Wood Stoves in the Northwest

Refining spatial allocation with updated surrogates in AIRPACT

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Outline

1. AIRPACT RWC Temp-Adjustment experiment – quick summary
   - Motivation to re-examine spatial allocation of RWC emissions

2. Spatial Surrogates for RWC emissions in AIRPACT-4
   - Test effects of different RWC surrogates on total wintertime $PM_{2.5}$
   - Different sites -> different surrogates
   - Composite surrogate for RWC emissions in AIPRACT-5?

3. Summarize RWC emission experiments

4. General AIRPACT4 $PM_{2.5}$ evaluation – Vikram, Alfredo

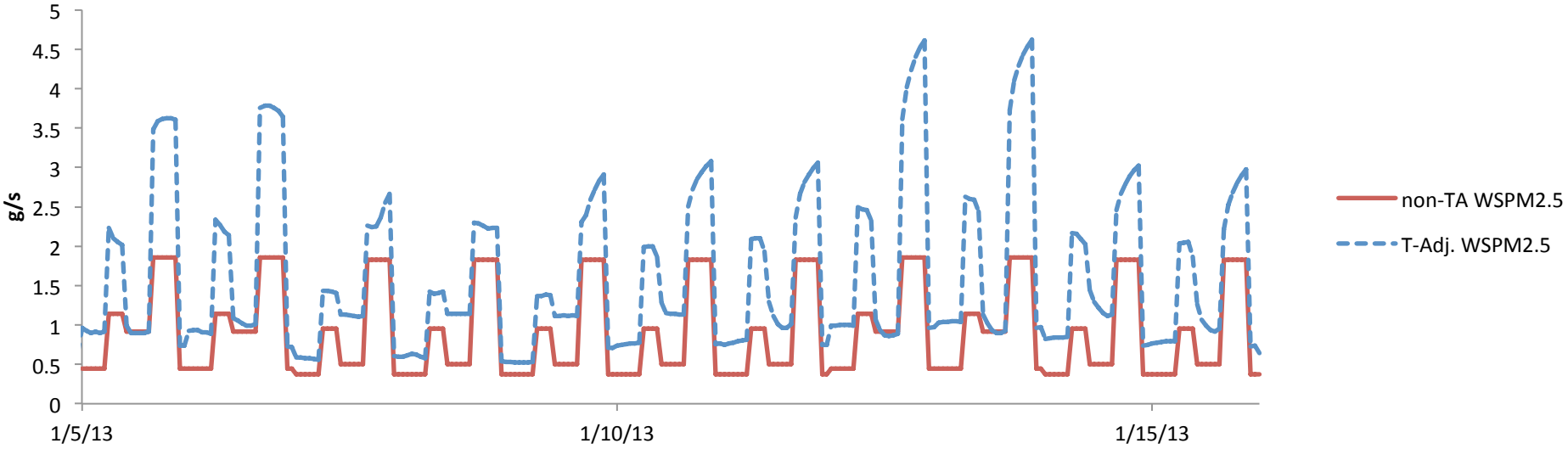
RWC Temperature-Adjustment Experiment

- Evaluation of AIRPACT-4 $PM_{2.5}$ forecasts against YAWNS obs. – Temporal inconsistencies
- Temperature adjustment algorithm – will it improve $PM_{2.5}$ forecasting in the NW?

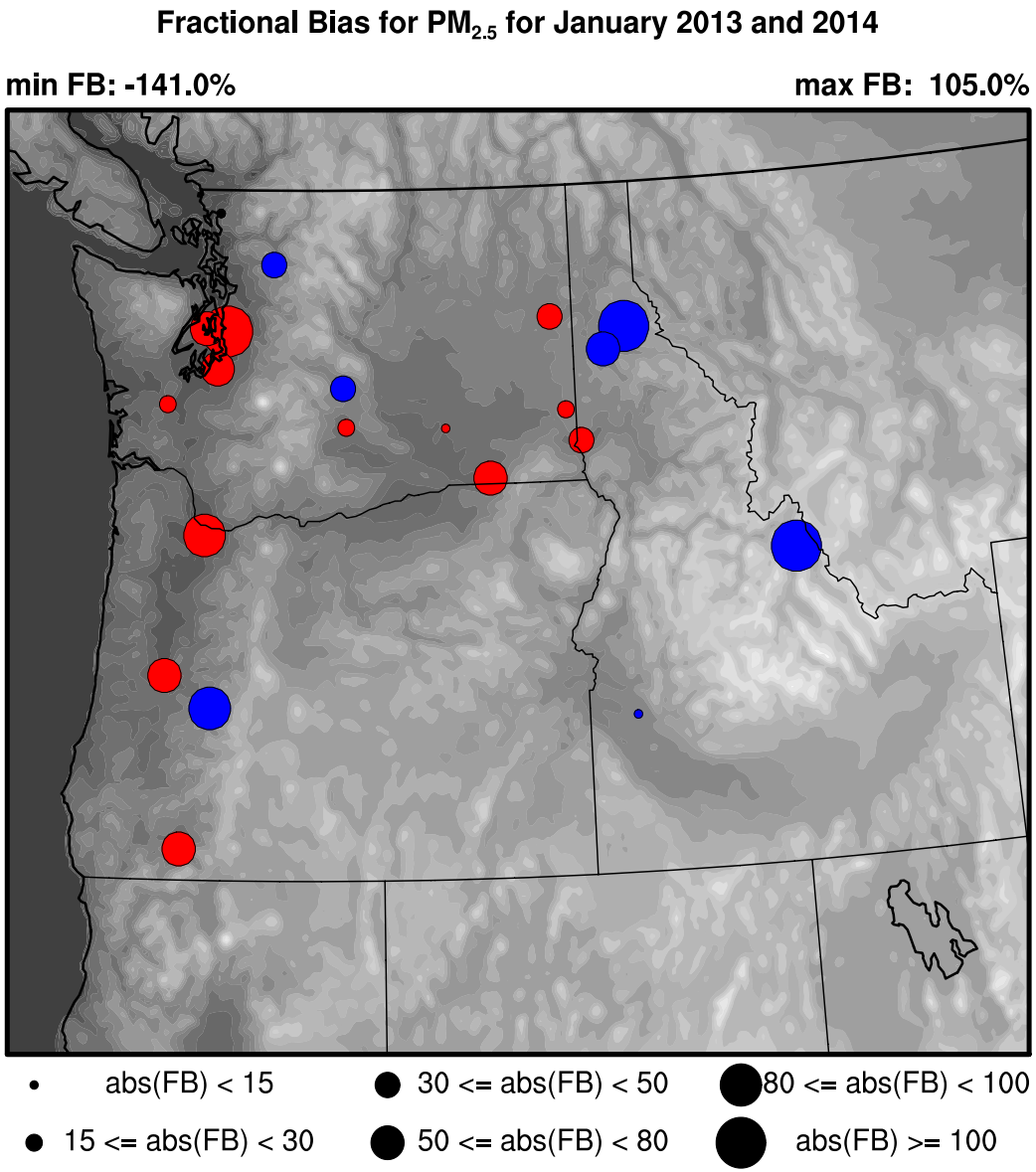
  1. Emissions [tons/HD-Day] imported, converted to hourly average

  3. Use "flat" temporal [tons/HD-Hr] emission profiles as base for 4 km cell emissions

  4. Apply expected day-of-week and diurnal temporal profiles, and 2-m **forecasted** temperature factor, relative to 50 F with min of 20 F: **Emis(i,j,1) = Tons/HDH(i,j,1)*HD_HOUR(i,j)*DAYOFWK_Fctr*HR_Factr**



RWC Temp-Adjustment Results: AIRPACT-4 Total $PM_{2.5}$ Forecasts



- Disregard Pinehurst, Salmon, Oakridge? (entrainment)

Blue = negative bias

Red = positive bias

RWC Temp-Adjustment Results: AIRPACT-4 Total $PM_{2.5}$ Forecasts

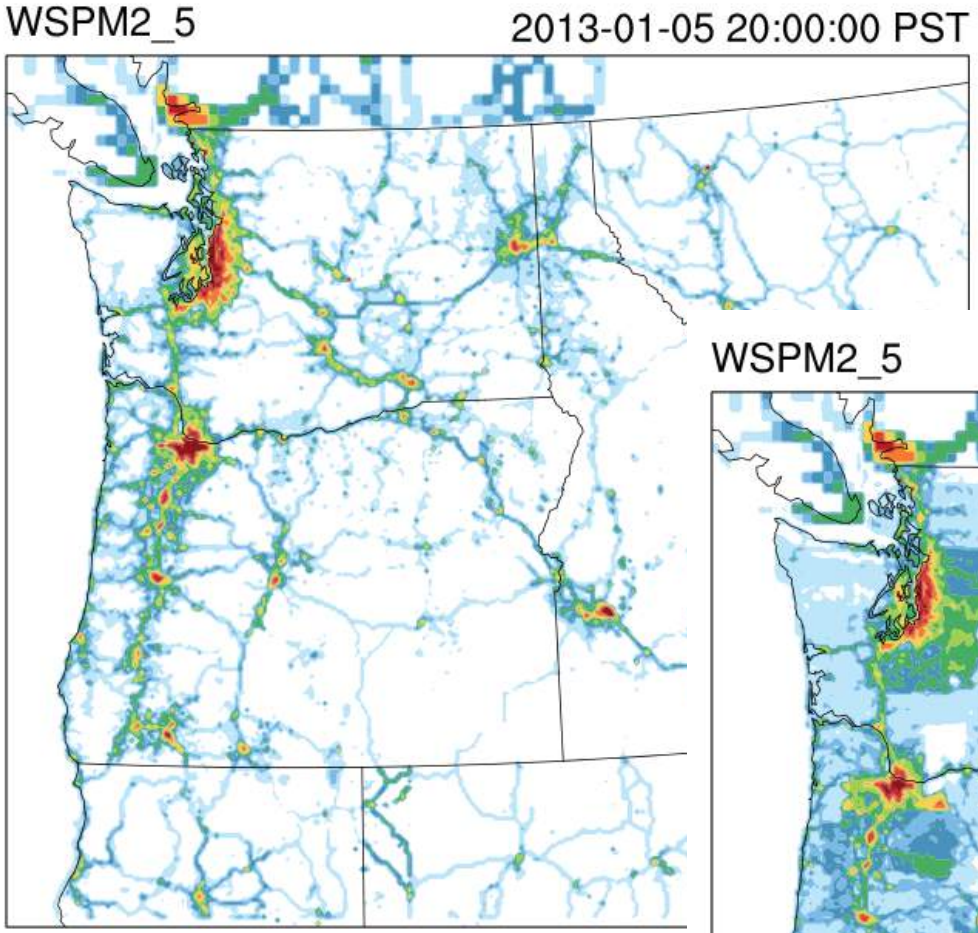
Site	Airpact MFB	Airpact MFE	T-Adj Airpact MFB	T-Adj Airpact MFE	Mean Obs PM2.5	Bias reduction
Beacon Hill, Seattle	87%	87%	**105%**	105%	8	-18%
Portland	81%	112%	**81%**	82%	13	0%
Bremerton, WA	51%	60%	**75%**	79%	6.7	-23%
Tacoma, WA	39%	50%	**72%**	73%	14	-33%
Eugene, OR	54%	64%	**67%**	73%	12.8	-13%
Walla Walla, WA	31%	69%	**61%**	77%	14.4	-30%
Medford, OR	25%	49%	**50%**	62%	21.8	-25%
Spokane	41%	53%	**44%**	55%	8	-3%
Lewiston, ID	44%	53%	**40%**	45%	5.1	4%
Yakima, WA	10%	49%	**21%**	51%	15	-10%
Aberdeen, WA	-23%	44%	**18%**	56%	9.8	5%
Pullman, WA	16%	30%	**17%**	30%	6.5	-1%
Kennewick	34%	57%	**12%**	45%	9.2	22%
Bellingham, WA	-18%	66%	**0%**	41%	10.3	18%
Ellensburg, WA	-38%	53%	**-31%**	48%	10.3	7%
Darrington, WA	-82%	92%	**-36%**	72%	13.9	46%
Plummer, ID	49%	64%	**-52%**	64%	6.6	-3%
Oakridge, OR	-121%	121%	**-93%**	100%	24.6	28%
Pinehurst, ID	-141%	141%	**-135%**	135%	21.4	6%
Salmon, ID	-147%	147%	**-141%**	142%	26	6%
MEAN						**-1%**

RWC Spatial Surrogates for testing

- New goal: Improve AIPRACT wintertime $PM_{2.5}$ forecasting by refining RWC spatial allocation

Wood Stove Spatial Surrogate	Description
USA 3001 (AP4)	Primary wood heating pop.
USA 165	0.5(Low intensity development) + 0.5(Residential wood heating pop.)
USA 165 version 2	0.5(Forest coverage) + 0.5(Rural population)
USA 165 version 3	0.5(Forest coverage) + 0.5(Residential wood heating pop.)
USA 165 version 4	0.5(Forest coverage) + 0.5(USA 165v1)
USA 165 version 5	0.5(Forest coverage) + 0.5(Low intensity development)
USA 527	Single Family Residential

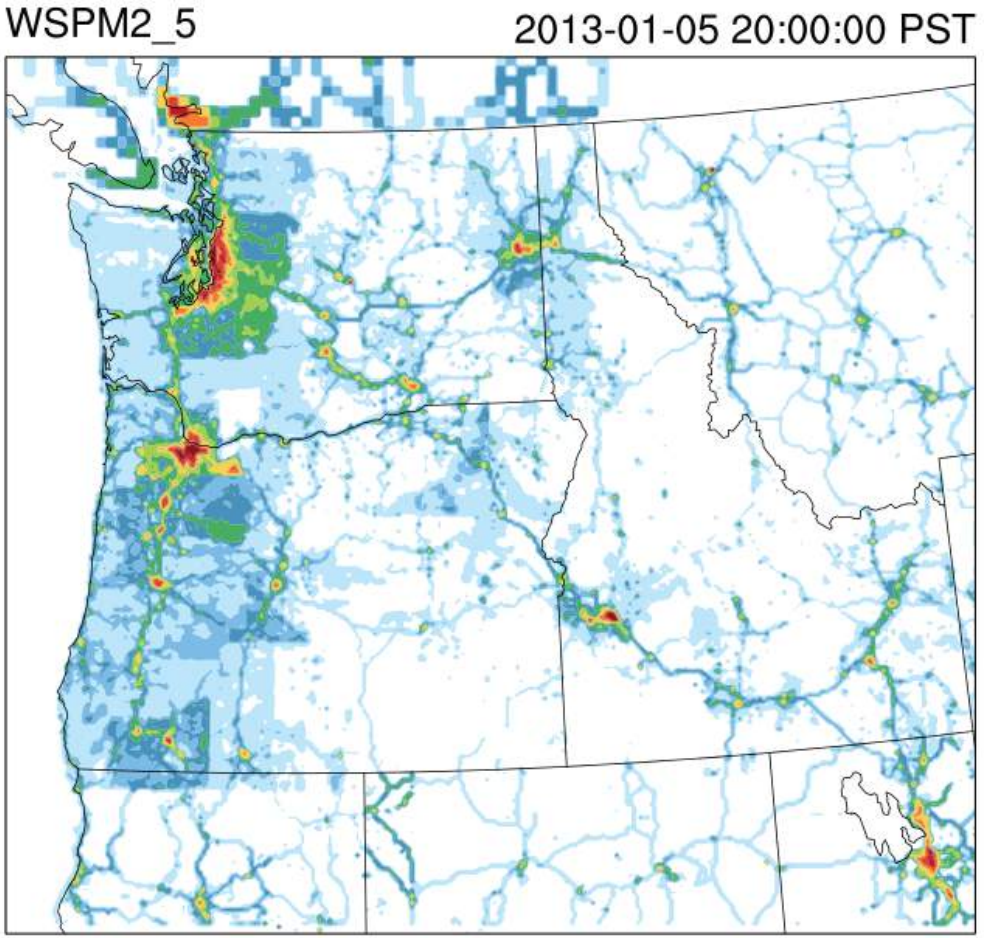
USA 3001 RWC emis: Res. Wood heating



gram s^{-1}

5

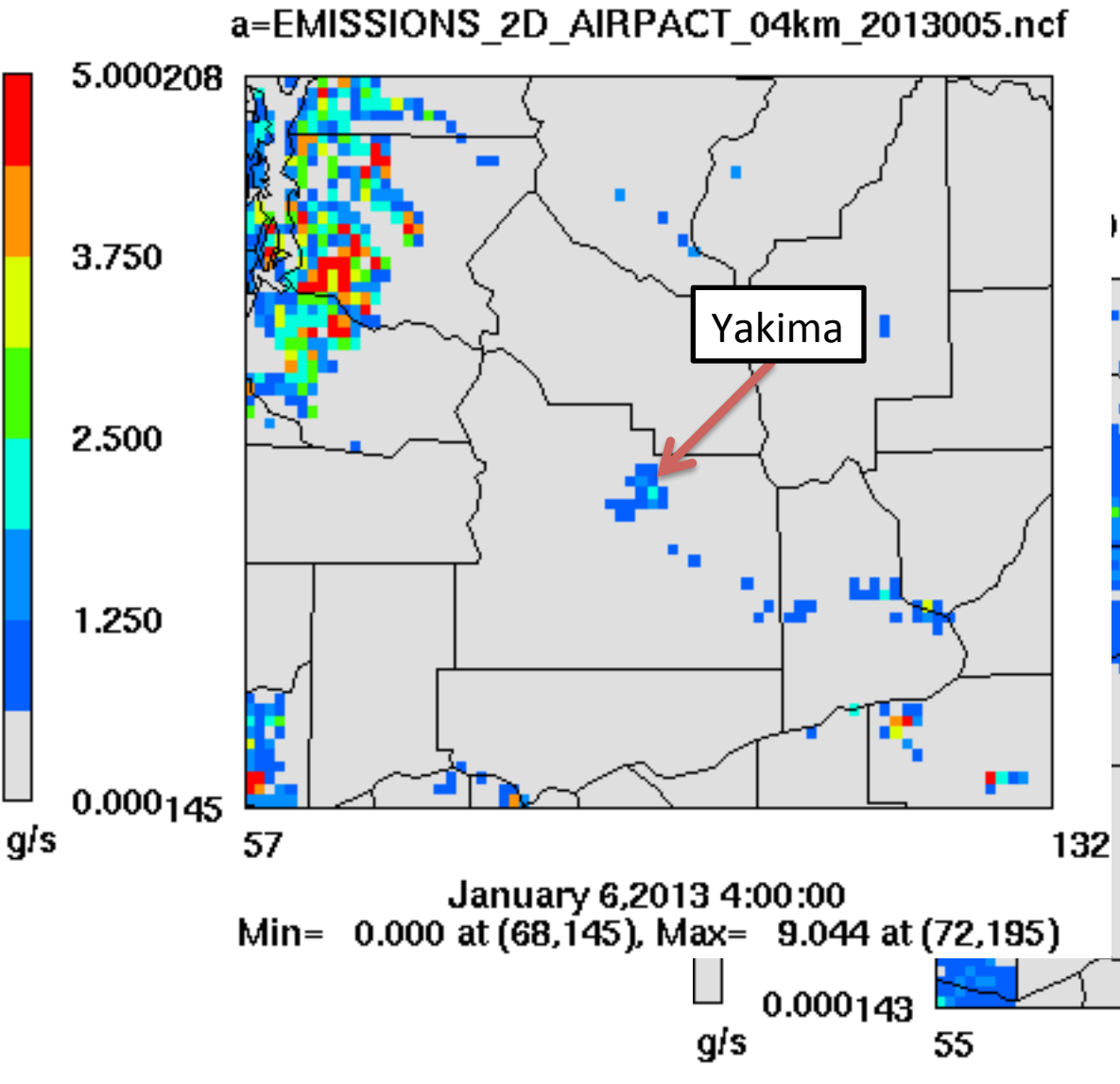
165 v2: Forest coverage + rural pop



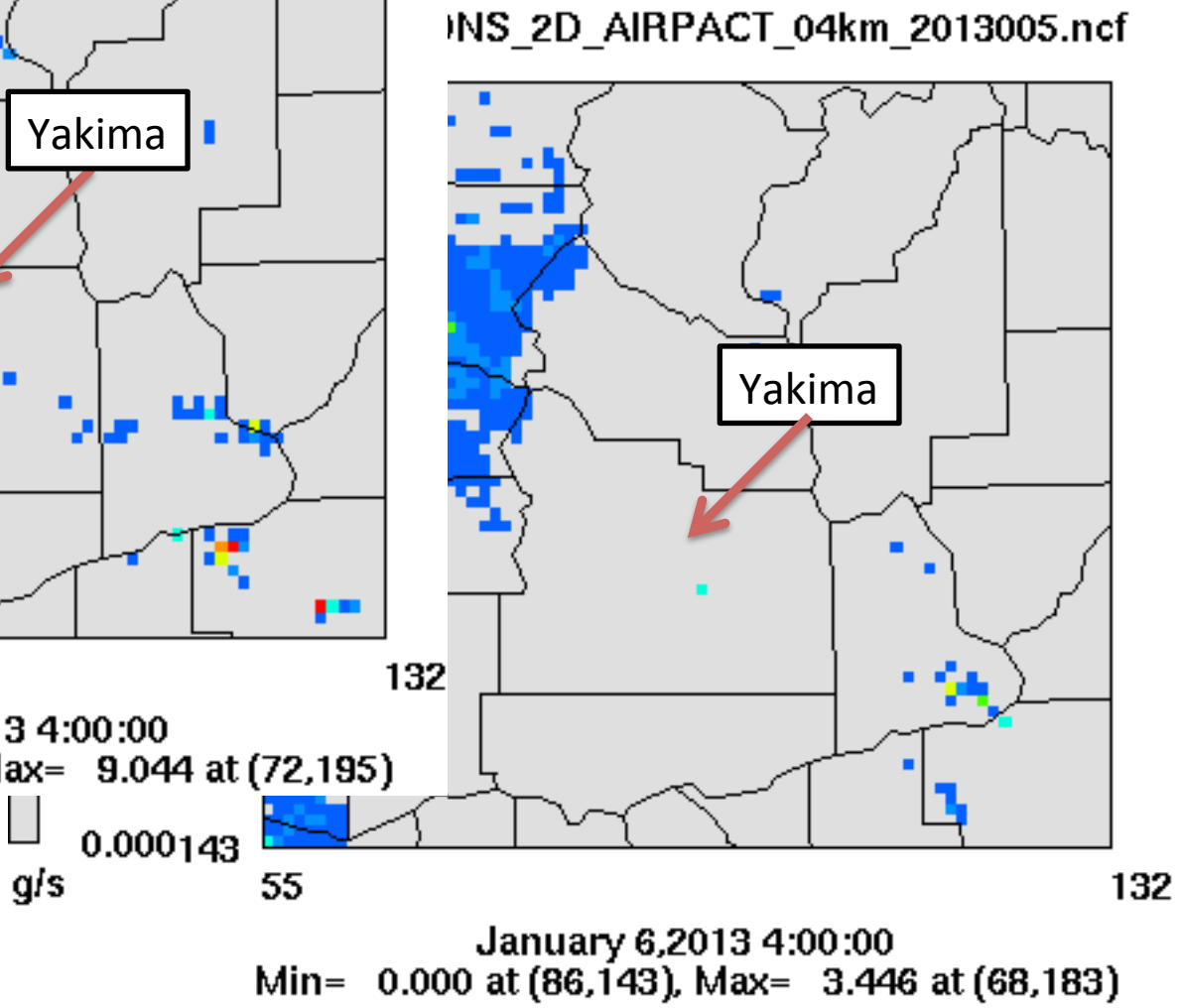
gram s^{-1}

5
4
3
2
1
0.5
0.2
0.1
0.05
0.01

USA 3001: Res. Wood heating



USA 165 v4: Res. Wood heating x Low intensity development



Possible Outcome: Composite RWC surrogate map?

Wood Stove Spatial Surrogate	Description
USA 3001 (AP4)	Primary wood heating pop.
USA 165	0.5(Low intensity development) + 0.5(Residential wood heating pop.)
USA 527	Single Family Residential (Agricultural?)
Other '165' modification?	Refined RWC census data (ODEQ)

AIRPACT4 - PM Evaluation for 2009-10

AIRQUEST Annual Meeting

June 24-26, 2015

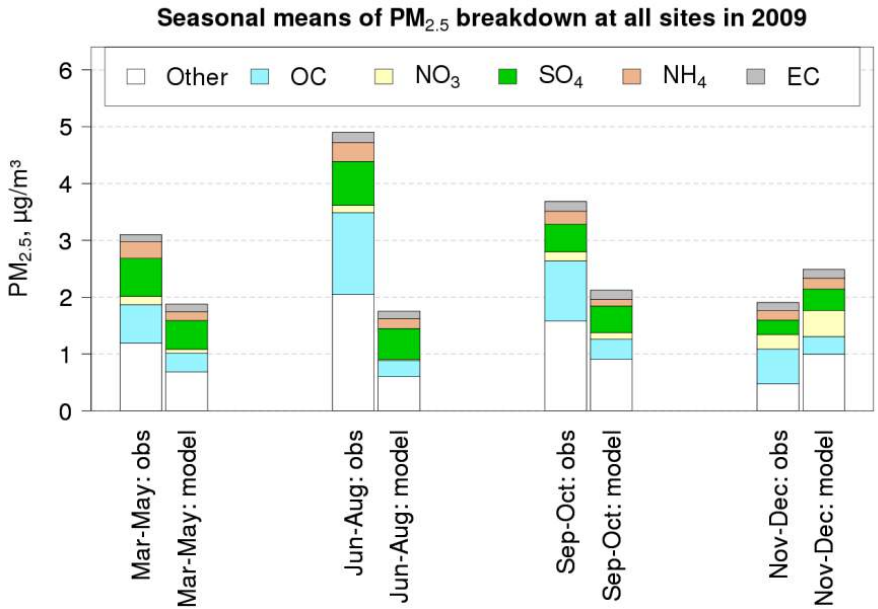
Portland OR

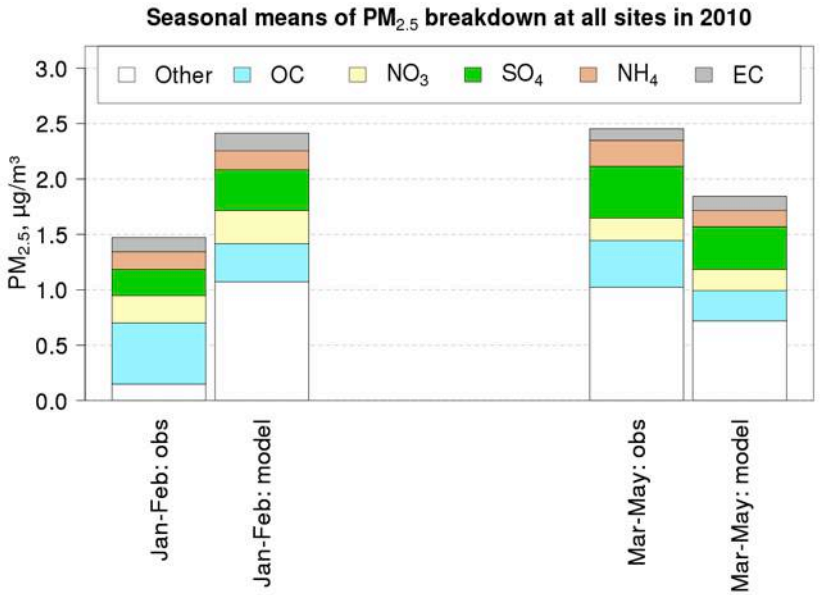
Regional Haze Modeling project

- Retrospective run with forecast meteorology
- Period of simulation: May 2009 – April 2010
- Emissions: Forest fires emissions not considered.
  - BASE case: all emissions
  - RACT case: with reduced SO2 and PM emissions from certain pulp/paper industries in WA
- Boundary conditions: based on monthly mean MOZART output (2009)
- AIRPACT4 evaluation:
  - PM2.5 and different PM species
  - Also evaluated for Ozone (hourly, 8-hr max and episodic ozone) and Visibility (Deciviews)

PM Evaluation

- OC and $(NH_4)_2SO_4$ dominant species during summer & fall months.
- NH_4NO_3 becomes significant during winter months.
- No fires considered: possible cause of OC underprediction during summer.





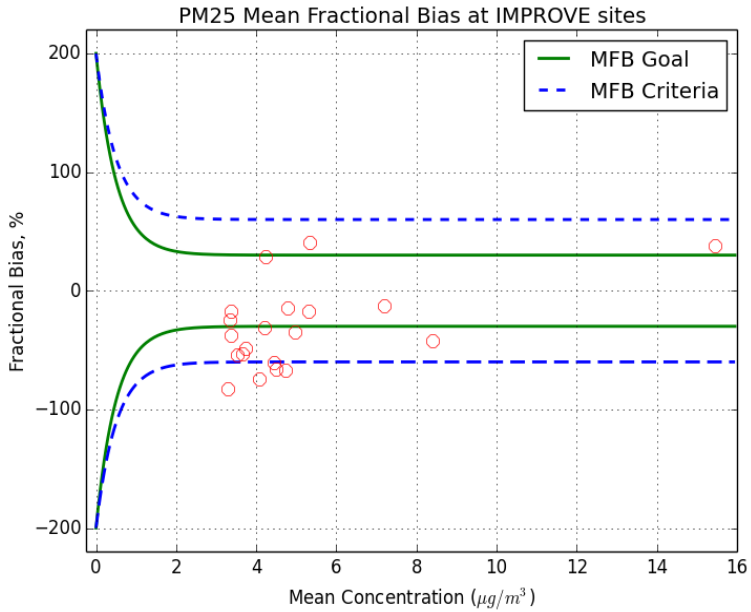
PM Evaluation cont…

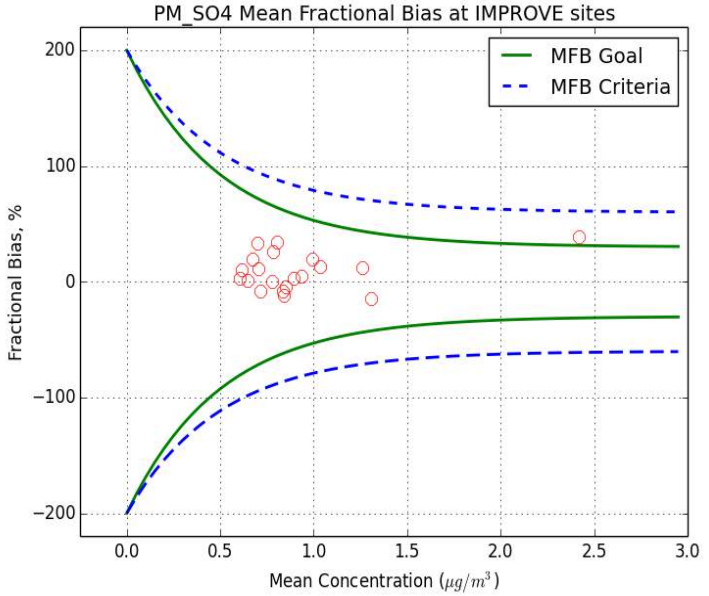
- MFB and MFE calculated at all IMPROVE sites:

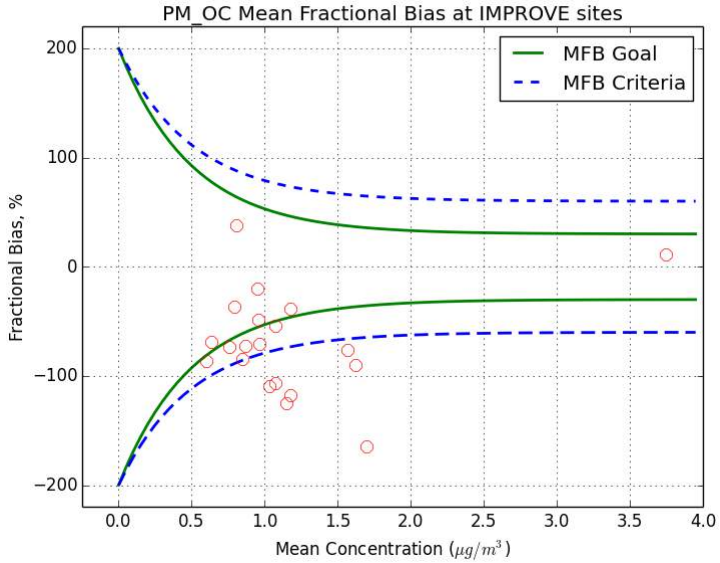
PM Species	MFB (%)	MFE(%)
Total $PM_{2.5}$	-31	72
Organic Carbon (OC)	-70	103
Elemental Carbon (EC)	-12	75
Sulfate (SO_4^{2-})	9	52
Nitrate (NO_3^-)	-42	115
Ammonium (NH_4^+)	-37	67

- Elemental carbon and sulfate have low bias compared to other species
- MFB is close to the median MFB from various model studies reported in Simon et. al. (2012)

Performance goals and criteria







- Doing good overall for total PM2.5 and sulfate
- 16 out of 20 IMPROVE sites within the performance criteria for $PM_{2.5}$
- OC still an issue in air quality models

Summary

- The model performance evaluation against MFB and MFE goals and criteria indicates that model demonstrates reasonable performance for $PM_{2.5}$, EC, SO_4^{2-} and NH_4^+.
- The model overpredicts $PM_{2.5}$ during winter and underpredicts during other times of year. This seasonality is observed for all PM species.
- AIRPACT4 performance similar to results from other air quality model evaluation studies as presented in Simmons et al. (2012)