UnLoadC3: Ensembles of climate change projections for two river catchment areas in Austria
Contributions to an overall uncertainty assessment framework for the modelling of water quantity and nutrient transport

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Background

The objective of UnLoadC3 is to examine the effects of uncertainties - inherent in data and modelling - on future, climate change driven projections of water flow and nutrient transport within two selected river catchment areas (Schwechat and Raab, see Figure 1) in Austria. This poster is devoted to the generation of ensembles of regional climate change projections (valid for the considered catchment areas), which are needed to simulate potential future changes in water flow and nutrient transport conditions. In order to access impacts of potential future climate changes as well as associated uncertainties, ensembles of climate projections from the EURO-CORDEX initiative are used. These ensembles are driven by two socio-economic scenarios (RCP4.5 and RCP8.5, see IPCC AR5, 2013). Climate change projections for the catchment areas are derived via statistical downscaling techniques and bias correction methods that are applied to the EURO-CORDEX runs. Thereby potential changes in daily minimum, maximum, mean temperatures and precipitation totals are derived until the end of the 21st century (see Figure 2). Results shown here refer to these changes and to pertaining uncertainties. Within UnLoadC3 the derived ensembles are entered into the water quality model SWAT, which simulates water balance, sediment- and nutrient-transport processes for the considered river watersheds.

Data and Method

UnLoadC3 focuses on the description of error accumulation in the process of adaption measure planning. This is achieved by varying characteristic parameters at different analysis steps. Here results of distribution mapping methods will be presented: the distribution functions of RCM-simulated climate values are corrected to agree with observed distribution functions, which can be by the application of transfer functions shifting occurrence distributions of parameters (Boe et al., 2007; Gudmundsson et al., 2012; Teutschbein and Seibert, 2012).

Modell	RCP4.5	RCP8.5
EUR-11_CNRM-CERFACS-CNRM-CM5_*_CLMcom-CCLM4-8-17	x	x
EUR-11_CNRM-CERFACS-CNRM-CM5_*_SMHI-RCA4	x	x
EUR-11_ICHEC-EC-EARTH_*_CLMcom-CCLM4-8-17	x	x
EUR-11_ICHEC-EC-EARTH_*_SMHI-RCA4	x	x
EUR-11_ICHEC-EC-EARTH_*_KNMI-RACMO22E	x	x
EUR-11_ICHEC-EC-EARTH_*_DMI-HIRHAM5	x	x
EUR-11_IPSL-IPSL-CM5A-MR_*_IPSL-INERIS-WRF331F	x	x
EUR-11_IPSL-IPSL-CM5A-MR_*_SMHI-RCA4	x	x
EUR-11_MPI-M-MPI-ESM-LR_*_CLMcom-CCLM4-8-17	x	x
EUR-11_MPI-M-MPI-ESM-LR_*_SMHI-RCA4	x	x
EUR-11_MOHC-HadGEM2-ES_*_SMHI-RCA4	x	x

Table 1: GCM-RCM model chains used to generate the different regional climate change projections used in this study.

Method	Description	Advantage (+) and disadvantage (-)
Raw RCM output data	RCM-simulated time series are used directly without any bias correction	+ simplest way to use RCM data – systematic model errors are ignored – can cause substantial errors in impact studies
Distribution mapping	matches the distribution functions of observations and RCM-simulated climate values a precipitation threshold can be introduced to avoid substantial distortion of the distribution caused by too many drizzle days	+ corrects mean, standard deviation, wet-day frequencies and intensities + events are adjusted non-linearly + variability of corrected data is more consistent with original RCM data

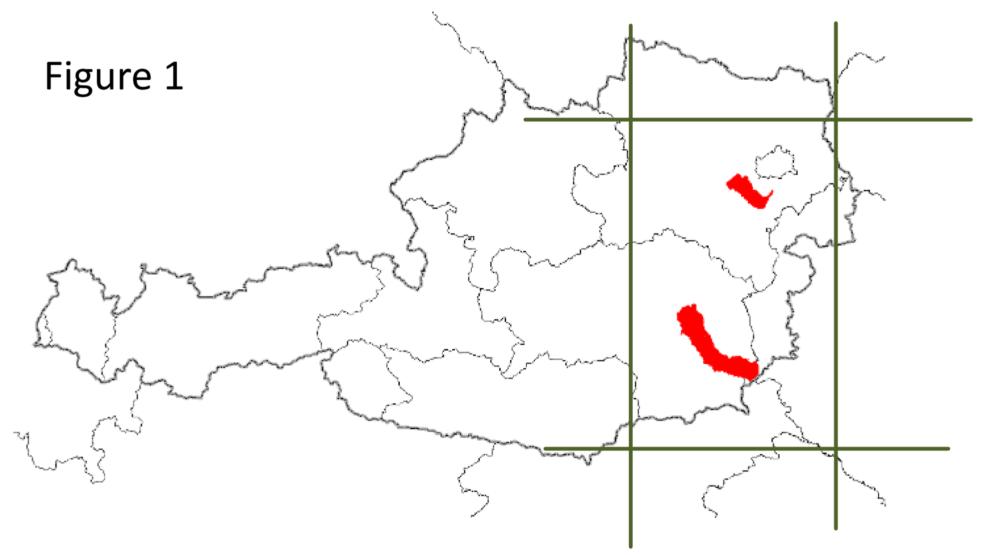
Table 2: Description of analyzed methods used in this study.

Results

We focus on three distinct periods of time: (i) 1971-2000 (1st and 2nd column in Figure 2), (ii) 2021-2050 (3rd and 4th column) and (iii) 2071-2100 (5th and 6th column).

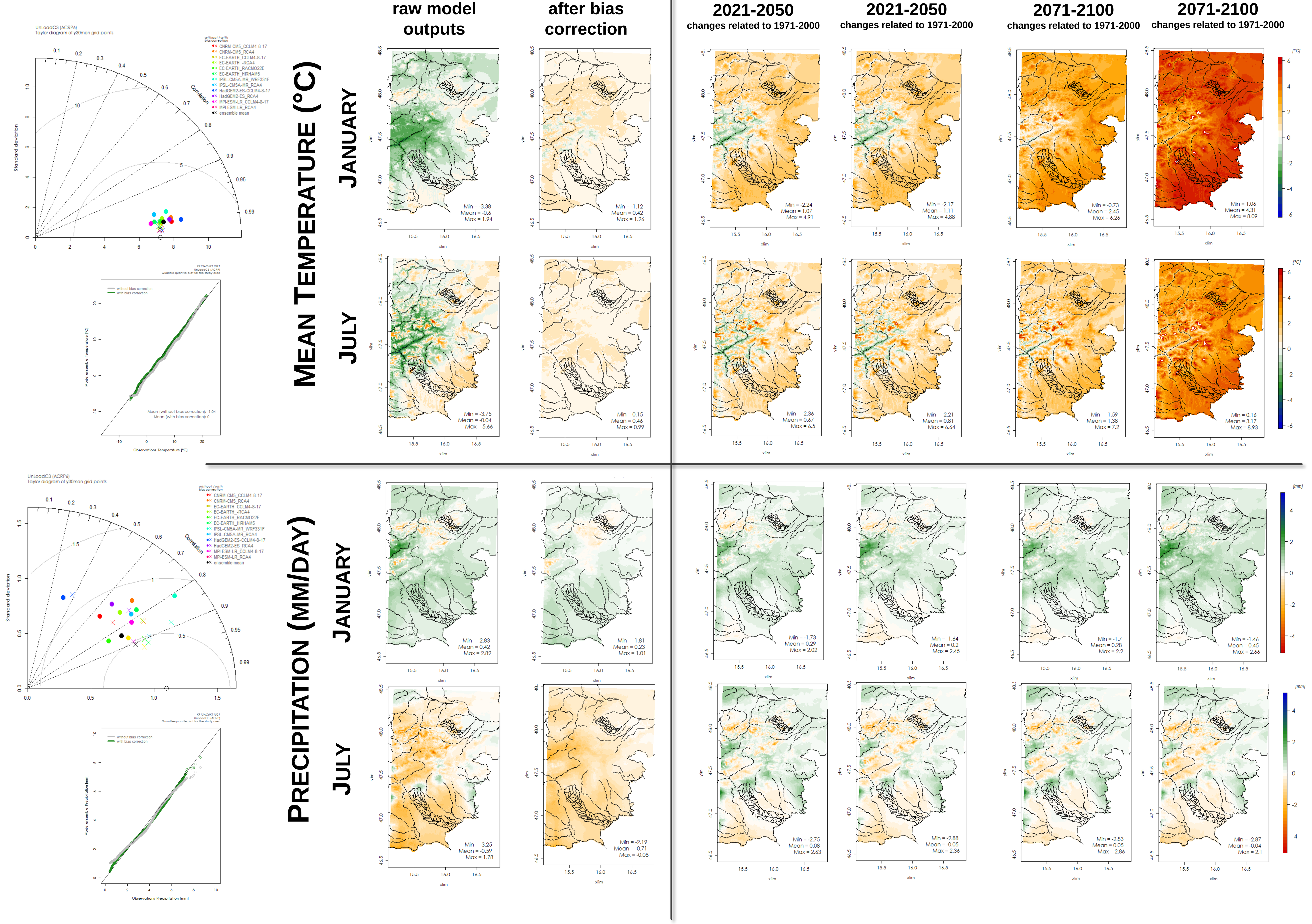
Temperature: (i) displays downscaled ensemble simulations of local scale January and July mean temperature values relative to observations (1st and 2nd row) without and after bias correction (1st and 2nd column). Findings reveal that bias-corrected simulations (by construction) better reproduce observed (1971-2000) daily temperature values than simulations not carried towards observed values. Albeit all simulated seasonal values are, after bias correction, closer to the observations, the seasonal ranking of pertaining spreads/uncertainties remains in effect (i.e. uncertainty/spread in MAM > SON > DJF > JJA). The first and second rows in (ii) and (iii) show potential future changes in mean January and July temperatures, whereby the left columns in (ii) and (iii) refer to RCP4.5 driven ensembles, whereas the right ones to RCP8.5. Results corresponding to the near future (2021-2050) show an overall temperature increase of about +1.5° C whereby no significant differences, between RCP4.5 and RCP8.5 driven projections, are obvious. This behavior changes towards the end of the 21st century (2071-2100 right columns in (ii) and (iii)): averaged temperature increases corresponding to RCP4.5 are approximately +2.5° C whereas those associated with RCP8.5 are about +4° C. Hence, towards the end of this century, RCP4.5 and RCP8.5 give reason for substantial differences in mean temperatures across the investigated part of Austria.

Figure 1



Precipitation: Results pertaining to precipitation totals are depict in the 3rd and 4th line of Figure 2. It is visibly at first sight, that ensemble simulations for the past period (1971-2000) are (compared to observations) too wet in January (3rd row 1st column) and too dry for July (4th row, 1st column). This fact is only slightly improved by bias-corrections (2nd column, 3rd and 4th row). Near (3rd and 4th column) and remote future changes (5th and 6th column) of January and July totals do not depend much on driving RCPs and show moderate increases towards the end of this century whereby rates of growth are larger in January than in July. Hence, unlike in the case of temperatures, which show substantial increases throughout the decades to come and (for the outgoing century) a strong dependence on the driving RCP – associated changes in precipitation totals are rather moderate and show no substantial dependence on driving RCPs.

Figure 2



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