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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Overview of mercury measurements in the Antarctic troposphere" *by* A. Dommergue et al.

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Dear Jozef Pacyna, Thank you for your comments and your questions.

Concerning your first question about the contribution of coal combustion or mining activities to the concentrations of Hg measured in the Antarctic troposphere?

Our knowledge of Hg inputs to Antarctica is really limited. I'd rather mention other trace elements of anthropogenic origin that have been measured for instance in snow collected in Antarctica. Lead has been used as an additive to gasoline (alkyl-lead) worldwide and engine combustion provided important lead emissions (as aerosols) to the atmosphere. Measuring isotopic lead ratio in environmental samples can help to trace the origin of the emissions. Snow samples (years 1960-1990) collected in

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Antarctica have shown that lead originated from a combination of sources from Brazil and south-America, Australia, New-Zealand and South-Africa (Planchon et al., 2003). A clear decrease of these inputs has been observed afterwards due to the abandon of leaded-gasoline. Before the 60's, anthropogenic lead inputs could have been due to coal combustion and non-ferrous metal production in South-America particularly. Unfortunately, studies in snow or ice collected in Antarctica are not able to trace anthropogenic inputs of Hg (Planchon et al., 2004; Witherow and Lyons, 2008; Jitaru et al., 2009). Indeed, inputs from natural sources (volcanoes, oceanic evasion, or terrestrial emissions) cannot be discriminated from anthropogenic inputs yet. This is mainly due to a lack of dedicated analytical techniques. Considering the case of many trace metal measured in Antarctica, there are no doubts that Southern Hemisphere emissions of Hg impact this continent.

The second question was: can anthropogenic sources located in the North Hemisphere contribute to the levels of Hg measured in the Antarctic troposphere?

The atmospheric circulation is a major pathway by which air pollutants are transported worldwide. Gaseous Hg+2 and particulate mercury emissions generally undergo direct wet or dry deposition to the Earth's surface locally. These species have relatively short residence times in the atmosphere ranging from hours to months. Gaseous Hg+2 has a residence time of just 5 to 14 days in the atmosphere, and may travel tens to hundreds of kilometers. Particulate forms of mercury (tend to fall out closer to the source of emissions, with larger particles falling out faster than smaller ones. The site-specific deposition of mercury is variable, and is affected by conditions like meteorology, temperature and humidity, solar radiation and emission characteristics (speciation, source, stack height, etc.). Now, if we consider Hg emission as gaseous elemental Hg°, which is less reactive and soluble than oxidized forms, interhemispherical transport is likely; however it is commonly admitted that it takes about one year for air to exchange between the northern and southern hemisphere. The residence time of Hg° in the troposphere is poorly known. It is due to our weak knowledge of Hg°

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oxidants (OH, O3, halogen radicals such as Br) and the experimental kinetics (Ariya et al., 2002). Residence time or life-time is estimated to be in the range of 0.5 to 2 years in the troposphere (Holmes et al., 2006; Selin et al., 2007). An averaged lifetime of 0.75 year is also proposed by Lindberg et al (2007) (Lindberg et al., 2007). Theoretically, if a life-time of less than one year is considered, Hg° emissions from the North Hemisphere could reach Antarctica. However air masses travelling towards Antarctica will encounter marine atmospheres, and the lifetime of Hg° could be shorten due to removal processes involving halogens (Holmes et al., 2006).

Actually, I believe that northern emissions will have an effect on the Antarctic environment anyway. This effect may be indirect due to reemission processes. Anthropogenic mercury will be removed from the atmosphere once (from a few days to one year or two). After being deposited, oxidized Hg can be buried, assimilated by organisms, reduced or transported by oceanic currents, and can be subsequently reemitted by a variety of processes such as biogenic emission, oceanic volatilisation. Hg is thus highly mobile. More than its residence time in the atmosphere, it is its high mobility that leads to consider Hg as a global pollutant. I hope that these comments will answer your questions.

Sincerely,

A Dommergue

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