

## ***Interactive comment on* “Source identification of short-lived air pollutants in the Arctic using statistical analysis of measurement data and particle dispersion model output” by D. Hirdman et al.**

### **Anonymous Referee #2**

Received and published: 27 December 2009

Review of “Source identification of short-lived air pollutants. . . .” by Hirdman et al.

This is an excellent paper that investigates the possible sources of short-lived species in the Arctic by using a combination of measurement data from 3 (near) sea-level sites, Zeppelin, Alert, Barrow and a “free troposphere” site, Summit in combination with a FLEXPART trajectory analysis. The data sets chosen are EBC, SO<sub>4</sub>, light-scattering aerosols which are relatively “short-lived” ~ few weeks or less and ozone which has a tropospheric lifetime ~ month outside of the PBL.

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With multiple back-trajectories they calculate the 2D time varying footprint emission sensitivity function  $S(x, y, t)$  and average it over the measurement periods identified, nominally seasonal in this case and also extract the top 10% and bottom 10% percentile,  $S(10)$  or  $S(90)$ . This is further processed to produce a relative fraction,  $R$ . The filtering against the highest (and lowest) measurements indicates source and sink regions for the appropriate time period.

Their analysis confirms results from other studies but in a largely independent fashion. They find that surface sites in the winter time are most affected by emissions from Eurasia (as well as local emission sites, of course). In the summer time the surface Arctic region tends to be isolated, whereas the data from the Summit/ (free troposphere) site suggests that the free troposphere tend to be more well-mixed that at the surface.

The EBC observations indicate that the burning of the Boreal Forest in Alaska, Western Canada and Siberia are sources of BC at surface Arctic stations in the summertime while anthropogenic sources in Eurasia are important in the wintertime. They were also able to identify  $SO_4$  sources and even though Norilsk in Siberia is a point source this region was identified as a major source except perhaps in summer.

Their ozone analysis locates the Arctic ocean as the region which major ozone sink (likely for ODEs (ozone depletion events)) during the spring time and also into mid-summer.

This study acts to consolidate results from a number of different studies and almost acts as an integrator and should be published. It is also useful means for a simple assessment of the impact of increased shipping traffic through the Arctic Ocean.

Some small points

Page 2 Line 55 (P2L55): “20th century current pollution events CAN indeed” – move word

P4L101 define “high” Arctic

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P4L105: “TRAFFIC FROM commercial shipping IS LIKELY TO INCREASE.” – seems a bit smoother.

P4L156: EBC – is used here without first being defined and the definition that occurs further down the page is a little unclear.

P7L195: How seriously does filtering of “clear-air sector” affect the results since possible real “high” or “low” results could have been filtered out?

P8L239/240: “footprint layer -100 m above ground” – The PBL varies (nominally) by 1 km during the daytime down to 100 m at night and ~ 500 m over the ocean. At 1 km the PBL is mixed thus diluting surface sources. How does this affect the results. Perhaps a reference to earlier work would suffice for the non-FLEXPART aficionados.  
iAŁ

P13L392: “eminent R90” -> larger R90. . .

P13L401/403 “related” -> associated/ with

P14L424: “other seasons than summer” -> “seasons other than summer” more common.

P15L436: “we show at one example” -? We show for one example. . .

P16L477/8: Could the “NW Canada” source of sulphate be related to the Tar Sands project in Northern Alberta? This is probably the largest “point” source of CO<sub>2</sub> on the globe and can also be seen in NO<sub>x</sub> (GOME) which would produce ozone and it is likely a SO<sub>2</sub>/SO<sub>4</sub> source. (see also P17L503, P19L568).

P17L514ff: The statement concerning the correlation of average ozone with height seems a little out of place given the variability of the data, change with season. It would be hard to justify and doesn't add to the overall picture.

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 19879, 2009.