Global source identification of Arctic air pollution using statistical analysis of particle dispersion model output and measurement data.

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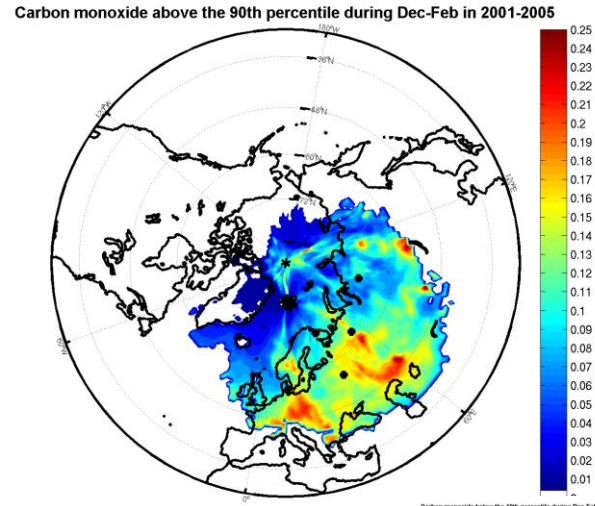
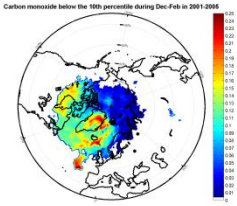
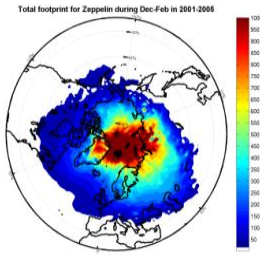
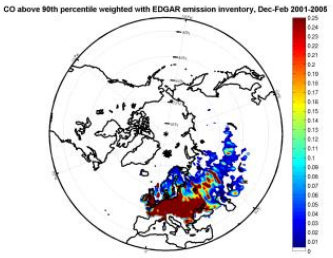
Conclusion:

By combining potential sensitivity fields from FLEXPART with measurement data, an emission inventory and statistical analysis, we find strong differences in source regions between clean (10th %-ile) and polluted (90th %-ile) air masses arriving at Zeppelin, Spitsbergen. The preferred transport routes of air masses into the lower Arctic troposphere over a 5 year period (left below), agree quite well with earlier studies(1,2,3). It confirms Europe as the main source region for this part of the Arctic atmosphere during autumn, winter and spring.



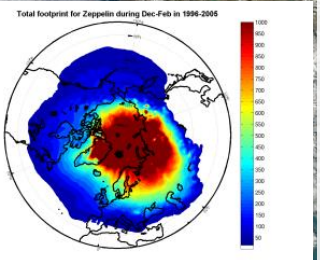


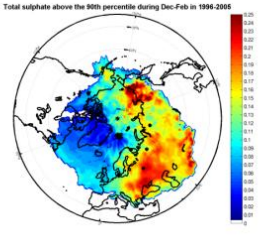


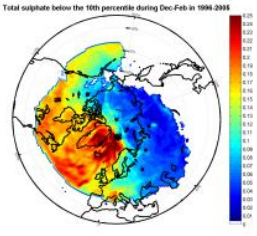


Source sensitivity maps for CO at the Arctic station Zeppelin, for clean (R) and polluted (U) air as well as the polluted sensitivity folded with an emission inventory (L).

Source sensitivity maps for sulphate at the Arctic station Zeppelin, for clean (D.R) and polluted (D.L) air, together with a summation of all sensitivity maps (R) for the winter months of 1996-2006.







Method:

FLEXPART (LPDM) is run 20 days backward in time from the Zeppelin station every 3 hours, for more than 10 years. With every calculation, a so-called potential emission sensitivity (PES) field is obtained, which identifies where the measured air mass has come into contact with the Earth's surface. It quantitatively measures the sensitivity of the signal obtained at the station, to emissions occurring near the surface. By combining these PES fields with measured concentrations of several trace species (shown here CO and sulphate) we identify where the measured species most likely originated from. Statistical analyses are performed both for average measured concentrations as well as the 10th and 90th percentiles of the measured frequency distribution. Selected footprints are normalized with the total footprint.

Results:

With the use of these maps in combination with an emission inventory map we are able to weight each source region's long-term contribution to the pollution events in the Arctic. We are able to identify the main source regions to stretch from central Europe to north-western Asia. For sulphate we also see indications of contribution from eastern Asia.

References:
(1)Barrie, L.A., Atmos. Environ., **20**, 643 (1986)
(2)Klonecki, A. et al., J. Geophys. Res. **108**, 10.1029/2002JD002199 (2003)
(3)Stohl, A. J.Geophys. Res. **111**, 10.1029/2005JD006888 (2006)