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Dataset Version: 1

Summary

This dataset contains Level 1 (L1) per-pixel geolocation information from the Hyperspectral Thermal Emission Spectrometer (HyTES) instrument. This is the NASA Earth Observing System Data and Information System (EOSDIS) facility instrument archive of these data. The NASA HyTES is an airborne imaging spectrometer with 256 spectral channels between 7.5 and 12 micrometers in the thermal infrared part of the electromagnetic spectrum and 512 pixels cross-track. HyTES has been deployed on DHC-6 Twin Otter, NASA's ER-2, and GulfStream V aircraft and completed its first flights in July 2012. Geolocation information includes latitude, longitude, altitude, and ray path length (m). The data are provided in ENVI format.

NASA facility instruments operate out of a NASA research center and support multiple science disciplines, field investigations, and NASA science objectives. Facility instruments are supported by managers in the Earth Science Division (ESD) Research and Analysis Program, and/or the Earth Observation System (EOS) Project Science Office.

This set of HyTES Facility Instrument datasets will include the L1 files from the HyTES flights starting from 2014-07-02.



Figure 1. Portion of a false color image derived from HyTES radiance data from flight over Garfield, Colorado on 2022-03-15. Flight: GarfieldCO Line 1, 20220315t230313.

Citation

Hook, S.J., G.C. Hulley, T.T. La, G. Rivera, W.R. Johnson, and B.T. Eng. 2026. HyTES L1 Geolocation, Facility Instrument Collection. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2459>

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1. Dataset Overview

Project: [HyTES](#)

The Hyperspectral Thermal Emissions Spectrometer (HyTES) is an airborne pushbroom imaging spectrometer developed by the Jet Propulsion Laboratory (JPL). It was designed to support the previous Hyperspectral Infrared Imager (HyspIRI) mission study and has been used in several research missions since July 2012. HyTES offers high spatial and spectral resolution measurements of brightness temperature (radiance), emissivity, and land surface temperature. It operates across 256 spectral channels between 7.5 and 12 μm wavelengths. HyTES instrument has 512 pixels across track with pixel sizes in the range of 5 to 50 m depending on the flight altitude. HyTES was funded through NASA's Earth Science Technology Office (ESTO) Instrument Incubator Program (IIP).

This dataset contains Level 1 (L1) per-pixel geolocation information from the HyTES instrument. This is the NASA Earth Observing System Data and Information System (EOSDIS) facility instrument archive of these data. The NASA HyTES is an airborne imaging spectrometer deployed on DHC-6 Twin Otter, NASA's ER-2, and GulfStream V aircraft. The first flights were completed in July 2012. Geolocation information includes latitude, longitude, altitude, and ray path length (m).

HyTES was designed to provide high spectral and spatial resolution thermal infrared (TIR) data as a precursor for the Hyperspectral Infrared Imager (HyspIRI) orbital mission. It is useful for a number of applications, including high-resolution surface temperature and emissivity measurements, point sources of air pollution, and volcano observations.

NASA facility instruments operate out of a NASA research center and support multiple science disciplines, field investigations, and NASA science objectives. Facility instruments are supported by managers in the Earth Science Division (ESD) Research and Analysis Program, and/or the Earth Observation System (EOS) Project Science Office.

This set of HyTES Facility Instrument datasets will include the L1 files from the HyTES flights starting from 2014-07-02.

Related Publications

Hook, S.J., W.R. Johnson, and M.J. Abrams. 2013. NASA's Hyperspectral Thermal Emission Spectrometer (HyTES). In: C. Kuenzer and S. Dech (eds). Thermal Infrared Remote Sensing. Remote Sensing and Digital Image Processing, vol 17. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-6639-6_5

Hulley, G.C., R.M. Duren, F.M. Hopkins, S.J. Hook, N. Vance, P. Guillevic, W.R. Johnson, B.T. Eng, J.M. Mihaly, V.M. Jovanovic, S.L. Chazanoff, Z.K. Staniszewski, L. Kuai, J. Worden, C. Frankenberg, G. Rivera, A.D. Aubrey, C.E. Miller, N.K. Malakar, J.M. Sánchez Tomás, and K.T. Holmes. 2016. High spatial resolution imaging of methane and other trace gases with the airborne Hyperspectral Thermal Emission Spectrometer (HyTES). Atmospheric Measurement Techniques 9:2393–2408. <https://doi.org/10.5194/amt-9-2393-2016>

Related Datasets

Hook, S.J., G.C. Hulley, T.T. La, G. Rivera, W.R. Johnson, and B.T. Eng. 2026. HyTES Level 1 Radiance, Facility Instrument Collection. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2462>

- Level 1 radiance products associated with these geolocation data.

Hulley, G.C., S. Hook, T.T. La, G. Rivera, W.R. Johnson, and B.T. Eng. 2026. HyTES L2 Emissivity and Land Surface Temperature, Facility Instrument Collection. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2460>

- Level 2 products derived from the L1 radiance data.

Acknowledgement

The HyTES instrument is maintained and operated by the Airborne Sensor Facility (ASF) at NASA Ames Research Center in Mountain View, California, under the oversight of the EOS Project Science Office at NASA Goddard. Data processing was conducted at NASA Ames Research Center and the Jet Propulsion Laboratory at the California Institute of Technology in Pasadena, California.

2. Data Characteristics

Spatial Resolution: variable (altitude dependent)

Temporal Coverage: 2014-07-02 to present

Temporal Resolution: One-time estimate

Data File Information

These per-pixel geolocation data are provided in ENVI format. Each granule includes an ENVI binary file (.dat) and its associated header file (*.hdr). The header includes metadata in text format including the number of lines and samples included in the ENVI binary.

The file naming convention is <flight prefix>_<loc>_<build>_<ver>.geo.<ext>, where

- <flight prefix> = flight line identifier, YYYYMMDDthhmmss, encoding the date and time by year (YYYY), month (MM), day (DD), hour (hh), minute (mm), and second (ss) of the flight (e.g., 20231115t105320).
- <loc> = location name (e.g., "NorthDeathValley") and may include the line number (e.g., "TheewatersBox19ZA_L1")
- <build> = software build ID: "B100". The files before 2019 do not have <build> in their names.
- <ver> = version number, e.g., " V03". This element is missing for many files.
- <ext> = file extension indicating file type: "dat" for ENVI binary and "hdr" for ENVI header.

Example file names:

20180918t204825_MegaboxLine52CA_geo.dat,
20180918t204825_MegaboxLine52CA_geo.hdr,
20231115t122324_RooibergBox12ZA_L1_B110_V03.geo.dat,
20231115t122324_RooibergBox12ZA_L1_B110_V03.geo.hdr

ENVI File Details

- 512 samples
- A variable number of lines
- Four bands: Latitude (degrees north), Longitude (degrees east), Altitude (m), Ray Path Length (m).
- Data type: Float32
- Interleave: BIP

The ENVI files are structured in instrument pixel coordinates (lines x samples). The “lines” dimension is the pixel identifier in the along-track (flight path) direction, indicating the row location of a pixel from the sensor image. The “samples” dimension is the pixel identifier in the across-track direction, indicating the column location of a pixel from the sensor image.

User Note: The line dimension of the geolocation is typically slightly less than that of the radiance data due to the slight variation from nadir (as is represented in the camera model); there is not enough geolocation (GPS) information for the last few lines of the scene. Therefore, there is a mismatch of a few lines between the L1 raw scene data and the pixel geolocation data. If one is using the pixel geolocation information with L1 raw data, the mismatch should be addressed by clipping radiance data from the end of the scene. This mismatch will be the case unless the pointing/camera model significantly changes.

3. Application and Derivation

HyTES was designed to provide high spectral and spatial resolution thermal infrared (TIR) data. It is useful for a number of applications, including high-resolution surface temperature and emissivity measurements, point sources of air pollution, and volcano observations.

4. Quality Assessment

None provided.

5. Data Acquisition, Materials, and Methods

The Hyperspectral Thermal Emission Spectrometer (HyTES) is an airborne imaging spectrometer with 256 spectral channels between 7.5 and 12 micrometers in the thermal infrared part of the electromagnetic spectrum and 512 pixels cross-track. HyTES incorporates several technologies including a Dyson spectrometer, long, straight slit, curved diffraction grating. The first version of HyTES used a Quantum Well Infrared Photodetector (QWIP). In 2021, the QWIP was replaced by a Barrier InfraRed Detector Focal Plane Array (BIRD FPA) to improve detector uniformity. HyTES has been deployed on DHC-6 Twin Otter, NASA’s ER-2, and GulfStream V aircraft and completed its first flights in July 2012.

HyTES was developed to support the [Hyperspectral Infrared Imager \(HyspIRI\) mission](#) and has been flown since 2012. (Johnson et al., 2011; Hook et al., 2013). It provides high spatial and high spectral resolution data on surface temperature and emissivity (Hulley et al., 2016). Its capabilities include identification of air pollution point sources (Hulley et al., 2016a) and geological studies. Additional details about the HyTES instrument are available at <https://hytes.jpl.nasa.gov>.

The included files hold per-pixel geolocation information, namely latitude, longitude, altitude, and ray-path length. The line dimension of the geolocation data is typically slightly less than that of the radiance data. Due to the slight variation from nadir (as is represented in the camera model), there is not enough geolocation (GPS) information for the last few lines of the scene. Therefore, there is a mismatch of a few lines between the raw scene data and the pixel geolocation data. If one is using the pixel geolocation information with L1A raw data, the mismatch should be addressed by clipping data from the end of the scene. This mismatch will be the case unless the pointing/camera model significantly changes. All the specific dimensions for geolocation information for each file are described within the associated header (.hdr) file.

Table 1. HyTES Instrument specifications.

Instrument Characteristic	Specification
Mass (Scanhead)	12 kg
Power	400 W
Volume	1 m x 0.5 m (cylinder)
Number of pixels x track	512
Number of bands	256
Spectral Range	7.5 - 12 μm
Spectral Sampling Interval	4.5 μm/256, i.e. 17 nm

Frame speed	35 or 22 fps
Integration time (1 scanline)	28 or 45 ms
Total Field of View	50 degrees
Calibration (preflight)	Full Aperture Blackbody
Detector Temperature	40 K
Spectrometer Temperature	100 K
Slit Length and Width	20 mm x 39 μ m
IFOV	1.7065999999999999
Pixel Size/Swath at 2,000 m flight altitude	3.41 m/1868.33 m
Pixel Size/Swath at 20,000 m flight altitude	34.13 m/18683.31 m
Saturation Temperatures	see Figure 2

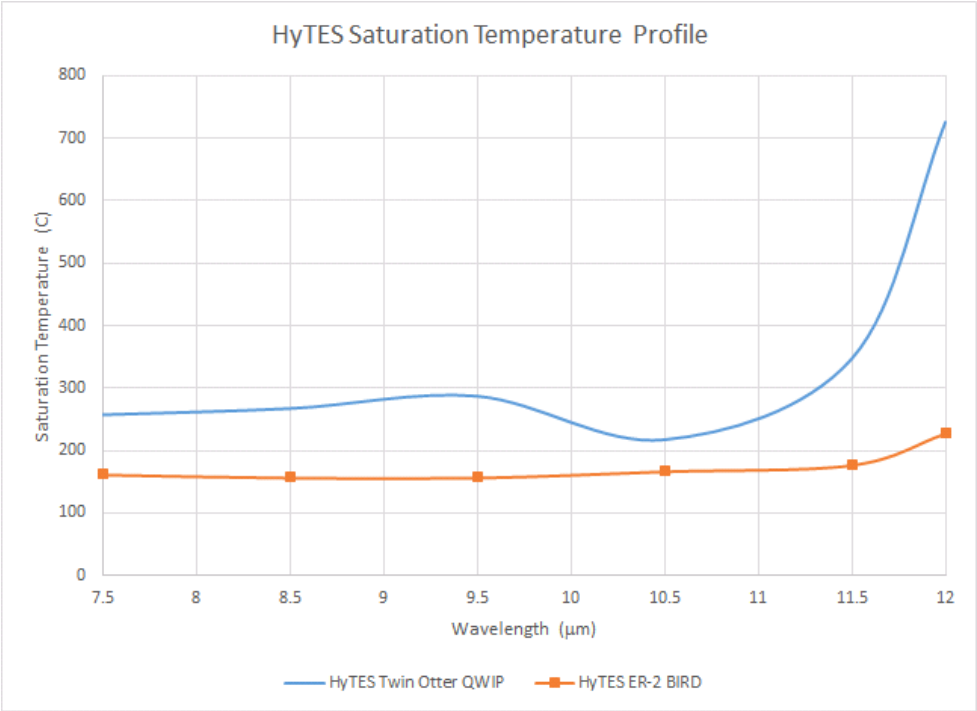


Figure 2. Saturation temperature profiles for QWIP and BIRD FPA photodetectors.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

HyTES L1 Geolocation, Facility Instrument Collection

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Hook, S.J., G.C. Hulley, T.T. La, G. Rivera, W.R. Johnson, and B.T. Eng. 2026. HyTES Level 1 Radiance, Facility Instrument Collection. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2462>

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Johnson, W.R., S. J. Hook, P. Mouroulis, D.W. Wilson, S.D. Gunapala, v. Realmuto, A. Lamborn, C. Paine, J.M. Mumolo, and B.T. Eng. 2011. HyTES: Thermal imaging spectrometer development. *IEEE Explore: Conferences, 2011 Aerospace Conference, Big Sky, Montana, USA*. <https://doi.org/10.1109/AERO.2011.5747394>



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