

AEROSOL RETRIEVAL AND IMPROVED SURFACE ALBEDO OVER URBAN SCENES USING COMBINED MODIS AND SUNPHOTOMETER MEASUREMENTS

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1. INTRODUCTION

Determination of aerosol optical depth from satellite remote sensing measurements is extremely difficult due to the large variability of aerosol optical properties as well as possible interaction with the ground. In fact, over urban land cover, most of the signal can be attributed to ground reflectance. In conventional approaches, it is necessary to look for “dark” pixels in an image as a way of isolating the aerosol contribution and minimizing uncertainties in the surface. Unfortunately, these conditions are not realistically met over large urban conditions such as New York City. In particular, due to a poor surface model based entirely on global considerations, an intercomparison between MODIS AOD and Aeronet Sky Radiometer AOD clearly shows MODIS retrievals to significantly overestimate optical depth.

In the previous collection 4 algorithm, a static relationship was assumed between the MIR and VIS channel surface albedo due to long term LANDSAT imagery which was valid primarily for vegetation [1]. This static relationship is clearly not suitable over complex surface types. In an effort to improve this situation, a new approach for inversion of aerosols over land was developed based on global matchups of Aeronet sky radiometer data and MODIS TOA reflectances [2]. In performing these matchups, it was found helpful to obtain global aerosol models based on cluster analysis techniques. Unlike the static aerosol models obtained by global cluster analysis used in CALYPSO analysis, an effort was made to modify the microphysical models for different AOD levels. Once these models were obtained and their climatology examined, aerosol models (depicting the fine mode aerosols) were chosen in the retrieval suitable for a specific geographic location. From these analysis, empirical relationships were found to describe the surface VIS-MIR correlation functions which were shown to be functions of surface type (as defined by a SWIR vegetation index which is not sensitive to atmospheric uncertainty) and to a lesser extent on scattering angle. These modifications were recently implemented in the Collection 5 retrieval algorithm.

2. RESULTS

However, as we show in this paper, this approach, while suitable for a global analysis, is less than optimal for regional studies of urban scenes. To examine this in detail, we first show using high spatial imagery from the high spatial resolution Hyperion sensor that the albedo models suitable for vegetation are not suitable for urban scenes. In particular, we show that the correlation coefficient assumption between the VIS and MIR channels are underestimated thereby leading to an underestimate in the VIS ground albedos and subsequent overestimate of the VIS optical depth. In addition, we show that even the refined collection 5 estimates of the surface albedo improve the bias only slightly.

To improve the surface model for MODIS regional applications in an urban area, we re-implement the matchup data sets over the NYC area. By examining a large set of coincident measurements properly filtered to improve surface retrieval between AERONET and MODIS to obtain a more accurate VIS/NIR correlation coefficient. Since we are after the surface albedo measurements over an extended area, a more suitable filter of the data must be employed including a limit on AOD, a limit on the Angstrom coefficient to ensure only fine mode aerosols are present and a flag to ensure only sufficiently homogeneous aerosol cases are considered. Besides improving accuracy in the retrieval, we also find that the spatial resolution of the retrieval can be improved since we can be less conservative in rejecting overbright pixels in the retrieval.

The results of this approach can be seen in figure 1 where the MODIS retrievals in collection 5 as well as those due to a modified regional surface albedo map are compared.

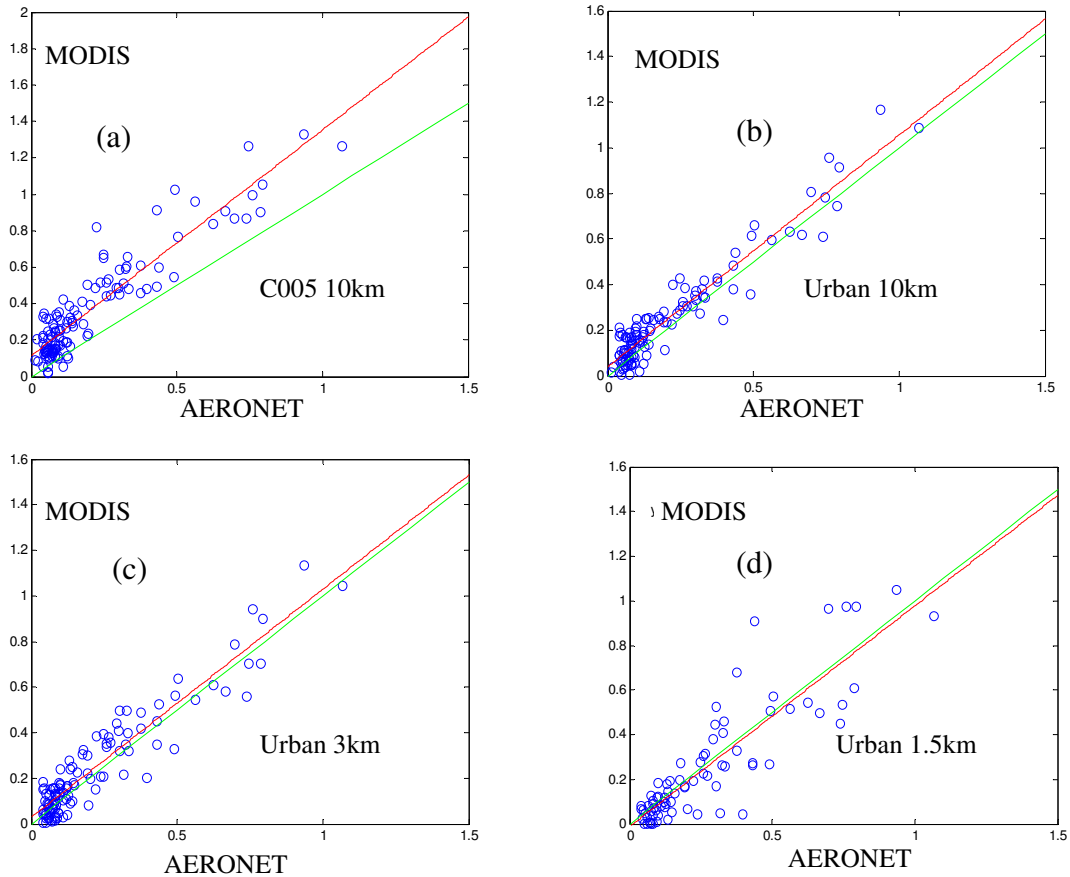


Fig 1 (a) MODIS L2 Aerosol Optical Depth at $0.55 \mu m$ compare with 4 hour (~ 2hr before and 2hr after MODIS (Terra) satellite overpass time) average of AERONET aerosol optical thickness. (b) ,(c) and (d) are retrieved AOD with new VIS/MID ratio plot with average of AERONET aerosol optical thickness

Further analysis shows that the VIS/MIR ratios depend only weakly on the scattering geometry allowing us to generate a regional VIS/MIR map at resolutions down to 1.5 km. In particular, we find that with the new VIS/MIR ratio model, the MODIS and AERONET optical thickness agreement is significantly improved as shown in figure 1. Furthermore, we show the high resolution surface model allows us to improve the resolution of the retrieved AOD to 3km. Although direct comparisons for a given day are not possible except at the aeronet site, we find the AOD variability seen spatially from our revised regional retrieval agrees very well with the variability of the aerosol optical depth observed from temporal statistics in the Aeronet retrieval.

Finally, the surface albedo results will be compared to MISR and GOES surface albedo retrievals in an effort to obtain consistent parameterizations which can be used for all observations

3. REFERENCES

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