Wind turbine blade heating – does it pay?

René Cattin, Meteotest, Switzerland

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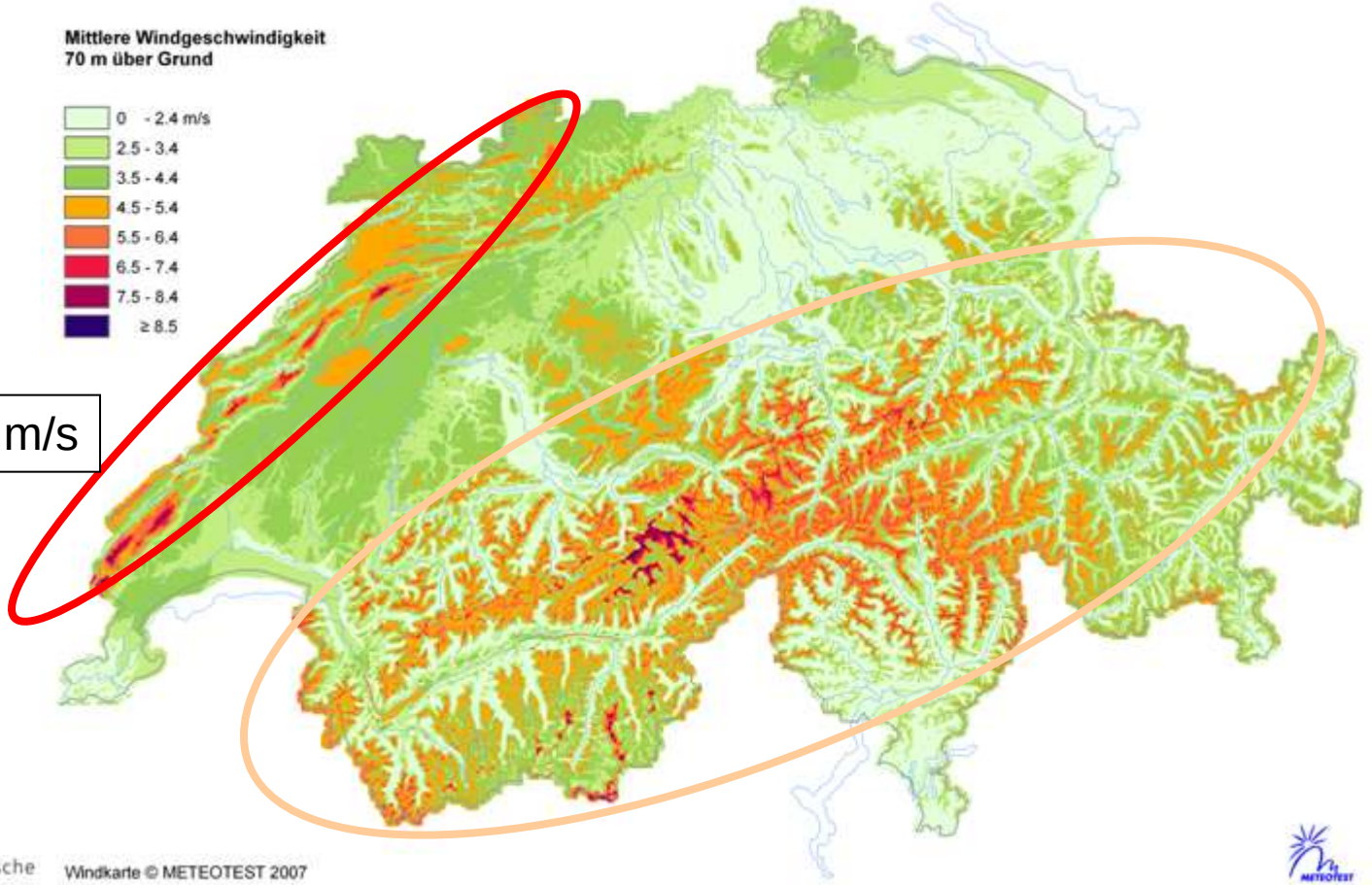
Wind turbine blade heating
Does it pay?

Wind map of Switzerland



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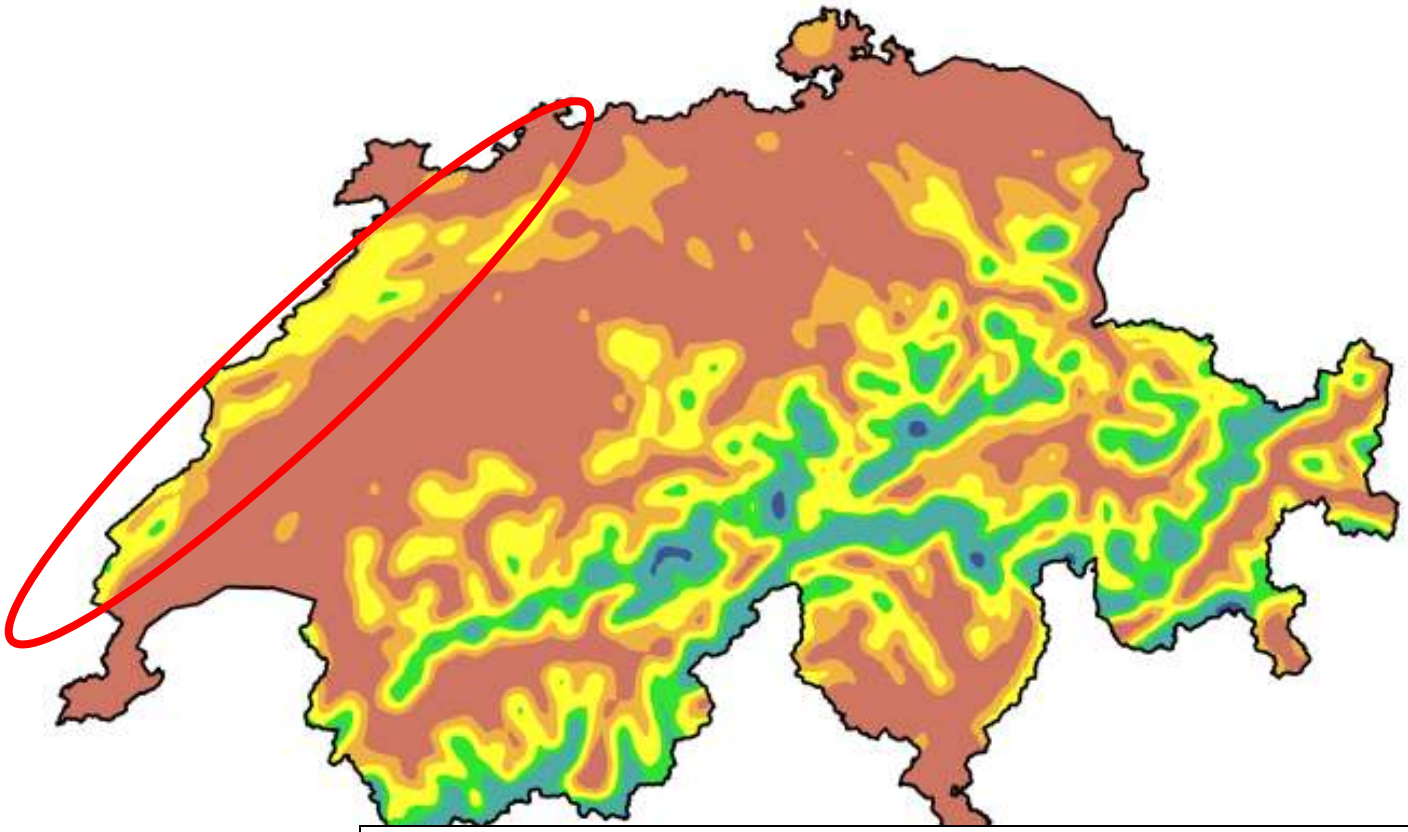
Wind map of Switzerland

Icing map of Switzerland



→ Almost all Swiss sites under icing conditions

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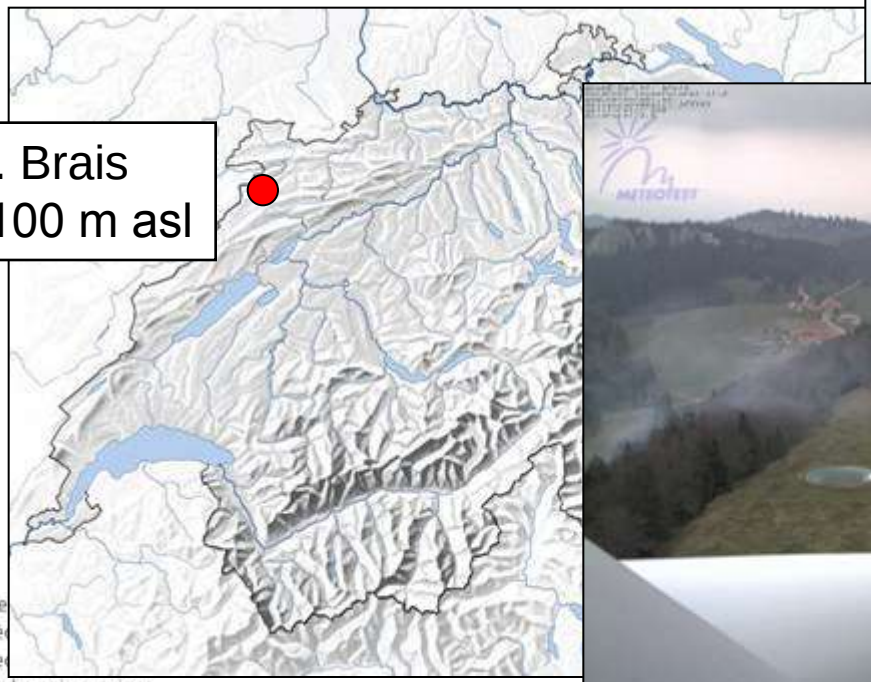
Does it pay?

Research project

2 Enercon E-82
Hub height 78 m
Enercon blade heating



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Wind turbine blade heating
Does it pay?

Icing Project St. Brais
(2009 to 2011)

1) Monitoring of a 2-MW-wind turbine in the Jura arc (2/3 of the planned Swiss wind parks) concerning **icing, turbulence and wind shear**

2) Evaluation and validation of different **systems for ice detection and de-icing**

3) Evaluation of the **production loss** due to icing and of the **gained energy** based on use of ice detection and de-icing systems

4) Evaluation of the **additional loads** caused by icing

5) Evaluation of the **noise emissions** of a wind turbine under icing conditions

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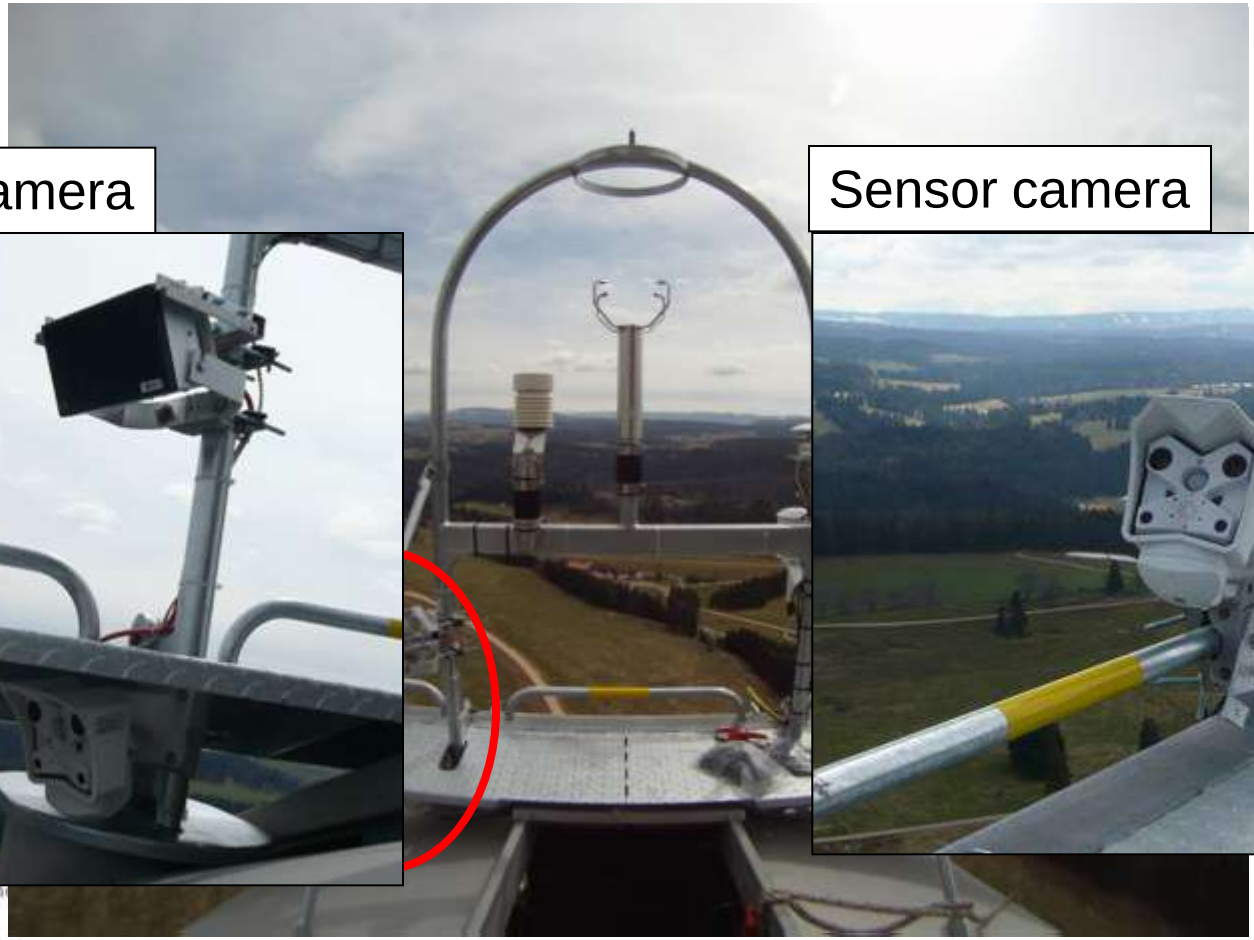
Instrumentation



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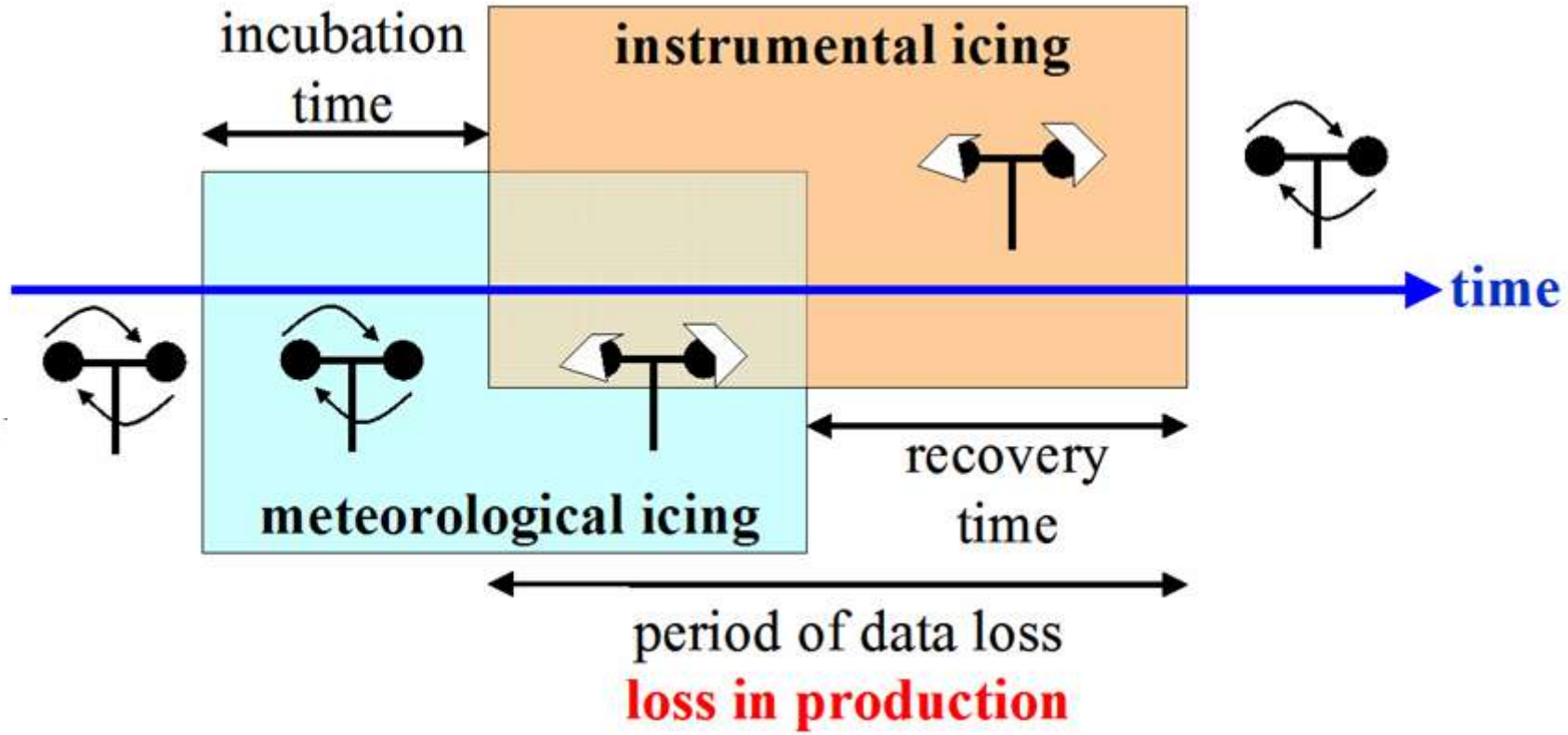
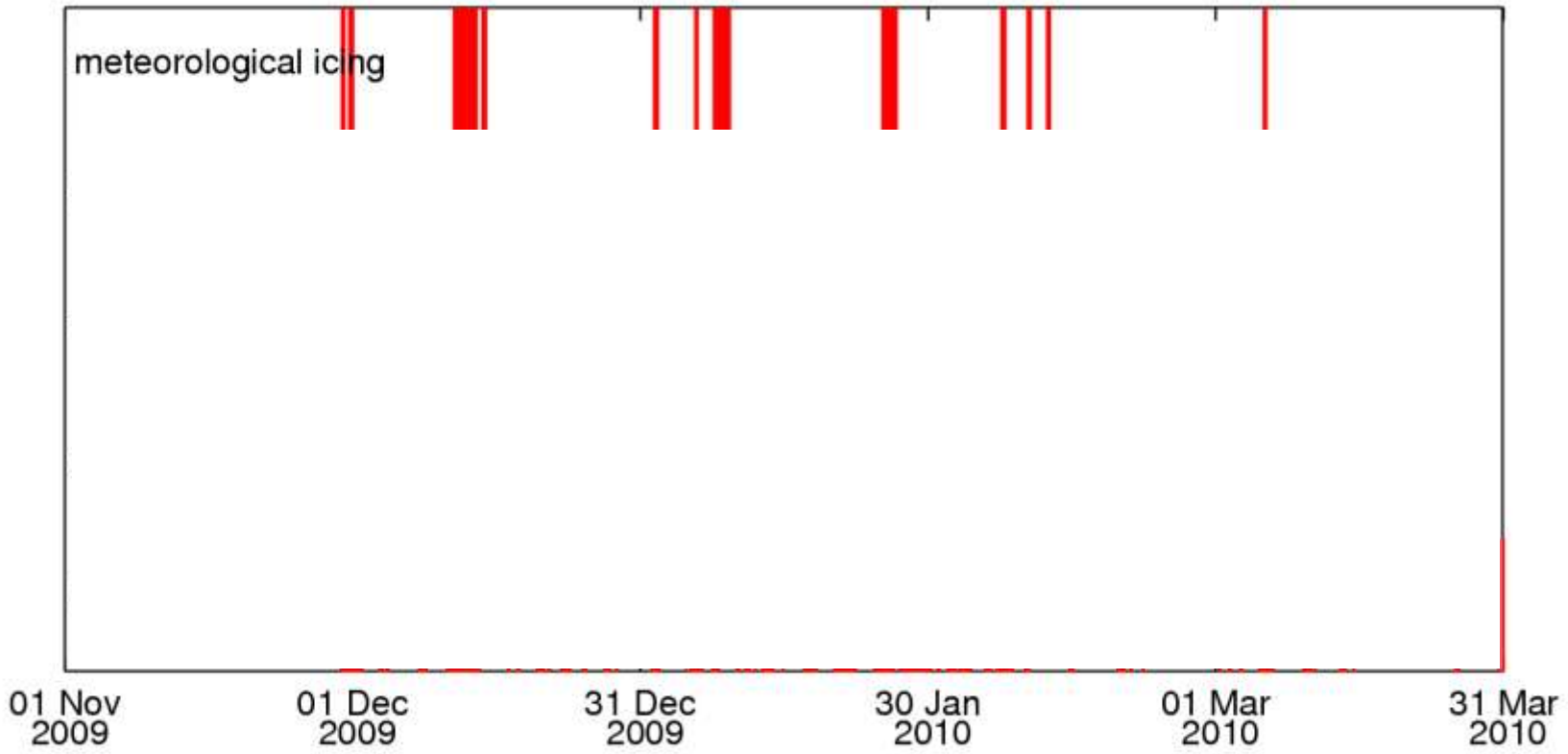
Analysis of meteorological and instrumental icing



Wind turbine blade heating
Does it pay?

Analysis of camera images



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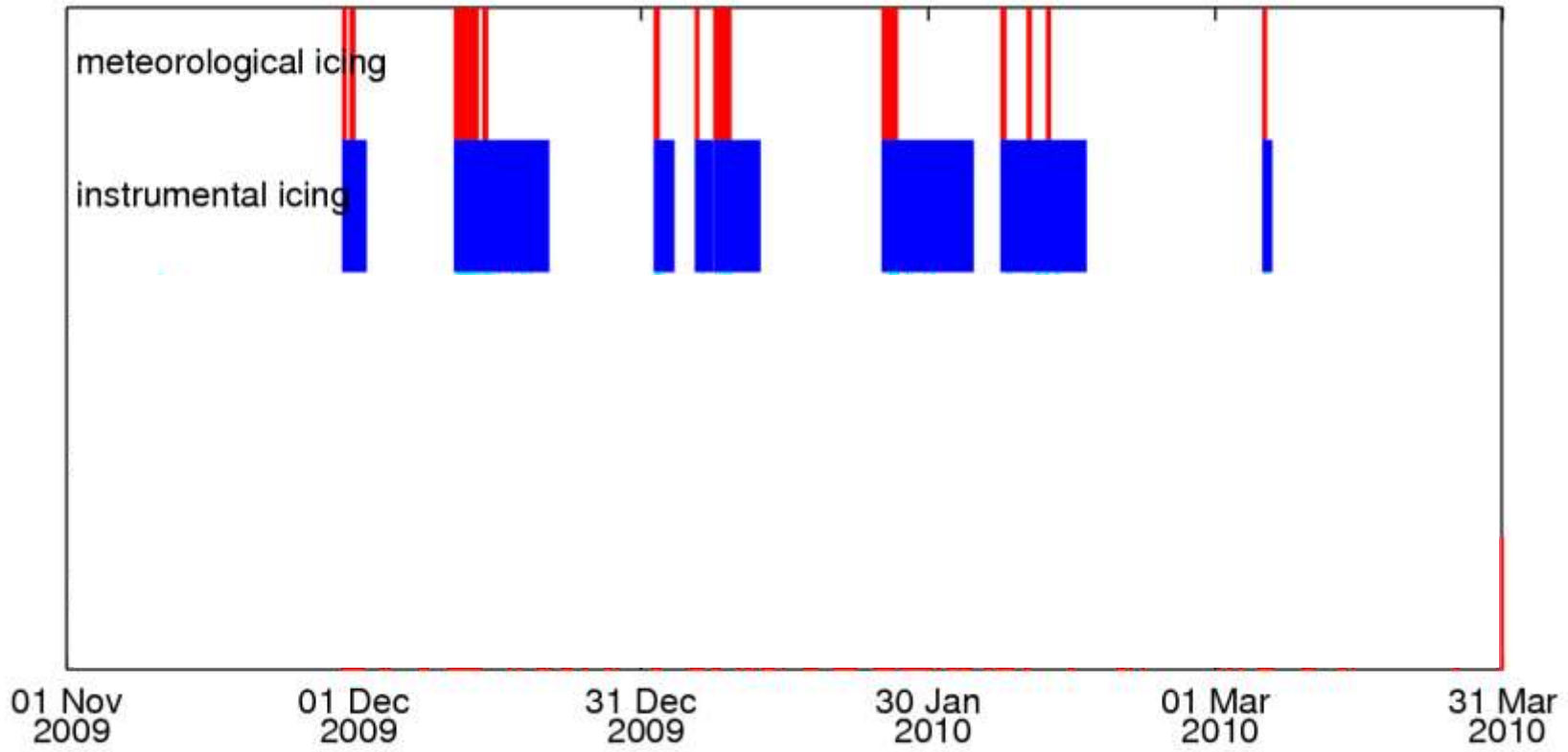

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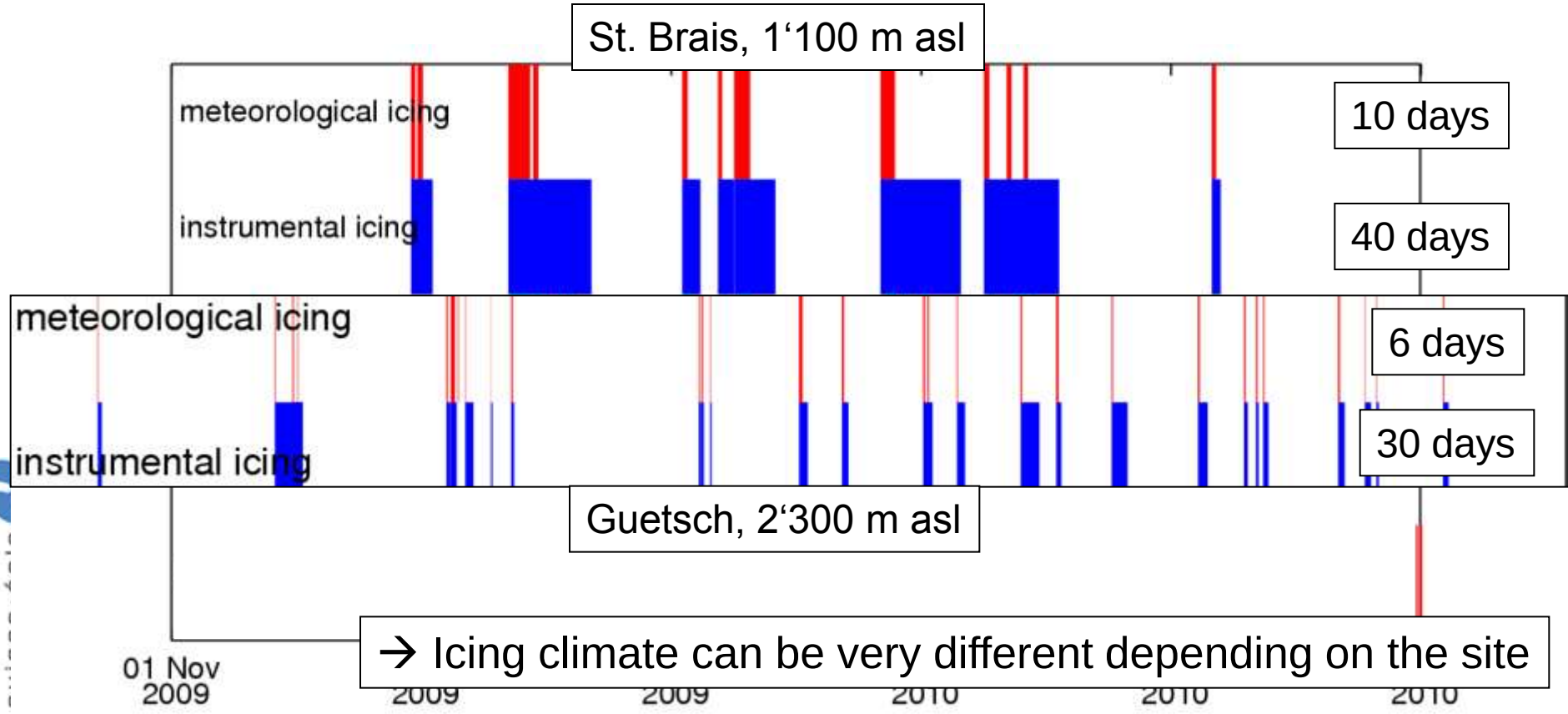


→ Icing climate can be very different depending on the site

Wind turbine blade heating
Does it pay?

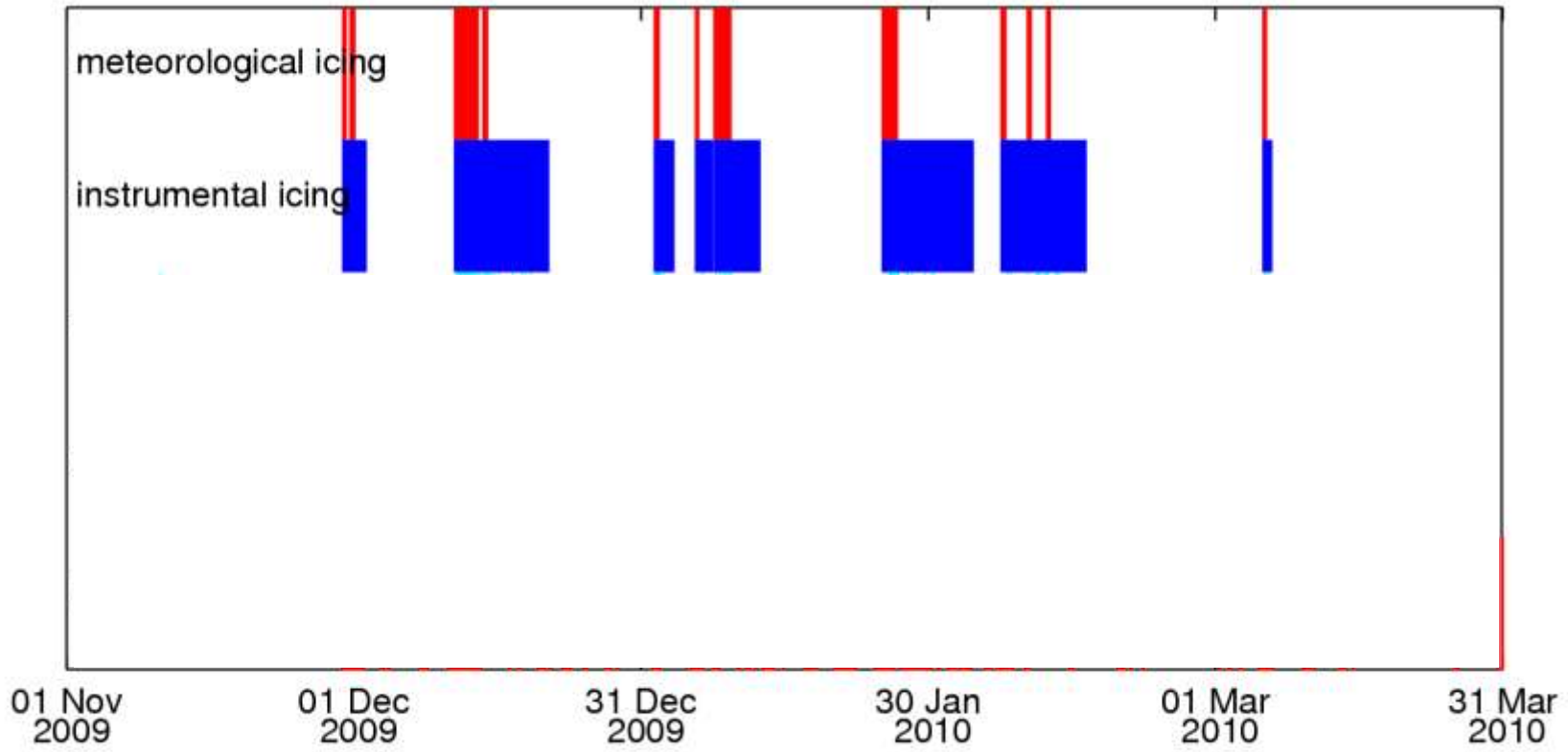
When was blade heating active?

Operation of Blade heating in winter 2009/10:

→ turbine is **stopped** when icing is detected
→ blades are **heated for 3 h**
→ turbine is **automatically restarted**

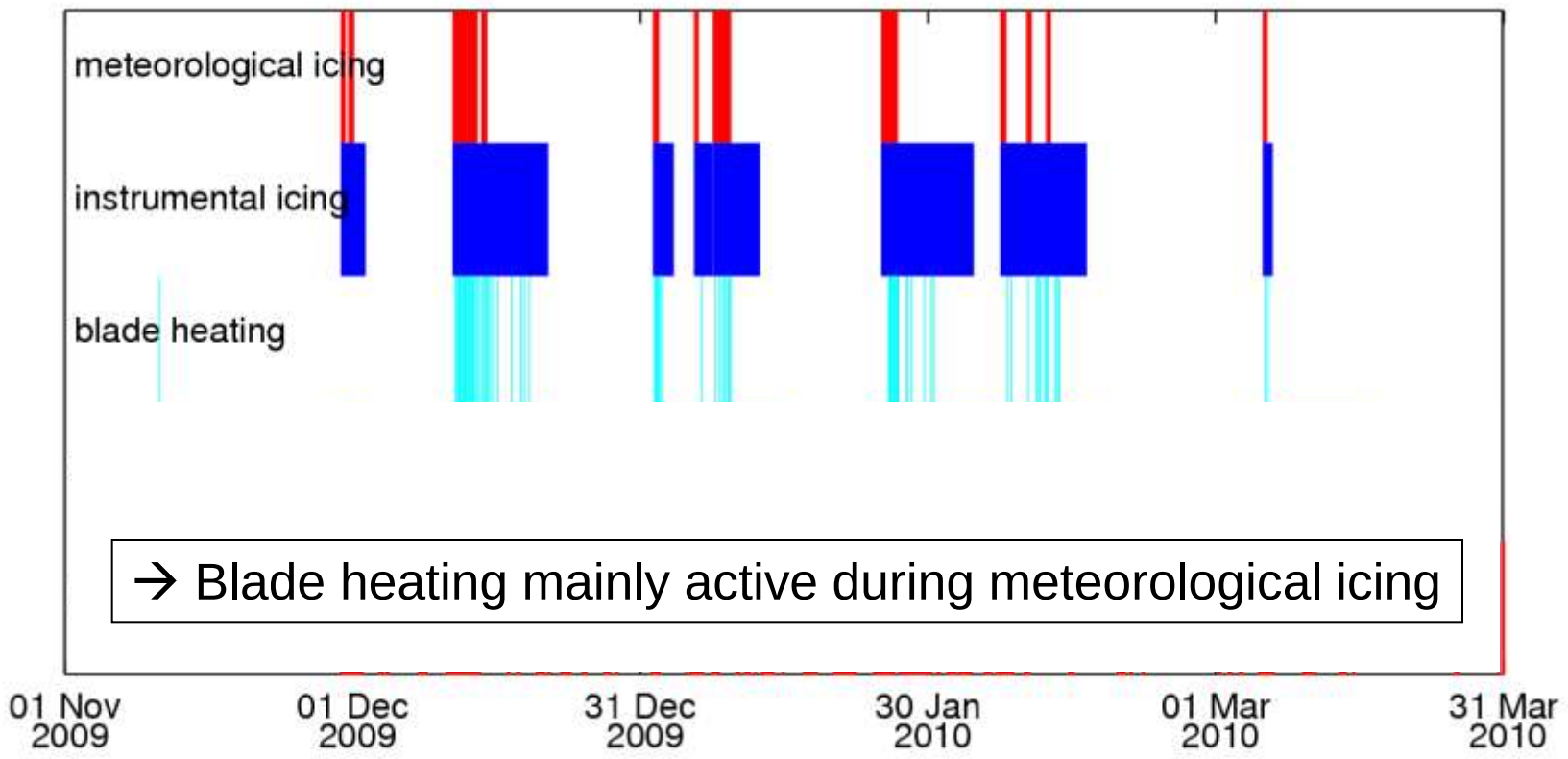
Wind turbine blade heating
Does it pay?

When was blade heating active?



Wind turbine blade heating
Does it pay?

When was blade heating active?



→ Blade heating mainly active during meteorological icing

Wind turbine blade heating
Does it pay?

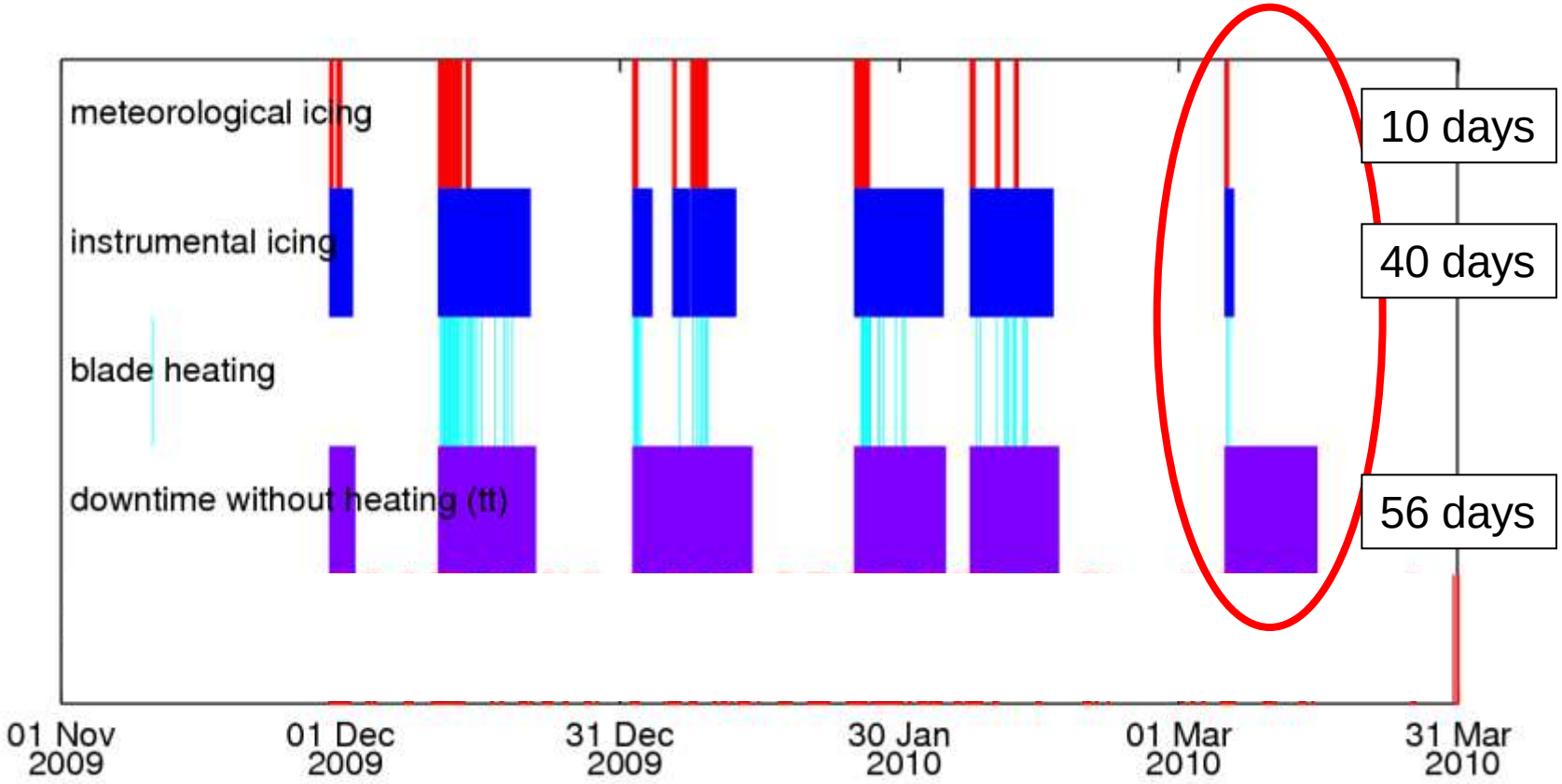
Case study: What would happen without blade heating?

Assumptions:

- Wind turbine **without blade heating**
- Turbine **stops** when ice is detected
- Automatic restart when temperature was **above 2°C for 6 hours**

Wind turbine blade heating
Does it pay?

Case study: What would happen without blade heating?



Wind turbine blade heating
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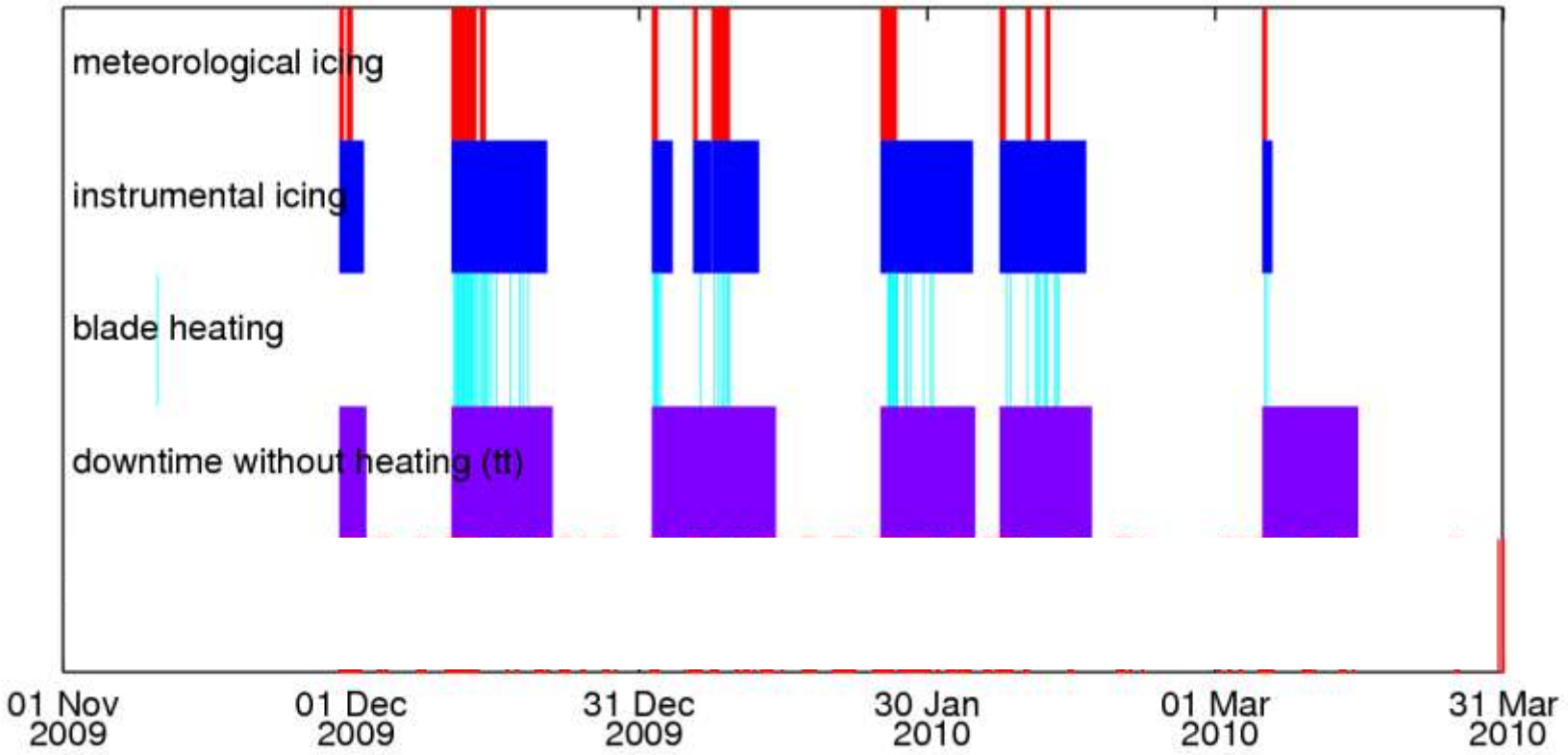
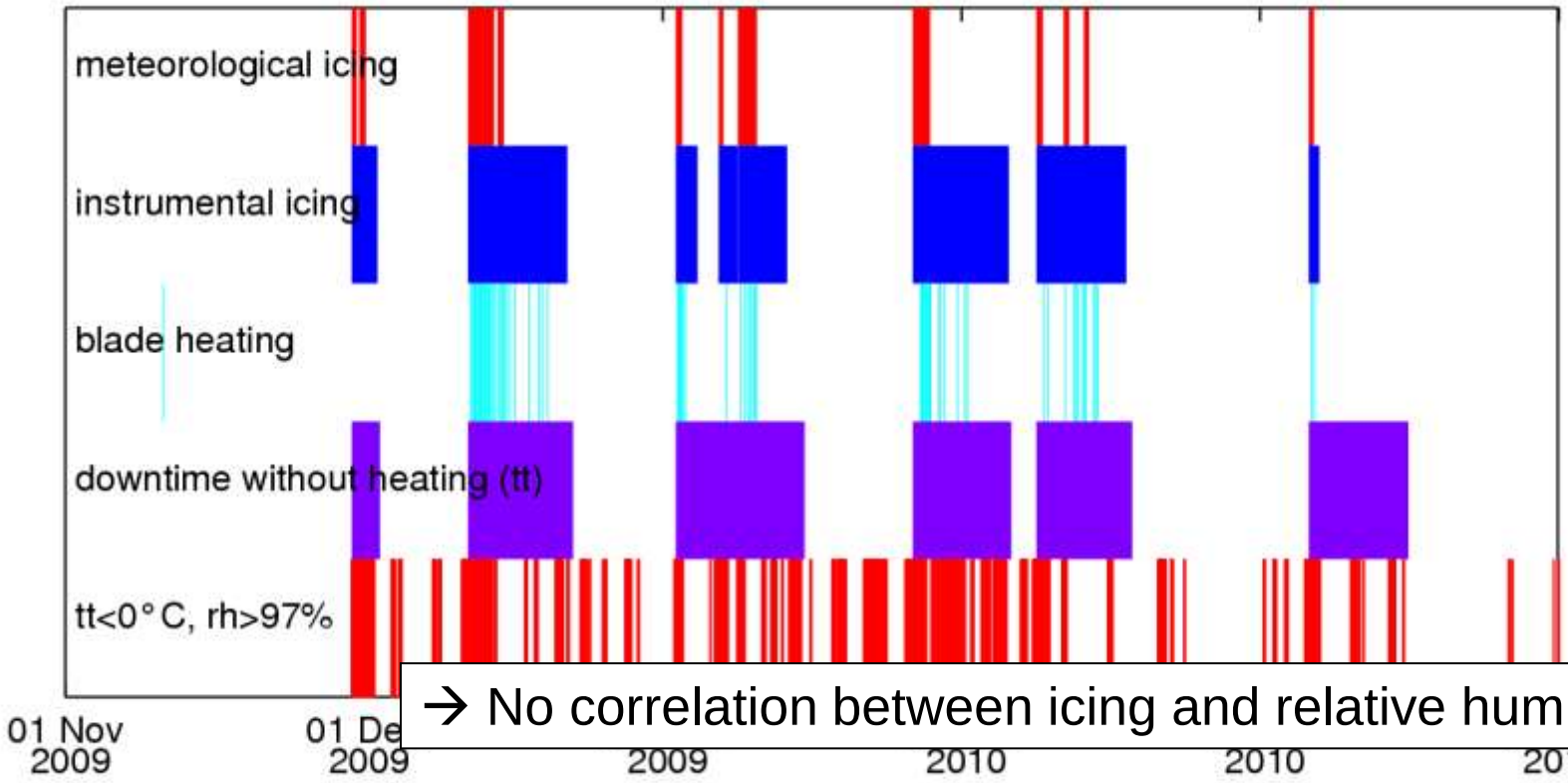
Temperature and relative humidity?



Wind turbine blade heating
Does it pay?

Temperature and relative humidity?



→ No correlation between icing and relative humidity

Wind turbine blade heating
Does it pay?

What was the benefit?

- Production loss without blade heating: **~10%**
- Additional production thanks to blade heating: **~7%**
- Energy needed for blade heating: **~0.4%**
- Production loss due to stopped turbine during heating: **~3%**

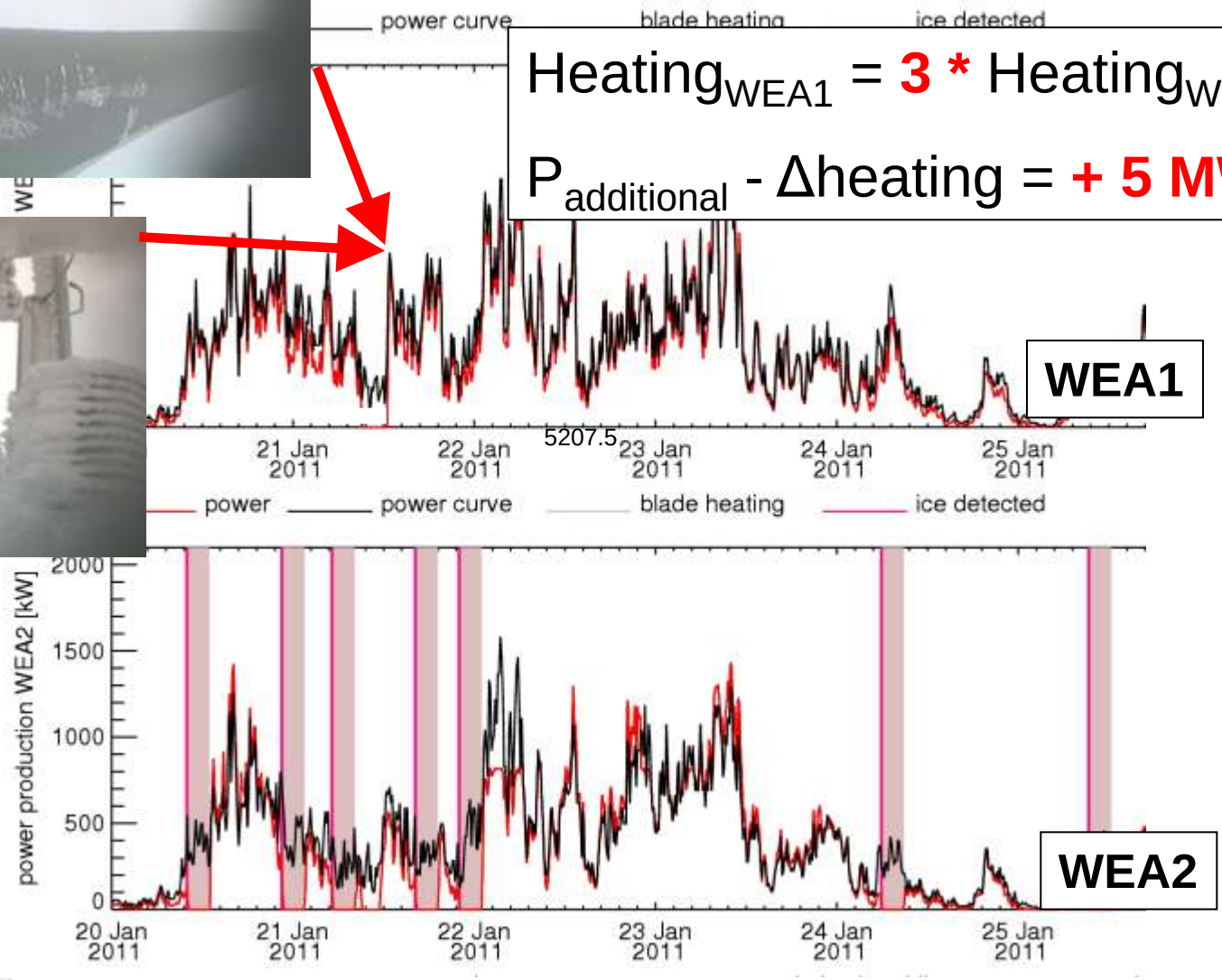
→Further optimisation: Heating during operation of the wind turbine
→ active since mid January 2011

→ 2 case studies

Wind turbine blade heating
Does it pay?

$Heating_{WEA1} = 3 * Heating_{WEA2}$

$P_{additional} - \Delta heating = + 5\ MWh$



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Wind turbine blade heating
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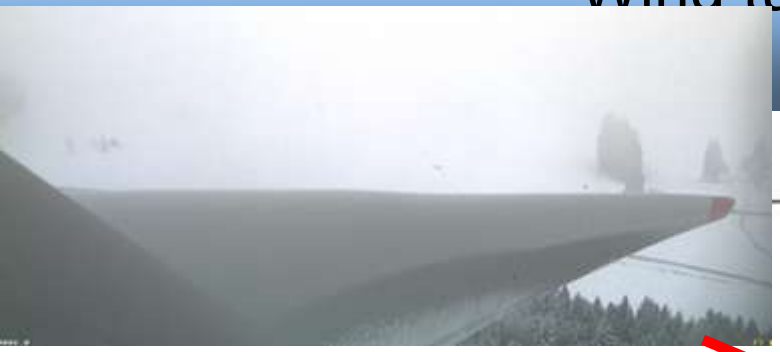
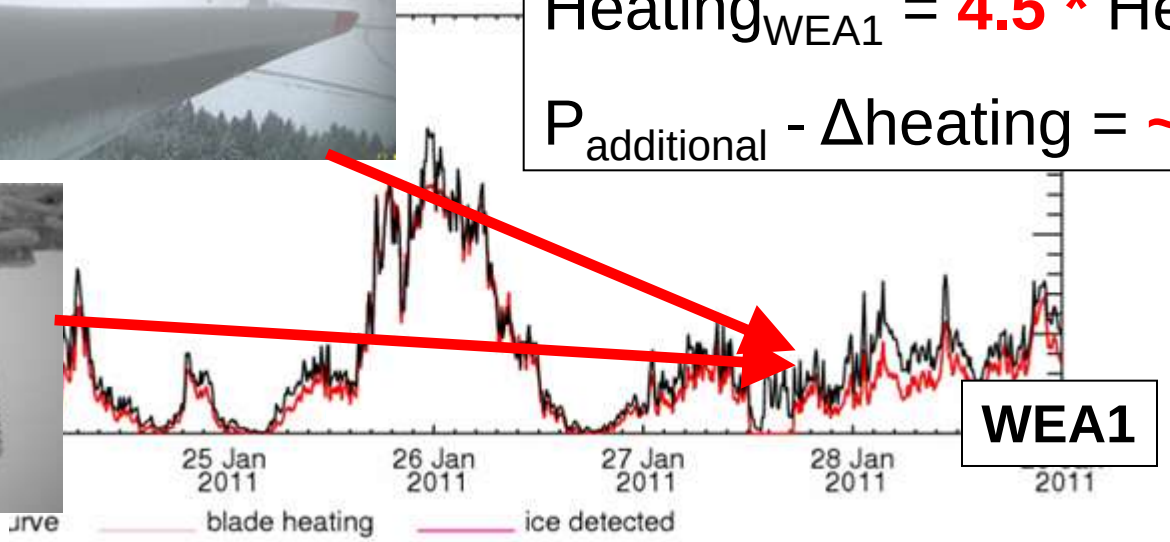
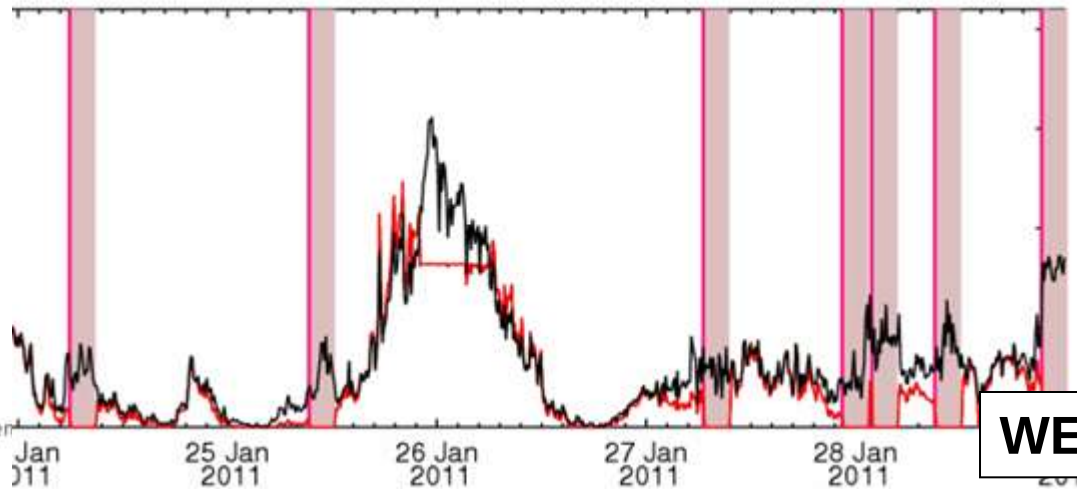


$Heating_{WEA1} = \mathbf{4.5} * Heating_{WEA2}$

$P_{additional} - \Delta heating = \mathbf{\sim 0\ MWh}$



WEA1



WEA2

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Wind turbine blade heating
Does it pay?

Summary

- Instrumental icing periods **~ 4 times longer** than meteorological icing
- Blade heating mainly active **during the periods of meteorological icing**.
- **Without blade heating** production losses of approximately 10%
- Blade heating allowed **~7% more production**
- Energy needed for blade heating: ~**0.4% of annual production**.
- Production **loss of ~3% remains** because wind turbine **stops** for heating.
- **Heating during operation** can further reduce the production loss when there is enough wind at the same time
- **Temperature and relative humidity** give **no indication** on icing conditions.
- In order to assess the economic benefit of a blade heating, it is crucial to **know the icing conditions** at the site in advance (**site classification**)

→ Yes it pays! (at this site)

Wind turbine blade heating
Does it pay?

Thank you for your attention!

→ visit us at booth A17