SECTION - Animal response and adaptation to a changing climate

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Impacts of climate change on the crop invasion of oilseed-rape by the rape stem weevil, *Ceutorhynchus napi*, in North-Western Germany

Key Findings

Our study demonstrated that simple models using locally-adjusted weather-based thresholds have the potential to offer sufficiently accurate forecasting of first immigration flights by *Ceutorhynchus napi*. This is the basis for an appropriate timing of insecticide application for controlling this pest. In addition, the new model was combined with regional climate change projections. The onset of the crop invasion by the rape stem weevil was projected to occur between 7 days (near future, 2021-2050) and 17 days (far future, 2069-2098) earlier in comparison to the reference period (1961-1990).

Introduction

The rape stem weevil, *Ceutorhynchus napi* Gyll., is a severe pest in oilseed rape (*Brassica napus* L.) in Europe and can cause yield loses up to 50%. Based on the refined model by Debouzie & Wimmer (1992), we analyzed interactions between meteorological variables and pest activity.

This new impact model was combined with a multi model ensemble of regional climate change projections covering the period from 1961 to 2100. All projections were based on the A1B SRES emission scenario. To eliminate systematic biases a non-linear bias correction scheme was applied to the air temperature and precipitation time series.

Materials and Methods

Based on long-term (1989-2010) observational data at Goettingen (Lat. 51°56', Long. 9°94') the threshold values of the forecast model by Debouzie and Wimmer (1992) were optimized. The new approach predicts the crop invasion, when daily maximum air temperature exceeds 12.0°C, 12.5°C, and 13.0°C on three consecutive days up to Mar 15. The daily totals of precipitation on these days must <2 mm. After that date only one day with full field conditions is taken into account.

Daily data of maximum air temperature as well as precipitation were retrieved from the data archive of the German Meteorological Service (1971-2010) and used to calibrate the impact model and for the bias correction of different RCMs. We used 15 GCM RCM combinations of the EU ENSEMBLES project, covering the period from 1961 until 2100 with a spatial resolution of 25 km. A non-linear bias correction (quantile mapping) was applied to all meteorological data sets.

Results - *Projecting air temperature*

The 30-year long-term averages of the multi-model annual mean air temperatures increased from 8.9°C in the reference period to 10.1°C in the near (2021-2050) and 11.7°C in the far future (2069-2098) (Fig. 1).

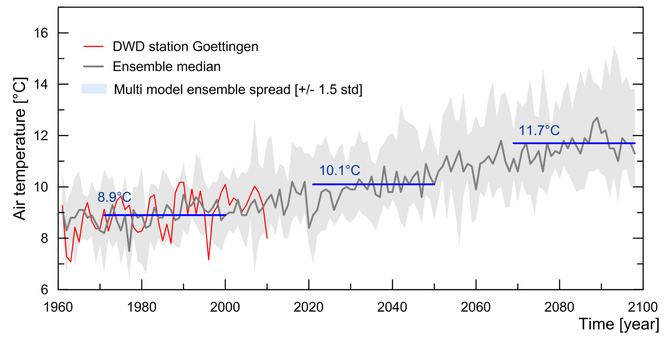

***Fig. 1**: Time-series of annual mean air temperature (spatial mean for Luxembourg): multi model (n=15) spread (grey shading); multi model mean (thin blue line) with long-term annual means from 1961 to 1990, 2021 to 2050, and 2069 to 2098 (thick lines).*

Projecting precipitation

The long-term average winter (DJF) precipitation sum - derived from the multi model ensemble mean - increased from 179 mm in the reference period to 200 mm in the near and 213 mm in the far future (Fig. 2).

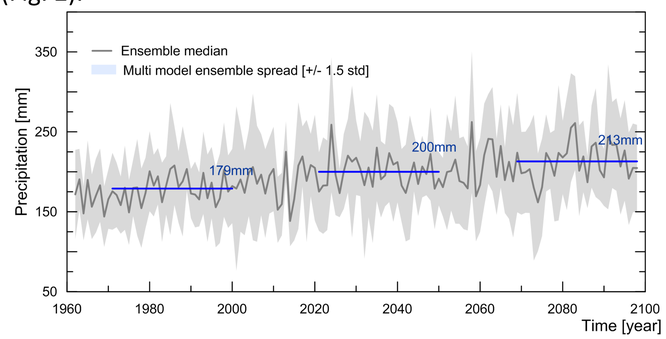

***Fig. 2:** Time-series of winter precipitation sums (spatial mean for Luxembourg): multi model (n=15) spread (grey shading); multi model mean (thin blue line) with long-term annual means from 1961 to 1990, 2021 to 2050, and 2069 to 2098 (thick lines).*

Optimizing the forecast model for rape stem weevil

The impact model adopted to the local climate conditions is able to reproduce the observed dates of crop invasion with a RMSE value of 10.9 (Fig. 3). In most of the years the differences are with less than 3 days very small.

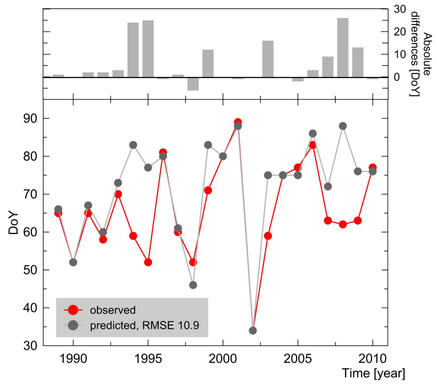

***Fig. 3:** Day of the year (DOY) of the first immigration of* C. napi *based on observations and predicted with adapted threshold values for the Goettingen test site; period 1989 to 2010. Upper part: Absolute differences between observed and predicted DOYs of immigration.*

Projecting crop invasion by the rape stem weevil

In the control time-span, first appearance was on average at DOY 77 ± 2.9 (Mar 18). For the two future time-spans, shifts towards earlier dates are expected: DOY 70 ± 5.7 (Mar 11) for the near and DOY 60 ± 12.3 (Mar 1) for the far future (Fig. 4).

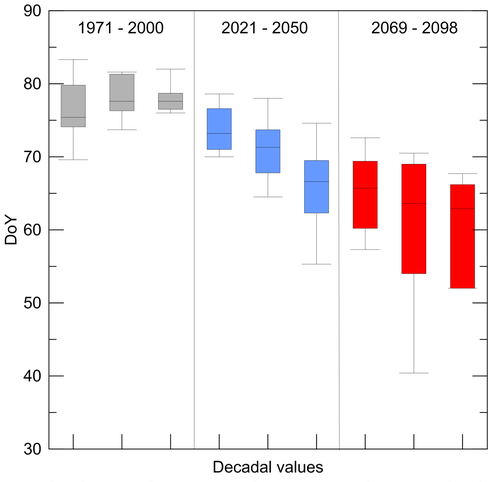

***Fig. 4:** Boxplots of model results (N = 15) for the Day of Year (DoY) of crop invasion by* C. napi *for the reference time span (1961-2000), near future (2021-2050) and far future (2069-2098).*

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