Expansion of Common Measure-Correlate-Predict Analysis Considerations

Effects of Period of Record Extension and Model Diversification

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INTRODUCTION

Current industry practice involves using at least a single year of on-site GHI measurements along with a minimum of one historical satellite model to develop long-term solar resource estimates. This study has focused on two areas in which industry practices may benefit from further consideration for a typical Measure-Correlate-Predict (MCP) analysis:

(1) On-site measurement campaign length

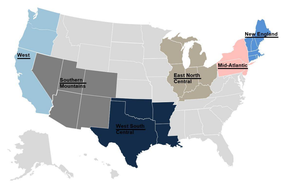
(2) Inclusion of multiple modeled long-term datasets

Objective: Assess the seasonality impacts of various campaign lengths, the potential for a long-term estimate to vary depending on reference data selection, and the potential benefits of relying on more than one dataset for MCP selection.

METHODS AND ANALYSIS

Test Setup:

- 10 sites, each with a minimum of two years of on-site data and covering varying regions of the U.S.
- Long-term reference data: four individual satellite models, labeled models A, B, C, and D
- MCP analysis: Annual linear regression using daily sums
- "Ensemble" represents the mean of the long-term MCP results of all four models



Moving Window Analysis:

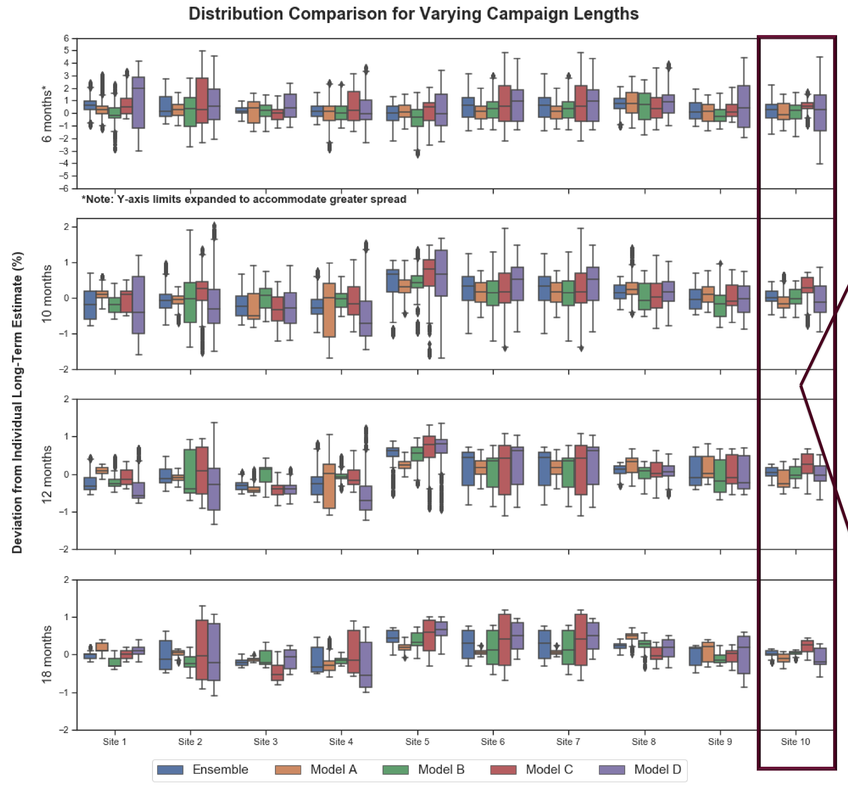
- For each test period of record (POR) length, start and end dates were iterated daily within the available two-year period of record.
  6-mon. example: 1/1/21 – 6/1/21, then 1/2/21 – 6/2/21
- The variation of resulting long-term estimates were used to assess the seasonal sensitivity of the length and timing of the campaign.
- Deviations were calculated for each model by comparing to each model's individual POR long-term value against its own single two-year estimate.

FINDINGS

The effect of campaign timing on MCP sensitivity is decreased when using a longer campaign and using multiple long-term reference models.

Figure 1 *Distribution Comparison for Varying Campaign Lengths*—Summary of the impacts of timing and POR length across all 10 sites.

At various sites, **the single model maximum deviation for the 6-month period reached an approx. 5% and was reduced to approx. 3% with the addition of 4 more months.** These values were further reduced to approx. 1.5% and 1.0% for the 12-month and 18-month periods, respectively.

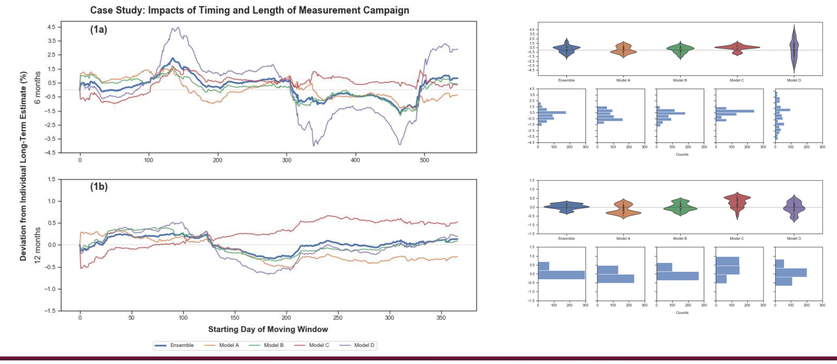


- **In all cases, as the measurement period length increased the uncertainty due to seasonal variability in GHI decreased.**
- For a longer POR, the distribution of each individual long-term dataset tended to be closest to its reference 2-year value.
- **A single modeled dataset may experience regional strengths and weaknesses.** Though it may result in consistent and stable results in one region, it might exhibit higher sensitivity in another.
- At most sites, the ensemble approach provided one of the narrowest variation ranges for the 6, 10, 12, and 18-month moving window periods presented.
- Though the ensemble was sensitive to the distribution in the individual datasets, the sensitivity decreased as the POR got longer. Selection criteria for inclusion into the ensemble can strengthen the benefits.

Figure 2 *Example of moving window analysis results for a single test site in Southwestern U.S.*

At this site, for the 6-month assessment window (1a), the max deviation from any single model was approx. 4.5% while in the 12-month period (1b) this max was reduced to approx. 0.7%. Therefore, the risk for a 6-month campaign utilizing only 1 long-term reference model here is seen to be up to 4.5%.

Further, the max 0.7% risk of a single model for a 12-month campaign at this site is reduced to a max of approx. 0.4% using the ensemble approach in this study.



CONCLUSIONS

- The potential for a long-term estimate to be affected by individual model trends for any given measurement period is exacerbated when assessed at a shorter period of record. A year of measurements could still be subject to some of these trends, but overall, as more data is measured, the fluctuation range decreases.
- Any single model may produce a wide variation range depending on the region, on average, utilizing more than one model may
- mitigate and narrow that spread.

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