README Document for

Global Land Data Assimilation System (GLDAS) Products

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Revision Date	*Changes*	*Author*
8/21/2007	Initial version	Henry Fang
10/5/2007	Revised based on review	Henry Fang
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Introduction

This document provides basic information on the land surface state (e.g., soil moisture and surface temperature) and flux (e.g., evaporation and sensible heat flux) parameters generated by the Global Land Data Assimilation System (GLDAS). GLDAS drives multiple, offline (not coupled to the atmosphere) land surface models, integrates a huge quantity of observation based data, and executes globally at high resolutions (2.5° to 1 km), enabled by the Land Information System (LIS) (Kumar et al., 2006). Currently, GLDAS drives four land surface models (LSMs): Mosaic, Noah, the Community Land Model (CLM), and the Variable Infiltration Capacity (VIC). More information is available at the Land Data Assimilation Systems (LDAS) and Land Information System (LIS) websites.

The temporal resolution for the GLDAS products is 3-hourly. Monthly products are also generated through temporal averaging of the 3-hourly products. Output files from these four models are briefly described here. Table 1 lists some basic characteristics of the GLDAS data.

Table 1. Basic characteristics of the GLDAS data.

Contents	Water and energy budget components, forcing data
Latitude extent	-60° to 90°
Longitude extent	-180° to 180°
Spatial resolution	0.25°, 1.0°
Temporal resolution	3-hourly or monthly
Temporal coverage	January 1, 1979 to present for the 1.0° data February 24, 2000 to present for the 0.25° data
Dimension	360 (lon) x 150 (lat) for the 1.0° data 1440 (lon) x 600 (lat) for the 0.25° data
Origin (1st grid center)	(179.5W, 59.5S) for the 1.0° data (179.875W, 59.875S) for the 0.25° data
Land surface models	CLM 2.0, GLDAS/CLM experiment 691 (1.0°) MOSAIC, GLDAS/MOSAIC experiment 691 (1.0°) NOAH 2.7, GLDAS/NOAH experiment 691 (1.0°) VIC water balance, GLDAS/VIC experiment 692 (1.0°) NOAH 2.7, GLDAS/NOAH experiment 881 (0.25°)

The data used by LIS include parameter data and forcing data. All model simulations were initialized on January 1, 1979 using soil moisture and other state fields from the respective LSM climatology for that day of the year. The 1.0 degree resolution data range from 1979 to present for the four models. The 0.25 degree data cover 2000 to present from the NOAH model. The forcing data set combines multiple data sets for the period of January 1, 1979 to present:

1979-1993: bias-corrected European Center for Medium-Range Weather Forecasts (ECMWF) Reanalysis data (Berg et al., 2003)
1994-1999: bias-corrected National Center for Atmospheric Research (NCAR) Reanalysis data (Berg et al., 2003)
2000: NOAA/GDAS atmospheric analysis fields
2001-2007: a combination of NOAA/GDAS atmospheric analysis fields, spatially and temporally disaggregated NOAA Climate Prediction Center Merged Analysis of Precipitation (CMAP) fields, and observation-based downward shortwave and longwave radiation fields derived using the method of the Air Force Weather Agency's AGRicultural METeorological modeling system (AGRMET)

In NOAH experiment 881, snow cover data derived from the MODIS sensor aboard NASA's Terra satellite were assimilated in order to constrain the modeled snow water equivalent (SWE), using the updating technique described by Rodell and Houser (2004). SWE was adjusted when and where there was a discrepancy between the modeled SWE state (snow or no snow) and the MODIS snow cover state. A quantity of 10 mm SWE was added to pixels where the model did not have snow but the fractional MODIS snow cover was greater than 40%. Snow was removed from model pixels where MODIS indicated fractional snow cover was less than 10%.

Future Updates

The initial release of the GLDAS LSM data is in three phases. Currently, with Phase 1 and Phase 2, users can access the data by searching and downloading via anonymous ftp or Mirador. Mirador, a Spanish word for a window offering an extensive view, uses keywords to find data quickly in a Google-like interface. The GLDAS data are also provided to the GrADS Data Server (GDS) users via http://agdisc.gsfc.nasa.gov/dods/. GDS users can access the data, perform subsetting and analysis operations without first downloading them. More advanced tools will be provided in Phase 3 and later releases, such as on-the-fly spatial and parameter subsetting and temporal aggregation in Mirador, and an online visualization and analysis tool (Giovanni). Giovanni is a Web-based application developed by the GES DISC that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data.

Please check periodically the GES DISC web site for the latest GLDAS data.

Data Citation

Please refer to Rodell et al. (2004) for more information about the GLDAS project.

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 following address:

GES DISC Help Desk
Code 610.2
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

Data Organization

File Naming Convention

1. 3-hourly data set

For the 3-hourly data set, GLDAS LSM data are named in accordance with the following convention:

<Land surface model><LSM resolution>SUBP.A<date>.<HHHH>.<product version>.<Production date and time>.grb

The format for the date is <YYYY><Day of year>
The format for the production date and time is
<YYYY><Day of year><HHMMSS>

For example, the 1.0°×1.0° LSM data from NOAH model at 15:00Z on 2 January 1979 can be found in the file named:
"NOAH10SUBP.A1979002.1500.001.2007159150213.grb".

2. Monthly average data set

The monthly GLDAS data set is distributed in two parts, the energy budget (EB) and water budget (WB) components. The monthly data are named in accordance with the following convention:

GLDAS_<Land surface model><LSM resolution>_M.<component>.A<date>.<product version>. grb

The format for the date is <YYYY><Month>

For example, the 1.0°×1.0° Energy Budget (EB) data from CLM model in January, 2007 are named: "GLDAS_CLM10_M.EB.A200701.001.grb".

The 1.0°×1.0° Water Budget (WB) data from CLM model in January, 2007 are named: "GLDAS_CLM10_M.WB.A200701.001.grb".

File Format Structure

The GLDAS LSM data were created using the GRIdded Binary (GRIB) format. For more details about the GRIB format, please see http://www.nco.ncep.noaa.gov/pmb/docs/on388/.

Please note that GLDAS applies user-defined parameter tables (see Appendix B) for the GRIB files.

Data Contents

Table 2 shows a list of parameters provided in the GRIB files. This table shows the GRIB Product Definition Section (PDS) ID and the corresponding parameter name. See the Parameter Information Page (PIP) for details about the parameters.

Table 2. Geophysical parameters in the subsetted GLDAS data set

PDS IDs	Full Name	Unit
001	Surface pressure	Pa
011	Near surface air temperature	K
032	Near surface wind magnitude	m/s
051	Near surface specific humidity	kg/kg
057	Total evapotranspiration	kg/m^2
065	Snow water equivalent	kg/m^2
071	Total canopy water storage	kg/m^2
085	Average layer soil temperature	K
086	Average layer soil moisture	kg/m^2
099	Snowmelt	kg/m^2/s
111	Net shortwave radiation	W/m^2
112	Net longwave radiation	W/m^2
121	Latent heat flux	W/m^2
122	Sensible heat flux	W/m^2
131	Snowfall rate	kg/m^2/s
132	Rainfall rate	kg/m^2/s
138	Average surface temperature	K
155	Ground heat flux	W/m^2
204	Surface incident shortwave radiation	W/m^2
205	Surface incident longwave radiation	W/m^2
234	Subsurface runoff	kg/m^2
235	Surface runoff	kg/m^2

The number of vertical levels for Soil Temperature (PDS 085) and Soil Moisture (PDS 086) is model specific. There are 10, 3, 4 and 3 layers for the CLM2, Mosaic, Noah, and

VIC models, respectively. In the VIC output, Average Layer Soil Temperature (PDS 085) is not available, and Ground Heat Flux (PDS 155) is nil due to the water balance mode used in the simulation.

Reading the Data

WGRIB, GrADS, or other GRIB readers are required for reading the GLDAS data. WGRIB is a program to manipulate, inventory, and decode GRIB files. The source code and installation instructions for WGRIB are available from http://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html.

WGRIB version 1.7.X is recommended to avoid any possible discrepancies caused by different WGRIB versions. The GLDAS data set applies a user-specific parameter table to indicate the content and parameter number.

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, GRIB, NetCDF, and HDF. The documentation and software for GrADS can be found at http://grads.iges.org/grads/.

S*ample WGRIB Usage*

Download the GRIBTAB and set the environmental variables (See Appendix B) first before using wgrib!

1. GRIB data verbose inventory

Usage: ./wgrib [grib file] [options]
Example:

wgrib GLDAS_CLM10SUBP_3H.A2007121.0000.001.2007297114034.grb -v > t

```
1:0:D=2007043021:SWnet:sfc:kpds=111,1,0:0-3hr ave:"Net Shortwave Radiation          W/m^2
2:37204:D=2007043021:LWnet:sfc:kpds=112,1,0:0-3hr ave:"Net Longwave Radiation          W/m^2
3:72510:D=2007043021:Qle:sfc:kpds=121,1,0:0-3hr ave:"Latent Heat Flux               W/m^2
4:109714:D=2007043021:Qh:sfc:kpds=122,1,0:0-3hr ave:"Sensible Heat Flux             W/m^2
5:146918:D=2007043021:Qg:sfc:kpds=155,1,0:0-3hr ave:"Ground Heat Flux               W/m^2
6:184122:D=2007050100:Snowf:sfc:kpds=131,1,0:anl:"Snowfall rate                  kg/m^2/s
7:221326:D=2007050100:Rainf:sfc:kpds=132,1,0:anl:"Rainfall rate                  kg/m^2/s
8:258530:D=2007050100:Evap:sfc:kpds=57,1,0:anl:"Total Evapotranspiration         kg/m^2/s
9:293836:D=2007050100:Qs:sfc:kpds=235,1,0:anl:"Surface Runoff                    kg/m^2/s
10:331040:D=2007050100:Qsb:sfc:kpds=234,1,0:anl:"Subsurface Runoff               kg/m^2/s
11:368244:D=2007043021:Qsm:sfc:kpds=99,1,0:0-3hr ave:"Snowmelt                   kg/m^2/s
12:380778:D=2007050100:AvgSurfT:sfc:kpds=138,1,0:anl:"Average Surface Temperature      K
13:412288:D=2007050100:SWE:sfc:kpds=65,1,0:anl:"Snow Water Equivalent            kg/m^2
14:449492:D=2007050100:TSoil10:0-110 cm down:kpds=85,112,110:anl:"Average layer 10 soil
temperature   K
15:481002:D=2007050100:TSoil10:0-109 cm down:kpds=85,112,109:anl:"Average layer 10 soil
temperature   K
```

```
16:512512:D=2007050100:TSoil10:0-108 cm down:kpds=85,112,108:anl:"Average layer 10 soil
temperature   K
17:544022:D=2007050100:TSoil10:0-107 cm down:kpds=85,112,107:anl:"Average layer 10 soil
temperature   K
18:575532:D=2007050100:TSoil10:0-106 cm down:kpds=85,112,106:anl:"Average layer 10 soil
temperature   K
19:607042:D=2007050100:TSoil10:0-105 cm down:kpds=85,112,105:anl:"Average layer 10 soil
temperature   K
20:638552:D=2007050100:TSoil10:0-104 cm down:kpds=85,112,104:anl:"Average layer 10 soil
temperature   K
21:670062:D=2007050100:TSoil10:0-103 cm down:kpds=85,112,103:anl:"Average layer 10 soil
temperature   K
22:701572:D=2007050100:TSoil10:0-102 cm down:kpds=85,112,102:anl:"Average layer 10 soil
temperature   K
23:733082:D=2007050100:TSoil10:0-101 cm down:kpds=85,112,101:anl:"Average layer 10 soil
temperature   K
24:764592:D=2007050100:SoilM10:0-110 cm down:kpds=86,112,110:anl:"Average layer 10 soil moisture
kg/m^2
25:801796:D=2007050100:SoilM10:0-109 cm down:kpds=86,112,109:anl:"Average layer 10 soil moisture
kg/m^2
26:839000:D=2007050100:SoilM10:0-108 cm down:kpds=86,112,108:anl:"Average layer 10 soil moisture
kg/m^2
27:876204:D=2007050100:SoilM10:0-107 cm down:kpds=86,112,107:anl:"Average layer 10 soil moisture
kg/m^2
28:913408:D=2007050100:SoilM10:0-106 cm down:kpds=86,112,106:anl:"Average layer 10 soil moisture
kg/m^2
29:950612:D=2007050100:SoilM10:0-105 cm down:kpds=86,112,105:anl:"Average layer 10 soil moisture
kg/m^2
30:987816:D=2007050100:SoilM10:0-104 cm down:kpds=86,112,104:anl:"Average layer 10 soil moisture
kg/m^2
31:1025020:D=2007050100:SoilM10:0-103 cm down:kpds=86,112,103:anl:"Average layer 10 soil
moisture   kg/m^2
32:1062224:D=2007050100:SoilM10:0-102 cm down:kpds=86,112,102:anl:"Average layer 10 soil
moisture   kg/m^2
33:1099428:D=2007050100:SoilM10:0-101 cm down:kpds=86,112,101:anl:"Average layer 10 soil
moisture   kg/m^2
34:1136632:D=2007050100:Canopint:sfc:kpds=71,1,0:anl:"Total canopy water storage    kg/m^2
35:1170040:D=2007050100:Wind:sfc:kpds=32,1,0:anl:"Near surface wind magnitude     m/s
36:1197756:D=2007050100:Tair:sfc:kpds=11,1,0:anl:"Near surface air temperature      K
37:1229266:D=2007050100:Qair:sfc:kpds=51,1,0:anl:"Near surface specific humidity    kg/kg
38:1245594:D=2007050100:PSurf:sfc:kpds=1,1,0:anl:"Surface pressure                  Pa
39:1282798:D=2007043021:SWdown:sfc:kpds=204,1,0:0-3hr ave:"Surface incident shortwave radiation
W/m^2
40:1320002:D=2007043021:LWdown:sfc:kpds=205,1,0:0-3hr ave:"Surface incident longwave radiation
W/m^2
```

The above inventory consists of several fields separated by colons. The contents of the fields are as follows:

1. Record number
2. Position in bytes
3. Date (YYYYMMDDHH)
4. Parameter name (LAND=land/sea mask)
5. Type of level/layer (grib PDS octet 10)
6. KPDS5, KPDS6, KPDS7 (grib PDS octets 9, 10, 11-12)

7. Forecasts, analysis, etc.
8. Description of parameter type

Users are suggested to refer to the metadata associated with the GRIB files for more details about the Type of level/layer information.

2. Extract a specific field from GRIB data, e.g., Total Evapotranspiration

Usage: wgrib -s infile | grep ":Evap:" | wgrib -i infile -o outfile
For example:

```
wgrib -s GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb | grep ":Evap:" |
wgrib -i GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb –o
evap.1979002.0000.grb
```

To convert it into a text file:

```
wgrib -s GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb | grep ":Evap:" |
wgrib -i –text GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb -o
evap.1979002.0000.txt
```

Preparation of GrADS Control File

Set the environmental variables (See Appendix B) first before starting GrADS. For more information, please visit grib2ctl home page.

1. Make a GrADS control file for GRIB files

Usage: grib2ctl [options] [grib file] [optional index file] >[control file]
Example:

grib2ctl.pl GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb >clm10.ctl

2. Create the "map" file for using GRIB data in GrADS

Usage: gribmap [options] [control file]
Example:

```
gribmap -e -i clm10.ctl
```

Hereunder is an example of a control file (clm10.ctl):

```
DSET   ^GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb
INDEX ^GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb.idx
UNDEF 9.999E+20
TITLE  GLDAS_CLM10SUBP_3H.A1979002.0000.001.2007219013746.grb
*  produced by grib2ctl v0.9.12.5p33i
DTYPE grib 0
```

```
YDEF   150 linear -59.500000 1
XDEF   360 linear -179.500000 1.000000
TDEF   2 linear 21Z01jan1979 3hr
ZDEF   10 levels
110 109 108 107 106 105 104 103 102 101
VARS 22
    AvgSurfTsfc  0 138,1,0  ** surface Average Surface Temperature       K
    Canopintsfc  0 71,1,0  ** surface Total canopy water storage    kg/m^2
    Evapsfc  0 57,1,0  ** surface Total Evapotranspiration          kg/m^2/s
    LWdownsfc  0 205,1,0  ** surface Surface incident longwave radiation W/m^2
    LWnetsfc  0 112,1,0  ** surface Net Longwave Radiation           W/m^2
    PSurfsfc  0 1,1,0  ** surface Surface pressure                Pa
    Qairsfc  0 51,1,0  ** surface Near surface specific humidity    kg/kg
    Qgsfc  0 155,1,0  ** surface Ground Heat Flux                 W/m^2
    Qhsfc  0 122,1,0  ** surface Sensible Heat Flux               W/m^2
    Qlesfc  0 121,1,0  ** surface Latent Heat Flux                W/m^2
    Qssfc  0 235,1,0  ** surface Surface Runoff                   kg/m^2/s
    Qsbsfc  0 234,1,0  ** surface Subsurface Runoff                kg/m^2/s
    Qsmsfc  0 99,1,0  ** surface Snowmelt                         kg/m^2/s
    Rainfsfc  0 132,1,0  ** surface Rainfall rate                  kg/m^2/s
    SWEsfc  0 65,1,0  ** surface Snow Water Equivalent            kg/m^2
    SWdownsfc  0 204,1,0  ** surface Surface incident shortwave radiation  W/m^2
    SWnetsfc  0 111,1,0  ** surface Net Shortwave Radiation          W/m^2
    Snowfsfc  0 131,1,0  ** surface Snowfall rate                 kg/m^2/s
    SoilM10dlr 10 86,112,0 ** Average layer 10 soil moisture     kg/m^2
    TSoil10dlr 10 85,112,0 ** Average layer 10 soil temperature  K
    Tairsfc  0 11,1,0  ** surface Near surface air temperature      K
    Windsfc  0 32,1,0  ** surface Near surface wind magnitude     m/s
ENDVARS
```

Retrieve GLDAS data through the GrADS Data Server (GDS)

Users can retrieve GLDAS data from a GDS server using analysis tools such as GrADS, Ferret, Matlab, or IDL. Here is an example of the GrADS script to access the GDS server and draw the Layer 10 soil moisture (soilm10) parameter from the CLM model.

```
'reinit'
'sdfopen http://agdisc.gsfc.nasa.gov/dods/GLDAS_CLM10SUBP_3H'
'set lon -180 180'
'set lat -60 90'
'set gxout grfill'
'set grads off'
'set t 1'
'd soilm10'
'draw title GLDAS CLM 3-Hourly 1.0 degree Average Layer 10 Soil
Moisture\ on Jan 2, 1979 at 00Z[k]'
```

Data Interpretation

Please see Appendix B for the user-defined parameter tables needed for interpreting GRIB files.

1. Due to the fact that forcing data for Greenland are unreliable and the lack of a glacier/ice sheet model, snow water equivalent accumulates indefinitely in Greenland and a few other Arctic points. Therefore it is highly recommended that Greenland and other points with abnormally large snow water equivalent values be masked out when performing global analyses.

2. Total precipitation is the sum of rainfall and snowfall.

3. Total runoff is the sum of subsurface runoff and surface runoff.

4. The number of vertical levels for soil moisture (SOILM) and soil temperature (TSOIL) is model specific. Please follow the table below for the correct depths of soil layers.

CLM 2.0 (10 layers)	
Depths	0-0.018, 0.018-0.045, 0.045-0.091, 0.091-0.166, 0.166-0.289, 0.289-0.493, 0.493-0.829, 0.829-1.383, 1.383-2.296, and 2.296-3.433 m.
MOS (3 layers)	
Depths	0-0.02,0.02-1.50, and 1.5-3.50 m.
NOAH (4 layers)	
Depths	0-0.1, 0.1-0.4, 0.4-1.0, and 1.0-2.0 m.
VIC (3 layers)	
Depths	0-0.1, 0.1-1.6, and 1.6-1.9 m.

5. The generic GRIB table defines the different soil layers as SoilMoist1, …, SoilMoist*N*, where *N* is the number of soil layers (See Appendix B).

6. Terrestrial water storage is the sum of soil moisture in all layers, accumulated snow, and plant canopy surface water.

7. Use temporal averaging, not accumulation, to upscale the data to different temporal resolutions. For example, rainfall and snowfall are provided as rates, i.e., kg/m2/s. So the correct method of upscaling is averaging, which does not change the units.

8. Monthly average files contain straight averages of 3-hourly data, so that each monthly average has units PER 3 HOURS. For example, total evapotranspiration (evap) for April 1979 is the average 3-hour mean rate of evapotranspiration over all the 3-hour intervals in April 1979. It is NOT the accumulated evapotranspiration in April 1979. To compute the latter, use this formula:

total_evapt (April) = evapsfc (April) * 10800 {sec/3hr} * 8{3hr/day}* 30{days}

This would be irrelevant, and the above formula should not be used, if the field of interest were a state (e.g., soil moisture)

Data Access

The NASA GES DISC maintains archives of all GLDAS data products and many other Hydrology data sets. The archived data can be accessed via FTP network transfer.

Data Volume

1. 3-hourly data

Model	Resolution	Files/day	GB/year
CLM	1.0° × 1.0°	8	3.8
Mosaic	1.0° × 1.0°	8	2.3
Noah	1.0° × 1.0°	8	2.6
Noah	0.25° × 0.25°	8	42
VIC	1.0° × 1.0°	8	2.1

2. Monthly data

Model	Resolution	Files/year	MB/year
CLM	1.0° × 1.0°	12	12.1
Mosaic	1.0° × 1.0°	12	9.0
Noah	1.0° × 1.0°	12	9.6
Noah	0.25° × 0.25°	12	153.6
VIC	1.0° × 1.0°	12	7.6

Search and Access System

GLDAS data can be accessed via the GES DISC's Hydrology Data and Information Services Center (HDISC)
http://disc.gsfc.nasa.gov/hydrology

Use the Mirador service to search and download GLDAS data in a batch mode (http://mirador.gsfc.nasa.gov/). Mirador is a fast interface for searching Earth science data at NASA GES DISC. In the Mirador interface, GLDAS data can be searched through a keyword (e.g., Noah) and the time span.

The GLDAS products are provided to the GrADS Data Server (GDS) users via http://agdisc.gsfc.nasa.gov/dods/. The GDS is a stable, secure data server that provides subsetting and analysis services across the internet. The GDS supports any operation that

can be expressed in a single GrADS expression, including basic math functions, averages, smoothing, differencing, correlation, and regression.

Anonymous ftp

The 3-hourly GLDAS data can be downloaded directly via the GES DISC anonymous ftp: ftp://agdisc.gsfc.nasa.gov/data/s4pa/GLDAS_SUBP/.

The monthly GLDAS data can be downloaded from ftp://agdisc.gsfc.nasa.gov/data/s4pa/GLDAS/.

Points of Contact

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: help-disc@listserv.gsfc.nasa.gov
301-614-5224 (voice)
301-614-5268 (fax)

For general science questions and comments, please contact:

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Greenbelt, MD 20771
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Phone: 301-286-3951

or

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References

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Appendices

A. Description of Metadata

Table A.1. Collection level metadata

Metadata items
C1. Collection data description
1. ShortName
2. LongName
3. TemporalRange
4. SpatialCoverage
5. DataResolution
6. Format (e.g., GRIB1)
7. LandSurfaceModel
8. LandSurfaceModelVersionID
C2. ScienceParameter group
(Parameters listed in Table 2)

Table A.2. Granule level metadata

Metadata items
G1. General description
1. GranuleID
2. GranuleDate
3. LatitudeResolution
4. LongitudeResolution
5. Format (e.g., GRIB1)
6. SizeBytesDataGranule
7. LandSurfaceModel
G2. Grib data description
1. SouthernmostLatitude
2. NorthernmostLatitude
3. WesternmostLongitude
4. EasternmostLongitude
5. BeginningDateTime
6. EndingDateTime
G3. ScienceParameter Group

1. ParameterShortName
2. ParameterLongName
3. Center
4. Subcenter
5. Process
6. Level (or Layer)
7. Height (or Pressure)
8. TimeRange
9. PeriodTime1
10. PeriodTime2
11. ForecastTimeUnit
12. GridSize
13. ForecastAnalysisFlag
14. NumberGridsAverage
15. MimValueData
16. MaxValueData
G4. Ingest information
1. ProductionDateTime
2. InsertDateTime

B. User-defined Parameter Tables for Different GRIB Files

GRIB files identify the contents (e.g., soil moisture, temperature) by parameter numbers. These numbers are linked to their respective parameter names in a parameter table. The parameter tables used for GLDAS data are shown in Tables B.1~B.4, for each land surface model, respectively. The name of the user-defined table is searched for in the following order:

1. Environment variable "GRIBTAB"
2. Environment variable "gribtab"
3. File gribtab

Defining an environment variable depends on the operating system and on the shell.

Example:

```
set GRIBTAB=~/data/gribtab                  (MS-DOS or Windows)
export GRIBTAB=~/data/gribtab               (bash)
setenv GRIBTAB ~/data/gribtab               (csh)
GRIBTAB=$HOME/data/gribtab; export GRIBTAB     (sh)
```

Table B.1. GRIBTAB for CLM output (gribtab.clm)

```
-1:-1:-1:-1
111:SWnet:Net Shortwave Radiation           W/m^2
112:LWnet:Net Longwave Radiation            W/m^2
121:Qle:Latent Heat Flux                   W/m^2
122:Qh:Sensible Heat Flux                 W/m^2
155:Qg:Ground Heat Flux                   W/m^2
131:Snowf:Snowfall rate                      kg/m^2/s
132:Rainf:Rainfall rate                      kg/m^2/s
057:Evap:Total Evapotranspiration           kg/m^2/s
235:Qs:Surface Runoff                      kg/m^2/s
234:Qsb:Subsurface Runoff                   kg/m^2/s
099:Qsm:Snowmelt                            kg/m^2/s
068:DelSoilMoist:Change in soil moisture           kg/m^2
078:DelSWE:Change in snow water equivalent   kg/m^2
135:SnowT:Snow Temperature                    K
136:VegT:Vegetation Canopy Temperature     K
137:BaresoilT:Temperature of bare soil          K
138:AvgSurfT:Average Surface Temperature       K
139:RadT:Surface Radiative Temperature     K
084:Albedo:Surface Albedo, All Wavelengths   -
065:SWE:Snow Water Equivalent             kg/m^2
085:TSoil1:Average layer 1 soil temperature     K
085:TSoil2:Average layer 2 soil temperature     K
085:TSoil3:Average layer 3 soil temperature     K
085:TSoil4:Average layer 4 soil temperature     K
085:TSoil5:Average layer 5 soil temperature     K
085:TSoil6:Average layer 6 soil temperature    K
```

```
085:TSoil7:Average layer 7 soil temperature    K
085:TSoil8:Average layer 8 soil temperature    K
085:TSoil9:Average layer 9 soil temperature    K
085:TSoil10:Average layer 10 soil temperature   K
086:SoilM1:Average layer 1 soil moisture     kg/m^2
086:SoilM2:Average layer 2 soil moisture     kg/m^2
086:SoilM3:Average layer 3 soil moisture     kg/m^2
086:SoilM4:Average layer 4 soil moisture     kg/m^2
086:SoilM5:Average layer 5 soil moisture     kg/m^2
086:SoilM6:Average layer 6 soil moisture    kg/m^2
086:SoilM7:Average layer 7 soil moisture    kg/m^2
086:SoilM8:Average layer 8 soil moisture    kg/m^2
086:SoilM9:Average layer 9 soil moisture    kg/m^2
086:SoilM10:Average layer 10 soil moisture   kg/m^2
070:RootMoist:Root zone soil moisture          kg/m^2
207:SoilWet:Total Soil Wetness                 -
210:TVeg:Vegetation transpiration         kg/m^2/s
200:ECanop:Interception evaporation       kg/m^2/s
199:ESoil:Bare soil evaporation            kg/m^2/s
071:Canopint:Total canopy water storage    kg/m^2
174:ACond:Aerodynamic conductance          m/s
032:Wind:Near surface wind magnitude     m/s
059:Rainfforc:Rainfall rate                    kg/m^2/s
064:Snowfforc:Snowfall rate                   kg/m^2/s
011:Tair:Near surface air temperature      K
051:Qair:Near surface specific humidity    kg/kg
001:PSurf:Surface pressure                 Pa
204:SWdown:Surface incident shortwave radiation  W/m^2
205:LWdown:Surface incident longwave radiation W/m^2
```

Table B.2. GRIBTAB for MOSAIC output (gribtab.mos)

```
-1:-1:-1:-1
111:SWnet:Net Shortwave Radiation          W/m^2
112:LWnet:Net Longwave Radiation           W/m^2
121:Qle:Latent Heat Flux                  W/m^2
122:Qh:Sensible Heat Flux                W/m^2
155:Qg:Ground Heat Flux                  W/m^2
131:Snowf:Snowfall rate                     kg/m^2/s
132:Rainf:Rainfall rate                     kg/m^2/s
057:Evap:Total Evapotranspiration          kg/m^2/s
235:Qs:Surface Runoff                     kg/m^2/s
234:Qsb:Subsurface Runoff                  kg/m^2/s
099:Qsm:Snowmelt                           kg/m^2/s
068:DelSoilMoist:Change in soil moisture           kg/m^2
078:DelSWE:Change in snow water equivalent   kg/m^2
138:AvgSurfT:Average Surface Temperature       K
085:SoT:Deep Soil Temperature                  K
084:Albedo:Surface Albedo, All Wavelengths   -
065:SWE:Snow Water Equivalent             kg/m^2
086:SoilM1:Average layer 1 soil moisture     kg/m^2
086:SoilM2:Average layer 2 soil moisture     kg/m^2
086:SoilM3:Average layer 3 soil moisture     kg/m^2
207:SoilWet:Total Soil Wetness                 -
200:ECanop:Interception evaporation       kg/m^2/s
210:TVeg:Vegetation transpiration         kg/m^2/s
199:ESoil:Bare soil evaporation            kg/m^2/s
```

```
070:RootMoist:Root zone soil moisture          kg/m^2
071:Canopint:Total canopy water storage    kg/m^2
174:ACond:Aerodynamic conductance          m/s
032:Wind:Near surface wind magnitude     m/s
059:Rainfforc:Rainfall rate                   kg/m^2/s
064:Snowfforc:Snowfall rate                  kg/m^2/s
011:Tair:Near surface air temperature      K
051:Qair:Near surface specific humidity    kg/kg
001:PSurf:Surface pressure                 Pa
204:SWdown:Surface incident shortwave radiation  W/m^2
205:LWdown:Surface incident longwave radiation W/m^2
```

Table B.3. GRIBTAB for NOAH output (gribtab.noah)

```
-1:-1:-1:-1
111:SWnet:Net Shortwave Radiation           W/m^2
112:LWnet:Net Longwave Radiation            W/m^2
121:Qle:Latent Heat Flux                  W/m^2
122:Qh:Sensible Heat Flux                W/m^2
155:Qg:Ground Heat Flux                  W/m^2
131:Snowf:Snowfall rate                     kg/m^2/s
132:Rainf:Rainfall rate                     kg/m^2/s
057:Evap:Total Evapotranspiration          kg/m^2/s
235:Qs:Surface Runoff                     kg/m^2/s
234:Qsb:Subsurface Runoff                  kg/m^2/s
099:Qsm:Snowmelt                           kg/m^2/s
068:DelSoilMoist:Change in soil moisture           kg/m^2
078:DelSWE:Change in snow water equivalent   kg/m^2
138:AvgSurfT:Average Surface Temperature       K
084:Albedo:Surface Albedo, All Wavelengths   -
065:SWE:Snow Water Equivalent             kg/m^2
085:TSoil1:Average layer 1 soil temperature  K
085:TSoil2:Average layer 2 soil temperature  K
085:TSoil3:Average layer 3 soil temperature  K
085:TSoil4:Average layer 4 soil temperature  K
086:SoilM1:Average layer 1 soil moisture     kg/m^2
086:SoilM2:Average layer 2 soil moisture     kg/m^2
086:SoilM3:Average layer 3 soil moisture     kg/m^2
086:SoilM4:Average layer 4 soil moisture     kg/m^2
207:SoilWet:Total Soil Wetness               -
200:ECanop:Interception evaporation       kg/m^2/s
210:TVeg:Vegetation transpiration         kg/m^2/s
199:ESoil:Bare soil evaporation            kg/m^2/s
070:RootMoist:Root zone soil moisture          kg/m^2
071:Canopint:Total canopy water storage    kg/m^2
032:Wind:Near surface wind magnitude     m/s
059:Rainfforc:Rainfall rate                   kg/m^2/s
064:Snowfforc:Snowfall rate                  kg/m^2/s
011:Tair:Near surface air temperature      K
051:Qair:Near surface specific humidity    kg/kg
001:PSurf:Surface pressure                 Pa
204:SWdown:Surface incident shortwave radiation  W/m^2
205:LWdown:Surface incident longwave radiation W/m^2
```

Table B.4. GRIBTAB for VIC output (gribtab.vic)

```
-1:-1:-1:-1
```

```
111:SWnet:Net Shortwave Radiation           W/m^2
112:LWnet:Net Longwave Radiation            W/m^2
121:Qle:Latent Heat Flux                   W/m^2
122:Qh:Sensible Heat Flux                 W/m^2
155:Qg:Ground Heat Flux                   W/m^2
132:Rainf:Rainfall rate                      kg/m^2/s
131:Snowf:Snowfall rate                      kg/m^2/s
057:Evap:Total Evapotranspiration          kg/m^2/s
235:Qs:Surface Runoff                     kg/m^2/s
234:Qsb:Subsurface Runoff                  kg/m^2/s
250:Qfz:Re-freezign of water in the snow  km/m^2/s
239:SnowT: Snow temperature                K
138:AvgSurfT:Average Surface Temperature       K
149:RadT:Surface Radiative Temperature       K
084:Albedo:Surface Albedo, All Wavelengths   -
085:TSoil1:Average layer 1 soil temperature  K
085:TSoil2:Average layer 2 soil temperature  K
085:TSoil3:Average layer 3 soil temperature  K
086:SoilM1:Average layer 1 soil moisture     kg/m^2
086:SoilM2:Average layer 2 soil moisture     kg/m^2
086:SoilM3:Average layer 3 soil moisture     kg/m^2
210:TVeg:Vegetation transpiration          kg/m^2/s
199:ESoil:Bare soil evaporation             kg/m^2/s
207:SoilWet:Total Soil Wetness                -
070:RootMoist:Root zone soil moisture          kg/m^2
065:SWE:Snow Water Equivalent              kg/m^2
099:Qsm:Snowmelt                           kg/m^2/s
068:DelSoilMoist:Change in soil moisture           kg/m^2
078:DelSWE:Change in snow water equivalent   kg/m^2
179:Acond: Aerodynamic conductance       m/s
032:Wind:Near surface wind magnitude     m/s
059:Rainfforc:Rainfall rate                   kg/m^2/s
064:Snowfforc:Snowfall rate                  kg/m^2/s
011:Tair:Near surface air temperature      K
051:Qair:Near surface specific humidity    kg/kg
001:PSurf:Surface pressure                 Pa
204:SWdown:Surface incident shortwave radiation  W/m^2
205:LWdown:Surface incident longwave radiation W/m^2
```

C. Acronyms

The following acronyms and abbreviations are used in this document.

AGRMET	Air Force Weather Agency's AGRicultural METeorological modeling system
CLM	Community Land Model
CMAP	Climate Prediction Center Merged Analysis of Precipitation
ECMWF	European Center for Medium-Range Weather Forecasts
GDAS	Global Data Assimilation System
GDS	GrADS Data Server
GES DISC	Goddard Earth Sciences Data and Information Services Center
Giovanni	GES-DISC Interactive On-line Visualization and Analysis Infrastructure
GLDAS	Global Land Data Assimilation System
GrADS	Grid Analysis and Display System
GRIB	GRIdded Binary
HDF	Hierarchical Data Format
HDISC	Hydrology Data and Information Services Center
LDAS	Land Data Assimilation System
LIS	Land Information System
LSM	Land Surface Model
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
netCDF	network Common Data Form
NEWS	NASA Energy and Water Cycle Study
NOAA	National Oceanic and Atmospheric Administration
NOAH	National Centers for Environmental Prediction/Oregon State University/Air Force/Hydrologic Research Lab Model
OPeNDAP	Open Source Project for a Network Data Access Protocol
PDS	Product Definition Section
PIP	Parameter Information Page
SWE	Snow Water Equivalent
VIC	Variable Infiltration Capacity