APPLICATIONS OF THE PACE MISSION ATMOSPHERIC DATA

Ali H. Omar (NASA Langley)
Collaborator: Maria Tzortziou (NASA/CCNY)

Groups/Subgroups: Atmospheric Correction, Applications, Atmospheric by-products

PACE Aerosol Measurements

OCI Only

Aerosol Optical Depth (τ_λ)

Aerosol Optical Depth Angstrom Exponents [$\alpha = -\log(\tau_{\lambda 1}/\tau_{\lambda 2})/\log(\lambda_1/\lambda_2)$]

Main Applications: Particulate Material (PM) concentrations –Air Quality Indices (PM + Ozone)

Limited information about aerosol type – Air Quality Forecasting

Some information about aerosol transport – Exceptional Event Flagging

OCI + Polarimeter (Multi-directional, Multi-spectral, Multi-polarization)

Aerosol Optical Depth, α, Absorption

Aerosol Type - Aerosol Size/Shape, Refractive Indices, Number

Aerosol Vertical Resolution – Plume height

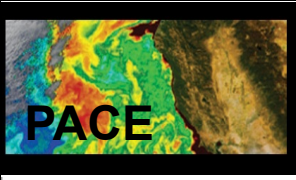
Main Applications: Air Quality Indices (PM + Ozone)

Air Quality Forecasting

Regional and Inter-hemispheric Transport– Exceptional Event Flagging and Demonstration

Disaster Monitoring – Extreme events, Wildfires, Volcanoes, Dust Storms

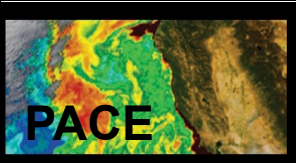
(cf. Waquet et al, 2010; Dubovik et al, 2011; Hasekamp et al, 2011)



Proposed Activities

- Identify existing applications that can be augmented by the PACE measurements
- Determine new applications that can be developed using PACE measurements
- Quantify the uncertainties of the data that will be used for these applications
- Assess and interpret the impact on applications of resolution, and accuracy requirements of the PACE data (also, possibly latency)
- Facilitate collaboration between science team members and the applications user community
- Provide data to early adopter communities to test their applications prior to the launch of PACE
- Achieve consensus on the applications outcomes of the proposed activities
- Estimate of the value of PACE data to society (cf. Macauley, 2007)

Macauley, M. K., and D. Diner (2007), Ascribing societal benefit to applied remote sensing data products: an examination of methodologies based on the Multi-angle Imaging SpectroRadiometer experience, *J. Appl. Rem. Sens*, *1*(1), 013538-013538-013520.

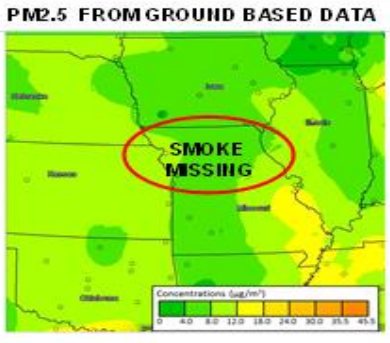


Upcoming Activities (2015)

- Identify key stakeholders and engage them in decisions about data, availability, and formatting within the parameters of mission capabilities
- Develop communication plans and tools. Present material on key applications areas at meetings relevant to PACE mission
- Foster the capacity building geared toward the use of PACE data and successor missions
- Develop Application Traceability Matrices and White Papers for Applied Sciences Program Applications areas (HABs and Air Quality Applications)

Suggestions for the identification, development, and dissemination of PACE applications from PI teams. The goal is to reach a consensus on the applications outcomes (and their uncertainties) by the end of the duration of the award.

PACE MISSION APPLICATIONS – AIR QUALITY



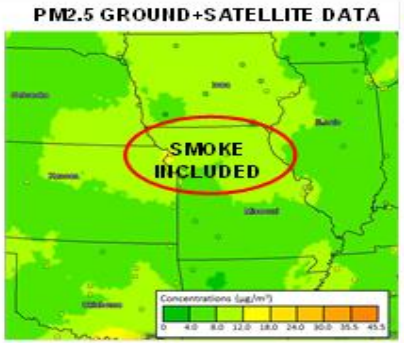


Figure 1. Ground monitors (denoted by small dots) for measuring the concentration of particulate material (PM). Without satellite data, the area of coverage would be limited only to the areas shaded green. The MODIS Satellite data is used to fill most of the gaps (but not all). The next columns show MODIS image of a typical air quality situation resulting from fires, the nominal solution (PM2.5 from ground based data), and NASA's contribution (PM2.5 from Ground + Satellite Data). In the nominal solution because the ground monitors in this region are very few, the interpolated PM2.5 data shows relatively good Air Quality (AQI of 0 – 4). The addition of satellite data shows that the Air Quality as a result of the fires is poorer at AQI = 4-8.0. Satellite data has real value in producing an Air Quality Index that actually protects the public from harm. If the satellite data were not there, there would be no indication of this poorer air quality (Images courtesy of the AirNow Group)

Application Question/Issue

What is the air quality forecast of particulate matter concentration (PM, an indication of the extent of air pollution) predicted from *satellite* measurements of the aerosol optical depth (AOD) in regions where there are no *ground* measurements of PM? Figure 1 is an illustration of such an application.

Who Cares and Why?

In regions where there are no ground measurements of PM, the EPA and thus the public has no indication of the extent of air pollution, a situation that has deleterious public health implications. Satellite measurements of AOD can be used to estimate PM in such areas. The Environmental Protection Agency (EPA) produces a daily air quality index (AQI) which comprises both the ozone and particulate matter concentrations. The latest surveys show 75 -80% of the public are aware of AQI and 50% report taking action based on the AQI.

Needed Measurement(s)

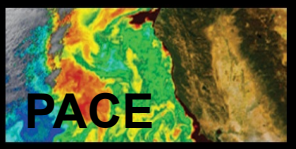
The accuracy of the daily (and forecast) AQI depends on the spatial resolution, latency and accuracy of the satellite-observed AOD and the validity of the relationship between column AOD and surface PM. To meet the needs of the public, the satellite measurements of AOD must be produced at spatial resolutions of less than 1 km at a latency not exceeding 1 hour and at an accuracy of ±0.05. The predicted PM using the column AOD and auxiliary measurements must be within ±(1 $\mu g/m^3$+42%)[c.f. van Donkelaar 2012]

The NASA Response

The PACE mission will produce AOD at an accuracy of ± 0.02 at a horizontal resolution of 250-500 m. It is expected that the latency of the broadcast PACE data will be at least as good as the Land Atmosphere Near Real-Time Capability for EOS (LANCE, http://lance-modis.eosdis.nasa.gov/data_products/) MODIS AOD products currently available in less than 90 minutes for the Level 2 10 km Swath AOD. Additional capabilities such as ground-based lidars, sondes or models of trajectories (e.g., HYSPLIT http://ready.arl.noaa.gov/HYSPLIT.php), and chemical transport models are required to identify elevated layers. This is because PACE will measure whole column AOD and the air quality concern is only the layer closest to the surface. The availability of a PACE Polarimeter will significantly reduce reliance on ground- based measurements and enhance accuracy of the predicted PM.

Comments? Thoughts?

The PACE website is designed engage the community of practice (CoP), accept and process feedback and queries, support interactive workshops and disseminate user tutorials and other pertinent information. Comments and feedback can be posted at http://decadal.gsfc.nasa.gov/pace.html



Applications Traceability Matrix

Application Question	Application Concept	Application Measurement Requirements	Applied Sciences Category	Potential Host Agency	Mission Data Product	Projected Mission Performance (SDR)	ARL	Ancillary Measurements
What is the air quality forecast of particulate matter (PM) predicted from PACE aerosol optical depth (AOD) in regions where there are no direct measurements of PM	In regions where there are no direct measurements of PM, satellite measurements of AOD can be used to estimate PM. The EPA produces a daily air quality index which comprises both the ozone and particulate matter concentrations	Multi- spectral observations of AOD at spatial resolutions of less than 1 km and latencies of less than 1-3 hours	Public Health and Air Quality	Environmental Protection Agency [James Szykman - EPA]	Multi-spectral AOD	AOD to ± 0.02 at a horizontal resolution < 1km	3	Aerosol vertical distributions Surface PM concentrations at a few locations
Volcanoes: What is the volcanic ash concentration during and after a volcanic eruption? Is there an impact on air quality as a result of a volcanic material deposited in coastal/populated regions?	Quantify concentration using measurements collected to support PACE atmospheric corrections and useful data to enable prudent aviation volcanic ash hazard mitigation policy and advisories?	Observations of AOD at spatial resolutions of less than 1 km and latencies of of 1-3 hours	Disaster Mitigation Health and Air Quality	Federal Aviation Administration (FAA), US EPA, NOAA, International Civil Aviation Organization, Volcanic Ash Advisory Centers [Shobha Kondragunta-NOAA]	Multi-spectral AOD	AOD within ± 0.02 at a horizontal resolution of < 1km	3	Aerosol vertical distributions Sulfur dioxide concentrations

Applied Sciences Category:	Disaster Mitigation, Ecological Forecasting, Health and Air Quality, Water Management, Agriculture, Climate, Energy, Oceans, and Weather
Justification for Application Readiness Level 3: Proof of Application Concept (Viability Established) Feasibility studies to assess the potential viability of and provide a proof-of-concept for the application have been conducted.	