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Merging Earth Observation imagery and model simulations to monitor long-term global snow cover dynamics

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Remote sensing imagery offers a unique tool to monitor the snow cover evolution both at global and regional scales. However, the availability of the time series of normally 3-4 decades limits the applicability of the data to understand the dynamics of snow processes at longer time scale (Pulliainen et al., 2020). In this perspective the possibility to generate hybrid dataset merging satellite records with model simulations is offering the chance to both cross-validate the model simulations and to extent the time series (Lenton et al 2024).

In this work, an approach proposed by Notarnicola 2022, with the aim to merge earth observation imagery and modelled data was adapted to generate longer time series. The method is a machine learning approach based on Artificial Neural Network (ANN), where the uncertainties on the ANN trained model were obtained through a bootstrap procedure with a resampling technique. As modelled data, the NOAA-CIRES-DOE 20th Century Reanalysis V3 contains land surface and meteorological maps and their uncertainty available in the period 1806-2015 was addressed (Slivinski et al., 2019). For satellite data, the longest time series on snow parameters were used derived from ESA Climate Change Initiative (CCI) Snow project, namely Snow Water Equivalent (SWE) data available from 1979 to 2020 (https://climate.esa.int/en/odp/#/project/snow). As predictors for the ANN training and test, dynamics variables such as air temperature and precipitation were considered as they regulate the snow dynamics and rainfall events. As static parameters, the location in terms of latitude and longitude, mean elevation, the land cover type, and percentage of vegetation cover were inserted. The target variable to be improved is the snow water equivalent value at pixel level.

Before the application of the ANN approach, a comparison between the SWE values in two data sets for the overlapping period (1979-2015) indicated an averaged correlation coefficient of around 0.52, a bias in the range 35-42 mm, the latter one being strongly depending on the different months. After the application of the model derived by the trained ANN applied to the test dataset, the correlation coefficients raised on average to 0.87, and the RMSE is reduced to around 20 mm. The merged data set will be further compared with ground data where available and then used to derive long-term trends for the SWE variable.

References

Lenton, T.M., Abrams, J.F., Bartsch, A. et al. Remotely sensing potential climate change tipping points across scales. Nat Commun 15, 343 (2024). https://doi.org/10.1038/s41467-023-44609-w

Notarnicola, C. Overall negative trends for snow cover extent and duration in global mountain regions over 1982–2020. Sci Rep 12, 13731 (2022). https://doi.org/10.1038/s41598-022-16743-w

Pulliainen, J. *et al.* Patterns and trends of Northern Hemisphere snow mass from 1980 to 2018. *Nature*, 582, E18, doi:10.1038/s41586-020-2416-4 (2020).

Slivinski L.C., Compo G.P., Whitaker J.S., et al. Towards a more reliable historical reanalysis: Improvements for version 3 of the Twentieth Century Reanalysis system. Q J R Meteorol Soc. 2019; 145: 2876–2908.https://doi.org/10.1002/qj.3598