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Sub-seasonal forecasting of agricultural pests in Switzerland

Downscaling monthly weather forecasts for pest modeling

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1. Introduction

Apple orchards are constantly threatened by pests and diseases, and the production depends on effective pest and disease control measures. In order to avoid unnecessary treatments and with regard to sustainable plant protection strategies, accurate pest forecasting tools have been developed to predict the infestation depending on actual weather conditions.

Figure 1. *Codling moth larva feeding in an apple.*

The codling moth (Fig. 1) is the major insect pest in apple orchards worldwide and damage is caused by the larvae, which burrow into the fruit to feed on the flesh. Depending on the climatic condition (and genetically determined phenology), the species can form up to five generations per year in the warmest apple growing regions or only one generation in the coolest production areas.

2. Current pest forecasting and upcoming extensions

The pest forecasting tool SOPRA (Samietz et al. 2008) is operationally used in Switzerland to provide information about the timing of different life phases of codling moth depending on local weather. The forecasted key events of the life cycle include the flight start of the overwintering adults in spring, oviposition, three larvae hatch phases (start, 20% and 45%), the flight introducing the next generation etc.

Currently, SOPRA is driven by observed hourly weather (i.e., temperature, solar radiation) up to the present day, plus the hourly climatology for the upcoming weeks (Fig. 2).

Here, we aim at investigating the potential benefits of including probabilistic monthly weather forecasts (MOFC) from ECMWF for predicting the timing of codling moth life phases in Switzerland. This requires a statistical downscaling of the MOFCs from weekly to hourly resolution in order to fit the requirements of the pest model and also to cope with bias in the MOFC fields.

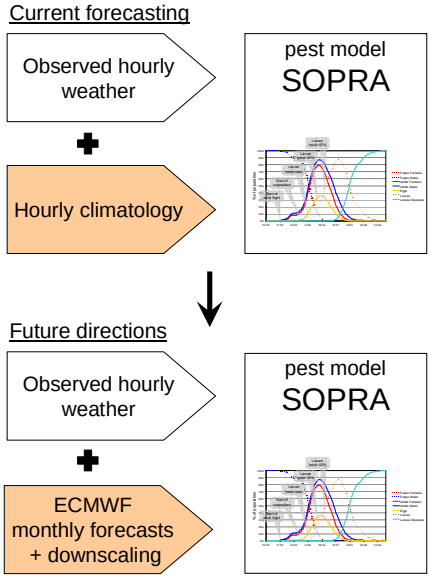

Figure 2. *Current and future pest forecasting.*

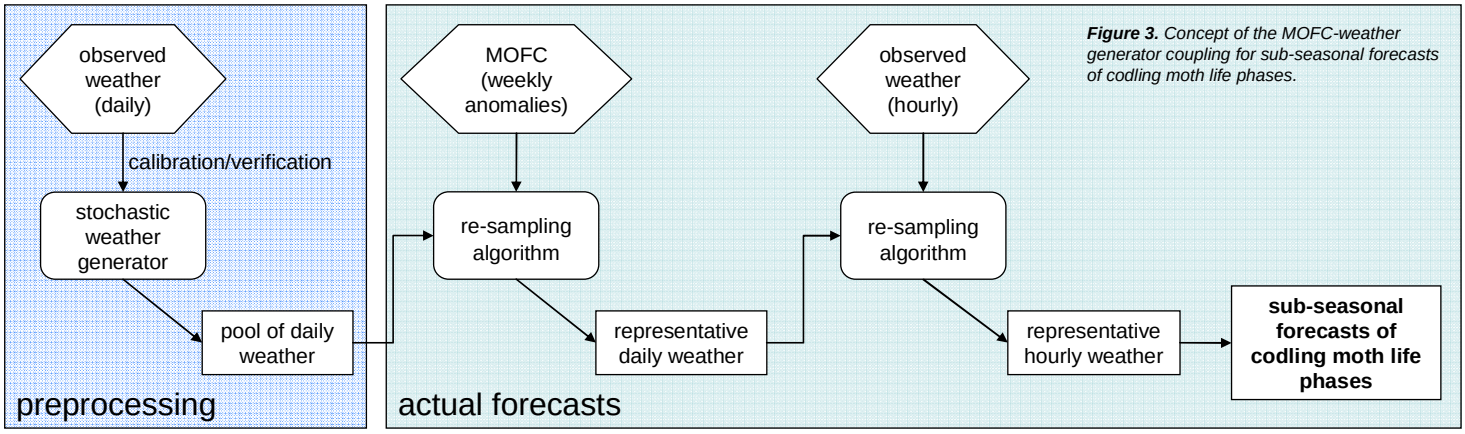

Figure 3. *Concept of the MOFC-weather generator coupling for sub-seasonal forecasts of codling moth life phases.*

3. Statistical downscaling concept

- In a first step (Fig. 3), a pool of synthetic daily weather series of precipitation, solar radiation and temperature (daily average and range) are produced using the parametric stochastic WG M&Rfi (Dubrovsky et al., 2004). These series are on average consistent with the climate at a given location.
- From this pool, representative weather series consistent with the weekly anomalies of the MOFC members are sampled. This implicitly bias-corrects the MOFCs (Calanca et al. 2011).
- In a last step, a *k*-nearest neighbor re-sampling from hourly observations is employed to disaggregate the selected synthetic daily weather series into hourly resolution. A similar procedure has been recently applied for downscaling climate change scenarios for future pest and disease projections (Hirschi et al., 2011).
- The resulting hourly series are then used as input for the pest forecasting model.

4. Next steps

- Implementation and verification of the statistical downscaling of MOFCs with hindcast experiments.
- Integration of the downscaled MOFCs into the SOPRA system and verification of forecasted timings of codling moth life phases in test mode.
- Operational implementation of the new forecasting systems and assessment of the benefits for the field management of codling moth.

5. References

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