README Document for

Data Products from
National Climate Assessment - Land Data Assimilation System (NCA-LDAS)

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Last revised: Nov. 09, 2016

Revision History

Revision Date	*Changes*	*Author*
10/08/2014	Initial version	Hualan Rui
10/31/2016	Review and revise	David Mocko
11/07/2016	Review and revise	Jordan Borak
11/09/2016	Review and revise	Hualan Rui

Contents

Introduction

One of the objectives of National Climate Assessment - Land Data Assimilation System (NCA-LDAS) is to consolidate and deliver the water analysis capabilities of the Land Information System (LIS) software to support an Integrated Terrestrial Water Analysis. More information about NCA-LDAS can be found from the project site at http://ldas.gsfc.nasa.gov/NCA-LDAS/.

The NCA-LDAS has generated the rain, snow, land-surface states (e.g., soil moisture and surface temperature), fluxes (e.g., radiation and latent and sensible heat fluxes), and routing variables (e.g., streamflow, flooded area, etc.) data, based on the atmospheric forcing data from North American Land Data Assimilation System Phase 2 (NLDAS-2).

This document provides basic information for the currently released NCA-LDAS daily data from the Noah Land Surface Model (LSM).

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	Daily
Temporal coverage	2 January 1979 to 31 December 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

Updates

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 revisions of the data sets: https://lists.nasa.gov/mailman/listinfo/ldas-users

DOI and Data 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.

To cite the data in publications:

Michael Jasinski et al., NASA/GSFC/HSL (2016), NCA-LDAS Noah-3.3 Land Surface Model L4 Daily 0.125 x 0.125 degree V001, Greenbelt, Maryland, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed [Data Access Date] (DOI in the application process)

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

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Data Organization

File Naming Convention

NCA-LDAS data files are named in accordance with following convention:

NCALDAS_NOAH0125_D.A<YYYYMMDD>.001.nc4

"0125" is an indication for 1/8th degree grid spacing.
"D" is an indication for daily.
"<YYYYMMDD>" is a date format for year, month, and day.
"001" indicates version.
"nc4" indicates the file is in NetCDF-4 format.

File Format Structure

The NCA-LDAS data are archived in NetCDF-4 format. The NetCDF-4 format 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 http://www.unidata.ucar.edu/software/netcdf/docs/faq.html.

Data Contents

1. Noah-3.3 LSM Data

This 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 Jan 1979 to Dec 2015 with daily temporal resolution. The file format is NetCDF-4.

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 first three layers form the root zone in non-forested regions, with the fourth layer included 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.

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

Reading the Data

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

How to work with NetCDF Files from the command line

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

Reading/viewing the data by Panoply

Panoply, http://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 Data Cookbook of NASA GES DISC provides a recipe for Quick View Data with Panoply, http://disc.sci.gsfc.nasa.gov/recipes/?q=recipes/Quick-View-Data-with-Panoply.

Reading/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, read and display the data. Below is an example showing how to use sdfopen to read a NCALDAS 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.001$ 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.A19790102.001.nc4
Scanning self-describing file:  NCALDAS_NOAH0125_D.A19790102.001.nc4
SDF file NCALDAS_NOAH0125_D.A19790102.001.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.A19790102.001.nc4
  Binary: NCALDAS_NOAH0125_D.A19790102.001.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.001.

NCALDAS_NOAH0125_D.001.xdf, a sample data descriptor file

```
DSET ./NCALDAS_NOAH0125_D.A%y4%m2%d2.001.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.001.xdf

```
ga-> xdfopen NCALDAS_NOAH0125_D.001.xdf
Scanning Descriptor File:  NCALDAS_NOAH0125_D.001.xdf
SDF file
/ftp/data/s4pa_TS2/NCALDAS/NCALDAS_NOAH0125_D.001/%y4/%m2/NCALDAS_NOAH012
5_D.A%y4%m2%d2.001.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.001.xdf
  Binary:
/ftp/data/s4pa_TS2/NCALDAS/NCALDAS_NOAH0125_D.001/%y4/%m2/NCALDAS_NOAH012
5_D.A%y4%m2%d2.001.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->
```

Data Access

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 HTTP. 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 http://disc.sci.gsfc.nasa.gov/registration/registration-for-data-access.

GES DISC Users who deploy scripting methods to list and download data in bulk via anonymous FTP are advised to review the How to Download Data Files from HTTP

Service with wget recipe that provides examples of GNU wget commands for listing and downloading data via HTTP.

Data Volume

Data Product	File Size	Volume/Year	Total Volume
Noah	14 MB	5.5 GB	200 GB

Search and Access System

NCA-LDAS data can be accessed via the GES DISC NCA-LDAS data portal, http://disc.sci.gsfc.nasa.gov/uui/datasets/NCALDAS_NOAH0125_D_001/summary?keywords=NCALDAS, which includes the following access interfaces,

- Online Archive for accessing the data via HTTP: http://hydro1.gesdisc.eosdis.nasa.gov/data/NCALDAS/

- Mirador is a data search interface that allows searching, browsing, and retrieving of Earth science data archived at NASA GES DISC:
- http://mirador.gsfc.nasa.gov/cgi-bin/mirador/homepageAlt.pl?keyword=NCALDAS_NOAH0125_D

- Use the Earthdata Search Client (EDSC) to find and retrieve data sets across multiple data enters:
- https://search.earthdata.nasa.gov/search?q=NCALDAS_NOAH0125_D

- OPeNDAP for accessing the data via the OPeNDAP protocol: http://hydro1.gesdisc.eosdis.nasa.gov/opendap/NCALDAS/

- The GES-DISC Interactive Online Visualization ANd aNalysis Interface (Giovanni) is a web-based tool that allows users to interactively visualize and analyze data: http://giovanni.gsfc.nasa.gov/giovanni/#dataKeyword=NCALDAS

Points of Contact

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

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Appendices

*A. **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 America Land Data Assimilation System
NOAA	National Oceanic and Atmospheric Administration