Slide 1

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UNSW
THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA

The First Australian Installation of the Wind Power Prediction Tool

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Slide 2

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Talk outline

- Introduction of project with Hydro Tasmania

- General Performance of the Wind Power Prediction Tool

- Large swings in wind power

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Slide 3

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Introduction

- The Roaring 40s Woolnorth wind farm has 37 turbines. Total 64.75 MW.
- Rated power represents 6.5% of typical overnight Tasmanian demand minimum (~1000 MW)
- Basslink, connecting Tasmania to Victoria and the mainland was commissioned on April 29, 2006

  Woolnorth

- Third stage of Woolnorth is due for completion in early 2007, taking the total rated power to 140 MW, or up to 14% of Tasmanian minimum demand
- Hydro Tasmania installed the Wind Power Prediction Tool (WPPT) in March 2006

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Slide 4

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Introduction

- Woolnorth has a very high wind resource due to the roaring 40s and the coastal site with the cliffs
- Woolnorth is also one of the most variable wind sites in the world
- Ideal test site for WPPT and observing large swings in wind power output
- Energy traders indicated large swings occurring at night would be worst scenario and predicting those is important

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How does WPPT work

- Statistically combines recent wind power measurements and future wind speed forecasts to make a wind power prediction
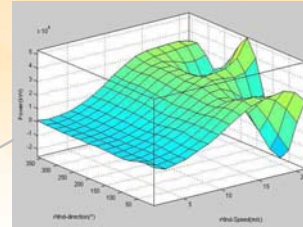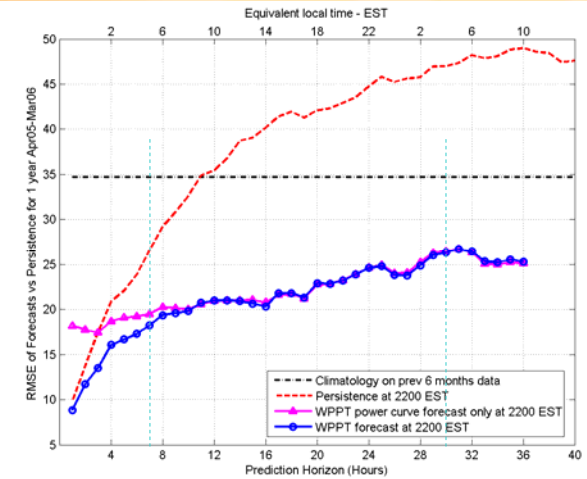
power curve

- At time *k*:

$$\hat{P}_{k+1} = \theta_1 P_k + \theta_2 P_{k-1} + \theta_3 \hat{f}_{pc}(wspd_{k+1}, wdir_{k+1}) + \theta_4[\cos, \sin \text{ of time}] + \theta_5$$

- Parameters *θ*, updated to minimise errors
- Naturally there are different optimum values for *θ* for different prediction horizons: weighting for P_k and P_{k-1} decreases as horizon increases.

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General Performance curve for WPPT

1 year of data Apr'05 to Mar'06 – normalised with wind farm rated power
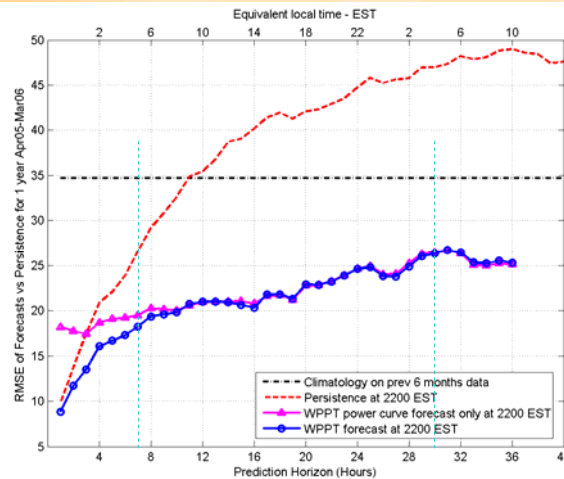

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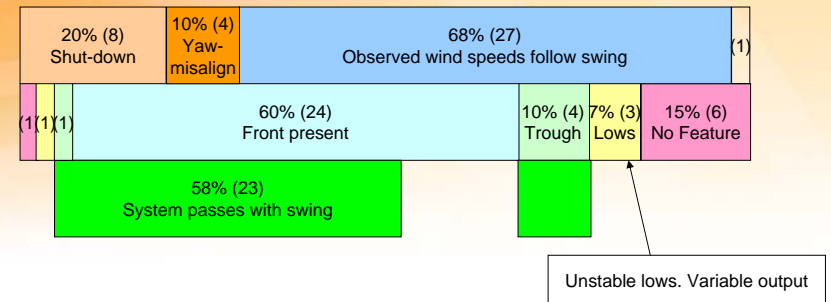## General Performance curve for WPPT

Persistence typically up to 35% (36hr) for less variable sites

Climatology typically 30% for less variable sites

WPPT performance in Europe for 36 hours is 12-20% for ANEMOS project (over 25% in one difficult case)
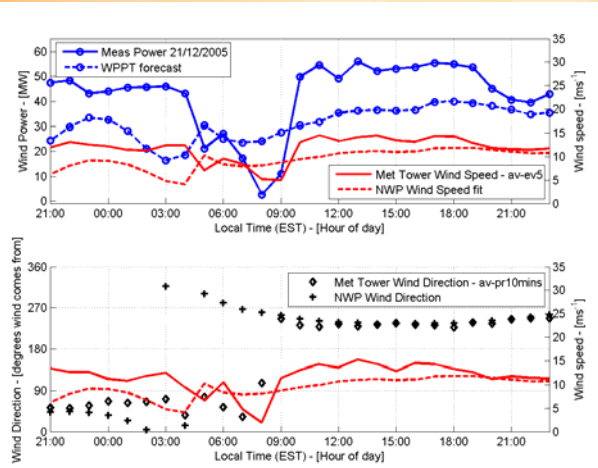

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Large swings for 1 year - summary

| 20% (8) Shut-down | 10% (4) Yaw-misalign | 68% (27) Observed wind speeds follow swing | (1) |

| 60% (24) Front present | 10% (4) Trough | 7% (3) Lows | 15% (6) No Feature |

58% (23) System passes with swing

Unstable lows. Variable output
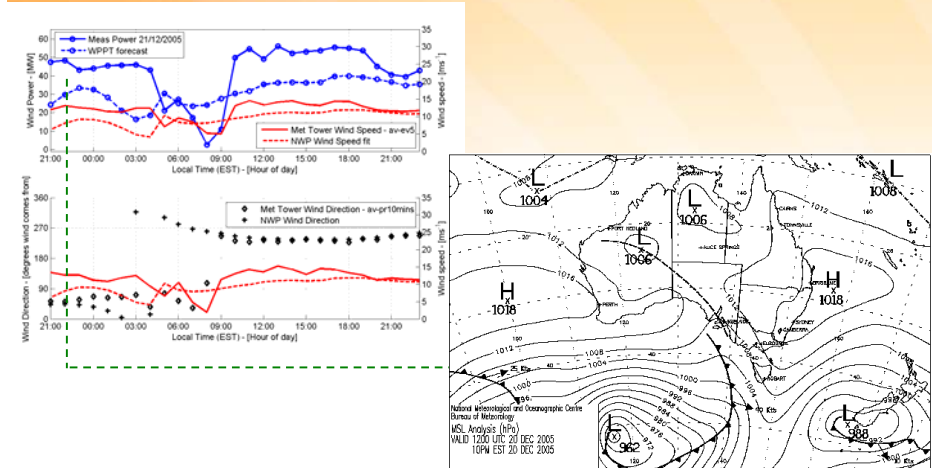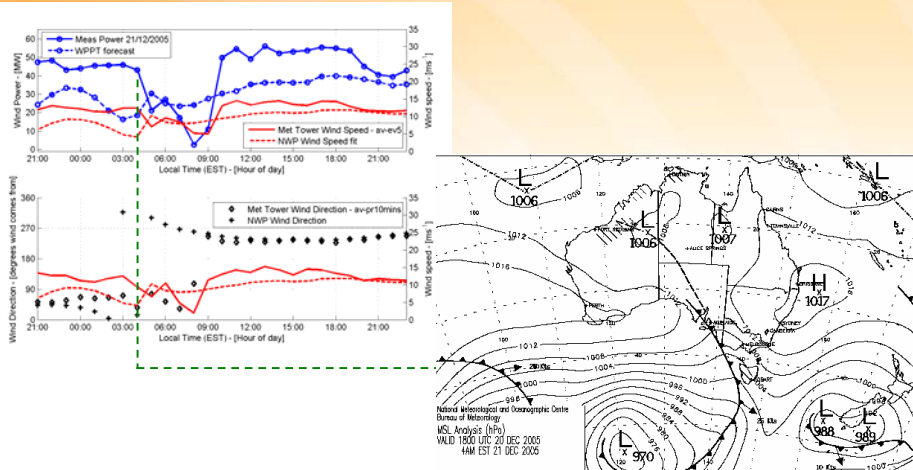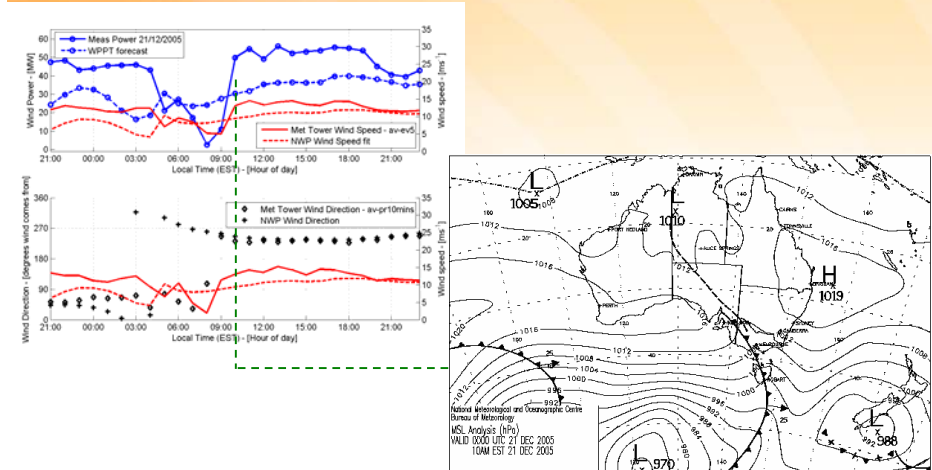
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Large swings examples

- Swing #48: 21 December, 2005. Trough precedes front

Large swings examples

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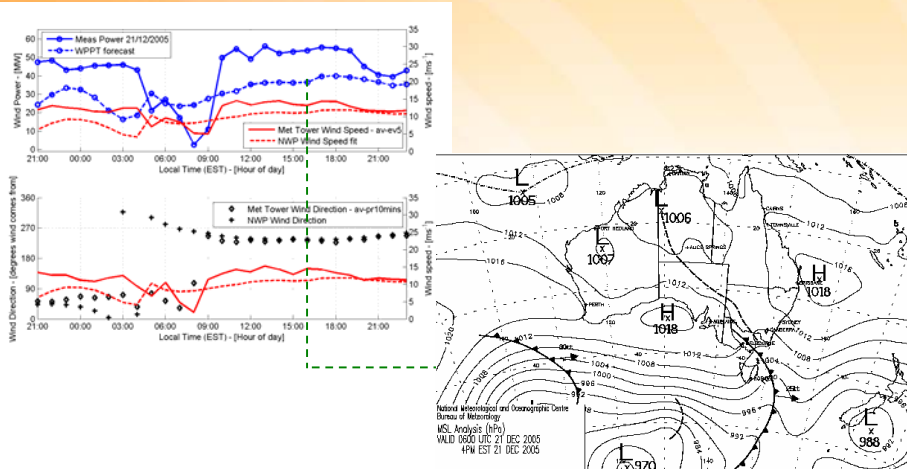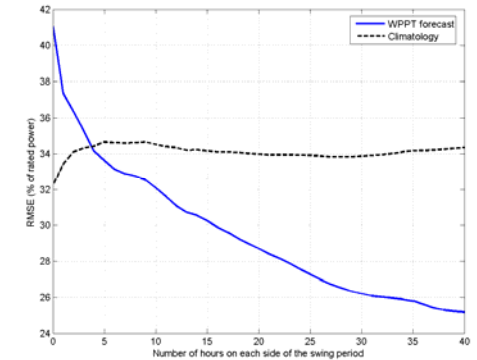
- Swing #48: 21 December, 2005. Trough precedes front

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Large swings – WPPT performance

- What about calculating RMSE for the periods of the large swings only?
- WPPT forecasts hourly: 15 large swings changing on hourly scale
- RMSE from 15 hourly-data swings gave ~40% - worse than climatology

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NWP predictions during large swings

- 27 Met Swings:

  15 wind changes on hourly time scale:
  - Info in NWP wind speeds 7/15 times (47%)
  - Info in NWP directions 11/15 times (73%)

- 8 shut-down Swings
  - Info in NWP wind speeds 4/8 times (50%)
  - Info in NWP directions 6/6 times (100%) it changes
- 4 yaw-misalignment Swings
  - Direction changes sharply each time but NWP directions do not

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Conclusions

- WPPT predictions at high end for ANEMOS experience overall due to highly variable site
- Woolnorth location subject to many large swings mostly caused by fronts
- More information in NWP directions than speeds for predicting large swings. In addition some directional changes occur on too small a time-scale for the NWP
- These conclusions are only for 1-1½ years of data
- Further research: expanding data set to SA and Victoria – and developing a forecast methodology focussing on large swings

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Roaring40ˢ
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- Thank you
- Questions?

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