ANALYSIS OF OZONE FROM THREE AIR INTAKE HEIGHTS AT CAPE POINT

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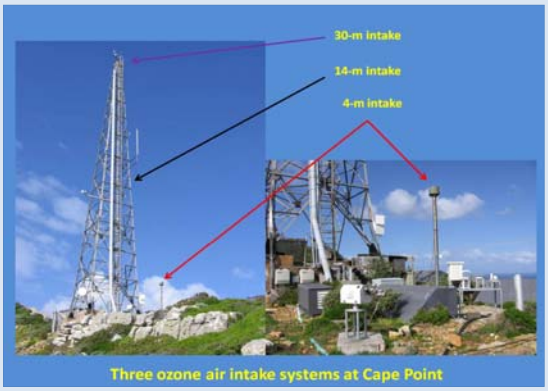
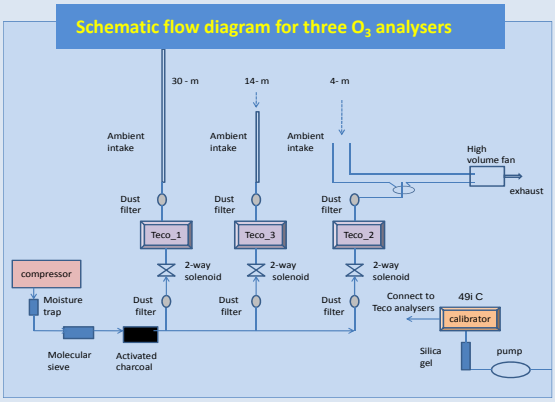
Overview

Surface ozone measurements have been made at Cape Point since 1982 from the top of a 30-m air intake mast. In 1996 measurements were also started from a 4 m high air intake and from September 2008 onwards, they were extended to 14-m elevation as well. Seven months of ozone data from 3 air intake levels: 4 m, 14 m and 30 m, respectively, are being compared and discussed here. The data have been analysed for background conditions as well as for air sampled during urban pollution episodes and biomass burning events.



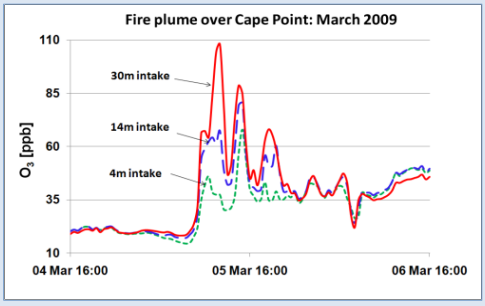
Analytical technique and data processing

The instruments in use comprise Thermo Electron (Teco) analysers based on an UV detection technique. An O_3 calibrator (TEI 49i-PS) is being used to calibrate the three instruments every four months. Daily zero and sensitivity checks are conducted automatically. Monthly zero-calibration levels are factored into the data processing routine, which yields 30-min. averages, while the SPAN sensitivity values provide information on long-term instrument stability. For the purpose of this study, ozone levels in unpolluted air (30-min. averages) were selected via a filtering technique based on carbon monoxide (CO) background data.

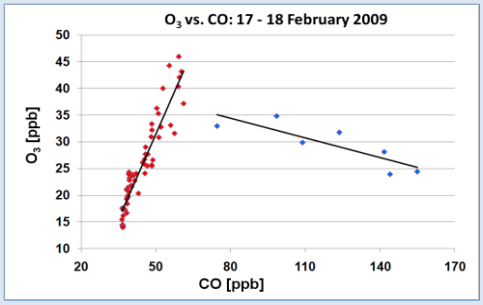


Results

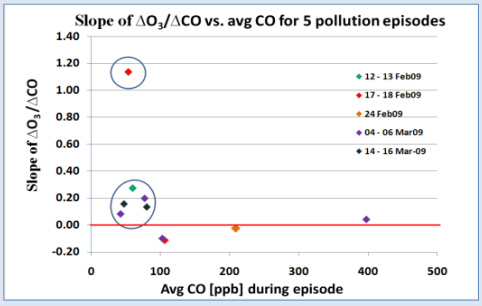
The seven months of comparative ozone data show on average good agreement (within 0.5 ppb) for the three intake levels under most of the prevailing conditions. Significant deviations occur during pollution episodes, which are particularly pronounced when biomass burning events are observed.



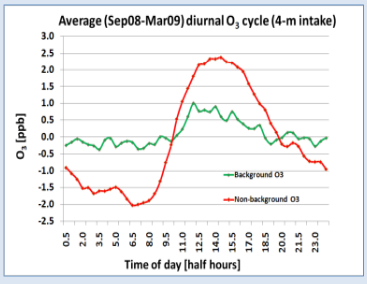
Five pollution episodes were selected from the period February-March 2009 (most of these were associated with biomass burning plumes). The O_3 levels observed at the three intakes, with differences sometimes > 65 ppb, do not reflect a consistent upward or downward gradient. It is speculated that these levels are haphazard and are a function of the individual fire plume.



Ozone shows either positive or negative correlations with the CO mixing ratios. These are indicative of conditions favourable for photochemical O_3 production or O_3 removal in polluted air masses, respectively. In most cases positive correlations and slope values of a linear regression ($\Delta[O_3]/\Delta[CO]$) were observed for daylight hours. However, there are cases where such ratios have persisted into the night hours.



The five pollution events are characterized by $(\Delta[O_3]/\Delta[CO]$ ratios ranging from +1.14 to – 0.11. Some episodes such as the one from the 4th – 6th of March encompass the whole range (day and night processes), whilst others (e.g. the 24th of February) indicate neither production nor destruction ($\Delta[O_3]/\Delta[CO] \approx 0$).



Average diurnal O_3 cycles (Sep 08 till Mar 09) for the 3 air intakes agree within the experimental error margin of 0.5 ppb. Shown here is O_3 (4-m intake) filtered via background and non-background CO. The former shows smaller diurnal cycling (1.2 ppb peak-to-peak) than the non-background data (4.4 ppb peak-to-peak). The latter is indicative of photochemical O_3 production during the day and possible O_3 loss (NO chemistry) at night.

Summary and Conclusions

- O_3 values from 3 analysers measuring air from 4, 14 and 30 m height, respectively, agreed within the analytical error margin of 0.5 ppb under background conditions.
- During pollution episodes (especially fire plumes) differences of > 60 ppb could be observed between the intakes. These differences are haphazard and do not represent a uniform upward or downward concentration gradient.
- $\Delta[O_3]/\Delta[CO]$ slope values during episodes varied between +1.14 and – 0.11.
- Diurnal O_3 cycles showed amplitudes of only 1.2 ppb during background, but up to 4.4 ppb for non-background conditions, thus reflecting different air-chemical conditions on local to regional scales.

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