

# 7H.33: Comparison between MODIS, AERONET, and Aircraft based Passive Cavity Aerosol Spectrometer Probe Aerosol Optical Depth data over Mali, West Africa

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## Objective

Study the performance of the MODerate resolution Imaging Spectroradiometer (MODIS) Aqua satellite Deep Blue cloud mask algorithm to retrieve Aerosol Optical Depth (AOD) at 550 nm by comparing its measurements to an Aerosol Robotic Network (AERONET) sunphotometer's values located in Mali, West Africa. AERONET data have been determined to be accurate, 0.015 uncertainty, with respect to AOD retrieval, but do not provide means for investigating a vertical distribution of aerosols.

Study the vertical distribution of aerosols by calculating an Aerosol Optical Thickness (AOT) for the lower troposphere using aircraft data collected by the Passive cavity Aerosol Spectrometer Probe (PCASP) for Mali's rain augmentation feasibility study conducted during late summer 2007.

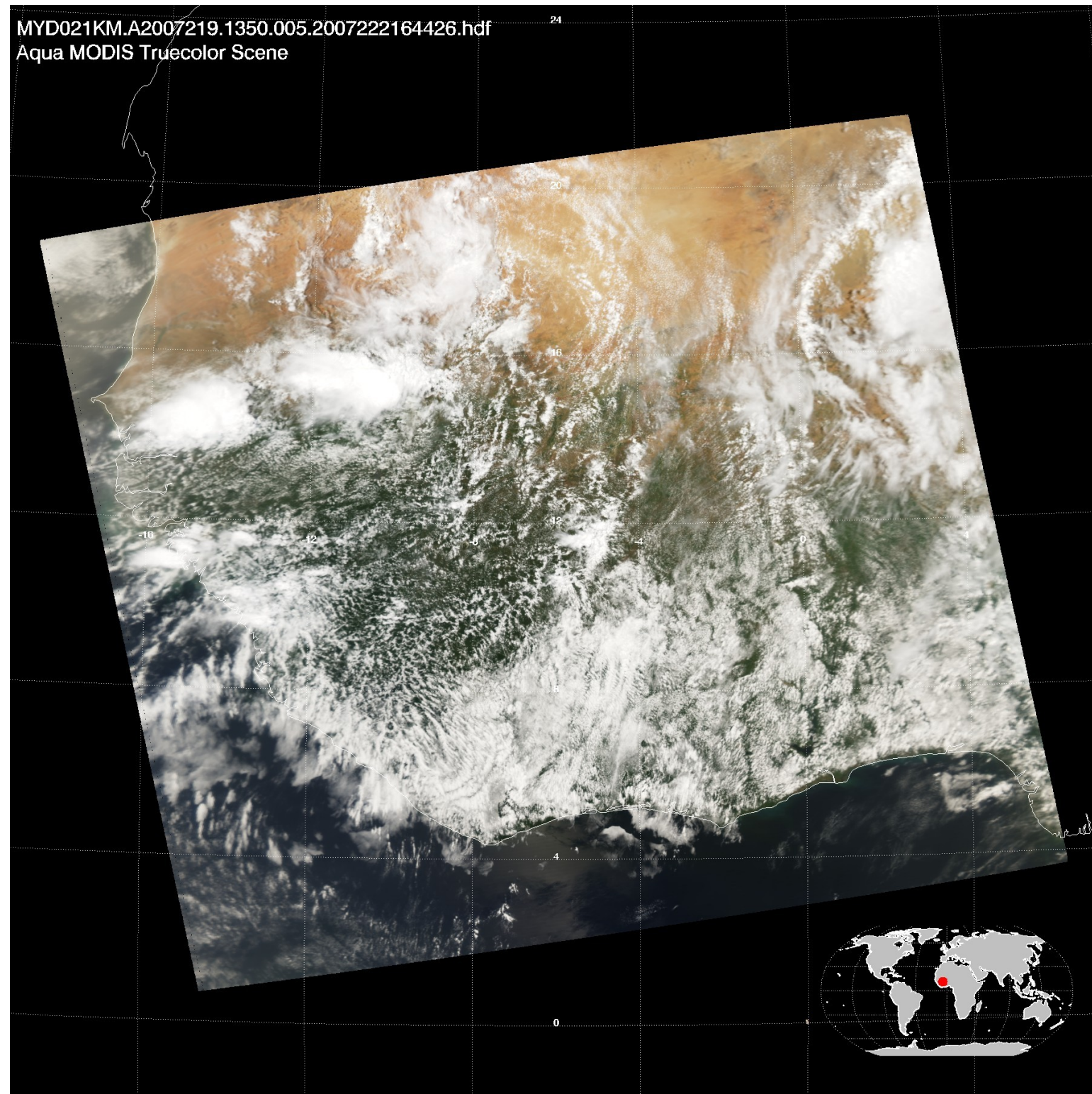
## Methodology

AERONET Site in Mali



Level 2.0 AERONET Data from the Mali site named IER\_Cinzana were obtained for years 2006 to 2008. AOT values for 550 nm wavelength were not sufficient in number for analysis, but 440 and 675 nm data were plentiful. The Angstrom exponent was determined using each of those wavelengths at each respective time, and employed to calculate AOT for 550 nm. This calculation was necessary for the comparison to MODIS Aqua Deep Blue algorithm AOD that is retrieved at 550 nm.

MODIS True Color over West Africa



Deep Blue data were downloaded for years 2006 to 2008, and quality controlled. Comparisons were made based on a distance check and time check. Two different distance criteria were implemented for this study. These were plus or minus five km and plus or minus 30 km from the respective AERONET site's latitude and longitude. Time for each AERONET time step was compared to each MODIS time and matched if within a plus or minus ten minute time frame surrounding the AERONET time. MODIS and AERONET time matches occurred more than once due to this envelope and thus repetitions were discarded.

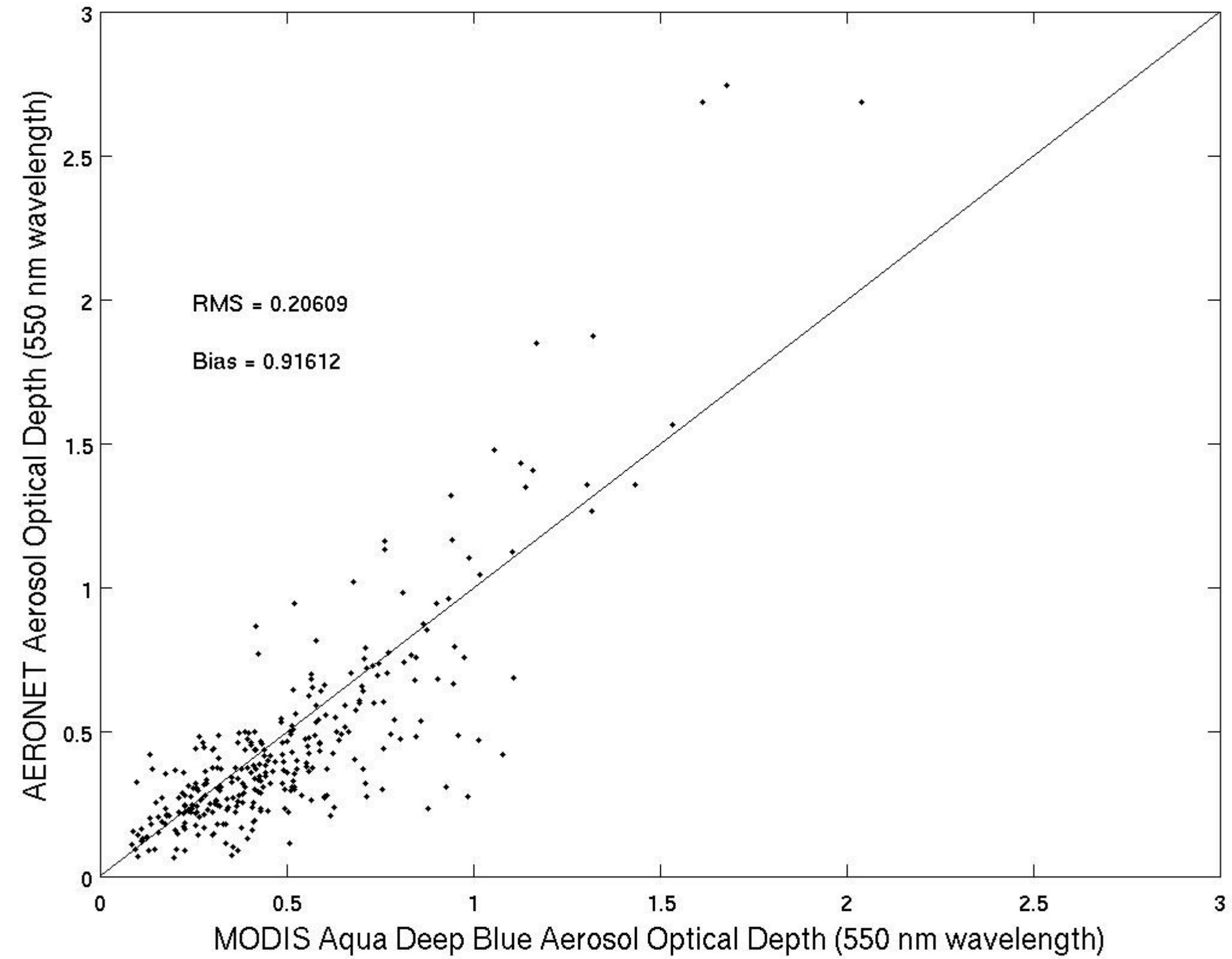
PCASP instrument used in Mali



Research flights during the summer of 2007 were only studied if the PCASP had been employed. Data for those flights were trimmed to include only the initial climb portion and data from that segment if a Forward Scattering Spectrometer Probe (FSSP) calculation was less than 0.05 g m<sup>-3</sup>. These data were considered to be out of cloud time and used with PCASP data to calculate the flights respective AOD assuming spherical particles.

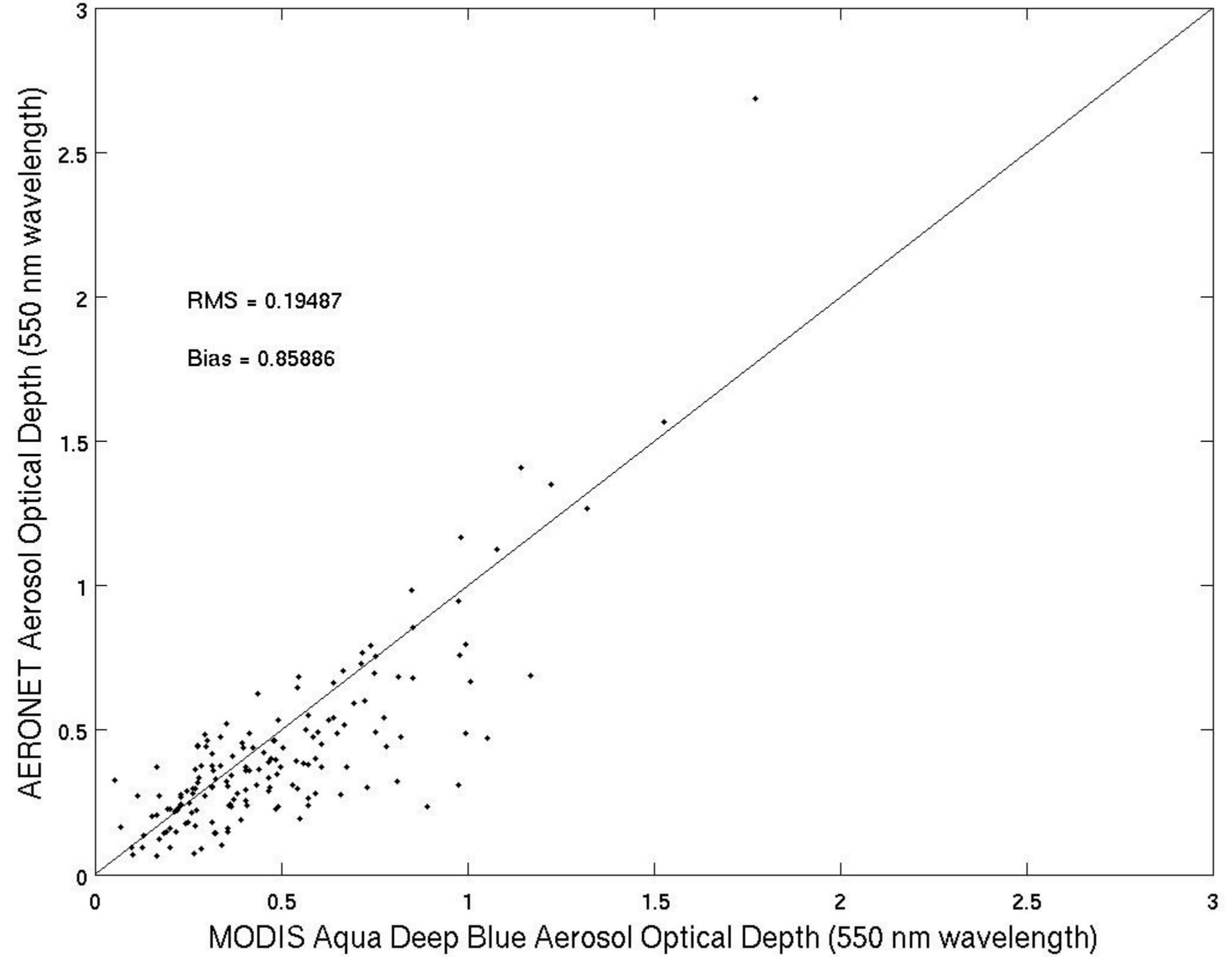
## Comparisons of AOD Measurements

AERONET vs average of MODIS Aqua Deep Blue AOD values (+/- 0.3 deg AERONET lat/lon)  
2006 to 2008



This Fig. displays AOD values at 550 nm for successful matches of AERONET and MODIS within the 30 km area surrounding the IER\_Cinzana AERONET site. The diagonal line represents a one to one comparison reference. Root Mean Square and Bias values were calculated using all data to produce the above plot are displayed. Bias is equal to the sum of all AERONET data divided by the sum of all MODIS data used to produce this plot. Successful matches plotted number 360, approximately.

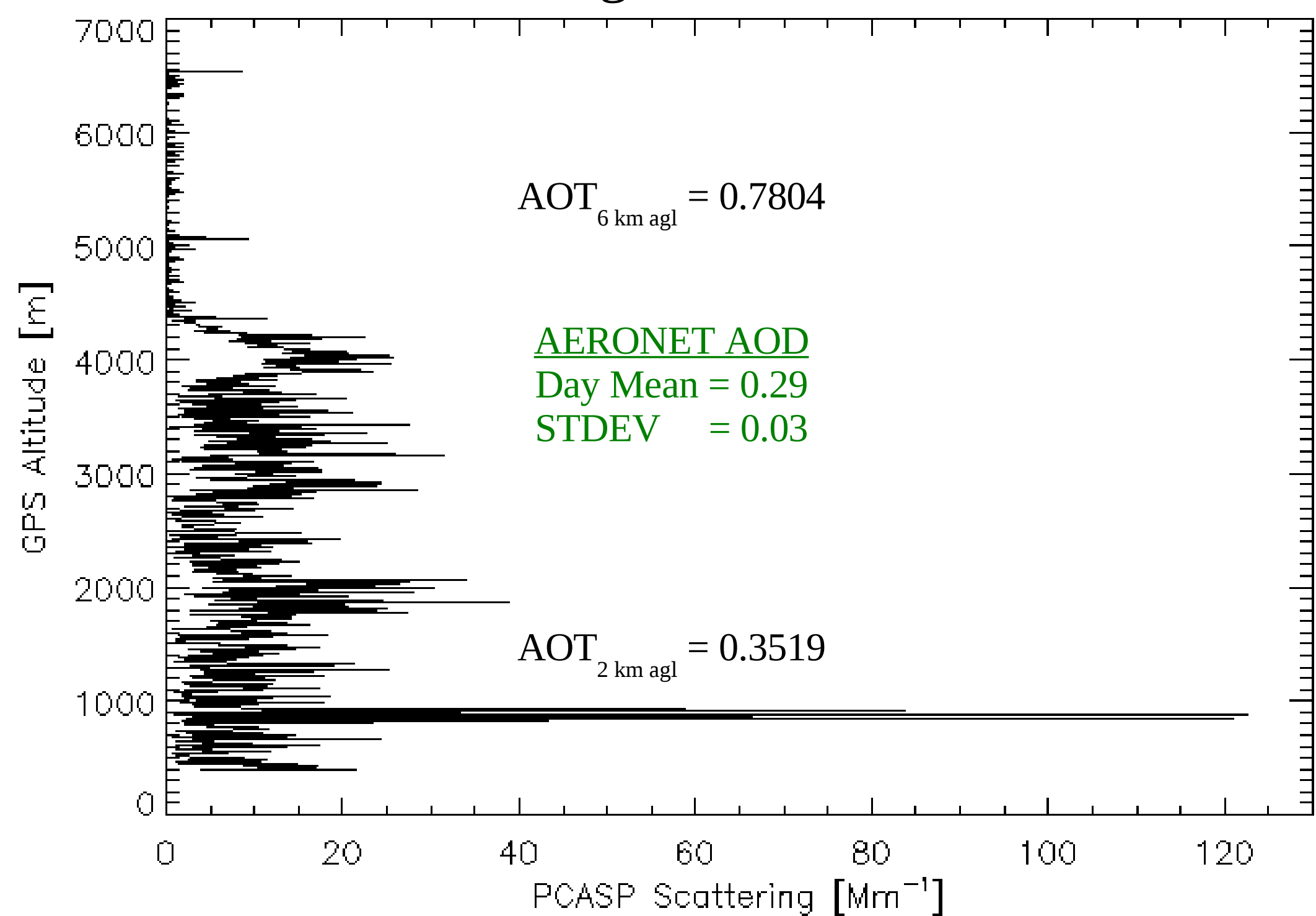
AERONET vs average of MODIS Aqua Deep Blue AOD values (+/- 0.05 deg AERONET lat/lon)  
2006 to 2008



This Fig. displays AOD values at 550 nm for successful matches of AERONET and MODIS within the 5 km area surrounding the IER\_Cinzana AERONET site. The diagonal line represents a one to one comparison reference. Root Mean Square and Bias values were calculated using all data to produce the above plot are displayed. Bias is equal to the sum of all AERONET data divided by the sum of all MODIS data used to produce this plot. Successful matches plotted number 130, approximately.

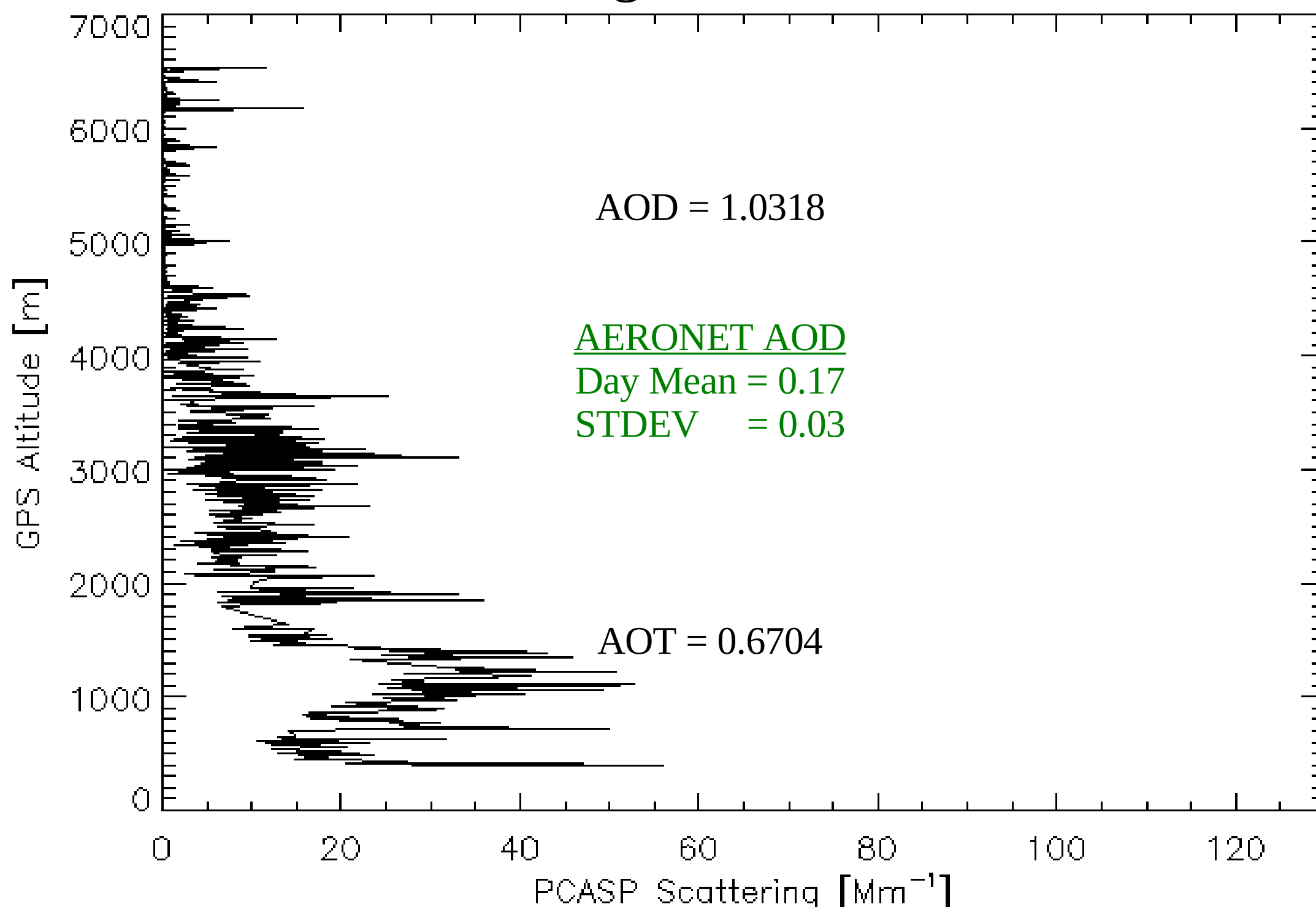
## Flight Cases

August 7, 2007



This Fig. represents the PCASP scattering coefficient as a function of altitude for a flight on August 7, 2007. AOT(6 km agl) was calculated using all flight level PCASP data. AOT(2 km agl) represents the layer less than and equal to two km. The AERONET AOT (550 nm) average and standard deviation are shown under the header titled AOD.

August 8, 2007



This Fig. represents the PCASP scattering coefficient as a function of altitude for a flight on August 8, 2007. AOT (6 km agl) was calculated using all flight level PCASP data. AOT(2 km agl) represents the layer less than and equal to two km. The AERONET AOD (550 nm) average and standard deviation are shown under the header titled AOD.

## Conclusions

MODIS Aqua Deep Blue algorithm achieved good agreement with AERONET sunphonometer AOD retrievals, and its cloud mask utility performed well during 2006, 2007, and 2008. Biases for the area averaging technique, 0.9162, and co-location technique, 0.8568, imply that AOD retrievals for MODIS were 10 and 15 percent larger over this three year period compared to AERONET. This is consistent with a MODIS validation done previously that concluded aerosols comprised of dust mostly produced a bias of positive 10 percent. Higher RMS values for the expanded area comparison imply that spatial distribution of aerosols is variable. Cloud masking performed well because out of nearly three years of AERONET and MODIS data only 130 and 360 valid matches were obtained for co-location and expanded area techniques, respectively.

Aerosols are clearly more rooted in the lowest four km depicted in the two flight cases above. Unfortunately due to the limited number of full vertical profile flights to 6 km no conclusion can be stated regarding a climatological vertical aerosol profile for the Bamako region. PCASP and AERONET AOT for August 7, 2008 did not correlate due a large dust layer present at 900 m, and the flight operation was conducted within an area located 200 km from the AERONET site. The August 8, 2007 PCASP and AERONET AOT did not correlate well due to a cloud layer at 1.5 km that is producing large scattering values of 40 Mm<sup>-1</sup>, and the aircraft flew in an area 200 km from the AERONET site. This indicates that the LWC threshold chosen for this study may not represent out of cloud conditions adequately, and there are spatial issues that need to be addressed.