Global Identification of Landfill Methane Super Emitters using Hyperspectral Satellite Observations

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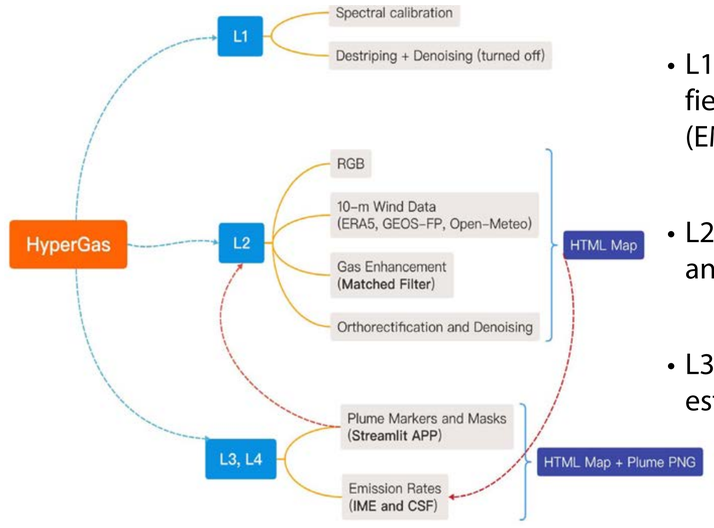
Why Study Landfill Methane Emissions?

- Anthropogenic activities account for ~60% of global methane emissions, with waste treatment as the third-largest source (~18%) after agriculture and fossil fuels.
- Global waste generation could increase by ~60% from 2016 to 2050.
- However, quantifying global landfill methane emissions remains challenging with a 78% uncertainty.
- The facility-scale coverage by satellites designed to observe methane is currently limited.
- In this study, we evaluate the potential of using hyperspectral imagers (HSIs) to extend that coverage and quantify emissions from individual landfills.

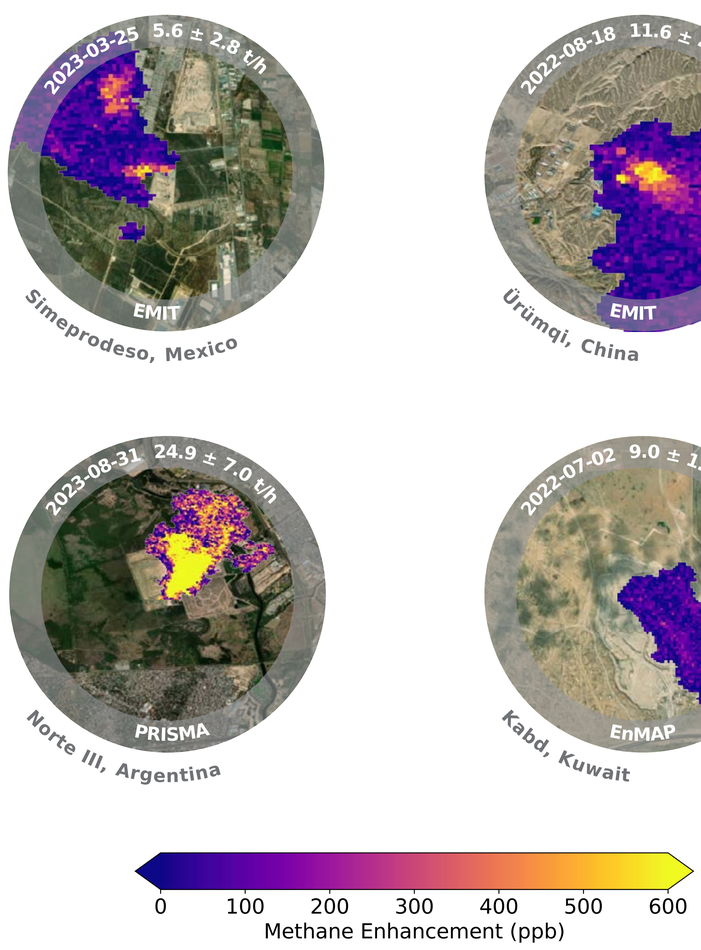
Methane Retrieval (HyperGas Package)



Workflow of the HyperGas Python package, which enables retrieval of methane enhancements, creation of plume masks, and calculation of emission rates.

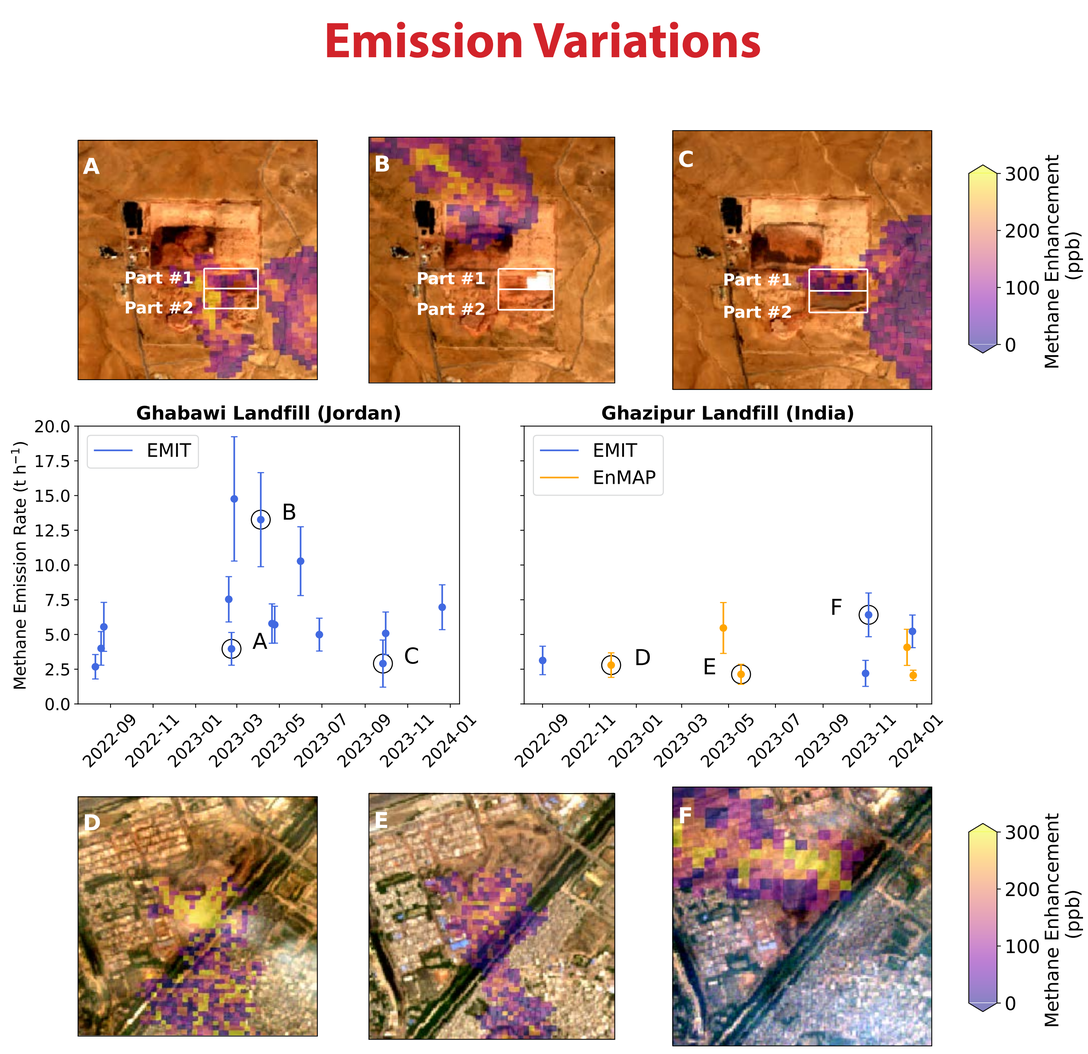
- L1 --> L2: Methane enhancement field derived from three HSIs (EMIT, EnMAP, PRISMA) L1 data
- L2 --> L3: Methane plume source and automated masking
- L3 -->L4: Methane emission rate estimation

Plume Detection Examples



- Landfill emissions detected at those hot spots using hyperspectral imagers including EMIT, EnMAP, and PRISMA.
- This highlights EMIT and EnMAP's importance in identifying landfill emission sources, whereas PRISMA exhibits a substantially higher detection threshold.

Emission Variations



Time series of methane emissions from the Ghabawi (Jordan) and Ghazipur (India) landfills as derived using EMIT and EnMAP data. (A-C) Methane plumes observed at the Ghabawi landfill shown over Sentinel-2 images captured within 3 days of the EMIT overpass. The white rectangles are two parts in the newly constructed southern section. (D-F) Similar observations for the Ghazipur landfill.

- These Sentinel-2 images confirm a shift in the plume source location from the northern cell to a newly established southern cell of the Ghabawi landfill.
- We combine EMIT and EnMAP observations, and find that the emission source of the Ghazipur landfill shifted from the southern section to the northeast, with the emission rate increasing.
- This trend is consistent with increasing activity in the northeastern section, as shown by the Sentinel-2 images.

Take-home Message

- The combination of multiple hyperspectral imagers reveals 'super emitter' landfills.
- EMIT and EnMAP have a higher sensitivity to landfill methane emissions than PRISMA
- This highlights the potential of hyperspectral imaging systems to enable global monitoring of methane emissions from landfills.

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