

# Bayesian Aerosol Retrieval (BAR) algorithm for retrieval of aerosol properties and surface reflectance

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We have developed a Bayesian Aerosol Retrieval (BAR) algorithm for retrieval of aerosol properties and surface reflectance using satellite-based observations. In the BAR algorithm, we carry out multi-pixel retrieval of cloud-free pixels, utilize spatial correlation models for the unknown aerosol parameters, use a statistical model for the surface reflectance, and take into account the uncertainties due to, for example, fixed aerosol models. The BAR algorithm is a general algorithm for aerosol retrieval: it utilizes satellite-measured reflectance data at different wavelengths and is not restricted to a specific instrument only. The BAR algorithm is based on a statistical approach and, instead of retrieving single values, it retrieves posterior probability distributions of the unknown parameters. These posterior probability distributions are then used to infer the most probable values and uncertainty estimates for the unknown parameters at pixel level. The main output of the algorithm is the aerosol optical depth (AOD) which is a measure of the amount of aerosols in the atmosphere. We have tested the BAR algorithm with MODerate Resolution Imaging Spectroradiometer (MODIS) data over land with 10 km spatial resolution and compared the AOD retrievals to operational MODIS retrievals and ground-based observations of AOD done with the Aerosol Robotic Network (AERONET). The results show that the BAR algorithm significantly improves the accuracy of aerosol retrievals when compared with the most widely used operational aerosol retrieval algorithm MODIS Dark Target, and Deep Blue algorithms. The computational costs of the BAR algorithm are higher than those of single-pixel retrieval algorithms used operationally but still low-enough to allow for near real-time processing of MODIS satellite data at 10 km resolution. The accuracy of the BAR algorithm retrievals can be even further improved using a novel machine learning based post-process correction of the retrievals.