Large climate datasets to support the development of Climate Services: examples from Digital Earth

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1. Digital Earth project

Digital Earth is a collaboration between natural scientists and data scientists in eight Helmholtz Centers in the research field of Earth & Environment. The data exploration methods include visual analytics tools and Machine Learning methods.

Here we focus large climate datasets, analysis, and visual analytics. Novel techniques help to extract relevant information from these data. We focus on usability for other users, with the aim of informing risks and opportunities.

We use different datasets generated by the REMO regional climate model, provided by the Climate Service Center Germany (GERICS) in Hamburg.

2. Example: Extreme rainfall events visualisation

The 'Heavy Precipitation Event Identification and Tracking Algorithm' of Nissen and Ulbrich (2017) is used:

- The index identifies areas of heavy precipitation exceeding the 10-year return period in 1-hour;
- The index is applied to 12 km REMO regional climate model EURO-CORDEX simulations;
- For each event a severity index is calculated according to its duration, intensity, and coverage area.

This dataset contains several simulations of the future climate, under different radiative forcing scenarios and using different driving General circulation models.

Within the Digital Earth project, we are developing a visual analytics data explorer, for this large dataset. The prototype visual data exploration tool is shown in Fig. 1. The challenge is to transform petabytes of data from (e.g. precipitation, temperature, wind) to:

- User applicable quantities (e.g. return periods of heavy precipitation for infrastructure maintenance and design);
- To combine physical with socio-economic data to link to societal concerns.

We aim to create a tool for efficient exploration, analysis, and extraction of locally relevant information. This should be regardless of data volume, software and data formats, technical infrastructure, and user background knowledge.

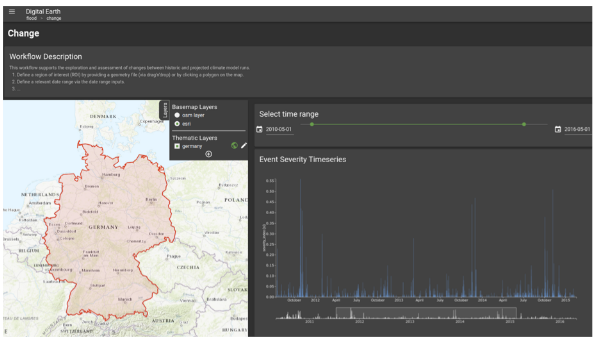

Fig. 1: Visual analytics prototype for the Digital Earth Flood Use Case (work in progress).

3. Example: Extreme temperature and drought projections

The HAPPI consortium created targeted experiments at 1.5°C and 2°C global mean warming levels, using 10 General Circulation Models (GCMs) (Mitchell et al. 2017). The HAPPI-DE consortium translated these simulations to regional information (Schleussner et al., 2018). Ensemble simulations (up to 1,000 years) from the REMO regional climaze model for the European domain were analysed.

- We present the assessment of 10 years REMO simulations in 25 ensemble runs driven by the NorESM GCM, and 100 ensemble runs driven by the ECHAM6 GCM.
- The large ensemble allows the better estimation of future weather extremes at small levels of in global warming;
- We provide examples for temperature extremes (Fig. 2), and drought (Fig. 3).

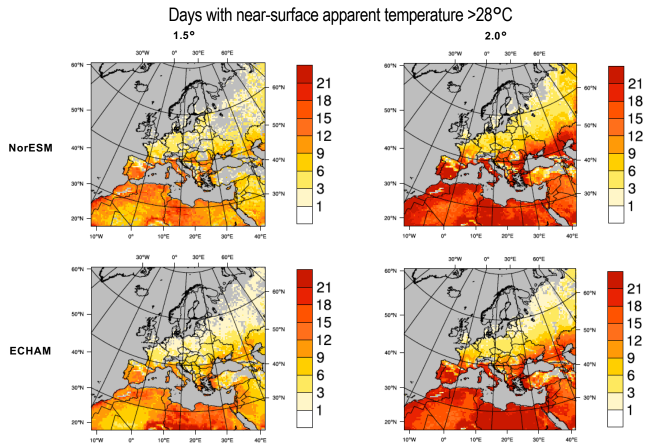

Fig. 2: Differences in the 95th percentile of the number of days with near-surface apparent temperature of more than 28°C (ATG28).

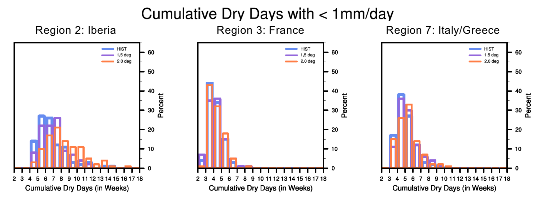

Fig. 3: Duration of drought events in three PRUDENCE regions under 1.5° and 2.0° global average warming (significance of changes tested with MW-U test).

4. Outlook

These results are useful for engineers and urban planners, for estimating plausible future changes of urban flood risks and for designing resilient drainage systems. More precise temperature extremes can be used for for estimating health impacts. Drought information is useful for the agricultural and water supply sectors.

- The prototype tool will be further developed, to assess and explore projected changes;
- We plan to measure the change in distributions of severity indices of the most severe events in REMO EURO-CORDEX historical and future climate projections;
- We will combine projected changes in extreme temperatures with models for (local) health impacts using Machine Learning approaches.

Digital Earth project website: https://www.digitalearth-hgf.de

References

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