



A Hierarchical Bayesian Approach for Aerosol Retrieval Using MISR Data

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Atmospheric aerosols can cause serious damage to human health and life expectancy. Using the radiances observed by NASA's Multi-angle Imaging SpectroRadiometer (MISR), the current MISR operational algorithm retrieves Aerosol Optical Depth (AOD) at a spatial resolution of 17.6 km x 17.6 km. A systematic study of aerosols and their impact on public health, especially in highly-populated urban areas, requires a finer-resolution estimate of the spatial distribution of AOD values.

We embed MISR's operational weighted least squares criterion and its forward simulations for AOD retrieval in a likelihood framework and further expand it into a Bayesian hierarchical model to adapt to a finer spatial scale of 4.4 km x 4.4 km. To take advantage of AOD's spatial smoothness, our method borrows strength from data at neighboring pixels by postulating a Gaussian Markov Random Field prior for AOD. Our model considers both AOD and aerosol mixing vectors as continuous variables. The inference of AOD and mixing vectors is carried out using Metropolis-within-Gibbs sampling methods. Retrieval uncertainties are quantified by posterior variabilities. We also implement a parallel MCMC algorithm to reduce computational cost. We assess our retrievals performance using ground-based measurements from the AErosol RObotic NETwork (AERONET), a hand-held sunphotometer and satellite images from Google Earth.

Based on case studies in the greater Beijing area, China, we show that a 4.4 km resolution can improve the accuracy and coverage of remotely-sensed aerosol retrievals, as well as our understanding of the spatial and seasonal behaviors of aerosols. This improvement is particularly important during high-AOD events, which often indicate severe air pollution.

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