

Preliminary Findings of the UMass Wood Heat & Air Quality Study

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Background

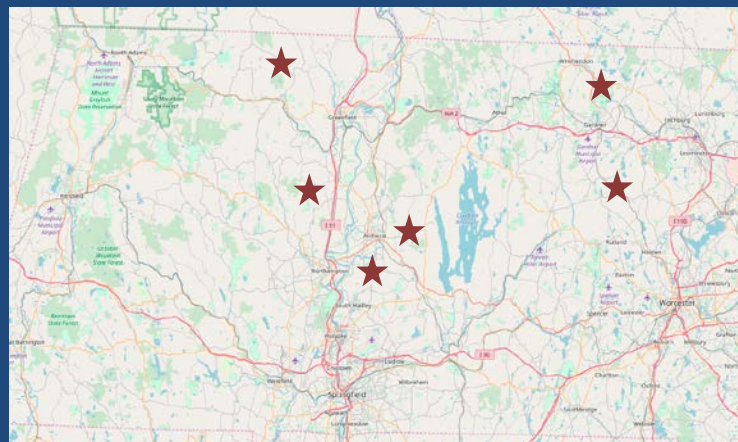
- What does a commercial-scale pellet boiler do to local air quality in a community?
- Focus on criteria pollutants – PM, NO_x, CO, etc.
- UMass well-equipped to make these measurements

Summary to Date

- Sampling period: Mar 2017 to May 2018.
- 6 distinct sites, all in rural Western Mass, in vicinity of large pellet boiler (and sometimes distillate).
- Huge dataset, will take a year (or more) to fully analyze; here, we present preliminary data.
- More than 500k total measurements of >30 different compounds to analyze.

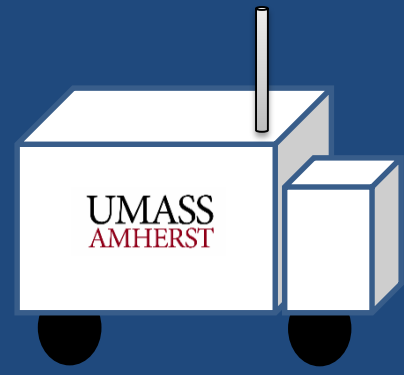
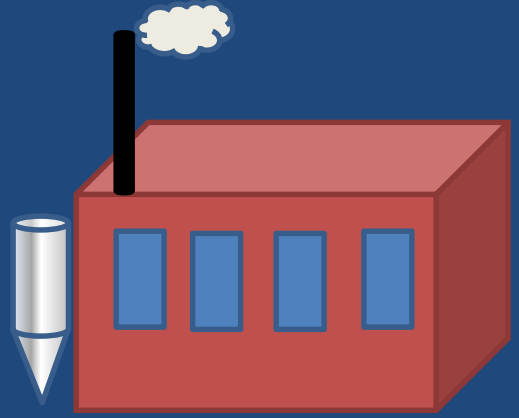
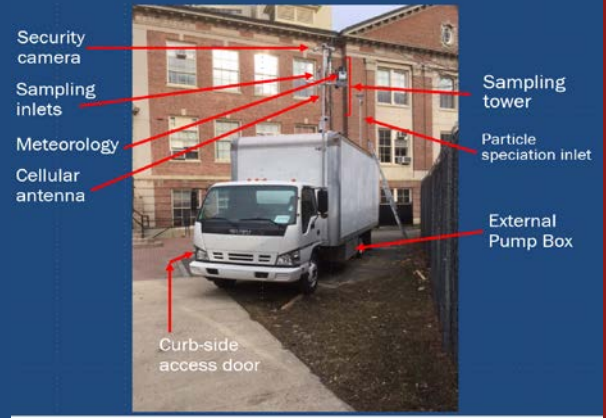
Sampled locations

Site Code	Town	Facility Type	Fuel	Sample Times
AC	Amherst, MA	Institutional building, academic	Pellets	31 Mar 2016- 26 May 2017
BES	Ashburnham, MA	Elementary School	Pellets	03 Nov 2017- 28 Nov 2017
WDCR	Princeton, MA	Institutional building, government	Pellets	13 Dec 2017 - 08 Jan 2018
SA	Ashfield, MA	Elementary School	Pellets	19 Jan 2018- Feb 6 2018
BFH	Belchertown, MA	Institutional building, government	Pellets	15 Mar 2018 - 04 Apr 2018
RHD	Rowe, MA	Institutional buildings, government	Pellets and distillate (opposing directions)	04 Apr 2018 - 01 May 2018



Measured parameters

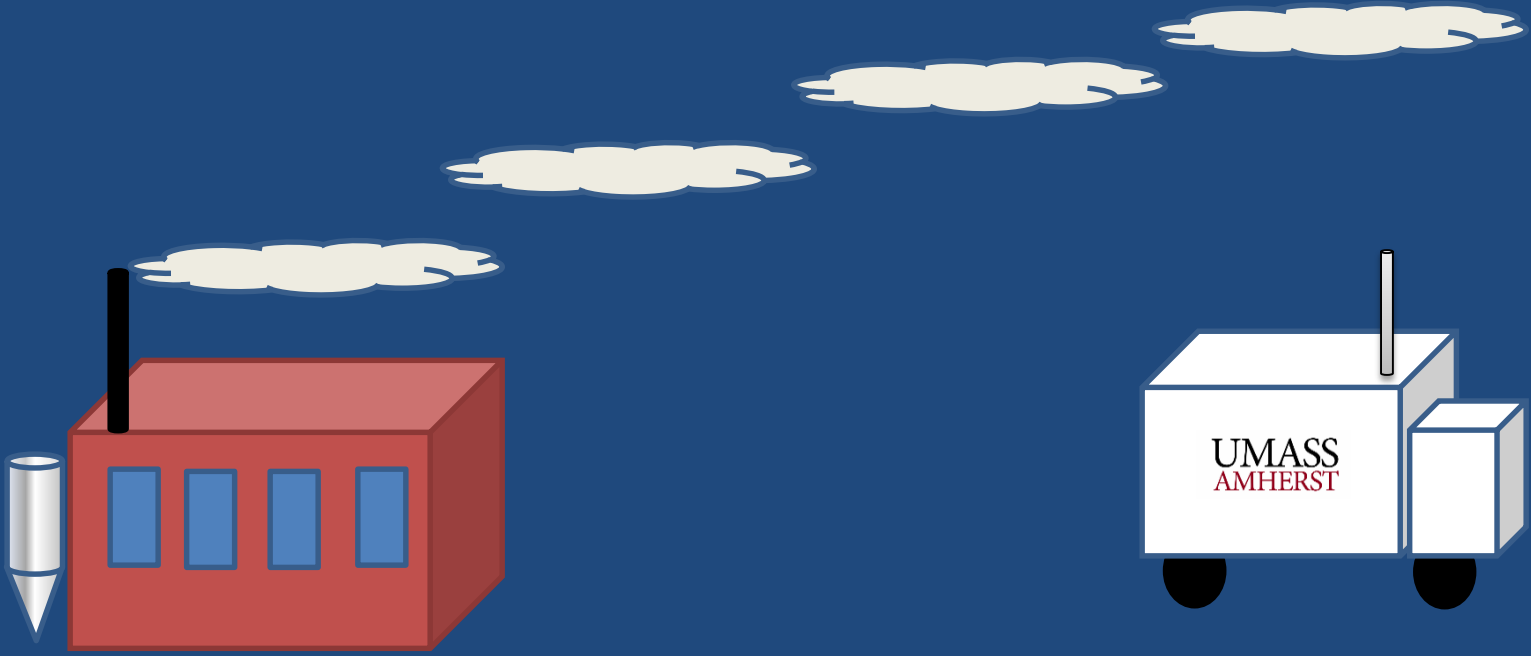
Compound	Instrument/Method	Resolution
Carbon Monoxide	TE 48i	1 min
NO ₂ , NO _x , NO _y	TE 42i	1 min
Ozone	TE 49i	1 min
SO ₂	TE 43i	1 min
CO ₂	Licor LI-820	2 sec
EC and OC	Sunset Labs Model 4	1 hour
BC and Biomass Carbon	Magee AE33	5 min
Particle Size, < 800nm	TSI, SMPS (3080/3750)	~2 min
Particle Size, >800nm	TSI, APS 3320	~2 min
Particle Mass, PM _{2.5}	Nephelometer, pDR1500	5 min
Particle Mass, PM ₁₀	Nephelometer, pDR1500	5 min
Particle mass, PFTE filter	Partisol 2025	24 hour
Particle speciation, offline	Partisol 2025	24 hour
Meteorology	Davis Vantage Pro 2	1 sec





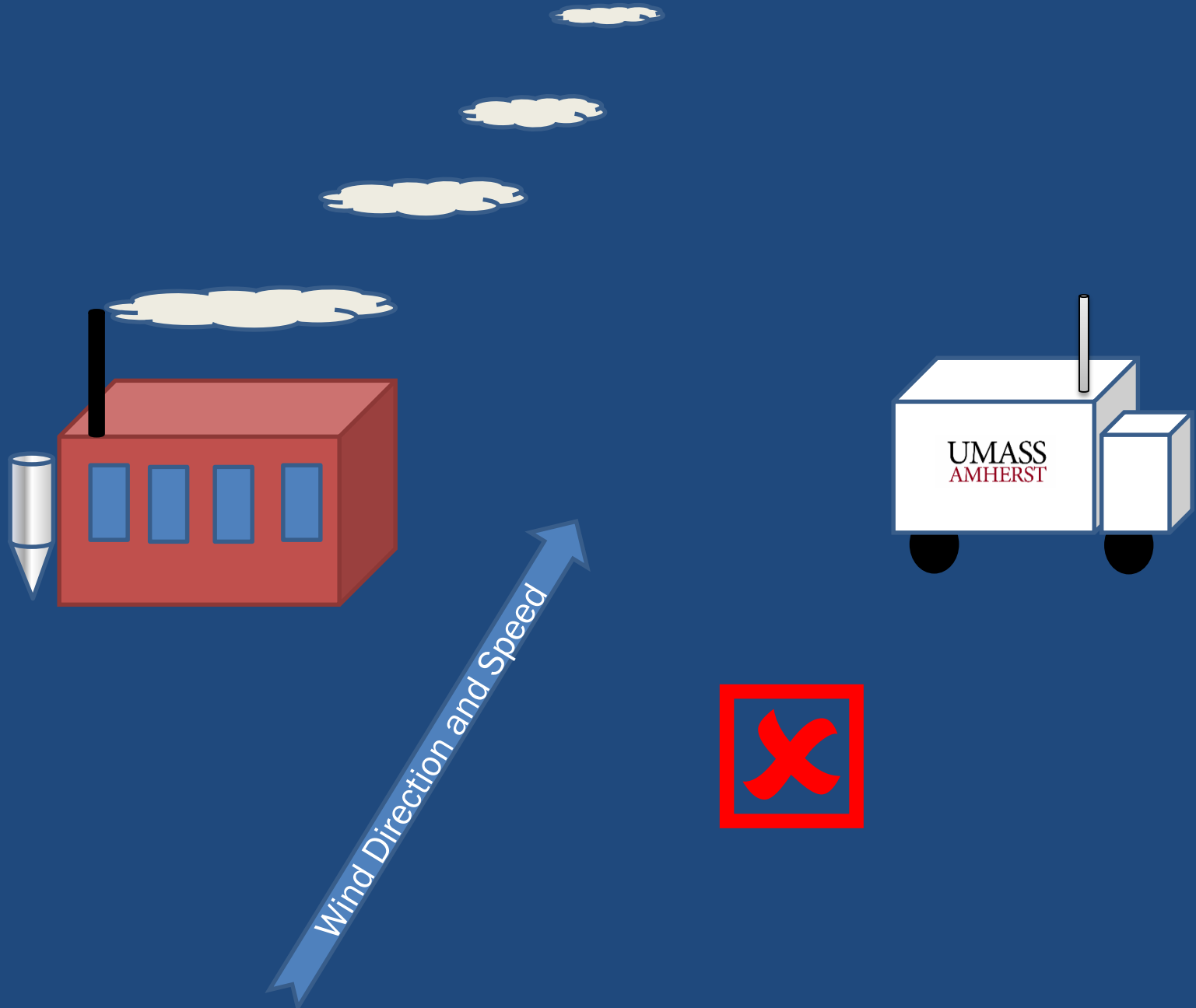
Wind Direction and Speed →





Wind
Direction
and Speed

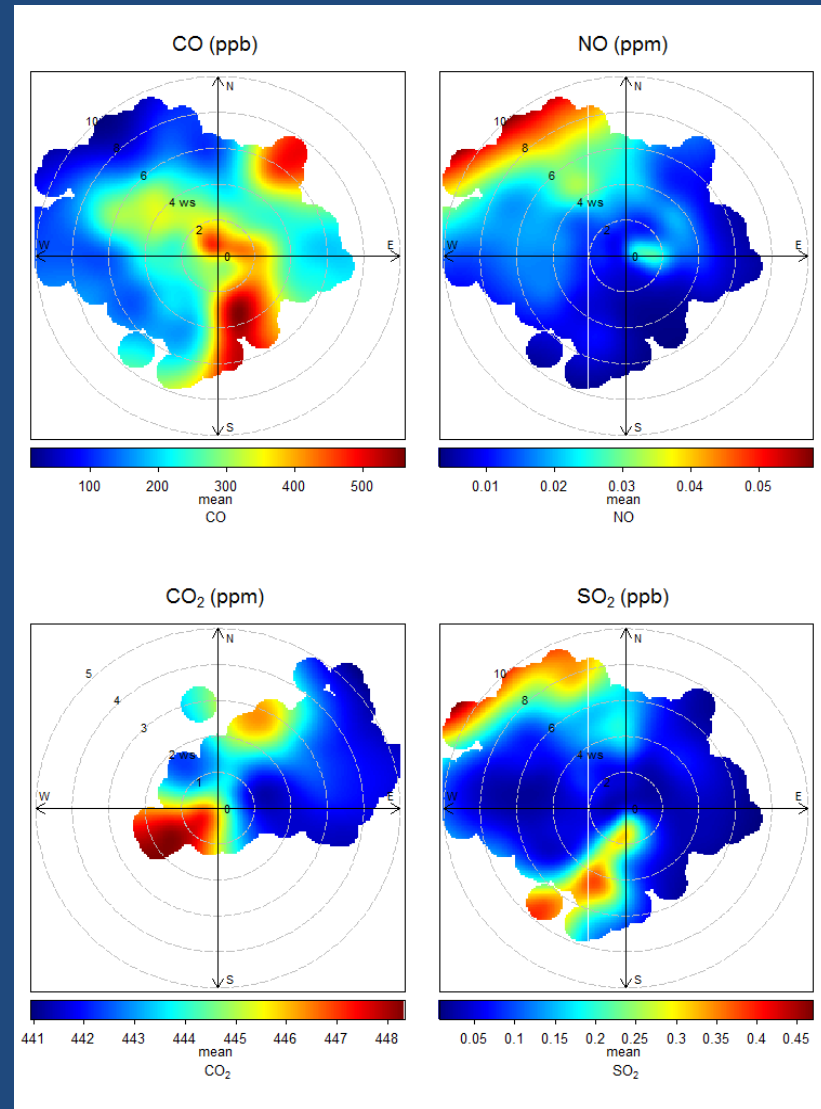
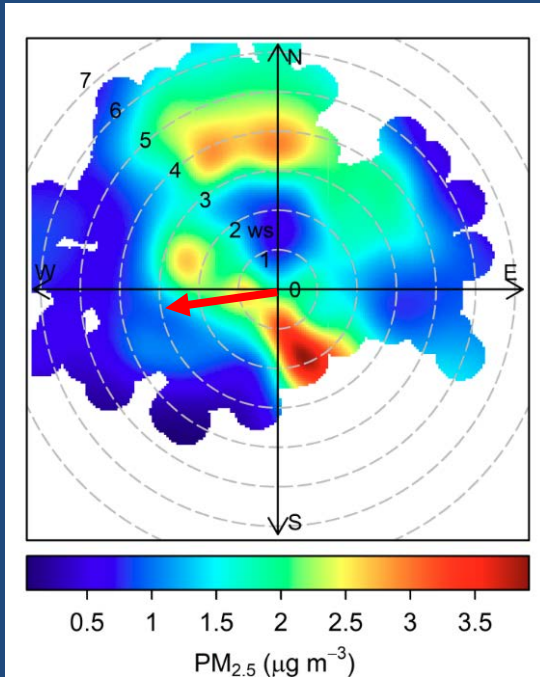




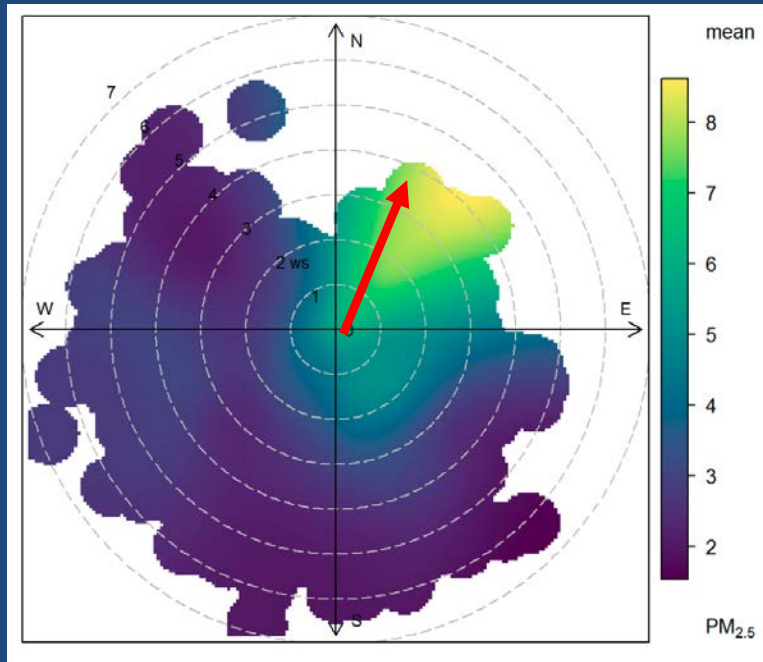
One way to understand complex data: Polar Plots

- Arrow points to boiler. Truck located at center.
- Direction from center indicates direction in degrees (north is up).
- Distance from center indicates wind speed.
- Concentration is modelled based on actual data (not a “concentration field”, *per se*, but lets us view relative impacts based on wind speed/direction)

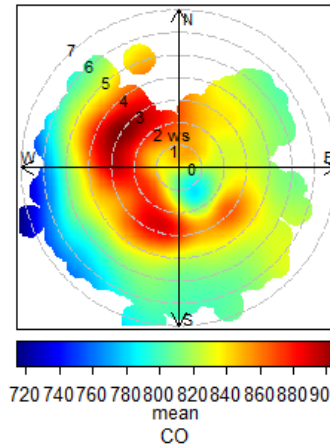
AC (Amherst)



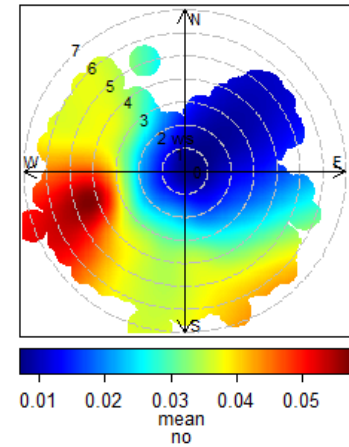
BES (Ashburnham)



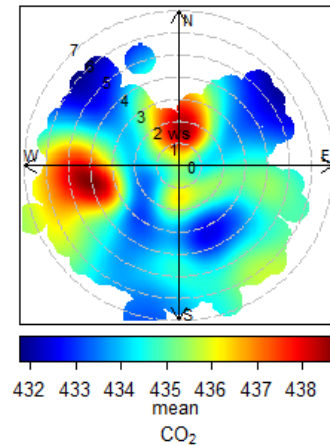
CO (ppb)



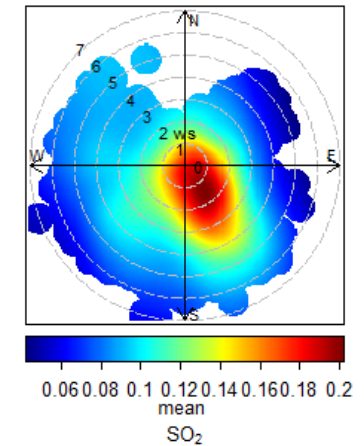
NO (ppm)



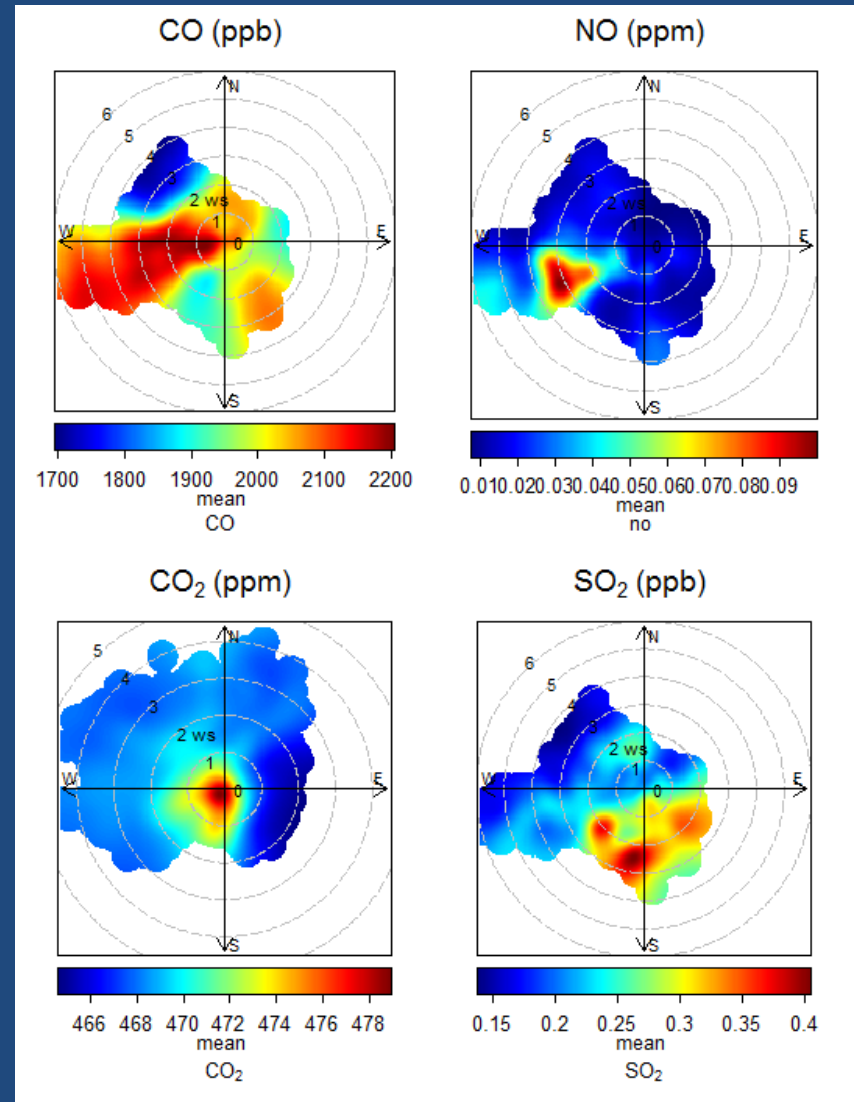
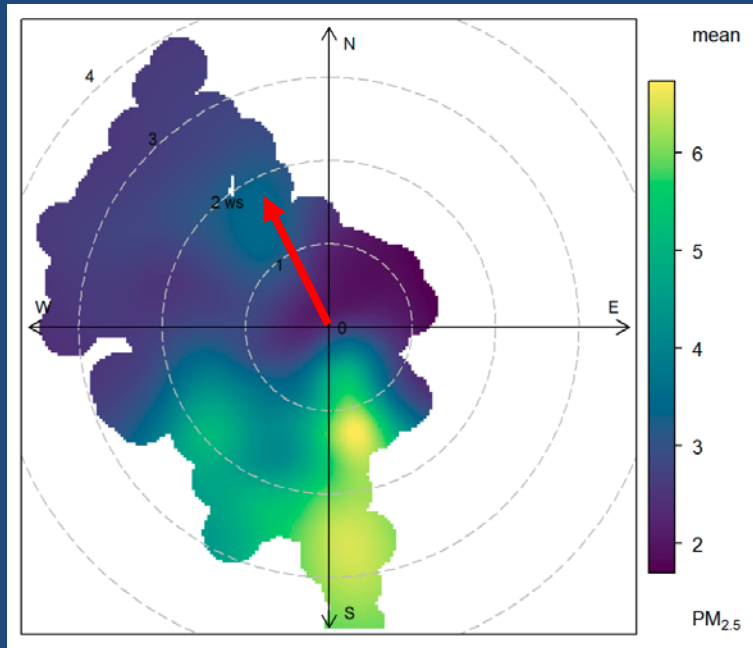
CO₂ (ppm)



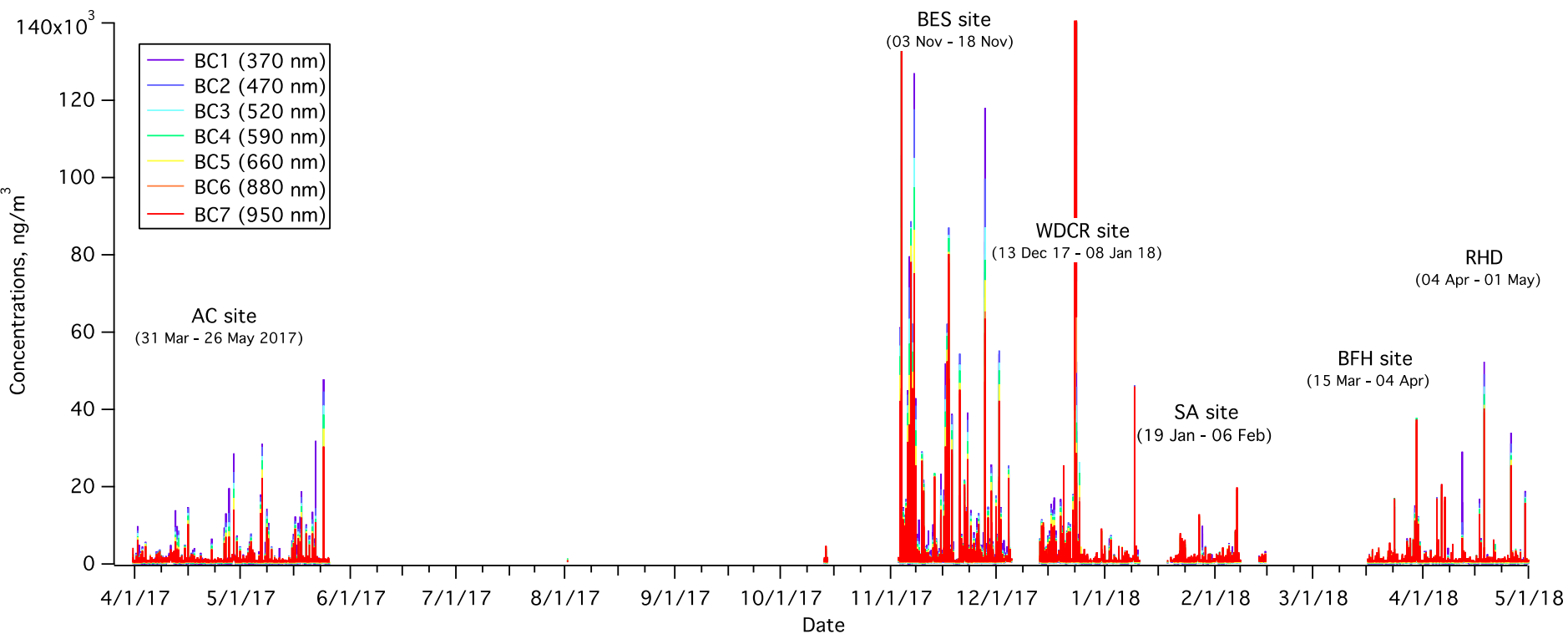
SO₂ (ppb)



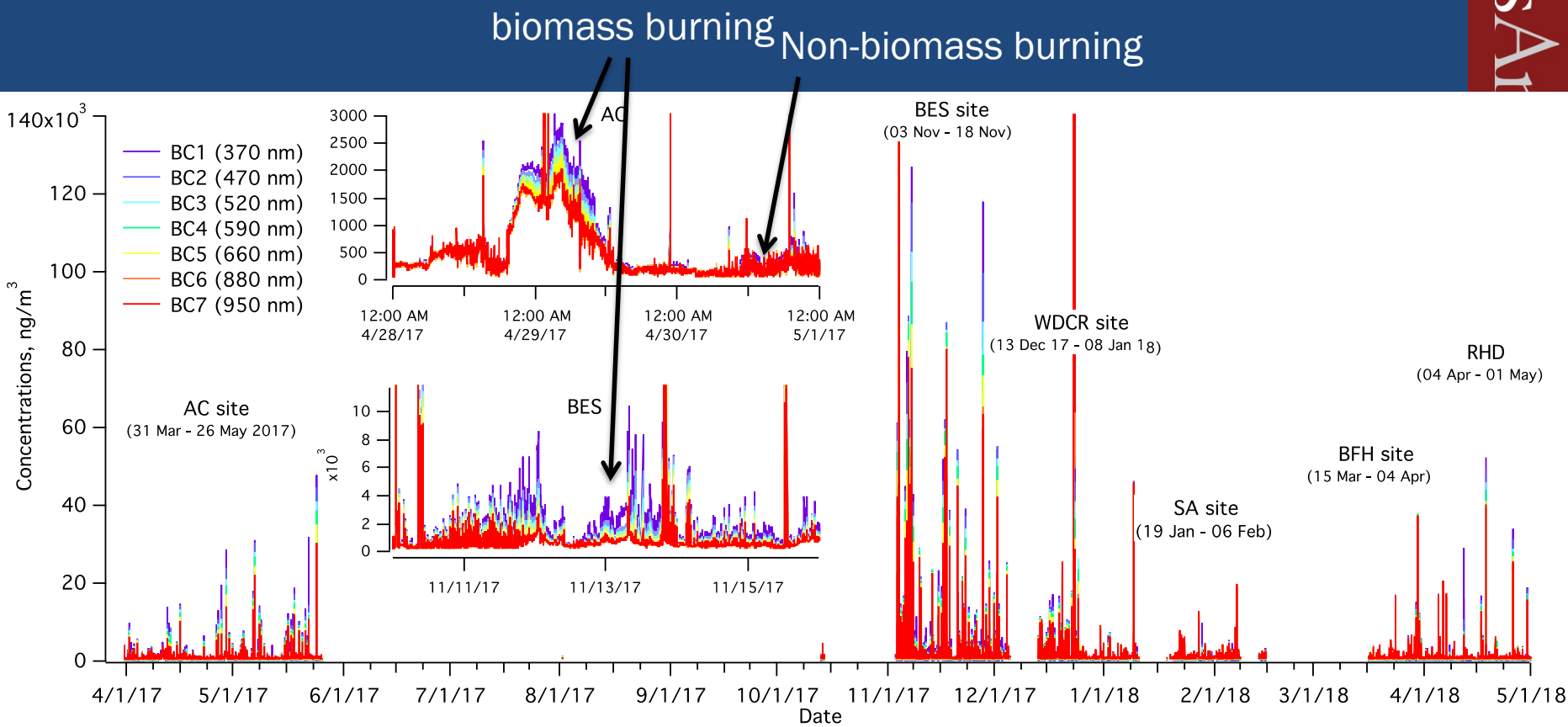
RHD (Rowe)



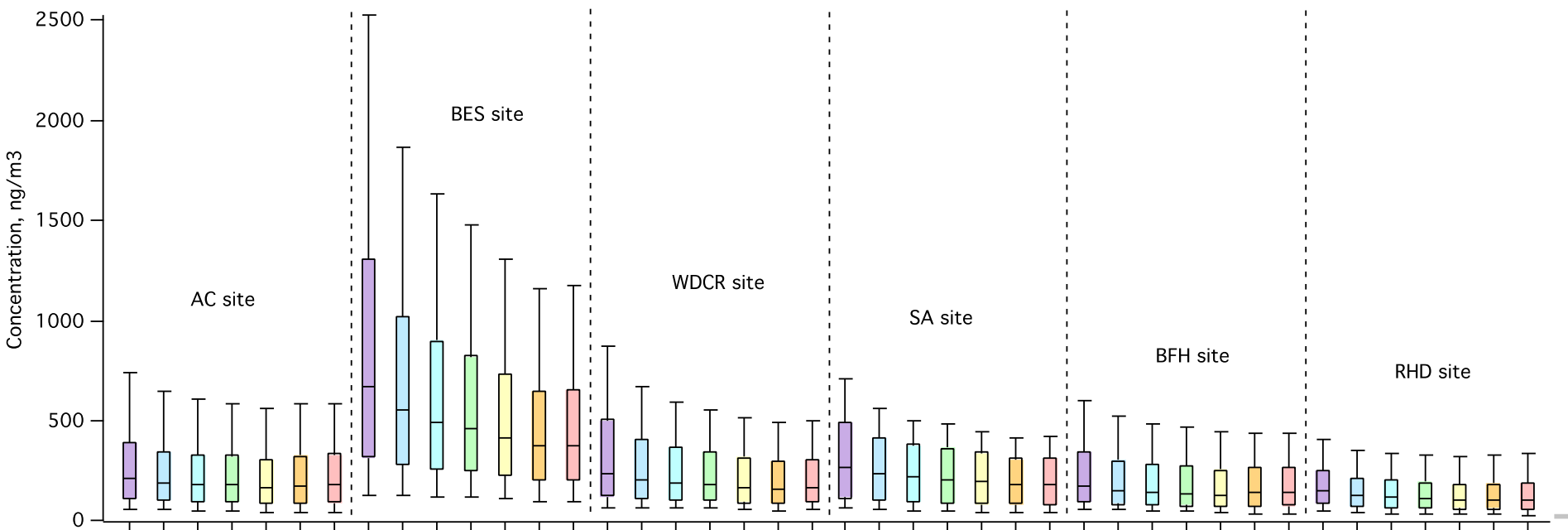
Time series of wavelength-depend BC concentrations at each sites.



Different wavelength-dependent pattern, indicating different sources



Concentrations of BC1 (purple) ~ BC7 (red) at each site



Higher BC1 (purple) than BC6 (orange) indicates higher biomass burning contribution, especially at BES site

What do we worry about for air quality *(and how pellet boilers might impact this)*

- Particulate matter
- Carbon monoxide
- Oxides of nitrogen
- Ozone
- SO₂
- Downwind community effects

What do we still not understand?

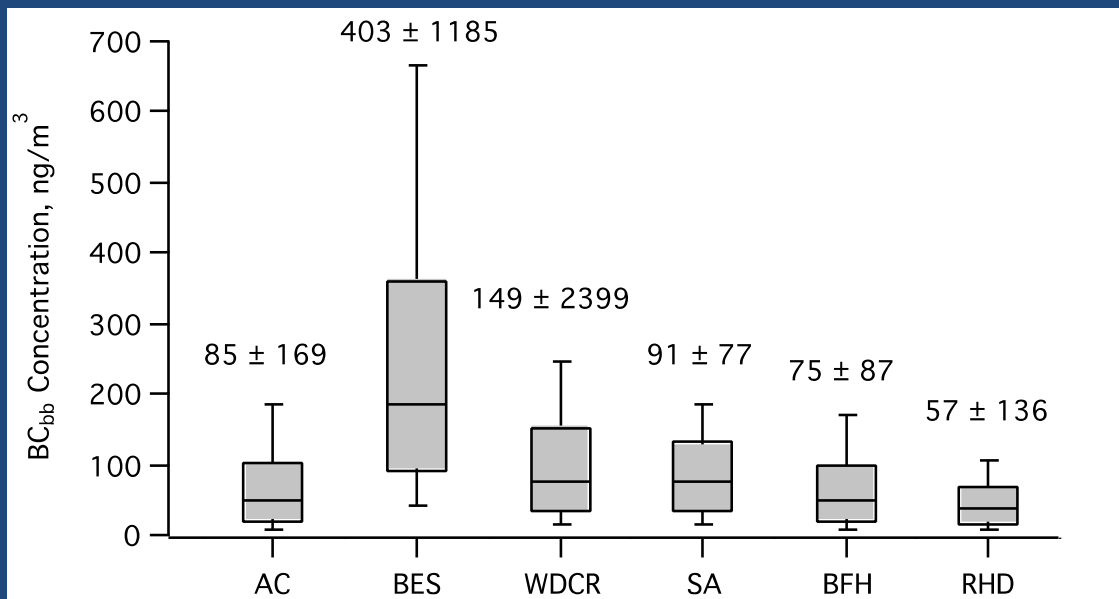
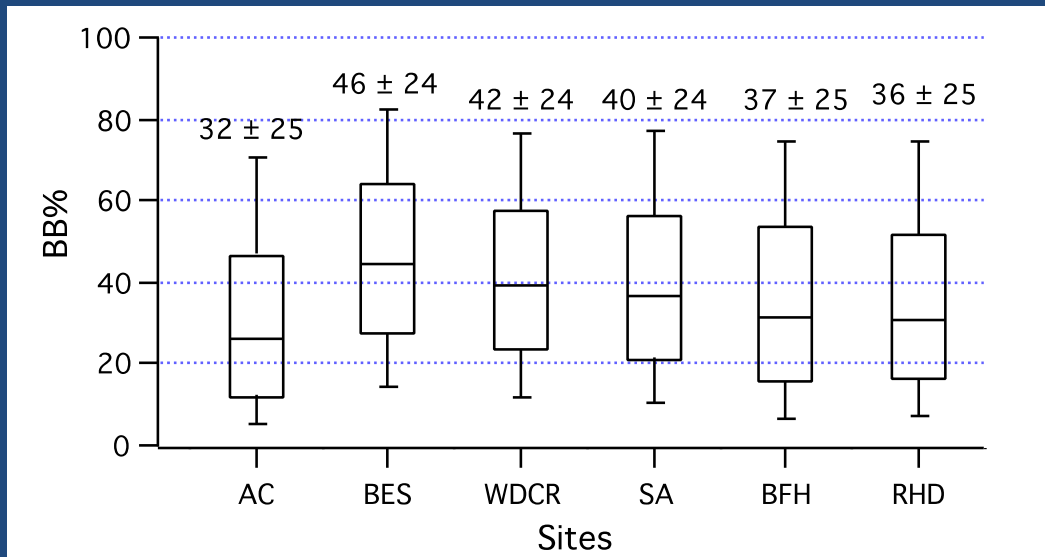
- Full chemical speciation (carcinogens, oxidizing compounds).
- Particle size distribution (inhalation risk, likelihood to contribute to downwind pollution).
- Metals and other health- and source-specific components.

Limitations

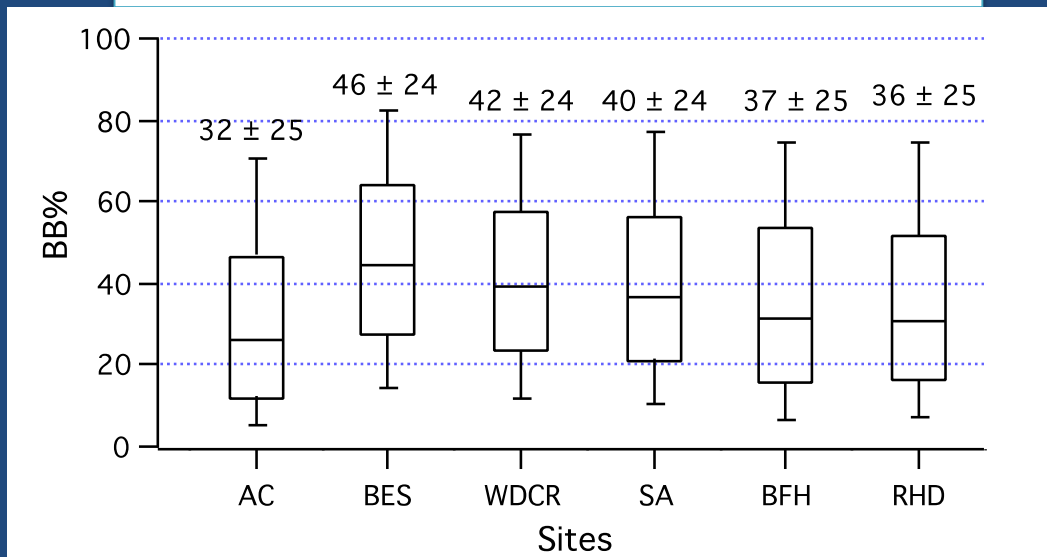
- Sampling focused on immediate, nearby impacts; and not on aged pollution.
- To some extent, we're still looking under the lamp post.
- Can be interaction effects, especially in highly polluted environments (which were not sampled here).
- Results still preliminary.

What does all of this mean?

- Biomass emissions observed do come from measured sources.
 - Concentrations of PM were generally low, and at smaller magnitudes to other sources of pollution. On the order of 1-2 $\mu\text{g}/\text{m}^3$.
- One site (BES) quite a bit more polluted.
 - This data needs more work.
- The use of pellets has a measurable effect on air quality, but it is of a smaller magnitude than other commonly-used heating appliances such as distillate.



Biomass burning contribution at each site

Concentration of biomass carbon (BC_{bb}) at each sites