AQRP Monthly Technical Report

PROJECT TITLE	Sources and Properties of Atmospheric Aerosol in Texas: DISCOVER-AQ Measurements and Validation	**PROJECT #**	14-005
PROJECT PARTICIPANTS	Sarah Brooks and Ping Yang	**DATE SUBMITTED**	4/8/2014
REPORTING PERIOD	**From:** March 1, 2015 **To:** March 31, 2015	**REPORT #**	2

A Financial Status Report (FSR) and Invoice will be submitted separately from each of the Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 15th of the month following the reporting period shown above.

Detailed Accomplishments by Task

Accomplishments for this month include identification of time periods in which MODIS and in-situ data are collocated, identification of time periods in which CALIOP and in-situ data are collocated, and identification of in-situ time periods for representative aerosol types and conditions.

Preliminary Analysis

Data is only available for a limited number of days in which satellite overpasses occurred during clear sky conditions in which the CASPOL was operation. Four CALIOP cases were found to be compared to CASPOL measurements. Eight Terra MODIS cases and four Aqua MODIS cases were found to be compared to CASPOL measurements.

Table 1. The nearest profiles in the four selected CALIOP cases.

Date (UTC)	Time (UTC)	Latitude	Longitude	Distance (km)
Sep. 11	8:27:44	29.87	-96.08	74.09
Sep. 16	19:45:28	29.79	-94.94	38.20
Sep. 23	19:51:24	29.49	-96.37	104.03
Sep. 27	8:27:32	29.88	-96.03	70.00

Table 2. The comparisons of Terra MODIS and AERONET AOD retrievals

			Terra Collection 6 3 km AOD retrievals		
Month	Day	Hour (CDT)	Terra AOD	AERONET AOD	Aerosol Type Inference from CASPOL
9	6	12	0.2624753	0.255	TBD
9	8	12	0.2780583	0.113	TBD
9	12	11	0.2336200	0.170	NA (Ship Channel ends at 6:00 am)
9	13	12	0.3118651	0.226	NA (Ship Channel starts at 7:00 pm)

9	19	12	0.4380088	0.090	Ship Channel
9	22	12	0.0979700	0.058	NA (Urban starts at 1:00 pm)
9	25	11	0.1519083	0.096	NA (Urban starts at 1:00 pm)
9	26	12	0.1328916	0.066	TBD

Table 3. The comparisons of Aqua MODIS and AERONET AOD retrievals

Aqua Collection 6 3 km AOD retrievals					
Month	Day	Hour (CDT)	Aqua AOD	AERONET AOD	Aerosol Type Inference from CASPOL
9	12	15	0.1000606	0.113	TBD
9	18	14	0.1459799	0.112	Ship Channel
9	25	14	0.1320245	0.132	Urban
9	26	15	0.1371576	0.096	TBD

Data Collected

In addition to CASPOL in-situ data, we will use the following:
-- 3-km AOD retrievals from the Terra and Aqua MODIS Collection 6
-- AOD retrievals from the University of Houston AERONET
-- Volume depolarization ratios from the version 4.00 of the CALIPSO lidar level 1B product
-- Vertical feature masks from the version 3.30 of the CALIPSO lidar level 2 product.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

CASPOL inferred aerosol types, i.e. urban, oceanic, and Houston Ship Channel (HSC) aerosols, are determined according to HYSPLIT back trajectories, whereas in the current CALIOP aerosol typing algorithm identified aerosol types determined based on a different criteria. In the CALIOP aerosol typing algorithm, aerosols are placed in the continental polluted aerosol type category for cases if the depolarization ratio is less than or equal to 0.075 and the integrated attenuated backscatter at 532 nm is greater 0.0005 [*Omar et al.*, 2009].

Rather than compare the typing algorithms of CASPOL and CALIOP, we plan to pursue a more direct comparison of the backscatter features of CALIOP to the CASPOL backscatter measurements. Specifically, we compare the ensemble backscatter characteristics from the CASPOL measurements 1 hour before and after the satellite overpass times. To do so, it will be necessary to reprocess the CASPOL data.

Goals and Anticipated Issues for the Succeeding Reporting Period

The goals of the next period are to re-process CASPOL data to over the times specified by the CALIOP and validate the CALIOP aerosol retrievals using the data. The CALIOP-CASPOL comparison will answer the following questions: Is the CALIOP responsive to ground level aerosol changes observed by CASPOL? An additional goal is to the MODIS aerosol retrievals using CASPOL and AERONET data.

Detailed Analysis of the Progress of the Task Order to Date

CASPOL-MODIS Comparisons

A number of studies have focused on the validations of MODIS AOD retrievals since the first-generation MODIS aerosol algorithm [*Chu et al.*, 2002; *Remer et al.*, 2005]. However, to the best of our knowledge, no study has validated MODIS AOD retrievals and aerosol type settings simultaneously. In our study, we compared the MODIS AOD and aerosol type assumptions to AERONET AOD and CASPOL aerosol typing in Houston urban area during the 2nd intensive DISCOVER-AQ campaign. The field campaign lasted from Sep. 5 to Oct. 1 in 2013 on the Moody Tower located at 29.7176° N and 95.3414° W. The CASPOL was operated on the Moody Tower during that time.

In addition to comparisons with CASPOL, MODIS data will be compared to aerosol optical depth (AOD) measurements provided by AERONET (AErosol RObotic NETwork). In the Houston-Galveston area, AOD retrievals were available during the field campaign at two AERONET sites—Univ_of_Houston and UH_Coastal_Center, the locations of which are 29.7176° N and 95.3419° W and 29.7178° N and 95.0428° W, respectively. We therefore picked the AOD retrievals from the closest AERONET site, which is the Univ_of_Houston site on the Moody Tower. Then, we used AOD retrievals from this site to validate the 3-km AOD retrievals from the Terra and Aqua MODIS Collection 6 [*Levy et al.*, 2013], which is the latest version of the MODIS aerosol product. The Univ_of_Houston site AOD retrievals are available at 1640 nm, 1020 nm, 870 nm, 675 nm, 500 nm, 440 nm, 380nm, and 340 nm. We interpolated the AOD retrievals at 675 nm and 500 nm in a logarithmic manner to 550 nm, which is the wavelength of MODIS AOD retrievals.

In the Houston-Galveston area, urban aerosols, oceanic/transported aerosols, and aerosols from the Houston Ship Channel show distinct backscatter intensity and depolarization ratio features from the CASPOL measurements. The depolarization ratios of oceanic aerosol particles are significantly higher than urban and ship channel aerosol particles. The depolarization ratios of almost all the urban aerosol particles are below 0.1. Compared to the urban aerosols, a considerable portion of HSC aerosol particles show lower backscatter intensities but higher depolarization ratios [*Orcutt et al.*, 2015 in preparation]. Consequently, as long as enough aerosol particles have been sampled by CASPOL, the dominant type of this group of aerosols may be inferred from the CASPOL backscatter measurements. We therefore typed each group of aerosol particles based on their ensemble backscatter characteristic from the CASPOL measurements 4 hours before and after the satellite overpassing time. A large number of particles can be collected during the 8 hours, allowing for the generation of a reliable CASPOL optical signature plot.

In agreement with the previous study, *Orcutt et al.* [2015] show significantly lower OC-to-EC ratios of the Ship Channel aerosol cases than those of the urban aerosol cases, suggesting Ship Channel aerosols are more absorptive than urban aerosols as inferred by CASPOL. Additionally, oceanic aerosols are less absorptive than continental aerosols. As a result, among the three CASPOL inferred aerosol types, Ship Channel aerosols are strongly absorptive; urban aerosols are moderately absorptive; oceanic aerosols are weakly absorptive.

CASPOL-CALIPSO Comparisons

During the period of the campaign, four CALIOP cases were found in which CALIPSO passed within 100 km of Moody Tower as show in Figure 1. Sep. 16 and Sep. 23 are daytime cases, the tracks of which tilt to east from south to north. Sep. 11 and Sep. 27 are nighttime cases, the tracks of which tilt to east from north to south. The satellite passing times and locations of each of the nearest profiles to the Moody Tower in the four cases are documented in Table 1. The

distance in Table 1 is the horizontal distance between the nearest profile to Moody Tower in km. Profiles of 532 nm total and perpendicular volume attenuated backscatter signals are archived in the CALIPSO lidar level 1B data products with a horizontal resolution of 1/3 km and a vertical resolution of 30 m between -0.5 and 8.3 km. The parallel component can be obtained by simply subtracting the perpendicular component from the total.

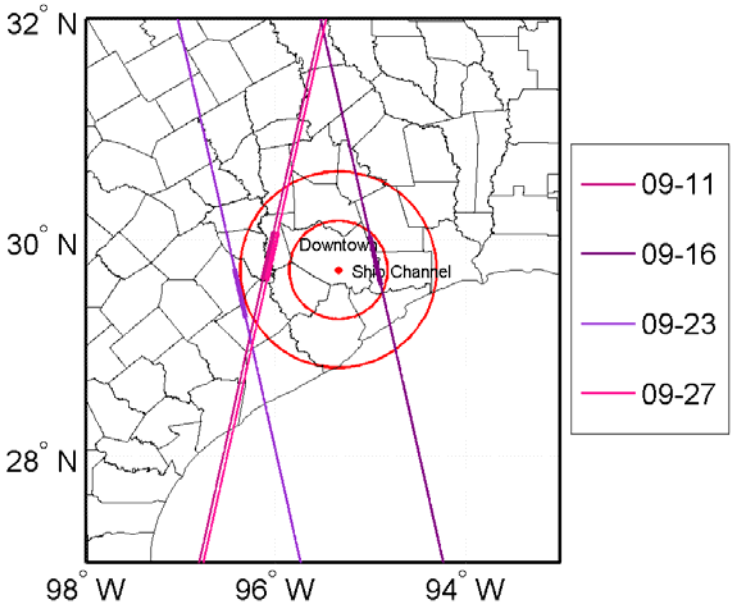

Figure 1. Map of the area from 27° N to 32° N and from 98° W to 93° W. The two concentric red circles are centered at the Moody Tower with radii of 50 km and 100 km, respectively. The four tilted lines are the CALIPSO tracks of the four selected cases Sep. 11, Sep. 16, Sep. 23, and Sep. 27. On each line, the thick segment is 50 km, along which spatial statistics of CALIOP depolarization ratio were made.

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