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Hydrology and Earth System Sciences Discussions

HESSD

Interactive comment

Interactive comment on "Toward high-spatial resolution hydrological modeling for China: Calibrating the VIC model" *by* Bowen Zhu et al.

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This study implemented a high-resolution (1/16) hydrological modeling over China based on the Variable Capacity (VIC) hydrologic model, wherein the VIC parameters was calibrated with the streamflow data record from 29 gauging stations. Comparing with the available in-situ/satellite-based products, the validation analyses demonstrated that the calibrated VIC hydrological modeling at a 0.0625_ spatial resolution is overall able to reproduce the key water budget terms, including the runoff hydrographs, evapotranspiration (ET) patterns, and soil moisture (SM) dynamics. The results may benefit the VIC model to be coupled with the operational China Land Data Assimilation System (CLDAS). Although this manuscript is well written and of good readability, I do have a few concerns to be addressed.

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Discussion paper

Reply: Thanks for the constructive comments. Please see the below response point-by-point.

1. The form of this manuscript is very reminiscent of past work by others. A general comment is that the authors need to clearly highlight the unique of such high-resolution off-line modeling dataset comparing with the existing similar datasets, including global coverage.

Reply: The purpose of this study is to develop a high-resolution hydrological modeling over China with a resolution of 1/16th degree and to show a potential to couple with the operational CLDAS. The modeling also provided hydrological dataset at this resolution. There are several features in the dataset. First, it holds high-spatial resolution, while existing simulated hydrological datasets for China have a coarse resolution, such as 1/4th degree (Zhang et al., 2014). The 1/16th degree simulations including ET, Runoff and SM could present more detailed information for detection of flooding and drought events (shown in section 3.4). Second, the dataset follows a physical constrain with energy and water balance that are well defined in the land surface hydrological model. In contrast, satellite remote sensing products generally have a limitation regarding the physical constrain despite their high resolution. And third, the dataset in this study was extensively evaluated using ground-based observations and remote sensing products.

2. Some assertions about model performance are made arbitrarily due to lacking of authoritative criteria. For instance, in terms of evaluating model calibration, the authors can cite one reference (Moriasi et al., 2007, doi:10.13031/2013.23153) that places a lower range to describe a “satisfactory” calibration.

Reply: Thanks for your suggestion. Moriasi et al. (2007) provided a summary for the statistics in model evaluation (e.g., NSE and PBIAS). As to the runoff simulation, our modelling presents a favorable performance regards of NSE comparing with the statistic median NSE which is 0.6. We will cite this reference in the revision.

3. Typically, the hydrological model is calibrated with long-term (>10-yr at least) stream-

flow observation record and validated over another independent period. In the current version, however, the record length of most calibration stations (Table 2) is too short (less than 3-yr) to ensure the robustness of model performance. Also, the streamflow validation over an independent period is still lacking for each calibration station.

Reply: We agree that the model evaluation at a few stations with relative short length of streamflow records may not assure the robustness of model performance. We discussed this limitation in section 4.3 and expect that more observations are available in future. The simulated hydrograph represents a natural flux without considering human activities. Streamflow data from a few stations may be affected by reservoir regulation or irrigation (Wang et al., 2013), which are not suitable for model validation because the current version of VIC fails to characterize such human activities. To remedy the limitation in streamflow evaluation, we employed soil moisture and ET data from in-situ observations and remote sensing products in order to evaluate the model performance. This further evaluation presents a favorable performance, indicating the VIC modeling in this study is robust for the state and fluxes simulation.

4. Soil moisture (SM) memory play an important role in the land surface water and energy budget. The authors should add the evaluation with respect to the SM persistency.

Reply: Thanks for suggestion. As for SM persistency, the autocorrelation of simulated SM is calculated as a function of the monthly lag of three selected stations, shown in Figure 1. The time-scales of simulated SM memory is 1-2 month which is similar to (Entin et al., 2000). Here we just present a simple calculation of SM memory as a few other factors may affect SM persistency (Hagemann and Stacke, 2014). We will provide more evolutions on SM memory in the revision.

5. VIC outputs include a set of snow related files, which are important for water and energy balance in the cold or mountainous regions. Please add the validation analysis of VIC snow output.

Reply: Thanks for suggestion. The high-resolution hydrological modeling discussed in the manuscript mainly including Runoff, ET and SM. As for snow cover, which is also an essential part of hydrological cycle in cold regions, has not been fully focused in our study due to uncertainties of VIC model in snow cover simulations (Islam and Déry, 2017). In the revision, we will validate the simulated snow cover dataset with the remote sensing product.

6. Line 240-242. Please provide more details on the parameter interpolation.

Reply: Each 1/4th degree grid cell contains 16 sub-grid cells of 1/16th degree resolution. Therefore, we regard each sub-grid cell has the same parameters as 1/4th degree grid. However, as for soil hydraulic properties parameters, (i.e., field capacity, wilting point, saturated hydraulic conductivity, and bulk density) for each of the three layers were obtained from the soil dataset (Dai et al., 2013) and then prescribed to the 1/16th grid in this study. These sensitive parameters of 1/16th degree have been fully calibrated after interpolation.

7. Line 282-283. "southeastern China" should be "southwest China".

Reply: Thanks. We will revise the words as suggested.

8. Line 340-343. This sentence is subject to grammar mistake. Please double-check this issue.

Reply: Thanks for your comment. We will modify this sentence in the revised manuscript.

9. The quantitative metric information is absent in most of figures. For instance, please add the RMSE information in each panel of Figure 4 and Figure 7.

Reply: The RMSE information between simulations and observations for SM and ET are represented in Figure 5 (c), which show the spatial distribution of RMSE. We will add the RMSE value in the Figure 4 and Figure 7 for the comparisons between observations and simulations of selected stations.

10. Figure 3 presents the comparison of monthly discharge, but the Y-axis is labeled with runoff (mm), rather than with discharge (m3/s). Please address this issue.

Reply: The runoff simulated by VIC represents the depth of runoff water, which unit is mm. To keep the consistence of two dataset, we converted the unit of observations (m3/s) to runoff (mm) during calibration and validation. We will address this issue in our manuscript.

Reference: Dai, Y., Shangguan, W., Duan, Q., Liu, B., Fu, S., and Niu, G.: Development of a China Dataset of Soil Hydraulic Parameters Using Pedotransfer Functions for Land Surface Modeling, Journal of Hydrometeorology, 14, 869-887, 10.1175/jhm-d-12-0149.1, 2013.

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Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-72/hess-2019-72-AC1-supplement.pdf

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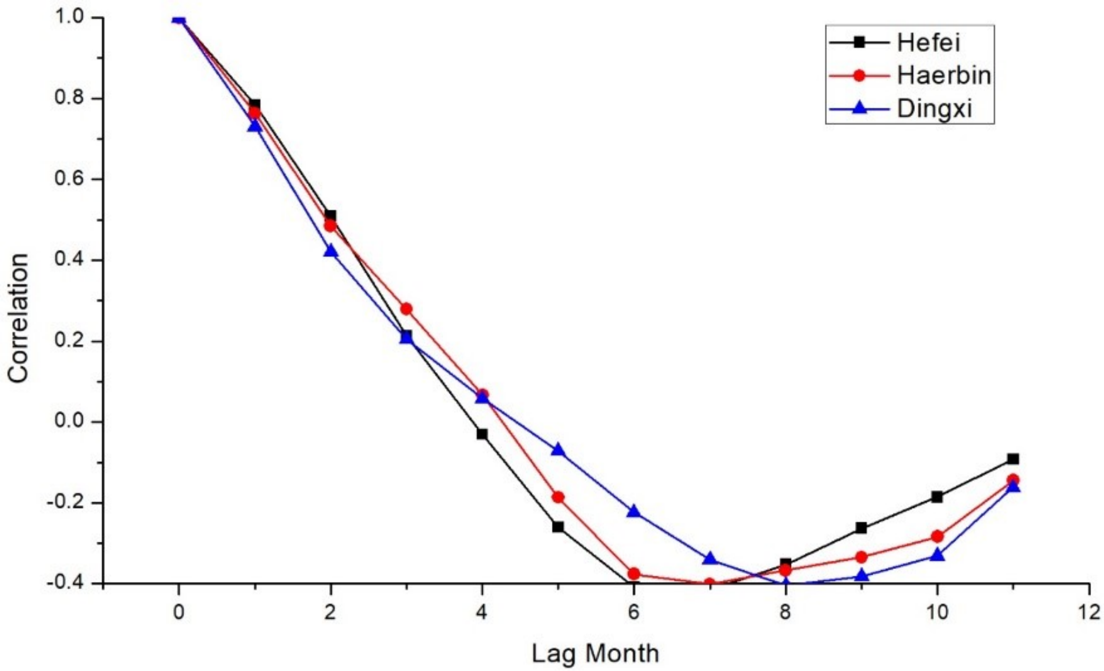

Fig. 1. Figure 1 Autocorrelation of simulated SM as a function of the monthly lag of three selected stations.

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