Questions & Answers Session

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 Ed Nowottnick (edward.p.nowottnick@nasa.gov) or Melanie Follette-Cook (melanie.cook@nasa.gov).

Question 1: When a lidar is ground-based, what type of measurements can be done upwards?
Answer 1: The same types of measurements can be performed from ground-based systems as airborne/space-based systems. The primary difference is that ground-based systems are looking upwards and are static and can measure time-series of atmospheric constituents. Additionally, ground-based systems can attenuate in the opposite direction as airborne/space-based systems, preventing measurements at higher altitudes. If there is a really thick cloud you may not be able to see the upper portion of the atmosphere, for example.

Question 2: When talking about different Lidar missions you didn't mention GEDI
Answer 2: We discussed GEDI as a type of lidar (altimeter) on the International Space Station but has less applications to atmospheric measurements (aerosol and clouds). It is targeting tree canopy heights.

Question 3: Which type of applications on clouds can be made using data from EarthCARE?
Answer 3: Earthcare has several types of instruments, including an HSRL lidar and a W-band radar to measure clouds. Lidar measurements may be impacted by attenuation and you can use the radar instrument to see what is below.

Question 4: Could I use LiDAR images to monitor subsidence of underground mines?
Answer 4: There are examples of drone-based lidar being used to monitor subsidence of underground mines, but not a focus of this training.

Question 5: Is there any priorly predicted value of distance dealing with the future advanced LiDAR mission? (EUMETSAT)
Answer 5: ESA and EUMETSAT have plans to build an Aeolus operational lidar to provide curtain measurements of wind to be incorporated into their forecast models.

Question 6: Where can I download information (images) from the amazon forest to analyze water vapor, gases, and vegetation canopy?
Answer 6: GEDI would be a good source. GEDI data can be found here: URL: https://gedi.umd.edu/data/products/

Question 7: How difficult is it to implement the HSRL in comparison to a conventional Elastic Lidar?
Answer 7: HSRL lidars have more sophisticated optics in their design, but ESA has demonstrated this capability with EarthCARE.

Question 8: Can we reduce the power usage by limiting noise transmission using ML algorithms?
Answer 8: Yes. There is work being done on this. Part 2 of this series we go into this (improving SNR)

Question 9: It would be nice to have a practical example of measuring aerosol plume height and a few other types of applications.
Answer 9: In part 2 of this series we go into how to interpret plume heights using real data examples.

Question 10: What is a rough cost estimate for a ground based system?
Answer 10: It will vary quite a bit given the system. MPLnet is more affordable, while space-based implementations are much more costly ($10s-$100sM). It will be system and target dependent.

Question 11: Your cross sections of the atmosphere were an excellent communication tool but you also showed how they are useful for assessing signal to noise ratio quality. Will you cover SNR and its relationship with how to identify atmospheric features in more detail next session?
Answer 11: Yes! We will walk through feature detection (theory and real world examples).

Question 12: How efficient is LiDAR in measurements for PM10 aerosols? Is there any better RS technique as compared to LiDAR for measuring PM10?
Answer 12: LiDAR does not measure mass concentrations of aerosol, however, near-IR lidar measurements will be better suited for PM10 estimates based on backscatter intensity (but not measurements).

Question 13: For my Master Thesis, I am working on "Mangroves & Blue Carbon in Littoral in Cameroon" One of my goals is to compute canopy height. Want to know which missions can be helpful for. I had a look at GEDI but as the samples are spaced enough, can the output be really informative using these data for Machine Learning?
I would also like to get some workflow, papers and useful links showing how to use LIDAR to compute canopy height
Answer 13: GEDI will be useful. ARSET conducted a training on Mangrove extent.

English:
https://appliedsciences.nasa.gov/get-involved/training/english/arset-earth-observations-blue-carbon-ecosystems

Previous ARSET training that includes GEDI:
https://appliedsciences.nasa.gov/get-involved/training/english/arset-use-solar-induced-fluorescence-and-lidar-assess-vegetation

Question 14: Can DIAL LIDAR be used to measure NO_2 concentrations and determine at what altitude the gas is located?
Answer 14: Yes, some groups are measuring NO_2 similar to ozone and water vapor to measure the vertical distribution of the constituents.

Question 15: (follow-up to question 6) Like it was 355nm for EarthCARE I had a query for this one that is EUMETSTAT? Also, Please explain what this 355nm distance is for? What does it represent, basically?
Answer 15: The laser is being transmitted at 355 nm. 355 is chosen because at 355 you get more backscattered Rayleigh signal needed for the HSRL technique.

Question 16: What are some examples of use cases covered by ground based lidar which cannot be served by doppler radars like the Nexrad radar system?
Answer 16: Radar will measure longer wavelengths which are best for larger particles (e.g. hydrometeors). Lidar and radar work together to measure the full atmospheric column in convective environments.

Question 17: How liDAR data is efficiently useful for monsoon prediction

Answer 17: It can be used to provide a NRT measurement (spaceborne) of cloud top height. Lidar will not be useful for seasonal predictions, but can provide information to constrain forecast models for a few days out.

Question 19: How can LiDAR be applied to precision agriculture, if at all?
Answer 19: This is beyond the scope of this training, but a quick search reveals LiDAR has been used for precision agriculture:
https://www.mdpi.com/1424-8220/24/16/5409

Question 20: Can lidar measurements at different wavelengths (e.g., 370 nm, 550 nm) detect and quantify the absorption properties of brown carbon (BrC) in the atmosphere?
Answer 20: When multiple wavelengths are provided in the UV and visible, particle absorption can be assessed to help inform type.

Question 21: LiDAR can suffer from daytime "solar background". Is this equally detrimental to observations in IR, UV, and visible, or does it impact each of the different wavelength ranges in different ways?
Answer 12: It impacts the solar background differently at the different bands. Solar background impacts UV and visible wavelengths more than in the IR.

Question 22: Could you elaborate on the uncertainties associated with classifying aerosol types based on lidar measurements?
Answer 22: We will cover this in Part 2. There are various ways aerosol typing is done, depending on the system design and consequently, measured quantities.

Question 23: How do you choose which wavelengths to use in an atmospheric LiDAR?
Answer 23: This depends on the targeted geophysical variable. Wavelengths can be targeted to measure backscattered intensities, as well as those that are transparent to compare to attenuated profiles to assess the presence of a geophysical variable.

Question 24: Is a ceilometer a type of lidar and, if so, how does it differ from lidars presented here?
Answer 24: Yes, it tends to be lower power, more affordable, and less sophisticated.

Question 25: Could you please re-explain/elaborate on high inclination vs. low inclination orbit?

Answer 25: Most NASA satellites are polar orbiting (MODIS on Aqua/Terra). AOD from a polar orbiting, sun-synchronous orbit will be captured at the same time per day. Low inclination (TRMM, GPM, instruments on the ISS) have increased temporal resolution and provide measurements at different times of the day.

Question 26: how can we use lidar in disaster management?
Answer 26: Wildfire plumes can be tracked using lidar (drone, UAV) to help track plume height. This helps real time situational awareness (AQ, air traffic).

Question 27: Are spaceborne lidar observations validated using ground-based measurements in any way?
Answer 27: Yes. Using aerosol plume height as an example, you may need the scene to be cloud free.

Question 28: What is the process of validating satellite measurements using data from surface-based instruments? I believe these types of activities can be used to build synergy for this type of validation.
Answer 28: Like in #7, the MPLnet network was used to validate. We also use airborne lidar flown under a spaceborne lidar to validate performance quite often.

Question 29: In the Caribbean, sargassum is becoming an increasingly serious problem, with large, dense patches. Do you think LiDAR — especially with multi-band configurations — could be effective for monitoring it, given the ability to operate at night and through cloud cover? Has NASA explored this type of application in dynamic marine environments?
Answer 29: This is a bit out of context but efforts are underway to use lidar for ocean color applications in coastal zones.

Question 30: What are the retrieval limitations of aerosol extinction profiles when using a single wavelength elastic LiDAR, and how does Raman or High Spectral Resolution LiDAR HSRL address this?
Answer 30: The limitation for elastic LiDAR is you often have to use information content from the measurement itself. HSRL and Raman allow you to measure extinction more directly.

Question 31: Is lidar data available for free on all parts of the Earth?
Answer 31: Yes, we will cover this in Part 2. NASA's data are publicly available.

Question 32: Are there any publicly available codes or software packages to process CALIPSO data?

Answer 32: Yes, please reach out to the CALIPSO team.