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Relationship between atmospheric BC concentration and vehicular traffic in high mountain locations, case of study: Portillo, Chilean Central Andes

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Black carbon (BC) has been pointed as the second largest contributor to climate change after greenhouse gases due to its superior ability to absorb solar radiation. This characteristic is particularly relevant in cryospheric environments, where the presence of BC has been related to a decrease in the albedo of ice/snow surfaces and the acceleration of their melting. In this sense, determination and quantification of BC levels in remote areas can be useful when defining and differentiating emission sources from which they come, considering the importance that the resources of the cryosphere mean for the surrounding populations for drinking water supply, agriculture, hydropower, mining, etc.

In this work, measurements of atmospheric BC from August 2016 to November 2019, carried out in Portillo, Chilean Central Andes, in the "Nunatak" laboratory-refuge (32°50'43"S, 70°07'47"W, 3000 m.a.s.l) are presented. This site, located in the highest altitude sector of the Andes mountain range, is very close to "Los Libertadores", the border between Chile and Argentina. The road connecting both countries has a very high traffic density, with many passenger cars and trucks traveling in both directions. Due to weather, this route has a seasonal operating schedule. During the austral summer (September 1 - May 31) vehicular traffic is allowed 24 hours a day, while in winter (June 1 - August 31) traffic is allowed only from 8 am to 8 pm. Additionally, during heavy snowfalls, the access for vehicles is banned. To establish the impact of vehicular traffic on the atmospheric BC levels in the area, BC concentrations were continuously monitored by a Multi-Angle Absorption Photometer (MAAP) (Model 5012, Thermo). BC was measured in PM2.5, sampled on a glass filter tape an inlet air flow of 1.0 m^3 h^{-1}. Measurements were based on the optical attenuation at a wavelength of 637 nm. Data were originally sampled in one-minute resolution, but hourly and monthly means were extracted for further analysis. Results showed a markedly seasonal profile. Summer months presented the highest levels of BC for all the studied years, when the max. values were observed during the night and early morning hours, reaching 2.1 µg m^{-3}. In turn, during the day there were significant declines in BC concentrations, with min. BC values of 0.2 µg m^{-3}. Conversely, for all the years studied, winter months had lower average BC values than the summer months, with a markedly different hourly profile, since the max. values (up to 1.7 µg m^{-3}) were reached in noon and afternoon hours, while the min. values fell up to 0.1

μg m^{-3} during night and early morning hours. Furthermore, BC concentration levels in Portillo were measured at an altitude where the main glaciers of central Andes are, showing the impact that BC could cause in the nearby glaciers. This marked seasonal pattern is in line with the traffic operational schedule above-mentioned, suggesting that in the study area, vehicular traffic is the main emission source of atmospheric BC. These findings are key pieces to identifying and implementing successful strategies for mitigation and adaptation on climate change.