Review of *NMP-Hydro 1.0: a C# language and Windows System based Ecohydrological Model Derived from Noah-MP*

Recommendation: Major revisions

The authors have more-or-less replicated the Noah-MP model physics in a C# environment in an effort to expand the Noah-MP and WRF-Hydro research community to personal computers with Windows operating systems. This undertaking is generally reasonable, and a windows ready C# version of Noah-MP coupled with streamflow may be useful to hydro-researchers unfamiliar with Fortran and Linux based computing systems. Further, the results show overall "good enough" agreement between the legacy model and the replication to support/justify use of NMP-Hydro as a research tool. However, there are significant unexplained differences between the two model frameworks that the authors disregard with minor speculation. The paper would be strengthened substantially if the authors actually tracked down the source of these differences and at least documented it as opposed to simply guessing that they are caused by "precision" differences. Such an effort could involve more isolated evaluation of the model components that seem to create these issues. Additionally, the paper would benefit from a cursory "speed" comparison between the WRF-Hydro version of Noah-MP and the NMP-Hydro version, such a comparison would help bolster the motivation for reproducing Noah-MP in C# beyond that of simply "some people don't like Fortran and Unix." Overall, I recommend major revisions with a focus on identifying and discussing why certain model components do not behave exactly as they do in the Fortran environment, and on benchmarking model performance.

General comments:

I think the authors should strongly consider a different name for the tool than NMP-Hydro since this is extremely close to WRF-Hydro or NWM branding and is essentially a replica of WRF-Hydro system. This would help differentiate the two modeling systems and avoid confusion within the research community. Perhaps something that involves the C#, since that is the main novelty of the system presented here.

In the experimental configuration, the authors describe using a 6km grid for Noah-MP with a 1 degree meteorological forcing. Is there any meteorological downscaling performed within either WRF-Hydro or NMP-Hydro to reconcile these resolution differences? If not, the simulations would effectively be running ~400 single-column Noah-MP runs with nearly identical meteorological inputs, and the only spatial-detail finer than 1 degree would come from differences in soil texture and land cover class. Further, some of the differences seen between the models, particularly in the winter season could be related to differences in downscaling, so I think it's important to at least clarify whether or not downscaling is applied.

It's not that surprising to me that the largest differences occur during the winter, though I suspect this has relatively little to do with the snow/frozen soil model physics, and rather

may have to do with minor differences in the energy balance over snow that causes small differences in snow temperature to affect snow and surface albedo which can feedback into the energy balance and cause greater model divergence.

Finally, is there any plan to maintain this version of Noah-MP to match new release versions (e.g., Noah-MP 5.0) as the Noah-MP developers at NCAR continue to expand the model capabilities? Even if the authors, justifiably, did not put effort into translating the new code structure associated with version 5.0, is there a plan to try and implement improved model physics into the NMP-Hydro framework? Some discussion around this topic may improve the manuscript.

Specific Comments:

Lines 57 – 59: This sentence is somewhat misleading and mildly incorrect. True, NoahMP has been integrated seamlessly into the WRF model as a two-way coupled LSM to the atmospheric model and has been since its initial release ~2011/2012. However, WRF-hydro is related to WRF only insofar as it uses the same coding conventions and architecture and can be coupled into the WRF framework. WRF-Hydro itself is a system designed to couple atmospheric forcing to a distributed version of Noah-MP (or other LSMs) and routing/stream flow models. Consider rewording.

Lines 68 – 70: additional wording concerns, specifically the words "coupled" and "models" in this context. HRLDAS and WRF-Hydro are not necessarily considered "models" so much they are frameworks used to couple various models together. Also, if you are going to mention the HRLDAS as a framework, consider also including the Land Information System (LIS) here. Consider rewording something like:

"Noah-MP is supported by several different modeling architectures and frameworks to facilitate coupling it to various other Earth system modeling components including, WRF, MPAS, HRLDAS, LIS, and WRF-Hydro. This makes NoahMP a powerful research and forecasting tool within the hydrology community"

Lines 70-72: This sentence is almost identical to a sentence on lines 59-60, please remove it.

Line 162: What is "each variable?" Soil temperature? Snow? Soil moisture? Surface temperature? Energy balance?

Line 208: The word "comprising" should be "comprised"

Line 261: Please change "*significant differences was"* to "*significant differences were"*

Lines 288 – 289: What is meant by "disparate parameter configurations?" If I understand this correctly, does this mean that the parameter tables (i.e., MPTABLE.TBL, etc) that define

specific snow/soil/vegetation properties might be different between WRF-Hydro and NMP-Hydro? This would be a huge issue trying to validate one against the other.

Line 296 – 273: It seems unlikely to me as well that floating-point errors would result in large differences here, LSM's are tightly constrained by the forcing, unlike global atmospheric models for example, such that floating-point errors don't really cascade. The authors mention snow/frozen soil as potential reasons for the discrepancy, have you looked at snow/frozen soil variables related to runoff? For example, differences in snow melt, soil ice content or total soil moisture? The Noah-MP snow and frozen soil models are simple enough that I would not expect trouble when converting code over from one language to another.

Table 3: Please change "The first experiment" to "control"

Lines 311-312: This line indicates that the authors compared NMP-Hydro with WRF-Hydro, but it's unclear to me that there is a model fun with WRF-Hydro in the experiment suite, rather it looks like a basic parameter-sensitivity study. Are the authors able to clarify which experiment is run with WRF-Hydro, or are all of the simulations presented in figures 9 and 10 NMP-Hydro? If that is the case, please edit this line to reflect that so there is no confusion.

Line 382: As I understand it here, the modeling isn't "Based on Noah-MP". It *is* Noah-MP, only recoded in the C# programming language and coupled to a streamflow model. Please edit to be clear about this point.