Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs FDEA
Agroscope

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology Meteo Swiss

Assessing climate change impacts on agricultural pests

Sibylle Stöckli[1], Elias M. Zubler[2,3], Pierluigi Calanca[4]
[1] Research Institute of Organic Agriculture (FiBL), CH-5070 Frick; [2] Federal Office of Meteorology and Climatology (MeteoSwiss) CH-8058 Zurich; [3] Center for Climate Systems Modeling (C2SM), ETH Zürich, CH-8092 Zürich; [4] Agroscope Reckenholz, CH-8046 Zürich

Climate change scenarios

Projections of future climate change impacts on agricultural pests are necessary to initiate adaptation strategies in time. Organisms do not respond to global averages but rather to regional settings and their variations in time. Highly resolved climate data and scenarios are necessary to assess the ecological impacts of climate change and the needs for adaptations. Regional climate models are not yet in the position to deliver this kind of information. Downscaling methods are therefore needed for developing climate change scenarios suitable for addressing shifts in the incidence of agricultural pests (Fig. 1). Two such approaches are presented here. The first relies on the application of a weather generator to obtain local scenarios with hourly resolution. The second is a spatial downscaling that is able to produce scenarios with a 2 km spatial resolution. Application to the study of two pests occurring in Switzerland are discussed.

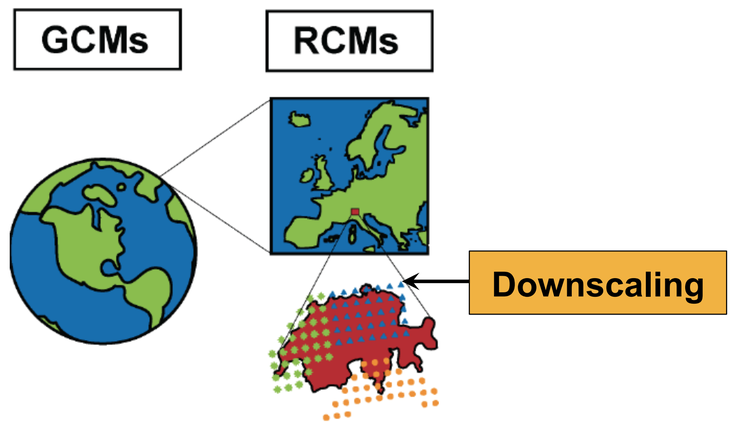

Fig. 1. Schematic illustration of the steps involved in the development of highly resolved climate change projections. Discussed in this contribution is the final step, i.e. the downscaling of RCM output. GCM/RCM: Global/Regional Climate Model.

Downscaling to hourly climate change data

A stochastic weather generator combined with a re-sampling approach was applied to produce synthetic hourly weather series valid for current and future climatic conditions (Hirschi *et al.* 2012). Implications of climate change for the development of the codling moth were analysed with the help of an operational phenology model (www.sopra.info).

Codling moth (*Cydia pomonella* L.)

- Earlier adult flight start: 14±0.4 days
- Increased risk of a pronounced second (69-100%) and of an additional third generation (66-100%)
- Adaptation in photoperiodic diapause induction: shorter-day-length

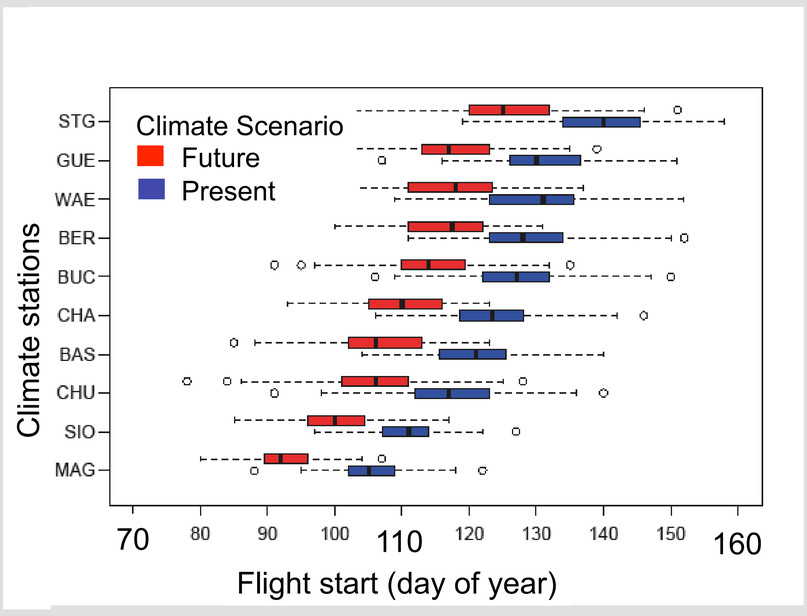

Fig. 2. Codling moth adult flight start for the overwintering generation. The boxplots were derived from synthetic weather data representing 100 years in the present and future climate. Magadino (MAG), Sion (SIO), Chur (CHU), Basel (BAS), Changins (CHA), Buchs (BUC), Bern (BER), Waedenswil (WAE), Guettingen (GUE), St. Gallen (STG).
Stoeckli S. *et al.* (2012) Impact of climate change on voltinism and prospective diapause induction in a global pest insect – *Cydia pomonella* (L.). PLoS ONE 7.

Spatial downscaling

Climate change scenarios for Switzerland at 2 km spatial resolution were produced by kriging of trend residuals with external drift, using height as auxiliary predictor (Zubler *et al*. 2014). The data was used as input to a simple temperature-sum phenology model to examine key developmental stages of the spotted wing drosophila, a pest that has only recently appeared in Switzerland but is already causing considerable damages.

Spotted wing drosophila (*Drosophila suzukii* Matsumura)

- Earlier egg laying start: 9±3 days (mean±sd)
- First egg laying day up to 20 days earlier (minimum)
- Lower winter mortality: decrease of 33±6 days < 10°C

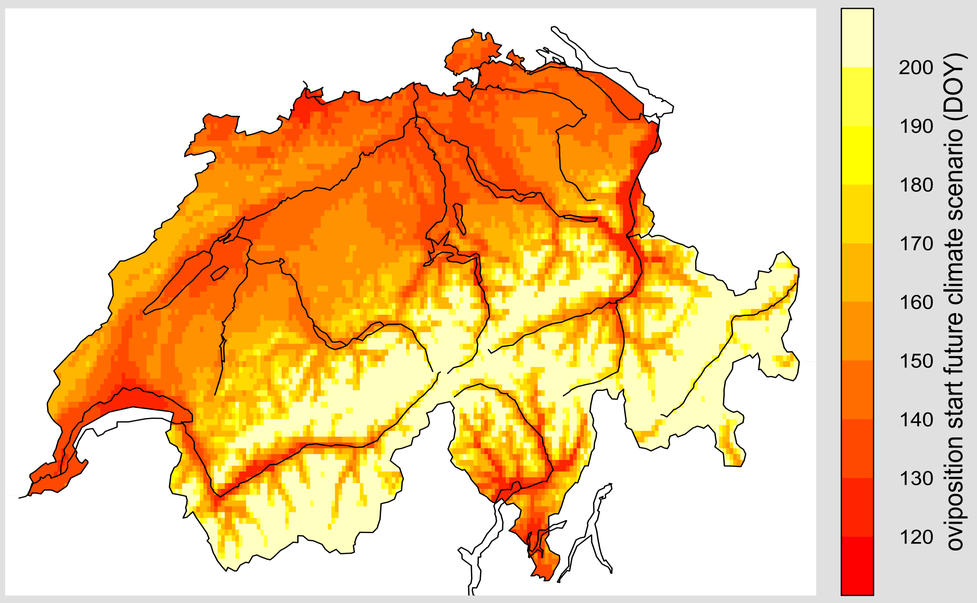

Fig. 3. Spotted wing drosophila. Start of egg-laying for overwintering flies under future climatic conditions. DOY: day of the year). Temperature-sum phenology model: 145 degree days > 10°C, start DOY 1. Stoeckli et al. (2015) In preparation.

Conclusion

- The use of weather generators is appropriate when detailed simulations of pest phenology at the local scale are needed as a basis for discussing specific adaptations of plant protection strategies.
- Spatial downscaling is adequate when the goal is to assess changes in species distribution, food-webs or relevant life-history traits at the regional or country scale.

Needs for future research

- Integration of additional climate and pest parameters in impact models: climate variability, life-history traits.
- Simulation of coupled host-pest dynamics.
- Coordination of monitoring, climate indicators and risk analysis across sectors and the EU.

Acknowledgement:
The codling moth project was funded by the Swiss State Secretariat for Education and Research SER in the framework of COST 734 The contribution of MeteoSwiss was additionally funded by the National Centre of Competence in Research on Clilmate (NCCR Climate) of the Swiss National Science Foundation.

References:
Fischer A.M. et al. (2012) Climate change projections for Switzerland based on a Bayesian multi-model approach. Int J Climatol. 32: 2348-2371.
Hirschi M. *et al.* (2012) Downscaling climate change scenarios for apple pest and disease modeling in Switzerland. Earth System Dynamics, 3, 33-47.
Zubler E.M. et al. (2014) Localized climate change scenarios of mean temperature and precipitation over Switzerland. Climatic Change, 123, 255-271.