Actual PCBs concentration in north Atlantic and Arctic air (NANUQ 2015-2016)

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The Passive Igloo Expedition (Nanuq 2015-16) is a demonstration project with the aim is to pass an Arctic winter in a self-sufficient sailing ship, without the use of fossil energy. The boat left Norway in summer 2015 to reach the North of the Greenland through a route of 4500 nautical miles from warm and densely populated Scandinavia to snow and ice-covered, sparsely populated Greenland, via Iceland. It was a unique opportunity to measure atmospheric PCB concentration, without the risk of air contamination by ship equipment (Lohman et al. 2004).

A passive polyurethane foam sampler was used to measure PCBs concentration all along a longitudinal and a latitudinal transect during the crossing in 2015 and the return path in summer 2016. PCB concentration was also measured in the Greenland air during winter 2015-2016 in the Qaanaaq region, far from any primary PCB source. NOAA's HYSPLIT model was used to calculate back air trajectories.

During the longitudinal transect in summer 2015 from Iceland to the South of Greenland (Narsasuaq), PCBs concentration in air reached 5.30 $pg.m^{-3}$ and PCBs profile was dominated (85%) by high molecular weight PCBs. Analysis of backward trajectories indicated that the North Atlantic atmosphere was influenced by movement from European and Russian source regions. Gioia et al (2008) have previously hypothesized that PCB concentration at the Zeppelin site are higher when air masses travelled over European countries and lower when air masses originated from Canada and traveled over Arctic ocean.
During the latitudinal transect from Narsasuaq to Qeqertat, arctic PCBs concentration was 1.77 $pg.m^{-3}$ with a profile equilibrated (50%) between low molecular weight PCBs (3-4-5 Cl ; LMW) and (50%) high molecular weight (HMW) PCBs. Air masses came from the North pole and the North of the Alaska probably justify this low PCBs concentration and the higher % of light PCBs.
Concentration of PCBs during the return path in summer 2016 from Siorapaluk to Maniitsop reached 6.51 $pg.m^{-3}$ with 90% of LMW PCBs. Air masses from Alaska, the North of Russian and the South of Europe could explain the modification of concentration and profile in comparison to summer 2015.
During the arctic winter (2015-2016) in Harward øer (Qaanaq region), mean air concentration was 1.55 $pg.m^{-3}$ with a profile dominated (80%) by 3-5Cl PCBs.

PCB air concentration declines with latitude increase, from Island to the Arctic. The relative contribution of trichlorinated PCBs to the total PCB concentration increased with latitude. Hung et al. (2016) have studied 20 years of monitoring under the Arctic Monitoring and Assessment Programme (AMAP). Results have shown that PCBs declined slowly in the Arctic air in relation with the reduction of primary emissions and the importance of secondary emissions. Lighter PCBs showed increasing trends in some locations and can be attributable to warming in the region result in re-emission of previously deposited PCBs from oceans and ice.

The latitudinal shift in congener pattern is reflecting the relative trend of the PCB congeners to have long-range transport in the Arctic. Moreover, these results can be explained by different phenomenon as cold condensation, melting ice and volatility of PCBs.
PCBs concentration in air obtained during this expedition will help to understand the atmospheric dynamics of these pollutants in the current context of climate change. As some scientists believe, arctic warming potentially may undermine global efforts to reduce environmental and human exposure to POPs.

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