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Volcanic ash over Scandinavia originating from the Grímsvötn eruptions in May 2011

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In May 2011, eruptions of Iceland's Grímsvötn volcano released huge amounts of material into the troposphere and lower stratosphere. Volcanic ash transported to southern Scandinavia could be identified in satellite observations and at air quality monitoring stations in Norway, Sweden, and Finland with PM10 exceeding 100 μg/m^3 for several hours. The overpass of the ash plume over Stockholm was also detected with a Raman lidar and a sun photometer (SPM). The first traces of ash were identified at 1900 UTC on 24 May 2011 by an increase in PM10 concentrations and strong lidar signals within the planetary boundary layer (PBL). A maximum ash concentration of 160 μg/m^3 was observed at 0000 UTC on 25 May 2011. A second maximum of 110 μg/m^3 occurred 4 h later. Measurements of particle size distributions at the surface showed 5 times higher concentrations of particles with diameters between 1 and 7 μm compared to measurements performed 24 h earlier and later, respectively. In addition, an elevated ash layer was detected by lidar between 1.5 and 3.0 km height from 0200 to 0800 UTC on 25 May 2011. The maximum aerosol optical thickness (AOT) of this layer was found to be 0.3 at 532 nm while the total AOT of both the PBL and the elevated layer was 0.6. The AOT obtained with lidar is in good agreement with SPM measurements after sunrise. Ash mass concentrations estimated from the lidar measurements were in the range of 140–270 μg/m^3 at 2.8 km height.