Evaluating Mesoscale Model Interface (MMIF) model performance and use in AERMOD

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Introduction

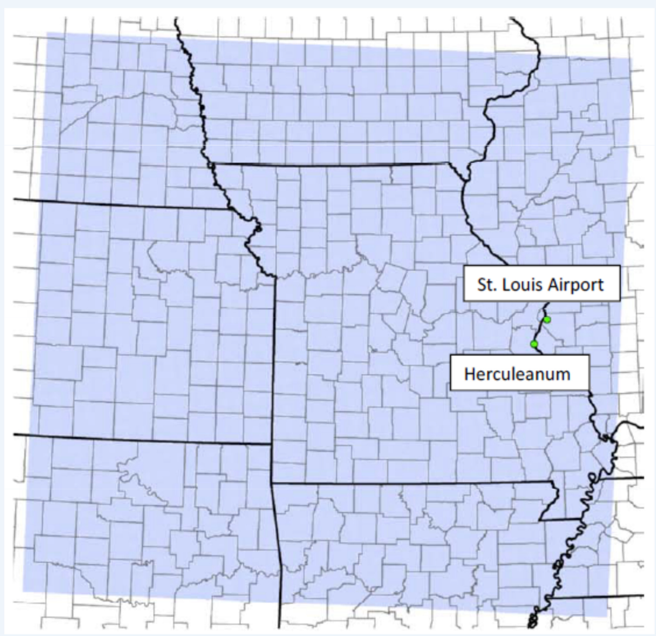
The New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs require that new sources or existing sources with proposed modifications must demonstrate that additional emissions emitted to the atmosphere will not cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS). The US EPA's Guideline on Air Quality Models (Appendix W to 40 CFR Part 51) currently specifies AERMOD as the preferred model for project-ing near-field dispersion of emissions for most NSR/PSD applications. One of the key modeling inputs to AERMOD is representative meteorological data which is generally derived either from National Weather Service (NWS) data or onsite meteorological data processed through AERMOD metrological preprocessor (AERMET).

This study looks at the performance of AERMOD using three different meteorological inputs (Onsite, NWS, MMIF) for a location in Herculaneum, MO, near the Doe Run Pb smelter. This study focuses on two Pb monitors operating concurrently in 2010, the Main St. and Mott St. monitors. The image to the right shows the locations of the monitors and meteorological station. The Doe Run plant is east of the Pb monitors.

Pb Monitor Locations and Met. Tower

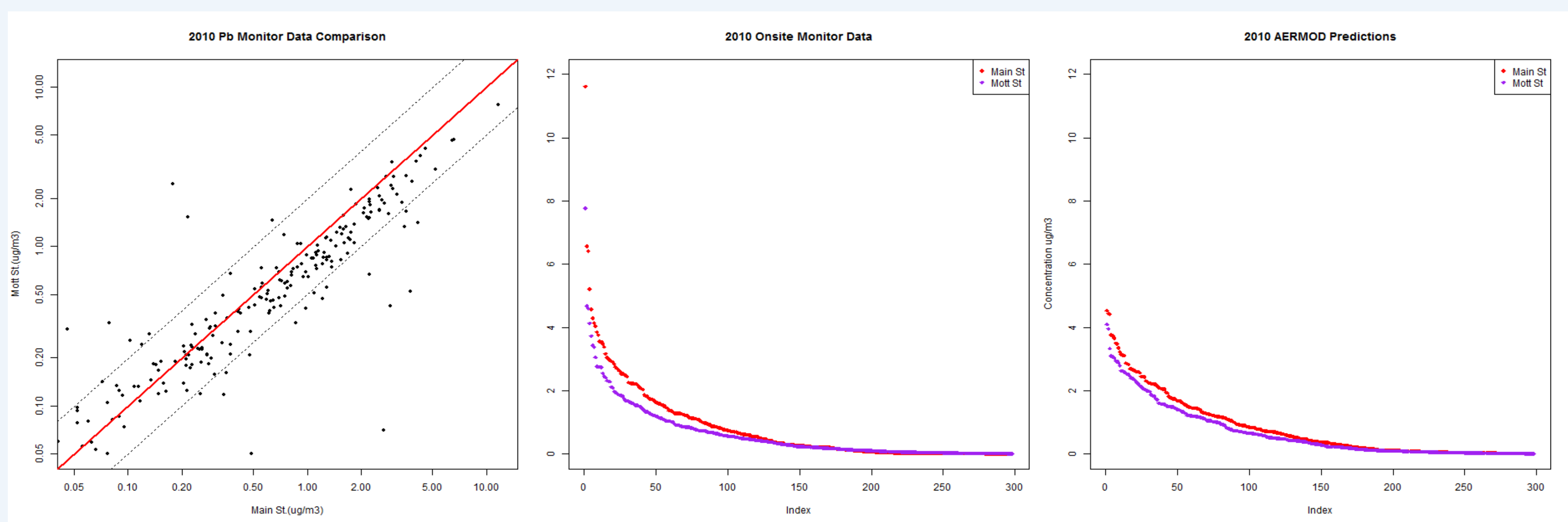
Approach

EPA Region 7 processed an annual 4km WRF simulation for 2010 that covers the entire state of Missouri. This WRF dataset was used to process a MMIF dataset that could then be used as an input to AERMOD to compare model predictions from onsite meteorological data against MMIF derived data. WRF version 3.5.1 along with MMIF version 3.0 was used for this analysis. WRF runs were performed on a LCC projection with 36,12,4km domains with the 36km domain centered at 40° N and 97° W. The 4km WRF domain was 220 x 211 staggered grid points. Key physics and model settings included, Morrison 2-mom, RRTM, ACM2, Kain-Fritsch, with 35 full sigma levels and both surface and 3D analysis nudging.



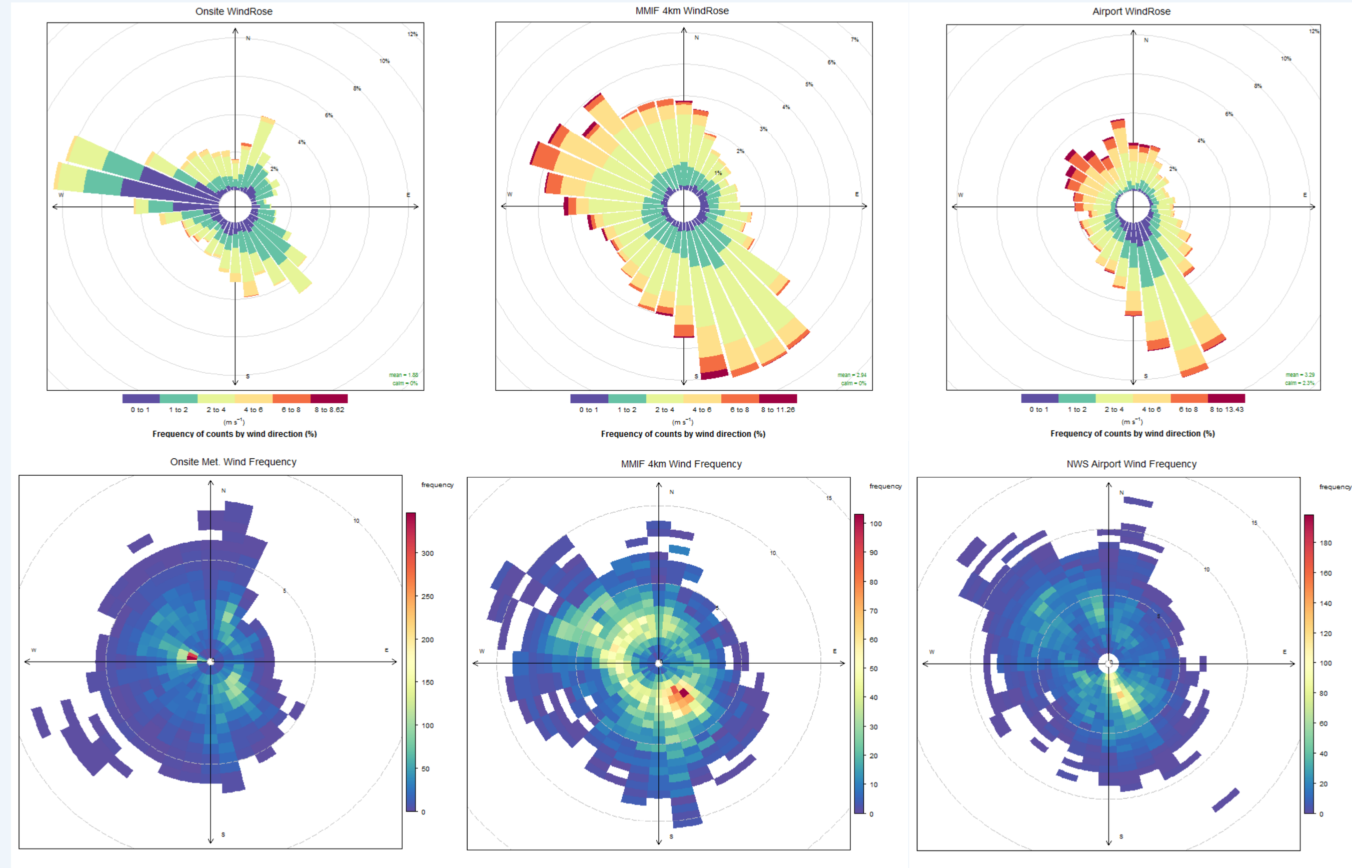
4km WRF Modeling Domain

Concurrent Pb monitoring data at the Main St. and Mott St monitoring locations were available on a daily basis for 302 days in 2010. This monitoring data was used for performance evaluations. Below are plots of the monitoring data comparing the available data in 2010. The Main St. monitor records higher concentrations for many days of the year even though the two monitoring locations are only approximately 80 meters apart, with the Main St. monitor located closer to the Dow Run facility. This same concentration gradient between monitor locations is seen in the AERMOD predictions using onsite meteorological data, although the peaks are under-predicted in AERMOD for both monitor locations.

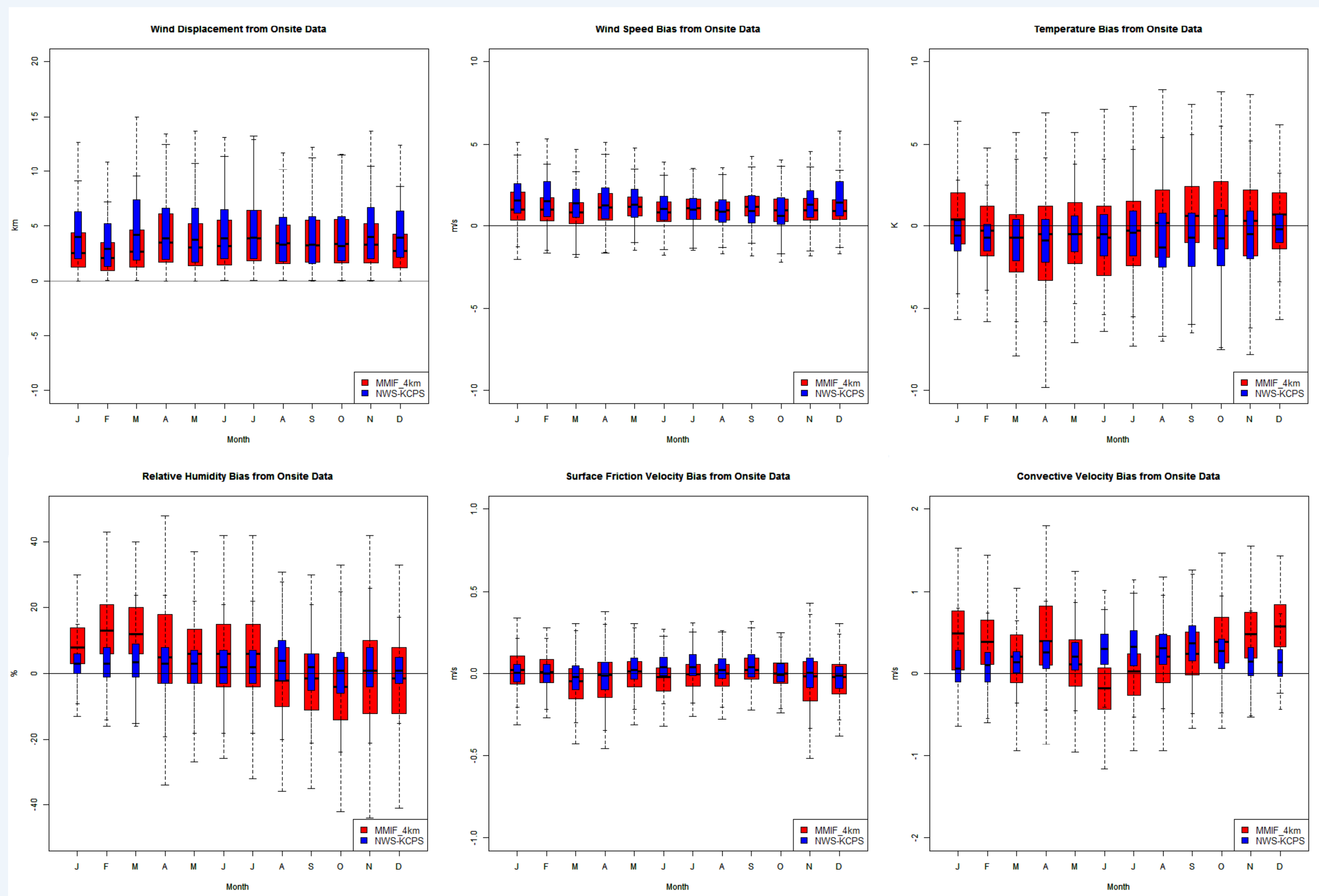


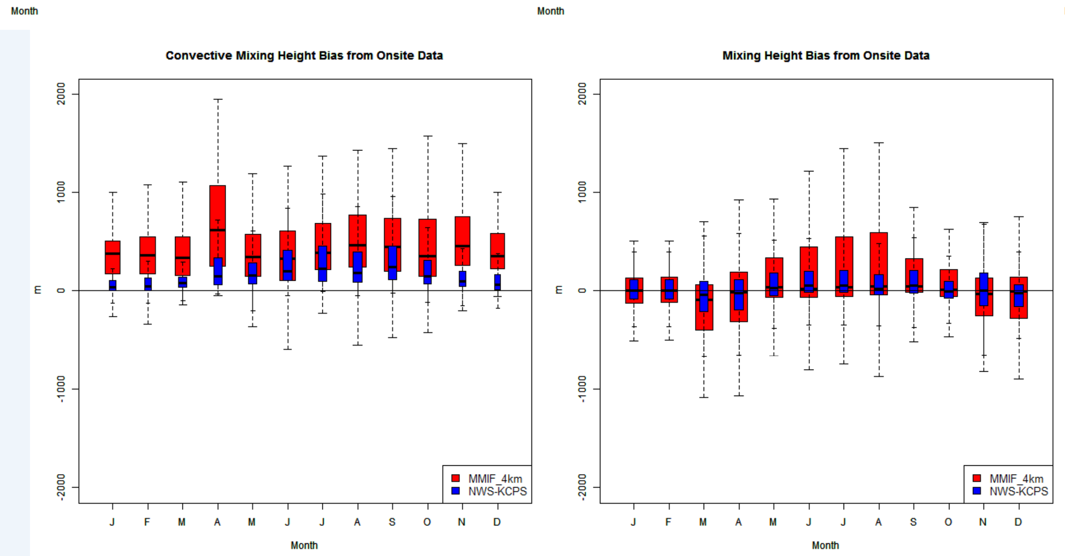
Results (Meteorology)

Windrose and frequency plots indicate that the MMIF generated winds are a better match with the onsite meteorology data although the onsite data has a clear westerly component not seen in either the MMIF or NWS datasets.



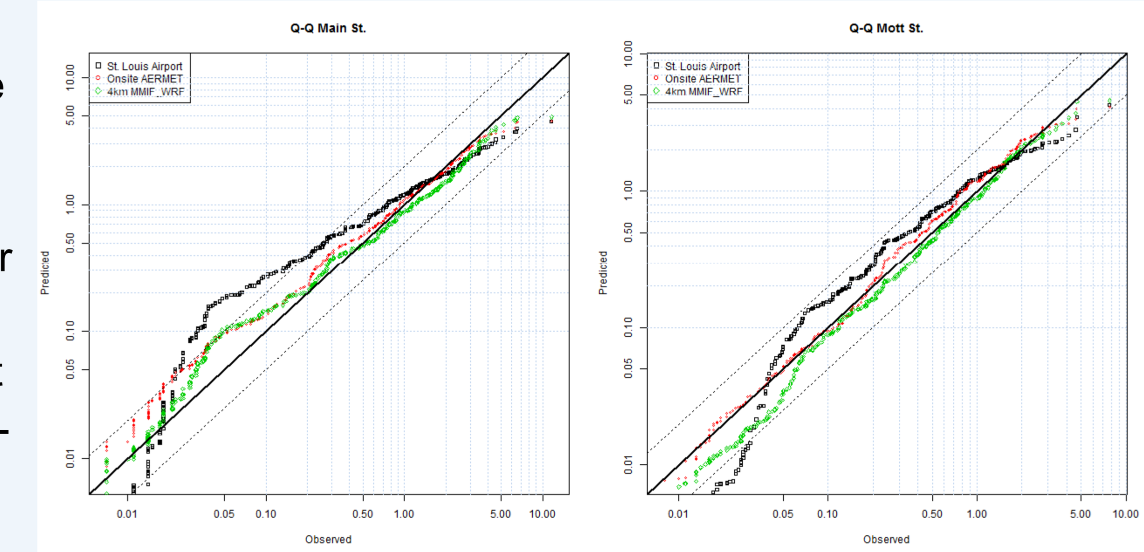
Monthly bias plots comparing the 4km MMIF and NWS to onsite meteorology data indicate the MMIF dataset is generally fairly close to the onsite data for wind speed and direction for most periods. Mixing heights are more variable in the MMIF dataset but in general the monthly mean is close to the onsite values.





Results (AERMOD)

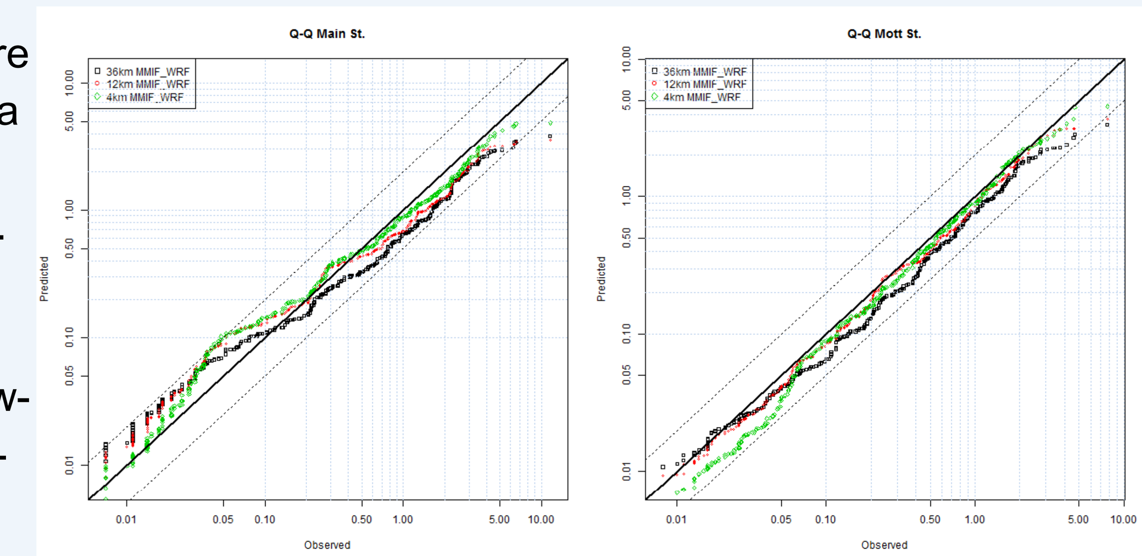
AERMOD was initially run using the three meteorological datasets. Comparisons of model performance for both monitoring sites are shown to the right. Results indicate acceptable performance of the 4km MMIF dataset, with performance of the 4km MMIF data indicating better performance than the NWS data. Overall the onsite data has the best model performance at both monitoring sites.



Robust Highest Concentration (RHC) statistics (n=26) were also calculated for the three meteorological scenarios. RHC ratios were all below 1 all indicating that AERMOD is under predicting the highest concentrations which is also seen in the Q-Q plots. This under prediction of the peaks is likely due to the underestimation of emissions since only a steady state estimate of emissions was available. The ratios also indicate that the predictions using the 4km MMIF dataset are most comparable to the predictions using the onsite measurements, and also seem to be more representative of this location than the predictions derived with the NWS dataset.

Location	Onsite	NWS	MMIF_4km
Main St.	0.79	0.56	0.75
Mott St.	0.91	0.59	0.78

Three different WRF resolutions were also used to generate the MMIF data files at 4km, 12km and 36km and AERMOD was run using these data. The 4km derived MMIF dataset appears to have the best performance with the 12km and 36km MMIF showing fairly similar Pb predictions overall.



Conclusions

- MMIF could be a viable representative meteorological input for AERMOD runs used in regulatory programs such as NSR or PSD.
- 4km MMIF dataset showed comparable AERMOD performance to onsite derived modeled outputs in the near field for a 24 hr averaging time.
- MMIF derived data may not be representative in other applications where complex terrain or shorter averaging periods are used.
- Onsite meteorological data provided the best AERMOD model performance.

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