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Mountain glaciers darkening: geochemical characterizazion of cryoconites and their radiative impact on the Vadret da Morteratsch (Swiss Alps)

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Mountain glaciers represent an important source of fresh water across the globe. It is well known that these reservoirs are seriously threatened by global climate change, and a widespread reduction of glacier extension has been observed in recent years. Surface processes that promote ice melting are driven both by air temperature/precipitation and surface albedo. This latter is mainly influenced by the growth of snow grains and by the impurities content (such as mineral dust, soot, ash etc.). The origin of these light-absorbing impurities can be local or distal, and often, as a consequence of melting processes, they can aggregate on the glacier tongue, forming characteristics cryoconites, that decrease ice albedo and hence promote the melting.
In this contribution, we coupled satellite images (EO1 – Hyperion and Landsat 8 - OLI) and ground hyperspectral data (ASD field spectrometer) for characterizing ice and snow surface reflectance of the Vadret da Morteratsch glacier (Swiss Alps). On the glacier ablation zone, we sampled ice, snow, surface dust and cryoconite material. To evaluate the possible impact of anthropogenic and natural emissions on cryoconites formation, we determined their geochemical composition (through the Neutron Activation Analysis, NAA) and the concentration of Black Carbon (BC), Organic Carbon (OC), Elemental Carbon (EC) and Levoglucosan.
From satellite data, we computed the Snow Darkening Index (SDI), which is non-linearly correlated with dust content in snow. Results showed that, during 2015 summer season, ice albedo in the ablation zone reached very low values of about 0.1-0.2. The darkening of the glacier can be attributed to the impact of surface dust (from lateral moraine and Saharan desert) and cryoconites, coupled with grain growth driven by the extremely warm 2015 summer. The geochemical characterization of non-ice material contained in the cryoconites can provide important information regarding their source and the possible impact of anthropogenic emissions on cryoconites formation and evolution.