

Validation of Mesoscale Wind Forecasts for Ireland

Paul Nolan, Peter Lynch
Meteorology & Climate Centre
University College Dublin

Outline

- Experiment Setup
- Computer Architecture
- Validation of the Model
- Conclusions

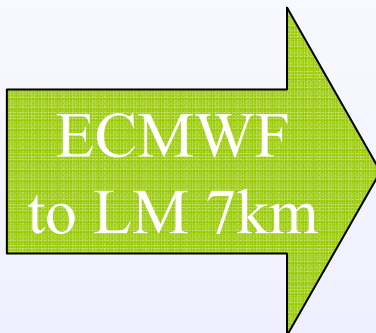
Experiment Setup

- Since the wind energy resource of Ireland exhibits a high degree of spatial heterogeneity it is vital to be able to accurately forecast wind speeds at high spatial resolution.
- We are using the non-hydrostatic Lokal Modell (3.21) to provide short term forecasts at the mesoscale level.
- The model is driven at the lateral boundaries by ECMWF global re-analysis data.
- Model domain: 101x102x45. Resolution of 7 km. $\Delta t = 40s$
- The wind fields are output at one hour intervals.

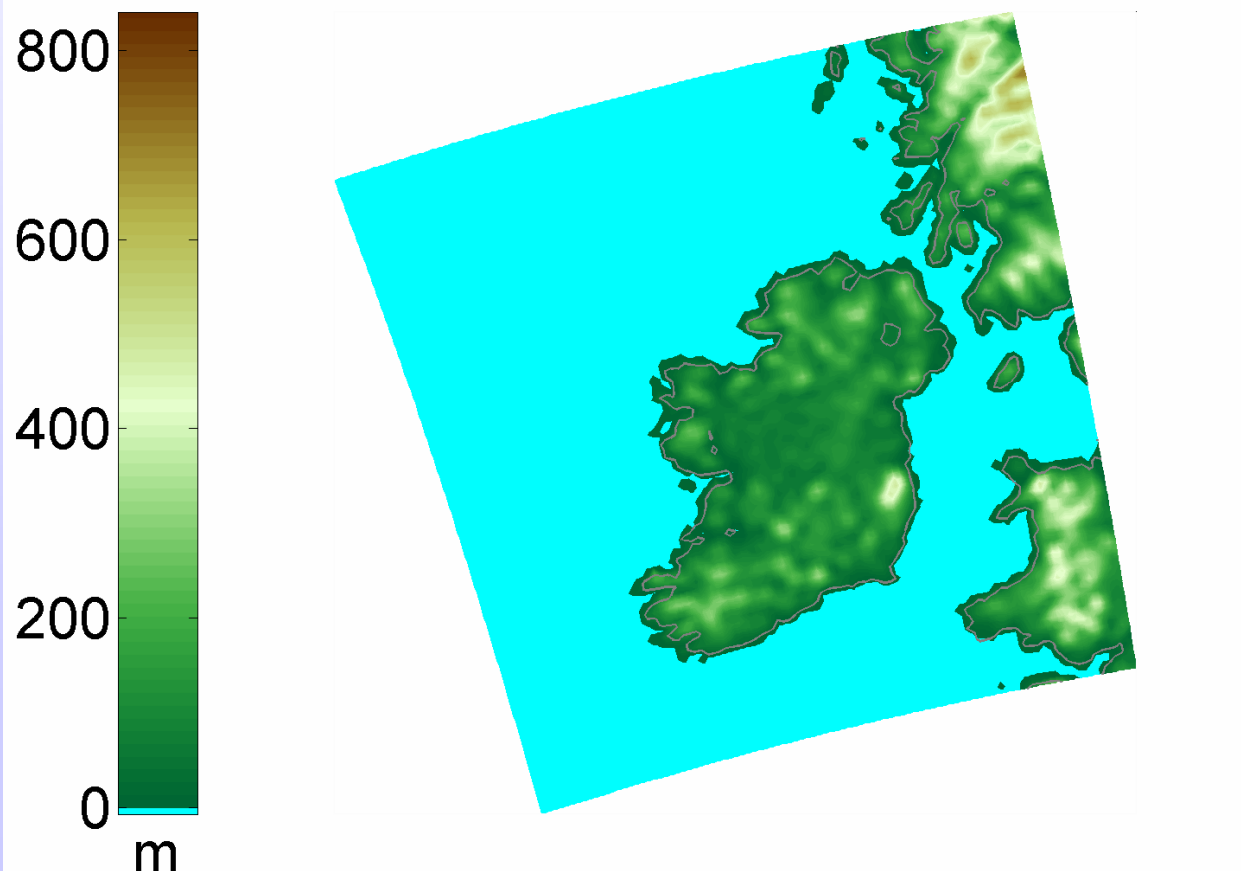
Experiment Setup

- To test the impact on wind forecasts of higher horizontal resolution, a further experiment, at 2.8 km resolution was carried out. Model Domain: 160x160x45. $\Delta t = 20s$
- The boundary conditions for this run have been provided every hour by the 7km model runs through a one-way nesting procedure.
- The experiment was run on a linux cluster (3.2GHz EM64T Intel Xeon CPUs, 4GiByte RAM).
- Intel C/C++ and Fortran Compilers version 9.1.

ECMWF Analysis
Resolution: 0.36 deg
0.225 deg (Post Feb 06)

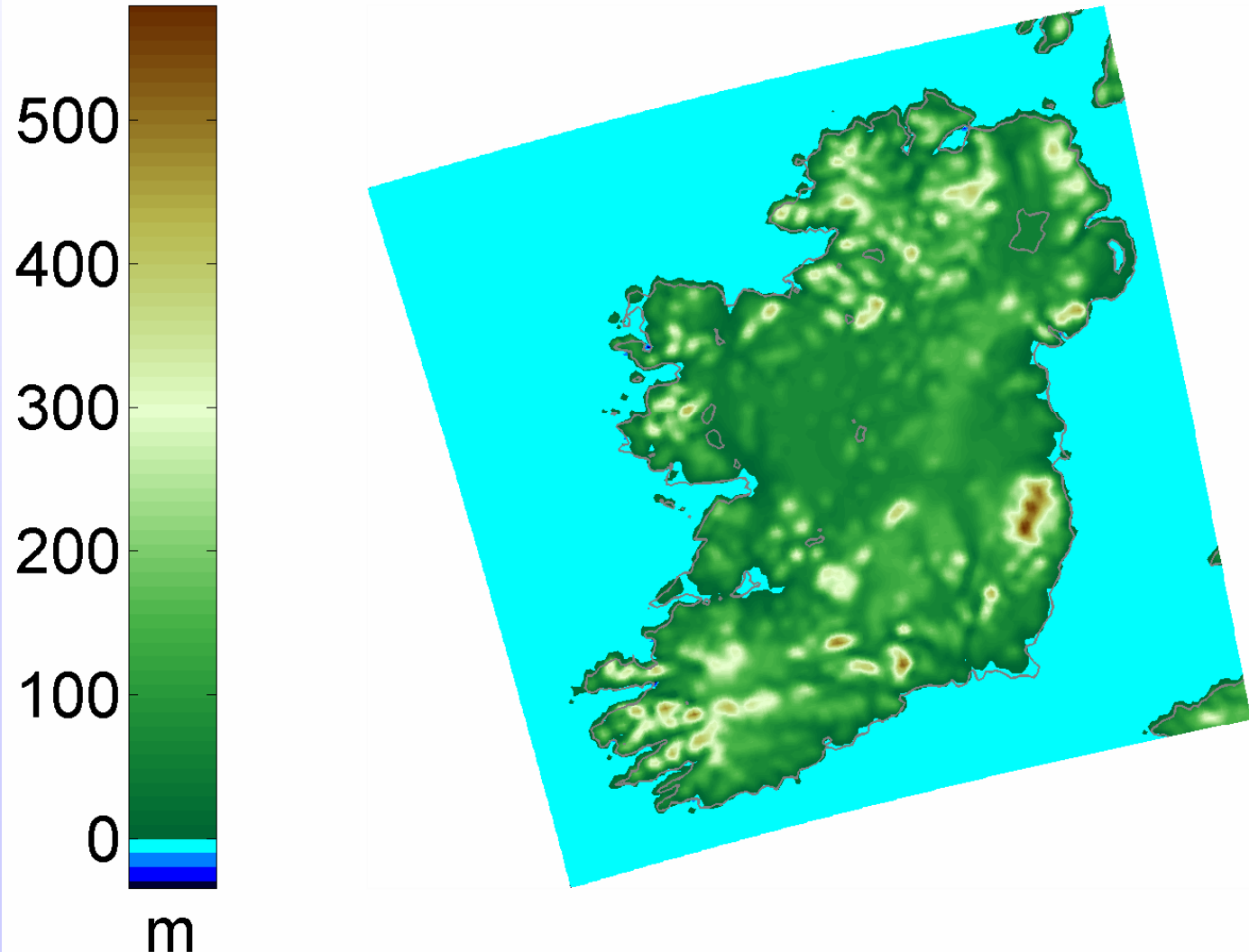


LM 7km Surface Topography (m)



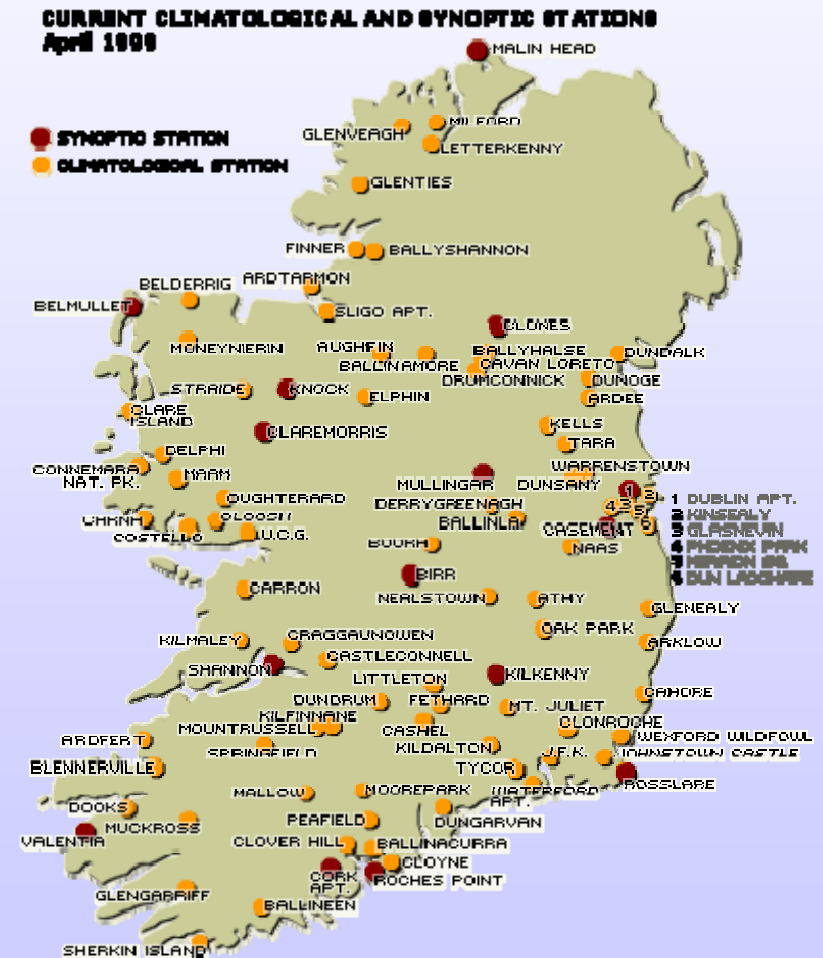
LM 7km
to LM 2.8km

LM 2.8km Surface Topography (m)

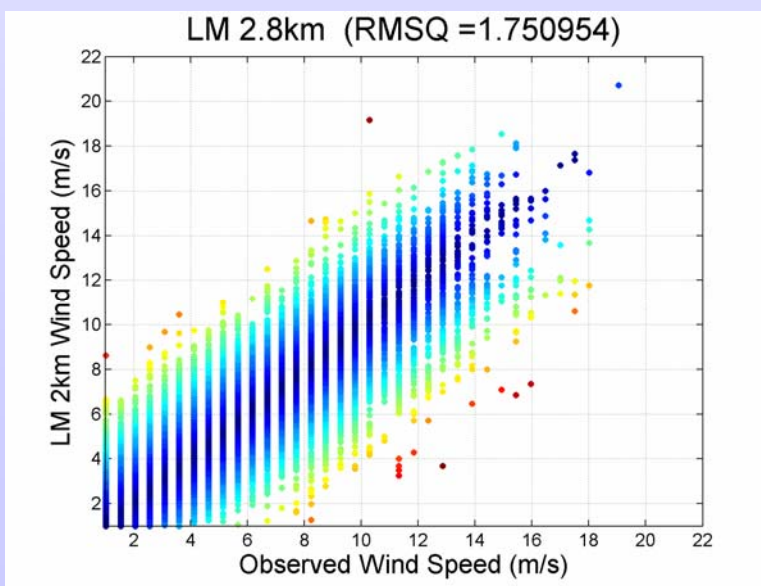
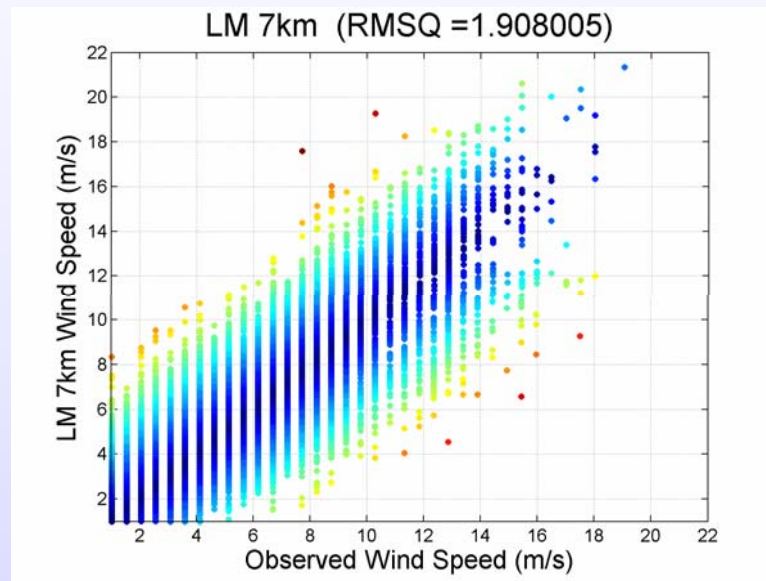
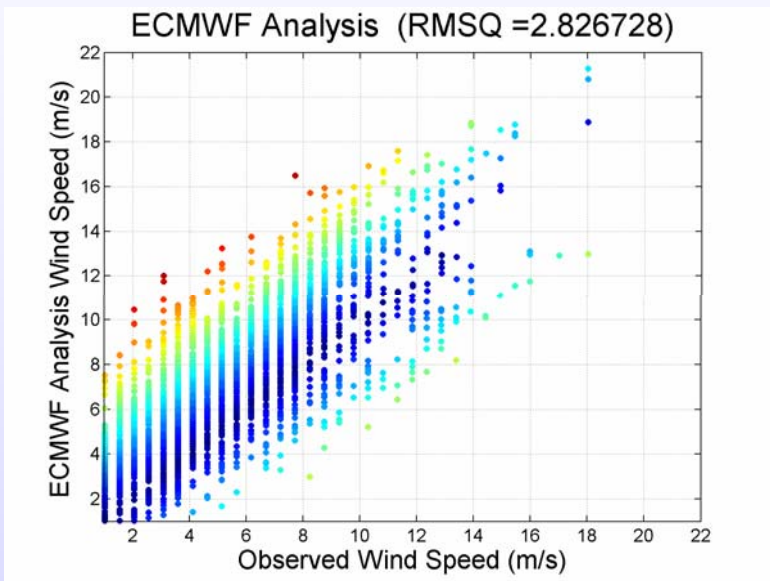


Validation of the LM Model

- The LM Model was validated by performing a 2-year series of 24hr forecasts (2005 – 2006)
- ECMWF Analysis data were used to drive the model
- We compared the results with observations and ECMWF Analysis data

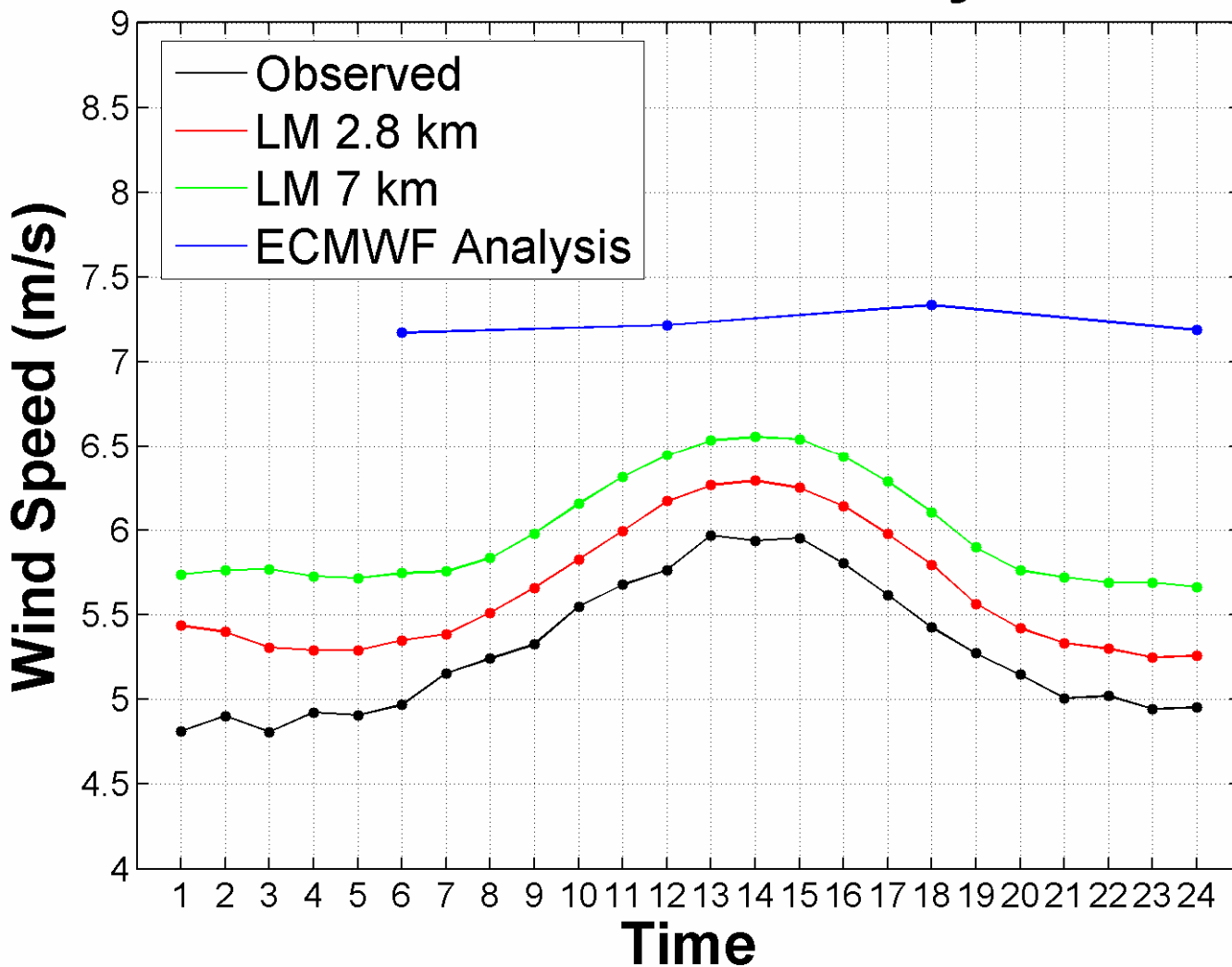


Wind Validation: Rosslare (2005 - 2006)

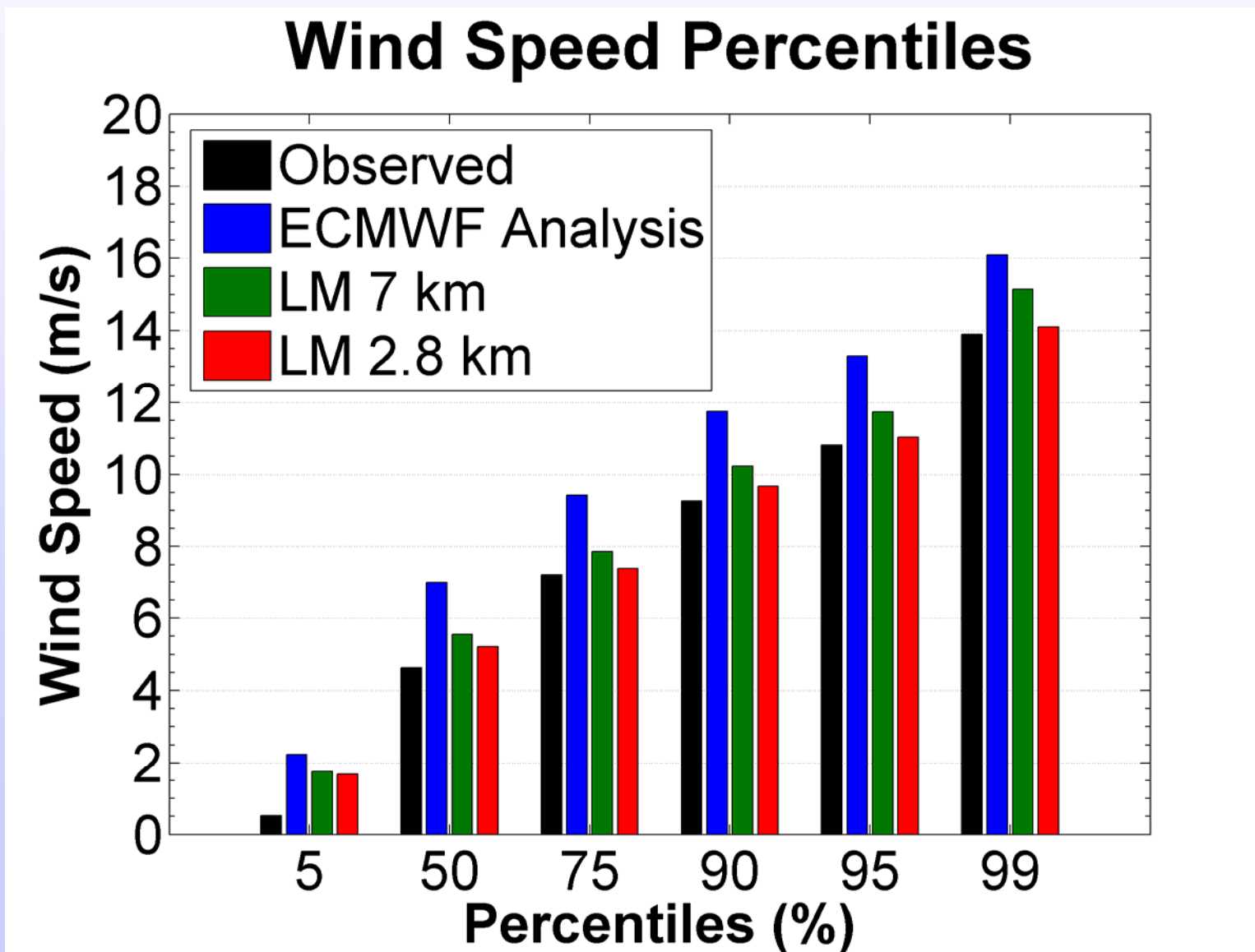


Wind Validation: Rosslare (2005 - 2006)

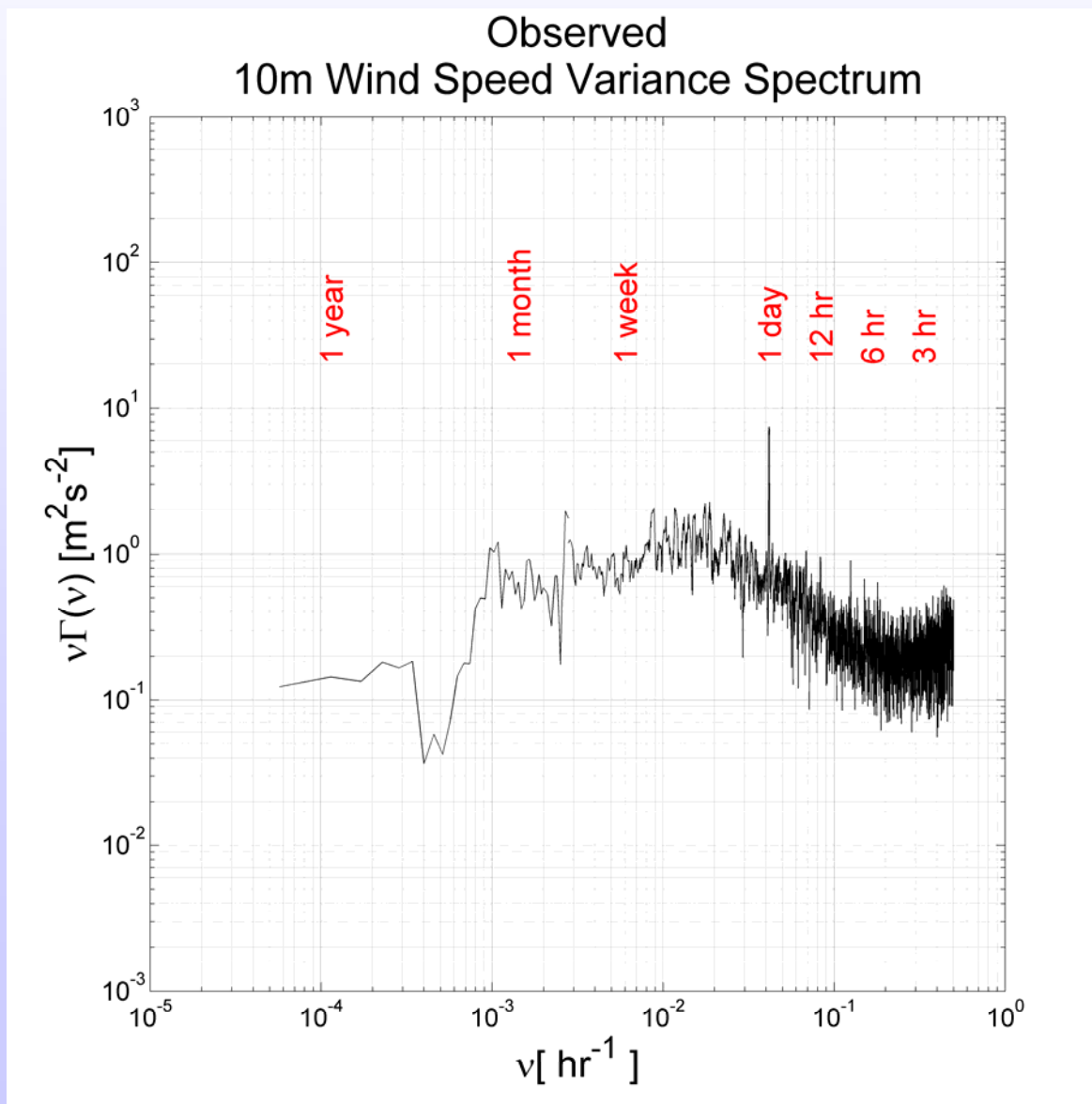
Rosslare Diurnal Cycle



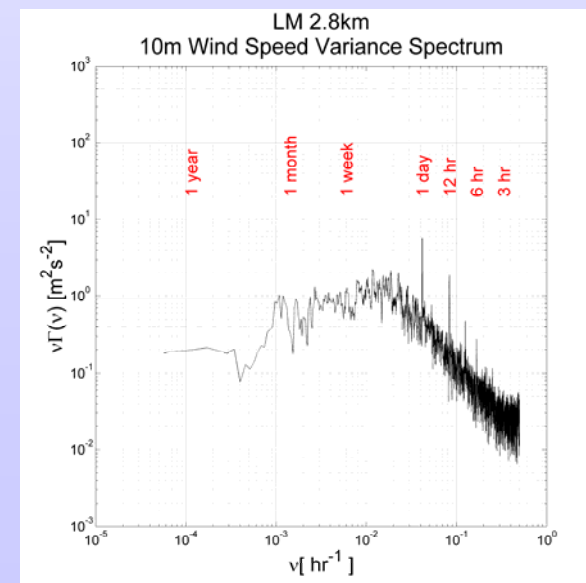
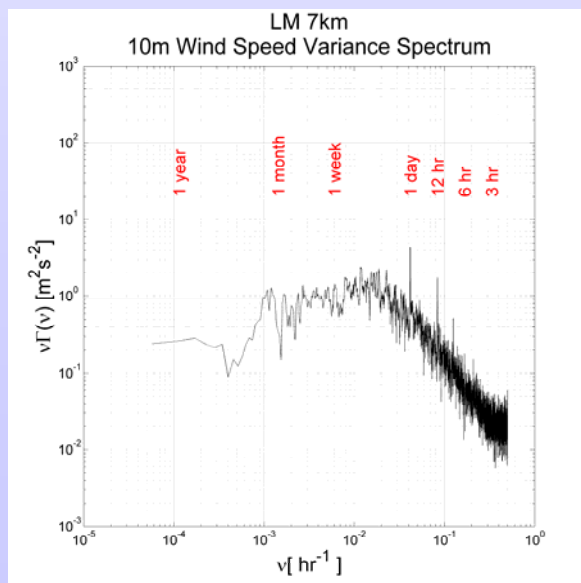
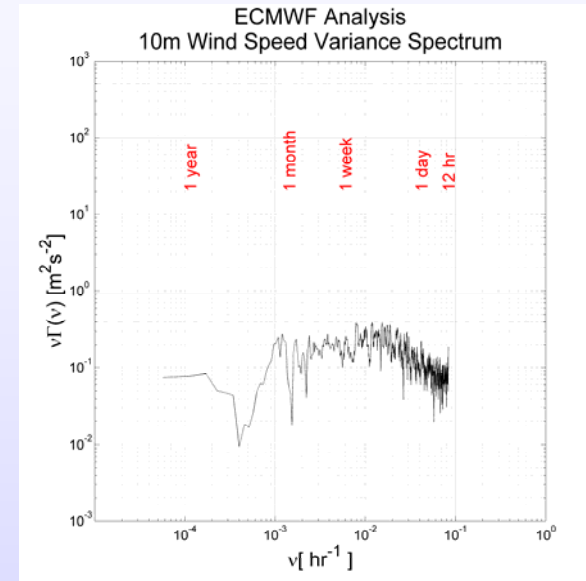
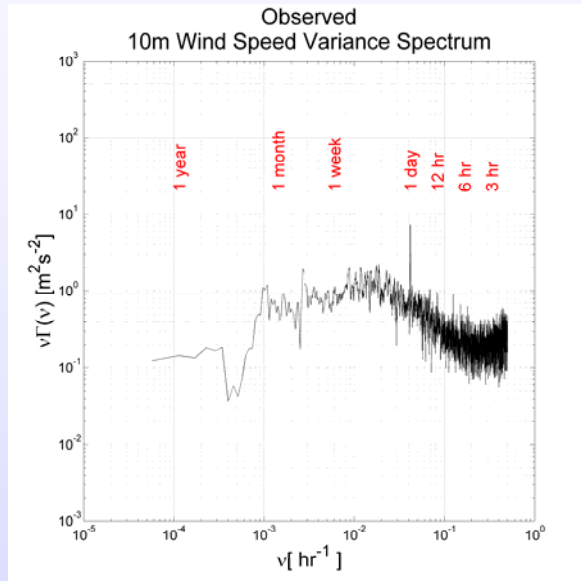
Wind Validation: Rosslare (2005 - 2006)



Wind Spectrum: Rosslare (2005 - 2006)

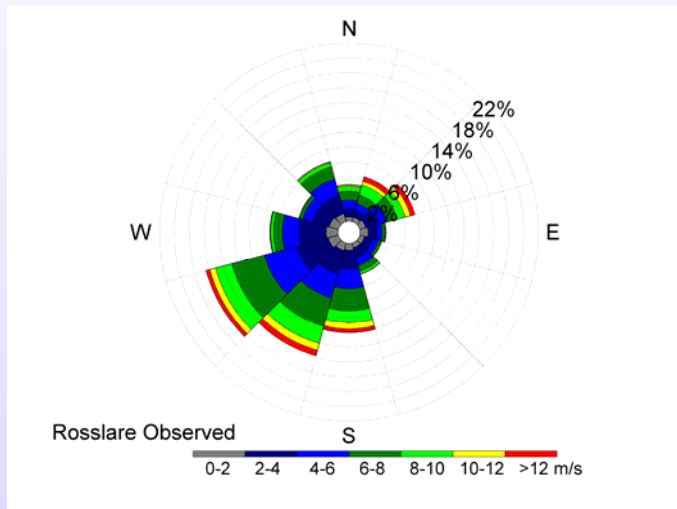


Wind Validation: Rosslare (2005 – 2006)

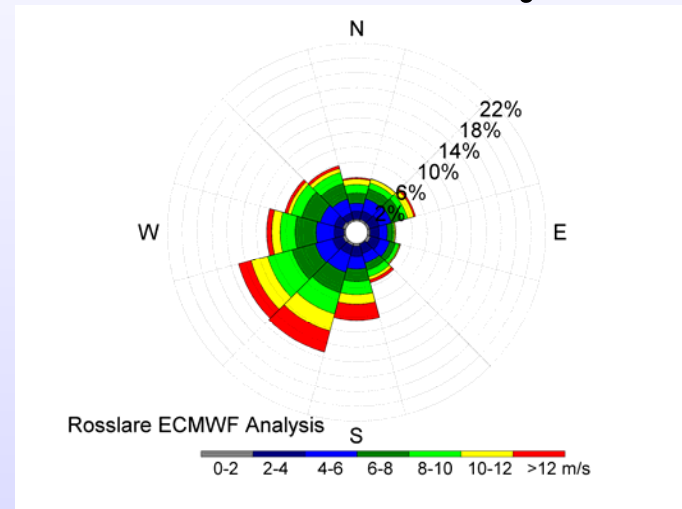


Validation: Rosslare Station (2005 - 2006)

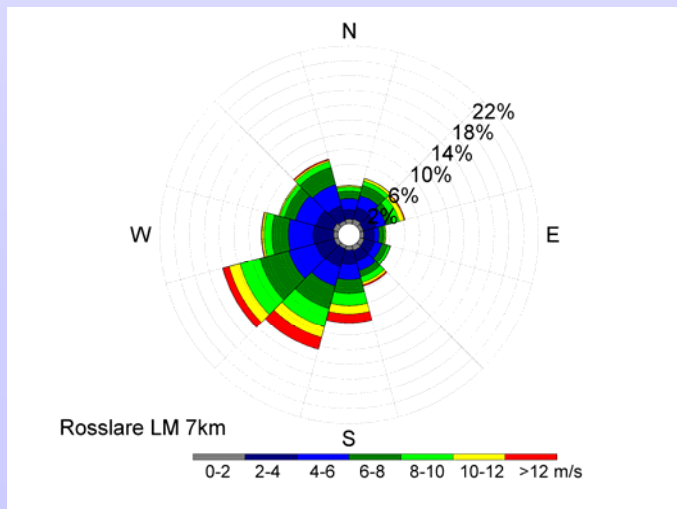
Observed



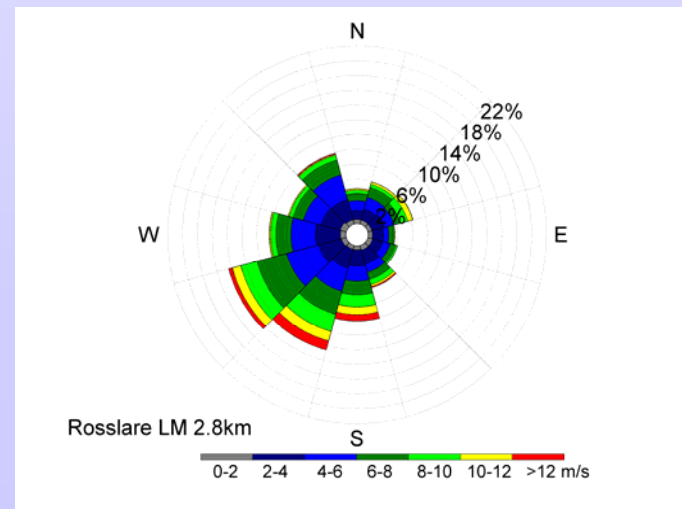
ECMWF Analysis



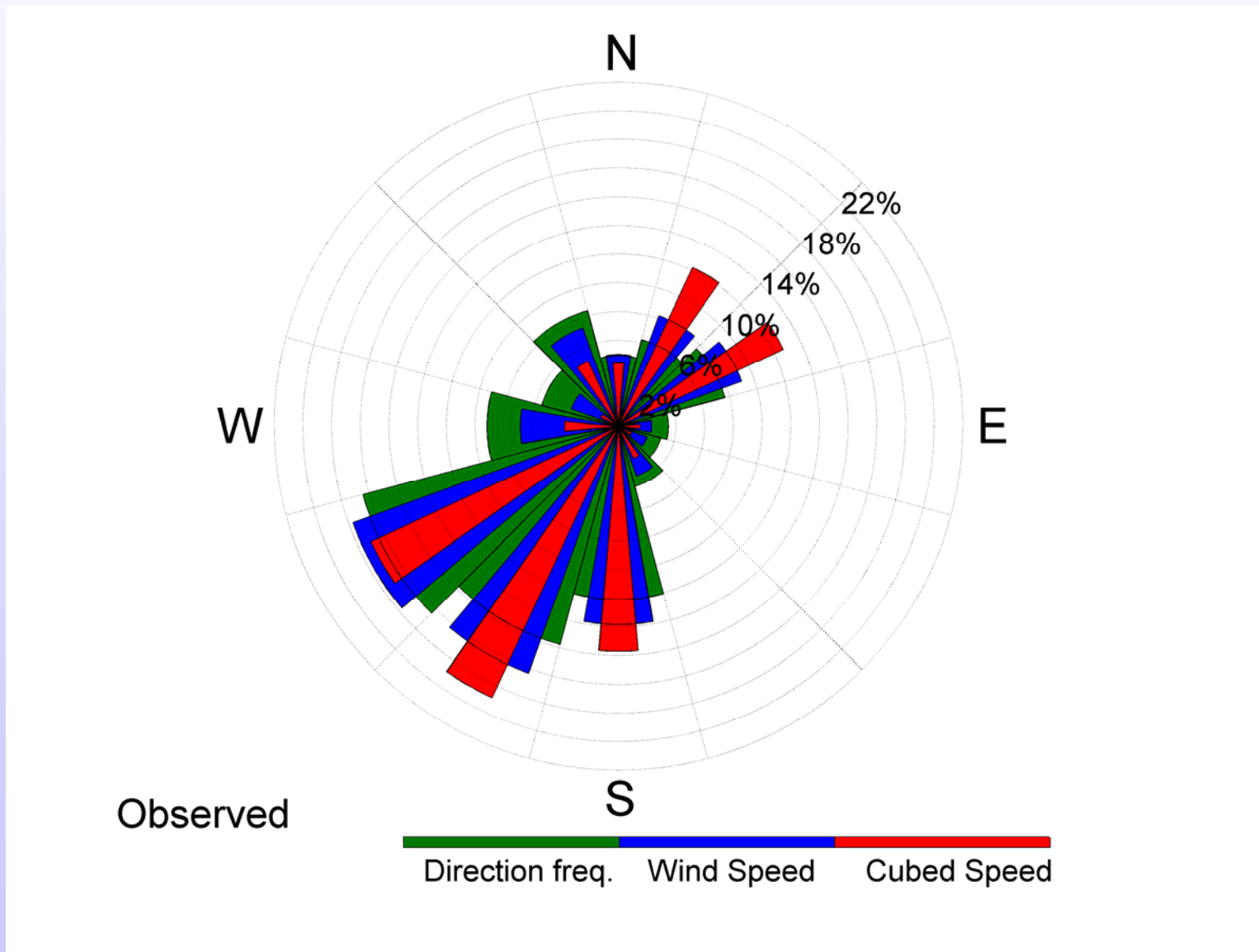
LM 7km



LM 2.8km

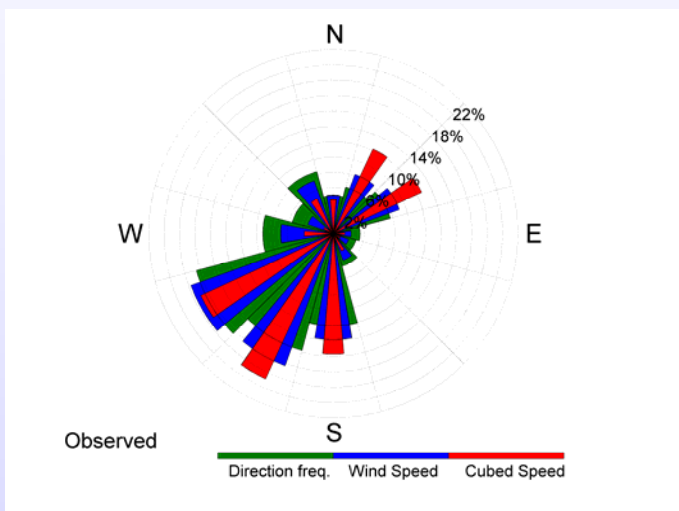


Power Wind Rose: OBS Rosslare (2005 - 2006)

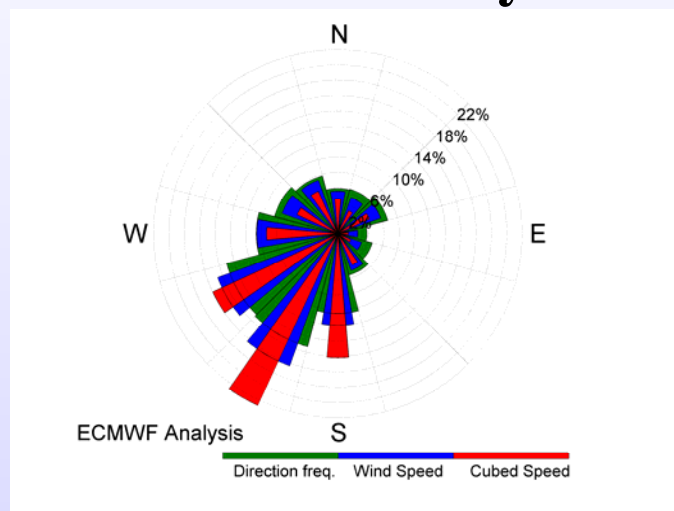


Validation: Rosslare Station (2005 - 2006)

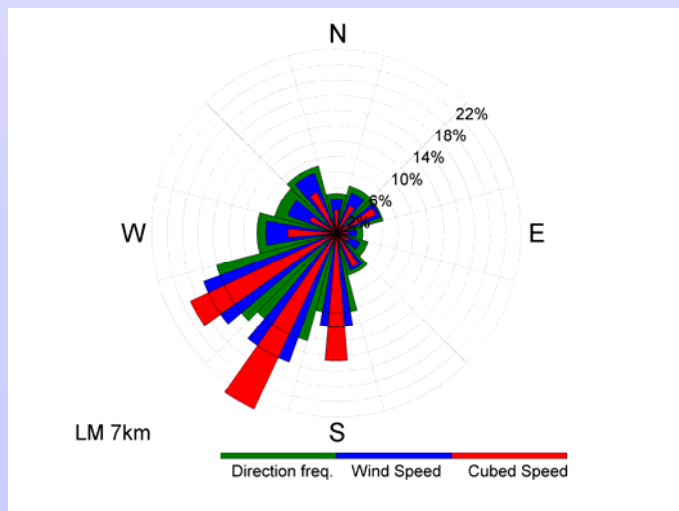
Observed



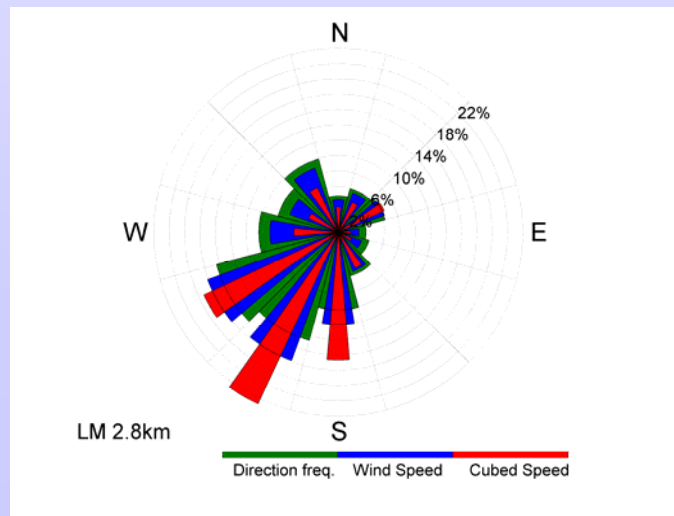
ECMWF Analysis



LM 7km



LM 2.8km

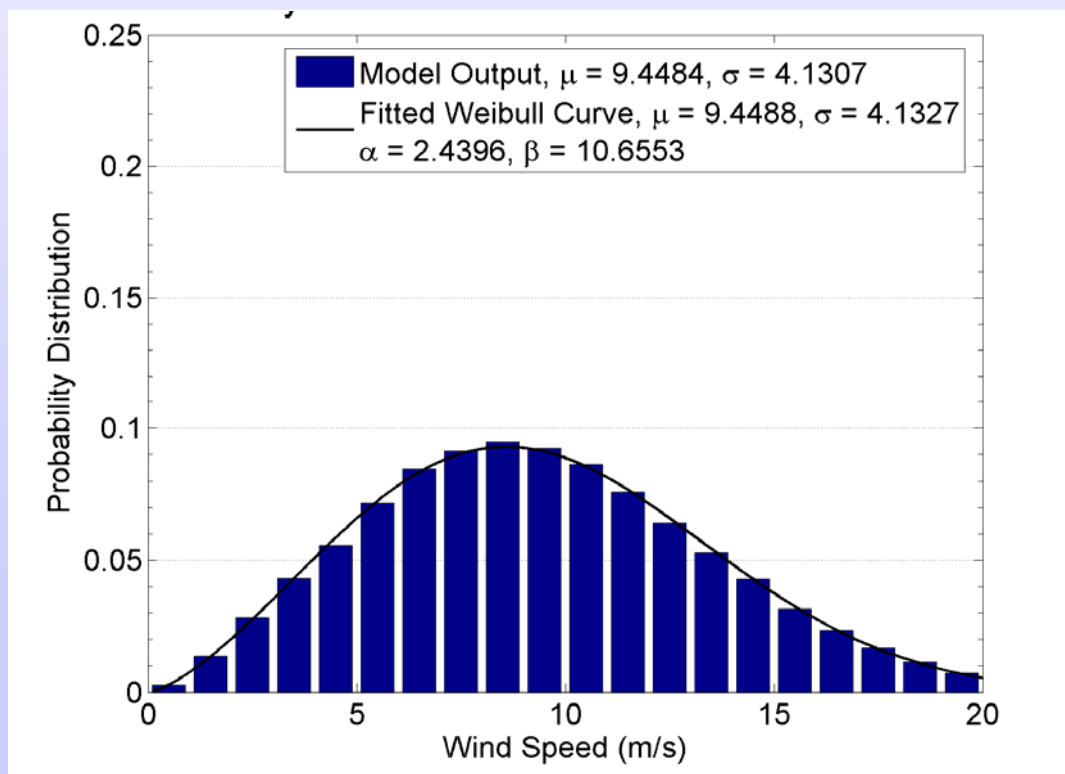


Weibull Distribution

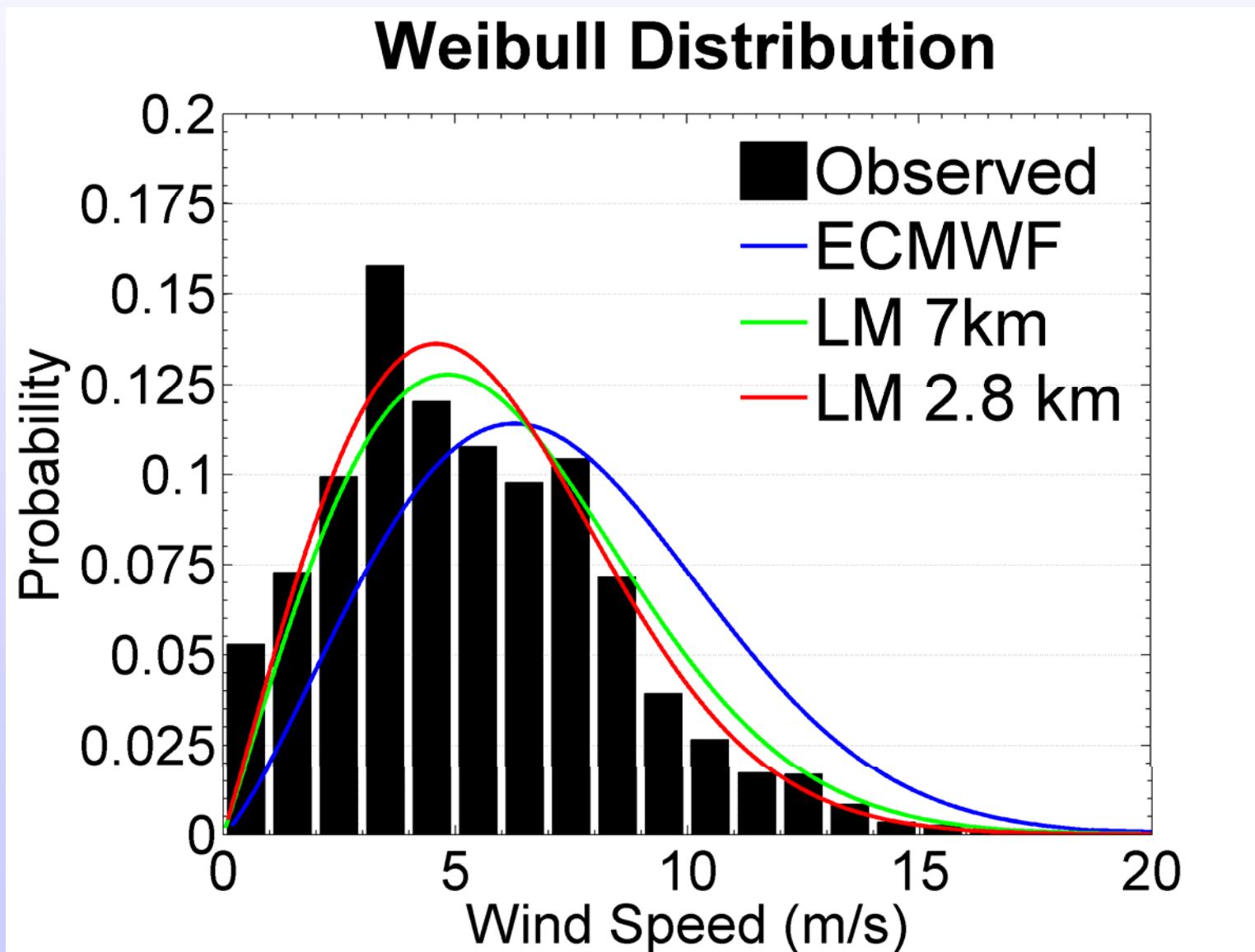
- At each grid point (i,j) we fit a Weibull distribution

$$W(x) = \alpha\beta^{-\alpha}x^{\alpha-1}e^{-\left(\frac{x}{\beta}\right)^\alpha} \quad \text{for } x \in (0, \infty), \alpha, \beta > 0$$

**Birry 60km
West of Galway**



Rosslare Weibull Distribution (2005 - 2006)



Weibull Statistics

$$\mu = E(X) = \beta\Gamma(1 + \alpha^{-1})$$

$$\sigma^2 = \text{Var}(X) = \beta^2[\Gamma(1 + 2\alpha^{-1}) - \Gamma^2(1 + \alpha^{-1})]$$

$$\frac{1}{N} \sum_{i=1}^N x_i^3 = E(X^3) = \beta^3\Gamma(1 + 3\alpha^{-1})$$

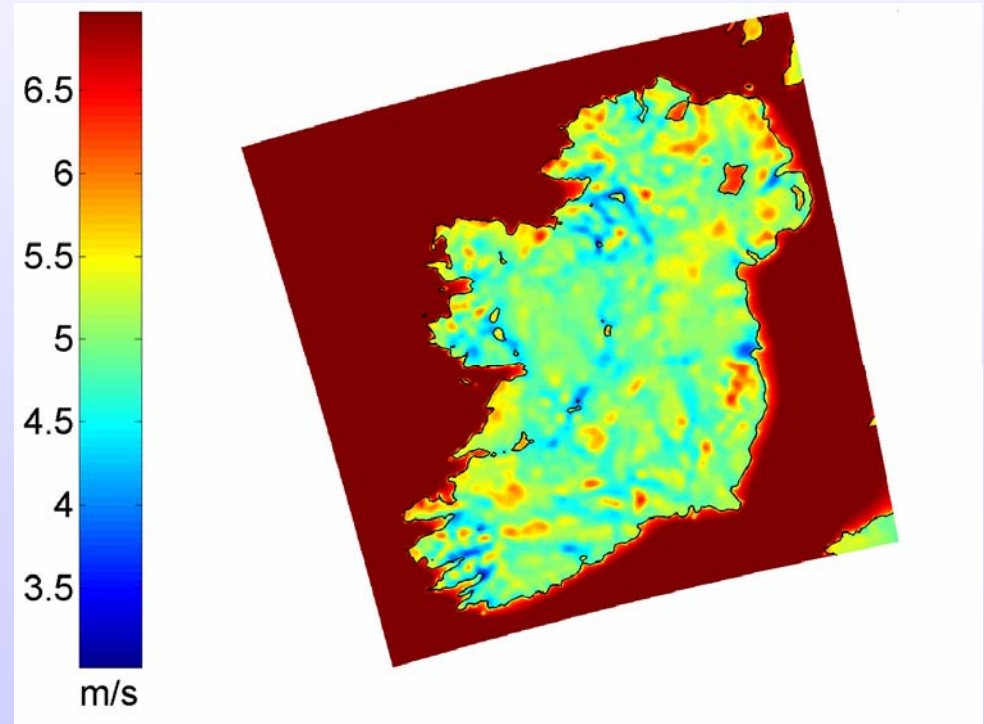
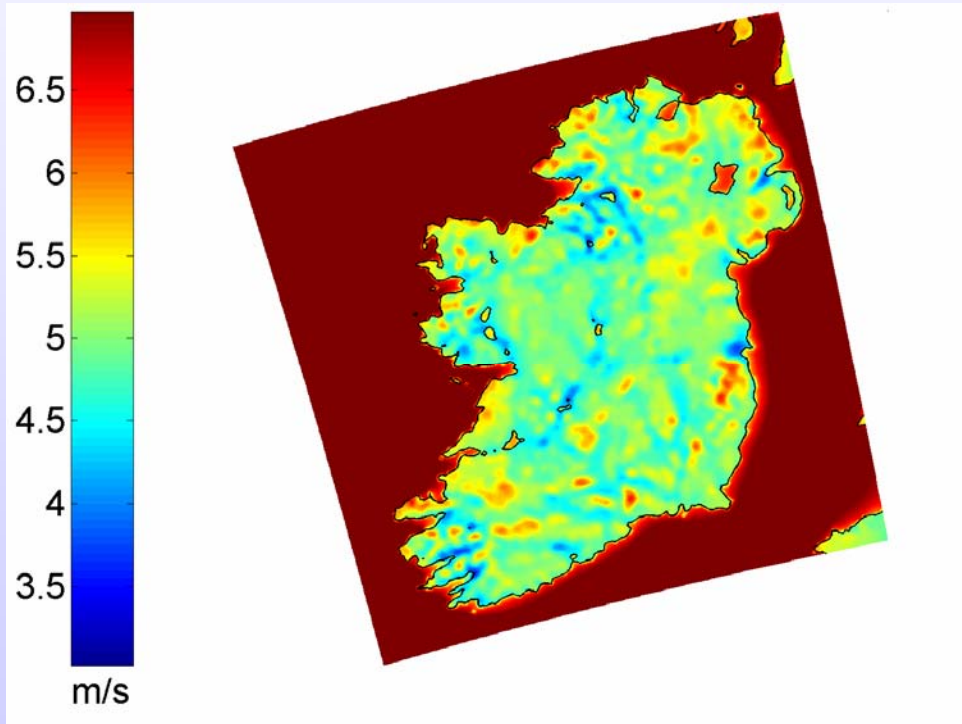
$$P(x_1 \leq X \leq x_2) = e^{-\left(\frac{x_1}{\beta}\right)^\alpha} - e^{-\left(\frac{x_2}{\beta}\right)^\alpha}$$

$$P_{(\chi.100)} = \beta \left[\log_e \frac{1}{1 - \chi} \right]^\alpha$$

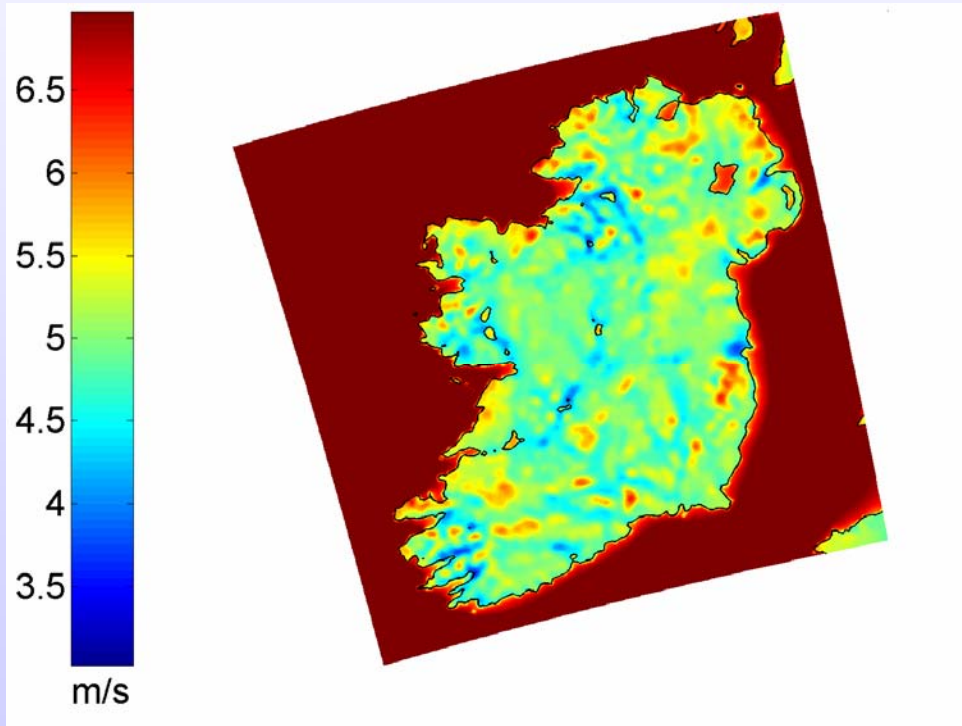
Mean Wind Speed LM 2.8 km (2005 - 2006)

Mean Wind Speed

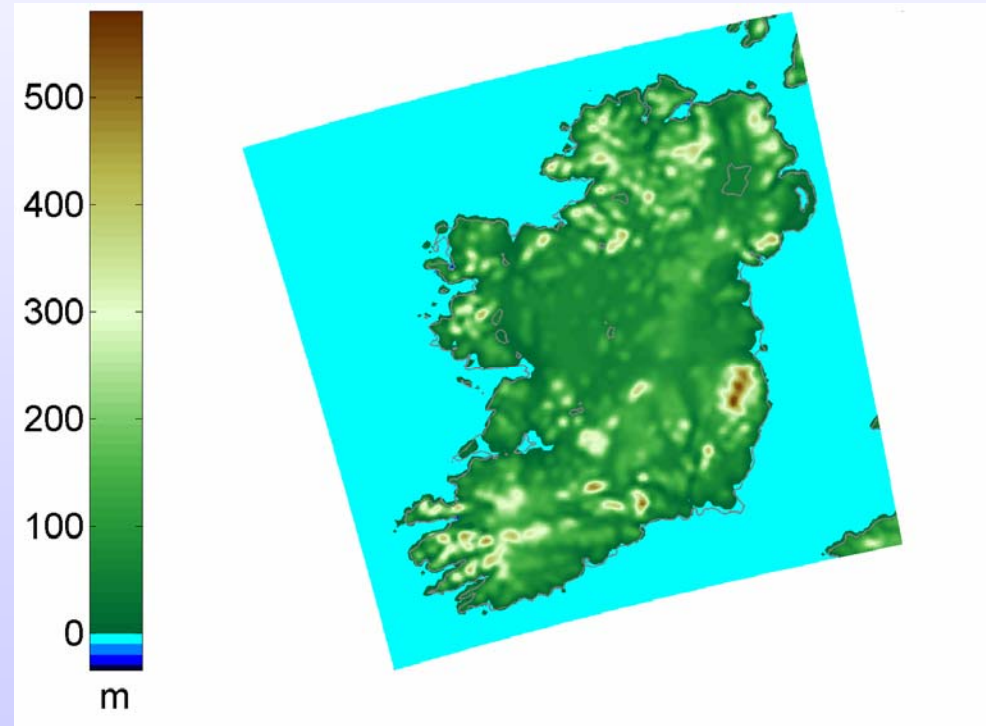
$$\mu = E(X) = \beta\Gamma(1 + \alpha^{-1})$$



Mean Wind Speed

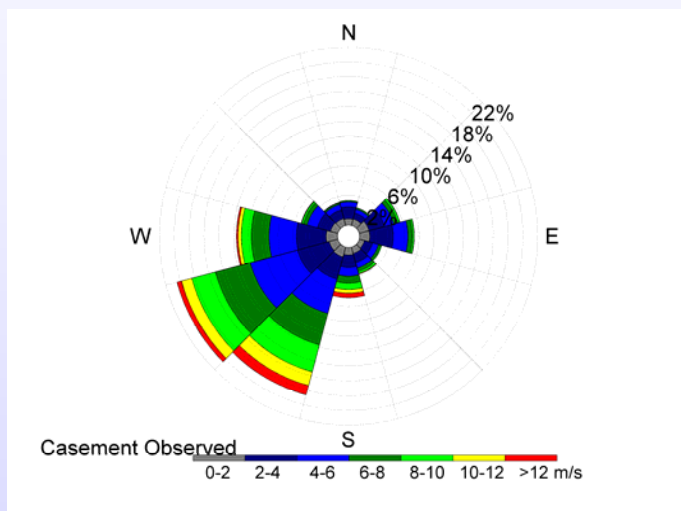


Topography

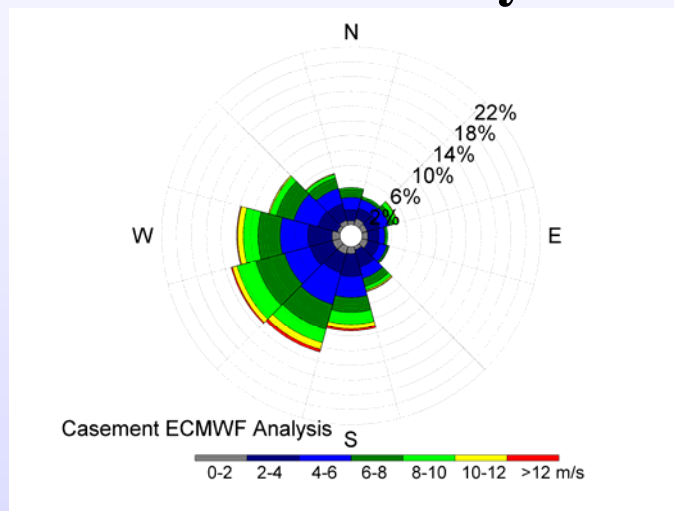


Validation: Casement (2005 - 2006)

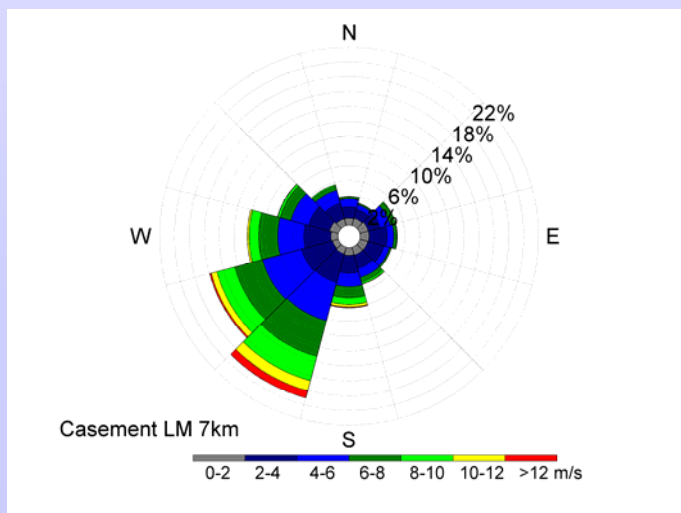
Observed



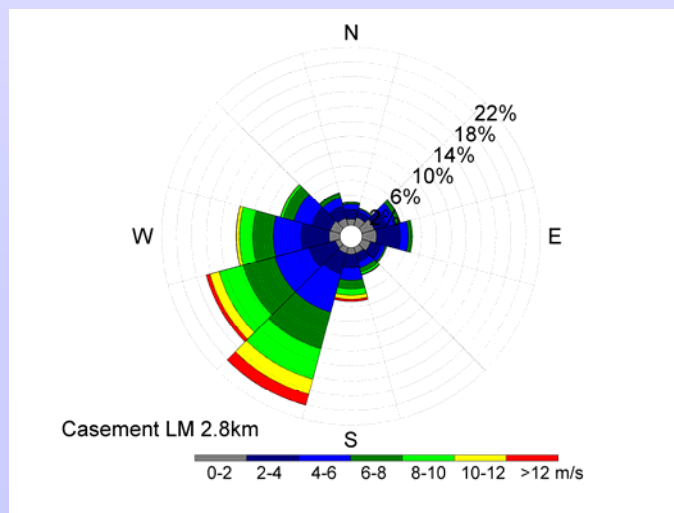
ECMWF Analysis



LM 7km



LM 2.8km



Conclusions

- We are using the non-hydrostatic Lokal Modell (3.21) to provide short term forecasts at the mesoscale level.
- The model is driven at the lateral boundaries by ECMWF global re-analysis data.
- The model was run at a resolution of 7 km & 2.8 km.
- The model has been validated by performing a 2-year series of 24hr forecasts. Results confirm that the model is able to simulate wind patterns over Ireland with a high level of accuracy.

Thank you for your attention.