

Supplementary material for “Drivers of the ECMWF SEAS5 seasonal forecast for the hot and dry European summer of 2022”

Matthew Patterson¹, Daniel J. Befort², Christopher O’Reilly¹, Antje Weisheimer^{3,4}

1. Department of Meteorology, University of Reading, Whiteknights Road, Earley Gate, Reading, RG6 6ET, UK

2. European Centre for Medium-Range Weather Forecasts (ECMWF), Bonn, Germany

3. National Centre for Atmospheric Science (NCAS), University of Oxford, Parks Road, OX1 3PU, UK

4. European Centre for Medium-Range Weather Forecasts (ECMWF), Shinfield Park, Reading, RG2 9AX, UK

Email: m.r.patterson@reading.ac.uk

Contents:

Figures S1-S11

ECMWF SEAS5 (C3Sv5.1) **2-metre temperature** (stippling where significance below 95%)
Start month: **MAY** - Valid months: **JJA**

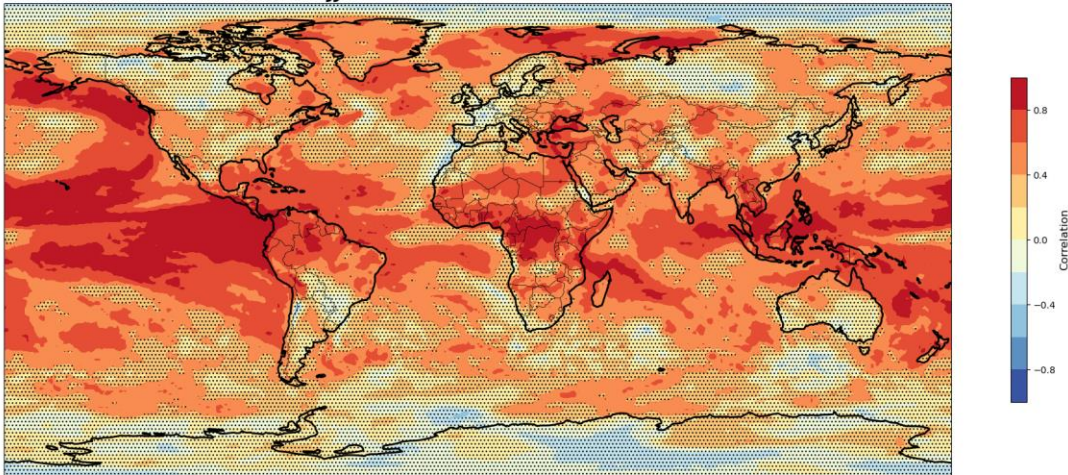


Figure S1: SEAS5 correlation skill in T2m for JJA, initialised on 1st May. Retrieved from <https://confluence.ecmwf.int/display/CKB/C3S+seasonal+forecasts+verification+plots>

ECMWF SEAS5 (C3Sv5.1) **total precipitation** (stippling where significance below 95%)
Start month: **MAY** - Valid months: **JJA**

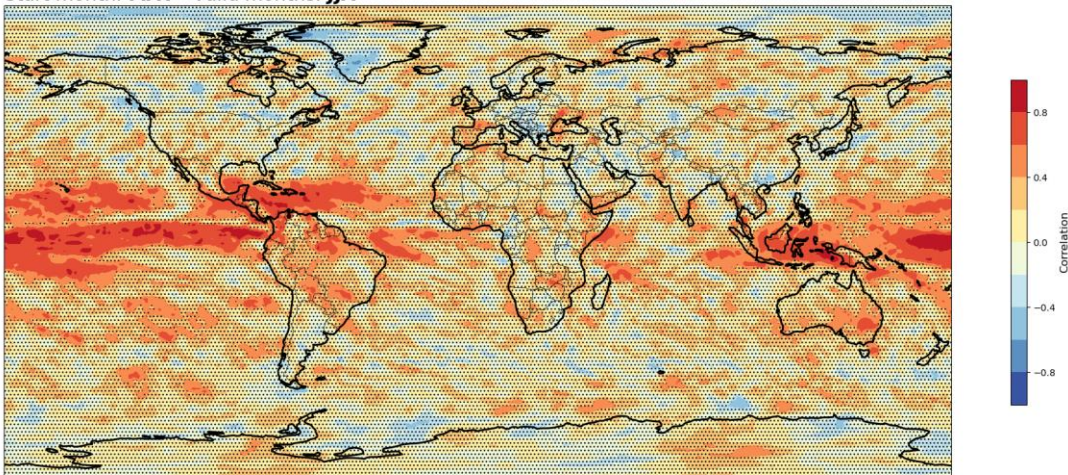


Figure S2: SEAS5 correlation skill in precipitation for JJA, initialised on 1st May. Retrieved from <https://confluence.ecmwf.int/display/CKB/C3S+seasonal+forecasts+verification+plots>

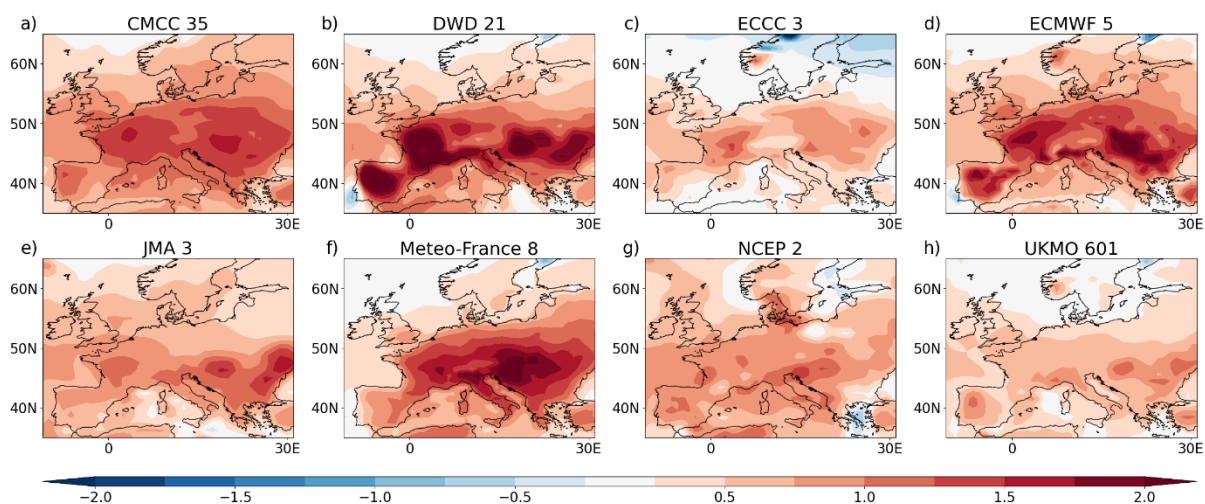


Figure S3: JJA 2022 T2m anomalies (relative to 1993-2016 rather than 1981-2021 due to the common hindcast period) for various seasonal forecasting systems participating in the Copernicus Climate Change Service (C3S), nominally initialised on 1st May. Systems shown are a) CMCC system 3.5, b) DWD system 2.1, c) ECCC 3, d) ECMWF system 5, e) JMA system 3, f) Meteo-France system 8, g) NCEP system 2, h) UK Met Office GloSea 6. Units of K.

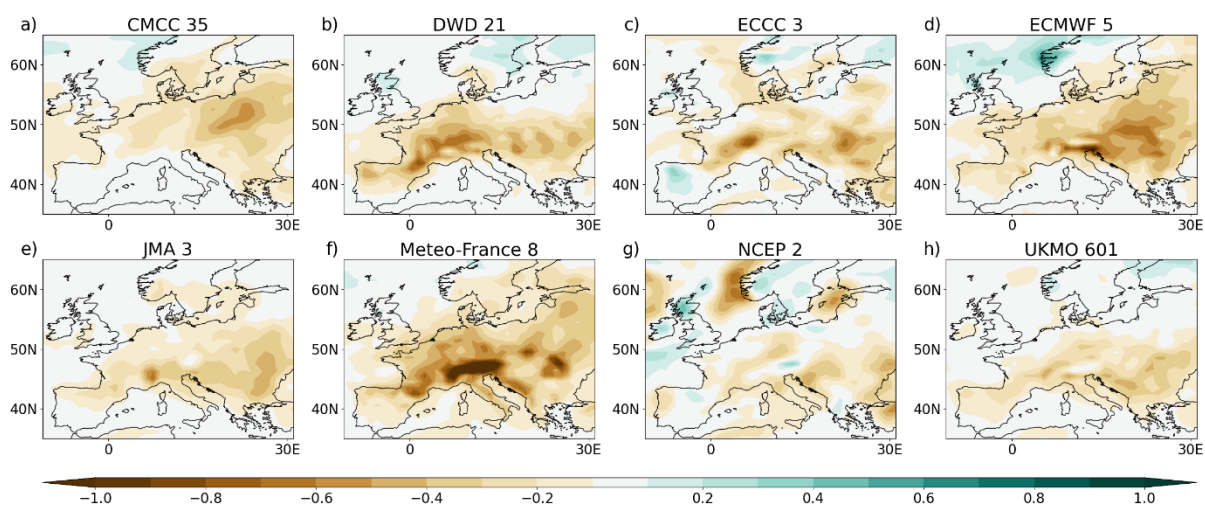


Figure S4: As in figure S3 but for precipitation. Units of mm/day.

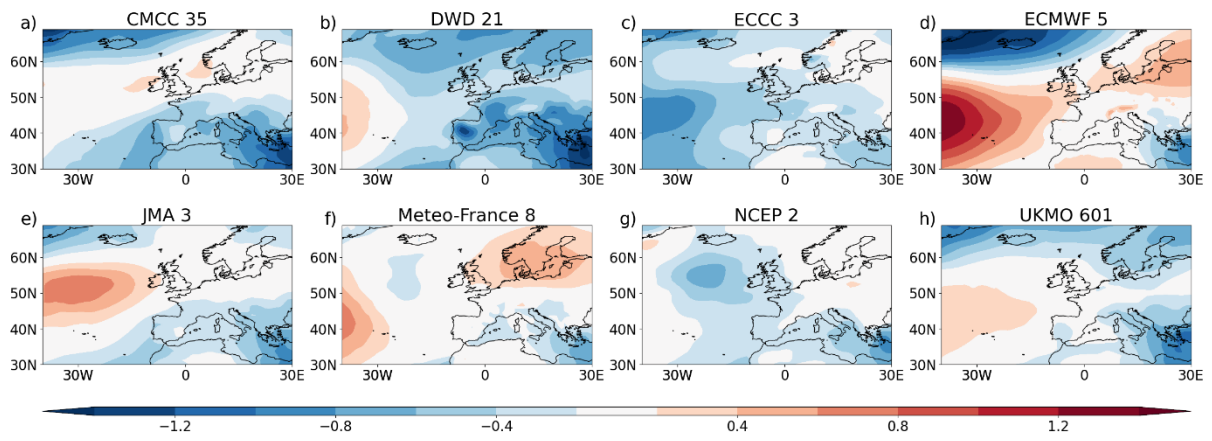


Figure S5: As in figure S3 but for sea level pressure. Units of hPa.

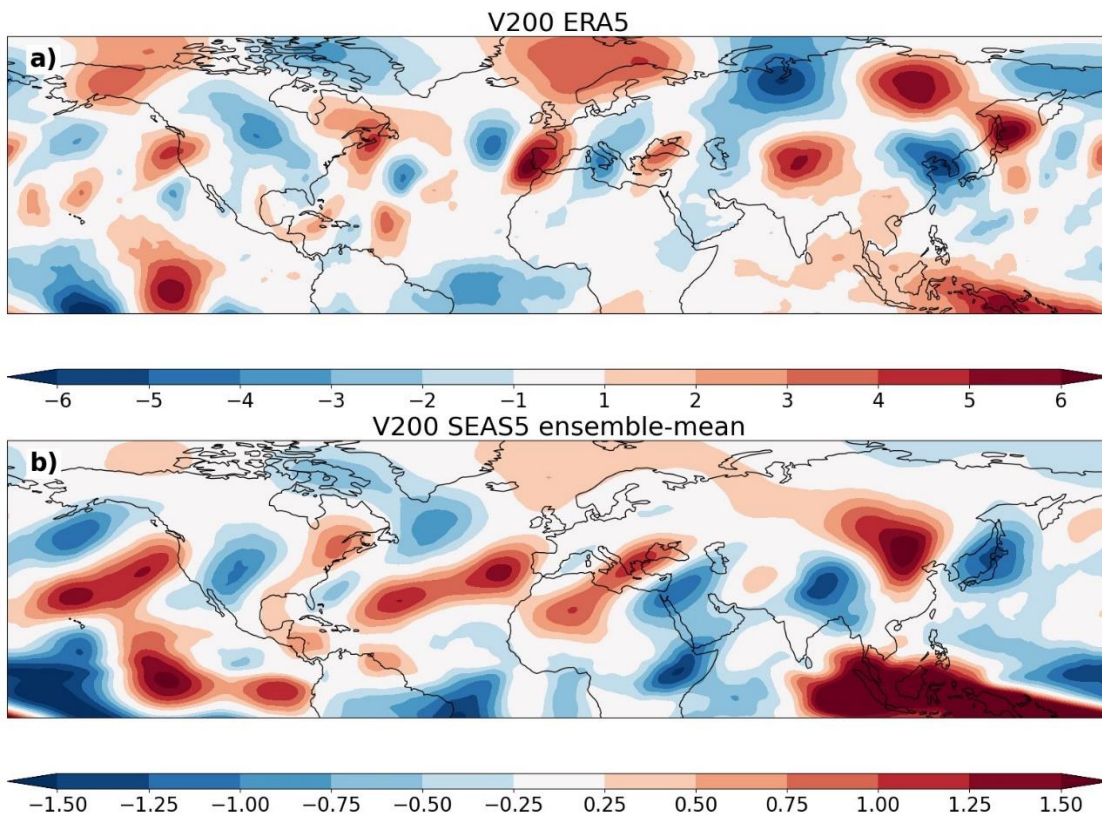


Figure S6: V200 anomalies in JJA 2022 for a) ERA5 and b) the SEAS5 ensemble-mean. Units are m/s.

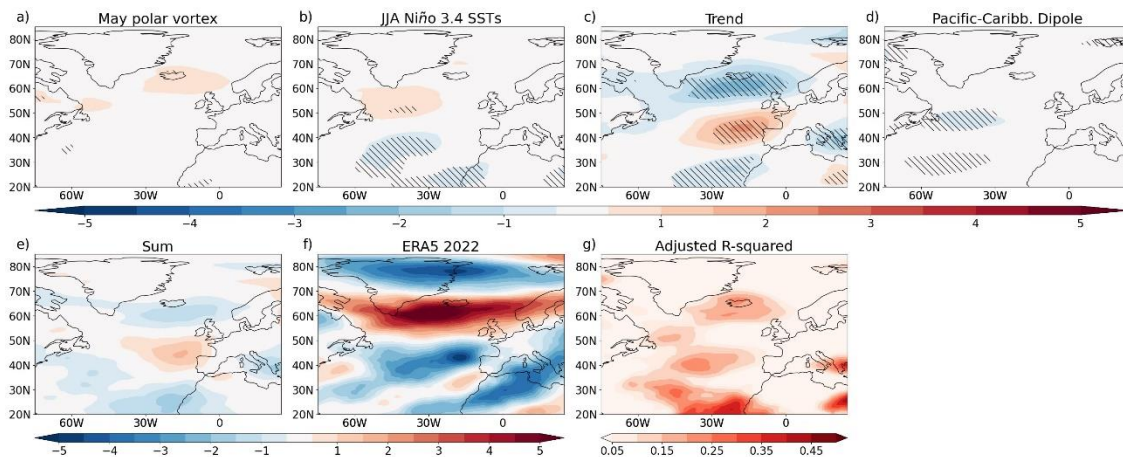


Figure S7: As in figure 5 of the main paper, but incorporating the Pacific-Caribbean Dipole Index of Wulff et al (2017) as a fourth predictor. This is defined as precipitation averaged over a Pacific box ($180^{\circ}\text{W}-110^{\circ}\text{W}$, $10^{\circ}\text{N}-20^{\circ}\text{N}$) minus a Caribbean box ($85^{\circ}\text{W}-65^{\circ}\text{W}$, $10^{\circ}\text{N}-25^{\circ}\text{N}$). Precipitation data is taken from monthly-mean GPCP data.

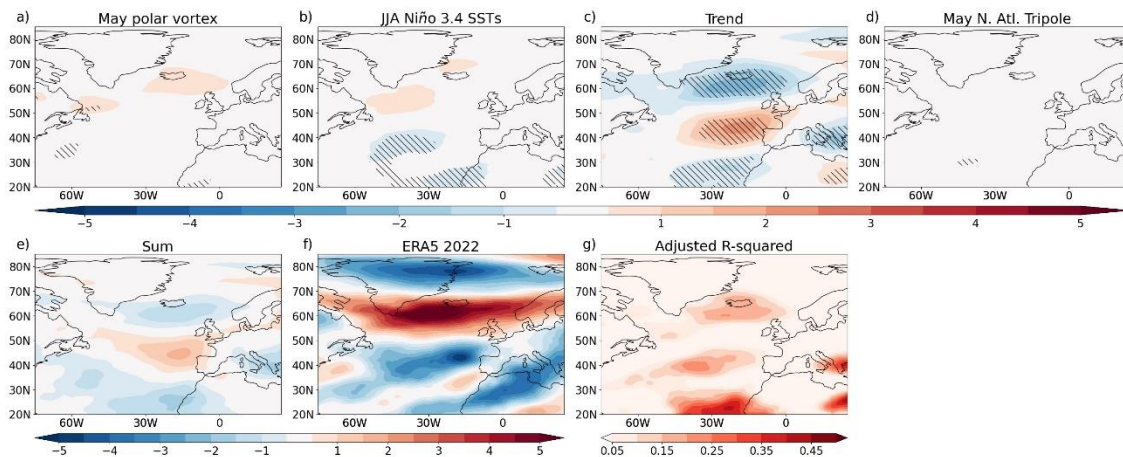


Figure S8: As in figure 5 of the main paper, but incorporating the North Atlantic tripole SST index of Dunstone et al (2019) for May as a fourth predictor. The index is calculated as $\text{MIDAT} - \text{SPG} - \text{TROPAT}$ where MIDAT, SPG and TROPAT are averages over SSTs in the mid-Atlantic ($60^{\circ}\text{W}-30^{\circ}\text{W}$, $20^{\circ}\text{N}-45^{\circ}\text{N}$), sub-polar gyre ($50^{\circ}\text{W}-20^{\circ}\text{W}$, $45^{\circ}\text{N}-60^{\circ}\text{N}$) and tropical Atlantic ($55^{\circ}\text{W}-25^{\circ}\text{W}$, $0^{\circ}\text{N}-20^{\circ}\text{N}$), respectively.

Dunstone, N., Smith, D., Hardiman, S., Eade, R., Gordon, M., Hermanson, L., Kay, G., Scaife, A. (2019) "Skilful Real-Time Seasonal Forecasts of the Dry Northern European Summer 2018" *Geophys. Res. Lett.* Vol 46, Issue 21, 16 November 2019, Pages 12368-12376

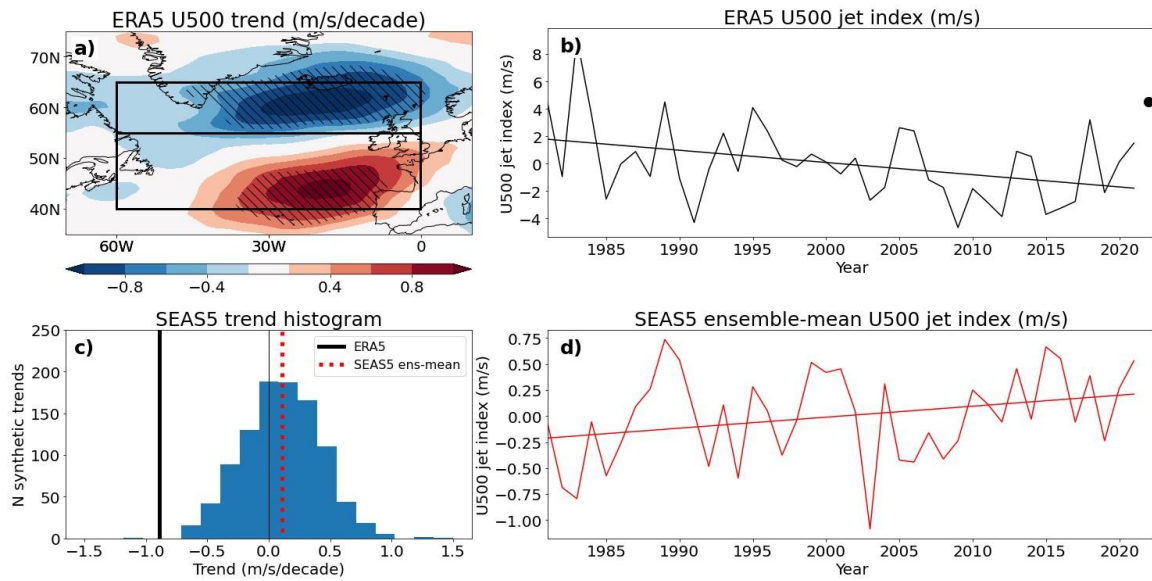


Figure S9: Trends in the summer North Atlantic jet (1981-2021). a) ERA5 U500 trend shown by shading with hatching indicating regions with statistically significant trends at the 5% level, following a Student's *t*-test. The box in a) indicates two boxes used to calculate a jet index with the index being the mean U500 in the northern box minus the mean U500 in the southern box. The jet index is plotted for b) ERA5 and d) the SEAS5 ensemble-mean with a histogram in c) showing a distribution of SEAS5 trends calculated by taking one member from each year. Linear trends are plotted for 1981-2021 in b) and d) with the 2022 value shown in b) by a filled circle. The ERA5 trend is shown in c) by a solid, black line and the SEAS5 ensemble-mean trend is indicated by a dotted, red line.

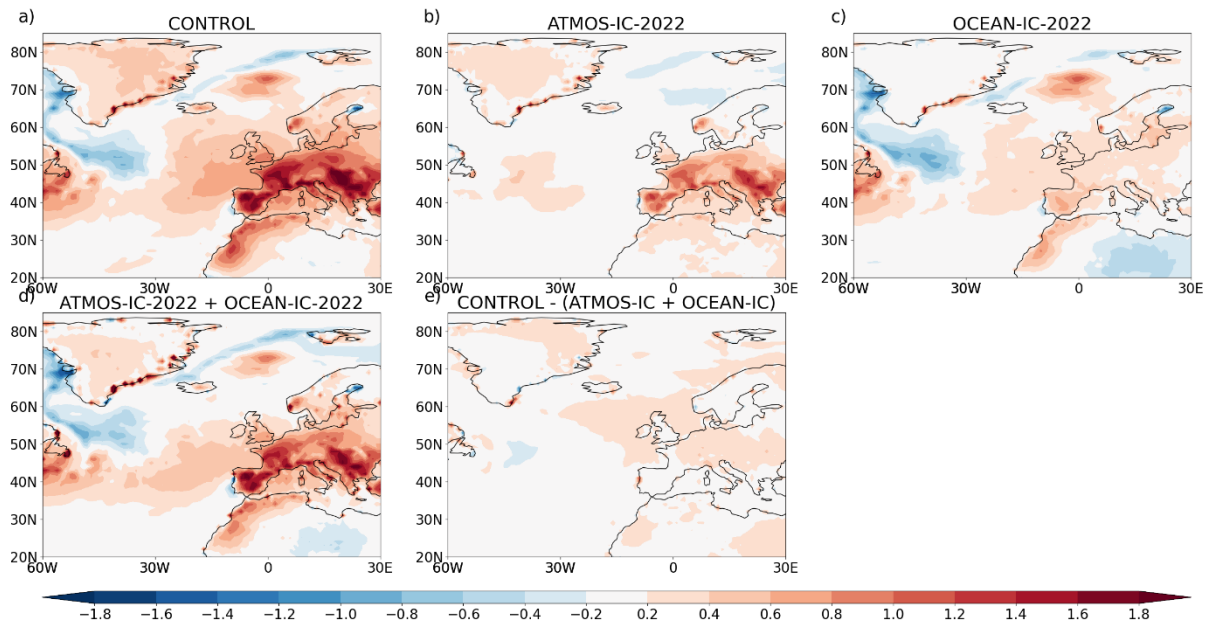


Figure S10: Additivity of T2m anomalies in the hindcast experiments. JJA-mean ensemble-mean T2m anomalies are shown for a) CONTROL, b) ATMOS-IC-2022, c) OCEAN-IC-2022, d) ATMOS-IC-2022 + OCEAN-IC-2022 and e) CONTROL – (ATMOS-IC-2022 + OCEAN-IC-2022). Panel e) therefore shows the degree of non-additivity.

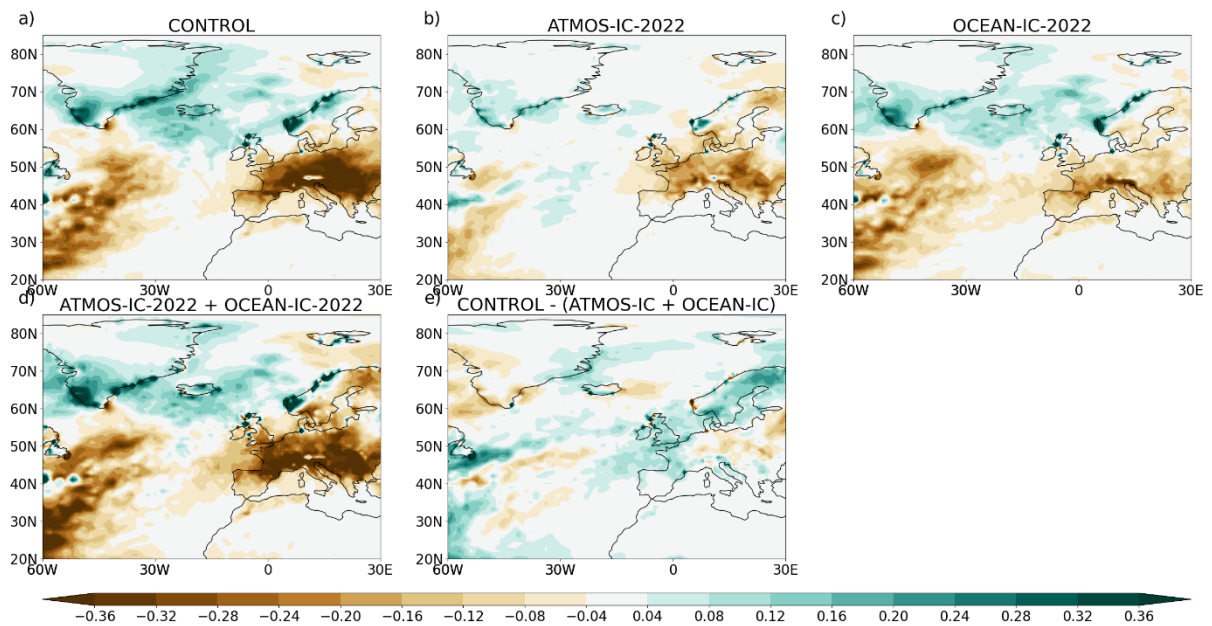


Figure S11: As in figure S10, but for precipitation.