Classification of Aerosol Retrievals From Spaceborne POLDER-3 Using a Multivariate Algorithm


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Abstract

Since the development of global aerosol measurements by satellites and AERONET, classification of observed aerosols into several types has been a useful tool for understanding aerosol sources, transformations, effects, and feedback mechanisms. It has improved accuracy of satellite retrievals and to quantify aerosol parameters for climate model parameterization in space and time. Several studies and groups have developed clustering algorithms on AERONET data for classifications of aerosol types observed by the POLDER-3 polarimeter on the PARASOL spacecraft.

2. Aerosol classification method

This poster uses AERONET data in two ways: (1) to illustrate how Mahalanobis classification works with a variable number of clusters to classify aerosols observed by the POLDER-3 polarimeter on the PARASOL spacecraft; and (2) to find the best number of clusters to use for SSA and SSA
differences for each of 2 size modes (fine and coarse).

2.1 Mahalanobis classification

This algorithm classifies aerosol parameters in relation to aerosol types

2.2. Specified clustering and Mahalanobis classification

How to report this Algorithm

3. Application to POLDER-PARASOL Retrieved Aerosol Parameters

We use our POLDER classification result (red color indicates it is closest to Pure Dust).

Summary and conclusions

We develop a data assimilation method for specifying the aerosol properties in a variational data assimilation system, which results in a significant improvement of the assimilation of aerosol properties compared to a method that does not take aerosol properties into account.

Fig. 1. Illustration of the Mahalanobis distance (D_M) for points and clusters, where M is the cluster mean and D is the effective radius. Parameters in Table 1 are used to define the pre-specified clusters (Table 2) using parameters retrieved from AERONET and CALIOP Level 1.3 data, respectively.

Fig. 4. Results of applying our 4-parameter SSA_AERONET method (a) to POLDER-PARASOL retrieved aerosol parameters from FORTH-Crete, Crete, Greece, April 2008 to April 2009. Colors denote aerosol type, with red indicating Pure Dust and black indicating Polluted Dust. 

Fig. 5. The classification of the FORTH-Crete aerosol data set using 4 parameters. (a) SSA_AERONET and SSA_POLDER results. The black diamonds are the true aerosol type, while the blue squares are the predicted aerosol type. The red lines are the decision boundaries.

Our method: Mahalanobis classification using prespecified clusters (Box) follows the specified clustering algorithm (2) using parameters retrieved from AERONET and POLDER-PARASOL. We apply the method to aerosol parameters retrieved from the POLDER-3 polarimeter on the PARASOL spacecraft. The POLDER-3 data are corrected for the effects of scattering and extinction by aerosols and clouds.

We apply our method to a large number of aerosol datasets, including both in situ and remote sensing data. Our method is robust to changes in the number of clusters and the number of aerosol parameters.

Our method uses a Mahalanobis distance to classify aerosol types. We find that this distance is a good indicator of aerosol type. We also find that the Mahalanobis distance is more sensitive to changes in aerosol parameters when the number of clusters is small.

Our method shows promise for improving the accuracy of aerosol classification in a variety of applications, including climate modeling and atmospheric chemistry.