Progress on Woodstove Emissions as a function of Temperature for AIRPACT

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NWRMC meeting, Sand Point NOAA Base

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with Contributions by Sally Otterson and Clint Bowman - WA Ecology

an old slide

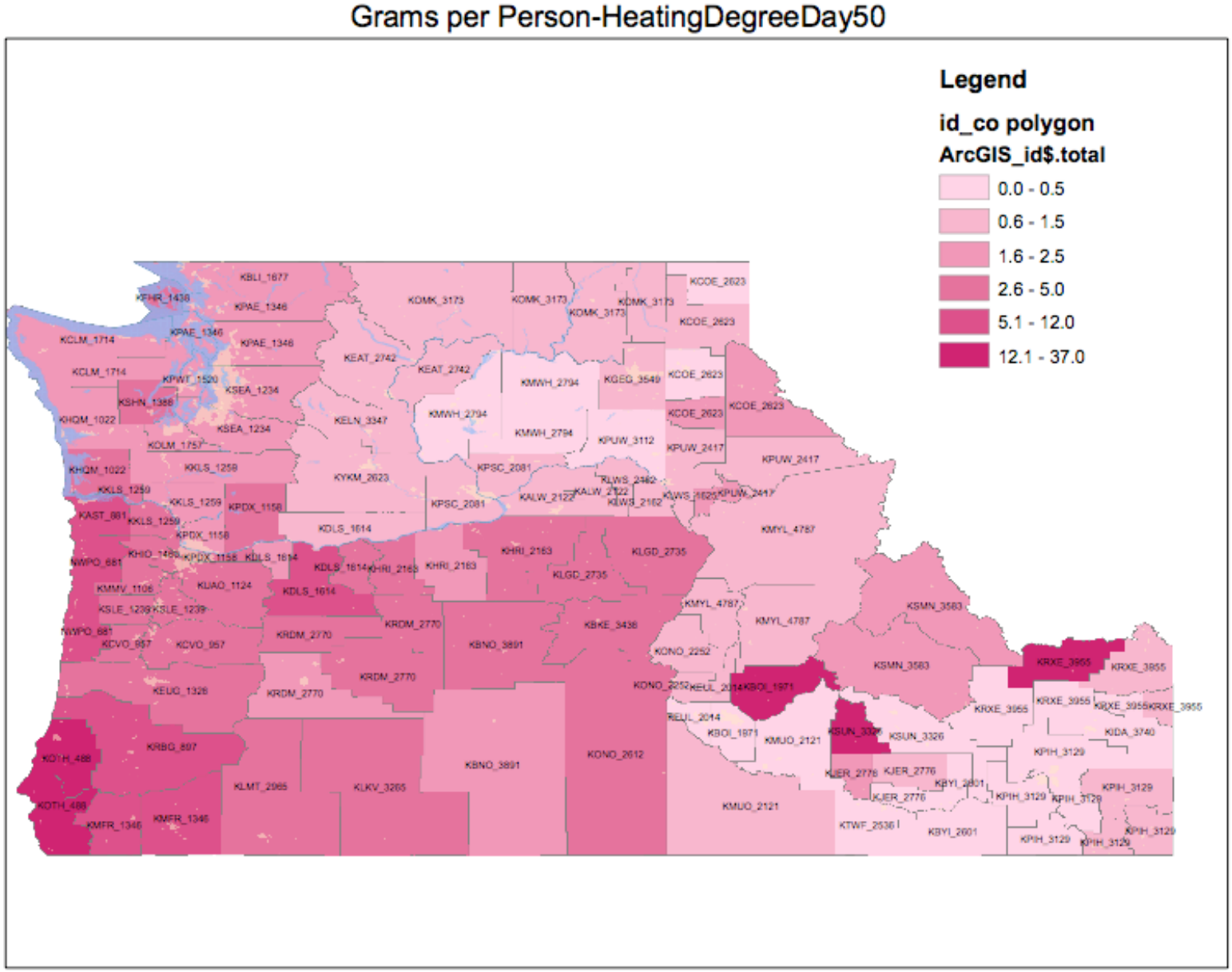
Updating AIRPACT-3 woodstove emissions

Stage 1: allocating wood stove emissions using a new surrogate, a census-determined layer of wood stoves used for primary hearing.

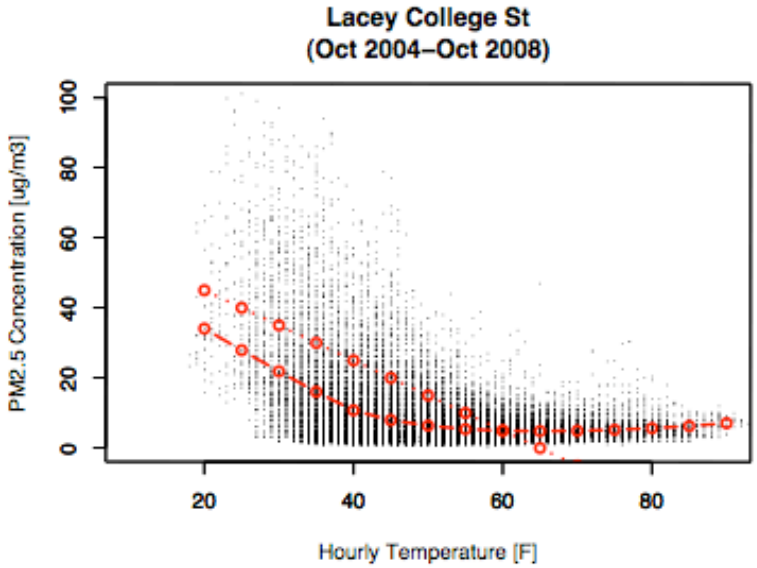
- – Ecology provided wood stove layer from census to use as surrogate.
- – Scripts executing SMOKE 2.4 used to generated the required time-invariant files.
- – AIRPACT scripting, using SMOKE v2.1, *was modified and tested* to produce hourly area emissions, including woodstove smoke to drive CMAQ.
- – Comparisons will follow, testing new emissions against old in comparison to observations.

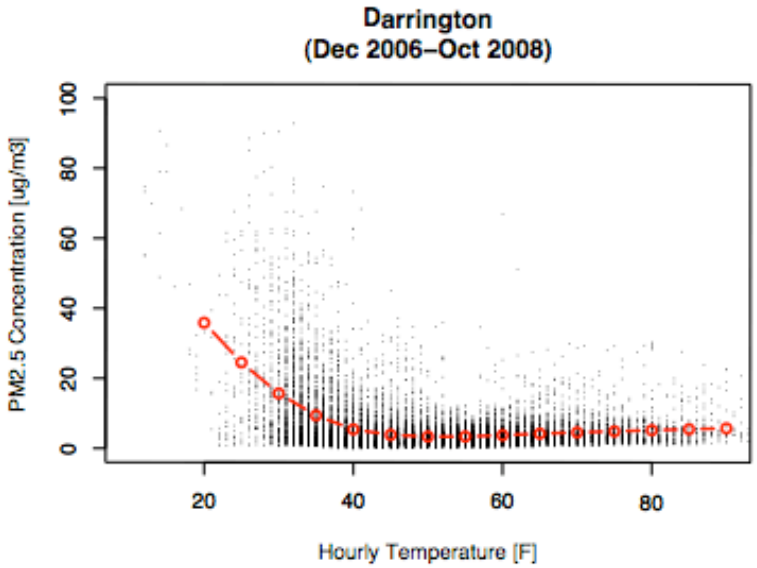
Stage 2: ambient (forecast) temperature adjustment of wood stove emissions.

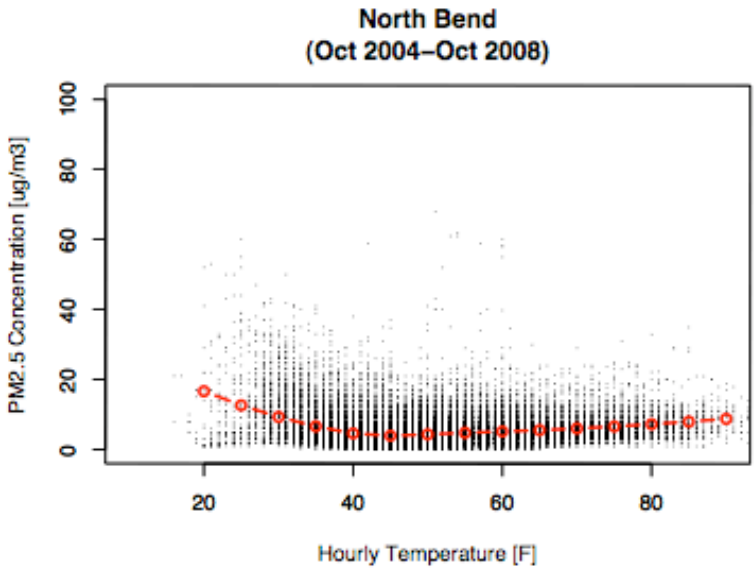
Source: Sally Otterson, WA Ecology

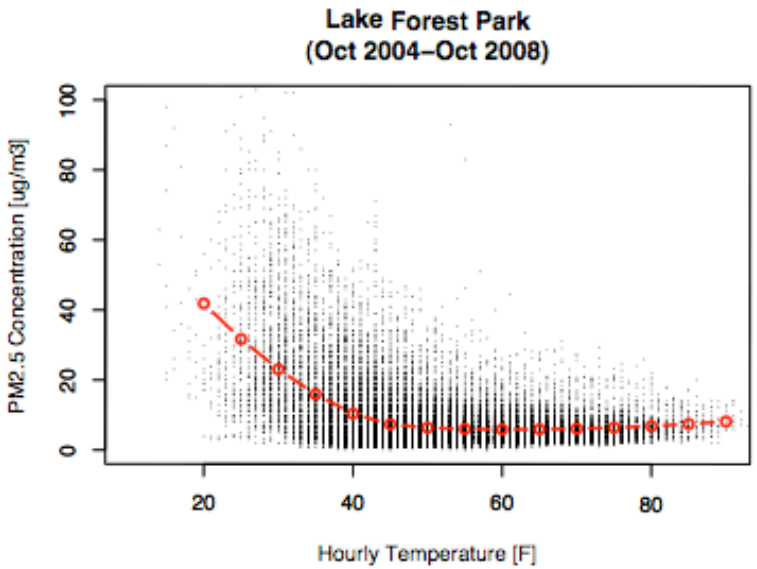


Clint Bowman performed analysis of PM response to Temperature







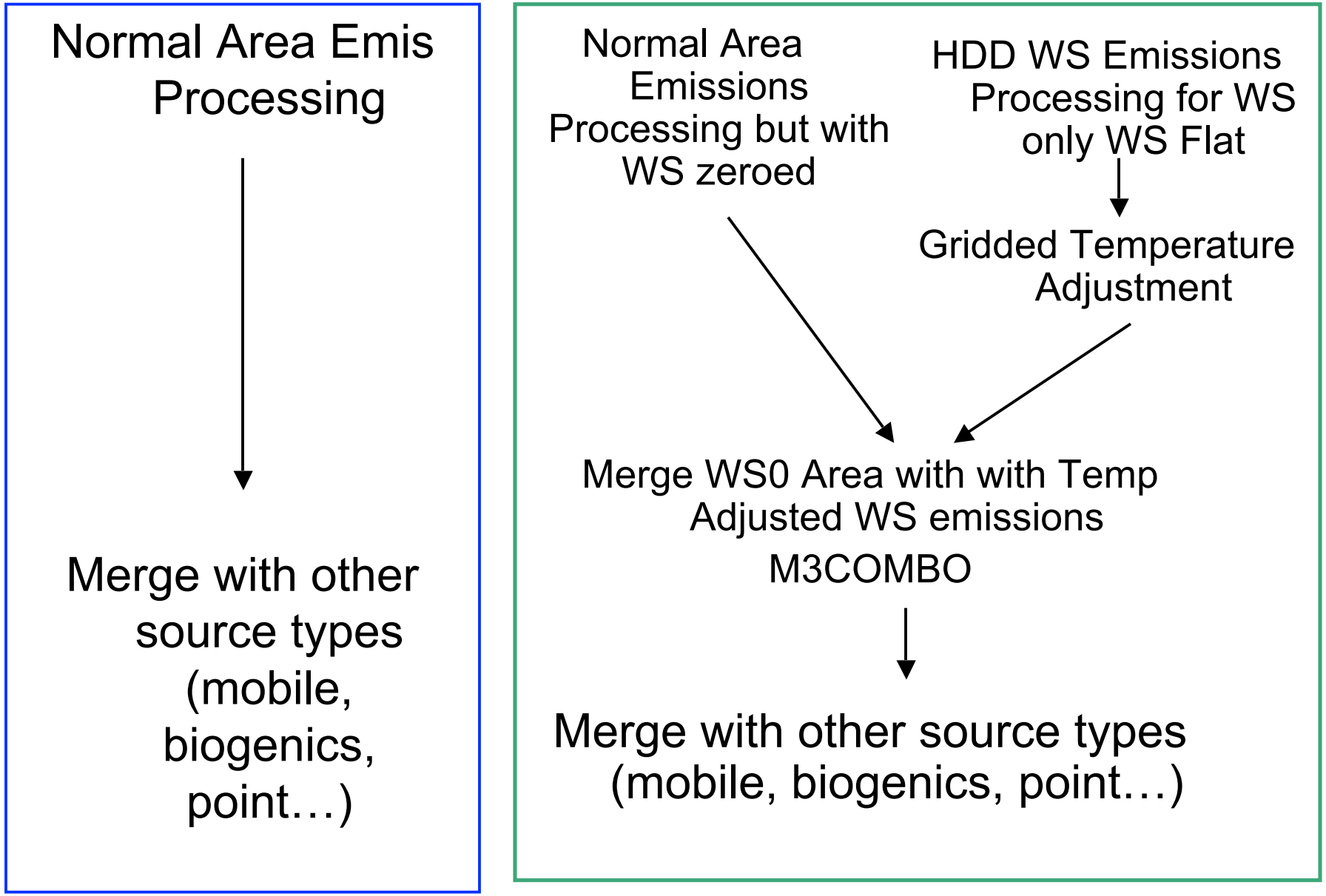


Simple algorithm implemented for testing *in this prototype*

- Emissions imported as tons/day (per HDD), flagged to SMOKE as Daily Average Values, to result in hourly emissions values as g/s per HDHr.
- Over all species from WS emissions,
- Between 20 F and 50 F,
- Delta Temp = abs (50 - Temp)
- Grid-cell hourly WS emissions =

  grid-cell g/s/HDHr * delta Temp

Prototype WS Emission as f(Temp)



Source description codes

- 2104008000Stationary Source Fuel Combustion;Residential;Wood;Total: Woodstoves and Fireplaces
- 2104008001Stationary Source Fuel Combustion;Residential;Wood;Fireplaces
- 2104008010Stationary Source Fuel Combustion;Residential;Wood;Woodstoves: General
- 2104008030Stationary Source Fuel Combustion;Residential;Wood;Catalytic Woodstoves: General
- 2104008050Stationary Source Fuel Combustion;Residential;Wood;Non-catalytic Woodstoves: General
- 2104008051Stationary Source Fuel Combustion;Residential;Wood;Non-catalytic Woodstoves: Conventional
- 2104008052Stationary Source Fuel Combustion;Residential;Wood;Non-catalytic Woodstoves: Low Emitting
- 2104008053Stationary Source Fuel Combustion;Residential;Wood;Non-catalytic Woodstoves: Pellet Fired

Area emissions cross-reference file with standard AIRPACT profile codes for woodstoves, and ‘zeroing profiles’ for others

- Source Code Ann Wk Daily
- 2104006000 4014 408 4004 -9 000000
- 2104006010 4014 408 4004 -9 000000
- 2104007000 4014 408 4004 -9 000000
- 2104008000 4003 407 4003 -9 000000
- 2104008001 4003 407 4003 -9 000000
- 2104008002 4003 407 4003 -9 000000
- 2104008003 4003 407 4003 -9 000000
- 2104008004 4003 407 4003 -9 000000
- 2104008010 4003 407 4003 -9 000000
- 2104008030 4003 407 4003 -9 000000
- 2104008050 4003 407 4003 -9 000000
- 2104008051 4003 407 4003 -9 000000
- 2104008053 4003 407 4003 -9 000000
- 2104011000 4014 408 4004 -9 000000
- 2199004002 4014 408 4004 -9 000000

Area emissions cross-reference file with Flat profile codes for woodstoves, and ‘zeroing profiles’ for others

- Source Code Ann Wk Daily
- 2104006000 4014 408 4004 -9 000000
- 2104006010 4014 408 4004 -9 000000
- 2104007000 4014 408 4004 -9 000000
- 2104008000 4015 409 4005 -9 000000
- 2104008001 4015 409 4005 -9 000000
- 2104008002 4015 409 4005 -9 000000
- 2104008003 4015 409 4005 -9 000000
- 2104008004 4015 409 4005 -9 000000
- 2104008010 4015 409 4005 -9 000000
- 2104008030 4015 409 4005 -9 000000
- 2104008050 4015 409 4005 -9 000000
- 2104008051 4015 409 4005 -9 000000
- 2104008053 4015 409 4005 -9 000000
- 2104011000 4014 408 4004 -9 000000
- 2199004002 4014 408 4004 -9 000000

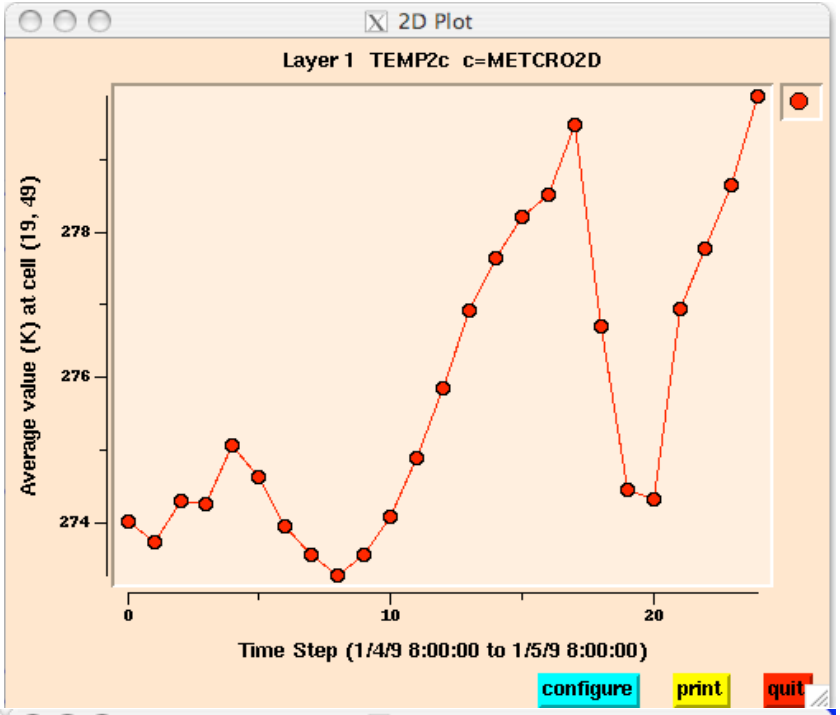
profiles

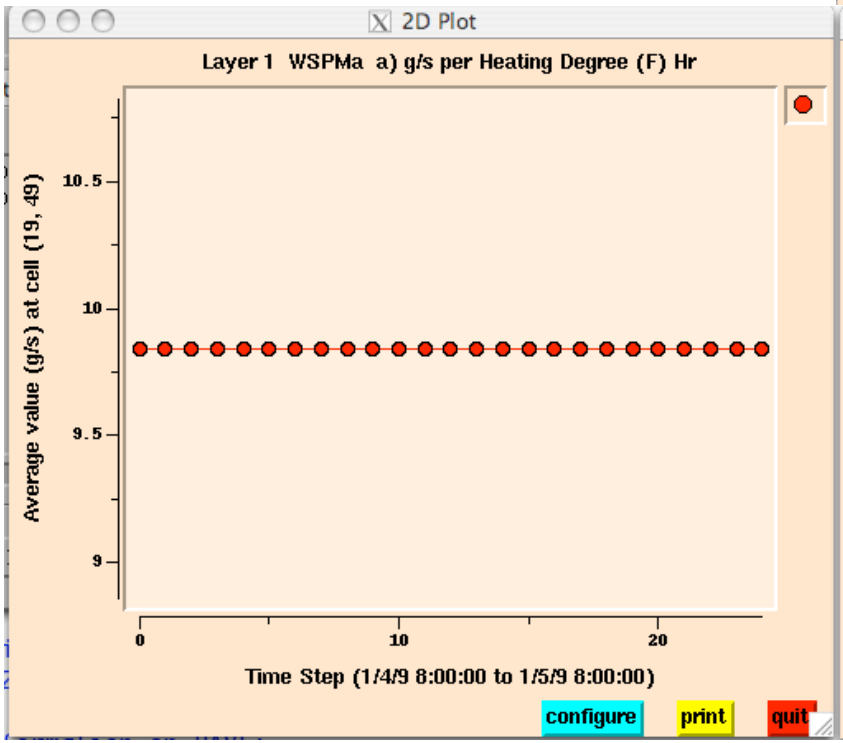
- ! NW-AIRQUEST Woodstoves from 2001 WSU survey, altered to change summer from 1.5% to 0%. 4003 140 140 84 84 84 0 0 0 109 109 109 140 999
- ! NW-AIRQUEST - Woodstoves from 2001 WSU survey, for days of week
  407 135 135 135 135 135 161 161 1000
- ! NW-AIRQUEST - Woodstoves from 2001 WSU survey, for hours of day
  4003 18 18 18 18 18 18 46 46 46 46 24 24 24 24 24 24 88 88 88 88 88 88 18 18 1000
- ! Zero profile for Months
  4014 0 0 0 0 0 0 0 0 0 0 0 0 0
- ! Flat profile for Months
  4015 1 1 1 1 1 1 1 1 1 1 1 1 12
- ! Turn off an emission for days of week
  408 0 0 0 0 0 0 0 0
- ! Flat Profile for days of week
  409 1 1 1 1 1 1 1 7
- ! Turn off an emission for hours of day
  4004 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0!
- Flat profile for woodstove for hours of day
  4005 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 24

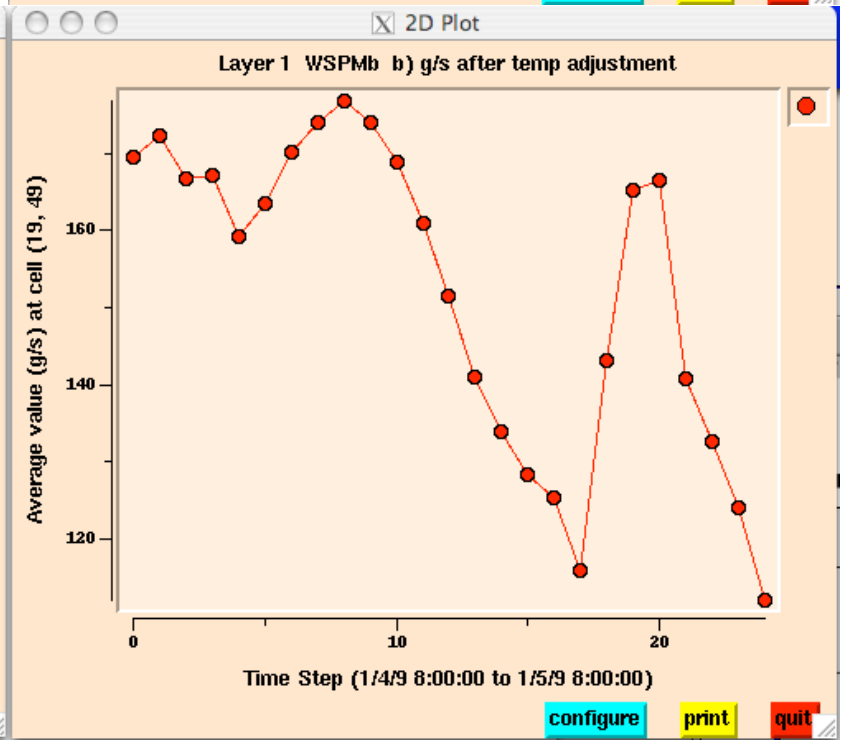
Steps to gaining control of SMOKE processing for blending Standard Area non-WS emissions with temperature adjusted WS emissions

- ws08_area_only
- ws08_area_only_WSonly
- ws08_area_only_WS0
- ws09_area_only_WSonly_TA/
- ws08_area_WS0_plus_WSTA09/

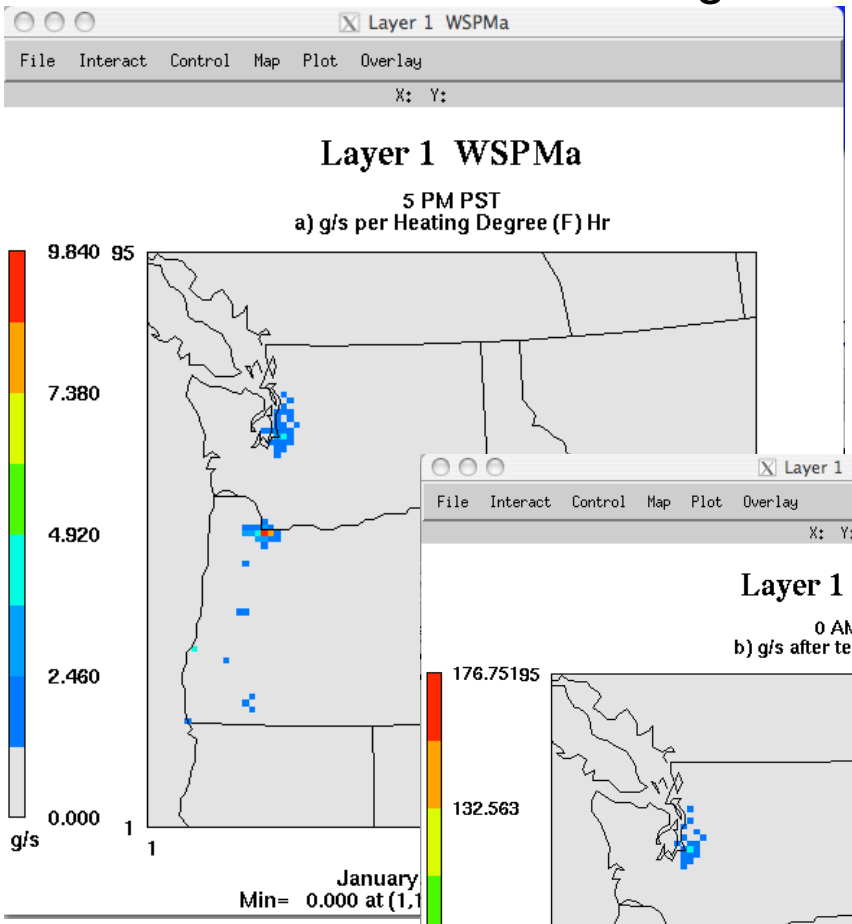
WS emissions (tons per HDD) were gridded, speciated & temporally allocated to a constant map (g/s per HD Hr by cell), then adjusted by hourly cell temperature.

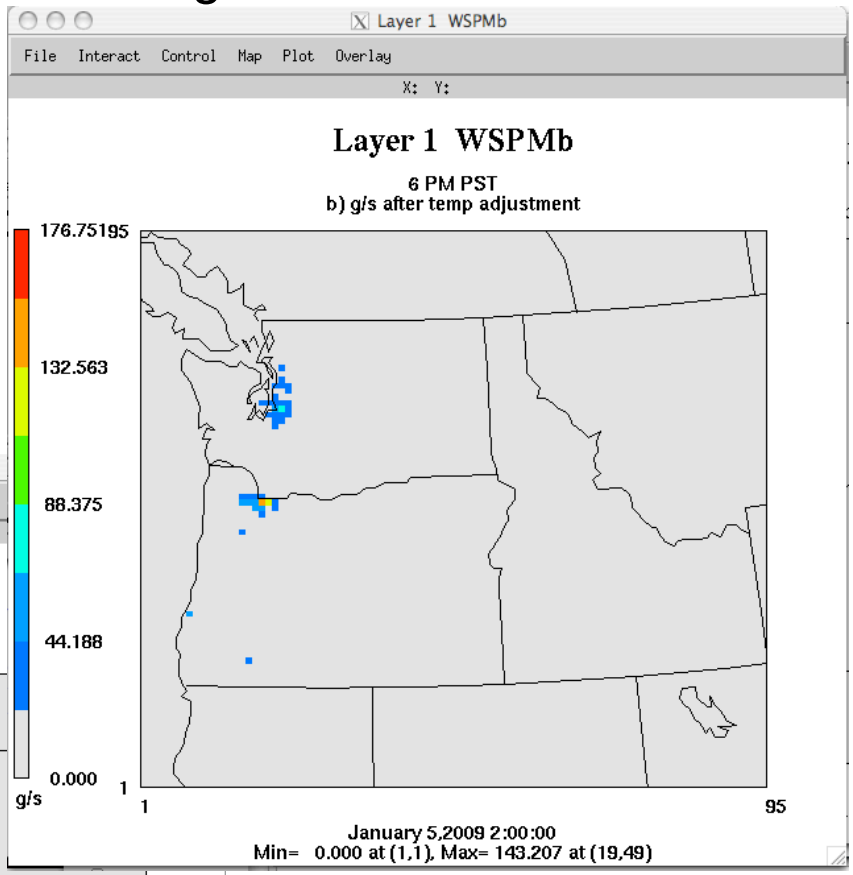


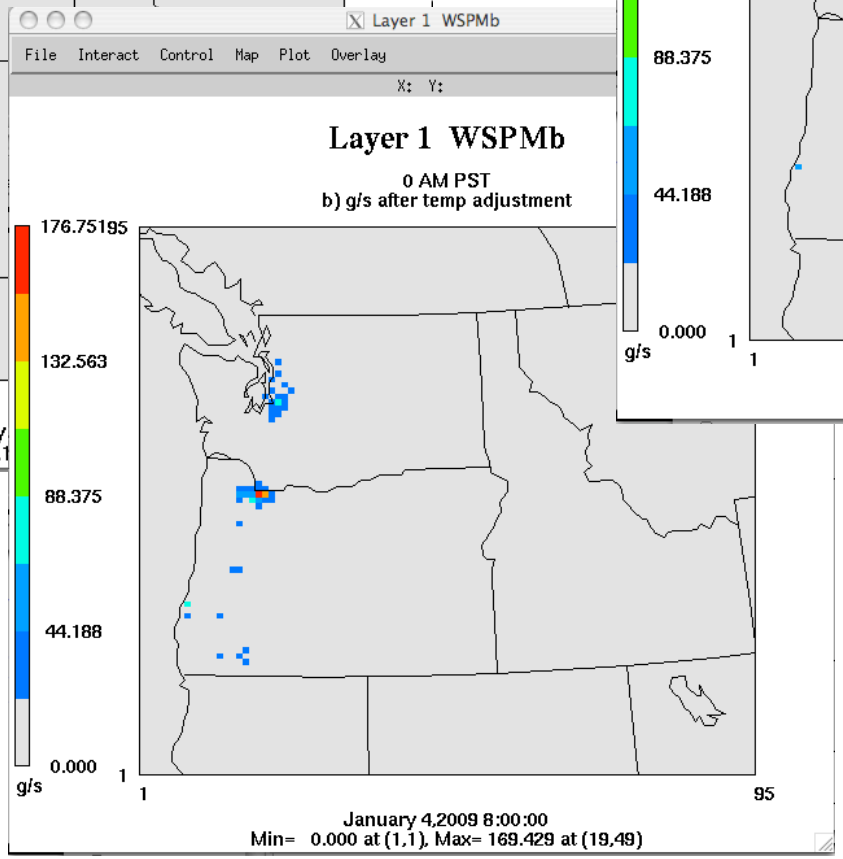




Constant emissions of 9.84 g/s/HDHr at Portland is temperature-adjusted to becomes 169 g/s at 0 PST and 143 g/s at 18 PST.

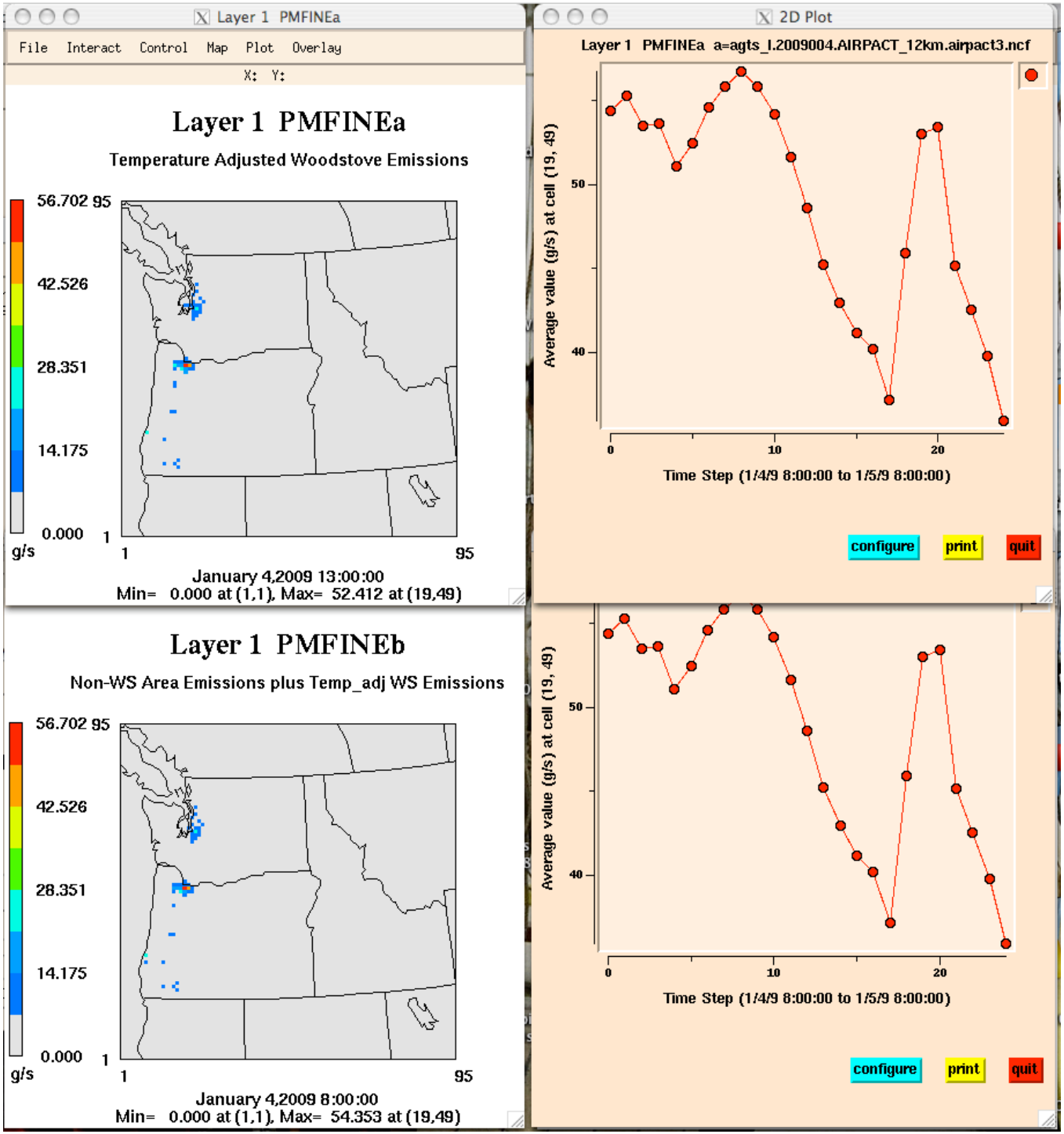






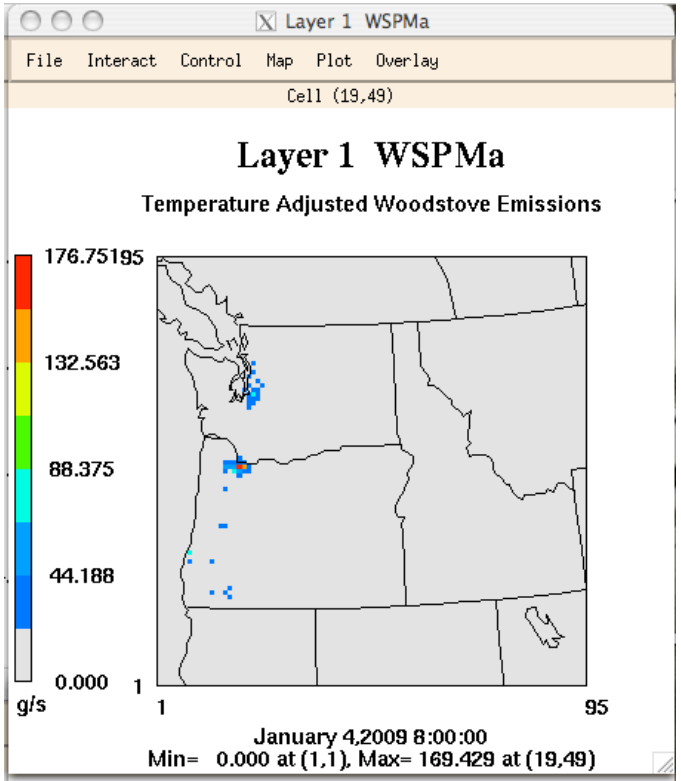
Temperature Adjusted WS emissions were added to Area Emissions with WS set to Zero.

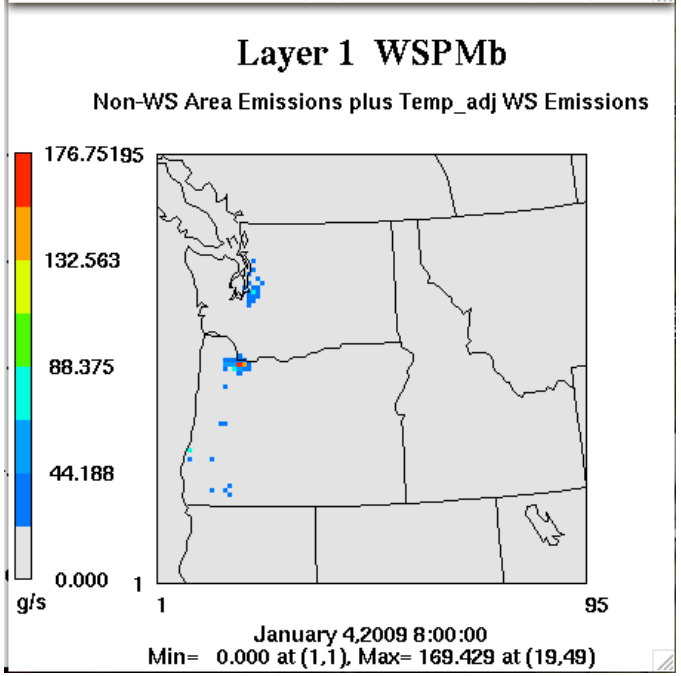
Max cell for PMFINE in Portland increases by ~2 g/s.



Temperature Adjusted WS emissions were added to Area Emissions with WS set to Zero.

Max cell for WSPM in Portland is unchanged.

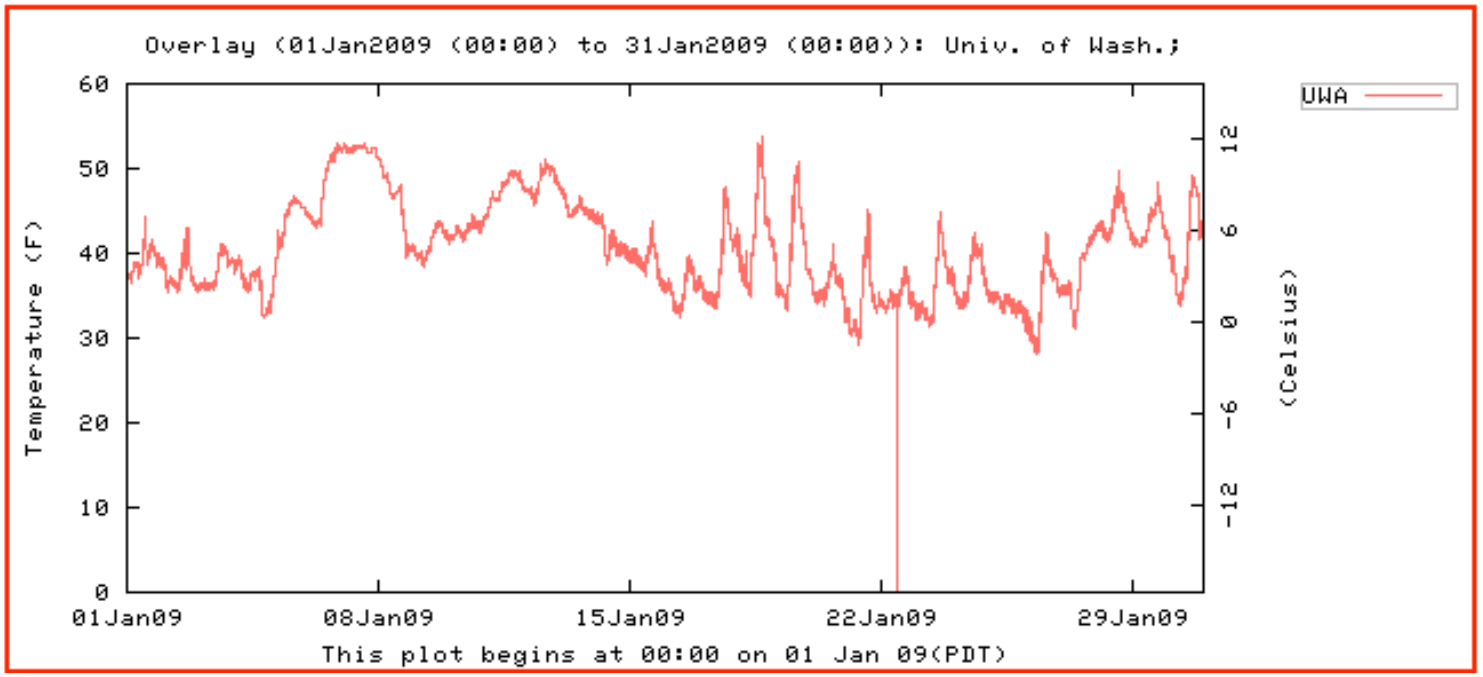




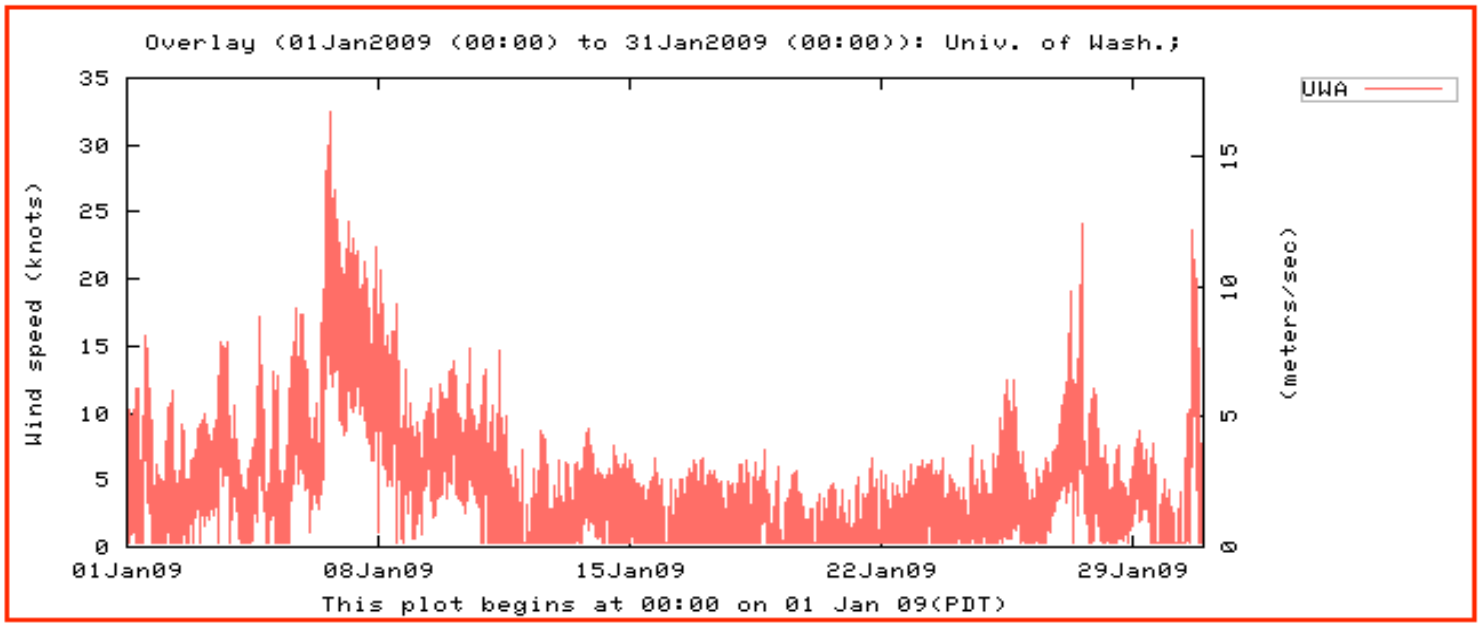
Periods to examine in CMQ results

- For best coupling of WS emissions to local PM results, we want low winds.
- Should look at both cold and warm periods in several areas.
- Avoid small towns for preliminary examination - due to mismatch of source footprint scale to cell size (and to protect against known grid discrepancy).

Air Temperature (Fahrenheit)



Wind speed (knots)



Created by:

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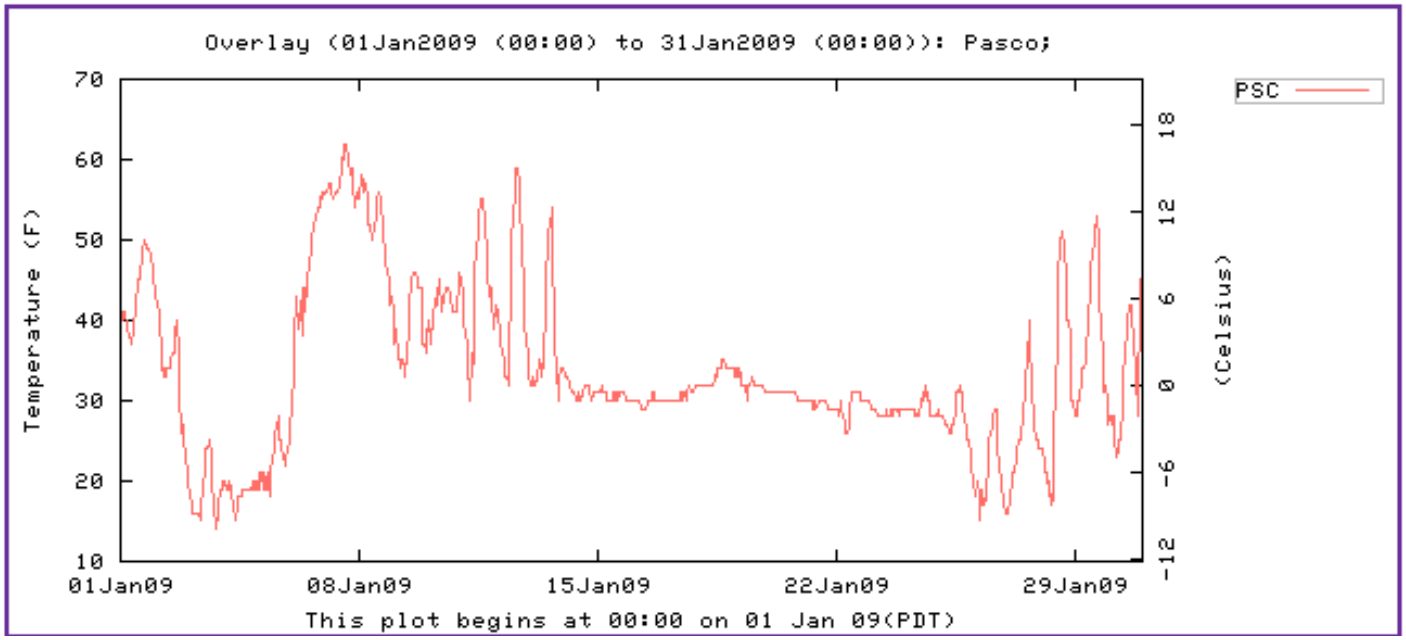
Air Temperature (Fahrenheit)



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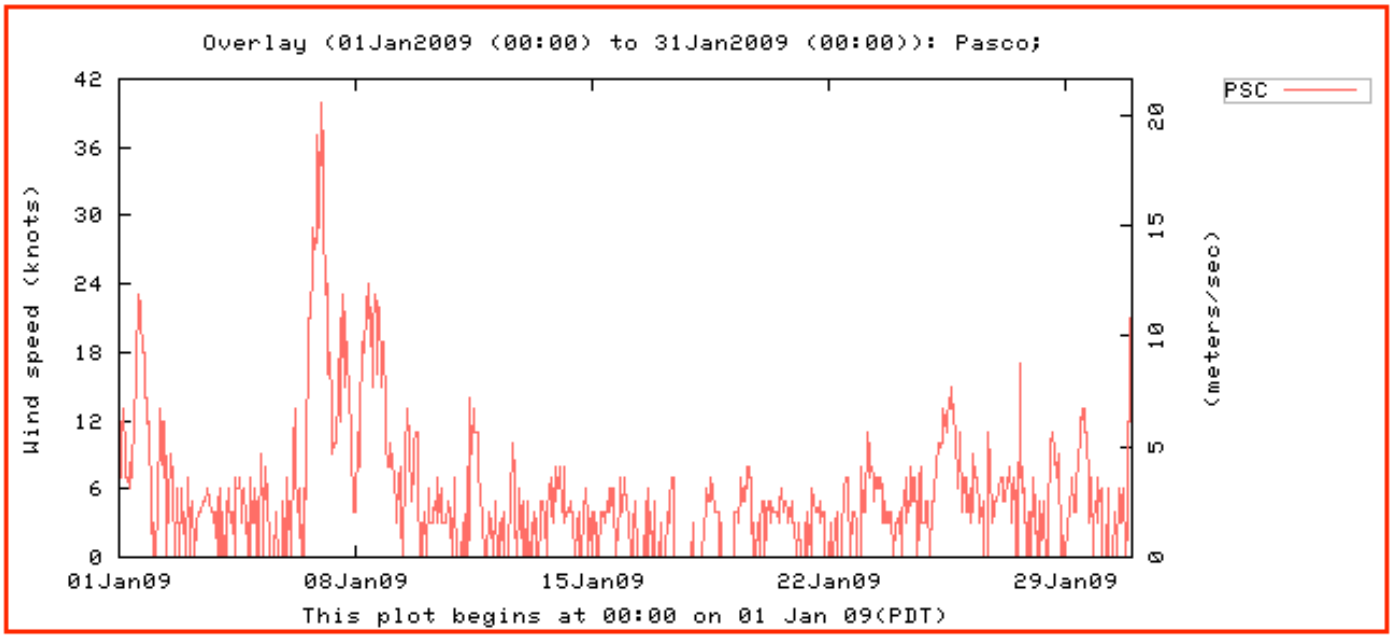
Wind speed (knots)



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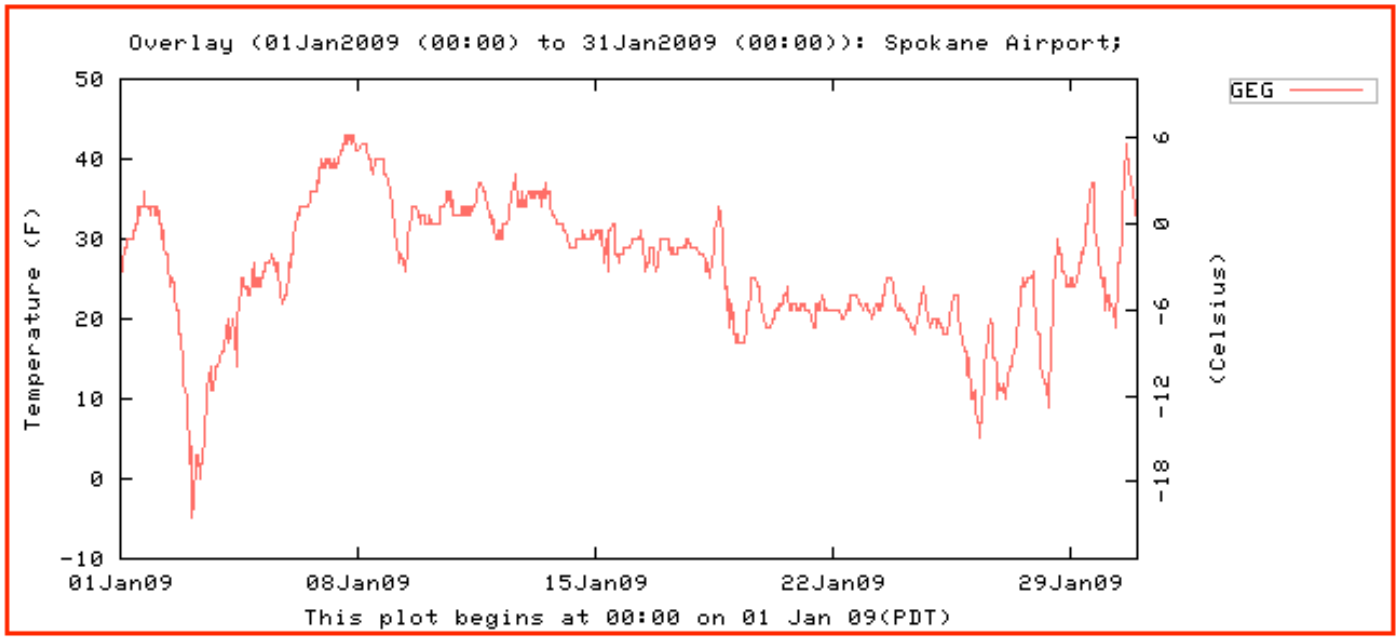
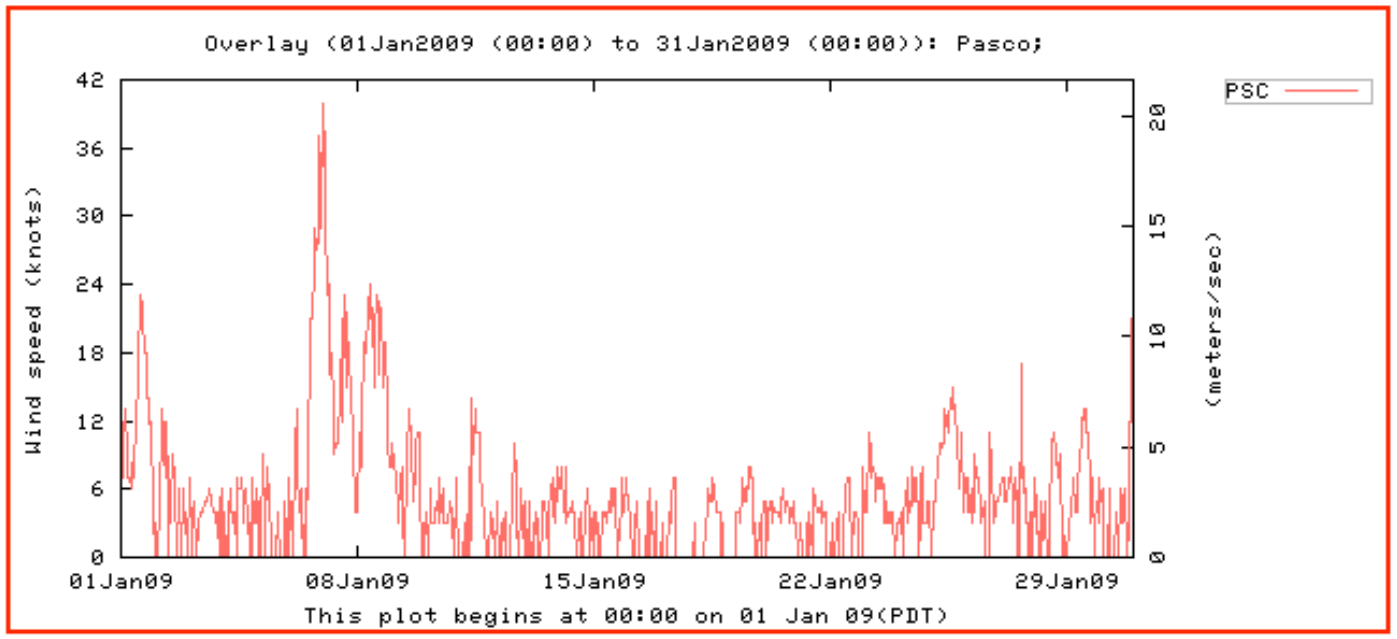
Air Temperature (Fahrenheit)



Wind speed (knots)



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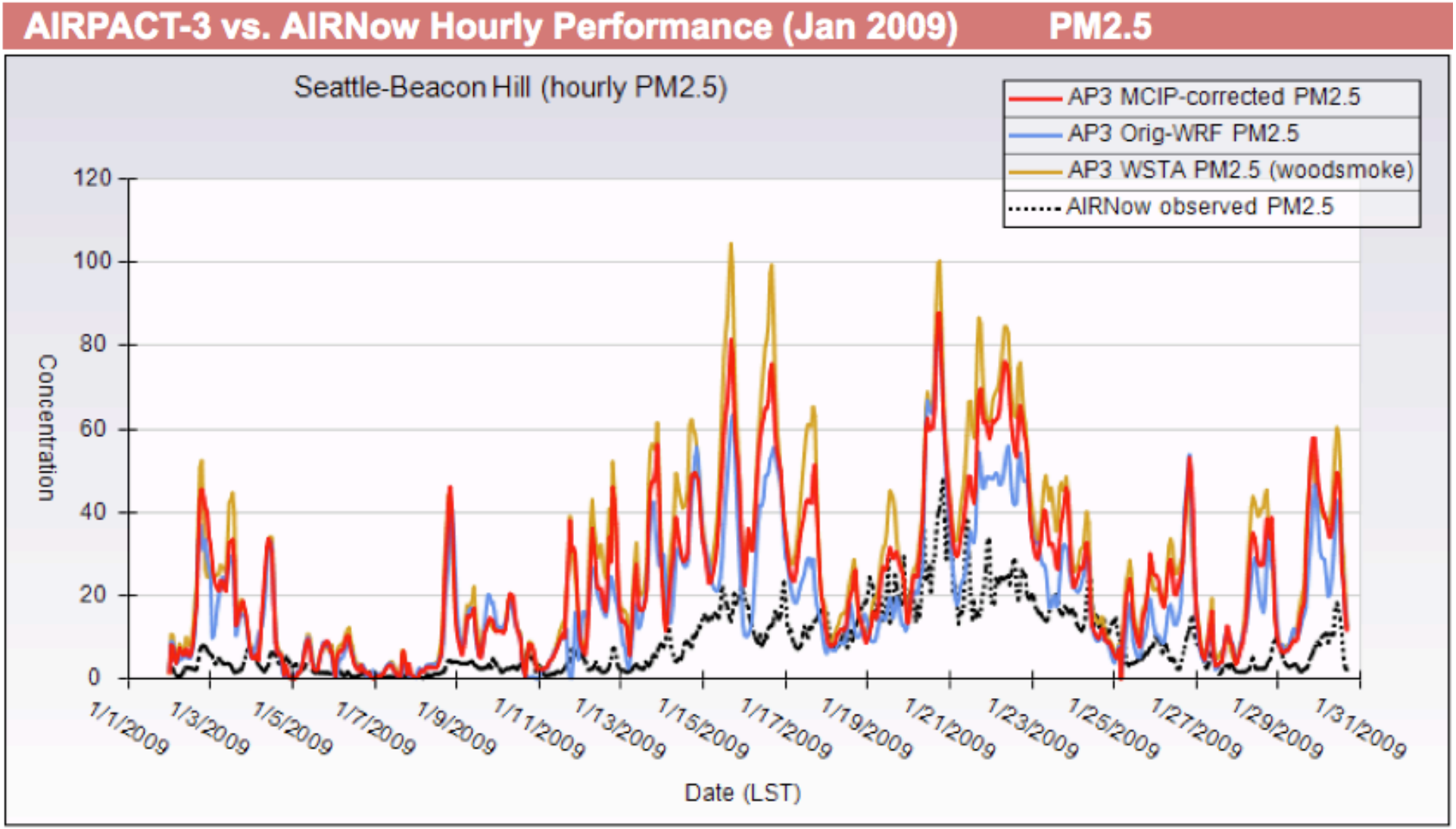
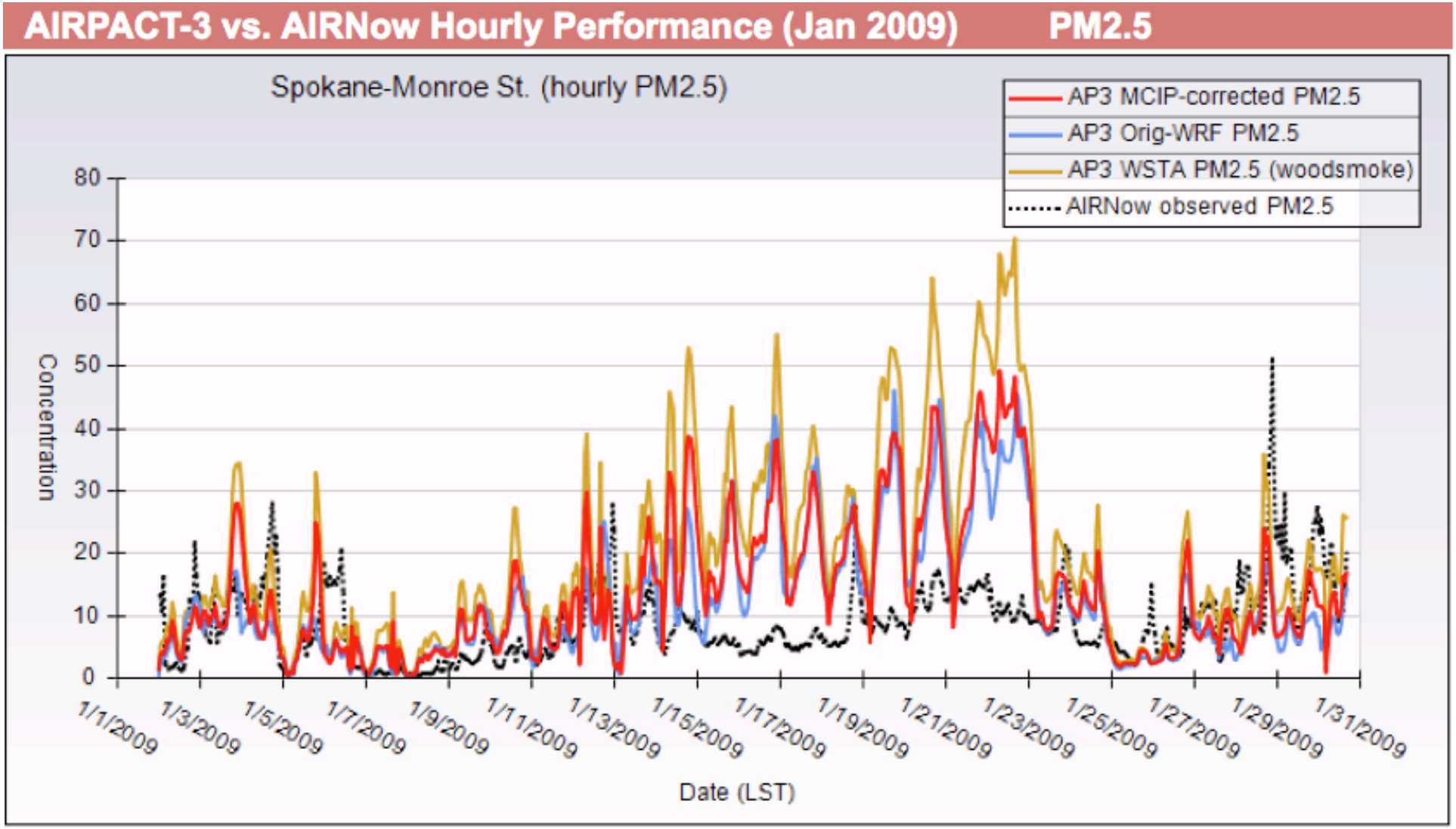
Dates for comparisons

	Conditions	Western WA (UW)	Central WA (Pasco)	Eastern WA (Spokane)
	Cold w/ light wind	Jan 4, 2009 30-38 F 0-14 kts (moderate wind)	Jan 4, 2009 < 20 F < 6 kts	*Jan 3, 2009* 0-15 F < 5 kts
	Warm w/ light wind	Jan 12, 2009 45-50 F ~ 5 kts	Jan 12, 2009 30-60 F ~ 6 kts	Jan 12, 2009 30-35 F < 5 kts

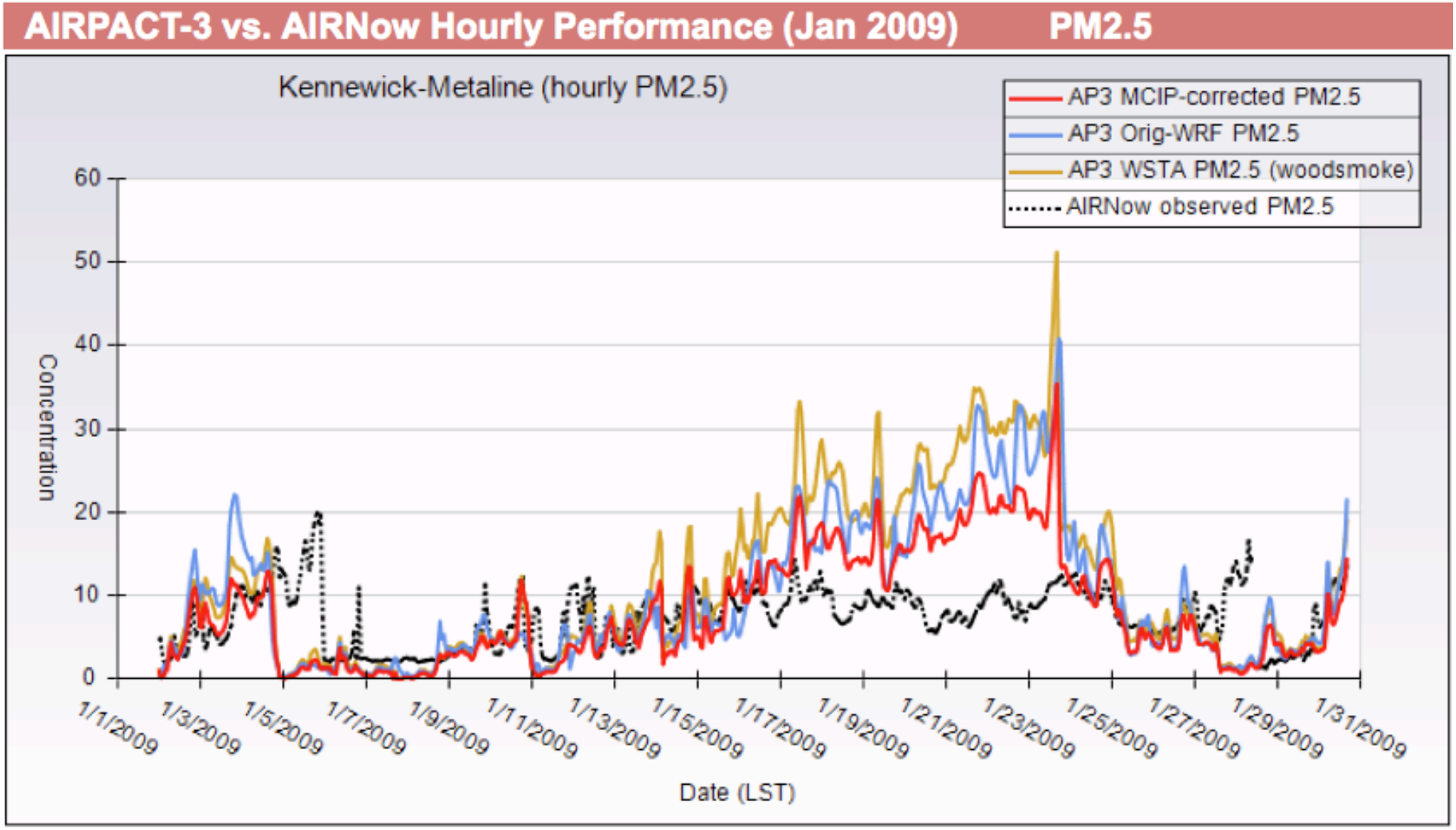
CMAQ results: Seattle Beacon Hill



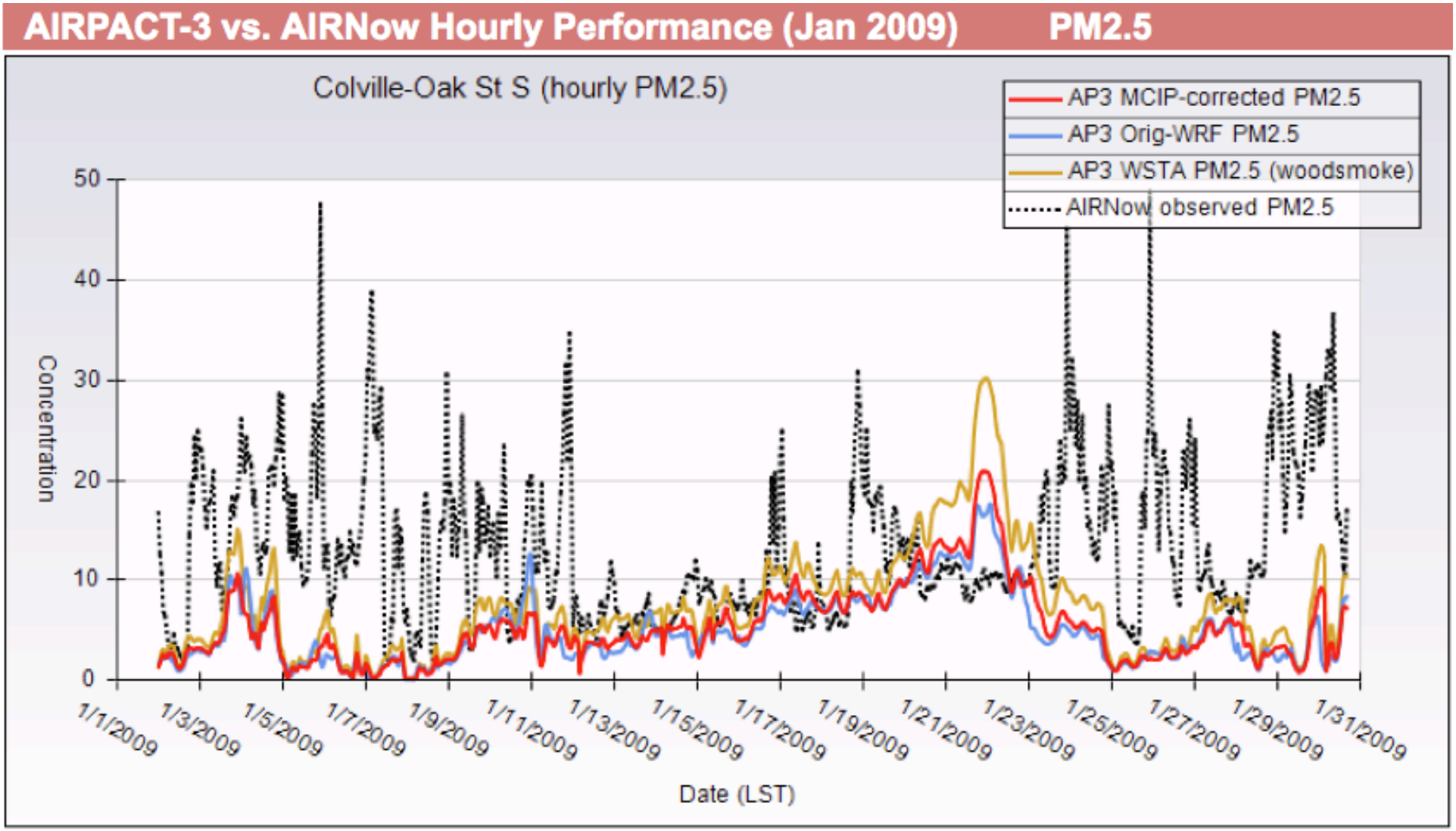
CMAQ results: Spokane Monroe Street



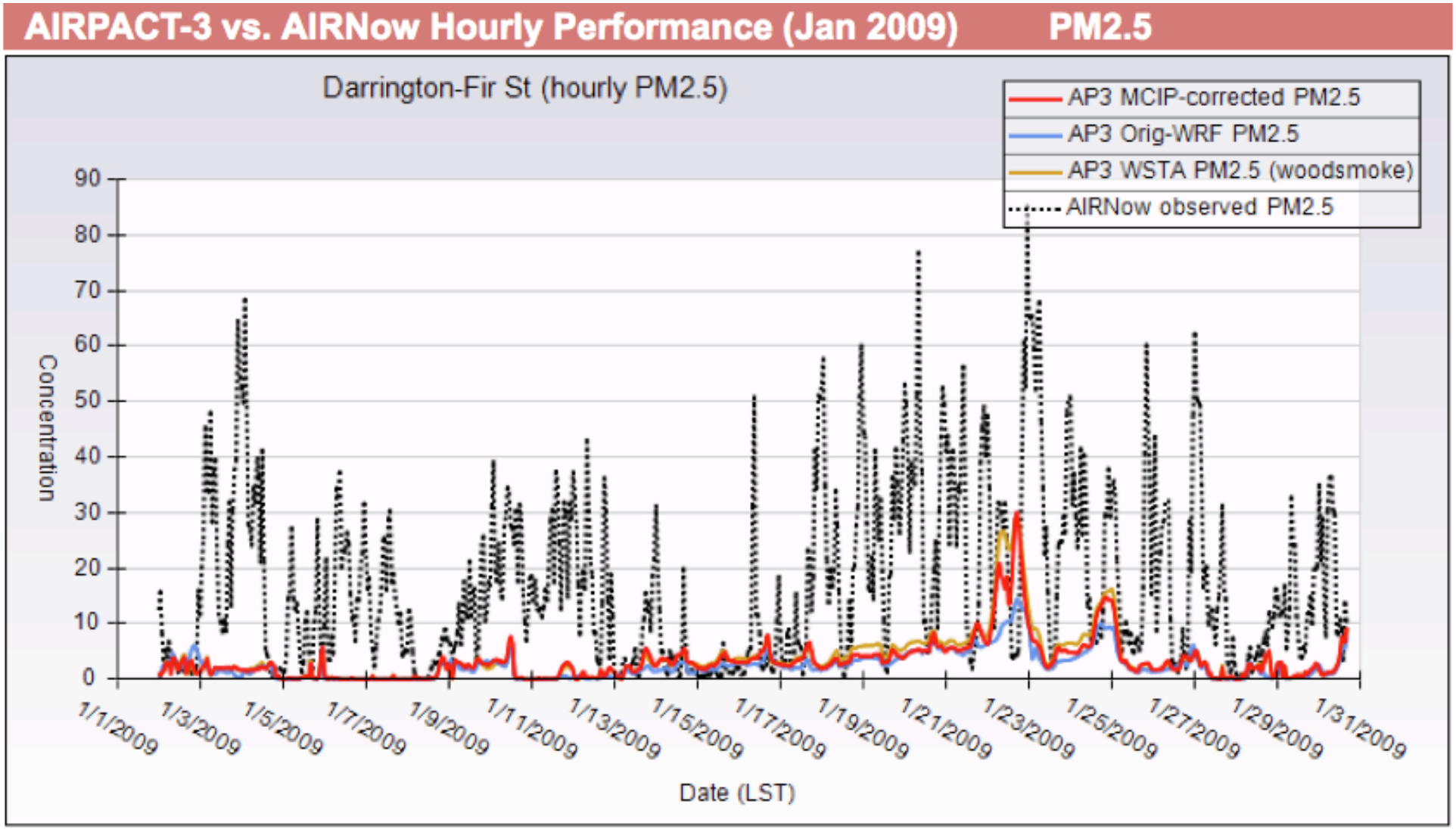
CMAQ results: Tri-Cities Kennewick-Metaline



CMAQ results: Colville - Oak Street S



CMAQ results: Darrington - Fir Street



Conclusion

- While more QA is needed to verify that prototype process is error-free, some tentative conclusions …
- This prototype process for adjustment of wood stove emissions by WRF-forecast temperature gives poor results, inferior for large cities and small towns.

Thank you for your patience.