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Title: Using Eddy Covariance to Quantify Methane Emissions from a Dynamic Heterogeneous Area

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Measuring emissions of CH_4, CO_2, H_2O, and other greenhouse gases from heterogeneous land area sources is challenging. Dynamic changes within the source area as well as changing environmental conditions make individual point measurements less informative than desired, especially when it is necessary to measure gas emission rates over long time periods. Quantitative understanding of greenhouse gas emissions from heterogeneous areas is essential for process-based modeling studies, determining mitigation strategies, and formulating controls and regulations by governments. Several methods are available to quantify greenhouse gas emissions from such source areas, including chamber-based methods, tracer plume, mass balance, and eddy covariance methods. Each method has its own advantages and disadvantages. The tracer plume method can provide a large measurement footprint, allowing it to be used to estimate greenhouse gas emission from area sources, such as oil and gas infrastructure, feedlots, lagoons, or landfills. However, this method does not lend itself to automation and is resource intensive. Advantages of the eddy covariance method are simplicity of automation, suitability for continuous unattended measurements, and low labor requirement. In this paper, we present the results obtained from one year of continuous CH_4 and CO_2 monitoring at an active landfill using the eddy covariance technique. Results are compared to tracer plume measurements taken from three measurement periods during the year. The two methods gave similar methane emission

rates when integrated over the three short-term periods available from tracer plume measurements, although the difference between the two could be large on a half hour basis. The eddy covariance approach provided continuous time-resolved measurements throughout the year, describing substantial hourly and seasonal dynamics in greenhouse gas emission rates and providing invaluable, and sometimes very novel, insights into landfill methane emissions.