Questions & Answers Sessions

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Pawan Gupta (pawan.gupta@nasa.gov) or Melanie Follette-Cook (melanie.cook@nasa.gov) or Ana Prados (aprados@umbc.edu)
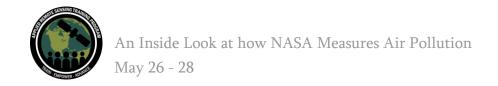
Question 1: Dr. Melanie mentioned that we should consider negative values when we are doing a monthly average. However, when we intend to use the values of each pixel in a unified way, what should we do with the negative values?

Answer 1: I'm not sure what is meant by 'in a unified way.' If you are calculating a monthly average, or if you are comparing tropospheric column values with ground measurements, or if you are looking at the change in the tropospheric column over time, you should include the negative values. Note: these are not the large negative fill values. AOD data comes with negative values too. We keep them to represent very clean conditions and while averaging over a longer period they help in reducing data biases.

Question 2: What is the difference between aerosols and particulate matter?

Answer 2: Aerosols and particulate matter (PM) are two ways to refer to particles suspended in the atmosphere and represent one of the two main categories of air pollutants. The other is gases (like NO2 and ozone). Aerosol term is more often used by the climate community and PM is typically used by the air quality (AQ) and health communities.

Question 3: As journalists, how can we responsibly display these changes in aerosol data during lockdown and describe what they mean? What caveats do we need to include? The pandemic has greatly increased interest in data and images like these.

Answer 3: Always feel free to contact ARSET directly if you have any questions regarding use of NASA data for reporting purposes, and we can guide you through how to incorporate any important caveats. When you describe them, just keep in mind that emissions (increases or decreases) are not the only factors determining the levels of pollution shown in the satellite imagery. There are other factors such as weather conditions, chemical and physical processes in the atmosphere, which directly or indirectly can impact air quality. NASA

scientists would be happy to help. We have already worked closely with a number of journalists in their reporting for this epidemic.

Question 4: Do you recommend any smartphone app for air quality measurement?

Answer 4: There are many. I would not recommend any particular one but look for ones that represent environmental agencies as they will be most reliable.

Question 5: Why is it that we can see smog/haze, even though PM2.5 might be within acceptable levels (i.e. the case of blue skies despite the same/worsening pm2.5 in some countries around the world with COVID)?

Answer 5: This is a good example of when PM2.5, being a point measurement, only represents the area around that station. Smoke and haze that can be seen in the sky and represents a larger area. Also, weather conditions play a role in sky color/haziness. There can also be pollutants up in the atmosphere but may not be reported at the ground station. This is where satellite data can be useful, providing a larger view and providing context on the differences between the two.
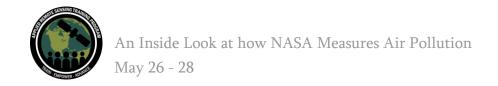
Question 6: You mentioned that NASA is also looking into low-cost air quality sensors. Is there any more information that you could share with us, any papers or results from NASA that could help us determine the best low-cost sensors?

Answer 6: Yes, we have been involved in such projects. Please email Pawan Gupta. Following is a NASA funded project related to low-cost sensor - https://aqcitizenscience.rti.org/

Question 7: AQI values do not seem to correspond to the World Health Organization thresholds for PM2.5 (25mug/m3 for the 24h mean concentration). What is the rationale for this?

Answer 7: Individual countries make these decisions based on their own health study data to define their standards for PM2.5. E.g. EPA has defined the standard as <35 ug/m3. WHO, an international body, has more stringent criteria (more like a guideline) for a safe level of PM2.5, and does not follow the standard of a single individual country.

Question 8: Why aren't there orbital gaps in VIIRS images? And how are the daily orbital gaps of MODIS filled?

Answer 8: VIIRS has a larger swath (~3000 km) than MODIS (2330 km), so there are no gaps between the orbits near the equator. The larger swath width allows it to cover the entire globe on a daily basis. VIIRS also has areas of overlap. The daily gaps in MODIS are not filled, MODIS provides global coverage in 1-2 days (1 days at higher latitudes, and >1 day at lower latitudes). These gaps in MODIS can get filled when we average (or combine) data from multiple days (over a week or month).

Question 9: Are there any NASA satellites which are currently providing measurements for tropospheric ammonia?
Answer 9: NASA's Atmospheric Infrared Sounder (AIRS) instrument on NASA's Aqua satellite provides some NH3 measurements. More details:
https://www.nasa.gov/feature/jpl/nasa-satellite-identifies-global-ammonia-hotspots
NASA's Atmospheric Infrared Sounder (AIRS) instrument on NASA's Aqua satellite.

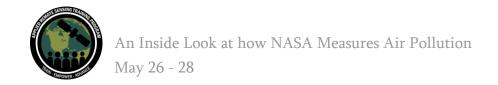Question 10: How do the VIIRS and MODIS AOD and fire counts compare and which one is better and where?
Answer 10: On global basis both compare well with each other (w/in expected uncertainty). But, both have multiple algorithms that produce AOD, all with similarities and differences. Larger differences in fire counts, due to different spatial resolution of the instruments.
MODIS - 1 km
VIIRS - 750 m (M-band), 375 m (I-band)
Because of this, VIIRS can detect smaller (and therefore more) fires than MODIS
Both have similar data quality.

Question 11: Does VIIRS provide the direct black carbon concentration data?
Answer 11: No, VIIRS provides observations of aerosol optical depth (AOD) which represent the total amount of aerosol from the surface to the top of the atmosphere and includes all types of aerosols. NOAA's VIIRS product has an aerosol type product (dust vs. smoke), but cannot distinguish between, say, black and organic carbon from smoke.

Question 12: When will NASA have data with finer resolution for NO2 and aerosols? Is it dependent on new satellite hardware or better data storage and processing capacity?
Answer 12: NASA data on aerosols are 1 km resolution. NASA is launching TEMPO specific for AQ, it will only make measurements over North America. One satellite will cover Asia

and Europe will be covered by another, These will be higher resolution. The NO2 data from TROPOMI (ESA) has spatial resolution of 3.5x5 km. Yes, the spatial resolution of data depends on satellite hardware, data storage and other factors.

Question 13: Is there a preference in using VIIRS on NOAA20 or JPSS? Is the difference just in time or in the quality of data, too?

Answer 13: JPSS was launched recently (2017). VIIRS on Suomi-NPP was launched in 2011, and will contain a longer data record. Similar design between the two, and they are ~50 min apart in terms of overpass time.

Question 14: What makes selection of bands 1, 3, and 4 for RGB respectively?

Answer 14: These are at particular wavelengths, red (0.67um), green (.55um), blue (0.47um). 1, 4, 3 just refer to sequential numbers for the MODIS bands. In order to create a RGB image, we need measurements in the red, green and blue part of the solar spectrum.

Question 15: Fire detection only works in the fire-prone area right? So how can I know at what intensity the fire detection will work?

Answer 15: If there is a fire, the algorithm will detect it depending on its size and intensity. Depending on the spatial resolution and sensitivity will affect that. Smaller scale (fire burning in a garbage bin) will be too small to be detected by sensors like MODIS.

Question 16: Does MODIS or VIIRS data provide burnt area information (hectare or sq.km.) on a NASA portal?
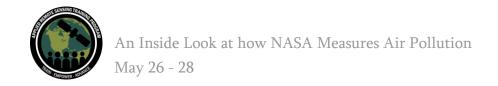
Answer 16: Yes, MODIS and VIIRS provide burned area products. Note, these are not available in near real time.

The MODIS product is MCD46A1:

https://search.earthdata.nasa.gov/search?q=C1364190927-LPDAAC_ECS
https://lpdaac.usgs.gov/products/mcd64a1v006/

VIIRS product is VNP64A1:

https://search.earthdata.nasa.gov/search?q=C1632559364-LPDAAC_ECS
https://cmr.earthdata.nasa.gov/search/concepts/C1632559364-LPDAAC_ECS.html

Question 17: Is it recommended to convert NETCDF into GeoTiff for better processing?
Answer 17: It depends on what software you are using. Whatever you're most comfortable with.

Question 18: How can we compare ground based PM 2.5 or PM with satellite based AOD values?
Answer 18: You will have to collocate the two data sets in space and time to compare. We have had advanced ARSET training and more details can be found at the link:
https://arset.gsfc.nasa.gov/airquality/webinars/advanced-AOD-PM

Question 19: Can fire itself reflect electromagnetic radiation?
Answer 19: Fires emit thermal radiation and smoke can interact with the electromagnetic spectrum in different ways.
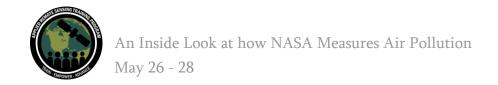
Question 20: How do we incorporate the effects of clouds or any other biases to calibrate emission data if QA value is not present?
Answer 20: Most satellite products that are retrieving information comes with a quality flag and how much cloud % was present. But, incorporating these into emissions estimates required very careful analysis and use of proper data and methods.

Question 21: How can we convert the image from RGB signal to RGB computerized image, considering an RGB image is in (256, 256, 256) limited range?
Answer 21: When you are making a measurement of RGB radiance, there is a reflectance from 0 to 1. 1 being highest. These reflectances can be scaled to grey levels (i.e 0-255) to display on the computer display system.

Question 22: If you are measuring at 550nm, I would expect the correlation to better to Aethalometers (Black Smoke Meters). Is this correct? I think this is the peak absorption/fluorescence wavelength for PAHs but I cannot remember which one.
Answer 22: Both absorption and scattering are functions of refractive index of particles. This determines whether particles are absorbing or scattering. Wavelength and particle composition will have a dependency on what you're observing and how they will correlate with different types of measurements.

Question 23: A few questions on the AOD data accuracy of MODIS/VIIRS product in the urban city. Which one is generally better between MODIS and VIIRS? Is the accuracy of 1-km AOD product better than the 10-km AOD product in MODIS in the urban city?

Answer 23: MODIS provides the data if diff spatial resolutions. As well as from diff algorithms. 1-km AOD has better accuracy over urban areas. VIIRS operational data from NASA are in 6km spatial resolution and use a different algorithm, therefore accuracy varies from place to place.

Question 24: What could be the possible reason for higher concentrations of PM2.5 at lower altitude regions than higher altitudes?

Answer 24: As we go higher in altitude, air pressure and density decreases. Profiles also depend on the source of pollution. Another factor can be the height of the lowest mixing layer (planetary boundary layer height), which can influence PM2.5 concentration at different altitudes.
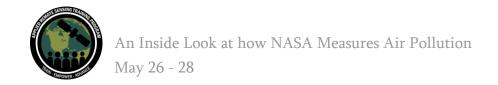
Question 25: Can you also use wind data (from any satellite, etc) to aid interpretation that the plume was transported to DC area or Saharan dust over the Atlantic Ocean?

Answer 25: Yes, there are several satellites that provide wind data. Refer to the worldview and you can find those datasets. Modeled reanalysis can incorporate wind for transport so look into that too.

Question 26: If I look at trends in MODIS AOD, is there a way I can remove the scenes with fire over an area?

Answer 26: In theory, yes. If you use both fire and MODIS AOD data, then you can avoid days or regions when fire is occurring or is experiencing smoke transport.

Question 27: Will we be able to view more fires if we use both MODIS day and night and Suomi NPP day and night filters when using NASA Worldview?

Answer 27: Yes, remember, each sensor is taking measurements at different times of the day (morning and afternoon for MODIS, Terra, and Aqua). Sometimes you will see the fire both times of the day. Many fires are gone after a few hours, so you may only see it once per day but if fires are burning for extended periods (i.e. wildfires) then the same fire can be observed multiple times from different satellite overpasses.

Question 28: Can different seasons affect AOD measurements because of the slightly different sun angles?

Answer 28: Yes, but when we are retrieving AOD we correct for this, so there should be no bias in the AOD because of this. There can be seasonal dependency on data quality but it comes from other sources.

Question 29: How does humidity affect the PM mass concentration over any region?

Answer 29: Water absorption can increase the size of certain types of the PM and can modify the size distribution of particles. Humidity can also affect the optical properties of PM/aerosols.

Question 30: Could you please indicate good refs for AOD to PM2.5 conversion?

Answer 30: Yes, there are a number of papers, and a previous ARSET training. You can email Pawan to follow-up. The following review paper can be a good starting point - https://www.tandfonline.com/doi/abs/10.3155/1047-3289.59.6.645

Question 31: Could you go over sun glint again - what it means and how to identify it? Is it always parallel to orbital gaps?

Answer 31: Glint is specular reflection over smooth areas (e.g the ocean). The equal angles of the sun and sensor will cause this. Glint angle can be calculated very precisely for each measurement. We mask those areas because of that.
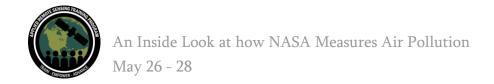
Question 32: Is the 1 x 1 km2 AOD data oversampled? Or does it only use the data with pixel centers within that grid square?

Answer 32: The MAIAC retrieval comes on a sinusoidal grid. They perform spatial smoothing where averages are calculated for each 1 km^2 pixel area. Please read the MAIAC documentation for further details. https://amt.copernicus.org/articles/11/5741/2018/

Question 33: Is the 1 km MODIS AOD data for both Terra and Aqua? And is it available for the entire time period (2000-2020)?

Answer 33: Yes. 1 km data is available from 2000-2020. The data product files will come in a combined file (terra and aqua).

https://amt.copernicus.org/articles/11/5741/2018/

Question 34: I am not clear about what the AOD is actually measuring. Is this at a specific wavelength?
Answer 34: Yes, it is measuring the amount of aerosols between the surface and the top of the atmosphere, at a specific wavelength. This is an optical measurement.

Question 35: Could you explain what you mean by gridded data in Level 3 products? I do not understand how the data of Level 2 products are processed to be gridded.
Answer 35: When the satellite is making a measurement, we call that swath data (level 2). As the viewing angle of the satellite changes (away from nadir towards the edge of the swath) the pixel sizes will be larger. So 1 km spatial resolution refers to the nadir angle (straight down), at the edges of the swath, pixels are larger. VIIRS can still retrieve at high spatial resolution near the edges of its swath.
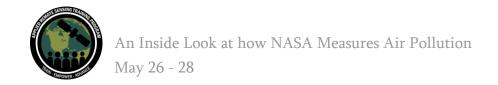
Swath data are then averaged on an equal angle area (equal latitude and longitude grids), taking all of the pixels that fall within a box (spatial area on surface) to calculate mean, median, std dev. This becomes the basis for level 3 data and often called gridded data. Level 3 data generation follows certain guidelines to ensure data quality and representation during the conversion of level 2 into level 3.

Question 36: Can I use 1km MODIS AOD data over bright surfaces like Saudi Arabia? Where can I access this?
Answer 36: Yes, you can. There is a slide in the ppt that gives details on how and where to access.

Question 37: Can clouds and smoke from forests appear the same in RGB?
Answer 37: It depends on how thick the plumes are and the area they are covering. They may look the same but if you look closely at the patterns, source points, etc you will learn to identify. Spectral signatures are used to differentiate.

Question 38: Why is gridded data more useful than native resolution data?
Answer 38: It depends on your expertise and your use of the data. They're easier to use. They are the same size and location every day. Native resolution data are also usually larger. But,

users have more control on level 2 data than level 3 data. Users should select appropriate data sets based on the application.

Question 39: Why do we take the AOD values at 550nm and not at any other wavelengths?

Answer 39: Both MODIS and VIIRS provide other wavelengths, but 550 nm is the one in which solar intensity peaks and it is also the one included in various climate models.

Question 40: Can the contribution of the specific factors influencing the data – emissions, chemistry, weather – be assessed with the intent of trying to determine the significance of the influence, i.e. can it be determined that in a particular set of data, weather played a 10% role, emissions a 30% role, chemistry a 60% role?

Answer 40: Yes and no. It really depends on the data, tools, and resources you have available. This would likely require many ground measurements and access to computer models. Models can use source apportionment tools that can give information on different pollutants sources.

Models can also help determine the weather influence (e.g. sensitivity experiments holding weather and/or emissions constant).
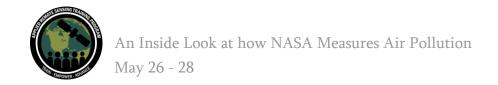
So you need both good measurements and a good model where you can deduce the influence of these different factors.

Question 41: Will NASA calculate the lockdown signal separate from the impact of chemistry and weather? If so, when might that be available?

Answer 41: There are NASA scientists currently working on this aspects and they usually publish in form or journal paper as they become available.

Question 42: How "sensitive" is the data collected to a specific sector (transportation, power generation, etc.) or source (powerplant, freeway expansion, sports stadium, etc.) which has just been opened? Can the data see this influence, say, compared to before and after the opening of the facility?

Answer 42:

Question 43: In the event of a volcanic event, is it impossible to discern ground-level aerosol pollution in the region affected, as AOD would be dominated by the volcanic aerosols emissions?
Answer 43:

Question 44: Is there a way to convert the AOD 550nm scale to μg/m3 concentrations?
Answer 44: There are methods to convert AOD into PM2.5 and errors are associated with each method.

Question 45: Are the AOD measurements available only over areas free of clouds or not?
Answer 45: Yes, AOD only in areas without clouds, as it is a passive sensor.

Question 46: Can we download averaged AOD value at a particular lat/long?
Answer 46: Yes, when you select the data you can subset by lat/long.

Question 47: Are the maps on slide 47 made with the processing of native data or were they made with Giovanni or similar programs?
Answer 47: Those were created by using Python codes using Level 2 data.

Question 48: Why has southern-central India experienced an increase in AOD during lockdown? Why were there so many fires? Is it because of cyclone conditions?
Answer 48: We are still investigating those aspects. That region often experiences crop residue burning during this season and can have an impact on AODs.

Question 49: So your scientists are willing to discuss these issues directly with journalists? Journalists rarely find this to be the case? What are their names? Phone numbers? You can contact us (ARSET). We have talked to several in the past few weeks and done lots of interviews.

Answer 49: Yes, feel free to contact us here at ARSET. If we can't answer we can forward your request onto the most appropriate person.