Using GPS Vertical Land Motion Data to Determine the Effect of GIA and Post Glacial Rebound on the Relative Sea Level Budget in Greenland and SE Alaska

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Sea level rise is a daunting problem to many coastal communities around the world. When decomposing the elements that contribute to the rate of sea level rise, it becomes apparent that vertical land motion has a large enough effect to warrant further investigation. Near current and past ice sheets, non-uniform local effects of glacial isostatic adjustment (GIA) and post-glacial rebound (PGR) are important components of the relative sea level budget. We expand upon existing sea level change studies of Greenland through the incorporation of updated GPS and tide gauge data records. We incorporate non-uniform effects of relative sea level rise (RSL) including non-linear GIA and mass-redistribution (fingerprinting) effects. The Greenland Ice Sheet is vulnerable to recent increases in atmospheric temperatures and will continue to be a major contributor to global mean sea level rise. GIA will continue to be an important component in Greenland because as the ice sheet melts, the lithosphere is unloading, resulting in uplift and causing the sea level in some areas to drop. In some areas of Greenland, the collapse of the Laurentide Ice Sheet forebulge is causing relative sea level to rise. We compare this with SE Alaska where uplift is primarily due to long-term PGR.

We use standard statistical methods to assess and quantify the quality, trends, seasonality, and non-linear patterns and discontinuities in both GPS and tide gauge data records. We utilize SARIMAX models to forecast GPS and tide gauge data, predicting the change in elevation at GNET locations in Greenland and other GPS stations in SE Alaska. Applying the modeled rates to the RSL budget equation we are able to predict the RSL rate of change in our sampling areas. These rates are based on linear regressions and so underestimate the effect of seasonal melt anomalies in Greenland (such as Summer 2010, 2012, and 2019) as these anomalies do not have a long term effect on the rate of change of the GIA component. The effect of tectonic motion on sea level is often disregarded, but through our statistical analysis we find it can have a significant effect on the interpretation of sea level trends in some places (e.g. SE Alaska). Quantifying modern day trends and underlying uncertainties will improve GIA models, estimates of ice sheet melt, and inform local adaptation decisions.