Lagrangian Snow Distributions for Sea-Ice Applications, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Liston, G. E., J. Stroeve, and P. Itkin. 2021. *Lagrangian Snow Distributions for Sea-Ice Applications, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/27A0P5M6LZBI. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0758

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1 DATA DESCRIPTION

1.1 Parameters

The main parameters of this data set are daily estimates of snow depth (m) and snow density (kg/m^3) for snow-on-sea-ice in the Arctic Ocean derived from a Lagrangian snow-evolution model forced with two sets of inputs: NASA's Modern Era Retrospective-Analysis for Research Applications Version 2 (MERRA-2) and the European Centre for Medium Range Weather Forecasts (ECMWF) Reanalysis, generation 5 (ERA5).

1.2 File Information

1.2.1 Format

NetCDF

1.2.2 File Contents

NetCDF files contain the following variables:

Table 1. File Variables and Descriptions

Variable	Description
sden	Snow density in kg/m^3; fill value -9999.0
snod	Snow depth in meters; fill value -9999.0
time	Time in hours since 1-1-1 00:00:00
x	Easting; in meters
y	Northing; in meters

1.2.3 Naming Convention

There are four NetCDF files in this set of data:

```
SM_sden_ERA5_01Aug1980-31Jul2021_v01.nc
SM_sden_MERRA2_01Aug1980-31Jul2021_v01.nc
SM_snod_ERA5_01Aug1980-31Jul2021_v01.nc
SM_snod_MERRA2_01Aug1980-31Jul2021_v01.nc
```

The file naming convention is described in Table 2.

Table 2. File Naming Convention

Variable	Description
SM	Data set: Snow Model
sden or snod	Parameters: sden = snow density snod = snow depth
ERA5 or MERRA2	Model forcing: ERA5 = European Centre for Medium-Range Weather Forecasts (ECMWF) ReAnalysis-5th Generation MERRA2 = Modern Era Retrospective Analysis for Research and Applications-Version 2
01Aug1980-31Jul2021	Temporal coverage: start and end dates of available data
v01	Version number

1.3 Spatial Information

1.3.1 Coverage

Northern Hemisphere

1.3.2 Resolution

25 km

1.3.3 Geolocation

These data are provided on the original 25 km Equal-Area Scalable Earth (EASE) Grid projection for the Northern Hemisphere. The following tables provide information for geolocating this data set; more details can be found on the EASE Grids website.

Table 3. EASE-Grid Projection Details

Geographic coordinate system	unspecified
Projected coordinate system	Northern Hemisphere Lambert Azimuthal
Longitude of true origin	0
Latitude of true origin	90
Scale factor at longitude of true origin	1
Datum	unspecified
Ellipsoid/spheroid	International 1924 Authalic Sphere
Units	meter

False easting	0
False northing	0
EPSG code	3408
PROJ4 string	+proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +a=6371228 +b=6371228 +units=m +no_defs
Reference	https://epsg.io/3408

Table 4. Grid Details

Grid cell size (x, y pixel dimensions)	25,067.53 m x 25,067.53 m
Number of rows	721
Number of columns	721
Geolocated lower left point in grid	N/A

1.4 Temporal Information

1.4.1 Coverage

01 August 1980 to 31 July 2021

1.4.2 Resolution

Daily

2 DATA ACQUISITION AND PROCESSING

2.1 The Lagrangian Snow Model (SnowModel-LG)

Snow-on-sea-ice plays a role in Earth's climate system, helping to define the surface energy budget. Snow-on-sea-ice accumulates and dissipates seasonally. Snow-on-sea-ice evolution can be tracked via estimates of snow depth and density as provided in this data set.

These data are derived using a physically based, Lagrangian snow-on-sea-ice model (SnowModel-LG) developed by Liston et al. (2018) to evolve snow-on-sea-ice parcels using atmospheric forcings and sea ice inputs of ice concentration and parcel motion. SnowModel-LG includes the physics required to simulate first-order processes such as blowing-snow redistribution and sublimation, density evolution, snow grain metamorphism, and thermal conductivity. The model framework is spatially distributed over a 1.5 x 1.5 km domain with a 1-meter resolution, time-evolving in 3-hourly steps, and resolves a dynamic multilayer snowpack. For details on the model components and algorithms, refer to Liston et al. (2020).

Once simulations are completed, the model outputs are regridded to the 25 km x 25 km EASE grid to simplify plotting and analyses of the results. This grid resolution matches that of the input ice parcel motion data set.

2.2 Model Inputs

The Lagrangian snow-evolution simulations require two types of inputs: (1) sea-ice parcel positions and concentrations and (2) atmospheric forcings of air temperature, relative humidity, wind speed, wind direction, and water-equivalent precipitation. For (1), this product uses Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data and ice parcel tracks from Polar Pathfinder Daily 25 km EASE-Grid Sea Ice Motion Vectors. With respect to (2), two simulations were carried out, each with a different set of atmospheric forcings: (a) NASA's Modern Era Retrospective-Analysis for Research and Applications, Version 2 (MERRA-2) and (b) the European Centre for Medium-Range Weather Forecasts (ECMWF) ReAnalysis, 5th Generation (ERA5). In both simulations, the type (1) inputs are the same. As a result, there are four files: snow density and snow depth with each atmospheric forcing input (MERRA-2 and ERA5).

2.3 Bias correction of precipitation inputs using data from Operation IceBridge

Operation IceBridge (OIB) data for the years 2009–2016 are used to bias correct the annual precipitation inputs so the averaged modeled snow depth equals the average observed OIB snow depth each year over the year-specific OIB observation tracks. Average precipitation scaling factors derived from the eight years of OIB data are then applied to the 41-year SnowModel-LG simulations across all parcels. For a detailed discussion of the use of OIB data to correct for precipitation, see section 2.5 of Liston et al. (2020).

2.4 Quality, Errors, and Limitations

SnowModel-LG reasonably matches almost any snow-related variable. It would benefit from additional data with which to compare modeled processes and outputs.

An early version of SnowModel-LG was validated using snow and atmospheric data collected during the Norwegian young sea ICE field expedition in 2015 (N-ICE2015). SnowModel-LG reproduced the observed snow depth variability on level, flat, ice areas and between pressure ridges within a margin of one standard error (Liston et al., 2018).

Lagrangian position errors are influenced by spatial resolution, geolocation, and binning errors for each image pixel (Meier et al., 2000; Tschudi et al., 2020), as well as atmospheric effects and temporal variability of the surface during summer. Filtering techniques reduce these errors and, in many cases, compensating errors have been shown to reduce the net parcel-location biases.

Further details regarding the limitations of this data set may be found in Liston et al. (2020).

3 SOFTWARE AND TOOLS

To view NetCDF files, use Panoply or HDFView.

4 CONTACTS AND ACKNOWLEDGMENTS

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5 REFERENCES

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6 DOCUMENT INFORMATION

6.1 Publication Date

27 May 2021

6.2 Date Last Updated

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