Question & Answer Session, Part 1

Please type your questions in the Question Box. We will try our best to answer all your questions. If we don't, feel free to Zach Bengtsson (bengtsson@baeri.org), Amber McCullum (amberjean.mccullum@nasa.gov), or Juan Torres-Pérez (juan.l.torres-perez@nasa.gov).

Question 1: Does GEE charge for commercial use? What are the costs? Are there additional features?
Answer 1: I believe that GEE is not officially available for commercial use at this point. This will likely change, and private commercial organizations may be charged for the use of GEE. All available features of GEE are available through the free accounts and you can usually contact the developers if you need more space allotted to your account.
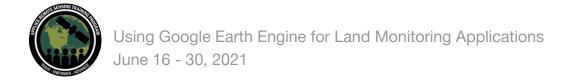
Question 2: What is the time lag from the time an image is collected by the satellites to the time it is made available in the GEE data catalogue? I am asking this question because I am thinking of using GEE for real time vegetation condition monitoring where I would want to Create a GEE app.
Answer 2: Processed imagery, like a Landsat surface reflectance product, should be available within a few days of imagery capture. It depends on the particular product, but I believe the standard is no later than 3-4 days after the imagery is released by the organization that distributes the data (like NASA or ESA). The intention of GEE is to provide as many NRT products as possible, with collection of these datasets being automated.

Question 3: Can we create shapefiles using GEE? If yes, can you please show a demonstration?
Answer 3: You can create shapefiles using GEE. Normally you would create a geometry in the interface as a feature collection and then use the Export.table function to export the feature collection as a shapefile. For more information about how to do this, use these instructions provided by the GEE developers:
https://developers.google.com/earth-engine/guides/exporting

Question 4: Is there integration between GEE and github?

Answer 4: I'm not sure about direct integration between GEE and github, but there is an active group of GEE developers on GitHub, with a variety of scripts and tools available in GitHub. You can find repositories from this group here: https://github.com/gee-community

I've also seen a variety of GEE codes hosted on GitHub, including direct links to the code in the JavaScript API (organization by organization basis).

Question 5: What are the limitations of JS codes using GEE over Python in functionality?

Answer 5: JavaScript is currently the primary API for engaging with GEE. So while I don't believe that there are many differences in potential functionality, the current GEE developer community tends to favor the JavaScript API. Which means there are usually more available scripts and tools for use in the JavaScript API. The Python API also requires an intermediate platform, like Colab, rather than the direct engagement possible with the JavaScript code editor. It is mostly based on your personal preference.
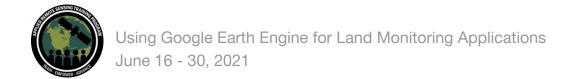
Question 6: Can you please explain the difference between top of atmosphere and surface reflectance datasets of landsat and sentinel? Which data set is recommended for applying image classifications and indices?

Answer 6: Top of Atmosphere data does not complete an atmospheric correction to eliminate the influences of the atmosphere. Surface reflectance data does complete this correction, so the reflectance data is more representative of the reflectance of light directly from the surface of the earth. We typically recommend using surface reflectance products since they account for the influences of the atmosphere.

Question 7: Can we change the coordinate reference system in GEE?

Answer 7: GEE is designed to take into account the projection of data on a product by product basis. But you should be able to change the coordinate reference with the projection information here: https://developers.google.com/earth-engine/guides/projections

Question 8: Can shapefiles generated by the user from platforms such as ArcGIS or QGIS be used for information queries?

Answer 8: Yes! These shapefiles will just need to be uploaded to GEE as assets. You can take any shapefile you are interested in using and you can upload it as an asset in GEE. We will show a more in-depth example during next week's session.

Question 9: Can I perform data fusion for multi-sensor in GEE?

Answer 9: The short answer is yes. I believe there are a variety of ways to do this depending on your data inputs, but this is a little beyond the scope of this session. It doesn't look like there are any GEE developer resources officially available for this, but take a look at this study which uses simple fusion techniques in GEE: https://www.mdpi.com/2072-4292/12/23/3900/pdf

Question 10: Can I integrate the GEE API with some web application to display the results?
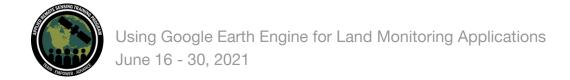
Answer 10: You have a couple of options here. You can display results directly in the map section of the JavaScripts API, and you can even code a graphical user interface so the user just has to run the code and can then point and click through the results. You may also choose to develop a GEE app, which I believe can be embedded on webpages to make them more accessible. On the slide referring to mangroves in the presentation, there are two links that will take you to GEE apps for your reference.

Question 11: Does the code editor allow for collaborative editing (i.e., can be shared amongst different users and track the changes)?

Answer 11: Yes. The code editor allows you to share snapshots of code, like we've done today, or the code file so multiple editors can change the same script. However, this editing cannot be done simultaneously. Version control is the closest you can get to collaborating on a piece of code.

Question 12: We can upload our own data, interesting. How much data? How do we upload it? Are there proprietary constraints? Is there a space limitation for upload? Can we also upload external spatial data that is not imagery and use it for modeling in GEE (like .tif or grid files)?

Answer 12: Yes! You can upload your own imagery and other data sources as assets in the GEE platform. I don't believe there are any proprietary constraints since you can keep your assets private. Space is limited per account, but you can usually contact the GEE developers to ask for additional space. There are a variety of non-imagery based products already available in GEE, and you can also upload any additional data. This is

usually done by uploading a CSV file as an asset. After uploading the asset, it can be kept private unless shared or made public.

Question 13: Is it ok to not have any info in Scripts and Assets while using the code.google link?

Answer 13: You shouldn't have had any issues since the code in the editor contains all the info you need to complete this exercise. Since everything is sourced directly from GEE, there should not be an issue with sharing. But in other scripts you could run into potential issues with assets if they are not made public or shared with you.

Question 14: For Landsat data, how can we check whether we are accessing Collection 1 or Collection 2 data set? Can we access both in GEE?

Answer 14: You can check all metadata from the data you are using in the catalog window. You can also use the print() function to view metadata. I believe the Landsat data in GEE is sorted by collections 1 and 2, depending on the dataset you're using.
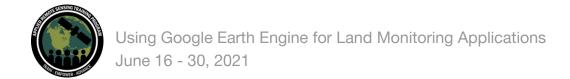
Question 15: What is the difference between Landsat 8 Surface Reflectance Tier 1 and Tier 2?

Answer 15: The difference between 1 and 2 is based on quality. The images of the best quality with the least amount of cloud cover are in tier 1. Tier 2 images are still good quality, but usually have more influence from clouds (cloud cover and shadow). When working with surface reflectance products, there are cloud masking and QA bands to consider that can help you filter pixels for optimal quality.

Question 16: Are the atmospherically corrected data ready for analysis to publish in peer-reviewed journals?

Answer 16: Surface reflectance imagery is typically ready for your own analysis, and as long as the atmospheric correction is adequate for your work, you likely won't need to do more pre-processing. But this depends on your study area. For example, if you are using Landsat data for something like a body of water, proceed with caution since Landsat surface reflectance products are typically processed using land specific atmospheric correction procedures.

Question 17: If a user uploads their own imagery for analysis through GEE, is this imagery only available to them?

Answer 17: The short answer is yes! Once you upload an asset to GEE it is kept private to your account. But you can make the asset public or share it with other individual accounts if you choose to do so.

Question 18: I want to learn GEE. I have zero knowledge of programming, zero knowledge of Javascript. I am trying to learn Jupyter notebooks. I don't have a computer science background. Should I start learning GEE using Python or Javascript?
Answer 18: It depends on your preference. If you like Jupyter Notebooks, I would suggest looking into the Python API in Colab. However, you'll likely find more learning resources in the JavaScript API, since this API has been around longer and is the API of choice for many GEE developers.

Question 19: Does the filter point tell GEE where the center of the landsat image should be?
Answer 19: The filter point selects the Landsat tile which contains the chosen point. If you filter by point, GEE will select the spatial bound around that point and in our example, the tile covers most of our area, but that is not necessarily common. It's more likely that your region of interest will include multiple Landsat tiles. So in this case, you would want to filter by a geometry or shapefile uploaded as an asset to get imagery coverage of the entire area.
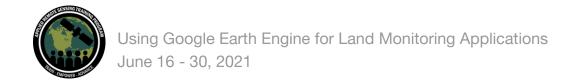
Question 20: Will we be covering the Machine Learning approach in the course?
Answer 20: Yes. We will be covering machine learning algorithms available in GEE and the Random Forest algorithm in a little more depth during our next session.

Question 21: Are the images atmospherically corrected?
Answer 21: The images used in this activity are atmospherically corrected since they are from the Landsat 8 surface reflectance tier 1 image collection.

Question 22: Here in var image, we select the first image of the collection, but how do we select the 2nd or 3rd image from the collection?
Answer 22: This isn't necessarily a typical way that we filter. In this example, we were looking for the highest quality image and we filtered for the highest quality image with the least amount of cloud cover, so we were able to use the .first function. In other analysis, you would likely want to select a single data, or create a composite over a number of months or for a single season.

Question 23: is there a certain order of the arguments - location, date, cloudiness, etc. - or can they go in any order?
Answer 23: There is not necessarily a specific order you have to go into. We first load the imagery and then apply all of our filter parameters. In a workflow sense, we recommend filtering by location, date, and then other quality metrics.

Question 24: How do you merge/analyze imagery with different spatial resolutions?
Answer 24: You can resample and reproject data to reduce spatial resolution. Check out this GEE developer link to see how these functions are used:
https://developers.google.com/earth-engine/guides/resample
If you were using data from Landsat and Sentinel-2, for example, you would want to resample and reproject the Sentinel imagery to 30m to match the Landsat data.

Question 25: Selecting the near-infrared and red bands and then using the .normalizedDifference() function, like what we're doing here... is that only when our dataset doesn't have its own NDVI band?
Answer 25: If your data already has a NDVI band, use the NDVI band. The .normalizedDifference() function has a variety of uses, including the calculation of NDVI. This was a way for us to show you how to calculate a normalized difference index. Normalized difference indices are also used for estimation of cover types like snow, soil, and water, so this function is helpful in calculating a series of indices useful for land monitoring.
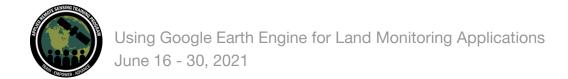
Question 26: Is there a resource similar to R's CRAN manuals with a glossary of functions?
Answer 26: On the GEE Code Editor, the "docs" tab can be used to show all of the available functions and their purposes. You can also refer to the API guides provided by the GEE developers here:
https://developers.google.com/earth-engine/guides

Question 27: With GEE, can I do gifs?
Answer 27: Yes! Here is an example of how to do this using MODIS data:
https://developers.google.com/earth-engine/tutorials/community/modis-ndvi-time-series-animation

Question 28: Can you elaborate on the EVI formula used in the code? Why is there a function for NDVI but not for EVI in GEE? Could this be added by someone and shared? For calculating NDVI in GEE, is it better to work with Surface Reflectance or Top of the Atmosphere images?

Answer 28: EVI is another way of using band combinations from Landsat to estimate vegetation. EVI is different from NDVI in that it uses the near-infrared band, the red band, the blue band, and a set of constant values to complete vegetation assessments. EVI is typically better for measuring vegetation in more densely vegetated areas. There are a series of EVI products in GEE, but they do not have active support. The calculation is more complex, so there is not a function for it in the same way as there is for the ubiquitous normalized difference index. I don't believe you can create a function and share it in the way you are asking, but by establishing an expression in your code, you can use this expression more easily within your code. We recommend surface reflectance products for calculating NDVI because these products eliminate most atmospheric influences.

Question 29: How can I export this NDVI within a boundary (e.g., I have a vector file boundary of a specific county here and I want the NDVI, exported just for that)? Many thanks :)
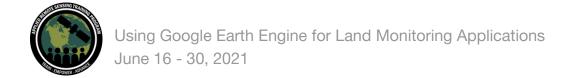
Answer 29: We can filter the bounds of imagery using the .filterBounds() function. You'll need some sort of geometry to filter by, which in your case is a vector file. You would want to ensure the vector file is uploaded as an asset. You can import this asset into your code and then use it along with the .filterBounds() function and .clip() function to display maps only for your region of interest. We'll go over this more in depth in session 2.

Question 30: The classifiers in GEE are mainly for classification of images. Is there any code or material to implement regression (RF or SVM) in GEE? Please do share if available

Answer 30: We will go over additional algorithms next session, especially those that utilize machine learning. So make sure to attend. There is also a slide in this session's presentation portion that will direct you to some useful resources, but here are a couple you might find helpful:

Machine Learning in GEE: https://developers.google.com/earth-engine/guides/machine-learning

Supervised Classification in GEE:

https://developers.google.com/earth-engine/guides/classification

Question 31: In which cases is better to use GEE before a GIS software or other earth imagery analysis processing language?
Answer 31: GEE is great for those that have computing limitations since all of the processing is done in the cloud versus on local hardware. There is not a specific reason to use one over the other, once again it is all about personal preference in regards to both software and what coding languages you may want to utilize. However, GEE can also act as an easy to use platform to search for, filter, and download imagery products in a way that most desktop GIS platforms cannot.

Question 32: Would analysis/classification need to be done for each image tile separately? Or can imagery be mosaicked together for further analysis?
Answer 32: You can mosaic imagery together to get full spatial coverage of your region of interest, so there is no need for separate processesing.

Question 33: How can we get statistics of the maps created by us? Is GEE capable of producing graphs/charts/tables with results of the various analyses?
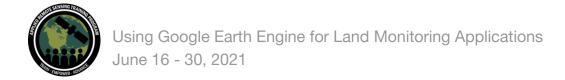Answer 33: Yes. GEE can produce figures for your analyses. We'll go over a few ways to visualize data in GEE later on, but here is an overview of GEE's data visualiztion capabilities: https://developers.google.com/earth-engine/guides/charts_overview

Question 34: How can you add a color bar to the maps? A legend?
Answer 34: Adding a legend is a user interface function. It's a little more complicated than you might be expecting, since you have to establish all of the graphics and positioning for display on the interface map, but make sure to attend our second session where we will show how to do this in detail.

Question 35: Is there a shortcut to commenting and uncommenting several lines of code at once in GEE?
Answer 35: Yes, there are 2 ways to do this. The firs is by placing a "/*" at the beginning of the lines you want to comment out and a "*/" at the end of the lines. The second is to highlight all the lines you want to comment out and use the key command Ctrl + / (on Windows) or Command + / (on Mac). These key commands can be used to comment and uncomment lines.

Question 36: Is it possible to change "the var" from point to polygon if we want to process some specific area?

Answer 36: Yes, but you will need to have a polygon to call upon. You can either upload a shapefile as an asset to establish a specific area or create a polygon directly in GEE using the draw polygon tool.

Question 37: How can we apply the expression as EVI and SAVI for a date interval (collection) and not for a single image?

Answer 37: You can choose to apply the EVI and SAVI to every image within the image collection of chosen dates. Or you can reduce the image collection to a mean or median. This takes the average or median of every pixel over your chosen time series, and then you can apply these calculations to the average or median image. Make sure to attend session 3 where we will go over a similar time series example.

Question 38: Is it possible to establish the variables before calculating the indices once and for all?
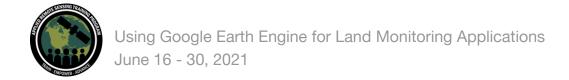
Answer 38: You can establish any variables at any time but you'll need to include the correct band data before actually applying variables to calculate the indices.

Question 39: The output for the EVI Collection Image (January-May) doesn't look different from the original output of the EVI Image (May only). Would we normally expect to see a difference, or is that just dependent on location, phenology, timespan, etc.? (Mostly, I'm just surprised to not see a difference between 1- and 5-month outputs.)

Answer 39: This was a very simplified way of mapping EVI. The similarity you're picking up on is likely due to May representing the greenest month within the series. May only has the greenest pixels compared to prior spring/winter months. There is also less seasonal variation in vegetation in the Bay Area than many other parts of the US. Both of these factors likely result in the average image looking similar to the May only image.

Question 40: What's the best way to filter imagery to have uniform lighting? I've come across certain areas where one image is brighter and thus generating mosaics becomes very difficult.

Answer 40: I have encountered this using top of atmosphere reflectance data, but I don't usually run into the same issue for surface reflectance data since atmospheric

influences are corrected for. Using surface reflectance products might help with this issue.

Question 41: In the example, the speaker chose a specific date for imagery that has the less cloud cover. I assume we have to identify it ourselves by looking at the imagery collection we'll use?

Answer 41: The way we actually filtered was using the cloud cover band in the Landsat 8 surface reflectance product. So we were able to establish a target time range, and then use cloud cover information to pick the least cloudy image. This type of filtering can save you from having to visually filter imagery.

Question 42: If I want to use the same code for another area like (60.478, 44.301), it is not sufficient to change the center map point. What else has to be changed?

Answer 42: If that is your only point of interest, you just have to change the very beginning part (basically just replacing the lat long values with your own) of the code to adapt to your specific use case.
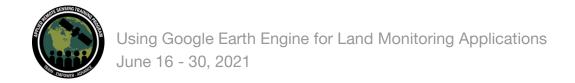
Question 43: In this example we have 7 images of the region. How could I display all 7 images to assess them individually? Can you go over the dynamics of a feature collection and a single image?

Answer 43: If you are interested in mapping all 7 images, you would apply any of these expressions to the full Image Collection rather than just to a single image. After this is complete, you can display the vegetation estimations for any and all of the 7 images. We will be covering this more in depth in the last session. For more information about feature collections, check out this GEE developer page:

https://developers.google.com/earth-engine/guides/feature_collections

Question 44: I would be very happy if you include how to import and use training points for classification and accuracy assessment in gee. Would you include it?

Answer 44: We will be going through land classification and accuracy assessment in Part 2. Please join us next week! Same time, same link.

We will have the recording from Part 1 up on the training's webpage here:
https://appliedsciences.nasa.gov/join-mission/training/english/arset-using-google-earth-engine-land-monitoring-applications within 48 hours for you to view and go through at your own pace.

Additional Google Resources:

https://developers.google.com/earth-engine/tutorials/tutorials

https://developers.google.com/earth-engine/tutorials/ttt