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Modeling and field study of the influence of bauxite mining residues tailings on snow albedo

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Mining residues tailings are a major environmental problem facing mining industries. These phenomena are a greater source of preoccupation during winter conditions since wind-borne dust emissions are less predictable; it is thus more difficult to prevent them. Also, mining residues tailings cause greater modulation of the albedo on permanently or seasonally snow-covered regions. Their potential impact is most acute on air quality but also on the visual aspect of snow which is an immediate concern to neighboring urban communities. A recent collaboration with a bauxite residue management center in Quebec made it possible to benchmark the Two-streAm Radiative TransfEr in Snow (i.e., TARTES) model using the bauxite mining residues tailings disseminated on snow at the management site. We report optical albedo and reflectivity measurements performed on snow showing strong dependency on its bauxite residues content. Those experimental data are compared to the TARTES model,[1] allowing a critical evaluation of the optical parameters, particle size distributions and physical properties of the bauxite residues and of the snow that are used as inputs. Deficiencies in the model indicate better account for particles size distributions, optical properties and abundances are essential to better describe and understand the effect of mining residues tailing on snow properties. Ongoing efforts towards the characterization of mining residues physico-chemical properties highlight a correlation between the different populations of the size distribution and the chemical composition of the bauxite residues as revealed by dynamic light scattering (DLS) and X-ray diffraction (XRD). The experimental characterization of the bauxite residues will therefore provide us with precise inputs to use in the TARTES model which will be validated with field measurements. The improvement of the theoretical model will make it possible to describe and have a better understanding of the alteration of various mine tailings on snow albedo.
[1] Q. Libois, G. Picard, J. France, L. Arnaud, M. Dumont , C. Carmagnola , and M. D. King, Influence of grain shape on light penetration in snow, The Cryosphere, 7, 1803-1818, (2013).

Significance statement

This study suggests that characterization of mine residues tailings allows optimization of a theoretical model describing their modulation on snow albedo

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