Project: **1064**

Project title: **Atmospheric Drivers of Extreme Flood Events (ADEFE)**

Principal investigator: **Mostafa Hamouda**

Report period: 2021-11-01 to 2022-10-31

Despite progress in flood research during the recent decades, there is still a large knowledge gap on the causative processes of extreme river floods and their spatial and temporal evolution. The objective of the research unit "Space-Time Dynamics of Extreme Floods" (SPATE) funded by the Deutsche Forschungsgemeinschaft (FOR 2416, http://spatefloods.com/) is to investigate these processes. SPATE project runs until summer 2023. The main goal of the Atmospheric Drivers of Extreme Flood Events (ADEFE) project is to support the SPATE project with information about the atmospheric state and atmospheric drivers of flood events.

The advantage of the high-resolution downscaling for EC-Earth CMIP6 phase

In 2019/2020, EC-Earth CMIP5 model was downscaled using COSMO-CLM and NEMO ocean model. Sea surface temperature was characterised by a pronounced cold bias with respect to observations (Hadley SST) (Figure 1,2). Late in 2020, we started the downscaling of EC-Earth CMIP6 phase. Figure 2 shows that the cold bias issue is solved mostly, especially in the warm season, in which our studies regarding Vb-cyclones will be affected the most, given Mediterranean SST's importance in regulating moisture supply (Krug et al. 2022). The Historical and SSP5-8.5 simulations were successfully finished in May 2022, exactly with the end of Mistral, to have a downscaled period from 1950 till 2099. The historical period shows a better Mediterranean seasonal cycle in summer, in which it is most important for our topic regarding summer extreme floods during Vb-cyclones.

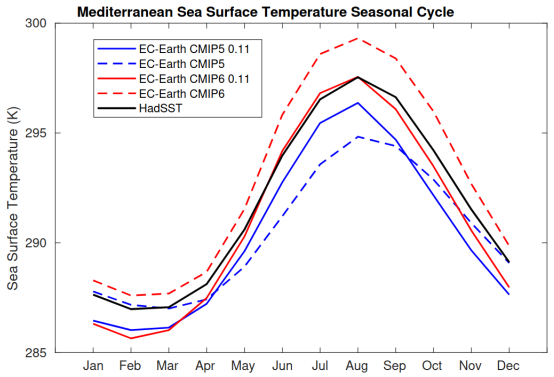

Figure 1. Sea surface temperature seasonal cycle of the Mediterranean Sea for EC-Earth CMIP5 and CMIP6 phases (GCM forcing and downscaled to 0.11 degree), compared with observation HadSST dataset

The Role of Convection in Vb-Cyclone

Using Mistral and Levante, we have successfully simulated 10 Vb-cyclone events using Convection Permitting Scale (CPS) at 3 km and 5 minutes spatial and temporal resolutions. The aim is to study the importance of convection precipitation during Vb-events. An example is shown in figure 2 (left), as it shows the time series of precipitation total, and the associated convection fraction using a Lagrangian tracking method after Purr et al. 2019. Another method using mid-tropospheric vertical velocity and vorticity after Poujol et al. 2019 is tuned accordingly, in order to indicate a similar convection fraction using the lagrangian tracking as a reference. The aim is to estimate the change in convection fraction in a warmer climate according to the Clausius-Clapeyron relationship. Figure 2 (right) shows convection fraction distribution in the current climate (in downscaled reanalysis and EC-Earth3) and in a warmer scenario of SSP5-8.5 (downscaled EC-Earth3). It is illustrated that over the Ore region, the convection fraction is most frequent in Vb-events between 15-30%. In a warmer climate however, the distribution is bi-modal, with two maxima at 30% and 60%. This clearly shows that a warmer climate would be vulnerable to localised convection-produced extreme rainfall events.

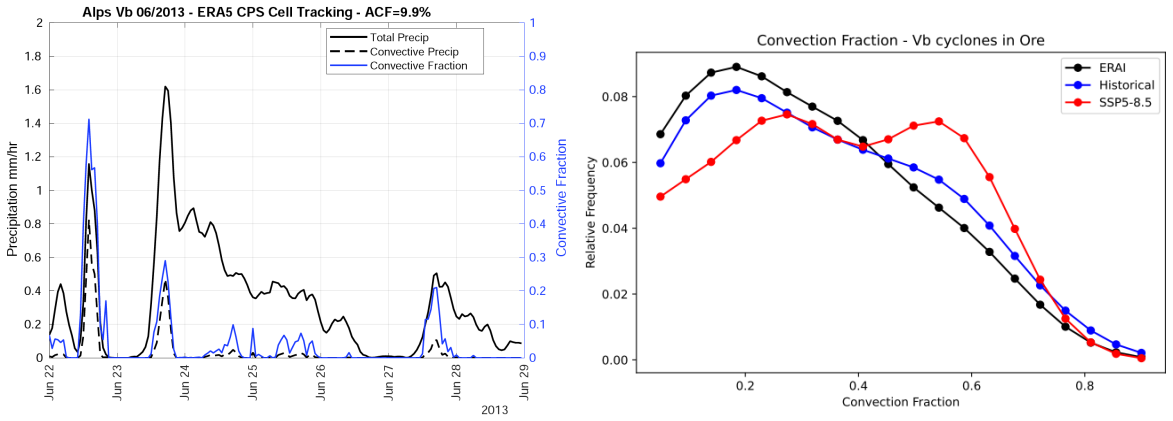

Figure 2. Left: Convection Fraction during Vb-cyclone June 2013 (ERA5). Right: Relative frequency of convection fraction in different climate simulations using COSMO-CLM coupled with NEMO-Mediterranean (ERA-Interim, Historical EC-Earth3, SSP5-8.5 EC-Earth3).

References:

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CAF files were provided for EC-EARTH3-Veg from 1950 to 2100, and stored on DKRZ archive.