Partitioning of urban CO_2ff emissions by source sector: Results from the INFLUX project

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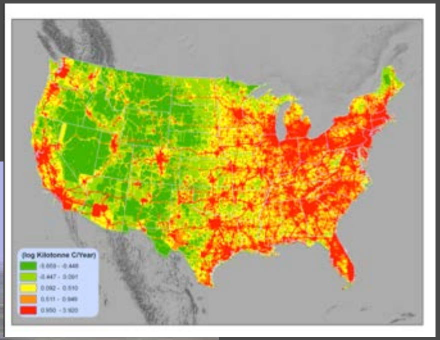
INFLUX: Indianapolis Flux Project

Develop and test techniques/approaches for measurement of urban-scale greenhouse gas emission fluxes and to quantify uncertainties

Aircraft-based measurements



Bottom-up inventories

Tower-based measurements

FTS

Driving tours

Data analysis and modeling

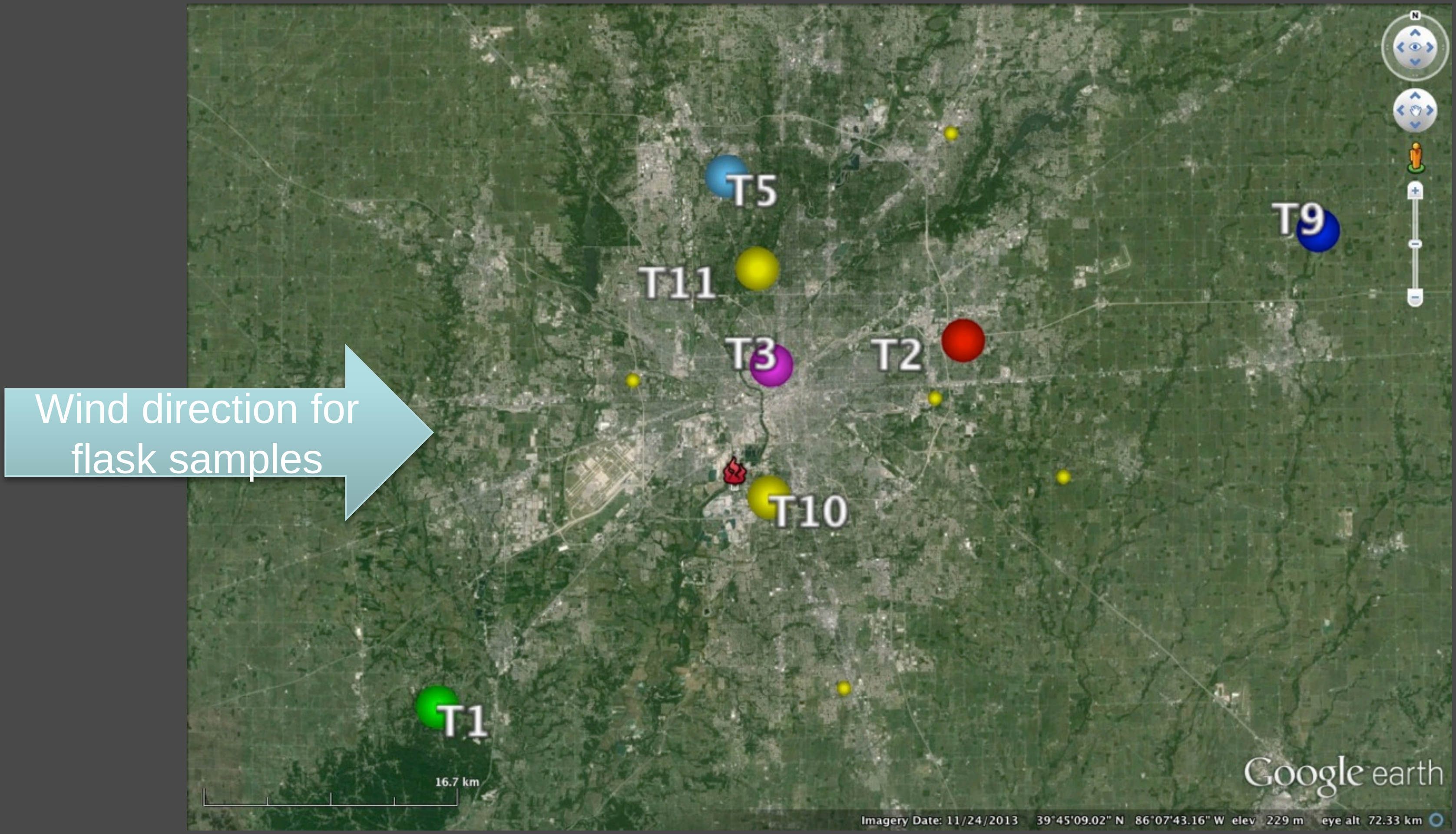
Outline of this talk

- **Tower flask and in situ sampling strategy**

- **δCO_2 as a wintertime proxy for δCO_2ff**

- **Partitioning CO_2ff source sectors using CO emission ratios (R_{CO})**
  - R_{CO} for each source sector
  - Diurnal variability in observed and bottom-up total R_{CO}

Tower Flask Sampling Strategy



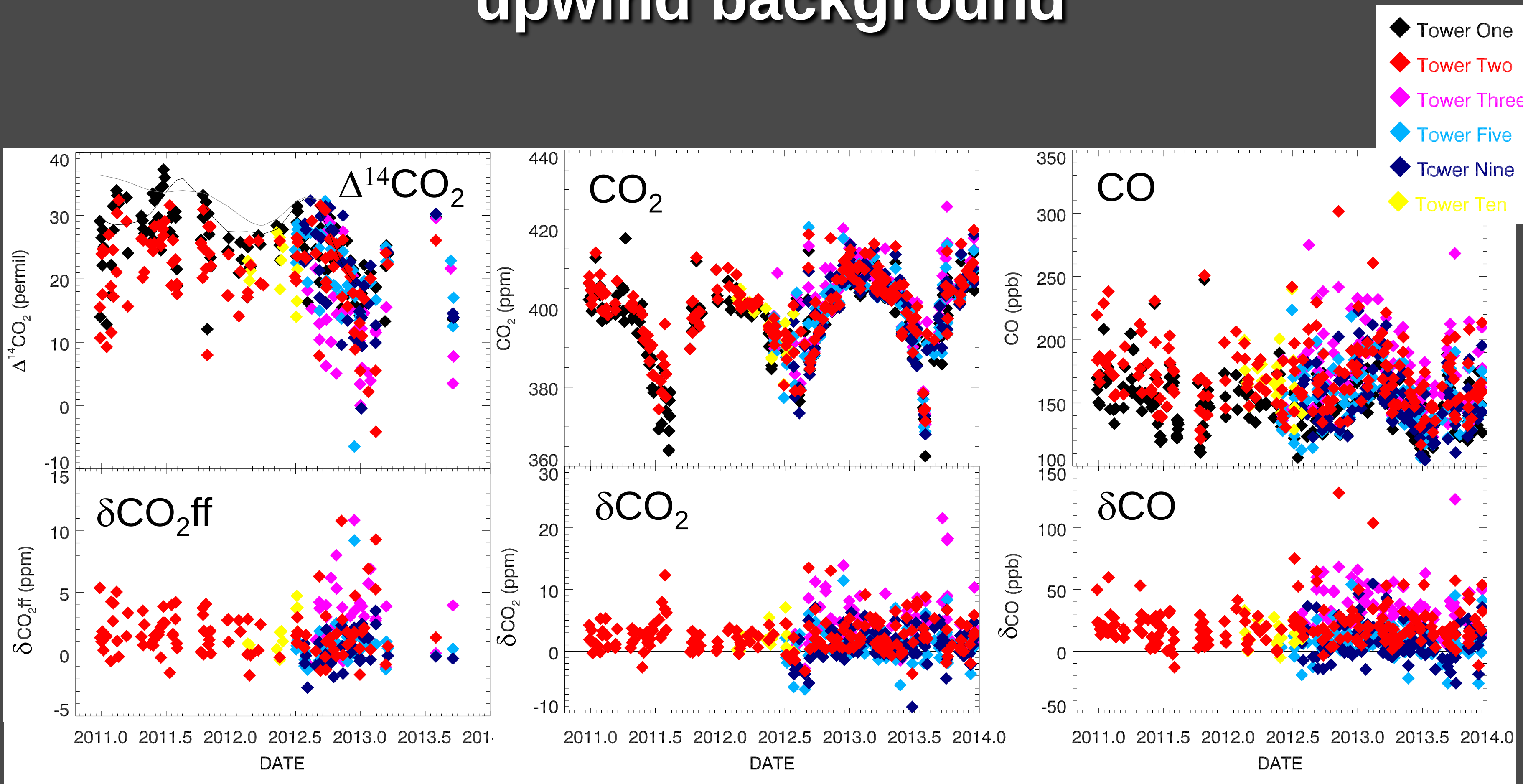
Instrumented towers, 75-150m high

Continuous in situ CO_2/CH_4/CO

Mid-afternoon conditional flask sampling

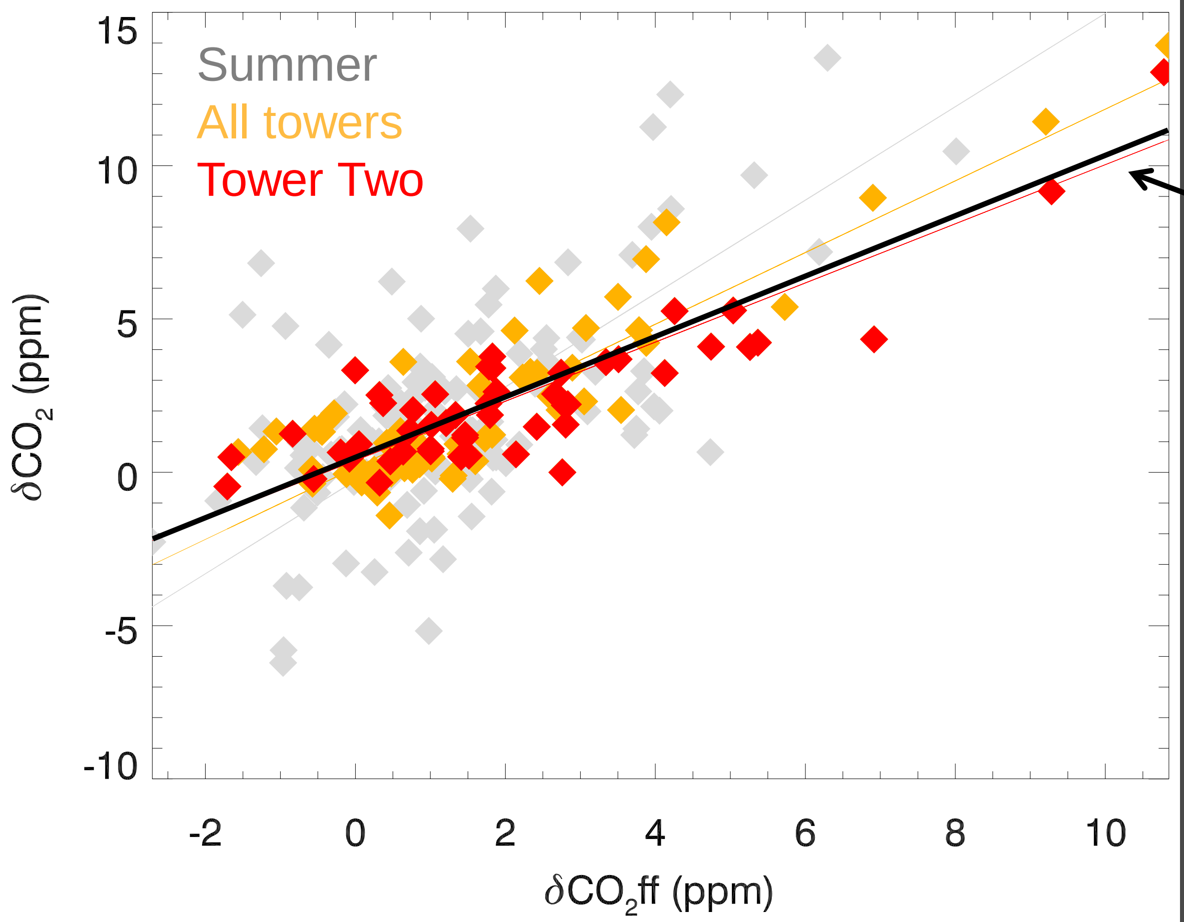
~50 species including CO_2 $^{14}CO_2$ CO CH_4 SF_6 hydrocarbons halocarbons

Trace gas enhancements relative to Tower One upwind background



Consistent enhancements in anthropogenic species at downwind towers

δCO_2 as a wintertime proxy for δCO_2ff



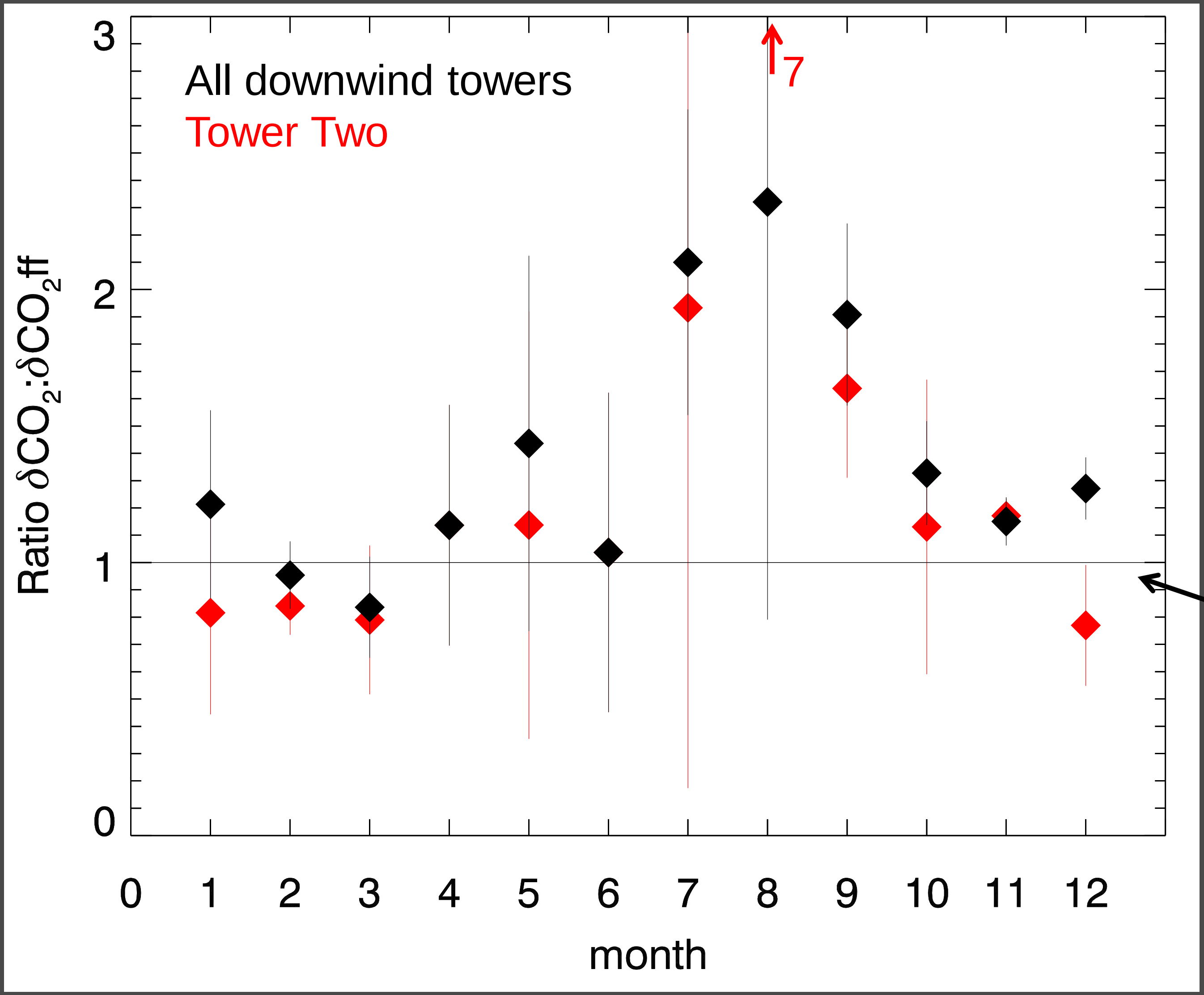
1:1 line if all δCO_2 is due to δCO_2ff

Winter correlations	**Slope $\delta CO_2/\delta CO_2$ff (ppm/ppm)**	**r^2**
All towers	1.2±0.1	0.8
Tower Two	1.0±0.2	0.8
LEF bkgd	1.7±0.2	0.6

In winter, δCO_2 is entirely explained by δCO_2ff when Tower One background is used

Continental background (LEF) gives quite different result

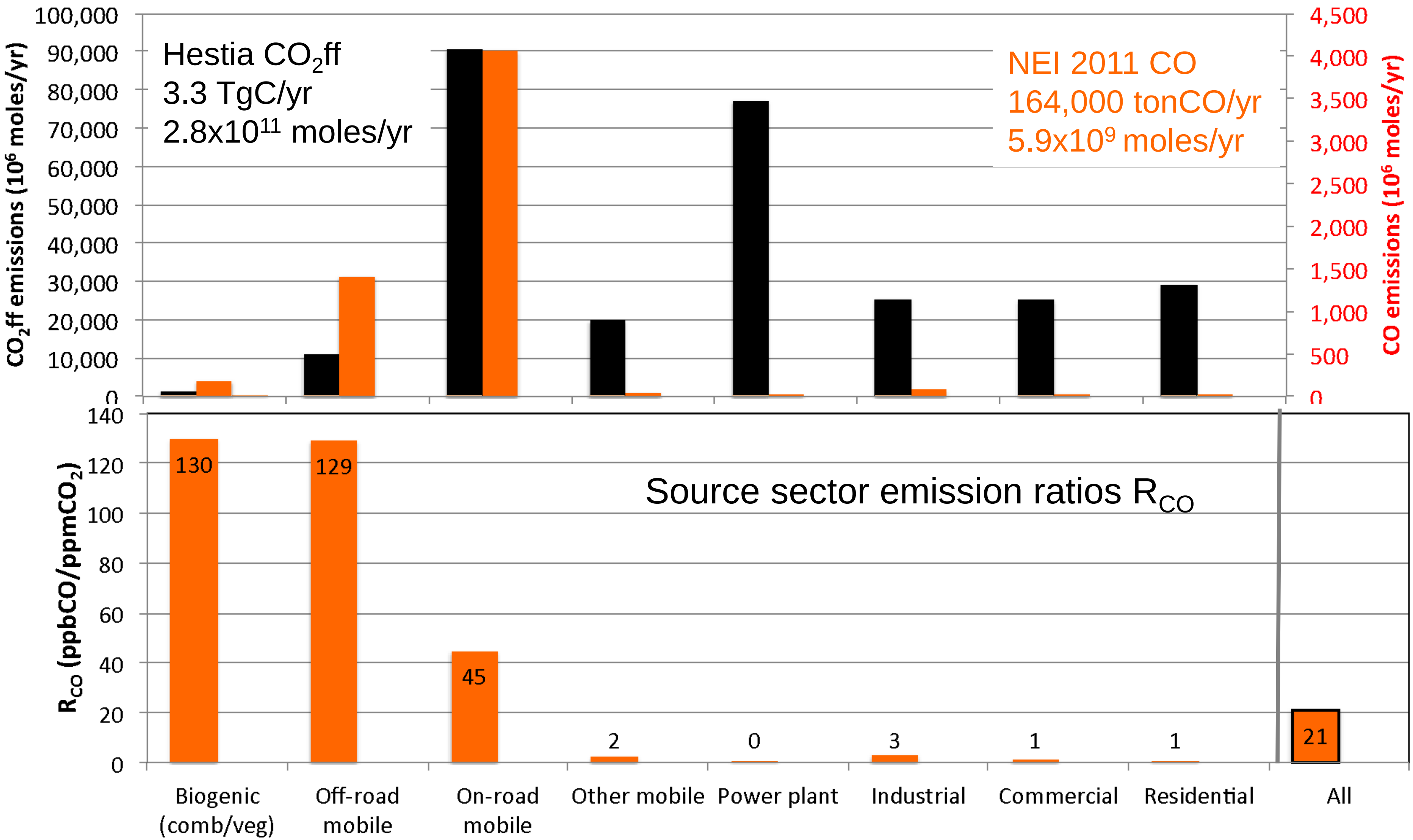
Seasonal variability in $\delta CO_2/\delta CO_2ff$



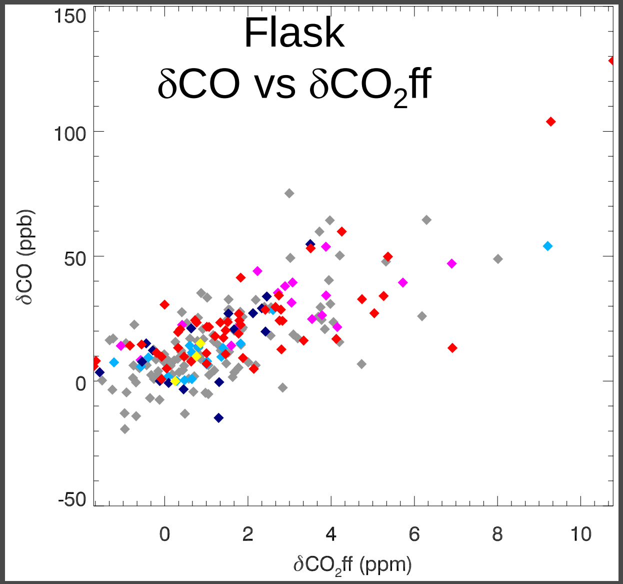
Ratio of 1 if all δCO_2 is due to δCO_2ff

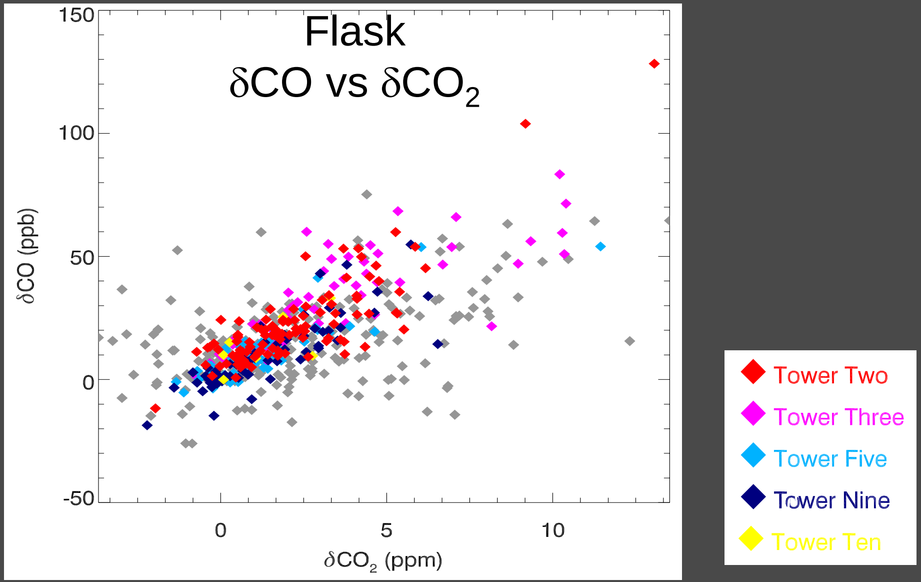
δCO_2 approximates δCO_2ff during mid-afternoon for Nov – April

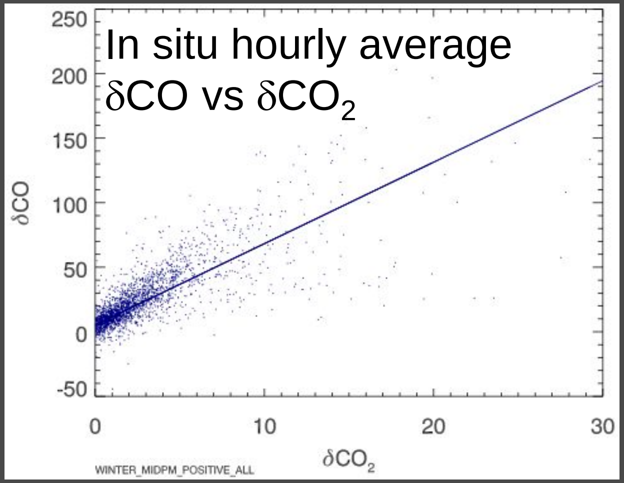
Partitioning CO_2ff emissions by source sector using CO



Validating bottom-up CO inventory with observed R_{CO}



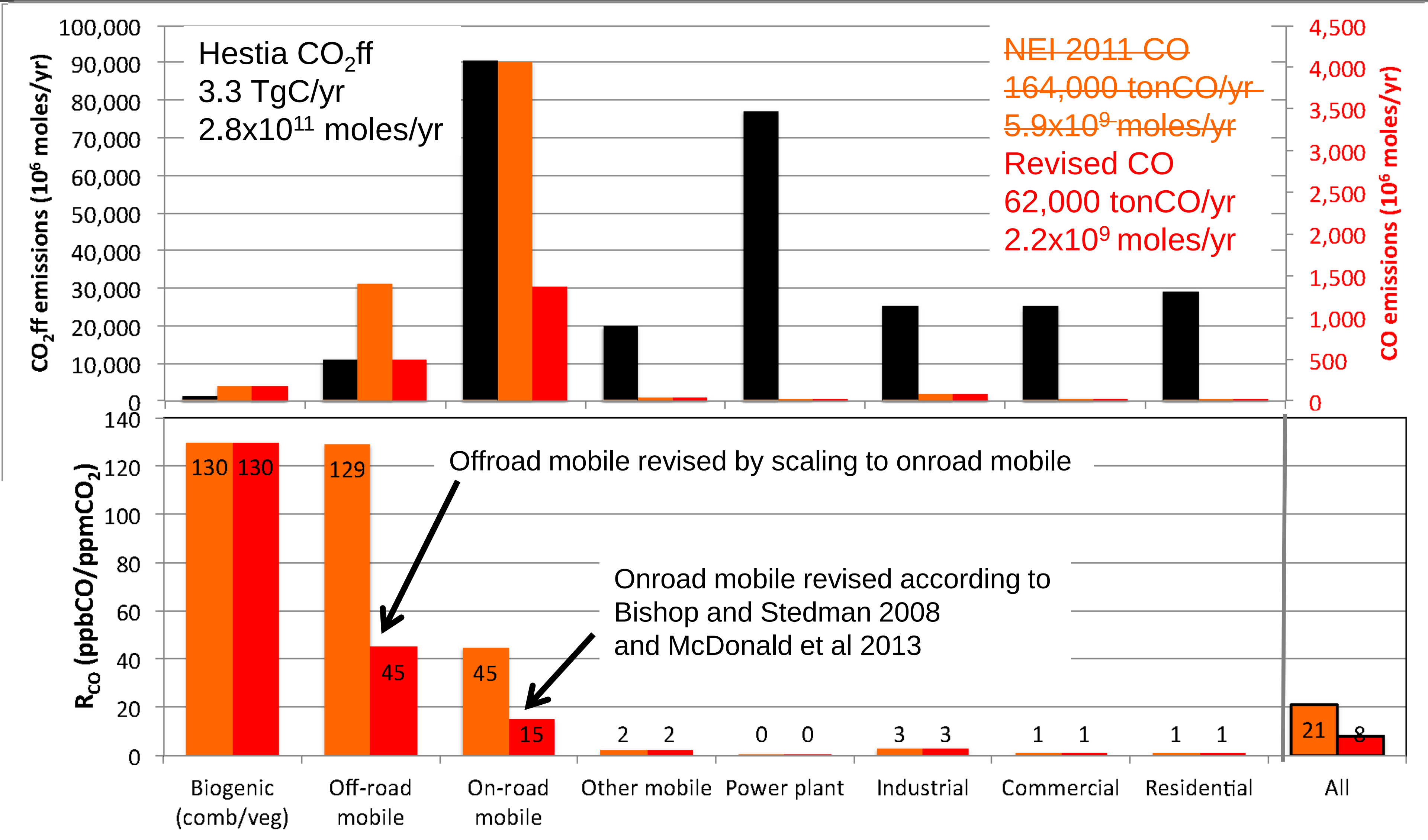




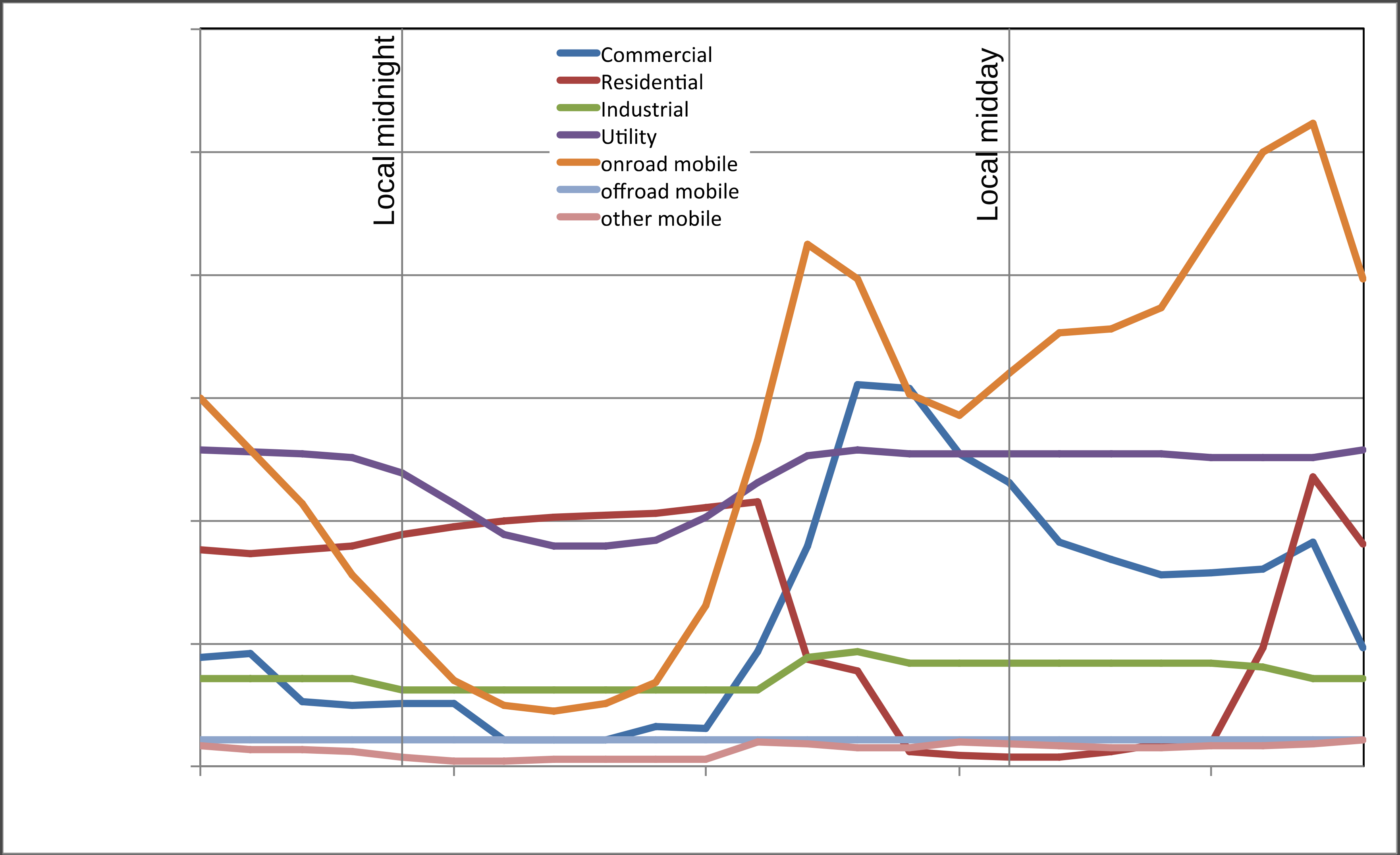
Winter correlations	**Slope RCO (ppb/ppm)**		
	Flask $CO:CO_2ff$	Flask $CO:CO_2$	In situ $CO:CO_2$
Tower Two	9 ± 2	9 ± 1	7 ± 2
All towers	8 ± 2	7 ± 1	6 ± 2
Bottom-up NEI 2011	**21**		

Suggests that bottom-up NEI 2011 CO inventory is ~2.5x too large

Revised CO emissions and emission ratios

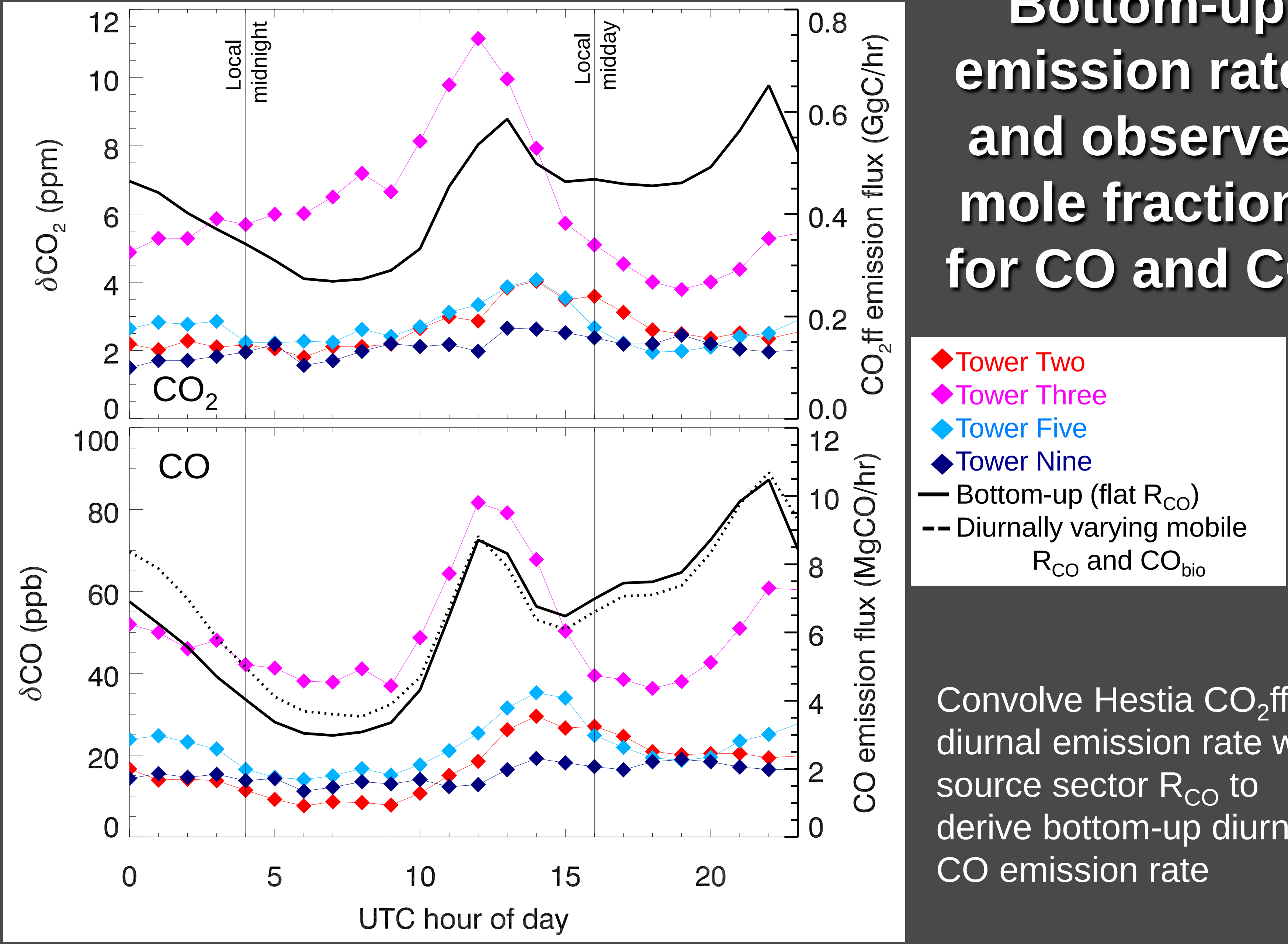


Hestia bottom-up diurnal cycle in CO_2ff emissions



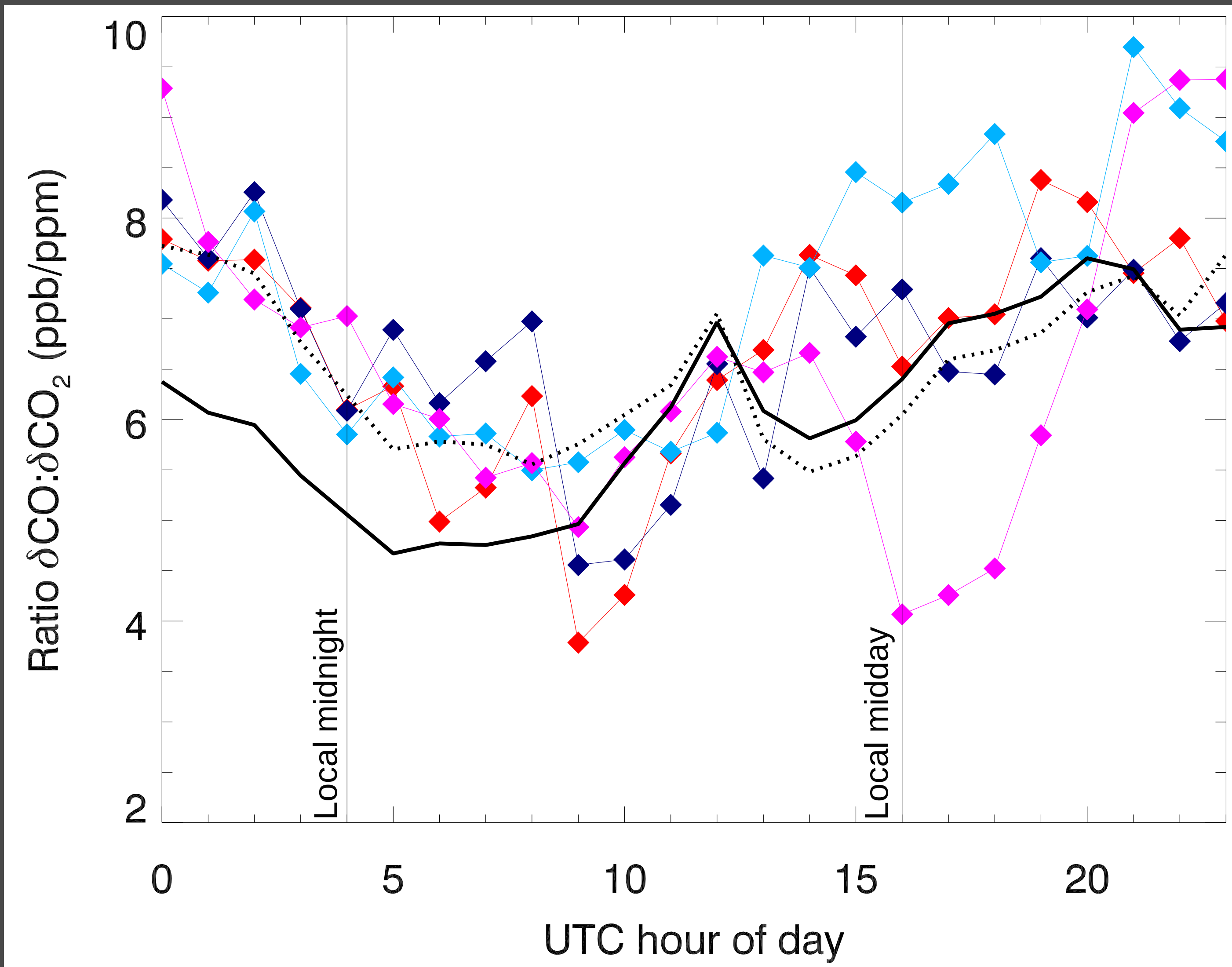
Can we use R_{CO} to detect the diurnal pattern in source sector CO_2ff emissions?

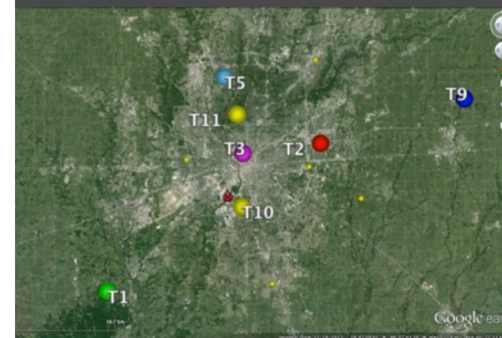
Bottom-up emission rates and observed mole fractions for CO and CO_2



Convolve Hestia CO_2ff diurnal emission rate with source sector R_{CO} to derive bottom-up diurnal CO emission rate

Bottom-up and in situ observed diurnal R_{CO}





Conclusions

When local upwind background constraint is used, δCO_2ff can be approximated by δCO_2 in winter

Correlate tracers are related to specific CO_2ff source sectors

In situ CO/CO_2 measurements for Indianapolis show that diurnal source sector partitioning for mobile emissions is approximately correct

Next steps

Improved source sector emission ratios

Transport modelling of emission ratios

Other correlate species