Abiotic impact of regional climate change on horticultural production in Lower Saxony

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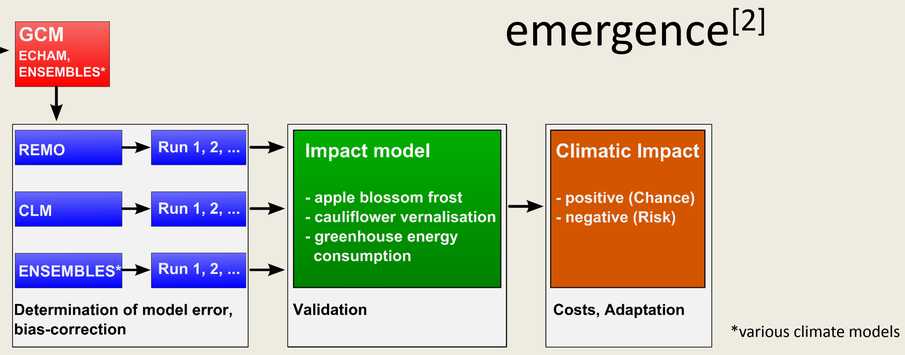
Take-away:

Introduction & Motivation

Climatic changes affect horticultural production. As this may hold unknown future risks, the objective is to assess future climate change impacts on horticultural production. Impacts and the resulting risk can be estimated via simulation. For this purpose, horticultural models are widely used and fed with measured and simulated climate series as input. The present study exemplarily analyzes the impact on 3 production systems, putting the impact in relation to climate model variability. A review was done to complete the picture.

Methodology

1. No. climate runs: 1 - 13
2. No. impact models: 1 - 7
3. Bias corr.: 1d, 2d[1]
4. Estimation of time of emergence[2]



The climate- and impact-model uncertainty was analyzed[3].

Results

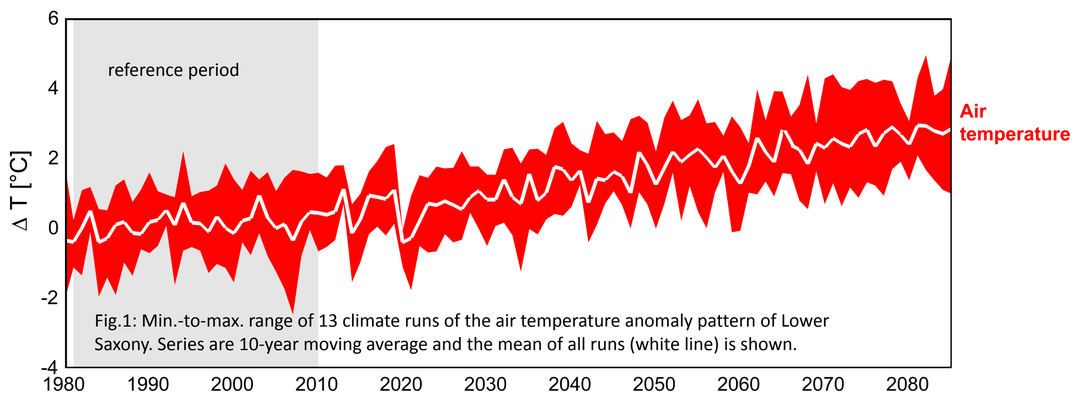


Fig.1: Min.-to-max. range of 13 climate runs of the air temperature anomaly pattern of Lower Saxony. Series are 10-year moving average and the mean of all runs (white line) is shown.

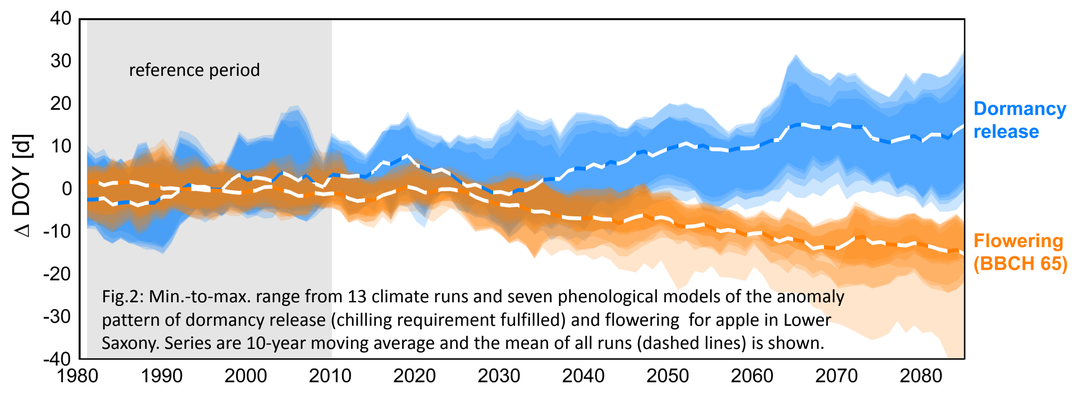


Fig.2: Min.-to-max. range from 13 climate runs and seven phenological models of the anomaly pattern of dormancy release (chilling requirement fulfilled) and flowering for apple in Lower Saxony. Series are 10-year moving average and the mean of all runs (dashed lines) is shown.

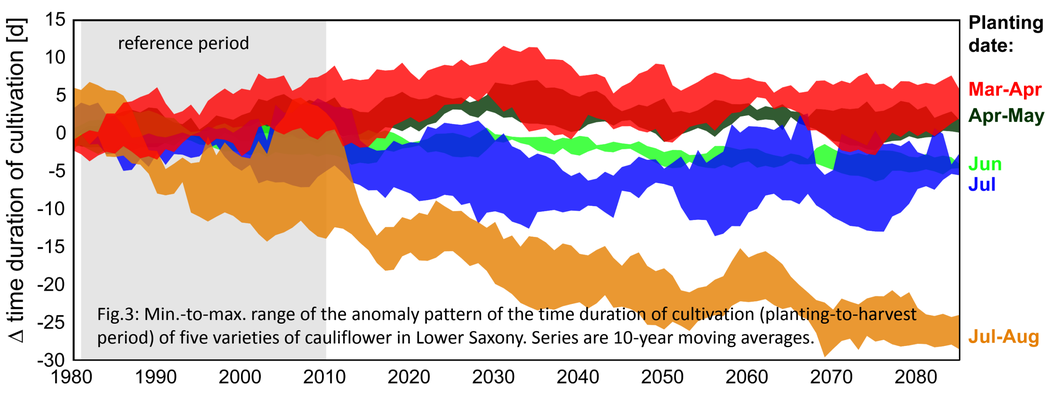


Fig.3: Min.-to-max. range of the anomaly pattern of the time duration of cultivation (planting-to-harvest period) of five varieties of cauliflower in Lower Saxony. Series are 10-year moving averages.

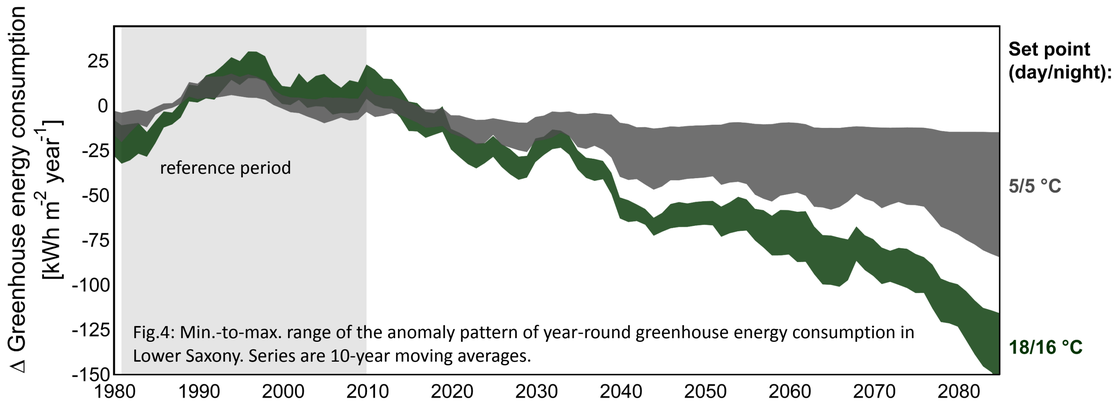


Fig.4: Min.-to-max. range of the anomaly pattern of year-round greenhouse energy consumption in Lower Saxony. Series are 10-year moving averages.

Tab.1: Expected future impact of climate on regional horticulture.

Parameter	Effect	Source	Confidence
Duration of vernalization	Increase	Simulation, review	Low
Duration of cultivation (Herbaceous, no vernalization)	Decrease	Simulation, review	Medium
Duration of cultivation (Herbaceous, obligate vernalization, early varieties)	No change	Simulation, review	Low
Duration of cultivation (Herbaceous, obligate vernalization, late varieties)	Decrease	Simulation, review	Low
Chilling	Decreases	Simulation, review	High
Fruit tree flowering	Advancement	Simulation, review	High
Blossom frost risk	No increase	Simulation, review	High
Irrigation water demand	Increase	Experiment, Simulation, review	Medium
Drought stress	No change	Experiment, Simulation, review	Low
Greenhouse energy consumption	Decrease	Simulation	High
Heat stress	Increase	Review	Low

Discussion and conclusions

Climate change will lead to substantial changes in crop production. For instance, known impacts on plant phenology can be expected to continue in the main. The loss of winter chill[3] and alteration of vernalization are projected. However, while changes in the former might lead to a decrease in blossom frost risk[3], the latter depends largely on the variety. Further, greenhouse energy required for heating was projected to drop[4]. As shown in tab. 1 it can be concluded, that despite large uncertainties regarding other effects as heat stress, horticultural production holds several options for adaptation.

Niedersächsisches Ministerium für Wissenschaft und Kultur

[1] Hoffmann, Rath, 2012. Theor Appl Climatol 110, 129-141.
[2] Hawkins, Sutton, 2009. B Am Meteorol Soc 90: 1095-1107.
[3] Hoffmann, Rath, 2013. PLOS one, accepted 9.8.2013
[4] Hoffmann, Rath, 2012. Eur J Hortic Sci 77, 241-248.

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