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Nowcasting Aerosol Optical Depth using multispectral Meteosat imagery

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Atmospheric dust and sand storms can influence clouds and precipitation , global oceans, the carbon cycle as well as the shortwave and longwave radiation budgets and surface and air temperatures. Thereby, they affect the Earth's atmospheric general circulation and climate at regional to global scales. Moreover, such events create hazardous air quality conditions which adversely affect human health, while having socio-economical impacts, for example preventing sea and air transports.

For these reasons, there is an increasing and strong interest for real-time dust detection, monitoring and nowcasting, especially through the synergy of satellite observations, which is a proven valuable tool. Furthermore, dust satellite remote sensing is also useful for providing long-term and global observations used for the creation of climatological datasets. Nevertheless, the majority of the current approaches mostly focus on dust detection and monitoring and not on nowcasting.

This study presents the results of an algorithm, based exclusively on Meteosat multispectral imagery and using AERONET station measurements as reference data, nowcasting atmospheric dust patterns (in terms of Aerosol Optical Depth, namely "AOD") over the Mediterranean basin. The algorithm is based on an Artificial Neural Network (ANN) model which quantifies dust in the Meteosat imagery, namely Meteosat Brightness temperatures (BTs) in the channels of 6.2, 7.3, 8.7, 10.8 and 12.0 μm. Following the same approach, these pixel-level Meteosat BTs are extrapolated and subsequently the ANN model estimates the AOD using the extrapolated BTs. For two selected case studies of dust outbreaks in the Mediterranean basin, the algorithm was run to produce forecasts every 30-min, for the next three hours. Repeating this procedure every 30-min, a satisfactory dataset of forecasted products for all the different time steps, was finally created. Finally, the forecasts were spatiotemporally correlated with the AERONET measurements in order to assess the overall accuracy of the developed nowcasting algorithm. This study is a first step towards the development of an integrated methodology for nowcasting dust load (in terms of AOD) using exclusively the Meteosat satellite imagery.