Part 1 Questions & Answers Session A

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 Amita Mehta (amita.v.mehta@nasa.gov) or Sean McCartney (sean.mccartney@nasa.gov).

Question 1: Could you suggest satellite data for small scale studies like 30 m for precipitation, ground water, and soil moisture?
Answer 1: There are no open source satellite data that provide precipitation, soil moisture and groundwater at 30 m resolution. There are mesoscale modeling systems (e.g., Weather Research and forecasting) and watershed models (e.g., Soil and Water Assessment Tool) forced by observed or other model data that can be used to get precipitation and soil moisture information at high resolutions.

Question 2: Is a deficit in soil moisture related to agricultural or hydrological drought?
Answer 2: Soil moisture affects both agricultural and hydrological droughts. Variability in surface and root zone soil moisture would impact vegetation. Prolonged dry periods would deplete column soil moisture that can result in hydrological drought.

Question 3: Can you explain why the SPI goes by 3, 6, 9, and 12 months, and not every 2 or 5 months? Is it about a cycle?
Answer 3: SPI can be calculated at any month, including 2 or 5 months. The important thing to consider when calculating SPI are the months/season of interest. Every region of the planet has a distinct rainy season or seasons – focusing on these months for your analysis will be much more insightful than calculating SPI on drier months. It's also important to note SPI is more appropriate in regions that are rain-fed and not irrigated.

Question 4: Can SPI be calculated for short-term periods (e.g., weekly and monthly)?

Answer 4: Meteorologists usually recognize one month as the shortest time scale for the calculation of SPI. Shorter time scales might underlie random fluctuations in precipitation.

Question 5: What is the correlation between soil/land degradation and drought?
Answer 5: A Google search will show several regional research studies about this! This report and references therein provide information about this.

Question 6: What is the age of the drought.gov archive data?
Answer 6: All the data displayed on Drought.gov is publicly available from other sources, including U.S. federal and state government agencies and academic institutions. As such, the period of record for each dataset varies, and we are regularly adding new datasets to our Data Catalog. Each data catalog page includes the period of record for that particular dataset.

Question 7: Is drought.gov only available for the US or for Asia Pacific also?
Answer 7: The website primarily provides information for the U.S. However, the Drought.gov Data Catalog contains links and information for several global drought datasets, and the International page contains links to featured maps and tools for monitoring drought worldwide. International tools are also linked in the training presentation slides.

Question 8: I want to work on soil moisture based drought prediction for a 450 km^2 watershed. How can I get high-resolution soil moisture data?
Answer 8: It depends on where your area of interest lies. For the contiguous United States, NASA-SPoRT has a 3 km modeled soil moisture product that is freely available. For higher-resolution datasets outside the US, please refer to Question 1. To learn more about the NASA-SPoRT product see the previous ARSET training: *Application of NASA SPoRT-Land Information System (SPoRT-LIS) Soil Moisture Data for Drought*.

Question 9: What method is good for predicting meteorological drought?
Answer 9: The Standardized Precipitation Index (SPI) uses precipitation only and is well suited for characterizing meteorological drought on a range of timescales.

Question 10: Are there any plans to add more datasets in Climate Engine related to the cryosphere or glacier monitoring? Are there any Climate Engine-type visualization portals? If you have any sources, can you please share any related materials or datasets?
Answer 10: We are unaware of plans to add datasets related to the cryosphere or glacier monitoring. As per the Climate Engine website:
"*We prioritize adding new datasets to Climate Engine based on their benefit to the user community and, often, their consistency with other datasets that are currently available. If you would like to request a dataset be added to Climate Engine, please message us with the subject line "Request New Dataset" through the support site's "Contact" form. We will use user requests to prioritize new datasets and features going forward, but cannot guarantee that a requested dataset will ultimately be added.*"
https://support.climateengine.org/article/30-faqs

For assessing and visualizing changes in the cryosphere and glaciers, we suggest exploring NASA's Sea Level Change Portal:
https://sealevel.nasa.gov/

Question 11: Is historical drought data available in other countries as well?
Answer 11: Yes, past observations of precipitation, surface temperatures, soil moisture, groundwater, and vegetation index are available globally and historically (10 to 20+ years of data).

Question 12: In order to use the data, do I have to download it or is it possible to be used on a cloud environment (for memory space)?
Answer 12: In the demonstrations shown today, you saw how to use Climate Engine and calculate SPI & VCI using Google Earth Engine (GEE), both cloud-based platforms for environmental monitoring. Once you've computed your results for an area of interest, you can download the results from both platforms.

Question 13: More of a broad overview question, but how would you fuse the data?
Answer 13: Different techniques are used, but relationships need to be established. See below for some references:
https://www.mdpi.com/2072-4292/12/20/3459

https://ieeexplore.ieee.org/document/10329928

Question 14: Can the drought data be extrapolated for floods from the JPEG pics shown?
Answer 14: Indices such as SPI can be used to detect both drought and flood conditions.

Question 15: How is NASA data useful for drought-prone area assessments in India? Is it possible to know the major causes of drought from a historical time frame from satellite data? If yes, then which satellite images can be used and how?
Answer 15: You will be looking at historical data available from GPM, SMAP, MODIS, and Landsat. These are all global data and can be used in India.

Question 16: Are there any drought models that show optimistic and pessimistic predictions regarding future drought conditions?
Answer 16: We will look at seasonal drought in upcoming parts of the webinar series. S2S will be discussed on Thursday.

Question 17: What is the highest resolution that can be achieved with the Climate Engine App?
Answer 17: There are different types of resolutions (e.g., temporal, spatial, spectral, etc). If you are referring to spatial resolution, the highest you can obtain from Climate Engine is Sentinel-2 MSI imagery at 10 m.

Question 18: Similar to GEE, can we select a custom region that may cross a series of administrative boundaries using Climate Engine?
Answer 18: Under the “Make Graph” tab in Climate Engine you have the option to select a custom region using a polygon or shapefile for a series of administrative boundaries of your choosing.

Question 19: The time series on Climate Engine can only produce charts and not maps, right?

Answer 19: Yes, that is correct. Under the “Make a Graph” tab you have the option to create a time series–the output is a graph with associated statistics. To make maps you must use the “Make Map” tab at the top left of the application.

Question 20: Can you extract datasets region by region?
Answer 20: All satellite data can be extracted for different regions.

Question 21: If we use portals like app.climateengine.org and analyze our data there itself without doing the finer steps ourselves but are the ones putting in the effort in bringing in ground data and our site interpretations can we directly use it in our research paper? I am a bit unclear what these new portals mean for plagiarism and research analysis when used by users. What does one need to be careful about?
Answer 21: Climate Engine provides terms of use for all of the individual datasets in Climate Engine at support.climateengine.org. Researchers should follow those terms of use and then cite Climate Engine as the tool they did their analysis with. Climate Engine is licensed under a Creative Commons CC-BY license. According to their website, this means you can “freely share (copy and redistribute the material in any medium or format) and adapt (remix, transform, and build upon the material) from this tool as long as you **give appropriate credit, provide a link to the license and indicate if changes were made**. If you wish you use the figures and maps generated by this site in a publication, newsletter, website, you can use the figure as-is or take a screenshot of the figure/map as-is, **as long as you make sure that the credit is visible** (i.e., Climate Engine in the lower right corner of maps or at the bottom of the figures.” You can find more citation information here.

Question 22: Let's say, 'OC2 Algorithm (Ocean chlorophyll’ from land 5/7/8/9 in the Climate Engine, I can see it. Is there a way to get the methodology? How is it calculating Chlorophyll from Landsat images using the OC2 algorithm?
Answer 22: For more information on how each algorithm is calculated in Climate Engine, refer to the following resource:
https://support.climateengine.org/article/103-metrics

Question 23: Are there free learning resources for further understanding of Climate Engine? If so please share, I really think it's a great resource.
Answer 23: For resources on using Climate Engine refer to the link below: https://support.climateengine.org/

Question 24: For the Climate Engine App, can you export the underlying GEE code after you perform an analysis? For example, you want to share a result with/build a web app with someone without having to download data and/or recreate those algorithms.
Answer 24: The Climate Engine API is a good way to scale your analysis and share code/results without having to download data. For more information refer to the following link: https://support.climateengine.org/article/12-climate-engine-apis.

Question 25: If I want to import Climate Engine in Google Colaboratory or in my local environment, how can I add that? Is there any detailed documentation/material/github account for it?
Answer 25: To work with Climate Engine in Google Colab, refer to the Climate Engine API. They have tutorials on bringing data from Climate Engine into the Colab environment:
https://support.climateengine.org/article/12-climate-engine-apis.

Question 26: Recently Google Earth Engine (GEE) updated their data access policy for non-commercial use (something related to the use of Cloud Projects). Is this going to imply some change to the use of App.ClimateEngine.org?
Answer 26: We are unaware of the recent changes in GEE impacting access or use of App.ClimateEngine.org.

Question 27: Is this the correct URL for the previous presentation and the app: https://www.climateengine.org/? I received a "not secure" message when accessing it. Is this app free, or do we need to pay for a subscription?
Answer 27: The link is https://www.climateengine.org/. We also see the error message that did not previously appear. Recent global IT outages may have created some errors. The website should be secure, but maybe allow a day or two for the error to resolve.

Question 28: Are there any datasets available for agriculture drought monitoring at the field scale?
Answer 28: You may want to explore OpenET, which provides evapotranspiration at the field level and can be used as an agricultural drought indicator. This tool is available for the US. There is also EEFLUX that provides Landsat-based 30-meter resolution ET and NDVI information.

Also, NASA SPoRT soil moisture and Vegetative Health Index are high-resolution products.

Question 29: Have there been any attempts to generate all different types of droughts globally?
Answer 29: Yes, there have been attempts. There is the North American drought monitor, a collaboration between Canada, Mexico, and the United States. Please refer to the presentation slides for links.

Question 30: What do you mean by socio-economic drought? Isn't all drought linked to socio-economics in terms of differential impact? What does this drought mean?
Answer 30: Socioeconomic drought occurs when demand for a good exceeds supply due to a low water supply.

Question 31: In the fire service, we often use KBDI (Keech Byram Drought Index), which takes into account daily temp, vegetation cover, and rainfall. Are any of these indicators especially good for monitoring fire conditions?
Answer 31: Yes, KBDI is used for both monitoring fire weather conditions and drought. For example, the U.S. Drought Monitor considers KBDI during the spring across the Florida Peninsula.

Question 32: Is the percentile relative to that place? So the actual conditions may be different across the country, but the relative severity is scaled to each place?
Answer 32: Percentiles of indicators are valid for specific locations but puts it into a historical context.

Question 33: Which modeled soil moisture data is recommended for drought modeling in developing countries, especially those regarded as data scarce regions? Interested in those where it could be difficult to validate the applicability of the data for that specific region.
Answer 33: NASA-USDA has a global soil moisture product available here: https://earth.gsfc.nasa.gov/hydro/data/nasa-usda-global-soil-moisture-data. The NASA-USDA Global soil moisture data provides soil moisture information across the globe at 0.25°x0.25°spatial resolution. These data sets include: surface and subsurface soil moisture (mm), soil moisture profile (%), surface and subsurface soil moisture anomalies (-).

Question 34: Is AI used as part of the US Drought Monitor?
Answer 34: Currently authors do not use AI.

Question 35: Can data extraction be done region by region instead?
Answer 35: Yes, as shown in the demonstrations, data extraction can be done in any area of interest.

Question 36: What do you mean by real time authoring?
Answer 36: Real time authoring was an example from early June when I was authoring to show the daily process.

Question 37: How do you use percentile method for drought analysis?
Answer 37: Percentiles are used to place various indicators (precipitation, soil moisture, and streamflow) into a historical context.

Question 38: Can Sentinel/Copernicus data be used in any way to produce drought indices?
Answer 38: Both Sentinel-1 and Sentinel-2 data can be useful for land cover mapping. Sentinel-2 data have red and infrared bands so can be used to calculate NDVI.

Question 39: Is the percentile relative to that place? So the actual conditions may be different across the country, but the relative severity is scaled to each place?
Answer 39: Percentiles of indicators are valid for specific locations but puts those indicators (precipitation, soil moisture, and streamflow) into a historical context.

Question 40: Can the link to the world agricultural production data webpage be shared? I did not notice one on the slide.
Answer 40: The USDA releases reports on world agricultural production and can be found here: https://apps.fas.usda.gov/psdonline/circulars/production.pdf

Question 41: Is this global dataset suitable for monitoring seasonal drought over a crop growth period? Specifically in a rainfed agricultural region. Which is the most efficient index to monitor such droughts?
Answer 41: Yes, the data shown today (precipitation, soil moisture, vegetation indices, etc.) are all well suited for monitoring seasonal drought over specific time periods (e.g., seasonal rain-fed agriculture). Seasonal drought can be characterized using SPI and VCI, both demonstrated today with JavaScript code provided in GEE, as well as in Climate Engine.

Question 42: How do I download the raster image of SPI & VCI?
Answer 42: You can uncomment sections of the code to export your results as GeoTIFF files to your Google Drive. Refer to the Part 1 Exercise on which lines to uncomment.

Question 43: In the case of GEE, should we correct the images (e.g., atmospheric and radiometric)?
Answer 43: The data provided in today's demo of GEE has already been atmospherically and radiometrically corrected.

Question 44: How deep are drought conditions suggested to trend (inches\feet below soil surface levels), and do drought trends affect aquifers?
Answer 44: How deep would depend on the intensity of the drought.

Question 45: Can we calculate VCI using Landsat 8 using the same code?
Answer 45: The code provided to calculate VCI was written specifically for Terra MODIS 16-day vegetation indices. It will not work for Landsat 8 imagery.

Question 46: Can someone clarify if there is an advantage to using SIF instead of NDVI, given SIF is so highly correlated with NDVI but available at a coarser resolution than NDVI.

Answer 46: SIF is more directly tied to plant health and activity than traditional measurements like greenness. See part three of this ARSET training: Use of Solar Induced Fluorescence and LiDAR to Assess Vegetation Change and Vulnerability.

Part 1 Questions & Answers Session B

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 Amita Mehta (amita.v.mehta@nasa.gov) or Sean McCartney (sean.mccartney@nasa.gov).

Question 1: Can the Standardized Precipitation Index (SPI) be predicted by a combination of variables or is it already a variable which is readily available?
Answer 1: SPI is a widely used index to characterize drought as well as above average precipitation at different time scales using **precipitation data alone**. SPI values can be interpreted as the number of standard deviations from the long-term mean, and the only variable you'll need to calculate the index is a time series of **precipitation data**. Ideally this time series will be a climatology of more than 25 years for your area of interest.

Question 2: Do we have to register first for Climate Engine before having access to data?
Answer 2: Yes, you will need to register an account with Climate Engine before having access to the application.

Question 3: Is it possible to download data in NetCDF format in Climate Engine?
Answer 3: From the application you can only download **map results** in GeoTIFF and PDF format. For **graphs and figures** it is possible to download results in PNG, JPEG, PDF, CSV, & XLS files.

Question 4: Can we download the data corresponding to any particular visualization?
Answer 4: When downloading map (visualization) results from Climate Engine, one can download in GeoTIFF and PDF file formats.

Question 5: Is the visualization in the Climate Engine available as a map only or as a csv or NetCDF file?

Answer 5: (see Answer 3) From the application you can only download **map results** in GeoTIFF and PDF format. For **graphs and figures** it is possible to download results in PNG, JPEG, PDF, CSV, & XLS files.

Question 6: Is there data available for every country?
Answer 6: Data in Climate Engine is global and available for every country.

Question 7: How do I download country based data from the ClimateEngine?
Answer 7: Under the "Make Graph" tab in Climate Engine, one can select any country to calculate a time series of environmental data with associated statistics. Once the results are graphed, it is possible to download the results in PNG, JPEG, PDF, CSV, & XLS file formats..

Question 8: Can we download a 1999 copy of your map?
Answer 8: The online archive of the U.S. Drought Monitor dates back to January 2000: https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

Question 9: Can this tool be used to monitor water poverty in a region?
Answer 9: Climate Engine can be used to monitor environmental hazards, but to characterize water poverty, you will need to combine biophysical and geophysical data with socioeconomic data. For information on monitoring water poverty please refer to the ARSET training: *Earth Observations for Humanitarian Applications*

Question 10: Slide 82 the Code (.earthengine link) shows 500 Internal Server Error. The server has either erred or is incapable of performing the requested operation. Could you kindly verify please?
Answer 10: We are unsure why you are receiving this error. Try re-pasting the link to the JavaScript GEE script in a new tab.

Question 11: In this presentation and on the NASA website, I noticed that US Hydrologic Unit Code (HUC) units are not developed based on standard methods in GIS for watershed delineation. Does this mean the US HUC2 units are checked and corrected for the alignments with true watershed boundaries?

Answer 11: The U.S. Drought Portal (www.drought.gov) uses HUC 2 watershed boundaries from this U.S. Geological Survey dataset: https://www.usgs.gov/national-hydrography/access-national-hydrography-products

Question 12: Is the data used for the US Drought Monitor also available for India?
Answer 12: The global SPI and vegetative health index are available for India. There is a global soil moisture product from SMAP. Also, precipitation and snow data are available.

Question 13: Is it possible to obtain drought data by state in Mexico?
Answer 13: The global SPI and vegetative health index are available for Mexico. There may be global soil moisture products. Also, the North American Drought Monitor (https://droughtmonitor.unl.edu/NADM/Home.aspx) includes Mexico and is updated each month.

Question 14: I am trying to register a noncommercial new Google Earth Engine project to use in the tutorial. I realize it will not be approved in time to follow along today, however I'm getting an error that the project cannot be created. Is this something you have experience with or know which panelist I could ask about this?
Answer 14: All Earth Engine usage must now be linked to Cloud projects. As of June 2024, all new Earth Engine access requires a Cloud project. If you are getting an error please reach out to the Earth Engine Registration Support: earth-engine-registration-support@google.com

Question 15: What are the key predictive models used by NASA for drought forecasting, and how accurate are they in different regions?
Answer 15: Goddard Earth Observing System Model, Version 5 (GEOS-5) is used for forecasting weather and climate conditions at 10-day, sub-seasonal to decadal timescales.

Question 16: How can NASA's Earth System Data be integrated with local meteorological and agricultural data to enhance the accuracy of drought predictions?
Answer 16: If you have local in situ data, you can use it to validate the models.

Question 17: How can we assess adaptation and resistance to drought in a region?
Answer 17: The National Institute of Health has a 2016 paper/study on assessing adaptation and resistance to drought:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4937719/

Question 18: Is there a protocol for flash drought onset mitigation?
Answer 18: Mitigation of impacts related to flash drought could be improved forecasts of rapid onset drought weeks in advance and better communication. Knowledge that there is an increased risk of flash drought within the next month could lead to water conservation efforts prior to its onset. Since flash drought is related to heat and higher evapotranspiration rates, flash drought forecasts can utilize skillful temperature predictions in the next two to four weeks.

Question 19: Would solar flux measurements from drones be useful?
Answer 19: Yes, if you have solar flux measurements from drones they can be used in your analysis. Please see this review paper https://doi.org/10.1016/j.rse.2019.04.030.

Question 20: Are there online global monitors of long term drought impacts like desertification?
Answer 20: Global Drought Information System provides global drought index. There is a model-based system, Global Integrated Drought Monitoring and Prediction System (GIDMaPS), which provides drought indices since 1980, however current updates are not available.