CETD, a global compound events detection and visualization toolbox and dataset

Cong Yin (cy2722@columbia.edu), Mingfang Ting, Kai Kornhuber, Radley M. Horton, Yaping Yang, Yelin Jiang

University of Chinese Academy of Sciences

COLUMBIA CLIMATE SCHOOL
LAMONT-DOHERTY EARTH OBSERVATORY

INTRODUCTION

- **Compound Events (CEs)** refer to the simultaneous occurrence of two or more univariate events at the same location. Compared to univariate events, CEs involve complex spatial and temporal interactions of multiple climate variables, often with impacts that exceed the sum of all univariate events.

- We introduce a **Compound Events Toolbox and Dataset (CETD)**, which provides the first integrated, interactive and extensible platform for CEs detection and visualization. CETD can quantify the frequency, duration, severity of CEs.

METHODOLOGY

- **Data preprocessing**: temporal resampling, spatial resampling and coordinate transformation.

- **Identification of univariate events**: use absolute, percentile, or combined thresholds to identify univariate events.

- **Identification of compound events**: use event coding and spatial connectivity algorithms to identify compound events.
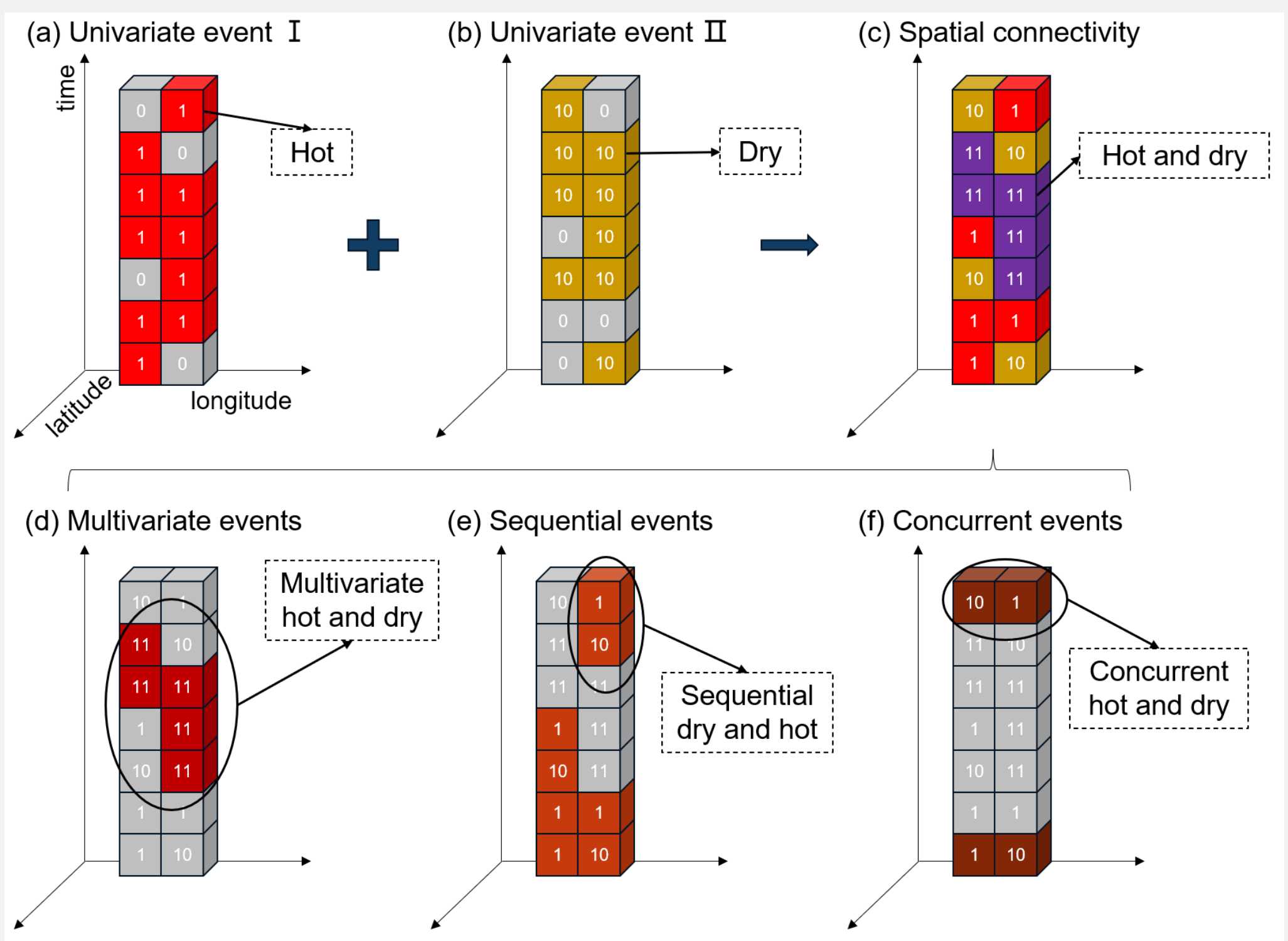

Schematic diagram of the event encoding and spatial connectivity.

RESULTS

Global most persistent CEs

- Within **low latitudes**, the most prevalent CE is hot-stagnation, where the annual average frequency surpasses 6 occurrences and the total duration exceeds 15 days.

- In the **mid-latitudes**, the dominant CE shifts to hot-dry, with average annual frequency of hot-dry events generally remaining below 6, and total duration below 15 days.

- In **higher latitudes**, there is a noticeable increase in the frequency and duration of wet-windy events.
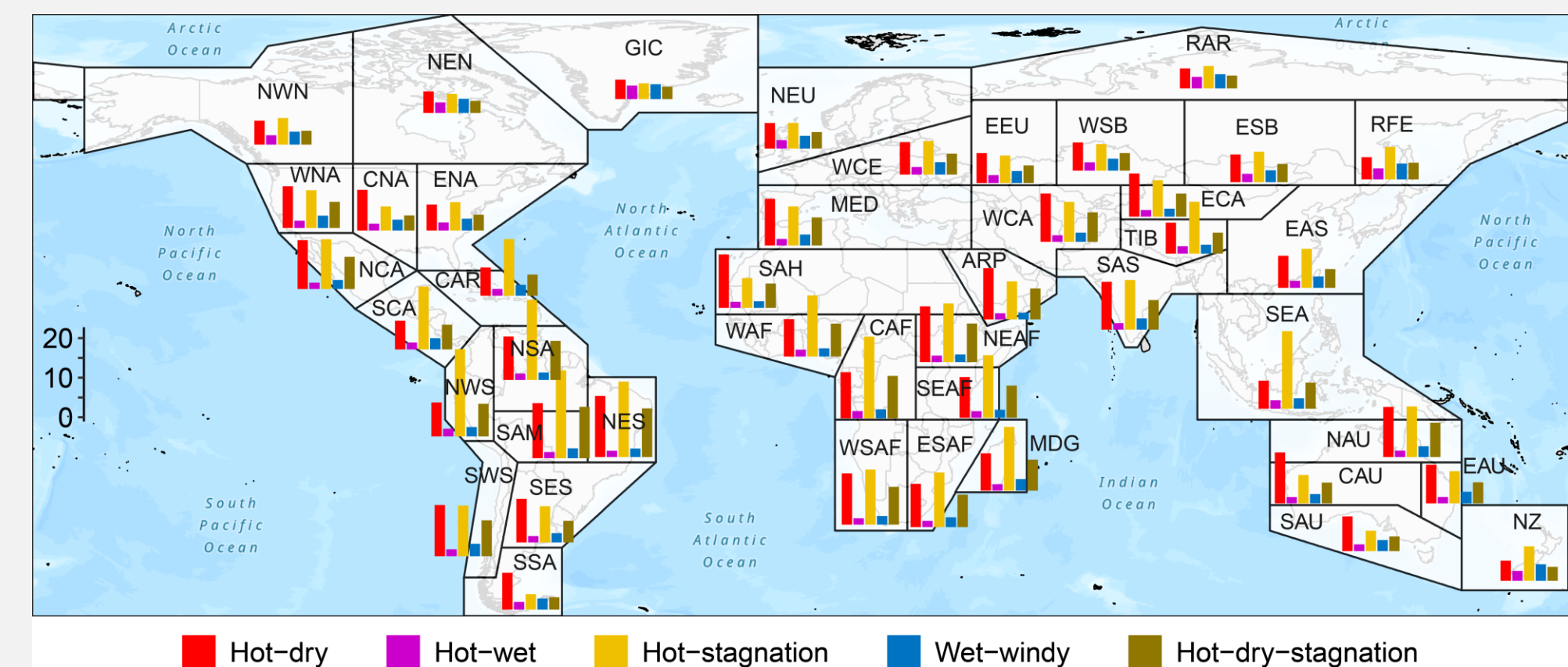
The most persistent CEs globally. The histograms show the average total duration from 1951 to 2022.

### Concurrent heat waves in 2023 summer

- Multiple regions worldwide simultaneously endured prolonged heatwaves. There is an increasing trend in concurrent heatwaves.
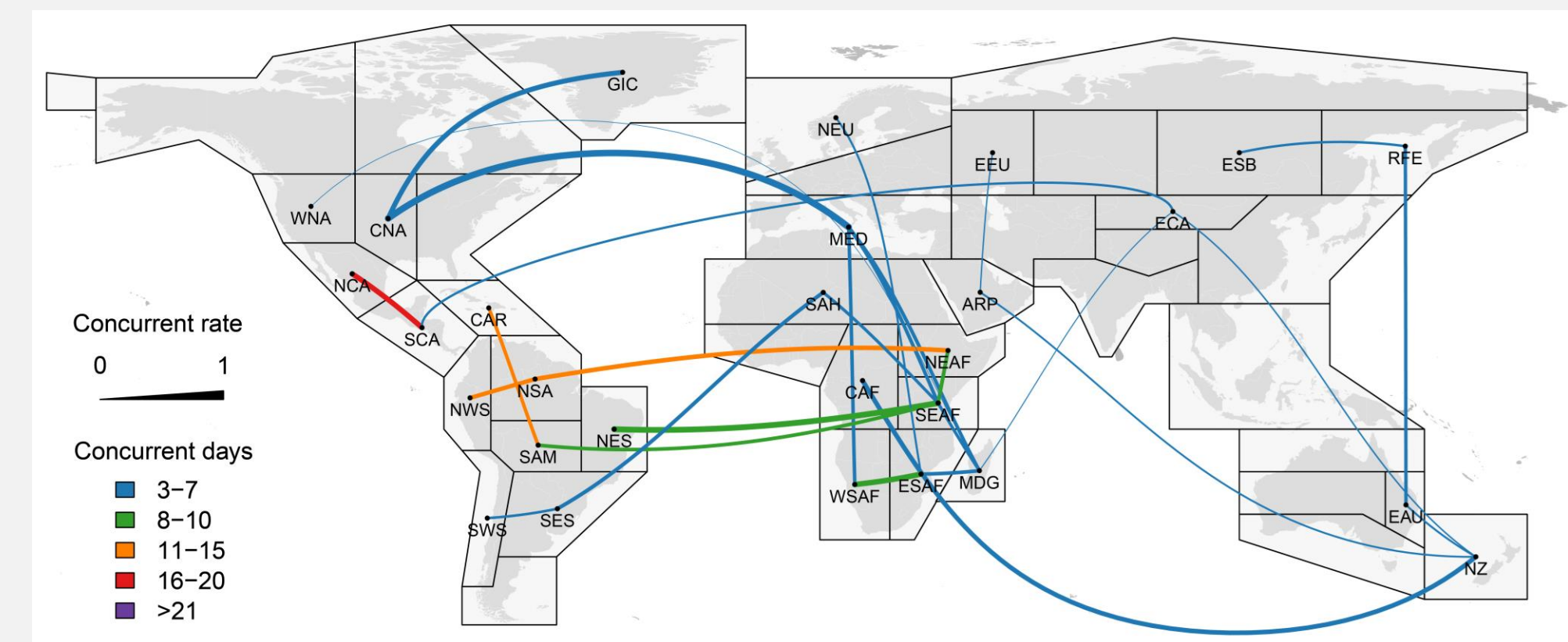
Concurrent days and concurrent rate of heat waves in the summer of 2023.

Compound Events Toolbox and Dataset

- An **integrated, interactive and expandable** Python-based toolbox for detecting and visualizing multiple climatic CE types: multivariate, sequential and concurrent events.

- Can analyze CEs often linked to severe impacts on human health, wildfires, and air pollution, such as **hot-dry, wet-windy, and hot-dry-stagnation**.

- Supports **a wide range of custom inputs**, such as data sources, regions, time, variables, and thresholds, and visualizes results instantly.
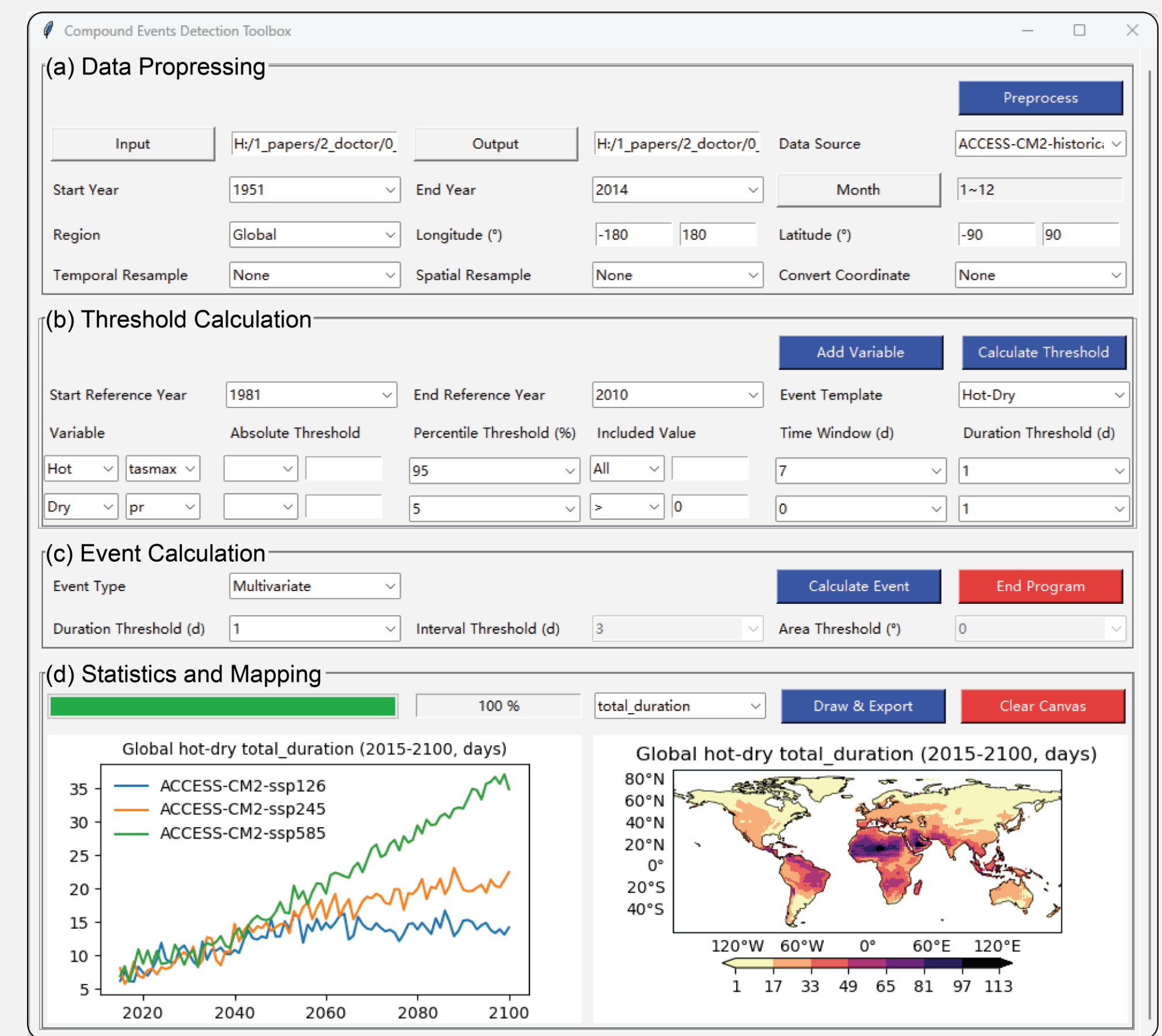
Graphical user interface of CETD.

CONCLUSIONS

- We introduce a Compound Events Toolbox and Dataset (CETD), which provides the first integrated, interactive and extensible platform for CEs detection and visualization.

- We find an upward trend in global concurrent heat waves, which is likely related to atmospheric dynamics.