# Improving the estimated surface reflectance ratios for VIIRS aerosol retrieval over land

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## Introduction

Surface reflectance ratios of M1/M5, M2/M5, M3/M5, and M11/M5 are crucial to the VIIRS AOT retrieval over land. Having better estimates of these ratios can improve AOT retrievals. Current VIIRS aerosol retrieval algorithm uses constant ratios over the whole globe. We present an investigation of the surface reflectance ratios over the global AERONET sites and show that we can improve the AOT retrieval by using more accurate surface reflectance ratios. Surface reflectance in the M1, M2, M3, M11 and M5 channels were retrieved at a large number of AERONET sites using AERONET-retrieved AOT. M1/M5, M2/M5, M3/M5, and M11/M5 surface reflectance ratios were then calculated for each site separately. These ratios vary strongly from site to site. This variability is the reason for the biases and standard deviations in the AOT retrieval when a single fixed value of the ratio is used. When instead the individual ratios are used in the AOT retrieval, their statistics (naturally) improve. In order to obtain these ratios without the help of the AERONET AOT, we tested a clear sky method, which assumes a low AOT and looks for the lowest atmospheric corrected M3/M5 ratio over a period of time. The clear sky ratios were obtained for each AERONET sites, which were then applied in land AOT retrieval. The resulting AOT retrievals also showed improvements over those from the original algorithm.

## VIIRS Aerosol Retrieval over Land

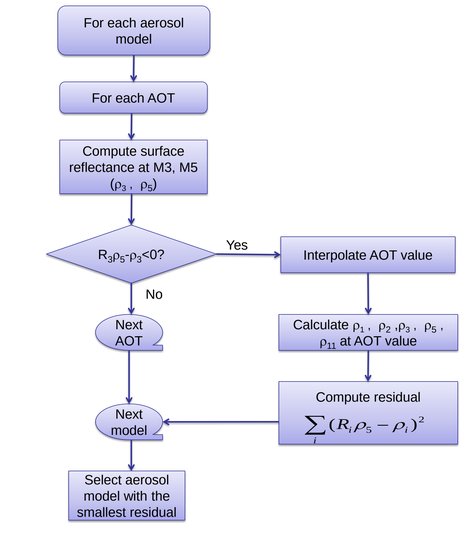



**Figure 1.** VIIRS AOT retrieval over land algorithm flow chart

In the flow chart, the ratios $R_i$ are surface reflectance ratios between each band and band M5 (672nm).

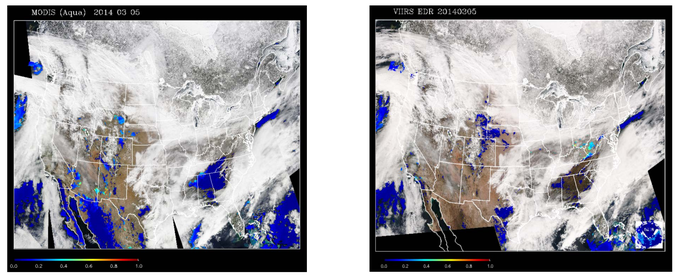
The accuracies of the AOT retrievals over land are dependent on the accuracies of the surface reflectance ratios used in the algorithm.

The ratio between M3 (488nm) and M5 determines the AOT value. AOT will usually be underestimated if a higher ratio is used and vise versa.

Current official VIIRS aerosol algorithm uses constant values globally.

On IDEA (Infusing satellite Data for Environmental Applications), NDVI dependent ratios are used.

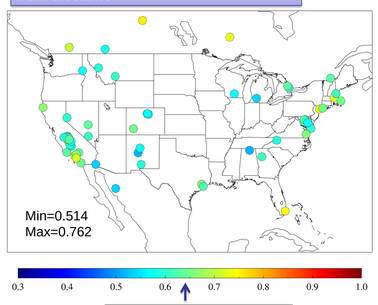
## VIIRS AOT data coverage




A comparison between MODIS Aqua (left) and VIIRS high quality EDR AOT (right) coverage over land: VIIRS AOT has less data coverage. Two reasons contribute to it: (1) VIIRS uses higher M3/M5 ratio than real value and therefore those no retrieval regions have negative AOT retrievals less than -0.05; (2) VIIRS does not have high quality AOT retrieval over soil dominated regions, which is defined as NDVI < 0.2.

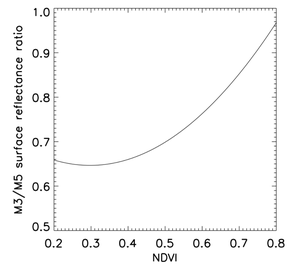
## Surface reflectance ratios

M3/M5 surface reflectance ratios at AERONET sites derived from AERONET AOT and VIIRS TOA reflectance




IDPS uses 0.645 for M3/M5 surface reflectance ratio

Algorithm in IDEA uses NDVI dependent ratios. The M3/M5 ratio has a range of [0.64,0.96]




Many sites have M3/M5 surface reflectance ratio less than 0.64. When AOT is close to 0, negative AOT will be retrieved on those locations.

## Estimate surface reflectance ratios at AERONET site

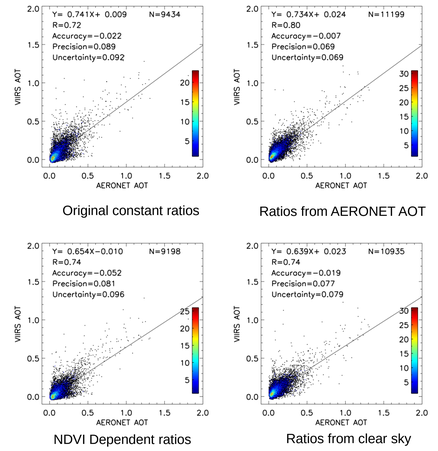
**Method 1 (Use AERONET AOT)**

- 2013 AERONET matchup dataset
- 25 km region
- Pixels with VIIRS IP AOT QF high or out of bound AOT (negative)
- AERONET AOT < 0.1
- Retrieve surface reflectance at M1,M2,M3,M5,M11 using TOA reflectance, AERONET AOT and LUT (look-up-table)

**Method 2 (Clear sky)**

- 2013 AERONET matchup dataset
- 25 km region
- Get surface reflectance ratios for each day, assuming AOT=0.05
- 20%+ pixels are high quality (high IP AOT quality or out of bound)
- Select the day with minimum M3/M5 ratio over the 30 day period
- Total 12 days over the whole year (Maybe less for the AERONET matchup dataset)
- Use the pixels from those 12 days to derive the ratios for each site

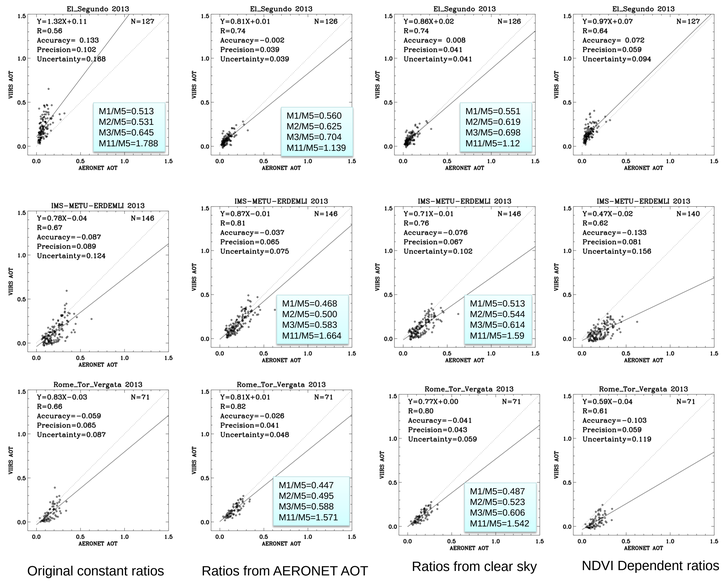
- Both methods add soil dominated pixels as high quality.
- The estimated surface reflectance ratios are then used for the AOT retrievals




**A comparison of AOT retrievals over global AERONET sites using different surface reflectance ratios**

- The one that uses AERONET AOT derived ratios is the best
- The clear sky method also improves the AOT retrievals
- Original and NDVI method do not contain soil dominated pixels. Therefore they have less matchups

## AOT retrievals at selected sites using different ratios




Original constant ratios | Ratios from AERONET AOT | Ratios from clear sky | NDVI Dependent ratios

Improvements of AOT retrievals are observed at the sites where the difference of the surface reflectance ratios are large Between those from AERONET AOT and the constant ratios used in the official algorithm

## Summary

- Using site specific surface reflectance ratios can improve AOT retrieval statistics
- Including soil dominated pixels does not degrade AOT statistics
- Future work:
  - ✓Expand clear sky method to the whole globe
  - ✓Develop surface ratio database
  - ✓Include seasonal variation of the surface ratios
  - ✓Test the algorithm sensitivity to the choice of the clear sky AOT (currently 0.05)

**Acknowledgment**

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