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| **Mapping Forest Height and Biomass change with Time series of ICESat-2 and Optical data: Why we need a time series of Satellite Lidar.**  |
| The first forest height and biomass products using GEDI and ICESat-2 started flowing around 2020, and often fusion of these satellite lidar data streams and optical time series (e.g. from Landsat) were used to estimate past biomass dynamics. Now, in 2024, we have a few years of lidar from GEDI and ICESat-2 and thus have an unprecedented opportunity to assess the accuracy of these past approaches. How sensitive are lidar-optical fusion methods to changes in forest structure? Can they be used to accurately predict loss associated with degradation, such as logging or fire? This research will present early results from validating a time series of lidar-optical fusion with repeat lidar measurements from ICESat-2 between 2019-2023 in boreal forests to determine the relative strengths and limitations of this approach.Models and maps were developed representing 2020 forest height and biomass conditions across the full boreal domain. These were developed using a high-resolution ICESat-2 ATL08 product (30 m sampling) in combination with wall-to-wall covariate stacks from Landsat, Sentinel-2, the Copernicus DEM and ESA worldcover. These spatial covariates can be mapped annually. This research applied the 2020 lidar model to covariate data from 2023 to estimate change, representative of a typical lidar-optical fusion approach for change mapping. A second approach used ICESat-2 data from 2023 to create a new 2023 model which is presumably more accurate of 2023 conditions. Differences between the two approaches illuminate the limitations of optical-lidar fusion. Often, spectral recovery (e.g. post fire) occurs much more rapidly than structural recovery (height, biomass) and thus traditional optical-lidar approaches likely overestimated the speed of ecosystem recovery from degradation, and underestimate associated biomass losses. Our preliminary results support the need for a continuous time series of satellite lidar, and call for new lidar missions to follow GEDI and ICESat-2 post 2030. |