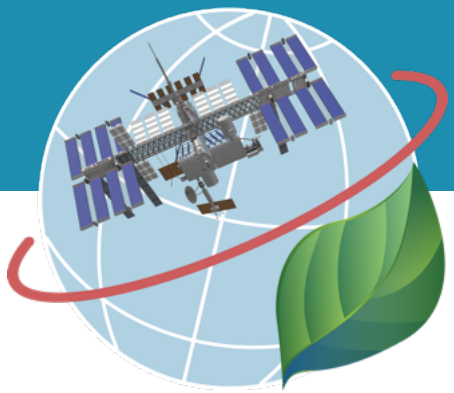


3

Accessing Remote Sensing Data With AppEEARS

Quick Links To Sections

Objectives:

1. Access and practice using the AppEEARS Interface.
2. Download ECOSTRESS land surface temperature data from AppEEARS.

Motivation For Today's Tutorial : Heat in Death Valley

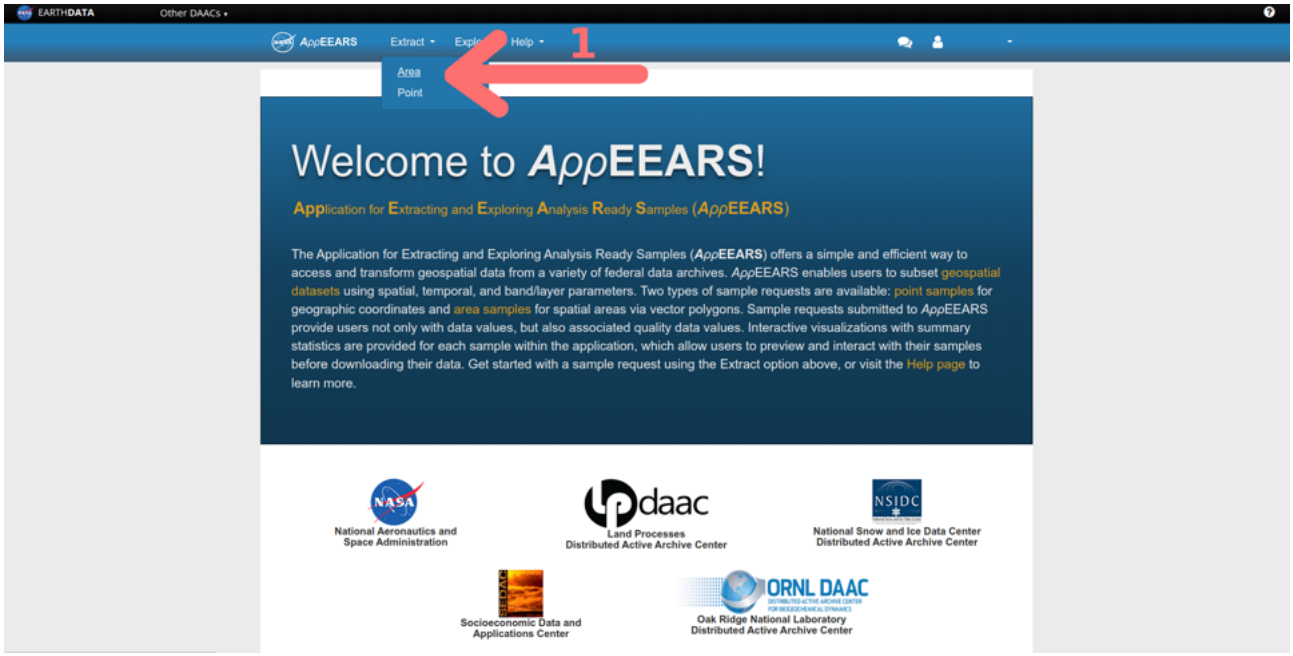
ECOSTRESS primarily measures land surface temperatures (LST), so let's look at the thermometer at one of the hottest places on the planet: Death Valley, California. The highest recorded ground temperature was verified at 201 degrees F on July 15, 1972. However, it recently had one of the hottest months on record, where air temperatures reached upwards of 128 degrees F in July of 2023. We are going to download the land surface temperature data from ECOSTRESS for those days to see how close it was to breaking the ground surface temperature record.

NOTE: ECOSTRESS launched on July 9, 2018, so as you think about potential projects, you cannot design a project that requires data before that date.

3.1 WELCOME BACK!

Today, we are introducing A$\rho\rho$EEARS, The Application for Extracting and Exploring Analysis Ready Samples, which is a web-based application designed to efficiently connect users with geospatial data that has been generated by satellite remote sensing instruments associated with agencies such as NASA and the U.S. Geological Survey. Satellite data is often available through different platforms, but today we are going to use A$\rho\rho$EEARS to access data from the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) instrument.

1. To begin, head over to https://appeears.earthdatacloud.nasa.gov/. Click the *Sign In* button to register for an Earthdata account, or login if you already have an account.



AρρEEARS is designed to allow you to download either point (i.e., data from a single pixel at a given latitude/longitude) or area (i.e., all of the pixels that fall within a given area defined by a polygon) data. It also allows you to choose the timespan for the data and the type of data you wish to request.

3.2 CREATE A REQUEST

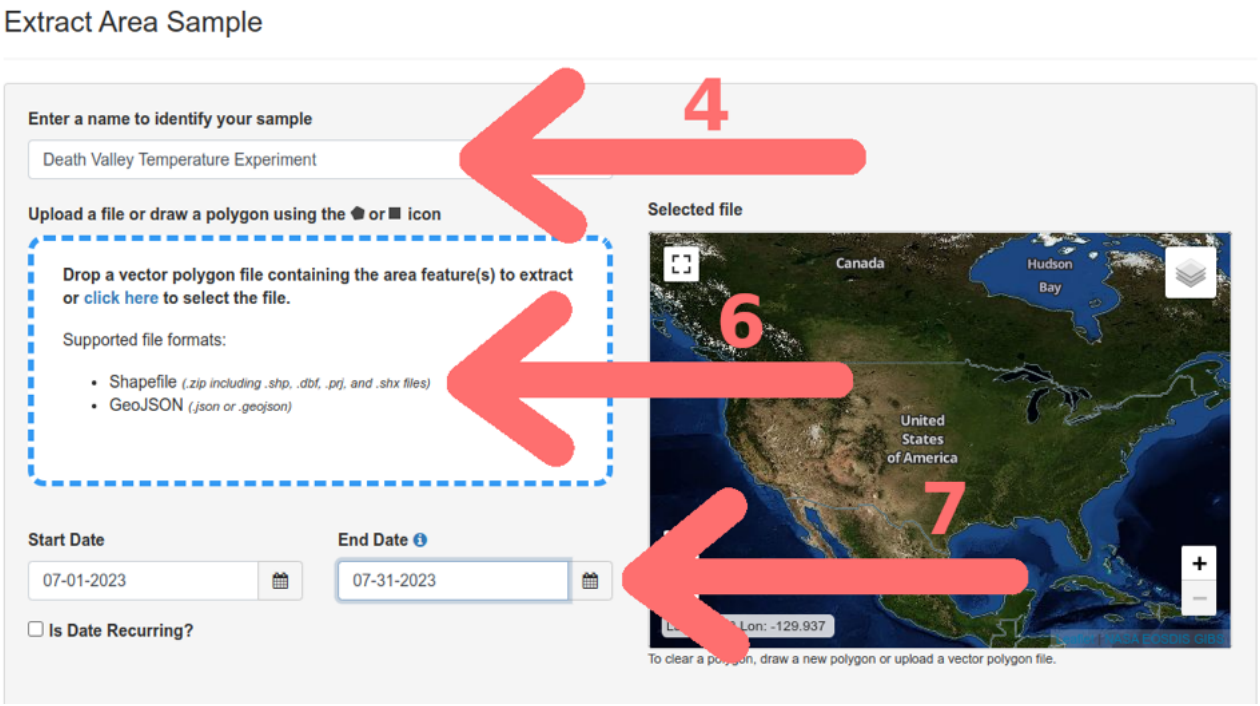
2. To access satellite data use the *Extract* dropdown menu to select *Area*.
3. Next select *Start a New Request*.
4. Select the *Start a new request* to request data for a new area and new time period.
5. Enter a useful name for the request you are going to submit, maybe something like “Death Valley Temperature Experiment”. Getting in the habit of assigning unique and relevant names will be useful when you start making many requests for data from AρρEEARS.

Now, we need to specify to AρρEEARS your geographic area of interest (AOI), which in this case is Death Valley National Park. This can be accomplished a few different ways:

- Using the map interface to draw a rectangle or polygon that encompasses your AOI.
- Uploading a shapefile that describes your AOI.

Today, we are going to use a shapefile describing a polygon of the park boundaries that we already drew for you in QGIS. In later tutorials, you will draw your own.

5. Download the DeathValleyNationalPark.zip shapefile and save it somewhere you can remember. A folder containing all of the files for this tutorial sounds effective and orderly.



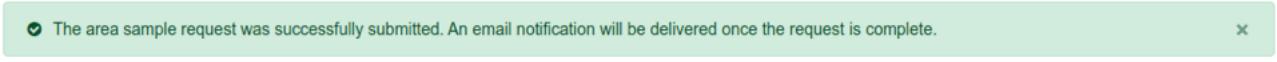
6. Drag and drop (or use the *click here to select the file* link) to upload the shapefile **DeathValleyNationalPark.zip**. The map should update with a polygon encompassing Death Valley National Park.
7. Update the *Start* and *End* Date Fields for our month of interest: 07/01/2023 to 07/31/2023

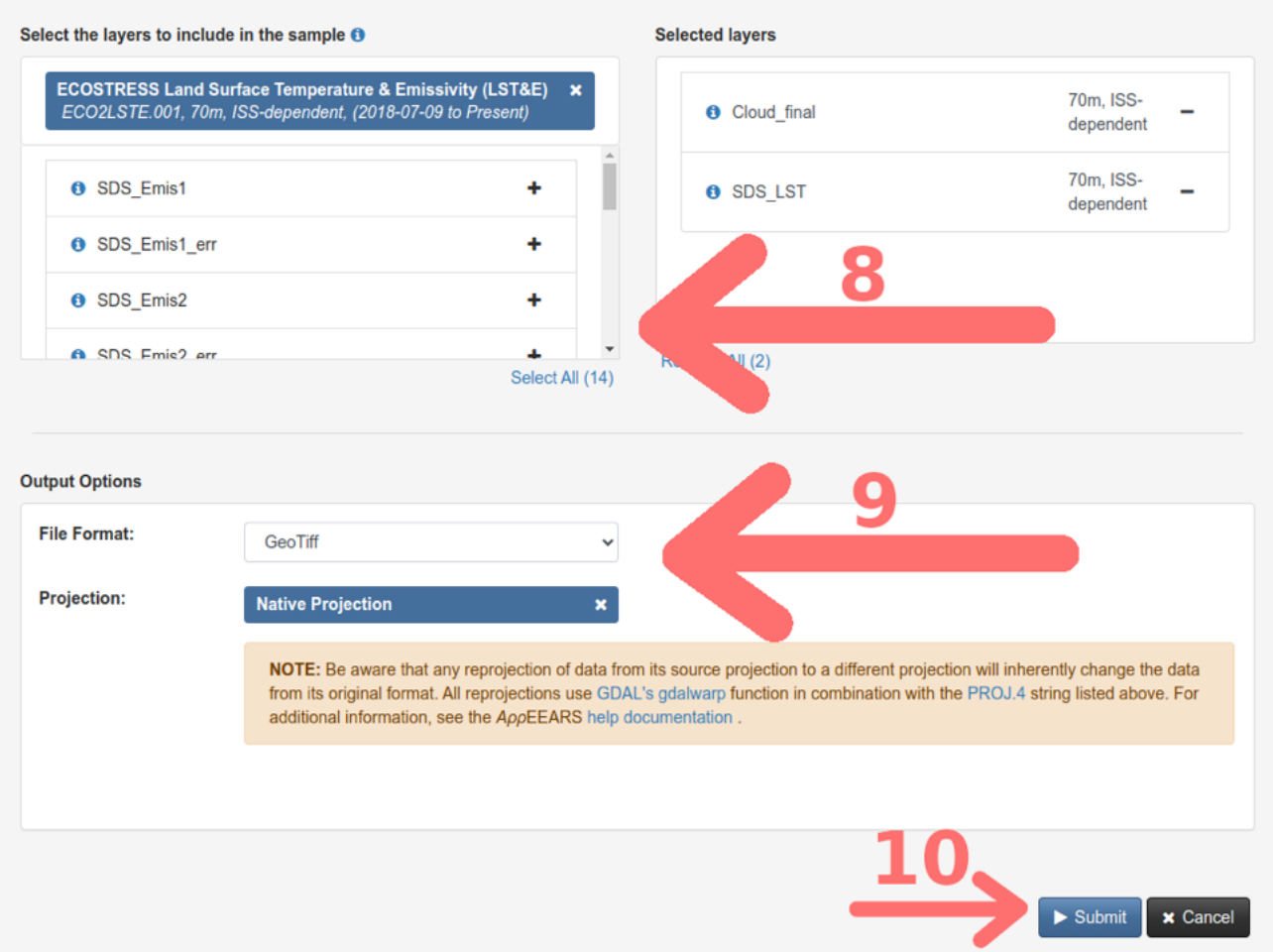
NOTE: While AρρEEARS provides access to a wealth of different data products, here we are primarily focusing on data from the ECOSTRESS instrument.

8. Under *Select the layers to include in the sample* type the word "ECOSTRESS" and scroll until you can click on *ECOSTRESS Land Surface Temperature & Emissivity (LST&E)*. From there, scroll until you see the Land Surface Temperature (*SDS_LST*) option. Click on the "+" sign to add the layer into your cart. Next, clear the current category selection using the small "x" to the right of the *ECOSTRESS Land Surface Temperature & Emissivity (LST&E)* blue box. Then search for "Cloud" and add *Cloud_final* from the *ECOSTRESS Cloud Mask Instantaneous* category to your selected layers cart.

NOTE: If you want to learn more about the types and formats of the ECOSTRESS Mission data, you can find all sorts of interesting facts here: https://lpdaac.usgs.gov/data/get-started-data/collection-overview/missions/ecostress-overview/

9. Under *Output Options*, we want to use GeoTIFF (Geographic Tagged Image File Format; an image file where the corresponding geographic information is embedded in the file) and *Native Projection* for projection.
10. Click *Submit* to complete the data request. At the top, you should see a green banner:

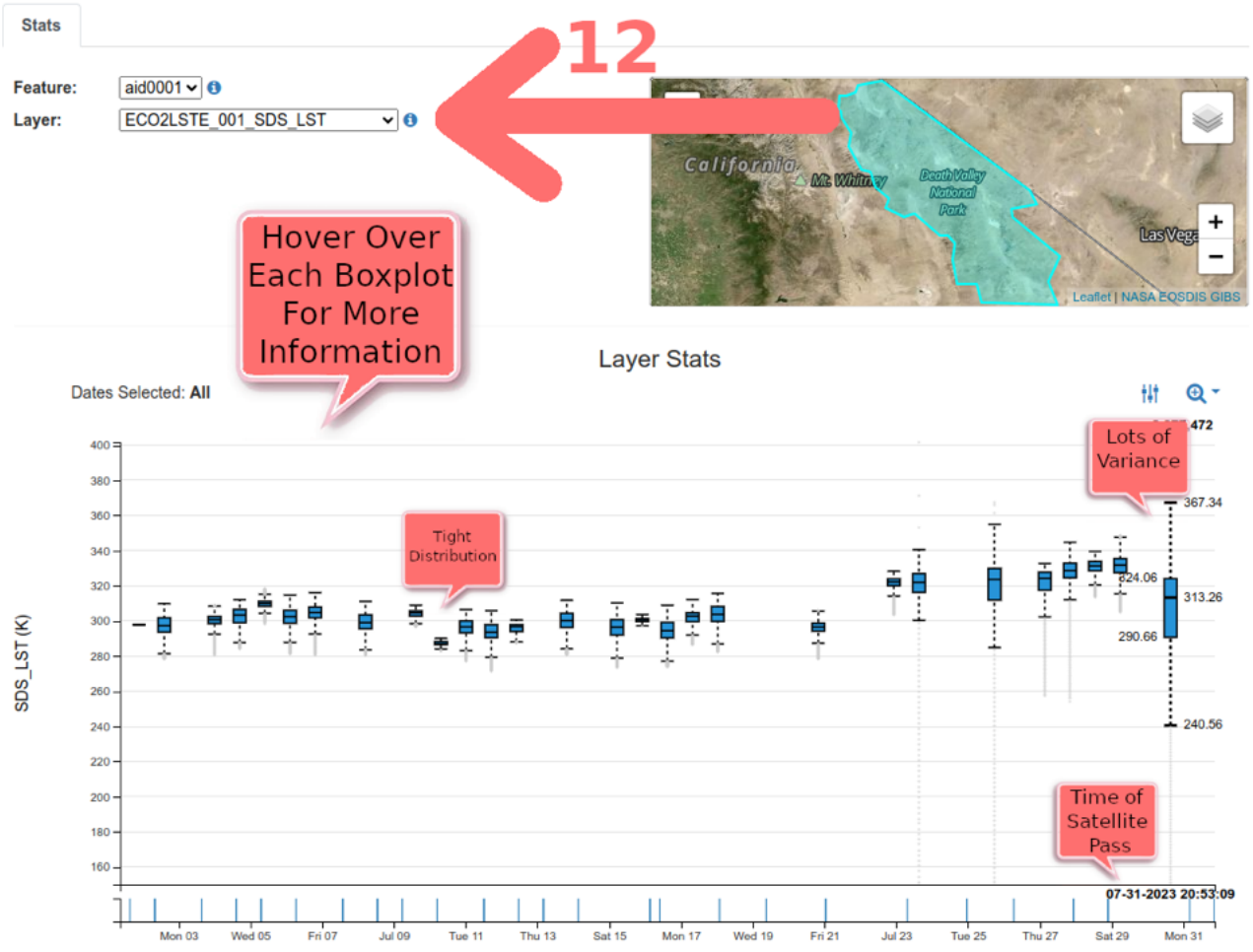




11. You can also track the progress of your request and access the data at https://appeears.earthdatacloud.nasa.gov/explore. Most small requests will take 15 minutes or less, larger ones can take upwards of an hour or more. Follow the *Explore* link in your completed request email (or via the explore menu tab on the A$\rho\rho$EEARS homepage) to access your data.

NOTE: While using the A$\rho\rho$EEARS interface you will occasionally encounter an error, or the system may be out-of-service for maintenance or updating. If it is the latter, there will be a banner at the top of the A$\rho\rho$EEARS webpage with information about the timeline to restore service. If you encounter an error without a banner present, you can submit a support ticket at : https://lpdaac.usgs.gov/lpdaac-contact-us/.

NOTE: For these tutorials, if the A$\rho\rho$EEARS interface is not functioning, we have provided links at the end of each page to the necessary files.

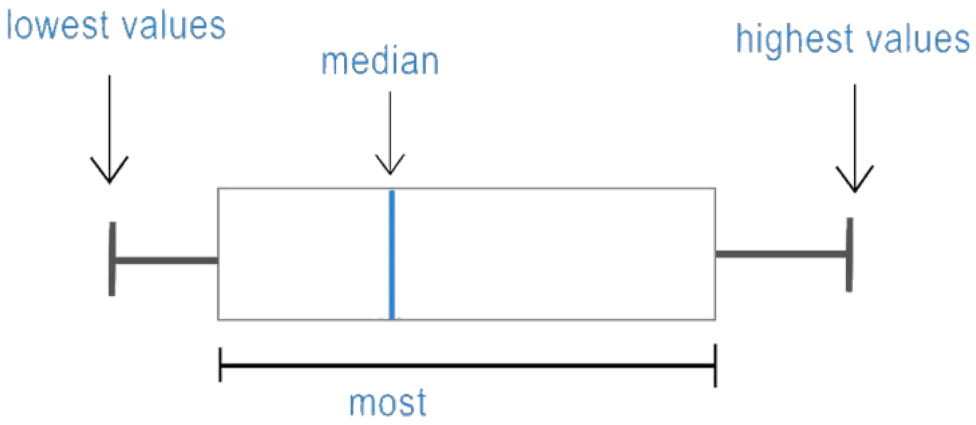


3.3 ALWAYS CHECK YOUR DATA

12. Before we download the files, we should preview the data using the built-in A$\rho\rho$EEARS visualizations. First, make sure the Land Surface Temperature (LST) layer is selected. Under *Layer Stats*, you will see a boxplot timeseries of the temperature data across the range of dates (x-axis) and observed temperature that the instrument observed for each date (y-axis). See the image below for what you can learn from a boxplot. Next, hover over the boxplots in the timeseries to see all sorts of useful information, including the date and time of day of the satellite pass. While 7/26/2023 had the hottest air temperature of the month, our observations of surface temperature are among the lowest! Why is that? Have we discovered some new physical property of the desert? Well no, the satellite pass was simply at 9:49 AM, which was not exactly the hottest part of the day.

NOTE: ECOSTRESS makes temperature observations on the Kelvin scale, not degrees Fahrenheit or Celsius.

How To Read A Boxplot

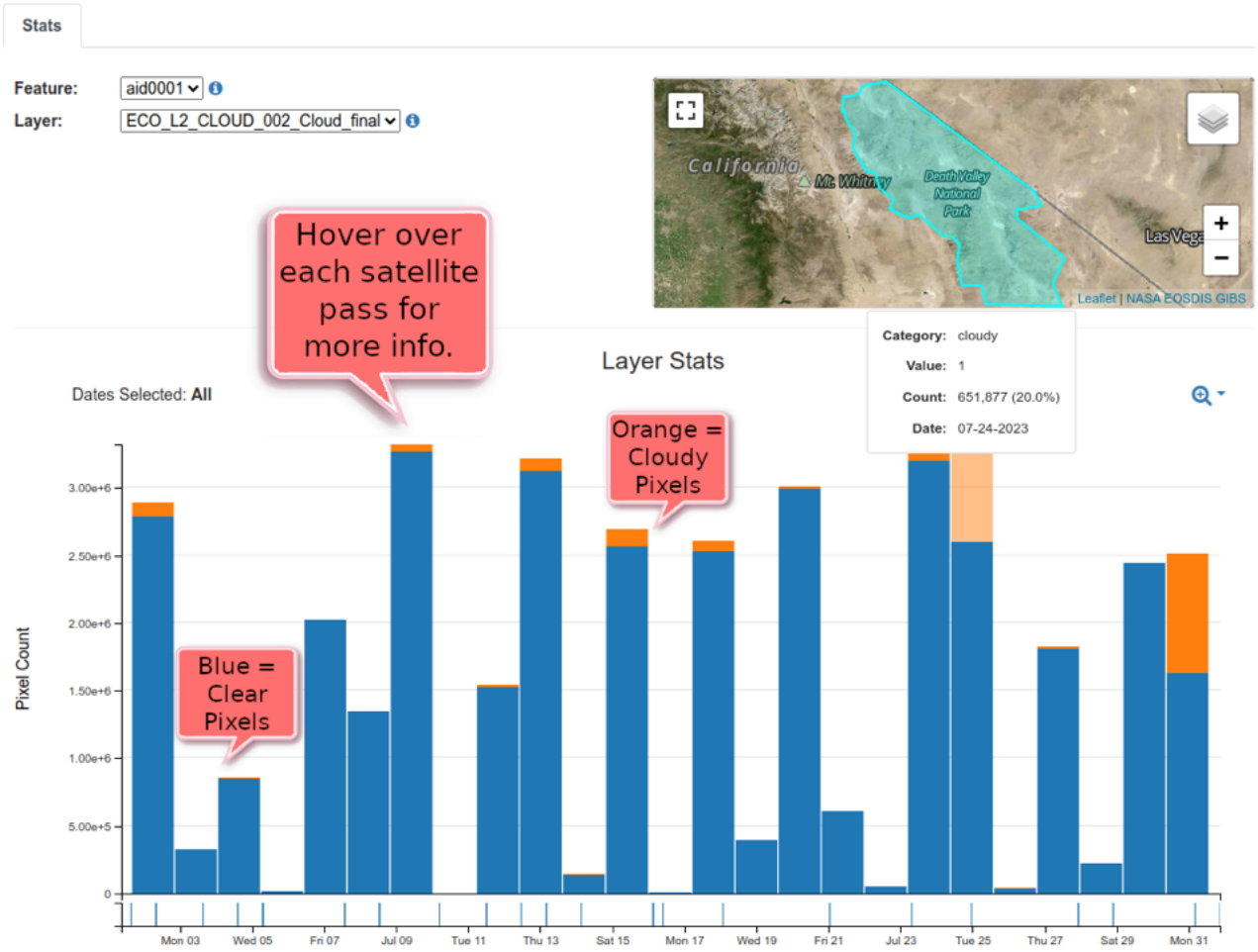


Cloudy Conditions

You are likely noticing that the distribution of temperatures for a given orbital pass from the instrument is quite variable. In some instances, like on Tuesday, 7/11/2023, all of the temperatures are close to the median. On other days, like Monday, 7/31/2023, the temperatures vary considerably. If this was a different locale, it could mean that there is a lot of variation in surface temperatures across this geographic area of interest. However, in this case we know Death Valley is consistently a hot desert, so it is more likely there is another culprit, clouds.

Satellite observations have many advantages, but they can not accurately measure through clouds. To account for this possibility, the ECOSTRESS mission (and others) have built cloud detection algorithms and included that data in A$\rho\rho$EEARS. Checking for the effects of cloud cover on the accuracy and precision of the results is an important part of data quality control and assurance.

13. Change the layer in the built-in A$\rho\rho$EEARS visualizations to Cloud_final. Now, we have a different visualization, the output of the cloud detecting algorithm. The bar chart breaks down the percentage of pixels that are clear (represented in blue) and pixels that have clouds (orange). Satellite passes that are free of clouds, or have few clouds, tend to have higher quality data with fewer outliers because there is little interference. To make our temperature map, let's use data from the hottest cloud free day: 7/28/2023.



3.4 DOWNLOADING DATA

Output data files returned by A$\rho\rho$EEARS have the following naming convention:

<ProductShortName>.<Version>_<LayerName>_doy<Year><JulianDate>_<AppEEARSFeatureID>.<FileFormat>

Example output file name (.tif):

- ECO2LSTE.001_SDS_LST_doy2023209214149_aid0001.tif

where:
<ProductShortName> ECO2LSTE
<Version> 001
<LayerName> ..... SDS_LST
<Year> 2023
<JulianDate> 209
<AppEEARSFeatureID> aid0001
<FileFormat> ..... tif

In this case, we are primarily concerned with the layer name, which corresponds to our variable of interest (i.e., Land surface temperature = *SDS_LST*), and with the time of the satellite pass (i.e. Year = 2023, Julian Date = 209).

JULIAN DATE CALENDAR

PERPETUAL

Select Month, In This Case July

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174				296	327	357
24	24	55	83	114	144	175				297	328	358
25	25	56	84	115	145	176				298	329	359
26	26	57	85	116	146	177				299	330	360
27	27	58	86	117	147	178	208		270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

Our day of year is 209

Select Day, In This Case 28

NOTE: You can access the Julian Calendar table anytime by clicking this link. Watch out for leap years!

14. Access the download page by scrolling to the top of the page, selecting the *Explore* menu and selecting the middle button next to your request, *Download the contents of the request*. Use the Julian Calendar and file naming convention listed above to determine what filename we need to download the land surface temperature data for 7/28/2023. There can be multiple files that match the date and layer you requested, in this case there are two. Download both files into the same folder that you saved the DeathValleyNationalPark.zip shapefile.

15. Cheers! You have now downloaded ECOSTRESS data. In the next tutorial we will use QGIS to visualize these LST observations.

Map of the Week Assignments

1. Watch the YouTube Video: Why All Maps Are Wrong
2. Read the article Lying With Maps from the University of Minnesota.

Datafiles

In case you encountered any issues with the A$\rho\rho$EEARS database, here are copies of the ECOSTRESS GeoTIFF files for Death Valley:

1. ECO2LSTE.001_SDS_LST_doy2023209214149_aid0001.tif
2. ECO2LSTE.001_SDS_LST_doy2023209214057_aid0001.tif

Recommended Citation: Forsythe, J.D., G.R. Goldsmith, and J.B. Fisher. 2023. Observing Earth from Above Tutorials. Chapman University. https://jeremydforsythe.github.io/icecream-tutorials/

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