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Radiative Forcing Assessment of Black Carbon in Snow from the Antarctic Peninsula

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The pristine Antarctic environment, despite its remoteness, is not immune to the influence of anthropogenic
pollutants. This study focuses on quantifying the Radiative Forcing (RF) resulting from Black Carbon (BC)
concentrations in snow samples collected from various points on the Antarctic Peninsula during the austral summer
of 2023, aiming to assess the impact of BC on the snowpack albedo and, consequently, on the regional climate. To the
best of our knowledge, in most of the locations studied, BC concentrations in snow have never been measured before.
Snow samples were meticulously collected from different locations on the Antarctic Peninsula, covering a diverse
range of environments, including base surroundings, remote locations, and icebergs. This effort was undertaken as
part of the ECA59 campaign, funded by the Chilean Antarctic Institute (INACH). The sampling constituted the initial
phase of a project involving three distinct sampling periods. Specifically, the collection sites were situated in the
eastern sector of the peninsula, known for its minimal human presence and limited prior research, making it a
relatively unexplored region. BC concentrations in our snow samples were measured following the method described
in Cereceda-Balic et al. (2022, https://doi.org/10.1016/j.envres.2022.113756). To understand the BC RF, the SNICAR
(SNow, ICe, and Aerosol Radiation) model was employed to simulate snow albedo for measured BC concentrations.
This methodology allowed for an assessment of the potential BC-induced changes in albedo and the resulting RF. The
analysis revealed a significant range of BC concentrations in Antarctic snow samples, spanning

from 2.4 to 1157 ng g-1. Simulating snow albedo using the SNICAR model indicated BC-induced albedo reductions of up to 20% relative to clean snow. The calculated BC-induced RF reached up to 38 W m-2, indicating a substantial climatic impact of BC in the Antarctic Peninsula region.

Our findings underscore the influence of BC on the radiative properties of snow in the Antarctic Peninsula. The diverse
BC concentrations observed here suggest varying sources and highlight the need for continued monitoring. The results
reveal the vulnerability of the Antarctic Peninsula to the impacts of anthropogenic pollutants, even in its seemingly
pristine surroundings. Acknowledging and addressing these influences is essential for assessing the broader
implications of climate change in polar regions. Continued research at these little-explored sites is crucial for refining
climate models and informing mitigation strategies to preserve the integrity of the Antarctic environment.

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