Questions & Answers Part 1 (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 Jonathan Case: Jonathan.Case-1@nasa.gov, Kevin Fuell (UAH at SPoRT): kevin.fuell@nasa.gov, or Sean McCartney: sean.mccartney@nasa.gov

Question 1: Is SPoRT data available in every part of the world?
Answer 1: NASA/SPoRT data are publicly available and SPoRT-LIS data availability will be addressed in Session 3 presentations. The SPoRT-LIS is currently only valid over the Continental United States (CONUS), but there are many other applications of LIS internationally, including Africa, south-central/southeast Asia, etc. We do have an eastern Africa run available on the SPoRT-LIS Viewer (coming up in Session 3; see https://weather.ndc.nasa.gov/sport/viewer/?dataset=lis_conus&product=rsoim0-100). Dr. Blankenship also has done a full Africa run to support the monitoring of locust migration and swarms. There is also SALDAS over South Asia, FEWSNET runs, and LIS runs in other parts of the planet. GLDAS at 25 km grid scale uses LIS globally. Many are done by regional organizations. Feel free to contact us for more details.

Question 2: How can we process a sequence of multi satellites, for example Sentinel 2 MSI, to analyze the trend of which parametre for 20 years? To study the evolution of land cover for approximately 30 years, which parameter should we use and how can we analyze a sequence of satellite imagery for this period of 30 years?
Answer 2: Sentinel 2A was launched in 2015, so that won't give you a robust time series going back 20 years. When analyzing trends it depends on what parameter(s) you want to see.
For a 30-year plus time series, Landsat would be best as it has records going back over 50 years.

Question 3: How can we integrate the idea of land surface temperature (LST) estimation with the factors that lead to drought? Can I say that LST has a direct impact on drought?
Answer 3: Drought is an imbalance between water supply and water demand. Water supply is precipitation, water demand (in nature) is evapotranspiration. Abnormally high

temperatures increase evapotranspiration, which can exacerbate existing drought conditions. But drought is largely a result of reduced water supply (lack of precipitation). Flash drought is becoming more of a research interest.
Hot temperatures coupled with lack of precipitation can lead to a rapid drought. LST can be used to monitor drought as an indicator (due to effects on vegetation, and high evaporation reduces soil moisture).

Question 4: What are the key components or steps involved in the process of data assimilation? How do different data assimilation methods, such as Kalman filtering or variational assimilation, work?
Answer 4: Data assimilation is essentially the process of updating your model prediction with observational inputs. A crude analogy is a ‘sleepy-driver’ scenario. You are driving on a road while feeling sleepy (model) and you open your eyes every so often (‘observations’) and correct your behavior.

The key information you need in data assimilation is to assign errors to model and observations - essentially how much do you trust observations and the model. If the observational error is low, then the assimilation will adjust the model closer to the observation. On the other hand, if you don’t trust the observations, you stick with the model prediction.

The Kalman filtering and variational methods are different in how they incorporate observational information. Variational methods find the updated model state by solving a minimization problem (minimizing an objective function). The Kalman filter is conceptually similar, but it uses an update approach that relies on estimating the minimum variance in the difference between the model and observations.

Question 5: Are there regions where the output demonstrates higher accuracy?
Answer 5: In general, validation of land surface models is limited to regions where we have adequately dense observations for verification. It is inherently easier to ensure model outputs are more accurate over observationally-dense regions compared to data sparse areas. Remotely sensed satellite retrievals can also help to validate models in regions with sparse in situ networks.

Question 6: Which season is best to study and understand the real drought condition in any area? Most of the slides here showed data in May.

Answer 6: The warm season is the most applicable and appropriate time of year for applying land surface/soil moisture to drought analysis. The cold season with frozen soil processes and dormant vegetation does not present substantial evaporative demand on the land surface layer. For longer-term hydrological drought, other multi-year factors play a role such as snow pack, reservoir levels, etc., especially in the U.S. West. [Note: Many of the graphics we highlight in the presentations came from recent dates, and that's why many examples happen to be from this spring 2023]

Question 7: Has the SPoRT-LIS tool been tested with data from Africa, especially sub-Saharan Africa? If not, can it be applied?
Answer 7: Yes, there are many examples of applying LIS to Africa. LIS is the foundational tool used in the Famine Early Warning Systems Network (FEWSNET) land data assimilation system (FLDAS). You can find more details at : https://ldas.gsfc.nasa.gov/fldas

Question 8: Can LIS easily ingest other input high resolution data sources (e.g. ERA5-Land) or is it configured only to use NLDAS and GLDAS meteorological forcing?
Answer 8: Yes, LIS has the capability to ingest several data sources including ERA5-land.

Question 9: Why is the SPoRT-LIS model that assimilates SMAP on a parallel instance? Are there plans to assimilate SMAP into the main system?
Answer 9: The alternative run of SPoRT-LIS with SMAP data assimilation is not currently bias-corrected to the non-assimilation climatology run. Therefore, the SMAP assimilated LIS output will not be consistent with the climatology of the historical model run and thus, percentiles and historical context will not be meaningful. The future NASA replacement solution for SPoRT-LIS over all of North America will apply bias-correction to both the historical and near-real-time assimilated datasets, thereby providing a consistent platform for contextualizing the current soil moisture states.

Question 10: Is SPoRT data comparable to SMAP? I need soil moisture data over India. I understand SPoRT is real time data, so is it similar to ASCAT?
Answer 10: The SPoRT-LIS is a land surface modeling solution, whereas SMAP is a satellite retrieval of shallow soil moisture, valid over about the 0-5 cm layer. So if a LIS run is set up over India, the most direct comparison to SMAP would be for the top, shallow soil layer. Another option would be to regularly assimilate SMAP data (either

Level 1 brightness temperatures or Level 2 retrievals) into LIS over a long period of time to produce the corrected assimilation solution.

Question 11: Which software can we use to analyze the evolution of land cover for 30 years or more to study the parameters of climate, vegetation and soil (in response to question #2)?
Answer 11: Any type of analysis software such as python could be used to read and analyze historical land cover data, e.g., from MODIS database of updated land cover type (https://modis.gsfc.nasa.gov/data/dataprod/mod12.php). The LDT could also be used to pre-process alternative land cover datasets, and if formatted properly, LVT could help analyze the variations in land cover type over a long period of time. I recommend consulting the LIS team at NASA/GSFC for more information on using the LDT/LIS/LVT software suite for accomplishing what you are interested in doing.

Question 12: During the last session, it was shown that the correlation with the Drought monitor was poorer for the southwest. Would this mean drought in other arid areas, e.g. arid parts of Africa, might also be expected to be under-predicted?
Answer 12: Not necessarily. The skill of the model depends on many factors, including the quality of inputs (e.g., precipitation), physical processes that are at play, and quality of remote sensing data. By combining the best available datasets (and models), we should be able to provide a high quality characterization of droughts over Africa (and other parts of the world).

A word of caution about the 'correlation with the drought monitor'. The drought monitor should not be regarded as the ground truth for validating soil moisture deficits. It is produced by analysts who subjectively blend many sources of information, and therefore does not necessarily correspond well to soil moisture deficits in all regions, as demonstrated in the presentation.

Question 13: Is there a source like GitHub to download SPoRT-LIS source code and configuration setup to run some test cases?
Answer 13: SPoRT runs an older version of LIS not on the LIS GitHub page, and the unique configuration in terms of Land surface Data Toolkit (LDT)/Land Information System (LIS) config files is not yet posted publicly. However, the LDT/LIS config files could be provided to those fluent in LIS, and we plan to make configuration files and

details available when the SPoRT-LIS database is hosted on the GHRC DAAC (https://www.earthdata.nasa.gov/eosdis/daacs/ghrc), planned for late 2023.

Question 14: Can the gridded soil survey geographic database (gSSURGO) data be used in LIS?
Answer 14: Yes, the capability is currently being implemented and will be available soon in GitHub.

Question 15: What is the main difference between Green Vegetation Fraction (GVF) and Leaf Area Index (LAI)?
Answer 15: GVF can be thought of as the horizontal density of healthy, transpiring vegetation, while LAI can be thought of as the vertical density of vegetation at a given pixel. They are closely interrelated, and in fact, LAI is the more important dependent variable incorporated into Noah-MP while GVF is held fixed (contrary to Noah LSM handling).

Question 16: Can these soil moisture percentiles be applied to local watersheds (approx. 1,030 square miles)?
Answer 16: Yes, one could apply a shapefile mask (in python or your favorite GIS software) to the grids of raw soil moisture data to create percentiles similar to how we have done it for U.S. counties. This would be a good exercise for future users of the SPoRT-LIS database, once it becomes publicly available on the GHRC DAAC (see Q1 above).

Question 17: Will SPoRT-LIS soil moisture be able to detect soil moisture at field scale? For example if the farm has plots that are about 7m wide?
Answer 17: Not in its current configuration, which depicts soil moisture averaged over ~3-km x 3-km pixels. One would need to apply downscaling methods using higher-resolution datasets to relate the SPoRT-LIS 3-km square pixel outputs to field-scale resolution. We are also limited by scale with SPoRT-LIS data and NISAR will help to provide high resolution data with a finer scale.

Question 18: Can LIS land & soil components be built into different models such as an eco-hydro model (ex: EPA's VELMA model)?
Answer 18: Potentially yes. In the past, there have been such efforts (to couple LIS to a Ammonia estimation model, e.g.) We have to understand the details of these models

before they can be coupled. Note that sometimes the variables in these models have specific interpretations/definitions. The coupling efforts should address such issues.

Question 19: In the animated soil moisture histogram graphs, what did the vertical dashed line represent again? What did the other colored vertical lines represent?
Answer 19: The vertical dashed line is the average 0-200 cm RSM for all grid points contained within the selected U.S. county. The other colored vertical lines are reference percentiles at 2, 5, 10, 20, 30 on the dry anomaly side, and 70, 80, 90, 95, and 98 on the wet anomaly side.

Question 20: Did you say that data for all of North America is available now, or soon? I am interested in data for Canada.
Answer 20: Forthcoming in the next 1-2 years, with a NASA solution in the works for expanding a real-time LIS prototype to all of North America at ~1-km grid spacing. The development effort is being led by Goddard Space Flight Center with a 1 to 2 year timeframe.

Question 21: For a regional watershed, can LIS be coupled with potential evapotranspiration (PET) & evapotranspiration (ET) data (from sources such as NASA's ECOSTRESS), as well as coupled with seasonal changes in "depth-to-groundwater" in shallow alluvial systems to understand how plants respond to varying levels in deep and shallow groundwater?
Answer 21: There have been regional efforts for this, but have been more research based. In different regions, ET is controlled by different factors.

Question 22: How can we deal with 'non-standard' climatic conditions like El Niño or La Niña? Any consideration for including this in the data assimilation? Those events can dramatically affect drought or wetness in soil in a particular period of time.
Answer 22: Since LIS as demonstrated here is not coupled to an atmospheric global climate model, the land surface response occurs based on the observational inputs. There are ongoing efforts to use regional or global climate models to simulate seasonal impacts. But, the forcing observations inherently contain precipitation anomalies associated with these phenomena.