Trends in ozone concentrations at the ozonesonde station of Uccle

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1 Introduction

- Ozonesonde profile data from Uccle (50°48'N, 4°21'E, 100 m a.s.l.) are available since 1969 at the Royal Meteorological Institute of Belgium. The station is located in the Southern suburbs of Brussels.
- In 1997, a changeover in ozonesonde sensor type took place from Brewer Mast (BM) towards Z-ECC.
- To ensure the homogeneity of this long time series, a comparison study has been done between ozonesonde data, retrieved from both sensor types by organizing dual flights during one year. This changeover has been well documented (De Backer, 1999).
- Trend results for the time period 1990 - 2009 are shown.
- A chemial transport model is used to make comparisons between model- and ozonesonde data at Uccle for the lower troposphere.

2 Trends

- Trends are based on the vertical ozone profiles at the ozone sounding station of Uccle.
- These trends have been calculated on different altitude levels and for different months. The vertical resolution is about 500 meters.
- On average, the tropopause height is situated around 11 km at Uccle.

2.1 1990-1999

- During the first decade, there is an overall decrease in ozone concentrations in the upper troposphere, except during winter season.
- For the lower troposphere, there is only a decrease in ozone concentrations from May until August.

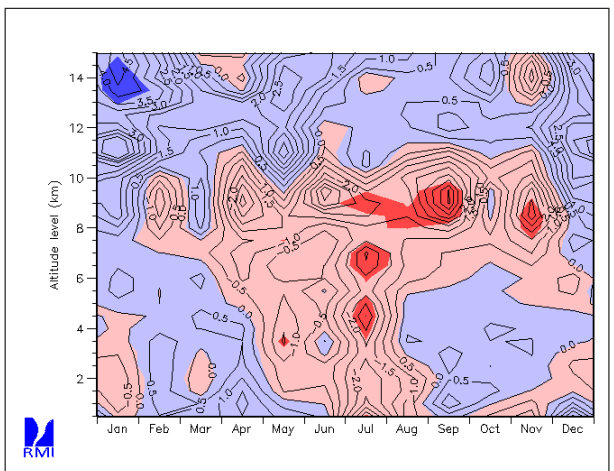

Figure 1. Season-height cross-section of ozone trends in percent per year at Uccle for the time period January 1990 to December 1999. Areas where the trend is statistically significant at the 95 % level are coloured darker (red for negative and blue for positive trends).

2.2 2000-2009

- The second time period is characterized by a general increase in ozone concentrations for higher tropospheric levels.
- In the boundary level, a decrease in ozone concentrations is detected from June until December.

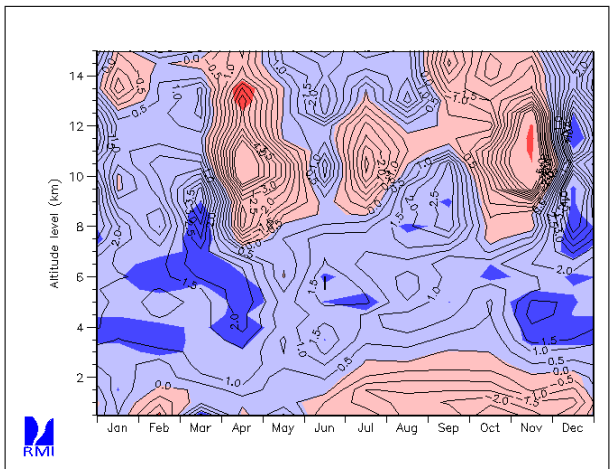

Figure 2. As in Figure 1 but for the time period January 2000 to December 2009.

2.3 1990-2009

- In general, there is an overall increase in free tropospheric ozone, due to a significant increase in ozone concentrations during spring and September.
- At other altitude levels, no significant trends in ozone concentrations have been detected.

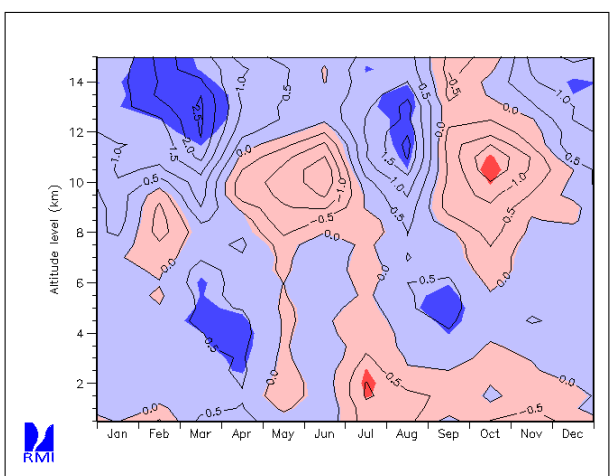

Figure 3. As in Figure 1 but for the time period January 1990 to December 2009.

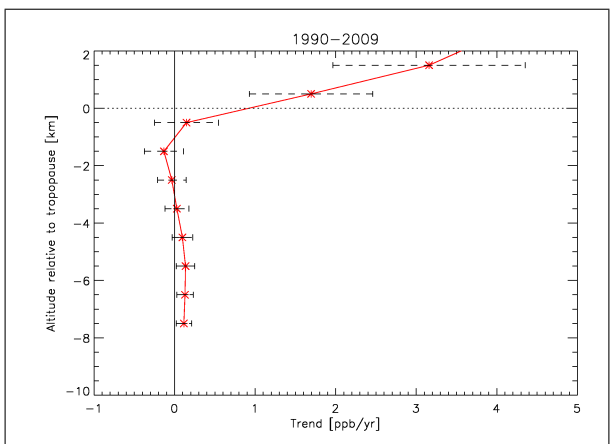

Figure 4. Vertical profile of ozone trends (ppb/year) for the time period 1990 - 2009. The height scale is relative to the tropopause. The 2 σ error bars are shown.

3 Chemical Transport Model

- A supplementary test to ensure the homogeneity of the time series in the lower levels of the ozonesonde data is provided by comparing this data with the output of a chemical transport model. Herefore we used the CHIMERE model (Vautard et al, 2001).
- The CHIMERE model is forced by ECMWF meteorological fields and by the EMEP emission database (2002) (Vestreng, 2003). The simulation domain covers Western Europe with a spatial resolution of 0.5 degree. The vertical resolution consists of eight layers from surface level until 500 hPa.
- To compare these different levels in CHIMERE with the ozonesonde data, data has been extracted applying a gaussian filter aproach, using fixed heights in the middle of the model levels.
- Figure 5 shows results from a comparison between the CHIMERE model output and the ozonesonde data at the 771 hPa level. It shows that before the BM to Z-ECC changeover in April 1997 (before the vertical black line on the plot), the variability in ozone concentrations is higher.
- After April 1997, Z-ECC ozonesondes are used and this results in lower variability in ozone concentrations. The moving average plot does not show any jumps around this time period. During the shown time period, there is no drift detectable in the differences between model output and observed ozonesonde data.

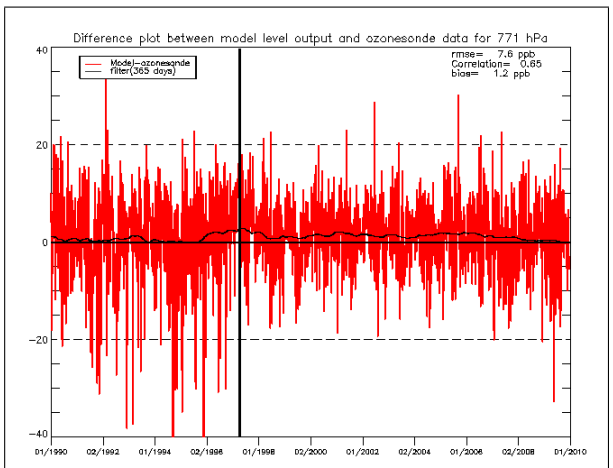

Figure 5. Difference plot between model output of the CHIMERE model and the ozonesonde data at the 771 hPa level.

4 Conclusions

- The homongeneity of the ozonesonde time series of Uccle have been verified against model output data for ozone concentrations in the lower troposphere.
- Trends on different altitude levels and for different time periods have been provided.
- In general, there is a significant increase in ozone concentrations in the mid free troposphere during the last 20 years.

References

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