Research brief
Recent papers utilizing Cape Point mercury monitoring data

Mercury is a globally important toxin that has the potential to cause significant adverse impacts to human and environmental health. Mercury that is released from natural or anthropogenic activities has the ability to enter the atmosphere and due to its long atmospheric lifespan it is able to be transported great distances around the world. As part of the biogeochemical cycling of mercury, gaseous elemental mercury (GEM) (the most abundant species of atmospheric mercury, accounting for >90% of the total atmospheric mercury) is able to be oxidised and is deposited in water and on land, where it undergoes further biogeochemical cycling to form methylated mercury.

The methylated mercury is biologically active and is able to enter the tissue of plants and animals and is potentially bio-accumulated and concentrated at higher trophic levels. It is particularly problematic in large piscivorous fish and marine mammals, which if consumed regularly can be a source of mercury toxicity for human populations. Globally, there are a number of sites that continuously monitor background concentrations of atmospheric mercury. Most of these sites are located in the Northern Hemisphere, however, there is one site in South Africa, located at the Cape Point Global Atmospheric Watch (GAW) station that has a near continuous monitoring record dating back to 1995.

The Cape Point GAW station is equipped with a Tekran 2537A vapour-phase mercury analyser resolution (Tekran Inc, Toronto Canada), set to a 15 minute temporal. The analyser has total gaseous mercury detection limit of ~0.05 ng/m^3. It is thought that under the conditions at the Cape Point station, only GEM will be measured since the inlet manifold has a 30m high inlet with PTFE tubing, a PTFE filter and the presence of sea salt aerosols that is expected to trap the other mercury species. In addition to the mercury measurements the Cape Point GAW station measures carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), ozone (O_3), nitrous oxide (N_2O) and halocarbons.

Several articles published in the international scientific literature use the atmospheric mercury record from the GAW Cape point station, emphasising once again the international importance of this site. A paper titled '**Comparison of mercury concentrations measured at several sites in the Southern Hemisphere**" was published written by Franz Slemr and others in Atmospheric Chemistry and Physics (Slemr et al., 2015). The authors used data from four remote monitoring stations located at Amsterdam Island (southern Indian Ocean between southern Africa and Australia), Cape Grim (Tasmania), Cape Point (South Africa) and Troll Research Station (Antarctica). They compare the monthly and annual average and median concentrations of the measurements taken at the four remote southern hemisphere stations. The Cape Point and Amsterdam Island Stations showed no significant differences in terms of the monthly mean values and both showed that there was no discernible seasonal variation. The Troll station in Antarctica showed significant seasonal variation with peaks in mercury concentrations in the months of February and March and a minimum during October - December. The Cape Grim data showed the greatest seasonal variation and a large and random scatter of the monthly median values, indicating that the data are not as homogenous as the other sites. Median monthly values for all the stations ranged from ~0.8- 1.1 ng/m^3. On an annual basis, the medians of the annual mercury gradients were small and did not exceed 0.2ng/m^3. However, at the Cape Point station an increasing trend in the mercury concentration was observed for the period 2007 to 2013, compared to a decreasing trend in the mercury concentrations between 1996 and 2004.

The second article is titled "**Statistical exploration of gaseous elemental mercury (GEM) measured at Cape Point from 2007 to 2011**" was by Andrew Venter and others (Venter et al., 2015). The paper had two main focal areas, namely 1) back trajectory analysis to improve the understanding of the source regions of GEM recorded at Cape Point, and 2) the development of a multiple linear regression model to predict the concentrations of GEM at Cape Point from the other parameters measured from monitored data for the period March 2007 to December 2011. The back trajectory analysis showed that the data could be represented in two main clusters with a separation at a GEM concentration of 0.904ng/m^3. The lower GEM concentration air masses have source regions that pass over the sparsely populated interior of South Africa and the remote marine regions, while the higher GEM concentration cluster is associated with air masses that originate along the shipping lanes that skirt the South African coast and the coastal cities.

The second part of the study used a process of multiple linear regressions to model the concentrations of GEM. The linear model included eight terms which showed either a positive or negative impact on the GEM concentrations. The terms that showed a positive correlation with the GEM concentration included absolute humidity, CO concentration, atmospheric pressure, temperature and methane concentration. The terms that showed a negative correlation with the GEM included ozone concentration, radon concentration and wind gust speed. When the monitored and predicted results are considered the fitted slope of the linear regression indicates a slight decreasing trend in the GEM concentrations for the period 2007-2011. This is in contrast to the increase observed in the 2007 - 2013 dataset discussed in the Slemr et al. (2015) paper. The authors suggest that the differences in the trends reported in these two studies are a result of differences in the data validation and processing procedures that were applied.

References

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