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| **Detecting non-stand replacing disturbances in a near-real time context using Landsat and Harmonized Landsat Sentinel-2 time series** |
| **Introduction:**  Non-stand replacing disturbances (NSRs) are events that do not result in complete removal of trees and generally occur at a low intensity over an extended period of time (e.g., insect infestation, drought), or at spatially variable intensities over short time intervals (e.g., windthrow, partial burn, frost). These variable disturbance intensities and spatial patterns often lead to heterogenous stand structures and changes to the quality and quantity of biomass, thereby impacting timber supply and ecosystem services. Conventional inventory methods for monitoring NSRs are often conducted as part of annual aerial surveys which can be insufficient in both temporal and spatial resolution for managers tasked with adaptive decision making.  The increased accessibility of moderate spatial resolution satellite imagery with frequent temporal revisit (e.g., 2-3 day return interval for Harmonized Landsat Sentinel-2; HLS) has seen an increase in algorithms designed to detect sub-annual change in forested landscapes over large spatial scales. One such algorithm, the Bayesian Estimator of Abrupt change, Seasonal change, and Trend (BEAST) has shown promise with sub-annual change detection in temperate environments, with > 88 % detection of disturbances when compared to a validation data set.  **Methods:**  Here we evaluate the sensitivity of BEAST to detect NSRs across a range of disturbance agents and severity levels in British Columbia (BC), Canada from 2002- 2020. To do so, Landsat (2000-2016; 2000-2001 was used to spin up the algorithm) and HLS (2016- 2020) data were used to create a time series of 16-day normalized burn ratio (NBR) composites for an area of 1.4 M-ha. This time series data was utilized by BEAST to produce rasters representing the change probability, which were then compared to the occurrence, severity, and timing of disturbances as mapped by the BC annual aerial overview survey (AOS). Differences in the distributions of BEAST probabilities between agents and levels of severity were then compared to undisturbed stands.  **Results:**  Results indicate that when compared to undisturbed stands, the BEAST disturbance probabilities were on average higher and statistically different (p < 0.05) for the most prevalent insect disturbances within the region (i.e., Mountain Pine Beetle, Aspen Leaf Miner, Spruce Beetle amongst others) in addition to abiotic disturbances (i.e., non-biological injuries, fire, windthrow, avalanche and snowslides, landslides, aspen decline, and cedar flagging). When assessed across different AOS defined severities, BEAST probabilities were on average higher and statistically different in 6 of the 6 years where very severe disturbance was observed, and in 15 of the 19 years where severe disturbance was observed. Lower-severity NSR events were less well discriminated from undisturbed stands.  **Conclusion:**  The sensitivity of BEAST change probabilities to a wide range of NSR disturbance agents at varying intensities suggests promising opportunities for earlier detection of NSRs to inform continuously updating forest inventories. And with this enhanced detection new possibilities for adaptation and mitigation tactics to be implemented. |