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Tailored AGROmeteorological FORECAST for improving resilience and sustainability of Austrian farming systems under changing climate

INTRODUCTION

Despite increasing appreciation of the potential value of weather forecasts for agriculture, there is still a gap between what scientists consider as "useful" information and what users (e.g. farmers, advisory services, policy makers) recognize as "usable" in their decision-making processes. To address the inadequate tailoring of weather forecasts into more "usable" forms, the basic probabilistic forecast data need to be translated into tailored agrometeorological forecast products for specific set of decisions in order to increase efficient use of resources (e.g. timing and amount of crop specific fertilization and irrigation).

PROJECT AIMS

The overall objective of AGROFORECAST is to combine agrometeorological models/indicators with weather forecasts in order to optimize agricultural decision-making in the face of changing climate and climate variability. Beside the forecast of weather-related cropping risks (see Tab. 1), a focus is laid on efficient use of inputs for crop production (water, fertilizer, agricultural chemicals) needed for smart and precision farming practices (application of the "icrop" crop model), while protecting (agro-) ecosystem resources and functions. This will assist the stakeholders in identification of suitable and, from a stakeholder perspective, acceptable adaptation and mitigation options.

METHODS and TOOLS

- Online Survey: Identify the key weather-related decisions and the needs and expectations of farmers (WP 1)
- Develop and test state-of-the-art downscaling approaches to bring the global seasonal ensemble forecasts closer to the scales convenient for farm decision making (WP 2)
- Develop and test tailored decision support information by linking weather forecasts with agro-climatic risk indicators and crop management indicators by validated risk algorithms (ARIS, Table 1) and crop models (iCrop) (WP 3)
- Evaluate/demonstrate the performance/accuracy as well as the socio-economic and ecological value of the combined forecast products and estimate its potential contribution for maintaining/increasing biodiversity and other ecosystem services in the landscape

RESULTS (first year)

- WP1: Results of survey of farmers needs available (Fig. 1; see separate Poster of M. Palka)
- WP2: Tested downscaling algorithms of seasonal forecasts and automatic data transfer routine (Fig. 2)
- WP3: The crop model iCrop tested for new N-fertilization algorithm; extended set of cropping risk indicators (pest models) available and tested with forecasts (Fig. 3)
- WP4: Dissemination and evaluation of tailored forecasts (started after first year, ongoing test of forecasting products for farm application with selected farmers)

OUTLOOK

- WP1: Collecting further farmer feedbacks during application of forecast products
- WP2: Validate downscaling performance with in-situ measurements for different lead times
- WP3: Application and further evaluation at farm level of the forecast indicator models; using feedbacks (WP1) for tailoring to farmer needs; assessing socio-economic impacts; develop policy recommendations
- WP4: Dissemination activities with stakeholder groups such as farmers and the general farming sector; scientific and public relation publications

Tab.1. ARIS cropping risk algorithms applied

	Description
Crop independent risk indicators	
Number of days with snow cover	Number of days with snow cover from September 1st to August 31st.
Number of early heat stress days	Number of days between January 1st and June 15th with mean daily temperatures above 28°C (optionally above 32°C or 35°C).
Number of heat wave days	Total number of days per year within episodes when maximum daily temperatures are continuously above 30°C and the minimum daily temperatures are continuously above 20°C for at least 3 consecutive days.
Number of frost stress days	Number of days from September 1st to August 31st with minimum daily temperatures below -10°C and no continuous snow cover (i.e. snow cover below 3 cm).
Number of winter severity days	Number of days with freezing temperatures (temperatures below 0°C) per year.
Sum of effective temperatures above 10°C [°C]	Sum of effective temperatures (base temperature = 0°C) per year for days with minimum daily temperatures equal or above 0°C, with mean daily temperatures above 10°C and with maximum daily temperatures equal or below 35°C.
Duration of the vegetation summer	Number of days per year with mean daily temperatures continuously above 15°C (i.e. mean daily temperatures do not drop below the threshold value for more than 3 days) and minimum daily temperatures above 0°C.
Potential water balance sum values [mm]	Sum of the differences between the daily precipitation values and the reference evapotranspiration values (PWB = ∑ precipitation – ET0) from April 1st to June 30th (optionally from April 1st to September 30th).
Crop specific risk and impact indicators	
Number of days with intensive water deficit [mm]	Number of days from April 1st to June 30th (optionally from April 1st to September 30th) with quotients of the actual evapotranspiration and the reference evapotranspiration below 0,4 (AET/ET0 < 0,4).
Effective global radiation sum Index [MJ/m2/day]	Sum of daily global radiation values per year during days with mean daily temperatures above 5°C and water stress coefficient values above 0,4.
Field working days (days with soil conditions suitable for harvesting)	Number of days per month when the mean daily precipitation value on day N is less than 0.5 mm; on day N-1 is less than 5 mm, on day N-2 is less than 10 mm and on day N-3 is less than 20 mm. Moreover, the soil water content of the soil's upper 20 cm must not be higher than 70% of the maximum soil water holding capacity.
Huglin index for grapes	The Huglin index is a function of the mean and maximum daily temperatures and is summed up from April 1st till September 30th.
Apple phenology and frost risk model	Considering chilling requirement and temperature sums for flowering time and coincidence with frost occurrence.
Overwintering damage risk cereals	Overwinter damage risk for winter barley and rape and general overwintering risk for cereals, based on damage risks with and without snow cover (frost risk and disease risk in combination)
Improved drought/heat risk damage risk for permanent grassland	Based on grassland yield field experiments the ADA algorithm was re-calibrated
Western Corn Root Warm risk	Algorithm for the occurrence of Western Corn Rootworm based on weather conditions and crop rotation
Grapevine peronospora risk	Successfully calibrated algorithm for grapevine peronospora tested on Austrian locations

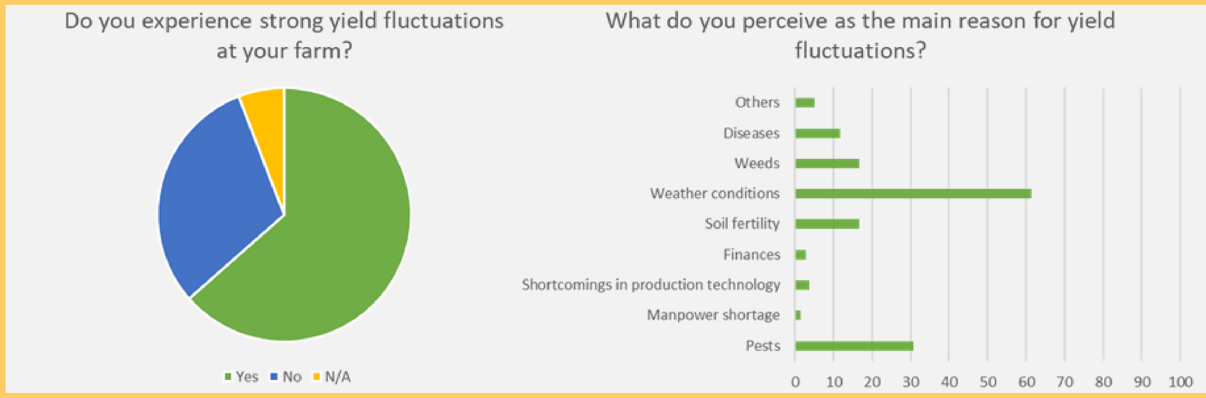

Fig.1. Example of the survey results from Austrian farmers

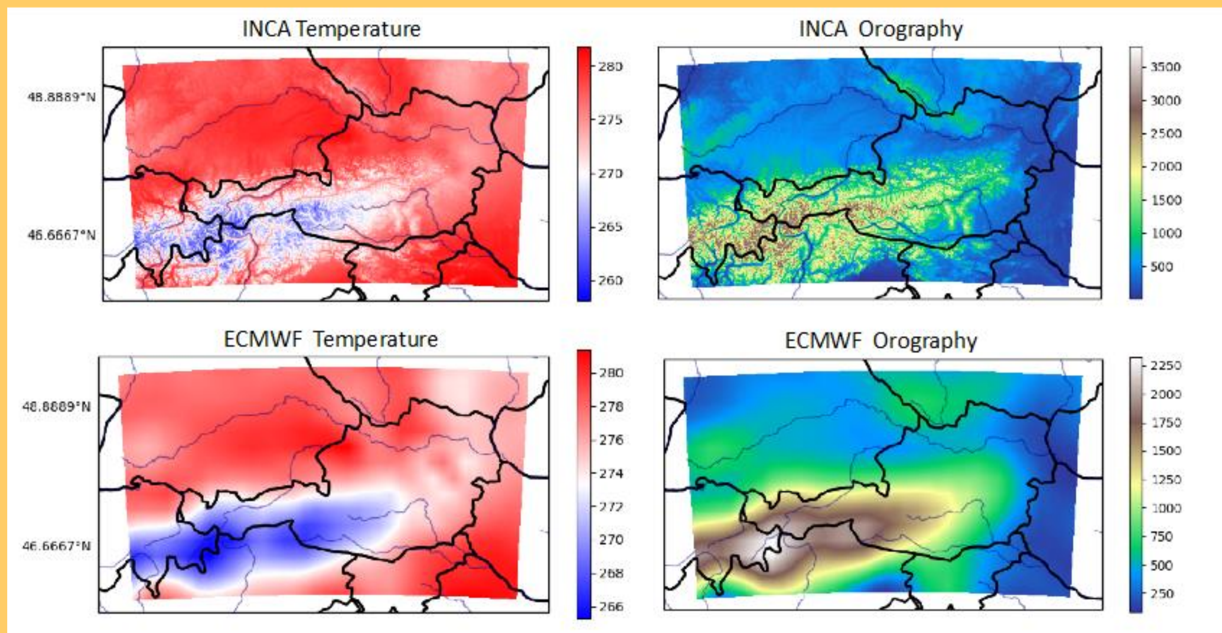

Fig.2. Example of the inputs (ECMWF fields in the lower row) and the outputs of the INCA downscaling methodology (upper left) using the 1 x 1 km resolution from a DEM model (upper right)

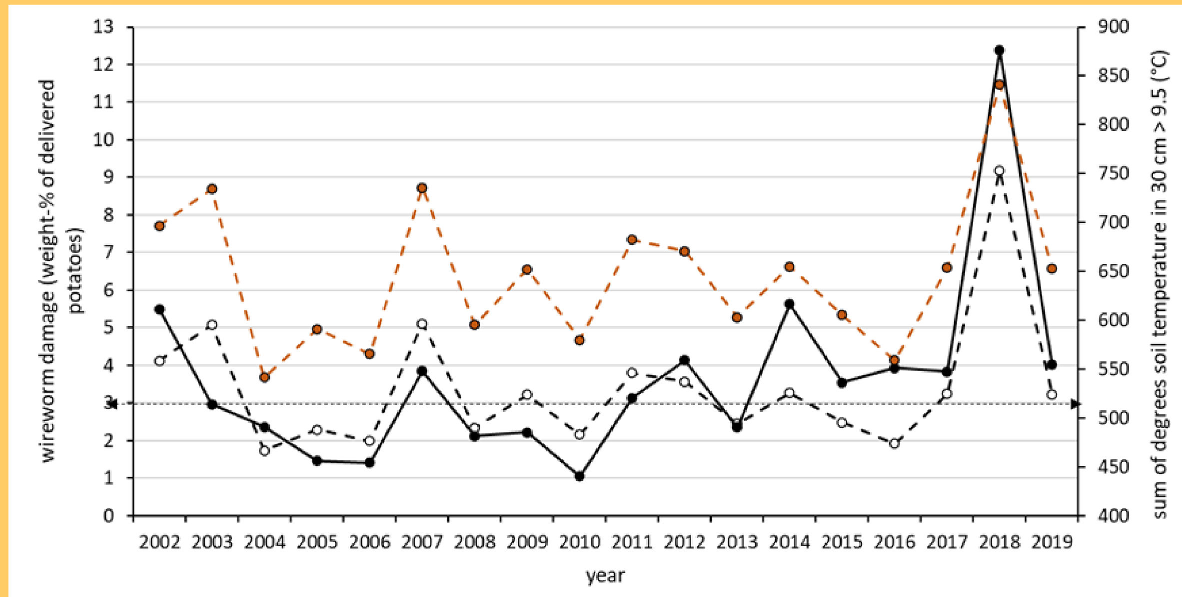

Fig.3. Example of developed and improved pest models: Established wireworm damage risk model in potatoes on basis of air temperature in spring.