Questions & Answer Session 2, Part 2

Please type your questions in the Question Box. We will try our best to get to all of your questions. If we don't, feel free to email Erika Podest (erika.podest@jpl.nasa.gov), Sean McCartney (sean.mccartney@nasa.gov) and/or Eric Fielding (eric.j.fielding@jpl.nasa.gov).

Question 1: What are the chances of not getting a perfect interferogram? I have low vegetation, took larger Bperp, ensured good temporal resolution with Sentinel 1. I am seeing less coherence with my area.
Answer 1: There are other surface changes that can cause low coherence besides vegetation. For example, heavy rain, snow cover, loose sand motion, flooding, and erosion or deposition can cause the radar reflection to change and therefore low coherence.

Question 2: What is the difference between SRTM and NASADEM?
Answer 2: The new NASADEM is a reprocessing of the original SRTM data acquired in 2000 to improve the quality.

Question 3: Displacement in a LOS (line of sight) image depends on correction. How can we correct this?
Answer 3: There are several corrections that can be done to measure LOS displacements with InSAR. The mandatory correction is to remove the topographic phase, which is one of the standard steps in InSAR processing. The other necessary correction is to convert the interferogram phase in radians to displacement in meters using the radar wavelength (actually the wavelength/4*π). There are other corrections that are more optional: atmospheric, for example.

Question 4: What is the minimum area (ROI) to study landslides with Sentinel 1? With respect to spatial resolution? Is it possible to use together with Sentinel 2?
Answer 4: The minimum size of landslide that you can study will depend directly on the spatial resolution of the satellite or airborne radar you use. In general, you need around 20 by 20 pixels to reliably measure motion with InSAR. Since Sentinel-1 has a resolution of about 14 meters, the smallest landslide you can study is about 250 meters wide. You can probably detect smaller landslides, but it will be difficult to study

them in detail. Sentinel 2 is optical and can be used to measure large motions using pixel offsets or detect landslides by changes in color.

Question 5: Is it possible to measure the depth of soil eroded with Sentinel 1? Or the amount of soil eroded in volume?
Answer 5: No. Once there is significant erosion, the InSAR phase will be incoherent and you can't measure the amount. You can detect where the erosion occurred by looking at the coherence map, but not the amount.

Question 6: Sentinel-1 provides ascending and descending. Which one should we use? Why?
Answer 6: You should use the look direction that best images the area you want to study. This will depend on the local slope direction and direction that the landslide is moving. If you can get good interferograms from both directions, then you can use the combination to separate vertical and horizontal motion.

Question 7: What are the requirements for interferometric analysis? Such as: image should be taken from similar orbit (ascending or descending), from one identical satellite (Sentinel-1A or Sentinel-1B) or images from both satellites can have the interferometry?
Answer 7: InSAR requires exactly the same orbital track. The Sentinel-1A and -1B satellites are built with identical radar systems and share the same orbit, so they can be used interchangeably.

Question 8: Are there SAR images in the x-band for South America available in the NASA database? And if they are free to use or download?
Answer 8: The X-band satellite data from TerraSAR-X and COSMO-SkyMed is only available from the German DLR and Italian ASI space agencies. NASA does not have permission to share that data, but ASI and DLR have some programs where researchers can apply to get data for no charge.

Question 9: Do you have any suggestions for selecting images based on the Perpendicular baseline? What is the most ideal baseline for PALSAR, Sentinel-1 and Tandem-X? I would like to do SBAS SAR processing.
Answer 9: The best baseline for measuring ground deformation is always zero. The Sentinel-1 satellites are operated to keep the baselines always short enough for InSAR. The JAXA ALOS satellite was allowed to drift during its mission, so the baselines vary a lot. The usable baseline depends on the slope, but in general perpendicular baselines

less than about 400-600 meters for ALOS. The TerraSAR-X and TanDEM-X satellites were operated at a variety of baselines to do single-pass (bistatic) InSAR for making a global topographic map. At some times, the baselines were long, around 600 meters. In most areas, you will get better results of repeat-pass DInSAR using TerraSAR-X and TanDEM-X pairs with baselines shorter than 100 m.

Question 10: Hi I'm interested to see landslides around Brandon, Manitoba in Canada. Is it available? Or Can you direct me to get those data?
Answer 10: Yes, Sentinel-1 is available globally, from the Copernicus Science Hub and NASA ASF. I would assume data is available every 12-24 days. You may only have one look direction in that location.

Question 11: My Sentinel-1 tool (SNAP) did not work. Can you help me to find the issue, why it is not working?
Answer 11: There is an excellent forum by ESA for the SNAP software and other software in their Science Toolbox Exploitation Platform or STEP (https://forum.step.esa.int/). I would suggest looking through that or asking questions there.

Question 12: What if the study area is located in the IW1 and IW2 but only in burst 1-2. Should we split the image and process the DinSAR separately and merge it after that?
Answer 12: In Almost all InSAR processing systems, you have to process the swaths separately, then merge. In the ISCE software, it can do the merge before unwrapping.

Question 13: If I don't see any fringes in ifg and also less coherence in the coh image, is there any chance I will be getting a good DEM using InSAR with Sentinel-1?
Answer 13: If you do not see fringes, you will not get a useful DEM.

Question 14: What are other possible applications for InSAR other than its usage in Landslides and Volcanology?
Answer 14: InSAR is used to study earthquakes and motion of glaciers as well. Another is to measure ground motion due to groundwater or oil extraction.

Question 15: The geographic coordinates depend on the map projection?
Answer 15: Yes, map projection will determine the coordinates you end up with.

Question 16: Is there any Python or R package for InSAR processing?
Answer 16: The InSAR Scientific Computing Environment (ISCE) is largely written in Python and can be called from Python 3. Not aware of R packages.

Question 17: Can I subset it from the start in order to use less memory and be less time consuming, or are the results altered, needing the whole scene to have it better?
Answer 17: Yes, SNAP allows you to select a limited subset of the bursts. Not on a lat-lon but instead based on the bursts. You need to have at least 2 bursts to do so. You can estimate the burst numbers from the quick-look image.

Question 18: Can I use "homemade" DEMs for topographic face removal? Such as digitized "paper" topographic maps?
Answer 18: Yes, this can be done. You have to format it correctly for your software.

Question 19: Which polarization is best for interferogram formation? Direct polarizations or cross polarizations (VV or VH, HH or HV)?
Answer 19: For InSAR, we almost always use the direct polarizations. VV or HH because the signal to noise level is better.

Question 20: What is the precision of the displacement?
Answer 20: On the order of about 1/10 or 1/20 of the radar wavelength. Sentinel is 6 cm, so precision of about 3-6 mm. Accuracy will still depend on the coherence.

Question 21: Is it possible to identify deformation in urban areas?
Answer 21: Yes, urban areas are some of the best locations because the coherences is high due to the presence of buildings.

Question 22: So, how can we combine different source interferograms, e.g. UAV vs. Satellite to try to complement and get a complete characterization of a landslide?
Answer 22: Once you convert your interferogram to LOC displacements, and you know the LOS (line-of-sight) vectors, you can combine multiple measurements.

Question 23: What is the minimum size of landslide for detection?
Answer 23: At least 20x 20 pixels for study. To see if a landslide is moving, 8 x 8 pixels will work (~100 x 100 m).

Question 24: We have used a VV polarized image now, what difference can we expect in an interferogram if we use HH or HV polarized images? 2) In what applications are HH,HV, and VV used?

Answer 24: Probably 99% of all InSAR studies use a single polarization for interferograms. The part of the ground surface and vegetation will vary depending on the polarization. In some cases, it is possible to use diff polarizations to detect differences in what height the radar is bouncing off of. There is a field called Pol-InSAR where people use the polarimetric differences of InSAR, mostly to measure vegetation.

Question 25: How are the displacements monitored based on multiple pairs of SAR images?

Answer 25: There are several time-series analysis methods that use multiple pairs to estimate the time-history of displacement. Two popular methods are called Small-Baseline Subset analysis, which uses regular multilook interferograms and persistent scatterer InSAR (often PS-InSAR) that is an advanced analysis of the full-resolution data from a set of coregistered single-look complex images.

Question 26: How can we unwrap phase better?

Answer 26: This is something people have been working on for a while. Better quality data will help. In many cases, doing more multi-looking or adjusting the filtering can make it easier to unwrap the phase of smoothly varying areas. For landslides, the small size and rapid variations of phase mean you need to use a small amount of multi-looking and a low amount of filtering to maintain resolution. Using a longer wavelength like L-band that will have fewer fringes and higher coherence, and will be easier to unwrap correctly.

Question 27: Will the phase unwrapping functionality not now available for Mac OS eventually be ported for Mac?

Answer 27: The SNAPHU phase unwrapping software will run on Mac OS, but ESA decided not to provide a pre-compiled binary version for the Mac, so you have to do your own installation by compiling the source code (https://web.stanford.edu/group/radar/softwareandlinks/sw/snaphu/). The ISCE package is another alternative that includes SNAPHU and can be installed on the Mac OS.

Question 28: How about validating obtained deformations? What other methods are usually used?

Answer 28: For earthquakes and volcanoes, people typically use GPS (now GNSS) stations to validate DInSAR measurements. For landslides, it is not common to have a GPS station on the slide, but sometimes they install one. If there are no GPS stations, then other ground measurements could be used, such as surveying or terrestrial laser scanning.

Question 29: Can we get offset tracking results in SNAP?
Answer 29: Yes, there is a module in SNAP. It was designed to look at ice sheets and works on the GRD images. I have not used for landslides.

Question 30: If looking at a large area, should the images (covering the whole area) be mosaiced before processing?
Answer 30: No, if you have to process each track separately for InSAR or DInSAR. Then combine them after processing.

Question 31: How do you select your master and slave datasets when you go for an interferogram? What natural conditions do you consider? Do you look at precipitation using TRMM? Please share your approach.
Answer 31: The selection of SAR pairs for InSAR processing depends on the area and the type of measurement you want to make. In areas of heavy vegetation, it is usually better to select pairs with short time intervals. In deserts, you can use long time intervals, as long as there is not much loose sand. To study areas of steep topography, it is best to use pairs with short baselines. You should also avoid SAR scenes with large snow cover as that will probably reduce coherence. I have not used TRMM (or newer GPM) to look at heavy precipitation, but it could be a useful technique to avoid using SAR data taken during heavy rainstorms.

Question 33: Following Question 6: how could the ascending/descending images be combined?
Answer 33: A simple method to get an approximate solution is to combine by adding or subtracting the two ascending and descending displacement maps from satellite DInSAR. The sum of the two will give you something like the vertical component, and the difference will give something like the east component. SAR satellites are not sensitive to the north component.

Question 34: For active fault movement assessment, can we effectively use from InSAR? If yes, then can we process it with SNAP or some other preferred software available?
Answer 34: Yes, we use InSAR for that all the time. SNAP or other InSAR software can be used to make interferograms and study fault movement. To see the slow movement of faults between earthquakes, it may be necessary to do time-series analysis of a number of interferograms over a longer time interval.

Question 35: Is there any information regarding ALOS-Palsar 2 open datasets?
Answer 35: JAXA announced they will be opening up the ALOS-2 PALSAR-2 wide-swath datasets. No details as of yet.

Question 36: Would it be possible to monitor a landslide using single-pass interferometric acquisitions?
Answer 36: Yes, single-pass interferometry is used to measure topography. If landslides move a high amount, this can be used to make topographic maps before and after the landslide motion. Accuracy will be in meters. For large catastrophic landslides, the topography differencing will be the only method.

Question 37: Besides SNAP, which other free software is available to use for the activity shown today?
Answer 37: JPL ISCE software, GMTSAR are available. Both are command-line programs that run only on Unix, Linux, or MacOS. UNAVCO has short courses on ISCE and GMTSAR.

Question 38: Is it possible to calculate landslides using Google Earth Engine? Is there any tutorial you could recommend?
Answer 38: No, not currently. GEE only has amplitudes, not phase or pixel offsets, so you can't measure landslide motion. Looking for amplitude changes to detect large landslides could be done in a way similar to flood mapping, but the radar amplitude might decrease or increase depending on the landslide and vegetation cover.

Question 39: Is there any cloud platform to process InSAR?
Answer 39: ESA has several cloud platforms for SAR processing called Geohazards TEP (Thematic Exploitation Platform).

Question 40: New NISAR is going to work with a wavelength of 12 cm, what is it necessary for? To cover medium-high vegetation?

Answer 40: Yes, with 2 different radar wavelength, it will be easier to measure differences in vegetation, especially the smaller plants. Two wavelengths can also help with soil moisture estimation.

Question 41: Is it possible to combine a DEM generated with a surveying work with the InSAR process?
Answer 41: Yes, there are methods to combine DEMs. An advanced topic.

Question 42: I am unable to install SNAP on my PC. Is there any help?
Answer 42: The SNAP forum will help. See question 11.

Question 43: Is it possible to subset the image based on a shapefile in SNAP?
Answer 43: No it is not.

Question 44: Why did we say good correlation at L-band in SAR?
Answer 44: Because L band has the higher wavelength. It does not affect the coherence.

Question 45: What are the advantages of PSInsar (Palsar?) and InSAR for landslide monitoring?
Answer 45: Persistent Scatterer InSAR (PS-InSAR) is an advanced processing technique that can extract coherent pixels from areas where there are small coherent patches in a less coherent area. This can measure landslides that are not coherent overall. Regular InSAR or DInSAR works better where the coherence is good over the whole landslide, and it is easier and less computation-intensive.

Question 46: Is the adaptive filter of 0.44 as applied in the demo fixed or the best determined range for landslides, or can one play around with the figure for the best possible results?
Answer 46: You should play around with the parameters to see what works best for your site.

Question 47: The pixel offset: do we need to have ground control points scattered in the image? If no GCPs, then how can the offset be assessed between two SAR images?
Answer 47: One of the advantages of SAR is that the image geometry is stable. You can measure displacements with only a single ground control point.

Question 48: Can we process optical images in SNAP?
Answer 48: Yes, you can. Sentinel-2 is fully supported. I think some others are also supported.

Question 49: Can you please briefly explain how to monitor landslides using optical images?
Answer 49: Optical images can be useful for detecting collapsed landslides that cause a large change in the surface properties, such as from forest cover to soil. Optical images can also be used for pixel offset tracking analysis, similar to the SAR images discussed here. The widely available Copernicus Sentinel-2 and USGS-NASA Landsat-8 optical images have finest resolutions of 10 and 15 meters, so they can only be used to measure very large landslides. Typically, pixel offsets are calculated with matching windows that are 32 by 32 or 64 by 64 pixels, so the Sentinel-2 and Landsat-8 pixel offsets can only be used for landslides that are about 1 km across or larger. To study smaller landslides, you need higher resolution data, such as the new Planet images from their PlanetScope satellites that have 3 meter pixels or the very high resolution data from DigitalGlobe WorldView or CNES Pleiades (smaller than 1 meter).