Investigations of ice sheet mass balance and the outlet glacier dynamics have been hampered by lack of comprehensive data. Recently, this situation has been remedied. Satellite laser altimetry data from the Ice Cloud and land Elevation Satellite mission (ICESat), combined with airborne laser altimetry, provide accurate measurements of surface elevation changes; while surface velocities, from various satellite platforms, yield information on glacier dynamics. Taken together, a rich and diverse dataset emerges, allowing us to characterize the spatial and temporal evolution of ice sheets and outlet glaciers; in particular, enabling quantitative studies of outlet glaciers undergoing rapid and complex changes. Although airborne and satellite laser altimetry provide precise measurements of ice sheet topography since the early 1990s, determining detailed and accurate spatial and temporal distribution of surface changes remains challenging. We present results from our novel, comprehensive method called Surface Elevation Reconstruction And Change detection (SERAC), which estimates surface changes through simultaneous reconstruction of surface topography from fused multisensor data. Using SERAC, we reconstructed the detailed temporal evolution of ice sheet surface elevation changes for the whole Greenland Ice Sheet, from the complete airborne and satellite laser altimetry observation record. This enables us to derive improved estimates of average surface elevation and volume change rates, as well as to reconstruct the temporal evolution of change rates for the first time. Our reconstruction, consistent with GRACE results, shows propagation of ice sheet thinning to higher elevation and latitudes during the last decade, indicating rapid variations in thinning rates on several outlet glaciers.