SWiFT: A GLOBAL ALERT SYSTEM FOR WINDSTORM DETECTION, FORECASTING AND MONITORING

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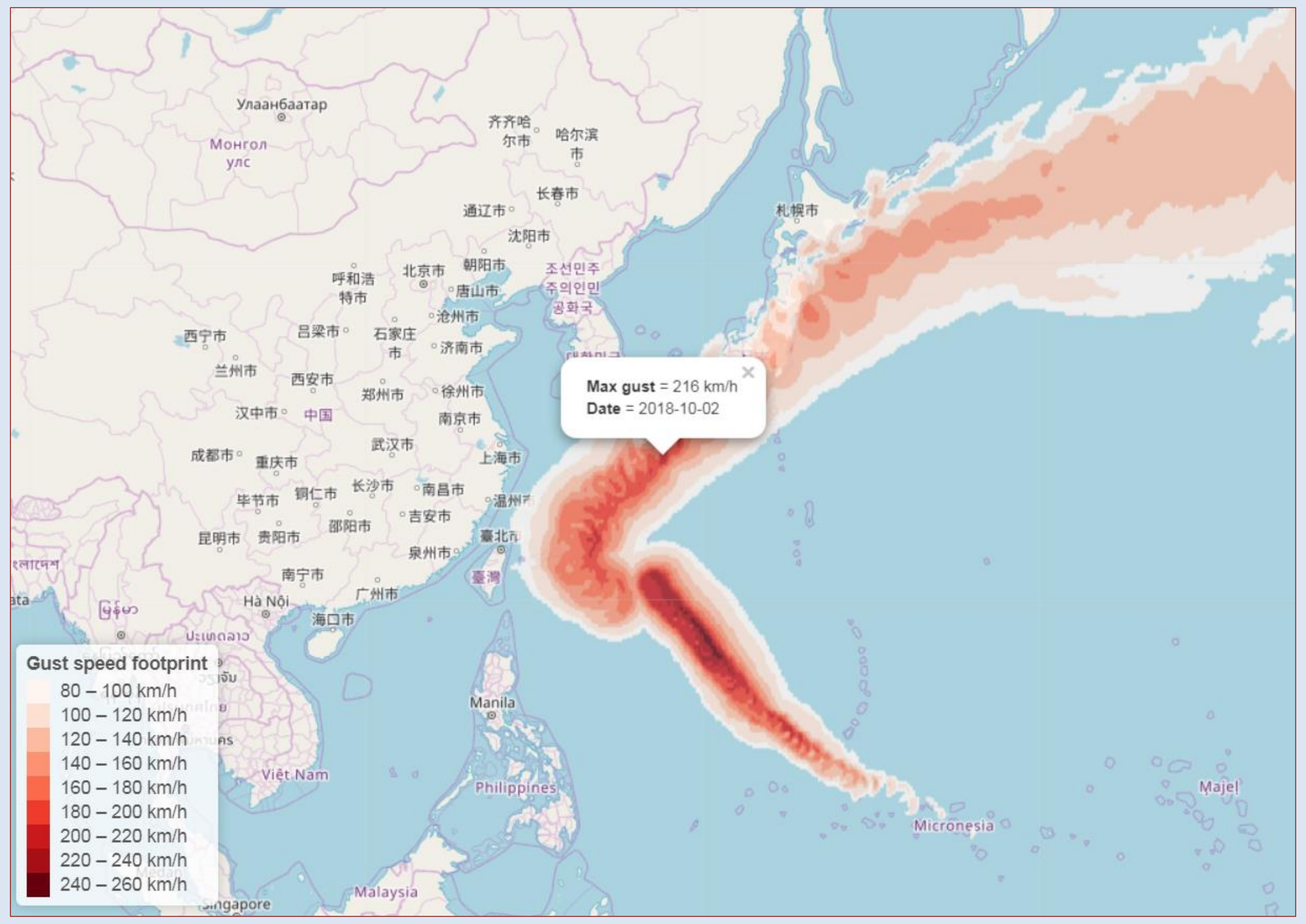
Over the last thirty years, ten European winter windstorms cost more than 2 billion USD each and caused many fatalities. An advance estimate of the potential losses associated with an upcoming storm would be of particular interest for public services as well as private companies such as insurers. Indeed, in the aftermath of such disasters, the compensation process, key process of the reconstruction, is often slowed by the unexpected amount of claims. At AXA we have developed an early warning tool called SWiFT (Severe Windstorms Forecasting Tool), designed to (i) alert on upcoming intense European winter windstorms and (ii) provide estimates of the potential total loss and number of claims for the French exposure portfolio. At AXA, its primary objective is to enable claims management departments to launch anticipated action plans adapted to the size of the upcoming event. SWiFT is organized in two modules: the first one detects and extracts the surface wind speeds associated with an intense upcoming event from meteorological forecasts provided by the NCEP Global Forecasting System; the second one converts the wind speeds into a loss and a number of claims for the French exposure. Entirely developed from the case study of two historical events (Klaus 2009 and Xynthia 2010), SWiFT has been running automatically since the 2013 / 2014 winter season, detecting most of the major events. While SWiFT was first developed for European windstorm, it is now a global tool that is able to detect also tropical cyclones and assess losses on portfolios in exposed regions.

SWiFT-SSI: Severe Windstorm Forecasting Tool based on the Storm Severity Index

We developed a pipeline where model data from the NCEP Global Forecasting System (GFS) at 0.25 degrees [1] is retrieved and processed at regular time intervals. The GFS continuously produces 6-hourly forecasts with an horizon of seven days. Model data such as mean sea level pressure (MSLP) and gust are processed by a detection algorithm based on the Storm Severity Index proposed by [3]. The nature of the SSI, integrating spatial extent and duration of a storm event, makes it a suitable index for damage assessment in a risk monitoring perspective. The alert system relies on a sequence of two algorithms.



Right panel: *Medicane Xenofon (or Zorbas) forecasted by the system over Greece (GFS 12 am run of September 27, 2018).*
Left panel: *Detection on the GFS 12 am run of September 27, 2018, of typhoons Trami and Kong Rei (October 2018). SWiFT correctly separates the events and reports the date and intensity of maximum gust. The tool enables to extract the event information from the model output 6 days ahead.*

First, the SSI is calculated regionally for a given run of GFS as a timeseries. The anomalies are detected and filtered so that the dates of the event within the forecast is extracted. Then, the corresponding wind footprints are extracted, clustered and spatially filtered to eliminate noise unrelated to the event. An event is reported when detected in successive runs. The combined use of a spatial and temporal filter provides a good resolving power in separating distinct events and their respective footprints. Also, the detection algorithm based on SSI enables a good forecast of smaller events such as the so-called Mediterranean tropical-like cyclones and winter storms in Europe, several days ahead.

References

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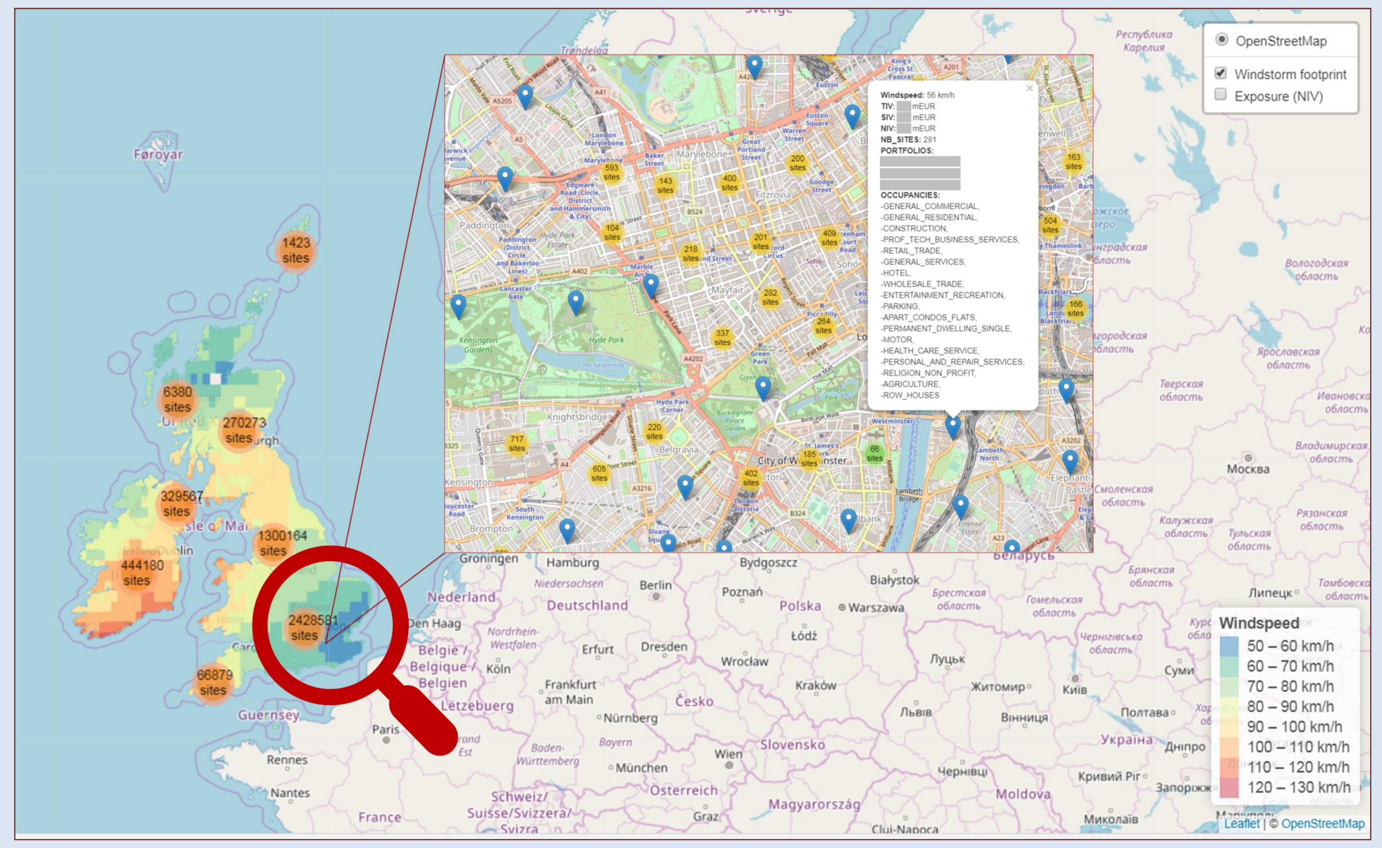
[5] Michael A. Walz, Tim Kruschke, Henning W. Rust, Uwe Ulbrich, and Gregor C. Leckebusch.Quantifying the extremity of windstorms for regions featuring infrequent events.AtmosphericScience Letters, 18(7):315–322.

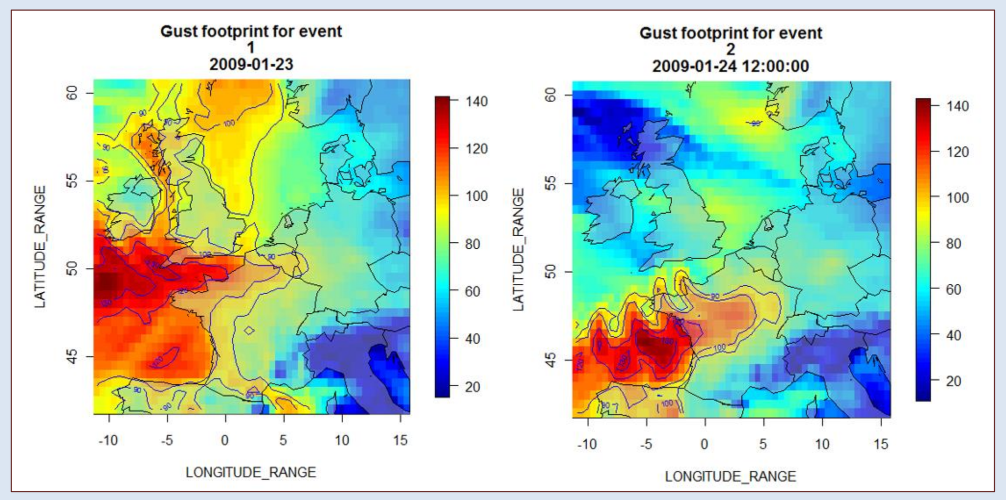
Loss forecasting

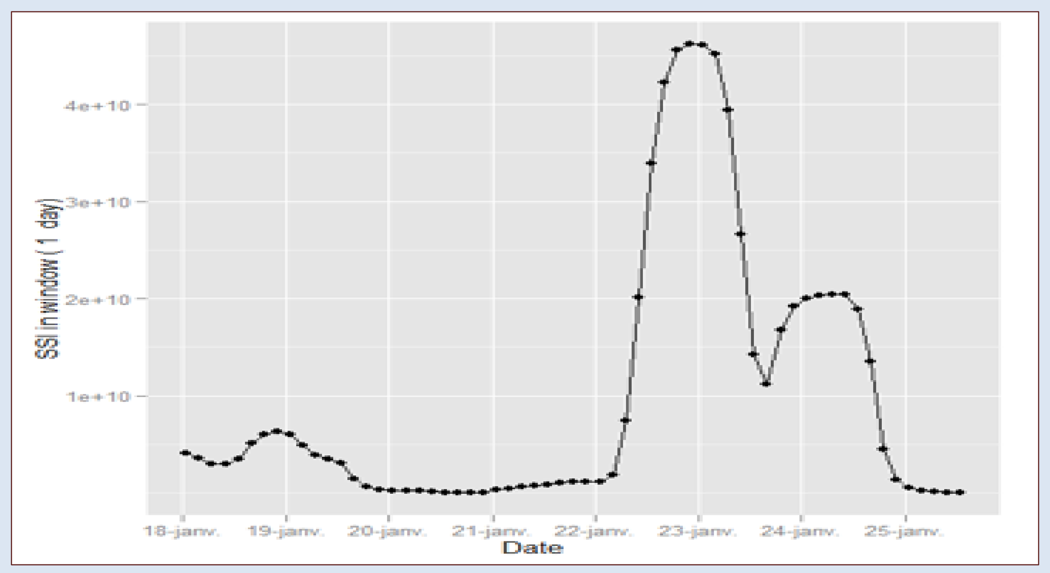
SWiFT enables anticipation of losses in an impact forecasting perspective. In-house knowledge of the insured site vulnerability to wind gusts gives insight on the potential losses. The financial conditions of the insured policies are applied to obtained the net losses. The impact can be anticipated up to six days before the actual event, and the forecast on losses can thus be updated every 6 hours, at each new available GFS run.



Right: *The alert system enables impact forecasting and loss estimation (Storm Ophelia, October 2017). Automatic reports on forecasted losses, exposure at risk and hazard are generated.*

Detection and segmentation algorithm



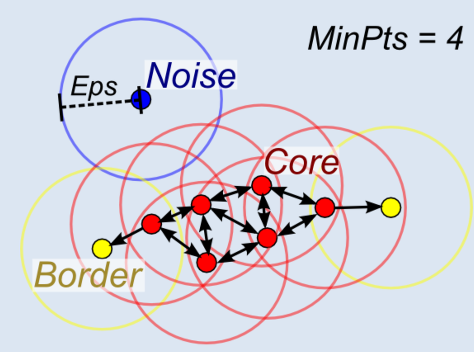


The timeseries analysis on SSI allows for a good time separation on events. The Storm Severity Index (SSI) is defined in the region indexed by cells $1..K$ over the time window of length T by [3] as:

$$SSI_{T,K} = \sum_{t=1}^{T}\sum_{k=1}^{K} A_k \max\left(0, \frac{v_{k,t}-v_{threshold,k}}{v_{threshold,k}}\right)^3,$$

where A_k is the area of cell k and $v_{threshold,k}$ is a threshold gust that can be locally adapted (often the 98th percentile).
The choice of the time-window is crucial in resolving the peaks that indicate an upcoming event with strong gusts with distinct phases such as storm Klaus in January 2009. A clustering algorithm is then applied so that the footprints can be isolated and represented on a map as distinct events with specific characteristics. We implemented the DBScan algorithm [2].

Left: *Separation of gust footprints (Klaus, 2009).*
Right: *Principles of the Density-based DBScan algorithm.*



Conclusions

The Severe Windstorm Forecasting Tool (SWiFT) developed at AXA is an operational alert system using the NCEP GFS data [1] to detect upcoming wind events globally and assess impact on the AXA portfolio. The use of the Storm Severity Index as the feature on which detection is performed allows for a satisfying separation of events, with a good anticipation time, and to relatively sort the importance of events. The use of a distribution independent SSI [5] could be an improvement as it attempts at quantifying the extremeness of an event and better allow for ranking storm severity independently on the geographical region. The complementary use of satellite data, especially for tropical cyclone monitoring, with a computer vision algorithm could also be envisaged [4].