# Seeds of Change: Equipping Scientists with NASA's Climate-Sensitive Agricultural Tools

Walid Ouaret[1] K. Arthur Endsley[2] Molly E. Brown[1] Mourad Latati[3] Mohsen Nabil[4]

[1]University of Maryland, U.S.A. [2]University of Montana, U.S.A. [3]École Nationale Supérieure Agronomique, Algiers, Algeria
[4]National Authority for Remote Sensing and Space Sciences (NARSS), Cairo, Egypt

## Barriers to Open, Data-Driven Agricultural Science

- I want to study long-term climate trends, but how do I keep all the data organized?
- How can I effectively communicate what I've discovered?
- I have research code but it's constantly changing!
- Climate data are too large and the files are too complex!
- Computation is done—how do I know I got the right result?

*Image credit: NASA Goddard Space Flight Center*

## Learning Outcomes ("I can..." or "I know how...")

### Project and Data Management

- Organize a project directory and name files to effectively keep track of relationships between code, results, and metadata.
- Use a package manager to install and manage software dependencies.

### Scientific Programming

- Understand and work with multidimensional arrays.
- Profile the resource use of a computational workflow.
- Read and write hierarchical datasets (HDF5 or netCDF4).

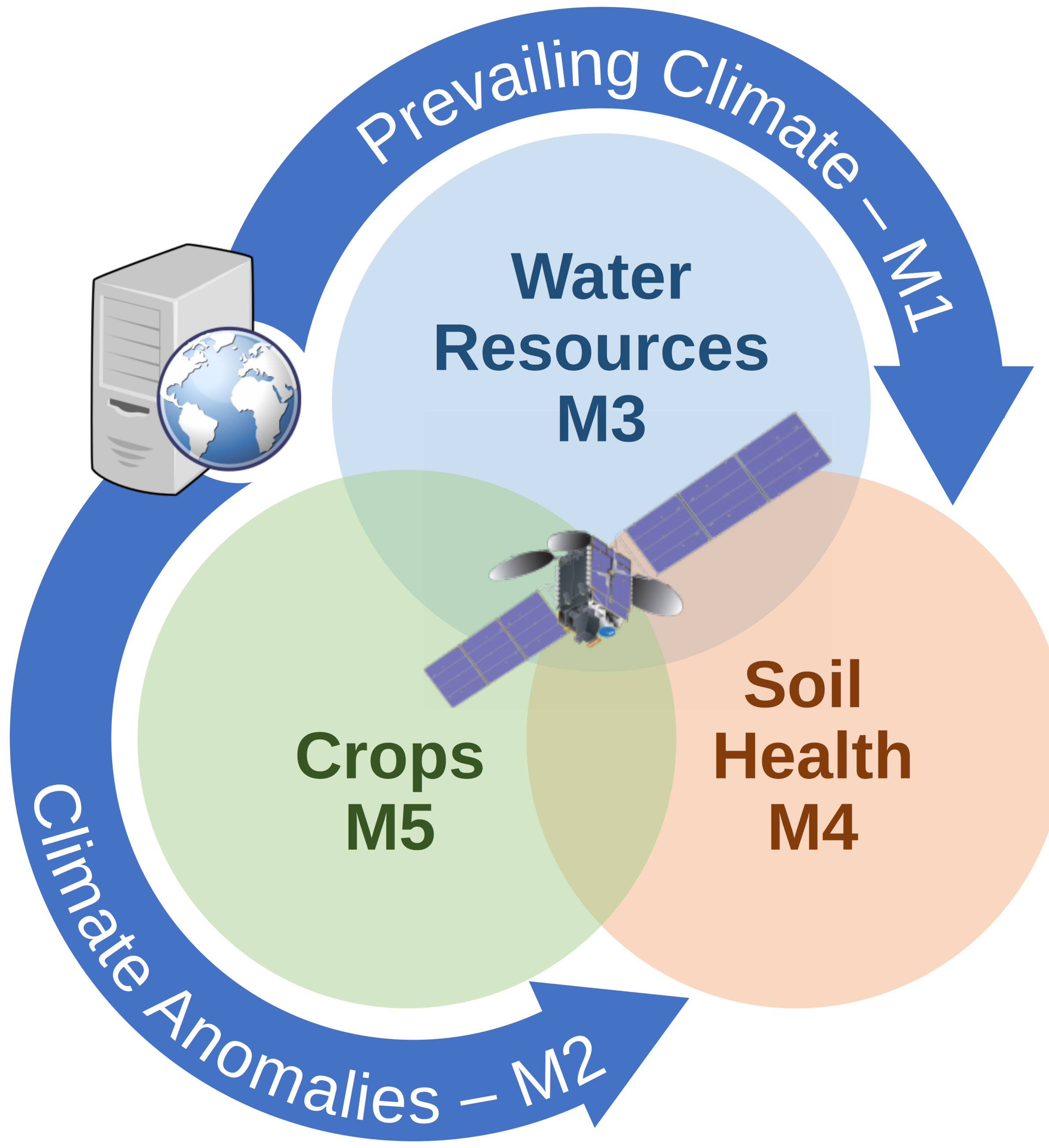
### Collaborative Computational Science

- Use source control management to track changes to research software.
- Avoid misleading data visualization techniques.
- Write in a consistent and legible coding style.
- Use literate programming to combine narrative, code, and analysis.

### Sustainable Computational Science

- Create reproducible workflows to support scientific claims.
- Document and expose the runtime input parameters for a software's API.
- Verify correct execution of computer code using assertions and tests.

## Our curriculum, "Open Climate Science for Agriculture," consists of five modules:

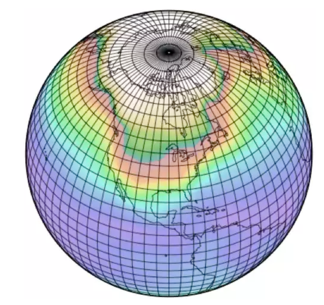



Make your contribution! Our open-source, Python-based curriculum is currently in development. For more information: https://OpenClimateScience.github.org


## M1: Open Climate Data

What NASA satellites, field data, and models can be used to analyze and predict Earth's climate variability?

- Learn how re-analysis data, General Circulation Models, and Earth Systems models are generated and how they differ.
- Discover climate datasets at relevant spatial and temporal scales.



## M2: Computational Climate Science

How can we analyze gridded climate datasets with spatial and temporal attributes? Culminates in calculating a drought index.

- Describe the interpretation and calculation of climate normals, climate anomalies, and a climatology.
- Learn what indices are available for meteorological drought, soil moisture, drought, atmospheric water demand, and canopy greenness.

## M3: Open Science for Water Resources

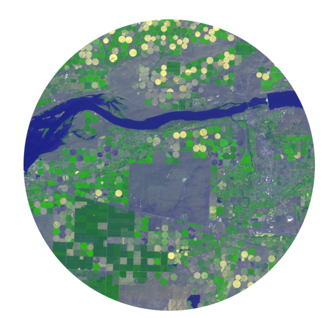
What tools and datasets are available to quantify water quantity and availability? How can we calculate a water budget?

- Learn about the major fluxes and pools of the terrestrial water cycle.
- Know where to access remotely sensed or modeled data on water storage anomalies, evapotranspiration, and soil moisture

## M4: Open Science for Soil Health

How can satellite observations and models help to predict and map indicators of soil health? Train a classifier to map dynamic soil properties.

- Know what remote-sensing and model-derived datasets are available to map dynamic soil properties (pH, SOC, soil texture).



## M5: Open Science for Crop Conditions and Crop Production

How can NASA datasets be used to map crop conditions?

- Understand how plants link between the carbon and water cycles through photosynthesis and evapotranspiration.



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