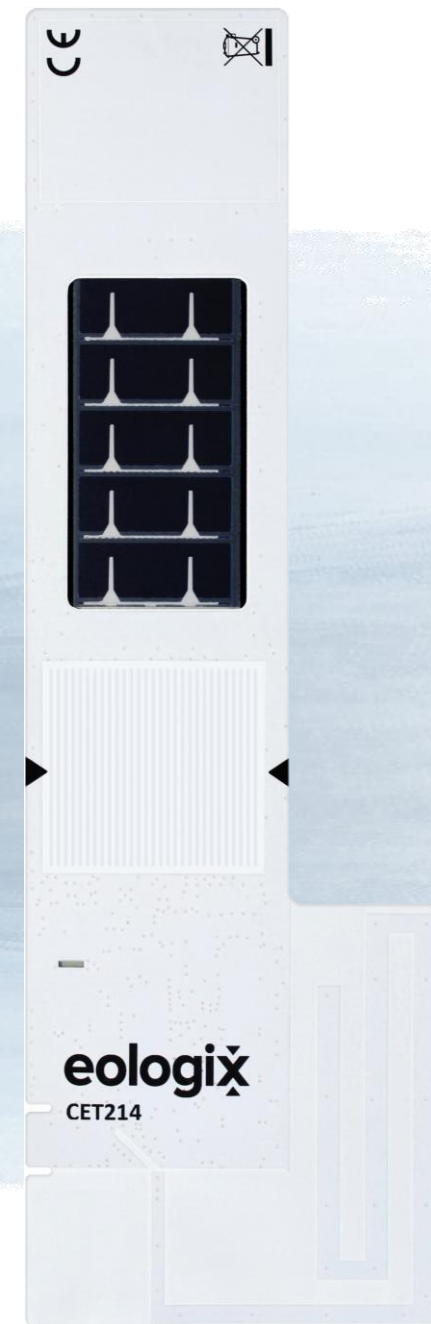


# From turbines to farms: Using distributed ice detection to increase safety and accessibility

Winterwind 2021

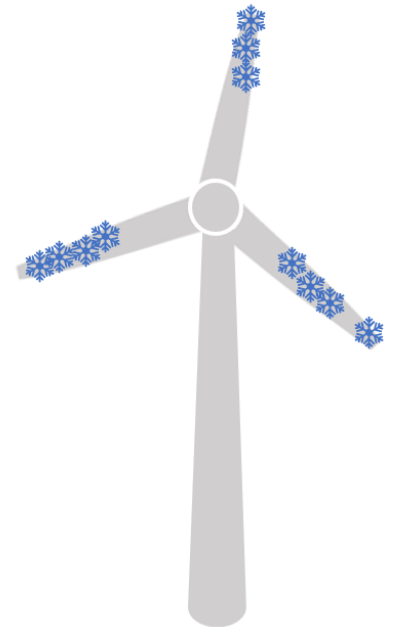
Theresa Loss, Michael Moser | eologix sensor technology gmbh



# Introduction

## Farm-based ice monitoring

- In cold climates, accessibility of turbines is limited by icing
- Occupational safety is important
- Scheduling of service / maintenance required
- Meteorological measurements  $\neq$  icing status of turbines



# Introduction

## Farm-based ice monitoring

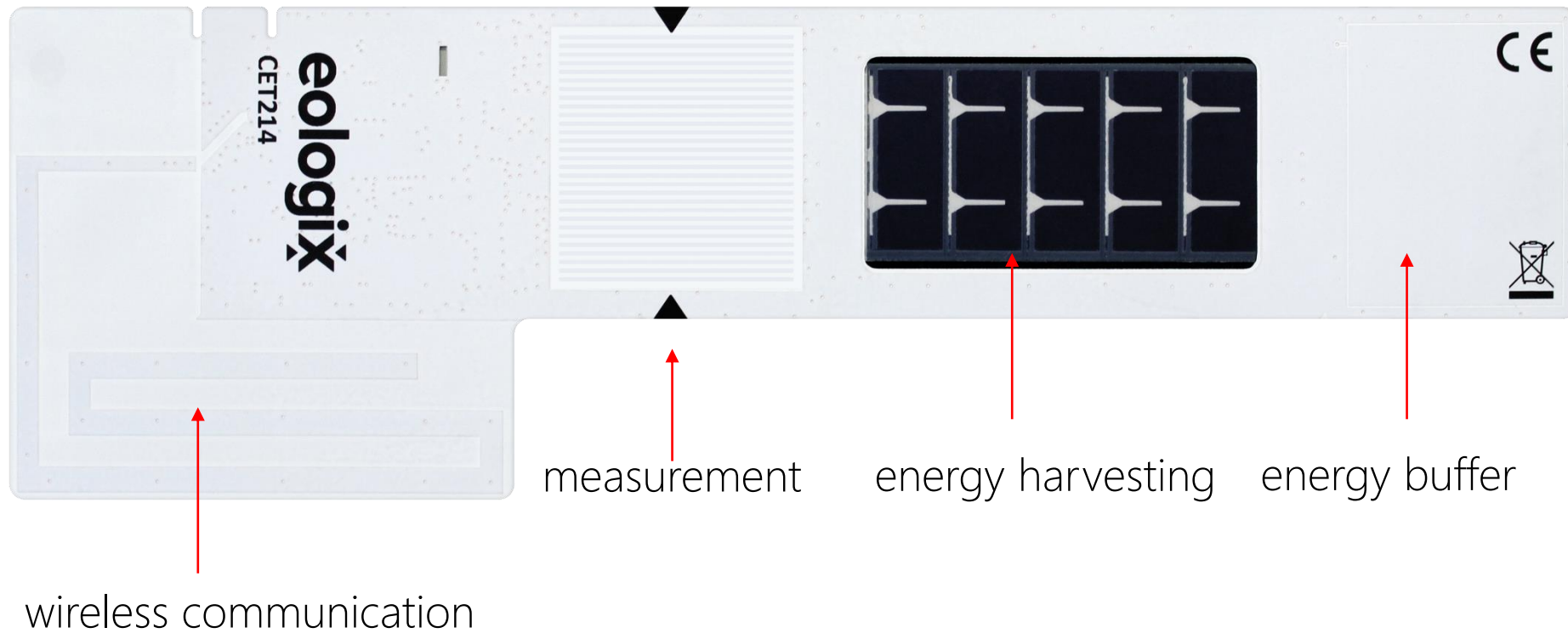
### → Can ice be monitored for several wind farms?

- › Reduce costs – only schedule maintenance if farm is accessible
- › Increase safety of employees
- › Reduce standstills, e.g. by using predictive heating



# Ice Detection System

## Sensor layout



# Ice Detection System

## Measurement of icing

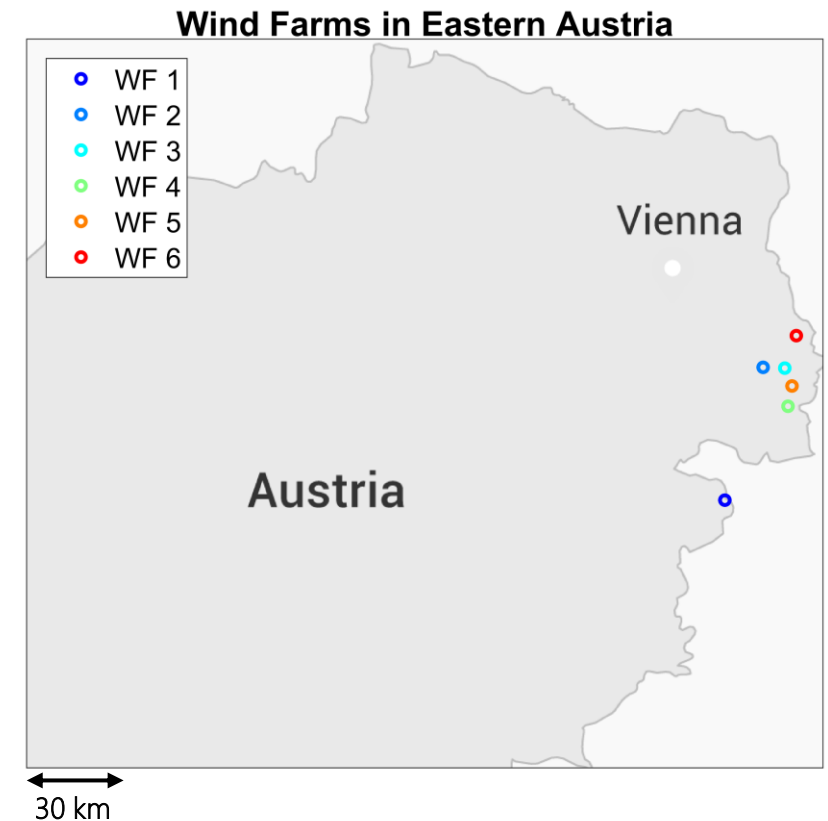
- Ice and temperature measurement
- 5 different levels to characterise surface conditions



# From Turbines to Farms...

## Set-up

- 6 wind farms with 28 turbines in total in Eastern Austria
- Topology: predominantly flat
- Evaluation period:  
15.11.2020 – 28.02.2021





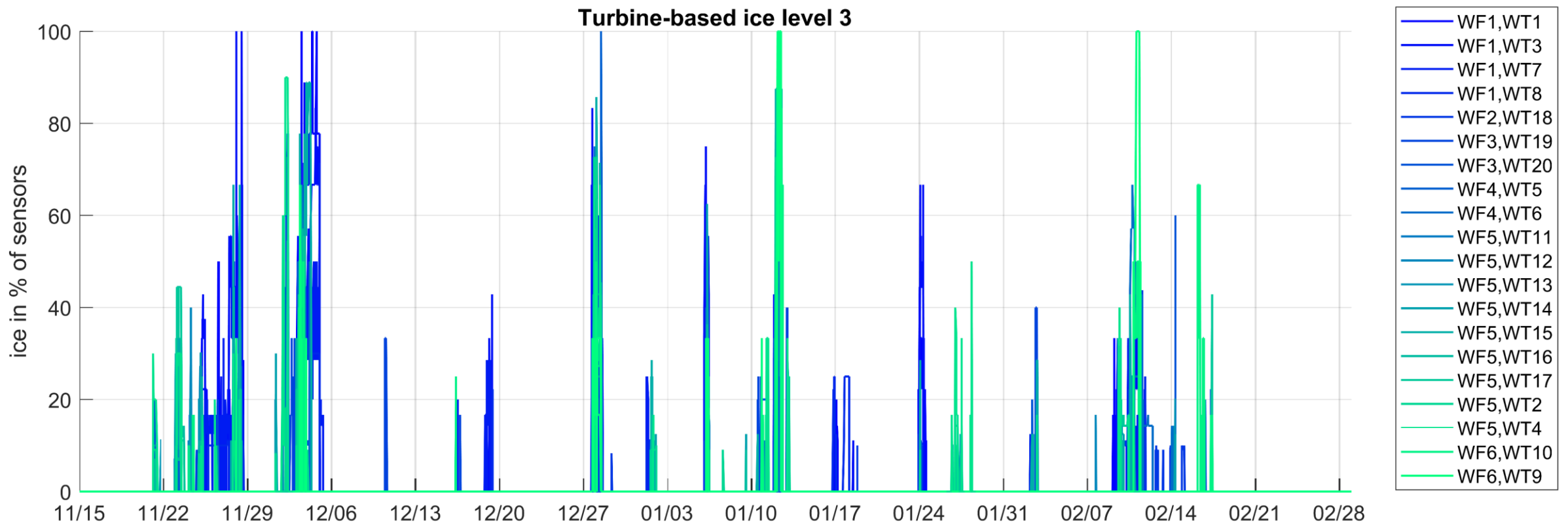
# From Turbines to Farms...

## Signal analysis

- Criterion per turbine: percentage of sensors with ice level 3 or higher
- Evaluation was conducted both
  - Turbine-based, i.e. percentage of L3 sensors per turbine
  - Farm-based, i.e. percentage of L3 sensors per farm

# From Turbines to Farms...

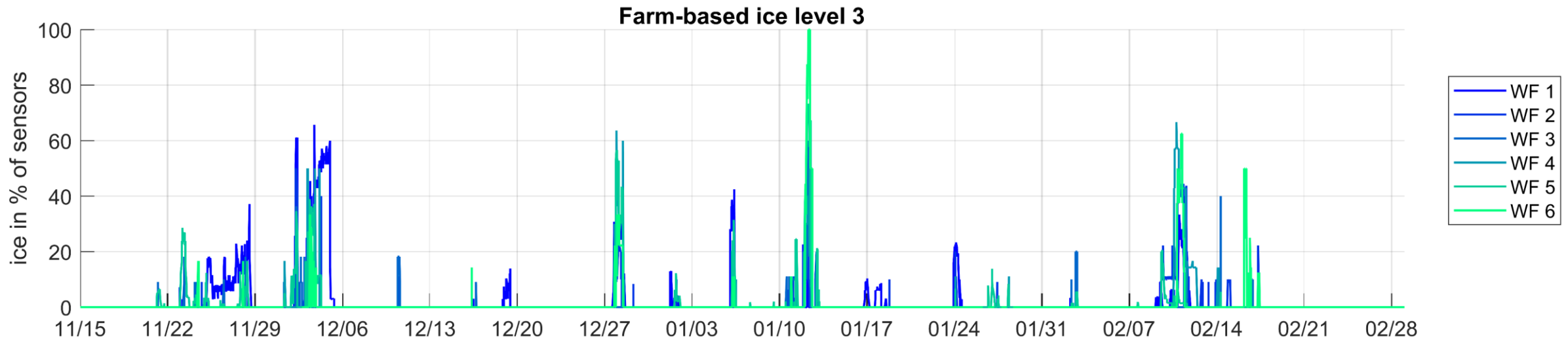
## Turbine-based icing





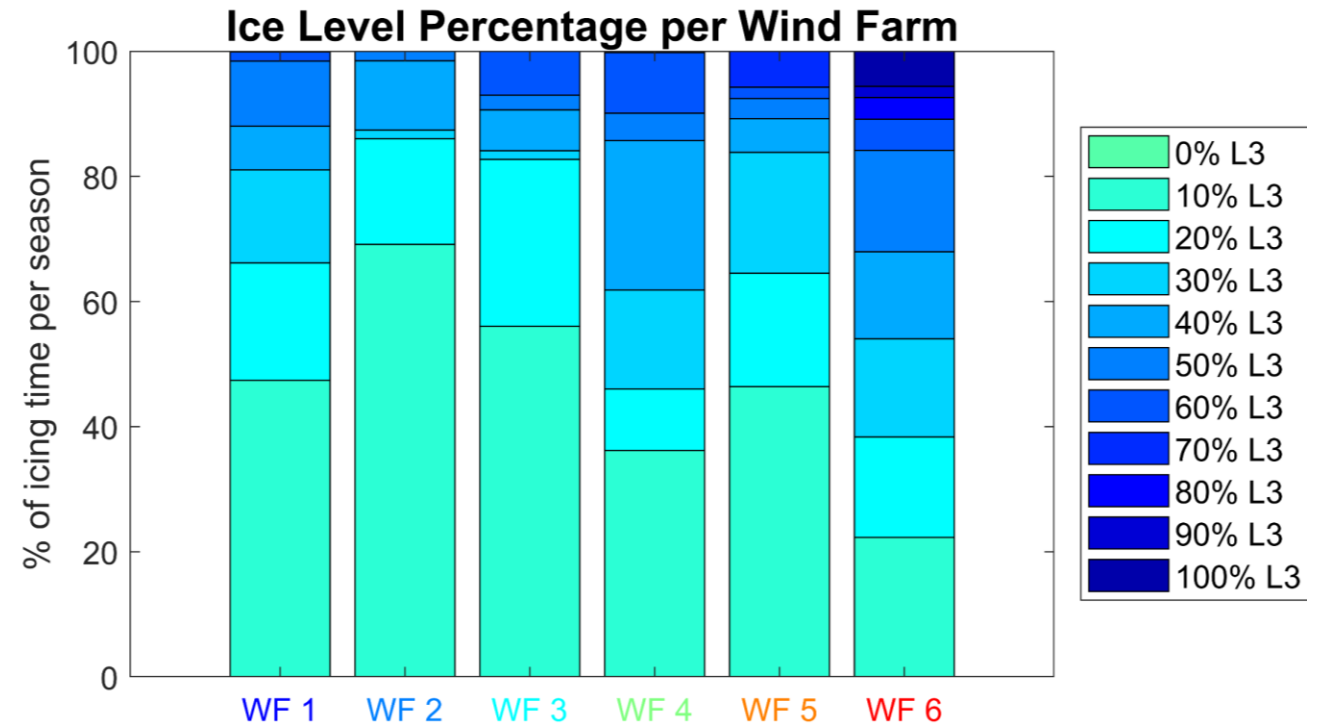
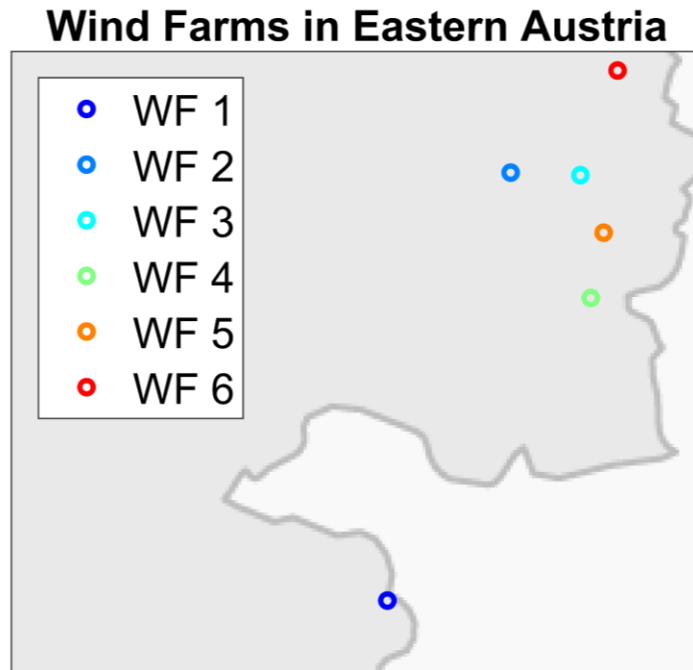
# From Turbines to Farms...

## Farm-based icing



# From Turbines to Farms...

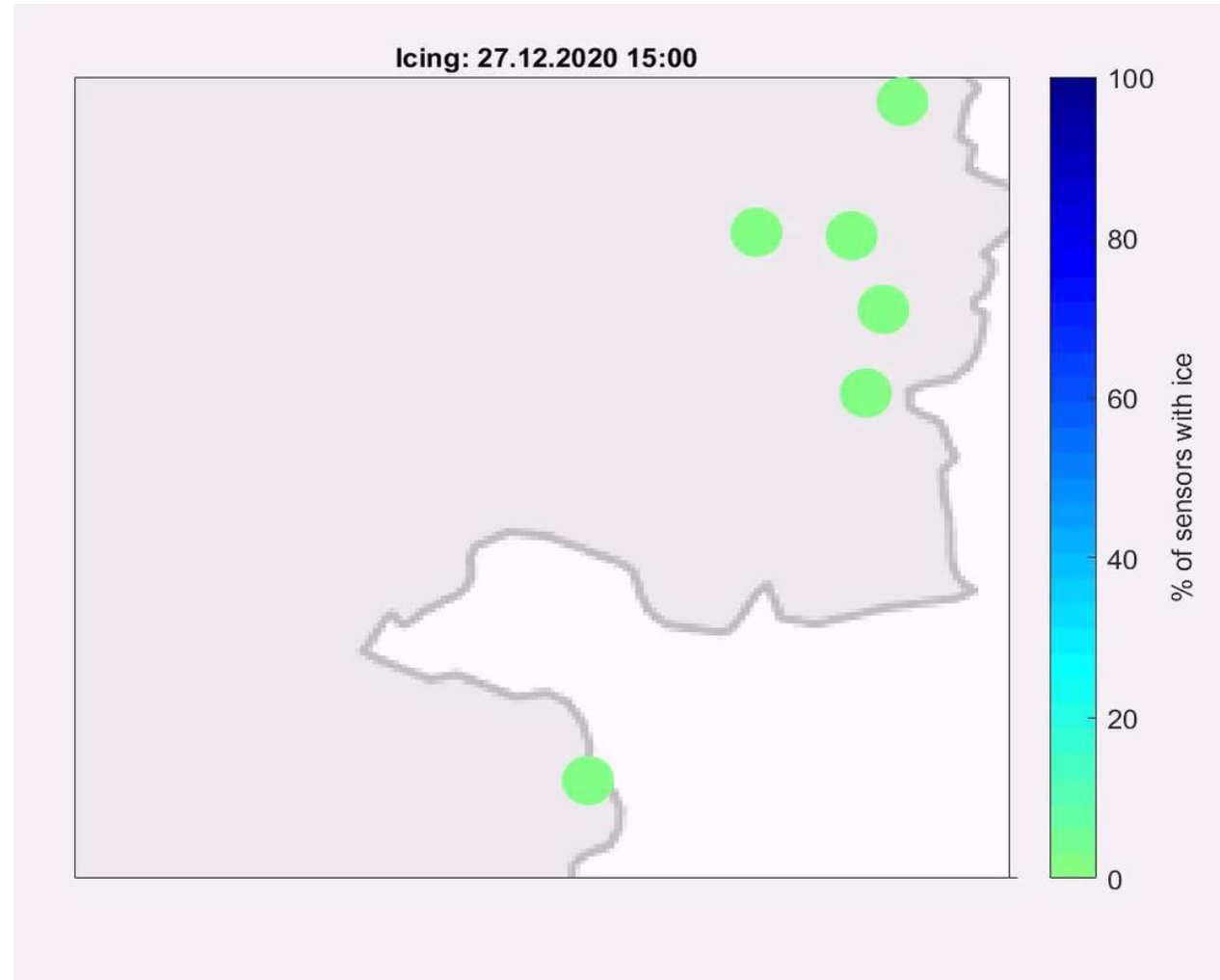
## Comparison of icing times



# Icing Patterns

## Visualisation

- Icing event from 27.-28.12.2020
- 5 / 6 farms involved
- Colouring in 10% steps



# Icing Patterns

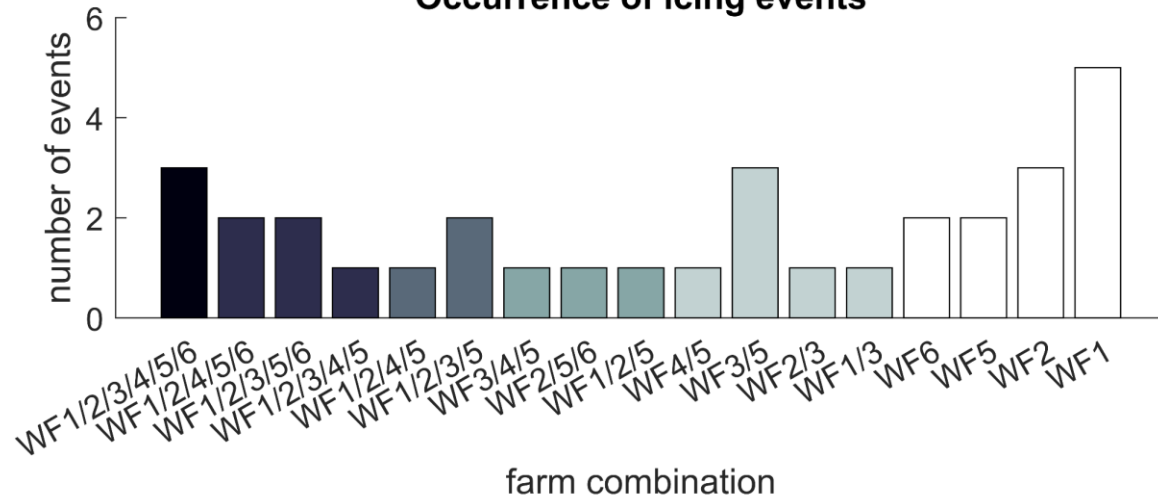
## Method

- Detect icing events: joint icing signal of all farms  
(moving median, filter length corresponds to 1 h)
- Icing event: more than 2 hours of icing, more than 1 hour of 'no ice' till next event
- Detect combinations of turbines
- Analyse occurrence of most frequent patterns

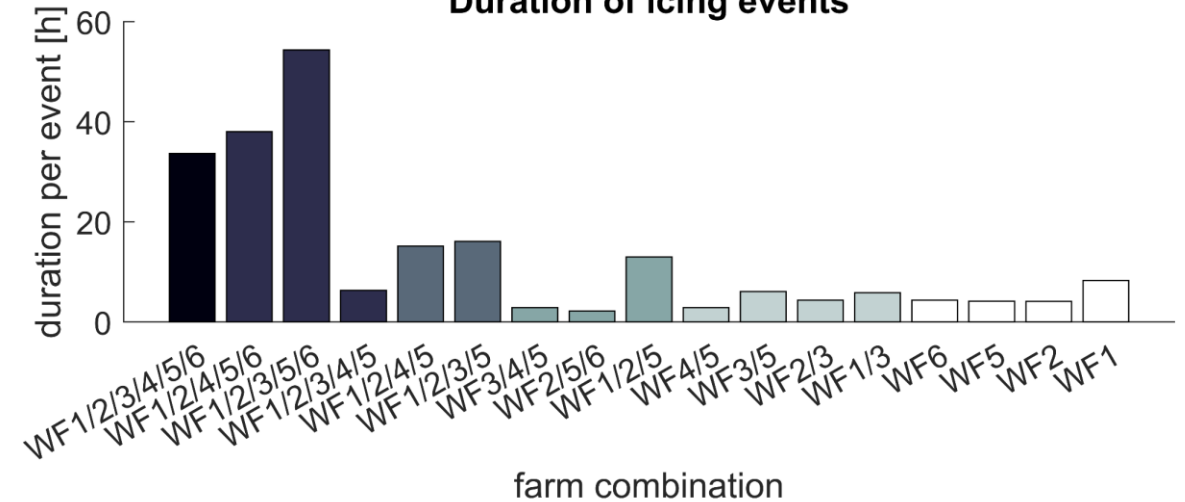
# Icing Patterns

## Occurrence of patterns and duration of events

**Occurrence of icing events**

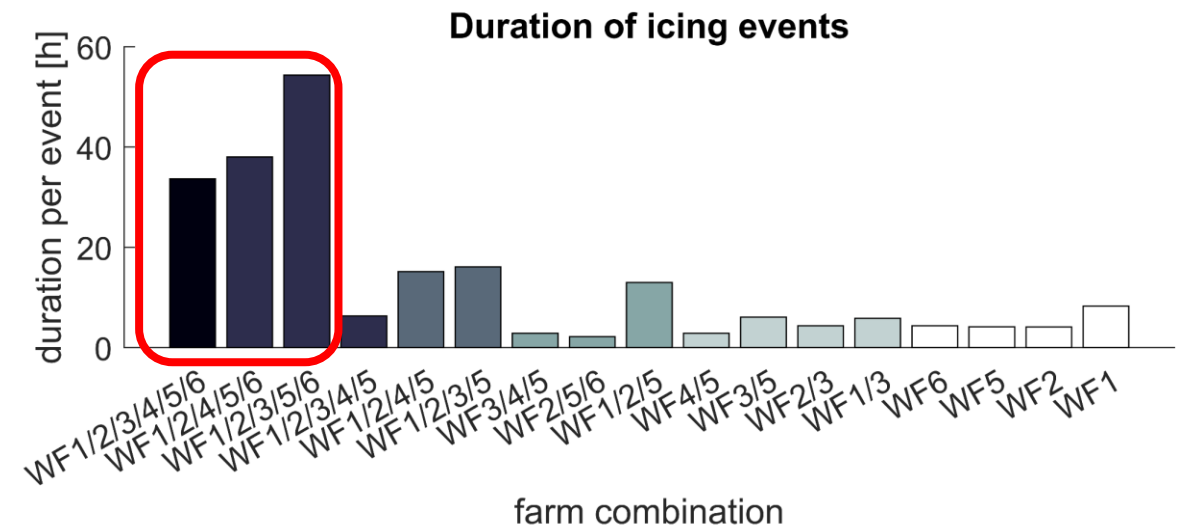
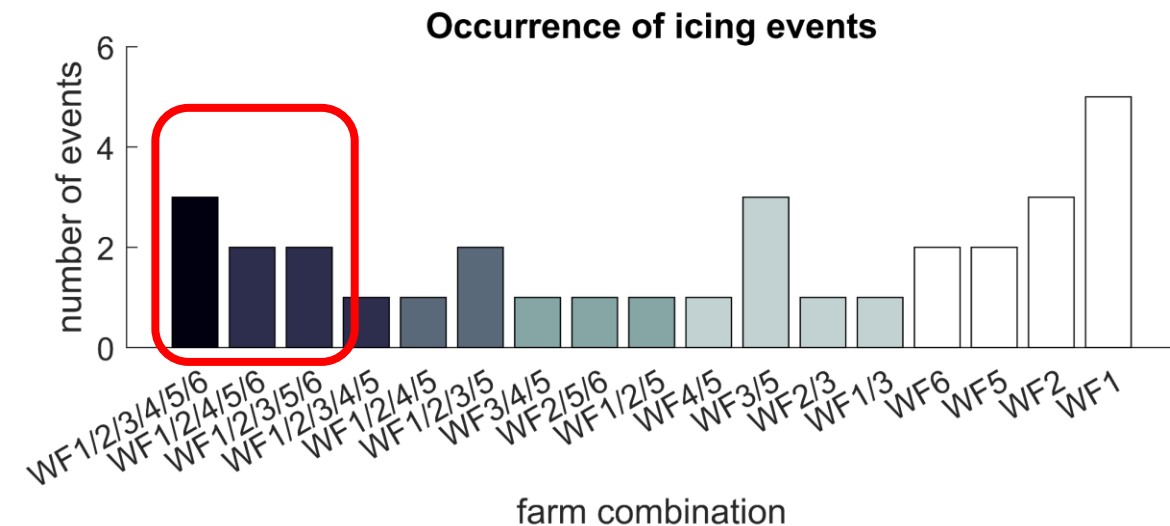


**Duration of icing events**



# Icing Patterns

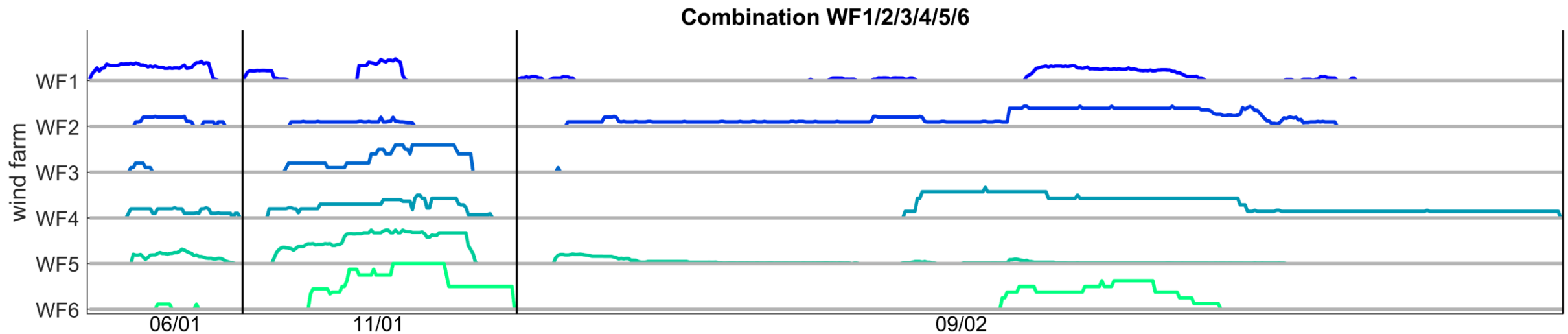
Occurrence of patterns and duration of events



# Icing Patterns

## Temporal occurrence

- Combination of all wind farms

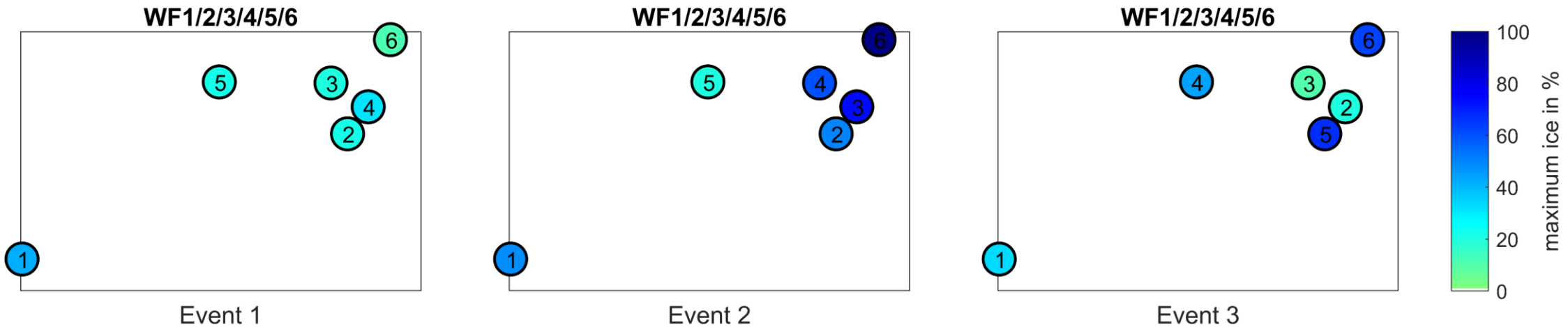




# Icing Patterns

## Pattern analysis

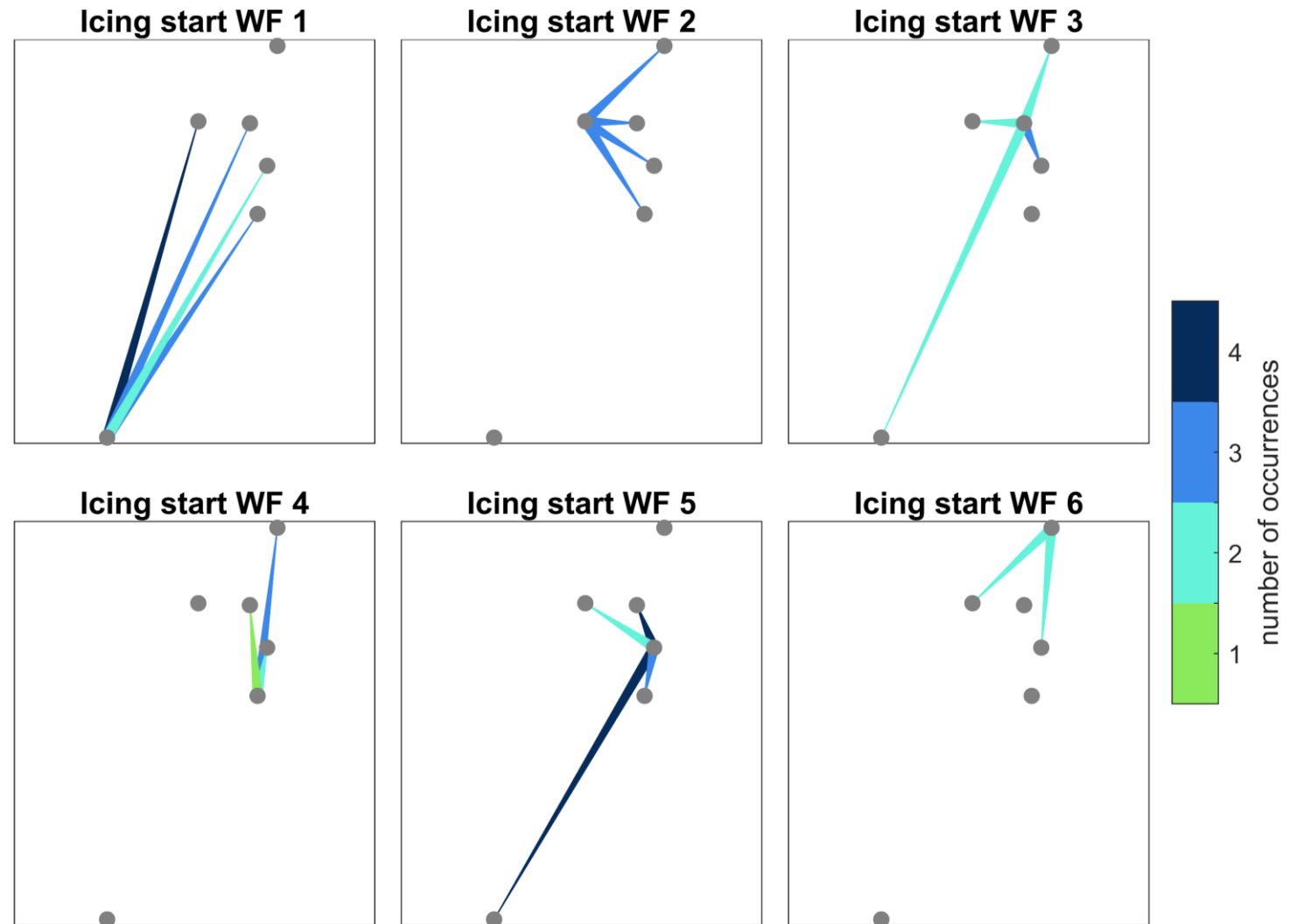
- Location = location of wind farm
- Colour = maximum percentage of icing
- Number = sequence of icing



# Icing Patterns

Which is the most common sequence of icing?

- Get 1-1 combinations
- Example: event 1-6-4-3  
event 1-2-4-3
- Combinations per WF
- Colour = occurrences
- Arrows = directions  
( i.e. WF 1 – WF2)



# Conclusion & Outlook

## Conclusion

- Evaluating icing in a larger (= farm-based) context helps to understand icing
- Data-based methods for analysing historic icing patterns
- Combinations of farms and sequence of icing could be detected
- Benefits for predictive maintenance, e.g. predictive heating, scheduling of maintenance etc.

## Outlook:

- Apply method to larger data sets (2+ years)
- Extend analysis to further locations, e.g. different topologies
- Include external meteorologic measurements, e.g. wind direction, atmospheric pressure



# ANY QUESTIONS?

Get in touch with us.  
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