Quantifying methane emissions from individual point sources with the GHGSat-D satellite instrument

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Anthropogenic methane is emitted by many small point sources:

- Coal mines
- Feedyards
- Landfills
- Oil & gas facilities
AVIRIS-NG aircraft remote sensing demonstrates methane plume imaging

Frankenberg et al. (2016)

Duren et al. (2019)
Rapid expansion of satellite fleet for observing methane point sources

- **Local focus**
- **Regional focus**

Satellites:
- EMIT
- MERLIN
- geoCARB
- MethaneSat
- Bluefield
- EnMAP
- PRISMA
- TROPOMI
- GHGSat
- GOSAT
- GOSAT-2
- SCIAMACHY

Timeline:
- 2000
- 2005
- 2010
- 2015
- 2020
- 2025
• Demonstration mission **GHGSat-D** launch in 2016
• Low Earth, sun-synchronous orbit at ~**500 km** altitude
• Based on a **Fabry-Perot** interferometer
• Observes methane at the **1.6 micron** absorption feature
• Images scenes at <**50 m** resolution
• Targeted domains of area ~**10×10 km²** (GHGSat-D, **12×12 km²**)
• Return time of ~**2 weeks**
• Design column precision of <**2%** of background (GHGSat-D, ~**13%**)
• Constellation follow-on missions **GHGSat-C1, -C2** launch in 2020
GHGSat-D has regularly monitored three coal mine vents since 2016 launch:

- **San Juan mine**
  - NM, United States
  - 24 obs

- **Appin mine**
  - NSW, Australia
  - 13 obs

- **Bulianta mine**
  - Inner Mongolia, China
  - 14 obs

# of cloud-free observations
Observing coal mines with GHGSat-D: San Juan mine (NM) observations

**Strong instantaneous plume**

San Juan mine (18/9/2018)

**Some other, more typical observations**

1541997, post = 106 deg
1011662, post = 138 deg
3019999, post = 129 deg
1C21999m, post = 207 deg
1A01099, post = 87 deg
14019999, post = 116 deg
Rotate and stack observations

Some other, more typical observations

Time averaging of observations to resolve plumes
Source rates from IME and cross-sectional flux methods consistent with previous estimates

Varon et al. (in prep.)
Source rates from IME and cross-sectional flux methods consistent with previous estimates

<table>
<thead>
<tr>
<th></th>
<th>San Juan (kg h(^{-1}))</th>
<th>Appin (kg h(^{-1}))</th>
<th>Bulianta (kg h(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME method:</td>
<td>1750 ± 950</td>
<td>3750 ± 1900</td>
<td>2050 ± 950</td>
</tr>
<tr>
<td>Cross-sectional flux</td>
<td>1550 ± 850</td>
<td>3200 ± 1500</td>
<td>1850 ± 900</td>
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<tr>
<td>method:</td>
<td></td>
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<tr>
<td>Previous:</td>
<td>360-2800 (Frankenberg et al., 2016)</td>
<td>1080-13,390 (CSIRO)</td>
<td>170-????? (SACMS)</td>
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<td></td>
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<td></td>
<td>1500 (Smith et al., 2017)</td>
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<tr>
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<td>2590 (EPA, 2017)</td>
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</tbody>
</table>

CSIRO = Commonwealth Scientific and Industrial Research Organization (Australia)
SACMS = State Administration of Coal Mine Safety (China)

Varon et al. (in prep.)
GHGSat-D detects massive methane plumes from oil/gas facilities

Varon et al. (2019) GRL
GHGSat-D detects massive methane plumes from oil/gas facilities

Varon et al. (2019) GRL

Background satellite images ©2019 DigitalGlobe, a Maxar company
Methane emissions from oil/gas infrastructure in the Korpezhe oil/gas field

Scarpelli et al. (2018)

Varon et al. (2019)

Background satellite images ©2019 DigitalGlobe, a Maxar company
TROPOMI confirms the magnitude of large emissions from Korpezhe

Varon et al. (2019) GRL
Korpezhe is at least one year old and total emissions are very large.

Total emissions:
- $142 \pm 34$ kilotonnes CH$_4$
- $446$ (189-750) kilotonnes CH$_4$

Varon et al. (2019) GRL
Fine-resolution satellite instruments like GHGSat-D can detect and quantify individual methane point sources.

Time-averaging of wind-rotated observations can lower detection thresholds, especially after optimizing wind directions.

Coarse identification of methane hotspots with TROPOMI can guide high-resolution satellite instruments to identify the responsible facilities.