Regional footprints and transport regimes for CO_2 measurement sites in New Zealand from backward Lagrangian dispersion modelling

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Since 1990, New Zealand's CO_2 equivalent greenhouse gas emissions increased by about 20%, yet it is estimated that its net greenhouse gas budget remained at 1990 levels due to a compensating increase in carbon uptake by forests. This terrestrial uptake plays a key role in the contemporary and future carbon cycle of the country, but remains poorly quantified. Global studies suggest that natural carbon sinks are sensitive to changes in climate and could already have become less efficient, with strong impacts on net carbon release.

We use the UK Met Office's Lagrangian dispersion model NAME III to link CO_2 observations at stations directly to atmospheric transport and potential source regions at the surface. By running the model in backward mode, we identify the degree to which potential regional sources of CO_2 contribute to observed mixing ratios, i.e. the footprint of the station. Footprints are computed over the period 2011-2012 for the three stations Baring Head, Lauder and Rainbow Mountain. NAME III uses hourly meteorological input from the regional forecast model NZLAM-12 over a domain covering New Zealand and the Tasman Sea at a horizontal resolution of 12 km. In addition, we use the large body of back trajectories to identify the predominant transport pathways for each station and to cluster the CO_2 observations into a discrete set of transport regimes. We present preliminary results of the footprint and cluster analyses and outline how the results will be used to estimate terrestrial sources and sinks of CO_2 at a regional scale.