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Geoscientific Model Development Discussions

Interactive comment on "The probabilistic hydrological model MARCS (MARkov Chain System): the theoretical basis for the core version 0.2" *by* Elena Shevnina and Andrey Silaev

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A. Frolov has stressed three remarks to the manuscript: (1) the applicability of the Eq. (4) to describe multi-year river runoff, (2) the confirmation for the mathematical formulations, and (3) the limitations of the method and its alternatives.

Remark 1: The equation describing the river runoff must not contain noise c, which is generated by measurement errors. The physical reason for this removal is that measurement errors cannot in any way form the river runoff. Therefore, multiplicative noise should be excluded from equation (4-Shev.-Sil.).

Answer: On our opinion, this remark is not correct, and the "noised" parameter is not generated by the errors inherent to measurements. The parameterization of the model (4) is done with observed time series of river runoff, and the measurements errors do not connected with the model (4).

Remark 2: The approximate method for solving the FPK equation proposed by V. Kovalenko cannot be considered correct until confirmed by professional mathematicians working in the field of Markov processes. In my humble opinion, it is better to use the proven recommendations contained in the classic monographs, for example, V. I. Tikhonov and M. A. Mironov "Markov processes" (1977).

Answer: On our opinion, this remark is not correct since it seems that A. Frolov doubts the professional skills of the authors. In this manuscript, we not only translated the parts of two books by Pugachev et al. (1974) and Kovalenko (1993) but also formulated the material logically to provide the equations for the new core of the hydrological model. The back ground of the authors comes from the Hydrology (the frequency analysis and physical modeling: http://polar-meteorology.fmi.fi/staff/elshe/elshe_simple.html) and the Radiophysics (the statistical theory of automatic system: https://www.hse.ru/en/org/persons/201924).

Remark 3: Paying tribute to the studies obtained by experts from Colombia, Côted'Ivoire, Mali etc., I dare to draw the attention of E. Shevnina and A. Silaev to my some results published in 2006 and 2011. I used the stochastic differential equation describing river runoff long-term fluctuations in the form (dq(t))/dt=-kq(t)+k[R(t)-E(t)],(1) where q (t) is the river runoff, k is the coefficient in the dependence between the q (t) and the total water reserves w (t) in the catchment area, q (t) = kw (t).The solution for (1) was obtained within the framework of the correlation theory of non-Gaussian random processes. On the basis of this solution, exact analytical dependences between the main statistical characteristics of the river runoff and the corresponding precipitation and evaporation parameters were obtained. Namely, the variance and autocorrelation function, the coefficient of variation, the coefficients of mutual correlation between river

runoff and precipitation and the one for the river runoff and evaporation. These formulas can be used to estimate the response of statistical characteristics of runoff to changes in precipitation and evaporation, for example,caused by climate change. Details can be found in the (Frolov, 2006). The discrete modification of model (1) was considered in (Frolov, 2011). I hope that references mention above will help E. Shevnina and A. Silaev to point out the advantages of their model of river runoff in comparison with the results obtained by me about 10 year sago. Respectfully, A. Frolov References Frolov F. V. Dynamic-stochastic modeling of long-term fluctuations in river runoff // Water resources. 2006. Vol.33. âËĞD ÌŃU5, Ñ ÌĘAÑ ÌĘA.483-493. Frolov F.V. Discrete dynamic-stochastic model of long-term fluctuations in river runoff // Water Resources. 2011. Vol.38. âËĞD ÌŃU5, Ñ ÌĘAÑ ÌĘA. 583-592.

Answer: We have had a look to the method suggested by A. Frolov in the publications 2006 and 2011. We found, that it requires for the time series of evaporation in additional to the time series of river runoff. In the MARCSHYDRO model core version 0.2, the only there non-central moments' estimates are evaluated from the historical observations on runoff. It should be noted, that the observational network on evaporation is less developed compare with hydrological networks, and it rises challenges to apply the method described by A. Frolov. More details on the method presented by A. Frovov can be founded on p. 89 in Kovalenko 2004: http://elib.rshu.ru/files_books/pdf/img-417153826.pdf together with the discussion on its applicability. We added the detailed answer for the Remark 3 (in Russian) as the Supplement). However, looking toward the model development, we will continue the versioning of the core of the model MARCSHYDRO and testing them on observations.

Generally, A. Frolov continue the discussion on the limitations of the AFA method, which has a long history including the Supplement (in Russian) to SC1 by 05.08.2018.

Please also note the supplement to this comment:
https://www.geosci-model-dev-discuss.net/gmd-2018-108/gmd-2018-108-AC5-

supplement.pdf

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