Reply to the Referee #1 for the manuscript (gmd-2017-174) submitted to GMD.

We would like to thank the referee for the comments on the manuscript. In this document we discuss the concerns of the referee and indicate how we could improve the presentation of this study if we are invited to submit a revised manuscript.

Responses to the Referee#1 : General Comment

The authors incorporate a well-established wind disturbance model (ForestGALES) into a dynamic global vegetation model, the ORCHIDEE-CAN. It is perhaps the first study of windthrows simulation by an Earth System Model (ESM). I emphasize the novelty of this study because it improves our understanding of an overlooked agent of tree mortality (wind) in forest ecosystems.

Thank you for your kind remark.

Responses to the Referee#1 : Specific concerns

(1) Winds are a major agent of tree mortality, a well-known fact that has been discussed extensively in the literature over a range of spatial scales and ecosystems. Yet, the introduction of this study is very limited and does not justify why windthrows need their own representation scheme in an ESM. Furthermore, there is not a formal definition of wind storms. Wind storms can vary from strong winds to tropical cyclones. The frequency and the spatial scales of these events justify this study. However the reader is left to wonder whether this type of study is important.

We agree that wind storms are not properly defined in the manuscript and we will add the definition of wind storms in the revised manuscript. We feel that the importance of simulating wind storm damage is rather extensively addressed in the discussion (Wind storm disturbances and their climate feedbacks). We will move this section forward and present it in the introduction)

(2) The use of a sigmoid function to represent the storm damage (Equation 9) was not justified.

Although different damage function with different dependencies could be conceived, for example, soil moisture dependent, topographic dependent and wind speed dependent, we considered that the wind speed variation is the most important factor in controlling the storm damage in a forest stand. A wind speed dependent approach was used and validated by Anyomi et al. (2017) for various tree species in the temperate climate. We will refer to this paper as justification for using this type of wind damage function to estimate the storm damage rate in our revised manuscript.

Reference: Anyomi, K. A., Mitchell, S. J., Perera, A. H., and Ruel, J. C.: Windthrow dynamics in Boreal Ontario: A simulation of the vulnerability of several stand types across a range of wind speeds, *Forests*, 8, 1–15, doi:10.3390/f8070233, 2017.

(3) The calculation of critical wind speed uses five tree species. How representative are these species of the whole simulation domain? Are these tree from the same Genus or Family?

Spruce, pine and birch make up almost the entire forest cover of Southern Sweden. Pine is the single most important species in Les Landes. These regions were only used to test the model. The simulation domain of this new development is Europe. The five species for which the model was tested make up 67% of the European forest cover. In terms of taxonomic families the representativeness increases to >90% (Novel Maps for Forest Tree Species in Europe, Renate Köble and Günther Seufert).

Reference: Köble R. and Seufert G.: Novel maps for forest tree species in Europe. Proceedings of the 8th European Symposium on the Physico-Chemical Behaviour of Air Pollutants: "A Changing Atmosphere!", Torino (It) 17-20 September 2001.

(4) The comparison of modeled damage versus the observational data would benefit from the inclusion of percentage.

We agree and will add the relative model simulation errors ((estimation-observation)/estimation) to the figures for the comparison of modeled damage versus the observational data. The new figures would then like the example shown below.

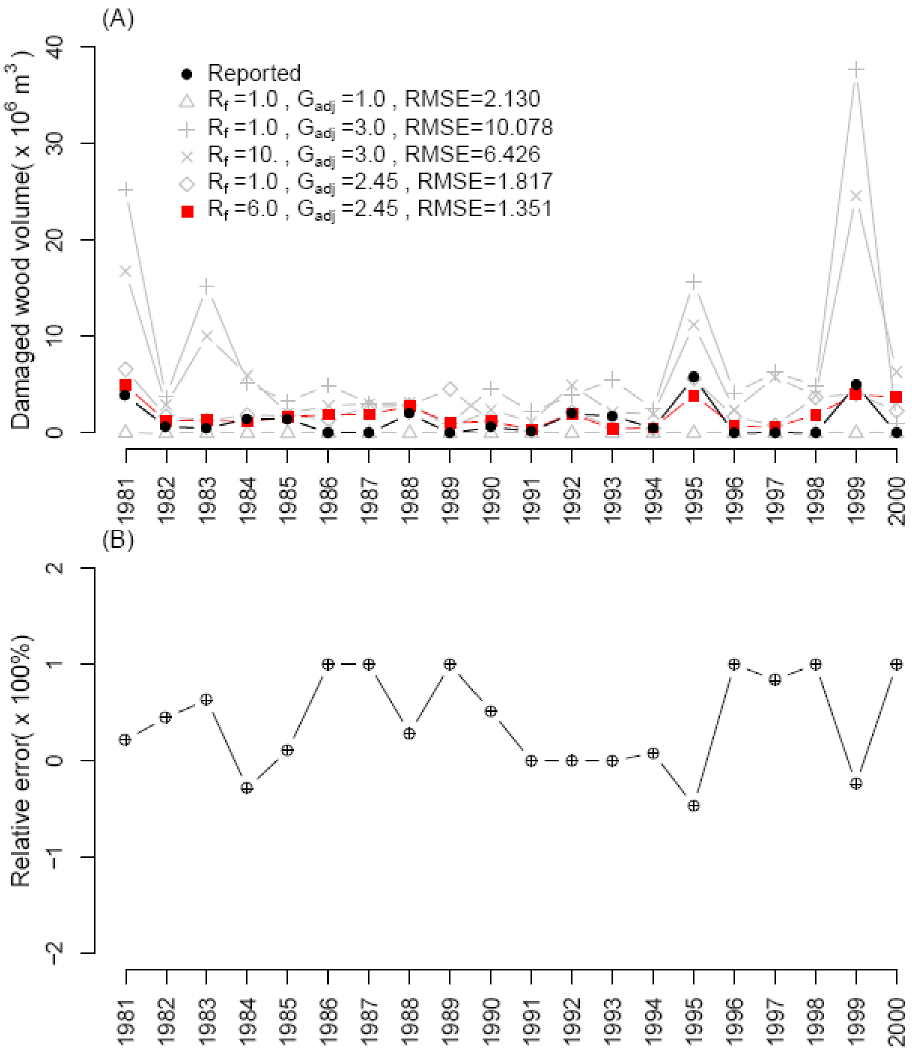

Fig 1. Sensitivity of the simulated storm damage over Sweden between 1981 and 2000 for different values for the relaxation parameter (R_f) and the gust factor adjustment G_{adj} (A). Observed storm damage is extracted from (Nilsson et al., 2004; Schlyter et al., 2006; Bengtsson and Nilsson, 2007; Gardiner et al., 2010). The relative model simulation error ((estimation-observation)=estimation) for the best tuned case (B).

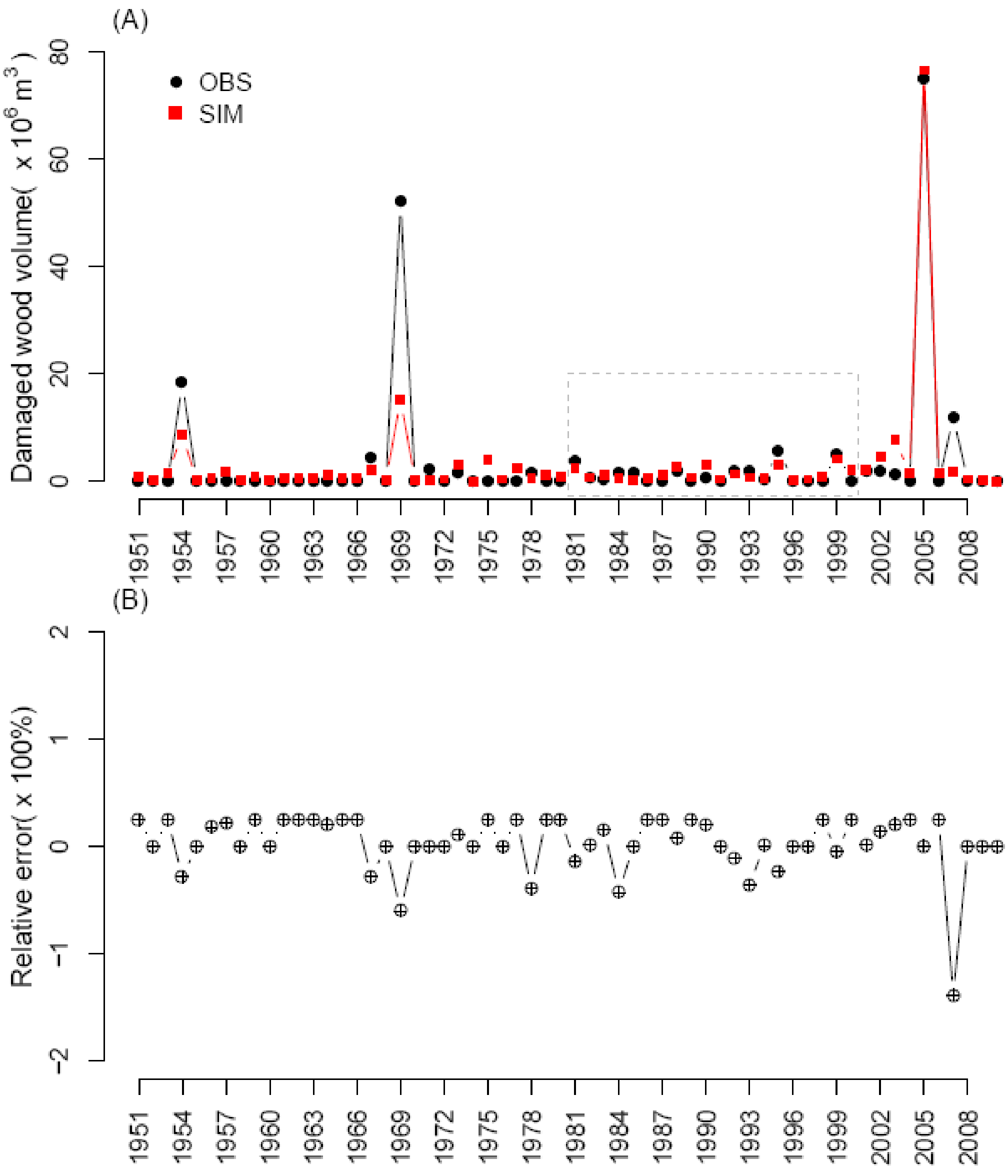

Fig 2. Comparison of the storm damage simulated by the ORCHIDEE-CAN and the annual primary wood damage over the Sweden from 1951 to 2010. Observed storm damage is extracted from (Nilsson et al., 2004; Schlyter et al., 2006; Bengtsson and Nilsson, 2007; Gardiner et al., 2010) The dashed-line area is the period from 1981 to 2000, which was selected for parametrization. The RMSE of the estimated storm damage is 1.35 x $10^6 m^3$ for the parametrization period and 5.05 x$10^6 m^3$ during the evaluation period. The validation period ranges from 1951 to 2010 but excludes the years 1981 to 2000. The relative model simulation error for the validation period from 1981 to 2010 (B).

(5) Critical wind speed and downscaling require more detail. What is the wind speed needed to overturn trees in the study area? How does it compares with the critical wind speed?

We propose to increase the level of detail in the revised manuscript by showing the modelled critical wind speeds for inner and outer forest areas and compared these CWS with daily maximum wind speed. We then used the contour lines to show the spatial distribution of the difference between minimum CWS and daily maximum wind speed (Fig. 4 in our revised manuscript). The new figure would then look like the example below.

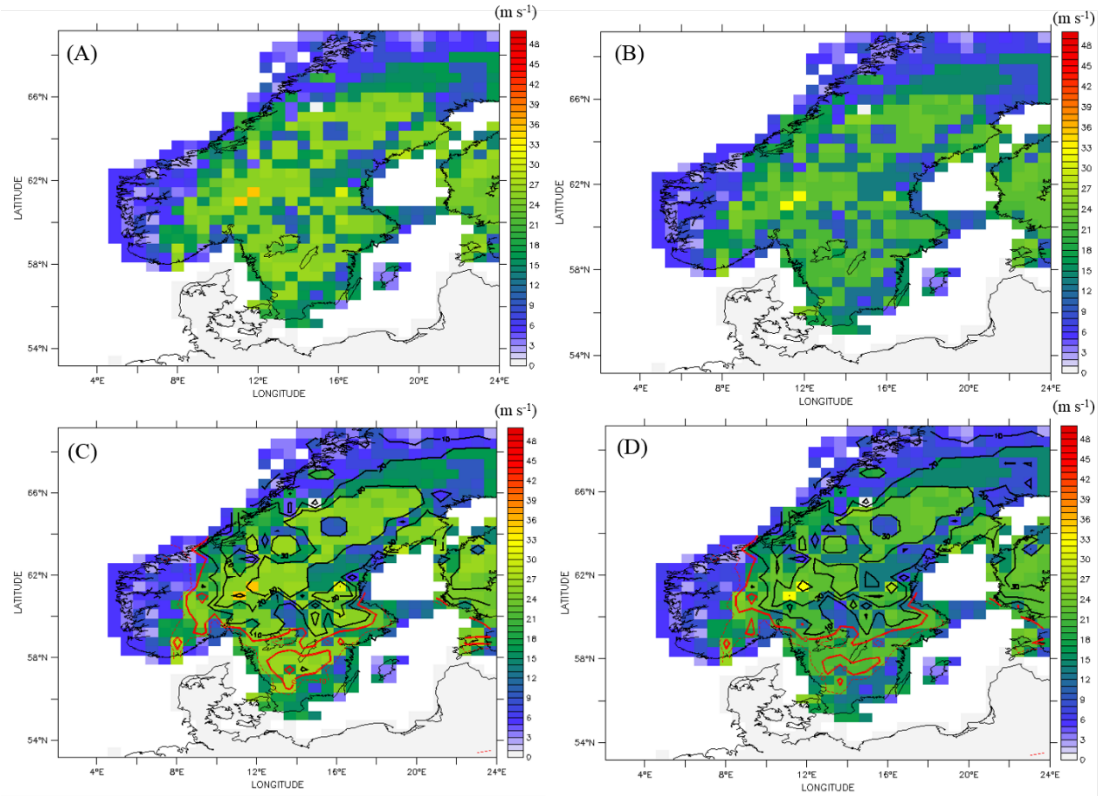

Fig 3. The ORCHIDEE-CAN calculated lowest critical wind speeds for overturning or stem breakage for forest located near to (inner) and away (outer) from a forest edge. When making the display, the critical wind speeds from the three diameter classes and four age groups from *Picea* species were compared. Note that this lowest value is used and compared with the daily maximum wind speed for estimating the damage due to storms. Lowest critical wind speeds in the forest away from a forest edge (outer) (A), lowest critical wind speeds in the forest near to a forest edge (inner) (B), lowest critical wind speeds overlaid with the difference between maximum daily wind speed and lowest critical wind speed in outer area on 9th January, 2005 (C), lowest critical wind speeds overlaid with the difference between maximum daily wind speed and lowest critical wind speed in the outer area (D). The contours show the positive wind speed difference in black and the negative wind speed difference in red. Forests within the red contours are expected to suffer from storm damage.

(6) An analysis of forest damage focusing on pixel heterogeneity vs wind speed is relevant for this study.

It is unclear to us what the referee had in mind when making this comment. Nevertheless, we realize that the current implementation overlooks many sources of sub-pixel heterogeneity when calculating storm damage but we would like to stress that one of the novelties of this study is that we found a solution (i.e., the calculation of an inner and outer area) to use the stand-level GALES at a much larger scale while avoiding the need to increase the spatial resolution (and thus the computational costs) of ORCHIDEE. Following a comment by the other referee, this novelty will be stressed in the methods, discussion and conclusion.

Further improvements towards accounting for sub-pixel heterogeneity are the topic of ongoing funding applications.