Application of regional climate data as input for hydrological modelling

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KALME VALSTS PĒTĪJUMU PROGRAMMA KLIMATA MAIŅAS IETEKME UZ LATVIJAS ŪDEŅU VIDI

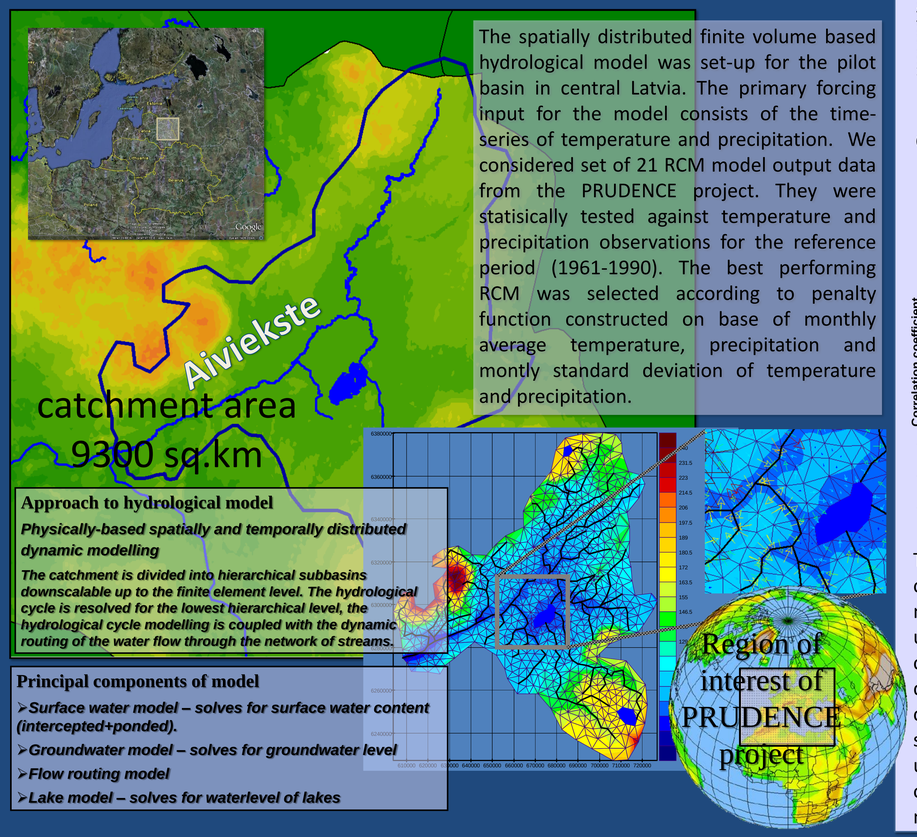
Summary

The goal of this study was to check the suitability of application of regional climate model (RCM) forcing data for hydrological modelling.

The calibrated hydrological model was employed for the run-off calculations of climatic reference period (1961-1990). The first step of the study was to statistically compare (1) observed discharge, (2) modelled discharge using observed temperature and precipitation as the forcing, (3) modelled discharge using the temperature and precipitation time series from the best RCM as the forcing. The monthly average observed discharge agrees well with the modelled discharge in case of usage of the observed forcing. The agreement of observed discharge with modelled discharge using RCM data is rather disappointing, especially during winter and spring snow melt flood periods. Usage of the meteorological forcing from the RCM's reference period overestimates yearly average discharge by approximately 70%.

The second step of our study was to modify and use the modified RCM data as an input for hydrological modelling. The modification method relies on equalizing of temperature and precipitation histograms between observed and RCM data for each day of the year and each observation location. We show that calculated monthly average discharges agree quite well with observed in the case of use of modified RCM data as a forcing.

In the third step we applied RCM modification method to the climatic scenarious A2 and B2 from selected regional climate model and calculated corresponding hydrological scenarious.



The spatially distributed finite volume based hydrological model was set-up for the pilot basin in central Latvia. The primary forcing input for the model consists of the time-series of temperature and precipitation. We considered set of 21 RCM model output data from the PRUDENCE project. They were statisically tested against temperature and precipitation observations for the reference period (1961-1990). The best performing RCM was selected according to penalty function constructed on base of monthly average temperature, precipitation and montly standard deviation of temperature and precipitation.

Approach to hydrological model

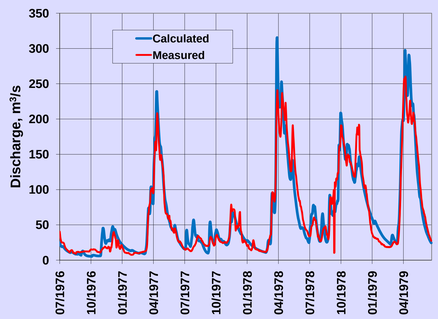
Physically-based spatially and temporally distributed dynamic modelling

The catchment is divided into hierarchical subbasins downscalable up to the finite element level. The hydrological cycle is resolved for the lowest hierarchical level, the hydrological cycle modelling is coupled with the dynamic routing of the water flow through the network of streams.

Principal components of model

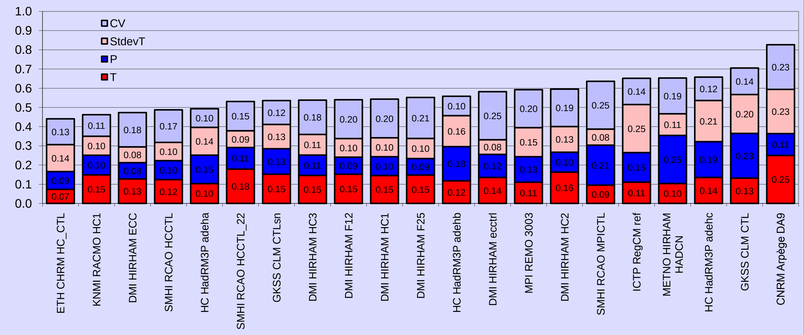
- ***Surface water model – solves for surface water content (intercepted+ponded).***
- ***Groundwater model – solves for groundwater level***
- ***Flow routing model***
- ***Lake model – solves for waterlevel of lakes***

Calibration results



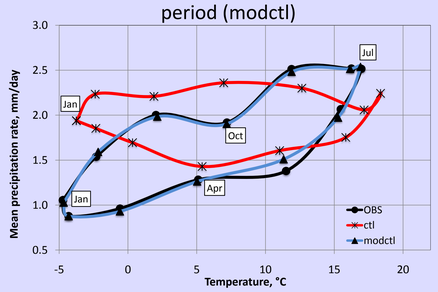
RCM selection

Penalty function and its components that characterize relative prediction skill of different RCM runs. P is precipitation, T temperature and CV is coefficient of variation of precipitation.

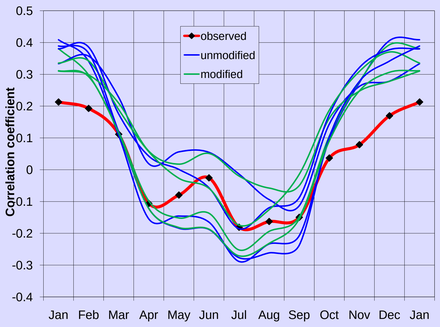


Meteorological data modification

Temperature-precipitation diagrams for observed data (obs), RCM control period (ctl), modified RCM control period (modctl)

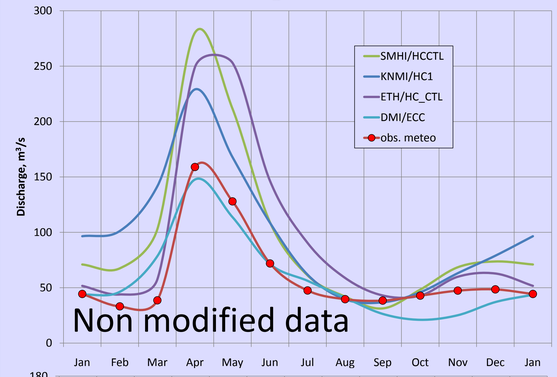


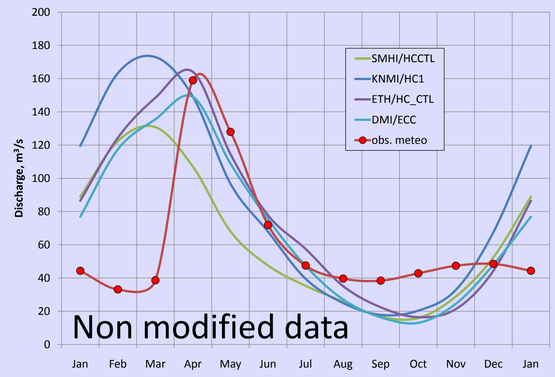
Correllation coefficients between temperature and precipitation. Results from the four most skilled models are depicted.

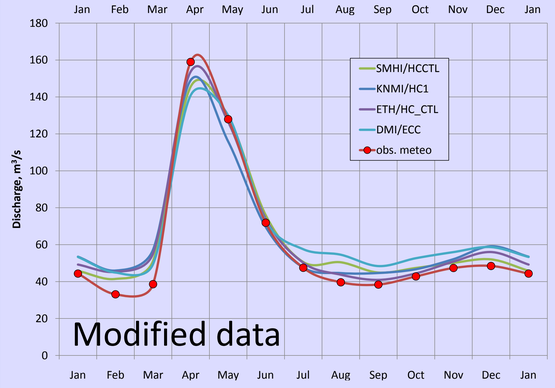


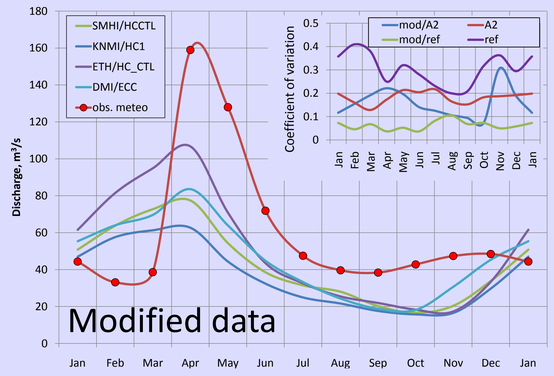
The agreement of temperature-precipitation correlation cannot be significantly improved by the modification method. Both modified and unmodified RCM output overestimates positive correlation between temperature and precipitation during autumn/winter (Nov-Feb) for all of the 4 considered models. It means that, on average, snow percentage in precipitation is underestimated. Some of the models may overestimate negative correlation during summer months.

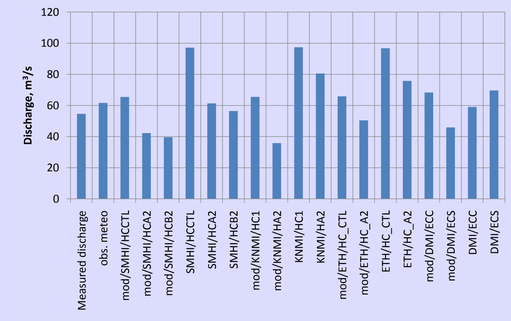
Aiviekste discharge











Conclusions

The main features of the future hydrological regime for our region were revealed, namely,

- yearly average run-off will decrease,
- winter run-off will significant increase,
- value of the peak discharge during spring snow-melt will be significantly smaller,
- spring peak shifts will occur earlier