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Cross-Technique Benchmarking of Snow Depth Retrieval Using Sentinel-1 SAR, ICESat-2 and In-Situ Observations

Motivation and Tasks

Dozens of studies have validated individual snow depth retrieval techniques. Sentinel-1 SAR, ICESat-2 laser altimetry, GNSS-IR, ultrasonic and laser point sensors. but far fewer directly compare multiple technique families against a common reference within the same region and season, and doing so requires no fieldwork at all, since all the necessary data is openly available. This thesis selects three or more retrieval families not typically evaluated together (for example: Sentinel-1 SAR-based retrieval, ICESat-2 via the SlideRule processing pipeline, and in-situ SNOTEL or DWD station records) and benchmarks them against a shared, higher-accuracy reference dataset, such as airborne lidar from a NASA SnowEx campaign or a dense regional station network and by using consistent error metrics (RMSE, bias, correlation) stratified by elevation, forest cover, and snow-climate class. Because several published intercomparisons already exist for individual technique pairs, novelty comes from either combining technique families not usually co-evaluated, applying a more rigorous cross-validation framework, or focusing specifically on how these methods perform (or fail) during the melt transition, where most techniques are known to degrade. The thesis produces a quantified performance comparison across at least one European and one North American test region, and clear guidance on which technique is most reliable under which conditions.

Required skills / prerequisites

- Strong Python skills, particularly numpy, pandas, xarray, rasterio, and geopandas
- Familiarity with Git/version control for a reproducible analysis pipeline
- Foundational remote-sensing knowledge (SAR backscatter principles, laser altimetry, or willingness to learn quickly)
- Statistics background sufficient for regression, error-metric computation, and stratified analysis

What we offer

- Opportunity to contribute your own ideas when designing solutions
- Supervision and support throughout the thesis

Contact

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