Influence of model resolution on short-range wind predictions in complex terrain

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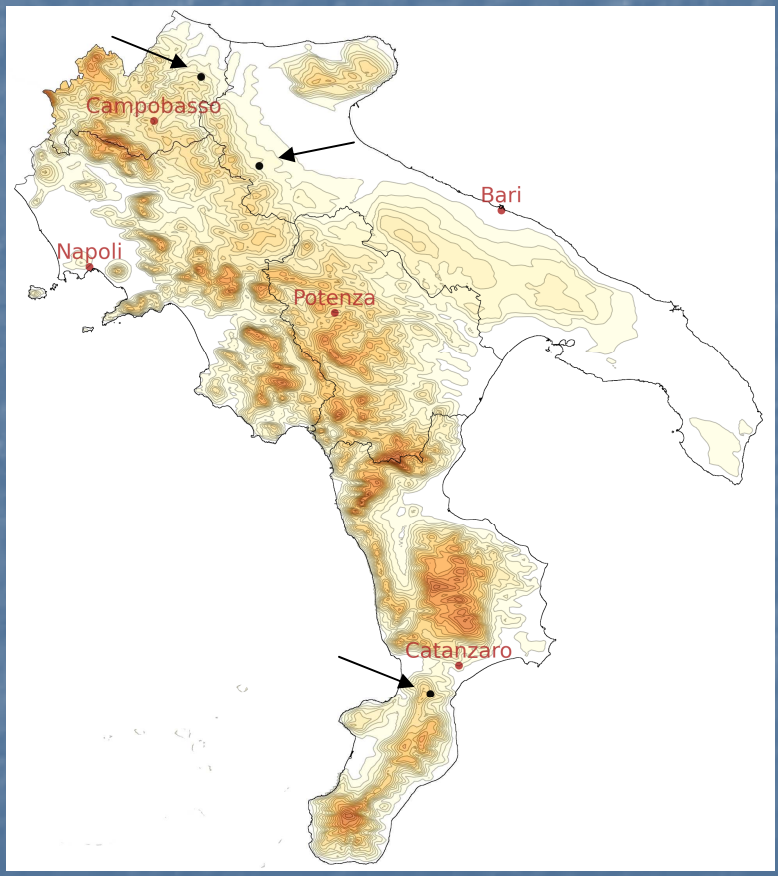
Preliminary Experimental Phase

3 Sites in Southern Italy
in complex orography and
with no dominating wind
patterns

Site 1: 20 Turbines at an
altitude from 279 to 636m
Site 2: 15 Turbines at an
altitude from 334 to 381m
Site 3: 38 Turbines at an
altitude from 374 to 717m



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Observational Wind Data

- 10 or 1 minute temporal resolution
- Anemometers at 10, 40, 60 and 80 meters above ground
- Average wind speed and direction
- Standard deviation of speed and direction

Phase I (experimental) : anemoter data
Phase II (operational) : data for every turbine

Numerical Model Data

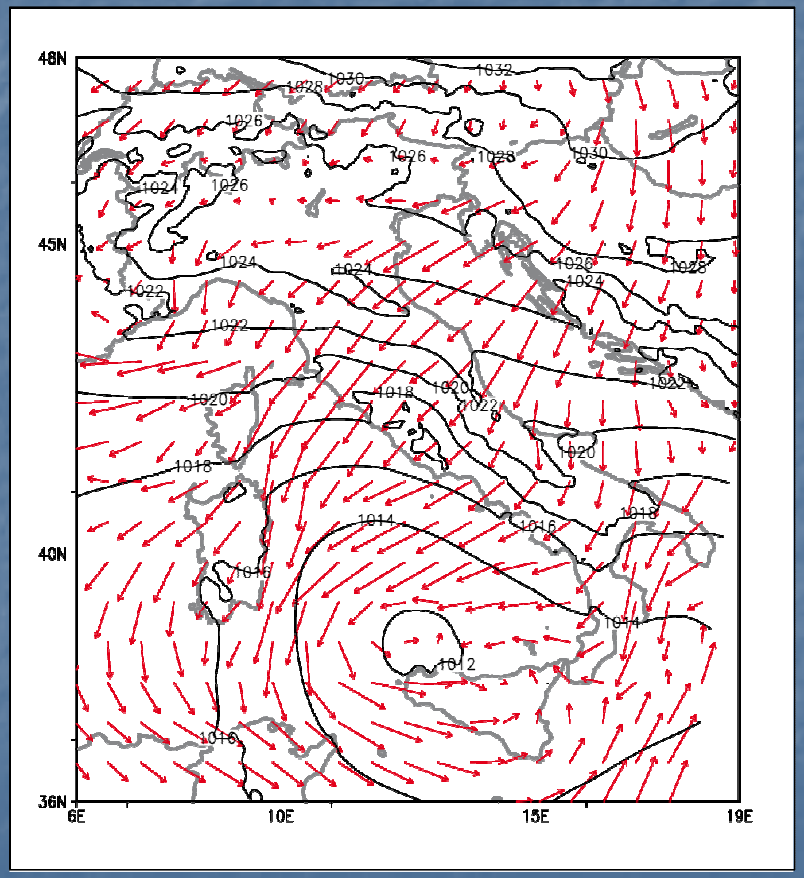
- WRF-ARW Version 3.3 / 3.4
- Triple nesting 8km, 2.6km, 0.89 km
- 42 vertical levels
- GFS Initialization and contour data
- 36 hour simulations
- Output every 10 minutes
- Linear vertical interpolation of desired fields

WRF Model Final Settings

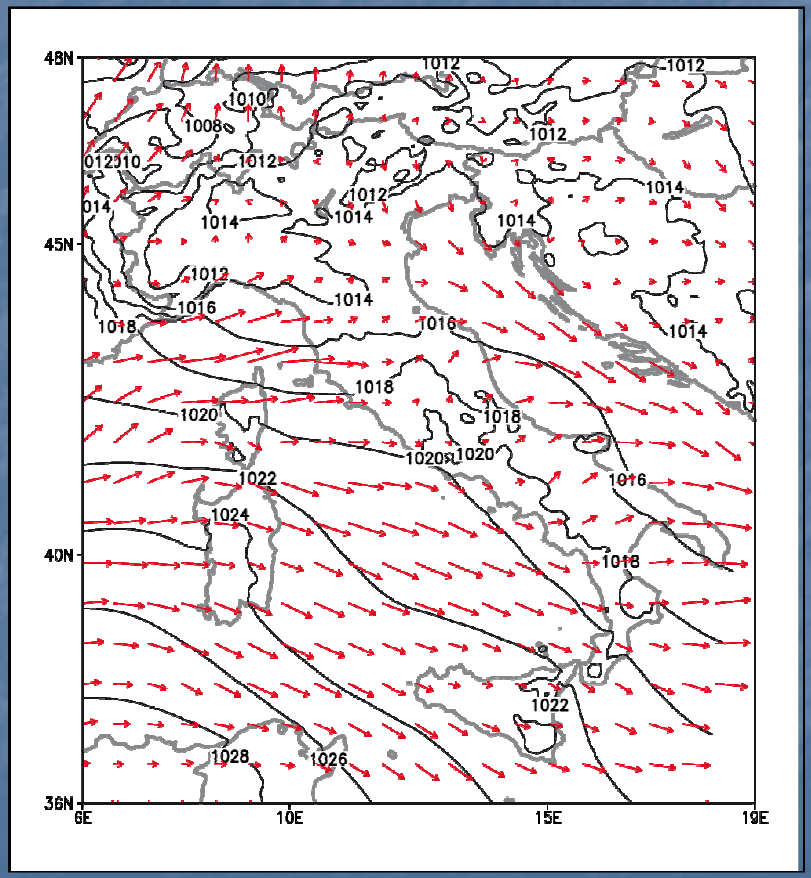
- 30” Topography
- Thompson graupel physical scheme
- RRTM long wave radiation scheme
- Goddard short wave radiation scheme
- Unified Noah land-surface model scheme
- Mellor-Yamada-Janjic TKE boundary layer scheme
- Kain-Fritsch convective scheme (coarser domain)
- Non-hydrostatic (finer domains)
- Topo_wind tested

2 Test Cases

14 October 2011



16 December 2011



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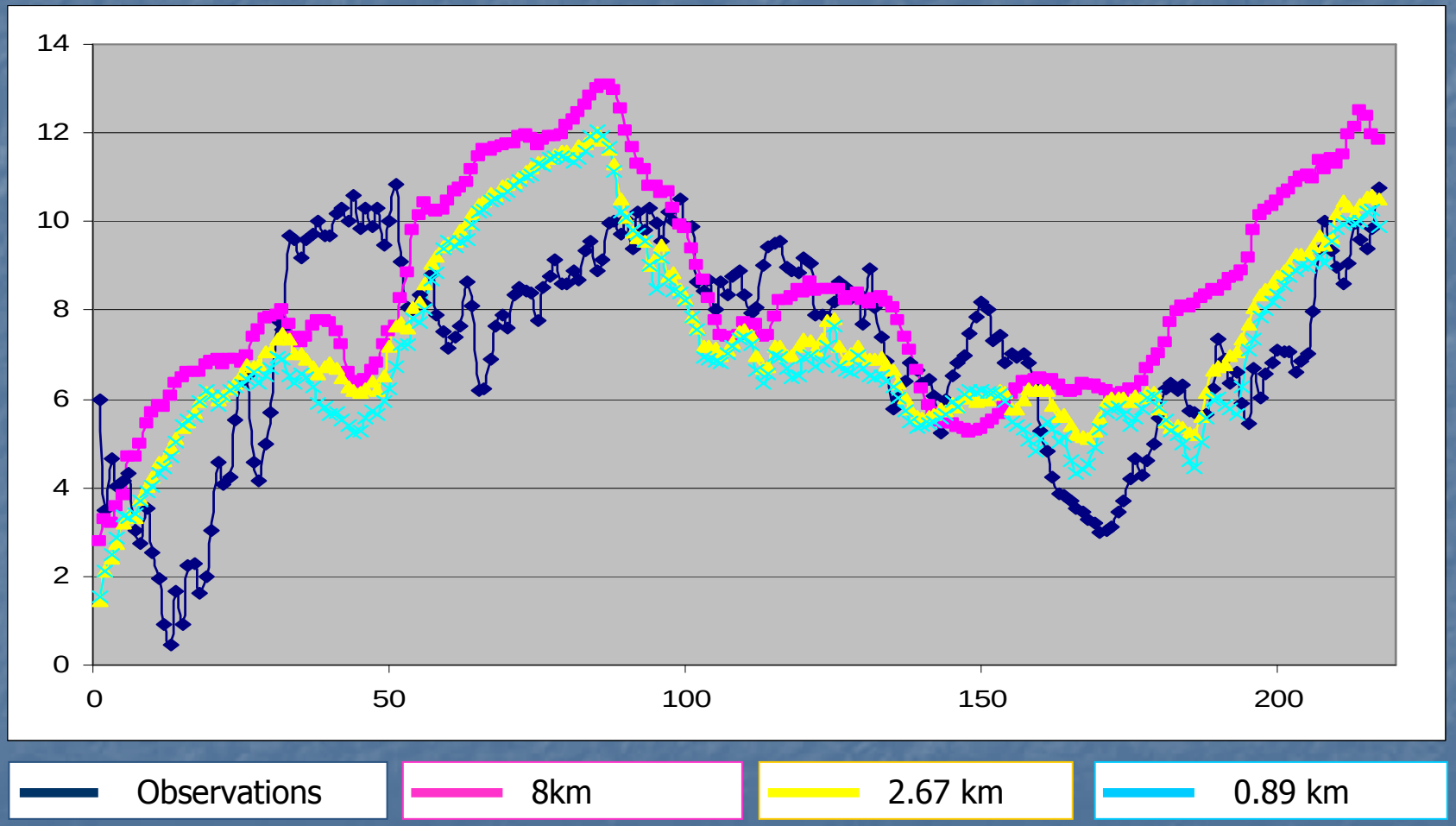
14 Oct 2011, Site 2, Wind Speed



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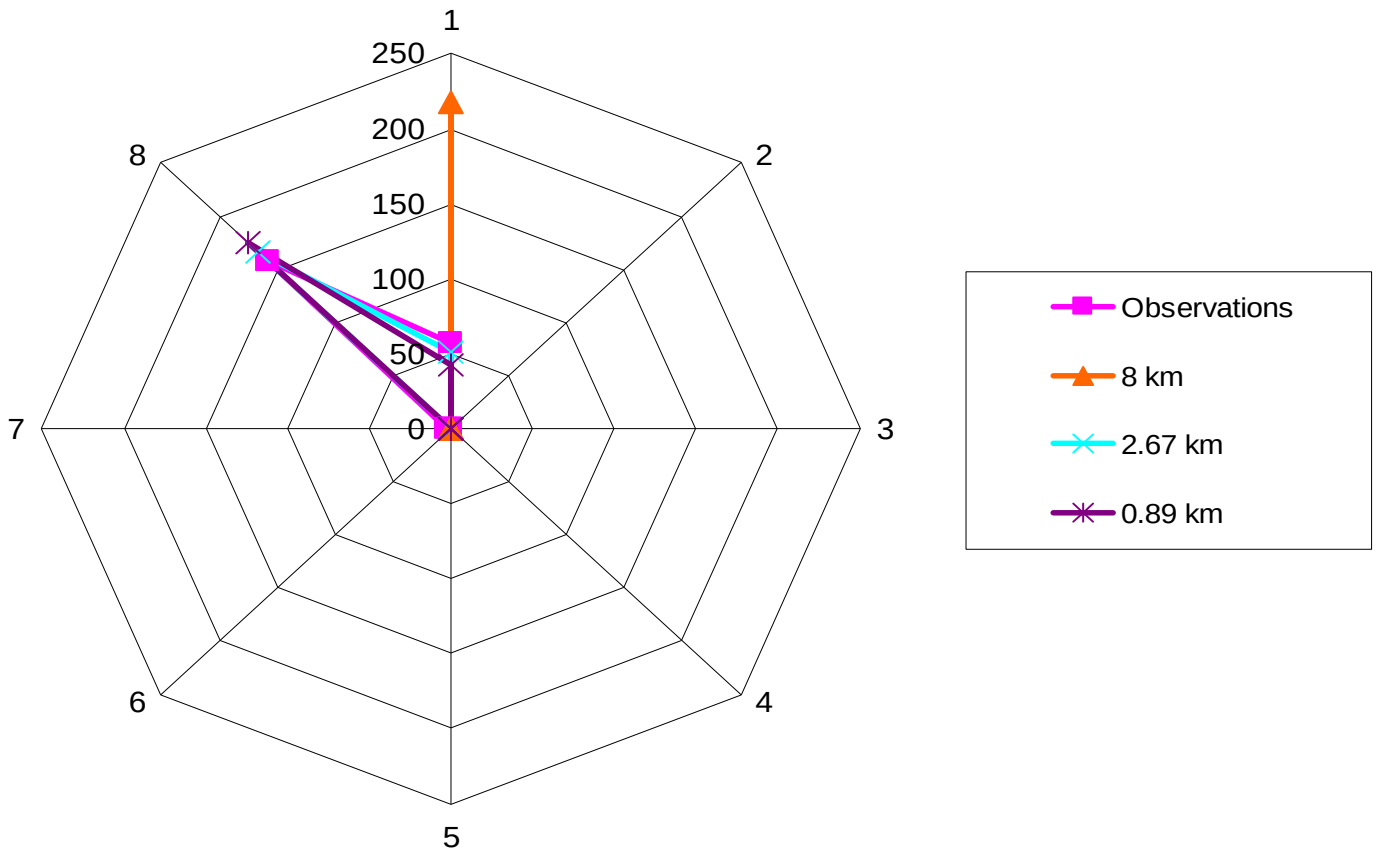
14 Oct 2011, Site 2, Wind Direction



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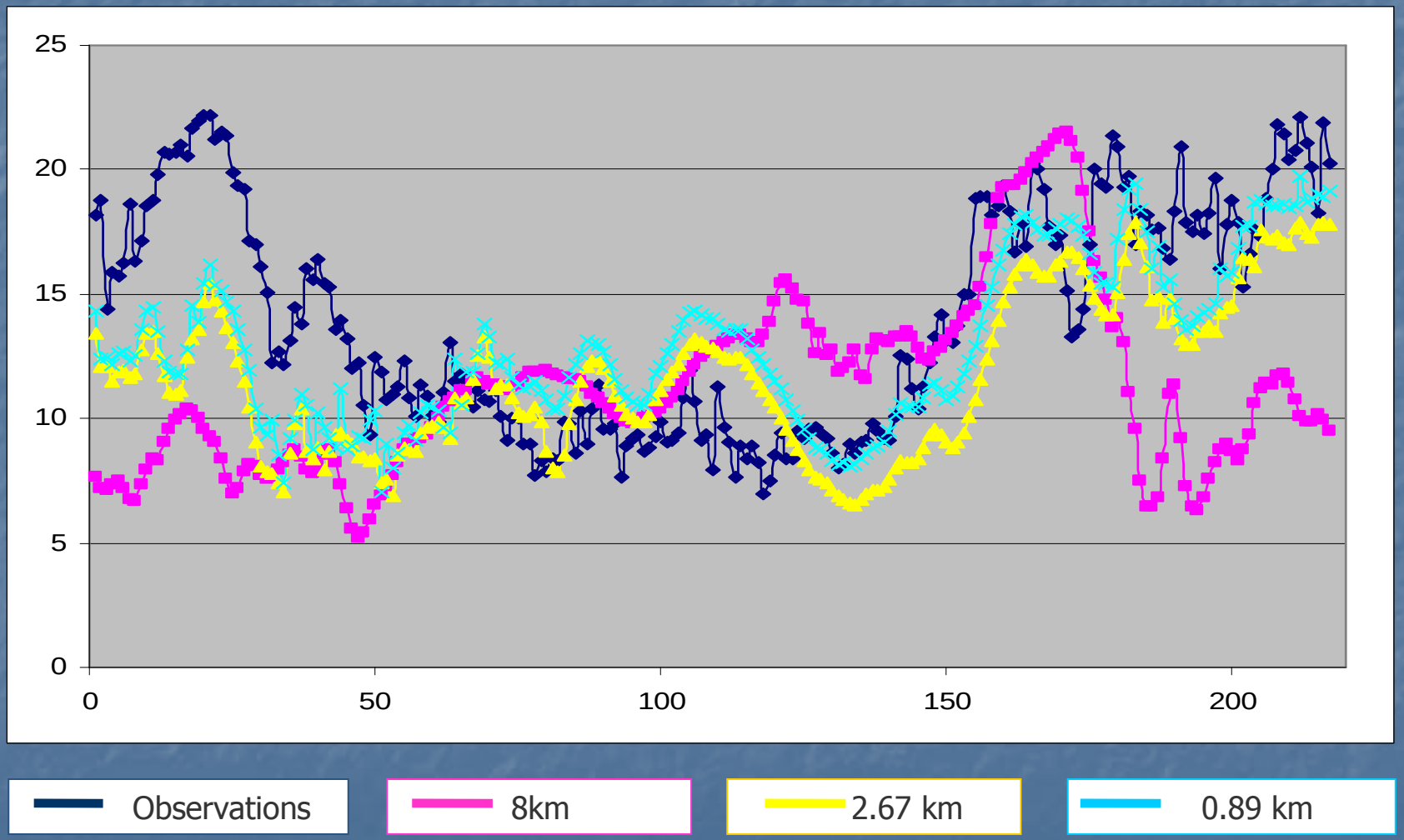
16 Dec 2011, Site 3, Wind Speed



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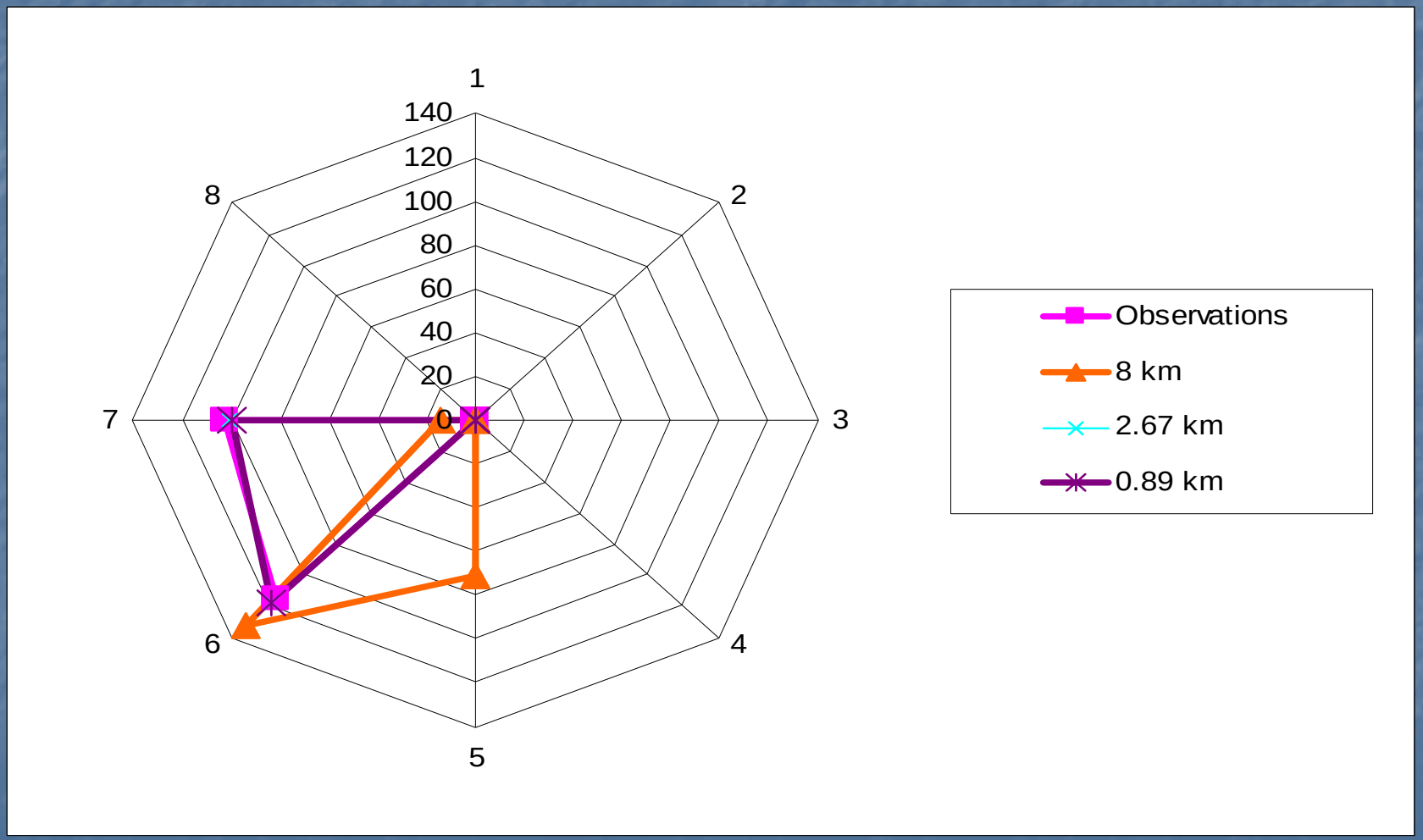
16 Dec 2011, Site 3, Wind Direction



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Wind Speed Mean Absolute Error

	Site 2 14 Oct	Site 3 14 Oct	Site 2 16 Dec	Site 3 16 Dec
8 km	2.150	3.789	8.580	5.220
2.67 km	1.713	3.043	6.706	3.391
0.89 km	1.768	2.788	6.932	2.926

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Linear Regression

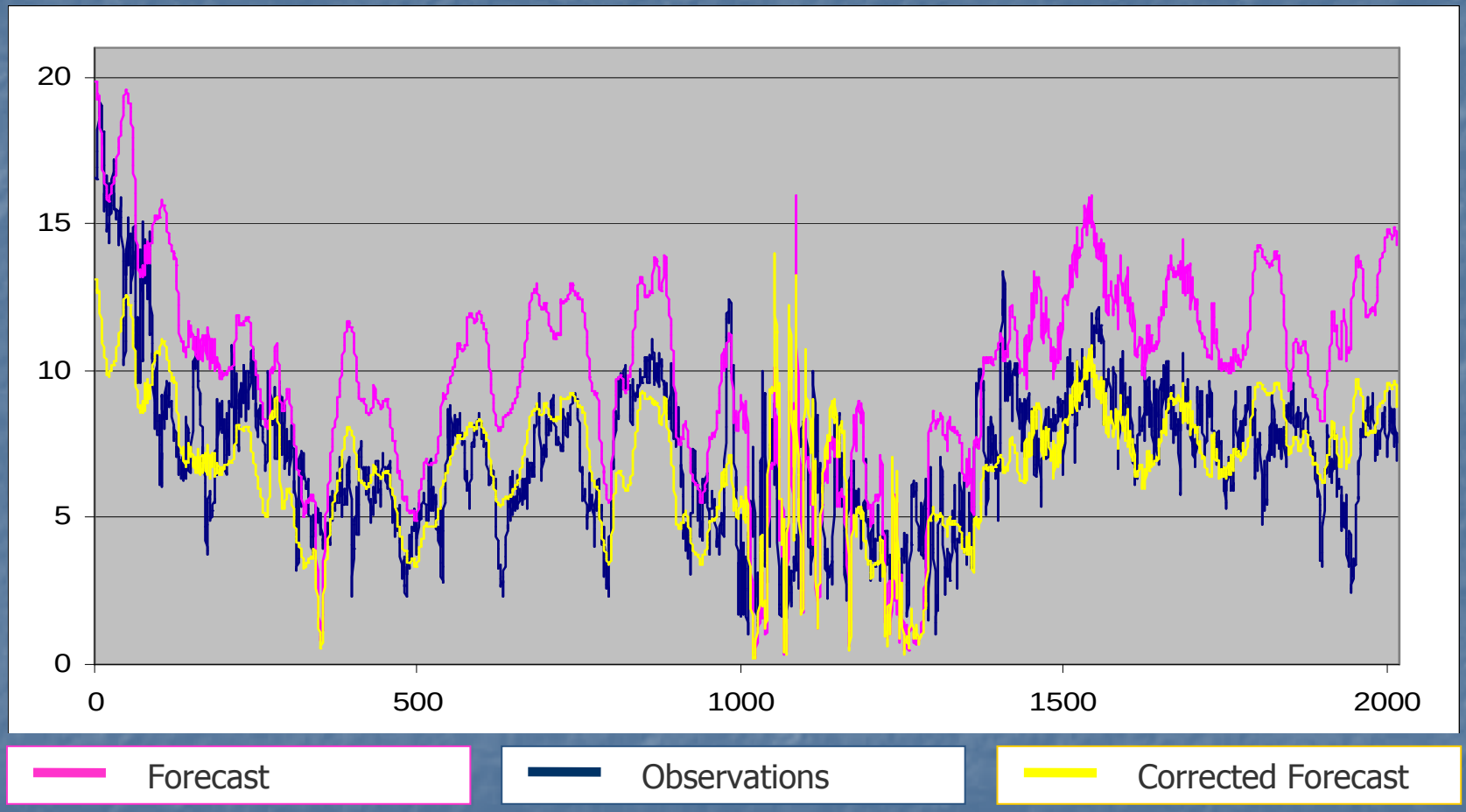
Corrected Wind = Forecasted Wind – Expected Error

Expected Error = Au + Bv + C

u and v are the wind components

A, B, C are calculated with linear regression of data of the last 15 days

2.67 km run Wind Speed for turbine 1 in Site 1



MAE: Forecast 3.20, Corrected Forecast: 1.67

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Operational results

Forecast MAE (FMAE) and Corrected Forecast MAE (CFMAE) for the 2.67 km domain runs for all sites on the 30th of July 2012:

Site 1 – FMAE: 3.89 – CFMAE: 3.22

Site 2 – FMAE: 5.12 – CFMAE: 4.08

Site 3 – FMAE: 4.08 – CFMAE: 3.31

$$\text{Power} \sim V^3$$

Conclusion and Future Work

- Increasing the resolution from 8 to 2.67 km produces more realistic wind fields
- MAE comparable when resolution increased from 2.67 to 0.89 km
- Linear regression produces greater improvement to results for wind speed and subsequently power fields

- Runs with resolution up to 100 meters will be tested