

# APPLICATION OF THE WEATHER GENERATOR FOR CROP GROWTH SIMULATIONS IN CLIMATE CHANGE IMPACT STUDIES

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## Introduction

To assess impacts of potential climate change on crop yields, the crop growth models are used to simulate yields in present vs. changed climate conditions. This contribution addresses some methodological aspects, results of the crop simulations are discussed elsewhere [Zalud *et al.*, 1999].

## Methods and Results

In order the findings obtained by comparing model crop yields related to present and changed climate have a statistical significance, it is desirable to process model yields from more years. Two approaches to the multi-year crop simulation experiments are suggested:

**A)** In the first approach, the crop model simulations use observed pedological, physiological and cultivation data specific for each individual year. Observed weather series are used in simulations in a present climate; the weather series are modified by increments taken from the climate change scenario for simulations in changed climate.

**B)** In the second approach, the pedological, physiological and cultivation data are taken from a single "representative" year and arbitrarily long synthetic weather series is created by the stochastic weather generator. Parameters of the generator derived from the observed series are used to generate weather series representing present climate; parameters of the generator are modified in accordance with climate change scenario to generate series representing changed climate. This approach allows to perform detailed sensitivity analysis to changes in statistical structure of weather series [Dubrovsky *et al.*, 1999].

In both above approaches, the summary statistics, such as means and standard deviations or quantile characteristics are calculated from a set of model yields and used for the comparison.

In a present study, stochastic weather generator Met&Roll [Dubrovsky, 1997; Dubrovsky, 1999] and crop growth models CERES-Maize and CERES-Wheat were used.

In order the results of the crop model simulations are reliable, the validation tests have been made:

- (i) **Validation of weather generator Met&Roll.** The statistical structure of synthetic vs. observed weather series was compared in Dubrovsky [1997]. Some differences were detected.
- (ii) **Validation of variability of grain yields simulated by CERES-Maize and CERES-Wheat crop models.** To examine how the weather generator's imperfections affect the model yields, the distributions of grain yields simulated with use of observed vs. synthetic weather series were compared (Fig. 1). No statistically significant difference was detected and it is thus accepted that the synthetic weather series generated by Met&Roll are applicable to crop growth simulations. [Dubrovsky *et al.*, 1999]
- (iii) **Validation of CERES models** (see Zalud *et al.* [1999])

The multi-year crop model simulations performed in both "direct modification of weather series" and "weather generator" approaches were made to demonstrate the effect of increased CO<sub>2</sub> (Fig. 2). It is seen, that the values of the summary statistics may differ but the trends indicating the effect of CO<sub>2</sub> are about the same.

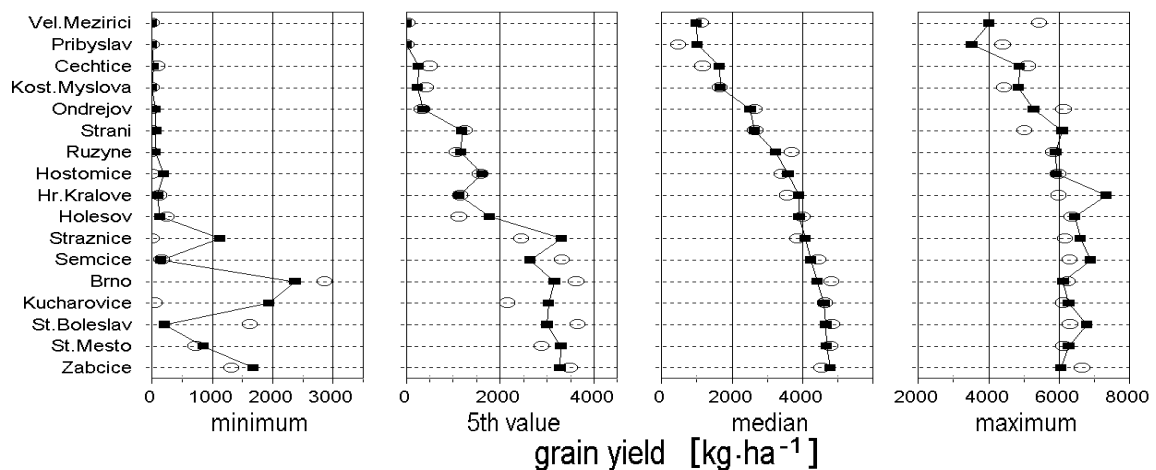


Figure 1. Validation of the variability of model maize yields. The minima, 5<sup>th</sup> smallest values, medians and maxima of the grain yields were calculated from the 30-year CERES-Maize simulations with use of observed (lines + rectangles) and synthetic (circles) weather series related to 17 Czech stations.

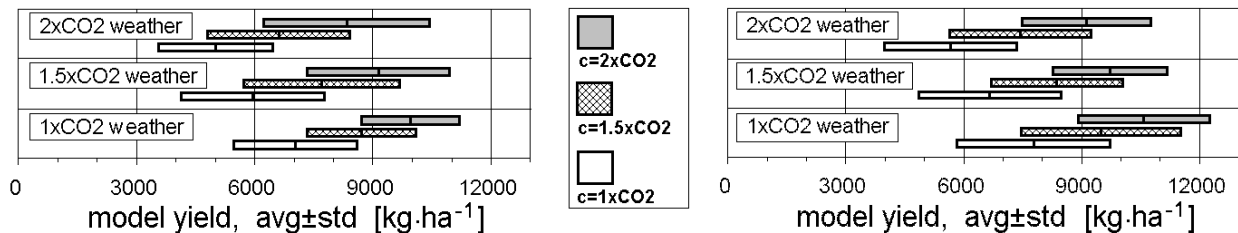


Figure 2 Effect of increased CO<sub>2</sub> on CERES-Maize yields. The horizontal bars demarcate (avg" std) calculated from the model yields obtained in a multi-year crop simulation experiments. Left: 17-year simulations in approach **A** (observed year-specific pedological, physiological, cultivation and weather data; weather series for changed climate obtained by direct modification of observed weather series); right: 99-year simulations in approach **B** ("representative" year + weather generator). "1xCO<sub>2</sub> weather" vs "1.5xCO<sub>2</sub> weather" vs "2xCO<sub>2</sub> weather" shows the effect of changed climate (due to increased CO<sub>2</sub>); "c=1xCO<sub>2</sub>" vs "c=1.5xCO<sub>2</sub>" vs "c=2xCO<sub>2</sub>" shows "direct" effect of increased CO<sub>2</sub> in the air.

## Conclusions

There were found some discrepancies in ability of the weather generator to reproduce the statistical structure of the observed daily weather series. However, the tests have not confirmed that these have any detectable effect on model crop yields. The results obtained in multi-year simulations with use of directly modified weather series and stochastically generated weather series show similar trends in crop yields related to CO<sub>2</sub> changes. The results obtained in crop growth simulation experiments are discussed in a greater detail in a separate contribution [Zalud *et al.*, 1999].

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