Title: Leveraging Red-Band Reflectance to Detect Ice Phenology in Small Mountain Lakes

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Winter ice cover regulates heat, controls light penetration, and affects biological activity in temperate lakes in the Northern Hemisphere. Mountain lakes at high elevations respond quickly to climate change and show evidence of losing ice cover. Due to the logistical challenges and dangerous conditions of mountainous regions during winter, in situ records are rare. When studying ice cover using remote sensing, fine temporal resolution observations are needed to capture ice-break up. Therefore, researchers commonly use remote sensing images with coarse spatial scales, consequently eliminating lakes smaller than 1 km^2 from observation. Most lakes worldwide, however, are smaller than 1 km^2, so these important ecosystems require a different method for consistent study. Using an algorithm that incorporates the Moderate Resolution Imaging Spectroradiometer (MODIS) 250m red band reflectance, the Landsat Fmask product, and the reanalysis mean temperature product from ERA-5, I detect ice cover in lakes as small as 0.1 km^2. This method has been tested in lowland lakes in Maine, using community science validation data. However, I am applying this method to mountain systems, using five long-term research sites in North America and Europe. The MODIS algorithm detected ice formation and breakup in the study sites with a mean absolute error of 7.2 days for ice formation and 6.5 days for ice breakup. Ice formation proved more difficult to detect, owing to more cloudy days in the study regions. Validating this method in mountain lakes was a critical step to create a database of ice phenology on a broad spatial scale, a needed dataset for lake ice analysis. Next steps involve employing this method using the global dataset, HydroLAKES, to detect trends in ice phenology in mountain systems.