Evaluation of a Lagrangian air quality model against AirNow observations and the AIRPACT 3-D air quality model

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PM and Climate Change
A novel Lagrangian modeling approach

Apply a Lagrangian air quality model to specific air quality source-receptor scenarios in the western US

Drive the model with downscaled current and future climate conditions to address an ensemble of climate realizations

Dynamically Downscaled Climate Data → 3-D Air Quality Model

Statistically Downscaled Climate Data

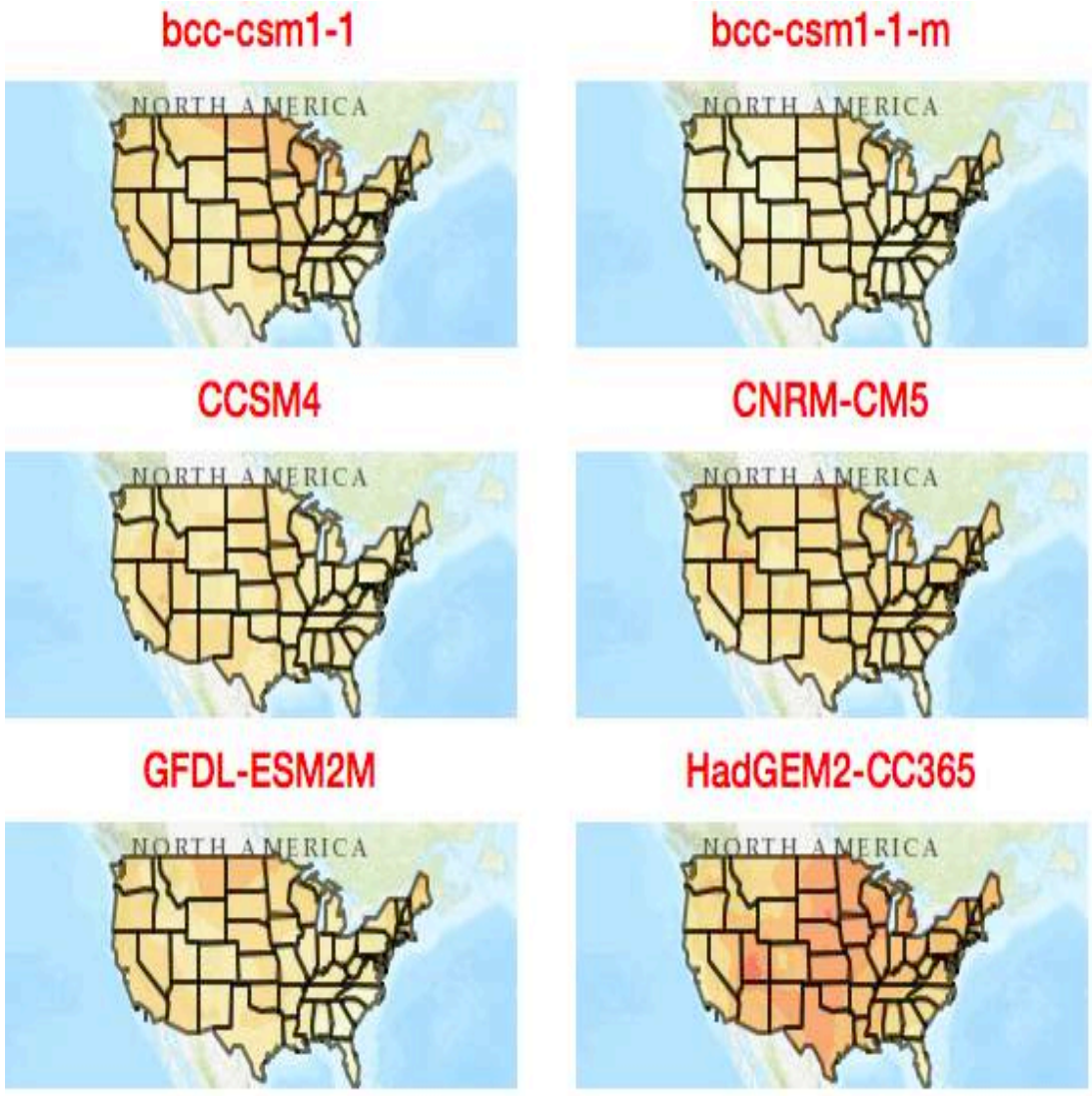
MACA (Multivariate Adaptive Constructed Analogue)

4 km gridded downscaled climate daily mean data with bias-correction (Abatzoglou and Brown, 2011)

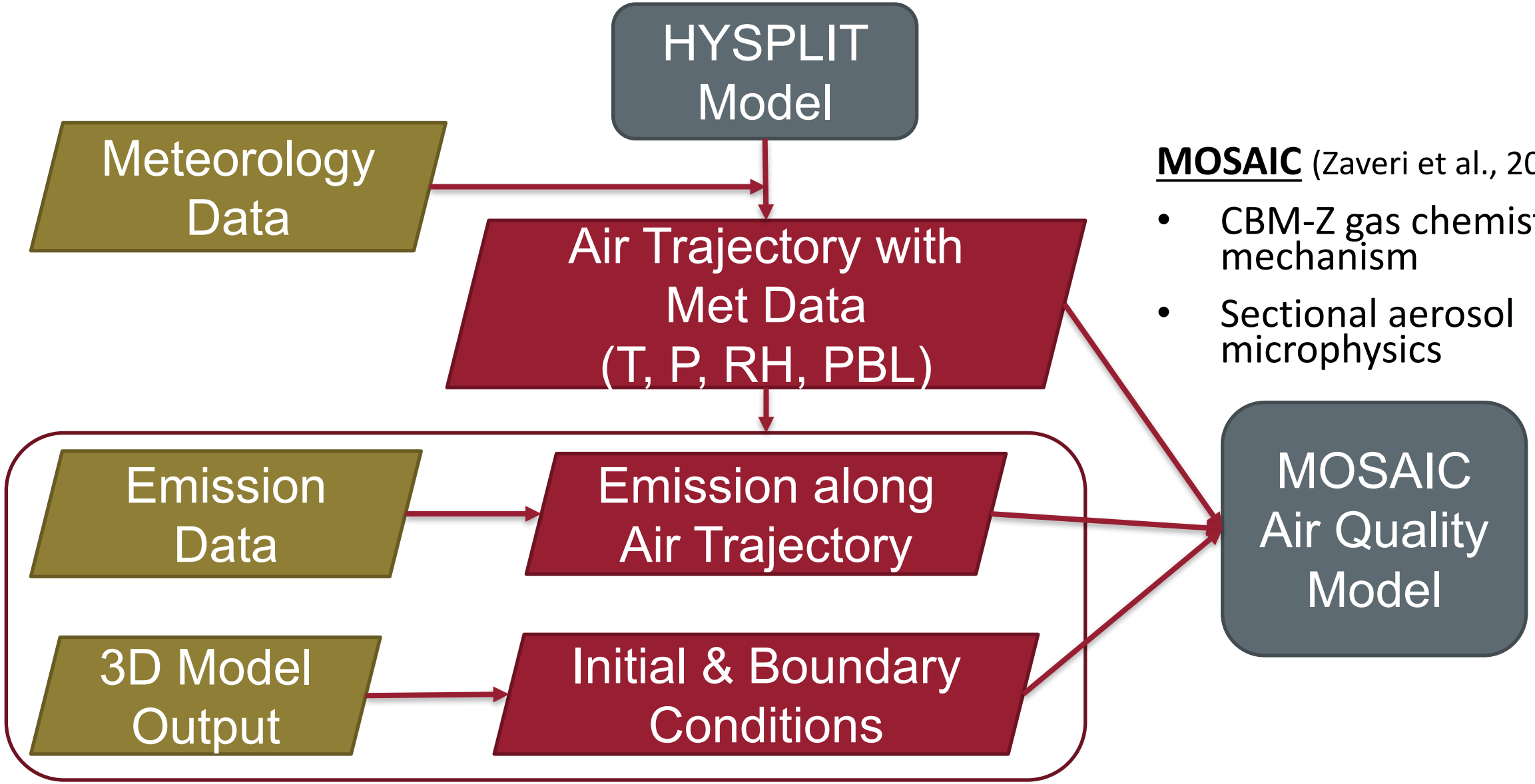
- max and min T & RH
- wind speed and direction
- precipitation
- specific humidity
- solar radiation

RCP 4.5—modest projected climate change

RCP 8.5—extreme projected climate change



A Lagrangian AQ Modeling Framework

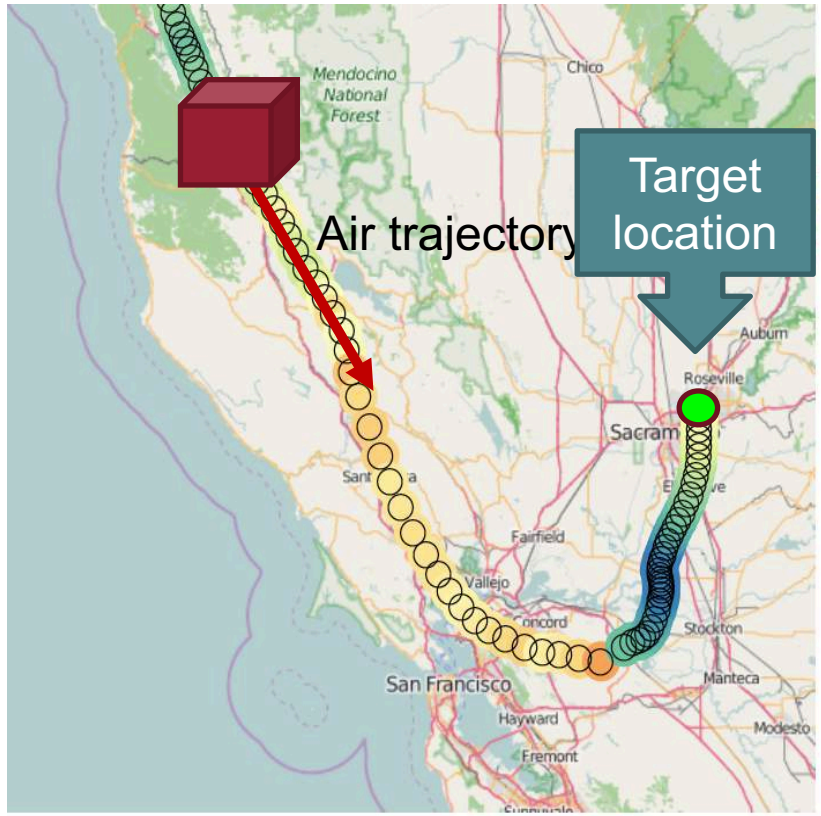


MOSAIC (Zaveri et al., 2008)

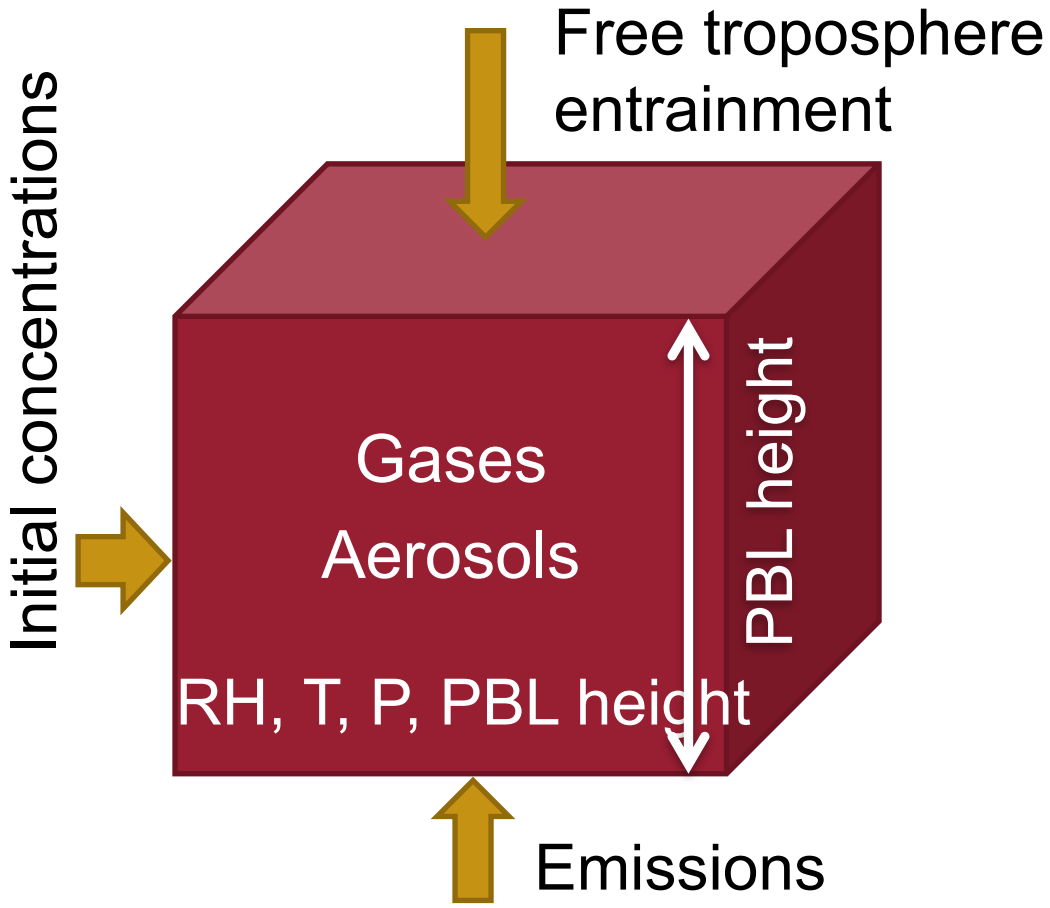
- CBM-Z gas chemistry mechanism
- Sectional aerosol microphysics

A Lagrangian AQ Modeling Framework

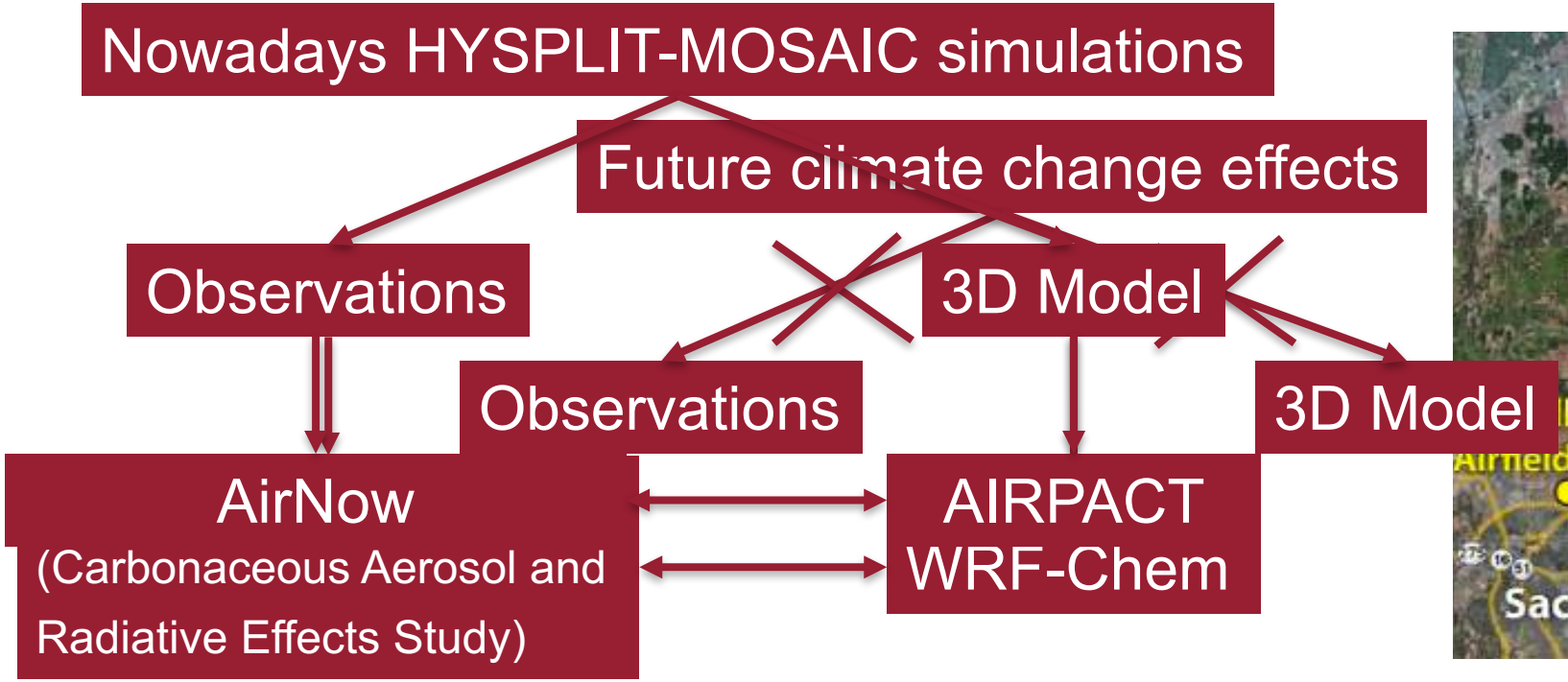
MOSAIC running along HYSPLIT air trajectory



MOSAIC box-scale air quality model



Why AIRPACT?

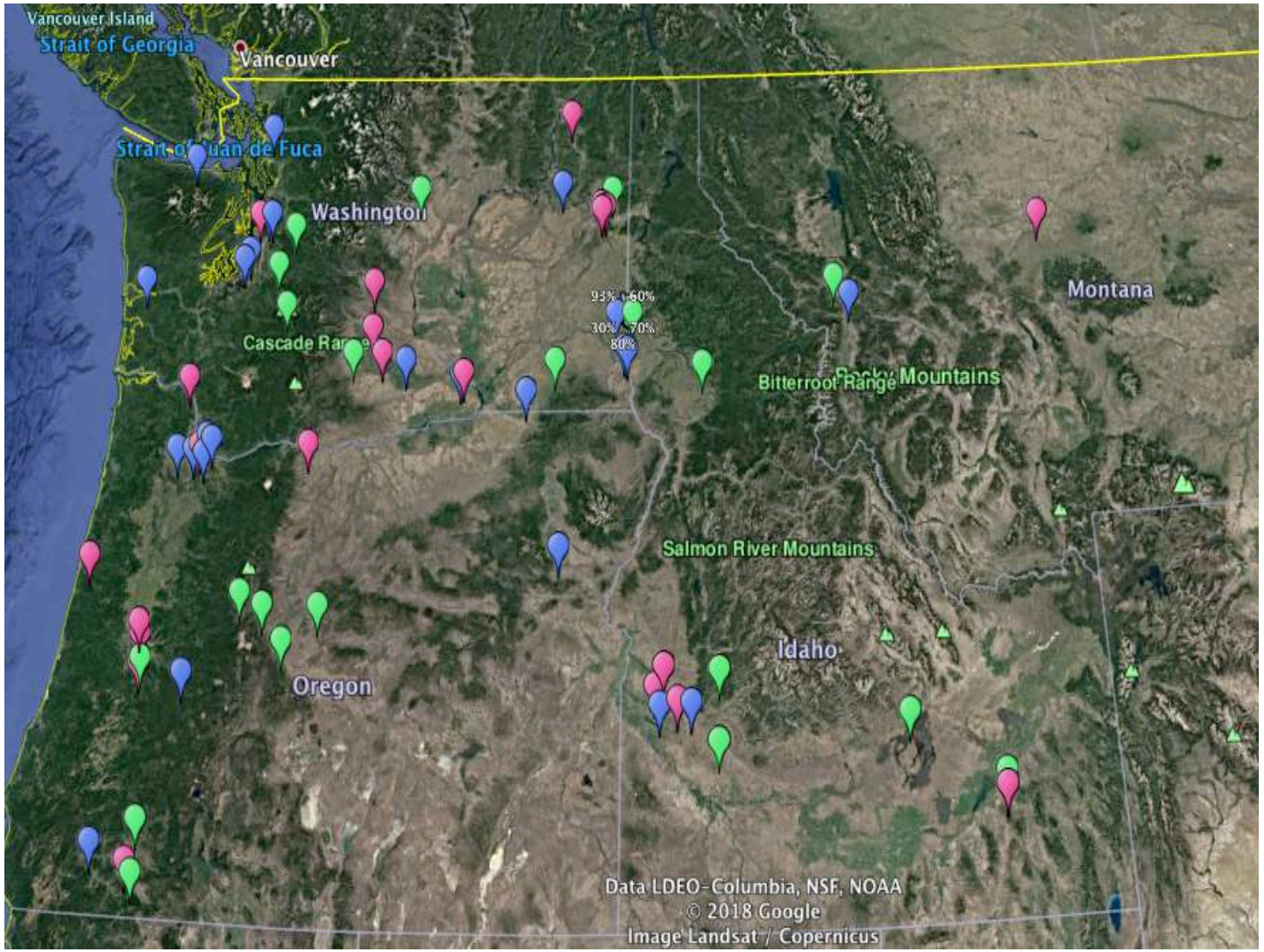


(Zaveri et al., 2012)

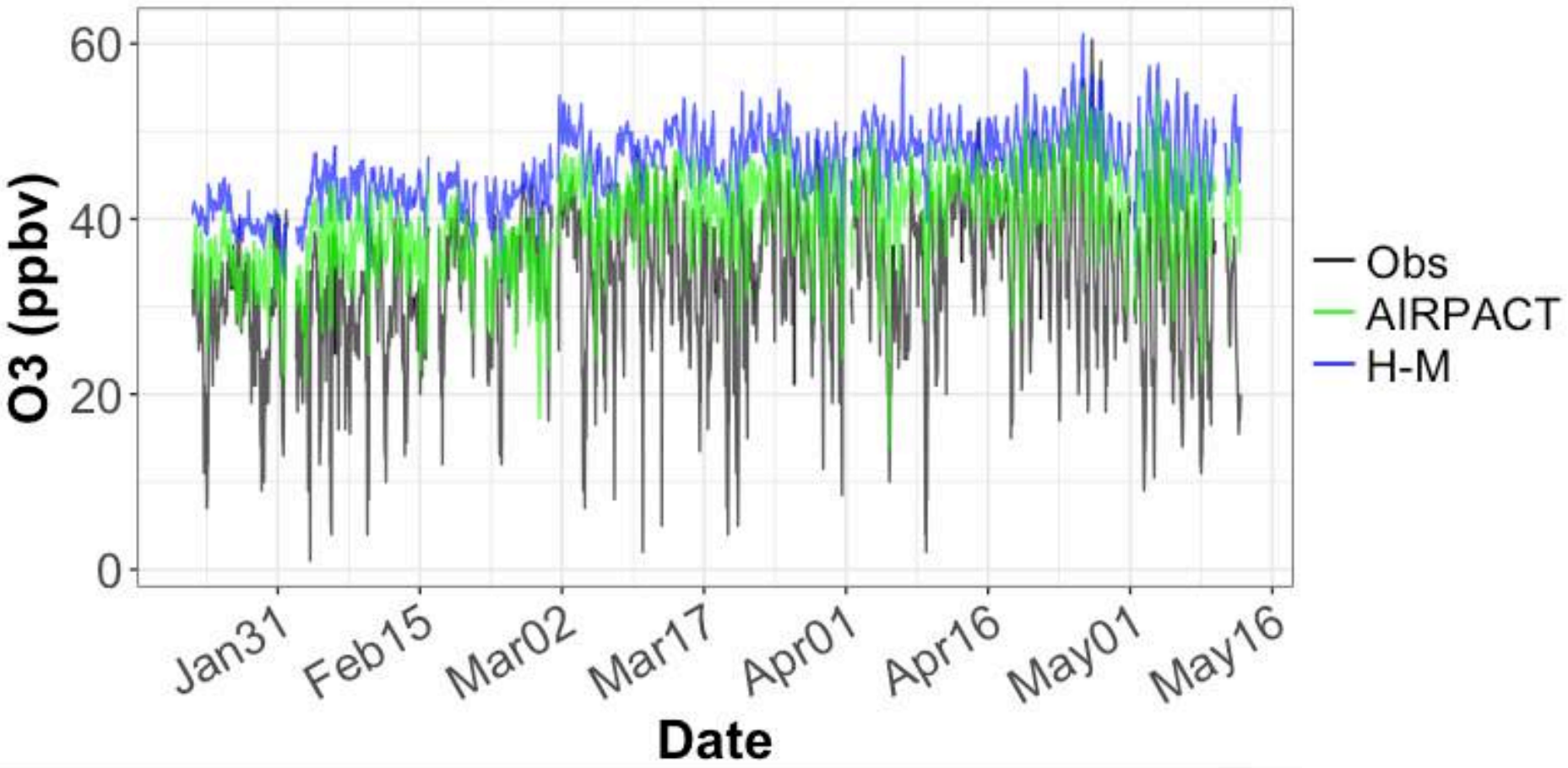
AIRPACT
(Air-quality forecasting for the Pacific Northwest)

January 22 to May 13, 2018 (16 weeks) in 55 sites

Evaluated species	
Gas species	O_3
Aerosol species	PM2.5 (SO_4, NO_3, NH_4, EC, POA)

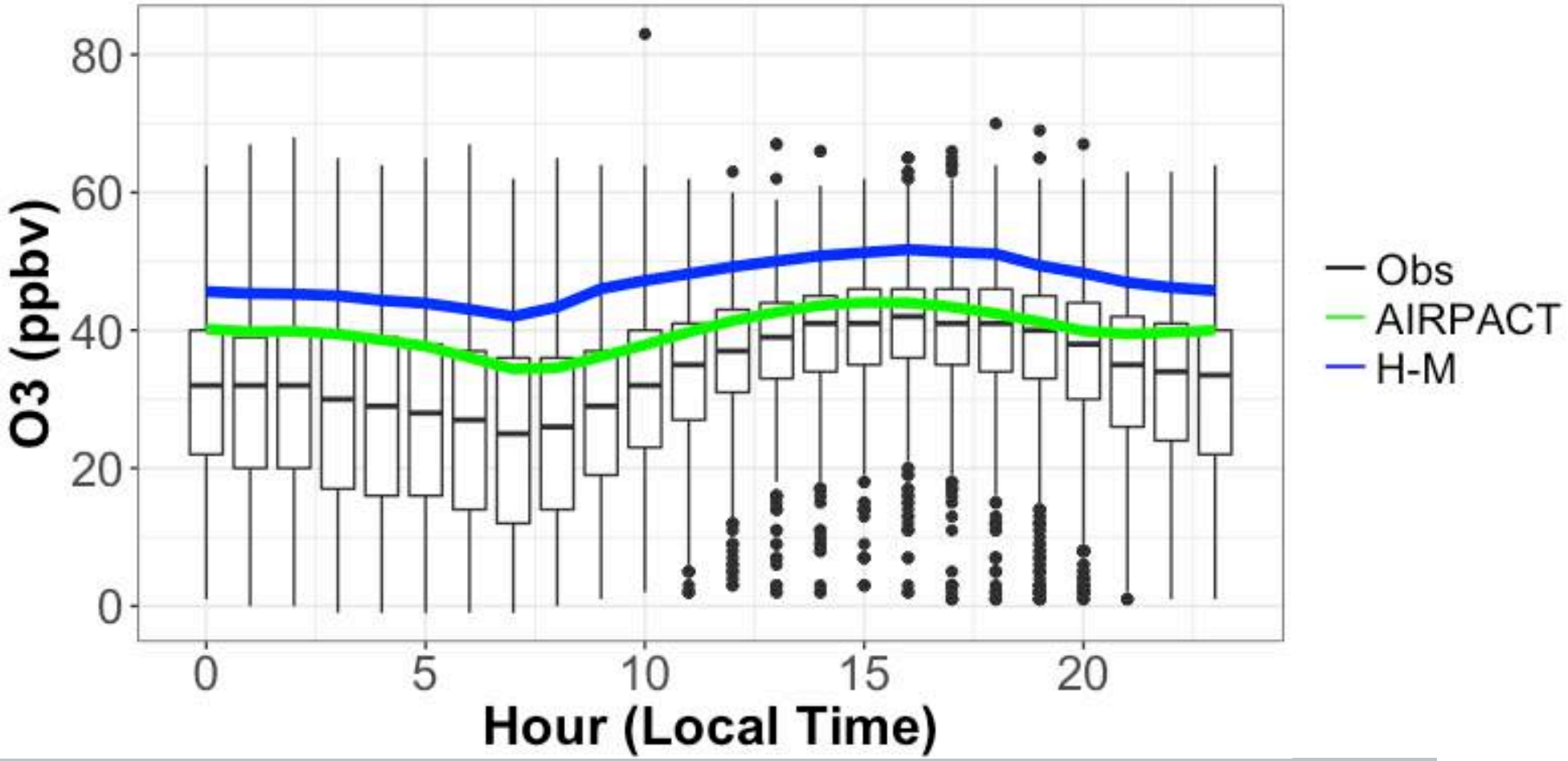


O_3 at 55 sites



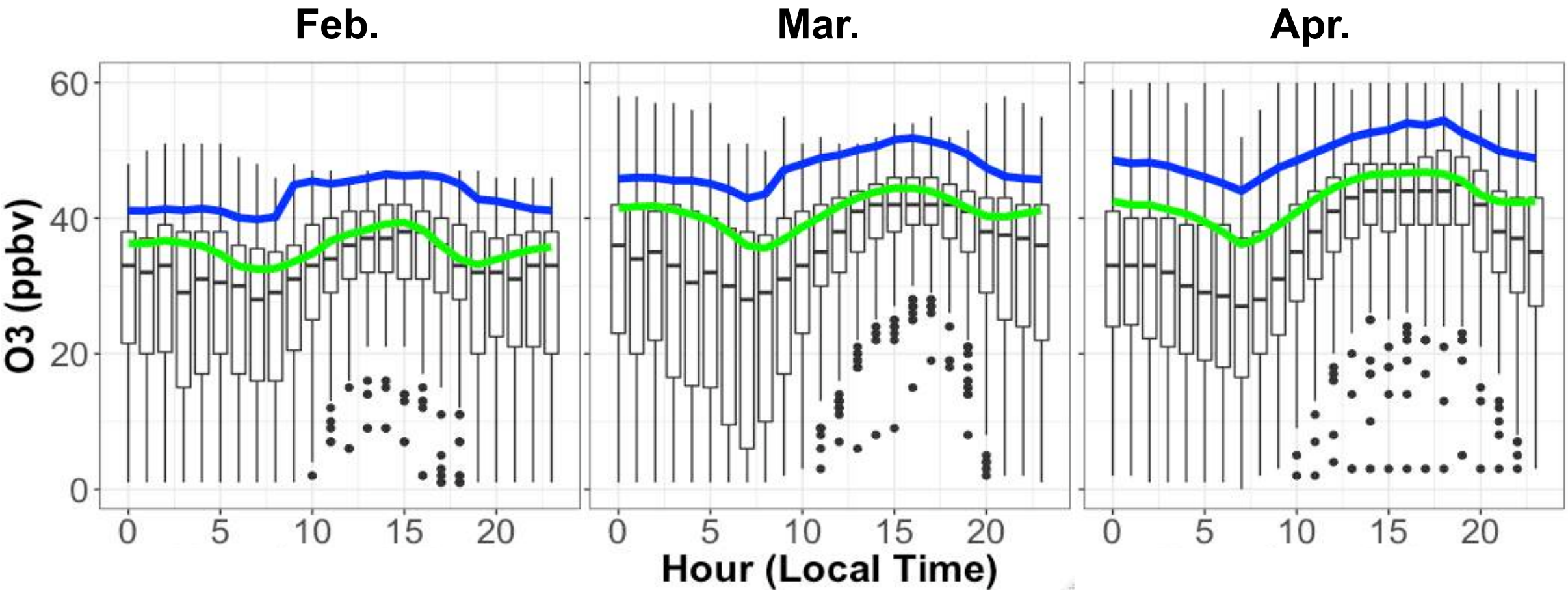
	R	FB	FE
AIRPACT vs. Obs.	0.65	27%	33%
H-M vs. Obs.	0.36	43%	44%
H-M vs. AIRPACT	0.48	18%	19%

Diurnal Averaged O_3 at 55 sites



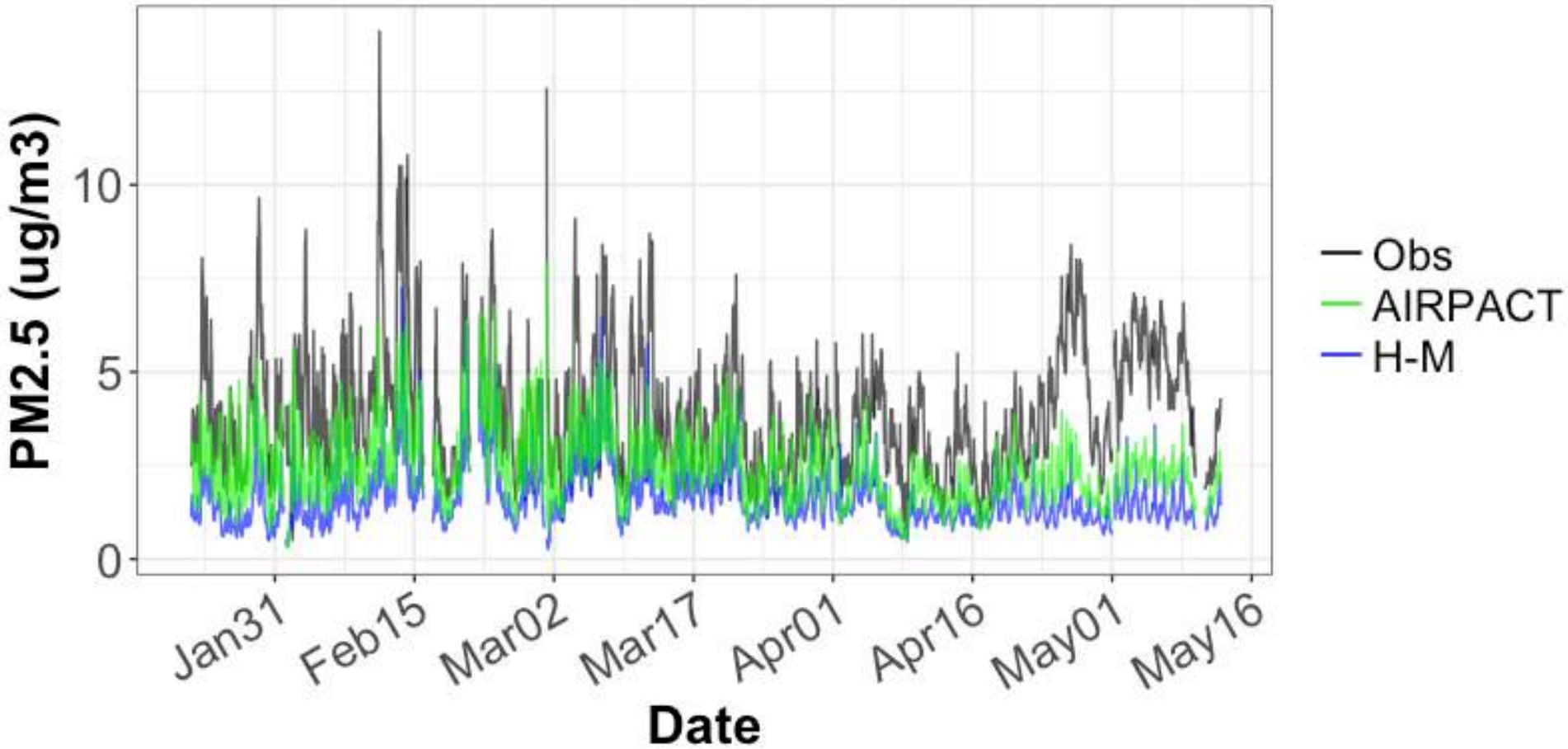
	R	FB	FE
AIRPACT vs. Obs.	0.92	21%	21%
H-M vs. Obs.	0.99	37%	37%
H-M vs. AIRPACT	0.90	17%	17%

Monthly Variation of Diurnal Averaged O_3 at 55 sites



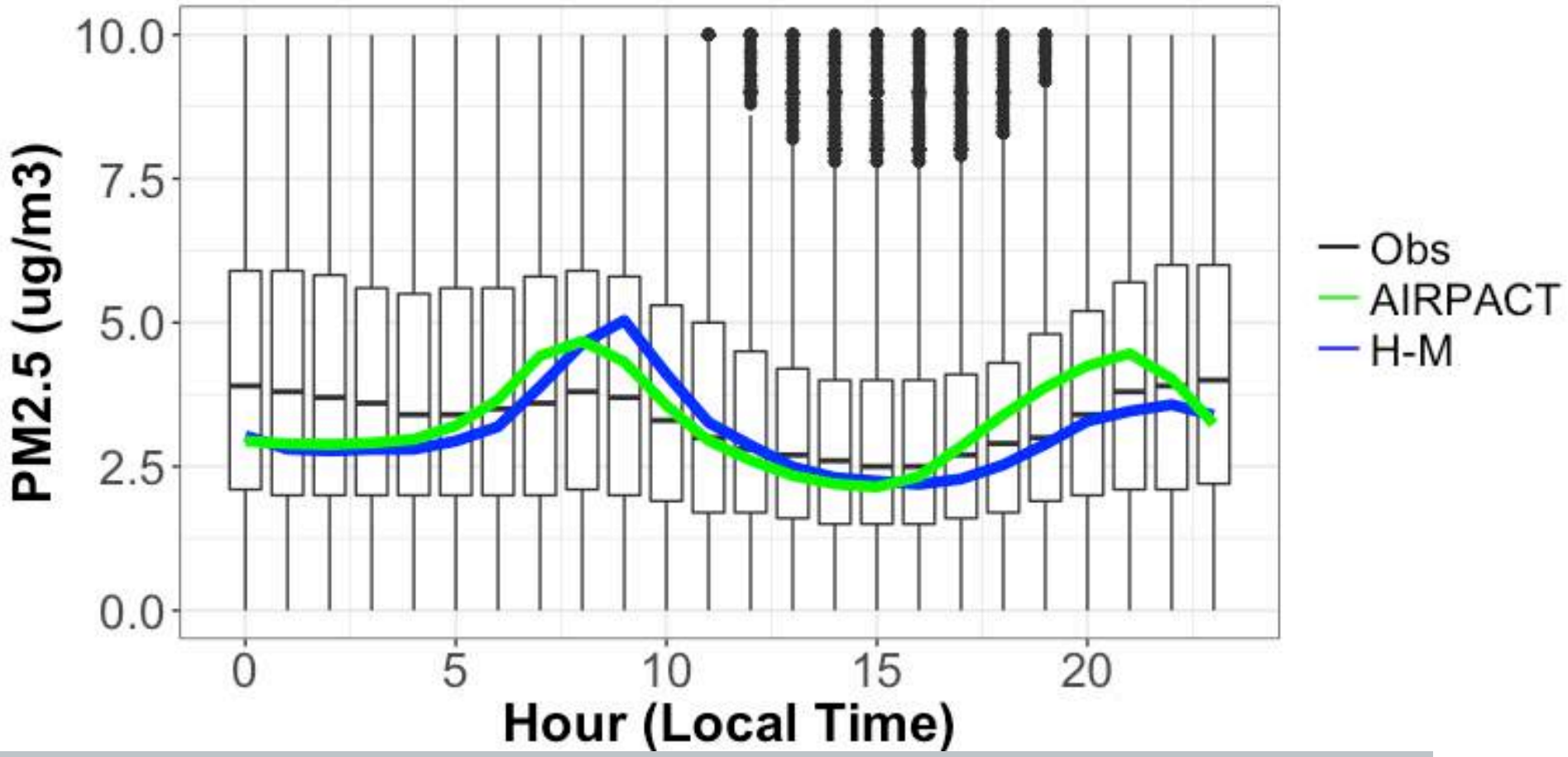
Mean O_3 (ppbv)	Feb.	Mar.	Apr.
Obs.	30	33	36
AIRPACT	36	41	43
H-M	43	47	50

PM2.5 at 55 sites



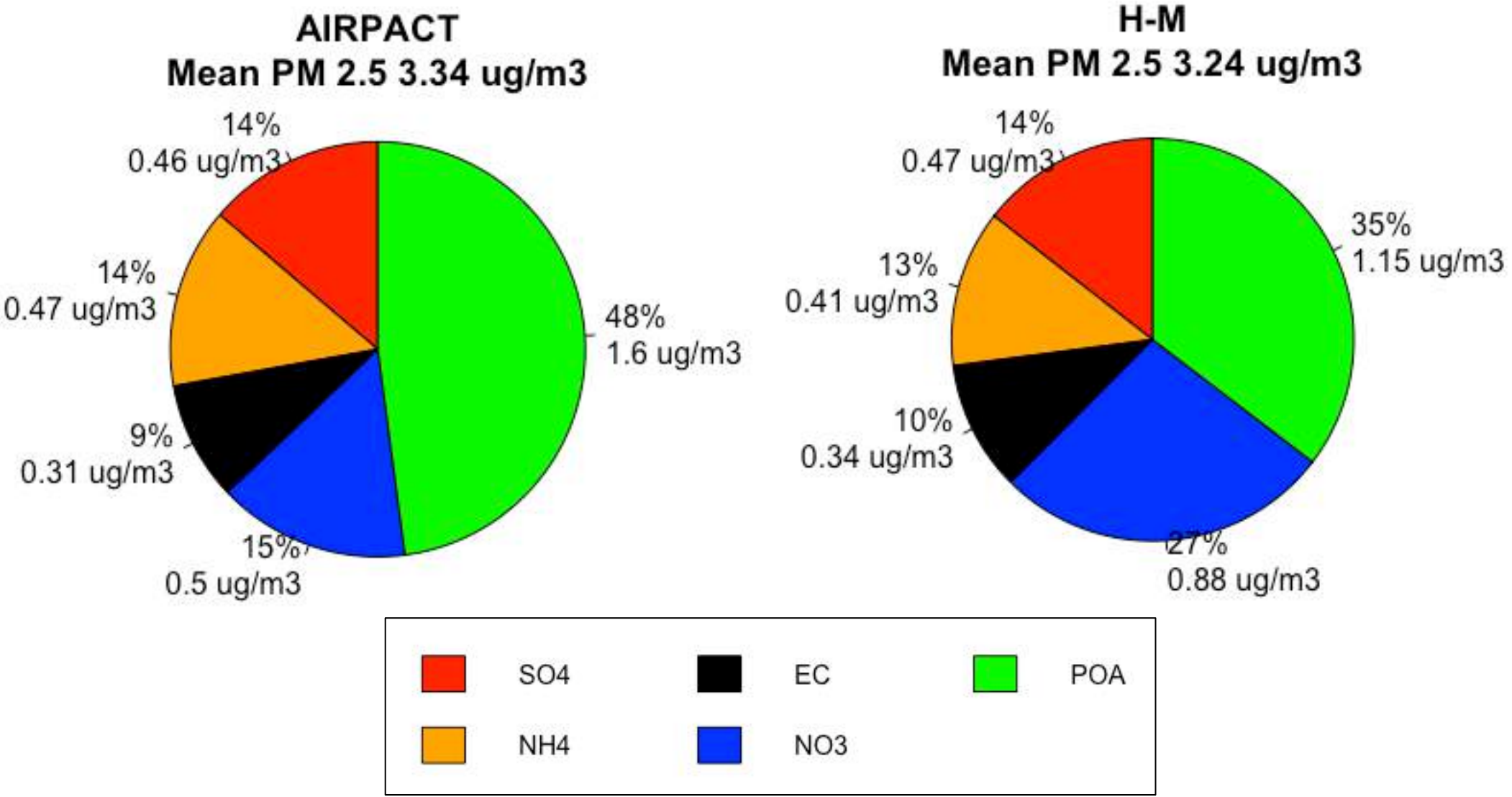
	R	FB	FE
AIRPACT vs. Obs.	0.21	-29%	73%
H-M vs. Obs.	0.18	-49%	87%
H-M vs. AIRPACT	0.62	-25%	49%

Diurnal Averaged PM2.5 at 55 sites

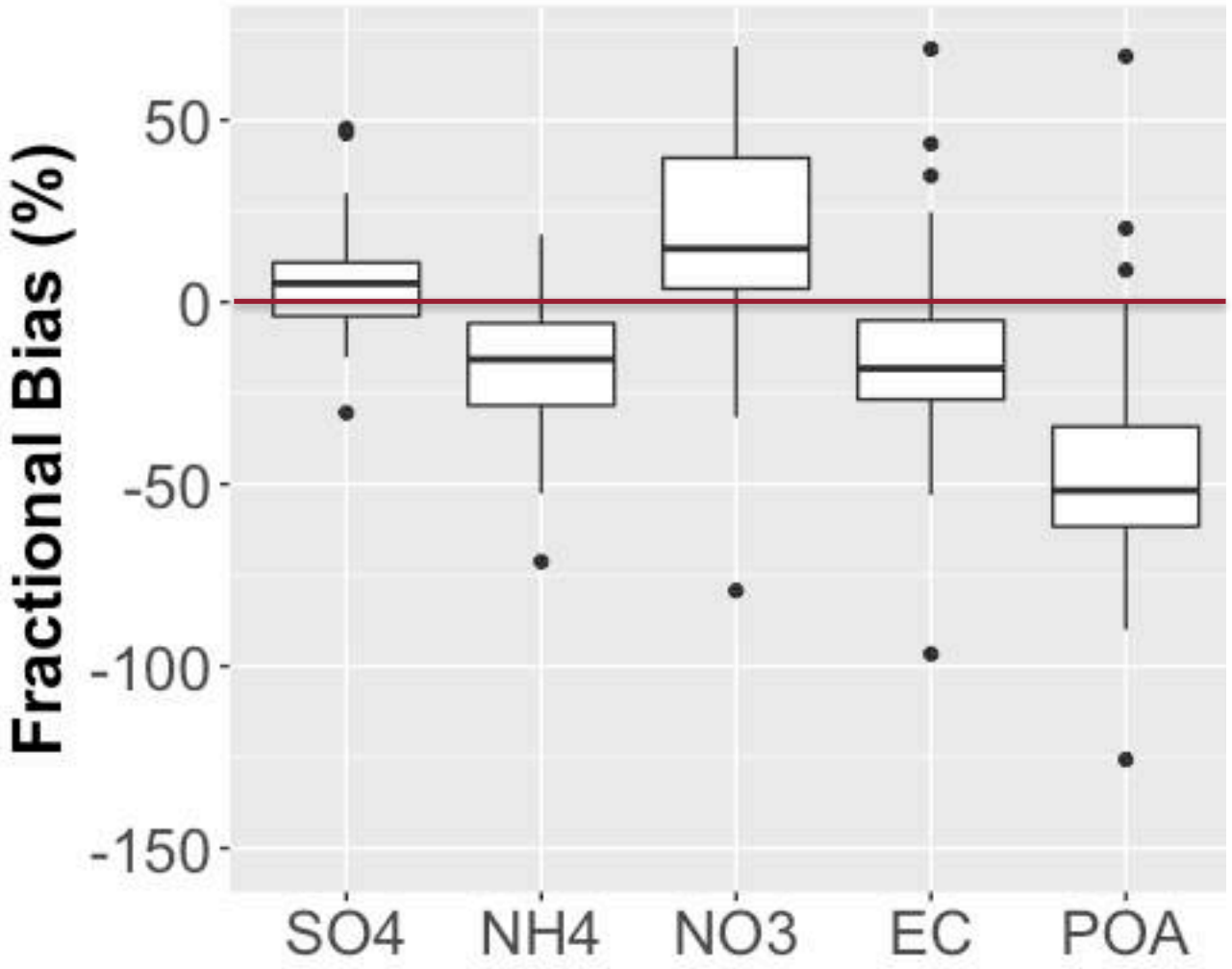


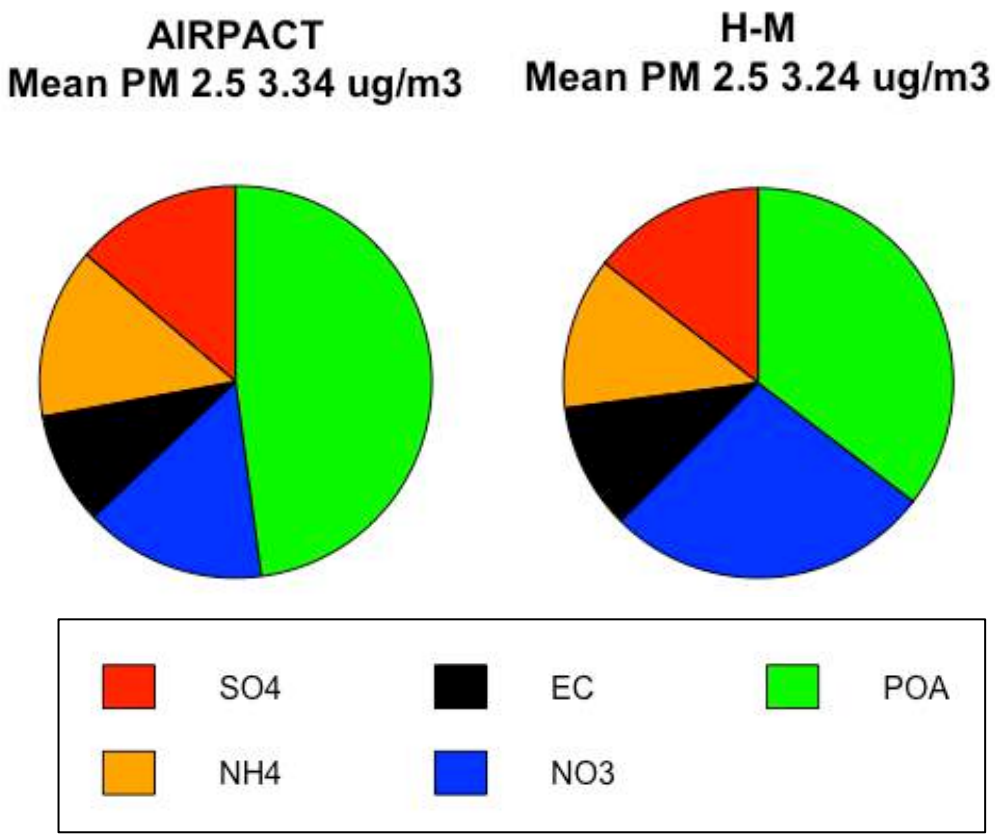
	R	FB	FE
AIRPACT vs. Obs.	0.48	-39%	40%
H-M vs. Obs.	0.46	-45%	45%
H-M vs. AIRPACT	0.80	-5.2%	11%

Average PM2.5 composition at 55 sites

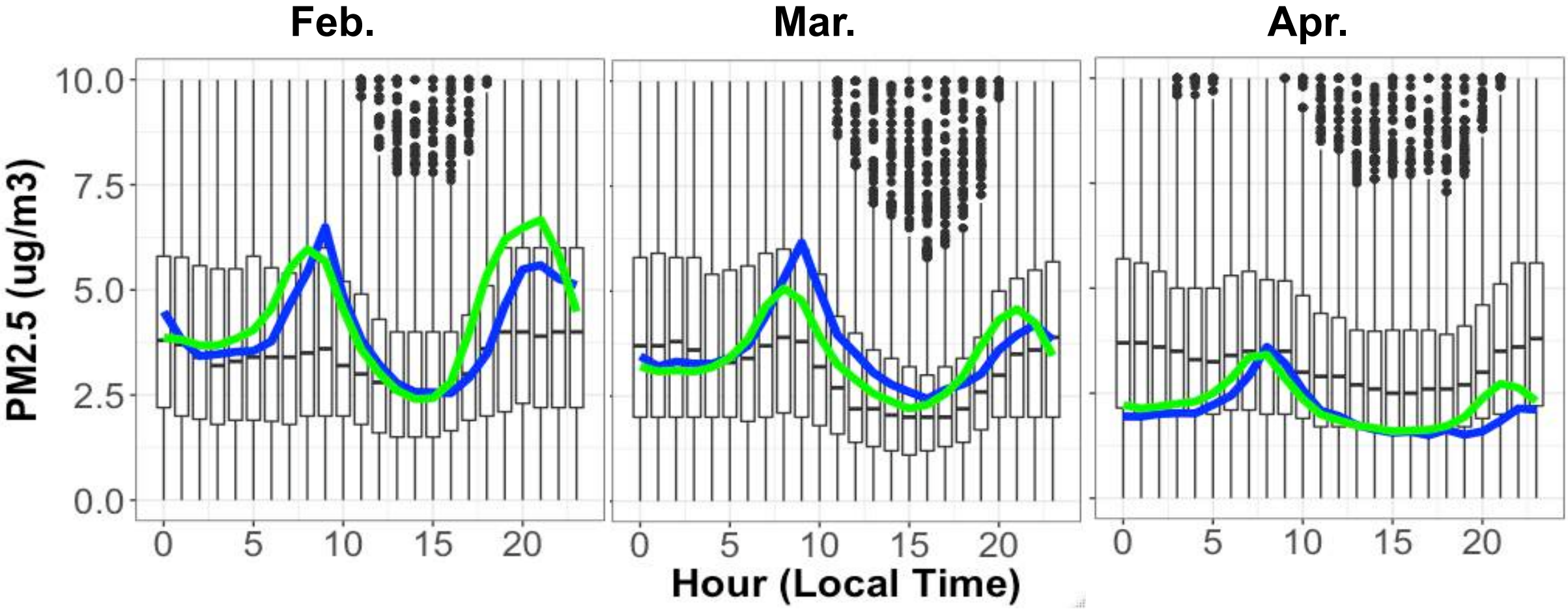


PM2.5 composition at 55 sites





Monthly Variation of Diurnal Averaged PM2.5 at 55 sites



Mean PM2.5 (µg/m³)	Feb.	Mar.	Apr.
Obs.	5.9	4.7	4.0
AIRPACT	4.4	3.4	2.3
H-M	4.1	3.6	2.1

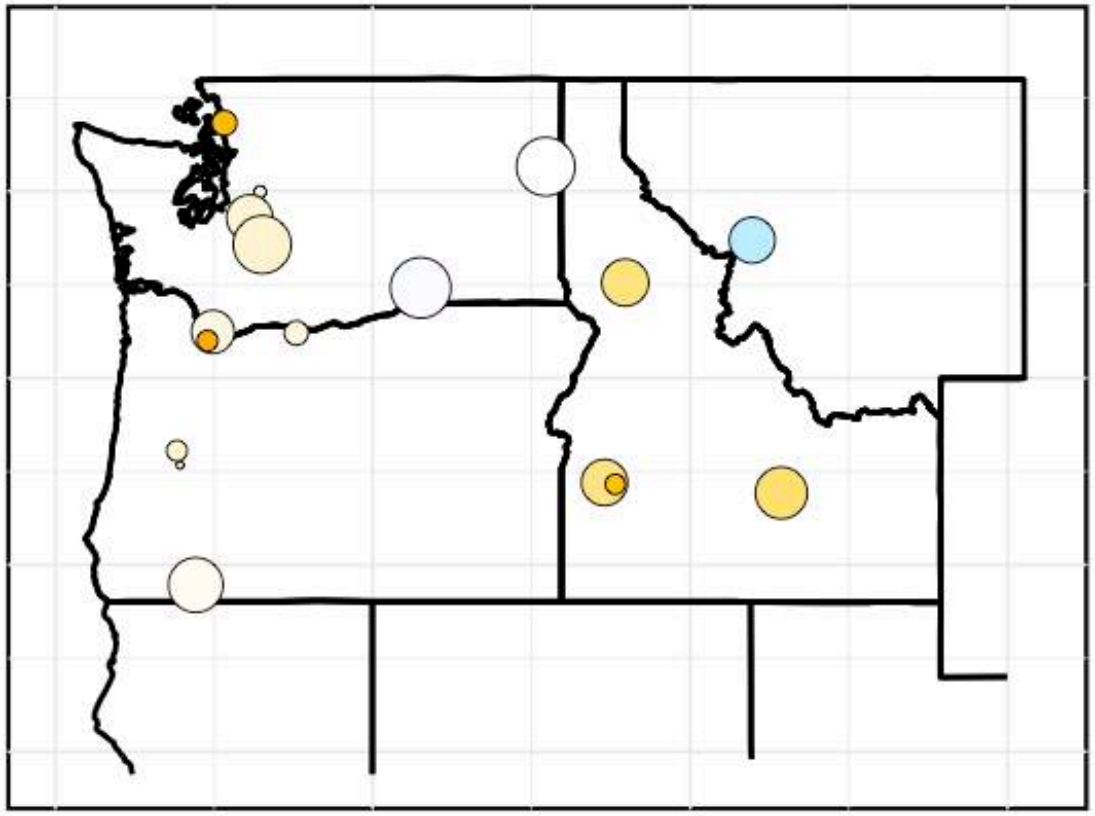
The National Ambient Air Quality Standards (NAAQS) for O_3 and PM2.5

Species	Averaging Time	Level	Calculation Method
O_3	8 hours	0.070 ppm	Moving 8-hour averages shall be computed from the hourly O3 concentration data for each hour
PM2.5	24 hours	35 μg/m^3	24-hour average concentrations will be computed from submitted hourly PM2.5 concentration data for each corresponding day

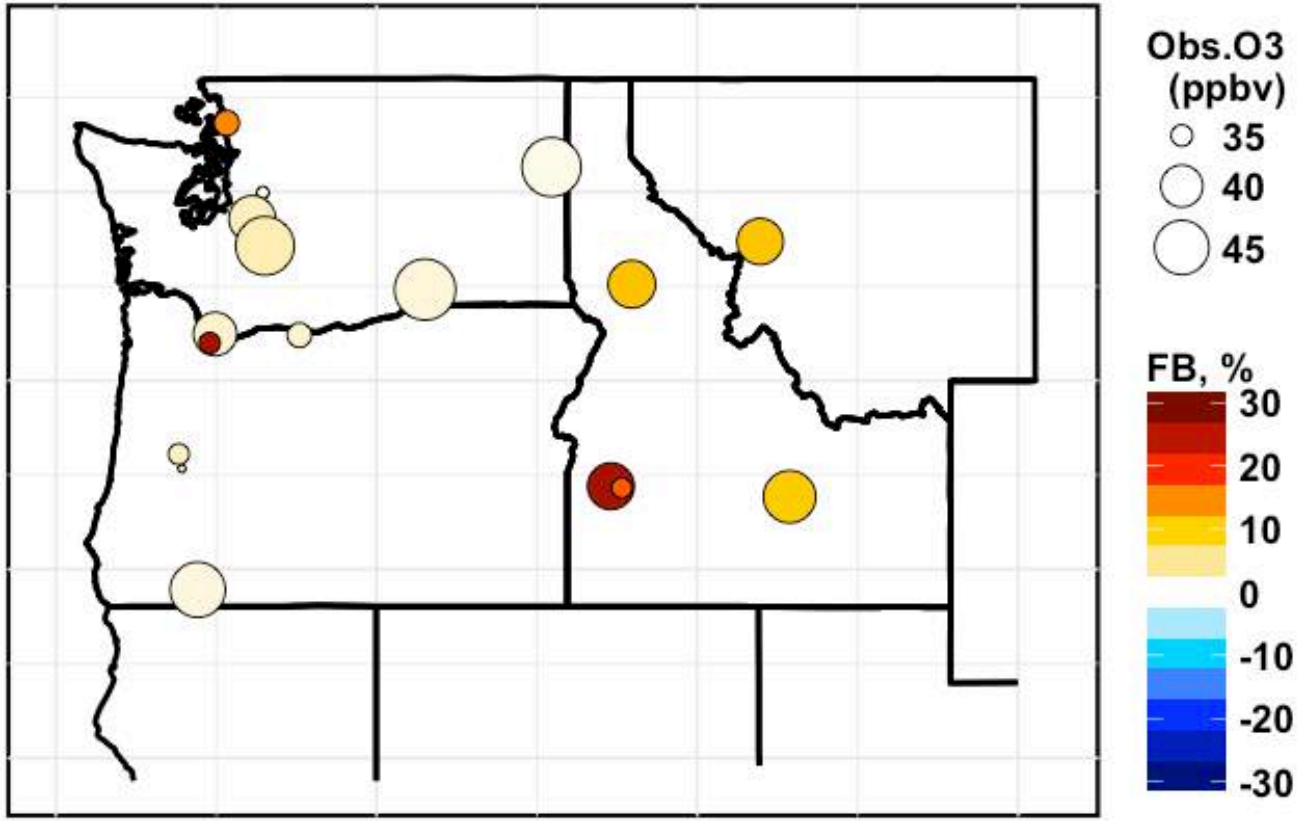
(Federal Register Vol. 78 No. 10 & Vol. 80, No. 206)

Daily maximum 8-hour average O_3

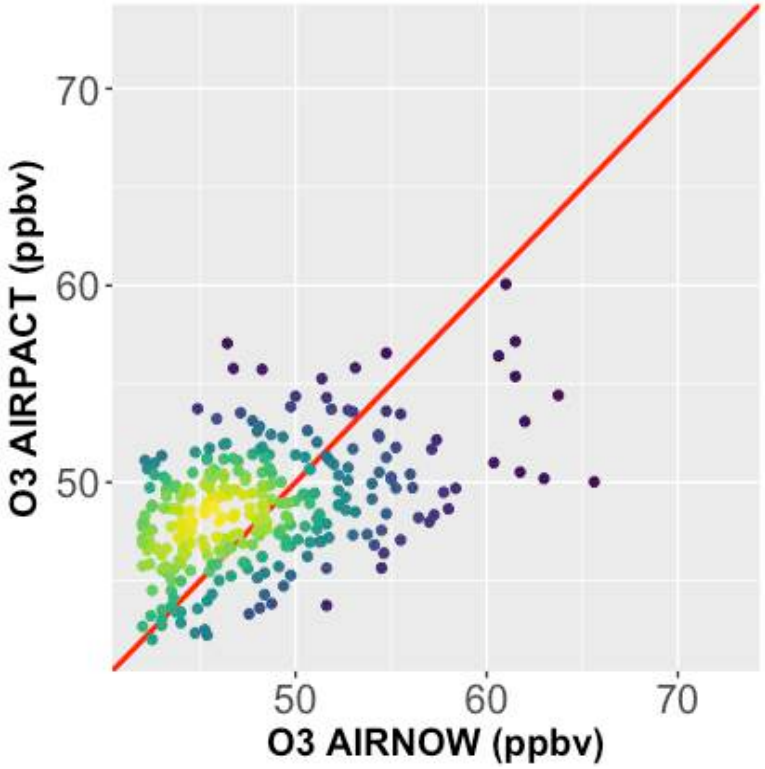
AIRPACT

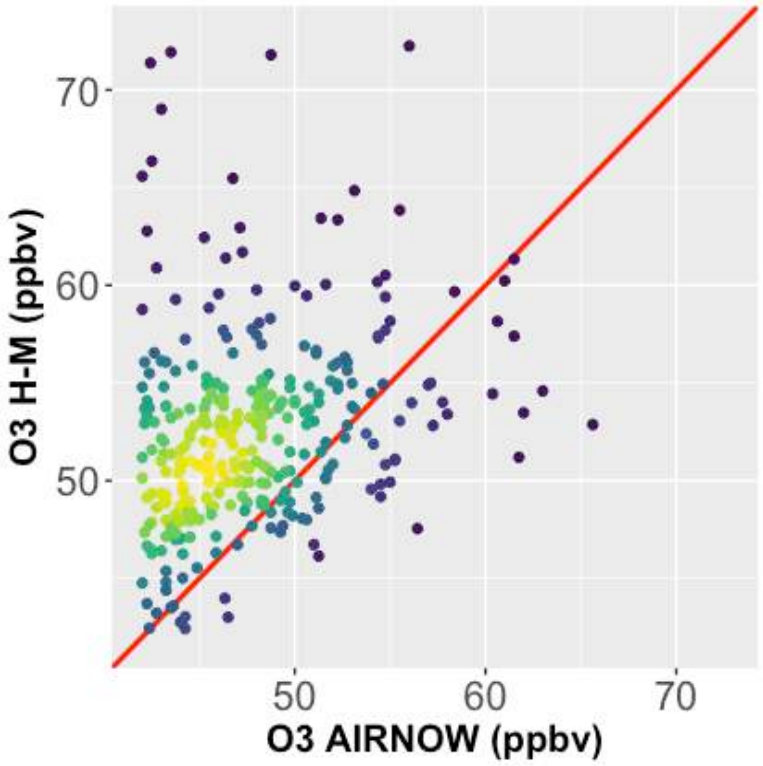


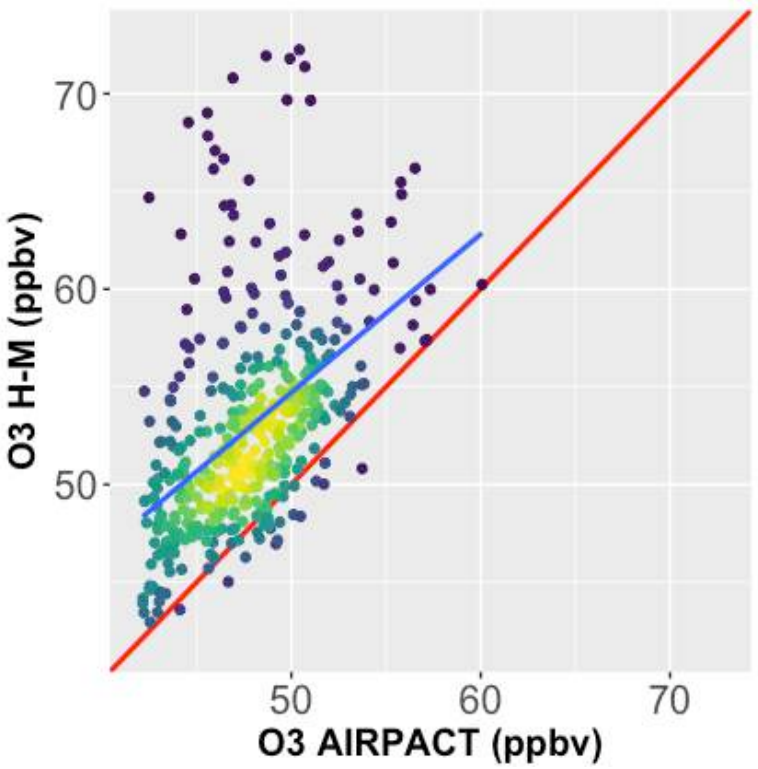
H-M



Daily maximum 8-hour average O_3

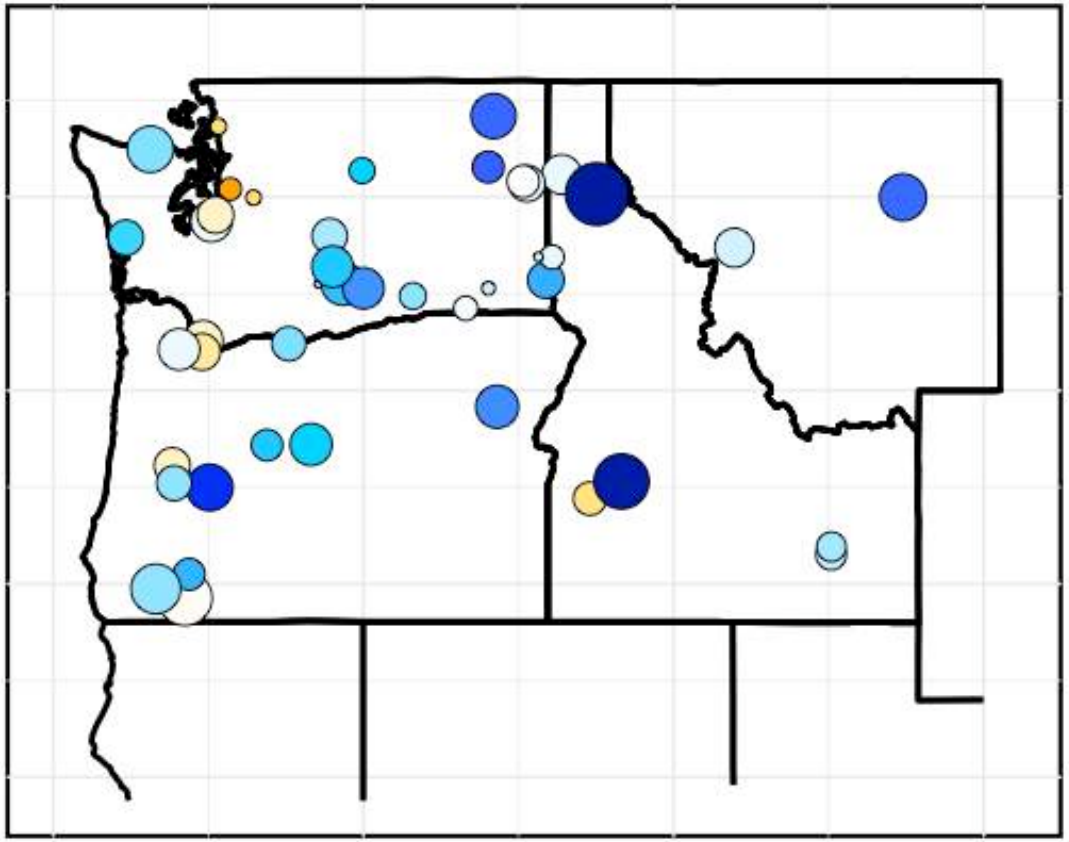




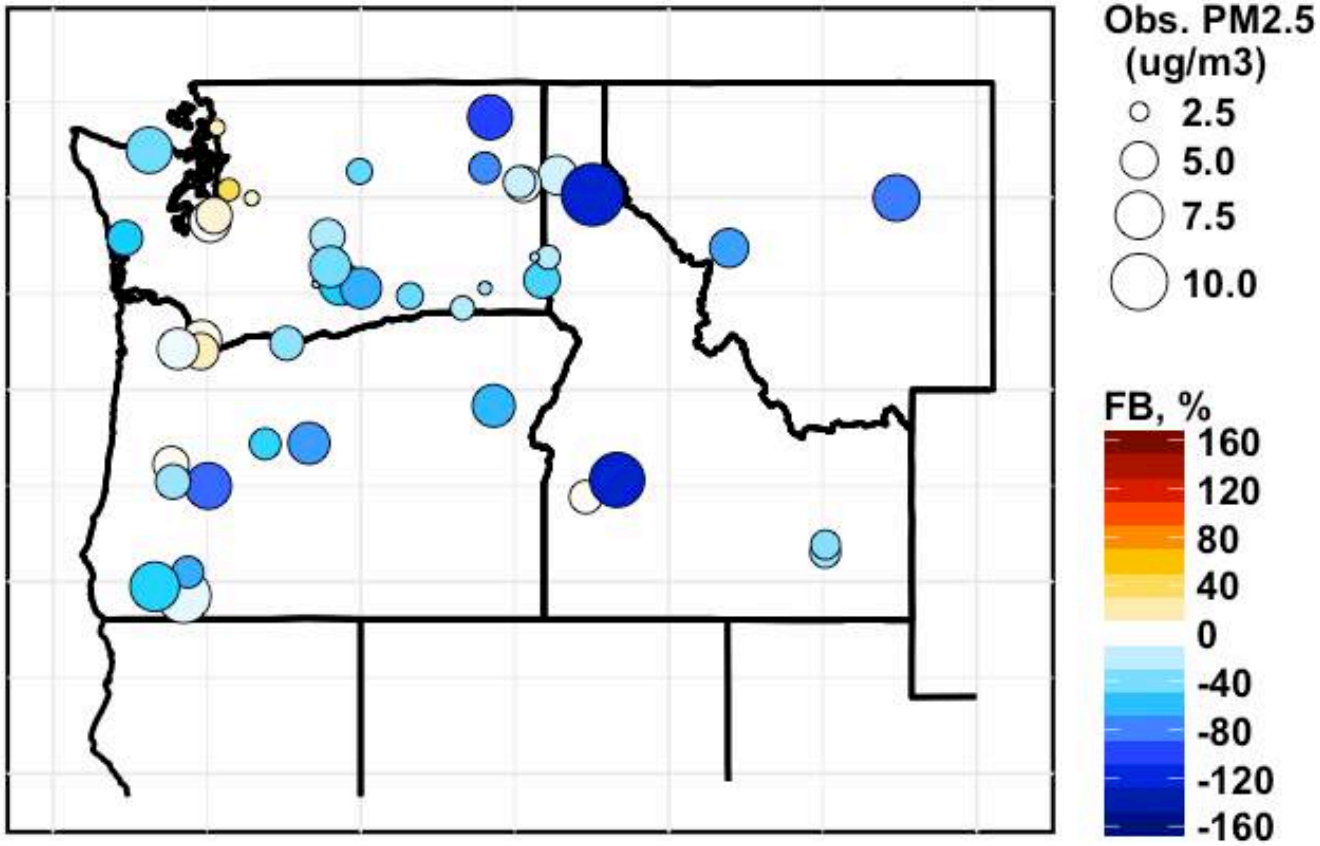


24 hour averaged PM2.5

AIRPACT



H-M



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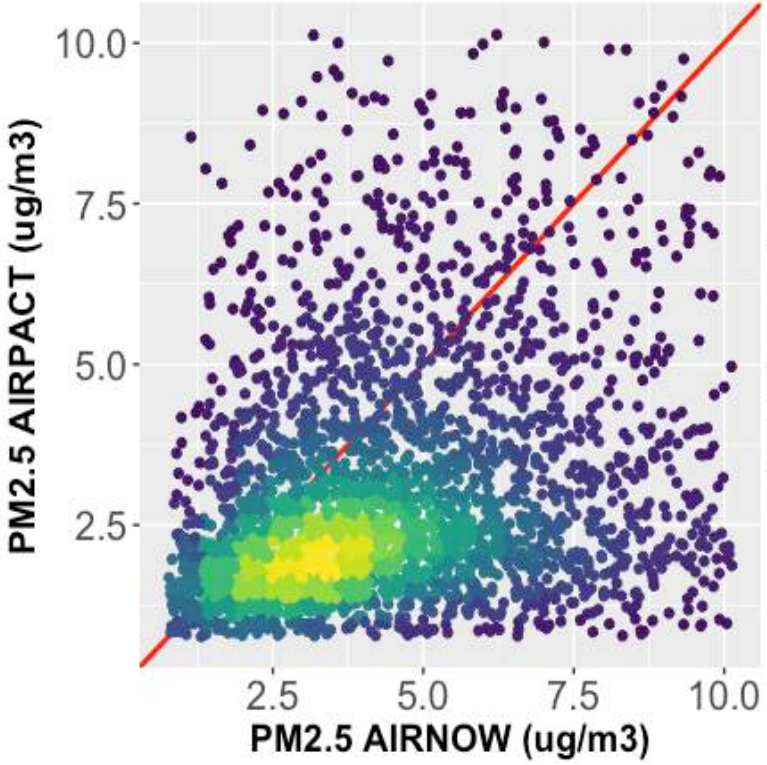

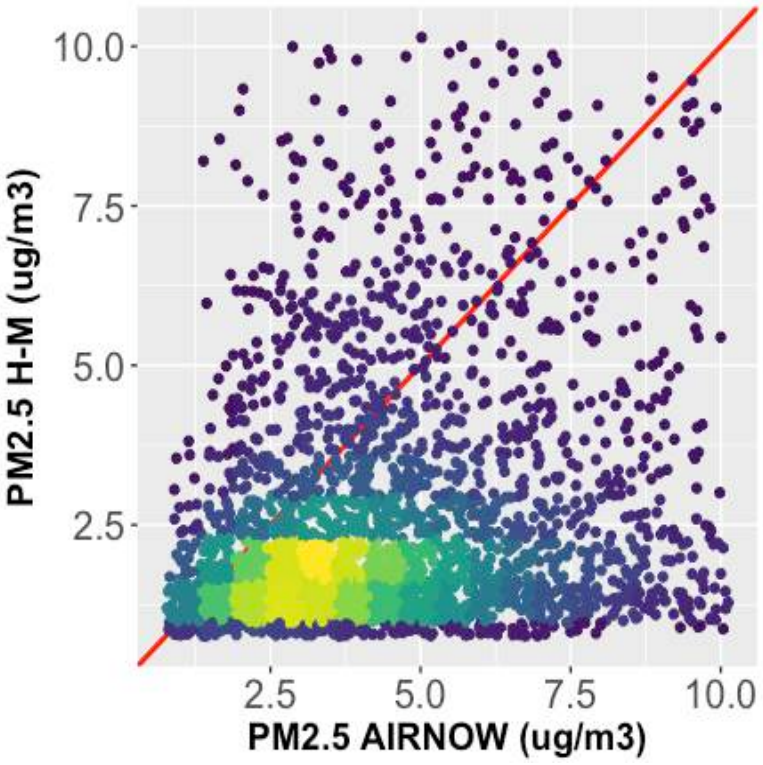

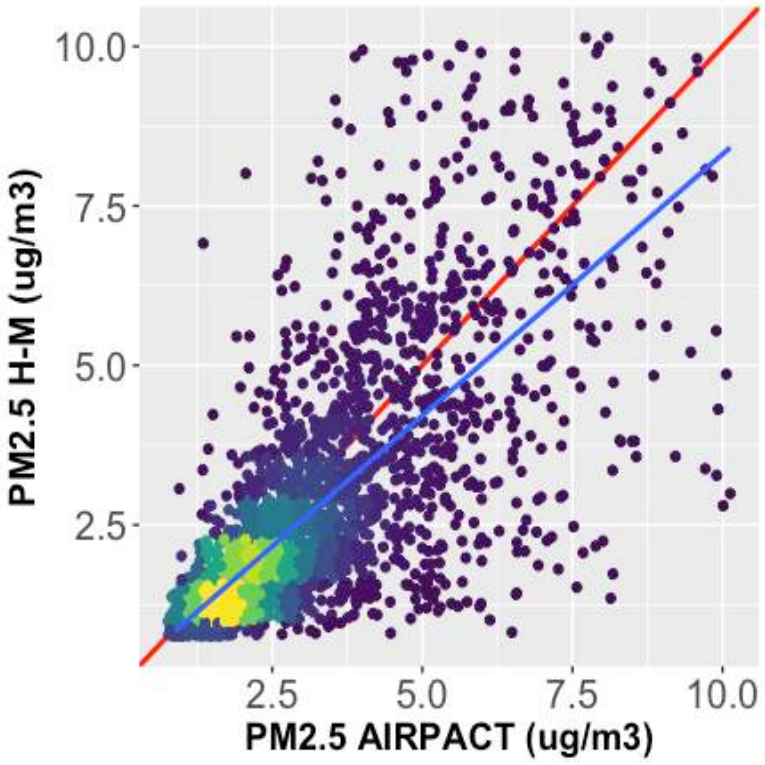

Summary

HYSPLIT-MOSAIC provides reasonable air quality simulations.

- H-M captures the diurnal cycle for O_3 and PM2.5 (R = 0.99, 0.46)
- Captures the monthly increasing trend for O_3 and decreasing trend for PM2.5 from winter to spring
- Predicts PM compositions reasonably well, but overpredicts nitrate by 0.38 μg/m^3 and underpredicts POA by 0.45 μg/m^3

Based on NAAQS standards, our model tends to overpredict maximum 8-hour averaged O_3 with 6.3% error, and underpredict 24-hour averaged PM2.5. For PM2.5, H-M results are similar to AIRPACT simulations (R = 0.78).

Thank you!