In this paper, the authors investigate the causes of mortality of beech (*Fagus* sylvatica), using a large dataset of yearly measurements of more than 4000 trees in an unmanaged forest located at the rear edge of the distribution range of the species.

To do that, they use two types of models, both of them at two scales: population and individuals:

statistical models (regression analyses)

a process-based model computing individual phenology, carbon fluxes and reserves, conductance etc, as a function of daily weather.

This is a very good contribution, and uses different approaches to investigate the causes of mortality, based on a large dataset and for a key species in a key location (rear-edge population directly threatened by climate change).

The results are:

1. both the statistical model and the process-based model infer that drought (as measured by low SPEI or low precipitations in the statistical model; as inferred from conductance loss in the process-based model) increases tree mortality
2. in addition, late frosts are inferred to increase mortality in the process-based model (this may have been investigated in the statistical model as well, but was not).
3. tree defoliation was found to very strongly increase mortality in the statistical model; yet in the process-based model, tree defoliation was found to decrease embolism (thus increase survival) and to decrease carbon stock (this decrease survival) → thus, the carbon starvation effect may be higher than the cavitation effect ?
4. tree size effects : small and large trees (and slow-growing ones) were found to have higher mortality in the statistical model; in the process based model, large trees have lower carbon stocks and higher embolism (thus lower survival) than small ones.
5. trees with early budburst have higher mortality rates in the statistical model; in the process-based model they have larger carbon stocks and larger embolism (thus diverging effects on mortality)
6. late frosts, long or strong drought, the presence of fungi, tree defoliation, all seem to interact to determine tree mortality.

Despite finding that this paper is a strong contribution, I have several comments which I think might help improve the quality of the manuscript.

1. I have had some difficulty understanding all results; some methods were not sufficiently developed in the Appendices in my opinion. For example, I could not find out why the Nstem competition index was chosen; I did not understand that from the data and explanations provided in Appendix 3.
2. For the choice of variables to use in the statistical models, two alternative approaches could have been used: (i) either rely on the PCA coordinates, to reduce the number of dimensions while not just choosing one variable correlated to each axis; or (ii) make a model comparison, by using a full set of models (not only the stepAIC procedure, which I have sometimes found

to identify really suboptimal models, as compared to testing all possible models); eg using R packages MuMIn or glmulti. The added value would be that all possible models could be tested (or an intelligent subset of these models). Also, I would have found it useful to use climatic variables more related to those used in the process-based model (or at least, to present the results of the process-based model – e.g. the number of days with late frost.

3. Also, in my opinion, it is rather difficult to compare the results of both types of models. I think that a table looking like the one below would really help understand (well, I am not sure the data in the table is fully accurate, but I needed to make it to understand the results).

	Statistical models	Process-based model
SPEI (high=weaker drought)	High SPEI → lower mortality	
Precip (driest month)	High precip in driest month (no drought) → lower mortality	
SPEI * Precip driest moth	Very strong effect on survival but I could not understand the direction	
%loss in conductance		Positively correlated with mortality
Carbon stock		Negatively correlated with mortality
Number of days of late frost	Not tested	Positively correlated with mortality
Defoliation	Strongly increases mortality, especially for small trees	Decreases carbon stock and %loss in conductance (thus diverging effects on survival)
Diameter	Small and large trees have higher mortality	Large trees have lower C stock and higher embolism (reduced survival)
MBAI (growth)	Fast-growing trees die less (especially the large ones)	Not tested
Budburst date	Earlier leaf onset → reduced survival	Earlier leaf onset → increased carbon stock and embolism → contrasting effects on survival
Number of stems (competition)	Decreased survival	Not tested
Presence of fungi	Decreased survival	Not tested

Minor comments

- The introduction section is very clear.
- I did not understand the equation on lines 193-194 ; I think it should read $MBAI_i = \pi\left(DBH2012_i^2 - DBH_i^2\right)/(4N_{yearsAlive,i})$.
- There are many abbreviations, probably a table mentioning all of them would be useful.
- Table 1: I did not understand why the max value for Compet Intra+ was inferior to the max value for Compet intra. Also the usit for MBAI should be $cm^2.year^{-1}$ (not $cm^{-2}.year^{-1}$).
- Lines 242-244; some more explanation on SPEI would be useful (do high values of SPEI indicate a wet year/period?)

- Table A1.1: Are values for AnP shown on a monthly basis? Does NLF indicate the number of frost days suffered by the early or by the late leaves?
- Supplementary Information Section 1 needs more explanations, as well as section 3.
- At the very end of the methods section, an explanation is missing as to why these specific simulations were run.
- l373-377: needs more explanation. Indeed, you state that 2009, 2011-2016 experienced a winter drought; yet the driest quarter is also the warmest quarter in 2011, 2013, 2016. Maybe a graphic would help at that point?
- l391-394: does this apply to the late or early trees?
- l426 and Fig 2b. First word of the line should be "higher" not "lower". In the dataset, MBAI is always <2.8 cm^2/yr (Table 1). Thus, how can this interaction be extrapolated to trees that grow 10 times faster than what is observed?
- l443-444: I do not follow: On Fig 3 right panel, early trees seem to show higher reserve than normal trees? and the trees that do not defoliate also have higher reserves?
- l553: On the contrary, on Fig S6 it seems that early trees have higher carbon stocks than normal trees. A statistical test would be useful at that point.