EMS Annual Meeting Abstracts
Vol. 14, EMS2017-481, 2017

Automatic Ceilometer-based Backscatter Coefficient Retrieval – Improving Network Capabilities by combining Ceilometer Networks and AERONET

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Since the eruption of the Eyjafjallajökul and the propagation of its plume towards Europe in 2010, the concern of monitoring the aerosol distribution in the atmosphere has grown significantly. Existing networks of aerosol profiling instruments like lidars and ceilometers were extended by further instruments and strengthened by inter-connecting and harmonizing them all over Europe. This task is coordinated under the roof of the European COST action TOPROF. Particularly the high number of existing ceilometers shall be combined to a European network. An important part of this network harmonization is the standardization of the retrieval algorithms for determining the aerosols backscatter profiles. So far, the focus was put on the improvement of the attenuated backscatter profile retrieval. Since ceilometers measure the elastic backscattered signal at one wavelength only, additional assumptions or calibration procedures are necessary to allow for the derivation of the particle backscatter coefficient profile. Such a calibration is provided by using the aerosol optical depth (AOD) measured by a sun-photometer. The instrument calibration and automatic data retrieval of optical and microphysical aerosol properties is already successfully coordinated in a world-wide network - AERONET. In Europe, the number of operating stations has grown from one in 1994 to about 70 stations in 2017. Although the number of ceilometer stations in Europe is still higher and by far not every ceilometer has a co-located sun photometer, combining both networks invokes a potential that should not be omitted.
At TROPOS, we developed an automatic retrieval algorithm for the calculation of the particle backscatter coefficient profile using the AERONET retrieved AOD for calibration of the ceilometer profile. In this paper, the procedure is exemplarily shown for two measurements sites: Leipzig, Germany, and Limassol, Cyprus. At TROPOS in Leipzig, a ceilometer of type CHM15k NIMBUS is in operation since February 2015. AERONET sun photometer measurements at TROPOS were conducted since 2001 using several instrument types, including sun, dual polar and lunar type. A time series of one-year data record from Leipzig is available for the demonstration of the performance of the automatic algorithm. In August 2016 the mobile facility LACROS (Leipzig Aerosol and Cloud Remote Observation System), including the ceilometer, was installed at a temporary site in Limassol, Cyprus. A suitable AERONET sun photometer is available from Cyprus University. This data-set is invoking more challenging aerosol conditions – i.e. dust layers from the deserts in Africa, the Arabian Peninsula, or Asia - for the approval of the algorithm. Perspectively, this automatic algorithm can be used to improve the capabilities of ceilometer networks.