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Contributions of Icelandic and other high-latitude sources to mineral dust in the Arctic

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Impurities in the Arctic atmosphere and cryosphere, such as mineral dust, can strongly affect the atmospheric radiation- and surface energy balance. Mineral dust can be transported into the Arctic from remote regions, but is also generated at high latitudes, for instance Iceland. With the dust mobilization scheme FLEXDUST and the Lagrangian atmospheric dispersion model FLEXPART we investigate sources of mineral dust at northern high latitudes.

FLEXDUST simulations over three years indicate that about 3% of global dust emission originate from northern high-latitude (>60°N) dust sources. About 10% thereof comes from Iceland. Due to limited up-lifting of this dust and relatively small transport distances, dust from nothern high-latitude sources contributes strongly to dust deposition (∼90%) and dust surface concentrations (∼85%) in the Arctic, according to our simulations. With increasing altitude, remote sources become more important for dust concentrations, thus influencing total atmospheric dust load rather than surface concentrations and contributing to dust deposition at higher altitude locations. Total atmospheric dust loads in the Arctic are strongly influenced by Asian (∼38%) and African (∼32%) dust. Only at higher altitudes, such as on the Greenland Ice Sheet, larger fractions of deposited dust originate from remote sources.

At lower altitudes, deposited dust appears to originate mostly from northern high-latitude sources. Dust mobilization from these sources is, however, rarely studied in detail. With some adaptations to FLEXDUST, we study dust emission, transport and deposition of Icelandic dust at high resolution for one year. We used a high-resolution map of soil types in Iceland and threshold friction velocity in dust sources was based on previous observations. Snow cover and precipitation were included as factors limiting dust mobilization.

In a one-year high-resolution simulation for 2012, driven with hourly meteorological data from the European Centre for Medium-Range Weather Forecasts at 0.2 degrees, we distinguish most important dust sources and study dust concentrations at remote distances from sources based on PM10 measurements in and near Reykjavik. Some dust events were described well with the model, while the model appears to overpredict dust concentrations in Reykjavik in late fall.

We further look into interannual variability of dust emission from Iceland with FLEXDUST simulations based on ERA Interim data over two decades. Here, we found that annual dust emission is on average about 3.5±0.7 Tg. In some years, the inland sources in the region of Dyngjusandur are most prominent, while in others near-coast southern dust sources are especially active. Much of the dust emitted from Iceland is transported southwards and therefore less than 6% of dust deposited in the near Arctic (>60°N) is from Icelandic sources.