The selection and pre-processing algorithms of CALIOP lidar data for aerosol concentration retrieval with LIRIC-S

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Abstract

Combined lidar and radiometer sounding (LRS) technique provides comprehensive investigations of the atmospheric aerosol aimed at retrieving altitude distributions of aerosol optical parameters and aerosol mode concentrations in an inhomogeneous aerosol layer. However, the insufficient number of coincident lidar and sun-radiometer stations restricts the scope of LRS for monitoring atmospheric aerosol. Data of the satellite lidar CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarization) can be used as a "space" part of input information in advance version of LRS technique. Results of the LRMC-17 (Lidar & Radiometer measurement campaign - 2017) cooperative measurements demonstrate feasibility of the combined terrestrial and satellite variant of LRS-technique for studying distribution of aerosol concentration over large regions using AERONET (Aerosol Robotic Network) data and results of sounding by satellite lidar, like CALIOP [1].

We present the selection algorithm of compatible measurements of the satellite lidar CALIOP and AERONET sun-radiometer (in time and space), particularly filename formation of CALIOP lidar data required for processing and downloading observation images, and the pre-processing algorithm of CALIOP lidar data, particularly cloud signal filtering, calculation of optical thickness, molecular and extinction models.

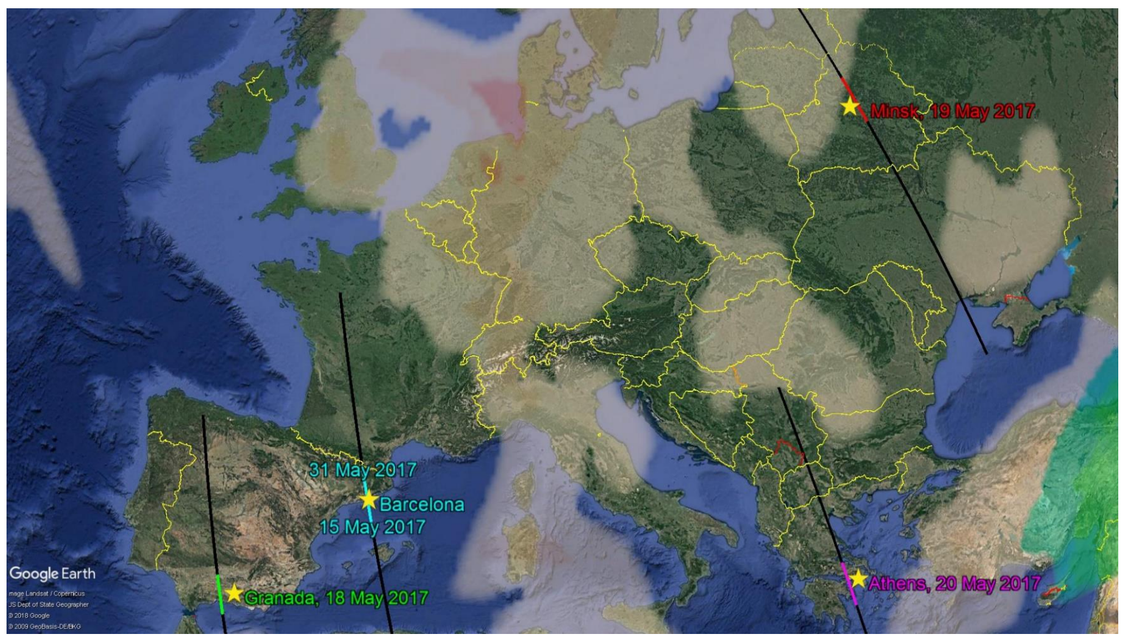
Introduction

To use CALIOP lidar data in LRS technique, we need to know (1) availability sun-radiometer measurements within the satellite pass, and (2) cloud cover percentage in measured lidar data.

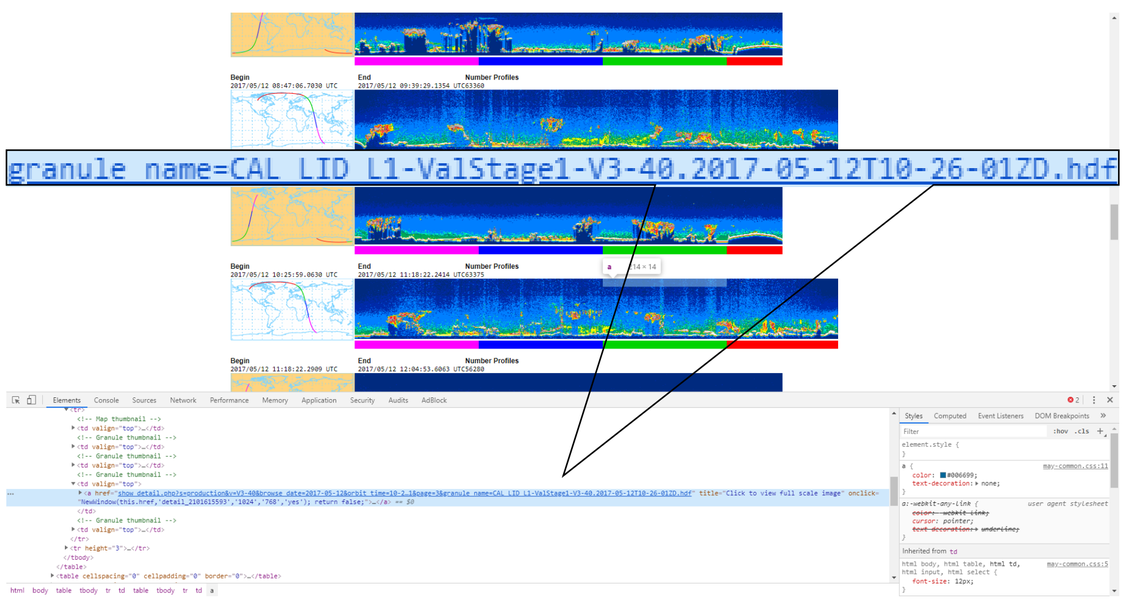
For limited observations we can get this information manually. But to process a large amount of data we need to implement the selection procedure for quick access to the required CALIOP lidar data. The selection and pre-processing algorithms were developed for subsequent processing of the lidar data by the Lidar-Radiometer Inversion Code, specially adopted for CALIOP lidar data (LIRIC-S).

Selection algorithm

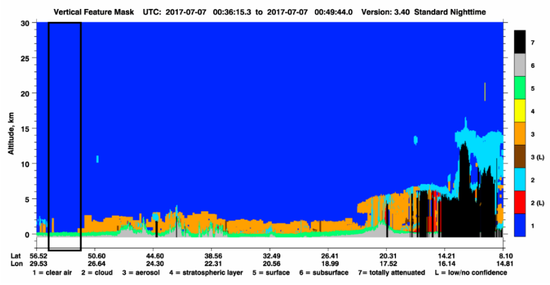
By choosing a station and a time window, we can obtain the date and time of sun-radiometer measurements [2, 3]. Knowing the station coordinates, we can obtain the date and time of satellite measurements within a circle of the prescribed radius [4]. The thus-obtained date and time are used to select compatible measurements of the satellite lidar CALIOP and AERONET sun-radiometer (1).



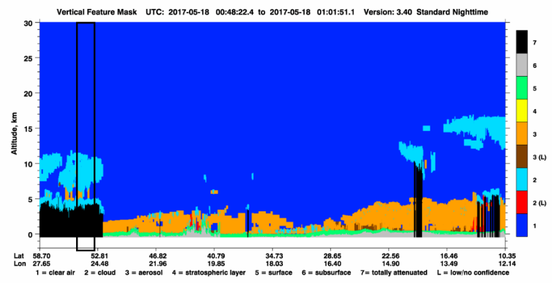
Knowing the date and time of compatible measurements, we can get the filenames of CALIOP lidar data [5].



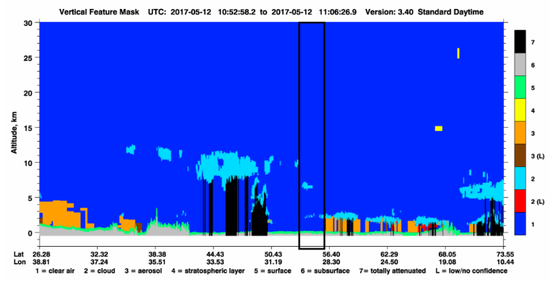
For forward estimate of atmospheric composition, observation images with highlighted area are formed (2). Input parameters for the below obtained images: AERONET site – Minsk (latitude – 53.92, longitude – 27.60), circle radius centered at the site – 200 km.



clear, 34 km to satellite track



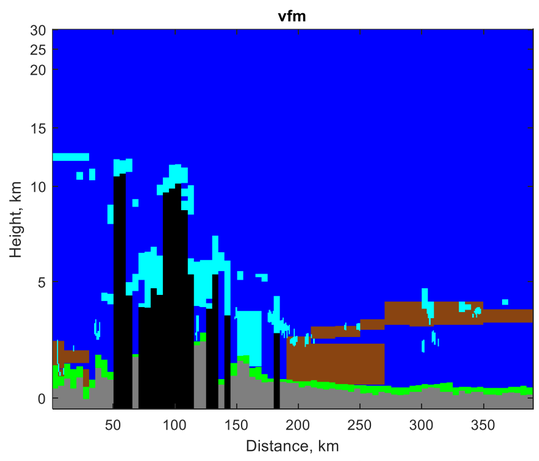
clouds, 163 km to satellite track

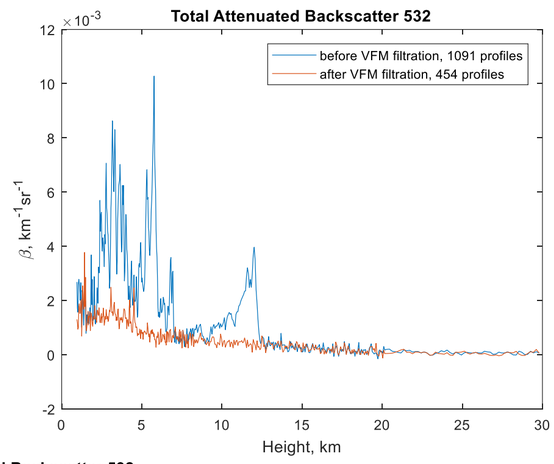


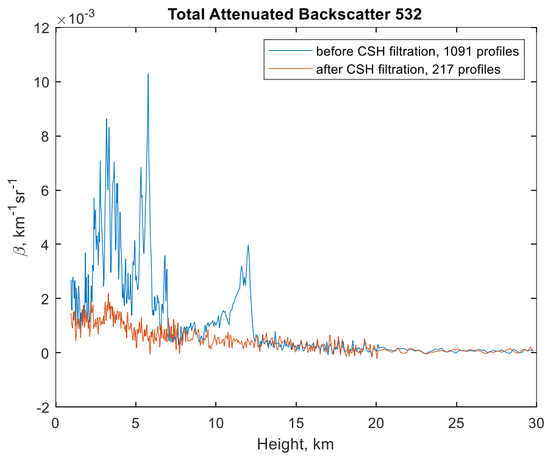
broken-cloud, 124 km to satellite track

Pre-processing algorithm

For an illustrative example of cloud signal filtering, the above "broken-cloud" case was chosen with the following parameters: AERONET site – HohenpeissenbergDWD (elevation – 1 km, latitude – 47.80, longitude – 11.01), datetime of CALIOP overpass time – 2017-05-30T12:25:33Z, circle radius centered at the site – 200 km (29 km to satellite track). If we have Vertical Feature Mask (VFM) data, we can use it and remove the cloud profiles. Otherwise, we can use an algorithm based on the Control of Spatial Homogeneity (CSH) of the profiles of backscattering coefficients.







After averaging, regridding and smoothing, profiles of optical thickness, molecular and extinction models are calculated for further processing in LIRIC-S.

Conclusions

The described pre-processing algorithms are to be integrated into modified LIRIC-S to form one fully functional package for aerosol concentration retrieval from the collocated observations by AERONET sun-radiometer and CALIOP lidar.

Also, Open-source Project for a Network Data Access Protocol (OPeNDAP) is slated to be used [6]. This will allow us to bypass the order procedure of CALIOP lidar data (with no wait, get data instantly) and save disk space (about 500 MB per one lidar data).

References

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