GREEN Grid
Future Proofing New Zealand's Electricity Supply

Quantifying the benefits of wind power diversity in New Zealand
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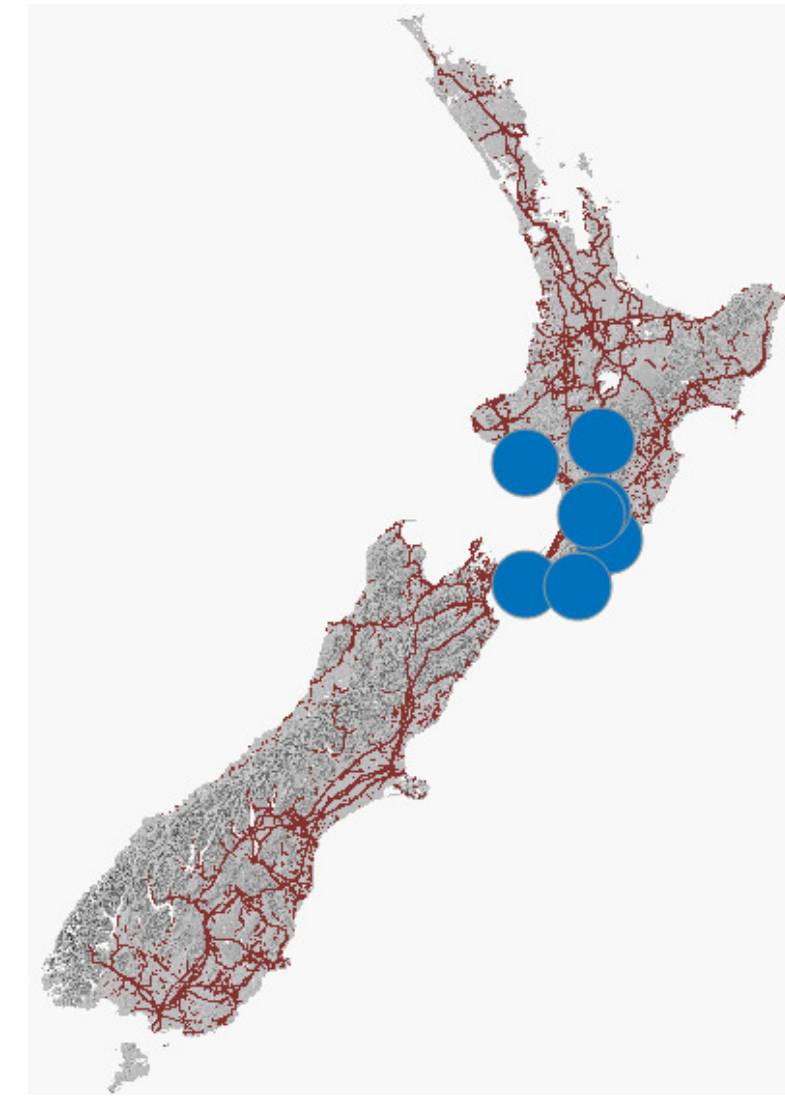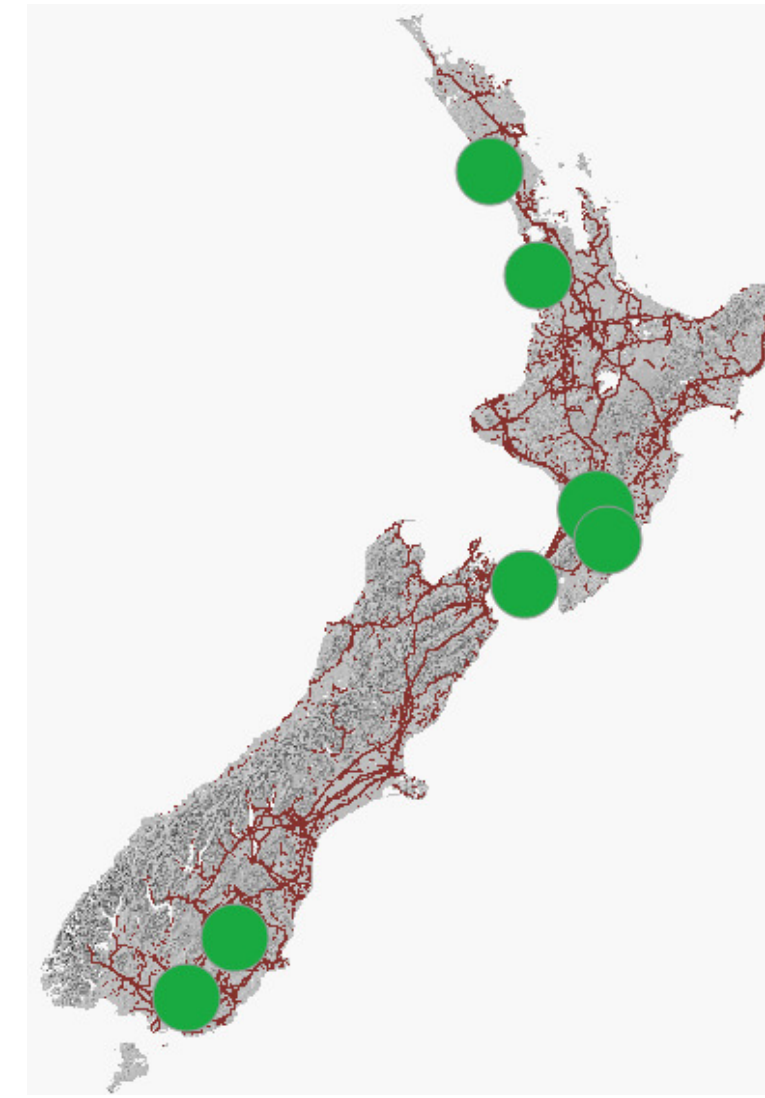University of Canterbury, New Zealand

New Zealand

Wind power integration studies often conclude that power systems can benefit through the spatial diversification of Wind Power Plants. However, that benefit is rarely quantified. Quantification requires temporally and spatially accurate models of wind power (see Power Simulation).
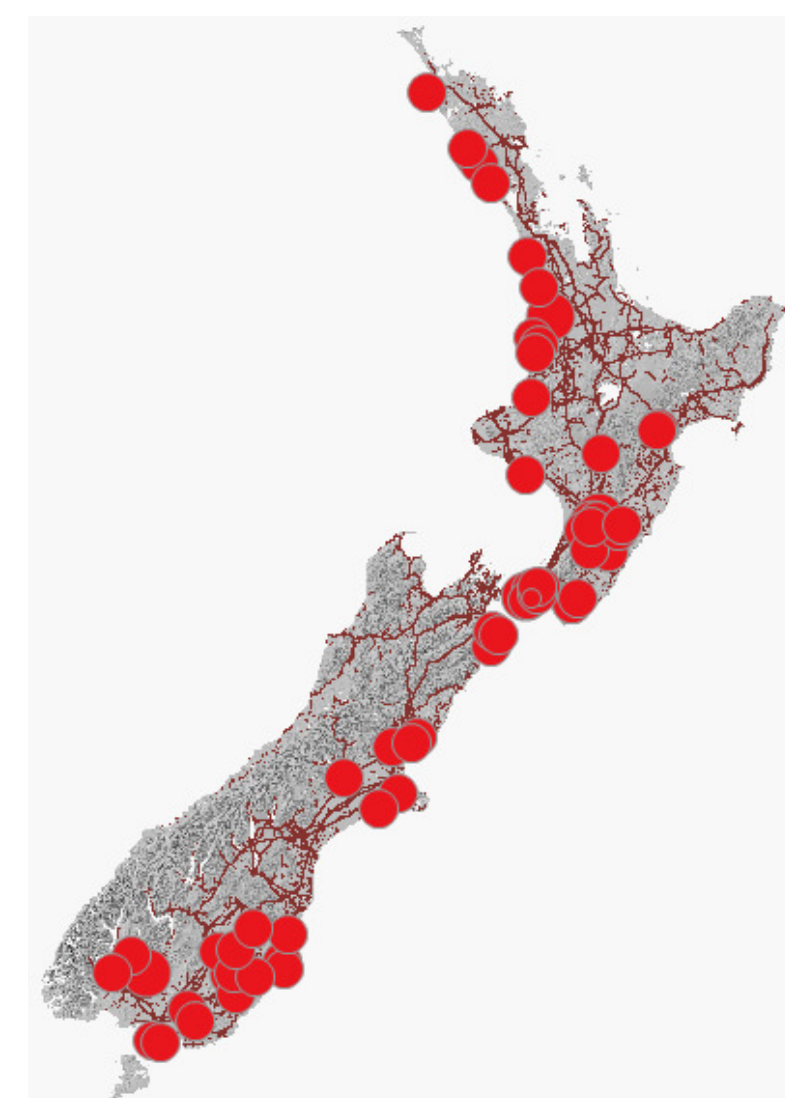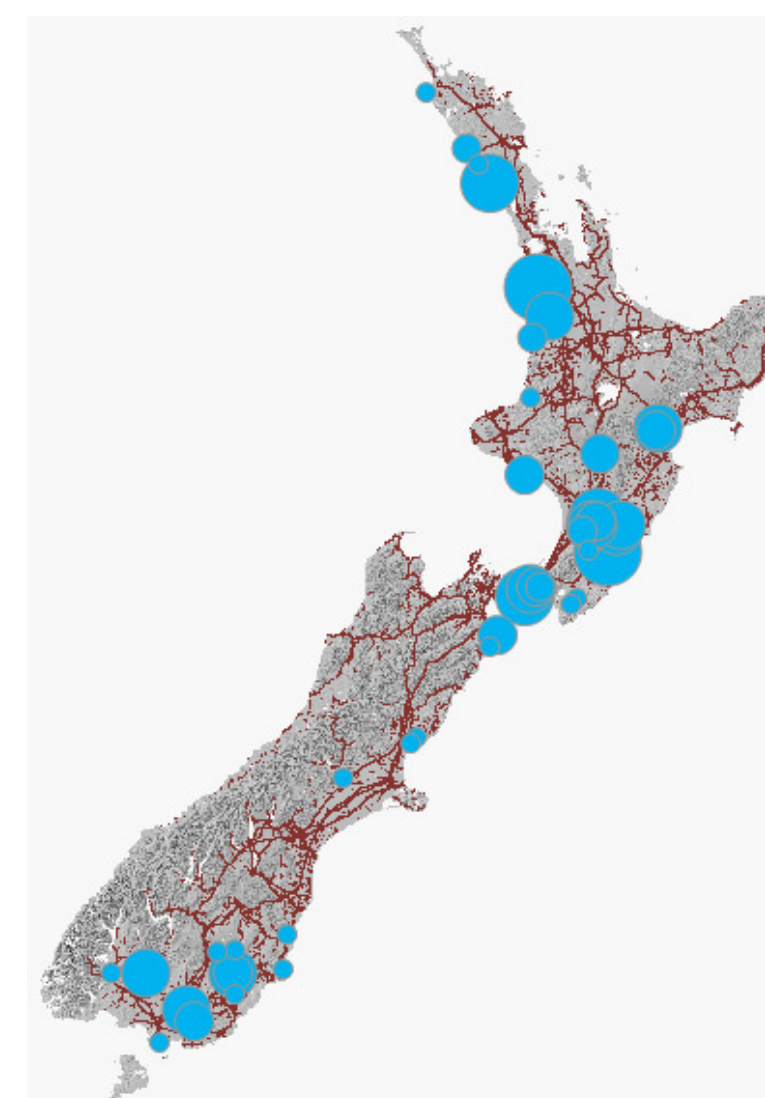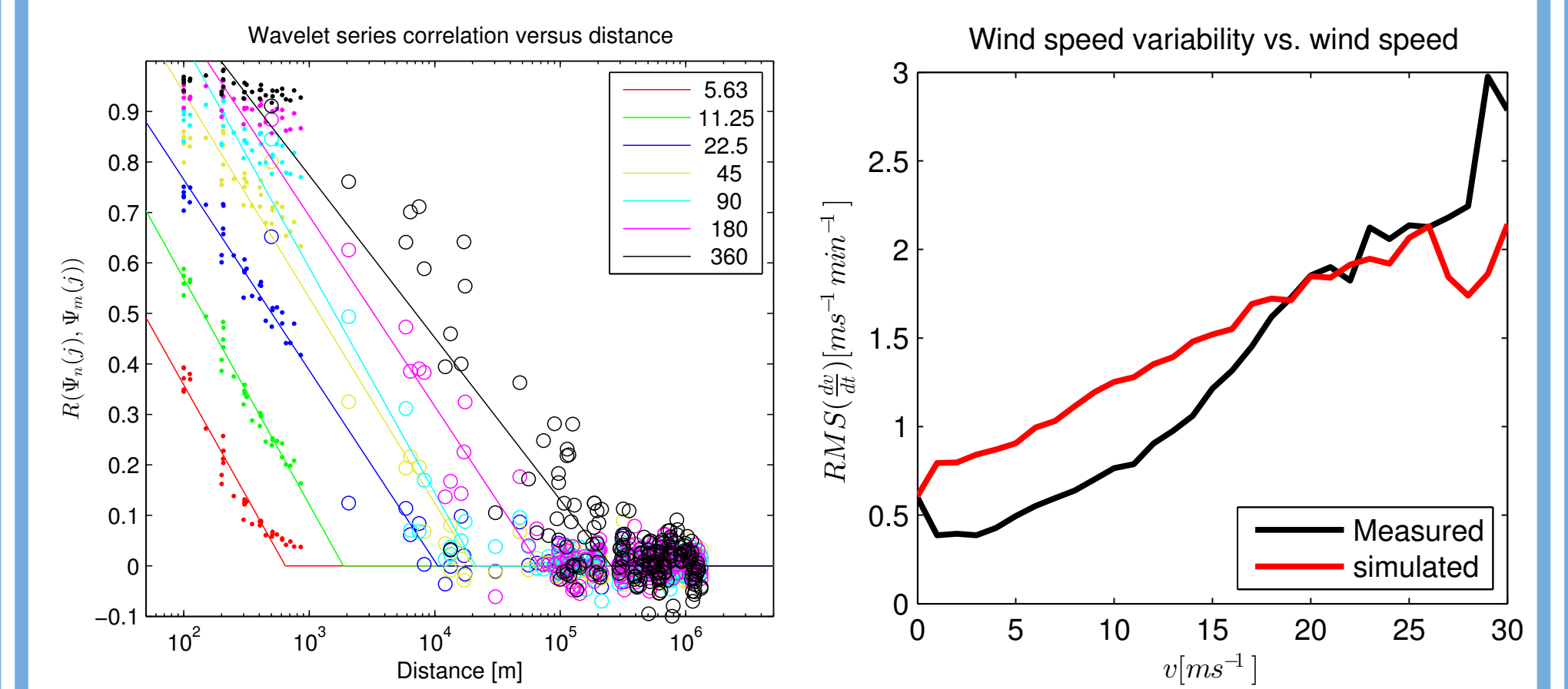
Power simulation
1. Get wind speed time-series from ECMWF-interim (grid, 10m, 6hr),
2. Interpolate using cubic splines (wind power plant points, 10m, 6hr)
3. Scale using MCP (point, hub height, 6hr),
4. Impute using **Wavelet Multi-resolution Analysis** (point, hub height, 5min),
5. Transform to power using wind power plant power curve,
6. Low pass filter to account for spatial integration of wind power plant,
7. Markov Chain model to account for availability,
8. Aggregate WPP power time-series to form scenario time-series.

2 GW scenarios

Compact
7 x ~300MW

Disperse
7 x ~300MW

Diverse
70 x ~30MW

Business As Usual
70 x 1-300MW

Wavelet Multi-resolution Analysis
Imputation "fills in" missing data (increasing temporal resolution) using a stochastic model.
Wavelet Multi-res. Analysis allows the correct spatio-temporal correlations to be simulated (see below left) while allowing for heteroskedasticity; literally meaning that it is gusty when it is windy (see figure below right).
Beylkin wavelet selected to reduce dimensionality.

Power time-series for each wind power plant simulated and aggregated to form scenario power time-series. Reaction to Cyclone Bola shown top right.
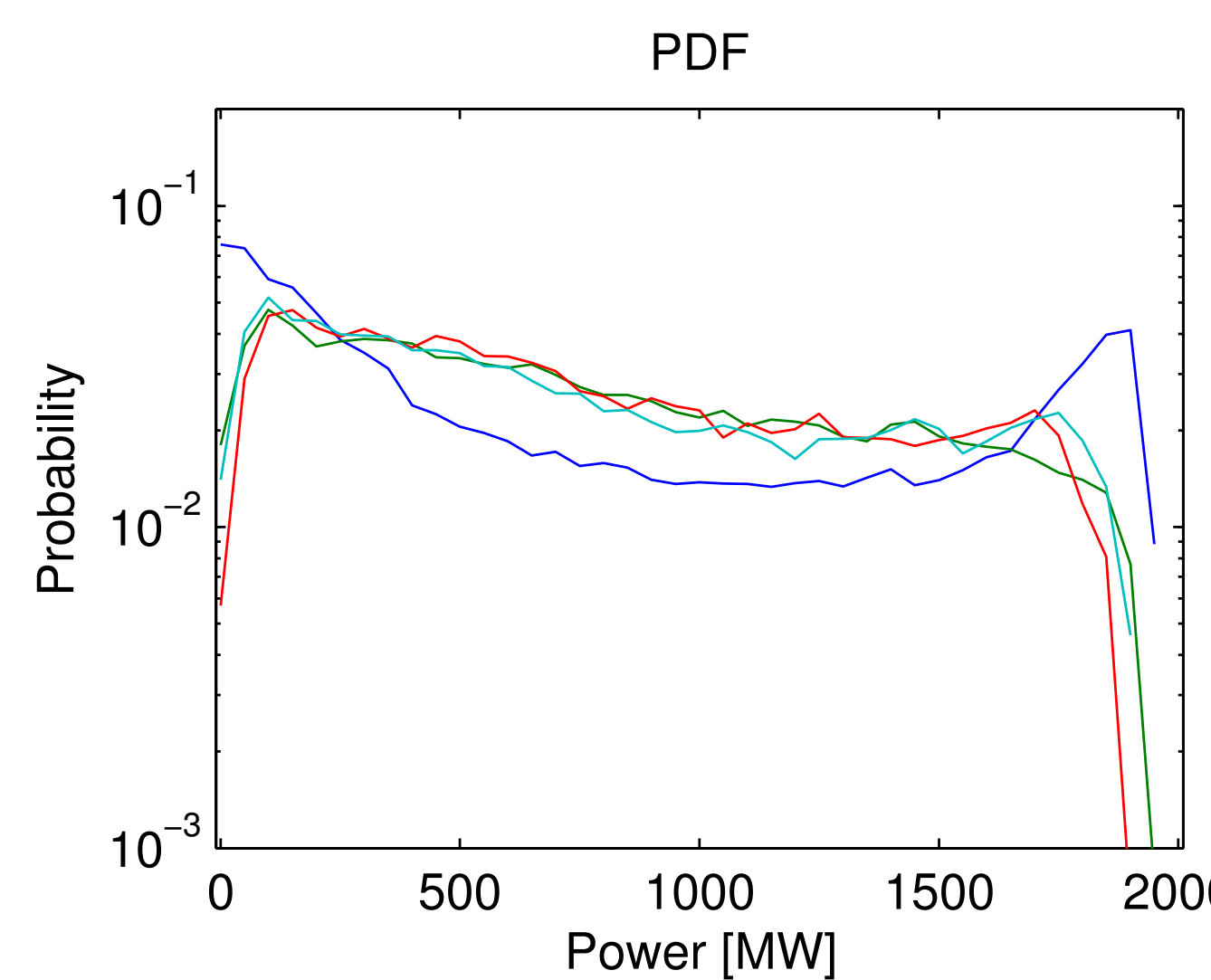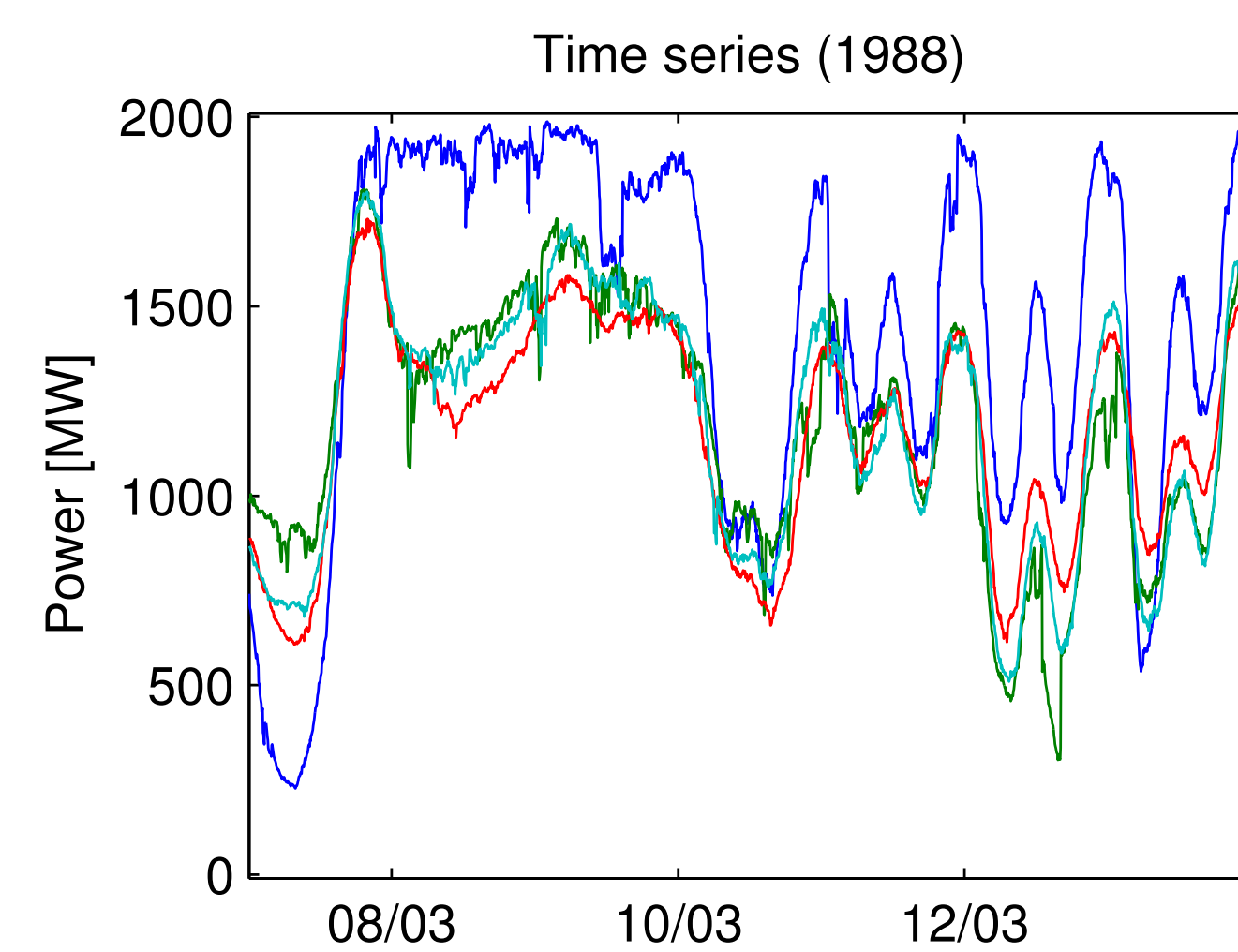
A compact portfolio decreases dependability.
Standard deviation of aggregate power +28% c.f. diverse scenario

Diversity decreases variability.
Ramp rates (5min, once per week) reduced by 25% c.f. compact scenario
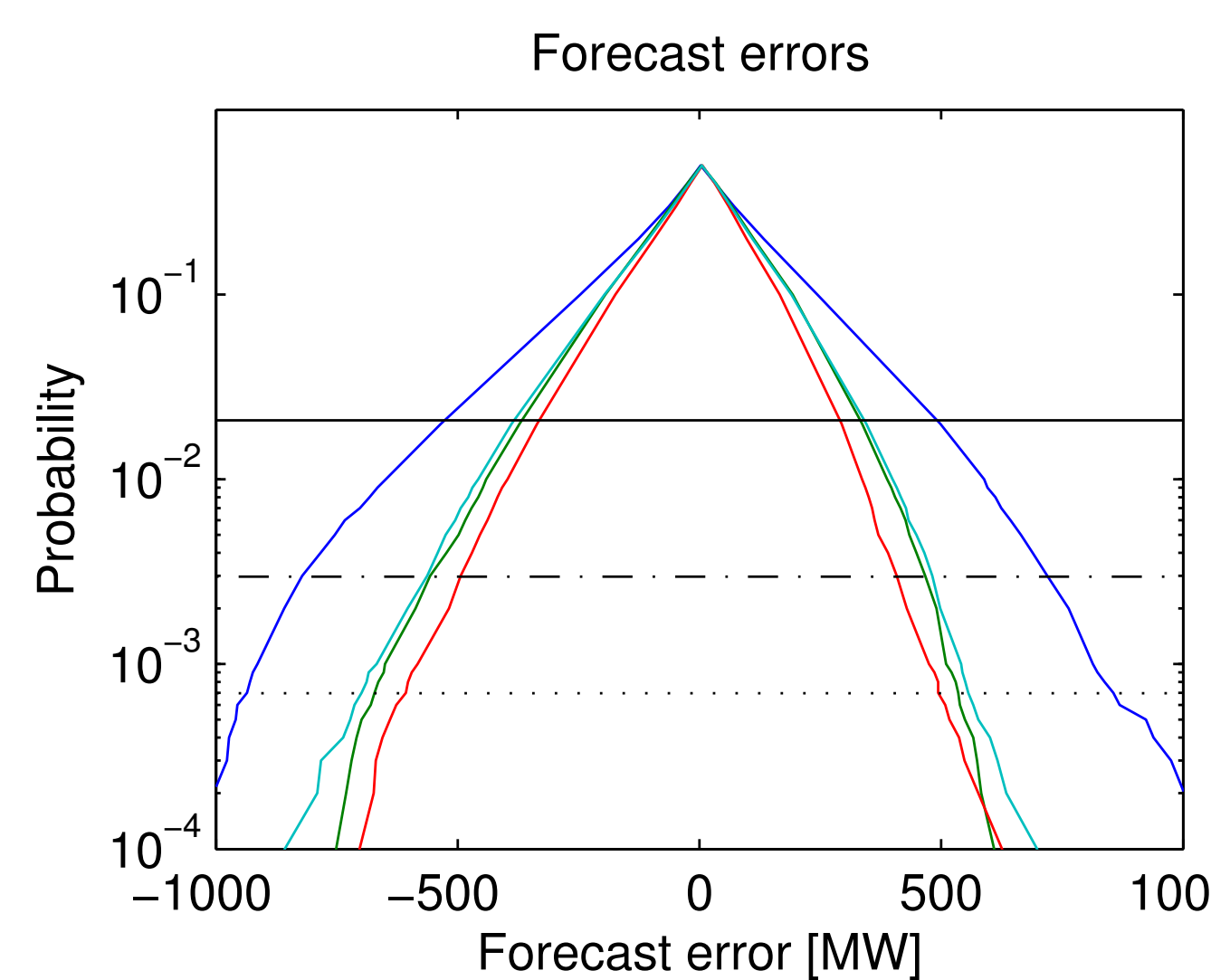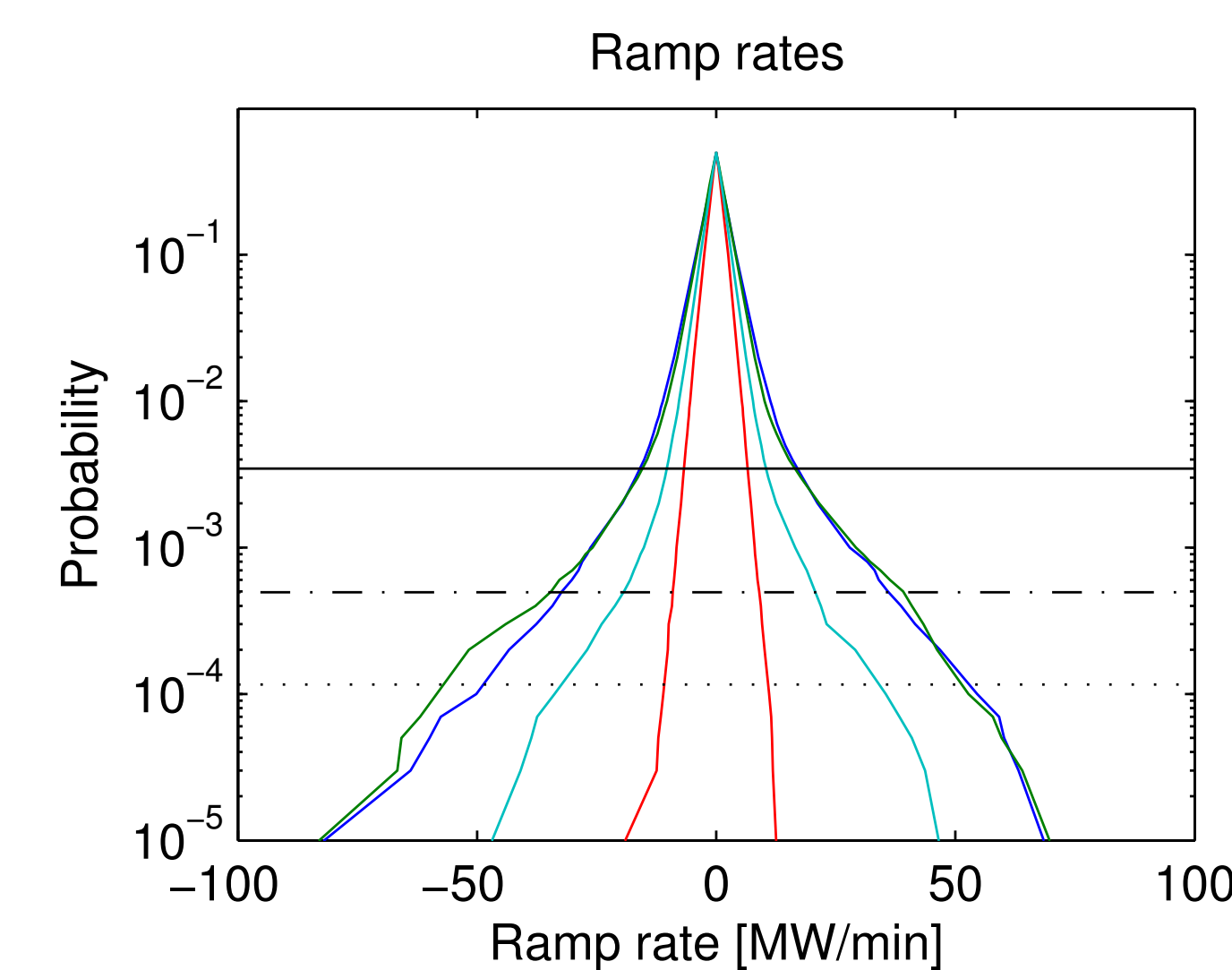
Dispersion increases predictability.
Forecast error (2hr once per week) -45% c.f. compact scenario

Business-As-Usual will achieved some of the benefits of spatial diversification; greater benefits could be gained through coordinated development.