Identification of Methane Emission Sources in the Baltimore-Washington Metropolitan Area

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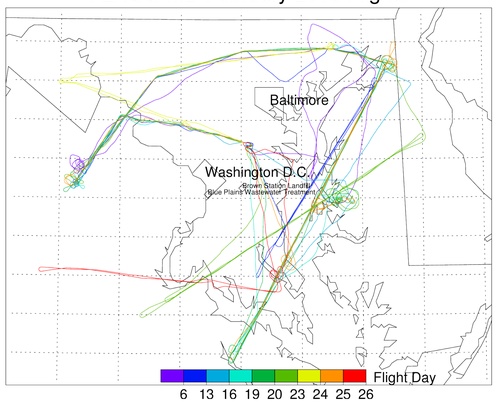
Introduction

- The Fluxes of Atmospheric Greenhouse Gases in Maryland (FLAGG-MD) project aims to estimate sources and sinks of carbon dioxide, methane, and carbon monoxide in the Baltimore-Washington metropolitan area.
- Flights were conducted on nine days in February 2015 to measure trace gas and aerosol concentrations in the region.
- Back trajectories originating from the flight track were computed using HYSPLIT model to analyze the measurements.

Flight Tracks

FLAGG-MD February 2015 Flights



Data

- HYSPLIT Meteorological Data: NAM 4km
  - Hourly data, 40 Vertical levels
- Aircraft: Cessna 402B
  - Measurements every second
  - Positional: Cessna Garmin GPS
  - [CO],[CO_2],[CH_4],[H_2O]: Picarro G2401-f
  - Wind: Estimated using aircraft airspeed/heading and GPS
- Natural Gas pipeline information
  - Acquired from NPMS Public Map Viewer

Reference

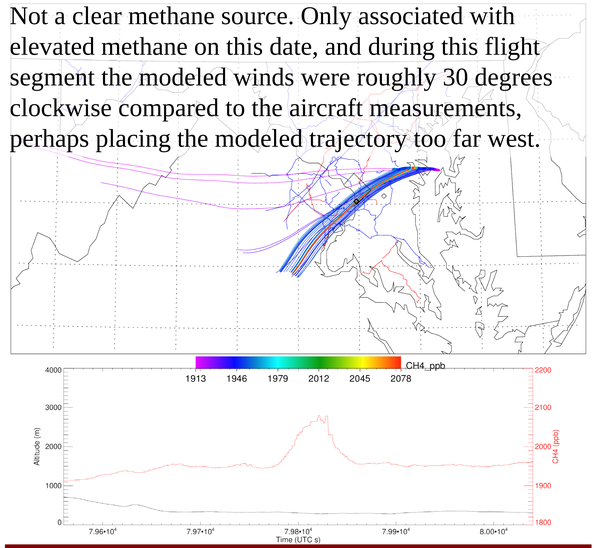
Jackson, R.B., et al. (2014). Natural gas pipeline leaks across Washington D.C. *Environmental Science & Technology, (48)*3, 2051-2058.

Blue Plains Water Treatment

Largest plant of its kind in the world, serving two million customers.

6-hr HYSPLIT back trajectories off of FLAGG-MD flight on 15 2 6, from 2206 to 2214 UTC

Not a clear methane source. Only associated with elevated methane on this date, and during this flight segment the modeled winds were roughly 30 degrees clockwise compared to the aircraft measurements, perhaps placing the modeled trajectory too far west.

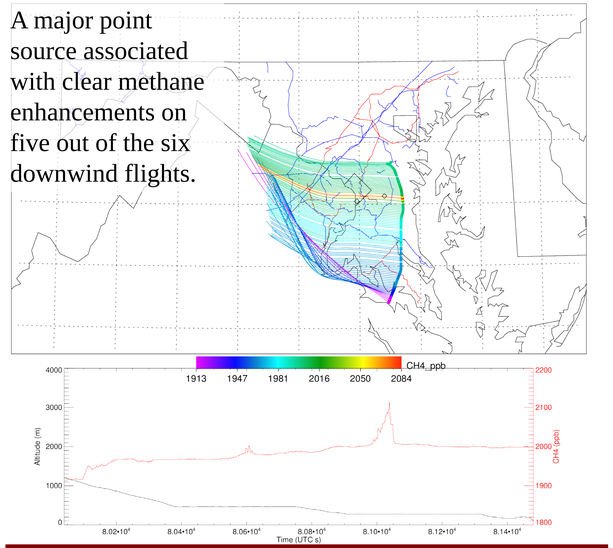


Brown Station Landfill

Largest landfill in the region; has a gas collection system to extract methane and burns it to generate electricity.

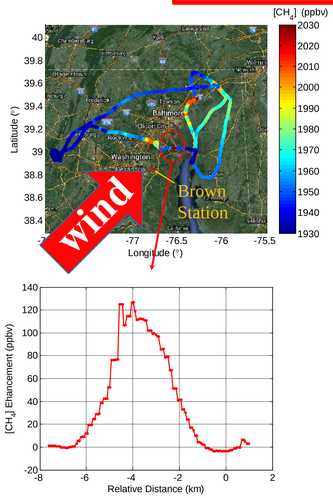
6-hr HYSPLIT back trajectories off of FLAGG-MD flight on 15 2 20, from 2214 to 2238 UTC

A major point source associated with clear methane enhancements on five out of the six downwind flights.



Mass Balance Estimate:

$$E.R._{CH_4} = \int_0^{z_i} \int_{-x}^{+x} ([C] - [C]_b) \times U_\perp \, dx dz$$



E. R. : emission rate (flux)
[C] : concentrations (downwind)
$[C]_b$: concentration (background)
$U_\perp$: perpendicular wind speed
z_i : boundary layer height

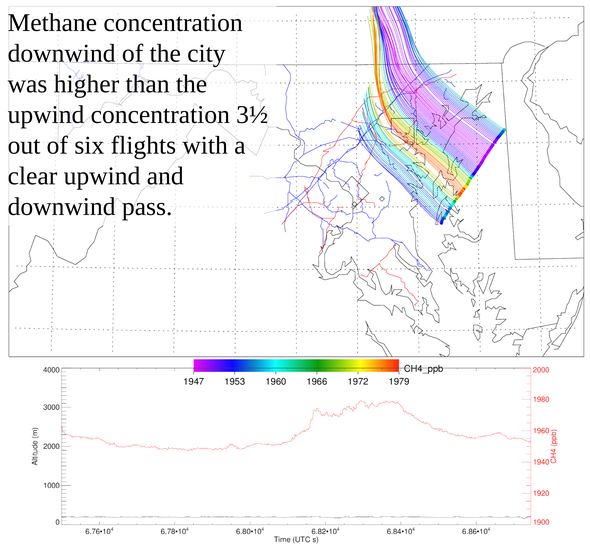
Flight Day	CH_4 Emission Rate (mol/s)
6	57.4
13	68.1
19	105.9
20	83.8
23	65.3
25	56.2
Mean	72.8 ± 19.0 (~11% of region total)

Baltimore

Not known if it is leaking methane from its infrastructure.

6-hr HYSPLIT back trajectories off of FLAGG-MD flight on 15 2 16, from 1845 to 1906 UTC

Methane concentration downwind of the city was higher than the upwind concentration 3½ out of six flights with a clear upwind and downwind pass.

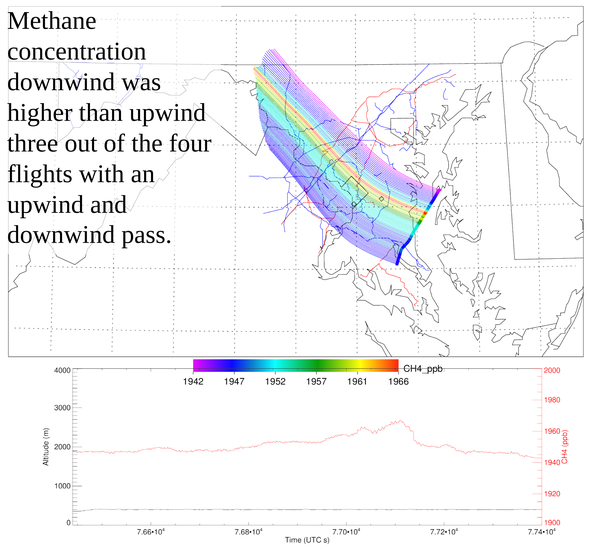


Washington D.C.

One study discovered large methane leaks coming from small natural gas distribution lines (Jackson et al., 2014).

6-hr HYSPLIT back trajectories off of FLAGG-MD flight on 15 2 13, from 2114 to 2130 UTC

Methane concentration downwind was higher than upwind three out of the four flights with an upwind and downwind pass.



Plot Information

- Back trajectories originating at the plane's position, indicated by the dot, were plotted every fifteen seconds along the flight track.
- The color of the dot and trajectory indicates the concentration of methane measured by the aircraft at the initial point of the trajectory.
- The plane was within the boundary layer for all flight segments shown
- The major natural gas distribution lines are indicated on the maps as red and blue lines; blue lines indicate gas phase transport, while red lines indicate liquid phase transport.

Conclusion

- Major methane sources in the Baltimore-Washington region are the two cities themselves and the point source Brown Station Landfill.
- Baltimore, like Washington, may be leaking methane from its gas distribution infrastructure.
- Major natural gas pipelines in the Baltimore-Washington region were not associated with methane enhancements and do not appear to be leaking significant amounts of methane.