

Impact of climate change on superficial water resources in the South of France: statistical modelling over historical and future scenario periods

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/ MOTIVATION

Climate change is expected to impact the availability of the water resources in the Mediterranean. The aim of this study is to quantify these impacts on 6 coastal watersheds of the Gulf of Lions (southern France, Figure 1) over the historical period 1959-2018, as well as for future projections.

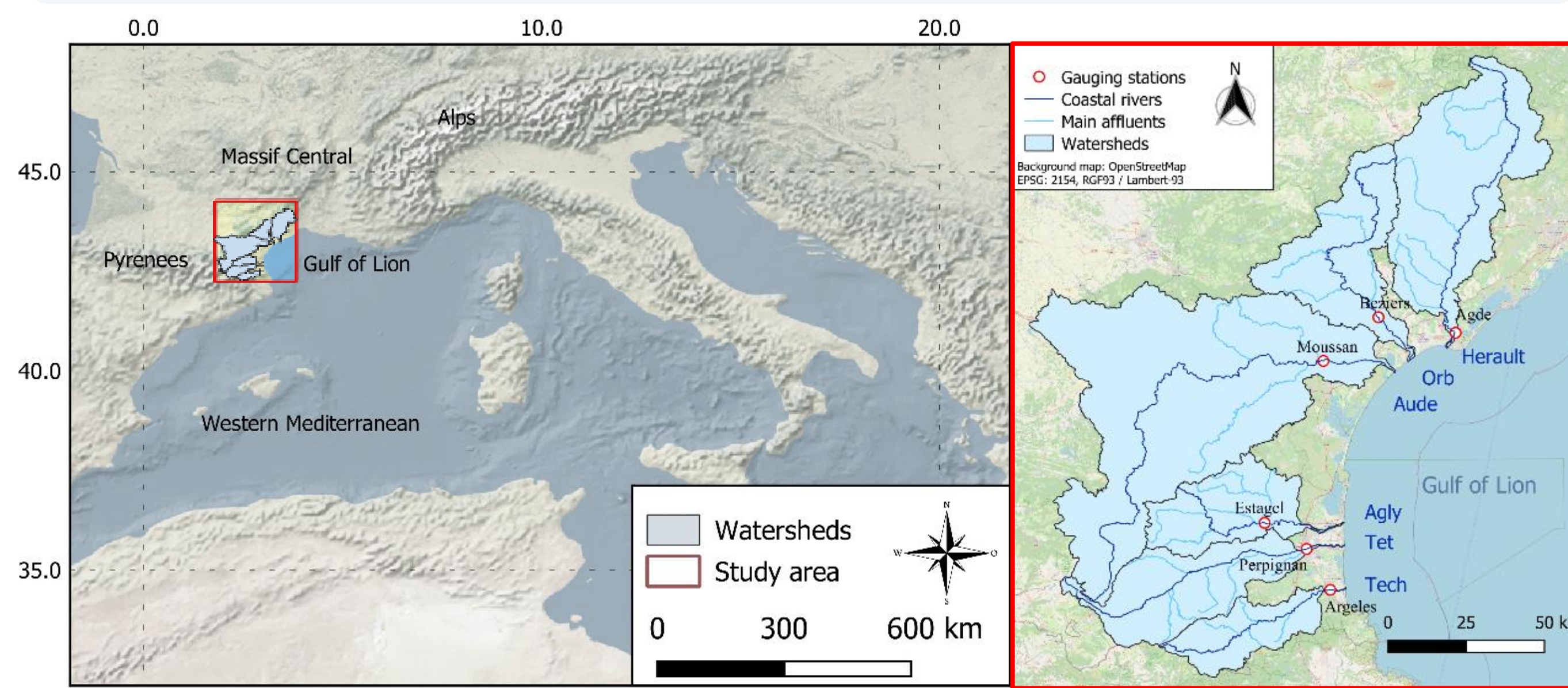


Figure 1: Location of the study area which covers six coastal watersheds flowing into the Gulf of Lion

/ MATERIALS AND METHODS

For past changes, we used observed data of hydrological series and climate variables for the construction and validation of a statistical model (Figure 2).

Ensemble average of a set of 6 Regional Climate Models (RCMs) are calculated to investigate future climate changes based on a RCP 8.5 scenario. The corresponding 5 Global Climate Models (GCMs) give gridded sea level pressure values that we used to examine the evolution of 4 teleconnection indices. Those are the NAO, Scand, WeMO, and MO. A K-mean clustering analysis was made to detect zones with potential different connections with the former indices.

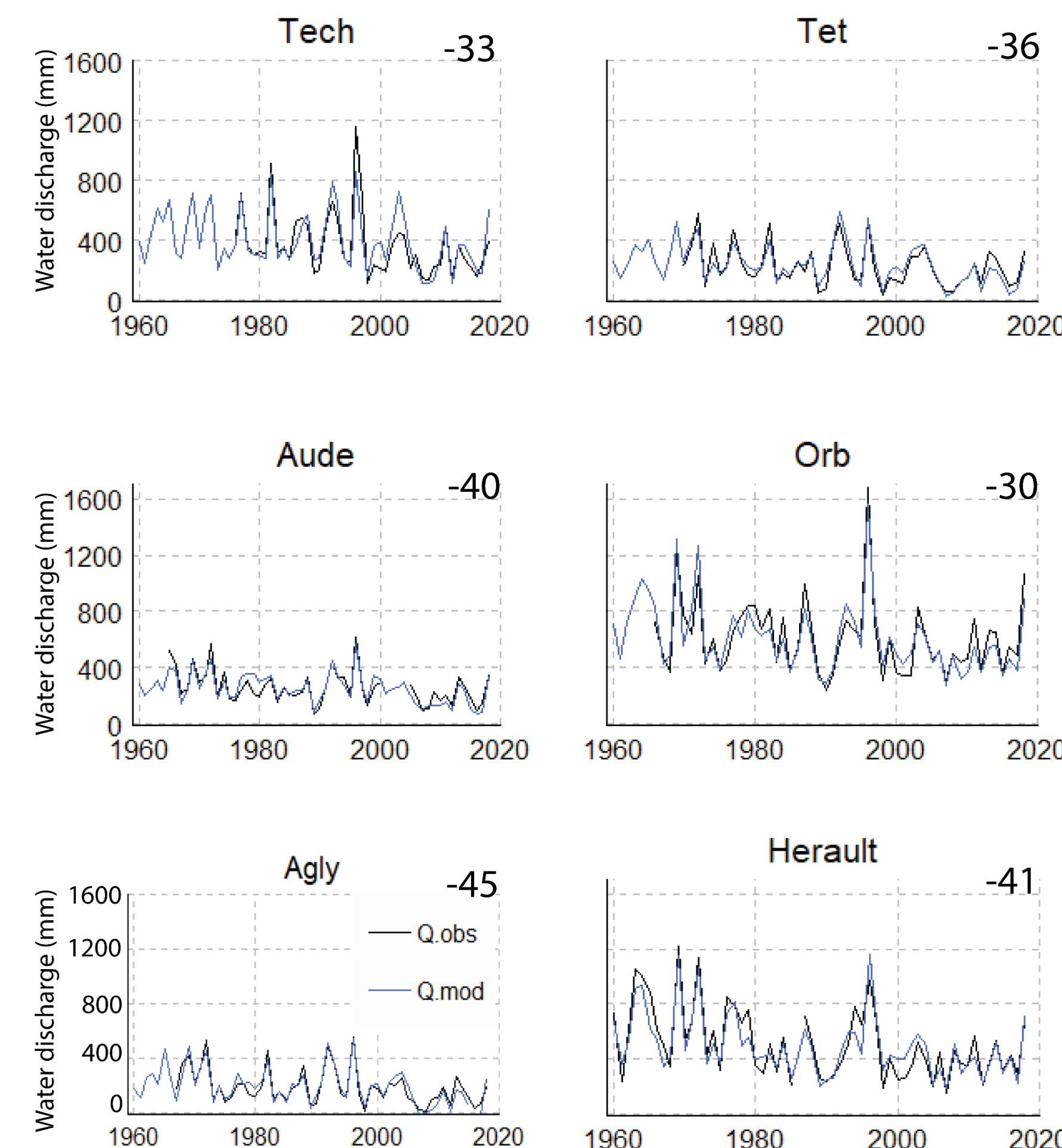


Figure 2: Annual evolution of the water discharge for the six rivers based on observation series (black lines/Qobs), and modelled series (blue lines/Qmod). Numbers on each top right corner are trends in percent for the period 1959-2018

/ RESULTS

Past observations and statistical analysis allowed us to detect a decrease of the six coastal river water discharge of about -30 to -45 % during the period 1959-2018 (Figure 2). Those changes were associated with climate changes (Labrousse et al. 2020). Same calculations are made for future projections under a scenario RCP 8.5 (Figure 3) and show a homogeneous increase of temperatures of about +4.5°C, a decrease of precipitations that only occur in the mid and south watersheds as well as a corresponding decrease of the water discharge of about -45/-88 % which is enhanced in the watersheds with decreasing precipitations.

The K-mean calculation performed on the drought index called RDI-03 indicates 2 main zones in our study area for which hydro-climatic behaviour is different (Figure 4). Both zones are strongly related to the four teleconnection pattern indices: Figure 5 shows the correlation for the historical period 1959-2018 between RDI-03 and the indices (top), and between the hydrological series and the indices (bottom). It furthermore indicates that the Eastern zone is closely linked to the Mediterranean indices of WeMO and MO whereas Western cluster is more associated with Atlantic indices of NAO and Scand.

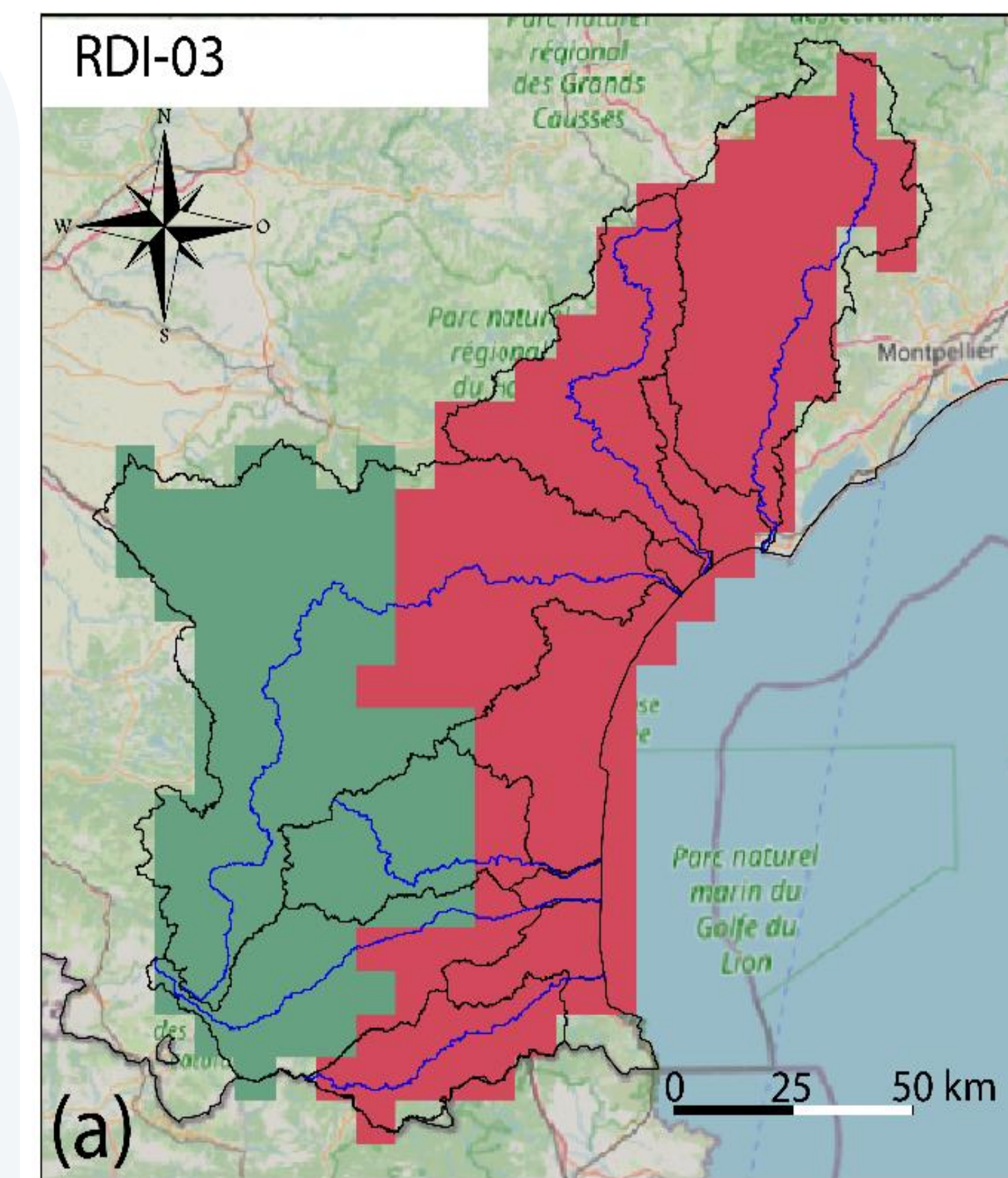


Figure 4 : K-mean clustering performed on the RDI-03 values and the two associated zones East and West

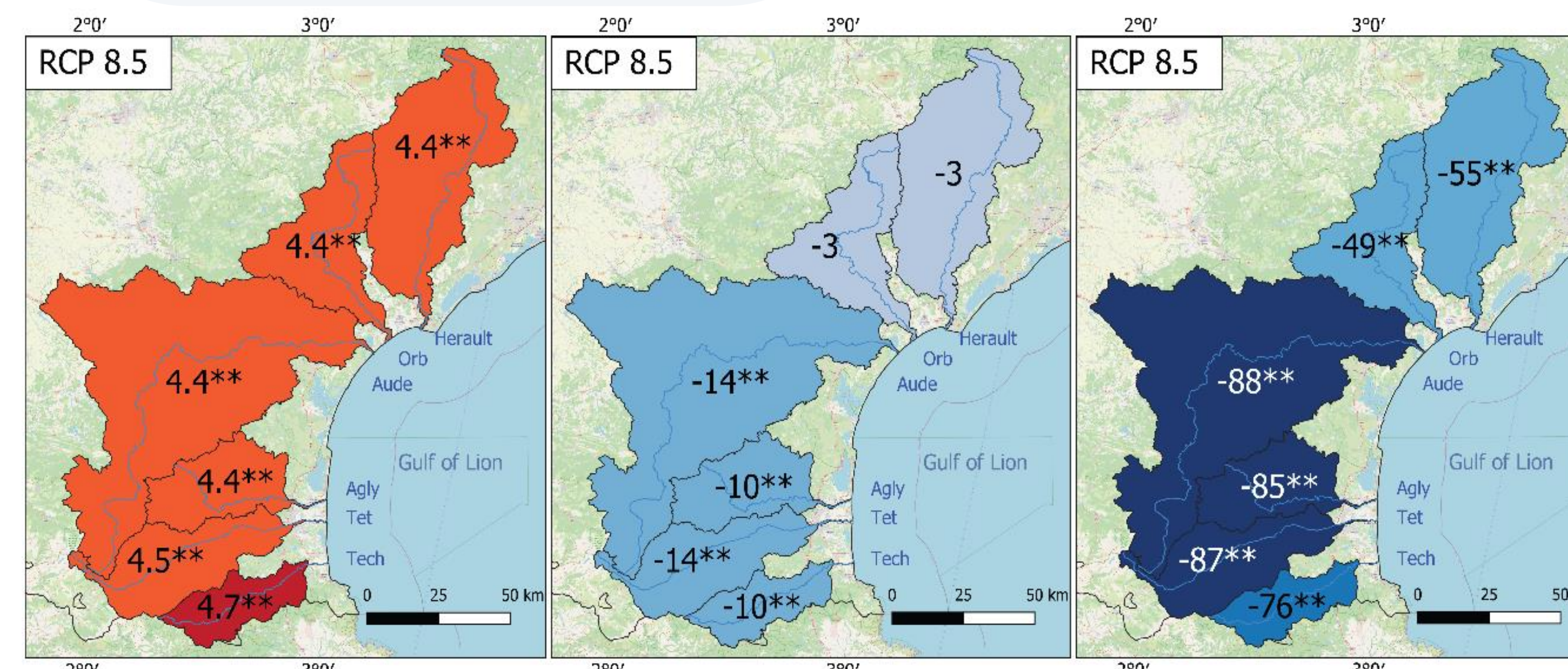


Figure 3: Mann-Kendall linear trends applied on the 6 RCMs ensemble mean and for the period 2006-2100 for temperatures (left), precipitations (middle), and water discharge (right).

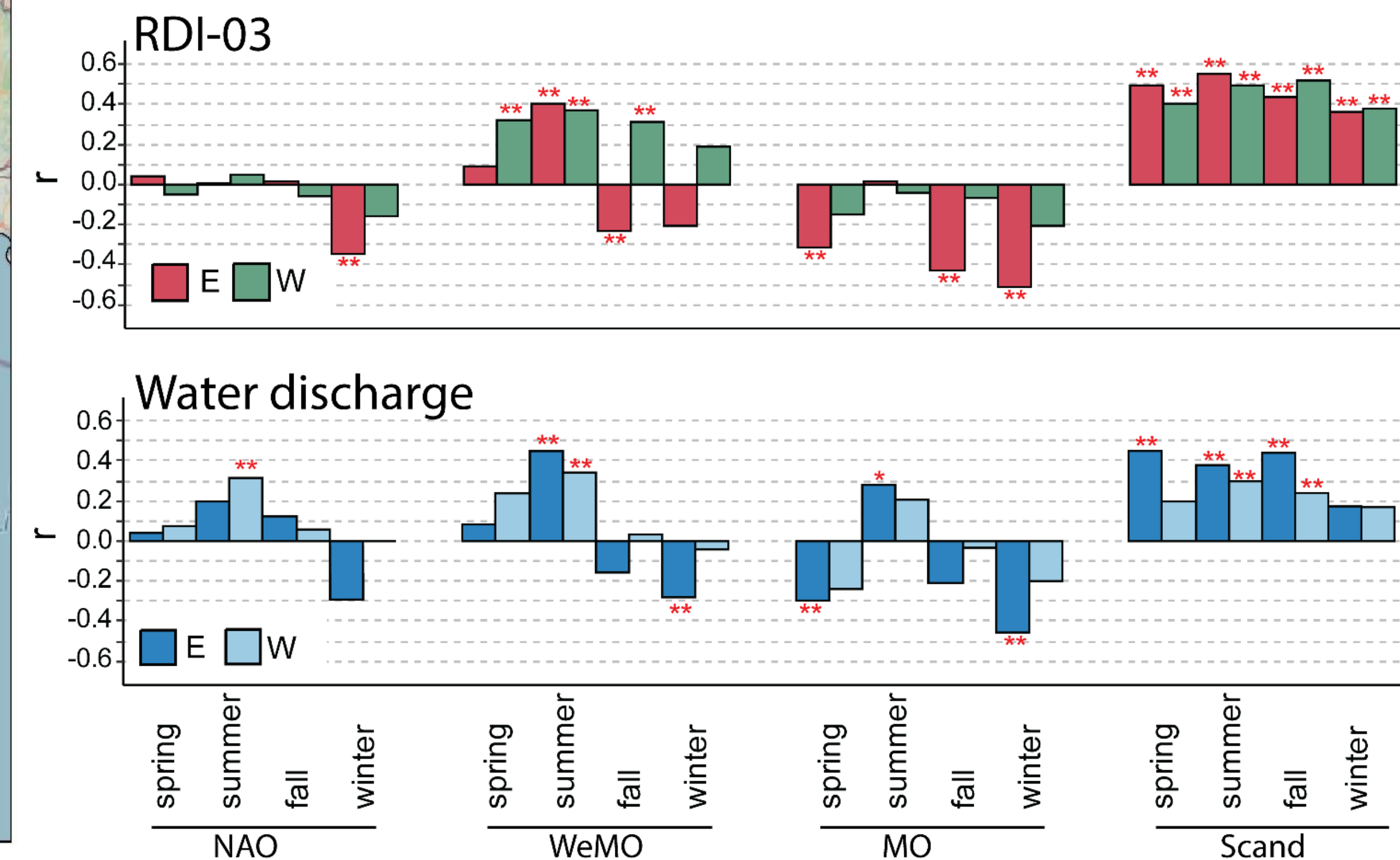


Figure 5: Spearman correlations between seasonal RDI-03 and water discharge of the eastern and western zones with teleconnection patterns of NAO, Scand, WeMO, and MO

/ CONCLUSION

As shown in the work of Labrousse et al.2020, the evolution of water resources in the study area is linked to climate change. The aim of this current study is to investigate the potential evolution of the six river water discharge for future climate projections and the role played by the atmospheric circulation in these. Preliminary conclusions can be drawn as follows:

- Climate projections under a scenario RCP 8.5 indicate a homogeneous warming of about +4.5°C with a decrease of precipitations of -12% only in the mid and southern watersheds.
- A K-mean clustering shows two zones with different hydro-climatic behaviour. An Eastern side includes the Hérault, Orb and Tech watersheds, and seems to be more related to the Mediterranean teleconnection indices (WeMO and MO). Whereas a Western side which includes the Aude, Agly, and Tet watersheds is more associated with Atlantic teleconnection indices (NAO and Scand)
- Given the observed differences in hydro-climatic trends for future projections, it is likely that these differences are due to connections with the overall atmospheric circulation

/ REFERENCES

Labrousse, C., Ludwig, W., Pinel, S., Sadaoui, M., and Lacquement, G.: Unravelling Climate and Anthropogenic Forcings on the Evolution of Surface Water Resources in Southern France, *Water*, 12, 3581, <https://doi.org/10.3390/w12123581>, 2020.