Lab and Questions & Answers Session 3

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: Is there any tool to automate all these processes? Or do we have to write code?
Answer 1: Yes, after obtaining the data, one has to write codes to do the calculations.

Question 2: Why did GLDAS shift to ECMWF when a lot of debate on un-remedied uncertainties of ECMWF is going on?
Answer 2: The ECMWF forcing for GLDAS-2.2 are used because it has short latency (~12hr) and this simulation is used for the US Drought Monitor operation that is updated weekly. Also, ECMWF is considered to be one of the better products (from Dr. Hiriko Beaudoing).

Question 3: What parameter should we take into account to determine which are the months of the dry season or months of the wet season (dry or wet period)? For example: the sum of precipitation or evapotranspiration in percent with respect to the annual total...making a water balance or what is the most desirable method?
Answer 3: For this webinar we have used long-term seasonal mean precipitation to select wet and dry seasons. You can use Giovanni to make seasonal, area-averaged time series of IMERG precipitation from 2000 June onward.

Question 4: Doesn't runoff need to be routed over the basin?
Answer 4: Yes, but in the GLDAS model it is not routed. Water cycling is studied using Precipitation, Evapotranspiration, Water Storage Change and Runoff. We are working on stream flow in the next generation of GLDAS (from Augusto Getirana). Average over a long period of time, you may be able to use that as the monthly average runoff.

Question 5: Can we get some other satellite product with higher resolution of the order of one km for evapotranspiration, runoff, and precipitation?

Answer 5: The MOD16 data we used have 500 m resolution, higher than 1 km. Also, there are Landsat-based products with 30 m resolution.

Question 6: Why is PED negative?
The count column is in decimal numbers. Is it because of the resolution of the raster
Answer 6: Yes, because of the resolution there are sub-basins where partial grid points are included. Negative Precipitation minus Evapotranspiration indicates overall water loss (i.e. greater ET than Precipitation).

Question 7: Please explain how to treat baseflow in a watershed where it is not negligible.
Answer 7: Baseflow modeled outputs are part of the total runoff. Surface runoff and baseflow = the total runoff

Question 8: How precise are these satellite-based precipitation- evapotranspiration-runoff values? Are these values close to those measured from the ground?
Answer 8: These data do not have the same precision everywhere, that is why comparison with in situ data is highly recommended in the region of your interest (e.g. rain gauges, stream gauges, etc.).

Question 9: You have used TWS datasets as it is, you didn't remove the seasonal cycle from it. Could you please briefly explain if there is any role of seasonality in calculating the water budget?
Answer 9: We are taking change in water storage over a season. For that I am not sure you want to remove seasonality. If you are looking at trends, then you may want to remove seasonality.

Question 10: Wouldn't water pumping and irrigation be encompassed within the GRACE / GLDAS Change in Water Storage variable?
Answer 10: In GLDAS 2.2 where GRACE is assimilated it may show water pumping if it is large enough to affect earth’s gravity. But there is no way to distinguish this effect in the outputs. It does not include human activities. Human impact is reflected in the storage metrics.

Question 11: Could you provide a reference which describes the differences between CLSM, NOAH, and VIC models.
Answer 11: Please look at https://ldas.gsfc.nasa.gov/gldas/publications for more information about these models. You may also contact Dr. M. Roddel (matthew.rodell@nasa.gov) for more details.

Question 12: Could we calibrate with the in situ streamflow data? What would be the size of the watershed?
Answer 12: Yes, if you are simulating streamflow you can calibrate the model using in situ data. The watershed has to be bigger than the lowest resolution water data sets used (i.e. > 0.25x0.25 degree for GLDAS and > 3x3 degree if GRACE data used).

Question 13: How to incorporate snow melt into the basin water budgeting presumably with GLDAS? or other methodology?
Answer 13: GLDAS total precipitation includes both liquid and frozen precipitation. Also, snow water equivalent and snowmelt are available from GLDAS. You do not need to add that to total runoff. It is already included.

Question 14: When available in situ data are not overlapping with any collected data from the existing Remote Sensing data, what is the best way to perform the validation? How reliable would that validation be?
Answer 14: If there is no in situ data for validation then you can first examine remote sensing-based water components estimates along with the same from various models. The range in these estimates may be considered uncertainties in the first approximation. You may consider taking multi-model and remote sensing based data and take ensemble means. But without some way of local validation it is not possible to decide the degree of accuracy.

Question 15: Last week's exercise was with the TWS data for the dry season, which was in negative values. I was wondering what the anomaly realistically means for the basin? As a follow up, my total discharge values also came out to be negative. Would that conclude that the basin is water deficit? What other conclusions can be drawn here?
Answer 15: Yes, negative change in water storage is showing that the basin has a water deficit. These datasets could also have errors which could lead to that.

Question 16: Slide 11 of the Part 3 presentation (summary slide), is the uncertainty based on the sum or the mean for each sub-basin?
Answer 16: It is based on the entire Limpopo Basin, yes.

Question 17: Is ET also multiplied by 3600 * 24 * days?
Answer 17: Yes, because we were looking at monthly totals.

Question 18: For the purpose of downloading data from MODIS ET from APPEARS for Ganges it was showing error due to complexity in the shapefile. What should be done to overcome this?
Answer 18: You can add a polygon around the basin to download data, then crop the data raster in QGIS using your shapefile.

Question 19: Is it recommended to estimate the water budget for two river basins (with area 89000 km^2 and 128000 km^2) combined (at level 05 of hydrosheds) especially in the context of uncertainty involved with GRACE/GRACE-FO data? What is your recommendation for estimating a river basin water budget estimation having an area of approx. 90,000 km^2?
Answer 19: You can use GLDAS with .25 resolution. 150,000+ sq. km is a good area to use the GRACE data. Smaller areas than that will likely introduce higher error.

Question 20: If MODIS data does not classify ET for water bodies, sparsely vegetated areas, permanent snow & ice, and permanent wetlands, doesn't excluding these areas from our ET estimate underestimate ET and bias our results? Certainly actual ET is greater than zero for these landcover classes (esp. wetlands).
Answer 20: Yes, that is correct, but the method used in deriving ET would not provide accurate ET over these regions. That is why it is not calculated/defined. There is a new portal coming soon (OpenET in 2021) that will have more accurate ET data.

Question 21: Why is the DTWS March minus December and why don't we use February and January too?
Answer 21: For each month you will be taking the difference: so for the DJF season it will be:
(TWSj-TWSd) + (TWSf-TWSj) + (TWSm-TWSf) = TWSm-TWSd

Question 22: Is there any difference to do the analysis using the original projection (WGS84) and reprojected one? I got a problem while calculating Area using the WGS84 system in Python. Reprojecting to another system gave me the same result as in QGIS.
Answer 22: If you change projections it is likely that you will get different areas. As long as all data are in the same projection overall numbers should not change a lot. You may re-project all the data in a specific projection that is more appropriate for the lat/lon/region of your interest and see how different the numbers are.

Question 23: To compute basin mean values of PR, ET, etc. from subbasin mean values, don't you need to weight by subbasin area?
Answer 23: Yes, that is why we are looking at the total water amount (weighted by the area). The basin mean taken from sub-basin means is just arithmetic mean and we are not using those for water budget estimation.

Question 24: To get all components of the water budget, do you download Precip from GLDAS 2.1 and the other parameters from GLDAS 2.2. Are there problems or special considerations for combining these data?
Answer 24: Yes, potentially there will be uncertainties introduced as GLDAS 2.1 precipitation is not the forcing used for GLDAS 2.2 and outputs from GLDAS 2.2 represent response/balance to a different forcing. Accuracy will be affected. The two versions use different forcing.

Question 25: If we only multiplicate the raster value by 3600 (s/hr) , 24(hr/day) and # days in month, we achieve the value in month. But with kg m-2 , what happens? How do we convert the kg m-2 in mm?
Answer 25: Yes, considering the water density of 1000 kg/m3 - this is equivalent to mm.

Question 26: Will I get a good assessment for a basin with 9,000 km^2?
Answer 26: Only if you have many in situ measurements over that area, possibly. You must know your basin very well though (irrigation, groundwater pumping, etc). The GRACE data spatial resolution will be the limiting factor.

Question 27: Can this model be used for flood evaluation?

Answer 27: Looking at daily/monthly TWS with respect to long-term TWS climatology may tell you if it is wetter than normal conditions, and there may be flooding going on. However, it is not so useful for flash floods. There you have to look at remote sensing data which are more frequent. Please see all of ARSET's past trainings on floods: https://appliedsciences.nasa.gov/join-mission/training?program_area=14

Question 28: Is GLDAS 2.1 suitable to study groundwater depletion?
Answer 28: Not by itself. GLDAS 2.1 does not assimilate GRACE information. We estimate by using the soil moisture. 2.1 is updated monthly (1 month latency). We suggest using GRACE data for depletion estimates.

Question 29: Do you know of any investigation which compares Remote Sensing Observations and Global Land Data Assimilation Model to calculate Water Budget Estimation? In which cases is it better using one or the other?
Answer 29: On a global scale, models usually close the water budget on an annual time scale, but it is tricky for local water budgets to decide what is more accurate.

Question 30: Will GRACE or GRACE combined with GLDAS 2.1 give more accuracy for groundwater availability?
Answer 30: Observations combined with modeled data can result in greater accuracy.

Question 31: The sum PR in volume done for the whole basin during the demonstration is the total accumulated or the average volume?
Answer 31: Yes, total accumulation in the basin.

Question 32: How to create a PR, ET, TWS tiff file with field data?
Answer 32: To include field data in one's analysis, save the point data with collected attributes as a shapefile and convert to raster. Make sure to use the same projection and spatial resolution as the files you are performing analysis on.

Question 33: In the exercise, page 15, it says that the Baseflow runoff is negligible and can be ignored. How then can I consider the groundwater in the water budget calculation, with TWS from GRACE data?
Answer 33: TWS includes groundwater in GLDAS.

Question 34: Are GRACE data from GFZ and CSR freely accessible?
Answer 34: Yes, they are. The JPL data portal has these data.