Parameterization of subgrid heterogeneities for hydrologic modelling

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1. Introduction

Soil heterogeneity is relevant for hydrological processes modelling and distributed hydrological models take into account that issue by an explicit representation of spatial variability. Parametric and mechanistic models are characterized by the problem that its parameter’s values depend on the scale at which they are calibrated. Going downwards in model development we need to know what level of complexity is sufficient to represent the main behavior of our hydrological systems.

We present a formulation to parameterize subgrid heterogeneities of soil hydraulic parameters and its incorporation within TETIS hydrological model. The parameterization approach was tested in a small experimental watershed and compared with TETIS parameterization without subgrid representation by using aggregated parameters at a coarser support. The representation of subgrid heterogeneities improve model performance in spatial-temporal validation.

2. Approach

Based on the assumption of Beta distribution of soil static storage capacity ($H_s$) and Lognormal distribution of saturated hydraulic conductivities ($k_s$) at point scale ($51$) we calculated derived distribution functions of flow variables at point scale. We propose the inversion of the Equations (1 and 2) to calculate non-stationary effective parameters at cell scale ($S_2$). This technique lets us to calculate $H_s(S_2)$ when $X(S_2)$ is larger than zero (Equation 3), that assumption preserves mass balance. The inversion of Equation 2 lets us to state that the parameter $X(S_2)$ is equal to $X(S_2)$, and a similar procedure was carried out to calculate effective parameters of $k_s$. The resulting equations are expressed in an integral form and the validity of those equations was tested by Monte Carlo simulations on a single cell containing N subcells.

3. Results

4. Conclusions

This work present the development of scaling equations to transfer the effect of subgrid spatial heterogeneities of soil parameters within a hydrological model. The implementation of these equations in TETIS model demonstrated its potential to improve the representation of the hydrological processes within the catchment.

The main advantage of taking into account sub-grid heterogeneity is that we can obtain a more robust calibrated hydrological model than using stationary effective parameters. The robustness is improved in the sense of better performance of runoff simulations at locations don’t used to hydrological model: calibration.

Nevertheless, the stationary effective parameters have shown a good representation of watershed properties for runoff modelling and its results are close to sub-grid results in high magnitude events.

The results of validation by continuous simulation confirms the utility of subgrid equations to represent the Hydrology of Goodwin Creek. But it is needed to contrast this hypothesis in other catchments to state a stronger analysis based on the study of a wide range of hydrologic conditions.

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References

