Land Data Toolkit (LDT)

LDT 7.3 Users' Guide

Version 1.13, 31 Mar 2021

Table of Contents

Revision	Summary of Changes	Date
1.13	LISF Public 7.3.1 release	Mar 31, 2021
1.10	LISF Public 7.3.0 release	Dec 21, 2020
1.9	LDT 557WW 7.3.0 release	Aug 24, 2020
1.8	LDT 557WW 7.3 release candidate 4	Aug 28, 2019
1.7	LDT 7.2 AFWA Release patch 1	Feb 9, 2018
1.6	LDT 7.2 AFWA Release	Feb 2, 2018
1.5	LDT 7.2 AFWA Beta Release	Nov 24, 2017
1.4	LDT 7.2 Public Release	May 6, 2017
1.3	LDT 7.1 Public Release patch 3	November 7, 2016
1.2	LDT 7.1 Public Release patch 1	October 22, 2015
1.1	LDT 7.1 Public Release	April 27, 2015
1.0	LDT 7.1 Initial Release	April 9, 2015

Chapter 1. Introduction

This is the User's Guide for the Land surface Data Toolkit (LDT). This document describes how to download and install the LDT software and instructions on building an executable.

This document consists of 7 sections, described as follows:

1. **Introduction**: the section you are currently reading.
2. **Background**: general information about LDT.
3. **Preliminary Information**: general information, steps, instructions, and definitions used throughout the rest of this document.
4. **Obtaining the Source Code**: the steps needed to download the source code.
5. **Building the Executable**: the steps needed to build the LDT executable.
6. **Running the Executable**: the steps needed to prepare and submit a run.
7. **LDT Config File**: describes the various run-time configurations.

1.1. What's New

1.1.1. Version 7.3

1. Includes new runmodes
   - USAF snow and ice analysis (USAFSI) runmode
   - optimization and uncertainty estimation procecssing runmode
   - LIS Hydro preprocessing runmode
   - climatological restart processing runmode
2. Supports additional data assimilation observations
   - GLASS LAI observations
   - GRACE QL tws observations
   - Land Parameter Retrieval Model (LPRM) vegetation optical depth observations
   - NASA SMAP vegetation optical depth observations
3. Supports additional parameters
   - CLM45 parameters
   - glacier parameters
   - JULES 5.0 parameters
   - MERIT1K aspect, slope, and elevation parameters
   - HYMAP flow type, baseflow dwi ratio, and runoff dwi ratio parameters
   - Barlage native max snow albebdo parameter
   - MODIS native PFT landcover data

- UKMO IGBP PFT landcover data
- UM ancillary landcover data
- NLDAS climatological precipitation data
- UKMO IGBP native PFT landmask data
- UKMO CAP landmask data
- ISRIC texture and soil fraction parameter data

4. Supports GCOMW AMSR2 TB data in artificial neural network processing running mode
5. Supports ERA5 metforcing data in Metforcing processing running mode

1.1.2. Version 7.2

1. Includes artificial neural network processing runmode
2. Supports NESDIS SMOPS datasets versions 1.3, 2.0, and 3.0
3. Supports JULES parameters
4. Supports ISRIC soil texture data

1.1.3. Version 7.1

1. Includes MetTimeDScale runmode
2. Includes Metforcproc runmode
3. Supports crop parameters
4. Supports CLM2 parameters
5. Supports Flake parameters
6. Supports Mosaic parameters
7. Supports Noah parameters
8. Supports SiB2 parameters
9. Supports VIC parameters
10. Supports TRMM 3B42 V7 real time precipitation
11. Supports Aquarius L2 soil moisture observations
12. Supports GCOMW AMSR2 L3 soil moisture observations
13. Supports SMOS L2 soil moisture observations
14. Supports simulated GRACE products

1.1.4. Version 7.0

1. This is the initial version developed for processing data inputs to LIS version 7.0 or higher.

Chapter 2. Background

A key step in preparing for land surface model (LSM) and hydrologic model simulations is ensuring that all parameters and data inputs belong to the same grid, projection, units, etc. The Land surface Data Toolkit (LDT) is an integrated framework designed specifically for processing data inputs for such land surface and hydrological models. The system not only acts as a pre-processor to the NASA Land Information System (LIS), which is an integrated framework designed for multi-model LSM simulations and data assimilation (DA) integrations, but as a land surface-based observation and DA input processor. LDT is also capable of deriving restart inputs and ensuring data quality control for inputs to LSMs and DA routines.

2.1. LDT

LDT provides an environment for processing LSM data and parameters, restart files and data assimilation based inputs (e.g., for bias correction methods). LDT offers and will offer a variety of user options and inputs to processing datasets for use within LIS and even stand-alone models. LDT is being designed with not only LIS in mind but for other independent models and data processing systems as well. This intended design is facilitated by the use of common data formats, like NetCDF, which provide detailed data header information.

LDT shares similar object oriented framework designs as LIS, with a number of points of flexibility known as “plugins”. Specific implementations are added to the framework through the plugin-interfaces. LDT uses the plugin-based architecture to support the processing of different types of observational data sets, ranging from in-situ, satellite and remotely sensed and reanalysis products.

2.2. Summary of key features

The key capabilities of LDT can be summarized as follows:

- Processing and grouping parameters needed for different LSMs and hydrologic models
- Producing observation-based data assimilation inputs (e.g., CDF matching)
- Generate custom-made restart files for LSMs
- Read in a variety of model inputs, for example:
    - Land cover maps — UMD AVHRR, MODIS-IGBP, USGS, etc.
    - Soil parameters — soil fractions, texture, color, etc.
    - Topographic — elevation, slope, aspect, etc.
    - Dynamic parameters — greenness fraction, LAI/SAI, albedo, etc.
- Expanding LSM parameter tiling options to include topographic, soils, and other parameter information, beyond just land cover type tiling
- Options for reading in or deriving a land/water mask during processing

Chapter 3. Preliminary Information

This section provides some preliminary information to make reading this guide easier.

Commands are written with a fixed-width font. E.g.:

```
% cd /path/to/LDT
```

```
% ls
```

"… compiler flags, then run `gmake`."

NOTE The `%` symbol represents the command-line prompt. You do **not** type that when entering any of the commands.

File names are written in italics. E.g.:

/path/to/LDT/src

Chapter 4. Obtaining the Source Code

This section describes how to obtain the source code needed to build the LDT executable.

Beginning with Land Information System Framework (LISF) public release 7.3, the LDT source code is available as open source under the Apache License, version 2.0. Please see Apache's web-site for a copy of the license.

From LDT public release 7.1rp1 through 7.2, the LDT source code is available as open source under the NASA Open Source Agreement (NOSA). Please see LISF's web-site for a copy of the NOSA.

Due to the history of LDT's development, versions of the LDT source code prior to 7.1rp1 may not be freely distributed. Older source code is available only to U.S. government agencies or entities with a U.S. government grant/contract. LISF's web-site explains how qualified persons may request a copy of older source code.

NOTE	All users are encouraged to go to LISF's web-site to fill in the Registration Form and join the mailing list.

4.1. Important Note Regarding File Systems

LDT is developed on Linux/Unix platforms. Its build process expects a case sensitive file system. Please make sure that you unpack and/or `git clone` the LDT code into a directory within a case sensitive file system. In particular, if you are using LDT within a Linux-based virtual machine hosted on a Windows or Macintosh system, do not compile/run LDT from within a shared folder. Move the LDT source code into a directory within the virtual machine.

4.2. Public Release Source Code

The LDT public release 7.3 source code is available both on LISF's web-site under the "Source" menu and on GitHub under the NASA-LIS organization at https://github.com/NASA-LIS/LISF under the "Releases" link.

After downloading the LISF tar-file:

Step 1

Create a directory to unpack the tar-file into. Let's call it *TOPLEVELDIR*.

Step 2

Place the tar-file in this directory.

```
% mv LISF_public_release_7.3.1.tar.gz TOPLEVELDIR
```

Step 3

Go into this directory.

```
% cd TOPLEVELDIR
```

Step 4

Unzip and untar the tar-file.

```
% gzip -dc LISF_public_release_7.3.1.tar.gz | tar xf -
```

4.3. master branch

The LDT source code is maintained in a git repository hosted on GitHub. If you wish to work with the latest development code (in the master branch), then you must use the `git` client to obtain the LDT source code. If you need any help regarding `git` or GitHub, please go to https://github.com.

Step 1

Create a directory to clone the code into. Let's call it *TOPLEVELDIR*.

Step 2

Go into this directory.

```
% cd TOPLEVELDIR
```

Step 3

Clone the master branch.

```
% git clone https://github.com/NASA-LIS/LISF
```

4.4. Source files

Unpacking or cloning the LISF source code (according to the instructions in Section Obtaining the Source Code) will create a directory named *LISF*. The LDT specific source code is in *LISF/ldt*.

NOTE	The directory containing the LDT source code, *LISF/ldt*, will be referred to as *$WORKING* throughout the rest of this document.

4.5. Documentation

Processed documentation may be found on LISF’s web-site under the “Docs” menu.

Chapter 5. Building the Executable

This section describes how to build the source code and create LDT's executable: named LDT.

Please see Section Important Note Regarding File Systems for information regarding using a case sensitve file system for compiling/running LDT.

5.1. Development Tools

This code has been compiled and run on Linux PC (Intel/AMD based) systems and Cray systems. These instructions expect that you are using such a system. In particular you need:

5.1.1. Linux

Compilers

- Intel Fortran Compiler versions 18, 19, or 20 with corresponding Intel C Compiler along with GNU's Compiler Collection version 9.2.0
- or GNU's Compiler Collection version 4.9.2 or 7.3, both gfortran and gcc.

Tools

- GNU's make, gmake, version 3.77 or 3.81
- Perl, version 5.10
- Python, version 2.7 or 3.8

IMPORTANT	Support for Python 2.7 is now deprecated. Future releases will depend on Python 3.

5.1.2. Cray/Linux

Compilers

- Intel Fortran Compiler version 18 or 19 with corresponding Intel C Compiler, along with GNU's Compiler Collection version 7.3.0

Tools

- GNU's make, gmake, version 3.77 or 3.81
- Perl, version 5.10
- Python, version 2.7 or 3.8

IMPORTANT	Support for Python 2.7 is now deprecated. Future releases will depend on Python 3.

5.2. Required Software Libraries

In order to build the LDT executable, the following libraries must be installed on your system:

5.2.1. Earth System Modeling Framework (ESMF) version 7.1.0r (or higher)

(https://earthsystemmodeling.org/)

5.2.2. OpenJPEG version 2.3.0 (or higher)

(http://www.openjpeg.org/)

5.2.3. ecCodes version 2.7.0 (or higher)

(https://confluence.ecmwf.int/display/ECC)

5.2.4. NetCDF either version 3.6.3 or version 4.5.0 (or higher)

(http://www.unidata.ucar.edu/software/netcdf)

Please read the on-line documentation for details on installing NetCDF.

Additional notes for NetCDF 4:

You must also choose whether to compile with compression enabled. Compiling with compression enabled requires HDF 5 and zlib libraries. To enable compression, add `--enable-netcdf-4` to the `configure` options. To disable compression, add `--disable-netcdf-4` to the `configure` options.

An example of installing NetCDF 4 without compression:

```
% ./configure --prefix=$HOME/local/netcdf-4.5.0 --disable-netcdf-4
% gmake
% gmake install
```

An example of installing NetCDF 4 with compression:

```
% CPPFLAGS=-I$HOME/local/hdf5/1.10.1/include \
> LDFLAGS=-L$HOME/local/hdf5/1.10.1/lib \
> ./configure --prefix=$HOME/local/netcdf/4.5.0 --enable-netcdf-4
% gmake
% gmake install
```

You must also download the *netcdf-fortran-4.4.4.tar.gz* file. First install the NetCDF C library, then install the NetCDF Fortran library. Again, please read the on-line documentation for more details.

An example of installing the NetCDF 4 Fortran library:

```
% LD_LIBRARY_PATH=$HOME/local/netcdf/4.5.0/lib:$LD_LIBRARY_PATH \
> CPPFLAGS=-I$HOME/local/netcdf/4.5.0/include \
> LDFLAGS=-L$HOME/local/netcdf/4.5.0/lib \
> ./configure --prefix=$HOME/local/netcdf/4.5.0
% gmake
% gmake install
```

5.3. Optional Software Libraries

The following libraries are not required to compile LDT. They are used to extend the functionality of LDT.

5.3.1. HDF

You may choose either HDF version 4, HDF version 5, or both.

HDF is used to support a number of remote sensing datasets.

If you wish to use MODIS snow cover area observations or NASA AMSR-E soil moisture observations, then you need HDF 4 support.

If you wish to use ANSA snow cover fraction observations, then you need HDF 5 support.

If you wish to use PMW snow observations, then you need both HDF 4 and HDF 5 support.

HDF 4

If you choose to have HDF version 4 support, please download the HDF source for version 4.2.13 (or higher) from https://portal.hdfgroup.org/display/support/Download+HDF4 and compile the source to generate the HDF library. Make sure that you configure the build process to include the Fortran interfaces by adding the `--enable-fortran` option to the `configure` command.

Note that HDF4 contains its own embedded version of NetCDF. You must disable this support by adding the `--disable-netcdf` option to the `configure` command.

IMPORTANT	When compiling LDT with HDF 4 support, you must also download and compile HDF-EOS2 version 2.19v1.00 or higher from http://hdfeos.org/software/library.php.

HDF 5

If you choose to have HDF version 5 support, please download the HDF source for version 1.10.1 (or higher) from http://www.hdfgroup.org/HDF5/ and compile the source to generate the HDF library. Make sure that you configure the build process to include the Fortran interfaces by adding the `--enable-fortran` option to the `configure` command.

5.3.2. GDAL version 2.4.1 (or higher)

(https://gdal.org)

IMPORTANT	When compiling LDT with GDAL support, you must also download and compile FortranGIS version 2.4 (or higher) from http://fortrangis.sourceforge.net.

5.3.3. GeoTIFF version 1.4.3 (or higher)

(https://github.com/OSGeo/libgeotiff)

5.3.4. Notes

To install these libraries, follow the instructions provided at the various URL listed above. These optional libraries have their own dependencies, which should be documented in their respective documentation.

Please note that your system may have several different compilers installed. You must verify that you are building these libraries with the correct compiler. You should review the output from the `configure`, `make`, etc. commands. If the wrong compiler is being used, you may have to correct your `$PATH` environment variable, or set the `$CC` and `$FC` environment variables, or pass additional settings to the `configure` scripts. Please consult the installation instructions provided at the various URL listed above for each library.

Note that due to the mix of programing languages (Fortran and C) used by LDT, you may run into linking errors when building the LDT executable. This is often due to (1) the Fortran compiler and the C compiler using different cases (upper case vs. lower case) for external names, and (2) the Fortran compiler and C compiler using a different number of underscores for external names.

5.4. Build Instructions

Step 1

Perform the steps described in Section Obtaining the Source Code to obtain the source code.

Step 2

Goto the *$WORKING* directory. This directory contains two scripts for building the LDT executable: *configure* and *compile*.

Step 3

Set the LDT_ARCH environment variable based on the system you are using. The following commands are written using Bash shell syntax.

For a Linux system with the Intel Fortran compiler

```
% export LDT_ARCH=linux_ifc
```

For a Linux system with the GNU Fortran compiler

```
% export LDT_ARCH=linux_gfortran
```

It is suggested that you place this command in your *.profile* (or equivalent) startup file.

Step 4

Run the *configure* script first by typing:

```
% ./configure
```

This script will prompt the user with a series of questions regarding support to compile into LDT, requiring the user to specify the locations of the required and optional libraries via several LDT specific environment variables. The following environment variables are used by LDT.

Variable	Description	Usage
`LDT_FC`	Fortran 90 compiler	required
`LDT_CC`	C compiler	required
`LDT_MODESMF`	path to ESMF module files	required
`LDT_LIBESMF`	path to ESMF library files	required
`LDT_OPENJPEG`	path to openJPEG library	required
`LDT_ECCODES`	path to ecCodes library	required
`LDT_NETCDF`	path to NetCDF library	required
`LDT_HDF4`	path to HDF4 library	optional
`LDT_HDF5`	path to HDF5 library	optional
`LDT_HDFEOS`	path to HDFEOS2 library	optional
`LDT_GDAL`	path to GDAL library	optional
`LDT_FORTRANGIS`	path to FortranGIS library	optional (required by GDAL)
`LDT_LIBGEOTIFF`	path to GeoTIFF library	optional

Note that the `CC` variable must be set to a C compiler, not a C++ compiler. A C++ compiler may mangle internal names in a manner that is not consistent with the Fortran compiler. This will cause errors during linking.

It is suggested that you add these definitions to your *.profile* (or equivalent) startup file.

You may encounter errors either when trying to compile LDT or when trying to run LDT because the compiler or operating system cannot find these libraries. To fix this, you must add these libraries to your `$LD_LIBRARY_PATH` environment variable. For example, say that you are using ESMF, ecCodes, NetCDF, and HDF5. Then you must execute the following command (written using Bash shell syntax):

```
% export
LD_LIBRARY_PATH=$LDT_HDF5/lib:$LDT_LIBESMF:$LDT_NETCDF/lib:$LDT_ECCODES/lib:$LD_LIBRAR
Y_PATH
```

It is also suggested that you add this command to your *.profile* (or equivalent) startup file.

Example

An example execution of the configure script is shown below:

```
% ./configure
------------------------------------------------------------------------
Setting up configuration for LDT
Parallelism (0-serial, 1-dmpar, default=0):
Optimization level (-3=strict checks with warnings, -2=strict checks, -1=debug,
0,1,2,3, default=2):
Assume little/big_endian data format (1-little, 2-big, default=2):
Use GRIBAPI/ECCODES? (0-neither, 1-gribapi, 2-eccodes, default=2):
NETCDF version (3 or 4, default=4)?:
NETCDF use shuffle filter? (1-yes, 0-no, default = 1):
NETCDF use deflate filter? (1-yes, 0-no, default = 1):
NETCDF use deflate level? (1 to 9-yes, 0-no, default = 9):
Use HDF4? (1-yes, 0-no, default=1):
Use HDF5? (1-yes, 0-no, default=1):
Use HDFEOS? (1-yes, 0-no, default=1):
Enable GeoTIFF support? (1-yes, 0-no, default=1):
Enable LIBGEOTIFF support? (1-yes, 0-no, default=1):
Include date/time stamp history? (1-yes, 0-no, default=1):
-----------------------------------------------------
 configure.ldt file generated successfully
-----------------------------------------------------
Settings are written to configure.ldt in the make directory.
If you wish to change settings, please edit that file.

To compile, run the compile script.
------------------------------------------------------------------------
```

At each prompt, select the desired value. If you desire the default value, then you may simply press the Enter key.

Most of the configure options are be self-explanatory. Here are a few specific notes:

- for `Parallelism (0-serial, 1-dmpar, default=1):`, dmpar refers to enabling MPI

- for `Assume little/big_endian data format (1-little, 2-big, default=2):`, select the default value of 2. By default, LDT reads and writes binary data in the big endian format. Only select the value of 1, if you have reformatted all required binary data into the little endian format.
- for `Use GRIBAPI/ECCODES? (0-neither, 1-gribapi, 2-eccodes, default=2):`, select the default value of 2. Technically, GRIB support is not required by LDT; however, most of the commonly used met forcing data are in GRIB, making GRIB support a practical requirement. ecCodes is ECMWF's replacement to their GRIB-API library. GRIB-API is supported only for historical reasons; thus, please use ecCodes.

IMPORTANT	GRIB-API support is now deprecated. Future releases will support only ecCodes.

- for `Enable GeoTIFF support? (1-yes, 0-no, default=1):`, GeoTIFF means the GeoTIFF support provided by the GDAL library.
- for `Enable LIBGEOTIFF support? (1-yes, 0-no, default=1):`, LIBGEOTIFF means GeoTIFF support provided by the GeoTIFF library.

Note that due to an issue involving multiple definitions within the NetCDF 3 and HDF 4 libraries, you cannot compile LDT with support for both NetCDF 3 and HDF 4 together.

Note that if you compiled NetCDF 4 without compression, then when specifying `NETCDF version (3 or 4, default=4):`, select 3. Then you must manually append `-lnetcdff` to the `LDFLAGS` variable in the *make/configure.ldt* file.

Step 5

Compile the LDT source code by running the *compile* script.

```
% ./compile
```

This script will compile the libraries provided with LDT, the dependency generator and then the LDT source code. The executable *LDT* will be placed in the *$WORKING* directory upon successful completion of the *compile* script.

Step 6

Finally, copy the *LDT* executable into your running directory, *$RUNNING*. (See Section Running the Executable.)

Chapter 6. Running the Executable

This section describes how to run the LDT executable.

First you should create a directory to run LDT in. It is suggested that you run LDT in a directory that is separate from your source code. This running directory shall be referred to as *$RUNNING*. Next, copy the LDT executable into your running directory.

```
% cp $WORKING/LDT $RUNNING
```

The single-process version of `LDT` is executed by the following command issued in the *$RUNNING* directory.

```
% ./LDT <configfile>
```

where `<configfile>` represents the file containing the run time configuration options for LDT. Currently LDT only supports a serial mode.

Some systems require that you submit your job into a batch queue. Please consult with your system adminstrator for instructions on how to do this.

Note that before running LDT, you must set your environment to have an unlimited stack size. For the Bash shell, run

```
% ulimit -s unlimited
```

To customize your run, you must modify the *ldt.config* configuration file. See Section LDT Config File for more information.

Chapter 7. LDT Config File

This section describes the options in the *ldt.config* file.

Not all options described here are available in the public version of LDT.

7.1. Overall driver options

`LDT running mode:` specifies the running mode used in LDT. Acceptable values are:

Value	Description
“LSM parameter processing”	LSM Parameter Processing Option
“DA preprocessing”	Data Assimilation Preprocessing Option
“Ensemble restart processing”	Deriving an ensemble restart file Option
“Climatological restart processing”	LSM Restart File Preprocessing Option
“Restart transformation processing”	LSM restart file transformation Option
“NUWRF preprocessing for real”	NUWRF Preprocessing Option
“ANN processing”	Artificial Neural Networks Processing Option
“Metforce processing”	Meteorological Forcing Processing Option (similar to LIS)
“Metforce temporal downscaling”	Meteorological Forcing Temporal Downscaling
“Statistical downscaling of met forcing”	Statistical options to downscale or generate forcing climatologies
“OPTUE parameter processing”	Process the OPT/UE output to generate optimized parameters
“USAFSI analysis”	USAF Snow and Ice analysis
“LISHydro preprocessing for WRFHydro”	Preprocessing Option for WRFHydro

Example ldt.config entry

```
LDT running mode:             "LSM parameter processing"
```

`Processed LSM parameter filename:` specifies the output filename (with netcdf extension) of the LSM parameters processed in LDT to go into LIS. See a sample *lis_input.d01.nc* (Appendix Description of output files from LDT) file for a complete specification description.

Example ldt.config entry

```
Processed LSM parameter filename:    ./lis_input.d01.nc
```

`LIS number of nests:` specifies the number of nests used for the run. Values 1 or higher are acceptable. The maximum number of nests is limited by the amount of available memory on the system. The specifications for different nests are done using white spaces as the delimiter. Please see below for further explanations. Note that all nested domains should run on the same projection and same land surface model.

Example ldt.config entry

```
LIS number of nests:           1
```

`Number of surface model types:` specifies the number of surface model types selected for the LIS simulation. Acceptable values are 1 or higher.

Example ldt.config entry

```
Number of surface model types:   1
```

`Surface model types:` specifies the names of the surface model types. Options include (but to be expanded later):

Value	Description
LSM	Land surface model type
Lake	Lake model type
Openwater	Openwater surface type

Example ldt.config entry

```
Surface model types:  "LSM"
```

`Land surface model:` specifies the land surface model to be run. Need to select the model you want to run in LIS, so the appropriate model parameters are included in the output netcdf file for LIS. Acceptable values are:

Value	Description
none	Template LSM
Noah.2.7.1	Noah 2.7.1
Noah.3.2	Noah 3.2
Noah.3.3	Noah 3.3
Noah.3.6	Noah 3.6
Noah.3.9	Noah 3.9
Noah-MP.3.6	Noah-MP 3.6
Noah-MP.4.0.1	Noah-MP 4.0.1
CLM.2	CLM version 2.0
CLM.4.5	CLM version 4.5

Value	Description
VIC.4.1.1	VIC 4.1.1
VIC.4.1.2	VIC 4.1.2
Mosaic	Mosaic
HySSIB	HySSIB
CLSMF2.5	Catchment, Fortuna 2.5
SAC.3.5.6	Sacramento
SNOW17	Snow17
RDHM.3.5.6	Sacramento+snow17
GeoWRSI.2	GeoWRSI, v2.0
SiB2	SiB v2
FASST	FASST
CABLE	CABLE
HTESSEL	HTESSEL
JULES.5.0	JULES.5.0

Example ldt.config entry

```
Land surface model:       Noah.3.3
```

`Lake model:` specifies the lake model type used in a LIS run. Currently, only the FLake lake model is incorporated in LIS, and both LDT and LIS are set up for additional support of lake model installation and development. For now, the option “none” is recommended.

Example ldt.config entry

```
Lake model:               none
```

`Routing model:` specifies the river routing model used in a LIS run. Both HYMAP and HYMAP2 routing scheme parameters are supported in LDT.

Example ldt.config entry

```
Routing model:             HYMAP
```

`Water fraction cutoff value:` specifies what gridcell fraction is to be represented by water (e.g., 0.6 would be 60% covered by water pixels). This value acts as a threshold in determining which gridcell will be included as a water or land point (used also in deriving the land/water mask).

Example ldt.config entry

```
Water fraction cutoff value:     0.5
```

`Number of met forcing sources:` specifies the number of met forcing datasets to be used. Acceptable values are 0 or higher.

Example ldt.config entry

```
Number of met forcing sources:  1
```

`Met forcing sources:` specifies the meteorological forcing data sources used for a LIS run.

For more information about LIS's meteorological forcing data reader options, please see the "Land Information System (LIS) Users' Guide" for more information. Acceptable values for the sources are:

Value	Description
"NONE"	none
"AGRMET"	AGRMET (AFWA-0.25 deg)
"AGRMET radiation (polar stereographic)"	AGRMET radiation fields
"CMAP"	CMAP precipitation fields
"CPC CMORPH"	CMORPH precipitation fields
"ECMWF"	ECMWF near-realtime analysis
"ECMWF reanalysis"	ECMWF reanalysis(II), based on Berg et al.(2003)
"GDAS"	GDAS near-realtime analysis
"GDAS(3d)"	GDAS full-atmosphere fields
"GEOS"	NASA-GEOS (v3-5) forcing analysis
"GEOS5 forecast"	GEOS v5 forecast fields
"GFS"	NCEP-GFS forecast fields
"GLDAS"	Coarse-scale GLDAS-1 forcing
"GSWP1"	GSWP1 forcing
"GSWP2"	GSWP2 forcing
"MERRALand"	NASA's MERRA-Land reanalysis
"MERRA2"	NASA's GMAO MERRA2 reanalysis
"NAM242"	NCEP-NAM 242 resolution (Alaska)
"NARR"	North American Regional Reanalysis
"NLDAS1"	NLDAS1 analysis fields
"NLDAS2"	NLDAS2 analysis fields

Value	Description
“PRINCETON”	Global Princeton long-term forcing records
“RFE2(daily)”	CPC Daily Rainfall estimator fields
“RFE2(gdas)”	CPC RFE2 rainfall adjusted with GDAS/CMAP precipitation
“CHIRPS2”	UCSB CHIRPS v2.0 precipitation dataset
“CPC STAGEII”	CPC Stage II radar-based rainfall
“CPC STAGEIV”	CPC Stage IV radar-based rainfall
“TRMM 3B42RTV7”	TRMM-based 3B42 real-time rainfall
“TRMM 3B42V6”	TRMM-based 3B42 V6 rainfall
“TRMM 3B42V7”	TRMM-based 3B42 V7 rainfall
“ERA5”	ERA5 reanalysis

Example ldt.config entry

```
Met forcing sources:       "NLDAS2"
```

`Blending method for forcings:` specifies the blending method to combine forcings if more than one forcing dataset is used. User-entry activated only when the “Metforce processing” run mode is selected. Acceptable values are:

Value	Description
overlay	Datasets are overlaid on top of each other in the order they are specified. For example, the forcing dataset in the second column is overlaid on top of the forcing dataset in the first column. In other words, the forcing data specified in the second column will be used in place of forcing data that is specified in the first column, for locations within the spatial extent of the second column’s forcing data. As an example, a user could specify a forcing dataset with a global extent in the first column and a forcing dataset with a regional extent in the second column. All locations within the regional extent of the second column’s forcing data will use that data as forcing, while locations outside of this regional extent will use data from the global extent of the first column’s forcing data. This continues for the number of met forcing sources specified, with the right-most column having the higher priority to be used as forcing, given its spatial extent.

Value	Description
ensemble	Each forcing dataset is assigned to a separate ensemble member (option not available yet in LDT).

Example ldt.config entry

```
Blending method for forcings: overlay
```

`Met spatial transform methods:` specifies the type of spatial transform or interpolation scheme to apply to the forcing dataset(s) selected. Acceptable values are:

Value	Description
“average”	Upscale via averaging
“neighbor”	Nearest neighbor scheme
“bilinear”	Bilinear interpolation scheme
“budget-bilinear”	Conservative interpolation scheme (“conserves” quantities)

Bilinear interpolation uses 4 neighboring points to compute the interpolation weights. The conservative approach uses 25 neighboring points. This option is designed to conserve water, like for precipitation. Also, nearest neighbor can be used, which may better preserve large pixels (e.g., 1x1 deg), if needed. “Average” can also be selected if upscaling from finer-scale meteorological fields (e.g., going from 4 km to 0.25 deg).

Example ldt.config entry

```
Met spatial transform methods:     bilinear
```

`Topographic correction method (met forcing):` specifies whether to use elevation correction on select forcing fields. Acceptable values are:

Value	Description
“none”	Do not apply topographic correction for forcing
“lapse-rate”	Use lapse rate correction for forcing

Current meteorological forcing datasets supported for applying this lapse-rate adjustment to the temperature, humidity, pressure and downward longwave fields, include: NLDAS1, NLDAS2, NAM242, GDAS, PRINCETON, and ECMWF. Future forcing dataset options will include: GEOS, GLDAS, GFS, ECMWF_reanalysis, and possible others.

ECMWF and GDAS forcing types include several terrain height maps and not just one overall, either due to change in versions or gridcell size, respective.

Example ldt.config entry

```
Topographic correction method (met forcing):  "lapse-rate"
```

`Temporal interpolation method (met forcing):` specifies the type of temporal interpolation scheme to apply to the met forcing data. Acceptable values are:

Value	Description
linear	linear scheme
trilinear	uber next scheme

The linear temporal interpolation method computes the temporal weights based on two points. Ubernext computes weights based on three points. Currently the ubernext option is implemented only for the GSWP forcing.

Example ldt.config entry

```
Temporal interpolation method (met forcing): linear
```

`Enable new zterp correction (met forcing):` specifies whether to enable the new zterp correction. Acceptable values are:

Value	Description
.false.	do not enable
.true.	enable

Defaults to `.false.`.

This is a scalar option, not per nest.

This new zterp correction addresses an issue that occurs at sunrise/sunset for some forcing data-sets when running at small time-steps (like 15mn). In these cases, swdown has a large unrealistic spike. This correction removes the spike. It also can affect swdown around sunrise/sunset by up 200 W/m2. Users are advised to run their own tests and review swdown to determine which setting is best for them.

For comparision against older LIS runs, set this option to `.false.`.

Example ldt.config entry

```
Enable new zterp correction (met forcing): .false.
```

`Temporal downscaling method:` specifies the temporal downscaling method to disaggregate a coarser forcing dataset into finer timesteps (e.g., go from daily to hourly).

User-entry activated only when the "Metforce temporal downscaling" run mode is selected. Acceptable values are:

Value	Description
“Simple weighting”	Use finer timescale forcing dataset to estimate weights and downscale coarser forcing dataset. The finer timescale forcing dataset should defined first in the *ldt.config* file.

Example ldt.config entry

```
Temporal downscaling method:    "Simple weighting"
```

`Processed metforcing output interval:` specifies the output interval for the processed meteorological forcing files. Entries are character-based names, like 6hr or 1da.

Example ldt.config entry

```
Processed metforcing output interval:   "6hr"
```

`Metforcing processing interval:` specifies the processing temporal interval for which meteorological forcing files are commonly and temporally aggregated (or downscaled) to when temporally downscaling a dataset.

Example ldt.config entry

```
Metforcing processing interval:     "1da"
```

`Statistical downscaling mode:` specifies the type of statistical downscaling method to be applied.

User-entry activated only when the “Statistical downscaling of met forcing” run mode is selected. Acceptable values are:

Value	Description
“downscale”	The downscale option is for bringing a coarser climate model or reanalysis dataset to a finer scale using statistical techniques (beyond interpolation).

Example ldt.config entry

```
Statistical downscaling mode:       "downscale"
```

`Statistical downscaling method:` specifies the method for downscaling or for climatology forcing generation. Current acceptable values are:

Value	Description
“Climatology”	This option supports the generation of meteorological climatology files, for different forcing data.
“Bayesian merging”	specifies what?

Example ldt.config entry

```
Statistical downscaling method:     "Climatology"
```

`Forcing climatology temporal frequency of data:` specifies the output time interval to which the forcing climatology will be calculated on and written to.

Example ldt.config entry

```
Forcing climatology temporal frequency of data:   "6hr"
```

`Bayesian merging seasonal stratification type:` specifies what?

Example ldt.config entry

```
Bayesian merging seasonal stratification type:
```

`Forcing variables list file:` specifies the file containing the list of forcing variables to be used. (Please refer to Section “Specification of Input Forcing Variables” in the *LIS Users' Guide* for a complete specification description of this file.)

Example ldt.config entry

```
Forcing variables list file:     ./input/forcing_variables.txt
```

`LDT diagnostic file:` specifies the name of run time LDT diagnostic file.

Example ldt.config entry

```
LDT diagnostic file:           ldtlog
```

`Mask-parameter fill diagnostic file:` specifies the name of the output diagnostic file for wherever mask-parameter points have forced agreement for a given landmask and parameter.

Example ldt.config entry

```
Mask-parameter fill diagnostic file:  LDTOUTPUT_temp/MPFilltest.log
```

`LDT output directory:` specifies the directory name for outputs from LDT. Acceptable values are any 40 character string. The default value is set to OUTPUT.

Example ldt.config entry

```
LDT output directory:       OUTPUT
```

`Undefined value:` specifies the undefined value. The default is set to -9999.

Example ldt.config entry

```
Undefined value:             -9999.0
```

`Add buffer to parameter grid domain:` adds a set buffer around a parameter file target domain. Acceptable values are:

Value	Description
"0"	No buffer added
"1"	Buffer included

The default value is 0.

Example ldt.config entry

```
Add buffer to parameter grid domain:     0
```

`Buffer count in x-direction:` adds a set number of pixels that buffer around a parameter file target domain, both in the x- and y-directions. Acceptable values are:

Value	Description
"0"	No buffer added
"1" (or greater)	Buffer points included

The default value is 5, and only activated if buffer option is selected.

Example ldt.config entry

```
Buffer count in x-direction:   10
Buffer count in y-direction:   10
```

`Number of ensembles per tile:` specifies the number of ensembles of tiles to be used. The value should be greater than or equal to 1.

Example ldt.config entry

```
Number of ensembles per tile:      1
```

The following options are used for subgrid tiling based on vegetation or other parameter types (e.g., soil type, elevation, etc.), and are required for generating an ensemble restart file or downscaling to a single-member restart file from an ensemble one. See the section on ensemble restart files for more information.

`Maximum number of surface type tiles per grid:` defines the maximum surface type tiles per grid (this can be as many as the total number of vegetation types). Note: Allowable values are greater than or equal to 1. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Maximum number of surface type tiles per grid: 1
```

`Minimum cutoff percentage (surface type tiles):` defines the smallest percentage of a cell for which to create a tile. The percentage value is expressed as a fraction. Allowable values are greater than or equal to 0. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Minimum cutoff percentage (surface type tiles): 0.05
```

`Maximum number of soil texture tiles per grid:` defines the maximum soil texture tiles per grid (this can be as many as the total number of soil texture types). Allowable values are greater than or equal to 1. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Maximum number of soil texture tiles per grid: 1
```

`Minimum cutoff percentage (soil texture tiles):` defines the smallest percentage of a cell for which to create a tile. The percentage value is expressed as a fraction. Allowable values are greater than or equal to 0. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Minimum cutoff percentage (soil texture tiles): 0.05
```

`Maximum number of soil fraction tiles per grid:` defines the maximum soil fraction tiles per grid (this can be as many as the total number of soil fraction types). Allowable values are greater than or equal to 1. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Maximum number of soil fraction tiles per grid: 1
```

`Minimum cutoff percentage (soil fraction tiles):` defines the smallest percentage of a cell for which to create a tile. The percentage value is expressed as a fraction. Allowable values are greater than or equal to 0. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Minimum cutoff percentage (soil fraction tiles): 0.05
```

`Maximum number of elevation bands per grid:` defines the maximum elevation bands per grid (this can be as many as the total number of elevation band types). Allowable values are greater than or equal to 1. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Maximum number of elevation bands per grid: 1
```

`Minimum cutoff percentage (elevation bands):` defines the smallest percentage of a cell for which to create a tile. The percentage value is expressed as a fraction. Allowable values are greater than or equal to 0. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Minimum cutoff percentage (elevation bands): 0.05
```

`Maximum number of slope bands per grid:` defines the maximum slope bands per grid (this can be as many as the total number of slope band types). Allowable values are greater than or equal to 1. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Maximum number of slope bands per grid: 1
```

`Minimum cutoff percentage (slope bands):` defines the smallest percentage of a cell for which to create a tile. The percentage value is expressed as a fraction. Allowable values are greater than or equal to 0. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Minimum cutoff percentage (slope bands): 0.05
```

`Maximum number of aspect bands per grid:` defines the maximum aspect bands per grid (this can be as many as the total number of aspect band types). Allowable values are greater than or equal to 1. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Maximum number of aspect bands per grid: 1
```

`Minimum cutoff percentage (aspect bands):` defines the smallest percentage of a cell for which to create a tile. The percentage value is expressed as a fraction. Allowable values are greater than or equal to 0. Note that the entry here should exactly match the entry used in the *lis.config* file.

Example ldt.config entry

```
Minimum cutoff percentage (aspect bands): 0.05
```

This section specifies the 2-d layout of the processors in a parallel processing environment.

This is a new feature within LDT.

The user can specify the number of processors along the east-west dimension and north-south dimension using `Number of processors along x:` and `Number of processors along y:`, respectively. Note that the layout of processors should match the total number of processors used. For example, if 8 processors are used, the layout can be specified as 1x8, 2x4, 4x2, or 8x1.

Example ldt.config entry

```
Number of processors along x:       2
Number of processors along y:       2
```

`Output methodology:` specifies whether to write output as a 1-D array containing only land points or as a 2-D array containing both land and water points. 1-d tile space includes the subgrid tiles and ensembles. 1-d grid space includes a vectorized, land-only grid-averaged set of values. Acceptable values are:

Value	Description
“none”	Do not write output
“1d tilespace”	Write output in a 1-D tile domain
“2d gridspace”	Write output in a 2-D grid domain
“1d gridspace”	Write output in a 1-D grid domain

The default value is “2d gridspace”.

Example ldt.config entry

```
Output methodology: "2d gridspace"
```

`Output data format:` specifies the format of the model output data. Acceptable values are:

Value	Description
“binary”	Write output in binary format
“grib1”	Write output in GRIB-1 format
“netcdf”	Write output in netCDF format

The default value is “netcdf”.

Example ldt.config entry

```
Output data format: netcdf
```

`Output naming style:` specifies the style of the model output names and their organization. Acceptable values are:

Value	Description
"2 level hierarchy"	2 levels of hierarchy
"3 level hierarchy"	3 levels of hierarchy
"4 level hierarchy"	4 levels of hierarchy
"WMO convention"	WMO convention for weather codes

The default value is "3 level hierarchy".

Example ldt.config entry

```
Output naming style: "3 level hierarchy"
```

7.2. Domain specification

This section of the config file specifies the LIS running domain (domain over which the simulation is carried out). The specification of the LIS Run domain section depends on the type of LIS domain and projection used. Section Overall driver options lists the projections that LIS supports.

`Map projection of the LIS domain:` specifies the output LIS domain grid to be used with LIS. Acceptable values are:

Value	Description
latlon	Lat/Lon projection with SW to NE data ordering
lambert	Lambert conformal projection with SW to NE data ordering
gaussian	Gaussian domain
polar	Polar stereographic projection with SW to NE data ordering
hrap	HRAP domain (based on polar stereographic projection)
mercator	Mercator projection with SW to NE data ordering
UTM	UTM domain

Example ldt.config entry

```
Map projection of the LIS domain:      latlon
```

7.2.1. Cylindrical lat/lon

This section describes how to specify a cylindrical latitude/longitude projection. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain lower left lat:          25.625
Run domain lower left lon:        -124.125
Run domain upper right lat:         52.875
Run domain upper right lon:        -67.875
Run domain resolution (dx):          0.25
Run domain resolution (dy):          0.25
```

7.2.2. Lambert conformal

This section describes how to specify a Lambert conformal projection. See Appendix Lambert Conformal Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain lower left lat:          32.875
Run domain lower left lon:        -104.875
Run domain true lat1:               36.875
Run domain true lat2:               36.875
Run domain standard lon:           -98.875
Run domain resolution:              25.0
Run domain x-dimension size:         40
Run domain y-dimension size:         30
```

7.2.3. Gaussian

This section describes how to specify a Gaussian projection. See Appendix Gaussian Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain first grid point lat:    -89.27665
Run domain first grid point lon:      0.0
Run domain last grid point lat:      89.27665
Run domain last grid point lon:     -0.9375
Run domain resolution dlon:          0.9375
Run domain number of lat circles:     95
```

7.2.4. Polar stereographic

This section describes how to specify a polar stereographic projection. See Appendix Polar Stereographic Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain lower left lat:          32.875
Run domain lower left lon:        -104.875
Run domain true lat:                36.875
Run domain standard lon:           -98.875
Run domain orientation:              0.0
Run domain resolution:              25.0
Run domain x-dimension size:         40
Run domain y-dimension size:         30
```

7.2.5. HRAP

This section describes how to specify a HRAP projection. See Appendix HRAP Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain lower left hrap y:         48
Run domain lower left hrap x:         17
Run domain hrap resolution:           1
Run domain x-dimension size:         1043
Run domain y-dimension size:         774
```

7.2.6. Mercator

This section describes how to specify a Mercator projection. See Appendix Mercator Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain lower left lat:         32.875
Run domain lower left lon:       -104.875
Run domain true lat1:              36.875
Run domain standard lon:          -98.875
Run domain resolution:             25.0
Run domain x-dimension size:        40
Run domain y-dimension size:        30
```

7.2.7. UTM

This section describes how to specify a UTM projection. See Appendix UTM Domain Example for more details about setting these values.

Example ldt.config entry

```
Run domain UTM zone:                 12
Run domain northing of SW corner:    3507393.0
Run domain easting of SW corner:     586018.0
Run domain x-dimension size:         660
Run domain y-dimension size:         333
Run domain resolution:               40
```

7.3. Parameters

`Landcover data source:` specifies the land cover dataset source to be read in. Current landcover source options include:

Value	Description
AVHRR	Univ. of Maryland 1992-93 AVHRR landcover map. Please see: https://doi.org/10.3334/ORNLDAAC/969
AVHRR_GFS	Similar to "AVHRR" option above but on a GFS grid.
MODIS_Native	Terra-MODIS sensor-based IGBP land classification map, modified by NCEP. For more info, please see: http://www.ral.ucar.edu/research/land/technology/noahmp_lsm.php
MODIS_LIS	Similar dataset as "MODIS_Native" above but processed by LISF-team.
USGS_Native	The 24-category USGS native landcover map. See: http://www.ral.ucar.edu/research/land/technology/noahmp_lsm.php
USGS_LIS	Similar dataset as "USGS_Native" but processed by LISF-team.
ALMIPII	AMMA/ALMIP Phase-2 landcover input option. For more info: http://www.cnrm.meteo.fr/amma-moana/amma_surf/almip2/input.html
CLSMF2.5	CLSM Fortuna 2.5 landcover dataset.
VIC412	Variable Infiltration Capacity model, v4.1.2, UMD land cover.
ISA	Impervious Surface Area (ISA) landcover dataset.
CLM45	CLM-4.5 landcover dataset.
CONSTANT	Ability to set a constant landcover type for a set classification.

Example ldt.config entry

```
Landcover data source:    "MODIS_Native"
```

`Landcover classification:` specifies the land cover classification type. Land cover or use classification types have been developed over the years by various organizations (e.g., USGS, IGBP) and research groups (e.g., satellite missions associated with groups, like UMD, BU, etc.). For more information on some of these different land classifications and their characteristics, please refer to: https://lpdaac.usgs.gov/documents/101/MCD12_User_Guide_V6.pdf and https://www.usgs.gov/media/files/global-land-cover-characteristics-data-base-readme-version2. Acceptable values are:

Value	Description
UMD	14 Landcover types
IGBP	16 Landcover types
USGS	24 Landcover types
IGBPNCEP	20 Landcover types
MOSAIC	7 Landcover types
ISA	13 Landcover types
CLM45	36 Landcover types
Bondville	Only for the Bondville metforcing benchmark testcase
CONSTANT	2 Landcover types (water, plus one constant type over all land)

Example ldt.config entry

```
Landcover classification:     "UMD"
```

`Landcover file:` specifies the location of the vegetation classification file.

`Landcover map projection:` specifies the projection of the landcover map data.

`Landcover spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the landcover map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell
neighbor	Use nearest neighbor to select closest value
tile	Read in tiled data or upscale by estimating gridcell fractions

Note: “tile” is a special case for landcover, which allows for reading in landcover data already in tiled form, or creating tiles from finer resolution landcover data.

Example ldt.config entry

```
Landcover file:                ../input/1KM/landcover_UMD.1gd4r
Landcover spatial transform:      tile
```

`Landcover fill option:` specifies the landcover classification data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

`Landcover fill value:` indicates which landcover value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing landcover point, a value of 5 could be assigned if no nearest neighbor values exists to fill).

`Landcover fill radius:` specifies the radius with which to search for nearby value(s) to help fill the missing value.

Example ldt.config entry

```
Landcover fill option:   neighbor    # none, neighbor
Landcover fill radius:     3.        # Number of pixels to search for neighbor
Landcover fill value:      5.        # Static value to fill where missing
```

This section also outlines the domain specifications of the landcover (and for now landmask) data. If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying landcover data. Note: The Landcover grid domain inputs below are really only required for the “_LIS” data source options and that do not include “_Native” in the data source entries. All native parameters do not require the below inputs for LDT. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Landcover map projection:        latlon
Landcover lower left lat:       -59.995
Landcover lower left lon:      -179.995
Landcover upper right lat:       89.995
Landcover upper right lon:      179.995
Landcover resolution (dx):         0.01
Landcover resolution (dy):         0.01
```

`Create or readin landmask:` offers the user the option to create or read in land/water mask file information. Options include the ability to impose the mask on landcover and also the other parameter fields.

Example ldt.config entry

```
Create or readin landmask:      "readin"
```

`Landmask data source:` specifies the land mask dataset source to be read in. If the user is interested in only using the selected landcover data source, then the user can select the same option for the landmask data source.

Other current landmask source options include:

Value	Description
MOD44W	The MODIS 44W land-water mask was developed and provided by: https://doi.org/10.5067/MODIS/MOD44W.006
HYMAP	The HYMAP basin area mask option.

Example ldt.config entry

```
Landmask data source:   "MODIS_Native"
```

`Landmask file:` specifies the location of land/water mask file. Note: If reading in the MOD44W land-water mask, make sure to enter "MOD44W" Landmask data source entry.

Example ldt.config entry

```
Landmask file:        ../input/1KM/landmask_UMD.1gd4r
```

`Landmask spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the landmask map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell
neighbor	Use nearest neighbor when downscaling (or upscaling, if needed)

Example ldt.config entry

```
Landmask spatial transform:    none
```

`Landmask map projection:` specifies the projection of the landmask map data.

Example ldt.config entry

```
Landmask map projection:      latlon
```

This section also outlines the domain specifications of the land water/mask data. The landmask map projection and extents are only needed if you specify "readin" for mask type and if the landmask data source is "MOD44W" or "_LIS".

If the map projection of parameter data is specified to be "latlon", the following extents and resolution configuration should be used for specifying landmask data. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Future landmask data sets will have the projection, grid extents and resolution on the data reader side and not needed to be specified in the *ldt.config* file, depending on the data source.

Example ldt.config entry

```
Landmask map projection:       latlon
Landmask lower left lat:      -59.995
Landmask lower left lon:     -179.995
Landmask upper right lat:      89.995
Landmask upper right lon:     179.995
Landmask resolution (dx):       0.01
Landmask resolution (dy):       0.01
```

`Lakecover data source:` specifies the data source for lake depth and/or fraction for lake models, like FLake.

Example ldt.config entry

```
Lakecover data source:       GLDBv1
```

`Lake depth map:` specifies the location of the lake depth file (in meters), which is also used to derive the lake gridcell fraction for lake models, like FLake.

Example ldt.config entry

```
Lake depth map:        ./flake_inputs/GlobalLakeDepth.dat
```

`Lake depth QC map:` is a file that specifies the location of the QC flag for the origin of the lake depth values, which is an optional field specified. This file can be used by lake models, like FLake, if needed.

Example ldt.config entry

```
Lake depth QC map:     ./flake_inputs/GlobalLakeStatus.dat
```

`Lake params spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the lake depth maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
tile	Upscale by selecting lake tiles for each gridcell (not fully implemented)

Example ldt.config entry

```
Lake params spatial transform:    average
```

`Lake wind fetch value:` is the user-specified input value for lake-based wind-fetch (in meters) in association with lake models like FLake. This value is constant (or global) for now until 2-D fields become available.

Example ldt.config entry

```
Lake wind fetch value:         10000.
```

`Lake bottom sediments depth value:` is the user-specified input value for the thermally active layer depth of bottom sediments (m) in association with lake models like FLake. This value is constant (or global) for now until 2-D fields become available.

Example ldt.config entry

```
Lake bottom sediments depth value:  10.
```

`Lake bottom sediments temperature value:` is the user-specified input value for the outer edge temperature (K) of the thermally active layer of the bottom sediments in association with lake models like FLake. This value is constant (or global) for now until 2-D fields become available.

Example ldt.config entry

```
Lake bottom sediments temperature value:   277.13
```

`Inland waterbody data source:` specifies the inland water body (e.g., lake types) dataset source to be read in. Current option is only:

Value	Description
GLWD	Global Lake and Wetland Database inland water type map

Example ldt.config entry

```
Inland waterbody data source:     GLWD
```

`Inland waterbody type map:` specifies the inland water body map file and path.

Example ldt.config entry

```
Inland waterbody type map:  ./inlandwater_parms/GLWD/rastert_glwd_31.flt
```

`Inland waterbody spatial transform:` specifies the inland waterbody spatial transform. Current options are:

Value	Description
none	No spatial transform selected
tile	Tile the inland waterbody types
mode	Locate the dominant inland waterbody types

Example ldt.config entry

```
Inland waterbody spatial transform:    tile
```

`Regional mask data source:` specifies a regional land mask dataset source to be read in. Should either match grid domain or be smaller to the LIS run domain.

Value	Description
file	Binary file type mask.
ESRI	Binary file type mask produced in ESRI-GIS software.
WRSI	A BIL-format (binary) mask file associated with WRSI model.

Example ldt.config entry

```
Regional mask data source:   "none"
```

`Regional mask file:` specifies the location of a regional mask file. This file can be either an index-based state, country, basin, catchment, etc. map used to mask further beyond the main water/land mask.

Example ldt.config entry

```
Regional mask file:    ../input/1KM/regional_statemask.1gd4r
```

`Regional mask map projection:` specifies the projection of the regional mask albedo map data.

Example ldt.config entry

```
Regional mask map projection:   latlon
```

`Clip landmask with regional mask:` A logical-based option that uses the regional mask to “clip” the original landmask that is read-in or created. `.true.` turns on the “clipping” option.

Example ldt.config entry

```
Clip landmask with regional mask:  .true.
```

`Regional mask spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to a regional mask map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
neighbor	Use nearest neighbor to select closest value
mode	Upscale by selecting dominant type for each gridcell

Example ldt.config entry

```
Regional mask spatial transform:   mode
```

This section also outlines the domain specifications of the regional-based land mask data. If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying regional mask data.

See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Regional mask lower left lat:       -59.995
Regional mask lower left lon:      -179.995
Regional mask upper right lat:       89.995
Regional mask upper right lon:      179.995
Regional mask resolution (dx):        0.01
Regional mask resolution (dy):        0.01
```

`Rootdepth data source:` specifies the source of the vegetation root depth dataset. Options include:

Value	Description
none	No data
ALMIPII	ALMIP II root depth field

Example ldt.config entry

```
Rootdepth data source:    none
```

`Root depth file:` specifies the path and name of the root depth file. Options include:

Value	Description
none	No data
ALMIPII	ALMIP II root depth field

Example ldt.config entry

```
Root depth file:      none
```

7.4. Crop-Irrigation Parameters

`Incorporate crop information:` specifies the logical flag with which to turn on the inclusion of crop information and also to allow the user to enter additional options that can ensure crop, landcover, and irrigation features are agreement.

Example ldt.config entry

```
Incorporate crop information:   .false.
```

`Crop type data source:` specifies the crop type map dataset source to be read in. Current landcover source options include:

Value	Description
UMDCROPMAP	UMD+CROPMAP crop type map. For more info, please refer to Ozdogan et al. (2010; JHM).
Monfreda08	FAOSTAT05 crop type maps. For more info, please refer to Monfreda et al. (2008).
CONSTANT	Ability to set a constant crop type for a set classification.

Example ldt.config entry

```
Crop type data source:  "none"
```

`Crop classification:` specifies the crop classification system used to determine the range of crops indexed for a particular crop library source.

Value	Description
none	Data is on same grid as LIS output domain

Value	Description
CROPMAP	19 classes; named by Ozdogan et al.(2010), used Leff et al.(2004)
FAOSTAT01	19 classes; Used by Leff et al.(2004), considered obsolete
FAOSTAT05	175 classes; Used by Monfreda et al. (2008)

Example ldt.config entry

```
Crop classification:      "FAOSTAT01"
```

`Crop library directory:` specifies the source of the crop library and inventory of crop classes, related to the `Crop classification:` entry (see above).

Example ldt.config entry

```
Crop library directory:  "../LS_PARAMETERS/crop_params/Crop.Library.Files/"
```

`Assign crop value type:` specifies the type of crop presence, such as a “single” crop or “multiple” crops given within a gridcell. Currently, only the “single” option is supported.

Example ldt.config entry

```
Assign crop value type:    "none"
```

`Assign single crop value:` specifies whether to assign a single crop value from an actual crop library inventory, such as FAOSTAT01, which is also known as the CROPMAP classification used in Ozdogan et al. (2010). By turning on this option (.true.), you can they specify what type of crop you want to assign, like “maize” to the user-specified option, `Default crop type:`. If “maize” was entered, then wherever the landcover map indicated a generic “cropland”, the crop type field would be given a dominant “maize” type.

Value	Description
.false.	Do not assign a single crop class to the crop type field.
.true.	Assign a single crop type, like “maize” to the crop type field.

Example ldt.config entry

```
Assign single crop value:     .true.
```

`Default crop type:` specifies the default crop type that the user can enter and can be used in conjunction with assigning a single crop type value (see above).

Example ldt.config entry

```
Default crop type:          "maize"
```

`Crop type file:` specifies the location of a crop type file. This file contains different crop types that can be used in in conjunction with a selected land cover map (as above).

Example ldt.config entry

```
Crop type file:  ./irrigation/conus_modis/UMD_N125C19.1gd4r
```

`Crop map spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to a crop type map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell
tile	Read in tiled data or upscale by estimating gridcell fractions

NOTE LIS will be expecting “mode” or dominant crop type per gridcell at this time. Future versions will include landcover-crop tile options.

Example ldt.config entry

```
Crop map spatial transform:   mode
```

`Irrigation type data source:` specifies the irrigation method type dataset source to be read in. Current source options include:

Value	Description
GRIPC	Irrigation map, by Salmon (2013).

Example ldt.config entry

```
Irrigation type data source:  "none"
```

`Irrigation type map:` specifies the location of an irrigation type file. This file contains different irrigation categories (types) that can be used in conjunction with an irrigation fraction map.

A special land-use/irrigation-related map, known as the Global Rain-Fed, Irrigated, and Paddy Croplands (GRIPC) Dataset (Salmon, 2013), has also been implemented as an option to LDT. Currently, no models in LIS utilize this map but opportunities exist for the user community to utilize for their landcover and irrigation modeling needs.

Example ldt.config entry

```
Irrigation type map: ../LS_PARAMETERS/irrigation/irrigtype_map.bin
```

`Irrigation type spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to irrigation-related maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell
neighbor	Use nearest neighbor to select closest value
tile	Read in tiled data or upscale by estimating gridcell fractions

Example ldt.config entry

```
Irrigation type spatial transform:    mode
```

`Irrigation fraction data source:` specifies the irrigation method type dataset source to be read in. Current source options include:

Value	Description
MODIS_OG	Irrigation area fraction map by Ozdogan and Gutman (2008)
GRIPC	Irrigation area fraction map by Salmon (2013) !UserDerived

Example ldt.config entry

```
Irrigation fraction data source:  "none"
```

`Irrigation fraction map:` specifies the location of an irrigation fraction map file. This file contains irrigation fraction (gridcell-based) that can be used in conjunction with an irrigation type map.

Example ldt.config entry

```
Irrigation fraction map:  ../irrigation/irrig.percent.eighth.1gd4r
```

`Irrigation fraction spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to irrigation-related maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain

Value	Description
average	Upscale by averaging values for each gridcell
neighbor	Upscale or downscale using nearest neighbor values

Example ldt.config entry

```
Irrigation fraction map projection:   laton
```

`Irrigation fraction map projection:` indicates the grid projection defines an input irrigation maps. Options include:

Value	Description
latlon	Lat/Lon projection with SW to NE data ordering

Example ldt.config entry

```
Irrigation fraction map projection:    latlon
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying irrigation data, if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Irrigation fraction lower left lat:      -59.87500
Irrigation fraction lower left lon:     -179.87500
Irrigation fraction upper right lat:      89.87500
Irrigation fraction upper right lon:     179.87500
Irrigation fraction resolution (dx):       0.2500
Irrigation fraction resolution (dy):       0.2500
```

7.5. Soil Parameters

Soils maps

`Sand fraction map:` specifies the sand fraction map file.

`Clay fraction map:` specifies the clay fraction map file.

`Silt fraction map:` specifies the silt map file.

`Gravel fraction map:` specifies the gravel map file.

`Porosity data source:` specifies the soil porosity dataset source to be read in. Current source options include:

Value	Description
FAO	LISF-team produced soil porosity data source.
CLSMF2.5	Similar to the above option but for CLSM F2.5 model.
CONSTANT	User can select a constant value.

`Porosity map:` specifies porosity map file.

`Soildepth data source:` specifies the soildepth dataset source to be read in. Current source option is:

Value	Description
ALMIPII	ALMIPII soil depth data source.

`Soil depth map:` specifies the soil depth map file.

`Saturated matric potential map:` specifies saturated matric potential map file.

`Saturated hydraulic conductivity map:` specifies saturated hydraulic conductivity map file.

`b parameter map:` specifies b parameter map file.

`Quartz map:` specifies quartz data map file.

Example ldt.config entry

```
Sand fraction map:        ../input/25KM/sand_FAO.1gd4r
Clay fraction map:        ../input/25KM/clay_FAO.1gd4r
Silt fraction map:        ../input/25KM/silt_FAO.1gd4r
Gravel fraction map:      ../input/25KM/gravel_Special.1gd4r
Porosity data source:        none
Porosity map:
Saturated matric potential map:
Saturated hydraulic conductivity map:
b parameter map:
Quartz map:
```

`Soil fraction data source:` specifies the source of the soil fraction dataset. Options include:

Value	Description
none	No soil fraction data source
FAO	FAO soil fraction percentage fields
STATSGO_LIS	LISF-team derived STATSGO v1 soil fraction fields
ALMIPII	ALMIP II soil fraction percentage fields
CONSTANT	If user wants to set a constant soil fraction values

Example ldt.config entry

```
Soil fraction data source:     FAO
```

`Soil fraction number of bands:` specifies the number of soil fraction bins to turn on soil fraction tiling capability.

Example ldt.config entry

```
Soil fraction number of bands:     1
```

`Soils spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the soils maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear
tile	Read in tiled data or upscale by estimating gridcell fractions

Example ldt.config entry

```
Soils spatial transform:     average
```

`Soils map projection:` specifies the projection of the soils map data.

`Soils fill option:` specifies the general soil data (e.g., fractions) fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

By selecting the soils fill option, neighbor, this activates the need to enter values for the Soils fill radius and fill value, as shown below. If a porosity map is read in and the soils fill option is set to neighbor, the user can then enter a fill value for porosity to ensure mask-parameter agreement.

`Soils fill radius:` specifies the radius with which to search for nearby value(s) to help fill the missing value.

`Soils fill value:` indicates which soils value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing soils value, a value of 0.33 could be assigned if no nearest neighbor values exists to fill).

`Porosity fill value:` indicates which porosity value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing porosity value, a value of 0.30 could be assigned if no nearest neighbor values exists to fill).

Example ldt.config entry

```
Soils fill option:   neighbor
Soils fill radius:   3
Soils fill value:    0.33
Porosity fill value: 0.30
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying soils data, if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Soils map projection:        latlon
Soils lower left lat:      -59.87500
Soils lower left lon:     -179.87500
Soils upper right lat:      89.87500
Soils upper right lon:     179.87500
Soils resolution (dx):       0.2500
Soils resolution (dy):       0.2500
```

`Hydrologic soil group source:` specifies the hydrological soil group (HSG) data source. Options include:

Value	Description
none	No HSG data source
STATSGOv1	STATSGO v1 HSG data source

Example ldt.config entry

```
Hydrologic soil group source:       STATSGOv1
```

`Hydrologic soil group map:` specifies the path and filename for the HSG input file.

Example ldt.config entry

```
Hydrologic soil group map:  ./input/STATSGO_v1/hsgpct.bsq
```

`Bulk density data source:` specifies the source of the soil bulk density data type. Currently no options supported at this time.

Example ldt.config entry

```
Bulk density data source:     none
```

`Water capacity data source:` specifies the source of the water holding capacity data type. Currently no options supported at this time.

Example ldt.config entry

```
Water capacity data source:   none
```

`Rock volume data source:` specifies the source of the amount of rock volume data type. Currently no options supported at this time.

Example ldt.config entry

```
Rock volume data source:   none
```

`Rock frag class data source:` specifies the source of the rock fragment classification type. Currently no options supported at this time.

Example ldt.config entry

```
Rock frag class data source:  none
```

`Permeability data source:` specifies the source of the permeability data type. Currently no options supported at this time.

Example ldt.config entry

```
Permeability data source:   none
```

`Soil texture data source:` specifies the soil texture dataset source to be read in. Current soil texture source options include:

Value	Description
STATSGOFAO_Native	The blended STATSGOv1 and FAO soil texture map. See: http://www.ral.ucar.edu/research/land/technology/lsm.php
STATSGOFAO_LIS	Similar dataset as to the above one but processed by LISF-team.
FAO	FAO or Reynolds et al. (1999) soil texture map.
ISRIC	ISRIC soil texture data source.
ZOBLER_GFS	Similar to above but on a GFS run domain.
STATSGOv1	The STATSGOv1-only soil texture map.

Value	Description
CONSTANT	User can set a constant soil texture class.

Example ldt.config entry

```
Soil texture data source:   "STATSGOFAO_Native"
```

`Soil texture map:` specifies the soil texture file.

`Soil texture spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the soil texture map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell
neighbor	Upscale by using nearest valid value for each gridcell
tile	Read in tiled data or upscale by estimating gridcell fractions

Example ldt.config entry

```
Soil texture map:  ../input/25KM/soiltexture_STATSGO-FAO.1gd4r
Soil texture spatial transform:     none
```

`Soil texture map projection:` specifies the projection of the soil texture map data.

`Soil texture fill option:` specifies the soil texture data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

`Soil texture fill value:` indicates which soil texture value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing soil texture value, a value of 6 could be assigned if no nearest neighbor values exists to fill).

`Soil texture fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Soil texture fill option:      neighbor
Soil texture fill radius:         3.
Soil texture fill value:          6.
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying soil texture data, if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Soil texture map projection:        latlon
Soil texture lower left lat:       -59.87500
Soil texture lower left lon:      -179.87500
Soil texture upper right lat:       89.87500
Soil texture upper right lon:      179.87500
Soil texture resolution (dx):        0.2500
Soil texture resolution (dy):        0.2500
```

`Soil color map projection:` specifies the projection of the soil color map data.

`Soil color data source:` specifies the soil color data source. Current option is: FAO

`Soil color map:` specifies the soil color map file. This soil map is mainly used by the Community Land Model (version 2).

`Soil color spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the soil color map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor

Example ldt.config entry

```
Soil color data source:        none
Soil color map:
Soil color spatial transform:     none
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying soil color data, data source option "FAO" or has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Soil color map projection:        latlon
Soil color lower left lat:       -59.87500
Soil color lower left lon:      -179.87500
Soil color upper right lat:       89.87500
Soil color upper right lon:      179.87500
Soil color resolution (dx):        0.2500
Soil color resolution (dy):        0.2500
```

7.6. Topography Parameters

`Elevation data source:` specifies the elevation dataset source to be read in.

`Slope data source:` specifies the slope dataset source to be read in.

`Aspect data source:` specifies the aspect dataset source to be read in.

`Curvature data source:` specifies the curvature dataset source to be read in.

Current options include:

Value	Description
GTOPO30_Native	The GTOPO30 elevation map native source. See: https://doi.org/10.5065/A1Z4-EE71
GTOPO30_LIS	Similar dataset as to the above one but processed by LISF-team.
GTOPO30_GFS	Similar dataset as to the above but on GFS grid.
SRTM_Native	The SRTM elevation map native source. See: http://dds.cr.usgs.gov/srtm/version2_1/SRTM30
SRTM_LIS	Similar dataset as to the above one but processed by LISF-team.
CONSTANT	User can set a constant elevation, slope or aspect class.
MERIT_1K	The MERIT elevation map, but processed by LISF-team to have a resolution '0.008333'. See: http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/index.html

Example ldt.config entry

```
Elevation data source:  "SRTM_Native"
Slope data source:      "SRTM_Native"
Aspect data source:     "SRTM_Native"
Curvature data source:  "SRTM_Native"
```

`Elevation number of bands:` specifies the number of elevation bands or bins to turn on elevation tiling capability.

`Slope number of bands:` specifies the number of slope bands or bins to turn on slope tiling capability.

`Aspect number of bands:` specifies the number of aspect bands or bins to turn on aspect tiling capability.

`Curvature number of bands:` specifies the number of curvature bands or bins to turn on curvature tiling capability.

Example ldt.config entry

```
Elevation number of bands:     1
Slope number of bands:         1
Aspect number of bands:        1
Curvature number of bands:     1
```

Topography maps

`Elevation map:` specifies the elevation of the LIS grid. If the elevation map type selected is SRTM_Native, then the elevation file entry is actually just the directory path, which contains the tiled SRTM elevation files.

`Slope map:` specifies the slope of the LIS grid. If the slope map type selected is SRTM_Native, then the file entry is actually just the directory path, which contains the tiled SRTM elevation files.

`Aspect map:` specifies the aspect of the LIS grid. If the aspect map type selected is SRTM_Native, then the file entry is actually just the directory path, which contains the tiled SRTM elevation files.

`Curvature map:` specifies the curvature of the LIS grid.

Example ldt.config entry

```
Elevation map:     ../input/25KM/elev_GTOPO30.1gd4r
Slope map:         ../input/25KM/slope_GTOPO30.1gd4r
Aspect map:        ../input/25KM/aspect_GTOPO30.1gd4r
Curvature map:     ../input/25KM/curv_GTOPO30.1gd4r
```

`Elevation fill option:` specifies the elevation data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

`Elevation fill value:` indicates which elevation value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing elevation value, a value of 100(m) could be assigned if no nearest neighbor values exists to fill).

`Elevation fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Elevation fill option:          neighbor
Elevation fill radius:           2.
Elevation fill value:           100.
```

`Slope fill option:` specifies the slope data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

`Slope fill value:` indicates which slope value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing slope value, an value of 0.1 could be assigned if no nearest neighbor values exists to fill).

`Slope fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Slope fill option:          neighbor
Slope fill radius:            2.
Slope fill value:            0.1
```

`Aspect fill option:` specifies the aspect data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

`Aspect fill value:` indicates which aspect value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing aspect value, an value of 2.0 could be assigned if no nearest neighbor values exists to fill).

`Aspect fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Aspect fill option:        neighbor
Aspect fill radius:           2.
Aspect fill value:           2.0
```

`Topography map projection:` specifies the projection of the topography map data.

`Topography spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the topographic map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear
tile	Read in tiled data or upscale by estimating gridcell fractions

Example ldt.config entry

```
Topography spatial transform:     tile
```

This section should also specify the domain specifications of the topography data. If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying topography data, especially if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Topography map projection:         latlon
Topography lower left lat:       -59.87500
Topography lower left lon:      -179.87500
Topography upper right lat:       89.87500
Topography upper right lon:      179.87500
Topography resolution (dx):        0.2500
Topography resolution (dy):        0.2500
```

7.7. LSM-specific Parameters

Albedo maps

`Albedo data source:` specifies the albedo climatology map dataset source to be read in. Current source options include:

Value	Description
NCEP_Native	Native monthly NCEP albedo files.

Value	Description
NCEP_LIS	Similar to the above option but LISF-team processed.
CONSTANT	User can select a constant value.

`Albedo map:` specifies the path of the climatology based albedo files. The climatology albedo data files have the following naming convention: <directory>/<file header>.<tag>.1gd4r The tag should be either sum, win, spr, or aut depending on the season, or the tag should represent the month (such as jan, feb, mar, etc.). The file header can be anything (such as alb1KM). The albedo field is used by Noah LSM versions.

`Albedo map projection:` specifies the projection of the albedo map data.

`Albedo climatology interval:` specifies the frequency of the albedo climatology in months.

Value	Description
monthly	Monthly interval for albedo files
quarterly	Seasonal interval for albedo files

`Albedo spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the albedo maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear

Example ldt.config entry

```
Albedo data source:           NCEP_LIS
Albedo map:                 ../input/25KM/albedo_NCEP
Albedo climatology interval:  monthly
Albedo spatial transform:     none
```

If selecting the Catchment LSM (F2.5 version), the model requires the near infrared (NIR) and visible (VIS) albedo factor files, as shown below for example. This particular albedo parameter set is currently only available for the Catchment LSM Fortuna 2.5 (CLSMF2.5).

`Albedo NIR factor file:` specifies the NIR albedo factor file.

`Albedo VIS factor file:` specifies the VIS albedo factor file.

These albedo parameter subroutines can be found in the albedo directory.

Example ldt.config entry

```
Albedo NIR factor file: ./GLDAS_1.0-deg/modis_scale_factor.albnf.clim
Albedo VIS factor file: ./GLDAS_1.0-deg/modis_scale_factor.albvf.clim
```

`Albedo fill option:` specifies the albedo data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
average	Use average to fill missing value

`Albedo fill value:` indicates which albedo value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing albedo value, a value of 0.12 could be assigned if no nearest neighbor values exists to fill).

`Albedo fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Albedo fill option:            average
Albedo fill radius:              2.
Albedo fill value:              0.12
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying albedo data where the albedo data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Albedo map projection:       latlon
Albedo lower left lat:      -59.87500
Albedo lower left lon:     -179.87500
Albedo upper right lat:      89.87500
Albedo upper right lon:     179.87500
Albedo resolution (dx):       0.2500
Albedo resolution (dy):       0.2500
```

`Max snow albedo data source:` specifies the maximum snow albedo dataset source to be read in. Current source options include:

Value	Description
NCEP_Native	Native NCEP maximum snow albedo source.
NCEP_LIS	Similar to the above option but LISF-team processed.

Value	Description
NCEP_GFS	Similar to the above option but on GFS grid.
SACHTET.3.5.6	Max snow albedo specific to the SAC-HTET model.
CONSTANT	User can select a constant value.

`Max snow albedo map:` specifies the map file containing data with the static upper bound of the snow albedo. The albedo field is used by all Noah LSM and RDHM-SAC LSM versions.

`Max snow albedo map projection:` specifies the projection of the max snow albedo map data.

`Max snow albedo spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the maximum snow albedo map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear

Example ldt.config entry

```
Max snow albedo data source:       NCEP_LIS
Max snow albedo map:   ../input/25KM/mxsnoalb_MODIS.1gd4r
Max snow albedo spatial transform:  none
```

`Max snow albedo fill option:` specifies the max snow albedo data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
average	Use average to fill missing value

`Max snow albedo fill value:` indicates which max snow albedo value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing snow albedo value, an value of 0.42 could be assigned if no nearest neighbor values exists to fill).

`Max snow albedo fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Max snow albedo fill option:          average
Max snow albedo fill radius:            3.
Max snow albedo fill value:            0.42
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying max snow albedo data, where the max snow albedo albedo data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Max snow albedo map projection:      latlon
Max snow albedo lower left lat:    -59.87500
Max snow albedo lower left lon:   -179.87500
Max snow albedo upper right lat:    89.87500
Max snow albedo upper right lon:   179.87500
Max snow albedo resolution (dx):     0.2500
Max snow albedo resolution (dy):     0.2500
```

Greenness fraction maps

Greenness vegetation fraction is considered the horizontal greenness fraction represented for a model gridcell. This parameter is used in the LSMs: all Noah LSMs, RDHM-SAC, Catchment F2.5.

`Greenness data source:` specifies the greenness fraction climatology dataset source to be read in. Current source options include:

Value	Description
NCEP_Native	Native NCEP monthly greenness climatology source.
NCEP_LIS	Similar to the above option but LISF-team processed.
CLSMF2.5	Similar to the above option but for CLSM F2.5 model.
SACHTET.3.5.6	Similar to the above option but for SAC-HTET model.
CONSTANT	User can select a constant value.

`Greenness map projection:` specifies the projection of the greenness map data.

`Greenness fraction map:` specifies the source of the climatology based gfrac files. The climatology greenness data files have the following naming convention: <directory>/<file header>.<tag>.1gd4r. The tag should represent the month (such as jan, feb, mar, etc.). The file header can be anything (such as green1KM).

`Greenness climatology interval:` specifies the frequency of the greenness climatology in months. Only current option is: “monthly”.

`Calculate min-max greenness fraction:` specifies a logical flag option to offer the user the ability to calculate minimum and maximum greenness fraction values from a given climatology (e.g., monthly). Acceptable values are:

Value	Description
.false.	Read in min and max greenness fraction value maps
.true.	Calculate greenness fraction from greenness climatology maps

`Greenness maximum map:` specifies the file of the climatological maximum greenness data from the monthly greenness files.

`Greenness minimum map:` specifies the file of the climatological minimum greenness data from the monthly greenness files.

`Greenness spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the greenness maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear

Example ldt.config entry

```
Greenness data source:          NCEP_LIS
Greenness fraction map:     ../input/25KM/gvf_NCEP
Greenness climatology interval:   monthly
Calculate min-max greenness fraction:  .true.
Greenness maximum map:      ../input/25KM/gvf_NCEP.MAX.1gd4r
Greenness minimum map:      ../input/25KM/gvf_NCEP.MIN.1gd4r
Greenness spatial transform:     none
```

`Greenness fill option:` specifies the greenness fraction data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines

Value	Description
average	Use average to fill missing value

`Greenness fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

`Greenness fill value:` indicates which greenness fraction value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing greenness value, a value of 0.2 could be assigned if exists to fill).

`Greenness maximum fill value:` indicates which maximum greenness fraction value to be used if an arbitrary value fill is needed.

`Greenness minimum fill value:` indicates which minimum greenness fraction value to be used if an arbitrary value fill is needed.

Example ldt.config entry

```
Greenness fill option:        average
Greenness fill radius:          3
Greenness fill value:          0.20
Greenness maximum fill value:  0.80
Greenness minimum fill value:  0.05
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying greenness data source, if the option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Greenness map projection:        latlon
Greenness lower left lat:      -59.87500
Greenness lower left lon:     -179.87500
Greenness upper right lat:      89.87500
Greenness upper right lon:     179.87500
Greenness resolution (dx):       0.2500
Greenness resolution (dy):       0.2500
```

LAI/SAI maps Leaf area index and stem area index maps are used to describe the vertical representation of leafy vegetation and the woody-branch areas within a given gridecell (respectively). LAI/SAI are used in the Community Land Model (CLM), Mosaic LSM, and Catchment LSM, version F2.5.

`LAI/SAI map projection:` specifies the projection of the LAI/SAI map data.

`LAI data source:` specifies the leaf area index (LAI) climatology dataset source to be read in. Current source options include:

Value	Description
AVHRR	LISF-team produced monthly LAI climatology source.
CLSMF2.5	Similar to the above option but for CLSM F2.5 model.
CONSTANT	User can select a constant value.

`SAI data source:` specifies the stem area index (SAI) climatology dataset source to be read in. Current source options include:

Value	Description
AVHRR	LISF-team produced monthly SAI climatology source.
CONSTANT	User can select a constant value.

`LAI map:` specifies the source of the climatology based LAI files. The climatology data files have the following naming convention: <directory>/<file header>.<tag>.1gd4r. The tag should be represent the month (such as jan, feb, mar, etc.). The file header can be anything (such as avhrr_lai_1KM).

`SAI map:` specifies the source of the climatology based SAI files. The climatology data files have the following naming convention: <directory>/<file header>.<tag>.1gd4r. The tag should be represent the month (such as jan, feb, mar, etc.). The file header can be anything (such as avhrr_sai_1KM).

`LAI/SAI climatology interval:` specifies the frequency of the LAI or SAI climatology in months. Current option is: “monthly”.

`Calculate min-max LAI:` specifies a logical flag option to offer the user the ability to calculate minimum and maximum LAI values from a given climatology (e.g., monthly). Acceptable values are:

Value	Description
.false.	Read in min and max LAI value maps
.true.	Calculate LAI from LAI climatology maps

`LAI maximum map:` specifies the file of the climatological maximum LAI data from the monthly LAI files.

`LAI minimum map:` specifies the file of the climatological minimum LAI data from the monthly LAI files.

`LAI/SAI spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the LAI and SAI maps. Only “none” option works for the “AVHRR” or “CLSMF2.5” LAI data source entries. Other spatial options for the include:

Value	Description
none	Data is on same grid as LIS output domain

Value	Description
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear

Example ldt.config entry

```
LAI data source:            CLSMF2.5
LAI map:          ../input/25KM/avhrr_lai_nldas
SAI map:          ../input/25KM/avhrr_sai_nldas
Calculate min-max LAI:      .false.
LAI maximum map:  ../input/CLSMF2.5/clsmf2.5_maxlai.1gd4r
LAI minimum map:  ../input/CLSMF2.5/clsmf2.5_minlai.1gd4r
LAI/SAI climatology interval:  monthly
LAI/SAI spatial transform:     none
```

`LAI/SAI fill option:` specifies the LAI/SAI data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
average	Use average to fill missing value

`LAI/SAI fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

`LAI fill value:` indicates which LAI value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing LAI value, a value of 1 could be assigned if exists to fill).

`LAI maximum fill value:` indicates which maximum LAI value to be used if an arbitrary value fill is needed.

`LAI minimum fill value:` indicates which minimum LAI value to be used if an arbitrary value fill is needed.

`SAI fill value:` indicates which SAI value to be used if an arbitrary value fill is needed.

Example ldt.config entry

```
LAI/SAI fill option:     average
LAI/SAI fill radius:       3
LAI fill value:            1
SAI fill value:           0.5
LAI maximum fill value:    4
LAI minimum fill value:    1
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying LAI/SAI data, if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
LAI/SAI map projection:        latlon
LAI/SAI lower left lat:      -59.87500
LAI/SAI lower left lon:     -179.87500
LAI/SAI upper right lat:      89.87500
LAI/SAI upper right lon:     179.87500
LAI/SAI resolution (dx):       0.2500
LAI/SAI resolution (dy):       0.2500
```

`Slope type data source:` specifies the slope type index dataset source to be read in. Current source options include:

Value	Description
NCEP_Native	Native NCEP slope type derived map source.
NCEP_LIS	Similar to the above option but LISF-team processed.
NCEP_GFS	Similar to the above option but on a GFS grid type.
CONSTANT	User can select a constant value.

`Slope type map:` specifies the slope type index as used in all Noah LSM versions.

`Slope type map projection:` specifies the projection of the slope type map data.

`Slope type spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the soils maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain
mode	Upscale by selecting dominant type for each gridcell

Value	Description
neighbor	Use nearest neightbor to select nearest gridcell neighbor

Example ldt.config entry

```
Slope type data source:        NCEP_LIS
Slope type map:         ../input/25KM/slopetype_NCEP.1gd4r
Slope type spatial transform:   none
```

`Slope type fill option:` specifies the slope type data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
neighbor	Use nearest neighbor to fill missing value

`Slope type fill value:` indicates which slope type value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing slope type value, an index value of 1 could be assigned if no nearest neighbor values exists to fill).

`Slope type fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Slope type fill option:        neighbor
Slope type fill radius:         2.
Slope type fill value:          1.
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying slope type data, if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Slope type map projection:       latlon
Slope type lower left lat:      -59.87500
Slope type lower left lon:     -179.87500
Slope type upper right lat:      89.87500
Slope type upper right lon:     179.87500
Slope type resolution (dx):       0.2500
Slope type resolution (dy):       0.2500
```

`Bottom temperature data source:` specifies the bottom temperature dataset source to be read in. Current source options include:

Value	Description
ISLSCP1	Native (NCEP) ISLSCP1 temperature derived map.
NCEP_LIS	Similar to the above option but LISF-team processed.
NCEP_GFS	Similar to the above option but on a GFS grid type.
CONSTANT	User can select a constant value.

`Bottom temperature map:` specifies the bottom boundary temperature data. This parameter is currently required by the Noah LSM versions and the recently added RDHM-SAC/Snow-17 models.

`Bottom temperature map projection:` specifies the projection of the bottom temperature map data.

`Bottom temperature spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the bottom temperature map. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Nearest neighbor scheme
bilinear	bilinear scheme
budget-bilinear	conservative scheme

Example ldt.config entry

```
Bottom temperature data source:       NCEP_LIS
Bottom temperature map:   ../input/25KM/tbot_GDAS_6YR_CLIM.1gd4r
Bottom temperature spatial transform:   none
```

`Bottom temperature fill option:` specifies the bottom boundary temperature data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
average	Averaging values for each missing value
neighbor	Use nearest neighbor to fill missing value

`Bottom temperature fill value:` indicates which bottom soil temperature value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing bottom temperature field, a value of 287 K could be assigned if no nearest neighbor values exists to fill).

`Bottom temperature fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

Example ldt.config entry

```
Bottom temperature fill option:   neighbor
Bottom temperature fill radius:     3.
Bottom temperature fill value:     287.0
```

`Bottom temperature topographic downscaling:` specifies the option with which to adjust bottom temperature field due to topographic impacts.

Value	Description
none	No topographic/elevation adjustment made to parameter data
lapse-rate	Adjust (or downscale) bottom temperature using lapse-rate correction.

Example ldt.config entry

```
Bottom temperature topographic downscaling:    none
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying bottom temperature parameter data, if the data source option has a "_LIS" in the name. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Bottom temperature map projection:      latlon
Bottom temperature lower left lat:     -59.87500
Bottom temperature lower left lon:    -179.87500
Bottom temperature upper right lat:     89.87500
Bottom temperature upper right lon:    179.87500
Bottom temperature resolution (dx):      0.2500
Bottom temperature resolution (dy):      0.2500
```

`Noah-MP PBL Height Value:` specifies the option which to set the planetary boundary layer height (PBLH) value for the Noah-MP model.

Example ldt.config entry

```
Noah-MP PBL Height Value:     900.    # in meters
```

If selecting the Community Land Model (4.5 version), the following config entires are also required.

`CLM45 parameter mode:` specifies whether to "readin" the CLM-4.5 parameters from pre-processed files. Currently, only the "readin" option is available.

`CLM45 domain file:` specifies the CLM-4.5 domain file. The domain file is used to define the grid and the landmask.

`CLM45 surface file:` specifies the CLM-4.5 surface data parameter file.

`CLM45 param spatial transform:` indicates which spatial transform type is to be applied to the CLM-4.5 surface file. Currently, only “none” is supported, as it is assumed that the domain and surface files are on the same grid as the desired LDT output domain.

Value	Description
none	Data is on same grid as LDT output domain

`CLM45 param map projection:` indicates the projection of the CLM-4.5 domain and surface files.

`CLM45 lower left lat:` specifies the lower left latitude of the CLM-4.5 domain and surface files.

`CLM45 lower left lon:` specifies the lower left longitude of the CLM-4.5 domain and surface files.

`CLM45 upper right lat:` specifies the upper right latitude of the CLM-4.5 domain and surface files.

`CLM45 upper right lon:` specifies the upper right longitude of the CLM-4.5 domain and surface files.

`CLM45 resolution (dx):` specifies the grid spacing in degrees in the x-direction (longitudinal) of the CLM-4.5 domain and surface files.

`CLM45 resolution (dy):` specifies the grid spacing in degrees in the y-direction (latitudinal) of the CLM-4.5 domain and surface files.

Example ldt.config entry

```
CLM45 parameter mode:                      "readin"
CLM45 domain file:
CLM45 surface file:
CLM45 param spatial transform:             none
CLM45 param map projection:                latlon
CLM45 lower left lat:                       -90.0
CLM45 lower left lon:                         0.625
CLM45 upper right lat:                       90.0
CLM45 upper right lon:                      359.375
CLM45 resolution (dx):                        1.25
CLM45 resolution (dy):                        0.9424060
```

Potential Evapotranspiration (PET) maps

`PET directory:` specifies the source of the monthly climatology based PET files. The climatology data files have the following naming convention: <directory>/<file header>.<tag>.1gd4r. The tag should be represent the month (such as JAN, FEB, MAR, etc.). The file header can be anything (such as avhrr_pet_1KM). Currently, this parameter is used only with the RDHM-SAC model.

`PET map projection:` specifies the projection of the PET map data.

`PET adjustment factor directory:` specifies the source of the m monthly climatology-based PET adjustment factor files. The climatology data files have the following naming convention: <directory>/<file header>.<tag>.1gd4r. The tag should be represent the month (such as JAN, FEB, MAR, etc.). The file header can be anything (such as avhrr_petadj_1KM).

`PET climatology interval:` specifies the frequency of the PET climatology in months. Current option is: “monthly”.

`PET spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to the PET maps. Options include:

Value	Description
none	Data is on same grid as LIS output domain (only option for now)

Example ldt.config entry

```
PET directory:              ../input/25KM/sachtet_pet
PET adjustment factor directory:  ../input/25KM/sachtet_petadj
PET climatology interval:    monthly
PET spatial transform:        none
```

`PET fill option:` specifies the PET climatology data fill option. Options include:

Value	Description
none	Do not apply missing value fill routines
average	Use average to fill missing value

`PET fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

`PET fill value:` indicates which PET value to be used if an arbitrary value fill is needed. (For example, when the landmask indicates a land point but no existing PET value, a value of 1 could be assigned if exists to fill. 10 pt

Example ldt.config entry

```
PET fill option:         average
PET fill radius:            3
PET fill value:            10.
```

If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying PET data. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
PET map projection:        latlon
PET lower left lat:      -59.87500
PET lower left lon:     -179.87500
PET upper right lat:      89.87500
PET upper right lon:     179.87500
PET resolution (dx):       0.2500
PET resolution (dy):       0.2500
```

`CLSMF25 map projection:` specifies the projection of the CLSMF25 map data.

`CLSMF25 tile coord file:` specifies the location of a CLSM F2.5 coordinate file. This file contains catchment tile coordinate information that can be used in Catchment LSM (CLSM) Fortuna 2.5 version model run.

Example ldt.config entry

```
CLSMF25 tile coord file:  ./cat_parms/PE_2880x1440_DE_464x224.file
```

`CLSMF25 soil param file:` specifies the location of a CLSM F2.5 soils file. This file contains catchment soil parameter information that can be used in Catchment LSM (CLSM) Fortuna 2.5 version model run.

Example ldt.config entry

```
CLSMF25 soil param file:  ./cat_parms/soil_param.dat
```

`CLSMF25 topo files:` specifies the locations of a CLSM F2.5 topo parameter files. These files contain catchment topographic parameter information that can be used in a Catchment LSM (CLSM) Fortuna 2.5 version model run.

`CLSMF25 topo ar file:` specifies the table file containing topographic shape parameters for the CLSM F2.5 model.

`CLSMF25 topo bf file:` specifies the table file containing topographic baseflow paramters for the CLSM F2.5 model.

`CLSMF25 topo ts file:` specifies the table file containing water transfer timescale parameters for the CLSM F2.5 model.

Example ldt.config entry

```
CLSMF25 topo ar file:  ../cat_parms/ar.new
CLSMF25 topo bf file:  ../cat_parms/bf.dat
CLSMF25 topo ts file:  ../cat_parms/ts.dat
```

`CLSMF25 surf layer ts file:` specifies the location of a CLSM F2.5 tau parameter file. This file contain catchment surface layer timescale (ts), tau, parameter information that can be used in

Catchment LSM (CLSM) Fortuna 2.5 version model runs.

Example ldt.config entry

```
CLSMF25 surf layer ts file:  ../cat_parms/tau_param.dat
```

`CLSMF25 top soil layer depth:` specifies the top soil layer depth. This parameter value specifies the depth of the top soil layer depth (unit: meters) and is needed in processing other parameters for a Catchment LSM (CLSM) Fortuna 2.5 version model run.

Example ldt.config entry

```
CLSMF25 top soil layer depth:   0.02
```

`CLSMF25 spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to CLSM F2.5 parameters. Options include (only “none” works at this time):

Value	Description
none	Data is on same grid as LIS output domain

Example ldt.config entry

```
CLSMF25 spatial transform:     none
```

This section also outlines the domain specifications of the Catchment LSM Fortuna 2.5 data. If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying CLSM data. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
CLSMF25 map projection:       latlon
CLSMF25 lower left lat:       25.0625
CLSMF25 lower left lon:     -124.9375
CLSMF25 upper right lat:      52.9375
CLSMF25 upper right lon:     -67.0625
CLSMF25 resolution (dx):       0.125
CLSMF25 resolution (dy):       0.125
```

`RDHM356 constants table:` specifies the location of the constants table required by the Research Distributed Hydrologic Model (RDHM) version 3.5.6 models, SAC-HTET and SNOW-17. This table file contains constant values for any listed SAC-HTET or SNOW-17 parameter types. If a constant value is >= 0., then the constant value is assigned for all gridcells for a parameter entry. If the value is negative, a 2-D gridded a priori map is read in. Also, the negative constant value can be used as a scaling factor of the 2-D grid by taking its absolute value and multiplying the entire field by it, if the value is other than -1.

`RDHM356 universal undefined value:` specifies an universal undefined value that can be used by either the SAC-HTET or SNOW-17 models for run-time purposes.

Example ldt.config entry

```
RDHM356 constants table:   ./rdhm_singlevalueinputs.txt
RDHM356 universal undefined value:  -1.
```

`Create or readin soil parameters:` specifies how the soil parameter files are either generated or brought in to the SAC-HTET model. Options include:

Value	Description
none	do not readin or create soil parameters
readin	read in existing SAC soil parameter files
create	generate SAC soil parameter fields in LDT (currently only available at native STATSGOv1 grid at the lat-lon grid and 0.00833 deg resolution).

Example ldt.config entry

```
Create or readin soil parameters:     "readin"
```

`SACHTET soil parameter method:` specifies the method that can generate the SAC soil parameters. Options include (for now):

Value	Description
none	do not readin or create soil parameters
Koren_v1	Based on Victor Koren (NOAA/OHD) original code developed to generate SAC soil parameters.

Example ldt.config entry

```
SACHTET soil parameter method:        "Koren_v1"    # none | Koren_v1
```

`SACHTET Cosby soil parameter table:` specifies the path of the Cosby soil parameter table needed for the SAC-HTET soil parameters, especially for the generation of the parameters.

Example ldt.config entry

```
SACHTET Cosby soil parameter table:  ./rdhm_parms/cosby_eq_newzperc.txt
```

`SACHTET parameter files:` specifies the locations of SACHTET 3.5.6 parameter files. These files contain soil-based and other model parameter information that can be used in SAC-HTET model runs. Most parameter files will come in the HRAP domain and XMRG-binary format found commonly in NOAA NWS/OHD/RFC applications. For the soil parameters, LZ indicates “lower zone” and UZ refers to “upper zone”.

`SACHTET soiltype parameter table:` specifies the dominant soiltype parameter table file.

`SACHTET vegetation parameter table:` specifies the vegetation parameter table file.

`SACHTET parameter spatial transform:` specifies generally the SAC-HTET grid spatial transform. Current option is “none”, and future options will be supported.

`SACHTET parameter fill option:` specifies generally the SAC-HTET parameter fill option. This option is not currently supported but can be in the future.

`SACHTET parameter fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

`SACHTET parameter fill value:` indicates which SACHTET parameter value to be used if an arbitrary value fill is needed.

`SACHTET map projection:` specifies the general SAC-HTET parameter grid projection. Currently, “hrap” is supported and soon other projections, like “latlon” will be.

`SACHTET LZFPM map:` specifies the lower zone primary free water (slow) maximum storage [mm]

`SACHTET LZFSM map:` specifies the lower zone supplemental free water (fast) maximum storage [mm]

`SACHTET LZPK map:` specifies the lower zone primary free water depletion rate [day`^{-1}`]

`SACHTET LZSK map:` specifies the lower zone supplemental free water depletion rate [day `^{-1}`]

`SACHTET LZTWM map:` specifies the lower zone tension water maximum storage [mm]

`SACHTET UZFWM map:` specifies the upper zone free water maximum storage [mm]

`SACHTET UZTWM map:` specifies the upper zone tension water maximum storage [mm]

`SACHTET UZK map:` specifies the upper zone free water latent depletion rate [day `^{-1}`]

`SACHTET PFREE map:` specifies the fraction percolation from upper to lower free water storage [day `^{-1}`]

`SACHTET REXP map:` specifies the exponent of the percolation equation (percolation parameter) [-]

`SACHTET ZPERC map:` specifies the maximum percolation rate [-]

`SACHTET EFC map:` specifies the fraction of forest cover [-]

`SACHTET PCTIM map:` specifies the impervious fraction of the watershad area [-]

`SACHTET ADIMP map:` specifies the additional impervious area [-]

`SACHTET SIDE map:` specifies the ratio of deep recharge to channel base flow [-]

`SACHTET RIVA map:` specifies the riparian vegetation area [-]

`SACHTET RSERV map`: specifies the fraction of lower zone free water not transferable to tension water [-]

`SACHTET TBOT map`: specifies the bottom boundary soil temperature [C]

`SACHTET STXT map`: specifies the SAC-HTET domain soil texture map file.

`SACHTET CKSL map`: specifies the ratio of frozen to non-frozen surface (increase in frozen ground contact, usually = 8 s/m) [s/m]

`SACHTET RSMAX map`: specifies the maximum residual porosity (usually = 0.58) [-]

`SACHTET ZBOT map`: specifies the lower boundary depth (negative value, usually = -2.5 m) [m]

`SACHTET offset time map`: specifies the path to the time offset map.

`SACHTET soil albedo map`: specifies the soil albed map.

Example ldt.config entry

```
SACHTET soiltype parameter table:    ./testcase/sachtet_soilparms.txt
SACHTET vegetation parameter table:  ./testcase/sachtet_vegparms.txt
SACHTET LZFPM map:          ./testcase/sac_LZFPM.gz
SACHTET LZFSM map:          ./testcase/sac_LZFSM.gz
SACHTET LZPK map:           ./testcase/sac_LZPK.gz
SACHTET LZSK map:           ./testcase/sac_LZSK.gz
SACHTET LZTWM map:          ./testcase/sac_LZTWM.gz
SACHTET UZFWM map:          ./testcase/sac_UZFWM.gz
SACHTET UZTWM map:          ./testcase/sac_UZTWM.gz
SACHTET UZK map:            ./testcase/sac_UZK.gz
SACHTET PFREE map:          ./testcase/sac_PFREE.gz
SACHTET REXP map:           ./testcase/sac_REXP.gz
SACHTET ZPERC map:          ./testcase/sac_ZPERC.gz
SACHTET EFC map:            ./testcase/sac_EFC.gz
SACHTET PCTIM map:          ./testcase/sac_PCTIM.gz
SACHTET soil albedo map:    ./testcase/sachtet_soilAlbedo.gz
SACHTET offset time map:    ./testcase/sachtet_offsetTime.gz
SACHTET STXT map:           ./testcase/frz_STXT.gz
SACHTET TBOT map:           ./testcase/frz_TBOT.gz
SACHTET CKSL map:                     none
SACHTET RSMAX map:                    none
SACHTET ZBOT map:                     none
SACHTET parameter spatial transform:  none
SACHTET parameter fill option:        none
SACHTET parameter fill radius:
SACHTET parameter fill value:
SACHTET map projection:               hrap
SACHTET offset time map:
```

`SNOW17 parameter files`: specifies the locations of SNOW-17 parameter files. These files contain snow and soil-based parameter information that can be used in the SNOW-17 model run.

`SNOW17 ADC directory:` specifies the location of the multiband Snow-17 curve coordinates.

`SNOW17 ADC number of points:` specifies the number of areal depletion curve (ADC) points along the curve defining snow depletion rates.

`SNOW17 PGM map:` specifies the ground melt (in mm) input map.

`SNOW17 parameter spatial transform:` specifies the general grid spatial transform option for SNOW-17. Only current option for now is “none”.

`SNOW17 parameter fill option:` specifies the general SNOW-17 parameter fill option. This option is not currently supported but can be in the future.

`SNOW17 parameter fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

`SNOW17 parameter fill value:` indicates which SNOW17 parameter value to be used if an arbitrary value fill is needed.

`SNOW17 map projection:` specfies the general SNOW-17 parameter map projection. Currently only “hrap” is supported. Others like, “latlon”, will be supported in the future.

`SNOW17 MFMAX map:` specifies the maximum melt factor [mm/(6hrC)]

`SNOW17 MFMIN map:` specifies the minimum melt factor [mm/(6hrC)]

`SNOW17 UADJ map:` specifies the the average wind function during rain-on-snow periods [mm/mb]

`SNOW17 ALAT map:` specifies the latitude [-]

`SNOW17 ELEV map:` specifies the elevation [m]

`SNOW17 SCF map:` specifies the snow fall correction factor [-]

`SNOW17 NMF map:` specifies the maximum negative melt factor [mm/(6hrC)]

`SNOW17 SI map:` specifies the areal water-equivalent above which 100 percent areal snow cover [mm]

`SNOW17 MBASE map:` specifies the base temperature for non-rain melt factor [C]

`SNOW17 PXTEMP map:` specifies the temperature which spereates rain from snow [C]

`SNOW17 PLWHC map:` specifies the maximum amount of liquid-water held against gravity drainage [-]

`SNOW17 TIPM map:` specifies the antecedent snow temperature index parameter [-]

`SNOW17 LAEC map:` specifies the snow-rain split temperature [C]

Example ldt.config entry

```
SNOW17 MFMAX map:       ./testcase/snow_MFMAX.gz
SNOW17 MFMIN map:       ./testcase/snow_MFMIN.gz
SNOW17 UADJ map:        ./testcase/snow_UADJ.gz
SNOW17 ALAT map:        ./testcase/snow_ALAT.gz
SNOW17 ELEV map:        ./testcase/snow_ELEV.gz
SNOW17 SCF map:                 none
SNOW17 NMF map:                 none
SNOW17 SI map:                  none
SNOW17 MBASE map:               none
SNOW17 PXTEMP map:              none
SNOW17 PLWHC map:               none
SNOW17 TIPM map:                none
SNOW17 PGM map:                 none
SNOW17 ELEV map:                none
SNOW17 LAEC map:                none
SNOW17 ADC directory:           none
SNOW17 ADC number of points:     11
SNOW17 parameter spatial transform:  none
SNOW17 parameter fill option:        none
SNOW17 parameter fill radius:
SNOW17 parameter fill value:
SNOW17 map projection:               hrap
```

`SiB2 static parameter directory:` specifies the location of Simple Biospheric v2 (SiB2) Model parameter files. These files contain vegetation- and soil-based parameter information that can be used in the SiB2 model run.

`SiB2 parameter spatial transform:` specifies the general grid spatial transform option for SiB2. Only current option for now is “none”.

`SiB2 map projection:` specfies the general SiB2 parameter map projection. What projections are available?

`SiB2 parameter fill option:` specifies the general SiB2 parameter fill option.

`SiB2 parameter fill radius:` specifies the radius with which to search for nearby value(s) to help fill in the missing value.

`SiB2 parameter fill value:` indicates which SiB2 parameter value to be used if an arbitrary value fill is needed.

Example ldt.config entry

```
SiB2 static parameter directory:  ./testdata/
SiB2 parameter spatial transform:   none
SiB2 parameter fill option:         none
SiB2 map projection:               latlon
SiB2 lower left lat:               25.025
SiB2 lower left lon:             -124.975
SiB2 upper right lat:              49.475
SiB2 upper right lon:             -67.025
SiB2 resolution (dx):               0.05
SiB2 resolution (dy):               0.05
```

7.7.1. WRSI model parameter files

`WRSI landmask file:` specifies the location of the GeoWRSI 2.0 land mask file (default file is in *BIL format).

`WRSI length of growing period file:` specifies the location of the GeoWRSI 2.0 length of growing period file (default file is in *BIL format).

`WRSI water holding capacity file:` specifies the location of the GeoWRSI 2.0 water holding capacity file (default file is in *BIL format).

`WRSI WRSI climatology file:` specifies the location of the GeoWRSI 2.0 WRSI climatology file (default file is in *BIL format).

`WRSI SOS climatology file:` specifies the location of the GeoWRSI 2.0 SOS climatology file (default file is in *BIL format).

`WRSI SOS file:` specifies the location of an (optional) current start-of-season (SOS) file (default file is in *BIL format).

`WRSI SOS anomaly file:` specifies the location of an (optional) current (SOS) anomaly file (default file is in *BIL format).

Example ldt.config entry

```
WRSI landmask file:                 ./data/Africa/Static/sawmask
WRSI length of growing period file: ./data/Africa/Static/lgp_south
WRSI water holding capacity file:   ./data/Africa/Static/whc3
WRSI WRSI climatology file:         ./data/Africa/Static/wsimedn_edc_s
WRSI SOS climatology file:          ./data/Africa/SOS/sosmedn_edc_s
WRSI SOS file:                       none
WRSI SOS anomaly file:               none
```

7.8. Climate Parameters

Climatology parameter maps

`PPT climatology data source:` specifies the monthly precipitation (PPT) climatology fields. Current source options include:

Value	Description
PRISM	PRISM US-only climate downscaled fields. For more info, see: http://www.prism.oregonstate.edu/
WORLDCLIM	Global climate layers downscaled. For more info, see: http://www.worldclim.org/

`PPT climatology maps:` specifies the source of the climatology based precipitation files. The climatology precipitation data files can have the following naming conventions, depending on the data source:

PRISM: <directory>/<file header>.<tag>.txt

- The file header can be anything (such as ppt_1931_2010).
- The tag should represent the month (such as jan, feb, mar, etc.).

WORLDCLIM: <directory>/<file header>.<tag>.1gd4r

- The file header can be prec_
- The tag should represent the month (such as 1, 2,…, 12).

`PPT climatology interval:` specifies the frequency of the precipitation climatology in months. Current option is: “monthly”

Example ldt.config entry

```
PPT climatology data source:  PRISM
PPT climatology maps:  ../LS_PARAMETERS/climate_maps/ppt_1981_2010
PPT climatology interval:     monthly
```

`TMIN climatology maps:` specifies the source of the climatology based minimum temperature files.

`TMAX climatology maps:` specifies the source of the climatology based maximum temperature files.

Example ldt.config entry

```
TMIN climatology maps:
TMAX climatology maps:
```

`Climate params spatial transform:` indicates which spatial transform (i.e., upscale or downscale) type is to be applied to climate parameters. Only “average” spatial transform works currently for the “WORLDCLIM” climatology files. Options include:

Value	Description
none	Data is on same grid as LIS output domain
average	Upscale by averaging values for each gridcell
neighbor	Reinterpolate by selecting nearest gridcell neighbor
bilinear	Reinterpolate by using bilinear interpolation
budget-bilinear	Reinterpolate by using conservative, budget-bilinear

Example ldt.config entry

```
Climate params spatial transform:   average
```

This section also outlines the domain specifications of climatology-based parameters, like higher scaled monthly precipitation or min/max temperatures. If the map projection of parameter data is specified to be lat/lon, the following configuration should be used for specifying climatology data. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
Climate params map projection:     latlon
```

7.9. Forcing Parameters

7.9.1. NLDAS-2 Forcing based parameter inputs

`NLDAS2 elevation difference map:` specifies the NLDAS-2 elevation difference file used to remove built-in elevation correction.

`NARR terrain height map:` specifies the terrain height map for the NLDAS-2 base forcing of the North American Regional Reanalysis (NARR).

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
NLDAS2 elevation difference map: ../NARR_elev-diff.1gd4r
NARR terrain height map:         ../NARR_elevation.1gd4r
```

7.9.2. NLDAS-1 Forcing based parameter inputs

`NLDAS1 elevation difference map:` specifies the NLDAS-1 elevation difference file used to remove built-in elevation correction.

`EDAS terrain height map:` specifies the terrain height map for the NLDAS-1 base forcing of the Eta Data Assimilation System (EDAS).

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
NLDAS1 elevation difference map: ../NLDAS1/EDAS_elev-diff.1gd4r
EDAS terrain height map:         ../NLDAS1/EDAS_elevation.1gd4r
```

7.9.3. PRINCETON Forcing based parameter inputs

`PRINCETON elevation map:` specifies the terrain height map for the Princeton University global forcing dataset.

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
PRINCETON elevation map:     ../PRINCETON/hydro1k_elev_mean_1d.asc
```

7.9.4. NAM242 Forcing based parameter inputs

`NAM242 elevation map:` specifies the terrain height map for the North American Mesoscale (NAM) NOAA grid 242 forcing dataset.

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
NAM242 elevation map:     ../NAM/terrain.242.grb
```

7.9.5. GDAS

GDAS parameter inputs: GDAS elevation maps specify lowest boundary layer information which can be used to downscale or lapse rate adjust GDAS meteorological variables, if given a higher resolution elevation height map. Original files are given in Grib-1 format and on their original Gaussian grids (from NCEP), so the GDAS elevation file reader is set up to support these files.

`GDAS forcing directory:` specifies the location of the GDAS forcing data files.

`GDAS T126 elevation map:` specifies the GDAS T126 elevation definition.

`GDAS T170 elevation map:` specifies the GDAS T170 elevation definition.

`GDAS T254 elevation map:` specifies the GDAS T254 elevation definition.

`GDAS T382 elevation map:` specifies the GDAS T382 elevation definition.

`GDAS T574 elevation map:` specifies the GDAS T574 elevation definition.

`GDAS T1534 elevation map:` specifies the GDAS T1534 elevation definition.

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
GDAS forcing directory:
GDAS T126 elevation map:  ./GDAS/global_orography.t126.grb
GDAS T170 elevation map:  ./GDAS/global_orography.t170.grb
GDAS T254 elevation map:  ./GDAS/global_orography.t254.grb
GDAS T382 elevation map:  ./GDAS/global_orography.t382.grb
GDAS T574 elevation map:  ./GDAS/global_orography.t574.grb
GDAS T1534 elevation map: ./GDAS/global_orography_uf.t1534.3072.1536.grb
```

7.9.6. ECMWF

ECMWF parameter inputs: ECMWF elevation maps specify lowest boundary layer information which can be used to downscale or lapse rate adjust ECMWF meteorological variables, if given a higher resolution elevation height map. Original files are given in Grib-1 format and on their original lat-lon grids (from ECMWF), so the ECMWF elevation file reader is set up to support these files.

`ECMWF forcing directory:` specifies the location of the ECMWF forcing data files.

`ECMWF IFS23R4 elevation map:` specifies the ECMWF IFS23R4 terrain height map file path.

`ECMWF IFS25R1 elevation map:` specifies the ECMWF IFS25R1 terrain height map file path.

`ECMWF IFS30R1 elevation map:` specifies the ECMWF IFS30R1 terrain height map file path.

`ECMWF IFS33R1 elevation map:` specifies the ECMWF IFS33R1 terrain height map file path.

`ECMWF IFS35R2 elevation map:` specifies the ECMWF IFS35R2 terrain height map file path.

`ECMWF IFS35R3 elevation map:` specifies the ECMWF IFS35R3 terrain height map file path.

`ECMWF IFS36R1 elevation map:` specifies the ECMWF IFS36R1 terrain height map file path.

`ECMWF IFS37R2 elevation map:` specifies the ECMWF IFS37R2 terrain height map file path.

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
ECMWF forcing directory:
ECMWF IFS23R4 elevation map:  ./ECMWF/ecmwf.2001092006.092006.elev_1_4
ECMWF IFS25R1 elevation map:  ./ECMWF/ecmwf.2003010806.010806.elev_1_4
ECMWF IFS30R1 elevation map:  ./ECMWF/ecmwf.2006020106.020106.elev_1_4
ECMWF IFS33R1 elevation map:  ./ECMWF/ecmwf.2008060306.060306.elev_1_4
ECMWF IFS35R2 elevation map:  ./ECMWF/ecmwf.2009031006.031006.elev_1_4
ECMWF IFS35R3 elevation map:  ./ECMWF/ecmwf.2009090806.090806.elev_1_4
ECMWF IFS36R1 elevation map:  ./ECMWF/ecmwf.2010012606.012606.elev_1_4
ECMWF IFS37R2 elevation map:  ./ECMWF/ecmwf.2011051806.051806.elev_1_4
```

7.9.7. ECMWF Reanalysis Forcing based parameter inputs

`ECMWF Reanalysis forcing directory:` specifies the location of the ECMWF Reanalysis forcing data files.

`ECMWF Reanalysis maskfile:` specifies the ECMWF Reanalysis mask file.

`ECMWF Reanalysis elevation map:` specifies the ECMWF Reanalysis elevation file.

`ECMWF Reanalysis elevation spatial transform:` specifies the terrain height map spatial grid transform option (e.g., average).

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

Example ldt.config entry

```
ECMWF Reanalysis forcing directory:
ECMWF Reanalysis elevation map: ./metforcing_parms/ECMWFRean/elev_ECMWF-
reanalysis.1gd4r
ECMWF Reanalysis elevation spatial transform:   "average"
ECMWF Reanalysis maskfile:
```

7.9.8. ERA5 Reanalysis Forcing based parameter inputs

`ERA5 forcing directory:` specifies the location of the ERA5 Reanalysis forcing data files.

`ERA5 forcing tile to grid mapping file:` specifies the file that maps the 1-d forcing to a 2-d format

`ERA5 forcing terrain height file:` specifies the ERA5 reanalysis elevation file

Example ldt.config entry

```
ERA5 forcing directory:              ./ERA5/
ERA5 forcing tile to grid mapping file: ../ERA5/mapping.nc
ERA5 forcing terrain height file: ../ERA5/era5_elev.nc
```

7.9.9. MERRA-2 Forcing based parameter inputs

`MERRA2 geopotential terrain height file:` specifies the MERRA-2 geopotential height file, which gets converted to terrain height (in meters) in LDT.

Example ldt.config entry

```
MERRA2 geopotential terrain height file:
./MERRA2_100/MERRA2_101.const_2d_asm_Nx.00000000.nc4
```

7.9.10. TRMM 3B42RTV7 precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.11. TRMM 3B42V6 precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.12. TRMM 3B42V7 precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.13. CMAP precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.14. CMORPH precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.15. MERRA-Land forcing

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.16. MERRA2 forcing

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.17. RDHM356 forcing

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.18. RFE2Daily precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.19. RFE2gdas precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.20. CHIRPSv2 precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.21. Stage II precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.22. Stage IV precipitation

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.23. AGRMET

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.24. GEOS5 forecast

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.9.25. GFS

If the run mode option selected is “Metforce processing” or “Metforce temporal downscaling”, please see the latest LIS Users’ Guide.

7.10. LIS restart preprocessing options

`Input restart file directory:` specifies the LIS output directory containing the restart files. It should be the same path as listed in “Output directory:” in the *lis.config* file used to generate the restart files.

`Input restart file naming style:` specifies the style of the LIS model and restart output names and their organization. Acceptable values are:

Value	Description
“2 level hierarchy”	2 levels of hierarchy
“3 level hierarchy”	3 levels of hierarchy
“4 level hierarchy”	4 levels of hierarchy
“WMO convention”	WMO convention for weather codes

`Input restart file output interval:` specifies the output interval of the restart files from the LIS output.

`Input restart model timestep used:` specifies the timestep of the LSM or Routing model from the LIS output used to generate the restart files.

`Input restart file format:` specifies the file format of the LIS restart files. Can be “netcdf” or “binary”. If config entry is not present, LDT defaults to “netcdf”. Note that the “binary” option is only supported for processing restart files from the VIC.4.1.2 LSM.

`Output restart file generation mode:` specifies the method of generation of the LDT output restart preprocessing files. The only current option is “climatological average”.

`Output restart file averaging interval type:` specified the averaging interval of the LDT output restart preprocessing files. The only current option is “monthly”.

NOTE

If the VIC.4.1.2 LSM is used with binary restarts, the following VIC-specific options are also required in *ldt.config*:

`VIC412 veg tiling scheme:` specifies whether VIC or LIS will perform vegetation-based sub-grid tiling.

For LIS sub-grid tiling, tiling is based on vegetation fractions from the “landcover file:” file, set this config entry to 1.

For VIC sub-grid tiling, tiling is based on vegetation fractions from the “VEGPARAM” file, set this config entry to 0.

See the LIS Users’ Guide and/or VIC’s documentation at: https://vic.readthedocs.io/en/vic.4.2.d/Development/VersionSummaries/ for more information about configuring these VIC options.

`VIC412_NLAYER:`

`VIC412_NODES:`

`VIC412_DIST_PRCP:`

`VIC412_SNOW_BAND:`

The above 5 config entries should all be the same values as specified in the *lis.config* file used to generate the VIC.4.1.2 LSM restart files.

Example ldt.config entry

```
Input restart file directory:                 ./path_to_lis_output_directory
Input restart file naming style:              "3 level hierarchy"
Input restart file output interval:           1mo
Input restart model timestep used:            15mn
Input restart file format:                    netcdf
Output restart file generation mode:          "climatology average"
Output restart file averaging interval type:    "monthly"
```

7.11. LIS restart transformation processing options

`LIS restart source:` specifices the land surface model restart file. Acceptable values are:

Value	Description
LSM	LSM restart file type

`Input restart filename:` specifies the name of the input restart file.

`Output restart filename:` specifies the name of the output restart file.

Example ldt.config entry

```
LIS restart source:      "LSM"
Input restart filename:  LIS_RST_NOAHMP401_201907010000.d01.coarse.nc
Output restart filename: LIS_RST_NOAHMP401_201907010000.d01.fine.nc
```

7.12. Ensemble restart model options

`LIS restart source:` specifies the surface model restart file source. Options are:

Value	Description
LSM	LSM restart file type
Routing	river or streamflow routing model restart file type

Example ldt.config entry

```
LIS restart source:   "LSM"
```

`Ensemble restart generation mode:` specifies the mode of ensemble restart generation. Options are:

Value	Description
upscale	convert from a single member restart to a multi-member restart

Value	Description
downscale	convert from a multi-member restart to a single member restart

Example ldt.config entry

```
Ensemble restart generation mode:   "upscale"
```

`Input restart filename:` specifies the name of the input restart file.

Example ldt.config entry

```
Input restart filename: ../OL/LIS_RST_NOAH33_201001010000.d01.nc
```

`Output restart filename:` specifies the name of the output restart file.

Example ldt.config entry

```
Output restart filename: ./LIS_RST_NOAH33_201001010000.d01.nc
```

`Number of ensembles per tile (input restart):` specifies the number of ensemble members used in the input restart file.

Example ldt.config entry

```
Number of ensembles per tile (input restart): 1
```

`Number of ensembles per tile (output restart):` specifies the number of ensemble members to be used in the output restart file.

Example ldt.config entry

```
Number of ensembles per tile (output restart): 12
```

NOTE

Make sure to specify the surface type, veg, soil, etc., subgrid tiling entries. For upscaling or downscaling of restart files, maximum number of tiles and minimum cutoff percentage entries for subgrid tiling based on vegetation or other parameter types (e.g., soil type, elevation, etc.) are required as entries.

For example, must include, `Maximum number of surface type tiles per grid:`

7.13. NUWRF preprocessing for real options

The section describes some of the LDT-based NUWRF real input processing options.

`LIS history file for land state initialization:` specifies the file name of the LIS history file to use to initialize the land state.

`Processed NUWRF file for input to real:` specifies the file name of the generated file that is then used as input to the real.exe program in NUWRF.

Example ldt.config entry

```
LIS history file for land state initialization:   EXAMPLE
Processed NUWRF file for input to real:     EXAMPLE
```

7.14. Data Assimilation preprocessing options

The start time is specified in the following format:

Variable	Value	Description
`Starting year:`	integer 2001 – present	specifying starting year
`Starting month:`	integer 1 – 12	specifying starting month
`Starting day:`	integer 1 – 31	specifying starting day
`Starting hour:`	integer 0 – 23	specifying starting hour
`Starting minute:`	integer 0 – 59	specifying starting minute
`Starting second:`	integer 0 – 59	specifying starting second

Example ldt.config entry

```
Starting year:                 2002
Starting month:                  1
Starting day:                    2
Starting hour:                   0
Starting minute:                 0
Starting second:                 0
```

The end time is specified in the following format:

Variable	Value	Description
`Ending year:`	integer 2001 – present	specifying ending year
`Ending month:`	integer 1 – 12	specifying ending month
`Ending day:`	integer 1 – 31	specifying ending day
`Ending hour:`	integer 0 – 23	specifying ending hour
`Ending minute:`	integer 0 – 59	specifying ending minute
`Ending second:`	integer 0 – 59	specifying ending second

Example ldt.config entry

```
Ending year:                  2010
Ending month:                  1
Ending day:                    1
Ending hour:                   0
Ending minute:                 0
Ending second:                 0
```

`LIS output timestep:` specifies the LIS output time-step.

Example ldt.config entry

```
LIS output timestep:          1da
```

`DA observation source:` specifies the source of the observation data on which preprocessing is performed. Options are:

Value	Description
"LIS LSM soil moisture"	soil moisture output from a LIS run
"Synthetic soil moisture"	synethtic soil moisture observations created from a LIS run
"AMSR-E(LPRM) soil moisture"	Land Parameter Retrieval Model (LPRM) retrievals of AMSR-E soil moisture
"AMSR-E(NASA) soil moisture"	NASA AMSR-E soil moisture
"ESA CCI soil moisture"	Essential Climate Variable (ECV) soil moisture retrievals
"WindSat soil moisture"	WindSat retrievals of soil moisture
"SMOPS soil moisture"	NESDIS Soil Moisture Operational Processing System (SMOPS) based soil moisture retrievals
"ASCAT TUW soil moisture"	ASCAT soil moisture retrievals from TU Wein
"GRACE TWS"	Terrestrial water storage observations from GRACE
"Simulated GRACE"	Simulated water storage observations from GRACE
"MCD15A2H LAI"	MODIS MCD15A2H v006 LAI product

Example ldt.config entry

```
DA observation source:   "AMSR-E(LPRM) soil moisture"
```

`DA preprocessing method:` specifies which preprocessing method should be used. Acceptable values are:

Value	Description
“Obs grid generation”	Create the observation space grid only
“CDF generation”	Create CDFs for the given data source
“Anomaly correction”	Create updated observations for DA by applying anomaly correction (Used for GRACE DA)

Example ldt.config entry

```
DA preprocessing method:  "CDF generation"
```

`Name of the preprocessed DA file:` specifies the name of the preprocessed DA file from LDT.

Example ldt.config entry

```
Name of the preprocessed DA file: "lprm_cdf"
```

`Number of bins to use in the CDF:` specifies the number of bins to use while computing the CDF.

Example ldt.config entry

```
Number of bins to use in the CDF: 100
```

`Temporal resolution of CDFs:` specifies whether to generate lumped (considering all years and all seasons) CDFs or to stratify CDFs for each calendar month. Acceptable values are:

Value	Description
monthly	stratify for each calendar month
yearly	lump (considering all years and all seasons)

Example ldt.config entry

```
Temporal resolution of CDFs:     monthly
```

`Enable spatial sampling for CDF calculations:` Normally CDFs are calculated (for a given grid cell) by using the data values available at that grid point only. If this option is enabled, then values around a specified radius will be used in the CDF calculations, effectively improving the sampling density at the risk of reduced geographic specificity.

Example ldt.config entry

```
Enable spatial sampling for CDF calculations: 1
```

`Spatial sampling window radius for CDF calculations:` specifies the radius with which to search for nearby value(s) in the CDF calculations.

Example ldt.config entry

```
Spatial sampling window radius for CDF calculations: 2
```

`Group CDFs by external data:` specifies whether to group CDFs for each pixel by an externally specified categorical map; for example, by landcover. Acceptable values are:

Value	Description
0	do not group by external data
1	group by external data

Example ldt.config entry

```
Group CDFs by external data:     0
```

`CDF grouping attributes file:` specifies the name of an ASCII file that specifies the attributes of the CDF grouping, if enabled. A sample file is shown below. The first line is a description. The second line is the name of the file containing the external data for grouping. The third line is a descrition. The fourth line is the minimum value of the categorical data, followed by the maximum value of the categorical data, followed by the number of bins of the categorical data.

#category file
landcover.1gd4r
#min max nbins
1 19 18

Example ldt.config entry

```
CDF grouping attributes file:     cdf_grouping.txt
```

`Temporal averaging interval:` specifies temporal averaging interval to be used while computing the CDF.

Example ldt.config entry

```
Temporal averaging interval:  "1da"
```

`Apply external mask:` specifies if an external mask (time varying) is to be applied while computing the CDF.

Example ldt.config entry

```
Apply external mask:   0
```

`External mask directory:` specifies the location of the external mask.

Example ldt.config entry

```
External mask directory:  none
```

`Observation count threshold:` specifies the minimum number of observations to be used for generating valid CDF data.

Example ldt.config entry

```
Observation count threshold:  500
```

`LIS soil moisture output format:` specifies the output format of the LIS model output. (binary/netcdf/grib1)

`LIS soil moisture output methodology:` specifies the output methodology used in the LIS model output (1d tilespace/1d gridspace/2d gridspace).

`LIS soil moisture output naming style:` specifies the output naming style used in the LIS model output (3 level hierarchy/4 level hierarchy, etc.).

`LIS soil moisture output nest index:` specifies the index of the nest used in the LIS model output.

`LIS soil moisture output directory:` specifies the location of the LIS model output.

`LIS soil moisture output timestep:` specifies the output timestep of the LIS soil moisture.

`LIS soil moisture output map projection:` specifies the map projection used in the LIS model output.

For Lat/Lon projections:

`LIS soil moisture domain lower left lat:` specifies the lower left latitude of the LIS model output.

`LIS soil moisture domain lower left lon:` specifies the lower left longitude of the LIS model output.

`LIS soil moisture domain upper right lat:` specifies the upper right latitude of the LIS model output.

`LIS soil moisture domain upper right lon:` specifies the upper right longitude of the LIS model output.

`LIS soil moisture domain resolution (dx):` specifies the resolution (in degrees) along the latitude of the LIS model output.

`LIS soil moisture domain resolution (dy):` specifies the resolution (in degrees) along the longitude of the LIS model output.

For Lambert and polar projections:

`LIS soil moisture domain lower left lat:` specifies the lower left latitude of the LIS model output

`LIS soil moisture domain lower left lon:` specifies the lower left longitude of the LIS model output

`LIS soil moisture domain true lat1:` specifies the true lat1 of the LIS model output

`LIS soil moisture domain true lat2:` specifies the true lat2 of the LIS model output

`LIS soil moisture domain standard lon:` specifies the standard longitude of the LIS model output

`LIS soil moisture domain resolution:` specifies the resolution of the LIS model output

`LIS soil moisture domain x-dimension size:` specifies the x-dimension size of the LIS model output

`LIS soil moisture domain y-dimension size:` specifies the y-dimension size of the LIS model output

For "WMO convention" style output

`LIS soil moisture security class:` specifies the security classification for the LIS model output file, used only for WMO-convention output.

`LIS soil moisture distribution class:` specifies the distribution classification for the LIS model output file, used only for WMO-convention output.

`LIS soil moisture data category:` specifies the data category for the LIS model output file, used only for WMO-convention output.

`LIS soil moisture area of data:` specifies the area of data for the LIS model output file, used only for WMO-convention output.

`LIS soil moisture write interval:` specifies the write interval for the LIS model output file, used only for WMO-convention output.

Example ldt.config entry

```
LIS soil moisture output format:            "netcdf"
LIS soil moisture output methodology:       "2d gridspace"
LIS soil moisture output naming style:      "3 level hierarchy"
LIS soil moisture output map projection:    "latlon"
LIS soil moisture output nest index:        1
LIS soil moisture output timestep:          EXAMPLE
LIS soil moisture output directory:         ../OL/OUTPUT
LIS soil moisture domain lower left lat:    18.375
LIS soil moisture domain lower left lon:    -111.375
LIS soil moisture domain upper right lat:   41.375
LIS soil moisture domain upper right lon:   -85.875
LIS soil moisture domain resolution (dx):   0.25
LIS soil moisture domain resolution (dy):   0.25
LIS soil moisture security class:
LIS soil moisture distribution class:
LIS soil moisture data category:
LIS soil moisture area of data:
LIS soil moisture write interval:
```

`Synthetic soil moisture observation directory:` specifies the location of the data directory containing the synthetic soil moisture data.

`Synthetic soil moisture observation timestep:` specifies the timestep of the synthetic soil moisture observations.

Example ldt.config entry

```
Synthetic soil moisture observation directory:  ./SYN_SM
Synthetic soil moisture observation timestep:   EXAMPLE
```

`AMSR-E(LPRM) soil moisture observation directory:` specifies the location of the data directory containing the LPRM AMSR-E data.

`AMSR-E(LPRM) use raw data:` specifies if raw data (instead of the retrievals CDF-matched to the GLDAS Noah climatology).

Example ldt.config entry

```
AMSR-E(LPRM) soil moisture observation directory:  ./LPRM.v5
AMSR-E(LPRM) use raw data:          1
```

`NASA AMSRE soil moisture observation directory:` specifies the location of the data directory containing the NASA AMSR-E data.

Example ldt.config entry

```
NASA AMSRE soil moisture observation directory: ./NASA_AMSRE
```

`ESA CCI soil moisture observation directory:` specifies the location of the data directory containing the ESA CCI soil moisture data.

`ESA CCI soil moisture version of data:` specifies the version of the ESA CCI soil moisture dataset.

Example ldt.config entry

```
ESA CCI soil moisture observation directory:  ./ECV
ESA CCI soil moisture version of data:        EXAMPLE
```

`GCOMW AMSR2 L3 soil moisture observation directory:` specifies the location of the data directory containing the GCOMW AMSR v2 L3 soil moisture data.

Example ldt.config entry

```
GCOMW AMSR2 L3 soil moisture observation directory:  ./GCOMW_AMSR2
```

`WindSat soil moisture observation directory:` specifies the location of the data directory containing the WindSat soil moisture data.

Example ldt.config entry

```
WindSat soil moisture observation directory:  ./WindSat
```

`Aquarius L2 soil moisture observation directory:` specifies the location of the data directory containing the Aquarius soil moisture data.

Example ldt.config entry

```
Aquarius L2 soil moisture observation directory:  ./Aquarias_SM/
```

`SMOS L2 soil moisture observation directory:` specifies the location of the data directory containing the SMOS soil moisture data.

Example ldt.config entry

```
SMOS L2 soil moisture observation directory:  ./SMOS_SM/
```

`SMOPS soil moisture observation directory:` specifies the location of the data directory containing the real time SMOPS soil moisture data.

`SMOPS soil moisture use ASCAT data:` specifies if the ASCAT layer of SMOPS is to be used.

`SMOPS soil moisture use SMOS data:` specifies if the SMOS layer of SMOPS is to be used.

`SMOPS soil moisture use AMSR2 data:` specifies if the AMSR2 layer of SMOPS is to be used.

`SMOPS soil moisture use SMAP data:` specifies if the SMAP layer of SMOPS is to be used.

`SMOPS soil moisture version:` specifies the version of the SMOPS soil moisture datasets. Defaults to “date-based”. Acceptable values are:

Value	Description
“date-based”	Assume the version of the dataset based on date. (default)
“1.3”	Treat the dataset as version 1.3.
“2.0”	Treat the dataset as version 2.0.
“3.0”	Treat the dataset as version 3.0.
“NESDIS V3.0 REGEN”	Assume the version of the dataset based on the NESDIS version 3.0 regeneration date.

There are three versions of the SMOPS datasets. According to the use by the 557th Weather Wing:

```
                      version_1.3 <  2016-10-31T12:00:00
2016-10-31T12:00:00 <= version_2.0 <  2017-08-24T12:00:00
                      version_3.0 >= 2017-08-24T12:00:00
```

Also, NESDIS has regenerated SMOPS version 3.0 datasets starting from 2012-08-01.

The value “date-based” will use the dates 2016-10-31 and 2017-08-24 to determine the version of the SMOPS datasets.

The value “NESDIS V3.0 REGEN” will use the date 2012-08-01 to determine the version of the SMOPS datasets.

Should you need to explicitly state the version of the SMOPS datasets, then you may specify their version with either “1.3”, “2.0”, or “3.0”.

`SMOPS search radius for openwater proximity detection:` specifies the radius in which LDT search to detect open water. Then removes all pixels within the radius in the CDF calculations.

Example ldt.config entry

```
SMOPS soil moisture observation directory:  ./RTSMOPS
SMOPS soil moisture use ASCAT data:       1
SMOPS soil moisture use SMOS data:        0
SMOPS soil moisture use AMSR2 data:       0
SMOPS soil moisture use SMAP data:        0
SMOPS soil moisture version:              "date-based"
SMOPS search radius for openwater proximity detection: 3
```

`ASCAT (TUW) soil moisture observation directory:` specifies the location of the data directory containing the TU Wein retrievals of ASCAT soil moisture data.

Example ldt.config entry

```
ASCAT (TUW) soil moisture observation directory:  ./TUW_ASCAT
```

`MCD15A2H LAI data directory:` specifies the location of the data directory containing the MODIS MCD15A2H LAI retrievals.

`MCD15A2H LAI data version:` specifies the version of the MCD15A2H LAI retrievals. The default version is "006".

`MCD15A2H LAI apply climatological fill values:` specifies whether to fill in climatological LAI values if there are missing values.

`MCD15A2H LAI apply QC flags:` specifies whether to apply quality control flags for LAI retrievals.

Example ldt.config entry

```
MCD15A2H LAI data directory:           ./MCD15A2H.006
MCD15A2H LAI data version:              "006"
MCD15A2H LAI apply climatological fill values: 1
MCD15A2H LAI apply QC flags: 1
```

`GRACE raw data filename:` specifies the name of the GRACE raw data.

`GRACE baseline starting year:` specifies the baseline starting year from which to establish the TWS climatology.

`GRACE baseline ending year:` specifies the baseline ending year from which to establish the TWS climatology.

`GRACE scale factor filename:` specifies the name of the file containing the GRACE scale factor. This is NetCDF file provided by JPL.

`GRACE measurement error filename:` specifies the name of the file containing the GRACE measurement error. This is a NetCDF file provided by JPL.

`GRACE process basin averaged observations:` specifies whether to process basin averaged observations. Default value is 0. Acceptable values are:

Value	Description
0	do not process
1	process

`GRACE basin map file:` specifies the file name of the basin map data.

`LIS TWS output format:` specifies the output format of the LIS model output (binary/netcdf/grib1).

`LIS TWS output methodology:` specifies the output methodology used in the LIS model output (1d tilespace/1d gridspace/2d gridspace).

`LIS TWS output naming style:` specifies the output naming style used in the LIS model output (3 level hierarchy/4 level hierarchy, etc.).

`LIS TWS output nest index:` specifies the index of the nest used in the LIS model output.

`LIS TWS output directory:` specifies the location of the LIS model output.

`LIS TWS output map projection:` specifies the map projection used in the LIS model output.

For lat/lon projection:

`LIS TWS output domain lower left lat:` specifies the lower left latitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain lower left lon:` specifies the lower left longitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain upper right lat:` specifies the upper right latitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain upper right lon:` specifies the upper right longitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain resolution (dx):` specifies the resolution (in degrees) along the latitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain resolution (dy):` specifies the resolution (in degrees) along the longitude of the LIS model output (if map projection is latlon).

For Lambert and polar projections:

`LIS TWS output domain lower left lat:` specifies the lower left latitude of the LIS model output

`LIS TWS output domain lower left lon:` specifies the lower left longitude of the LIS model output

`LIS TWS output domain true lat1:` specifies the true lat1 of the LIS model output

`LIS TWS output domain true lat2:` specifies the true lat2 of the LIS model output

`LIS TWS output domain standard lon:` specifies the standard longitude of the LIS model output

`LIS TWS output domain resolution:` specifies the resolution of the LIS model output

`LIS TWS output domain x-dimension size:` specifies the x-dimension size of the LIS model output

`LIS TWS output domain y-dimension size:` specifies the y-dimension size of the LIS model output

Example ldt.config entry

```
GRACE raw data filename:    ../GRACE_tws/GRACE.CSR.LAND.RL05.DS.G200KM.nc
GRACE baseline starting year:      2004
GRACE baseline ending year:        2009
GRACE scale factor filename:       EXAMPLE
GRACE measurement error filename:  EXAMPLE
LIS TWS output format:                  "netcdf"
LIS TWS output methodology:             "2d gridspace"
LIS TWS output naming style:            "3 level hierarchy"
LIS TWS output map projection:          "latlon"
LIS TWS output nest index:              1
LIS TWS output directory:               ../OL_NLDAS/OUTPUT
LIS TWS output domain lower left lat:         25.0625
LIS TWS output domain lower left lon:        -124.9375
LIS TWS output domain upper right lat:        52.9375
LIS TWS output domain upper right lon:        -67.0625
LIS TWS output domain resolution (dx):          0.125
LIS TWS output domain resolution (dy):          0.125
```

`Simulated GRACE data directory:` specifies the directory containing the simulated GRACE observations.

`Simulated GRACE configuration:` specifies the simulated GRACE configuration. Acceptable values are:

Value	Description
“default”	default
“follow-on”	follow on

Value	Description
“GRACE-2”	GRACE-2

`Simulated GRACE baseline starting year:` specifies the baseline starting year from which to establish the simulated TWS climatology.

`Simulated GRACE baseline ending year:` specifies the baseline ending year from which to establish the simulated TWS climatology.

`LIS TWS output format:` specifies the output format of the LIS model output (binary/netcdf/grib1).

`LIS TWS output methodology:` specifies the output methodology used in the LIS model output (1d tilespace/1d gridspace/2d gridspace).

`LIS TWS output naming style:` specifies the output naming style used in the LIS model output (3 level hierarchy/4 level hierarchy, etc.).

`LIS TWS output nest index:` specifies the index of the nest used in the LIS model output.

`LIS TWS output directory:` specifies the location of the LIS model output.

`LIS TWS output map projection:` specifies the map projection used in the LIS model output.

For lat/lon projection:

`LIS TWS output domain lower left lat:` specifies the lower left latitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain lower left lon:` specifies the lower left longitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain upper right lat:` specifies the upper right latitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain upper right lon:` specifies the upper right longitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain resolution (dx):` specifies the resolution (in degrees) along the latitude of the LIS model output (if map projection is latlon).

`LIS TWS output domain resolution (dy):` specifies the resolution (in degrees) along the longitude of the LIS model output (if map projection is latlon).

For Lambert and polar projections:

`LIS TWS output domain lower left lat:` specifies the lower left latitude of the LIS model output

`LIS TWS output domain lower left lon:` specifies the lower left longitude of the LIS model output

`LIS TWS output domain true lat1:` specifies the true lat1 of the LIS model output

`LIS TWS output domain true lat2:` specifies the true lat2 of the LIS model output

`LIS TWS output domain standard lon:` specifies the standard longitude of the LIS model output

`LIS TWS output domain resolution:` specifies the resolution of the LIS model output

`LIS TWS output domain x-dimension size:` specifies the x-dimension size of the LIS model output

`LIS TWS output domain y-dimension size:` specifies the y-dimension size of the LIS model output

Example ldt.config entry

```
Simulated GRACE data directory:         sim_grace
Simulated GRACE configuration:          default
Simulated GRACE baseline starting year: 2004
Simulated GRACE baseline ending year:   2009
LIS TWS output format:                  "netcdf"
LIS TWS output methodology:             "2d gridspace"
LIS TWS output naming style:            "3 level hierarchy"
LIS TWS output map projection:          "latlon"
LIS TWS output nest index:              1
LIS TWS output directory:               ../OL_NLDAS/OUTPUT
LIS TWS output domain lower left lat:         25.0625
LIS TWS output domain lower left lon:       -124.9375
LIS TWS output domain upper right lat:        52.9375
LIS TWS output domain upper right lon:       -67.0625
LIS TWS output domain resolution (dx):          0.125
LIS TWS output domain resolution (dy):          0.125
```

`NASA SMAP soil moisture data designation:`

Value	Description
“SPL2SMP”	employ level2 36km radiometer only product
“SPL2SMP_E”	employ level2 9km enhanced/oversampled product
“SPL3SMP”	employ level3 36km radiometer only product
“SPL3SMP_E”	employ level3 9km enhanced/oversampled product

`NASA SMAP soil moisture observation directory:` specifies the location of the data directory containing the NASA SMAP data.

Example ldt.config entry

```
NASA SMAP soil moisture data designation:
NASA SMAP soil moisture observation directory:
```

`NASA SMAP vegetation optical depth observation directory:` specifies the location of the data directory containing the L2 SMAP vegetation optical depth retrievals.

`NASA SMAP vegetation optical depth data designation:` specifies the type/source of VOD retrievals. Acceptable values are:

Value	Description
"SPL2SMP"	employ level2 36km radiometer only product
"SPL2SMP_E"	employ level2 9km enhanced/oversampled product

Example ldt.config entry

```
NASA SMAP vegetation optical depth observation directory: ../SPL2SMP_E.002
NASA SMAP vegetation optical depth data designation:      'SPL2SMP_E'
```

`SMAP(NASA) soil moisture Composite Release ID (e.g., R16):` specifies first three characters of the Composite Release ID (CRID) (e.g., R16)

Example ldt.config entry

```
SMAP(NASA) soil moisture Composite Release ID (e.g., R16):
```

`SMOS NESDIS soil moisture observation directory:` specifies the location of the data directory containing the SMOS soil moisture retrievals from NOAA NESDIS.

Example ldt.config entry

```
SMOS NESDIS soil moisture observation directory:
```

`LPRM vegetation optical depth observation directory:` specifies the location of the data directory containing the LPRM vegetation optical depth retrievals from LPRM.

`LPRM vegetation optical depth data designation:` specifies the type/source of VOD retrievals. Acceptable values are:

Value	Description
"X-band"	employ X-band based VOD
"C-band"	employ C-band based VOD

Example ldt.config entry

```
LPRM vegetation optical depth observation directory: ../LPRM_VOD
LPRM vegetation optical depth data designation:      'X-band'
```

This section describes the parameters needed for the HYMAP and the HYMAP2 routing models. The config entries only have "HYMAP" within them, as they apply to both HYMAP versions.

`HYMAP river width map:` specifies the name of the HYMAP river width data file.

`HYMAP river height map:` specifies the name of the HYMAP river height data file.

`HYMAP river length map:` specifies the name of the river length data file.

`HYMAP river roughness map:` specifies the name of the HYMAP river roughness data file.

`HYMAP floodplain height map:` specifies the name of the HYMAP floodplain height data file.

`HYMAP floodplain height levels:` specifies the number of the HYMAP floodplain height levels.

`HYMAP floodplain roughness map:` specifies the name of floodplain roughness data file.

`HYMAP flow direction x map:` specifies the name of the x-flow direction data file.

`HYMAP flow direction y map:` specifies the name of the y-flow direction data file.

`HYMAP grid elevation map:` specifies the name of the grid elevation data file.

`HYMAP grid distance map:` specifies the name of the grid distance data file.

`HYMAP grid area map:` specifies the name of the grid area data file.

`HYMAP drainage area map:` specifies the name of the drainage area data file.

`HYMAP basin map:` specifies the name of the basin map data file.

`HYMAP basin mask map:` specifies the name of the basin mask data file.

`HYMAP runoff time delay map:` specifies the name of the runoff time delay data file.

`HYMAP runoff time delay multiplier map:` specifies the name of the runoff time delay multiplier data file.

`HYMAP baseflow time delay map:` specifies the name of the baseflow time delay data file.

`HYMAP baseflow dwi ratio map:` specifies the name of the baseflow dwi ratio data file. This is an optional parameter that is required only when “HYMAP2 routing model dwi flag” is set to 1 (turned on) in LIS in the *lis.config* file. If this flag is set to 0 in the *lis.config* file, the baseflow dwi ratio map is not required.

`HYMAP runoff dwi ratio map:` specifies the name of the runoff dwi ratio data file. This is an optional parameter that is required only when “HYMAP2 routing model dwi flag” is set to 1 (turned on) in LIS in the *lis.config* file. If this flag is set to 0 in the *lis.config* file, the runoff dwi ratio map is not required.

`HYMAP river flow type map:` specifies the name of the river flow type data file. This is an optional parameter that is required only when “HYMAP2 routing method” is set to “hybrid” in LIS in the *lis.config* file. If the routing method is set to a different option, the river flow type map is not required.

Example ldt.config entry

```
HYMAP river width map:                    ../HYMAP_parms/lis_rivwth_0125.bin
HYMAP river height map:                   ../HYMAP_parms/lis_rivhgt_0125.bin
HYMAP river length map:                   ../HYMAP_parms/lis_rivlen_0125.bin
HYMAP river roughness map:                ../HYMAP_parms/lis_rivman_0125.bin
HYMAP floodplain height map:              ../HYMAP_parms/lis_fldhgt_0125.bin
HYMAP floodplain height levels:           10
HYMAP floodplain roughness map:           ../HYMAP_parms/lis_fldman_0125.bin
HYMAP flow direction x map:               ../HYMAP_parms/lis_nextx_0125.bin
HYMAP flow direction y map:               ../HYMAP_parms/lis_nexty_0125.bin
HYMAP grid elevation map:                 ../HYMAP_parms/lis_elevtn_0125.bin
HYMAP grid distance map:                  ../HYMAP_parms/lis_nxtdst_0125.bin
HYMAP grid area map:                      ../HYMAP_parms/lis_grarea_0125.bin
HYMAP drainage area map:                  ../HYMAP_parms/lis_uparea_0125.bin
HYMAP basin map:                          ../HYMAP_parms/lis_basin_0125.bin
HYMAP basin mask map:                     ../HYMAP_parms/lis_mask_0125.bin
HYMAP runoff time delay map:              ../HYMAP_parms/lis_getirana_paiva_0125.bin
HYMAP runoff time delay multiplier map:   ../HYMAP_parms/lis_trunoff_0125.bin
HYMAP baseflow time delay map:            ../HYMAP_parms/lis_tbasflw_0125.bin
HYMAP baseflow dwi ratio map:             ../HYMAP_parms/lis_basdwi_0125.bin
HYMAP runoff dwi ratio map:               ../HYMAP_parms/lis_rundwi_0125.bin
HYMAP river flow type map:                ../HYMAP_parms/lis_rivflw_0125.bin
```

This section also outlines the domain specifications of the HYMAP parameter data. For the HYMAP parameters spatial transform option, only “none” is supported at this time, and the user is required to input the HYMAP parameters at the grid and resolution of interest.

If the map projection of parameter data is specified to be “latlon”, the following configuration should be used for specifying HYMAP parameters. See Appendix Cylindrical Lat/Lon Domain Example for more details about setting these values.

Example ldt.config entry

```
HYMAP params spatial transform:     none
HYMAP params map projection:        latlon
HYMAP params lower left lat:        -59.9375
HYMAP params lower left lon:       -179.9375
HYMAP params upper right lat:        89.9375
HYMAP params upper right lon:       179.9375
HYMAP params resolution (dx):         0.125
HYMAP params resolution (dy):         0.125
```

7.15. Artificial neural networks

`ANN input data sources:` specifies what?

`ANN mode (training/validation):` specifies what?

`ANN number of hidden neurons:` specifies what?

`ANN number of input data sources:` specifies what?

`ANN number of iterations:` specifies what?

`ANN number of parameters in each input source:` specifies what?

`ANN output data source:` specifies what?

`ANN training output file:` specifies what?

Example ldt.config entry

```
ANN input data sources:
ANN mode (training/validation):
ANN number of hidden neurons:
ANN number of input data sources:
ANN number of iterations:
ANN number of parameters in each input source:
ANN output data source:
ANN training output file:
```

7.15.1. GHCN

`GHCN data directory:` specifies what?

`GHCN station file:` specifies what?

Example ldt.config entry

```
GHCN data directory:
GHCN station file:
```

7.15.2. LIS soil moisture output

`LIS soil moisture output timestep:` specifies what?

`LIS soil moisture output format:` specifies what?

`LIS soil moisture output methodology:` specifies what?

`LIS soil moisture output naming style:` specifies what?

`LIS soil moisture output map projection:` specifies what?

`LIS soil moisture output nest index:` specifies what?

`LIS soil moisture output directory:` specifies what?

For Lat/Lon projections:

`LIS soil moisture domain lower left lat:` specifies the lower left latitude of the LIS model output

`LIS soil moisture domain lower left lon:` specifies the lower left longitude of the LIS model output

`LIS soil moisture domain upper right lat:` specifies the upper right latitude of the LIS model output

`LIS soil moisture domain upper right lon:` specifies the upper right longitude of the LIS model output

`LIS soil moisture domain resolution (dx):` specifies the resolution (in degrees) along the latitude of the LIS model output

`LIS soil moisture domain resolution (dy):` specifies the resolution (in degrees) along the longitude of the LIS model output

For Lambert and polar projections:

`LIS soil moisture domain lower left lat:` specifies the lower left latitude of the LIS model output

`LIS soil moisture domain lower left lon:` specifies the lower left longitude of the LIS model output

`LIS soil moisture domain true lat1:` specifies the true lat1 of the LIS model output

`LIS soil moisture domain true lat2:` specifies the true lat2 of the LIS model output

`LIS soil moisture domain standard lon:` specifies the standard longitude of the LIS model output

`LIS soil moisture domain resolution:` specifies the resolution of the LIS model output

`LIS soil moisture domain x-dimension size:` specifies the x-dimension size of the LIS model output

`LIS soil moisture domain y-dimension size:` specifies the y-dimension size of the LIS model output

Example ldt.config entry

```
LIS soil moisture output timestep:
LIS soil moisture output format:
LIS soil moisture output methodology:
LIS soil moisture output naming style:
LIS soil moisture output map projection:
LIS soil moisture output nest index:
LIS soil moisture output directory:
LIS soil moisture domain lower left lat:
LIS soil moisture domain lower left lon:
LIS soil moisture domain upper right lat:
LIS soil moisture domain upper right lon:
LIS soil moisture domain resolution (dx):
LIS soil moisture domain resolution (dy):
```

7.15.3. MOD10A1

`MOD10A1 data directory:` specifies what?

Example ldt.config entry

```
MOD10A1 data directory:
```

7.15.4. MODIS LST

`MODIS LST data directory:` specifies what?

Example ldt.config entry

```
MODIS LST data directory:
```

`Search radius for openwater proximity detection:` specifies the radius in which LDT search to detect open water Then removes all pixels within the radius in the CDF calculations.

Example ldt.config entry

```
Search radius for openwater proximity detection:
```

7.16. USAF Snow and Ice Analysis

`USAFSI netcdf filename prefix:` prefix used in constructing USAFSI netcdf filenames

`USAFSI valid date (YYYYMMDDHH):` valid date and hour (UTC) of analysis

`USAFSI fractional snow data directory:` directory with CDFS-II fractional snow data

`USAFSI modified data directory:` directory with legacy SNODEP "modified" data

`USAFSI surface obs data directory:` directory with surface snow reports

`USAFSI SSMIS data directory:` directory with SSMIS snow depth retrievals

`USAFSI surface temperature data directory:` directory with legacy 0.25 deg LIS ungribbed surface temperatures

`USAFSI static data directory:` directory with legacy SNODEP static data

`USAFSI unmodified data directory:` directory with legacy SNODEP "unmodified" data

`USAFSI VIIRS data directory:` directory with VIIRS TIFF files

`USAFSI SSMIS raw data directory:` directory with SSMIS BUFR files

`USAFSI SSMIS snow depth retrieval algorithm:` version of SSMIS retrieval algorithm. Acceptable values are:

Value	Description
1	Hollinger (1991)
2	Chang et al (1987)
3	Foster et al (1997), recommended

`USAFSI SSMIS forest fraction file:` path to netCDF forest fraction file (for Foster et al (1997) algorithm)

Example ldt.config entry

```
USAFSI netcdf filename prefix:  usafsi
USAFSI valid date (YYYYMMDDHH):  2018120618
USAFSI fractional snow data directory:     ./SNODEPIN/snofrac/
USAFSI modified data directory:            ./SNODEPIN/modified/
USAFSI surface obs data directory:         ./SNODEPIN/sfcobs/
USAFSI SSMIS data directory:               ./SNODEPIN/SSMIS/algorithm03/
USAFSI surface temperature data directory: ./SNODEPIN/sfctmps/
USAFSI static data directory:              ./SNODEPIN/static/
USAFSI unmodified data directory:          ./PREVDIR/algorithm03/
USAFSI VIIRS data directory:               ./SNODEPIN/viirs/
USAFSI SSMIS raw data directory:           ./SNODEPIN/OBSI_SSMISUPP/
USAFSI SSMIS snow depth retrieval algorithm option:   3
USAFSI SSMIS forest fraction file:     ./SNODEPIN/ForestFraction_0p25deg.nc
```

`USAFSI decimal fraction adjustment of snow depth towards climo):` controls drift to climo in data void region

`USAFSI default snow depth (m) when actual depth unknown:` bogus value for when snow detected but depth unknown

`USAFSI minimum snow depth (m) for which to print a diagnostic:` threshold for printing surface ob report

`USAFSI maximum number of surface observations allowed:` self-explanatory

`USAFSI SSMIS shallow snow depth threshold (m):` minimum SSMIS snow depth considered reasonable

`USAFSI latitudes (deg * 100) for summer climo check:` three latitude bands used for sanity checking snow reports

`USAFSI elevations (m) for summer climo check:` four elevations used for sanity checking snow reports

`USAFSI temperature (deg K * 10) above which no snow is allowed:` used to adjust snow analysis

`USAFSI minimum ice concentration (%) needed to set ice flag:` used when constructing binary sea ice field

USAFSI high latitude thresholds (deg) for sea ice:: 24 latitudes, each row defining a hemisphere (NH, then SH), each column defining a month (J F M A M J J A S O N D). Used to define "high latitudes" in SSMIS-based sea ice analysis.

USAFSI low latitude thresholds (deg) for sea ice: 24 latitudes, each row defining a hemisphere (NH, then SH), each column defining a month (J F M A M J J A S O N D). Used to define "low latitudes" in SSMIS-based sea ice analysis.

USAFSI max age of VIIRS pixels to use: used to ignore old VIIRS data

USAFSI min VIIRS fraction to mark point as bare ground: fraction of no-snow VIIRS pixels in LDT grid box required to mark as "no-snow"

USAFSI min VIIRS/CDFS-II fraction to mark point as snow: fraction of snowy VIIRS pixels or CDFS-II in LDT grid box required to mark as "snow"

USAFSI use CDFS-II fractional snow data: self-explanatory

USAFSI use VIIRS snow mask: self-explanatory

Example ldt.config entry

```
USAFSI decimal fraction adjustment of snow depth towards climo: 0.1
USAFSI default snow depth (m) when actual depth unknown: 0.1
USAFSI minimum snow depth (m) for which to print a diagnostic: 0.025
USAFSI maximum number of surface observations allowed: 200000
USAFSI SSMIS shallow snow depth threshold (m): 0.15
USAFSI latitudes (deg * 100) for summer climo check: 4000 3000 2000
USAFSI elevations (m) for summer climo check: 1000 1500 1000 1000
USAFSI temperature (deg K * 10) above which no snow is allowed: 2820
USAFSI max reported temperature (deg K * 10) allowed around poles: 3030
USAFSI minimum ice concentration (%) needed to set ice flag: 15
USAFSI high latitude thresholds (deg) for sea ice::
       81.0 81.0 81.0 81.0 81.0 81.0 81.0 82.0 82.0 82.0 81.0 81.0
       90.0 90.0 78.0 78.0 68.0 68.0 67.0 67.0 66.0 66.0 68.0 70.0
::
USAFSI low latitude thresholds (deg) for sea ice::
       45.0 44.0 44.0 45.0 51.0 52.0 55.0 65.0 65.0 62.0 53.0 50.0
       60.0 62.0 62.0 60.0 58.0 56.0 55.0 55.0 53.0 54.0 55.0 57.0
::
USAFSI max age of VIIRS pixels to use: 3
USAFSI min VIIRS fraction to mark point as bare ground: 0.6
USAFSI min VIIRS/CDFS-II fraction to mark point as snow: 0.4
USAFSI use CDFS-II fractional snow data: .true.
USAFSI use VIIRS snow mask: .true.
```

USAFSI observation error variance (m^2): error variance assigned to surface snow reports

USAFSI background error variance (m^2): error variance assigned to first-guess field

USAFSI background error horizontal correlation length (m): correlation length for spreading snow depth corrections horizontally

`USAFSI background error vertical correlation length (m):` correlation length for spreading snow depth corrections vertically

`USAFSI elevQC difference threshold (m):` threshold for sanity checking snow report elevation against LDT

`USAFSI skewed backQC snow depth threshold (m):` threshold for rejecting abnormally small snow depth reports

Example ldt.config entry

```
USAFSI observation error variance (m^2):  0.0006
USAFSI background error variance (m^2):   0.0010
USAFSI background error horizontal correlation length (m):  55555.
USAFSI background error vertical correlation length (m):      800.
USAFSI elevQC difference threshold (m): 400.
USAFSI skewed backQC snow depth threshold (m):  0.4
```

`USAFSI bogus climatology snow depth value (m):` bogus value for climatology if not available

`USAFSI GOFS SST data directory:` directory with GOFS sea surface temperature netCDF files

`USAFSI GOFS CICE data directory:` directory with GOFS sea ice netCDF files

`USAFSI LIS GRIB2 data directory:` directory with LIS GRIB2 2-m temperature analyses

`USAFSI LIS GRIB2 security class:` used for constructing LIS GRIB2 filename

`USAFSI LIS GRIB2 data category:` used for constructing LIS GRIB2 filename

`USAFSI LIS GRIB2 data resolution:` used for constructing LIS GRIB2 filename

`USAFSI LIS GRIB2 area of data:` used for constructing LIS GRIB2 filename

`USAFSI GALWEM root directory:` root directory for GALWEM data

`USAFSI GALWEM subdirectory:` subdirectory for GALWEM data

`USAFSI GALWEM use timestamp directories:` option to use YYYYMMDD in constructing full GALWEM directory; 1 is yes, 0 is no

`USAFSI GALWEM nominal resolution (km):` 17 or 10 (17 currently used in operations)

Example ldt.config entry

```
USAFSI bogus climatology snow depth value (m): 0.2
USAFSI GOFS SST data directory: ./SNODEPIN//GOFS
USAFSI GOFS CICE data directory: ./SNODEPIN//GOFS
USAFSI LIS GRIB2 data directory: /discover/nobackup/emkemp/AFWA/data/LIS_GRIB2
USAFSI LIS GRIB2 security class: U
USAFSI LIS GRIB2 data category:  C
USAFSI LIS GRIB2 data resolution: C0P09DEG
USAFSI LIS GRIB2 area of data: GLOBAL
USAFSI GALWEM root directory: USAF_FORCING
USAFSI GALWEM subdirectory: GALWEM
USAFSI GALWEM use timestamp directories: 1
USAFSI GALWEM nominal resolution (km): 17
```

`LIS OPT/UE output file:` name of the OPT/UE output file generated from a LIS simulation

Example ldt.config entry

```
LIS OPT/UE output file: ./GA.0059.1gd4r
```

Appendix A: Description of output files from LDT

This section provides a description of various output files generated during an LDT processing run. The main output format for LDT is NetCDF (*.nc*). This includes NetCDF with HDF5 compression capabilities.

The output file could be named something like, lis_input.d01.nc. To view the header and/or data information, you will need ncview and/or ncdump utilities, both provided by the Unidata webpage (http://www.unidata.ucar.edu/software/netcdf/).

Some of the main components (as found in the header information) will include:

- dimensions : *east_west, north_south, month, sfctypes, etc.*
- variables : *time, LANDMASK, LANDCOVER, SURFACETYPE, etc.*
- global attributes : *title, references, MAP_PROJECTION, DX, DY, etc.*

A.1. Dimensions attributes

The LDT output file, like the NetCDF file, contains header information for the dimensions. The list can include:

```
dimensions:
       east_west = 80 ;
       north_south = 37 ;
       month = 12 ;
       time = 1 ;
       sfctypes = 14 ;
       soiltypes = 16 ;
       soilfracbins = 3 ;
       elevbins = 1 ;
       slopebins = 1 ;
       aspectbins = 1 ;
```

This file can be used to determine the number of tiles used in a LIS model simulation. The number of tiles are specified in this dimensions header information.

A.2. Variable attributes

The LDT output file, like the NetCDF file, contains header information for the variable or paremeter file attributes. The list can include: (for example)

```
variables:
    float LANDCOVER(sfctypes, north_south, east_west) ;
            LANDCOVER:standard_name = "UMD land cover" ;
            LANDCOVER:units = "-" ;
            LANDCOVER:scale_factor = 1.f ;
            LANDCOVER:add_offset = 0.f ;
            LANDCOVER:missing_value = -9999.f ;
            LANDCOVER:vmin = 0.f ;
            LANDCOVER:vmax = 0.f ;
            LANDCOVER:num_bins = 14 ;
        
```

Appendix B: Cylindrical Lat/Lon Domain Example

This section describes how to compute the values for the run domain and/or the domain for a parameter or variable file on a cylindrical lat/lon projection.

First, the 'LIS-produced' parameter data are defined on a Latitude/Longitude grid, from `-180` to `180` degrees longitude and from `-60` to `90` degrees latitude. Whereas most 'Native' parameter datasets can extend down to `-90` degrees latitude, accounting for glacial areas like Antarctica.

LDT is designed to bring a read-in parameter file directly to a common LIS-based domain grid, projection and resolution. Currently, the user can upscale or downscale from a given lat/lon projection to any other lat/lon projection but also lambert conformal and other projections.

For this example, consider reading in an older 'LIS-produced' parameter file at 1/4 deg resolution. The coordinates of the south-west and the north-east points must be specified at the grid-cells' centers. Here the south-west grid-cell is given by the box `(-180,-60), (-179.750,-59.750)`. The center of this box is `(-179.875,-59.875)`. [1] Thus the `lower left lat:` is `-59.875`, and the `lower left lon:` is `-179.875`.

The north-east grid-cell is given by the box `(179.750,89.750), (180,90)`. Its center is `(179.875,89.875)`. Thus the `upper right lat:` is `89.875`, and the `upper right lon:` is `179.875`.

Setting the resolution (0.25 deg) gives `domain resolution dx:` is `0.25` and `domain resolution dy:` is `0.25`.

Now let's consider setting the bounding coordinates for your desired LIS-based run domain.

If you wish to run over the whole domain defined by a parameter data domain then you simply set the values defined in the parameter domain section in the run domain section. For this example, this gives:

```
Run domain lower left lat:   -59.875
Run domain lower left lon:  -179.875
Run domain upper right lat:   89.875
Run domain upper right lon:  179.875
Run domain resolution dx:      0.25
Run domain resolution dy:      0.25
```

Just note that if you wish to run on a LIS run domain that happens to be greater (e.g. all of North America) than the extents of a read-in parameter file (e.g., STATSGO domain), then checks are in place for LDT to stop the running process.

Now say you wish to run LIS only over the region given by `(-97.6,27.9), (-92.9,31.9)`. Since the running domain is a sub-set of the parameter domain, it is also a Latitude/Longitude domain at 1/4 deg. resolution. This gives `Run domain resolution dx:` is `0.25` and `Run domain resolution dy:` is `0.25`

Since the running domain must fit onto the parameter domain, the desired running region must be expanded from `(-97.6,27.9), (-92.9,31.9)` to `(-97.75,27.75), (-92.75,32.0)`. The south-west grid-cell for the running domain is the box `(-97.75,27.75), (-97.5,28.0)`. Its center is `(-97.625,27.875)`. This gives `Run domain lower left lat:` is `27.875` and `Run domain lower left lon:` is `-97.625`.

The north-east grid-cell for the running domain is the box `(-93,31.75), (-92.75,32.0)`. Its center is `(-92.875,31.875)`. This gives `Run domain upper right lat:` is `31.875` and `Run domain upper right lon:` is `-92.875`.

All together, the bounding coordinates for this sub-setted region are:

```
Run domain lower left lat:   27.875
Run domain lower left lon:  -97.625
Run domain upper right lat:  31.875
Run domain upper right lon: -92.875
Run domain resolution dx:     0.25
Run domain resolution dy:     0.25
```

Note, the LIS project has defined 5 km resolution to be 0.05 deg. and 1 km resolution to be 0.01 deg. If you wish to run at 5 km or 1 km resolution, redo the above example to compute the appropriate grid-cell values.

See Figure Snap to grid for an illustration of adjusting the running grid. See Figures South-west example and North-east example for an illustration of the south-west and north-east grid-cells.

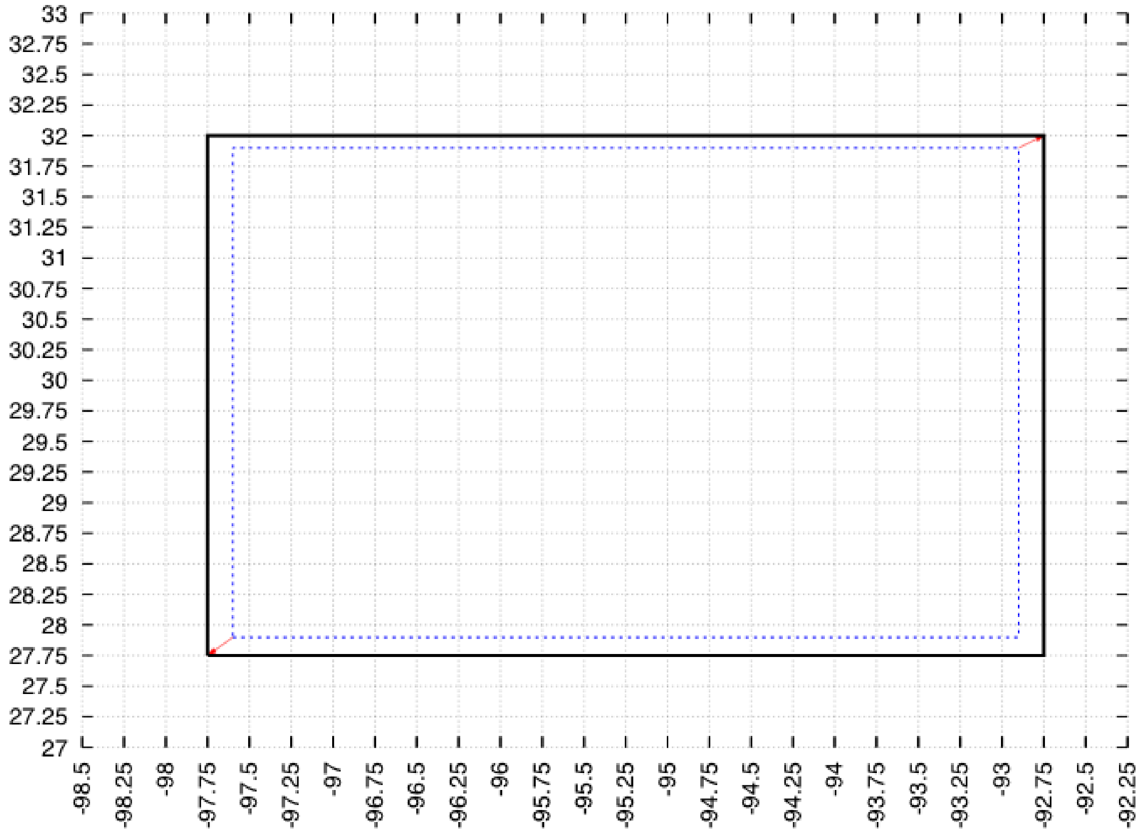

Figure 1. Illustration showing how to fit the desired running grid onto the actual grid

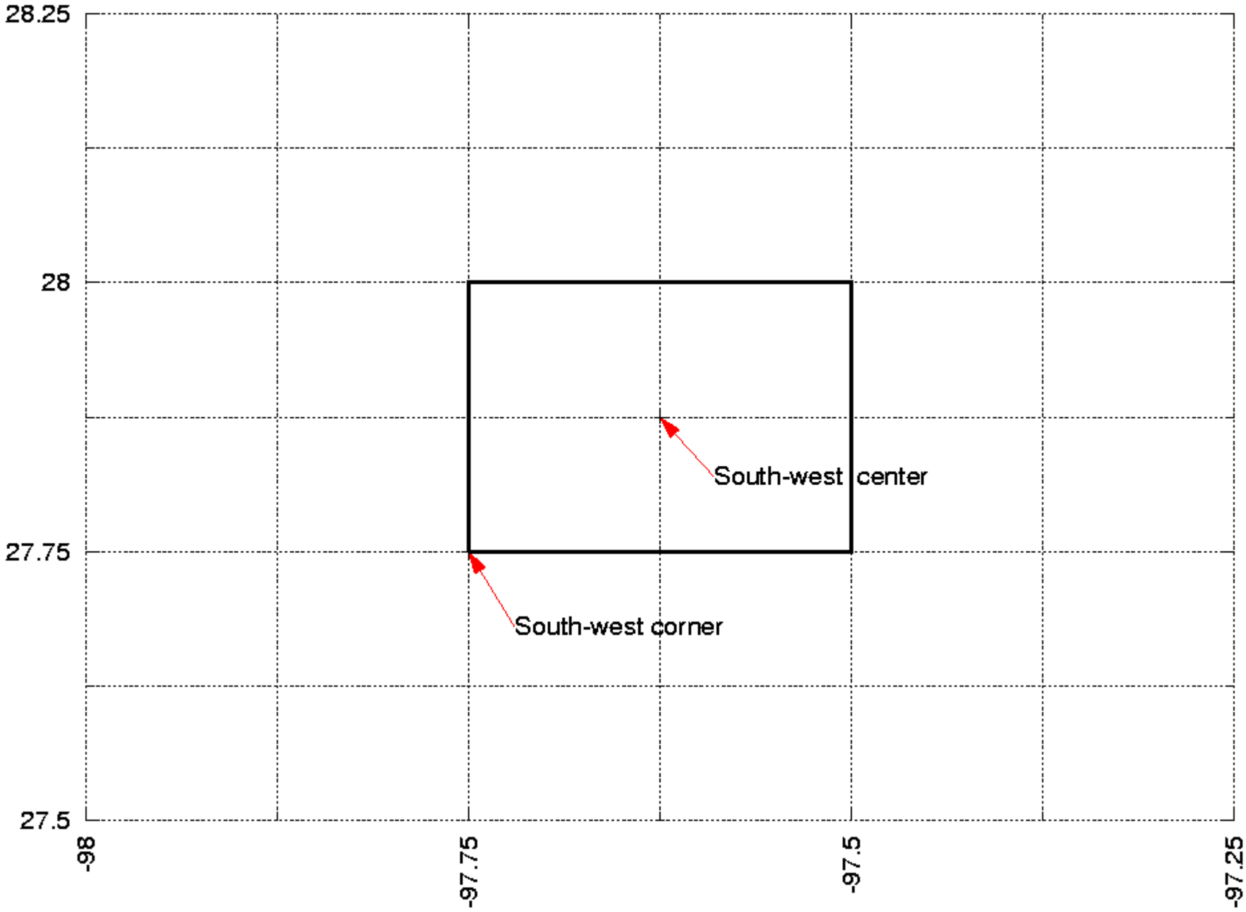

Figure 2. Illustration showing the south-west grid-cell corresponding to the example in Section Cylindrical Lat/Lon Domain Example

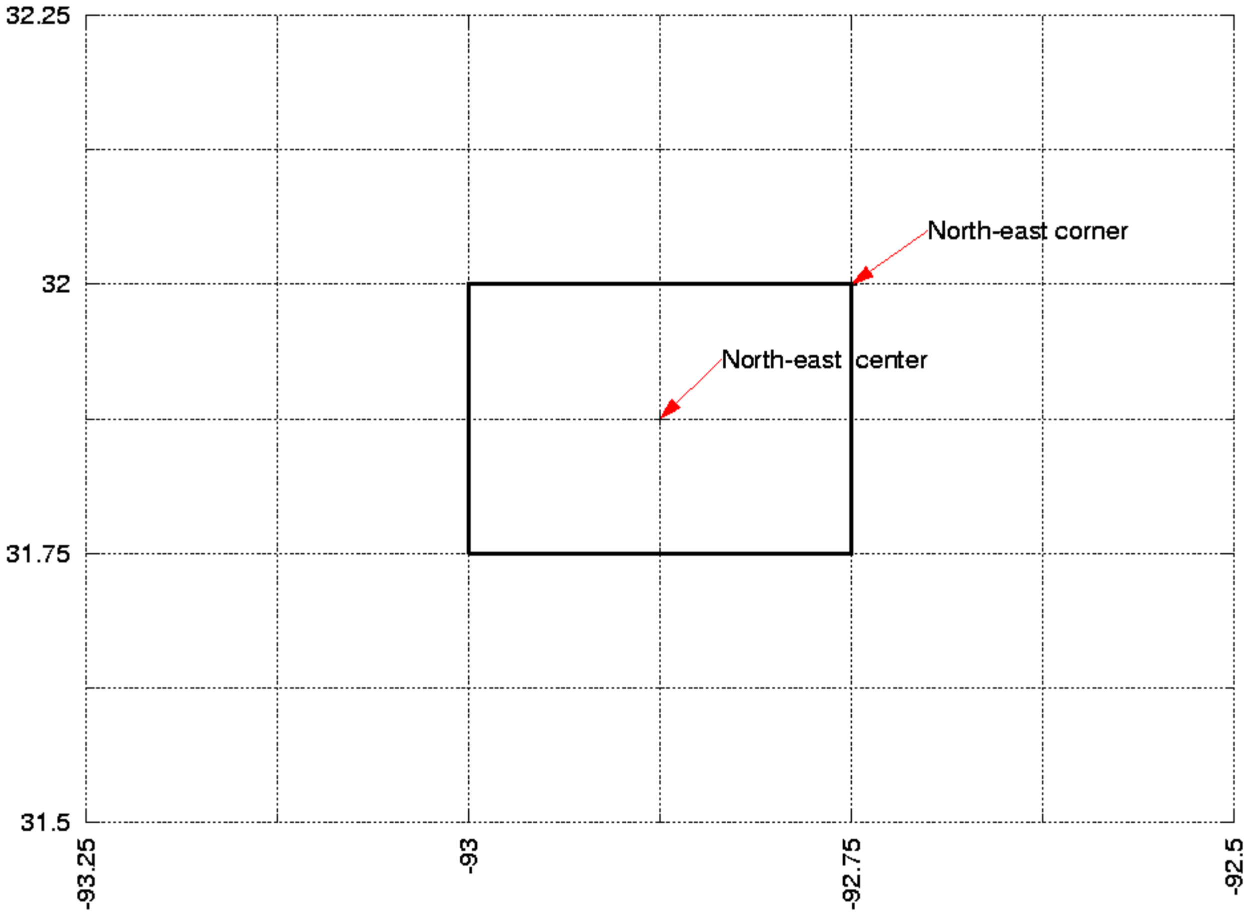

Figure 3. Illustration showing the north-east grid-cell corresponding to the example in Section Cylindrical Lat/Lon Domain Example

[1] Note, these coordinates are ordered (longitude, latitude).

Appendix C: Lambert Conformal Domain Example

This section describes how to compute the values for the run domain and param domain sections on a Lambert conformal projection.

Note that this projection is often used for a coupled run with the Weather Research and Forecasting (WRF) model. As such, Lambert domains are first generated when configuring WRF via WRF's preprocessing system (WPS). The domain information is then copied into LIS' *lis.config* file.

Please see WRF's User's Guide found at http://www.mmm.ucar.edu/wrf/users/ for more information.

Appendix D: Gaussian Domain Example

This section describes how to compute the values for the run domain and param domain sections on a Gaussian projection.

First, note that LIS' Gaussian parameter data is defined from `-180` to `180` degrees longitude and from `-90` to `90` degrees latitude. Note that the first longitude point is at `0`. For the T126 Gaussian projection:

```
... first grid point lat:          -89.27665
... first grid point lon:            0.0
... last grid point lat:            89.27665
... last grid point lon:            -0.9375
... resolution dlon:                 0.9375
... number of lat circles:          95
```

If you wish to run over the whole domain defined by the parameter data domain then you simply set the values defined in the parameter domain section in the run domain section. This gives:

```
Run domain first grid point lat:          -89.27665
Run domain first grid point lon:            0.0
Run domain last grid point lat:            89.27665
Run domain last grid point lon:            -0.9375
Run domain resolution dlon:                 0.9375
Run domain number of lat circles:          95
```

If you wish to run over a sub-domain, then you must choose longitude and latitiude values that correspond to the T126 Gaussian projection. Tables of acceptable longitude and latitude values are found below.

Now say you wish to run only over the region given by `(-97.6,27.9), (-92.9,31.9)`. Since the running domain must fit on the T126 Gaussian grid, the running domain must be expanded to `(-98.4375,27.87391), (-91.875,32.59830)`. Thus the running domain specification is:

```
Run domain first grid point lat:           27.87391
Run domain first grid point lon:          -98.4375
Run domain last grid point lat:            32.59830
Run domain last grid point lon:           -91.875
Run domain resolution dlon:                 0.9375
Run domain number of lat circles:          95
```

Table 1. Gaussian T126 acceptable longitude values

0.000000	0.937500	1.875000	2.812500	3.750000
4.687500	5.625000	6.562500	7.500000	8.437500
9.375000	10.312500	11.250000	12.187500	13.125000
14.062500	15.000000	15.937500	16.875000	17.812500
18.750000	19.687500	20.625000	21.562500	22.500000
23.437500	24.375000	25.312500	26.250000	27.187500
28.125000	29.062500	30.000000	30.937500	31.875000
32.812500	33.750000	34.687500	35.625000	36.562500
37.500000	38.437500	39.375000	40.312500	41.250000
42.187500	43.125000	44.062500	45.000000	45.937500
46.875000	47.812500	48.750000	49.687500	50.625000
51.562500	52.500000	53.437500	54.375000	55.312500
56.250000	57.187500	58.125000	59.062500	60.000000
60.937500	61.875000	62.812500	63.750000	64.687500
65.625000	66.562500	67.500000	68.437500	69.375000
70.312500	71.250000	72.187500	73.125000	74.062500
75.000000	75.937500	76.875000	77.812500	78.750000
79.687500	80.625000	81.562500	82.500000	83.437500
84.375000	85.312500	86.250000	87.187500	88.125000
89.062500	90.000000	90.937500	91.875000	92.812500
93.750000	94.687500	95.625000	96.562500	97.500000
98.437500	99.375000	100.312500	101.250000	102.187500
103.125000	104.062500	105.000000	105.937500	106.875000
107.812500	108.750000	109.687500	110.625000	111.562500
112.500000	113.437500	114.375000	115.312500	116.250000
117.187500	118.125000	119.062500	120.000000	120.937500
121.875000	122.812500	123.750000	124.687500	125.625000

Table 2. Gaussian T126 acceptable longitude values (continued)

126.562500	127.500000	128.437500	129.375000	130.312500
131.250000	132.187500	133.125000	134.062500	135.000000
135.937500	136.875000	137.812500	138.750000	139.687500
140.625000	141.562500	142.500000	143.437500	144.375000
145.312500	146.250000	147.187500	148.125000	149.062500
150.000000	150.937500	151.875000	152.812500	153.750000
154.687500	155.625000	156.562500	157.500000	158.437500
159.375000	160.312500	161.250000	162.187500	163.125000
164.062500	165.000000	165.937500	166.875000	167.812500
168.750000	169.687500	170.625000	171.562500	172.500000
173.437500	174.375000	175.312500	176.250000	177.187500
178.125000	179.062500	180.000000	-179.062500	-178.125000
-177.187500	-176.250000	-175.312500	-174.375000	-173.437500
-172.500000	-171.562500	-170.625000	-169.687500	-168.750000
-167.812500	-166.875000	-165.937500	-165.000000	-164.062500
-163.125000	-162.187500	-161.250000	-160.312500	-159.375000
-158.437500	-157.500000	-156.562500	-155.625000	-154.687500
-153.750000	-152.812500	-151.875000	-150.937500	-150.000000
-149.062500	-148.125000	-147.187500	-146.250000	-145.312500
-144.375000	-143.437500	-142.500000	-141.562500	-140.625000
-139.687500	-138.750000	-137.812500	-136.875000	-135.937500
-135.000000	-134.062500	-133.125000	-132.187500	-131.250000
-130.312500	-129.375000	-128.437500	-127.500000	-126.562500
-125.625000	-124.687500	-123.750000	-122.812500	-121.875000
-120.937500	-120.000000	-119.062500	-118.125000	-117.187500
-116.250000	-115.312500	-114.375000	-113.437500	-112.500000
-111.562500	-110.625000	-109.687500	-108.750000	-107.812500

Table 3. Gaussian T126 acceptable longitude values (continued)

-106.875000	-105.937500	-105.000000	-104.062500	-103.125000
-102.187500	-101.250000	-100.312500	-99.375000	-98.437500
-97.500000	-96.562500	-95.625000	-94.687500	-93.750000
-92.812500	-91.875000	-90.937500	-90.000000	-89.062500
-88.125000	-87.187500	-86.250000	-85.312500	-84.375000
-83.437500	-82.500000	-81.562500	-80.625000	-79.687500
-78.750000	-77.812500	-76.875000	-75.937500	-75.000000
-74.062500	-73.125000	-72.187500	-71.250000	-70.312500
-69.375000	-68.437500	-67.500000	-66.562500	-65.625000
-64.687500	-63.750000	-62.812500	-61.875000	-60.937500
-60.000000	-59.062500	-58.125000	-57.187500	-56.250000
-55.312500	-54.375000	-53.437500	-52.500000	-51.562500
-50.625000	-49.687500	-48.750000	-47.812500	-46.875000
-45.937500	-45.000000	-44.062500	-43.125000	-42.187500
-41.250000	-40.312500	-39.375000	-38.437500	-37.500000
-36.562500	-35.625000	-34.687500	-33.750000	-32.812500
-31.875000	-30.937500	-30.000000	-29.062500	-28.125000
-27.187500	-26.250000	-25.312500	-24.375000	-23.437500
-22.500000	-21.562500	-20.625000	-19.687500	-18.750000
-17.812500	-16.875000	-15.937500	-15.000000	-14.062500
-13.125000	-12.187500	-11.250000	-10.312500	-9.375000
-8.437500	-7.500000	-6.562500	-5.625000	-4.687500
-3.750000	-2.812500	-1.875000	-0.937500	

Table 4. Gaussian T126 acceptable latitude values

-89.27665	-88.33975	-87.39729	-86.45353	-85.5093
-84.56487	-83.62028	-82.67562	-81.73093	-80.78618
-79.84142	-78.89662	-77.95183	-77.00701	-76.06219
-75.11736	-74.17252	-73.22769	-72.28285	-71.33799
-70.39314	-69.44829	-68.50343	-67.55857	-66.61371
-65.66885	-64.72399	-63.77912	-62.83426	-61.88939
-60.94452	-59.99965	-59.05478	-58.10991	-57.16505
-56.22018	-55.2753	-54.33043	-53.38556	-52.44069
-51.49581	-50.55094	-49.60606	-48.66119	-47.71632
-46.77144	-45.82657	-44.88169	-43.93681	-42.99194
-42.04707	-41.10219	-40.15731	-39.21244	-38.26756
-37.32268	-36.37781	-35.43293	-34.48805	-33.54317
-32.5983	-31.65342	-30.70854	-29.76366	-28.81879
-27.87391	-26.92903	-25.98415	-25.03928	-24.0944
-23.14952	-22.20464	-21.25977	-20.31489	-19.37001
-18.42513	-17.48025	-16.53537	-15.5905	-14.64562
-13.70074	-12.75586	-11.81098	-10.8661	-9.921225
-8.976346	-8.031467	-7.086589	-6.141711	-5.196832
-4.251954	-3.307075	-2.362196	-1.417318	-0.4724393
0.4724393	1.417318	2.362196	3.307075	4.251954
5.196832	6.141711	7.086589	8.031467	8.976346
9.921225	10.8661	11.81098	12.75586	13.70074
14.64562	15.5905	16.53537	17.48025	18.42513
19.37001	20.31489	21.25977	22.20464	23.14952
24.0944	25.03928	25.98415	26.92903	27.87391
28.81879	29.76366	30.70854	31.65342	32.5983
33.54317	34.48805	35.43293	36.37781	37.32268

Table 5. Gaussian T126 acceptable latitude values

38.26756	39.21244	40.15731	41.10219	42.04707
42.99194	43.93681	44.88169	45.82657	46.77144
47.71632	48.66119	49.60606	50.55094	51.49581
52.44069	53.38556	54.33043	55.2753	56.22018
57.16505	58.10991	59.05478	59.99965	60.94452
61.88939	62.83426	63.77912	64.72399	65.66885
66.61371	67.55857	68.50343	69.44829	70.39314
71.33799	72.28285	73.22769	74.17252	75.11736
76.06219	77.00701	77.95183	78.89662	79.84142
80.78618	81.73093	82.67562	83.62028	84.56487
85.5093	86.45353	87.39729	88.33975	89.27665

Table 6. Gaussian T1534 acceptable longitude values

0	0.1171875	0.234375	0.3515625	0.46875	0.5859375
0.703125	0.8203125	0.9375	1.054688	1.171875	1.289062
1.40625	1.523438	1.640625	1.757812	1.875	1.992188
2.109375	2.226562	2.34375	2.460938	2.578125	2.695312
2.8125	2.929688	3.046875	3.164062	3.28125	3.398438
3.515625	3.632782	3.749969	3.867157	3.984344	4.101532
4.218719	4.335907	4.453094	4.570282	4.687469	4.804657
4.921844	5.039032	5.156219	5.273407	5.390594	5.507782
5.624969	5.742157	5.859344	5.976532	6.093719	6.210907
6.328094	6.445282	6.562469	6.679657	6.796844	6.914032
7.031219	7.148407	7.265594	7.382782	7.499969	7.617157
7.734344	7.851532	7.968719	8.085907	8.203094	8.320282
8.437469	8.554657	8.671844	8.789032	8.906219	9.023407
9.140594	9.257782	9.374969	9.492157	9.609344	9.726532
9.843719	9.960907	10.07809	10.19528	10.31247	10.42966
10.54684	10.664	10.78119	10.89838	11.01556	11.13275
11.24994	11.36713	11.48431	11.6015	11.71869	11.83588
11.95306	12.07025	12.18744	12.30463	12.42181	12.539
12.65619	12.77338	12.89056	13.00775	13.12494	13.24213
13.35931	13.4765	13.59369	13.71088	13.82806	13.94525
14.06244	14.17963	14.29681	14.414	14.53119	14.64838
14.76556	14.88275	14.99994	15.11713	15.23431	15.3515
15.46869	15.58588	15.70306	15.82025	15.93744	16.05463
16.17181	16.289	16.40619	16.52338	16.64056	16.75775
16.87494	16.99213	17.10931	17.2265	17.34369	17.46088
17.57806	17.69525	17.81244	17.92963	18.04681	18.16397
18.28116	18.39835	18.51553	18.63272	18.74991	18.8671
18.98428	19.10147	19.21866	19.33585	19.45303	19.57022
19.68741	19.8046	19.92178	20.03897	20.15616	20.27335
20.39053	20.50772	20.62491	20.7421	20.85928	20.97647
21.09366	21.21085	21.32803	21.44522	21.56241	21.6796
21.79678	21.91397	22.03116	22.14835	22.26553	22.38272
22.49991	22.6171	22.73428	22.85147	22.96866	23.08585

Table 7. Gaussian T1534 acceptable longitude values (continued)

23.20303	23.32022	23.43741	23.5546	23.67178	23.78897
23.90616	24.02335	24.14053	24.25772	24.37491	24.4921
24.60928	24.72647	24.84366	24.96082	25.078	25.19519
25.31238	25.42957	25.54675	25.66394	25.78113	25.89832
26.0155	26.13269	26.24988	26.36707	26.48425	26.60144
26.71863	26.83582	26.953	27.07019	27.18738	27.30457
27.42175	27.53894	27.65613	27.77332	27.8905	28.00769
28.12488	28.24207	28.35925	28.47644	28.59363	28.71082
28.828	28.94519	29.06238	29.17957	29.29675	29.41394
29.53113	29.64832	29.7655	29.88269	29.99988	30.11707
30.23425	30.35144	30.46863	30.58582	30.703	30.82019
30.93738	31.05457	31.17175	31.28894	31.40613	31.52332
31.6405	31.75769	31.87488	31.99207	32.10925	32.22644
32.34363	32.46082	32.578	32.69516	32.81235	32.92953
33.04672	33.16391	33.2811	33.39828	33.51547	33.63266
33.74985	33.86703	33.98422	34.10141	34.2186	34.33578
34.45297	34.57016	34.68735	34.80453	34.92172	35.03891
35.1561	35.27328	35.39047	35.50766	35.62485	35.74203
35.85922	35.97641	36.0936	36.21078	36.32797	36.44516
36.56235	36.67953	36.79672	36.91391	37.0311	37.14828
37.26547	37.38266	37.49985	37.61703	37.73422	37.85141
37.9686	38.08578	38.20297	38.32016	38.43735	38.55453
38.67172	38.78891	38.9061	39.02325	39.14044	39.25763
39.37482	39.492	39.60919	39.72638	39.84357	39.96075
40.07794	40.19513	40.31232	40.4295	40.54669	40.66388
40.78107	40.89825	41.01544	41.13263	41.24982	41.367
41.48419	41.60138	41.71857	41.83575	41.95294	42.07013
42.18732	42.3045	42.42169	42.53888	42.65607	42.77325
42.89044	43.00763	43.12482	43.242	43.35919	43.47638
43.59357	43.71075	43.82794	43.94513	44.06232	44.1795
44.29669	44.41388	44.53107	44.64825	44.76544	44.88263
44.99982	45.117	45.23419	45.35138	45.46857	45.58575
45.70294	45.82013	45.93732	46.0545	46.17169	46.28888

Table 8. Gaussian T1534 acceptable longitude values (continued)

46.40607	46.52325	46.64044	46.75763	46.87482	46.992
47.10916	47.22635	47.34354	47.46072	47.57791	47.6951
47.81229	47.92947	48.04666	48.16385	48.28104	48.39822
48.51541	48.6326	48.74979	48.86697	48.98416	49.10135
49.21854	49.33572	49.45291	49.5701	49.68729	49.80447
49.92166	50.03885	50.15604	50.27322	50.39041	50.5076
50.62479	50.74197	50.85916	50.97635	51.09354	51.21072
51.32791	51.4451	51.56229	51.67947	51.79666	51.91385
52.03104	52.14822	52.26541	52.3826	52.49979	52.61697
52.73416	52.85135	52.96854	53.08572	53.20291	53.32007
53.43726	53.55444	53.67163	53.78882	53.90601	54.02319
54.14038	54.25757	54.37476	54.49194	54.60913	54.72632
54.84351	54.96069	55.07788	55.19507	55.31226	55.42944
55.54663	55.66382	55.78101	55.89819	56.01538	56.13257
56.24976	56.36694	56.48413	56.60132	56.71851	56.83569
56.95288	57.07007	57.18726	57.30444	57.42163	57.53882
57.65601	57.77319	57.89038	58.00757	58.12476	58.24194
58.35913	58.47632	58.59351	58.71069	58.82788	58.94507
59.06226	59.17944	59.29663	59.41382	59.53101	59.64819
59.76538	59.88257	59.99976	60.11694	60.23413	60.35132
60.46851	60.58569	60.70288	60.82007	60.93726	61.05444
61.17163	61.28882	61.40598	61.52316	61.64035	61.75754
61.87473	61.99191	62.1091	62.22629	62.34348	62.46066
62.57785	62.69504	62.81223	62.92941	63.0466	63.16379
63.28098	63.39816	63.51535	63.63254	63.74973	63.86691
63.9841	64.10129	64.21848	64.33566	64.45285	64.57004
64.68723	64.80441	64.9216	65.03879	65.15598	65.27316
65.39035	65.50754	65.62473	65.74191	65.8591	65.97629
66.09348	66.21066	66.32785	66.44504	66.56223	66.67941
66.7966	66.91379	67.03098	67.14816	67.26532	67.38251
67.49969	67.61688	67.73407	67.85126	67.96844	68.08563
68.20282	68.32001	68.43719	68.55438	68.67157	68.78876
68.90594	69.02313	69.14032	69.25751	69.37469	69.49188

Table 9. Gaussian T1534 acceptable longitude values (continued)

69.60907	69.72626	69.84344	69.96063	70.07782	70.19501
70.31219	70.42938	70.54657	70.66376	70.78094	70.89813
71.01532	71.13251	71.24969	71.36688	71.48407	71.60126
71.71844	71.83563	71.95282	72.07001	72.18719	72.30438
72.42157	72.53876	72.65594	72.77313	72.89032	73.00751
73.12469	73.24188	73.35907	73.47626	73.59344	73.71063
73.82782	73.94501	74.06219	74.17938	74.29657	74.41376
74.53094	74.64813	74.76532	74.88251	74.99969	75.11688
75.23407	75.35126	75.46844	75.58563	75.70282	75.82001
75.93719	76.05438	76.17154	76.28873	76.40591	76.5231
76.64029	76.75748	76.87466	76.99185	77.10904	77.22623
77.34341	77.4606	77.57779	77.69498	77.81216	77.92935
78.04654	78.16373	78.28091	78.3981	78.51529	78.63248
78.74966	78.86685	78.98404	79.10123	79.21841	79.3356
79.45279	79.56998	79.68716	79.80435	79.92154	80.03873
80.15591	80.2731	80.39029	80.50748	80.62466	80.74185
80.85904	80.97623	81.09341	81.2106	81.32779	81.44498
81.56213	81.67932	81.79651	81.9137	82.03088	82.14807
82.26526	82.38245	82.49963	82.61682	82.73401	82.8512
82.96838	83.08557	83.20276	83.31995	83.43713	83.55432
83.67151	83.7887	83.90588	84.02307	84.14026	84.25745
84.37463	84.49182	84.60901	84.7262	84.84338	84.96057
85.07776	85.19495	85.31213	85.42932	85.54651	85.6637
85.78088	85.89807	86.01526	86.13245	86.24963	86.36682
86.48401	86.6012	86.71838	86.83557	86.95276	87.06995
87.18713	87.30432	87.42151	87.5387	87.65588	87.77307
87.89026	88.00745	88.12463	88.24182	88.35901	88.4762
88.59338	88.71057	88.82776	88.94495	89.06213	89.17932
89.29651	89.4137	89.53088	89.64807	89.76526	89.88245
89.99963	90.11682	90.23401	90.3512	90.46835	90.58554
90.70273	90.81992	90.9371	91.05429	91.17148	91.28867
91.40585	91.52304	91.64023	91.75742	91.8746	91.99179
92.10898	92.22617	92.34335	92.46054	92.57773	92.69492

Table 10. Gaussian T1534 acceptable longitude values (continued)

92.8121	92.92929	93.04648	93.16367	93.28085	93.39804
93.51523	93.63242	93.7496	93.86679	93.98398	94.10117
94.21835	94.33554	94.45273	94.56992	94.6871	94.80429
94.92148	95.03867	95.15585	95.27304	95.39023	95.50742
95.6246	95.74179	95.85895	95.97614	96.09332	96.21051
96.3277	96.44489	96.56207	96.67926	96.79645	96.91364
97.03082	97.14801	97.2652	97.38239	97.49957	97.61676
97.73395	97.85114	97.96832	98.08551	98.2027	98.31989
98.43707	98.55426	98.67145	98.78864	98.90582	99.02301
99.1402	99.25739	99.37457	99.49176	99.60895	99.72614
99.84332	99.96051	100.0777	100.1949	100.3121	100.4293
100.5464	100.6636	100.7808	100.898	101.0152	101.1324
101.2496	101.3668	101.4839	101.6011	101.7183	101.8355
101.9527	102.0699	102.1871	102.3043	102.4214	102.5386
102.6558	102.773	102.8902	103.0074	103.1246	103.2418
103.3589	103.4761	103.5933	103.7105	103.8277	103.9449
104.0621	104.1793	104.2964	104.4136	104.5308	104.648
104.7652	104.8824	104.9995	105.1167	105.2339	105.3511
105.4683	105.5855	105.7027	105.8199	105.937	106.0542
106.1714	106.2886	106.4058	106.523	106.6402	106.7574
106.8745	106.9917	107.1089	107.2261	107.3433	107.4605
107.5777	107.6949	107.812	107.9292	108.0464	108.1636
108.2808	108.398	108.5152	108.6324	108.7495	108.8667
108.9839	109.1011	109.2183	109.3355	109.4527	109.5699
109.687	109.8042	109.9214	110.0386	110.1558	110.2729
110.3901	110.5073	110.6245	110.7417	110.8589	110.9761
111.0933	111.2104	111.3276	111.4448	111.562	111.6792
111.7964	111.9136	112.0308	112.1479	112.2651	112.3823
112.4995	112.6167	112.7339	112.8511	112.9683	113.0854
113.2026	113.3198	113.437	113.5542	113.6714	113.7886
113.9058	114.0229	114.1401	114.2573	114.3745	114.4917
114.6089	114.7261	114.8433	114.9604	115.0776	115.1948
115.312	115.4292	115.5464	115.6636	115.7808	115.8979

Table 11. Gaussian T1534 acceptable longitude values (continued)

116.0151	116.1323	116.2495	116.3667	116.4839	116.6011
116.7183	116.8354	116.9526	117.0698	117.187	117.3042
117.4214	117.5386	117.6558	117.7729	117.8901	118.0073
118.1245	118.2417	118.3589	118.4761	118.5933	118.7104
118.8276	118.9448	119.062	119.1792	119.2964	119.4135
119.5307	119.6479	119.7651	119.8823	119.9995	120.1167
120.2339	120.351	120.4682	120.5854	120.7026	120.8198
120.937	121.0542	121.1714	121.2885	121.4057	121.5229
121.6401	121.7573	121.8745	121.9917	122.1089	122.226
122.3432	122.4604	122.5776	122.6948	122.812	122.9292
123.0464	123.1635	123.2807	123.3979	123.5151	123.6323
123.7495	123.8667	123.9839	124.101	124.2182	124.3354
124.4526	124.5698	124.687	124.8041	124.9213	125.0385
125.1557	125.2729	125.3901	125.5073	125.6245	125.7416
125.8588	125.976	126.0932	126.2104	126.3276	126.4448
126.562	126.6791	126.7963	126.9135	127.0307	127.1479
127.2651	127.3823	127.4995	127.6166	127.7338	127.851
127.9682	128.0854	128.2026	128.3198	128.437	128.5541
128.6713	128.7885	128.9057	129.0229	129.1401	129.2573
129.3745	129.4916	129.6088	129.726	129.8432	129.9604
130.0776	130.1948	130.312	130.4291	130.5463	130.6635
130.7807	130.8979	131.0151	131.1323	131.2495	131.3666
131.4838	131.601	131.7182	131.8354	131.9526	132.0698
132.187	132.3041	132.4213	132.5385	132.6557	132.7729
132.8901	133.0073	133.1245	133.2416	133.3588	133.476
133.5932	133.7104	133.8276	133.9448	134.062	134.1791
134.2963	134.4135	134.5307	134.6479	134.765	134.8822
134.9994	135.1166	135.2338	135.351	135.4682	135.5854
135.7025	135.8197	135.9369	136.0541	136.1713	136.2885
136.4057	136.5229	136.64	136.7572	136.8744	136.9916
137.1088	137.226	137.3432	137.4604	137.5775	137.6947
137.8119	137.9291	138.0463	138.1635	138.2806	138.3978
138.515	138.6322	138.7494	138.8666	138.9838	139.101

Table 12. Gaussian T1534 acceptable longitude values (continued)

139.2181	139.3353	139.4525	139.5697	139.6869	139.8041
139.9213	140.0385	140.1556	140.2728	140.39	140.5072
140.6244	140.7416	140.8588	140.976	141.0931	141.2103
141.3275	141.4447	141.5619	141.6791	141.7963	141.9135
142.0306	142.1478	142.265	142.3822	142.4994	142.6166
142.7338	142.851	142.9681	143.0853	143.2025	143.3197
143.4369	143.5541	143.6713	143.7885	143.9056	144.0228
144.14	144.2572	144.3744	144.4916	144.6088	144.726
144.8431	144.9603	145.0775	145.1947	145.3119	145.4291
145.5463	145.6635	145.7806	145.8978	146.015	146.1322
146.2494	146.3666	146.4838	146.601	146.7181	146.8353
146.9525	147.0697	147.1869	147.3041	147.4213	147.5385
147.6556	147.7728	147.89	148.0072	148.1244	148.2416
148.3588	148.476	148.5931	148.7103	148.8275	148.9447
149.0619	149.179	149.2962	149.4134	149.5306	149.6478
149.765	149.8822	149.9994	150.1165	150.2337	150.3509
150.4681	150.5853	150.7025	150.8197	150.9369	151.054
151.1712	151.2884	151.4056	151.5228	151.64	151.7572
151.8744	151.9915	152.1088	152.226	152.3431	152.4603
152.5775	152.6946	152.8118	152.929	153.0462	153.1634
153.2806	153.3978	153.515	153.6321	153.7493	153.8665
153.9837	154.1009	154.2181	154.3353	154.4525	154.5696
154.6868	154.804	154.9212	155.0384	155.1556	155.2728
155.39	155.5071	155.6243	155.7415	155.8587	155.9759
156.0931	156.2103	156.3275	156.4446	156.5618	156.679
156.7962	156.9134	157.0306	157.1478	157.265	157.3821
157.4993	157.6165	157.7337	157.8509	157.9681	158.0853
158.2025	158.3196	158.4368	158.554	158.6712	158.7884
158.9056	159.0228	159.14	159.2571	159.3743	159.4915
159.6087	159.7259	159.8431	159.9603	160.0775	160.1946
160.3118	160.429	160.5462	160.6634	160.7806	160.8978
161.015	161.1321	161.2493	161.3665	161.4837	161.6009
161.7181	161.8353	161.9525	162.0696	162.1868	162.304

Table 13. Gaussian T1534 acceptable longitude values (continued)

162.4212	162.5384	162.6556	162.7728	162.89	163.0071
163.1243	163.2415	163.3586	163.4758	163.593	163.7102
163.8274	163.9446	164.0618	164.179	164.2961	164.4133
164.5305	164.6477	164.7649	164.8821	164.9993	165.1165
165.2336	165.3508	165.468	165.5852	165.7024	165.8196
165.9368	166.054	166.1711	166.2883	166.4055	166.5227
166.6399	166.7571	166.8743	166.9915	167.1086	167.2258
167.343	167.4602	167.5774	167.6946	167.8118	167.929
168.0461	168.1633	168.2805	168.3977	168.5149	168.6321
168.7493	168.8665	168.9836	169.1008	169.218	169.3352
169.4524	169.5696	169.6868	169.804	169.9211	170.0383
170.1555	170.2727	170.3899	170.5071	170.6243	170.7415
170.8586	170.9758	171.093	171.2102	171.3274	171.4446
171.5618	171.679	171.7961	171.9133	172.0305	172.1477
172.2649	172.3821	172.4993	172.6165	172.7336	172.8508
172.968	173.0852	173.2024	173.3196	173.4368	173.554
173.6711	173.7883	173.9055	174.0227	174.1399	174.2571
174.3743	174.4915	174.6086	174.7258	174.843	174.9602
175.0774	175.1946	175.3118	175.429	175.5461	175.6633
175.7805	175.8977	176.0149	176.1321	176.2493	176.3665
176.4836	176.6008	176.718	176.8352	176.9524	177.0696
177.1868	177.304	177.4211	177.5383	177.6555	177.7727
177.8899	178.0071	178.1243	178.2415	178.3586	178.4758
178.593	178.7102	178.8274	178.9446	179.0618	179.179
179.2961	179.4133	179.5305	179.6477	179.7649	179.8821
179.9993	-179.8835	-179.7664	-179.6492	-179.532	-179.4148
-179.2976	-179.1804	-179.0633	-178.9461	-178.8289	-178.7117
-178.5945	-178.4774	-178.3602	-178.243	-178.1258	-178.0086
-177.8914	-177.7742	-177.657	-177.5399	-177.4227	-177.3055
-177.1883	-177.0711	-176.9539	-176.8367	-176.7195	-176.6024
-176.4852	-176.368	-176.2508	-176.1336	-176.0164	-175.8992
-175.782	-175.6649	-175.5477	-175.4305	-175.3133	-175.1961
-175.0789	-174.9617	-174.8445	-174.7274	-174.6102	-174.493

Table 14. Gaussian T1534 acceptable longitude values (continued)

-174.3758	-174.2586	-174.1414	-174.0242	-173.907	-173.7899
-173.6727	-173.5555	-173.4383	-173.3211	-173.2039	-173.0867
-172.9695	-172.8524	-172.7352	-172.618	-172.5008	-172.3836
-172.2664	-172.1492	-172.032	-171.9149	-171.7977	-171.6805
-171.5633	-171.4461	-171.3289	-171.2117	-171.0945	-170.9774
-170.8602	-170.743	-170.6258	-170.5086	-170.3914	-170.2742
-170.157	-170.0399	-169.9227	-169.8055	-169.6883	-169.5711
-169.4539	-169.3367	-169.2195	-169.1024	-168.9852	-168.868
-168.7508	-168.6336	-168.5164	-168.3992	-168.2821	-168.1649
-168.0477	-167.9305	-167.8134	-167.6962	-167.579	-167.4618
-167.3446	-167.2274	-167.1102	-166.993	-166.8759	-166.7587
-166.6415	-166.5243	-166.4071	-166.2899	-166.1727	-166.0555
-165.9384	-165.8212	-165.704	-165.5868	-165.4696	-165.3524
-165.2352	-165.118	-165.0009	-164.8837	-164.7665	-164.6493
-164.5321	-164.4149	-164.2977	-164.1805	-164.0634	-163.9462
-163.829	-163.7118	-163.5946	-163.4774	-163.3602	-163.243
-163.1259	-163.0087	-162.8915	-162.7743	-162.6571	-162.5399
-162.4227	-162.3055	-162.1884	-162.0712	-161.954	-161.8368
-161.7196	-161.6024	-161.4852	-161.368	-161.2509	-161.1337
-161.0165	-160.8993	-160.7821	-160.6649	-160.5477	-160.4305
-160.3134	-160.1962	-160.079	-159.9618	-159.8446	-159.7274
-159.6102	-159.493	-159.3759	-159.2587	-159.1415	-159.0243
-158.9071	-158.7899	-158.6727	-158.5555	-158.4384	-158.3212
-158.204	-158.0868	-157.9696	-157.8524	-157.7352	-157.618
-157.5009	-157.3837	-157.2665	-157.1493	-157.0321	-156.9149
-156.7977	-156.6805	-156.5634	-156.4462	-156.329	-156.2118
-156.0946	-155.9774	-155.8602	-155.743	-155.6259	-155.5087
-155.3915	-155.2743	-155.1571	-155.0399	-154.9227	-154.8055
-154.6884	-154.5712	-154.454	-154.3368	-154.2196	-154.1024
-153.9852	-153.868	-153.7509	-153.6337	-153.5165	-153.3993
-153.2821	-153.1649	-153.0477	-152.9305	-152.8134	-152.6962
-152.579	-152.4618	-152.3446	-152.2274	-152.1102	-151.993
-151.8759	-151.7587	-151.6415	-151.5243	-151.4071	-151.2899

Table 15. Gaussian T1534 acceptable longitude values (continued)

-151.1727	-151.0555	-150.9384	-150.8212	-150.704	-150.5868
-150.4696	-150.3525	-150.2353	-150.1181	-150.0009	-149.8837
-149.7665	-149.6494	-149.5322	-149.415	-149.2978	-149.1806
-149.0634	-148.9462	-148.829	-148.7119	-148.5947	-148.4775
-148.3603	-148.2431	-148.1259	-148.0087	-147.8915	-147.7744
-147.6572	-147.54	-147.4228	-147.3056	-147.1884	-147.0712
-146.954	-146.8369	-146.7197	-146.6025	-146.4853	-146.3681
-146.2509	-146.1337	-146.0165	-145.8994	-145.7822	-145.665
-145.5478	-145.4306	-145.3134	-145.1962	-145.079	-144.9619
-144.8447	-144.7275	-144.6103	-144.4931	-144.3759	-144.2587
-144.1415	-144.0244	-143.9072	-143.79	-143.6728	-143.5556
-143.4384	-143.3212	-143.204	-143.0869	-142.9697	-142.8525
-142.7353	-142.6181	-142.5009	-142.3837	-142.2665	-142.1494
-142.0322	-141.915	-141.7978	-141.6806	-141.5634	-141.4462
-141.329	-141.2119	-141.0947	-140.9775	-140.8603	-140.7431
-140.6259	-140.5087	-140.3915	-140.2744	-140.1572	-140.04
-139.9228	-139.8056	-139.6885	-139.5713	-139.4541	-139.3369
-139.2197	-139.1025	-138.9854	-138.8682	-138.751	-138.6338
-138.5166	-138.3994	-138.2822	-138.165	-138.0479	-137.9307
-137.8135	-137.6963	-137.5791	-137.4619	-137.3447	-137.2275
-137.1104	-136.9932	-136.876	-136.7588	-136.6416	-136.5244
-136.4072	-136.29	-136.1729	-136.0557	-135.9385	-135.8213
-135.7041	-135.5869	-135.4697	-135.3525	-135.2354	-135.1182
-135.001	-134.8838	-134.7666	-134.6494	-134.5322	-134.415
-134.2979	-134.1807	-134.0635	-133.9463	-133.8291	-133.7119
-133.5947	-133.4775	-133.3604	-133.2432	-133.126	-133.0088
-132.8916	-132.7744	-132.6572	-132.54	-132.4229	-132.3057
-132.1885	-132.0713	-131.9541	-131.8369	-131.7197	-131.6025
-131.4854	-131.3682	-131.251	-131.1338	-131.0166	-130.8994
-130.7822	-130.665	-130.5479	-130.4307	-130.3135	-130.1963
-130.0791	-129.9619	-129.8447	-129.7275	-129.6104	-129.4932
-129.376	-129.2588	-129.1416	-129.0244	-128.9072	-128.79
-128.6729	-128.5557	-128.4385	-128.3213	-128.2041	-128.0869

Table 16. Gaussian T1534 acceptable longitude values (continued)

-127.9697	-127.8525	-127.7354	-127.6182	-127.501	-127.3838
-127.2666	-127.1494	-127.0322	-126.915	-126.7979	-126.6807
-126.5635	-126.4463	-126.3291	-126.2119	-126.0947	-125.9775
-125.8604	-125.7432	-125.626	-125.5088	-125.3916	-125.2744
-125.1572	-125.04	-124.9229	-124.8057	-124.6885	-124.5713
-124.4541	-124.3369	-124.2197	-124.1025	-123.9854	-123.8682
-123.751	-123.6338	-123.5166	-123.3994	-123.2822	-123.165
-123.0479	-122.9307	-122.8135	-122.6963	-122.5791	-122.4619
-122.3447	-122.2275	-122.1104	-121.9932	-121.876	-121.7589
-121.6417	-121.5245	-121.4073	-121.2901	-121.1729	-121.0557
-120.9385	-120.8214	-120.7042	-120.587	-120.4698	-120.3526
-120.2354	-120.1182	-120.001	-119.8839	-119.7667	-119.6495
-119.5323	-119.4151	-119.2979	-119.1807	-119.0635	-118.9464
-118.8292	-118.712	-118.5948	-118.4776	-118.3604	-118.2432
-118.126	-118.0089	-117.8917	-117.7745	-117.6573	-117.5401
-117.4229	-117.3057	-117.1885	-117.0714	-116.9542	-116.837
-116.7198	-116.6026	-116.4854	-116.3682	-116.251	-116.1339
-116.0167	-115.8995	-115.7823	-115.6651	-115.5479	-115.4307
-115.3135	-115.1964	-115.0792	-114.962	-114.8448	-114.7276
-114.6104	-114.4932	-114.376	-114.2589	-114.1417	-114.0245
-113.9073	-113.7901	-113.6729	-113.5557	-113.4385	-113.3214
-113.2042	-113.087	-112.9698	-112.8526	-112.7354	-112.6182
-112.501	-112.3839	-112.2667	-112.1495	-112.0323	-111.9151
-111.7979	-111.6807	-111.5635	-111.4464	-111.3292	-111.212
-111.0948	-110.9777	-110.8605	-110.7433	-110.6261	-110.5089
-110.3917	-110.2745	-110.1573	-110.0402	-109.923	-109.8058
-109.6886	-109.5714	-109.4542	-109.337	-109.2198	-109.1027
-108.9855	-108.8683	-108.7511	-108.6339	-108.5167	-108.3995
-108.2823	-108.1652	-108.048	-107.9308	-107.8136	-107.6964
-107.5792	-107.462	-107.3448	-107.2277	-107.1105	-106.9933
-106.8761	-106.7589	-106.6417	-106.5245	-106.4073	-106.2902
-106.173	-106.0558	-105.9386	-105.8214	-105.7042	-105.587
-105.4698	-105.3527	-105.2355	-105.1183	-105.0011	-104.8839

Table 17. Gaussian T1534 acceptable longitude values (continued)

-104.7667	-104.6495	-104.5323	-104.4152	-104.298	-104.1808
-104.0636	-103.9464	-103.8292	-103.712	-103.5948	-103.4777
-103.3605	-103.2433	-103.1261	-103.0089	-102.8917	-102.7745
-102.6573	-102.5402	-102.423	-102.3058	-102.1886	-102.0714
-101.9542	-101.837	-101.7198	-101.6027	-101.4855	-101.3683
-101.2511	-101.1339	-101.0167	-100.8995	-100.7823	-100.6652
-100.548	-100.4308	-100.3136	-100.1964	-100.0792	-99.96204
-99.84485	-99.72766	-99.61047	-99.49329	-99.3761	-99.25891
-99.14172	-99.02454	-98.90735	-98.79016	-98.67297	-98.55579
-98.4386	-98.32141	-98.20422	-98.08704	-97.96985	-97.85266
-97.73547	-97.61829	-97.5011	-97.38391	-97.26672	-97.14954
-97.03235	-96.91516	-96.79797	-96.68079	-96.5636	-96.44641
-96.32922	-96.21204	-96.09485	-95.97766	-95.86047	-95.74329
-95.6261	-95.50891	-95.39172	-95.27454	-95.15735	-95.04016
-94.92297	-94.80579	-94.6886	-94.57141	-94.45422	-94.33704
-94.21985	-94.10266	-93.98547	-93.86829	-93.7511	-93.63391
-93.51672	-93.39954	-93.28235	-93.16516	-93.04797	-92.93079
-92.8136	-92.69641	-92.57922	-92.46204	-92.34485	-92.22766
-92.11047	-91.99329	-91.8761	-91.75891	-91.64172	-91.52454
-91.40735	-91.29022	-91.17303	-91.05585	-90.93866	-90.82147
-90.70428	-90.5871	-90.46991	-90.35272	-90.23553	-90.11835
-90.00116	-89.88397	-89.76678	-89.6496	-89.53241	-89.41522
-89.29803	-89.18085	-89.06366	-88.94647	-88.82928	-88.7121
-88.59491	-88.47772	-88.36053	-88.24335	-88.12616	-88.00897
-87.89178	-87.7746	-87.65741	-87.54022	-87.42303	-87.30585
-87.18866	-87.07147	-86.95428	-86.8371	-86.71991	-86.60272
-86.48553	-86.36835	-86.25116	-86.13397	-86.01678	-85.8996
-85.78241	-85.66522	-85.54803	-85.43085	-85.31366	-85.19647
-85.07928	-84.9621	-84.84491	-84.72772	-84.61053	-84.49335
-84.37616	-84.25897	-84.14185	-84.02466	-83.90747	-83.79028
-83.6731	-83.55591	-83.43872	-83.32153	-83.20435	-83.08716
-82.96997	-82.85278	-82.7356	-82.61841	-82.50122	-82.38403
-82.26685	-82.14966	-82.03247	-81.91528	-81.7981	-81.68091

Table 18. Gaussian T1534 acceptable longitude values (continued)

-81.56372	-81.44653	-81.32935	-81.21216	-81.09497	-80.97778
-80.8606	-80.74341	-80.62622	-80.50903	-80.39185	-80.27466
-80.15747	-80.04028	-79.9231	-79.80591	-79.68872	-79.57153
-79.45435	-79.33716	-79.21997	-79.10278	-78.9856	-78.86841
-78.75122	-78.63403	-78.51685	-78.39966	-78.28247	-78.16528
-78.0481	-77.93091	-77.81372	-77.69653	-77.57935	-77.46216
-77.34497	-77.22778	-77.1106	-76.99341	-76.87622	-76.75903
-76.64185	-76.52466	-76.40747	-76.29028	-76.1731	-76.05591
-75.93872	-75.82153	-75.70435	-75.58716	-75.46997	-75.35278
-75.2356	-75.11841	-75.00122	-74.88403	-74.76685	-74.64966
-74.53247	-74.41528	-74.2981	-74.18091	-74.06372	-73.94653
-73.82935	-73.71216	-73.59497	-73.47778	-73.3606	-73.24341
-73.12622	-73.00903	-72.89185	-72.77466	-72.65747	-72.54028
-72.4231	-72.30591	-72.18872	-72.07153	-71.95435	-71.83716
-71.71997	-71.60278	-71.4856	-71.36841	-71.25122	-71.13403
-71.01685	-70.89966	-70.78247	-70.66528	-70.5481	-70.43091
-70.31372	-70.19653	-70.07935	-69.96216	-69.84497	-69.72778
-69.6106	-69.49341	-69.37622	-69.25903	-69.14185	-69.02466
-68.90747	-68.79028	-68.6731	-68.55591	-68.43872	-68.32153
-68.20435	-68.08716	-67.96997	-67.85278	-67.7356	-67.61841
-67.50122	-67.38403	-67.26685	-67.14966	-67.03247	-66.91528
-66.7981	-66.68091	-66.56372	-66.44653	-66.32935	-66.21216
-66.09497	-65.97778	-65.8606	-65.74341	-65.62622	-65.50903
-65.39185	-65.27466	-65.15747	-65.04028	-64.9231	-64.80591
-64.68872	-64.57153	-64.45435	-64.33716	-64.21997	-64.10278
-63.9856	-63.86841	-63.75122	-63.63403	-63.51685	-63.39966
-63.28247	-63.16528	-63.0481	-62.93091	-62.81372	-62.69653
-62.57941	-62.46222	-62.34503	-62.22784	-62.11066	-61.99347
-61.87628	-61.75909	-61.64191	-61.52472	-61.40753	-61.29034
-61.17316	-61.05597	-60.93878	-60.82159	-60.70441	-60.58722
-60.47003	-60.35284	-60.23566	-60.11847	-60.00128	-59.88409
-59.76691	-59.64972	-59.53253	-59.41534	-59.29816	-59.18097
-59.06378	-58.94659	-58.82941	-58.71222	-58.59503	-58.47784

Table 19. Gaussian T1534 acceptable longitude values (continued)

-58.36066	-58.24347	-58.12628	-58.00909	-57.89191	-57.77472
-57.65753	-57.54034	-57.42316	-57.30597	-57.18878	-57.07159
-56.95441	-56.83722	-56.72003	-56.60284	-56.48566	-56.36847
-56.25128	-56.13409	-56.01691	-55.89972	-55.78253	-55.66534
-55.54816	-55.43103	-55.31384	-55.19666	-55.07947	-54.96228
-54.84509	-54.72791	-54.61072	-54.49353	-54.37634	-54.25916
-54.14197	-54.02478	-53.90759	-53.79041	-53.67322	-53.55603
-53.43884	-53.32166	-53.20447	-53.08728	-52.97009	-52.85291
-52.73572	-52.61853	-52.50134	-52.38416	-52.26697	-52.14978
-52.03259	-51.91541	-51.79822	-51.68103	-51.56384	-51.44666
-51.32947	-51.21228	-51.09509	-50.97791	-50.86072	-50.74353
-50.62634	-50.50916	-50.39197	-50.27478	-50.15759	-50.04041
-49.92322	-49.80603	-49.68884	-49.57166	-49.45447	-49.33728
-49.22009	-49.10291	-48.98572	-48.86853	-48.75134	-48.63416
-48.51697	-48.39978	-48.28259	-48.16541	-48.04822	-47.93103
-47.81384	-47.69666	-47.57947	-47.46228	-47.34509	-47.22791
-47.11072	-46.99353	-46.87634	-46.75916	-46.64197	-46.52478
-46.40759	-46.29041	-46.17322	-46.05603	-45.93884	-45.82166
-45.70447	-45.58728	-45.47009	-45.35291	-45.23572	-45.11853
-45.00134	-44.88416	-44.76697	-44.64978	-44.53259	-44.41541
-44.29822	-44.18103	-44.06384	-43.94666	-43.82947	-43.71228
-43.59509	-43.47791	-43.36072	-43.24353	-43.12634	-43.00916
-42.89197	-42.77478	-42.65759	-42.54041	-42.42322	-42.30603
-42.18884	-42.07166	-41.95447	-41.83728	-41.72009	-41.60291
-41.48572	-41.36853	-41.25134	-41.13416	-41.01697	-40.89978
-40.78259	-40.66541	-40.54822	-40.43103	-40.31384	-40.19666
-40.07947	-39.96228	-39.84509	-39.72791	-39.61072	-39.49353
-39.37634	-39.25916	-39.14197	-39.02478	-38.90759	-38.79041
-38.67322	-38.55603	-38.43884	-38.32166	-38.20447	-38.08728
-37.97009	-37.85291	-37.73572	-37.61853	-37.50134	-37.38416
-37.26697	-37.14978	-37.03259	-36.91541	-36.79822	-36.68103
-36.56384	-36.44666	-36.32947	-36.21228	-36.09509	-35.97791
-35.86072	-35.74353	-35.62634	-35.50916	-35.39197	-35.27478

Table 20. Gaussian T1534 acceptable longitude values (continued)

-35.15759	-35.04041	-34.92322	-34.80603	-34.68884	-34.57166
-34.45447	-34.33728	-34.22009	-34.10291	-33.98578	-33.86859
-33.7514	-33.63422	-33.51703	-33.39984	-33.28265	-33.16547
-33.04828	-32.93109	-32.8139	-32.69672	-32.57953	-32.46234
-32.34515	-32.22797	-32.11078	-31.99359	-31.8764	-31.75922
-31.64203	-31.52484	-31.40765	-31.29047	-31.17328	-31.05609
-30.9389	-30.82172	-30.70453	-30.58734	-30.47015	-30.35297
-30.23578	-30.11859	-30.0014	-29.88422	-29.76703	-29.64984
-29.53265	-29.41547	-29.29828	-29.18109	-29.0639	-28.94672
-28.82953	-28.71234	-28.59515	-28.47797	-28.36078	-28.24359
-28.1264	-28.00922	-27.89203	-27.77484	-27.65765	-27.54047
-27.42328	-27.30609	-27.1889	-27.07172	-26.95453	-26.8374
-26.72021	-26.60303	-26.48584	-26.36865	-26.25146	-26.13428
-26.01709	-25.8999	-25.78271	-25.66553	-25.54834	-25.43115
-25.31396	-25.19678	-25.07959	-24.9624	-24.84521	-24.72803
-24.61084	-24.49365	-24.37646	-24.25928	-24.14209	-24.0249
-23.90771	-23.79053	-23.67334	-23.55615	-23.43896	-23.32178
-23.20459	-23.0874	-22.97021	-22.85303	-22.73584	-22.61865
-22.50146	-22.38428	-22.26709	-22.1499	-22.03271	-21.91553
-21.79834	-21.68115	-21.56396	-21.44678	-21.32959	-21.2124
-21.09521	-20.97803	-20.86084	-20.74365	-20.62646	-20.50928
-20.39209	-20.2749	-20.15771	-20.04053	-19.92334	-19.80615
-19.68896	-19.57178	-19.45459	-19.3374	-19.22021	-19.10303
-18.98584	-18.86865	-18.75146	-18.63428	-18.51709	-18.3999
-18.28271	-18.16553	-18.04834	-17.93115	-17.81396	-17.69678
-17.57959	-17.4624	-17.34521	-17.22803	-17.11084	-16.99365
-16.87646	-16.75928	-16.64209	-16.5249	-16.40771	-16.29053
-16.17334	-16.05615	-15.93896	-15.82178	-15.70459	-15.5874
-15.47021	-15.35303	-15.23584	-15.11865	-15.00146	-14.88428
-14.76709	-14.6499	-14.53271	-14.41553	-14.29834	-14.18115
-14.06396	-13.94678	-13.82959	-13.7124	-13.59521	-13.47803
-13.36084	-13.24365	-13.12646	-13.00928	-12.89209	-12.7749
-12.65771	-12.54053	-12.42334	-12.30615	-12.18896	-12.07178

Table 21. Gaussian T1534 acceptable longitude values (continued)

-11.95459	-11.8374	-11.72021	-11.60303	-11.48584	-11.36865
-11.25146	-11.13428	-11.01709	-10.8999	-10.78271	-10.66553
-10.54834	-10.43115	-10.31396	-10.19678	-10.07959	-9.962402
-9.845215	-9.728027	-9.61084	-9.493652	-9.376465	-9.259277
-9.14209	-9.024902	-8.907715	-8.790527	-8.67334	-8.556152
-8.438965	-8.321777	-8.20459	-8.087402	-7.970215	-7.853027
-7.73584	-7.618652	-7.501465	-7.384277	-7.26709	-7.149902
-7.032715	-6.915527	-6.79834	-6.681152	-6.563965	-6.446777
-6.32959	-6.212402	-6.095215	-5.978027	-5.86084	-5.743652
-5.626465	-5.509277	-5.39209	-5.274963	-5.157776	-5.040588
-4.923401	-4.806213	-4.689026	-4.571838	-4.454651	-4.337463
-4.220276	-4.103088	-3.985901	-3.868713	-3.751526	-3.634338
-3.517151	-3.399963	-3.282776	-3.165588	-3.048401	-2.931213
-2.814026	-2.696838	-2.579651	-2.462463	-2.345276	-2.228088
-2.110901	-1.993713	-1.876526	-1.759338	-1.642151	-1.524963
-1.407776	-1.290588	-1.173401	-1.056213	-0.9390259	-0.8218384
-0.7046509	-0.5874634	-0.4702759	-0.3530884	-0.2359009	-0.1187134

Table 22. Gaussian T1534 acceptable latitude values

-89.90934	-89.79441	-89.67735	-89.56031	-89.44327	-89.32623
-89.20895	-89.09194	-88.97473	-88.85756	-88.74057	-88.62342
-88.50629	-88.38905	-88.27195	-88.15485	-88.03766	-87.92048
-87.8034	-87.68624	-87.56908	-87.45193	-87.33479	-87.21764
-87.10051	-86.98331	-86.86618	-86.74905	-86.63193	-86.51473
-86.39761	-86.28048	-86.16329	-86.04616	-85.92902	-85.81188
-85.6947	-85.57755	-85.46041	-85.34326	-85.2261	-85.10899
-84.99183	-84.87466	-84.75753	-84.64039	-84.52324	-84.40609
-84.28893	-84.17179	-84.05462	-83.93748	-83.82035	-83.70319
-83.58604	-83.46889	-83.35176	-83.23459	-83.11744	-83.0003
-82.88316	-82.766	-82.64886	-82.53171	-82.41454	-82.29739
-82.18025	-82.06311	-81.94596	-81.82881	-81.71165	-81.59451
-81.47736	-81.36021	-81.24307	-81.12591	-81.00877	-80.89161
-80.77446	-80.65731	-80.54017	-80.42301	-80.30588	-80.18873
-80.07158	-79.95442	-79.83728	-79.72014	-79.60297	-79.48582
-79.36868	-79.25153	-79.13438	-79.01723	-78.90009	-78.78293
-78.66579	-78.54864	-78.43148	-78.31432	-78.19718	-78.08003
-77.96289	-77.84574	-77.72859	-77.61144	-77.49429	-77.37714
-77.25999	-77.14284	-77.0257	-76.90854	-76.79139	-76.67425
-76.5571	-76.43994	-76.32279	-76.20565	-76.0885	-75.97136
-75.8542	-75.73705	-75.6199	-75.50275	-75.3856	-75.26846
-75.15131	-75.03416	-74.91701	-74.79985	-74.6827	-74.56556
-74.44841	-74.33126	-74.21411	-74.09696	-73.97981	-73.86266
-73.74551	-73.62836	-73.51122	-73.39407	-73.27691	-73.15977
-73.04262	-72.92546	-72.80832	-72.69117	-72.57402	-72.45686
-72.33972	-72.22257	-72.10542	-71.98827	-71.87112	-71.75397
-71.63682	-71.51968	-71.40253	-71.28537	-71.16824	-71.05108
-70.93392	-70.81679	-70.69963	-70.58248	-70.46534	-70.34818
-70.23103	-70.11389	-69.99673	-69.87959	-69.76244	-69.64529
-69.52814	-69.41099	-69.29384	-69.17669	-69.05954	-68.9424
-68.82524	-68.70809	-68.59094	-68.4738	-68.35664	-68.23949
-68.12234	-68.0052	-67.88805	-67.7709	-67.65375	-67.5366
-67.41945	-67.3023	-67.18515	-67.06799	-66.95085	-66.83371

Table 23. Gaussian T1534 acceptable latitude values (continued)

-66.71655	-66.59941	-66.48226	-66.3651	-66.24796	-66.13081
-66.01366	-65.89651	-65.77936	-65.66222	-65.54506	-65.42791
-65.31077	-65.19361	-65.07647	-64.95931	-64.84216	-64.72501
-64.60786	-64.49072	-64.37356	-64.25642	-64.13927	-64.02212
-63.90497	-63.78783	-63.67067	-63.55352	-63.43637	-63.31922
-63.20208	-63.08492	-62.96778	-62.85063	-62.73347	-62.61633
-62.49918	-62.38203	-62.26488	-62.14773	-62.03058	-61.91343
-61.79628	-61.67913	-61.56199	-61.44483	-61.32769	-61.21053
-61.09339	-60.97623	-60.85909	-60.74194	-60.62479	-60.50764
-60.39049	-60.27335	-60.15619	-60.03904	-59.9219	-59.80474
-59.6876	-59.57044	-59.4533	-59.33615	-59.219	-59.10184
-58.9847	-58.86755	-58.7504	-58.63325	-58.5161	-58.39895
-58.2818	-58.16465	-58.04751	-57.93036	-57.81321	-57.69605
-57.57891	-57.46176	-57.34461	-57.22746	-57.11031	-56.99316
-56.87601	-56.75886	-56.64171	-56.52456	-56.40741	-56.29026
-56.17311	-56.05597	-55.93881	-55.82167	-55.70452	-55.58737
-55.47022	-55.35307	-55.23592	-55.11877	-55.00162	-54.88447
-54.76732	-54.65018	-54.53302	-54.41588	-54.29873	-54.18158
-54.06443	-53.94728	-53.83013	-53.71298	-53.59583	-53.47868
-53.36153	-53.24438	-53.12724	-53.01008	-52.89294	-52.77578
-52.65863	-52.54148	-52.42433	-52.30719	-52.19003	-52.07289
-51.95574	-51.83859	-51.72144	-51.60429	-51.48714	-51.36999
-51.25284	-51.13569	-51.01854	-50.9014	-50.78424	-50.6671
-50.54995	-50.4328	-50.31565	-50.1985	-50.08135	-49.9642
-49.84705	-49.7299	-49.61275	-49.4956	-49.37845	-49.2613
-49.14416	-49.027	-48.90985	-48.79271	-48.67556	-48.55841
-48.44126	-48.3241	-48.20696	-48.08981	-47.97266	-47.85551
-47.73836	-47.62122	-47.50406	-47.38691	-47.26976	-47.15261
-47.03547	-46.91831	-46.80117	-46.68402	-46.56687	-46.44972
-46.33257	-46.21542	-46.09827	-45.98112	-45.86397	-45.74682
-45.62967	-45.51252	-45.39537	-45.27822	-45.16108	-45.04393
-44.92678	-44.80963	-44.69248	-44.57533	-44.45818	-44.34103
-44.22388	-44.10673	-43.98958	-43.87244	-43.75528	-43.63813

Table 24. Gaussian T1534 acceptable latitude values (continued)

-43.52098	-43.40384	-43.28669	-43.16954	-43.05238	-42.93524
-42.81809	-42.70094	-42.58379	-42.46664	-42.34949	-42.23234
-42.1152	-41.99804	-41.88089	-41.76374	-41.6466	-41.52945
-41.4123	-41.29514	-41.178	-41.06085	-40.9437	-40.82655
-40.7094	-40.59225	-40.4751	-40.35796	-40.2408	-40.12365
-40.00651	-39.88935	-39.77221	-39.65506	-39.53791	-39.42076
-39.30361	-39.18646	-39.06931	-38.95216	-38.83501	-38.71786
-38.60072	-38.48357	-38.36641	-38.24926	-38.13211	-38.01497
-37.89782	-37.78067	-37.66352	-37.54637	-37.42922	-37.31207
-37.19492	-37.07777	-36.96062	-36.84347	-36.72632	-36.60917
-36.49202	-36.37487	-36.25772	-36.14058	-36.02342	-35.90628
-35.78913	-35.67198	-35.55483	-35.43768	-35.32053	-35.20338
-35.08624	-34.96909	-34.85193	-34.73479	-34.61763	-34.50048
-34.38334	-34.26618	-34.14904	-34.03189	-33.91474	-33.79759
-33.68044	-33.56329	-33.44614	-33.32899	-33.21184	-33.09469
-32.97754	-32.86039	-32.74324	-32.62609	-32.50895	-32.3918
-32.27465	-32.1575	-32.04035	-31.9232	-31.80605	-31.6889
-31.57175	-31.4546	-31.33745	-31.2203	-31.10315	-30.986
-30.86885	-30.75171	-30.63456	-30.5174	-30.40026	-30.28311
-30.16596	-30.04881	-29.93166	-29.81451	-29.69736	-29.58021
-29.46307	-29.34591	-29.22877	-29.11161	-28.99447	-28.87732
-28.76017	-28.64302	-28.52587	-28.40872	-28.29157	-28.17442
-28.05727	-27.94012	-27.82297	-27.70582	-27.58867	-27.47153
-27.35438	-27.23722	-27.12008	-27.00293	-26.88578	-26.76863
-26.65148	-26.53433	-26.41718	-26.30003	-26.18288	-26.06573
-25.94858	-25.83143	-25.71428	-25.59714	-25.47998	-25.36283
-25.24569	-25.12854	-25.01139	-24.89424	-24.77709	-24.65994
-24.54279	-24.42564	-24.30849	-24.19134	-24.07419	-23.95704
-23.8399	-23.72274	-23.60559	-23.48845	-23.3713	-23.25415
-23.137	-23.01985	-22.9027	-22.78555	-22.6684	-22.55125
-22.4341	-22.31695	-22.1998	-22.08265	-21.96551	-21.84836
-21.7312	-21.61406	-21.49691	-21.37976	-21.26261	-21.14546
-21.02831	-20.91116	-20.79401	-20.67686	-20.55971	-20.44256

Table 25. Gaussian T1534 acceptable latitude values (continued)

-20.32541	-20.20826	-20.09111	-19.97396	-19.85681	-19.73967
-19.62252	-19.50537	-19.38822	-19.27107	-19.15392	-19.03677
-18.91962	-18.80247	-18.68532	-18.56817	-18.45103	-18.33388
-18.21672	-18.09958	-17.98243	-17.86528	-17.74813	-17.63098
-17.51383	-17.39668	-17.27953	-17.16238	-17.04523	-16.92808
-16.81093	-16.69378	-16.57664	-16.45948	-16.34233	-16.22519
-16.10804	-15.99089	-15.87374	-15.75659	-15.63944	-15.52229
-15.40514	-15.28799	-15.17084	-15.05369	-14.93654	-14.81939
-14.70224	-14.5851	-14.46795	-14.3508	-14.23365	-14.1165
-13.99935	-13.8822	-13.76505	-13.6479	-13.53075	-13.4136
-13.29645	-13.1793	-13.06215	-12.945	-12.82786	-12.7107
-12.59356	-12.47641	-12.35926	-12.24211	-12.12496	-12.00781
-11.89066	-11.77351	-11.65636	-11.53921	-11.42206	-11.30491
-11.18776	-11.07061	-10.95346	-10.83632	-10.71917	-10.60202
-10.48487	-10.36772	-10.25057	-10.13342	-10.01627	-9.89912
-9.781971	-9.664822	-9.547672	-9.430523	-9.313374	-9.196224
-9.079076	-8.961926	-8.844776	-8.727627	-8.610477	-8.493328
-8.376179	-8.259029	-8.14188	-8.024731	-7.907581	-7.790431
-7.673283	-7.556134	-7.438984	-7.321835	-7.204686	-7.087536
-6.970387	-6.853238	-6.736088	-6.618938	-6.501789	-6.38464
-6.267491	-6.150342	-6.033192	-5.916042	-5.798893	-5.681744
-5.564595	-5.447445	-5.330295	-5.213146	-5.095997	-4.978848
-4.861699	-4.744549	-4.627399	-4.51025	-4.393101	-4.275951
-4.158802	-4.041653	-3.924504	-3.807354	-3.690205	-3.573056
-3.455906	-3.338757	-3.221607	-3.104458	-2.987309	-2.870159
-2.75301	-2.635861	-2.518711	-2.401562	-2.284412	-2.167263
-2.050114	-1.932964	-1.815815	-1.698666	-1.581516	-1.464367
-1.347218	-1.230068	-1.112919	-0.9957695	-0.8786201	-0.7614708
-0.6443214	-0.5271721	-0.4100228	-0.2928734	-0.175724	-0.05857468
0.05857468	0.175724	0.2928734	0.4100228	0.5271721	0.6443214
0.7614708	0.8786201	0.9957695	1.112919	1.230068	1.347218
1.464367	1.581516	1.698666	1.815815	1.932964	2.050114
2.167263	2.284412	2.401562	2.518711	2.635861	2.75301

Table 26. Gaussian T1534 acceptable latitude values (continued)

2.870159	2.987309	3.104458	3.221607	3.338757	3.455906
3.573056	3.690205	3.807354	3.924504	4.041653	4.158802
4.275951	4.393101	4.51025	4.627399	4.744549	4.861699
4.978848	5.095997	5.213146	5.330295	5.447445	5.564595
5.681744	5.798893	5.916042	6.033192	6.150342	6.267491
6.38464	6.501789	6.618938	6.736088	6.853238	6.970387
7.087536	7.204686	7.321835	7.438984	7.556134	7.673283
7.790431	7.907581	8.024731	8.14188	8.259029	8.376179
8.493328	8.610477	8.727627	8.844776	8.961926	9.079076
9.196224	9.313374	9.430523	9.547672	9.664822	9.781971
9.89912	10.01627	10.13342	10.25057	10.36772	10.48487
10.60202	10.71917	10.83632	10.95346	11.07061	11.18776
11.30491	11.42206	11.53921	11.65636	11.77351	11.89066
12.00781	12.12496	12.24211	12.35926	12.47641	12.59356
12.7107	12.82786	12.945	13.06215	13.1793	13.29645
13.4136	13.53075	13.6479	13.76505	13.8822	13.99935
14.1165	14.23365	14.3508	14.46795	14.5851	14.70224
14.81939	14.93654	15.05369	15.17084	15.28799	15.40514
15.52229	15.63944	15.75659	15.87374	15.99089	16.10804
16.22519	16.34233	16.45948	16.57664	16.69378	16.81093
16.92808	17.04523	17.16238	17.27953	17.39668	17.51383
17.63098	17.74813	17.86528	17.98243	18.09958	18.21672
18.33388	18.45103	18.56817	18.68532	18.80247	18.91962
19.03677	19.15392	19.27107	19.38822	19.50537	19.62252
19.73967	19.85681	19.97396	20.09111	20.20826	20.32541
20.44256	20.55971	20.67686	20.79401	20.91116	21.02831
21.14546	21.26261	21.37976	21.49691	21.61406	21.7312
21.84836	21.96551	22.08265	22.1998	22.31695	22.4341
22.55125	22.6684	22.78555	22.9027	23.01985	23.137
23.25415	23.3713	23.48845	23.60559	23.72274	23.8399
23.95704	24.07419	24.19134	24.30849	24.42564	24.54279
24.65994	24.77709	24.89424	25.01139	25.12854	25.24569
25.36283	25.47998	25.59714	25.71428	25.83143	25.94858

Table 27. Gaussian T1534 acceptable latitude values (continued)

26.06573	26.18288	26.30003	26.41718	26.53433	26.65148
26.76863	26.88578	27.00293	27.12008	27.23722	27.35438
27.47153	27.58867	27.70582	27.82297	27.94012	28.05727
28.17442	28.29157	28.40872	28.52587	28.64302	28.76017
28.87732	28.99447	29.11161	29.22877	29.34591	29.46307
29.58021	29.69736	29.81451	29.93166	30.04881	30.16596
30.28311	30.40026	30.5174	30.63456	30.75171	30.86885
30.986	31.10315	31.2203	31.33745	31.4546	31.57175
31.6889	31.80605	31.9232	32.04035	32.1575	32.27465
32.3918	32.50895	32.62609	32.74324	32.86039	32.97754
33.09469	33.21184	33.32899	33.44614	33.56329	33.68044
33.79759	33.91474	34.03189	34.14904	34.26618	34.38334
34.50048	34.61763	34.73479	34.85193	34.96909	35.08624
35.20338	35.32053	35.43768	35.55483	35.67198	35.78913
35.90628	36.02342	36.14058	36.25772	36.37487	36.49202
36.60917	36.72632	36.84347	36.96062	37.07777	37.19492
37.31207	37.42922	37.54637	37.66352	37.78067	37.89782
38.01497	38.13211	38.24926	38.36641	38.48357	38.60072
38.71786	38.83501	38.95216	39.06931	39.18646	39.30361
39.42076	39.53791	39.65506	39.77221	39.88935	40.00651
40.12365	40.2408	40.35796	40.4751	40.59225	40.7094
40.82655	40.9437	41.06085	41.178	41.29514	41.4123
41.52945	41.6466	41.76374	41.88089	41.99804	42.1152
42.23234	42.34949	42.46664	42.58379	42.70094	42.81809
42.93524	43.05238	43.16954	43.28669	43.40384	43.52098
43.63813	43.75528	43.87244	43.98958	44.10673	44.22388
44.34103	44.45818	44.57533	44.69248	44.80963	44.92678
45.04393	45.16108	45.27822	45.39537	45.51252	45.62967
45.74682	45.86397	45.98112	46.09827	46.21542	46.33257
46.44972	46.56687	46.68402	46.80117	46.91831	47.03547
47.15261	47.26976	47.38691	47.50406	47.62122	47.73836
47.85551	47.97266	48.08981	48.20696	48.3241	48.44126
48.55841	48.67556	48.79271	48.90985	49.027	49.14416

Table 28. Gaussian T1534 acceptable latitude values (continued)

49.2613	49.37845	49.4956	49.61275	49.7299	49.84705
49.9642	50.08135	50.1985	50.31565	50.4328	50.54995
50.6671	50.78424	50.9014	51.01854	51.13569	51.25284
51.36999	51.48714	51.60429	51.72144	51.83859	51.95574
52.07289	52.19003	52.30719	52.42433	52.54148	52.65863
52.77578	52.89294	53.01008	53.12724	53.24438	53.36153
53.47868	53.59583	53.71298	53.83013	53.94728	54.06443
54.18158	54.29873	54.41588	54.53302	54.65018	54.76732
54.88447	55.00162	55.11877	55.23592	55.35307	55.47022
55.58737	55.70452	55.82167	55.93881	56.05597	56.17311
56.29026	56.40741	56.52456	56.64171	56.75886	56.87601
56.99316	57.11031	57.22746	57.34461	57.46176	57.57891
57.69605	57.81321	57.93036	58.04751	58.16465	58.2818
58.39895	58.5161	58.63325	58.7504	58.86755	58.9847
59.10184	59.219	59.33615	59.4533	59.57044	59.6876
59.80474	59.9219	60.03904	60.15619	60.27335	60.39049
60.50764	60.62479	60.74194	60.85909	60.97623	61.09339
61.21053	61.32769	61.44483	61.56199	61.67913	61.79628
61.91343	62.03058	62.14773	62.26488	62.38203	62.49918
62.61633	62.73347	62.85063	62.96778	63.08492	63.20208
63.31922	63.43637	63.55352	63.67067	63.78783	63.90497
64.02212	64.13927	64.25642	64.37356	64.49072	64.60786
64.72501	64.84216	64.95931	65.07647	65.19361	65.31077
65.42791	65.54506	65.66222	65.77936	65.89651	66.01366
66.13081	66.24796	66.3651	66.48226	66.59941	66.71655
66.83371	66.95085	67.06799	67.18515	67.3023	67.41945
67.5366	67.65375	67.7709	67.88805	68.0052	68.12234
68.23949	68.35664	68.4738	68.59094	68.70809	68.82524
68.9424	69.05954	69.17669	69.29384	69.41099	69.52814
69.64529	69.76244	69.87959	69.99673	70.11389	70.23103
70.34818	70.46534	70.58248	70.69963	70.81679	70.93392
71.05108	71.16824	71.28537	71.40253	71.51968	71.63682
71.75397	71.87112	71.98827	72.10542	72.22257	72.33972

Table 29. Gaussian T1534 acceptable latitude values (continued)

72.45686	72.57402	72.69117	72.80832	72.92546	73.04262
73.15977	73.27691	73.39407	73.51122	73.62836	73.74551
73.86266	73.97981	74.09696	74.21411	74.33126	74.44841
74.56556	74.6827	74.79985	74.91701	75.03416	75.15131
75.26846	75.3856	75.50275	75.6199	75.73705	75.8542
75.97136	76.0885	76.20565	76.32279	76.43994	76.5571
76.67425	76.79139	76.90854	77.0257	77.14284	77.25999
77.37714	77.49429	77.61144	77.72859	77.84574	77.96289
78.08003	78.19718	78.31432	78.43148	78.54864	78.66579
78.78293	78.90009	79.01723	79.13438	79.25153	79.36868
79.48582	79.60297	79.72014	79.83728	79.95442	80.07158
80.18873	80.30588	80.42301	80.54017	80.65731	80.77446
80.89161	81.00877	81.12591	81.24307	81.36021	81.47736
81.59451	81.71165	81.82881	81.94596	82.06311	82.18025
82.29739	82.41454	82.53171	82.64886	82.766	82.88316
83.0003	83.11744	83.23459	83.35176	83.46889	83.58604
83.70319	83.82035	83.93748	84.05462	84.17179	84.28893
84.40609	84.52324	84.64039	84.75753	84.87466	84.99183
85.10899	85.2261	85.34326	85.46041	85.57755	85.6947
85.81188	85.92902	86.04616	86.16329	86.28048	86.39761
86.51473	86.63193	86.74905	86.86618	86.98331	87.10051
87.21764	87.33479	87.45193	87.56908	87.68624	87.8034
87.92048	88.03766	88.15485	88.27195	88.38905	88.50629
88.62342	88.74057	88.85756	88.97473	89.09194	89.20895
89.32623	89.44327	89.56031	89.67735	89.79441	89.90934

Appendix E: Polar Stereographic Domain Example

This section describes how to compute the values for the run domain and param domain sections on a polar stereographic projection.

STUB!

Appendix F: HRAP Domain Example

This section describes how to compute the values for the run domain and param domain sections on a HRAP projection.

STUB!

The spatial HRAP resolution has a default value of 1.0, which indicates a horizontal resolution of 4.7625 KM (valid at 1.0). Finer resolution values are then entered as 0.5, 0.25, etc. to represent half, quarter, etc. of the original 4.7625 KM gridcell length. All other HRAP-based polar stereographic grid parameters are already handled within the LDT or LIS code, since HRAP utilizes specific true latitude, standard longitude, and orientation values.

Note that HRAP is a special case of a polar stereographic grid. For HRAP,

true lat = 60.0

standard lon = -105.000

orientation = 0.0

resolution at true lat is 4.7625 km when resolution is set to 1.0; i.e.,

```
Run domain hrap resolution:            1
```

Appendix G: Mercator Domain Example

This section describes how to compute the values for the run domain and param domain sections on a Mercator projection.

Note that this projection is often used for a coupled run with the Weather Research and Forecasting (WRF) model. As such, Mercator domains are first generated when configuring WRF via WRF's preprocessing system (WPS). The domain information is then copied into LIS' *lis.config* file.

Please see WRF's User's Guide found at http://www.mmm.ucar.edu/wrf/users/ for more information.

Appendix H: UTM Domain Example

This section describes how to compute the values for the run domain and param domain sections on a UTM projection.

STUB!

References

- [protex] W. Sawyer and A. da Silva. ProTeX: A sample Fortran 90 source code documentation system. Technical report, NASA GMAO, 1997. DAO Office Note 97-11.