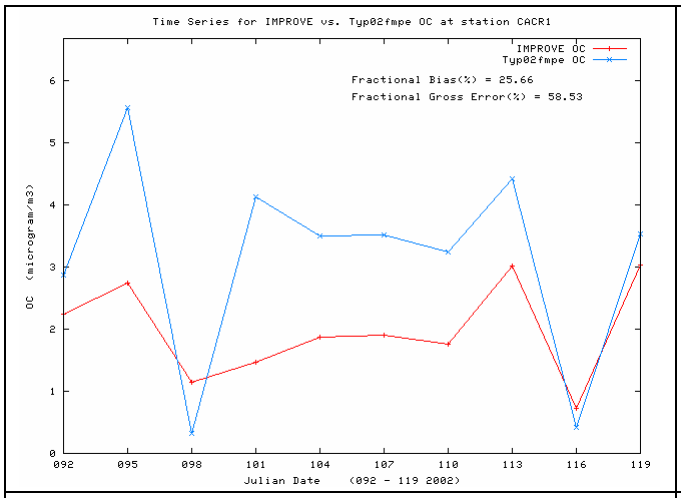
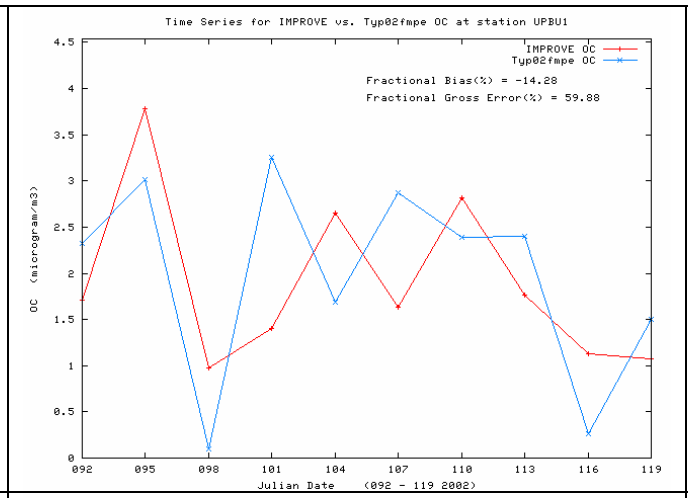
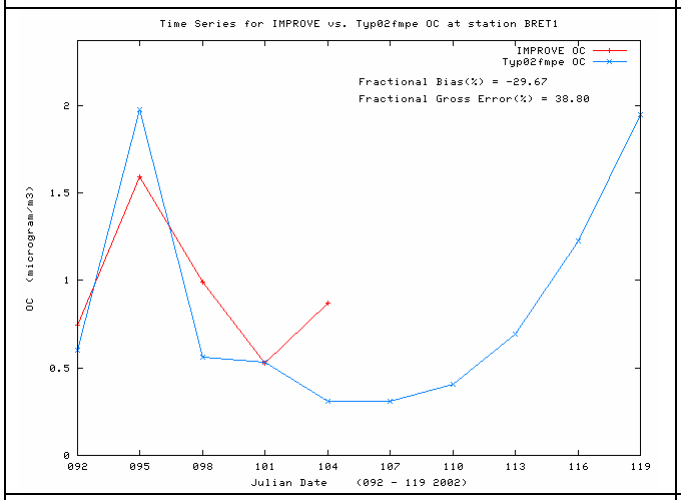
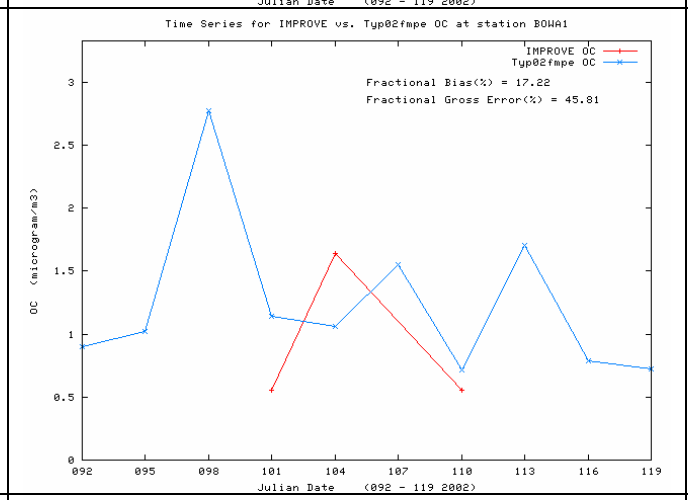
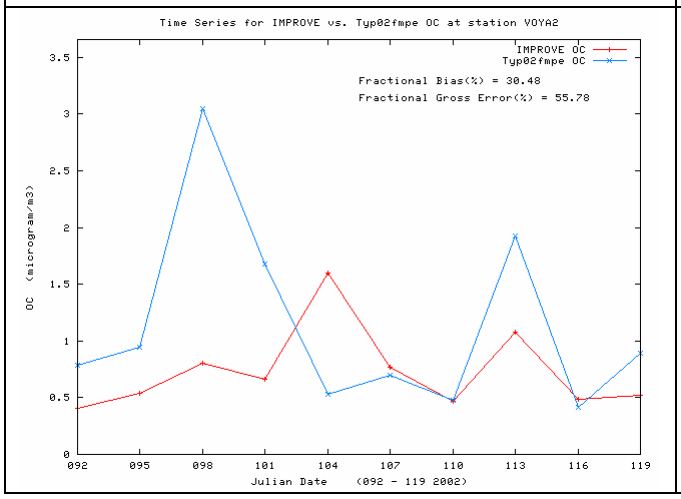
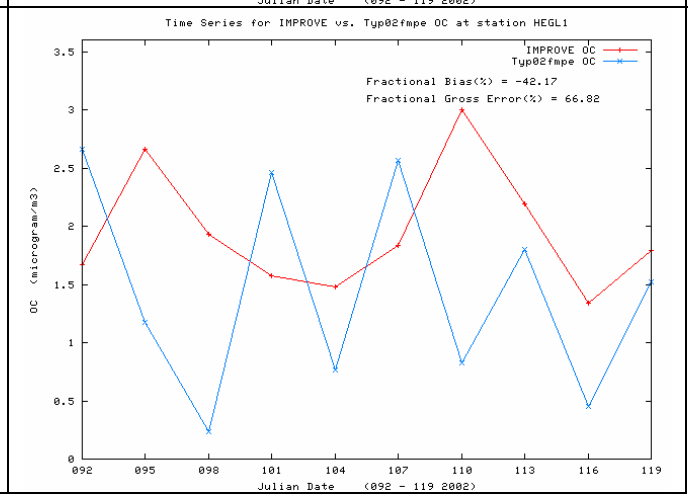

Time Series for IMPROVE vs. Typ02fmpe OC at station CACR1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 25.66
Fractional Gross Error(%) = 58.53
OC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station UPBU1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -14.28
Fractional Gross Error(%) = 59.88
OC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station BRET1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -29.67
Fractional Gross Error(%) = 38.80
OC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station BOWA1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 17.22
Fractional Gross Error(%) = 45.81
OC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station VOYA2
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 30.48
Fractional Gross Error(%) = 55.78
OC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station HEGL1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -42.17
Fractional Gross Error(%) = 66.82
OC (microgram/m3)
Julian Date (092 - 119 2002)

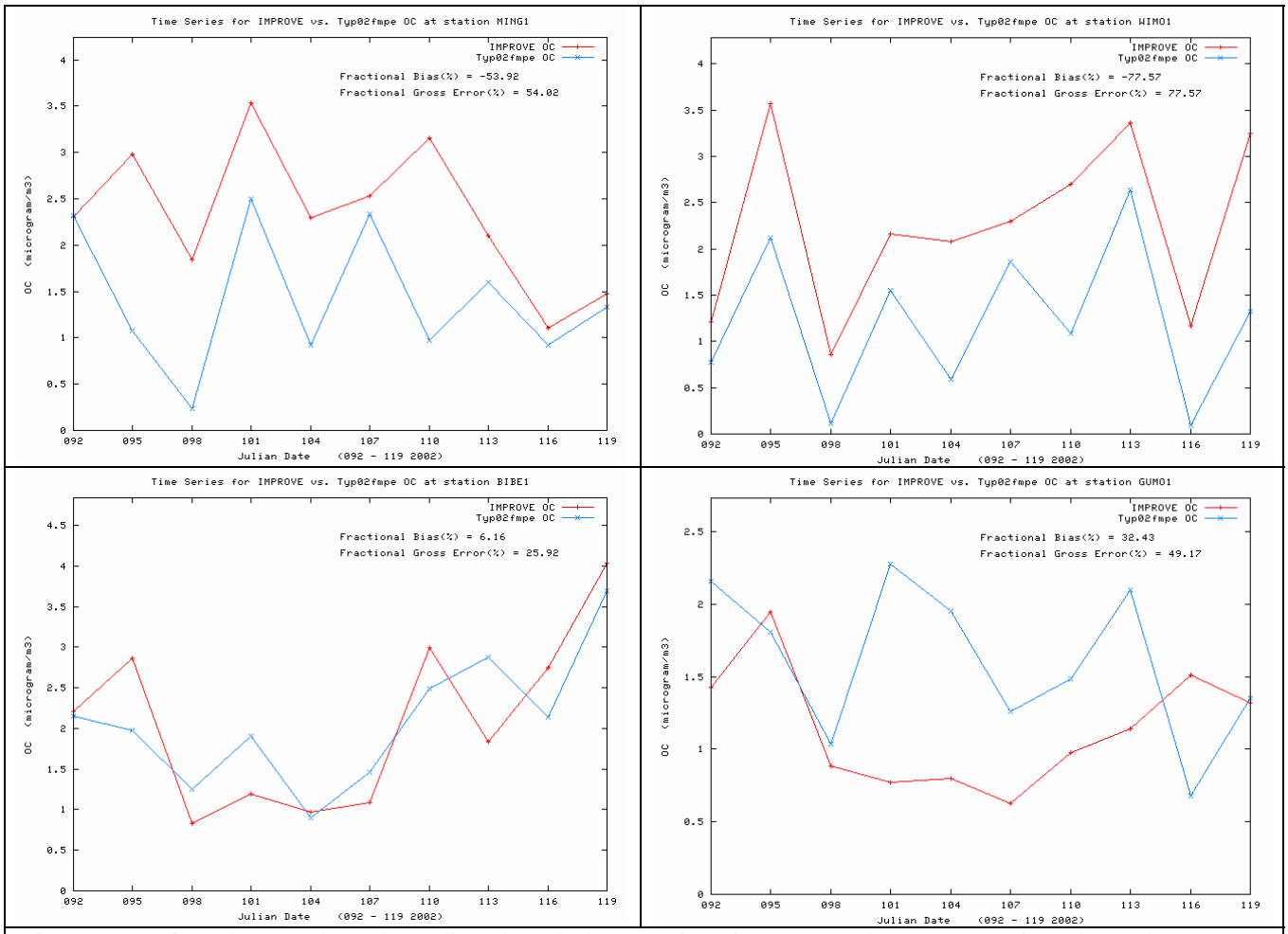


Figure C-17b. Time series of predicted and observed 24-hour organic matter carbon (OMC) concentrations at CENRAP IMPROVE CLASS I AREA sites in April 2002 for CMAQ 2002 36 km Base F base case simulation.

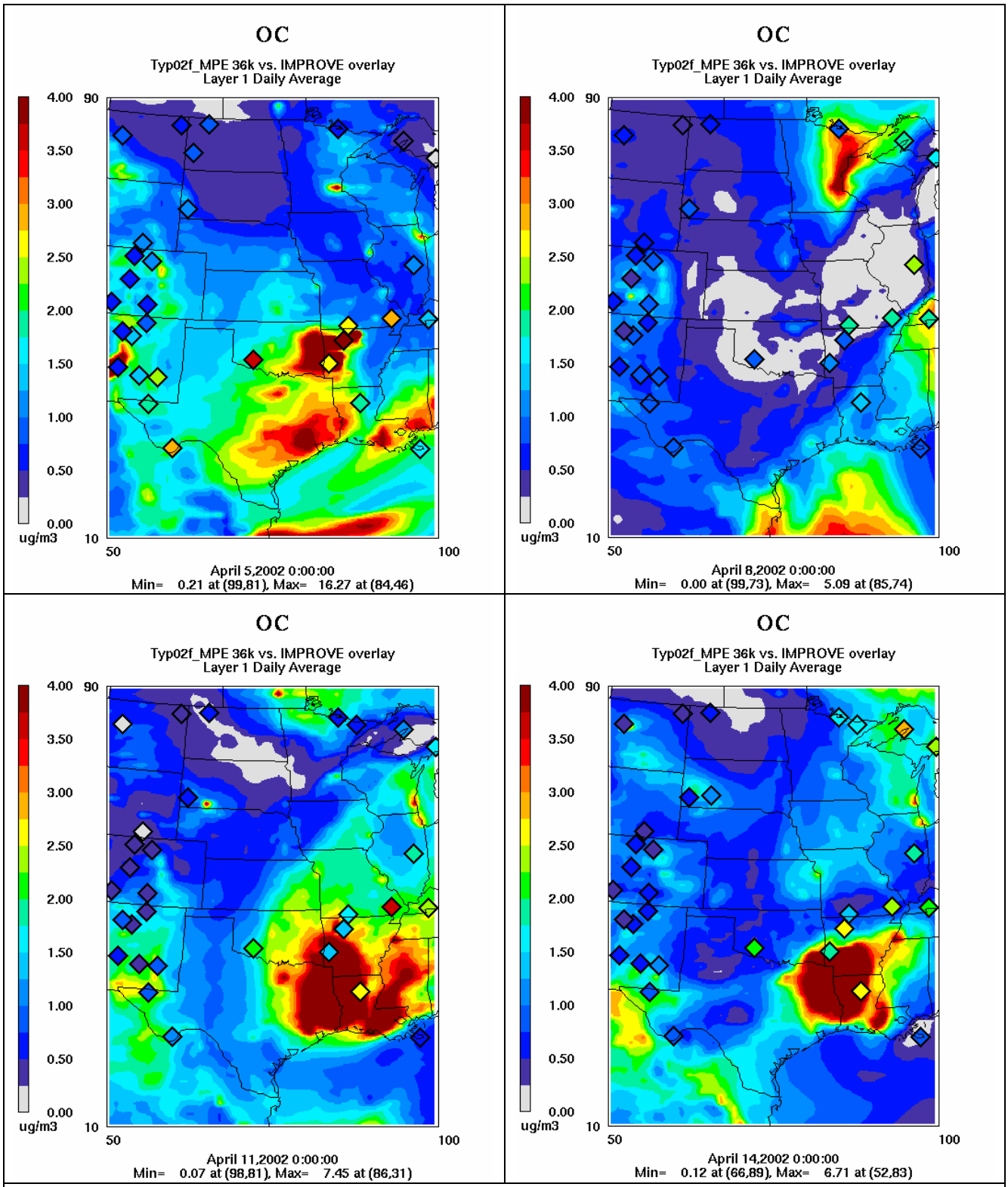


Figure C-17c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour OMC concentrations for April 5, 8, 11 and 14, 2002.

C.3.3.3 OMC in July 2002

Modeled and observed OMC are higher in July due to the impacts of more secondary organic aerosols (SOA) and fires. OMC bias values of -18% and -41% exist across the IMPROVE and STN networks in July (Figure C-18a). Two of the observed OMC values at the IMPROVE sites are very high (> 15 µg/m^3). An examination of the time series plots (Figure C-18b) reveals that these two values occur on Julian Day 200 and the two northern Minnesota sites (VOYA and BOWA) and are likely due to fire impacts. The model is also estimating elevated OMC at these sites on these two days, but not as high as observed. At most sites the model is racking the temporal variation of the observed OMC reasonably well. OMC data for MING were missing in July 2002. The model reproduces the observed high OMC in northern Minnesota and centered on Louisiana and adjacent areas on July 7 and 10 quite well, but also predicts elevated OMC in the Denver area that is not reflected in the observations (Figure C-18c). The model is exhibiting less skill in predicting the spatial distribution of the observed OMC on July 13 and 16.

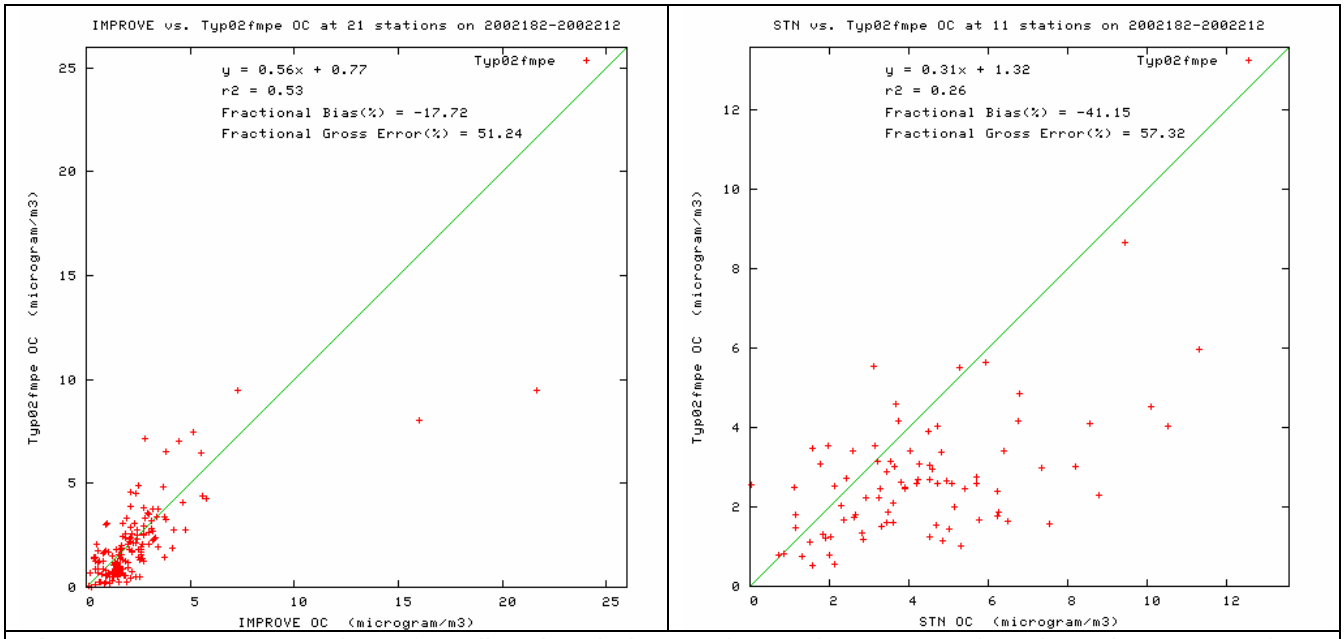
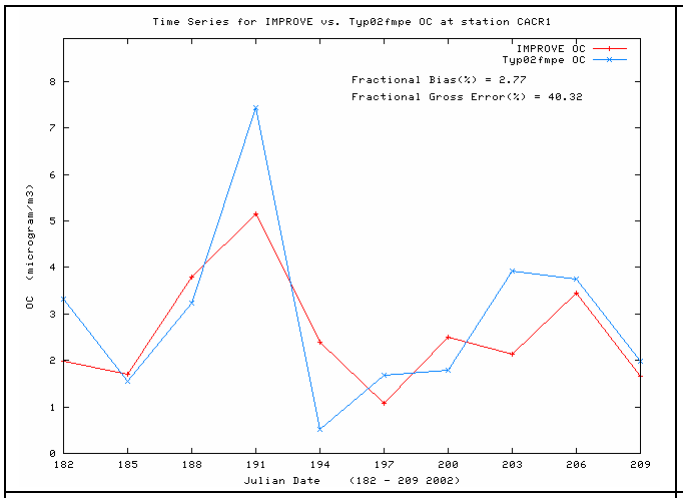
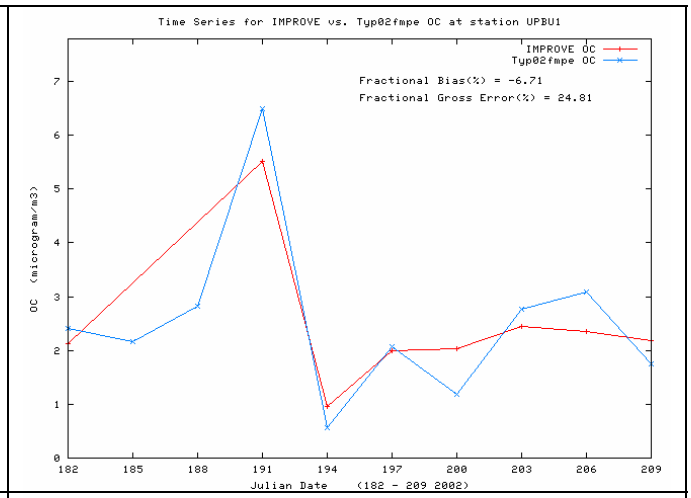
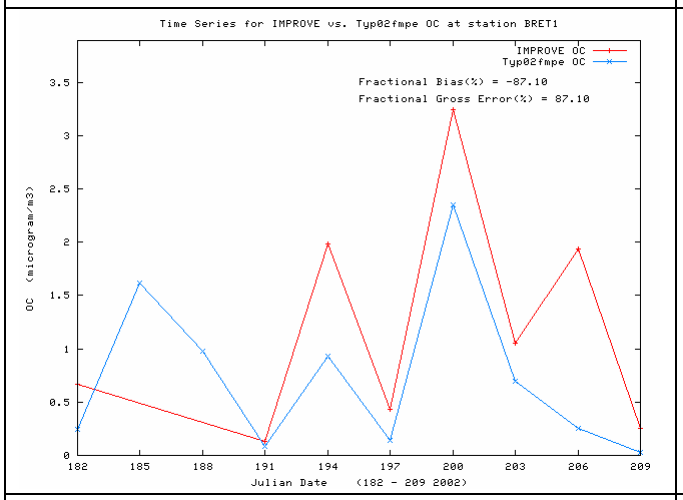
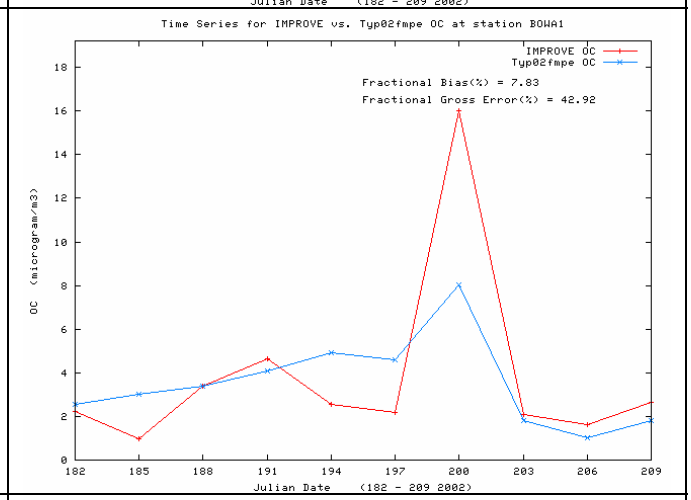


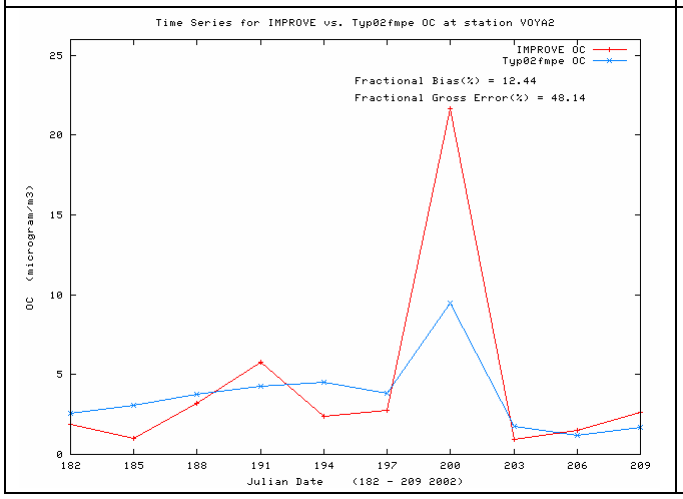
Figure C-18a. Scatter plots of predicted and observed organic matter carbon (OMC) concentrations for July 2002 and sites in the CENRAP region using IMPROVE (left) and STN (right) monitoring networks using the CMAQ 2002 36 km Base F base case simulation.

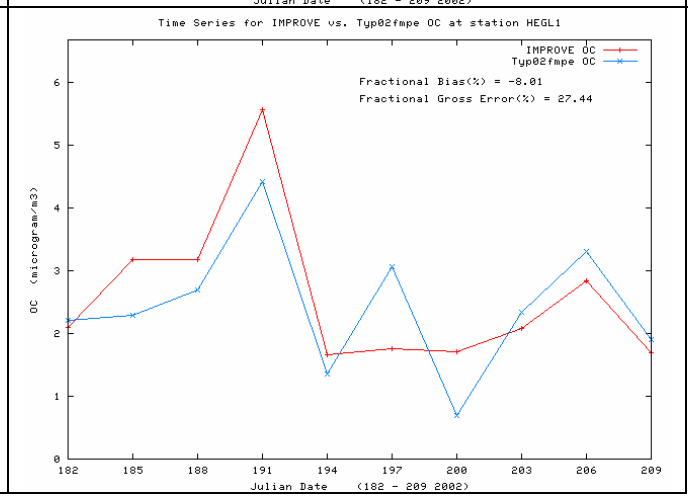

Time Series for IMPROVE vs. Typ02fmpe OC at station CACR1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 2.77
Fractional Gross Error(%) = 40.32
OC (microgram/m3)
Julian Date (182 - 209 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station UPBU1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -6.71
Fractional Gross Error(%) = 24.81
OC (microgram/m3)
Julian Date (182 - 209 2002)

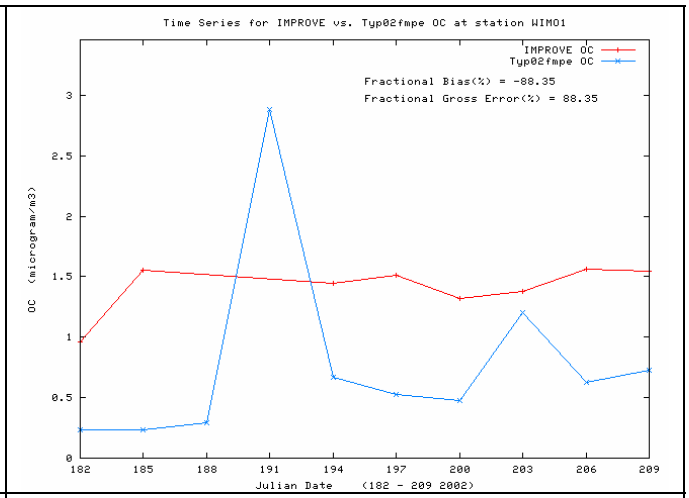

Time Series for IMPROVE vs. Typ02fmpe OC at station BRET1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -87.10
Fractional Gross Error(%) = 87.10
OC (microgram/m3)
Julian Date (182 - 209 2002)

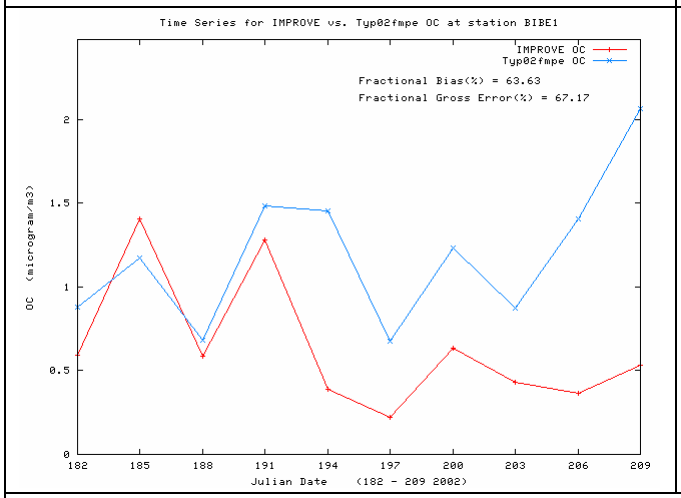

Time Series for IMPROVE vs. Typ02fmpe OC at station BOWA1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 7.83
Fractional Gross Error(%) = 42.92
OC (microgram/m3)
Julian Date (182 - 209 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station VOYA2
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 12.44
Fractional Gross Error(%) = 48.14
OC (microgram/m3)
Julian Date (182 - 209 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station HEGL1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -8.01
Fractional Gross Error(%) = 27.44
OC (microgram/m3)
Julian Date (182 - 209 2002)

No Data for Mingo (MING)





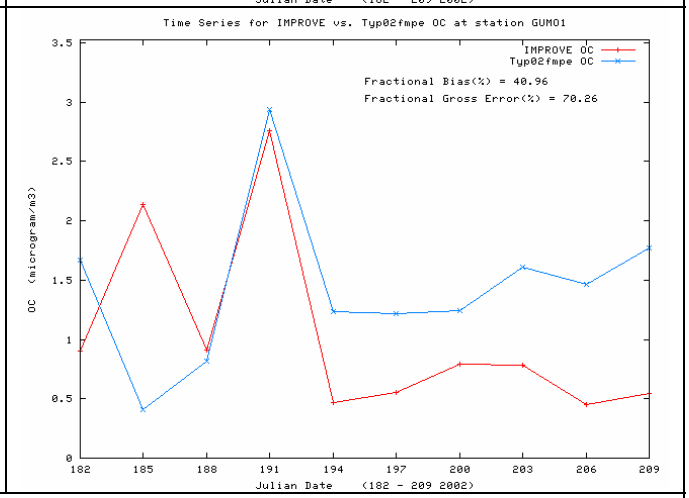


Figure C-18b. Time series of predicted and observed 24-hour organic matter carbon (OMC) concentrations at CENRAP IMPROVE CLASS I AREA sites in July 2002 for CMAQ 2002 36 km Base F base case simulation.

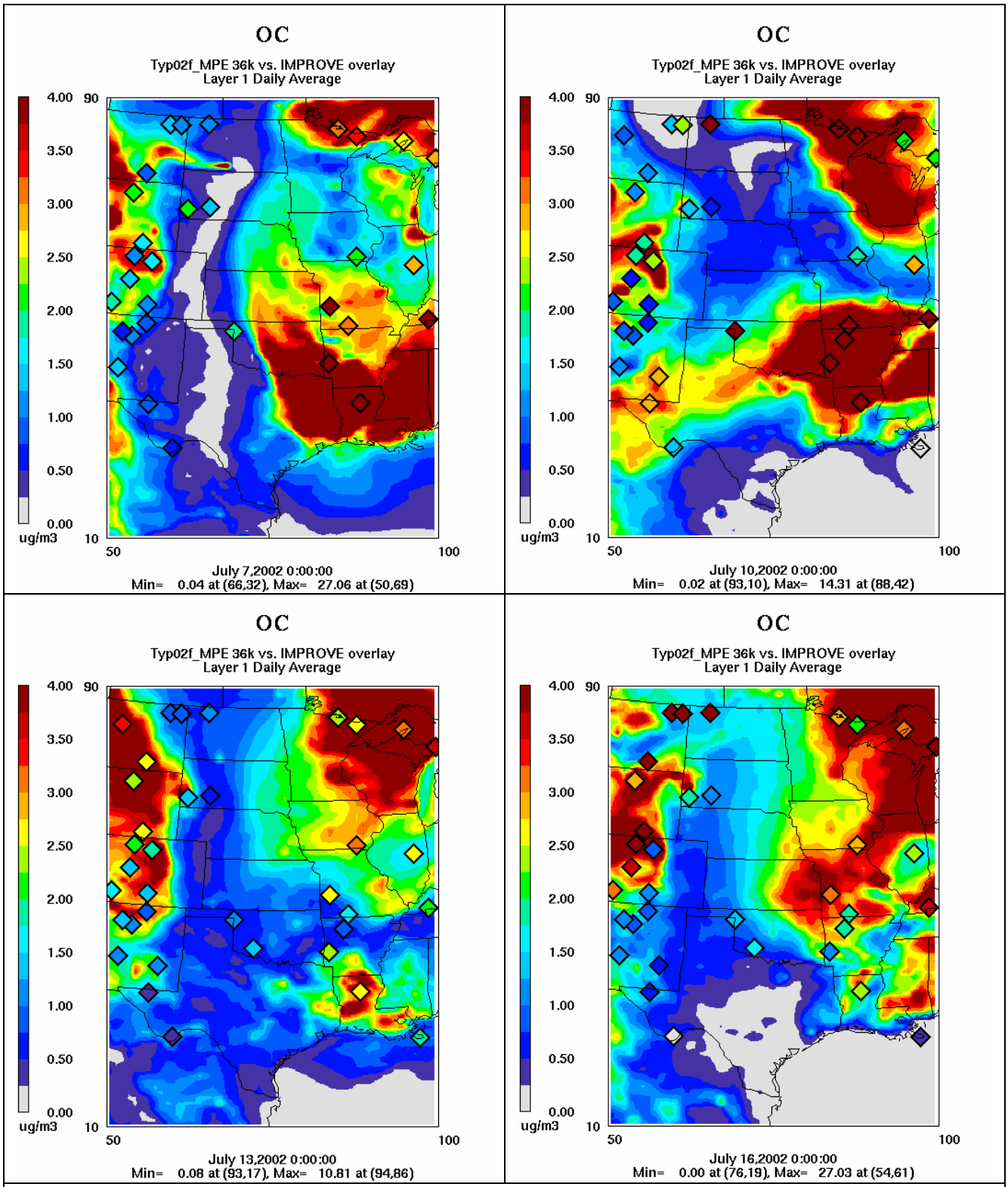


Figure C-18c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour OMC concentrations for July 7, 10, 13 and 16, 2002.

C.3.3.4 OMC in October 2002

OMC model performance in October 2002 is similar to the other months with near zero bias across the IMPROVE sites and an underestimation bias across the STN sites in the CENRAP region (Figure C-19a). Although OMC overestimation bias occurs at the Texas sites (BIBE and GUMO), the model is exhibiting remarkable ability to reproduce the observed temporal variation in OMC at several of the sites (e.g., CACR, UPBU, VOYA and HEGL; Figure C-19b). The model also performs reasonable well in reproducing the day to day and spatial variability in the observed OMC (Figure C-19c).

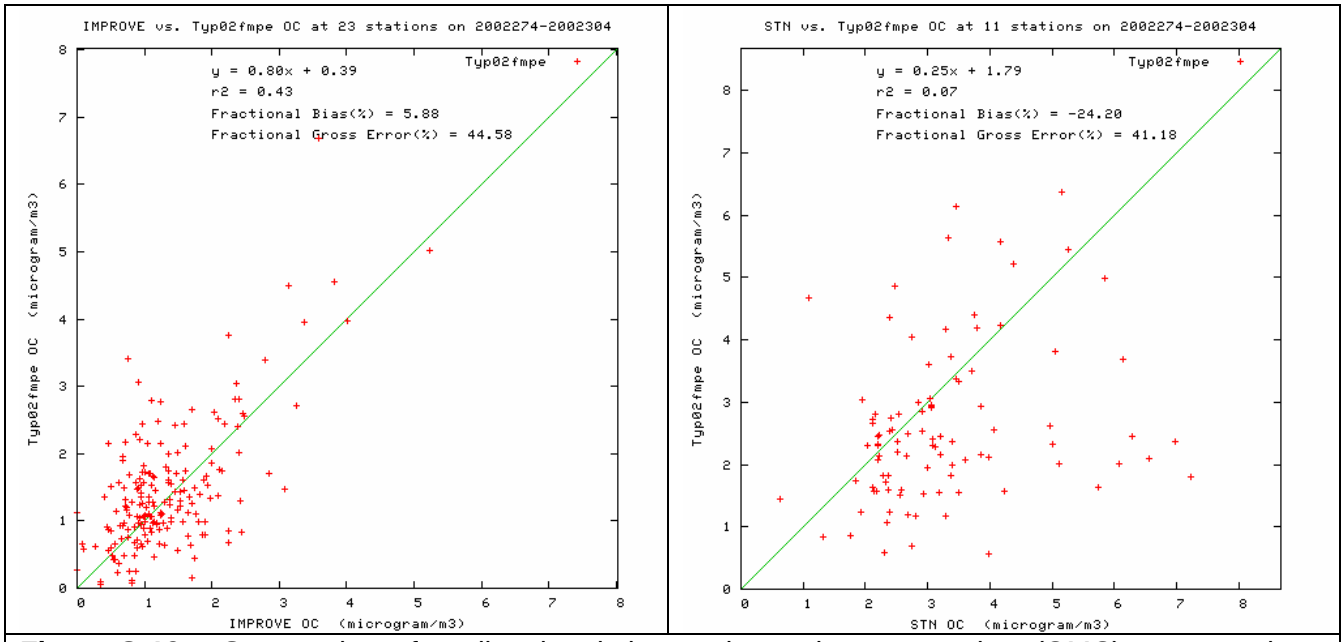
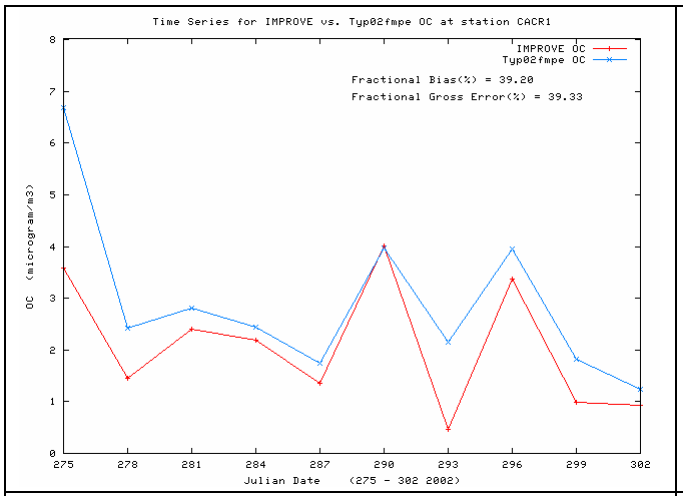
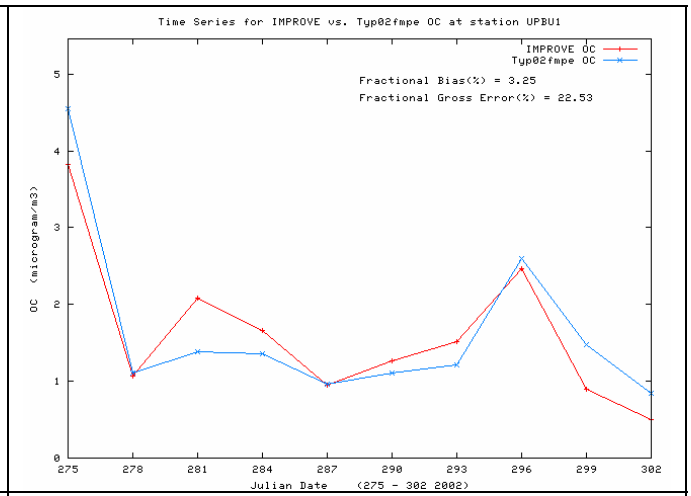
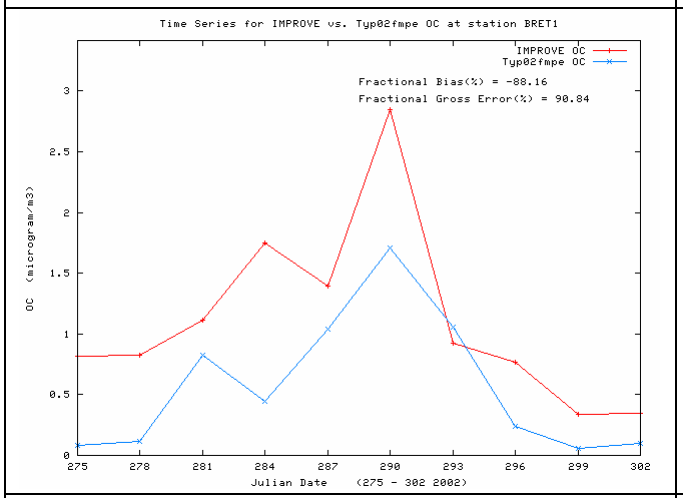
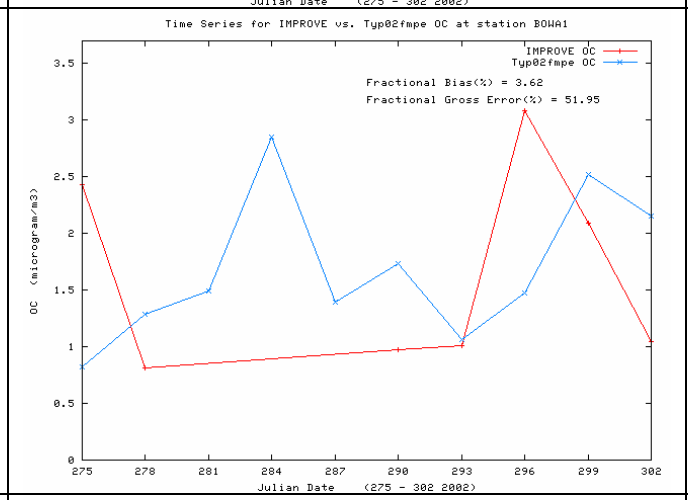


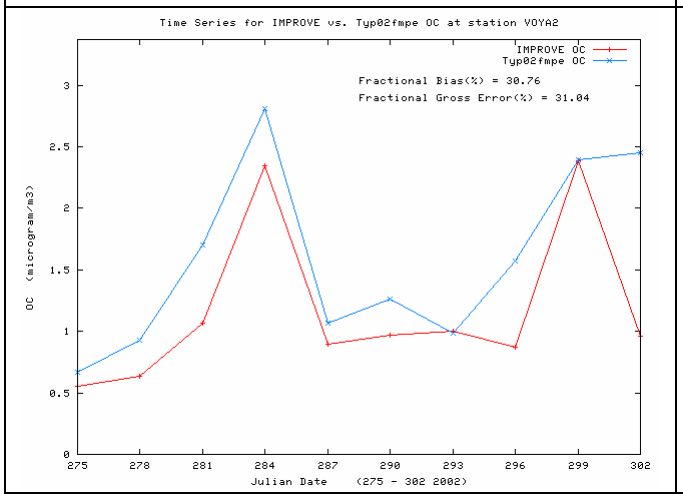
Figure C-19a. Scatter plots of predicted and observed organic matter carbon (OMC) concentrations for October 2002 and sites in the CENRAP region using IMPROVE (left) and STN (right) monitoring networks using the CMAQ 2002 36 km Base F base case simulation.

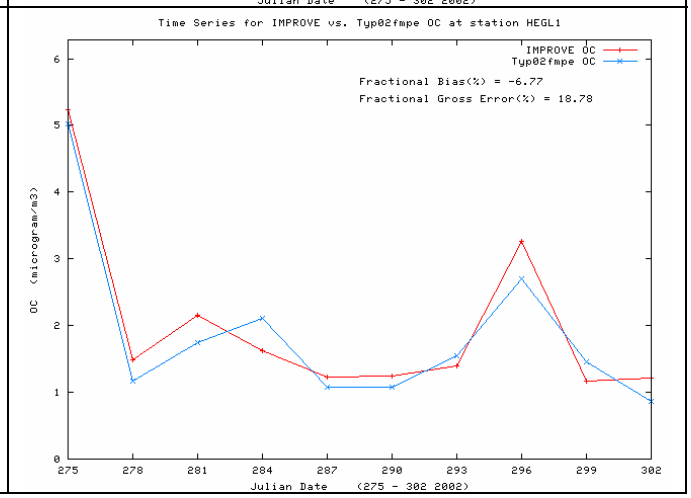

Time Series for IMPROVE vs. Typ02fmpe OC at station CACR1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 39.20
Fractional Gross Error(%) = 39.33
OC (microgram/m3)
Julian Date (275 - 302 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station UPBU1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 3.25
Fractional Gross Error(%) = 22.53
OC (microgram/m3)
Julian Date (275 - 302 2002)

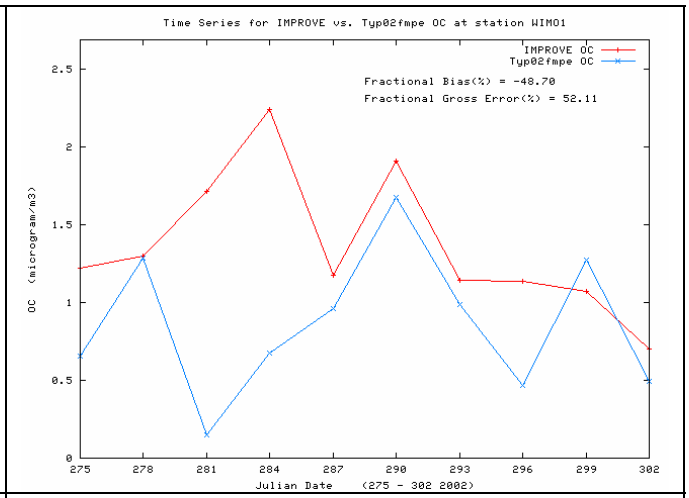

Time Series for IMPROVE vs. Typ02fmpe OC at station BRET1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -88.16
Fractional Gross Error(%) = 90.84
OC (microgram/m3)
Julian Date (275 - 302 2002)

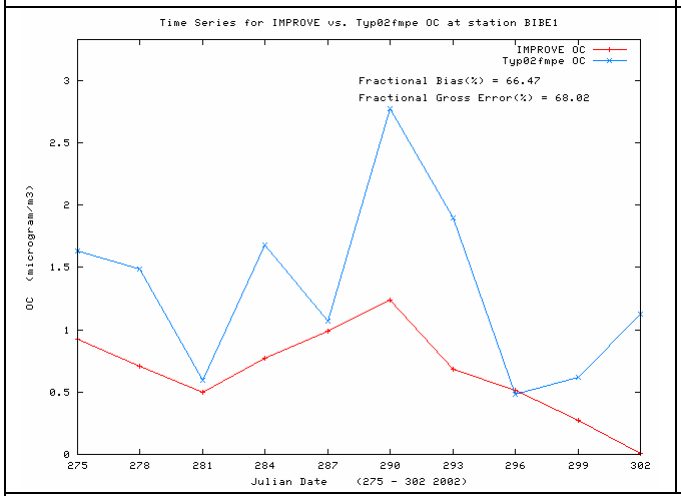

Time Series for IMPROVE vs. Typ02fmpe OC at station BOWA1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 3.62
Fractional Gross Error(%) = 51.95
OC (microgram/m3)
Julian Date (275 - 302 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station VOYA2
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = 30.76
Fractional Gross Error(%) = 31.04
OC (microgram/m3)
Julian Date (275 - 302 2002)


Time Series for IMPROVE vs. Typ02fmpe OC at station HEGL1
IMPROVE OC
Typ02fmpe OC
Fractional Bias(%) = -6.77
Fractional Gross Error(%) = 18.78
OC (microgram/m3)
Julian Date (275 - 302 2002)

No Data for Mingo (MING)





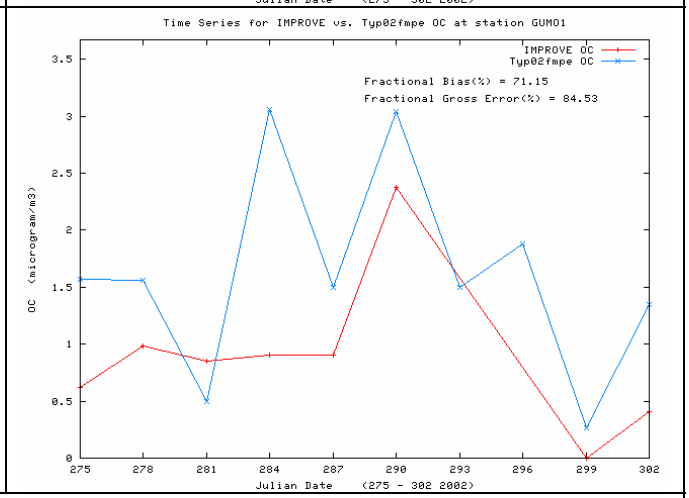


Figure C-19b. Time series of predicted and observed 24-hour organic matter carbon (OMC) concentrations at CENRAP IMPROVE CLASS I AREA sites in October 2002 for CMAQ 2002 36 km Base F base case simulation.

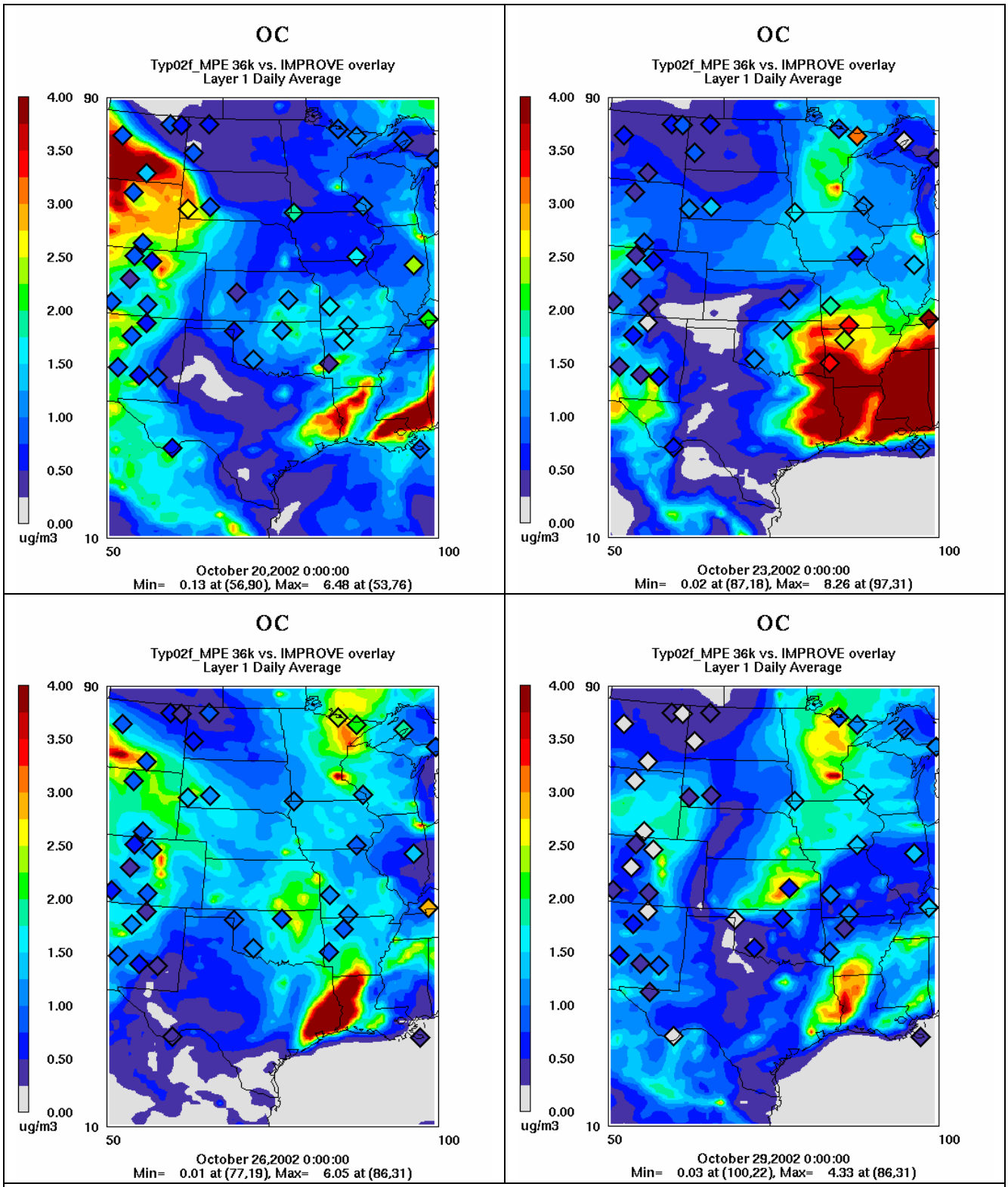


Figure C-19c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour OMC concentrations for October 20, 23, 26 and 29, 2002.

C.3.3.5 OMC Monthly Bias and Error

The OMC monthly bias and error across IMPROVE and STN sites in the CENRAP region are shown in Figure C-20. The bias performance for OMC at the IMPROVE sites are quite good throughout the year with values generally within ±20%, albeit with a slight winter overestimation and summer underestimation bias. At the urban STN sites the model exhibits an underestimation bias throughout the year that ranges from -20% to -50%. Fractional errors are mostly within 40% to 60% with the STN network generally exhibiting more error than IMPROVE.

The good performance of the model for OMC at the IMPROVE sites is also reflected in the Bugle Plot (Figure C-21) with the bias and error achieving the proposed PM model performance goal for all months of the year. At the STN sites, however, the OMC bias falls between the proposed PM model performance goal and criteria, with error right at the goal for most months.

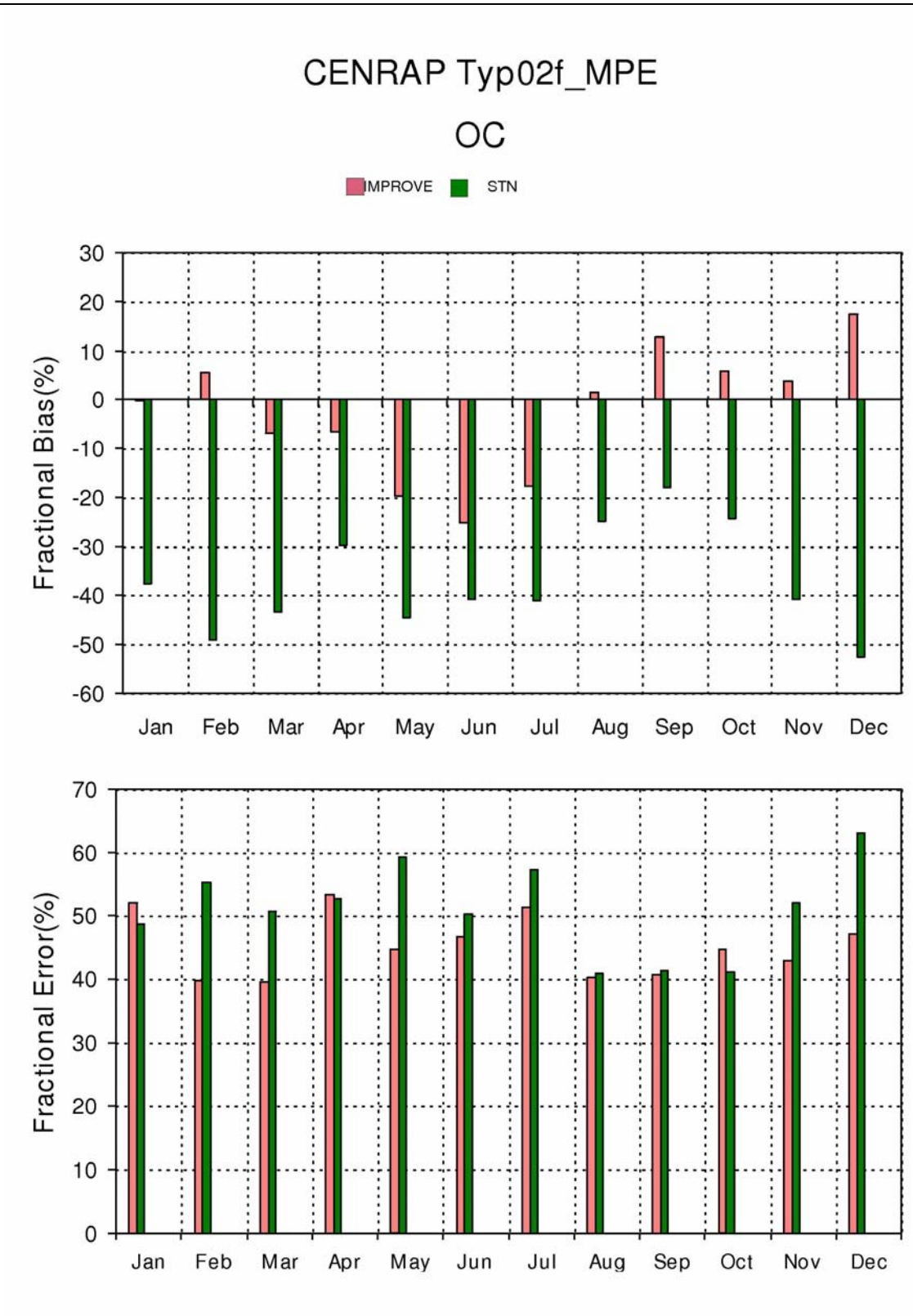


Figure C-20. Monthly OMC fractional bias (top) and fractional gross error (bottom) statistical measures for IMPROVE and STN monitoring sites in the CENRAP region.

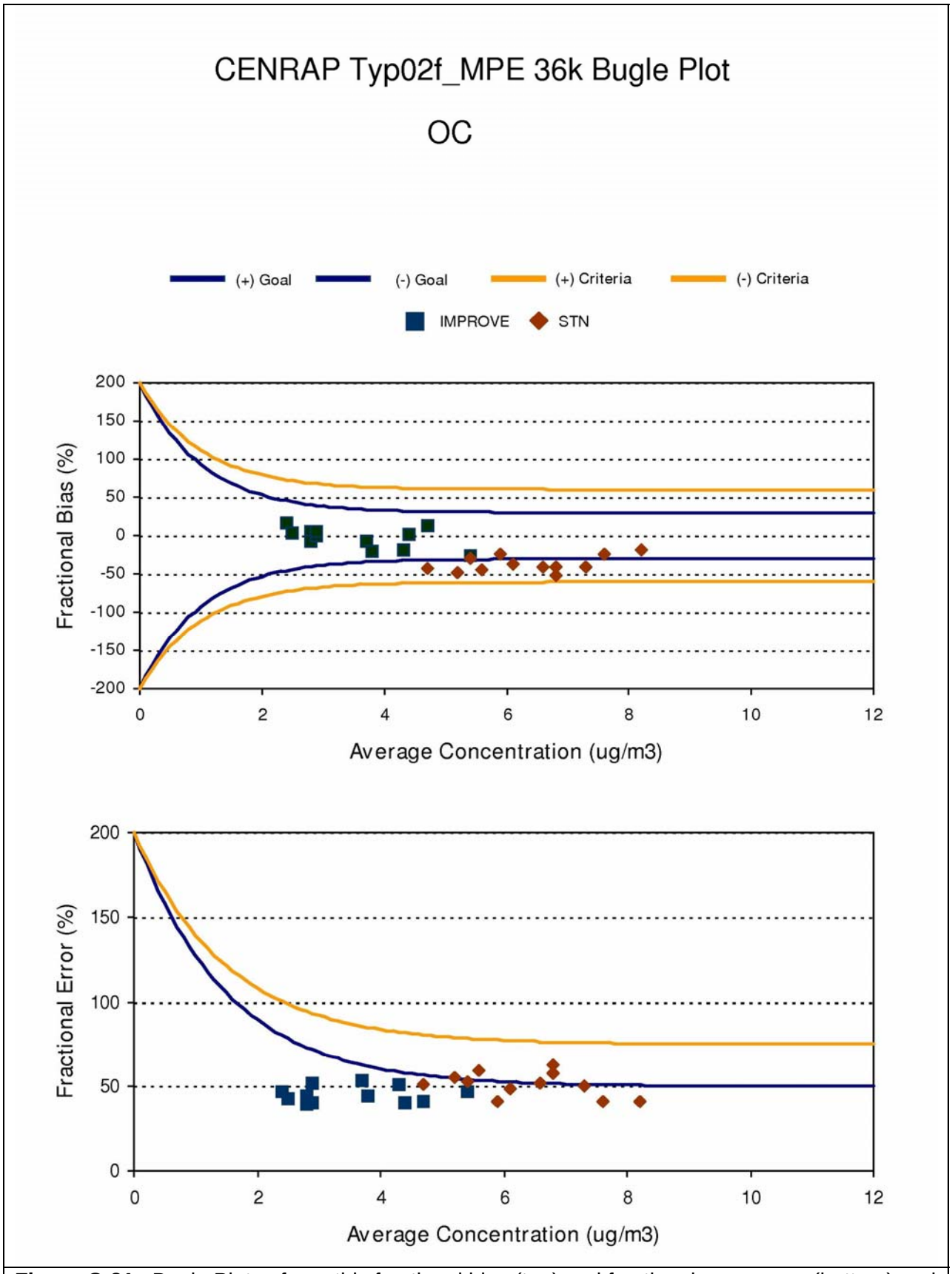


Figure C-21. Bugle Plots of monthly fractional bias (top) and fractional gross error (bottom) and comparisons with model performance goals and criteria for OMC and IMPROVE and STN monitoring sites in the CENRAP region.

C.3.4 Elemental Carbon (EC) Monthly Model Performance

Elemental Carbon (EC) measurements are also uncertain, with the IMPROVE and STN using different measurement technologies with different measurement artifacts.

C.3.4.1 EC in January 2002

Although there is a lot of scatter in the January EC scatter plots at the IMPROVE and STN sites, the bias is fairly low (-24% and 1%) with errors in the 40%-50% range (Figure C-22a). The time series comparisons (Figure C-22b) suggest an EC underestimation bias at BRET and an overestimation bias at the northern Minnesota sites (VOYA and BOWA). The model generally agrees with the observed spatial distribution of EC in January with higher values on the eastern than western portions of the CENRAP region (Figure C-22c).

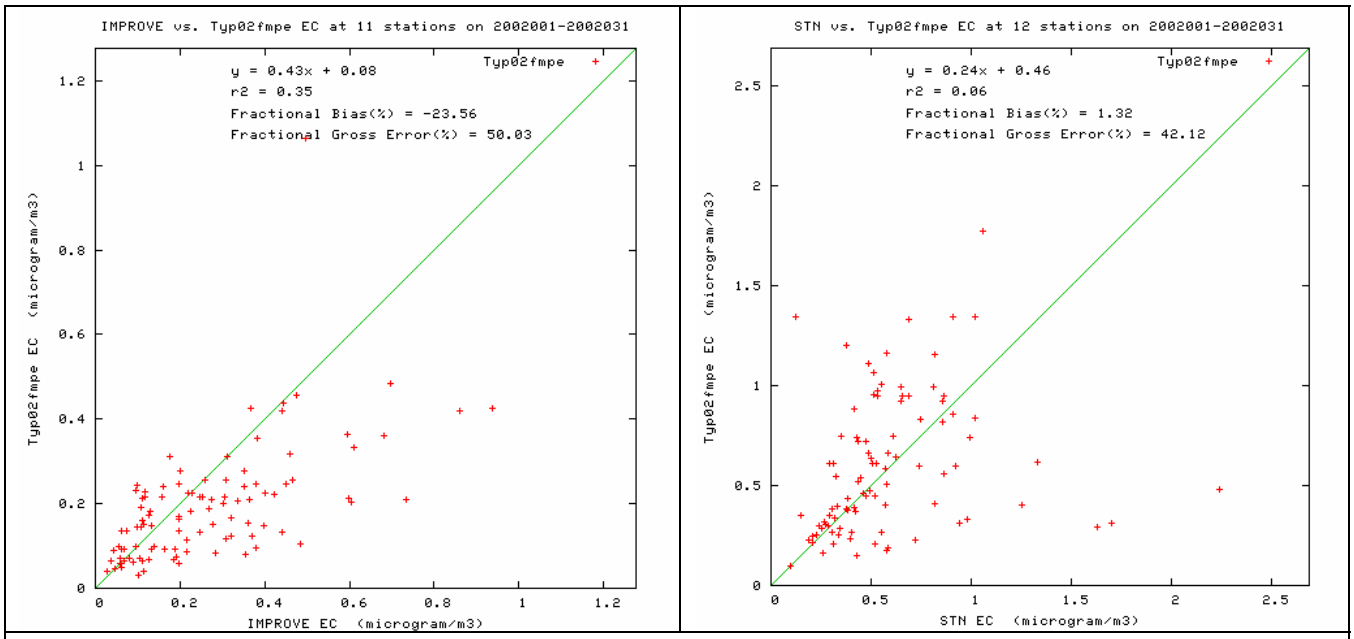
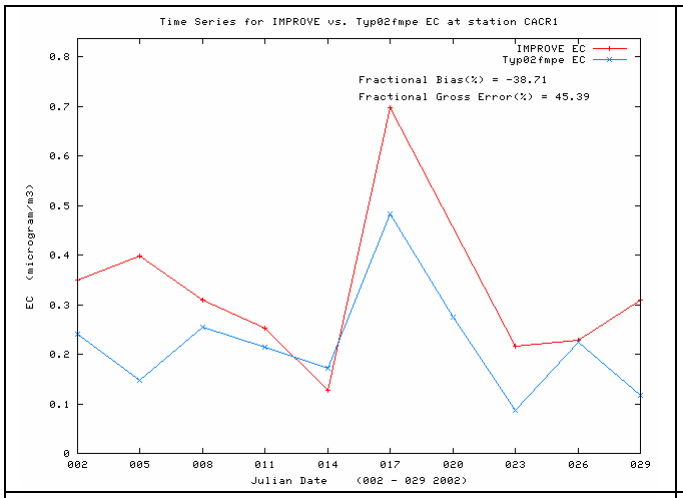
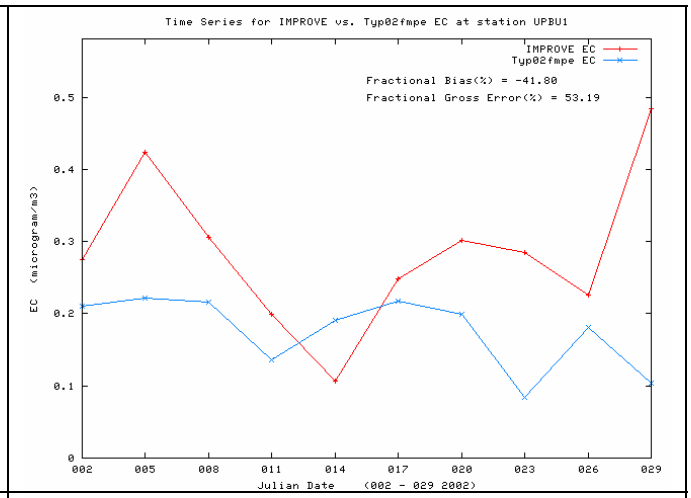
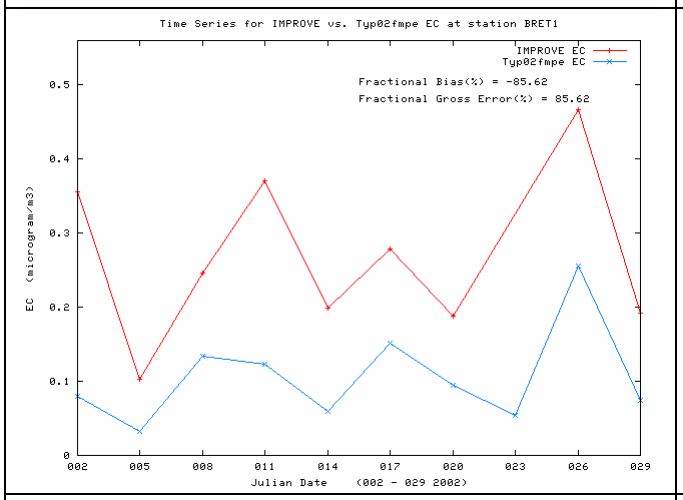
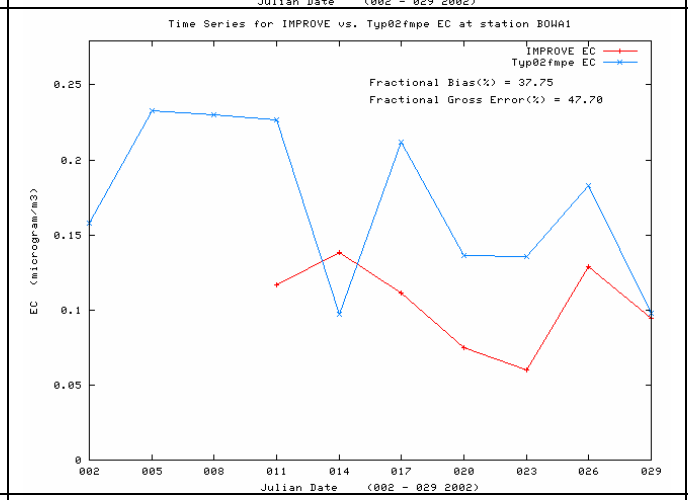


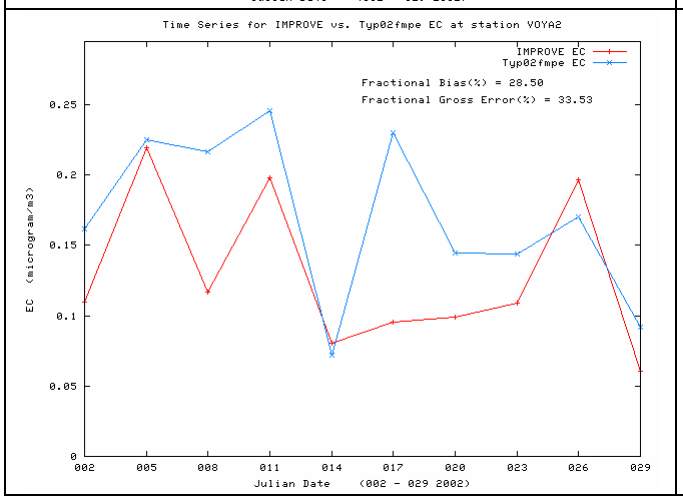
Figure C-22a. Scatter plots of predicted and observed elemental carbon (EC) concentrations for January 2002 and sites in the CENRAP region using IMPROVE (left) and STN (right) monitoring networks using the CMAQ 2002 36 km Base F base case simulation.

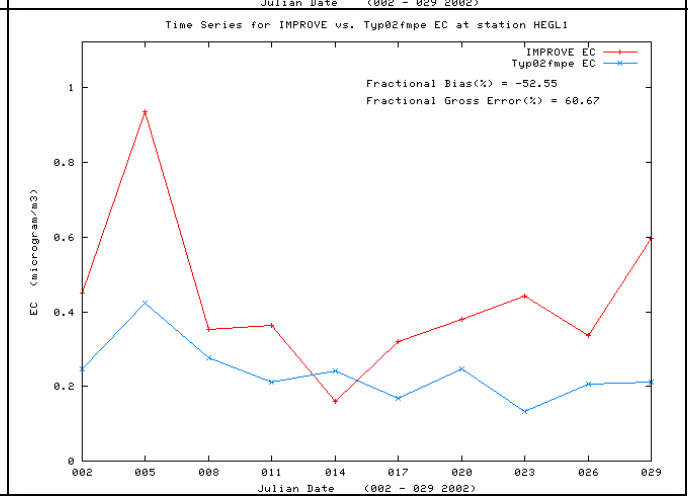

Time Series for IMPROVE vs. Typ02fmpe EC at station CACR1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -38.71
Fractional Gross Error(%) = 45.39
EC (microgram/m3)
Julian Date (002 - 029 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station UPBU1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -41.80
Fractional Gross Error(%) = 53.19
EC (microgram/m3)
Julian Date (002 - 029 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station BRET1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -85.62
Fractional Gross Error(%) = 85.62
EC (microgram/m3)
Julian Date (002 - 029 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station BOWA1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = 37.75
Fractional Gross Error(%) = 47.70
EC (microgram/m3)
Julian Date (002 - 029 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station VOYA2
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = 28.50
Fractional Gross Error(%) = 33.53
EC (microgram/m3)
Julian Date (002 - 029 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station HEGL1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -52.55
Fractional Gross Error(%) = 60.67
EC (microgram/m3)
Julian Date (002 - 029 2002)

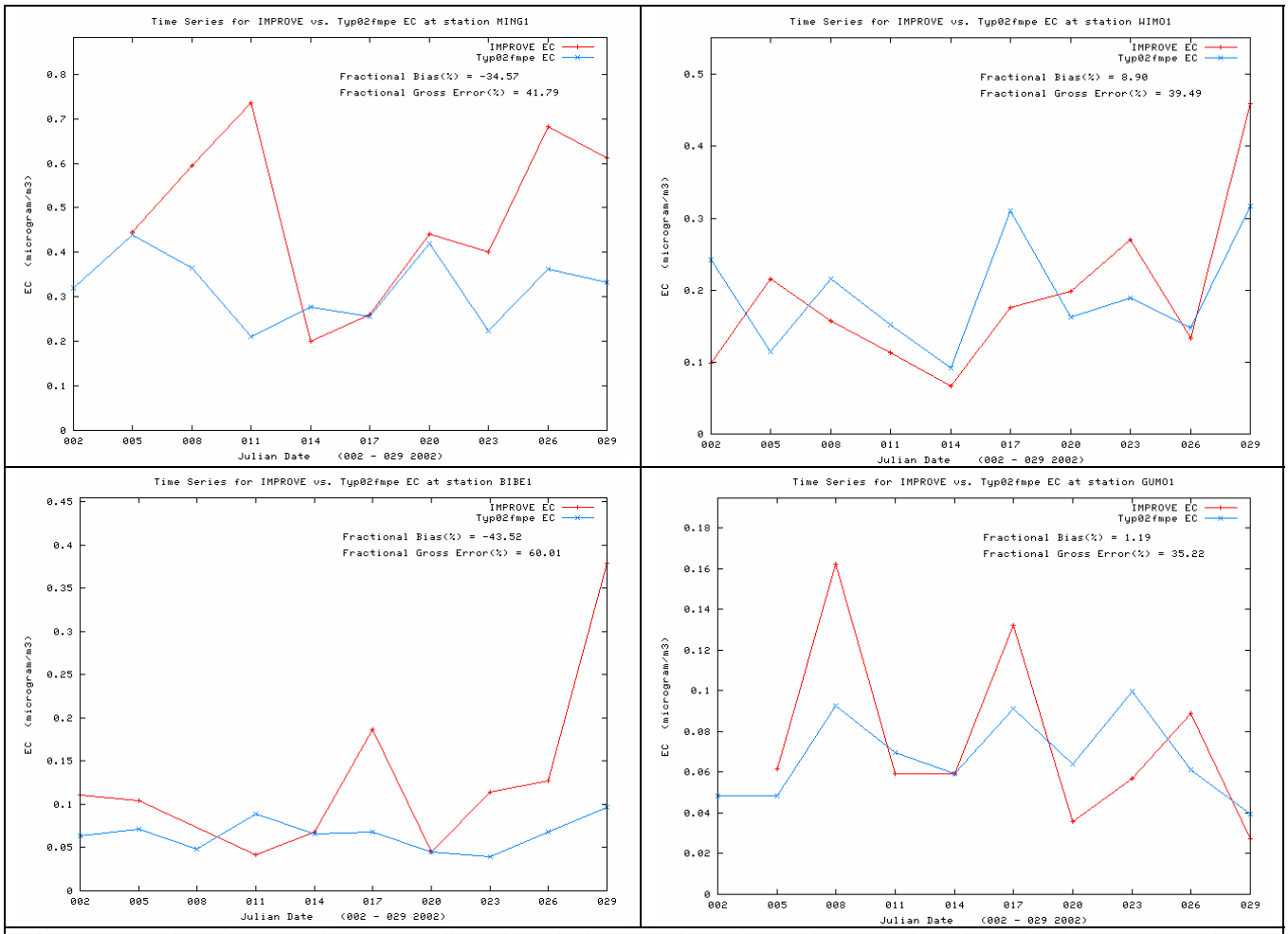


Figure C-22b. Time series of predicted and observed 24-hour elemental carbon (EC) concentrations at CENRAP IMPROVE CLASS I AREA sites in January 2002 for CMAQ 2002 36 km Base F base case simulation.

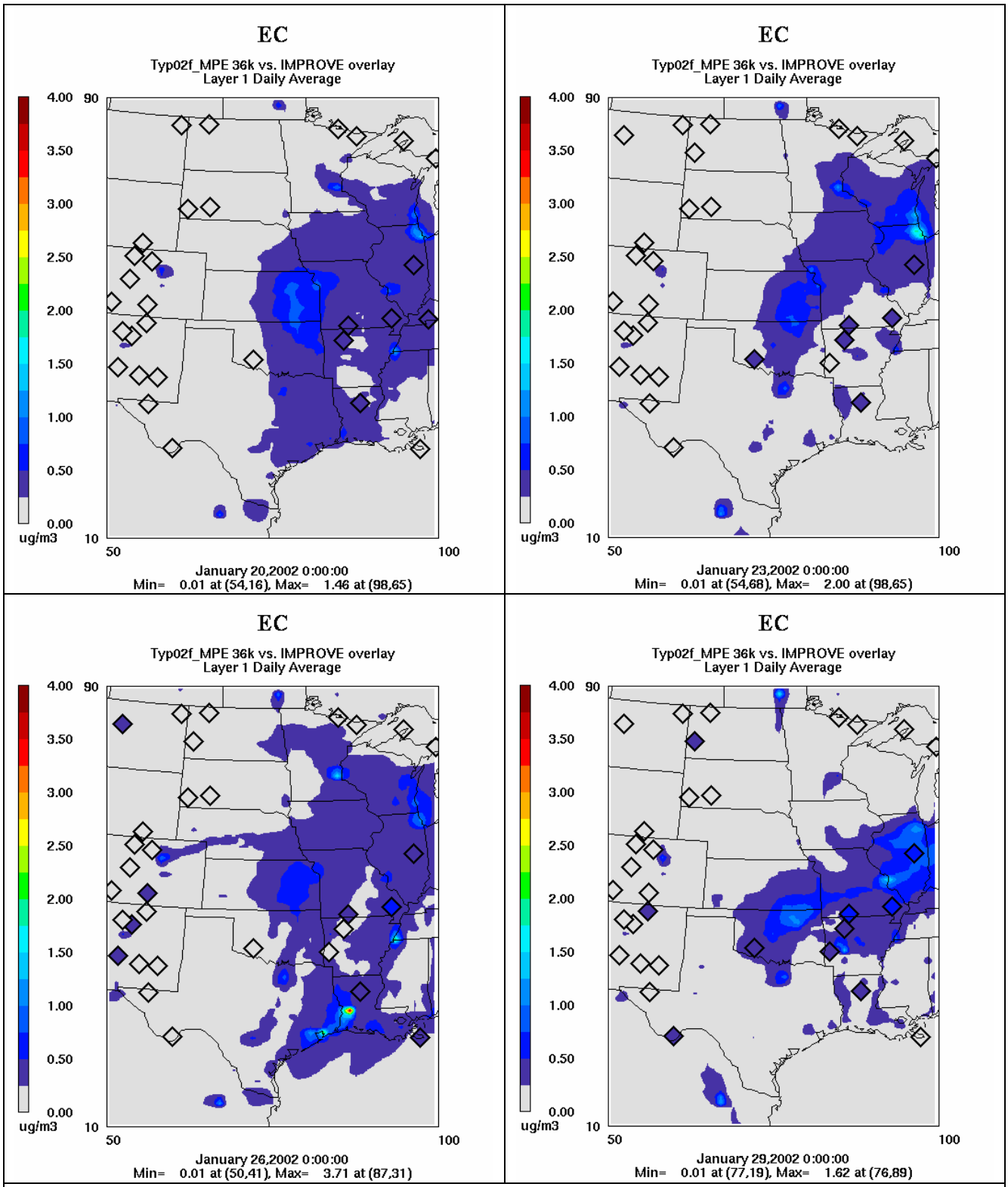


Figure C-22c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour EC concentrations for January 20, 23, 26 and 29, 2002.

C.3.4.2 EC in April 2002

EC is underestimated at the IMPROVE sites in April (bias of -48%), but reproduced well at the STN sites (bias of -13%). Although EC is underestimated at the IMPROVE sites both the model and observations agree that EC concentrations are very small and not a significant component of the PM budget. The model fails to capture the day-to-day variability in the observed EC at the IMPROVE sites and exhibits a systematic under-prediction tendency at some sites (Figure C-23b). On April 5 and 11 the model reproduces the spatial distribution of the observed EC reasonable well with higher values in the eastern than western portion of the CENRAP region. But on April 8 and 14 the model is much to clean in the eastern portion of the CENRAP region (Figure C-23c).

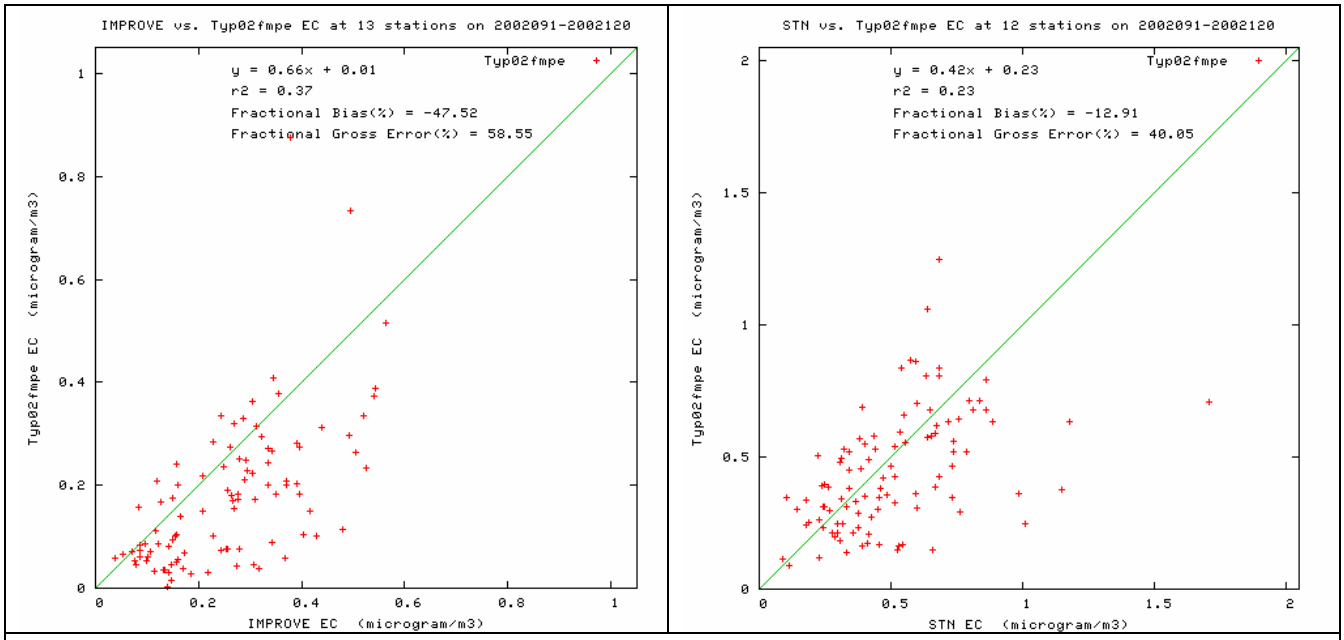
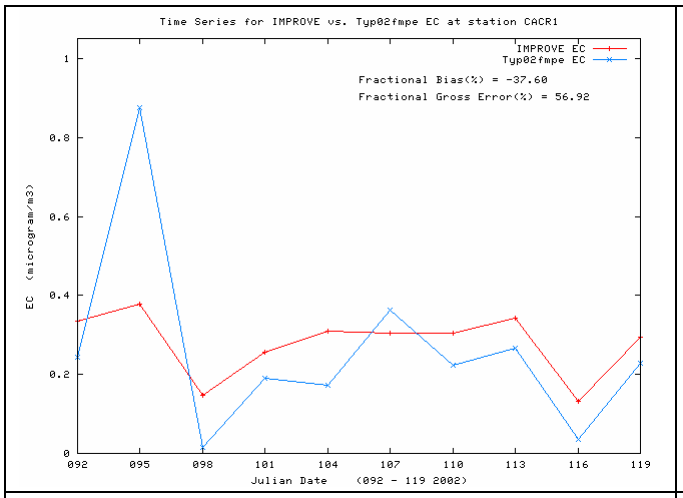
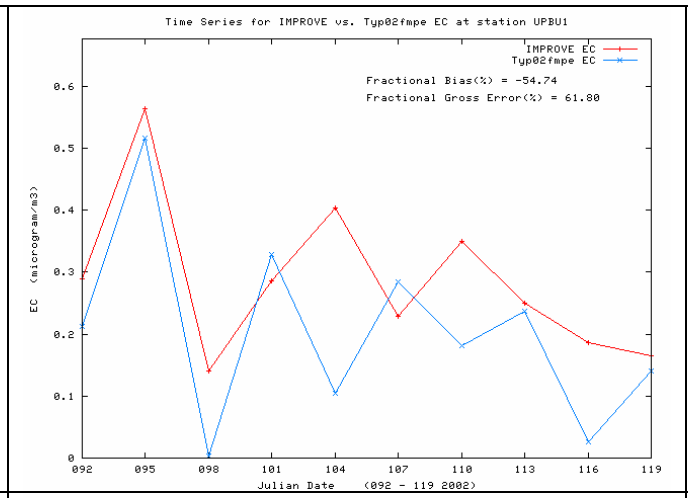
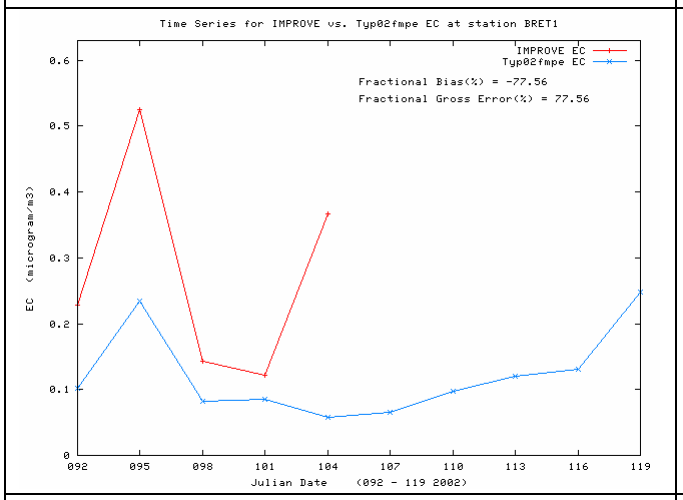
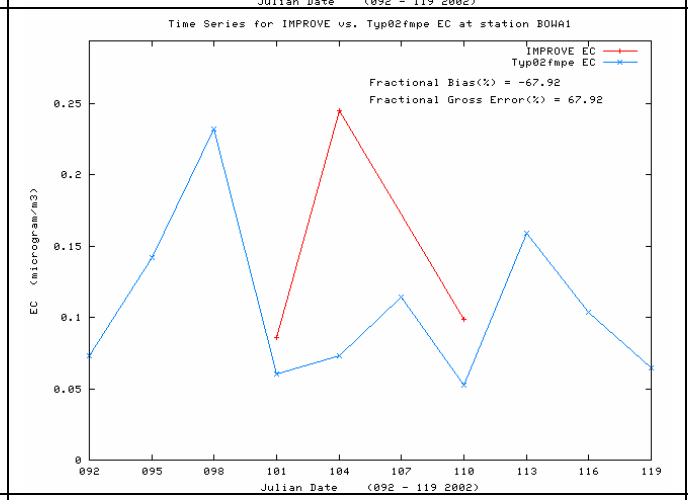


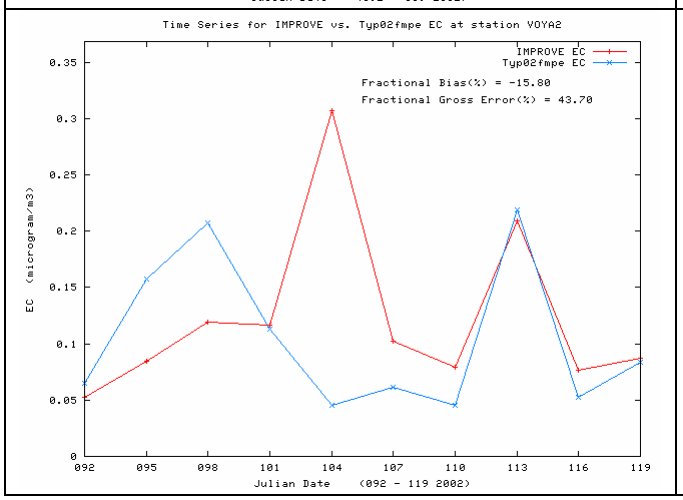
Figure C-23a. Scatter plots of predicted and observed elemental carbon (EC) concentrations for April 2002 and sites in the CENRAP region using IMPROVE (left) and STN (right) monitoring networks using the CMAQ 2002 36 km Base F base case simulation

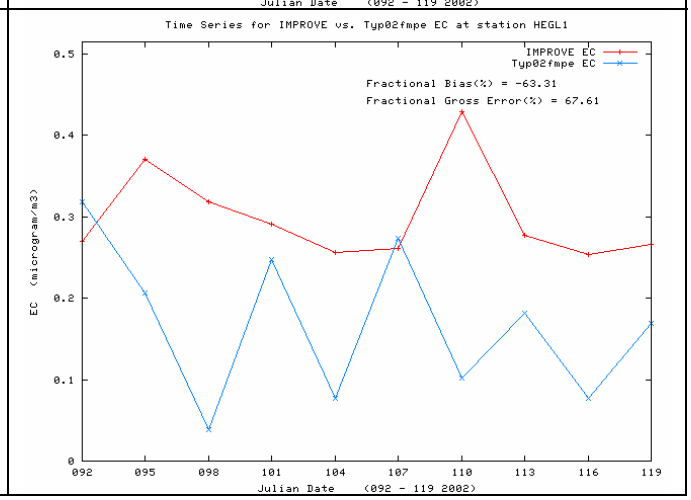

Time Series for IMPROVE vs. Typ02fmpe EC at station CACR1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -37.60
Fractional Gross Error(%) = 56.92
EC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station UPBU1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -54.74
Fractional Gross Error(%) = 61.80
EC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station BRET1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -77.56
Fractional Gross Error(%) = 77.56
EC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station BOWA1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -67.92
Fractional Gross Error(%) = 67.92
EC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station VOYA2
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -15.80
Fractional Gross Error(%) = 43.70
EC (microgram/m3)
Julian Date (092 - 119 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station HEGL1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -63.31
Fractional Gross Error(%) = 67.61
EC (microgram/m3)
Julian Date (092 - 119 2002)

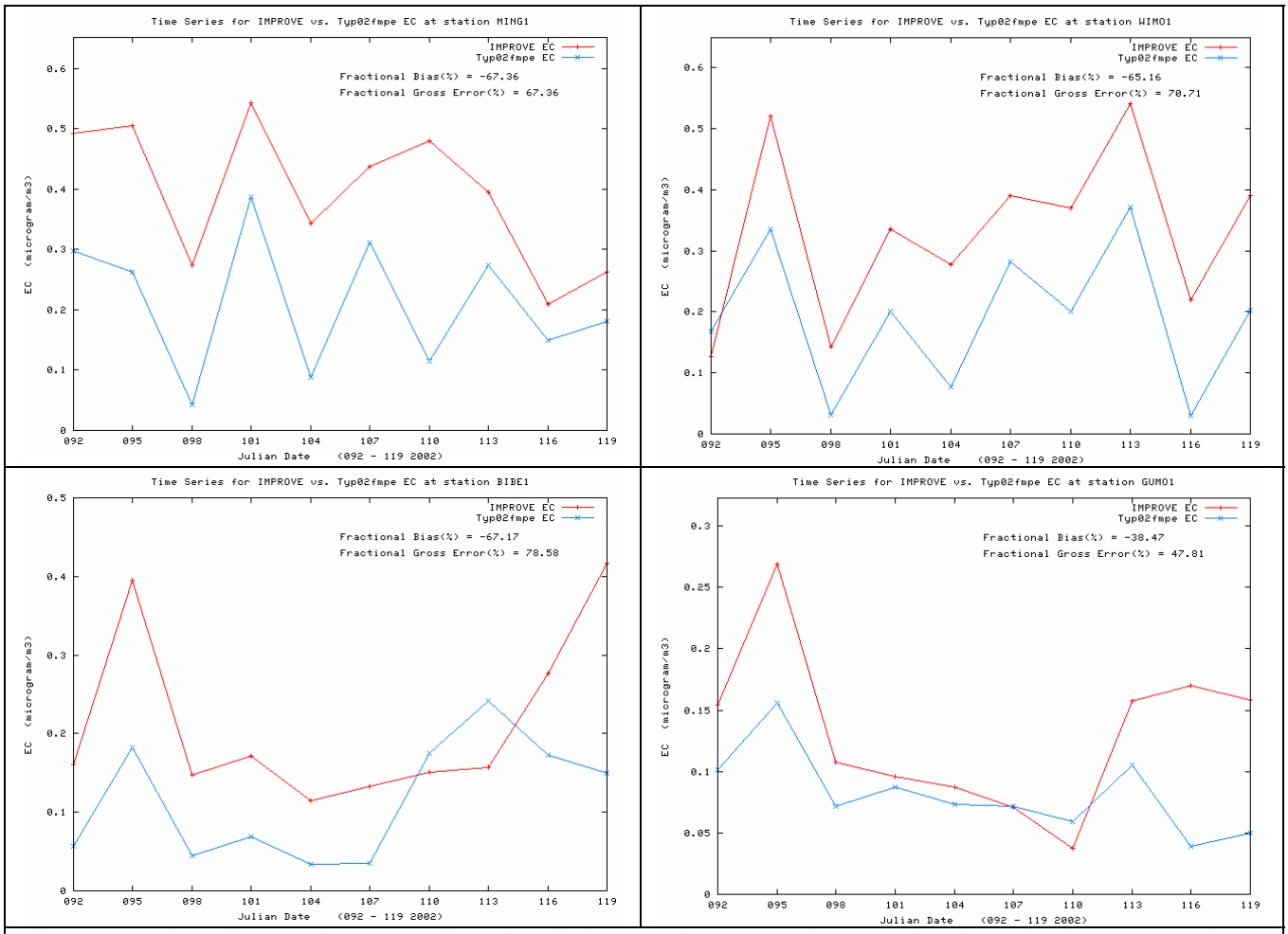


Figure C-23b. Time series of predicted and observed 24-hour elemental carbon (EC) concentrations at CENRAP IMPROVE CLASS I AREA sites in April 2002 for CMAQ 2002 36 km Base F base case simulation.

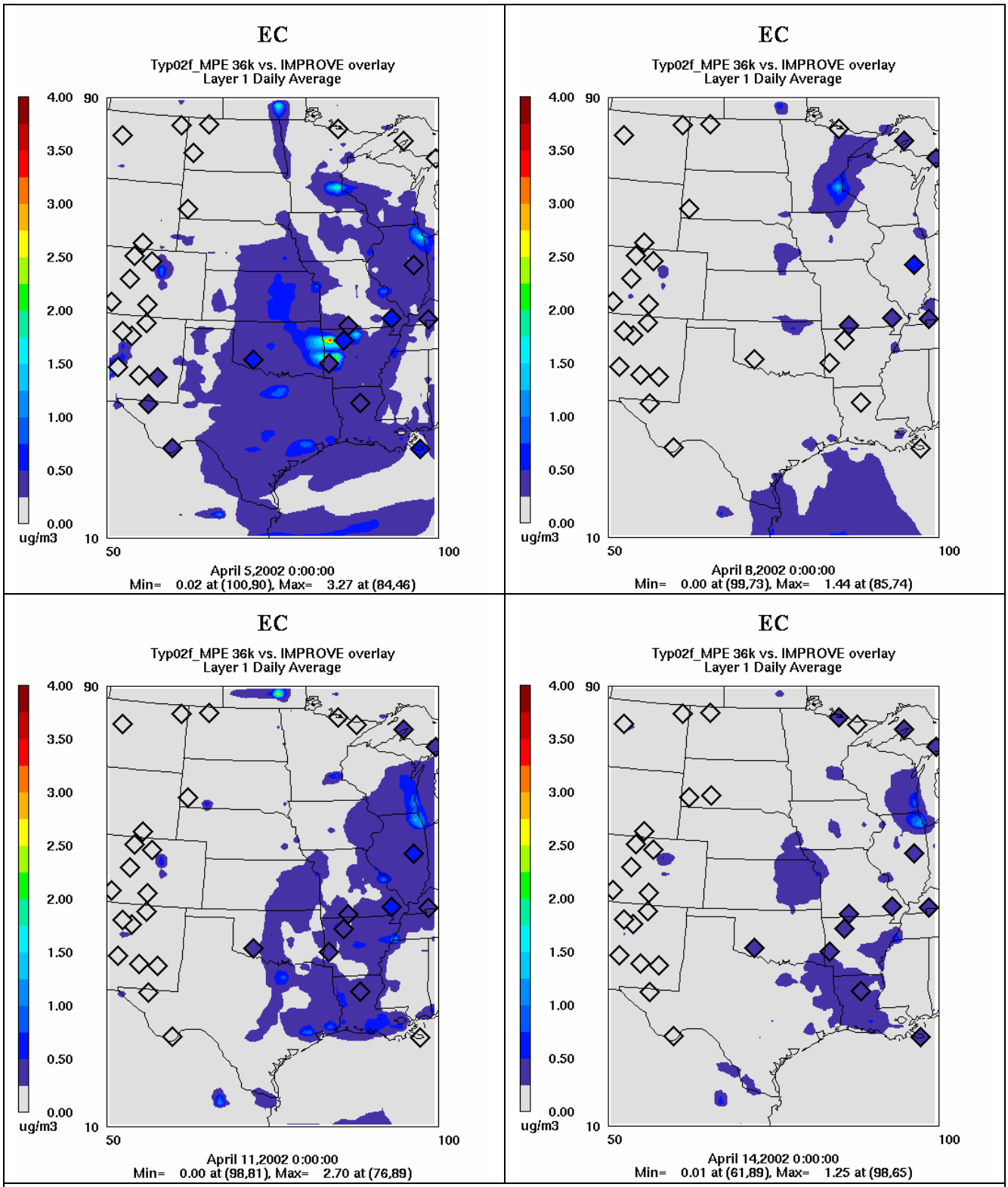


Figure C-23c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour EC concentrations for April 5, 8, 11 and 14, 2002.

C.3.3.3 EC in July 2002

July EC performance is similar to the other months with near zero bias across he STN sites and an underestimation bias across the IMPROVE sites (Figure C-24). Again the model and observations agree that EC is low in July and not a significant component of visibility impairment.

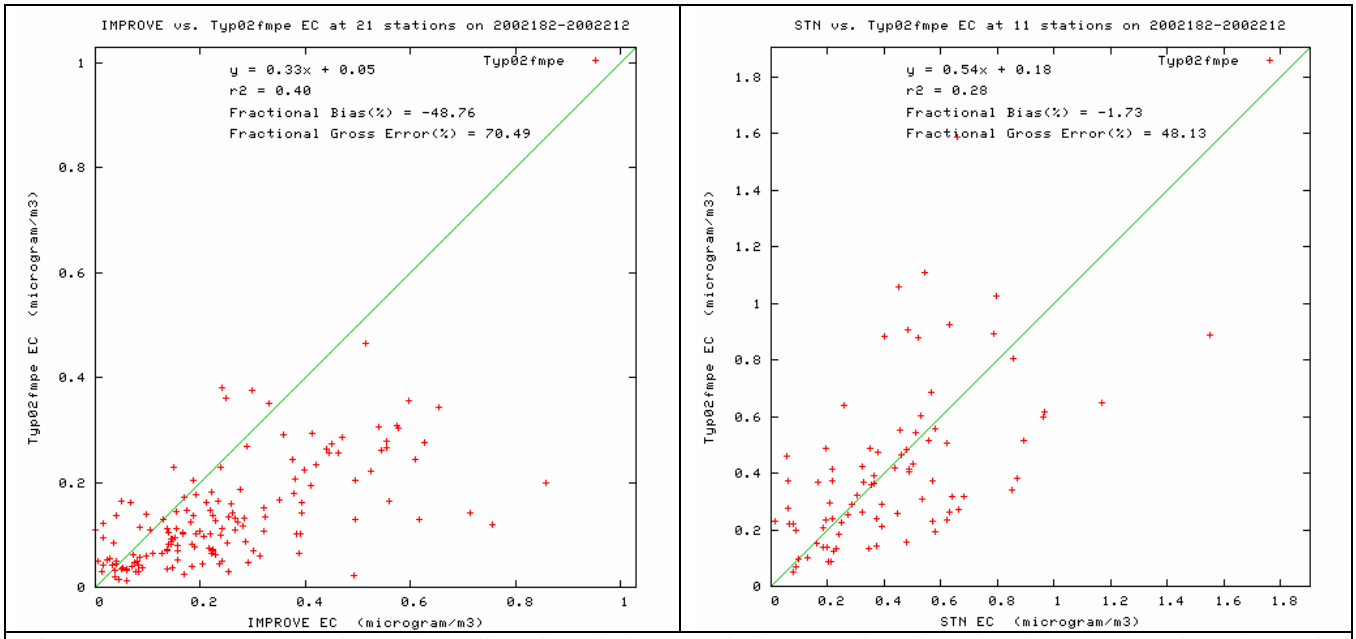
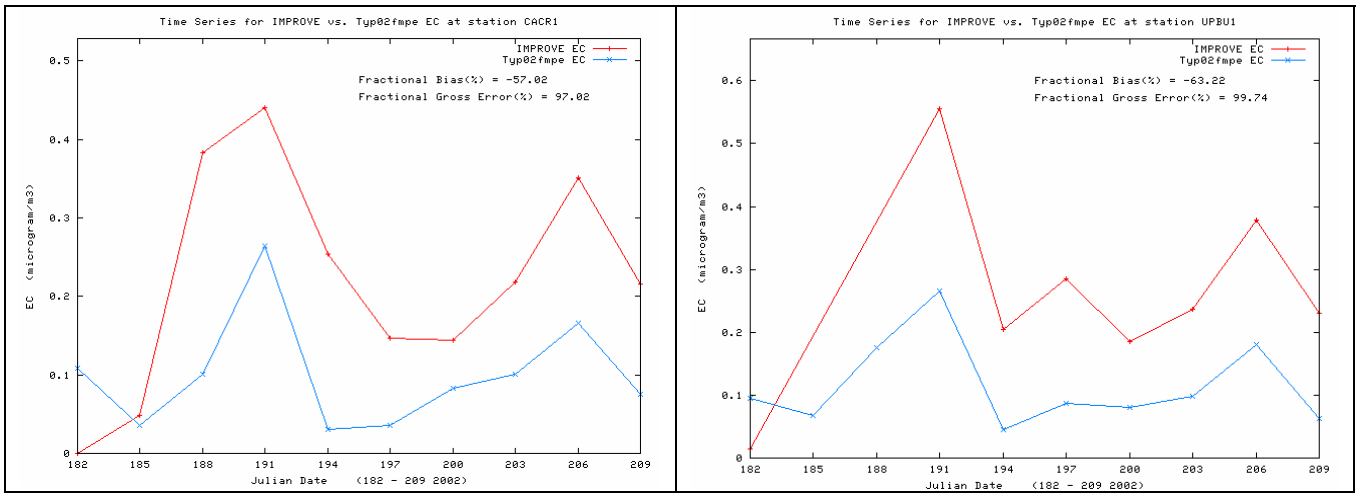
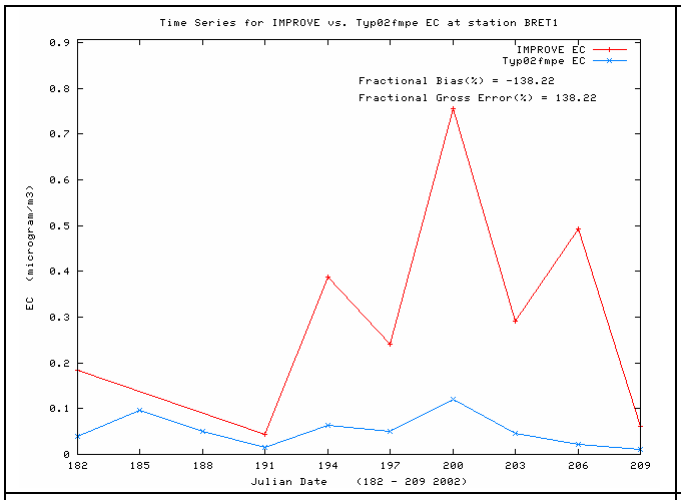
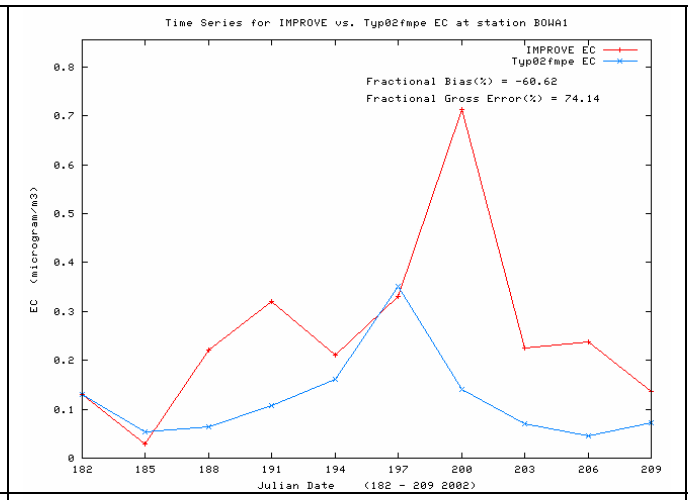
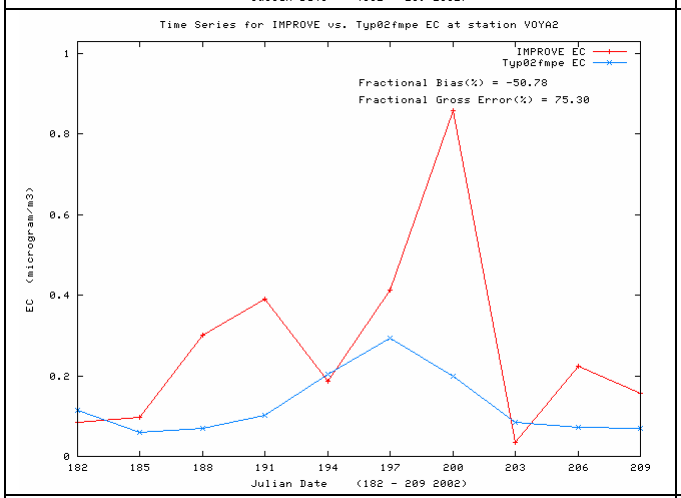


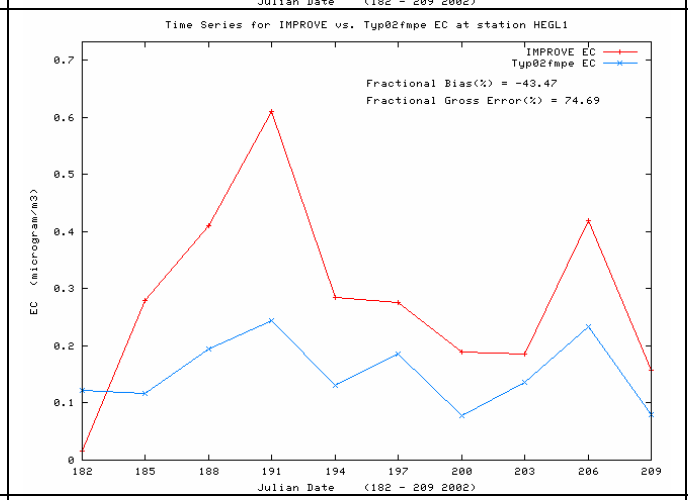
Figure C-24a. Scatter plots of predicted and observed elemental carbon (EC) concentrations for July 2002 and sites in the CENRAP region using IMPROVE (left) and STN (right) monitoring networks using the CMAQ 2002 36 km Base F base case simulation.



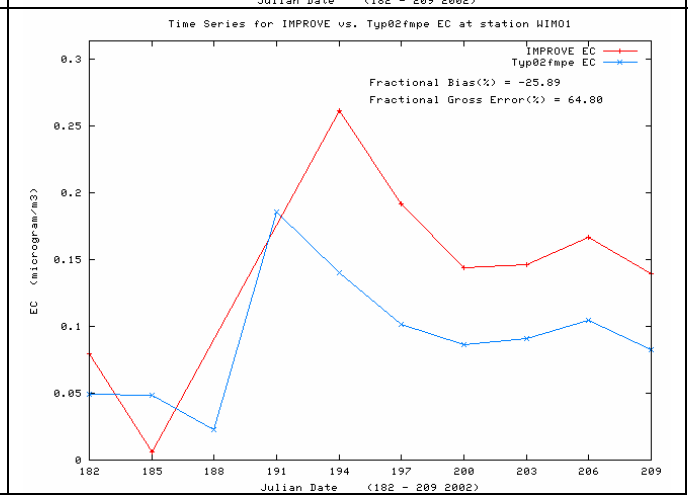


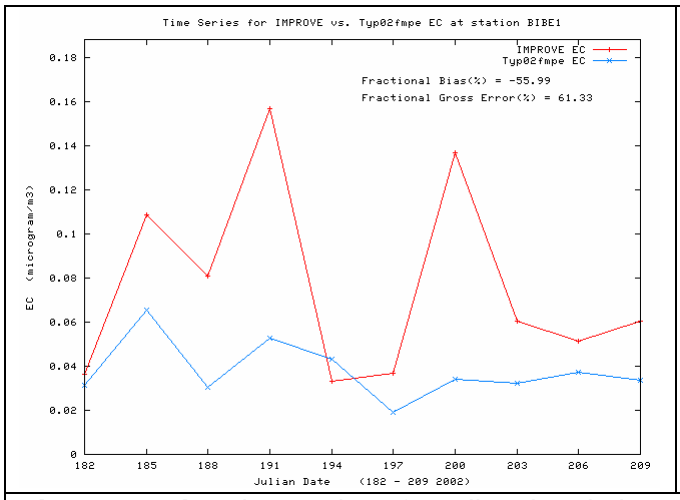






No Data for Mingo (MING)





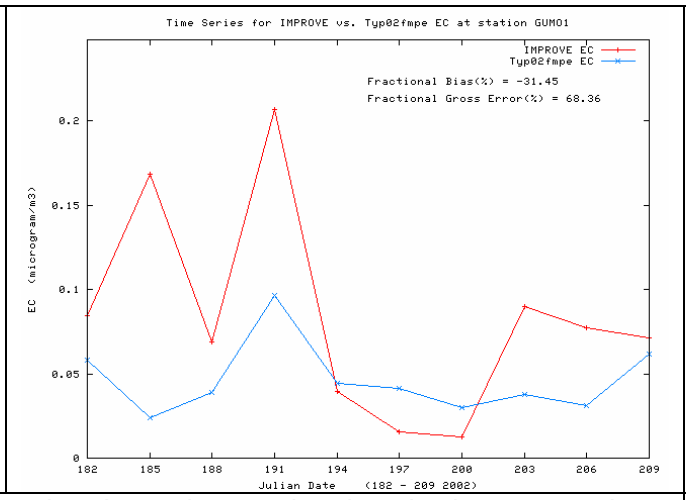


Figure C-24b. Time series of predicted and observed 24-hour elemental carbon (EC) concentrations at CENRAP IMPROVE CLASS I AREA sites in July 2002 for CMAQ 2002 36 km Base F base case simulation.

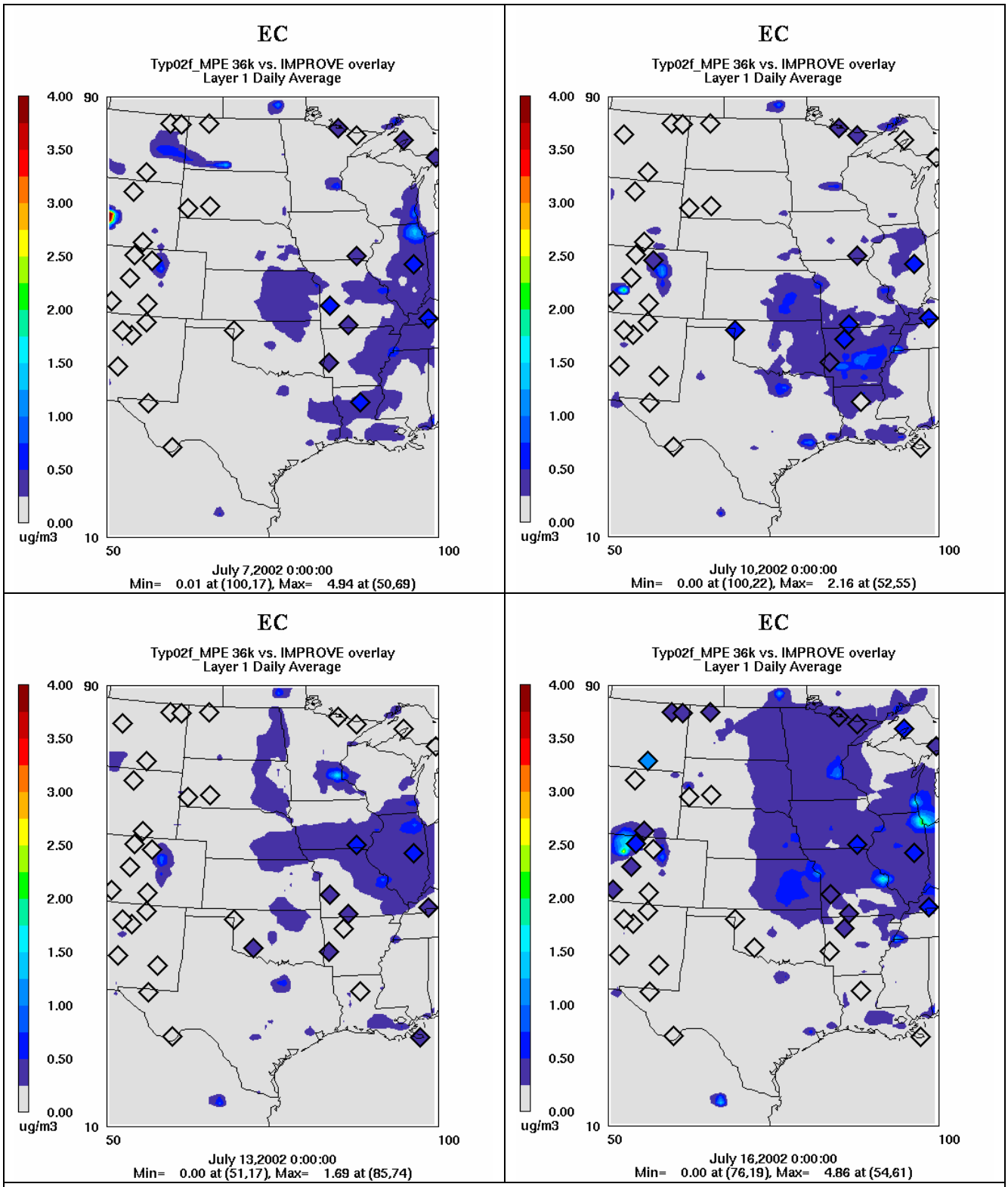


Figure C-24c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour EC concentrations for July 7, 10, 13 and 16, 2002.

C.3.4.4 EC in October 2002

EC performance is improved at the IMPROVE sites in October with lower bias (9%) than the previous months where an under-prediction tendency was seen (Figure C-25a). EC bias is also fairly low at the STN sites with errors across both networks of approximately 50%. Although there is a systematic underestimation of EC at BRET, the agreement between the predicted and observed October time series (Figure C-25b) is remarkable at several sites (e.g., CACR, UPBU, VOYA and HEGL).

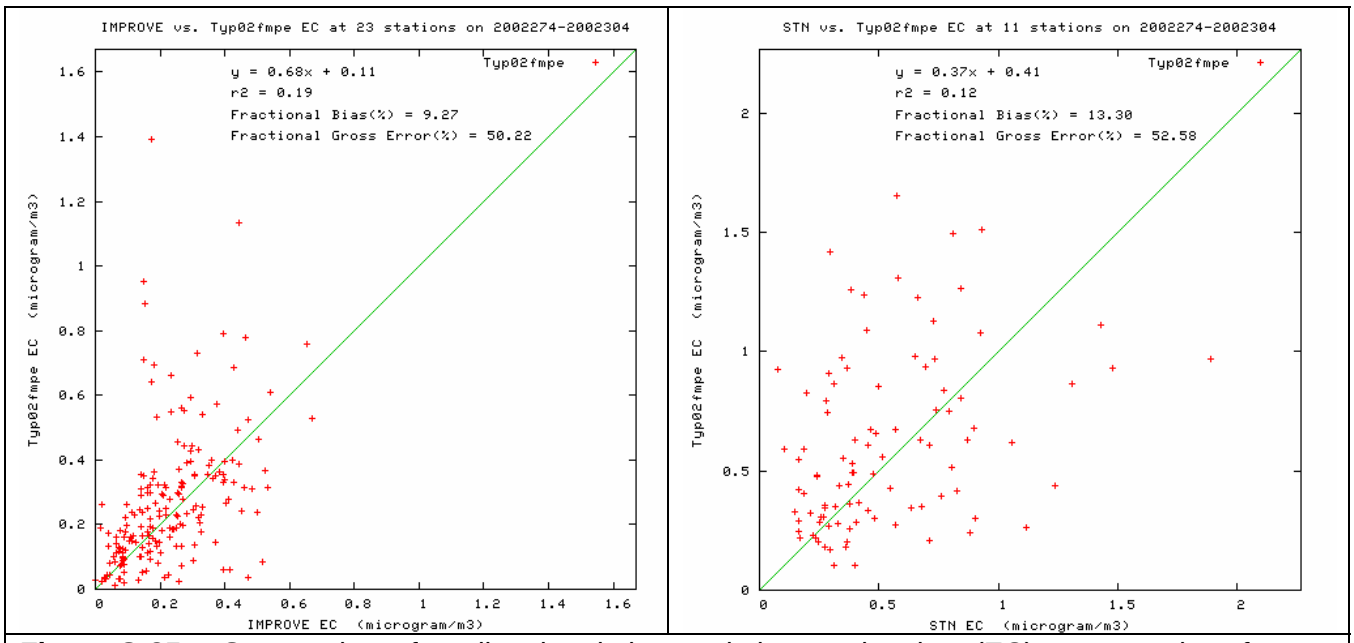
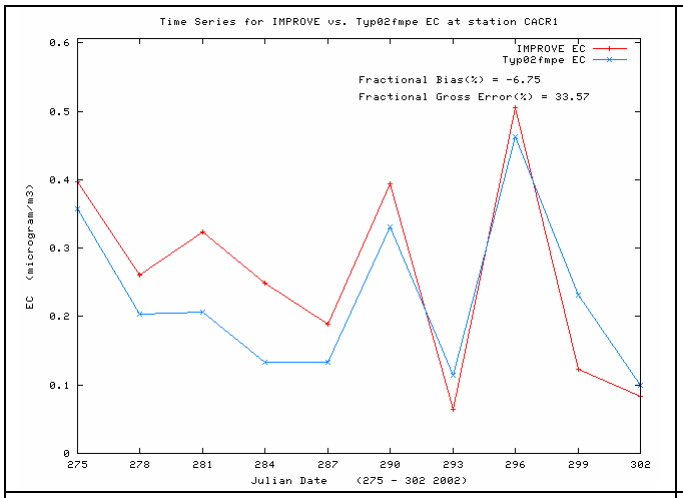
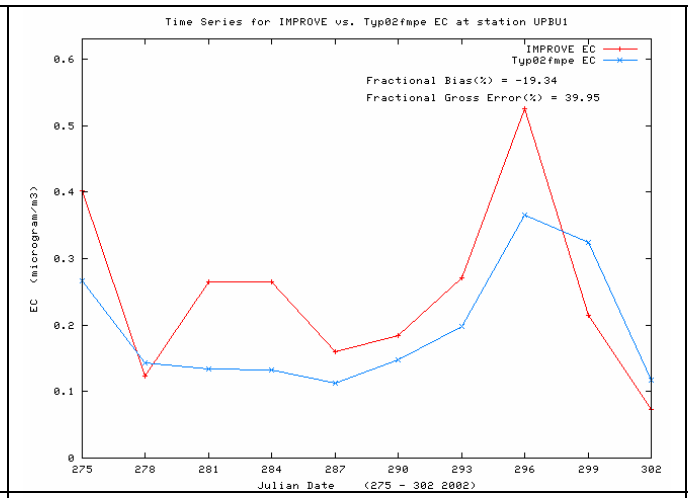
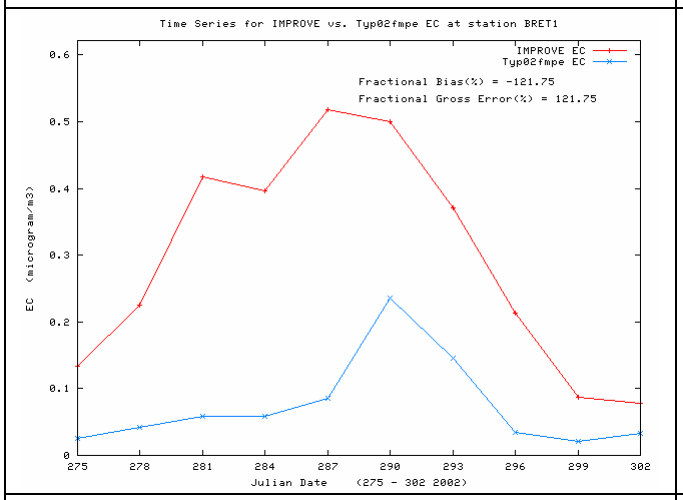
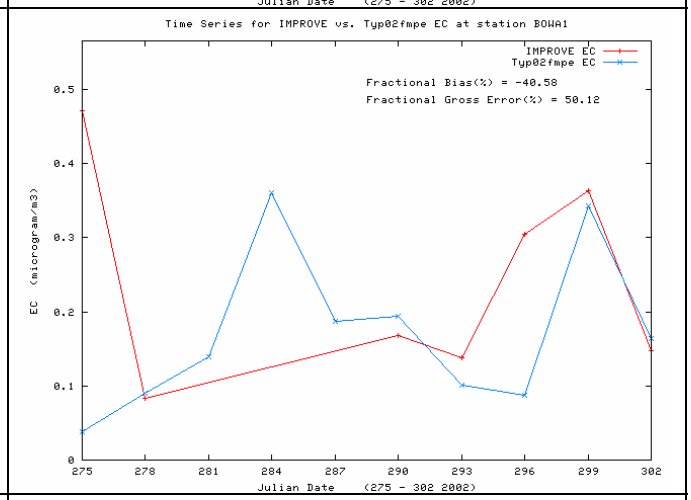


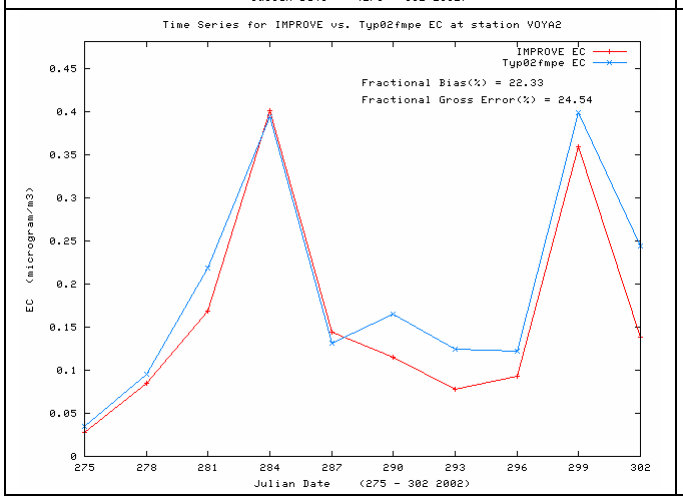
Figure C-25a. Scatter plots of predicted and observed elemental carbon (EC) concentrations for October 2002 and sites in the CENRAP region using IMPROVE (left) and STN (right) monitoring networks using the CMAQ 2002 36 km Base F base case simulation.

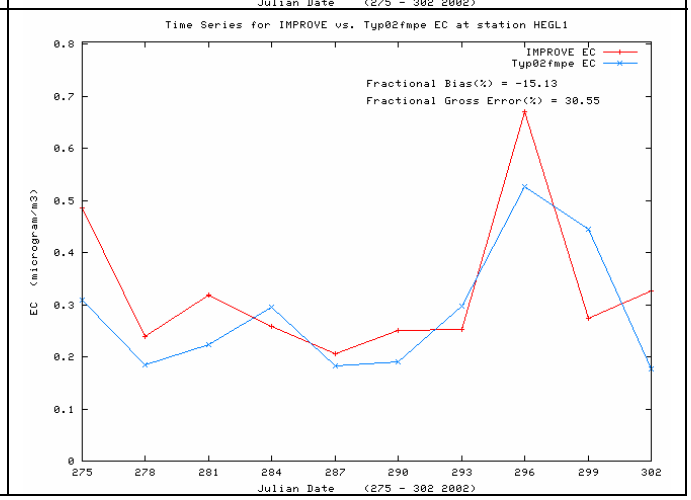

Time Series for IMPROVE vs. Typ02fmpe EC at station CACR1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -6.75
Fractional Gross Error(%) = 33.57
EC (microgram/m3)
Julian Date (275 - 302 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station UPBU1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -19.34
Fractional Gross Error(%) = 39.95
EC (microgram/m3)
Julian Date (275 - 302 2002)

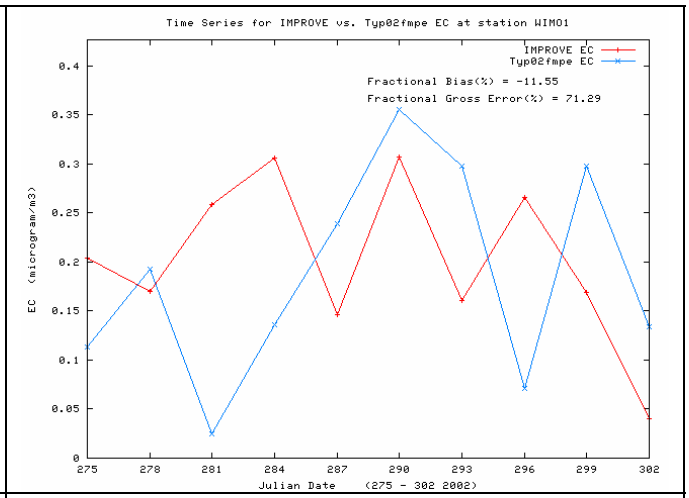

Time Series for IMPROVE vs. Typ02fmpe EC at station BRET1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -121.75
Fractional Gross Error(%) = 121.75
EC (microgram/m3)
Julian Date (275 - 302 2002)

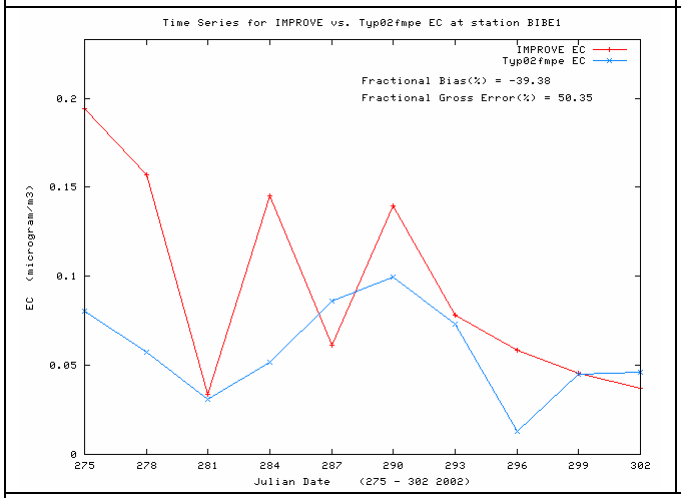

Time Series for IMPROVE vs. Typ02fmpe EC at station BOWA1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -40.58
Fractional Gross Error(%) = 50.12
EC (microgram/m3)
Julian Date (275 - 302 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station VOYA2
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = 22.33
Fractional Gross Error(%) = 24.54
EC (microgram/m3)
Julian Date (275 - 302 2002)


Time Series for IMPROVE vs. Typ02fmpe EC at station HEGL1
IMPROVE EC
Typ02fmpe EC
Fractional Bias(%) = -15.13
Fractional Gross Error(%) = 30.55
EC (microgram/m3)
Julian Date (275 - 302 2002)

No Data for Mingo (MING)





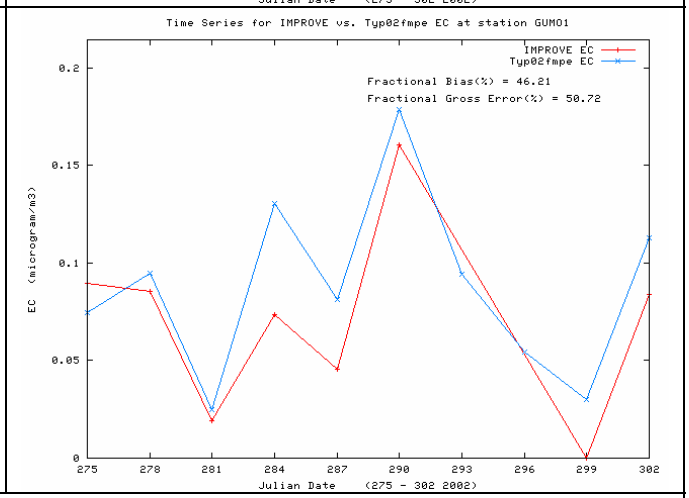


Figure C-25b. Time series of predicted and observed 24-hour elemental carbon (EC) concentrations at CENRAP IMPROVE CLASS I AREA sites in October 2002 for CMAQ 2002 36 km Base F base case simulation.

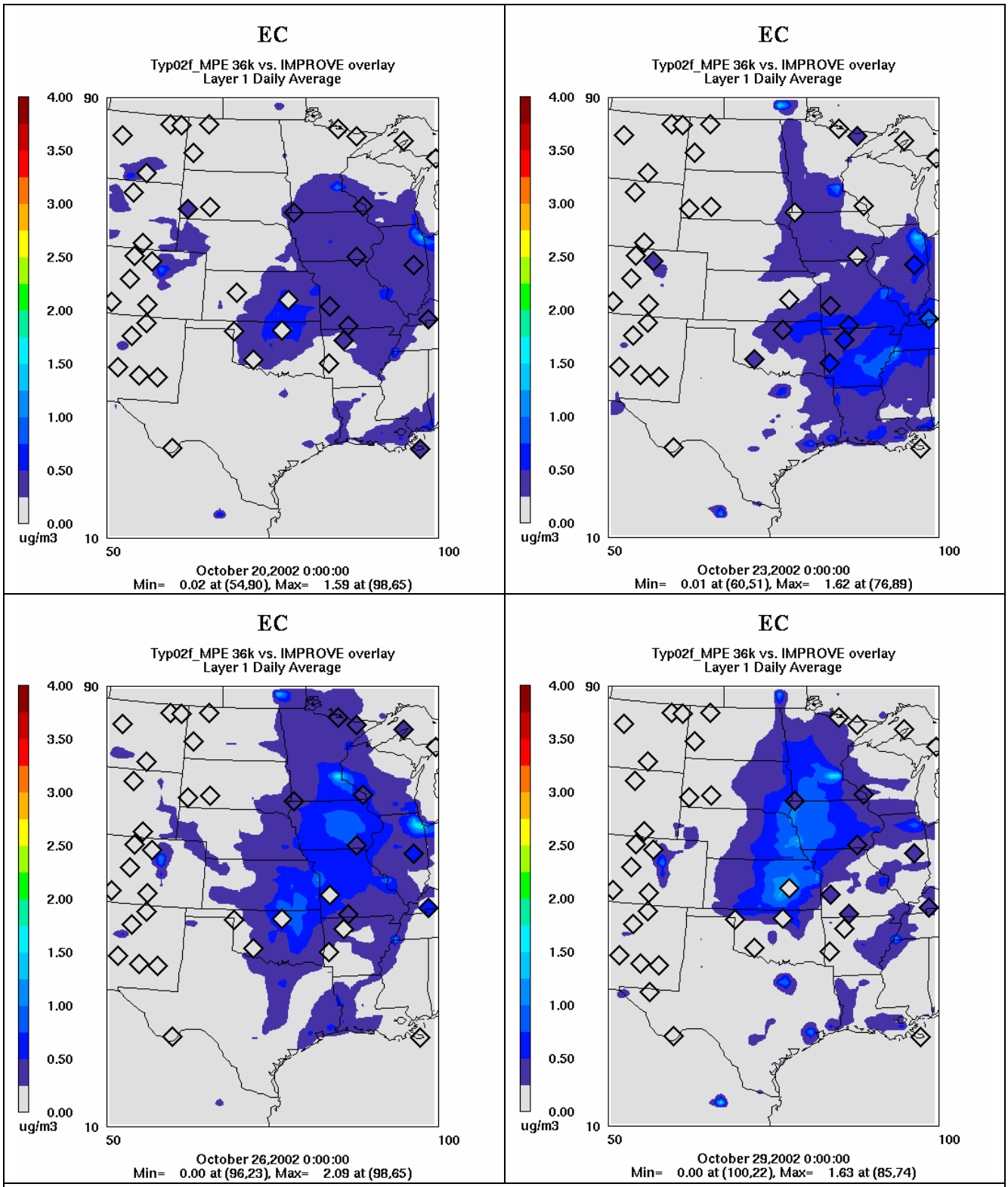


Figure C-25c. Spatial plot comparisons of the predicted and IMPROVE observed 24-hour EC concentrations for October 20, 23, 26 and 29, 2002.