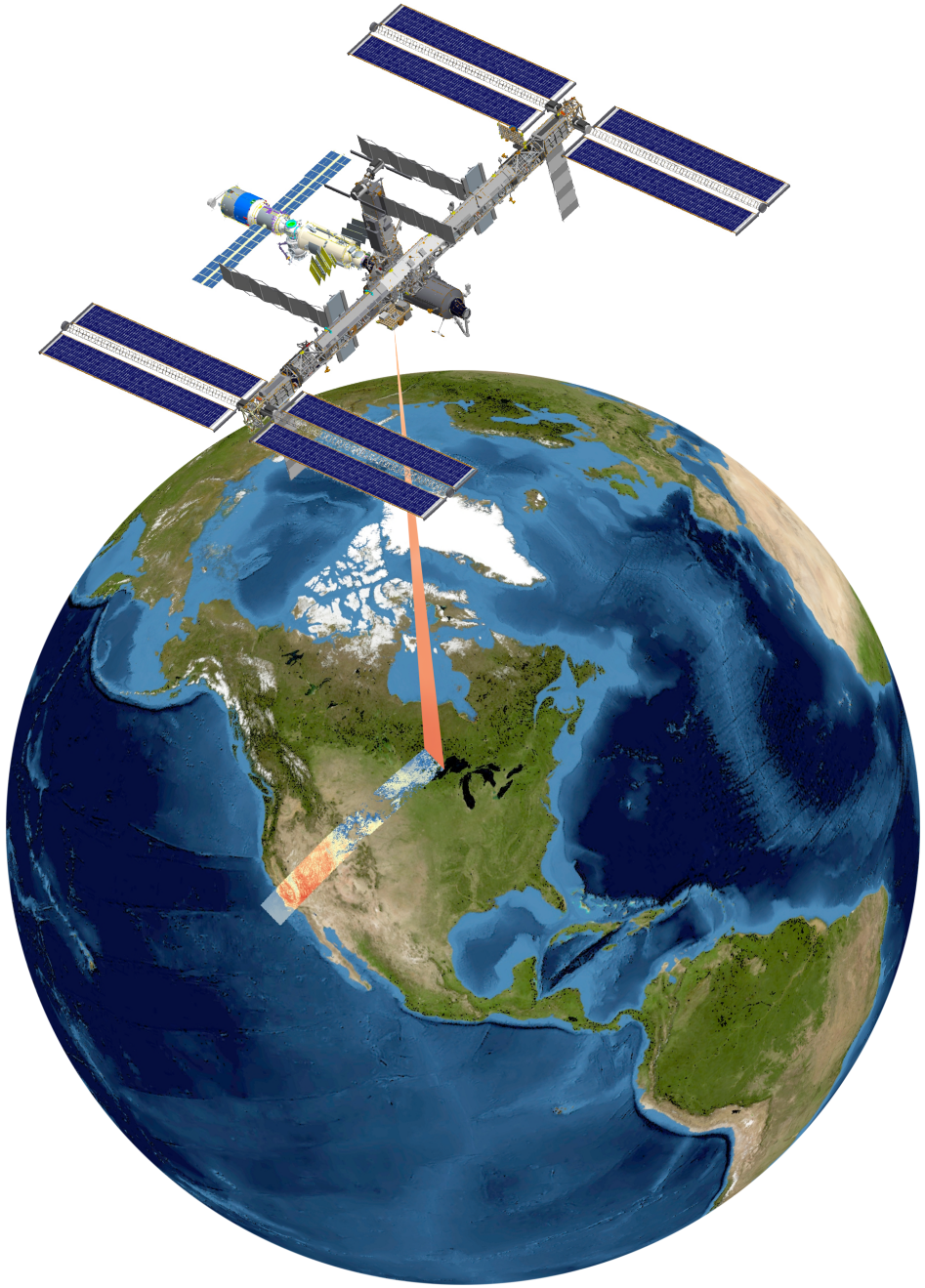
Hands-on Workshop for Accessing, Visualizing, and Analyzing ECOSTRESS Data



Gregory Halverson
Jet Propulsion Laboratory, California
Institute of Technology, Pasadena, CA, USA

Cole Krehbiel[1]
[1]LP DAAC Remote Sensing Scientist
KBR Inc., contractor to USGS EROS
Sioux Falls, South Dakota

*Work performed under USGS contract G15PD00766

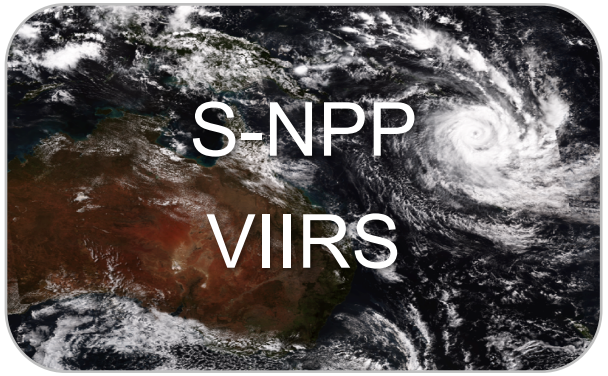
U.S. Department of the Interior
U.S. Geological Survey

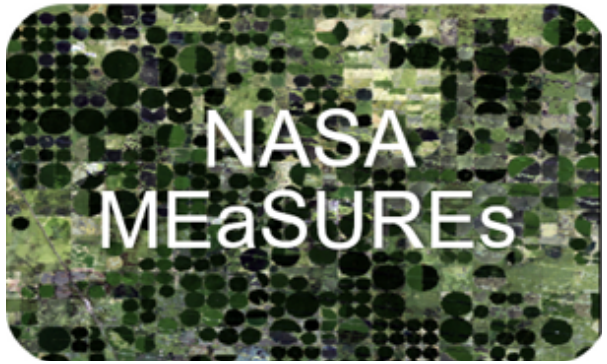
Wednesday, February 12, 2020

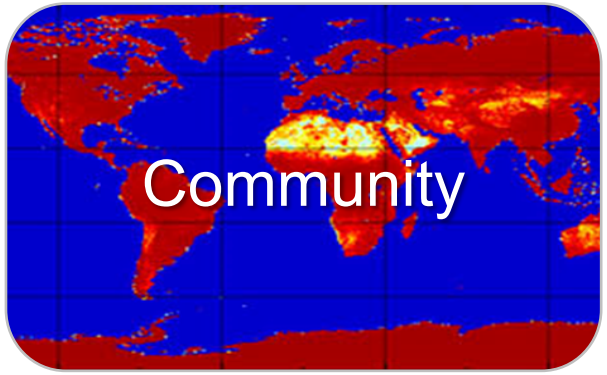
Outline

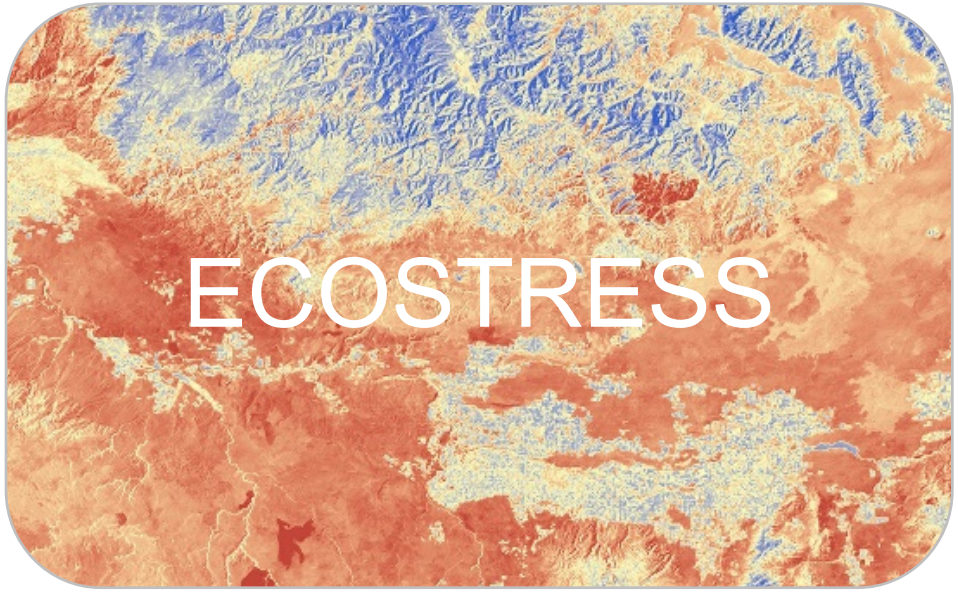
- Introductions
- ECOSTRESS Products
- E-Learning Materials and Resources
- AppEEARS
- AppEEARS Walk-through: Accessing ECOSTRESS data for a real-world use case
- Processing and quality filtering in Python: Jupyter Notebook
- Techniques for Visualizing ECOSTRESS Data in QGIS
- Making Maps in QGIS

LP DAAC Data Collections



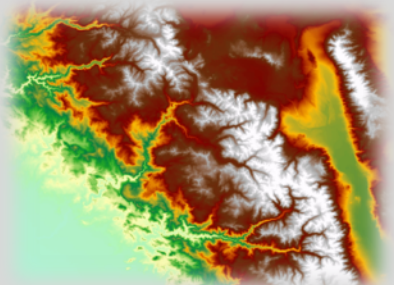






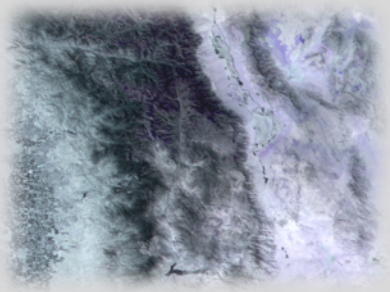
USGS NASA

ECO1BATT.001

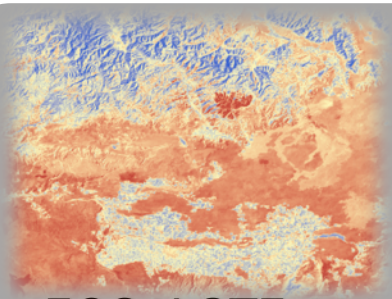


ECO1BGEO.001

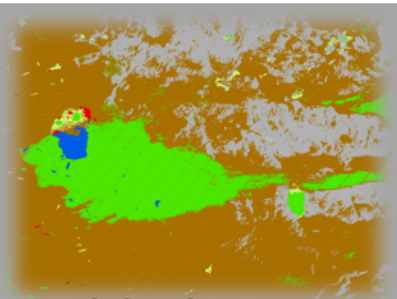
ECO1BRAD.001



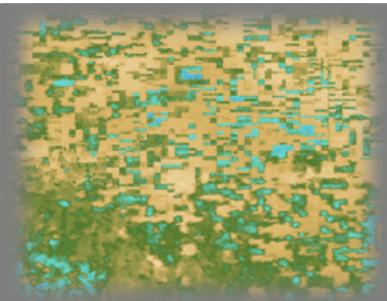
ECO1BMAPRAD.001



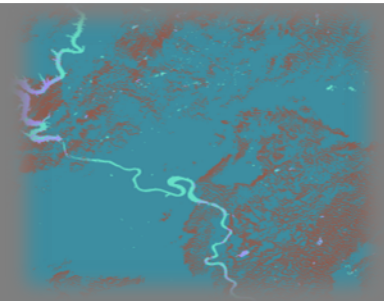
ECO2LSTE.001



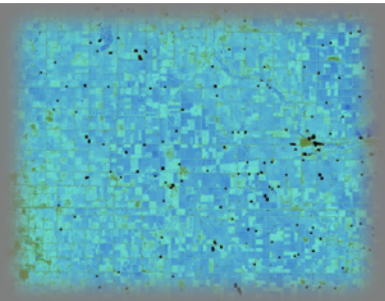
ECO2CLD.001



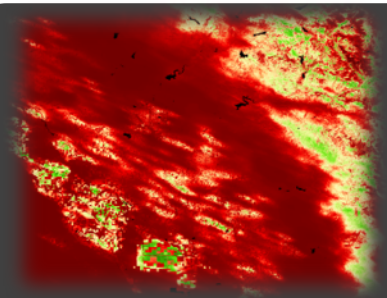
ECO3ETPTJPL.001



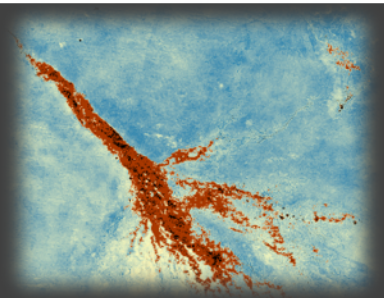
ECO3ANCQA.001



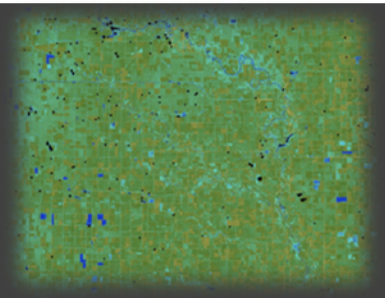
ECO3ETALEXIU.001



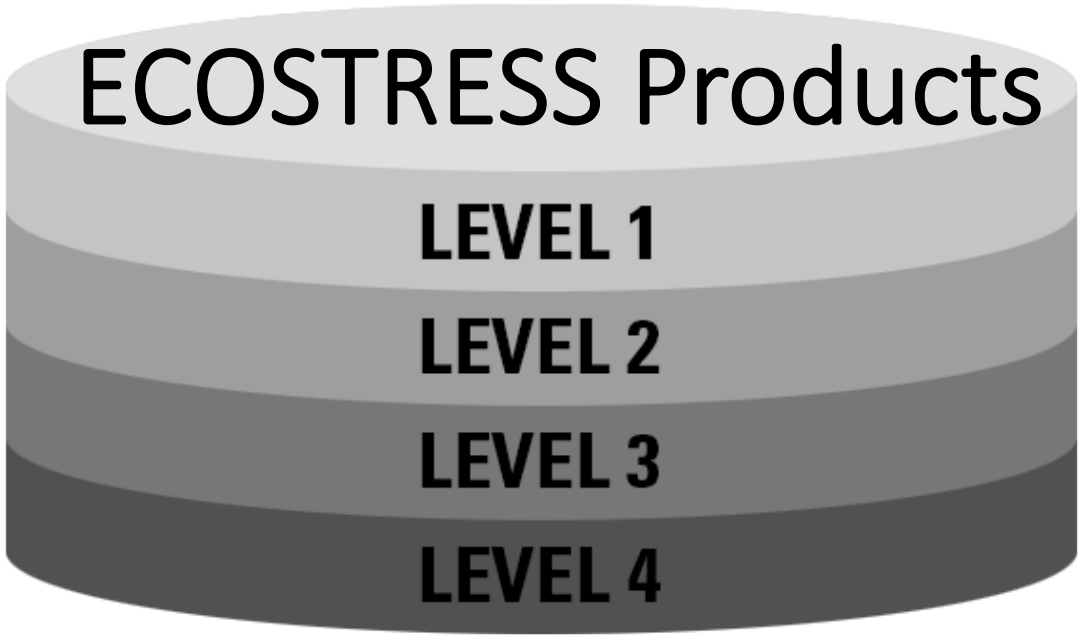
ECO4ESIPTJPL.001



ECO4WUE.001



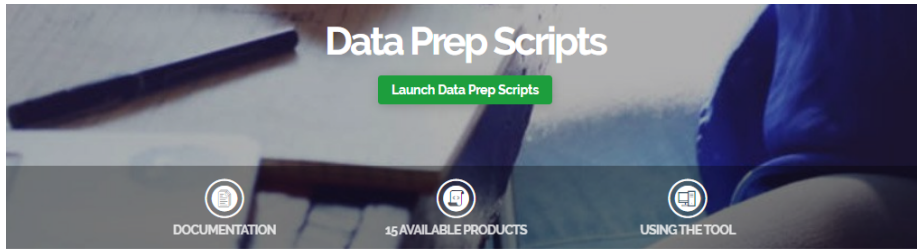
ECO4ESIALEXIU.001



Coming Soon:

- **ECO3ETALEXI**
- **ECO4ESIALEXI**
- **Gridded L2-L4 Products**

LP DAAC Data Prep Scripts: https://lpdaac.usgs.gov/tools/data-prep-scripts/



Homepage / Tools / **Data Prep Scripts**

Description

This collection of R and Python scripts can be used to download data and perform basic data processing functions such as georeferencing, reprojecting, converting, and reformatting data. Scripts are available in Python and/or R and each have a README that provides additional information. All scripts are available for download from the LP DAAC User Resources BitBucket Code Repository.

ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS)
- ECOSTRESS Swath to Grid Conversion Script

Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)
- Convert ASTER L1T Radiance to Top of Atmosphere Reflectance
- Reformat and Georeference ASTER L1T HDF Files

Visible Infrared Imaging Radiometer Suite (VIIRS)
- Reformat and Georeference VIIRS Surface Reflectance HDF-EOS5 Files

ASTER Global Emissivity Dataset (GED)
- Convert ASTER GED V3 Science Datasets to Georeferenced GeoTiffs using R and Python
- Convert ASTER GED V4.1 Science Datasets to Georeferenced GeoTiffs using R and Python

How to Download LP DAAC Data
- How to Access the LP DAAC Data Pool with Python
- How to Access the LP DAAC Data Pool with R

LP DAAC Data User Resources / ECOSTRESS_swath2grid

Source

master ··· **ECOSTRESS_swath2grid** /

Browse | Filter

Source	Description	Last Modified
ECOSTRESS_swath2grid.py	Updated package dependencies for Windows and corrected build 6.0 Fill Value issue	6 days ago
GDAL-2.3.2-cp36-cp36m-win_amd64.whl	New environment set up for windows	26 Oct 2018
h5py-2.8.0-cp36-cp36m-win_amd64.whl	New environment set up for windows	26 Oct 2018
macOS.yml	Changed mkl package version	12 Dec 2018
README.md	Updated list of layers for ECO3ANCQA.001	08 May 2019
WindowsEnvironment.zip	Updated package dependencies for Windows and corrected build 6.0 Fill Value issue	6 days ago
windowsOS.yml	Updated package dependencies for Windows and corrected build 6.0 Fill Value issue	6 days ago

README.md

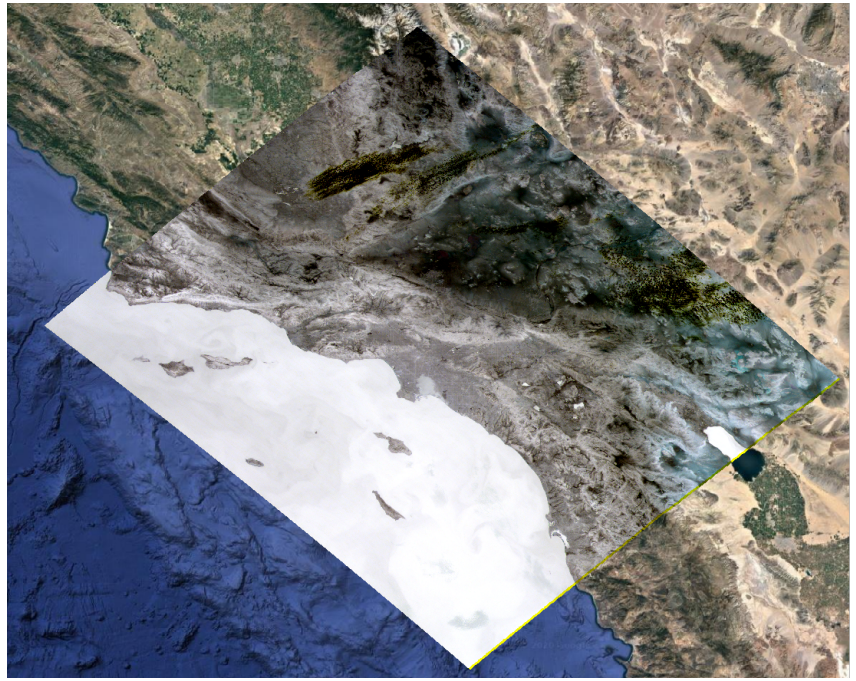
ECOSTRESS Swath to Grid Conversion Script

Objective:

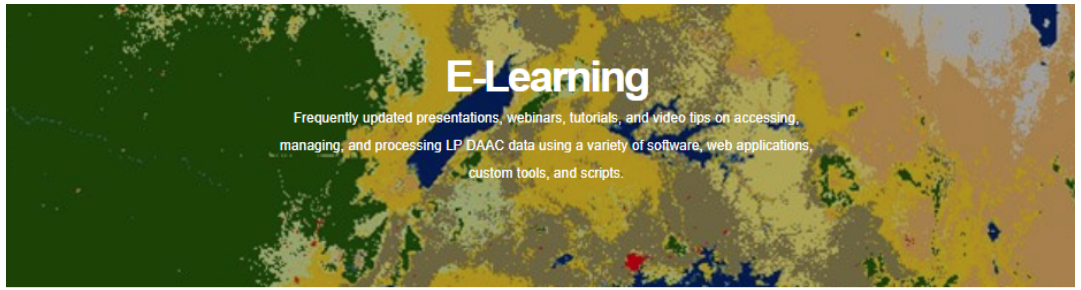
The ECOSTRESS_swath2grid.py script converts ECOSTRESS swath data products, stored in Hierarchical Data Format version 5 (HDF5, .h5) into projected GeoTIFFs. When executing this script, a user will submit a desired output projection and input directory containing ECOSTRESS swath data products as command line arguments. The script begins by opening any of the ECOSTRESS products listed below that are contained in the input directory. Next, it uses the latitude and longitude arrays from the ECO1BGEO product (except for L3/L4 ALEXI_USDA and ECO1BMAPRAD products) to resample the swath dataset to a grid using nearest neighbor resampling (`Pyresample/kdtree`). Note that you will need to download the ECO1BGEO files that correspond to your higher level product files. From there, the script defines the coordinate reference system (CRS) input by the user (options include UTM Zones and Geographic (EPSG:4326)). There is an optional argument to override the default UTM zone selected by the script (see below) if needed. Ultimately, the script exports the gridded array as a GeoTIFF (`GDAL`). By default, the script will loop through and perform the aforementioned steps for each science dataset (SDS) in the HDF5 file. There is an optional argument that allows you to select a subset of SDS layers within a given product (see details below). The resulting GeoTIFF files can be imported with spatial reference into GIS and Remote Sensing software programs. The script also will batch process all ECOSTRESS swath files contained in the input directory provided. For ECOSTRESS products that include a scale factor in the metadata, the output will be scaled, and for products that include a fill value in the file metadata, this will be carried over into the GeoTIFF outputs. For layers that do not contain a fill value in the file metadata, the fill value will be defined as the highest possible value for the given datatype of an SDS.

New Release:

- **Brightness Temperature conversion has been added to the ECOSTRESS_swath2grid.py script!**



LP DAAC E-Learning: https://lpdaac.usgs.gov/resources/e-learning/#ecostress



Homepage / Resources / E-Learning

View All | Presentations | Tutorials | Video Tips | Webinars

ecostress

ECOSTRESS: NASA's Next-Generation Mission to Measure Evapotranspiration from the ISS
APRIL 2, 2019
DATA POOL · NASA EARTHDATA SEARCH · DATA PREP SCRIPTS · ECOSTRESS · EVAPOTRANSPIRATION (ET) · LAND SURFACE TEMPERATURE (LST) · SURFACE RADIANCE
Video Tip

Hands-on Workshop for Accessing, Processing, and Analyzing ECOSTRESS Data
MARCH 27, 2019
NASA EARTHDATA SEARCH · DATA PREP SCRIPTS · ECOSTRESS · EVAPOTRANSPIRATION (ET)
Materials

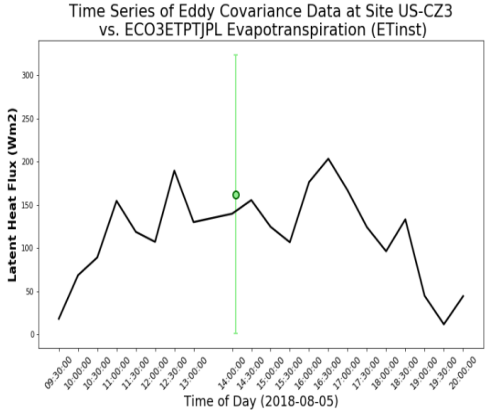
Working with ECOSTRESS Evapotranspiration Data
MARCH 14, 2019
DATA PREP SCRIPTS · ECOSTRESS · EVAPOTRANSPIRATION (ET)
Tutorial | Jupyter Notebook

Jupyter Notebook

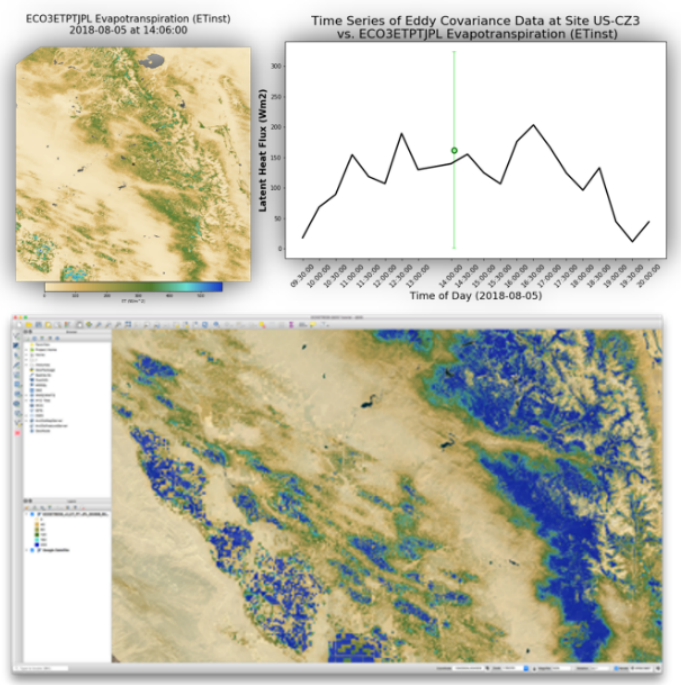
Finally, compare the ECOSTRESS Evapotranspiration and uncertainty with the time series of observations from the flux tower.

In [36]:
```
# Set the figure size, create a subplot
fig = plt.figure(1, figsize=(12, 7))
ax = fig.add_subplot(111)

# Plot the flux tower observatisons followed by the ecostress median ET and median uncertainty
ax.plot(towerData.Time, towerData.LE, 'k', lw=2.5, color='black')
ax.plot(overpass, ETmedian, 'bo', ms=10, color='darkgreen')
ax.errorbar(overpass, ETmedian, yerr=UNmedian, lw=2.0, c='lightgreen', fmt='o', capsize=3, capthick=2)

# Set x/y axes and labels
ax.set_xlabel(f'Time of Day ({date})', fontsize=18);
ax.set_xticks(np.array(towerData.Time));
ax.set_xticklabels(towerData.Time, rotation=45,fontsize=12);
ax.set_ylabel("Latent Heat Flux (Wm2)", fontsize=16, fontweight='bold')

# Add a title and export figure as png file
ax.set_title(f"Time Series of Eddy Covariance Data at Site US-CZ3\n vs. {title} ({SDSname})", fontsize=22)
figure_filename = join(outDir, "{}_{}_vs_fluxtower.png".format(ecoName, SDSname))
print("figure filename: {}".format(figure_filename))
fig.savefig(figure_filename, bbox_inches='tight')
```

figure filename: C:\ECOSTRESS\output\ECOSTRESS_L3_ET_PT-JPL_00468_007_20180805T220314_0502_02_ETinst_vs_fluxtower.png



Workshop Materials

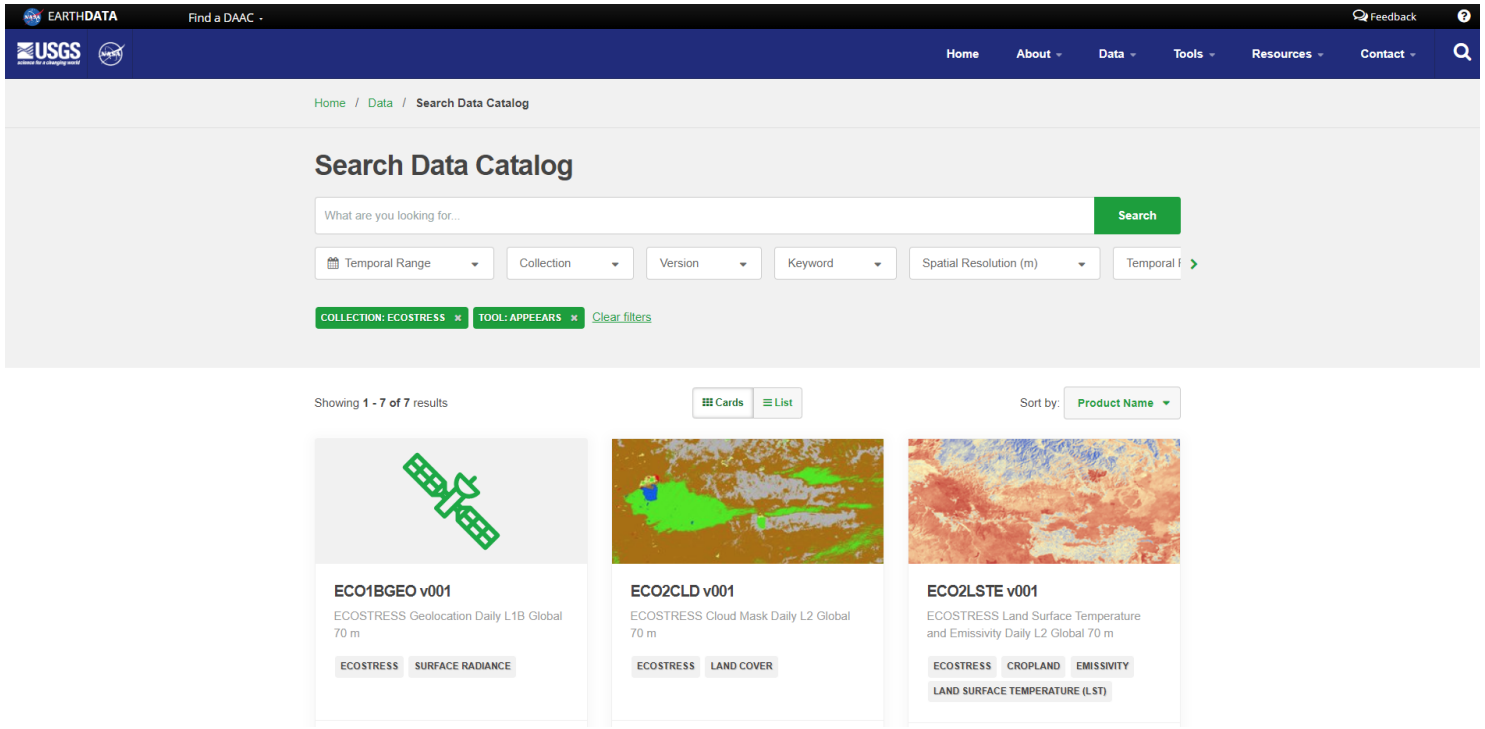


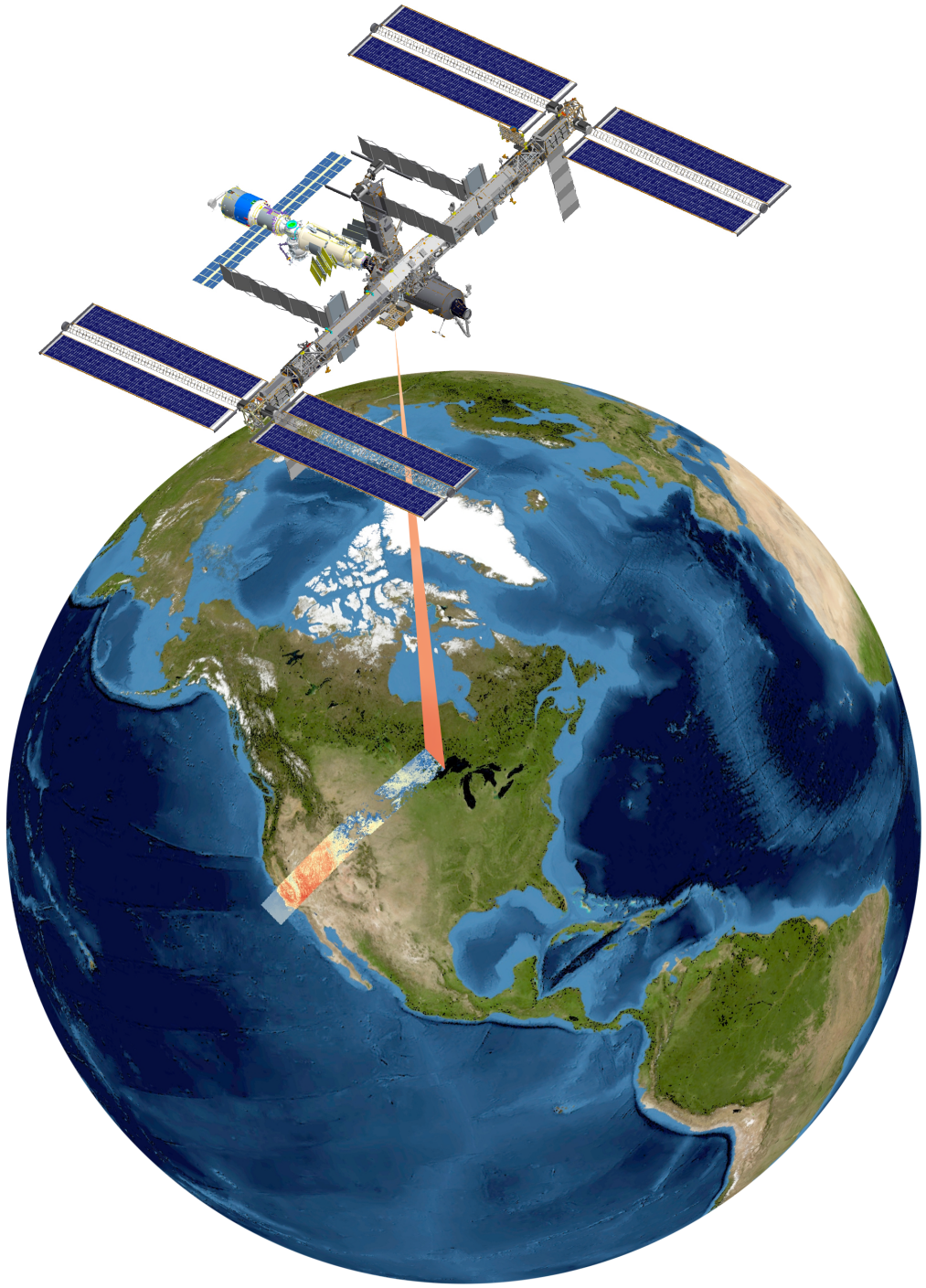
USGS NASA

Provided in collaboration with the ECOSTRESS Science Team at JPL: https://ecostress.jpl.nasa.gov/

Website Demo:

https://lpdaac.usgs.gov/



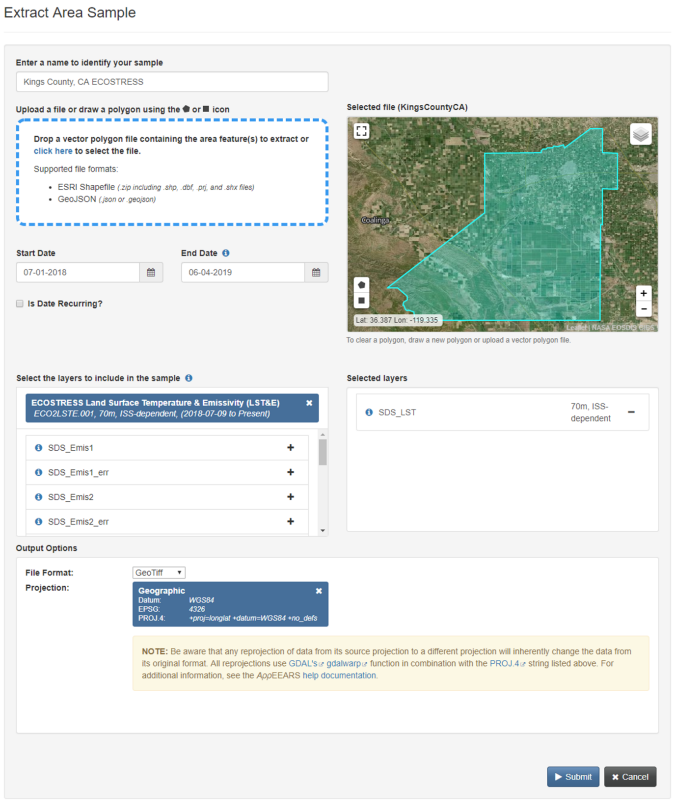


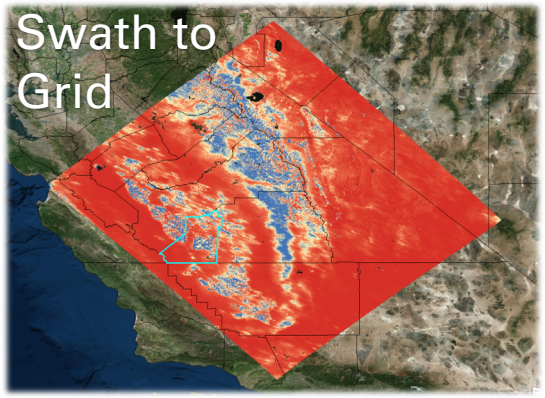
USGS NASA

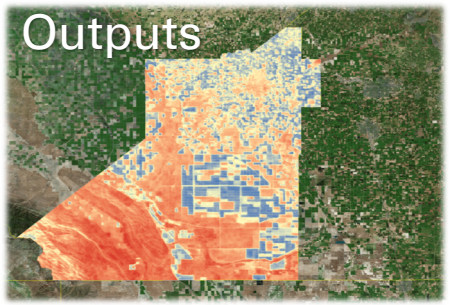
ECOSTRESS Data in AppEEARS

Subset data:

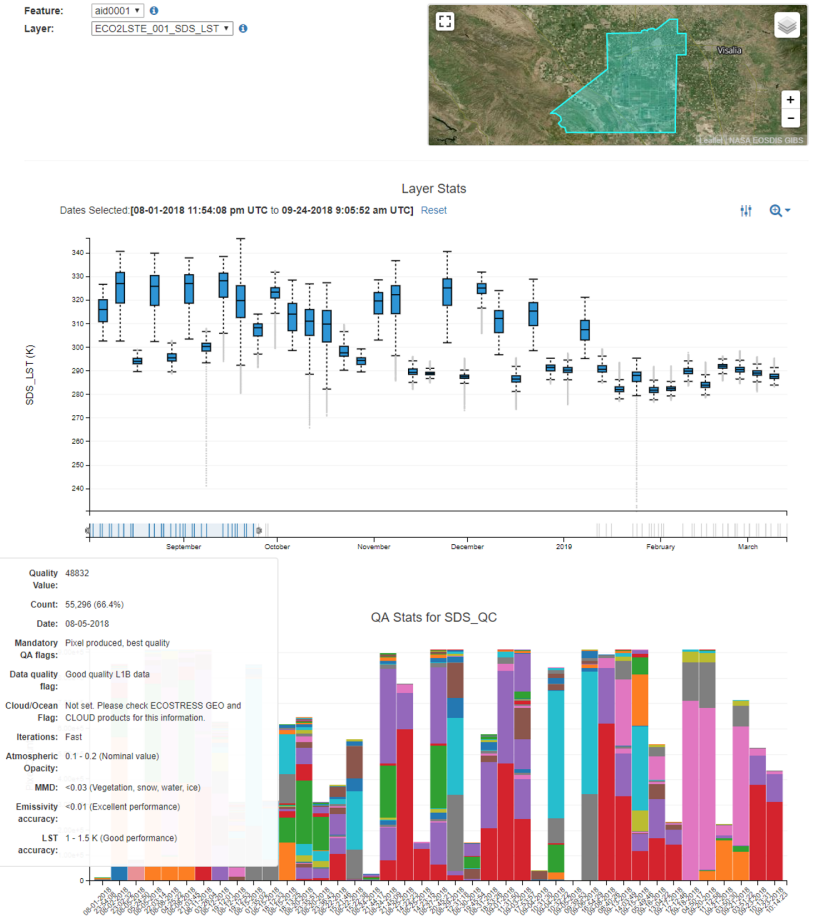
- Spatially
- Temporally
- By band/layer
- Output options







Visualizations



Decoded QC

LP DAAC — NASA VIIRS Surface Reflectance, Vegetation Indices, Fire, LSTE, NBAR, and LAI/FPAR Products

LP DAAC — Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) Land Products

LP DAAC — NASA MEaSUREs Shuttle Radar Topography Mission (SRTM) v3

USGS — eMODIS Weekly Smoothed NDVI & SSEBop Monthly ET

SEDAC — UN-Adjusted Gridded Population of the World v4

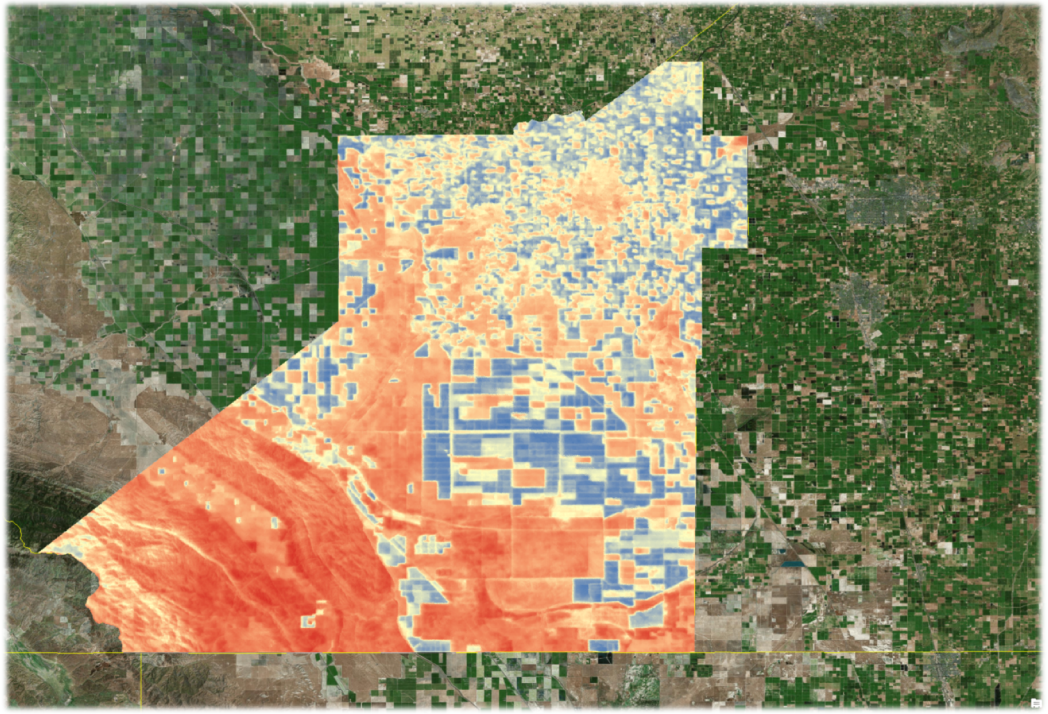
NSIDC DAAC — Terra and Aqua MODIS – Snow Products

NSIDC DAAC — Soil Moisture Active Passive (SMAP) Soil Moisture Products

USGS NASA

Data Added in 2019:

- LP DAAC
  - ASTER GDEM V3
  - ECOSTRESS
- USGS
  - Landsat Analysis Ready Data (ARD)
- ORNL DAAC
  - Daymet (Gridded estimates of daily weather parameters)



Future Datasets:

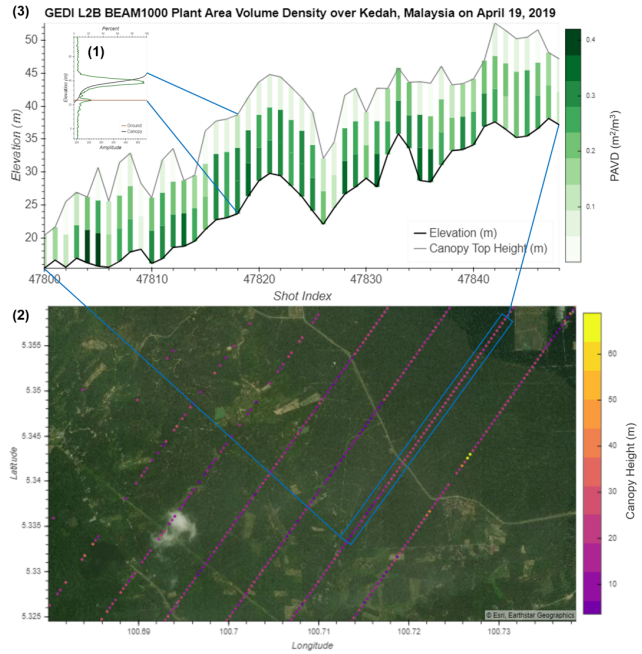
- LP DAAC
  - GEDI
  - Additional S-NPP NASA Visible Infrared Imaging Radiometer Suite (VIIRS)
  - Additional MODIS Version 6.1 Data Products

New Functionality:

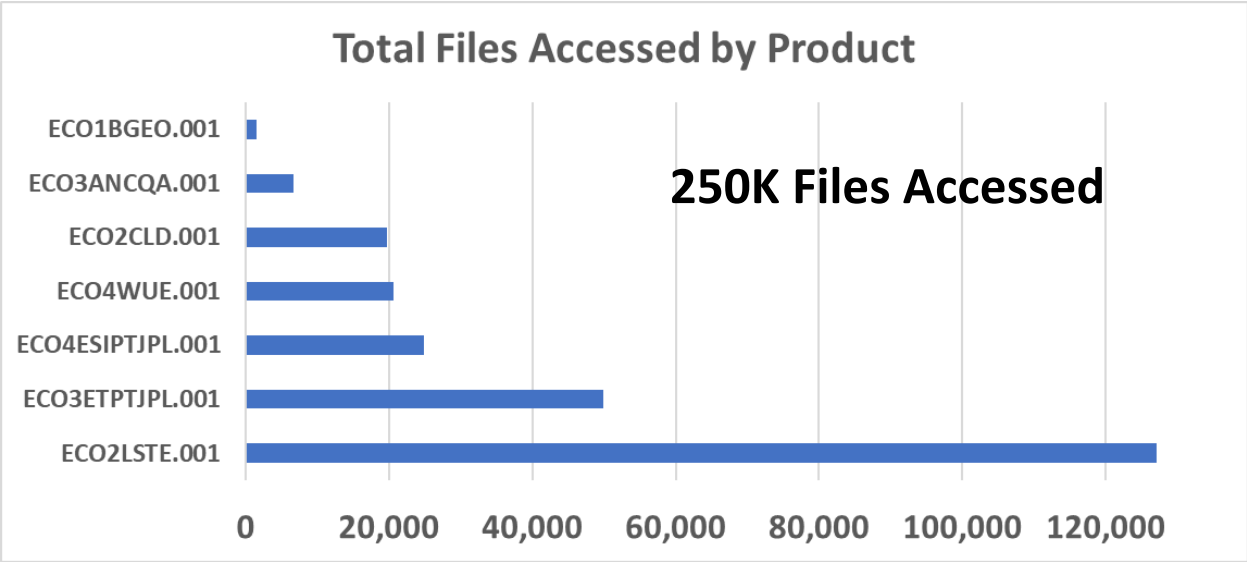
- A*pp*EEARS API
- A*pp*EEARS to the Cloud
  - NASA-compliant General Application Platform (NGAP)

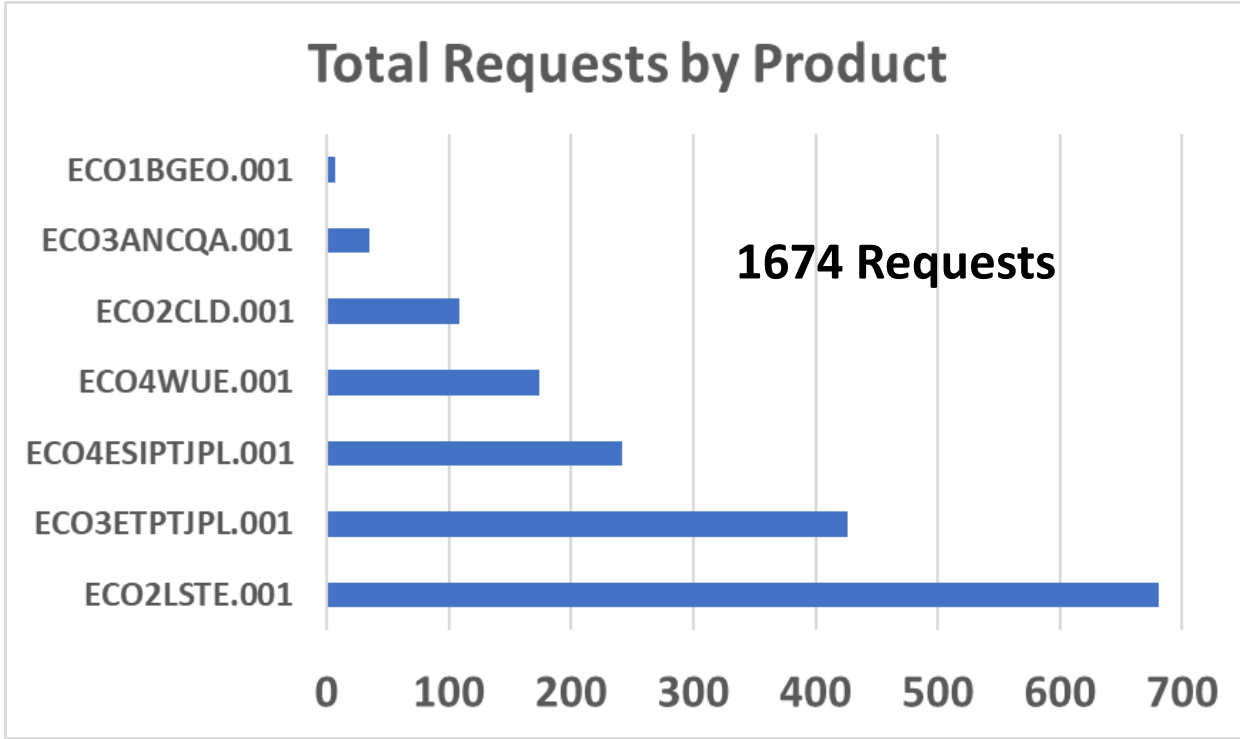
```
import json
import requests

# Load the task request from a file
with open('sample-request.json') as json_file:
    task = json.load(json_file)

# submit the task request
token = token_response['token']
response = requests.post(
    'https://lpdaacsvc.cr.usgs.gov/appeears/api/task',
    json=task,
    headers={'Authorization': 'Bearer {0}'.format(token)})
task_response = response.json()
print(task_response)
```

NGAP



ECOSTRESS in AppEEARS





Product	Volume of Granules Accessed (tb)	Volume Returned (tb)	% Reduction in Volume
ECO2LSTE.001	41.884	1.008	97.593
ECO3ETPTJPL.001	1.306	0.421	67.769
ECO4WUE.001	1.380	0.179	86.993
ECO4ESIPTJPL.001	0.362	0.080	77.929
ECO1BGEO.001	120.485	0.008	99.994
ECO3ANCQA.001	1.221	0.002	99.850
ECO2CLD.001	0.324	0.001	99.576

USGS NASA

272 Unique Users!

Area Use Case Example: Observing Plant Response to Changing Conditions using ECOSTRESS LST and ET

WHO: Researchers from UC-Santa Barbara

WHAT: Tasked with monitoring tree mortality and riparian habitat conditions in response to changing climatic conditions

WHERE: Riparian Areas along the Santa Clara River in California

WHY: To understand how resilient riparian forest stands are to drought

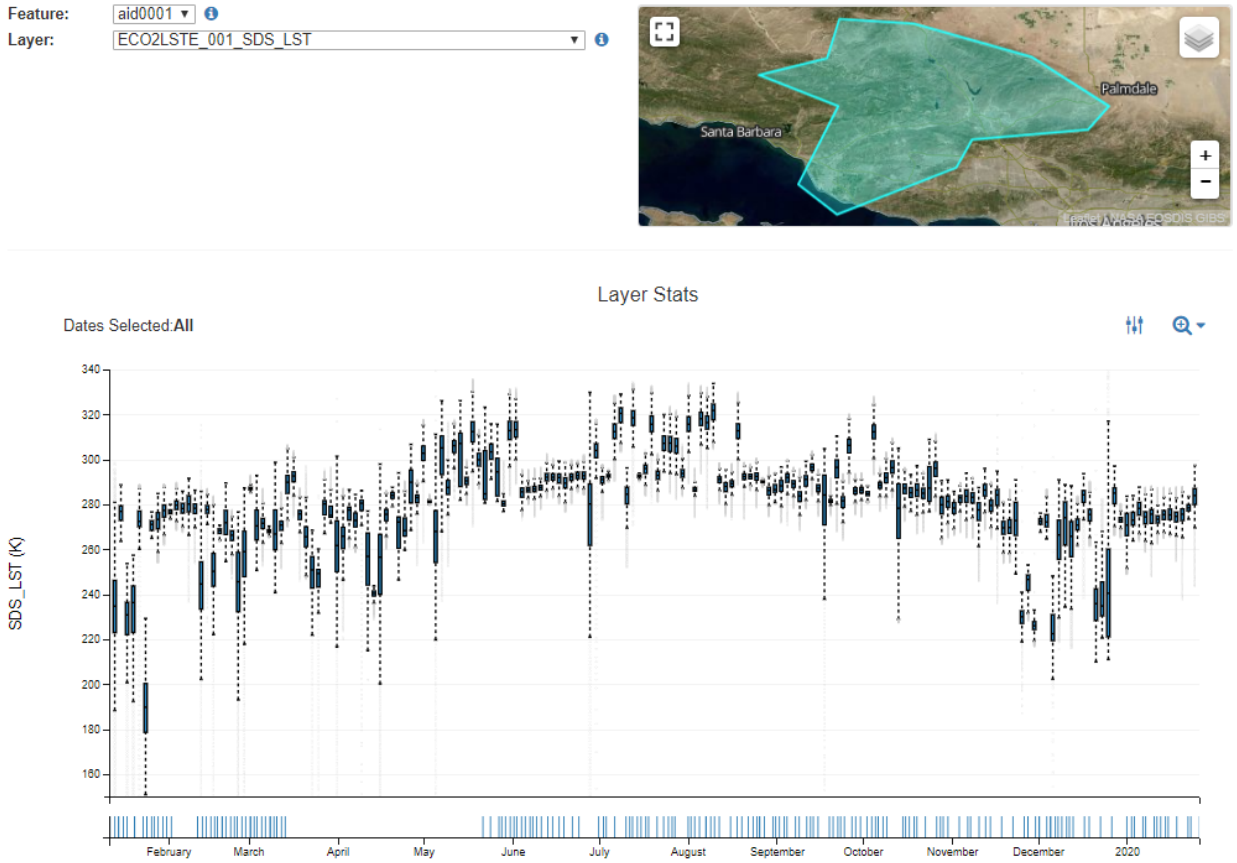
WHEN: August 2018

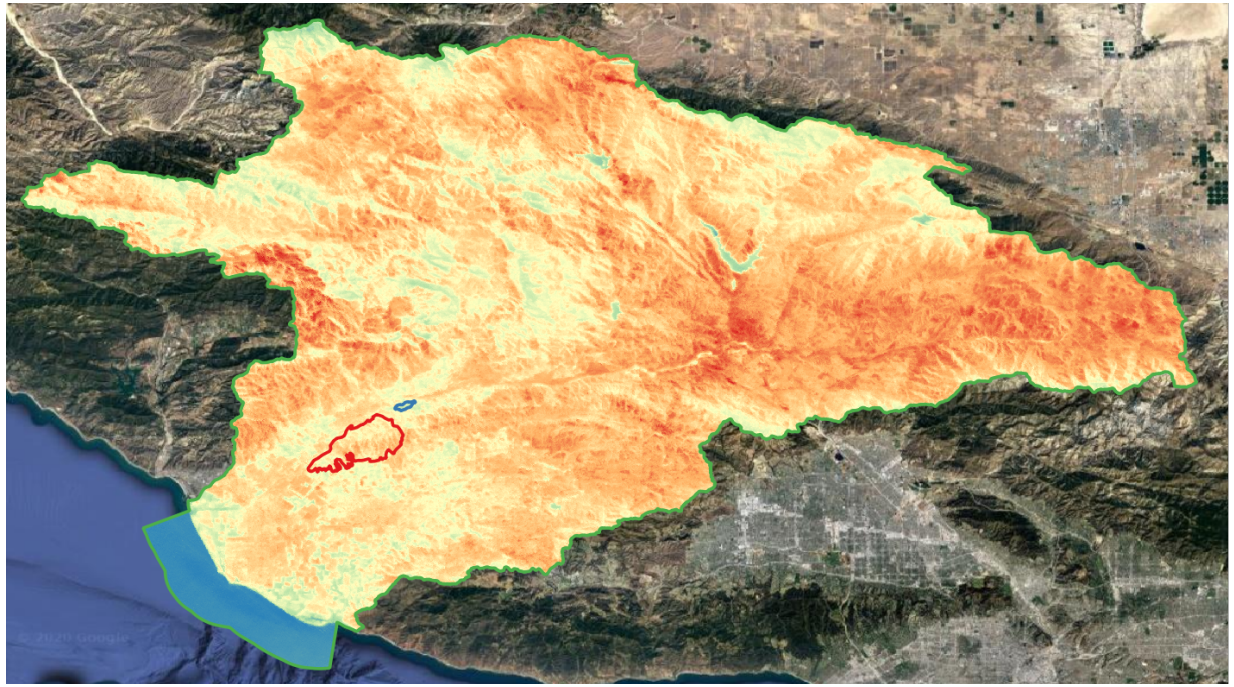
HOW: Extract time series of ECOSTRESS LST, ET, and Landsat 8 OLI and filter for highest-quality daytime images (clear sky, 9 am – 4 pm and low VZA) to do image comparison and use Landsat 8 to generate mixing model outputs of green vegetation (GV), non-photosynthetic vegetation (NPV), and soil fraction

Problem: Need to find efficient strategy to filter highest quality ECOSTRESS observations for comparison and combine with Landsat 8 OLI observations

USGS NASA

Live Demo:
https://lpdaacsvc.cr.usgs.gov/appeears/



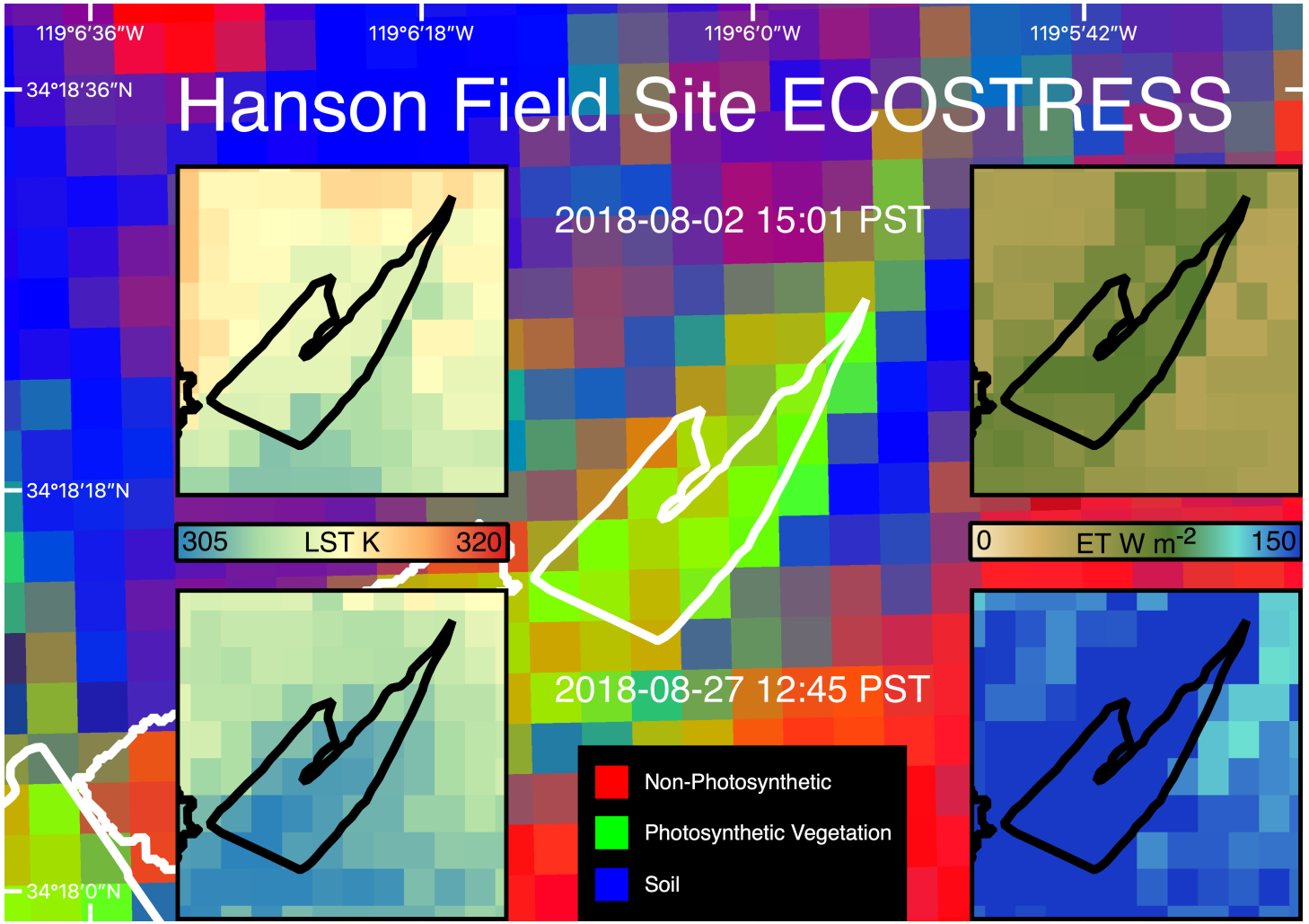


urs.earthdata.nasa.gov

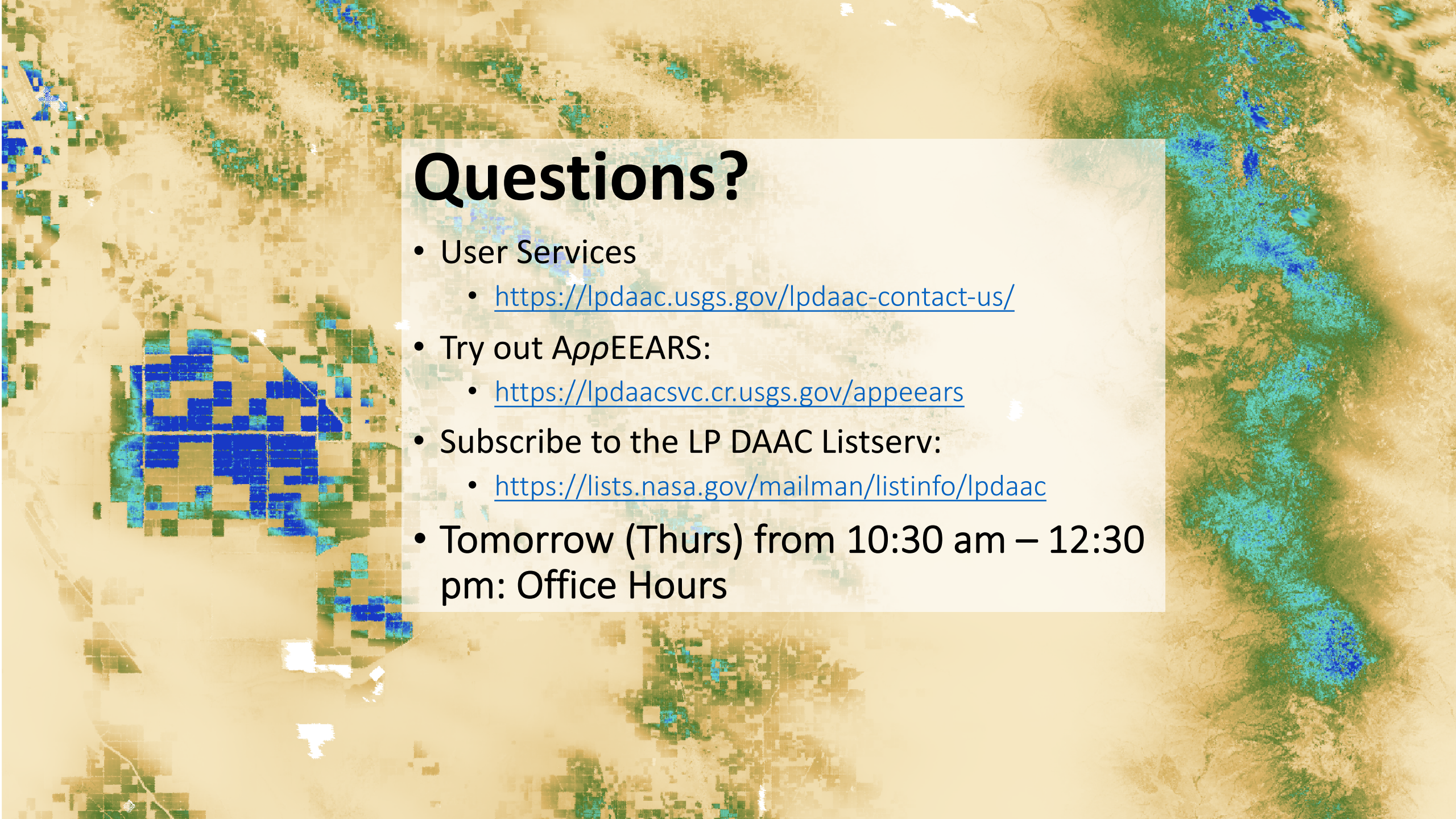
Username: appeearstesting

Password: NASApixels2017

Working with ECOSTRESS Data in Python and QGIS



USGS NASA



Questions?

- User Services
  - https://lpdaac.usgs.gov/lpdaac-contact-us/
- Try out A*pp*EEARS:
  - https://lpdaacsvc.cr.usgs.gov/appeears
- Subscribe to the LP DAAC Listserv:
  - https://lists.nasa.gov/mailman/listinfo/lpdaac
- Tomorrow (Thurs) from 10:30 am – 12:30 pm: Office Hours