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Temporal scale analysis of AIRPACT5 Performance for O_3 and $PM_{2.5}$ in the Pacific Northwest

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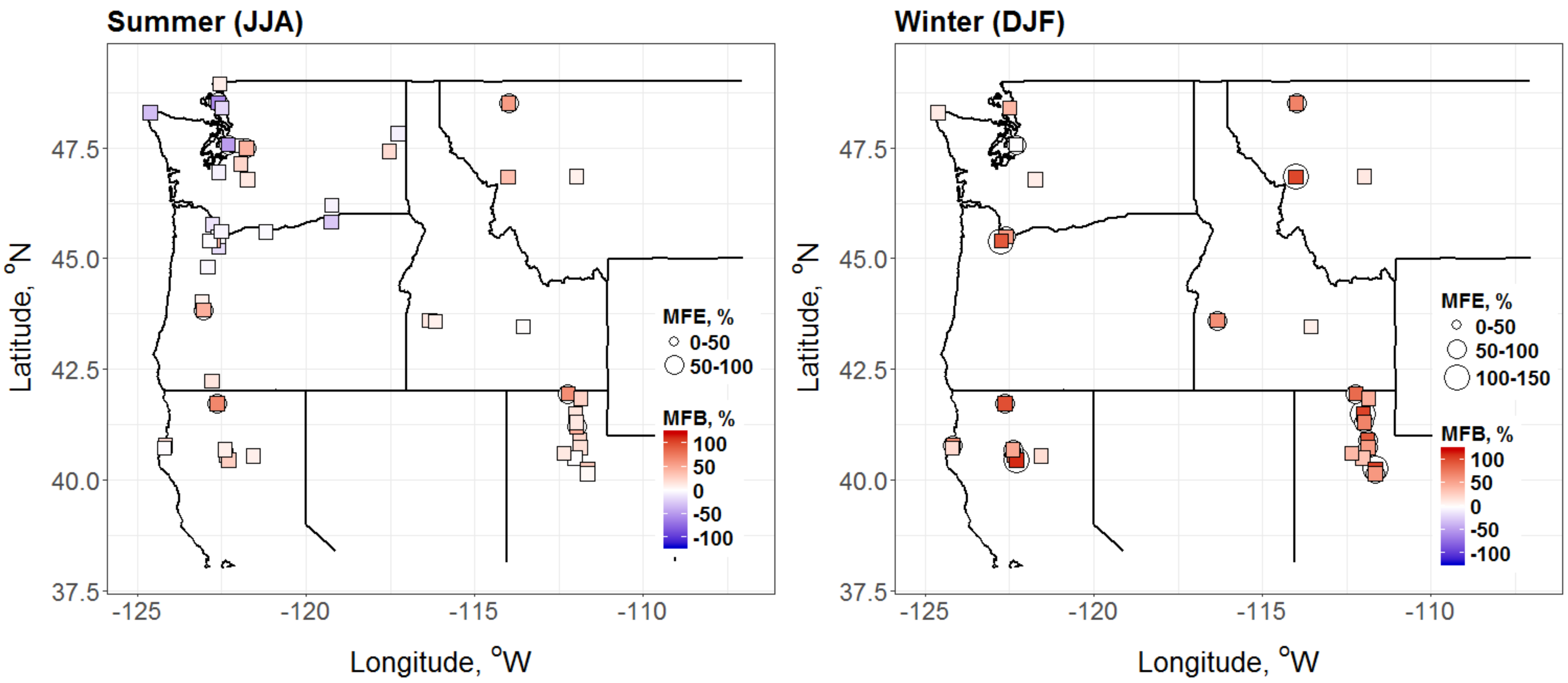
Ozone: Mean Fractional Error (MFE) and Mean Fractional Bias (MFB)



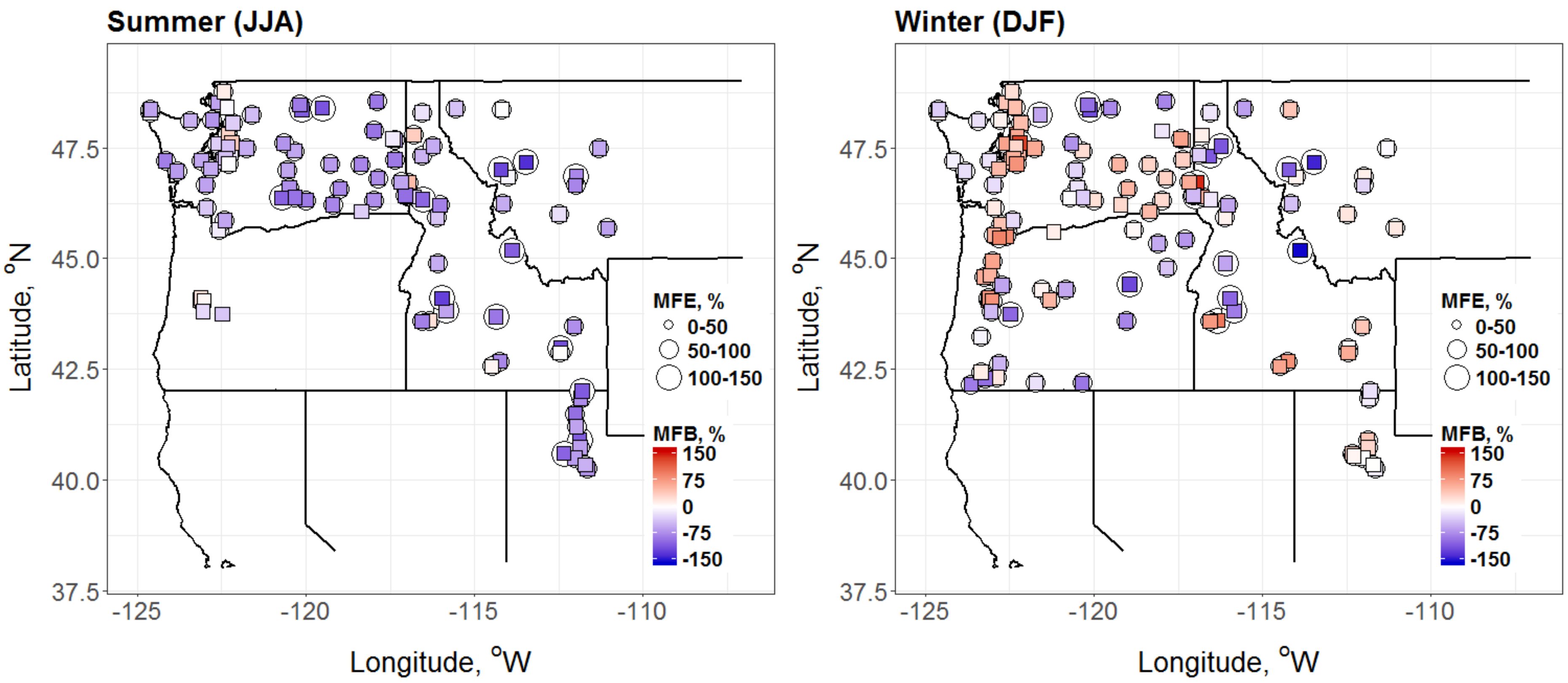
Operational Evaluation for 2016:

Summer (49 sites): Good agreement (MFBs > ± 30% at 11 sites)

Winter (28 sites): Overestimation (MFBs > ± 30% at 21 sites)

Benchmark for O3: NME <±15% and NME <35% (about same as MFB <±30% and MFE < 50%)

$PM_{2.5}$: Mean Fractional Error (MFE) and Mean Fractional Bias (MFB)



Operational Evaluation for 2016:

Summer (103 sites): Underestimation at most sites (~60% MFBs)

Winter (129 sites): Overestimated in urban (~70% MFBs) , underestimated in rural areas (~60% MFBs)

Benchmark for PM2.5: MFB <±30% and MFE < 50%

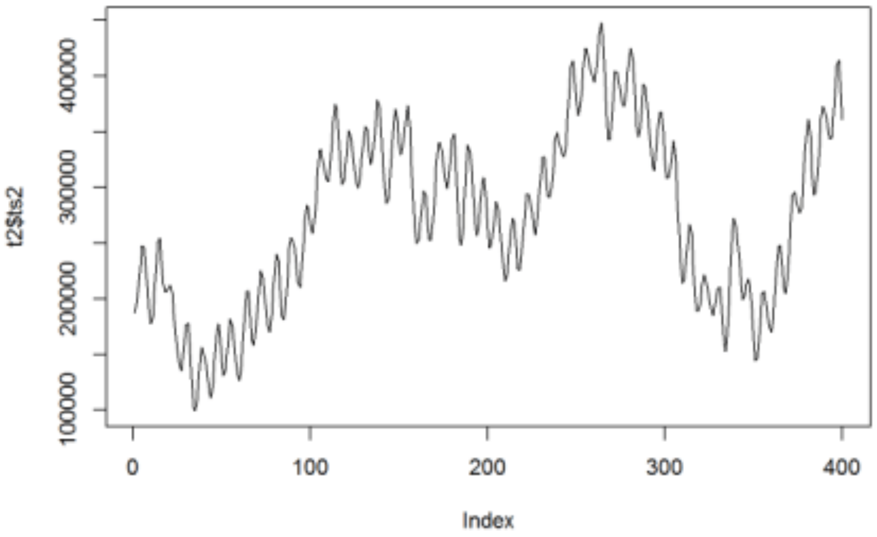
Objective

To assess the AIRPACT-5 ability for reproducing the important temporal scale components embedded in observed O_3 and $PM_{2.5}$ concentrations

Data and Method

- Hourly O_3 concentrations, ~50 AQS sites
- Hourly $PM_{2.5}$ concentrations, ~140 AQS sites
- The AIRPACT-5 outputs for 2016
- Spectral analysis (temporal scale separation) using the Kolmogorov–Zurbenko (KZ) filtering

Analyzing a time series in distinct temporal scales



A time series = Mean + Various temporal scale fluctuations + Trend

$$Y_i = \frac{1}{m} \sum_{j=-k}^{k} X_{(t+j)}$$

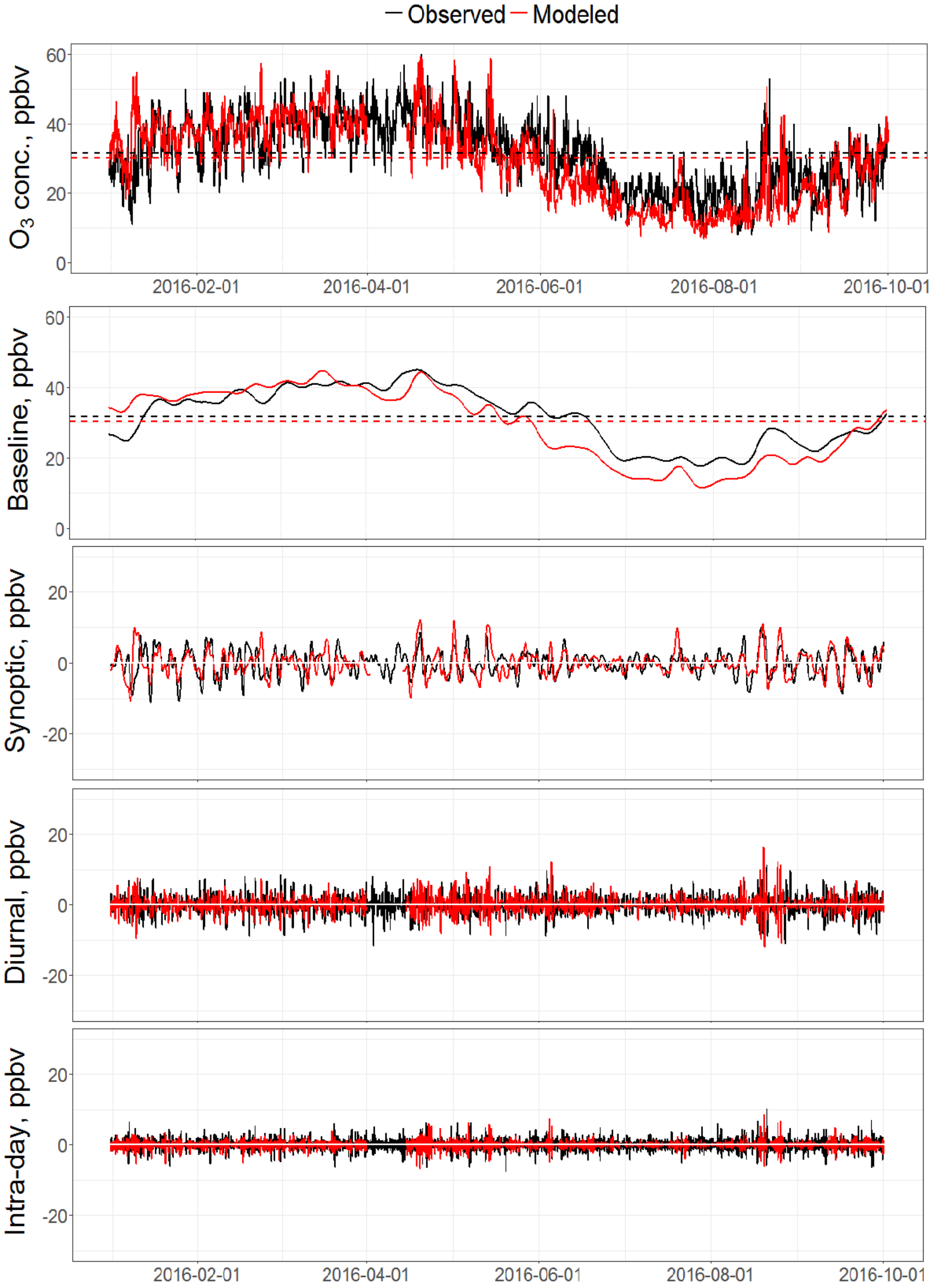
Kolmogorov–Zurbenko (KZ) filter

(Zurbenko, 1986)

Example:
O_3 time series decomposition

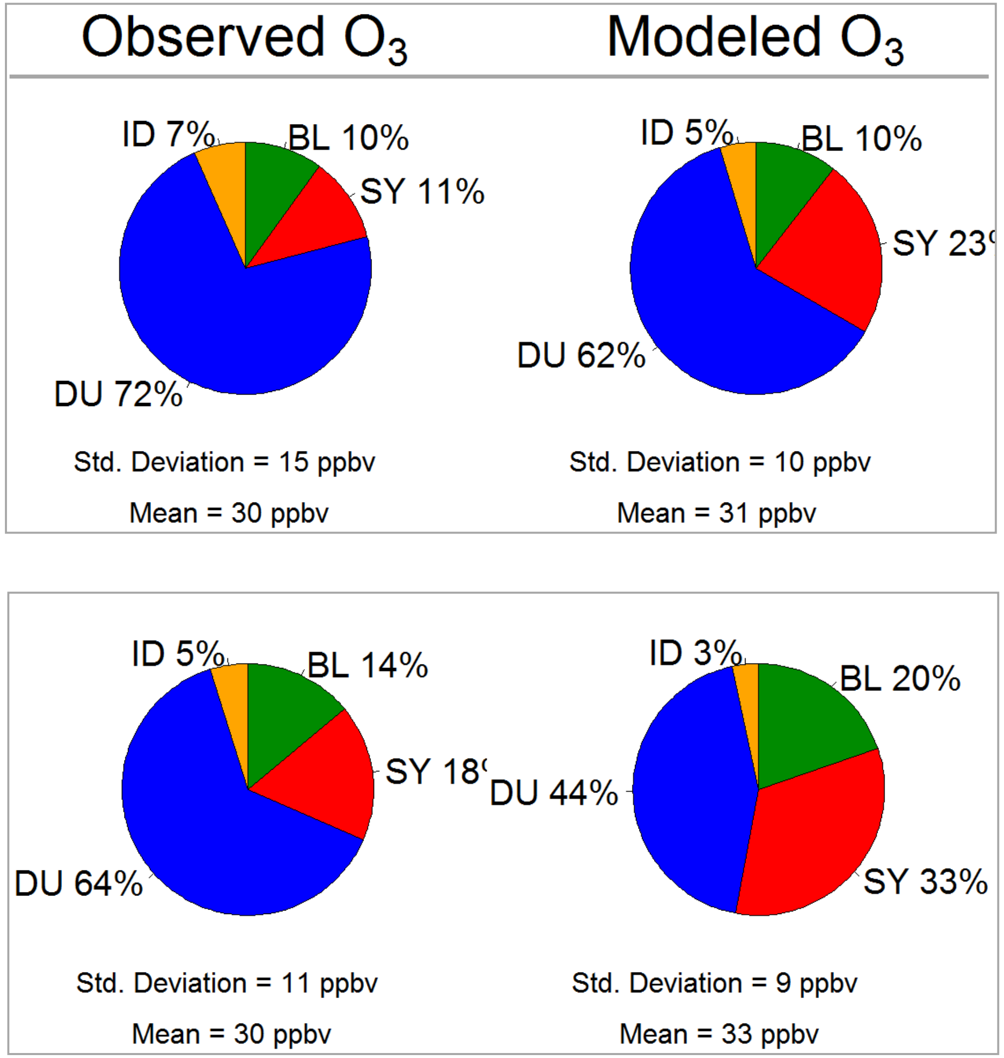
(Site # 530090013, RURAL/Forest, WA)

Baseline (>21 days)	— Seasonal variation of solar radiation — Deposition due to changes in surface properties — Slow changing precursors' emissions
Synoptic (3-21 days)	— Changes in weather conditions (stagnant high pressure system, frontal passage) — Associated changes in mixing heights, cloud cover, and circulation patterns
Diurnal (11-36 hrs)	— Diurnal pattern of solar radiation — Difference between daytime production & nighttime removal for O_3
Intraday (<11 hrs)	— Convective mixing — Local emissions changes — Photolysis rates associated with the actinic flux

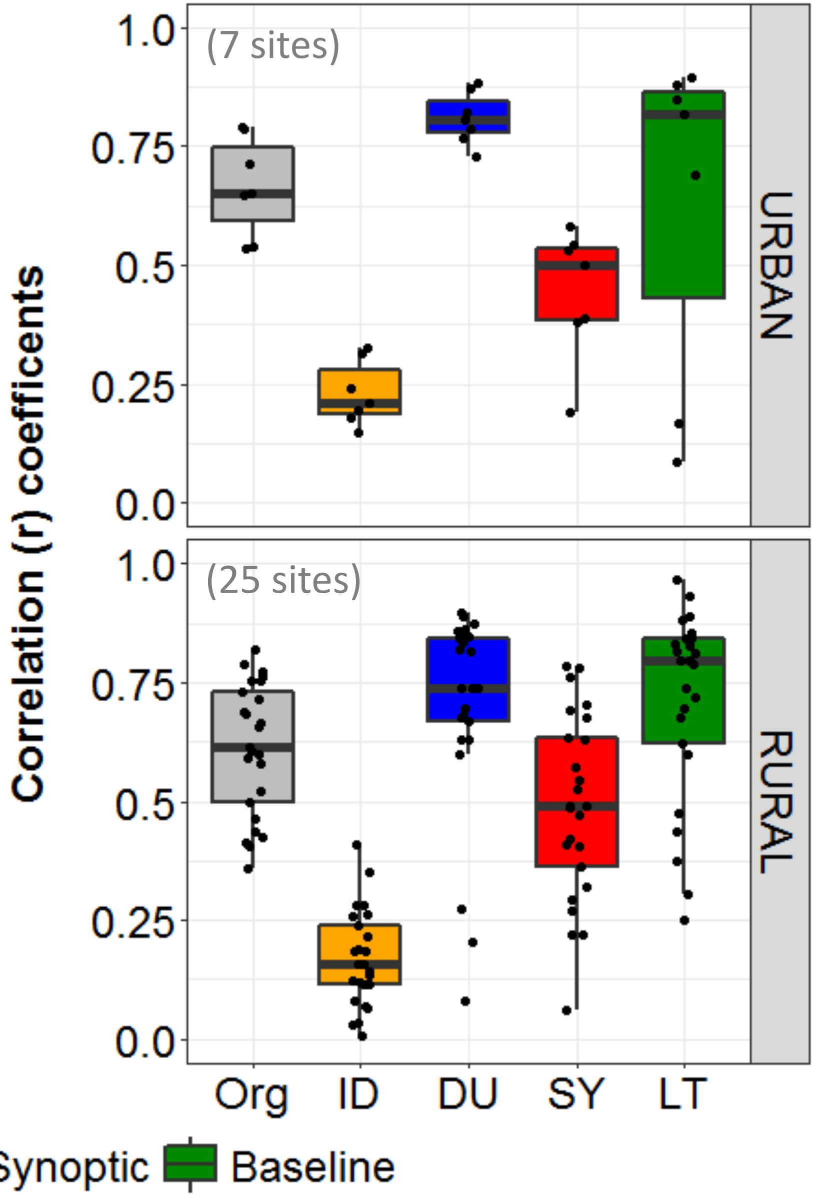


Summertime O_3:

Variance Contributions



Component Correlations



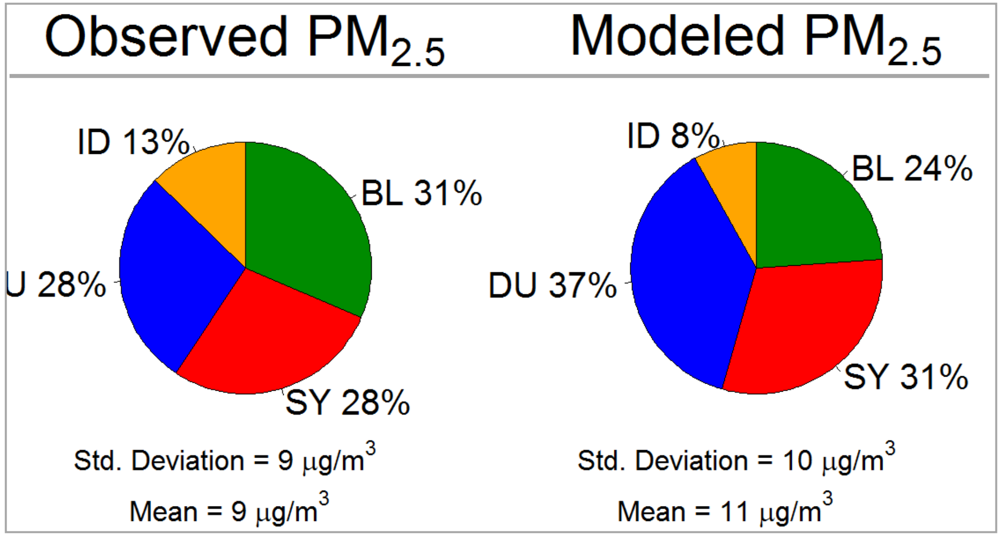
Findings for summertime O_3:

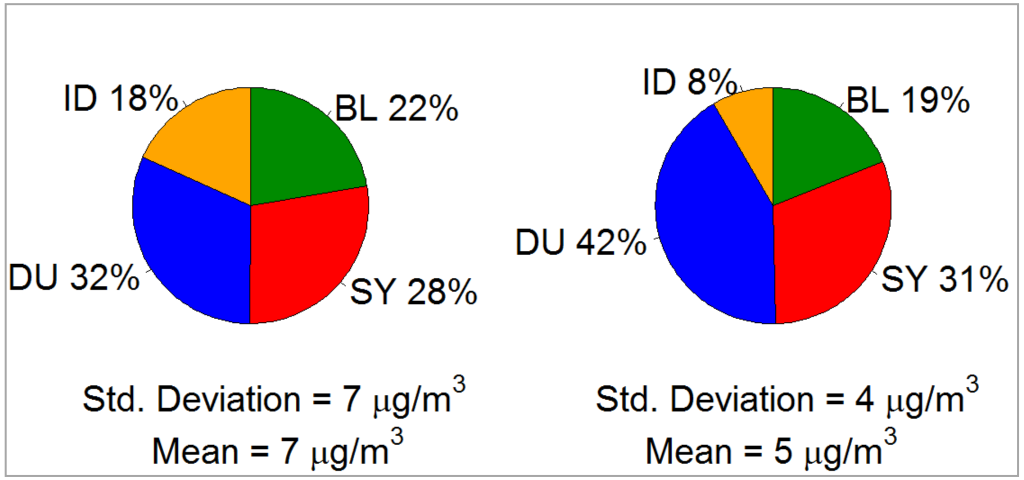
- Variance contributions for observed O_3:
  - Diurnal (~67%), Synoptic (~15%), Baseline (**~12%**), and Intraday(~5%) components.
  - Diurnal component is higher in urban vs. rural areas (72% vs. 64%).
  - The baseline/synoptic components tend to be higher in rural vs. urban areas (18% vs. 12%).
- Model underestimated variance contribution for diurnal (~16% less) and overestimated for synoptic (~15% more) and baseline (~6% more) components.
- Diurnal component was the best correlated because of inherent cyclical nature of the diurnal process for O_3 production/destruction.
- Correlations at the baseline scale are better than those for synoptic and intraday time scales, but vary by site (median *r* = 0.6, MAD = 0.3).

HOURLY PM2.5 CONCENTRATIONS
(88101:FRM/FEM ~40 SITES)
(88502: NON-FRM/FEM ~100 SITES)

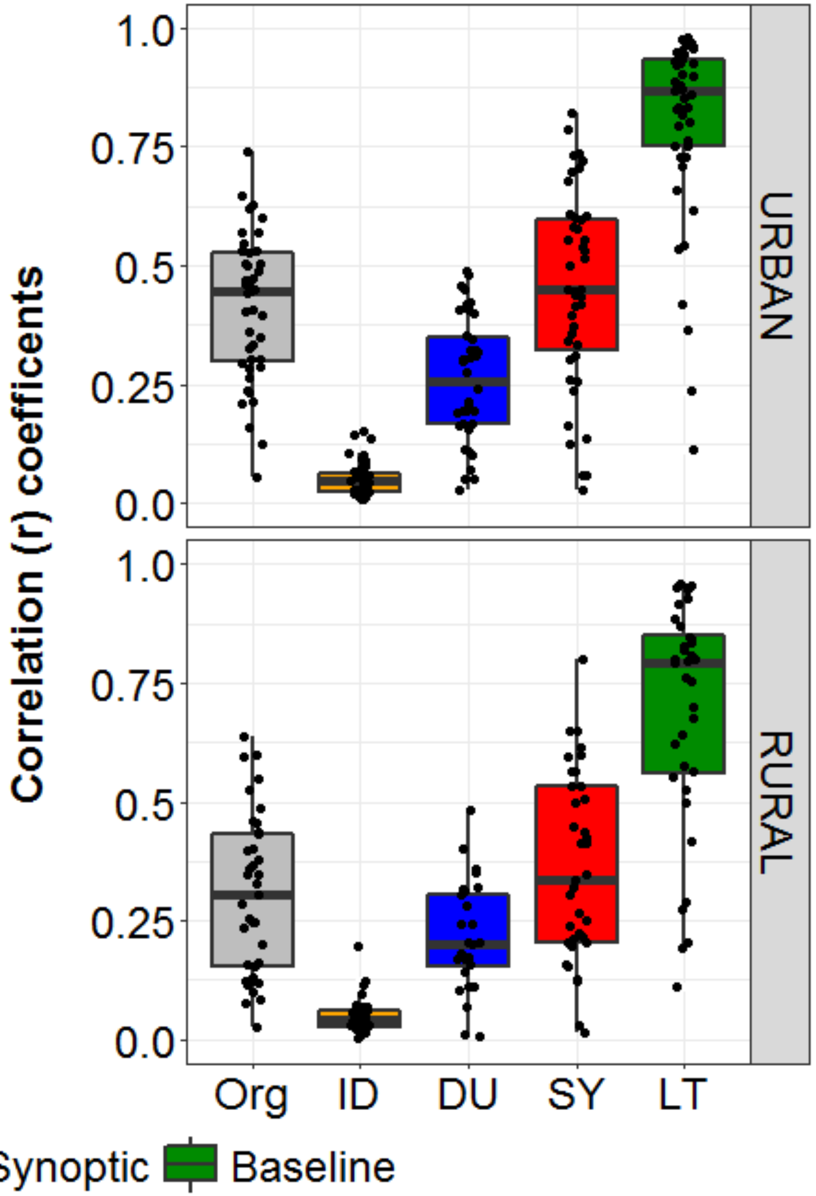
Wintertime $PM_{2.5}$:

Variance Contributions





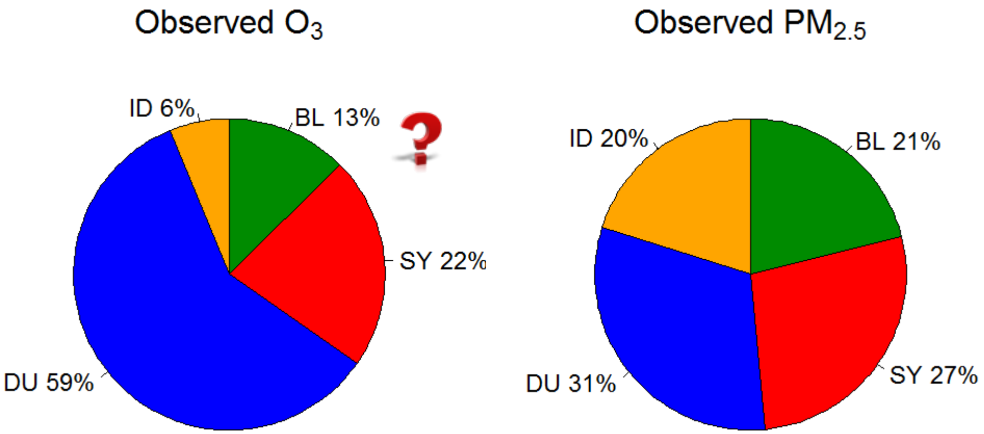
Component Correlations



Findings for wintertime $PM_{2.5}$:

- Variance contributions for observed $PM_{2.5}$:
  - Diurnal (~30%), baseline (~26%), synoptic (~25**%**), and Intraday(~15%) components.
  - Contribution of intraday component increases from urban to rural sites (13% to 18%).
- Model tends to give slightly higher mean for urban/suburban sites and lower for rural sites.
- The model underestimated variances of the intraday, diurnal, and baseline components (~10% less for each) and overestimated for synoptic component (~7% more).
- Correlations between modeled vs. observed components increase from diurnal to baseline, but display a large variability (median R =0.2-0.8, MAD = 0.3).

Spectral analysis shows…

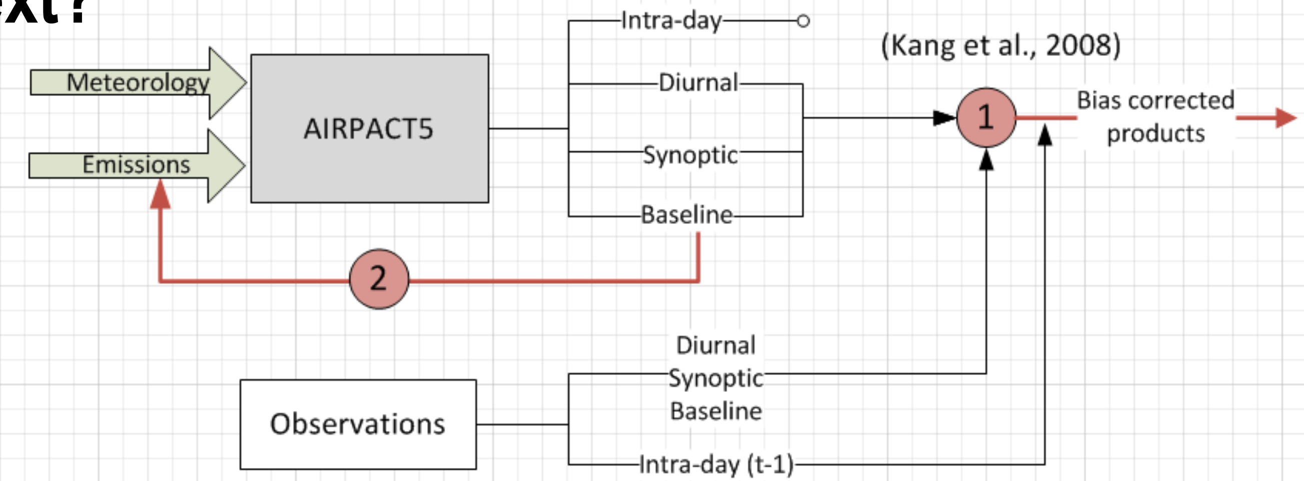


Variance contributions from different temporal scales based on entire time series

- The diurnal and baseline components are the most important temporal scales for O_3 and $PM_{2.5}$ concentrations.
- Improving the baseline component:

Baseline (>21 days)
— Seasonal variation of solar radiation — Deposition due to changes in surface properties — Seasonal allocation of O_3 precursors' emissions

What next?



THANK YOU.

FEEDBACKS AND QUESTIONS?