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A comparison of top-down and bottom-up carbon dioxide fluxes in the UK using a multi-platform measurement network.

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Having a comprehensive understanding, on a countrywide scale, of both biogenic and anthropogenic CO_2 emissions is essential for knowing how best to reduce anthropogenic emissions and for understanding how the terrestrial biosphere is responding to global fossil fuel emissions. Whilst anthropogenic CO_2 flux estimates are fairly well constrained, fluxes from biogenic sources are not. This work will help to verify existing anthropogenic emissions inventories and give a better understanding of biosphere - atmosphere CO_2 exchange.

Using an innovative top-down inversion scheme; a hierarchical Bayesian Markov Chain Monte Carlo approach with reversible jump "trans-dimensional" basis function selection, we aim to find emissions estimates for biogenic and anthropogenic sources simultaneously. Our approach allows flux uncertainties to be derived more comprehensively than previous methods, and allows the resolved spatial scales in the solution to be determined using the data. We use atmospheric CO_2 mole fraction data from the UK Deriving Emissions related to Climate Change (DECC) and Greenhouse gAs UK and Global Emissions (GAUGE) projects. The network comprises of 6 tall tower sites, flight campaigns and a ferry transect along the east coast, and enables us to derive high-resolution monthly flux estimates across the UK and Ireland for the period 2013-2015.

We have derived UK total fluxes of 675

78 Tg/yr during January 2014 (seasonal maximum) and 23

96 Tg/yr during May 2014 (seasonal minimum). Our disaggregated anthropogenic and biogenic flux estimates are compared to a new high-resolution time resolved anthropogenic inventory that will underpin future UNFCCC reports by the UK, and to DALEC carbon cycle model. This allows us to identify where significant differences exist between these "bottom-up" and "top-down" flux estimates and suggest reasons for discrepancies. We will highlight the strengths and limitations of the UK's CO_2 emissions verification infrastructure at present and outline improvements that could be made in the future.