

This is my review comments for the article GMD-2015-19: "SPHY v2.0: Spatial Processes in Hydrology" by W. Terink, A. F. Lutz, G. W. H. Simons, W. W. Immerzeel and P. Droogers.

I feel reasonably well qualified to review this manuscript and do not have a conflict of interest with the authors. I have carefully and thoroughly reviewed the manuscript and I believe that the subject of the paper can sit well within the journal's objectives.

The article presents with adequate detail the 2nd version of the SPHY model; a process-based model capable of describing processes for snow/ice accumulation and melting, vegetation, evapotranspiration, soil moisture, discharge generation, groundwater recharge, some human alterations (irrigation), and routing through rivers and lakes. Three practical examples are also provided to demonstrate the model's potential in different tasks, i.e. irrigation management, snow hydrology, and hydrological forecasting.

Overall the manuscript is well written (despite being rather long) and provides enough information for the understanding of the algorithms (model hypotheses). Although I do want the article to be eventually published, there are currently various parts/sections that require, in my opinion, minor to major revisions.

Major comments:

1. SPHY is certainly not the "first" hydrological model developed for the large scale (to my knowledge, there are plethora applications of LISFLOOD, VIC, SWAT, SWIM, HYPE, mHM etc.) and even used for similar applications as those presented in the article for almost a decade (Lindström et al., 2010; Samaniego et al., 2010). Apart from reference to those models and articles, I believe that it would be very insightful to present the pros and cons (for instance, in a table) of SPHYv2 in comparison to other hydrological models for the large scale. Why would a modeller work with SPHY and not with another model structure? It is also important to state the model structural improvements in comparison to the model's 1st version; hence highlighting the novelty of the new version.

Minor comments:

Page 1688 Line 4: How would you define "best components"? I would suggest replacing with "important" or "dominant"

Page 1688 Line 6: "... under various land use and climate conditions". Is it only those? Why only mentioning land use and climate? To me a model should be applied in various physiographies and hydro-climatic conditions. Rephrase accordingly.

Page 1688 Line 9: Delete "Compared to other hydrological models, that typically focus on the simulation of streamflow only" to avoid misinterpretation. The statement is also not correct! Hydrological models at the large scale, they can describe many dominant hydrological processes including human alterations.

Page 1688 Line 12: "remote sensing data". Why limiting this to remote sensing data? I suggest replace this with "forcing meteorological data"

Page 1689 Line 9: You can cite the paper by Pechlivanidis et al. (2011)

Page 1689 Line 14: I suggest rephrasing as "... provide hydrologic information on high temporal..."

Page 1689 Line 15: What do you mean with "and for difficult to observe sub-processes"?

Page 1689 Line 18-19: "Such scenarios are often referred to as projections." I do not agree with this statement. There is a distinction between scenarios and projections. For instance a climate projection is based on an emission scenario. Would you call a scenario of T+2oC as projection? I suggest deleting this sentence to avoid misunderstandings.

Page 1689 Line 23-24 and Page 1690 Line 1-2: The statement is clearly a personal opinion and not clarified by a reference. In my opinion though, the HBV model is generally considered as a benchmark (Ceola et al., 2014). To avoid biases towards personal opinions, I suggest deleting those sentences.

Page 1690 Line 12-14: What about irrigation?

Page 1690 Line 15-18: This is very specific and should be further discussed. Models should be flexible to incorporate any kind of information, i.e. a reservoir operation scheme, demands for irrigation, levels in the lakes etc.

Page 1690 Line 19-24: What about parameterisation? I would have interpreted that "model setup" includes parameterisation, however here you only mention switching on/off processes.

Page 1691 Line 4: Maybe use 'Background' instead of 'Introduction'

Page 1691 Line 5: "best component". See my previous comment.

Page 1691 Line 9: You discuss about land use but what about soil and topography?

Page 1692 Line 19: "... scheme is used; depending on the..."

Page 1693 Line 2-5: I believe that calibration/evaluation should be discussed in a separate subsection.

Page 1693 Line 6-8: There are many more variables that could be extracted from a model. However, you only do this for the most needed components.

Page 1693 Line 7-8: I suggest "... maps of all the available hydrological processes, i.e. actual evapotranspiration..."

Page 1693 Line 10: I suggest "... base, but can also be aggregated at monthly or annual time periods."

Page 1693 Line 11: Instead of "location" do you mean "cell"?

Page 1693 Line 12: The “under current and future conditions” is not necessary information. I suggest deleting.

Page 1693 Line 12: What about inflows, water level in lakes/reservoir, water demands, snow water equivalent etc.?

Page 1693 Line 19-22: This is not stated well. There is a difference between ‘interested in simulating only’ and ‘dominant processes occur’. Despite the interest on certain processes if the remaining is important they should be switched on.

Page 1693 Line 28: Delete since the message is given in the previous sentence.

Page 1694 Line 3: It should be “... available: (i)...”

Page 1694 Line 9-20: This is unnecessary repetition of facts or methods which are well known. I would personally stick to the major limitation to provide data for the highly demanded energy based methods. Hence the need for simplistic algorithms based on temperate only.

Page 1694 Line 12: “standard method”.

Page 1695 Line 18: “... or use a time-series of crop coefficients as model input.” Isn’t that related to the dynamic module?

Page 1695 Line 20: Delete sentence “and therefore... simulation period.”

Page 1696 Line 3-6: Such an approach can only be used when NDVI data are available. In the case of assessment under future conditions, how do you calculate Kc dynamically?

Page 1698 Line 22: Delete “easily”.

Page 1705 Line 21-22: What type of parameters? What are they related to?

Page 1719: Reference to Fig. 7 seems to be missing.

Page 1725 Line 5: “applicable, (iv) can easily be ..., and (v) can be applied...”

Page 1743: In Figure 4, it is difficult to distinguish the two lines. Give a different colour and line style (to even be distinguishable in grey scale).

Page 1744: Same as in Figure 4.

Page 1747: Same as in Figure 4.

Suggested references:

Ceola, S., Arheimer, B., Blöschl, G., Baratti, E., Capell, R., Castellarin, A., Freer, J., Han, D., Hrachowitz, M., Hundecha, Y., Hutton, C., Lindström, G., Montanari, A., Nijzink, R., Parajka, J., Toth, E., Viglione, A., and Wagener, T.: Virtual laboratories: new opportunities for collaborative water science, *Hydrol. Earth Syst. Sci. Discuss.*, 11, 13443-13478, doi:10.5194/hessd-11-13443-2014, 2014.

Lindström, G., Pers, C., Rosberg, J., Strömqvist, J., & Arheimer, B. (2010). Development and testing of the HYPE (Hydrological Predictions for the Environment) water quality model for different spatial scales. *Hydrology Research*, 41(3-4), 295–319. doi:10.2166/nh.2010.007

Pechlivanidis I.G., Jackson B., McIntyre N., Wheeler H.S., 2011, 'Catchment scale hydrological modelling: A review of model types, calibration approaches and uncertainty analysis methods in the context of recent developments in technology and applications', *Global NEST Journal*, 13 (3): 193-214.

Samaniego, L., R. Kumar, and S. Attinger, 2010: Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale. *Water Resour. Res.*, 46, W05523, doi:10.1029/2008WR007327.