

Increasing compound warm spells and droughts during the growing season in the Mediterranean Basin

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[Introduction](#)

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Mediterranean Basin: a particularly imperiled region

- **Increasing** number of **droughts** and **heat waves** and **heavy precipitation** events (Cramér et al. 2018)
- Future **warming** in the Mediterranean expected to **exceed global rates by 20%** (Lionello & Scarascia 2018)

→ Climate change **Hot-Spot** region (Giorgi 2006)

- **Research questions:**
 - [Does the number of compound warm spells and droughts increase in the Mediterranean over the last 40 years?](#)
 - [Which months show the highest increase?](#)
 - [Which is the main component for increases of compound droughts and warm spells?](#)

Data from ERA5 and study area



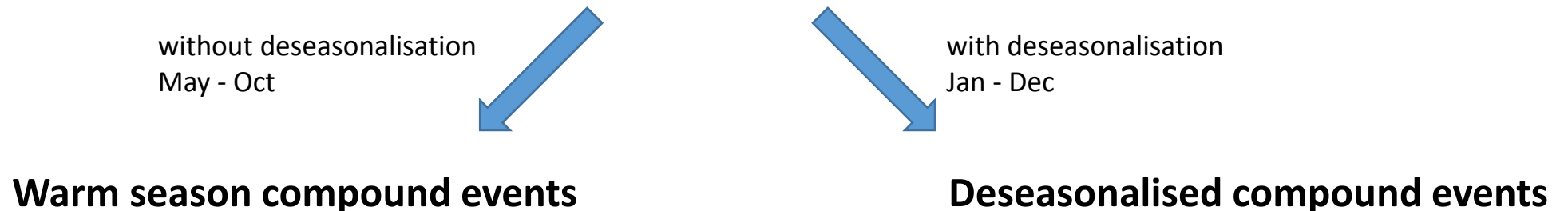
- Time Span: 1979 – 2018
 - Spatial resolution: $0.25^{\circ} \times 0.25^{\circ}$
 - Variables
 - Daily maximum 2m air temperature
 - Monthly Standardized Precipitation Index (SPI)
 - Monthly Standardised Precipitation-Evapotranspiration Index (SPEI)
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- Study area
 - Köppen-Geiger categories Csa and Csb (Warm temperate climate with dry and hot / warm summer) within the Mediterranean Basin



<https://cds.climate.copernicus.eu/cdsapp#!/home>

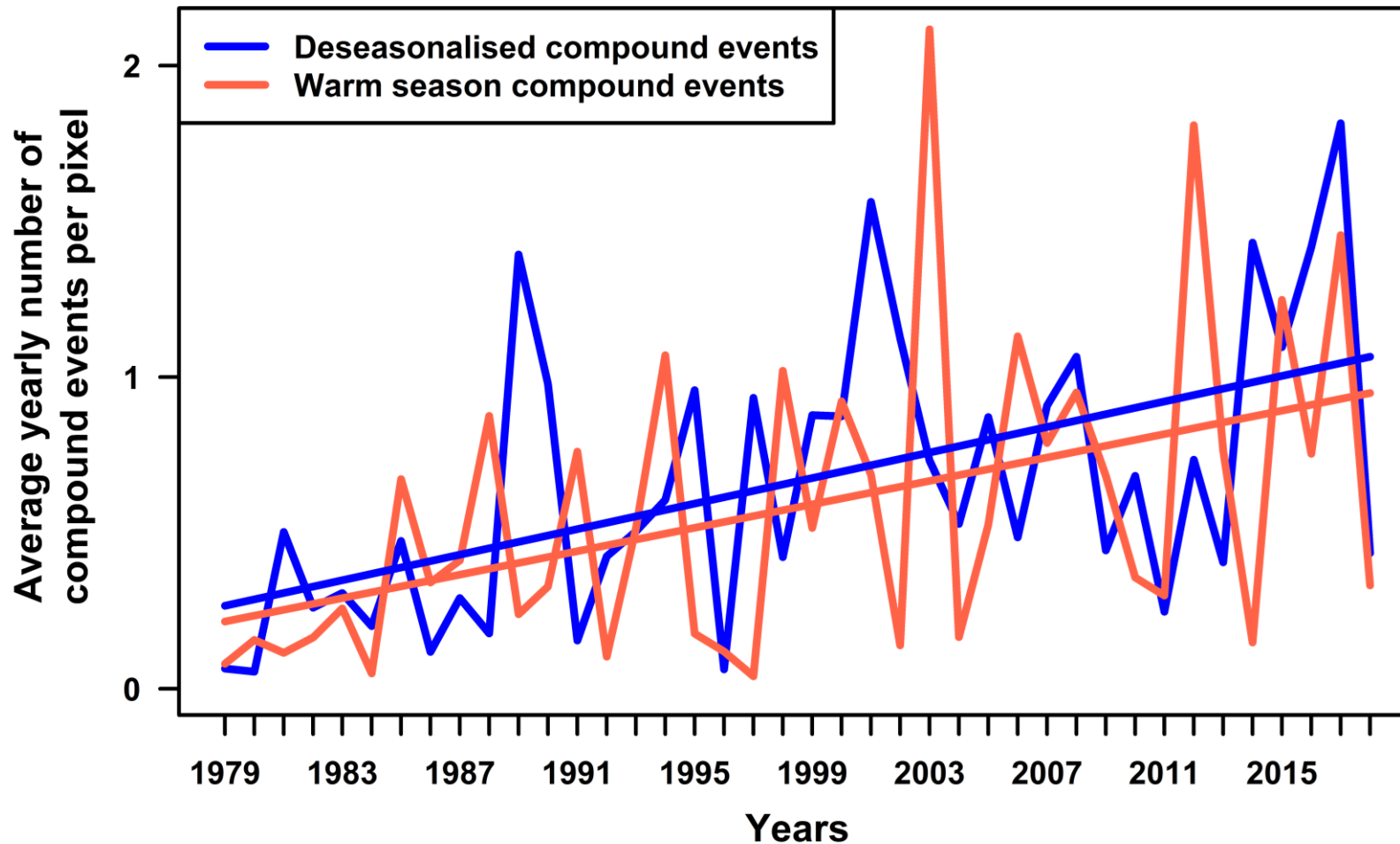
Event coincidence analysis on compound warm spells and droughts

- Warm spells defined by **daily** maximum air temperature above the 90th percentile for a duration of at least 5 days
- Droughts defined by **monthly** Standardized Precipitation Index $SPI < -0.8$
- Compound events termed as co-occurrence of warm spells and droughts
- Deseasonalisation for assessment of extremeness respective to the corresponding time of the year



Development over time

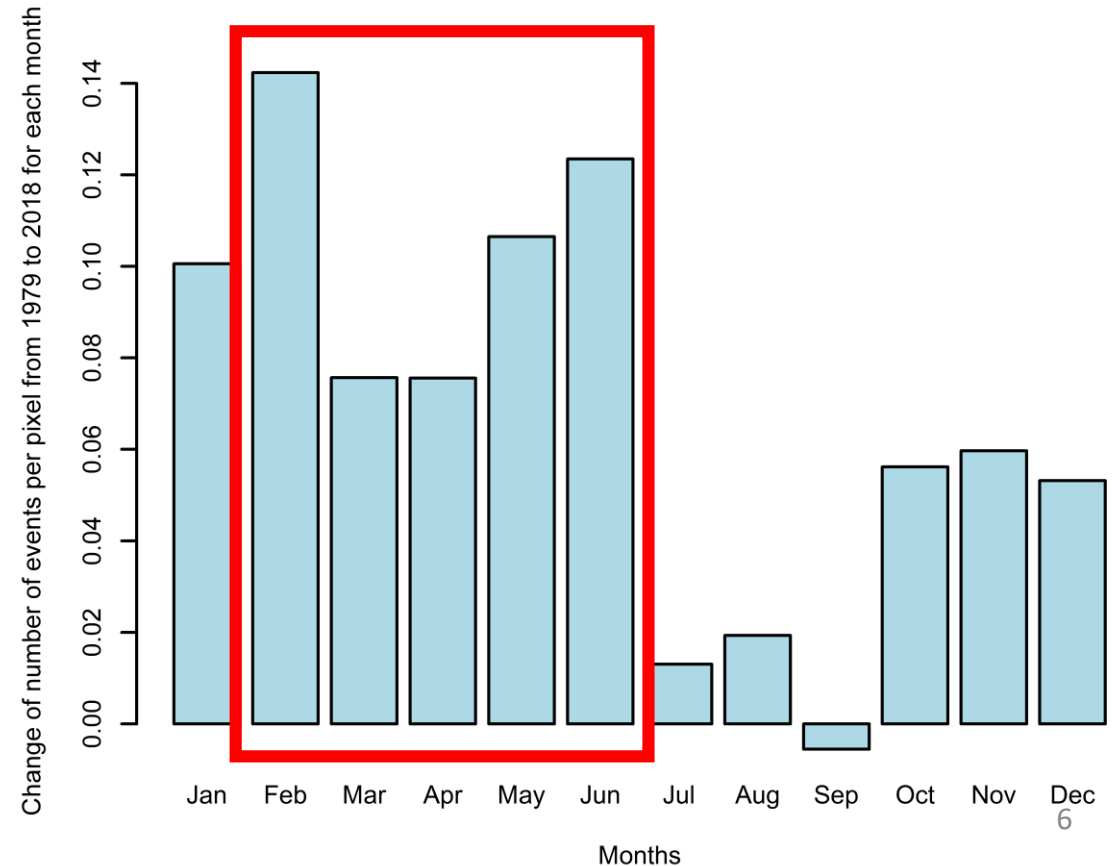
Significant increases for both warm season and deseasonalised compound events over the last 40 years



Change in number of compound events for each month

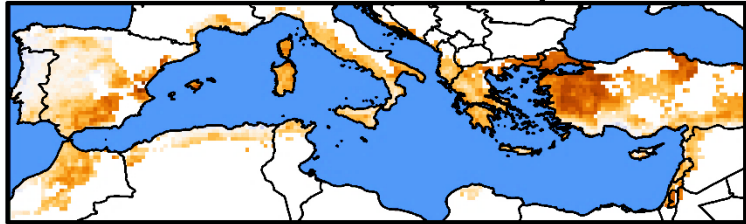
Deseasonalised compound events

- Peak in change of number of compound events in spring and early summer
→ Potential cause: Depletion of water resources earlier in the year caused by increased temperatures and associated ecosystem productivity (and thus transpiration) in spring

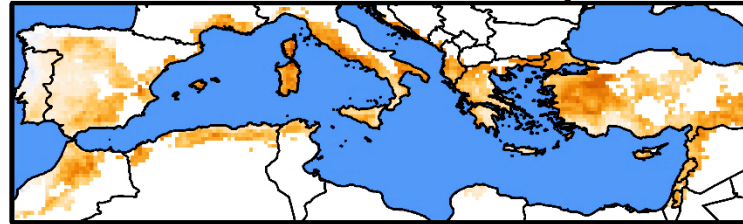


Proportion of events between 1979-1998 and 1999-2018 for warm spells and droughts

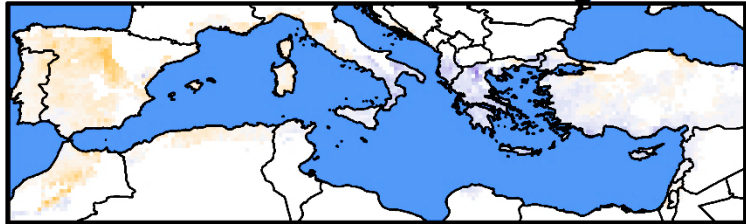
Warm season warm spells



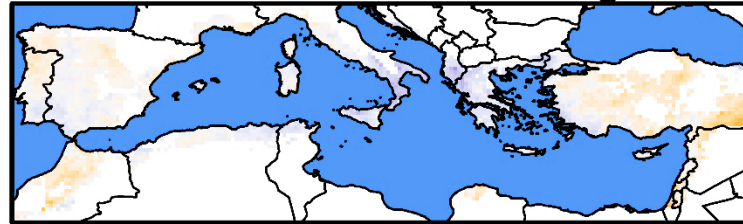
Deseasonalised warm spells



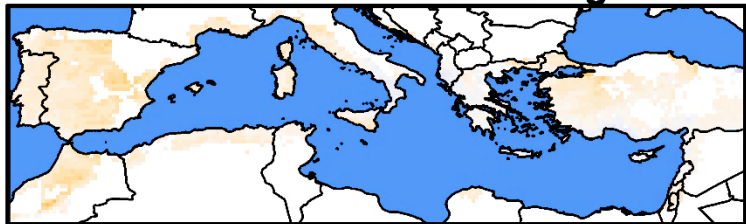
Warm season SPI-3 droughts



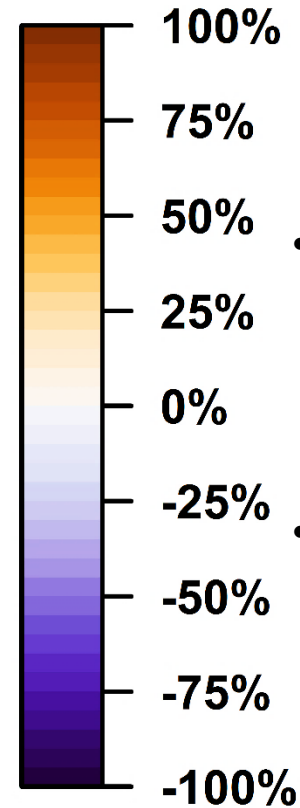
Deseasonalised SPI-3 droughts



Warm season SPEI-3 droughts



Deseasonalised SPEI-3 droughts



$$E_{\text{prop}} = \frac{N_{99-18} - N_{79-98}}{N_{79-18}}$$

- N_{79-98} , N_{99-18} and N_{79-18} are the number of events occurring in the time spans 1979 - 1998, 1999 - 2018 and 1979 - 2018, respectively
- Strong increases are observed in the number of warm spells, whereas SPI droughts remain mostly constant

Main findings

- Significant increases in the number of compound warm spells and droughts in the Mediterranean Basin over the last 40 years
- Increases of deseasonalised compound warm spells and droughts especially occur in spring (peak of growing season) with potentially harmful effects on ecosystems and agriculture
- Increase in temperature and not decline in precipitation is the main driver for these changes

References

- Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J.P., Iglesias, A., Lange, M.A., Lionello, P., Llasat, M.C., Paz, S., Peñuelas, J., Snoussi, M., Toret, A., Tsimplis, M.N., Xoplaki, E., 2018. Climate change and interconnected risks to sustainable development in the mediterranean. *Nature Climate Change* 8, 972-980. doi:10.1038/s41558-018-0299-2.
- Giorgi, F., 2006. Climate change hot-spots. *Geophysical Research Letters* 33, 1-4. doi:10.1029/2006GL025734.
- Lionello, P., Scarascia, L., 2018. The relation between climate change in the mediterranean region and global warming. *Regional Environmental Change* 18, 1481-1493. doi:10.1007/s10113-018-1290-1.