

Evidence

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Measuring landfill methane emissions using unmanned aerial systems

Project summary SC140015

Scientists from the Centre for Atmospheric Science and the School of Mechanical, Aerospace and Civil Engineering at the University of Manchester have developed and tested an unmanned aerial system (UAS) to quantify the methane, a potent greenhouse gas, released into the atmosphere from landfill sites.

The project built on a previous feasibility study on the use of remote sensing techniques to quantify methane emissions from landfills. This earlier study examined sensor and UAS platform technology, and the requirements of Civil Aviation Authority (CAA) regulations governing flights by unmanned aircraft.

The feasibility study concluded that a mass balancing approach was the most promising method of calculating bulk methane fluxes from landfill sites using an unmanned aerial system. A mass balancing method, which requires dense sampling downwind of the emitted plume, was therefore adopted for the next stage of the development process.

The project had 3 parts:

- development, integration and testing of rotary and fixed wing UAS platforms
- planning and execution of a field trial of both systems at a landfill site
- assessment of the data collected and the method used to measure the methane flux

Two UAS platforms were developed:

- a multirotor system with 6 rotors (called a hexrotor) with a tethered sampling line to sample vertical profiles of methane and carbon dioxide using high-precision instrumentation back on the ground
- a fixed wing electrically powered aircraft with an onboard high-precision carbon dioxide infrared reference cell

There is currently no high-precision methane instrument suitable for flying on a small fixed wing UAS, although it is anticipated that such instruments will become available in the near future. In the absence of dedicated methane monitoring instrumentation, carbon dioxide measurements were collected in this project as a proxy for methane.

This proxy approach is based on the principle that a representative ratio of carbon dioxide to methane on the day of measurement can be established for a particular landfill using the measurements of both gases obtained using the tethered hexrotor. Methane concentrations in the wider landfill plume can then be inferred from the carbon dioxide measurements obtained using the free-flying fixed wing system. When a suitable methane instrument becomes available, the proxy approach will no longer be necessary as the methane concentrations will be measured directly.

The UAS platforms were operated successfully for 10 days of field work, with many important lessons learned for future operational guidance.

The report details the field trial activities and provides guidance on flight design and operational practice in varying environmental conditions. It also presents a method for methane flux calculation and uncertainty, and discusses the use and limitations of this method in practice.

The UAS approach developed in this project has the potential to provide a cost effective method for measuring methane fluxes from landfills. However, further work is required to improve the UAS software and hardware systems.

The next step in developing the approach set out in this report would be further validation against alternative methane measurement methods to examine sources of systematic bias or uncertainty resulting from sampling.

This summary relates to information from project SC140015, reported in detail in the following output(s):

Report: SC140015/R

Title: Measuring landfill methane emissions using unmanned aerial systems: field trial and operational guidance

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