SPATE

Space-Time Dynamics of Extreme Floods

Newsletter

Edition 6

Coordinator: Prof. Dr. Andreas Schumann

Ruhr-University Bochum
Institute of Hydrology, Water Resources Management and Environmental Engineering
D – 44801 Bochum

Phone: +49 (0)234 / 3224693

Fax: +49 (0)234 / 3214153

E-Mail: andreas.schumann@rub.de

www.spate-floods.com

SPATE goes digital

Dear colleagues and followers of the SPATE research unit,

COVID19 pandemic has affected many researchers all over the world. Unfortunately, our SPATE research unit was affected, too, and so far, two of our regular meetings had to be cancelled. But of course we do not stop working and there is still a lot of progress and new research results that we want to present to you. Since personal meeting was not possible, we switched to online meetings, which have taken place four times since March. Of course, it is sad to not see all our friends and colleagues in person, to not have interesting talks in the meeting breaks and exciting dinners with all members. However, we had a great time online, too. And, with the starting of the second funding phase in July this year, there was a lot of planning and exchanging to do. Our new Task Forces started to work and already very interesting new projects have started. This year, as many joint papers as never before have been published by our research unit. This is a great success especially in these difficult times and we want to thank the whole team for all the efforts they put into somehow coping with this situation.

In this edition we will present the newest research results and give some insight in the plans for future.

Please, see also the newest edition of the magazine of the German Research Association DFG, where you can find an article that describes the recent research results of our research unit.

https://www.dfg.de/download/pdf/dfg_magazin/aus_der_forschung/forschung_magazin/2020/forschung_2020_3.pdf

We hope you find some interesting research in this newsletter for you!

On behalf of the whole SPATE-project, with kind regards,

Svenja Fischer and Andreas Schumann

Members of the SPATE-project

Dr. Svenja Fischer, Prof. Dr. Andreas Schumann, Philipp Bühler
Subproject 1 (Ruhr-University Bochum)

Prof. Dr. Bodo Ahrens, Amelie Krug, Moritz Kirschner
Subproject 2 (Goethe-University Frankfurt)

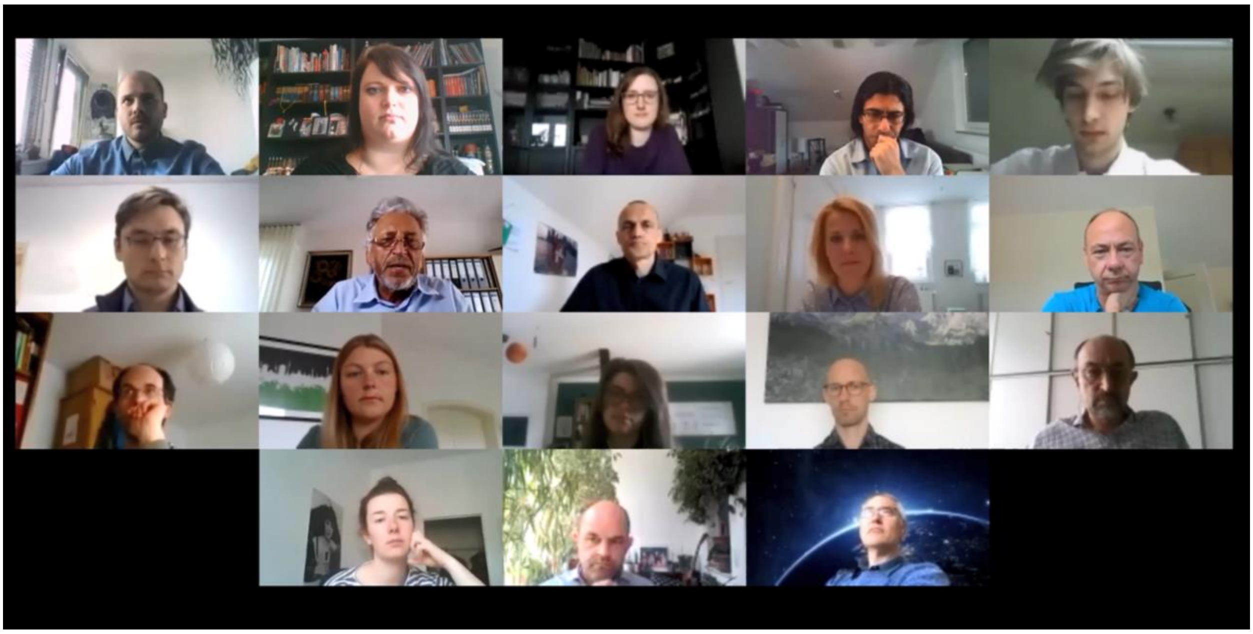
Dr. Sergiy Vorogushyn, Prof. Dr. Bruno Merz, Dr. Björn Guse, Elena Macdonald, Sophie Ullrich, Luzie Wietzke
Subproject 3 (GFZ Potsdam)

Prof. Dr. Ralf Merz, Larisa Tarasova
Subproject 4 (UFZ Halle/Saale)

Prof. Dr. András Bárdossy, Dr. Jochen Seidel, Faizan Anwar
Subproject 5 (University of Stuttgart)

Prof. Dr. Günter Blöschl, Dr. Andrea Kiss, David Lun
Subproject 6 (Technical University of Vienna)

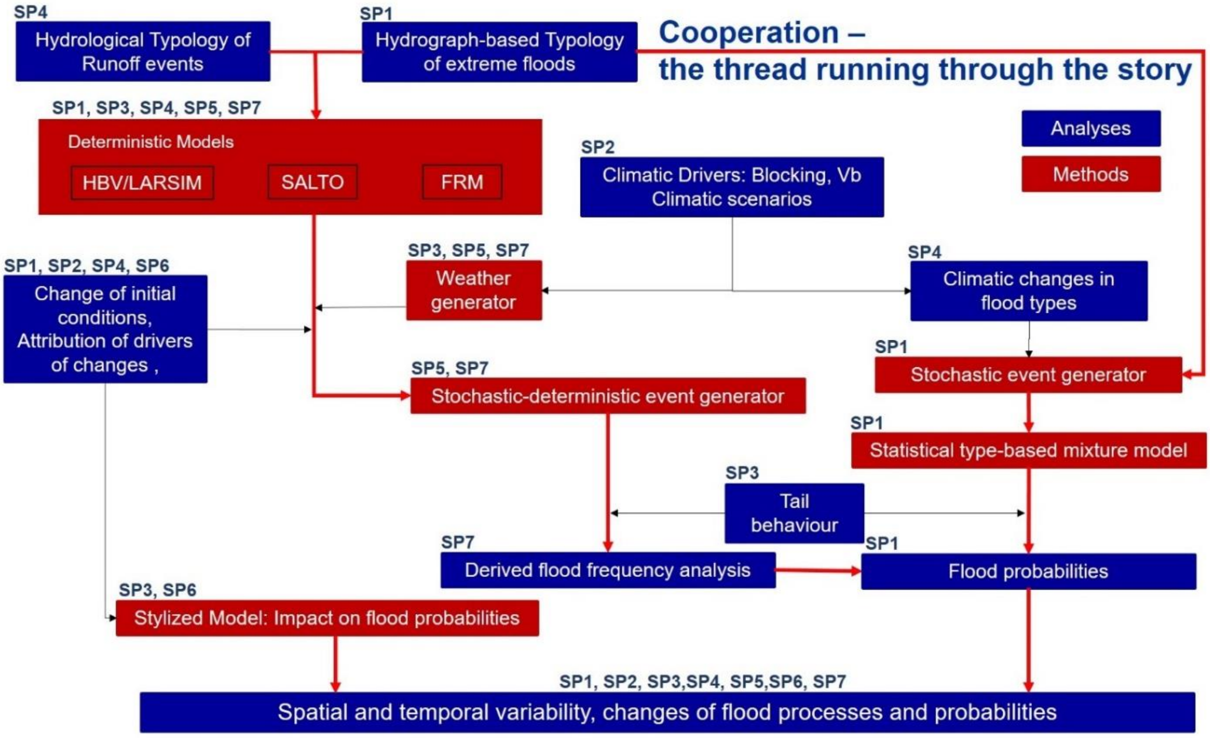
Prof. Dr. Uwe Haberlandt, Dr. Anne Fangmann, Ross Pidoto, Luisa Thiele
Subproject 7 (Leibniz University Hannover)



Members of the research unit SPATE at the first online SPATE-Meeting

SPATE – Beginning of the second phase

This July, the second funding phase of our research unit SPATE started. Besides some new faces, also the research focus now is different than before. While in the first phase, joint research themes were developed that mainly focused on aspects of events, space, time and uncertainty, the second phase will concentrate on the joint development of methods and models. The research results from the first phase and especially the cooperation between the subprojects are now used to gather new links between the topics. Each subproject has significantly contributed to the framework that now helps us to better capture the greater picture. It shows how we want to achieve the general goal of specifying the spatial and temporal variabilities of floods and changes in the core processes of flood generation and the resulting changes in flood probabilities in different ways.



For this, a mixture of new methodologies, new data sets and new hypotheses has been obtained in the first phase. All these aspects together form new links between the topics to reach the overall aim. The subprojects support each other in their knowledge. For example, several deterministic models are applied. The knowledge of each of these is pooled in a task force to compare drawbacks and benefits of the models in different situations. In general, task forces will provide the most valuable tool in the second research phase. Six new task forces will extend the research themes from the first phase. More precisely, we have the six task forces

I. Analysis of extreme flood events, specification of drivers and assessment of their regional specific characteristics – data-based approaches
II. Deterministic hydrological models to estimate extreme floods
III. New statistical methodologies to specify upper tails in flood probability distribution functions
IV. Derived flood frequency analyses: How to combine weather generators with hydrological models to simulate flood series
V. Probabilistic (stylized) hydrological models to generalise flood changes and their attribution
VI. Climate Change, changes in flood types and future changes in flood probabilities.

The targets and planned activities of these task forces are:

I. Analysis of extreme flood events, specification of drivers and assessment of their regional specific characteristics – data-based approaches

The analysis of extreme events is one of the key aims of the Research Unit. Since every project contributes in numerous ways, this task force will provide a guideline for the analysis of extreme events. The starting point to understanding extreme events is a flood typology, which can either be meteorologically driven (SP4) or based on hydrographs (SP1). Here, two automatic typing approaches will be applied. Once the types have been assigned, floods can be further analysed regarding their runoff generating processes and the antecedent conditions, where methods such as the estimation of antecedent soil moisture or the spatial and temporal distribution of runoff generation are developed by SP1 and SP4. Climatological drivers linked to certain flood types, such as floods related to atmospheric blocking or Vb cyclones, are analysed by SP2. As flood events are modified within a river basin, e.g. by dike breaches or flood wave superposition, the interactions of tributary components have to be considered. Methods to assess these impacts are developed in SP3. Finally, changing flood regimes are attributed to their drivers in SP6. The aim of this task force will be the development of an automated step-by-step procedure to combine these different approaches in analyses of the anatomy of floods, a characterization of flood regimes based on such data analyses and a categorization of flood regime types in Germany and Austria.

The head of the task force will be A. Schumann (SP1), members are S. Vorogushyn (SP3), B. Merz (SP3), R. Merz (SP4), G. Blöschl (SP6) and B. Ahrens (SP2)

II. Deterministic hydrological models to estimate extreme floods

The role of deterministic models in SPATE is twofold: (a) Models are used to formalize knowledge, resulting e.g. from event analyses; (b) Models are used to simulate rare extreme events, and to explore the interactions between processes and the sensitivity to modified drivers and boundary conditions.

Since one research question of the Research Unit is the ability of deterministic models to explain extreme events, this task force will integrate the findings of several SPs with regards to extremes. The aim is not to develop a common model but to compare several models with regards to optimal descriptions of nonlinearities and thresholds in the response of watersheds to heavy rainfall. As the subprojects have different perspectives on extreme events, also their modelling approaches differ. The models range from mHM, SALTO, Larsim and HBV to newly developed model chains to consider single processes (e.g. flood routing) in a modular way and to test the opportunities to simulate a wide range of possible flood events. While SP1, 4 and 7 focus on testing deterministic models concerning their ability to perform well for all event types, SP3 will use a model chain that includes the entire flood process cascade from triggering meteorological events to river routing, e.g. to consider dyke failures. Regarding role (b), deterministic models will be used to explore the relevance of different factors that contribute to the maximization of floods. SP1 will investigate how the interchange of triggering components affects the extreme floods, while SP5 will concentrate on the simultaneous occurrence of extremes by including phase randomisation and simultaneous calibration. Finally, SP7 will deliver insights on the need for non-stationary parameters. The hydrological models will simulate all events types and the whole spectrum of magnitudes of floods in space and time. To ensure their accuracy, the task force will evaluate the advantages and disadvantages of the individual models and give recommendations on the optimal combination of deterministic models and weather generators. In addition, the ability of models to simulate extreme floods will be evaluated to specify the need for further developments in this sector.

The head of the task force will be S. Vorogushyn (SP3), members are: A. Schumann (SP1), A. Bardossy (SP5), R. Merz (SP4) and U. Haberlandt (SP7).

III. New statistical methodologies to specify upper tails in flood distribution functions (flood probabilities)

The occurrence of heavy tails in flood statistics is most relevant for characterising the probabilities of extreme floods. In the first phase, patterns of heaviness of tails were detected in precipitation and flood series for selected river basins e.g. Mulde and Inn (SP1) as well as for many other catchments in Germany (SP3). In the second phase, these findings will be generalized in a cooperation between SP 1, 3 and 7. The knowledge obtained in the first phase by SP1 and SP3 is condensed to the following hypotheses:

- Heavy flood tails are inherited from heavy tails of rainfall,
- The non-linear runoff generation response to precipitation creates heavy tails,
- Distinct flood types dominate the right tail,
- The mixture of flood event types generates heavy flood tails,
- Dryer catchments exhibit heavier flood tails, whereas lighter tails pertain to the wetter and snow dominated catchments,
- Larger catchments have lighter tails due to dampening of non-linear processes.

A special focus will be on the impact of flood types on the tail behaviour. The mixture model developed by SP1 will be used to quantify this impact in a spatially distributed fashion. The results will be used by SP3 to provide a linkage with the catchment state and runoff generation. For this purpose, the detected patterns of the first phase can be linked directly with the statistical quantiles. The results will be compared with the findings of homogeneous groups of gauges within the regionalisation approach of SP7. Moreover, the temporal patterns can be included in the non-stationary methods used by SP6 and 7. In SP1, the flood tail behaviour will be related to the catchment state and the runoff generation by using machine learning tools. Regional differences can be compared with the regionalisation results of SP7, e.g. the dependence on antecedent states. These considerations lead to a multivariate treatment of catchment state, precipitation and flood event characteristics. SP1 will develop critical values for multivariate models to define multivariate tail ranges.

The head of the task force will be S. Fischer (SP1), members are B. Merz (SP3) and U. Haberlandt (SP7)

IV. Derived flood frequency analyses: How to combine weather generators with hydrological models to simulate flood series

Derived flood frequency analyses (DFFA) are used to interlink the meteorological forcing with flood series by hydrological models. Since the aim of the research group is the development of a general framework to analyse and predict characteristics of extreme floods, methodological developments of components for the DFFA are planned outcomes in many subprojects. The aim of this task force is to combine these results of different subprojects and compare the developed DFFA models concerning their spatial applicability and transferability. A key tool for DFFA is the use of a stochastic weather generator. Such generators are developed by SP3 for large basins with a daily resolution and by SP7 together with SP5 for medium sized catchments with an hourly resolution. The latter model will be further improved by spectral simulation and the extension to regionalization and uncertainty considerations as well as by an alternating renewal rainfall model using radar data. Based on the results of regional event analyses, SP1 will estimated flood frequencies by a stochastic-deterministic event generator without explicitly referring to weather variables. Overall, three approaches to DFFA will be developed and compared:

- the model chain based approach of SP3 that will simulate daily series of meteorological (precipitation, temperature), hydrological (soil moisture, snowmelt, river discharge) and hydrodynamic (inundation) variables for large basins;
- the multivariate DFFA approach developed by SP7 together with SP5 for medium sized basins that operates at an hourly resolution; and
- a stochastic-deterministic event generator developed by SP1 that differs between flood types and considers extreme events with a deterministic threshold approach,

The intercomparison of the three approaches will shed light on the relative strengths of the methods and the relevance of the individual process descriptions for estimated extreme flood probabilities. The intercomparison will also provide insights into the triggers (precipitation, temperature, soil moisture etc.) and the distributions of the flood events (peak, volume, duration etc.).

The head of the task force will be U. Haberlandt (SP7), members are A. Bardossy (SP5), B. Merz and S. Vorogushyn (SP3), A. Schumann (SP1) and A. Viglione (Mercator-fellow)

V. Probabilistic (stylized) hydrological models to generalise flood changes and their attribution

The upper tail behavior of the probability distributions of flood peaks depends on a large variety of factors. Besides the derived flood frequency analysis for specific catchments, more general probabilistic models will be developed to describe these relationships. For this purpose, SP3 will extend the developed deterministic model chain by using a stylized model chain to obtain insights on the impact of the single components on the distribution tail. SP6 will develop a probabilistic model that explicitly focuses on the mechanisms of changes, such as increasing air temperatures leading to earlier spring snow melt and enhanced evaporation. Both models will consider flood types and characteristics of flood events and will be compared concerning their ability to model the probabilities of flood mechanisms and the linkages to the probability of flood events. The stylized models of change will draw on the experiences with the detection of flood rich periods in the first phase as well as on the findings of flood change attribution in the second phase. Specifically, the regionalisation results (i.e. the spatial patterns of flood change sensitives to their drivers) will be important for generalising the findings on flood change from individual gauged catchments to ungauged catchments and more general causal relationships that may also be applicable to catchments outside the study region. The findings of the uncertainty theme (U) from SP5 and 7 will also be very relevant for quantifying the uncertainties of generalised flood change attribution.

The head of the task force will be G. Blöschl (SP6), members are B. Merz (SP3) and A. Viglione (Mercator-fellow)

VI. Climate Change, changes in flood types and future changes in flood probabilities

The frequency of events belonging to specific flood types varies strongly with time. It is expected that this variability will increase with climate change (e.g. for snow-induced flood events). This task force will investigate the impact of climate change on flood types and their frequencies with regard to possible consequences for flood statistics. While, in the first phase results from the Mulde, Inn and a few smaller catchments in Austria have indicated that changes in the frequency and magnitude of flood types can be detected and it is possible to attribute the drivers, in the second phase these findings will be generalised to a broader set of catchments across Germany and Austria, and to predictions of future scenarios. SP2 will provide downscaled global climate simulations, and findings on how relationships between climate drivers and heavy precipitation will change with a special focus on Vb weather patterns and atmospheric blocking. These climate scenarios will be used by SP4 to simulate future event type occurrences and to link changed climate variables with changes in the flood types. The change point test for changes in the flood frequencies developed by SP1 will be applied to quantify the significance of changes in the frequency, while the method of record-breaking floods will be used to detect significant increases in flood magnitudes. These changes will be linked with the flood attribution model and the spatial patterns of variability of flood change mechanisms detected by SP6. The final task will be the consideration of the impact of these changes on flood probabilities. The statistical model, developed by SP1, will quantify the changes of single flood types of extreme events and their impact on flood statistics. These results will be compared to the probabilistic model of SP6 that explicitly represents the mechanisms of change for a specific flood type. SP7 will investigate the performance of current flood prediction tools under changes and modify the weather generator parameters to consider projections in future climates. Possible future changes in flood probabilities will be contrasted to past changes and their drivers in order to understand whether findings from the past can be extrapolated to the future.

The head of the task force will be R. Merz (SP4), members are S. Fischer (SP1), B. Ahrens (SP2), G. Blöschl (SP6) and U. Haberlandt (SP7).

New Members of the SPATE Research Unit

Beside the continuity of our “old” staff, we can welcome some new faces in the SPATE research unit. Two new PhD students started their work this summer and we would like to shortly introduce them.

For Subproject 2, Moritz Kirschner has joined the group. Moritz has finished his M.Sc. in Physics at the Institute of Environmental Physics at Heidelberg University, Germany, this year, where he quantified the influence of natural forcing on water isotopes and climate in polar and alpine regions. Now, he supports SP2 to analyse the link between global climate drivers and rain-on-snow floods, using reanalysis data and future climate projections.

For Subproject 3, Elena Macdonald now supports the team. Elena studied geo-ecology at University in Potsdam, where she finished her Master thesis this year. She has investigated European urban air quality, where she compared long-term trends in observations and emission inventories of NOx. Moreover, she also worked for several year as student associate at the GFZ Potsdam and the Institute of Advanced Sustainability Studies (IASS). Now, she will support SP3 in their research on virtual experiments on a generalized flood process cascade.

We appreciate it very much to have such diverse backgrounds included in our research unit and are looking positively forward to future research results. A heartily welcome to our new members!

We can also be very happy that so many of our young researchers from the first phase decided to continue their work in the research unit. Not only will three of our PhD students graduate within the first year, but additionally three of our early career researchers became project (co-)leader in the second phase. This continuity in staff strengthens the interdisciplinary work and makes joint research easy.

A big thanks to all our researchers in the SPATE research unit.

Offered professorships, honours, awards

The paper "Causative classification of river flood events" by Tarasova, L., (SP4), Merz, R., (SP4), Kiss, A., (SP6), Basso, S., (SP4), Blöschl, G., (SP6), Merz, B., (SP3), Viglione, A., (SP6), Plötner, S., (SP7), Guse, B., (SP3), Schumann, A., (SP1), Fischer, S., (SP1), Ahrens, B., (SP2), Anwar, F., (SP5), Bárdossy, A., (SP5), Bühler, P., (SP1), Haberlandt, U., (SP7), Kreibich, H., (SP3), Krug, A., (SP2), Lun, D., (SP6), Müller-Thomy, H, Pidoto, R., (SP7), Primo, C., (SP2), Seidel, J., (SP5), Vorogushyn, S., (SP3), Wietzke, L., (SP3), received Wiley Top Downloaded Paper Award 2018-2019.

Publications

1) Publications in journals

accepted:

Merz, R., Tarasova, L., Basso, S.: The Flood Cooking Book: Ingredients and regional flavors of floods across Germany, in press for ERL

Published since last newsletter:

Bertola, M., Viglione, A., Lun, D. (SP6), Hall, J., & Blöschl, G. (SP6) (2020): Flood trends in Europe: are changes in small and big floods different?. Hydrology & Earth System Sciences, 24(4), doi:10.5194/hess-24-1805-2020.

Blöschl, G., Kiss, A., (both SP6), Viglione, A. et al. (2020): Current European flood-rich period exceptional compared with past 500 years. Nature 583, 560–566 https://doi.org/10.1038/s41586-020-2478-3

Breinl, K., Di Baldassarre, G., Mazzoleni, M., Lun, D., (SP6), and Vico, G. (2020): Extreme dry and wet spells face changes in their duration and timing. Environmental Research Letters, 15(7), 074040.

Conticello, F. R., Cioffi, F., Lall, U., Merz, B. (SP3) (2020): Synchronization and Delay Between Circulation Patterns and High Streamflow Events in Germany. Water Resources Research, 56, 4, e2019WR025598. https://doi.org/10.1029/2019WR025598

Fischer, S. (SP1), Bühler, P. (SP1), Büttner U., and Schumann, A. (SP1) (2020): The use of maximum entropy to increase the informational content of hydrological networks by additional gauges. Hydrological Sciences Journal. DOI: 10.1080/02626667.2020.1802028.

Guse, B., Merz, B., Wietzke, L., Ullrich, S., (all SP3), Viglione, A., & Vorogushyn, S. (SP3) (2020): The role of flood wave superposition in the severity of large floods. Hydrology and Earth System Sciences, 24, 1633-1648, doi:10.5194/hess-24-1633-2020.

Hundecha, Y., Parajka, J., & Viglione, A. (2020). Assessment of past flood changes across Europe based on flood-generating processes. Hydrological Sciences Journal, 65(11), 1830-1847, doi:10.1080/02626667.2020.1782413.

Kemter, M., Merz, B. (SP3), Marwan, N., Vorogushyn, S. (SP3), Blöschl, G. (SP6) (2020): Joint Trends in Flood Magnitudes and Spatial Extents Across Europe. - Geophysical Research Letters, 47, 7, e2020GL087464. https://doi.org/10.1029/2020GL087464

Krug, A. (SP2), C. Primo (SP2), S. Fischer (SP1), A. Schumann (SP1), B. Ahrens (SP2) (2020): On the temporal variability of widespread rain-on-snow floods. Meteorologische Zeitschrift. 29(2), p. 147 - 163. DOI: 10.1127/metz/2020/0989

Lun, D. (SP6), Fischer, S. (SP1), Viglione, A., and Blöschl, G. (SP6) (2020): Detecting flood-rich and flood-poor periods in annual peak discharges across Europe. Water Resources Research, 56(7), e2019WR026575, doi:10.1029/2019WR026575.

Merz, R., Tarasova, L., (both SP4) Basso, S. (2020): Parameter's controls of distributed catchment models – How much information is in conventional catchment descriptors? Water Resour. Res., 56(2)

Metin, A. D., Nguyen, D., Schröter, K., Vorogushyn, S. (SP3), Guse, B. (SP3), Kreibich, H. and Merz, B. (SP3) (2020): The role of spatial dependence for large-scale flood risk estimation. - Natural Hazards and Earth System Sciences (NHESS), 20, 967-979. https://doi.org/10.5194/nhess-20-967-2020

Oppel, H., and Fischer, S. (SP1) (2020): A New Unsupervised Learning Method to Assess Clusters of Temporal Distribution of Rainfall and Their Coherence with Flood Types. Water Resources Research. DOI: 10.1029/2019WR026511.

Pothapakula, P.K., C. Primo (SP2), S. Soerland, B. Ahrens (SP2) (2020): The synergistic impact of ENSO and IOD on the Indian Summer Monsoon Rainfall in observations and climate simulations - an information theory perspective. Earth System Dynamics, https://doi.org/10.5194/esd-2020-50

Shustikova, I., Neal, J. C., Domeneghetti, A., Bates, P. D., Vorogushyn, S. (SP3), Castellarin, A. (2020): Levee Breaching: A New Extension to the LISFLOOD-FP Model. - Water, 12, 4, 942. https://doi.org/10.3390/w12040942

Tarasova, L. (SP4), Basso, S., Wendi, D., Viglione, A., Kumar, R., Merz, R. (SP4) (2020): A Process-Based Framework to Characterize and Classify Runoff Events: the Event Typology of Germany, Water Resour. Res., 56(5)

Wietzke, L. (SP3), Merz, B. (SP3), Gerlitz, L., Kreibich, H., Guse, B. (SP3), Castellarin, A. and Vorogushyn, S. (SP3) (2020): Comparative analysis of scalar upper tail indicators. - Hydrological Sciences Journal - Journal des Sciences Hydrologiques, 65, 10, 1625-1639. https://doi.org/10.1080/02626667.2020.1769104

2) Software

F. Anwar and A. Bárdossy (both SP5), “phsann: multivariate/multisite time series simulation using Phase Annealing.”, Python package, https://github.com/faizan90/phsann.

Talks

1) Invited talks:

Fischer, S. (SP1): Multivariate Design Flood Estimation in Large River Basins under Consideration of Tributary Impacts and Flood Types. AGU Fall Meeting 2020.

2) Other talks on conferences

Krug, A. (SP2), Aemisegger, F., Sprenger, M., Primo, C. (SP2), and Ahrens, B. (SP2): Moisture sources of extreme Vb-floods in Central Europe, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-2315, https://doi.org/10.5194/egusphere-egu2020-2315, 2020

Purr, C., Brisson, E., and Ahrens, B. (SP2): Temperature scaling of convective cells in present and future conditions, EGU General Assembly 2020, Online, 4–8 May 2020, https://doi.org/10.5194/egusphere-egu2020-20581, 2020

3) Poster

Anwar, F. and Bárdossy, A. (SP5): Using Phase Annealing to generate surrogate discharge time series, EGU General Assembly 2020, Online, 4–8 May 2020.

Dung, N.V., Metin, A.D., Alfieri, L., Vorogushyn, S. (SP3) and Merz, B. (SP3) (2020): Ignoring spatial dependence misestimates flood risk at the European scale, EGU General Assembly 2020, Online, 4–8 May 2020, doi: 10.5194/egusphere-egu2020-19606.

Guse, B. (SP3), Wietzke, L. (SP3), Ullrich, S. (SP3), Merz, B. (SP3), Vorogushyn, S. (SP3) (2020): Impact of river confluences on return periods of large floods, EGU General Assembly 2020, Online, 4–8 May 2020, doi: 10.5194/egusphere-egu2020-19448.

Kemter, M., Merz, B. (SP3), Marwan, N., Vorogushyn, S. (SP3) and Blöschl, G. (SP6) (2020): Mutual increases in flood extents and magnitudes intensify flood hazard in Central and Western Europe, EGU General Assembly 2020, Online, 4–8 May 2020, doi: 10.5194/egusphere-egu2020-4731.

Krug, A. (SP2), Aemisegger, F., Purr, C., Primo, C. (SP2), Sprenger, M., and Bodo Ahrens (SP2): Intensification processes of extreme Vb-floods in Central Europe, AGU Fall Meeting 2020.

Pothapakula, P.K., Primo, C. (SP2), Soerland, S. and Ahrens, B. (SP2): Information Synergy Between IOD and ENSO on the Indian Summer Monsoon Rainfall in Observations, Reanalysis, and in GCM-RCM Model Chain, AGU Fall Meeting 2020.

Purr, C., Brisson, E. and Bodo Ahrens (SP2): Projected changes in characteristics and scaling behavior of convective rain cells in Germany, AGU Fall Meeting 2020.

Workshops, Conferences

General Assembly of the European Geosciences Union 2020, Session HS2.2.1 “Models and data: Understanding and representing spatio-temporal dynamics of hydrological processes, convened by Guse, B. (SP3), Gharari, S., Khatami, S., Samaniego, L. and Stisen, S.

General Assembly of the European Geosciences Union 2020, Session HS2.4.3 “Space-time dynamics of floods: processes, controls, and risks”, convened by Farmer, W., Kreibich, H., Mediero, L., Viglione, A. (SP6) and Vorogushyn, S. (SP3).

General Assembly of the European Geosciences Union 2020, “Spatio-temporal and/or (geo) statistical analysis of hydrological events, floods, extremes, and related hazards”, convened by S. Fischer (SP1), G. Corzo, A. Bardossy (SP5), R. Woods and P. Dimitriadis.