ECOSTRESS data description

ECOSTRESS data are released in HDF5 and geotiff formats, complete with datasets and attribute information. A full description of the data format will be described in User Guides and Product Specification Documents. However, the user may be interested in particular fields, such as:

L1B_RAD:
/Radiance/radiance_1
/Radiance/radiance_2
/Radiance/radiance_3
/Radiance/radiance_4
/Radiance/radiance_5

L1B_GEO:
/Geolocation/latitude
/Geolocation/longitude

Frequently Asked Questions

1. Why are there stripes in the data?

a) Detectors in TIR bands 1 and 5 and the SWIR band were damaged during testing, before launch. This will result in 8 lines of missing data every 128 lines in the across-track direction in those bands, and an error code of -9998 for the missing pixels.
b) Because of the detector placement on the instrument, there are occasions when data seen by band 1 are not seen by other bands. This missing data is flagged with the error code of -9997.
c) In the last instance, what can appear as striping is not due to missing data. ECOSTRESS is a push-whisk instrument, which means that a scene is made up of 44 scans, stacked in the along-track direction. Each of these scans has an overlap, and so before geolocation, some apparent spatial discrepancies may be observed. This will be visually corrected through geolocation. (Note that all data is still correct as presented; it is simply the visualization that may be difficult to understand.)

2. Why should I be using Collection 2?

In Collection 2 you will find improved radiance calibration (based on field observations), geolocation (by increasing the number of match points), cloud masking (through development of a new algorithm), and evapotranspiration (primarily by improving ancillary inputs).

3. When will Collection 2 processing be completed?

Collection 2 radiance, geolocation, cloud, land surface temperature and emissivity products have been produced since late CY2022, and evapotranspiration and higher-level products have been produced since early CY2024. The full record will be reprocessed to Collection 2, anticipated to be completed in the first quarter of CY2025.

4. Why is there very little data over my region of interest?

ECOSTRESS was a low-cost mission with targeted acquisition areas. In the first year of mission, ECOSTRESS suffered an anomaly to the on-board data storage units and the team developed new firmware that enabled "direct streaming" of the data. This actually allowed the mission to acquire far more data than the proposed target areas, but nevertheless, ECOSTRESS acquires data faster than it can transmit the data back to earth, so we have a hierarchy of sites for acquisition priority. The highest priority targets are almost always acquired (e.g. certain field validation sites will have >3 acquisitions per week). The lowest priority sites are only acquired when bandwidth is available, and the CLASP algorithm ensures that all sites are captured eventually (usually at least once a month, depending on location). If you would like to request that your site be bumped in priority, please reach out to the science team.

5. Why do swath and tiled products give slightly different answers over my site?

ECOSTRESS is a push-whisk instrument. That means that it acquires a rectangle of data in a single whisk, then relies on the forward motion of the ISS to acquire the next rectangle in another whisk. There is overlap between these two rectangles, and small differences between them (due to small anomalies in the scanning mirror). Depending on how you are projecting or reading the L2 swath data, the resampling used to create L2T may create small differences.

6. Why is there a checkerboard pattern in the data?

Small differences in overlapping scanlines may look like a checkerboard due to the nearest neighbor resampling technique. For most applications these differences are "in the noise", but they may be significant for certain low-signal applications. We chose to apply a nearest neighbor resampling in order to preserve data fidelity. However, users can also reproject the data scanline-by-scanline using a different technique by starting from the swath data.

7. Where is the ET data for 2023?

The Collection 1 ET processing pipeline failed towards the end of 2022 when one of the ancillary inputs changed the way their product could be accessed. Collection 2 will fill this gap once implemented.

8. What is the data latency?

A typical product latency is:
Radiance: ~4 hours (from acquisition to data availability)
Land Surface Temperature: ~1 day (this product relies on atmospheric reanalysis data, which drives the latency)
Evapotranspiration: ~3-5 days (the input with the longest lag time here is harmonized Landsat Sentinel (HLS) data.)

9. Why does the "daily" ECOSTRESS ET product seem to be 2x as high as my comparison daily ET?

The "daily" ECOSTRESS ET is actually *daytime* ET. Your comparison daily ET may be including night, so those values would be roughly half of the daytime (e.g., 12 hours of night with 0 ET). You'll need to do an hours of daylight calculation to make a direct comparison.

10. How much did the ECOSTRESS Mission Cost?
The ECOSTRESS mission was cost capped at $30M. This includes the cost of building the instrument and conducting the science.

11. How much do ECOSTRESS Data Cost?
ECOSTRESS data are freely available. Links for downloading the data are on the "Data" tab of the ECOSTRESS website (http://ecostress.jpl.nasa.gov/data).

12. What is the make and model of the thermal "camera" on ECOSTRESS?
ECOSTRESS is a thermal infrared radiometer that was designed, developed and built by NASA's Jet Propulsion Laboratory.

13. What is the operating temperature of the ECOSTRESS detector array?
The detectors operate at 65K (degrees Kelvin). More information on the specification of the instrument are available https://ecostress.jpl.nasa.gov/instrument

14. Who are the science team members working on the ECOSTRESS Mission?
See https://ecostress.jpl.nasa.gov/team

15. How long will ECOSTRESS continue to operate?
None of the parts of the ECOSTRESS instrument are near their end of life, and ECOSTRESS can remain on the ISS until 2029. Whether ECOSTRESS continues to be operated past FY2026 is determined by NASA Headquarters as part of the Senior Review process that happens every 3 years.

16. Is ECOSTRESS in a sun synchronous orbit?
A sun synchronous orbit is when the satellite passes over any given location at the same time on each overpass. ECOSTRESS is mounted on the International Space Station (ISS), which is in a precessing orbit. This means ECOSTRESS acquires data at different times of day allowing it to determine how plants respond to water stress throughout the day.

17. Where do I go to find if there is ECOSTRESS data over my site?
The best place to start is the "Data" tab on the ECOSTRESS website https://ecostress.jpl.nasa.gov/data

18. Can I use an ECOSTRESS gallery image for my presentation?
Unless otherwise noted, images and video on JPL public web sites (public sites ending with a jpl.nasa.gov address) may be used for any purpose without prior permission, subject to the special cases noted in the Image Policy. Use the proper credit information provided in the image policy.

19. Why are ECOSTRESS ET values greater than my eddy covariance measurements?
Check a few things:

1. Cloud mask: sometimes clouds cause low LST, and hence a false high ET retrieval when the cloud mask misses a cloud (related, you should look at the in-situ light measurements for cloudiness—if the day is really cloudy, or the ET values are unusually high, consider excluding that day);
2. Quality flag/uncertainty: be sure to use the quality flags;
3. Site heterogeneity: highly heterogeneous sites may have outside-pixel contamination;
4. Eddy covariance energy balance closure: did you close your EBC? Typically, eddy flux ET may need to be increased to deal with EBC (e.g., fluxnet.fluxdata.org/data/fluxnet2015-dataset/data-processing; see processing code, e.g., at github under "Robust Ecosystem Water and Energy Fluxes").

20. How does ECOSTRESS ignore the clouds or rain storms?

ECOSTRESS cannot see through the clouds and relies on clear skies. However, since the instrument is on the ISS and based on its orbits ECOSTRESS passes over the same area fairly frequently for a given day.

21. Will the data be available on a subscription-based system?

There is no subscription-based system and NASA provides the data freely available via the Land Processes Distributed Active Archive Center (LP DAAC).

22. How do I interpret the data quality flag in the Level-2 Land Surface Temperature and Emissivity product (ECO2LSTE)?

The Collection 1 ECO2LSTE product contains a 16-bit Quality Control (QC) flag (see section 2.4 in the user guide at https://lpdaac.usgs.gov/documents/423/ECO2_User_Guide_V1.pdf). User need to unpack the bits in the data to interpret the flag. This can be done using the 'bitget' function in either Python, MATLAB, or R for example.

Two use case scenarios:

1. I only want pixels that have the best quality, clear-sky data (e.g. to be used for validation purposes).
    - Read bits 1 and 2 in the QC bit flag. Look for pixels where bit 1 = 0 and bit 2 = 0. These pixels correspond to best quality data with low uncertainty in the retrieval, and use the most clear-sky conservative cloud mask, i.e. cloud detection is overestimated (see next QA question for more information on the cloud mask).
    - In addition, check bits 15 and 16 that represent the LST uncertainty, or directly read the LST_err uncertainty variable in the h5 data file that provides pixel level uncertainty estimate based on an uncertainty model.
2. I am using the data mostly for qualitative analysis and can tolerate some level of uncertainty.
    - Read bits 1 and 2 in the QC bit flag. Look for pixels where bit 1 = 0 and bit 2 = 0, or bit 1 = 1 and bit 2 = 0. The pixels represent both best quality and nominal quality pixels that are flagged based on outputs from the retrieval and atmospheric conditions detailed in the user guide.

23. How do I apply a Level-2 ECO2LSTE data quality flag to filter only good pixels, grid the data, and output to a geotiff file?

The AppEEARs tool produces geotiff output, and Collection 2 data are available in geotiff. For the interested user, this piece of matlab code reads in ECOSTRESS L2 and L1GEO data, sets all bad quality data to nans, grids the output to a specified study area, and outputs the data to a geotiff to be read in by GIS software.

Step 1: Read in LST and QC data from ECO2LSTE swath product (fL2 = L2 hdf5 filename, fL1geo = L1GEO hdf5 filename);

```
LST_eco = hdf5read(fL2,'/SDS/LST','V71Dimensions',true);
LST_eco = double(LST_eco).*0.02;
QC = hdf5read(fL2,'/SDS/QC','V71Dimensions',true);
Lat_eco = double(hdf5read(fL1geo,'/Geolocation/latitude','V71Dimensions',true));
Lon_eco = double(hdf5read(fL1geo,'/Geolocation/longitude','V71Dimensions',true));
```

Step 2: Screen for poor quality pixels using QC, set to nan (or some other value)

```
% Bits 0 and 1
test1 = bitget(QC,1);
test2 = bitget(QC,2);
QCtestgood = (test1==0 & test2==0);  % Best quality
LST_eco(~QCtestgood) = nan;
```

Step 3: Geolocate data to a WGS84 equal-angle grid with resolution of ~70m, e.g. over Los Angeles

```
%Limits of study area
minlat = 33.5; maxlat = 34.35;
minlon = -118.74; maxlon = -117.6;
lats = minlat:0.0007:maxlat; lons = minlon:0.0007:maxlon;
[latg,long] = meshgrat(lats,lons);
latg = flipud(latg);
LSTgrid_eco = griddata(Lat_eco,Lon_eco,LST_eco,latg,long,'cubic');
```

Step 4: Output data to a geotiff file

```
latlim = [min(latg(:)) max(latg(:))];
lonlim = [min(long(:)) max(long(:))];
rasterSize = size(latg);
R = georefcells(latlim,lonlim,rasterSize,'ColumnsStartFrom','north');
geotiffwrite(fileswrite,LSTgrid_eco,R);
```

24. How do I interpret the Collection 1 Level-2 cloud mask product (ECO2CLOUD) and are there any alternative methods for cloud screening?

Similar to the ECO2LSTE QC flag, the ECOCLOUD product consists of one 8-bit flag representing outputs from the cloud mask detection algorithm.

Three use case scenarios:

1. I want the 'clearest' pixels, with few cloud shadows and cloud edge effects (e.g. for validation purposes).
    - Use ECO2LSTE QC case 1 scenario above. The cloud mask product is not required in this case since the most clear sky conservative result is included in the

ECO2LSTE QC (bit 1 = 0 and bit 2 = 0). This result uses a combination of both cloud tests and includes region-growing around detected cloud pixels by 5 pixels, and morphological filling in 'holes' between clouds in order to remove cloud shadowing and thermal adjacency effects.

2. I can tolerate some degree of cloud omission error, cloud edge, and shadowing.
    - Read bit 1 first. If bit 1 = 1 then the cloud mask was determined based on good quality L1B data.
    - Read bit 3. If bit 3 = 1 then a cloud was detected either with band 4 brightness threshold test or the band 4 – 5 thermal difference tests.

25. Why is the geolocation less accurate over some images?

ECOSTRESS is mounted on the International Space Station (ISS). The ISS doesn't measure its position and pointing as accurately as we need it to for geolocation of 70m pixels (it doesn't need to for its own orbit control). So we use the ISS positioning as a first estimate, and do a secondary geolocation correction using the Landsat basemap. All the scenes in an orbit are used for the correction, and unfortunately factors such as high cloud cover over a significant portion of the orbit - resulting in insufficient matches - can also affect clear areas within that orbit even if the particular scene of interest is clear. A metadata item you can look for in the geolocation file is "/L1BGEOMetadata/OrbitCorrectionPerformed". If it is listed as {false}, that means that the correction wasn't performed. Other fields of interest are: "/StandardMetadata/AutomaticQualityFlag" and "/StandardMetadata/AutomaticQualityFlagExplanation".

26. Why does Landsat TIR at 100 m look sharper than ECOSTRESS TIR at 70 m?

Landsat downscales their TIR data to 30 m using bicubic interpolation to match the spatial scale of the VNIR data. Also, ECOSTRESS is a scanner (push-whisk) so the pixel resolution on swath edges degrades from 70m to 90-110m. Landsat is a pushbroom so has consistent pixel resolution, but smaller swath width.

27. What image processing and/or visualization software is commonly used for ECOSTRESS and related Landsat imagery?

There is a version of QGIS that has been enhanced to visualize ECOSTRESS imagery. It is available from the ECOSTRESS website at: https://ecostress.jpl.nasa.gov/applications . For general image processing, the JPL-developed VICAR/AFIDS software is Open Source and available at: https://github.com/NASA-AMMOS/AFIDS-POMM .