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Highlight results

- **Alarms, alerts, early warnings and alarm bells/signals of high-impact events**
- **Optimal setting of Extreme Forecast Index thresholds for maximising hits**

Background:

The Extreme Forecast Index (EFI) was developed at ECMWF as a tool to provide forecasters with an indication of potential extreme weather events based on information from the ensemble predictions [1]. Verification results [2] show that the EFI has substantial skill in forecasting extreme events several days in advance, confirming the subjective experience of forecasters in the Member States where the EFI is widely used. The typical forecast horizon of EFI has been the early medium-range (3 to 5 days). During this time interval, EFI predictions of an extreme weather event can be considered as an 'early indication'. Beyond day 5, EFI values may serve as 'alarm bells' resulting from the ability of the ensemble to capture the risk of very intense weather systems (possible windstorms) at medium- and late medium-range.

Rare Severe Events (High-Impact Weather):

National Meteorological Services provide warnings about severe or high-impact events that can result in considerable damage and large losses. Fortunately severe events tend to be rare

events, hence the use of the term 'Rare Severe Event' (RSE) [3]. Such events are also loosely referred to as 'Extreme Events' in atmospheric science. RSEs can come in many forms, associated for example with very intense winds (as the one contained in Figure 1), heavy rain, extreme heat and cold, floods and droughts. Forecasting RSEs poses specific problems because they are infrequent, poorly documented by observations, and at the limit of predictability.

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Figure 1: A fire at a wind farm in Scotland, 9 December 2011. (© Daily Mail Online)

Extreme events and the EFI:

The ability of models to generate extreme/severe storms with realistic frequency has improved significantly in recent years. The EFI [4] has been developed to identify the risk of extreme events depending on location and season. The EFI measures the difference between the probability distribution of the ensemble forecast and that of the model climate. The underlying assumption is that if a forecast is extreme relative to the model climate, the real weather is also likely to be extreme compared to the real climate. The EFI is defined such that it lies between -1 and +1.

Detecting extremes based on the EFI:

Early Detection of extreme winds with ECMWF EFI

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Clear signs that EFI values are closely linked to daily maximum wind speeds are contained in Figure 2. The 24-hour forecast is used in this example, but similar results apply for the other forecast horizons. These results reveal beyond any doubt that all daily extremes (falling in the >99% percentile category) for Hannover correspond to strong positive EFI values.

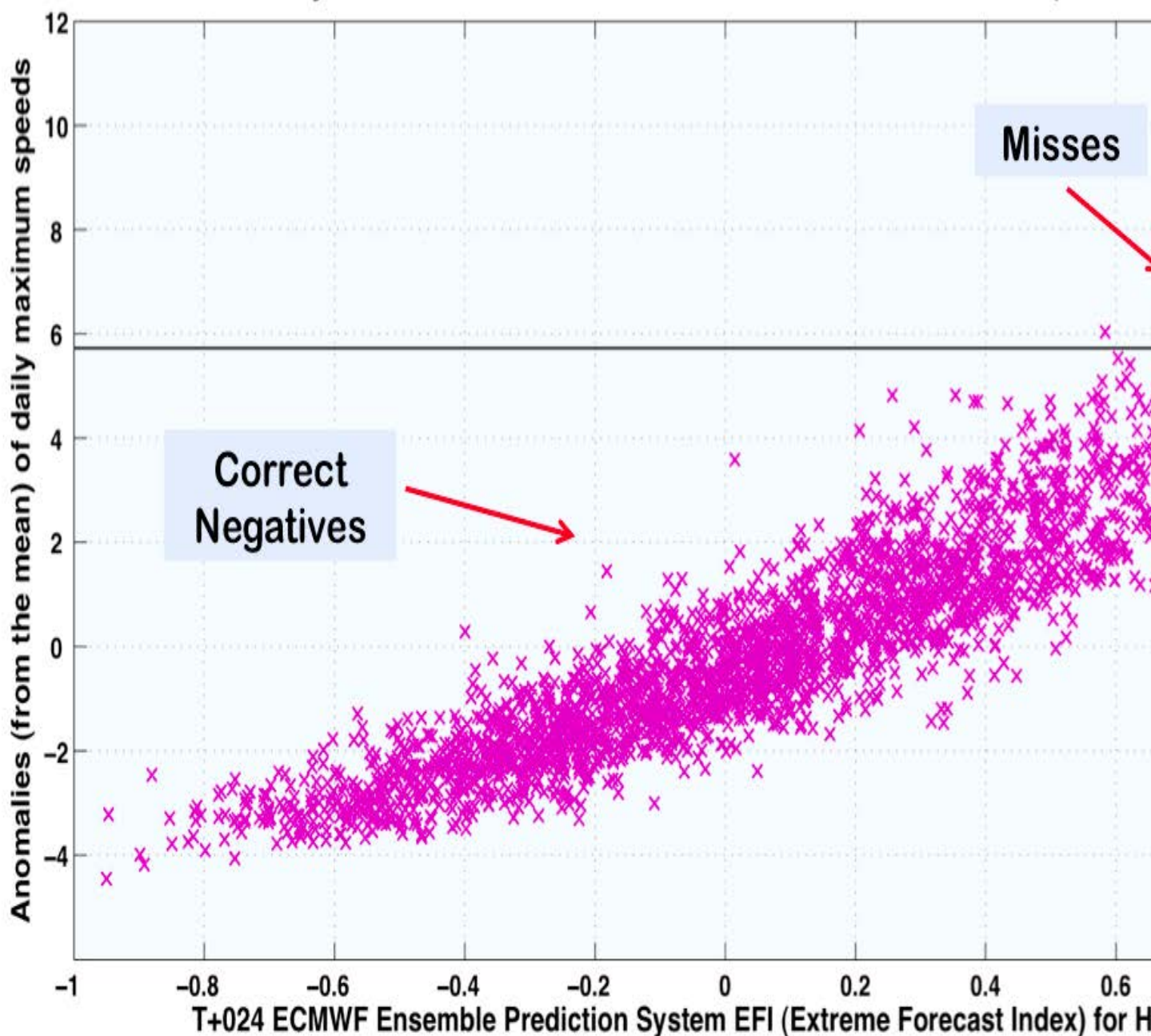


Figure 3: Anomalies of daily maximum speeds against T+24 EFI for the 96% percentile (line).

Setting an optimal EFI threshold:

By selecting a period of uniform model resolution (1 February 2006 to 26 January 2010), Figure 3 is constructed. It becomes obvious that the number of hits for the 24-hour forecast is equal to 6, but there are also 8 misses and 8 false alarms. The 'zero misses' EFI threshold (i.e. the one corresponding to the 96% percentile), is able to capture all 14 hits (i.e. zero misses), although by doing so the number of false alarms is increased significantly and reaches 44. Some users will be especially sensitive to missed events while others will be interested in limiting the number of false alarms. As this study has shown, each user is able to choose an appropriate EFI threshold for their own requirements, to provide an optimal trade-off between hits and false alarms [5].

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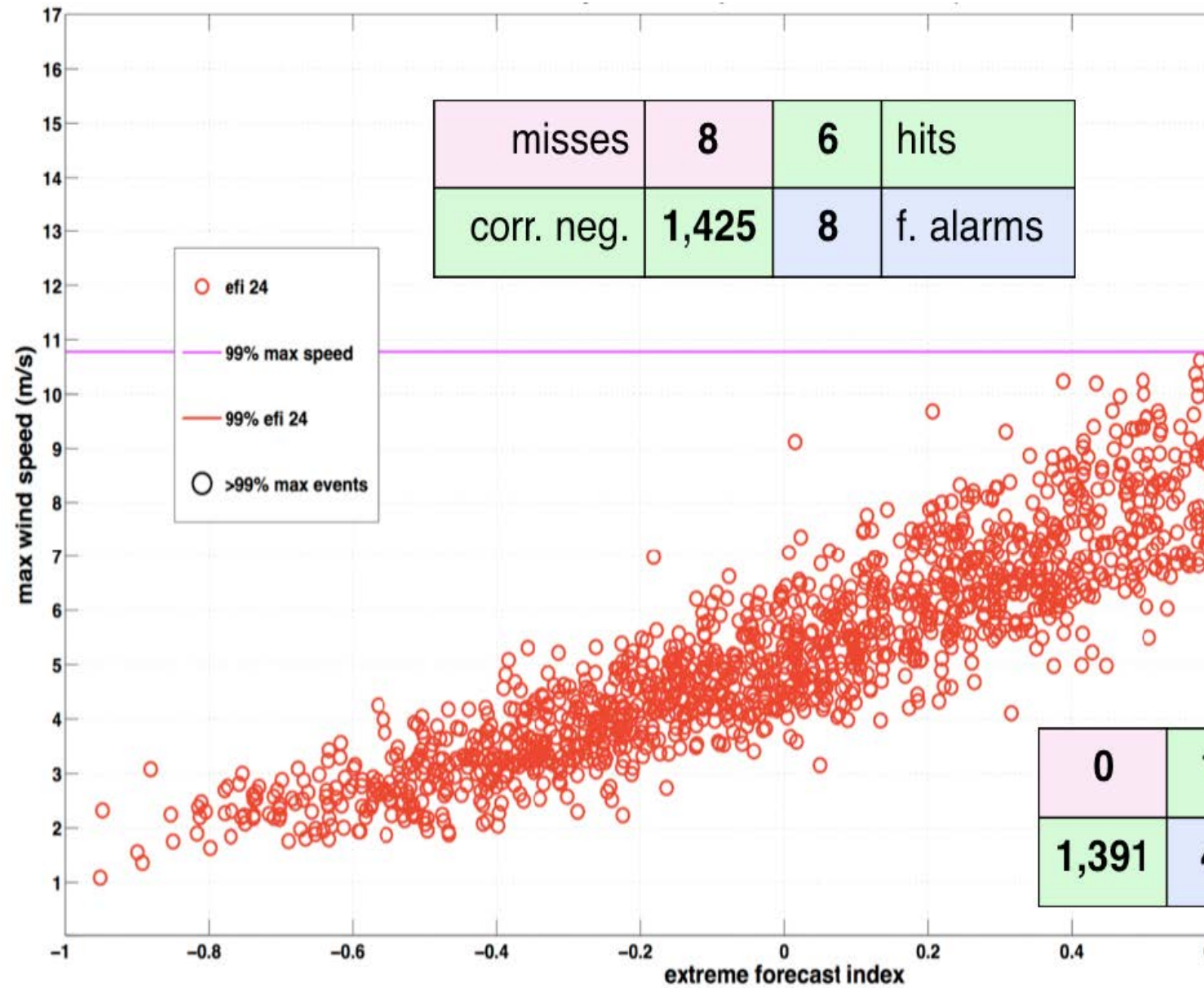


Figure 3: Daily maximum wind speeds against T+24 EFI values for Hannover (1 February 2006 to 26 January 2010). The 96% percentile (black vertical line) represents the “zero misses” EFI threshold.

Further work (user-tailored EFI thresholds):

Although the EFI is designed to be used qualitatively as a general “alarm bell” for potential extreme weather, it is also possible to use the EFI in a more quantitative way. The user can select a specific EFI threshold and take appropriate action whenever the EFI exceeds this (optimal) threshold [6].

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