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Global Snow Cover Extent Mapping Using Sentinel-1

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Seasonal snow cover extent (SCE) is a critical component not only for the global radiation balance and climatic behavior but also for water availability of mountainous and arid regions, vegetation growth, permafrost, and winter tourism. However, due to the effects of the global warming, SCE has been observed to behave in much more irregular and extreme patterns in both temporal and spatial aspects. Therefore, a continuous SCE monitoring strategy is necessary to understand the effect of climate change on the cryosphere and to assess the corresponding impacts on human society and the environment. Nevertheless, although conventional optical sensor-based sensing approaches are mature, they suffer from cloud coverage and illumination dependency. Consequently, spaceborne Synthetic Aperture Radar (SAR) provides a pragmatic solution for achieving all-weather and day-and-night monitoring at low cost, especially after the launch of the Sentinel-1 constellation.

In the present study, we propose a new global SCE mapping approach, which utilizes dual-polarization intensity-composed bands, polarimetric H/A/α decomposition information, topographical factors, and a land cover layer to detect the SCE. By including not only amplitude but also phase information, we overcome the limitations of previous studies, which can only map wet SCE. Additionally, a layer containing the misclassification probability is provided as well for measuring the uncertainty. Based on the validation with in-situ stations and optical imagery, around 85% accuracy of the classification is ensured. Consequently, by implementing the proposed method globally, we can provide a novel way to map high resolution (20 m) and cloud-free SCE even under cloud covered/night conditions. Preparations to combine this product with the optical-based DLR Global SnowPack are already ongoing, offering the opportunity to provide a daily snow mapping service in the near future which is totally independent from clouds or polar darkness.