Changes in the Frequency and Persistence of Central European Circulation Types

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Motivation

- Circulation types are key drivers of weather conditions in Central Europe
- Persistent circulation types may favour extreme temperature anomalies, dry spells (e.g. summer 2018) and heavy rain- and snowfall events (e.g. January 2019)

Thus, we address the following research questions:

a) Is there an observed trend in the frequency or persistence of certain circulation types?
b) Can GCMs reproduce observed statistics of circulation types?
c) Is the frequency and persistence of the Central European circulation projected to change under global warming?

Model Data and Methods

- We classify ten individual circulation types using daily geopotential height at 500 hPa over Central Europe from three model setups with the cost733class[1] classification software
- GCM and reanalysis data:

ERA-40/-Interim	CESM12-LE	CMIP5
1 reanalysis product	1 model, 84 realisations	18 models, 23 realisations
	historical + rcp85	historical + rcp85
1960-2017	1960-2099	1960-2099

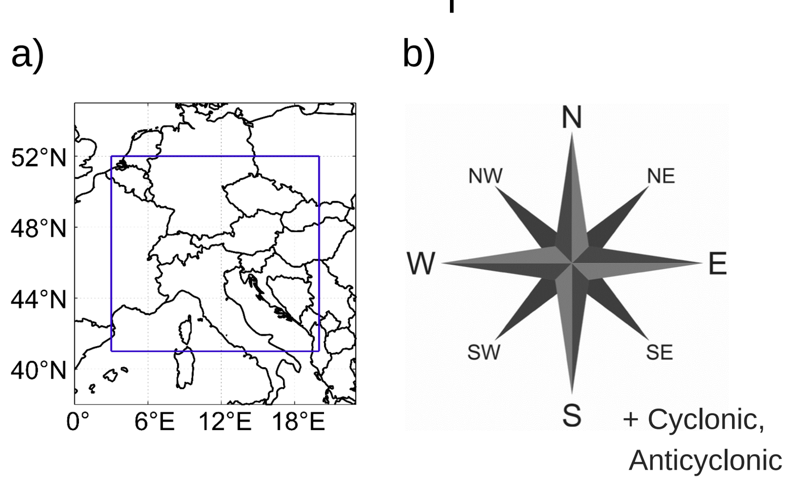

Fig. 1 In (a) the Central European classification domain 3°E – 20°E and 41°N – 52°N and in (b) the ten circulation types.

[1]Demuzere, M., Kassomenos, P., & Philipp, A. *Theoretical and Applied Climatology*, **105**, 143–166 (2011).

Key Points and Summary Figure

- Climate models project warmer and drier summer conditions in Central Europe under unabated global warming independent of the circulation type..
- The main circulation types (West, Southwest, Northwest and North) are projected to be slightly more persistent in summer, with an ambiguous signal in winter
- Overall projected changes in the frequency and persistence are consistently small and likely within the range of internal variability

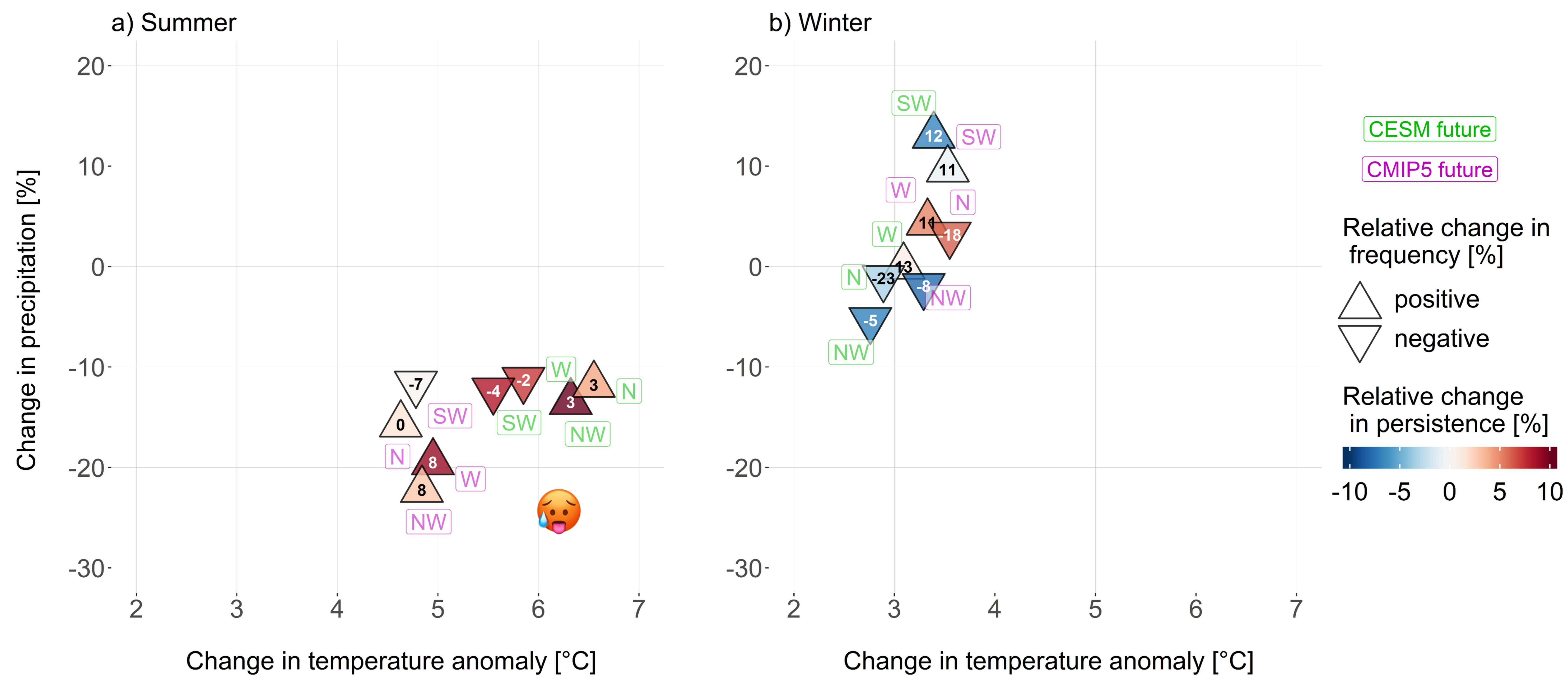

Fig. 4 Summary of projected temperature [°C], precipitation [%], frequency [%] and persistence [%] changes of the four main Central European circulation types in (a) summer and (b) winter for 2070-2099 relative to 1988-2017. The sign of the frequency change is given by the triangle shape and the magnitude of its change as the value within in [%]. The persistence change is given as the shading of each triangle.

Frequency Changes

- Models reproduce the observed frequency of circulation types reasonably well, but in winter somewhat overestimate westerlies/north-westerlies while underestimating northerly wind and the rarer circulation types
- In summer, projected changes in the frequency of circulation types are consistently small in all models
- CESM simulates a significant increase in westerlies during winter for the future time period

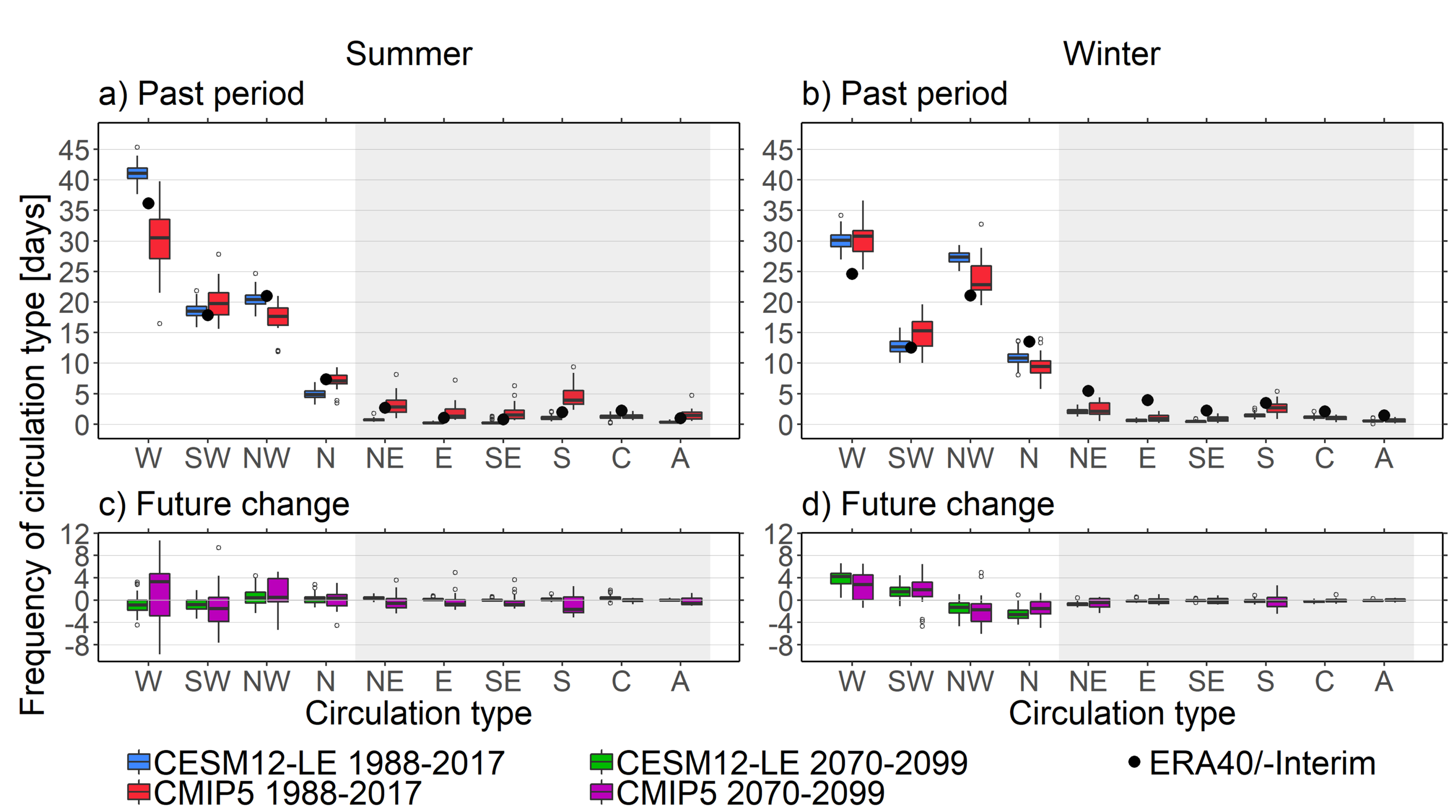

Fig. 2 Frequency of the ten circulation types during (a) summer and (b) winter for the time period 1988-2017. In (c) and (d) is the projected change in the models for the future time period 2070-2099 relative to the past period given as an absolute value. The shaded area indicates the rare circulation types.

Persistence Changes

- The length of a consecutive circulation type period and the seasonal frequency of that type are related by a logarithmic regression
- We evaluate changes in the persistence as changes in the slope of the regression between the past and future time period
- Westerly winds in summer are projected to become more persistent as the slope decreases

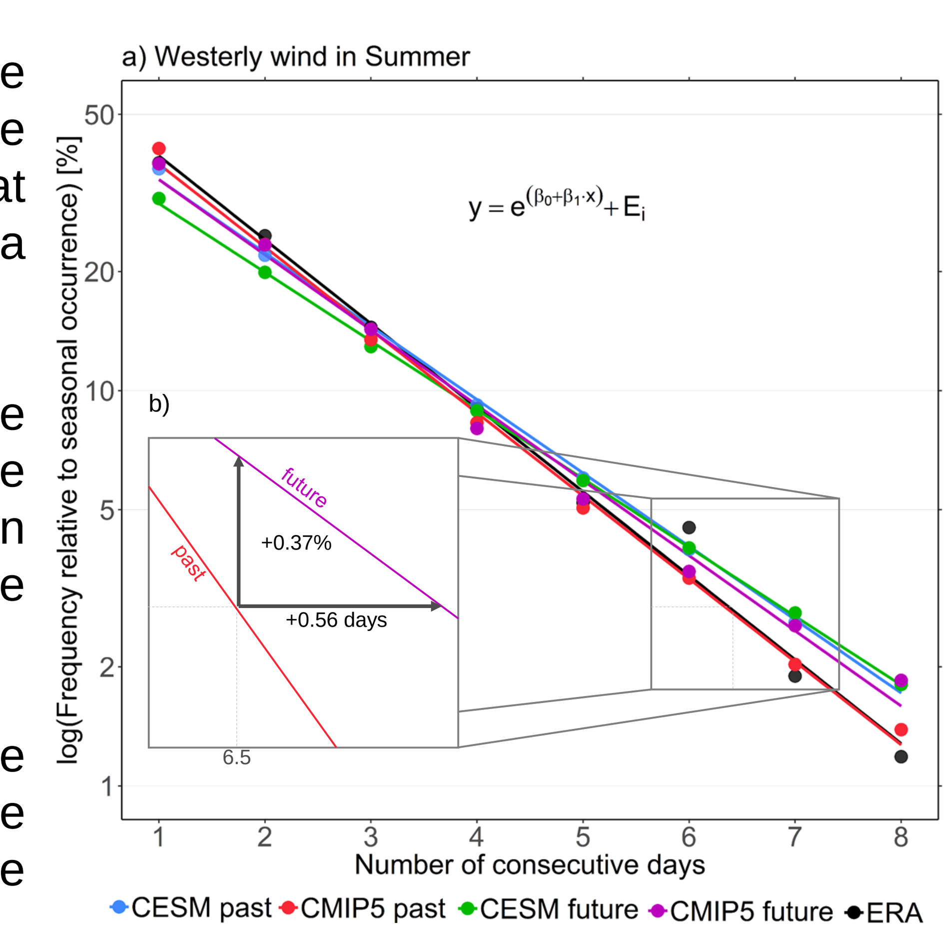

Fig. 3 In (a) the frequency of consecutive westerly wind (W) periods relative to the seasonal average for the past (1988-2017) and future (2070-2099) time period on a logarithmic y-axis with a logged response regression fit. In (b) an inset for the CMIP5 data showing the changes to a consecutive 6.5-day-long time period. Subfigure (b) is not to scale.

- .pdf link: https://polybox.ethz.ch/index.php/s/X8bLMuTf8GU1d3C
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