Questions & Answers Session Part 5

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 our trainers Amita Mehta (amita.v.mehta@nasa.gov), Sean McCartney (sean.mccartney@nasa.gov) or Elijah Orland (elijah.orland@nasa.gov).

Question 1: What should I do if my net package ends in between and I am not able to attend further?
Answer 1: If you lose internet in between sessions, you can always access the materials and video from the training page: https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-observations-and-tools-fire-risk-detection-and

Question 2: What type of camera is an "automated rain-triggered camera"? I ask because most remote cameras are triggered by movements, so they would capture movements made by wind, animals, etc.
Answer 2: (From Eli) - These cameras are often installed by the USGS, so I cannot speak personally to their process. That said, each monitoring site has at least one rain gauge with it, so I think it is likely the camera activity is tied with what the rain gauge is recording. Even when motion-sensing cameras are used, rain events would be visually separated from other movements made by winds, animals etc.

Question 3: Can we check runoff of another period where there's high precipitation and no fire events just to ensure that indeed the fire event led to increased runoff?
Answer 3: (From Eli) The short answer is yes! That said, sometimes what you will end up seeing is largely based on where your monitoring instrument(s) is/are located, as well as the degree of burn severity by the fire. So in practice, it might not be as clear of a difference as you might expect. Nonetheless, the risk of post-fire debris flows remains even if a heightened runoff signal isn't quite clear. It is hard to see in practice, but it is there.
(Amita) Even If there is no fire, heavy rainfall and increased runoff can bring sediments and nutrients in streams and lakes, but post-fire the runoff would be higher due to lack of vegetation to hold the water. Also, there would be more ash and debris due to the burn area.

Question 4: Is Climate Engine analysis available globally?
Answer 4: Some of the climate and hydrology datasets are only available for the United States, but the majority are available globally, as well as all of the remote sensing data products.

Question 5: Can you please provide information for a formal SPI calculation, to a given period, (for example 3 months)?
Answer 5: A 3-month Standardized Precipitation Index calculation is comparing the same 3-month period to every other 3-month period from your dataset. The SPI values can be interpreted as the number of standard deviations by which the observed anomaly deviates from the long-term mean. For more information refer to the link below:
https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi

Question 6: Besides NDVI, what other vegetation indexes are the most recommended for post-fire analysis on vegetation?
Answer 6: The normalized burn ratio (NBR) is a frequently used metric. I'll refer to the USGS page here:
https://www.usgs.gov/core-science-systems/nli/landsat/landsat-normalized-burn-ratio

Question 7: When using Climate Engine, many regions on the globe do not return data such as precipitation using CHIRPS-Pentad Precipitation. How can we access data for these regions?
Answer 7: CHIRPS precipitation products span 50°S-50°N (and all longitudes). It could be that your study area is outside of this.
If you are having issues with CHIRPS analysis on your machine, it could be due to internet connectivity leading to time out errors. One of the ways to troubleshoot this issue is to reset the processing by clicking on "Reset" in the top-right corner of the window.

Question 8: Are there any studies to compare the precipitation data between ground station data collection and its data from Landsat? If any, which one is more reliable?
Answer 8: Landsat is not used to get rainfall data. Landsat has visible and NIR bands and is used primarily to observe land cover.
If you are interested in literature comparing satellite precipitation data with ground data refer to the link below (references included therein):
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6581458/

Question 9: Could you explain a bit more about editing the code in Google Earth Engine (GEE) and to set the time period and region? For example creating a map based on calculation of mean for June 2020 in California.
Answer 9: The link below shows how to calculate median from a collection of images, but can be used for getting mean as well.
https://code.earthengine.google.com/?scriptPath=Examples%3ADatasets%2FLANDSAT_LC08_C01_T1_SR

There are a number of tutorials on using GEE and we encourage you to explore the link below:
https://developers.google.com/earth-engine/tutorials/tutorials

We also hope you will join us next month for an ARSET training specifically on GEE:
Google Earth Engine Applications for Land Monitoring

Question 10: How do wildfires affect agricultural lands and crop productivity? Are some crops more at-risk than the others?
Answer 10: Wildfires can have positive effects also! They keep ecosystems healthy (https://www.nationalgeographic.org/encyclopedia/wildfires/). Also, fires can remove unwanted vegetation, help promote efficient water seeping in agricultural land (may want to visit https://www.gov.mb.ca/agriculture/crops/crop-residue-burning-program/why-do-farmers-burn.html). Not sure which crops are more at risk -- it is the post-harvest stubble and straw that can burn faster.

Refer to Part 2 of the webinar series that covers anthropogenic fires for agriculture.

Question 11: Would you have the Google Earth Engine link for this model?
Answer 11: If this in reference to the PFDF model, the link will be publicly available upon publication of the model in the coming months. As we are continuously refining our workflow, anything that will be made public will likely change substantially. Stay tuned!

Question 12: Have you been able to automate the scene selection process necessary for dNBR assessment (pre-scene/post-scene)? Or does this require an analyst to manually evaluate (as currently practiced by MTBS)?
Answer 12: The whole process is automated via GEE with extra precautions taken to ensure the scenes are reasonable approximations of the burn area. This is primarily

done via creating cloud free composites of pre/post fire imagery (6-month time series) and selecting the median pixel. This is a method supported by the literature as well. Here's a paper about it: https://www.mdpi.com/2072-4292/10/6/879/htm

Monitoring Trends and Burn Severity Group (MTBS). For info on MTBS, here's their homepage: https://www.mtbs.gov/

Question 13: Any example of the conceptual model in Google Earth Engine? Code or published paper? (Not sure if this is the same question as 11.)
Answer 13: Unfortunately this model is a work in progress and thus needs to remain unreleased until we can fully validate it and pass NASA export control. Please stay tuned though, because we will release it later this year!

Question 14: Many thanks for this fabulous presentation. I'd like to know the spatial and temporal resolution of the CHIRPS precipitation data. Cheers!
Answer 14: The spatial resolution of CHIRPS precipitation data is 4800 m (1/20-deg). The temporal resolution incorporates daily, pentadal, and monthly 1981-present precipitation estimates.

Question 15: How is the accuracy level for small areas?
Answer 15: For the PFDF model, the accuracy is somewhat limited for small areas, given the coarser spatial resolution of rainfall information we have available worldwide (11km pixel size). If you wish to recreate this for a local area, 30m Landsat/10m Sentinel/slope data should suffice, but I encourage the use of local rain gauges or any ground based radar estimates available for your area of interest.

Question 16: Mr. Elijah Orland could you please repeat Slide 13 (Setting a Decision Boundary)?
Answer 16: For the sake of time today, let me refer you to a written resource here: https://towardsdatascience.com/understanding-auc-roc-curve-68b2303cc9c5

In the meantime, I will briefly note that the ROC curve examines how a model's true and false positive rates vary as a function of the probability threshold you set. This is a unique relationship for each model, so it is something that must be set manually.

Question 17: In your slide - "Burned soils are chemically altered
by high heat to form a hydrophobic layer." Is this damage less with low-intensity fires like prescribed burnings?

Answer 17: I won't speculate on prescribed burnings in particular (I focus mostly on wildfire), but yes this indeed varies as a function of burn severity! This is a continuing area of study so expect to see more information about this in the coming years.

Question 18: Is there any impact of fire smoke on the quality of the data imagery like cloud cover?
Answer 18: Yes. One of the ways we work around this is creating cloud free composite imagery using Landsat data. We will provide links to resources as well. Refer back to Parts 3 & 4 for additional information.

Question 19: Do we have a real-world example where a PFDF forecast enabled preventive measures before the event occurred?
Answer 19: The point of our work is trying to answer this exact question. We will link a paper to Staley et al. (2017) with a nice case study at the end:
https://www.sciencedirect.com/science/article/pii/S0169555X16302756

Question 20: I would like to ask if there is any plan on improving the global burning area mapping models using better resolution.
Answer 20: Yes. This is a continuing area of study. This is not in our particular line of expertise. Developments within this field are rapid.

Question 21: How do you process and fix the scan line error in Landsat 7, which results in some missing data in the ROI?
Answer 21: Please see the link below for scan line corrector information:
https://www.usgs.gov/core-science-systems/nli/landsat/landsat-7?qt-science_support_page_related_con=0#qt-science_support_page_related_con

Question 22: As somebody not familiar with machine learning, how did you produce the Receiver Operating Characteristic (ROC) Curve for your case study?
Answer 22: This is something you can do manually, but there are a number of resources from software engineers used for machine learning. Scikit-Learn is a resource that we utilized. Link: https://scikit-learn.org/stable/

Question 23: How do you assess the accuracy of your prediction model?
Answer 23: In the simplest sense, there is a measure derived from ROC curves that has a value from 0 to 1. Threat scores show differences between false positives and false negatives. There is no one right answer, but using different tools helps.

Question 24: Can one use SAR (e.g. Sentinel-1), to record debris flows?
Answer 24: SAR can monitor debris flow. Scientists at JPL are working on a project focusing on this, but it is a work in progress.

Question 25: Does the CO_2 released in all global fires greatly exceed anthropogenic CO_2?
Answer 25: Globally, this is not clear. But in the cases of California and British Columbia, Canada wildfires CO_2 does exceed anthropogenic (transportation sector) CO_2.
(https://www.cbc.ca/radio/quirks/sept-15-2018-summer-science-camping-under-a-volcano-plastic-in-beluga-bellies-and-more-1.4821942/how-do-co2-emissions-from-forest-fires-compare-to-those-from-fossil-fuels-1.4821944)
(https://www.sfchronicle.com/california-wildfires/article/California-wildfires-emitted-a-huge-amount-of-15775044.php.)

Question 26: Is the runoff coefficient for various permeable surfaces considered, like Manning's coefficient for estimating surface runoff, for different surfaces like vegetation, hard surfaces, pavement, etc.
Answer 26: GLDAS does take into account what surface it is.

Question 27: I assume that today you are mostly talking about large wildfire events. We are located on the continental watershed, and the farmers' practice is to annually burn at the beginning of spring (just before the rainfall season), so we do have large areas that burn each year, with some runaway fires as well. How would you measure the effects these fires have on downstream water quality, and how would this be quantified?
Answer 27: If this happens every year, it will impact water quality annually - sediments and ash would show variations on the annual scale and can be examined by monitoring pre- and post- fire satellite imagery. In situ data and watershed parameters of pre- and post- fire season may be necessary for accurate assessment.

Question 28: Can you recommend some reference to understand the decision boundary?
Answer 28: Yes! I would start here:
https://towardsdatascience.com/understanding-auc-roc-curve-68b2303cc9c5

Question 29: In fire risk modeling you usually include variables with different spatial resolutions (e.g. MODIS NDVI and CHIRPS precipitation). How do you combine these two resolutions? And what is the spatial resolution of the model?
Answer 29: We define the model resolution at the “basin scale” which is the scale of the WWF Level 12 watersheds--the highest resolution global dataset I’ve found. This varies between 20-60km^2, with individual pixels within each basin at ~30m and IMERG values closer to 11km. The ultimate modeling question is: “based on inputs at these resolutions, can we expect a DF within the basin area?”

Question 30: PFDF are possibly based on heavy rainfall in subsequent years. How can post fire damage be dynamically monitored for possible debris flow? Do we have any specific satellite application in this regard?
Answer 30: We will provide a link to a publication utilizing the leaf area index from the USGS: https://onlinelibrary.wiley.com/doi/10.1029/2021JF006091

Question 31: Any chance to get your links towards GEE analytics?
Answer 31: They will come once we are able to.

Question 32: What is the best way to isolate (masking) the burn scar from other objects in satellite data to create, for example, a shapefile in GIS software?
Answer 32: We will be showing examples of burn scar next session (Part 6 of this series). If you have a raster showing the burn scar, you will need to find the burn scar pixel values using the “Extract” tool in GIS software then convert the values into a shapefile.

Question 33: Hello, Eli. I really enjoyed your presentation, especially the part about understanding model probability and how to set a decision boundary.
Do you think the debris flow model will work well for burns that occur in flat areas? Have you ever looked at it?
Which variables did you discover to be the most important?
Did you perform an uncertainty analysis on the input data before feeding it into the model?
I was wondering if the HydroSHEDs were inaccurate, or if the NBR (burn severity) was less accurate on the steep slope due to the shadow?)
Answer 33: These events are contained to steep slopes. If a slope is greater than 14 degrees, this will come into play (broad example). In relation to HydroSHEDs, we are limited to what the tool provides. The data used for NBR is Collection 2 Landsat data. Shadows are not meant to be of concern.

Question 34: Is there any software developed for the burn severity mapping? This is a simple software which I've developed using the Sentinel-2 dataset in GEE:
git clone https://earthengine.googlesource.com/users/RMDMK/WWSAT
Answer 34: There are a number of publications that do reference certain softwares.

Question 35: Thanks a lot for highlighting machine learning! How confident are you on the application of deep learning for remote sensing? More particularly combined sources (optical, SAR, etc...).
Answer 35: Machine learning is a general form of statistically informed modelling. Deep learning in particular has promise with several applications in the geospatial field. Most limitations involve processing time and it is still experimental. Work from my colleagues: https://www.sciencedirect.com/science/article/pii/S0013795221000119. This is a random forest implementation, but a deep learning based application via CNNs is coming. For applications of DL in industry, here's an example: https://orbitalinsight.com/. Note that they are not an Earth Science focused company but employ a number of DL techniques with geospatial data sources.

Question 36: The water quality gets degraded due to post-fire debris flow into the streams and beyond. How can we assess those changes? Detecting changes in IOPs, CDOM, color, chlorophyll concentration, or by other ways?
Answer 36: Yes, these parameters would help assess water quality. Also, suspended sediments and Secchi Depth will also help. Parameters such a chlorophyll/algal bloom may not change right away but may develop later on.

Question 37: I wonder if it is possible to optimise the ROC threshold by changing the slope data input from binary to multiple input?
Answer 37: We are working on continuous values to show this information.

Question 38: Is there a deep learning algorithm that uses pre-fire indicators (like soil moisture, temperature) to predict forest fires in the future?
Answer 38: We don't have an exact answer, but we will update this document with examples when we find them.

Question 39: Thank you for mentioning Machine Learning in the presentation. Which Machine Learning algorithm is the best for predicting wildfire in your opinion?
Answer 39: It depends less on the algorithm and more on your data sources. With tabular data, tree based models tend to perform well. With messy datasets, the

algorithm will fit with noise. No algorithm can solve inadequate data. Here's a model I like: https://xgboost.readthedocs.io/en/latest/. But again, the quality of your data will always be more important than the algorithm you choose!