



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

README Document for Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System Version 2 (FLDAS2) Products

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1.0 Introduction

This document provides the basic information for using the Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System version 2 (FLDAS2) data products.

FLDAS2 is a custom instance of the NASA Land Information System (LIS; <http://lis.gsfc.nasa.gov>) that has been adapted to work with domains, data streams, and monitoring and forecast requirements associated with food security assessment in data-sparse, developing country settings. Adopting LIS allows FLDAS2 to leverage existing land surface models and generate ensembles of soil moisture, evapotranspiration (ET), and other variables based on multiple meteorological inputs and land surface models. The overall goal of the FLDAS project is to effectively use the limited hydroclimatic observations available in food-insecure regions. The FLDAS2 models are designed for routine use in FEWS NET decision support.

1.1 Dataset Description

FLDAS2 data are produced using the Noah Multi-Parameterization (Noah-MP) version 4.0.1 Land Surface Models (LSMs). Note that the LSM versions referenced in this document follow the LIS numbering scheme. The FLDAS2 data archive consists of one simulation run producing regional data over the Central Asia domain (21° to 56°N, 30° to 100°E). Meteorological forcing data and datasets used for model parameterization are spatially disaggregated in LIS to match the 0.01° model resolution. Additionally, a LIS-based temporal disaggregation scheme is applied to meteorological forcing datasets so they can be used in energy and water balance calculations.

The FLDAS2 Central Asia dataset is produced daily at a one-day latency and data is available for October 1, 2000 to present. This run is forced by GDAS meteorological data. It was initialized on October 1, 2000 using soil moisture and other state fields from the respective model climatology for that day of the year. Lapse-rate and slope-aspect topographical corrections are applied to the meteorological forcings, implemented in LIS.

Table 1. Basic Characteristics of the FLDAS2 daily, Central Asia data.

Contents	Forcing data, Noah Land Surface Model output
Format	netCDF
Latitude Extent	21° to 56°
Longitude Extent	30° to 100°
Spatial Resolution	0.01° x 0.01°
Temporal Resolution	Daily
Temporal Coverage	October 2000 to present
Dimension (lat x lon)	3500 x 7000
Grid box center points	Lower left: 21.005°, 30.005° Upper right: 55.995°, 99.995°

1.2 Data Disclaimer

1.2.1 Acknowledgment

Please refer to McNally et al. (2017, 2022) for more information about the FLDAS project. McNally, A. *et al.* A land data assimilation system for sub-Saharan Africa food and water security applications. *Sci. Data* 4:170012 doi: 10.1038/sdata.2017.12 (2017)

McNally, A. *et al.* A Central Asia hydrologic monitoring dataset for food and water security applications in Afghanistan. *Earth Syst. Sci. Data* 14, 3115–3135 doi: 10.5194/essd-14-3115-2022 (2022)

NASA requests including 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 following email address: gsfc-dl-help-disc@mail.nasa.gov

1.2.2 Contact Information

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

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1.2.3 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. Table 2 lists DOIs for FLDAS2 data products.

Table 2. DOIs for FLDAS2 Noah-MP Version 001 Data Products

Product Name	DOI
FLDAS_NOAHMP001_G_CA_D_001	10.5067/C4IOYF41EEZB

Each of the DOIs in Table 2 is linked to the corresponding data product page, and the Data Citation for the data product is located on the page. If you use these data in your research or applications, please include a reference in your publication(s) similar to the following example:

Slinski, Kimberly and Sarmiento, Daniel NASA/GSFC/HSL (2023), *FLDAS2 Noah-MP GDAS Land Surface Model L4 Global Monthly 0.1 x 0.1 degree* Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed [**Data Access Date**], [10.5067/C4IOYF41EEZB](https://doi.org/10.5067/C4IOYF41EEZB)

1.3 What are the differences between FLDAS data and GLDAS data?

The FEWS NET LDAS is optimized for FEWS NET agricultural drought monitoring applications in Africa, Latin America and the Caribbean, and Central Asia. By using CHIRPS rainfall and MERRA-2 meteorological inputs, the FLDAS “C” run simulations produce hydrologic estimates consistent with other FEWS NET products derived from CHIRPS and MERRA-2 data. The “CP” and “G” simulations produce near-real time output used for timely assessment of agroclimatological conditions for FEWS NET decision support. FLDAS shares many features with GLDAS: both use NASA LIS 7 as the underlying software framework, use FAO soils parameters, and provide similar input and output variables. The main differences are the meteorological inputs, the spatial resolution (10 km and 1 km), the LSM models (Noah-3.6 and Noah-MP 4.0.1), and data latency (1-day, 5-day, and 20-day). For more information on GLDAS data, please refer to the GLDAS Readme document:

https://hydro1.gesdisc.eosdis.nasa.gov/data/GLDAS/README_GLDAS2.pdf.

1.4 What are the differences between FLDAS Central Asia and FLDAS2 Central Asia data?

There are several differences between the FLDAS Central Asia and FLDAS2 Central Asia simulations. First, the LSM was upgraded from Noah 3.6 to Noah-MP 4.0.1. The FLDAS2 Central Asia simulations utilize several LSM physics upgrades and options made available in the Noah-MP 4.0.1 model, including the vegetation canopy energy balance, the multi-layer snowpack, runoff using the TOPMODEL scheme, frozen soil and infiltration, vegetation

phenology, and the Jordan scheme for partitioning precipitation into snowfall and rainfall. Refer to Niu et. al 2011 for further detail on Noah-MP LSM model physics and options. Second, the FLDAS2 Central Asia simulations run continuously from October 1, 2000 to present. The FLDAS Central Asia simulations were initialized at the start of each water year (October 1) using a static climatological restart file. Finally, FLDAS2 Central Asia soil texture is defined using the FAO Soils product (Reynolds et al. 2000). Meteorological forcing data, model spatial and temporal resolution, data latency, and the datasets used to define other LSM parameters were not changed between the FLDAS Central Asia and FLDAS2 Central Asia simulations.

1.5 What's New?

1.5.1 What are the newest data sets for FLDAS?

Updates to the FLDAS Noah version 3.6 Central Asia daily data for the “G” runs (product FLDAS_NOAH001_G_CA_D) were discontinued on October 1, 2023 and the product will be decommissioned in March 2024. Users are encouraged to use the new FLDAS2 Noah-MP version 4.0.1 Central Asia daily data for the “G” runs (product FLDAS_NOAHMP001_G_CA_D), which covers the same temporal range and spatial domain as the discontinued product.

1.5.2

The regional FLDAS Noah Land Surface Model and VIC Land Surface Model monthly data for the “C” runs were decommissioned on September 16, 2019. The regional FLDAS Noah LSM and VIC LSM daily and monthly data for the “A” runs were decommissioned on November 1, 2019. FLDAS users are encouraged to use the global datasets, which span the same temporal range as the regional datasets and encompass all three of the African regions.

In November 2020, all FLDAS data were post-processed with the MOD44W MODIS land mask. Previously, some grid boxes over inland water had non-missing values where the model considered these as land data, as opposed to open water. The post-processing corrected this issue and masked out all model output data over inland water. This issue only affected model output data variables, and all of the meteorological forcing variables (denoted by a `_f_` in their short names) were unchanged. If you have downloaded the FLDAS data prior to November 2020, please download the data again to receive this update. The MOD44W MODIS land mask is available to download from the FLDAS Project site: <https://ldas.gsfc.nasa.gov/fldas/vegetation-class>.

In April 2021, two new FLDAS datasets were added to the FLDAS mission. They are: FLDAS Noah Land Surface Model L4 Global Monthly 0.1 x 0.1 degree (GDAS and CHIRPS-PRELIM) V001, and FLDAS Noah Land Surface Model L4 Central Asia Daily 0.01 x 0.01 degree V001.

2.0 Data Organization

The currently released FLDAS2 data are version 001 daily data.

2.1 File Naming Convention

FLDAS2 data are grouped and named based on LSM, spatial resolution, forcing data, spatial coverage, and temporal resolution as listed below. Each group is referred to as a data product and named in accordance with the following convention:

FLDAS_<Model><Grid spacing>_<Forcing type>_<Region>_<Temporal spacing>

Table 3: Data product naming convention

Attribute	Description
<Model>	“NOAHMP” for the Noah-MP LSM
<Grid spacing>	“01” for 0.1 degree
	“001” for 0.01 degree
<Forcing type>	“C” for forced with MERRA-2 and CHIRPS data
	“CP” for forced with GDAS and CHIRPS-Prelim data
	“G” for forced with GDAS data
<Region>	“GL” for Global
	“CA” for Central Asia
<Temporal Spacing>	“D” for daily data
	“M” for monthly data
	“MA” for monthly anomaly data
	“MC” for monthly climatology data

For example, FLDAS_NOAHMP001_G_CA_D is the product name for the FLDAS2 Central Asia daily data from the Noah-MP LSM forced by GDAS data, at 0.01 x 0.01 degree resolution.

FLDAS2 data files are named in accordance with the following convention:

Monthly: <Product ID>.A<Date>.<Product version>.nc

Table 4: File naming convention

Attribute	Description
<Product ID>	Data Product Short Name (see Table 3)
<Date>	<YYYYMMDD> for daily data products
<Product version>	“001” for Version 1

For example, “FLDAS_NOAHMP001_G_CA_D.20120401.001.nc” is the filename for FLDAS2 Central Asia data from the Noah-MP LSM forced by GDAS data, at 0.01 x 0.01 degree resolution for April 1, 2012.

2.2 File Format and Structure

The FLDAS2 data are archived 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 [[see more](#)].

3.0 Data Contents

3.1 Data Products

Based on the data product naming convention listed in Section 2.1, the FLDAS2 data products that are currently available at the GES DISC are named in Table 4.

Table 5. FLDAS2 Data Products

	Model	Forcing Data	Region	Data Product Short Name
Daily	Noah-MP	GDAS Referred to as “G”	Central Asia (CA)	FLDAS_NOAHMP001_G_CA_D

3.2 Data Parameters

3.2.1 FLDAS2 Central Asia Model Data: Daily

The FLDAS2 daily data from the Noah-MP LSM (FLDAS_NOAHMP001_G_CA_D) contain 27 fields, as listed in Table 6.

Table 6. Parameters from FLDAS2 Noah model data for the monthly dataset.

Short Name	Description	Unit
Evap_tavg	Evapotranspiration	kg m ⁻² s ⁻¹
Psurf_f_tavg	Surface pressure	Pa
Qair_f_tavg	Specific humidity	kg kg ⁻¹
Qs_tavg	Storm surface runoff	W m ⁻²
Qsb_tavg	Baseflow-groundwater runoff	kg m ⁻² s ⁻¹
Qsm_tavg	Snowmelt	kg m ⁻² s ⁻¹
RadT_tavg	Surface radiative temperature	K
RadT_tavg_max	Maximum surface radiative temperature	K
RadT_tavg_min	Minimum surface radiative temperature	K
Rainf_f_tavg	Rainfall flux	kg m ⁻² s ⁻¹
Rainf_tavg	Total precipitation rate	kg m ⁻² s ⁻¹

Snowcover_inst	Snow cover	1
SnowDepth_inst	Snow depth	m
Snowf_tavg	Snowfall rate	kg m ⁻² s ⁻¹
SoilMoi00_10cm_tavg	Soil moisture (0 - 10 cm underground)	m ³ m ⁻³
SoilMoi10_40cm_tavg	Soil moisture (10 - 40 cm underground)	m ³ m ⁻³
SoilMoi40_100cm_tavg	Soil moisture (40 - 100 cm underground)	m ³ m ⁻³
SoilMoi100_200cm_tavg	Soil moisture (100 - 200 cm underground)	m ³ m ⁻³
SoilTemp00_10cm_tavg	Soil temperature (0 - 10 cm underground)	K
SoilTemp10_40cm_tavg	Soil temperature (10 - 40 cm underground)	K
SoilTemp40_100cm_tavg	Soil temperature (40 - 100 cm underground)	K
SoilTemp100_200cm_tavg	Soil temperature (100 - 200 cm underground)	K
SWdown_f_tavg	Surface downward shortwave radiation	W m ⁻²
SWE_inst	Snow water equivalent	kg m ⁻²
Swnet_tavg	Net shortwave radiation flux	W m ⁻²
Tair_f_tavg	Near surface air temperature	K
TWS_tavg	Terrestrial water storage	mm

The short names with “_f” are forcing variables.

3.3 Data Attributes

Global Attribute	Description	Type
institution	Where the data were produced	string
missing_value	Value if data is missing	float
MAP_PROJECTION	Applies to gridded data.	string
DX	Latitude resolution	float
DY	Longitude resolution	float
ShortName	An abbreviated name of the product	string
LongName	A descriptive product name	string
title	A succinct description of the data set	string
VersionID	Version of the data set	string
GranuleID	This is the file name	string
Format	Format of the data, e.g., NetCDF-4 or HDF-EOS5.	string
RangeBeginningDate	Start date of the data in the file (format YYYY-MM-DD)	string
RangeBeginningTime	Start UTC time of the data (format hh:mm:ss.ssssss)	string
RangeEndingDate	End date of the data in the file (format YYYY-MM-DD)	string
RangeEndingTime	End UTC time of the data (format hh:mm:ss.ssssss)	string
IdentifierProductDOIAuthority	http://doi.org/	string

IdentifierProductDOI	Product Digital Object Identifier (DOI)	string
ProducitonDateTime	Date the granule was produced	string
ProcessingLevel	Level of data processing	string
DataSetQuality	Overall assessment of quality of data, including relevant articles.	string
Source	Platforms/Instruments and any other factors related to the origin of the data product or products	string
references	Published or Web-based references that describe the data or methods used to produce the data	string
website	Website for additional information	string
history	An audit trail for modifications to the original data.	string
conventions	CF conventions followed	string
SouthernmostLatitude	Southernmost latitude of global grid of data set	float
WesternmostLongitude	Northernmost latitude of global grid of data set	float
NorthernmostLatitude	Westernmost longitude of global grid of data set	float
EasternmostLongitude	Easternmost longitude of global grid of data set	float

4.0 Options for Reading the Data

4.1 Utilities

The FLDAS2 data are archived in self-describing and machine-independent netCDF format. The Unidata page, <http://www.unidata.ucar.edu/software/netcdf/software.html>, provides a list of software for manipulating or displaying netCDF Data.

4.2 Panoply

Panoply, <https://www.giss.nasa.gov/tools/panoply/>, is a cross-platform application that plots geo-referenced and other arrays from netCDF, HDF, GRIB, and other datasets.

The [How-To](#) section of NASA GES DISC provides a recipe for [Quick View Data with Panoply](#).

5.0 Data Services

The NASA GES DISC maintains archives of all FLDAS2 data products and many other Hydrology data sets. The archived data can be accessed via HTTPS network transfer. FLDAS2 data can be accessed via the GES DISC Unified User Interface (UI) at <https://disc.gsfc.nasa.gov/datasets?keywords=FLDAS>.

5.1 HTTPS Access

The FLDAS2 data can be downloaded directly via the GES DISC HTTPS server:

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

5.2 EOSDIS Earthdata Search System

The EarthData Search can be used to find and retrieve datasets across multiple data centers:

<https://search.earthdata.nasa.gov/search?q=FLDAS&ok=FLDAS>.

5.3 OPeNDAP Access

The FLDAS2 data can be accessed via OPeNDAP for variable and spatial subsetting:

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

5.4 Giovanni

The GES-DISC Interactive Online Visualization ANd aNalysis Interface (Giovanni) is a web-based tool that allows users to interactively visualize and analyze data:

<https://giovanni.gsfc.nasa.gov/giovanni/#dataKeyword=FLDAS>.

6.0 More Information

6.1 Data Volume

Product	Average File Size	Average Volume per year
FLDAS_NOAHMP001_G_CA_D	1.5 GB	540 GB

The table will be updated as data volume information for other products become available.

7.0 Acknowledgements

The Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System (FLDAS) project was initially developed with support from NASA ROSES Decisions-08-0070 “A Land Data Assimilation System for Famine Early Warning.” Continued support is provided by the Bureau of Humanitarian Assistance, U.S. Agency for International Development, under the terms of PAPA BHA22H00005 “FAMINE EARLY WARNING SYSTEMS NETWORK (FEWS NET)” and the NASA Harvest Consortium, grant # 80NSSC17K0625 entitled “NASA Harvest: NASA's Global Food Security and Agriculture Consortium.” The opinions expressed in this document are those of the authors and do not necessarily reflect the views of the U.S. Agency for International Development of the United States government. Computing is supported by resources at the NASA Center for Climate Simulation (NCCS).

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Appendix

The following acronyms and abbreviations are used in this document.

CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
FLDAS	Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System
GDAS	Global Data Assimilation System
GES DISC	Goddard Earth Sciences Data and Information Services Center
Giovanni	GES-DISC Interactive Online Visualization and Analysis Infrastructure
GrADS	Grid Analysis and Display System
HDF	Hierarchical Data Format
HDISC	Hydrology Data and Information Services Center
LDAS	Land Data Assimilation System
LIS	Land Information System
LSM	Land Surface Model
MERRA	Modern Era Retrospective-analysis for Research and Applications
MERRA-2	MERRA Version 2
MODIS	Moderate Resolution Imaging Spectrometer
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NetCDF	network Common Data Form
NIDIS	National Integrated Drought Information System
Noah	National Centers for Environmental Prediction/Oregon State University/ Air Force/Hydrologic Research Lab (Noah)