ASSESSMENT OF MEASUREMENT ERROR IN CSN DATA USING COLLOCATED SAMPLERS

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Washington University in St. Louis

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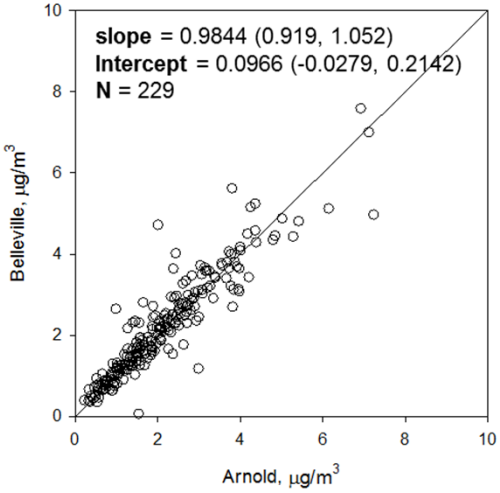

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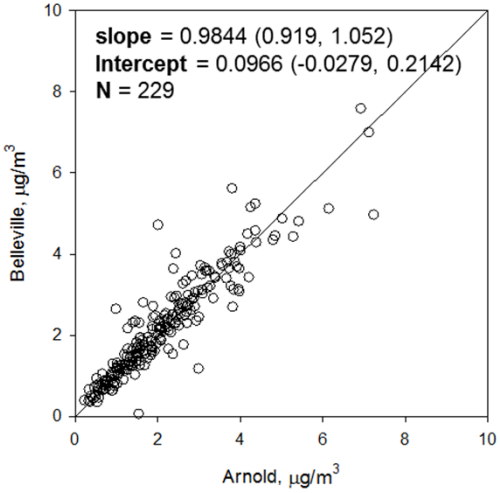

- **Network Operations**

COLLOCATED SAMPLING SITES IN THE CSN NETWORK

MANIFESTATIONS OF MEASUREMENT ERROR

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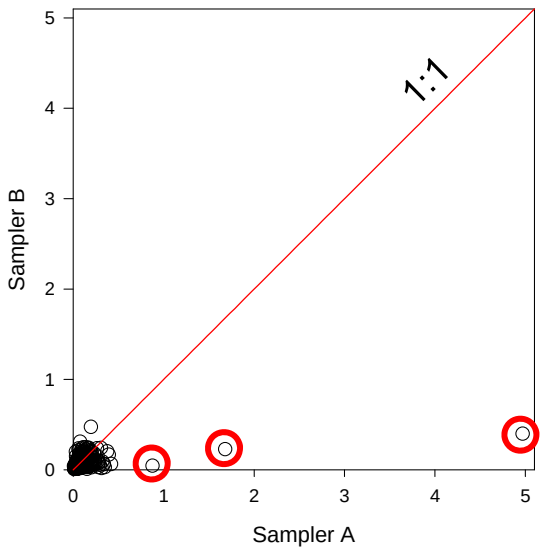

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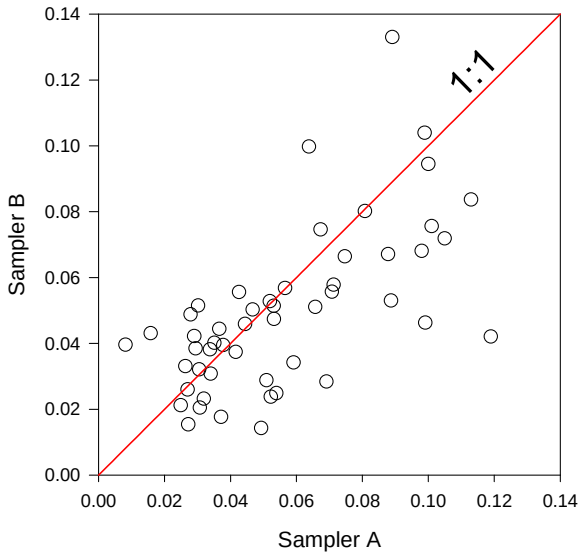
- **Systematic Bias**



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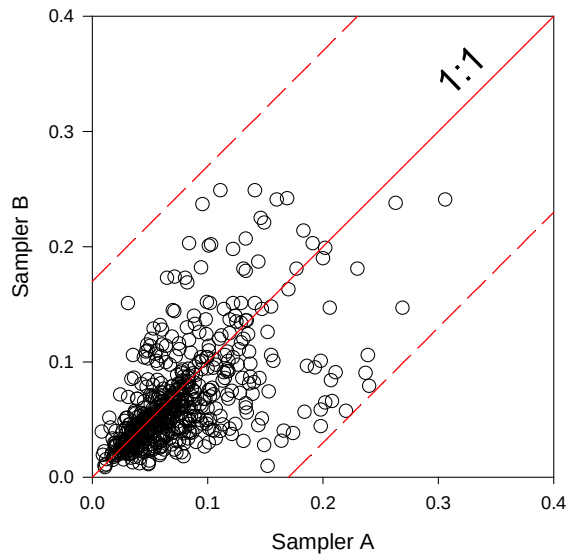

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PRECISION AND UNCERTAINTY

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Top-Down Approach:

Sample Specific Bias (D_i) = $\frac{(C_{i1} - C_{i2})/\sqrt{2}}{\bar{C}_i}$

C_{i1} = sample *i*, primary
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Precision Comparison between Collocated Samplers

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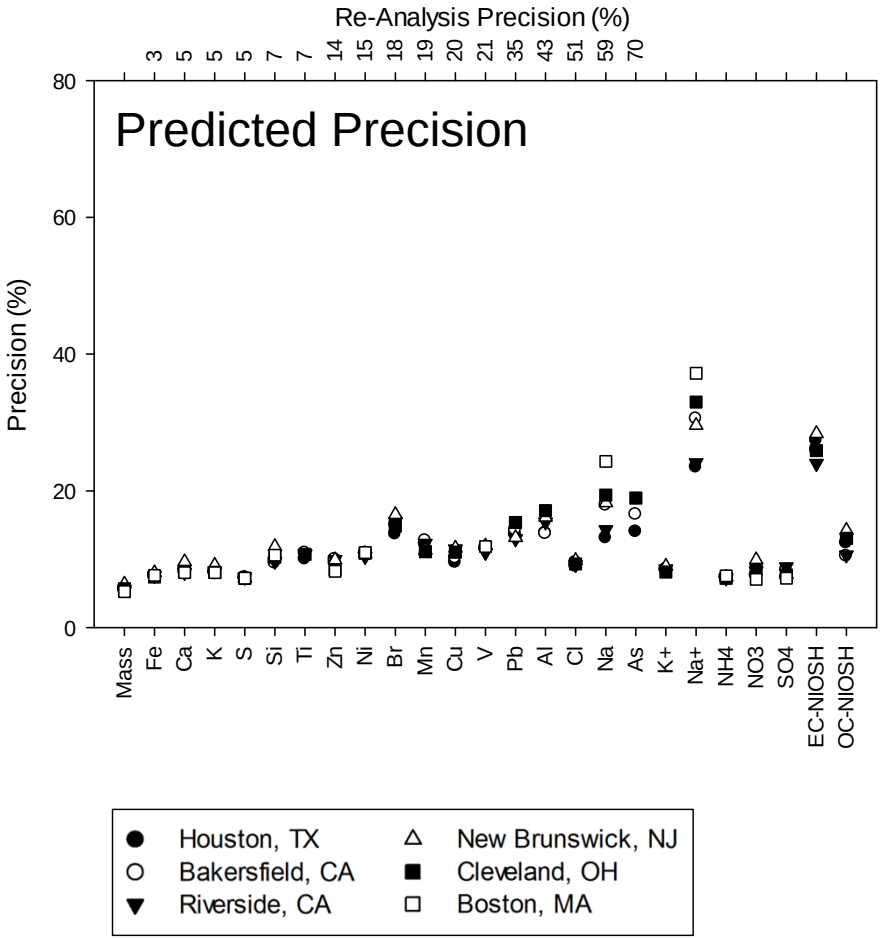

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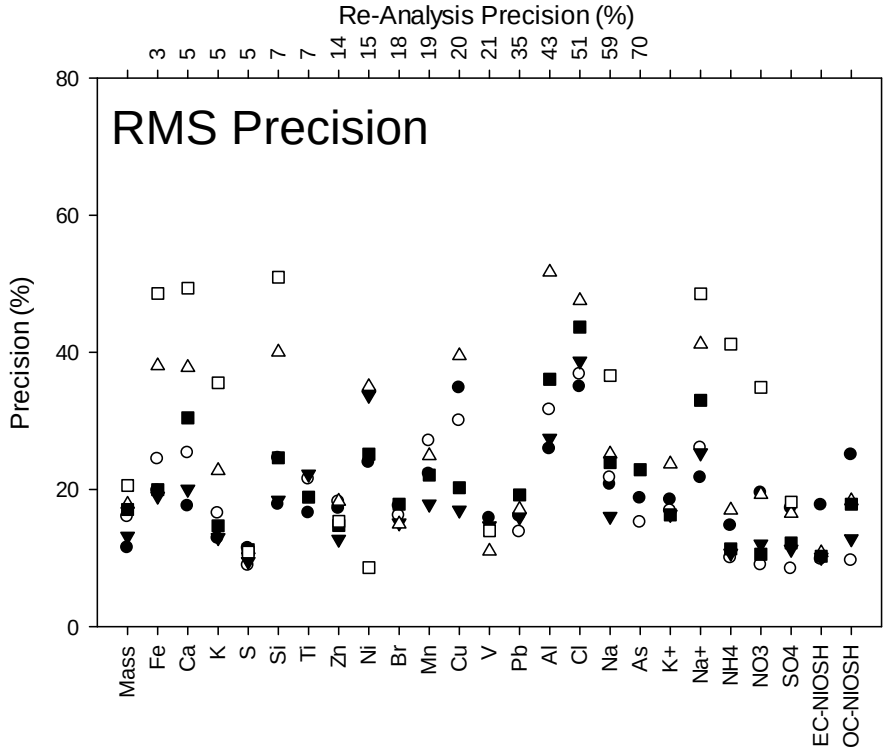

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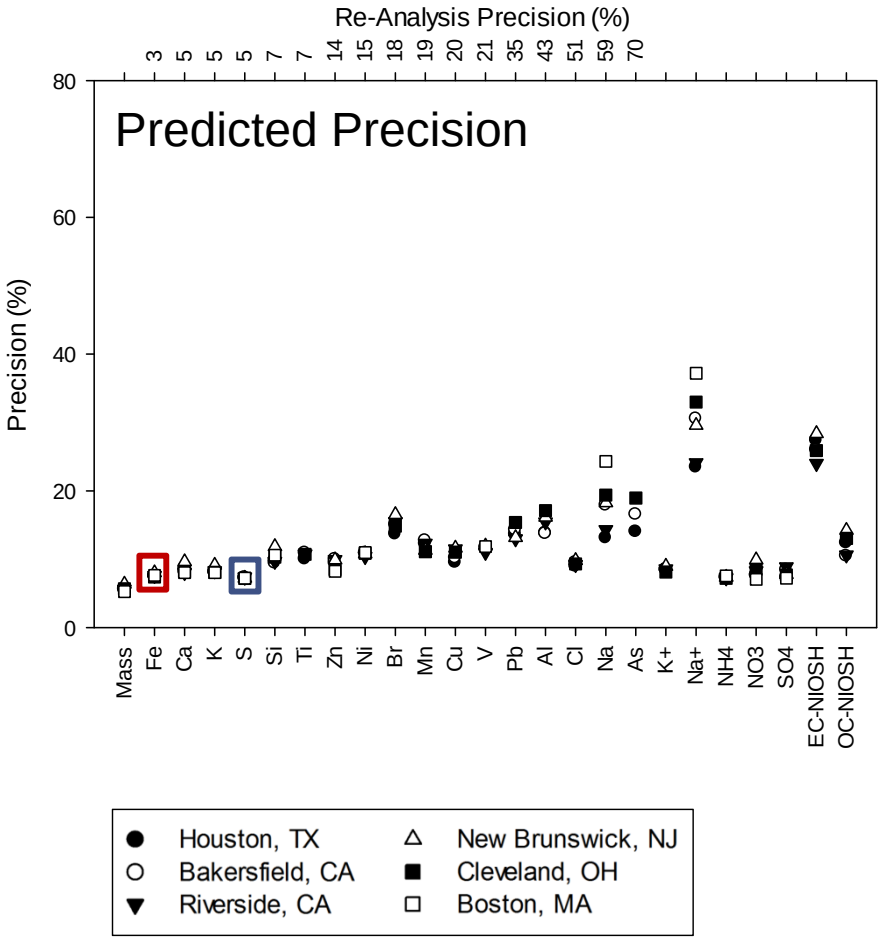

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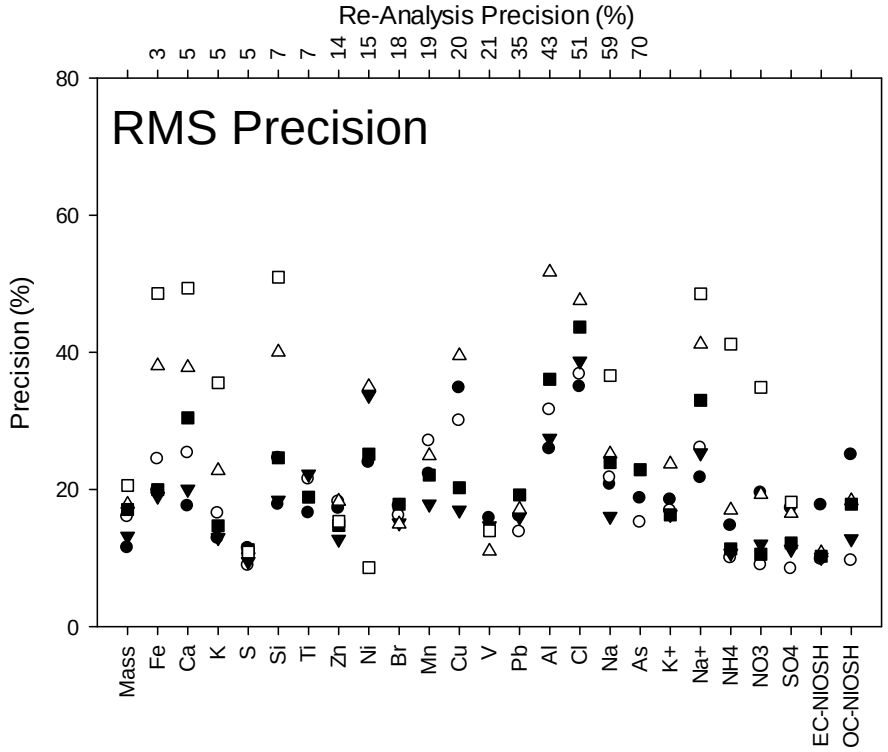

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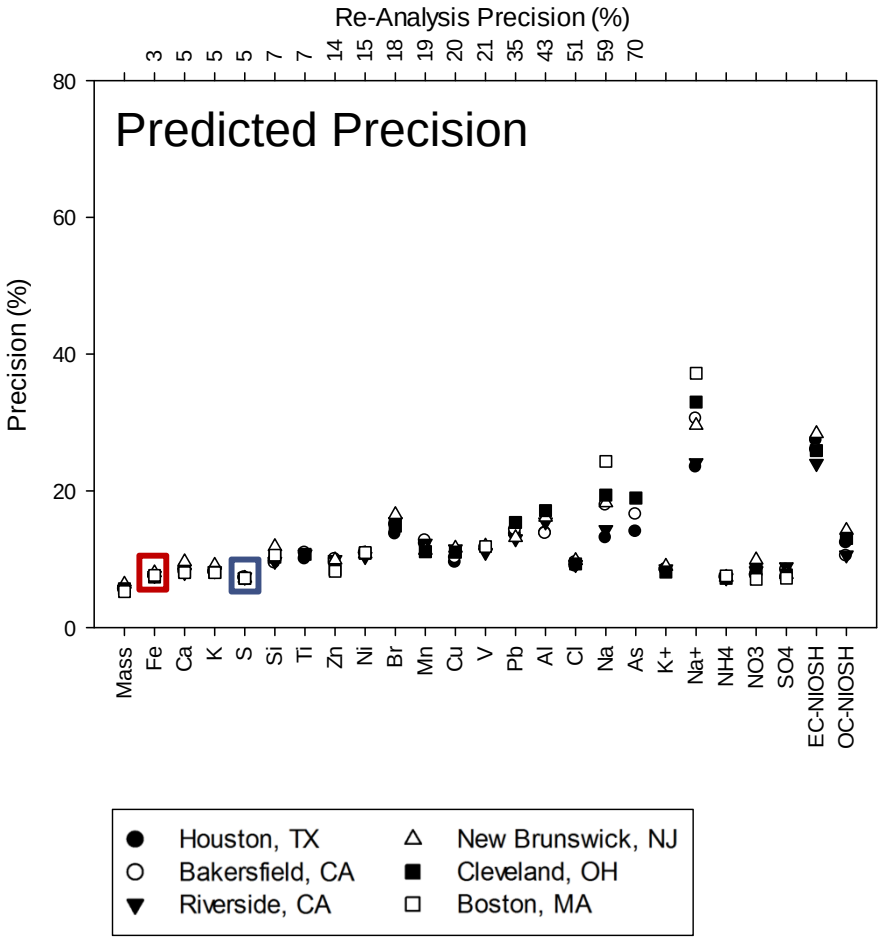

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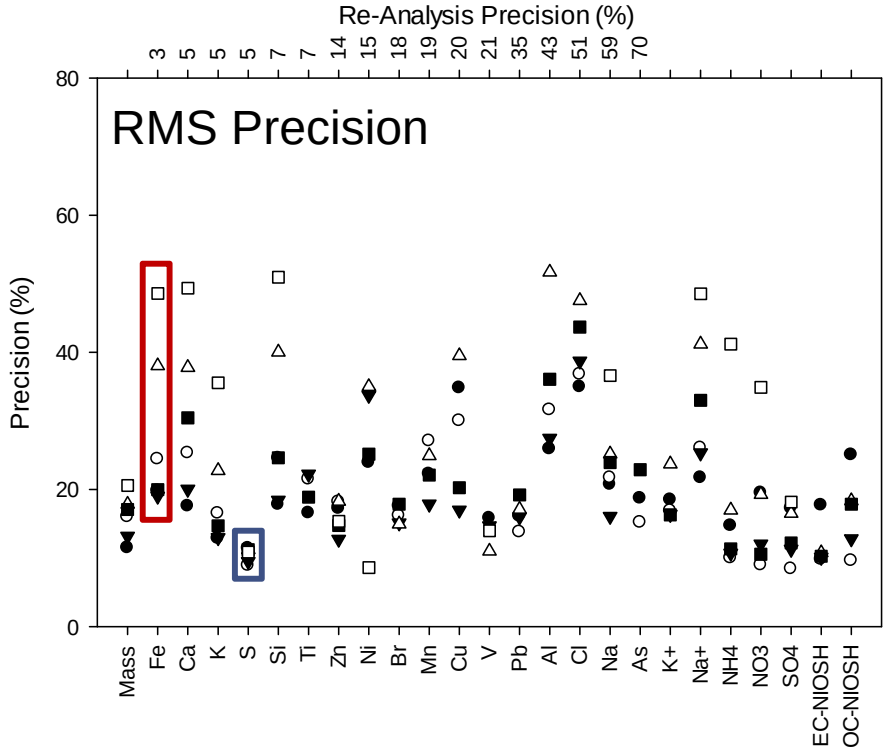
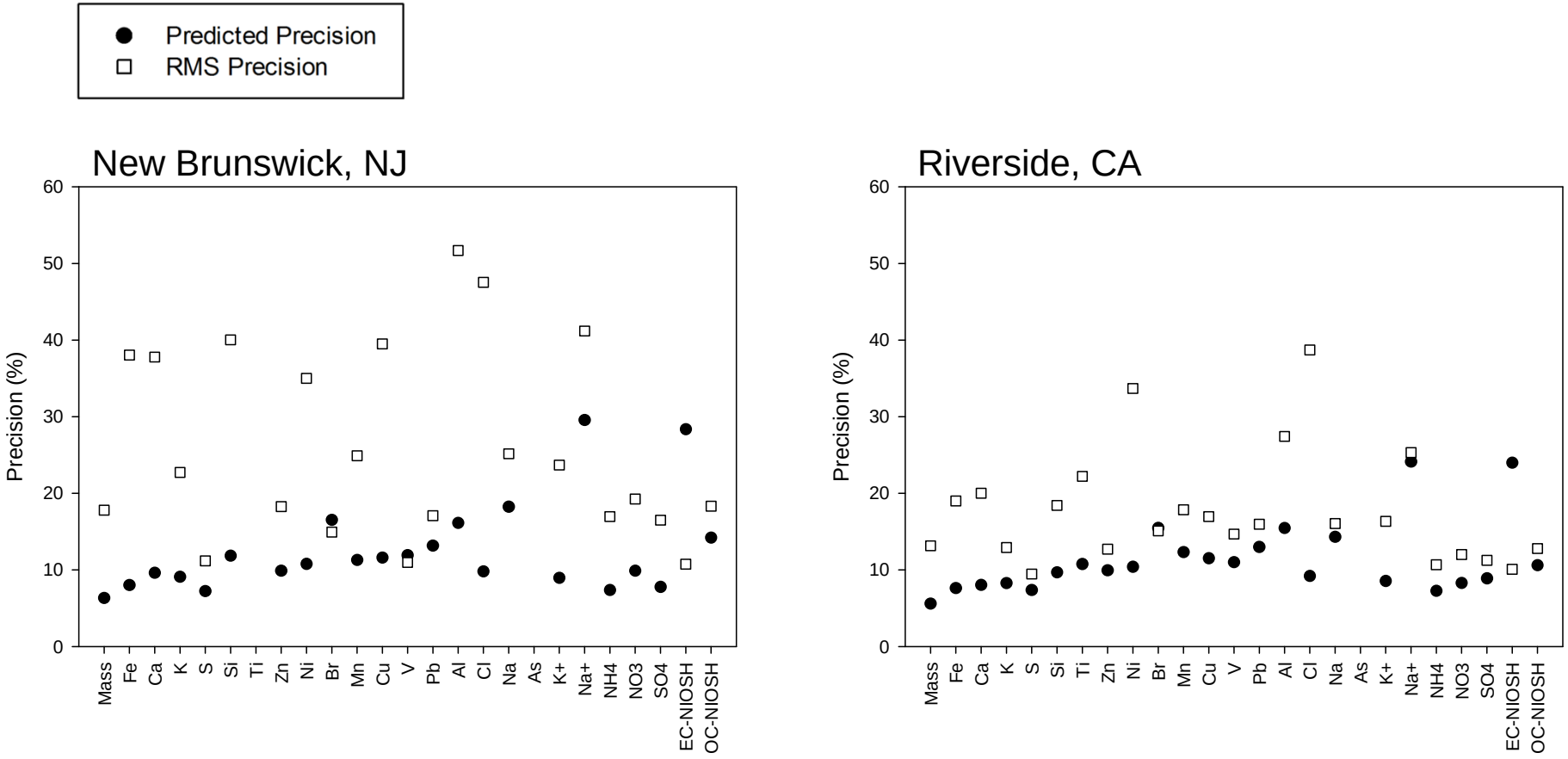


RMS Precision vs. Predicted Precision



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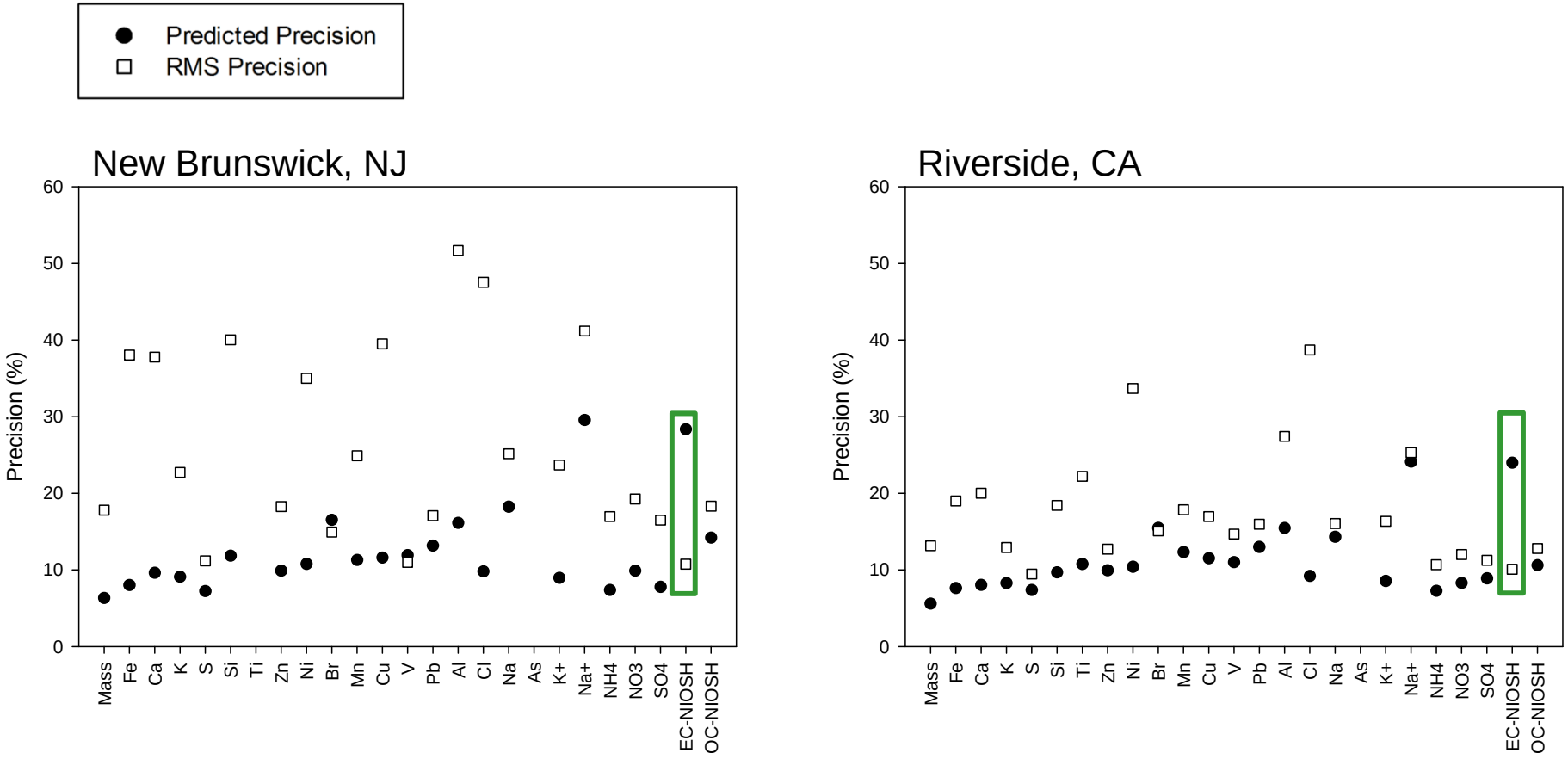

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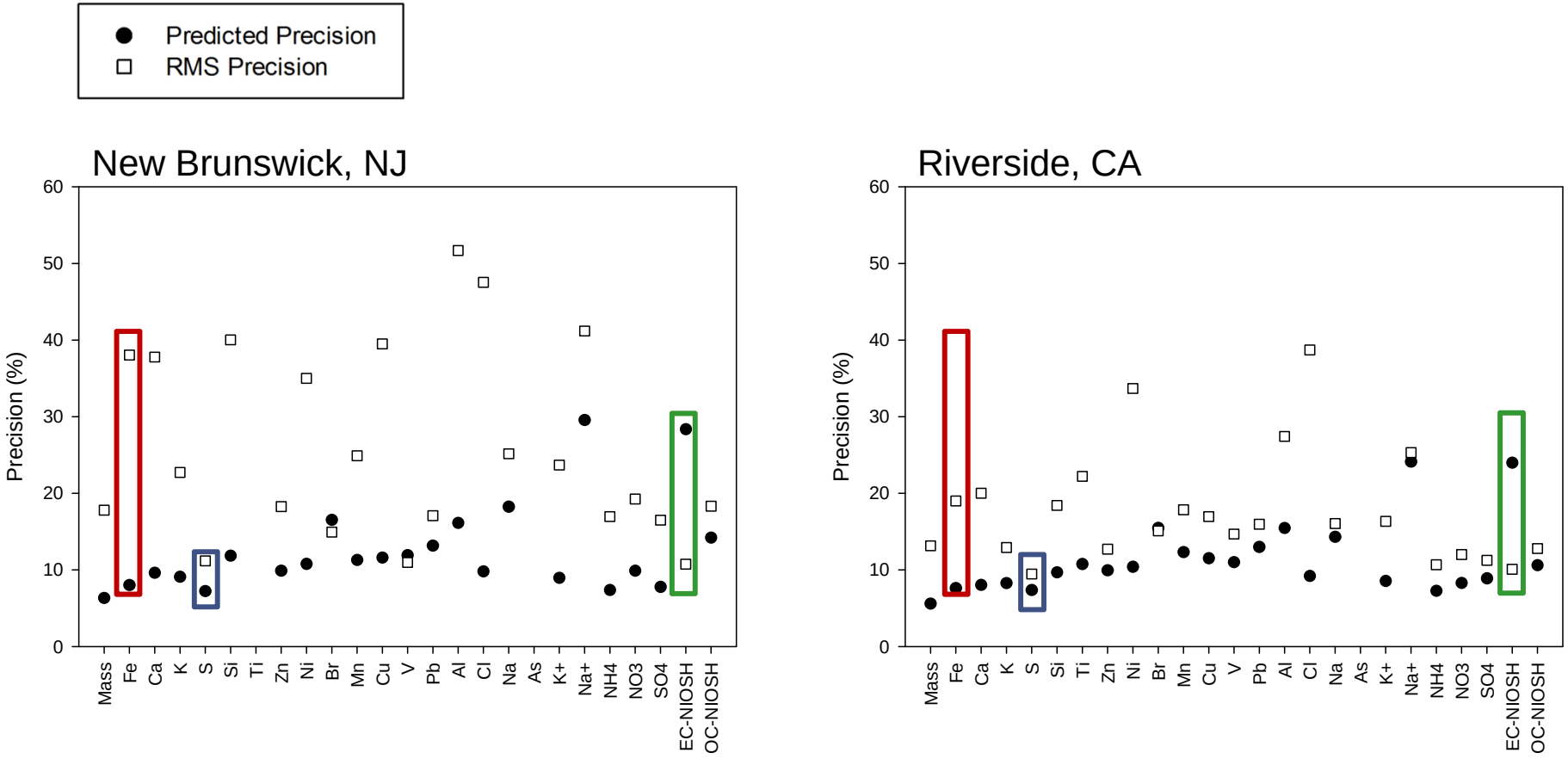

PERCENTILE PRECISION

$$\textbf{Percentile Precision (\%)} = \frac{1}{2}\left[P_{84}(D_i) - P_{16}(D_i)\right] \times 100$$

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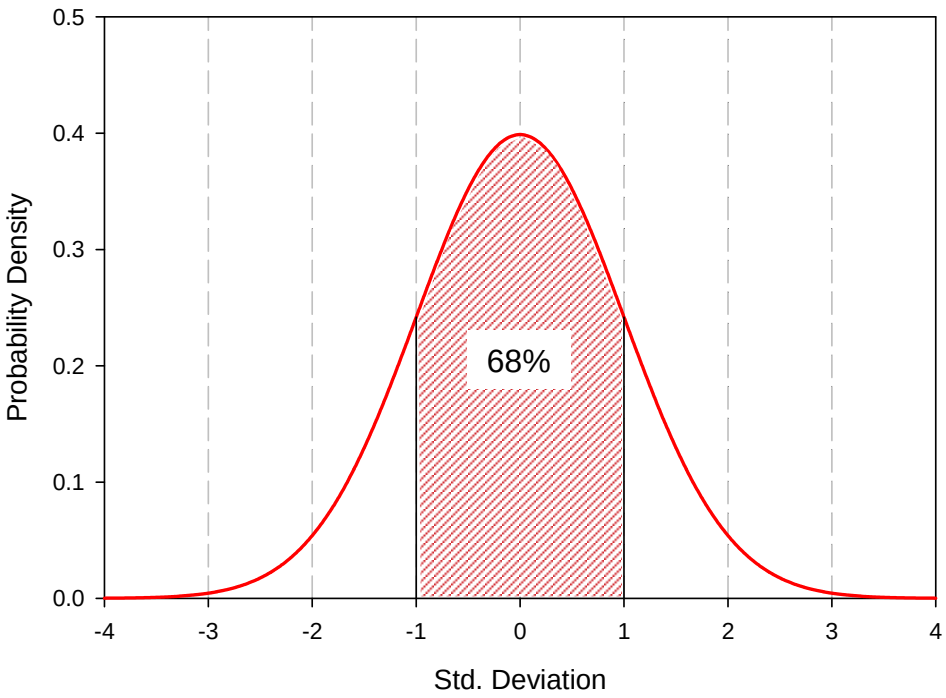

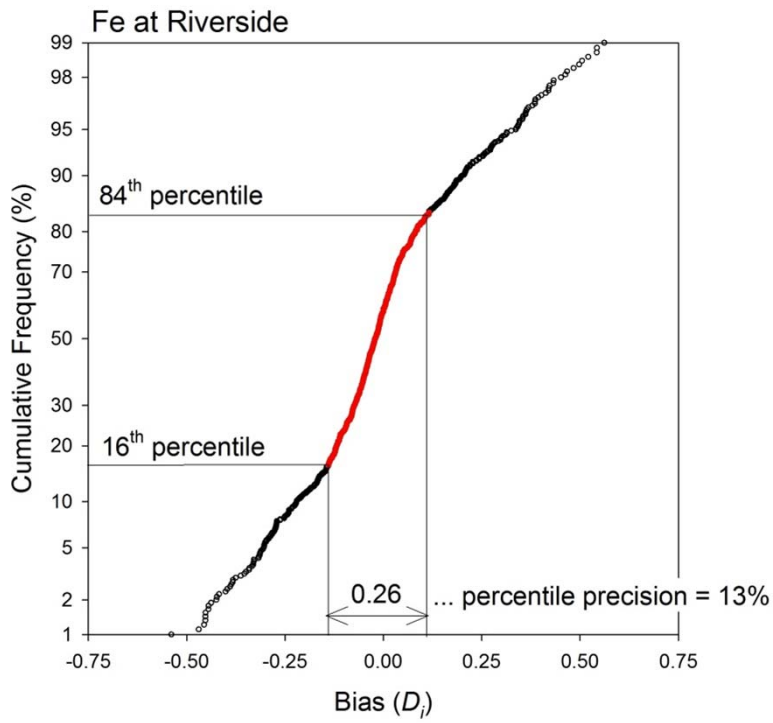

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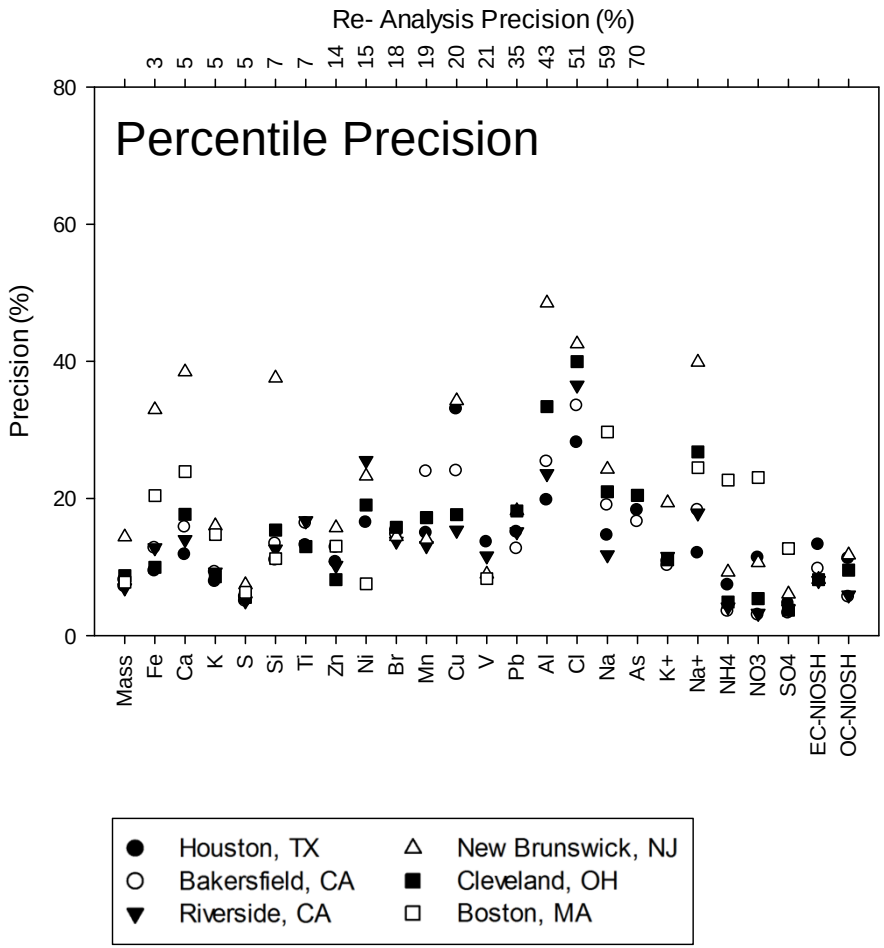

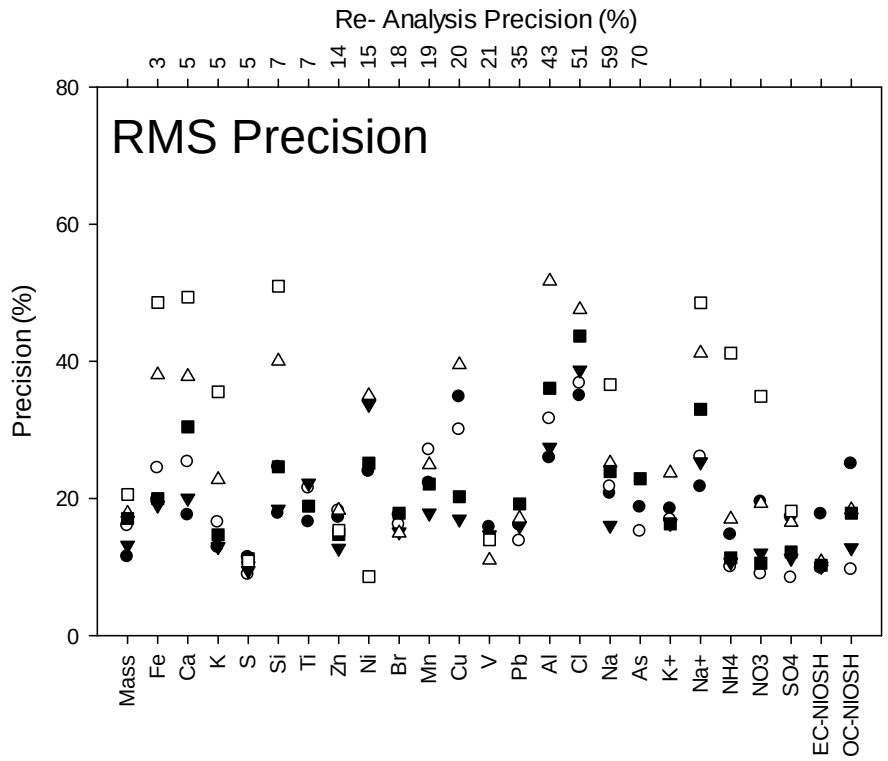

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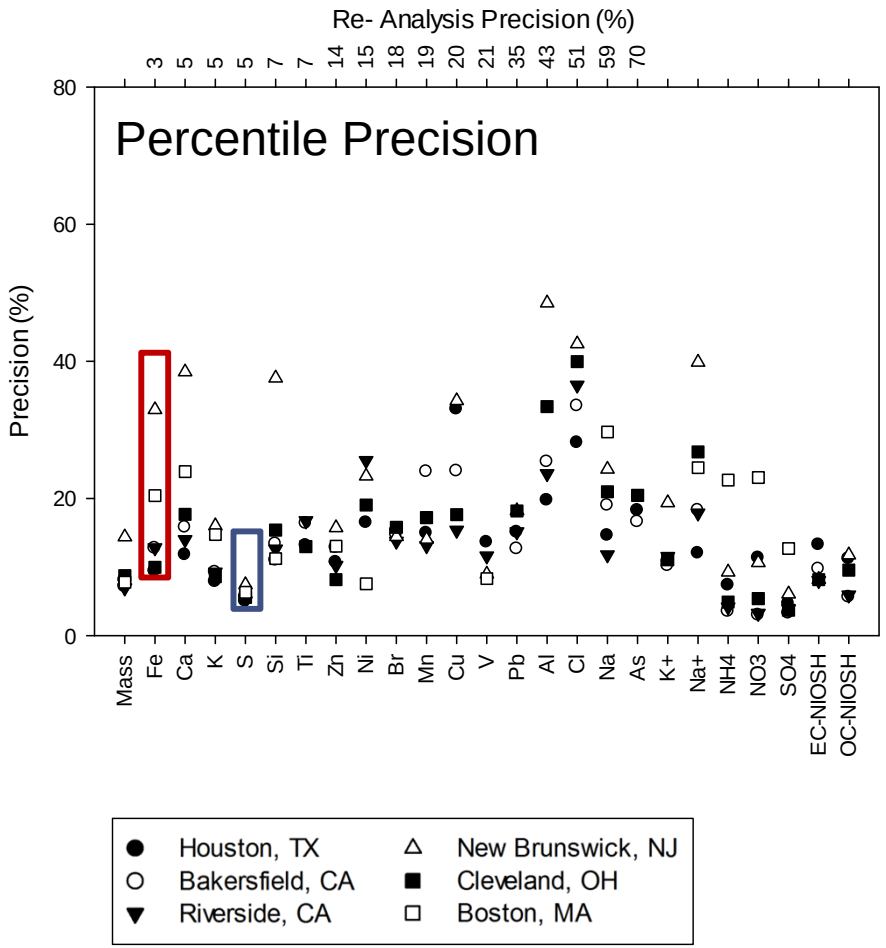

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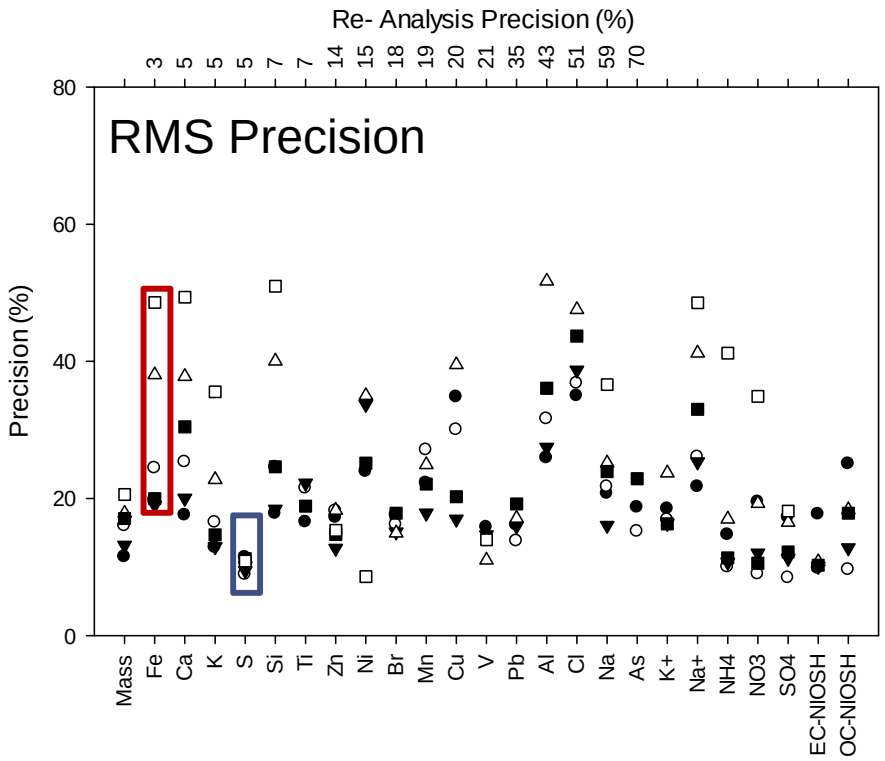

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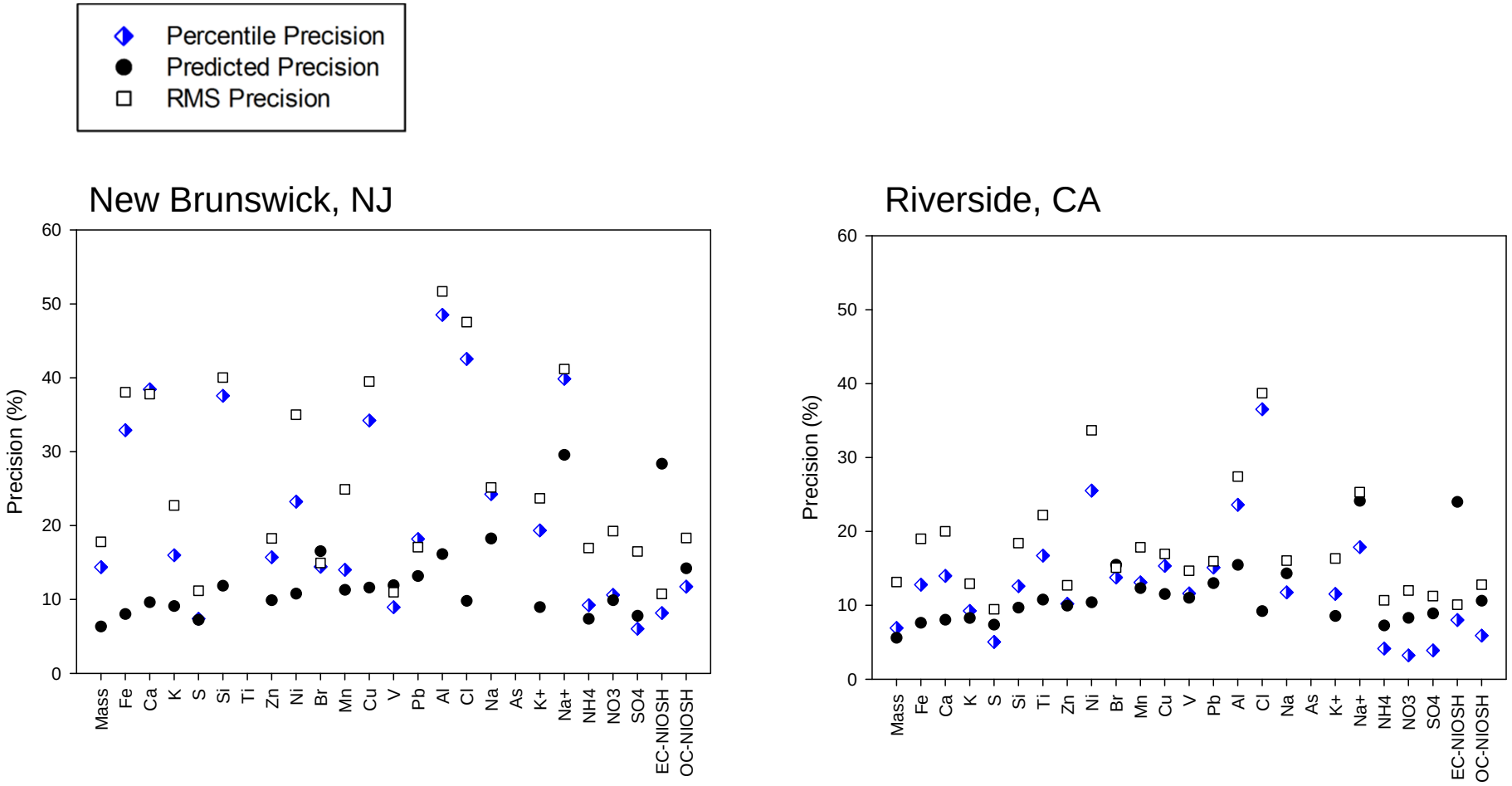

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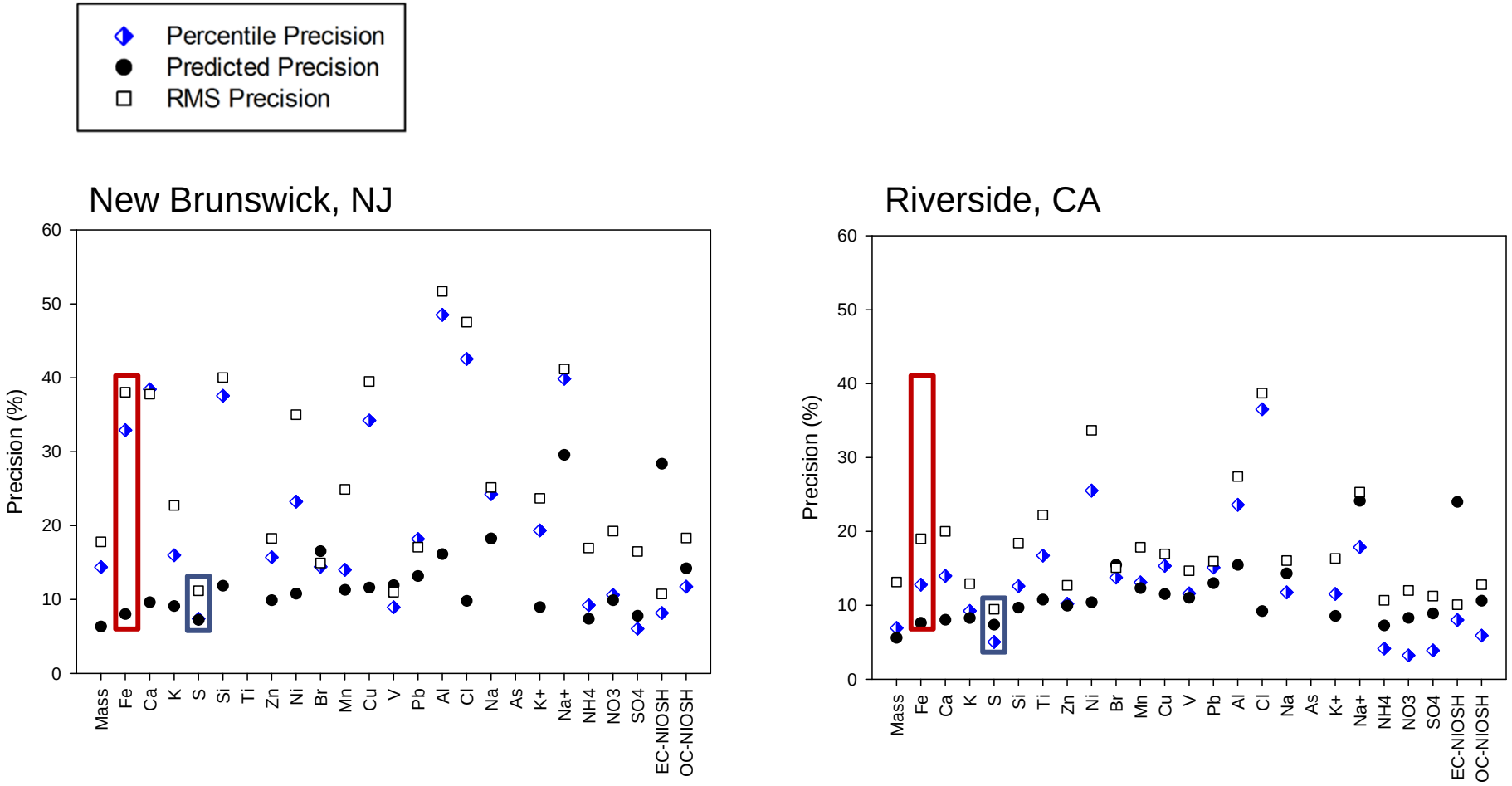

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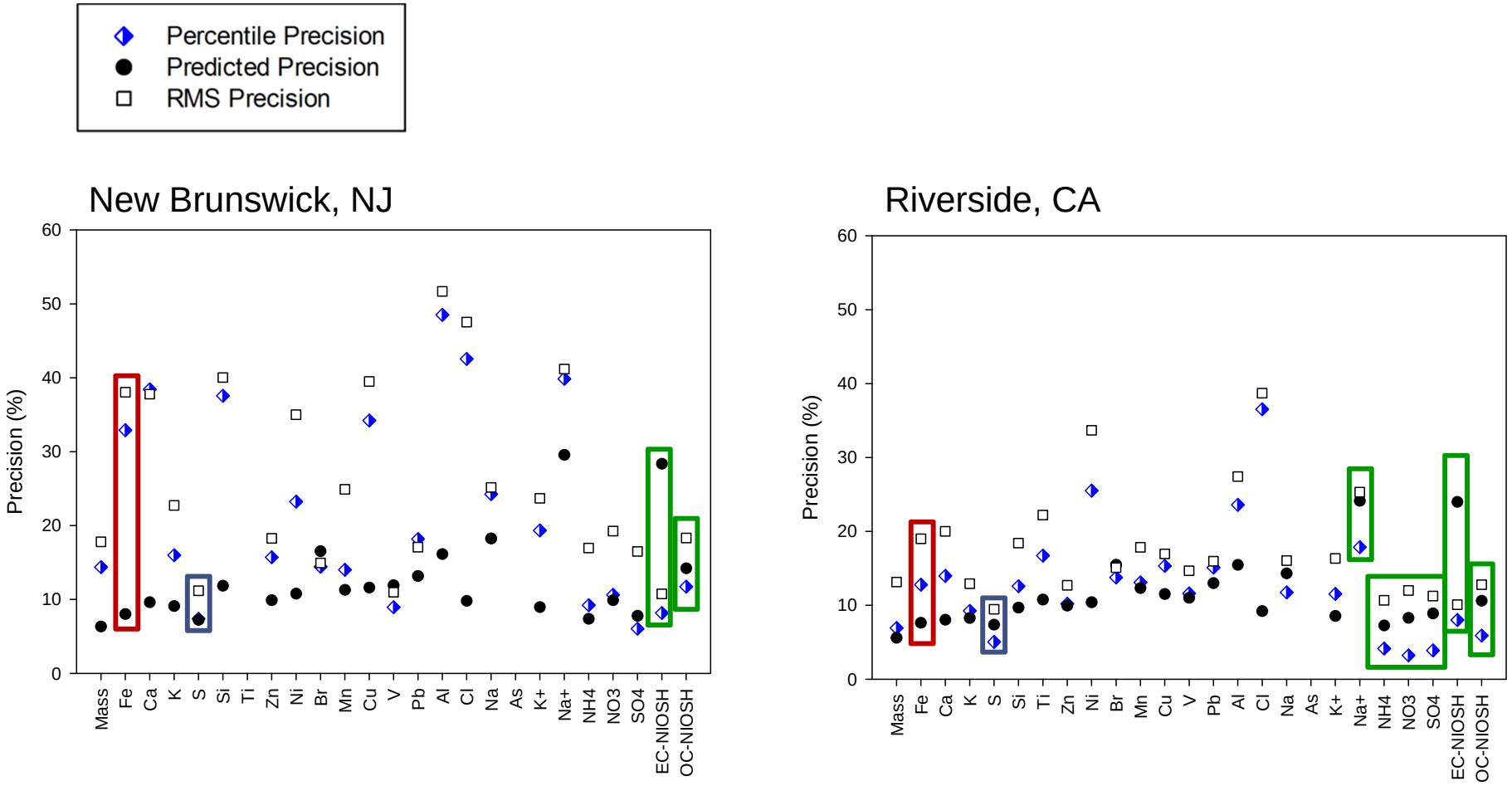

ASSESSMENT OF MEASUREMENT ERROR THUS FAR:

For most (but not all!) XRF species…

- **Predicted precision underestimates the RMS precision which uses all data**
- **Predicted precision also underestimates the percentile precision which uses the "best" 2/3 of the data (e.g., no influence from outliers)**
- **To what extent does <u>systematic bias</u> influence the collocated data precision estimates?**

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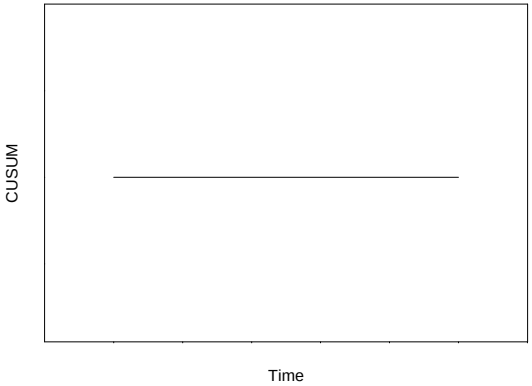
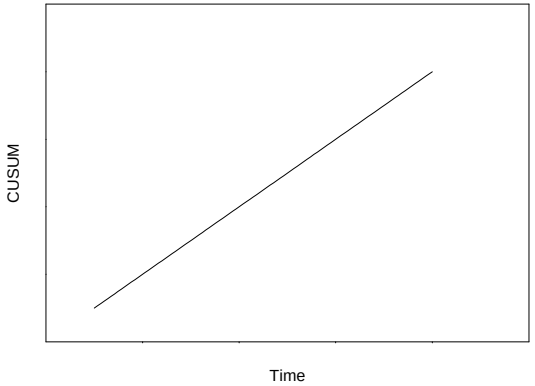
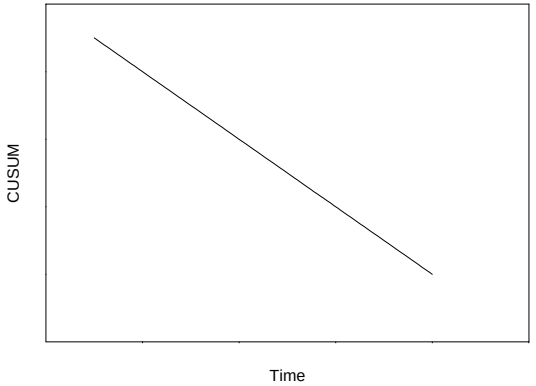


Horizontal: No difference between samplers

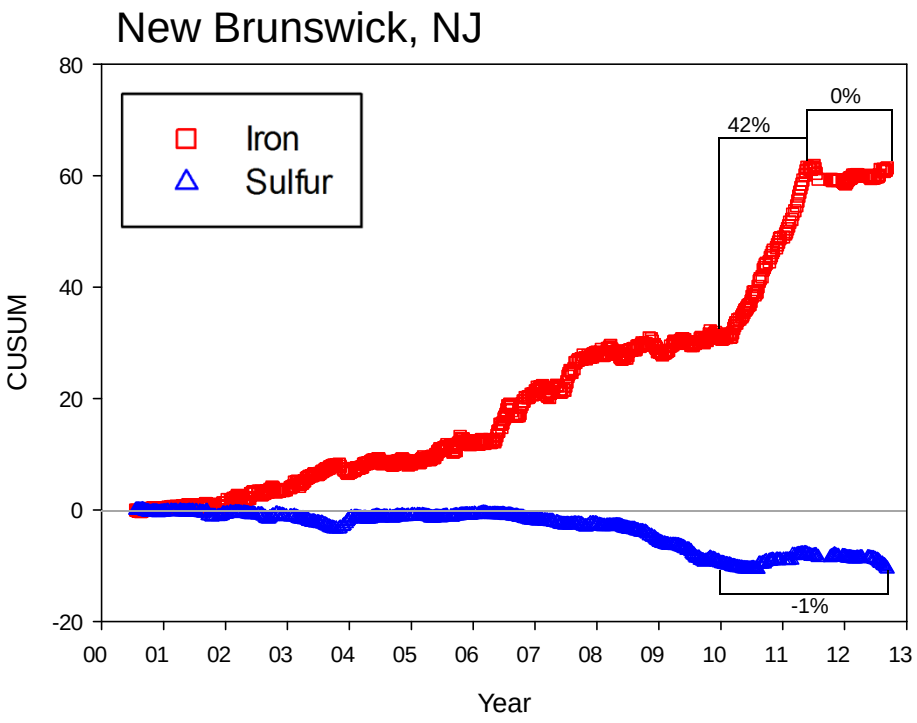


Positive Slope: Sampler A greater than Sampler B

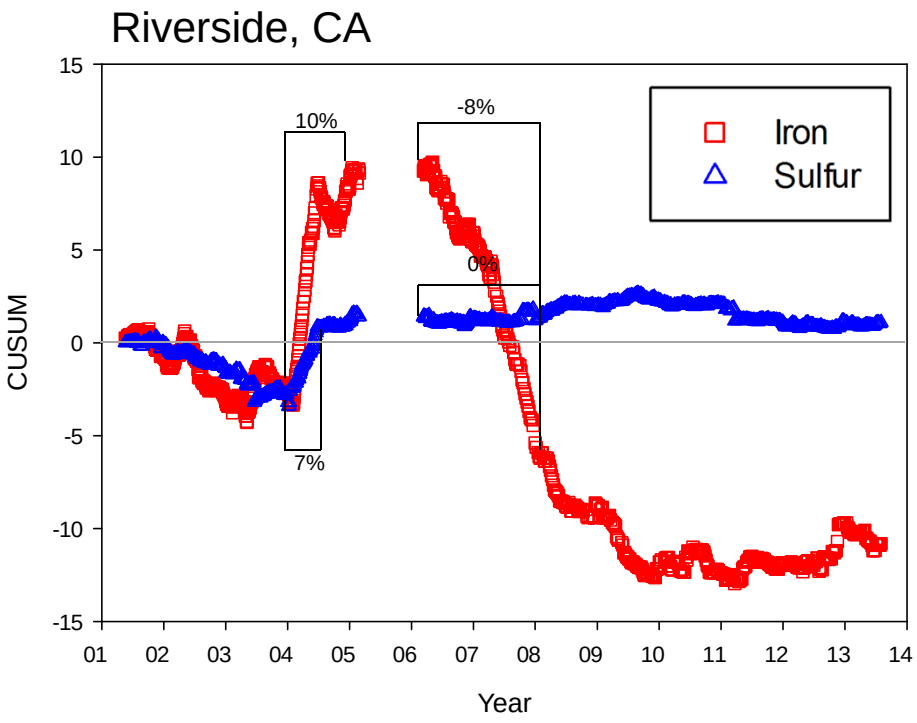


Negative Slope: Sampler B greater than Sampler A

TEMPORAL PATTERNS IN THE BIAS



Overall Bias:
Iron: 10%
Sulfur: -2%



Overall Bias:
Iron: -1%
Sulfur: 0%

SOURCES OF PERSISTENT BIAS

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- **Size discrimination**
- **Flow rate error**

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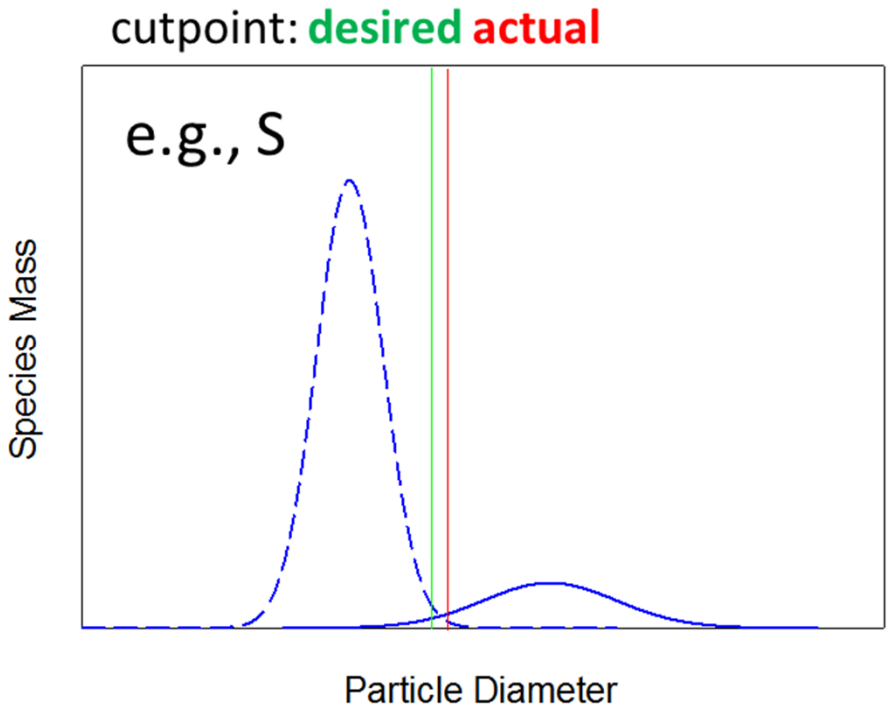
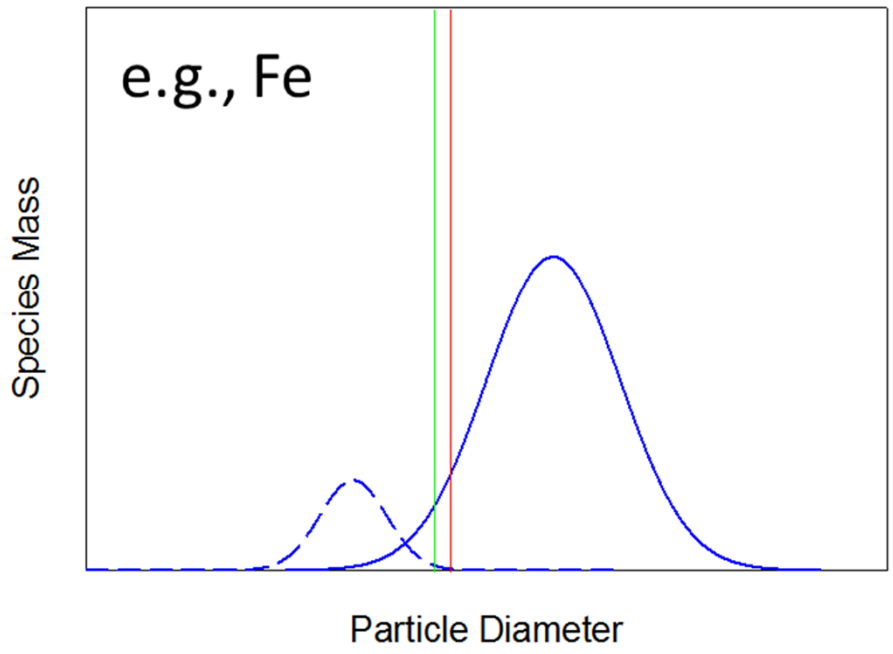
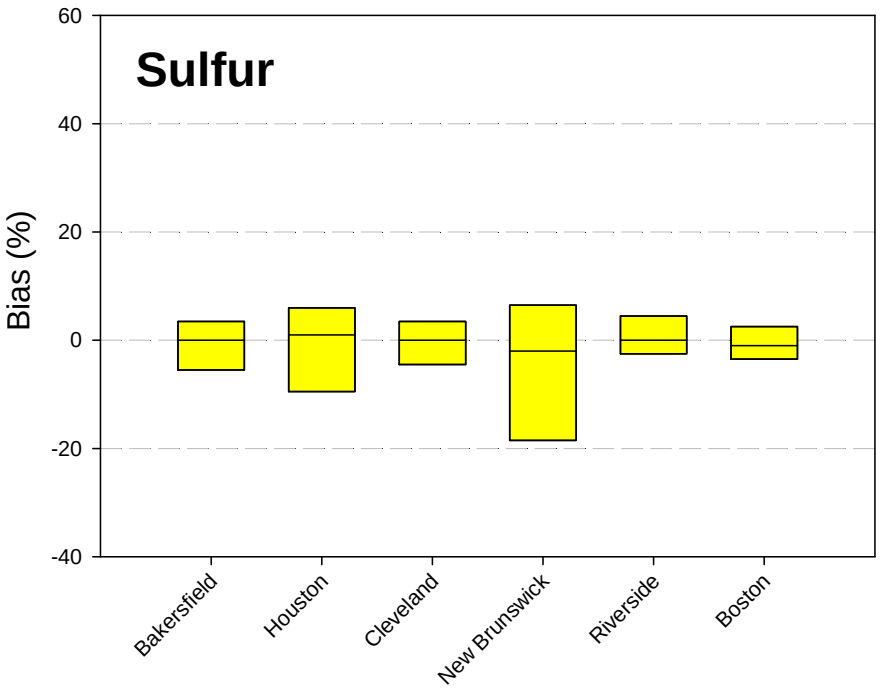
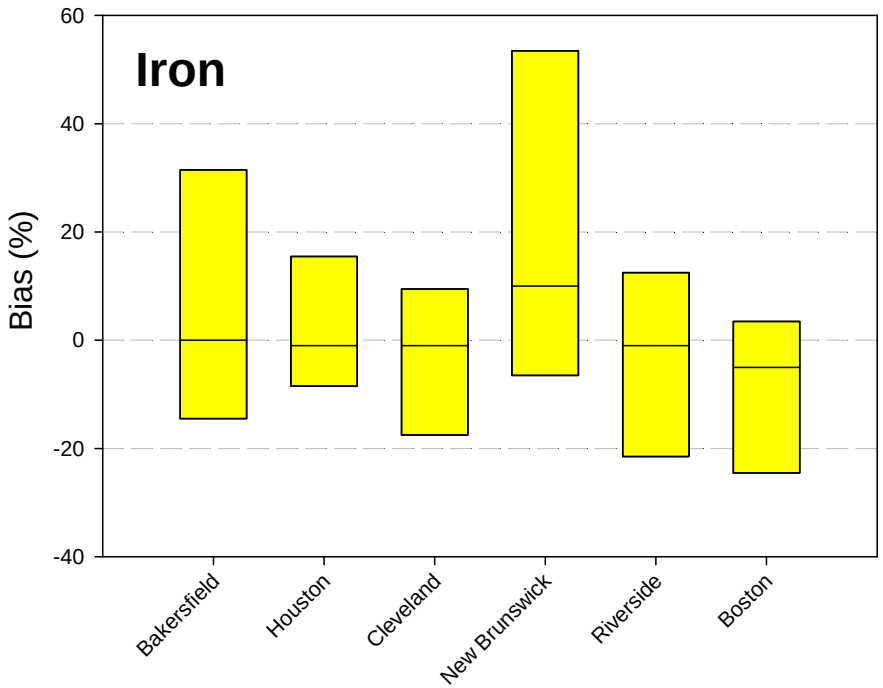
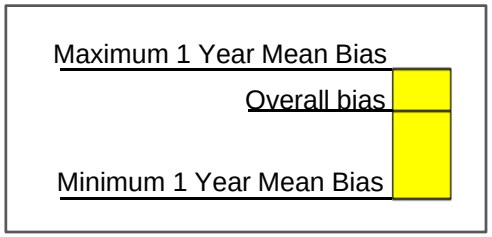




EXTENT OF PERSISTENT BIAS







*Censored to include: only values 3X the method detection limit; data points from days where iron, mass, and sulfur have recorded values at all three sites; n>80 within the 365 day window

CONCLUSIONS

- **For most species, the uncertainty estimates are missing one or more components of measurement error**
- **Periods of persistent bias, sometimes large, are observed throughout the network**
- **For long time series, the overall bias may not adequately characterize the influence of bias on precision estimates**
- **Future work: Identify the major drivers of bias to help optimize network operations**

ACKNOWLEDGEMENT

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