Wind power icing loss forecasting and evaluations against T19IceLossMethod

Winterwind
INTERNATIONAL WIND ENERGY CONFERENCE
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The Problem

Icing on wind blades leads to **production loss** and high imbalance

Up to **25% of the total yearly imbalance volume** for a wind farm

Energy forecast **errors during winter months are 30% higher** (MAPE 35% v.s. 25%)

“A couple of bad icing forecast days can **ruin the imbalances** for an entire year”

Current solutions

Existing methods

Asset-based (T19) estimates ice-losses based on turbine-level measurements (SCADA)

Non-asset based uses weather data only

Current solutions

The **T19 Method cannot solely be used** as a forecasting tool

1

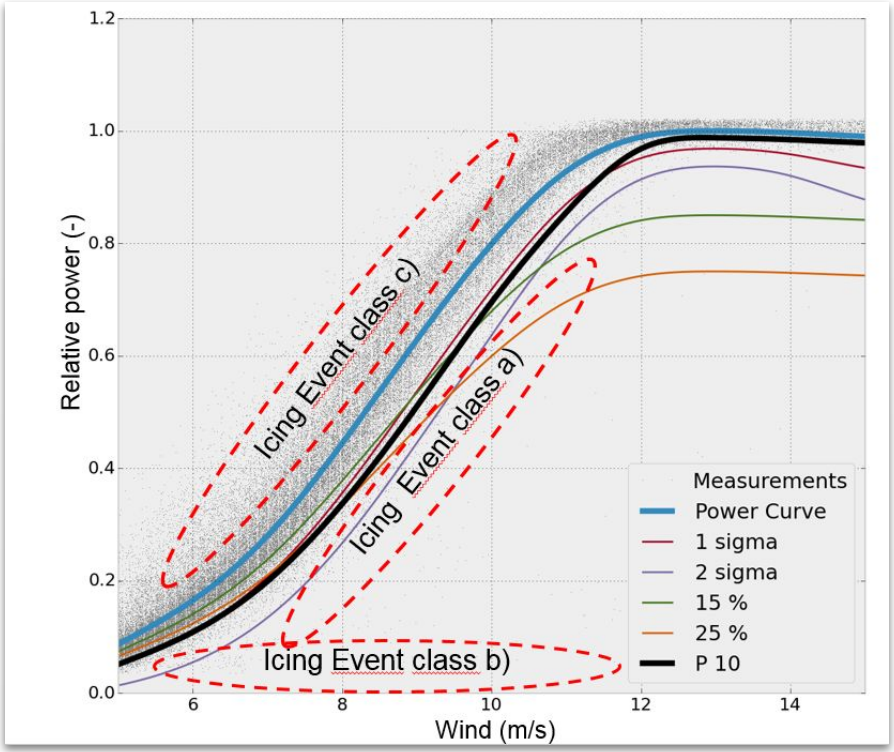
T19 requires turbine-level measurements

- Windspeed
- Temperature
- Power
- Operation mode

2

Steps in the **T19 Methodology**

- Forms the non-iced power curve
- Determines the icing intervals
- Estimates production losses during the icing intervals



Source: https://github.com/IEAWind-Task19/T19IceLossMethod

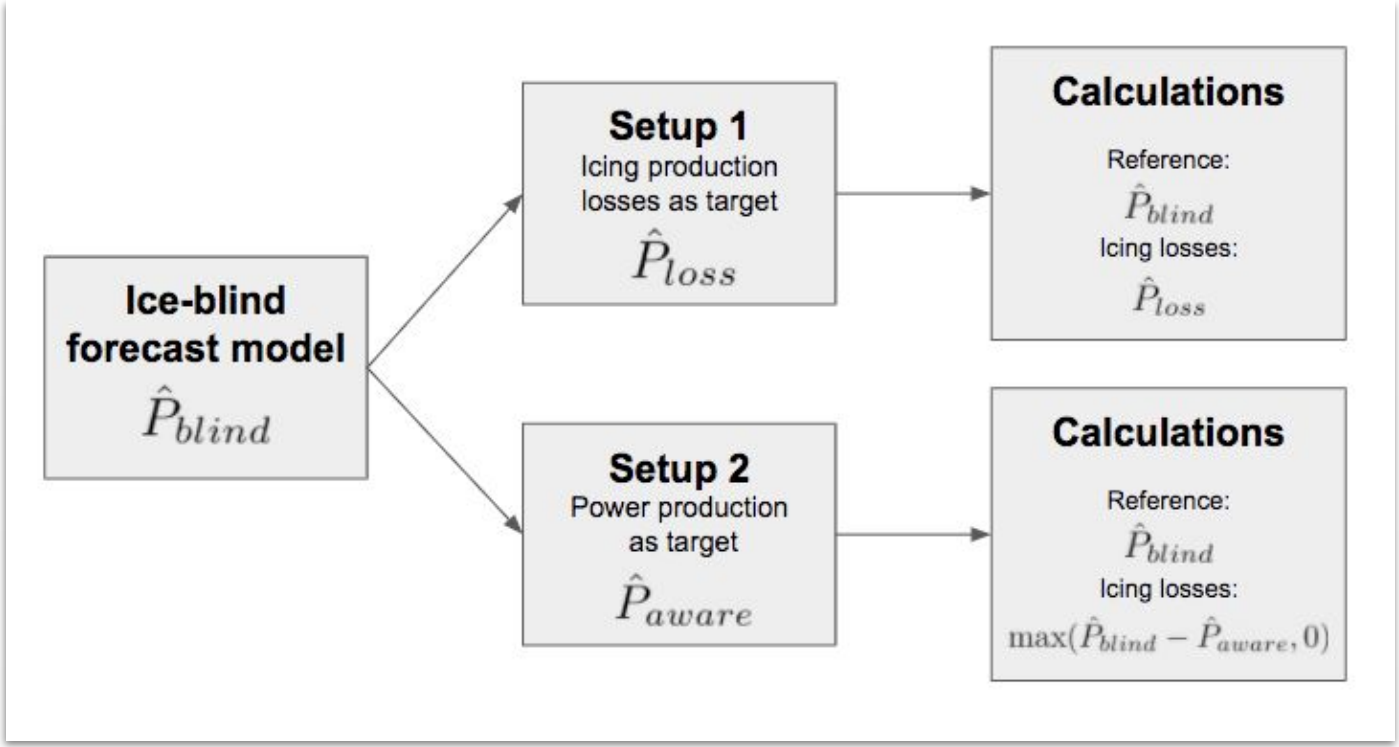
Methodology

Development of a ice-loss forecasting model, **using only historical data**

1. Use **machine learning-based forecasting** models to predict ice loss
2. Use **T19 Method** to create the training set
3. Develop a model that uses **turbine-level weather observations**
4. Develop a model that **predicts icing only using historical production data**
5. Develop a model that can be used at **park or grid connection level**

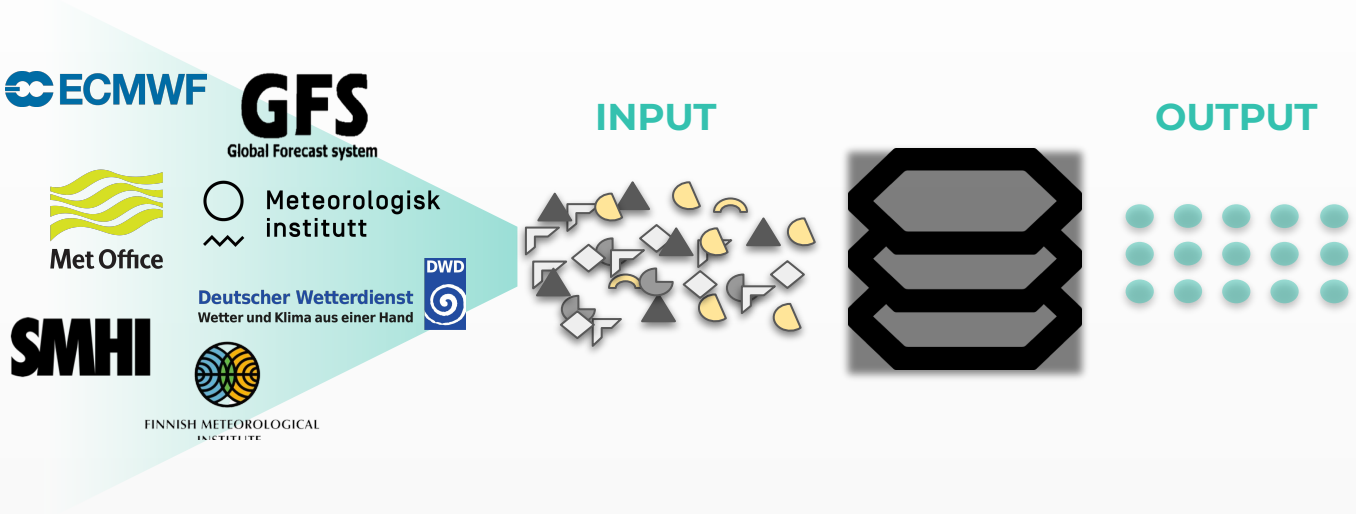
Methodology

Structural approach to the ice loss problem



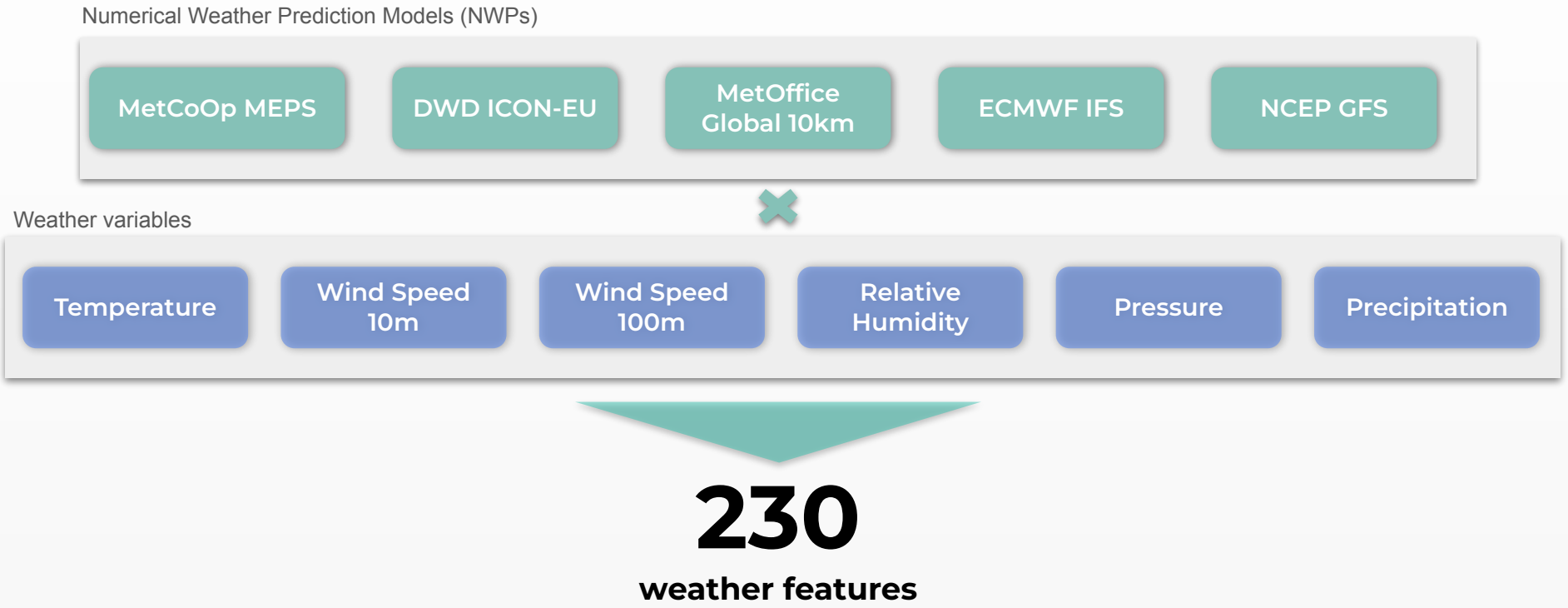
The Data

Aggregated weather data from the **Rebase Platform**



The Feature set

Large dataset when combining NWPs



230

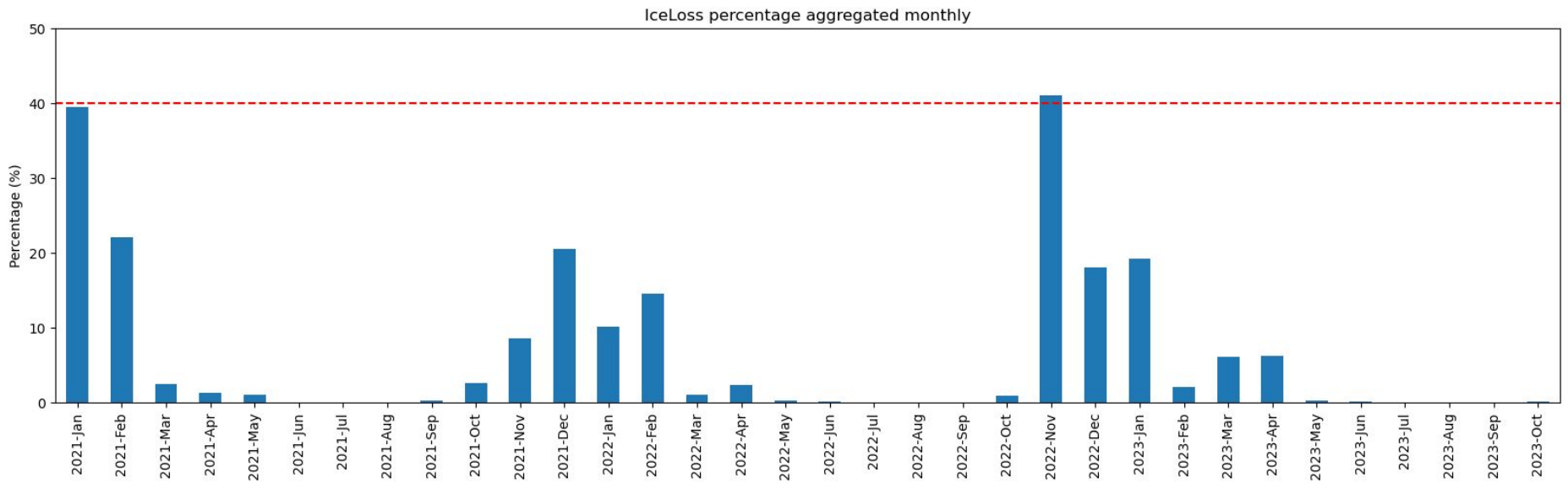
weather features

Case study

Analysis run on a larger than **100 MW wind park in SE2**

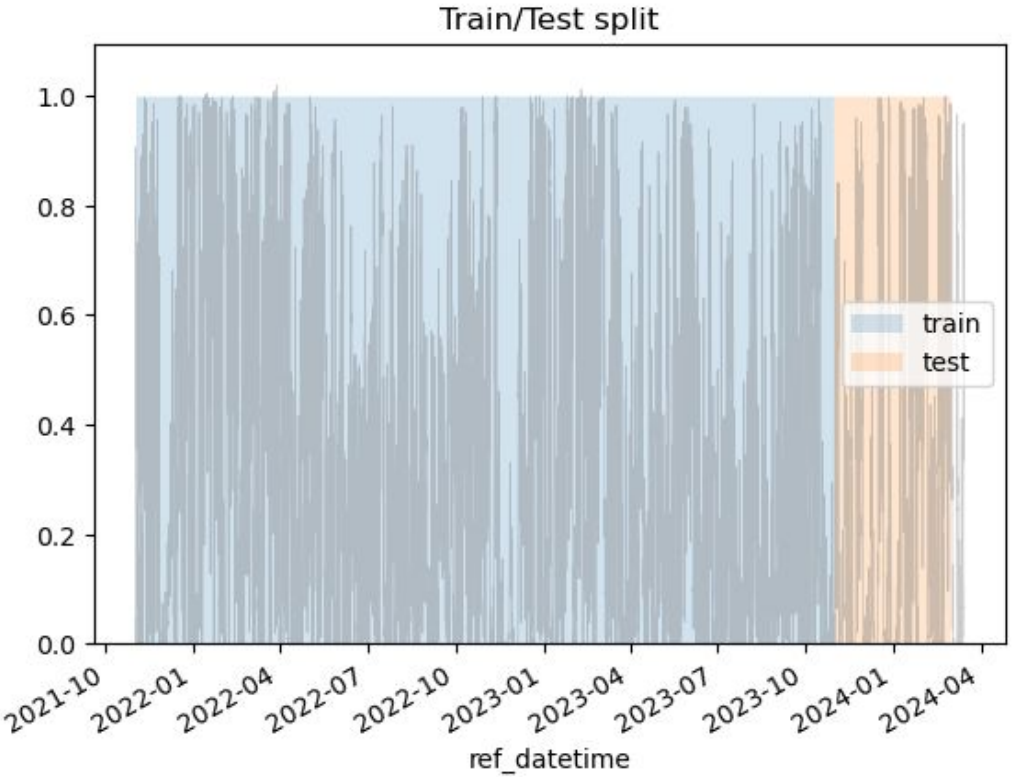
- Location - SE2
- Production data
  2021-11-01 → 2024-02-29
- Hourly Resolution
- Test dataset
  2023-11-01 → 2024-02-29

Loss production due to icing



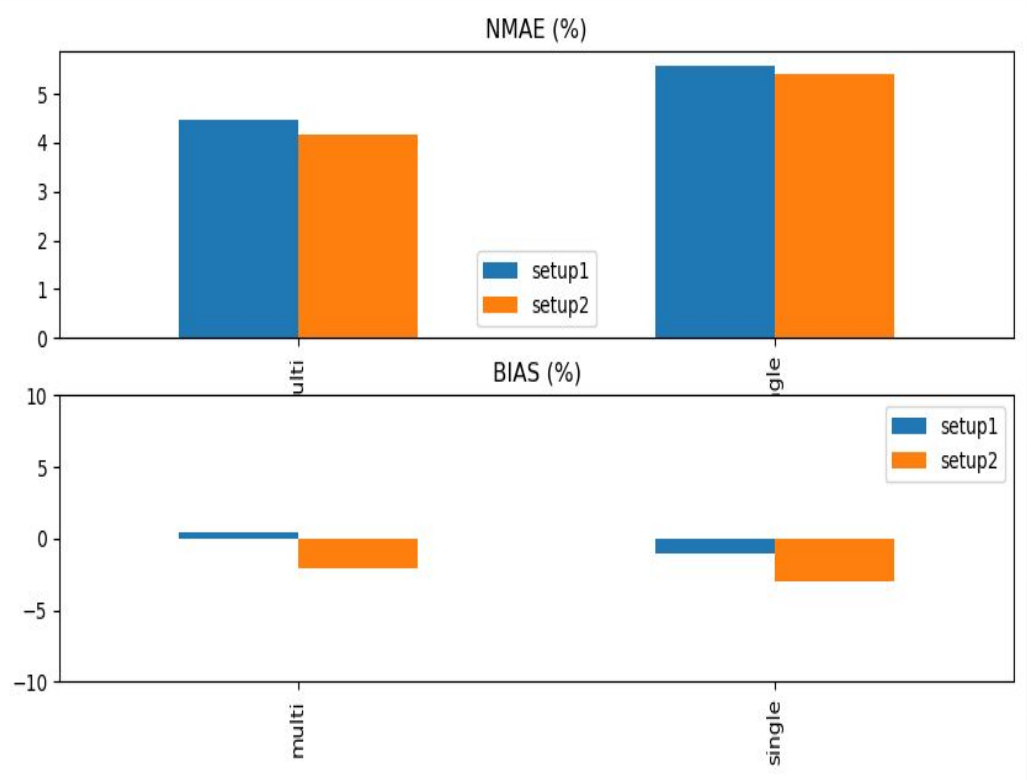
Up to 40% during winter months

Training/test data



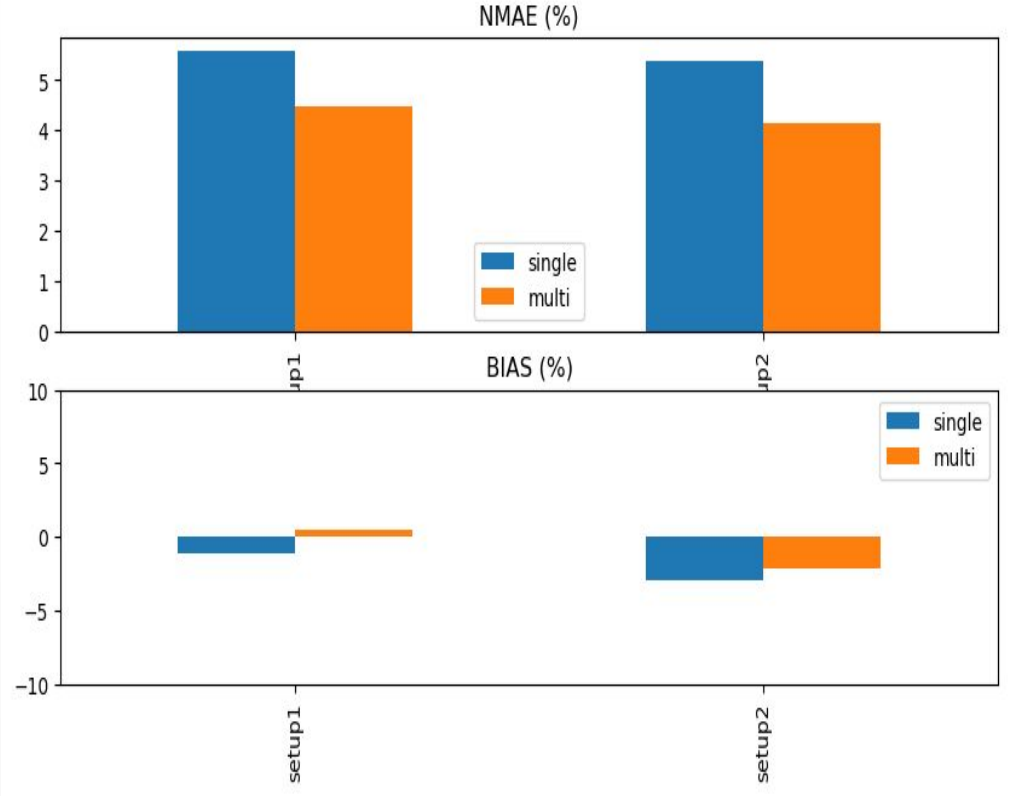
Results - Setup1 vs Setup2

- Ice-blind-Ice-aware model perform better than T19-based model
- *Setup2* models show a 5% forecast skill when considering *Setup1* as baseline
- Setup2 models show a sligher larger bias

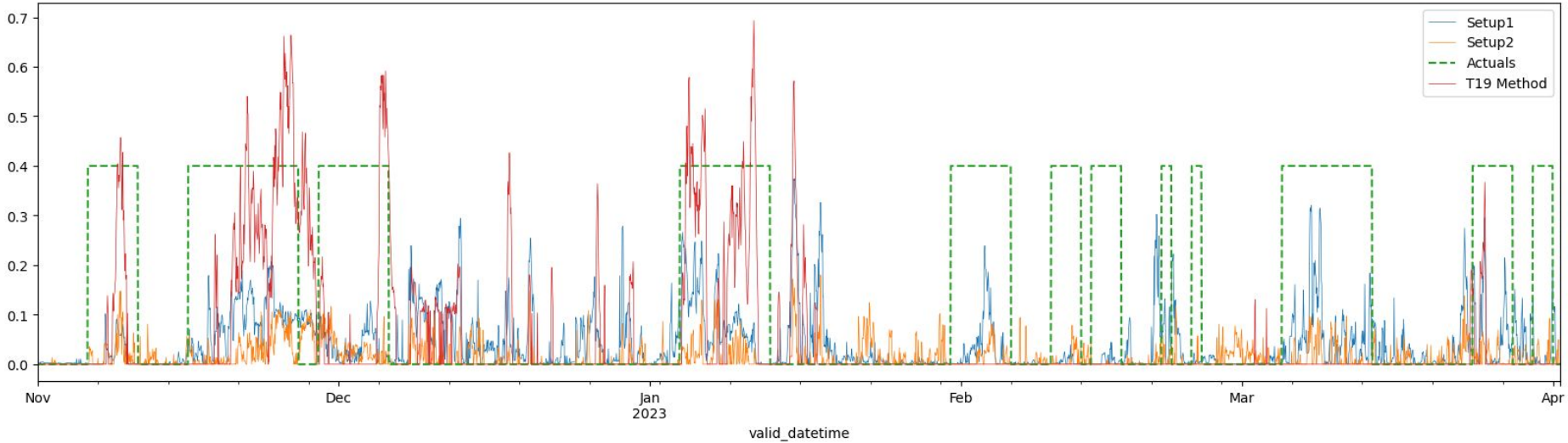


Results - Single vs Multiple NWPs

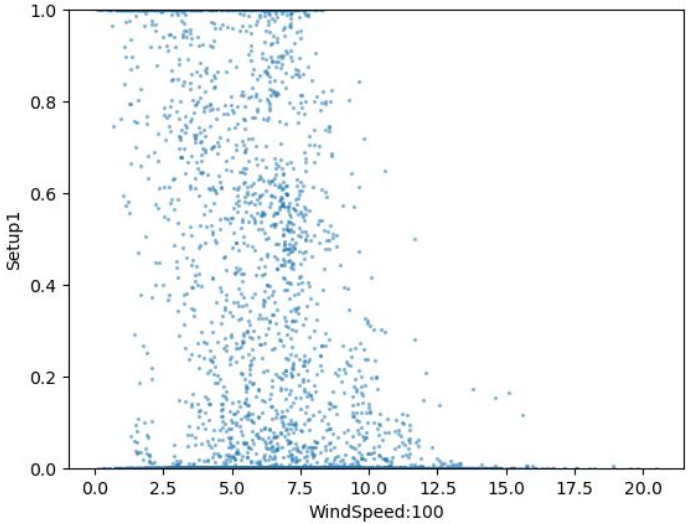
- Multiple NWPs lead to better accuracy
- Ensembling forecasts show a 21% forecast skill
- Slightly higher bias on ensemble models

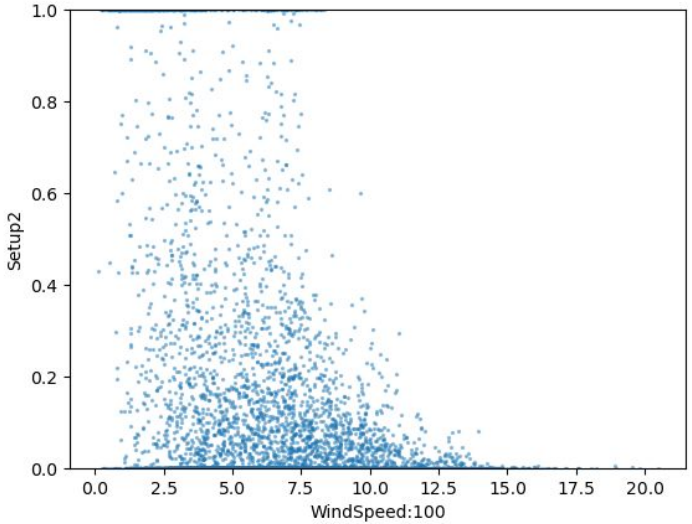


Confirmed icing events



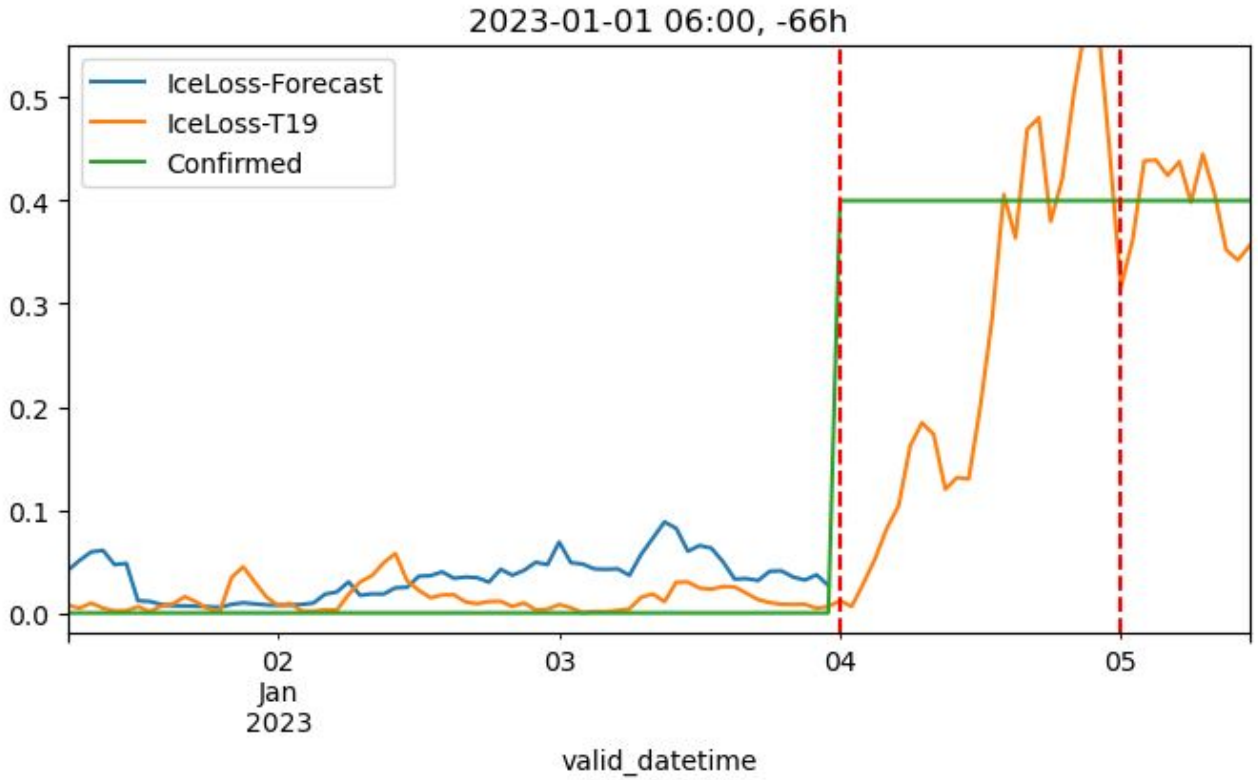
Ice loss decreases at high wind speeds





- Both model catch the lack of icing at during wind speeds
- *Setup2* has clearly a bias towards lower ice loss percentage

Early detection of icing events



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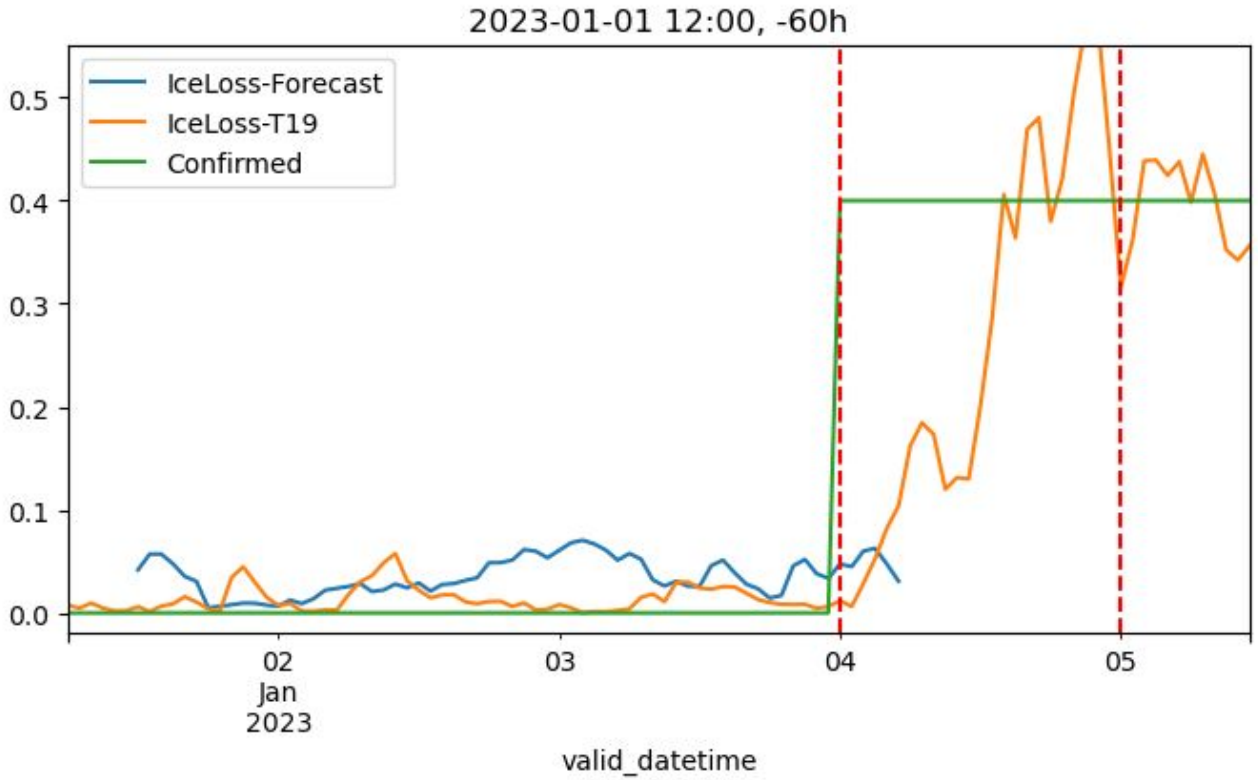

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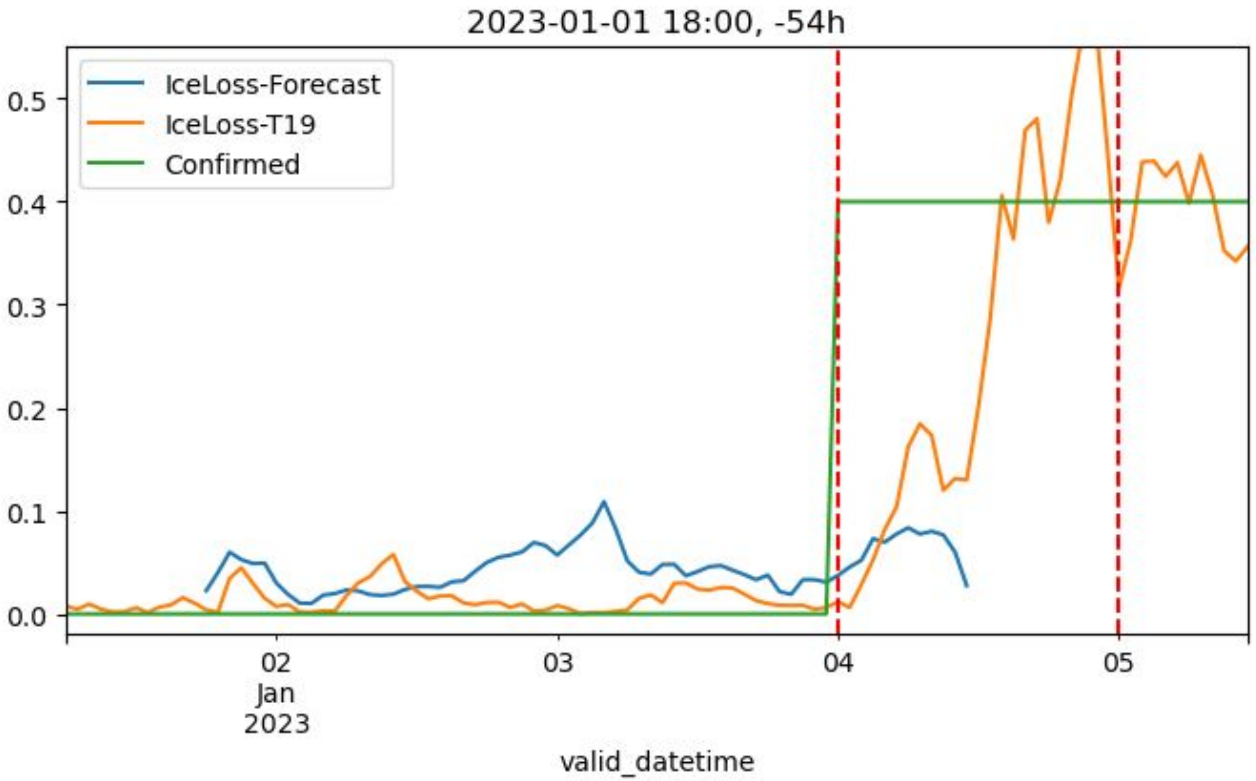

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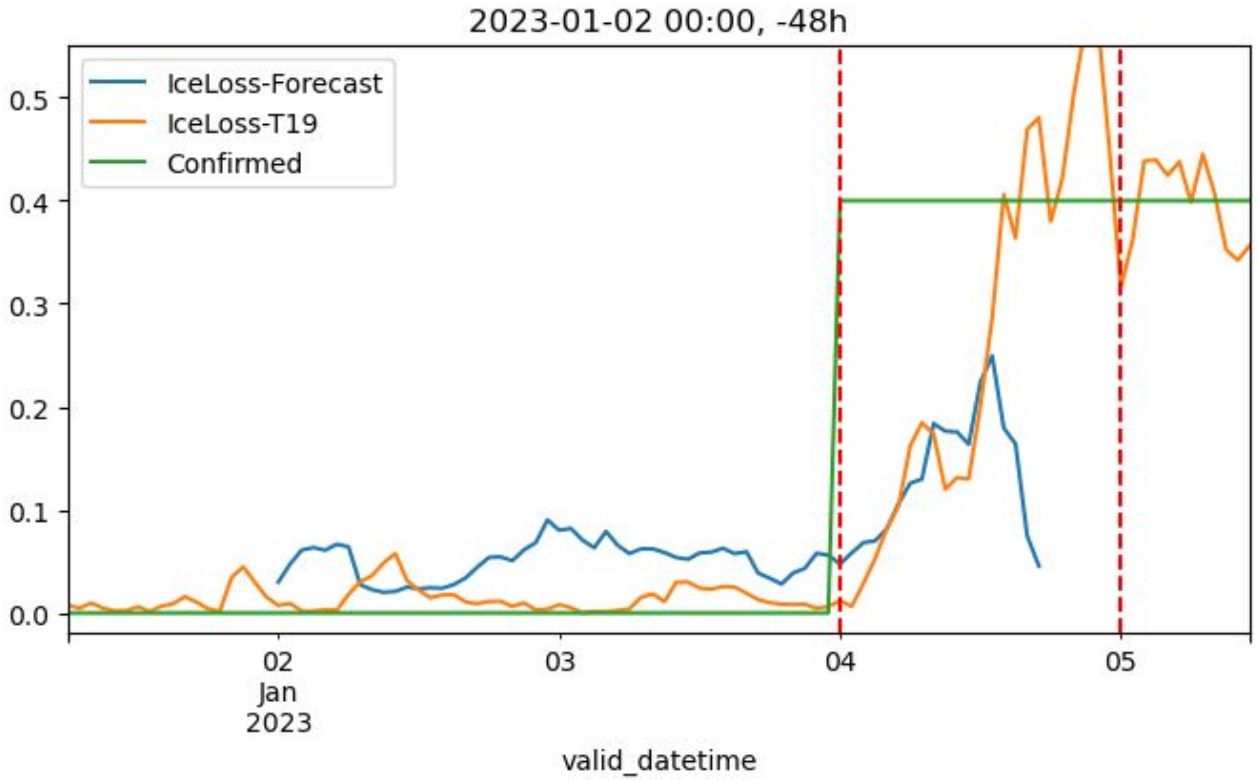

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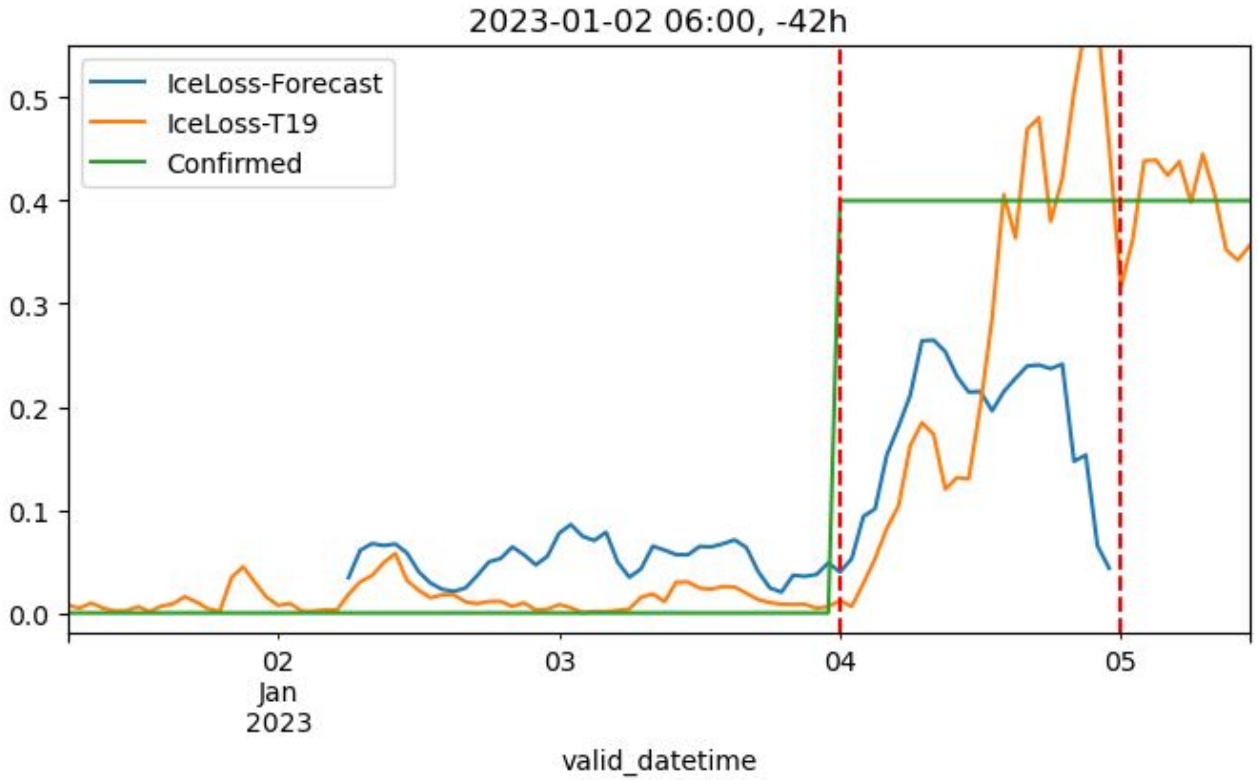

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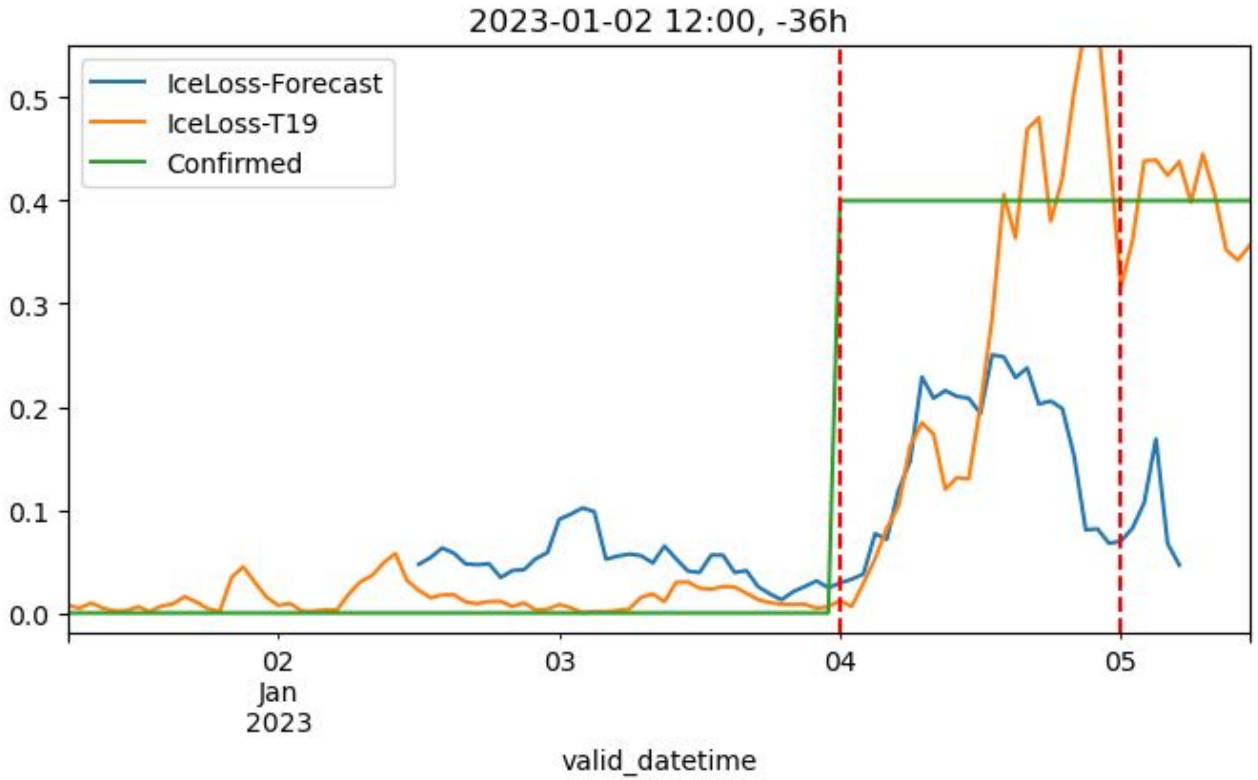

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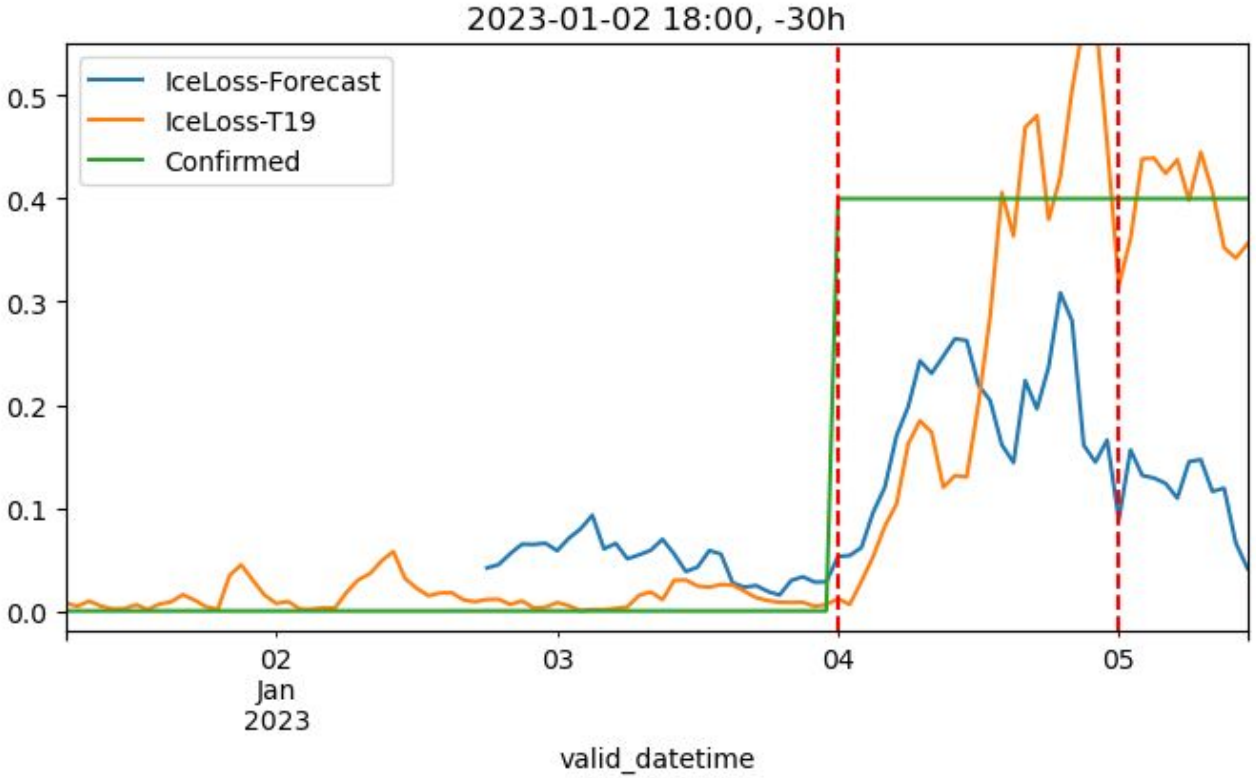

Summary

Clear value proposition by using Rebase Platform

1. The T19Method output can be used by statistical models to produce ice loss forecasts
2. Combining multiple NWPs significantly improves the forecast accuracy
3. Icing events can be forecasted on a longer time horizon
4. “Icing forecasts helps to handle the risks and make better production forecasts”, both DA/ID and especially for Ancillary Services
5. “Site and met knowledge incl numerous of real time data and close cooperation and site reporting from the producers are input to the statistical and physical forecasting approach”.

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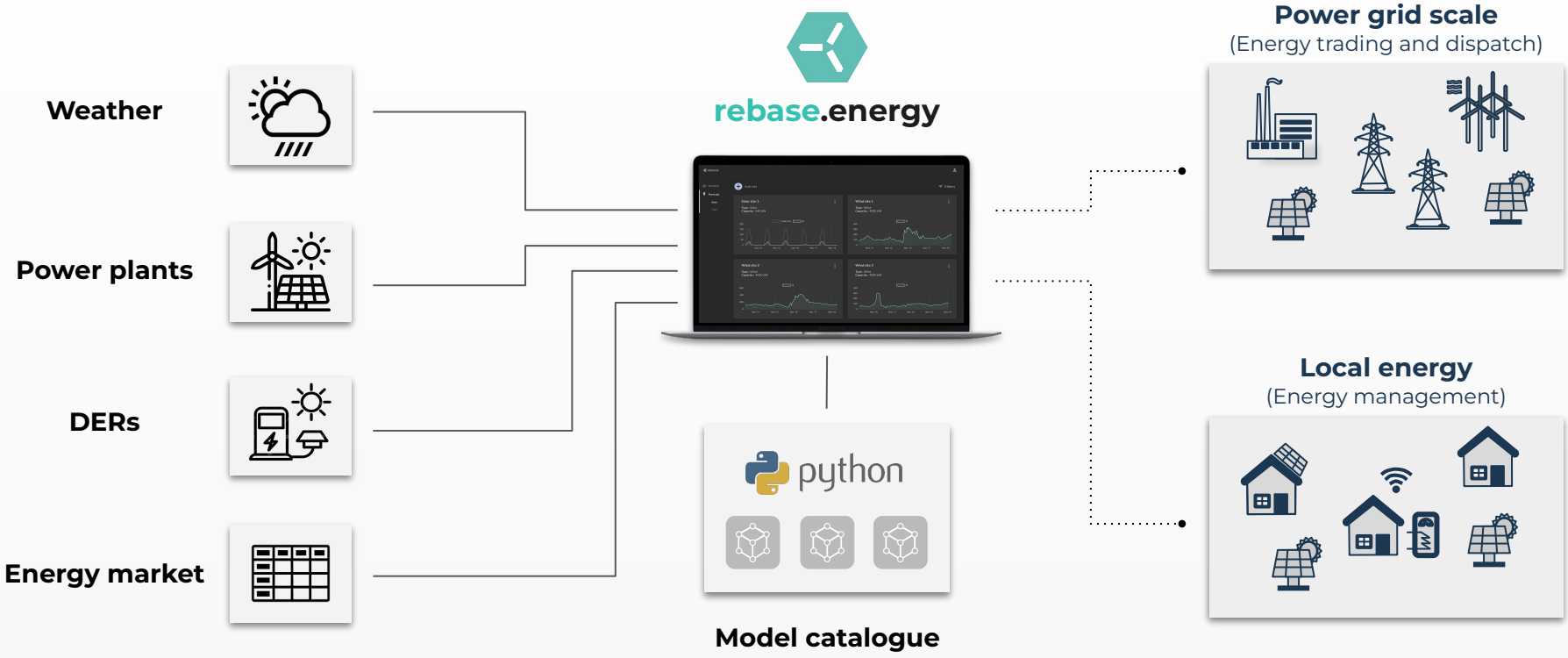
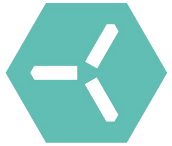
Our Platform

Platform for **accurate and flexible** energy forecasting





Thank you!

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