RECENT RESULTS FROM MEASUREMENTS OF CO_2, CH_4, CO and N_2O AT THE GAW STATION, CAPE POINT

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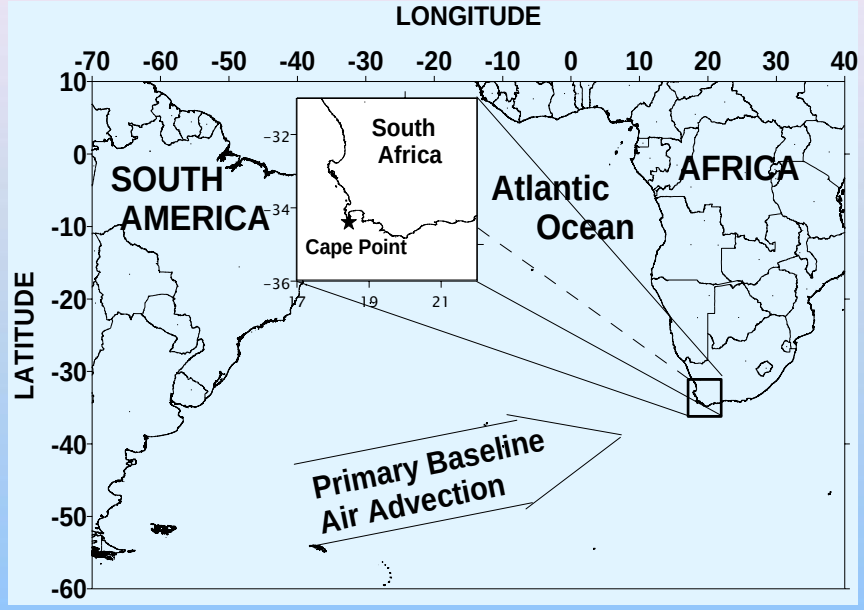
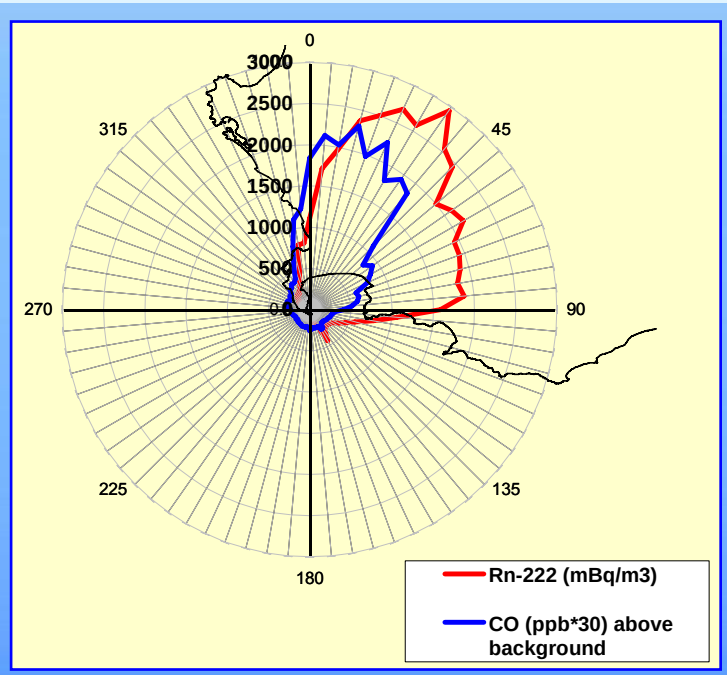
Overview

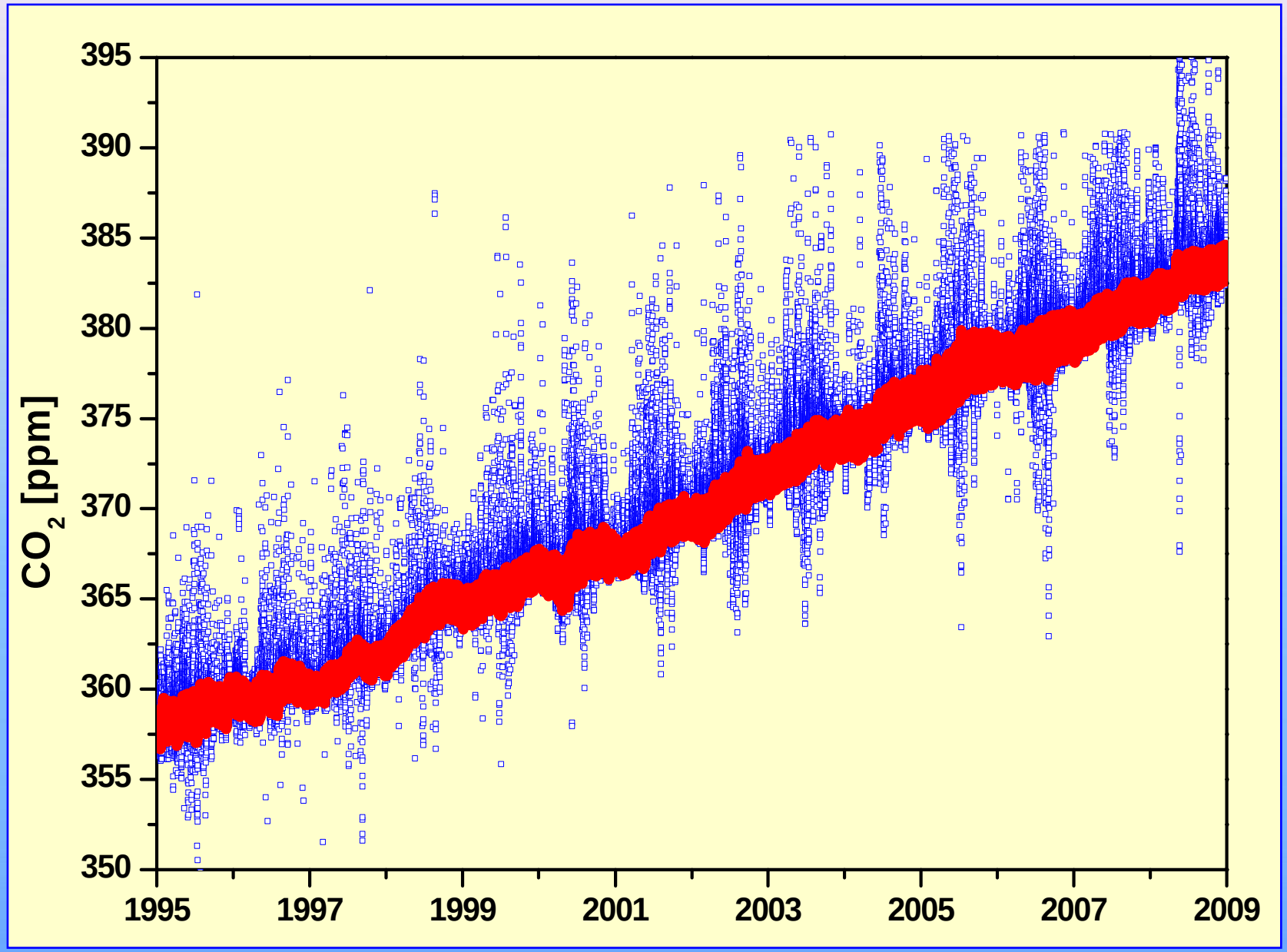
1) CO_2: time series and DDEs
2) CH_4: increasing again
3) CO: recent decreasing trend
4) N_2O: analytical challenges

Advection of air masses

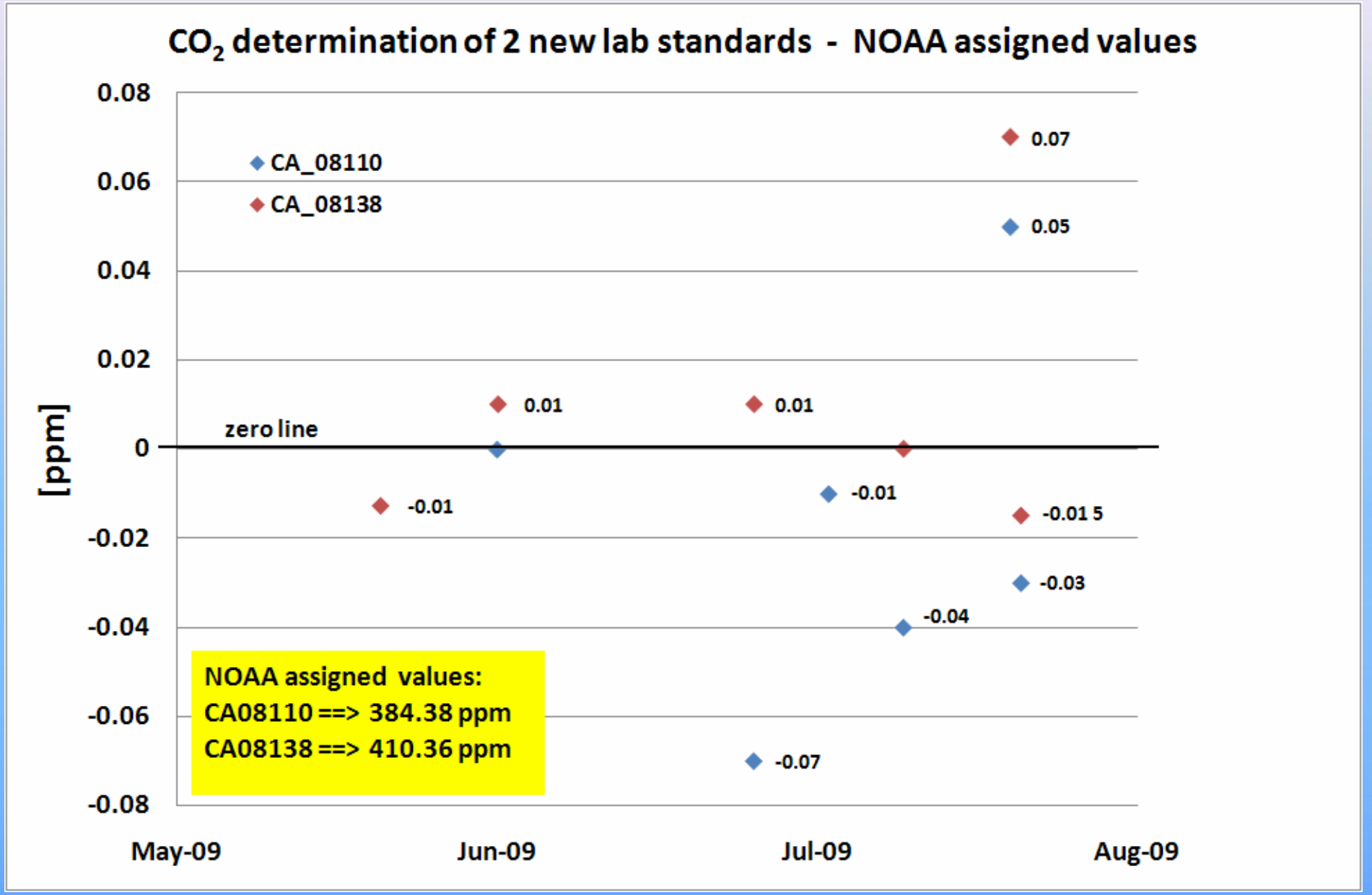


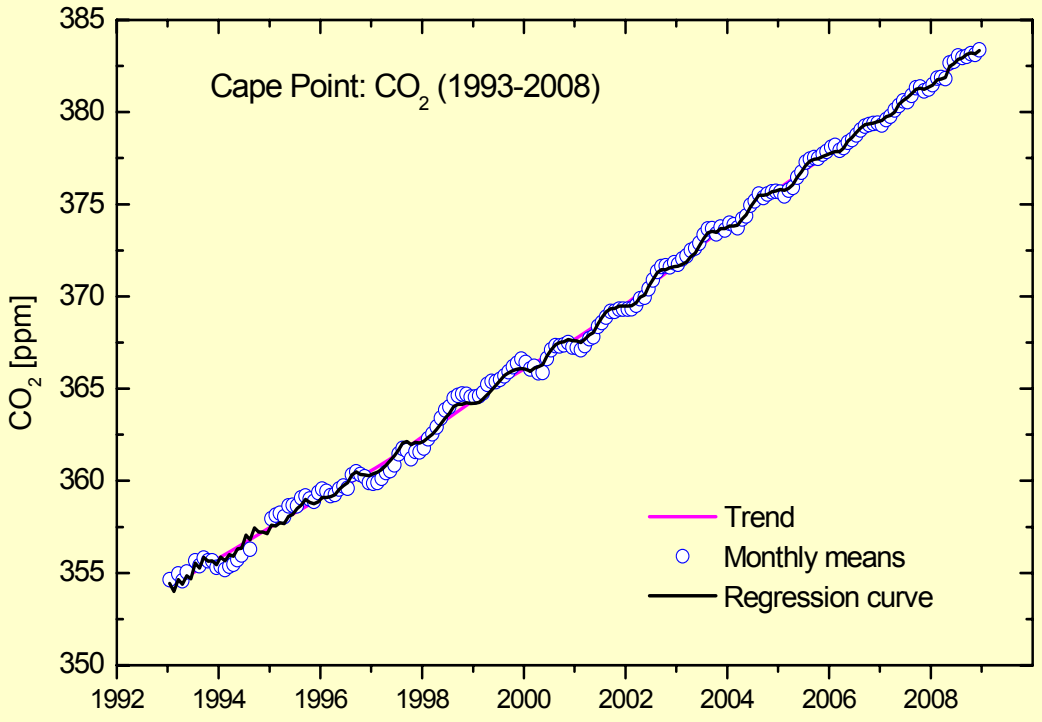


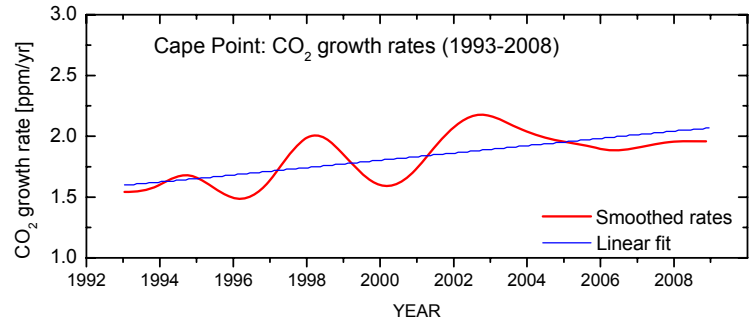
Cape Point: CO_2 half-hourly means



Recently assessed CO_2 uncertainty





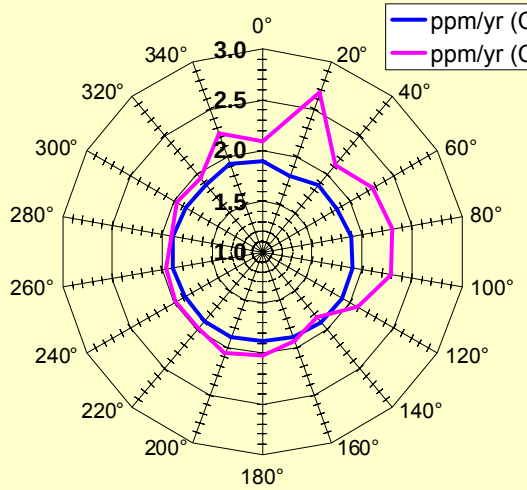


CO_2 levels: Increased by 7.6% (27 ppm) since 1993. The growth rate has increased from 1.6 ppm yr^{-1} in early 1993 to 2.1 ppm yr^{-1} at the end of 2008.

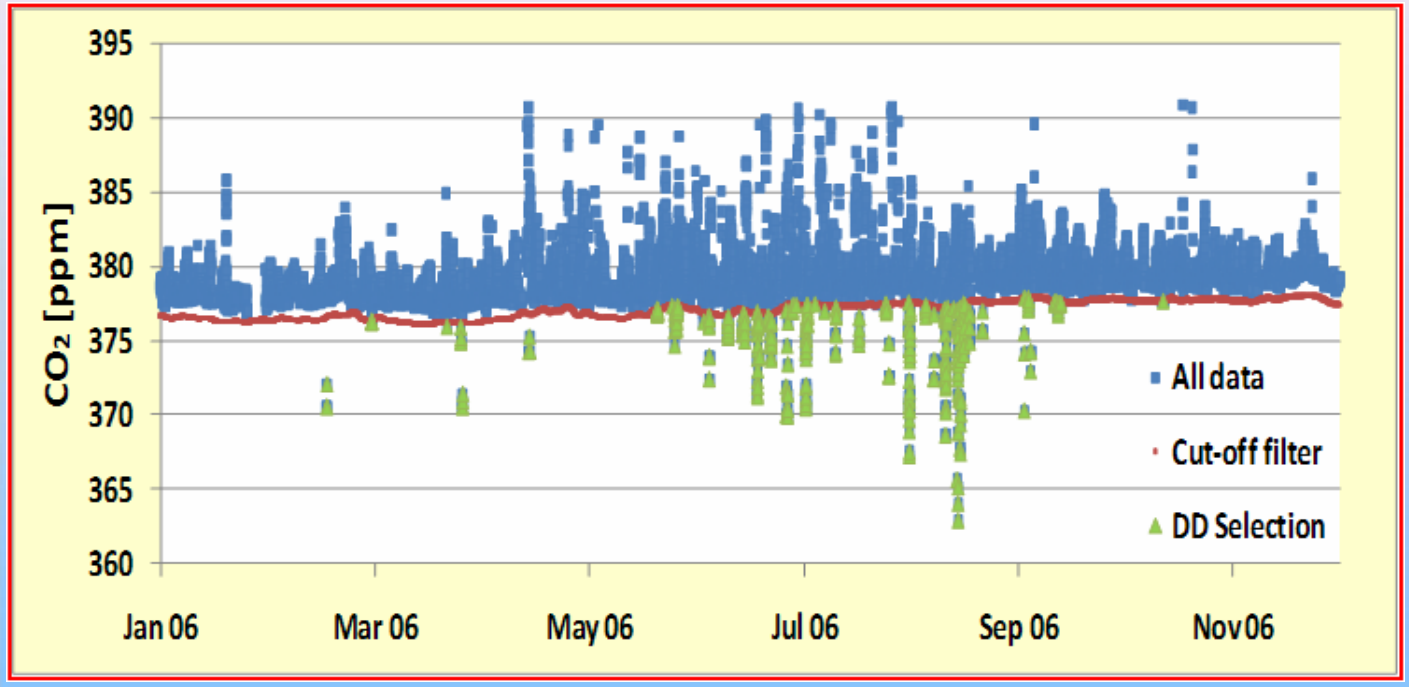
Growth rates of CO_2 [ppm yr^{-1}] as a function of wind direction for the periods 1999 – 2005 and 2006 – 2008.

→ Maximal for the northerly sector. increasing anthropogenic sources associated with the recent expansion of the greater Cape Town area.

CPT: Wind sector-dependent CO2 growth rates, 1999-2005 & 2006-2008



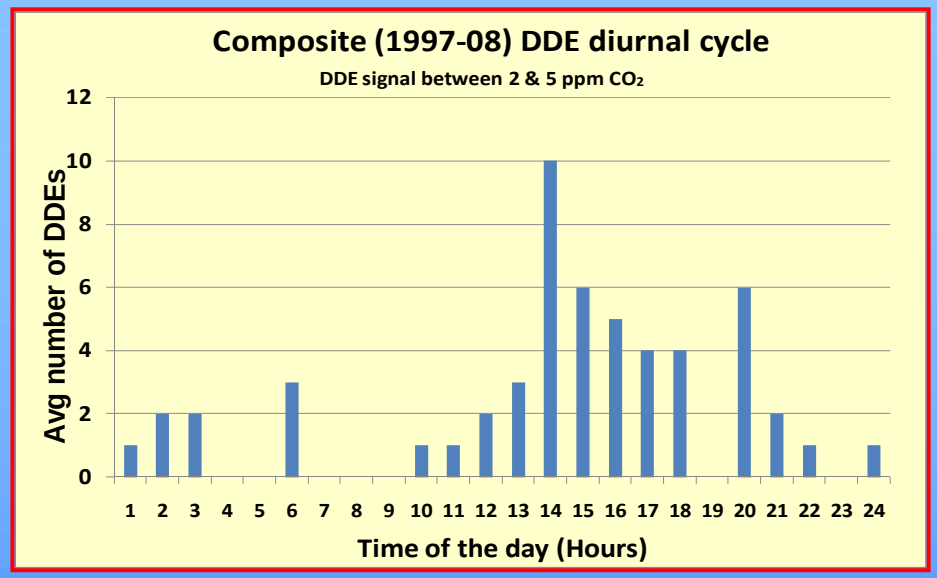
CO_2 Draw-Down Events (DDEs)



Lower cut-off line applied to the CO_2 time series.

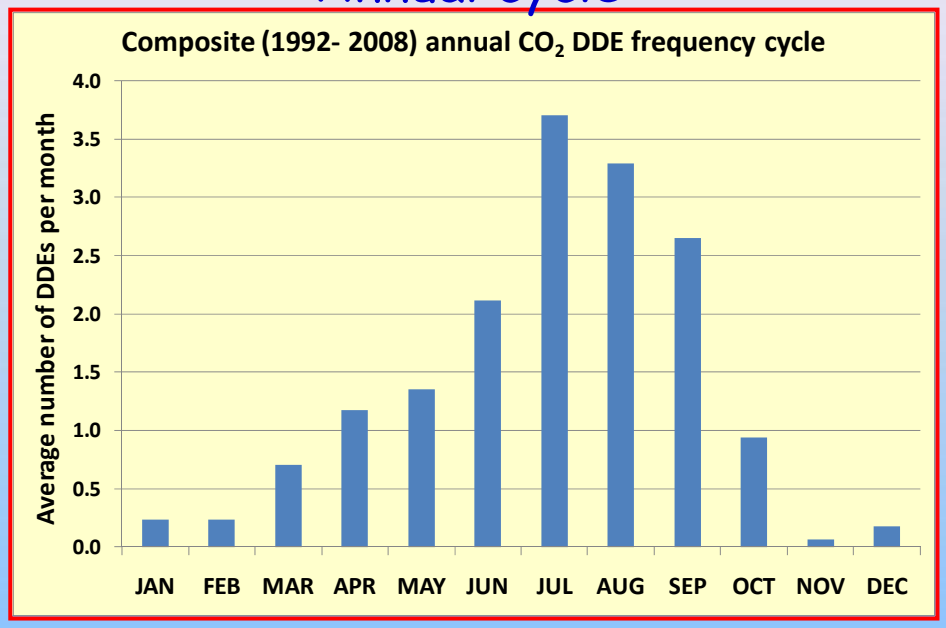
Values below this line (> 5 ppm and > 1.5 hrs) have been classified as draw-down events (DDEs).

DDEs are observed primarily in the afternoon.
Calculated travelling time of approx. 4.2 hours (avg. wind velocity of 10 m/s) from the main draw-down area, 150 km to the east of the station, where a maximum CO_2 uptake around noon is assumed.

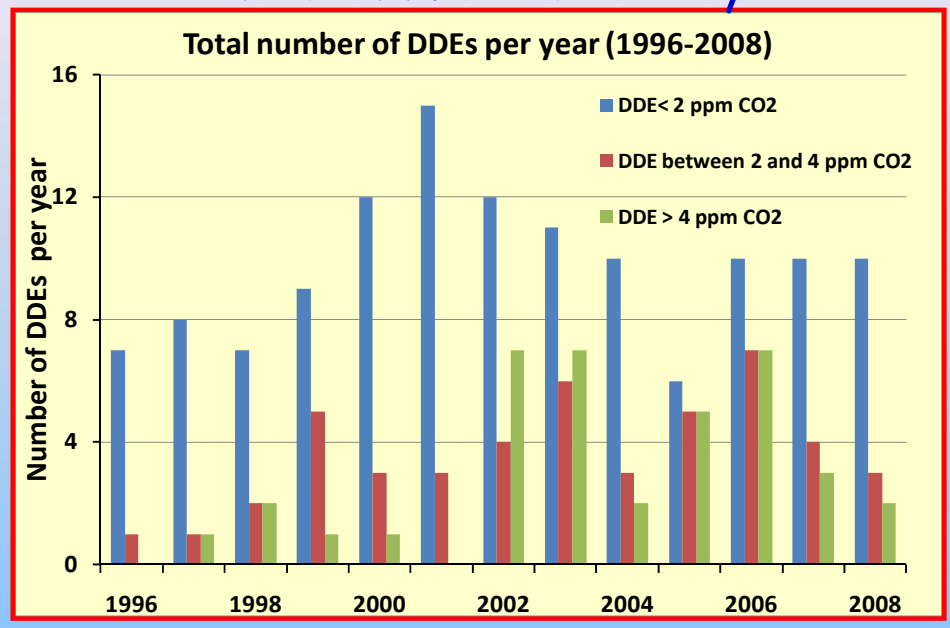


Frequency of DDEs as a function of rainfall in source regions

Annual cycle



Interannual variability

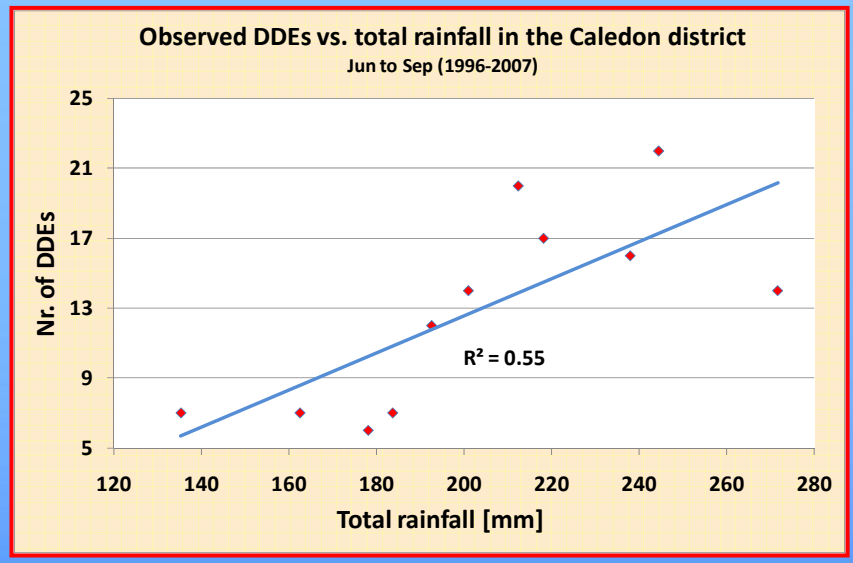


DDEs preferentially during mid-year (peak of the rainy season) and when the regional wheat crops reach their maximum growth potential.

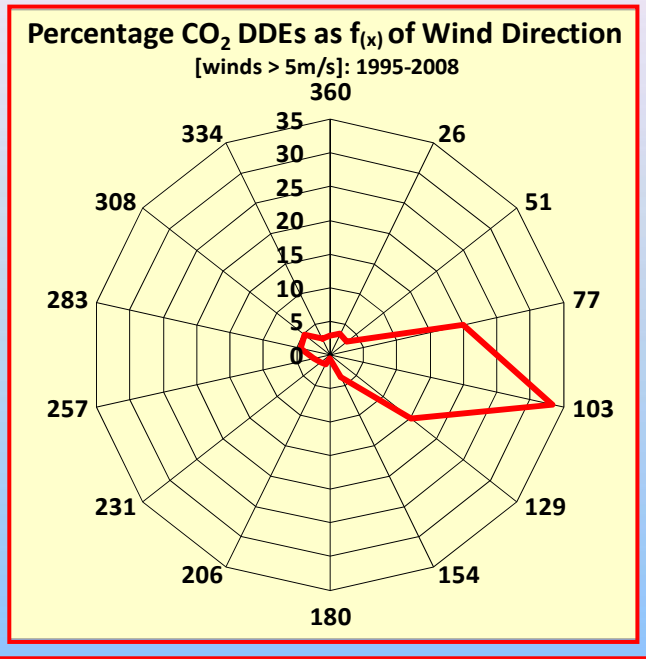
DDE frequency correlates well with total winter rainfall.

→ Asumption that greater wheat production (during wet years) leads to more extensive and effective CO_2 uptake.

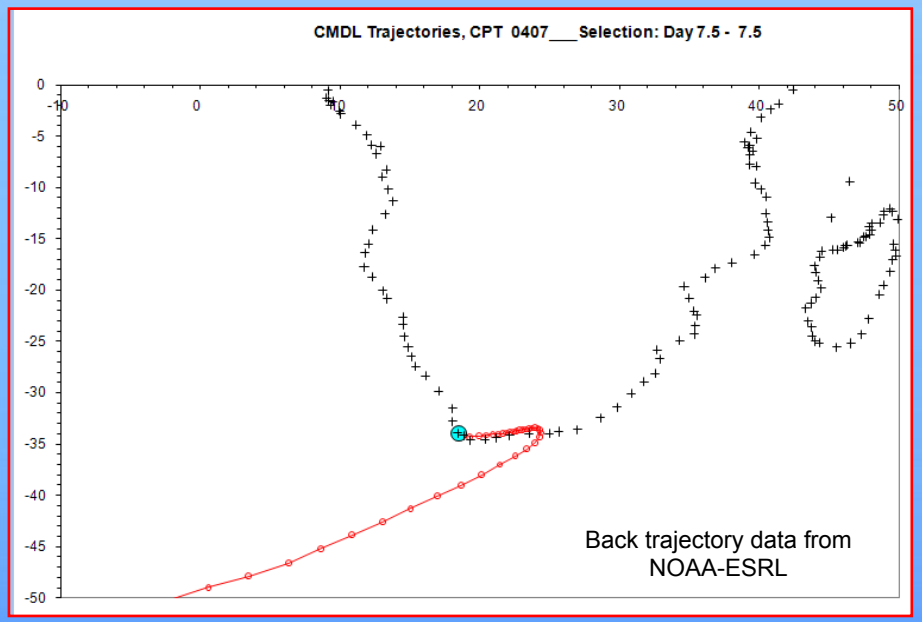
Number of DDEs vs. rainfall

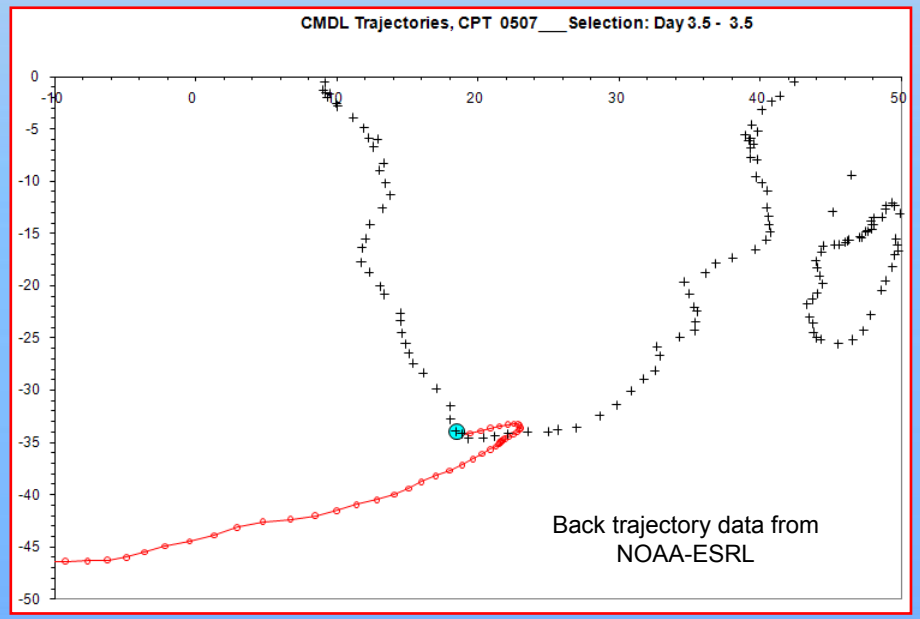


Evidence for CO_2 draw-down regions to the East

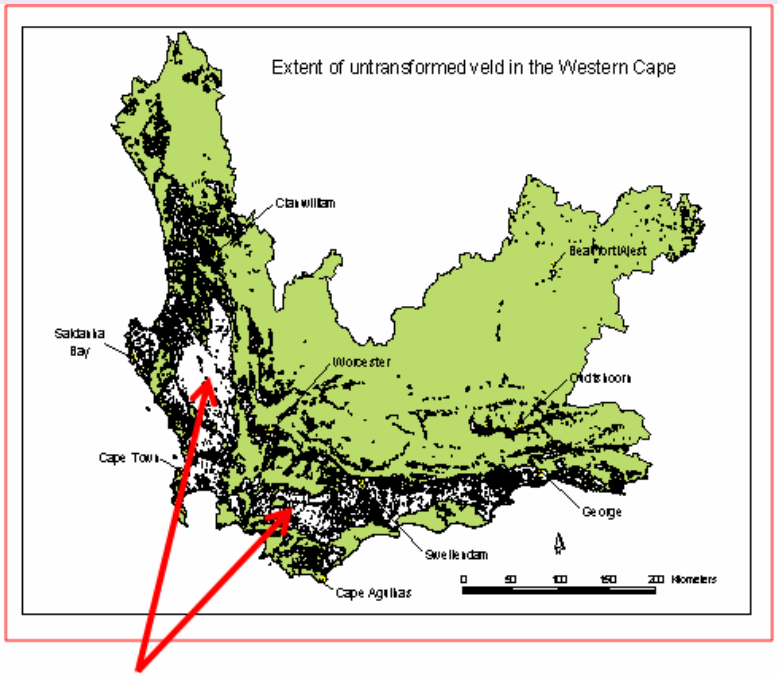


Wind and trajectory data point to significant CO_2 terrestrial sink (wheat growing region) to the east of Cape Point (150 to 300 km radius).





CO_2 Draw-Down Regions



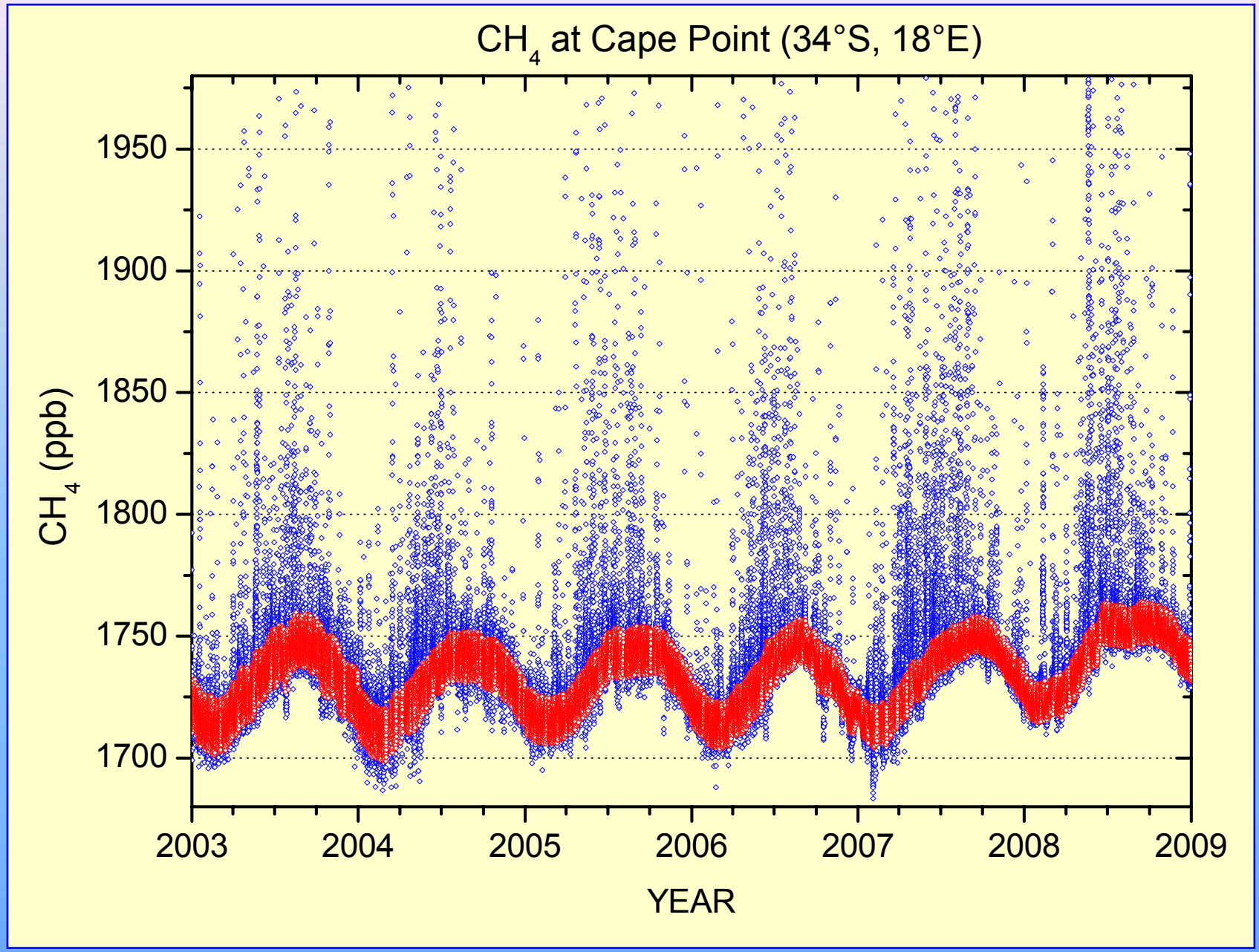
N (Malmesbury) & E (Caledon) wheat growing zones

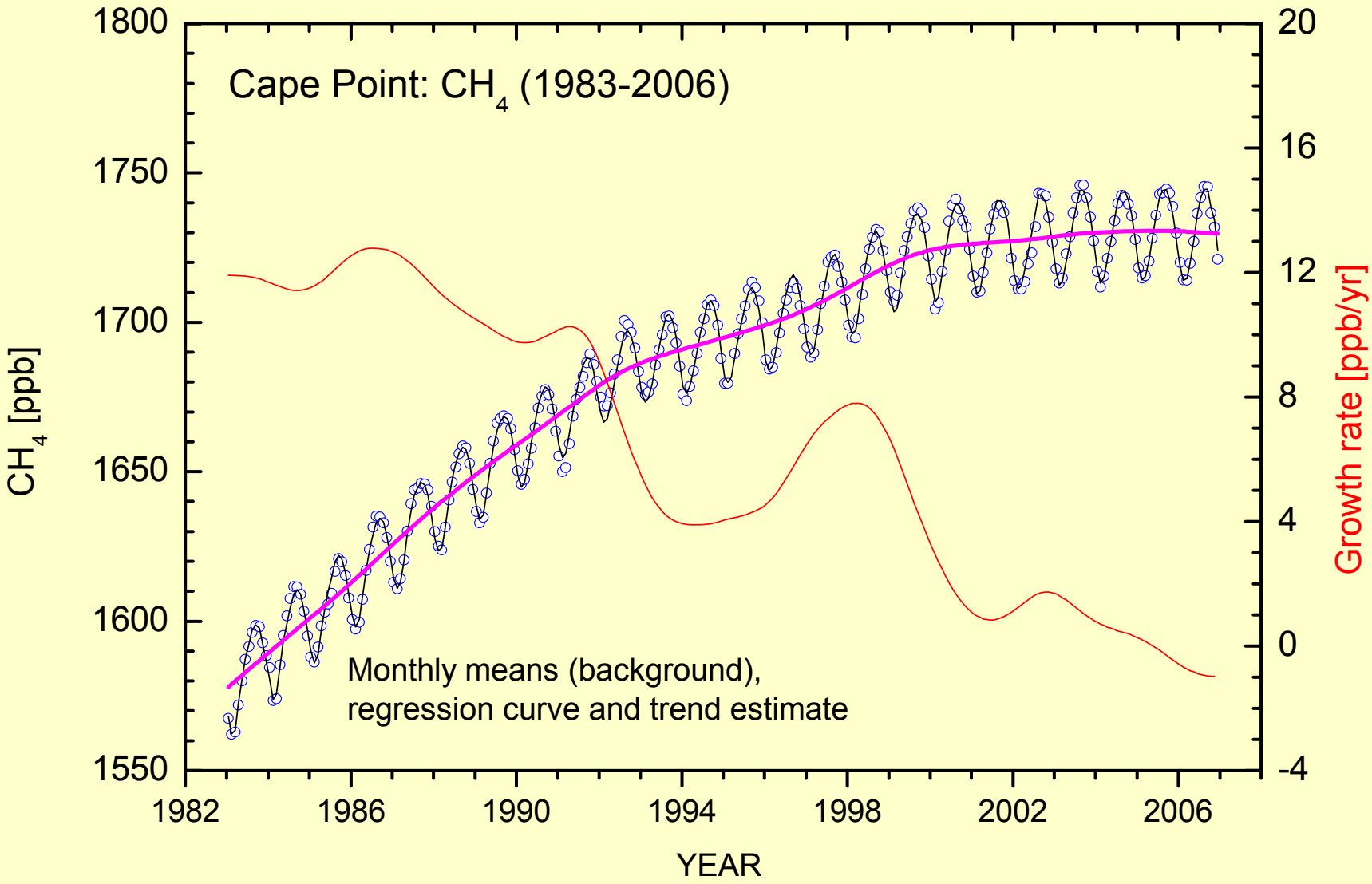
Canola

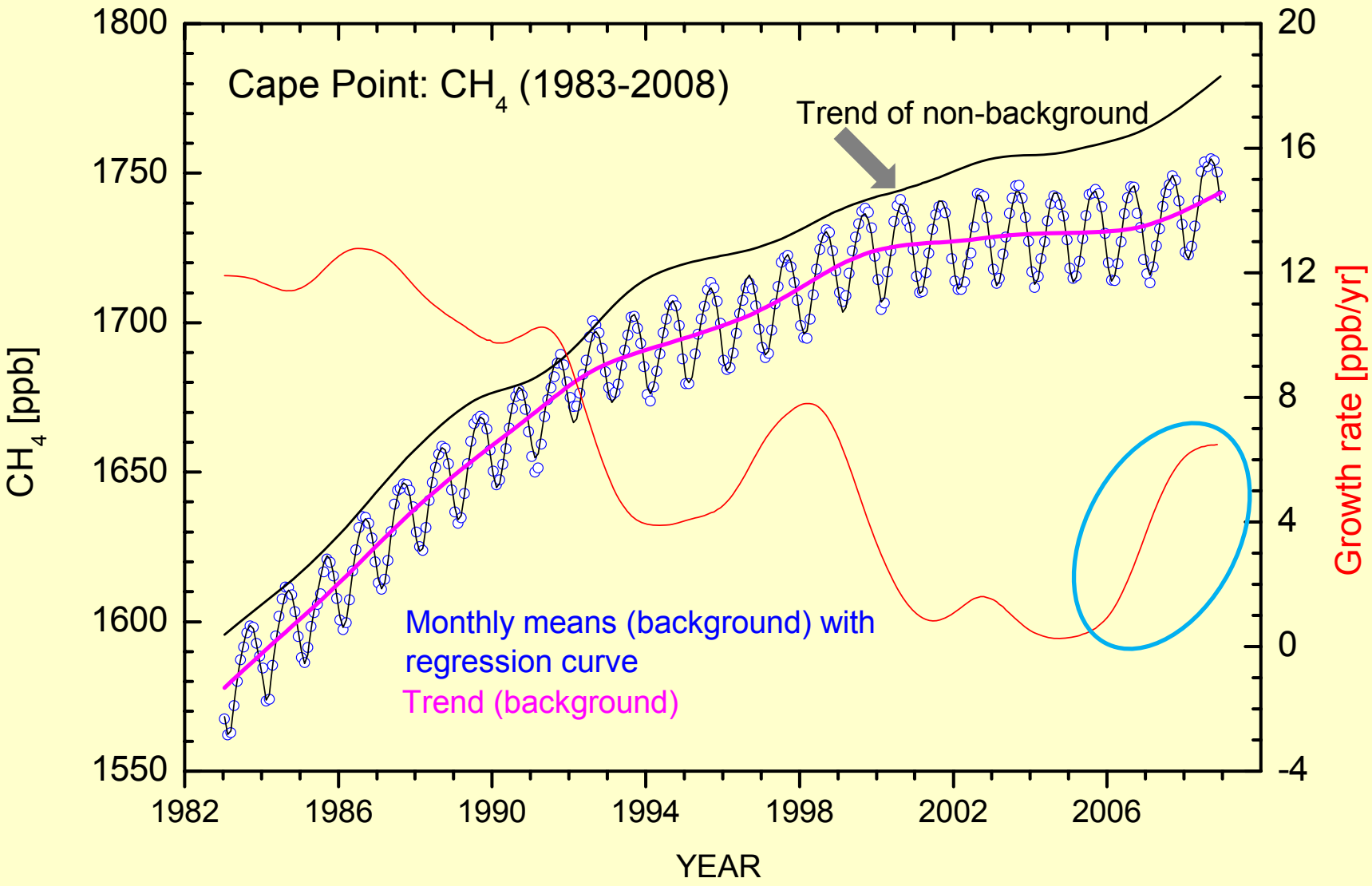
Barley

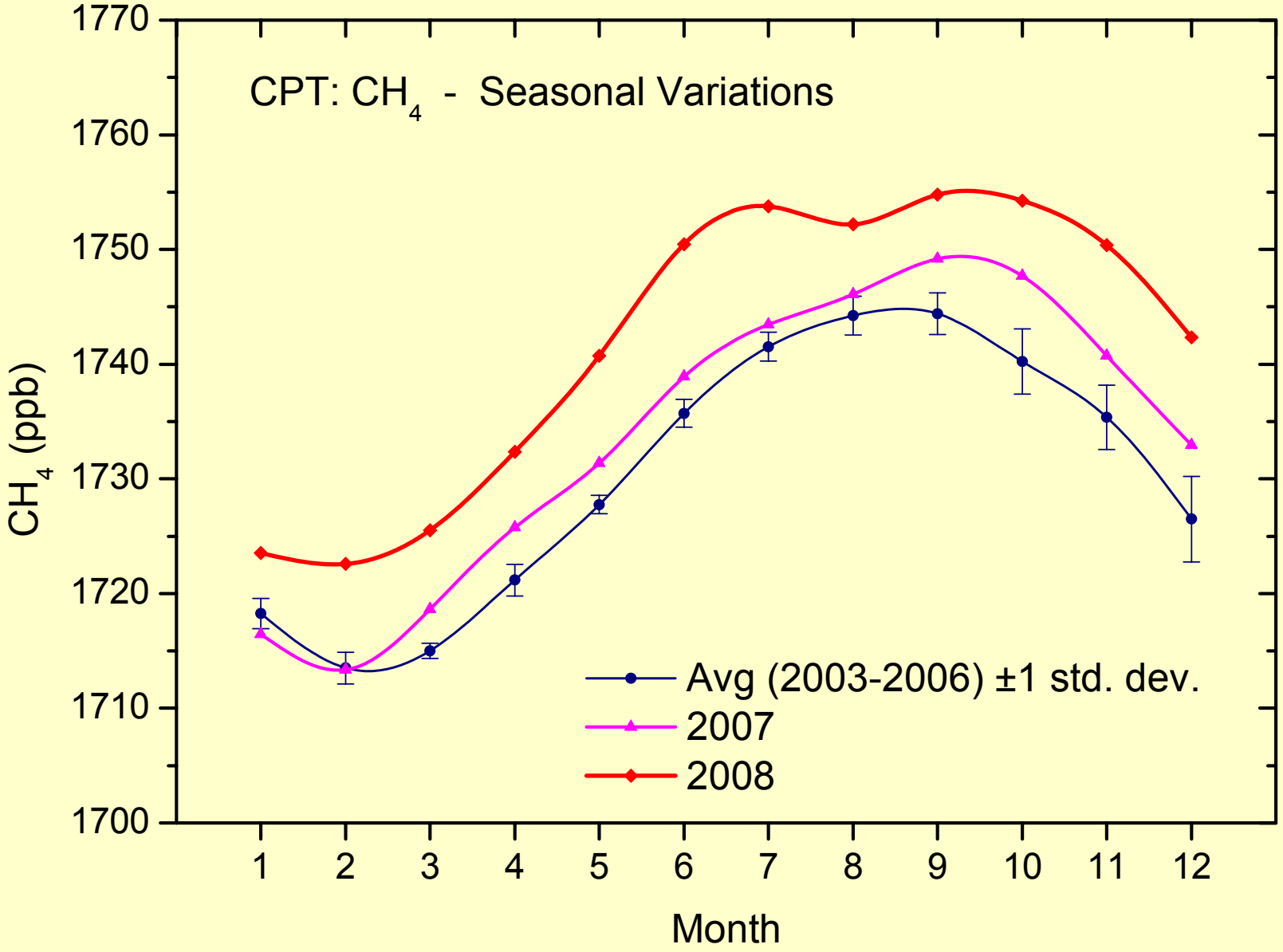
Wheat growing regions to the north and east of Cape Point (150 to 300 km radius).

Cape Point: CH_4 half-hourly means

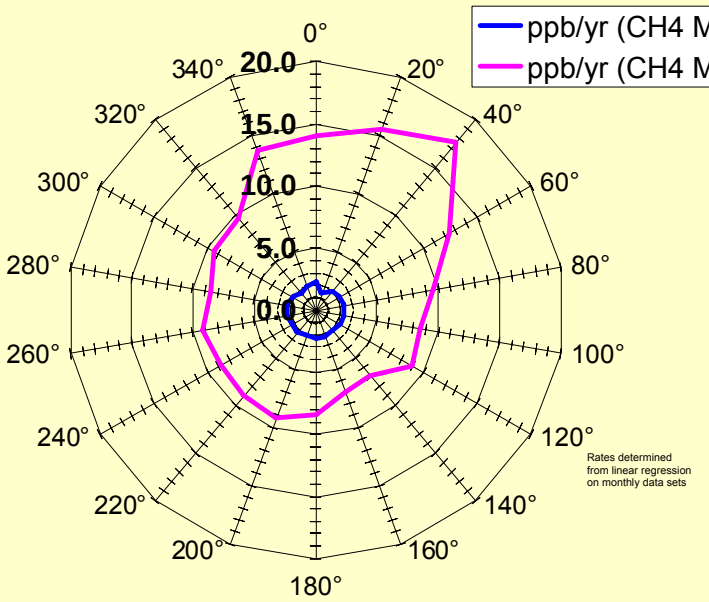



Cape Point: CH4 (1983-2006)
Monthly means (background),
regression curve and trend estimate
CH4 [ppb]
Growth rate [ppb/yr]
YEAR
1800
1750
1700
1650
1600
1550
20
16
12
8
4
0
-4
1982
1986
1990
1994
1998
2002
2006


Cape Point: CH4 (1983-2008)
Trend of non-background
Monthly means (background) with regression curve
Trend (background)
CH4 [ppb]
Growth rate [ppb/yr]
YEAR
1800
1750
1700
1650
1600
1550
20
16
12
8
4
0
-4
1982
1986
1990
1994
1998
2002
2006

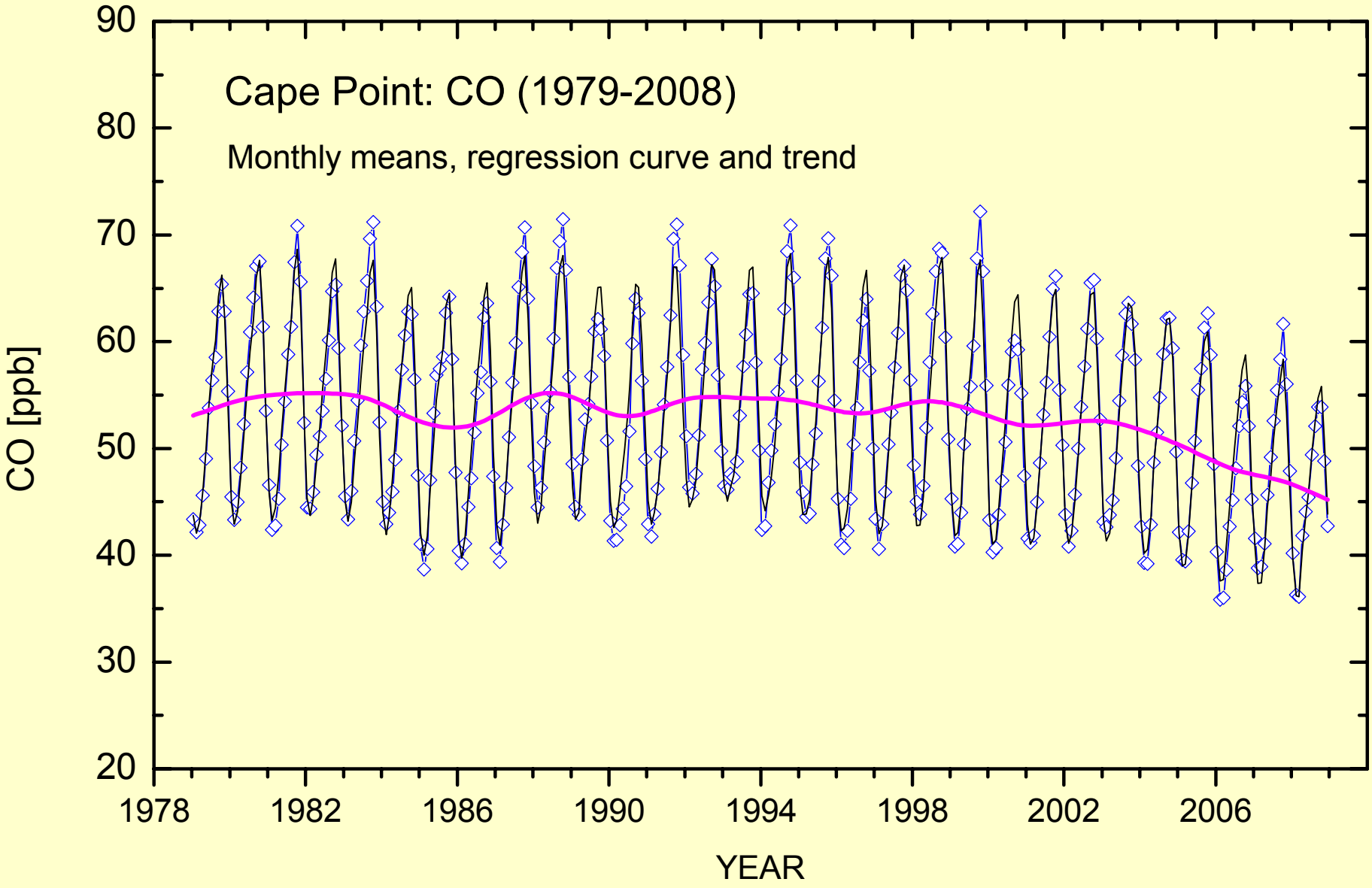

CPT: CH4 - Seasonal Variations
CH4 (ppb)
1770
1760
1750
1740
1730
1720
1710
1700
1
2
3
4
5
6
7
8
9
10
11
12
Month
Avg (2003-2006) ±1 std. dev.
2007
2008

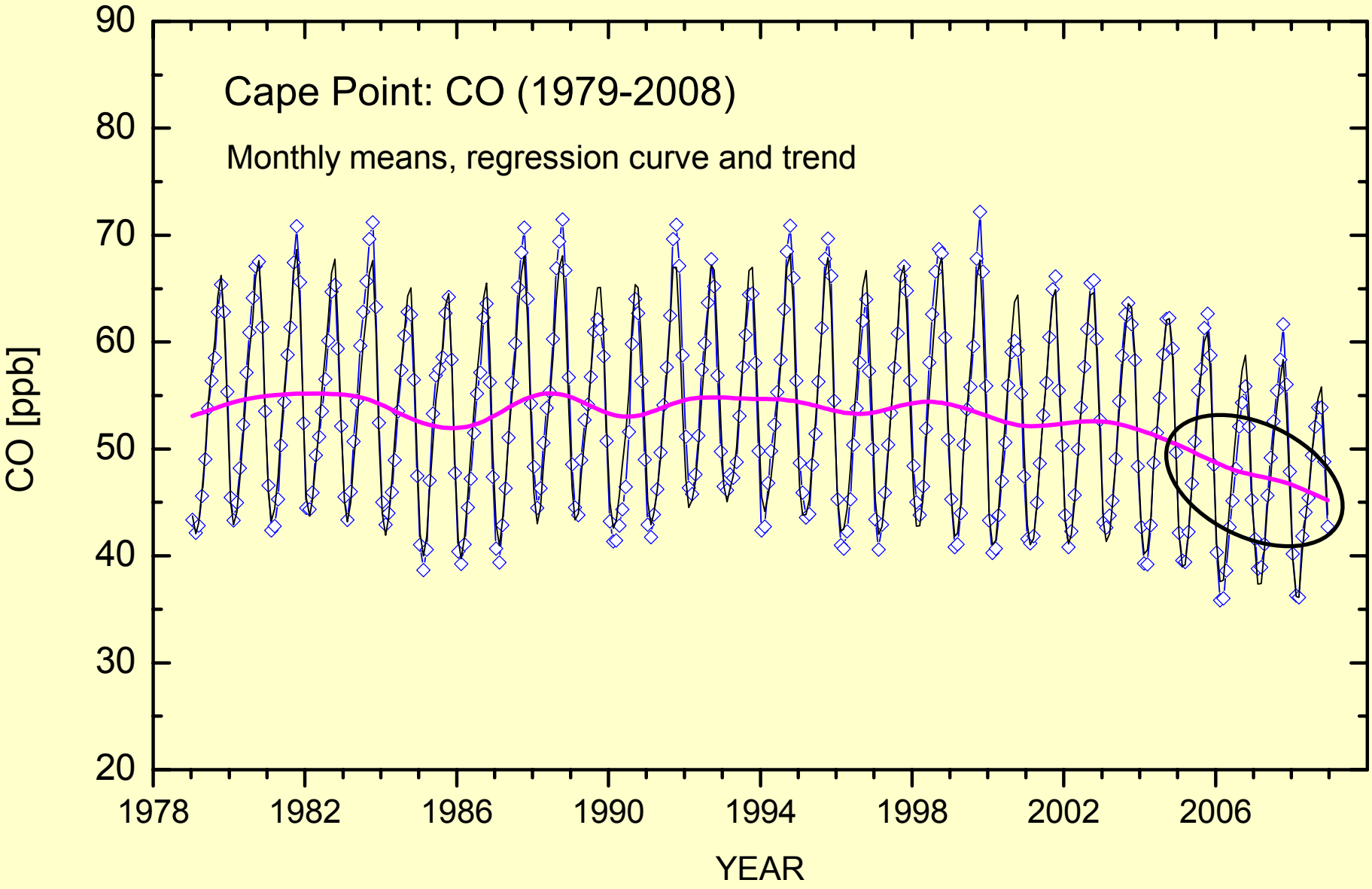
CPT: Wind sector-dependent CH4 growth rates, 1999-2005 & 2006-2008



Growth rates of CH_4 [ppb yr^{-1}] as a function of wind direction for the periods 1999 – 2005 and 2006 – 2008 are maximal for the northerly sector.

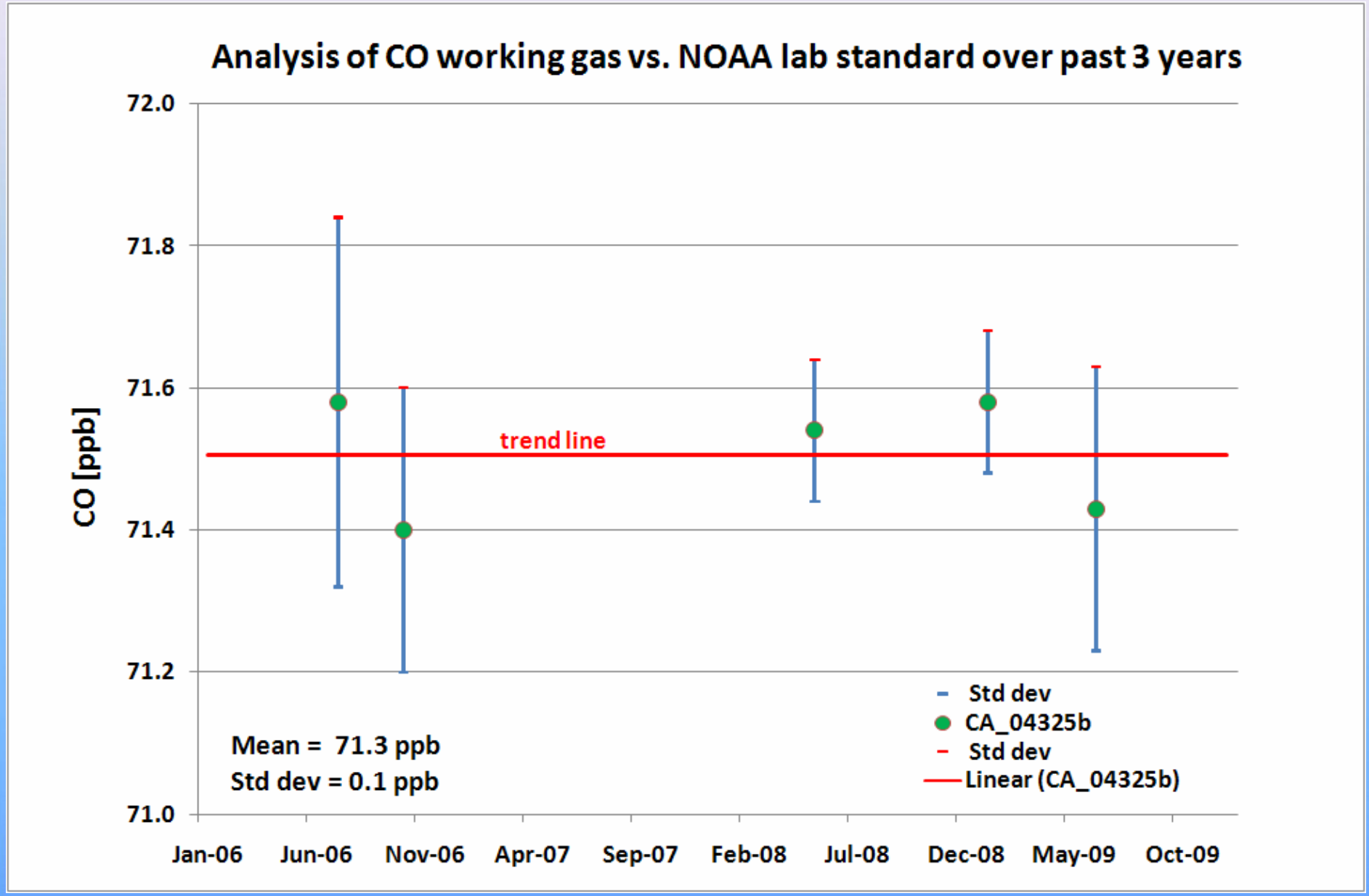
→ Increasing anthropogenic sources associated with the recent expansion of the greater Cape Town area (e.g. new waste treatment plants).

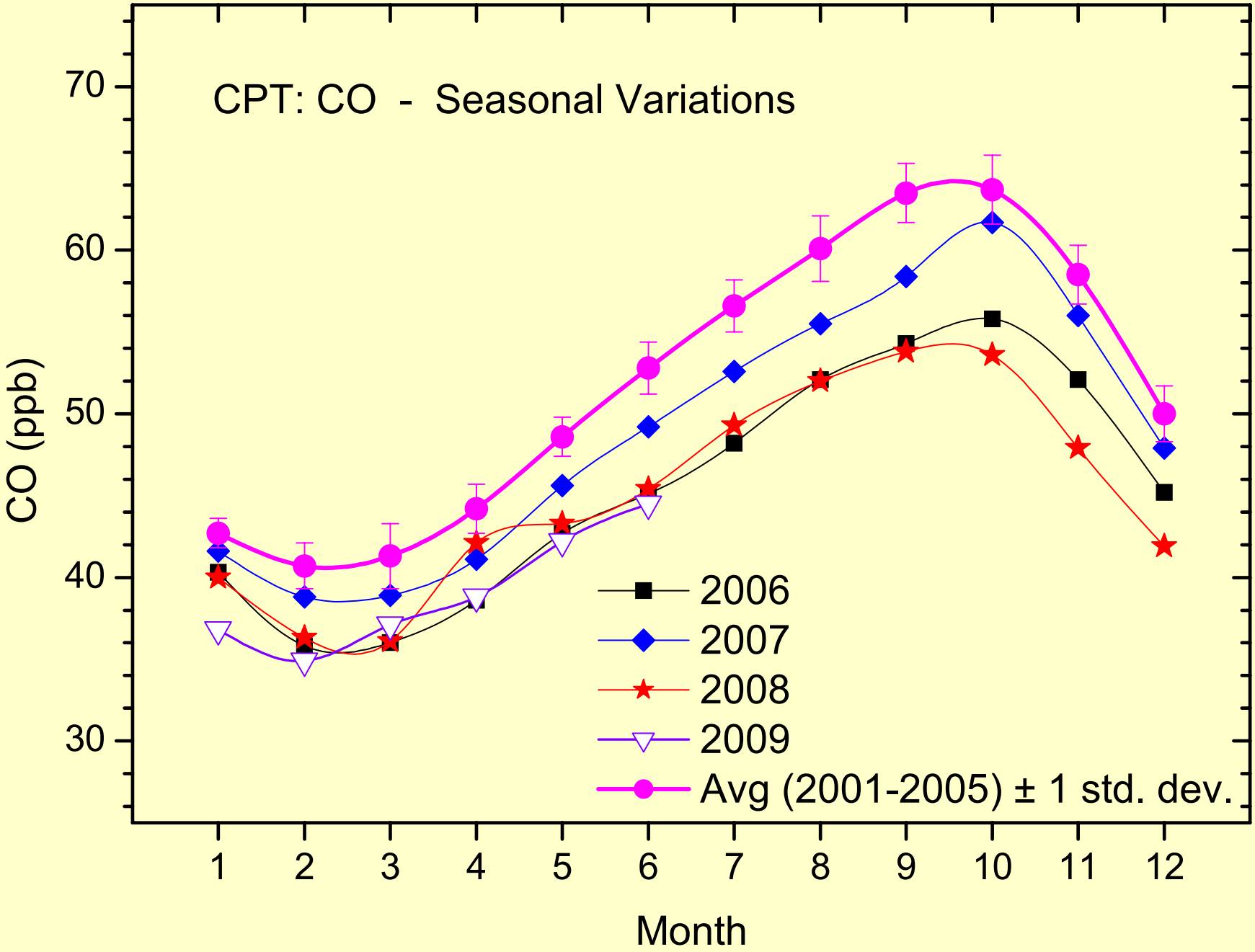

Cape Point: CO (1979-2008)
Monthly means, regression curve and trend
CO [ppb]
90
80
70
60
50
40
30
20
1978
1982
1986
1990
1994
1998
2002
2006
YEAR

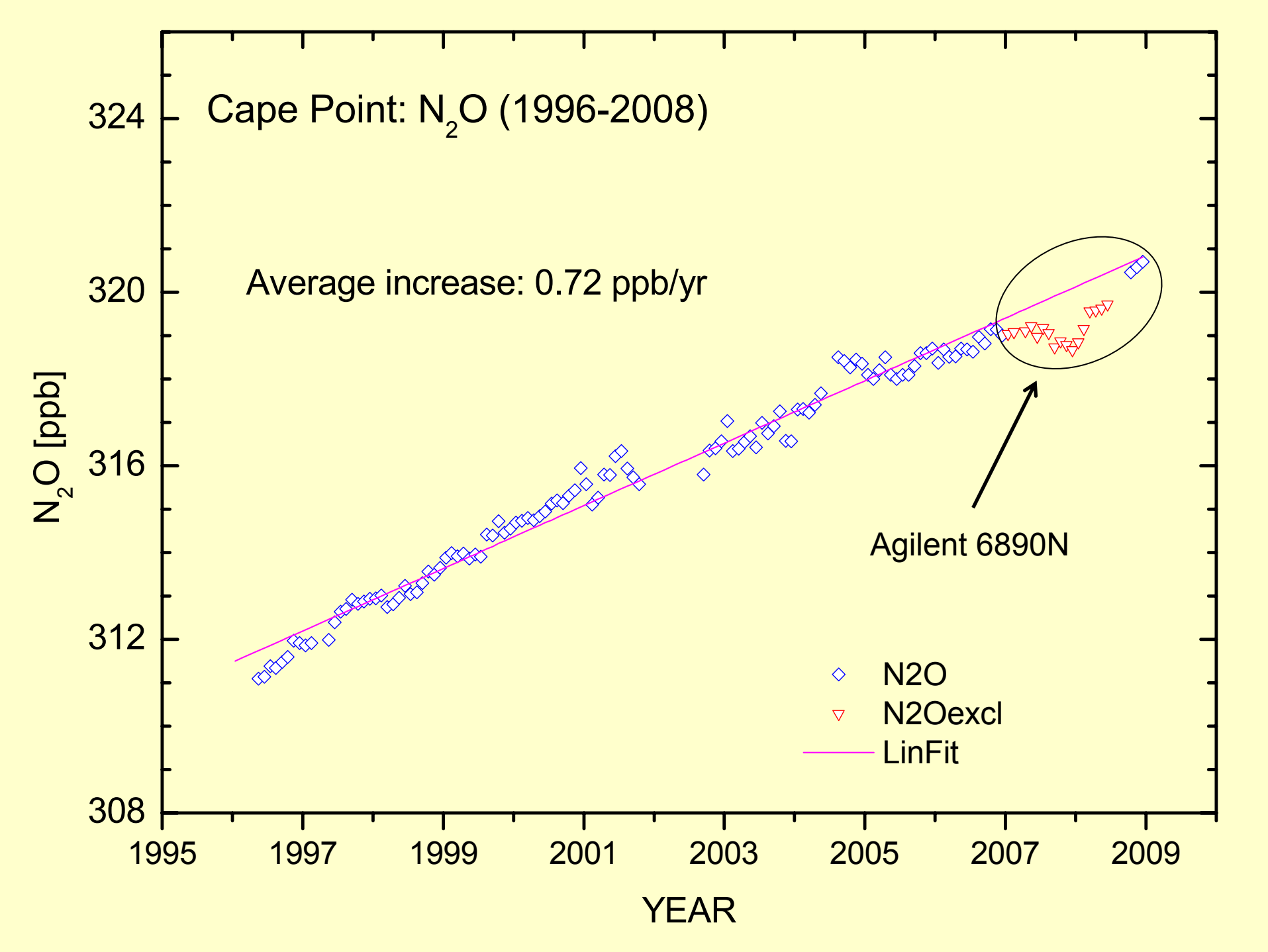


Results currently still on CPT CO scale. Update to GAW scale in preparation.

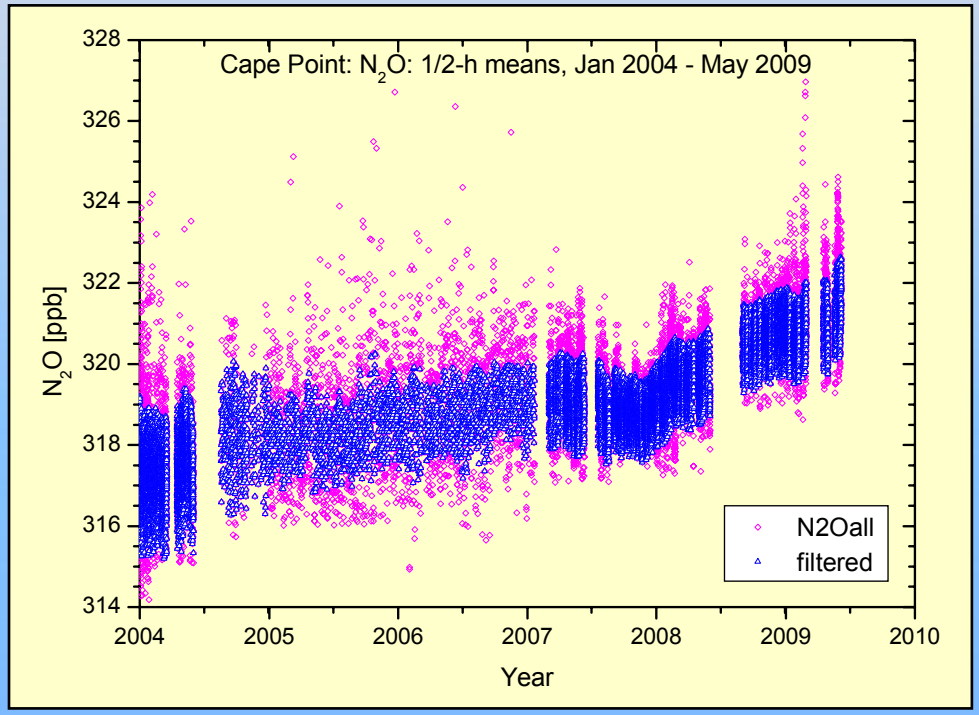
Analytical stability of CO system




CPT: CO - Seasonal Variations
CO (ppb)
70
60
50
40
30
1
2
3
4
5
6
7
8
9
10
11
12
Month
2006
2007
2008
2009
Avg (2001-2005) ± 1 std. dev.


Cape Point: N_2O (1996-2008)
Average increase: 0.72 ppb/yr
Agilent 6890N
N2O
N2Oexcl
LinFit
N_2O [ppb]
YEAR
324
320
316
312
308
1995
1997
1999
2001
2003
2005
2007
2009

N_2O: Analytical problems and challenges after upgrade to new GC

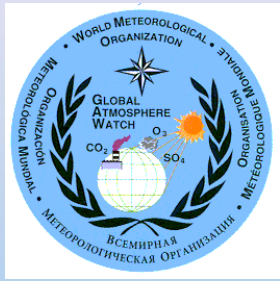


- Visually good N_2O chromatograms from an Agilent 6890N GC (with back flush & O_2 removal and without). Peak/baseline ratio ≈ 1900.
- N_2O reproducibility ≥ 0.3 ppb. Mostly values of NOAA lab standards (when injected as unknowns) only determined with an uncertainty of 1 ppb.
- ECD stability sometimes inversely related to atmospheric pressure.
- Peak outliers sometimes follow a specific pattern and at other times occur sporadically.
- Question of unidentified interfering effects. However, scrubbers for CO_2 and moisture have not revealed such problems.
- Satisfying results for comparisons of SF_6.

Summary

- CO_2 levels have increased by 7.6% (27 ppm) since measurements began in 1993. The growth rate itself has also increased from 1.6 ppm yr^{-1} in early 1993 to 2.1 ppm yr^{-1} at the end of 2008.
- CO_2 time series also characterised by DDEs, which often reach values of about 5 ppm below the background minimum. This is mainly a winter phenomenon and associated with wheat growing regions.
- Analysis of 2009 NOAA lab standards showed that CO_2 falls within 0.02 ppm of assigned values with respect to existing lab standards.
- Long-term CH_4 increase with overall decrease in growth-rates between 1983 and 2003. Stabilisation until 2006 followed by recent increase.
- CO: Since 2003 a slight overall decline with abnormally low annual mean values for 2006 and 2008. Possibility of recent analytical artefacts cannot be ruled out.
- N_2O: Uncertainty ~1 ppb with new analytical system. Several phenomena (problems) observed. However, no clear indication of their causes. Systematic tests to be continued. Any external advice is welcome.

Acknowledgements



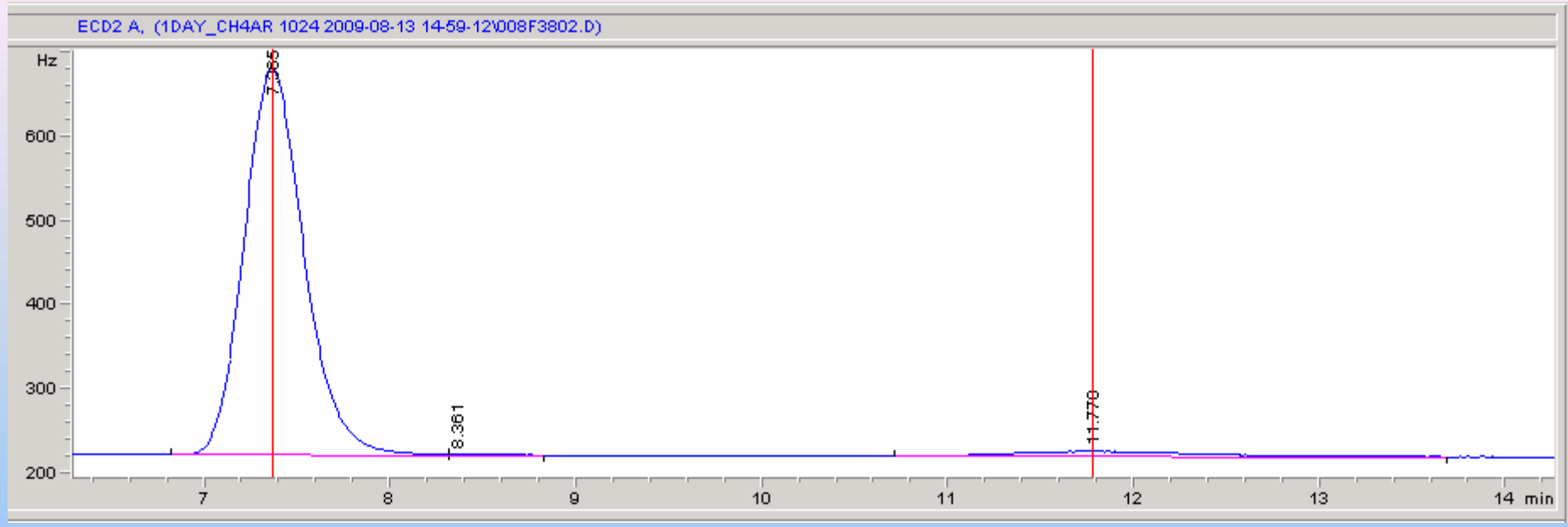
Local authorities:

South African National Parks (SANP)

Portnet

South African Weather Service

South African Weather Service



- Integration of N_2O and SF_6 peaks with a forced baseline method. AC being used at present to obtain best results.
- Tailing can cause integration problems
  - Integration can occur anywhere from AB to AC.