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The case for refining bottom-up methane emission inventories using top-down measurements

Bryce F.J. Kelly (1), Charlotte P. Iverach (1), Elisa Ginty (1), Safdar Bashir (1,2), Dave Lowry (3), Rebecca E. Fisher (3), James L. France (4), and Euan G. Nisbet (3)

(1) Connected Waters Initiative Research Centre, UNSW Australia, UNSW Sydney, NSW, 2052, Australia, (2) University of Agriculture Faisalabad, Faisalabad Pakistan, (3) Royal Holloway, University of London, Egham Hill, Egham, Surrey TW20 0EX, United Kingdom, (4) School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, United Kingdom

Bottom-up global methane emission estimates are important for guiding policy development and mitigation strategies. Such inventories enable rapid and consistent proportioning of emissions by industrial sectors and land use at various scales from city to country to global. There has been limited use of top-down measurements to guide refining emission inventories. Here we compare the EDGAR gridmap data version 4.2 with over 5000 km of daytime ground level mobile atmospheric methane surveys in eastern Australia. The landscapes and industries surveyed include: urban environments, dryland farming, intensive livestock farming (both beef and lamb), irrigation agriculture, open cut and underground coal mining, and coal seam gas production.

Daytime mobile methane surveys over a 2-year period show that at the landscape scale there is a high level of repeatability for the mole fraction of methane measured in the ground level atmosphere. Such consistency in the mole fraction of methane indicates that these data can be used as a proxy for flux.

A scatter plot of the EDGAR emission gridmap Log[ton substance / 0.1 degree x 0.1 degree / year] versus the median mole fraction of methane / 0.1 degree x 0.1 degree in the ground level atmosphere highlights that the extent of elevated methane emissions associated with coal mining in the Hunter coalfields, which covers an area of 56 km by 24 km, has been under-represented in the EDGAR input data.

Our results also show that methane emissions from country towns (population < 100,000) are underestimated in the EDGAR inventory. This is possibly due to poor information on the extent of urban gas leaks.

Given the uncertainties associated with the base land use and industry data for each country, we generalise the Australian observations to the global inventory with caution. The extensive comparison of top-down measurements versus the EDGAR version 4.2 methane gridmaps highlights the need for adjustments to the base resource data and/or the emission factors applied for coal mining, especially emissions from underground-mine venting. Also, more detail is required on the areal extent and rate of leakage from the gas distribution systems. This is likely to be the case for many other countries. Our results highlight the value of mobile methane surveys for guiding the refinement of bottom-up emission estimates, and they also suggest the expansion of all forms of top-down emission estimates would result in reduced uncertainty in the global methane budget.