Pan-Arctic enhancements of light absorbing aerosol concentrations due to North American boreal forest fires during summer 2004

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The summer of 2004 set a new record, 2.7 million hectares, for the annual area burnt in Alaska.

This is more than ten times as much as the long-term annual average of about 0.2 million hectare. Another 3.1 million hectare burned in Canada, 50% above the long-term average.

This poster and a paper with the same title *(Stohl et al., in press in J. Geophys. Res.)* shows how pollution plumes from these fires were transported into the Arctic and affected aerosol concentrations there. Of particular interest are the concentrations of Black Carbon (BC), because these highly light-absorbing aerosols have a strong effect on atmospheric radiation transmission over the snow- and ice-covered Arctic surfaces with their high albedo. Measurements of light absorption at four Arctic stations (Barrow, Alaska; Summit, Greenland; Alert, Canada; Zeppelin, Spitsbergen, Norway) showed clear episodes when **smoke strongly increased the light absorption in the atmosphere**.

Measurements at Barrow, Summit and Zeppelin of **aerosol optical depth (AOD) showed influence from smoke over extended periods.**

We also suggest that deposition of BC aerosols on snow caused a **decrease of the snow albedo at Summit**.

Overall, this poster shows that **the role of forest fires as an aerosol source for the Arctic has been underestimated in the past**.

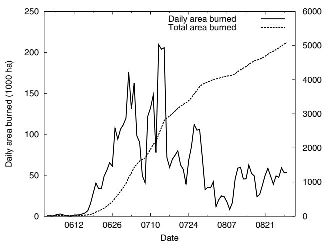

Figure 1: Daily areas burned (1000 ha) in Alaska and Canada (solid line), and total areas burned accumulated over the fire season (dashed line), from June through August 2004. ***Areas burned peak in July 2004.***

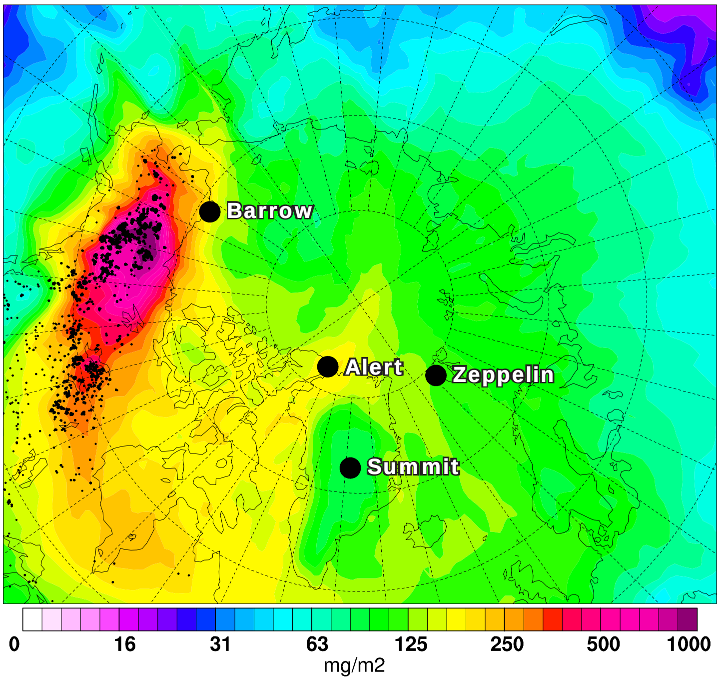

Figure 2: Results of a tracer simulation with FLEXPART, carrying a carbon monoxide (CO) tracer from the locations of forest fires (small black dots are MODIS fire detections). Total columns of the forest fire CO tracer are averaged over the months of July and August 2004. Large black dots show the positions of the measurement sites where the smoke was detected. ***FLEXPART suggests that the Arctic was also strongly impacted by smoke from the fires. Light absorption and aerosol optical depth (AOD) measurements from Barrow, Alert, Summit and Zeppelin clearly show the pan-Arctic impact of the smoke. Here, we only present light absorption/ black carbon data from Barrow and Summit.***

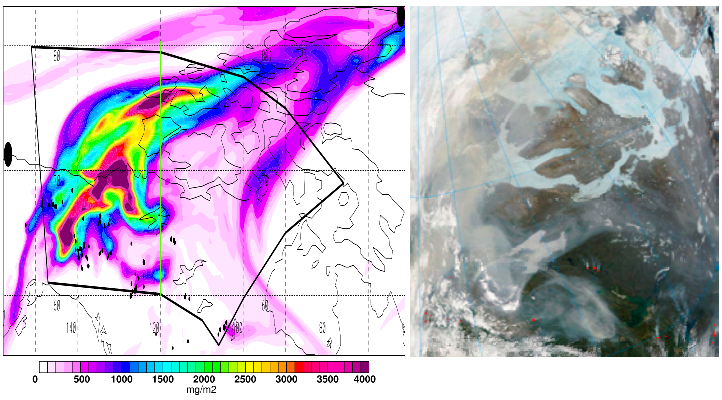

Figure 3: Total columns of the FLEXPART CO tracer at 18-21 UTC (left) and MODIS Terra image at 19:35 UTC (right) on 5 July 2004. The approximate region shown by the MODIS image is indicated by the thick black line in the CO tracer plot. MODIS fire detections are shown as black and red dots in the left and right image, respectively. Large black dots in the left image indicate the locations of Barrow on the far left and Alert in the top right corner. ***Both FLEXPART and MODIS show a forest fire plume intruding into the Arctic and over ice-covered surfaces. Note the light appearance of the smoke over the dark vegetated surfaces but the brownish hues over the ice surfaces, demonstrating the importance of light absorption in the Arctic.***

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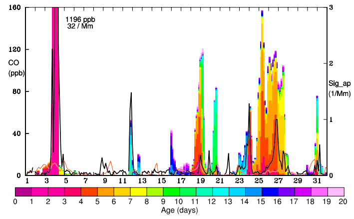

Figure 4: Comparison of the time series of 3-hour mean light absorption values measured by a PSAP (black line, in Mm[-1]) and CO tracer mixing ratios (ppb) obtained from a FLEXPART backward simulations, for Barrow for July 2004. Anthropogenic CO tracer, accumulated over all 20 days of transport, is shown by the red line, whereas North American forest fire CO tracer is shown as stacked bars whose color indicates its age, i.e., the time passed since emission at the fire locations. Numbers near the top of the panel indicate modeled and measured values outside the data range shown in the plot. ***The light absorption measured at Barrow during various smoke episodes are among the highest ever measured at the station. AOD values (not shown) were the highest ever recorded.***

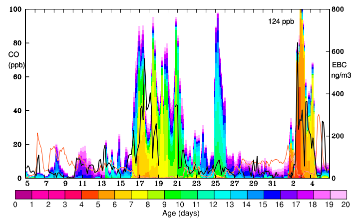

Figure 5: Same as Fig. 4, but for Summit, for the period 5 July til 5 August 2004. Instead of light absorption, equivalent BC concentrations (ng m^{-3}) from an aethalometer are shown. ***Summit was strongly impacted during two episodes. AOD values were strongly enhanced almost continuously over a period of two months.***

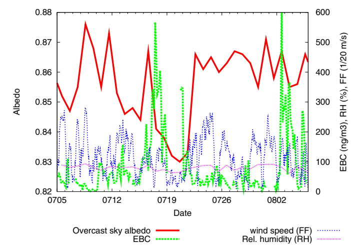

Figure 6: Time series of daily mean overcast sky albedo (red line), equivalent BC (green line), wind speed (blue line), and daily minimum relative humidity (pink line) at Summit, for the period 5 July til 5 August 2004. ***The albedo during the first smoke episode decreased significantly. Subsequent increase as well as the absence of a clear signal during the second episode are likely related to snow drift during high wind and the accumulation of fresh snow, respectively. While we cannot prove that the albedo decrease is indeed due to BC aerosol deposition, this is a likely explanation for the albedo decrease during the first episode.***

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