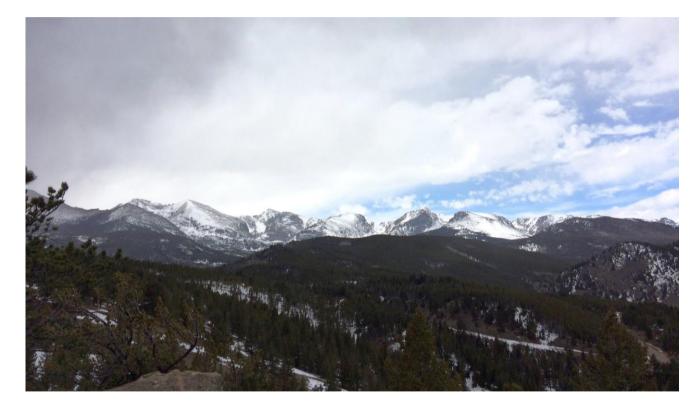
Western Regional Modeling and Analysis Platform

2014 Model Performance

Evaluation

Ralph Morris, Pradeepa Vennam, Tejas Shah Marco Rodriguez, Chao-Jung Chien

Ramboll





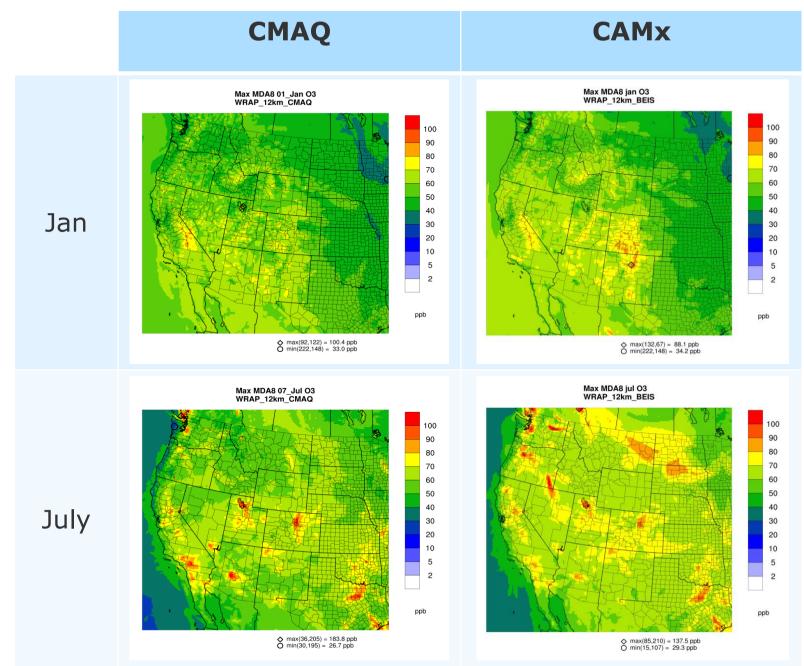
Annual Simulations Configuration

	CAMx	CMAQ
Version	v.6.50	v.5.2.1
Meteorology	WAQS	
Horizontal Domain	12WUS2	
BCON	No eruptions GEOS-Chem for June and July	
Biogenic Emissions	BEIS	
Windblown Dust	Offline-CAMx windblown dust	
Lighting Emissions	Offline-CAMx LNOx pre- processor	In-line
Sea Salt Emissions	Offline-CAMx oceanic pre- processor. Includes DMS as SO2	In-line
Chemical Mechanism	CB6r4 with SOAP + ISORROPIA	CB6r3 with AE6 + ISORROPIA (CB6r3_AE6_AQ)



Ozone: Model Inter-comparison

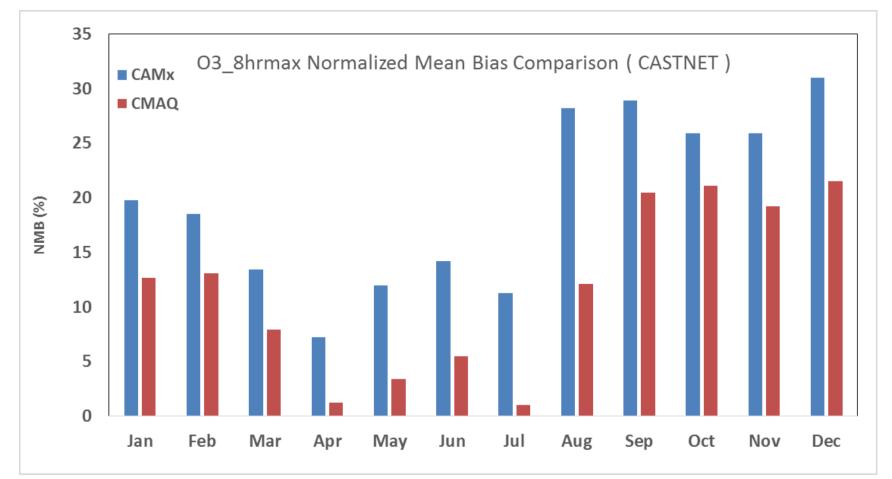
- Maximum daily 8-hr average ozone concentrations
- CAMx generally looks to have higher concentrations



RAMBOLL

Ozone Monthly Domain Wide Statistics

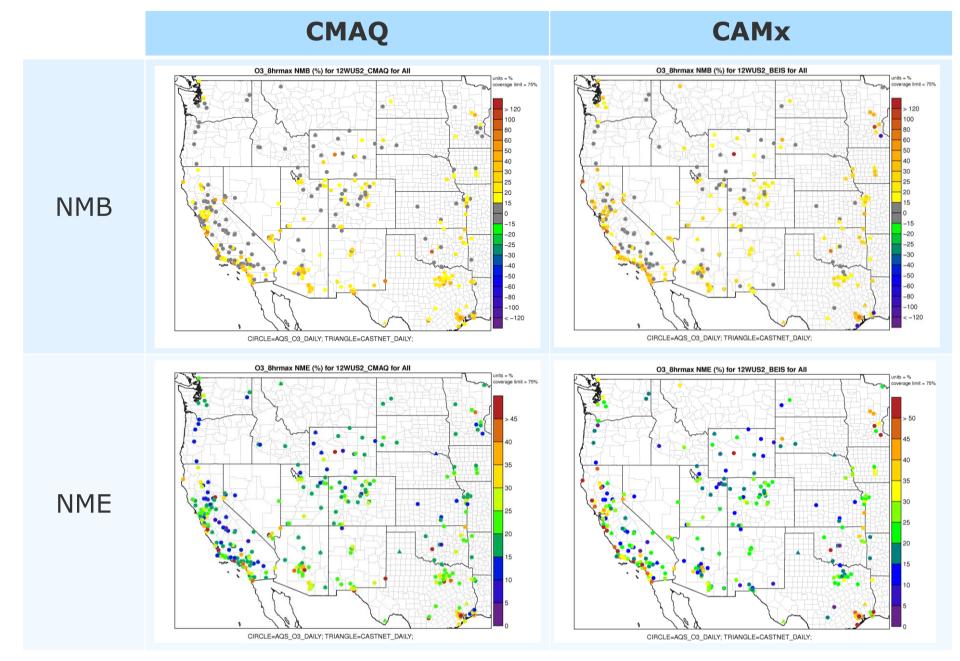
- Both models overpredict ozone concentrations through the year due in part to overstated GEOS-Chem ozone BCs3
- CMAQ has lower biases than CAMx





Ozone (8hr_DMAX): Bias/Error Overlay (Annual)

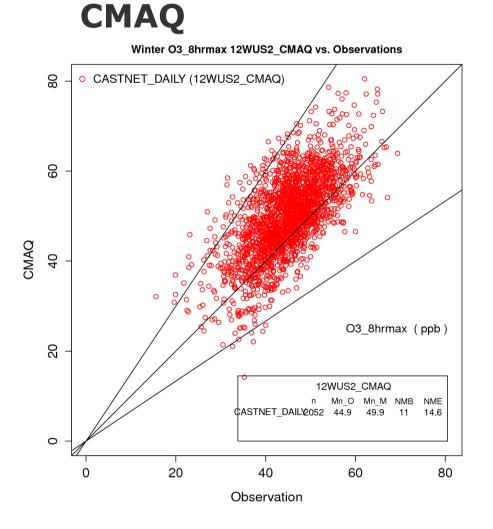
- Similar Bias and Error spatially
- CMAQ tends to have slightly better performance in UT, WY, CO, CA



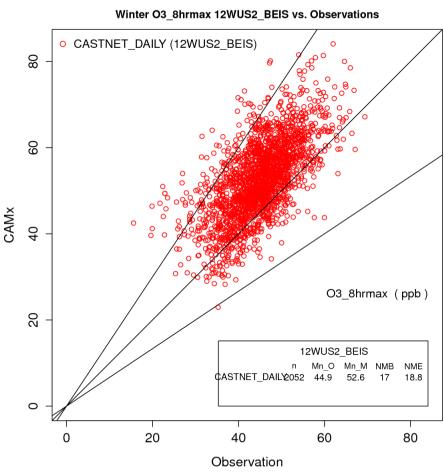


Ozone (8hr_DMAX) Scatter plots (CASTNET): Winter

CAMx
 overpredictions in
 Winter more
 pronounced than
 CMAQ



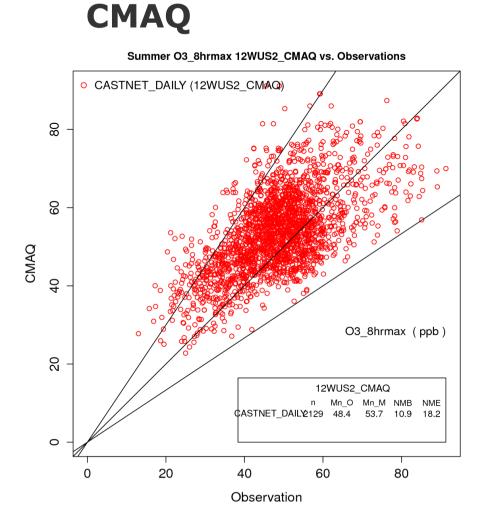
CAMx





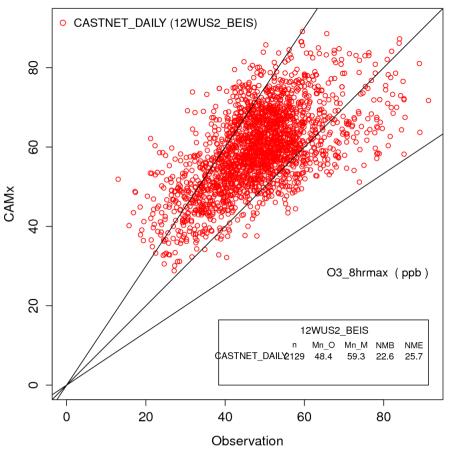
Ozone (8hr_DMAX) Scatter plots (CASTNET): Summer

CAMx
 overpredictions in
 Summer more
 pronounced than
 CMAQ



CAMx

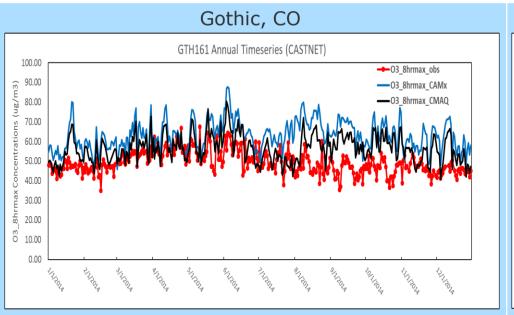


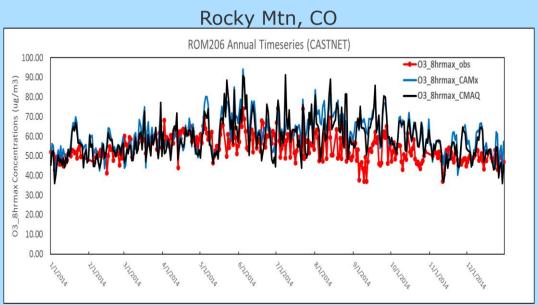


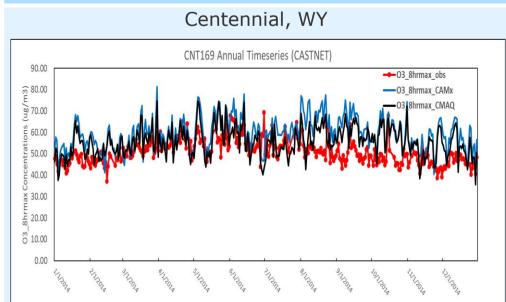


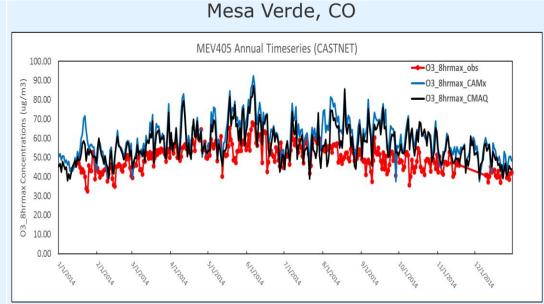
Ozone Timeseries: High Altitude Sites

overpredictions obvious in Gothic. Less so in other sites









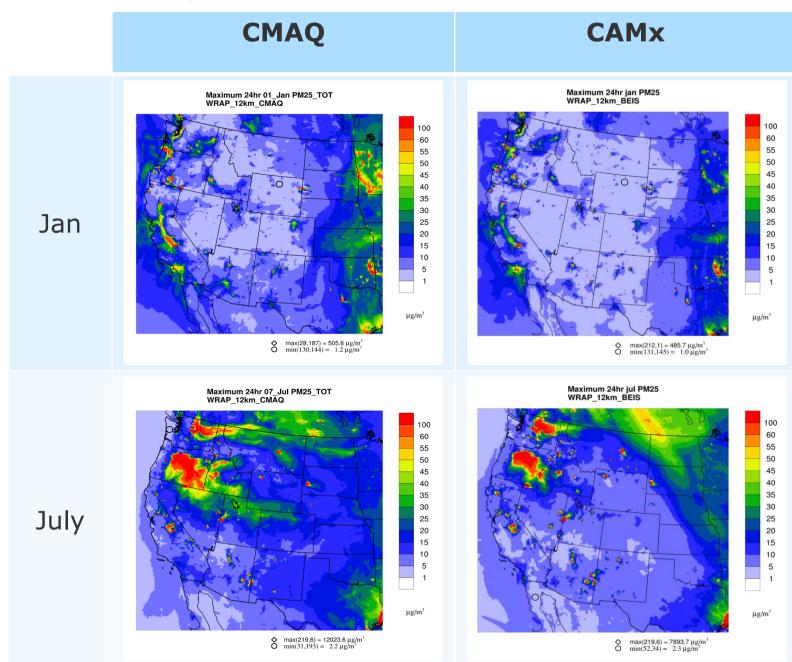


PM 2.5



PM2.5: Model Inter-comparison

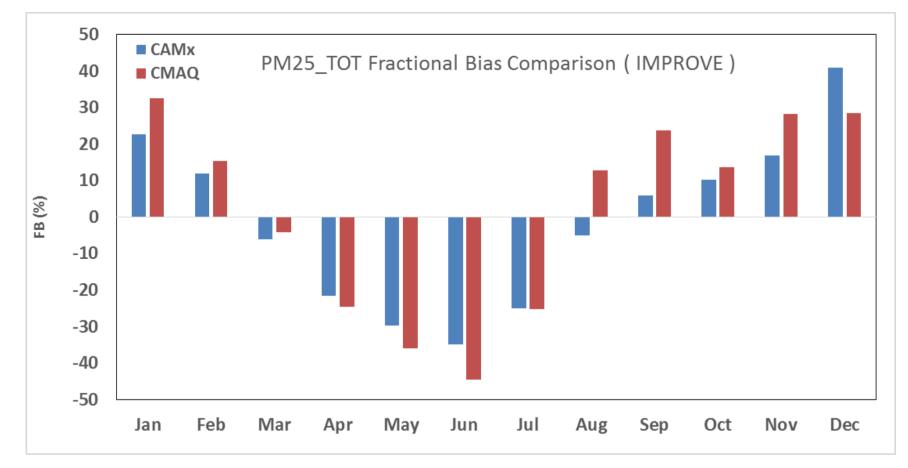
- Maximum daily 24-hr PM2.5 concentrations
- CAMx generally shows lower concentrations compared to CMAQ
- July fires dominate PM2.53



RAMBOLL

PM2.5 Monthly Domain Wide Statistics

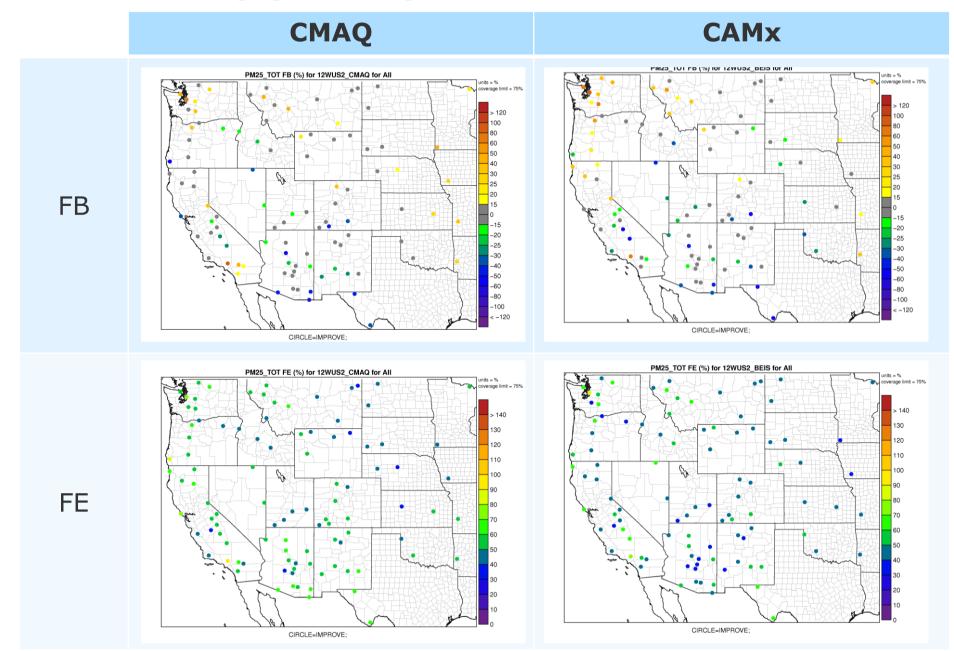
- Both models overpredict PM2.5 in Winter and Fall
- Both models underpredict PM2.5 in Spring and Summer
- CAMx generally has lower biases than CMAQ





PM25 Bias/Error Overlay (Annual)

 Similar Bias and Error spatially for both models

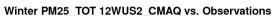


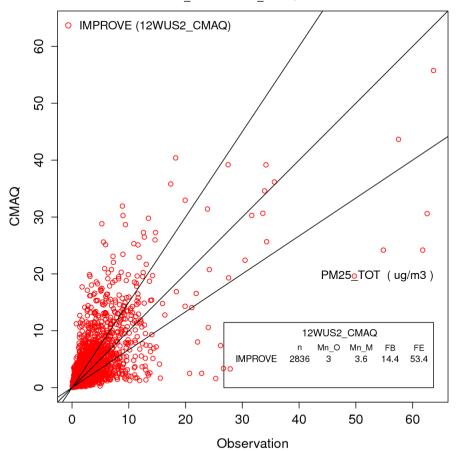
RAMBOLL

PM25 Scatter plots (IMPROVE): Winter

No model is obviously better

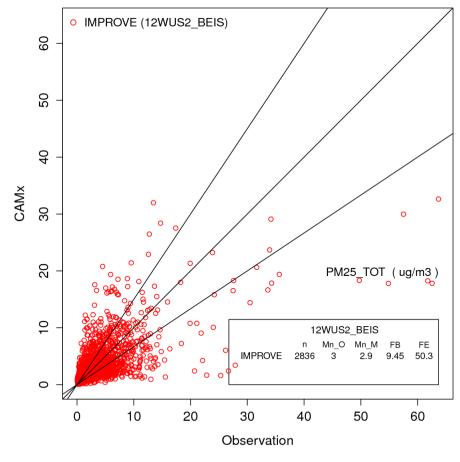
CMAQ





CAMx

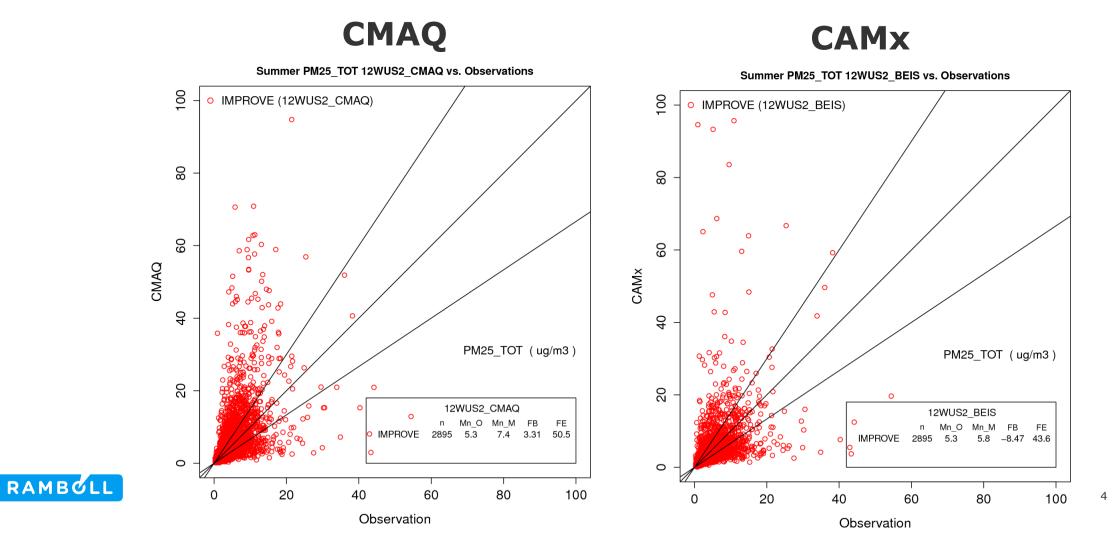




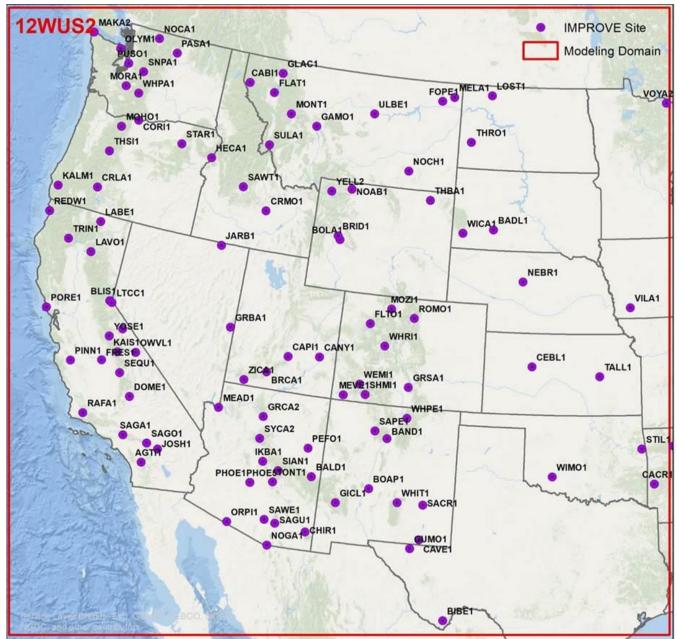


PM25 Scatter plots (IMPROVE): Summer

- No obvious model is better. Not plotting outliers over 600 μg/m³
- CMAQ overpredictions for obs ~ 10 μg/m³



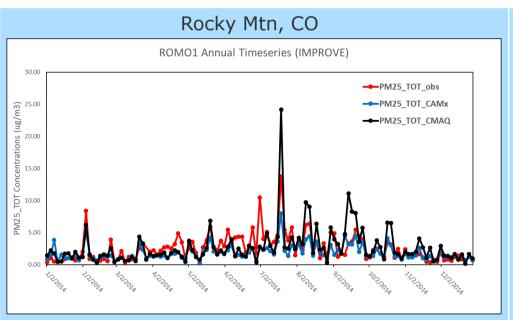
IMPROVE Sites in 12WUS2 Domain

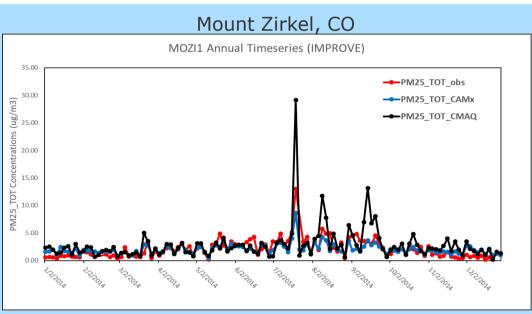


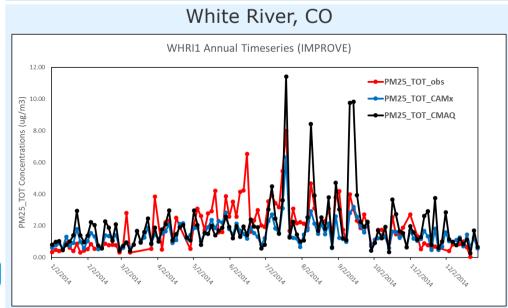


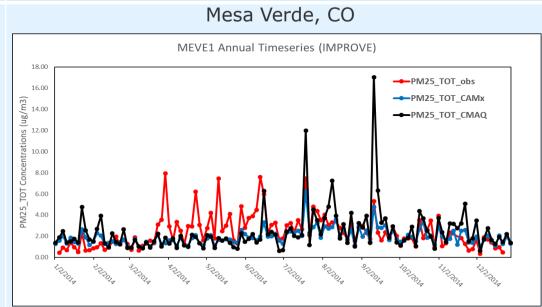
PM2.5 Timeseries: High Altitude Sites

- CMAQ overpredictions at certain days
- Observed
- CAMX
- CMAQ









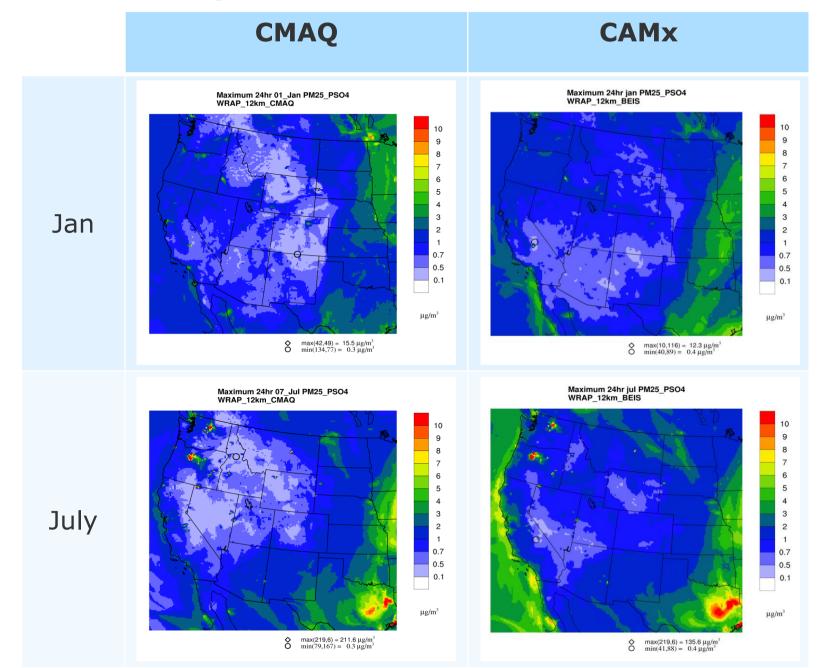


Sulfate



Sulfate: Model Inter-comparison

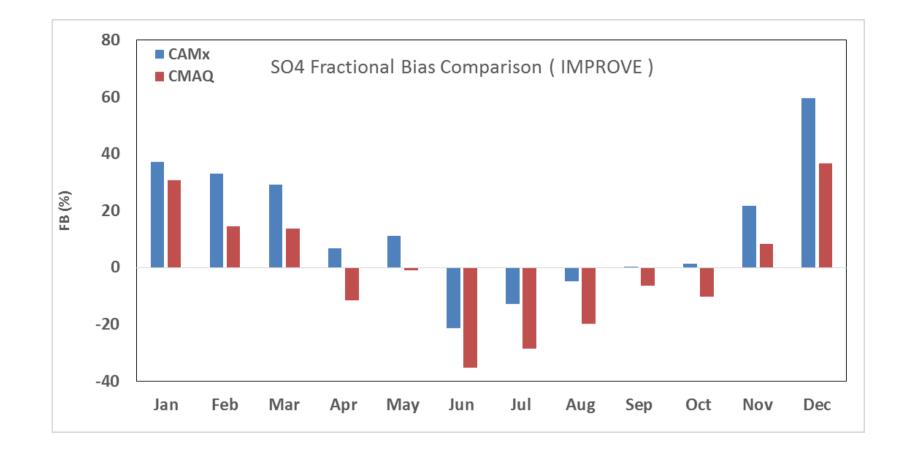
- Maximum daily 24-hr PM2.5 concentrations
- CAMx generally shows higher concentrations compared to CMAQ
- Coastal sulfate in CAMx might be the result of sea salt and/or DMS emissions



RAMBOLL

SO4 Monthly Stats Comparisons

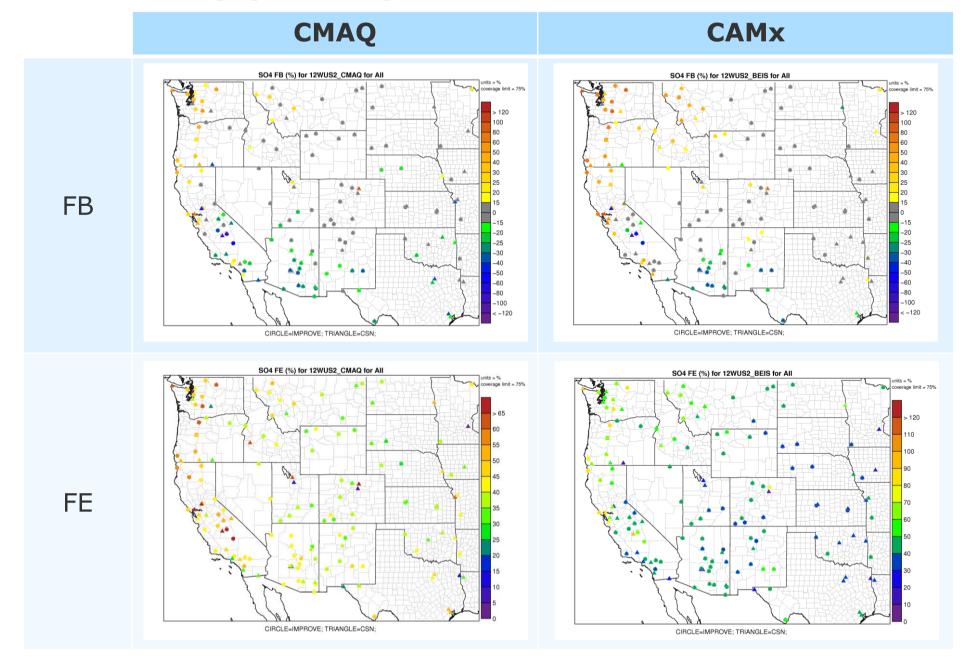
- Both models overpredict sulfate in Winter-early Spring and late Fall
- CMAQ has lower biases during the overprediction periods
- CAMx has lower biases during underprediction periods (mostly Summer)





SO4 Bias/Error Overlay (Annual)

 Similar Bias and Error spatially for both models



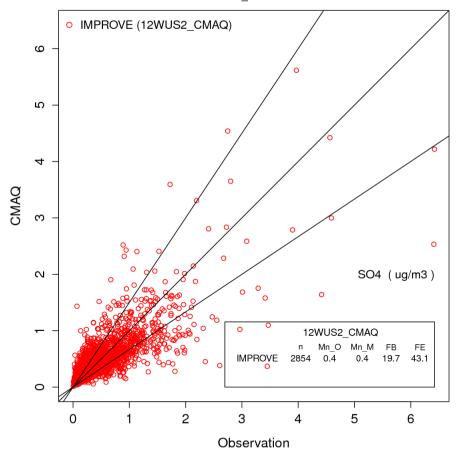


SO4 Scatter plots (IMPROVE): Winter

 No obvious model is better

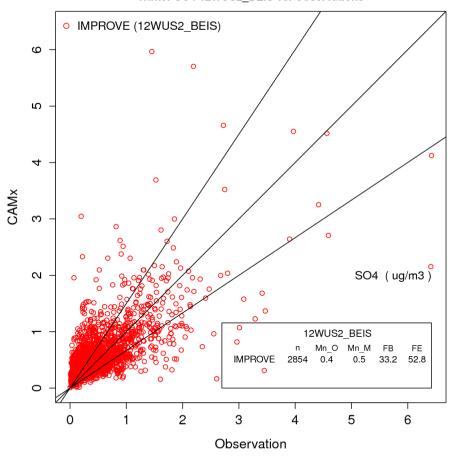






CAMx

Winter SO4 12WUS2 BEIS vs. Observations



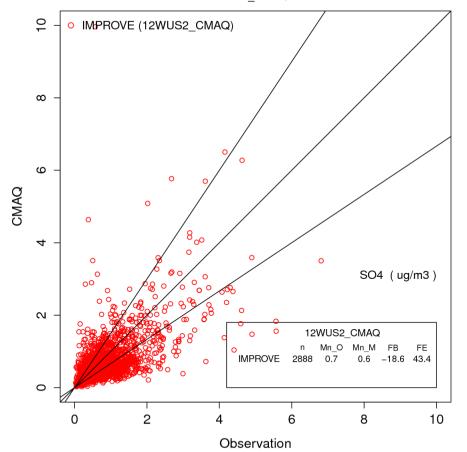


SO4 Scatter plots (IMPROVE): Summer

 No obvious model is better

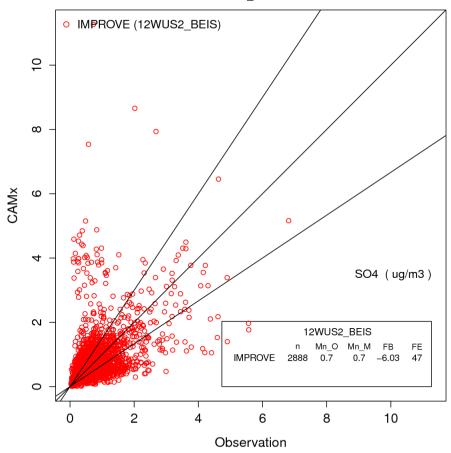
CMAQ

Summer SO4 12WUS2 CMAQ vs. Observations



CAMx

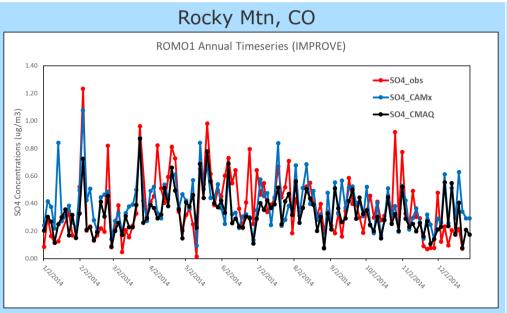
Summer SO4 12WUS2 BEIS vs. Observations

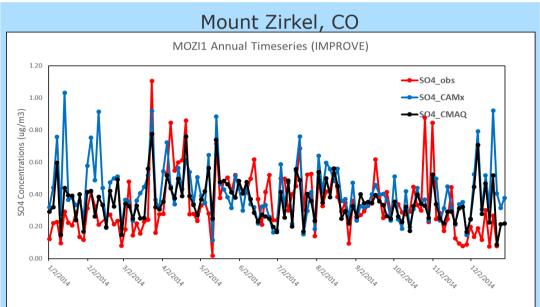


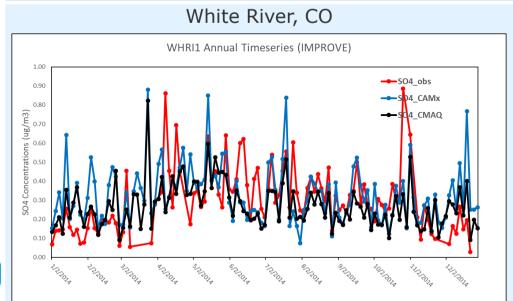


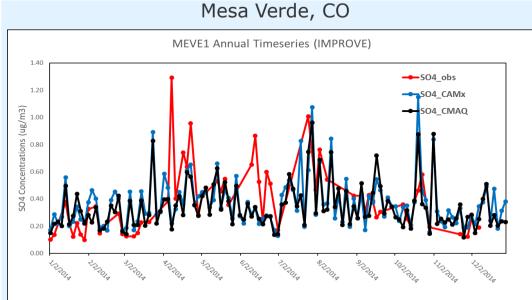
Sulfate Timeseries: High Altitude Sites

Models
 performs
 similar at these
 sites







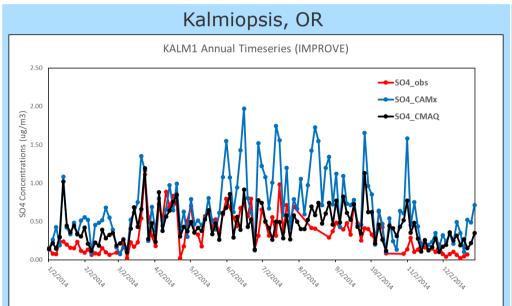


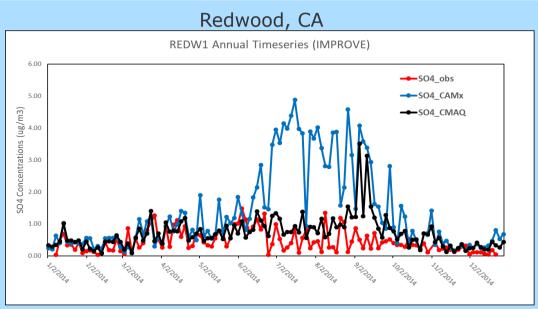


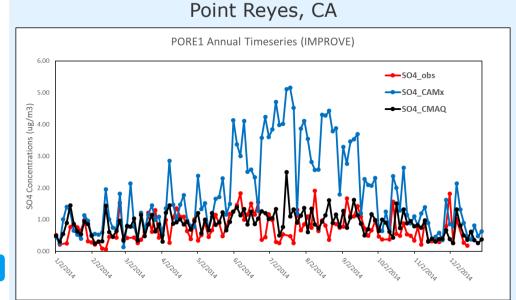
Sulfate Timeseries: Pacific Coast Sites

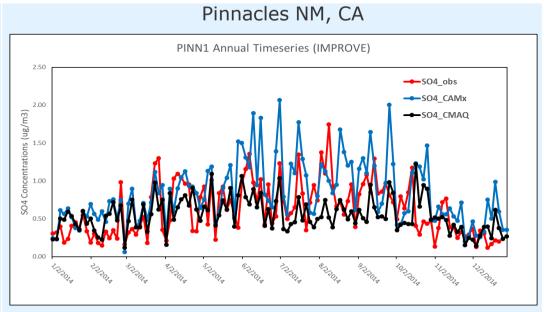
- CAMx shows
 high sulfate
 from June to
 October at
 coastal sites,
 but not CMAQ
- Once inland effect diminishes rapidly (Pinnacles)
- Difference might be due to CAMx sea salt and/or DMS emissions











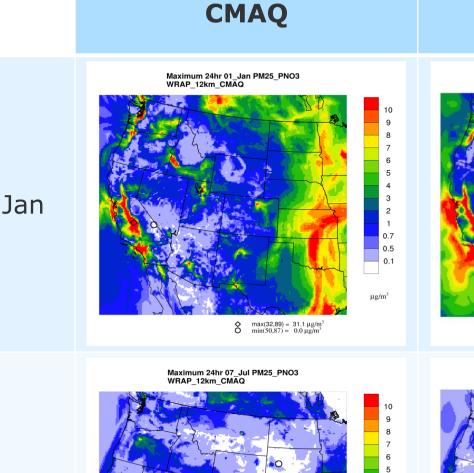
Nitrate



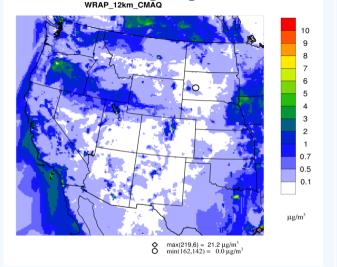
Nitrate: Model Inter-comparison

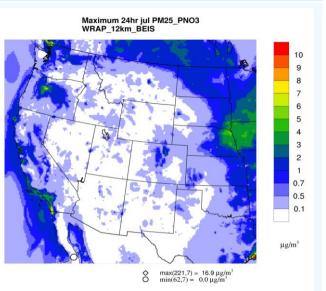
July

- Maximum daily 24-hr PM2.5 concentrations
- CAMx generally shows lower concentrations compared to CMAQ in Midwest
- Comparable in the four corners region
- CAMx higher over the Pacific (sea salt emissions)



RAMBOLL





0.1

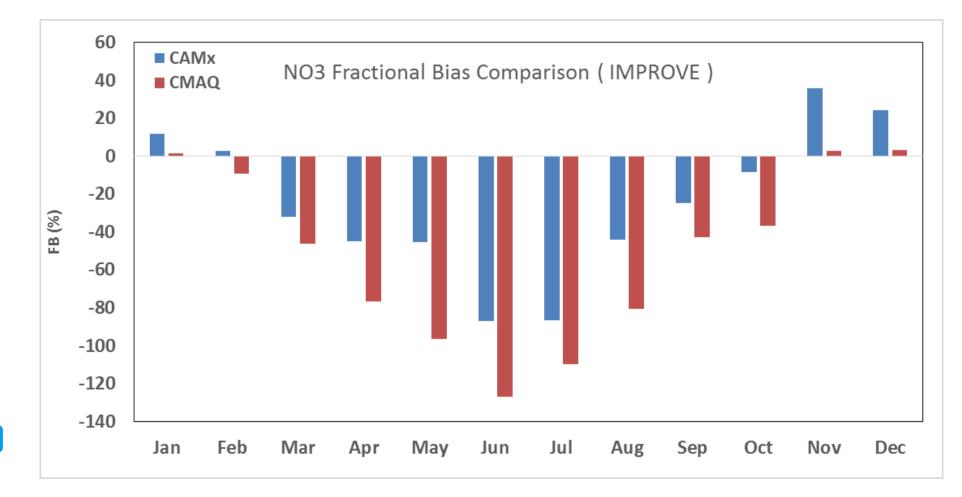
μg/m³

CAMx

Maximum 24hr jan PM25_PNO3 WRAP_12km_BEIS

NO3 Monthly Stats Comparisons

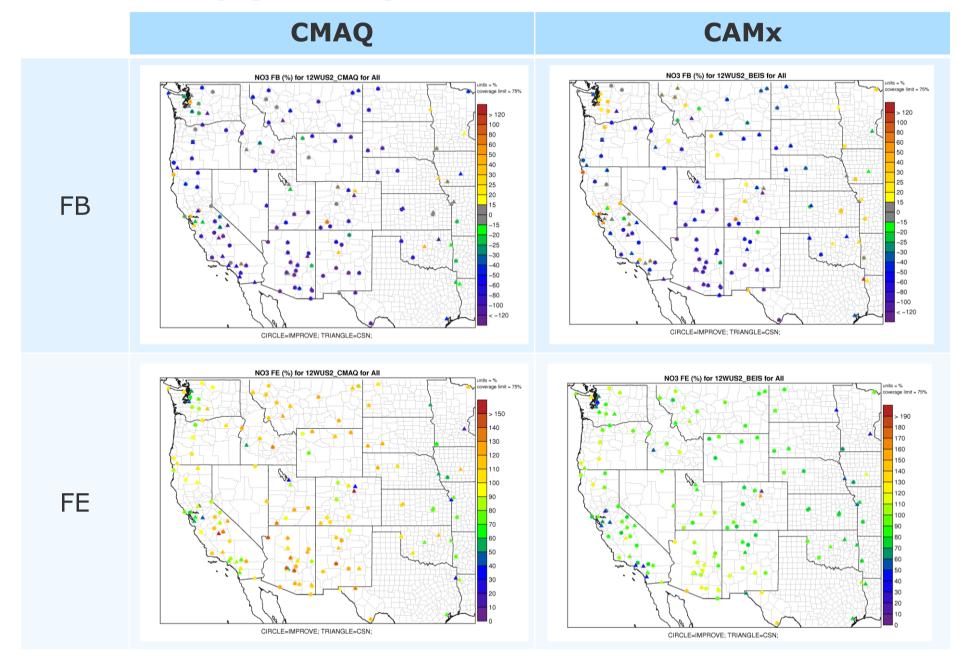
- Both models overpredict nitrate in Winter. Both underpredict rest of the year
- Biases smaller for CMAQ in the winter
- CAMx has lower biases during underprediction periods





NO3 Bias/Error Overlay (Annual)

 Similar Bias and Error spatially for both models



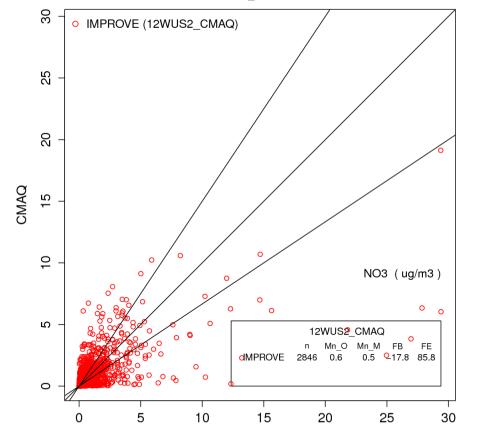


NO3 Scatter plots (IMPROVE): Winter

No model is obviously better

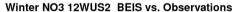


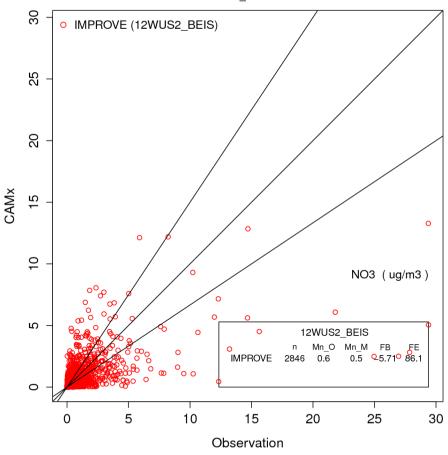




Observation

CAMx







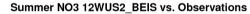
NO3 Scatter plots (IMPROVE): Summer

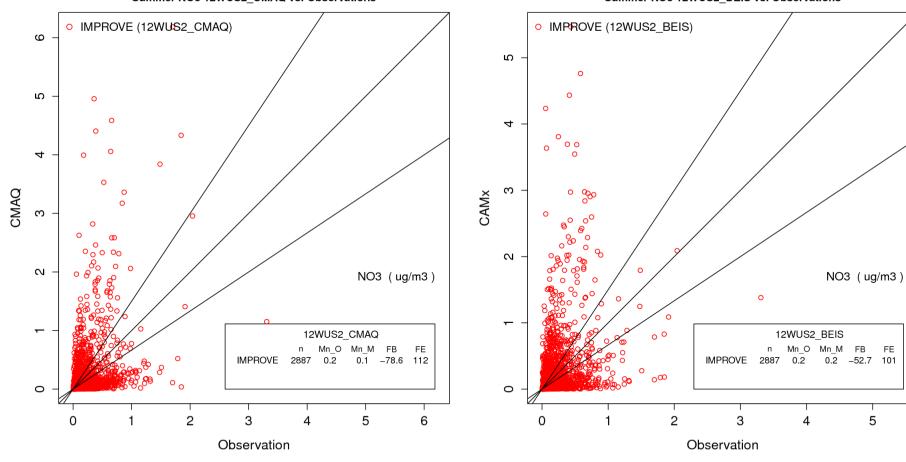
No model is obviously better



CAMx



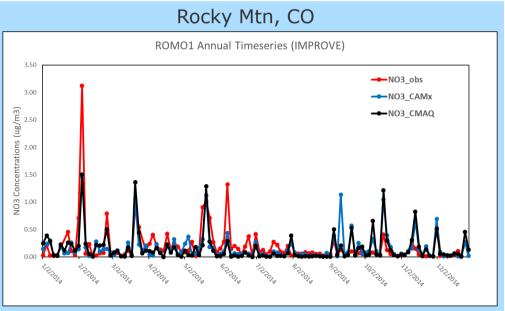


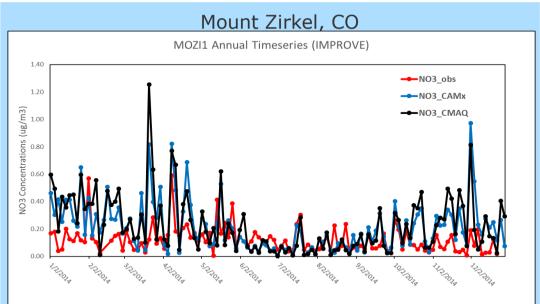


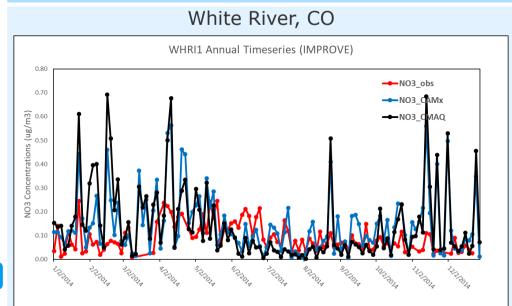


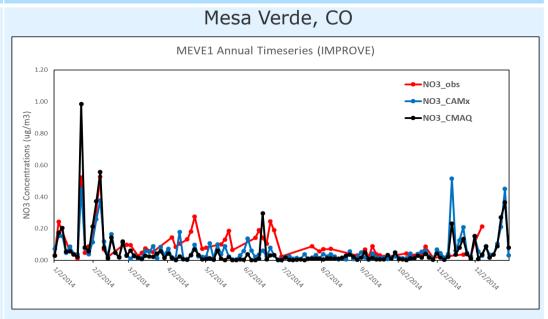
Nitrate Timeseries: High Altitude Sites

Models performs similar at these sites









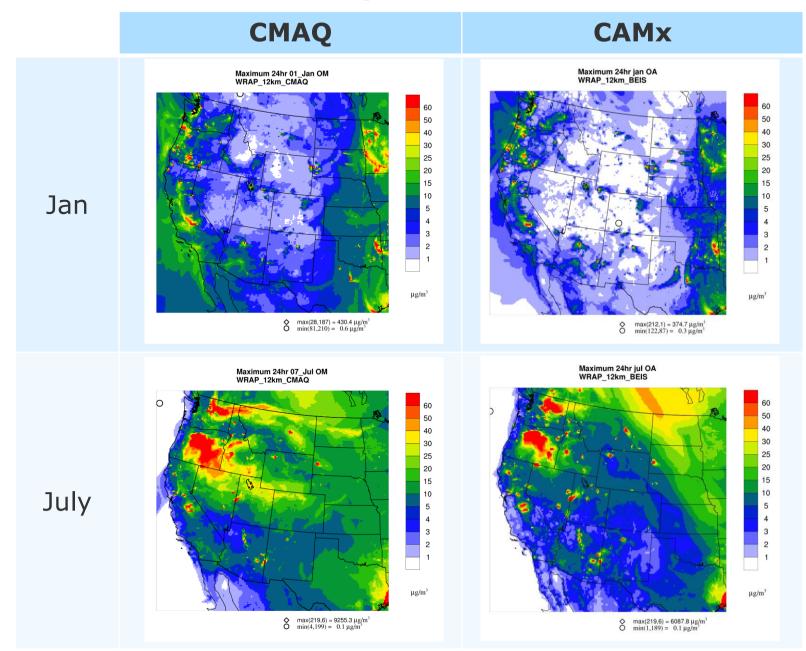


Organic Aerosol



Organic Aerosol: Model Inter-comparison

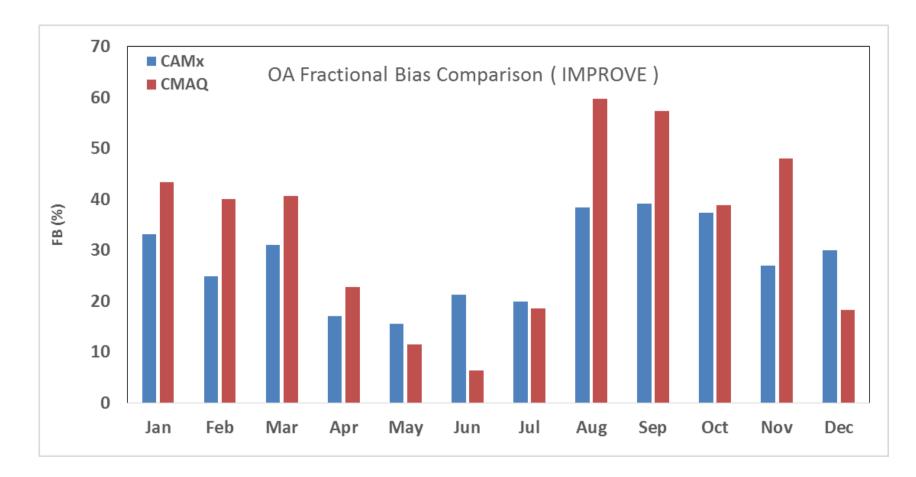
- Maximum daily 24-hr PM2.5 concentrations
- CAMx generally shows lower concentrations compared to CMAQ





OA Monthly Stats Comparisons

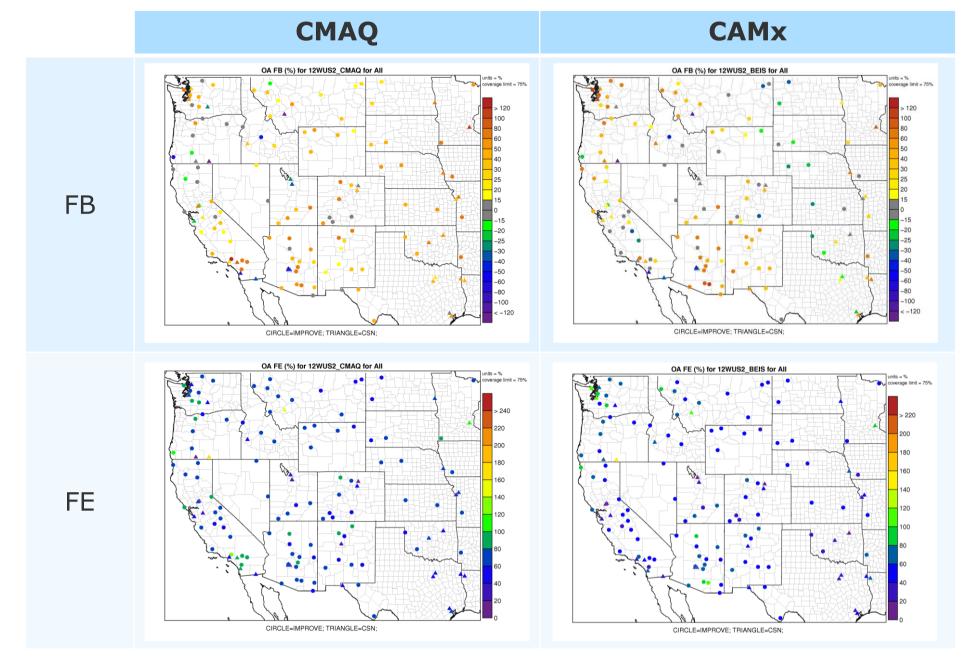
- Both models overpredict OA through the year potentially overstated BEOS TERP/SESQ emissions?3
- Biases smaller for CAMx generally lower than CMAQ





OA Bias/Error Overlay (Annual)

 Similar Bias and Error spatially for both models



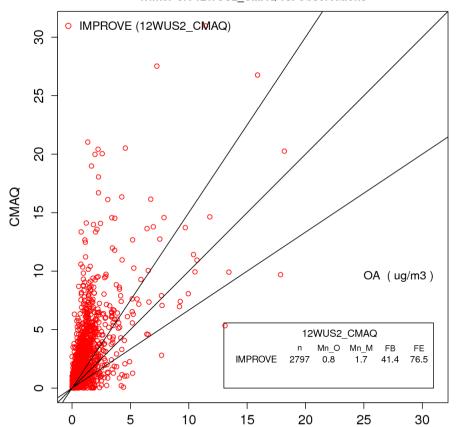


OA Scatter plots (IMPROVE): Winter

CMAQ shows clear overpredictions

CMAQ

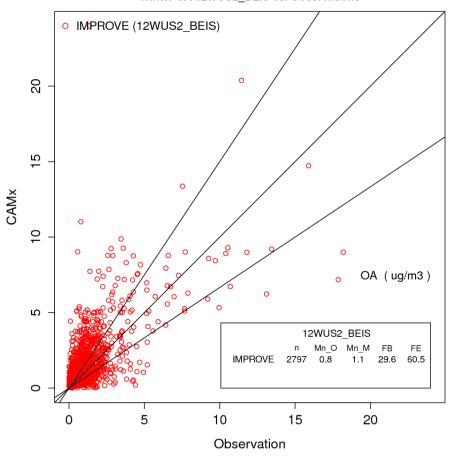
Winter OA 12WUS2 CMAQ vs. Observations



Observation

CAMx

Winter OA 12WUS2 BEIS vs. Observations



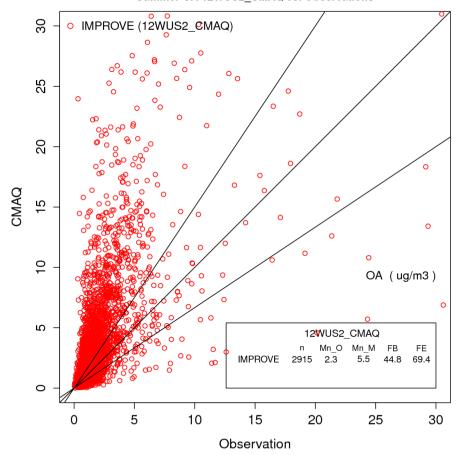


OA Scatter plots (IMPROVE): Summer

CMAQ shows clear overpredictions

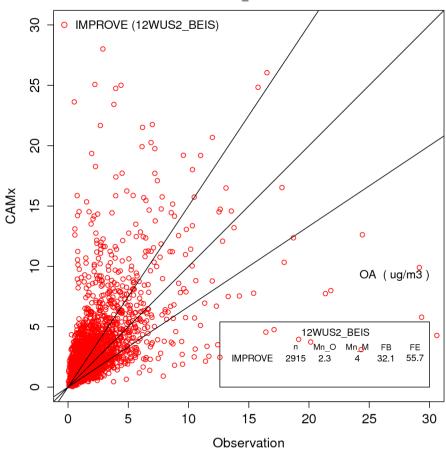
CMAQ

Summer OA 12WUS2 CMAQ vs. Observations



CAMx

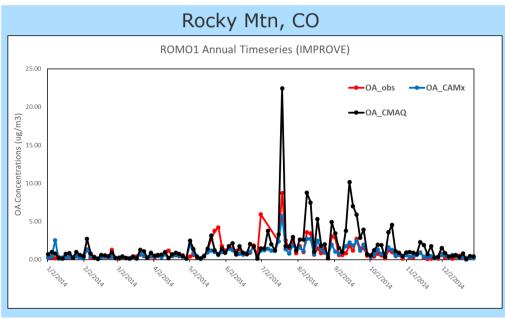
Summer OA 12WUS2 BEIS vs. Observations

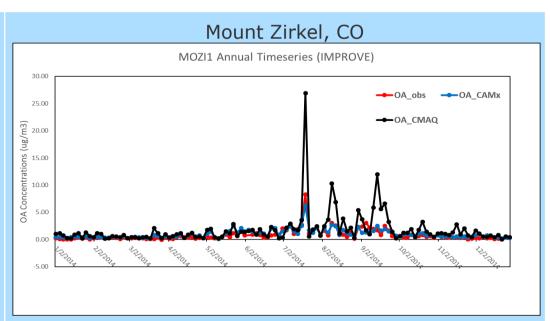


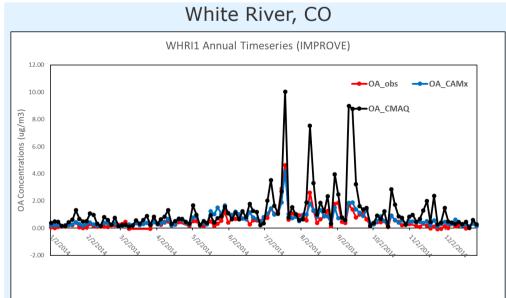


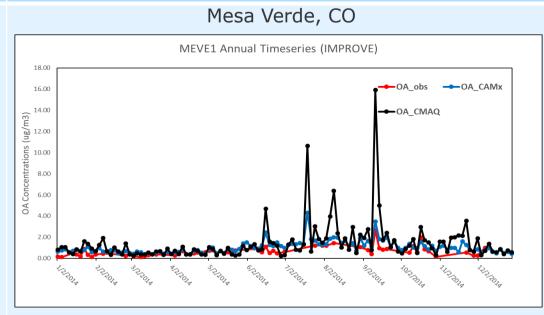
OA Timeseries: High Altitude Sites

Models
 performs
 similar at these
 sites except
 CMAQ `sudden'
 spikes









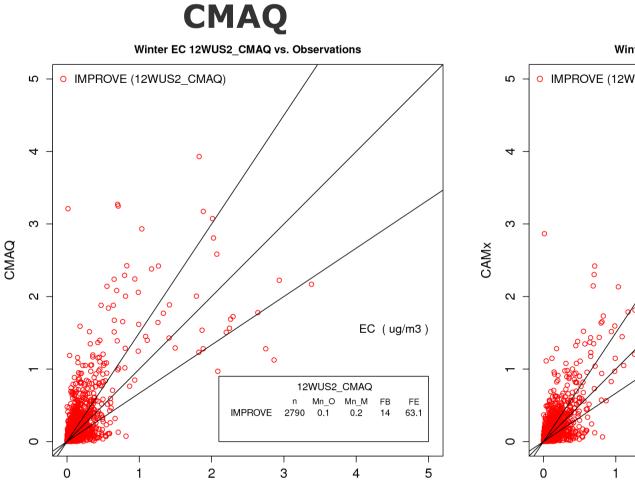


Elemental Carbon and Coarse Mass



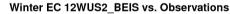
EC Scatter plots (IMPROVE): Winter

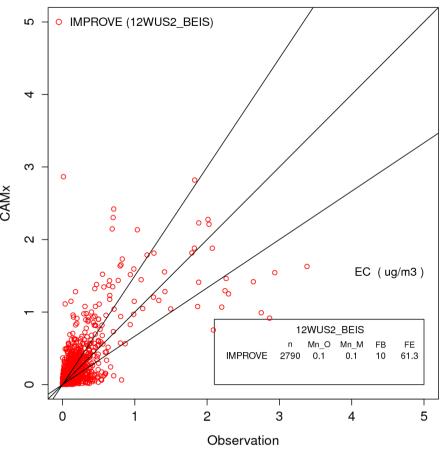
Both models are similar



Observation

CAMx

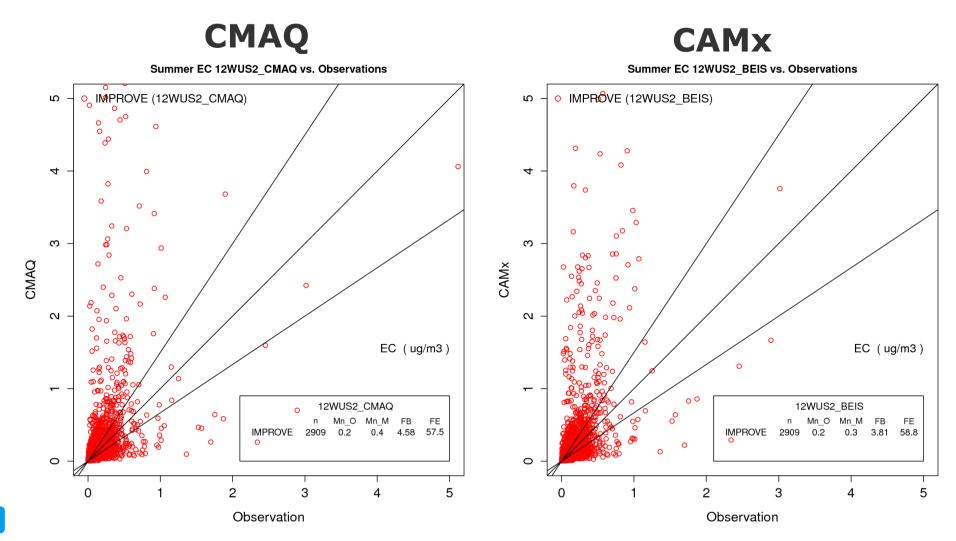






EC Scatter plots (IMPROVE): Summer

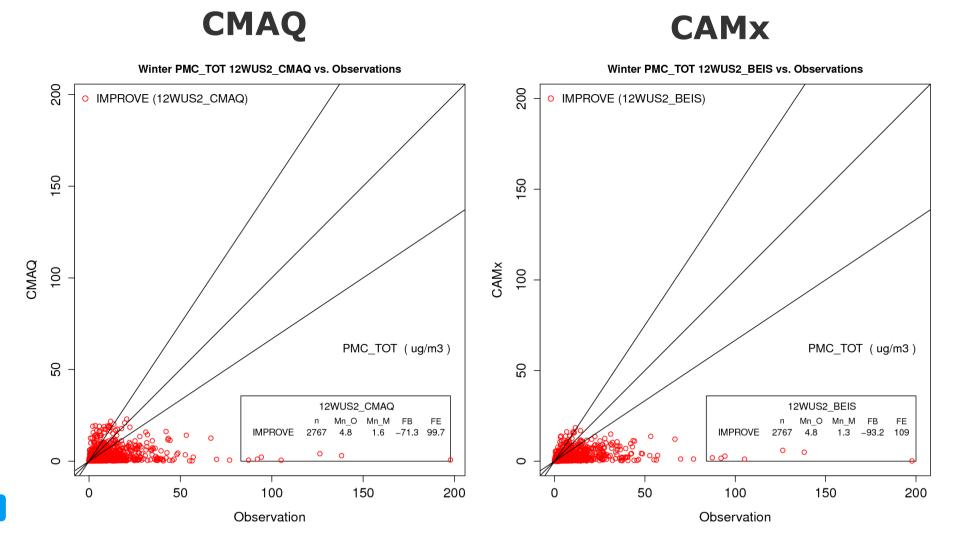
 Both models overpredict in summer





Coarse Mass (CM) Scatter plots (IMPROVE): Winter

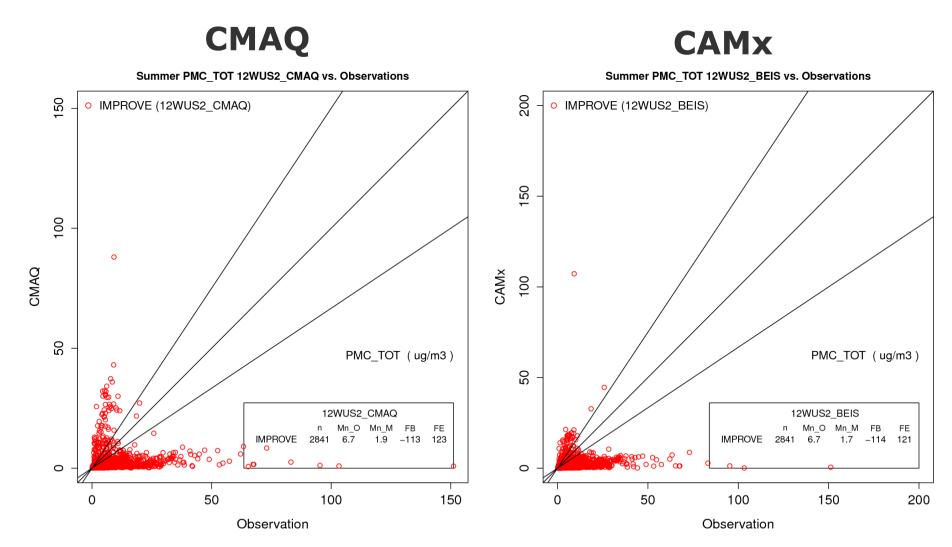
Both models show systematic underpredictions





Coarse Mass (CM) Scatter plots (IMPROVE): Summer

Both models show systematic underpredictions





20 % Worst Days vs Most Impaired Days

IMPROVE PM2.5 species concentration (SO4, NO3, OA, EC, Soil and PMC) not light extinction. Light extinction SO4 \sim 10x PMC

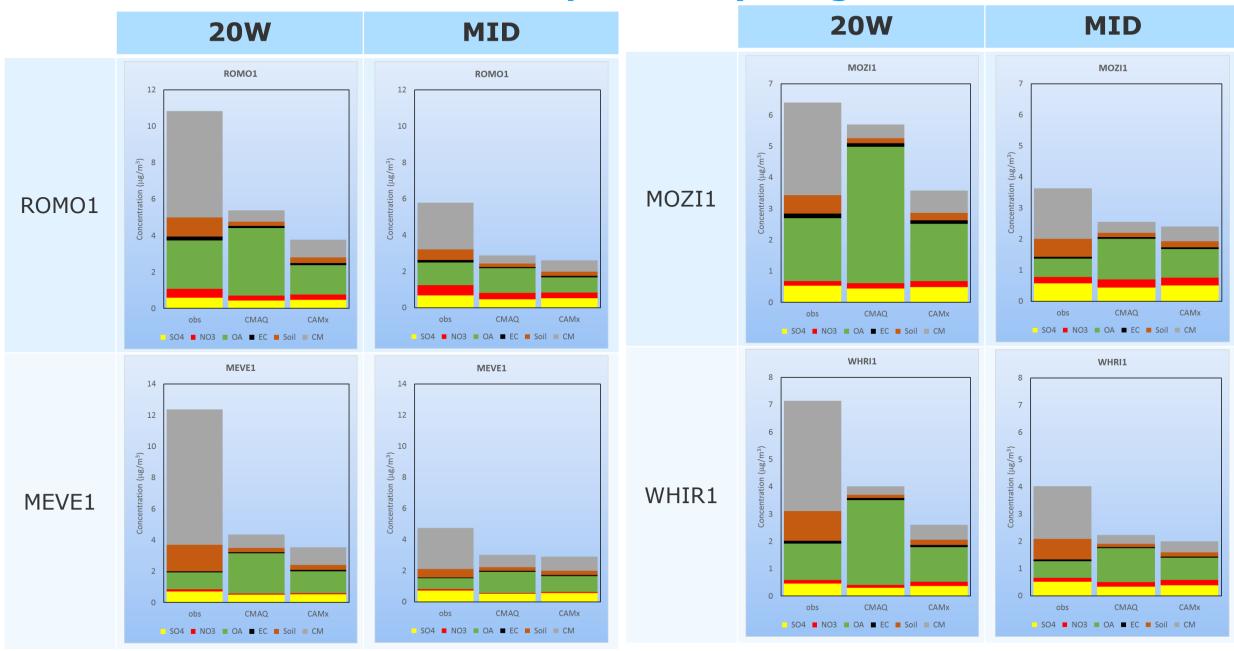


Overview

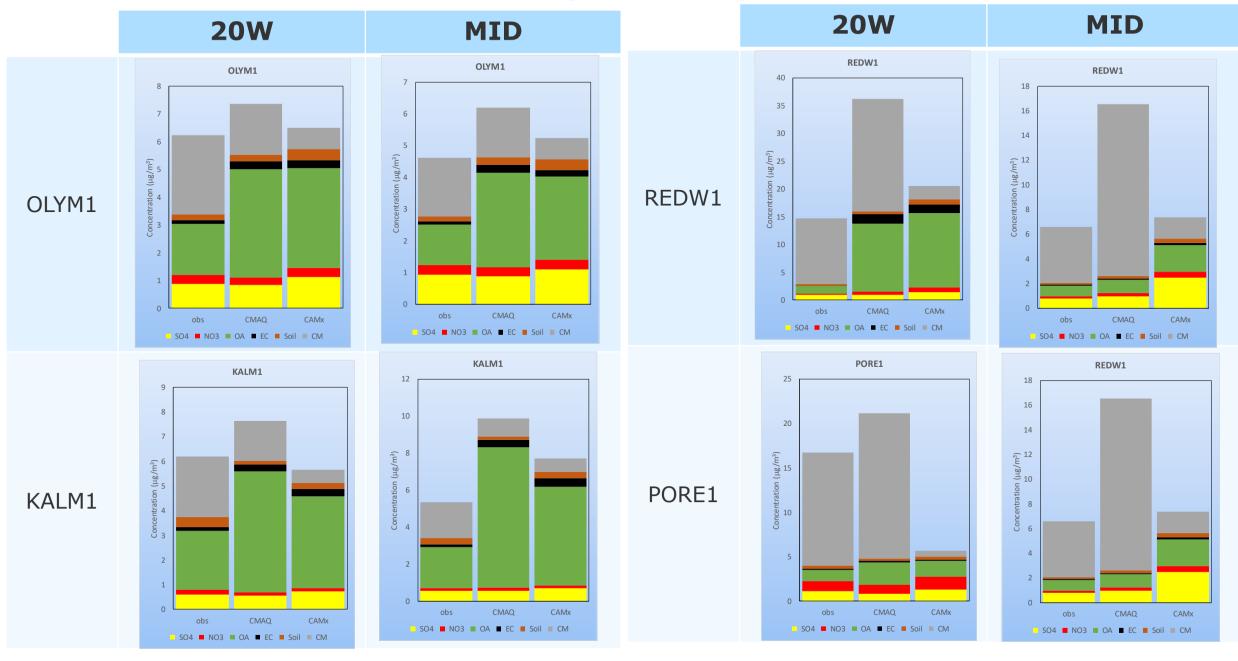
- IMPROVE data flags were used to determine which days belong to the 20% Worst days
- Two set of the IMPROVE data used:
 - One with flags for the 20W
 - One with flags for the most impaired days
- Model is paired in space and time with both datasets to produce comparisons
- Generally the 20%W in many western sites have high OA (fire influences) and many if not most days
 fall in the summer months
- The MID have more of a mixture of days through the year and less days fall in the summer.
- For selected sites the sulfate and nitrate concentrations between 20W and MID look similar or almost the same3
- The most relevant change occurs with decreased OA in the MID



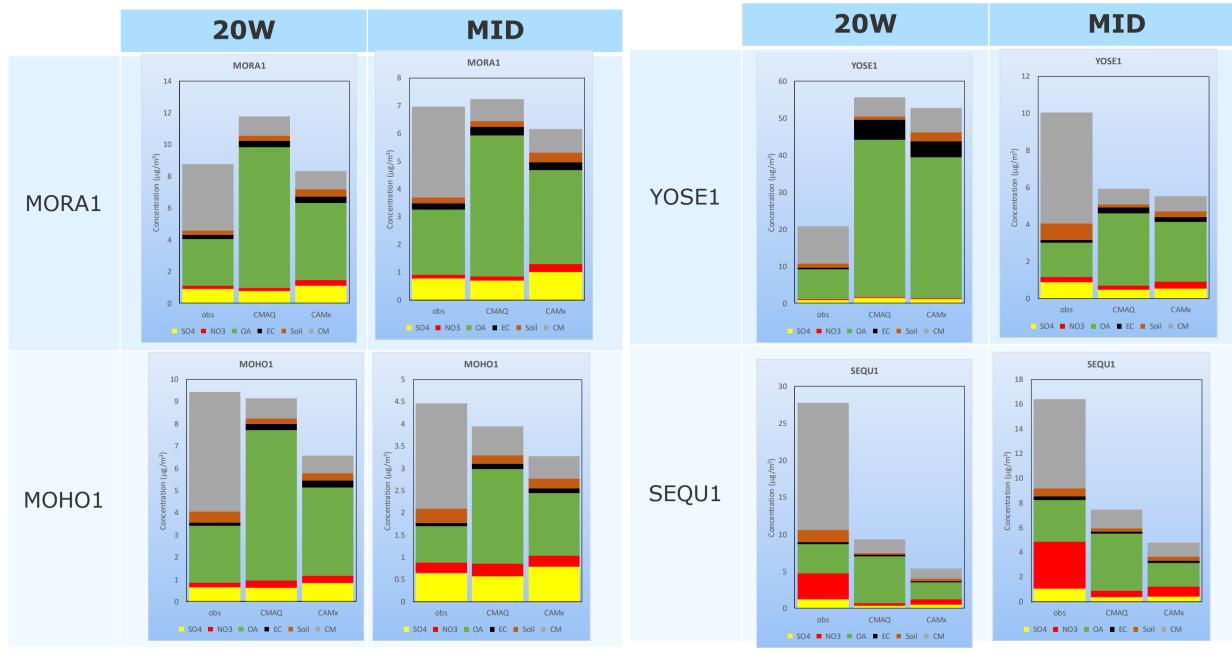
PM2.5 20%Worst vs Most Impaired Days: High Altitude sites



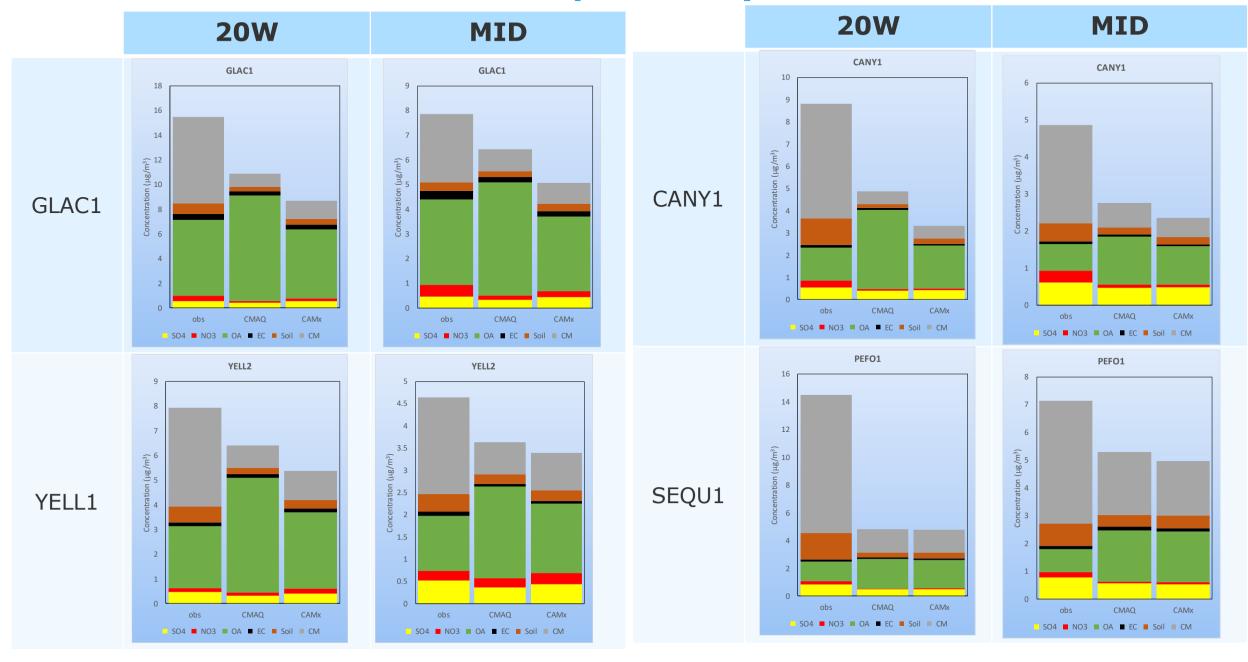
PM2.5 20%Worst vs Most Impaired Days: Coastal Sites



PM2.5 20%Worst vs Most Impaired Days: Inland High Terrain



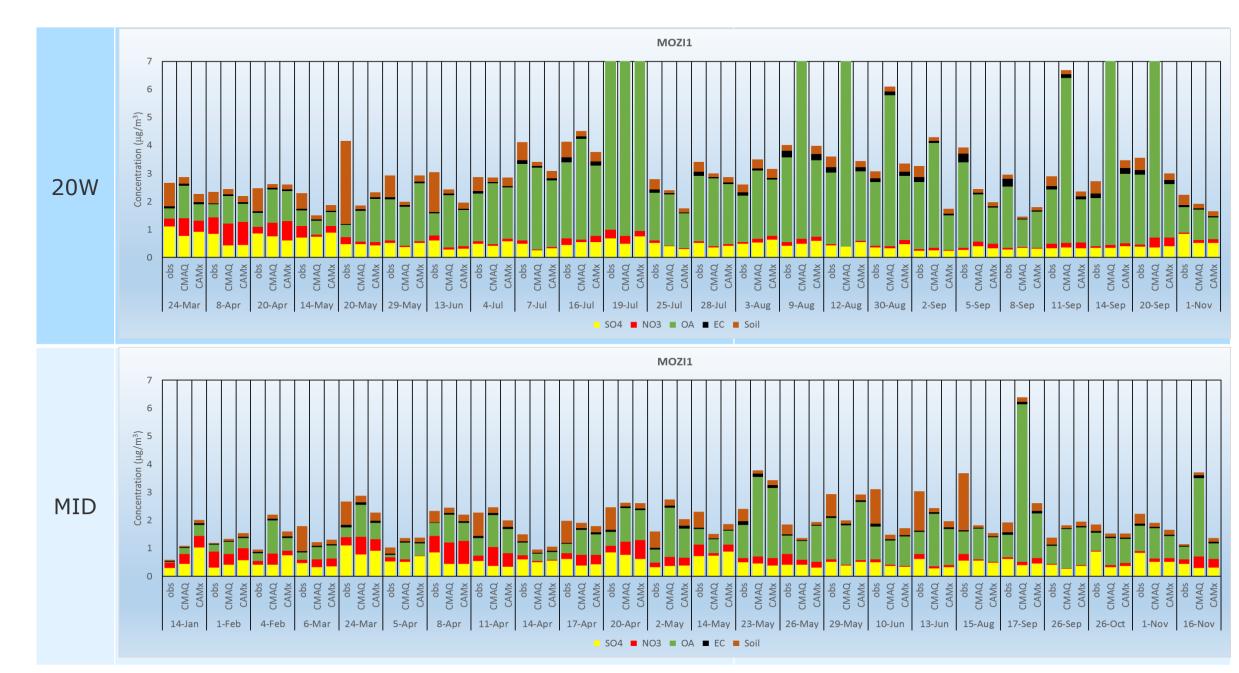
PM2.5 20%Worst vs Most Impaired Days: More Inland



PM2.5 20%Worst vs Most Impaired Days: ROMO1



20%Worst vs Most Impaired Days: MOZI1



Conclusions

- **O3**: Both models overpredict throughout the year (GCBC).
- **PM2.5**: Both models show similar model performance, overpredict (Winter and Fall) and underpredict (Spring and Summer). CAMx generally better than CMAQ
- **SO4**: Both models showed similar seasonal trends. CAMx reduced the under-predictions but at the same time increased the over-predictions when compared with CMAQ
- **NO3**: Both models overpredict nitrate in Winter. Both underpredict rest of the year. Biases smaller for CMAQ in the winter
- **OA**: Systematically over-predicted throughout the year, CAMx model performance slightly better than CMAQ.
- EC: Similar performance between both models. Both overpredict in the summer
- CM: Both models systematically underpredict concentrations throughout the year
- **20W vs MID**: Decreasing OA contributions for MID may help performance since both models systematically overpredict OA.

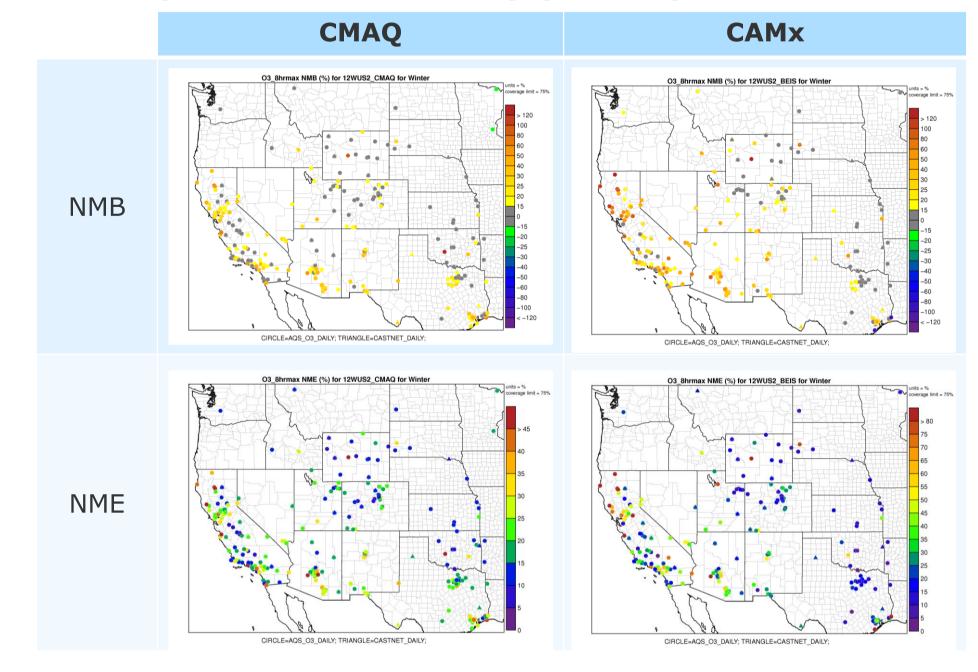


Additional Slides

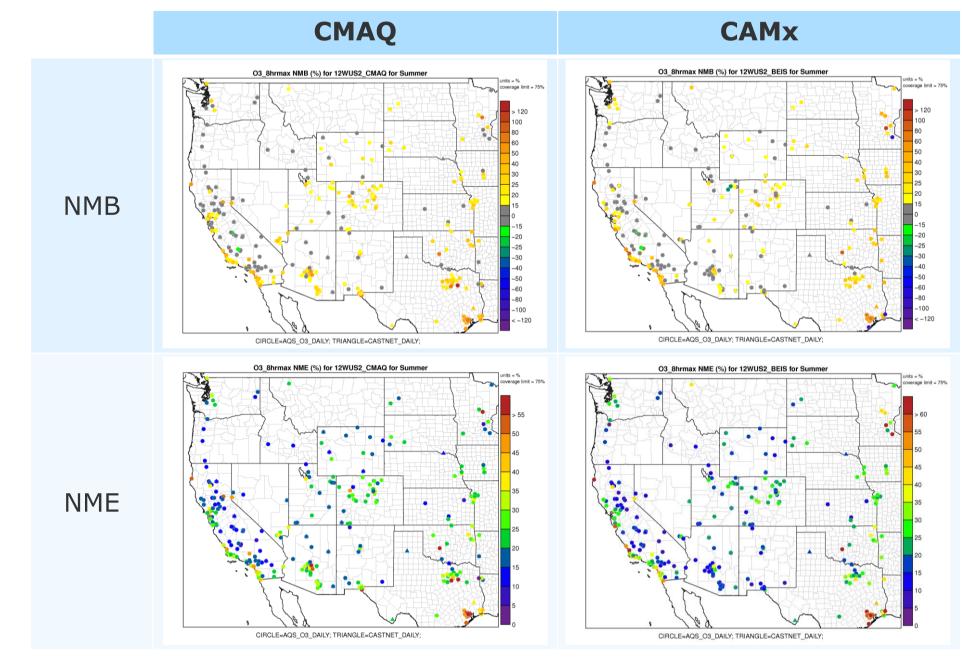


Ozone (8hr_DMAX): Bias/Error Overlay (Winter)

RAMBOLL

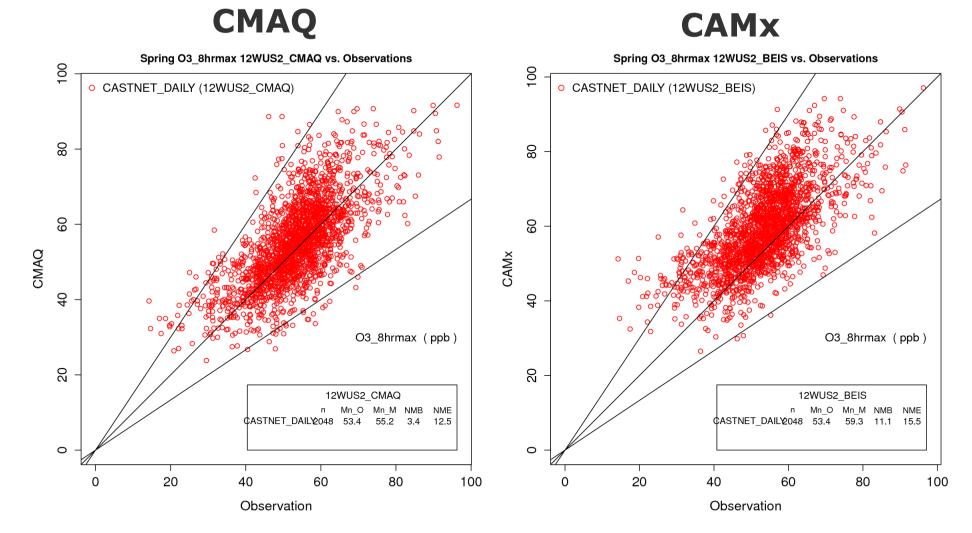


Ozone (8hr_DMAX): Bias/Error Overlay (Summer)



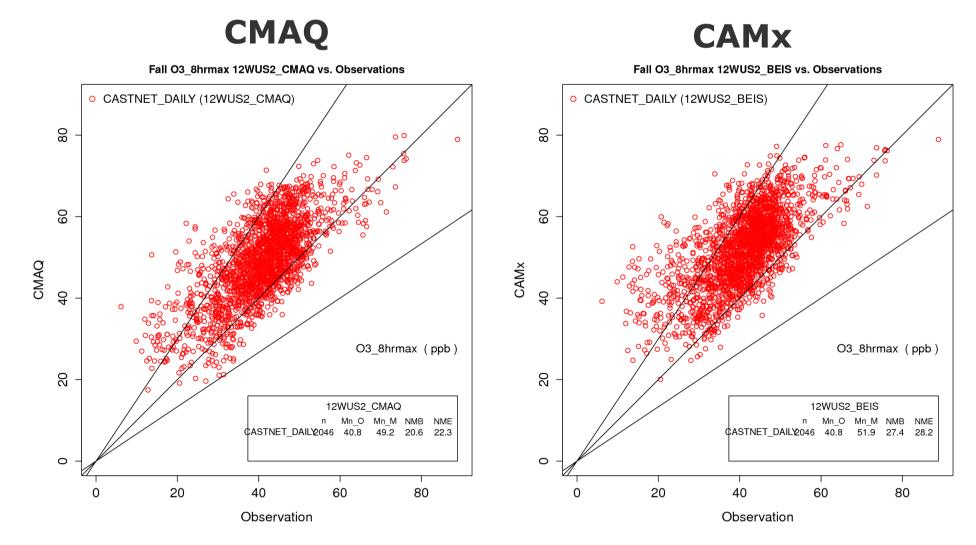


Ozone (8hr_DMAX) Scatter plots (CASTNET): Spring





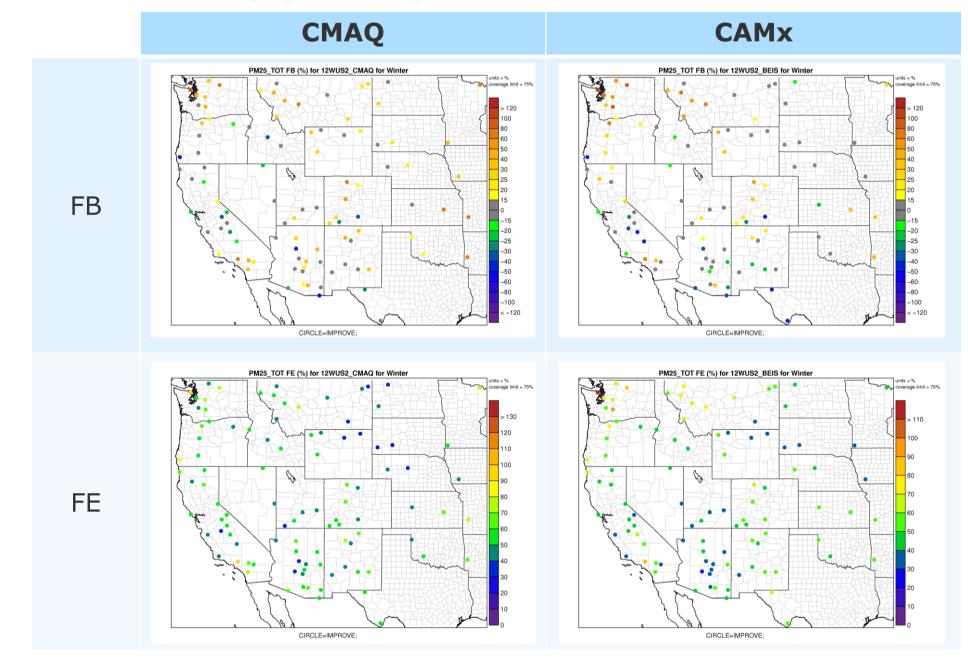
Ozone (8hr_DMAX) Scatter plots (CASTNET): Fall



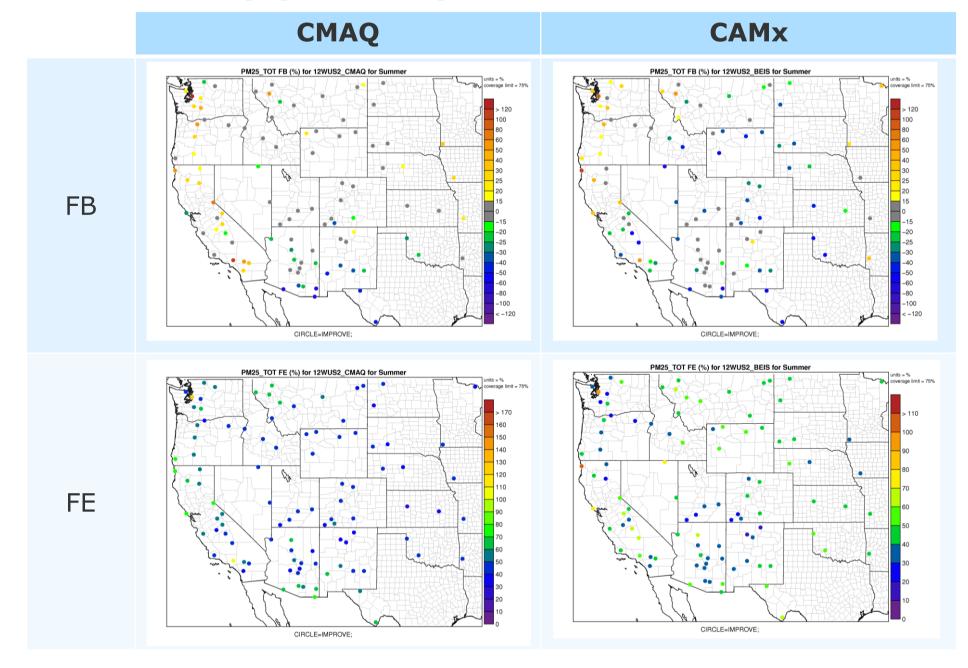


PM25 Bias/Error Overlay (Winter)

RAMBOLL

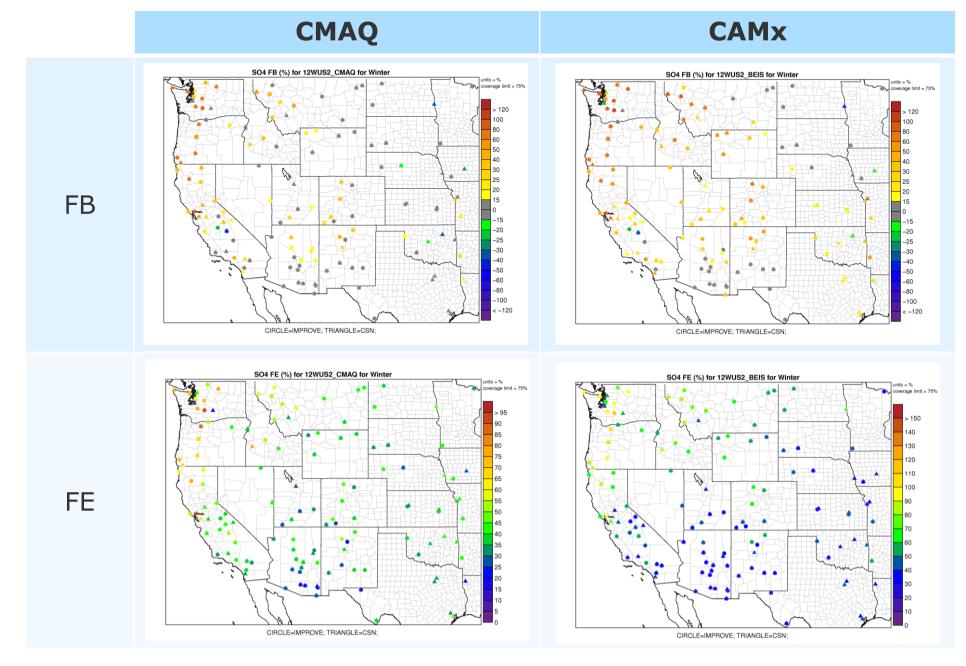


PM25 Bias/Error Overlay (Summer)



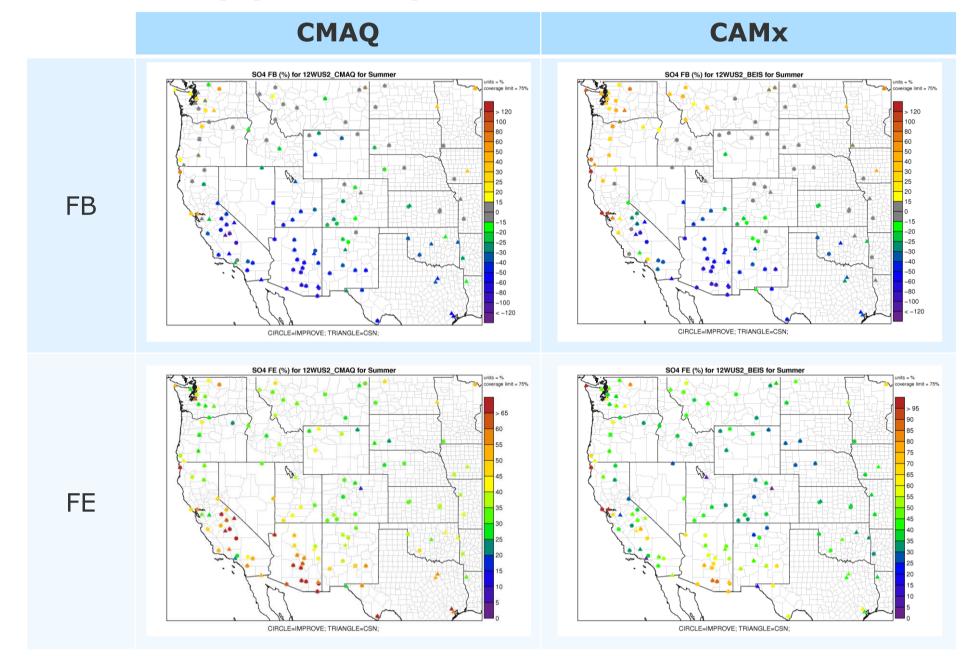


SO4 Bias/Error Overlay (Winter)



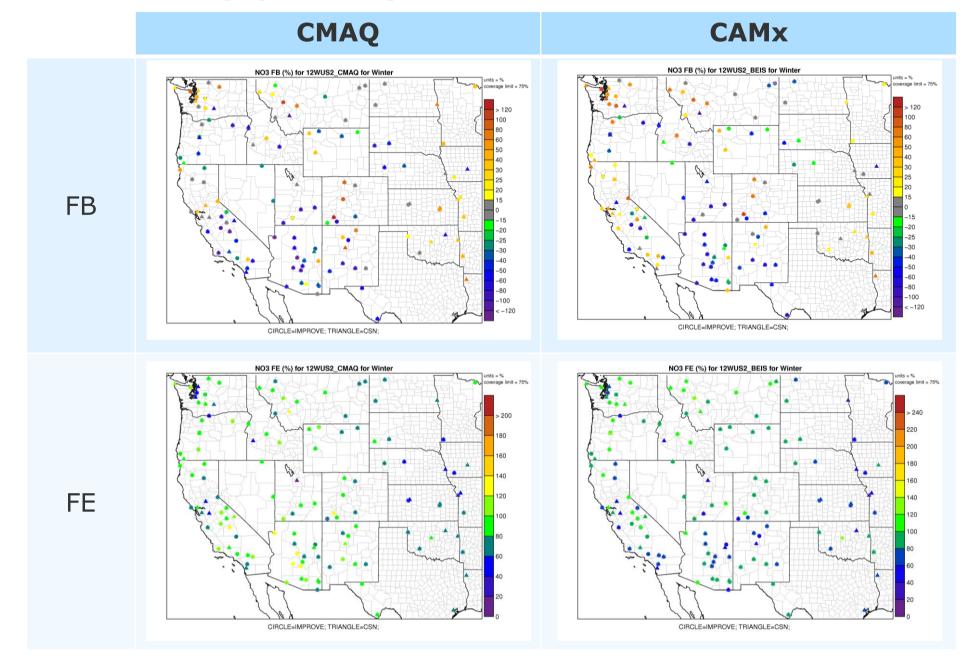


SO4 Bias/Error Overlay (Summer)





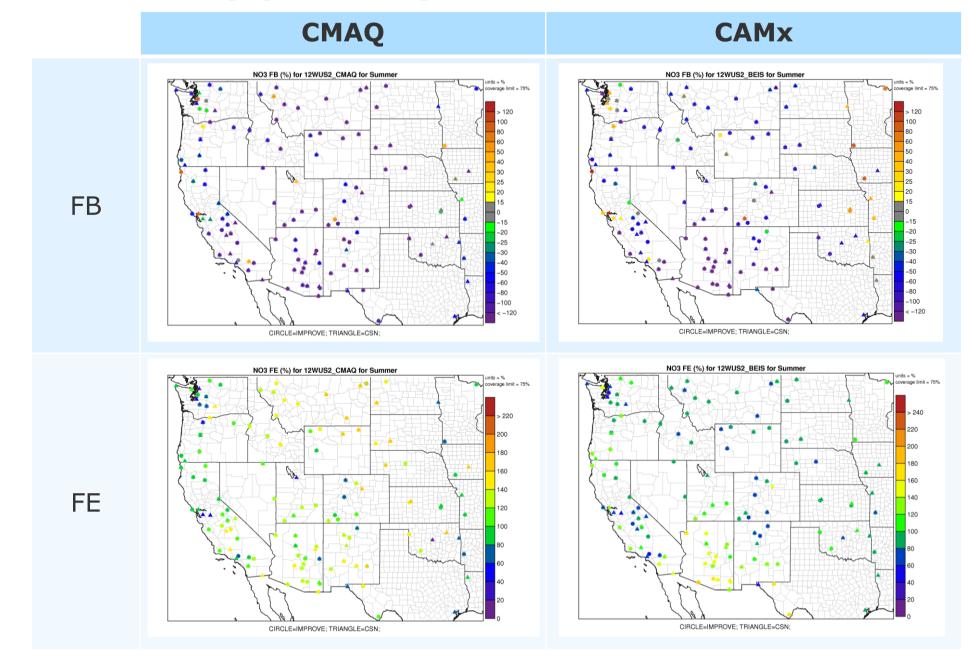
NO3 Bias/Error Overlay (Winter)



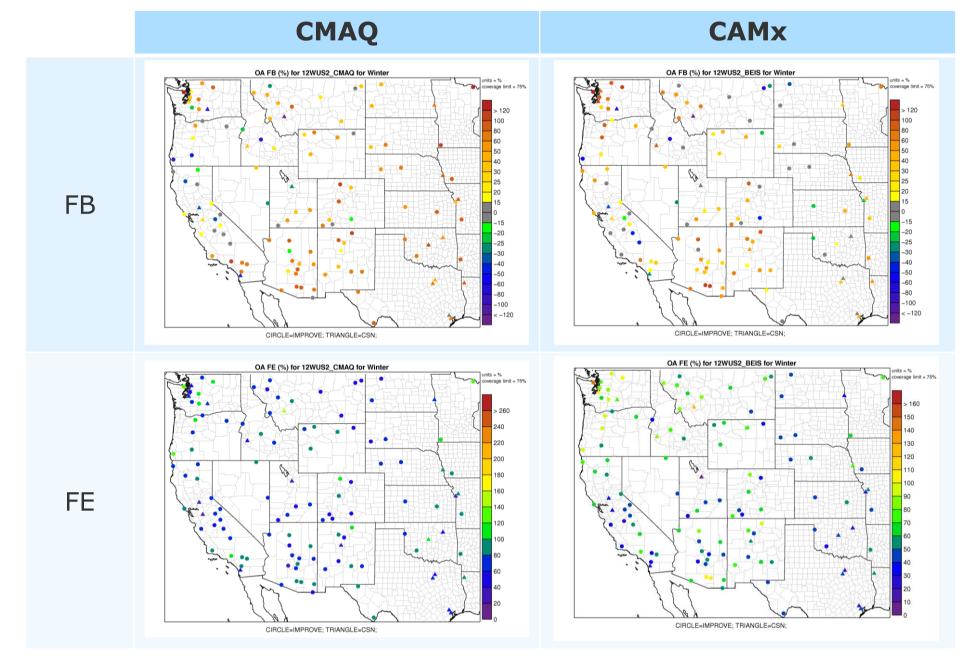


NO3 Bias/Error Overlay (Summer)

RAMBOLL



OA Bias/Error Overlay (Winter)





OA Bias/Error Overlay (Summer)

