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Probabilistic Projection of Future Climatic Characteristics for Sites in Europe and U.S.A *(... focus on a methodology)*

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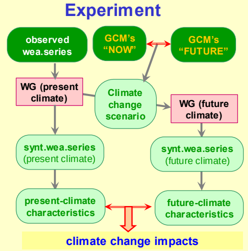
Introduction

Many uncertainties affect the climate change impact experiments. We aim to address those, which we can quantify. To prepare the site-specific weather series for the impact models (e.g. crop models) we use the M&Rfi stochastic weather generator (WG) (Dubrovsky et al., 2000; Dubrovsky et al., 2004; Trnka et al., 2004a, 2004b), whose parameters are modified according to the climate change scenario. The climate change scenario for a specific future is derived by the pattern scaling method: the standardised scenario related to 1K rise in global mean temperature (ΔT_C) is multiplied by the projected change in ΔT_G. The standardized scenario is derived from a specific GCM run, ΔT_C is determined by simple climate model MAGICC for selected combination of climate sensitivity and emission scenario. This approach allows to account for multiple uncertainties: **(i)** climate sensitivity, **(ii)** emission scenario, **(iii)** model (GCM) uncertainty *[Fig. 1]*. In addition, the use of WG allows to account for the **(iv)** uncertainty related to natural climate variability.

On the other hand, some problems arise when using this methodology. These include incompleteness of GCM database: monthly series are long enough (1961-2100 period is available) to get an acceptable accuracy in determining the climate change scenarios) but they do not allow to estimate changes in some important climatic characteristics, which affect the future climate weather series and thereby an output from the impact model fed by these weather series. These climatic characteristics include **(i)** daily temperature range (DTR = TMAX-TMIN), **(ii)** probability of wet day occurrence (Pwet), and **(iv)** variability of daily temperature (here represented by std(T)). These charactaristics must be derived from the daily weather series, which are, however, much shorter. Moreover, these characteristics are available for a lower number of GCMs (compared to monthly series). **The question thus stands: is the effect of possible changes in these characteristics [DTR, Pwet, s(T)] significant or can we neglect them and avoid using the daily series? (this would make the determination of GCM-based climate change scenarios easier and also imply that we can use much more GCMs)**

To address this problem, the present poster shows impacts of the changes in the above three characteristics on selected extreme temperature and precipitation characteristics.

Experiment



WG: weather generator = M&Rfi:
- Δt = 1 day
- PREC occurrence ~ Markov chain(1)
- PREC amount ~ Gamma distribution
- (TMAX, TMIN) ~ AR(1); conditioned on PREC

GCMs: see *Table 1*

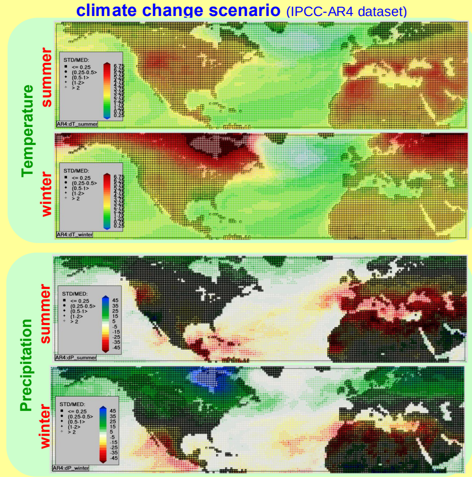
observed weather series: 10 EU+11 U.S stations (see *Table II*)

the scenario consists of *(5 degrees of complexity of scenario)*:
- **A:** dPREC, dTAVG
- **B:** dPREC, dTMAX, dTMIN
- **C:** dPREC, dTMAX, dTMIN, d[s(TMAX)], d[s(TMIN)]
- **D:** dPREC, dTAVG, dPWET
- **E:** dPREC, dTMAX, dTMIN, d[s(TMAX)], d[s(TMIN)], dPWET

(projected changes in selected characteristics are shown in Fig.2)

climatic characteristics: *the list is given in Fig.3*

Fig.1: Multi-GCM grid-specific standardised climate change scenario (IPCC-AR4 dataset)



Probabilistic projection of summer/winter changes in temperature and precipitation. The **colour** indicates median value of the change, the **shape** of the symbol indicates the between-GCM uncertainty in terms of Q = STD/MEDIAN, where STD and MEDIAN are based on a set of GCMs from IPCC-AR4 database [i.e. squares and circles (■, •) indicate good between-GCM concordance, star-like symbols (✦,✧) indicate poor concordance].

Tab.1: GCMs (IPCC-AR4 database, SRES-A2 emissions)

Acronym	Model	Center	resolution $n_{lat} \times n_{lon}$	present	future	
BCM2	BCM2.0	Bjerknes Center for Climate Research, Norway	124×64	1961-90	2081-2088	
CGMR	CGCM3 (T47 res.)	Canadian Center for Climate Modelling and Analysis	96×48	1961-90	2081-2100	A
CNCM3	CM3	Centre National de Recherches Meteorologiques, France	128×64	1961-90	2081-2100	
CSMK3	Mk3.0	Australia's Commonwealth Scientific and Industrial Research Organisation	192×96	1961-90	2081-2100	
GFCM20	CM2.0	Geophysical Fluid Dynamics Laboratory, USA	144×90	1961-90	2081-2100	
GFCM21	CM2.1	Geophysical Fluid Dynamics Laboratory, USA	144×90	1961-90	2081-2088	
MPEH5	ECHAM5 -OM	Max-Planck-Institut for Meteorology, Germany	192×96	1961-78	2081-2100	
NCPCM	PCM	National Centre for Atmospheric Research, USA	128×64	1961-90	2081-2099	

A: 3 runs available

Summary of results shown in Fig.3 *(focus on effects of changes in DTR, s(T) and Pwet into scenarios)*

1. **effect of using dTMAX+dTMIN instead of dTAVG (B vs. A):**
   - maximum length of hot spell is affected (increases or decreases)
   - lower effect on cold spells
2. **effect of including changes in daily variability of TAVG / TMAX / TMIN (C vs. B):**
   - very small effect on both hot and cold spells
3. **effect of including changes in Pwet [(D vs. A) and (E vs. C)]:**
   - significant increase in length of dry spells in several stations

- As one might expect, changes in temperature characteristics and PREC (assuming no change in Pwet) has no effect on dry and wet spells (as these are based purely on Markov chain model. On the other hand, changes in Pwet may affect temperature characteristics.
- Altogether, of the above three weather generator parameters [DTR, s(T) and Pwet], the Pwet appears to have the greatest effect..
- Though there is some effect of DTR and s(T) changes, these mostly appear to be negligible with respect to the between GCM uncertainty

Tab.2: Station Weather Data

Europe [1961-1990; EC&D project; eca.knmi.nl]

Europe	station
BAMB	Bamberg, DE
CORF	Corfu, GR
HOHE	Hohenpeissenberg, DE
JYVA	Jyvaskyla, FI
KOJN	Kojnas RU
PRAH	Praha, CZ
SALA	Salamance, ES
SMOL	Smolensk, RU
VALT	Valentia, Ir
ZUGS	Zugspitze, DE

USA [1953-1973; from D.Wilks]

USA	station
ATL	Atlanta, GA
BOI	Boise, ID
CLE	Cleveland, OH
GJT	Grand Junction, CO
GSO	Greensboro, NC
LAS	Las Vegas, NV
LIT	Little Rock, AR
OKC	Oklahoma City
PWM	Portland, ME
SAT	San Antonio, TX
SSM	Sault Ste. Marie, MI

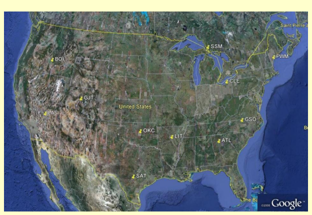


Fig.2: multi-GCM WG-friendly* climate change scenarios – PRAGUE
(* = scenarios in terms of WG parameters; 2081-2100 vs 1961-1990)

The scenarios are determined by comparing WG parameters derived from daily GCM series: 2081-2100 w.r.t. 1961-1990.
- The vertical bars indicate sampling error in determining the changes in WG parameters
- **The scenarios show changes in** these WG parameters:
  - **TAVG** = mean daily temperature
  - **DTR** = mean daily temperature range (= TMAXï TMIN)
  - **PREC** = mean daily precipitation
  - **std(TAVG)** = std.dev, of mean daily temperature
  - **PWET** = probability of wet day occurrence

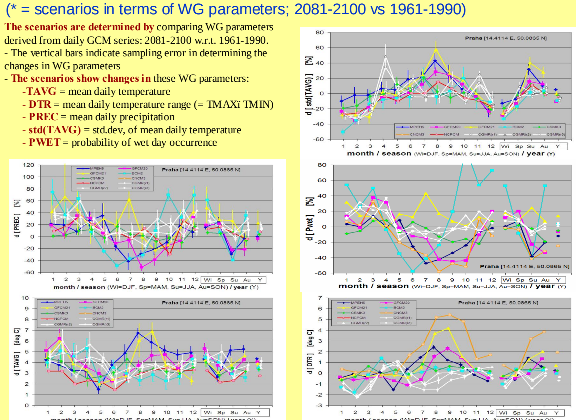


Fig.3 Results

The figures show climatic characteristics derived from the synthetic weather series produced by M&Rfi weather generator, whose parameters were modified according to GCM-based climate change scenarios. **NOW** relates to present-climate synthetic weather series. **A-E scenarios** are specified in ñExperimentò box. **Grey bars** indicate ±std calculated from the 10 GCM runs.

climatic characteristics:
- **hot spells** = period with TMAX ≥ p_{95}(TMAX)
- **cold spells** = period with TMIN ≤ p_5(TMIN)
  (p_5 and p_{95} are the 5[th] and 95[th] percentiles);
- **dry spell** = period with all days being dry
- **wet spell** = period with all days being wet
- **1day PREC** = 1day precipitation sum
- **5day PREC** = 5-day precipitation sum

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