Hydrology and
Earth System
Sciences
Discussions

Interactive comment on "Anthropogenic Influence on the Rhine water temperatures" by Alex Zavarsky and Lars Duester

Anonymous Referee #1

Received and published: 26 November 2019

GENERAL COMMENTS

The manuscript presents a study of short term and long term changes in river temperature and investigates the influence of natural and anthropogenic drivers of these changes which is interesting and generally within the scope of HESS. River temperatures at various monitoring locations along the river Rhine as well as industrial production and nuclear power plant activities are analysed. The authors further develop a novel approach of calculating a catchment-wide average air temperature which is used in the linear regression relationship between air and river temperature.

Overall, the scientific approach and the methods appear to be valid. However, there are some points which need further clarification:

(1) The relationships between river temperature and its drivers are investigated using multiple linear regressions separating the so-called Rhine base temperature (i.e. the river temperature without influences of air temperature and discharge) and air temperature and discharge influences on river temperature. More information on the multiple linear regressions for each location is required for the reader to be able to evaluate the robustness of this approach

(2) The computation of the catchment-wide average air temperature is based on the air temperature in each grid cell of the catchment area and the hydrological distance to the river temperature monitoring station assuming a constant flow speed. It would be interesting on what basis the constant flow speed has been derived and how the flow speed varies in space and time and what is the justification of combining a rather complex averaging method of air temperature with a constant flow speed. In order to show the benefits of this rather complex method, benchmarking with simple approaches (e.g. catchment average air temperature in combination with constant lag time, as in Pohle et al., 2019) is suggested.

(3) A data filter is used to compare river temperature and gross domestic product. It would be interesting how the filter parameters have been chosen and how sensitive the results are to different values of these filter parameters.

(4) As short-term and long-term changes of river temperature and its drivers are presented, it would be interesting to know if the data also show statistically significant trends and change points.

The introduction section would benefit from more information and references to recently published literature. Also, the results need to be discussed with reference to related work and including appropriate reference to studies on river temperature. To that end, the authors are suggested to further familiarize with recently published studies on factors influencing river temperature (e.g. Garner et al., 2017; Lisi et al., 2015), river temperature modelling (e.g. Ketabchy et al., 2019; Wondzell et al., 2019; Zhu

et al., 2019) as well as short-term and long-term changes in river temperature and its drivers (e.g. Basarin et al., 2016; Caldwell et al., 2015; Isaak et al., 2018; Pohle et al., 2019).

The manuscript is overall well-written and structured. The results section includes many statements which would be better suited in the methods section. Further, I suggest adding a separate discussion section.

SPECIFIC COMMENTS

Page 1 – line 22 Probably it is better to use "physical based" than "physical". Also, please check whether "deterministically" is the right term – probably it is referred to statistical models?

Page 2 – line 6/7 Is the statement by Markovic true for all rivers? (Their paper refers to Elbe & Danube.)

Page 2 – line 20 The equation is very specific and may be better suited in the "methods" part.

Page 2 – line 21 Suggestion to define coefficents already directly below the equation.

Page 2 – line 25/26 Is this statement universal or only valid for the rivers studied in the cited papers – in that case please name these rivers.

Page 3 – line 3 What is the original temporal resolution of the datasets? What were the procedures for quality control and have there been missing values?

Page 4 – Fig. 1 Please revise the map: make the river Rhine more visible, include monitoring stations and NPPs. Do the time lags refer to hydrological distance or to the grid? How have 0.733 m/s been derived? How robust is this number – I would assume spatial & temporal variability of flow speed.

Page 5 – tab. 2 How exactly have these values been derived?

Page 7 – line 10 Sentence not needed.

Page 7 – line 13-15 Suggest moving sentence to "methods" section.

Page 8 – Fig. 3, tab. 3 Suggest adding 2nd figure column for air temperature. Merge figure and table (i.e. add slope values to the table). Please check robustness of number of digits of slopes, also state whether slopes are statistically significant.

Page 8 – line 3 Which difference? It is stated that Ta warming rates are not really different.

Page 9 – line 3/4 Please be more specific what is meant with "average European river"

Page 9 – line 9/10 Move to "methods" section.

Page 9 & 10 Combine tab. 4 & 5 and highlight the best model for each criterion & location

Page 11 - tab. 6 What does "GW" stand for? Omit "the table shows"

Page 11 – line 16 What is meant with "on average constant" – what time step does the average refer to?

Page 11 – line 25 Why has this particular company (BASF) been chosen?

Page 12 – line 2 Provide test statistics for significance or reword.

Page 14 – line 2 Linear models have also been applied elsewhere. However, it is unclear from this sentence how a linear relationship between air and river temperature implies universal applicability of the method presented in this paper. Furthermore, Morrill et al. found a better fit of non-linear models which might be even more pronounced outside of the tropics (i.e. conditions when air temperature, unlike river temperature, goes far below 0°C)

Page 15 – line 8 For reproducibility, please also name the data providers.

TECHNICAL CORRECTIONS

Page 1 – line 2/3 Sentence unclear – please revise.

Page 1 – line 15 What does "their" refer to?

Page 2 – line 8 Please revise sentence structure.

Page 2 – line 16 Please correct spelling to "assess"

Page 2 – line 24 Is the Markovic reference at the correct position of the sentence?

Page 3 – tab. 1 Move table into methods section.

Page 3 – line 13 Please correct to "European Centre for Medium-Range Weather Forecast".

Page 3 – line 23 Hydrological distance between what? Noun missing.

Page 4 – line 12 Please consider moving reference to end of sentence.

Page 6 – line 3 "2019" instead of "20019"

Page 7 – line 2 Better "reunification" as "unification" refers to 1871.

Page 9 – line 9&10 Nash-Sutcliffe ("e" missing").

Page 12 – Fig. 5 Y-Axis missing for Worms.

Page 12 – line 3 Remove duplicate "by a".

Page 13 – line 2 Check spelling of "Mineralölraffinerie" and use the official name "Oberrhein" instead of "Karlsruhe".

Page 13 – line 2 Use Author (Year) citation format.

Page 14 – line 2 Remove given name from reference.

Page 14 – line 10 Sentence unclear – "and" missing?

Page 14 – line 15 Use Author (Year) citation format. Suggest to use "physical-based"

rather than "physical"

Page 15 – line 21 Please revise word order of sentence.

Page 15 – line 9 Verb missing?

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