Quantification of Transport Errors in Regional CO_2 Inversions Using a Physics-based Ensemble of Weather Research & Forecast (WRF)-Chem Simulations

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Atmospheric transport model errors are one of the main contributors to the uncertainty affecting CO_2 inverse flux estimates, but have not been quantified thoroughly. This study aims to assess the transport errors over the Mid-Continental Intensive domain with an ensemble of simulations created with the WRF mesoscale model using different physical parameterizations (e.g., atmospheric boundary layer (ABL) schemes and land surface models (LSMs)). Modeled meteorological variables and atmospheric CO_2 concentrations were compared to observations during the summer of 2008. The model-data mismatch for several meteorological variables was used to examine the spread of the ensemble and identify the model configurations that were systematically biased. Preliminary results show that the spread of the ensemble is too small for the wind speed (Figure 1a), but large enough for the ABL height (Figure 1b). Across the domain, the bias in wind speed, mainly influenced by the LSM, is within a range of ±2m/s, whereas the ABL height, highly influenced by the choice of the ABL scheme, is within ±500m. Finally, we evaluated the impact of transport errors in atmospheric CO_2 concentrations and found that transport errors represent about 55% of the CO_2 model-data mismatch, potentially impacting our inverse flux estimate unless carefully addressed.

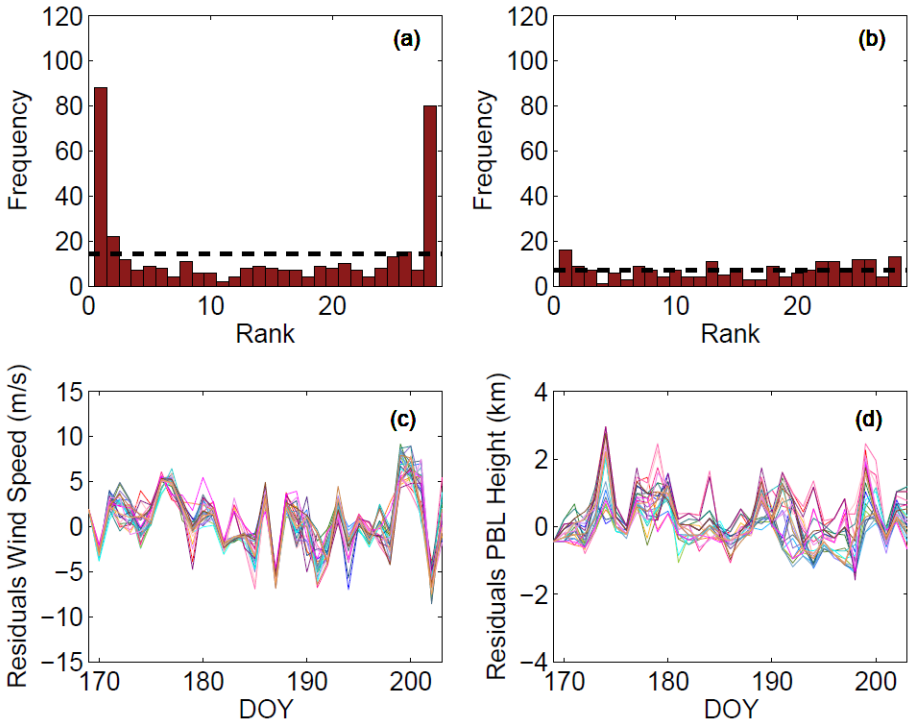

Figure 1. Rank histograms of all the sites for wind speed (a) and ABL height (b). The so-called "U-shape" rank histogram (a) implies that the ensemble under-estimates the model-data mismatch for the wind speed, whereas the flat rank histogram (b) implies that the ensemble represents the model-data mismatch in ABL height at the various observation locations. Wind speed (c) and ABL height (d) residuals (model-data mismatch) for 0000 UTC rawinsondes observations at Omaha, NE from 17 June to 21 July 2008. Colored lines represent each model configuration.