Geophysical Research Abstracts
Vol. 18, EGU2016-15449, 2016
EGU General Assembly 2016

Towards national-scale greenhouse gas emissions evaluation with robust uncertainty estimates

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Through the Deriving Emissions related to Climate Change (DECC) network and the Greenhouse gAs Uk and Global Emissions (GAUGE) programme, the UK's greenhouse gases are now monitored by instruments mounted on telecommunications towers and churches, on a ferry that performs regular transects of the North Sea, on-board a research aircraft and from space. When combined with information from high-resolution chemical transport models such as the Met Office Numerical Atmospheric dispersion Modelling Environment (NAME), these measurements are allowing us to evaluate emissions more accurately than has previously been possible. However, it has long been appreciated that current methods for quantifying fluxes using atmospheric data suffer from uncertainties, primarily relating to the chemical transport model, that have been largely ignored to date. Here, we use novel model reduction techniques for quantifying the influence of a set of potential systematic model errors on the outcome of a national-scale inversion. This new technique has been incorporated into a hierarchical Bayesian framework, which can be shown to reduce the influence of subjective choices on the outcome of inverse modelling studies. Using estimates of the UK's methane emissions derived from DECC and GAUGE tall-tower measurements as a case study, we will show that such model systematic errors have the potential to significantly increase the uncertainty on national-scale emissions estimates. Therefore, we conclude that these factors must be incorporated in national emissions evaluation efforts, if they are to be credible.