Detection of extreme events and timely warnings

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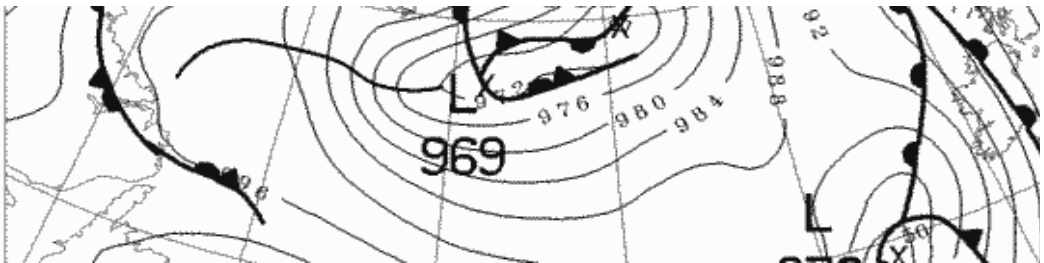
Safewind Project - End Users' Workshop
Fredericia, Denmark

2012/03/02



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Company profile

- Integration of renewables into grids and markets
- Service provider for energy meteorology since 2004
- Areas of business
  - Wind and solar power predictions worldwide
  - Forecasts for selling wind and solar power directly to energy markets
  - Software for Virtual power plants / demand side management
  - Development
    - Industry projects
    - European research projects

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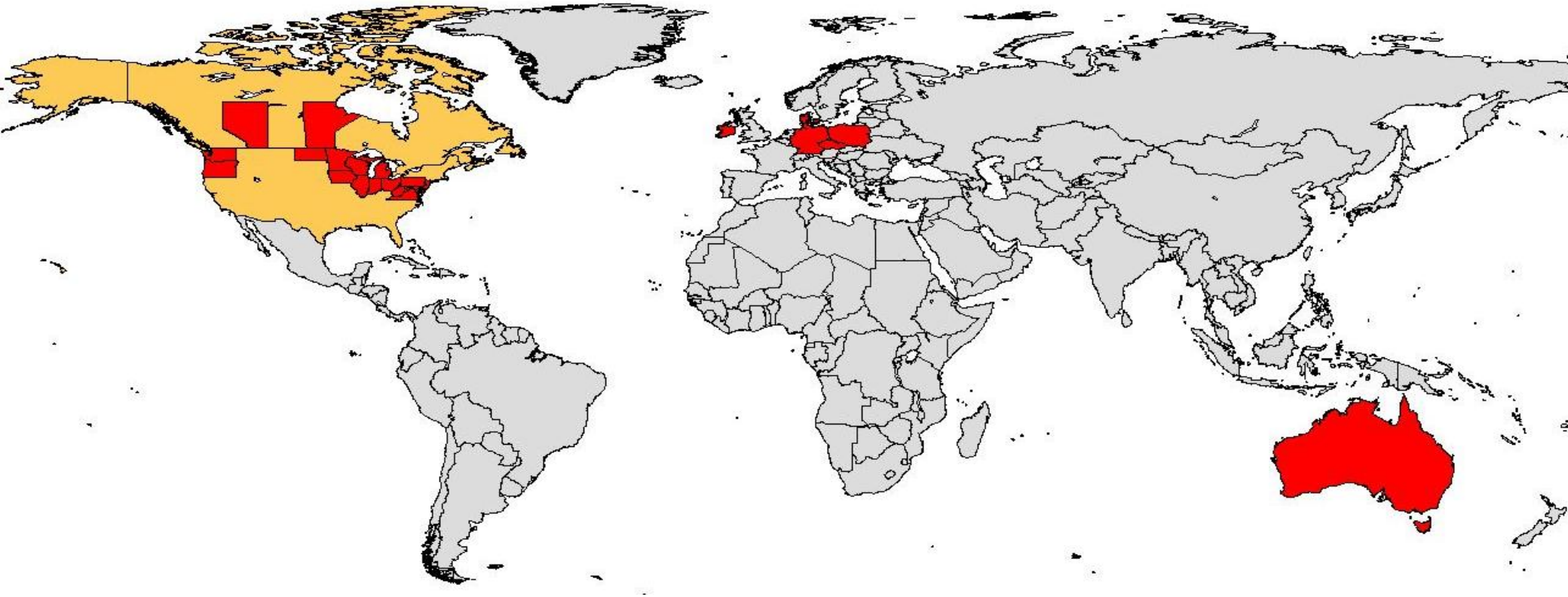
Areas with operational forecasting experience

- 55 GW of installed wind power currently predicted



Previento wind power forecasting for grid operators

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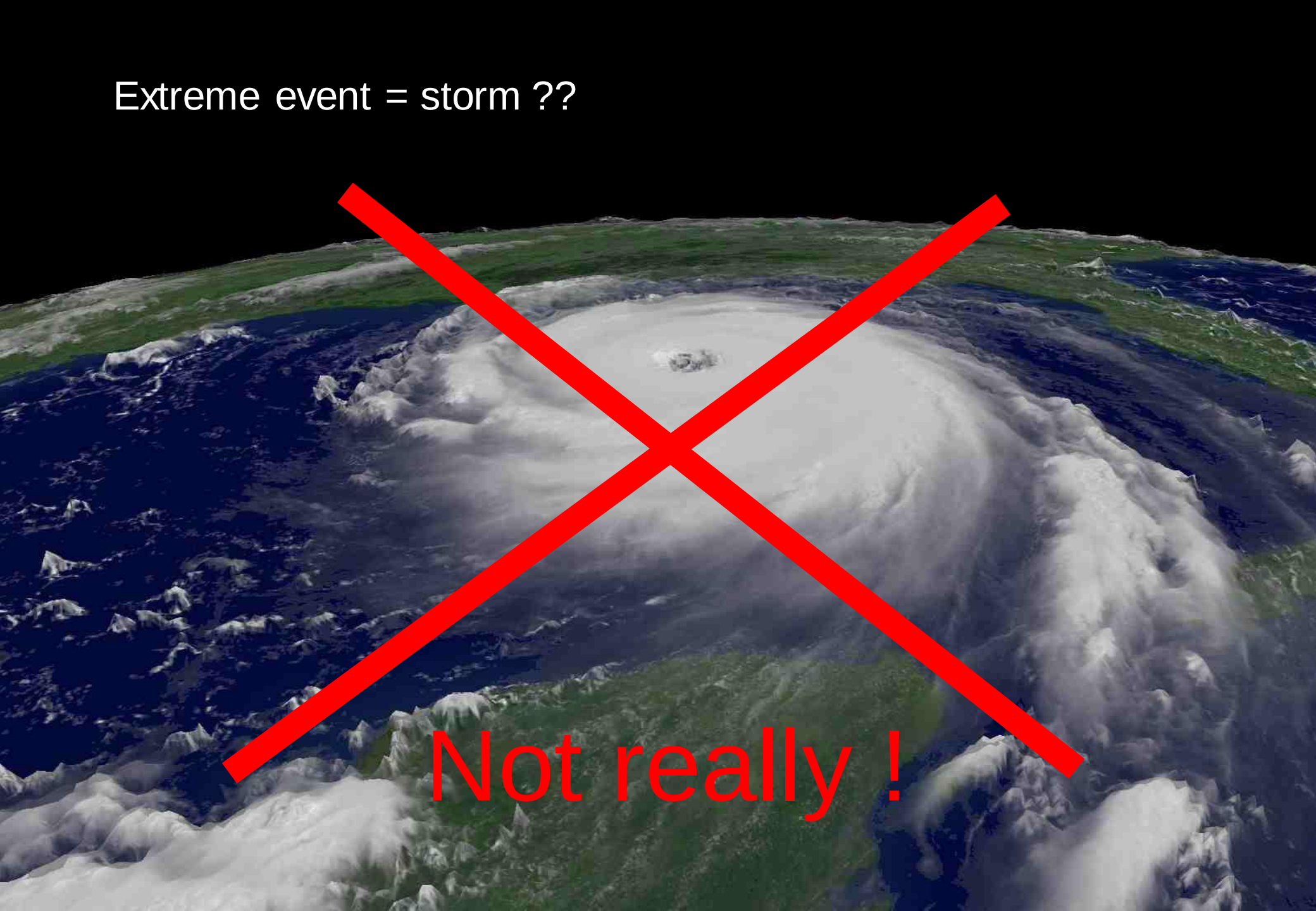
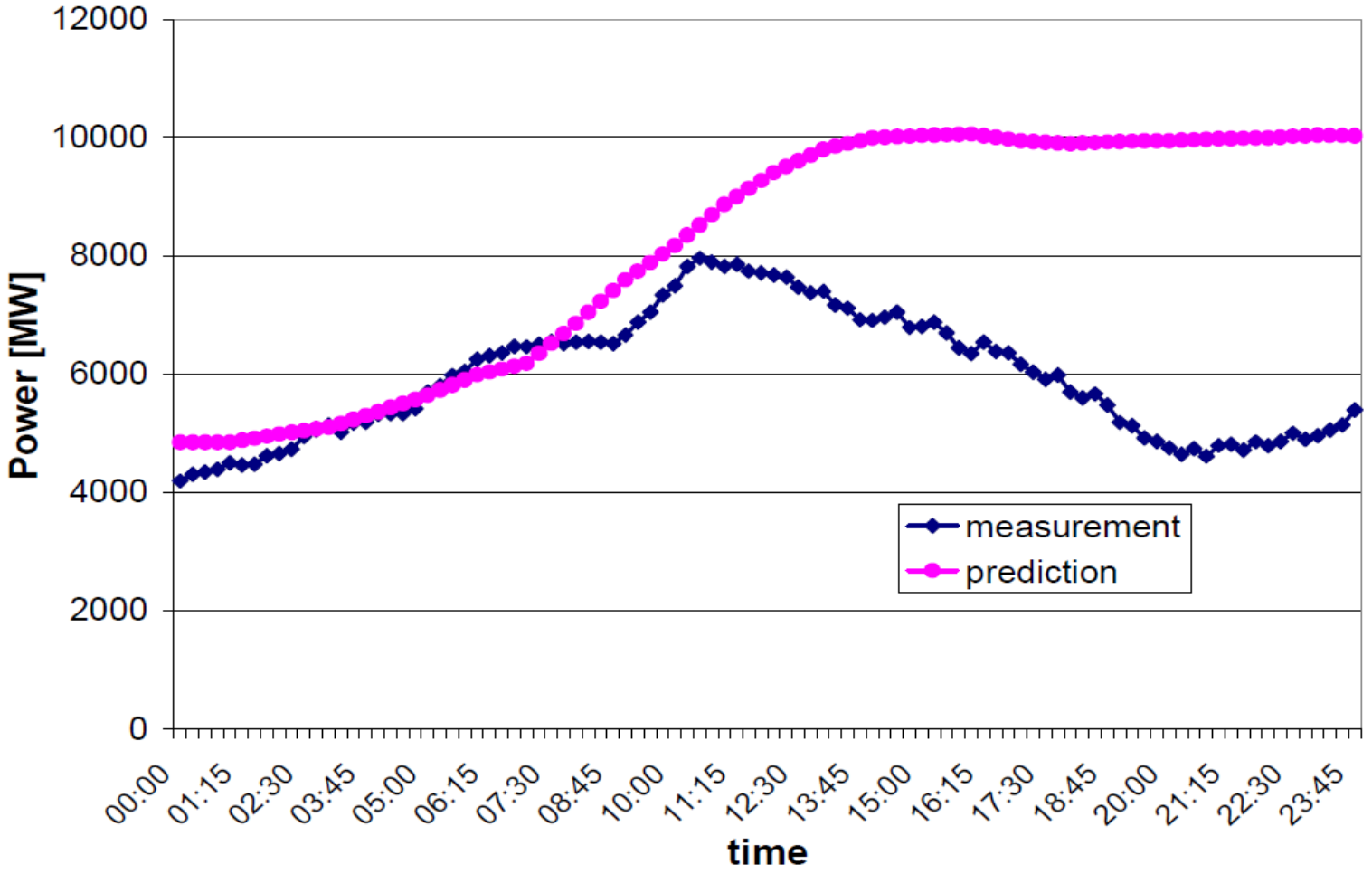
Extreme event = storm ??



Extreme Event = Large forecasting error!



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Lessons learned in wind power forecasting

Reasons for large errors

- Forecasting error in numerical weather model
  - Pressure system off track
  - Phase errors in fronts
  - Convective weather pattern (thunderstorm)
  - ...
- Icing
- Cut-off due to high wind speeds
- Down regulation
  - by grid operator
  - due to market price
- Unannounced maintenance

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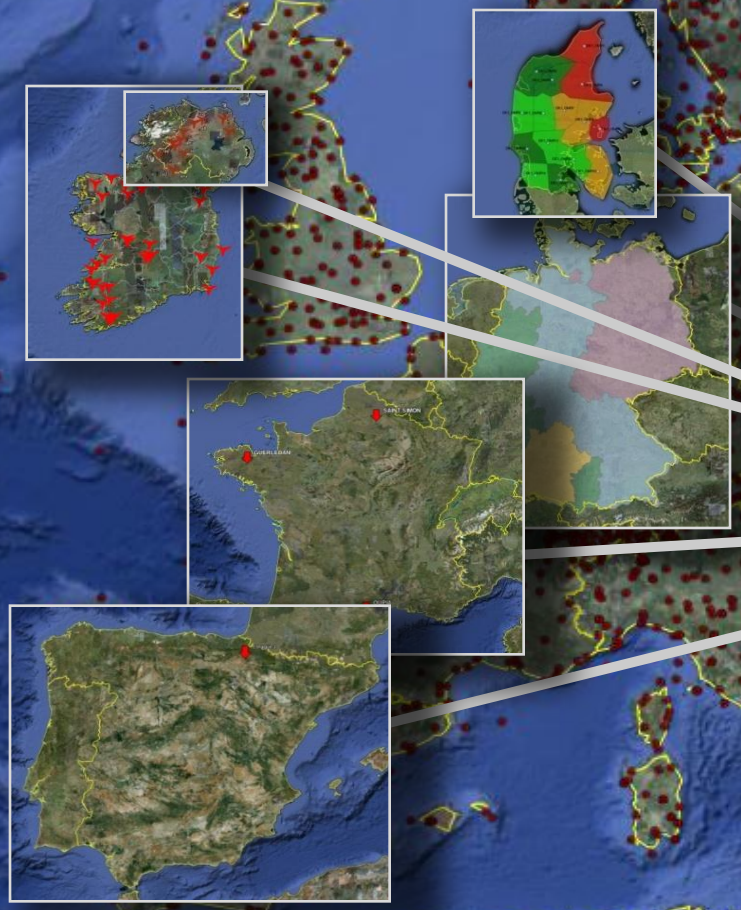
Vision of Safewind

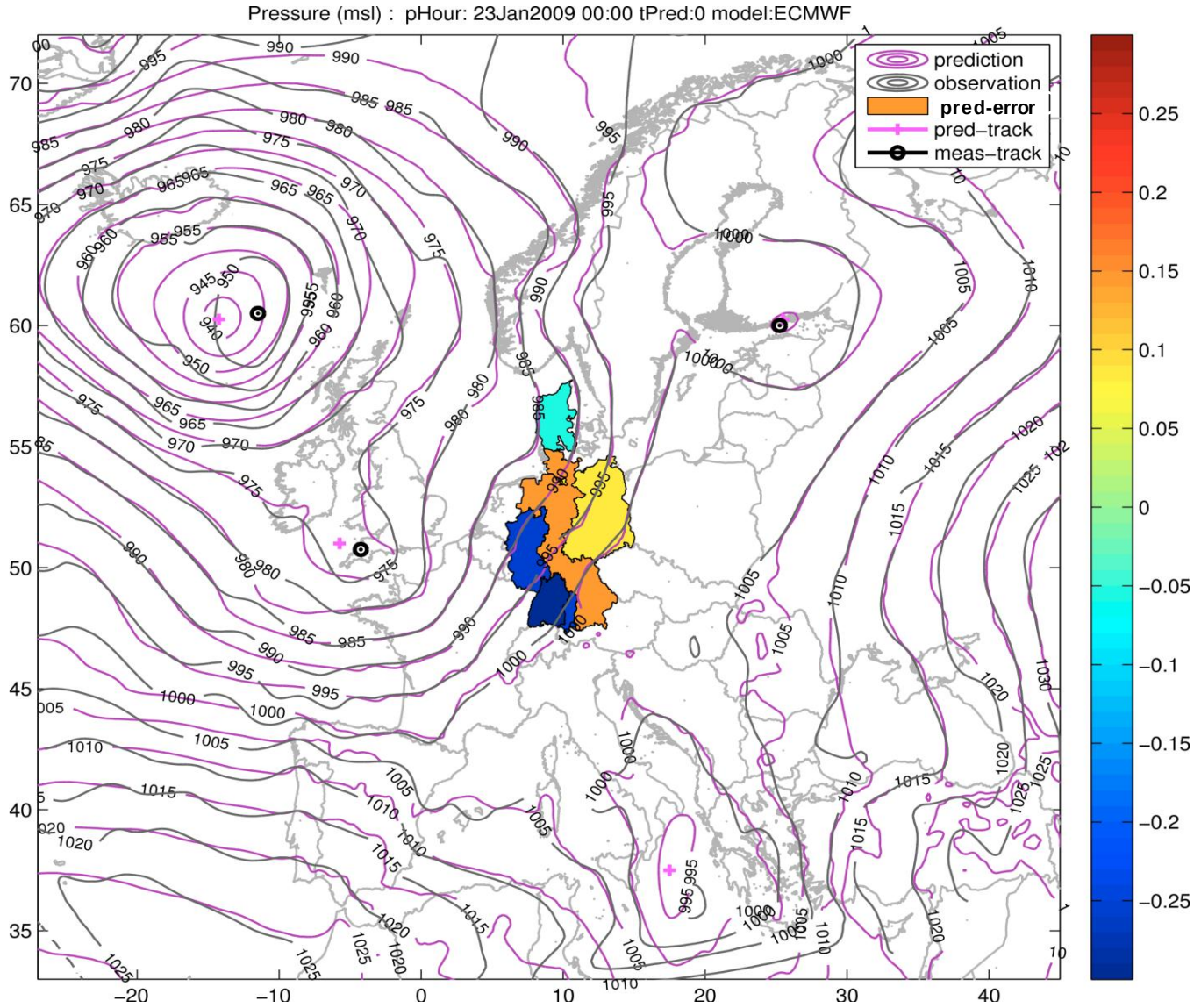
Monitor the large-scale Wind Energy Weather over Europe with real-time with observations



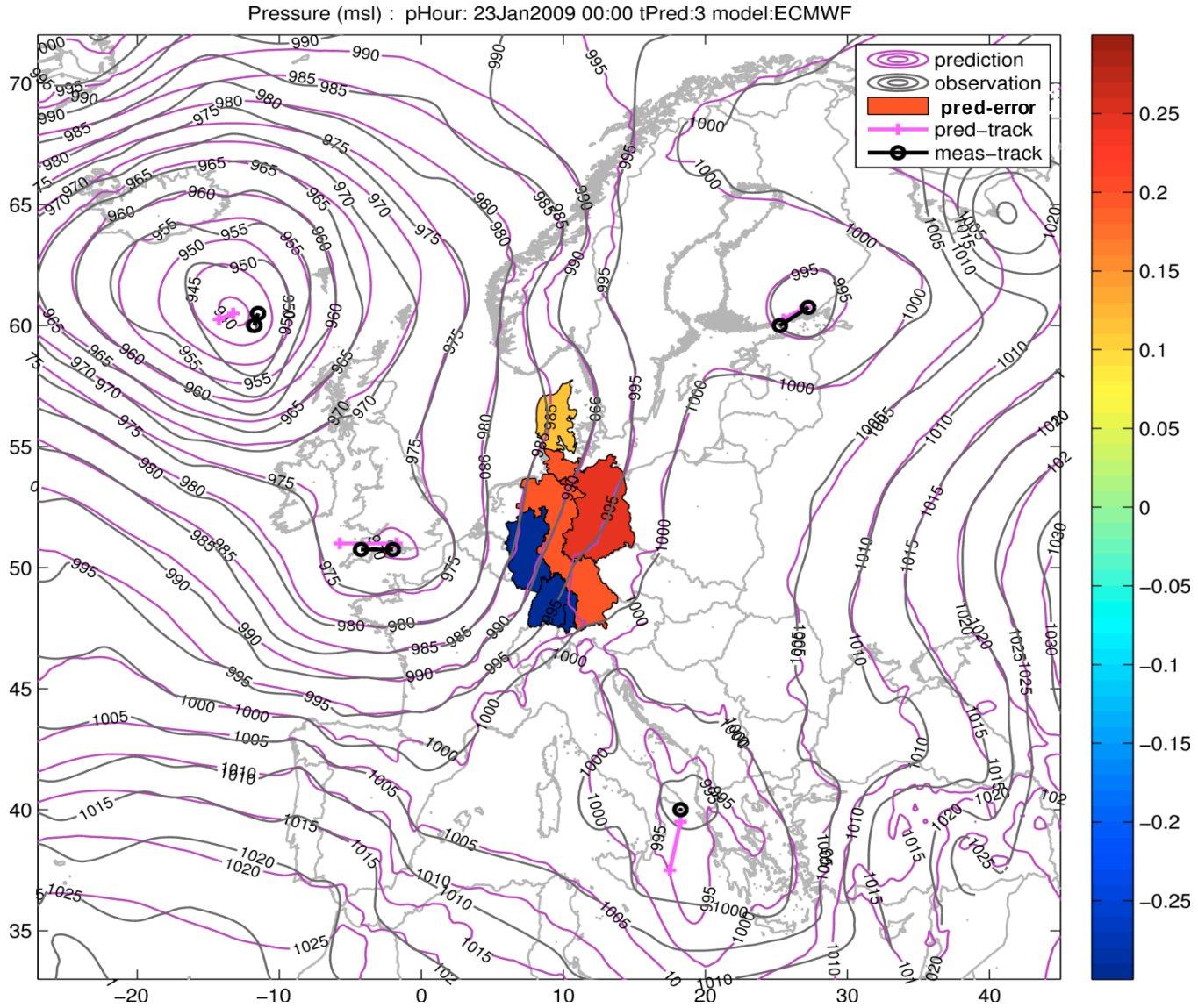
- More than 2000 weather stations
- 120 single wind farms
- 19 regions
- 1 met mast

Safewind

Monitoring the Weather Situation



Monitoring the Weather Situation



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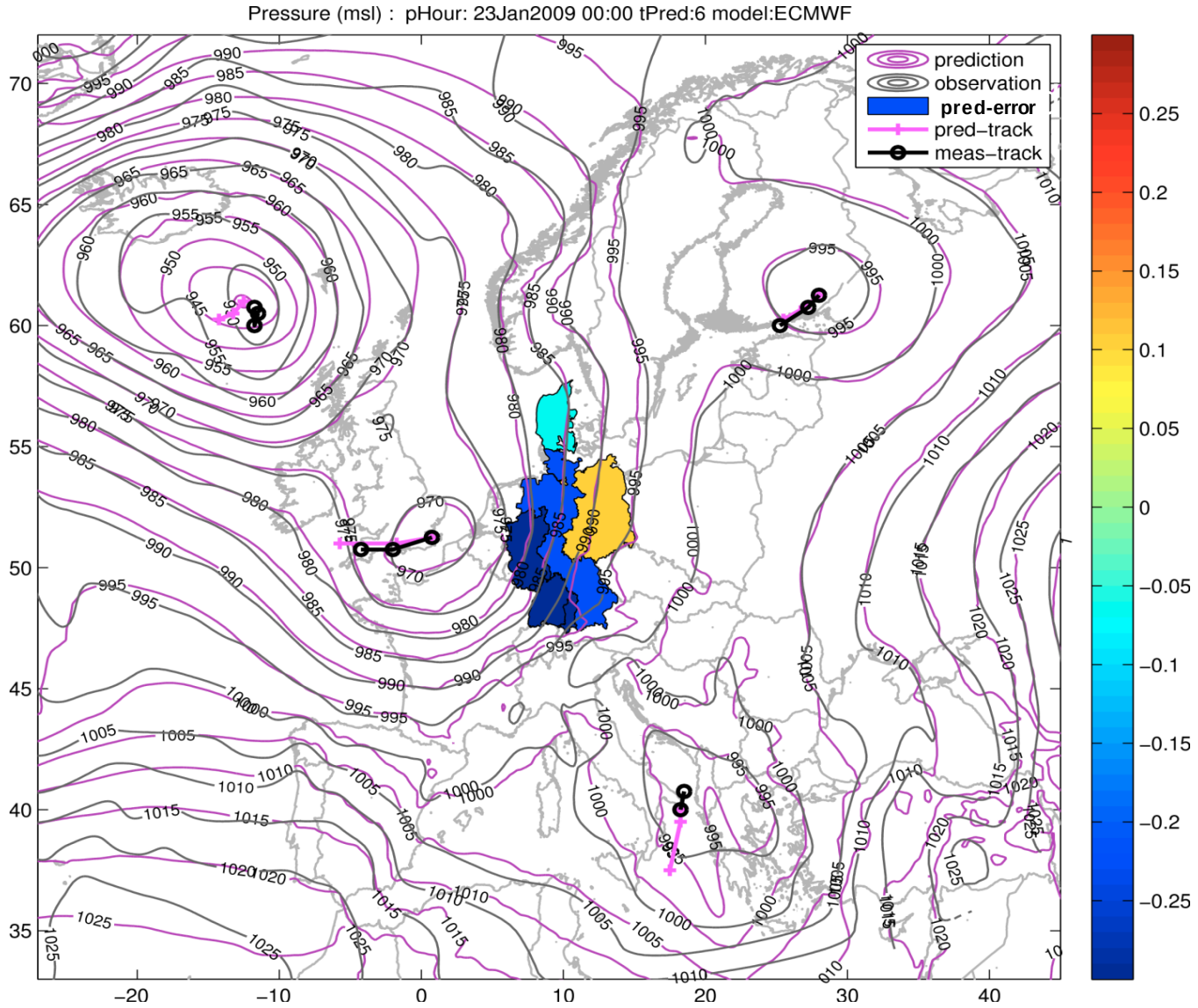

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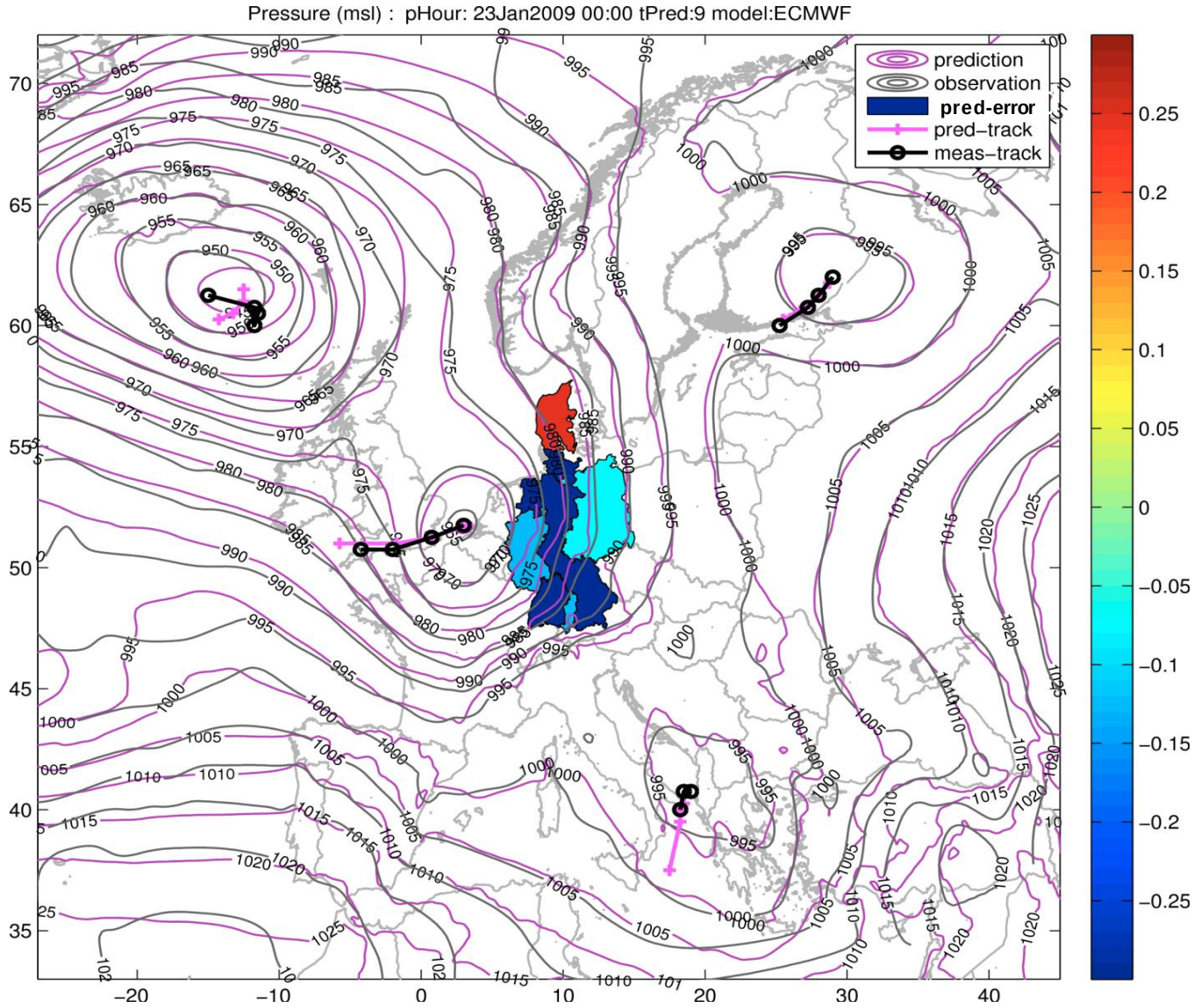

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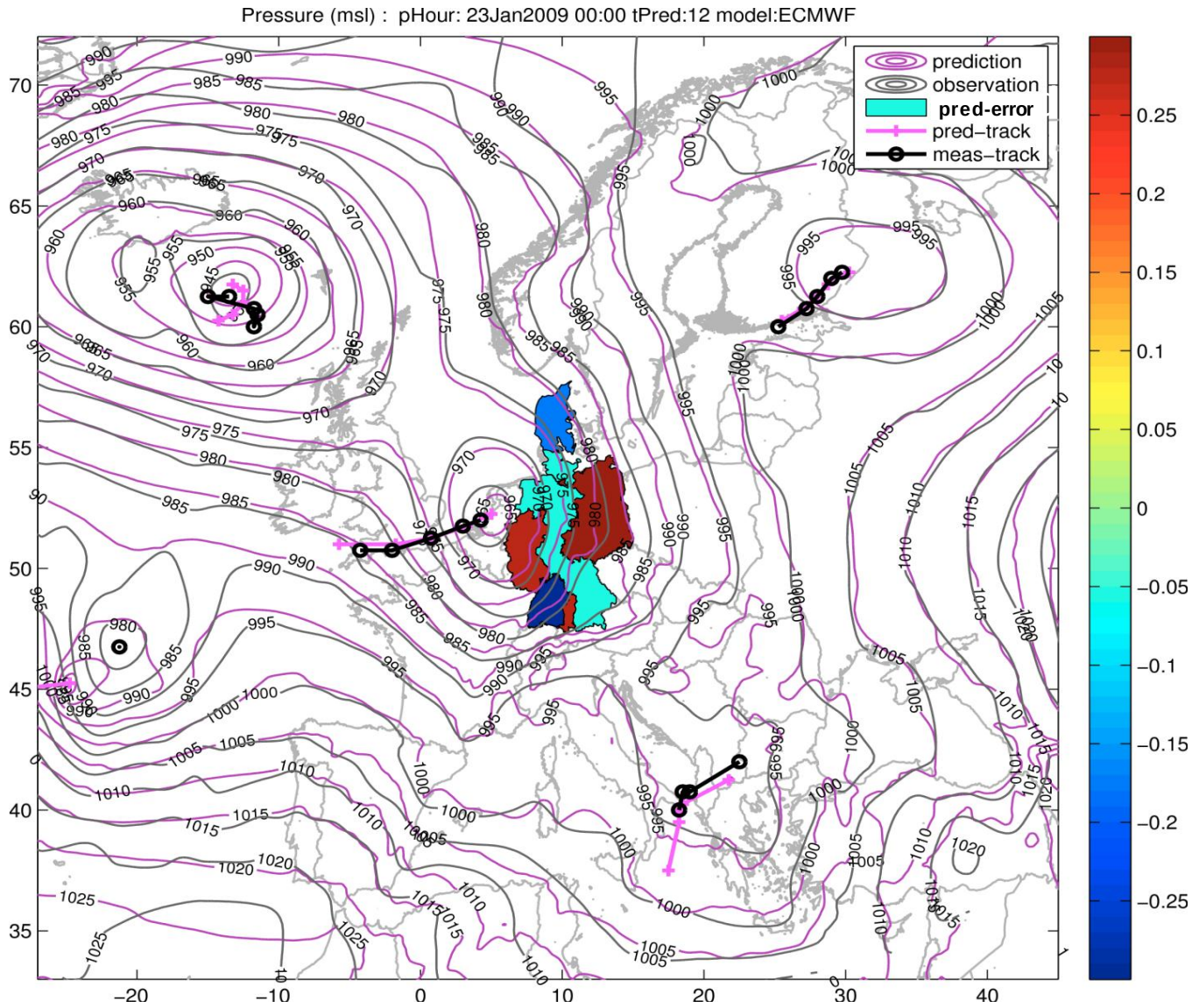

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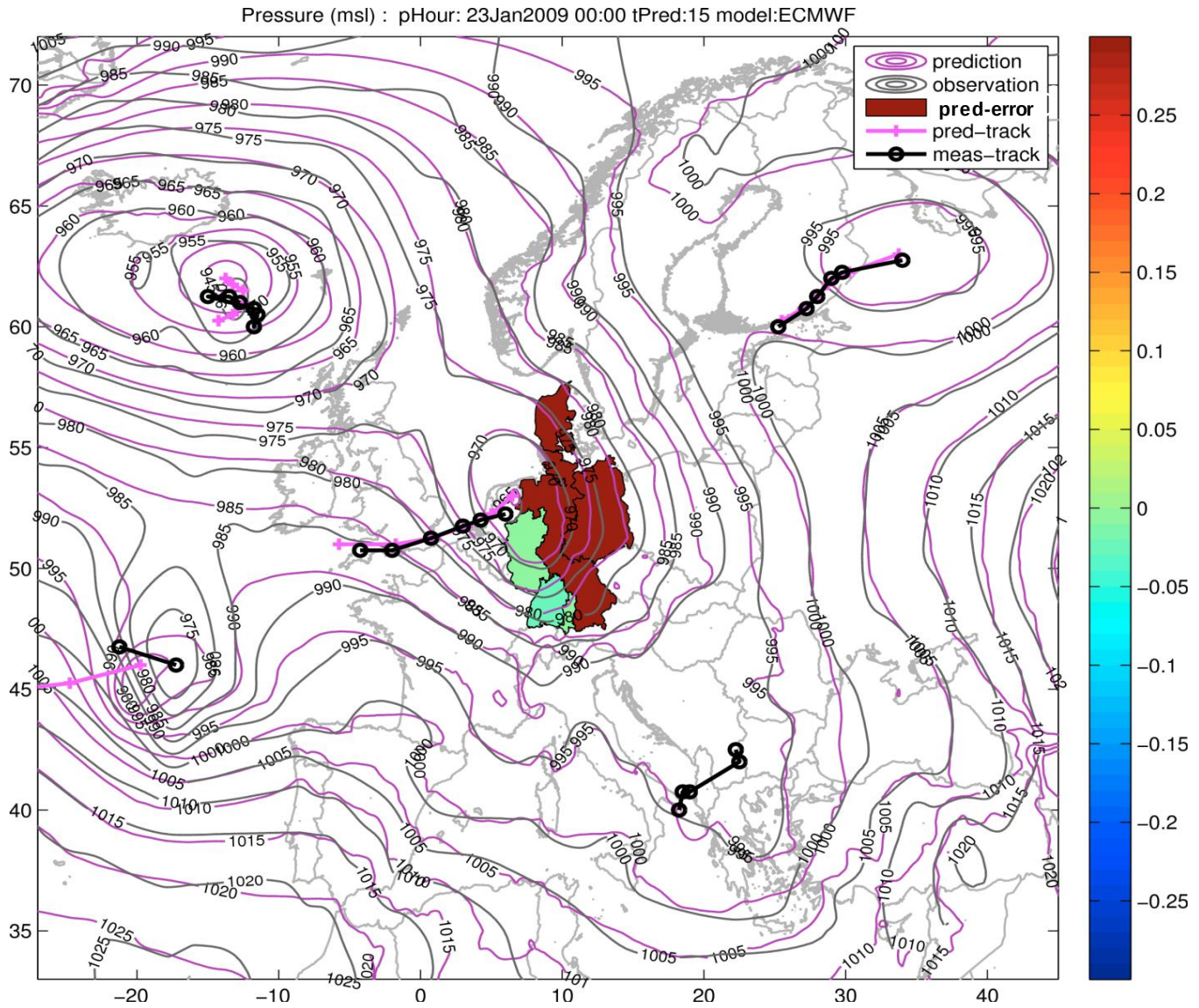

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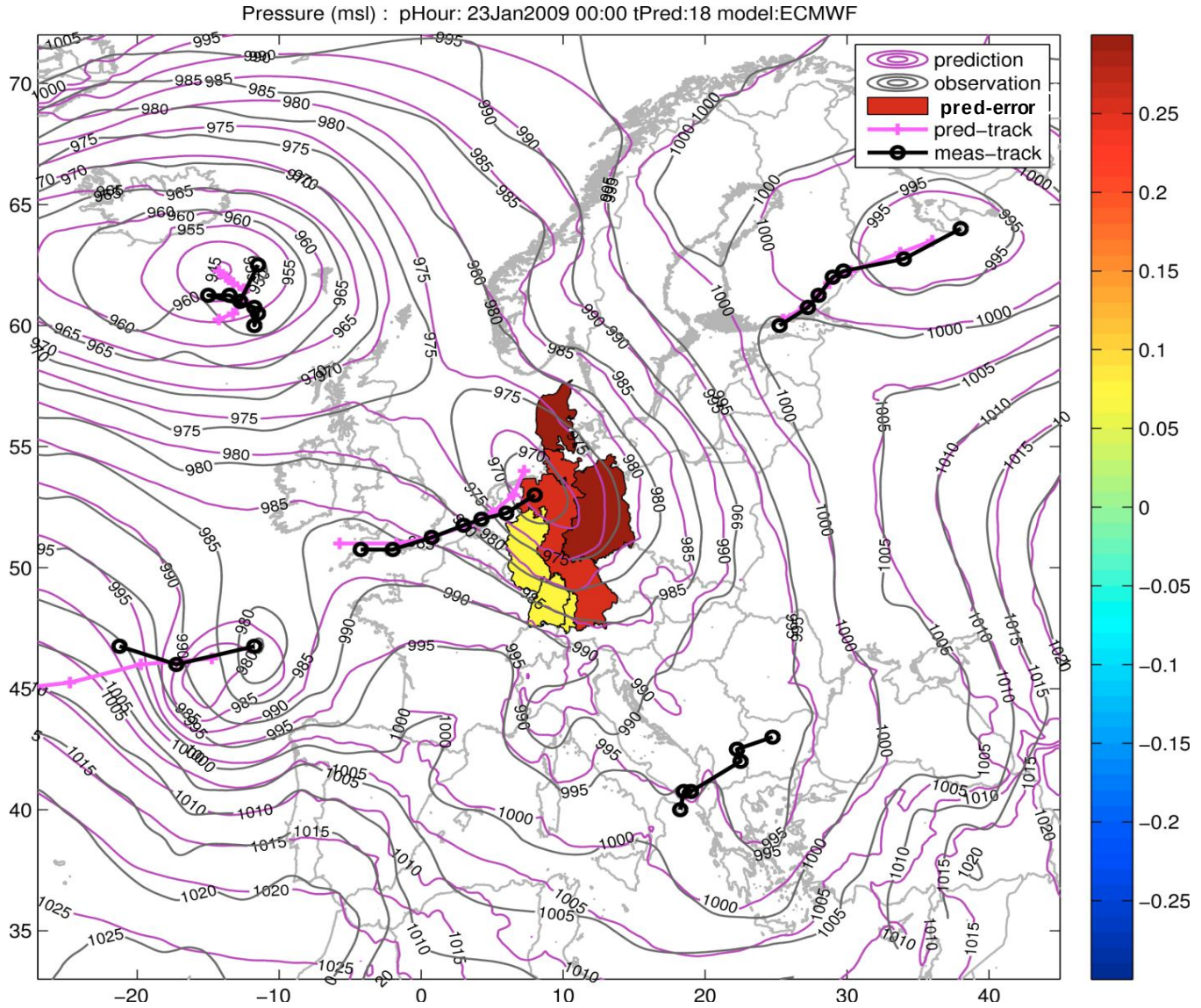

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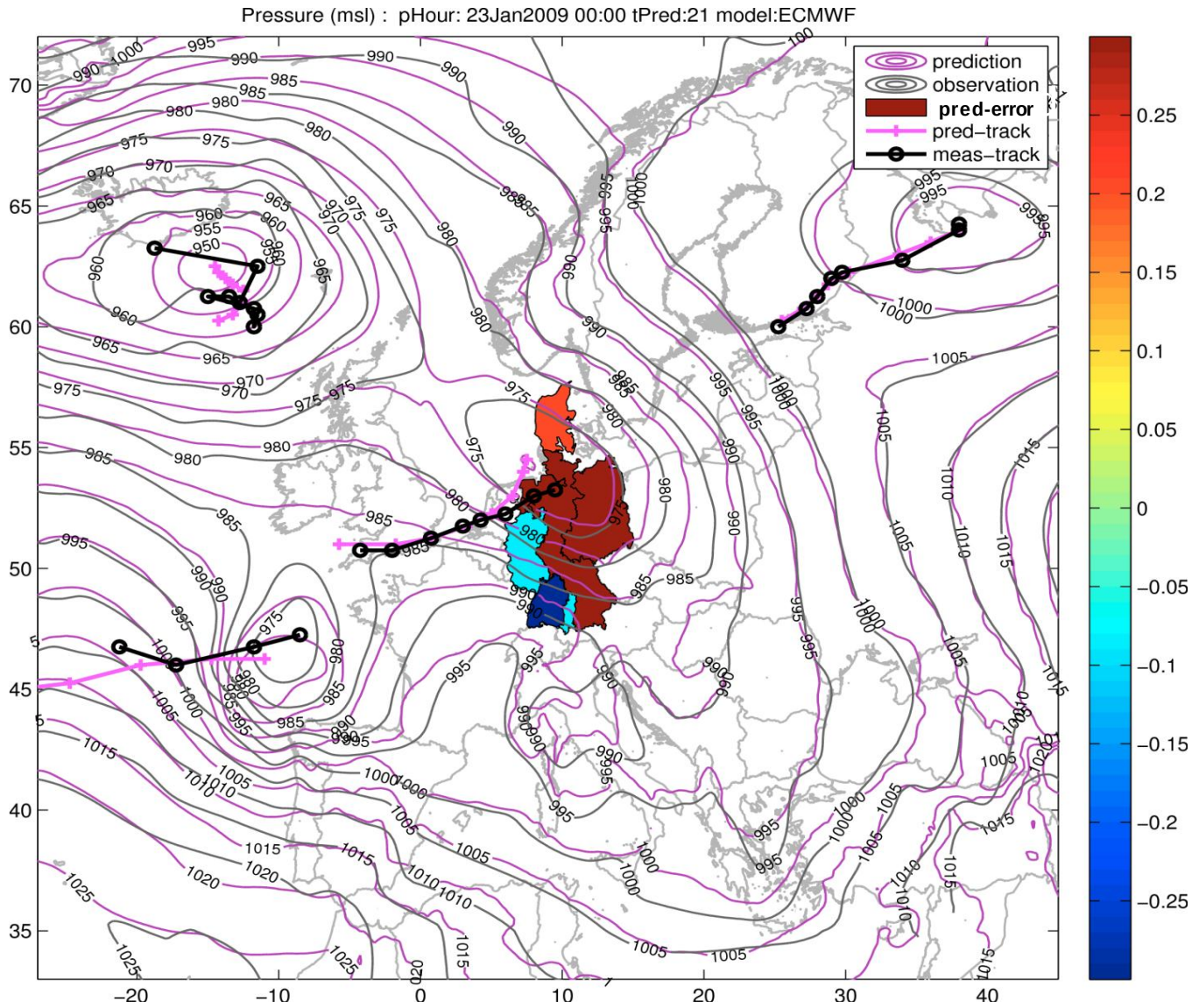
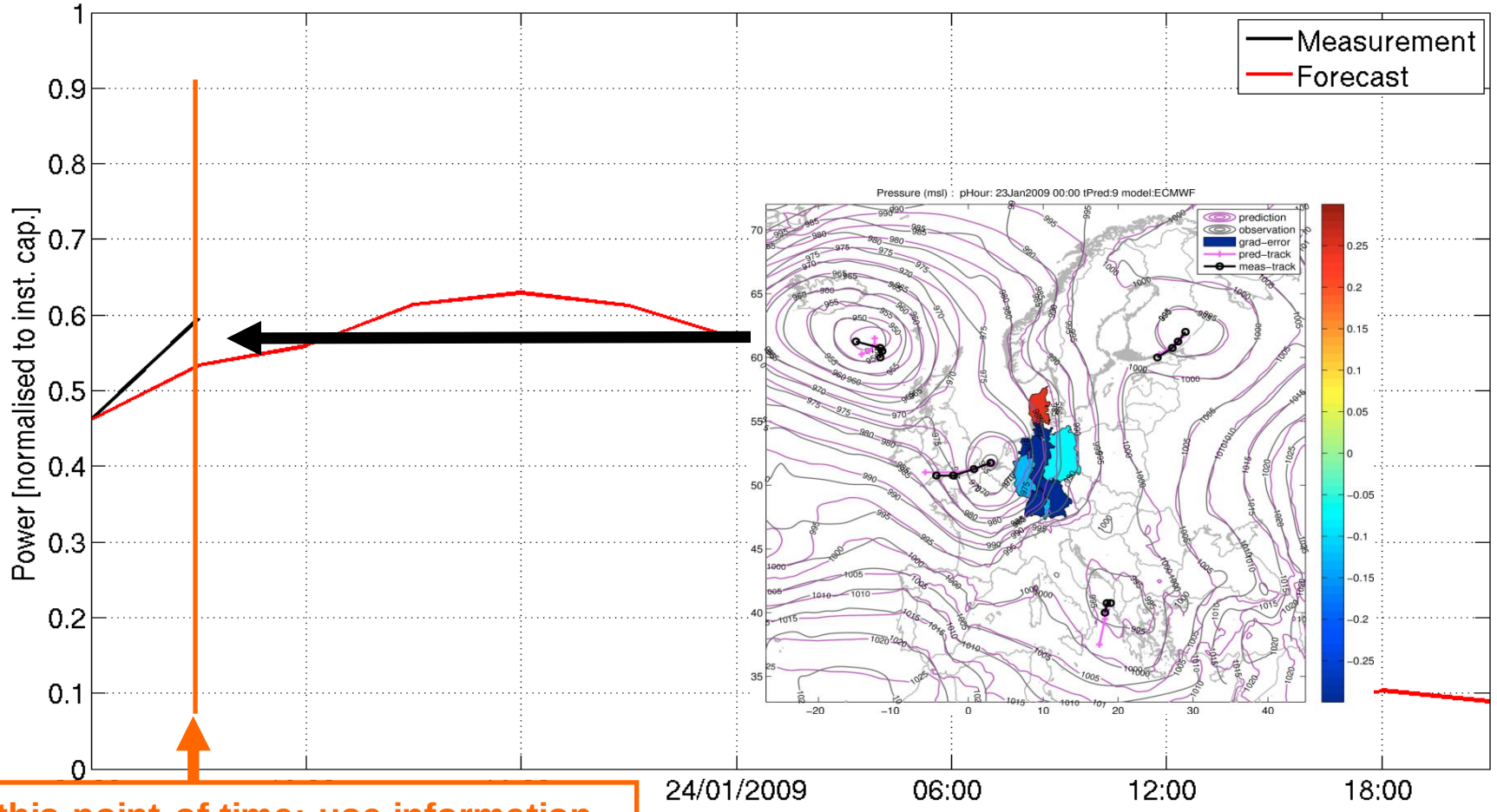


Time Series Example: 50Hertz TSO 23/1/2009 00UTC



At this point of time: use information on weather situation and current forecasting

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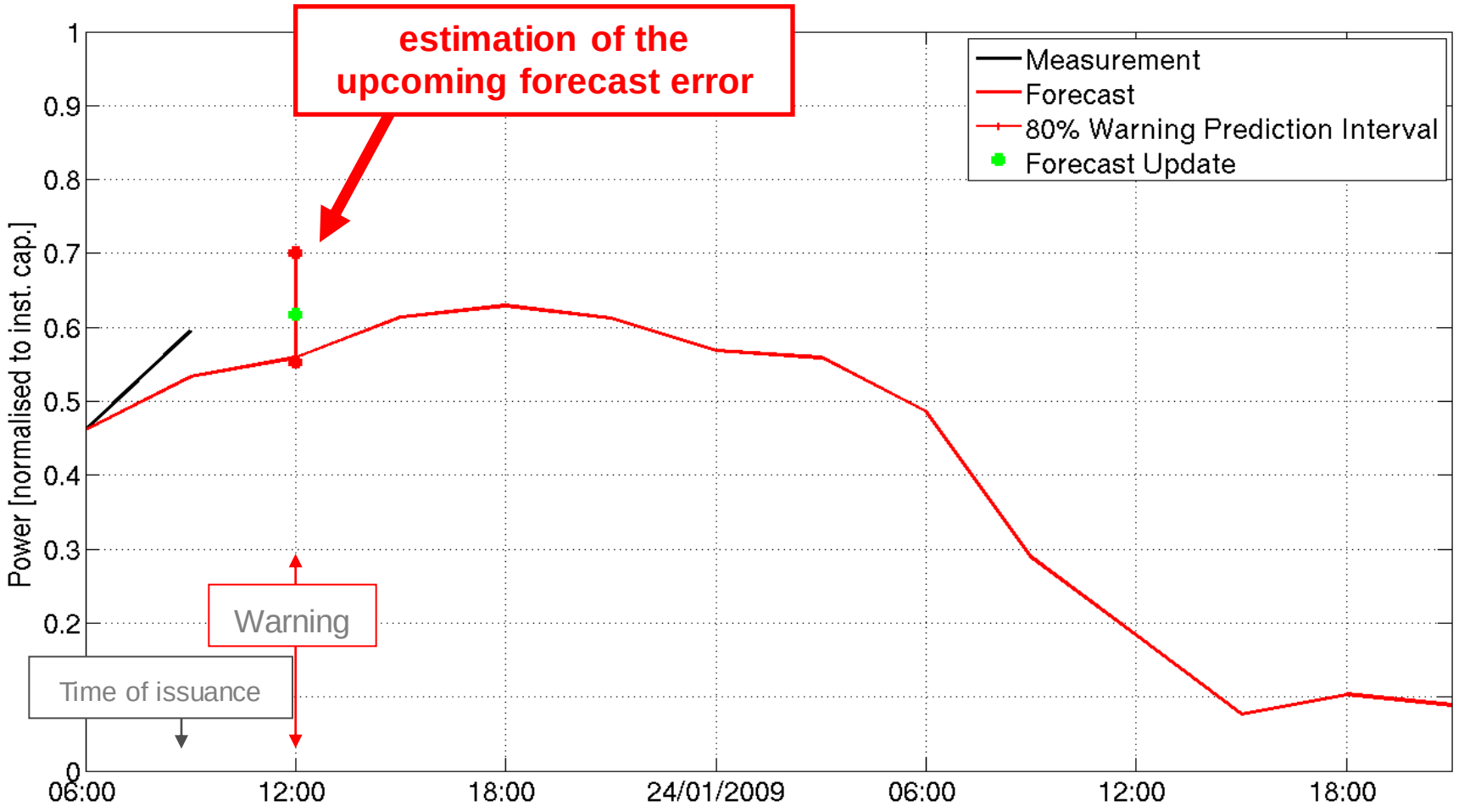

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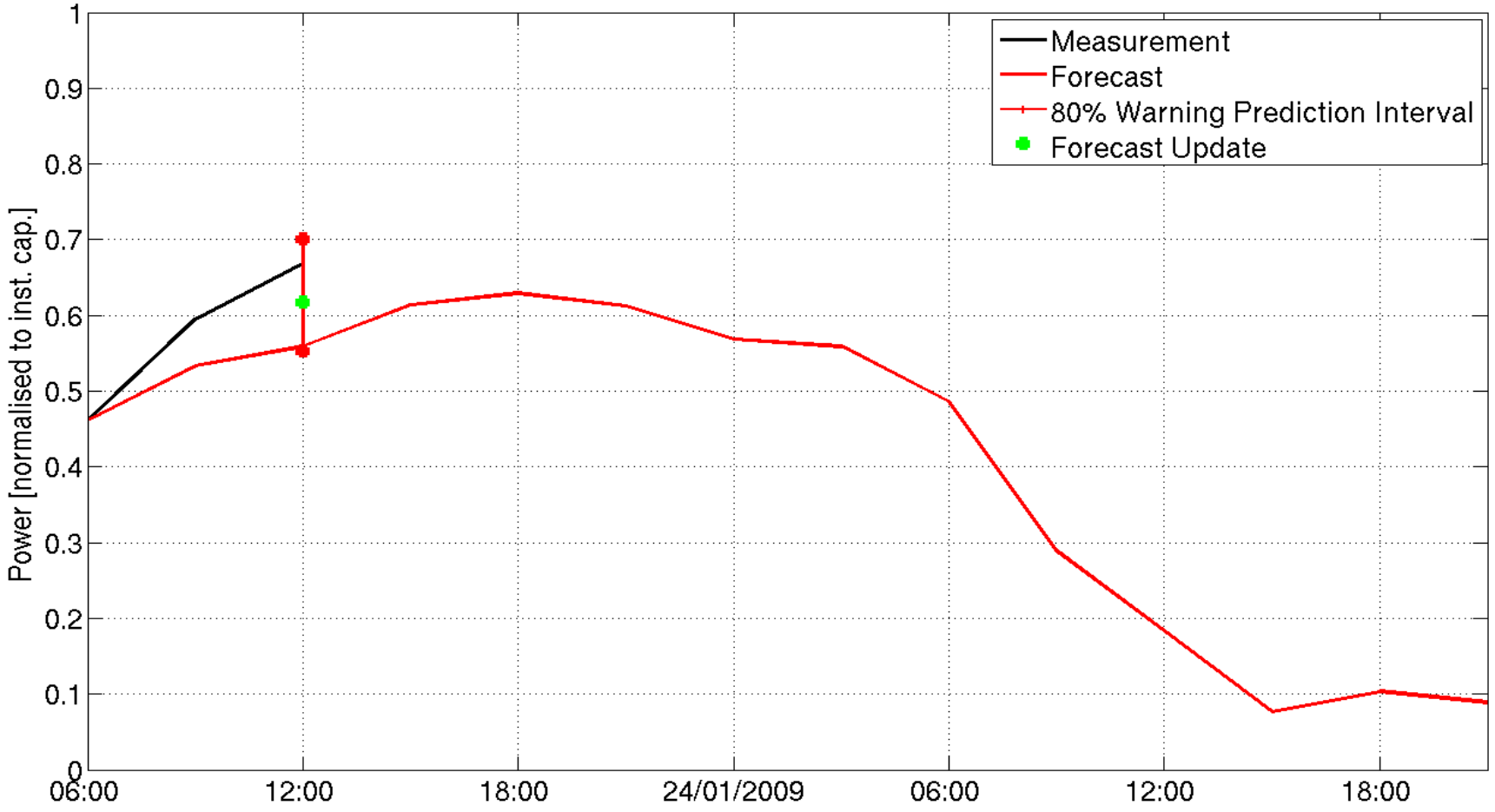

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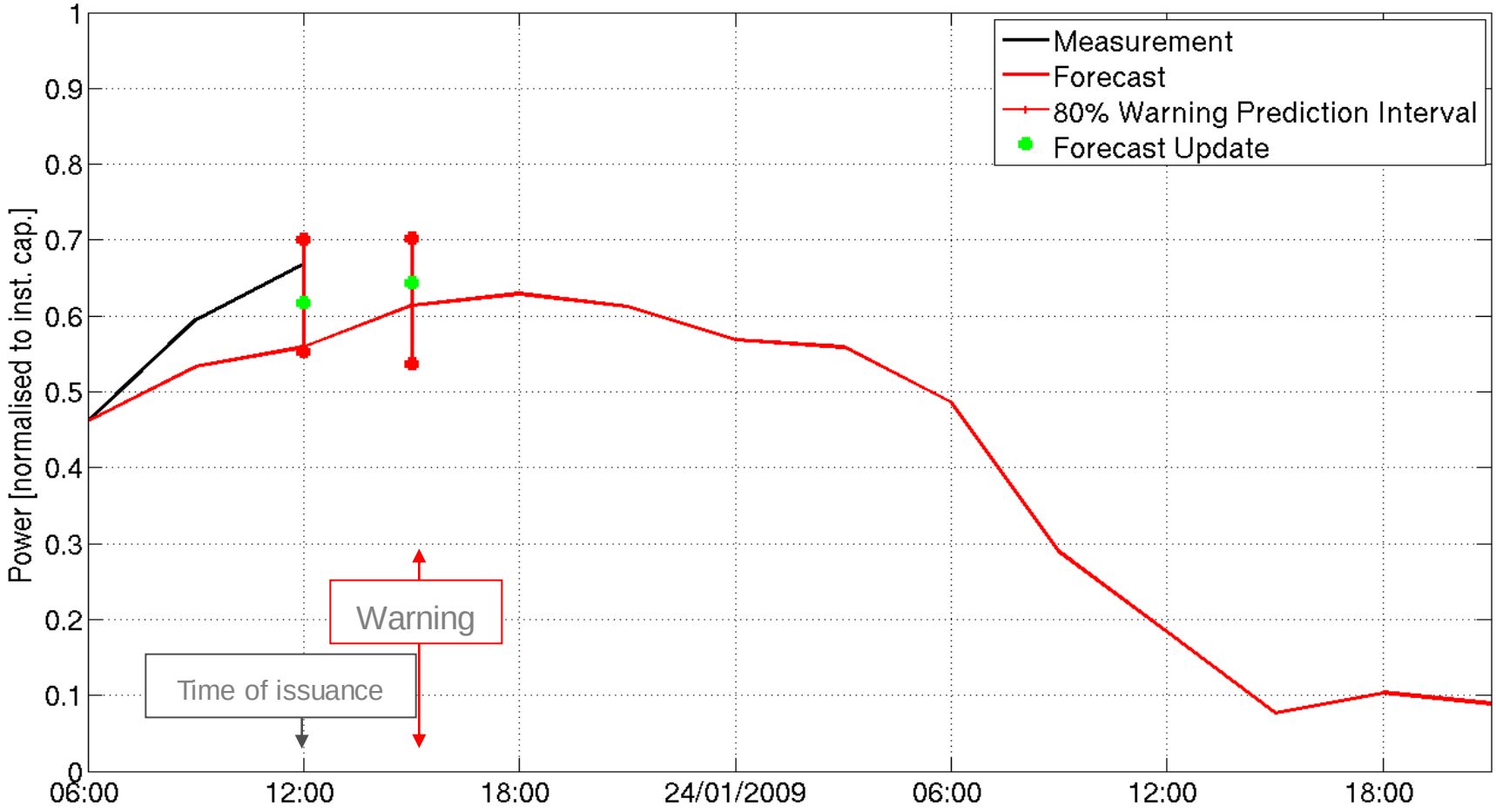

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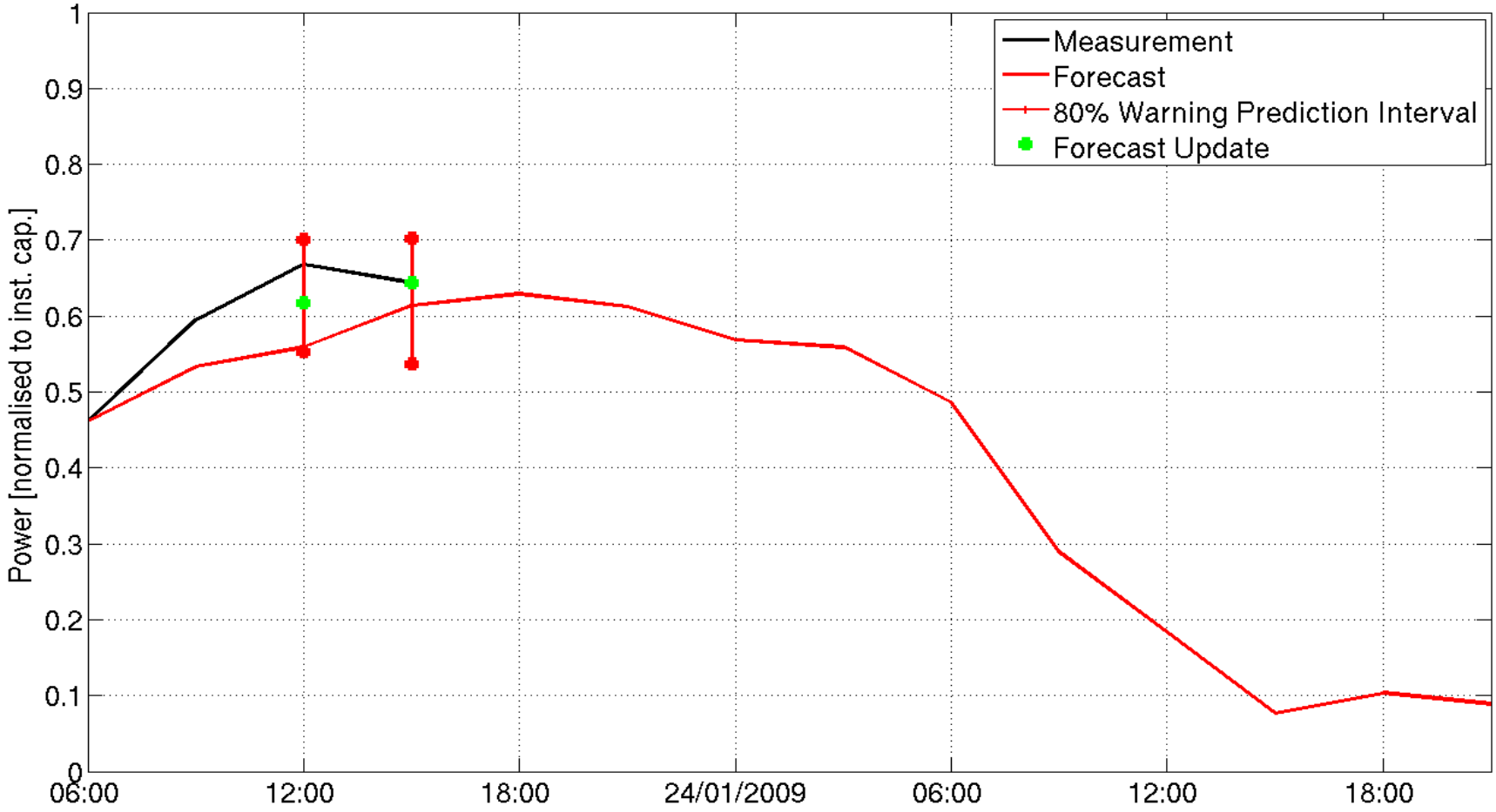

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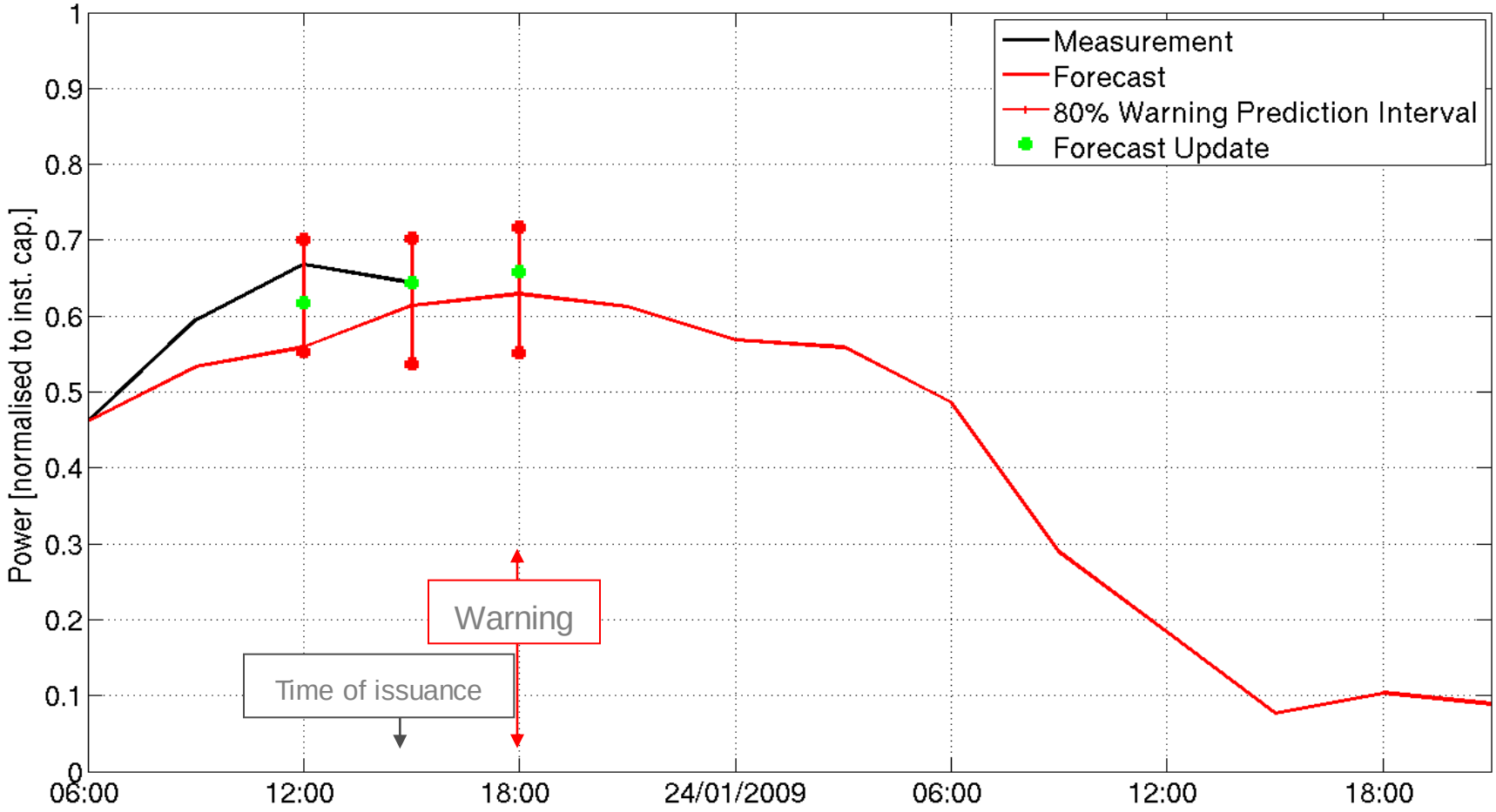

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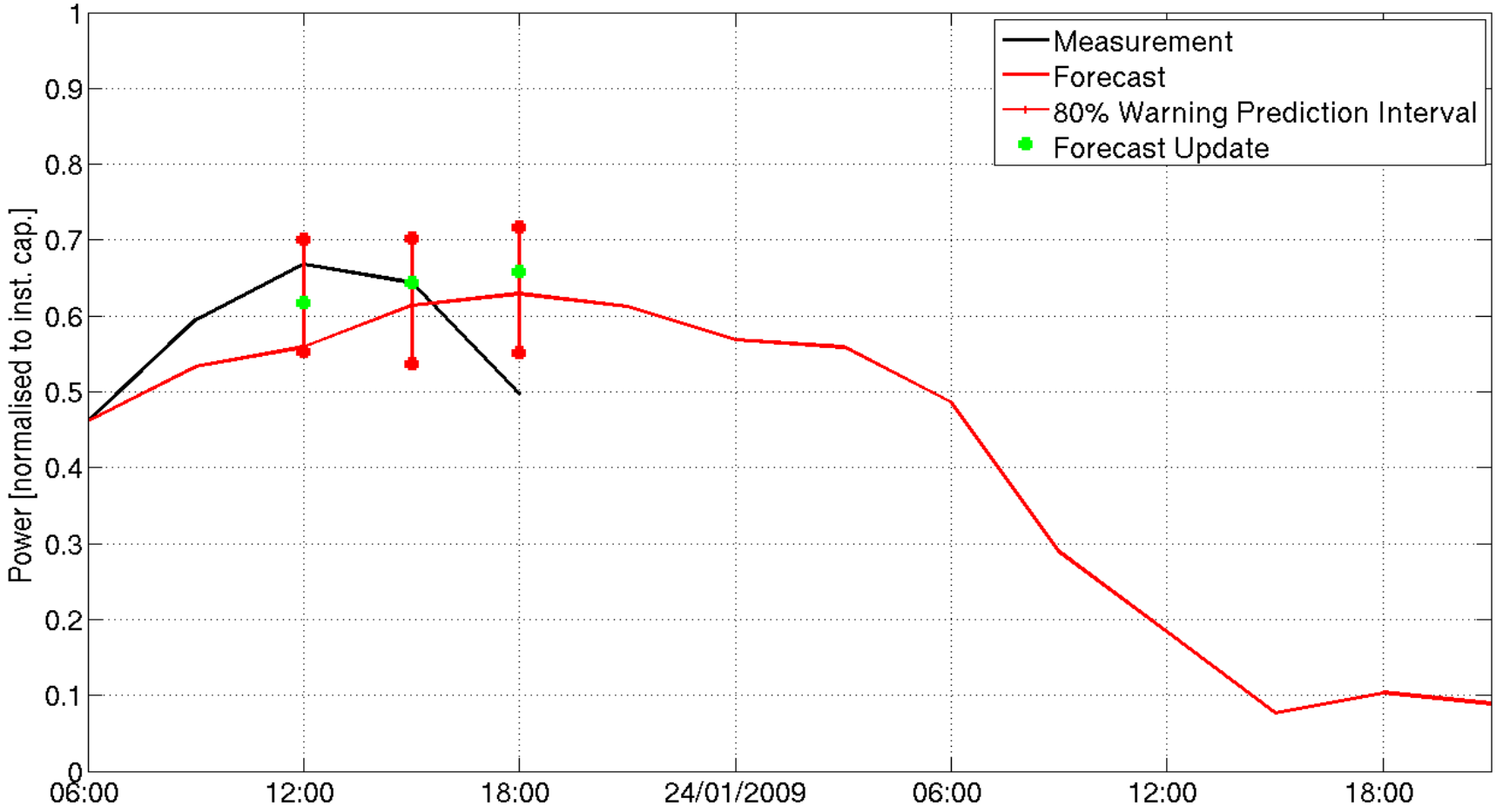

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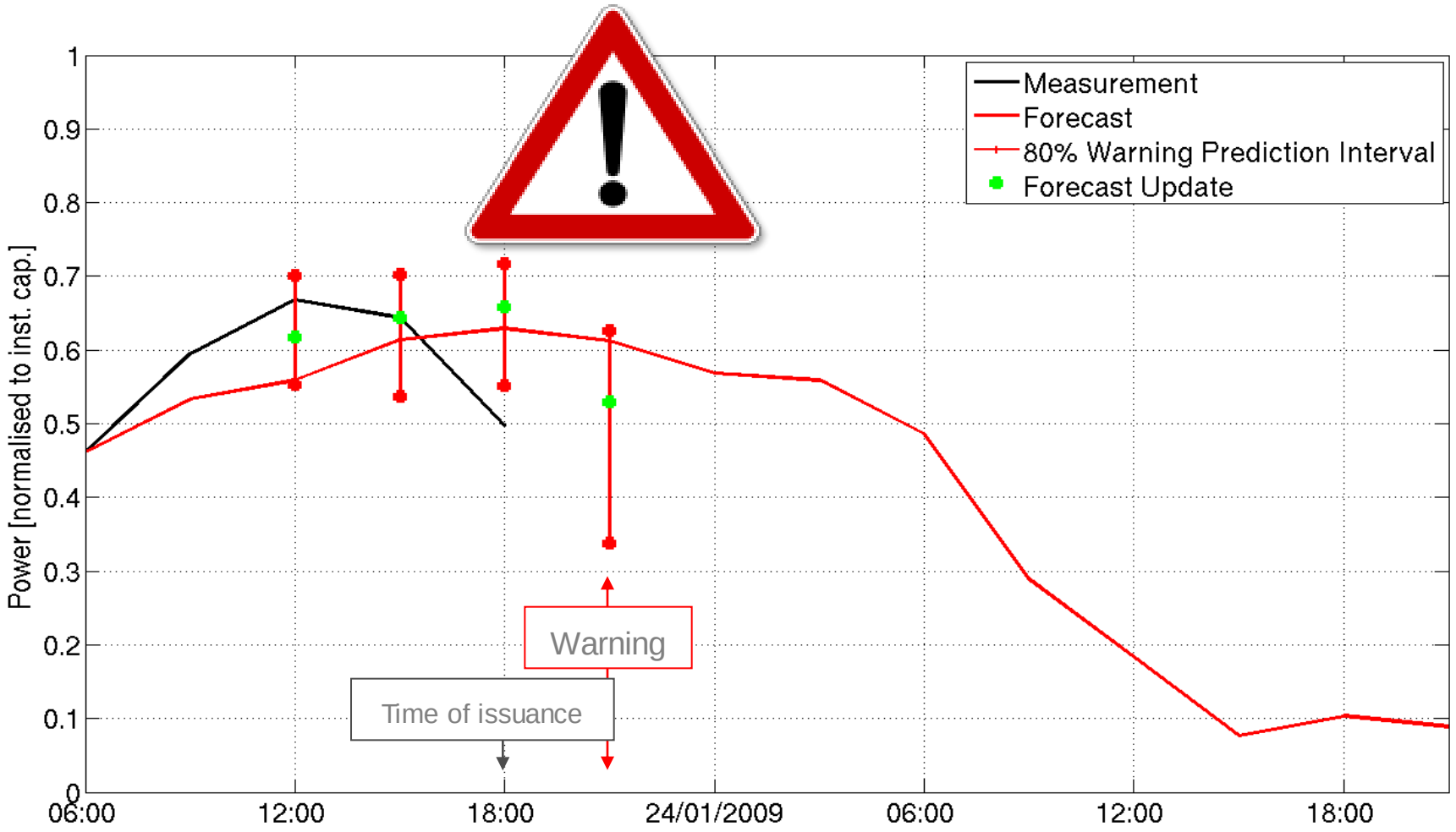

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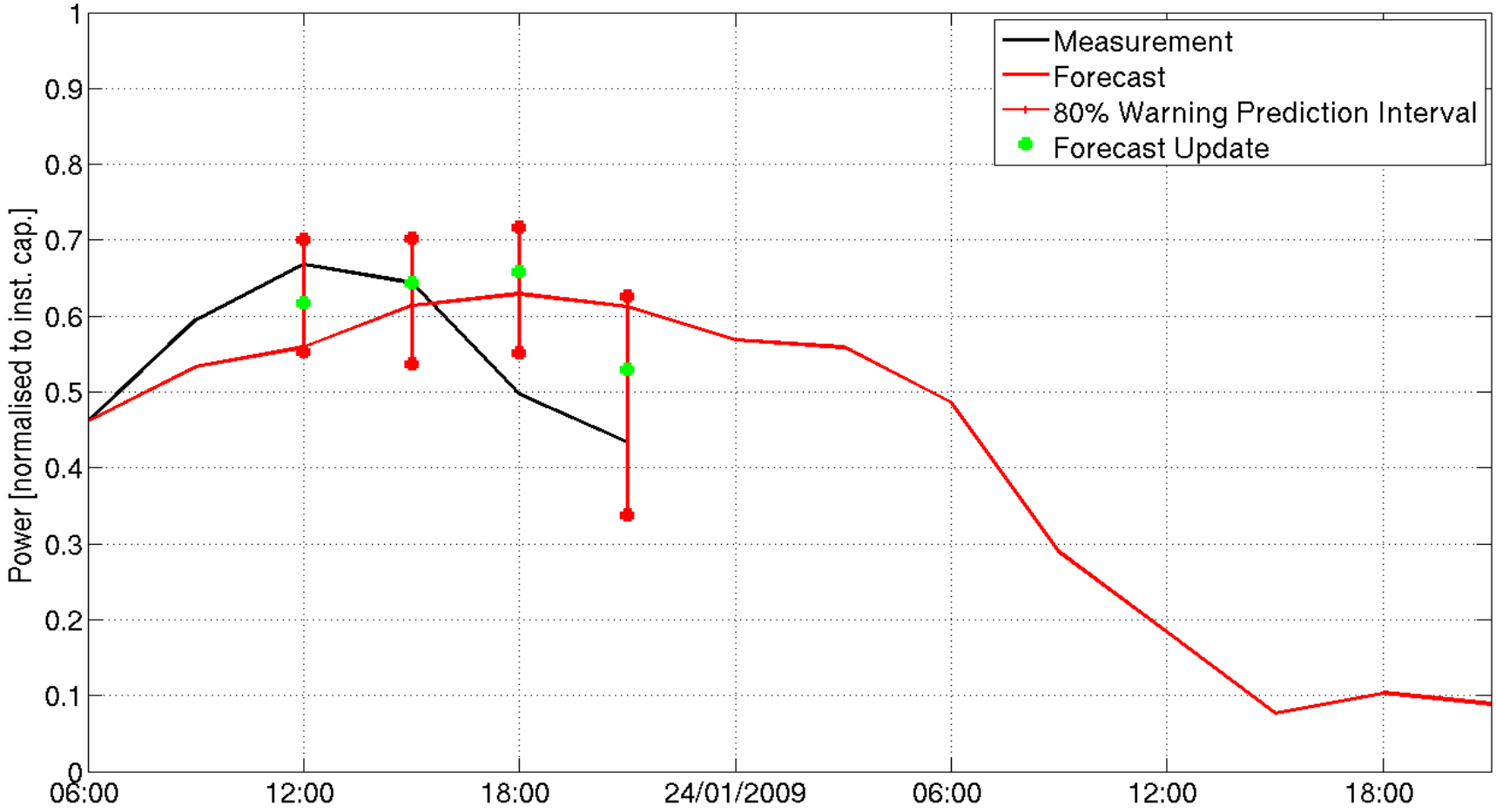

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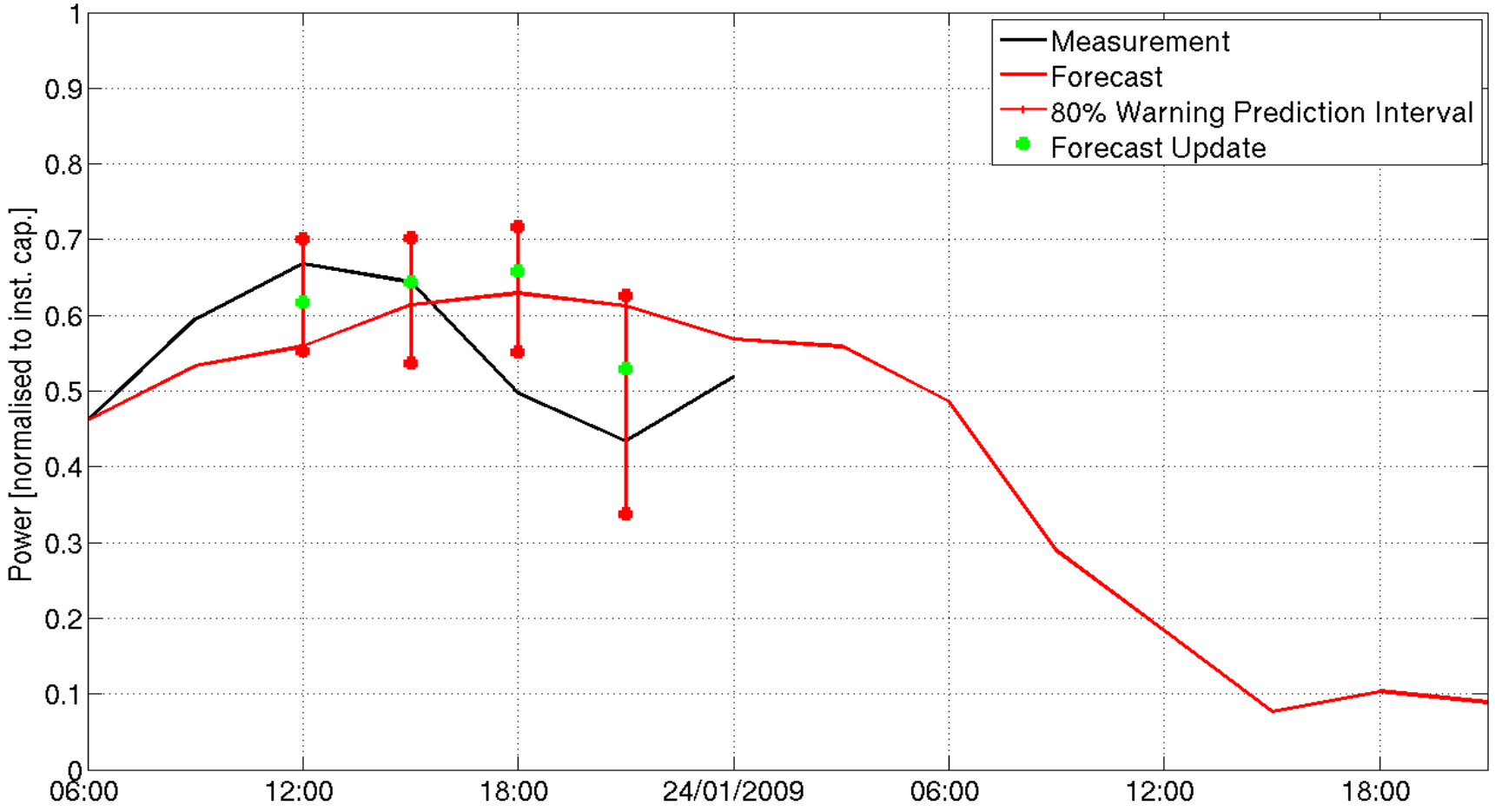

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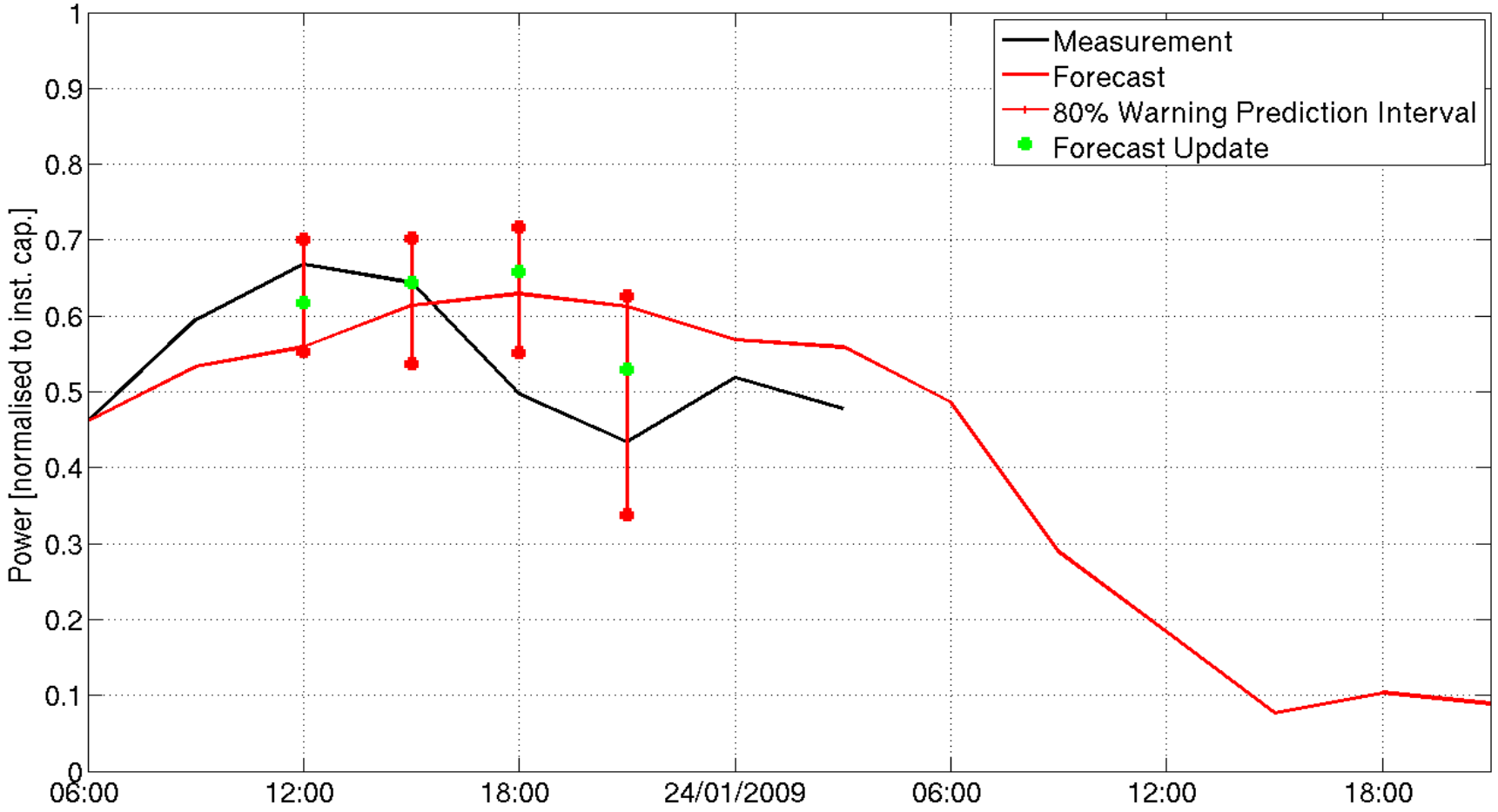

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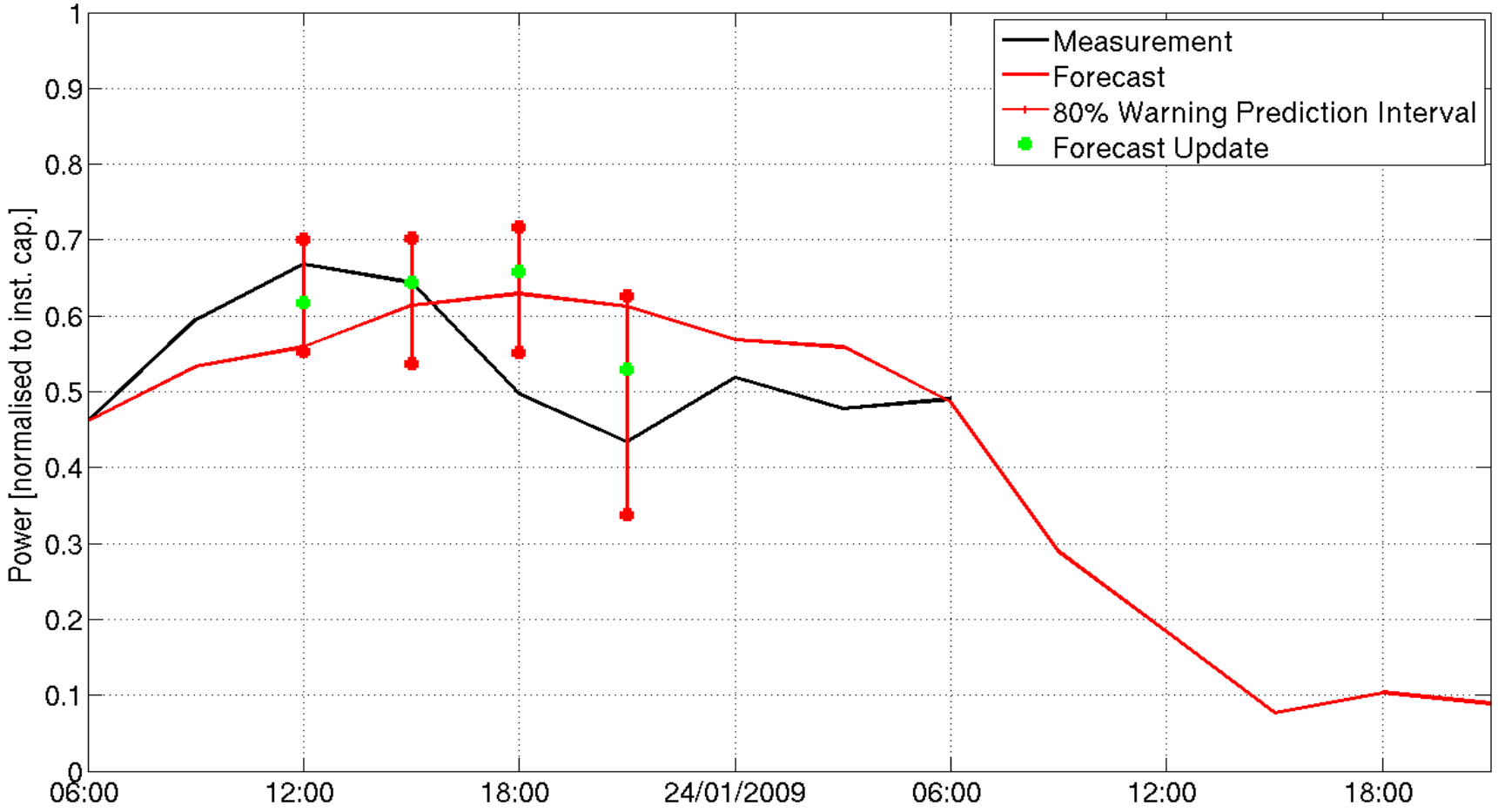

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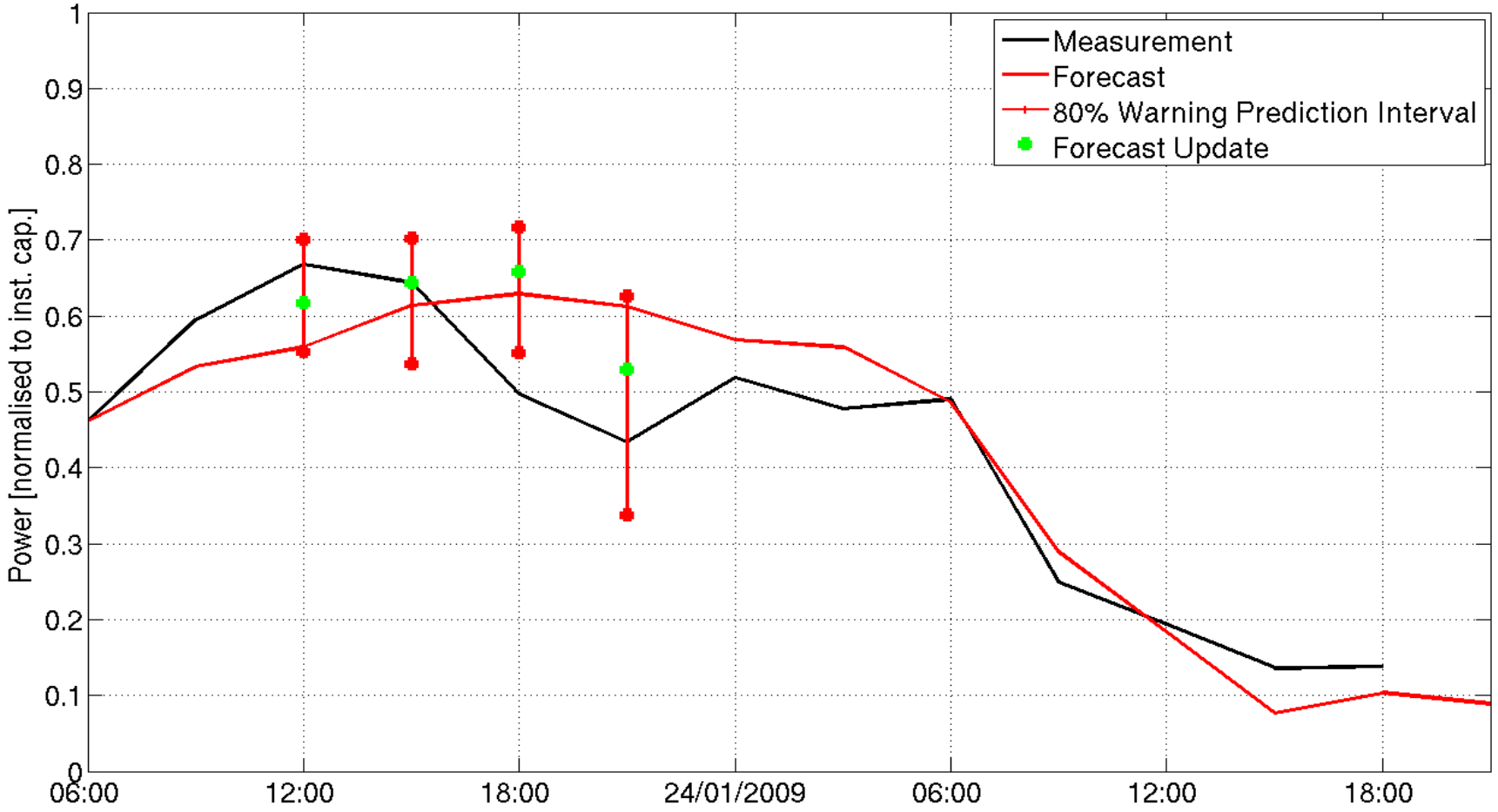

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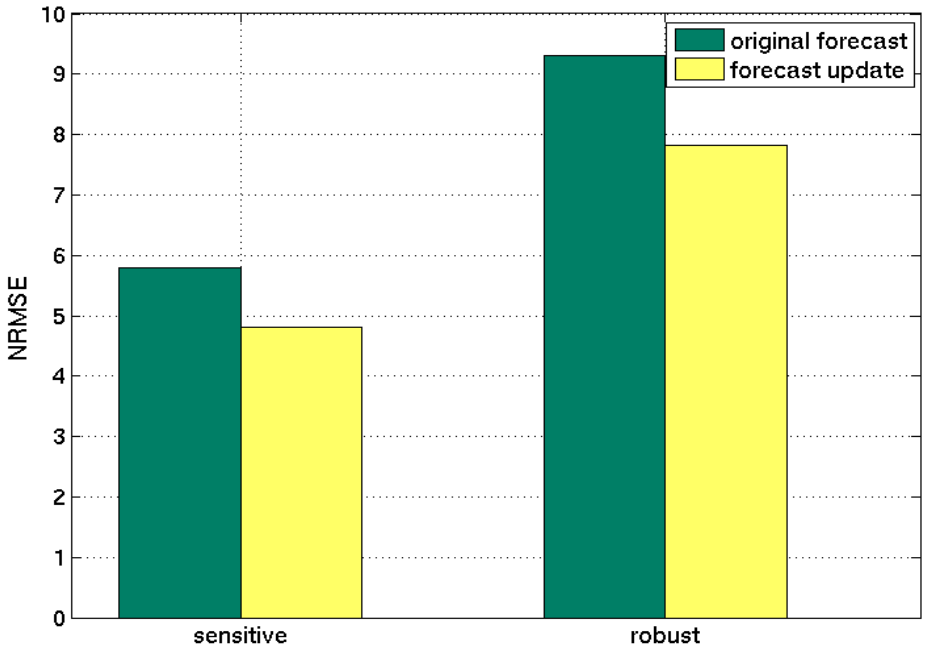
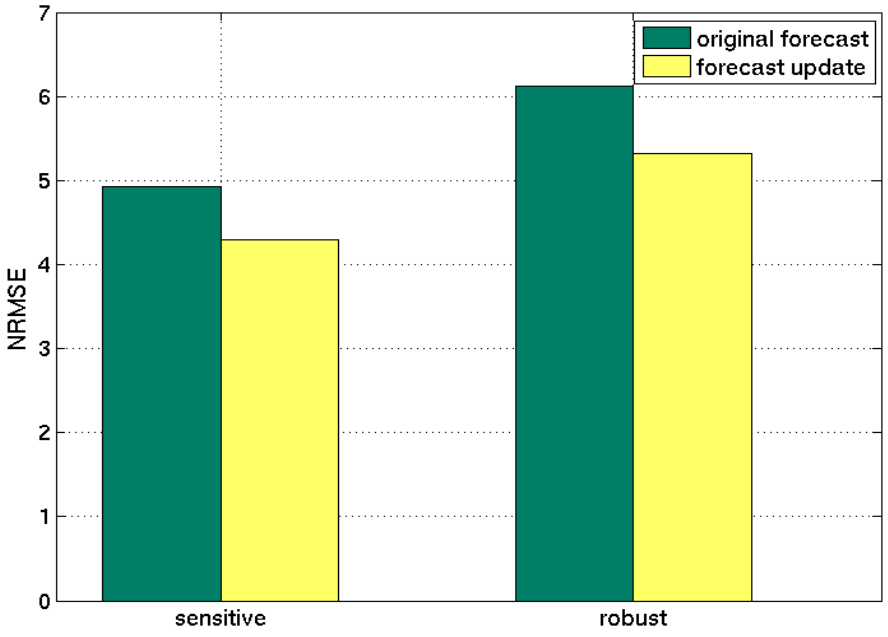
Improvement by forecasting updates

50Hertz TSO Germany



6% of situations 1% of situations

DK1 energinet.dk Denmark



6.5% of situations 1.3% of situations

„robust“ and „sensitive“ are different thresholds of warning level

Messages

- Detection of upcoming forecasting errors by comparing predicted and real weather situation at any time
- Warnings can be sent out to inform end-users at least 3 hours in advance
- 3h-updates of power predictions lead to signifcant improvements
- Performance depends on relation between detected error in weather pattern and error in power prediction
- System works best in low pressure situations, fronts still challenging, not covered so far: high pressure with thermal stability issues
- Data requirements are very high in terms of online-availability and quality

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Thanks for your attention !

www.energymeteo.com

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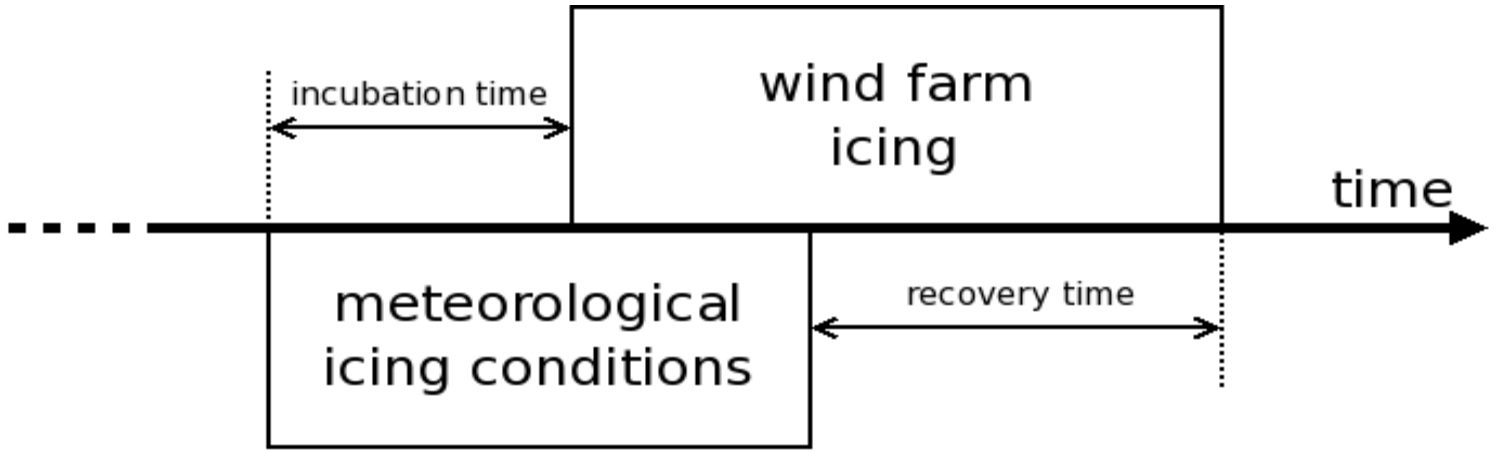
Icing

- Shut-offs due to icing can lead to large forecasting errors
- Icing conditions occur in certain regions, typically not large-scale
- Time delay between meteorological conditions and impact on turbines



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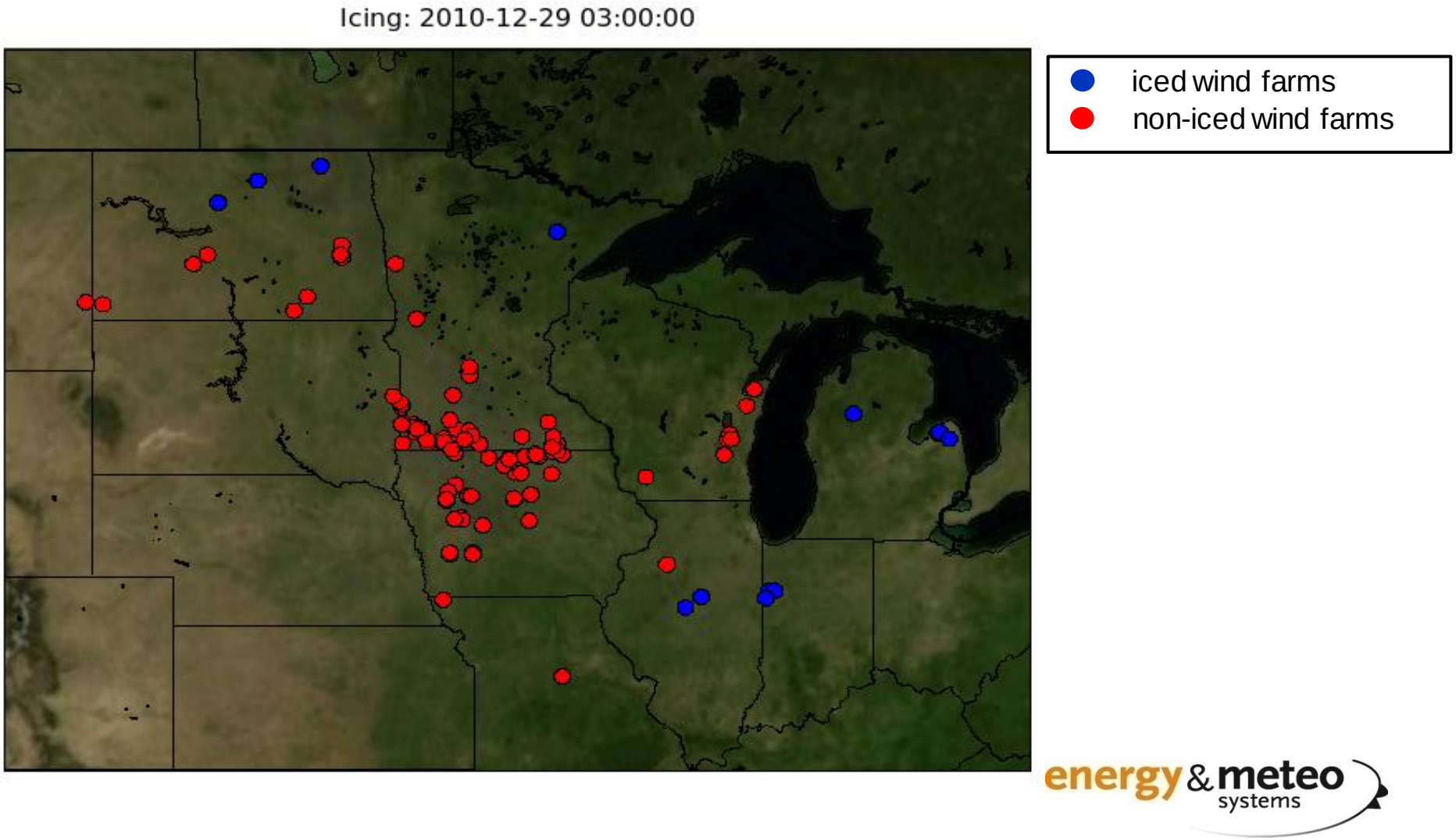
Regional icing prediction



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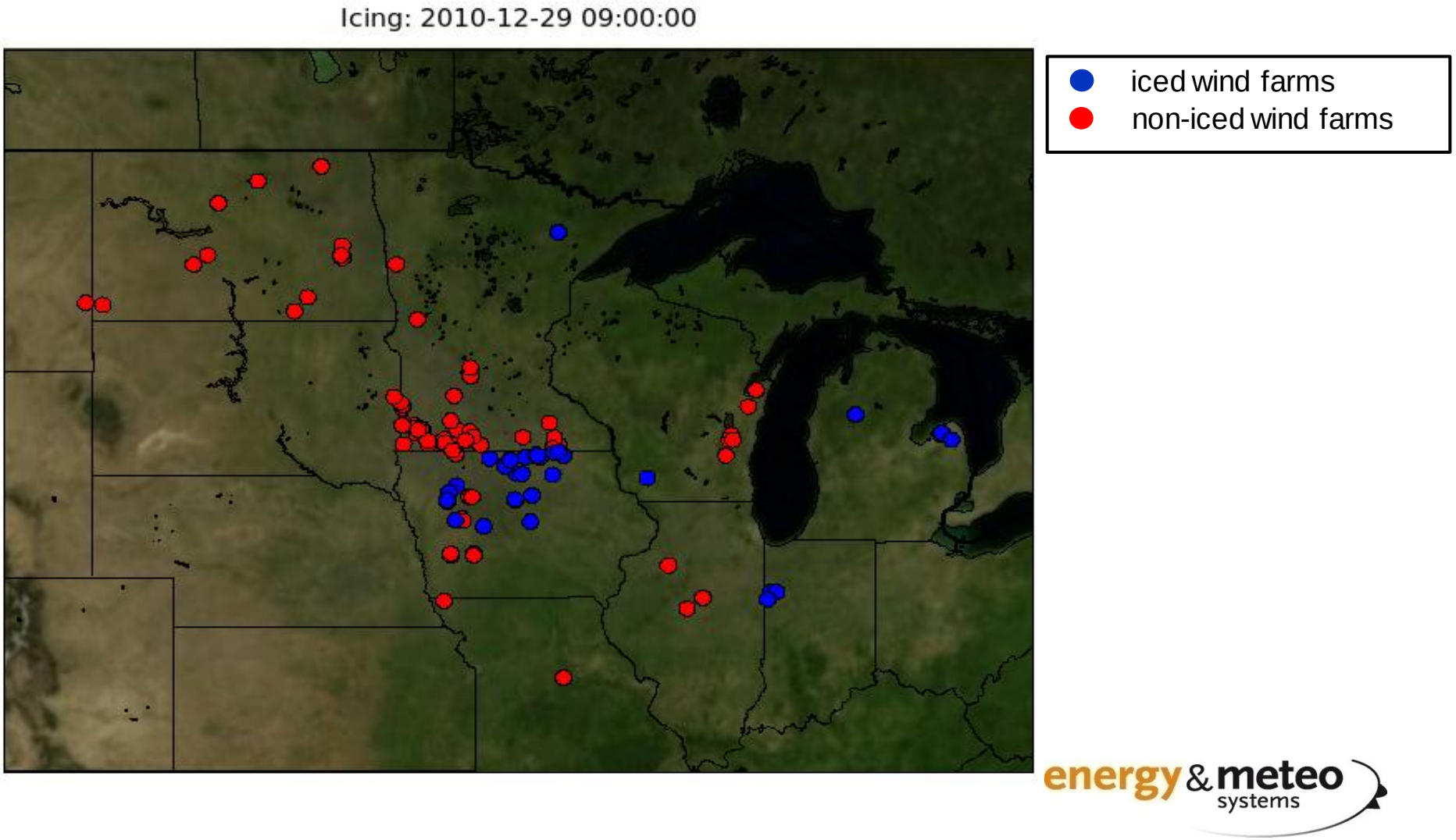

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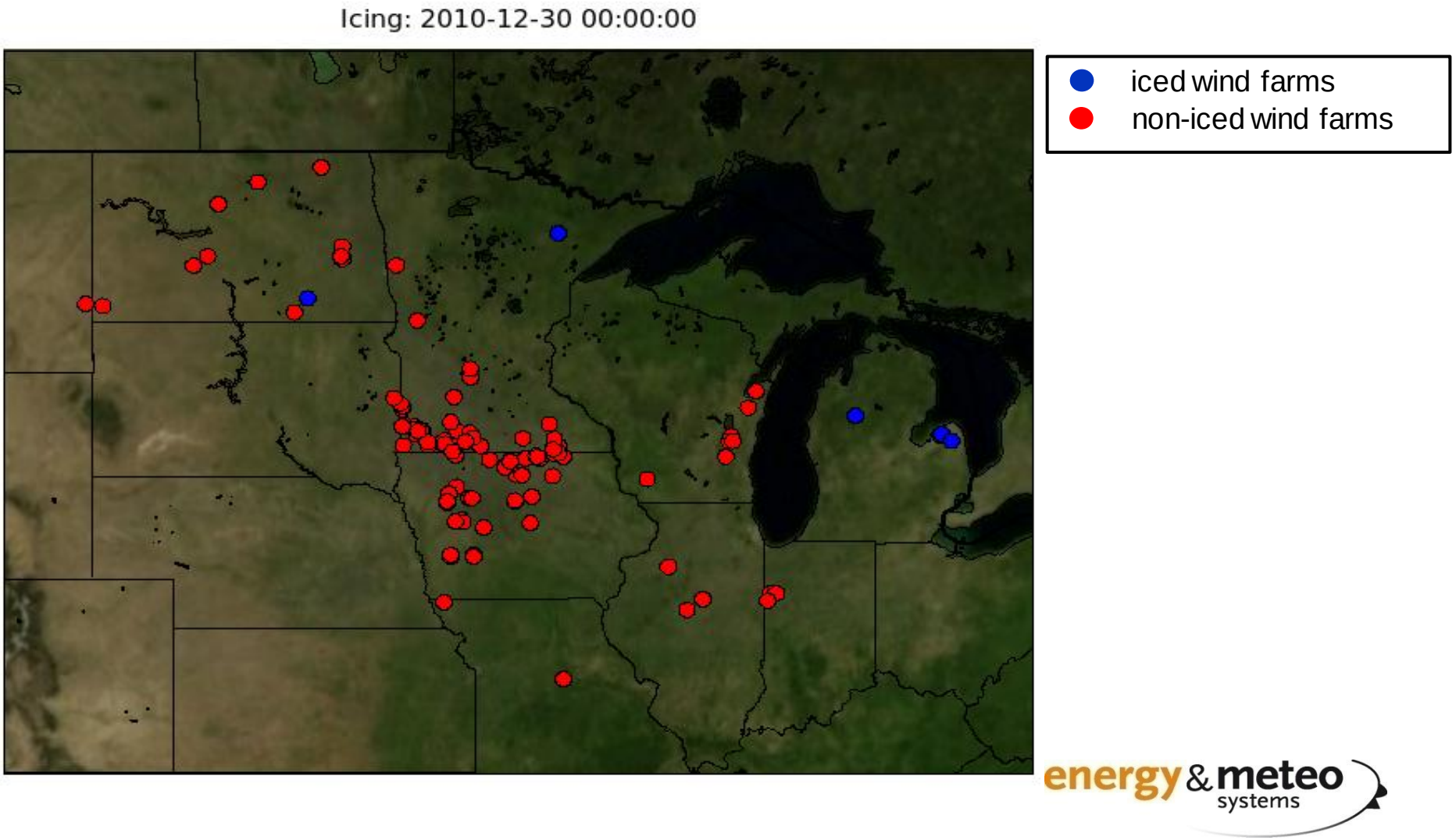

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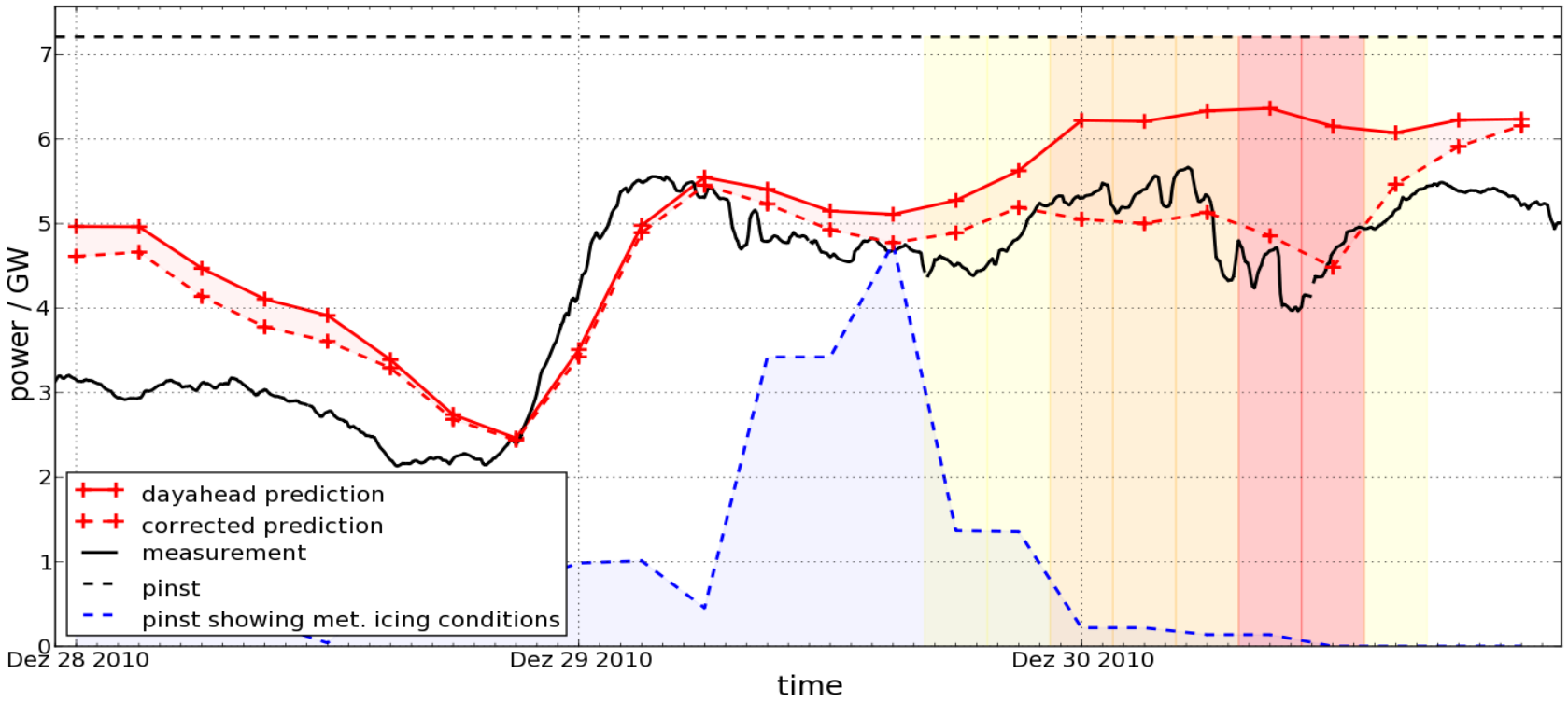
Icing forecast and warning



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