

>> SYNTHESIZE MOUNTAINS OF KNOWLEDGE <<

Submitted Abstract

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Abstract

We have investigated the source and role of light-absorbing impurities (LAIs) deposited on the glaciers of the Olivares catchment, in Central Chile. LAIs can considerably darken (lowering albedo) the glacier surface, enhancing their melt. We combined chemical and mineralogical laboratory analyses of surface and ice core samples with field-based spectral reflectance measurements to investigate the nature and properties such LAIs. Using remote sensing-based albedo maps, we upscaled local information to glacier-wide coverage. We then used a model to evaluate the sensitivity of surface mass balance to a change in ice and snow albedo. The across-scale surface observations in combination with ice core analysis revealed a history of over half a century of LAIs deposition. We found traces of mining residuals in glacier surface samples. The glaciers with highest mass loss in the catchment present enhanced concentrations of surface dust particles with low reflectance properties. Our results indicate that dust particles with strong light-absorbing capacity have been mobilized from mine tailings and deposited on the nearby glacier surfaces. Large-scale assessment from satellite-based observations revealed darkening (ice albedo lowering) at most investigated glacier tongues from 1989 to 2018. Mass balance is sensitive to ice albedo. However, we believe that an accelerated winter and spring snow albedo decrease, partially triggered by surface impurities, might be responsible for the above-average mass loss encountered in this catchment.