

Hydrol. Earth Syst. Sci. Discuss., referee comment RC3  
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## Comment on hess-2021-632

Anonymous Referee #3

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Referee comment on "High-resolution satellite products improve hydrological modeling in northern Italy" by Lorenzo Alfieri et al., Hydrol. Earth Syst. Sci. Discuss.,  
<https://doi.org/10.5194/hess-2021-632-RC3>, 2022

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Dear Editor, Dear Authors,

Thank you very much for considering me as a reviewer for the manuscript by Alfieri et al., titled "High resolution satellite products improve hydrological modeling in northern Italy" (hess-2021-632). I find the title of the study appropriate, thus read with much interest the manuscript written and presented in high quality. The study deals with the integration of multi-sensor and multi-resolution satellite products into hydrological modeling based on different experiments/simulations. Against the background of the mentioned "Digital Twin" of the Earth, this approach is of high relevance to the scientific community and implies the potential for future investigations. To my understanding, the study's introduction provides sufficient background and includes relevant references. About the description of the research design and methods applied, I see some need for improvement to further specify. According comments/questions are listed below.

For the aspect of language and style, I do not see any serious flaws, thus only minor spell checking is recommended.

**Line 14:** Use the plural for resolution (i.e., spatial and temporal resolutions)

**Line 15:** You write "high-resolution" here in this line, but in the title, you go for "high resolution". This is minor; however, I recommend using consistent writing.

**Line 16:** As you have introduced EO as an acronym for Earth observation in line 13 already, I recommend using this acronym consistently.

**Line 16:** As the abstract acts as an “appetizer” to your study, I would prefer to read more specific information, thus recommend adding the number of experiments investigated (i.e., “In a set of six experiments, [...]”).

**Lines 31 and 44:** What is the order of your references listed? Alphabetical? Chronological?

**Line 66:** No comma after Po River Basin.

**Line 78:** How was the spatial resolution of the DEM resampled from 90 m to 1 km spatial resolution?

**Line 80:** Was is the reasoning for an upstream area larger than 240 km<sup>2</sup>? Did you choose?

**Line 81:** What is the source of the high-resolution stream network of the main rivers?

**Line 83:** The hydrological model Continuum used in the study is mentioned here for the first time. So far, the readership was not informed about the specifications of this model, thus reasoning why this model was chosen for the simulation experiments.

**Line 84:** What do you mean specifically with a “hydrological soil type map”? What soil hydrological/hydraulic properties are provided?

**Line 85:** What do you mean specifically with “soil capacity”?

**Line 86:** Use plural for “fraction”, i.e., fractions of sand and clay.

**Line 87:** So far, the datasets provided are represented by grids. I assume that the spatial data on the glacier areas is provided in vector data. If so, how was the data implemented?

**Line 89:** Your information on the vegetation coverage originates from the ECOCLIMAP dataset with 1 km spatial resolution. What is the reasoning for using this dataset whilst you have used the ESA CCI Land Cover product (300 m) for deriving your curve number?

**Lines 92-95:** You write of a set of variables relating to the dam reservoirs and natural lakes. How do those variables go into the parameterization of Continuum, particularly specific information on the weir length? This parameterization and the reasoning are not getting clear.

**Sub-chapter 2 "Data":** Before reading extensive information on the various datasets, I would prefer to have information on the temporal domain (i.e., observation period) considered for your study. Moreover, I am missing information on the study area (area size, climate, physical properties, land cover) that would support the readability and interpretation of the further information provided and results.

**Line 110:** What is the specific reasoning for selecting 22 stations for cal and five stations for val? What were your criteria for selection (position in the Po River Basin?, Data coverage? Data density?)?

**Figure 1:** Your figure looks very appealing. However, up to now, the meaning of the virtual stations (black dots) is not clear. Maybe you can add a general study workflow leading into this subchapter? Also, I am wondering if a smaller "overview map" (e.g., placed in the upper left corner of Fig. 1) would be meaningful.

**Line 129:** How were the two datasets rescaled? What is the common reference? What are the relative systematic differences between the products?

**Line 132:** Add the acronym "GPM" after "Global Precipitation Measurement" in line 117 to introduce this abbreviation.

**Figure 2:** When comparing Fig. 1 to Fig. 2, I recommend using the same "spatial extent" for both figures to increase the figures' readability.

**Lines 150 and 151:** It is minor again, however, I recommend using the same style for writing the spatial resolutions (1 km vs. 1-km).

**Figure 3:** I recommend adding the boundary of your spatial domain into Fig. 3 a (left). If possible, I would prefer to see subfigure Fig. 3b (right) a bit enlarged to enhance readability.

**Line 176:** How is the “natural vegetation” composed? (e.g., woodland, grassland, etc.).

**Line 177:** Where is the Oltrepo station located? As you write of different stations many times, I am wondering if their positions can be indicated in Fig. 1?

**Figure 4:** In your caption, you mix between writing “full wording” (i.e., Surface Soil Moisture) and abbreviations (i.e., SM). I recommend choosing one style to make the caption(s) a more stand-alone version. For the shading indicating the SD, I found it very hard to “read” in both digital and color printed format. Maybe you can decrease the opacity a bit?

**Line 194:** When you write that the observed snow data were processed, what do you mean specifically? How were they processed? How was their aggregation towards a daily resolution done (median or mean)?

**Figure 5:** I would prefer reading measures of performance ( $R^2$ , RMSE) in the scatterplot (Fig. 5d).

**Line 214:** I would prefer seeing the position of the five stations indicated in a map to support orientation and interpretability. How did you deal with the fact of cloud coverage and its impact on the availability of the reflectance data?

**Figure 6:** As you have provided the averaged NS and KGE in the paragraph, I would additionally prefer to see those station-based metrics in the according sub-figures. For the left column of Fig. 6 (a-e), a slight increase in the gaps between those sub-figures is recommended.

In **line 226**, your description of the methods applied starts. For the previous sub-chapters providing information on the datasets for integration, also methods and results are provided. I am wondering if this was part of your analysis too and part of other or previous studies. I find this part hard to follow and would therefore prefer having clarification. Also, since now the reader got a lot of information on your different EO satellite datasets, an overview table stating the spatial resolution, temporal resolution, and purpose (model parameterization, data assimilation) would be helpful. As your spatial target model resolution is 1 km, more specific information on the resampling techniques from all different spatial resolutions (< 1 km and > 1 km) might be helpful.

**Line 248:** What are your performance measures to evaluate the “best match”? Maybe add in brackets.

**Line 250:** I recommend adding the figure reference for Figure 1 in brackets after “[...] at the 22 considered calibration stations” to support orientation.

**Lines 252-253 (and beyond):** Personally, I prefer seeing those “feature symbols” (i.e., cf, ct, CN, ws) in italic letters.

**Line 261:** Specify “J”.

**Line 264:** Again, this is minor, but choose on consistent style (Sentinel 1 vs. Sentinel-1).

**Lines 270 and 272:** Unfortunately, it is not getting very clear to me if *G* here refers to the same or two different variables (kernel function and gain). Please specify if needed.

**Figure 7:** I would prefer knowing the locations of the basins and having more information available (e.g., land cover) to increase understanding of the interpretation.

**Line 311:** Specify towards potential evaporation (?).

**Figure 9:** I very much like your figures in the entire manuscript. However, I am wondering if you could change the color code of the KGE in Figure 9 towards more purple (or else) colors to allow for better differentiation from the background (e.g., stream network).

**Figure 11:** Please see my comment for Figure 9. Also, I would rather see a stand-alone version of Figure 11' caption instead of “like Figure 9”.

**Line 368:** So far, the abbreviation PE (potential evaporation) was not introduced. Please do so in an adequate position.

**Figure 13:** The legend placed in one of the subfigures (upper row, middle) is valid for all sub-figures, right? I would rather see it in a more meaningful position.

**Discussion:** How is the river discharge affected by different land covers/land uses in your study area (e.g., upstream). I am missing a more critical discussion on this effect, as the

effect of the land cover also on soil moisture should be more highlighted in terms of uncertainty (effect of vegetation, surface properties).