Testing of the conceptual TUW model structure for the Austrian catchments

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ABSTRACT

The runoff modelling efficiency of the conceptual HBV type models in connected with the many problems. These problems can be connected with the calibration or validation process. In our paper we focused on the estimation of the parameters and selection of the most suitable model structure for the 180 Austrian catchments. For the calibration and validation, we select the two version of the conceptual HBV type model TUW. We performed the calibration and validation in lumped and semi-distributed version of the model TUW. The interested area take place in 180 Austrian catchments, which do not have influenced runoff with dams and canals. The calibration was performed in the period 1991-2000. Subsequently, we ran the validation for the years 2014-2016. Finally, we compare the results of the runoff model efficiency between semi-distributed and lumped version. For the comparison, we select the combination of the Nash Sutcliffe coefficient and logarithmic Nash Sutcliffe. We also divide the catchments into two groups Alpine and Lowland. The results, show to us that semi-distributed version performed better in both calibration and validation.

1 Methods

- In our work we used the conceptual HBV type model TUW, the model run on 15 parameters (Parajka a kol. 2007, 2009), we used the two model version, lumped and semi-distributed.
- Lumped version calculate the chatchments as a one unit
- Semi-distributed version calculate by subcatchments divided by 200 vertical meters.
- The both lumped and semi-distributed models consists of three modules that represent snow accumulation and melting, root zone soil moisture changes, and runoff generation and routing
- The TUW model was calibrated for period 1991-2000, and validated 2014-2016
- We use an automatic calibration procedure using a differential evolution algorithm (Ardia et al., 2015)
- Objective function (OF) combines Nash-Sutcliffe coeficient (NSE) estimated from normal and logaritmic , we called it RME- Runoff Model Efficiency transformed (log NSE) daily streamflow values:
- RME $=\frac{1-NSE}{2}+\frac{1-logNSE}{2}$
- For comparison we divide the catchments into two groups Alpine and Lowland (Sleziak, 2017) Alpine – the runoff is highly influenced by the water from melted snow and glaciers. Lowland – the rain is the main contributor to the runoff

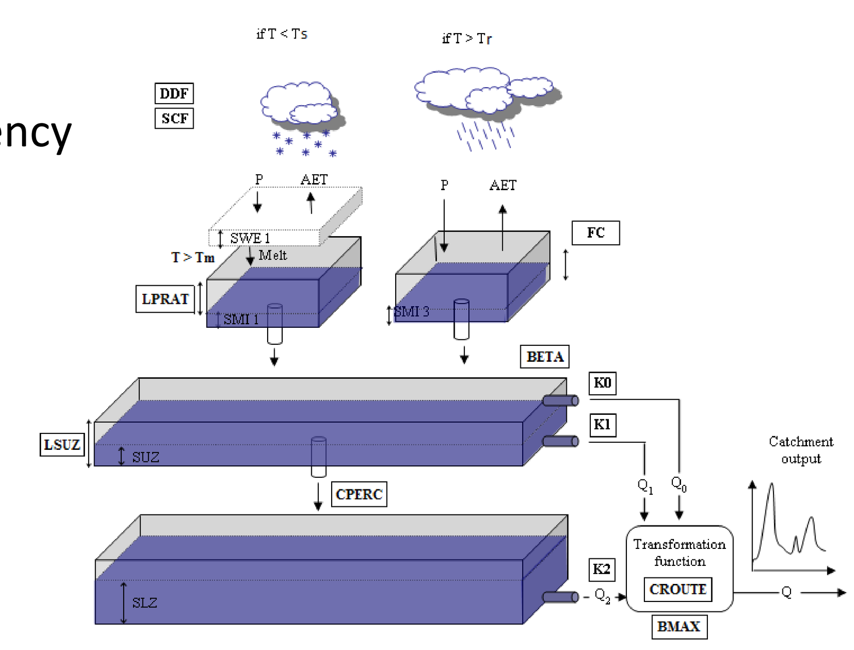

Fig. 1: Structure of the lumped TUW model.

2 Input data

- **Lumped :**
- Air temperatures - from 1091 stations by the method of external drift kriging
- Rain - from 1091 stations by the method of external drift kriging
- Potential evapotranspiration - Blaney-Criddle
- Discharge - from 180 gauged stations (Austrian Hydrographical Service).
- **Semi-distributed:**
- Air temperatures - from the Spartacus database (Hiebl et al., 2016)
- Rain - from the Spartacus database (Hiebl et al., 2016)
- Potential evapotranspiration - Blaney-Criddle
- Discharge - from 180 gauged stations (Austrian Hydrographical Service).

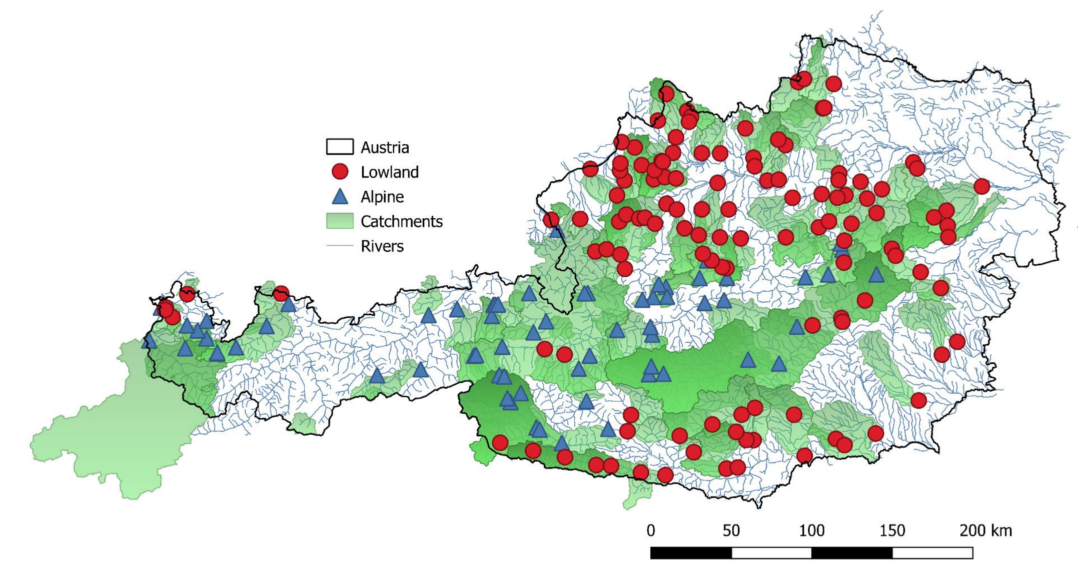

Fig. 2: *Selected Austrian catchments, Blue – alpine, and green – lowland catchments*

3 Results Snow Water Equivalent simulation

Calibration:

- Median of the calibration results for the 180 Austrian catchments

180 catchments (1991-2000)	Lumped	Semi-distributed
Median RME	0.65	**0.79**
Median RME Alpine	0.67	**0.83**
Median RME Lowland	0.64	**0.76**

Validation:

- Median of the validation results for the 180 Austrian catchments

180 catchments (2014-2016)	Lumped	Semi-distributed
Median RME	0.63	**0.71**
Median RME Alpine	0.65	**0.81**
Median RME Lowland	0.64	**0.66**

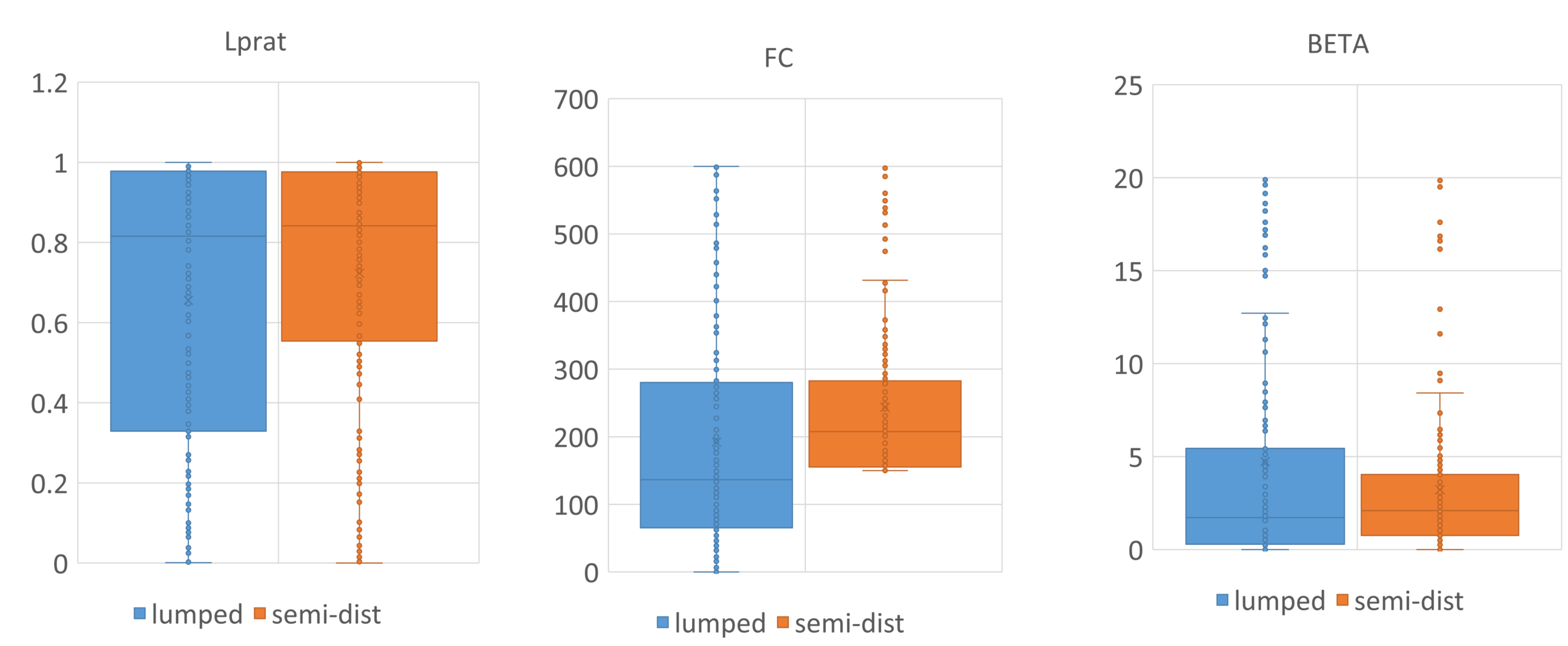

Fig. 3: *Spread of the soil submodel parameters for 180 Austrian catchments*

- We focused on the Runoff Model Efficiency (RME), were results show us that semi distributed version provide better performance in both Alpine and Lowland in both validation and calibration
- When we compared the spread of the parameters for soil submodel of the TUW model, results show us that semi-distributed version provided lower spread of the parameters than Lumped version, that means that lumped version is more sensitive and semi-distributed version is more robust

4 Discussion

In this work we tested the TUW model structure for the 180 Austrian catchments. Calibration was performed in the lumped and semi-distributed version of the conceptual HBV type TUW model. We run the calibration for the period 1991-2000. Subsequently, we run the validation for the period 2014-2016. For the comparison of the model performance we used the combination of the Nash Sutcliffe and logarithmic Nash-Sutcliffe, we also divide the catchments into two groups based on the rainfall-runoff regimes to Alpine and Lowland. The results showed better performance of the semi-distributed version. In the calibration period the semi-distributed version preformed better in both Alpine (where was improvement of the 180 catchments median = 16%) and Lowland (12 % improvement) groups of catchments. The semi/distributed version also performed better in the validation period, in Alpine catchments (16 % improvement), but in the Lowland catchments we detect only 2% improvement. Finally, we compared the spread of the parameters from calibration for lumped and semi-distributed version, where we detect that semi/distributed version provide the lower spread of the parameters, that means that lumped version is more sensitive and parameters more react to the different types of the catchments and semi-distributed version in more robust.

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