THE CAPE POINT TIME SERIES OF CO_2, CH_4, CO AND O_3

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1. INTRODUCTION

Measurements of environmentally important trace gases, notably CO_2, CH_4, CO and O_3, have been made at the coastal station Cape Point (CPT, 34 °S, 18 °E) spanning differing time periods (Scheel et al., 1994; Oltmans et al., 2006 and Brunke et al., 2009). Observations range from 16 complete years for CO_2 to 30 years in the case of CO. The latest trend and growth rate estimates for these four gases, based on data filtered with respect to background concentrations, are presented. It should be noted that the temporal variability of trend curves and growth rates is dependent on the degree of smoothing chosen for the calculations.

2. METHOD AND DATA

Trace gas measurements are being made continuously from air intake pipes that are attached to a 30 m high mast at the station. For most trace gases, calibrations are conducted several times a day by means of working standards, which in turn are compared to laboratory standards from NOAA-ESRL. Major improvements in the processing of the raw data from the instruments (GCs, IR and UV techniques) were made possible from 2000 onwards, when a more powerful data acquisition system was introduced. The processed data (devoid of analytical artefacts) are archived as 30-min. averages. A filtering tool (based on 11-day moving percentiles) is used to remove local pollution influences from the data (Brunke et al., 2004). The filtered data set (essentially background data) was used for the calculation of long-term trends presented here.

3. RESULTS

Carbon dioxide (CO_2) levels have steadily increased from 355.6 ppm at the start of the measurements in 1993 to approximately 383 ppm in 2008 (Fig. 1). Growth rates were calculated as derivatives of the trend curve obtained via 5-year smoothing. These fluctuated between 1.5 and 2.2 ppm yr^{-1}. Linear regression performed on the growth rates indicates an increase of the fit from 1.6 ppm yr^{-1} in early 1993 to 2.1 ppm yr^{-1} at the end of 2008.

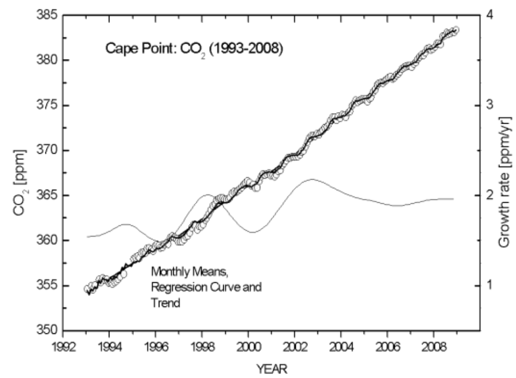

Fig. 1: CO_2 trend and growth rate curve.

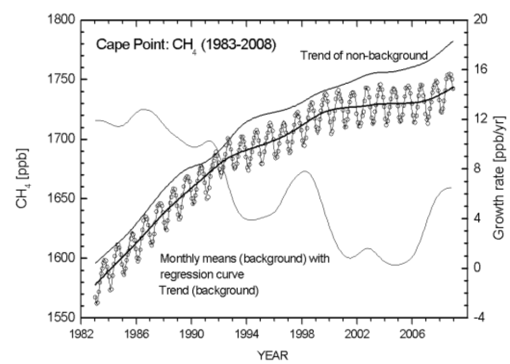

Fig. 2: CH_4 time series with long-term-trend and growth rate curve.

In the case of CH_4, an overall decrease in growth-rates, fluctuating markedly over the years, has been noted since 1983 (Fig. 2). Methane levels have stabilized since 2003, and during 2006 the growth rate even dropped to about -1 ppb yr^{-1}. A linear fit of the growth rates has yielded values of 13 ppb yr^{-1} for the beginning of 1983 and zero growth for mid-2005. However, starting around October 2007, an increase was observed again. This is in line with observations at several southern and northern hemispheric locations. Possible causes, such as increase in emissions in both hemispheres or drop in hydroxyl radical concentration are still under discussion (e.g., Rigby et al., 2008).

Over most of its 30-year measuring period, the CO time series has not displayed any significant long-term trend, whereas some inter-annual variability is evident (Fig. 3). However, since 2003 an overall decline has been observed in the CO mole fractions with an abnormally low annual minimum during February 2006 as well as a lower than normal annual maximum in October 2006. Thereafter CO returned to previously observed levels again, but decreased to an unprecedented low annual maximum in 2008. The causes of the decrease are still under investigation. In spite of thorough instrumental checks, the possibility of recent analytical artefacts cannot be ruled out. Seasonal variations yield a maximum in September/October and a minimum in February.

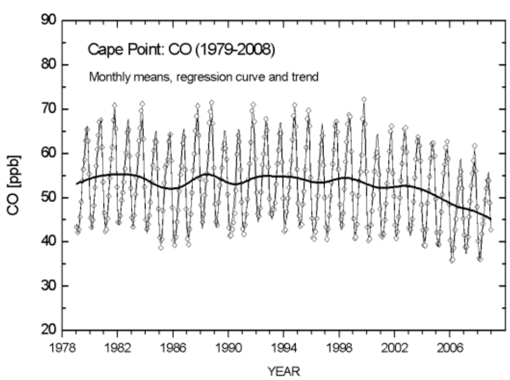

Fig. 3: CO time series showing no significant lomg-term trend.

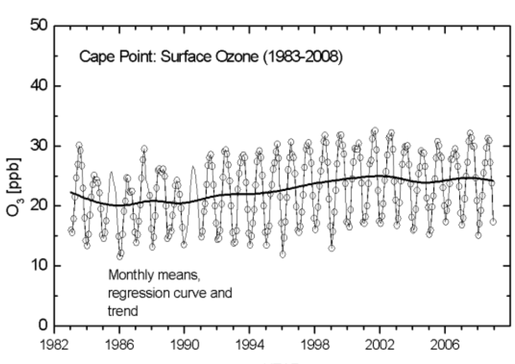

Fig. 4: Time series of surface ozone displaying a small overall increase since the beginning of the 1990s.

For surface ozone (Fig. 4), a positive trend was recorded between 1990 and 2002, accompanied by an increase in seasonal peak-to-peak amplitudes. Since 2003 the increase has levelled off again. The seasonal variations show a flat July-September maximum and a minimum in January.
In addition, trends of non-background CO_2 and CH_4 have been examined for the past 14 years. Wind sector-dependent growth rates for the two gases (based on all data) reveal increasing anthropogenic sources to the north of the station, where densely populated areas are located.

4. REFERENCES

Brunke, E-G., Labuschagne, C., Parker, B., Scheel, H.E. and Whittlestone, S. (2004). Baseline air mass selection at Cape Point, South Africa: Application of ^{222}Rn and other filter criteria to CO_2. Atmos. Environ. 38, 33, 5693 - 5702.

Brunke, E-G., Labuschagne, C. and Scheel, H.E. (2009). Recent changes in trace gas levels at Cape Point, South Africa. in: 14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (T. Laurila, ed.), GAW Report No. 186, WMO/TD-No. 1487, 100-102.

Oltmans, S.J. et al. (2006). Long-term changes in tropospheric ozone. Atmos. Environ. 40, 3156-3173.

Rigby, M., et al. (2008). Renewed growth of atmospheric methane, Geophys. Res. Lett., 35, L22805, doi:10.1029/2008GL036037.

Scheel, H.E., Brunke, E-G., Sladkovic, R. and Seiler, W. (1998). In situ CO concentrations at the sites Zugspitze (47 °N, 11 °E) and Cape Point (34 °S, 18 °E) in April and October 1994. J. Geophys. Res. 103, D15, 19295-19304.