

# AQRP Monthly Technical Report

<b>PROJECT TITLE</b>	<b>Sources and Properties of Atmospheric Aerosol in Texas: DISCOVER-AQ Measurements and Validation</b>	<b>PROJECT #</b> Project 14-005	Choose an item.
<b>PROJECT PARTICIPANTS</b>	Sarah Brooks and Ping Yang	<b>DATE SUBMITTED</b> <b>July 8, 2015</b>	6/9/2014
<b>REPORTING PERIOD</b>	<b>From:</b> June 1, 2015 <b>To:</b> June 30, 2015	<b>REPORT #</b> <b>5</b>	Choose an item.

Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 15<sup>th</sup> of the month following the reporting period shown above.

## Detailed Accomplishments by Task

- Domain-averaged MODIS Fine Mode Fraction ( $\eta$ ) data
- CASPOL aerosol size distribution data
- Laboratory calibration of the CASPOL size-cut offs.

## Preliminary Analysis

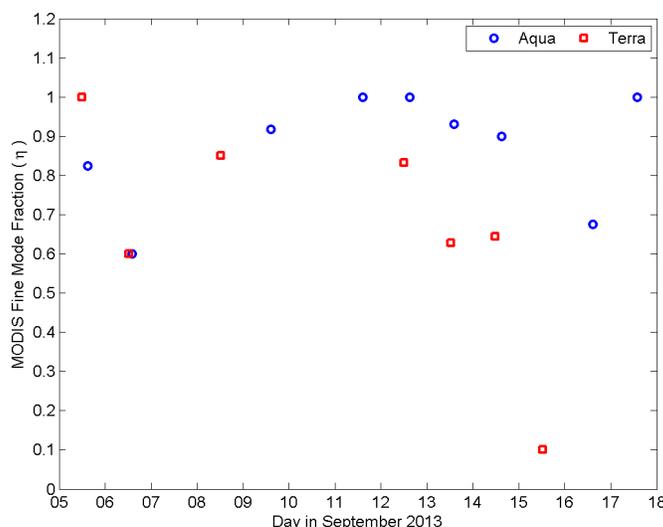


Figure 1. Domain-averaged Terra and Aqua MODIS Fine Mode Fraction ( $\eta$ ) retrievals during 5-19 September of 2013.

As described in our previous report on MODIS aerosol optical depth analysis, here we averaged the fine mode fraction data for all MODIS data available within a circle centered at the Moody Tower with a radius of 50 km. This resulted in 7 retrieval cases for MODIS on the Terra satellite and 9 Aqua retrieval cases found during the period when CASPOL aerosol size distributions are also available.

As can be seen in Figure 1, fine mode fractions observed from onboard the Aqua and the Terra satellites on the same day vary by as much as ~30%. While Aqua passes over the Moody Tower three hours after Terra, the time lag does not explain the large differences observed in fine mode fraction. It has been recommended that the fine mode fraction of MODIS is a relative metric at best. Hence, we will treat this metric as a qualitative descriptor of the aerosol population.

### **Data Collected**

-- 3-km Fine Mode Fraction ( $\eta$ ) retrievals from the Terra and Aqua MODIS Collection 6

### **Identify Problems or Issues Encountered and Proposed Solutions or Adjustments**

Through communicating with other scientists at the recent AQRP workshop, we found good agreement with trends in other particle concentration measurements collected at Moody prior to Sept. 17, 2013, but wide discrepancies between the measurements after September 17, 2013. A plausible cause is an (unspecified) instrument sampling in the CASPOL inlet line at that time. Hence, we will remove comparison cases later than September 17, 2013. Meanwhile, as described in our last report, our original plan was to compare MODIS data to 8-hour segments of CASPOL data. Given those criteria, not enough overpass cases were found for a reasonable comparison study. Therefore, it was determined that data would be compared at 1 hr intervals, rather than 8 hours. To make good use of the CASPOL data, the original metric, aerosol optical signature, needs to be replaced with another metric. The reprocessing of the data to compare MODIS fine mode fraction to CASPOL fine mode fraction is underway at this time.

MODIS Fine Mode Fraction ( $\eta$ ), a retrieved aerosol size parameter, is defined as the contribution of aerosol optical depth ( $\tau$ ) from fine particles. Fortunately, aerosol size distributions and hence the fractions of fine particle numbers can be derived from the forward scattering measurements from CASPOL. We will compare the CASPOL fine particle fraction,  $f$ , to the MODIS  $\eta$ . However, CASPOL fine particle fraction is the ratio of the number of fine particles to the total number of particles. Hence, it is only possible to compare the variations of MODIS optical fine mode fraction to CASPOL number fine mode fraction parameters qualitatively.

### **Goals and Anticipated Issues for the Succeeding Reporting Period**

- Processing of MODIS dataset to look at Mode Fraction ( $\eta$ ) retrievals
- Completion of laboratory CASPOL size calibrations.
- Reprocessing of CASPOL data to generation Fine Mode Fractions
- Comparison between the CASPOL with the MODIS Fine Mode Fractions

### **Detailed Analysis of the Progress of the Task Order to Date**

In the MODIS aerosol algorithm, aerosol particles are assumed to consist of two modes—the fine and coarse modes, based on observations of bimodal aerosol size distributions. In September of 2013 over the Houston area, the fine model was fixed to the weakly absorptive aerosols over Houston. The coarse model is always assumed to be dust aerosols.

Table 1 shows the parameters of size distributions for weakly absorptive and dust aerosols prescribed in the MODIS algorithm, and Figure 1 shows the corresponding size distributions of aerosol volume. Aerosol size distributions are not retrieved in the MODIS algorithm, but rather they are assumed to generated look-up tables, providing the scattering parameters in different

conditions. The retrieved  $\tau$  includes contributions from both the fine and coarse modes. The product of  $\tau$  and  $\eta$  is the proportion of  $\tau$  contributed by the fine mode.

Table 1. The median radii ( $r_v$ ,  $\mu\text{m}$ ) and standard deviations ( $\sigma$ ,  $\mu\text{m}$ ) of the assumed lognormal distributions of weakly absorptive and dust aerosols [Levy *et al.*, 2009]

	Non-absorbing Urban and Industrial		Spheroid/Dust	
	Fine	Coarse	Fine	Coarse
$r_v(\mu\text{m})$	$0.0434\tau+0.1604$	$0.1411\tau+3.3252$	$0.1416\tau^{-0.0519}$	2.2
$\sigma(\mu\text{m})$	$0.1529\tau+0.3642$	$0.1638\tau+0.7595$	$0.7561\tau^{0.148}$	$0.554\tau^{-0.0519}$

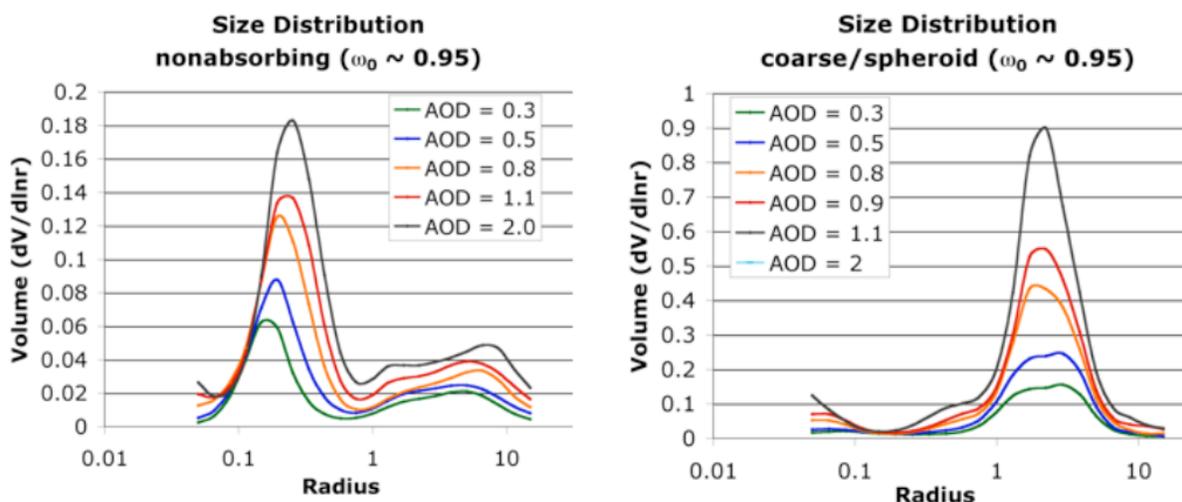


Figure 2. The size distributions of aerosol volume for weakly absorptive and dust aerosols in MODIS [Levy *et al.*, 2009].

Knowledge of how much difference between MODIS  $\eta$  retrievals and fine particle fractions in the real atmosphere will be informative for future applications of MODIS aerosol retrievals. The bimodal feature of aerosol size distributions is to be examined by CASPOL measurements; the fractions of fine particles are to be defined and then compared with the MODIS  $\eta$  retrievals, estimating the deviations of  $\eta$  from the realistic groups of aerosol particles.

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