Climate Adaptation Digital Twin (DE340)

The HydroMet Use Case: Extreme rain event analysis and catalogization

C. Hartick, S. Sayed

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

INTRODUCTION

The impact of climate change is often experienced through extreme events. The Eifel floods (12 - 15 July 2021 in Western Europe) specifically led to considerable loss of life and an estimated €50 bn in property losses. The HydroMet use case scopes to detect and identify extreme rainfall events in the Climate Adaptation Digital Twin (Climate DT) data stream. The summarized data and information will be listed within an event catalogue. The main software components and packages for this application are the KOSTRADAMUS and WetCat packages, adapted and updated versions of DWD (Deutscher Wetterdienst) internally developed codes. The application is being implemented by closely interacting with the German Adaptation Strategy to Climate Change (DAS) Core Service "Climate and Water", which provides data and information about climate change for adaptation management and the Bavarian Environment Agency.

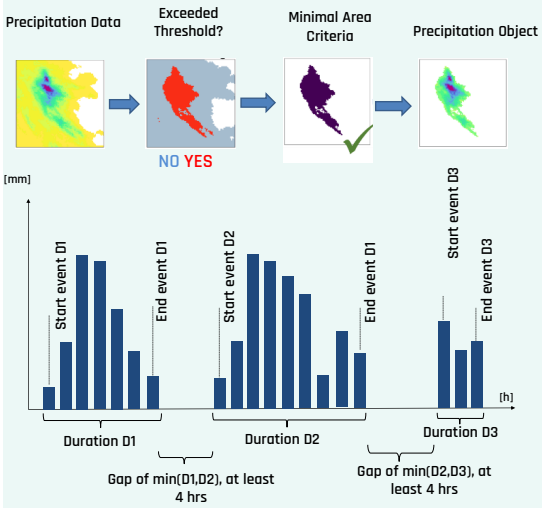
IMPLEMENTATION IN THE CLIMATE DT WORKFLOW

The HydroMet use case operates on total precipitation (tp) data from Climate DT simulations, undergoing multiple processing steps via distinct software and sub-routines. A pre-processing script, integrated into the One-pass layer, computes and aggregates historical data necessary for extreme rain statistics calculation in the KOSTRADAMUS component. The WetCat software defines precipitation objects based on exceeded thresholds, considering temporal and spatial independencies for each object. It utilizes statistical output from KOSTRADAMUS and reads directly from the GSV. Two criteria are applied to select events while accounting for spatial and temporal dependencies:

How can the initiative help to improve the state of the art methods in the hydrology sector?

For this we can identify the user needs and requirements that the ClimateDT will be able to address:

Needs	Requirements
Estimate likelihood of extreme precipitation events.	Observe and analyse return time of extreme rain events, cover extreme value statistics for sub-hourly durations to several days.
Detect and observe areas of high risk.	Deal with regionality of rain events. Ability to detect convective weather patterns (<10 km).
Observe and estimate temporal trends of extreme precipitation.	Deal with transient behaviour of rain events, especially extreme rain e.g. Thunderstorms (<30 minutes).
Observe and estimate spatial trends of extreme precipitation.	Analyse spatial distribution of heavy rain in Germany, determine small scale/regional patterns (<10 km) and trends.



1. Spatial independency
Events must not spatially overlap in case a time step includes objects of several duration windows.

2. Temporal independency
Between two events covering the same or similar area, there has to be a time gap, the length of the duration window of the shorter event, but at least 4 hours.

Fig. 1 The two criteria of a rain event selection.

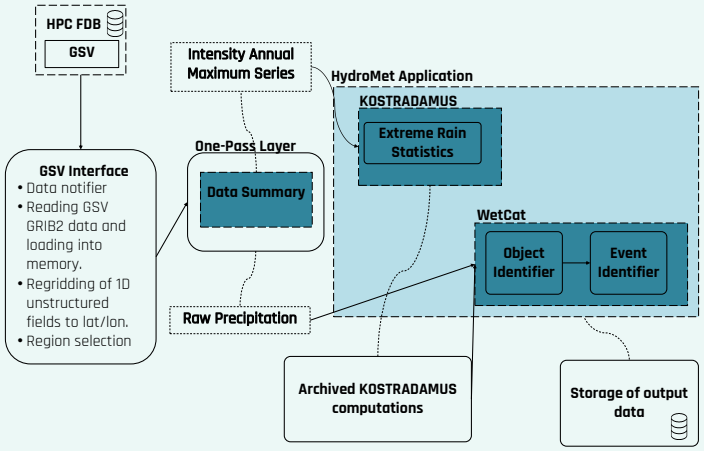


Fig. 2 Architecture of the HydroMet application and its implementation to the Climate DT workflow.

RESULTS AND NEXT STEPS

The analysis presented here is focused on the Climate DT ICON historical and ssp370 scenario data for the area of Germany. The input data has 10 km spatial and 1 hour temporal resolution. KOSTRADAMUS computed the extreme rain statistics from 1990 to 2015 for the ICON historical run, enabling threshold identification for various return periods and durations. Figure 3 illustrates the WetCat catalogue's output, presenting a bar plot of detected events per year. A large increase in events can be registered. It must be mentioned that a significant bias in precipitation was observed in these runs.

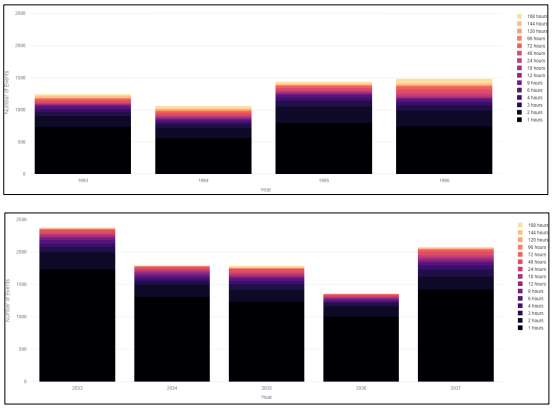


Fig. 3 Timeline of the yearly event distribution for every duration window for the ICON simulations over Germany: 2677 events historical simulation (1993 - 1996) (top) and 9388 events in the scenario (2033 - 2037), (below).

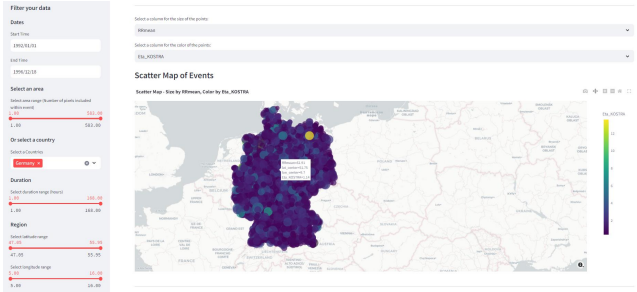


Fig. 4 Prototype of the dashboard to visualize the catalogue output

Most events were shorter than 24 hours and smaller than 100 km^2, highlighting the need for even higher-resolution simulations. In conclusion, this use case highlights the HydroMet application's adaptability and utility in addressing modern requirements and user needs. The further development of the use case includes the extension and testing of the usability of the software for Europe and the whole globe. In a further step the information will be more interactively accessible for users by developing a dashboard application. It will include search functions, visualization of the events and summaries of the main characteristics of each event as depicted exemplary in figure 4. By successfully integrating into the Climate DT streaming workflow, HydroMet provides a valuable tool for analysing extreme rain events and assessing their impact.

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