A top-down approach for quantifying methane and speciated VOC emissions from North Sea oil and gas facilities

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The North Sea is home to around 200 offshore platforms that extract oil and natural gas from beneath the sea. Total offshore emissions (carbon dioxide (CO2), nitrogen oxides (NO + NO2 = NOx), nitrous oxide (N2O), sulphur dioxide (SO2), carbon monoxide (CO), methane (CH4) and total VOCs) from upstream oil and gas production in the UK increased by 7% from 2016 to 2017. Therefore, the accurate measurement and analysis of leakage is critical for global emissions inventories and in terms of mitigating climate change. A recent study (Riddick et al., 2019) showed that on average methane leakage during normal operations is more than double what is reported to the UK National Emissions Inventory (NAEI) for each installation. Here we provide a top-down emissions estimation methodology from which emissions of CH4 and up to 30 individual volatile organic compounds (VOCs) can be estimated for point-source platforms. We apply a direct integration technique, and use VOC measurements obtained within downwind plumes as a tool for source identification. A total of 16 research flights were conducted as part of a joint project between the UK National Centre for Atmospheric Science (NCAS), BEIS, the UK Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) and Ricardo Energy & Environment to characterise emissions from platforms in the North Sea. The hydrocarbon to ethane enhancement ratio within downwind plumes, measured under well-mixed boundary layer conditions, was used to scale a 1 Hz ethane measurement from the aircraft to other hydrocarbons collected using whole air samplers and measured using GC-FID. This allowed individual VOC emission rates to be calculated and compared to existing inventories. This work highlights how a top down technique can be used to quantify emissions and also provide insight into specific emission sources, in contrast to existing methods which often fail to achieve both simultaneously.