MASTER L3 Data Product User Guide

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Pasadena, California

November 2025

D-111669

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Change History Log

Revision	Effective Date	Prepared by	Description of Changes
Draft	07/23/2025	Madeleine Pascolini-Campbell	Outline and first draft – Outline and details on MASTER L3 ET
Draft	06/11/2025	Madeleine Pascolini-Campbell	Draft update

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1. Introduction

The MODIS/ASTER (MASTER) airborne simulator is a collaborative project developed by the Airborne Sensor Facility at NASA Ames Research Center, the Jet Propulsion Laboratory, and the USGS EROS Data Center. Its primary objective is to support the ASTER and MODIS instrument teams in algorithm development, calibration, and validation efforts. MASTER is based on the design of the MODIS Airborne Simulator (MAS) developed by the MODIS project (King et al., 1996), but with key enhancements.

MASTER contains 50 spectral channels: channels 1–25 in the visible to shortwave infrared region, and channels 26–50 in the mid-infrared and thermal infrared regions.

MASTER has an instantaneous field of view of 2.5 milliradians, with pixel size dependent on flight altitude. The instrument can be deployed on a variety of airborne platforms, including the DOE King Air Beechcraft B200, Sky Research Cessna Caravan C208, NASA DC-8, NASA ER-2, and NASA WB-57. These platforms enable the collection of data with pixel sizes ranging from approximately 3 to 50 meters, depending on the aircraft: 5–15 m (B200), 3–15 m (C208), 10–30 m (DC-8), 50 m (ER-2), and 5–50 m (WB-57).

Comprehensive details of the MASTER instrument are provided in (Hook, et al., 2001), whereas additional information, including product ordering, is available at:

https://masterprojects.jpl.nasa.gov/

More information on MASTER instrument can be found in the following publication:

- *Hook, S. J., Myers, J. J., Thome, K. J., Fitzgerald, M., & Kahle, A. B. (2001). The MODIS/ASTER airborne simulator (MASTER)—A new instrument for earth science studies. Remote Sensing of Environment, 76(1), 93-102.*

2. MASTER L3 ET Data Products

The MASTER Level 3 product follows the format that was established by NASA Ames same naming convention of MASTER L1B data with the addition of the Build ID and Software Version ID and addition level three nomenclature given different types of level three products.

<Product level name MASTERLn(xxx)>_<Mission number ID>_<scene number (2 digits)>_<date YYYYMMDD>_<start time HHMM>_<end time HHMM>_<Version number VNN>_<Build id number>_<Software version number>-<specific sub product with or without bands>

The MASTER L3 ET product is composed of HDF5, GEOTIFF, PNG and .KMZ.

The MASTER L3 Evapotranspiration (ET) product is provided (in units of W/m^2)[*1]. MASTER L3 ET is derived from MASTER L1B Calibrated Radiance, MASTER L2 Emissivity and Land Surface Temperature (LST), and ancillary meteorological data from Global Modeling and Assimilation Office (GMAO) Goddard Earth Observing System (GEOS)-5-Forward Processing (FP) (https://portal.nccs.nasa.gov/datashare/gmao/geos-fp/das/). The Surface Temperature Initiated Closure (STIC) algorithm is used to calculate ET which directly uses MASTER L2 LST in calculation of surface wetness. In addition, STIC also uses normalized difference vegetation index (NDVI) and albedo calculated using MASTER L1B calibrated radiance products. Ancillary meteorological data is obtained from GEOS-5 FP. STIC has been applied to other thermal satellite and airborne missions. The MASTER L3 ET product is in units W/m^2 and is therefore considered as an energy variable, i.e. latent energy. ET can also be expressed as mass of water evaporated from surfaces and plants, in units of mm/day by applying a conversion using the latent heat of vaporization (MJ/kg).

The STIC algorithm used for the L3 ET product is described in detail in Mallick et al. (2015; 2018): Description of the application of the STIC algorithm to satellite and airborne remote sensing is described in Pierrat et al. (2025) and Pascolini-Campbell et al. (2024).

3. Data product details

MASTER L3 products are composed in a HDF5 file, GeoTiff, PNG and KMZ. Details and product characteristics of each MASTER Level 3 product are described in Table 1 below.

Table 1: Description of Scientific Data Sets (SDS) available in the MASTER L3 ET Products

Product	**SDS**	**Data type**	**Units**	**Valid Range**	**Fill Value**	**Scale Factor**	**Offset**
ET	Evapotranspiration	Float32	W/m^2	[≥ 0]	NaN	n/a	n/a

4. Examples of MASTER L3 ET Product

4.1. Level 3 Evapotranspiration (L3 ET)

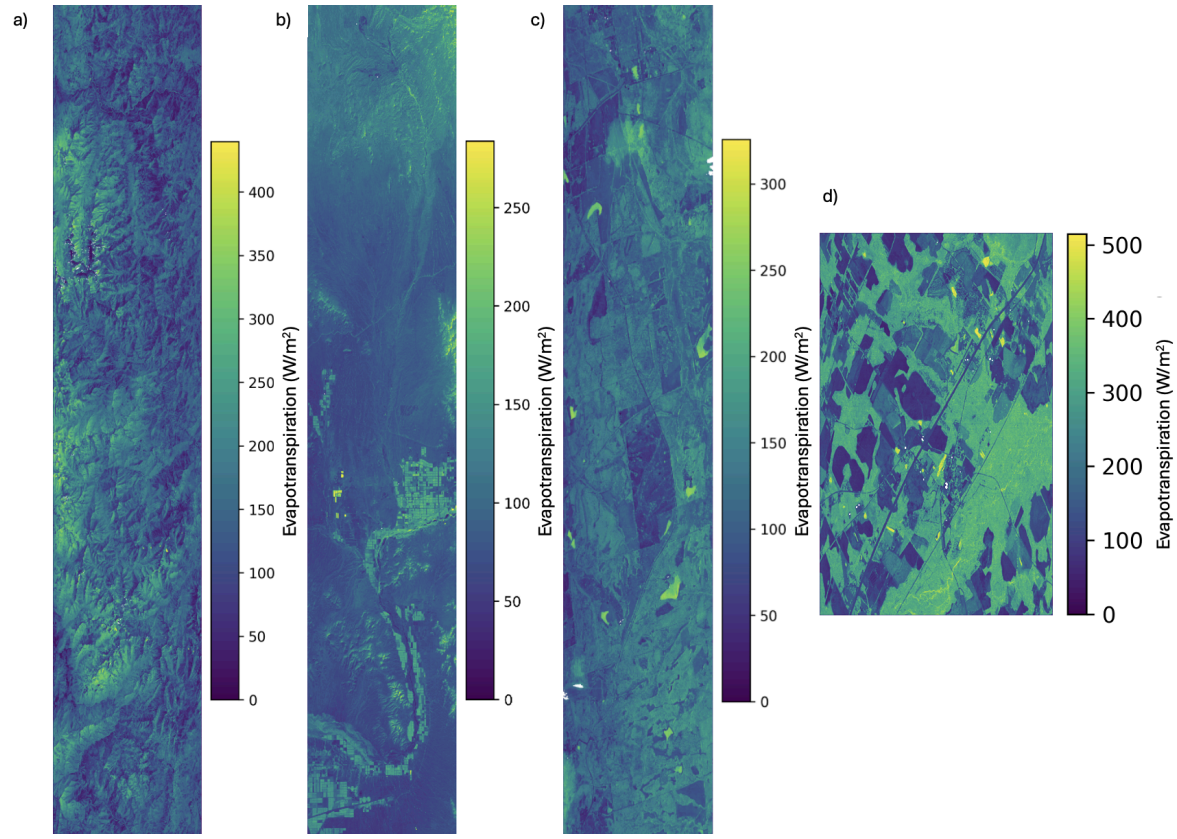

Figure 1. Example of the MASTER L3 evapotranspiration (ET) products (W/m^2) for: a) Northwestern California / Southern Oregon 2024-06-24 (18:41:21), b) Southwestern Arizona (AZ03) 2024-04-03 (18:59:29), c) Alabama / Florida 2025-03-25 (19:08:13) and d) Fort Stewart GA 2025-04-18 (18:12:42). Colormaps represent regions of low (purple) to high (yellow) ET values. Agricultural fields show higher rates of ET compared to adjacent non-agricultural landscapes (b). Dark areas in (d) indicate fields of bare soil with low rates of ET alongside naturally wooded areas.

Acknowledgements

This research was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration (NASA).

References

Hook, S. J., Myers, J. J., Thome, K. J., Fitzgerald, M., & Kahle, A. B. (2001). The MODIS/ASTER airborne simulator (MASTER)—A new instrument for earth science studies. *Remote Sensing of Environment, 76(1), 93-102*

Mallick, K., Boegh, E., Trebs, I., Alfieri, J. G., Kustas, W. P., Prueger, J. H., ... & Jarvis, A. J. (2015). Reintroducing radiometric surface temperature into the P enman‐M onteith formulation. *Water Resources Research*, *51*(8), 6214-6243.

Mallick, K., Toivonen, E., Trebs, I., Boegh, E., Cleverly, J., Eamus, D., ... & Garcia, M. (2018). Bridging thermal infrared sensing and physically‐based evapotranspiration modeling: From theoretical implementation to validation across an aridity gradient in Australian ecosystems. *Water Resources Research*, *54*(5), 3409-3435.

Pascolini-Campbell, M., Hook, S., Mallick, K., Langsdale, M., Hulley, G., Cawse-Nicholson, K., ... & Rabuffi, F. (2024). A first assessment of airborne HyTES-based land surface temperature and evapotranspiration. *Remote Sensing Applications: Society and Environment*, *36*, 101344.

Pierrat, Z. A., Purdy, A. J., Halverson, G., Fisher, J. B., Mallick, K., Pascolini‐Campbell, M., ... & Cawse‐Nicholson, K. (2025). Evaluation of ECOSTRESS Collection 2 evapotranspiration products: Strengths and uncertainties for evapotranspiration modeling. *Water Resources Research*, *61*(6), e2024WR039404.