(31-220415-A) **CarbonWatchNZ: Regional to National Scale Inverse Modelling of New Zealand's Carbon Balance**

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Current greenhouse gas reduction strategies rely on CO_2 exchange and budget estimates from local to global scale, with a particular focus on regional and national scale carbon accounting. In the CarbonWatchNZ research programme, we use inverse modelling to estimate New Zealand's carbon uptake and emissions using atmospheric measurements and models. Our decade long (2011-2020) CO_2 inversion results (230±52 Tg CO_2 yr^{-1}) show a stronger sink relative to prior estimates (116±79 Tg CO_2 yr^{-1}). Here, we demonstrate the capability of our inversion system to quantify national scale CO_2 fluxes and comprehensively test the sensitivity of our inversion setup to different assumptions.

We tested the sensitivity of our results against the choice of background CO_2 values, prior fluxes and transport models (Figure 2), with a special focus on diurnal cycle effects based on an observing system simulation experiment (OSSE). We find that the inversion results are the most sensitive to the choice of the prior terrestrial model. Using updated terrestrial flux estimates of New Zealand's ecosystems and conditions further increase the posterior CO_2 sink. We additionally performed a CO_2 diurnal cycle test to identify the impact of using monthly prior terrestrial fluxes that excluded the diurnal variability in CO_2 fluxes. The diurnal cycle test points to both under and overestimated posterior fluxes; however, we have not identified a consistent bias in the resulting fluxes.

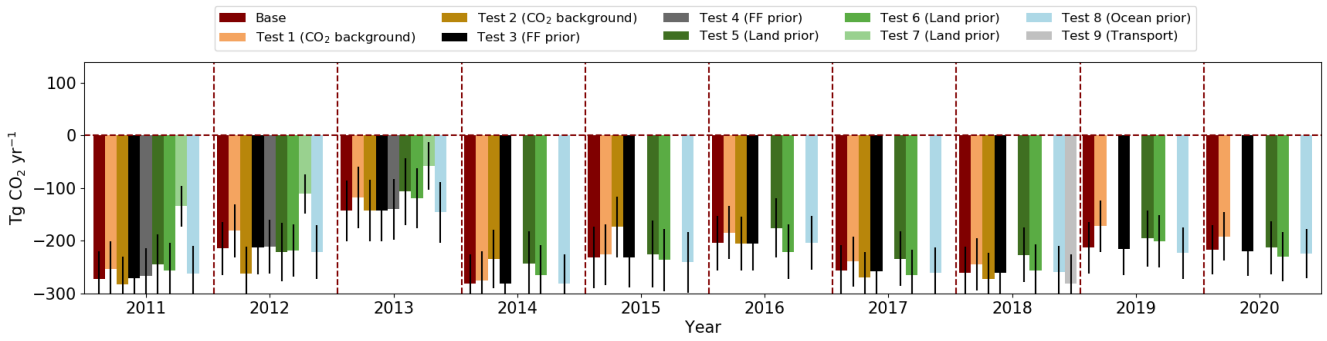

Figure 1. Figure 1. Annual posterior flux estimates from our base inversion and different sensitivity runs based on the choice of background CO_2 values (Test 1 and 2), prior fluxes (fossil fuel, land, land-use maps and ocean, Tests 3-8) and transport model (Test 9). The error bars represent the posterior uncertainty. Note, not all tests were performed for the whole inversion time period.