been removed between the words “by” and “eruptions”.

- In the sentence that begins with “The Pinatubo ... ” at p.1307 and line 15, the word “The” has been removed.

- In the whole first paragraph on p. 1308, all trends are now given with negative signs (minus symbols have been added).

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Interactive comment on Atmos. Chem. Phys. Discuss., 6, 1301, 2006.