



USER MEETING 2011

UTILIZING WRF DATA IN WINDSIM FOR SITE ASSESSMENT

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windsim

CONTENT

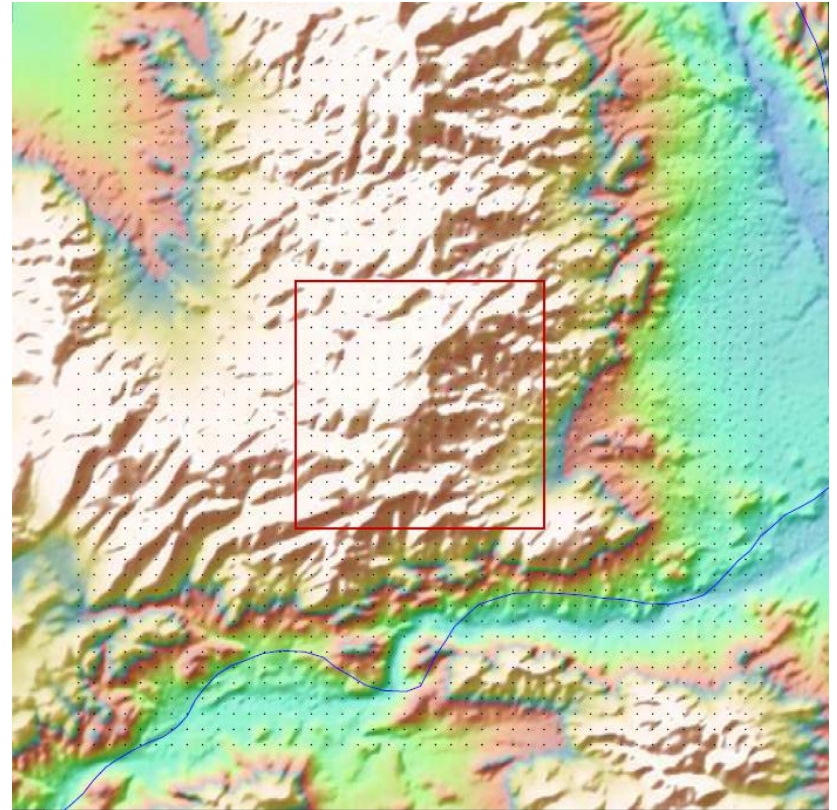
- **Introduction: Why is mesoscale data of interest in site assessment?**
- **Approaches to use of mesoscale data in WindSim**
- **Findings from validation work to date**
 - Wind Speeds
 - Wind Directions
- **Conclusions and plans for future work**

Introduction

-High-resolution mesoscale meteorological model data has many potential applications to site assessment.

-In general such data is not freely available, and must be purchased from data providers or created by running models in house.

-Data can be used to check and supplement observation data as well as perform MCPs and account for large scale, time-varying effects.



Validation Sites to Date

Site 1: A large and only moderately complex site in the Western United States. This site contained eleven 60m met masts for validation.

- 'Raw' WRF errors ~3.5%

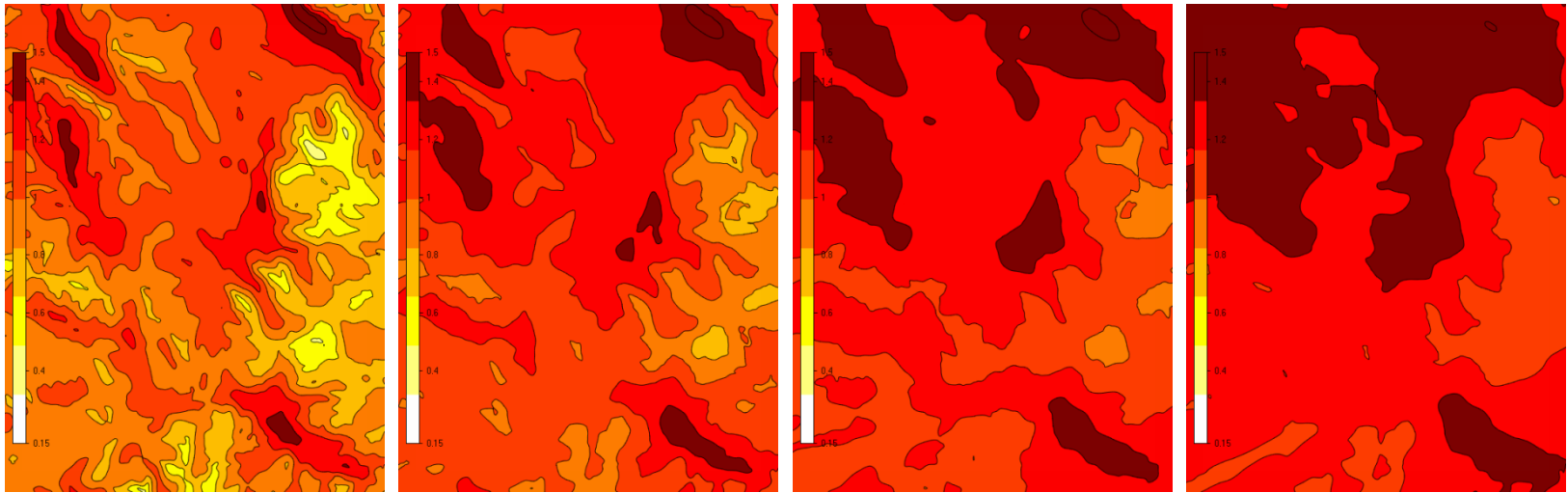
Site 2: A smaller but very complex site in the mountainous Western United States for which four 50-60m measurement masts were available.

- 'Raw' WRF errors ~13%

Site 3: A single 10m mast from a weather station in an extremely rugged region of the Scottish Highlands called Bealach Na Ba.

- 'Raw' WRF errors ~ 50%

Wind Speeds



100m

200m

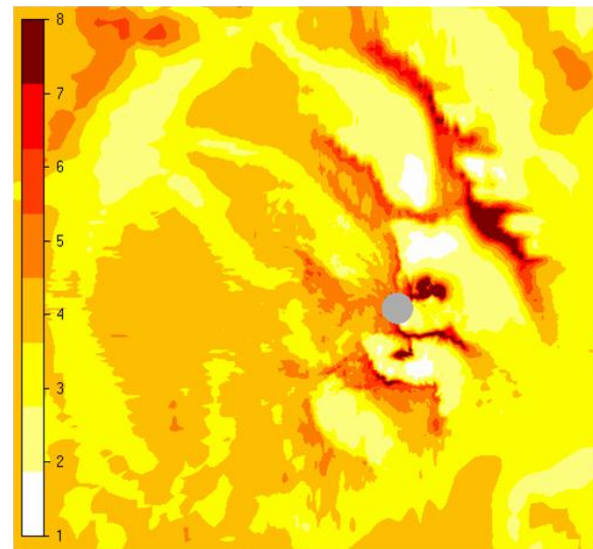
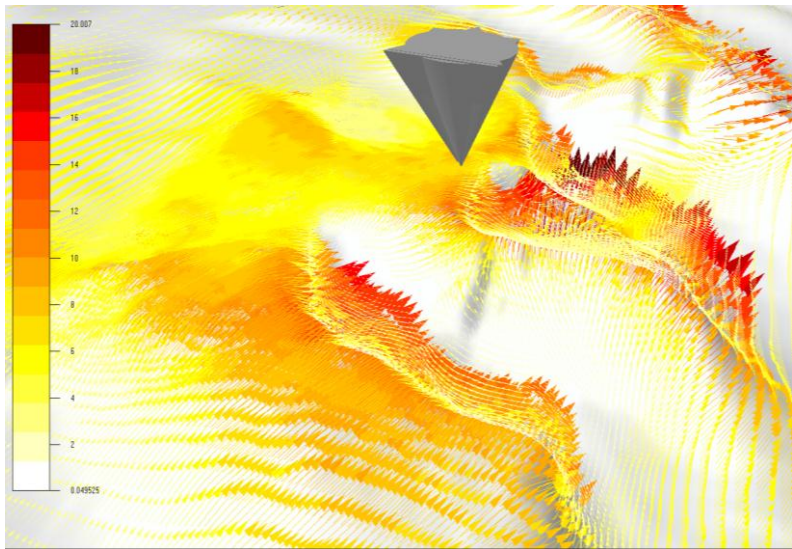
300m

400m

- Terrain-induced speed ups are damped with increasing height.

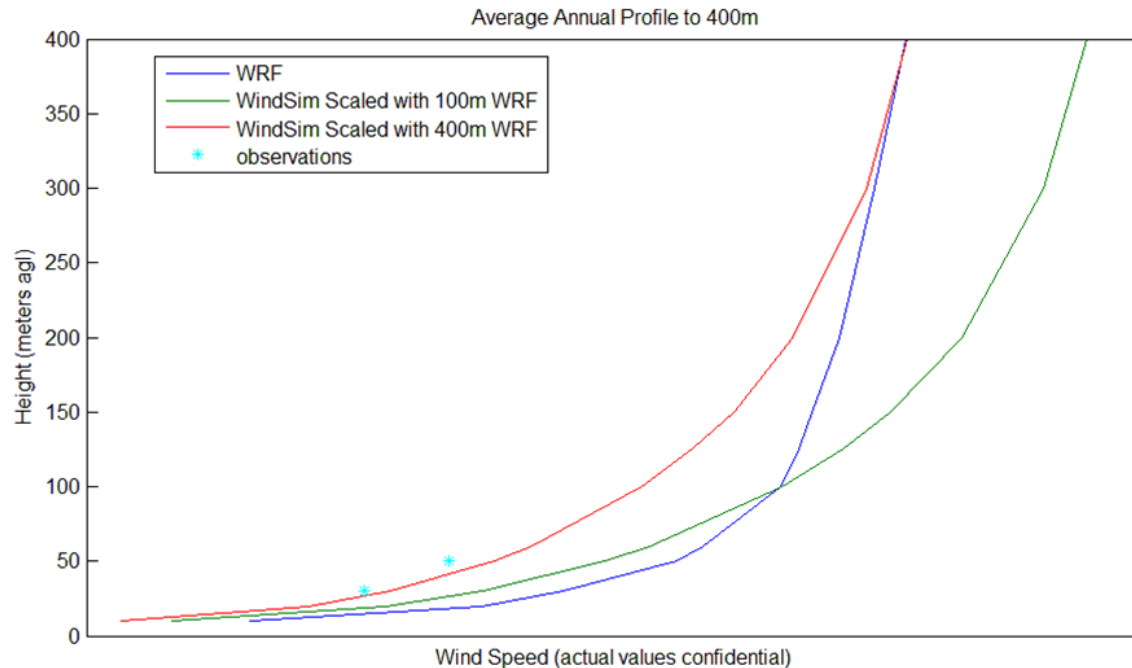
Wind Speeds, Cont'd

Site 3: Bealach Na Ba



- Use WindSim to characterize complex wind fields near the ground
- Scale with WRF time series from away from the ground to correct WRF timeseries for terrain effects.

Wind Speeds, Cont'd



- Simple use of upper-level timeseries (3-400m a.g.l.) from WRF as climatologies in WindSim drastically reduces error in mean wind speed for complex sites.
- Further improvements possible by accounting for direction shifts by using directions from <100m WRF.

Error improvements using WindSim + WRF

Site 1: A large and only moderately complex site in the Western United States. This site contained eleven 60m met masts for validation.

- 'Raw' WRF errors ~3.5% → **3.5%**

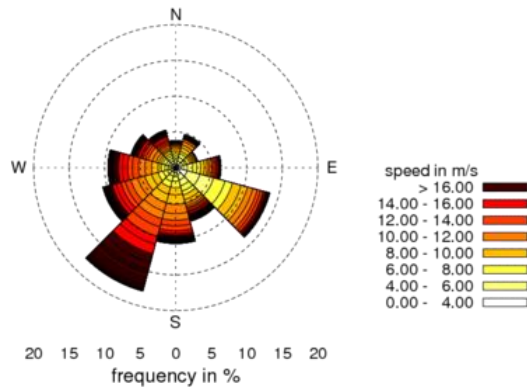
Site 2: A smaller but very complex site in the mountainous Western United States for which four 50-60m measurement masts were available.

- 'Raw' WRF errors ~13% → **6%**

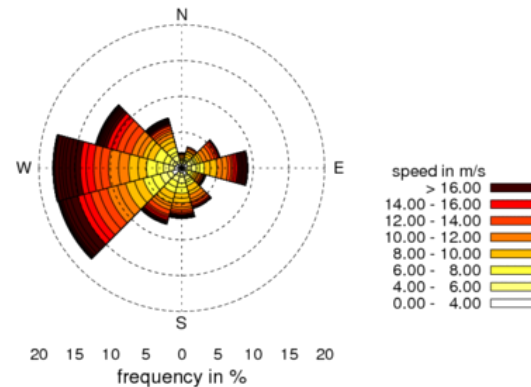
Site 3: A single 10m mast from a weather station in an extremely rugged region of the Scottish Highlands called Bealach Na Ba.

- 'Raw' WRF errors ~50% → **5%**

But what about Wind Directions?



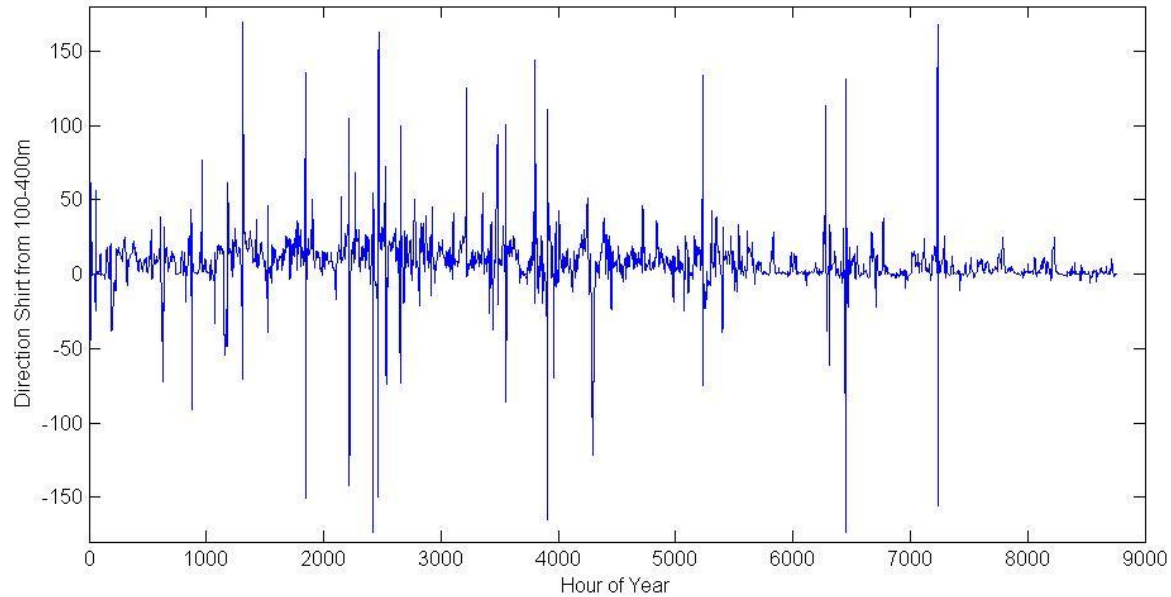
Bealach Observed Wind Rose



Wind Rose from WRF+WindSim

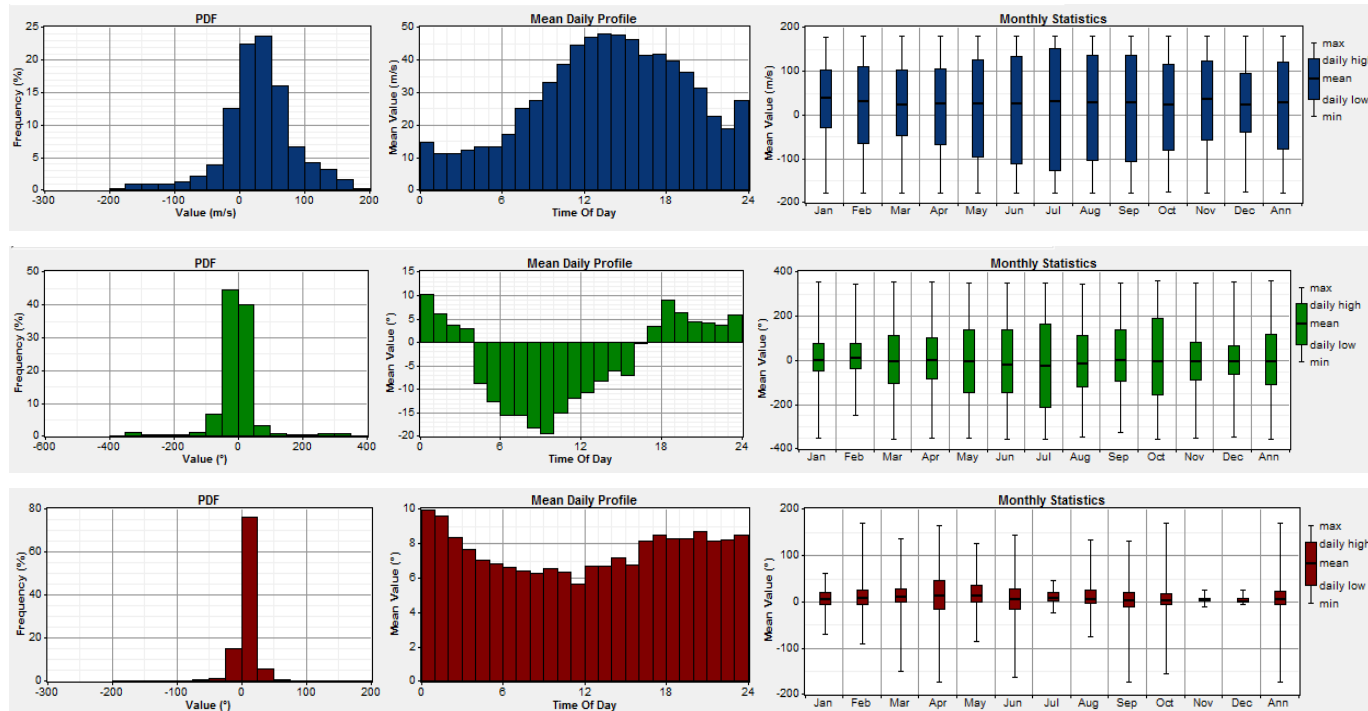
- Even when winds speeds are well predicted there can be large errors in wind direction.

Direction Shifts



- Shift in wind direction with height is highly variable and site-specific.

Direction Shifts, Cont'd



- For three different sites, three very different patterns of direction shifts 100-400m!
- Average Annual Direction Shifts 400-100m ~ +20°, -15°, 0° respectively.
- In all cases the lower WRF levels (<100m) compared best with Observations

Recommendations for using WRF data in WindSim

- Take wind speeds from well above the ground for complex sites, 3-500m.
- Inspect direction shifts with height from WRF and consider taking direction from below 100m.
- Use WRF to understand stability and consider running stable simulations for appropriate sectors.

CONCLUSIONS

- Raw errors in mean wind speed from WRF increased with terrain complexity for the three validation cases mentioned.
- ‘Simple’ use of upper-level time series from WRF as climatologies allowed drastic reduction in the errors for predicted wind speed for the complex sites.
- Further reductions in error are thought possible through site-specific understanding of direction shifts with height.

Plans for future work

- Continue validation with the three existing sites and additional sites in other climate regimes.
- Automate the process of using WRF data in WindSim (e.g. With stability and direction shifts.)
- Investigate use of Neural Networks to find connections between WRF wind fields and observations.

ACKNOWLEDGEMENTS

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