1 Anonymous Referee #1

1.1 Overall:

This paper provides an excellent and useful product, and the complexities and methods used to derive this product. There are some minor organizational and grammatical errors, but overall I think this paper is a good contribution to broad-scale hydrologic modeling and analysis.
Thank you for offering such encouraging and detailed suggestions for improving the structure of the paper. We appreciate your efforts to improve the structure and the clarity of the paper. We will revise the introduction as suggested by the reviewer. We added additional analyses for addressing the questions: 1) How the assumption of a static land cover before 1990 impacts the model results, and 2) What are the relative characteristics of the 222 catchments and how do they relate to model performance. In the following, we present the referee's comments as well as our point-by-point response to all of them.
The paper could benefit from some additional attention to organization, specifically in the introductory sections. The authors limit themselves in the stated aim of the paper in the introduction, and go on to state other aims later in the paper. The aim as stated in the introduction is to derive a consistent set of national-scale hydrologic data for Germany at high spatial and temporal resolutions. If this was the extent of the paper, I would recommend that this be re-submitted as a methods paper; however, the authors go on to append additional aims/goals in the body of the paper which go beyond this, such as: Page 5, line 22: to derived consistent model parameters to perform nationwide simulations of water fluxes and states. Page 7, line 8: to analyze the temporal dynamics of soil moisture Page 13, line 21: spatio-temporal differences of uncertainties caused by the 100 ensemble parameter sets As it is written, this paper reads as an aggregation of papers instead of one cohesive contribution. This could be easily fixed by restating the aim in the introduction to include all the parametric uncertainty analyses that are presented in the paper. Please gather and reassess the purpose and scope of the entire papers contribution to the field of hydrologic science, and state this in the introduction.
We thank the reviewer for his/her assessment of the manuscript. We will revise the manuscript based on your suggestion and reorganize the (methodological) aims in the introduction.
There are also several spots in the paper which could be improved by directly assessing the limitations of the data or analyses. An example of where this is done well in the paper is page 7, lines 7-8: A direct comparison between observed and simulated soil moisture may therefore be misleading due to differences in spatial representativeness and sampling depth.
We will address limitations of data and analyses where we identified them in the revised manuscript, e.g., the limitations of an observational driven, simulated hydrologic dataset.

Specific comments:

Page 1, line 24: Formatting of the citation does not match others.
We edited the format of the citation.
Page 2, line 6: State limitations of using observational data.

Thank you for pointing this out. We mention this limitations in the revised manuscript as "First, due to a limited amount of observed variables modeling approaches like the estimation of potential evapotranspiration have to be adopted to the available data. In consequence temperature based methods may be preferred to more physically based radiation approaches. Second, the interpolation of point observations induces uncertainties depending on the applied interpolation method. Further, small-scale, convective precipitation events may not be caught by gauging networks and lead to an underestimation in precipitation."

Page 2, line 9: add contiguous or continental United States.

Done.

Page 2, line 13-14: grammar. ... who stated a need for higher-resolution spatial data and models...

Thank you, done.

Page 3, line 11: add entirely, only catchment entirely covered by German territory

We changed that accordingly.

Page 3, line 17: grammar, average discharge of the seven catchments ranges

Thank you, done.

Page 4, line 1-2: How does this assumption of static land cover before 1990 impact results?

The impact of changing land cover is remarkably high near urban areas, since most of the changes there happened between 1950 and 2010. The effects of these changes are, however, low at the model resolution of $4\times4\text{km}^2$ as the table underneath shows. This table shows the differences between the hydrological state and fluxes between two scenarios. In the first scenario the land cover is fixed to the state of 1990. In the second scenario we fix the land cover to the conditions observed in 2006. The model time period is 1951 to 2010 and the domain is Germany. The comparison is based on daily values of the respective flux or state. Mean relative biases of less than 5% indicate that the assumption of static land cover has an impact on the modeled fluxes and states which is low compared to the effect of the parametric uncertainty. Changes apart from urbanization will have low effects on the modeled hydrological variables because mHM works with three land cover classes, i.e., sealed (mostly urban), forest and a mixed class. We restricted our study to only 3 land cover scenes because the well established CORINE data are only available for the years 1996, 2000, and 2006.

The table shows the mean and standard deviation between 2 land cover scenarios.

variable	bias [mm d^{-1}]	rel. bias [%]	correlation [-]	RMSE [mm d^{-1}]
evapotranspiration	0±0.02	0.22±1.46	1.0±0	0.01±0.03
soil moisture	0±0	-0.02±0.67	1.0±0	0±0
generated runoff	0±0.02	-0.57±4.91	1.0±0.03	0.03±0.07
recharge	0±0.01	0.43±2.79	1.0±0	0±0.01

Page 4, line 2: What are your aggregation/resampling methods?
We remapped the data using a nearest neighbor approach. We address this question in the revised manuscript.
Page 4, line 4: Remove information after gauging station
Done.
Page 4, line 7: What are the relative characteristics of the 222 catchments? Size? Is there a map?
The location of the catchments and their size can be retrieved from Figure 4 in the manuscript. For a better insight we relate basin specific characteristics to the model performance (see Figure 1 below). This figure is included and discussed in the revised manuscript. Furthermore, a table containing all the relevant information (location, mean elevation, mean slope, mean precipitation, etc.) will be published as supplement to this manuscript.

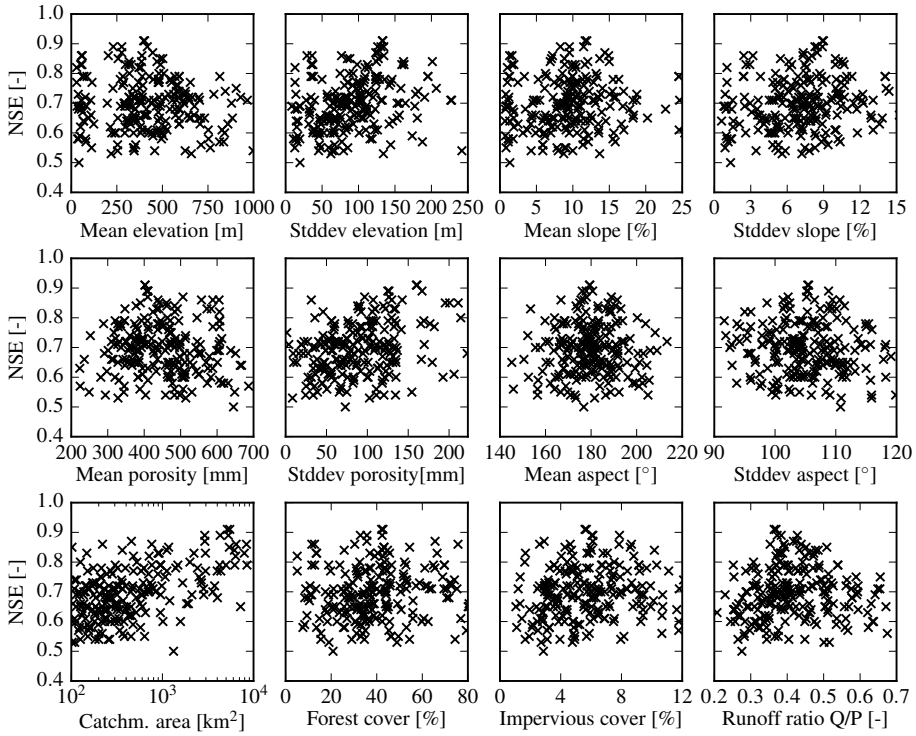

Figure 1: Relation between land surface and hydro-climatic conditions and model performance for the 222 river basins. The mean and standard deviation (stddev) of a characteristic for the single basins are based on the morphological input data at the 100×100 m^2 resolution. standard deviation.

Page 4, line 18: Authors state that this spatial resolution is appropriate without additional reasoning or citation. Please provide one or both.
We orientate the choice for a spatial resolution to the density of the precipitation stations. Two main arguments were considered: 1) The spatial resolution should be lower than the mean lowest distances between existing stations, 2) The chosen resolution shouldn't be so low that the interpolated meteorological variable is

mainly an artifact of the interpolation method (e.g., elevation driven external drift). Therefore, we argument that half of the minimum distances, i.e., 3 km, is a reasonable choice. Because of model specific reasons, we decided for the closest even number to 3 km, i.e., 4 km. We revised the manuscript to make this connection between spatial model resolution and average minimum distance between precipitation stations more clear.

Page 5, line 3: Change precipitation to rainfall.

Done.

Page 5, line 6: On average, it is 1.8 m deep in Germany. Given the previous sentence this is confusing. What is the it in this sentence?

We clarified this point in the revised manuscript.

Page 5, line 11: since Germany is a part of Europe, various river basins across Europe (including Germany), and the USA. . .

Done.

Page 5, line 14: remove the before porosity.

Done.

Page 5, line 22: This goal is not included in the introductory aim. Page 7, line 8-9: this aim is not included in the introduction.

Thank you. We address both points in revised the manuscript as stated above.

Page 8, line 1-2: mean and standard deviation symbols defined in line 1, just use symbols in following sentence.

Done.

Page 8, line 25: Choose basins or catchments and be consistent. I would recommend Basins, which would require going back and changing this throughout the paper.

We follow your recommendation and changed the manuscript accordingly.

Page 8-9:This section could benefit from more organization, such as the use of a more explicit introductory paragraph. Presentation jumps from analysis of results overall to specific basins, which is difficult to follow.

We will rewrite and reorganize this section.

Page 9, line 26: remove is at the end of the sentence.

Done.

Page 10, lines 16-24: You discuss the energy- and water-limited conditions, which could also be added to the figure. It also appears that at this point the data switch from under representation to over representation (within the uncertainty bounds). Please discuss this.

Since Figure 4 has already a high information content, we dare to add further information as, e.g., the separation to energy and water limited areas, by introducing another line or coloring. Nevertheless, we elaborated the caption of the figure to address this point. We discuss the issue of under- and overrepresentation in the text now. Thank you for pointing this out.

Page 11, line 5: Your data groupings get confusing here. In the figure daily and monthly (I think?) data are grouped by color in seasons. In the table you report monthly and daily values. Be explicitly clear about what is being reported here. Maybe have a different symbol for monthly and daily data to differentiate (if they are both in the scatterplots. . . still not clear.).

The scatterplot only shows daily data. We adopted the figure caption accordingly.

Page 11, line 6: "The results of the scatter plot... indicate..." this phrasing is awkward. Consider "The scatterplots shown in Figure 5 indicate..."

Thank you for your suggestion. We reformulated the sentence.
Page 11, lines 17-23: Add "limitations" before Hargreaves-Samani approach to improve clarity of the paragraph.
Done.
Page 11, line 24-page 12 line 2: Does land cover type play a role in the ability to interpolate point to grid data? Are some land cover types likely to be more spatially heterogenous with respect to ET and soil moisture? Could this be incorporated into an uncertainty analysis?
For the above mentioned analysis no spatial variabilities of morphological information are considered at all. The hydrological model is run on the point scale, i.e., a single grid cell ($100 \times 100 m^2$), for this analysis. The relation of land cover and modeled evapotranspiration at the resolution of 4×4 km^2 is shown in Figure 8 and shortly discussed in section 4.5.
Page 12, line 11: These features (Central Uplands, Alps) are not on the map.
We changed the text in way that the location can be identified on the map in Figure 9.
Tables: Capitalize all headers, to be consistent (Table 1 no headers are capitalized, Table 2 some are, some arent.
We capitalized all table headers.
Table 1. Header for Major German Basins
We added the header in the revised manuscript.
Table 2. Describe RMSE, BIAS and in a footnote, and what [-] means in a footnote or caption. Station- name should be two words.
Thank you for pointing out that the abbreviations are not explained at all. We added the descriptions in the captions of both tables.
Figures:
Figure 1: What do colors represent? Please describe in figure caption.
The colors are only to better distinguish the different catchments. We added an explanation to the caption.
Figure 4: Using the same color scale is a little misleading. Include the locations of the eddy covariance stations on the map.
The location of the eddy covariance stations are depicted in Figure 1. We have chosen the same colors for the Budyko plot and the map plot to give the reader the opportunity to see wether model performances are clustering for a particular climatic regime and/or geographical location. For the maps on the right side, we are using the inverse color bar. We intend to ease up the comparison of catchments showing a relatively good performance (green) with relative low NSE ranges (green) and vice versa.
Figure 5: Consider changing symbols so that this figure is readable in black and white.
We changed the illustration of the different seasons to four different marker symbols.
Figure 6: Why are these four stations selected?
First, of all to represent the major mHM land cover classes (forest and mixed) are represented. And second, because they have at least continuous 3 year long time series without big data gaps. Further the four station are spread over the three regions where eddy covariance observations are available. We added this reasoning to the figure caption.
Figure 7: The Central Uplands and Alps (referenced on page 12, line 11) are not explicitly shown on this map.

We changed the text such that the location can be identified on the map in Figure 9.