



Question & Answer Session, Part 3

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 reach out to Zach Bengtsson (bengtsson@baeri.org), Amber McCullum (amberjean.mccullum@nasa.gov), or Juan Torres-Pérez (juan.l.torres-perez@nasa.gov).

Question 1: Could you please better explore the differences LinearRegression reducers types applied over image collections? Do they provide different results (slope values and/or error band for example)?

`ee.Reducer.linearFit()`

`ee.Reducer.linearRegression()`

`ee.Reducer.robustLinearRegression()`

`ee.Reducer.ridgeRegression()`

Answer 1: If you use a different reducer, you'll get a different result. Choosing a reducer depends on the statistical needs of your project. So it's up to you to decide how your data should be processed. Take a look at this GEE developer page about reducers (which also includes a link to regression reducers):

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

Question 2: Is there any quota/limit for computing power per GEE user? How long may analyses like the one on slide 11 take to process on GEE?

Answer 2: There is a user limit on processing in GEE. You'll receive an error if you have reached this limit. Processing time in GEE is usually much quicker than that of your own computer. I can't necessarily speak to the time it would take a project like the one on slide 11 to process, but I would imagine processing time per land cover map would not vary much from our land cover example last session, given the size of the study area. However, the whole time series might take a while to process. In a case like this, you might need to run the classification a few years at a time to avoid memory limits. You can always break up your analysis and processing to avoid memory limits!

Question 3: How do we harmonize the analysis when using e.g., combination of Landsat 5 and 8 in time series analysis?

Answer 3: There are methods for harmonizing data from different sensors in the Landsat series using GEE. Here is a link of how to do this from the GEE developer website:



<https://developers.google.com/earth-engine/tutorials/community/landsat-etm-to-oli-harmonization>

Question 4: The graph showing 1986 values of NDVI, which dataset is used to get for 1986 NDVI values?

Answer 4: This graph was created using Landsat NDVI. The Landsat series includes 30m resolution data going all the way back to 1982 I believe. The fire event in question happened in 1988.

Question 5: How do you conduct multi-date land cover classification in GEE for land cover change detection? Do you need training data for each of these dates?

Answer 5: Yes, you would need training data for each of these dates. However, there are methods for integrating tools like LandTrendr into your analysis to better automate your classification. Take a look at these papers:

<https://www.mdpi.com/2072-4292/12/18/2883/htm>

https://www.sciencedirect.com/science/article/pii/S0924271619302400?casa_token=WARBL698sQwAAAAA:bvQILSZwN3Lay3Uf1_0qFCoH72q5MhfnOH7SLb00PqurhaAEVFOHHkiArP3ZDB_pvNHSBFroPA

Question 6: Not sure if this will be covered, but is it possible to show or send a link to code to export the image results and/or time series to use in other software (e.g., QGIS, ENVI)?

Answer 6: We go over how to export yearly EVI tif files in our code activity! These files can then be used in your preferred desktop GIS. The default file type for GEE export is GeoTIFF.

Question 7: Is it possible to demonstrate an NDVI chart for big area changes over the years?

Answer 7: Yes! Take a look at the link from slide 16 (MODIS NDVI line chart) here:

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

Question 8: Could you recommend methods for object-based change detection, as opposed to pixel-based change detection?

Answer 8: A good place to start is the object-based methods page from the GEE website here:

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



Question 9: Is it possible to set a seed within GEE for analysis involving random components that you would like to repeat exactly?

Answer 9: When looking for a random selection of data points, GEE will perform these analyses on a case by case basis. If you're running a classification in GEE, there is a parameter for a seed. As long as you are using the same number, it should repeat, but will define a random seed if left blank.

Question 10: How do you use multiple datasets to create your image collection?

Answer 10: You can use concatenate to combine multiple dataset for an image to classify. For example:

```
ee.Image.cat(LANDSAT_COMPOSITE, SENINTEL_COMPOSITE)
```

Merge also works:

```
ee.ImageCollection(1e7.merge(1e8).merge(1e5))
```

Question 11: What does it mean when it says "This asset is depreciated" when you hover over the Landsat name?

Answer 11: A new Landsat dataset just came out, so future support for Landsat data will be occur through this new dataset. Unfortunately, this new dataset came out on GEE just as we created these activities, so we weren't able to incorporate them. Our code will still work if you replace the ImageCollection import. You'll just want to make sure to update your cloud/cloud shadow bit masking and band labels. The new Landsat 8 dataset can be found here:

https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C02_T1_L2

Question 12: How do you know when to divide by 10000 to scale for reflectance? Do you ever need to divide by a different number? What does it mean to "scale for reflectance"?

Answer 12: Each sensor should have information about the scale required. For example, Landsat's scale for reflectance can be found on the USGS website:

https://www.usgs.gov/faqs/how-do-i-use-a-scale-factor-landsat-level-2-science-products?qt-news_science_products=0#qt-news_science_products

Scaling for reflectance means scaling the dataset so it is in absolute units. This allows direct comparisons to other datasets. Imagery in Earth Engine are scaled differently and have their scaling factors reported.



Question 13: Is the "step list" function acting as analogous to a "for" loop? like for years 2014 to 2020, do this for every year?

Answer 13: This is the right way to think about this, it isn't a for loop, but it applies our chosen years across the image collection. The end result of using this "List" function and the filtering and masking function we've added after this gives us seasonal composites for each year from 2014 to 2020. It uses a map function to do this. It is best not to use a traditional for loop in GEE (as it was not made for that).

Question 14: In line 28, for the function(year), where did "year" come from? How do I find where that variable is defined? So if I wanted to filter by something else, such as month, where would I go to find what those options are?

Answer 14: Year is in reference to any year within the image collection. We sorted from May 1 - September 15 for each year.

Question 15: Is it possible to plot a chart with multiple datasets? For example, different precipitation products on the same chart.

Answer 15: Yes! In this case you would be plotting multiple bands of an image collection. An example of this can be found here, on the Image Collection Charts page: https://developers.google.com/earth-engine/guides/charts_image_collection

Question 16: Is there a way to control the resolution of output images in the image collection from within the functions?

Answer 16: Yes, you would want to change the scale of any outputs that you're interested in. Take a look at scaling in GEE here:

<https://developers.google.com/earth-engine/guides/scale>

You can also adjust the scale in your export of an image. For example, in line 112 of the code in our activity you could change the scale to something other than 30 to scale the exported image differently. GEE has a sort of "dynamic" scale that is based on zoom level. You can define a set scale, but that is done to check if your imagery is working as intended within your analysis.

Question 17: Is there an undo? I accidentally just erased 5 lines of code.

Answer 17: Yes, you can use "Ctrl + Z" on windows and "Command + Z" on mac to undo.

Question 18: Is there a citable reference/background publication for this methodology that is being presented?



Answer 18: There is not a specific background publication for this methodology. This activity is a compilation of techniques and functions meant to be a broad overview of how to manipulate data within GEE. We go into a lot of functions within this code to show you what's possible, but you should always do your own research when completing analysis to see what works best (and is most scientifically sound) for your study system. Here is an example of some of the publications used when creating this code:

EVI - <https://www.mdpi.com/1424-8220/7/11/2636>

Standard Anomaly Calculation -

<https://www.frontiersin.org/articles/10.3389/fenvs.2019.00187/full>

There is also a citation on the webpage.

Question 19: Can you not just clip the entire collection at once instead of year by year?

Answer 19: You can use `.filterBounds()` on an entire collection, but for an image you have to use `.clip()`. Clipping imagery is a computationally expensive task to run, so clipping should be kept to a minimum if possible.

Question 20: In the code, the part you choose the EVI image for each year (lines 60-90), is it easier to do this in a loop or is it not possible? I have more than 30 years of images. It will be complicated to write this for each year.

Answer 20: GEE doesn't use loops per se, but you could create a function that adds the year of data collection as a band to the collection. You could then use this to write another function that calculates median EVI for each year. You could filter it into a table and export the data.

Question 21: Is it possible to export the image collection, all the images that are part of the time series at the same time?

Answer 21: You could try exporting the image collection, but there is a high likelihood that you would exceed the user memory limit for the export function. If you run into this issue at any time, you can always separate your exports into sections to download incrementally. Splitting up the export will not affect the end result.

Question 22: Where is the legend? Why not use different colours to show different features more clearly, rather than just different shades of green (or is this possible?)

Answer 22: We went over coding a legend in the interface last session. This is quite a bit of code, so we did not include it here for time reasons. However, we are aware of the simple color scale in this case, so we can interpret change in our maps. You can use a more complex color palette in your own work, but for our purposes in this short



session, we kept it simple. Take a look back at session 2 to see how to implement a more complex color scale.

Question 23: When displaying each layer (like you did with each year of EVI), are the layers overlapping so that you can see the actual overlap? For example, if 2014 EVI had a really dark green patch, and then you turn on the 2015 EVI layer and that same area is replaced with light green patch, would you be able to see that overlap? Or when turning on each layer, is it displayed as if the layer has no background layers on (and you wouldn't see any overlap in the green areas)? Hopefully this makes sense.

Answer 23: Layers display one on top of another, not additively. The layer closest to the top will be the one displayed, and you can check and uncheck them in the layers tab to view each layer.

Question 24: In GEE, how can we create line charts of time series over polygons/areas or lines rather than points?

Answer 24: You can change the region in lines 120 or 128 of the code to call a polygon rather than a point. This will reduce the EVI over the extent of the polygon and plot the average value.

Question 25: What is the maximum size of imagery in square kilometers, with respect to the Area of Interest (AOI) we can analyze within the GEE memory limit? What is the maximum area that we can have when exporting?

Answer 25: This will depend on the data you are using. Bigger, high resolution data is more memory intensive. Likewise, more complicated analyses can hit the memory limit quicker. There are ways around this, like exporting imagery for a land cover classification as an asset and then running your analysis.

Question 26: Is it possible to see the exact dates of the images that contributed for a EVI seasonal band created?

Answer 26: Yes, you would likely want to separate your filtering year by year, and then use the print function to examine which specific dates each yearly composite is made from.

Question 27: Is there a way to fill the gaps in a time series? Maybe if my area of interest had high cloud cover throughout the year.

Answer 27: You might be able to use data from another sensor to supplement your primary dataset. For example, you could supplement data from Landsat 8 with imagery



from Sentinel-2. If cloud cover persists as an issue, you may want to consider using radar data, like Sentinel-1 SAR, since radar can penetrate clouds.

Question 28: Z-score for anomalies hinders time-lag effects on the change. How do you deal with this anomalies approach when anomalies are fixed comparing recurrent dates? Are there other anomalies used for analyzing anomalies?

Answer 28: Z-score is not the only method for analyzing anomalies. You may find that comparing single dates or years to a long term average works better for your purposes.

Here is a paper that describes a couple of other methods for examining anomalies:

<https://www.frontiersin.org/articles/10.3389/fenvs.2019.00187/full>

Ultimately, you will need to conclude which statistical methods work best for your specific needs.

Question 29: Can we filter outliers in time series with GEE?

Answer 29: Yes. If you determine that values beyond a certain threshold are “outliers” and should be excluded from further analysis, you can mask them out. This means you would need to complete additional filtering steps to mask pixels above or below a certain value.

Question 30: With the simple image differencing, is it possible to have areas of change and areas of no change, rather than having 3 classes? And could you please clarify the 3 classes once again? The red represents areas of change, right? What about the yellow and green?

Answer 30: Red and green areas in this example are areas of change (negative and positive change in EVI). Yellow areas represent areas that are relatively unchanged. Image differencing in the case of a vegetation index, like EVI, shows change in either direction as well as those areas that did not change.