East Coast Outflow

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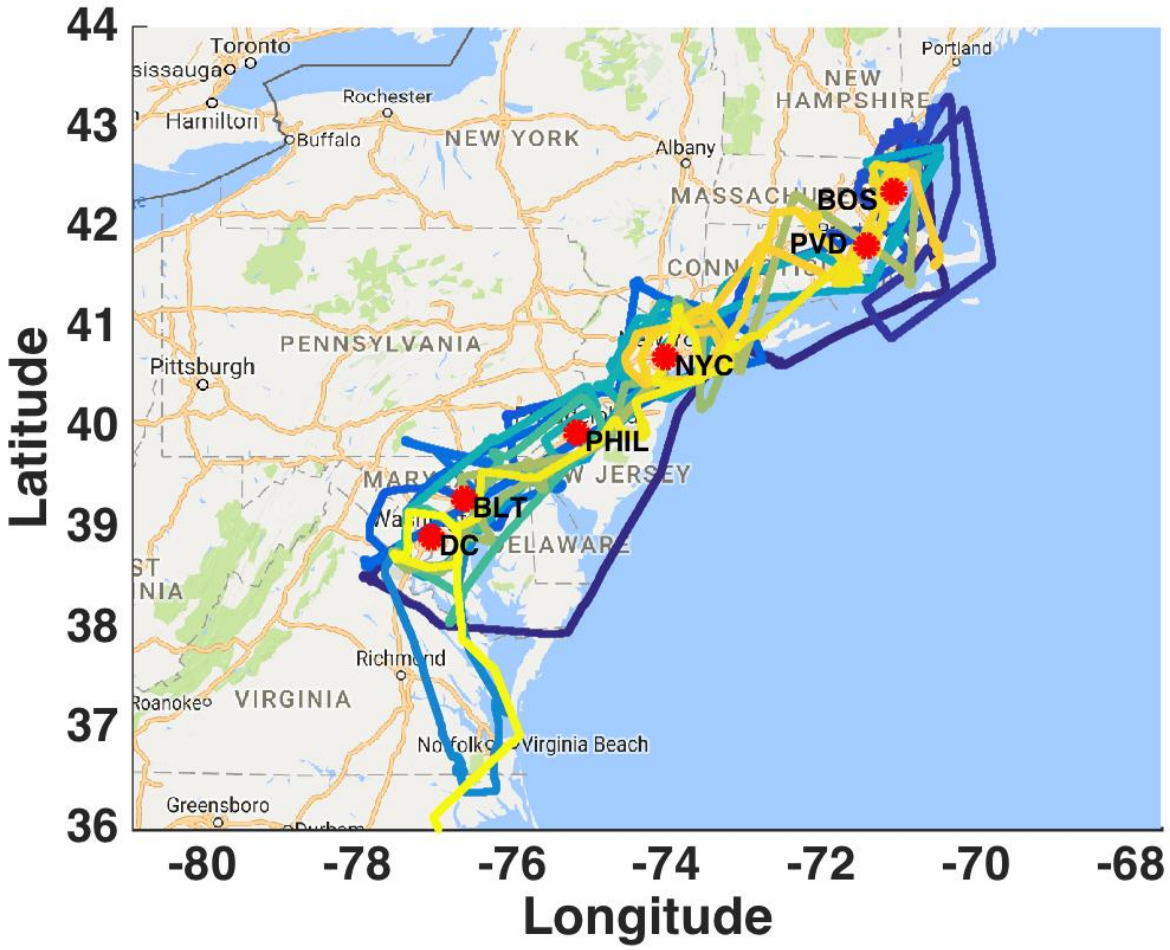
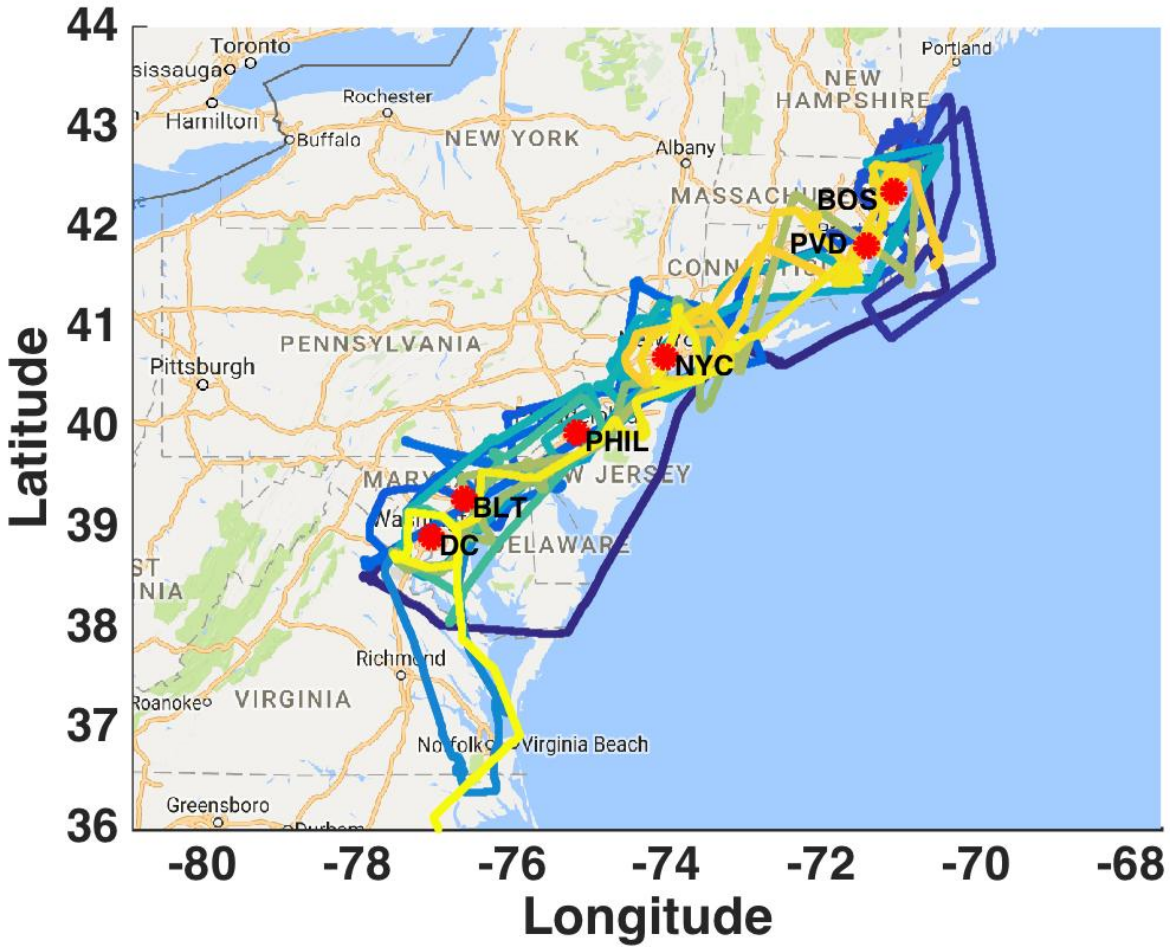
ECO Flights



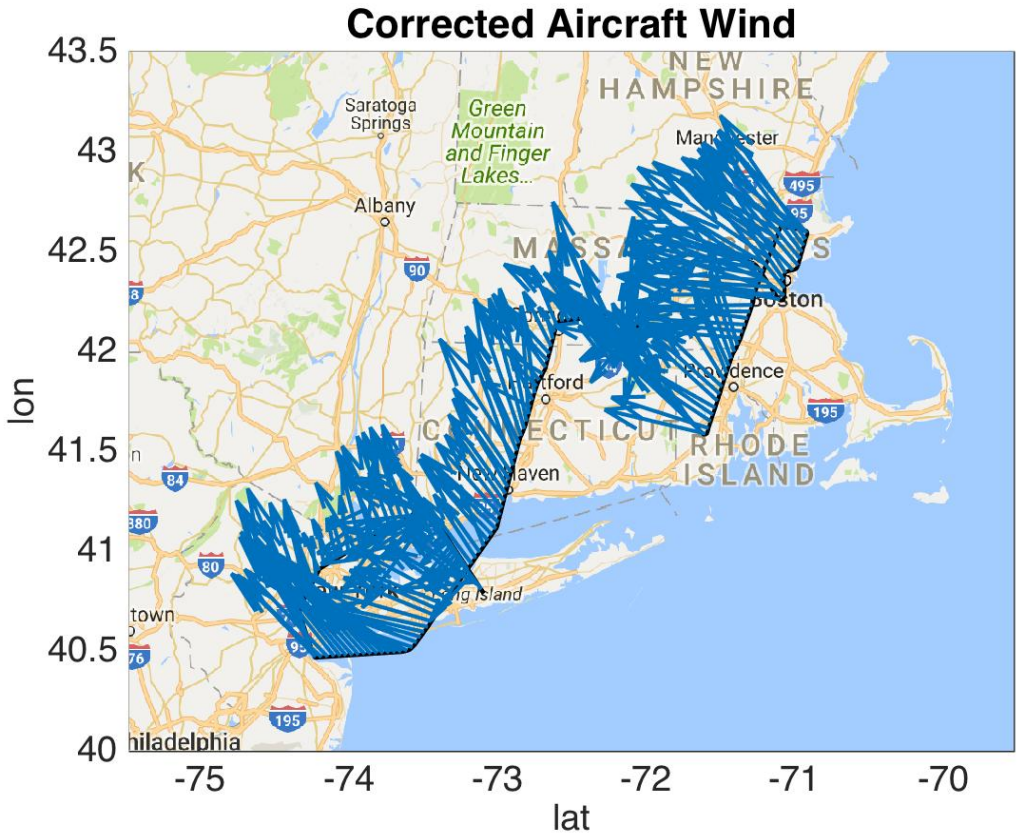
- 120 Flight hours
- 20 Research flights
- Insitu measurements:
  - Picarro $CO_2/CH_4/CO/H_2O$
  - Aerodyne Ethane
  - Winds (probe, differential)
  - Rosemount Temperature
  - Vaisala RH
- Flasks (20)
  - `> 55 trace gas species
  - C14

ECO Flights

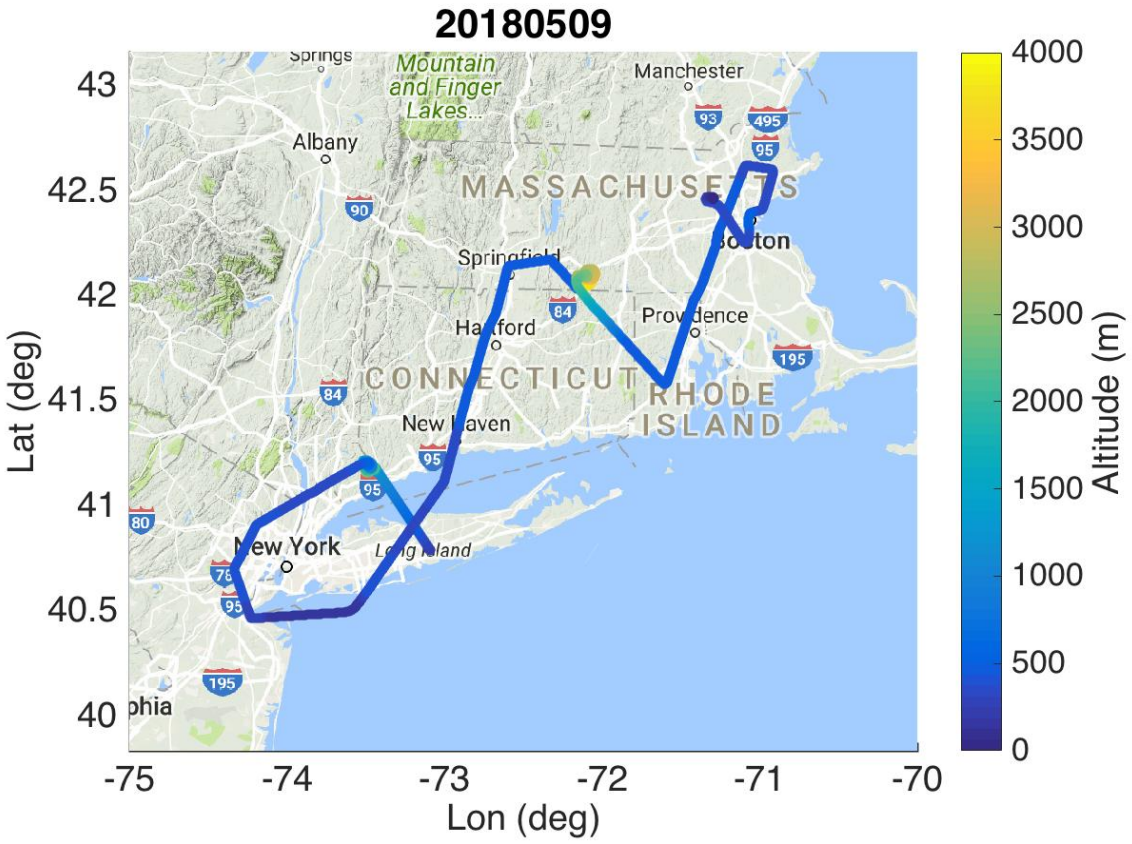


- **50% of the population are living in cities**
- **65% of the population will be living in cities by 2050**
- **70% of the anthropogenic emissions come from cites**

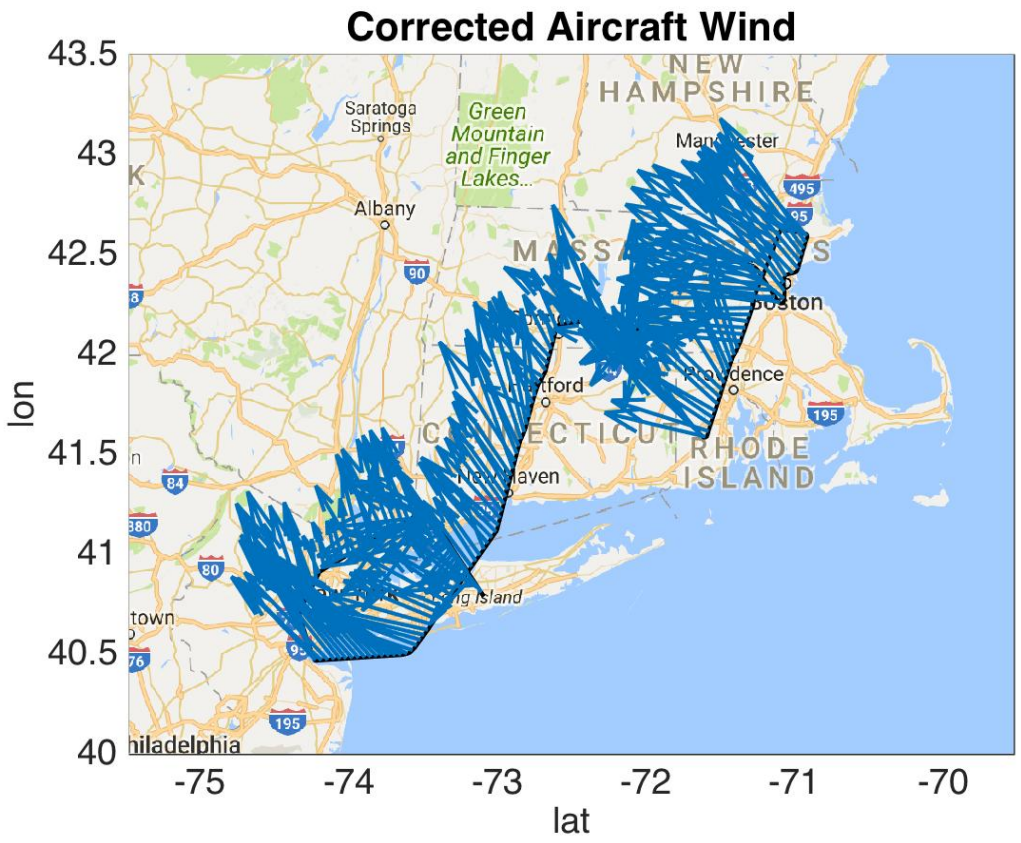
Typical Flight

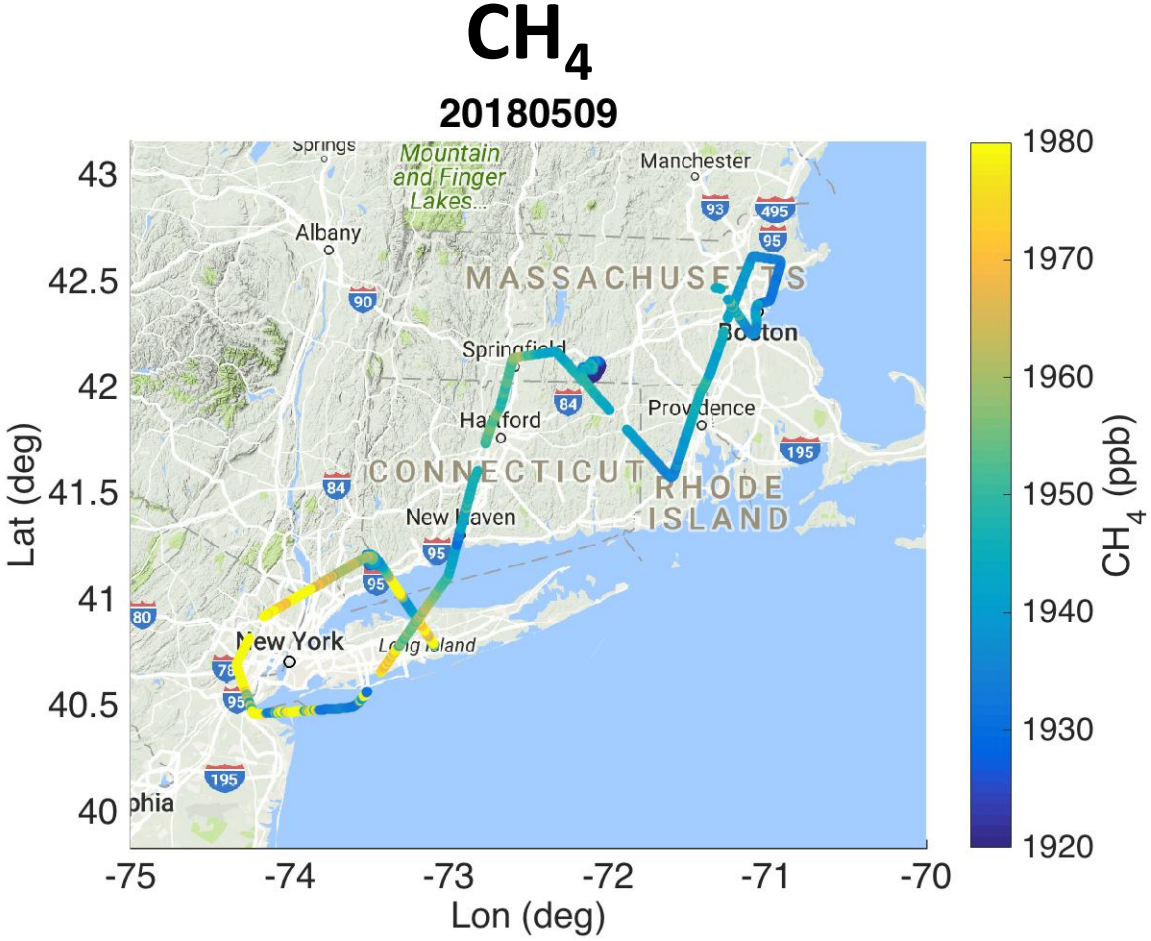


Altitude

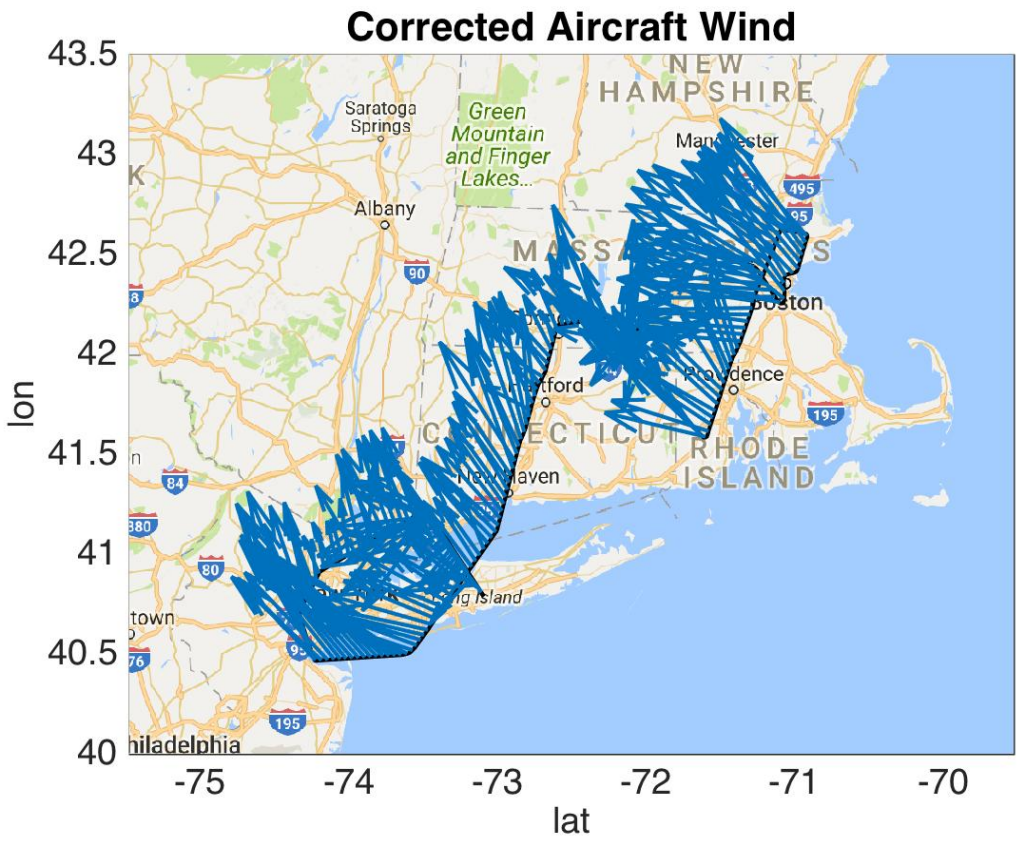


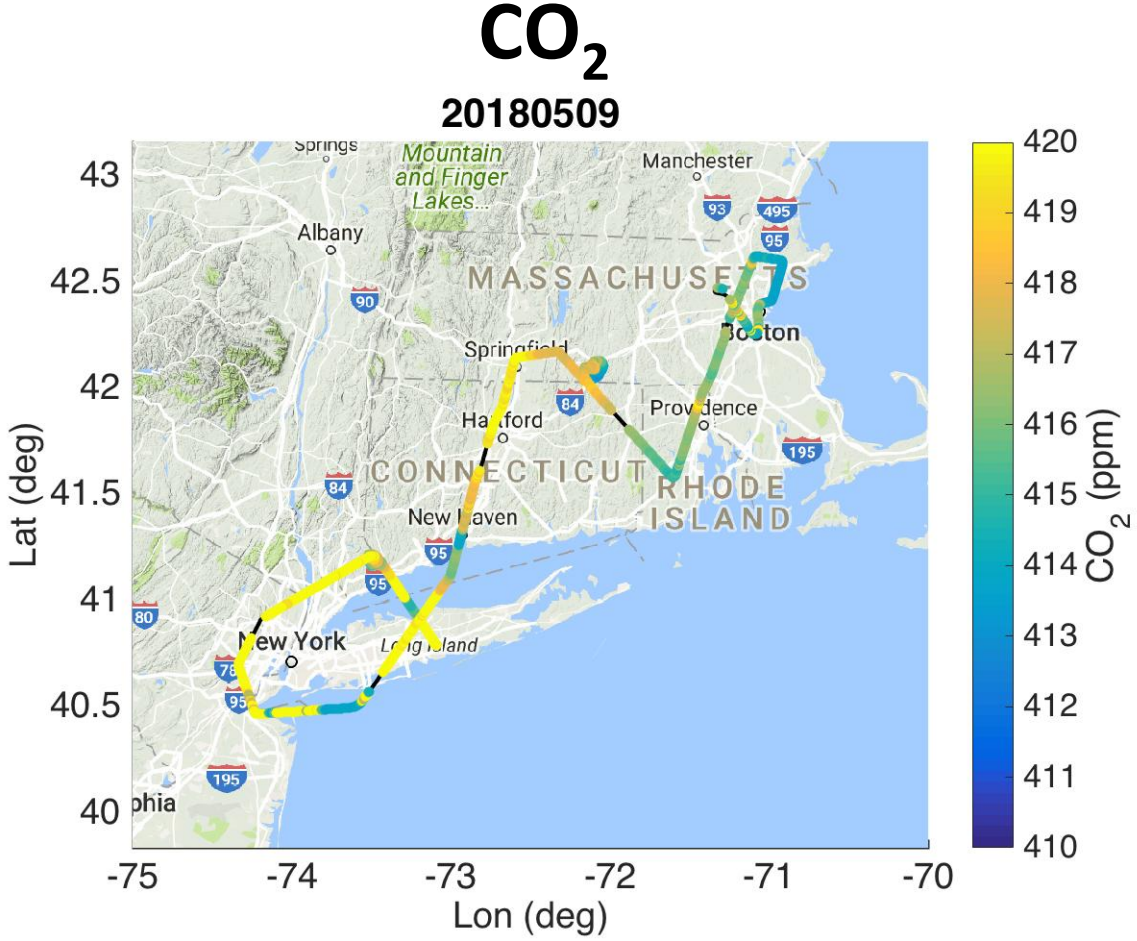
Typical Flight



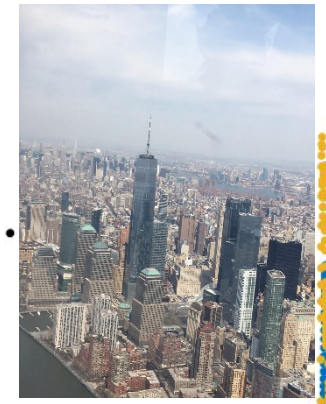


Typical Flight

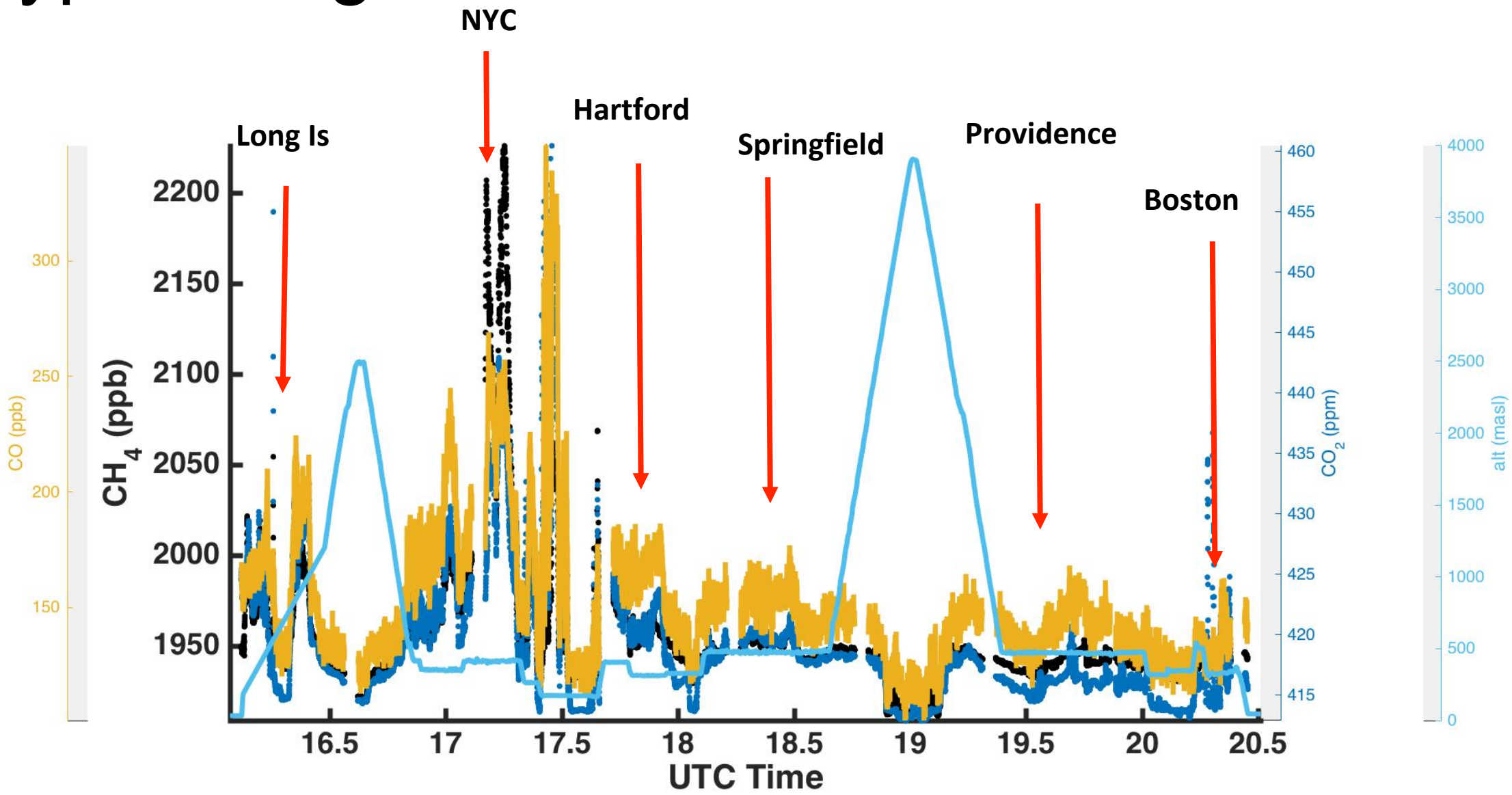




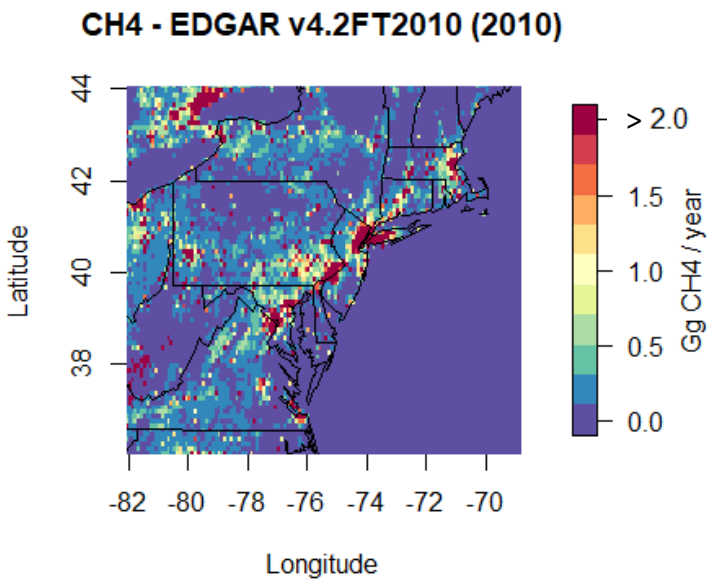
Typical Flight

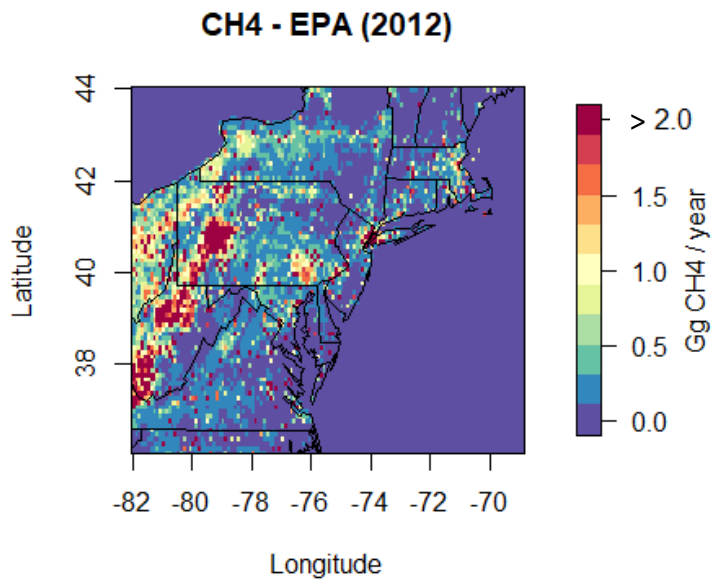


Typical Flight

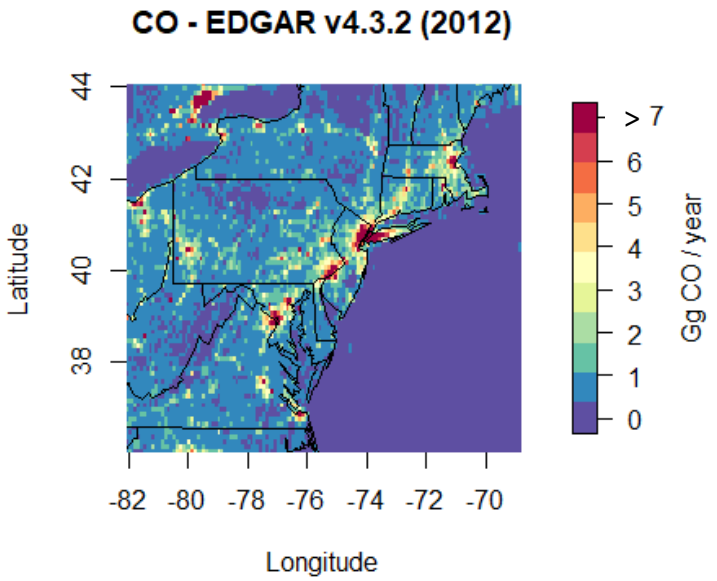


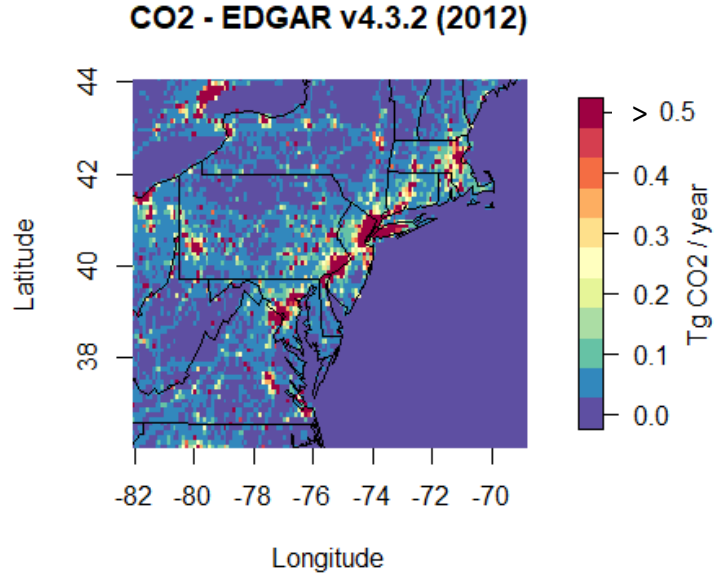
Anthropogenic emissions estimates





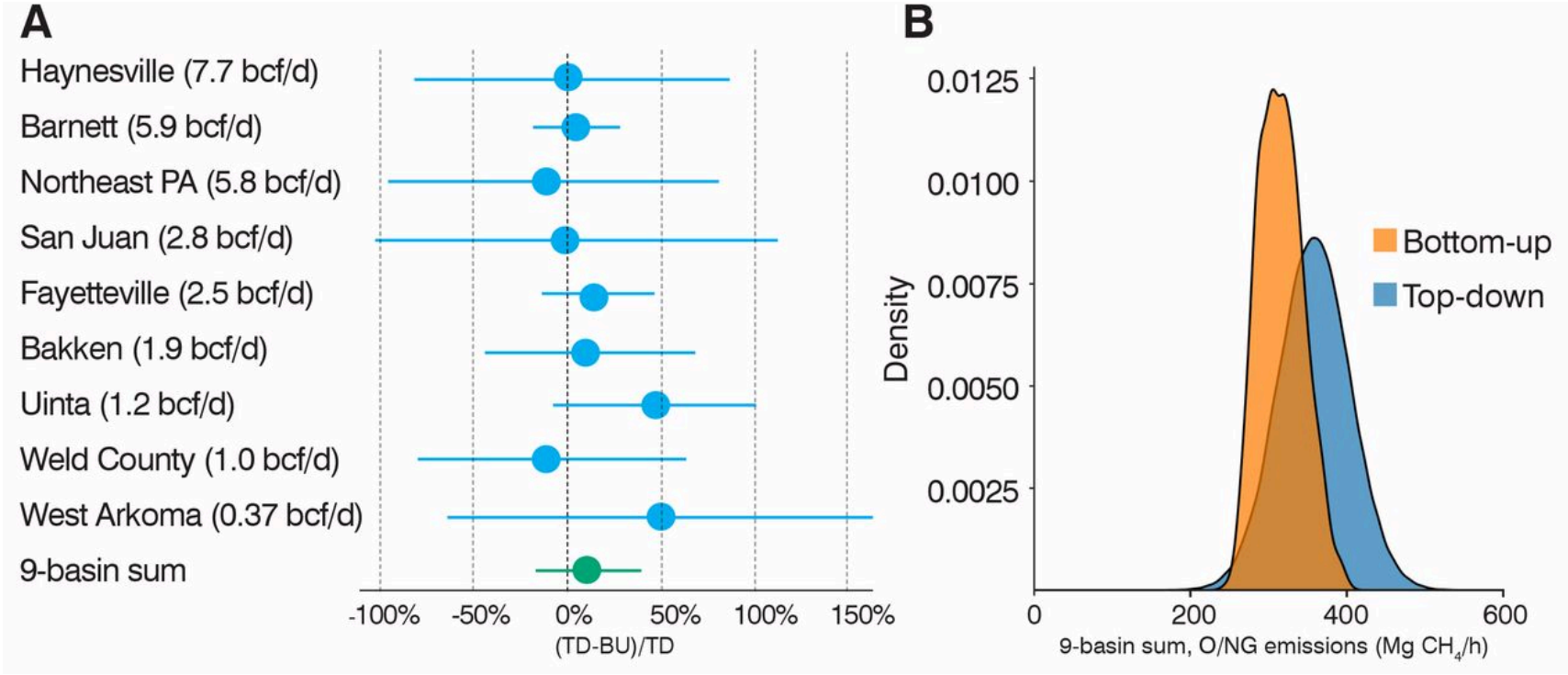
Recent emissions of CH4 for EDGARv4.3 2012 and EPA show a significant shift of emissions out of cities and into the major production areas for oil and gas.





Question: Can we use enhancements in CH_4/CO2 and CH4/CO to understand whether whether this readjustment in CH4 sources is justified

Methane emissions

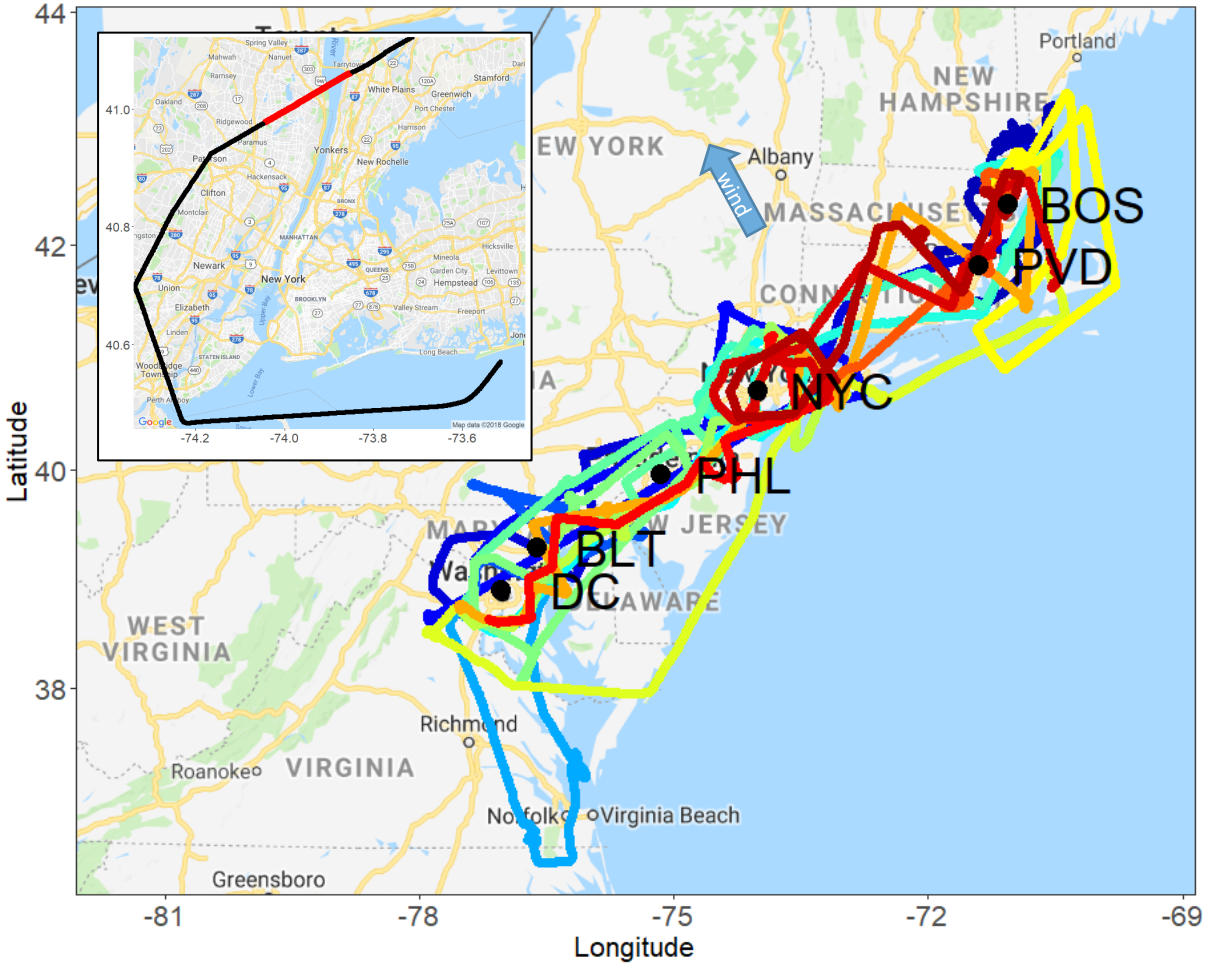


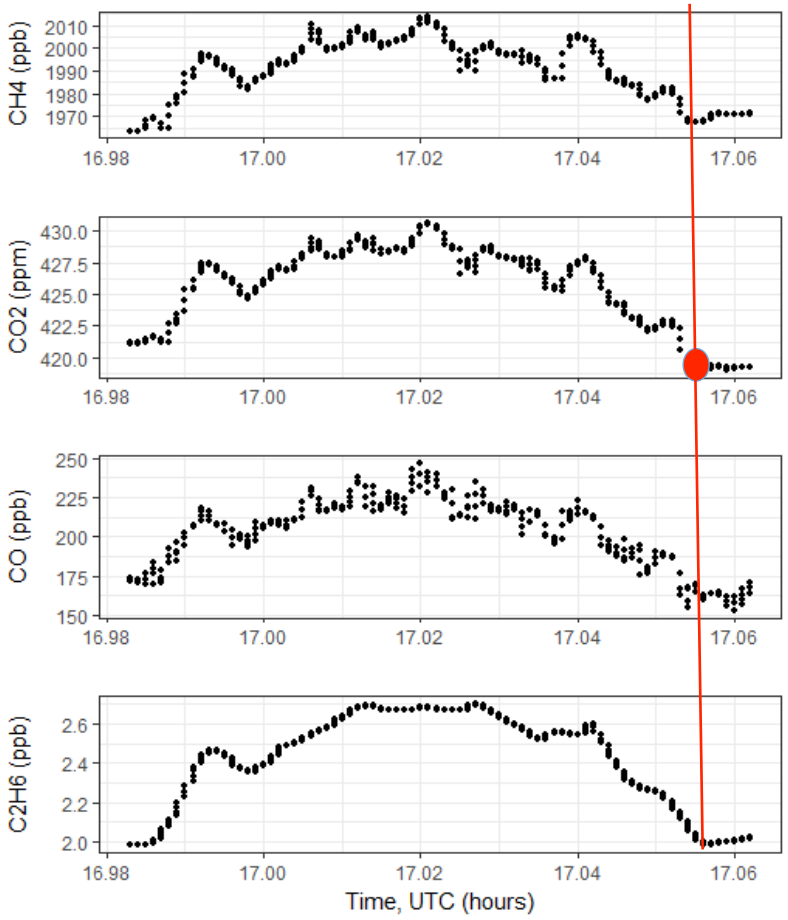
Alvarez et al., 2018

Production and distribution emission = 13Tg/yr (2.3% of production)

Urban Enhancements

- Local minima in CO2 from each region are used to calculate the enhancements of all gases





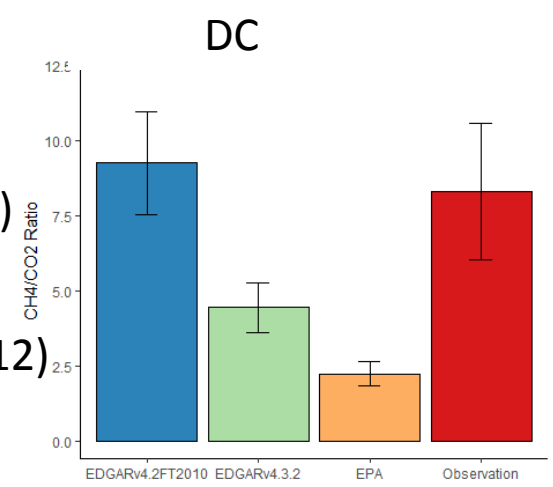
ΔCH4/ΔCO2 Emissions Ratios

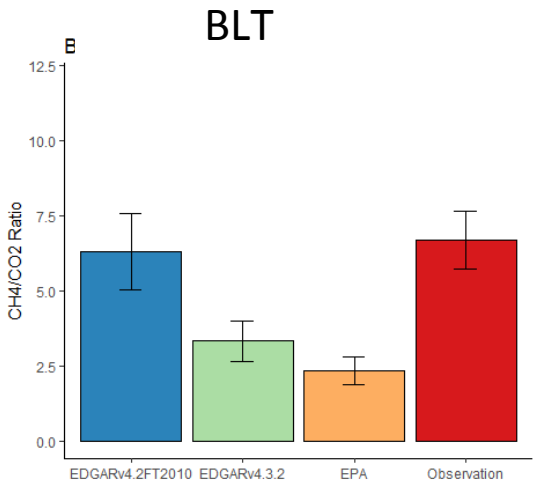
EDGARv4.2 (2010)

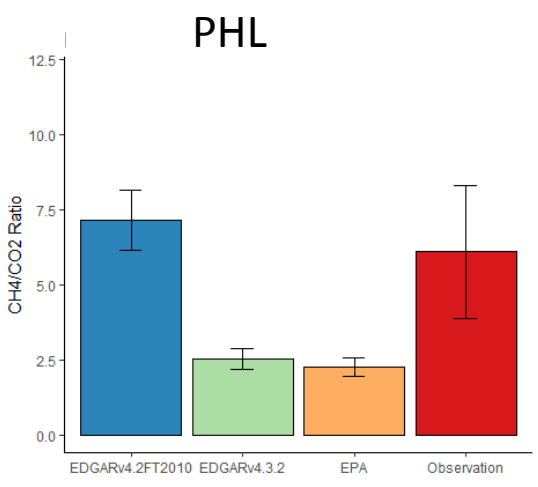
EDGARv4.3.2 (2012)

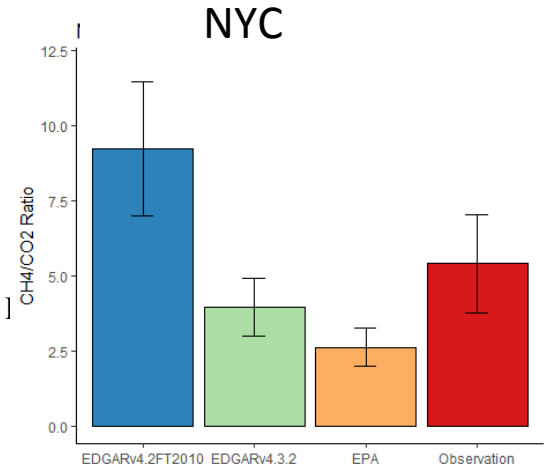
EPA (2012)

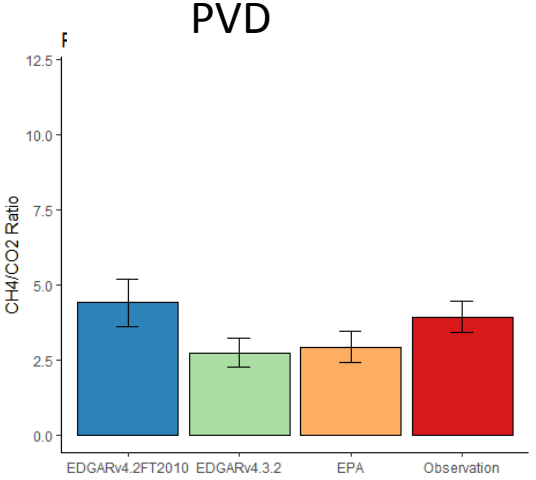
Observations

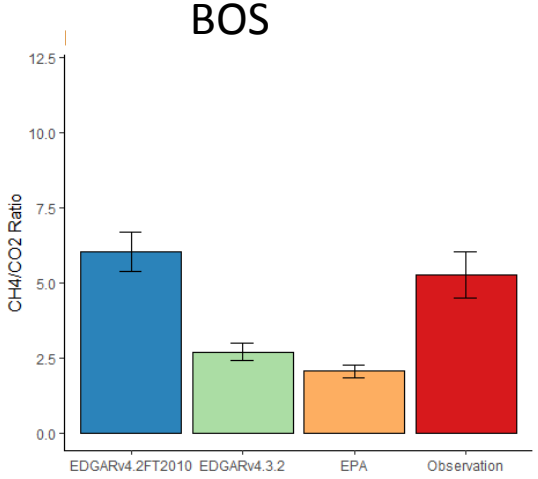




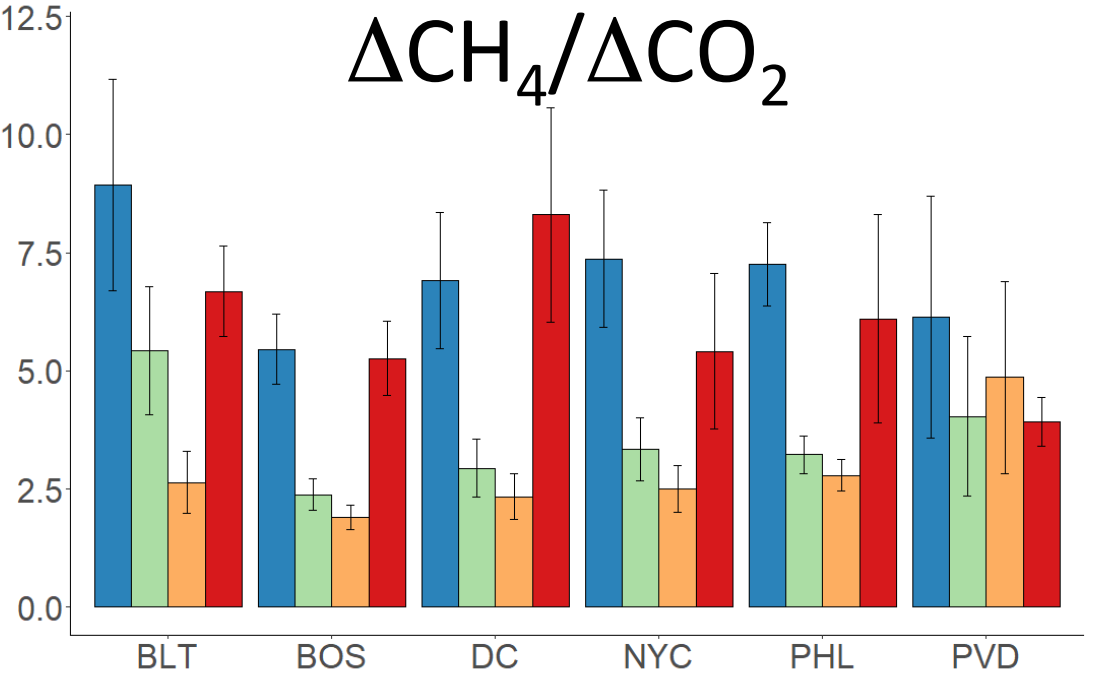


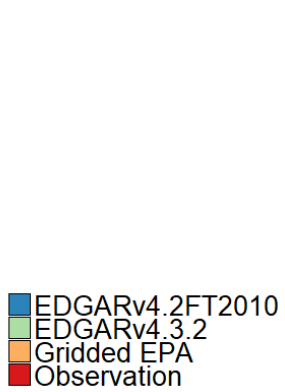


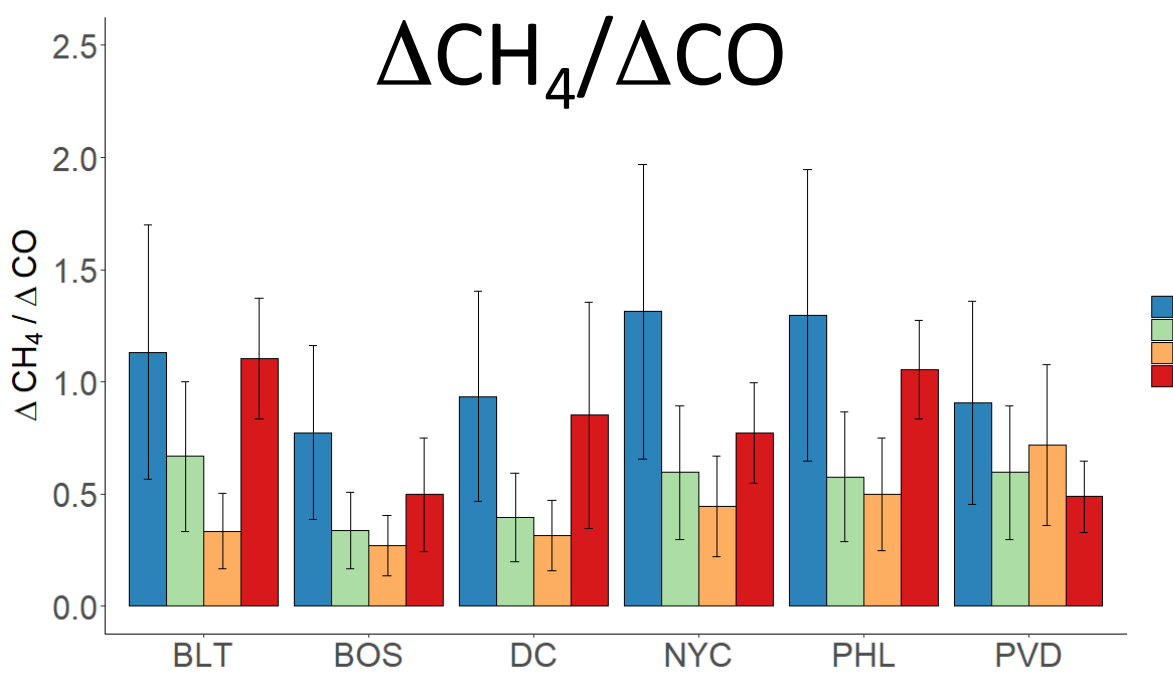




$\Delta CH_4/\Delta CO_2$ verses $\Delta CH_4/\Delta CO$



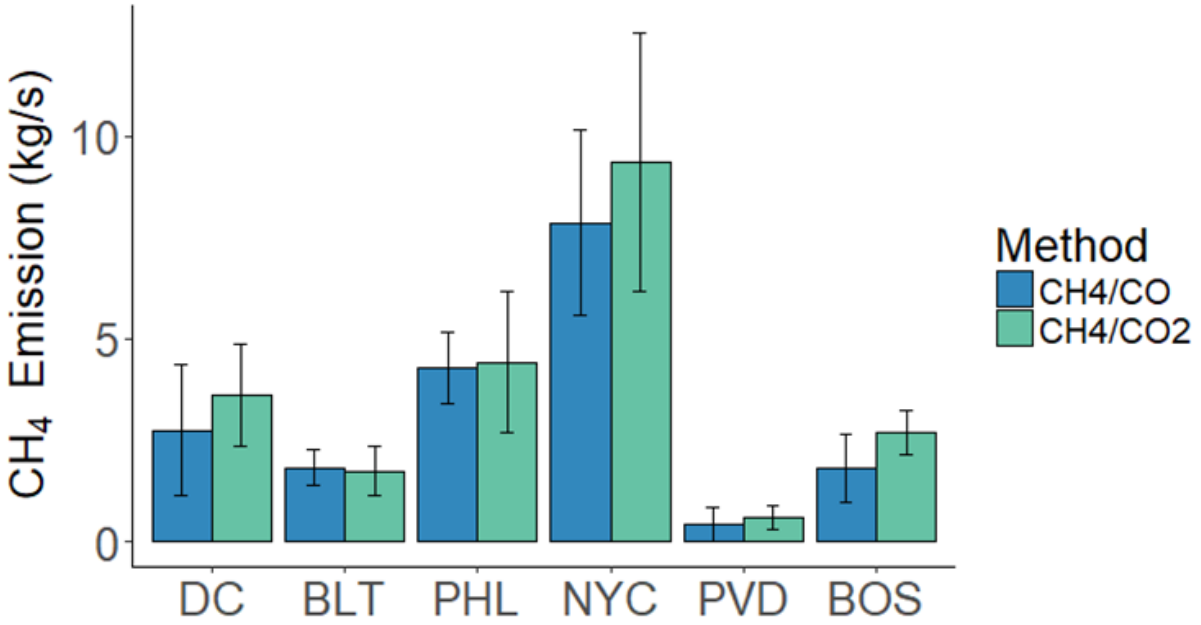


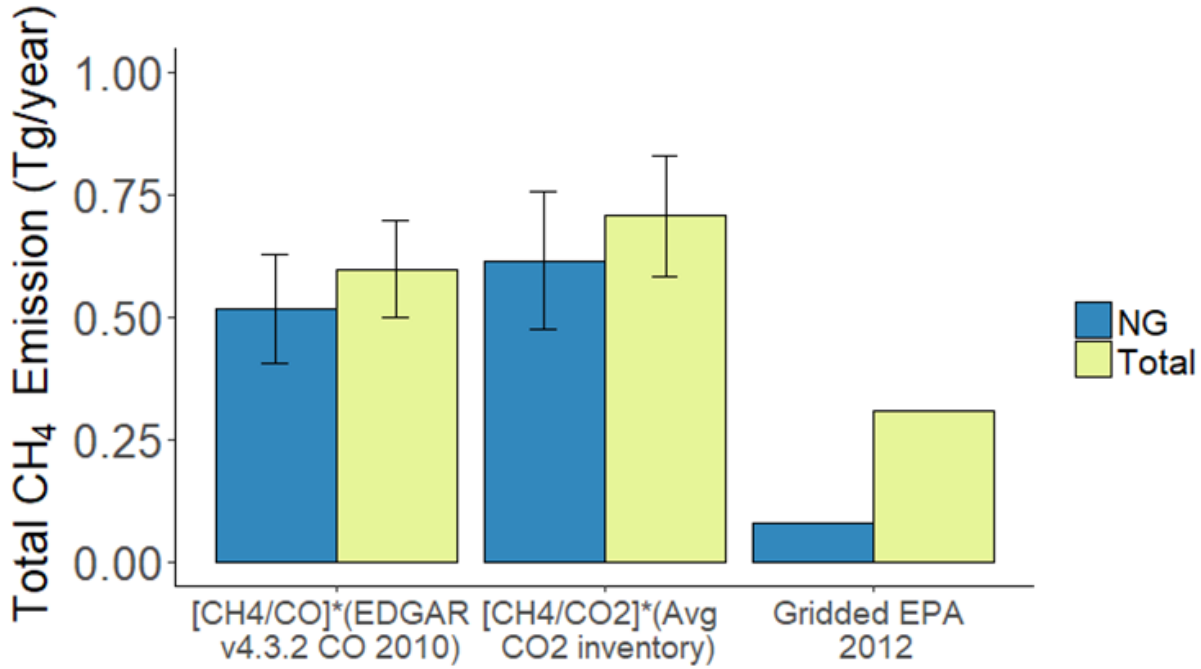


Consistent relationships between $\Delta CH_4/\Delta CO_2$ and $\Delta CH_4/\Delta CO$

Estimated CH_4 emissions

- New EPA inventory might be off by an order of magnitude for urban CH_4 emissions





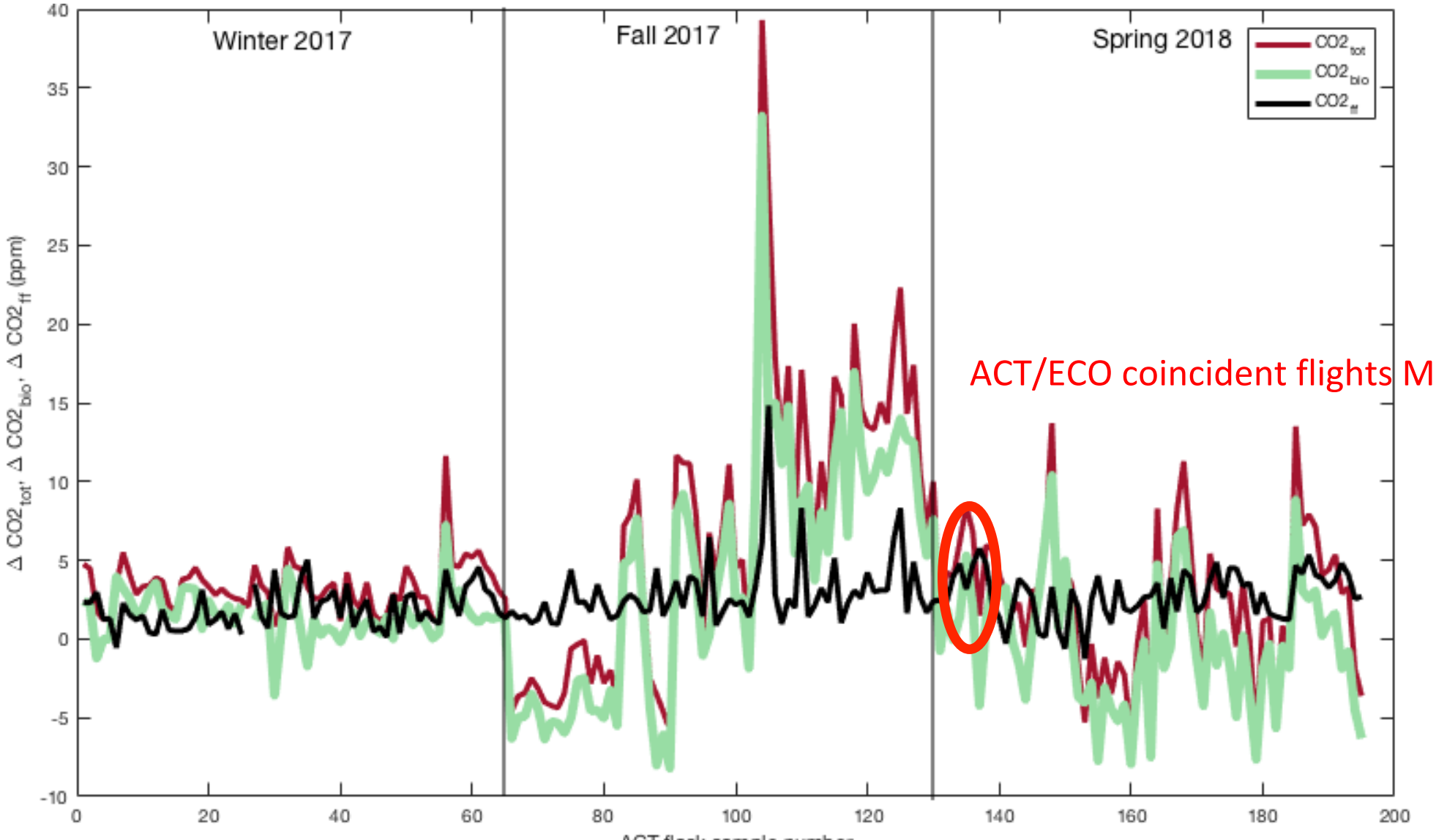
$$CH_4 emissions = CO_{2inventory(avg)} \frac{CH_{4obs}}{CO_{2obs}}$$

$$CH_4 emissions = CO_{inventory(EDGARv4.3.2)} \frac{CH_{4obs}}{CO_{obs}}$$

Natural gas

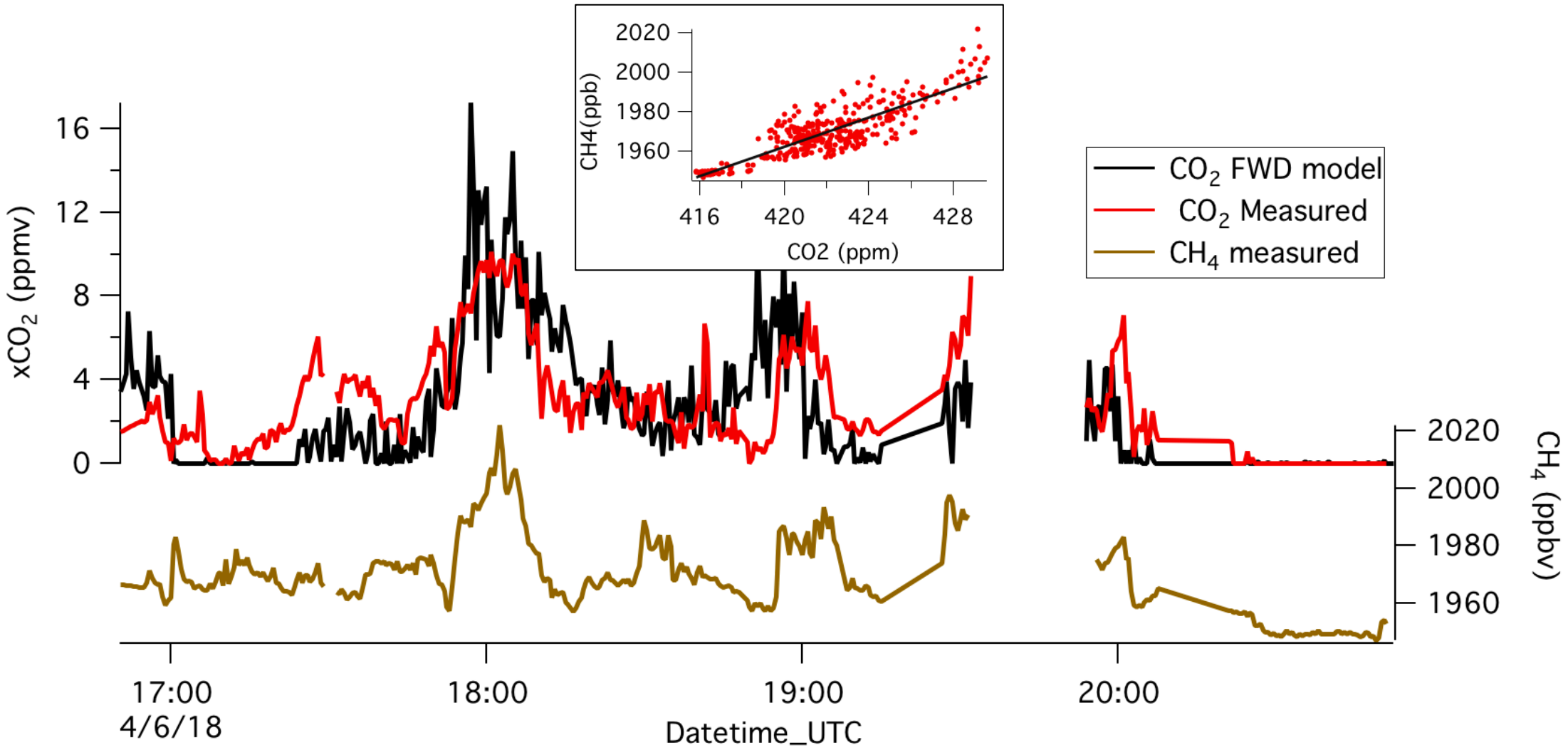
Total CH_4 emissions

Validity of CO2 fossil fuel estimate

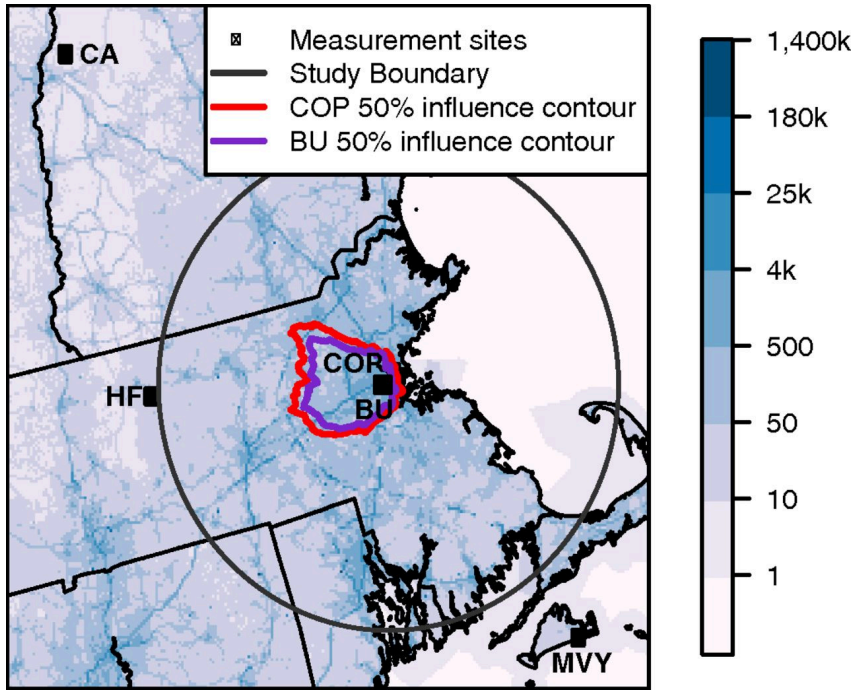


ACT/ECO coincident flights May 8/9, 2018

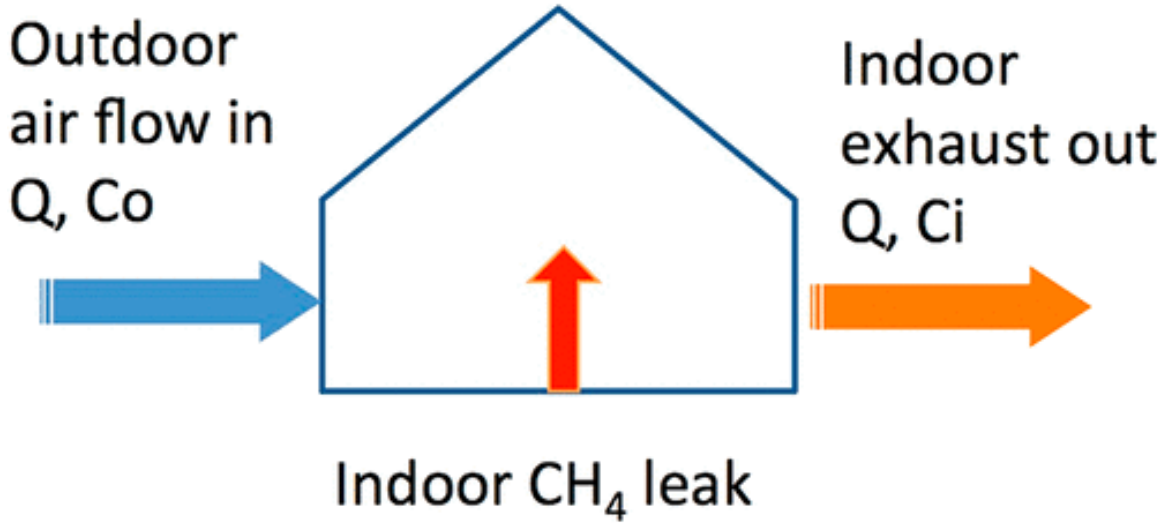
Modeled (ACES-STILT) vs Measured [20180406]



Supporting studies:



K.M McKain et al (2018).
- CH4 emissions from Boston are more than 2x inventory estimates



M.L. Fischer et al (2018).
- Leak rate for appliances if off by an order of magnitude

Conclusions:

- New EPA and EDGAR CH4 emissions maps show significant change in amount of emissions coming from urban areas.
- Emissions ratios are more consistent with older inventories which had proportionally more emissions in urban regions than in production regions.
- Suggests that current inventories might need almost an order of magnitude increase in natural gas CH_4 emissions for urban areas.