



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 Erika Podest (erika.podest@jpl.nasa.gov), Amber McCullum (amberjean.mccullum@nasa.gov) or Juan Torres-Peréz (juan.l.torresperez@nasa.gov).

Question 1: I am quite confused between Radar & Microwave. Is it the same?

Answer 1: SAR is a type of active data collection where a sensor produces its own energy and then records the amount of that energy reflected back after interacting with the Earth. Radar data are collected in the microwave portion of the electromagnetic spectrum. So SAR (a type of radar data) is the active data collection of microwave data. Here is a nice explanation too: <https://earthdata.nasa.gov/learn/what-is-sar>.

Question 2: Why are X and C bands good for agriculture? Is it because of their wavelengths?

Answer 2: Because their wavelengths are shorter there is greater interaction of the signal with the crop structure than L-band. With longer wavelengths such as L-band, a large portion of the signal also comes from the soil and not necessarily from the plants.

Question 3: Is there any reason for naming bands as X & C?

Answer 3: The letter codes were originally selected arbitrarily to ensure military security during the early stages of radar development in World War II, which is why the denominations are not in alphabetical order.

Question 4: Why does HH polarization penetrate more than the other polarizations?

Answer 4: HH penetrates further in general due to less attenuation.

Question 5: Is there a relation between roughness and backscatter (given fixed dielectric like sea-water)?

Answer 5: Yes. The greater the roughness, the higher the backscatter.

Question 6: Where can I download the SMAP Radar Mosaic of the Amazon?

Answer 6: You can download SMAP Data from the Alaska Satellite Facility.

Question 7: Is double bounce interaction radar good for analyzing flooded forests?



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Answer 7: Yes. That is one of radar's strengths since flooded forests are characterized by double-bounce scattering.

Question 8: is P-band useful to monitor moistened land surface?

Answer 8: Yes. You can penetrate deeper with P-Band, but the higher the moisture content, the less the penetration.

Question 9: How can you overcome the problem of near and far range in the images regarding classification? Taking control points from both sides for the same class?

Answer 9:

Yes, that is one way to overcome that. Say you have forest class, the backscatter characteristics of that class could be different, depending on the incidence angle. So try to train in both near range and far range and label accordingly.

Question 10: Can a DEM be used to correct the shadow effect?

Answer 10: There are ways to do so, but there can be issues where there is a discontinuity where the values are filled in. I normally just mask out the areas where there is shadow.

Question 11: What is saturation of a signal?

Answer 11: That means that the radar backscatter increases as the vegetation density increases but at a certain point the signal saturates, meaning it is not changing according to the density of the vegetation. You can estimate forest biomass with SAR but at a certain level of biomass, you can no longer see the difference due to saturation of the signal.

Question 12: Can a ML algorithm be used for Speckle filtering to minimize the resolution loss?

Answer 12: There have been some recent publications on the use of ML for speckle filtering, however, these are not widely used by the community (at least not yet).

Question 13: it is possible to composite HH-HV-HH polarization in one image?

Answer 13: Yes and we showed an example of that. Just know where each polarization is in the RGB channels in order to interpret the colors (and mixing of colors). You can compost an RGB image any way that suits you.

Question 14: Kindly explain more on the multi temporal PALSAR vegetation RGB colour code meaning.



Answer 14: If an area in the RGB image is red for example, it means that the backscatter in the red channel was higher than backscatter in the green and blue channels. If pink is the predominant color, then red and blue backscatter is high compared to green. There is a table in the pdf presentation that explains how to interpret an RGB image.

Question 15: What is the global coverage of NISAR?

Answer 15: NISAR will be global with an observation plan that covers all Earth's land and ice covered surfaces at least once each 12-day cycle from the ascending and descending portions of the orbit. There's more information about the mission and observational plan here:

<https://directory.eoportal.org/web/eoportal/satellite-missions/n/nisar>

Question 16: It was mentioned that incidence angle can affect land use land cover mapping. Can incidence angle affect the detection of forest types (based on species composition)? If yes, how can it be avoided?

Answer 16:

Yes, incidence angle can affect species composition (as related to structure, which is what radar is sensitive to). First you want to see what's the incidence angle range in the image. If it is wide, ~10-15 degrees or more then look at the class statistics for the same class in the near range and the far range. If they differ widely then you will want to train your classifier with the same class in different parts of the image. For example, instead of defining a class named forest, define one that is named forest_near_range (from forest pixels in the near range), another one named forest_middle_range, and another one named forest_far_range. An alternative is to cut the edges of the image and just classify the middle of the image where the incidence angle variation is less than 10 degrees.

Question 17: What is the geometric resolution of Sentinel 1 images available in Google Earth Engine?

Answer 17: The resolution is 10 meters. For radar, you do need to apply a speckle filter, which will degrade resolution unless you do a time series average to reduce speckle.

Question 18: How would you do the analysis with a longer time series (10-15 images using Google Earth Engine)?

Answer 18: Using the filter by date option, you can add additional dates and create a new variable based on the dates you are interested in analyzing. This is slide 58 in the presentation.



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10-15 images get more complicated. You will want to detect change in radar backscatter for each pixel through time and identify when the change was below a certain threshold to mark it as the point when there was vegetation loss. The SAR Handbook from NASA SERVIR Chapter 3 by Josef Kelndorfer has an excellent description on different methods that can be applied for time series analysis:
<https://directory.eoportal.org/web/eoportal/satellite-missions/n/nisar>

Question 19: How were the min and max identified for display?

Answer 19: The min and max set for display is trial and error. First you should use the inspector tab to have an idea of the backscatter values and range in your image by clicking on very bright areas or very dark areas. You can then set the min and max for display based on this initial assessment and you can then adjust the min/max based on how bright or dark is your displayed image.

Question 20: How can we know the suitable min and max value are in the add layer function?

Answer 20: Please see the response to Question 19.

Question 21: Are Sentinel-11 images on GEE calibrated in Sigma0 or Gamma0?

Answer 21: Sigma0.

Question 22: What would be the consequence of not using speckle filters?

Answer 22: That graininess will introduce errors in your final products. For example, a classification will result in that graininess effect.

Question 23: Can we determine from the FCC if vegetation has changed to a different type? e.g. from trees to agriculture?

Answer 23: Yes, you should be able to determine change from forest to agriculture.

Question 24: There is a problem in the script. I got an error: "first2016VV" is not defined in this scope.

Answer 24: We are not sure what that is but we will update the presentation with a link to the code.

Question 25: How do you determine the stretch?

Answer 25: That was explained in Q19



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Question 26: I might have missed the explanation: why are the images in log scale (dB), and what is the advantage to keep the images in a log scale?

Answer 26: Backscatter is a measure of power. The intensity of each pixel represents the proportion of microwave backscattered from an area on the ground. The pixel intensity values are converted to a physical quantity called the **backscattering coefficient** or **normalised radar cross-section** measured in decibels (dB).

Any publication of SAR backscattering values is discussed in dB.

Question 27: Why are you changing the stretch for every layer? $\{-15,0\}$ vs $\{-27,0\}$, vs $\{-9,9\}$?

Answer 27: The reason the stretch is different because the range of values of each layer is different. Try running a histogram on each of the radar images so you can have an idea of the range of the values or you can also use the inspector tool to explore the data range within the image by clicking on areas with very low or very high backscatter.

Question 28: Is there an online viewer for SAR data that would make it easy for rapid assessment of SAR data? I am curious how well it differentiates between irrigated grassland vs willows.

Answer 28: Not that we are aware of.

Question 29: How do we display areas covered by the land use land cover (LULC) class and LULC change conversion in a table?

Answer 29: You will have to run the stats as we did at the end of the exercise today (# pixel change for each class).

Question 30: Are there other platforms you can suggest to process and analyze SAR data that does not require learning javascript?

Answer 30: I suggest using the Sentinel Toolbox by the European Space Agency (ESA). It uses a GUI interface where you can process and analyze data without having to code. You do have to download SAR images, which can be large in size (~ 1GB).

The Sentinel toolbox is free and you can download through the following link:

<http://step.esa.int/main/download/snap-download/>

There are efforts to have an online interface, which will also process data via cloud computing however, it will probably not be ready until Sept./Oct. of 2020.

Question 31: How do you know how to associate which histogram is which VH difference? Is this just based on simply drawing order from the code snippet?

Answer 31: Yes, it is based on the drawing order on the code.



Question 32: Why was the SAR imagery not within the roi (red)? Will it shift from the area of interest?

Answer 32: The roi was defined using a line. Therefore, any image that touched that line was selected. In our case there were more time series images to analyze in that western part of the roi.

However, a better way to define your roi when searching for images is to draw it using a solid polygon such that GEE can search for images that fall anywhere within the polygon.

Question 33: Is it possible to calculate SAR vegetation index to enhance the vegetation information in pasture or agriculture?

Answer 33: There is a radar vegetation index, which is an indicator of the presence of vegetation. Here are some references:

https://servirglobal.net/Portals/0/Documents/Articles/2019_SAR_Handbook/SAR_Vegetation%20Indices_one-pager.pdf

<https://www.mdpi.com/2072-4292/10/11/1776/htm>

Question 34: How can we export or download these data outputs from GEE?

Answer 34: We added a section at the end of the code to export your file as a GeoTIFF:

<https://code.earthengine.google.com/cfa42183bac06bdac5a16ed8a05233a5>

Keep in mind that GEE does not automatically export your file. You need to go to the "Tasks" tab in the upper left window and select run for the file that you want to export.

Question 35: Can you repeat the equation for threshold or expand upon how that is determined? Why does the threshold computed for "new region" which is a larger region, work to threshold the new smaller "stats region" when the std dev for the "stats region" is going to be different?

Answer 35: The stats region defined at the end was a smaller region where we determined vegetation loss between two different years. You can run it for the entire region if you wish by using the new region ROI. The reason we ran the statistics for vegetation loss between two years for a smaller region is because there was clearly a change in that stats region and we wanted to highlight that difference.

Question 36: Why is the Sentinel 1 image loaded in GEE outside of our region of interest?

Answer 36: Please refer to question 32.



Question 37: How do you get the upper threshold value?

Answer 37: Setting the threshold involves some trial and error. The histogram will help you see the distribution of the values in your image. We started by setting the threshold to $1.5 \times \text{standard deviation} + \text{mean}$. However, you can increase or decrease that threshold depending on how well it worked in identifying areas of vegetation loss.

Question 38: When we run the code in Google Earth Engine, will it run all the lines every time and rewrite the layers?

Answer 38: Yes, every time you run the code GEE will rewrite the layers.

Question 39: Why does there seem to be a lot of vegetation loss on the river?

Answer 39: Great question! The reason for this is because the roughness of the water was different between the different images. It is hard to see with the stretch used for the demo, however, if you change the stretch (e.g. -35 to -5 for HV) you will see differences in the roughness of the water, probably due to wind.

Question 40: Can we compute how much the loss is? Like how much area is lost?

Answer 40: Yes, definitely. That is what the last step was all about. We first counted the pixels masked as vegetation loss for the stats region defined for two years and then based on the grid resolution (10 meters), we calculated vegetation loss in hectares for each year.

Question 41: What land cover changes could be difficult to classify correctly using the methods described?

Answer 41: Probably detecting vegetation loss due to forest degradation given that the change in backscatter can be small depending on the level of degradation.

Question 42: Why isn't the number of pixels an integer?

Answer 42: Probably because the border of the polygon defining the stats_area is cutting through pixels.

Question 43: Do these codes/filters only apply to the area we selected?

Answer 43: You can adapt the code and apply it to other areas but you will have to calculate the thresholds again.

Question 44: How do we define threshold? Is there any rule of thumb?

Answer 44: Please see question 37.



Question 45: How can the accuracy of the estimated changes be assessed (possibly the confidence intervals)?

Answer 45: Accuracy can be assessed with reference data, whether in situ data or validated maps.

Question 46: How would the type of vegetation affect the effectiveness of the thresholding?

Answer 46: The type of vegetation should not affect the effectiveness of the thresholding since we are looking at change in the backscatter signal. However, the degree of change might affect the effectiveness of thresholding. For example, if a forested area suffered degradation rather than deforestation then the threshold might not capture that level of change.

Question 47: Can you explain in more detail what the depolarization of the signal means?

Answer 47: The signal interacts with components in the surface. There are several backscattering mechanisms (e.g. specular scattering, rough surface scattering, double-bounce scattering, and volume scattering). Volume scattering occurs when the signal interacts with several components within a medium, for example within a vegetation canopy the signal can scatter from leaves to stems to branches multiple times. This multiple scattering of the signal can cause it to change polarization or depolarize from horizontal to vertical or from vertical to horizontal. In those cases you have cross polarization, meaning HV or VH.

Question 48: What does the ratio of co-pol to cross-pol tell us?

Answer 48: The depolarization ratio can be used to determine relative surface roughness identifying areas with different vegetation structures and type and help discriminate between forest and non-forest areas.

Question 49: How do you work around sensor saturation in places with large biomass?

Answer 49: Unfortunately there is no way to work around it. Sensor saturation is a limitation of the frequency used. The most you can do is use a lower frequency (for example L-band rather than C-band) because it will saturate with higher biomass.

Question 50: Would you recommend combining SAR results with other indices like NDVI?



Answer 50: Yes, absolutely. You can do this in a classification approach. The great thing about GEE is that you can easily run a classification with different layers and you can compare how the accuracy results differ when you include a layer such as NDVI with the SAR images vs. just the SAR images.

Question 51: When filtering the image results, you specified the descending orbit. What difference does it make if you choose descending or ascending orbits?

Answer 51: In this case there were more images over the area of interest with the descending orbit. This might be the case for other areas, but it should certainly be something that you should explore especially if you are doing a time series analysis

Question 52: What determines the 10 x 10m resolution? Is this based on the radar signal used? What is the minimum size of deforestation do you think Sentinel 1 data could pick up? Perhaps single tree mortality?

Answer 52: The 10x10 m resolution is the resolution of the Sentinel-1 gridded product. The across track resolution is determined by the length of the pulse and the along track resolution is determined by the length of the antenna. Here is a website that explains it detail:

<https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/remote-sensing-tutorials/microwave-remote-sensing/viewing-geometry-and-spatial-resolution/9341>

Sentinel-1 will not pick up single tree mortality. A single pixel is 100 m². It is very difficult to base your classification accuracy on a single pixel. I would say the minimum area for detecting deforestation is an area on the order of 5-10 pixels together.

Question 53: Is there any method to reduce the shadow effect?

Answer 53: There are ways to interpolate values using a DEM in areas where there is radar shadow. This is something that you don't have to worry about unless you are working in areas with complex topography, which is where radar shadow occurs. In such cases I recommend creating a mask and treating those areas as gaps rather than trying to fill in the values with some interpolation technique.

Question 54: How would you differentiate a dense agroforestry system, like shade-grown cacao to a natural forest?

Answer 54: You would have to first explore the backscatter response to these two different systems to see how much they differ. The best way to do this is to select polygons over these two different systems and plot their histograms in both polarizations to determine how much overlap there is between them.



Question 55: Is it suitable to use Sentinel-1 for assessing flooded areas and/or measuring height of trees within an urban environment?

Answer 55: Sentinel-1 can be used to detect flooded areas, however, because the signal saturates over a certain level of biomass, you will not be able to identify flooding in forested areas with a given density. C-band is better at detecting flooding in areas where there is low vegetation. C-band is not particularly for measuring tree height (see the last session in this series).

Question 56: What are the threshold values you recommend in terms of knowledge about the density of vegetation?

Answer 56: The density of vegetation should not drive your threshold values. The threshold is set to identify areas where there has been a change in backscatter, in this case due to vegetation loss. If you are trying to identify areas where there has been forest degradation then the threshold might not work as well, depending on the level of degradation.

Question 57: How can we differentiate between flooded urban and inundated vegetation areas in SAR data products?

Answer 57: It is very difficult because the dominant scattering mechanism for flooded vegetation and urban areas is double-bounce. You could use an urban mask to eliminate those areas altogether. Texture measurements have also shown to help differentiate between these two classes because urban areas tend to be more homogeneous than flooded areas.

Question 58: Is there a way to mosaic different bands within the same ROI?

Answer 58: I am sure there is. There are several google earth engine forums, which are great places to either post a question or find answers to questions that have already been posted.

Question 59: About using $1.5 \times \text{Standard Deviation}$. Does that not make your classification very sensitive to the area you selected? Is there a way to deal with that issue?

Answer 59: The issue with using a threshold is that it might be area sensitive. You should test the threshold or calculate a new one if you are focusing on a different area where conditions might be different.



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Question 60: During the speckle filter step, the radius size given was 50. What is the logic and criteria for this?

Answer 60: The size of the filter is exploratory. The larger the filter size the greater the loss in spatial resolution. Finding the right size filter depends on the level of detail that you are interested in preserving and dealing with the speckle effect in the product derived. A filter size of 50 seemed to be that right balance in this case, but you can explore and use larger or smaller sized filters and see how that translates to the generated result.

Question 61: It seems that the data (Sentinel-1) is not available everywhere, can we use different resolutions to conduct the analysis (if available), assuming that we will get degraded performance for those areas?

Answer 61: Yes, you can use different resolutions. You should test it and see what sort of results you get.

Question 62: Is it possible to import own ROIs, for example, as shapefiles to EarthEngine? Or directly search for regions (country boundaries, NUTS regions)?

Answer 62: Yes you can. Session three of this webinar series shows how to ingest shape files into GEE.

Question 63: Does water that has high organic matter affect scattering?

Answer 63: Radar is not sensitive to the chemical composition of surface components, including water. Radar is sensitive to moisture and structure, hence high organic matter will not affect scattering unless, for some reason the high organic matter in the water will change the surface roughness considerably (such as oil for example).

Question 64: Is it possible to interpret other degradation processes apart from vegetation using SAR data?

Answer 64: I am not sure what would be those other degradation processes.

Question 65: Is it useful to combine optical data and SAR data - because optical data can suffer from clouds (which SAR data can avoid) but might be better in some areas for dealing with topographical variation?

Answer 65: It is useful and the next session will focus on the combination of SAR and optical data.

Question 66: Can we use this approach for forest fire monitoring (burnt area mapping)?



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Answer 66: Yes, you can use a threshold approach or you can also use a classification approach.

Question 67: How to overcome the problems on classification related to near and far range? Should we select points of control on both sides?

Answer 67: Please refer to question 16.

Question 68: Can the spatial variation in Above-ground biomass be detected accurately using radar sensor data in tall, high-biomass, tropical forests?

Answer 68: The longer the wavelength the better you can estimate biomass in dense tropical forests, however, the signal will saturate at some point. If the spatial variation in biomass is above the signal saturation point then you will not be able estimate those variations, otherwise yes. Chapter 5 of the SERVIS SAR Handbook is focussed on how to estimate biomass using SAR:

<https://servirglobal.net/Global/Articles/Article/2674/sar-handbook-comprehensive-methodologies-for-forest-monitoring-and-biomass-estimation>

Question 69: Could the codes/scripts you used for the analysis be applied in any roi?

Answer 69: Yes, you can adapt the code to other regions of interest, however, you will need to recalculate the thresholds.

Question 70: You mentioned that the speckle filter reduces the resolution because of the smoothing effect, but that the data is gridded to its original resolution. Wouldn't that throw off the loss/gain estimates within the difference calculation?

Answer 70: Yes, absolutely given that the true resolution of the image is not 10 meters.