Description of the compiled experimental data available in the MACSUR CropM database

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Abstract

The input data necessary for crop model simulations and data for their calibration/validation (and thus requirements for observations and measurements in suitable experiments) have been collected through out the project together with data for additional analysis of abiotic factors influencing yields. A list of possible dataset was collated in the first year of project however very few of the existing datasets were found usable for the crop model simulation as they fell short of the requirements defined in the part 2.3. However database has been populated as planned with the results of the ongoing MACSUR studies and will serve in the same way for the MACSUR 2 duration.

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Introduction

This task was aimed at collecting data from all other WPs, including both experimental data as well as model simulated results and will draw on experience gained during past activities, e.g. Kersebaum et al. (2007), Palosuo et al. (2011) or Rötter et al. (2014).
At present crop models represent one of the few tools available for complex studies assessing the potential climate change impacts and available adaptation options but they depend on the extensive experimental datasets for proper calibration and evaluation. Therefore it was one of the goals of MACSUR to ensure further development of the crop models which cannot be realized without significant use of new experimental data. However as it will be shown the experiments designed for crop model calibration and validation are still scarce. That is despite existing for new information to inform crop modelling on aspects not well covered in the models (Craufurd et al., 2013).

From the on-going experiments that have been set-up for different purposes, we have tried to select those that could be used for crop model calibration and validation. In this way for relatively small cost high quality datasets could be obtained in relatively short time. The dataset went through the evaluation to what extend they fulfil the protocol submitted in the C:2.3. In the same time it was decided to use the build up database to serve as data repository of completed crop model runs including especially their input and output data.

Methods

During the first 6 months of the project following sets of data listed in the Tables 1 and 2 were collated and checked for the consistency with the crop modelling criteria. These tables presented in as the Excel tables include over 120 experiments which were made available by the partners. The data on these experiments included not only their description but also the sample of the data. Additional queries were made in case that provided data were not found to be sufficient.
Based on the critical survey of the data following datasets were selected for the first analysis carried ou by Kollas et al. (EJA – in print). In this case study five experimental crop rotation datasets (Figure 1), each containing a different set of different treatments (Table 3) were selected. The datasets cover the European environmental zones of the Atlantic North, Atlantic Central, Continental and Pannonia (lowlands, valleys and mountain peripheries on the Middle- and the Lower-Danube Plains and the Black Sea area), according to Metzger et al. (2005,). Overall, the study provided experimental data on 301 growing seasons and ten distinct crops that are now part of the database. The study by Pirttioja et al. (in print) focused on four sites (Figure 2) and continues wealth of data from 21 individual models and 26 independent model runs both for the present and future climate. Finally study by Hlavinka et al. (in print) contains data from 3 sites and single model (Figure 3) but it is being followed by large scale modelling exercise including 13 crop modelling groups using 9 different crop models.

Table 3: List of the experimental data that are part of the common database including the crop model runs. In black those used in the Kollas et al. (EJA in print) study; in red those used by Pirttioja (in press) and in green those used by Hlavinka et al. (in print) studies.

- DK – Foulum (crop rotation with high observation density for winter wheat added)
- DE – Münchenberg (crop rotation with high observation density data)
- DE – Braunshweig FACE CO2 experiment (crop rotation)
- AT – Hirstetten (3 soil types with crop rotation) – in Pannonian basin
- FR – Thibie – (crop rotation experiment)
- FI – Jokkionen (crop model and weather calibration data)
- DE – Dikopshof (crop model and weather calibration data)
- DE – Nossen (crop model and weather calibration data)
- EP Lleida (crop model and weather calibration data)
- CZ Domanínek, Věrovany, Lednice (single crops – experiments designed for crop model testing and improvement) includes spring barley, winter wheat, oil seed rape. Plus crop rotation experiments by crop models

Fig. 1. Set of experimental sites used in the Kollas et al. (in print) study that are now part of the database.

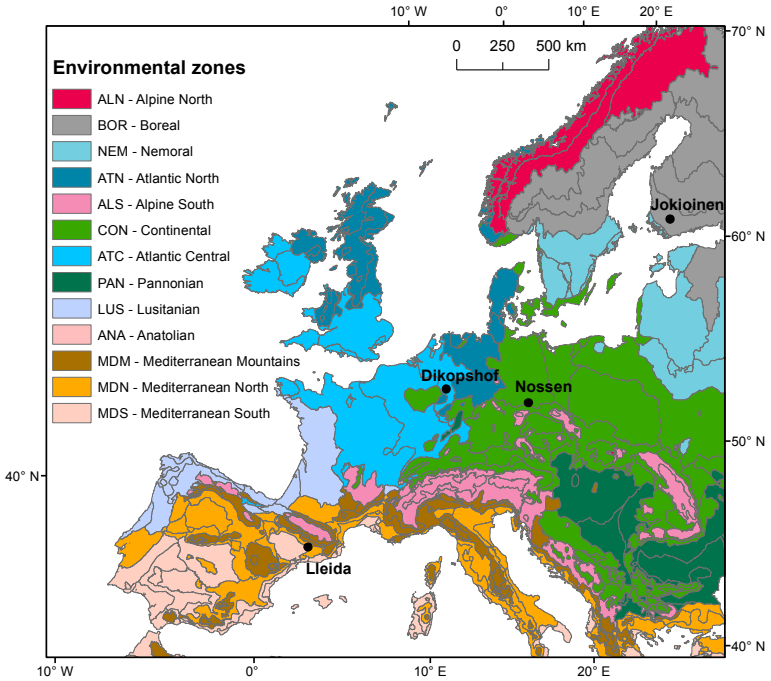

Figure 2. Locations of weather stations used in this study superimposed on environmental zones as defined by Metzger et al. (2005).

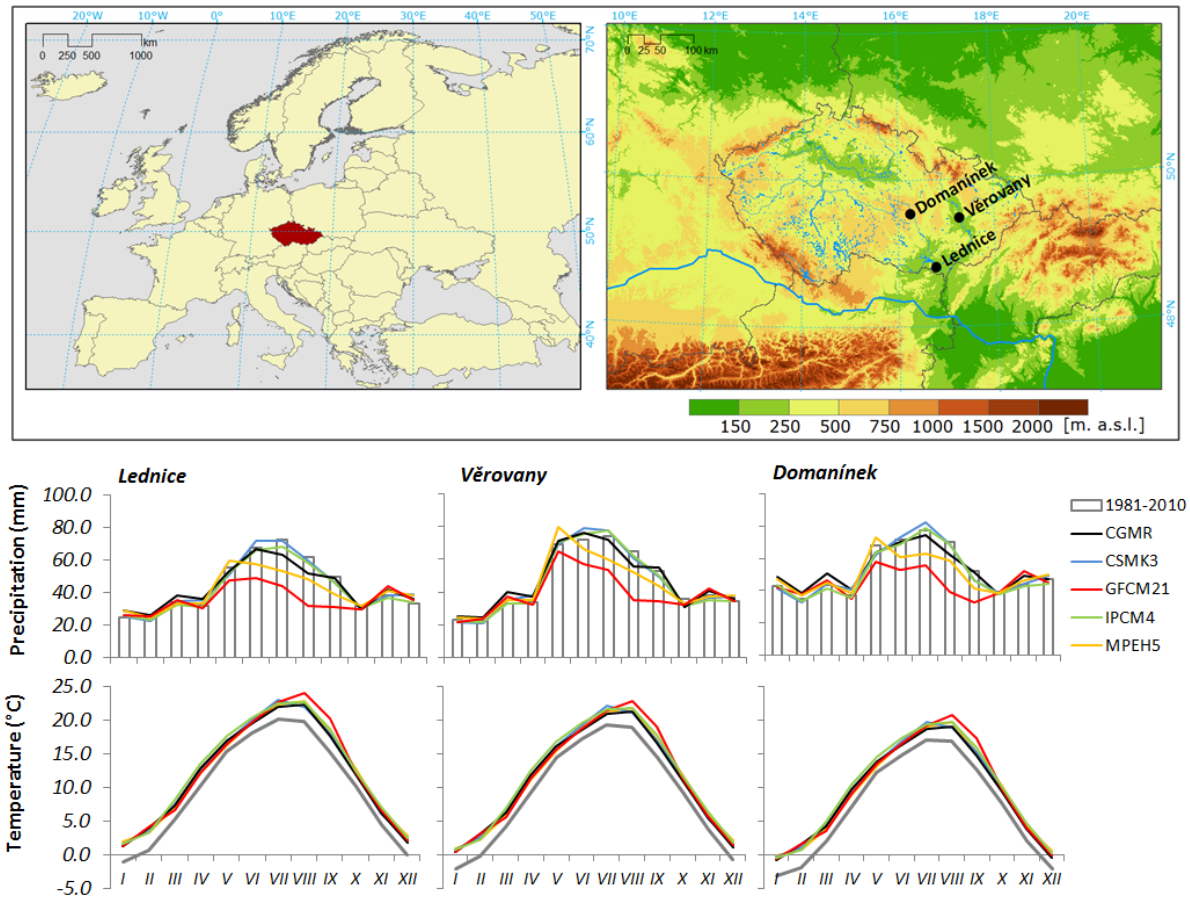

Fig. 3 Position and monthly air temperature and precipitation totals for 3 included stations: measurements from 1981-2010 and expected values for the period 2061-2080 according to the RCP 4.5 (climate sensitivity 3.0 K) associated with 5 GCMs (MPEH5, CSMK3, CGMR, GFCM21, and IPCM4) used in the Hlavinka et al. (in print) study.

The data contained in the database typically include:

- Daily weather data typically at least:
    - Global radiation that might be measured directly or calculated from daily sunshine duration hours or cloud cover estimates;
    - Maximum and minimum temperatures measured at 2 m height
    - Precipitation
    - Mean air humidity and daily mean wind speed (optional)
- Soil data should include detailed description of the soil profile at the experimental site, especially
    - Description of the main horizons, their thickness and the soil type
    - Soil texture data for each horizon in the soil profile. Texture information should contain data on the percentage of stone and gravel content as well as clay, silt and sand.
    - Bulk density of individual horizons.
    - Carbon (or organic matter content) and content of total nitrogen (optional) in individual profiles (mainly for tillage layer).
    - Depth of the water table and with information on seasonal variation, if needed.
- Initial condition data contain "start" conditions for the experiment (optional)
    - NO_3 and NH_4 content in individual soil horizons at the time preceding sowing
    - Water content in individual soil horizons at the time preceding sowing
- Crop information include
    - Name of the crop species and name of cultivar and ideally its origin and type
    - Dates of sowing, emergence, anthesis, maturity and harvest
    - Grain yield (as dry matter) and grain N content
    - Number of grains and ears per area for cereals (optional)
- Management information include
    - Information on the layout and technology used in the experiment
    - Previous crop
    - Dates, amounts and types of fertilization, in particular for nitrogen (if not given as pure nutrient amount, nutrient content per application unit has to be given, e.g. for slurry)
    - Seed density (or seed rate) and depth of seeding
    - Soil tillage, including type, dates and depth
    - Date and amounts of irrigations (optional: if relevant nutrient content)
    - Other operations (e.g. application of pesticides), which have affected crop growth
- Meta-data shold include as detail assessment of the experimental season as possible including reports on the positive and negative factors influencing yield especially
    - Occurrence of extreme meteorological events (hail, drought, floods, etc.)
    - Lodging or other direct damage to the experiment
    - Occurrence of weeds, pests and diseases especially in cases which could influence significantly the yield level or phenology

At the moment however larger number studies are ongoing including continuation of the studies by Pirttioja et al. and Hlavinka et al that will include different sites and have trans-European reach.

To supplement the experimental analyses conducted in WP1 and WP3, the data necessary to perform a statistical analysis of the data collected to derive empirical relationships between climate variables and crop yield as well as other indicators of cropping system functioning have been collected since 2012 and after careful check fed into the database. Currently the work includes data on oil seed rape (Table 4) that has been checked and put into the database. Similar collection efforts takes place for winter, spring wheat and spring barley under the leadership of the MTT and CzechGlobe with participation of other 10 MACSUR countries. The data are being grouped into different categories separating data

Table 4: List of data for empirical analysis of the oil seed rape collected and uploaded to the MACSUR database.

Country	No. Of sites	Site	Number of Years	Data- Level 1	Data - Level 2	Remarks
Italy	10	Anzola	3	+	+	
		Cassibile	2	+	+	
		Cesa	2	+	+	
		Gravina	3	+	+	
		Legnaro	2	+	+	
		Osimo	4	+	+	
		Palazzolo	2	+	+	
		Ussana	2	+	+	
		Ottana	1	+	+	
		Ottava	2	+	+	
Poland	4	Palikije	2	+	+	
		Radostowo	3	+	+	
		Lisewo	4	+	+	
		Zelislawki	3	?	+	soil type is missing
Romania	1	Rusu Teodor	3	+	-	
Germany	22	Beetzendorf	18	+	+	
		Biestow	15	+	+	
		Birkenmoor	10	+	+	
		Borwede	15	+	+	
		Bösingen	18	+	+	
		Christgrün 1	10	+	+	
		Eichhof	16	+	+	
		Forchheim	14	+	+	
		Futterkamp 1	13	+	+	
		Gadegast	16	+	+	
		Krauchenwies	18	+	+	
		Nossen 3	11	+	+	
		Oberhaunstadt	13	+	+	
		Oberhummel	17	+	+	
		Pommritz	16	+	+	
		Reith	16	+	+	
		Rosenhof	17	+	+	
		Schuby 1	14	+	+	
		Sophienhof 1	15	+	+	
		Söllitz	13	+	+	
		Walbeck	18	+	+	
		Walbeck 2 /(BSV)	12	+	+	
Czech Republic	12	Chlumec nad Cidlin	6	+	-	soil type is missing
		Chrastava	18	+	-	soil type is missing
		Horažďovice	14	+	-	soil type is missing
		Hradec nad Svitavo	20	+	-	soil type is missing
		Jaroměřice nad Rok	18	+	-	soil type is missing
		Krásné Údolí	7	+	-	soil type is missing
		Lednice	7	+	-	soil type is missing
		Libějovice	17	+	-	soil type is missing
		Lípa u Havlíčkova B	17	+	-	soil type is missing
		Pusté Jakartice	16	+	-	soil type is missing
		Staňkov	17	+	-	soil type is missing
		Vysoká	16	+	-	soil type is missing
Denmark (more than 5 years of data available)	22	Brønderslev	7	+	+	
		Fakse	7	+	+	
		Hadsten	7	+	+	
		Hinnerup	6	+	+	
		Hjerm	6	+	+	
		Holeby	17	+	+	
		Horsens	11	+	+	
		Karise	6	+	+	
		Klarup	7	+	+	
		Køge	8	+	+	
		Odder	6	+	+	
		Ringsted	8	+	+	
		Rødekro	6	+	+	
		Skive	15	+	+	
		Skælskør	14	+	+	
		Store-Heddinge	6	+	+	
		Sønderborg	9	+	+	
		Tølløse	6	+	+	
		Vrå	10	+	+	
		Ørbæk	14	+	+	
		Aabenraa	11	+	+	
		Aakirkeby	15	+	+	

at different scales and for different cultivation (management) conditions. A methodology derived by Kristensen et al., 2010 to group weather impacts into different crop phenological phases is being used together with a range of climatic and agroclimatic

indicators within different crop phenological phases will be used as predictors for crop yield. The resulting relationships will be compared with analyses based on crop models in WP1 and WP3, under both current climate and projected climate change.

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Annex

Table 1 and 2: http://ojs.macsur.eu/index.php/Reports/rt/suppFiles/199/164

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