

# Atmospheric synoptic circulations linked to short-term droughts over Europe: A CMIP6 evaluation

Pedro Herrera Lormendez<sup>1</sup>, AMAL JOHN<sup>2</sup>, Hervé Douville<sup>2</sup>, and Jörg Matschullat<sup>1</sup>

<sup>1</sup>TU Bergakademie Freiberg

<sup>2</sup>Météo-France

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## Abstract

Synoptic circulation classifications represent a helpful tool to characterize daily atmospheric patterns that strongly relate to the dominant regional meteorological conditions. As global warming influences the dynamical response of circulation patterns, their changes might enhance or mitigate the behaviour of extreme weather events. We investigate the synoptic circulations linked to short-term meteorological droughts. The automated Jenkinson-Collison classification is used to classify daily atmospheric patterns, based on mean sea-level pressure data. Links between monthly relative frequency anomalies of the synoptic circulations and short-term meteorological droughts were found using the 1-month Standardized Precipitation Index (SPI-1). We evaluate the ability of the historical runs of global climate models (GCMs) to reproduce the observed features in the ERA5 reanalysis during the 1961 - 1990 climatological reference period. The evaluation is performed by a multi model ensemble (MME) approach based on 22 GCMs. Links between the mean directional flow characteristics of the circulation types and dry months were found and are well represented in the GCMs MME. The strongest relationships were found within anticyclonic, easterly and low flow types since these circulation types show higher than normal occurrences during dry events. Inverse relationships emerged from the dominant westerly directional types given their lower occurrences dominated by the dry months.

# ATMOSPHERIC SYNOPTIC CIRCULATIONS LINKED TO SHORT-TERM DROUGHTS OVER EUROPE: A CMIP6 evaluation

Pedro Herrera-Lormendez<sup>1</sup>, Amal John<sup>2</sup>, Hervé Douville<sup>2</sup>, Jörg Matschullat<sup>1</sup>  
<sup>1</sup>TUBAF, <sup>2</sup>Météo-France

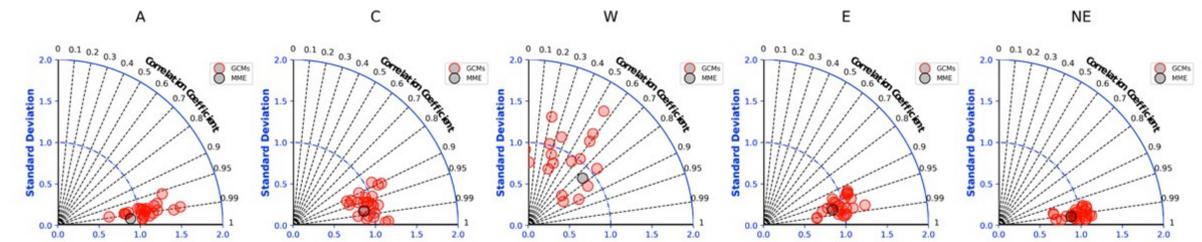


Fig 3. Taylor diagrams assessing the CMIP6 GCMs and MME skill simulating the summer (JJA) relative frequencies of five main CTs over Europe. Anticyclonic (A), Cyclonic (C), Westerly (W), Easterly (E) and North-easterly (NE). Normalized values are shown.

## Motivation

Investigate links between large-scale near-surface atmospheric circulation and 1-month meteorological droughts over Europe. Explore the ability of CMIP6 Global Climate Models (GCMs) to reproduce these features during the 1950-2000 reference climate period.

CMIP5 GCMs perform relatively well in simulating the spatial patterns of the relative frequency of summer CTs.

## Methods

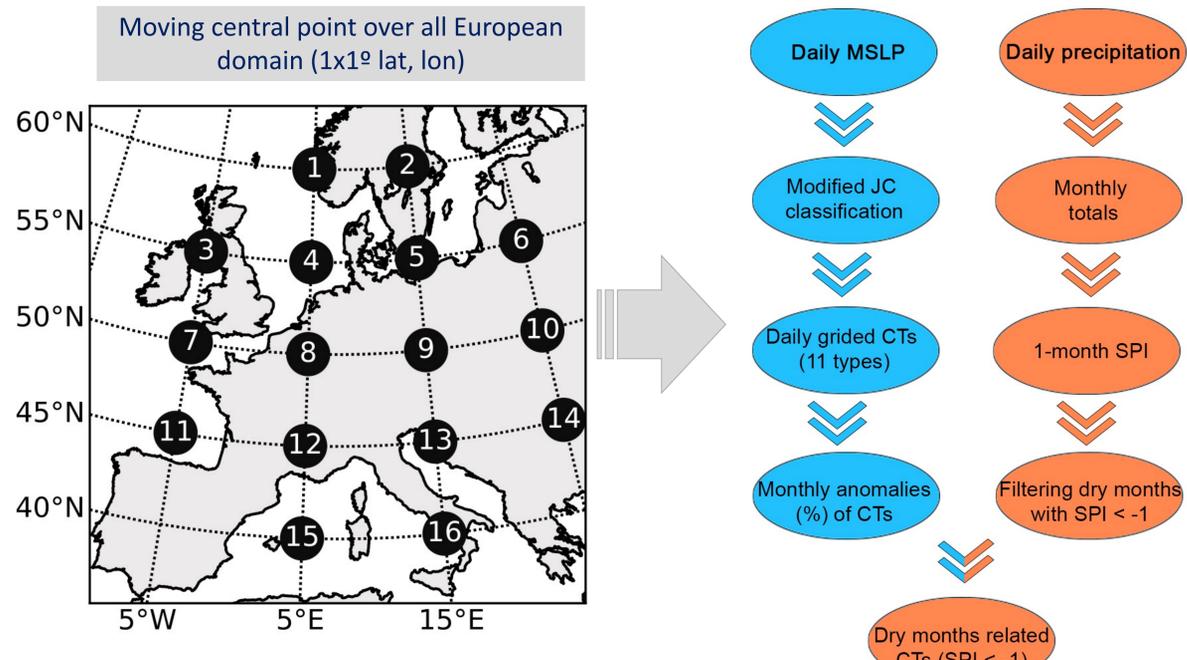


Fig 1. Distribution of the 16 MSLP grid points employed in the computation of the JC classification (Source: Herrera-Lormendez et al., 2021)

Disagreement in simulating the relative frequency of westerlies with GCMs underestimating them.

Higer than average occurrence of anticyclones (everywhere) and easterlies (W EU) during dry months

Lower than average occurrence of cyclones (everywhere) and westerlies (W EU) during dominant dry months

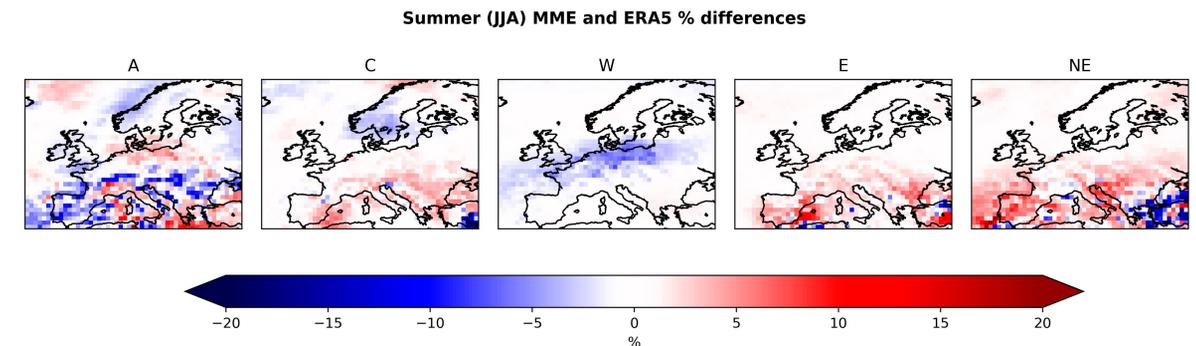


Fig 4. Summer relative frequency differences between MME and ERA5.

## Synoptic circulations linked to dry months

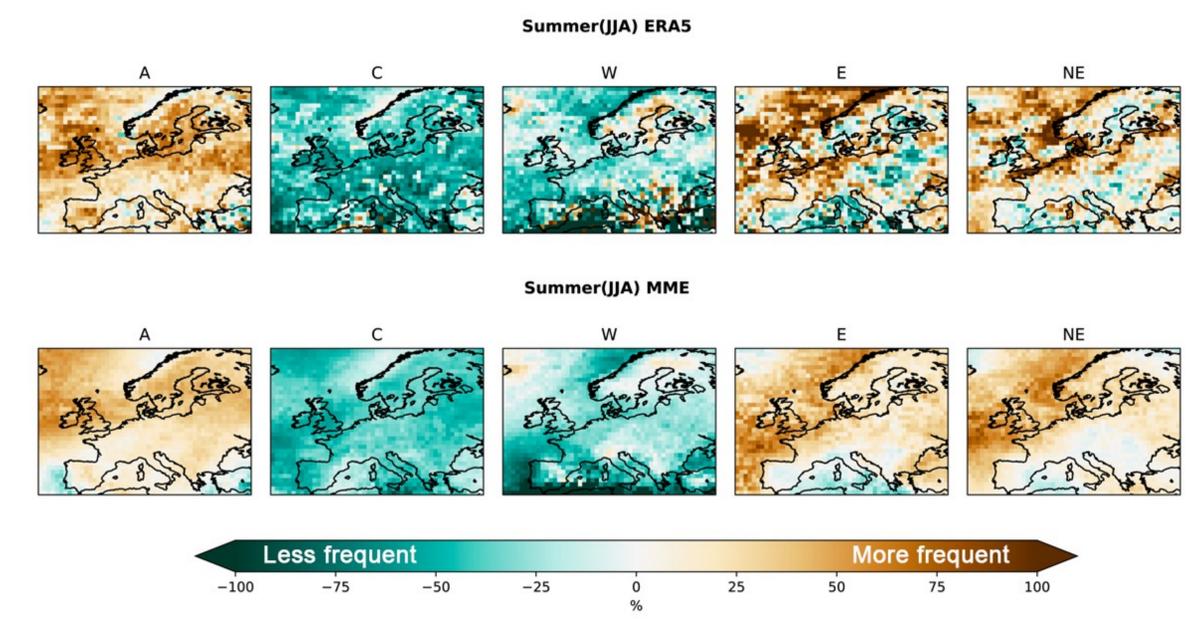


Fig 5. Summer comparison of ERA5 and CMIP6 GCMs MME of CTs frequency anomalies linked to 1-month dry months (SPI < -1)

## GCMs' evaluation

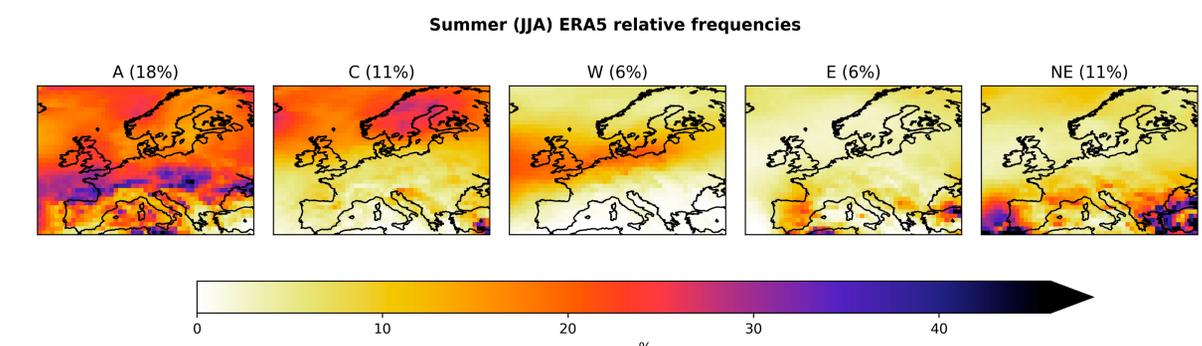


Fig 2. ERA5 summer relative frequencies of five main CTs.