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Interactive comment on "An approach to build an event set of European wind storms based on ECMWF EPS" *by* R. Osinski et al.

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Introduction ends abruptly. Particularly the last sentence is very vague and needs further explanation. What do you mean by "jumps and trends as well as biases" ?

The EPS is generated by perturbing the initial conditions as well as the model physics. We want to study if the perturbations lead to a systematic difference in the storm properties (intensity, the size and duration) compared to reanalysis data for example. Another issue could be a possible drift of the model making it necessary to correct the data before they can be used for statistical applications. At the same time, it is required to develop a homogenization of the EPS dataset, as it includes data from several versions of the IFS model with different resolutions, as well as different approaches

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to produce the ensemble (different resolutions for the singular vector calculations, without/with moist physics, without/with tropical singular vectors, without/with stochastic perturbations, etc).

The paper aims at demonstrating that it is possible to produce an enhanced statistics of storms under observed climate conditions based on EPS forecasts and leading to more reliable statistics. Our aim is a representation of the recent climate, which distinguishes our approach from others based for example on climate projections. Summarizing, our study intends to describe a possibility for producing more reliable storm statistics which are still very close to the observed climate. This part will be added to the introduction.

Data and Methods. The strongness of this work is, in my opinion, the new methodology here presented which shows how the EPS may be used to characterize extreme storms. Thus, the methodology should be better explained. It is not clear how the datasets are built. Do you apply the tracking algorithm developed by Leckebusch et al. (2008) to a gridded 10 m wind time series, for each ensemble, for the period 1992-2010 (Table 1)? For the reader which is not used to EPS data this should be further clarified. Please see comment concerning Figure 6.

The EPS consists of single forecasts lasting ten days on a grid with constant horizontal resolution. For each day up to 50 perturbed members and one control forecast (comparable to the deterministic one in lower resolution) initialized at 00UTC and 12UTC were produced and archived. This means that every single day is represented by up to 1000 perturbed EPS forecast days (50 member * twice a day * 10 forecast days). The tracking algorithm is applied on each of these single forecasts (up to 100 forecasts per day; 50 perturbed member * twice a day) produced and archived in operational service between 1992 and 2010. If there are no systematic biases in the EPS, or they can be removed, the observed storm sample is extended by nearly the factor of represented forecast days. As each forecast lasts only ten days, we used the six days window, described in section 4.3, to create representative samples. An additional explanation about how the data set is used will be added to the description of the tracking algorithm.

Section 3.1 – The variables in equation (1) should be defined. What is Ak? Furthermore, the section does not explain which properties are used to characterize storms as the section title suggests. Only SSI? Cf. Table 2. What is the definition of the "Size" of the storm?

The definitions of the variables will be added. Ak is the area of the k-th grid cell. As the area of a grid cell is decreasing with increasing latitudes, this is used to normalize the SSI values to a grid cell of a unit size. The detection of the storms is done by searching for areas of coherent exceedances of the 98th percentile. The size of a storm is represented by the area of exceedance. Storm duration is based on the number of clusters assigned to a track and the temporal resolution of the data.

Based on the SSI values assigned to individual storms in the EPS, an estimation of return periods of winter storms can be performed. We also compute the statistics for lifetime and wind field size, using them to investigate the sample for systematic errors.

Section 3.2 (and section 3.2.2) – The quantile-quantile mapping approach (pg 1237, ln 10-13) should be further explained. Eventually some figures could be presented as appendix or as supplementary material. As stated above, the methodology should be clearly explained as it is the main novelty of this study.

A quantile-quantile mapping is a standard method used for bias correction, see for example Maraun (2013) for details. In this study, percentiles of wind speed are empirically determined for the EPS and ERA-Interim. Then the EPS distribution is matched with its ERA-Interim counterpart. This means that the i-th quantile in the EPS and ERA-Interim are forced to have the same values after the mapping in both datasets, also resulting in identical wind speed distributions. SSI computations of two storms that have identical percentile exceedances would then lead to the same SSI value, even though absolute values assigned to a percentile originally differed. Thus, the SSI values computed from the EPS data are normed to the reference dataset ERA-

Interim. For the detection of the storms, however, the QQ-mapping is not used. Storm detection is based solely on the EPS data, while the severity is referenced on ERA-Interim as a reference dataset. For this reason the spatiotemporal properties of the events are not influenced by the QQ-mapping.

Section 4.2 – This section is dedicated to Emma storm. Figure 7 and its description (pg 1240, ln 10-16) deserve more attention. Probably it could be included on section 4.3.

The section about storm Emma visualizes the effects of the perturbations on a single event, and is used to demonstrate the effect of the perturbations on the storm properties. The variability in the different storm representations is essential for our purposes. Without this variability, the large size of the ensemble would not give a benefit. Several points can be explained using the example Emma, why we dedicated Emma a separate section. The perturbations lead to modifications in the intensity, in the spatiotemporal extent as well as in the track of the storms. This can not be seen from fig. 7. Furthermore, the example is meant to illustrate that for longer lead times, the differences between the ensemble member are getting larger, meaning that dependencies between the member are getting smaller. Moreover, the example shows that the track of storm Emma is best represented by an extreme EPS representation. It motivates well the basic idea behind the chosen approach that each member includes a feasible realization, and can therefore be used for statistical purposes.

Figure 7 raised to me the major concerns on this work/methodology, in view of riskassessment: "help to better estimate potential storms risk"(cf pg 1240, ln 14-16) as well as the evaluation of the "potential for an occurrence of storms more extreme than observed" (cf conclusions, pg 1247, ln 1). As the authors stated on discussing Fig. 2 even though differences in the tail of wind speed seem small, they are impacting the results on SSI (which is the cubic of excess over percentiles). Results of SSI on Fig. 7 exceed too much those on ERA-Interim – which should be "considered as the reality". There is an obvious improvement when making the statistics of a larger sub-

set but how realistic are forecasted storm properties? What is the effect of the term Ak on the SSI calculation on EPS members? The authors should further discuss this question in terms of risk potential. Would you find a similar level of agreement if you would perform the same analysis presented on Figures 14 to 15 only to the dataset of extreme storms?

The term Ak describes the grid cell area and is used to norm the SSI to eliminate a latitude dependence. Section 4.4 shows that the distributions of SSI values are in good agreement between ERA-Interim and the EPS, and storms of comparable severity show comparable sizes and durations. As demonstrated for the example of storm Emma, the perturbations lead to modifications in the spatiotemporal extent and in the intensity. For storm Emma exists an EPS representation with about 50% larger extent, as can be seen in the modified figure 1 (fig. 5 revised) below. This can already lead to higher SSI values. If the wind velocity over such large areas is only slightly larger than in the EPS, the SSI value will strongly increase, as a consequence of the utilization of the cubic of the threshold. The steepness of the cubic function leads to an enlargement of the range of values. The comparison to ERA-Interim approves that the EPS storm properties are realistic. The sample of historical events in observation near datasets is very small. Though it is not very likely that several cases of the most extreme events possible, appeared during the short period for which observations are available. As a consequence even the most severe events, appeared in reality, could have been more severe if they would have been developed slightly different. The EPS includes a large number of such different developments, from which some present more severe counterparts of severe historical events. They describe versions of past events for a slightly different initial situation. This allows to get (additional) events in the tail of the distribution of storm severity resulting in better estimates of the risk potential. In the figures 14 and 15 the longer lasting events already are extreme storm events, as the SSI increases with storm duration. If you consider only storms with a very large SSI (high intensity and/or large spatialtemporalspatiotemporal extent), you will remove a larger part of the events. This will affect the statistics, but stronger for ERA-Interim than for the EPS. A comparison of the results becomes more difficult if concerning only the most extreme events, because the sample size of ERA-Interim is in this case not large enough to get reliable results.

Section 5.3 – Figure is not referred.
→ reference added

Section 5.5 – definition of "wind field size"?
→ The detection of the storm systems is done using coherent areas of exceedances of the 98th percentile of 10 m wind speed. The size of the wind field is for this reason the size of the coherent areas detected and connected to a track.

Table 3 – how have errors been computed ?
→ A gaussian distribution was fitted using maximum-likelihood. The errors are the exact standard errors of the fit.

Figure 1 – which land boxes? A figure would be useful.
→ The domain used in this study is going from $40°$W to $40°$E and $25°$N to $80°$N. To identify the land and sea grid boxes, the original land-sea masks belonging to the EPS forecasts and ERA-Interim reanalysis were applied. All land and sea grid boxes inside the domain were used for the investigations. A figure was not shown, because of the limited space available, but the domain can be seen for example in fig. 12.

Figure 3 – Plots are too small. Caption: "right axis"?
→ Plots will be enlarged. Caption right axis: Time after initialization [h]

Figure 5 – As in Fig. 4, the ERA-Interim reference would help (perhaps with an extra filled column or a line as in Fig. 4)
→ added, see figure 1

Figure 6 – Caption refers 50 EPS members initialized for 28 February and 25 February.This raised the doubt on the used datasets. How do you build the storms datasets?And the SSI datasets? This should be further explained.

The tracking algorithm is applied on each single EPS forecast. On each day there are up to 50 perturbed members initialized at 00UTC and 12UTC. Example a in figure 6 show the events identified and presenting storm Emma in each of the 50 ensemble members initialized at 25 February 2008 00:00UTC, and example b at 28 February 2008 12:00UTC. For each detected event a SSI value is calculated. This means that all of the 50 storms coming from the 50 members of one initialisation date are getting there own SSI. An information how the dataset is built, will be added to the paragraph about the tracking algorithm.

Figure 7 – Which is the first winter represented on the Figure? 2000-2001? Please insert ticks indicating "2001-01" and other winters.

The grid lines are indicating the first of January of each year. Ticks are at the upper line and the graphic will be adapted to be clearer. The 10 m wind speed of the EPS data in 6-h resolution are only available after 13 January 2000. For this reason the figure starts at this date. Before this date, EPS wind speed is only available in 12h resolution. The SSI values differ systematically between the two temporal resolutions, because the SSI is an integral measure, which integrates over more sampling points with higher resolution.

Figure 12 – Normed? Normalized? How have these been performed?

The values are divided by the number of ensemble member, forecast days and initializations per day. As a six days window is used, one initialization per day and 50 perturbed member, the number is divided by 300.

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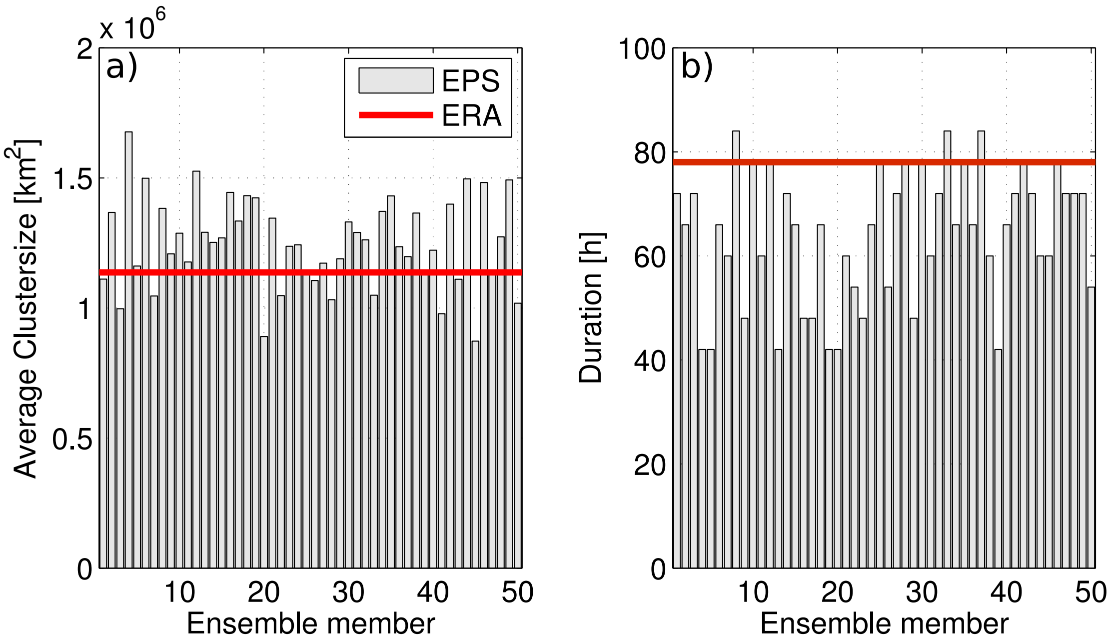

Fig. 1. (Fig. 5 rev.): (a) Average cluster size [km^2] for storm representation Emma (28 February 2008 18:00UTC detected in ERA-Interim) in 50 EPS member initialized 28 February 2008 12:00UTC (b) duration [h]

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