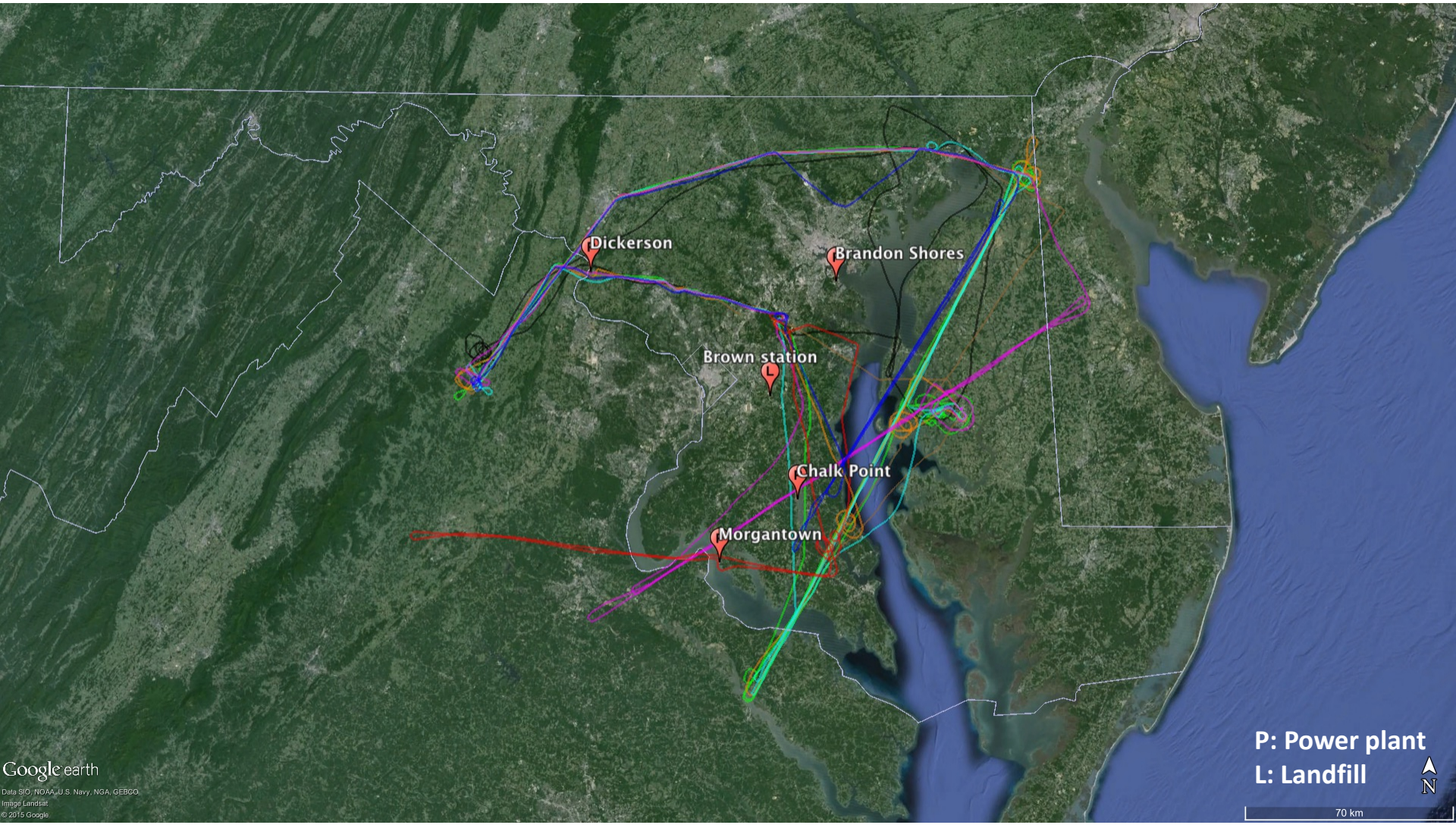
[FLAGG-MD: Fluxes of Atmospheric Greenhouse Gases(GHG) in Maryland]

Identification of GHG Sources in Maryland Using HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) Model

Russel R. Dickerson, PI **Ross J. Salawitch**, CO-PI **Xinrong Ren**, CI for observations
Doyeon Ahn, Graduate student **Jonathan Hansford,** Undergraduate student

10. 13. 2015

Major Power Generating Stations and Landfill facilities



Period: 6 Feb to 26 Feb, 2015. (9 Flights)

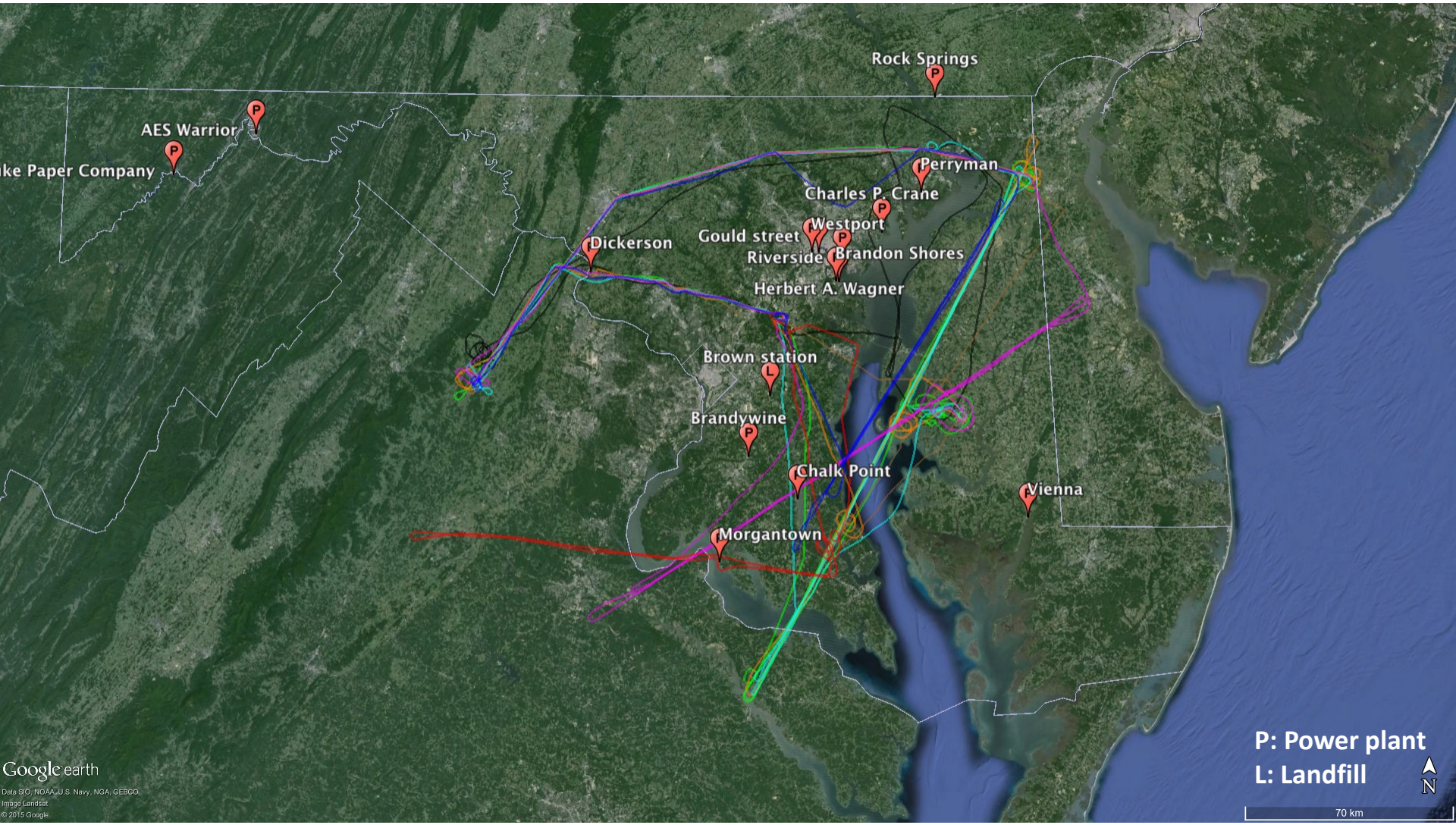
Region: Baltimore/Washington area

Aircraft: UMD Cessna 402B (with Picarro CO_2/CH_4/CO analyzer and NOAA/NIST calibration equipment)

Website: http://aosc.umd.edu/~flaggmd/

Supported by NIST and linked to INFLUX(Indianapolis Flux Experiment)

All power generating stations



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HYSPLIT

1. Back trajectory analysis

1-a. CO_2

1-b. CH_4

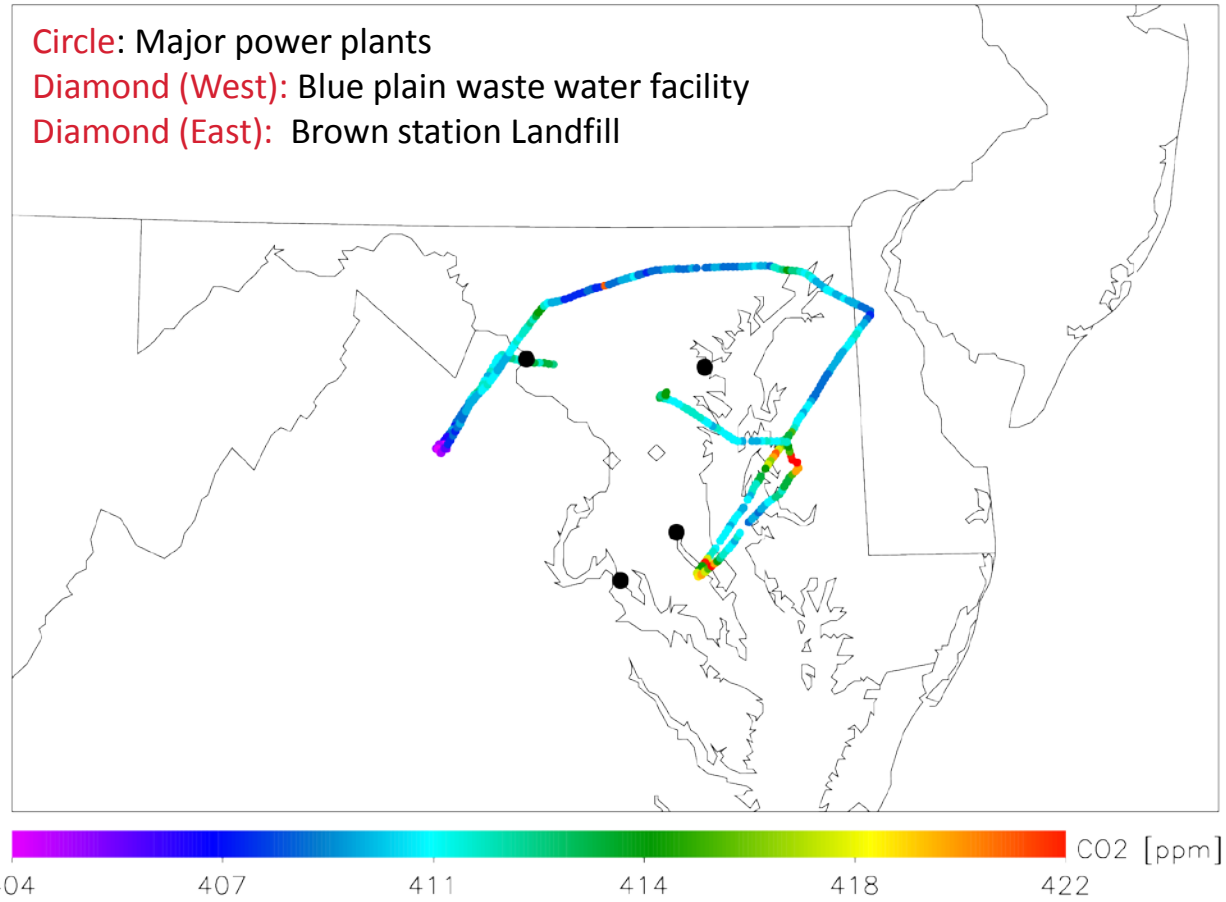
2. Particle dispersion analysis

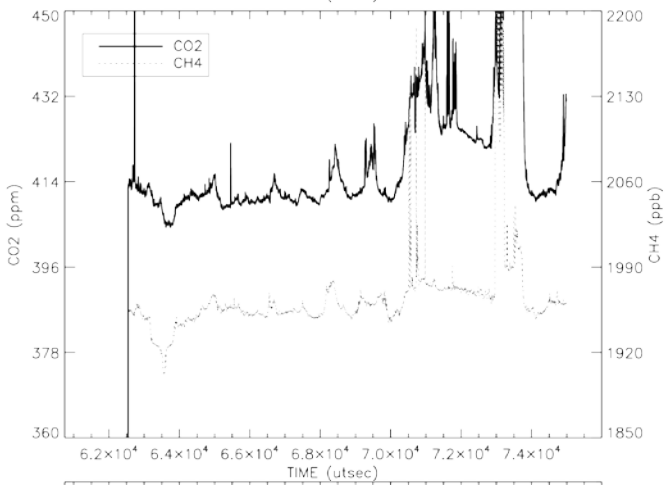
3. Future plans

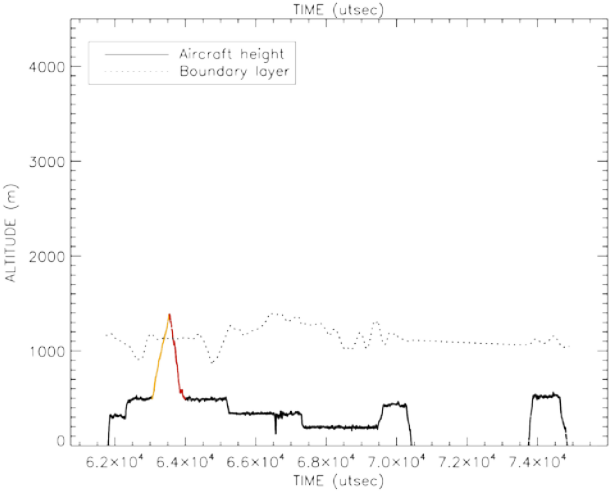
[Flight #3] Feb 16 2015

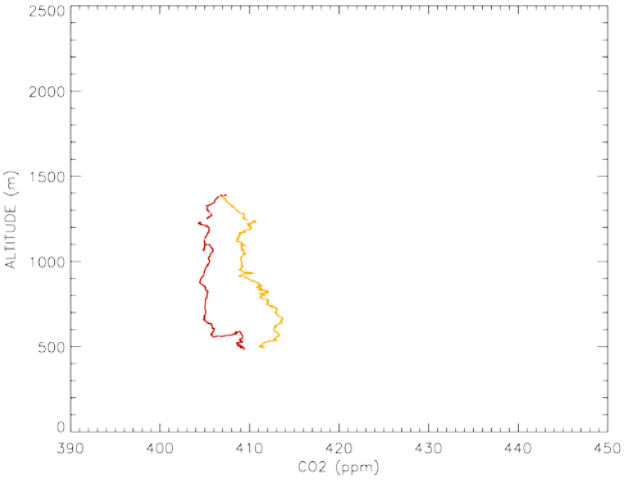
CO2 mixing ratio on flight track

Circle: Major power plants
Diamond (West): Blue plain waste water facility
Diamond (East): Brown station Landfill





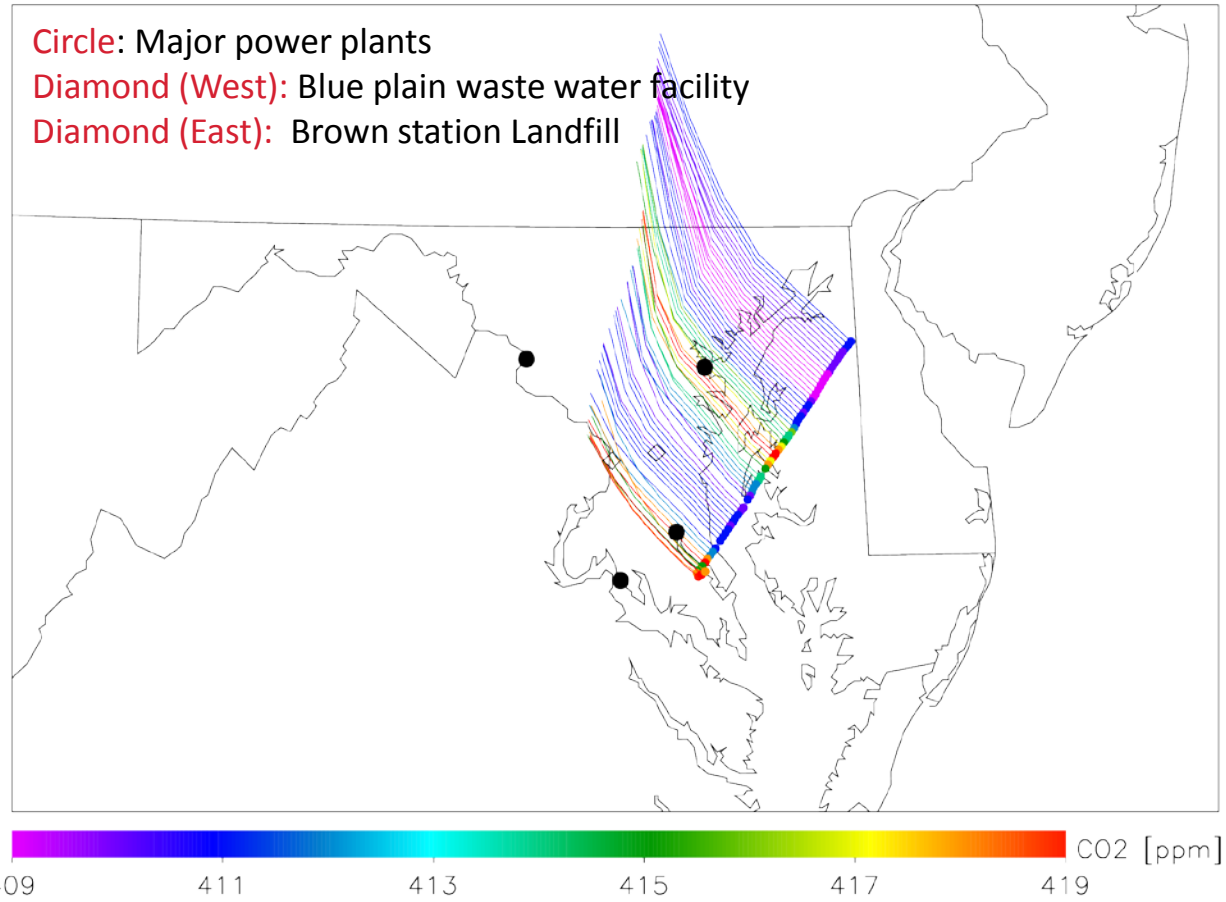


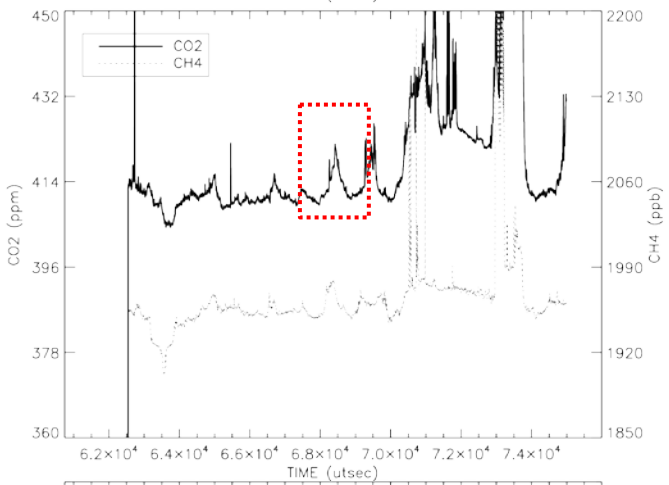


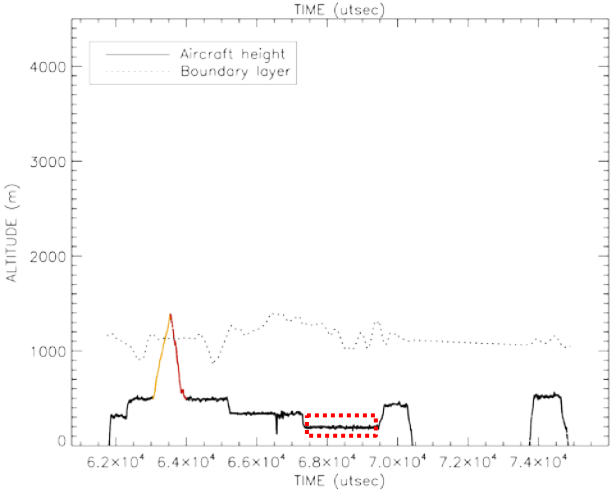
[Flight #3] Feb 16 2015

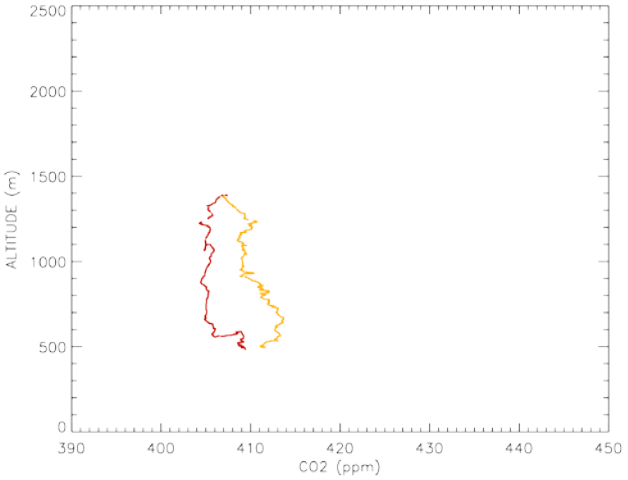
Back trajectory analysis (1)

(-6 hours, every 15 seconds)





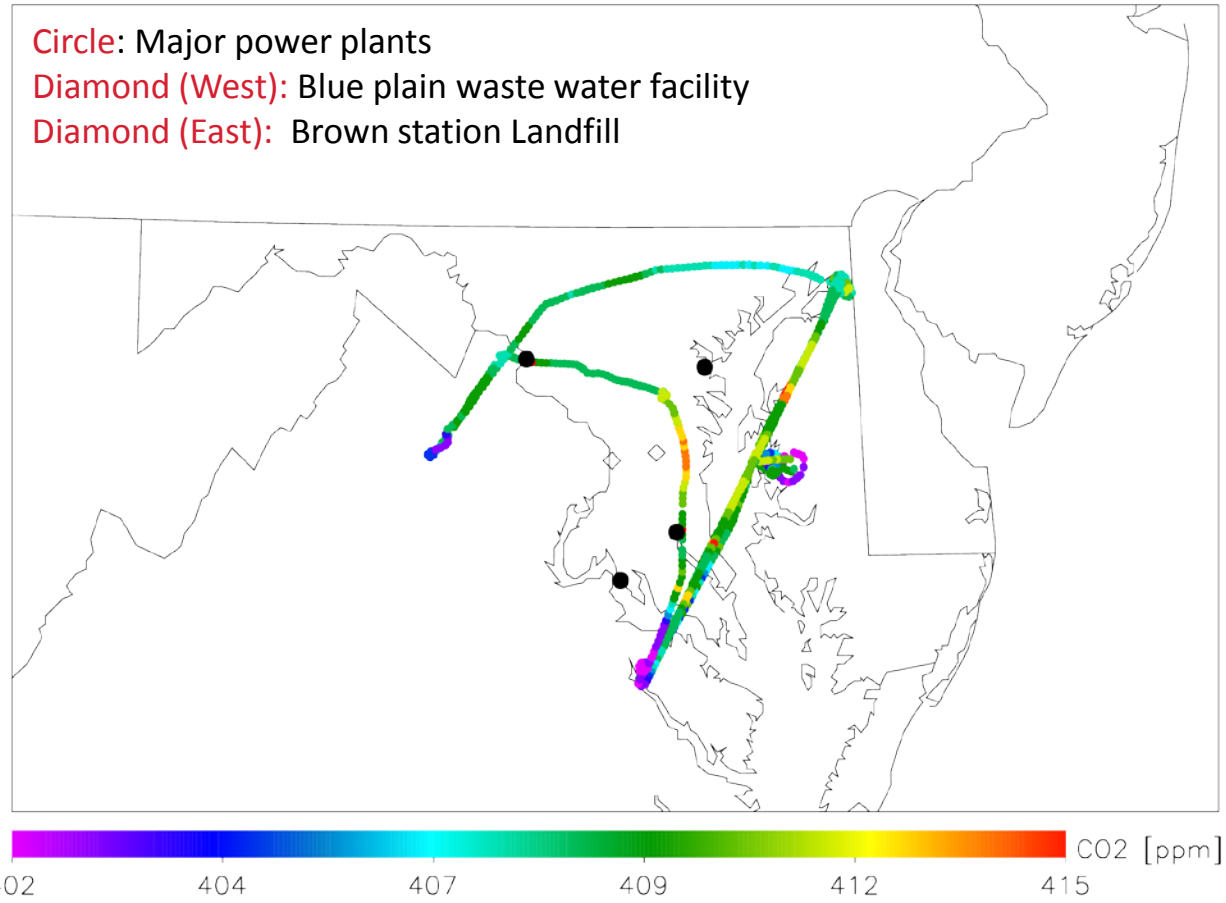


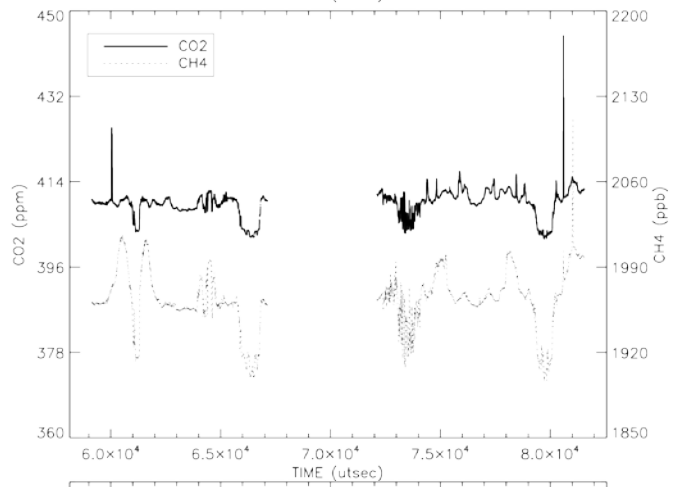


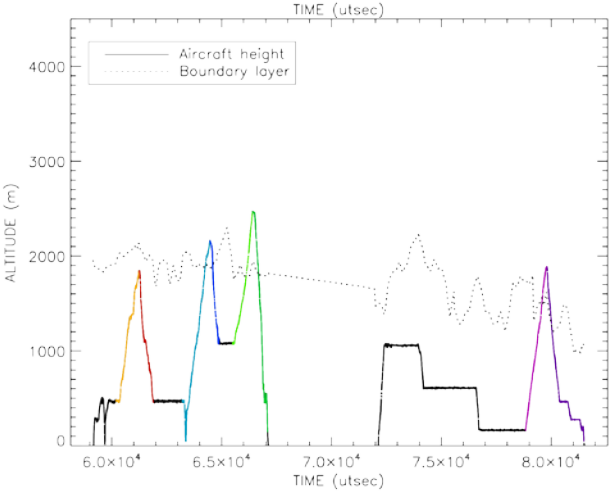
[Flight #5] Feb 20 2015

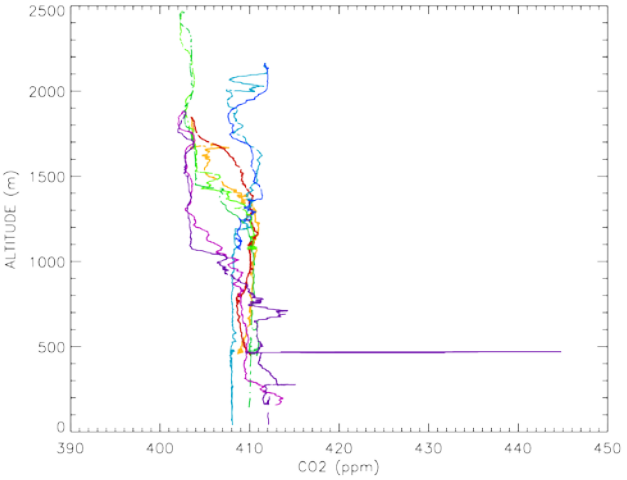
CO2 mixing ratio on flight track

Circle: Major power plants
Diamond (West): Blue plain waste water facility
Diamond (East): Brown station Landfill





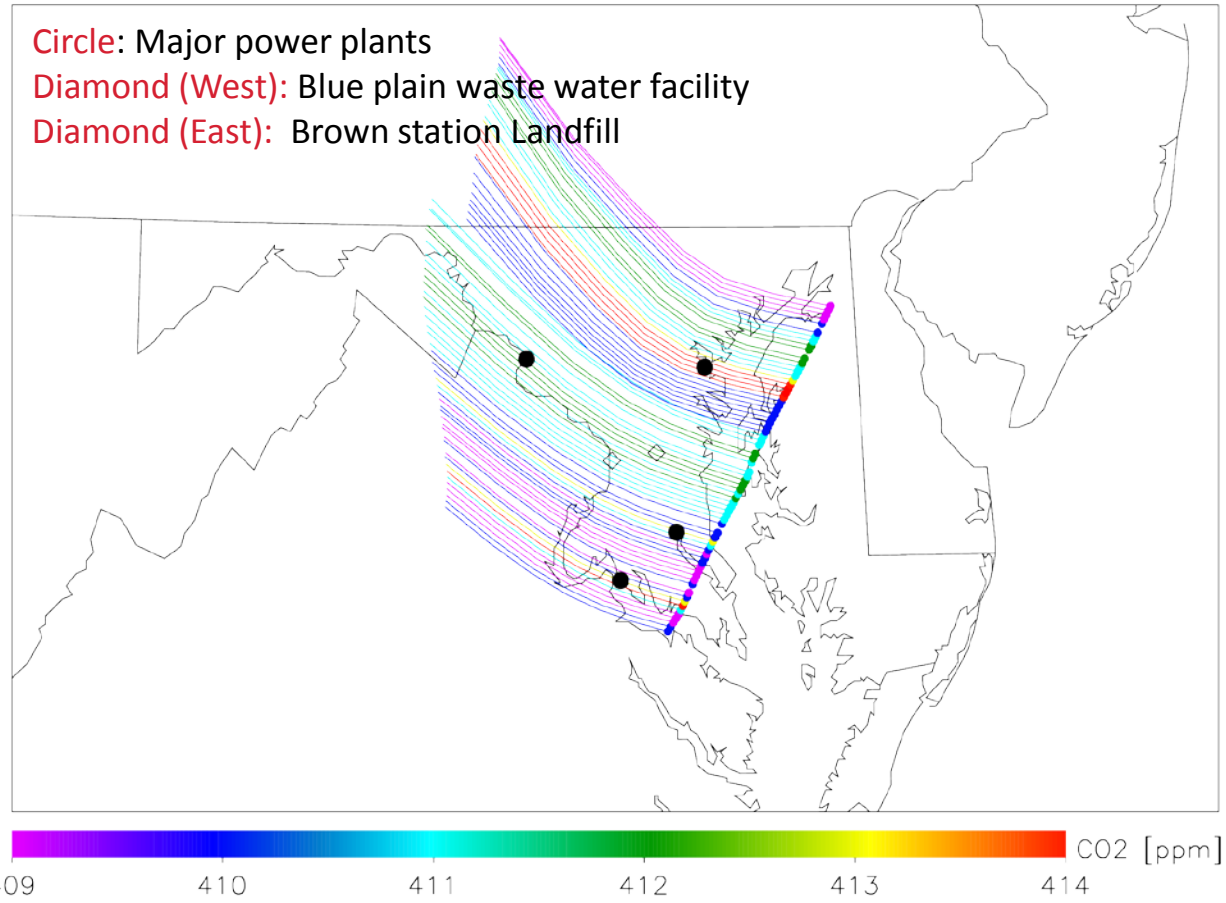


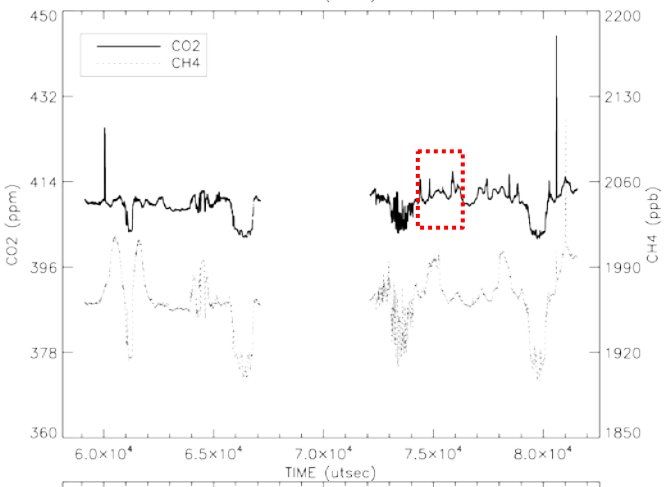


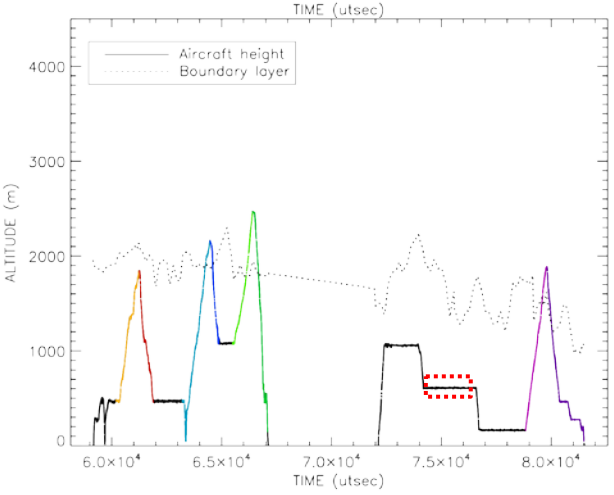
[Flight #5] Feb 20 2015

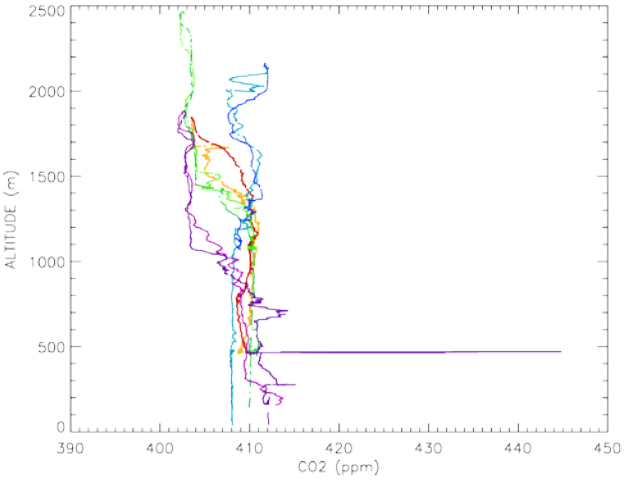
Back trajectory analysis (1)

(-6 hours, every 15 seconds)









[Flight #5] Feb 20 2015

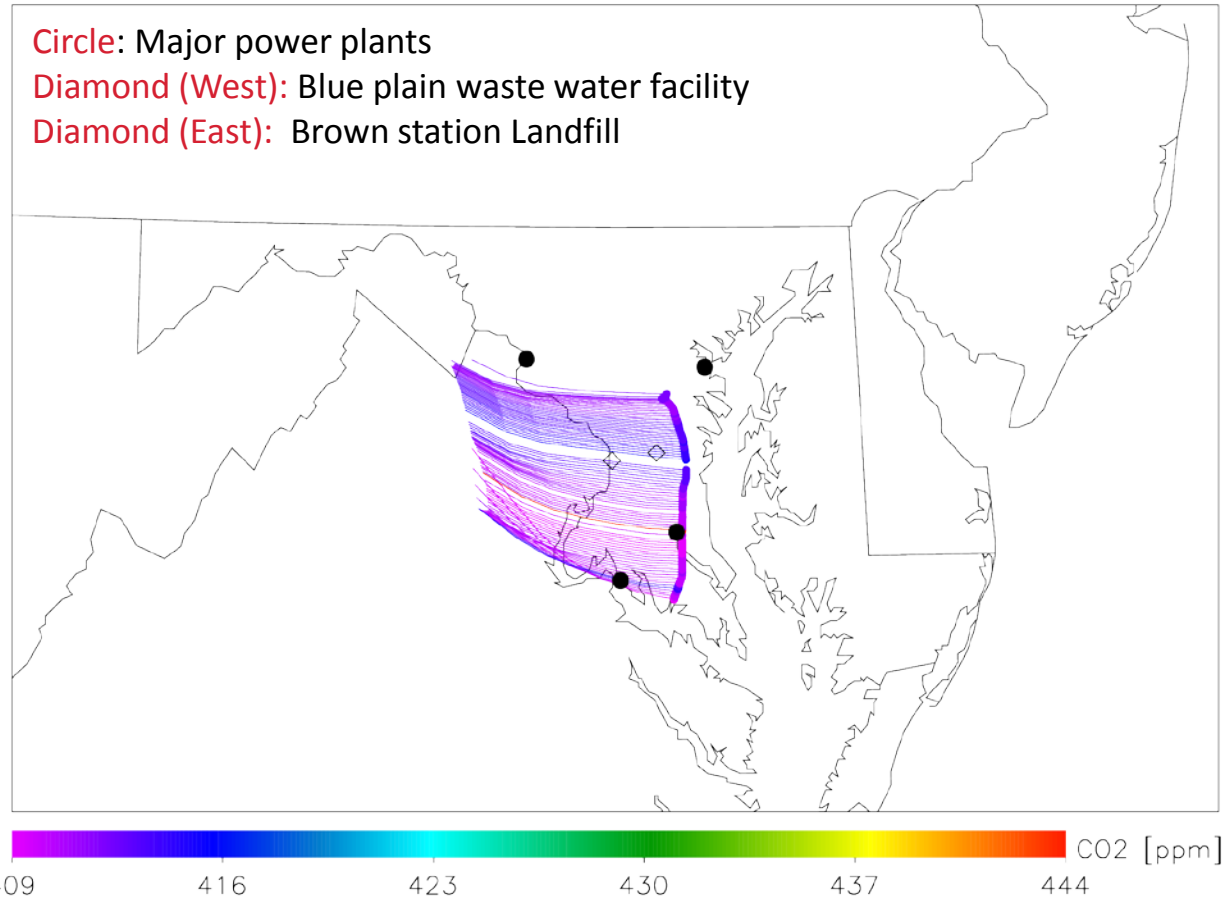
Back trajectory analysis (2)

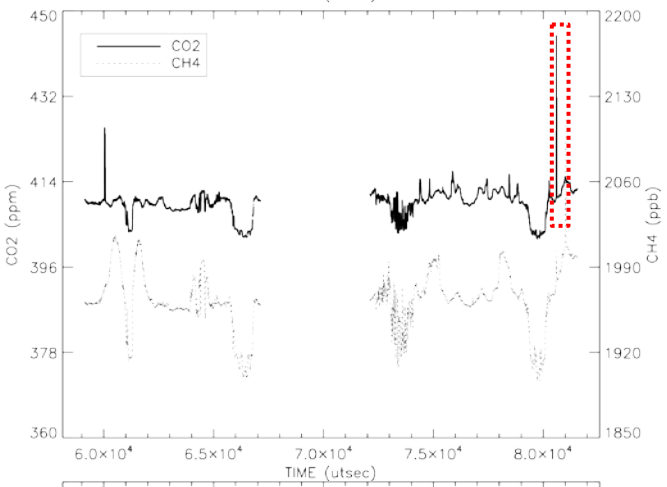
(-6 hours, every 15 seconds)

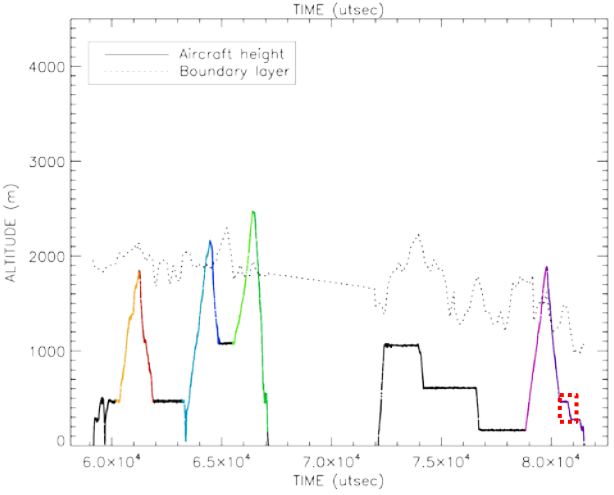
Circle: Major power plants

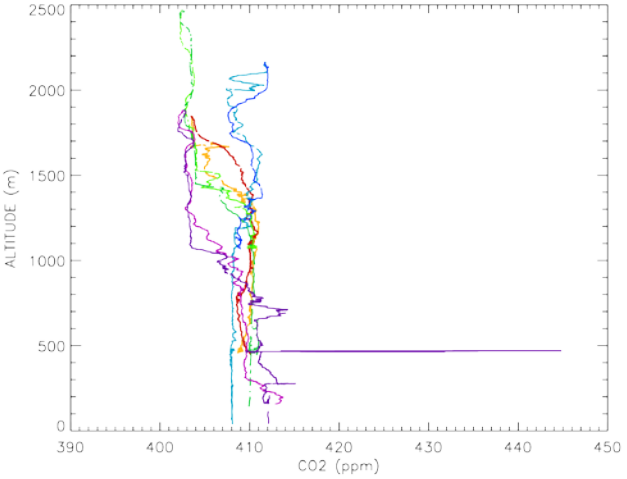
Diamond (West): Blue plain waste water facility

Diamond (East): Brown station Landfill









HYSPLIT

1. Back trajectory analysis

1-a. CO2

1-b. CH4

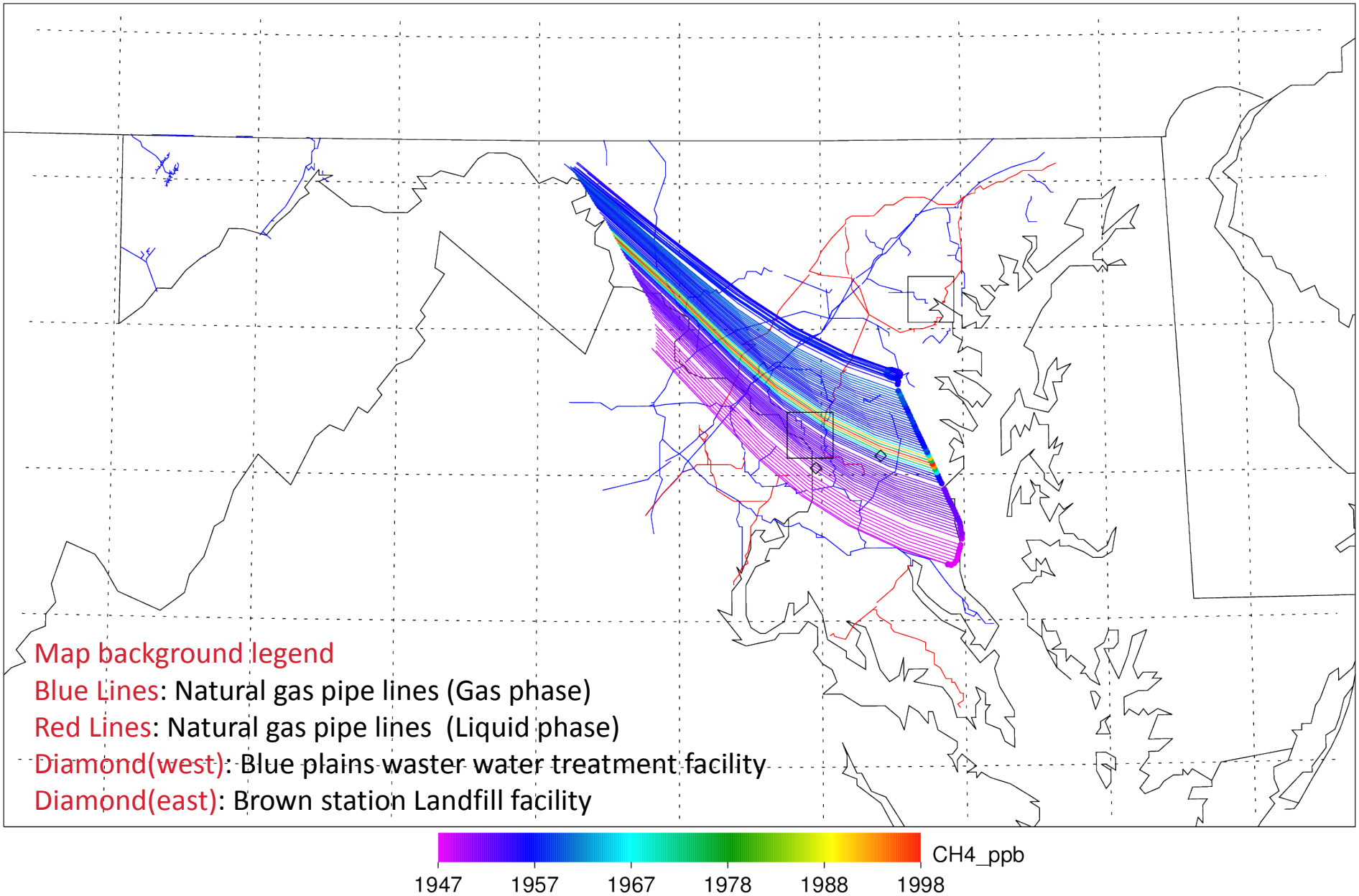
2. Particle dispersion analysis

3. Future plans

[Flight #2] Feb 13 2015

Back trajectory analysis (1)

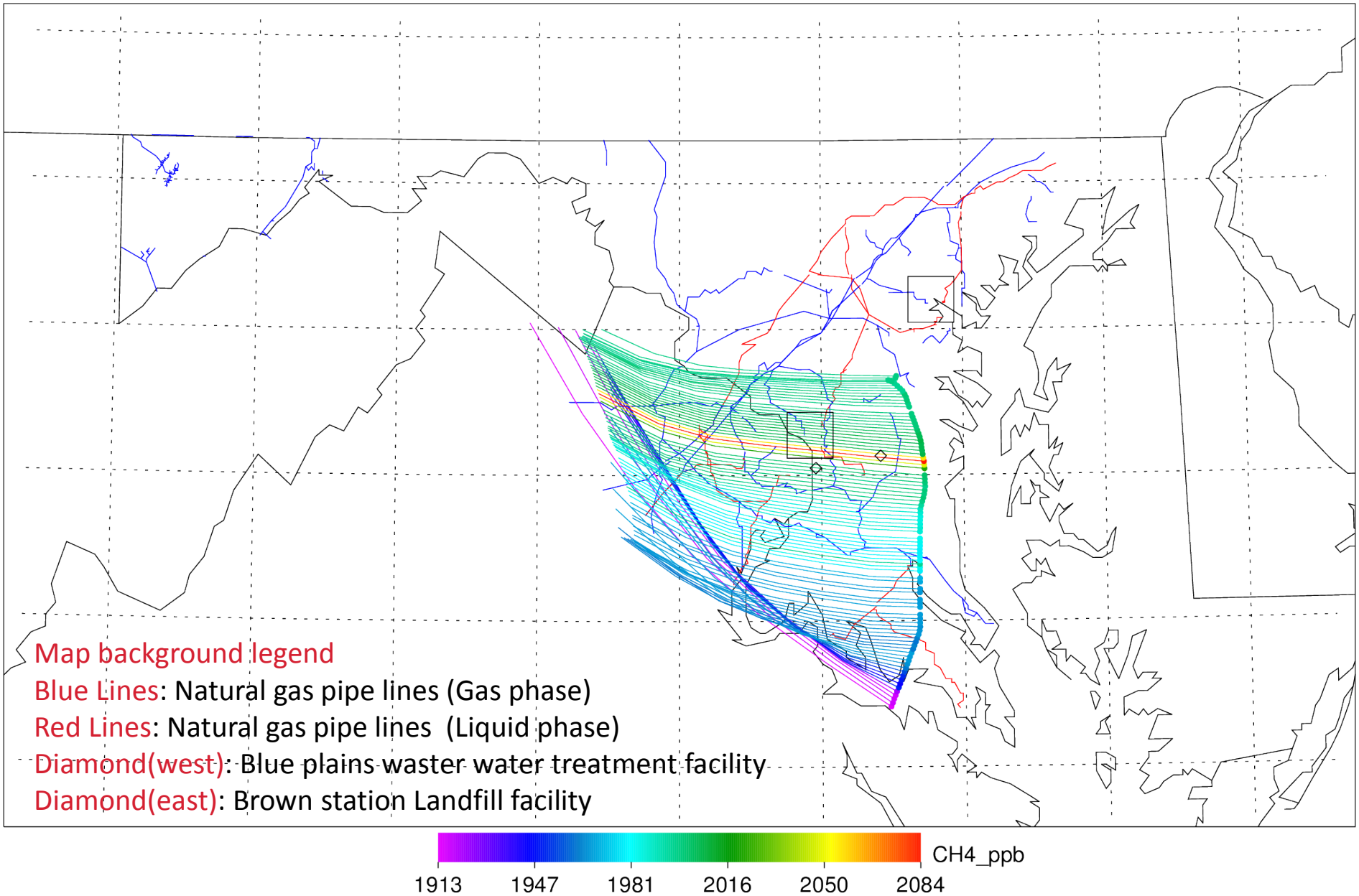
(-6 hours, every 15 seconds)



[Flight #5] Feb 20 2015

Back trajectory analysis (1)

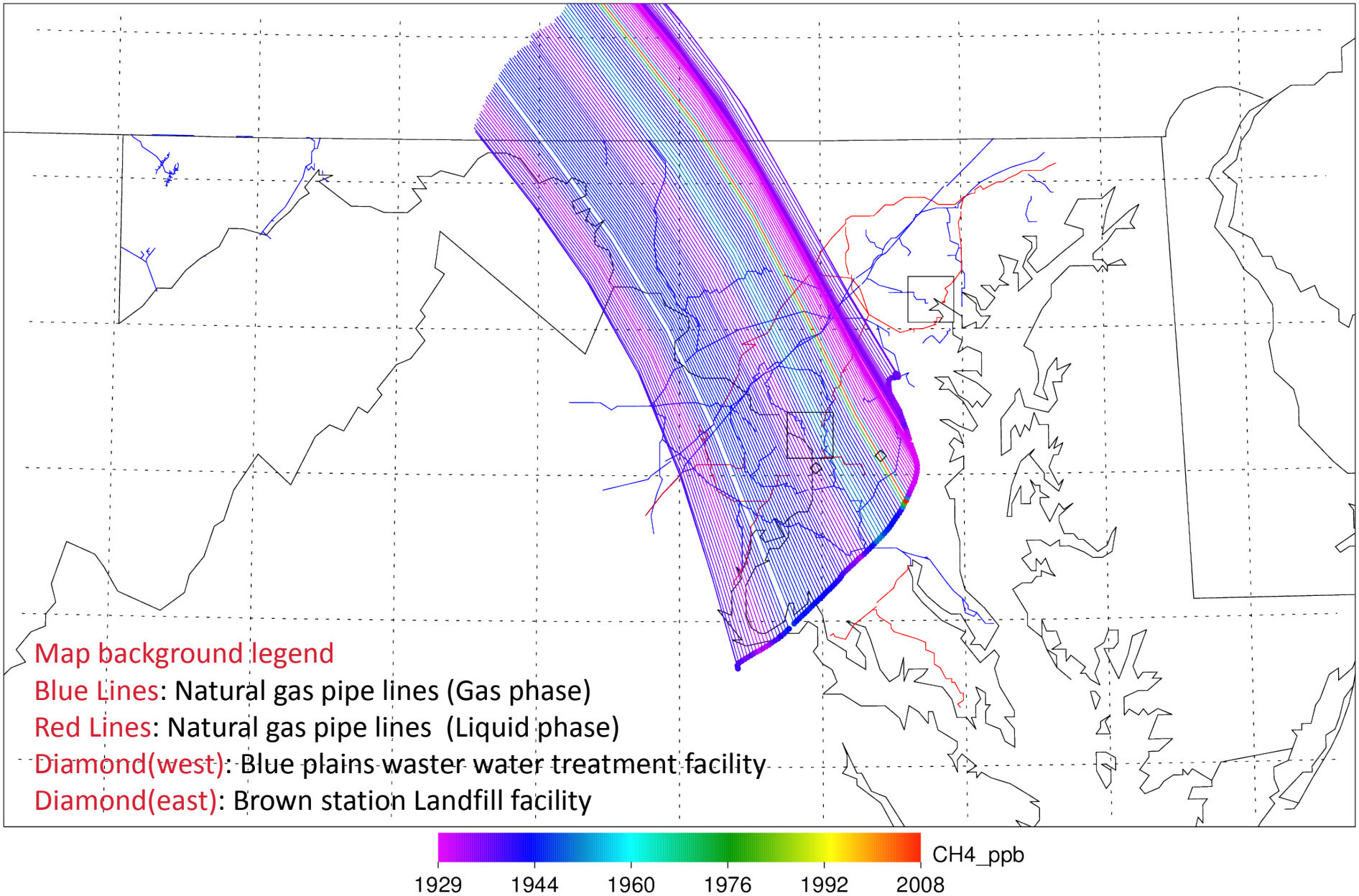
(-6 hours, every 15 seconds)



[Flight #6] Feb 23 2015

Back trajectory analysis (1)

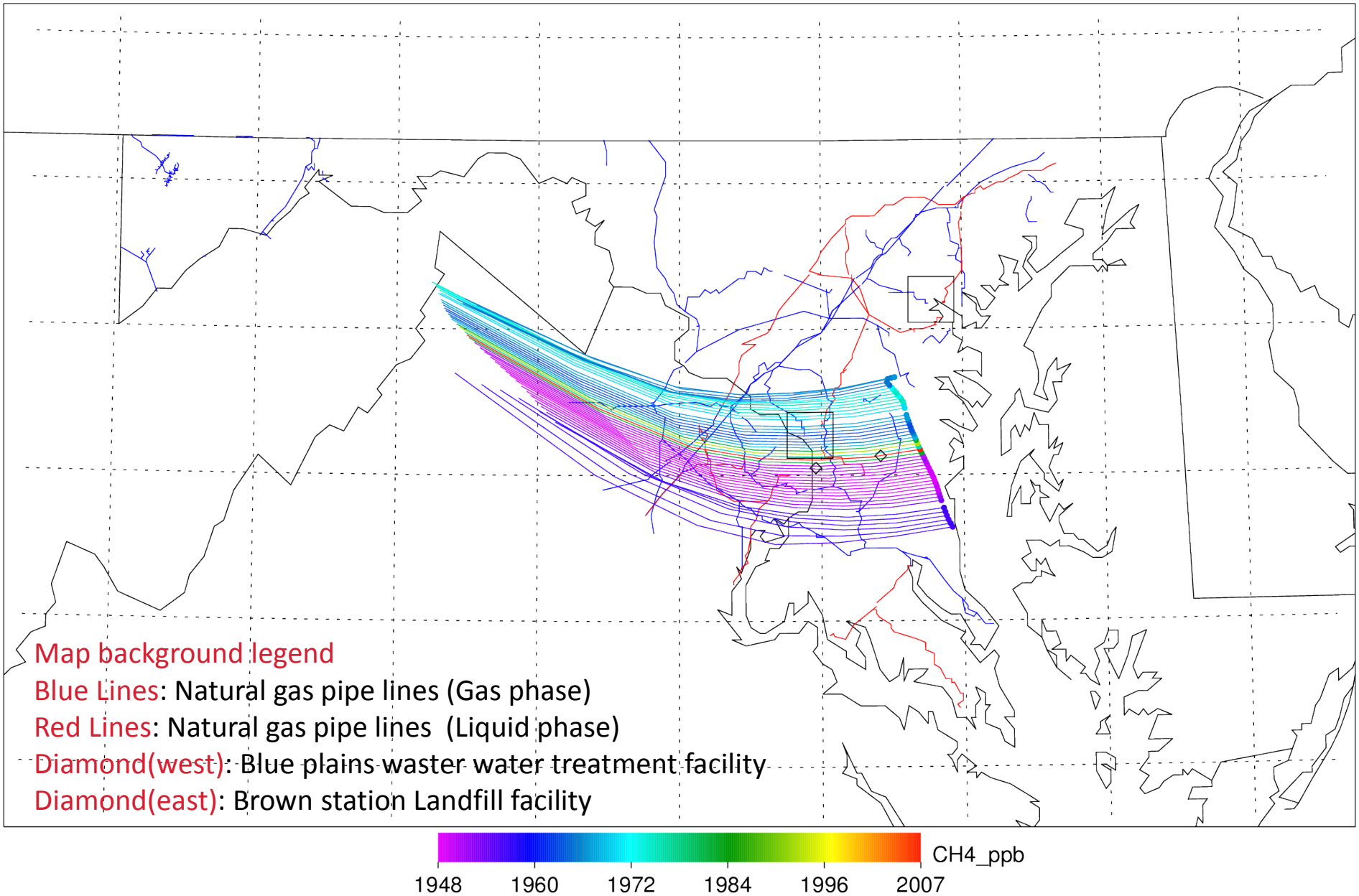
(-6 hours, every 15 seconds)



[Flight #8] Feb 25 2015

Back trajectory analysis (1)

(-6 hours, every 15 seconds)



Brown Station Landfill (Upper Marlboro, Prince George's County)

- Largest landfill in the state
- Processes most of its waste on site, rather than shipping it away
- Since 1987, Brown Station has been sending LFG to the nearby Prince George's County Correctional Facility to generate steam and electricity.

nature climate change

LETTERS

PUBLISHED ONLINE: 21 SEPTEMBER 2015 | DOI: 10.1038/NCLIMATE2804

Estimates of solid waste disposal rates and reduction targets for landfill gas emissions

Jon T. Powell[1]*, Timothy G. Townsend[2] and Julie B. Zimmerman[1,3]

Landfill disposal of municipal solid waste represents one of the largest anthropogenic global methane emission sources[1], and recent policy approaches have targeted significant reductions of these emissions to combat climate change in the US (ref. 2). The efficacy of active gas collection systems in the US was examined by analysing performance data, including fire occurrence, from more than 850 landfills. A generalized linear model showed that the operating status of a landfill—open and actively receiving waste or closed—was the most significant predictor of collection system performance. Gas collection systems at closed landfills were statistically significantly more efficient ($p < 0.001$) and on average 17 percentage points more efficient than those at open landfills, but open landfills were found to represent 91% of all landfill methane emissions. These results demonstrate the clear need to target open landfills to achieve significant near-term methane emission reductions. This observation is underscored by landfill disposal rates in the US significantly exceeding previously reported national estimates, with this study reporting 262 million tonnes in the year 2012 compared with 122 million tonnes in 2012 as estimated by the US Environmental Protection Agency[3].

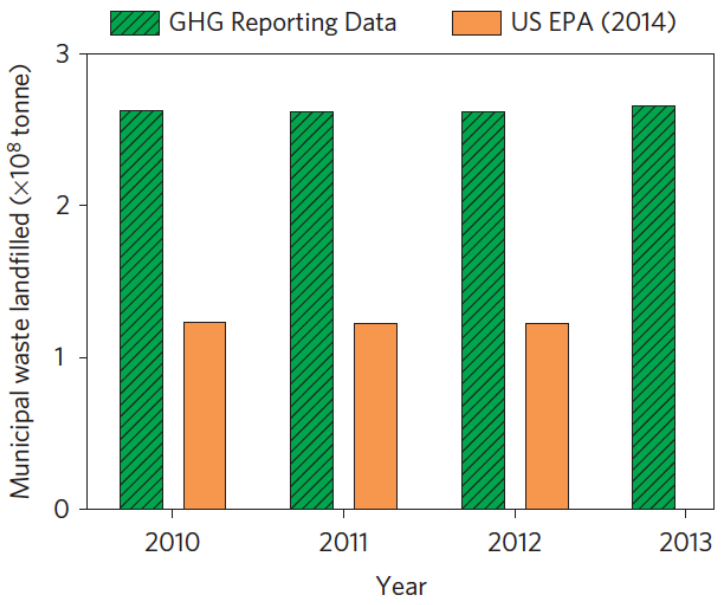


Figure 1 | Quantity of municipal solid waste disposed of in US landfills. This study calculated the 'GHG Reporting Data' columns. Reported US EPA (2014) data[3] were calculated using a materials flow analysis approach that calculates the disposal quantity on the basis of US census data and waste factors for industrial activity. US EPA data for the year 2013 were not available.

HYSPLIT

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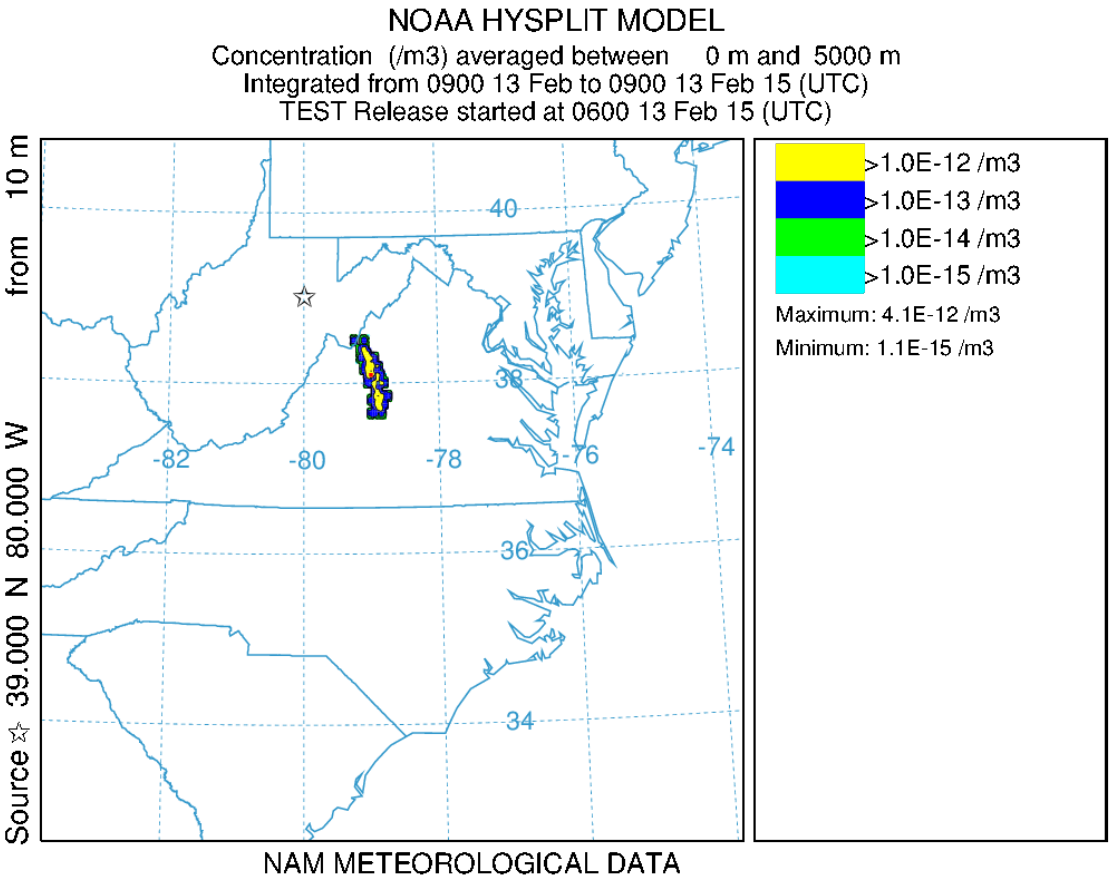
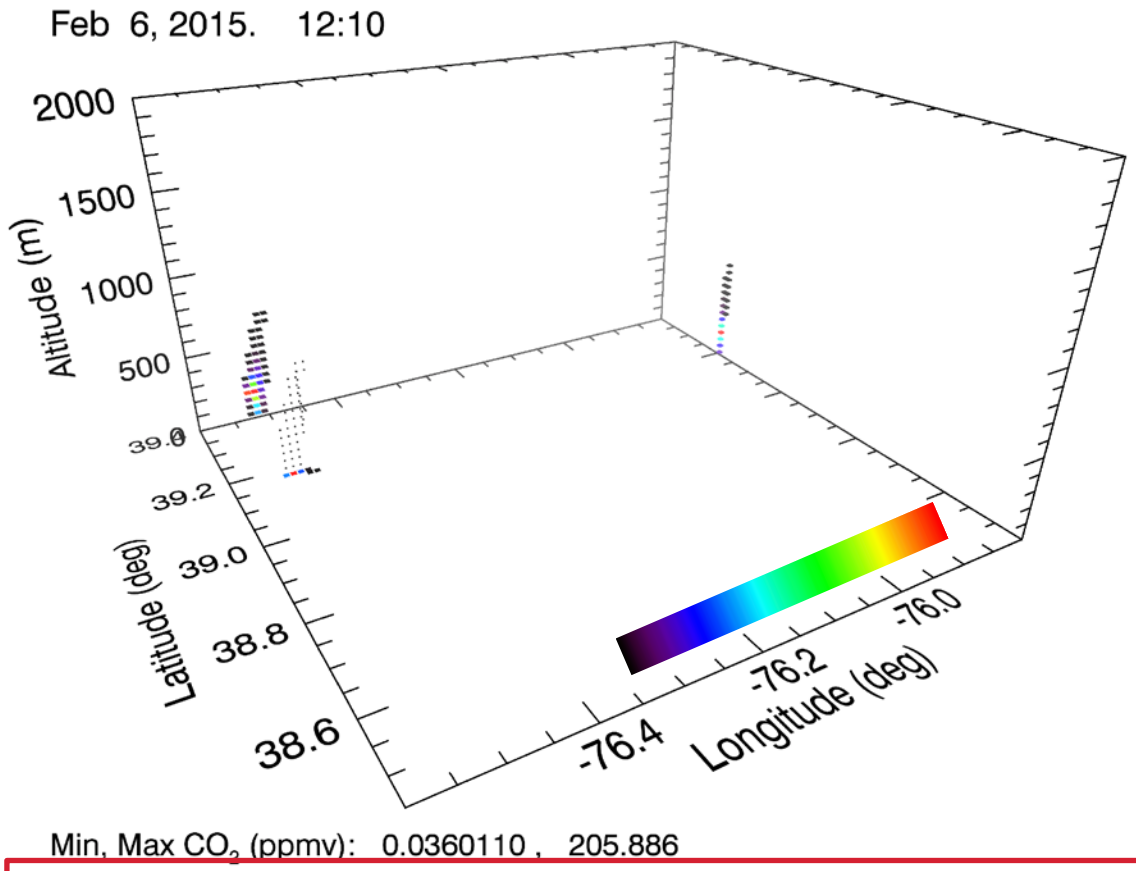
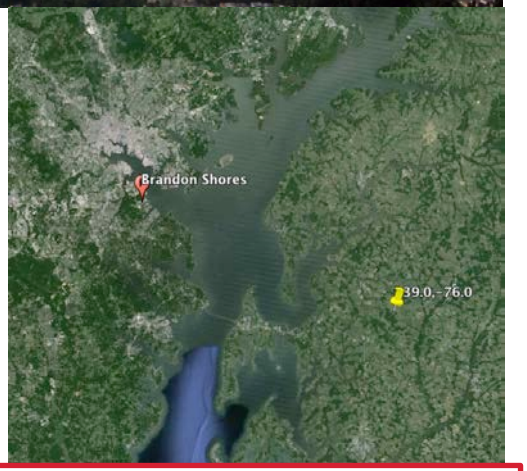
HYSPLIT Particle dispersion analysis

Top-down view



Three-dimensional view





Emission location: Brandon Shores Power Plant (Lat: 40.0' Lon: -79.0' Alt: 120 m)
Emission duration: 1 hr (contiuous)
Emission amount: 100000 particles, (302,600 Kg of CO_2)
Animation: 2 hrs (Every 10 min)

Meteorological dataset: Feb 06, Nam 12
Spatial resolution: 12 km
Temporal resolution: 3hrs
Vertical levels: 27
(1000 hpa, 975 hpa, 950 hpa, … , 100 hpa)

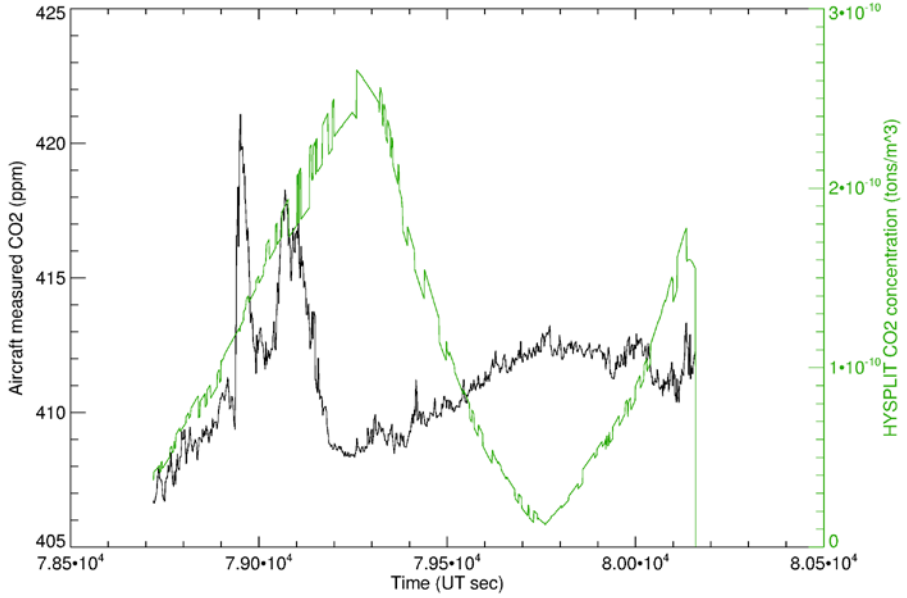
*** Kg/m3 (HYSPLIT Default) to ppmv conversion**

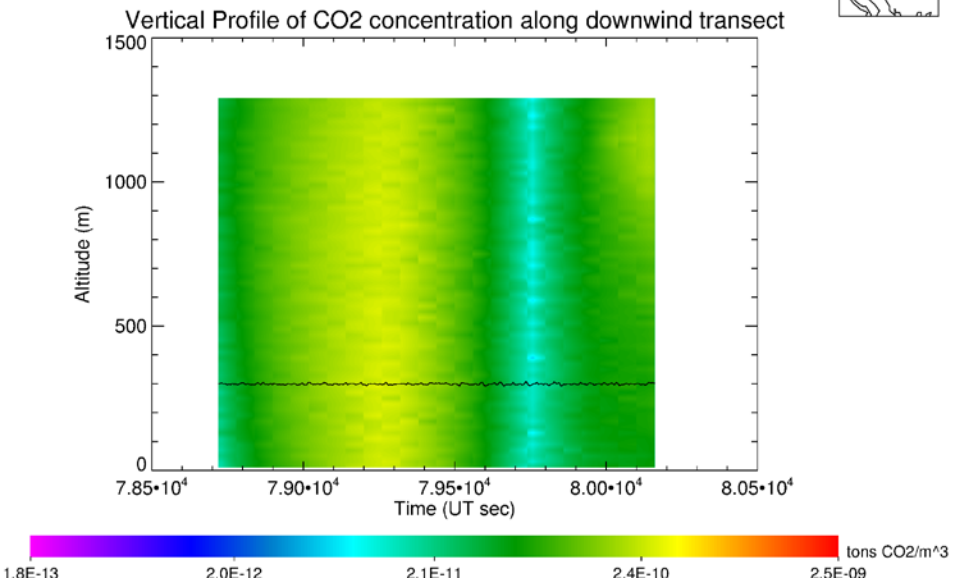
$$CO_2 \text{ ppmv} = \frac{CO_2 \text{ kg/m3}}{\text{Air density kg/m3}} \times \frac{28.9644 \text{ g/mole}}{44.01 \text{ g/mole}}$$

HYSPLIT Particle dispersion analysis

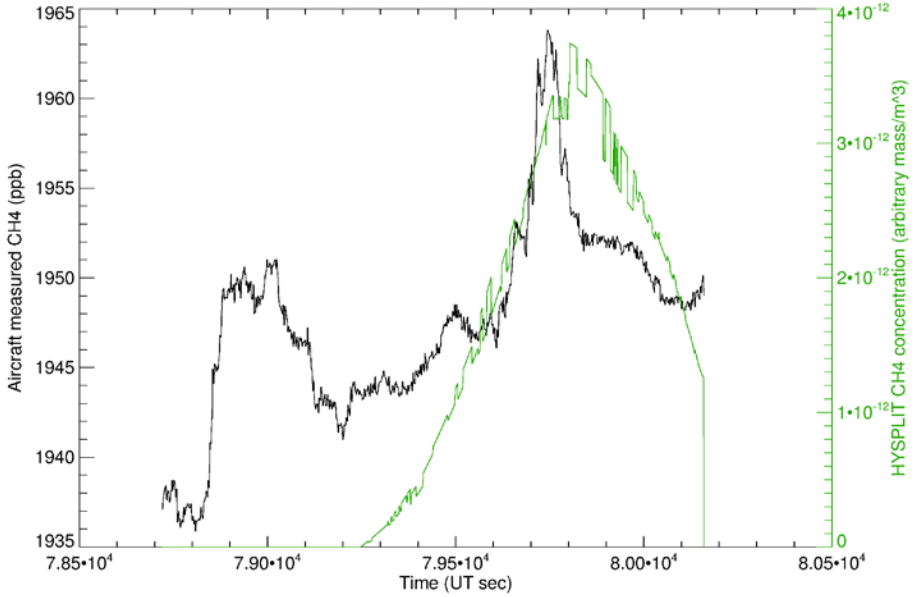
Contribution from major power plants and Landfill

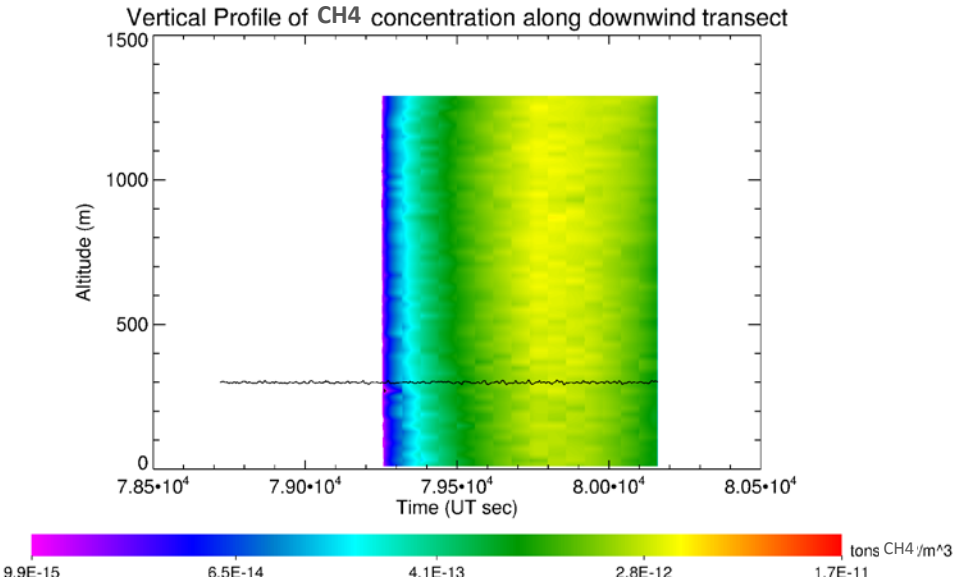
CO2





CH4





HYSPLIT

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Future Plans

- **Particle dispersion Analysis**
  - **Adopting higher resolution meteorological data (WRF)**
  - **Optimization of Input parameters embedded in HYSPLIT model**
    - **Vertical motion method**
    - **Combining Puff release mode and associated parameters (STILT)**
    - **Particle numbers / Grid spacing**
  - **Reducing uncertainties on the quantification of greenhouse gas fluxes**

  - **Further quantitative analysis on GHG emissions from possible point/area sources**
    - **Landfill facilities**
    - **Cement facilities**
    - **Auto mobiles (GIS Traffic count data from Dept. Transportation, MD)**
    - **Natural gas pipe lines, Etc.**