A Long-term Evaluation of AIRPACT

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Background

- Air Information Report for Public Access and Community Tracking (AIRPACT)
  - Predicts AQ in the PNW
    - How?
      - Weather Research and Forecasting Model (WRF)
      - Community Model for Air Quality (CMAQ)

This Evaluation

- ≈10 years of observed and model data
  - Meteorology
    - WRF derived meteorology is spotty over this time period
  - Pollutants
    - Used AIRPACT predictions at AIRNOW sites
- Compared both to the EPA's AQS database
  - Quality controlled data

Meteorology

Parameters

• Meteorology
- RH
- Temperature
- Wind Speed
- Wind Direction

Table 1 : Performance criteria for meteorological model results (from Emery et al., 2001)
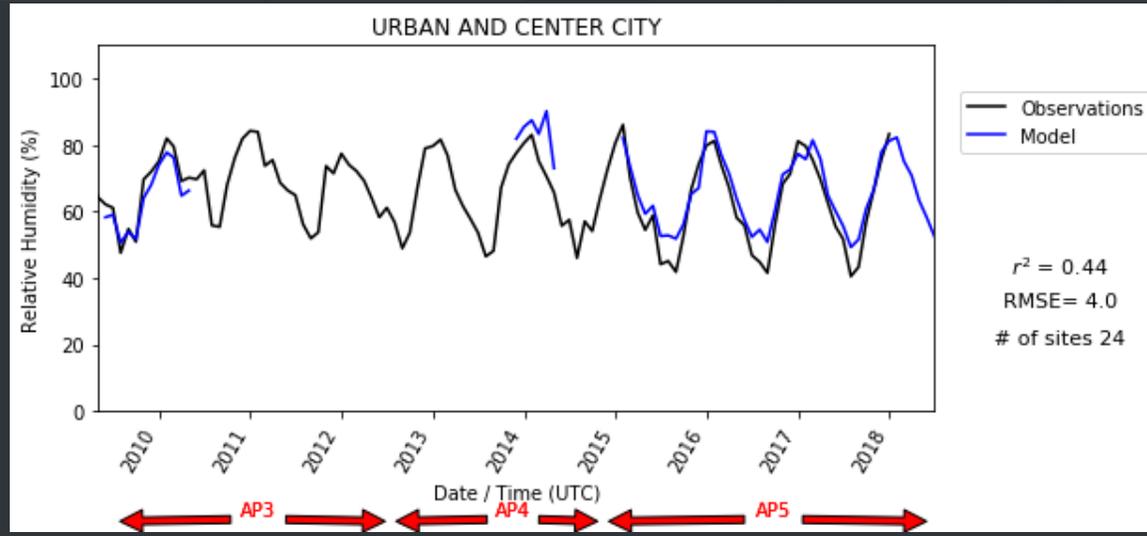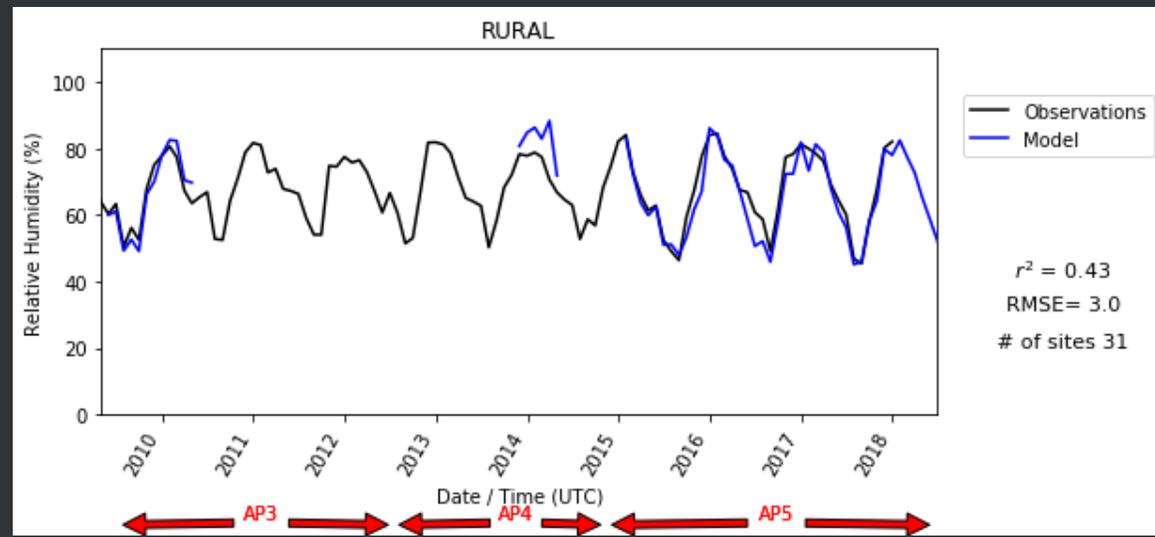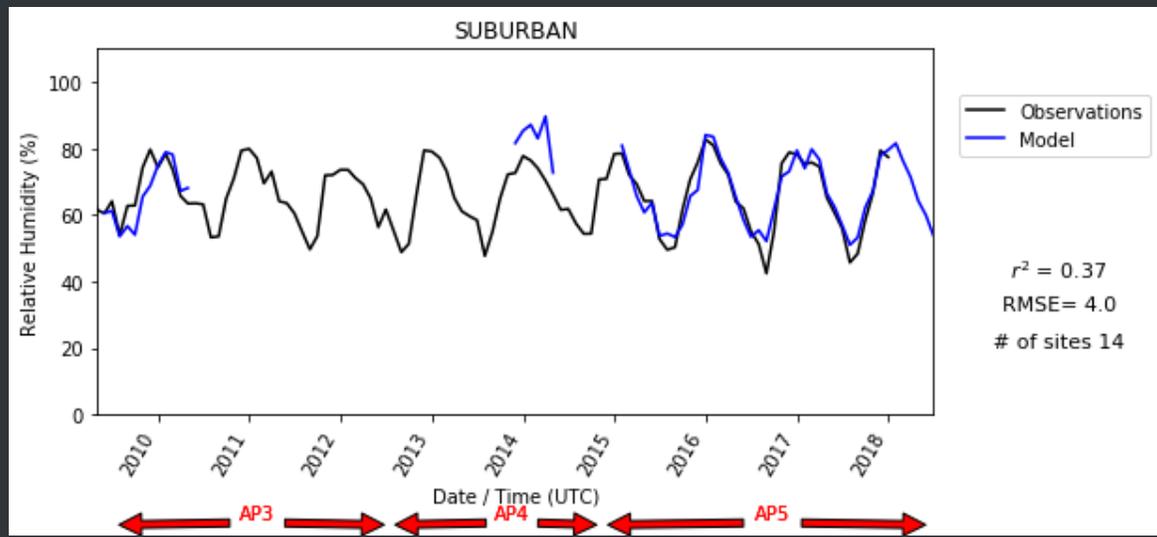
Parameter	Metric	Criteria
Wind speed	RMSE	≤ 2 m/s
	Bias	$\leq \pm 0.5$ m/s
	IOA	≥ 0.6
Wind direction	Gross error	≤ 30 deg
	Bias	$\leq \pm 10$ deg
Temperature	Gross error	$\leq 2K$
	Bias	$\leq \pm 0.5$ K
	IOA	≥ 0.8
Humidity	Gross error	≤ 2 g/kg
	Bias	$\leq \pm 1$ g/kg
	IOA	≥ 0.6

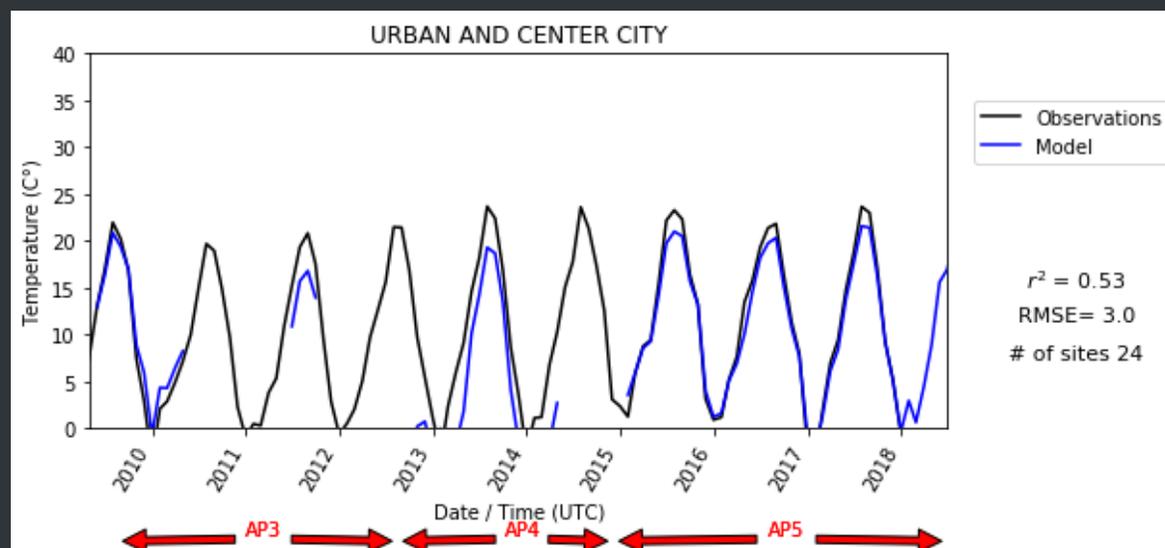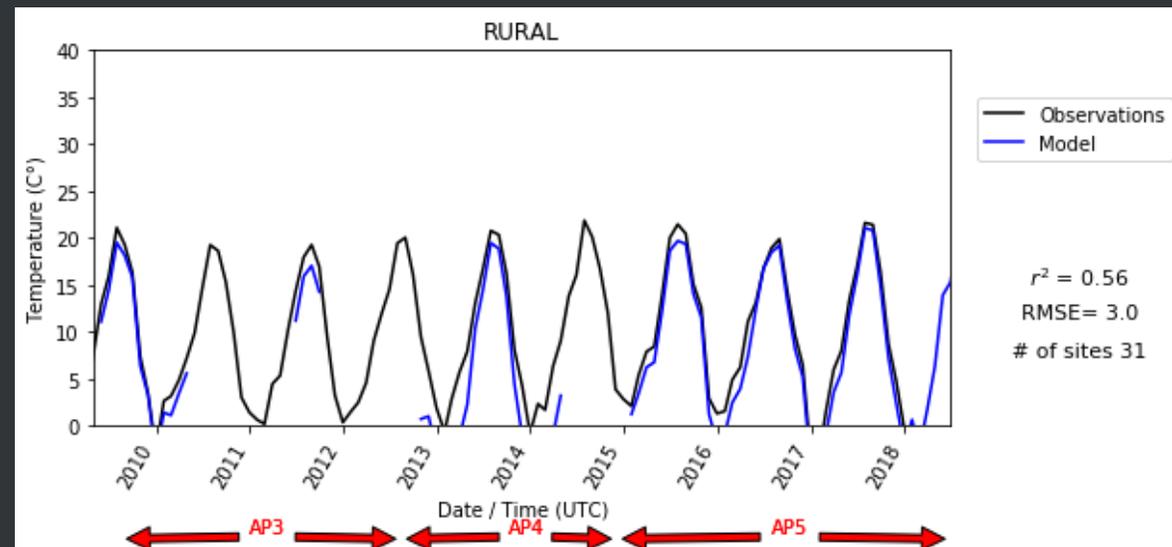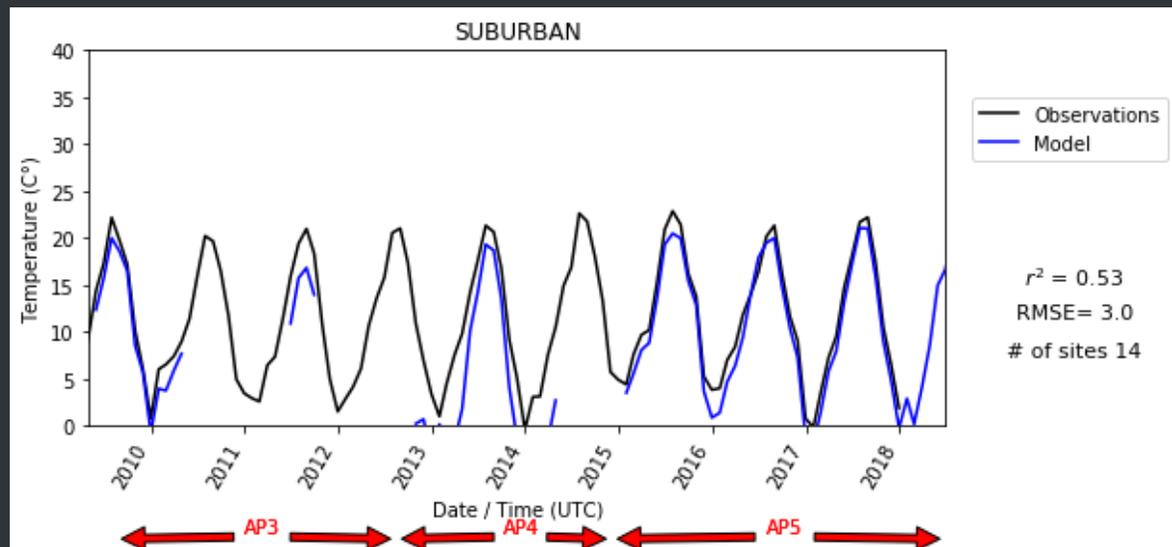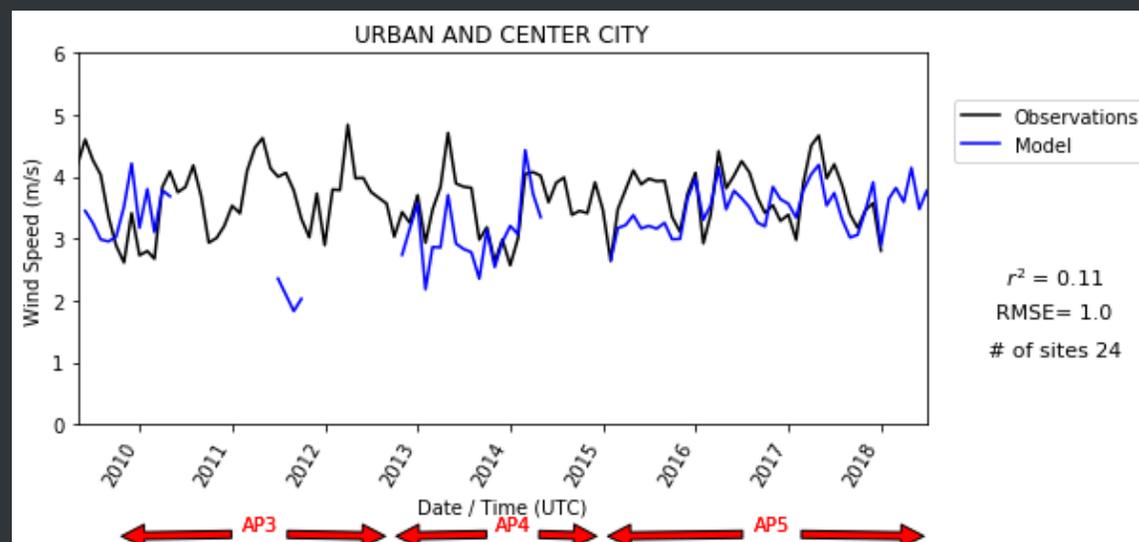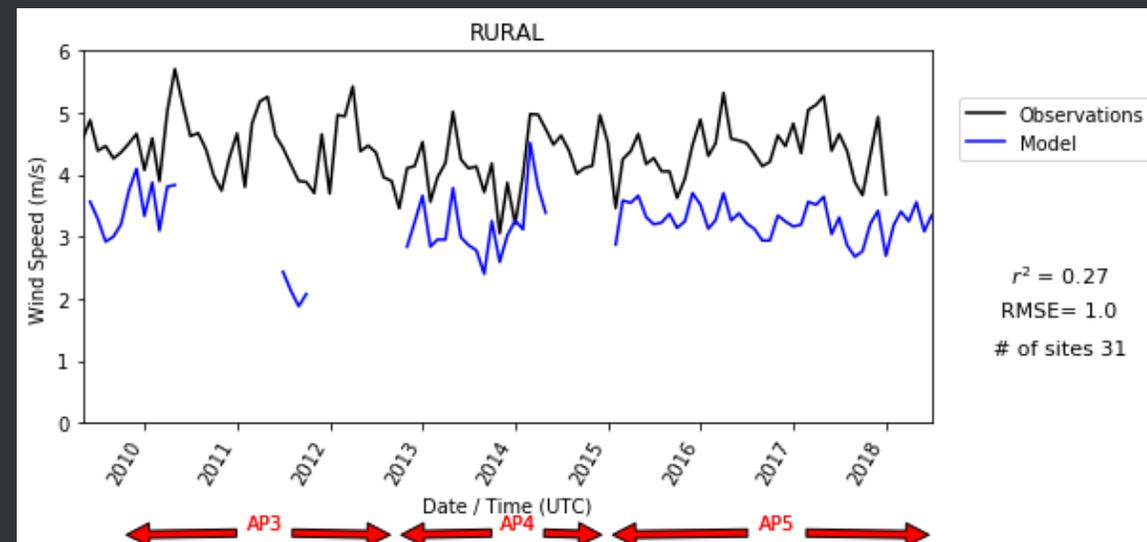"A procedure for air quality models benchmarking" by P. Thunis et al., February 2011
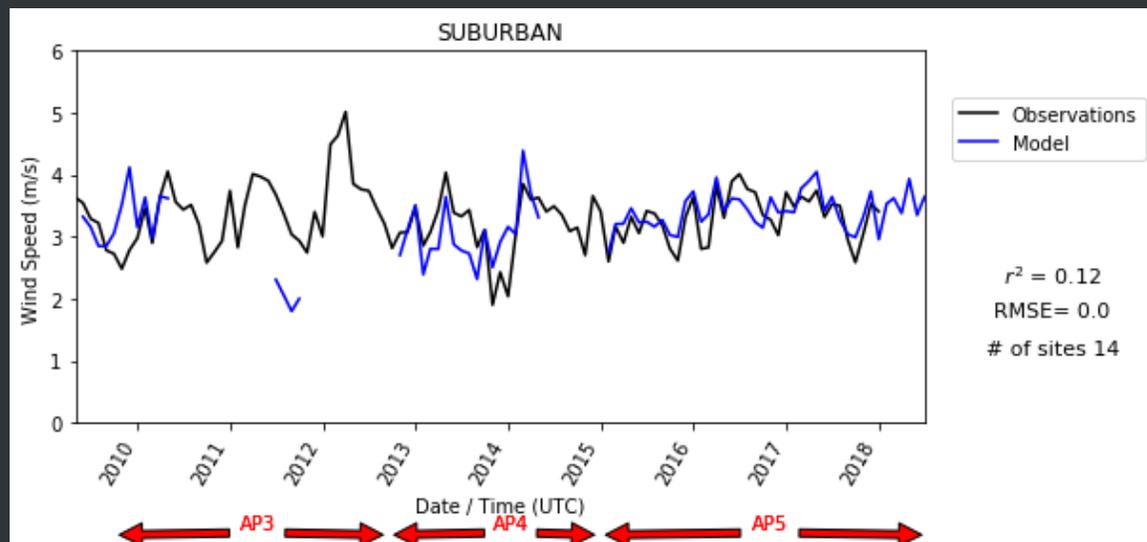
Relative Humidity

Monthly Averaged

Temperature

Wind Speed

Overall Performance for AP3, 4 & 5
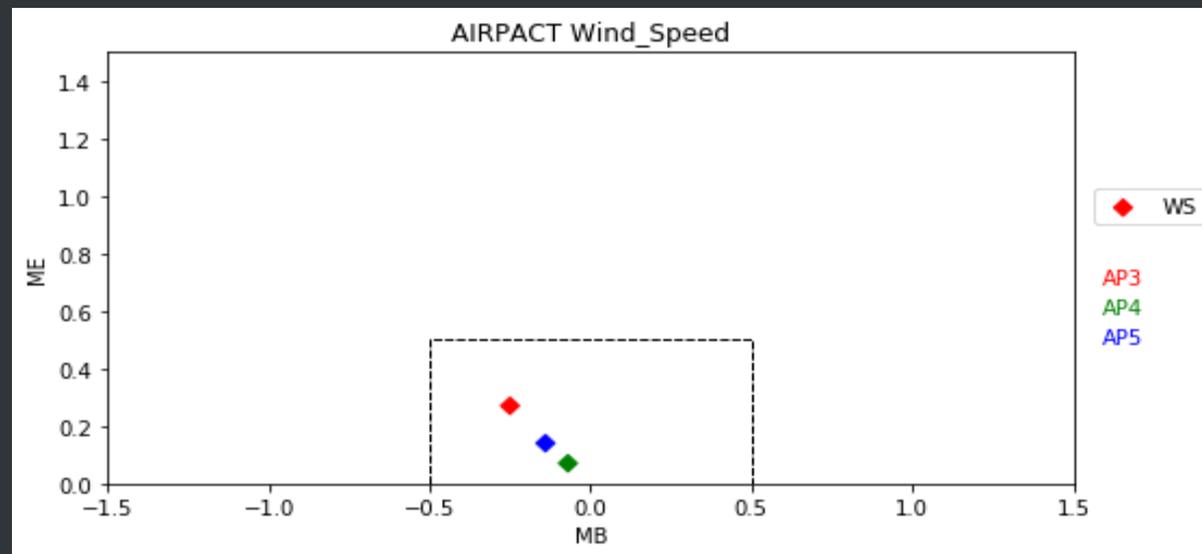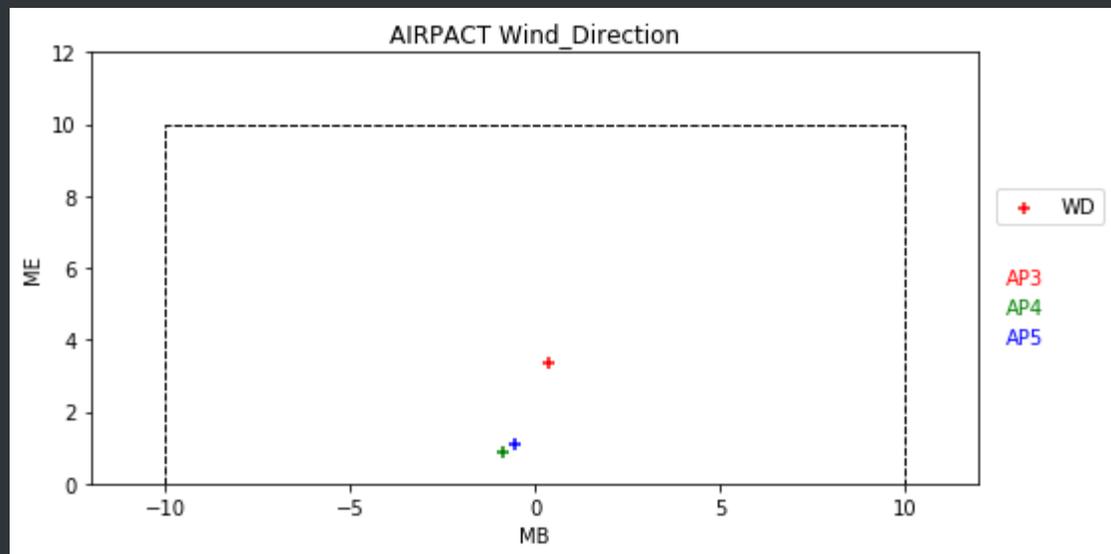
QQ Temperature

QQ Wind Speed
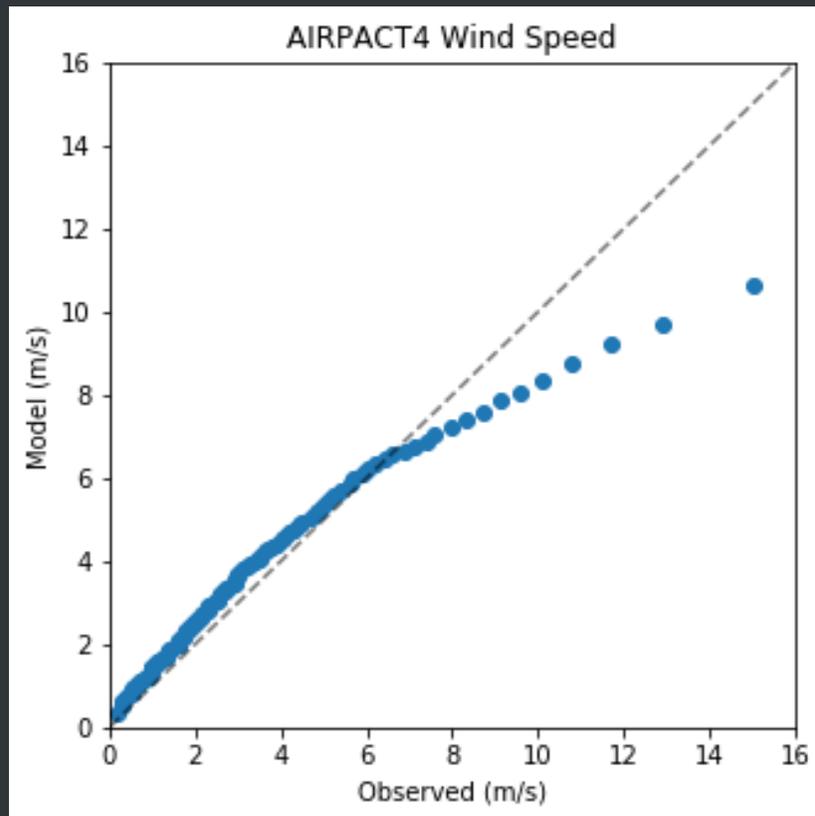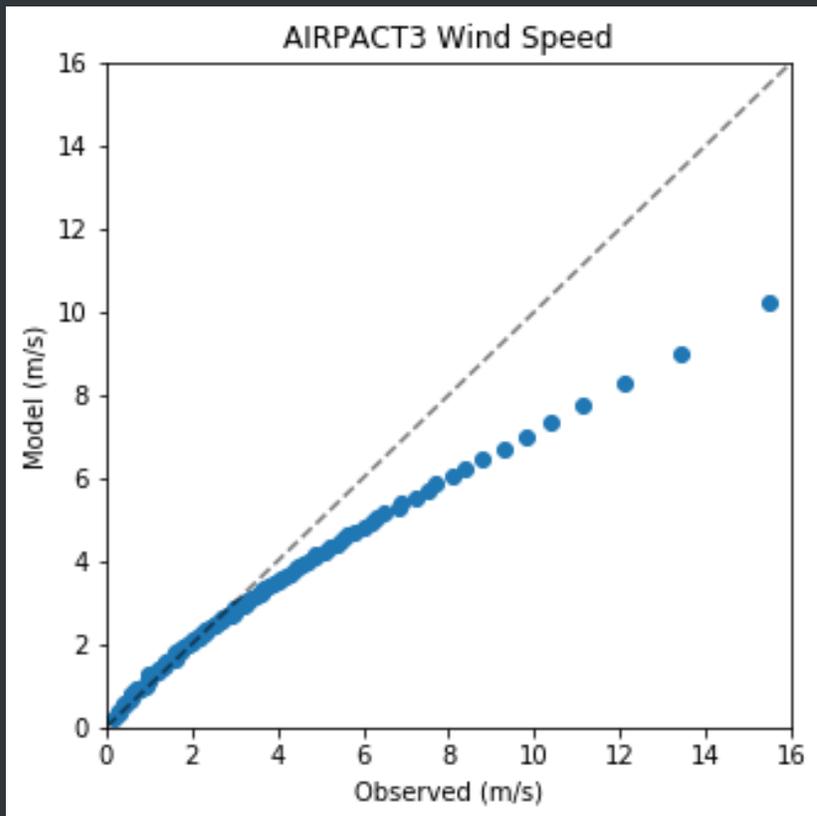
QQ Wind Direction

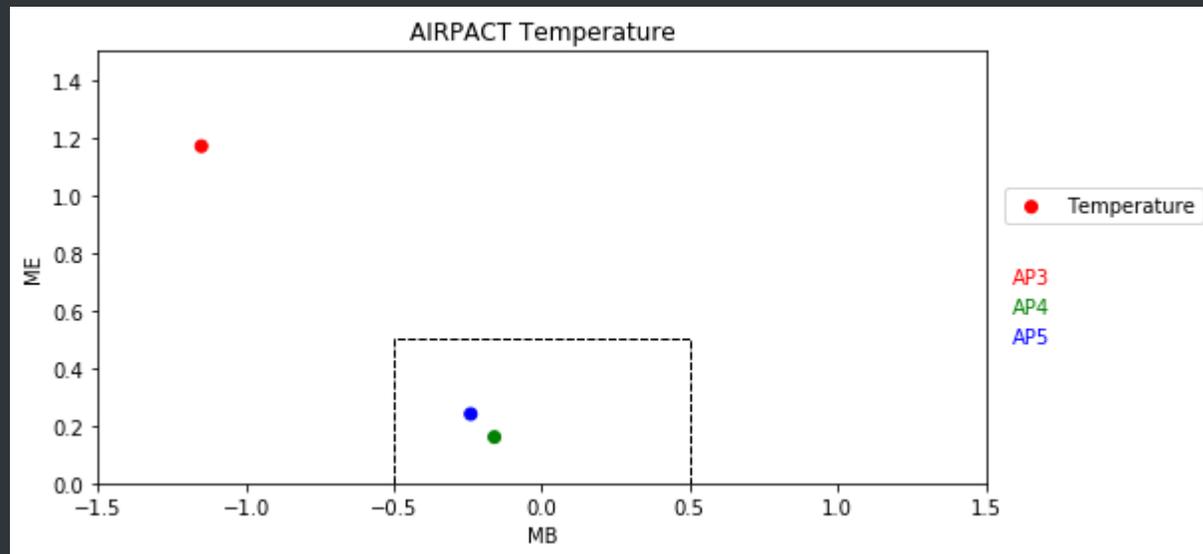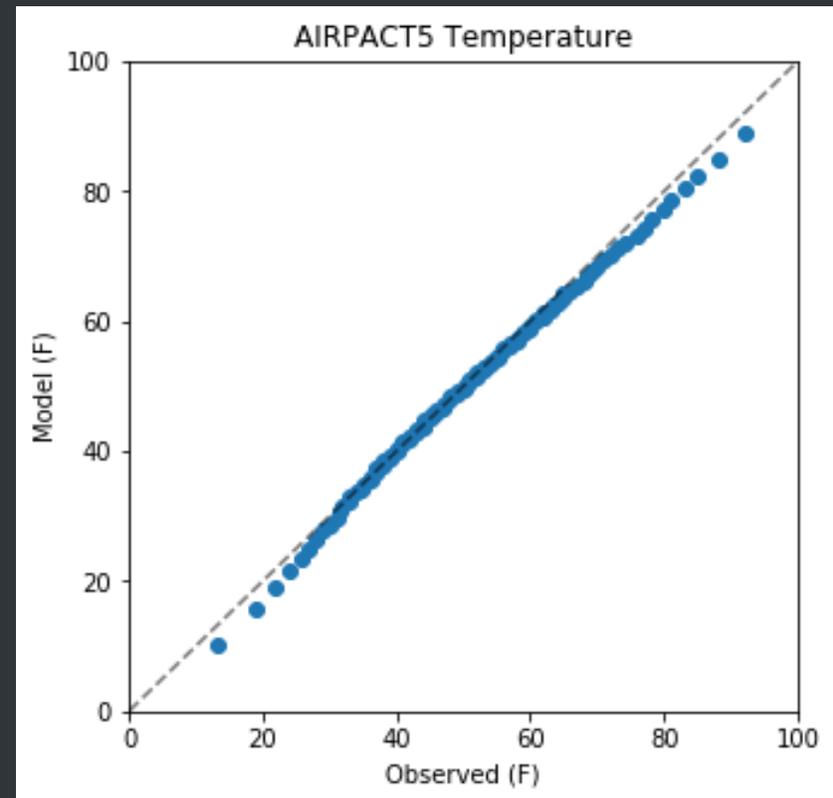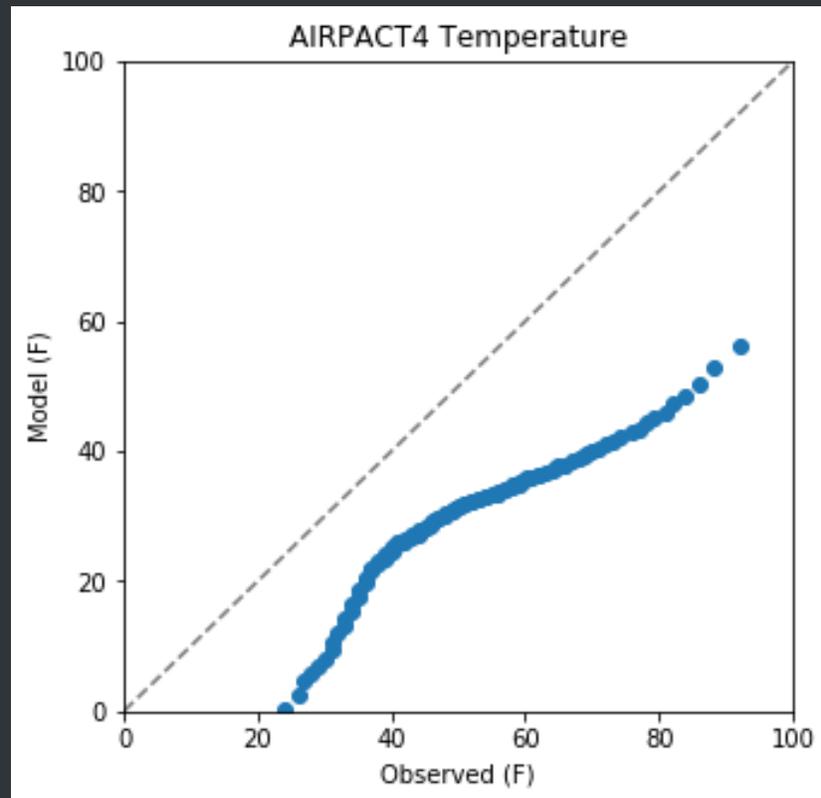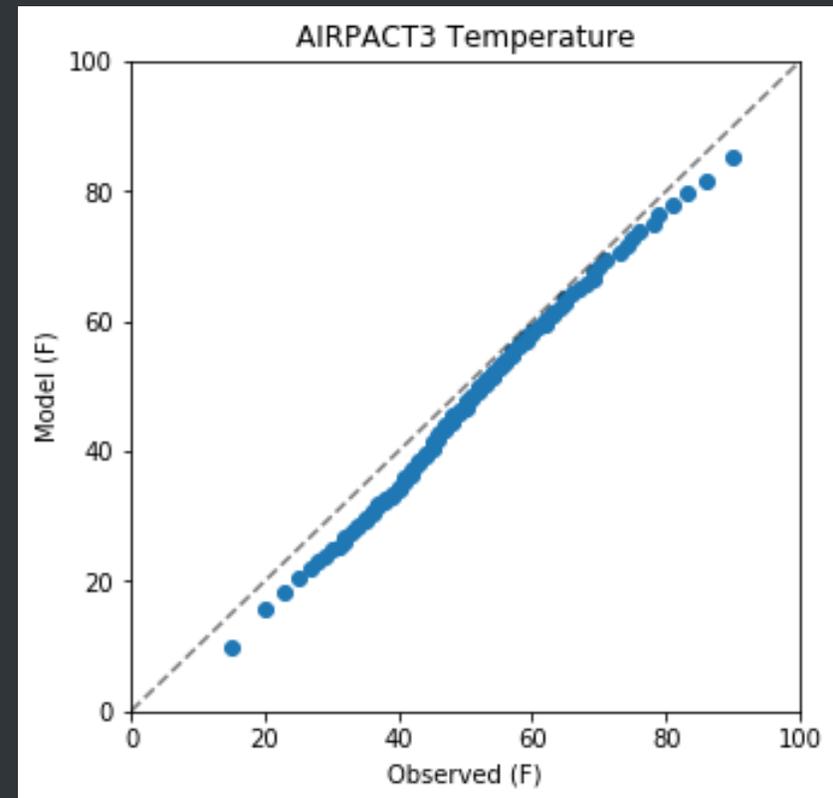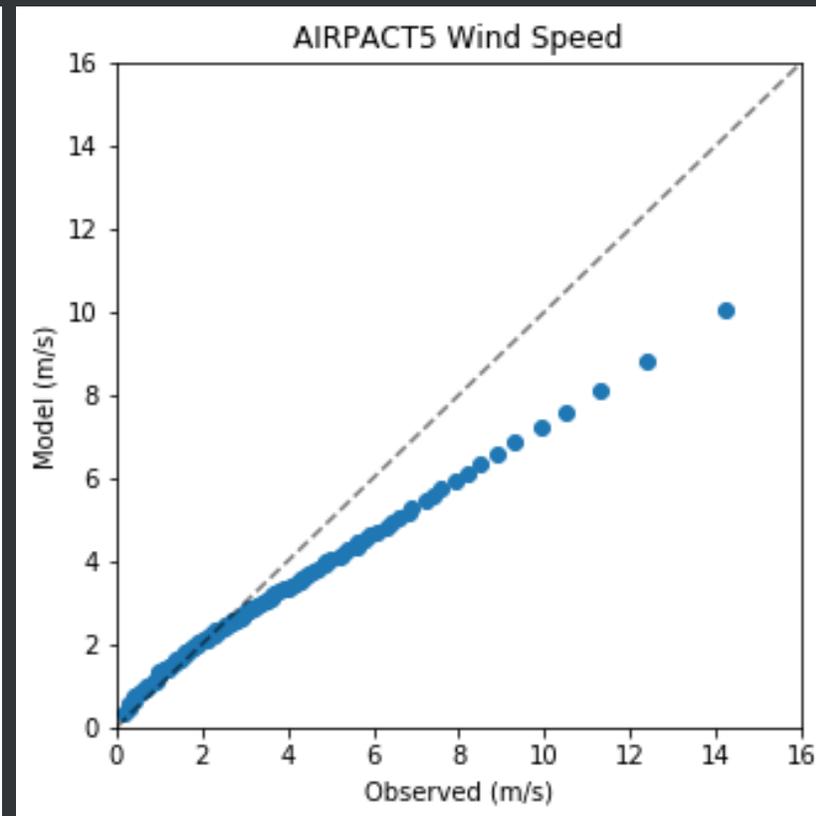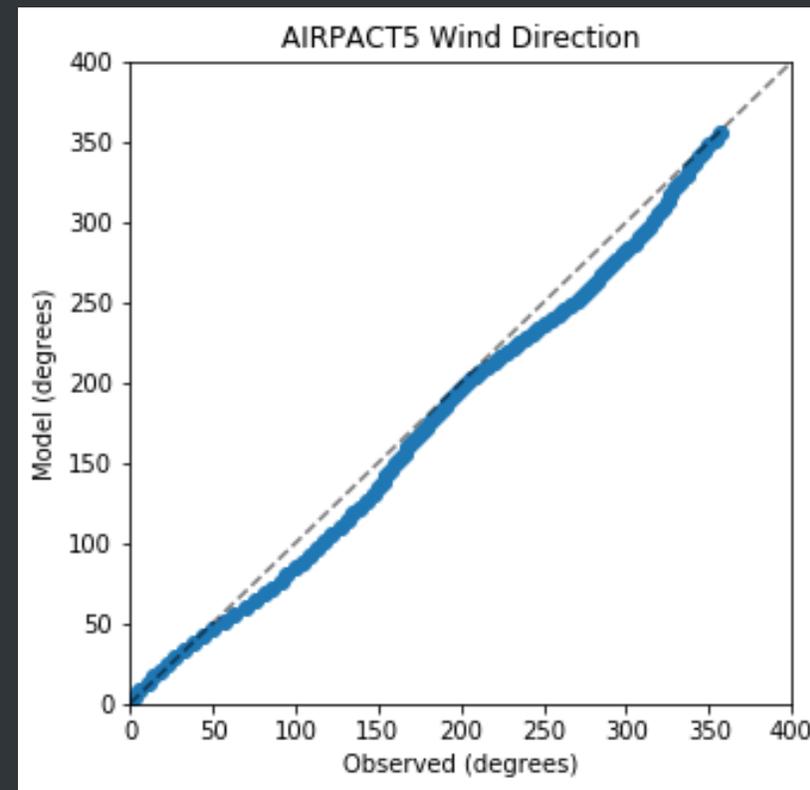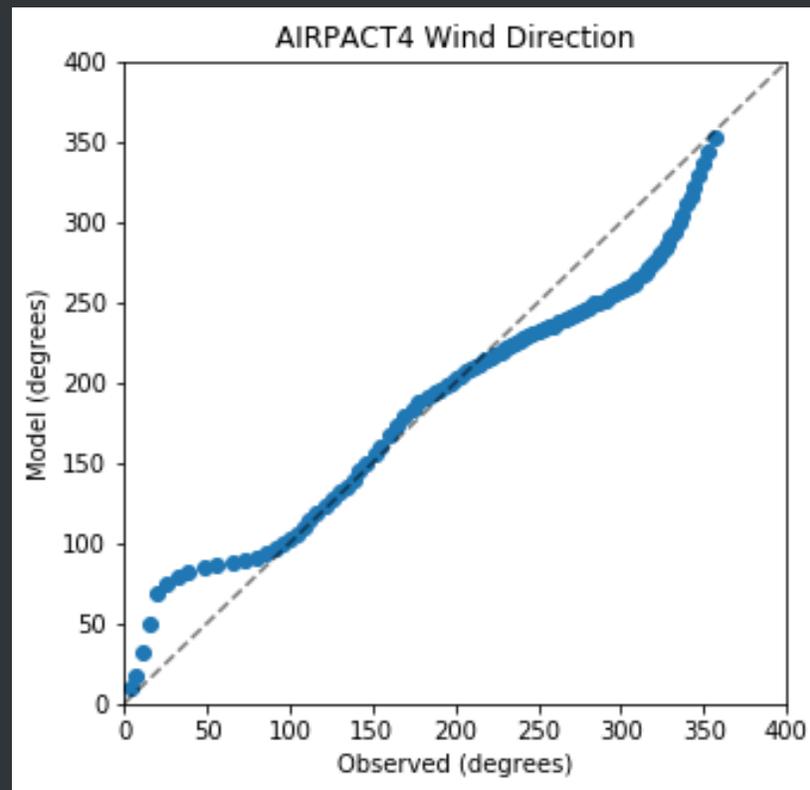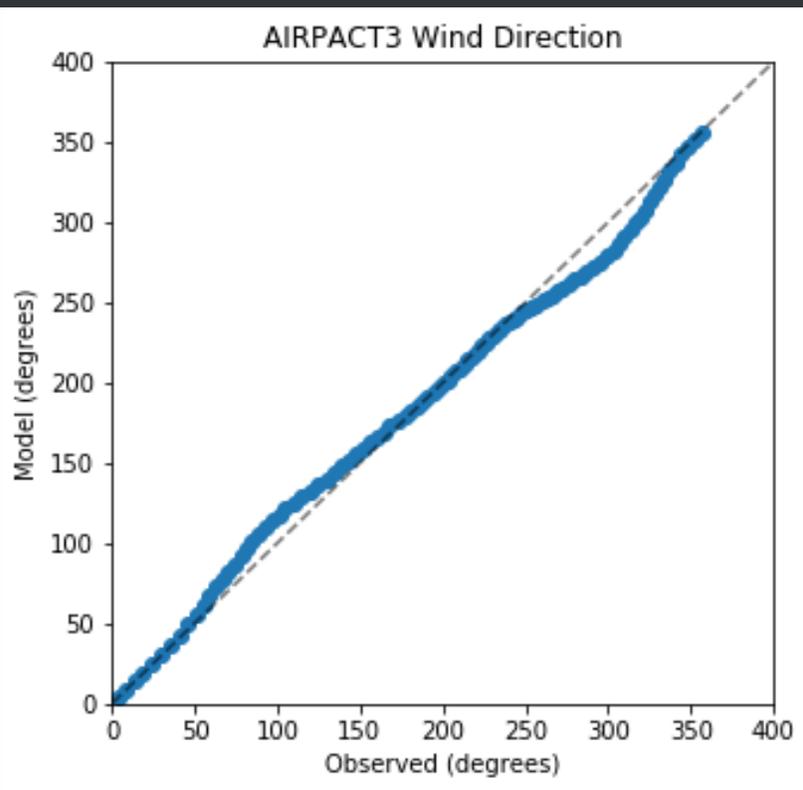# QQ Relative Humidity
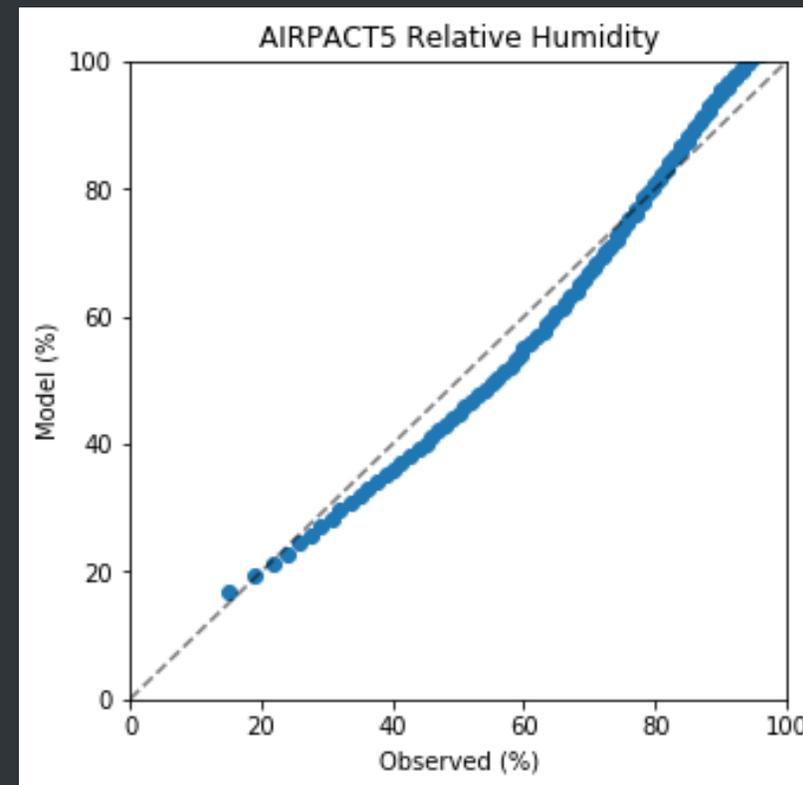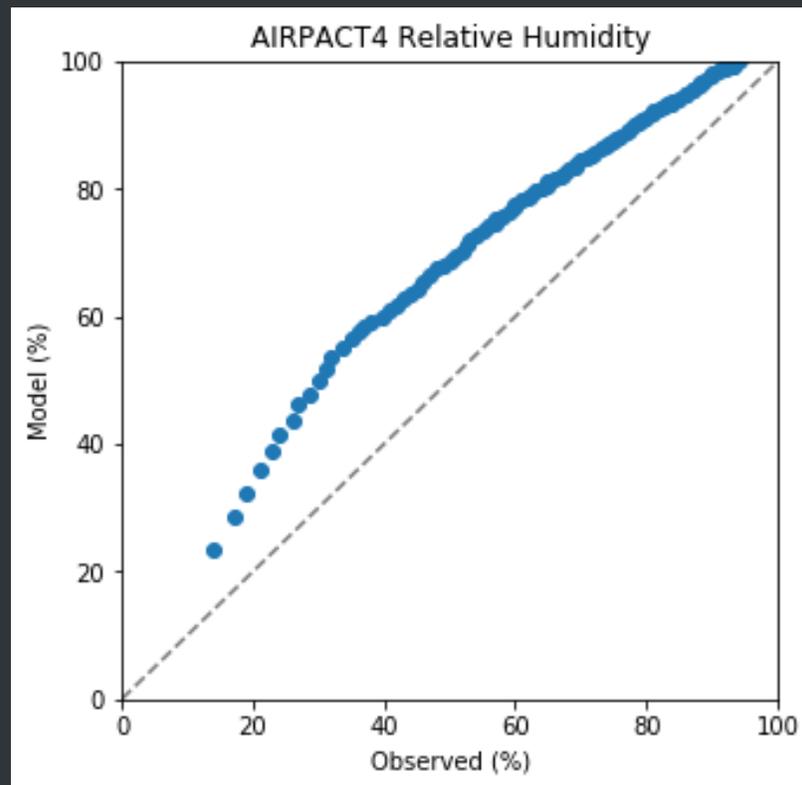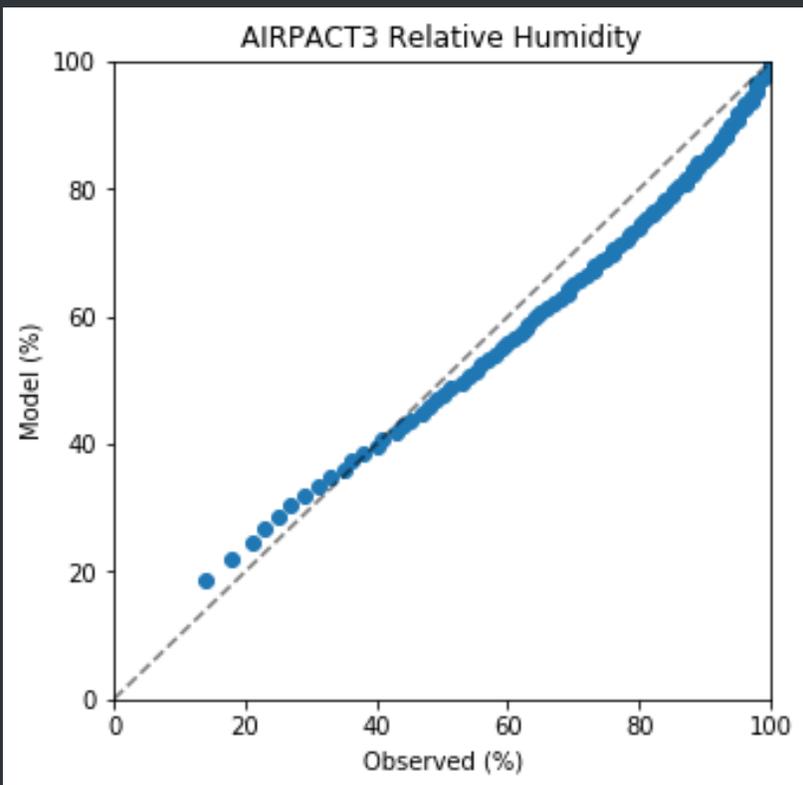
Pollutants

Parameters

• Species
 – Ozone
 – PM$_{2.5}$

Table 2 : Performance criteria and goals for gas- and aerosol phase species (from EPA, 2007 , Boylan and Russell ,2006 and Chemel et al. 2010)

Species	Metric	Criteria	Goal
Main PM constituents (> 30% total mass), PM2.5	MFE MFB	75% ±60%	50% ±30%
Minor PM constituents (< 30% total mass)		Exp variations to reach 100%/200% at 0 concentrations	
Ozone	MFE MFB	45% ±30%	30% ±15%

"A procedure for air quality models benchmarking" by P. Thunis et al., February 2011

Ozone
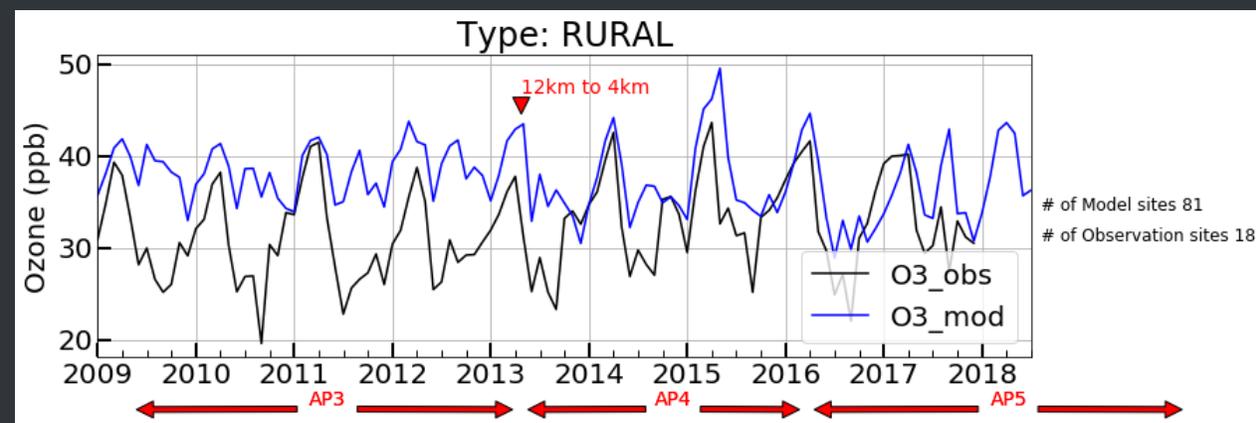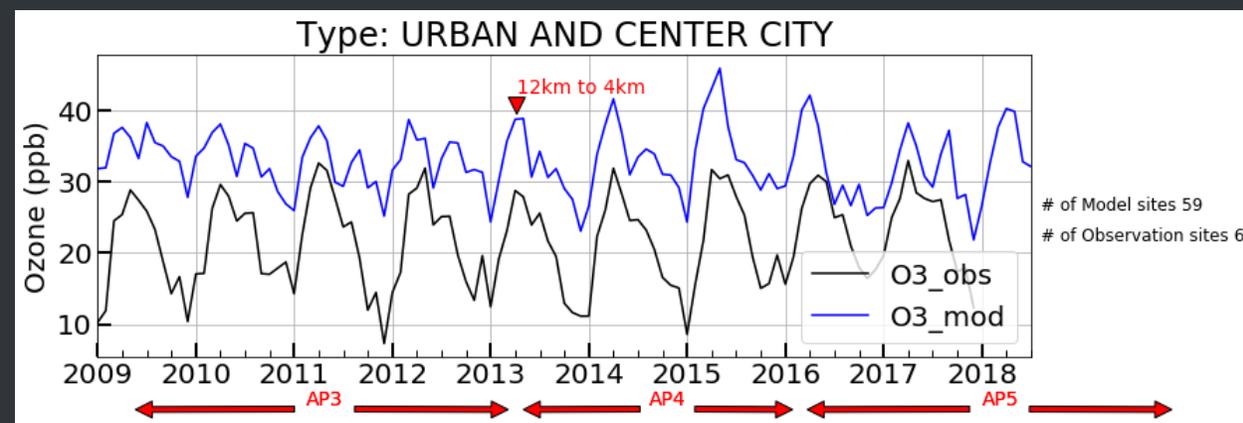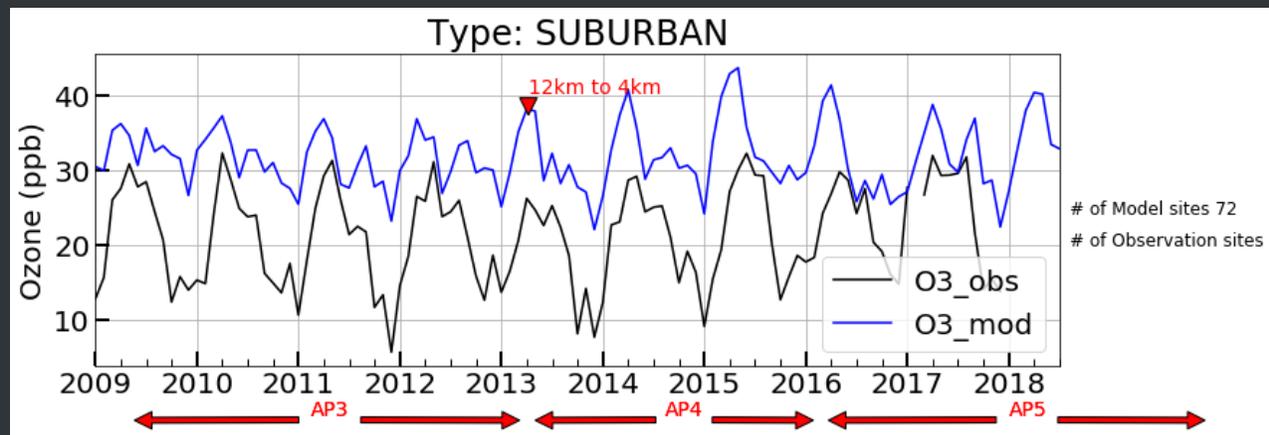
PM$_{2.5}$

	2009	2010	2011	2012	2013	2014	2015	2016	2017
MB	5.18	0.6	-0.9	0.02	2.67	4.95	4.15	2.14	2.71
ME	5.18	0.6	0.9	0.02	2.67	4.95	4.15	2.14	2.71
RMSE	12.51	12.34	11.79	12.61	14.78	12.08	11.79	10.71	14.48
FB	25.04	-14.7	-14.26	-9.11	2.89	26.52	25.97	15.04	16.17
FE	56.3	73.93	71.65	59	66.78	46.37	48.66	41.63	42
r²	0.45	0.34	0.55	0.48	0.41	0.53	0.54	0.49	0.4

Ozone Suburban

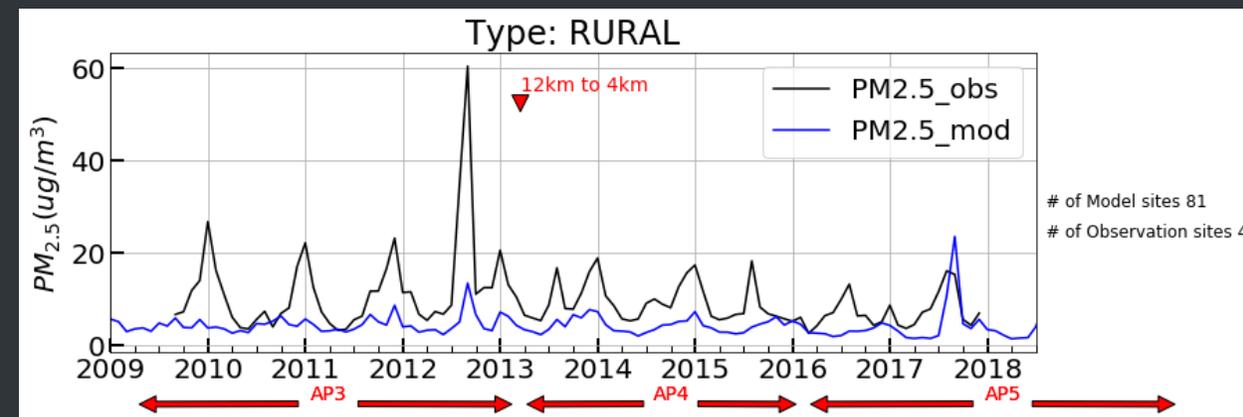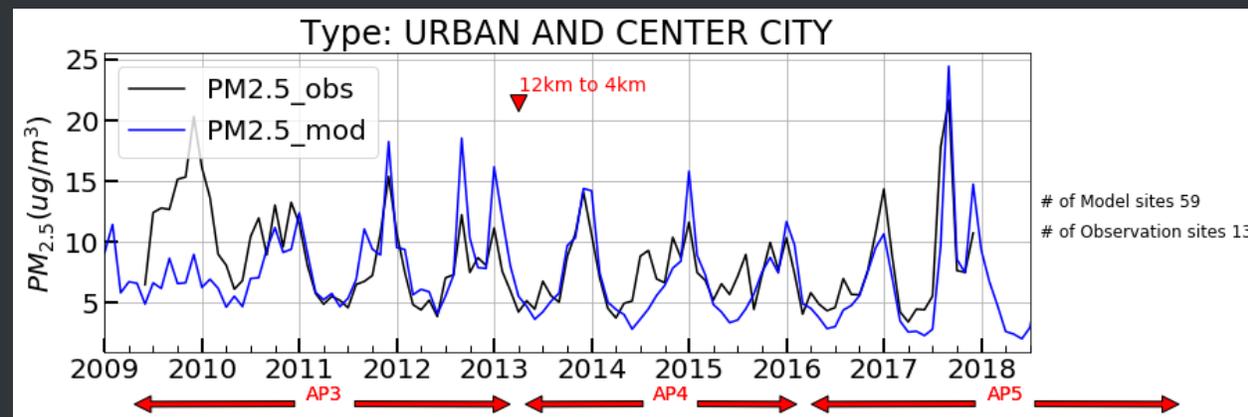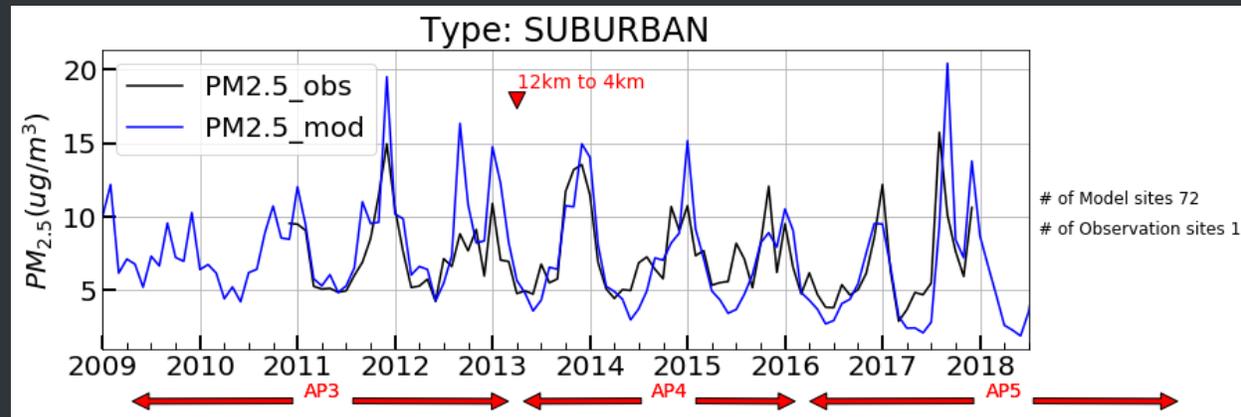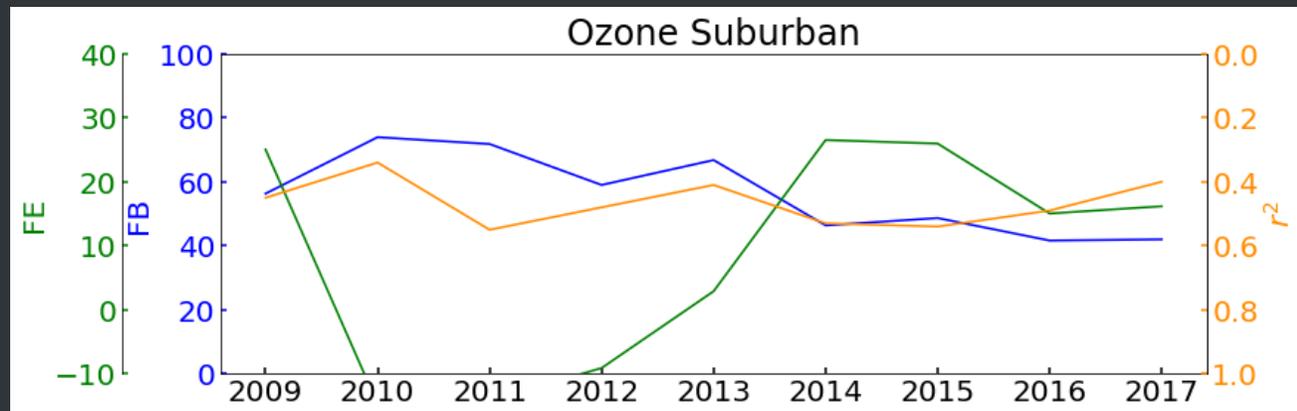|	2009	2010	2011	2012	2013	2014	2015	2016	2017
MB	8.27	7.99	5.32	6.76	7.58	5.5	4.08	1.75	2.38
ME	8.27	7.99	5.32	6.76	7.58	5.5	4.08	1.75	2.38
RMSE	13.52	13.07	12.88	13.64	14.43	12.02	13.03	10.22	13.08
FB	34.49	34.34	23.59	28.97	29.2	21.33	15.24	9.56	10.47
FE	40.3	41.16	40.46	41.02	41.75	32.94	32.94	31.75	30.18
r²	0.42	0.42	0.37	0.36	0.41	0.45	0.37	0.48	0.37

Ozone Rural
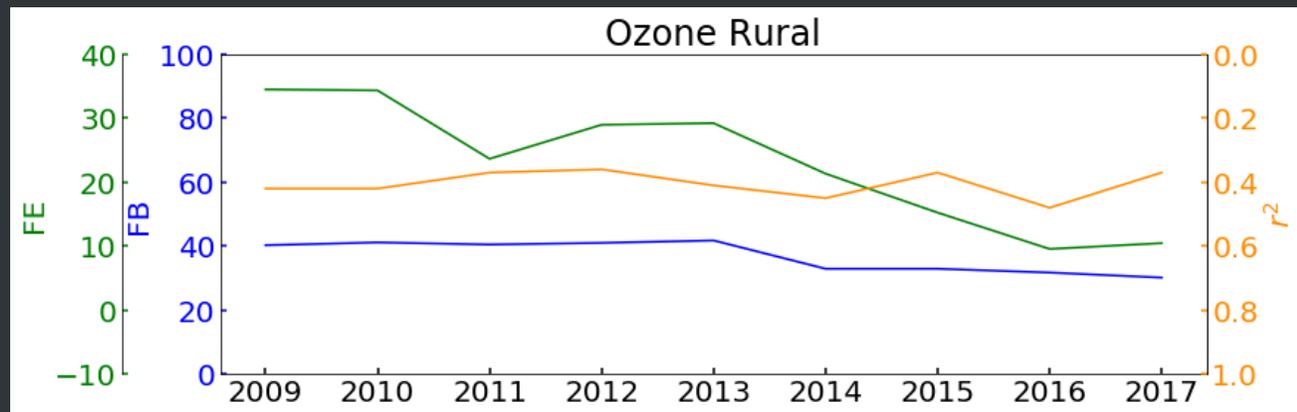
	2009	2010	2011	2012	2013	2014	2015	2016	2017
MB	-0.53	2.76	-0.19	1.66	2.35	5.33	5.04	0.12	0.85
ME	0.53	2.76	0.19	1.66	2.35	5.33	5.04	0.12	0.85
RMSE	13.05	12.24	11.94	13	14.05	13.54	14.08	11.72	13.01
FB	1.44	9.64	-8.26	2	-1.38	24.05	21.8	0.3	1
FE	74.95	59.94	62.46	62.15	70.64	56.72	55.86	52.06	50.37
r²	0.26	0.44	0.49	0.44	0.39	0.41	0.4	0.39	0.4

Ozone Urban
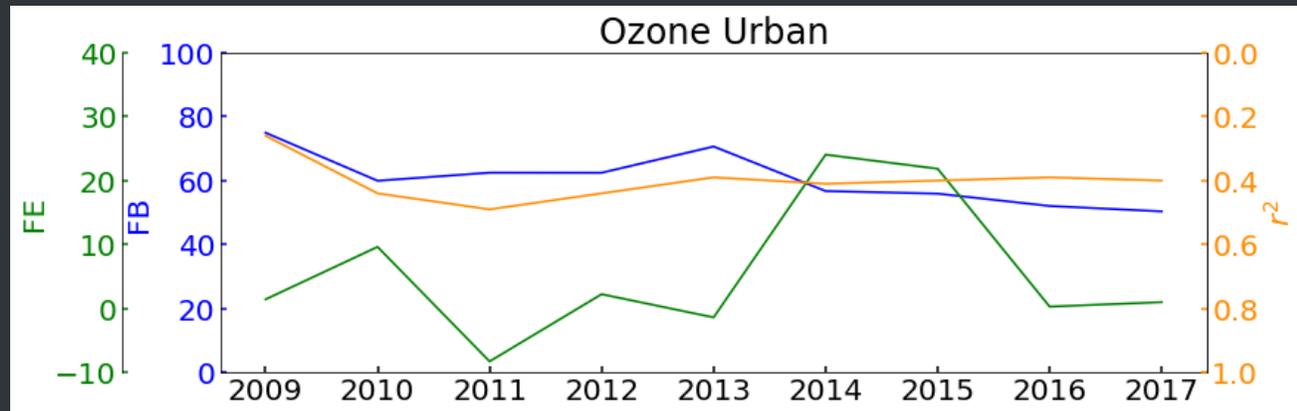
	2009	2010	2011	2012	2013	2014	2015	2016	2017
MB	6.54	6.63	4.9	1.82	-0.13	1.33	2.27	1.14	6.54
ME	9.43	8.86	7.76	5.79	4.71	5.55	5.53	7.11	9.43
RMSE	14.14	13.66	13.42	10.09	7.86	10.88	9.03	13.35	14.14
FB	50.13	49.89	45.09	18.97	-0.75	23.49	34.02	23.57	50.13
FE	84.82	76.46	79.17	65.24	68.14	71.23	82.55	93.59	84.82
r^2	0.13	0.27	0.09	0.2	0.16	0.1	0.11	0.2	0.13
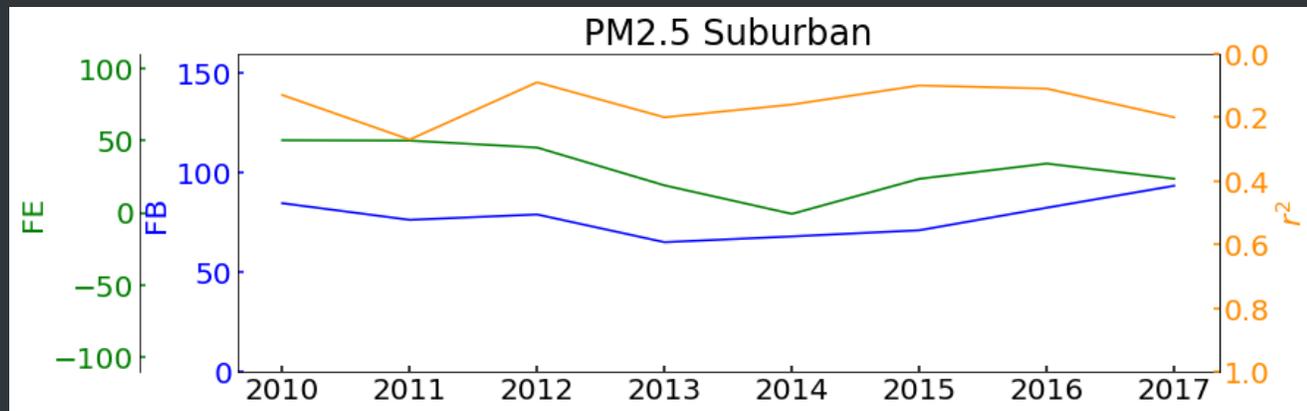
	2009	2010	2011	2012	2013	2014	2015	2016	2017
MB	-11.35	-7.93	-8.39	-13.83	-10.17	-10.53	-7.26	-4.74	-4.57
ME	12.06	9.6	10.24	17.25	10.86	11.06	7.52	5.39	6.4
RMSE	18.45	16.46	17.09	38.57	17.49	17.78	13.24	7.66	11.36
FB	-103.37	-22.02	0.99	-26.35	-78.91	-82.68	-91.26	-66.44	-71.86
FE	114.44	139.49	152.11	134.81	134.18	143.4	107.52	127.31	121.89
r^2	0.02	0	0.02	0.24	0.06	0.02	0.03	0.01	0.23
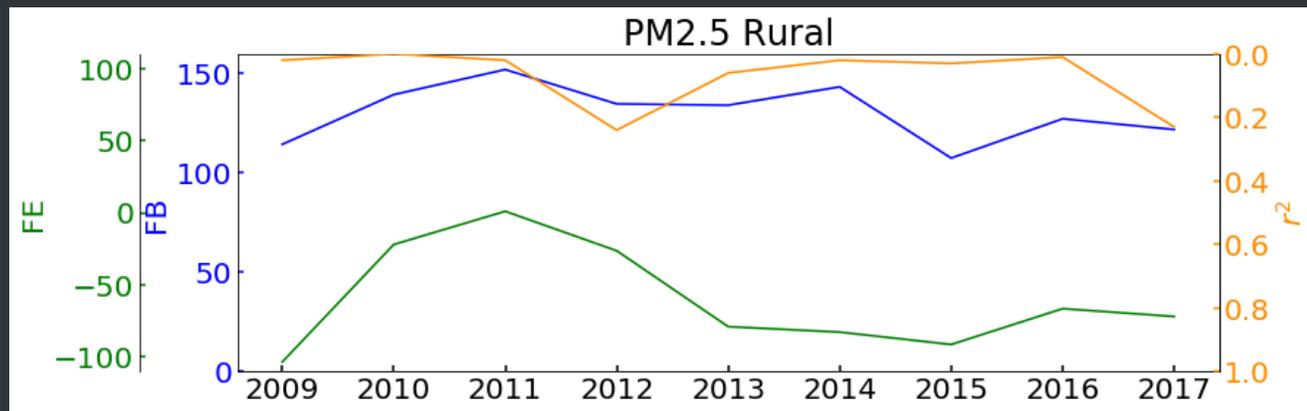
	2009	2010	2011	2012	2013	2014	2015	2016	2017
MB	-8.07	3.28	3.61	2.32	2.16	-1.67	-0.78	0.32	-0.51
ME	9.05	9.13	8.78	7.29	6.77	5.17	5.32	5.31	7.4
RMSE	15.52	13.86	14.08	11.87	10.81	8.49	8.66	8.97	14.85
FB	-76.47	15.6	15.44	17.4	9.49	-24.55	-9.08	6.82	1.1
FE	91.78	80.78	82.1	83.65	72.57	80.03	78.37	83.92	90.82
r^2	0.01	0.06	0.04	0.06	0.14	0.07	0.1	0.1	0.48
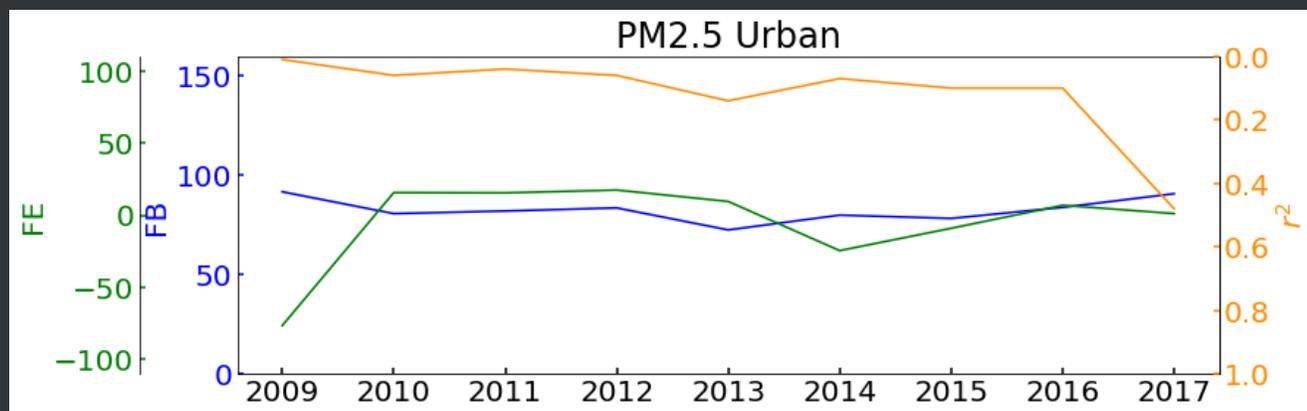
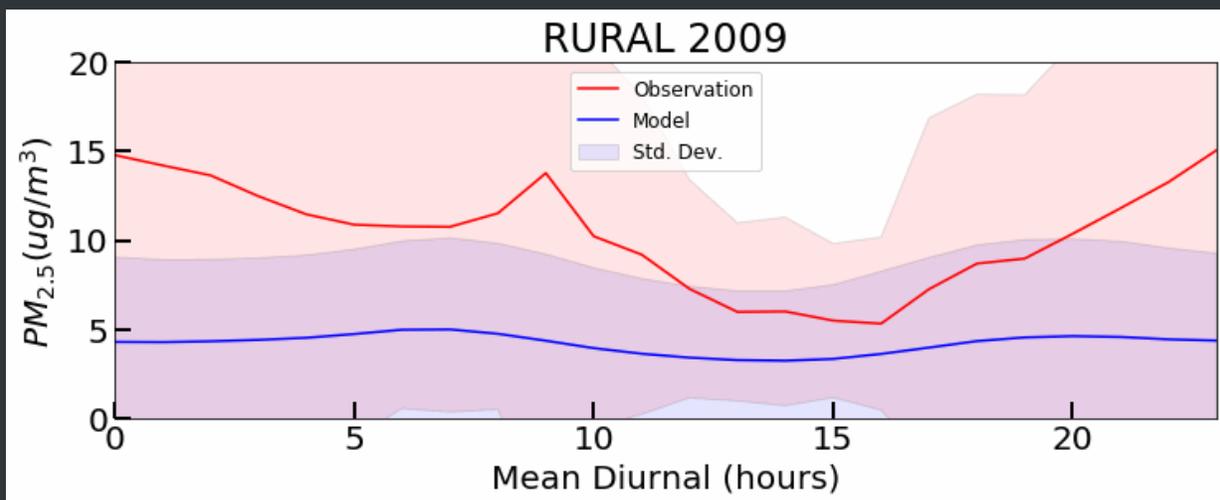# Diurnal Ozone
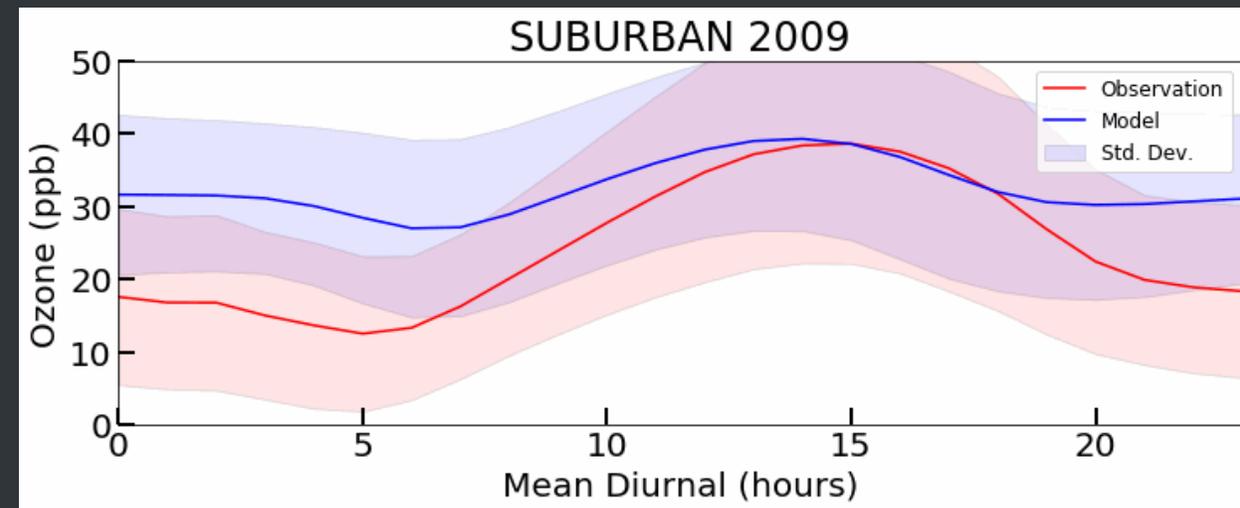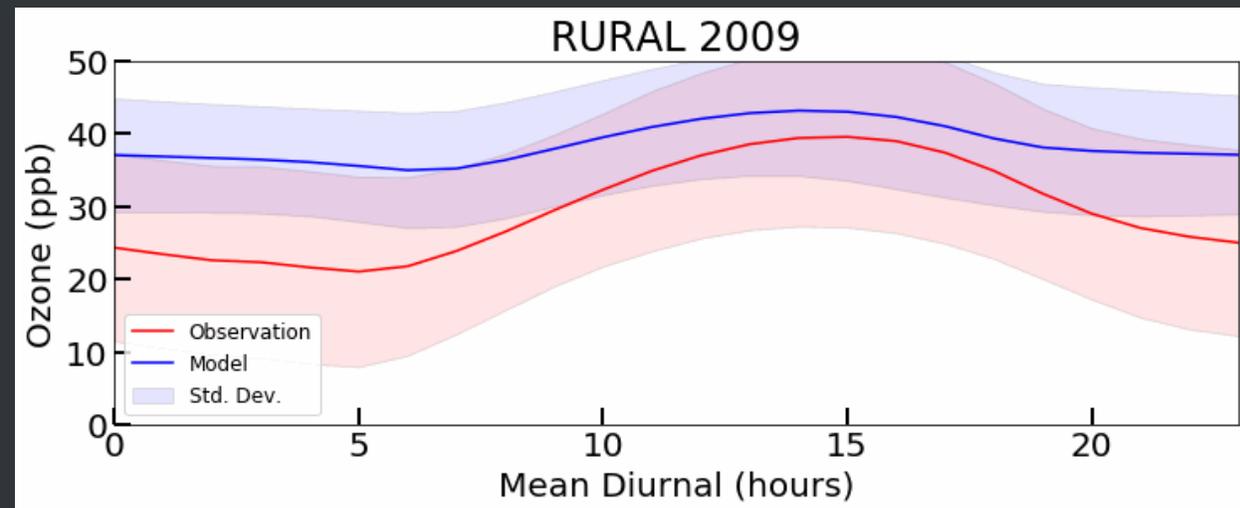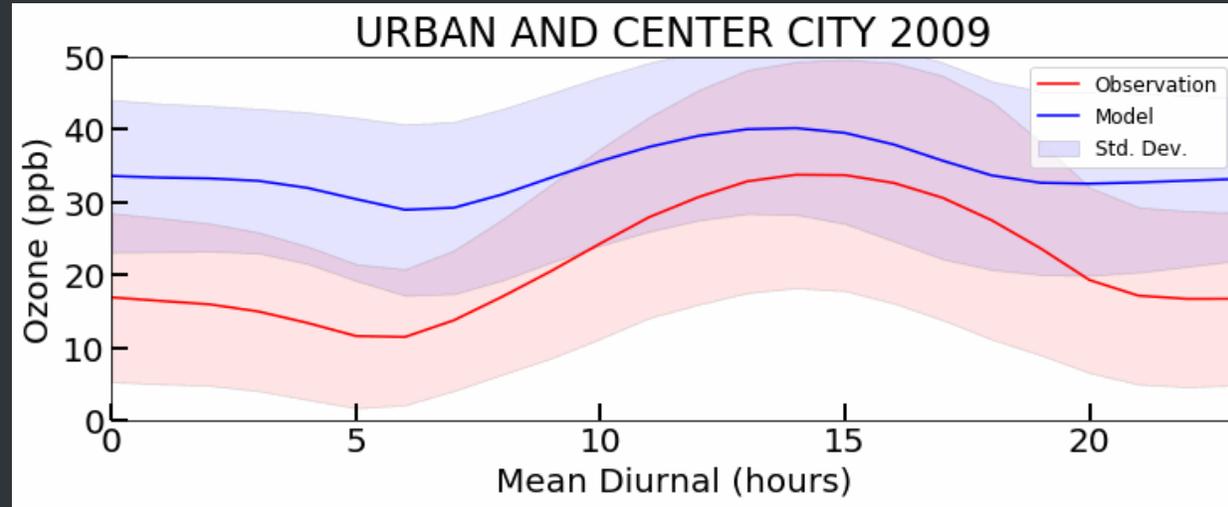
Diurnal PM$_{2.5}$
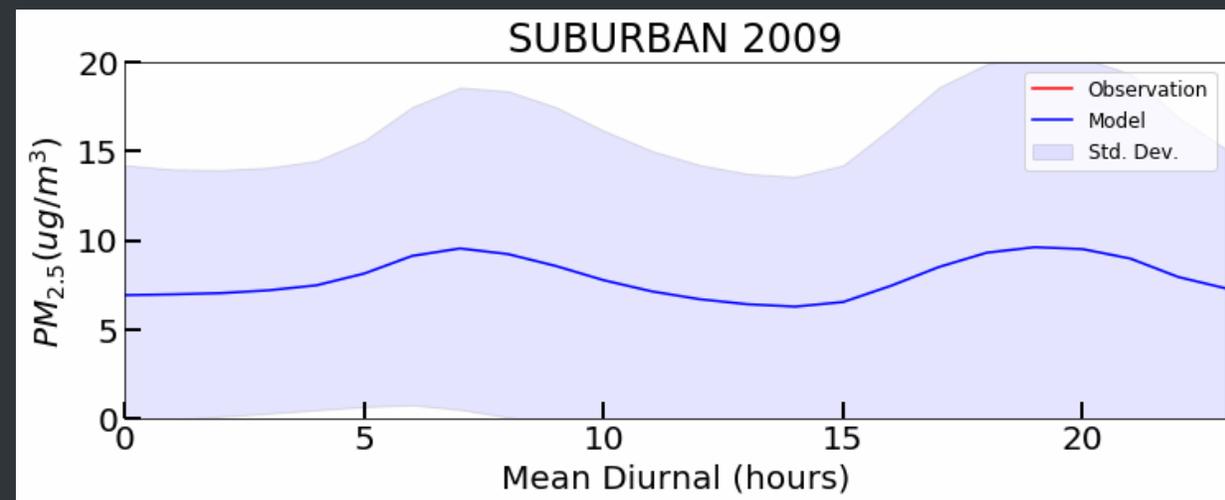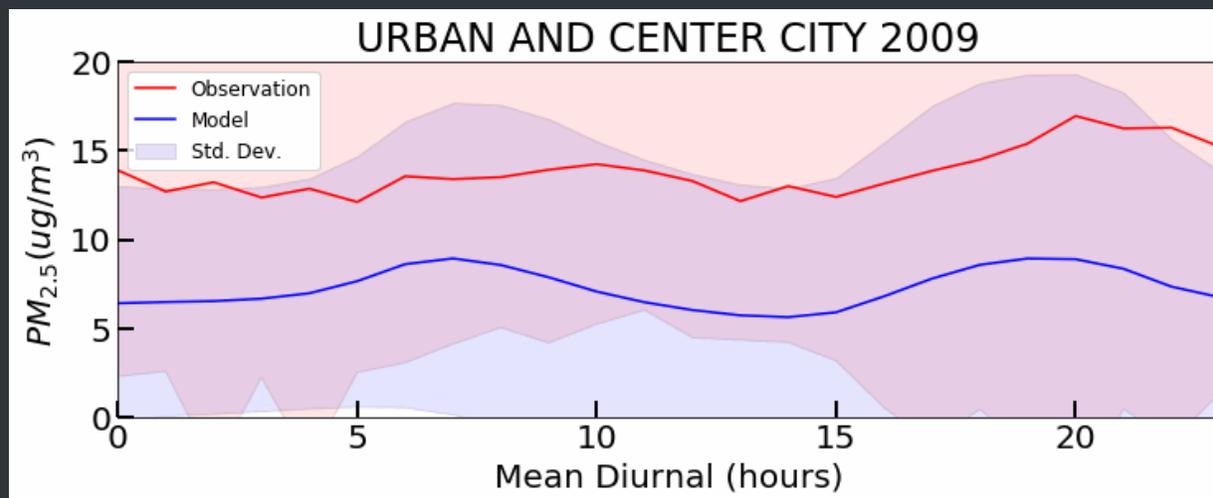
Ozone and PM2.5 Evaluation

O3 per AIRPACT Version

PM_2.5 per AIRPACT Version
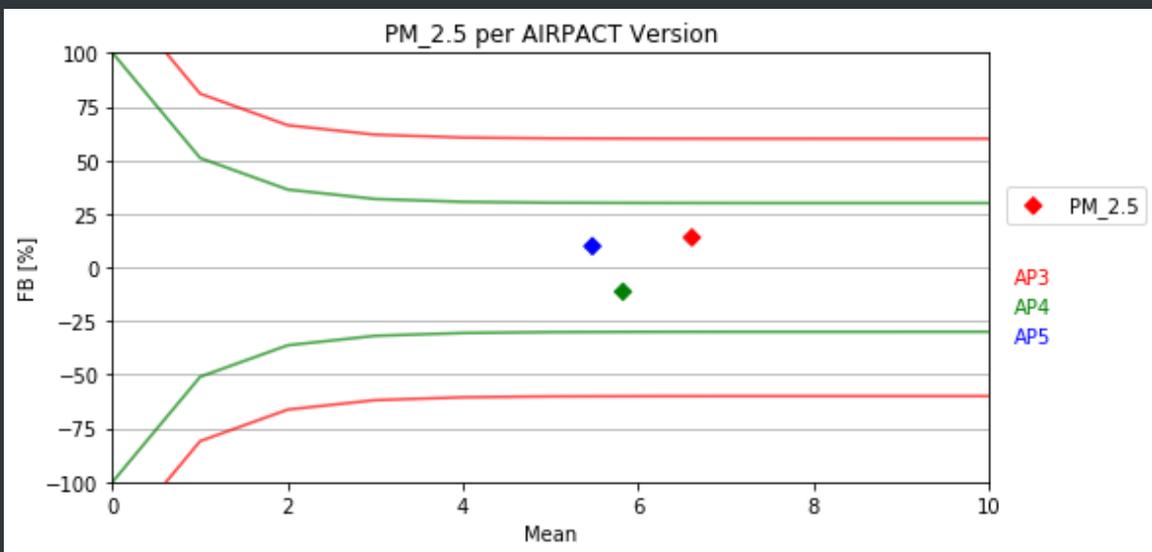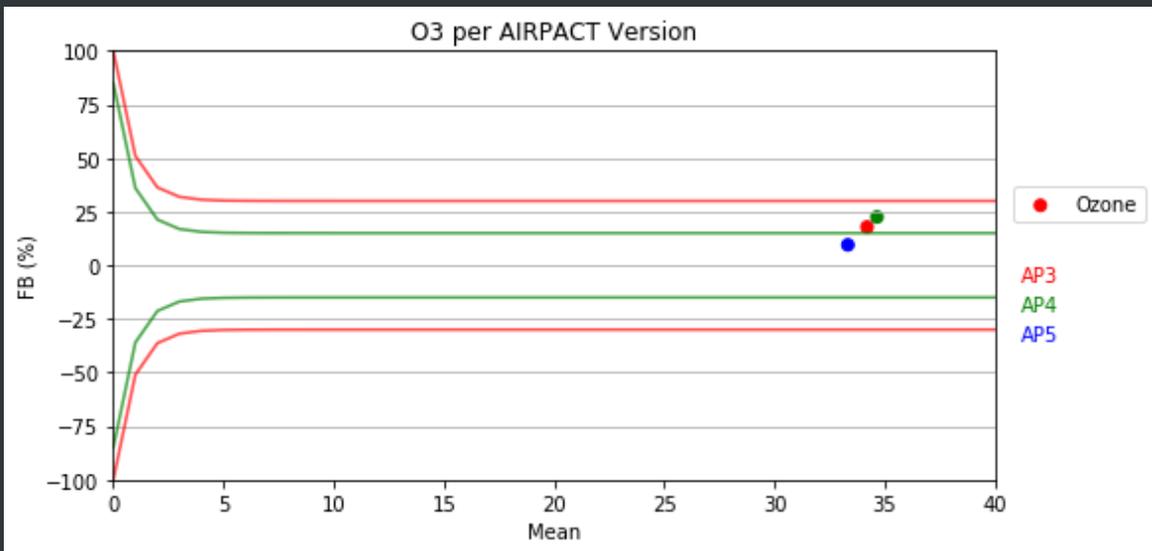
index	Mean	MB	ME	FB	FE	NMB [%]	NME [%]	RMSE [var units]	R^2 [-]	Version
O3_mod	34.19	0.38	0.78	17.9	49.2	12	25	4	0.03	AP3
PM2.5_mod	6.61	0.08	0.45	13.9	84.6	13	71	3	0.01	AP3
O3_mod	34.6	0.47	0.92	22.5	43.9	16	31	4	0.05	AP4
PM2.5_mod	5.82	-0.11	0.55	-11.3	77.6	-12	56	3	0.01	AP4
O3_mod	33.3	0.14	0.62	9.52	38.0	6	28	3	0.04	AP5
PM2.5_mod	5.48	0.03	0.59	9.89	92.4	4	79	4	0.03	AP5

Conclusions

- Meteorology
  - Significant improvement from AIRPACT 3 to AIRPACT 4 and 5. Differences between AIRPACT 4 and 5 are small
    - AIRPACT 3 failed to meet temperature criteria

Conclusions

- Pollutants
  - PM2.5
    - Within benchmark goals for all versions
  - Ozone
    - AIRPACT has improved from just meeting criteria to meeting the goal standard
    - Significant improvement at urban and rural sites