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Challenges in High Latitude Dust (HLD) measurements and HLD interactions with clouds and solar radiation

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Two billion tons of dust are annually suspended in the Earth´s atmosphere. HLD contributes about 5% to the global atmospheric dust budget. Active HLD sources cover > 1,600,000 km^2 and are located in both the Northern (Iceland, Alaska, Canada, Greenland, Svalbard, North Eurasia, and Scandinavia) and Southern (Antarctica, Patagonia, New Zealand) Hemispheres. *In-situ* HLD measurements are sparse, but numerous research groups investigate HLD and its impacts on climate in terms of effects on cryosphere, cloud properties and marine environment (IceDust Association, UArctic Thematic Network on HLD, NORDDUST, CAMS NCP Iceland).

Long-term dust i*n situ* measurements conducted in Arctic deserts of Iceland and Antarctic deserts of Eastern Antarctic Peninsula in 2018-2024 revealed some of the most severe dust storms in terms of particulate matter (PM) concentrations. While one-minute PM_{10} concentrations is Iceland exceeded 50,000 ugm^{-3}, hourly PM_{10} means in James Ross Island, Antarctica exceeded 300 ugm^{-3} in 2021-22. Additionally, examples of aerosol measurements from Svalbard and Greenland will be shown. There are newly two online models (DREAM, SILAM) providing daily operational dust forecasts of HLD. DREAM is first operational dust forecast for Icelandic dust available at the World Meteorological Organization Sand/Dust Storm Warning Advisory and Assessment System (WMO SDS-WAS). SILAM from the Finnish Meteorological Institute provides HLD forecast for both circumpolar regions.

Icelandic dust has impacts on atmosphere, cryosphere, atmospheric chemistry, clouds, air quality and radiation. It has critical impacts on cryosphere as it is suspended at high latitudes, decreasing albedo of both glacial ice/snow similarly as Black Carbon. Icelandic dust reduces supercooled water content of mixed phase clouds changing their albedo. Suspended Icelandic dust tends to be more absorbing towards the near-infrared. The imaginary part of the complex refractive index k(λ) between 660–950 nm is 2–8 times higher than most of the dust samples sourced in northern Africa and eastern Asia. There is also an evidence that volcanic dust particles scavenge efficiently SO_2 and NO_2 to form sulphites/sulfates and nitrous acid. High concentrations of volcanic dust and Eyjafjallajokull ash were associated with up to 20% decline in ozone concentrations in 2010. In marine environment, Icelandic dust with high total Fe content (10-13 wt%) and the initial Fe solubility of 0.08-0.6%, can impact primary productivity and nitrogen fixation in the N Atlantic Ocean, leading to additional carbon uptake.

Sand and dust storms, including HLD, were identified as a hazard that affects 11 of the 17 Sustainable Development Goals. IceDust Association with > 110 members from 57 institutions in 22 countries became member aerosol association of the European Aerosol Assembly in 2022. In addition, HLD has potential to increase the research interest of HARMONIA members/stakeholders in comparing observations from established measurement sites at high latitudes and numerous areas without monitoring.