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Machine learning methods for detection of dust from Meteosat imagery

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Dust and sand storms can create potentially hazardous air quality conditions and adversely affect climate on a regional and world-wide scale, by modifying the shortwave and longwave radiation budgets, and human health. The indirect effects of dust are also significant because they modify cloud and precipitation properties and influence the general circulation of the atmosphere. In addition, consideration of dust has been shown to improve the weather forecast ability of models. For these reasons, there is an increasing and strong interest for real-time dust detection and monitoring as well as for dust load estimation from satellite observations, which offer the best solution to the problem. Indeed, remote sensing has been shown to be a valuable tool for detecting, mapping and forecasting dust events. Furthermore, dust satellite remote sensing is also useful in providing long-term and global observations of dust. Nevertheless, the majority of the approaches for dust detection and monitoring are still based on simple thresholding of the multispectral satellite imagery.
This study is an effort to investigate the efficiency of machine learning techniques in order to accurately classify different cloud features in Meteosat imagery and detect dust in different atmospheric layers over the greater Mediterranean basin. More specifically, different Support Vector Machines (SVM) and Artificial Neural Network (ANN) schemes are tested to conclude on the most appropriate parameterization of the examined classification schemes. The training samples are collected after spatiotemporal correlation of AERONET station measurements with Meteosat images. he efficiency of the examined algorithms is also tested using AERONET station data in selected cases. This study is first step toward the development of an integrated methodology for an accurate detection, monitoring and estimation of dust using exclusively satellite imagery.