Global Identification of Landfill Methane Super Emitters using Hyperspectral Satellite Observations

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Landfills are the third largest anthropogenic source of methane and mitigating their emissions is crucial in addressing the global challenge of climate change. However, quantifying methane emissions from individual landfills remains challenging. Estimates are often based on modeling or scarce aircraft measurements. Therefore, space-borne monitoring offers a way to improve global estimates. While not originally designed to detect methane, hyperspectral imagers (HSI) provide an opportunity to expand coverage beyond methane-specific instruments and study methane emissions from strongly-emitting landfills.

Here, we combine three high-resolution (30~60 m) HSIs (EMIT, EnMAP, and PRISMA) to quantify and monitor emissions from 38 ‘super emitter’ landfills, focusing on methane hotspots identified by the TROPOspheric Monitoring Instrument (TROPOMI). EMIT has clear-sky observations for all 38 landfills due to its wider swath coverage and successfully detects methane plumes from 36 of them. EnMAP has a comparable detection capability, capturing plumes from 16 out of the 18 landfills with clear-sky observations, whereas PRISMA only detects 4 out of 32 due to its lower signal-to-noise ratio and higher full width half maximum. The total area-source methane emissions from these landfills are 194 ± 12 t h-1, with a majority of the analyzed landfills located in India, Argentina, Brazil, and Mexico. The cumulative distribution reveals that the top 20% highest emitters (7~20 t h-1 each) contribute

45% of the inferred total emission. Using observations spanning multiple months, we study the variation of emissions and investigate the influence of using different wind speed products on the estimated emission variance.

We also compare our emission estimations with the facility-level Climate TRACE and city-level WasteMAP solid waste emission inventories. Results show that for the super-emitting landfills, our estimations exceed Climate TRACE and WasteMAP by a factor of 2.0 and 5.5, respectively. Our study only targeted 0.4% of landfills included in the Climate TRACE dataset, but covered ~5% of their estimated global landfill emissions. This shows the potential use of HSI imagers to better understand landfill estimates across the globe.

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