CloudSat Project

A NASA Earth System Science Pathfinder Mission

**CloudSat CRYOSPHERE-AUX Auxiliary Data Product**

**Process Description and Interface Control Document**

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# INTRODUCTION

The CRYOSPHERE-AUX data set is an intermediate product that contains a subset of ancillary Near-Real-Time Ice and Snow Extent data (NISE; Nolin et al., 1998, 2019; Brodzik and Stewart, 2016) collocated with each CloudSat cloud profiling radar (CPR) footprint. Input data are obtained from the AN-NISE dataset, provided by the National Snow and Ice Data Center (NSIDC), and the 1B-CPR product. The CRYOSPHERE-AUX data are used as input to the 2B-FLXHR-LIDAR and 2C-PRECIP-COLUMN algorithms in the CloudSat data processing system. This document describes the subset process, input product specifications, and format of the CRYOSPHERE-AUX product.

# DESCRIPTION OF THE SUBSET PROCESS

The AN-NISE data contain Near-Real-Time SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent (NISE) data fields and geolocation at a nominal resolution of 25 kilometers (see Section 3.2 for a more detailed description). To produce the CRYOSPHERE-AUX product, the geolocation data from the 1B-CPR product are used as the reference dataset. Operating one CloudSat ray at a time and using a great-circle nearest-neighbor scheme, the closest AN-NISE pixel is located. If the CloudSat geolocation for a particular ray is missing or the closest AN-NISE pixel is more than 20 kilometers from the CloudSat ray, the resulting NISE geolocation data and the associated data vectors are filled with a missing value flag.

# ALGORITHM INPUTS

## 1B-CPR Specifications

Fields available in the 1B-CPR P\_R05 data set used by this algorithm include

**(1) Seconds since the start of the granule**

**Name in file:** Profile\_time **Range:** 0 to 6000

**Source:** 1B-CPR P\_R05 **Missing value:** N/A

**Field type (in file):** REAL(4) **Missing value operator:** N/A

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** nray **Offset:** 0

**Units:** seconds

Seconds since the start of the granule for each profile. The first profile is 0.

**(2) UTC seconds since 00:00 Z of the first profile**

**Name in file:** UTC\_start **Range:** 0 to 86400

**Source:** 1B-CPR P\_R05 **Missing value:** N/A

**Field type (in file):** REAL(4) **Missing value operator:** N/A

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** <scalar> **Offset:** 0

**Units:** seconds

The UTC seconds since 00:00 Z of the first profile in the data file.

**(3) TAI time for the first profile**

**Name in file:** TAI\_start **Range:** 0 to 6×108

**Source:** 1B-CPR P\_R05 **Missing value:** N/A

**Field type (in file):** REAL(8) **Missing value operator:** N/A

**Field type (in algorithm):** REAL(8) **Factor:** 1

**Dimensions:** <scalar> **Offset:** 0

**Units:** seconds

The International Atomic Time (TAI time) as the number of seconds since January 1, 1993 00:00:00Z.

**(4) Spacecraft Latitude**

**Name in file:** Latitude **Range:** -90 to 90

**Source:** 1B-CPR P\_R05 **Missing value:** -999

**Field type (in file):** REAL(4) **Missing value operator:** ==

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** nray **Offset:** 0

**Units:** degrees

Spacecraft geodetic latitude.

**(5) Spacecraft Longitude**

**Name in file:** Longitude **Range:** -180 to 180

**Source:** 1B-CPR P\_R05 **Missing value:** -999

**Field type (in file):** REAL(4) **Missing value operator:** ==

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** nray **Offset:** 0

**Units:** degrees

Spacecraft geodetic longitude.

## AN-NISE Specifications

The AN-NISE Version 5 dataset provided by the NSICD contains DMSP-F18, SSMIS-derived sea ice concentrations and snow extents derived from the Special Sensor Microwave Imager/Sounder (SSMIS) aboard the Defense Meteorological Satellite Program (DMSP) F18 satellite (Brodzik and Stewart, 2016) and is used as input to CRYOSPHERE-AUX products 2018-present. Version 4 contains DMSP-F17, SSMIS-derived data (Nolin et al., 1998) and is used as input to CRYOSPHERE-AUX products 2009–2017. Version 2 contains DMSP-F13, Special Sensor Microwave Imager (SSMI) derived data (Nolin et al., 2019) and is used as input to CRYOSPHERE-AUX products 2006–2008. The HDF-EOS2 format files contain the following fields:

**(1) Age before the date of the data file**

**Name in file:** Age **Range:** 0 to 255

**Source:** AN-NISE **Missing value:** 255

**Field type (in file):** UINT(8) **Missing value operator:** ==

**Dimensions:** XDim, YDim **Factor:** 1

**Units:** days  **Offset:** 0

The age of the input data relative to the data file; the difference between the day of acquisition for the input data and the day of production for the NISE HDF-EOS file. Possible values include: 0-254: age (in days) before the date of the data file; 255: fill value for corner points (off-Earth) and undetermined data pixels (Brodzik and Stewart, 2016).

**(2) Snow Extent and Sea Ice Concentration**

**Name in file:** Extent **Range:** 0 to 255

**Source:** AN-NISE **Missing value:** 255

**Field type (in file):** UINT(8) **Missing value operator:** ==

**Dimensions:** XDim, YDim **Factor:** 1

**Units:** percent  **Offset:** 0

 The snow coverage and sea ice concentration of all pixels in the study areas; coastal pixels are also identified. Possible values include: 0: Snow-free land 1-100: Sea ice concentration (%) 101: Permanent ice coverage (Greenland, Antarctica); 102: Not used; 103: Pixel has snow; 104-251: Not used; 252: Coastal pixel (unable to reliably apply microwave algorithms); 253: Pixel suspected of having ice; 254: Corner points (undefined); 255: Ocean (Brodzik and Stewart, 2016).

# DATA PRODUCT OUTPUT SPECIFICATIONS

Each HDF-EOS2 product file is built for the orbit specified by the input 1B-CPR data. Within each file, the Geolocation Fields contain the NISE geolocation of the subset pixels along with time information for the CloudSat ray. The Data Fields contain the NISE science data for the subset pixels as well as information tracing back to the input AN-NISE files. The specifications for the CRYOSPHERE-AUX P\_R05 product are as follows:

**(1) Geodetic latitude of NISE pixels**

**Name in file:** NISE\_latitude **Range:** -90 to 90

**Source:** AN-NISE **Missing value:** -999

**Field type (in file):** REAL(4) **Missing value operator:** ==

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** nise\_grid, nray **Offset:** 0

**Units:** degrees

This array contains the vector of latitudes for the closest 49 pixels to the CloudSat CPR footprint in a 7x7 pixel grid.

**(2) Geodetic longitude of NISE pixels**

**Name in file:** NISE\_longitude **Range:** -180 to 180

**Source:** AN-NISE **Missing value:** -999

**Field type (in file):** REAL(4) **Missing value operator:** ==

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** nise\_grid, nray **Offset:** 0

**Units:** degrees

This array contains the vector of longitudes for the closest 49 pixels to the CloudSat CPR footprint in a 7x7 pixel grid.

**(3) Seconds since the start of the granule**

**Name in file:** Profile\_time **Range:** 0 to 6000

**Source:** 1B-CPR P\_R05 **Missing value:** N/A

**Field type (in file):** REAL(4) **Missing value operator:** N/A

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** nray **Offset:** 0

**Units:** seconds

Seconds since the start of the granule for each profile. The first profile is 0.

**(4) TAI time for the first profile**

**Name in file:** TAI\_start **Range:** 0 to 6×108

**Source:** 1B-CPR P\_R05 **Missing value:** N/A

**Field type (in file):** REAL(8) **Missing value operator:** N/A

**Field type (in algorithm):** REAL(8) **Factor:** 1

**Dimensions:** <scalar> **Offset:** 0

**Units:** seconds

The International Atomic Time (TAI time) as the number of seconds since January 1, 1993 00:00:00Z.

**(5) UTC seconds since 00:00 Z of the first profile**

**Name in file:** UTC\_start **Range:** 0 to 86400

**Source:** 1B-CPR P\_R05 **Missing value:** N/A

**Field type (in file):** REAL(4) **Missing value operator:** N/A

**Field type (in algorithm):** REAL(4) **Factor:** 1

**Dimensions:** <scalar> **Offset:** 0

**Units:** seconds

The UTC seconds since 00:00 Z of the first profile in the data file.

**(6) Age before the date of the NISE data file**

**Name in file:** Age **Range:** 0 to 255

**Source:** AN-NISE **Missing value:** 255

**Field type (in file):** UINT(8) **Missing value operator:** ==

**Field type (in algorithm):** UINT(8) **Factor:** 1

**Dimensions:** nise\_grid, nray **Offset:** 0

**Units:** days

The age of the input data relative to the data file; the difference between the day of acquisition for the input data and the day of production for the NISE HDF-EOS file. Possible values include: 0-254: age (in days) before the date of the data file; 255: fill value for corner points (off-Earth) and undetermined data pixels (Brodzik and Stewart, 2016).

**(7) Snow Extent and Sea Ice Concentration**

**Name in file:** Extent **Range:** 0 to 255

**Source:** AN-NISE **Missing value:** 255

**Field type (in file):** UINT(8) **Missing value operator:** ==

**Field type (in algorithm):** UINT(8) **Factor:** 1

**Dimensions:** nise\_grid, nray **Offset:** 0

**Units:** percent

The snow coverage and sea ice concentration of all pixels in the study areas; coastal pixels are also identified. Possible values include: 0: Snow-free land 1-100: Sea ice concentration (%) 101: Permanent ice coverage (Greenland, Antarctica); 102: Not used; 103: Pixel has snow; 104-251: Not used; 252: Coastal pixel (unable to reliably apply microwave algorithms); 253: Pixel suspected of having ice; 254: Corner points (undefined); 255: Ocean (Brodzik and Stewart, 2016).

**(8) NISE X-Dimension Pixel Index**

**Name in file:** NISE\_pixel\_index\_x **Range:** N/A

**Source:** AN-NISE **Missing value:** -999

**Field type (in file):** INT(16) **Missing value operator:** ==

**Field type (in algorithm):** INT(16) **Factor:** 1

**Dimensions:** nise\_grid, nray **Offset:** 0

**Units:** N/A

X-dimension pixel index of the data points in the origin AN-NISE file. This is primarily used for consistency checks between AN-NISE and CRYOSPHERE-AUX.

**(9) NISE Y-Dimension Pixel Index**

**Name in file:** NISE\_pixel\_index\_y **Range:** N/A

**Source:** AN-NISE **Missing value:** -999

**Field type (in file):** INT(16) **Missing value operator:** ==

**Field type:** INT(16) **Factor:** 1

**Dimensions:** nise\_grid, nray **Offset:** 0

**Units:** N/A

Y-dimension pixel index of the data points in the origin AN-NISE file. This is primarily used for consistency checks between AN-NISE and CRYOSPHERE-AUX.

# CAVEATS AND KNOWN ISSUES

None at this time.

# CHANGES SINCE ALGORITHM VERSION P\_R04

No algorithmic changes were made when upgrading to P\_R05. The product is now generated with R05 inputs.

# ACRONYM LIST

CPR Cloud Profiling Radar

DMSP Defense Meteorological Satellite Program

EOS Earth Observing System

HDF Hierarchical Data Format

NISE Near-Real-Time Ice and Snow Extent

NSIDC National Snow and Ice Data Center

SSMIS Special Sensor Microwave Imager/Sounder

# REFERENCES

Brodzik, M. J. and J. S. Stewart. 2016. Near-Real-Time SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent, Version 5. 2018–present. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/3KB2JPLFPK3R. Accessed 10/25/2021.

Nolin, A. W., R. Armstrong, and J. Maslanik. 2019. Near-Real-Time SSM/I EASE-Grid Daily Global Ice Concentration and Snow Extent, Version 2. 2006–2008. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/4FSODMDM1WEJ. Accessed 10/25/2021.

Nolin, A. W., R. Armstrong, and J. Maslanik. 1998. Near-Real-Time SSM/I-SSMIS EASE-Grid

Daily Global Ice Concentration and Snow Extent, Version 4. 2009–2017. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/VF7QO90IHZ99. Accessed 10/25/2021.