Project Database of ICP Forests

PROJECT DESCRIPTION

PROJECT INFORMATION

Project title:	**Investigating the spatial variance of spring phenology across temperate European forests**
Project ID:	212
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PROJECT DESCRIPTION

The phenology of plants has gained increasing attention in recent years due to its close connection to current climate change trends (Tang et al. 2016). Trees are generally timing their phenological events based on climatic cues such as temperature, irradiance and photoperiod, although the importance of individual climatic factors vary based on species, biomes and site environment (Richardson et al. 2013; Tang et al. 2016). Despite these variations, deciduous trees in temperate European forests show a general trend towards advanced budburst timing in the last 50 years across different species (Menzel, Estrella, and Fabian 2001; Badeck et al. 2004; Richardson et al. 2013). Beside these temporal trends, there is however a large spatial heterogeneity in budburst-timing across European forests. A study by Peaucelle et al. (2019) shows that depending on the species about half of the spatial variance in budburst can be explained by a range of long-term climatic variables including temperature, precipitation and radiation intensity (Peaucelle et al. 2019). Intriguingly, similar observations have been made for the phenology of birds for which climatic variables were not sufficient to explain the spatial variation in the shifts of breeding behaviour between European great and blue tits (Marcel et al. 2003; Matthysen, Adriaensen, and Dhondt 2011). This suggests that local, non-climatic factors (e.g. soil parameters, stand density, forest biodiversity) contribute to the variance of budburst among stands either directly or by interacting with climatic drivers. However, spatial variability in budburst due to non-climatic factors is not accounted for in land surface models (Olsson and Jönsson 2015). This could explain why models are often not able to accurately predict observed spatial differences of leaf unfolding on a regional scale (Migliavacca et al. 2012; Olsson and Jönsson 2015). Identifying how stand non-climatic factors affect the spatial variance of spring phenology and characterizing how they interact with climatic variables would therefore highly improve our understanding of phenological timings and the performance of our global models.

Another problem in identifying the drivers of spatial variability is represented by inter-individual and inter-species variability. On one hand, individuals differ in their timing of budburst depending on their previous year phenology and tree size (Marchand et al. 2020). On the other hand, this inter-individual variability is then encompassed by an inter-species variability, reflecting different ecological adaptions and evolutionary traits of the species. To accurately investigate the spatial differences of budburst it needs to be established how these different levels of variabilities scale against each other.

This project will therefore investigate the following questions.

1) Are non-climatic factors on a stand level influencing the spatial variability in budburst? Do these factors interact with climatic variables?

2) Is the scale of inter-individual and inter-species variability of budburst the same across European forests? How does it compare against the scale of variability among stands?
3) Can non-climatic factors affecting spatial variability in tree budburst be also the drivers of the spatial variability in bird phenology?

While this is the overarching framework of the study, we will try to answer sub-questions, potentially suitable for publications, such as:

a) Is inter-individual budburst variability affected by the demographic structure of the stand?
b) Do trees in uniformly composed forests/stands differ in their timing of budburst to trees in more diversely composed forests/stands?
c) Are trees adjusting their timing of budburst according to earlier experienced leaf damage?

Method and data required from contributing partners

To assess these questions we are building a database of long term phenological observations in connection with other, non-climatic stand measurements as these are not available on existing pheno-databases. Data providers will be continually updated about the work and invited in publications using the data. Ideally, we are looking for phenological observations of budburst for at least 10 years, site climatic measurements (or information if there is a climate station nearby with reasonably access possibility) and with the following additional information concerning non-climatic factors. Furthermore, it would be interesting if you know if any studies regarding bird phenology were conducted in the area at any time. If a part of this data we need is already in publications, we will retrieve it from there. We ask for your effort filling the tables only for non-published observations or fully private data that we will not be able to find elsewhere.

References

Badeck, Franz-W., Alberte Bondeau, Kristin Bottcher, Daniel Doktor, Wolfgang Lucht, Jorg Schaber, and Stephen Sitch. 2004. "Responses of Spring Phenology to Climate Change." New Phytologist 162 (2): 295–309. https://doi.org/10.1111/j.1469-8137.2004.01059.x.

Marcel, E. Visser, Frank Adriaensen, Johan H. van Balen, Jacques Blondel, André A. Dhondt, Stefan van Dongen, du Feu Chris, et al. 2003. "Variable Responses to Large-Scale Climate Change in European Parus Populations." Proceedings of the Royal Society of London. Series B: Biological Sciences 270 (1513): 367–72. https://doi.org/10.1098/rspb.2002.2244.

Marchand, Lorène Julia, Inge Dox, Jožica Gričar, Peter Prislan, Sebastien Leys, Jan Van den Bulcke, Patrick Fonti, et al. 2020. "Inter-Individual Variability in Spring Phenology of Temperate Deciduous Trees Depends on Species, Tree Size and Previous Year Autumn Phenology." Agricultural and Forest Meteorology 290 (August): 108031. https://doi.org/10.1016/j.agrformet.2020.108031.

Matthysen, Erik, Frank Adriaensen, and André A. Dhondt. 2011. "Multiple Responses to Increasing Spring Temperatures in the Breeding Cycle of Blue and Great Tits (Cyanistes Caeruleus, Parus Major): CHANGES IN THE BREEDING CYCLE OF BIRDS." Global Change Biology 17 (1): 1–16. https://doi.org/10.1111/j.1365-2486.2010.02213.x.

Menzel, Estrella, and Fabian. 2001. "Spatial and Temporal Variability of the Phenological Seasons in Germany from 1951 to 1996." Global Change Biology, 10. Migliavacca, M., O. Sonnentag, T. F. Keenan, A. Cescatti, J. O'Keefe, and A. D. Richardson. 2012. "On the Uncertainty of Phenological Responses to Climate Change, and Implications for a Terrestrial Biosphere Model." Biogeosciences 9 (6): 2063–83. https://doi.org/10.5194/bg-9-2063-2012.

Olsson, Cecilia, and Anna Maria Jönsson. 2015. "Budburst Model Performance: The Effect of the Spatial Resolution of Temperature Data Sets." Agricultural and Forest Meteorology 200 (January): 302–12. https://doi.org/10.1016/j.agrformet.2014.10.003.

Peaucelle, Marc, Ivan A. Janssens, Benjamin D. Stocker, Adrià Descals Ferrando, Yongshuo H. Fu, Roberto Molowny-Horas, Philippe Ciais, and Josep Peñuelas. 2019. "Spatial Variance of Spring Phenology in Temperate Deciduous Forests Is Constrained by Background Climatic Conditions." Nature Communications 10 (1): 5388. https://doi.org/10.1038/s41467-019-13365-1.

Richardson, Andrew D., Trevor F. Keenan, Mirco Migliavacca, Youngryel Ryu, Oliver Sonnentag, and Michael Toomey. 2013. "Climate Change, Phenology, and Phenological Control of Vegetation Feedbacks to the Climate System." Agricultural and Forest Meteorology 169 (February): 156–73. https://doi.org/10.1016/j.agrformet.2012.09.012.

Tang, Jianwu, Christian Körner, Hiroyuki Muraoka, Shilong Piao, Miaogen Shen, Stephen J. Thackeray, and Xi Yang. 2016. "Emerging Opportunities and Challenges in Phenology: A Review." Ecosphere 7 (8): e01436. https://doi.org/10.1002/ecs2.1436.