Title: **Absorbing aerosol in the troposphere of the Western Arctic during the 2008 ARCTAS/ARCPAC airborne field campaigns**

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Comments:

Manuscript No. acp-2010-858 presents the results derived from the measurements of absorption characteristics of polar aerosols performed during the 2008 ARCTAS/ARCPAC airborne field campaigns over the Western Arctic region of North America, using the NASA DC-8, and P-3b aircrafts and the NOAA WP-3D airplane. The large set of measurements taken at altitudes ranging between altitudes close to surface and 12 km level contained multiple wavelength data on aerosol optical properties, trace gases, aerosol chemical composition, and in particular on the black carbon mass and aerosol size distribution features in air masses containing both anthropogenic/industrial aerosols from polluted areas and dust and biomass burning aerosols mainly transported from Asia. For this reason, due to the significant representation of some of the most frequent features observed in the Arctic aerosols the present set of results constitutes a precious contribution to the knowledge of the radiative properties of aerosols for improving the knowledge of the Arctic aerosols of various origins on the radiative forcing induced directly by aerosol particles in this land region, which presents relatively high characteristics of surface albedo for a certain period of the year.

The results illustrated in the paper pertain to CO concentration data, this parameter being used as a tracer for individuating the presence of biomass burning aerosol plumes, and evaluates the airborne Black Carbon mass concentrations. The measurements of airborne CO concentrations recorded during the flights are examined in terms of overall relative frequency histograms giving evidence to the episodes characterized by the presence particularly high concentration of CH3CN associated with high concentrations of both Burning Biomass aerosols, and high AMS ratios of organics to sulfate substances. This analysis provides evidence that the high concentration values of CO are very often associated with the presence of biomass burning particulates.
The Black Carbon concentrations were found to increase almost linearly as a function of CO concentration with higher slopes for the biomass burning cases than in cases relative to aerosol loadings of urban/industrial origin. It is also interesting the comparison between the mean vertical profiles of CO, submicrometer dry aerosol extinction coefficient and mean black carbon content obtained from the data-sets of the three airborne platforms, to give evidence of the multi-layer features deriving from long-range transport episodes.

The paper provides also useful evaluations of the Mass Absorption Efficiency of black carbon for total aerosol absorption at three wavelengths, showing that the efficiency decreases as wavelength increases from 470 to 660 nm, and defining the wavelength dependence form of this optical

parameter, and evaluating total mass absorption efficiency for light absorbing carbon and for brown carbon, for different classes of absorption Ångström exponent, coarse mode fraction, and scattering Ångström exponent.

The episodes of mineral dust transport were also carefully examined to identify the layers of mineral dust aerosol particles and to examine the weight of the coarse particle fraction at the various altitudes, characterizing the multimodal size-distribution features of these Asian dust particles and comparing them with those obtained in previous Experiments. Also for this class of particles, estimates of the Mass Absorption Efficiency at various wavelengths have been performed. Finally, a comparison was made between the vertical profiles of black carbon and mineral dust masses to evaluate the light absorption contributions due to black carbon and brown carbon, separately for the urban/industrial and biomass burning emissions.

For this reason, my evaluation is that the paper presents precious information for characterizing the optical characteristics of polar aerosols in the Western Arctic. I agree with the authors on the fact that the data-set derived from the three aircraft campaigns is not exhaustive and that the atmosphere of the Western Arctic remains critically under-sampled. This is true also for the ground-based activities of characterization of Arctic aerosols. However, the present results constitute a useful contribution to the knowledge of the aerosol radiative properties and will find applications in modelling studies of the direct and indirect aerosol-induced radiative forcing.

For these reasons, manuscript No. acp-2010-858 deserves to be published.

I mean that there is not need to review further the manuscript, after the first revision, provided that some minor changes will be made to the text, as listed below:

Lines 168 – 178.
The presentation of the vertical profiles of BC mass in Figure 2 is certainly a useful data-set for the scientific community. In your comments, you provide evidence of the fact that the concentration values found in the middle-troposphere absorbing aerosol peak are reduced by a factor 4 at levels close to the surface. In addition, you states that median values are about half the mean values. This implies a skewed distribution due to a limited number of strong episodes.
Also in discussing the results shown in Figures 9 and 12, attention is paid to the fact that the distribution features are quite different within the first 2 km atmospheric depth and within the depth from 2 to 6 km altitude. This information is very useful for applications of the present results to aerosol-induced radiative forcing modelling. For this reason, I suggest to add a figure in the text presenting the relative frequency histograms (similar to those shown in Figure 5) giving the decadal logarithm of BC mass concentration within the 0-2 km layer and the 2-6 km layer (also of the upper region > 6 km, possibly) to provide evidence of their (differently ?) skewed distributions, and of the differences between mean and median values.

Line 188:
Please, specify the meaning of BB (biomass burning): it is the first time that it is used in the text (?).

Line 260:
Please, take out one of the two “the” written in the text.

Line 314:

Please, use preferably the term “single scattering albedo” in place of “single scatter albedo”.

Line 352 and the following ones, and in the legends of Figures 7 (twice) and 8 (twice):

Please, write Ångström in place of Angstrom.