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Estimation of Antarctic Peninsula rheology from viscoelastic modelling constrained by GPS observations

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The collapse of Antarctic Peninsula ice shelves during the past few decades has resulted in increased ice mass loss from tributary glaciers due to removal of the buttressing ice shelf. Most notably the collapse of the Larsen B ice shelf in 2002 has led to continued acceleration and thinning of glaciers flowing into this embayment. Ice mass changes in this region induce a solid Earth response, which, due to the low viscosity nature of the Earth, occurs on a decadal timescale and may be observed as uplift in GPS records. In addition to several long term GPS stations in the Antarctic Peninsula, six LARISSA (LARsen Ice Shelf System, Antarctica) GPS stations installed in 2009-2010 are ideally placed to record uplift close to the site of mass loss and enable tighter constraints to be placed on the Earth's rheology in this region.

Using eleven GPS records from the Northern Antarctic Peninsula we attempt to isolate the uplift due to the collapse of the Larsen B ice shelf. Corrections are made for a background rate, representing the steady-state rate prior to the collapse of Larsen B, and for the elastic effects of anomalous accumulation. We find that the ongoing elastic effect of present-day ice mass loss from the Larsen B tributary glaciers alone is not enough to explain the observed uplift rates. After ruling out other possible concurrent phenomena, we show that the resultant uplift rates can be used to constrain a high resolution viscous model of the Earth's rheology. The range of rheological parameters that fit the data is partially consistent with a previous study (Ivins et al. 2011); however we find a lower viscosity (around 5x10ˆ18 Pa s) upper mantle below a thicker lithosphere (around 50 km).