A DISTRIBUTED RAINFALL-RUNOFF MODEL TO EXPLORE THE CONNECTION BETWEEN FLOODS AND CLIMATE EXTREMES IN THE EUROPEAN ALPS

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THE RAINFALL-RUNOFF MODEL CALIBRATION REGIONALIZATION AND VALIDATION

The model used is a variation of the *TUWmodel* [1] that has been coupled with a *Nash-Cascade* (Fig. 1). To calibrate the model the *weighted Nash-Sutcliffe* efficiency *wNSE* [2] function has been optimized, a variation of the commonly used *Nash-Sutcliffe* efficiency *NSE*, that gives additional weight on high flows. To reach the goal of the proposed model, which aim to reproduce large scale regional events, a regionalization procedure has been performed based on the *HydroPASS* [3] algorithm, which utilizes a machine learning approach based on regression trees. The regional model was finally validated both temporally and spatially using a training cluster of catchments and a test cluster of catchments (Fig. 2).

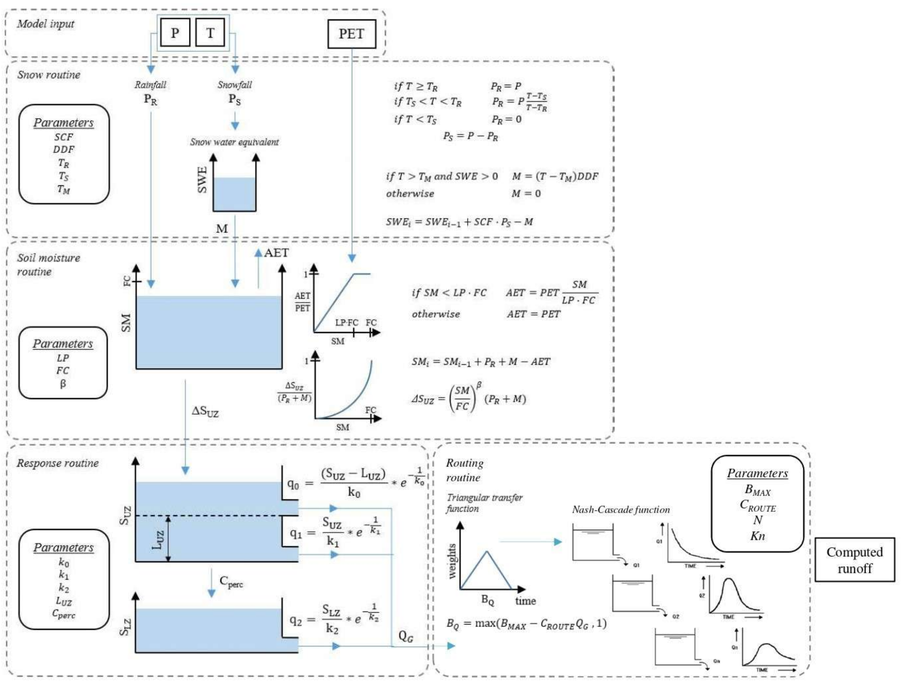
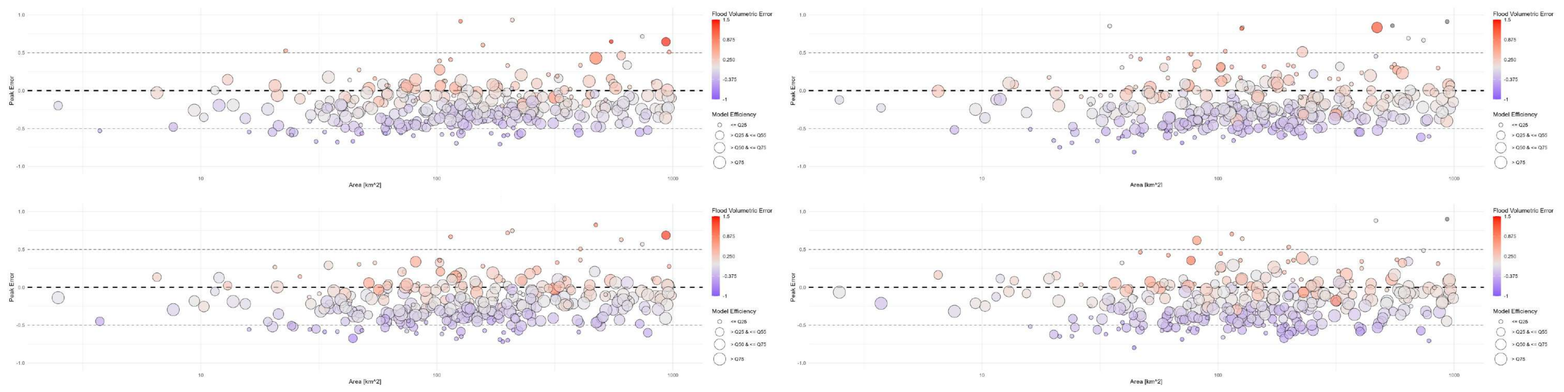


Fig. 1: Schematic representation of the fully modified *TUWmodel*



$$\%BIAS_P = \frac{\sum_{i=1}^{n}(Ps_{i,C} - Po_{i,C})}{\sum_{i=1}^{n} Po_{i,C}} \qquad \%BIAS_V = \frac{\sum_{i=1}^{n}(Vs_{i,C} - Vo_{i,C})}{\sum_{i=1}^{n} Vo_{i,C}}$$

Fig. 2: Regional model *weighted Nash-Sutcliffe* efficiency (above calibration period 2010 – 2020, below validation period 2000 – 2010, left train catchments, right test catchments), colors are scaled on percentual volumetric bias and size on efficiency quantiles

SPATIO-TEMPORAL EVENT IDENTIFICATION

With *ERA5-Land* input data from 1951-2023 we simulate the discharge all around the *Greater Alpine Region*. We identified events simultaneously in space and time calculating the *Growth Factor* for each day and each location (Fig. 3) and selecting as events all the situations above the threshold of *GF* equal to 2.

$$GF_{xy,di} = \frac{q_{xy,di}}{q_{mean\,xy,di}} \qquad \text{where} \qquad q_{mean\,xy,di} = \frac{\sum_1^n q_{xy,max91d}}{n_{years}}$$

Once we have detected events, we can classify them according to their extent, duration or intensity: we found that, even using different metrics, the most important events appear in each classification, which means that the method can be considered robust.

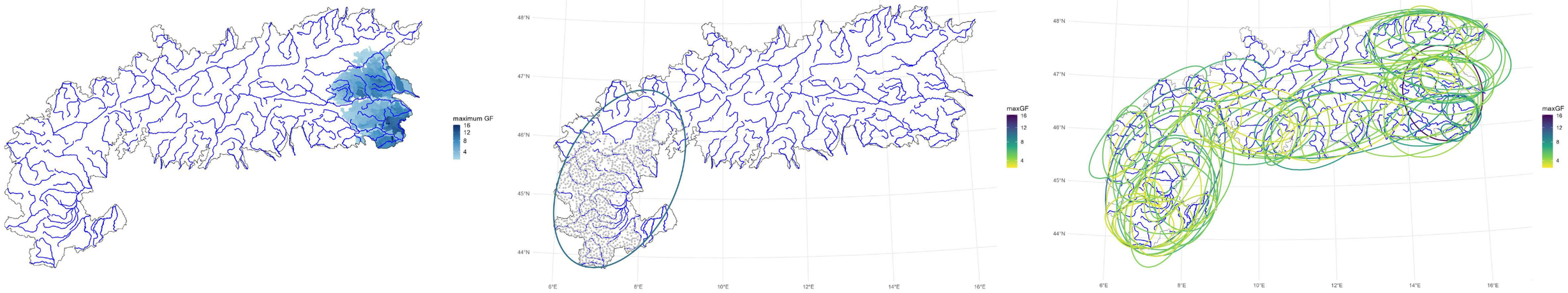


Fig. 3: (left) Spatial projection of one of the main events identified in the *Greater Alpine Region* for the period 1951 – 2023 (center) Representation of events with the concept of ellipses (right) Interpolation ellipses of the 73 most important events

EVENT ANALYSIS

Events can be stratified into different classes [4], using the state variables from the model. The layers identified are: the geographical position, the seasonality, the meteorological nature and temporal organization of the triggering event and the antecedent soil moisture conditions. (Fig. 4 and Fig. 5).

Fig. 4 – All flooding events detetcted with their maximum *GF* registered and the top 73 events stratified in different classes

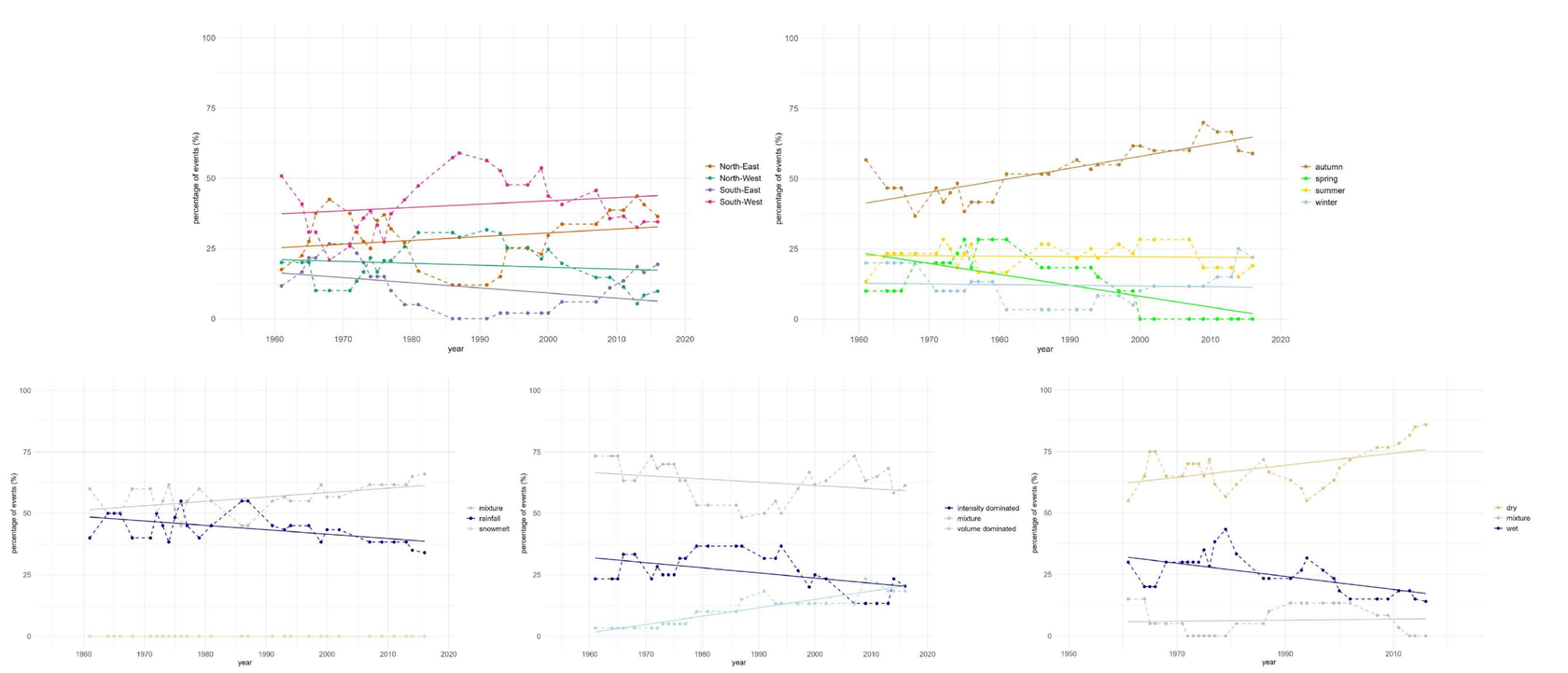
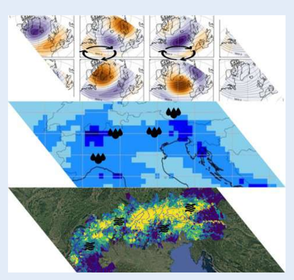


Fig. 5 - 10years moving mean of the annual percentage of the different event classes with their trends

Clim2FlEx

This poster is part of the *Clim2FlEx* project [5] which main objective is to build a end-to-end chain from global climate to river flood hydrology models to relate climate and flood extremes in the *Greater Alpine Region.*
To achieve this, the next phase of our work will attempt to communicate the events as defined from an hydrological and climatic point of view, so that possible links between them can be identified, also according to the different types of events and boundary conditions.



MAIN REFERENCES: [1] Merz, R., Blöschl , G. (2004), Regionalisation of catchment model parameters. [2] Yeshewatesfa, H., Andràs, B. (2004), Modeling of the effect of land use changes on the runoff generation of a river basin through parameter regionalization of a watershed model. [3] Merz, R., Tarasova, L., & Basso, S. (2020), Parameter's controls of distributed catchment models - How much information is in conventional catchment descriptors? [4] Tarasova, L., Basso, S., Wendi, D., Viglione, A., Kumar, R., & Merz, R. (2020), A process-based framework to characterize and classify runoff events: The event typology of Germany. [5] http://www.idrologia.polito.it/web2/ricerca/valutazione-piene/clim2flex/