Atmos. Chem. Phys. Discuss., 6, S836–S842, 2006
www.atmos-chem-phys.org/acpd/6/S836/
European Geosciences Union

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.

Received and published: 14 May 2006

Referee comments are divided into 7.

comment 1: "The error analysis is primitive though and the confidence with which the authors can state the conclusions is therefore unfounded. Without considering autocorrelation or using the standard means of obtaining errors from a least squares analysis the authors understate (actually they do not describe the derivation of) their errors. Before this paper can be of publishable quality their error analysis must be reworked by the methods that are now standard in the simplest of trend derivations - but due to the authors nice data record, the under representation of such in the

Full Screen / Esc
Print Version
Interactive Discussion
Discussion Paper

literature and the authors desire to draw strong conclusions I strongly urge the authors to resubmit their paper with this change"

answer 1:

We agree with the reviewer's remark concerning autocorrelation consideration. In fact, in order to reduce autocorrelation noise, it is highly required, prior to any trend investigation, to examine data independency. The statistical trend uncertainty given in the manuscript by the equation on p.1308, line 6 is a simplified formula. It can be used only if the data are independent.

In the present work, temperature measurements were derived from daily systematic sampling and have been reduced to monthly means, per pressure level. With such sampling the autocorrelation of the residuals is not significantly different from zero and reveals that the data used in the present study can be considered as independent. Indeed, this is in agreement with the findings of Tiao et al. (1990): the precision of the trend estimates depends critically on the magnitude of autocorrelations in the monthly observations, but it is not sensitive to temporal sampling rates of daily measurements under systematic sampling.

Then, the statistical trend uncertainty can be given by the quantity expressed by the equation on p.1308, line 6.

The following references have been added to the References list:

- Tiao G.C., Xu Daming, J.H. Pedrick, Zhu Xiaodong, G.C. Reinsel, Effect of autocorrelation and temporal schemes on estimates of trend and spatial correlation, J. Geophys. Res., 95, 20507-20517, 1990

comment 2: "Pg 1302 line17 while temperature does influence ozone abundance as the authors note, vice versa is also true, that ozone abundance influences temperature (the reason for the stratification of the stratosphere) - add vice versa to the sentence."

answer 2:

This has been done. The sentence on p.1302/line 17 “ Temperature controls the rates of chemical reactions and thus ozone abundance, ... ” has been changed as follows:

“ Temperature controls the rates of chemical reactions and thus ozone abundance (and vice versa), ... ”

comment 3: "Pg 1303 line 13 reference that the authors have overlooked - Bodeker 1998, southern hemisphere, Lauder, investigation of trends in ozone and temperature for another southern hemisphere."

answer 3:

The sentence on page 1303 and lines 11-13 “ Some authors have performed trend analyses from the large ozonesonde databases (Logan, 1994; Harris et al., 1997), but again, these are predominantly available for the NH. ” has been changed as follows:

“ Some authors have performed trend analyses from the large ozonesonde databases (Logan, 1994; Harris et al., 1997), but with the exception of Bodeker et al (1998), these are predominantly available for the NH. ”

The References section has been modified accordingly.

- Bodeker G.E., I.S. Boyd, W.A. Matthews, Trends and variability in vertical ozone and temperature profiles measured by ozonesondes at Lauder, New-Zealand: 1986-1996, J. Geophys. Res., 103, D22, p.28,661, 1998

comment 4: "Pg 1304 line 19 Extending the data set to include the morning soundings as (by still keeping them separate) would I hope also contain a similar message strengthening conclusions."

answer 4:

As suggested by Referee#2, 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 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:

ACPD
6, S836–S842, 2006

Interactive Comment

EGU

- 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 5: "Pg 1305 Line 17, quantify the anti-correlation"

answer 5:

This has been done.

The sentence on p.1306 and lines 16-18 “ Figure 2 shows that the seasonal variations of temperature at the 150-hPa and local tropopause (100-hPa) heights are quite similar, but are anti-correlated with the 250-hPa temperature variations ” has been changed as follows :

“ Figure 2 shows that the seasonal variations of temperature at the 150-hPa and local tropopause (100-hPa) heights are quite similar, but are anti-correlated (correlation values of -0.93 and -0.97, respectively) with the 250-hPa temperature variations ”

comment 6: "Pg 1307 How is the variance of the trend term derived? Is the variance of the residual in time space used to define the error term for the trend? The authors do not provide the exact description of the method used to derive their trend error. For the trends to have any physical meaning the methodology used to derive the error must be described. More importantly to be a valid estimation of the trend error the autocorrelation of the residuals must be considered. How to include first order autocorrelation is now standard in trend determination and has been described by {Reinsel, 1987 #678}{Tiao, 1990 #592}{Weatherhead, 1998 #602} how the autocorrelation of the residual term is essential to prescribe the correct error to the trend term. Further, other authors have found that second order correlation provides the most accurate estimate of the trend error {Bodeker, 1998 #399}.

answer 6: Same as comment 1.

comment 7: "Pg 1309 line 11. The authors might consider using a fourier transform expansion or a 12 term monthly expansion of the trend term and derive the seasonality of the trends as described by the above references. This would be a more rigorous approach and provide additional interesting information about this nice dataset."

answer 7:

We thank the reviewer for his suggestion.

In that regard, we have applied the least-squares model separately to the 12-month time-series in order to derive the seasonality of temperature trends. A new figure (Fig.6) has been added. It shows monthly trend estimates as derived at tropospheric and stratospheric levels (200, 100 and 70 hPa).

In the troposphere, monthly trends are almost equal to zero, except for September and October when the cooling rates are similar to those in the stratosphere (about -0.8 K/decade). At the tropopause, seasonal trends show the same variations as those obtained in the stratosphere. However, the time of the maximum cooling at the tropopause (obtained in the June-July period) does not coincide with that in the stratosphere (obtained in March).

Moreover, thanks to the referee's suggestion, it comes out from these seasonal trends that the cooling reduction in the stratosphere is not limited to winter. In fact, reduction of cooling rate in the stratosphere occurs by May and September (by early and late winter, respectively). The seasonal dependence of temperature trends may be related to trends in wave activity in the southern UTLS.

Using ECMWF-ERA40 reanalyses and temperature profiles obtained with a Rayleigh Lidar operating at Durban, Bencherif et al. (2000) showed that temperature variability

ACPD

6, S836–S842, 2006

increases by early winter (May), when the transition of the stratospheric zonal-mean winds to the westerly regime occurs and the planetary Rossby waves propagate upward. Moreover, as mentioned in the manuscript, Bodeker and Scourfield (1995), using TOMS data recorded over the period 1979-1992 and an EOF analysis on the vertical component of Eliassen-Palm flux, have reported an increasing trend in wave activity during winter in the southern UTLS.

The following reference has been added to the References list:

- Bencherif, H., B. Morel, A. Moorgawa, M. Michaelis, J. Leveau, J. Porteneuve, A. Hauchecorne, and D. Faduilhe, Observation and first validation of stratospheric temperature profiles obtained by a Rayleigh-Mie LIDAR over Durban, South Africa, South African J. of Sc., Vol. 96, 487-492, 2000

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