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Measurement of spatiotemporal variability of snow depth and cover using drones

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Seasonal snow accumulation and melt dominates the hydrology in high latitude areas, providing water storages for both ecological and human needs. However, we are currently lacking a cost-efficient way to measure the spatial and temporal variability of the snow depth and cover in high resolution. The ground based *in situ* measurements are laborious, point scale, and unable to capture the full spatial variability. Satellite-derived products can offer high coverage, but the resolution is generally low while manned aircraft can provide higher resolution with regional coverage, but the cost of measurement is relatively high. Unmanned aerial vehicles (UAVs) can offer spatial resolutions up to few centimetres, depending on the weather and light conditions, camera quality and drone specification. These measurements bridge the gap between onsite and satellite data and provide catchment scale coverage in very high resolution. In this study, we use quadcopter and fixed wing UAVs (with and without RTK-GPS) to determine the spatiotemporal variability of snow depth and cover in three test plots (forested slope, open peatland, and peatland-forest) in subarctic northern Finland, where winter weather and light conditions are challenging. The measurement campaign is conducted in winter 2018/2019 with survey flights once a month during the snow accumulation season and at least twice a month on the snow melt season. Snow depth maps are constructed using Structure from Motion (SfM) photogrammetry technique and by differentiating the acquired models from snow-covered and snow-free surveys. Furthermore, the snow depth maps are validated using *in situ* snow surveys. We evaluate the spatiotemporal variability of the snow depth and compare the results acquired from different UAVs. The technology and acquired snow maps can be used in snow process studies and as input or calibration data for distributed hydrological models.