Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-337-AC3, 2021

Biogeosciences Discussions
Open Access
EGU

Interactive comment on "Does drought advance the onset of autumn leaf senescence in temperate deciduous forest trees?" *by* Bertold Mariën et al.

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Received and published: 12 January 2021

Dear Anonymous Referee 1,

Thank you for your review and suggestions. We will respond here to your comments:

1) The Referee asks whether we considered alternatives (e.g. simple thresholds in canopy coloration percentage) to the piecewise linear regressions to determine the timing of the onset of leaf senescence. We are aware that different methodologies (e.g. from simple thresholds to complex network-based approaches) can, and are, used to estimate the timing of leaf senescence. In fact, we compared the results obtained using piecewise linear regressions and 50% canopy coloration/ leaf fall thresholds (i.e. assuming that the onset of leaf senescence can be approximated with the timing when

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50% of the canopy lost the green color) in previous work, and showed that the methods provide different results, with 50% thresholds giving results that are consistently later (Mariën et al., 2019). We agree that comparing different methods might nevertheless yield advantages, as the timing of leaf senescence is inherently a problem of deriving a trend in complex ecological data (i.e. data that is, for example, hierarchical and non-linear). Exactly for deriving this trend, and as an extra regression method to compare to the piecewise linear regressions, we used the generalized additive mixed models and plotted the resulting factor-smooth interaction smoothers with 95% simultaneous confidence intervals.

2) The Referee asks whether we considered different physiological drought indices (e.g. the ratio of actual over potential evapotranspiration as in Stocker et al. (2018)). We agree that other indices would be useful. However, calculating the index proposed in Stocker et al. (2018) would not be feasible in a short term. An additional difficulty is that these calculations would require a hydrological model and are strongly dependent on local soil characteristics. Furthermore, most local meteorological stations do not provide evaporation data. Finally, note that long-term values of the rainfall deficit, as reported in Fig. 3, are rather exceptional. Therefore, the drought stress index that is reported here should be sufficiently representative for our purposes. Note that we actually do not use the drought index in our calculations or models but only use it to describe the meteorological conditions within the three year study period.

3) The Referee asks whether we observed an effect of the timing of the leaf unfolding on the senescence timing and whether we considered including other variables into our model. The age of leaves might indeed affect the timing of the onset of senescence, especially in species with an indeterministic growth pattern (e.g. birch). Therefore, we will test the correlation between leaf unfolding and senescence timing (some preliminary results are available in the supplementary file 'TEST_BB_OLS_markdown'). However, our dataset will be limited to mature trees in 2018 and 2019, as spring data for 2017 are not available and leaf unfolding for the trees in the manipulative experiment was

affected by establishment effects. However, note that we did not follow the exact same leaves from bud burst to senescence. In addition, it is hard to disentangle whether the different timing of the bud burst affects the timing of leaf senescence, or whether the opposite is the case (Marchand et al 2020). Our models simply included “treatment”, “leaf position”, “day of the year” and ”individual_tree” for the manipulative experiment, and “year”, “species”, “leaf position”, “day of the year” and ”individual_tree” for mature trees. So, they did not include meteorological variables. A significant upgrade in the modeling work is the application of GAMM or GAMLSS models, where correlations between e.g. seasonal chlorophyll data and meteorological data, are accounted for. The amount of work in applying these models to senescence trends is significant and we are working on this in the next manuscript.

4) The referee suggests highlighting the effect of drought stress on CCI and greenness in the abstract, as discussed on L. 464 (“For the mature trees, the different drought response of the autumn pattern of chlorophyll (no effect) and the loss of canopy greenness (advanced and enhanced) is probably an important reason of confusion still present today in the literature on the relationship between drought and autumn senescence”). We thank the referee for this suggestion and will consider this in the revision.

Kind regards,

The authors

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2020-337/bg-2020-337-AC3-supplement.pdf

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-337, 2020.

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