**WaPOR Evapotranspiration Validation Exercise**

In this exercise, you will validate WaPOR AETI data at [SD-DEM flux tower](https://fluxnet.org/doi/FLUXNET2015/SD-Dem) (location in Sudan: Latitude: 13.2829, Longitude: 30.4783). You will practice converting reference data (i.e., latent heat flux from Eddy Covariance flux tower) to the same unit, temporal and spatial scale of WaPOR AETI layers.

**First, download the data provided for this exercise from the OCW.** This spreadsheet includes

* FLUXNET2015 daily subset for SD-DEM station
  + Data can also be downloaded from <https://fluxnet.org/data/download-data/#0>
* Areal Time-series of a buffer zone around SD-DEM from WaPOR v2 AETI Level 1 and Level 2 (buffer zone also available on OCW)
  + Data can also be downloaded from WaPOR portal. See how to collect Area Time-Series data in the tab “accessing WaPOR”.

**Task 1: Calculate daily ET from Latent heat flux**

* In the first tab of the spreadsheet, you will find the **FLX\_SD-Dem\_FLUXNET2015\_FULLSET\_DD\_2005-2009\_2-4** subset of FLUXNET2015. In the ***1\_DailyET*** tab, a subset of the first tab for the year 2009 with only 3 variables: LE\_F\_MDS, LE\_F\_MDS\_QC, and LE\_CORR.
* Read the description of FLUXNET2015 dataset at <https://fluxnet.org/data/fluxnet2015-dataset/fullset-data-product/>
* Convert LE\_CORR to Actual evapotranspiration mm day-1 (or mm/day)

*Answer the questions below*

Based on the description of FLUXNET2015 dataset, which of the following statements are true?

* LE\_F\_MDS is the Latent heat flux (W m-2), gapfilled using MDS method
* LE\_F\_MDS\_QC is Quality flag for LE\_F\_MDS and LE\_CORR. Fraction between 0-1, indicating percentage of measured and good quality gapfill data.
* LE\_F\_MDS is the Actual evapotranspiration (mm day-1), gapfilled using MDS method
* LE\_F\_MDS\_QC is Quality flag for LE\_F\_MDS and LE\_CORR. Fraction between 0-1, indicating percentage of bad quality gapfill data.
* LE\_CORR (W m-2) is the Latent heat flux, corrected LE\_F\_MDS by energy balance closure correction factor
* LE\_CORR (W m-2) is the Actual evapotranspiration (mm day-1), corrected LE\_F\_MDS by energy balance closure correction factor

If we consider only the dates with more than 60% of measured and good quality gapfill data, which of the following dates should be excluded?

* 04/12/2009
* 05/12/2009
* 03/12/2009

**Task 2: Calculate dekadal ET**

* In ***2\_DekadalET*** tab, you will find the first and last dates of each dekad.
* Calculate the daily average ET of each dekad.
  + Hint: You can use AVERAGEIFS function in spreadsheet. For example, *C3 = AVERAGEIFS('1\_DailyET'!$F$2:$F$366;'1\_DailyET'!$B$2:$B$366;">="&'2\_DekadalET'!A3;'1\_DailyET'!$B$2:$B$366;"<="&'2\_DekadalET'!B3)*
* Answer the questions below

Because WaPOR dekadal AETI data are daily average, we need to calculate the daily averages of dekads from the daily actual evapotranspiration data when validating WaPOR data.

* True
* False

The buffer zone was used to extract time-series so that WaPOR data can be compared with the area that the flux tower represents.

* True
* False

**Task 3: Calculate performance metrics and visualize data**

* Plot the time-series of observed ET and WaPOR L1, and WaPOR L2
* Exclude the dekads with low-quality EC flux tower data
* Calculate performance metrics applying the formula in the ***3\_PerformanceMetrics*** tab of the exercise spreadsheet
* Pearson's correlation coefficient (r) [ - ]
* Root Mean Squared Error (RMSE) [mm/day]
* Bias or Mean Error [mm/day]
* Mean Absolute Percentage Error (MAPE) [%]
* Coefficient of determination (R2) [ -  ]
* Hints: You can use spreadsheet functions
* *PEARSON*to calculate Pearson's correlation coefficient
* *COUNT*to calculate the number of values
* *SUM*to calculate the sum of selected values
* *SUMSQ*to calculate the sum of the squares of selected values
* *AVERAGE*to calculate the mean of selected values
* *ABS*to calculate absolute of selected value
* Answer the questions below

What is the number of dekads with good quality reference data that can be used for validation?

* 34
* 35
* 33
* 36

*Place the values into the correct spaces*

For validation of WaPOR AETI at SD-DEM EC flux tower:

Pearson's correlation coefficient of WaPOR L1 is \_\_\_\_\_\_\_\_\_ and WaPOR L2 is \_\_\_\_\_\_\_\_\_\_.

Root Mean Squared Error of WaPOR L1 is \_\_\_\_\_\_\_\_\_\_ and WaPOR L2 is \_\_\_\_\_\_\_\_\_\_ mm/day.

Bias or Mean Error of WaPOR L1 is \_\_\_\_\_\_\_\_\_\_ and WaPOR L2 is  \_\_\_\_\_\_\_\_ mm/day.

Mean Absolute Percentage Error of WaPOR L1 is \_\_\_\_\_\_\_\_\_ and WaPOR L2 is \_\_\_\_\_\_\_ %.

Coefficient of determination of WaPOR L1 is \_\_\_\_\_\_\_\_\_\_\_ and WaPOR L2 is \_\_\_\_\_\_\_.

0.761

0.632

0.893

0.94

0.305

0.756

0.227

45.88

47.39

0.6410