High-Resolution Monitoring of the Snow Cover on the Moroccan Atlas Through the Spatio-Temporal Fusion of Landsat and Sentinel-2 Images

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Mapping seasonal snow cover dynamics provide essential information to predict snowmelt during spring and early summer. Such information is vital for water supply management and regulation by national stakeholders. Recent advances in remote sensing have made it possible to reliably estimate and quantify the spatial and temporal variability of snow cover at different scales. However, due to technical limitations, there is a trade-off between the spatial and temporal resolutions of currently available satellite sensors. In addition, cloud contamination and poor atmospheric conditions may increase the discontinuity of satellite data. Therefore, data from a single satellite are insufficient to capture rapid snow dynamics more accurately, especially in semi-arid areas where snowfall is highly variable in space and time. Considering these limitations, the combined use of the next generation of multispectral sensor data from the Landsat-8 (L8) and Sentinel-2 (S2) with a high spatial resolution (varying from 10 to 30 m), provides unprecedented options for such applications. Hence, our study aims to show how the synergistic use of these optical sensors can effectively support research on snow cover mapping by using multisensor image fusion techniques to provide a very dense and detailed time series of the Normalized Snow Difference Index (NDSI). Among the existing fusion methods, we used the Enhanced Spatial and Temporal Adaptive Reflectance Fusion Model (ESTARFM), the Flexible Spatio-Temporal Data Fusion Model (FSDAF), and the Pre-classification Flexible Spatio-Temporal Data Fusion Model (Pre-classification FSDAF) to merge L8 and S2 data. The results show that the Pre-Classification FSDAF method creates more accurate fused NDSI and retains more spatial detail than the other methods by generating the lowest Root Mean Square Error (RMSE = 0.12) and the highest Correlation Coefficient (R = 0.96). This method has been used to create high-resolution merged snow series to fill gaps in satellite data sets and directly compensate for the lack of ground-based snow cover data.