Daily SnowModel Outputs Covering the ABoVE Core Domain, 3-km Resolution, 1980-2020

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Dataset Version: 1

Summary

This dataset provides daily SnowModel simulation outputs on a 3-km grid for the period 1 September 1980 through 31 August 2020, covering the Core ABoVE Domain. The daily outputs include: air temperature (deg C), relative humidity (%), wind speed (m/s), wind direction (deg from True North), total precipitation (rain+snow) (m), rainfall (m), snowfall (m), snow melt (m), snow sublimation (m), runoff (m), surface temperature (deg C), bulk snowpack thermal resistance (K/W), snow depth (m), snow density (kg/m3), and snow-water-equivalent (SWE) depth (m). Model data inputs included land cover and topography, ground-based observations of snow, remote sensing observations of snow from satellites and aircraft, and meteorological forcing data from weather stations and reanalysis data. The SnowModel includes the processing modules MicroMet, Enbal, SnowDunes, SnowAssin, SnowPack, and SnowTran-3D. The data are provided in NetCDF format.

There are 615 data files in NetCDF (.nc4) format with this dataset. There is also one companion file provided in .pdf format which provides additional information on SnowModel. The companion file must be downloaded separately from the data files.

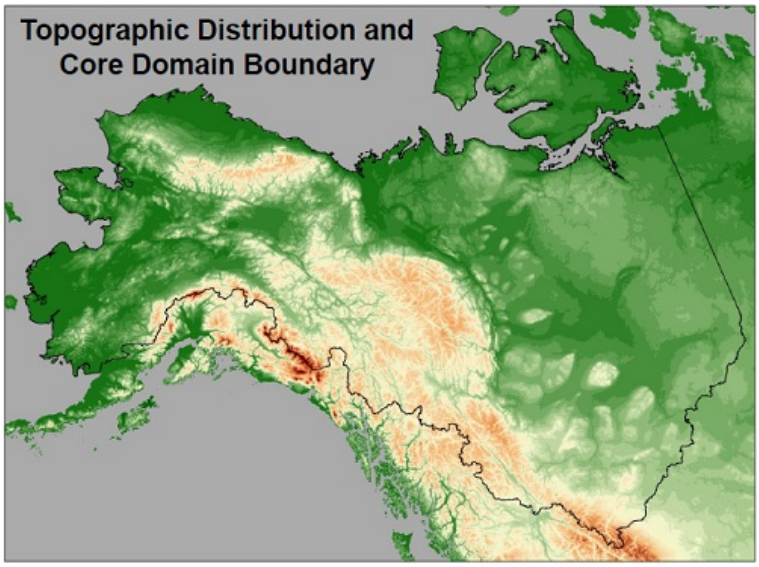

Figure 1. The topographic distribution and core domain boundary of the ABoVE study area (image is from Liston and Reinking, 2022).

Citation

Liston, G.E., A.K. Reinking, and N.T. Boleman. 2023. Daily SnowModel Outputs Covering the ABoVE Core Domain, 3-km Resolution, 1980-2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2105

Table of Contents

1. Dataset Overview

This dataset provides daily SnowModel simulation outputs on a 3-km grid for the period 1 September 1980 through 31 August 2020 covering the Core ABoVE Domain. SnowModel processing modules include MicroMet, Enbal, SnowPack, SnowTran-3D, SnowAssim, SnowPack, and SnowDunes. Inputs to SnowModel included land cover and topography, ground-based observations of snow, remote sensing observations of snow from satellites and aircraft, and meteorological forcing data from weather stations and reanalysis data. The SnowModel includes the processing modules MicroMet, Enbal, SnowDunes, SnowAssin, SnowPack, and SnowTran-3D.

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign being conducted in Alaska and western Canada, for 8 to 10 years, starting in 2015. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis, and modeling capabilities needed to understand and predict ecosystem responses to, and societal implications of, climate change in the Arctic and Boreal regions.

Related Dataset

Mahoney, P., G. Liston, B. Mangipane, and L.R. Prugh. 2018. ABoVE: Dall Sheep Response to Snow and Landscape Covariates, Alaska, 2005-2008. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1602

- This dataset also used SnowModel to simulate snow depth and snow density.

Related Publication

Liston, G. E., P. Itkin, J. Stroeve, M. Tschudi, J.S. Stewart, S.H. Pedersen, A.K. Reinking, and K. Elder. 2020. A Lagrangian snow-evolution system for sea-ice applications (SnowModel-LG): Part I—Model description. Journal of Geophysical Research: Oceans 125:e2019JC015913. https://doi.org/10.1029/2019JC015913

Acknowledgement

This dataset was funded by the NASA Arctic-Boreal Vulnerability Experiment (ABoVE), grant number 80NSSC19M0109.

2. Data Characteristics

Spatial Coverage: Alaska, US, and Canada

ABoVE Reference Locations:

Domain: Core ABoVE

State territory: Alaska

Spatial resolution: 3 km

Temporal coverage: 1980-09-01 to 2020-08-31

Temporal resolution: daily

Study Areas (All latitude and longitude given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
ABoVE core domain: Alaska, US, and Canada	-159.0263056	-84.32824167	70.10852222	49.80375833

Data File Information

This dataset contains 615 data files in NetCDF (*.nc4) format. The files provide daily SnowModel simulation outputs on a 3-km grid for the period September 1, 1980 through August 31, 2020 covering the Core ABoVE Domain. There are 15 daily output variables listed in Table 1.

The data files are named **SnowModel_variable_YYYY.nc4.** Refer to Table 1 for the **variable** names used in the data files. **YYYY** is 1980-2020.

Table 1. Variables in the data files.

Variable names used in data file names	Abbreviated variable names in .nc4 files	Units/format	Description
air_temperature	tair	degrees C	Air temperature
bulk_thermal_resistance	bthr	K W^{-1}	Bulk snowpack thermal resistance
lwe_surface_snow_thickness	swed	m	Snow water equivalent depth
rain_precipitation	rpre	m	Precipitation from rain
relative_humidity	relh	%	Relative humidity
snowpack_base_runoff	roff	m	Runoff
snow_density	sden	kg m^{-3}	Snow density
snow_depth	snod	m	Snow depth
snow_melt	smlt	m	Snow melt
snow_precipitation	spre	m	Precipitation from snow

surface_snow_sublimation	ssub	m	Snow sublimation
surface_temperature	tsfc	Degrees C	Surface (skin) temperature
total_precipitation	prec	m	Total precipitation
wind_direction	wdir	degrees from True North	Wind direction
wind_speed	wspd	m s^{-1}	Wind speed

Projection information

Projection: ABoVE standard Albers Conical Equal Area

Spheroid: 6378137,298.2572221010042,

Unit: degree, 0.0174532925199433,

Parameter: standard parallel 1, 50,

Parameter: standard parallel 2, 70,

Parameter: latitude of center, 40,

Parameter: longitude of center, -135,

Parameter: false easting, 0,

Parameter: false northing, 0,

Authority: EPSG 9001,

+proj=aea +lat_1=50 +lat_2=70 +lat_0=40 +lon_0=-135 +x_0=0 +y_0=0 +ellps=GRS80 +units=m +no_defs

Companion file

Additional details on SnowModel are provided in the companion file: **SnowModel_Summary_ABoVE_Core_Domain_3km.pdf.**

3. Application and Derivation

MicroMet (Liston and Elder 2006b) and SnowModel (Liston and Elder 2006a; also see appendices in Liston et al., 2020) have been widely used for climate, hydrology, remote sensing, wildlife, vegetation, avalanche, glacier and ice sheet mass balance, and other studies. Results from these studies include identifying snow-related Wekiu bug (*Nysius wekiuicola*) population health and distributions near the summit of Mauna Kea, Hawaii; mapping polar bear (*Ursus maritimus*) maternity den habitat in Alaska, Svalbard, and Franz Josef Land; quantifying the annual mass balance of every Northern Hemisphere glacier larger than 1 km^2; simulating snow-water resources in the western U.S. for water-management and infrastructure-design purposes; and simulating pan-Arctic snow-property trends for climate applications. Processes simulated by SnowModel include snow precipitation; blowing-snow redistribution and sublimation; forest canopy snow interception, unloading, and sublimation; snow density evolution; and snowpack ripening and melting.

MicroMet and SnowModel have been used to simulate snow distributions in Colorado, Wyoming, Idaho, Oregon, Alaska, Arctic Canada, Siberia, Japan, Tibet, Chile, Germany, Austria, Svalbard, Norway, Greenland, Antarctica, and the Arctic Ocean as part of a wide variety of snow and ice studies. These applications used grid increments ranging from 1 m to 25 km, over spatial domains ranging from points to continental, and over temporal domains ranging from hours to decades; descriptions of these studies are available in over 180 refereed publications (see Liston et al., 2020 for a sample of these publications).

4. Quality Assessment

A modeling system as complex and comprehensive as SnowModel contains numerous parameters that impact this ABoVE Core Domain simulation. However, errors in the model parameters are generally smaller than errors in the currently available atmospheric forcing inputs. As an example, Liston et al. (2020) indicated that errors in reanalyses precipitation forcing range from approximately 50% to 200%, and uncertainties in the reanalyses air temperatures can have a large impact on things like snow onset and snow-melt season length. See Bolosovich et al. (2015) for an analysis of MERRA-2 biases and uncertainty metrics. With these atmospheric forcing errors, errors in snow properties like grain size and thermal conductivity are relatively unimportant; these snow properties only directly impact the conduction term in the surface energy balance (conduction is typically a few percent of the energy budget, or less) and these snow properties only indirectly affect the snow temperature, and therefore, the snow density (Liston et al., 2020). In addition, adequate, high-quality, snow observations to compare our model outputs against, over the simulated spatial and temporal domains do not exist. For these reasons, no parameter sensitivity simulations were performed as part of this SnowModel ABoVE application; such simulations have already been performed in the existing suite of SnowModel publications; see Liston et al. (2020) for additional information.

Users of this ABoVE dataset are encouraged to compare the results with field observations and report back to the data authors to discuss whether model adjustments or data assimilations are required to improve the simulations for their project requirements.

5. Data Acquisition, Materials, and Methods

This dataset provides daily SnowModel simulation outputs on a 3-km grid for the period 1 September 1980 through 31 August 2020, covering the Core ABoVE Domain. SnowModel processing modules include MicroMet, Enbal, SnowPack, SnowTran-3D, SnowAssim, SnowPack, and SnowDunes:

- MicroMet (Micro-Meteorlogical Distribution Model)- provides the downscaled meteorological forcings provided by meteorological station data sets and gridded atmospheric model or (re)analyses data sets (Liston and Elder, 2006a).
- EnBal (Surface Energy Balance/Melt Model)- estimates surface energy exchanges (Liston et al., 1999).
- SnowPack (Multi-layer Snowpack Model) -snow depth and water-equivalent evolution (Liston and Mernild, 2012).
- SnowTran-3D (Blowing and Drifting Snow Model)- snow redistribution by wind (Liston et al., 2007; Liston and Sturm, 1998).
- SnowAssim (Snow Data Assimilation Model)- assimilates both available field (i.e., weather stations) and remote sensing datasets (Liston and Hiemstra 2008).
- SnowDunes- snow surface features simulated by SnowDunes represent all snow distributions that result from local, *O*(1–10 m), erosion, and

deposition features on relatively level, undeformed sea ice. Refer to Filhol and Sturm (2015) and Doumani (1967) for additional information.

Inputs to SnowModel include meteorological forcing data- including weather station data and reanalysis data, environmental input data-land cover and topography, and snow observations-ground-based observations and remote sensing snow observations from satellites and aircraft.

Refer to the companion file **SnowModel_Summary_ABoVE_Core_Domain_3km.pdf** for additional information.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Daily SnowModel Outputs Covering the ABoVE Core Domain, 3-km Resolution, 1980-2020

Contact for Data Center Access Information:

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