AQRP Monthly Technical Report

PROJECT TITLE	Using Satellite Observations to Quantify Surface PM$_{2.5}$ Impacts from Biomass Burning Smoke	PROJECT #	20-005
PROJECT PARTICIPANTS	Matthew Alvarado, Archana Dayalu, Qiang Sun (AER)	DATE SUBMITTED	11/06/2020
REPORTING PERIOD	From: 10/01/2020 To: 10/31/2020	REPORT #	3

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 for reporting period

Task 1. We continued quantifying the overlap of the three smoke products (HMS, GOES, UVAI) in the Texas/Gulf of Mexico region from January through July 2020. However, as noted in the original project plan, simple comparisons of the three smoke products will only allow us to assess their consistency; none of the products provide a "truth" dataset to use as a reference. For our "truth" datasets, we refer to estimates of brown carbon from observations of OMI Aerosol Optical Depth (AOD) as well as the ratio of total column ammonia (NH3) to carbon monoxide (CO). The results of this analysis are summarized in Figure 1 for a test day on May 22, 2020. We explore the implications of these results in the Preliminary Analysis section.

Task 2. We have begun Task 2 by collecting AOD information associated with GOES smoke pixels. The AOD has been compared to a recently published relationship between MAIAC plume height estimates and AOD measurements.

General. In this reporting period, we also produced the expected quarterly report where we indicated the projected synthesis and wrap-up of Tasks 1 and 2 by the end of the year.

Preliminary Analysis

Consistent with the previous reporting period and the quarterly report, we continue to illustrate our progress with the May 22 2020 example date. Figure 1 summarizes the main components of Task 1, where the three smoke products are shown along with BrC estimates and NH$_3$/CO ratios for the Texas/Gulf of Mexico region. Based on a literature review, we found that typical total column NH$_3$/CO ratios for cropland biomass burning can range from 0.01 to 0.04; in general, cropland biomass burning NH$_3$/CO ratios are skewed lower than those of other fire types. Figure 1 (bottom panel) supports the expectation of heavy agricultural fire influence in the region on May 22, 2020. We again note the variability and inconsistency among the three smoke products. However, Southern Mexico towards the Yucatán is the notable exception with consistent overlap among all three smoke products (southern Mexico, indicated by the medium-to-dense region on

the HMS map). This region of smoke consistency is further supported by the presence of BrC-dominant aerosols in the same region (Figure 1, top panel) and NH_3/CO ratios indicative of agricultural biomass burning (Figure 1, bottom panel). We continue to process data for multiple days from January 2020 through July 2020 to provide robust statistics on not only overlap among the three smoke products but importantly their comparison with independent validation products such as BrC proxies and NH_3/CO ratios.
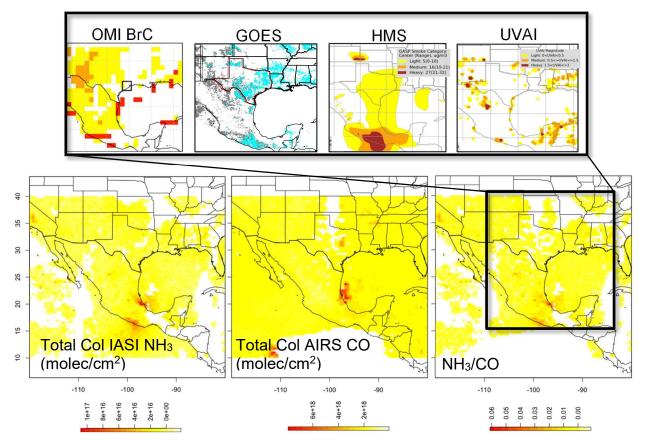

Figure 1. Summary of Task 1 products and results for a sample date on May 22 2020. Bottom panel (left to right): Total column IASI NH3; AIRS CO; and their ratio as NH_3/CO. Top panel (left to right): 48-h averaged brown carbon estimates from OMI, with yellow and red indicating light and heavy BrC mixtures respectively, and orange indicating no BrC; GOES smoke product at 1300 UTC with high quality smoke pixels colored in cyan; HMS daily aggregated smoke product, colored from light to heavy; TROPOMI UVAI daily smoke estimate colored from light to heavy.

For our Task 2 analysis, we began exploring the MAIAC twice-daily Terra/Aqua plume heights associated with suspected smoke events. A recent study by Cheeseman et al., 2020 (https://doi.org/10.1029/2020GL088949) evaluated the correlation of MAIAC plume height with AOD across the United States. In our analysis, we obtain high-quality GOES AOD and subset the AOD further to correspond to the high-quality filtered GOES smoke data. The resulting AOD dataset therefore reflects AOD associated with smoke pixels (filtered for high-quality). This process is displayed in Figure 2 for a sample hour on May 22 2020 at 1300 UTC. These smoke-related AOD values are then binned and compared to the relationship with plume height suggested in Cheeseman et al., 2020. The results of this preliminary plume height analysis are summarized in Figure 3 below. For reference, we provide the relevant figure from Cheeseman et
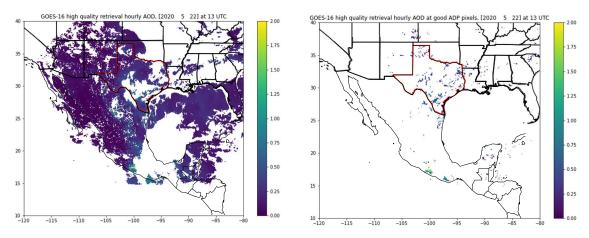
Figure 2. Hourly Averaged good quality GOES AOD at 1300UTC on May 22, 2020. (Left): Not filtered for smoke pixels. (Right): high quality AOD values corresponding to high quality smoke pixels only.

al., 2020 displaying the plume height/AOD relationship. The average AOD for the 1300 UTC time slice was 0.48 (SD: 0.32). Based on the inset in Figure 2 from Cheeseman et al., 2020 a preliminary assessment suggests that these smoke-related AOD values correspond to plume heights of 500-600m.
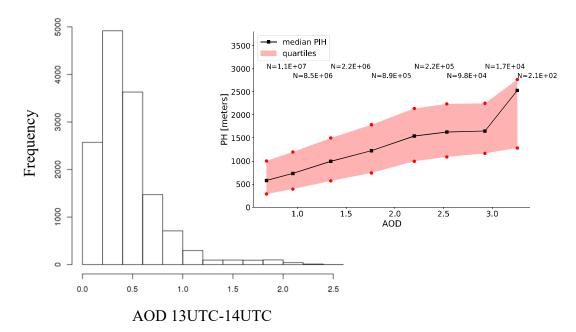

AOD 13UTC-14UTC

Figure 3. Histogram of high-quality GOES AOD values corresponding to high-quality GOES smoke pixels. Inset figure is from Cheeseman et al., 2020 displaying the relationship of MAIAC Plume Height and MAIAC AOD.

Data Collected

We are gathering NH_3 and CO data for the remainder of the 93-day analysis time period.

Identify Any Problems or Issues Encountered and Proposed Solutions or Adjustments

None

Goals and Anticipated Issues for the Succeeding Reporting Period

We will provide summary statistics for Task 1 for suspected smoke dates in the Texas/Gulf of Mexico region spanning January 2020-July 2020. We will finalize our comparison methodology both across smoke products and relative to BrC and NH_3/CO measurements. We will provide an assessment of key features associated with consistency among smoke products as well as an assessment of relationship with individual smoke products and smoke presence suggested by BrC presence and NH_3/CO measurements.

For Task 2, we will continue to examine the relationship of MAIAC plume heights with AOD for the full date range addressed in Task 1. We will also begin our analysis of plume windspeed and direction.

Detailed Analysis of the Progress of the Task Order to Date

We have selected 93 dates between January and July 2020 with suspected smoke intrusions in the Texas area. For these dates:
- We are completing and refining our comparisons of three different smoke products, the first milestone of Task 1 from the task order. We will also incorporate time of measurement to further refine our comparisons.
- We have begun our comparison with OMI brown carbon estimates derived from AOD and AAOD measurements.
- We have also begun our comparison with AIRS CO and IASI total column NH_3 data.
- We have begun our analysis of plume heights associated with smoke pixels from GOES; we are using a published relationship of MAIAC plume heights and aerosol optical depth associated with GOES smoke pixels.

Do you have any publications related to this project currently under development? If so, please provide a working title, and the journals you plan to submit to.

☐ **Yes**   ☒ **No**

Do you have any publications related to this project currently under review by a journal? If so, what is the working title and the journal name? Have you sent a copy of the article to your AQRP Project Manager and your TCEQ Liaison?

☐ **Yes**   ☒ **No**

Do you have any bibliographic publications (ie: publications that cite the project) related to this project that have been published? If so, please list the reference information. List all items for the lifetime of the project.

☐ **Yes**   ☒ **No**

Do you have any presentations related to this project currently under development? If so, please provide working title, and the conference you plan to present it (this does not include presentations for the AQRP Workshop).
        ☒ **Yes**   ☐ **No**

Identifying Smoke-Impacted Regions using the Optical Properties of Brown Carbon Aerosol, accepted for poster at AGU Fall Meeting

Do you have any presentations related to this project that have been published? If so, please list reference information. List all items for the lifetime of the project.

        ☒ **Yes**   ☐ **No**

Identifying Smoke-Impacted Regions using the Optical Properties of Brown Carbon Aerosol, accepted as oral presentation at the CMAS Fall Meeting

Have any personnel changes occurred that were not listed in the original proposal? If so, please include a detailed description of the personnel change(s) below.

        ☒ **Yes**   ☐ **No**

We added AER Sr. Research Associate Qiang Sun to the project to help gather and process data for Task 1.

Are any delays expected in the progress of the research? If so, please include a detailed description of the potential delay below.

        ☐ **Yes**   ☒ **No**

Describe any possible concerns/issues (technical or non-technical) that AQRP should be made aware of.

None

Are you anticipating using all the available funds allocated to this project by the end date? If not, why and approximately what is the amount to be returned?

        ☒ **Yes**   ☐ **No**

Submitted to AQRP by
Matthew James Alvarado