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Numerical modeling of the Icelandic mineral dust transport and processes - towards the operational forecasting system

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Numerous scientific studies and reports indicate that the Icelandic topsoil sediments are the largest and the most important European source of the mineral dust, representing also one of the best-studied high-latitude dust areas. The majority of the dust particles in this region are sediments of volcanic origin, either deposited as volcanic ash or reworked by physical weathering of volcanic rocks by glaciers and other physical factors. Located in the North Atlantic Storm track and affected by frequent atmospheric low pressure systems, this area is exposed to frequent strong winds. This excessive atmospheric circulation induces intense emissions of volcanogenic dust particles from local sources. It has been estimated that there are about 130 dust events per year, ranging from minor storms to more than 300,000 t of dust emitted in a single storm. Mid-tropospheric winds carry away these fine aerosol particles for thousands of kilometers. High concentrations of airborne dust particles strongly affect the local air quality, human health and transportation. Deposited on snow and glaciers in the high latitude regions, mineral dust particles enhance their melting and reduce surface albedo. On the other hand, high content of Fe-rich minerals deposited over neighboring seas could be a source of nutrients for the marine system, thus bringing positive effects to the ecosystem.

These findings motivated us to design a numerical modeling system in order to simulate, predict and quantify Icelandic mineral dust process, which could be used both as an operational forecasting system and as a reliable tool for examining various effects on environment and climate change. For this purpose The Dust Regional Atmospheric Model (DREAM) has been implemented by introducing numerous upgrades to the original model, such as : improved dust source specification with geographic distribution of Icelandic dust sources based on detailed soil data of the Agricultural University of Iceland; variable particle size distribution following corresponding local measurements; introduced active snow cover instead of its climatological values. The fact that dust emission from several relatively small dust hotpots is comparable to mass emitted from all other mineral dust sources in the Iceland has been implemented, resulting in accordingly adjusted model dust emission scheme.

Modeled surface dust concentration has been validated against PM10 observations from several air quality measurement stations located at Iceland, Faroe Islands and United Kingdom. Forecasted Aerosol Optical Depth (AOD) has been validated using NASA MODIS AOD retrievals. Results from two intense dust episodes, each lasting for several days and transporting dust more than thousand kilometers away from Iceland source regions will be presented in this study.

The study has been partly performed through collaboration within the EU COST Action CA16202 “International Network to Encourage the Use of Monitoring and Forecasting Dust Products (inDust)”.