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Biogeosciences Discussions

Interactive comment on "Ideas and perspectives: New research examples of autumnal climate change ecology" *by* Ulf Büntgen and Paul J. Krusic

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Dear Editors

We are thankful to Armanda S. Gallinat and Flurin Babst for both their fair and constructive evaluation of our article. We carefully considered all comments and suggestions, and improved the manuscript accordingly. All minor and major changes are outlined in the detailed point-by-point response below. As a result, we believe that the revised work – herein already provided as an electronic supplement with all changes marked in yellow – is now suitable for publication, and will appeal to a wide, interdisciplinary audience.

Please do not hesitate contacting us if anything remains unclear and/or further information is needed. We appreciate you considering this Ideas and perspectives contribution in Biogeosciences and look forward to hearing from you soon.

On behalf of the authors; Yours respectfully - ulf buentgen

Point-by-point response letter

F. Babst (Referee; received and published, 11 Aug 2017) This perspective article highlights three innovative approaches to study seasonal ecosystem responses to climate change. The authors emphasize the need to better understand autumnal and hibernal processes that have so far remained less studied compared to vernal phenology. Seasonality in ecosystem processes is a timely topic and I agree that "diversity and creativity in future studies" (l. 87) are needed to address it.

Many thanks for this overall positive and encouraging evaluation of our work.

The manuscript reads well, but I have a hard time fully grasping its message. The call for studies on ecosystem processes in autumn and winter is in itself not new. By framing the manuscript around this topic, the authors mostly second earlier papers, e.g. by Gallinat or Williams (as cited), that have advertised the same issues in more detail. This is unfortunate, because the research examples provided in sections 1-3 are innovative and this novelty is somewhat lost in a known framework. My main suggestion is to de-emphasize the "autumn-winter message" and instead emphasize the merits of creative research approaches to tackle the full seasonality in climate change impacts. The three examples (animal habitat range, xylogenesis, and mushroom phenology) are not limited to the autumn season, but can provide valuable information for other seasons as well. Such information can nicely complement widely established data streams, such as CO2-flux measurements or remotely sensed observations of vegetation dynamics. The paper would then advocate (even stronger than it does already) for the integration of a series of complementary (and so far, underused) data sources to really understand the phenology and dynamics of ecosystems and how they

respond to climate change. The authors could provide a list of possible such resources (including the ones in sections 1-3 and others) that would be inspiring and useful for researchers.

We re-centred the manuscript around the merits of more innovative research approaches to address the full seasonal cycle in modern attempts of climate change biology/ecology. The thoroughly revised article, now including an additional 16 references, is not only longer but also more nuanced.

l. 39: The “full annual cycle” of what? Do you mean seasonal migration here?

This part of the manuscript has been complete re-written and expanded to “Such findings underscore the advantage of considering climate and its influence on environmental conditions throughout the year. By the same token, early-year census data – from which autumnal hunting quotas are derived – could be mined for resolving connections between population density, harvest intensity and climate variability. Thus, a more complete picture of the external drivers of wildlife performance, including inter-annual changes in species-specific returns to winter ranges (Rivrud et al., 2016) is obtained.”.

l. 47: I suggest replacing “micro-anatomy” with “cell-level measurements”

Changed “State-of-the-art studies combining high-resolution dendrometer readings with cell-level measurements have found xylem lignification of conifer species in north-eastern France to persist into late autumn/early winter (Cuny et al., 2015).”.

l. 48: I suggest adding . . . “favorable” autumn conditions . . .

Done.

l. 54: A link to productivity could be drawn here via wood density. Favorable autumn conditions may result in denser wood also earlier in the annual ring (Franceschini et al. 2012, Holzforschung) and thus more biomass per volume.

Added “Consequently, our ability to connect short-term seasonal climate variations

and weather extremes with intra-annual fluctuations in wood quality and quantity has dramatically increased (Battipaglia et al., 2016; De Micco et al., 2016).”.

L. 94-97: This statement deserves a reference.

Added “(Williams et al., 2015)”.

L. 107-108: This sentence basically summarizes my main suggestion (above) and could be somehow reflected in the title of the paper.

We changed the title to “Pursuing climate change ecology throughout the year”. Moreover, we added a more general ‘Introduction’ paragraph and 16 new references.

L. 108-111: The authors have not talked about mechanistic modeling earlier in the text and this ending feels very detached from the rest of the manuscript. I suggest either removing this statement or then making modeling a more inherent part of the paper.

We re-moved and improved the sentence to a much earlier position (under ‘Tree-ring’formation) “Following recent advances in quantitative wood anatomy (Steppe et al., 2015), and improvements in process-based plant physiological modeling (Yang et al., 2017), our understanding of the circumstances that control the precise timing of lignification has greatly improved.”, and added a new concluding statement “Future efforts should also consider mining the whole range of non-traditional, environmental inventories and metrics that exist today, or even planned to be available in due course. Quantifying the effects of seasonal climate on those biological controls regulating yearly growth patterns can only improve the efficacy of (process-based) mechanistic models by providing valuable details of how seasonal-specific conditions and responses are inter-correlated throughout an organisms’ life cycle.”.

A. S. Gallinat (Referee; received and published, 11 Sep 2017) This paper highlights how three novel data sources have been used to research the effects of climate change on autumn and winter ecology. The authors discuss the use of (1) records from big-game hunting to measure shifting ranges that coincide with warmer autumn condi-

tions, (2) high-resolution observations of wood anatomy to measure late-season woody biomass production, and (3) mycological inventories and data from poison centers to measure fungal productivity, diversity, and phenology. I agree with the authors that innovative methods such as these are important to the future study of ecological shifts in the autumn season.

We are pleased to read these lines.

While I appreciate the message that autumn and winter ecology should receive more focus in biogeoscience research, that does not seem to be the true goal or added value of this paper. The value this paper adds is to explore the feasibility and potential of novel, creative data sources for autumn research. To make that goal clear and to accomplish it, I believe this paper requires some reframing and additional information. I recommend the following changes: 1) The addition of an introduction would help to outline the specific problem/s this paper aims to solve. For instance– the effects of climate change on autumn and winter are relatively unknown, and traditional/historical data sets are limited. The authors suggest, therefore, that creative, novel data sources be used for autumn and winter ecology, and provide three examples of such data sources, including proof of their value to climate change research, future opportunities for their use, and unique features and biases of the data. This context would help to nest the three examples within the paper as just that– *examples* within the greater context of novel data sets, that might help the reader to identify additional creative data sources and identify the potential and biases of those data sets. Currently the examples come off as the main message of the paper, rather than as support for a larger, cohesive, original message.

We added a new introductory paragraph “1 Background and motivation”, which now provides a wider context for our examples.

2) Connecting the three examples with a common format would help to remind the reader of the main message they illustrate. For instance, if the message is that novel

data sources have demonstrated value, future possibility, and unique quirks that should be understood for optimal use, I would suggest the following format for each example: I. a description of the data source II. a summary of what has been found so far using the data (including specific information– for instance, what is the magnitude/extent of the range shifts detected from big-game records?) III. a description of what is left to be discovered from these records, or similar records (what else could we learn from big-game records? What other game records could be used to fill gaps in our knowledge of autumn and winter ecology?) IV. what are the unique biases and limitations of the data (with all novel data sources, this is an important question for researchers to consider– for instance, are calls to poison centers a robust record of mushroom phenology or simply of foraging phenology?).

Again, we re-structured the entire paper, including an introductory paragraph, and added 16 further citations/references.

3) If the goal is to encourage researchers to identify additional novel resources for studying autumn and winter ecology, the conclusion could be reframed (away from what we do not know about autumn and winter) to explicitly point researchers toward other novel data sources, and/or to suggest a list of questions researchers might ask to determine the potential and limitations of their own unconventional data sources. What I’ve described above is one potential direction for this paper that would be both valuable and original. If the authors prefer to go in another direction, it will still be important to identify a clear message that ties the three examples together, and to be explicit and detailed about what has already been demonstrated using these data sources and what is left to glean from them.

We hope that the revised – longer and more nuanced – manuscript version provides a much clearer message, and is thus suitable for publication.

L30-31: Mobility and behavioral plasticity also *allow* us to detect climate-induced population movements. Perhaps stating what other factors populations might move in

response to, or being more specific about how detection is complicated, would help to clarify this sentence. It is also not clear whether this is about migration or range shifts.

Changed to “Although often complex at different spatiotemporal scales, the mobility and behavioral plasticity of large animals may offer an opportunity to detect climate-induced population movements throughout different parts of the year.”.

L37: What is the magnitude of the shift?

We re-wrote and expanded this section “A species-specific upward trend in the ungulates’ autumnal harvest locations between 1991 and 2003 coincides with a mean September-October temperature increase of 1.3 °C during the same period, which translates into more favorable, snow-free and vegetation-rich autumnal conditions. Linear regression slopes reveal statistically significant ($p < 0.05$) uphill shifts of 135, 95 and 79 m for ibex, chamois and red deer (Büntgen et al., 2017b), respectively. Such findings underscore the advantage of considering climate and its influence on environmental conditions throughout the year.”.

L38-40: This sentence is vague; what full annual cycle is this in reference to? How will these findings improve awareness, and for whom?

This section has been completely re-written (see also previous response to referee 1).

L44: Better to explicitly state the physiological processes here, otherwise the point is vague until two sentences later.

Expanded “Though tree-ring formation in many extra-tropical species occurs during most of the warm season, several auxin-driven plant development processes (Vanneste and Friml, 2009), such as the thickening and lignification of xylem-cell walls, mainly occurs at the end of a growing season.”.

L47-48: How far into autumn can xylem lignification persist? Specifics will help to justify the value of this data source.

Added “State-of-the-art studies combining high-resolution dendrometer readings with cell-level measurements have found xylem lignification of conifer species in north-eastern France to persist into late autumn/early winter (Cuny et al., 2015). The timing and duration of such processes strongly depends on the species, microenvironment, and climate.”.

L66: What is the duration of these phenology records? Are they all wild observations?

Re-written “Despite mushrooms’ smaller economic, social and ecological importance (Büntgen et al., 2017c), in comparison to plants and animals, over seven million in situ observations of wildlife mushroom fruiting bodies, representing >10,000 fungal species from nine countries spanning most of the 20th century (Andrew et al., 2017), have been drawn from various scientific and citizen-science projects.”.

L67-68: What magnitude of shift? For how many species? Any additional details here will, again, strengthen the evidence that this is a valuable data source.

Added “In addition to providing evidence of warming-induced spatiotemporal shifts in autumn mushroom phenology – the mean annual day of fruiting has become several days to weeks later (Kauserud et al., 2012), a pan-European mycological inventory offers unique macro-ecological opportunities to assess how fungal communities interact with the environment (Büntgen and Egli, 2014), including symbiotic associations with their host vegetation (Büntgen et al., 2013).”.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-265/bg-2017-265-AC1-supplement.pdf

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-265, 2017.