Using NASA's A*pp*EEARS to Slice and Dice Big Earth Data

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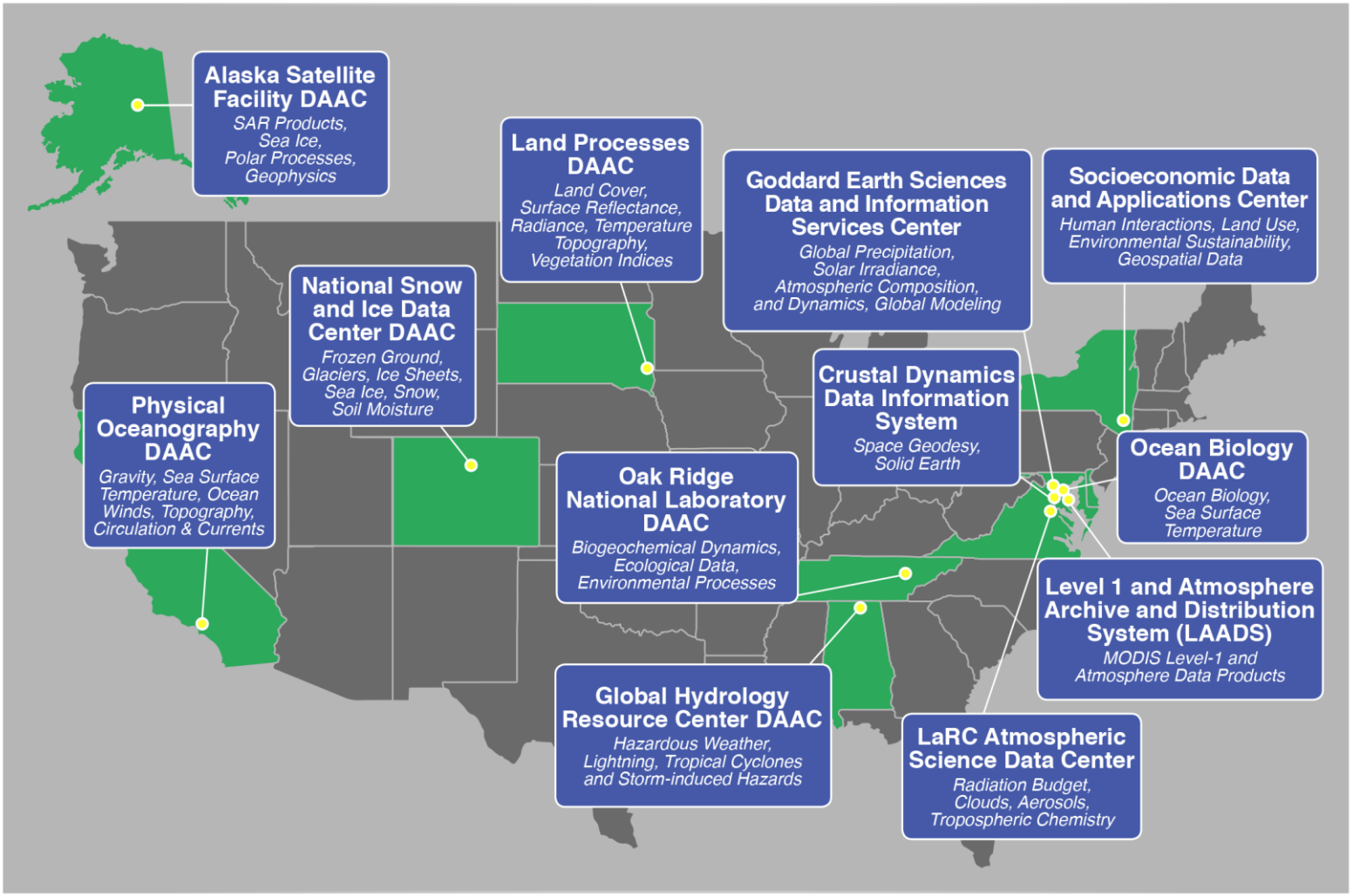
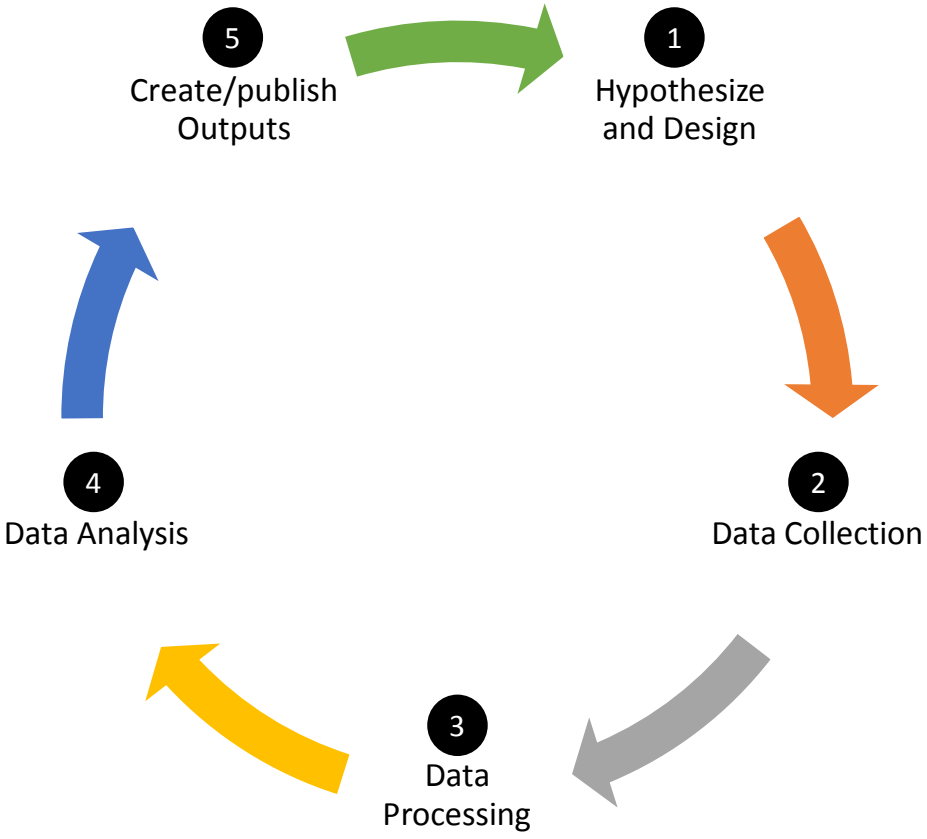
**Work performed under USGS contract G15PD00467*

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

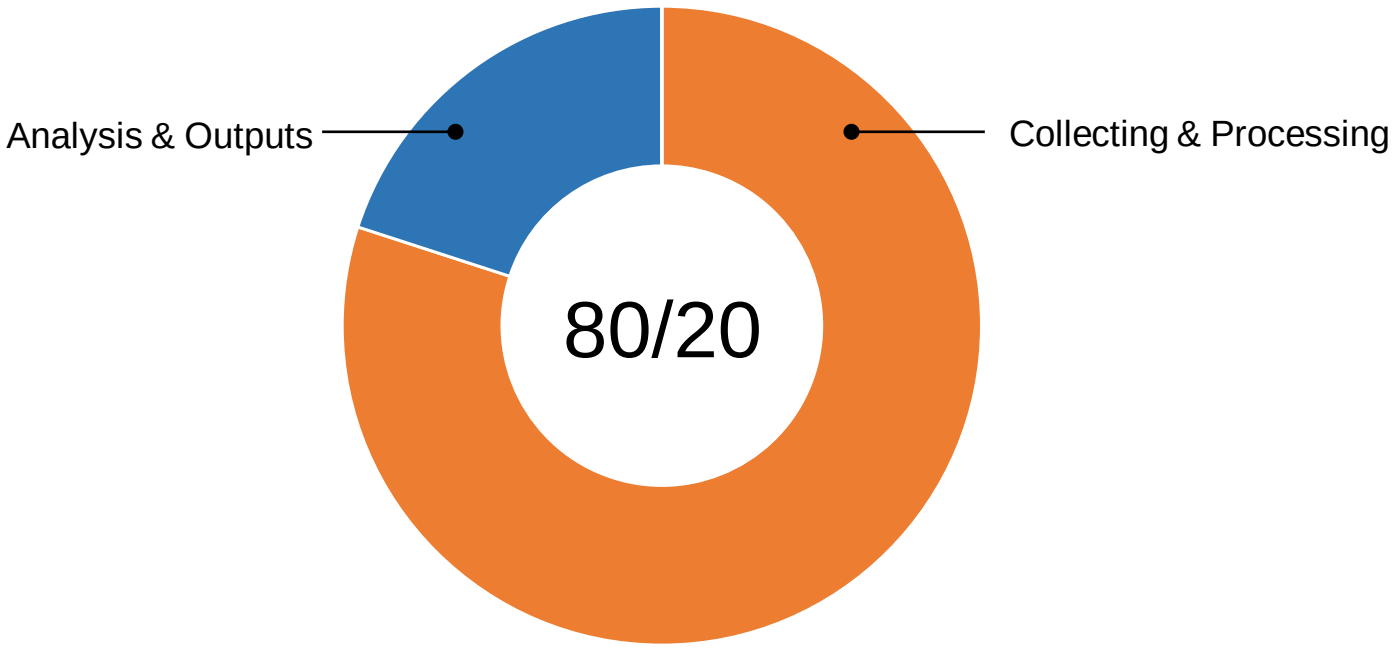

Alaska Satellite Facility DAAC
SAR Products, Sea Ice, Polar Processes, Geophysics
Land Processes DAAC
Land Cover, Surface Reflectance, Radiance, Temperature Topography, Vegetation Indices
Goddard Earth Sciences Data and Information Services Center
Global Precipitation, Solar Irradiance, Atmospheric Composition, and Dynamics, Global Modeling
Socioeconomic Data and Applications Center
Human Interactions, Land Use, Environmental Sustainability, Geospatial Data
National Snow and Ice Data Center DAAC
Frozen Ground, Glaciers, Ice Sheets, Sea Ice, Snow, Soil Moisture
Physical Oceanography DAAC
Gravity, Sea Surface Temperature, Ocean Winds, Topography, Circulation & Currents
Crustal Dynamics Data Information System
Space Geodesy, Solid Earth
Ocean Biology DAAC
Ocean Biology, Sea Surface Temperature
Oak Ridge National Laboratory DAAC
Biogeochemical Dynamics, Ecological Data, Environmental Processes
Level 1 and Atmosphere Archive and Distribution System (LAADS)
MODIS Level-1 and Atmosphere Data Products
Global Hydrology Resource Center DAAC
Hazardous Weather, Lightning, Tropical Cyclones and Storm-induced Hazards
LaRC Atmospheric Science Data Center
Radiation Budget, Clouds, Aerosols, Tropospheric Chemistry

USGS NASA

Typical Research Workflow



Research Workflow - Time



Welcome to *AppEEARS*!

Application for **E**xtracting and **E**xploring **A**nalysis **R**eady **S**amples (***AppEEARS***)

AppEEARS offers users a simple and efficient way to perform data access and transformation processes. By enabling users to subset data spatially, temporally, and spectrally, the volume of data downloaded for analysis is greatly reduced. Sample requests submitted to ***AppEEARS*** provide users with data values and associated quality data for a variety of remote sensing data products for specific point locations or areas of interest. Two types of sample requests are available: point samples of geographic coordinates or area samples of vector polygons. Interactive visualizations with summary statistics of the sample results are provided within the application to allow the user to preview and interact with their sample before downloading the data. Get started with a sample request using the Extract option above, or visit the Help page to learn more.

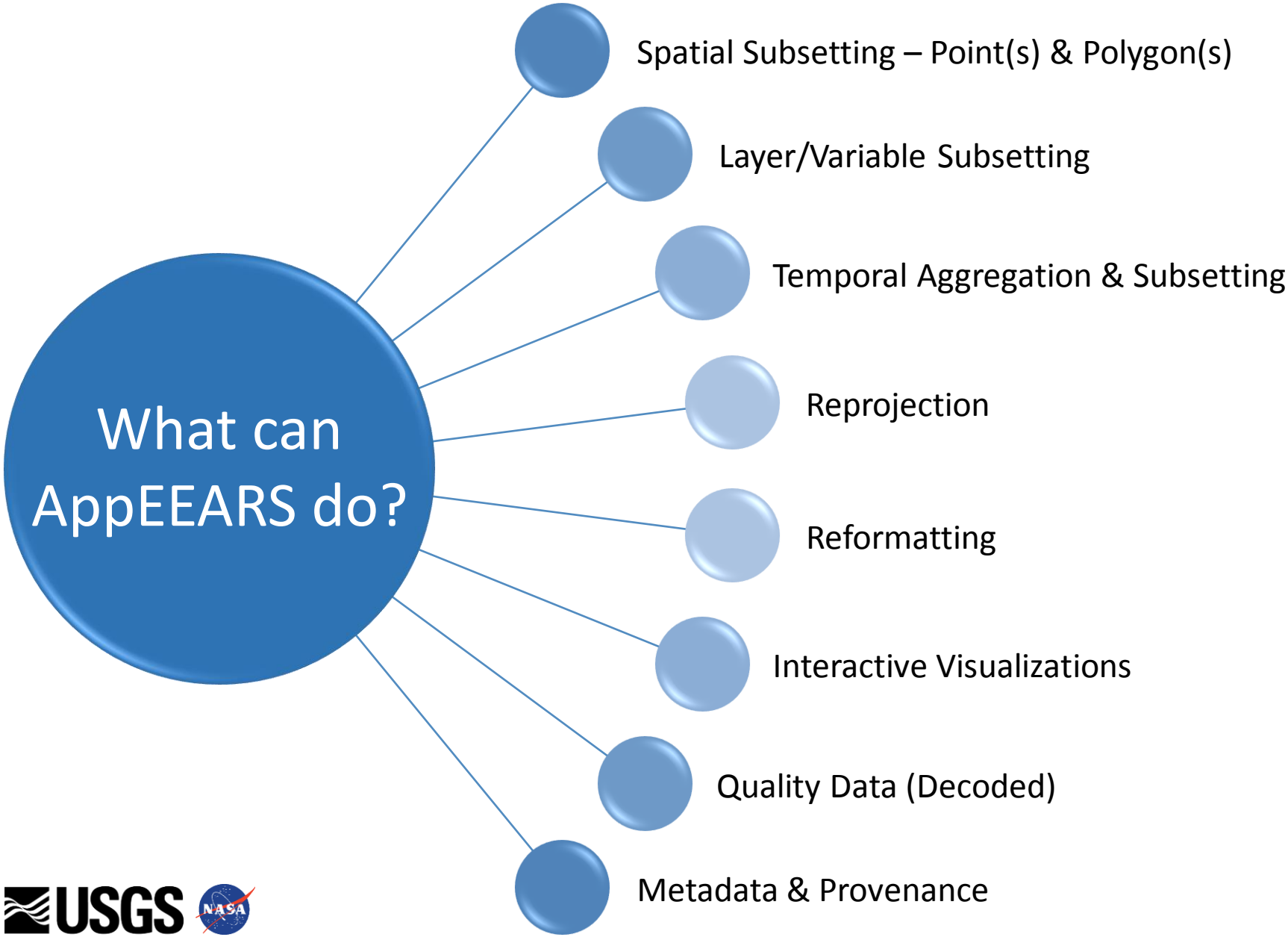
National Aeronautics and Space Administration

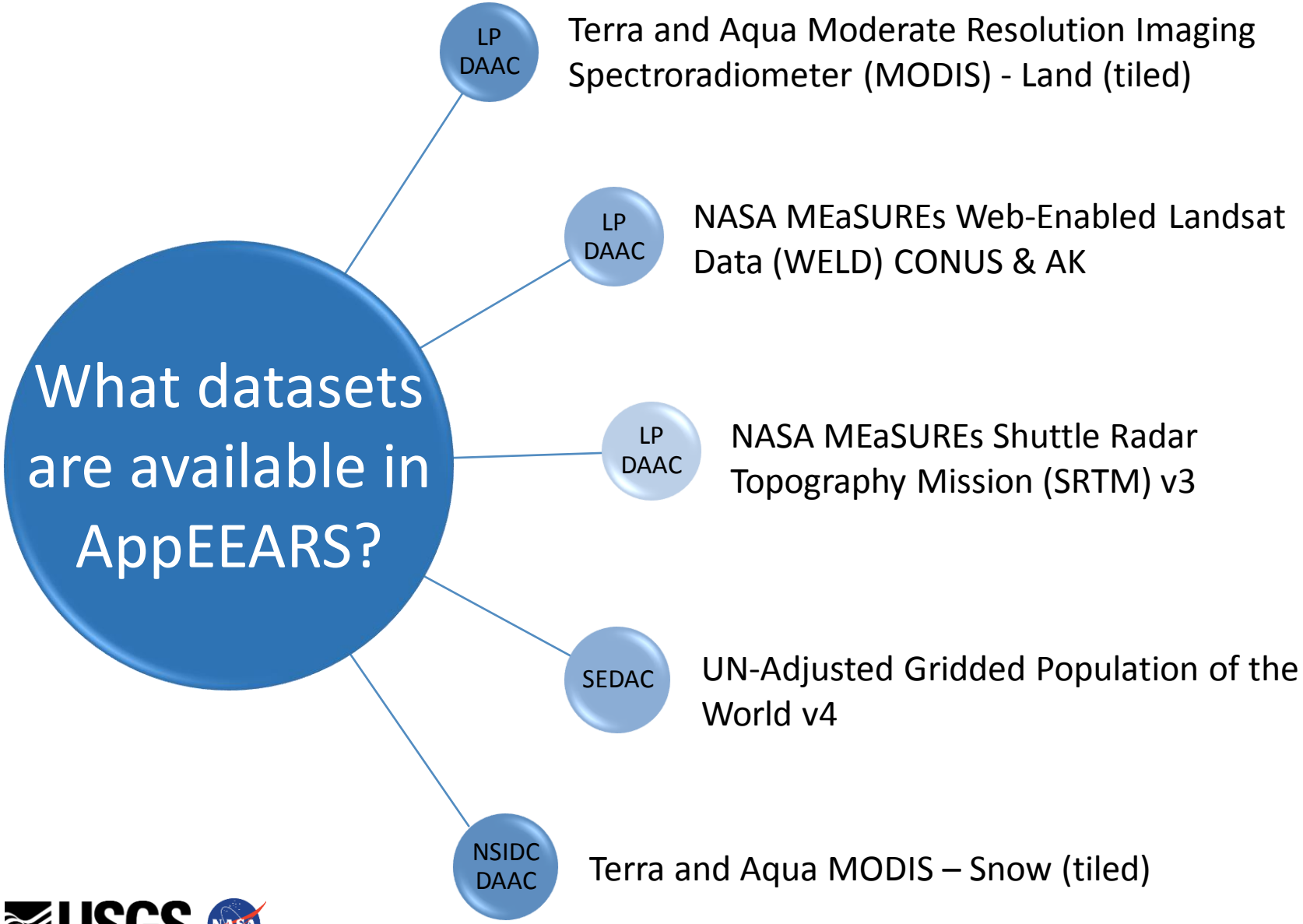
United States Geological Survey

Land Processes Distributed Active Archive Center

National Snow and Ice Data Center Distributed Active Archive Center

Socioeconomic Data and Applications Center


What can AppEEARS do?
Spatial Subsetting – Point(s) & Polygon(s)
Layer/Variable Subsetting
Temporal Aggregation & Subsetting
Reprojection
Reformatting
Interactive Visualizations
Quality Data (Decoded)
Metadata & Provenance


What datasets are available in AppEEARS?
LP DAAC
Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) - Land (tiled)
LP DAAC
NASA MEaSUREs Web-Enabled Landsat Data (WELD) CONUS & AK
LP DAAC
NASA MEaSUREs Shuttle Radar Topography Mission (SRTM) v3
SEDAC
UN-Adjusted Gridded Population of the World v4
NSIDC DAAC
Terra and Aqua MODIS – Snow (tiled)

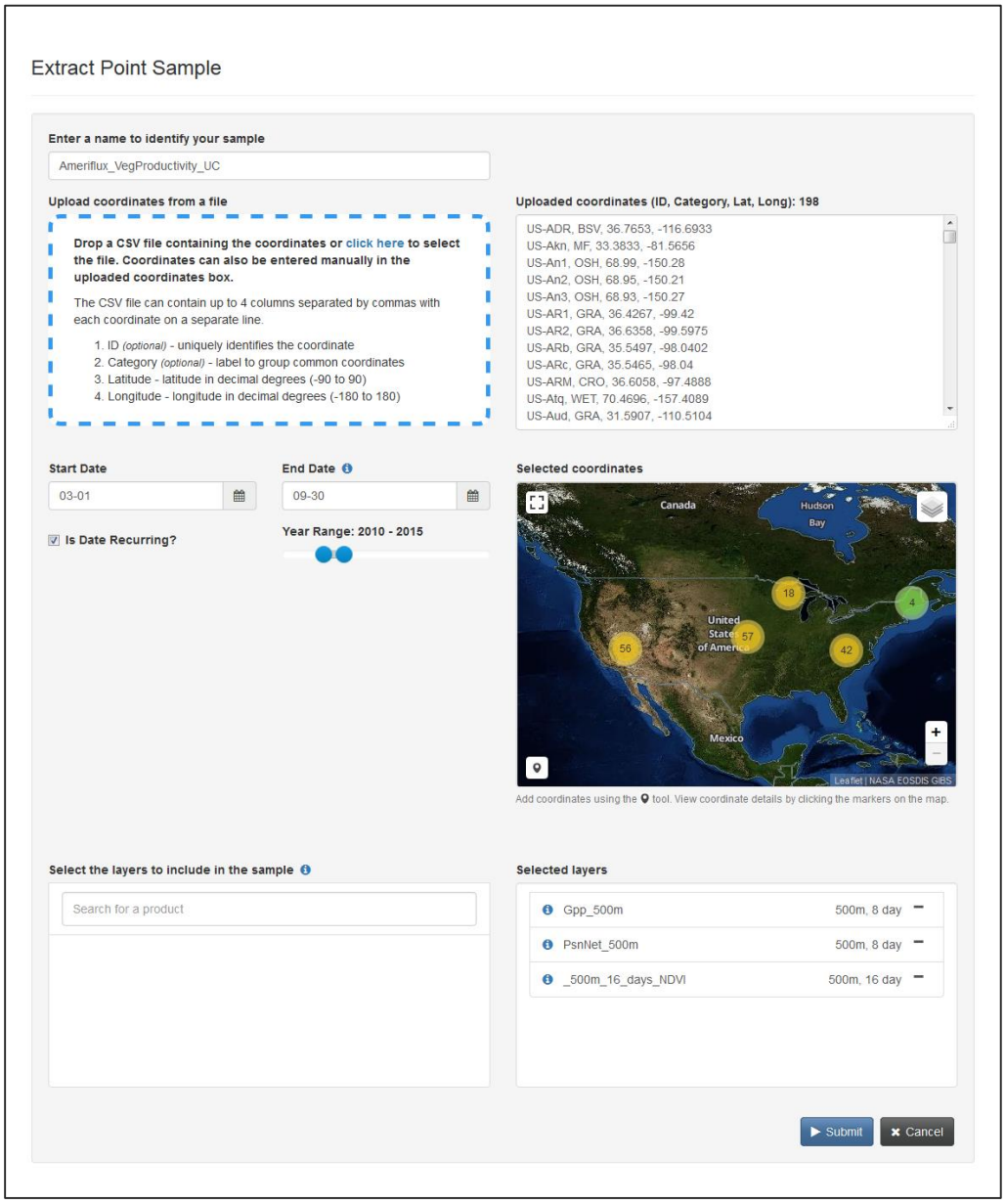
Demo

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

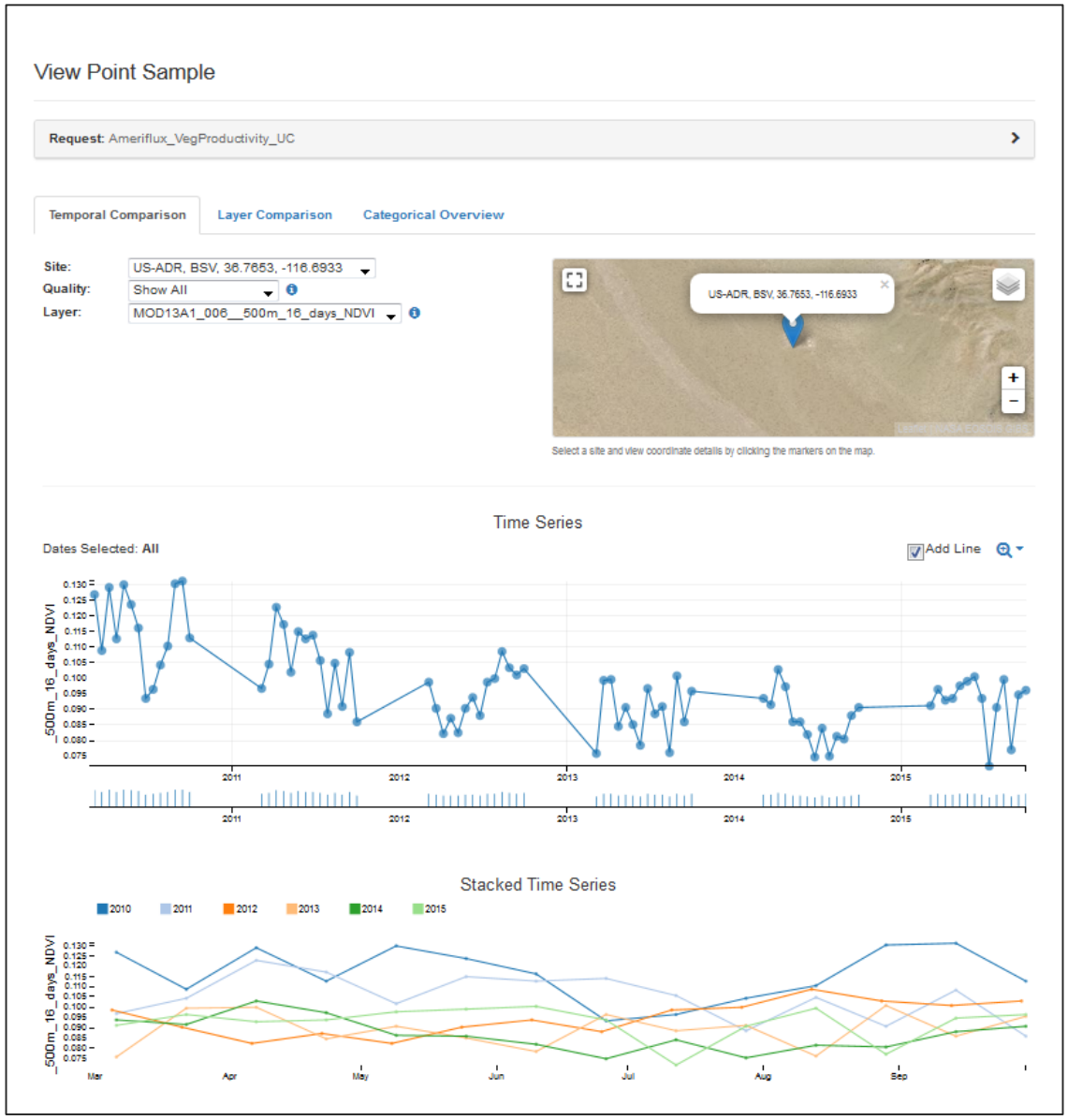
Use Cases

Use Case – Ameriflux Point Sample

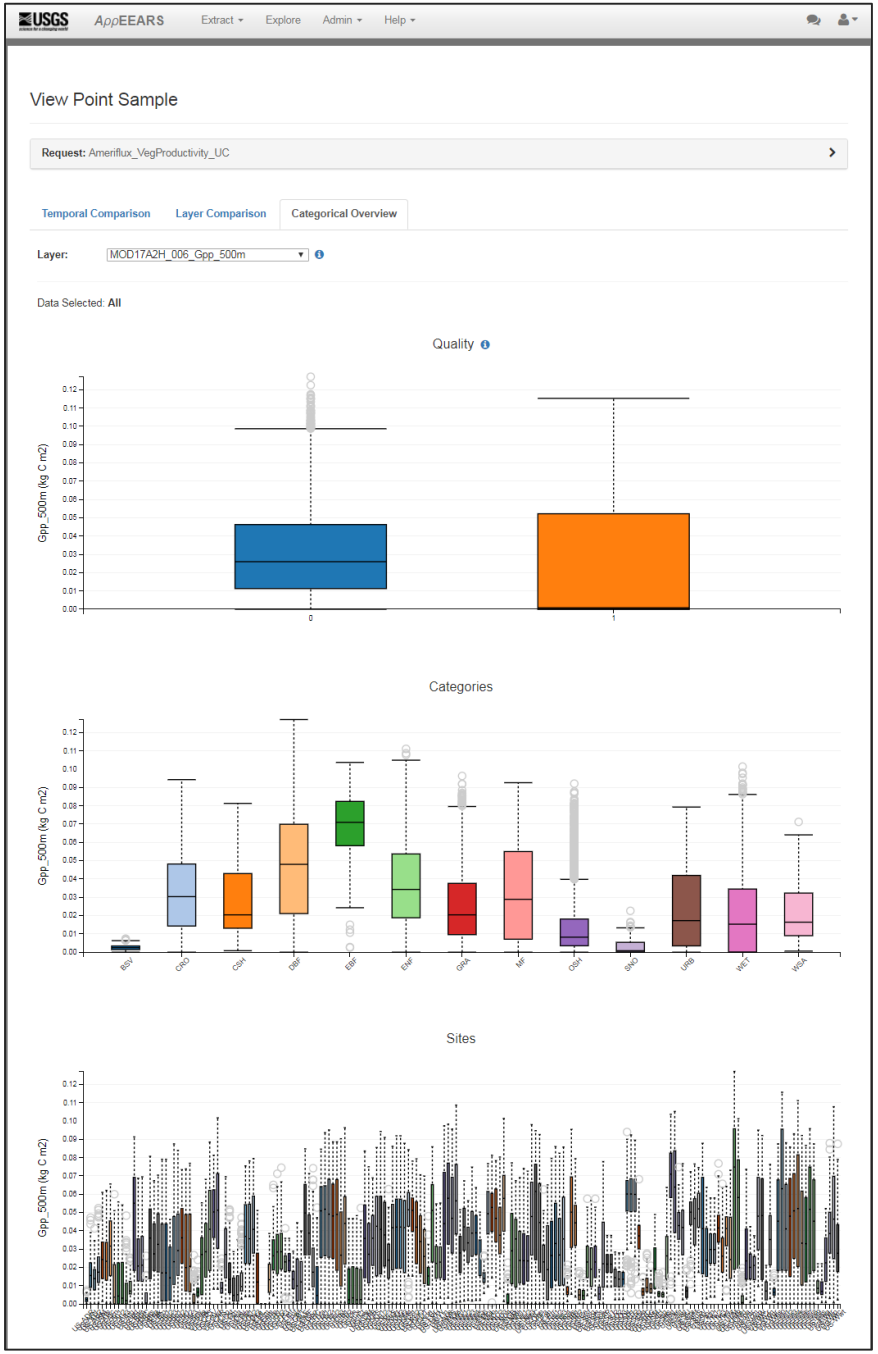
- Researcher: Gil
- Objective: Intercompare and evaluate vegetation productivity using satellite remote sensing observations and measurements taken from Ameriflux sites



- ❑ 198 Point Locations
- ❑ Touches 3936 files
- ❑ Extracts and decode QA
- ❑ ~ 17 hrs to complete

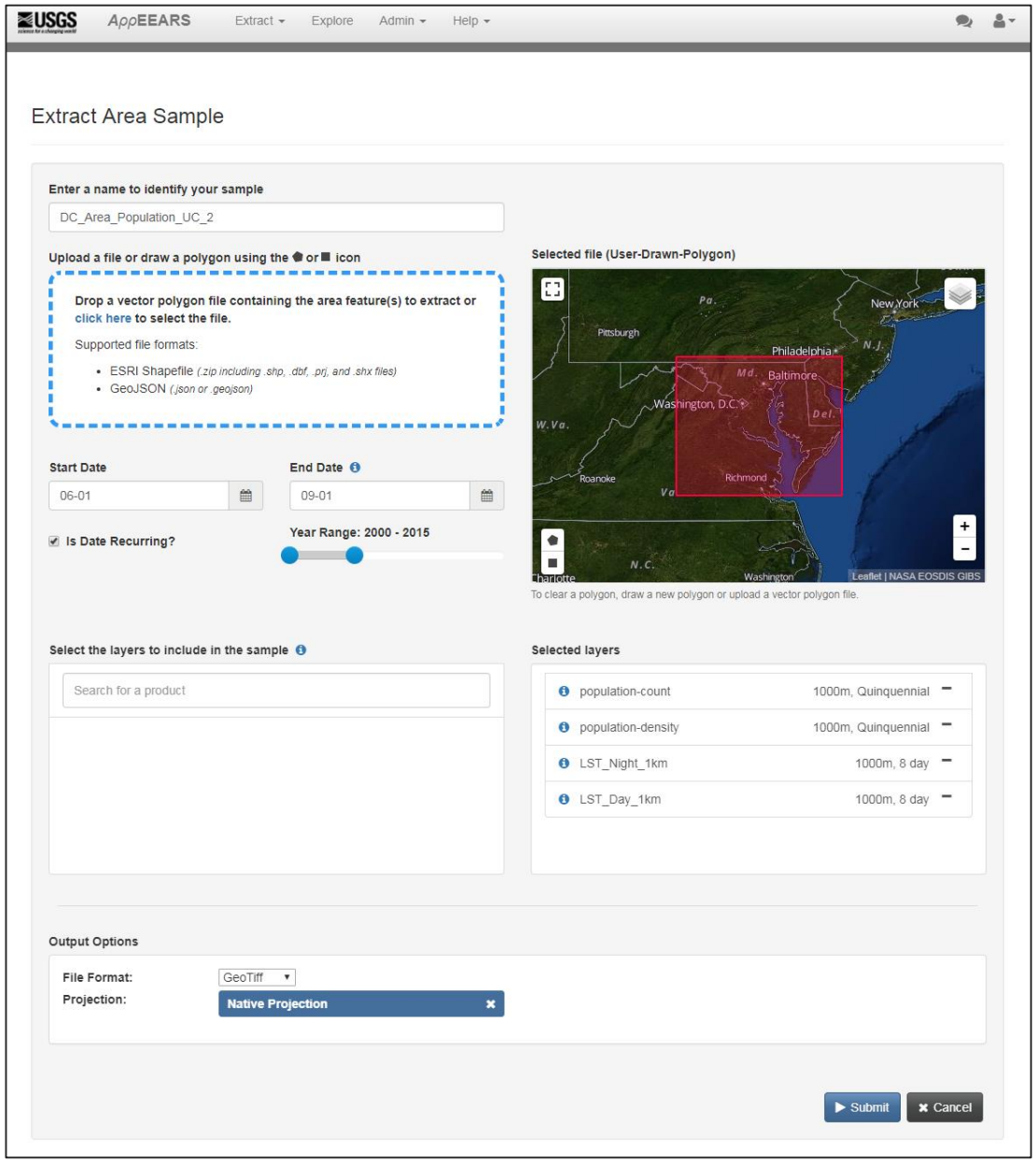

View Point Sample
Request: Ameriflux_VegProductivity_UC
Temporal Comparison
Layer Comparison
Categorical Overview
Site:
US-ADR, BSV, 36.7653, -116.6933
Quality:
Show All
Layer:
MOD13A1_006__500m_16_days_NDVI
US-ADR, BSV, 36.7653, -116.6933
Select a site and view coordinate details by clicking the markers on the map.
Time Series
Dates Selected: All
Add Line
500m_16_days_NDVI
2011
2012
2013
2014
2015
Stacked Time Series
2010
2011
2012
2013
2014
2015
Mar
Apr
May
Jun
Jul
Aug
Sep

USGS
AppEEARS
Extract
Explore
Admin
Help
View Point Sample
Request: Ameriflux_VegProductivity_UC
Temporal Comparison
Layer Comparison
Categorical Overview
Site: US-An2, OSH, 68.95, -150.21
Quality: Show All
Layer 1: MOD17A2H_006_Gpp_500m
Layer 2: MOD13A1_006__500m_16_days_NDVI
Time Series
Dates Selected: All
Add Lines
MOD17A2H_006_Gpp_500m
MOD13A1_006__500m_16_days_NDVI
Gpp_500m (kg C m2)
_500m_16_days_NDVI
2011
2012
2013
2014
2015
Scatter Plot
Gpp_500m (kg C m2)
_500m_16_days_NDVI


USGS
AppEEARS
Extract
Explore
Admin
Help
View Point Sample
Request: Ameriflux_VegProductivity_UC
Temporal Comparison
Layer Comparison
Categorical Overview
Layer:
MOD17A2H_006_Gpp_500m
Data Selected: All
Quality
Gpp_500m (kg C m2)
Categories
Sites

Use Case – User Drawn feature

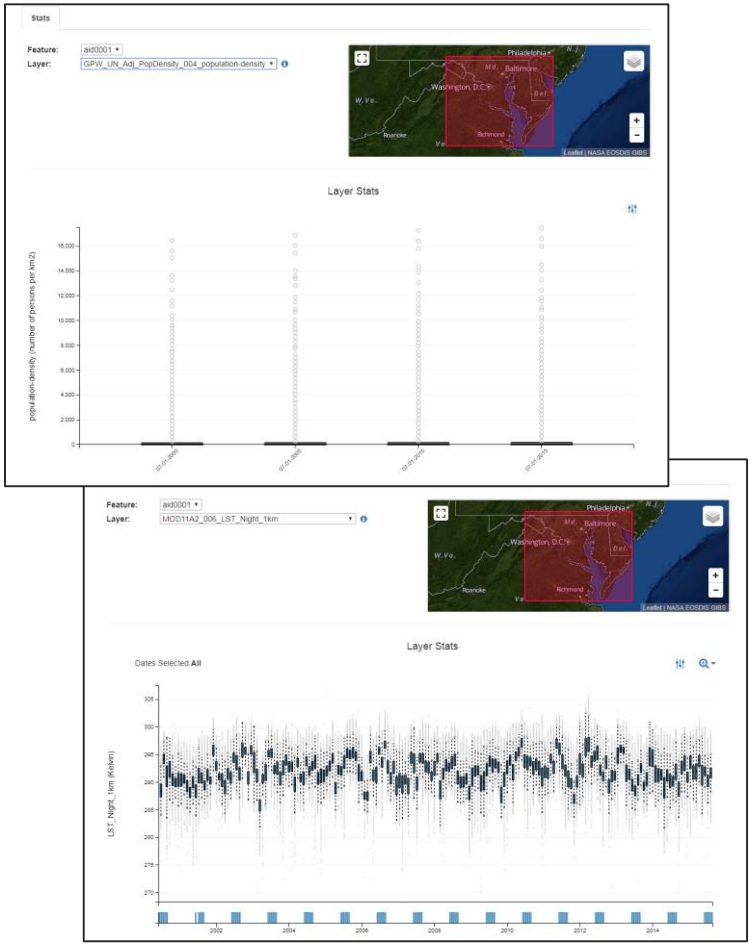
- Researcher: John (not a researcher, but AppEEARS is really easy to use!)
- Objective: Interested in visualizing how population densities have changed in and around the DC metropolitan area…and why not add some land surface temperature too because AppEEARS can do that!



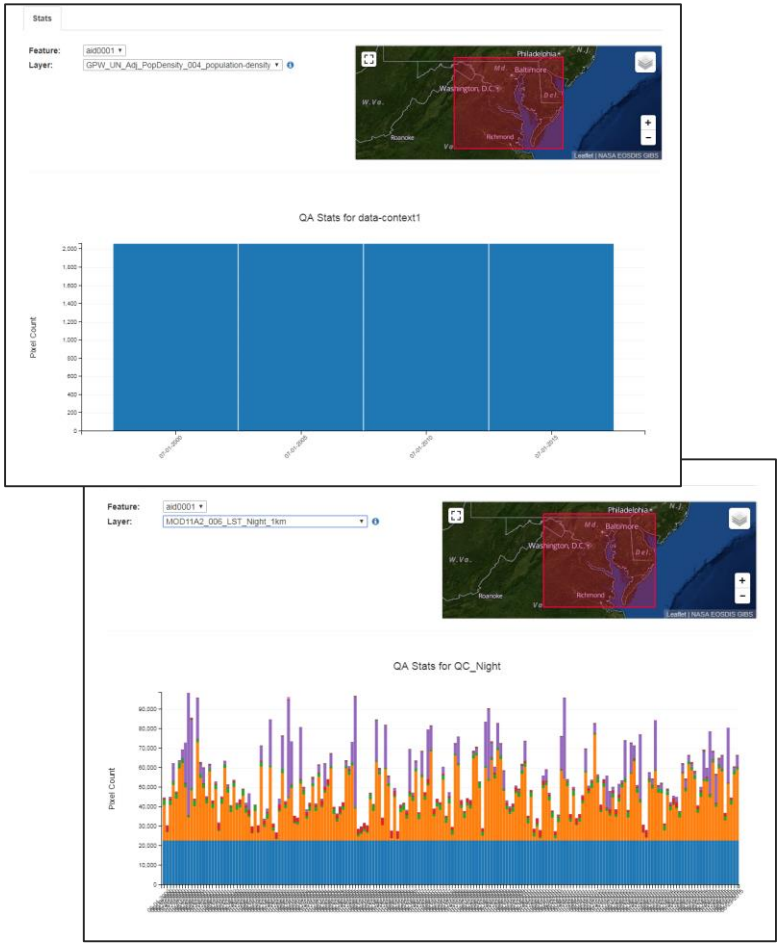
- ❑ Single user-drawn feature
- ❑ Touches 771 files
- ❑ Extracts QA layer
- ❑ Creates QA lookup table
- ❑ 772 Output GeoTIFFS (Clipped to feature boundary)
- ❑ ~ 2 minutes to complete

AppEEARS Area Statistics

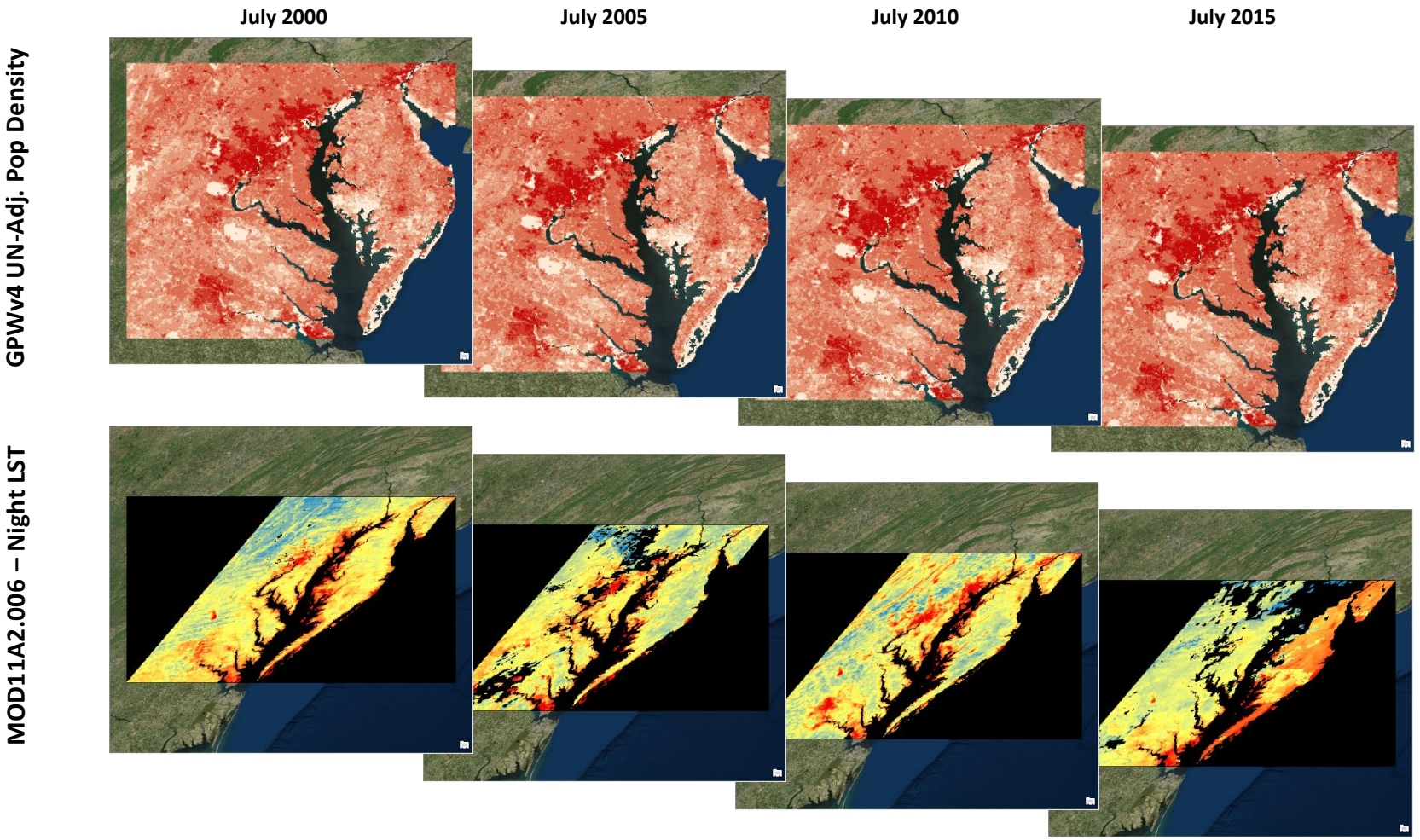
Aggregated Box and Whisker plot



Aggregated Quality Bar chart



AppEEARS GeoTIFF Outputs



AppEEARS GeoTIFF Metadata

```
C:\Users\afriesz\Documents\lp_daac\use_cases\Population_Draw_UC
λ gdalinfo GPW_UN_Adj_PopDensity.004_population-density_doy2000183_aid0001.tif
Driver: GTiff/GeoTIFF
Files: GPW_UN_Adj_PopDensity.004_population-density_doy2000183_aid0001.tif
       GPW_UN_Adj_PopDensity.004_population-density_doy2000183_aid0001.tif.aux.xml
Size is 400, 334
Coordinate System is:
GEOGCS["WGS 84",
    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563,
            AUTHORITY["EPSG","7030"]],
        AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
    AUTHORITY["EPSG","4326"]]
Origin = (-78.375000000000540,39.833333333333606)
Pixel Size = (0.008333333333333,-0.008333333333333)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  ( -78.3750000,  39.8333333) ( 78d22'30.00"W, 39d50' 0.00"N)
Lower Left  ( -78.3750000,  37.0500000) ( 78d22'30.00"W, 37d 3' 0.00"N)
Upper Right ( -75.0416667,  39.8333333) ( 75d 2'30.00"W, 39d50' 0.00"N)
Lower Right ( -75.0416667,  37.0500000) ( 75d 2'30.00"W, 37d 3' 0.00"N)
Center      ( -76.7083333,  38.4416667) ( 76d42'30.00"W, 38d26'30.00"N)
Band 1 Block=400x5 Type=Float32, ColorInterp=Gray
  Min=0.000 Max=16436.471
  Minimum=0.000, Maximum=16436.471, Mean=158.160, StdDev=514.574
  NoData Value=-407649103000000
  Metadata:
    STATISTICS_COVARIANCES=264786.2983758965
    STATISTICS_MAXIMUM=16436.470703125
    STATISTICS_MEAN=158.15970175753
    STATISTICS_MINIMUM=0
    STATISTICS_SKIPFACTORX=1
    STATISTICS_SKIPFACTORY=1
    STATISTICS_STDDEV=514.57389981994
```

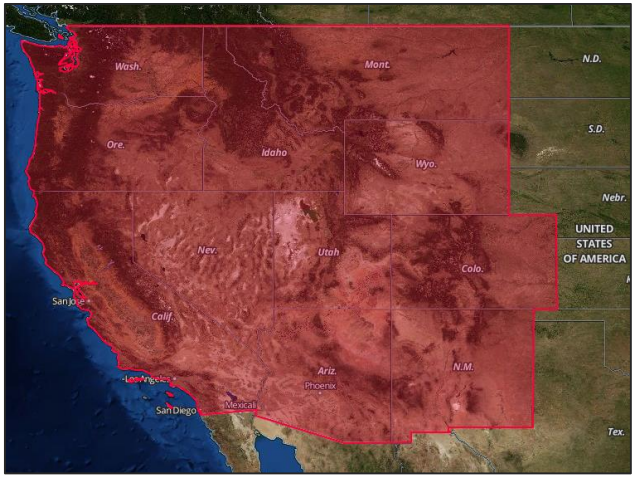
```
C:\Users\afriesz\Documents\lp_daac\use_cases\Population_Draw_UC
λ gdalinfo  MOD11A2.006_LST_Night_1km_doy2000185_aid0001.tif
Driver: GTiff/GeoTIFF
Files: MOD11A2.006_LST_Night_1km_doy2000185_aid0001.tif
Size is 591, 334
Coordinate System is:
PROJCS["unnamed",
    GEOGCS["unnamed ellipse",
        DATUM["unknown",
            SPHEROID["unnamed",6371007.181,0]],
        PRIMEM["Greenwich",0],
        UNIT["degree",0.0174532925199433]],
    PROJECTION["Sinusoidal"],
    PARAMETER["longitude_of_center",0],
    PARAMETER["false_easting",0],
    PARAMETER["false_northing",0],
    UNIT["metre",1,
        AUTHORITY["EPSG","9001"]]]
Origin = (-6955250.500515002800000,4429269.570005557500000)
Pixel Size = (926.625433055555960,-926.625433055555960)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (-6955250.501, 4429269.570) ( 81d27'17.11"W, 39d50' 0.00"N)
Lower Left  (-6955250.501, 4119776.675) ( 78d22'21.55"W, 37d 3' 0.00"N)
Upper Right (-6407614.870, 4429269.570) ( 75d 2'28.50"W, 39d50' 0.00"N)
Lower Right (-6407614.870, 4119776.675) ( 72d12' 6.57"W, 37d 3' 0.00"N)
Center      (-6681432.685, 4274523.123) ( 76d42'59.17"W, 38d26'30.00"N)
Band 1 Block=591x6 Type=UInt16, ColorInterp=Gray
  NoData Value=0
```

USGS NASA

Use Case – Snow Zones

- Researcher: Lindsey
- Objective: Create snow zone maps for the western United States and evaluate how meteorological and topographic variables impact snow zone extent and persistence.

Moore C, Kampf S, Stone B, Richer E. 2015. A GIS-based method for defining snow zones: application to the Western United States. *Geocarto Int.* 3(1): 62–81, doi: 10.1080/10106049.2014.885089.



Study Area

- Western United States
  - 11 States
- Single feature shapefile

Datasets

- MODIS 8d/500 m Snow
  - Snow Cover
  - Snow Extent
- MODIS 8d/1,000 m LST
  - LST
- NASA SRTM 3 arc second
  - Elevation

Time Span

- 2000 – 2010
- January 1st – Jul 1st

Projection

- Sinusoidal

Format

- GeoTIFF

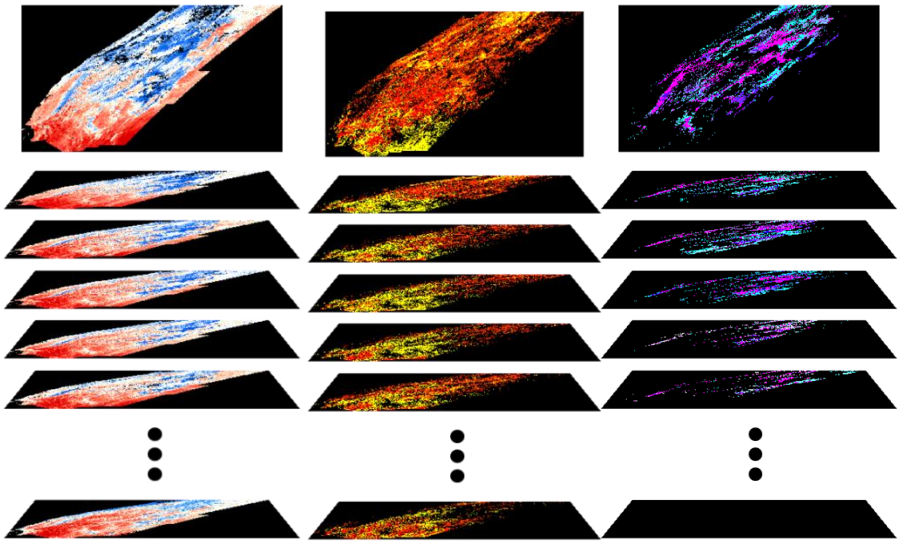
Time to Complete

- ~ 1 hr

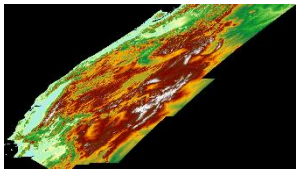
MOD11A2.006
LST_Day_1km

MOD11A2.006
QC_Day

MOD10A2.006
8_Day_Snow_Cover



SRTMGL3
Elevation



Without AppEEARS	*With AppEEARS*
• **7,852 files**	• **988 files**
• **20.26 GB**	• **3.4 GB**

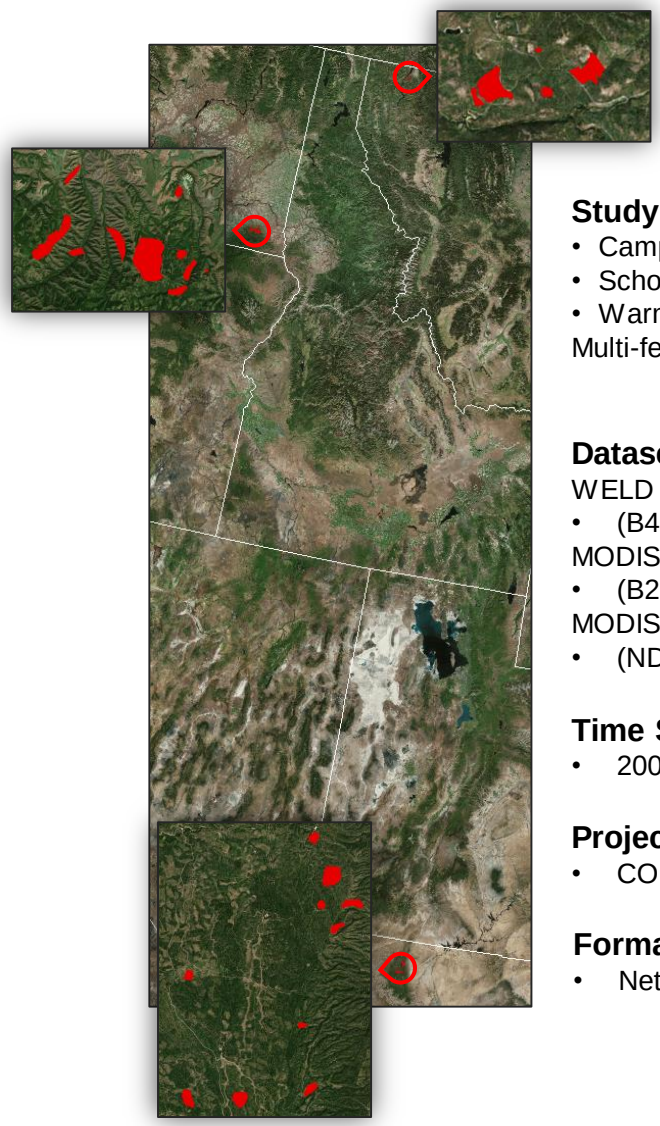
Took me longer to calculate the Without AppEEARS numbers than it took to run the request!

Use Case – Assessing Fuel Treatments

- Researcher: Chris
- Objective: Understand how forest management practices impact wildfire severity in fire-prone ecosystems.

Wimberly M, Cochrane M, Baer A, Pabst K. 2009. Assessing Fuel Treatment Effectiveness Using Satellite Imagery and Spatial Statistics. Ecological Applications. 19(6):1377-1384, doi:10.1890/08-1685.1

USGS NASA



Study Area
- Camp 32 Fire (Montana)
- School Fire (Washington)
- Warm Fire (Arizona)

Multi-feature shapefiles
25 features total

Datasets

WELD CONUS Weekly/30m
- (B4, B7, NDVI)

MODIS 8d/500m Surface Reflectance
- (B2, B7)

MODIS 16d/250m VI
- (NDVI)

Time Span
- 2005-2006

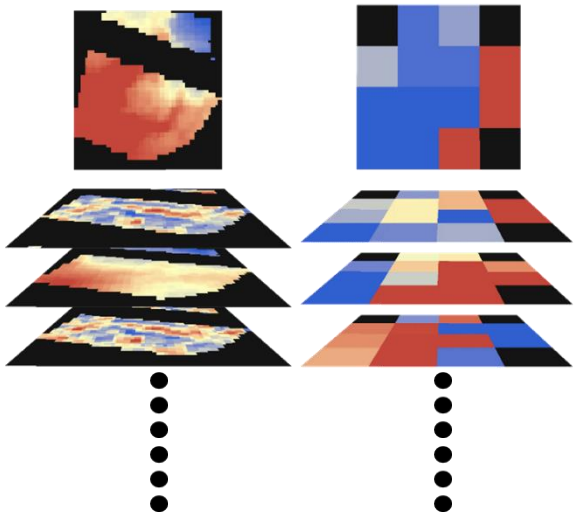
Projection
- CONUS Albers EA

Format
- NetCDF

Feature 1

WELDUSWK V015
Band4_TOA_REF

MOD09A1.006
Surf_refl_b02



Plus the remaining features & variables

Without AppEEARS	*With AppEEARS*
• 900 files	• 75 files
• ~ 101 GB	• 0.009 GB

USGS NASA

What's Next for AppEEARS

New Datasets	S-NPP NASA Visible Infrared Imaging Radiometer Suite (VIIRS) – Surface Reflectance (tiled) – **LP DAAC**
	Soil Moisture Active Passive (SMAP) – **NSIDC**
	Additional MODIS Version 6 Data Products – **LP DAAC**
	Daymet (Gridded estimates of daily weather parameters for North America) – **ORNL DAAC**
	Landsat Analysis Ready Data (ARD) – **USGS**
New Functionality	AppEEARS API
	AppEEARS to NGAP

Give us your Feedback!

https://lpdaacsvc.cr.usgs.gov/appeears/feedback

"I wish I had this in grad school“

x 100

“By the way, being an environmental epidemiologist (Health sector) I would like really to thank you for the AppEEARS that makes exploration of data simple, ultra efficient and the last but not the least in this field quick ! This was needed.

The UI is splendid and user-friendly. Warm congratulations to all people who contributed to make it.”

“… this tool alone is going to eliminate 90% of his busy work, i.e. downloading images and making time-series plots.

I'm sure they'll find some more busy work for him though!"

NASA Applied Remote Sensing Training (ARSET) group has featured AppEEARS as an easy to use tool for their applications users in the land community