Climate Modelling User Group [CMUG]

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Technical note providing feedback to the CCI Snow project on the use of their datasets

Centres providing input: IPSL (LSCE)

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This technical note provides feedback on the three CCI Snow products used in the study: Snow Cover Fraction Viewable (SCFV), Snow Cover Fraction on the Ground (SCFG) and Snow Water Equivalent (SWE). The analysis was performed on the last versions of the SCF and SWE products at the time of the study: v3.0 for SCF and v3.1 for SWE.

Regarding the SCFV and SCFG, the feedback applies only to the MODIS-derived maps, as these were the primary focus of our analysis.

Overall, the quality of the three products is highly satisfactory and beneficial for our research, though some caveats remain. Further details are provided below.

Temporal and spatial resolution

High temporal resolution is crucial for optimizing LSMs, as it enables the evaluation of seasonal cycles and provides a high number of data points for validation. The daily resolution provided by the three datasets aligns well with our needs for snow analysis.

The current spatial resolution of the products (0.01° for SCF and 0.1° for SWE) is sufficiently refined for our studies, as global LSMs rarely operate at resolutions finer than 0.1° which is about the finest resolution of global reanalysis products such as ERA5-Land.

For future product developments, it would be beneficial to be able to have the possibility to choose between different spatial resolutions when loading the data (e.g., coarser resolutions, such as 0.1°, 0.25°, or 0.5° which are the most used grid resolutions of the atmospheric forcings). The SCF and SWE products currently have different resolutions and upscaling to the model grid is generally required for model evaluation. We think that having a SCF dataset at the same resolution as the SWE dataset would be advantageous. It can indeed be challenging to upscale the data as a product user, and the high-resolution datasets can also require substantial disk space. Additionally, upscaling uncertainties is a non-trivial process. A consistent product providing multiple resolutions alongside corresponding uncertainty estimates would be highly valuable.

Challenges with the Snow Cover Fraction Product

SCF data presents some challenges, particularly in achieving continuous time series due to cloud cover and polar night conditions. Despite these limitations, the SCF product remains highly useful. A gap-filled version could be particularly beneficial, provided that the associated uncertainties remain within acceptable limits. A tool or a map that quantifies the number of valid data points per pixel and per year would be useful as well in order to be able to select the most interesting sites when doing local optimisations. Additionally, composite SCF products, such as monthly mean values, derived from the gap-filled product, could further enhance usability.

Figure 1 shows the amount of valid daily SCFV values over the period 2011-2020 at an upscaled resolution of 0.05° (with upscaling performed by omitting areas where NaN values were present in daily maps). The data is normalized by the total number of days in the considered period (3652 days). When the SCFV is equal to 0% at a given time step, it is not counted. It is very rare to have locations where more than 20% of the data can be available for the entire period of time, highlighting the limitations of the current product and the actual need for a gap-filled version of the SCF maps.

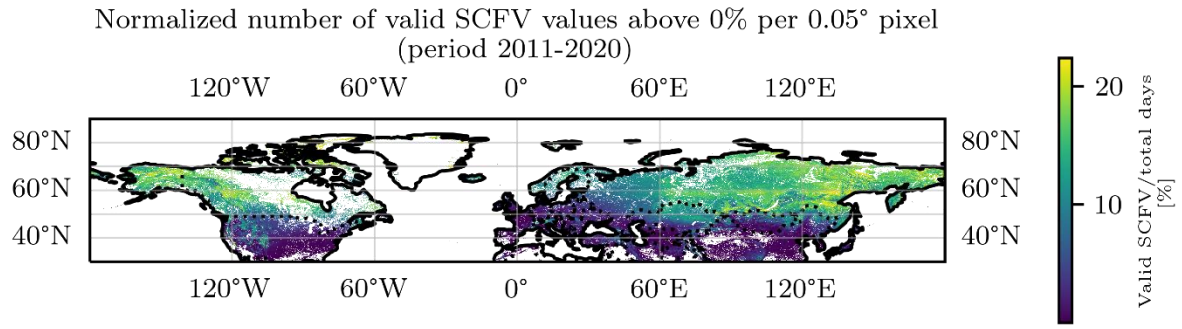

Figure 11: Ratio of the valid SCFV data with values above 0% at a 0.05° resolution over the total number of days of the period 2011-2020. The ratio is provided in %.

Snow Water Equivalent Data

SWE data exhibits significant uncertainties, particularly in early versions of the product. While recent improvements have been made, reliance on these datasets for optimization remains challenging. A bias-corrected version of SWE, available at both daily and monthly resolutions, would be highly helpful.

Moreover, we have noted that retrievals were not produced for coastal regions of Greenland, and data for mountainous areas were not provided. If the future developments enable to reduce the uncertainties on such regions, their inclusion would be a significant improvement.

Consistency between the three products

Figure 2 provides an example of time series that can be obtained with the three products. It presents the time series for SCFV, SCFG and SWE for one pixel at the location 69.25°N and 118.70°E. The time series for the SCF are derived from the original maps (resolution of 0.01°) while the SWE time series correspond to the nearest pixel at 0.1° resolution, for the year 2018. A good consistency between the different products can be noted, with the SCF values increasing/decreasing at the same time as the SWE. Also, the timing of snow disappearance is consistent across all products.

There are still large uncertainties provided with the SWE product, although it was improved compared to the earlier versions of the product. Initially, the product's high uncertainty limited its usability for model optimization. However, enhancements in the latest version, along with planned bias correction, should increase confidence in the dataset.

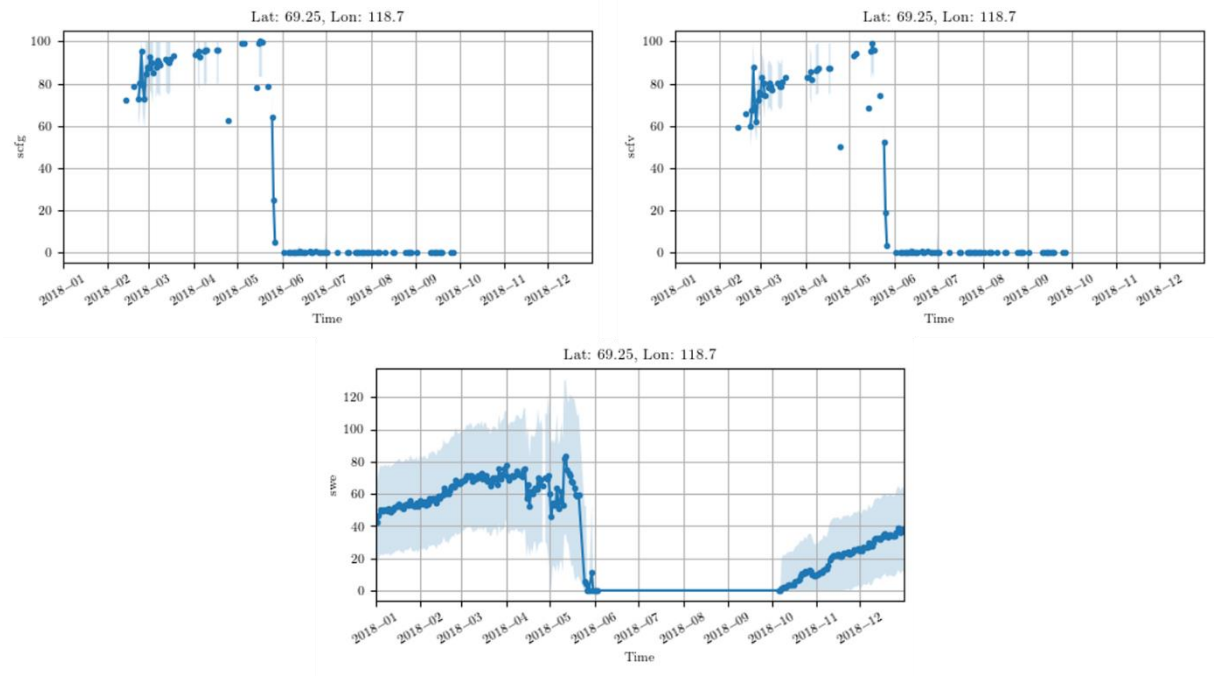

Figure 2: From left to right, and top to bottom: time series of MODIS SCFG [%], MODIS SCFV [%] and SWE [mm] with the provided uncertainties at a selected point in Siberia (69.25°N, 118.70°E)