Big Data, organization and analysis

Evapotranspiration data from Satellite MODIS product

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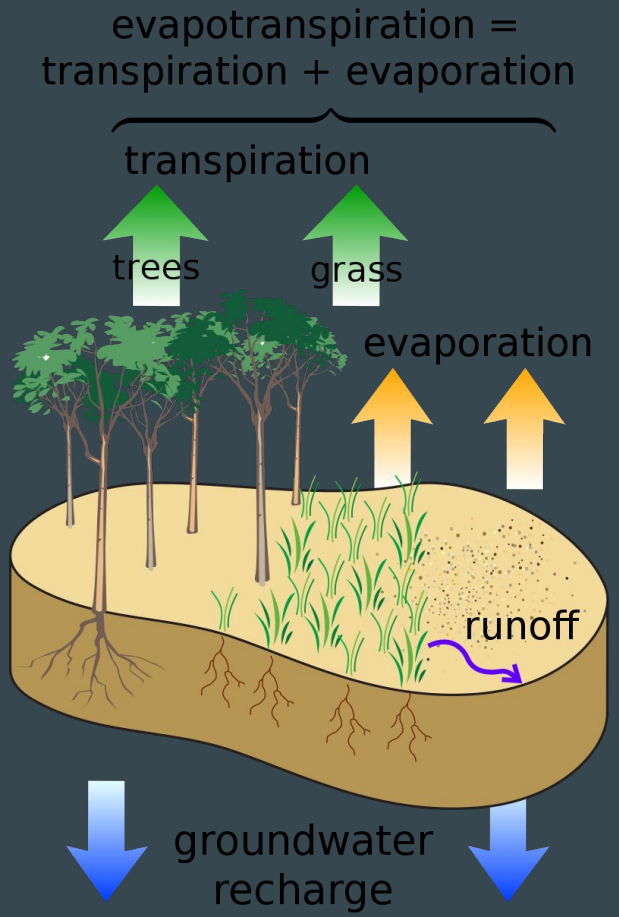
Outline

- Understand what is Evapotranspiration
- Water balance in river basins, Forest photosynthesis
- Application for Extracting and Exploring Analysis Ready Samples (AρρEEARS)
- Download the data
- Import the data into Google Colab
- Resample the data
- Plot and compare different watersheds

What is Evapotranspiration?

What is Evapotranspiration?

- Transpiration + Evaporation
- Potential x Real evapotranspiration

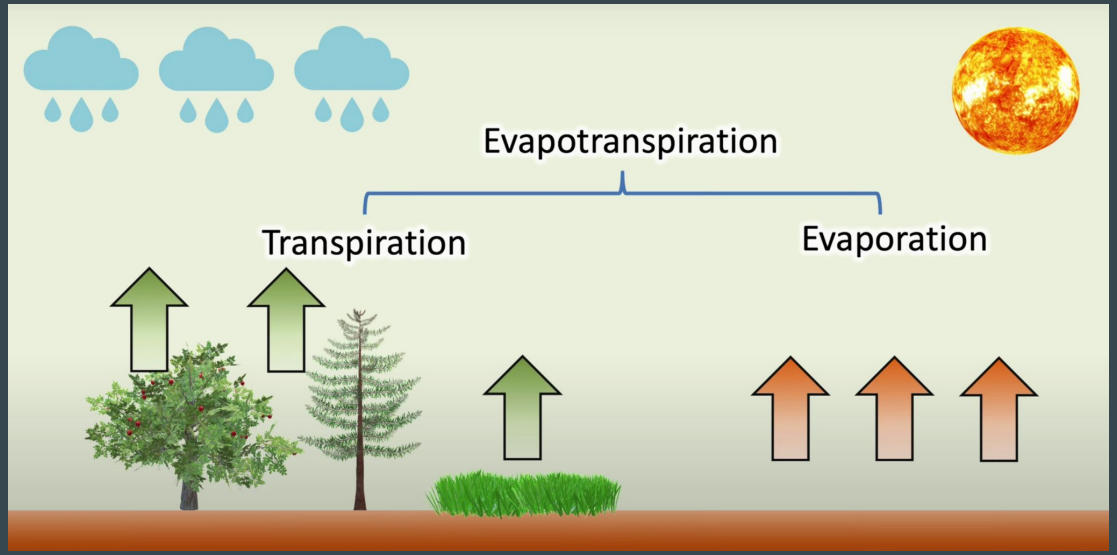


https://en.wikipedia.org/wiki/Evapotranspiration

What is Evapotranspiration?

Forces governing ET:

- Solar radiation
- Water availability in soil/plant
- Water vapor gradient in air
- Water vapor wind transport



Introduction to MODIS Evapotranspiration (MOD16) - a free global dataset of ET & PET
https://www.youtube.com/watch?v=3r_6il0EViw

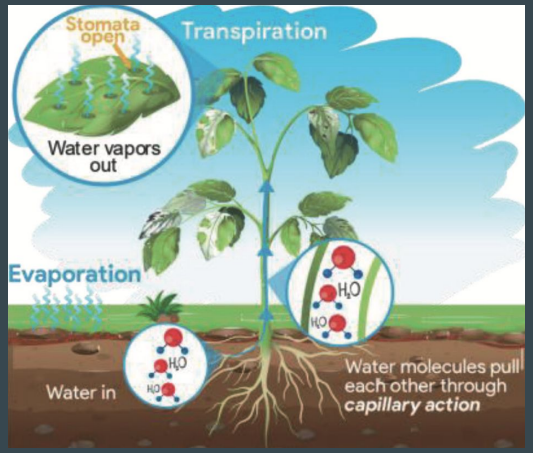
In **vascular plants**, water exits the plants through the **stomata** in the leaves whereas, in **nonvascular plants** (Bryophytes, Moss and Algae), it exits through the **phyllids**.

https://en.wikipedia.org/wiki/Non-vascular_plant

Transpiration in Vascular Plants

- plants retain less than 5% of water absorbed by roots for growth.

  ⟶ it goes back to the atmosphere!

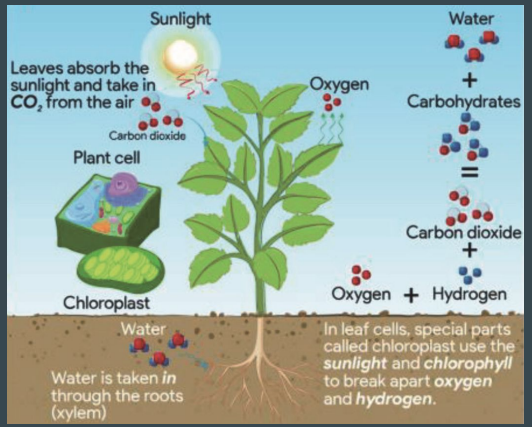


transpiration

Photosynthesis

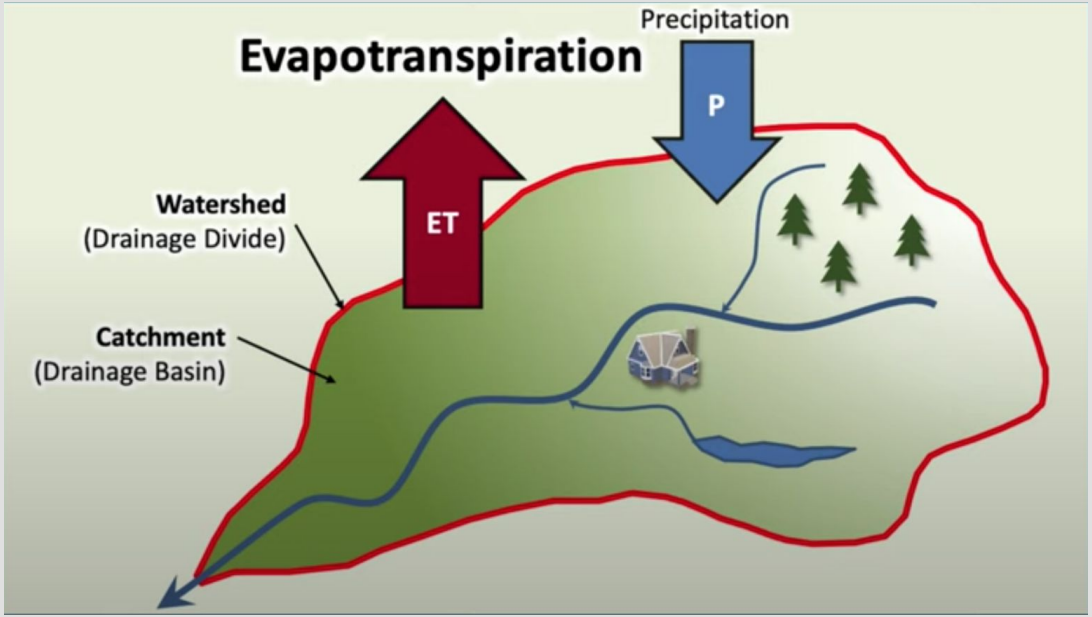
$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{H_2O} + \underset{\text{light energy}}{\text{photons}} \rightarrow \underset{\text{carbohydrate}}{[CH_2O]} + \underset{\text{oxygen}}{O_2}$$

- To make sugars, plants must absorb carbon dioxide (CO2) from the atmosphere through **stomata.**



photosynthesis

Water balance in river basins



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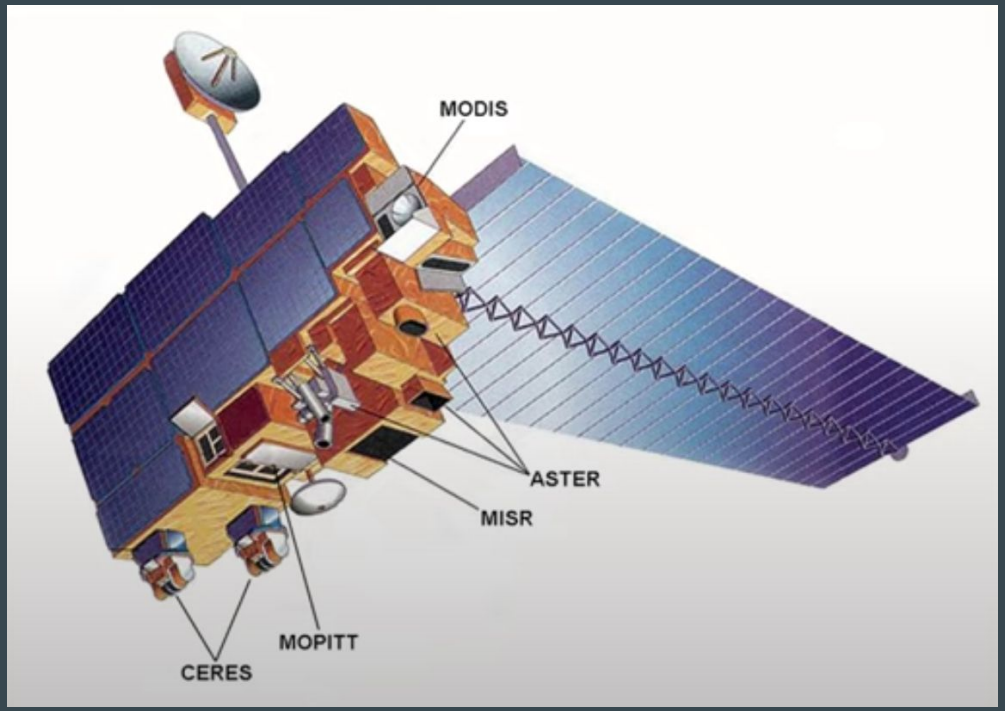
What is MODIS?



- Instrument on board of TERRA & AQUA satellites (NASA)

- TERRA = "MOD"
- AQUA = "MYD"

MODIS MOD16 ET Product

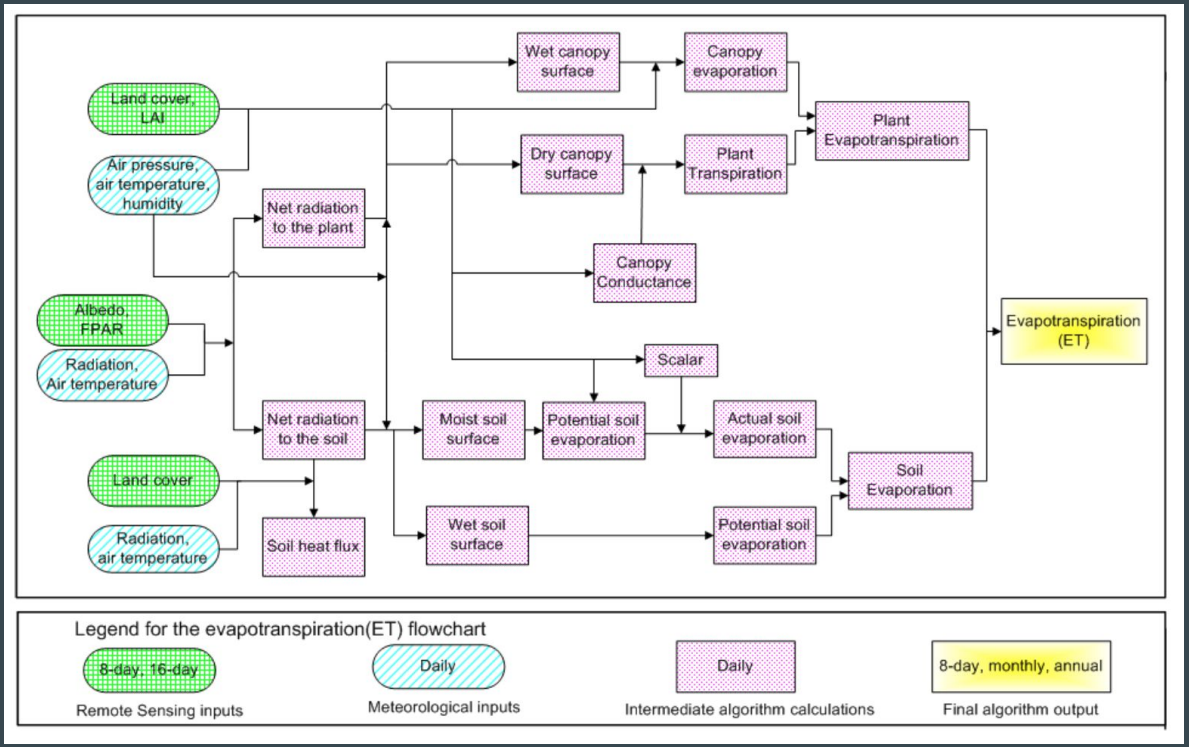
- Evapotranspiration (ET) ➡
  - Total ET
  - Total PET
- Latent Heat Flux (LE)
- Quality control flags

MODIS MOD16 ET Product

- MODIS ET algorithm follows the Penman-Monteith equation.
- Includes evaporation from wet and moist soil, evaporation from rainwater intercepted by the canopy before it reaches the ground, and the transpiration through stomata on plant leaves and stems
- The MOD16A2/A3 ET products are produced at the 8-day and annual intervals.

https://lpdaac.usgs.gov/documents/93/MOD16_ATBD.pdf

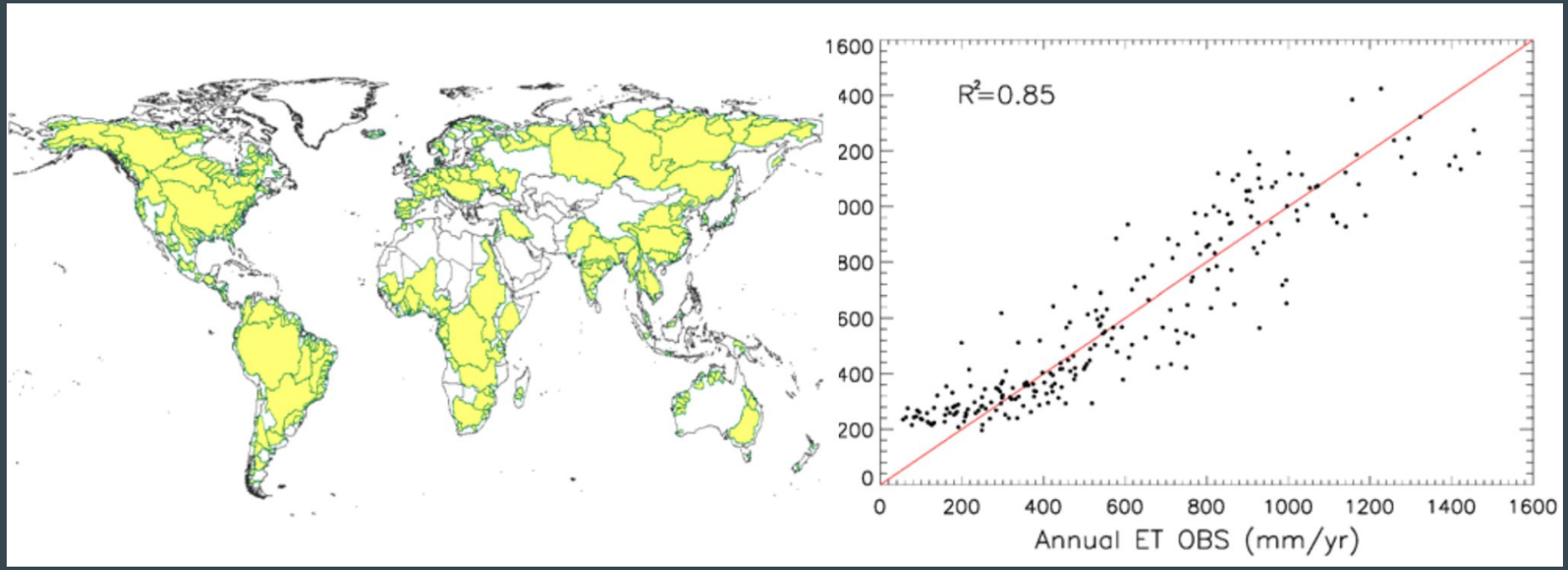
Flowchart of the improved MOD16 ET algorithm.



LAI: leaf area index; FPAR: Fraction of Photosynthetically Active Radiation.

https://lpdaac.usgs.gov/documents/93/MOD16_ATBD.pdf

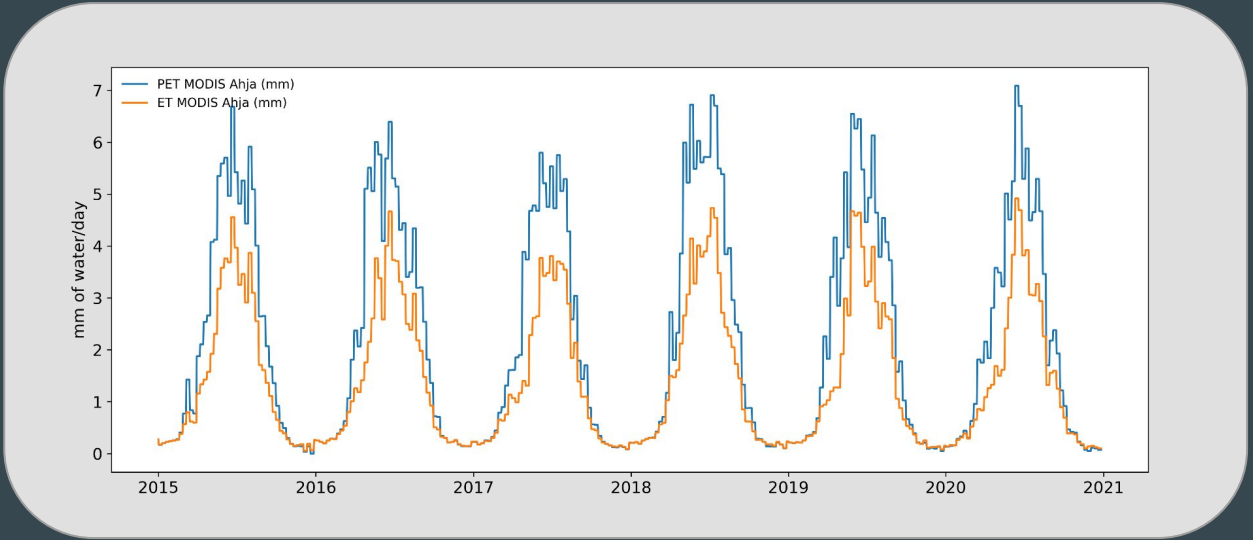
Algorithm Performance at Global Watersheds



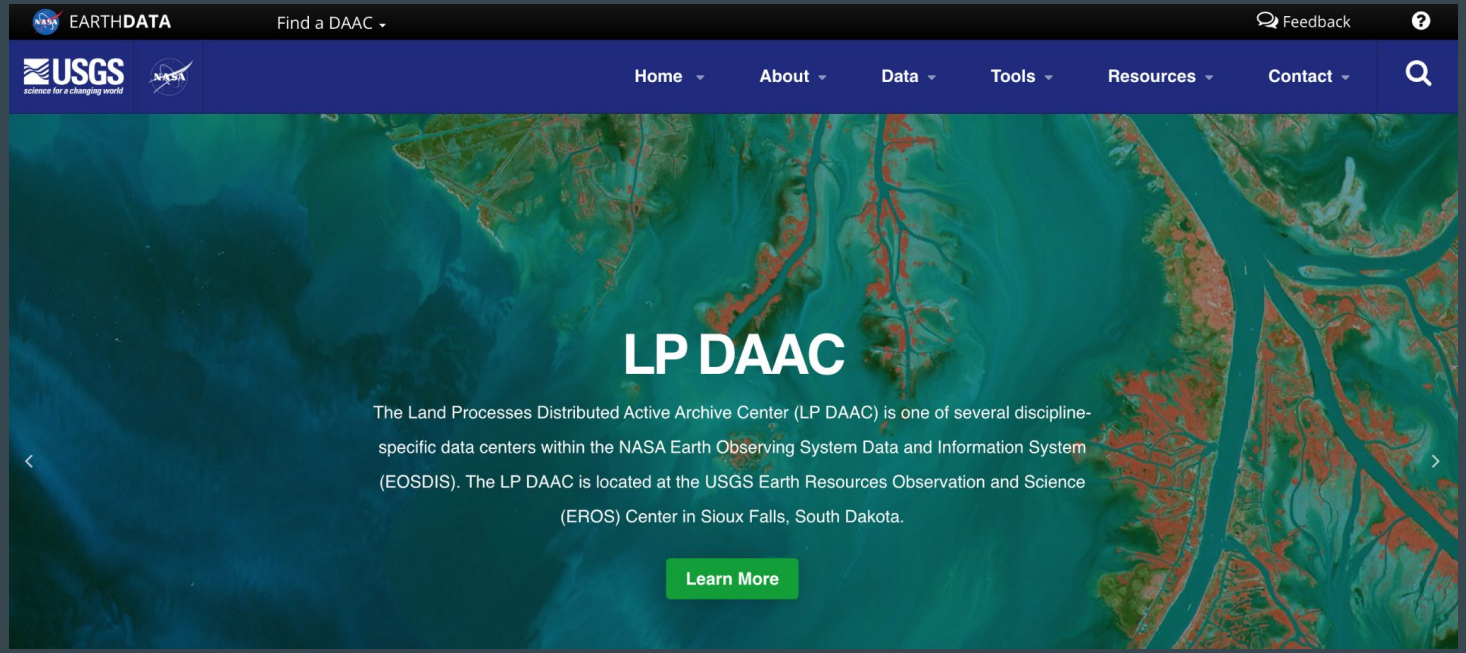
The MOD16 ET estimates can explain 85% of the variations of the pseudo-ET observations for 232 river basins.

Time series: 2015 to 2021

- Global evapotranspiration data set
- Spatial resolution: 500 x 500 m
- View some ET and PET data from Ahja river basin, Estonia

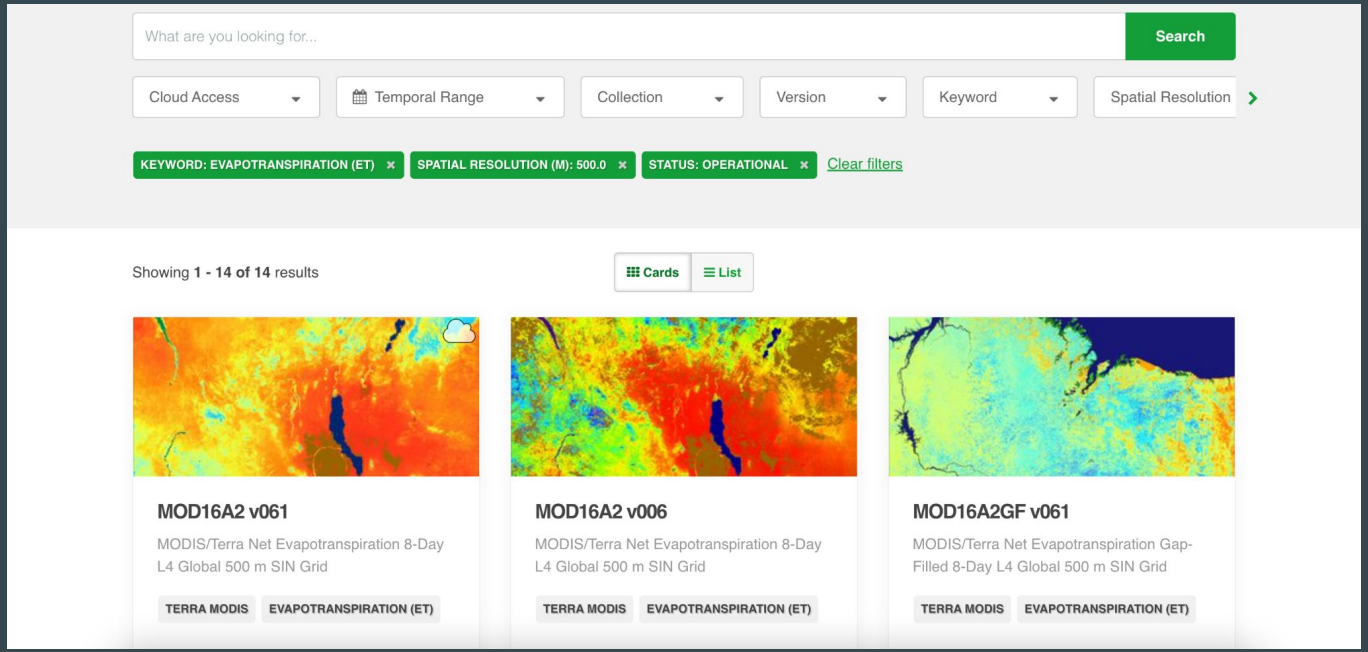


Search Data Catalog



The Land Processes Distributed Active Archive Center (LP DAAC) is one of several discipline-specific data centers within the **NASA Earth Observing System Data**
https://lpdaac.usgs.gov/

Search Data Catalog

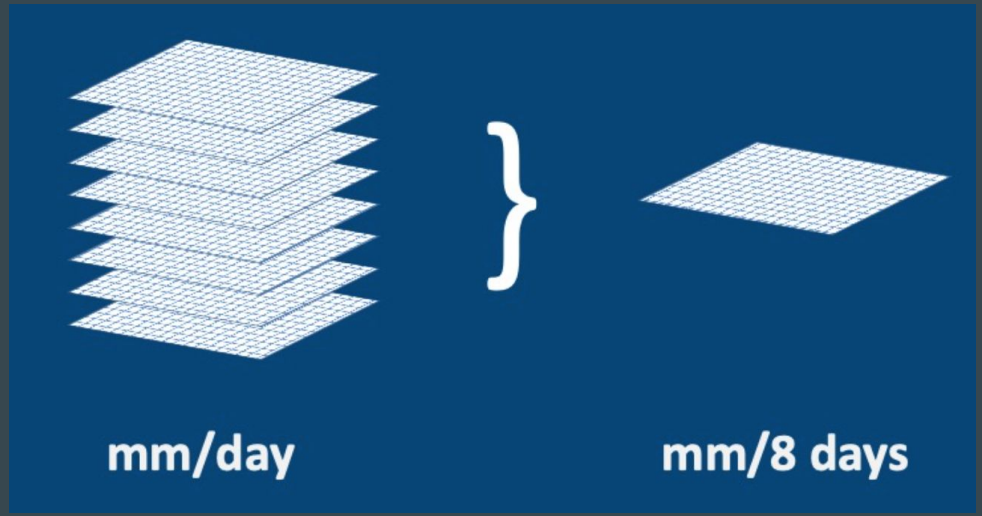


MOD16A2.* and MOD16A2GF.* files
https://lpdaac.usgs.gov/

MODIS MOD16A2GF Version 6

- Global ET & PET dataset
- Spatial resolution: 500 m x 500 m
- Time series: January 2000 - 2022 (22 anos)
- Time steps: 8-day composite

8-day composite



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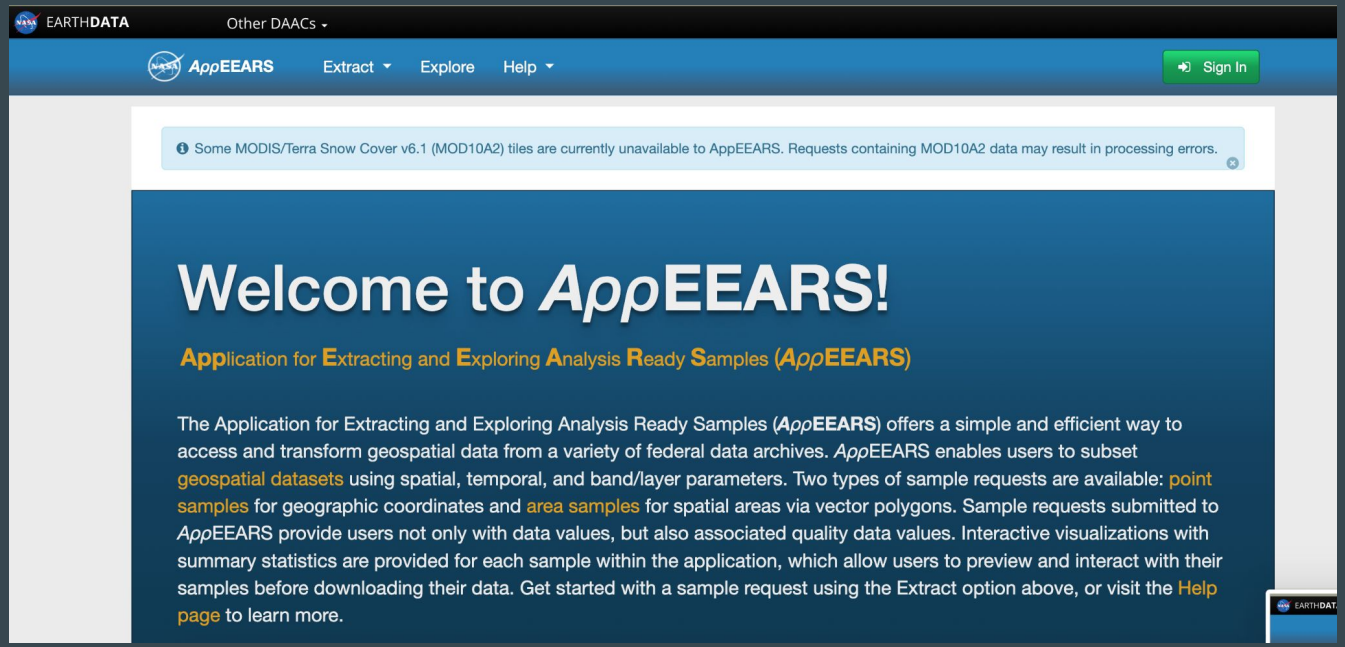
AppEEARS - sign in!



Application for Extracting and Exploring Analysis Ready Samples (AppEEARS)
https://appeears.earthdatacloud.nasa.gov/

AppEEARS - Downloading the ET data

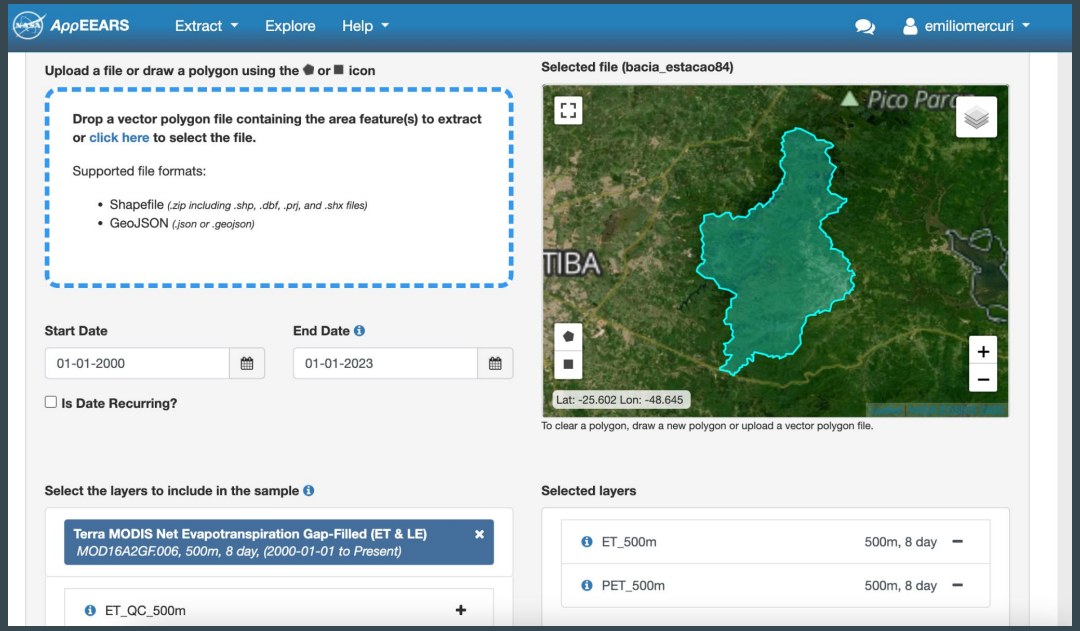
- Access the GitHub of the class:

  https://github.com/stenoe/BDOA

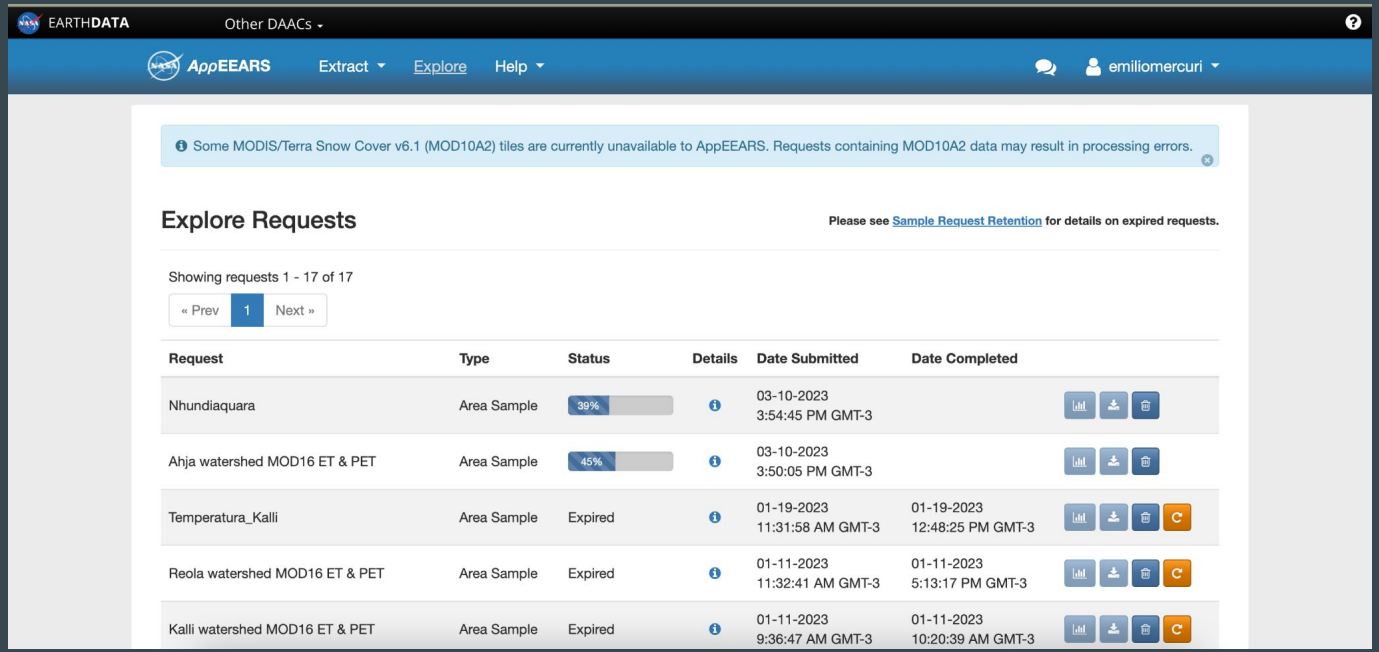
- Download 3 Shapefiles (perimeter of the water basins)
  - Nhundiaquara river (Paraná - Brazil)
  - Ahja river (Estonia)
  - Salma river (Afghanistan)
- Download the 3 zip files!

Access AppEEARS - Downloading the ET data

- Extract -> Area -> Start a new request
  - Enter a name to identify your sample: **Nhundiaquara**
  - Drop a vector polygon: **nhundiaquara.zip**
  - Select the layer: **MOD16A2GF**



AppEEARS - data from Estonia, Afghanistan and Brazil



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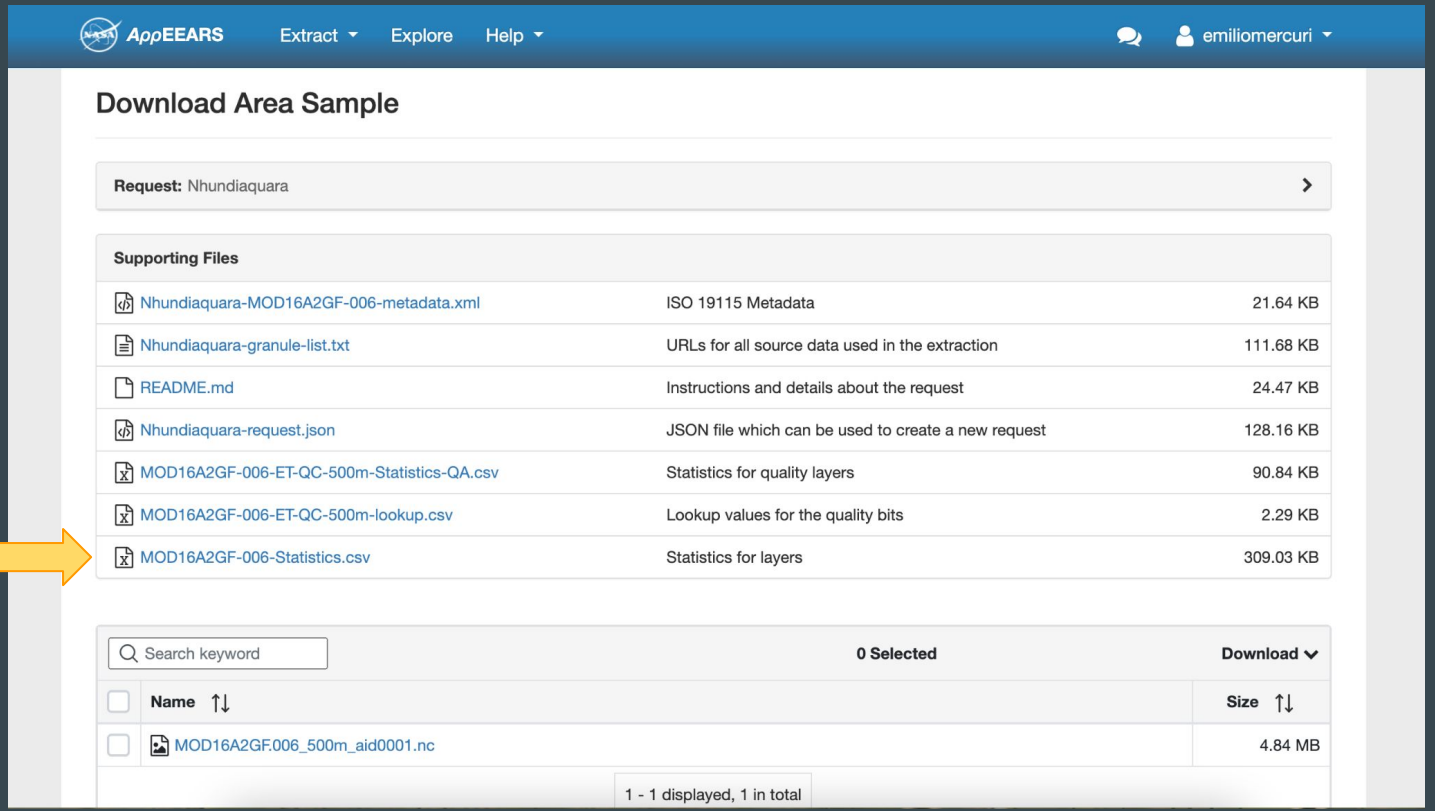
Download the data



Download the data - File formats, projections

- QGIS - Shapefile preparation -> zipfile
- **Data formats:**
  - NetCDF (Network Common Data Form) version 4
  - GeoTIFF
  - CSV file (MOD16A2GF-006-Statistics.csv) - We will only use this one!
    - ET and PET comes in $kg/m^2/8\text{-day} = mm/8\text{-day}$
- **Projection:**
  - Geographic
  - Datum: WGS84

Thanks! Let's code!

Google Colab

What we will do:

- Import the data into COLAB
- Process it to daily data
- Compare ET from Afghanistan Brazil and Estonia