

Supporting Information for:
Compilation and Interpretation of Photochemical Model Performance Statistics Published
between 2006 and 2012

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This supporting information supplies additional plots. First, summary plots for various performance metrics are supplied for ozone and PM precursors and for criteria pollutants not included in the main text. Second, plots are presented that break down ozone and speciated PM performance by four characteristics: model resolution, region of the US, spatial scale, and forecast versus retrospective model applications. For regional breakdowns, studies were grouped into East, West, and continental categories, with Eastern including all studies which focused on locations east of the Rocky Mountains, Western including all studies which focused on locations from the Rocky Mountains west, and continental including studies which covered the entire US. The spatial scale categorizations included: local, regional, and superregional. Local studies are defined as covering areas within a single state (or equivalently small region of Canada) mostly focused on urban areas. Regional studies included multiple states. Superregional studies included areas which covered half or more of the US. These breakdowns are only presented for pollutants and metrics for which adequate data is available in multiple categories. The width of each box in the box-and-whisker plots is proportional to the sample number for that category.

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Tables

Table S 1: Performance metric distributions for hourly ozone based on data from Appel et al (2011).

Hourly ozone				Quantile Estimate				
cut-off	metric	units	n	10%	25%	50%	75%	90%
none	r ²		20	0.49	0.49	0.50	0.52	0.53
none	MB	ppb	20	4.47	4.97	6.81	7.97	10.21
none	FB	%	20	15.42	20.33	26.60	31.30	40.97
none	NMB	%	20	13.53	15.80	21.25	25.00	32.90
none	RMSE	ppb	20	11.09	11.20	11.65	12.40	13.43
none	ME	ppb	20	14.39	14.68	15.15	16.23	17.12
none	FE	%	20	40.29	40.88	43.10	44.75	49.38
none	NME	%	20	33.09	33.80	35.10	38.38	44.76
60 ppb	r ²		20	0.15	0.18	0.23	0.28	0.30
60 ppb	MB	ppb	20	-10.33	-9.48	-7.11	-6.73	-5.86
60 ppb	FB	%	20	-17.51	-15.70	-11.70	-11.28	-10.28
60 ppb	NMB	%	20	-14.93	-13.33	-10.15	-9.57	-8.67
60 ppb	RMSE	ppb	20	12.48	12.80	13.85	15.88	16.63
60 ppb	ME	ppb	20	9.64	9.84	10.50	11.90	12.53
60 ppb	FE	%	20	15.10	15.40	16.40	19.18	20.23
60 ppb	NME	%	20	13.98	14.28	14.90	16.95	17.92
75 ppb	r ²		20	0.04	0.06	0.15	0.19	0.21
75 ppb	MB	ppb	20	-16.78	-14.93	-11.80	-10.75	-10.46
75 ppb	FB	%	20	-23.69	-20.15	-16.40	-15.33	-14.55
75 ppb	NMB	%	20	-20.12	-17.13	-14.15	-13.20	-12.47
75 ppb	RMSE	ppb	20	16.18	16.88	17.50	21.33	23.36
75 ppb	ME	ppb	20	12.97	13.65	14.15	17.10	18.22
75 ppb	FE	%	20	17.68	18.23	19.00	22.55	25.23
75 ppb	NME	%	20	15.79	16.25	16.95	19.63	21.57

Table S 2: Performance metric distributions for PM_{2.5} evaluations in all studies included in this review

pollutant	metric	units	n	Quantile Estimate				
				10%	25%	50%	75%	90%
PM _{2.5}	r ²		59	0.09	0.16	0.34	0.49	0.62
PM _{2.5}	MB	µg/m ³	71	-3.3	-0.9	0.0	1.8	4.6
PM _{2.5}	FB	%	15	-44.4	-33.5	-12.0	-3.0	0.4
PM _{2.5}	NMB	%	65	-32.9	-21.1	0.0	10.4	24.7
PM _{2.5}	RMSE	µg/m ³	35	5.1	5.9	7.8	10.6	12.8
PM _{2.5}	ME	µg/m ³	32	2.4	3.6	4.9	7.1	9.1
PM _{2.5}	FE	%	13	31.4	34.0	49.0	54.0	59.2

PM _{2.5}	NME	%	56	30.4	36.9	41.2	50.7	67.0
OC	r ²		24	0.02	0.07	0.19	0.37	0.45
OC	MB	µg/m ³	12	-2.6	-0.8	-0.2	0.0	0.0
OC	FB	%	23	-85.2	-58.0	-37.0	-1.5	7.2
OC	NMB	%	32	-62.6	-30.8	5.2	19.6	25.8
OC	RMSE	µg/m ³	5	1.8	2.0	2.1	3.4	3.5
OC	ME	µg/m ³	9	0.3	0.6	0.7	1.6	2.8
OC	FE	%	13	41.4	43.0	49.0	64.0	100.6
OC	NME	%	31	39.6	47.5	52.7	67.0	77.4
OM	r ²		11	0.01	0.34	0.43	0.50	0.61
OM	MB	µg/m ³	6	-7.7	-4.6	-0.7	-0.2	0.0
OM	FB	%	5	-47.2	-1.0	-1.0	2.0	2.0
OM	NMB	%	10	-67.5	-61.8	-47.5	-14.5	-2.8
OM	RMSE	µg/m ³	3	1.7	2.0	2.5	2.6	2.7
OM	ME	µg/m ³	4	1.3	1.4	3.9	7.2	8.6
OM	FE	%	5	38.2	40.0	45.0	50.0	69.2
OM	NME	%	10	34.8	50.9	57.5	67.2	71.5
EC	r ²		19	0.09	0.16	0.22	0.42	0.73
EC	MB	µg/m ³	15	-0.3	-0.1	-0.1	0.1	0.2
EC	FB	%	18	-45.0	-34.0	-7.0	2.8	8.7
EC	NMB	%	27	-45.2	-29.4	-21.0	-3.0	13.0
EC	RMSE	µg/m ³	6	0.2	0.3	0.5	0.8	0.9
EC	ME	µg/m ³	12	0.1	0.1	0.3	0.5	0.8
EC	FE	%	16	36.0	41.5	52.0	66.3	67.0
EC	NME	%	26	38.6	40.7	52.5	59.5	62.5
TC	r ²		4	0.15	0.17	0.19	0.21	0.22
TC	MB	µg/m ³	12	-1.4	-0.8	-0.1	0.1	0.3
TC	FB	%	2	-15.3	-11.3	-4.5	2.3	6.3
TC	NMB	%	10	-45.9	-40.4	-24.4	-5.0	1.4
TC	RMSE	µg/m ³	2	2.4	2.4	2.4	2.4	2.4
TC	ME	µg/m ³	9	0.4	0.7	0.8	1.3	1.4
TC	FE	%	2	35.8	37.0	39.0	41.0	42.2
TC	NME	%	9	38.8	40.1	41.9	47.3	56.0
sulfate	r ²		31	0.10	0.25	0.46	0.59	0.82
sulfate	MB	µg/m ³	32	-0.8	-0.3	-0.1	0.2	1.2
sulfate	FB	%	26	-32.5	-19.8	-2.5	1.0	5.5
sulfate	NMB	%	39	-15.5	-8.2	-1.7	6.1	10.4
sulfate	RMSE	µg/m ³	47	0.2	0.3	0.6	1.1	1.5
sulfate	ME	µg/m ³	28	0.3	0.4	0.6	1.4	2.8
sulfate	FE	%	25	23.4	27.0	41.0	57.0	62.6

sulfate	NME	%	38	21.0	22.2	26.9	41.0	50.5
nitrate	r ²		27	0.02	0.11	0.25	0.46	0.54
nitrate	MB	µg/m ³	27	-0.5	-0.2	-0.1	0.0	0.5
nitrate	FB	%	26	-163.5	-136.8	-35.5	-2.5	17.0
nitrate	NMB	%	34	-75.7	-49.1	-7.7	11.1	57.2
nitrate	RMSE	µg/m ³	46	0.1	0.1	0.3	0.5	0.7
nitrate	ME	µg/m ³	23	0.2	0.2	0.4	0.6	0.7
nitrate	FE	%	25	51.8	81.0	100.0	156.0	164.6
nitrate	NME	%	33	55.4	66.6	73.0	79.7	88.9
ammonium	r ²		21	0.1	0.3	0.5	0.6	0.8
ammonium	MB	µg/m ³	17	-0.9	-0.2	-0.1	0.0	0.1
ammonium	FB	%	20	-61.0	-37.3	-4.5	0.0	3.2
ammonium	NMB	%	31	-42.6	-16.8	-2.9	6.5	22.7
ammonium	RMSE	µg/m ³	6	0.5	0.5	0.7	1.5	1.8
ammonium	ME	µg/m ³	14	0.2	0.2	0.3	1.2	1.4
ammonium	FE	%	18	16.4	22.3	41.0	54.8	69.3
ammonium	NME	%	29	23.0	26.8	37.4	47.3	54.5

Table S 3: Performance metric distributions for total wet deposition pollutants

Pollutant	Performance Metric	units	N	Quantile Estimate				
				10%	25%	50%	75%	90%
Total Sulfate Wet Deposition	FB	%	16	-70	-8	12	19	30
Total Sulfate Wet Deposition	FE	%	16	65	76	86	98	107
Total Sulfate Wet Deposition	NMB	%	76	-9	-1	8	23	38
Total Sulfate Wet Deposition	NME	%	16	50	61	68	93	115
Total Ammonium Wet Deposition	FB	%	16	-89	-11	15	25	33
Total Ammonium Wet Deposition	FE	%	16	75	83	88	99	114
Total Ammonium Wet Deposition	NMB	%	76	-33	-21	-10	0	28
Total Ammonium Wet Deposition	NME	%	16	51	57	78	91	98
Total Nitrate Wet Deposition	FB	%	16	-64	-34	-15	10	18

Total Nitrate Wet Deposition	FE	%	16	64	72	91	98	108
Total Nitrate Wet Deposition	NMB	%	76	-45	-37	-8	10	19
Total Nitrate Wet Deposition	NME	%	16	45	51	62	71	85
Total Mercury Wet Deposition	FE	%	9	75	77	84	87	89
Total Mercury Wet Deposition	NMB	%	13	-4	12	19	40	65
Total Mercury Wet Deposition	NME	%	13	42	71	85	99	110
Total Mercury Wet Deposition	r^2		26	0.14	0.16	0.54	0.65	0.78

Summary plots for ozone and PM precursor and criteria pollutants

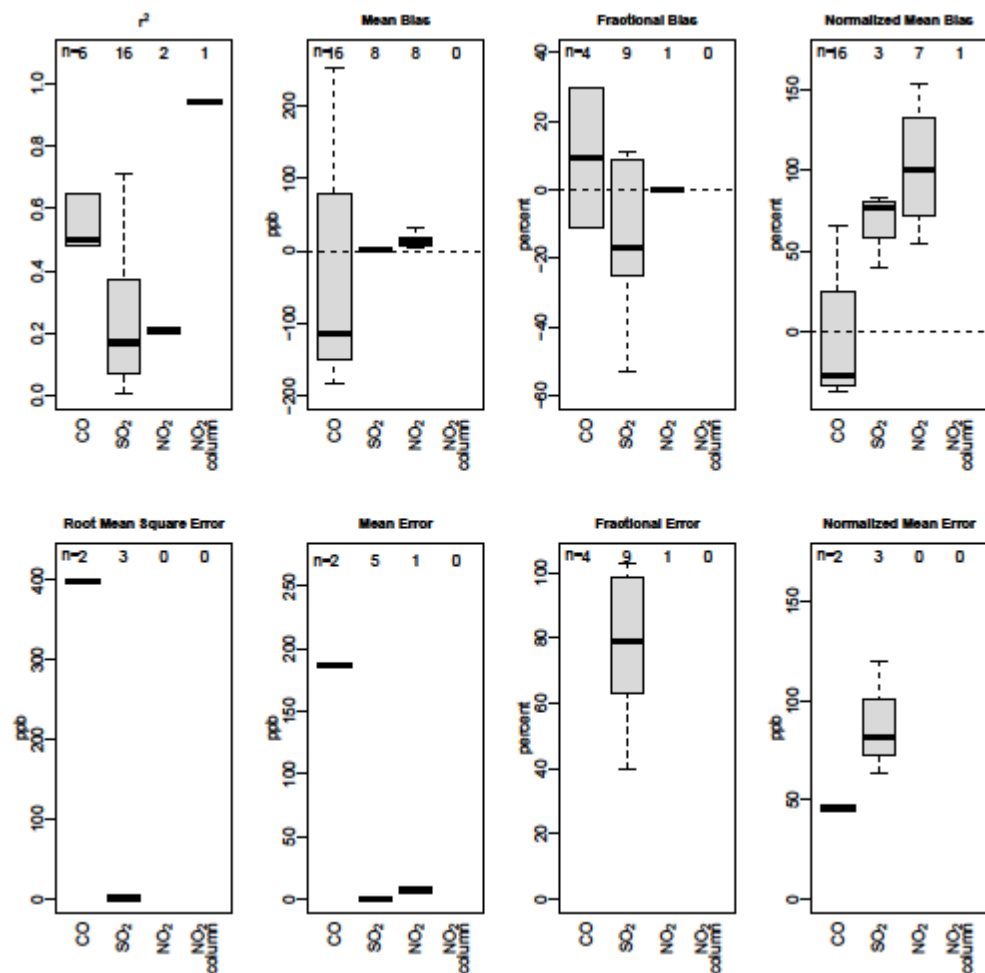


Figure S 1: Summary of criteria pollutant performance metrics reported in the evaluated modeling studies. Centerlines show median values, boxes outline the 25th and 75th percentile values and outliers extend to 1.5 times the interquartile range.

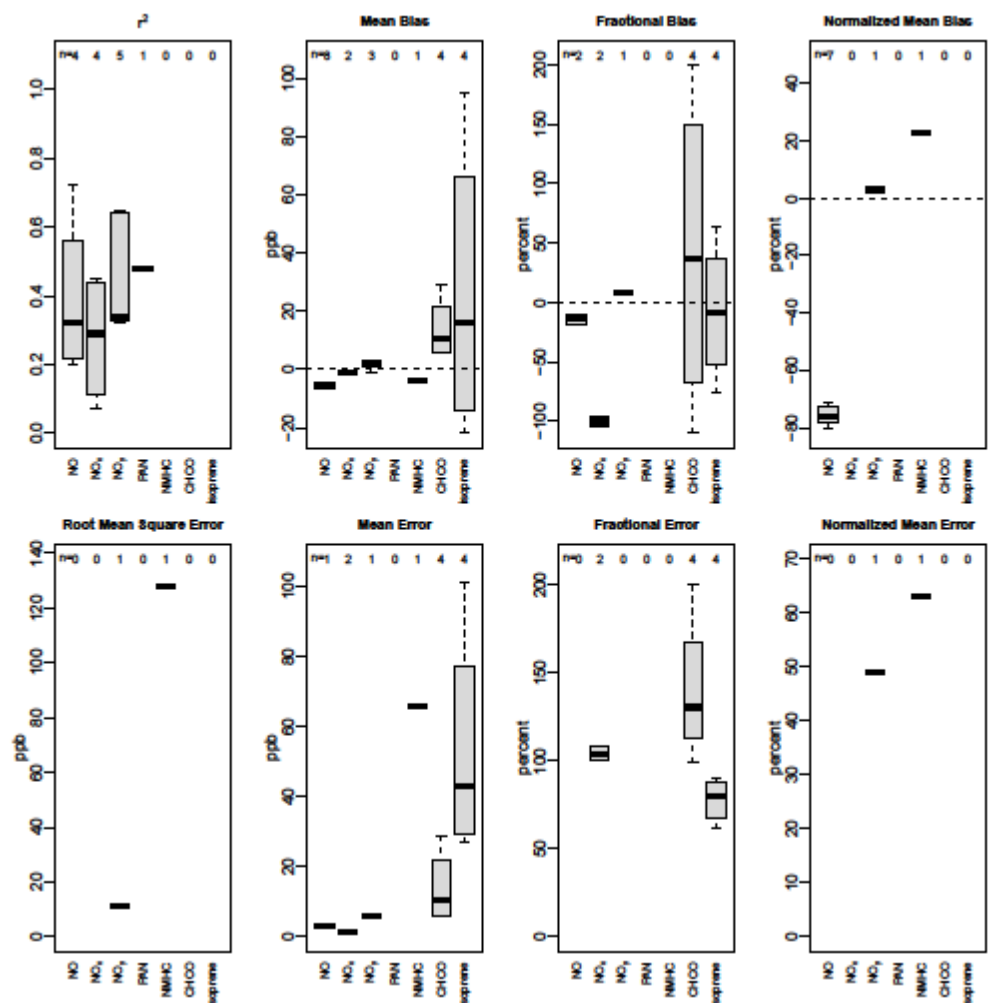


Figure S 2: Summary of ozone and PM precursor species performance metrics reported in the evaluated modeling studies. Centerlines show median values, boxes outline the 25th and 75th percentile values and outliers extend to 1.5 times the interquartile range.

Ozone Plots

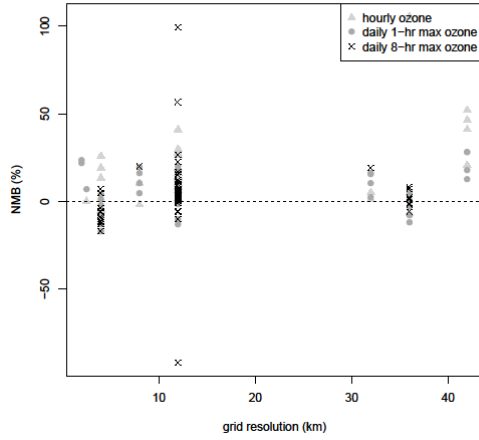


Figure S 3: Ozone normalized mean bias by grid resolution

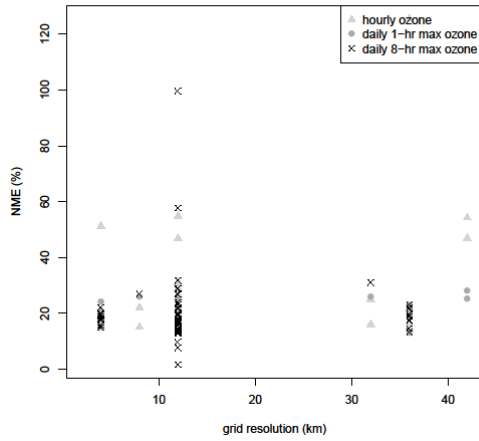


Figure S 4: Ozone normalized mean error by grid resolution

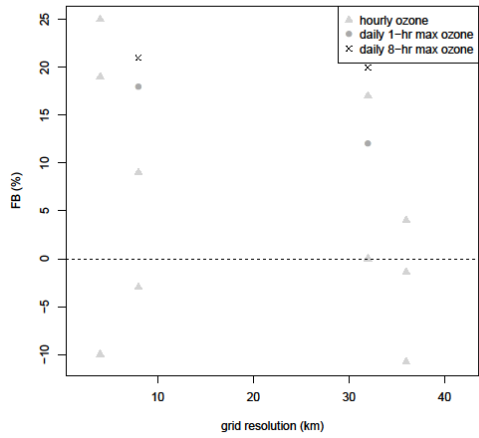


Figure S 5: Ozone fractional bias by grid resolution

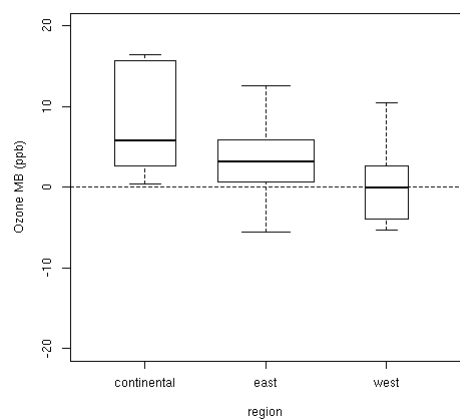


Figure S 6: Hourly ozone mean bias by region

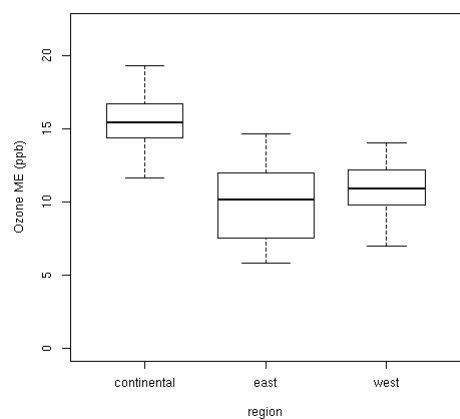


Figure S 7: Hourly ozone mean error by region

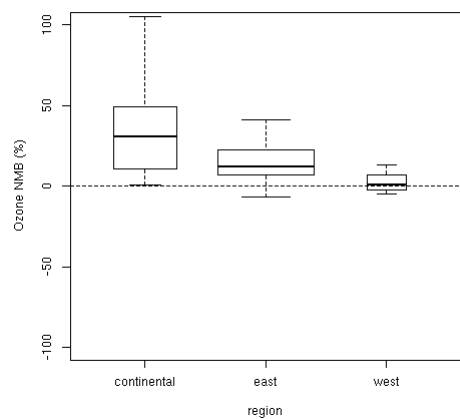


Figure S 8: Hourly ozone normalized mean bias by region

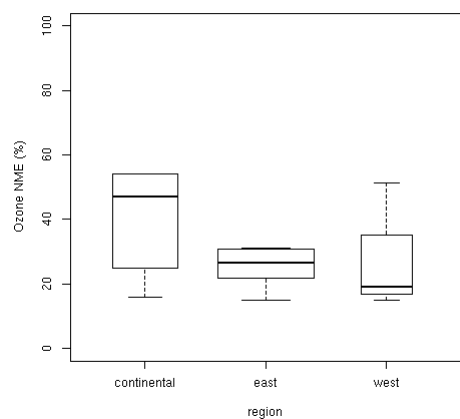


Figure S 9: Hourly ozone normalized mean error by region

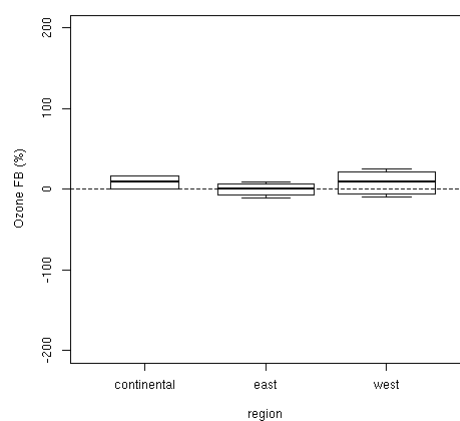


Figure S 10: Hourly ozone fractional bias by region

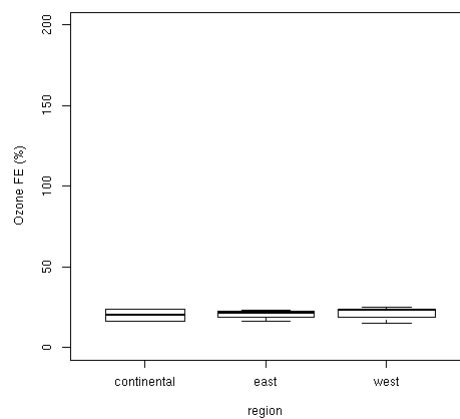


Figure S 11: Hourly ozone fractional error by region

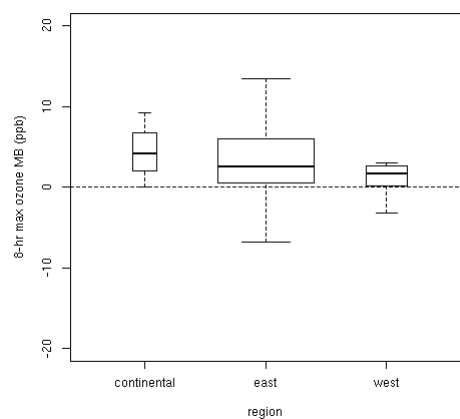


Figure S 12: 8-hr daily maximum ozone mean bias by region

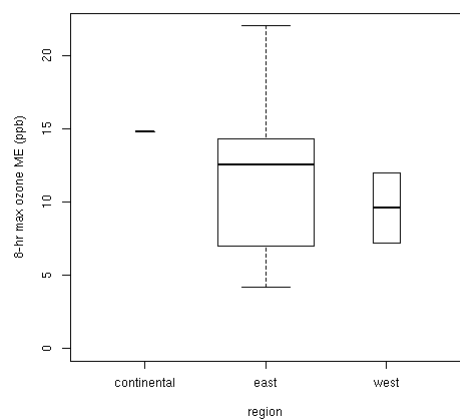


Figure S 13: 8-hr daily maximum ozone mean error by region

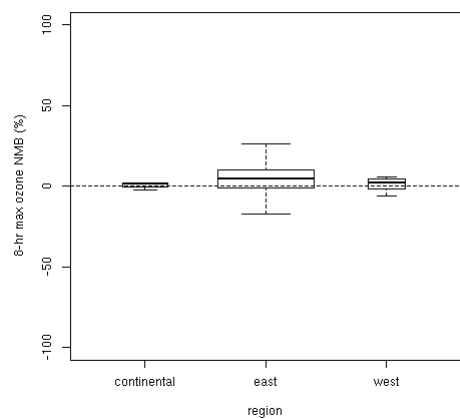


Figure S 14: 8-hr daily maximum ozone normalized mean bias by region

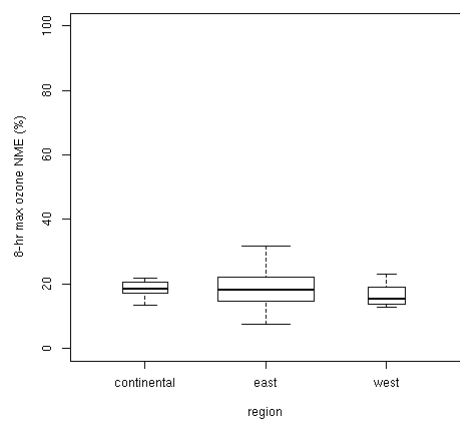


Figure S 15: 8-hr daily maximum ozone normalized mean error by region

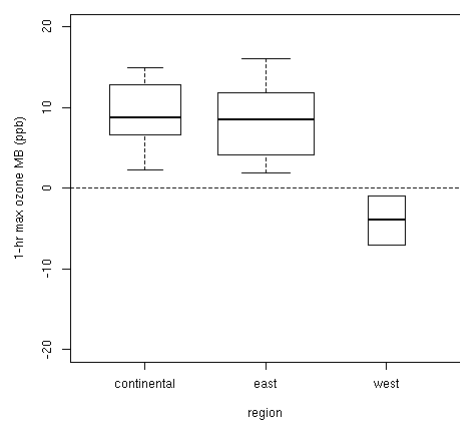


Figure S 16: 1-hr daily maximum ozone mean bias by region

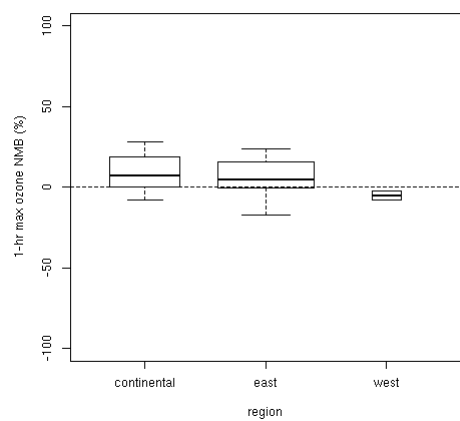


Figure S 17: 1-hr daily maximum ozone normalized mean bias by region

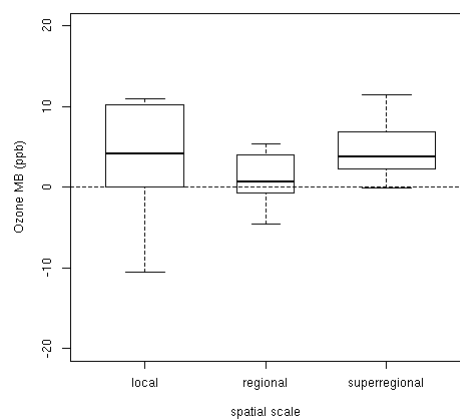


Figure S 18: Hourly ozone mean bias by spatial scale

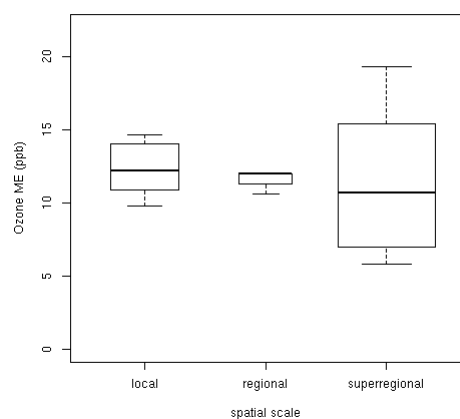


Figure S 19: Hourly ozone mean error by spatial scale

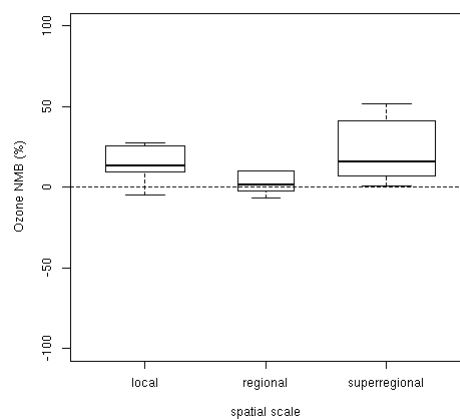


Figure S 20: Hourly ozone normalized mean bias by spatial scale

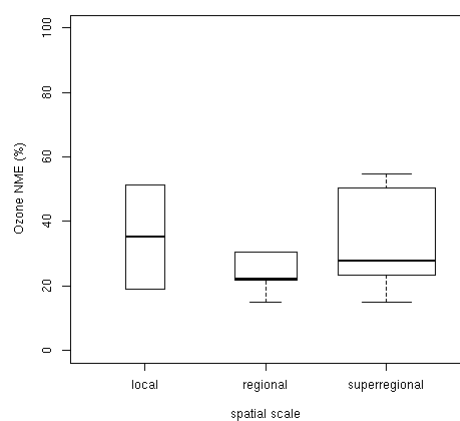


Figure S 21: Hourly ozone normalized mean error by spatial scale

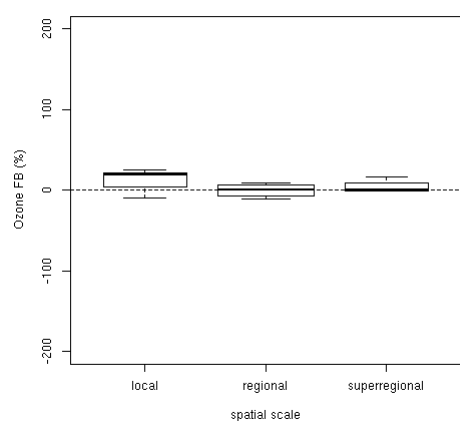


Figure S 22: Hourly ozone fractional bias by spatial scale

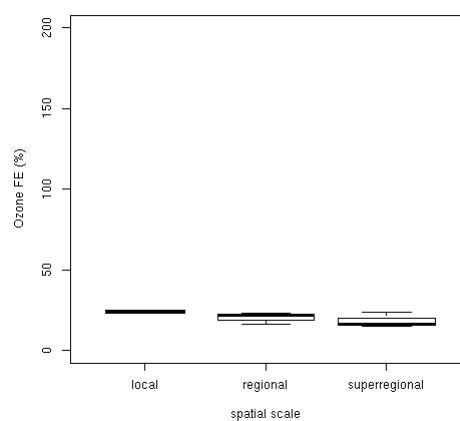


Figure S 23: Hourly ozone fractional error by spatial scale

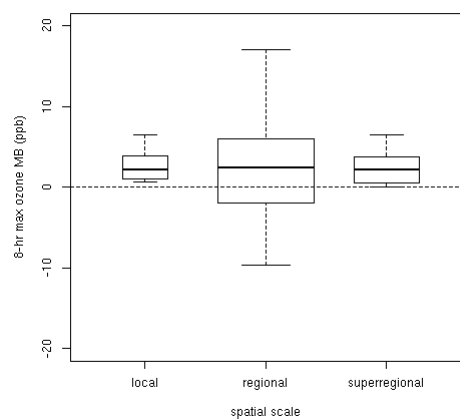


Figure S 24: 8-hr daily maximum ozone mean bias by spatial scale

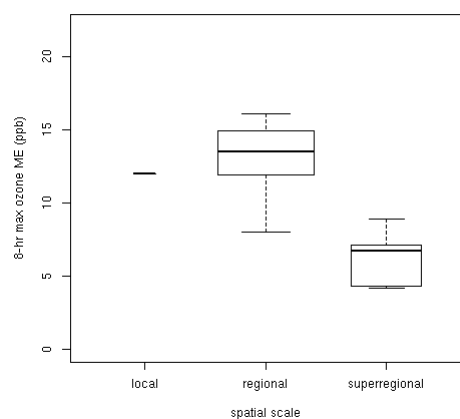


Figure S 25: 8-hr daily maximum ozone mean error by spatial scale

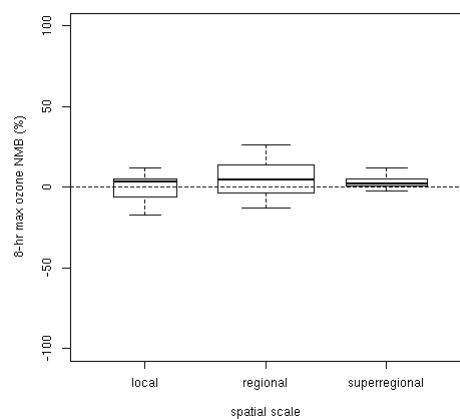


Figure S 26: 8-hr daily maximum ozone normalized mean bias by spatial scale

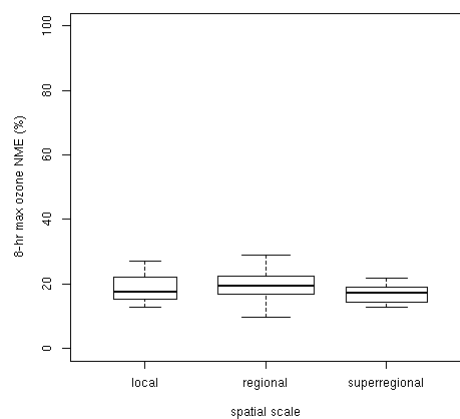


Figure S 27: 8-hr daily maximum ozone normalized mean error by spatial scale

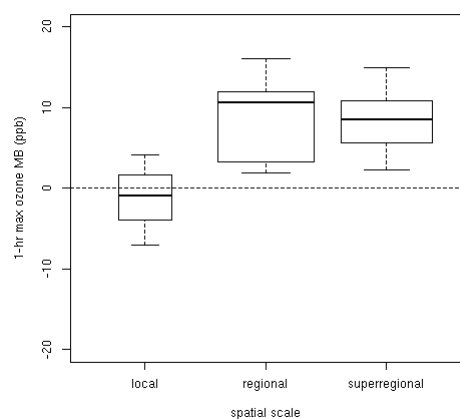


Figure S 28: 1-hr daily maximum mean bias by spatial scale

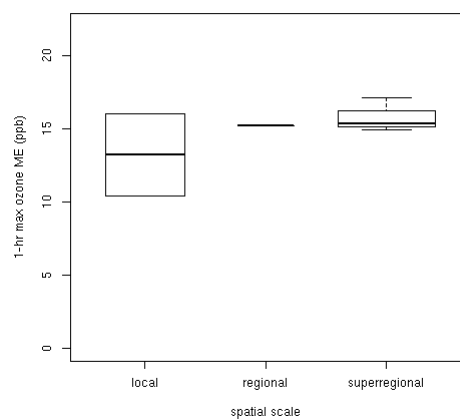


Figure S 29: 1-hr daily maximum ozone mean error by spatial scale

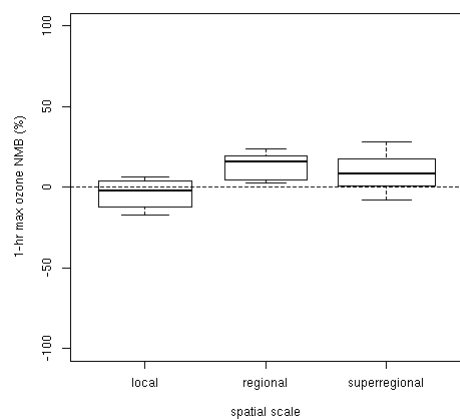


Figure S 30: 1-hr daily maximum normalized mean bias by spatial scale

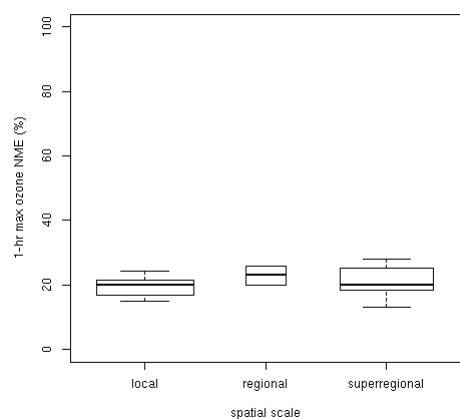


Figure S 31: 1-hr daily maximum normalized mean error by spatial scale

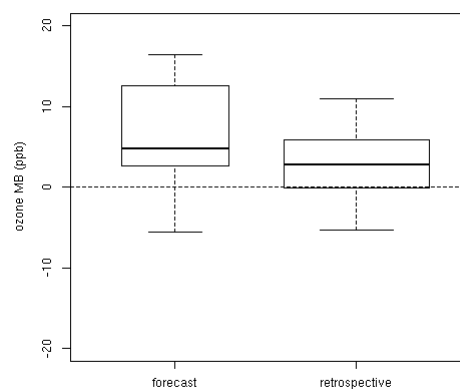


Figure S 32: Hourly ozone mean bias by retrospective versus forecast application

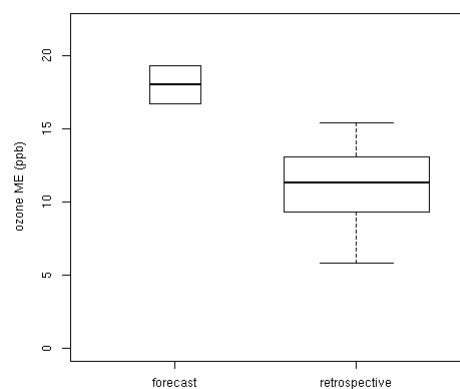


Figure S 33: Hourly ozone mean error by retrospective versus forecast application

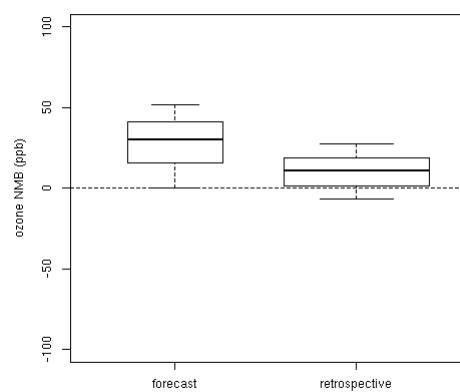


Figure S 34: Hourly ozone normalized mean bias by retrospective versus forecast application

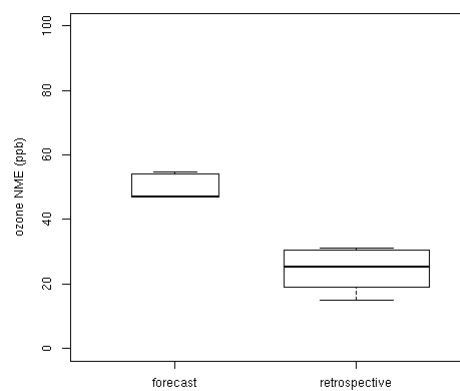


Figure S 35: Hourly ozone normalized mean error by retrospective versus forecast application

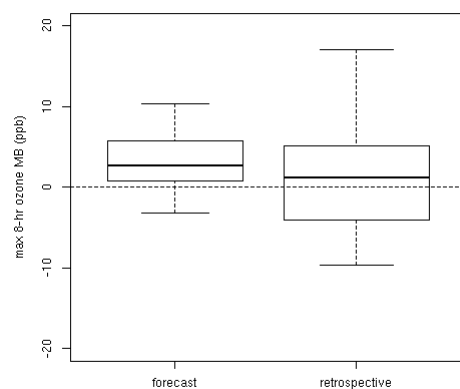


Figure S 36: 8-hr daily maximum ozone mean bias by retrospective versus forecast application

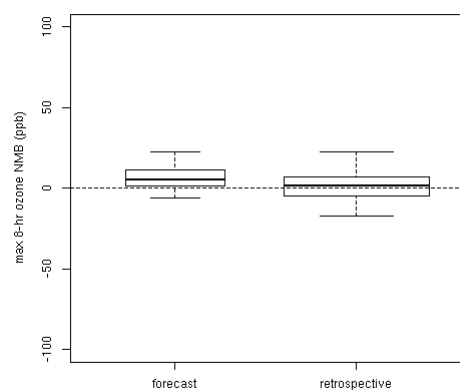


Figure S 37: 8-hr daily maximum ozone normalized mean bias by retrospective versus forecast application

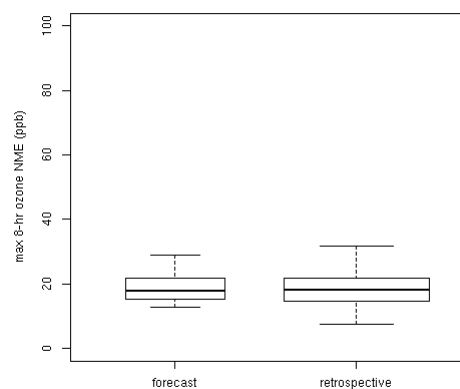


Figure S 38: 8-hr daily maximum ozone normalized mean error by retrospective versus forecast application

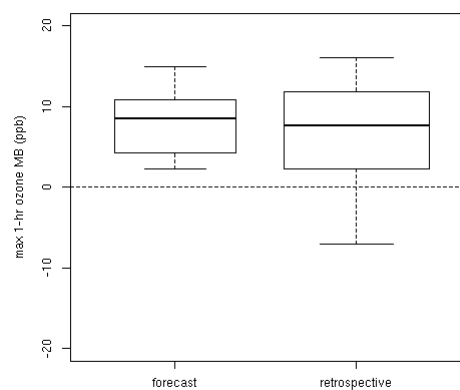


Figure S 39: 1-hr daily maximum ozone mean bias by retrospective versus forecast application

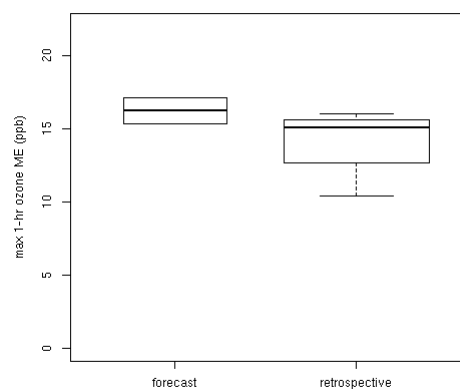


Figure S 40: 1-hr daily maximum ozone mean error by retrospective versus forecast application

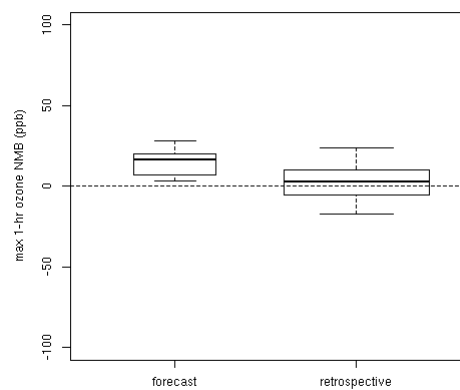


Figure S 41: 1-hr daily maximum ozone normalized mean bias by retrospective versus forecast application

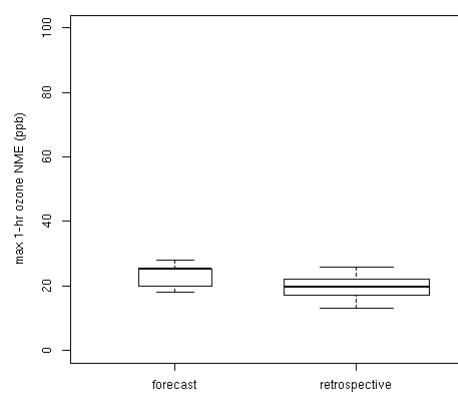


Figure S 42: 1-hr daily maximum ozone normalized mean error by retrospective versus forecast application

PM_{2.5} plots

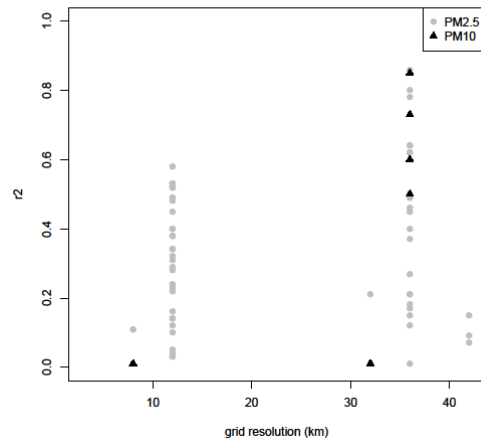


Figure S 43: PM_{2.5} r^2 by grid resolution

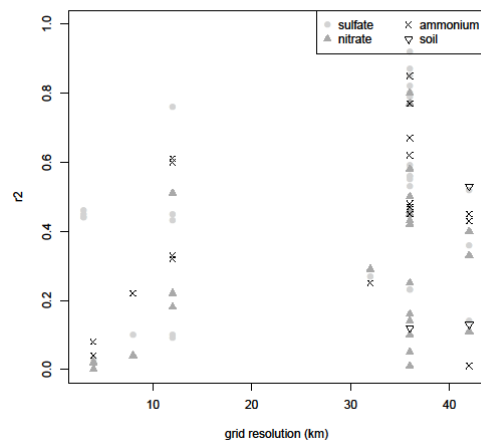


Figure S 44: Inorganic PM_{2.5} r^2 by grid resolution

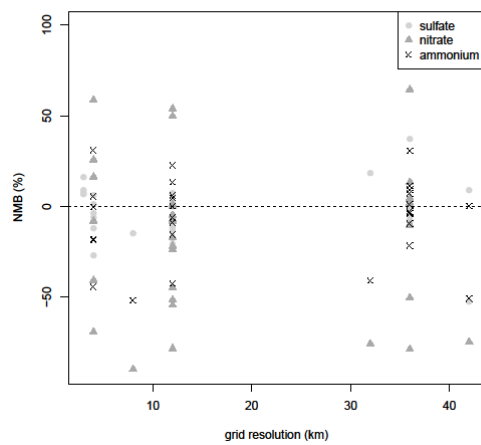


Figure S 45: Inorganic PM_{2.5} normalized mean bias by grid resolution

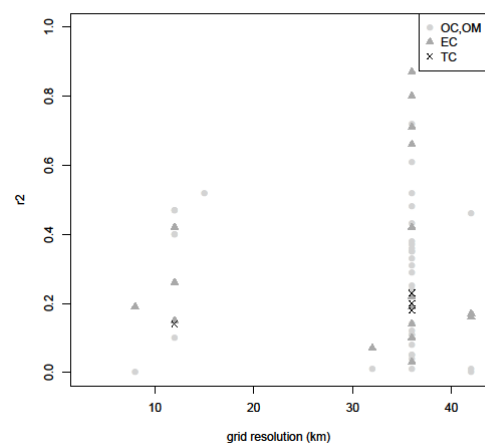


Figure S 46: Organic $PM_{2.5}$ r^2 by grid resolution

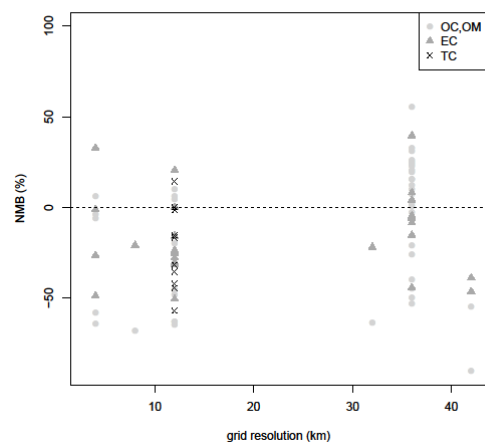


Figure S 47: Organic $PM_{2.5}$ normalized mean bias by grid resolution

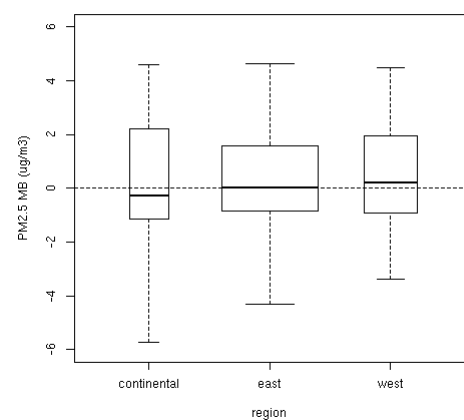


Figure S 48: $PM_{2.5}$ mean bias by region

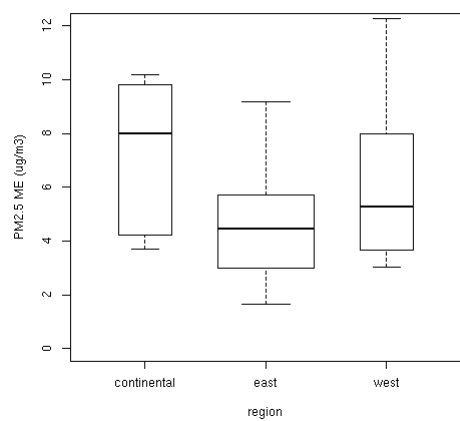


Figure S 49: PM_{2.5} mean error by region

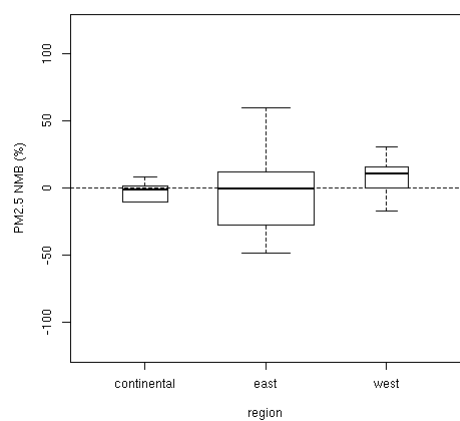


Figure S 50: PM_{2.5} normalized mean bias by region

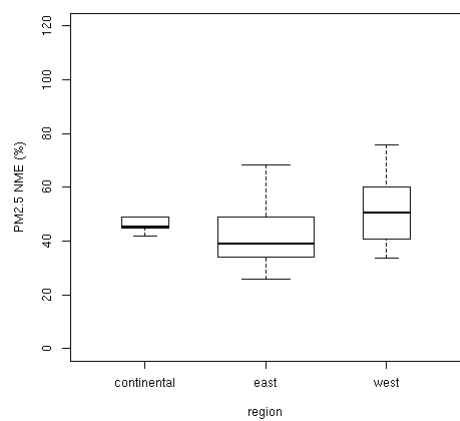


Figure S 51: PM_{2.5} normalized mean error by region

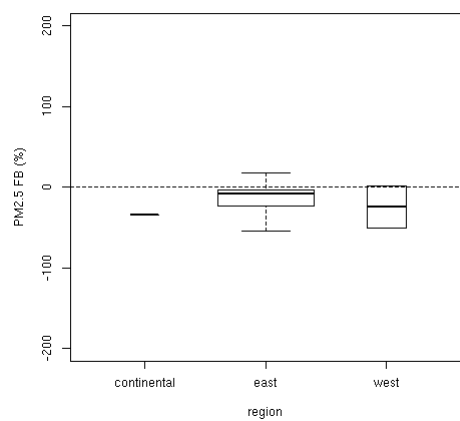


Figure S 52: PM_{2.5} fractional bias by region

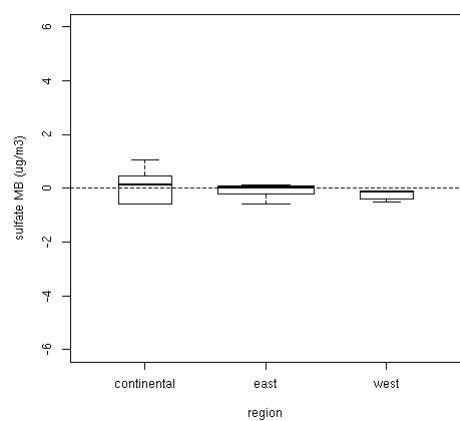


Figure S 53: Sulfate mean bias by region

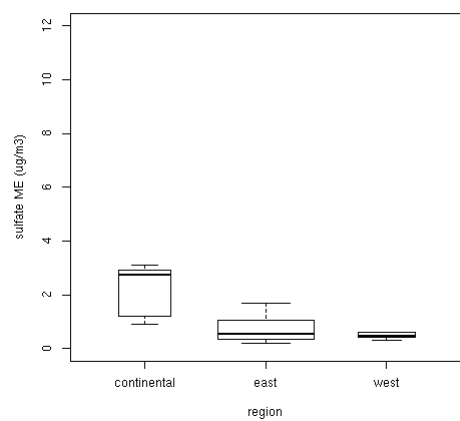


Figure S 54: Sulfate mean error by region

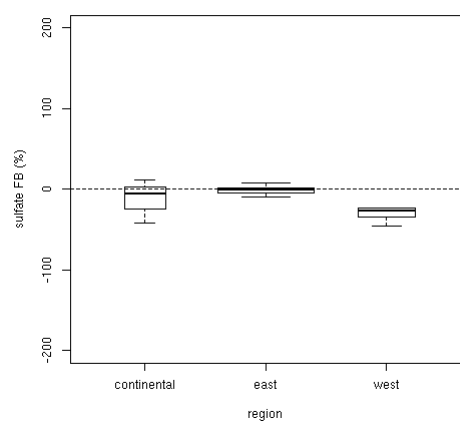


Figure S 55: Sulfate fractional bias by region

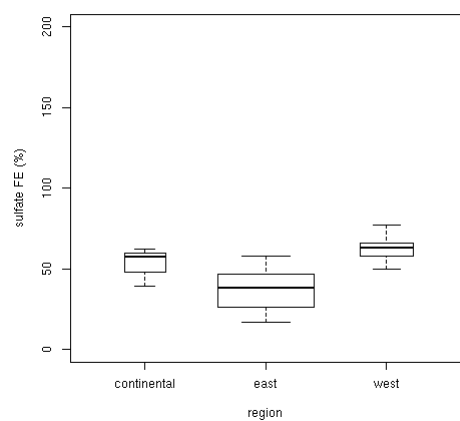


Figure S 56: Sulfate fractional error by region

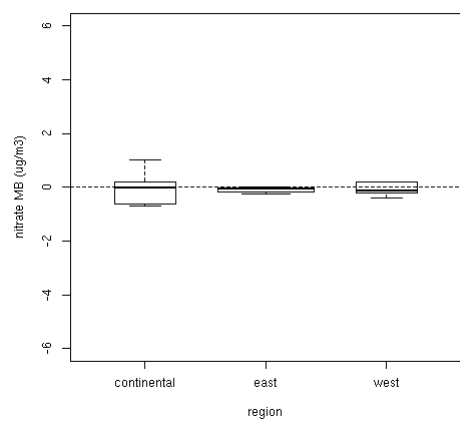


Figure S 57: Nitrate mean bias by region

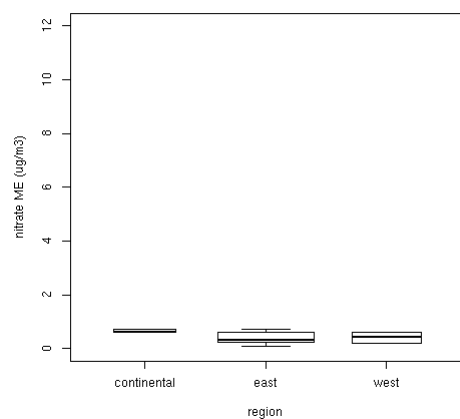


Figure S 58: Nitrate mean error by region

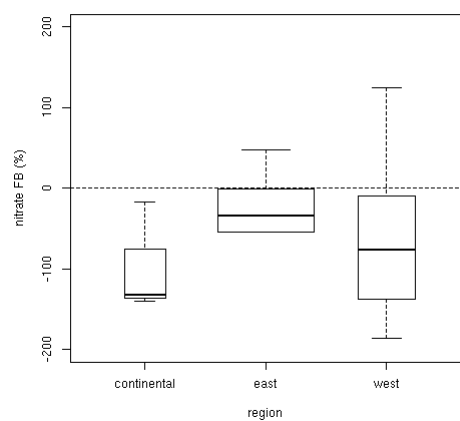


Figure S 59: Nitrate fractional bias by region

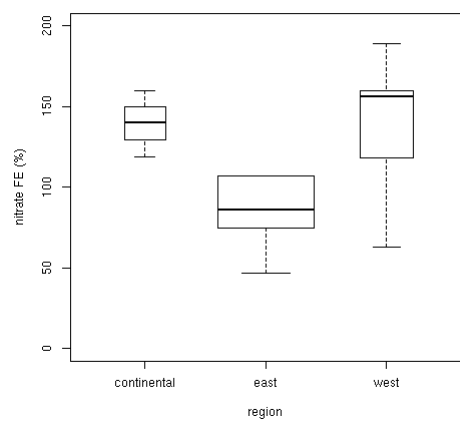


Figure S 60: Nitrate fractional error by region

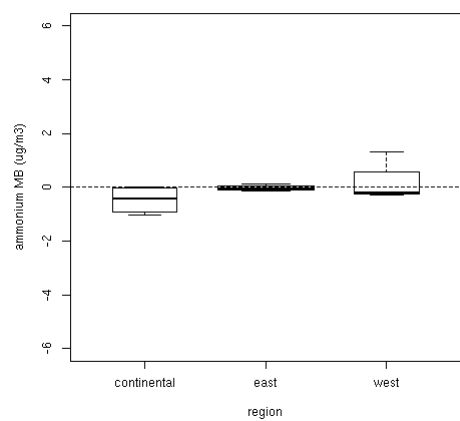


Figure S 61: Ammonium mean bias by region

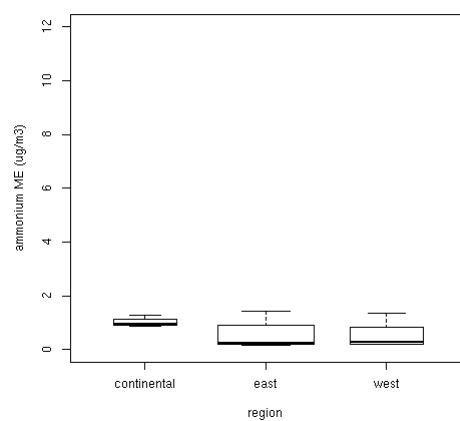


Figure S 62: Ammonium mean error by region

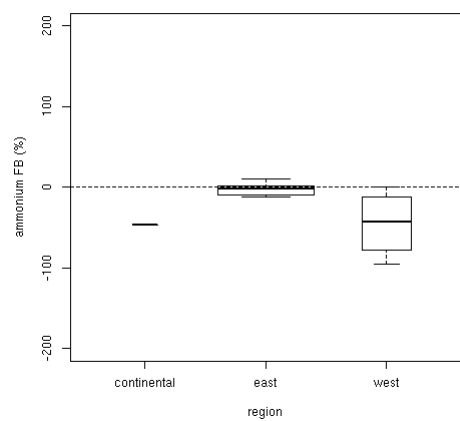


Figure S 63: Ammonium fractional bias by region

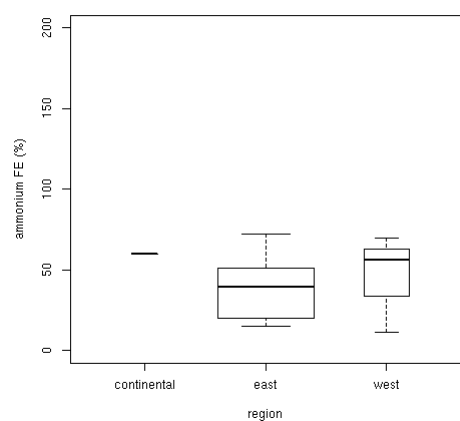


Figure S 64: Ammonium fractional error by region

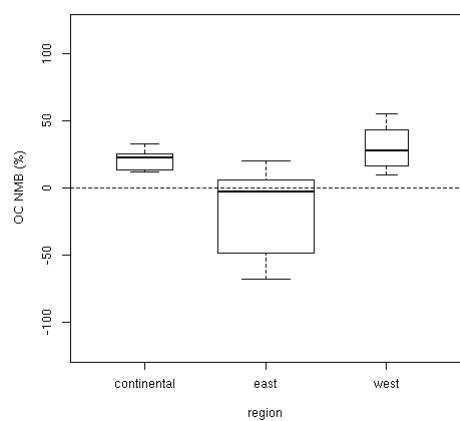


Figure S 65: OC normalized mean bias by region

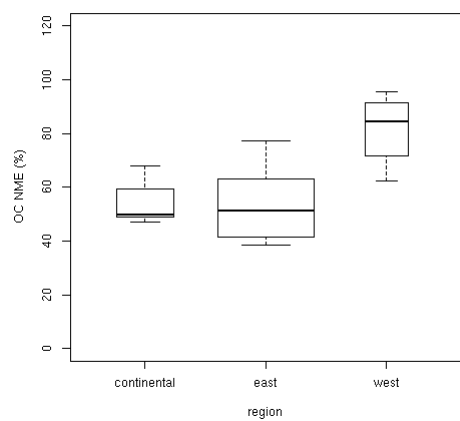


Figure S 66: OC normalized mean error by region

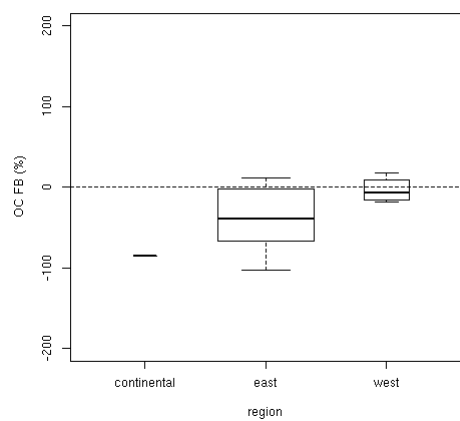


Figure S 67: OC fractional bias by region

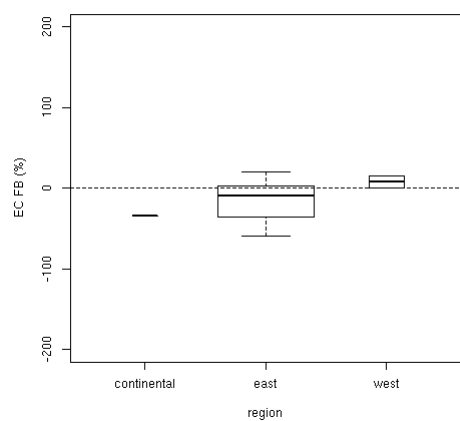


Figure S 68: EC fractional bias by region

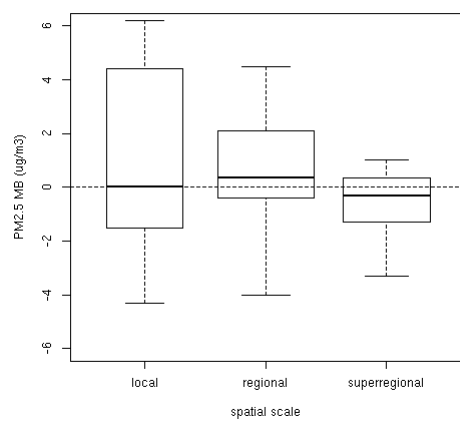


Figure S 69: PM_{2.5} mean bias by spatial scale

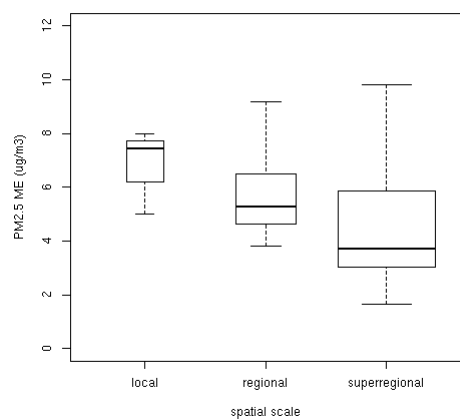


Figure S 70: PM_{2.5} mean error by spatial scale

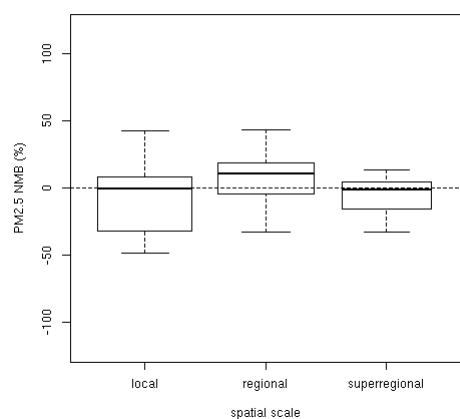


Figure S 71: PM_{2.5} normalized mean bias by spatial scale

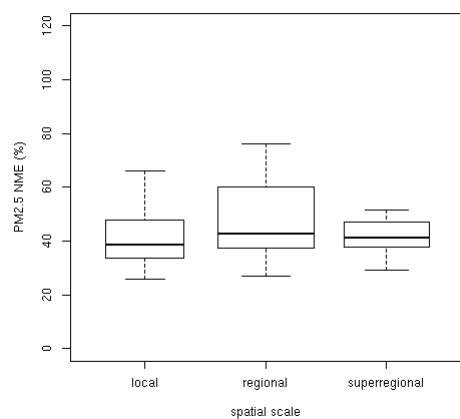


Figure S 72: PM_{2.5} normalized mean error by spatial scale

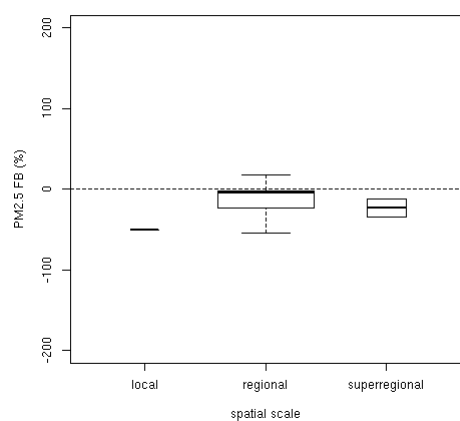


Figure S 73: PM_{2.5} fractional bias by spatial scale

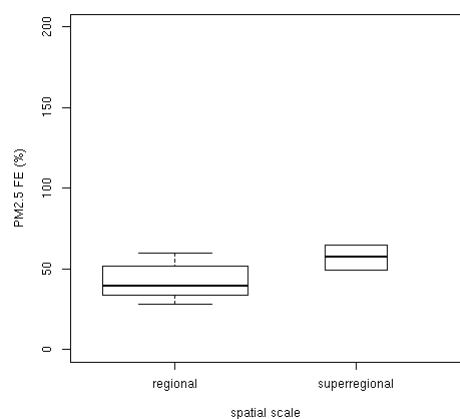


Figure S 74: PM_{2.5} fractional error by spatial scale

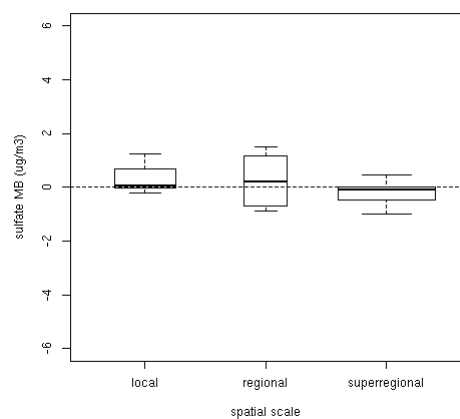


Figure S 75: Sulfate mean bias by spatial scale

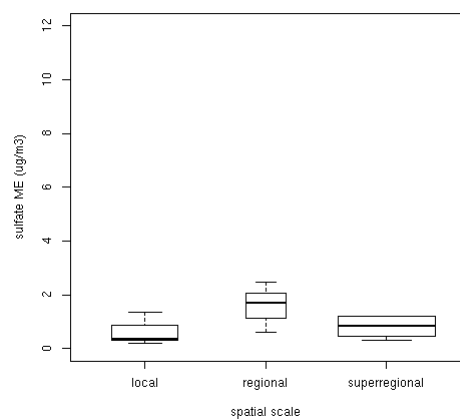


Figure S 76: Sulfate mean error by spatial scale

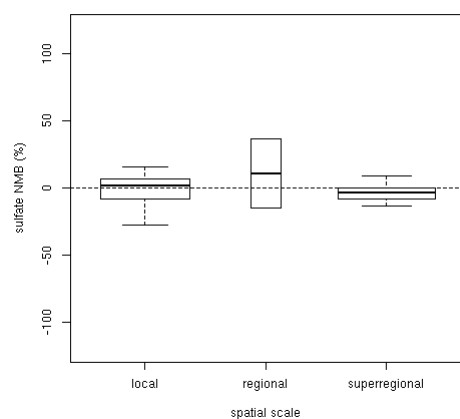


Figure S 77: Sulfate normalized mean bias by spatial scale

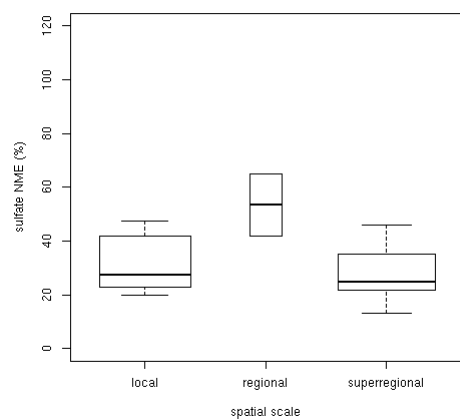


Figure S 78: Sulfate normalized mean error by spatial scale

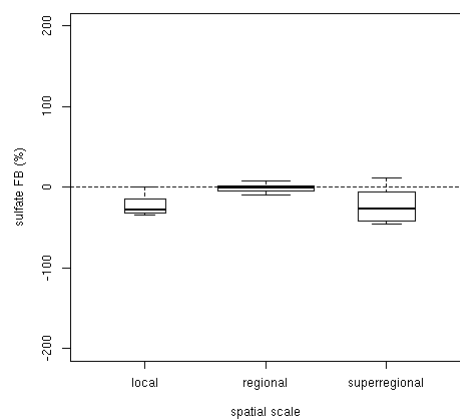


Figure S 79: Sulfate fractional bias by spatial scale

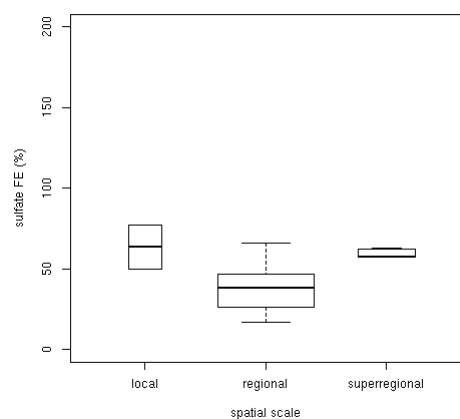


Figure S 80: Sulfate fractional error by spatial scale

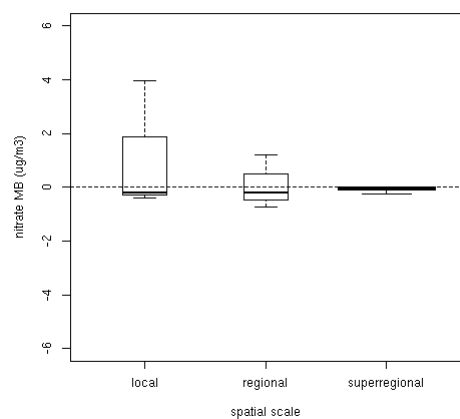


Figure S 81: Nitrate mean bias by spatial scale

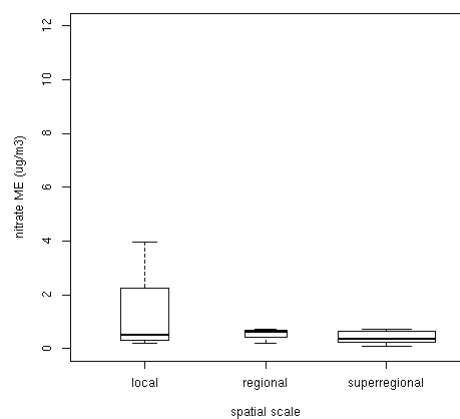


Figure S 82: Nitrate mean error by spatial scale

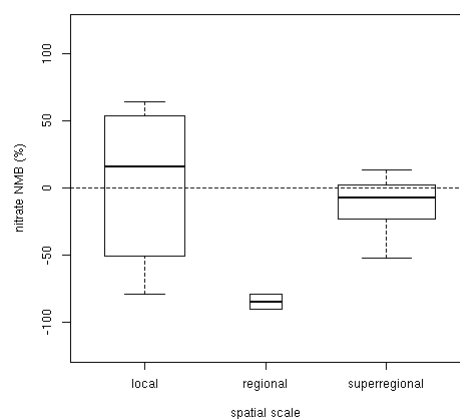


Figure S 83: Nitrate normalized mean bias by spatial scale

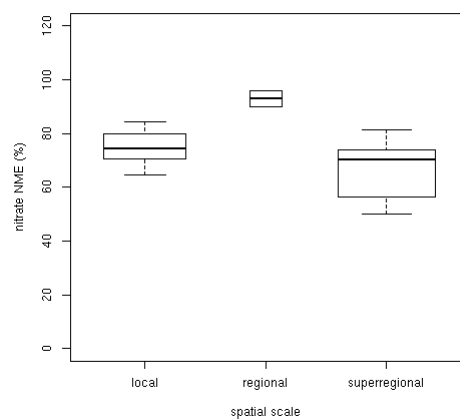


Figure S 84: Nitrate normalized mean error by spatial scale

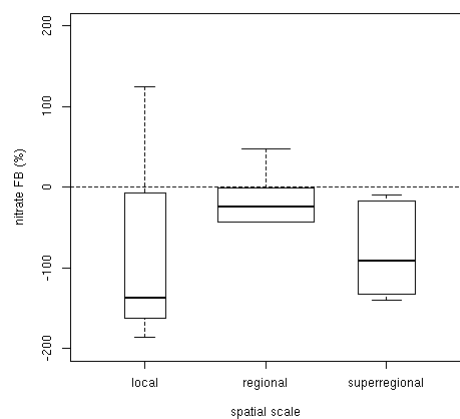


Figure S 85: Nitrate fractional bias by spatial scale

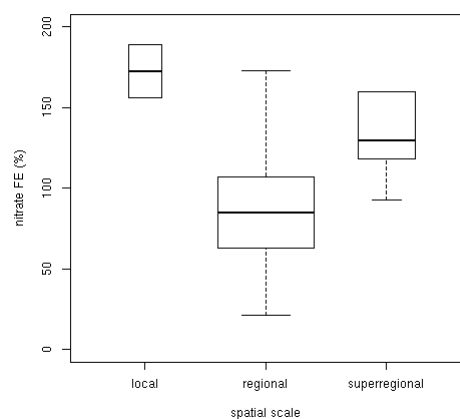


Figure S 86: Nitrate fractional error by spatial scale

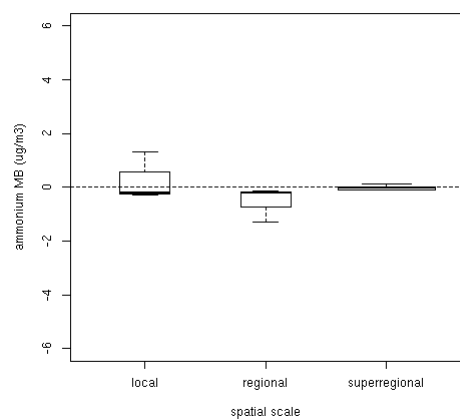


Figure S 87" Ammonium mean bias by spatial scale

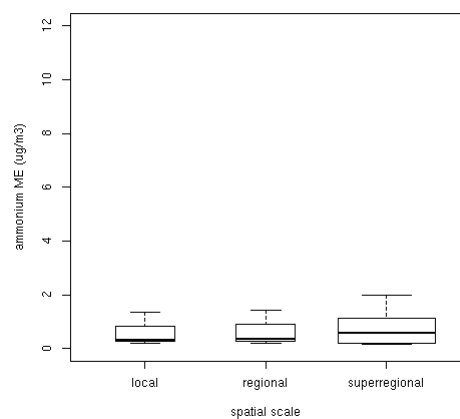


Figure S 88: Ammonium mean error by spatial scale

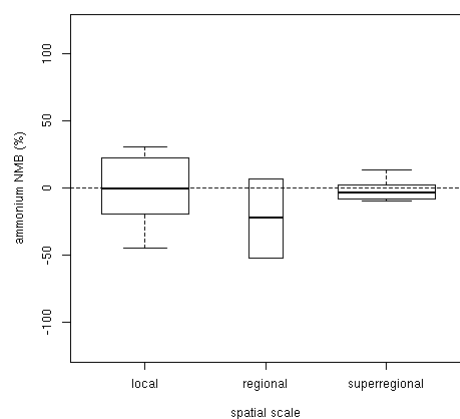


Figure S 89: Ammonium normalized mean bias by spatial scale

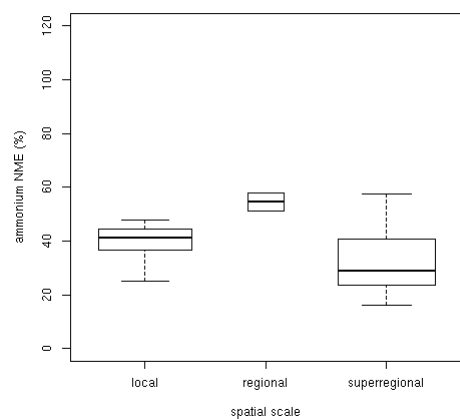


Figure S 90: Ammonium normalized mean error by spatial scale

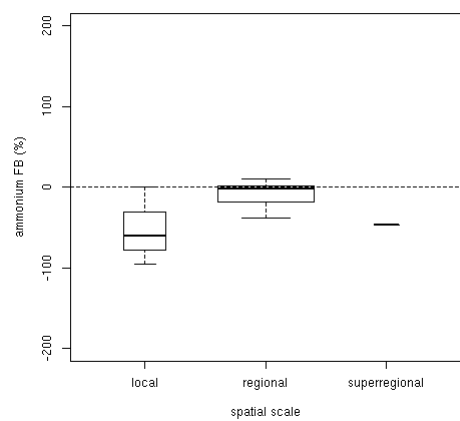


Figure S 91: Ammonium fractional bias by spatial scale

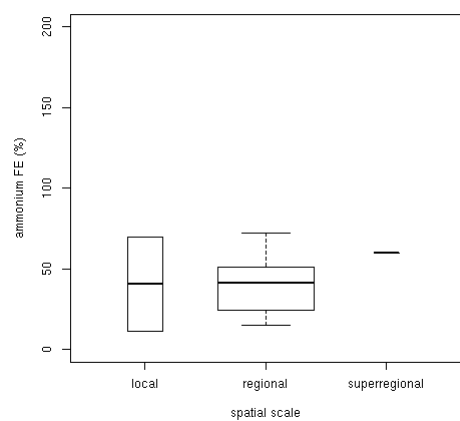


Figure S 92: Ammonium fractional error by spatial scale

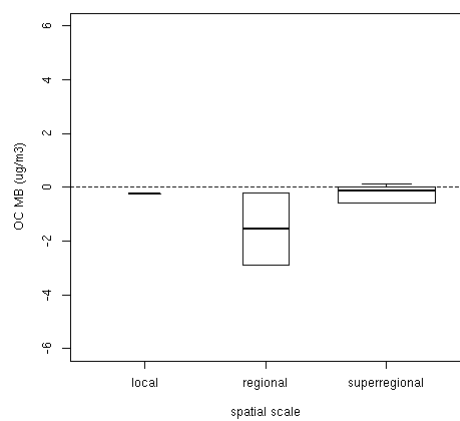


Figure S 93: OC mean bias by spatial scale

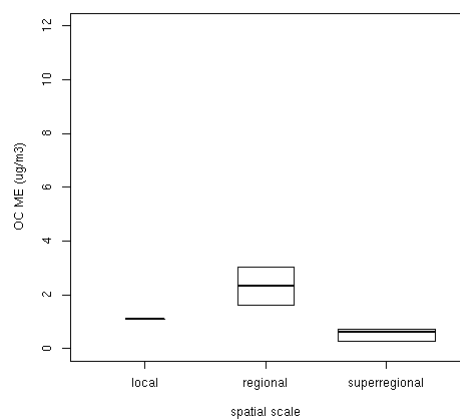


Figure S 94: OC mean error by spatial scale

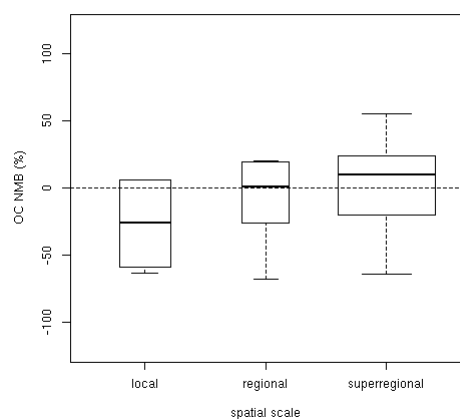


Figure S 95: OC normalized mean bias by spatial scale

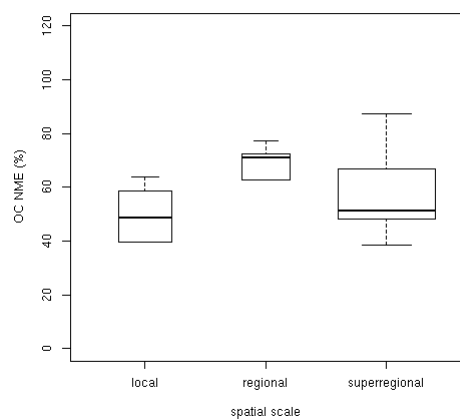


Figure S 96: OC normalized mean error by spatial scale

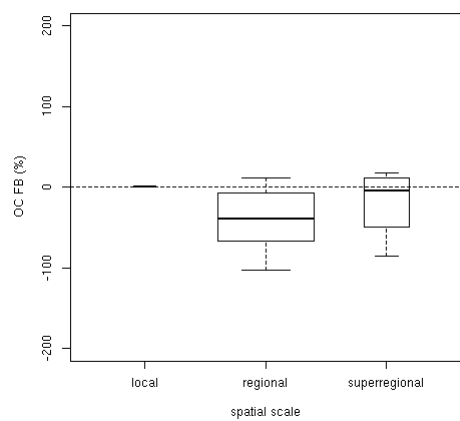


Figure S 97: OC fractional bias by spatial scale

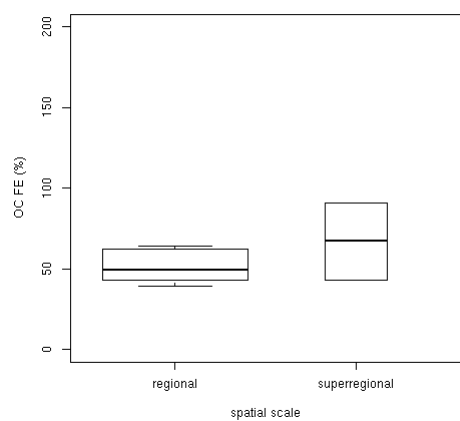


Figure S 98: OC fractional error by spatial scale

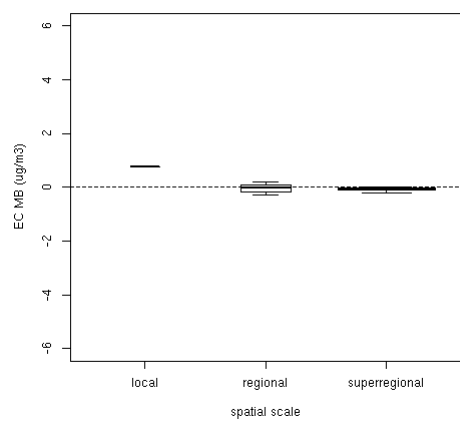


Figure S 99: EC mean bias by spatial scale

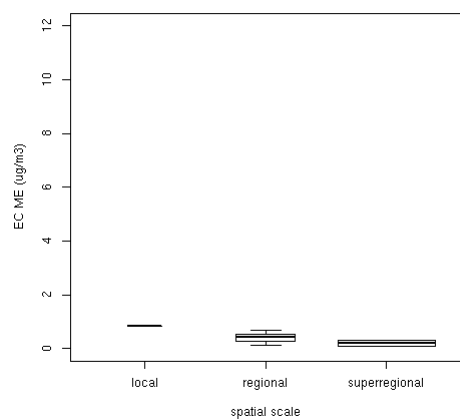


Figure S 100: EC mean error by spatial scale

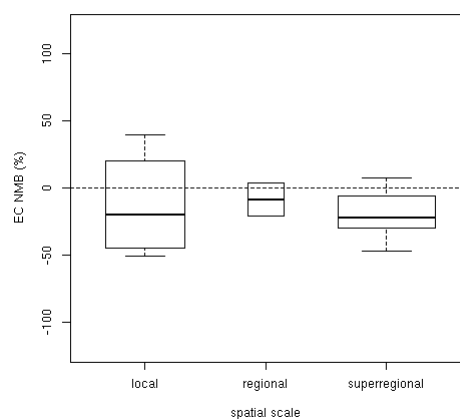


Figure S 101: EC normalized mean bias by spatial scale

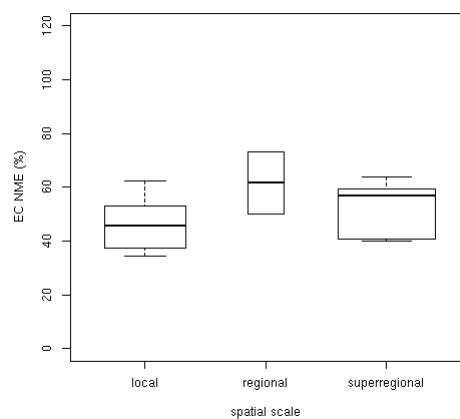


Figure S 102: EC normalized mean error by spatial scale

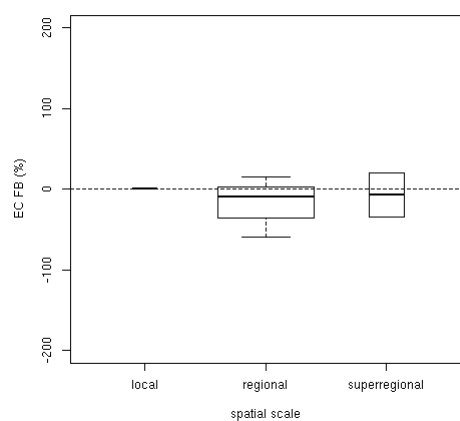


Figure S 103: EC fractional bias by spatial scale

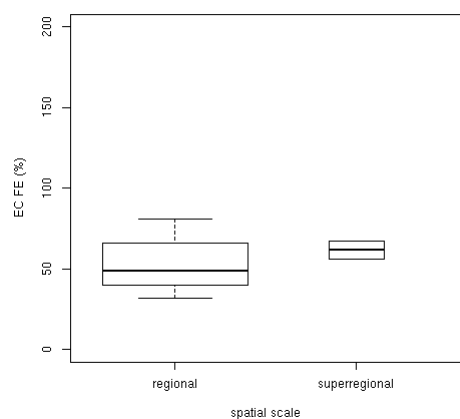


Figure S 104: EC fractional error by spatial scale

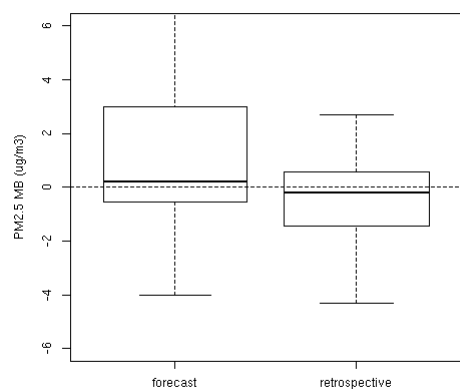


Figure S 105: PM_{2.5} mean bias by retrospective versus forecast application

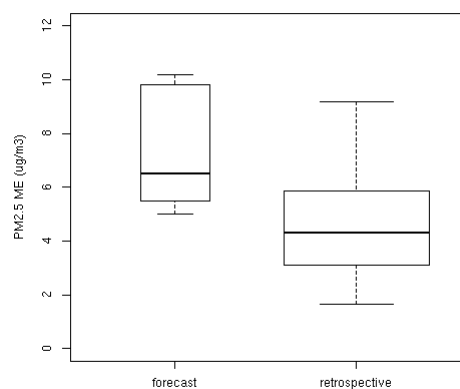


Figure S 106: PM_{2.5} mean error by retrospective versus forecast application

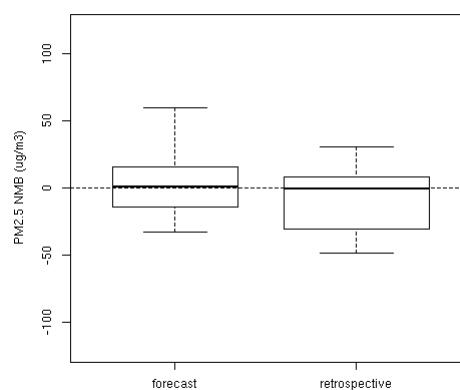


Figure S 107: PM_{2.5} normalized mean bias by retrospective versus forecast application

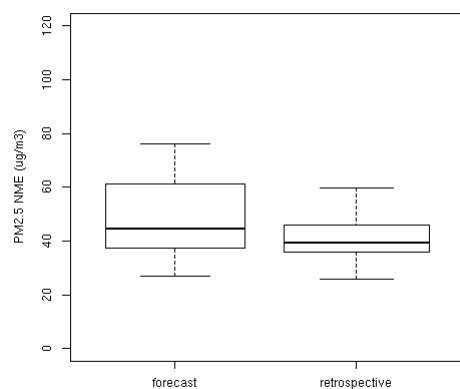


Figure S 108: PM_{2.5} normalized mean error by retrospective versus forecast application

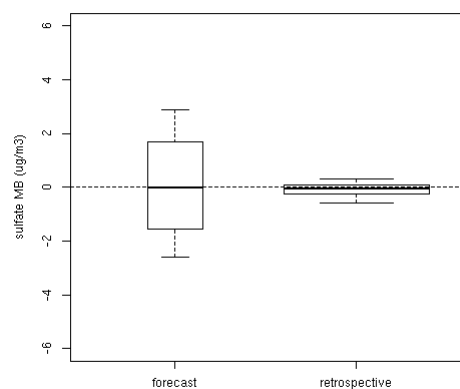


Figure S 109: Sulfate mean bias by retrospective versus forecast application

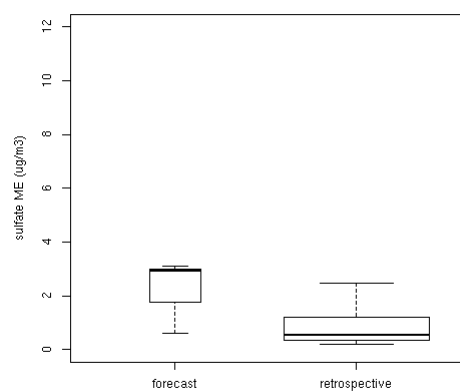


Figure S 110: Sulfate mean error by retrospective versus forecast application

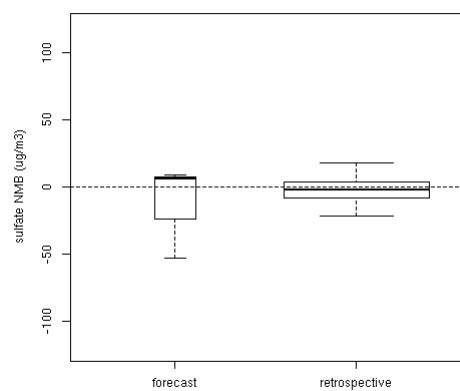


Figure S 111: Sulfate normalized mean bias by retrospective versus forecast application

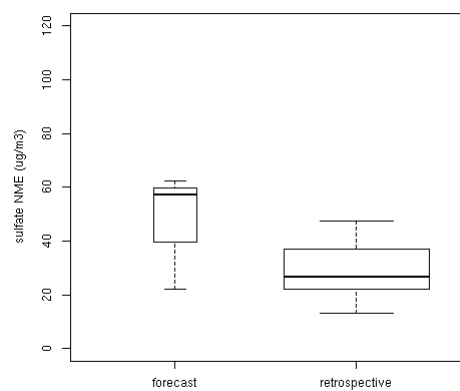


Figure S 112: Sulfate normalized mean error by retrospective versus forecast application

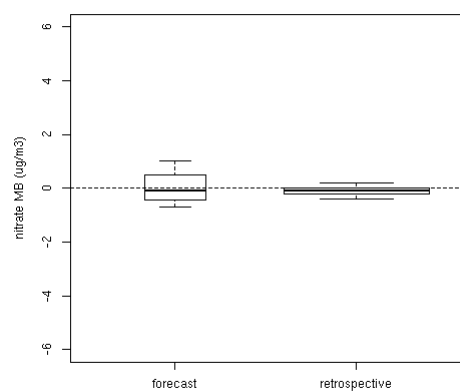


Figure S 113: Nitrate mean bias by retrospective versus forecast application

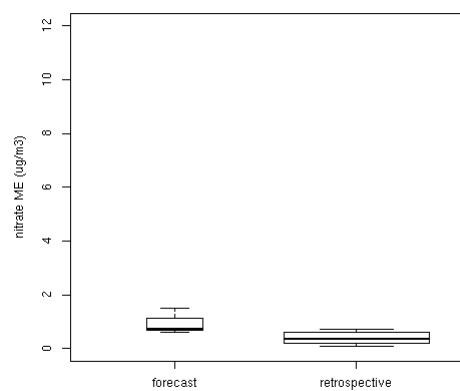


Figure S 114: Nitrate mean error by retrospective versus forecast application

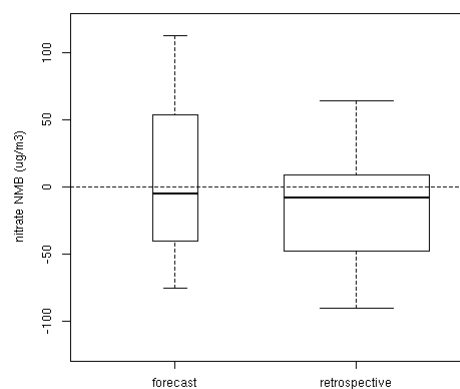


Figure S 115: Nitrate normalized mean bias by retrospective versus forecast application

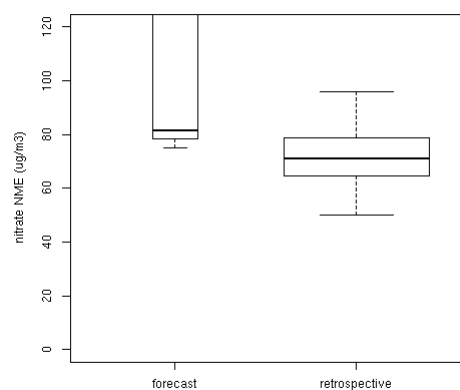


Figure S 116: Nitrate normalized mean error by retrospective versus forecast application

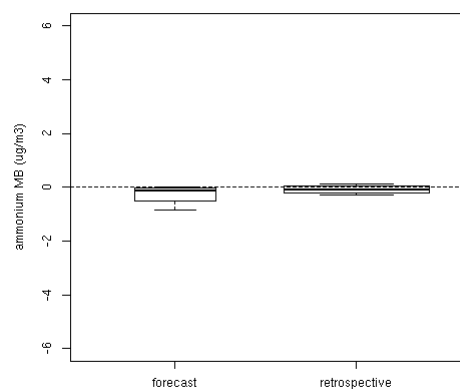


Figure S 117: Ammonium mean bias by retrospective versus forecast application

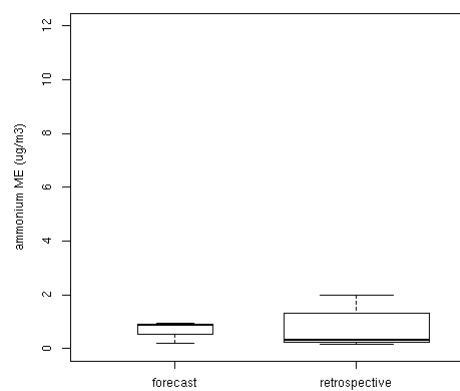


Figure S 118: Ammonium mean error by retrospective versus forecast application

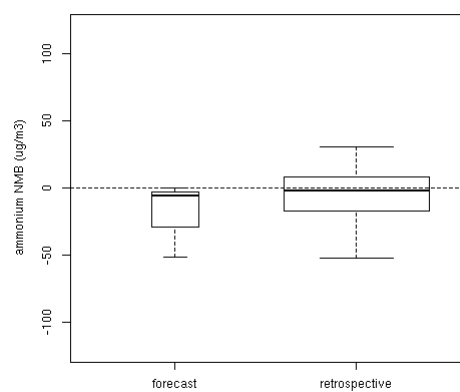


Figure S 119: Ammonium normalized mean bias by retrospective versus forecast application

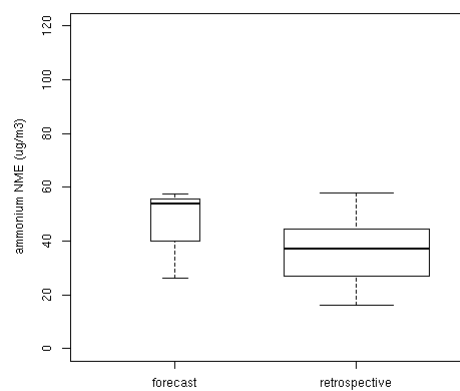


Figure S 120: Ammonium normalized mean error by retrospective versus forecast application

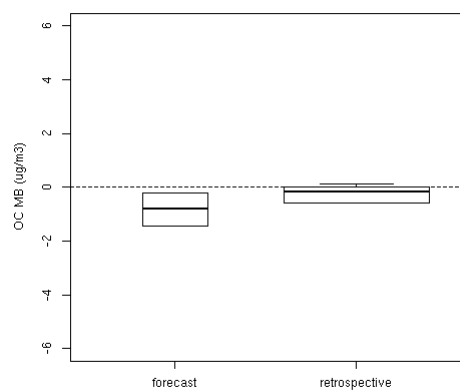


Figure S 121: OC mean bias by retrospective versus forecast application

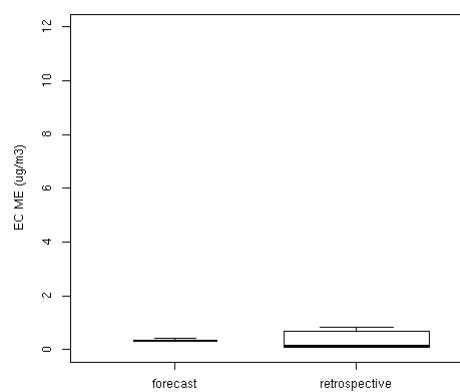


Figure S 122: EC mean error by retrospective versus forecast application

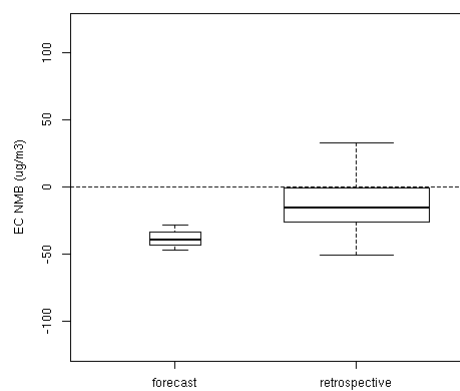


Figure S 123: EC normalized mean bias by retrospective versus forecast application

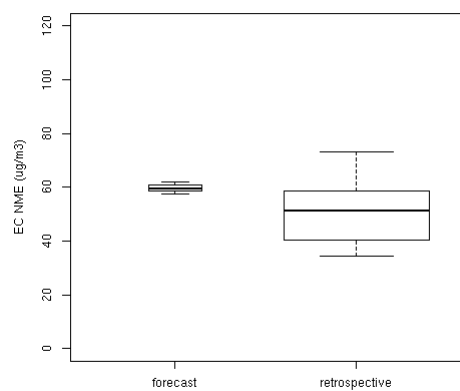


Figure S 124: EC normalized mean error by retrospective versus forecast application