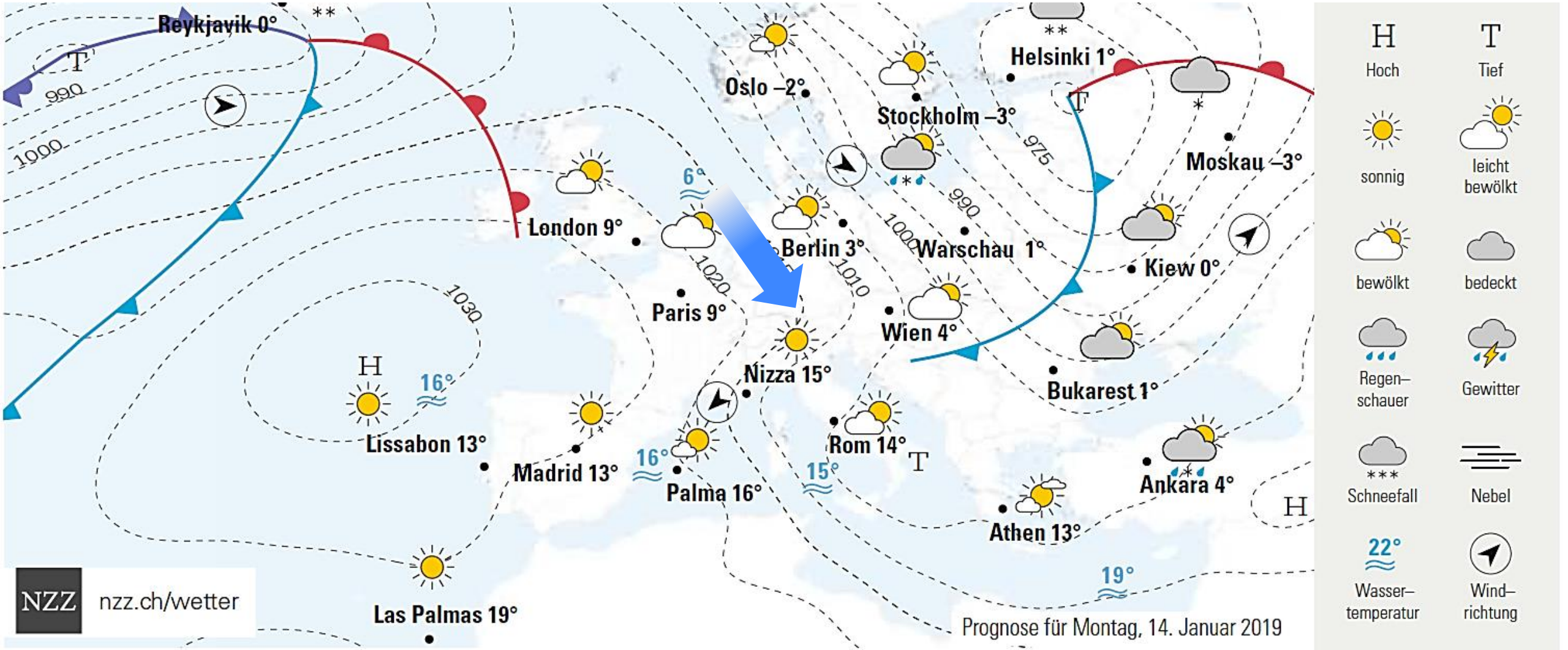
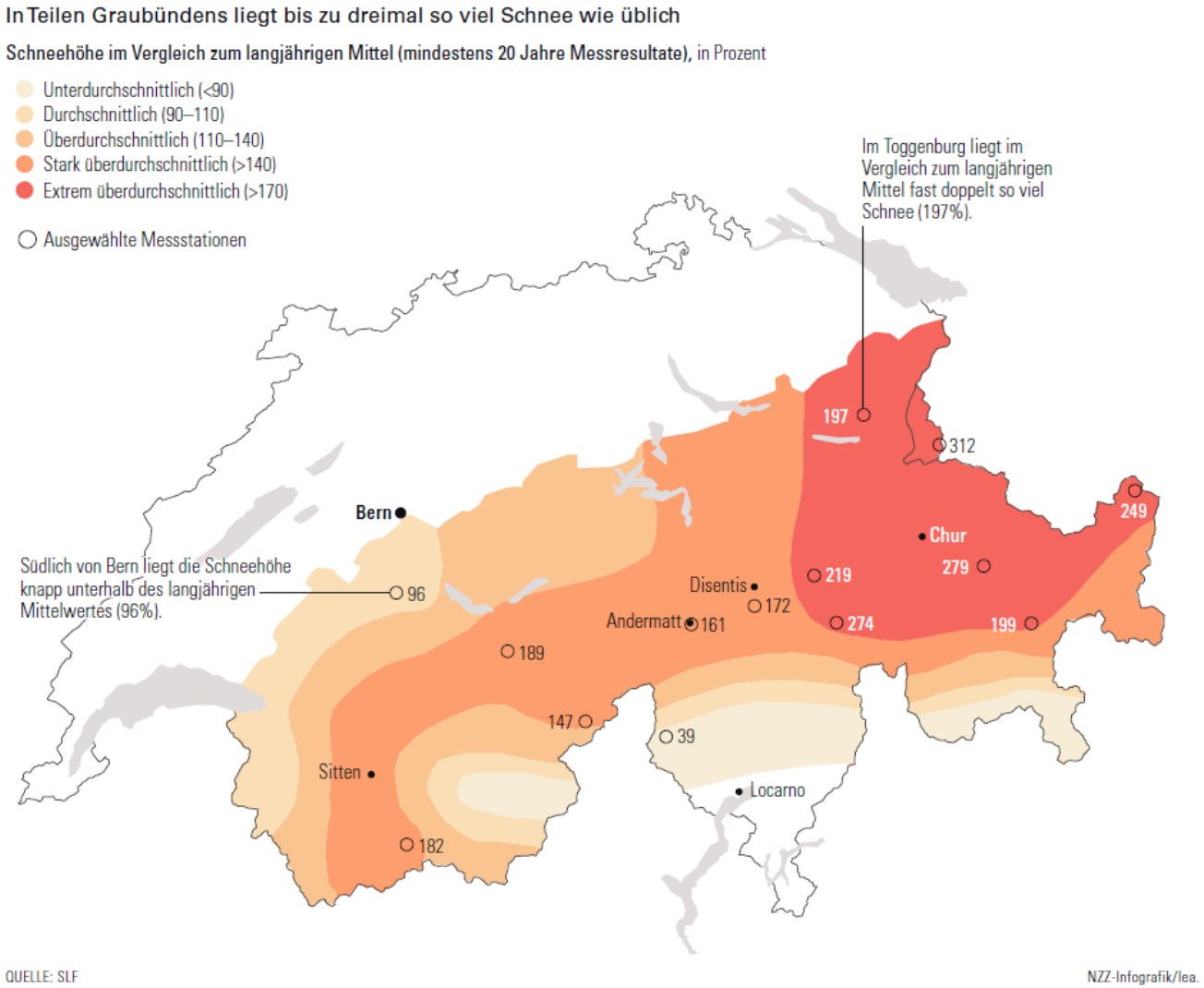
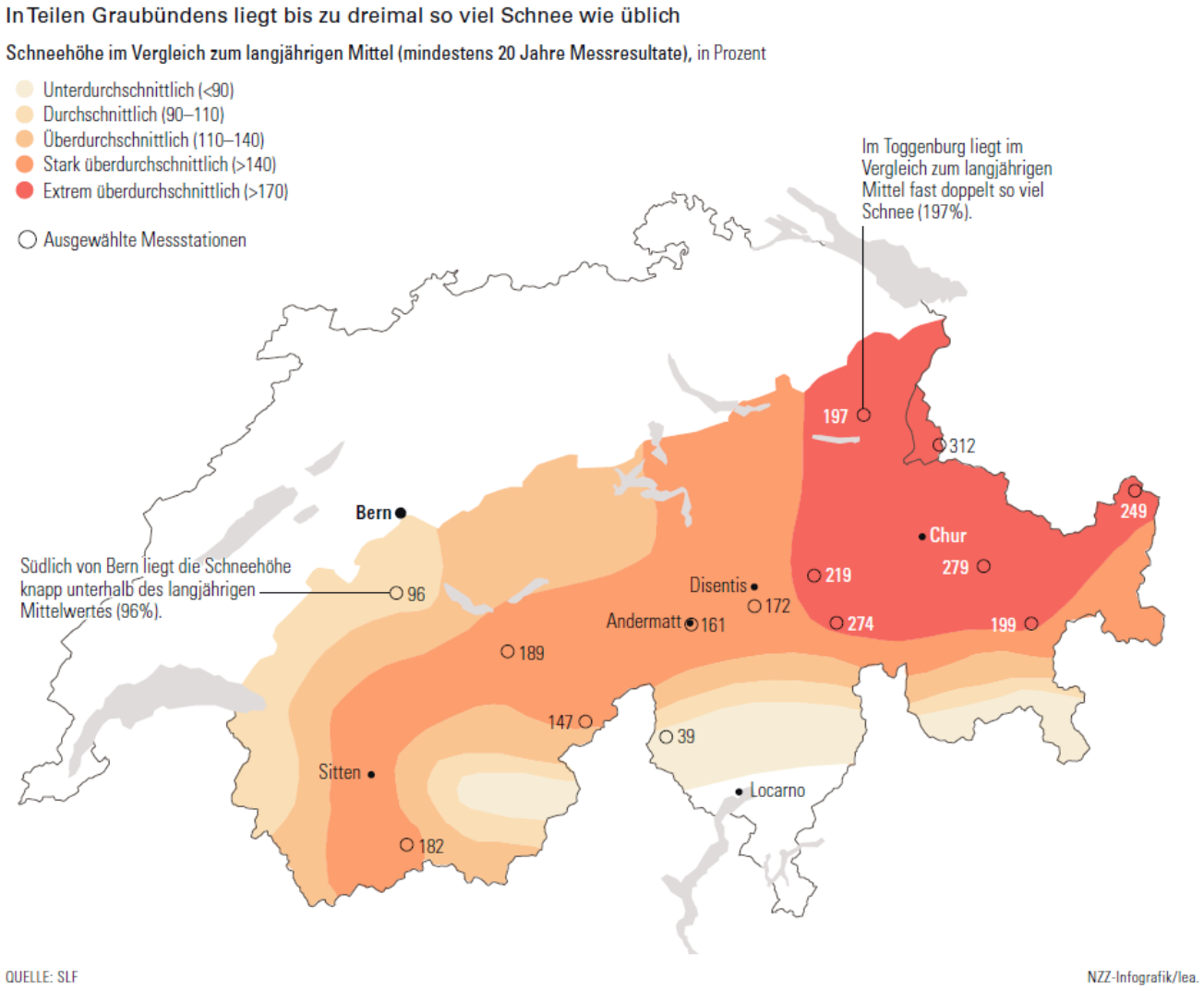


Monday, 14th January 2019

The setting


In Teilen Graubündens liegt bis zu dreimal so viel Schnee wie üblich
Schneehöhe im Vergleich zum langjährigen Mittel (mindestens 20 Jahre Messresultate), in Prozent
Unterdurchschnittlich (<90)
Durchschnittlich (90–110)
Überdurchschnittlich (110–140)
Stark überdurchschnittlich (>140)
Extrem überdurchschnittlich (>170)
Ausgewählte Messstationen
Im Toggenburg liegt im Vergleich zum langjährigen Mittel fast doppelt so viel Schnee (197%).
Südlich von Bern liegt die Schneehöhe knapp unterhalb des langjährigen Mittelwertes (96%).
Bern
Chur
Disentis
Andermatt
Sitten
Locarno
197
312
249
219
279
172
161
274
199
96
189
147
39
182
QUELLE: SLF
NZZ-Infografik/lea.

The setting

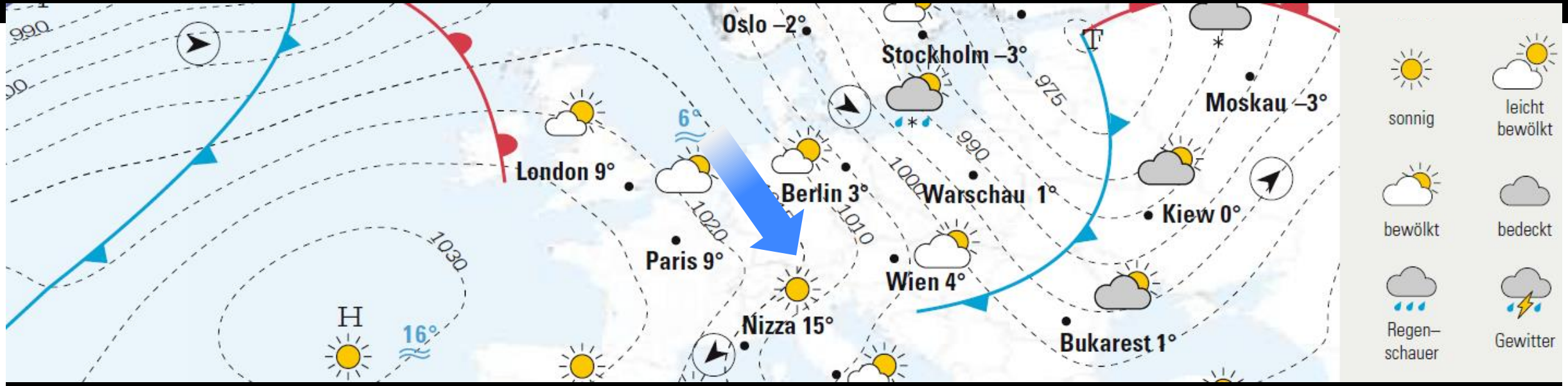


Ischgl, western Austria

youtu.be/X1f7lp6zyLg

ETH zürich

Bundesamt für Meteorologie und Klimatologie MeteoSchweiz



Changes in the Frequency and Persistence of Central European Circulation Types

Me[1,2], Erich M. Fischer[1], Sven Kotlarski[2], Simon C. Scherrer[2], Cornelia Schwierz[2] and Reto Knutti[1]

[1]Institute for Atmospheric and Climate Science, ETH Zürich, [2]Federal Office of Meteorology and Climatology, MeteoSwiss

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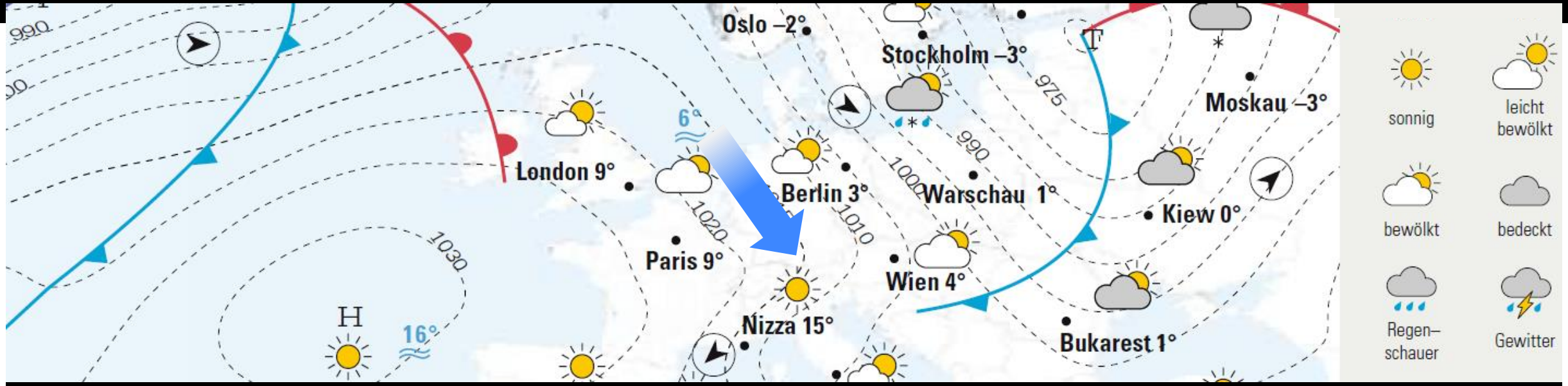

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and Urs Beyerle 😎

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Research Questions

- Can GCMs reproduce observed statistics of circulation types?

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- Do we already observe trends in the frequency or observe changes in the persistence of certain types?
- Is the frequency and persistence of the Central European circulation projected to change under global warming?

Global Model Data Sets

ERA-40/-Interim	CESM12-LE	CMIP5

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1 reanalysis product	1 model, 84 realisations	18 models, 23 realisations

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1960-2017	1960-2099	1960-2099

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

Classification with cost733class[1] software

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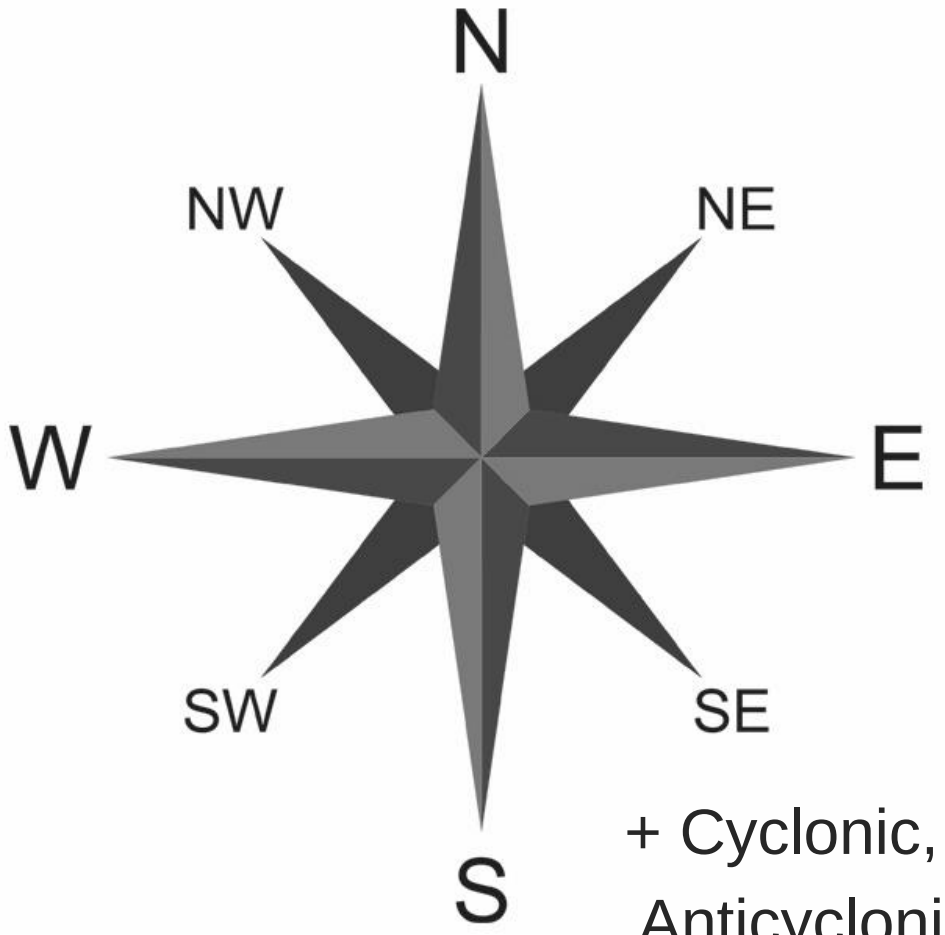
Classification with cost733class[1] software

- 10 circulation types

→ correlation with strictly zonal, meridional or cyclonic direction



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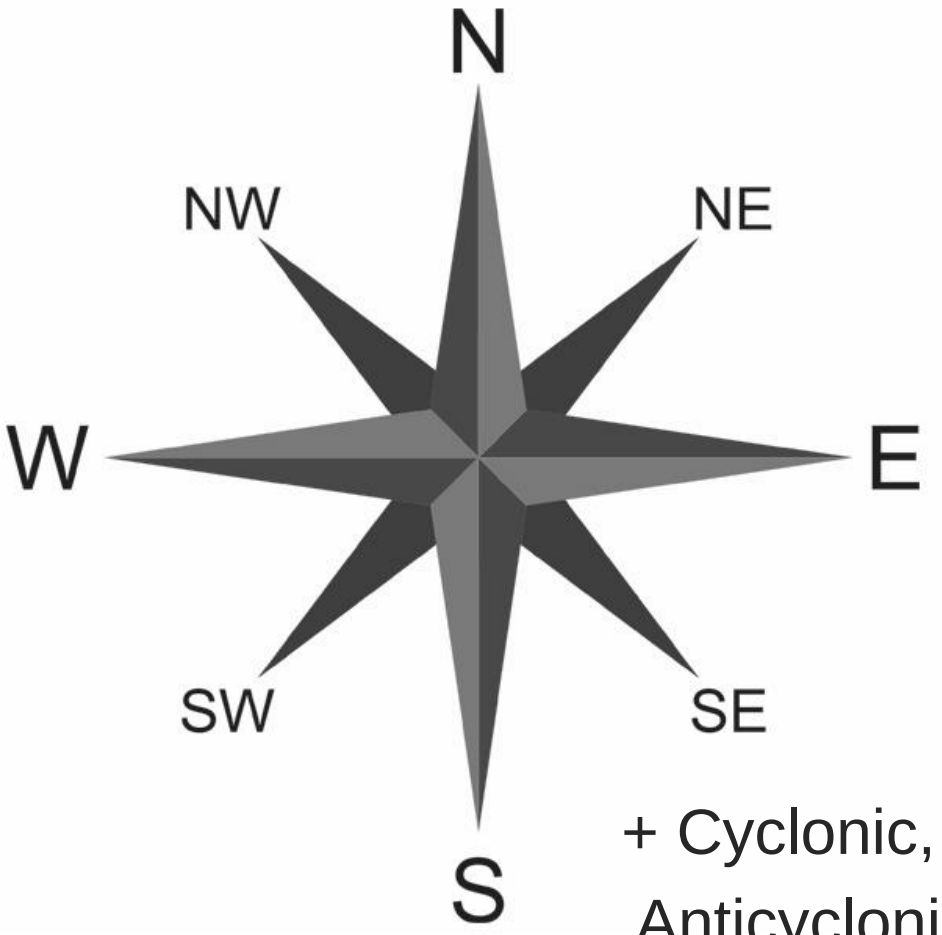

+ Cyclonic,
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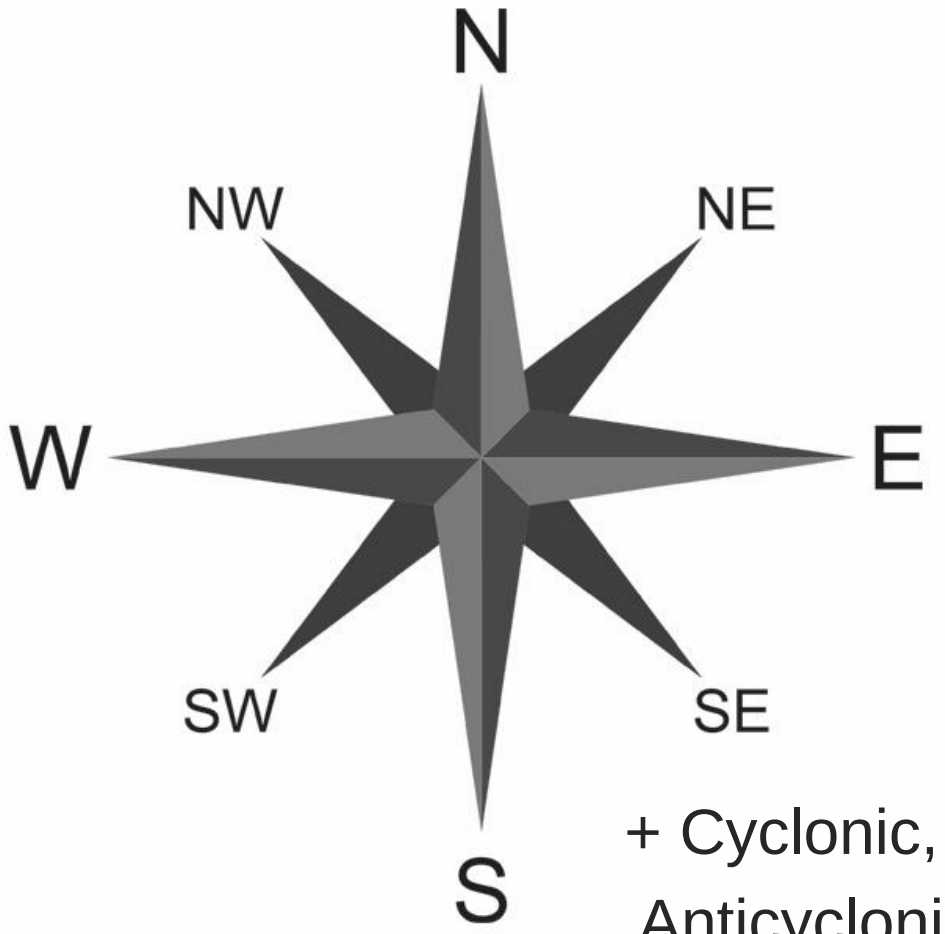

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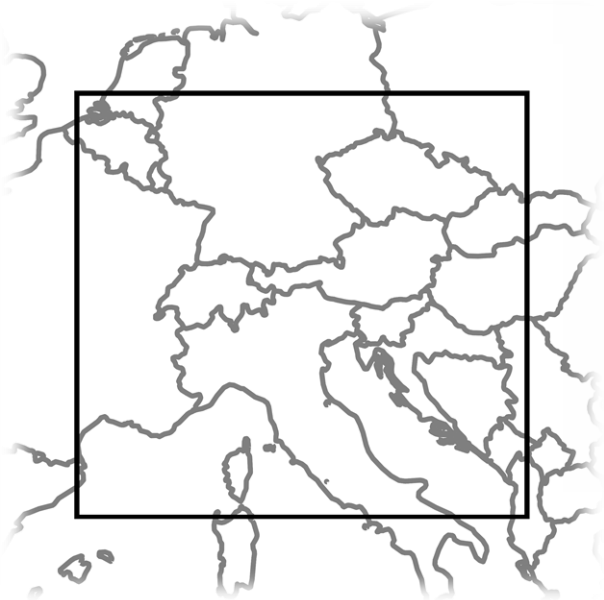
- daily geopotential height at 500 hPa

- Central Europe:



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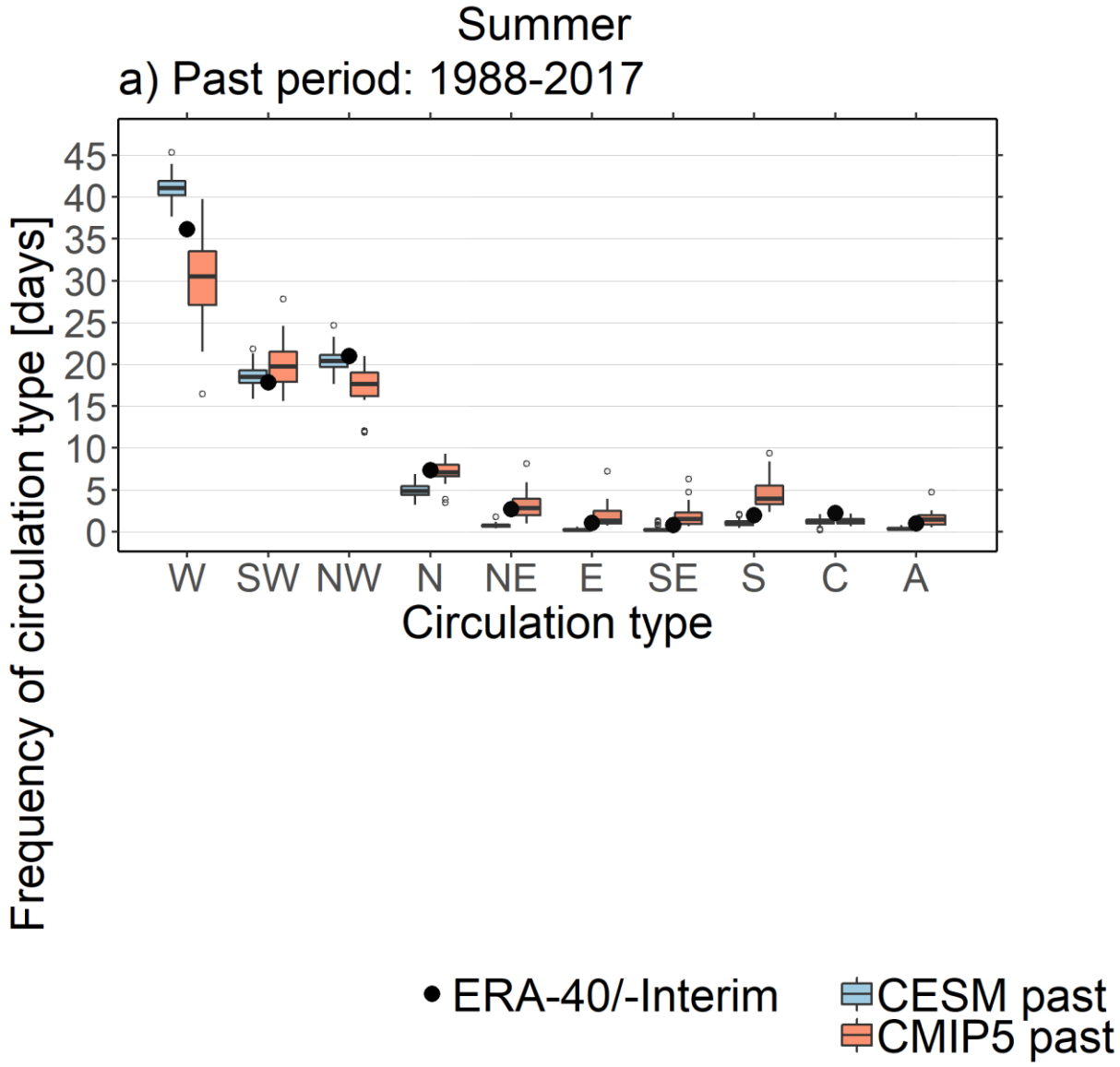
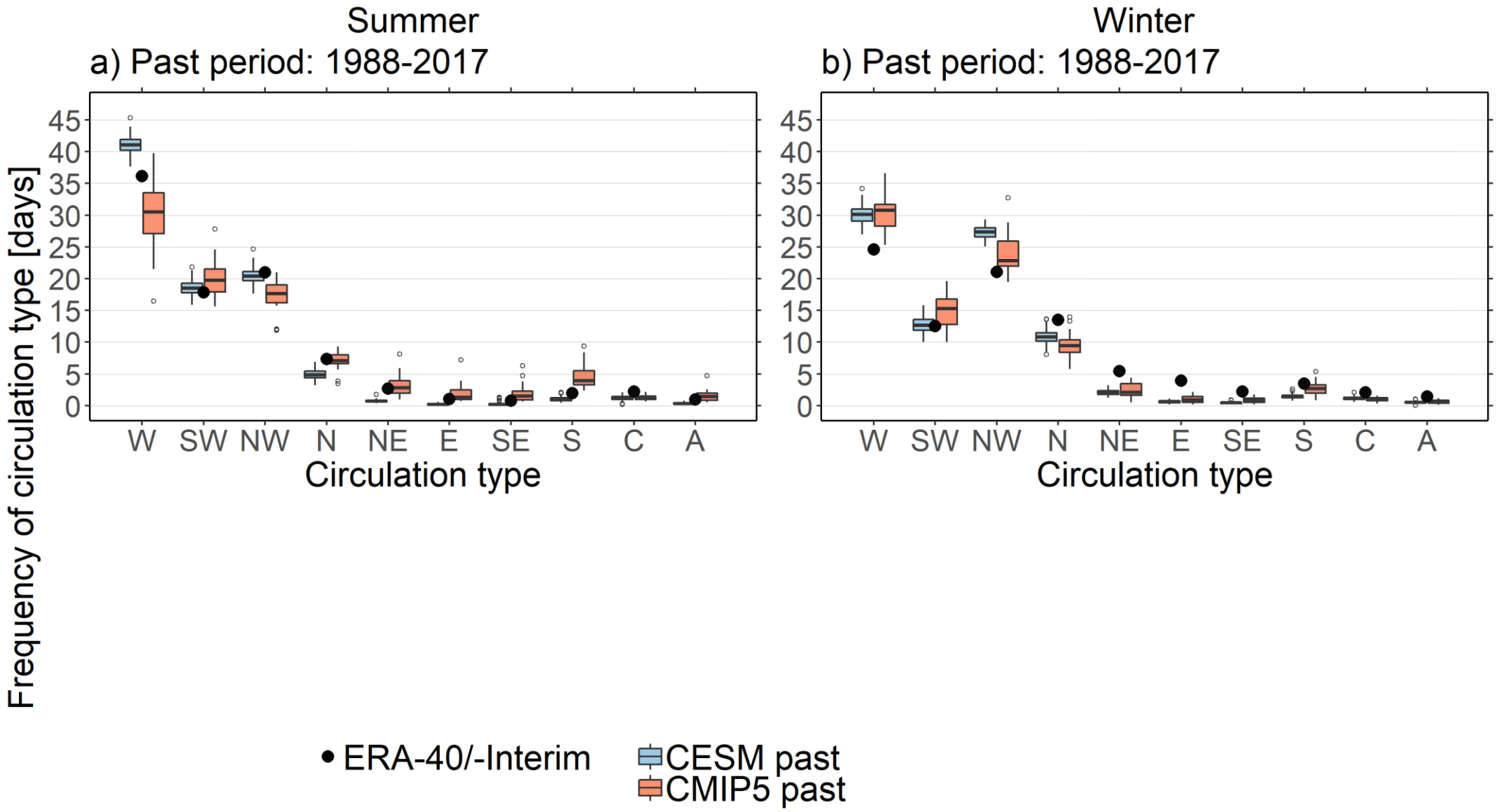
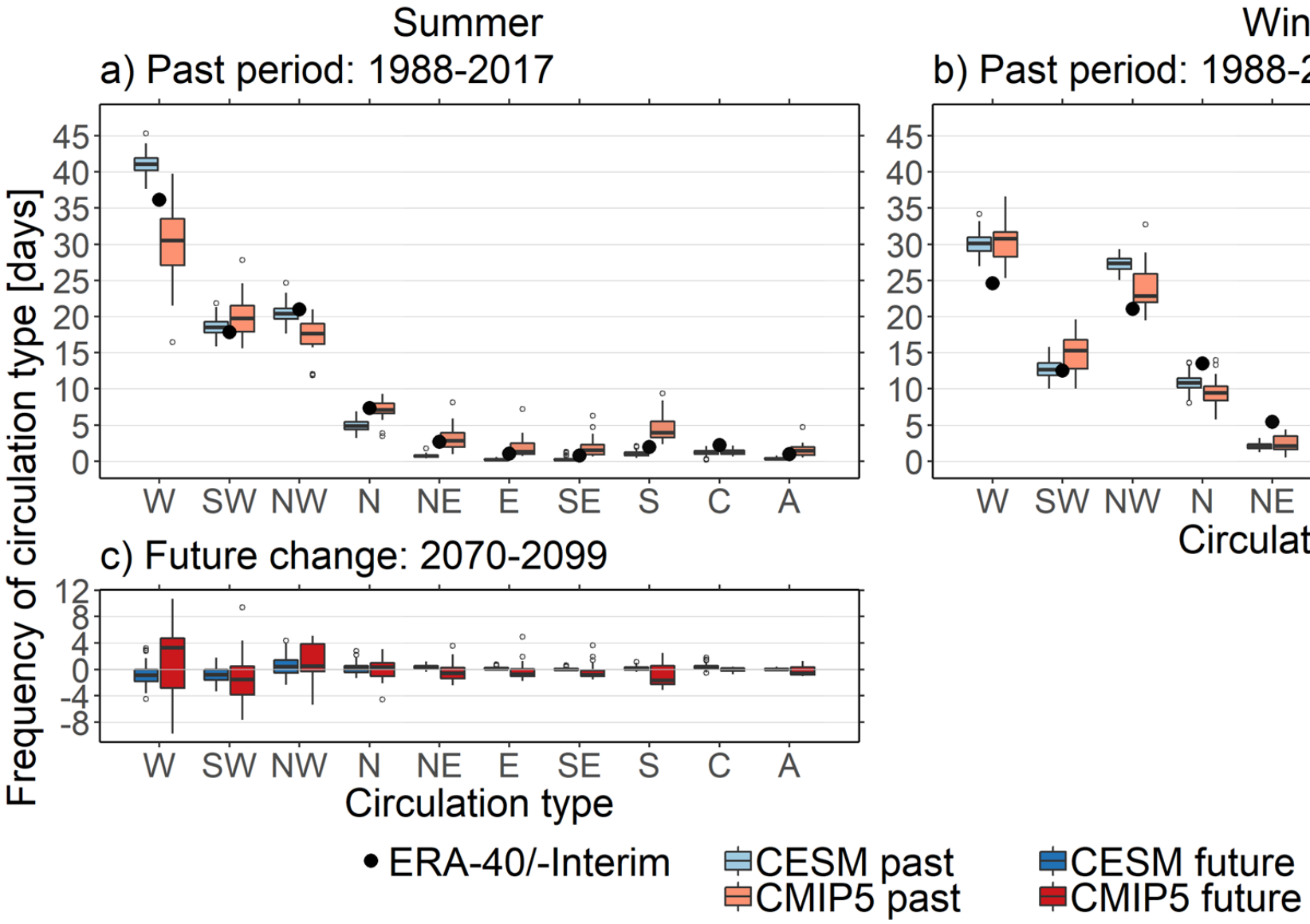
Changes in Frequency



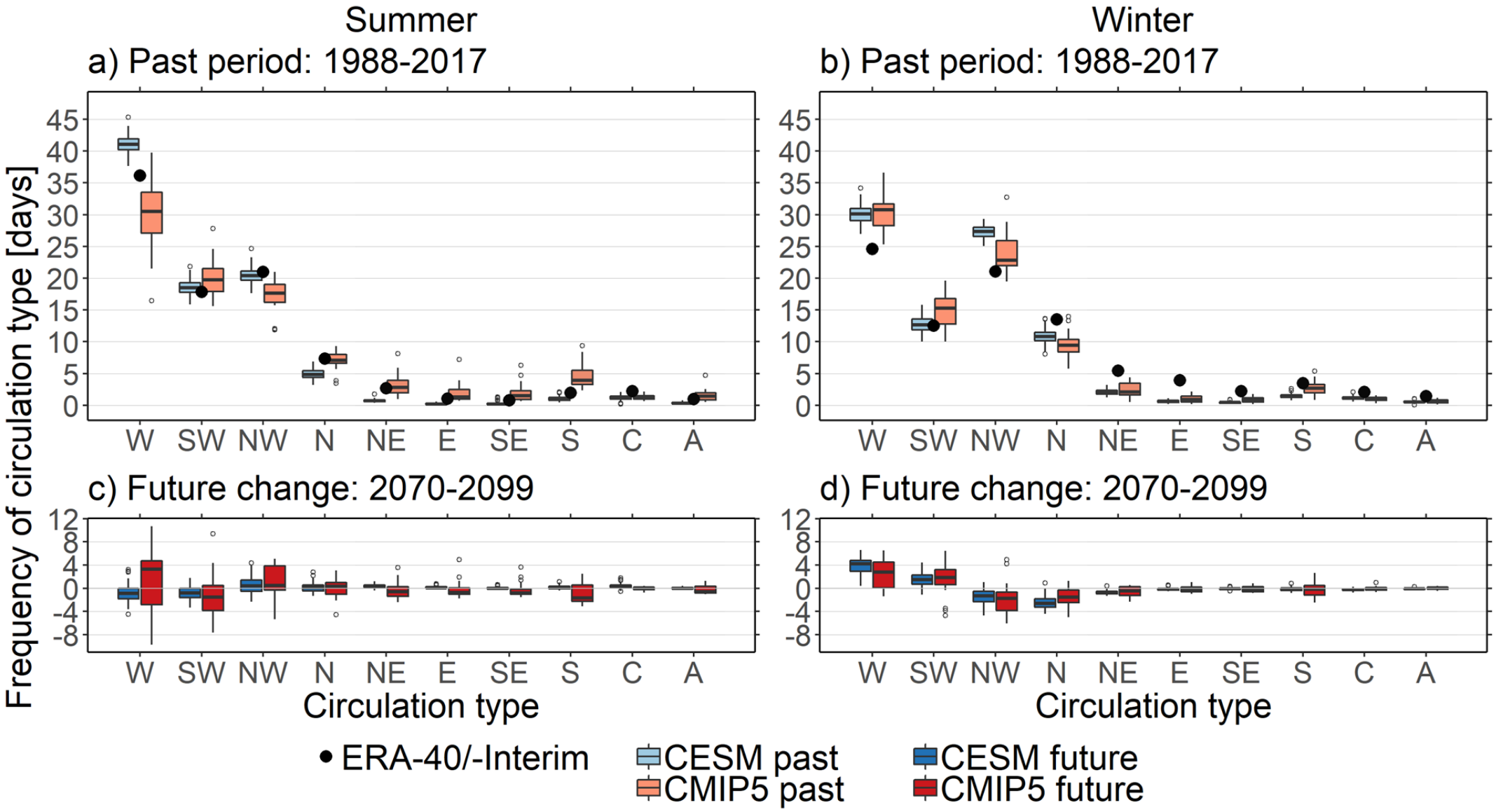
Changes in Frequency



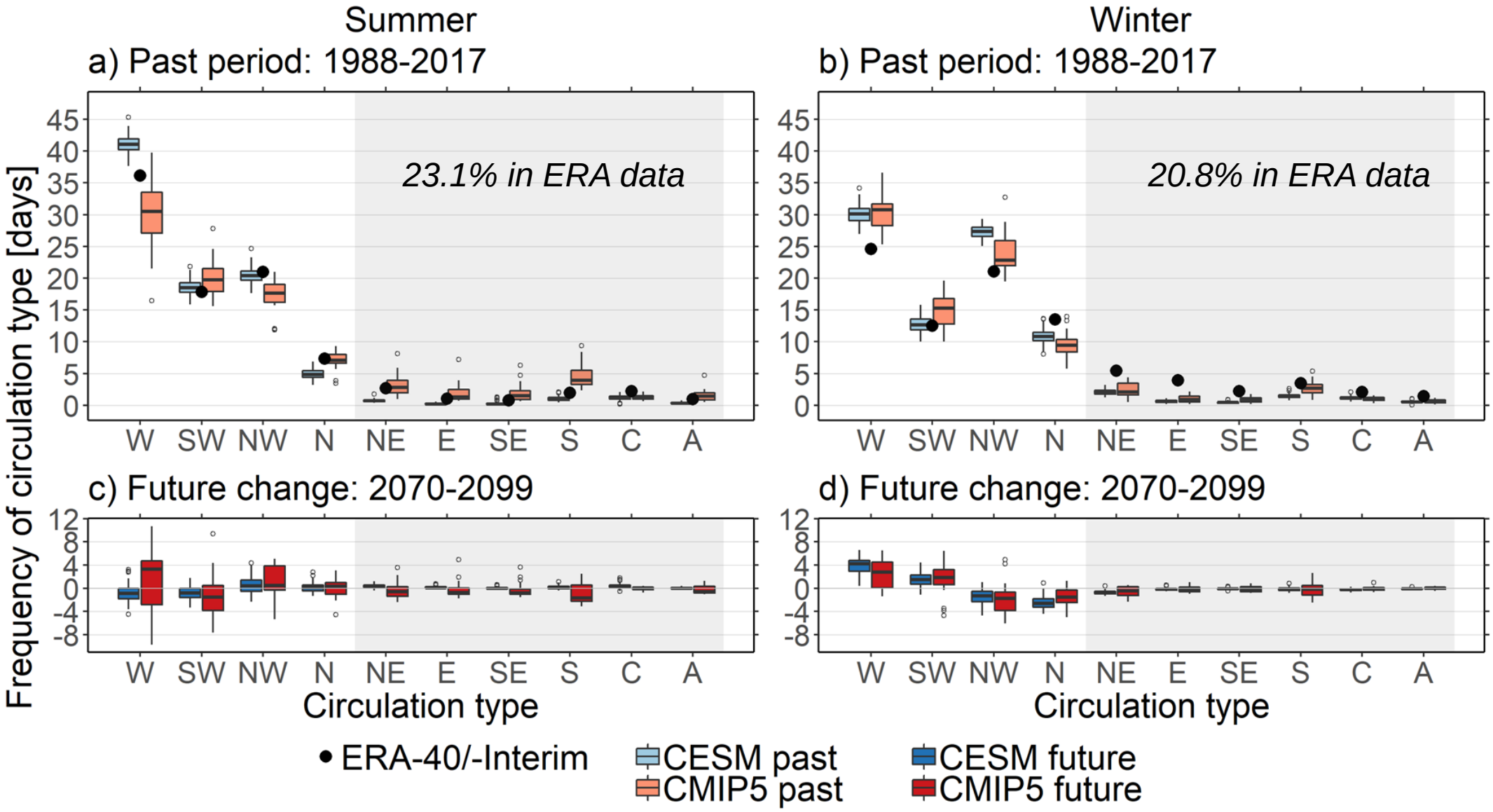
Changes in Frequency



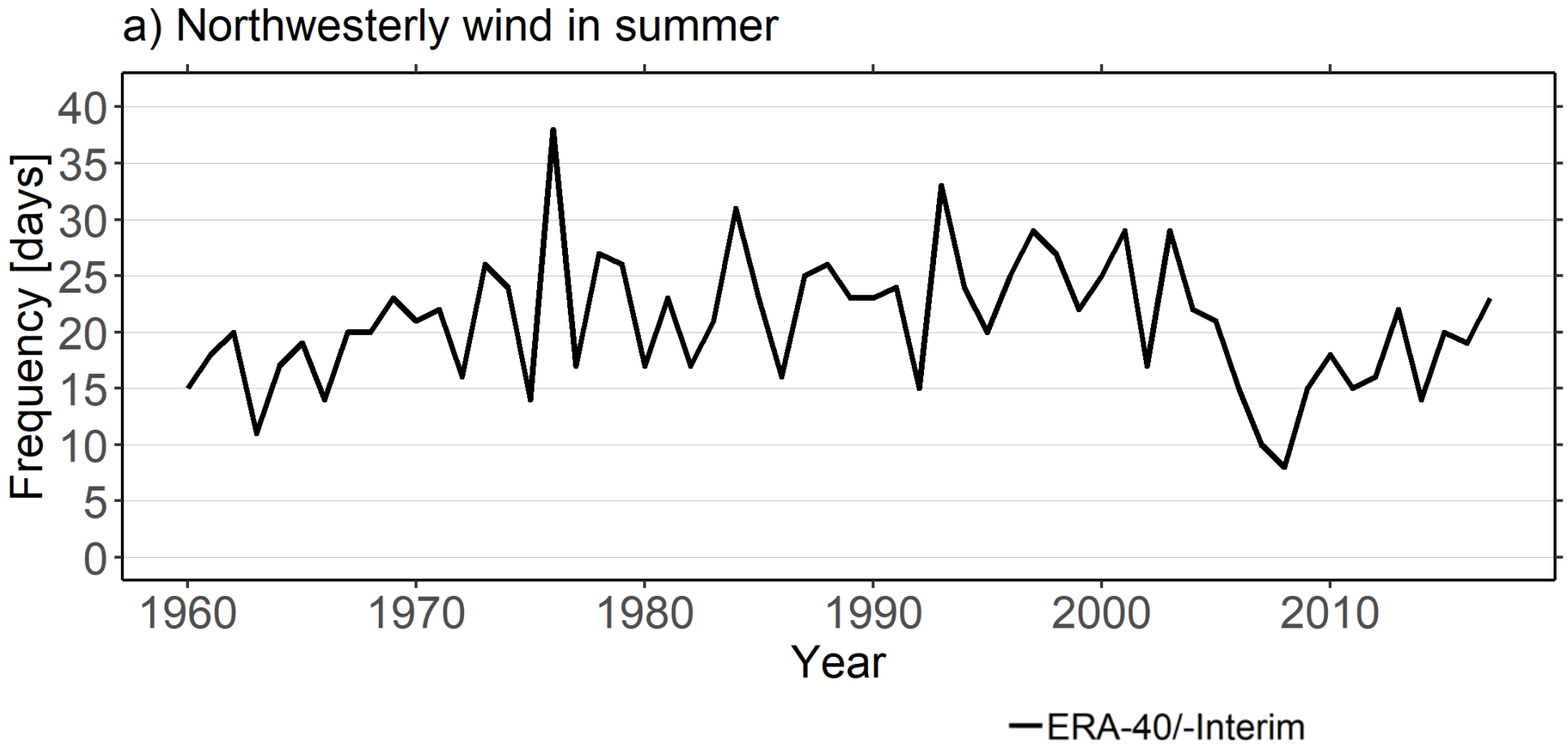
Changes in Frequency



Changes in Frequency



Time Series and Trends



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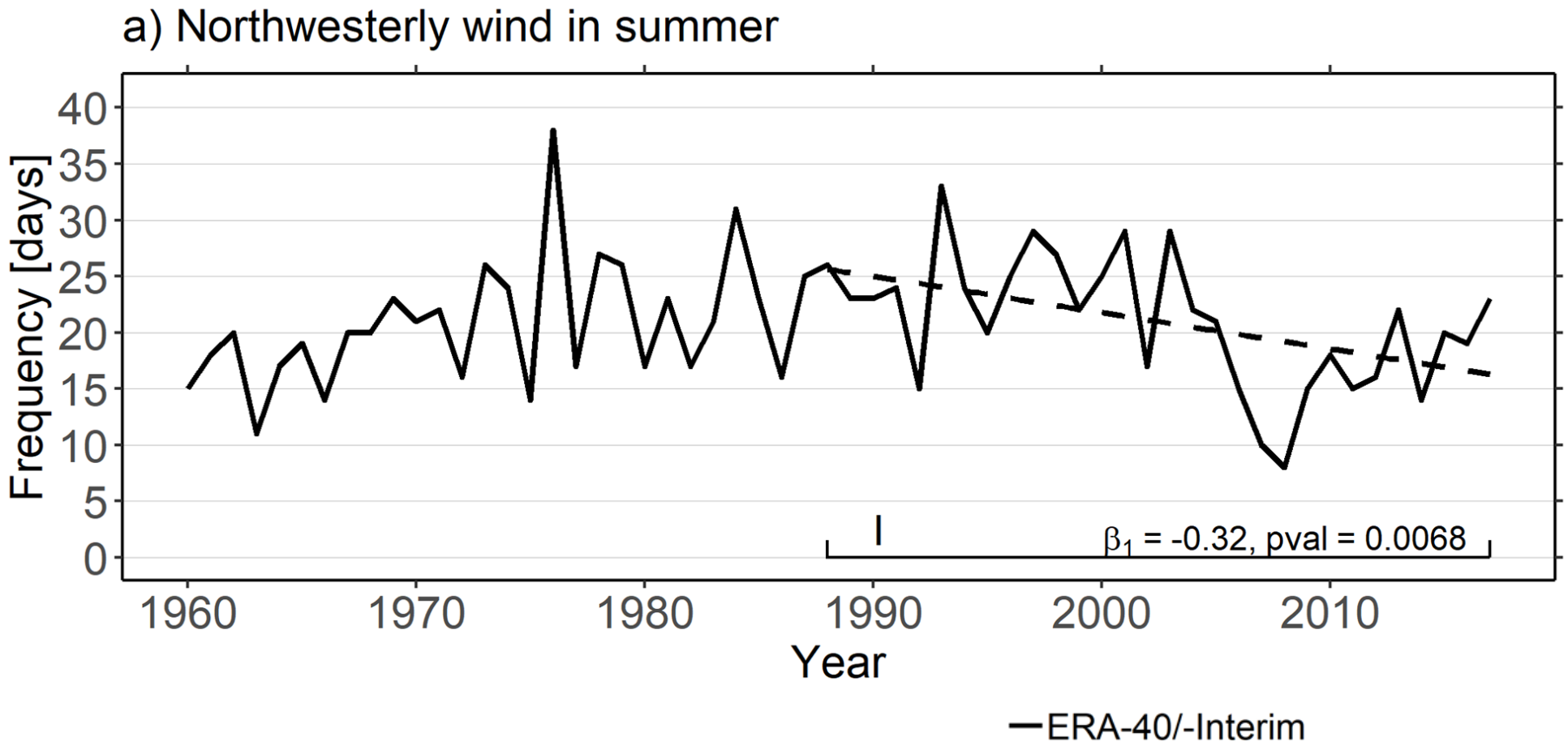
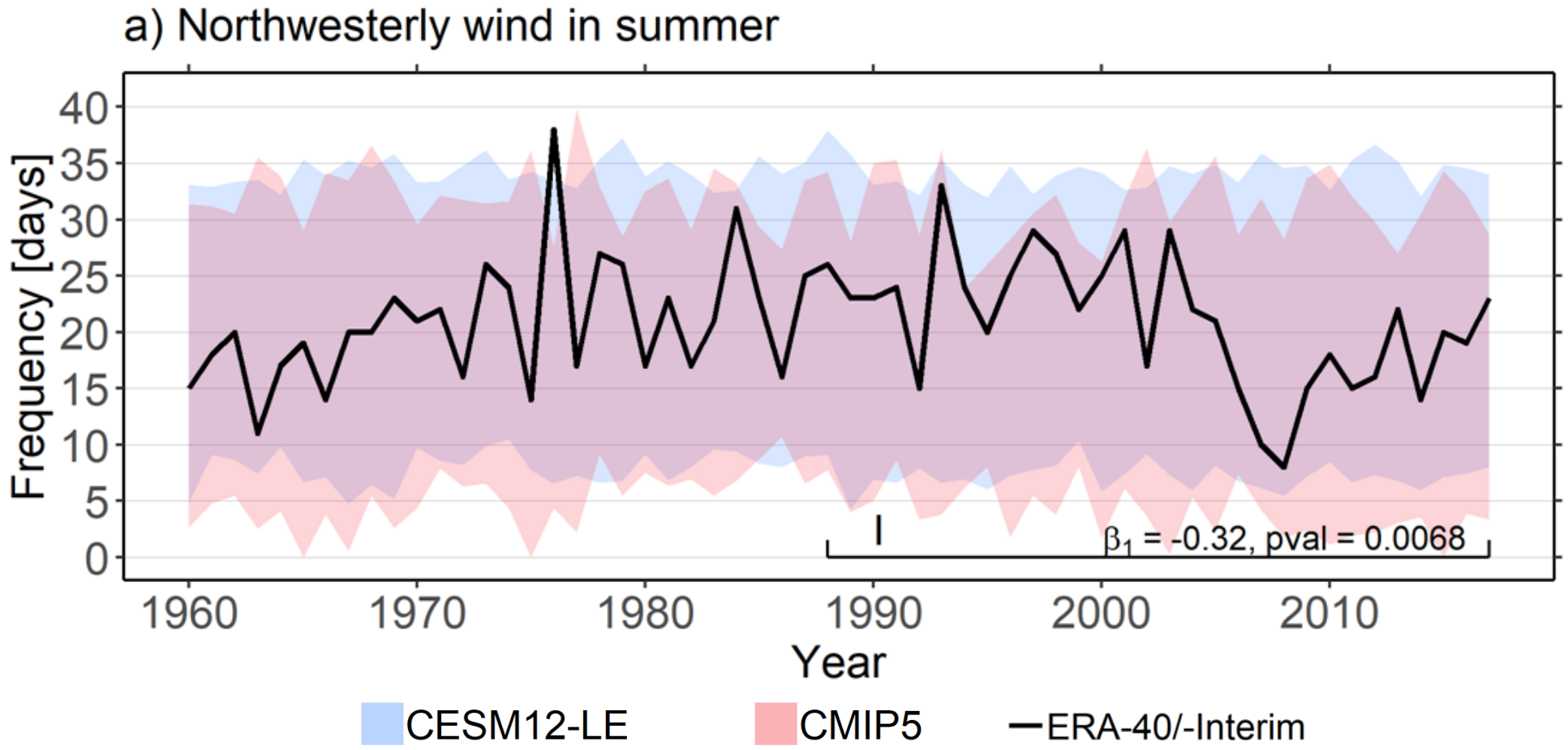
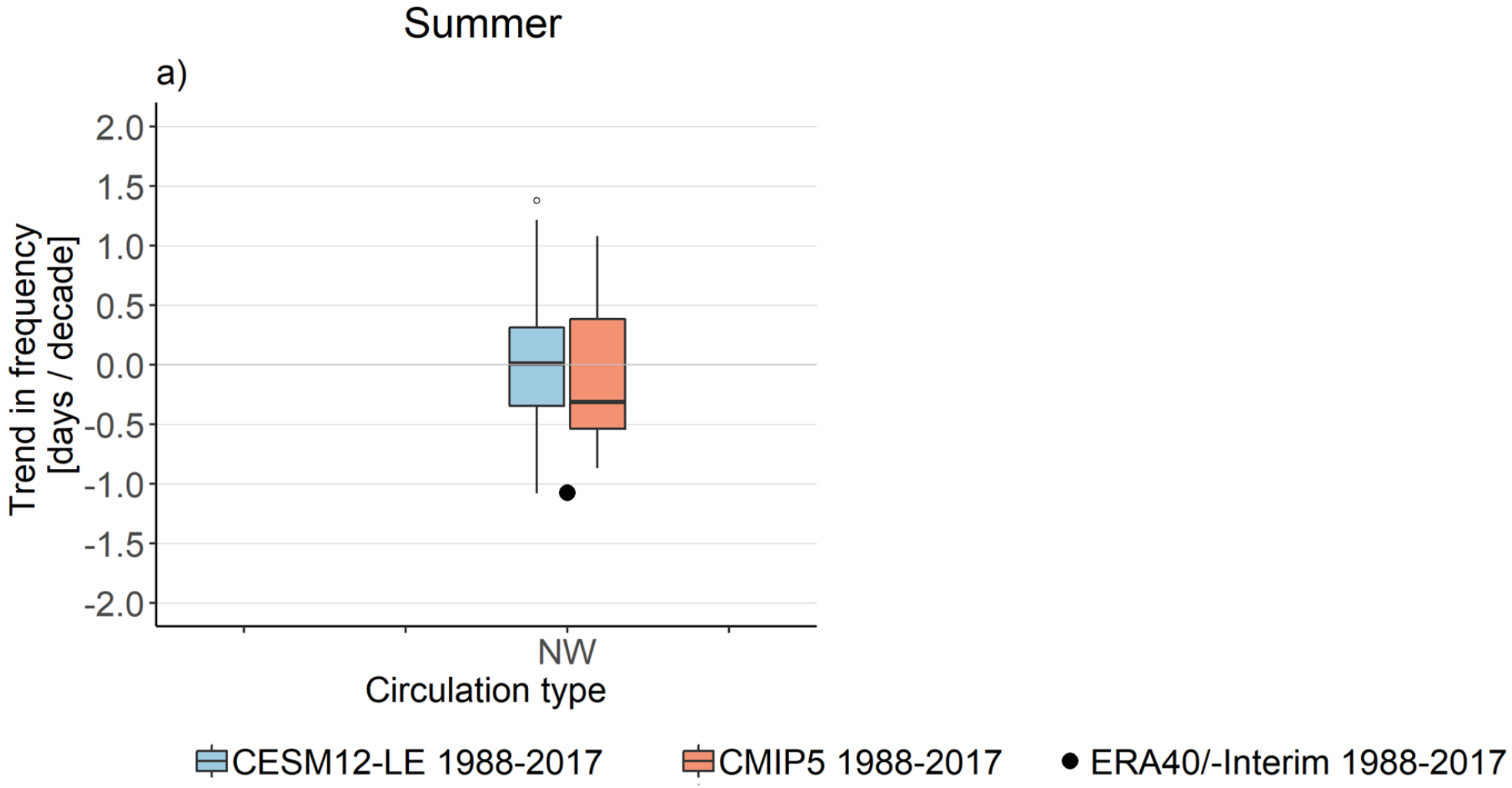


Time Series and Trends



Trends of the Past Period



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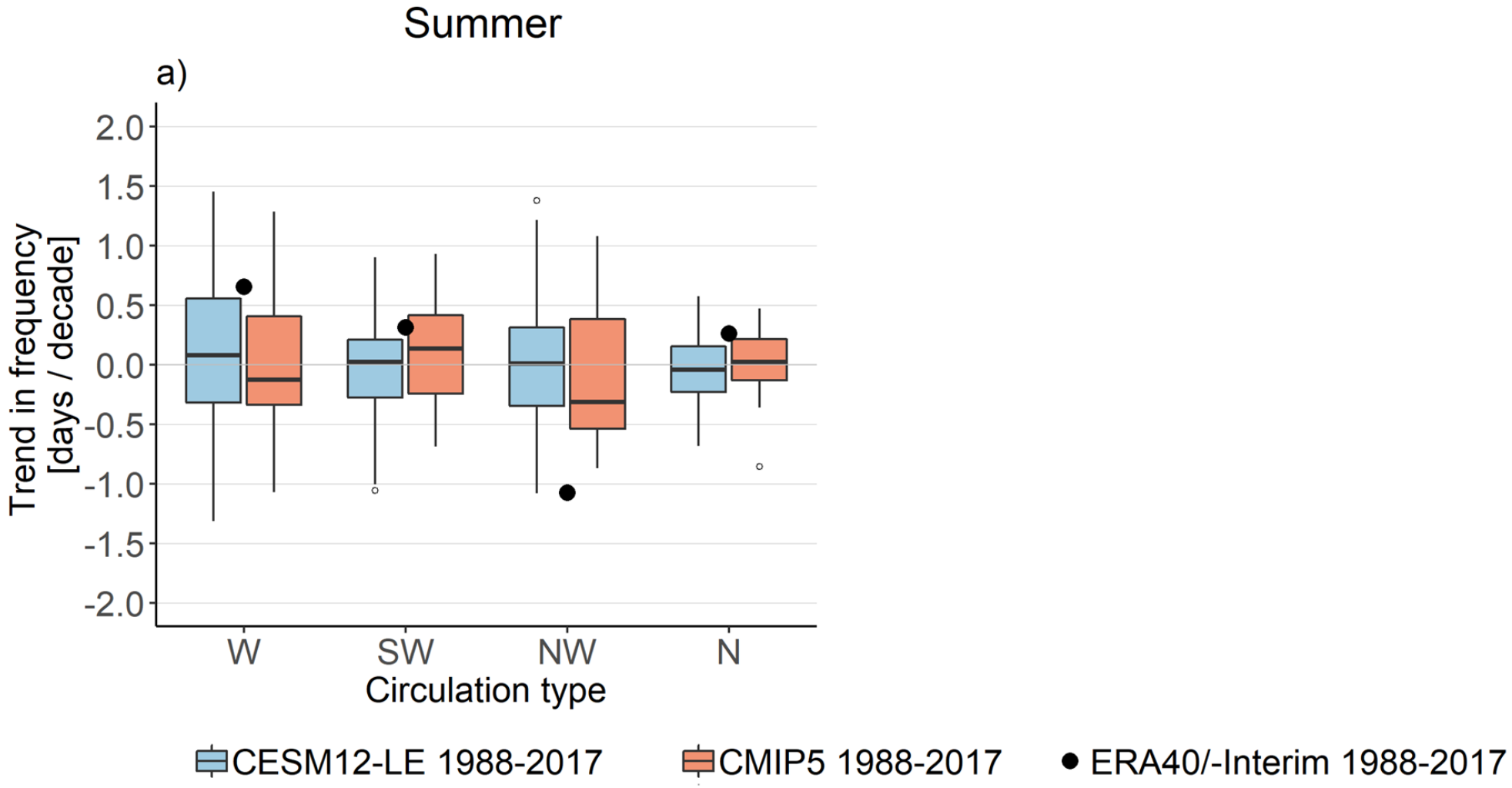
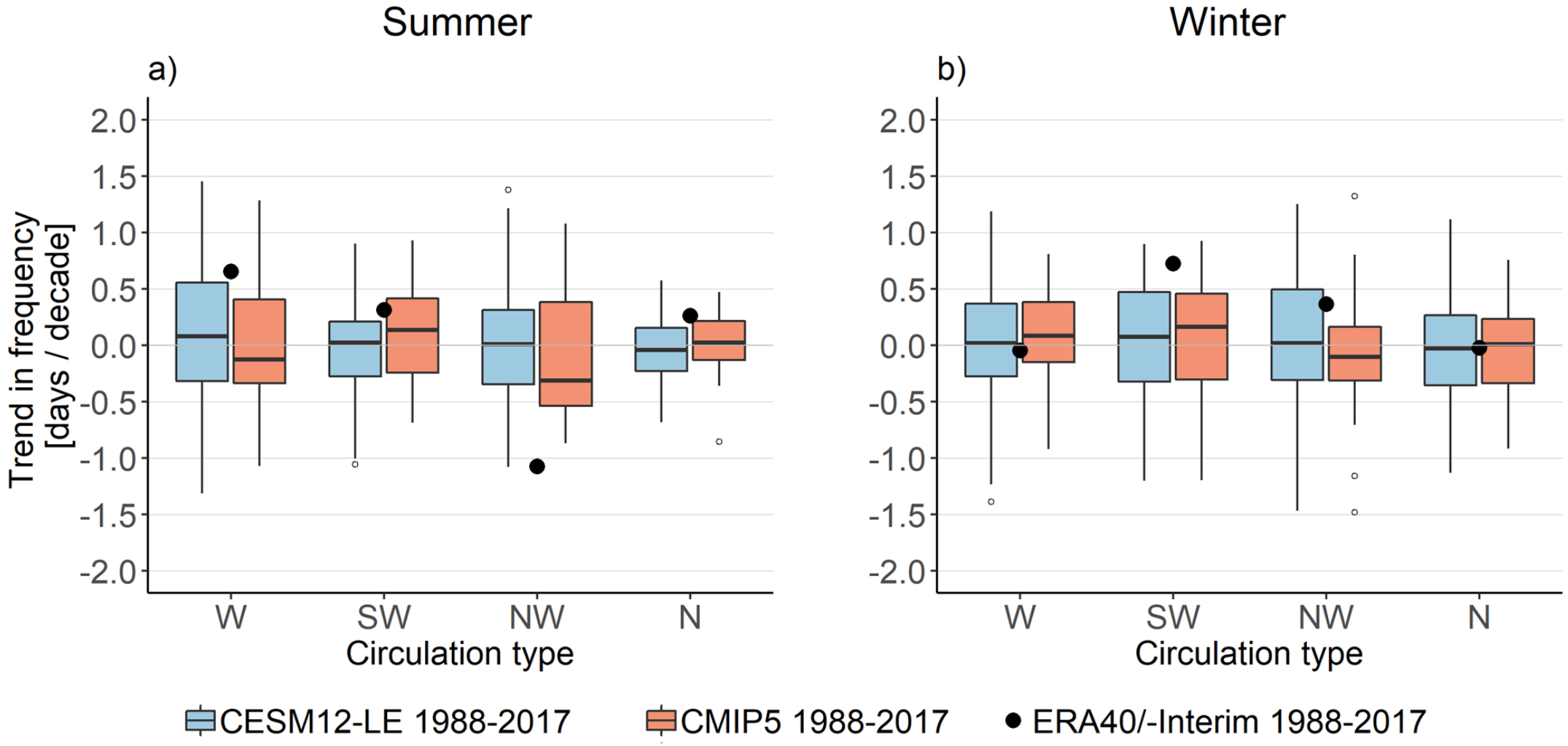


Trends of the Past Period



Maps: 1988-2017

z500 & SAT_a

Summer

CESM

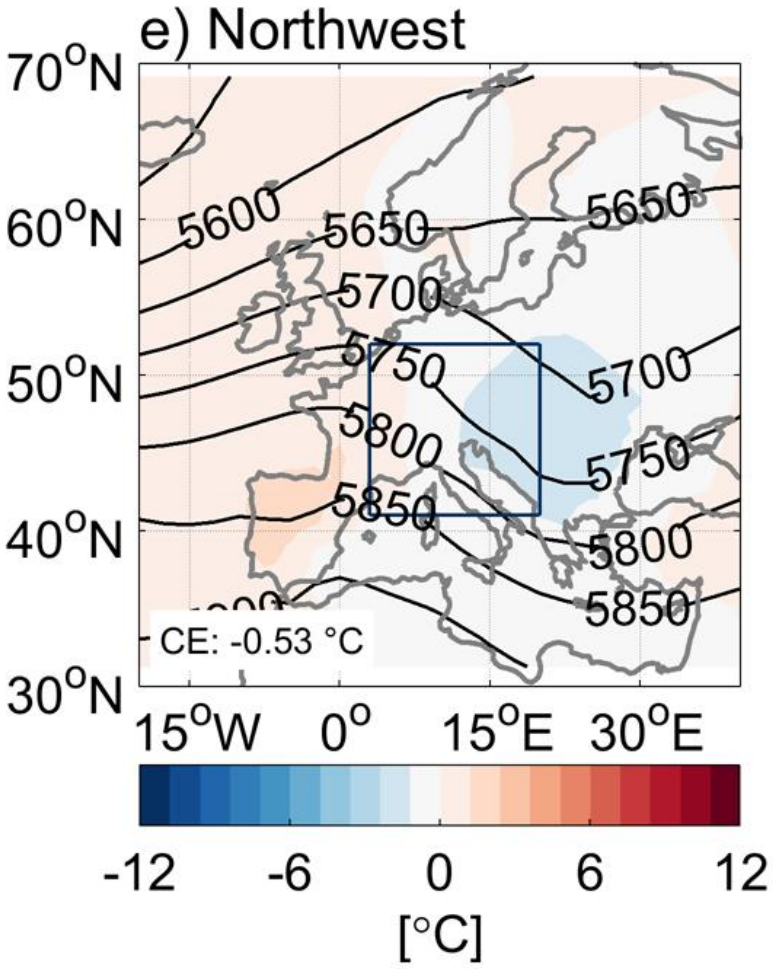
CMIP5

Maps: 1988-2017

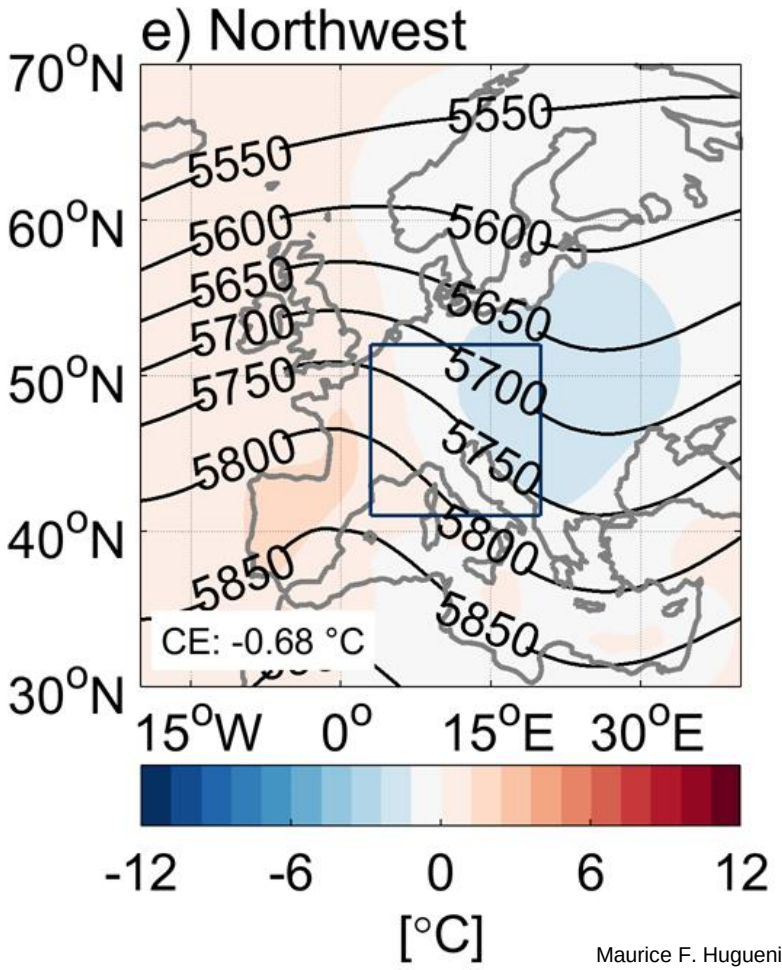
z500 & SAT_a

Summer

CESM



CMIP5

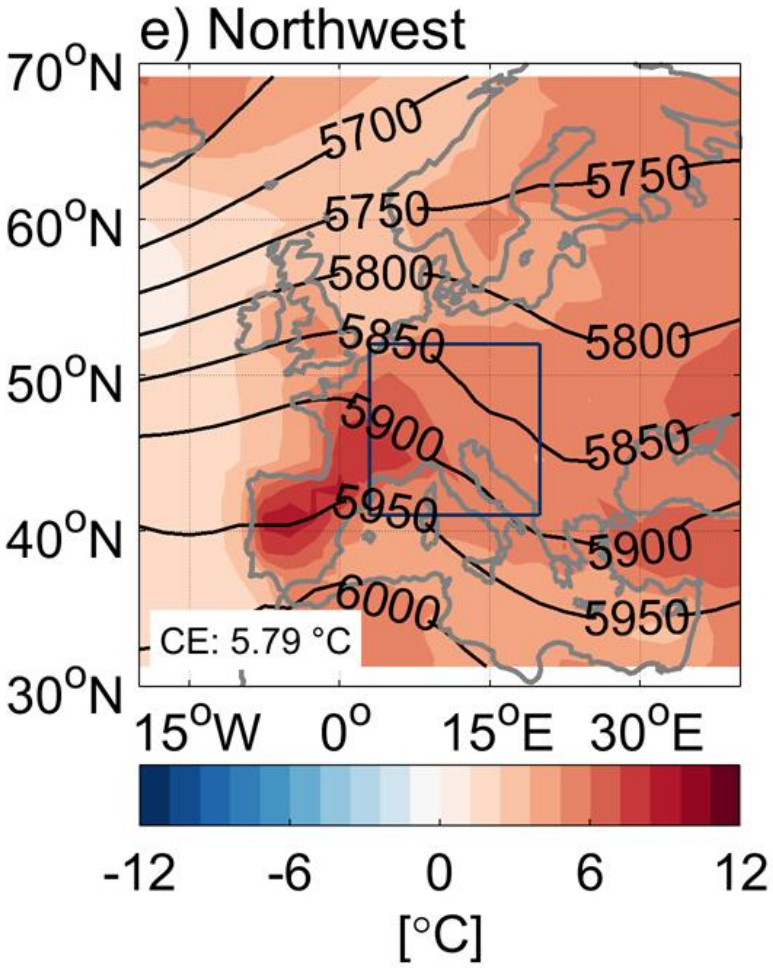


Maps: 2070-2099

z500 & SAT_a

Summer

CESM



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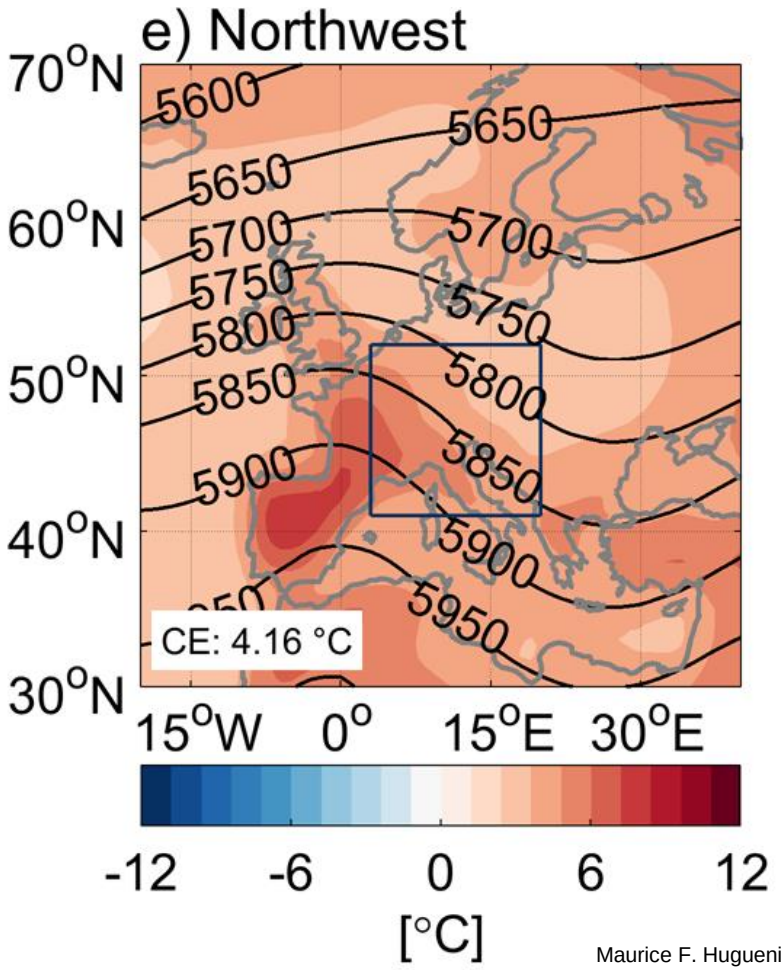

Changes in the Persistency

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How frequent are consecutive periods of the same circulation type?

How does the length of these change?

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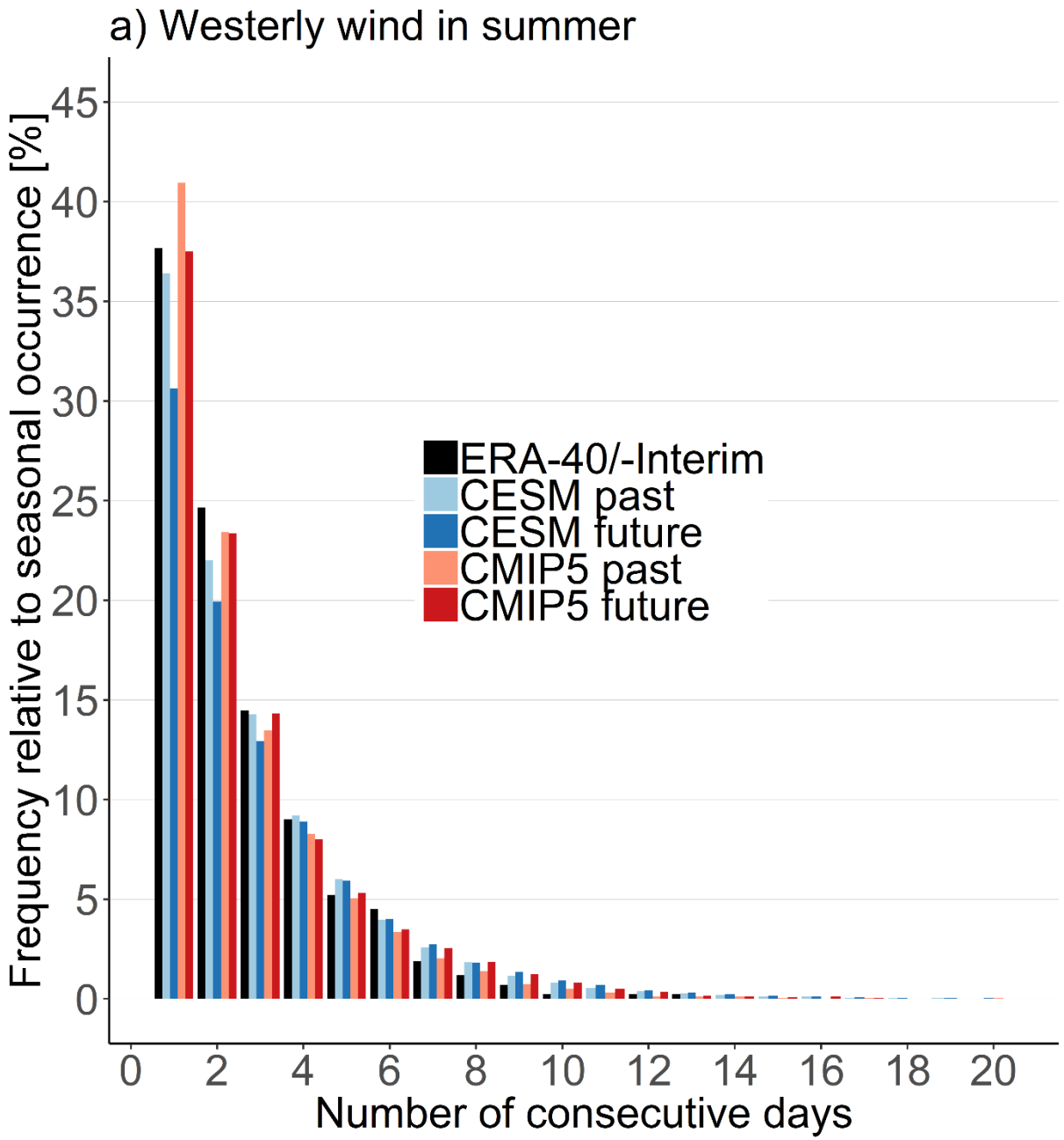

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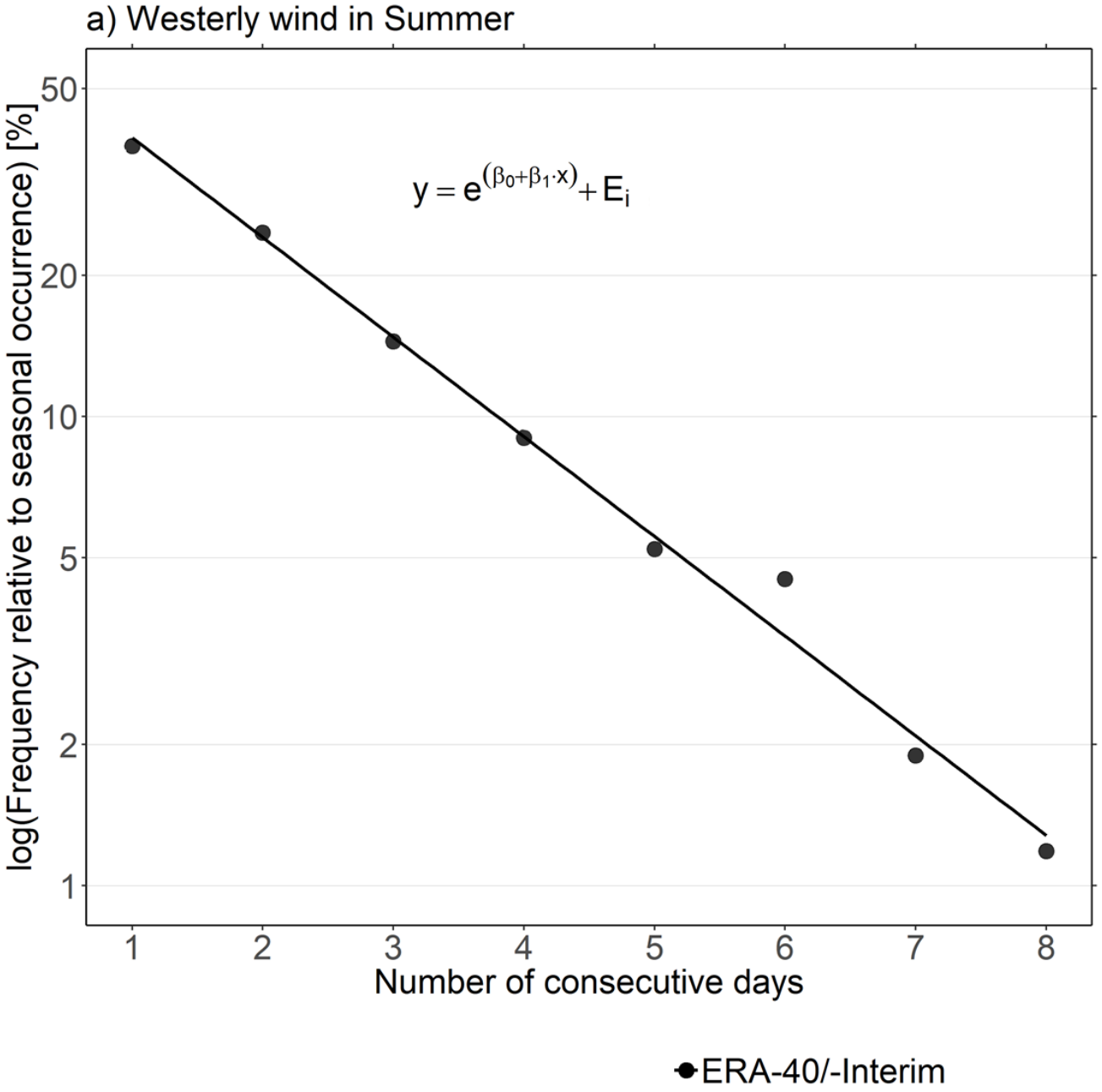
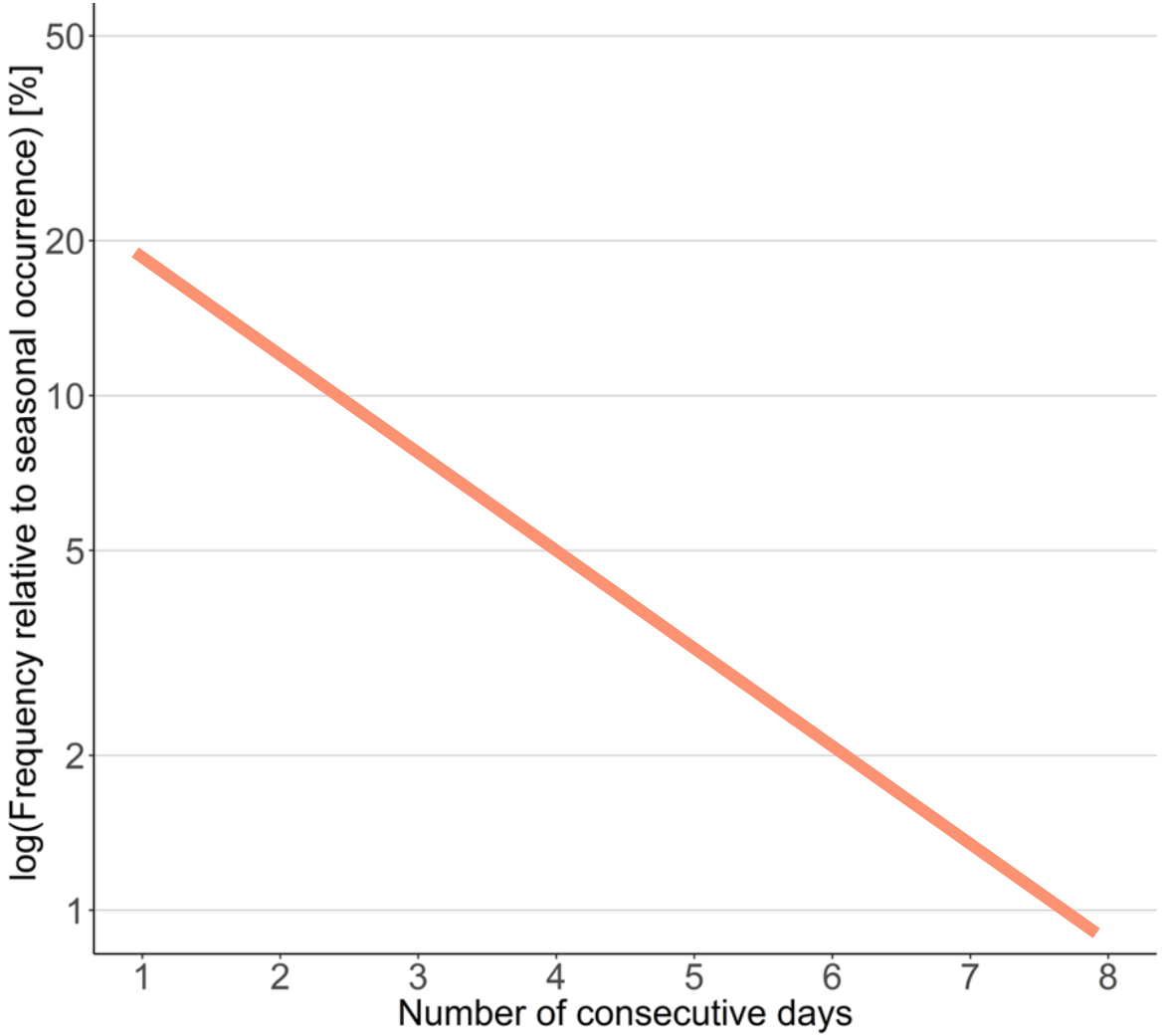


Changes to the Slope

CMIP5 past → CMIP5 future



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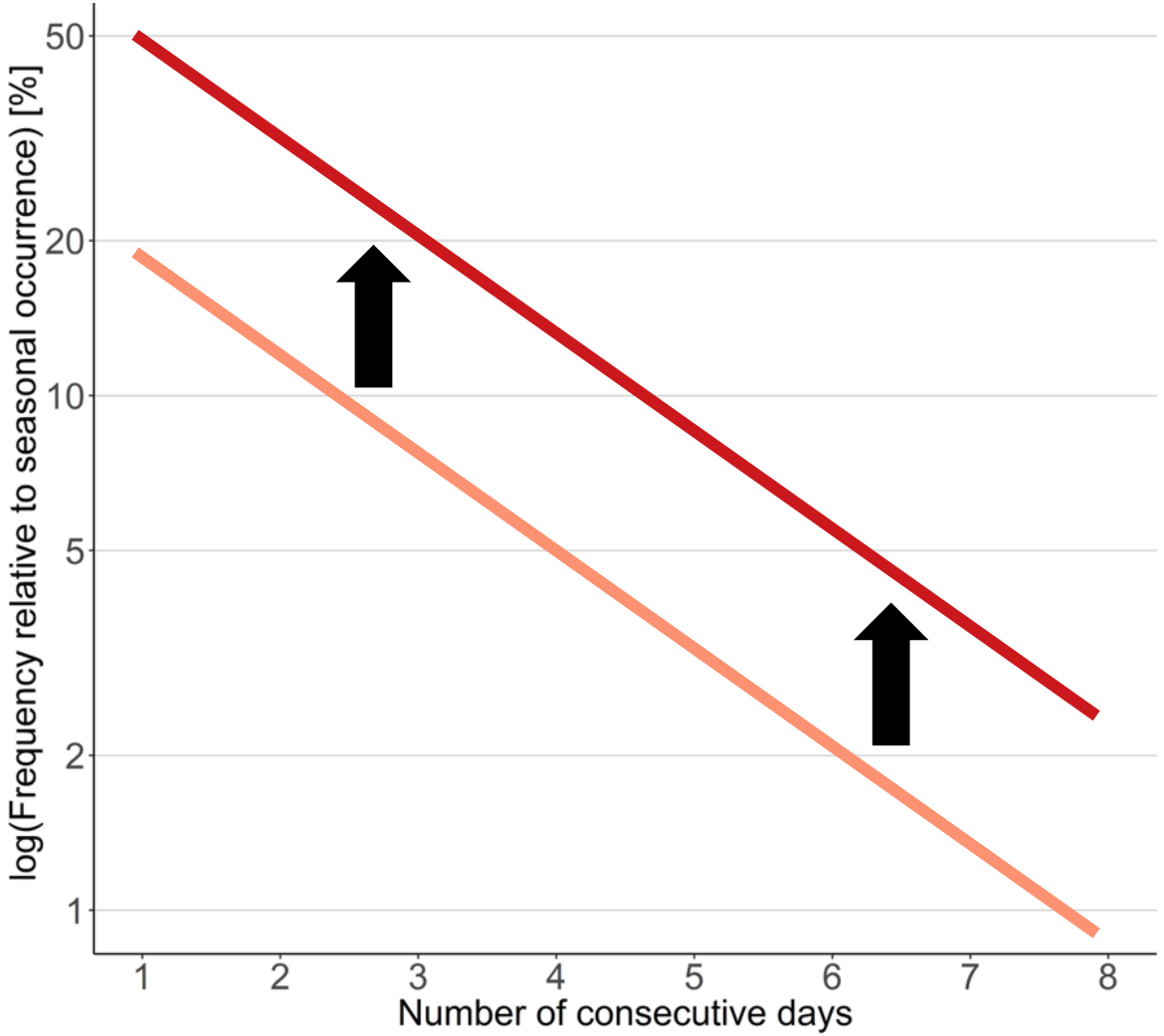

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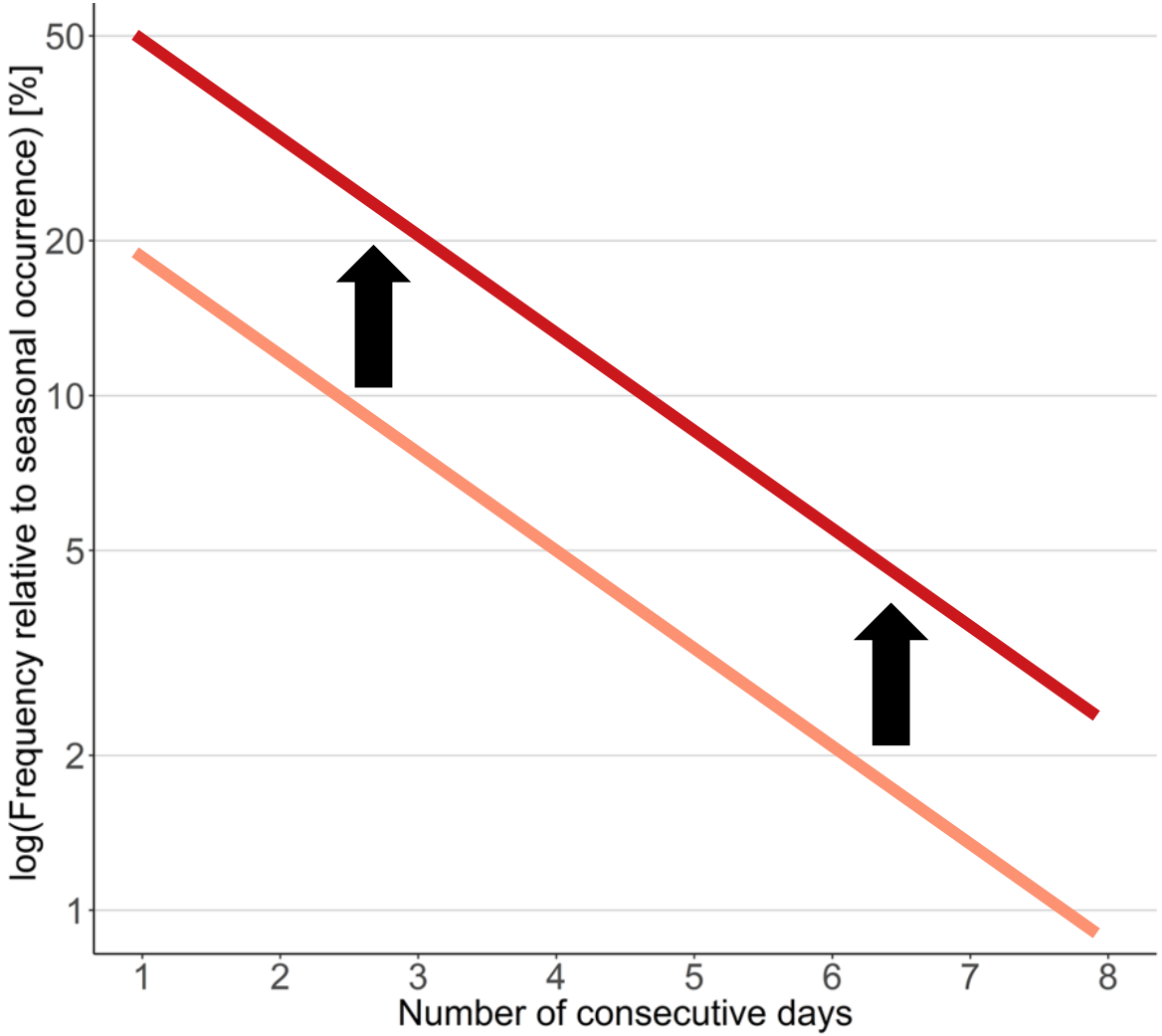

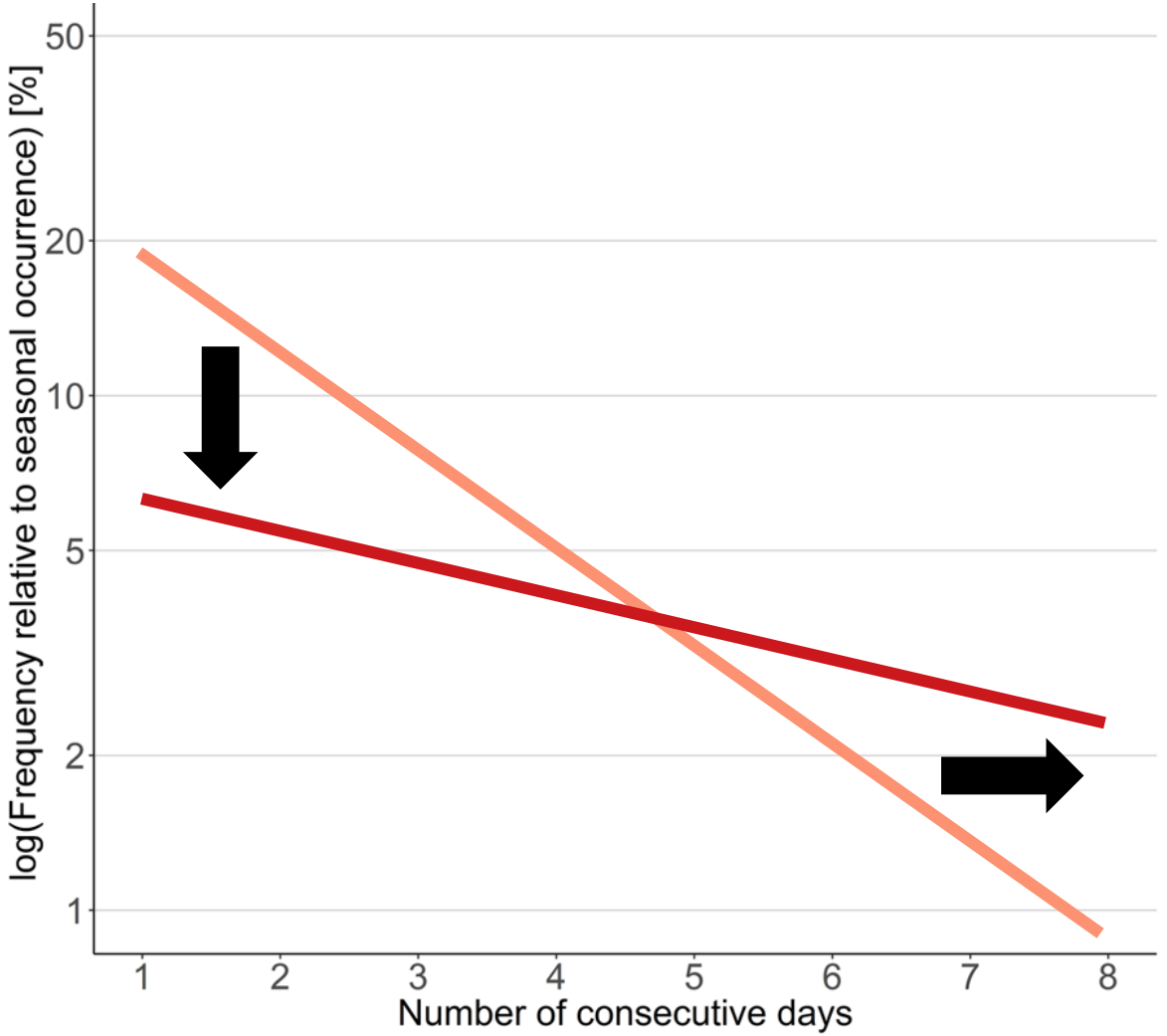

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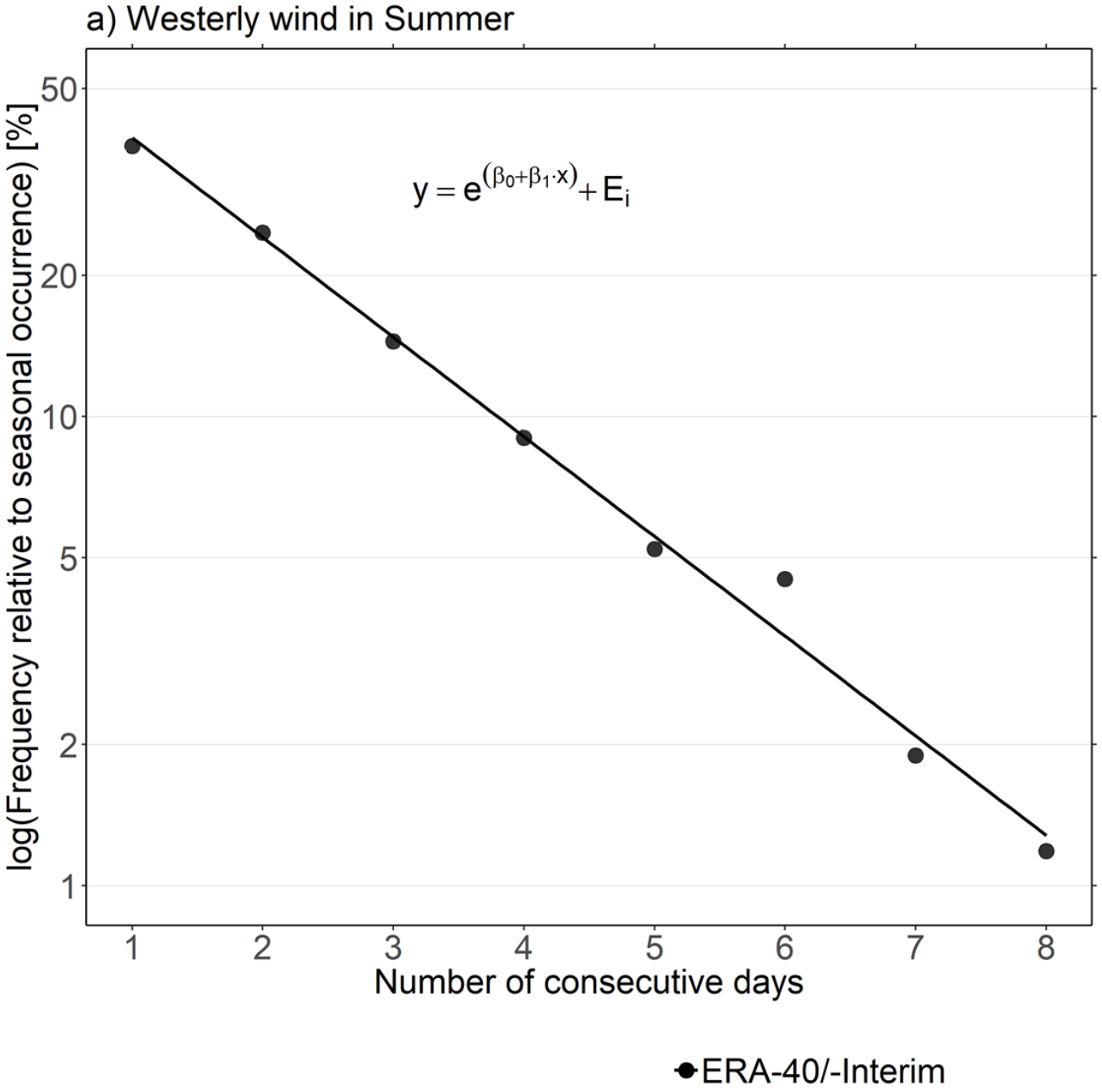

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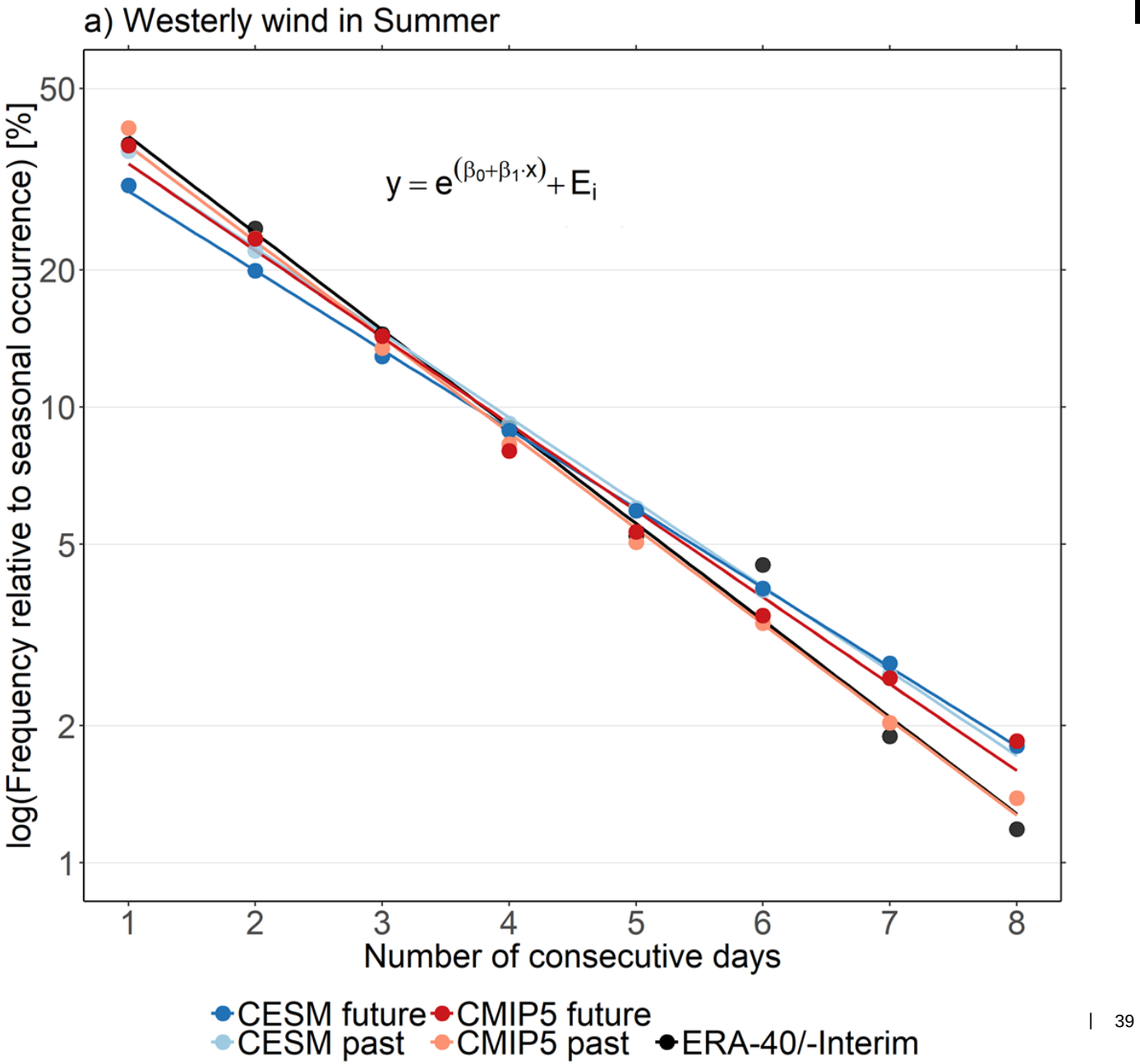

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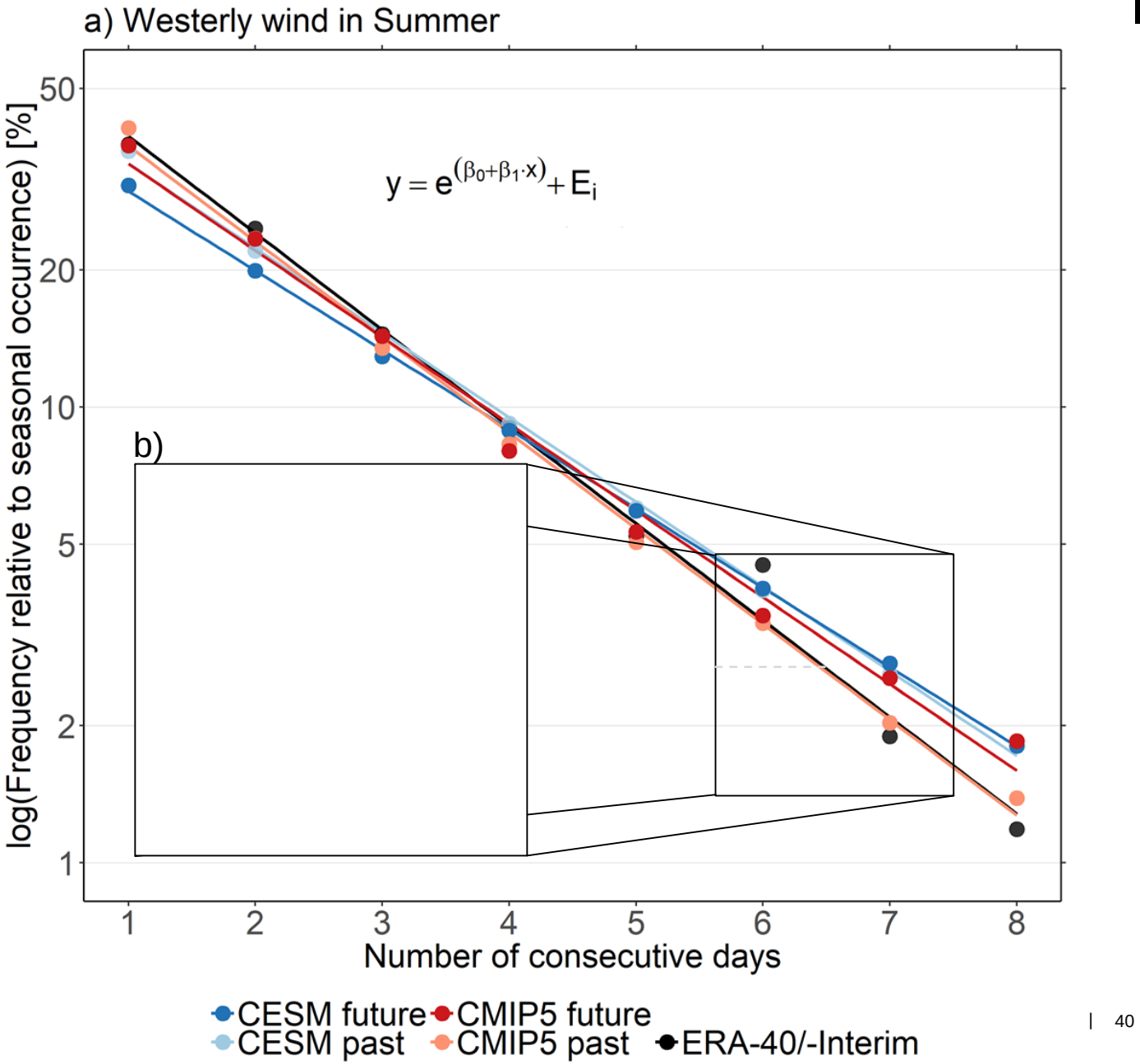

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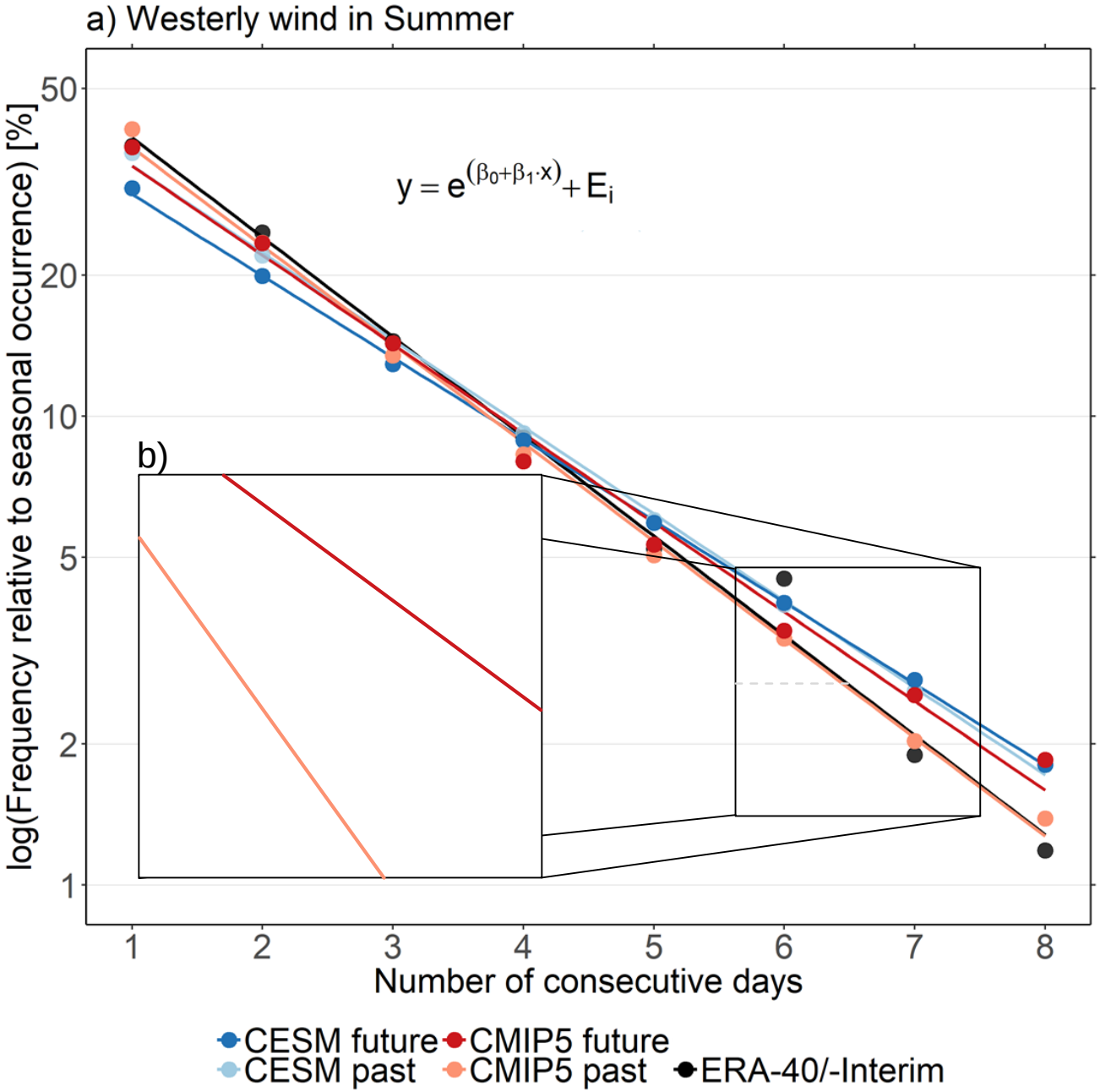

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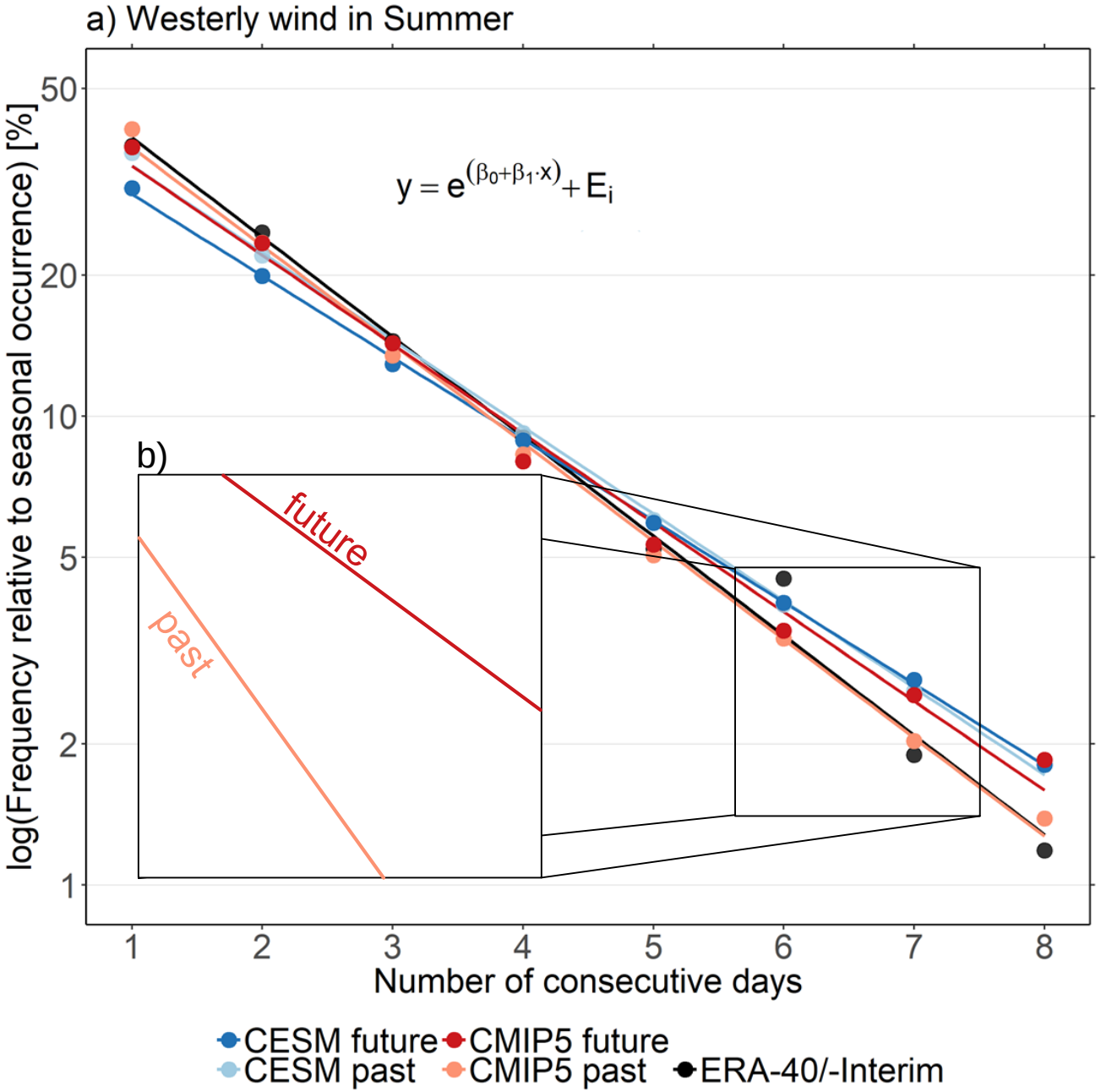
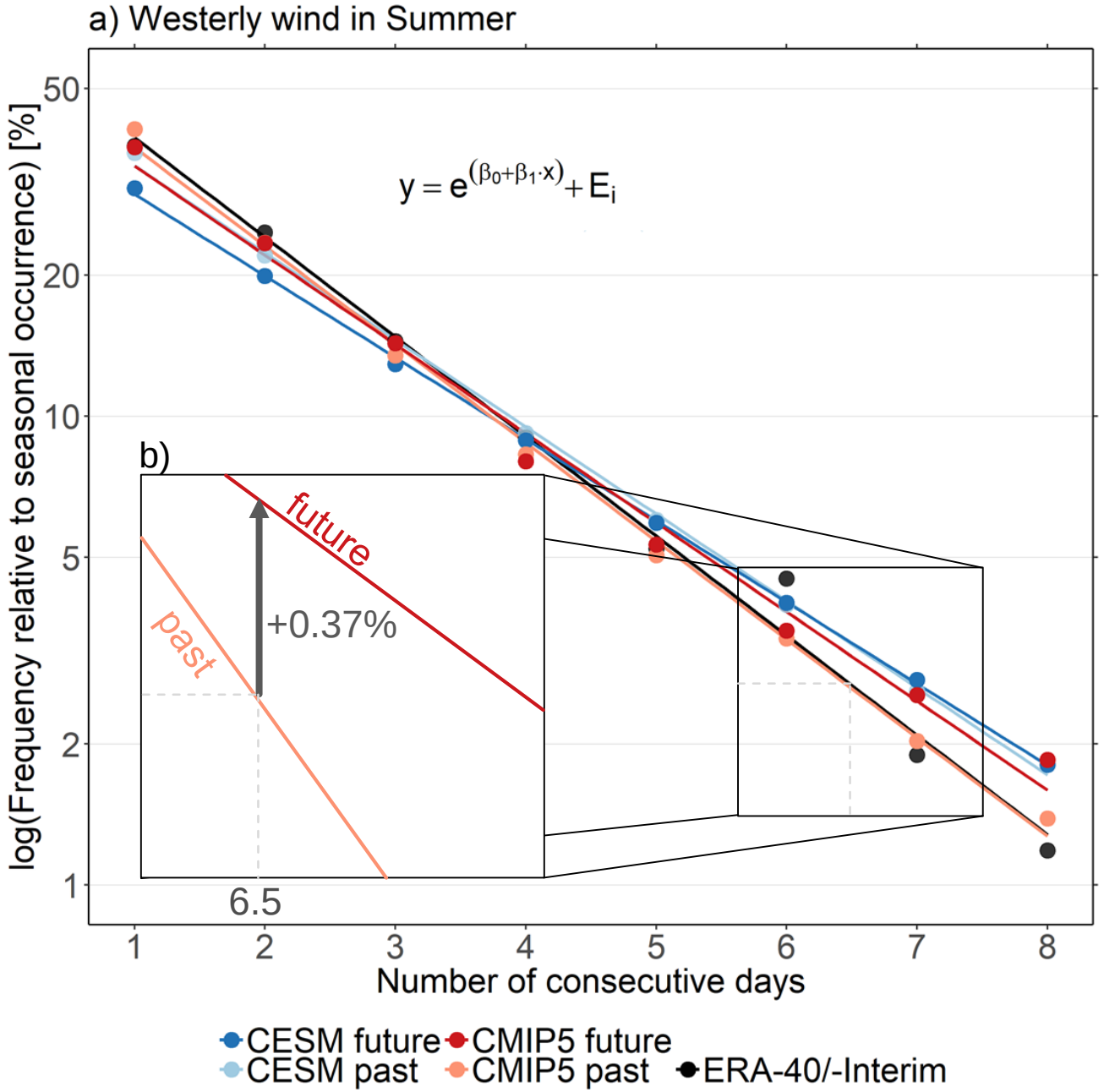


Changes in the Persistency

CMIP5 past → CMIP5 future

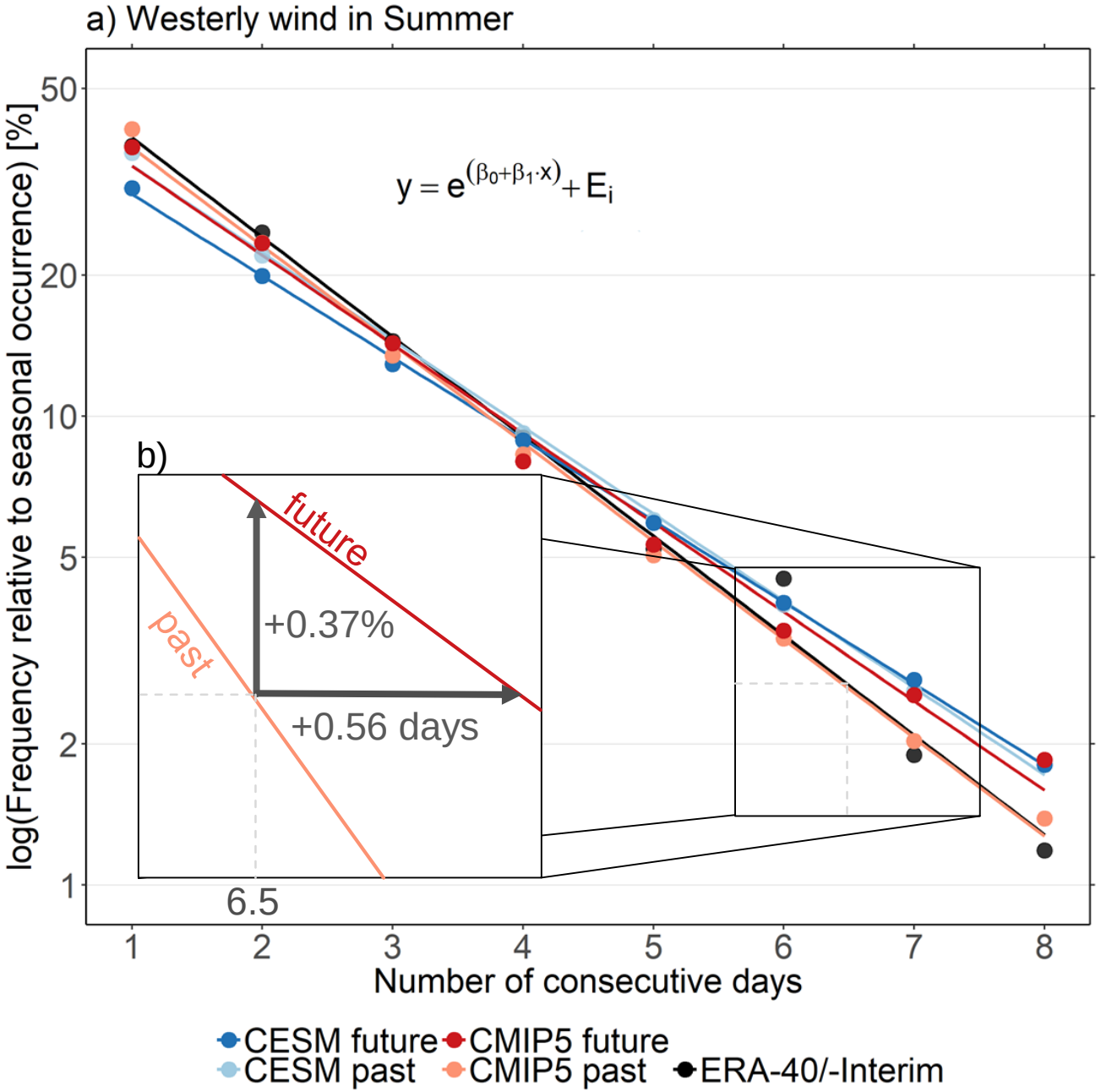
- increases in frequency by 0.3%



Changes in the Persistency

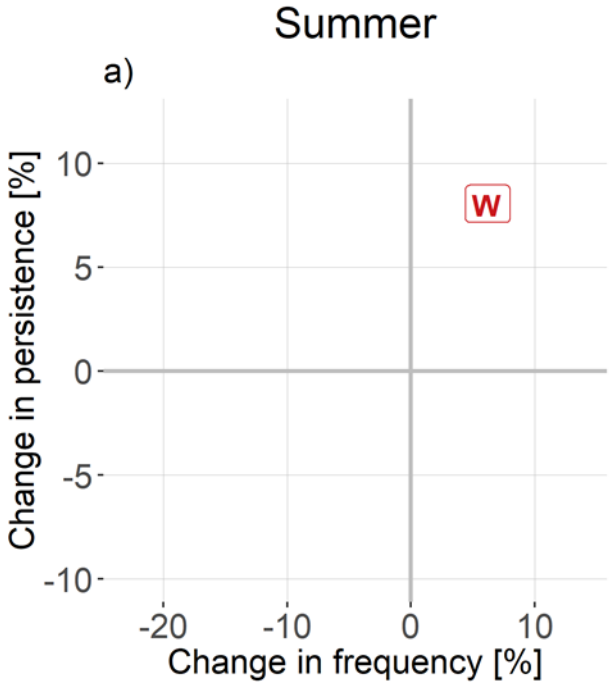
CMIP5 past → CMIP5 future

- increases in frequency by 0.3%
- as frequent today as a 7-day period in the future

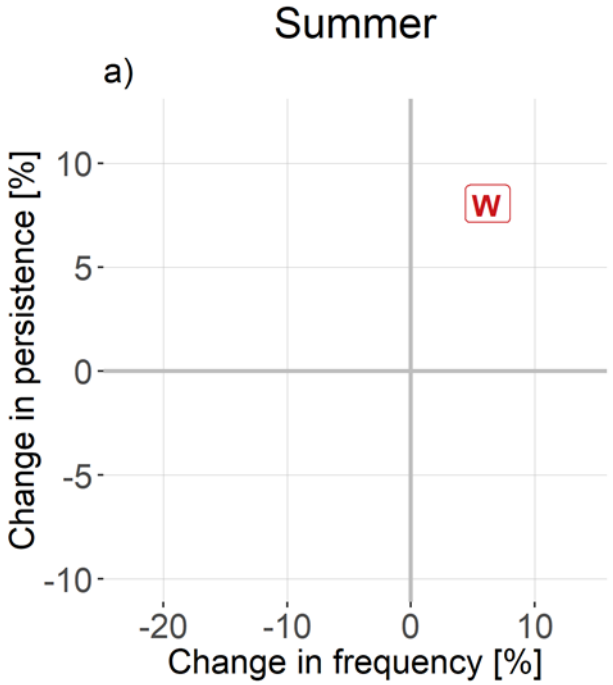


Summary Figure

CMIP5 future



Summary Figure



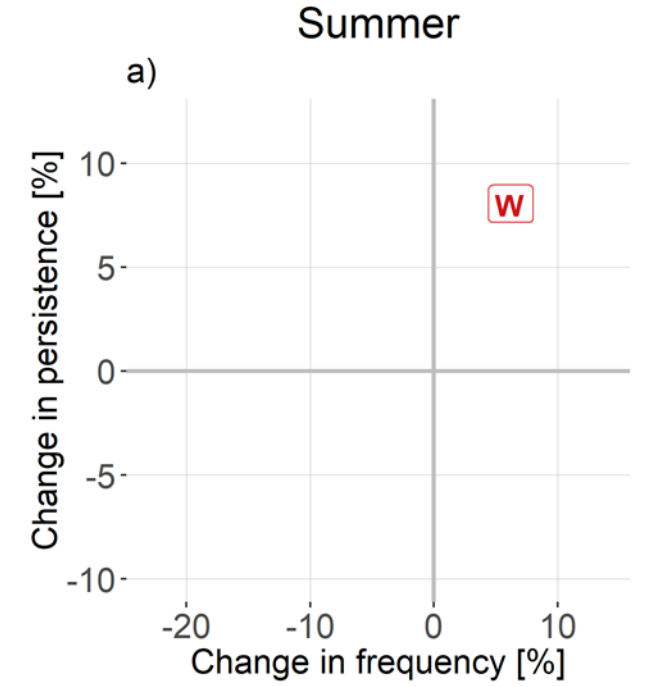
CMIP5 future

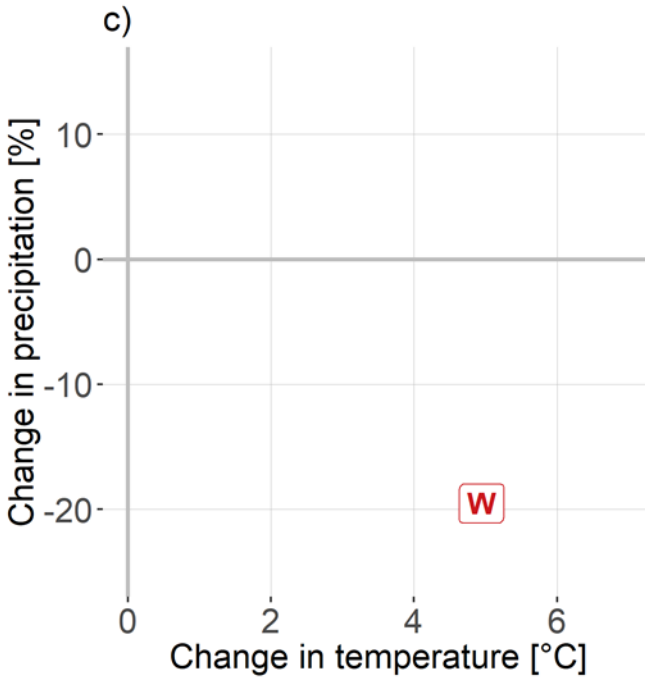
- more frequent
- more persistent

Summary Figure

CMIP5 future

- more frequent
- more persistent

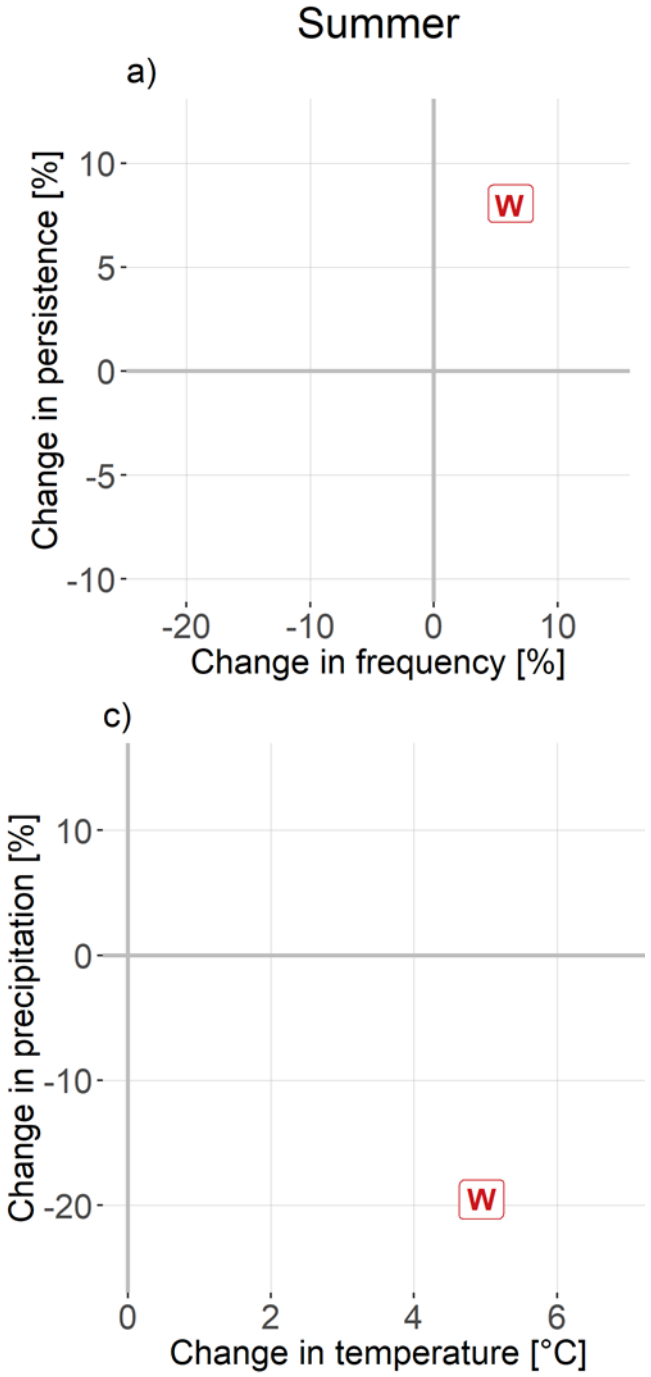




Summary Figure

CMIP5 future

- more frequent
- more persistent
- drier
- warmer

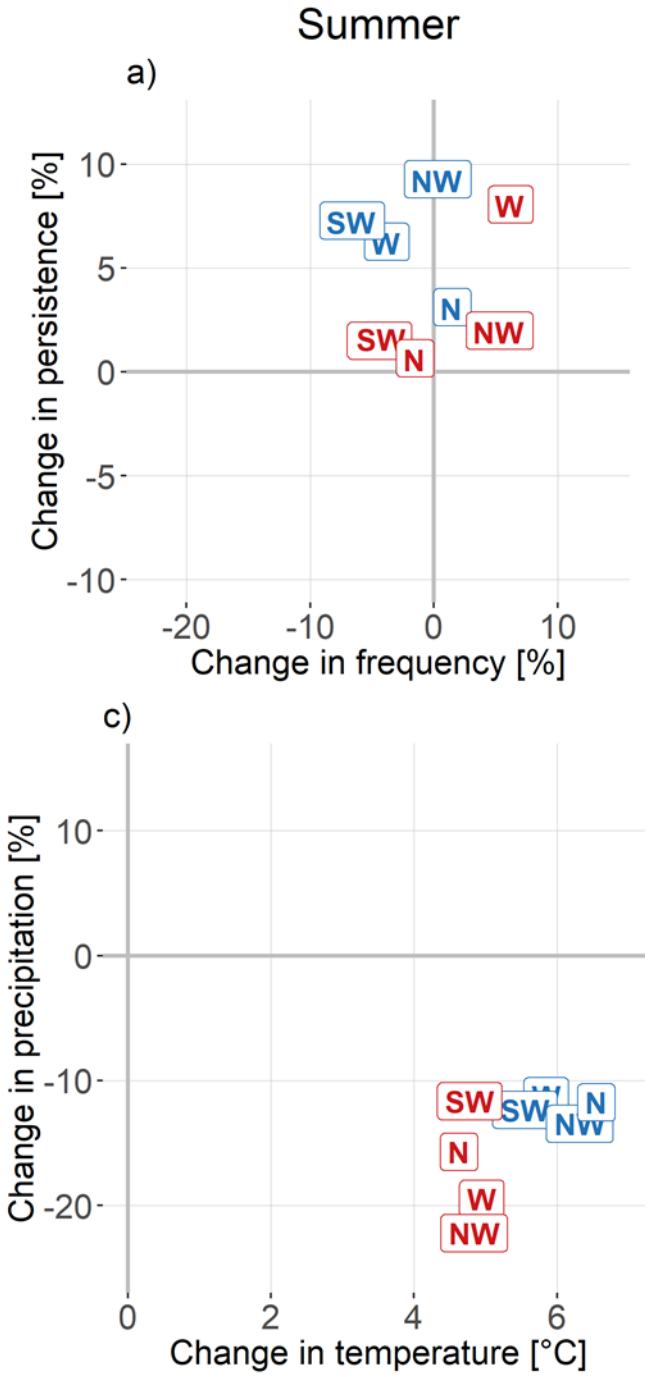


Summary Figure

CESM future

CMIP5 future

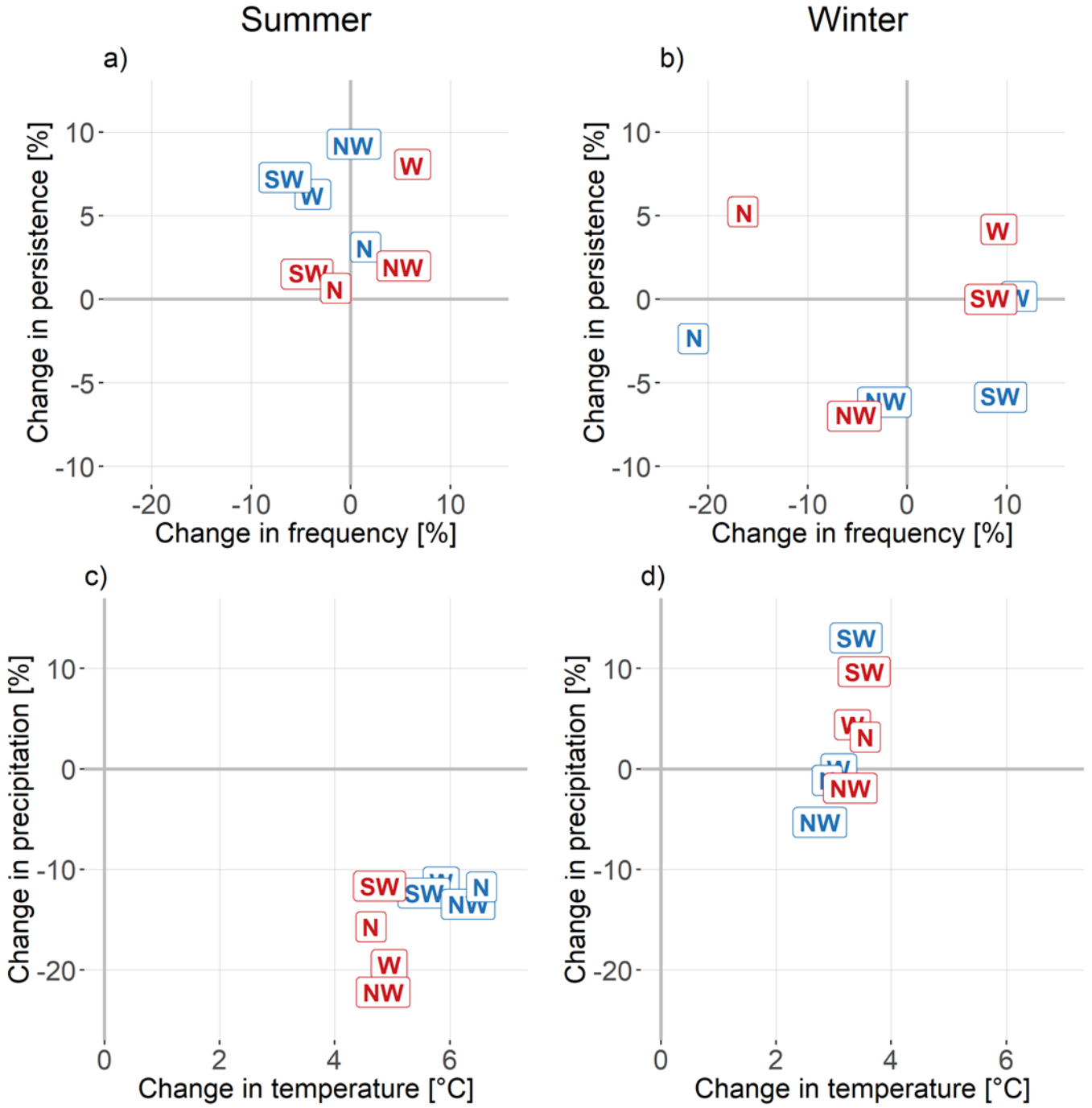
- more persistent
- drier
- warmer



Summary Figure

CESM future

CMIP5 future



Summary of Summary Figure

- warmer and drier summer in Central Europe, independent of the circulation type

Summary of Summary Figure

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- main types (W, SW, NW and N) slightly more persistent in summer – ambiguous signal in winter

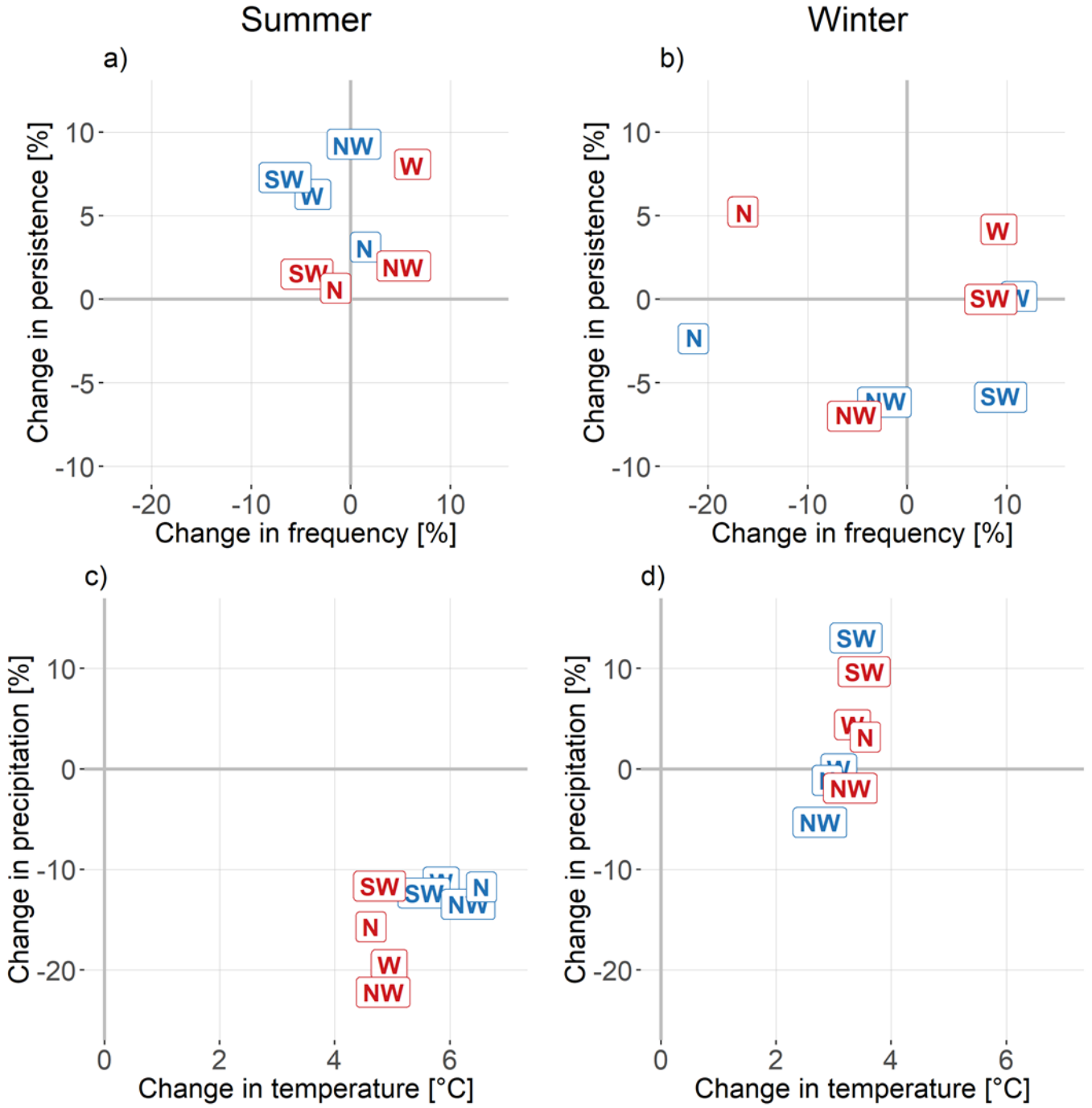
Summary of Summary Figure

- warmer and drier summer in Central Europe, independent of the circulation type
- main types (W, SW, NW and N) slightly more persistent in summer – ambiguous signal in winter
- overall projected changes consistently small & likely within internal variability

Summary Figure

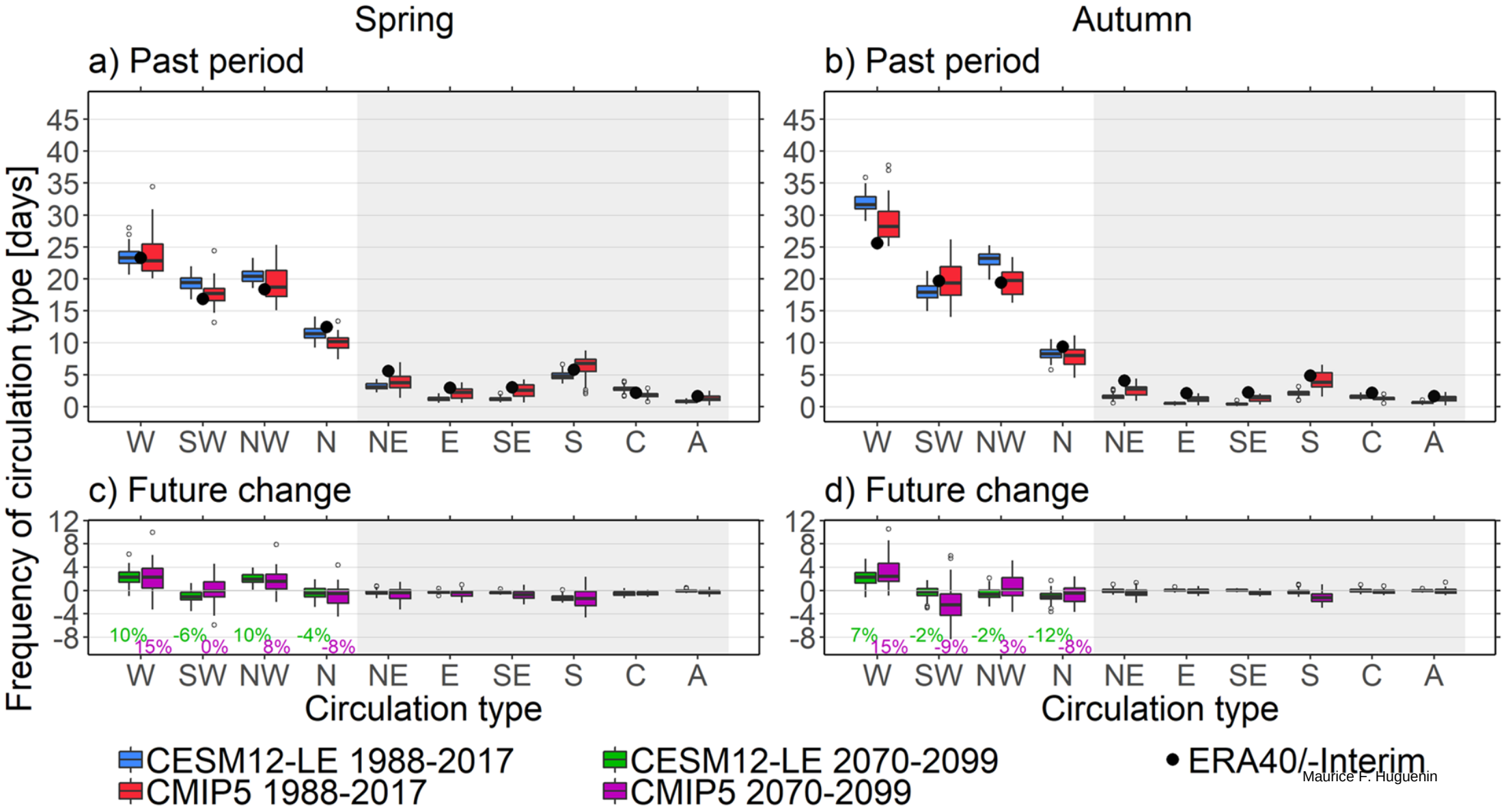
CESM future

CMIP5 future

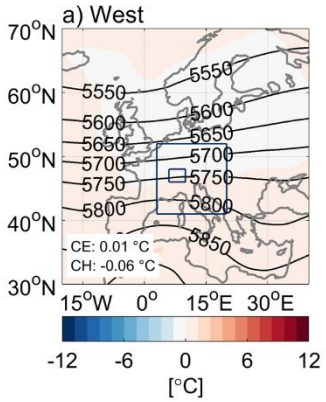


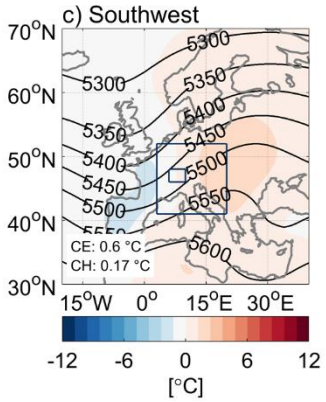
Additional Figures

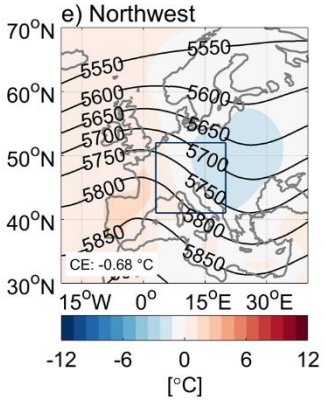
Changes in Frequency

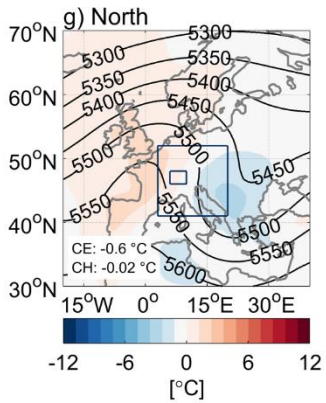


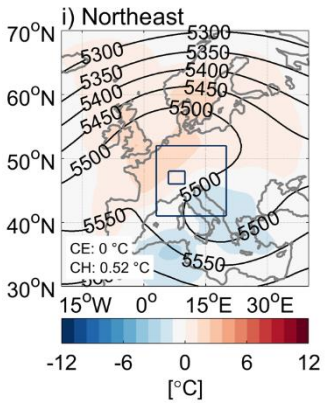
Maps CMIP5 summer past

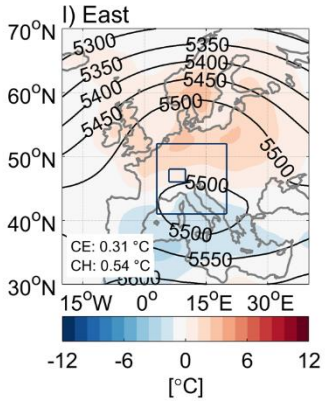


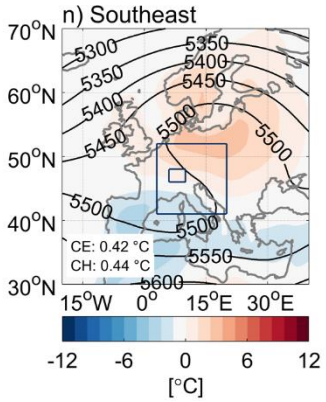


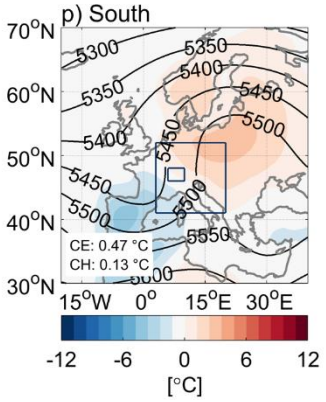


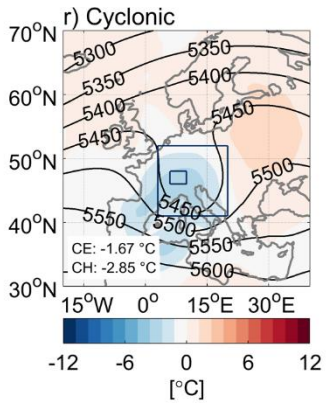


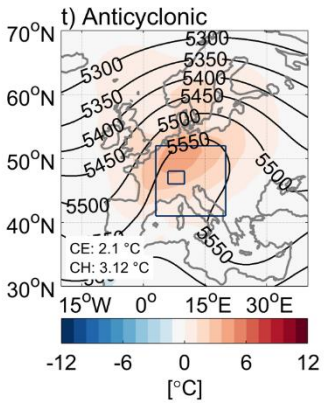




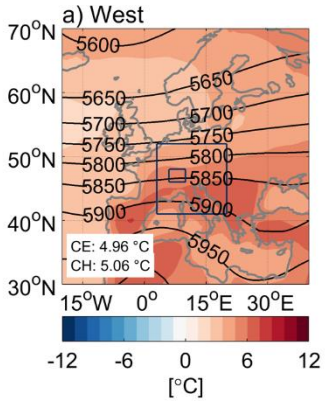


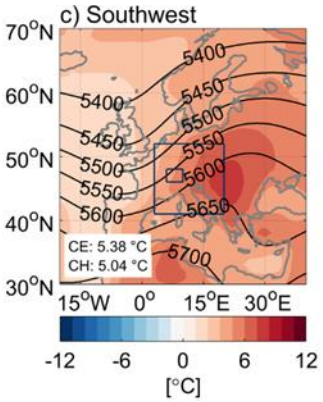


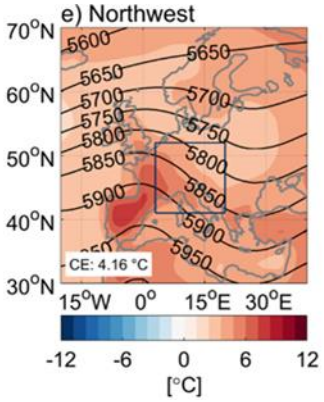


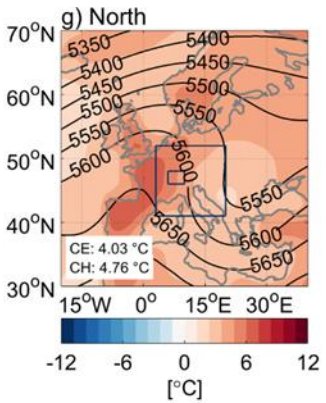


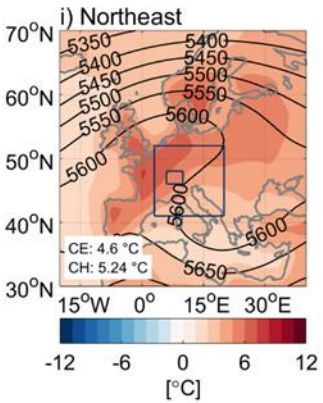
Maps CMIP5 summer future

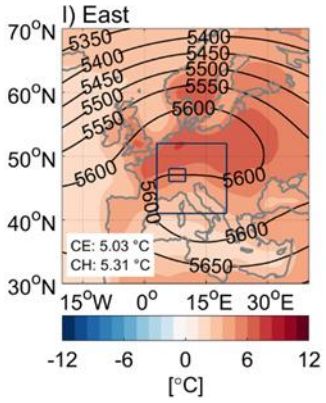


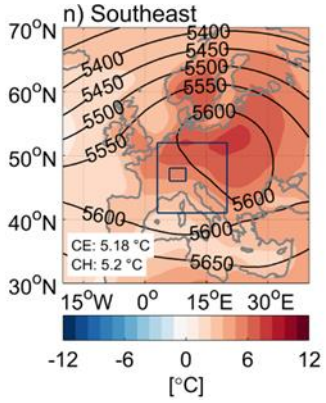


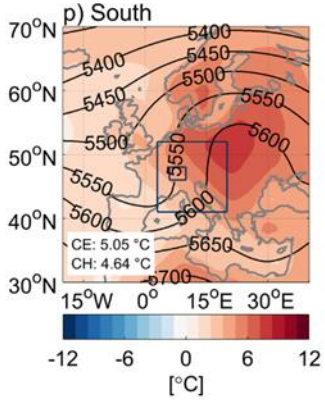


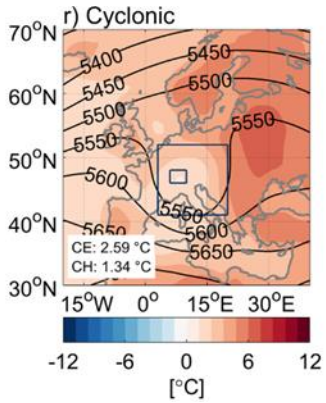


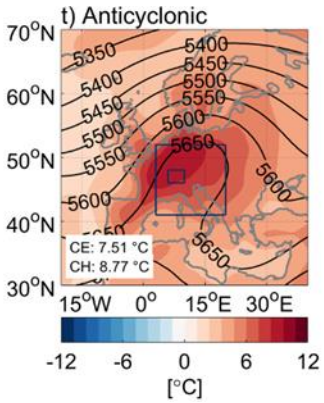




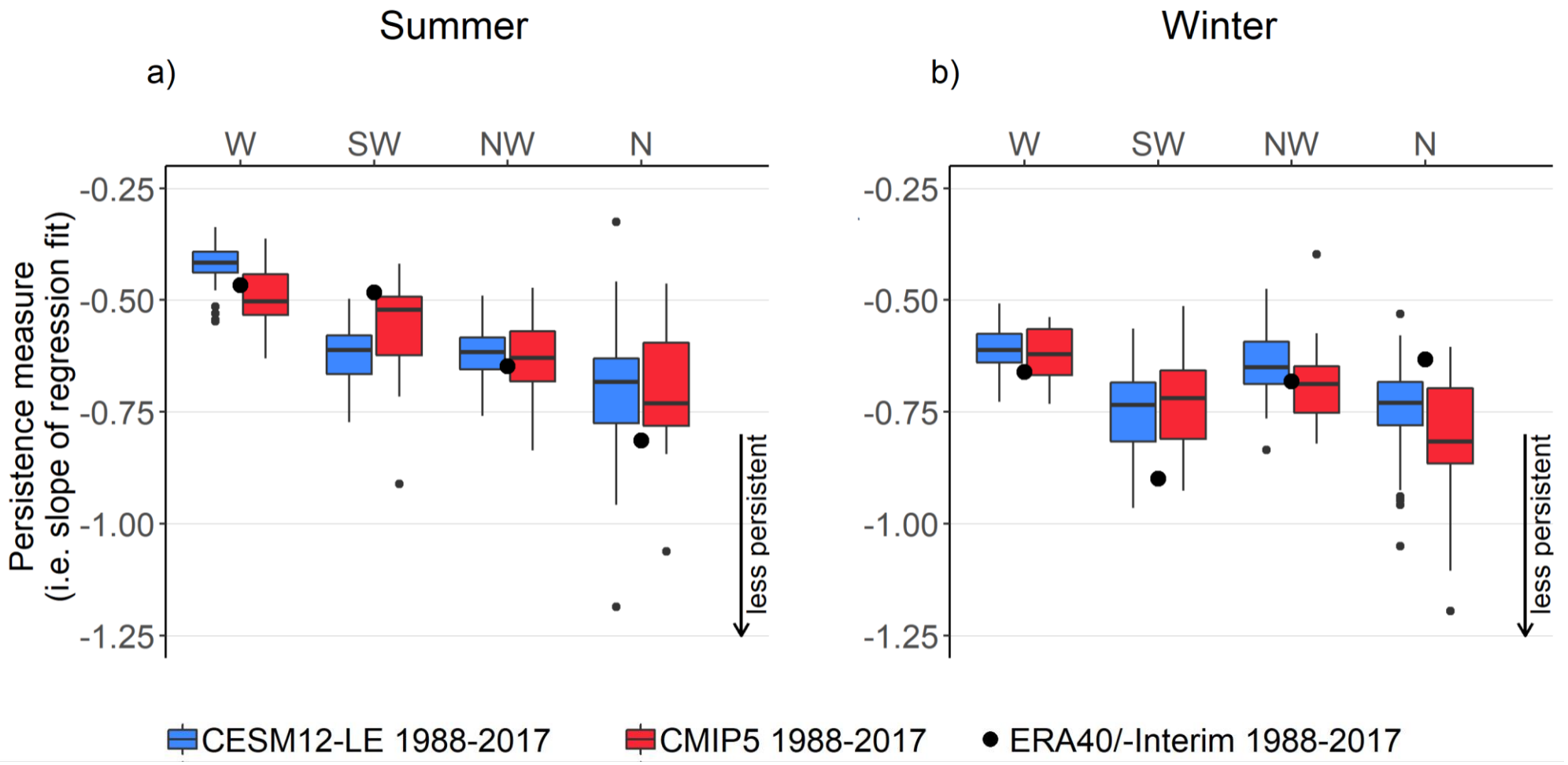




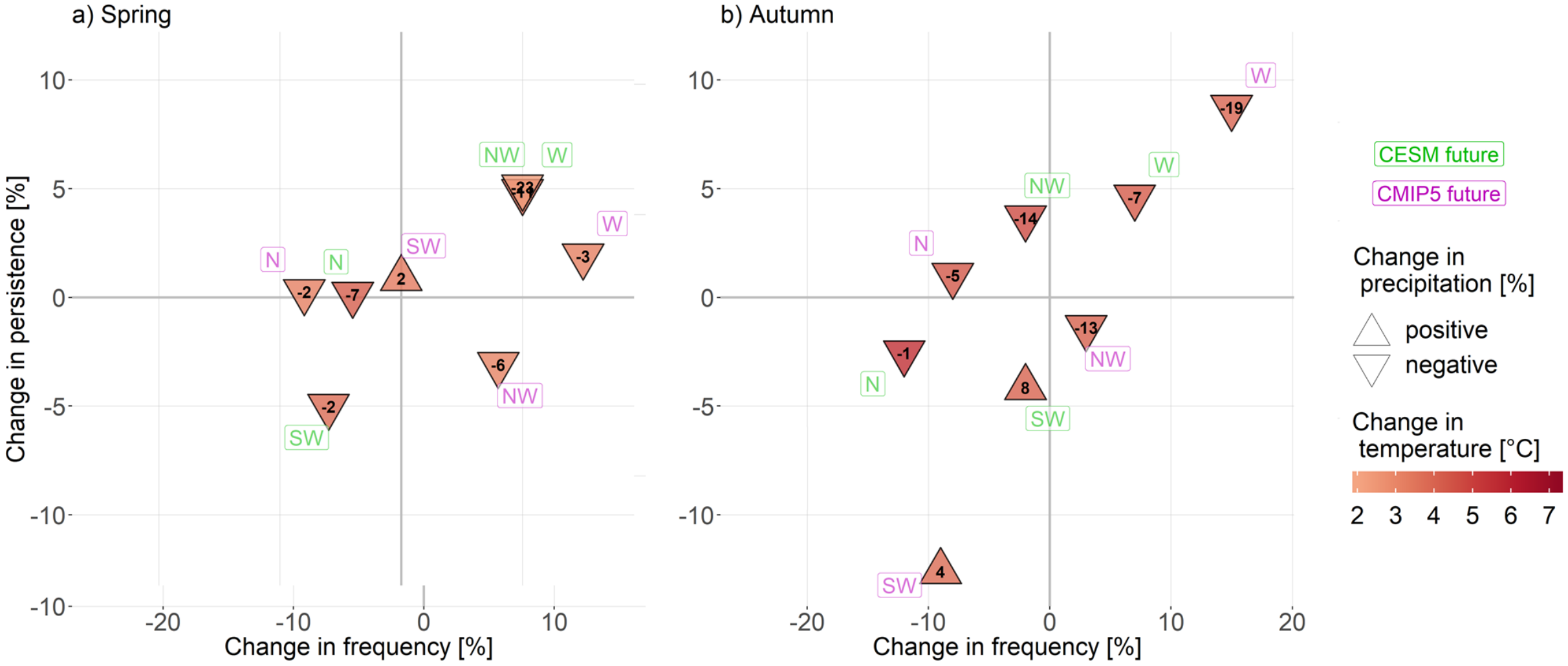




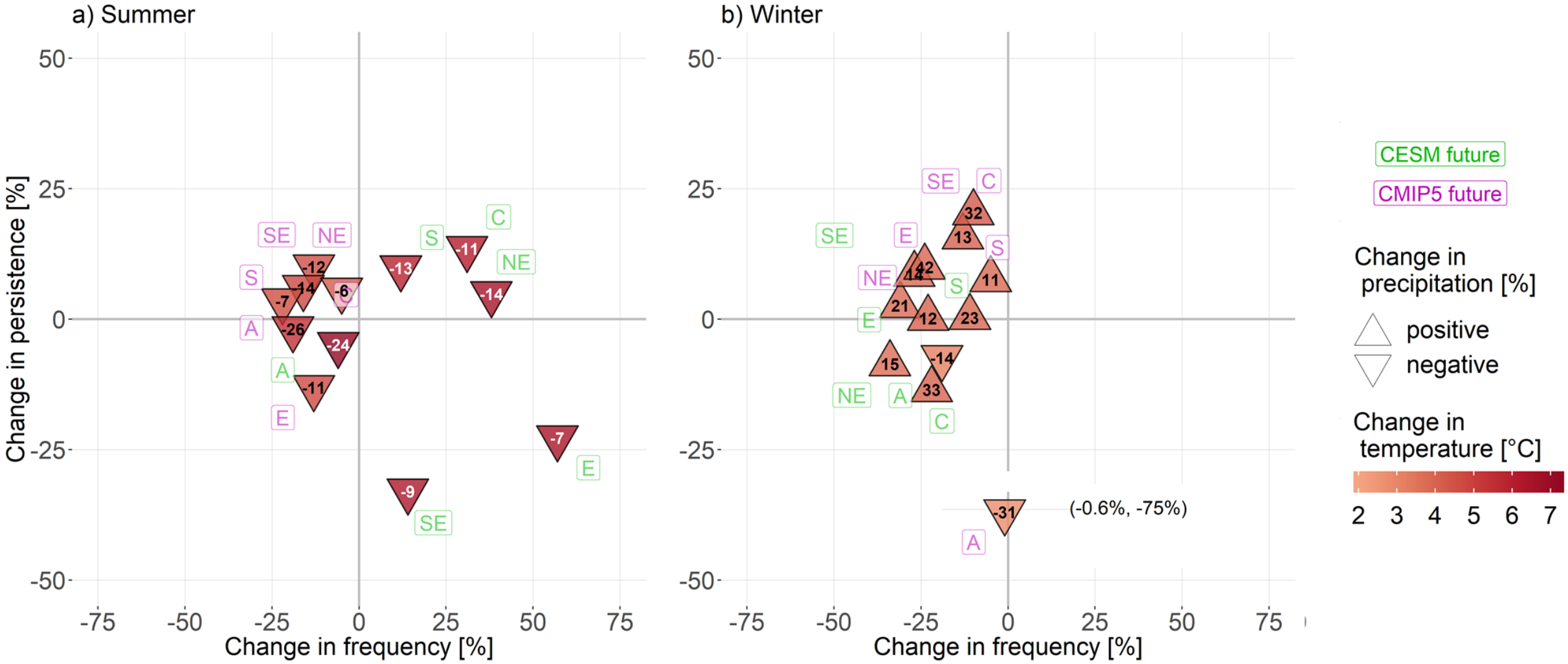
Observed persistence



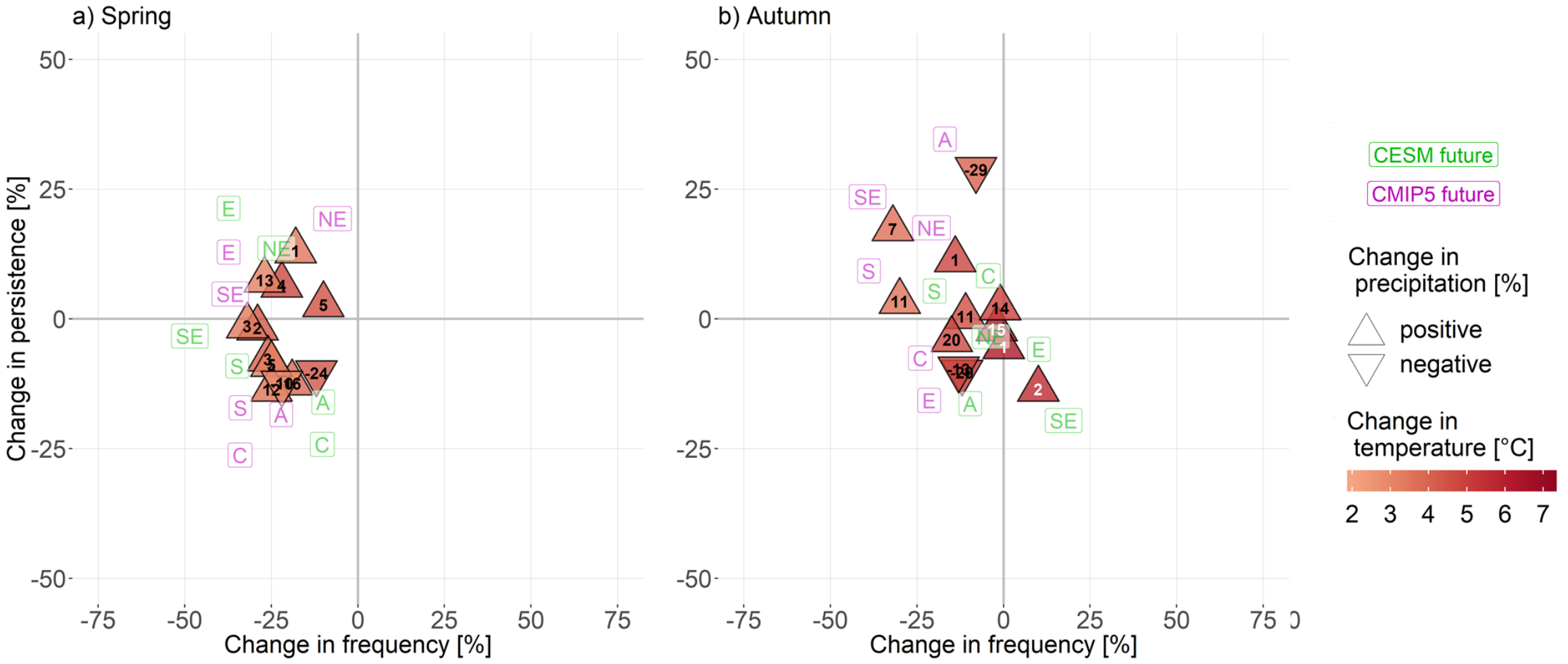
Summary Figure – Spring and Autumn, main types



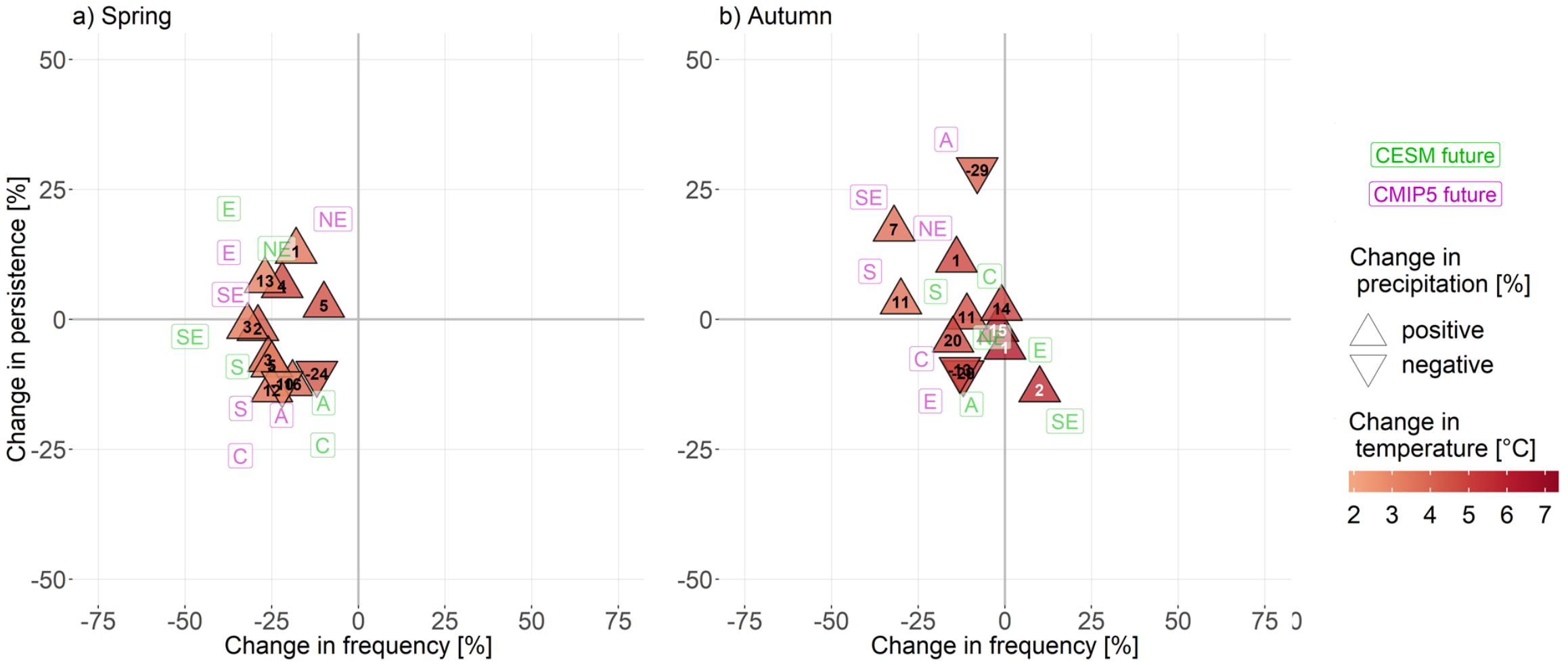
Summary Figure – Summer and Winter, rare types



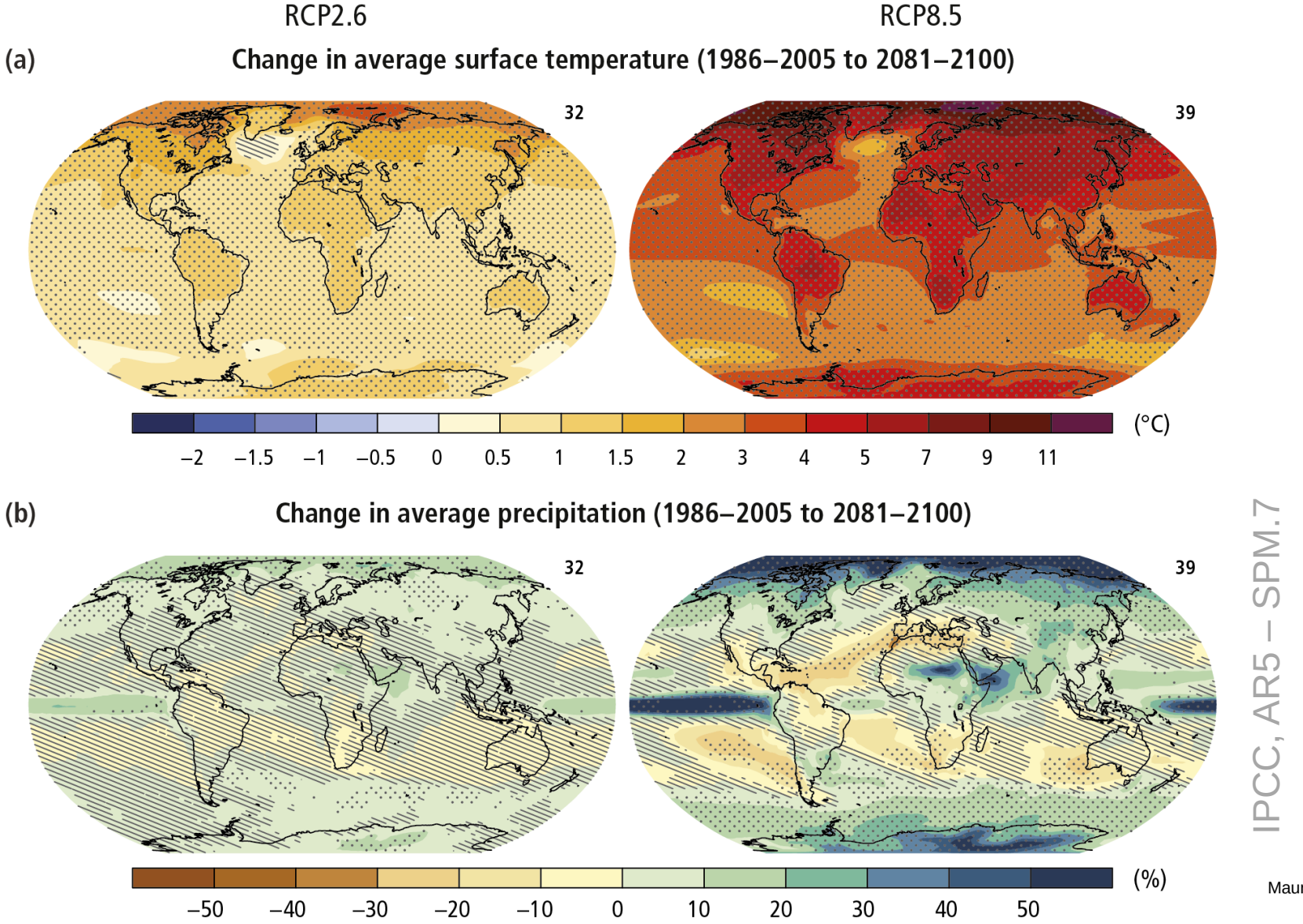
Summary Figure – Spring and Autumn, rare types



Summary Figure – Spring and Autumn, rare types



Projected Change in Temperature and Precipitation



IPCC, AR5 – SPM.7

CMIP5 Model List

ACCESS1-0
ACCESS1-3
BNU-ESM^{CH2018}
CanESM2^{CH2018}
CMCC-CM
CMCC-CMS
CMCC-CM5
FGOALS-g2^{CH2018} (no maps though)
GFDL-CM3^{CH2018}
GFDL-ESM2G^{CH2018}
GFDL-ESM2M^{CH2018}
IPSL-CM5A-LR^{CH2018}
IPSL-CM5A-MR^{CH2018}
IPSL-CM5B-LR^{CH2018}
MRI-CGCM3
MRI-ESM1
NorESM1-M^{CH2018}

Trends in the Persistence?