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Comprehensive Study of Carbonaceous Species in Arctic Snow: from Snow Type to Carbon Sources and Sinks in the Snowpack

D. Voisin (1), J. Cozic (1), S. Houdier (1), M. Barret (1), J.L. Jaffrezo (1), M.D. King (2), H.J. Beine (3), F. Domine (1,4)

(1) LGGE, UJF-CNRS, Grenoble, France (didier.voisin@ujf-grenoble.fr), (2) Dept Earth Sciences, RHUL, London, England, (3) LAWR, UC-Davis, Davis, USA, (4) Takuvik Joint International Laboratory, Université Laval and CNRS, Quebec, Canada

Carbonaceous species play critical roles in the interaction of snow with the overlying atmosphere. Elemental or Black Carbon strongly increases solar energy uptake and snow melt, therefore influencing the snow-climate feedback loop. Carbonyls and complex organic molecules such as Humic Like Substances also absorb UV and visible light, therefore influencing photochemistry and light penetration depths in the snowpack. It has been proposed that some of those complex organic molecules, acting as electron donors in photochemical reactions might change the photolysis paths of nitric acid from NO / NO_2 to HONO. Yet, comprehensive investigations of the organic matter in arctic snowpack are scarce, and often limited to a few specific species.

Such a comprehensive representation of carbonaceous species in Arctic snow is the focus of the present work, lead during the OASIS field campaign in Barrow and focuses on major classes of carbonaceous species, defined operationally: Elemental Carbon (EC), which is close to BC; Water Insoluble Organic Carbon (WInOC); Dissolved Organic Carbon (DOC), which altogether represent the Total Carbon Content (TCC) of the snowpack. Among DOC species, we will more particularly focus on HUmic LIke Substances (HULIS), C2 – C5 dicarboxylic acids and short chain aldehydes, as these compounds are most particularly involved in snow photochemistry, especially HULIS, whose optical properties (UV-Vis absorbance) are measured and discussed.

In order to link observed concentrations to physico-chemical processes in the snow pack, we use snow type as a morphological marker of those processes and of the snowpack's history. Similarly, as the different classes of compounds measured are differently affected by the physical processes that lead the transformation of the snowpack, they can be used to probe into those processes. This strategy enables us to discuss in a common framework physical and chemical processes affecting carbonaceous species and the snowpack.

Total Carbon Content is highest in is highest in soil influenced indurated depth hoar layers and in diamond dust precipitation. It is found to decrease as snow ages, due to cleaving photochemistry and physical equilibration of the most volatile fraction of DOC. A precise evaluation of this recycled fraction would need a more precise evaluation of the annual importance of diamond dust as a source of carbon to the snowpack. Organic Carbon in surface snows appears to have a very significant ($\sim$40%) insoluble fraction. HULIS, short chain diacids and aldehydes are quantified, and showed to represent altogether a modest (<20%) proportion of DOC, and less than 10% of DOC+WinOC. HULIS optical properties are measured and could be consistent with aged biomass burning or an unknown source; a marine source is suggested.