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Tide induced lateral movement of Ronne Ice Shelf, Antarctica

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Six geodetic-quality GPS receivers, deployed during the Austral summer of 2007-08 on the central Ronne Ice Shelf, Antarctica, recorded three-dimensional ice shelf motion over observational periods of 2 to 58 weeks. Broadly spaced across the ice shelf, two sites were located close to the ice front; with three more approximately 200 km, and one 400 km, further inland. The horizontal displacements at all the sites show very similar variation at all tidal periods ranging from a few hours to $\sim$182 days including semi-diurnal, diurnal and $\sim$14.76 days. During spring tides, velocities close to the ice front oscillate by up to $\pm$3500 m a-1 over a six-hourly, semi-diurnal period. These oscillations, superimposed on a mean annual ice velocity of 500-1300 m a-1, result in regular reversals in ice shelf motion. In addition, the strain between GPS sites shows similarly large oscillations at tidal frequencies superimposed on the mean strain, suggesting that the ice shelf also experiences significantly enhanced stresses, particularly during spring tides. Semi-diurnal tidal frequencies dominate the daily horizontal ice shelf motion, which is strongly elliptical and similar to that observed on Brunt Ice Shelf. Previous studies have been unable to identify a specific mechanism that causes these tidally related horizontal ice shelf motions. Using the data from Ronne Ice Shelf, we show that in the direction of mean ice shelf flow the maximum horizontal displacement at each site and the maximum strain between sites coincides with the maximum tidal slope.