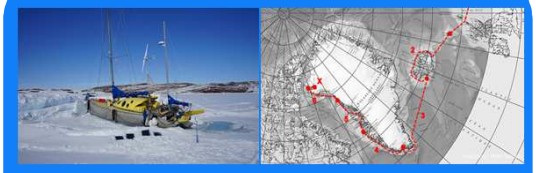
Actual PCBs concentration in north Atlantic and Arctic air (NANUQ 2015-2016)

Nathalie COTTIN[1], Philippe FANGET[1], Peter GALLINELLI[2], Frédéric GILLET[2], Emmanuel NAFFRECHOUX[1]
[1] LCME Université Savoie Mont Blanc 73000 CHAMBERY (France)
[2] ACAPELA passive igloo, 1219 Genève (Suisse)

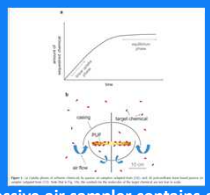
The Passive Igloo Expedition is a demonstration project with the aim is to pass an Arctic winter in a self-sufficient sailing ship, without the use of fossil energy. The boat left Norway in summer 2015 to reach the North of the Greenland through a route of 4500 nautical miles from warm and densely populated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

STUDIED SITES



A passive polyurethane foam sampler was used to measure Polychlorinated Biphenyls (PCB) concentration all along a longitudinal and a latitudinal transect during:
- The crossing in summer 2015
- The winter 2015-2016 in the Qaanaq region
- The return path in summer 2016

PASSIVE AIR SAMPLER



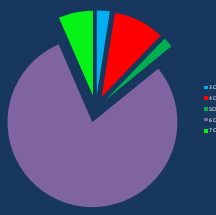
The passive air sampler contains a PUF disk placed between two stainless steel metal domes to protect the disk from precipitation, sunlight, wind speed effects and coarse particle deposition.

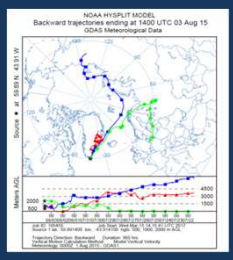
ANALYTICAL METHODS

- **PUF EXTRACTION** by Accelerated Solvent Extraction (ASE200 Dionex)
- **CLEAN UP** by Solid Phase Extraction (SPE) and activated silice
- **PCB ANALYSIS** by GC-PDID (ECD mode)
- **UPTAKE RATE of PCBs** vary from 3 to 7 m^3/day
- **NOAA's HYSPLIT model** was used to analyze back air trajectories

ISLAND to NARSASUAQ
ATLANTIC OCEAN - SUMMER 2015

PCB concentration in air = 5.3 pg.m^{-3}
85% of High Molecular Weight PCBs



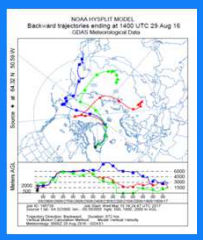


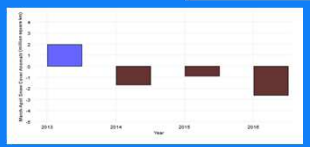
ANALYSIS OF BACKWARD TRAJECTORIES

- North atlantic atmosphere influenced by movement from European and Russian source regions
- PCB concentration are higher for air masses from European countries (Gioia et al. 2008)
- Backward trajectories can explain the high PCB concentration and the level of High Molecular Weight PCB

SIORAPALUK to MANIITSOQ
ARCTIC OCEAN
RETURN PATH IN SUMMER 2016

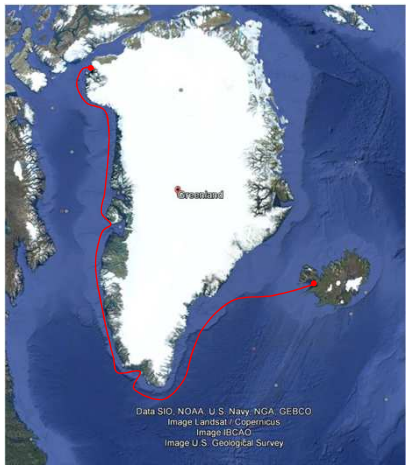
PCB concentration in air = 6.5 pg.m^{-3}
90% of Low Molecular Weight PCBs





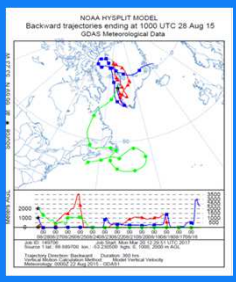
NOAA, Climate Change: Minimum Arctic Sea Extent, Derek ParK, January 11, 2017
On September 2016, Arctic sea ice extent dipped to 4.14 million square kilometers tied with 2007 for second-lowest extent in the satellite record

This phenomenon can explain the highest PCBs concentration in atmosphere during summer 2016 and the PCB profile constitued by light PCBs.
De-glaciation of ice may result in re-emission of previously deposited PCBs from ocean and ice, increasing concentration of lighter PCBs such as PCB101
(H.Hung and al., 2016)



NARSASUAQ to QEQERTAT
ARCTIC OCEAN – SUMMER 2015

PCB concentration in air = 1.8 pg.m^{-3}
50% of Light Molecular Weight PCB
50% of Low Molecular Weight PCBs

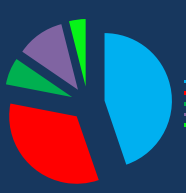


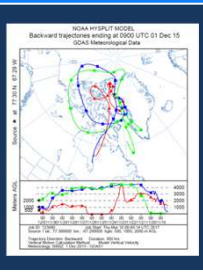
ANALYSIS OF BACKWARD TRAJECTORIES

- Air masses came from the North Pole and the Alaska
- PCB concentration are lower for air masses from Canada and traveled over Arctic Ocean (Gioia et al. 2008)
- Backward trajectories can justify the low PCBs concentration

WINTER 2015-2016
Harward øer

PCB concentration in air = 1.6 pg.m^{-3}
80% of Low Molecular Weight PCBs





PCB measured in the Greenland air far from any PCB sources

- Air masses came from the North Pole and the north of the Alaska
- Low PCBs concentration and profile dominated by lighter PCBs (3-4 Cl)

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.

R. Lohman and al., Environ. Sci. Technol. 2004, 38, 3965-3970; R. Gioia and al., Journal of Geophysical Research, 113 (2008) 1-11; H. Hung and al., Environmental Pollution, 217 (2016) 52-61.