

# WP6: climate change impact on agriculture and forestry sectors

*IAP's (CZ) contribution  
- focus on climate scenarios and  
crop model simulations*

*(presented by Martin Dubrovsky)*

*Cecilia meeting \*\*\* Chalkidiki, June 13-15, 2007*

# IAP's (CZ) group involved in WP6

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- **agriculturists from IAP+MZLU CZ (Trnka, Zalud, Semeradova, Hlavinka** */unfortunately, no one of them is here/*): run crop models (and other agric. models), which need daily weather data
  - calibration and application of models
  - interpretation of results (including GIS methods)
  - present and changed climate
- **me (Dubrovsky, IAP Prague)**: provides weather input for the above models
  - GCM-based climate change scenarios
  - producing synthetic daily weather series (input to crop growth models) with the stochastic weather generator

# climate change scenarios

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- Scenarios based on RCMs and SDS are not yet available. So we continue developing and application of our climate change impacts assessment methods using the **“surrogate” scenarios (based on most recent GCM simulations)**

# GCM-based scenarios

- **pattern scaling technique:**

$$\Delta X(t) = \Delta X_S \times \Delta T_G(t)$$

where:

$\Delta T_G$  = **change in global mean temperature** .... determined by MAGICC

$\Delta X_S$  = **standardised scenario** ( = scenario related to  $\Delta T_G = 1 \text{ }^\circ\text{C}$  )

... is derived from a “long” (e.g. 100-year) GCM simulation by regressing changes in given climatic variable vs  $\Delta T_G$

***note:** applicability of this method to some climatic characteristics is questionable (e.g. PREC), but we (or just me?) believe that it is justifiable if used together with WG, which can simulate the natural variability*

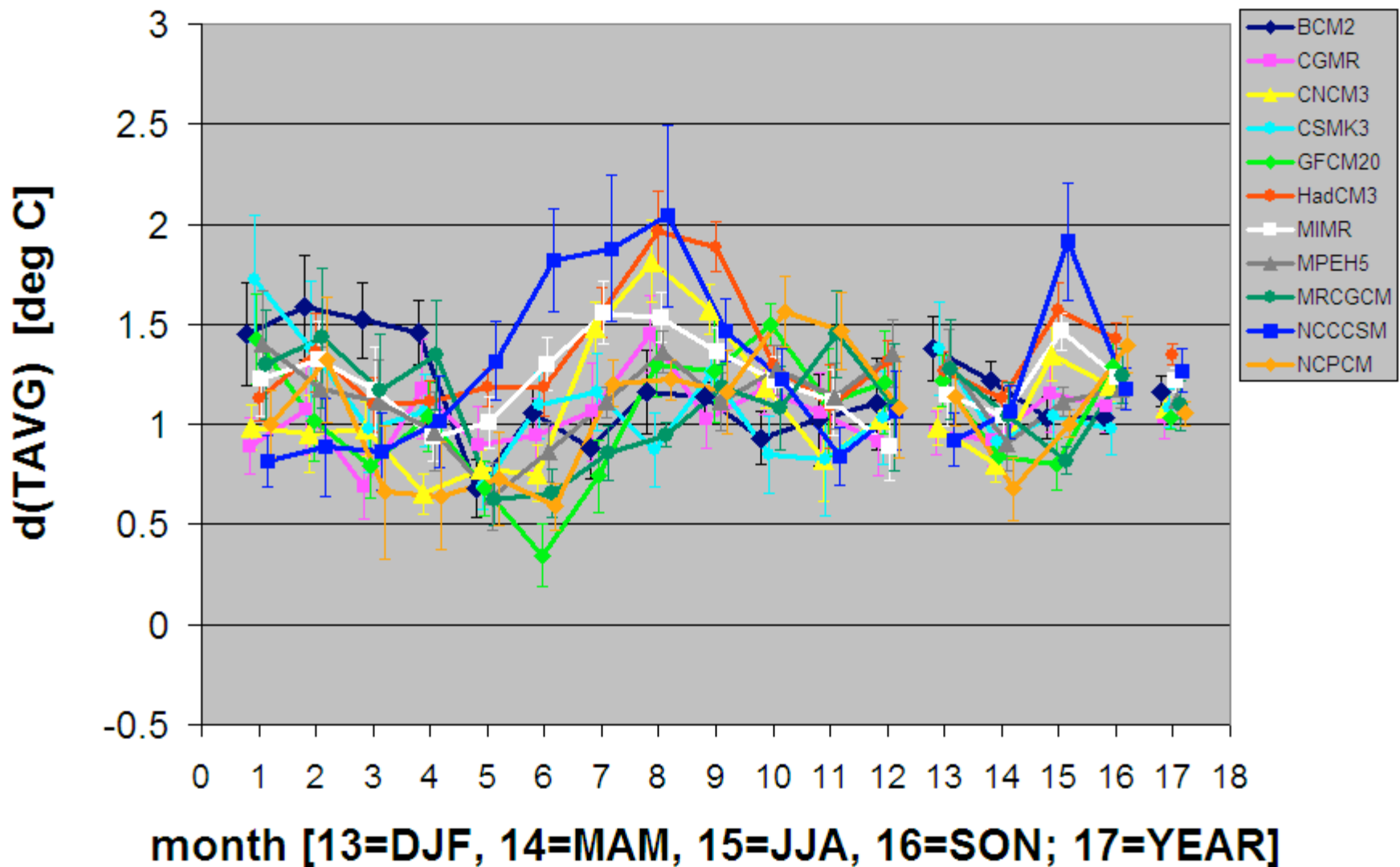
- **we use sets of scenarios to account for uncertainties**

- **uncertainty in scenario pattern:** set of GCMs (*HadCM, ECHAM, NCAR-PCM, CSIRO, ...*)
- **uncertainty in the scaling factor** (function of emission scenario and climate sensitivity in MAGICC) -> 3 versions of the scaling factor for a given period:

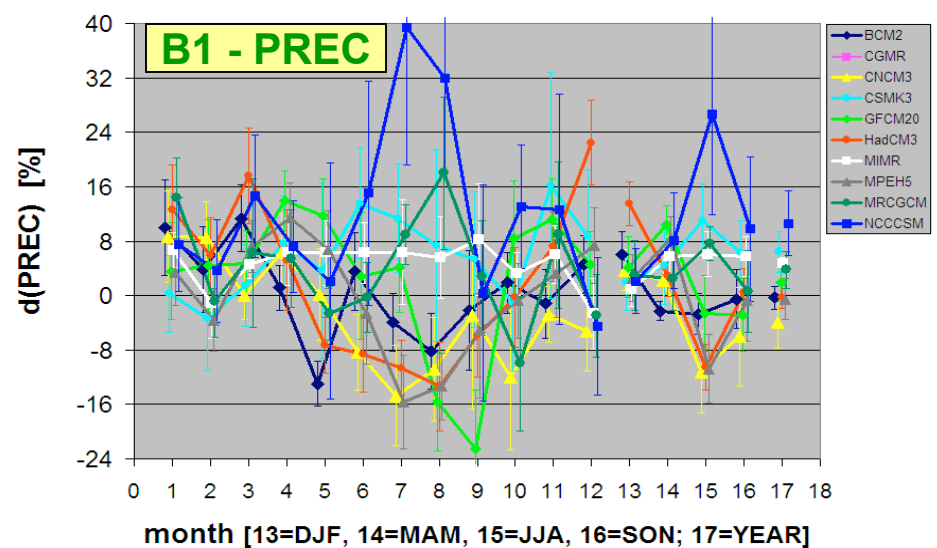
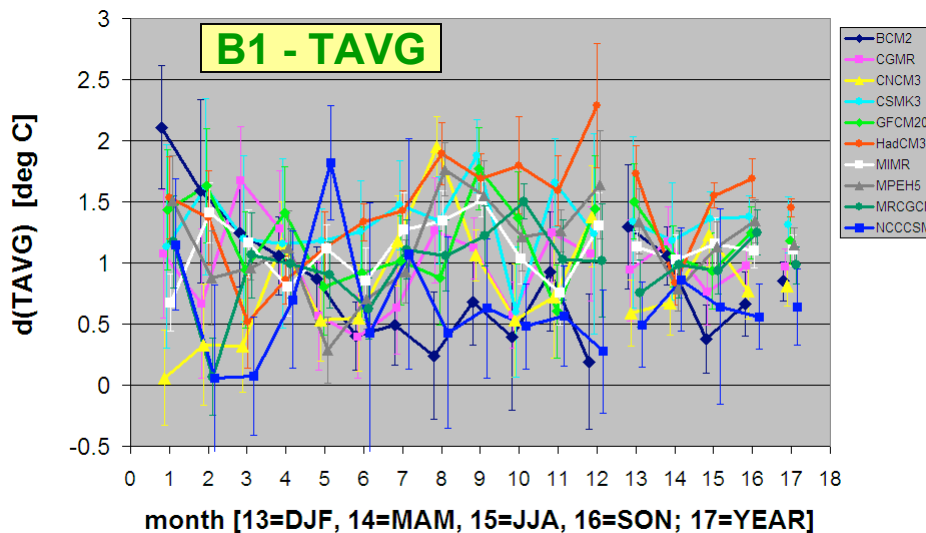
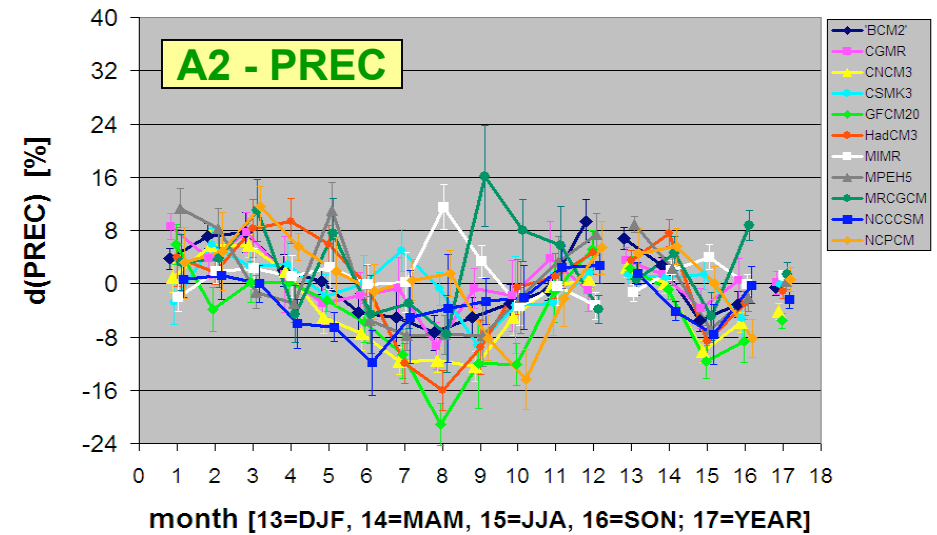
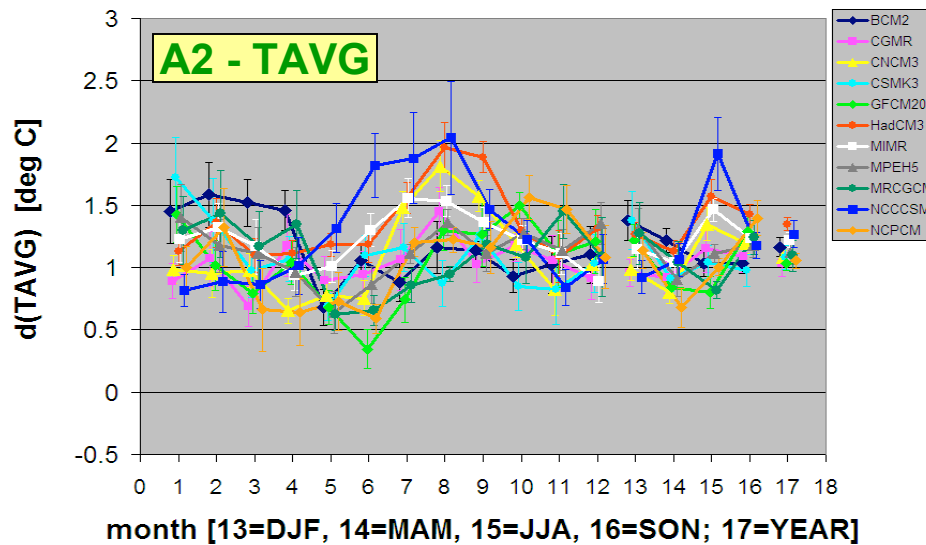
- **high**: high emissions (SRES-A2) + high CS (+4.5 K)
- **mid** : mid. emiss. (SRES-A1b) + mid. CS (+2.5 K)
- **low** : low emissions (SRES-B1) + low CS (+1.5 K)

D(Tg)	2025	2050	2100
low	0.49	0.76	1.17
mid	0.78	1.35	2.09
high	1.17	2.08	4.29

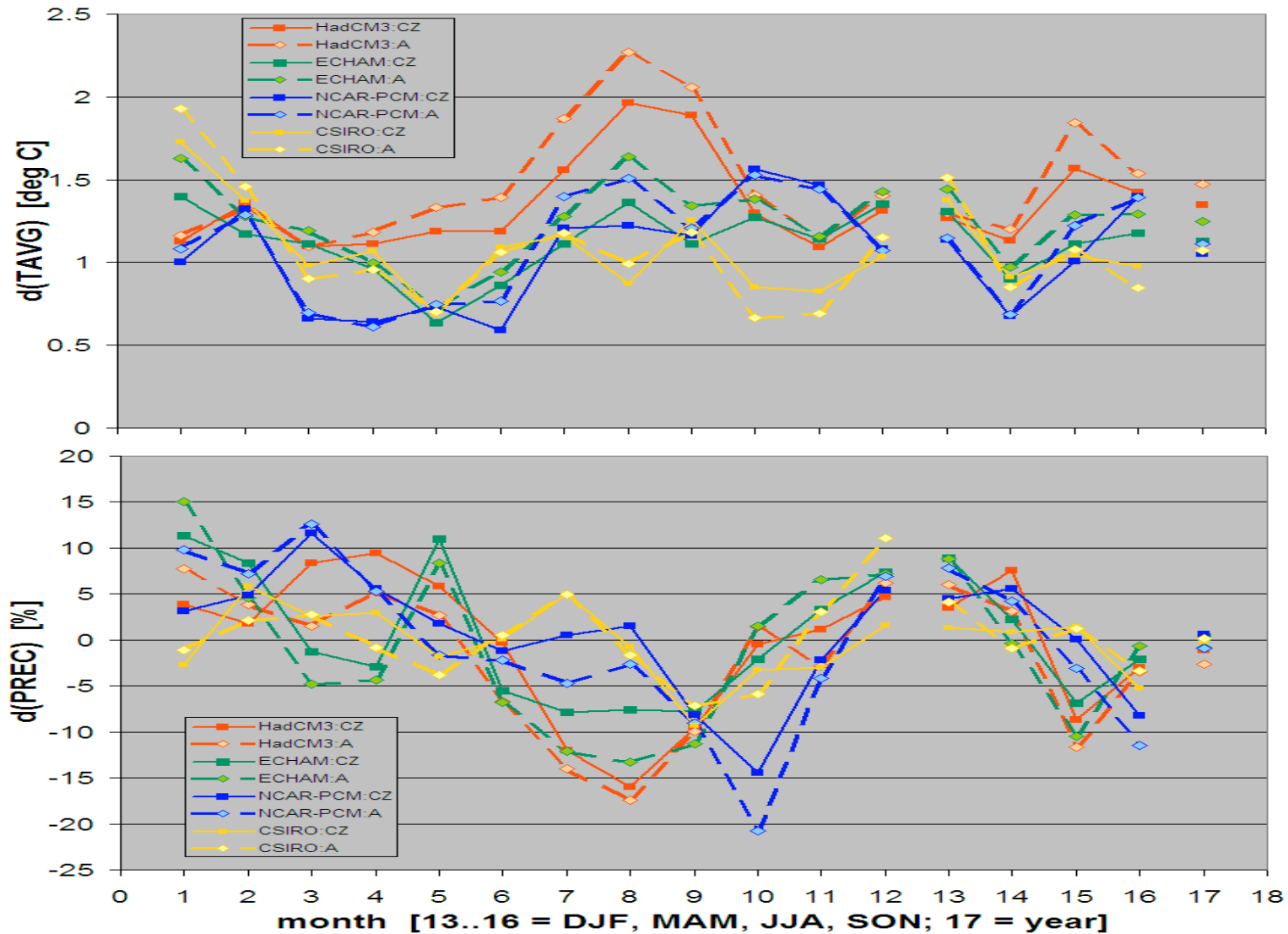
# standardised scenarios for the centre of Czechia [based on GCMs from IPCC-AR4]



# standardised scenarios for the centre of Czechia [based on GCMs from IPCC-AR4]



# standardised scenarios for NE Austria [16.7E, 48.2N] & centre of Czechia [15.5E, 49.8N] (selected 4 GCMs)



# Experiment: spatial crop model simulations for Czechia

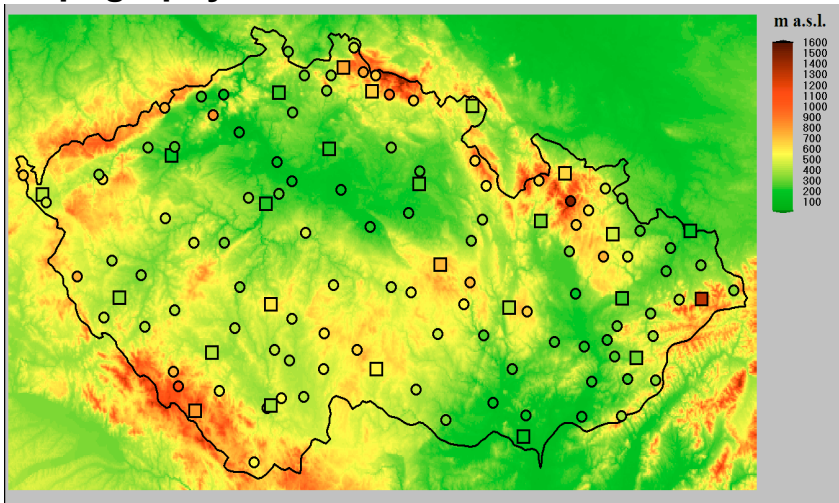
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- **crop model = CERES-Wheat** (*Mirek's words: "very carefully calibrated"*)
- **spatial analysis** (for given climate scenario):
  - **step 1:** the model is used to simulate crop growth for each possible [weather station, soil type] combination
    - (**394 soil types** X **125 stations** = 49250 crop model simulation)
    - soil map:** product of MUAF
    - weather data:** from CHMI
    - each simulation:** 99-year crop model run with **input daily weather series** (*PREC, SRAD, TMAX, TMIN*) produced by the stochastic **weather generator M&Rfi** (follower of Met&Roll; M&Rfi = Met&Roll flexible)
    - present climate:** WG is calibrated using station daily weather series
    - changed climate:** WG parameters are modified according to CC scenario
  - **step 2:** **crop yields are interpolated into 0.5x0.5km soil grid map**. For each grid box, the yield is interpolated from the 125 simulations made for a given grid-specific soil type (interpolation method = nearest neighbours with accounting for the x-y-z trends)

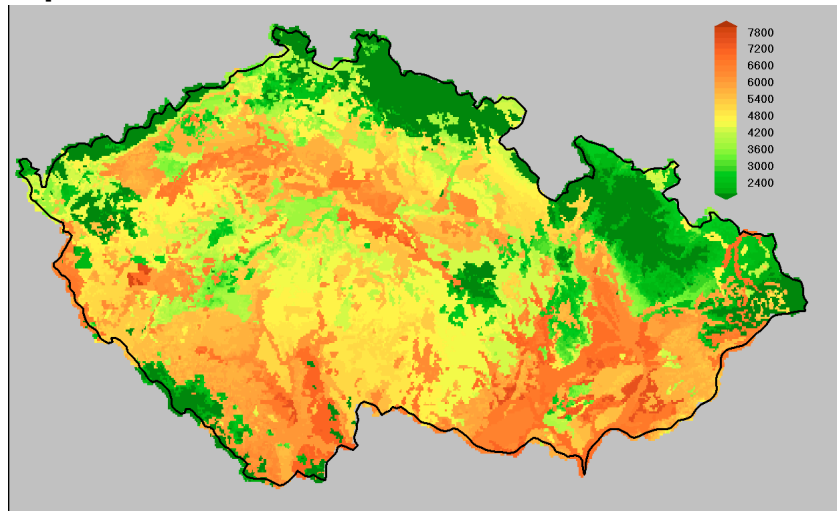
# Interpolated model wheat yields for now and 2050

(data: 125 weather stations X 394 soil types; HadCM3/SRES-A2-high scenario)

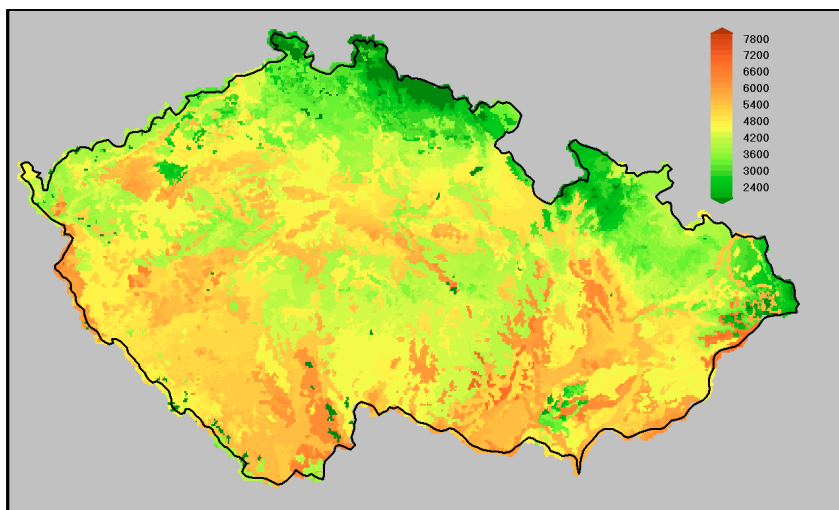
topography of Czechia + 125 weather stations



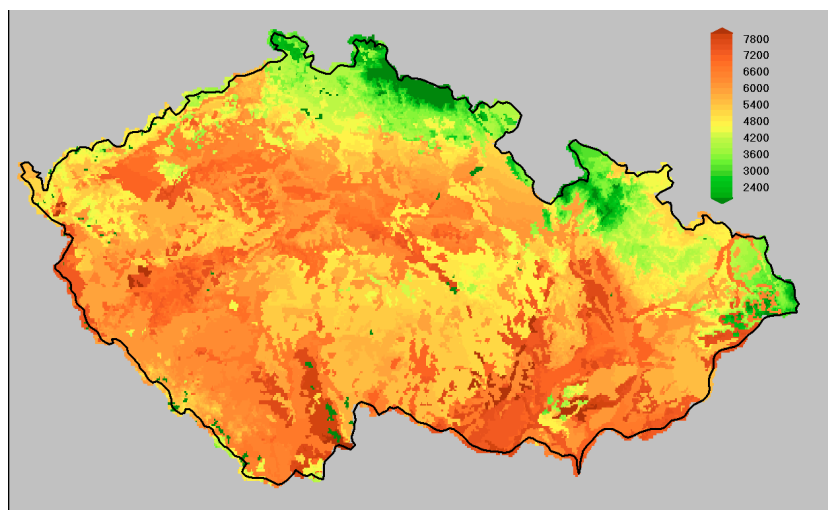
present climate



2050: only changed weather effect



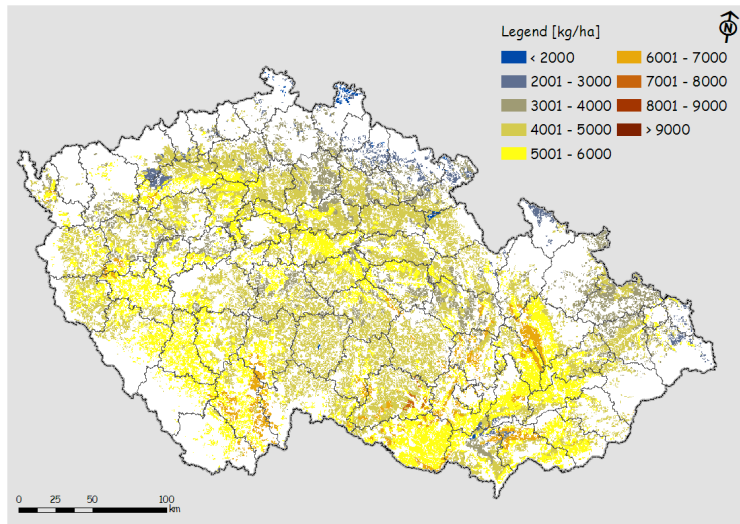
2050: combined effect of CO2+weather changes



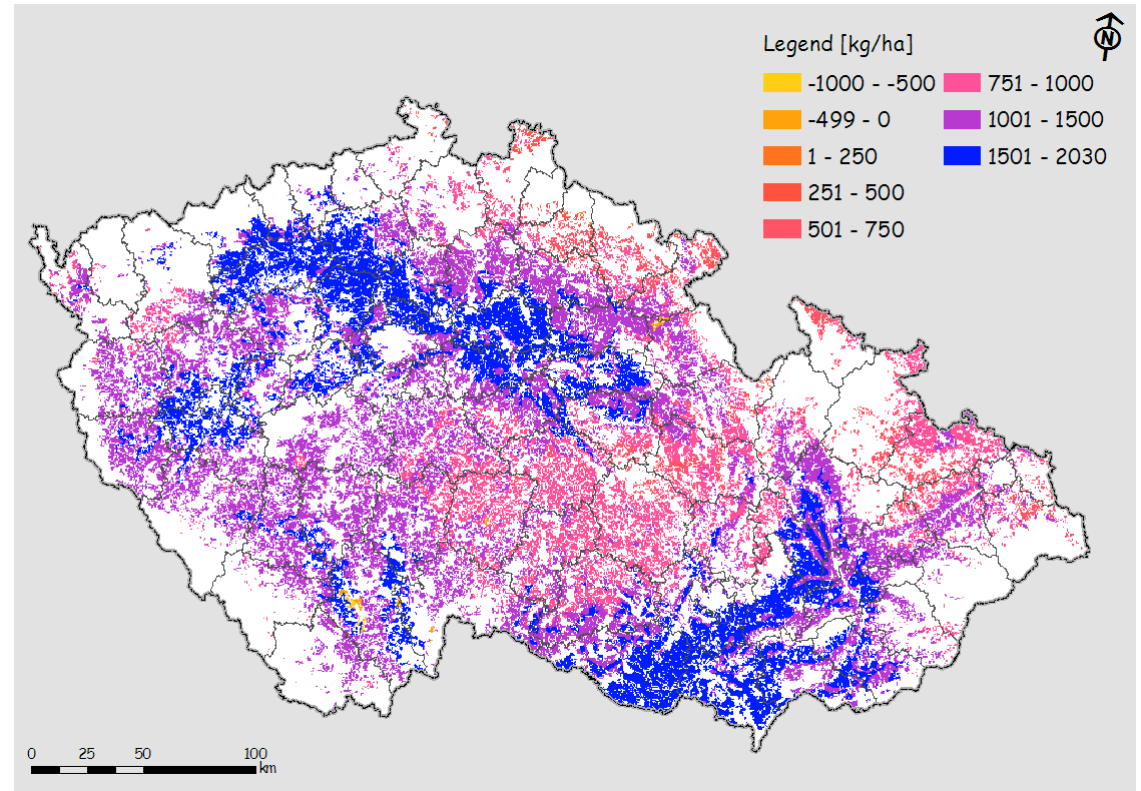
# CC impact on wheat yields - arable lands

(2050 - HadCM3/SRES-A2-high scenario)

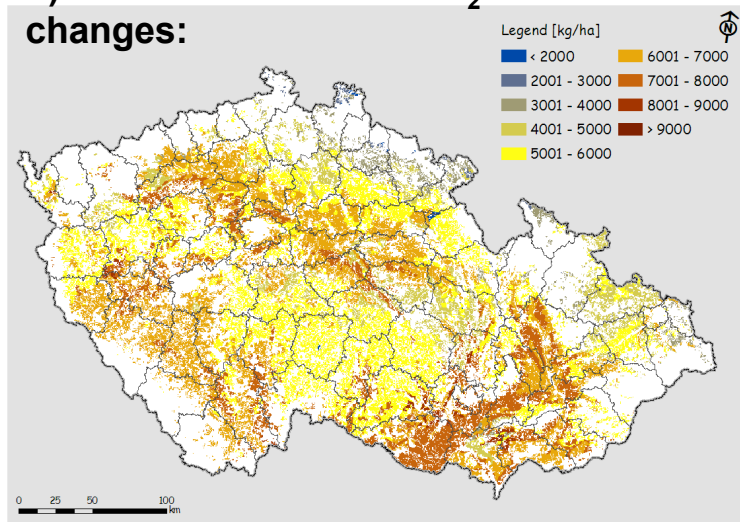
a) only changed weather effect



c) difference: combined effect *minus* weather effect  
( = CO<sub>2</sub> fertilisation effect under changed climate)



b) combined effect of CO<sub>2</sub>+weather changes:



# conclusion

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- **“to do” list:**
  - more detailed analysis of present results; e.g.
    - in terms of other growth/yield characteristics
    - aggregation at district level and validation against observed yields, ...
  - application of the present experimental settings to other crops
  - inclusion of changes in variability (monthly, daily) into the climate change scenarios
  - application of climate change scenarios based on RCMs (to start with PRUDENCE/ENSEMBLES data?) and statistical downscaling (when available)
- **suggestion for other groups involved in Cecilia:**
  - M&Rfi weather generator is freely available
  - climate change scenarios derived with our methodology may be derived for any site of your choice