# Performance of Tuned vs. Untuned Windspeed Forecasts

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## Background

The Global Weather Corporation (GWC) produces wind power forecasts by combining hub-height windspeed forecasts from weather models and tuning to observational data received in real-time. In this study, we evaluate the benefits of forecast tuning as a function of local terrain by comparing forecasts with and without tuning for three sites in Europe. With tuning, the day-ahead forecast MAE for two sites in complex terrain improved by 17% and 23%. For the third site, in homogeneous terrain, the day-ahead tuned forecast accuracy was similar to the untuned forecast. This result suggests the applicability of low-cost untuned forecasts in regions lacking significant terrain variability while highlighting the value of tuning in complex terrain.

## GWC Tuned Wind Forecasts

- DICast software tunes to local obs, generating dynamically weighted, bias-corrected model average

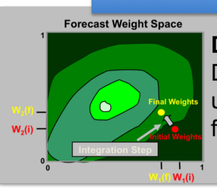
**DICast**: **D**ynamic, **I**ntegrated Fore**Cast** System

**1) Ingest raw forecasts and observations**

Weather Model 1 | Weather Model 2 | Weather Model 3 | Weather Model 4 | Weather Model 5

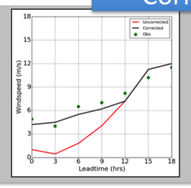

**Regression calculation:** forecasts generated from available model inputs bias-corrected to observations
**Dynamic MOS (DMOS) forecast generated:** updated on past 90 day history

**2) Forecast Integration**




**Dynamic weighting:** DMOS forecasts weighted using fuzzy logic; optimal forecast derived

**3) Forward Error Correction (FEC)**




Forecast at **short lead times** corrected for consistency with observations

## Objectives

- Evaluate performance of tuned (weighted model average and bias corrected) versus untuned (unweighted model average) forecasts for three sites with different local terrain features. **Does hub-height windspeed forecast tuning provide greater benefit in uniform terrain, complex terrain, or both?**
- Assess performance of the DICast system in isolation, and not the subsequent power conversion algorithm. Therefore, only statistics for the hub-height windspeed forecasts are presented.

## Verification Methodology

### Three Sites:

- Homogeneous Terrain, Plains: Poland
- Complex Terrain, Coastal: Greece
- Complex Terrain, Hills/Valleys: France

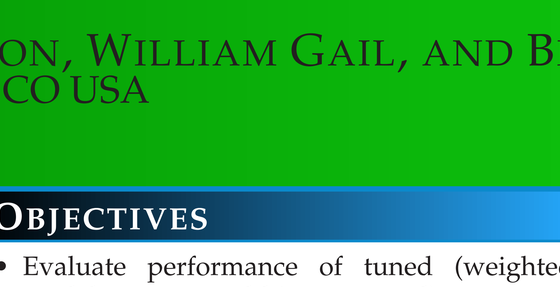



**Figure 1:** Maps showing a) the general location of all three sites and a close-up view of topography in the vicinity of b) the Plains site, c) the Coastal site, and d) the Hills/Valleys site. Notable terrain features are indicated, and the location of each wind farm is indicated by the 4-pointed red star. Note: Maps do not occupy the same scale, but roughly, panels b), c), and d) are 40 miles accross. Images from Google Maps.

### Day-Ahead Verification:

- Standard metric Mean Absolute Error (MAE):

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|Fcst(i) - Observed(i)|$$

- Verified 0800 UTC forecast, valid midnight to midnight next UTC day

### Initial results: June 2015 – May 2016

| Site Terrain | Untuned MAE (m/s) | Tuned MAE (m/s) |
|---|---|---|
| Plains | 1.31 | 1.31 |
| Coastal | 2.10 | 1.74 |
| Hills/Valleys | 1.94 | 1.49 |

## Results – Day-Ahead

### Results by Month

- Tuning resulted in significant reduction in MAE and bias at the Coastal and Hills/Valleys sites
- Bias reduction only observed at the Plains site (see Discussion)

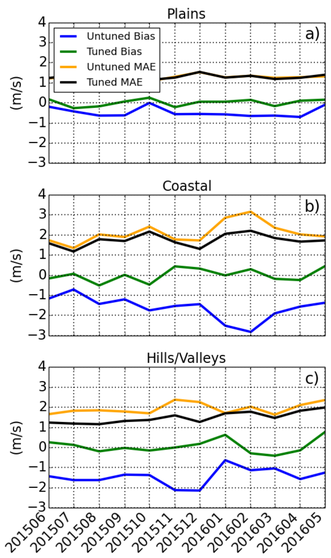



**Figure 2:** Time series of monthly untuned bias (blue) and tuned bias (green); untuned MAE (orange) and tuned MAE (black) for a) Plains, b) Coastal, and c) Hills/Valleys.

### Case Studies

- Analyzed detailed monthly performance under varying conditions: I) large untuned bias, II) large windspeed variability, III) extreme winds
- Under what specific circumstances does tuning provide the most benefit?
- Tuning lowers the bulk error in complex terrain, but are important events better forecasted?

### Case Study I: Bias Reduction

- Tuned forecast exhibits significant bias improvement across wide range of wind speed magnitudes

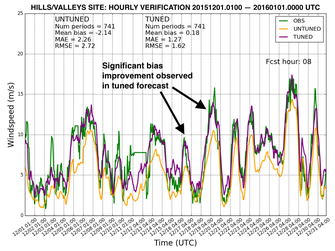



**Figure 3:** Hourly observed windspeed (green), untuned (orange), and tuned forecast (purple) for December 2015 at the Hills/Valleys site.

### Case Study II: Variable Periods

- Tuned forecast better represents large windspeed variability

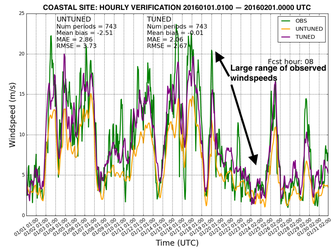



**Figure 4:** As in Figure 3, but for January 2016 at the Coastal site.

### Case Study III: Extreme Winds

- Tuned forecast captures isolated, **ramp-like** windspeed maxima

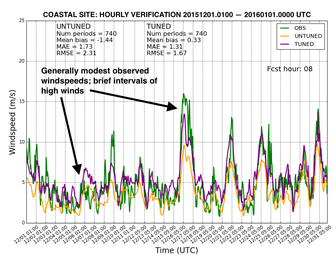



**Figure 5:** As in Figure 3, but for December 2015 at the Coastal site.

## Results – Short Lead Times

- At 2-hours ahead at all sites, Forward Error Correction (FEC) resulted in larger tuned forecast improvement compared to day-ahead

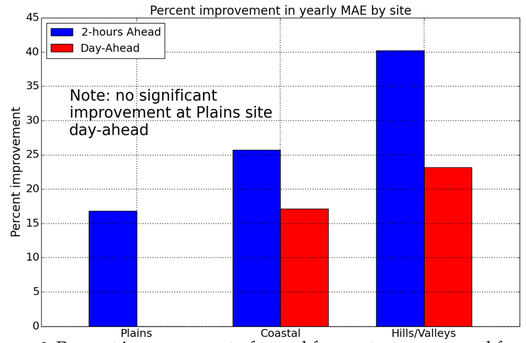



**Figure 6:** Percent improvement of tuned forecast over untuned forecast at each site at 2-hours ahead (blue) and day-ahead (red).

## Discussion

- Untuned MAE at the Plains site is lower than at other sites – suggests tuning provides little improvement when errors are already small
- Tuning in complex terrain likely better captures localized effects such as land/sea breezes and mountain/valley flows
- Results suggest value of low-cost untuned forecasts in uniform terrain (e.g., large portfolio in the US Great Plains)
- Significant improvement with tuning observed at all sites at short lead times – value for same-day market adjustments
- Motivation to investigate improvements to both tuned and untuned forecasts