Long Term Potential Evapotranspiration and Evapotranspiration Data and Services at NASA GES DISC

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Abstract:

Recently, the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) has released global land 3-hourly Potential Evapotranspiration and Supporting Forcing Data Version-1 (**PET_PU_3H025.001**). The data have a spatial resolution of 0.25x0.25 degree, spanning the 23-year period from 1984 to 2006. Version-2 will be released in the near future, covering the time period 1979-2016. This dataset was generated by the Princeton University Terrestrial Hydrology Group through NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) project.

PET_PU_3H025.001 contains PET data estimated by using three different physically-based methods:

Penman open-water method (Penman): The Penman equation assumes Potential Evapotranspiration (PET) occurs from an open water surface, and calculates PET based on observations of surface net radiation, near-surface air temperature, wind speed, and specific humidity (Shuttleworth, 1993).

Priestley-Taylor method (PT): This method calculates PET based on surface net radiation and near-surface air temperature, and does not account for the aerodynamic component (Priestley and Taylor, 1972).

Reference crop evapotranspiration using the UN Food and Agricultural Organization approach (FAO): This method is a specific application of the Penman-Monteith equation for crop and short-grass reference surfaces, and is based on surface net radiation, near-surface air temperature, wind speed, and specific humidity (Allen, 1998)

Potential evapotranspiration (PET) is a representation of the environmental demand for evapotranspiration (ET). ET and PET are important components necessary for global water cycle estimation, and are also critical to advancing our understanding of the climate system. NASA GES DISC archives and distributes various global and regional PET and ET datasets from several projects, for example: Land Data Assimilation System (LDAS); Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2); MEaSUREs Projects, such as Land Surface Atmospheric Boundary Interaction Product by William Rossow; and Surface Radiation Budget/Global Energy and Water cycle Experiment (SRB/GEWEX) evapotranspiration (Penman-Monteith) by Eric F. Wood.

Potential Evapotranspiration (PET)

Global Coverage Data:

Product Name	Variable Name	Variable Longname	Unit	Temporal /Spatial resolution	Temporal coverage
PET_PU_3H025_001	Petpen	Potential Evapotranspiration from Penman method (Shuttleworth, 1993)	mm	3-hourly / 0.25x0.25 deg	1984-2006
	Petpt	Potential Evapotranspiration from Priestley-Taylor method (Priestley and Taylor, 1972)	mm		
	Petref	Reference Crop Evapotranspiration (Allen, 1998)	mm		
GLDAS_NOAH025_3H_2.0	potevap_tavg	potential evaporation rate	W/m^2	3-hourly / 0.25x0.25 deg	1948-2010
GLDAS_NOAH10_3H_2.0	potevap_tavg	potential evaporation rate	W/m^2	3-hourly / 1x1 deg	1948-2010
GLDAS_NOAH025_3H_2.1	potevap_tavg	potential evaporation rate	W/m^2	3-hourly / 0.25x0.25 deg	2000-present
GLDAS_NOAH10_3H_2.1	potevap_tavg	potential evaporation rate	W/m^2	3-hourly / 1x1 deg	2000-present
GLDAS_NOAH025_M_2.0	potevap_tavg	potential evaporation rate	W/m^2	Monthly / 0.25x0.25 deg	1948-2010
GLDAS_NOAH10_M_2.0	potevap_tavg	potential evaporation rate	W/m^2	Monthly / 1x1 deg	1948-2010
GLDAS_NOAH025_M_2.1	potevap_tavg	potential evaporation rate	W/m^2	Monthly / 0.25x0.25 deg	2000-present
GLDAS_NOAH10_M_2.1	potevap_tavg	potential evaporation rate	W/m^2	Monthly / 1x1 deg	2000-present

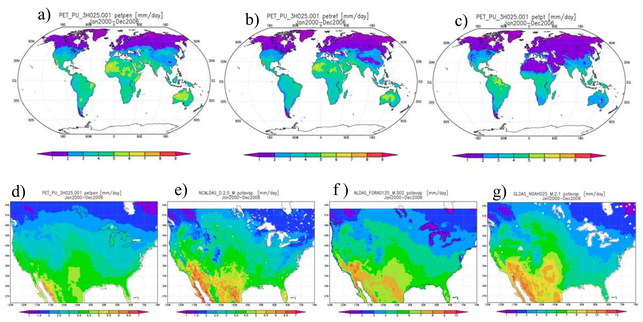
Regional Coverage Data - Over North America:

Product Name	Variable Name	Variable Longname	Unit	Temporal /Spatial resolution	Temporal coverage
NLDAS_FORA0125_H_002	PEVAP/**pevapsfc**	potential evaporation hourly total	kg/m^2	Hourly / 0.125x0.125 deg	1979-present
NLDAS_NOAH0125_H.002	PEVPR/**pevprsfc**	Potential latent heat flux (potential evaporation)	W/m^2	Hourly / 0.125x0.125 deg	1979-present
NCALDAS_NOAH0125_D_2.0	PotEvap	Potential evaporation rate	kg/m^2/s	daily 0.125x0.125 deg	1979-2016
NLDAS_FORA0125_M_002	PEVAP	potential evaporation hourly total	kg/m^2	monthly / 0.125x0.125 deg	1979-present
NLDAS_NOAH0125_M.002	PEVPR/**pevprsfc**	Potential latent heat flux (potential evaporation)	W/m^2	Monthly/0.125x0.125 deg	1979-present

Note: To compare the data from different data collections, we have converted units of PET and ET to mm/day for all products, as shown in the sample plots.

Sample Images of PET and ET Data

Mean Annual Potential Evapotranspiration

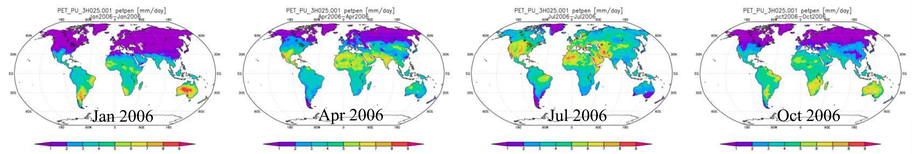


Global images are 2000-2006 mean annual PET from the collection PET_PU_3H025.001 for these methods:
a) Penman
b) Reference crop
c) PT

Images over North America are 2000-2006 mean annual PET from four collections:
d) PET_PU_3H025.001 Penman methods
e) NCALDAS_NOAH0125_D.2.0
f) NLDAS_FORA0125_M_002
g) GLDAS_NOAH025_M_2.1

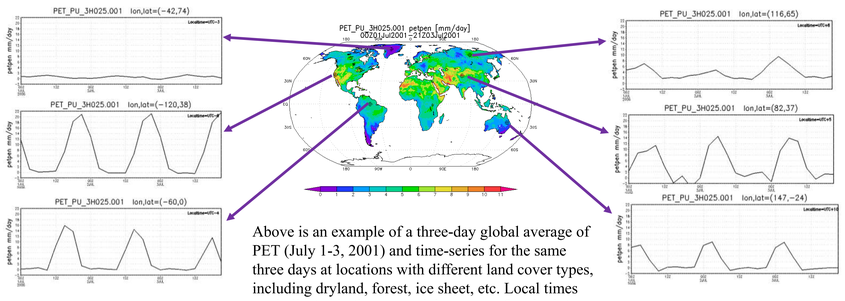
The PET data from different methods and/or models may differ significantly at some locations, which reflects the uncertainty in quantifying PET and its driving data.

Seasonal Variation of Potential Evapotranspiration



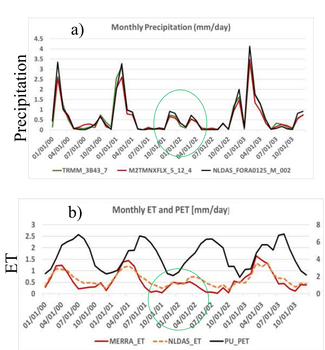
The images above are monthly mean PET from PET_PU_3H025.001 (Penman method) for January, April, July, and October 2006, showing clearly the seasonal variations.

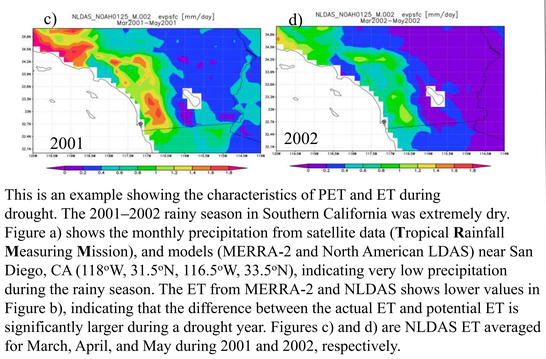
Diurnal Variation of Potential Evapotranspiration



Above is an example of a three-day global average of PET (July 1-3, 2001) and time-series for the same three days at locations with different land cover types, including dryland, forest, ice sheet, etc. Local times are indicated in the upper-right corner of each plot.

Precipitation, Potential Evapotranspiration, & Evapotranspiration Anomalies for 2002 over California

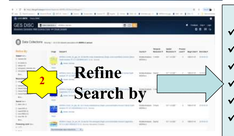




This is an example showing the characteristics of PET and ET during drought. The 2001–2002 rainy season in Southern California was extremely dry. Figure a) shows the monthly precipitation from satellite data (**T**ropical **R**ainfall **M**easuring **M**ission), and models (MERRA-2 and North American LDAS) near San Diego, CA (118ºW, 31.5ºN, 116.5ºW, 33.5ºN), indicating very low precipitation during the rainy season. The ET from MERRA-2 and NLDAS shows lower values in Figure b), indicating that the difference between the actual ET and potential ET is significantly larger during a drought year. Figures c) and d) are NLDAS ET averaged for March, April, and May during 2001 and 2002, respectively.

Finding, Downloading, and Visualization of Data

https://disc.gsfc.nasa.gov/



- ✓ Measurement
- ✓ Source (Platform/Instrument)
- ✓ Processing Level
- ✓ Project
- ✓ Temporal Resolution
- ✓ Spatial Resolution

Data Access Services:

- ✓ Subsetting service
- ✓ Direct download (HTTPS)
- ✓ OPeNDAP
- ✓ GDS (GrADS Data Server)
- ✓ TDS (THREDDS Data Server)
- ✓ WMS, WCS
- ✓ Giovanni: online visualization

Online Documentation:

- ✓ Related documents are linked from the data product landing page, such as User Guide, Algorithm, Known Issues, References, etc.
- ✓ Data How-to (step-by-step instructions on accessing, reading, & viewing data with various data tools)
- ✓ FAQ

Examples - subsetting data:

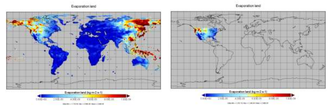
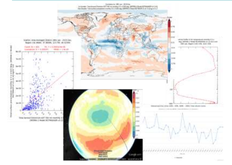


Figure: Example of subsetting data: M2T1NXLND.5.12.4. Original file (left) contains 49 variables, file size ~198 MB; subset file (right) contains 1 variable (ET) over north America, file size ~ 372 KB).

Giovanni: Sample Plot Types:

Over 1800 variables in Giovanni



Evapotranspiration (ET)

Global Coverage Data:

Product Name	Variable Name	Variable Longname	Unit	Temporal /Spatial resolution	Temporal coverage
M2T1NXLND_5.12.4	EVLAND	Evapotranspiration over land	kg m^{-2} s^{-1}	Hourly / 0.5x0.625 deg	1980-present
GLDAS_CLM10SUBP_3H_001	EVAP	Total evapotranspiration	kg m^{-2} s^{-1}	3-hourly / 1x1 deg	1979-present
GLDAS_VIC10_3H_001	EVAP	Total evapotranspiration	kg m^{-2} s^{-1}	3-hourly / 1x1 deg	1979-present
GLDAS_NOAH10_3H_2.1	EVAP_tavg	Evapotranspiration	kg m^{-2} s^{-1}	3-hourly / 1x1 deg	2000-present
GLDAS_NOAH025_3H_2.1	EVAP_tavg	Evapotranspiration	kg m^{-2} s^{-1}	3-hourly / 0.25x0.25 deg	2000-present
WC_PM_ET_050_1	ET	Evapotranspiration	kg m^{-2} s^{-1}	3-hourly / 0.5x0.5 deg	1984-2007
LANDMET_1	ET	Evapotranspiration	W/m^2	3-hourly / 1x1 deg	1998-2007
GLDAS_CLSM025_D_2.0	EVAP_tavg	Evapotranspiration	kg m^{-2} s^{-1}	Daily / 0.25x0.25 deg	1948-2014
GLDAS_NOAH025_M_2.0	EVAP_tavg	Evapotranspiration	kg m^{-2} s^{-1}	Monthly / 0.25x0.25 deg	1948-2010
GLDAS_NOAH025_M_2.1	EVAP_tavg	Evapotranspiration	kg m^{-2} s^{-1}	Monthly / 0.25x0.25 deg	2000-present
M2TMNXLND_5.12.4	EVLAND	Evapotranspiration over land	kg m^{-2} s^{-1}	Monthly / 0.5x0.625 deg	1980-present
GLDAS_CLM10_M_001	EVAP	Total evapotranspiration	kg m^{-2} s^{-1}	Monthly / 1x1 deg	1979-present
GLDAS_VIC10_M_001	EVAP	Total evapotranspiration	kg m^{-2} s^{-1}	Monthly / 1x1 deg	1979-present
GLDAS_NOAH10_M_2.1	EVAP_tavg	Evapotranspiration	kg m^{-2} s^{-1}	Monthly / 1x1 deg	2000-present
NEWS_WEB_MCLIM_1.0	ET/E	evapotranspiration or ocean evaporation (surface latent heat)	W/m^2	Climatology/ 19 regions	1998-2010

Regional Coverage Data - Over North America:

Product Name	Variable Name	Variable Longname	Unit	Temporal /Spatial resolution	Temporal coverage
NLDAS_MOS0125_H_002	EVP	total evapotranspiration	kg m^{-2}	Hourly / 0.125x0.125 deg	1979-present
NLDAS_NOAH0125_H_002	EVP	total evapotranspiration	kg m^{-2}	Hourly / 0.125x0.125 deg	1979-present
NLDAS_VIC0125_H_002	EVP	total evapotranspiration	kg m^{-2}	Hourly / 0.125x0.125 deg	1979-present
NCALDAS_NOAH0125_D_2.0	EVAP	Evapotranspiration	kg m^{-2} s^{-1}	Daily / 0.125x0.125 deg	1979-2016
NLDAS_MOS0125_M_002	EVP	total evapotranspiration	kg m^{-2}	Monthly / 0.125x0.125 deg	1979-present
NLDAS_NOAH0125_M_002	EVP	total evapotranspiration	kg m^{-2}	Monthly / 0.125x0.125 deg	1979-present
NLDAS_VIC0125_M_002	EVP	total evapotranspiration	kg m^{-2}	Monthly / 0.125x0.125 deg	1979-present

Shuttleworth, W.J. (1993), Chapter 4-Evaporation. In: Handbook of Hydrology (ed Maidment DR). McGraw-Hill, Sydney, Australia.
Priestley, C. H. B., & Taylor, R. J. (1972), On the assessment of surface heat flux and evaporation using large-scale parameters. Monthly weather review, 100(2), 81-92, DOI: 10.1175/1520- 0493(1972)1002.3.CO;2
Allen, R. G., Pereira, L. S., Raes, D., & Smith, M. (1998), Crop evapotranspiration-Guidelines for computing crop water requirements-FAO Irrigation and drainage paper 56. FAO, Rome, 300(9), D05109.