

## CHEMICAL CYCLING AND DEPOSITION OF ATMOSPHERIC MERCURY IN POLAR REGIONS: NEW INSIGHTS AND REMAINING RESEARCH GAPS

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### Introduction

Mercury (Hg) causes adverse health effects to wildlife and humans. Hg travels globally via the atmosphere in its gaseous form (Hg(0)), deposits to ecosystems as Hg(II), converts to methylmercury (MeHg), and bioaccumulates in aquatic systems (Selin, 2009). In order to reduce Hg effects, the pathway from emissions to impacts needs to be traced. Atmospheric modeling provides a first step by tracing the link from emissions to deposition onto environmental surfaces. Uncertainties in atmospheric Hg models arise from our incomplete understanding of atmospheric processes (e.g., oxidation pathways, deposition, and reemission). Atmospheric Hg reactivity is exacerbated in high latitudes (e.g., Schroeder et al., 1998) and there is still much to be learned from Polar Regions in terms of atmospheric processes.

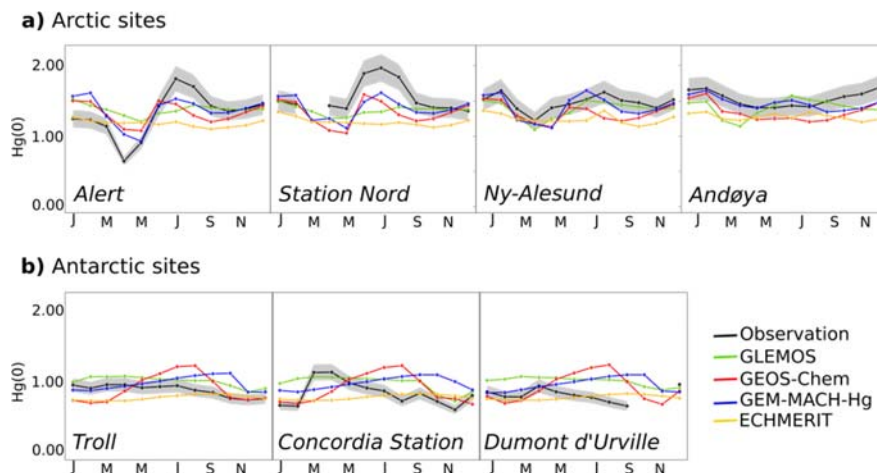
### Methods

This study provides a comprehensive synthesis of the atmospheric Hg monitoring data available in recent years (2011-2015) in Polar Regions. In addition, multi-model simulations are compared to observed mercury concentrations. From the comparison of model with data, we can identify whether processes that affect Hg oxidation and deposition are appropriately represented in the models.

### Results

GEOS-Chem and GEM-MACH-Hg, both implementing processes related to Polar Regions, reproduce quite fairly the observed seasonal cycle of atmospheric Hg(0) at Arctic sites (Figure 1a). They are both able, to a certain extent, to reproduce the occurrence of springtime atmospheric Hg depletion events (AMDEs). AMDEs are observed throughout the Arctic as the result of an oxidation of Hg(0) by reactive bromine species and lead to the deposition of hundreds of tons of Hg each year (Steffen et al., 2008). However, models are unable to reproduce the observed seasonal cycle at Antarctic sites (Figure 1b). Recent studies

have highlighted new atmospheric processes in the Antarctic boundary layer both in winter and summer time (Angot, Dion, et al., 2016; Angot, Magand, et al., 2016; Nerentorp Mastromonaco et al., 2016) leading to the formation and subsequent deposition of reactive Hg. Simulated deposition of Hg in pristine Antarctic ecosystems is most likely biased low.



**Figure 1.** Year 2013 averaged monthly Hg(0) concentrations ( $\text{ng/m}^3$ ) at all sites: observations (in black) and concentrations according to various global models (GLEMOS in green, GEOS-Chem in red, GEM-MACH-Hg in blue, and ECHMERIT in yellow). The grey shaded regions indicate a 10% uncertainty for observations.

## Conclusion

Atmospheric processes recently revealed in Antarctica are yet unexplained and not reproduced by models. They likely involve new types of oxidants and heterogeneous reactions. The combined use of sensitivity tests/box modeling and observations is key and will lead to a better understanding of the involved physico-chemical processes and to improved global transport and deposition models.

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