The Variable Relationship Between Observed and Reanalysis Wind Speeds: Effects on MCP Bias

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Introduction: What is MCP?

**Measure:** Met towers measure the local wind resource (typically for a period of 2-5 years)

**Correlate:** Local met data are correlated to a long-term reference dataset (ASOS or re-analysis data)

**Predict:** Correlation parameters are used to predict how the local wind resource will vary over a long-term time period

*Image Credit: Jie Zhang*
Key Assumptions of MCP

**Assumption:** Reference data can be extrapolated and downscaled using primarily statistical methods

**Reality:** Downscaling a 50-km resolution re-analysis dataset to a discrete point is a complex process

**Assumption:** What happened in the past will happen in the future

**Reality:** Wind resource is expected to shift as a result of climate change¹

**Assumption:** Correlation parameters developed during the training period are applicable across all time periods

**Reality:** Training parameters can vary depending on the particular training period

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Assumption: Consistent Bias Between Target and Reference Sites

-- MERRA -- Observed

Quarterly Avg. Wind Speed (m/s)

Year

Reality: Variable Bias Between Target and Reference Sites

-- MERRA -- Observed
Effect of Training During a Low Bias Period

P50 Bias from this Training Set: -5.5%
Effect of Training During a High Bias Period

P50 Bias from this Training Set: +2.2%
How Does Training Period Affect Bias for 21 Towers?

- Northern Plains (6)
- Central Plains (4)
- Southern Plains (9)
- Midwest (2)
Overlapping Time Period: July 2012 – July 2015

- Common 3-year time period was selected for training and testing MCP methods
- Period contains part of the “wind drought” of 2015
Application of MCP

- MCP applied twice to each tower
  - Test 1: Train on first 2 years, test on last year
  - Test 2: Train on last 2 years, test on first year

- Proprietary MCP method was used
  - Takes diurnal and seasonal effects into account
  - Debiases in the energy space

- 2.5 MW power curve applied to observed and trained wind speeds to calculate P50 bias

- $P50 \text{ Bias (})\% = \text{mean}(\text{Power}_{\text{mdl}} - \text{Power}_{\text{obs}}) / \text{mean}(\text{Power}_{\text{obs}})$
Results: Out-Of-Sample P50 Bias by Tower

Sign of bias changes for nearly every tower when training and testing sets are swapped.
How Is Wind Speed Bias Changing With Time?

Southern Plains Tower

MERRA bias becomes less negative over the 3-year test period*

*Research using long record length towers suggests that changes in MERRA bias are likely cyclical over longer time periods
Why Is Wind Speed Bias Changing With Time?

Southern Plains Tower

Last year of dataset has lower average wind speeds, which are not adequately captured by MERRA.
Potential Link to Climate Oscillations

Southern Plains Tower

- MERRA
- Observed

Wind Speed (m/s)

Start of Rolling Average

2010  2012  2014
Potential Link to Climate Oscillations

Southern Plains Tower

MERRA Wind Speed Bias (%) vs. Start of Rolling Average (2010-2016)
Potential Link to Climate Oscillations

Southern Plains Tower

MERRA Wind Speed Bias (%)

-14
-12
-10

Start of Rolling Average

La Niña

El Niño
Mitigation Strategies

- Assign higher uncertainty to towers with short record lengths, particularly if towers collected data during an anomalously low or high wind period.

- When longer record length towers are available, examine bias time series.
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**Diagram:**
- Average bias of Tower 2 is similar to long-term average → Expect similar P50 estimate to Tower 1.
Mitigation Strategies

- Assign higher uncertainty to towers with short record lengths, particularly if towers collected data during an anomalously low or high wind period.

- When longer record length towers are available, examine bias time series. Average bias of Tower 3 is less negative than long-term average → Expect lower P50 estimate than Tower 1.