A method for comparison of regional climate model compliance with observations

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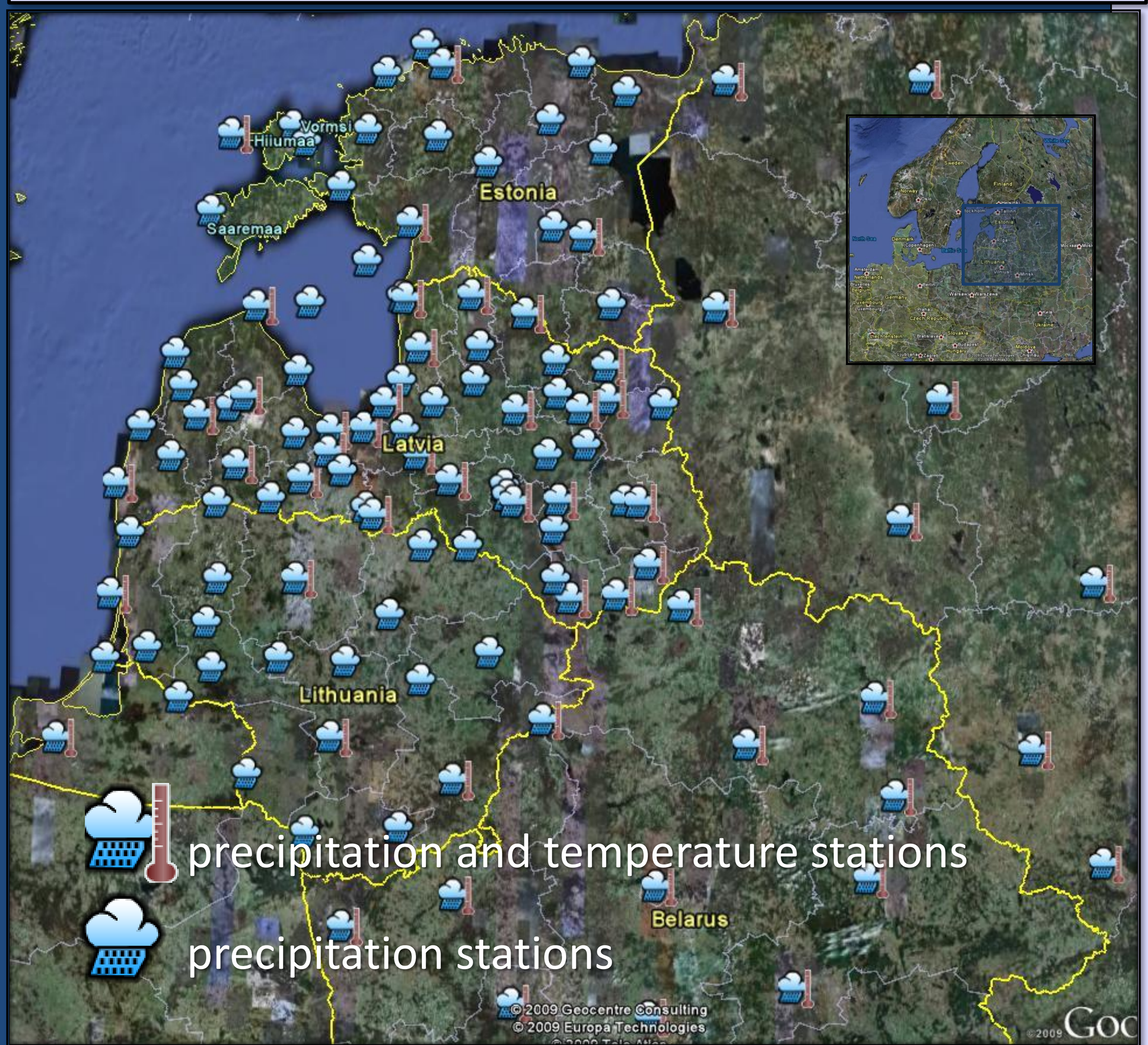
VTPMML

KALME VALSTS PĒTĪJUMU PROGRAMMA KLIMATA MAIŅAS IETEKME UZ LATVIJAS ŪDEŅU VIDI

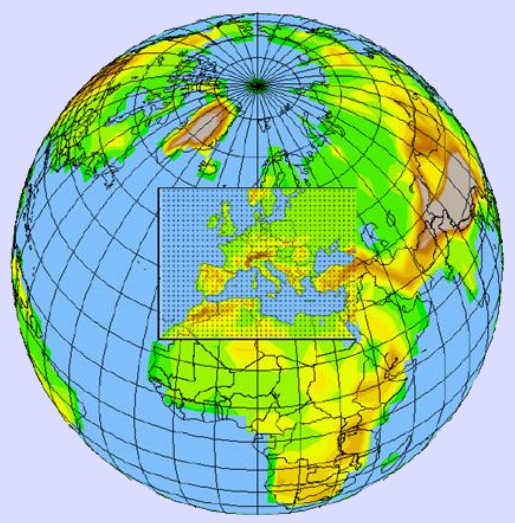
Introduction

The main goal of this work was to identify the regional climate model (RCM) which provides the best climate time series for the further hydrological modelling of the Latvian rivers drainage area. The selected area is located in the eastern Baltic region and covers territory of several countries: Estonia, Latvia, Lithuania, Russia and Belarus. The main forcing parameters for hydrological modeling are temperature and precipitation time series. Our approach of an estimation of RCM accuracy was based on statistical analysis of these time series. The set of 21 RCM from PRUDENCE project was used. We used calculations for reference period (daily data). The RCM reference data for the contemporary climate (1961-1990) was statistically compared to the measured weather stations data of the same period. We used measured data series from the National Climatic Data Center (www.ncdc.noaa.gov), RIHMI-WDC (meteo.ru), European Climate Assessment & Dataset (ECA&D) project (http://eca.knmi.nl) and the Latvian Environment, Geology, and Meteorology Agency. The area covered by these stations is approximately 400 thousand square kilometers. For the time series comparison model data was interpolated to the observation location from each model's grid.

Location observation stations

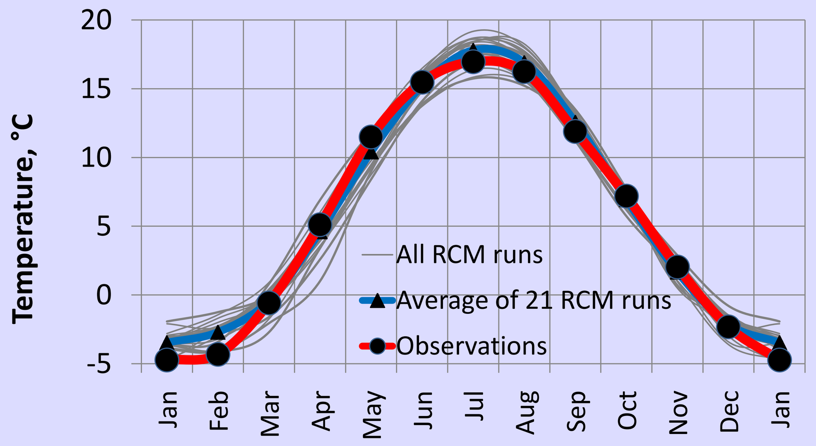


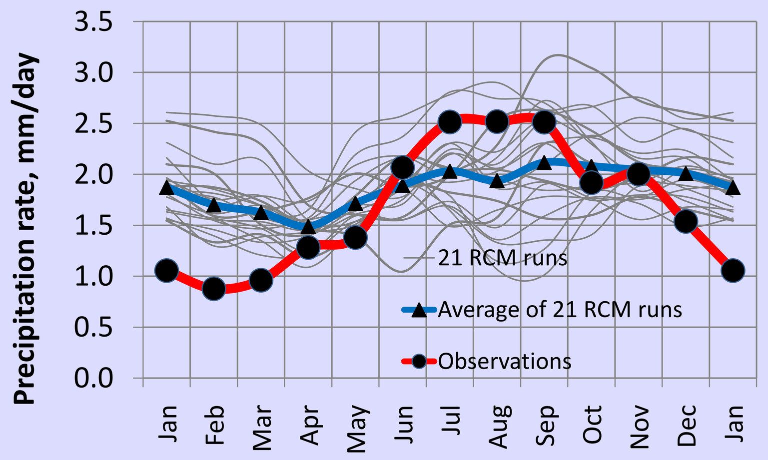
Region of interest of PRUDENCE project



PRUDENCE is a European FP5 scientific project to quantify confidence and the uncertainties in predictions of future climate and its impacts, using an array of climate models, provide a series of high-resolution climate change scenarios for 2071-2100 for Europe.

Monthly average temperature and precipitation in Riga



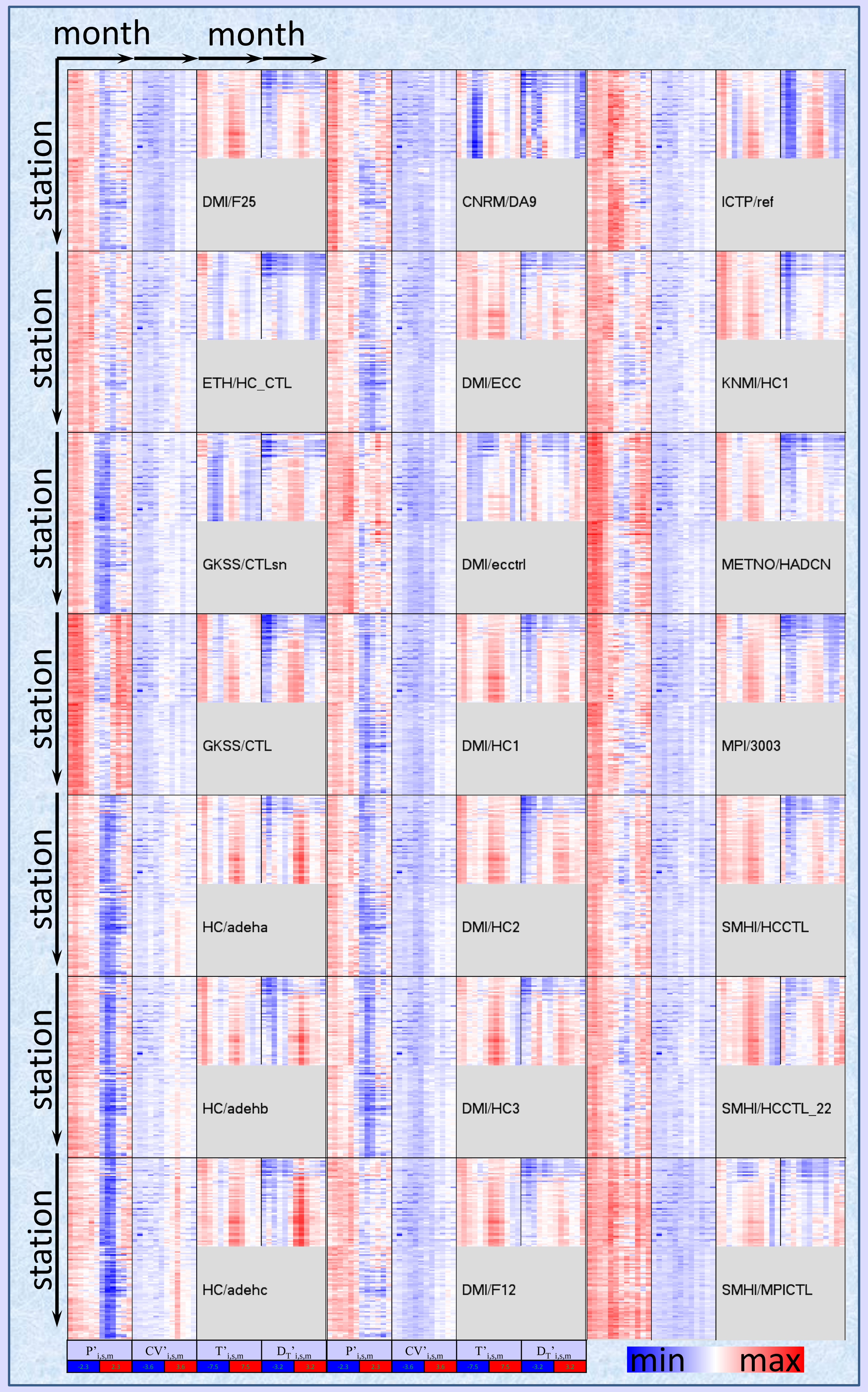


Comparison

The deviation of particular parameter (say T) of selected RCM results (index i) takes into account all months of the year (index m), all stations (index s) and are constructed as a sum of squares of differences between observed ($T^*_{i,s,m}$) and calculated ($T_{i,s,m}$) monthly average parameter.

$$\Delta T_i = \frac{1}{N}\sum_{s,m}\left(T'_{i,s,m}\right)^2,\ N = \sum_{s,m} 1$$

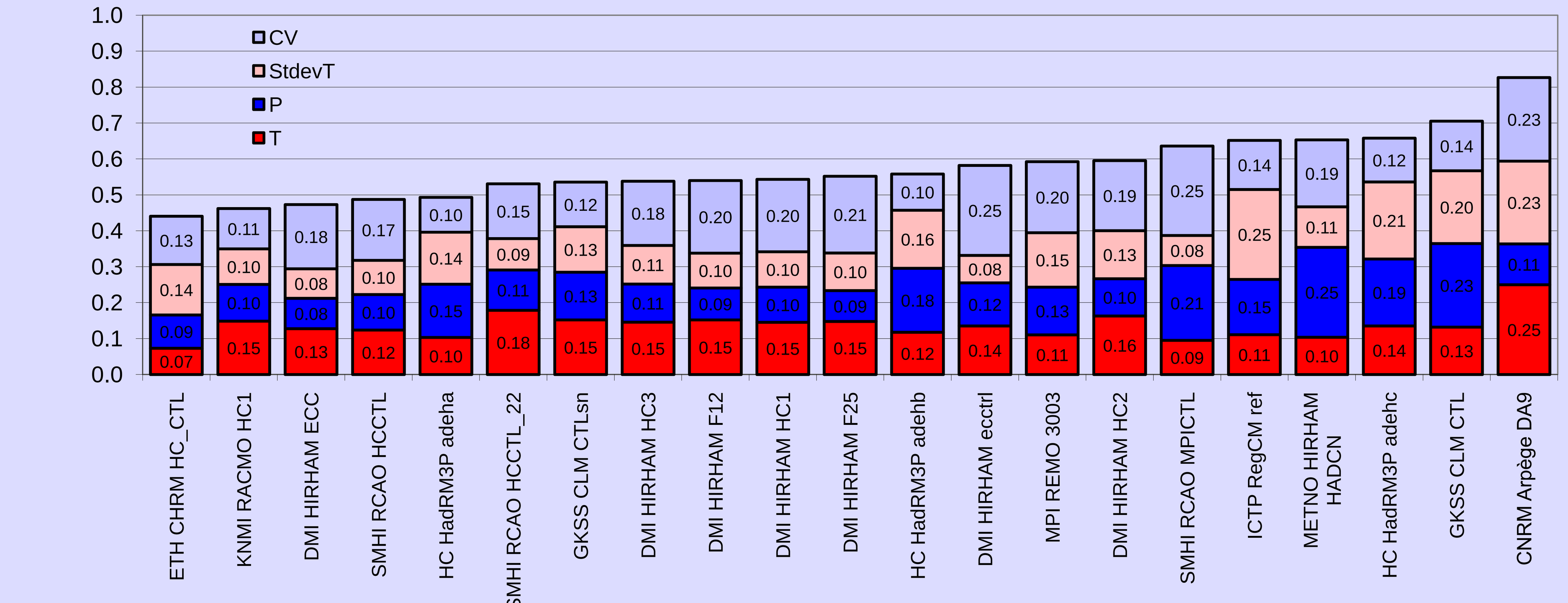
$$T'_{i,s,m} = \frac{T_{i,s,m} - T^*_{s,m}}{T_{\max}},\ T_{\max} = \max_{i,s,m}\left(\left|T_{i,s,m} - T^*_{s,m}\right|\right)$$



Penalty function (K) consists of four parts. Each part is deviation of selected RCM results (i) from observations in respect to monthly mean temperature (ΔT_i), monthly mean precipitation (ΔP_i), standard deviation of daily temperatures (ΔD_{Ti}), coefficient of variation (ΔCV_i). CV is standard deviation of daily precipitation divided by mean precipitation. Each of the parts is normalized to its maximum value among the model runs.

$$K_i = \frac{1}{4}\left(\frac{\Delta T_i}{\max\limits_j \Delta T_j} + \frac{\Delta P_i}{\max\limits_j \Delta P_j} + \frac{\Delta D_{T_i}}{\max\limits_j \Delta D_{T_j}} + \frac{\Delta CV_i}{\max\limits_j \Delta CV_j}\right)$$

Penalty function and its components that characterize relative prediction skill of different RCM runs



Correlation coefficients between model rank and the components of the penalty function - ΔT, ΔP, ΔDT and ΔCV are, respectively, 0.23, 0.63, 0.59, and 0.33. It means that, on average, better skilled model runs predict also each of the components better, especially for mean precipitation and standard deviation of temperature, whilst regarding temperature and CV of precipitation all of the model runs are more equal.

Conclusions

Results of the comparison show that considered parameters of modelled data set (monthly mean temperatures, monthly net precipitation, standard deviation of temperature and precipitation) for the present-day climate noticeably differs from the measured data. Although different models indicate different statistical deviation from the observation, one may find the common deviation patterns:

- overestimated winter precipitation,
- increased winter temperature,
- rather poor reflection of the annual cycle of precipitation.

Obviously, direct use of RCM climatic data for hydrological modelling without modification is not desirable.

These differences between model and observation data during winter period have strong influence on the hydrological regime of Latvian rivers because of snow accumulation and snowmelt in the spring.