



# snow\_cci

## a multi-sensor climate data record of global snow products from satellite data

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### ABSTRACT:

snow\_cci generates a homogeneous, validated, long-term time series of snow parameters (snow extent and snow mass) from multi-sensor satellite data for climate applications. A main motivation is the discrepancy in the climatology, anomalies, and trends in global snow cover time series from different satellite snow products, revealed in the ESA QA4EO Satellite Snow Product Intercomparison and Evaluation project (SnowPEX). The specification of the snow products is driven by the climate research community. We present the first version of the 40 years time series of global daily snow extent products from optical satellite data and of daily northern hemispheric snow water equivalent products from passive microwave data.

## Product Specifications

The snow products are specified according to user requirements collected during a workshop on 29 November 2018 in Vienna, Austria, and by approaching a wider user community by means of an online survey. The international snow-climate research community, other CCI projects, the members of the snow\_cci climate research group provided requirements on snow products for climate applications.

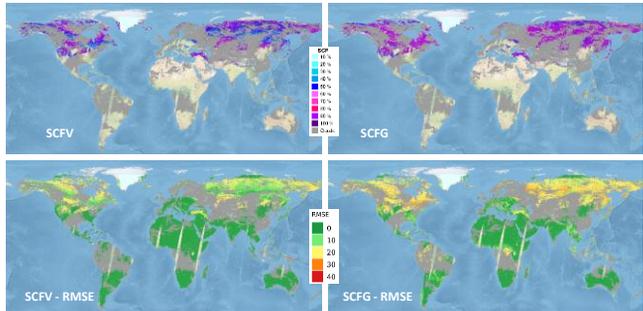
*Consolidated product specification and user requirements for the snow\_cci products snow cover fraction and snow water equivalent. Bold italic highlighted user requirements indicate agreement with the product specification, normal text in the user requirements indicates further development required to meet the requirement.*

	<b>Snow Cover Fraction</b> <i>Final Specifications</i>	<b>Snow Cover Fraction</b> <i>User Requirements</i>	<b>Snow Water Equivalent</b> <i>Final Specifications</i>	<b>Snow Water Equivalent</b> <i>User Requirements</i>
<b>Description</b>	Visible Snow (snow on top of forest canopy) Snow on Ground (canopy correction applied)	<b>Correction for canopy effects to yield snow on ground information in forested areas.</b>	SWE in mm	SWE in mm
<b>Spatial Coverage</b>	Global (without Antarctica and Greenland ice sheet)	<b>Global (without ice sheets of Antarctica and Greenland, but include ice free areas in Greenland).</b>	Northern-hemisphere non-mountain areas (without Antarctica and all of Greenland)	Northern Hemisphere
<b>Spatial Resolution</b>	0.05 deg (ca. 5 km) (1981 – present) 0.01 deg (ca. 1 km) (1999 – present)	<b>500 m to 1 km</b>	0.25 deg (ca. 25 km)	25 km Some higher resolution requirements
<b>Map Projection</b>	Geographic Grid (Lat/Lon)	<b>Geographic Grid (Lat/Lon)</b>	Geographic Grid (Lat/Lon)	<b>Geographic Grid (Lat/Lon)</b>
<b>Period</b>	1981 – onwards (0.05 deg) 1989 – onwards (0.01 deg)	<b>As long as possible</b> Ensure inter-sensor consistency	1980 – onwards	1980 – onwards
<b>Frequency</b>	Daily	Daily Weekly	Daily Monthly	Daily
<b>Spatial Aggregation</b>	None	0.25 deg CMUS requirement	None	CMUS requirement
<b>Format</b>	netCDF	netCDF	netCDF	netCDF
<b>Accuracy</b>	10-20% RMSE	<b>10-20% RMSE</b>	20-30% RMSE	10-25%
<b>Unavailability Metric</b>	Unbiased RMSE	<b>Unbiased RMSE</b>	Unbiased RMSE	Unbiased RMSE
<b>Gap Filling</b>	None	Separate product with physically-based cloud-filling scheme and associated flagging.	None	Separate product with algebraic filling and associated flagging.
<b>Weather Station Consistency</b>	–	–	Basic filtering and consistency criteria	Test product against: (1) Use of all available weather stations; (2) use of only consistent weather stations.
<b>Data Access</b>	CCI data portal (includes ftp)	<b>Delivery via ftp</b>	CCI data portal (includes ftp)	<b>Delivery via ftp</b>

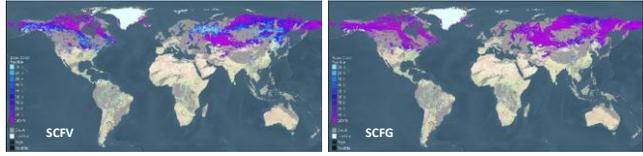
## Snow Cover Extent

The snow\_cci snow extent products provide the snow cover fraction (SCF) per pixel, and are derived from optical satellite data (AVHRR, MODIS, A/ATSR-2 and SLSTR). To serve the needs of different users, snow in forested areas is given as two parameters: (i) "viewable snow" (SCFV) provides the snow extent as seen by the satellite; (ii) "snow on ground" (SCFG) provides the snow extent on the ground, accounting for the masking effect of forests. For open land, both products provide the same SCF. For each pixel, the uncertainty of SCF is attached.

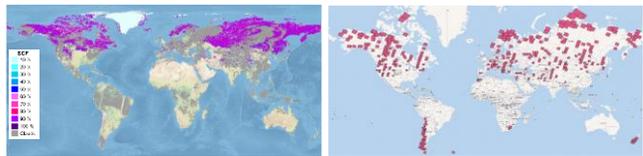
Snow Cover Extent products, 1 km, from MODIS, and associated uncertainty per pixel, 2002-02-04



Snow Cover Extent products, 5 km, from AVHRR, 2003-03-10

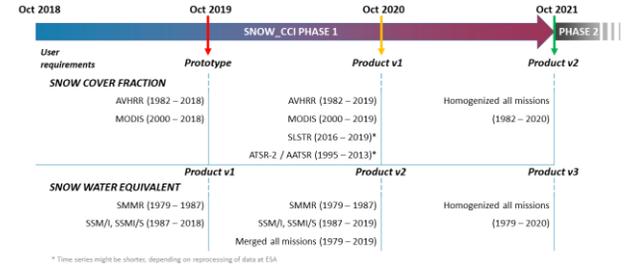


SCFG product from SLSTR, 1 km, 2020-03-06



## Schedule for Product Generation

In the snow\_cci climate data records of daily global snow cover extent maps are generated from optical satellite data from 1982 onwards, daily northern hemispheric snow water equivalent products are generated from passive microwave satellite data from 1979 onwards.



## Climate Use Cases for snow\_cci products

- The snow\_cci Climate Research Group assesses the value and usability of snow\_cci products by carrying out climate relevant use cases:
  - **Regional and Global Snow Cover Trend Analysis (ECCC):** Evaluate snow\_cci product trends by comparative analyses and contribute to updated estimates of global and regional snow extent and SWE trends from multi-dataset analysis which also includes observationally constrained land surface models.
  - **Evaluation of the Phase 6 of the Coupled Model Inter-comparison Project (CMIP6) simulations (CNRS):** Evaluate CMIP6 simulations (coupled land-atmosphere-ocean, land-atmosphere, and land-only) with respect to their capacity to correctly represent historical snow cover evolution on large scales.
  - **Evaluation of Earth System Model Snow Model Inter-comparison Project (ESM-SnowMIP) simulations using snow\_cci products (UED):** The aim of this case study aim is to evaluate the use of CCI+ snow products to extend the evaluation of simulations over larger regions and longer times than those for which detailed in situ measurements are available.
  - **Use of CCI+ snow products to explain impacts of climate change on the hydrological regime in the pan-arctic drainage basin of the arctic Ocean (SMHI):** Use the snow\_cci snow cover fraction and snow water equivalent products to investigate how their temporal and spatial changes contribute to changes on the hydrological regime over the large pan-arctic drainage basin of the Arctic Ocean.
  - **Multi-decadal comparison between the ECMWF ERA5 climate reanalysis and the snow\_cci snow cover data records (ECMWF, external partner):** Snow\_cci products will be assessed for their potential contribution to ERA5 ECMWF reanalysis, with potential engagement with other operational centres.

**Acknowledgement:** The cloud\_cci team provided the geolocated AVHRR GAC data for the period 1981 – 2019 used for SCF production from AVHRR within snow\_cci.

## Snow Water Equivalent

The snow\_cci snow water equivalent (SWE) products are derived by assimilating passive microwave satellite data with in-situ snow measurements. The product is fully validated using in-situ snow measurements. The version 1 of the daily snow\_cci SWE product covering the time period 1979 to 2018 can be downloaded from the CCI Data Portal.

Snow Water Equivalent product of 15 February 2010

