



Detection and Attribution of anthropogenic climate impacts on phenological phases

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An important consequence of climate change is the impact on phenological spring timing events. Although it is generally understood that anthropogenic mechanisms play a major role in the warming trend of the climate and that the timing of phenological phases depends largely on the temperature, the link has yet to be quantitatively shown for different kind of areas. In this study the goal is to show this for a Central European region. In order to do this a multistep attribution to external forcings is carried out, linking the earlier timing of phenological spring events to changed climate conditions (increasing temperature) and this change in the environment to external (anthropogenic) forcing.

The goal is to apply the 'optimal fingerprint' technique to detect and attribute anthropogenic causes to the earlier timing of phenological events (Hasselmann, 1997). In order to achieve this, one has to use data from different models. First, to assess the variability of the climate without any kind of forcing (neither natural, nor anthropogenic), pre-industrial control (piControl) simulations from Global Circulation Models (GCMs) are needed. Second, one needs different historical GCM runs, some forced by natural forcings only and others with anthropogenic forcing included.

To be able to compare the large Scale Information from the GCMs with the local scale information in the form of phenological observations, an empirical-statistical downscaling model is used, to overcome the scale differences. Afterwards, a phenological model is fed with the downscaled temperature data to obtain distinctly forced, simulated phenological data.

The study is successful if and only if a discrepancy between naturally forced climate conditions and observations is found, so that the estimated statistical significance level of the detection of a net climate change satisfies the requirements (rejection of the null hypothesis that the change can be explained by natural variability only or naturally forced climate conditions). And if it can only be explained when factoring in anthropogenic forcings, meaning the observations are only consistent when incorporating them. This attribution part in using the aforementioned technique is a consistency check and yields confidence values to quantitatively assess the anthropogenic impact.

HASSELMANN, Klaus. Multi-pattern fingerprint method for detection and attribution of climate change. *Climate Dynamics*, 1997, 13. Jg., Nr. 9, S. 601-611.