Part 2: Question & Answer 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 Erika Podest (erika.podest@jpl.nasa.gov).

Question 1: Does the compatibl e Python for GEDI data have to be Python version 3.7 or could it be the last version, Python 3.9.2?
Answer 1: I have only tested the GEDI Subsetter python script in Python version 3.7, however you should be able to use Python 3.9.2, as long as that version is supported by all of the python packages used in the script. However, I would recommend using the suggested python environment that I showed in the demo, which can be found in the README: https://git.earthdata.nasa.gov/projects/LPDUR/repos/gedi - subsetter/browse/README.md.

Question 2: Can GEDI be used to extract canopy height of mangroves? Has it been done before?
Answer 2: Yes. GEDI measures the heightof vegetation above the surface, so inundation (e.g. tides) will impact the estimation of canopy height. Validation of GEDI products is an active area of research, but targeted NASA LVIS acquisitions in the Pongara region (Gabon) are being used for this purpose. Dr. Lola Fatoyinbo (NASA GSFC) is a good point of contact.

Question 3: Hello, we compared the LVIS and GEDI L2A product at footprint level in Lope, Gabon. There is a significant discrepancy between LVIS RH100 and GEDI RH100 in dense forests, e.g. forests taller than 35m. And the difference between LVIS and GEDI RH100 seems highly correlated with the difference between LVIS and GEDI DTM. Which criteria should be considered if we want to exclude these footprints? Or is there any method to calibrate t hese points instead of removing them? Many thanks!
Answer 3: GEDI version 1 data uses a conservative approach for detecting signals from beneath dense canopies so the ground elevations in Gabon (for example) are likely to be higher than they should be. This discrepancy should be improved in release 2. Version 1 files do however contain the results from 5 other algorithm setting groups and

one of these may provide improved results. In Gabon, setting 5 likely improves the results.

Question 4: What will be t he difference between version 1 and version 2 GEDI data? Thank you.

Answer 4: Version 2 data will:
-have a factor of two improvement in geolocation accuracy (10 - 11m in V2 vs. 20-25m in V1)
- improved algorithm setting group selection (so predicting which o f the six height estimates per shot is the most applicable for that location);
- new ancillary land cover datasets related to water, urban, phenology and vegetation type;
-have sub-orbit granules (leading to smaller file sizes) vs. full orbit granules in V. 1.;
-have the ability to perform spatial queries in EDSC vs. unable to perform spatial queries (without using the GEDI Finder).

From a Data Access Perspective:
-Spatial metadata has been added that will allow users to see footprints of the sub -orbit granules in the map view of Earthdata Search Client. This will also allow users to spatially query GEDI Version 2 sub-orbit granules directly in Earthdata Search Client. This will make for a nice data access workflow in that a user can search for GEDI V2 data for a region of interest (spatial query), view the footprints of the sub-orbit granules intersecting the region of interest, and then use the GEDI EGI Subsetting services to subset the data and just download the specific data you are interested in (no ne ed to download source data granules).
-there are also a few new datasets including the SRTM digital elevation model, and some new land cover datasets including a Landsat water persistence layer, layers related to leaf on/off data, and urban proportion.
-We are also working on getting GEDI Version 2 data added into AppEEARS as well.

Question 5: Can GEDI data be compared and/or clubbed with flux -tower measurements to compare GPP, NEE etc. for carbon sequestration studies? Can you provide some references o n these as well?

Answer 5: GEDI data will provide useful measurements (e.g, height, effective LAI, biomass) to parameterize carbon flux and other ecosystem process models. Direct

comparison of flux tower and and GEDI observations is complicated by GEDI and flux measurement footprint size.

Question 6: Since the canopy height and biomass products from GEDI are not available yet, can one download the raw data and do processing to extract canopy height and biomass?
Answer 6: Canopy height products are available in the Level 2A and Level 2B product files. Biomass data are expected to be released in the very near future through the ORNL DAAC. The Level 1B data files however, do contain the relevant information to enable users to run/develop their own waveform interpretation algorithms and extract the geolocation information.

Question 7: Are granules the same as the tiles, like in MODIS data?
Answer 7: No. GEDI data are provided as swath data. In version 1, a GEDI "granule" includes one entire ISS orbit, whose footprint is roughly 4.2 km across track. In version 2, since GEDI is being split into sub-orbit granules, each "granule" will be roughly one quarter of an ISS orbit. Also, GEDI L1 and L2 data is really vector data, not raster data. There are Level 3 and Level 4 GEDI products coming in the future that will be gridded raster products, which will be more similar to MODIS data.

Question 8: Can you use GEDI to estimate smoke plume heights from fires or aerosol concentrations i n urban areas?
Answer 8: GEDI has not been designed for atmospheric profiling.

Question 9: Is it possible to select only specific metrics to download (e.g., download only RH98)?
Answer 9: Yes, using the GEDI EGI Subsetting Services provided in Earthdata Search Client, you can perform band or layer subsetting, which would allow you to just download RH98.

Question 10: Are there plans to allow data access through a GUI? If so, can you give info of when it's likely to be ready? And where will it be located?
Answer 10: Great question. As was shown on the ppt. slide, we are working on integrating GEDI version 2 data into AppEEARS, or the Application for Extracting and Exploring Analysis Ready Samples: https://lpdaacsvc.cr.usgs.gov/appeears/ . I do not

have a definitive timeline of when those data will be available in AppEEARS. Also, the demo of the GEDI EGI Subsetting services in NASA's Earthdata Search Client would be a GUI-based route that you can use today, and will be really well suited for once the GEDI V2 data are released.

Question 11: Do we need to join spatial data with non -spatial data?
Answer 11: Hopefully this helps answer the question, but because GEDI data are stored in HDF5 file format, the single HDF5 file will encompass all of the spatial and non-spatial (metadata) data for GEDI within a single file.

Question 12: How are researchers using GEDI data for climate change studies?
Answer 12: Key scientific motivations for GEDI are to provide a quantitative, globally consistent, and transparent assessment of the spatial distribution of carbon stocks in the world's forests at spatial resolutions relevant to monitoring, reporting, and verification of carbon stocks and flows; and predicting the f uture response of forest carbon to changing weather patterns and land management decisions. We suggest visiting the GEDI website for more information and latest references (https://gedi.umd.edu/).
Also, new members of the GEDI science team (e.g. Paul Moorecroft, Stephen Good; https://gedi.umd.edu/mission/competed -science-team/) are undertaking such analyses and may be good points of contact.

Question 13: Where is it possible to obtain the metadata?
Answer 13: Granule level metadata is stored in the HDF5 files, and each HDF5 file also includes a .met xml file with some information. For collection level information, check out the DOI landing pages, ex: https://doi.org/10.5067/GEDI/GEDI01_B.001 . You can also find Collection level metadata in NASA's Earthdata Search Client or using NASA's Common Metadata Repository, or CMR.

Question 14: H ow is the best algorithm for detecting the ground selected? Is it possible to test them to your specific study site?
Answer 14: We have used airborne lidar data sets (LVIS and commercial ALS) to develop an approach for selecting the best algorithm settings for each footprint. It is based on plant functional type, geographic region and laser return energy. If there is

coincident airborne data available for your site of interest, you can verify or fine tune the selection. All the algorithm setting results are available for each laser shot.

Question 15: Are there gaps in GEDI data for sloped areas or mountainous regions?

Answer 15: There shouldn't be gaps in the GEDI data over high-relief or mountainous terrain. However, use the quality flags to assure that you are only using high-quality returns over those regions. Be mindful that the uncertainty will increase over high slopes.

Question 16: Does GEDI and the DEM use the same geoid or datum? Is it possible to use a DEM with a different datum and then the GEDI data does not line up?

Answer 16: The DEM data in the GEDI data files have been adjusted to use the same reference frame as GEDI. Which is WGS84-ellipsoidal. If you are using an external DEM, then you should translate it to be WGS84 otherwise you may end up with both vertical and horizontal offsets in your comparisons.

Question 17: would GEDI be useful for crops canopy or would it be more useful for larger vegetation like trees?

Answer 17: GEDI is more useful for woody vegetation. It is less useful for crops.

Question 18: Could you comment on the Global Forest Canopy Height which is an extrapolation of GEDI with Landsat to create a continuous canopy height model.

Answer 18: That was led by the GLAD team at UMD. There are limitations, such as saturation above 30m height. It was the first demonstration of combining GEDI with Landsat for mapping canopy height.
(Hansen et al; combining optical with version 1 data).

Question 19: Can you elaborate more on how GEDI data can be used in post-disaster damage assessment?

Answer 19: GEDI captures vertical structure of vegetation so you can use pre and post disturbance crossover points to detect if the vertical structure has changed. Other changes, e.g. topographical, can also be assessed.

Question 20: Does the Python script have to be in the same directory with the downloaded GEDI data?
Answer 20: It does not need to be in the same directory as the downloaded GEDI data, as you can use the -dir argument to point to the directory containing the downloaded GEDI data.

Question 21: Are ICESat -2 and GEDI tree height data comparable?
Answer 21: GEDI is designed to measure canopy height. ICESat-2 and GEDI measure in different ways with GEDI being full waveform and ICESat-2 being photon counting. This is an active area of research, so stay tuned!

Question 22: Can GEDI be used to create above -ground biomass/carbon maps?
Answer 22: Yes, and in fact the first GEDI maps will be available soon. This is a primary objective of the GEDI mission.

Question 23: How do you find the accuracy of GEDI derived forest canopy height on the ground?
Answer 23: The accuracy is determined by comparison to existing airborne lidar sets, LVIS and commercial ALS, but to do this comparison we account for geolocation uncertainty and derive equivalent height metrics. Open source software to simulate GEDI waveforms and collocate these with airborne lidar is available (see https://doi.org/10.1029/2018EA000506). LVIS data are available to download from NSIDC and Earthdata (links are provided at https://lvis.gsfc.nasa.gov)

Question 24: Can we access the GEDI data in Google Earth Engine? If not, is there a plan to ingest it? Thanks.
Answer 24: From a DAAC perspective, I am unsure if those data are in GEE. And I do not know if Google plans to ingest it. There is a derived GEDI dataset in GEE (release 1 data). Sean Healey (USFS; GEDI Science Team) has published some of the release 1 data on GEE (see https://doi.org/10.3390/rs12172840).

Question 25: I was wondering, have any accuracy assessments been performed in mountainous regions for GEDI data such as the Himalayan region?

Answer 25: GEDI data are compared with airborne lidar over regions where data exist, but it doesn't include the Hi malayas at this time. We have compared GEDI to LVIS data over mountainous terrain in the US, Canada and Costa Rica.

Question 26: Hi! I want to ask that I have different tree species location data and I want to find their canopy height. Is it possible to u se the GEDI dataset with the location data of tree species to find their height and canopy height parameters?
Answer 26: It is possible to co-locate GEDI data with airborne LiDAR data, which needs to be done to account for geolocation uncertainty. GEDI is also a sampling mission, so there may not be GEDI measurements available at the locations of field measurements.

Question 27: Are clouds considered in the quality flag?
Answer 27: Yes. Clouds are filtered using the Land surface flag and are a part of other quality flags as well.
GEDI L2 User Guide has good information on the interpretation of the quality flags: https://lpdaac.usgs.gov/documents/589/GEDIL02_User_Guide_V1.pdf

Question 28: What is the exact size of GEDI footprint?
Answer 28: The nominal laser footprint diameter is about 25m. Laser footprint size is determined by the laser beam divergence angle and the altitude of GEDI above the surface. The nominal laser divergence is 56 micro radians, measured at the 1/e^2 point of the 2D gaussian energy distribution (the standard definition of laser footprint size). For example, from an altitude of 400km, the GEDI laser footprint is ~22m in diameter.

Question 29: Can we use version 1 data in AppEEARS?
Answer 29: No. We are planning on adding GEDI Version 2 into AppEEARS in the future.

Question 30: As explained, the temporal resolution is dependent o n the ISS, but what is the usual revisit time?
Answer 30: I really don't know that there is a "usual" revisit time --certain areas will never be sampled, certain areas will be sampled once, and certain areas will be sampled many times over the lifetime of GEDI. Due to the ISS orbit as you approach 50 N/S you will see the frequency (and density) of returns increase. Less observations near the equator.

Question 31: What are the expected spatial/temporal resolutions for the L3/L4 products? How often do you ex pect one or more beams to sample each pixel?
Answer 31: Spatial resolution of L3/L4 products are 1 km. It depends on cloud cover. As the mission progresses, we will get better coverage on that 1 km grid. Because of gaps in coverage, some areas will not have coverage.

Question 32: How do you generate gridded products from GEDI footprints metrics?
Answer 32: Our initial release 1 gridded products are for ground elevation and canopy height (rh100) metrics and for release 1 these are simply the mean and standard deviation value for a 1km cell. We plan on more sophisticated approaches for subsequent releases, as well as expanding the gridded products we are providing.

Question 33: Can we categorise different plants using GEDI? Is it possible to use GEDI to dist inguish different vegetation class types (like differentiate orchards from olives or forests)? Can version 1 GEDI be used for classifying different vegetation structures?
Answer 33: In principle, yes. How well they differentiate between vegetation types w e have yet to see. It will depend upon the differences in vegetation types.

Question 34: Can we bulk download GEDI data over ROI using shapefile instead of using the bounding box?
Answer 34: Yes--the workflow that I showed in Earthdata Search Client for bulk downloading version 2 can also be used with an ROI--I believe that you can drag and drop a shapefile or geojson directly into Earthdata Search Client. Again, you will need to wait until GEDI Version 2 data are publicly available though.

Question 35: How do we filter the GEDI data for day and night?
Answer 35: You can use the solar_elevation dataset, and filter any shots with values less than zero, meaning that the shot was acquired at night. Positive values indicate day time acquisition. L2 User's Guide has the details:
https://lpdaac.usgs.gov/documents/589/GEDIL02_User_Guide_V1.pdf

Question 36: Do we ne ed to combine the L1A data with L2A/L2B to generate tree height?
Answer 36: The L2A/B data contain our estimates for tree height derived from the laser waveform. But if you're interested in developing new algorithms and approaches to do this, or develop new data products, then the L1B dataset contains the information you need.

Question 37: Does it make more sense to think of the 5m height variables as integrations over an elevation range (i.e., from 10m to 15m above ground) or as very thin cross -sections?
Answer 37: The vertical profiles are cumulative profiles.

Question 38: What is the vertical accuracy of GEDI?
Answer 38: From comparisons to airborne LVIS data, we see 2-3m range for RH98. A large part of this is horizontal geolocation error and the fac t that canopy height varies over very short scales. It will improve as waveform processing and footprint horizontal geolocation accuracy improves. The waveform is vertically geolocated to an accuracy of 0.3-0.5m and will improve in future releases. The shot to shot range precision over flat ground is on the order of a few centimeters.

Question 39: Is GEDI suitable for reed vegetation studies? Would GEDI be useful for monitoring vegetation loss on rangeland and transhuman corridors?
Answer 39: It can be difficult to separate canopy and ground in that environment. Reed vegetation is primarily found in water and inundation can affect the estimation Non-woody canopy can be difficult.

Question 40: Can we use GEDI data for bathymetry? Any examples of erosion monitoring in estuaries?
Answer 40: No, 1 micron data does not penetrate water.

Question 41: Which data level/attributes would you recommend to derive a measure of ecosystem complexity?
Answer 41: Vertical profile, a parameter called Foliage Height Diversity.

Question 42: Is the lifetime short duration of the equipment on the ISS relate d to upgrades to the equipment (e.g. tunable lasers)?
Answer 42: The mission life of GEDI is designed to answer the science questions. GEDI does have a finite life that will hopefully continue into 2023.

Question 43: Can the LiDAR above ground biomass mod el developed from airborne lidar be applied to GEDI directly?
Answer 43: We have trained GEDI above ground biomass models against simulated GEDI waveforms using a global database of field and ALS data. It depends on a number of details, but if you have a model that only has top canopy height as a predictor and was trained at the same spatial resolution of GEDI, it may be applicable. Generally it will be more complicated because the same lidar metrics may have different interpretations between airborne lidar and GEDI waveforms

Question 44: What is the geolocation accuracy of GEDI? Is there a way to correct any geolocation errors with the current version?
Answer 44: The Version 2 mean 1-sigma horizontal geolocation error is 10.3 meters (compared with 20.9 meters for Version 1).

Question 45: As GEDI works in 1064 nm and ICESat -2 works on 532 nm, is there any advantage of GEDI so far as forest studies are concerned?
Answer 45: GEDI was specifically designed for high quality measurements of vertical canopy profiles and canopy height. Canopy foliage has higher reflectance at 1064 nm (GEDI) compared to 532 nm (ICESat-2).