Highlighted local research
Mercury measurements at Cape Point, South Africa – an update on recent findings

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Mercury (Hg) is regarded as a highly toxic, heavy metal and is also considered as a global pollutant due to its long range transport and bio-accumulation in the aquatic nutrition chain, which is not fully understood yet. For this reason and also to initiate international legislation aimed at controlling the use of mercury, a European Union-funded Global Mercury Observing System (GMOS), in which the Cape Point Global Atmospheric Watch (GAW) station participated, was initiated in 2010. The South African Weather Service (SAWS) as well as the Council for Scientific and Industrial Research (CSIR) have been conducting mercury measurements at the Cape Point GAW station since 1995 and 2007, respectively. While SAWS focussed on the measurement of Gaseous Elemental Mercury (GEM) in air, the CSIR has carried out analyses of Total mercury (TotHg) in precipitation samples. The GEM measuring programme, which is ongoing, has led to several publications dealing with long-term trends, seasonal cycles, depletion events and continental emission estimates for Hg.

In a recent study (Brunke et al., 2015) - briefly summarized here - a comparison between these two Hg species (i.e. GEM and TotHg) is made over a seven year period (2007-2013) using the results obtained during the rainy season (May – October). This study represents a follow-up (with new findings) to an initial investigation conducted by Gichuki and Mason (2013) which comprised a much smaller data set.

Rain events experienced at Cape Point are almost exclusively linked to cold fronts from the Atlantic Ocean. For the 2007 - 2013 period, 75% of all air mass trajectories coupled to these rain episodes reached the Cape Point GAW station directly from the southern ocean, while 19% arrived there with a short bypass over the Cape Town metropolitan area. Merely 6% approached Cape Point along the sea from the East via the Cape Agulhas sub-continental region. The atmospheric levels of carbon monoxide (CO) and ^{222}Rn (a tracer for marine air) in the 85 rain events identified are largely characteristic of maritime conditions. Although a few rain fronts which had passed over the greater Cape Town area before arriving at Cape Point from the North - sometimes revealed slightly elevated CO and ^{222}Rn levels, no statistically significant local anthropogenic influences were detected in the GEM and TotHg data. Over the 2007 - 2013 period, the May to October averages for GEM ranged from 0.913 ng m^{-3} to 1.108 ng m^{-3}, while TotHg concentrations ranged from 0.03 to 52.5 ng L^{-1} (overall average: 9.91 ng L^{-1}).

A close coupling has been found to exist between GEM and TotHg (2007-2014). The average GEM levels for the wet season show a positive correlation (R^2 = 0.49; n=7) with TotHg. Furthermore, both GEM and TotHg display similar, relative inter-annual concentration variations over the measuring period as a function of rain depth (not shown here, see published article).

The most noteworthy result, however, is the strong correlation observed between GEM and the El-Niño Southern Oscillation (ENSO) signal, especially during the 1996 - 2004 period (Figure 1).

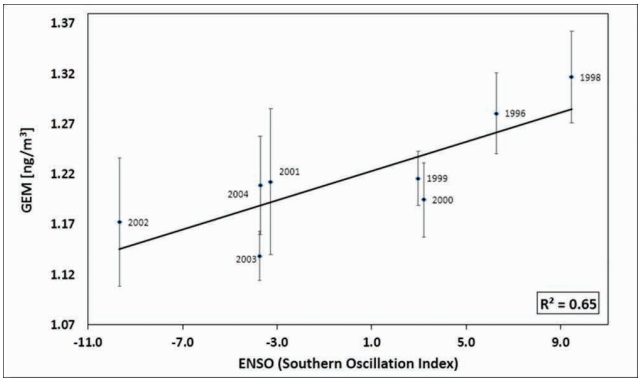

***Figure 1**: Relationship between GEM averages (May to October) and Southern Oscillation Index (SOI, http://www.bom.gov.au/climate/current/soi2.shtml): 1996 - 2004. The error bars represent GEM standard deviations. Linear regression: GEM = 0.007*SOI + 1.216 [taken from Brunke et al., 2015].*

These correlations (Figure 1) suggest that the inter-annual variations of GEM (and also TotHg) concentrations are primarily influenced by large scale weather phenomena. Meteorological processes can affect mercury emissions directly, for example, by periodic changes of surface ocean temperatures during ENSO events, or indirectly via extended droughts leading to increased biomass burning which in many cases is also a source of GEM. These processes can also influence the oxidation of GEM to species prone to rain and washout as has been reported elsewhere. However, changing oxidation rates would influence TotHg concentrations to a substantially larger degree than those of GEM, and would, at constant emissions, lead to an anti-correlation between GEM and TotHg concentrations and this is not observed.

We thus conclude that meteorological influences on mercury emissions is the major reason for the positive GEM versus TotHg and GEM versus SOI correlations. The SOI influence on tropospheric mercury concentrations has since been further investigated – also for the Northern Hemisphere in an unpublished study (currently under review) by Slemr et al. ("El-Niño Southern Oscillation (ENSO) influence on tropospheric mercury concentrations").

References

Brunke E-G, Walters C, Mkololo T, Martin L, Labuschagne C, Silwana, B, Slemr F, Weigelt A, Ebinghaus R and Somerset V. Mercury in the atmosphere and in rainwater at Cape Point, South Africa. *Atmospheric Environment 2015*, DOI:10.1016/j.atmosenv.2015.10.059.

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