



*National Aeronautics and Space
Administration Goddard Earth Science Data
Information and Services Center (GES DISC)*

README Document for Western Land Data Assimilation System (WLDAS) Version D1.0

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Revision History

<i>Revision Date</i>	<i>Changes</i>	<i>Author</i>
2022/09/20	Initial version based on README for LDAS products	Stephanie Stettz
2023/06/06	Added DOI, updated file naming convention and variable list	Stephanie Stettz
2023/08/21	Additional information and revisions from WLDAS team	Jessica Erlingis
2023/10/03	Revisions based on WLDAS team feedback	Stephanie Stettz

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1.0 Introduction

This README document is for the Western Land Data Assimilation System (WLDAS) data version D1.0 archived in netCDF format at NASA GES DISC. Hereafter this data collection in netCDF format is referred as WLDAS.

WLDAS, developed at Goddard Space Flight Center (GSFC) and funded by the NASA Western Water Applications Office, provides water managers and stakeholders in the western United States with a long-term record of near-surface hydrology for use in drought assessment and water resources planning. WLDAS leverages advanced capabilities in land surface modeling and data assimilation to furnish a system that is customized for stakeholders' needs in the region. WLDAS uses NASA's Land Information System (LIS) to configure and drive the Noah Multiparameterization (Noah-MP) Land Surface Model (LSM) to simulate land surface states and fluxes. WLDAS uses meteorological observables including precipitation, incoming shortwave and longwave radiation, near surface air temperature, humidity, wind speed, and surface pressure along with parameters such as vegetation class, soil texture, and elevation as inputs to a model that simulates land surface the energy and water budget processes. Outputs of the model include soil moisture, snow depth and snow water equivalent, evapotranspiration, soil temperature, as well as derived quantities such as groundwater recharge and anomalies of the state variables.

1.1 Dataset Description

WLDAS data are produced using hourly North American Land Data Assimilation System, version 2 (NLDAS-2) forcing and the Noah-MP LSM version 3.6. The temporal resolution for the WLDAS data is daily. Table 1 lists some basic characteristics of the WLDAS data.

Table 1. Basic characteristics of the WLDAS data.

Contents	
Latitude extent	25° to 53°
Longitude extent	-125° to -89°
Spatial resolution	0.01 x 0.01 degree
Temporal resolution	Daily
Temporal coverage	January 3, 1979 to present
Dimension	3591 (lon) x 2787 (lat)
Grid box center points	Lower left: -124.925 , 25.0625 Upper right: -89.025, 52.925
Land surface model	Noah-Multiparameterization (Noah-MP) v3.6
File format	netCDF

1.2 Digital Object Identifier (DOI) and Citation

A Digital Object Identifier or DOI is a unique alphanumeric string used to identify a digital object and provide a permanent link online. DOIs are often used in online publications in citations.

The DOI is linked to the corresponding dataset page, and the Data Citation for the dataset is located on the page. If you use this data in your research or applications, please include the corresponding citations in your publication(s). The following is a citation example for WLDAS:

Erlingis, J., Li, B. and Rodell, M., NASA/GSFC/HSL (2023), WLDAS Noah-MP 3.6 Land Surface Model L4 Daily 0.01 degree x 0.01 degree Version D1.0, Greenbelt, Maryland, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], [10.5067/ABBHPUIGJH5M](https://doi.org/10.5067/ABBHPUIGJH5M)

Please also cite the primary reference for WLDAS:

Erlingis, J., M. Rodell, C.D. Peters-Lidard, B. Li, S.V. Kumar, J.S. Famiglietti, S.L. Granger, J.V. Hurley, P.-W. Liu, and D. Mocko, 2021: A High-Resolution Land Data Assimilation System Optimized for the Western United States, *Journal of the American Water Resources Association*, 1-19, doi: [10.1111/1752-1688.12910](https://doi.org/10.1111/1752-1688.12910).

1.3 Data Disclaimer

Please check the [GES DISC web site](#) periodically for the latest WLDAS data. The WLDAS data are available at the GES DISC with about a latency of about two weeks. Please consider signing up for the Idas users mailing list (Idas-users@lists.nasa.gov) to receive updates and revisions of the datasets. Instructions on how to sign up for the mailing list can be found [here](#).

1.3.1 Acknowledgement

Please refer to Erlingis et al. (2021) for more information on the WLDAS project. Along with the dataset DOI(s), NASA requests that you include the following acknowledgment in papers published using these data:

"The data used in this study were acquired as part of the mission of NASA's Earth Science Division and archived and distributed by the Goddard Earth Sciences (GES) Data and Information Services Center (DISC)."

We would appreciate receiving a copy of your publication, which can be forwarded to the GES DISC Help Desk at gsfc-dl-help-disc@mail.nasa.gov.

1.3.2 Contact Information

For information about or assistance in using any GES DISC data, please contact the GES DISC Help Desk at:

GES DISC
Code 619.0
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771
Email: gsfc-dl-help-disc@mail.nasa.gov
301-614-5224 (voice)
301-614-5268 (fax)

For general science questions and comments, please contact:

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2.0 Data Organization

2.1 File Naming Convention

WLDAS data files are named in accordance with following convention:

WLDAS_NOAHMP001_DA1_<YYYYMMDD>.D10.nc

“NOAHMP” denotes Noah-Multiparameterization model.

“001” is an indication for 0.01 degree grid spacing.

“DA1” is an indication for daily.

“<YYYYMMDD>” is a date format for year, month, and day.

“D10” indicates the data version for WLDAS version D1.0.

“nc” indicates the file is in netCDF format.

2.2 File Format and Structure

The WLDAS LSM data are in netCDF format. NetCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data that was developed by UCAR/Unidata (<http://doi.org/10.5065/D6H70CW6>) <https://www.unidata.ucar.edu/software/netcdf/> . Each

netCDF file contains geolocation information (latitude and longitude of grid box centers), and a series of land surface variables (forcing or model output).

3.0 Data Contents

3.1 Dataset Attributes (File Metadata)

In addition to arrays containing variables and dimension scales, global metadata is also stored in the files. Some metadata are required by standard conventions, some are present to meet data provenance requirements and others as a convenience to users of WLDAS products. A summary of global attributes present in all files is shown in Table 2.

Table 2. Global attributes present in the metadata of each file.

Global Attribute	Description	Type
CDI	CDI version used to generate product	string
institution	Archive center	string
missing_value	Value for missing data	float
title	Description of product	string
references	Primary references for the product	string
conventions	CF conventions used for this product	string
comment	Related information on product	string
MAP_PROJECTION	Spatial projection of data	string
SOUTH_WEST_CORNER_LAT	Latitude of most southwestern point of data area	float
SOUTH_WEST_CORNER_LON	Longitude of most southwestern point of data area	float
DX	Latitude spatial resolution	float
DY	Longitude spatial resolution	float
CDO	Version of CDO used to generate file	string
history_of_appended_files	Description of last changes made	string

ShortName	Dataset product name	string
LongName	Descriptive dataset product name	string
IdentifierProductDOI	DOI for product	string
IdentifierProductDOIAuthority	Authorizer of DOI	string
Source	Model and data used to create product	string
ProcessingLevel	Processing level contained in the file	string
Format	File format (netCDF)	string
VersionID	Data product version	string
DataSetQuality	Description of quality issues or link to related publication	string
GranuleID	Filename	string
ProductionDateTime	Date and time when file was created	string
RangeBeginningDate	Starting date of data coverage	string
RangeBeginningTime	Starting time of data coverage	string
RangeEndingDate	Ending date of data coverage	string
history	A trail for modifications to the original data (commands)	string
NCO	NCO version used	string
RangeEndingTime	Ending time of data coverage	string

3.2 Variable Data Attributes

Table 3. Attributes present in the metadata for each variable.

Attribute	Description	Type
Units	Units for the variable	string
Standard name	CF conventions variable name	string
Long name	More descriptive variable name	string
vmin	Minimum acceptable value for this variable across entire dataset	Float

vmax	Maximum acceptable value for this variable across entire dataset	Float
Cell_methods	Computation method applied to dimension of variable (e.g. "time: mean")	String

4.0 Parameters

Table 4. Variables in the WLDAS data files. Short names that include *_f* indicate forcing data.

Short name	Long name	Units
time	time	days since 1979-01-01
lon	longitude	degree
lat	latitude	degree
Swnet_tavg	net downward shortwave radiation	W m-2
Lwnet_tavg	net downward longwave radiation	W m-2
Qle_tavg	latent heat flux	W m-2
Qh_tavg	sensible heat flux	W m-2
Qg_tavg	soil heat flux	W m-2
Snowf_tavg	snowfall rate	kg m-2 s-1
Rainf_tavg	precipitation rate	kg m-2 s-1
Evap_tavg	total evapotranspiration	kg m-2 s-1
Qs_tavg	surface runoff	kg m-2 s-1
Qsb_tavg	subsurface runoff amount	kg m-2 s-1
Qsm_tavg	snowmelt	kg m-2 s-1
VegT_tavg	canopy temperature	K
BareSoilT_tavg	bare soil temperature	K
AvgSurfT_tavg	surface temperature	K
SWE_tavg	snow water equivalent	kg m-2
SnowDepth_tavg	snow depth	m
ECanop_tavg	interception evaporation	kg m-2 s-1
TVeg_tavg	vegetation transpiration	kg m-2 s-1
ESoil_tavg	bare soil evaporation	kg m-2 s-1
CanopInt_tavg	total canopy water storage	kg m-2
TWS_tavg	terrestrial water storage	mm
GWS_tavg	ground water storage	mm
Snowcover_tavg	snow cover	-

Wind_f_tavg	wind speed	m s-1
Rainf_f_tavg	rainfall flux	kg m-2 s-1
Tair_f_tavg	air temperature	K
Qair_f_tavg	specific humidity	kg kg-1
Psurf_f_tavg	surface pressure	Pa
SWdown_f_tavg	surface downward shortwave radiation	W m-2
LWdown_f_tavg	surface downward longwave radiation	W m-2
WT_tavg	water in aquifer and saturated soil	mm
SoilMoi00_10cm_tavg	soil moisture content	m ³ m-3
SoilTemp00_10cm_tavg	soil temperature	K
SoilMoi10_40cm_tavg	soil moisture content	m ³ m-3
SoilTemp10_40cm_tavg	soil temperature	K
SoilMoi40_100cm_tavg	soil moisture content	m ³ m-3
SoilTemp40_100cm_tavg	soil temperature	K
SoilMoi100_200cm_tavg	soil moisture content	m ³ m-3
SoilTemp100_200cm_tavg	soil temperature	K
time_bnds		

All fields represent the average for the 24-hour period ending at the date in the file name. Times are in Coordinated Universal Time (UTC). For example, a file with the time stamp 20200910_0000 represents the 24-hour period ending at 0000 UTC on 10 September 2020.

More information can be found from the WLDAS Model Output Information page at:
<https://ldas.gsfc.nasa.gov/wldas/model-output>

5.0 Options for Reading the Data

The following are a few of the many command line and visualization tools available for reading netCDF format data, such as the WLDAS datasets. For more comprehensive lists of tools, please see the following:

<https://www.unidata.ucar.edu/software/netcdf/docs/>

https://www.hdfgroup.org/products/hdf5_tools/

Most of the following tools (e.g., GrADS, NCO, CDO, NCL, IDL) can subset variables or subset data within specified temporal and/or spatial ranges. These tools can also calculate statistics like mean, standard deviation, maximum, minimum, etc.

5.1 Command Line Utilities

5.1.1 *ncdump* (free)

The `ncdump` tool (<http://www.unidata.ucar.edu/downloads/netcdf/>) generates the CDL (Common Data Language) text (ASCII) representation of a netCDF or compatible file and writes to standard output. The tool can also be used as a simple browser for netCDF files, to display the dimension names and lengths; variable names, types, and shapes; attribute names and values; and, optionally, the values of data for all variables or selected variables. A common use of `ncdump` is with the `-h` option, with which only the header information is displayed. The `ncdump` tool comes with the netCDF library as distributed by Unidata.

5.1.2 *h5dump* (free)

The `h5dump` tool (<https://support.hdfgroup.org/HDF5/doc/RM/Tools.html#Tools-Dump>) enables users to examine the contents of an HDF5 file and dump those contents to an ASCII file or, optionally, as XML or binary outputs. It can display the contents of the entire HDF5 file or selected objects, which can be groups, datasets, a subset of a dataset, links, attributes, or datatypes. Please note `h5dump` may not work with older netCDF formats. The `h5dump` tool is included with the HDF5 distribution from The HDF Group.

5.1.3 *NCO* (free)

The netCDF Operator (NCO) (<http://nco.sourceforge.net/>) toolkit manipulates and analyzes data stored in netCDF-accessible formats, including DAP, HDF4, and HDF5.

5.1.4 *CDO* (free)

CDO (Climate Data Operators) (<https://code.zmaw.de/projects/cdo>) is a collection of command line operators to manipulate and analyze Climate and Numerical Weather Prediction (NWP) model Data.

5.2 Visualization Tools

5.2.1 *Ncview* (free)

`Ncview` is a quick and easy way to visualize the contents of netCDF files.

http://meteora.ucsd.edu/~pierce/ncview_home_page.html

5.2.2 *Panoply* (free)

`Panoply` is a Java application, developed by the NASA Goddard Institute for Space Studies (GISS), that plots geo-referenced and other arrays from netCDF, HDF, GRIB, and other data types. Among other capabilities, `Panoply` enables one to slice and plot geo-referenced latitude-longitude, latitude-vertical, longitude-vertical, time-latitude, or time-vertical arrays from larger multidimensional variables; combine two geo-referenced arrays in one plot by differencing,

summing, or averaging; plot maps using various map projections; and access remote catalogs to retrieve data files.

<http://www.giss.nasa.gov/tools/panoply/>

The *How-To's* of NASA GES DISC provides a recipe for [How to View Remote Data in OPeNDAP with Panoply](#).

5.2.3 HDFview (free)

HDFView is a Java-based visual tool created by The HDF Group for browsing and editing HDF4 and HDF5 files. It allows users to view all objects in an HDF file hierarchy, which is represented as a tree structure, and create, add, delete, and modify object contents and attributes.

<https://portal.hdfgroup.org/display/support>

5.2.4 GrADS netCDF tools (free)

Users familiar with the GrADS programming language [GrADS Documentation \(gmu.edu\)](#) can use the netCDF functions available with the GrADS software package to read and visualize the data.

5.2.5 NCL (free)

The NCAR Command Language (NCL) (<http://www.ncl.ucar.edu/>) is a free interpreted language designed specifically for scientific data processing and visualization.

5.2.6 Python (free)

More information on how to access data using Python can be found [here](#). Additionally, GES DISC provides several “How-Tos” on how to use Python to load and visualize data:

<https://disc.gsfc.nasa.gov/information/howto?page=1&dataTools=Python>

6.0 GES DISC Data Services

The NASA GES DISC maintains archives of the WLDAS dataset and many other Hydrology datasets. The archived data can be accessed via HTTPS network transfer. WLDAS can be accessed via the GES DISC Unified User Interface at:

<https://disc.gsfc.nasa.gov/datasets?keywords=WLDAS>

Detailed instructions on how to register and receive authorization to access all GES DISC data are provided at: <https://disc.gsfc.nasa.gov/data-access>.

GES DISC users who deploy scripting methods to list and download data in bulk are advised to review the instructions from the link above that provide examples of GNU wget commands for listing and downloading data via HTTPS.

If you need assistance or wish to report a problem, please contact us:

Goddard Earth Sciences Data and Information Services Center, Code 619.0

NASA Goddard Space Flight Center

Greenbelt, MD 20771

Email: gsfc-dl-help-disc@mail.nasa.gov

Phone: 301-614-5224

Fax: 301-614-5268

Address: Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 619.0 Greenbelt, MD 20771 USA

6.1 HTTPS Access

The WLDAS data can be downloaded directly via the GES DISC HTTPS server:

<https://hydro1.gesdisc.eosdis.nasa.gov/data/WLDAS/>

6.2 Earthdata Search

The EarthData Search Client (EDSC) can be used to find and retrieve datasets across multiple data centers: https://search.earthdata.nasa.gov/search?q=WLDAS_NOAHMP001_DA1

6.3 GES DISC Subsetter/Regridder

Access the GES DISC Regridder and Subsetter tool through WLDAS search results page or any WLDAS dataset landing page by selecting the Subset/Get Data link. This tool allows for spatial, temporal, and variable subsetting, as well as re-gridding the data to various other grids through several interpolation methods. You can find an instructional How-To document [here](#) on the GES DISC website.

6.4 OPeNDAP

The WLDAS data can be accessed via OPeNDAP for variable and spatial subsetting:

<https://hydro1.gesdisc.eosdis.nasa.gov/opendap/WLDAS/>.

7.0 More Information

7.1 Data Volume

Table 5. Volume of WLDAS files and archive.

Product	Average File Size	Average Volume per year
WLDAS_NOAHMP001_DA1	841 MB	307 GB

8.0 Acknowledgements

WLDAS is supported by NASA's Applied Sciences Program and the Western Water Applications Office. Model simulations were conducted using the NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center. The NLDAS-2 forcing data used in this effort were acquired as part of the activities of NASA's Science Mission Directorate and are archived and distributed by the Goddard Earth Sciences (GES) Data and Information Services Center (DISC).

References

Erlingis, J., M. Rodell, C.D. Peters-Lidard, B. Li, S.V. Kumar, J.S. Famiglietti, S.L. Granger, J.V. Hurley, P.-W. Liu, and D. Mocko, 2021: A High-Resolution Land Data Assimilation System Optimized for the Western United States, *Journal of the American Water Resources Association*, 1-19, doi: [10.1111/1752-1688.12910](https://doi.org/10.1111/1752-1688.12910).

Li, B., M. Rodell, C. Peters-Lidard, J. Erlingis, S. Kumar, and D. Mocko, Groundwater Recharge Estimated by Land Surface Models: An Evaluation in the Conterminous United States. *J. Hydrometeorol.*, **22**, 499–522, doi:10.1175/JHM-D-20-0130.1.

Acronyms

The following acronyms and abbreviations are used in this document.

GES DISC	Goddard Earth Sciences Data and Information Services Center
HDISC	Hydrology Data and Information Services Center
LDAS	Land Data Assimilation System
LIS	Land Information System
LSM	Land Surface Model
NASA	National Aeronautics and Space Administration
netCDF	network Common Data Form
NLDAS	North American Land Data Assimilation System
WLDAS	Western Land Data Assimilation System