**NASA DEVELOP National Program**



NASA Jet Propulsion Laboratory

*Summer 2015*

New Mexico Water Resources and Agriculture

Delivering Automated Evapotranspiration Data to the New Mexico Office of the State Engineer for Enhanced Water Resource Decision Making in New Mexico

 **Technical Report**

Rough Draft – June 25, 2015

Sol Kim (Project Lead)

Agustin Muniz

Trevor Mcdonald

Joshua Fisher, NASA Jet Propulsion Laboratory (Science Advisor)

Greg Moore, NASA Jet Propulsion Laboratory (Science Advisor)

# I. Abstract

[Placeholder - do not put anything here until the final draft submission. The abstract in the project summary is where the working draft of the abstract should “live”]

**Keywords**

Evapotranspiration, drought, remote sensing, water management, land management, emergency response

# II. Introduction

Equipping water resource management with evapotranspiration data becomes increasingly vital, as New Mexico is experiencing some of the most severe drought in the US. Knowledge of rangeland conditions is necessary for decisions regarding water resources management, cattle management, emergency response for rapid rangeland and farmland deterioration, fire management risk decisions, and determining drought severity. This project delivered a high-resolution evapotranspiration product to New Mexico decision-makers and addressed two NASA national application areas: water resources and agriculture.

New Mexico land managers currently assess rangeland conditions using spatially limited *in situ* spot checks, which provides limited information. Additionally, weekly evapotranspiration products for New Mexico counties are not widely distributed nor easily accessible.

By providing an automated, streamlined, non-proprietary evapotranspiration product to the New Mexico Office of the State Engineer, New Mexico decision makers will have easy access to critical evapotranspiration data which will drive water resource decision making. The analysis will start January 2000 and conclude with the present date.

# III. Methodology

The current data set consists of fourteen level-two data products. Six MODIS land, four MODIS atmosphere, and four NCEP datasets provide high-resolution continuous data over land for the period of interest. We downloaded data from several archive centers into the JPL institutional machine, zodiac. We accessed data archive centers on a daily basis to check for new data. This provides near real-time functionality by automatically retrieving and processing additional data seamlessly without the need for manual interaction. We validated the data and stored it in a pre-processing location where the conversion process can access it.

The MODIS atmospheric products that required re-gridding and tilling were: MOD04, MOD05, MOD06, and MOD07. These are all level-2 MODIS products that come in swath format. We initially retrieved the data from NASA’s level-1 and Atmosphere Archive and Distribution System (LAADS) then stored it in a pre-processing database.

The format of the remaining MODIS data used in the evapotranspiration is in the format of Sinusoidal Tile Grid. Tiles are ten by ten degrees at the equator and were re-gridded to transform the swath data into Sinusoidal Tile Grid format. The evapotranspiration algorithm calculates on a tile-by-tile basis to allow for parallel computing. To accomplish this transformation, the data goes through three different steps: gridding on sinusoidal projection, stitching appropriate granules together, and finally subsetting out tiles.

The primary tool used to accomplish the three step transformation is the HDF-EOS to GeoTIFF Conversion Tool (HEG). The first step uses a bourne shell scrip to grid the swath data onto sinusoidal projection. The shell script takes the pre-processing database and performs a swath to grid function, swtif, to every hierarchical data format (hdf) file that is from the same day. The parameters used:

* Output file type: hdf
* Resampling type: nearest neighbor
* Projection: sinusoidal
* Pixel Size (X,Y): 4633.1271653m (Corresponds to 5km resolution)

For every file input, the output is a new hdf file that is gridded in sinusoidal projection and an ASCII file that contains metadata.

Once all files for a given day are converted to sinusoidal grid format, another shell script determines the domain of each Sinusoidal Tile Grid that overlaps Earth using a text file that contains the bounding coordinates. When the tile’s domain is determined, the newly created output files containing metadata are searched to find granules that have any overlap with the given tile. If it overlaps the tile’s domain, it is recorded for use as an input file. When all the files that contain overlap with the tile are collected they are then stitched together using HEG to create one mosaicked file.

The last step is taking the mosaicked file and subsetting out the tile’s domain and saving it to a post-processing database.

# IV. Results & Discussion



**Figure 1.** A visual representation of the automated data pipeline architecture. The pipeline initially retrieves the data and sends some data for processing. Once processing is done, all data is fed into an evapotranspiration (ET) algorithm to create ET outputs. The outputs will be hosted on a web server.





**Figure 2.** Taking a granule of swath MODIS (MOD05\_L2 Water Vapor Infrared) data (top) and re-gridding onto a sinusoidal projection (bottom).

# V. Conclusions

Final conclusions. Word count: 200-600 (~a page).

# VI. Acknowledgments

We thank everyone who helped in our project. Science advisors Joshua Fisher, Greg Moore, and Manish Verma provided insight and expertise that greatly assisted the research. Gwen Miller, Christine Rains, and Daniel Jensen assisted throughout the project guiding us through deliverables and answering research questions. This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.

# VII. References

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# VIII. Content Innovation

We have used HDF-EOS to GeoTIFF Conversion Tool (HEG) to regrid MODIS Level 2 Atmospheric Products into Sinusoidal Tile Grid format. A combination of three features within HEG are used to accomplish the task: regrid/projection, stitching, and subsetting.

We implemented the data pipeline architecture to facilitate the unsupervised near real-time retrieval and processing of MODIS data. We wrote the pipeline that consists of a data retrieval component in Python. The Python code invokes Wget commands. These Wget commands perform the heavy lifting of actually downloading the data. Wget is a non-interactive utility that retrieves content over the web. To have the download component execute regularly, a cron job is setup to invoke the Python code on a daily basis. The Cron software utility is a time-based job scheduler in Unix-like operating systems.

# IX. Appendices

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