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Different climate change impacts in 144 natural and agricultural phenophases in Germany derived by Bayesian statistics

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Regional changes in temperature have already affected biological systems around the globe. Changes in the start of greening- up and the length of the growing season are equally derived by satellite data. However, among different species, the impacts of warming on phenological dates, such as flowering, leaf unfolding, fruit ripening, leaf colouring and leaf fall, is species and phases specific. Fitter and Fitter (2002) published first results that annual were more likely to flower early than congeneric perennials, and insect-pollinated species more than wind-pollinated ones. In addition, human driven (false) phases in agriculture, such as tillering, may be totally different. This fact should be taken into account when analysing different climate change indicators.

We used mean anomaly time series (1951-2003) of 144 phenological records (species x phases) in Germany. Phases were adjusted following the BBCH code (Meier 1997) and information about pollination type, species type (natural, agricultural plants), overwintering type was added. Following the Bayesian approach of non-parametric function estimation by Dose & Menzel (2004), we tested 3 models (constant, linear, one-change-point) for description of functional behaviour of these time series, and determined their rates of change (trend) as well as the frequency distribution of the corresponding change point probabilities. The most important aspects of the method are rigorous treatment of uncertainties, prediction of missing and future data with associated uncertainties, and quantified comparison of different models. Here, we tested whether preference for certain models, year with maximum change point probability

and trends were linked to mean onset dates, plant and species type, pollination and overwintering type. The results suggested clear differences especially for phenophase groups in the derived time series characteristics.