COST-727 ACTION: Measurements and Simulations

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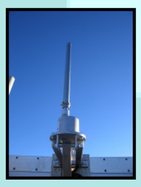
INTRODUCTION

Icing on structures is an important issue when planning infrastructures such as overhead power lines, wind turbines, cable cars or meteorological stations. At the same time, there is not much information about icing risks, neither from measurements nor from modelling. Therefore, the COST-727 Action ”measuring and forecasting atmospheric icing on structures” was defined with the aim to deepen the understanding of icing (especially in-cloud icing), wet snow and freezing rain events in the atmospheric boundary layer and their distribution over Europe as well as to improve the potential to observe, monitor and forecast them.

Main objective of phase 2 of the COST-727 Action is to perform joint icing measurement campaigns at different locations in Europe, to test and verify existing ice detectors and ice detecting methods and to collect a dataset of icing events and ice loads. This data of selected icing events is used for verification of icing simulations with an ice accretion model driven by the weather model WRF.

ICE DETECTORS

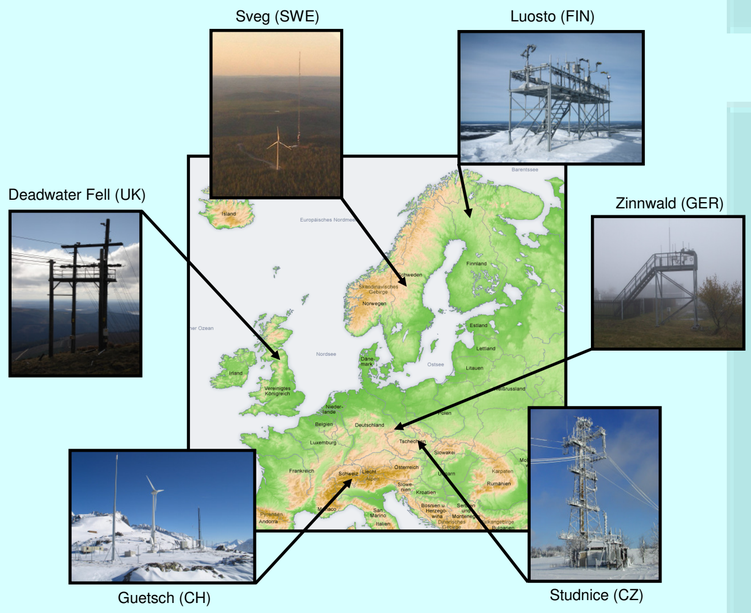
The **Combitech Mk I IceMonitor** is manufactured according to ISO 12494. It uses a freely rotating vertical cylinder and measures the weight of ice accreted on the probe.



The **Goodrich ice detector 0872J1** has a probe that oscillates at 40 kHz and monitors the frequency change due to ice accretion. A heater melts the ice at regular intervals depending on the accretion rate.

ICING MEASUREMENTS

Since icing differs for various geographical regions regarding the dominance of in-cloud icing, wet snow or freezing rain, icing measurements with the Combitech IceMonitor were performed under different climatological conditions at 6 test stations in Europe.



At all the stations, unique data sets of icing measurements performed with operational icing sensors were collected during winter 2007/08: Luosto: 5 icing periods, Sveg: 1 icing period, Zinnwald: 4 icing periods, Deadwater Fell: 3 icing periods, Studnice: 6 icing periods, Guetsch: 2 icing periods (Schwyberg: 2 icing periods).

ICING SIMULATIONS

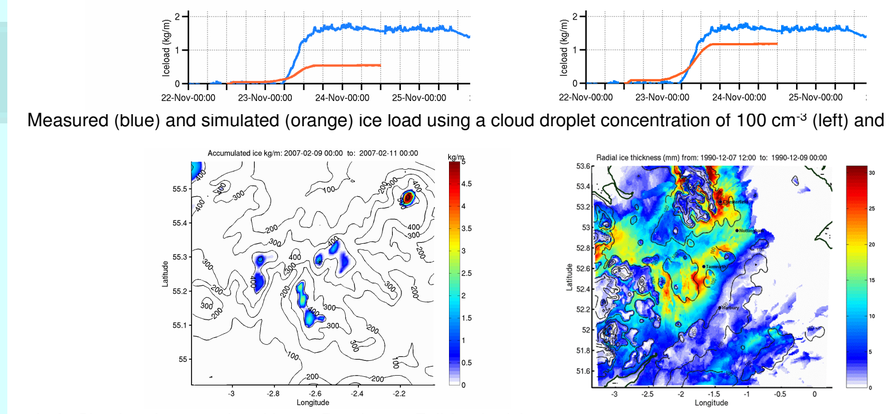
Icing simulations are performed by using an ice accretion model and high-resolution output of the **weather forecast model WRF**. Air temperature, wind speed, Liquid Water Content (LWC) and Median Volume Diameter (MVD) for droplets are needed to integrate the ice accretion. The result of icing simulations is three-dimensional spatial and temporal information on ice accretion.

RESULTS OF ICING SIMULATIONS

The first results from in-cloud icing simulations for Guetsch and Deadwater Fell show very promising results. The icing events at Guetsch and Deadwater Fell are all captured by the model and especially the timing is predicted very well.

The maximum ice load for the Guetsch case is underestimated by the model by about 40%. A possible explanation is that the spatial resolution is not high enough to resolve all details of the surrounding terrain. Additionally, sensitivity studies showed that inaccurate LWC might be one of the reasons for the underestimation and the simulated ice load strongly depends on the droplet concentration. Thus, measurements of LWC and size distribution would be of great help for evaluation and development of the icing model.

A first study of a wet snow event in the area of Nottingham, UK also showed very good results. The timing was predicted very well, but the amount of ice accreted was slightly underestimated.



Measured (blue) and simulated (orange) ice load using a cloud droplet concentration of 100 cm^{-3} (left) and 35 cm^{-3} (right).

Left: Simulated accumulated ice at Deadwater Fell for the icing event from 9th to 11th of February 2007 [kg/m].
Right: Wet snow accretion on small conductors in the December storm in the Nottingham area.

CONCLUSIONS

- The measurements performed with the Combitech IceMonitor have shown spurious oscillations at all stations. Additionally, measurements at Luosto showed that the present design concept of a freely rotating cylinder was not really suitable for conditions of high levels of accretion since ice tends to creep up on the body of the instrument and finally restrict or even stop the rod’s free movement. Therefore, in connection with the manufacturer, a new prototype was designed (Mk II) with forced rotation and hanging cylinder. Prototypes of this new sensor should be available for the winter 2008/09.
- In spite of the technical difficulties experienced with the ice detectors, a unique data set of icing measurements with operational icing sensors at six test stations located in Europe could be collected during winter 2007/08.
- The first results from in-cloud icing simulations using an ice accretion model driven by WRF results show very promising results for in-cloud icing as well as for wet snow accretion despite small deficiencies in the quantitative prediction of ice amount.
- Sensitivity studies showed that LWC and droplet concentration have a strong effect on the simulated ice loads. Thus, measurements of LWC and size distribution would be of great help for evaluation and further development of the icing model.