OZONE OBSERVATIONS AT CAPE POINT (1983 - 2010)

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Overview

1) Introductory remarks
2) Divide O_3 time series (1983 – 2010) into specific time periods
3) Use different approaches (e.g. moving averages, anomalies) to determine growth rates
4) Analyze ozone data in terms of six percentiles
5) Characterize air between 4 m and 30 m intakes
6) Summary and conclusions

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Site description:

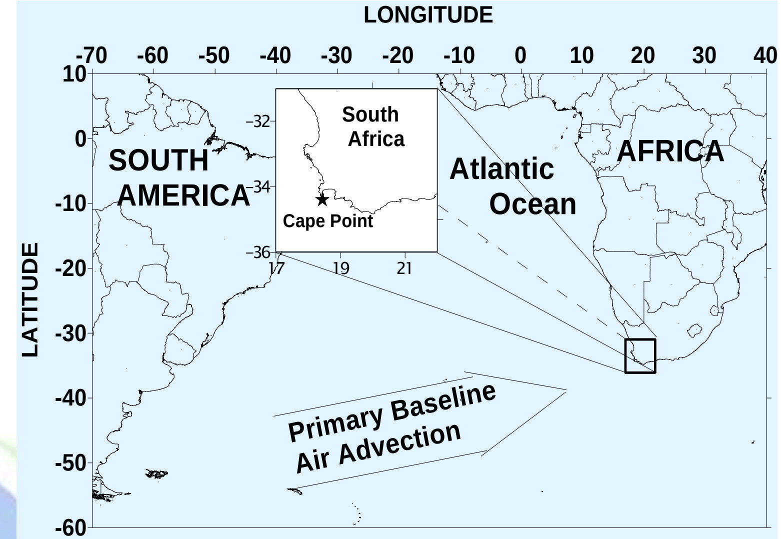
Cape Point (GAW) station: 34^0 S; 18^0 E; 230 m asl.

Situated on a rock face within a nature reserve at the southern point of the Cape Peninsula.

Station 60 km south of Cape Town.

Shrub (fynbos) vegetation. Winter rainfall.

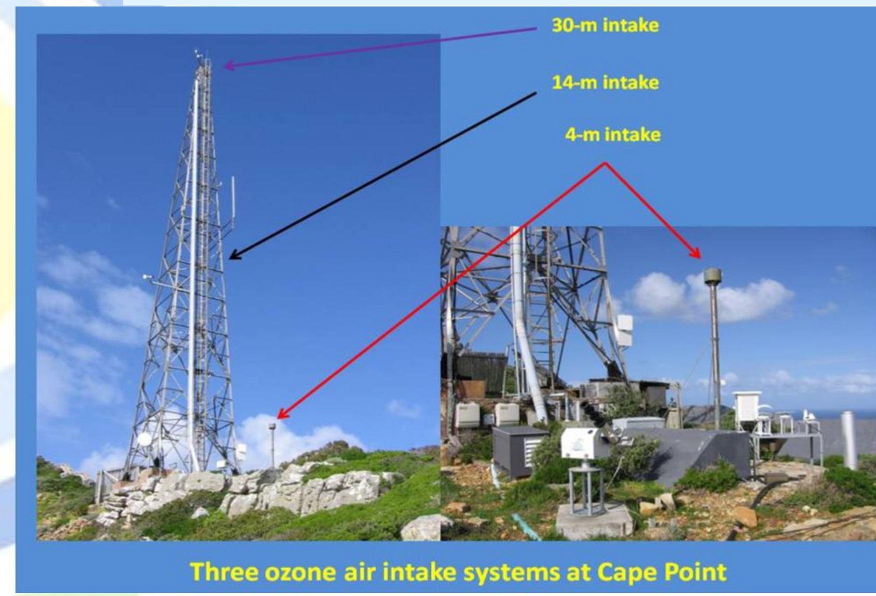
Prevailing winds from SE; however, main large-scale advection from SW.



Instrumentation:

3 analysers Thermo Electron TE 49. Air intakes at 4 m; 14 m and 30 m.

Calibration tied to the WMO/GAW scale.



Three ozone air intake systems at Cape Point

Data sets for surface ozone:

30 m: 1983 – 2010 with major gap in 1990;

4 m: 2000 - 2010

Data filtered for background conditions stored separately.

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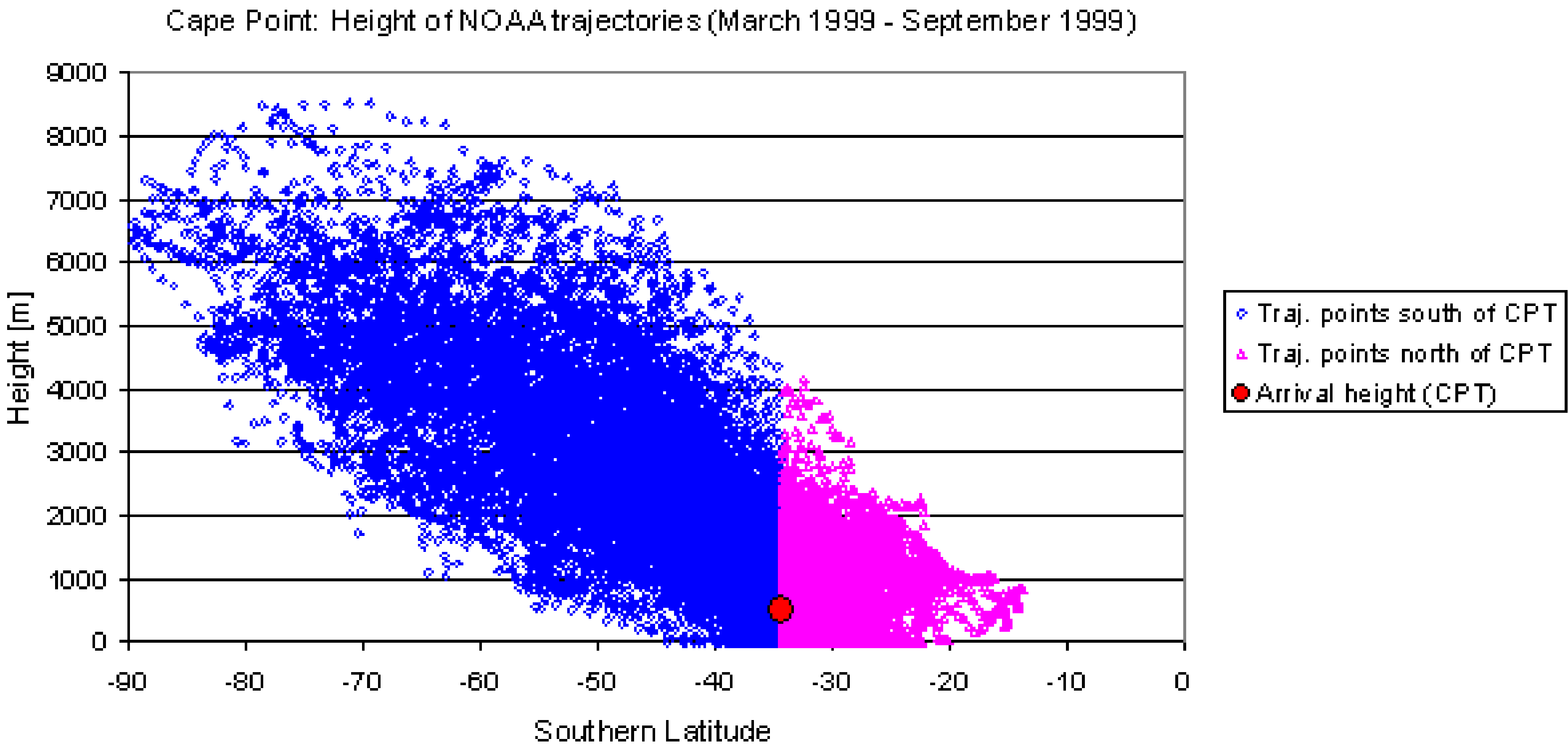
Years of general tendency change: 1989 – 1991, when an overall O_3 increase began.

Dominance of subsiding air masses at Cape Point



Plot of the height of 10-day back trajectory data points versus latitude for data from March – September 1999. Trajectories by courtesy of NOAA CMDL (Joyce Harris).
(Taken from: Brunke and Scheel, Final Project Report 2002)

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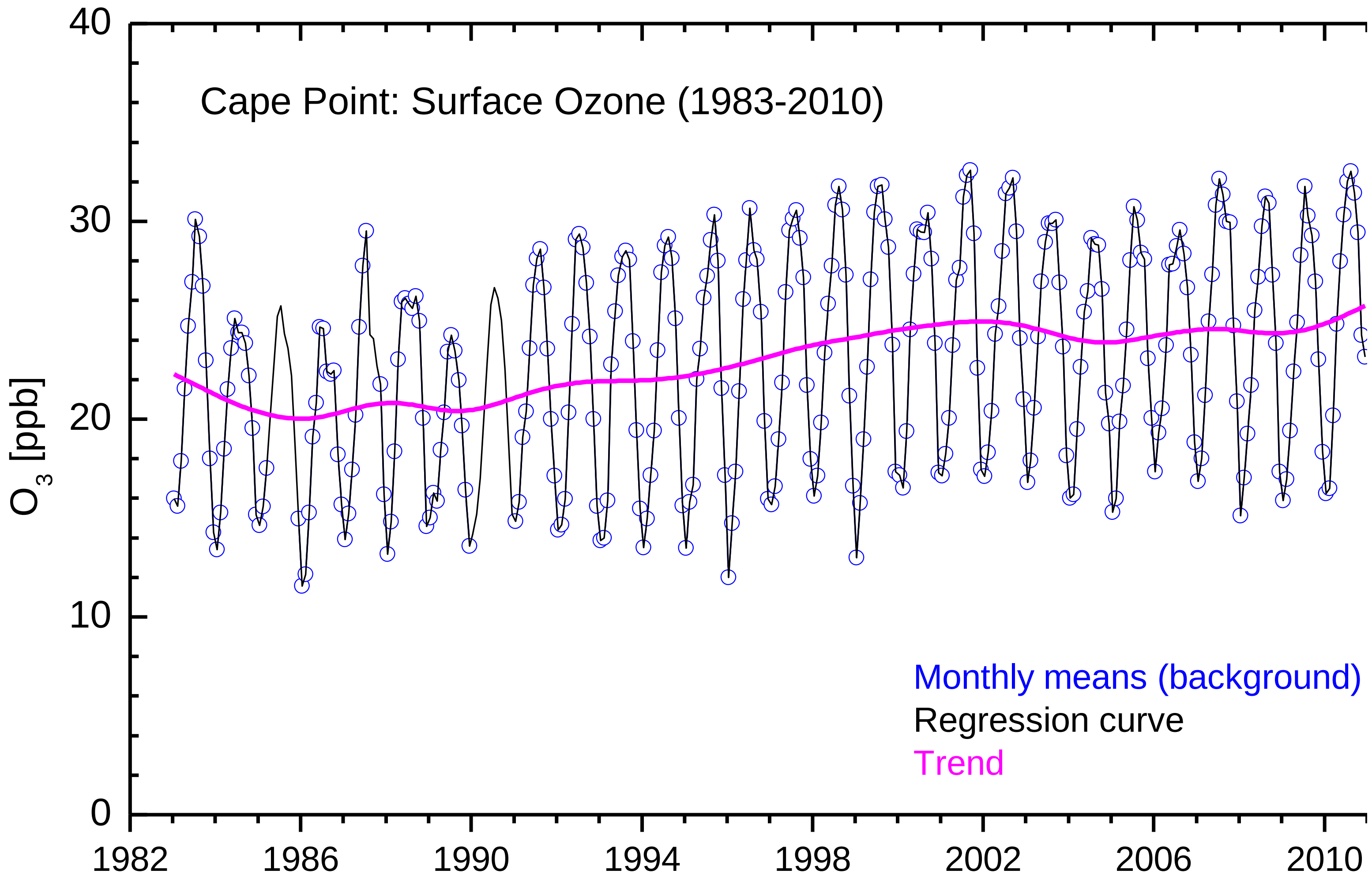
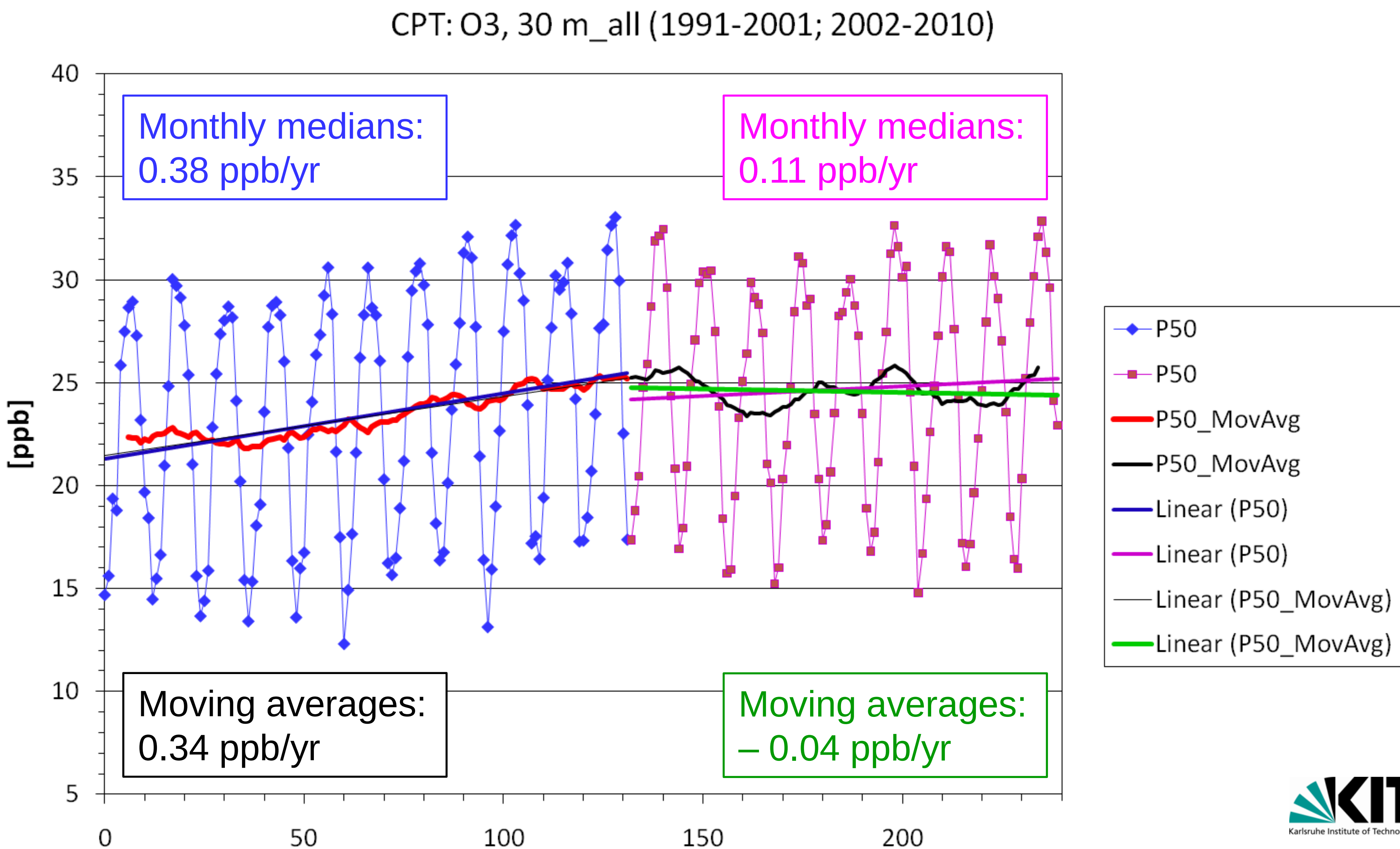
O_3 monthly mean values (1983 – 2010) together with regression curve and long-term trend component



Time series for 30-m air intake, statistical background filter

O_3 monthly median values (1991 – 2010) and 12-month moving averages together with linear regression



Months numbers 0 – 131: Jan 1991 – Dec 2001; 132 – 239: Jan 2002 – Dec 2010

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Definition of concept of anomalies

1) **Monthly anomaly** (e.g. December) for a given year (yi) is calculated as follows:

Dec_yi = Dec_mean_yi – Dec_mean_all

where Dec_mean_all is the average of all Decembers for the time period being investigated.

2) **Seasonal anomaly** (e.g. summer) for a given year (yi) is calculated as follows:

Summer_yi = [(Dec_yi - Dec_mean) + (Jan_yi - Jan_mean) + (Feb_yi - Feb_mean)]/3

where Dec_mean is the average of all Decembers for the respective time period.

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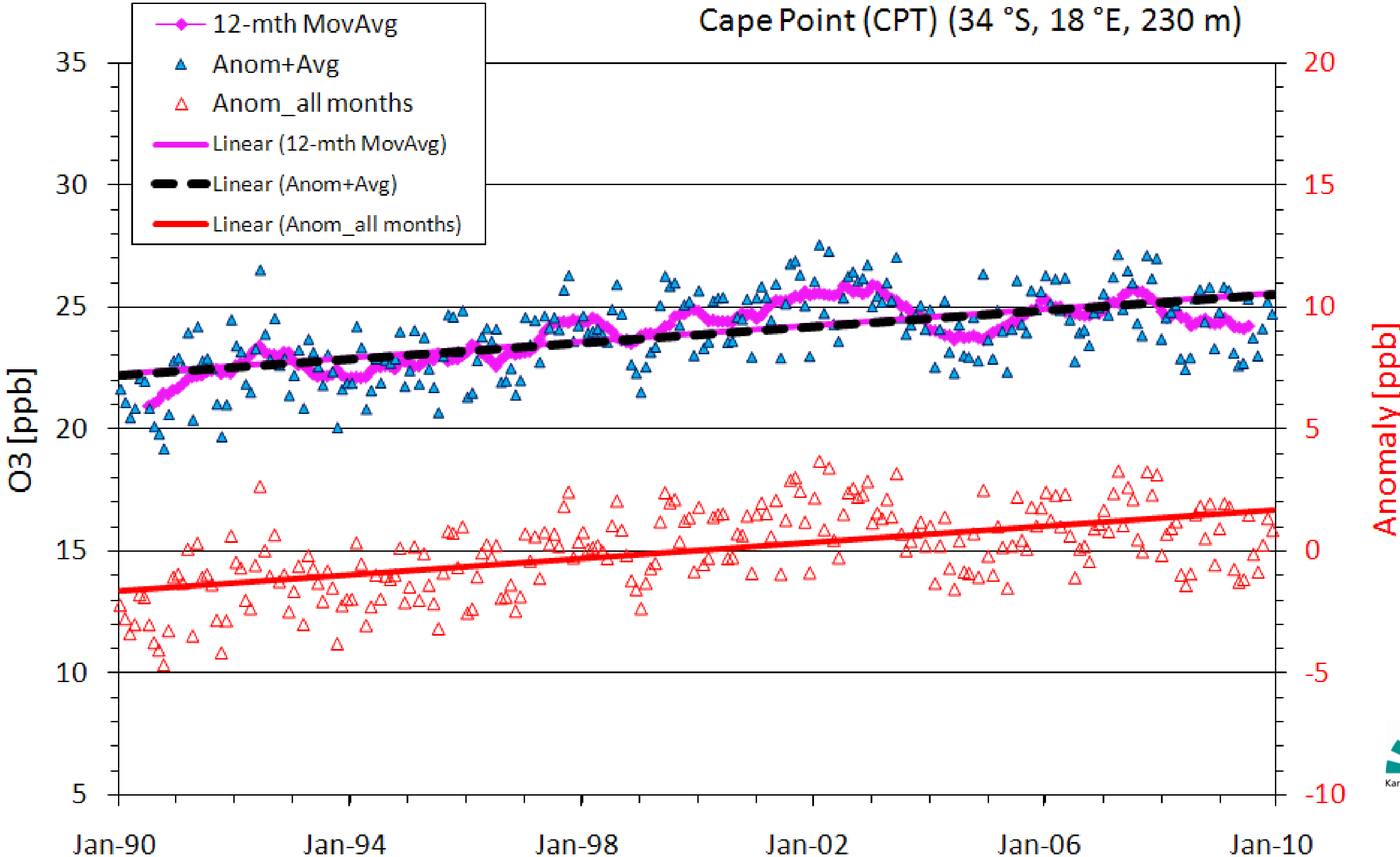
The above processes deseasonalize the data.

30-m air intake, unfiltered data

Annual Trends

Comparison of anomalies (relative and absolute) with 12-month moving averages (1990 – 2009)

Slope *(95%-conf. interval)*	**0.17** (0.14 – 0.20)
Intercept Jan 2000 (C.I.)	23.9 (23.7 – 24.1)
r ^2 [%]	32.9 %



absolute anomaly = calculated anomaly + average O_3. Ref. = January 2000

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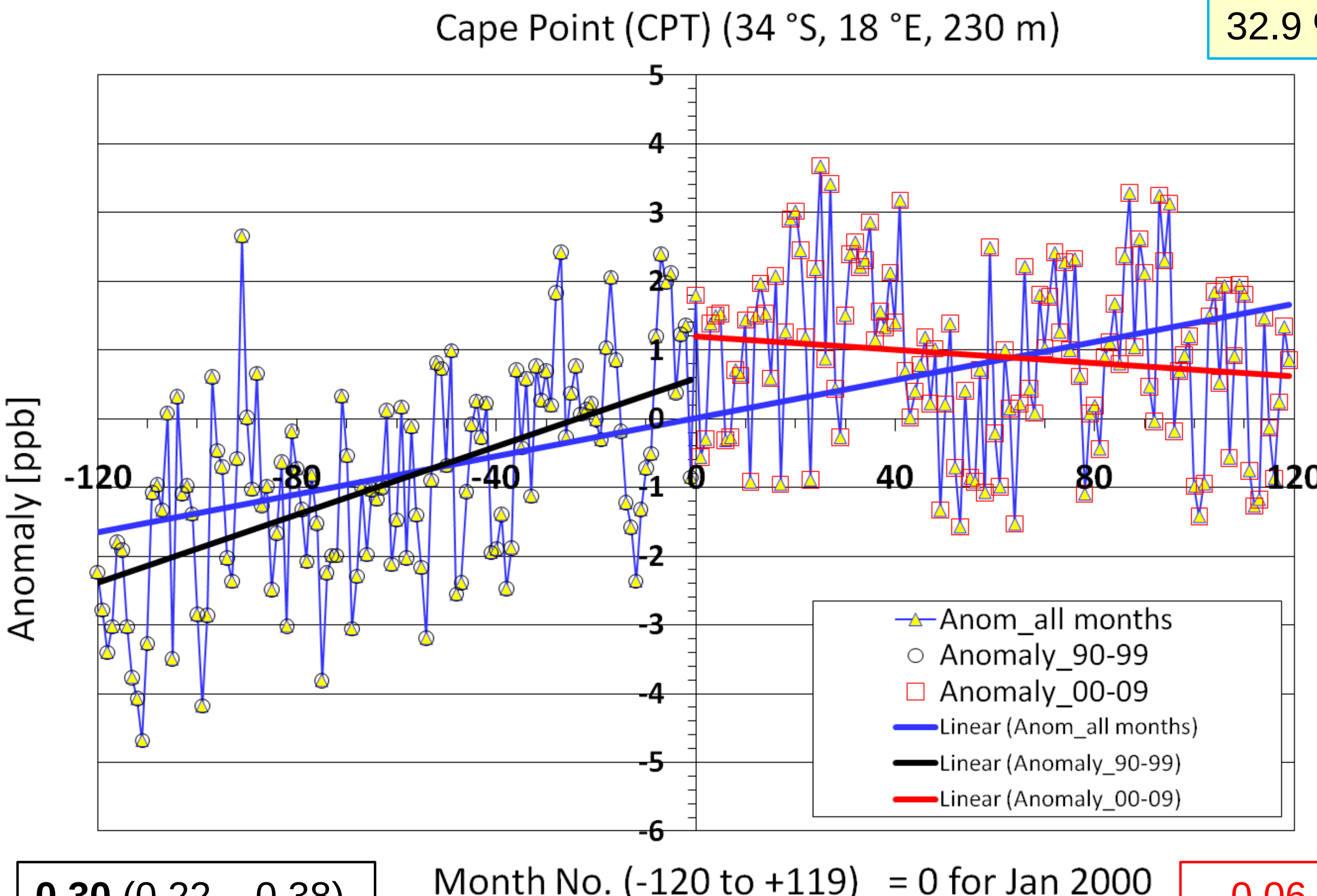
30-m air intake, unfiltered data

Annual Trends

Average ozone increase according to anomalies of the periods **1990 – 2009**, **1990 – 1999**, **2000 - 2009**

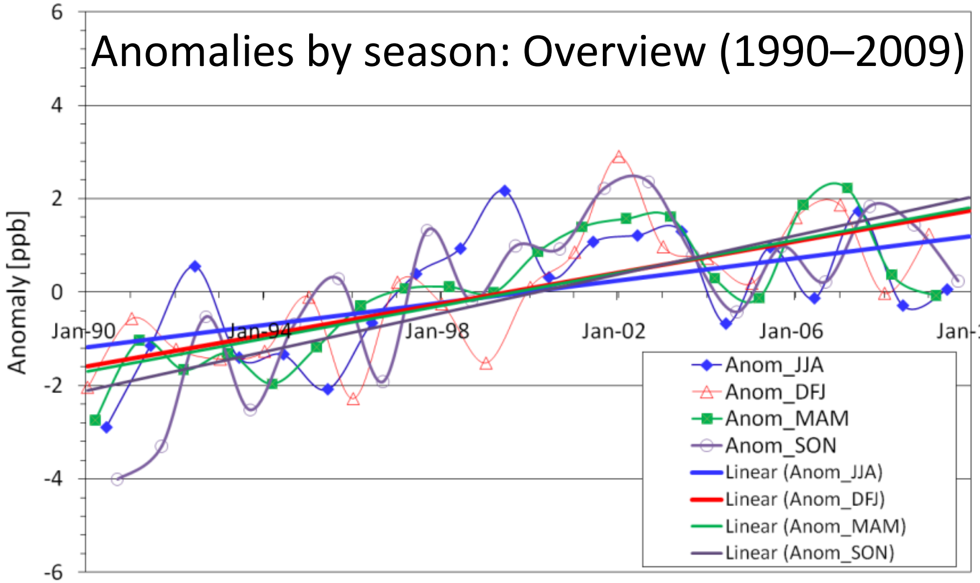
0.17 (0.14 – 0.20)
23.9 (23.7 – 24.1)
32.9 %



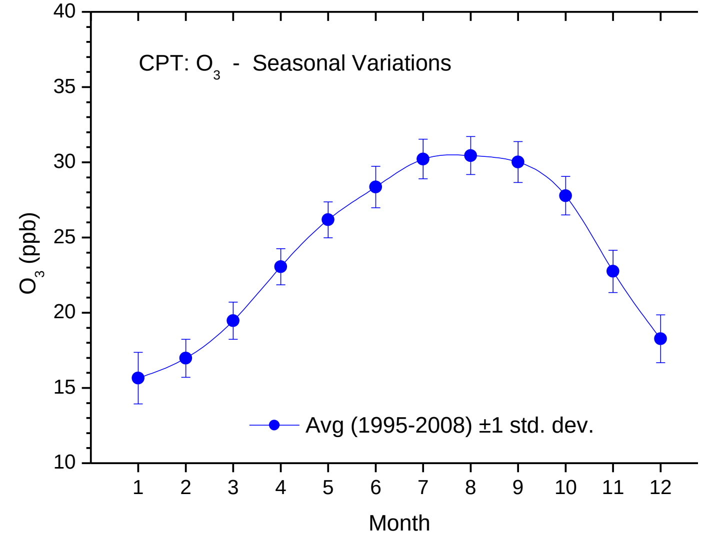
0.30 (0.22 – 0.38)
24.5 (24.0 – 24.9)
31.1 %

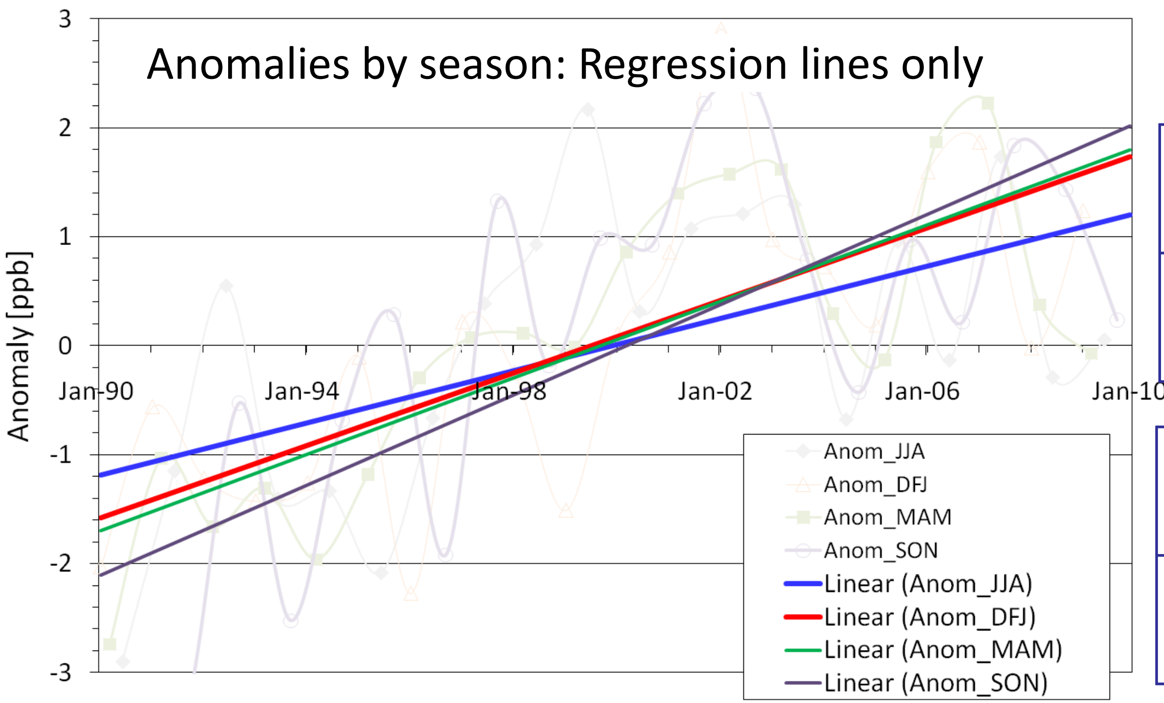
– 0.06 (- 0.14 - 0.02)
25.1 (24.6 – 25.5)
1.8 %

Seasonal Trends: Max. SON, Min. JJA



Cape Point surface ozone:
Average seasonal variations (1995 – 2008)
with flat July-September maximum and
minimum in January.





DFJ SH summer	**MAM** SH autumn
0.17 (0.09 – 0.25) 17.0	**0.18** (0.10 – 0.25) 23.0

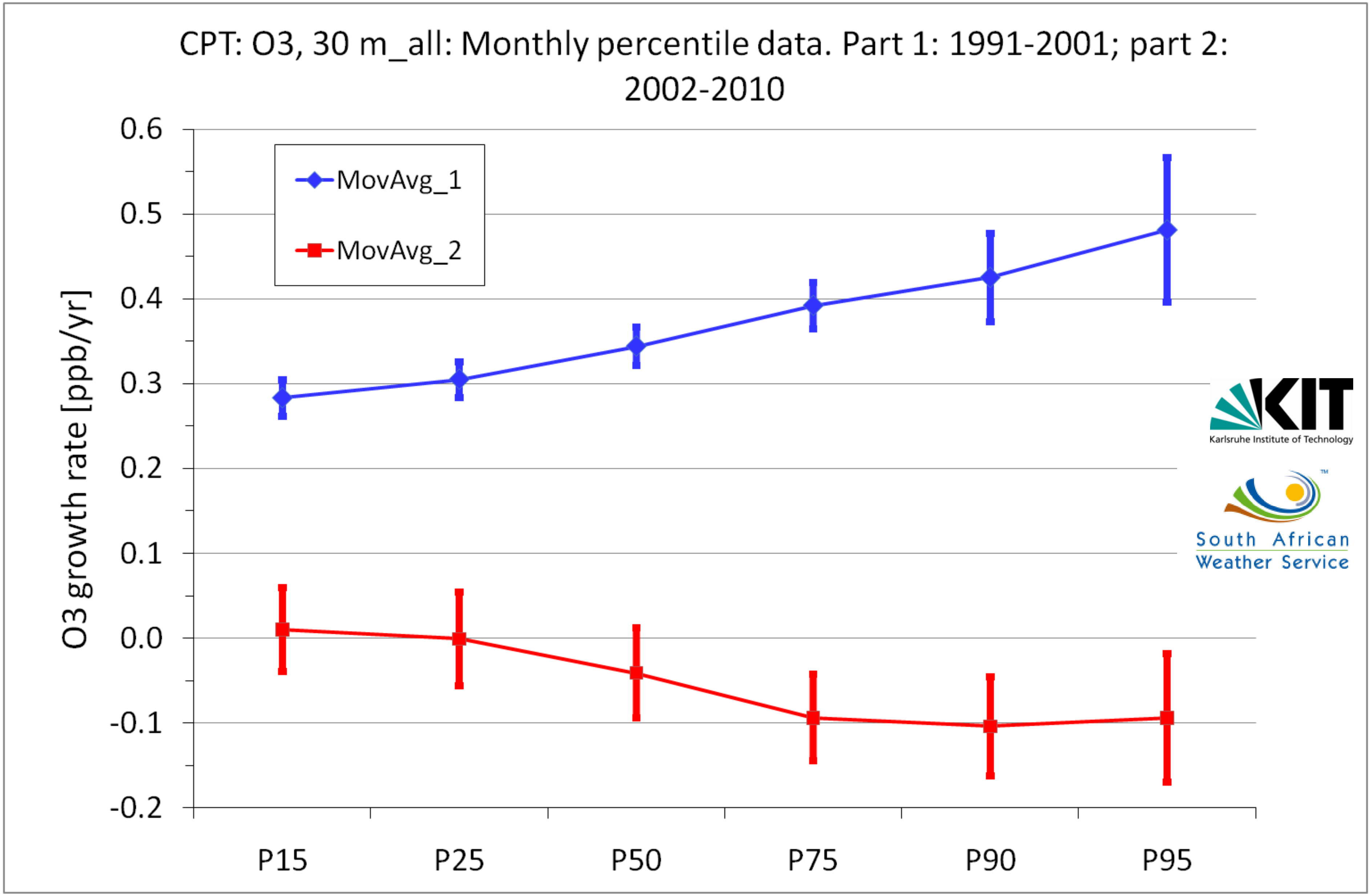
JJA SH winter	**SON** SH spring
0.12 (0.03 – 0.21) 29.2	**0.21** (0.10 – 0.31) 26.5

Site: **CPT** **Annual trends**	Slope and 95% confidence interval	From monthly mean anomalies (all available data) 30-m air intake	Statistical background filtering applied	4-m air intake (all data) 2000 - 2009
1990 – 2009	Slope [ppb/yr]	**0.17** (0.14 – 0.20)	**0.17** (0.15 – 0.20)	-------------
1990 - 1999	Slope [ppb/yr]	**0.30** (0.22 – 0.38)	**0.34** (0.27 – 0.40)	-------------
2000 - 2009	Slope [ppb/yr]	– 0.06 (- 0.14 - 0.02)	– 0.06 (–0.13 - 0.01)	– 0.07 (–0.24 - 0.10)

Significant positive rates in **bold** None of the negative rates is significant

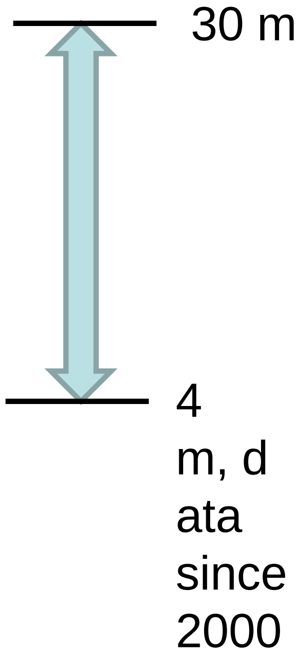
Seasonal trends (30 m all)	DFJ SH summer	MAM SH autumn	JJA SH winter	SON SH spring
1990 – 2009	**0.17** (0.09 – 0.25)	**0.18** (0.10 – 0.25)	**0.12** (0.03 – 0.21)	**0.21** (0.10 – 0.31)
1990 - 1999	0.08 (– 0.14 - 0.29)	**0.27** (0.14 – 0.41)	**0.37** (0.08 – 0.65)	**0.48** (0.18 – 0.77)
2000 - 2009	0.00 (– 0.24 – 0.24)	– 0.07 (–0.29 - 0.15)	– 0.07 (–0.28 - 0.14)	– 0.09 (–0.32 - 0.15)

O_3 growth rates calculated for 12-month moving averages of different percentiles for 1991-2001 and 2002-2010

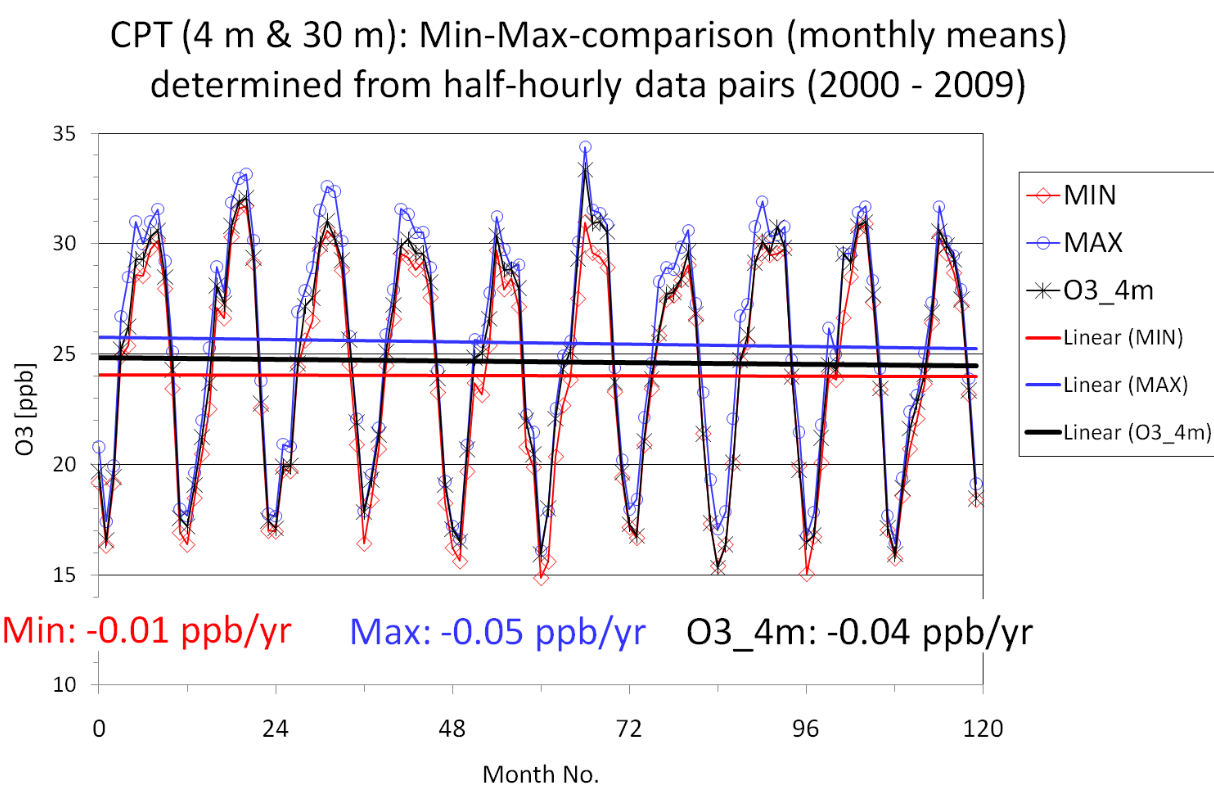


Characterisation of the air between 4 m and 30 m

CPT, air intake heights



Goal: Estimate of representativeness of the air at the 2 intake heights.
Approach: 1/2-h means for the 2 heights, sorted as maximum and minimum of the data pairs. Calculation of monthly means, visualisation of both time series together with linear regression.
Result: Between 4 and 30 m the O_3 maxima and minima within the half-hour periods differ only by 1.5 ppb on average. No indication of different trend behaviour.
The 2000-2009 O_3 averages over the monthly means for 4 m and 30 m agree within ≈ 0.2 ppb.



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Summary and Conclusions

- Time series can be roughly divided into 3 parts with smooth transitions:
1983 – 1989/90: No clear trend behaviour, 2 major gaps.
1990/91 – 2001/02: Ozone increase statistically significant.
2002/03 onwards: Stabilization (insignificant growth rates).

- The significant O_3 increase between 1990/91 – 2001/02 took place without seasonal dependence.

- Different statistical techniques yield compatible growth rate estimates.

- O_3 growth rates of six percentiles show that the rise for 1991-2001 and the slight decrease for 2002-2010 is represented by the total O_3 population, thereby suggesting an overall hemispheric process. Regional driving forces might have contributed to the systematic differences within the suite of percentiles of both periods.

- Long-term trends of surface O_3 at Cape Point are not critically dependent on air intake height.

- Since a great deal of the results cannot be explained from the observations alone, modelling studies are called for.

Acknowledgements

Local authorities:

South African National Parks (SANP)

Portnet

Thank you!