

S1. Flow chart and applied calibration procedure for HBV (Wallner and Haberlandt, 2015)

S2. HBV model parameters modified during calibration with limiting ranges (please note that although for some parameters the values are given in days, all models are run at hourly time step.)

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| --- | --- | --- | --- | --- |
| Parameter | Unit | Explanation | Minimum | Maximum |
| *wsmf* | [mm-1] | Wet snow melt factor | 1 | 4 |
| *tt* | [°C] | Threshold temperature | -1.5 | 1.5 |
| *dd* | [mm°C-1d-1] | Degree day factor | 0.5 | 5 |
| *fc* | [mm] | Field capacity | 50 | 300 |
| *lp* | [-] | Limit for potential evapotranspiration | 0.1 | 0.95 |
| *ß* | [-] | Empirical factor for runoff calculation from the soil layer | 0.5 | 4 |
| *hl* | [mm] | Threshold value for surface runoff | 1 | 30 |
| *k0* | [d] | Storage coefficient surface runoff | 0.25 | 5 |
| *k1* | [d] | Storage coefficient interflow | 3 | 40 |
| *k2* | [d] | Storage coefficient baseflow | 50 | 500 |
| *kperc* | [d] | Storage coefficient perculation | 3 | 40 |
| *maxbas* | [h] | Length of the triangular unit hydrograph impulse | 3 | 10 |
| *mx* | [-] | Weighting factor of Muskingum method | 0.1 | 0.4 |
| *mk* | [h] | Retention constant of Muskingum method | 0.25 | 10 |



S3. Bivariate spatial rainfall characteristics of V1, V2 and V3 in comparison to observations for the catchment Reckershausen (for one realization, black circles represent observations - for details the reader is referred to Müller and Haberlandt (2015)).



S4. Bivariate spatial rainfall characteristics of V1, V2 and V3 in comparison to observations for the catchment Tetendorf (for one realization, black circles represent observations - for details the reader is referred to Müller and Haberlandt (2015)).

S5. Non-exceedance curve of areal rainfall intensities for V1, V2 and V3 for one subcatchment of Pionierbrücke (for one realization)

S6. NSC-values for all catchments and all criteria without calibration for validation period

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| --- | --- | --- | --- | --- |
| Catchment | Criteria | V1 | V2 | V3 |
| Reckershausen | *Extr-Su* | 0.20 | 0.26 | 0.14 |
| *Extr-Wi* | 0.76 | 0.77 | 0.77 |
| *FDC* | 0.97 | 0.97 | 0.97 |
| *Q-mon* | 0.99 | 0.99 | 0.99 |
| Pionierbrücke | *Extr-Su* | -1.68 | -1.58 | -1.59 |
| *Extr-Wi* | 0.01 | 0.10 | 0.06 |
| *FDC* | -0.07 | -0.07 | -0.07 |
| *Q-mon* | 0.96 | 0.96 | 0.96 |
| Tetendorf | *Extr-Su* | 0.52 | 0.54 | 0.55 |
| *Extr-Wi* | -7.78 | -7.78 | -8.41 |
| *FDC* | 0.19 | 0.19 | 0.19 |
| *Q-mon* | -0.06 | -0.05 | -0.11 |

S7. *Ostat*-values for all catchments and all criteria without parameter calibration for validation period

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| --- | --- | --- | --- |
| Catchment | V1 | V2 | V3 |
| Reckershausen | 0.27 | 0.25 | 0.28 |
| Pionierbrücke | 1.14 | 1.10 | 1.11 |
| Tetendorf | 2.79 | 2.79 | 2.96 |