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

README Document for

National Climate Assessment - Land Data Assimilation System (NCA-LDAS) Version 2.0

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Goddard Earth Sciences Data and Information Services Center (GES DISC)
http://disc.gsfc.nasa.gov
NASA Goddard Space Flight Center
Code 610.2
Greenbelt, MD 20771 USA

Prepared By:

Hualan Rui

Name
GES DISC
GSFC Code 610.2

David Mocko

Name
HSL
Code 617

January 29, 2018

Date

Reviewed By:

Carlee Loeser

Name
GES DISC
GSFC Code 610.2

Michael Jasinski

Name
HSL
GSFC Code 617

Goddard Space Flight Center
Greenbelt, Maryland

Revision History

Revision Date	*Changes*	*Author*
01/29/2018	Initial version: updated based on the README for V001	Hualan Rui
01/30/2018	Review and revise	David Mocko
03/30/2018	Add DOI for data product NCALDAS_NOAH0125_D.2.0	Hualan Rui
06/20/2019	Add a new reference citation for Jasinski et al. (2019)	Hualan Rui
06/20/2019	Update the Introduction	Hualan Rui
06/24/2019	Review and revise	Carlee Loeser
08/26/2019	Review and revise	Michael Jasinski
09/05/2019	Review and revise	Carlee Loeser
10/11/2019	Add new NCALDAS_NOAH0125_Trends_2.0 dataset	Carlee Loeser
03/01/2021	Update the email address of GES DISC Help Desk	Hualan Rui

Table of Contents

1.0 Introduction

This document provides basic information for using NCA-LDAS Noah-3.3 Version 2.0 daily data and trends data products.

The National Climate Assessment - Land Data Assimilation System, or NCA-LDAS, is an integrated terrestrial water analysis system created for sustained assessment, analyses, and dissemination of hydrologic indicators in support of the United States NCA activities. The current primary features are high resolution, gridded, daily time series of terrestrial water and energy balance stores, states, and fluxes over the continental U.S., derived from land surface hydrologic modeling with multivariate assimilation of satellite Environmental Data Records (EDRs). The core of NCA-LDAS is the multivariate assimilation of past and current satellite-based data records within the Noah Version 3.3 land-surface model (LSM) using NASA's Land Information System (LIS; https://lis.gsfc.nasa.gov/; Kumar et al. 2006) software framework during the Earth observing satellite era.

NCA-LDAS contributes to the U.S. Global Change Research Program's (USGCRP) strategic plan to build sustained assessment capacity that improves the Nation's ability to understand, anticipate, and respond to global change impacts and vulnerabilities. The 42 daily NCA-LDAS land surface energy and water data products are offered to scientists and applied users for computing and understanding terrestrial hydrology trends and other indicators of climate variability and change over the conterminous United States for the period of 1979 to 2016.

The development of NCA-LDAS is supported by the NASA Earth Science Division with the goal of improving scientific understanding, adaptation, and management of hydrologic and related energy resources during a changing climate.

An overview of NCA-LDAS is provided in Jasinski et al. (2019, doi:10.1175/JHM-D-17-0234.1) together with sample indicators of annual hydrologic trends over the conterminous U.S. Details on the data assimilation used in NCA-LDAS are described in Kumar et al. (2019, doi:10.1175/JHM-D-17-0125.1), demonstrating high skills for soil moisture, snow depth, runoff, and evapotranspiration when compared with other land surface models. Simulations were performed at NASA NCCS (NASA Center for Climate Simulation) using the NASA Land Information System (LIS) software framework. More information about the data, data access, and data services are available in the NCA-LDAS v2.0 product pages at https://disc.gsfc.nasa.gov/datacollection/NCALDAS_NOAH0125_D_2.0.html and https://disc.gsfc.nasa.gov/datacollection/NCALDAS_NOAH0125_Trends_2.0.html.

NCA-LDAS Version 2.0 generates 42 daily hydrologic products including land-surface fluxes (e.g. precipitation, radiation, and latent and sensible heat, etc.), stores (e.g. soil moisture and snow), states (e.g., surface temperature), and routing variables (e.g., runoff, streamflow, flooded area, etc.), driven by the atmospheric forcing data from North American Land Data Assimilation System Phase 2 (NLDAS-2; Xia et al., 2012). NCA-LDAS builds upon NLDAS through the addition of multivariate assimilation of earth observations such as soil moisture (Kumar et al, 2014), snow (Liu et al, 2015; Kumar et al, 2015a) and irrigation (Ozdogan et al, 2010; Kumar et al, 2015b). The EDRs that have been assimilated into the NCA-LDAS include soil moisture and snow depth principally from microwave sensors including SMMR, SSM/I, AMSR-E, ASCAT, AMSR-2, SMOS, and SMAP; irrigation intensity estimates from MODIS; and snow covered area from MODIS and the multi-sensor IMS snow product.

The NCA-LDAS Version 2.0 daily dataset was used to create a suite of historical trends in terrestrial hydrology over the conterminous United States estimated for the water years 1980-2015. The trends in annual hydrologic indicators are reported here using the nonparametric Mann-Kendall test at $p < 0.1$ significance. An additional precipitation trend field (annual total), with no significance test applied, is included for comparison purposes.

More information about NCA-LDAS can be found from the project site at https://ldas.gsfc.nasa.gov/NCA-LDAS/.

1.1 Basic characteristics of the NCA-LDAS data

Table 1. Basic characteristics of the NCA-LDAS data.

Contents	**Land-surface model output and routing data**
Latitude extent	25° to 53°
Longitude extent	-125° to -67°
Spatial resolution	1/8th degree
Temporal resolution	NCA-LDAS V2.0 daily: Daily (00Z to 00Z daily average for all fields except the daily minimum and daily maximum temperature fields) NCA-LDAS V2.0 trends: 36 years
Temporal coverage	NCA-LDAS V2.0 daily: 2 January 1979 to 31 December 2016 NCA-LDAS V2.0 trends: 1 October 1979 to 30 September 2015
Dimension	464 (lon) x 224 (lat)
Grid box center points	Lower left: 25.0625, -124.9375 Upper right: 52.9375, -67.0625
Land surface model	Noah Land-Surface Model Version 3.3 (Noah-3.3)
Format	NetCDF-4

1.2 Digital Object Identifier (DOI) and Citation

When submitting publications that include the NCA-LDAS data, the dataset citations listed below should be used. These citations include the Digitial Object Identifier (DOI), which is a unique alphanumeric string used to identify a digital object and provides a permanent link online. DOIs are often used in online publications in citations.

DOI for NCA-LDAS Noah-3.3 Land Surface Model L4 Daily 0.125 x 0.125 degree V2.0: 10.5067/7V3N5DO04MAS.

DOI for NCA-LDAS Noah-3.3 Land Surface Model L4 Trends 0.125 x 0.125 degree V2.0: 10.5067/QFZZBKCO5YJG

To cite the data in publications:

Jasinski, M.F., S.V. Kumar, J.S. Borak, D.M. Mocko, C.D. Peters-Lidard, M. Rodell, H. Rui, H. Kato Beaudoing, B.E. Vollmer, K.R. Arsenault, B. Li, and J.D. Bolten (2018), NCA-LDAS Noah-3.3 Land Surface Model L4 daily 0.125 x 0.125 degree V2.0, Greenbelt, Maryland, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: **[*Data Access Date*]** 10.5067/7V3N5DO04MAS

Jasinski, M.F., J.S. Borak, S.V. Kumar, D.M. Mocko, C.D. Peters-Lidard, M. Rodell, H. Rui, H. Kato Beaudoing, B.E. Vollmer, K.R. Arsenault, B. Li, J.D. Bolten, and N. Tangdamrongsub (2019), NCA-LDAS Noah-3.3 Land Surface Model L4 Trends 0.125 x 0.125 degree V2.0, Greenbelt, Maryland, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: ***[Data Access Date],*** 10.5067/QFZZBKCO5YJG

We would appreciate receiving a copy of your publication, which can be forwarded to the following address:

GES DISC Help Desk
Code 610.2
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
Phone: 301-614-5224
Fax: 301-614-5268
Email: gsfc-dl-help-disc@mail.nasa.gov

1.3 Contact Information

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

GES DISC
Code 610.2
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:

Michael F. Jasinski
Hydrological Sciences Laboratory, Code 617
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771
Email: Michael.F.Jasinski@nasa.gov
301-614-5782 (voice)
301-614-5808 (fax)

1.4 What's New?

NCA-LDAS version 2.0 is an improvement of the previous version of the dataset. All variables and units remain the same. V2.0 extends the data one additional year, to now include all of 2016. Several scientific improvements were also made, including the data assimilation of SMAP soil moisture, refinements to the data assimilation techniques and error co-variances, and modifications to the irrigation intensity scheme.

Please check periodically the GES DISC NCA-LDAS data site for the latest NCA-LDAS data. Also, please consider signing up for the LDAS mailing list for updates and announcements on revisions of the data sets: https://lists.nasa.gov/mailman/listinfo/ldas-users.

2.0 Data Organization

2.1 File Naming Convention

NCA-LDAS V2.0 daily data files are named in accordance with the following convention:

NCALDAS_NOAH0125_D.A<YYYYMMDD>.002.nc4

Where:
"0125" indicates 1/8th degree grid spacing;
"D" indicates daily;
"<YYYYMMDD>" is the date format for year, month, and day;
"002" indicates version 2.0;
"nc4" indicates the file is in NetCDF-4 format.

Example: NCALDAS_NOAH0125_D.A19790102.002.nc4

NCA-LDAS V2.0 trends are packaged in a single file:

NCALDAS_NOAH0125_Trends.A198010_201509.002.nc4

2.2 File Format and Structure

The NCA-LDAS data files are in NetCDF-4 format, which was introduced in NetCDF version 4.0, with more powerful forms of data representation and data types at the expense of some additional complexity. 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. More information about NetCDF format is available at https://www.unidata.ucar.edu/software/netcdf/docs/faq.html.

3.0 Data Contents

The Noah model was developed as the land component of the NOAA NCEP mesoscale Eta model [Betts et al. (1997); Chen et al. (1997); Ek et al. (2003)]. As used in NCA-LDAS, recent modifications were made to Noah's cold-season [Livneh et al. (2010)] and warm-season [Wei et al. (2012)] parameterizations. Noah serves as the land component in the evolving Weather Research and Forecasting (WRF) regional atmospheric model, the NOAA NCEP coupled Climate Forecast System (CFS), and the Global Forecast System (GFS). The model simulates the soil freeze-thaw process and its impact on soil heating/cooling and transpiration, following Koren et al. (1999). The model has four soil layers with spatially-invariant thicknesses of 10, 30, 60, and 100 cm. The root zone comprises only the top layer in desert/bare soil and urban regions, the top three layers in the other non-forested regions, and all four layers in forested regions. The HyMAP streamflow router (Getirana et al., 2012) was used to generate streamflow and flooded area, using the LSM output surface runoff and baseflow as an input to HyMAP.

3.1 Noah-3.3 LSM Daily Data

The daily data set contains a series of land surface variables simulated from the Noah-3.3 land-surface model (LSM) for the NCA-LDAS. The data are mapped to a geographic grid with 1/8th-degree grid spacing, and cover a period of record that ranges from January 1979 to December 2016 with daily temporal resolution. All variables are daily averages from 00Z to 00Z of the date defined by the metadata of the "time:begin_date" in the file. The two exceptions to this are the daily minimum and daily maximum temperature fields, which are the minimum and maximum temperatures over the same 00Z to 00Z daily period, respectively.

There are 42 fields in the NCA-LDAS Noah LSM daily data files, as listed in Table 2.

Table 2. Parameters in the NCA-LDAS Noah output

Short Name	Long Name	Unit
SWnet	Net shortwave radiation flux	W m-2
LWnet	Net longwave radiation flux	W m-2
Qle	Latent heat net flux	W m-2
Qh	Sensible heat net flux	W m-2
Qg	Heat flux	W m-2
Snowf	Snow precipitation rate	kg m-2 s-1
Rainf	Rain precipitation rate	kg m-2 s-1
Evap	Evapotranspiration	kg m-2 s-1
Qs	Storm surface runoff	kg m-2 s-1
Qsb	Baseflow-groundwater runoff	kg m-2 s-1
Qsm	Snow melt	kg m-2 s-1
RadT	Average radiative temperature	K
SWE	Snow depth water equivalent	kg m-2
SnowDepth	Snow depth	m
SnowFrac	Snow covered fraction	fraction
SoilMoist0_10cm	Soil moisture (0 - 10 cm)	m^3 m-3
SoilMoist10_40cm	Soil moisture (10 - 40 cm)	m^3 m-3
SoilMoist40_100cm	Soil moisture (40 - 100 cm)	m^3 m-3
SoilMoist100_200cm	Soil moisture (100 - 200 cm)	m^3 m-3
SoilTemp0_10cm	Soil temperature (0 -10 cm)	K
SoilTemp10_40cm	Soil temperature (10 - 40 cm)	K
SoilTemp40_100cm	Soil temperature (40 - 100 cm)	K
SoilTemp100_200cm	Soil temperature (100 -200 cm)	K
PotEvap	Potential evaporation rate	kg m-2 s-1
ECanop	Canopy water evaporation rate	kg m-2 s-1

TVeg	Transpiration rate	kg m-2 s-1
ESoil	Direct evaporation rate from bare soil	kg m-2 s-1
SubSnow	Snow sublimation rate	kg m-2 s-1
CanopInt	Plant canopy surface water	kg m-2
Streamflow	Streamflow	m^3 s-1
FloodedFrac	Flooded fraction	fraction
FloodedArea	Flooded area	m^2
IrrigatedWater	Irrigated water rate	kg m-2 s-1
Wind_f	Wind speed	m s-1
Rainf_f	Total precipitation rate	kg m-2 s-1
Tair_f	Temperature	K
Tair_f_min	Daily minimum temperature	K
Tair_f_max	Daily maximum temperature	K
Qair_f	Specific humidity	kg kg-1
Psurf_f	Pressure	Pa
SWdown_f	Downward shortwave radiation flux	W m-2
LWdown_f	Downward longwave radiation flux	W m-2

The short names with "_f" are forcing variables.
All variables are daily averages from 00Z to 00Z of the date listed in the filename, except the daily minimum and daily maximum temperature fields.

3.2 Noah-3.3 LSM Trends Data

The trends dataset consists of 15 historical trend variables over the United States estimated for water years (October-September) 1980-2015 using the NCA-LDAS V2.0 reanalysis.

Short Name	**Long Name**	**Unit**
Trend_Rainf_f	Trend in Total Annual Precipitation, p < 0.10	mm yr-1
Trend_Rainf_f_NoSigTest	Trend in Total Annual Precipitation, p < 1.00	mm yr-1
Trend_Max_5D_Rainf_f	Trend in Maximum Annual 5-day Total Precipitation, p < 0.10	mm yr-1
Trend_Heavy_Rainf_f	Trend in Annual Heavy Precipitation, p < 0.10	d decade-1
Trend_Very_Heavy_Rainf_f	Trend in Annual Very Heavy Precipitation, p < 0.10	d decade-1
Trend_Tair_f	Trend in Mean Annual Air Temperature, p < 0.10	K decade-1

Trend_Rnet_f	Trend in Mean Annual Net Radiation, p < 0.10	W m-2 yr-1
Trend_ET	Trend in Mean Annual Evapotranspiration, p < 0.10	W m-2 yr-1
Trend_EF	Trend in Mean Jun-Jul-Aug Evaporative Fraction, p < 0.10	decade-1
Trend_Runoff	Trend in Total Annual Runoff (= Qs + Qsb), p < 0.10	mm yr-1
Trend_Min_Runoff	Trend in Annual 7-day Low Runoff (= Qs + Qsb), p < 0.10	mm yr-1
Trend_Max_Runoff	Trend in Annual 3-day High Runoff (= Qs + Qsb), p < 0.10	mm yr-1
Trend_SWE	Trend in Mean Oct-Jun Snow Water Equivalent (7-day smoothed), p < 0.10	mm yr-1
Trend_SnowDays	Trend in Annual Number of Snow-Covered Days, p < 0.10	d yr-1
Trend_SoilMoist	Trend in Annual Total-Column Soil Moisture Content, p < 0.10	mm yr-1

The short names with "_f" are forcing variables.
The runoff variables are computed as the sum of surface and sub-surface flows.
Heavy precipitation is considered at least 10 mm, and very heavy precipitation is considered at least 20 mm.
Total column soil moisture refers to the top 2 meters of soil.

4.0 Options for Reading the Data

4.1 Utilities

The NCA-LDAS data are archived in NetCDF-4 format. There are many software packages that can be used for manipulating or displaying NetCDF data. This Unidata site provides references about these packages.

How to work with NetCDF Files from the command line:
https://www.unidata.ucar.edu/software/netcdf/docs/netcdf_working_with_netcdf_files.html

The NetCDF-4 Tutorial Documentation:
https://www.unidata.ucar.edu/software/netcdf/netcdf-4/newdocs/netcdf-tutorial.html

4.2 Reading and viewing the data by Panoply

Panoply (https://www.giss.nasa.gov/tools/panoply/) is a cross-platform application that plots the content of geo-referenced and other arrays from NetCDF, HDF, GRIB, and other data file formats. The HowTo section of NASA GES DISC provides a recipe for How to View Remote Data in OPeNDAP with Panoply.

4.3 Reading and viewing the data by GrADS

The Grid Analysis and Display System (GrADS) is an interactive desktop tool for easy access, manipulation, and visualization of earth science data. GrADS supports several data formats, such as binary, NetCDF, HDF, and GRIB. The documentation and software for GrADS can be found at: http://cola.gmu.edu/grads/.

Each individual NCA-LDAS NetCDF file can be opened by the GrADS utility sdfopen directly without a data descriptor file (i.e., a ctl file). After calling sdfopen, GrADS commands, such as "q file", "d [variable_name]", etc. can be used to query file information, and read and display the data. Below is an example showing how to use sdfopen to read a NCA-LDAS NetCDF file and query for its dimensions and variables.

Example for using sdfopen to open a NCA-LDAS NetCDF file:

```
hrui@hydro1:~/NCALDAS_NOAH0125_D.2.0$ grads

        Welcome to the OpenGrADS Bundle Distribution
        -------------------------------------------

For additional information enter "grads -h".

Starting "/opt/grads-2.1.a2.oga.1/Linux/Versions/2.1.a2.oga.1/x86_64/grads  " ...

Grid Analysis and Display System (GrADS) Version 2.1.a2.oga.1
Copyright (c) 1988-2013 by the Institute for Global Environment and Society (IGES)
GrADS comes with ABSOLUTELY NO WARRANTY
See file COPYRIGHT for more information

Config: v2.1.a2.oga.1 little-endian readline grib2 netcdf hdf4-sds hdf5 opendap-grids,stn
athena geotiff shapefile cairo
Issue 'q config' command for more detailed configuration information
Loading User Defined Extensions table </opt/grads-
2.1.a2.oga.1/Linux/Versions/2.1.a2.oga.1/x86_64/gex/udxt> ... ok.
Landscape mode? ('n' for portrait):
GX Package Initialization: Size = 11 8.5
ga-> sdfopen NCALDAS_NOAH0125_D.A19790102.002.nc4
Scanning self-describing file:  NCALDAS_NOAH0125_D.A19790102.002.nc4
```

```
SDF file NCALDAS_NOAH0125_D.A19790102.002.nc4 is open as file 1
LON set to -124.9375 -67.0625
LAT set to 25.0625 52.9375
LEV set to 0 0
Time values set: 1979:1:2:0 1979:1:2:0
E set to 1 1
ga-> q file
File 1 : NCA-LDAS Noah-3.3 LIS land surface model output
  Descriptor: NCALDAS_NOAH0125_D.A19790102.002.nc4
  Binary: NCALDAS_NOAH0125_D.A19790102.002.nc4
  Type = Gridded
  Xsize = 464  Ysize = 224  Zsize = 1  Tsize = 1  Esize = 1
  Number of Variables = 42
    swnet  0  t,y,x  Net shortwave radiation flux
    lwnet  0  t,y,x  Net longwave radiation flux
    qle  0  t,y,x  Latent heat net flux
    qh  0  t,y,x  Sensible heat net flux
    qg  0  t,y,x  Heat flux
    snowf  0  t,y,x  Snow precipitation rate
    rainf  0  t,y,x  Rain precipitation rate
    evap  0  t,y,x  Evapotranspiration
    qs  0  t,y,x  Storm surface runoff
    qsb  0  t,y,x  Baseflow-groundwater runoff
    qsm  0  t,y,x  Snow melt
    radt  0  t,y,x  Average radiative temperature
    swe  0  t,y,x  Snow depth water equivalent
    snowdepth  0  t,y,x  Snow depth
    snowfrac  0  t,y,x  Snow covered fraction
    soilmoist0_10cm  0  t,y,x  Soil moisture
    soilmoist10_40c  0  t,y,x  Soil moisture
    soilmoist40_100  0  t,y,x  Soil moisture
    soilmoist100_20  0  t,y,x  Soil moisture
    soiltemp0_10cm  0  t,y,x  Soil temperature
    soiltemp10_40cm  0  t,y,x  Soil temperature
    soiltemp40_100c  0  t,y,x  Soil temperature
    soiltemp100_200  0  t,y,x  Soil temperature
    potevap  0  t,y,x  Potential evaporation rate
    ecanop  0  t,y,x  Canopy water evaporation
    tveg  0  t,y,x  Transpiration
    esoil  0  t,y,x  Direct evaporation from bare soil
    subsnow  0  t,y,x  Snow sublimation
    canopint  0  t,y,x  Plant canopy surface water
    streamflow  0  t,y,x  Streamflow
    floodedfrac  0  t,y,x  Flooded fraction
    floodedarea  0  t,y,x  Flooded area
    irrigatedwater  0  t,y,x  Irrigated water rate
    wind_f  0  t,y,x  Wind speed
    rainf_f  0  t,y,x  Total precipitation rate
```

```
    tair_f  0  t,y,x  Temperature
    tair_f_min  0  t,y,x  Daily minimum temperature
    tair_f_max  0  t,y,x  Daily maximum temperature
    qair_f  0  t,y,x  Specific humidity
    psurf_f  0  t,y,x  Pressure
    swdown_f  0  t,y,x  Downward shortwave radiation flux
    lwdown_f  0  t,y,x  Downward longwave radiation flux
ga->
```

GrADS command xdfopen may be used with a GrADS descriptor file to open multiple NCA-LDAS NetCDF files simultaneously, therefore, enabling time aggregation related visualization and data analysis. Below is a GrADS sample descriptor file for NCA-LDAS Noah daily data product NCALDAS_NOAH0125_D_2.0.

NCALDAS_NOAH0125_D.002.xdf, a sample data descriptor file:

```
DSET ./NCALDAS_NOAH0125_D.A%y4%m2%d2.002.nc4
OPTIONS template
TDEF time 5 LINEAR 02Jan1979 1dy
*** Variable name may not appear completely (max 15 characters)
```

An example for using xdfopen to open the NCALDAS_NOAH0125_D.002.xdf:

```
ga-> xdfopen NCALDAS_NOAH0125_D.002.xdf
Scanning Descriptor File:  NCALDAS_NOAH0125_D.002.xdf
SDF file /ftp/data/s4pa
/NCALDAS/NCALDAS_NOAH0125_D.002/%y4/%m2/NCALDAS_NOAH0125_D.A%y4%m2%d2.002.nc4
is open as file 1
LON set to -124.938 -67.0625
LAT set to 25.0625 52.9375
LEV set to 0 0
Time values set: 1979:1:2:0 1979:1:2:0
E set to 1 1
ga-> q file
File 1 : NCA-LDAS Noah-3.3 LIS land surface model output
  Descriptor: NCALDAS_NOAH0125_D.002.xdf
  Binary:
/ftp/data/s4pa_TS2/NCALDAS/NCALDAS_NOAH0125_D.2.0/%y4/%m2/NCALDAS_NOAH0125_D.A%y
4%m2%d2.002.nc4
  Type = Gridded
  Xsize = 464  Ysize = 224  Zsize = 1  Tsize = 5  Esize = 1
  Number of Variables = 42
    swnet  0  t,y,x  Net shortwave radiation flux
    lwnet  0  t,y,x  Net longwave radiation flux
    qle  0  t,y,x  Latent heat net flux
    qh  0  t,y,x  Sensible heat net flux
```

```
    qg  0  t,y,x  Heat flux
    snowf  0  t,y,x  Snow precipitation rate
    rainf  0  t,y,x  Rain precipitation rate
    evap  0  t,y,x  Evapotranspiration
    qs  0  t,y,x  Storm surface runoff
    qsb  0  t,y,x  Baseflow-groundwater runoff
    qsm  0  t,y,x  Snow melt
    radt  0  t,y,x  Average radiative temperature
    swe  0  t,y,x  Snow depth water equivalent
    snowdepth  0  t,y,x  Snow depth
    snowfrac  0  t,y,x  Snow covered fraction
    soilmoist0_10cm  0  t,y,x  Soil moisture
    soilmoist10_40c  0  t,y,x  Soil moisture
    soilmoist40_100  0  t,y,x  Soil moisture
    soilmoist100_20  0  t,y,x  Soil moisture
    soiltemp0_10cm  0  t,y,x  Soil temperature
    soiltemp10_40cm  0  t,y,x  Soil temperature
    soiltemp40_100c  0  t,y,x  Soil temperature
    soiltemp100_200  0  t,y,x  Soil temperature
    potevap  0  t,y,x  Potential evaporation rate
    ecanop  0  t,y,x  Canopy water evaporation
    tveg  0  t,y,x  Transpiration
    esoil  0  t,y,x  Direct evaporation from bare soil
    subsnow  0  t,y,x  Snow sublimation
    canopint  0  t,y,x  Plant canopy surface water
    streamflow  0  t,y,x  Streamflow
    floodedfrac  0  t,y,x  Flooded fraction
    floodedarea  0  t,y,x  Flooded area
    irrigatedwater  0  t,y,x  Irrigated water rate
    wind_f  0  t,y,x  Wind speed
    rainf_f  0  t,y,x  Total precipitation rate
    tair_f  0  t,y,x  Temperature
    tair_f_min  0  t,y,x  Daily minimum temperature
    tair_f_max  0  t,y,x  Daily maximum temperature
    qair_f  0  t,y,x  Specific humidity
    psurf_f  0  t,y,x  Pressure
    swdown_f  0  t,y,x  Downward shortwave radiation flux
    lwdown_f  0  t,y,x  Downward longwave radiation flux
ga->
```

5.0 Data Services

5.1 NASA Earthdata Login System

Starting August 1st, 2016, access to GES DISC data requires all users to be registered with the Earthdata Login system. Data continue to be free of charge and accessible via HTTPS. Access to data via FTP will no longer be available on or after October 3rd, 2016. Detailed instructions on how to register and receive authorization to access GES DISC data are provided at https://disc.gsfc.nasa.gov/data-access.

If you need assistance or wish to report a problem:

Email: gsfc-dl-help-disc@mail.nasa.gov
Voice: 301-614-5224
Fax: 301-614-5268
Address:
Goddard Earth Sciences Data and Information Services Center
NASA Goddard Space Flight Center
Code 610.2
Greenbelt, MD 20771 USA

5.2 Data Services

The NCA-LDAS data product landing pages provide product summary, data citation, documentation, and data access.

NCA-LDAS V2.0 daily:
https://disc.gsfc.nasa.gov/datacollection/NCALDAS_NOAH0125_D_2.0.html
NCA-LDAS V2.0 trends:
https://disc.gsfc.nasa.gov/datacollection/NCALDAS_NOAH0125_D_2.0.html

5.2.1 HTTPS

Access the online archive data via HTTPS:

https://hydro1.gesdisc.eosdis.nasa.gov/data/NCALDAS/NCALDAS_NOAH0125_D.2.0/
https://hydro1.gesdisc.eosdis.nasa.gov/data/NCALDAS/NCALDAS_NOAH0125_Trends.2.0/

5.2.2 Earthdata Search

Use Earthdata Search Client to find and retrieve data sets across multiple data centers:

https://search.earthdata.nasa.gov/search?q=NCALDAS_NOAH0125_D
https://search.earthdata.nasa.gov/search?q=NCALDAS_NOAH0125_Trends

5.2.3 OPeNDAP

Access the data via the OPeNDAP protocol for parameter and spatial subsetting:

https://hydro1.gesdisc.eosdis.nasa.gov/opendap/NCALDAS/NCALDAS_NOAH0125_D.2.0
https://hydro1.gesdisc.eosdis.nasa.gov/opendap/NCALDAS/NCALDAS_NOAH0125_D.2.0

5.2.4 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=NCALDAS_NOAH0125_D_2.0
https://giovanni.gsfc.nasa.gov/giovanni/#dataKeyword=NCALDAS_NOAH0125_Trends_2.0

The sample image below is generated by NASA Giovanni.

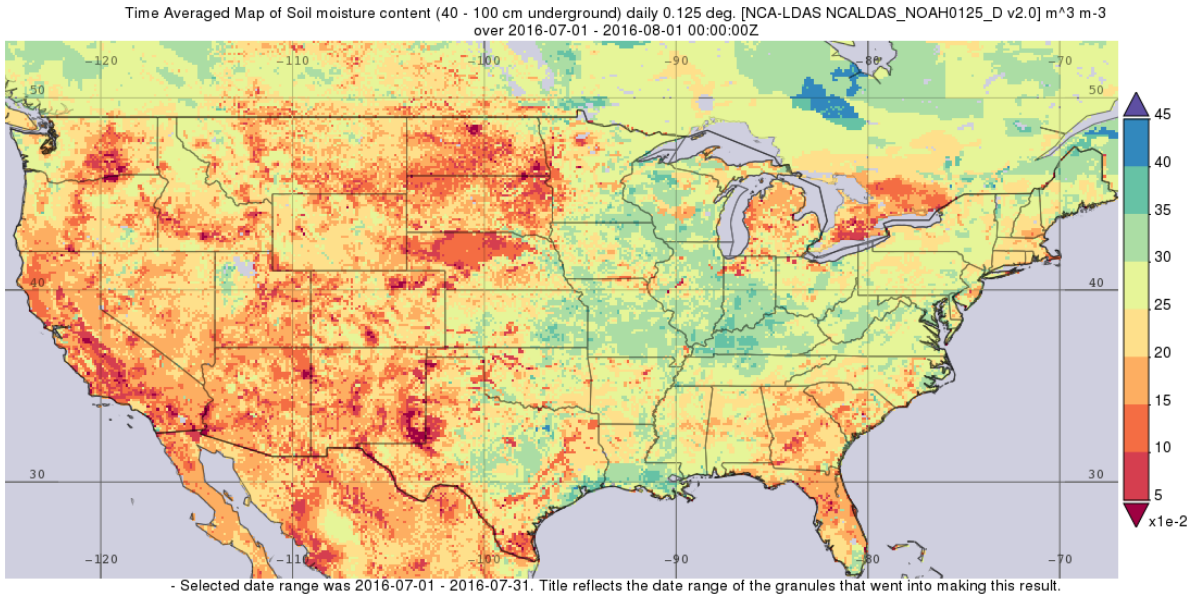

Figure 1. Soil moisture (40 – 100 cm) map for July 2016, from the NCA-LDAS v2.0 Noah 0.125 x 0.125 degree daily data product.

5.2.5 Typical Mean Annual Hydrologic Trends From NCA-LDAS

Typical mean annual trends in several hydrologic quantities estimated using NCA-LDAS v2.0 daily products are provided below (from Jasinski et al., 2019). Trends were estimated using the Mann-Kendall test at $p<0.1$ significance. Figures 2 through 5 illustrate mean annual trends in precipitation, number of days with heavy precipitation (>10 mm), number of snow-covered days, and evaporative fraction (Jun-Jul-Aug only), respectively.

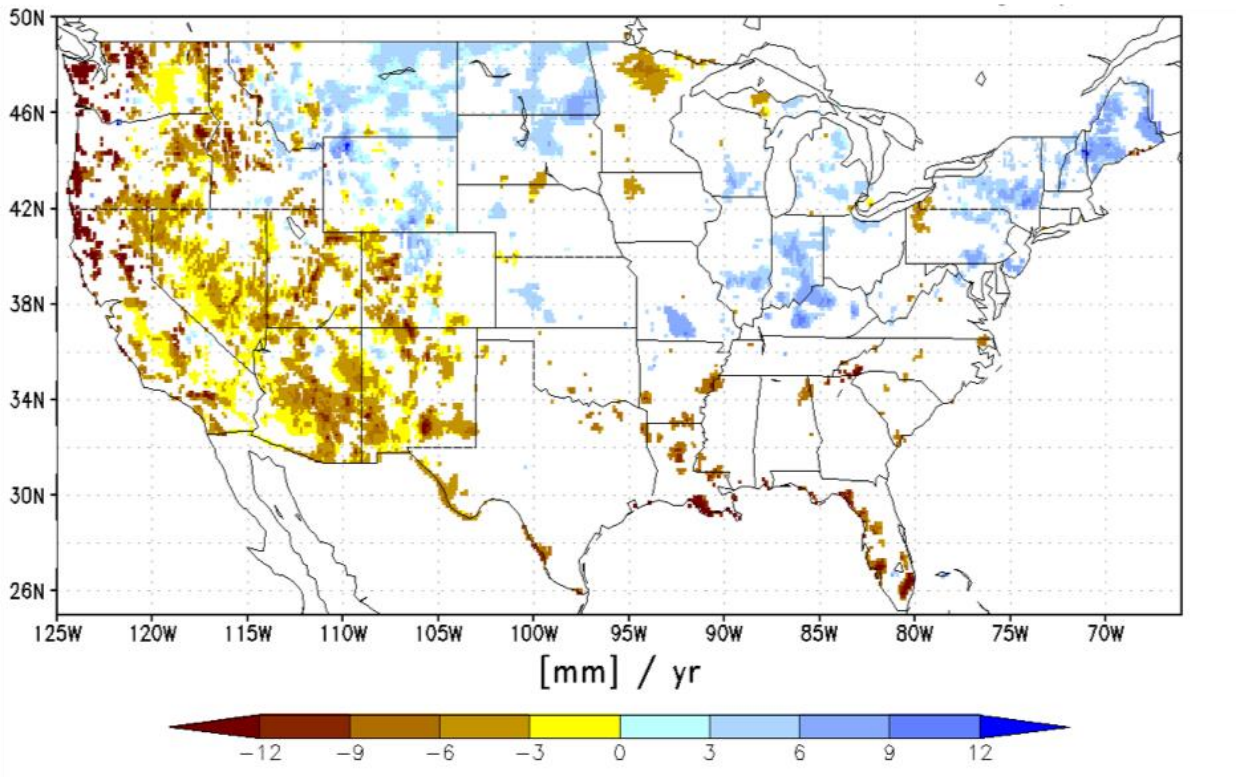

Figure 2. NCA-LDAS trends in mean annual precipitation for water years 1980-2015 for p<0.1 significance.

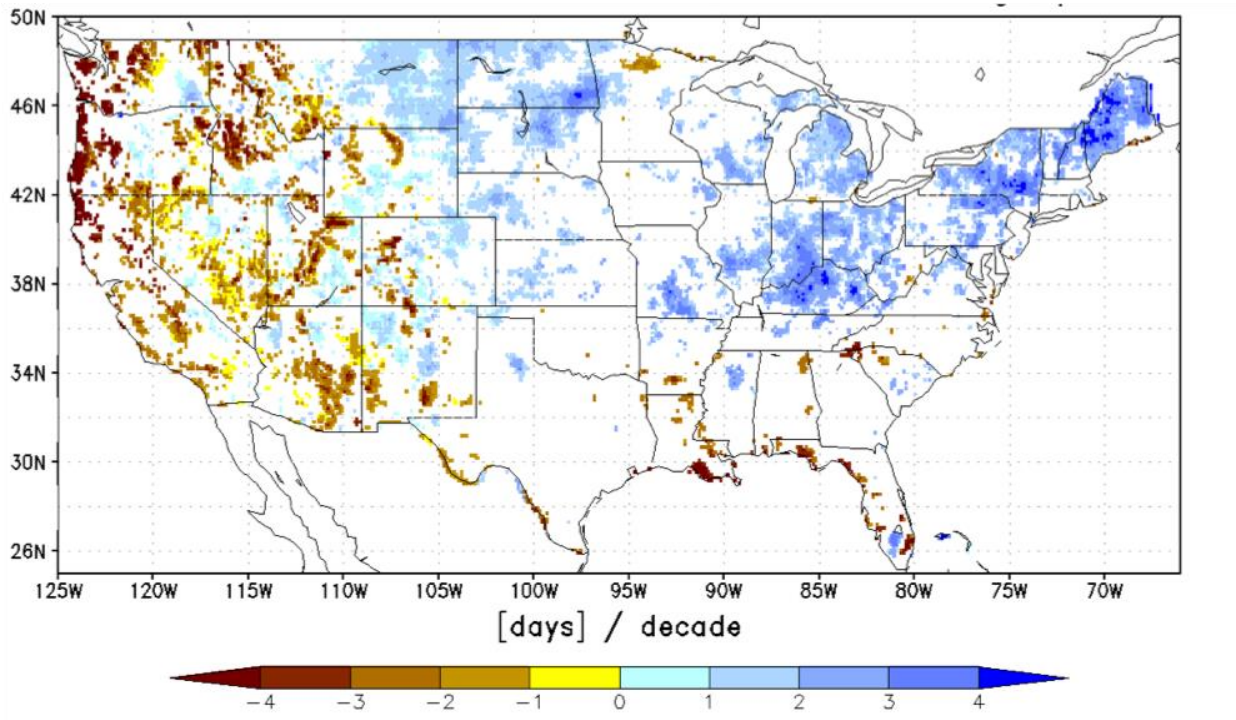

Figure 3. NCA-LDAS trends in mean annual number of days with heavy precipitation for water years 1980-2015 for p<0.1.

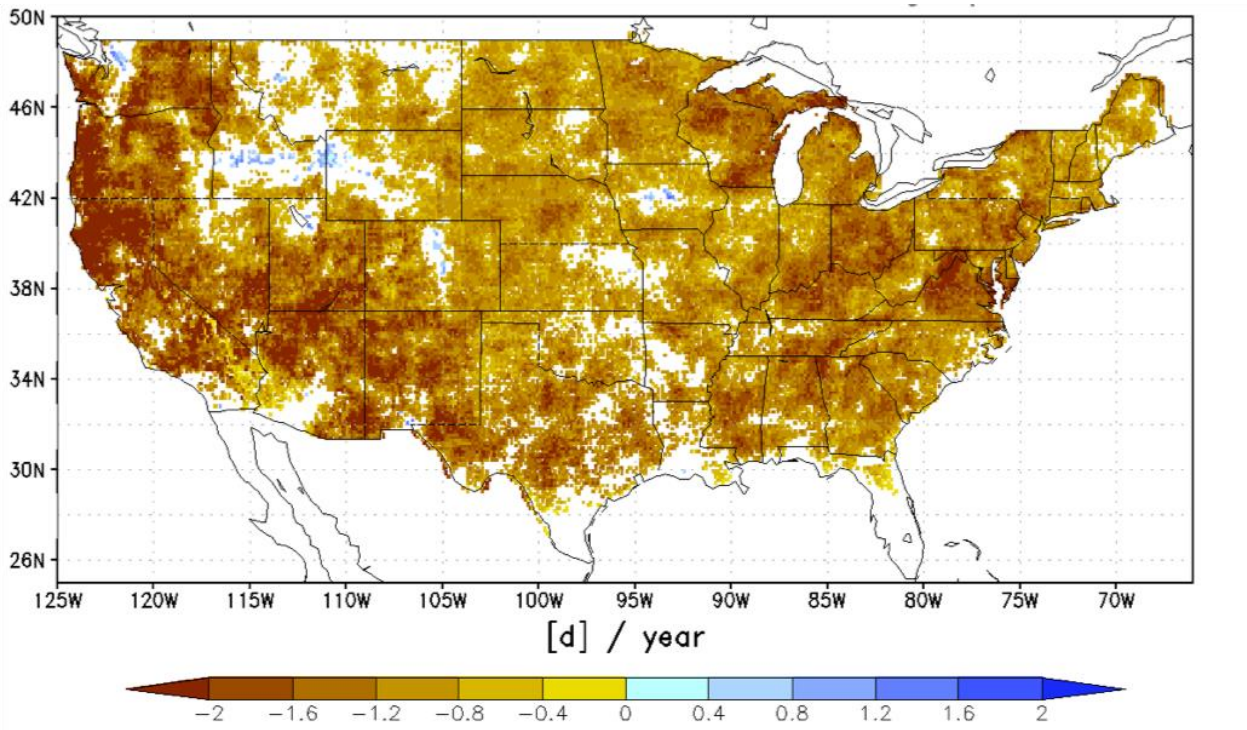

Figure 4. NCA-LDAS trends in mean annual number of snow-covered days for water years 1980-2015 for p<0.1.

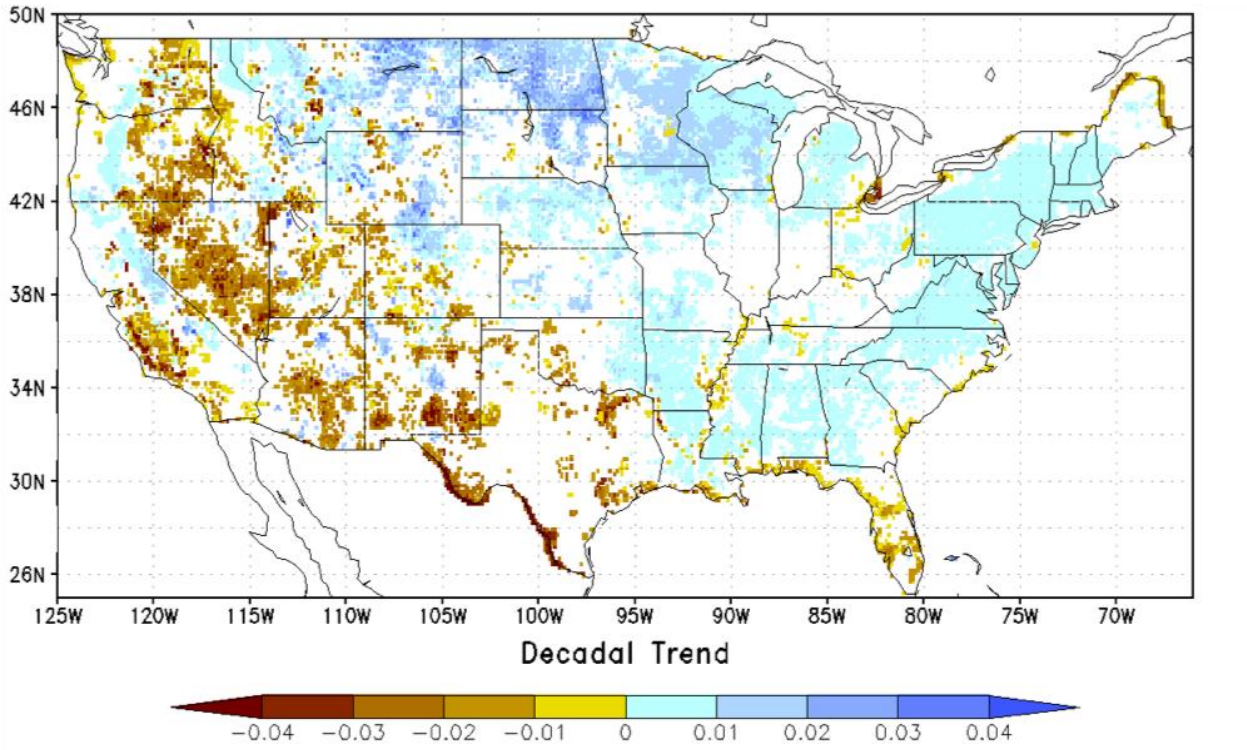

Figure 5. NCA-LDAS trends in mean evaporative fraction for water years 1980-2015 for p<0.1.

6.0 More Information

Land Data Assimilation System (LDAS) Project: https://ldas.gsfc.nasa.gov/

7.0 Acknowledgements

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Acronyms

The following acronyms and abbreviations are used in this document.

GES DISC	Goddard Earth Sciences Data and Information Services Center
Giovanni	GES-DISC Interactive On-line Visualization and Analysis Infrastructure
GrADS	Grid Analysis and Display System
GRIB	GRIdded Binary
HDF	Hierarchical Data Format
LDAS	Land Data Assimilation System
LIS	Land Information System
LSM	Land Surface Model
Mirador	Fast interface for searching Earth science data at NASA GES DISC
NASA	National Aeronautics and Space Administration
NCA	National Climate Assessment
NCEP	National Centers for Environmental Prediction
NetCDF	Network Common Data Form
NLDAS	North American Land Data Assimilation System
NOAA	National Oceanic and Atmospheric Administration