



## Questions & Answers Session 1

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](mailto:pawan.gupta@nasa.gov)) or Melanie Follette-Cook ([melanie.cook@nasa.gov](mailto:melanie.cook@nasa.gov)).

Question 1: The Indo-Gangetic Plain has emerged as an NH<sub>3</sub> hotspot in the world. Can NH<sub>3</sub> concentration also be measured through Remote Sensing, and is there a direct correlation between NO<sub>2</sub> concentration and concentration of NH<sub>3</sub>?

Answer 1: NASA's Atmospheric Infrared Sounder (AIRS) instrument on NASA's Aqua satellite provides some NH<sub>3</sub> 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

NO<sub>2</sub> likely won't correlate well with NH<sub>3</sub>, as they have different sources. NO<sub>2</sub> is primarily produced via combustion, whereas NH<sub>3</sub> comes primarily from agricultural sources.

Question 2: Can the ARSET team provide training on how to get 3D air pollutant retrievals from MISR?

Answer 2: MISR does not provide gas measurements but gives information on aerosols. Limited data on the vertical distribution of aerosols is also available from MISR.

Question 3: As a wildlife conservationist, are any NASA partners or affiliates quantifying poor air quality on animal (versus human) health?

Answer 3: NASA is primarily concerned with making measurements. Different agencies will perform analyses such as this, but we are not aware of a study looking at that currently.

Question 4: What is the difference between spectral radiance and irradiance?

Answer 4: Spectral radiance - radiance of a surface per unit frequency or wavelength from a particular direction.



Spectral irradiance - irradiance of a surface per unit frequency or wavelength (from all directions)

Question 5: Can we convert the data into CSV? Because generally it is difficult to work with HDF and NetCDF data formats.

Answer 5: Python codes to output variables from native resolution (Level 2) hdf (OMI) and/or netcdf (TROPOMI) files to a csv file are available from this training:

<https://arset.gsfc.nasa.gov/airquality/webinars/advanced-NO2-2019>

We do not currently offer codes to do this for gridded Level 3 data, but you could adapt the above codes.

Question 6: How did we delete the other molecules above the troposphere and only focus on the troposphere?

Answer 6: When the retrieval is being done, they use models and other satellite measurements to calculate that amount above the troposphere and subtract that from the total column. We use the tropospheric column because it corresponds the most with changes at the surface.

Question 7: How can we compare the ground based data which is in ppm and satellite data which is in column and the unit is molecules/cm<sup>2</sup>?

Answer 7: They relate to one another, but to convert one to the other you need vertical information, typically from models. Empirical relationships can be derived and used.

Question 8: If OMI images contain so many obstruction factors as discussed in slide 40, like cloud and anomaly, why is it still the standard data measurement for analysis?

Answer 8: Satellite data in general is valuable for its spatial coverage. OMI's long data record lets us look at the historical record, which is not possible with, for example, TROPOMI. The available data are still very useful for many applications, even though clouds will remain a problem for all passive sensors.

Question 9: How well does the tropospheric-column NO<sub>2</sub> represent the PBL-NO<sub>2</sub> and surface NO<sub>2</sub>?



Answer 9: PBL (planetary boundary layer) refers to the layer closest to the surface. Changes in the column will give us information about the surface. How well the column represents the surface will vary in both space and time.

Question 10: I understand decreasing concentrations with height and the correlation with surface conditions, but is there no additional algorithm in the post processing that says it is at the surface with certainty?

Answer 10: The retrieval algorithms calculate tropospheric column NO<sub>2</sub>. You can do your own analysis of ground measurements to verify how well it represents the surface in your region.

Question 11: According to slide no 41, how can we calculate the monthly total amount of NO<sub>2</sub>?

Answer 11: There are text files for some gridded datasets. You can average daily files over a month. If your goal is to produce a map, you can use Giovanni. Using Giovanni we plotted Level 3 monthly data averages over 30 days.

Question 12: Why does the India map show high values in geography without a city identified? Are these remote power plants?

Answer 12: Yes, I believe they were power plants and mining facilities.

Question 13: How do we actually identify if the image is a total column or a tropospheric column dataset?

Answer 13: Most, if not all, applications will use the tropospheric column. Additionally, any figure showing OMI data will likely specify the quantity being shown.

Question 14: Hello. At ([giovanni.gsfc.nasa.gov](http://giovanni.gsfc.nasa.gov)) there is only Ozone Total Column (in DU) data. I would like to know where I can find ozone tropospheric or surface data obtained by OMI. Is there another source for that?

Answer 14: Ozone is an example of a long-lived pollutant. Tropospheric column ozone will not give us useful information about ozone at the surface. So there will never be a surface ozone product from OMI.

Giovanni does not have tropospheric column O<sub>3</sub> available.



Question 15: Granted, we can't say "all" of the changes are relevant to COVID, but it seems like we could say "most" of them are. Can we? Is that a fair statement of fact that a responsible journalist could state in a news story? If not, what is?

Answer 15: Great Question! I don't think we can say "most". Figuring out the percentage due to the pandemic is an ongoing effort at NASA and at other research centers around the world. We can absolutely see the signal of the decrease due to the economic slowdown (that is not in question), but we cannot say how much as a percentage. Fee free to contact us if you have further questions about this and how to convey this information in news stories.

Question 16: Question about the image we were just looking at on slide 41. Is there a way we can tell, just from the image itself (outside the context of this presentation), that this is tropospheric column data rather than total column data? The magnitude of the values in the legend, maybe?

Answer 16: Most, if not all, applications will use the tropospheric column. Additionally, any figure showing OMI data will likely specify the quantity being shown.

Question 17: Can you give a percentage of the likelihood of what is seen in slide 41 that is attributable to Covid-19 since you know weather, chemistry, and emission (or lack thereof) information. That is, can you ascribe percentage influences to slide 41 associated with emissions, chemistry, and weather?

Answer 17: See question 15. Careful analysis will be needed to ascribe a percentage.

Question 18: I am interested to know if you have been able to measure ground level ozone from space; and if so how have you been able to remove the signal due to upper tropospheric ozone?

Answer 18: It is much harder for the satellites to detect ozone than NO<sub>2</sub> at the surface due to interference with other species. We do not recommend using ozone column data for air quality studies.

Question 19: How can the data be correlated with ground level concentrations?

Answer 19: If you know a ground station, you can obtain measurements from a local ground station. Then use the gridded data that corresponds to that station.



Question 20: Is there any relation between NO<sub>2</sub>, land surface temperature, and air temperature?

Answer 20: Yes, the lifetime of NO<sub>2</sub> will depend on the temperature of the air.

Question 21: I didn't get 0.1 \* 0.1 degree resolution? Can you explain this in detail?

Answer 21: 0.1 by 0.1 corresponds to ~ 10x10 km<sup>2</sup> grid cells. For more details:

<https://www.sciencedirect.com/science/article/pii/S1352231015002794>

Question 22: Is there any L4 product, as with other sensors on other platforms?

Answer 22: L4 will correspond to products derived from Level 3 products. An example of a L4 product from OMI would be the surface NO<sub>2</sub> estimates I mentioned in the presentation. But this is a research product.

Question 23: Are there any commands or ways to make corrections to NO<sub>2</sub> data from OMI Data?

Answer 23: Yes, if you are dealing with L2, native resolution data, there are filters and data quality flags you want to use. You can look at the readme documentation, and our past webinar goes into some detail:

<https://arset.gsfc.nasa.gov/airquality/webinars/advanced-NO2-2019>

Question 24: Can you please explain row anomaly again?

Answer 24: A piece of hardware is blocking the sensor's view on the satellite creating the anomaly.

Question 25: Are the images available for any country?

Answer 25: If you wish to make your own image as we showed in Giovanni over most countries. The NO<sub>2</sub> data are global, you can make an image for your own area. A lot of the images I showed in the presentation were created by the NASA Science Visualization Studio in close collaboration with the OMI science team.

Question 26: We haven't touched on NO<sub>2</sub> emissions from forest fires. Any comments in that regard? Point sources as compared to large forest fire areas?



Answer 26: The primary signal will be from combustion of fossil fuels such as power plants and vehicles. NO<sub>2</sub> emissions from combustion due to forest fires have a weaker signal globally (they don't produce as much NO<sub>2</sub>).

Question 27: Did you say NO<sub>2</sub> data is not available after 2016? Why is it so?

Answer 27: Not true. OMI is still taking measurements. TROPOMI is also taking measurements. TROPOMI was launched in Oct 2017.

Question 28: Is there a list or compendium of the widely-used indices or processing used for analytics? I'm more interested in L2 data and want to avoid searching literature if someone has already aggregated the standard product steps and any standard applications.

Answer 28: See our 2019 advanced NO<sub>2</sub> webinar and the OMNO<sub>2</sub> documentation:

<https://arset.gsfc.nasa.gov/airquality/webinars/advanced-NO2-2019>

[https://disc.gsfc.nasa.gov/datasets/OMNO2\\_003/summary](https://disc.gsfc.nasa.gov/datasets/OMNO2_003/summary)

Question 29: Is there any fine resolution data? What is the maximum resolution available as of today?

Answer 29: 5.5x3.5 km<sup>2</sup> from TROPOMI

Question 30: While performing atmospheric modeling, we need to collocate the variable temporally and spatially. Since all the satellite data have different spatial and temporal resolution, how do we deal with such cases?

Answer 30: Since a model will be available everywhere at all times, you need to be careful. Satellite data gives you a picture at a certain time of day (e.g. OMI is in the early afternoon). Different satellites have different overpass times. A model will give you output for every hour. In addition, the model will probably be at a different spatial resolution than the satellite observations.

Question 31: Sometimes, and particularly in NO<sub>2</sub> products, certain values are negative (for example -0.00039), so how do we deal with those values? Or do we consider those data as missing data?

Answer 31: No. If you are creating a mean or average over an area, and looking at change over time, the retrieval teams suggest you include that data. Missing data will be flagged with very large negative "fill" values.



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Question 32: How can we compare the NO<sub>2</sub> Tropospheric column data with ground data. Since both have different measurement height and unit. Is there any way to integrate both sets of data?

Answer 32: No. What you can do is you can see how changes in one correlate to changes in the other.

Question 33: Is there a particular browser in which Giovanni works best?

Answer 33: We are not certain. If it was slow for you today, it may be because many participants were going to the site at once.

You can send an email to the Giovanni help email address on their website and they will be able to tell you which one works best. [gsfc-help-disc@lists.nasa.gov](mailto:gsfc-help-disc@lists.nasa.gov)

Question 34: Can all these Giovanni steps for generating the maps be programmed through an API?

Answer 34: Giovanni's Help Team will be able to address this. [gsfc-help-disc@lists.nasa.gov](mailto:gsfc-help-disc@lists.nasa.gov)

Question 35: What is happening - I guess, from a calculation perspective - when you choose data smoothing?

Answer 35: Giovanni has documentation on the smoothing they do.

Question 36: How well does NO<sub>2</sub> derived from OMI agree with data from ground stations? Could you provide some references to researchers that looked into this?

Answer 36: This will vary in time and spatially. References include Lok Lamsal. (google him to find publications).

Question 37: Is 2020 data also from OMI or from TROPOMI?

Answer 37: Both, since they are both currently taking measurements. We only showed data for OMI in this presentation.

Question 38: In Giovanni, is it possible to select a city by the name?

Answer 38: I don't believe so. You can email their help desk at [gsfc-help-disc@lists.nasa.gov](mailto:gsfc-help-disc@lists.nasa.gov)

Question 39: Is it possible to download netcdf, and plot the data using python sns?



Answer 39: Yes, if you wanted to use Giovanni to subset and then download the data, you can then plot it with Python or any other software of choice..

Question 40: I don't quite understand the effect of maximum or minimum data range selecting. Why did you change from 2 to 1?

Answer 40: I knew that we were going to compare different years. Having a large max value will smear out features in years with cleaner air. I reduced the max so that we would be able to see features in cleaner years like 2020.

Question 41: What are the units in the definition of data range at Giovanni?

Answer 41: molecules/cm<sup>2</sup> (see plot title in Giovanni at the top)

Question 42: Hi, which tool do you recommend to work with a time series of years?

Answer 42: Giovanni can plot a time series, but I recommend you choose a very small spatial area if generating a long time series. You can also find monthly data on the avdc website in ascii format:

<https://avdc.gsfc.nasa.gov/index.php?site=356862610&type=1&iDayShow=0&chProductCaptionHere=Monthly%20Average>

Question 43: Can we compare ground-based data which are in ppm and satellite data of OMI which is in molecules/cm<sup>2</sup> Tropospheric Vertical Column?

Answer 43: You need information about the vertical distribution of the pollutants to convert one quantity to the other. But changes in the tropospheric column will usually reflect changes at the surface.

Question 44: Is there any publicly available training material (jupyter notebook) to analyze OMI data in python? OR any software for analysis?

Answer 44: We gave a webinar from 2018 that has codes to do this with L2, native data. We plan to add jupyter notes in the near future.

<https://arset.gsfc.nasa.gov/airquality/webinars/2018-hiresdatasets>

And

<https://arset.gsfc.nasa.gov/airquality/webinars/advanced-NO2-2019>





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