Research brief

A review of four decades of atmospheric trace gas measurements at Cape Point, South Africa

Casper Labuschagne[1], Brett Kuyper[2*], Ernst-Gunther Brunke[1], Thumeka Mokolo[1], Danie van der Spuy[1], Lynwill Martin[1], Ernst Mbambalala[1], Bhawoodien Parker[1,4], M. Anwar H. Khan[3], Michael T. Davies-Coleman[2], Dudley E. Shallcross[2,3], and Warrent Joubert[1]

[1]Global Atmospheric Watch, South African Weather Service, Stellenbosch, South Africa

[2]Department of Chemistry, University of the Western Cape, Cape Town, South Africa

[3]Atmospheric Chemistry Research Group, School of Chemistry, University of Bristol, United Kingdom

[4]Department of Environmental Affairs and Development Planning, Western Cape Government, South Africa

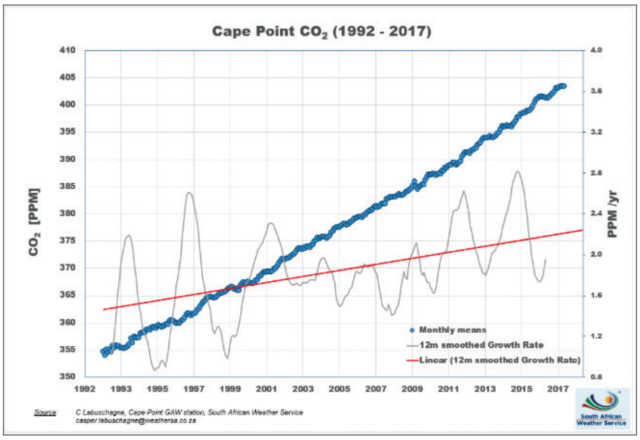
*Author for correspondence E-mail: brett@kuyper@gmail.com

http://dx.doi.org/10.17159/2410-972X/2018/v28n2a10

In the late 1970's the need to start monitoring the composition and changes within the clean atmosphere was raised. Since then, the Cape Point (CPT) stations' unique, strategic position has filled a crucial latitudinal gap in atmospheric trace gas monitoring in the overall sparsely sampled Southern Hemisphere (SH). Local meteorological conditions typically consists of clean marine air originating from deep within the southern Atlantic Ocean, making the Cape Point station an ideal baseline facility to monitor key indicators of changes and trends in the atmosphere of the SH. The site has two dominant, but distinctly different air-mass regimes. During austral spring to autumn (November to April), clean marine air predominates when the Cape Peninsular is buffeted by strong south easterly to south westerly winds. This is usually contrasted with winter months (June–August), when the South Atlantic High Pressure system retreats towards the equator relative to its summer position, and results in the intensification and advancement polar frontal systems (in the form of westerly winds) across the southern tip of the African sub-continent.

A recent article, published by the *Transactions of the Royal Society of South Africa*, highlighted the activities and achievements of the CPT GAW program. The measurement program, now in its 4th decade of operation, targets a wide spectrum of air chemical species, which are known to either enhance the anthropogenic greenhouse effect, e.g. CO_2, and CH_4, and various nitrogen oxides represented as NO_x, or can induce global cooling, e.g. regional aerosol measurements. Instrument calibrations are performed through analysis of gas cylinders, having known greenhouse gas mole fractions, which are obtained from the WMO GAW Central Calibration Laboratory (CCL) maintained by NOAA ESRL in Boulder, USA. After internal quality checks have been assured, the Cape Point greenhouse gas data are annually submitted to the World Data Centre for Greenhouse Gases (WDCGG, http://ds.data.jma.go.jp/gmd/wdcgg/) in Tokyo, Japan, as well as our local South African Air Quality Information System (SAAQIS: http://www.saaqis.org.za/). Recently, the archiving responsibility for reactive gases (other than CO) has been moved to the newly established GAW World Data Centre for Reactive Gases (WDCRG) hosted by the Norwegian Institute for Air Research (NILU).This enables the wider scientific community to utilize the data sets for their own research objectives.

Due to Cape Point's air-mass footprint being mostly from the pristine Southern Ocean marine environment, GAW measurements are highly valued within the United Nations



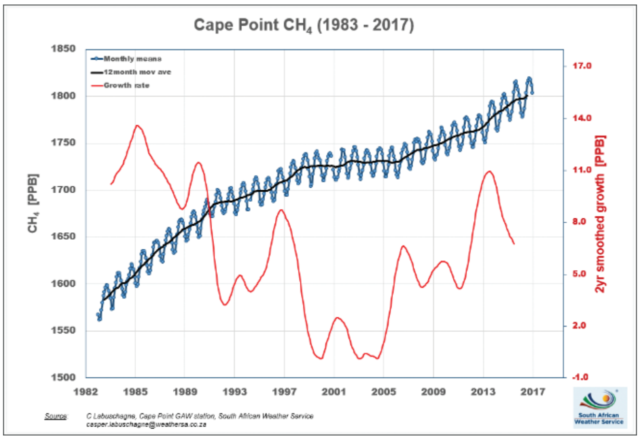


Figure 1 (left): *CO_2 time series (1993–2017) showing background monthly means and smoothed growth rate.* ***Figure 1 (right):*** *CH_4 time series (1983–2017) for background data. Red line highlights the 2-yr smoothed growth rate.*

Environment Programme (UNEP)/WMO Ozone and IPCC Climate Assessments) and serve as a bellwether for regional changes in southern African atmospheric composition. One of the aims of the Cape Point GAW station is to fulfil a mandate from the scientific and policy communities by providing regional trace gas background data for utilization in future climate change scenarios. Moreover, it also honours environmental treaties such as the United Nations Framework Convention on Climate Change (UNFCCC; http://unfccc.int/2860.php) and provides sound scientific information to policy makers as well as the Intergovernmental Panel for Climate Change (IPCC; http://www.ipcc.ch/).

Figure 1 shows the time series of the two most prominent greenhouse gases measured at Cape Point since the early 1980's (CH4) and 1990's (CO_2). When short-term variations attributed to local influences have been removed by data filtering techniques, both of these climatically relevant gases display atmospheric growth rates which have intensified substantially over the past few years and currently shows no signs of slowing down.

Figure 1 (left): CO_2 time series (1993–2016) showing background monthly means and a moving average (red line). Figure1 (Right): CH4 time series (1983–2016) for background data. Red line highlights the moving average.

For CO_2 a 5-year smoothing of the growth rate for the entire data record shows an annual fluctuation, ranging between 1.65 (for 1993) and 2.80 ppm/year^{-1} (for 2017). These estimations for CPT in concurrence with the globally observed CO_2 growth rates. Atmospheric CH_4 mixing ratios at CPT highlights the need for long-term, continuous measurements, by having had various periods of strong growth rates, which was followed by zero or negative growth rates, and then most recently again record high growth rates (2016 -2018). Interestingly, in contrast, after two decades of minimal change in CO mixing ratios measured at Cape Point, the concentration of atmospheric CO has steadily decreased since 2005. A similar decline in CO mixing ratios has been reported from a number of global atmospheric monitoring sites and also from satellite observations.

Bibliography

Labuschagne C., Kuyper B., Brunke E-G., Mokolo T., Van der Spuy D., Martin L., Mbambalala E., Parker B., Khan M.A.H., Davies-Coleman M.T., Shallcross D.E., and Joubert W., (2018): *A review of four decades of atmospheric trace gas measurements at Cape Point, South Africa*, Transactions of the Royal Society of South Africa. https://doi.org/10.1080/0035919X.2018.1477854

Casper Labuschagne
SAWS Cape Point GAW
Casper.Labuschagne@weathersa.co.za