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MODIS AOD retrieval at high horizontal resolution with MAIAC on the Alpine region

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Satellite data allow to determine the spatial distribution and variability of aerosols at a large scale. The standard products are developed for global applications and have a coarse resolution, for example 10 km for MODIS standard product (MOD04) Aerosol Optical Depth (AOD). On the other hand, the concentration of aerosols in in mountain regions like the Alps, is very heterogeneous and characterized by scales of variability of several kilometers. Therefore, satellite high resolution products are needed to provide an accurate aerosol mapping in mountain areas.
Several approaches to derive aerosol optical depth (AOD) from MODIS at high resolution have been proposed in the recent years. They provide new opportunities for regional scale analysis, but application of these algorithms remains confined to few studies. Recently, the Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm was developed for MODIS, which performs a simultaneous retrieval of surface bidirectional reflection and aerosol properties at a resolution of 1km. This algorithm has a global scope and works over both dark and bright surfaces; it has an internal cloud mask and snow detection, and provides an enhanced data coverage with respect to the MODIS standard product, which is very appealing for the Alpine region.
In this study we analyze the quality and potential of MAIAC AOD in the European Alpine region using the 1km resolution AOD maps for the years 2008-2009. Since unresolved clouds and snow pixel contamination increase the noise of the AOD retrieval, we developed a filter that preserves the spatial resolution of the product and enhances the accuracy of MAIAC AOD for air-quality and climatological applications. The filtering approach is divided in three steps: a coarse and fine mode fraction filter, a proximity-cloud filter and an AOD standard deviation filter.
The MAIAC AOD was validated with AERONET measurements in the region and compared with MODIS product MOD04. Similar accuracies are found for both products (RMSE=0.05) but with MAIAC providing about 50% more observations in the area, because of its higher spatial resolution and less restrictive filtering. Comparison with ground measurements of aerosol mass (PM10) shows that MAIAC AOD can be used to detect the fine scales of aerosol variability (2-3 km) in the mountains. Evidence of AOD variability in the mountains (up to $0.1-0.2$) at scales of several km (width of valleys) is confirmed by the satellite retrieval.
Finally, AOD maps for the Alpine region demonstrate thattopography is correlated with the average aerosol spatial distribution.
We conclude that 1km retrieval gives valuable insights for mapping aerosols in a topographically complex terrain, provided that some care is used with cloud/snow related artifacts. Sampling frequency have been quantified in the region and is everywhere lower than 50%, but the product of AOD accuracy and sampling frequency with MAIAC is higher than the one achievable with other polar orbiting sensors or MODIS global AOD algorithm.