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The DWD ceilometer network for Saharan dust observations

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The German Meteorological Service (DWD) operates a dense network of ceilometers for cloud base height observations. About 50 of these ceilometers are CHM15K-Nimbus by Jenoptik, Germany. Those very powerful ceilometers allow for the detection and characterization of aerosol layers.

The CHM15K-Nimbus instruments are equipped with a diode-pumped Nd:YAG solid state laser that emits laser pulses with a power of about 8 μJ per pulse at 1064 nm with a repetition rate of 5-7 kHz. The back-scattered light is collected with a Newtonian receiving telescope, then filtered with a narrow-band interference filter before it is detected with an avalanche photodiode in photon counting mode. The signal can be used from about 600 m above ground level up to 15 km with a vertical resolution of 15 m. Raw data of all network ceilometers are transferred online to DWD's data analysis center at the Hohenpeißenberg Meteorological Observatory.

The DWD ceilometer network has been used for the detection and estimation of mass concentrations of volcanic ash layers over Germany during and after the eruptions of Eyjafjallajökull (2010) and Grimsvötn (2011). The CHM15k-Nimbus can also be used for the detection of Sahara dust layers in the free troposphere. Such events occur at about 30 days per year over Germany.

We will present in detail the episode of August 18-24, 2012, when a Saharan dust plume crossed Germany from West to East. The plume arrived during the evening of August 18, 2012. It was first detected by stations in the North-West of Germany between 2 and 4 km altitude. During the next day, the dust plume became visible also over stations in easterly parts of Germany. Mixing with the planetary boundary layer (PBL) started about noon of August 19. Dust transport to the southernmost part of Germany was observed during 20/21 August in altitudes between 2 and 5 km. The dust was mixed down into the PBL during August 21 and remained only in the southern parts of Germany until August 23. During these days the dust was located between ground and 4 km altitude.

The AERONET sun photometer network measured maximum values of the coarse mode optical depth of the Saharan dust of 0.15 over Hamburg during the morning of 19th, 0.25-0.28 over Mainz and Leipzig during the morning of 20th, and more than 0.3 during the afternoon of 21st over Munich.

Our network observations confirm very well the simulations of the Barcelona supercomputing Center DREAM model. There is an excellent agreement between observations and model simulations concerning the location, transport and evolution of the Saharan dust plume. Even the vertical location of the dust plume was well predicted for the stations Garmisch-Partenkirchen, Munich, and Leipzig. The observed optical depth with maximum values of 0.25 was only slightly underestimated by the model.