EGU24-13103, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-13103
EGU General Assembly 2024

High Latitude Dust (HLD) measurements in Iceland, Antarctica, Svalbard, and Greenland, including HLD impacts on climate and HLD networking

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Two billion tons of dust are annually transported in our atmosphere all around the world. High latitudes include active desert regions with at least 5 % production of the global atmospheric dust. Active High Latitude Dust (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. Recent studies have shown that HLD travels several thousands of km inside the Arctic and > 3,500 km towards Europe. In Polar Regions, HLD was recognized as an important climate driver in the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate in 2019. *In situ* HLD measurements are sparse, but there is increasing number of research groups investigating HLD and its impacts on climate in terms of effects on cryosphere, cloud properties and marine environment.

Long-term dust i*n situ* measurements conducted in Arctic deserts of Iceland and Antarctic deserts of Eastern Antarctic Peninsula in 2018-2023 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. The largest HLD field campaign was organized in Iceland in 2021 where 11 international institutions with > 70 instruments and 12 m tower conducted dust measurements (Barcelona Supercomputing Centre, Darmstadt, Berlin and Karlsruhe Universities, NASA, Czech University of Life sciences, Agricultural University of Iceland etc.). 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, marine and terrestrial environments. It decreases albedo of both glacial ice/snow similarly as Black Carbon, as well as albedo of mixed phase clouds via reduction in supercooled water content. There is also an evidence that volcanic

dust particles scavenge efficiently SO2 and NO2 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. HLD research community is growing and Icelandic Aerosol and Dust Association (IceDust) has > 110 members from 57 institutions in 22 countries (https://icedustblog.wordpress.com, including references to this abstract). IceDust became new member aerosol association of the European Aerosol Assembly in 2022. New UArctic Thematic Network on HLD was established in 2023.