

Shifting hail hazard under global warming: supplementary information

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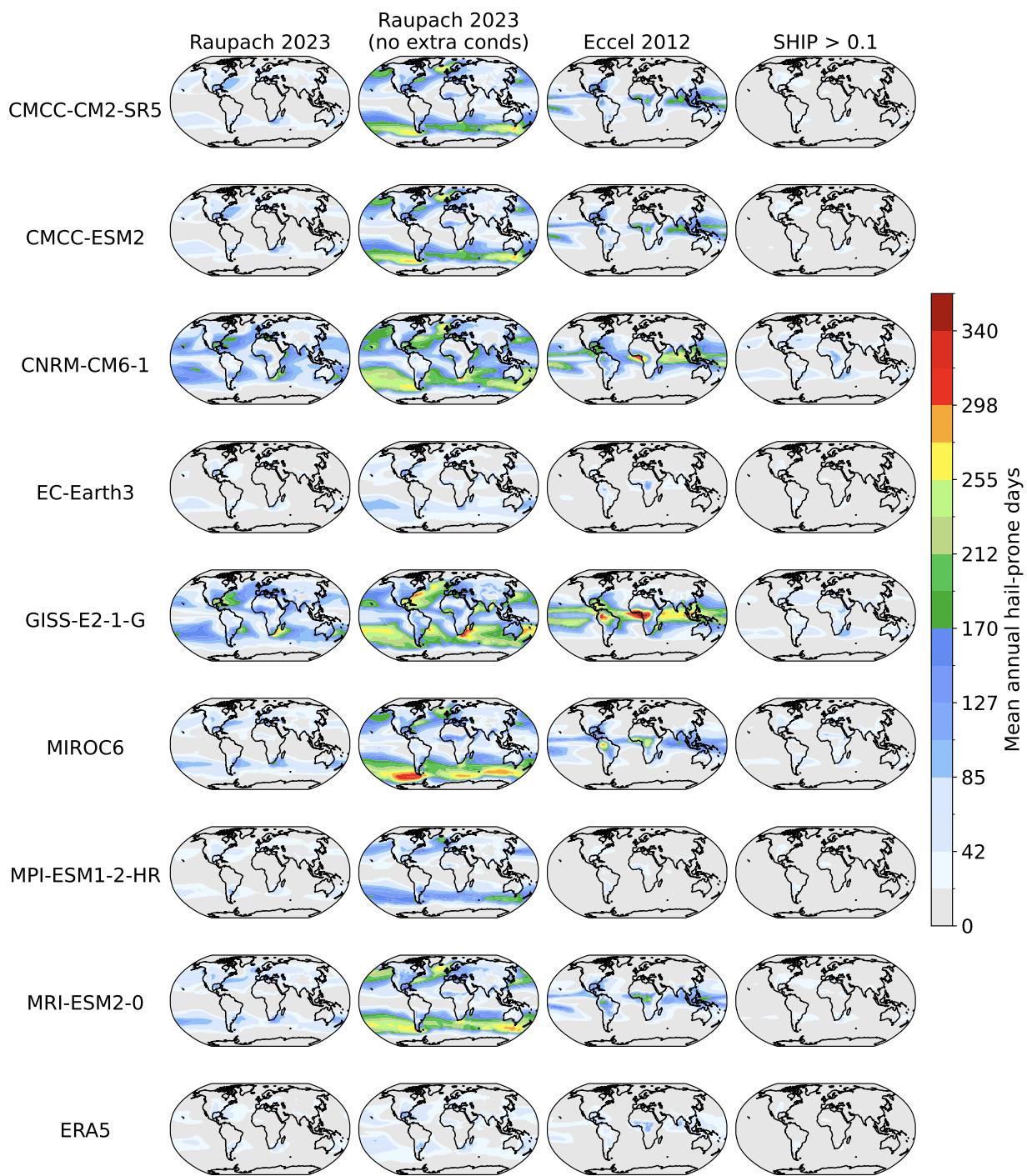
2: ARC Centre of Excellence for Climate Extremes, UNSW Sydney, Sydney, Australia

3: Agroscope, Swiss Federal Office for Agriculture, Zurich, Switzerland

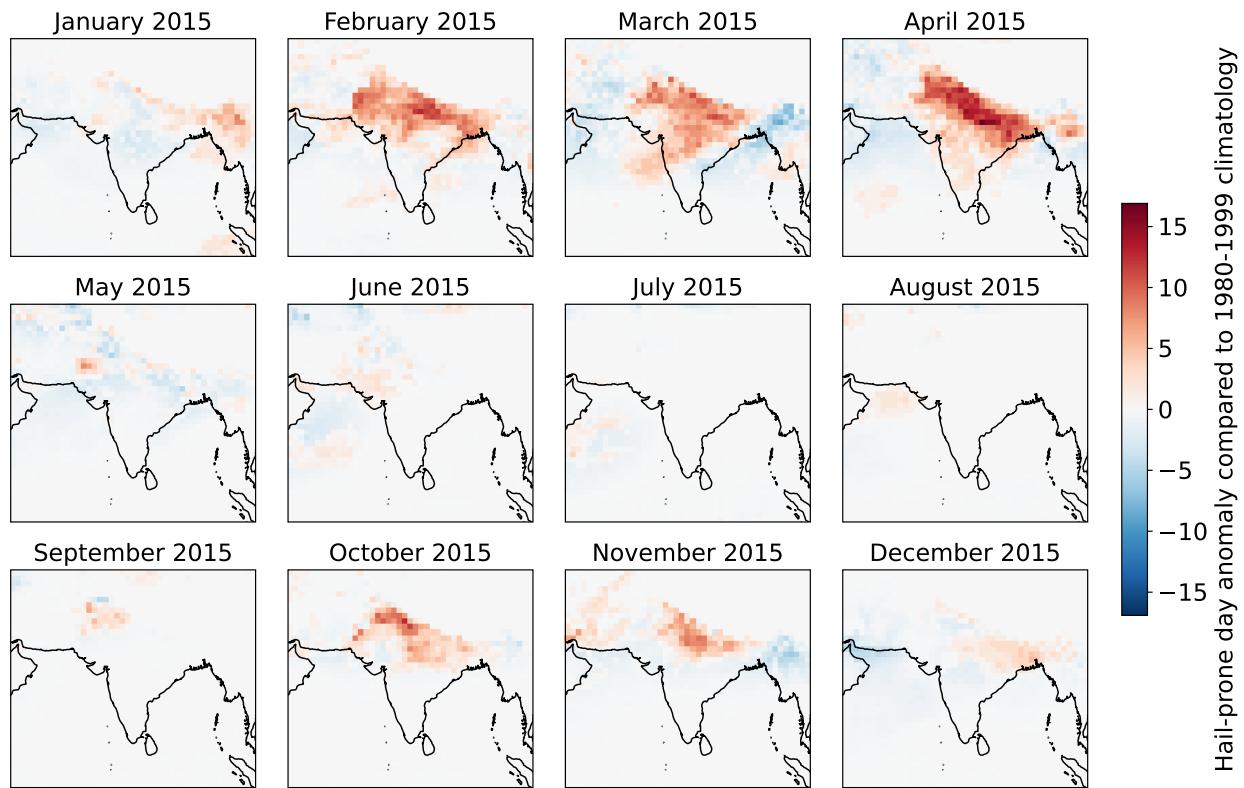
4: Uncharted Waters Research, Sydney, Australia

Model	Institution	Experiment	Ensemble	Start	End	Res	Vert	Orog
CMCC-CM2-SR5	CMCC	historical	r1i1p1f1	1980	1999	nan	30.0	
CMCC-CM2-SR5	CMCC	ssp585 (2C)	r1i1p1f1	2037	2056	nan	30.0	
CMCC-CM2-SR5	CMCC	ssp585 (3C)	r1i1p1f1	2054	2073	nan	30.0	
CMCC-ESM2	CMCC	historical	r1i1p1f1	1980	1999	nan	30.0	
CMCC-ESM2	CMCC	ssp585 (2C)	r1i1p1f1	2041	2060	nan	30.0	
CMCC-ESM2	CMCC	ssp585 (3C)	r1i1p1f1	2056	2075	nan	30.0	
CNRM-CM6-1	CNRM-CERFACS	historical	r1i1p1f2	1980	1999	nan	91.0	
CNRM-CM6-1	CNRM-CERFACS	ssp585 (2C)	r1i1p1f2	2042	2061	nan	91.0	X
CNRM-CM6-1	CNRM-CERFACS	ssp585 (3C)	r1i1p1f2	2057	2076	nan	91.0	X
EC-Earth3	EC-Earth-Consortium	historical	r1i1p1f1	1980	1999	nan	91.0	
EC-Earth3	EC-Earth-Consortium	ssp585 (2C)	r1i1p1f1	2031	2050	nan	91.0	
EC-Earth3	EC-Earth-Consortium	ssp585 (3C)	r1i1p1f1	2052	2071	nan	91.0	
GISS-E2-1-G	NASA-GISS	historical	r1i1p1f2	1980	1999	nan	40.0	X
GISS-E2-1-G	NASA-GISS	ssp585 (2C)	r1i1p1f2	2028	2047	nan	40.0	X
GISS-E2-1-G	NASA-GISS	ssp585 (3C)	r1i1p1f2	2055	2074	nan	40.0	X
MIROC6	MIROC	historical	r1i1p1f1	1980	1999	nan	81.0	
MIROC6	MIROC	ssp585 (2C)	r1i1p1f1	2051	2070	nan	81.0	
MIROC6	MIROC	ssp585 (3C)	r1i1p1f1	2072	2091	nan	81.0	
MPI-ESM1-2-HR	MPI-M	historical	r1i1p1f1	1980	1999	nan	95.0	
MPI-ESM1-2-HR	DKRZ	ssp585 (2C)	r1i1p1f1	2053	2072	nan	95.0	
MPI-ESM1-2-HR	DKRZ	ssp585 (3C)	r1i1p1f1	2075	2094	nan	95.0	
MRI-ESM2-0	MRI	historical	r1i1p1f1	1980	1999	nan	80.0	
MRI-ESM2-0	MRI	ssp585 (2C)	r1i1p1f1	2038	2057	nan	80.0	
MRI-ESM2-0	MRI	ssp585 (3C)	r1i1p1f1	2062	2081	100 km	80.0	

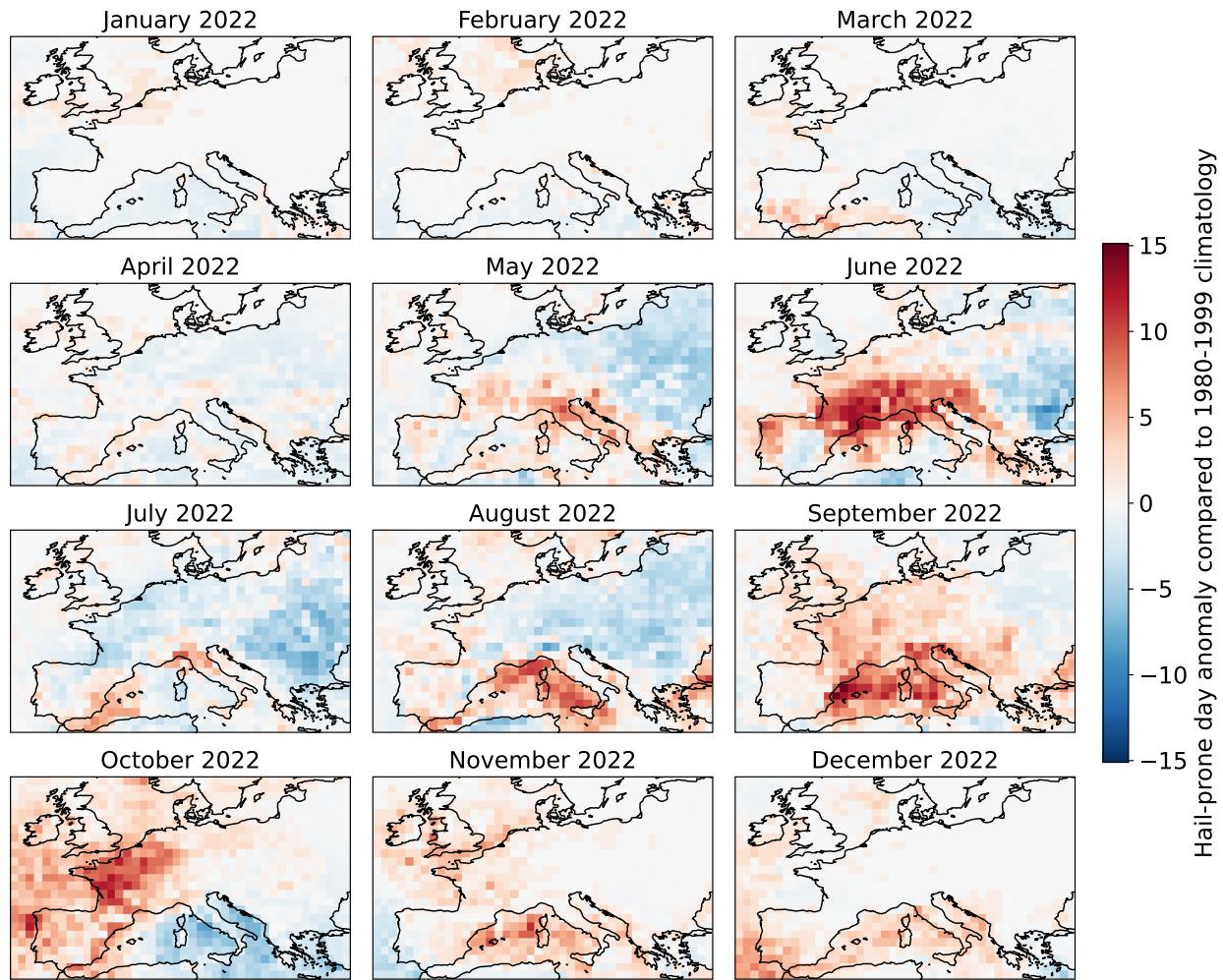
Table 1: **CMIP6 model details.** “Res” is nominal model resolution, “Vert” is the number of vertical levels in the model. An X in the column “Orog” indicates models for which no orography was provided; in these cases the orography for the historical run of CNRM-CM6-1 was interpolated to the model grid for use here.



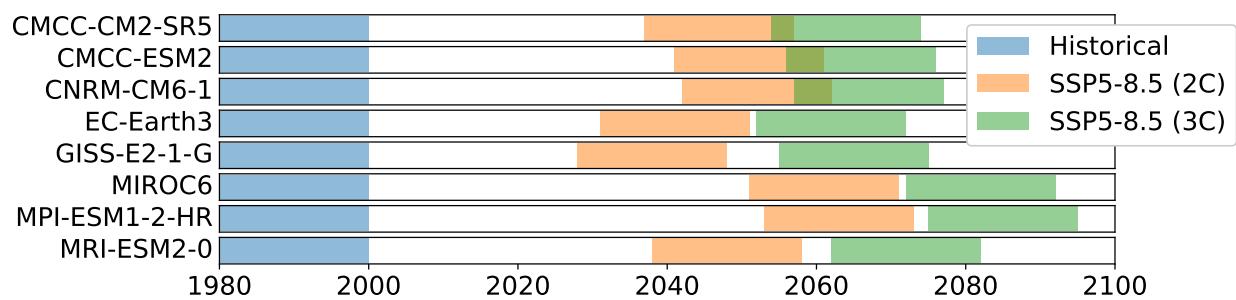
Supplementary Figure 1: **Mean annual hail-prone days in historical (1980-1999) runs.** Plots are by CMIP6 model and for ERA5 reanalysis data.



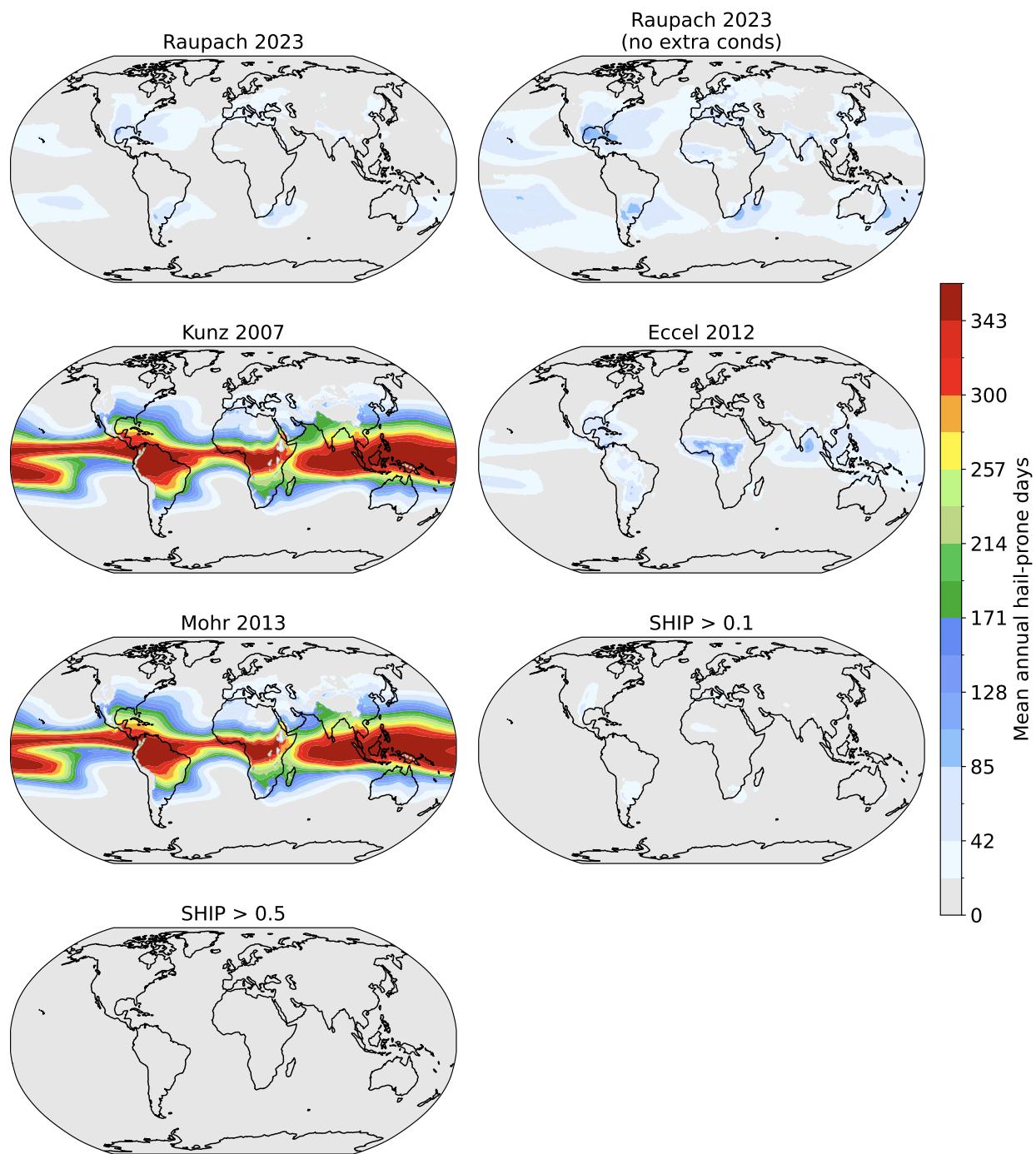
Supplementary Figure 2: Monthly proxy-based hail-prone day anomalies for the Indian region in 2015. Anomalies are calculated using ERA5 data with respect to the monthly ERA5 historical climatology (1980-1999).



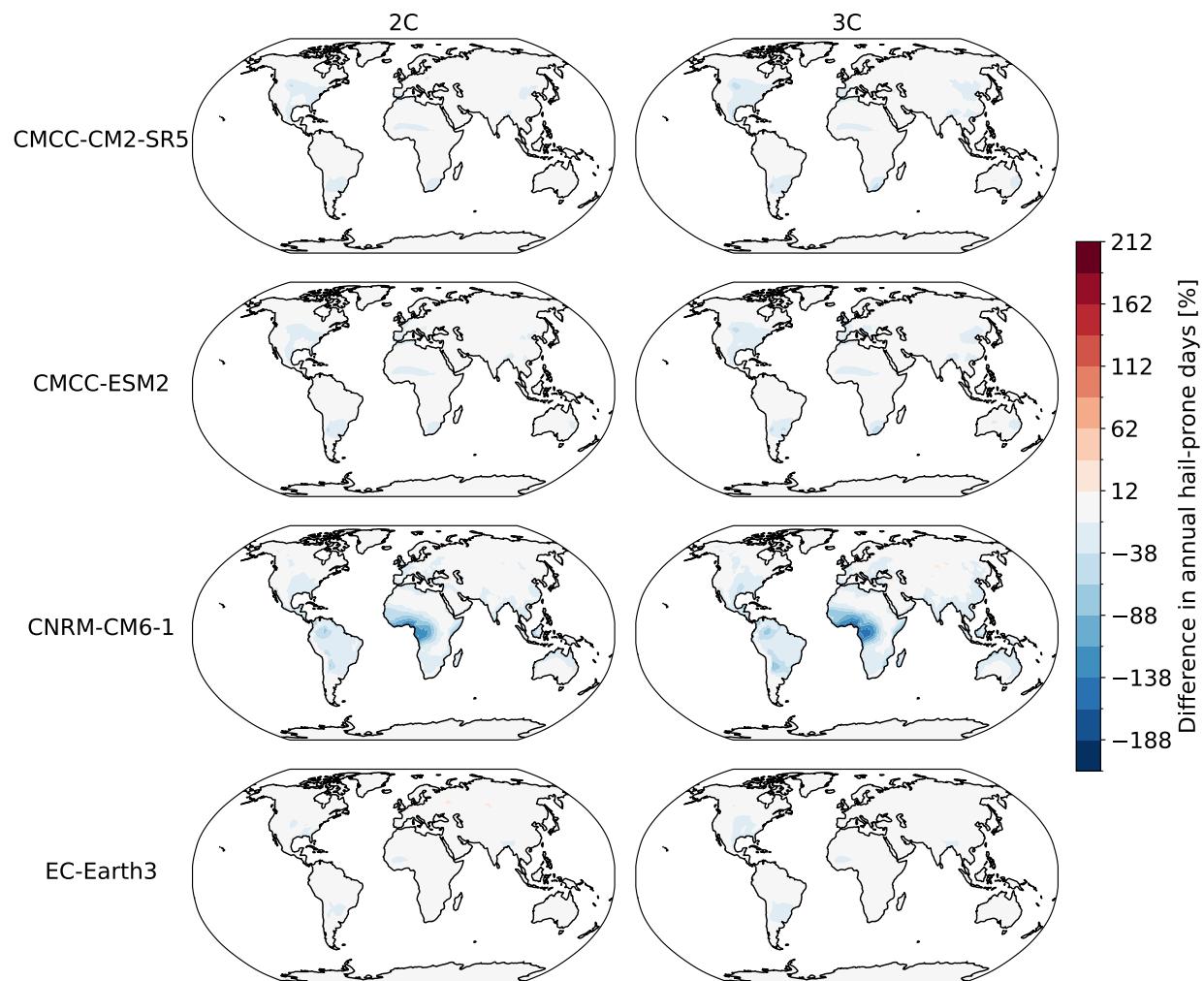
Supplementary Figure 3: **Monthly proxy-based hail-prone day anomalies for the European region in 2022.** As for Figure 2 but for Europe in 2022.



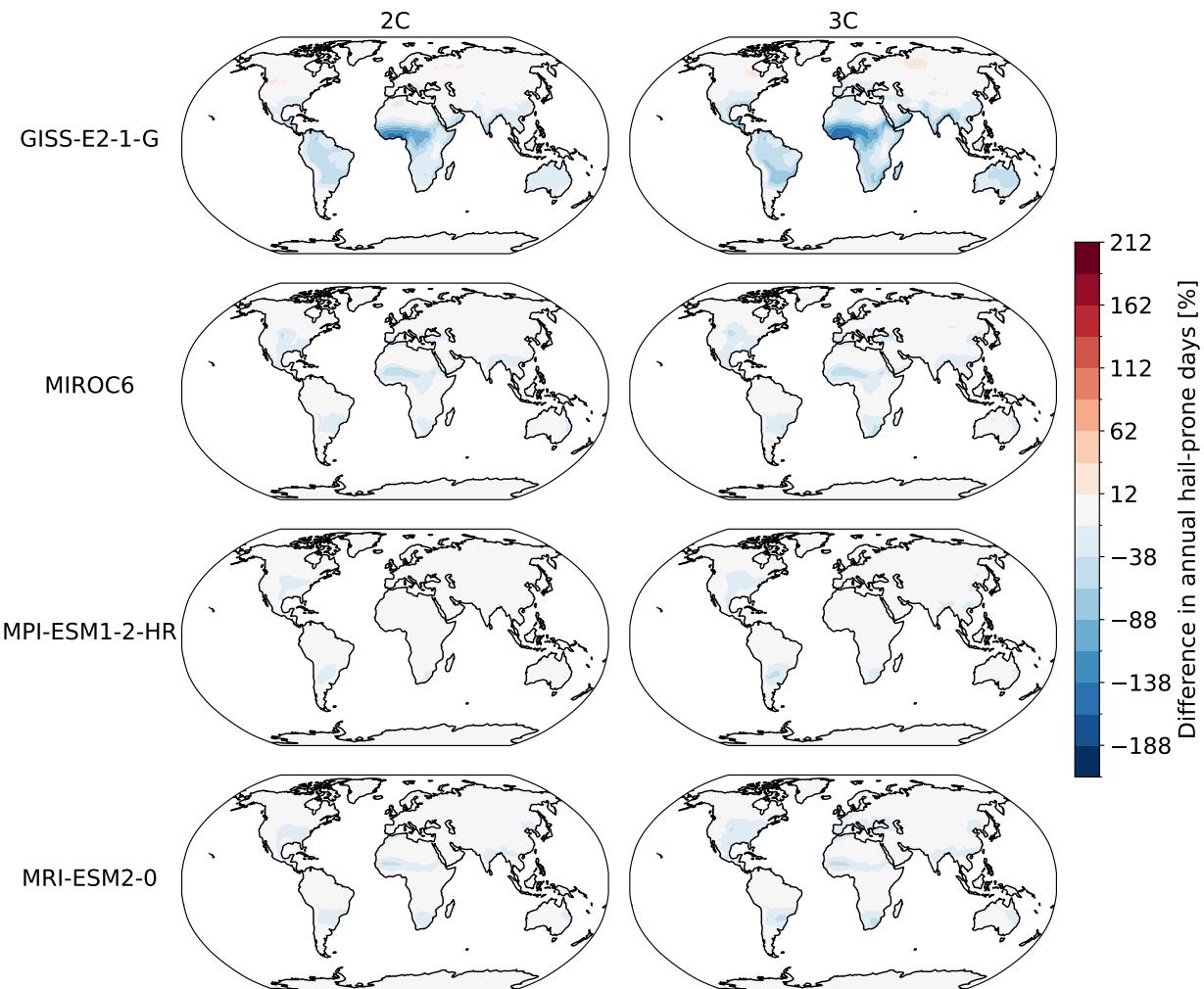
Supplementary Figure 4: **CMIP6 models and per-degree-framework date ranges.** The reference period from historical simulations is shown in blue, while periods with 2 and 3 degrees C warming over the reference period, in SSP5-8.5 simulations, are in orange and green respectively.



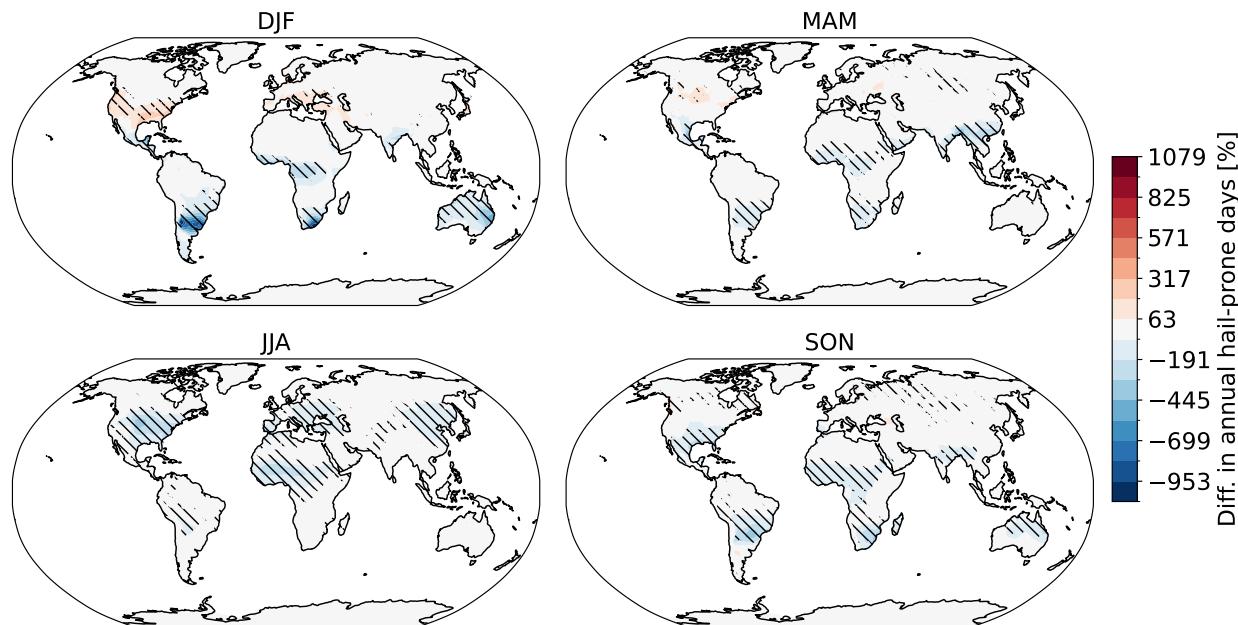
Supplementary Figure 5: **Mean annual hail-prone days for ERA5 reanalysis (1980-1999) for all applied hail proxies.**



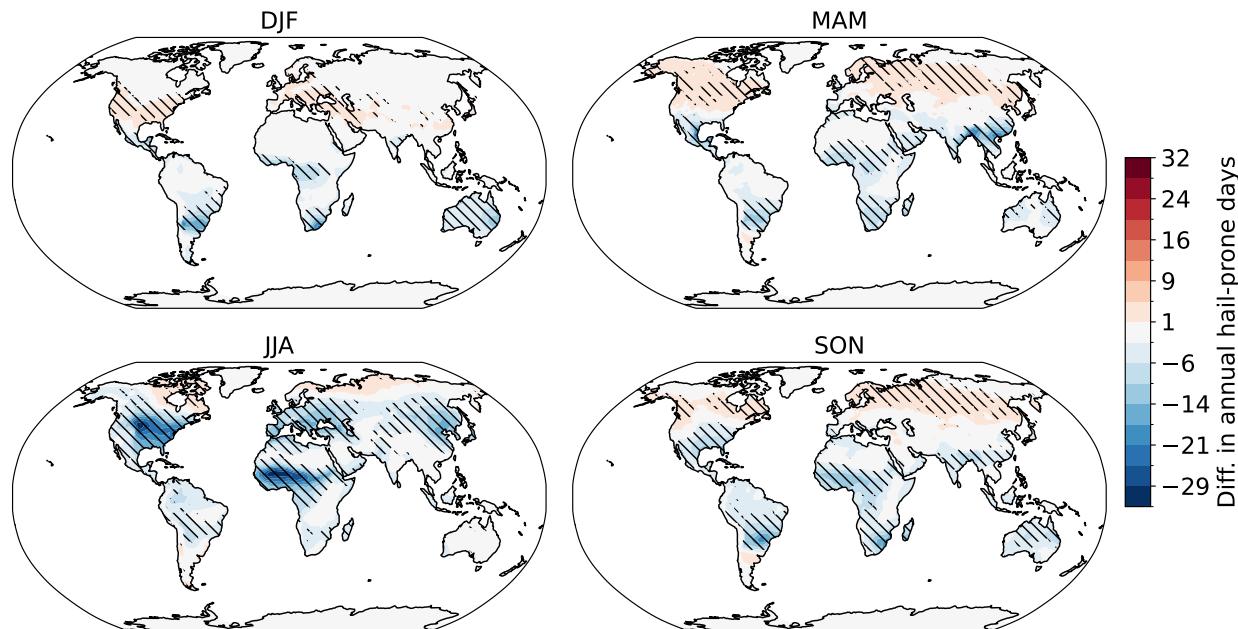
Supplementary Figure 6: **Differences in mean annual hail-prone days by model and epoch, part 1.**



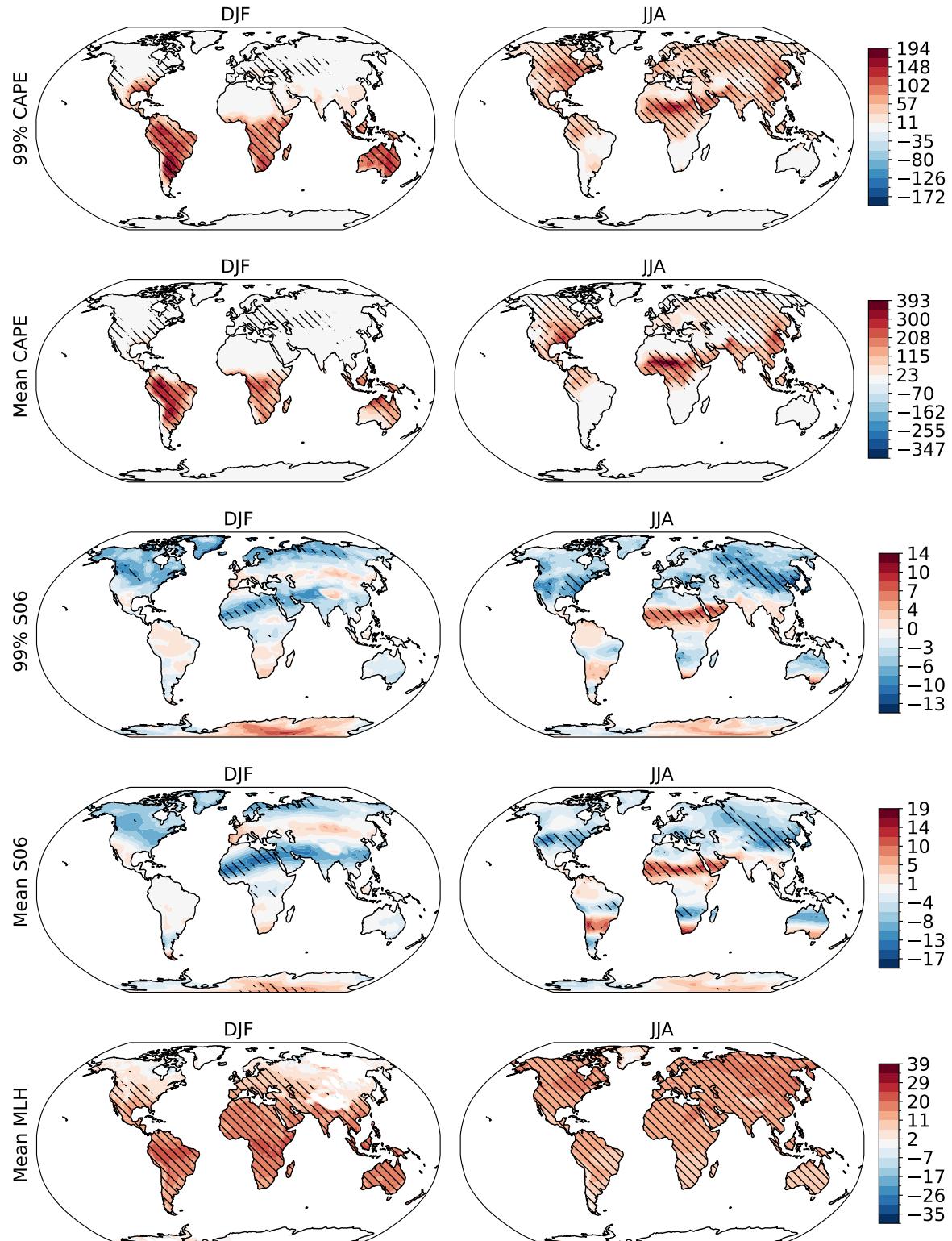
Supplementary Figure 7: **Differences in mean annual hail-prone days by model and epoch, part 2.**



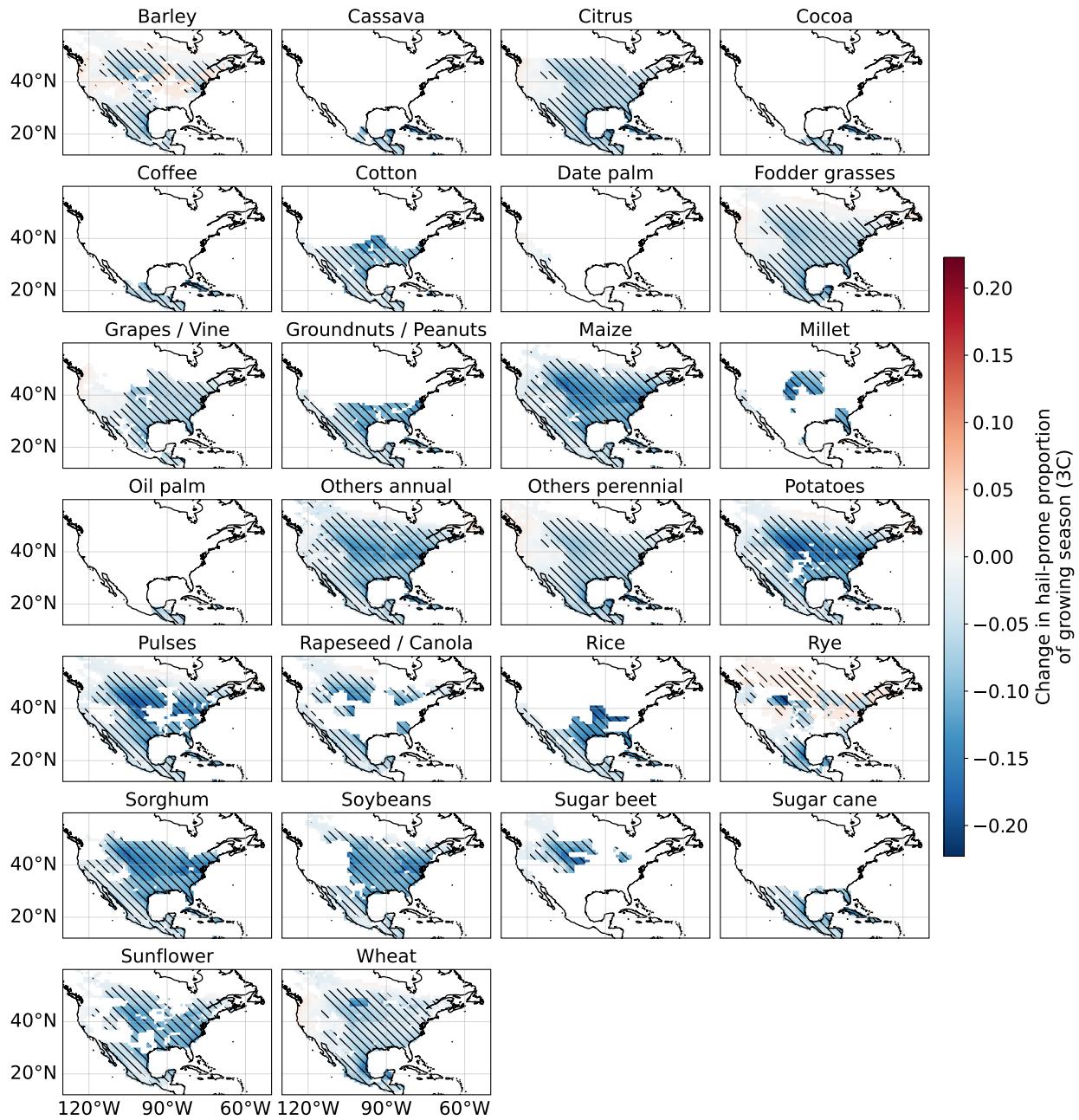
Supplementary Figure 8: Differences in mean annual hail-prone days by season, for 2 C warming. Stippling shows regions for which the difference between scenario means (across models) was statistically significant ($p < 0.05$ using Welch's t-test) and for which more than half of the models agreed on the sign of the change.



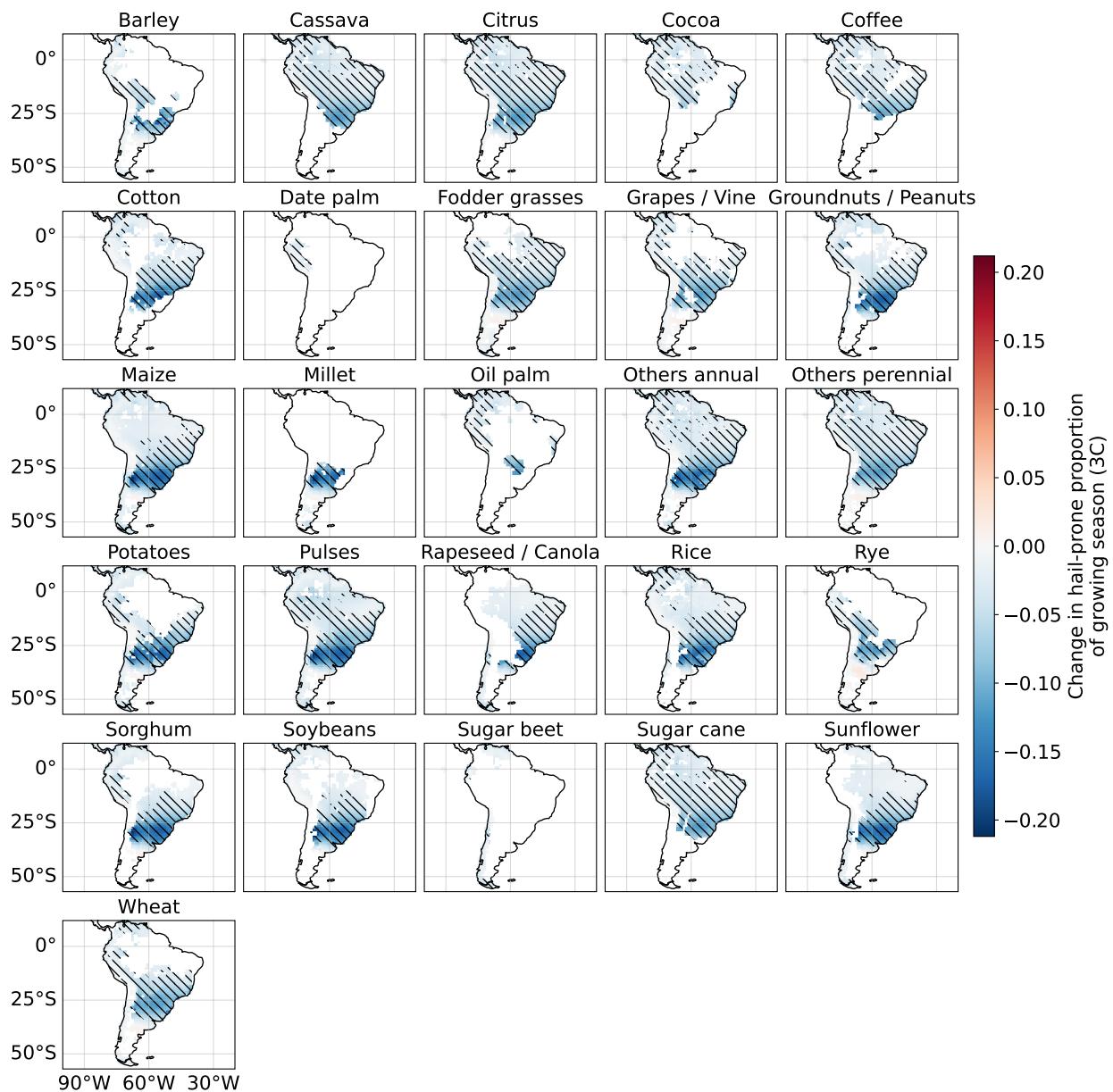
Supplementary Figure 9: Differences in mean annual hail-prone days by season, for 3 C warming. Stippling as for Figure 8.



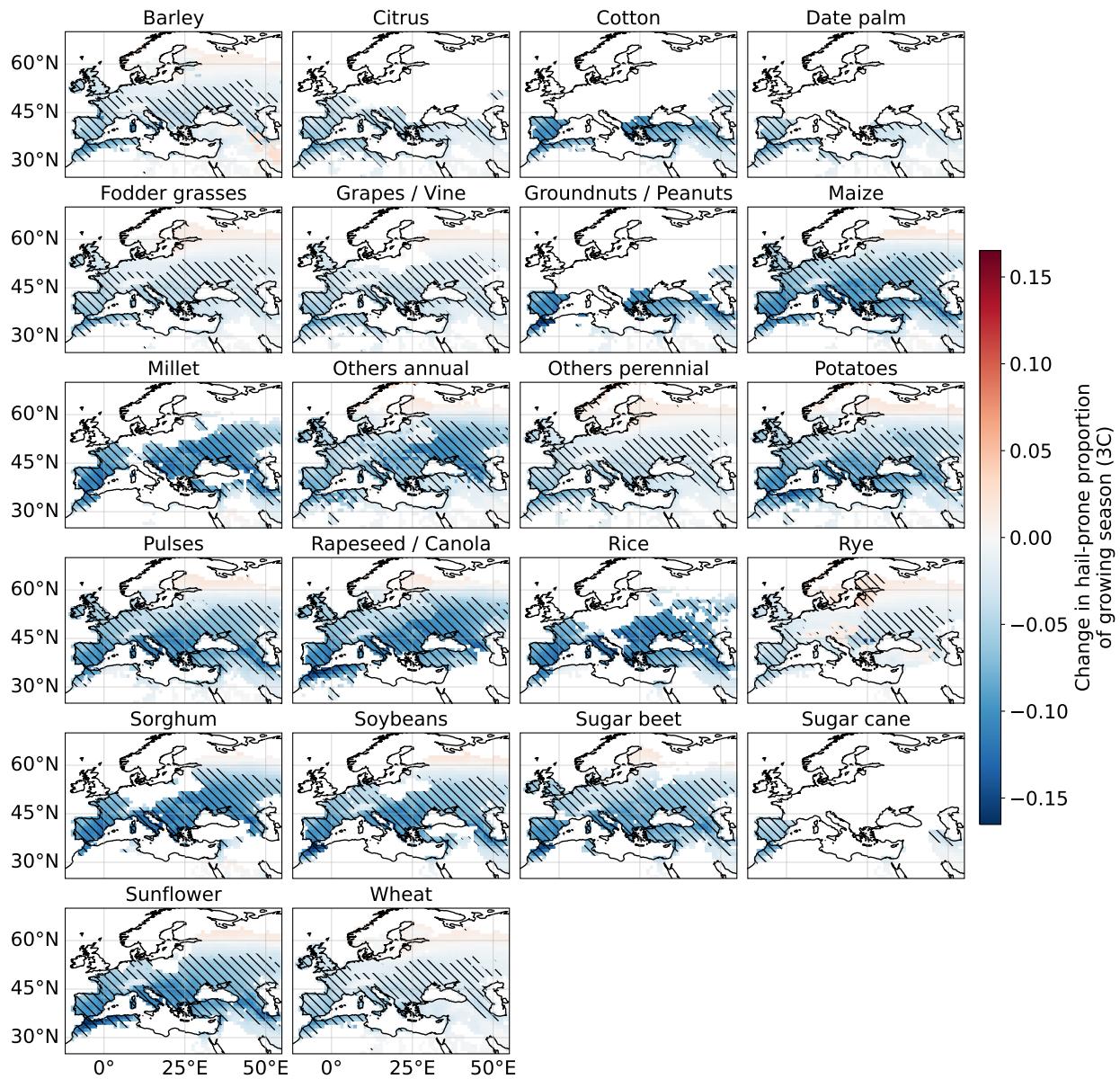
Supplementary Figure 10: **Multi-model mean relative differences in hail ingredients for 2 C warming.** Stippling as for Figure 8.



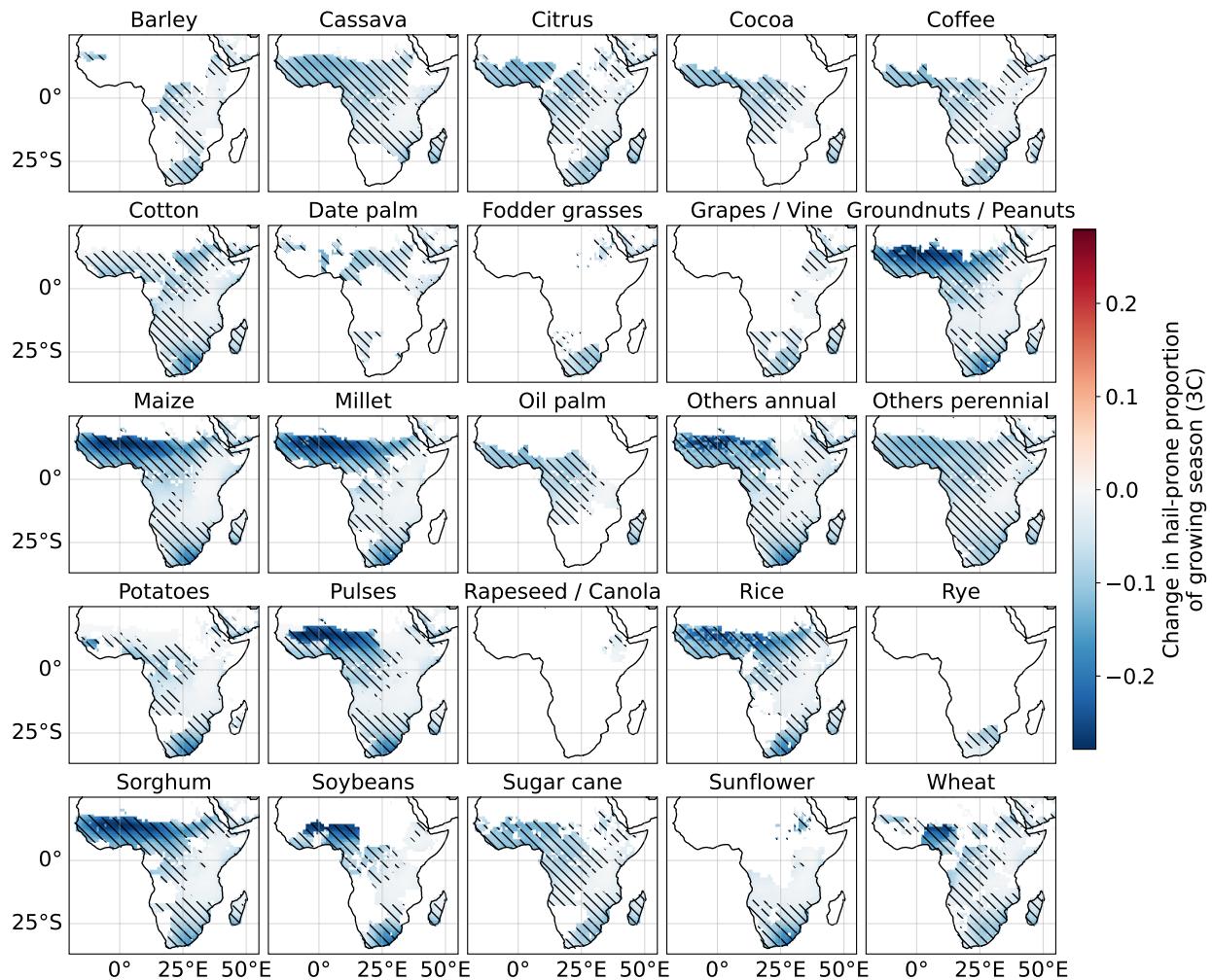
Supplementary Figure 11: Multi-model mean change in hail-prone proportion of growing season, for 2 C warming, for North America. Stippling as for Figure 8. Crops for which there were no significant changes are not shown.



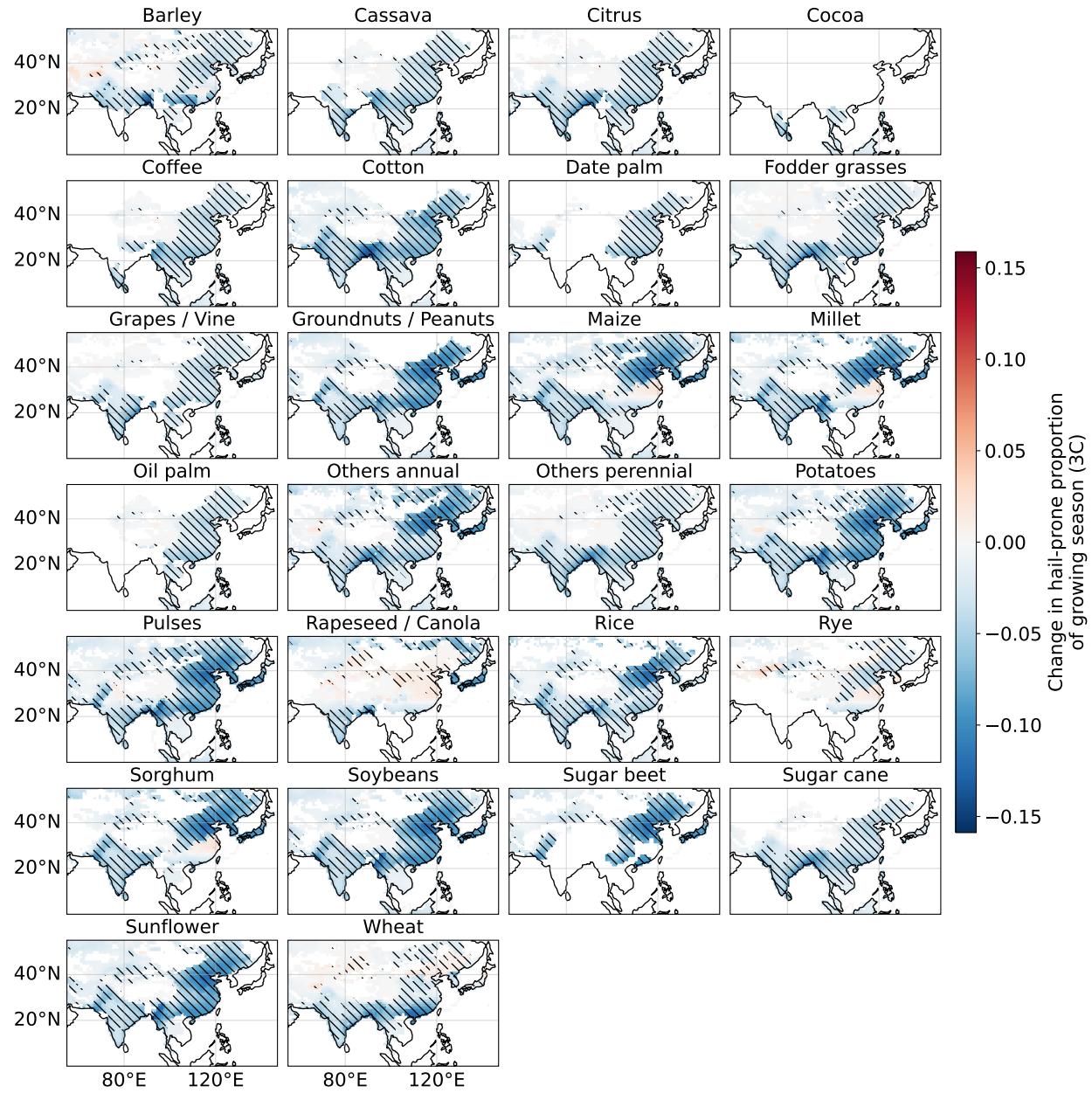
Supplementary Figure 12: As for Figure 11 but for South America.



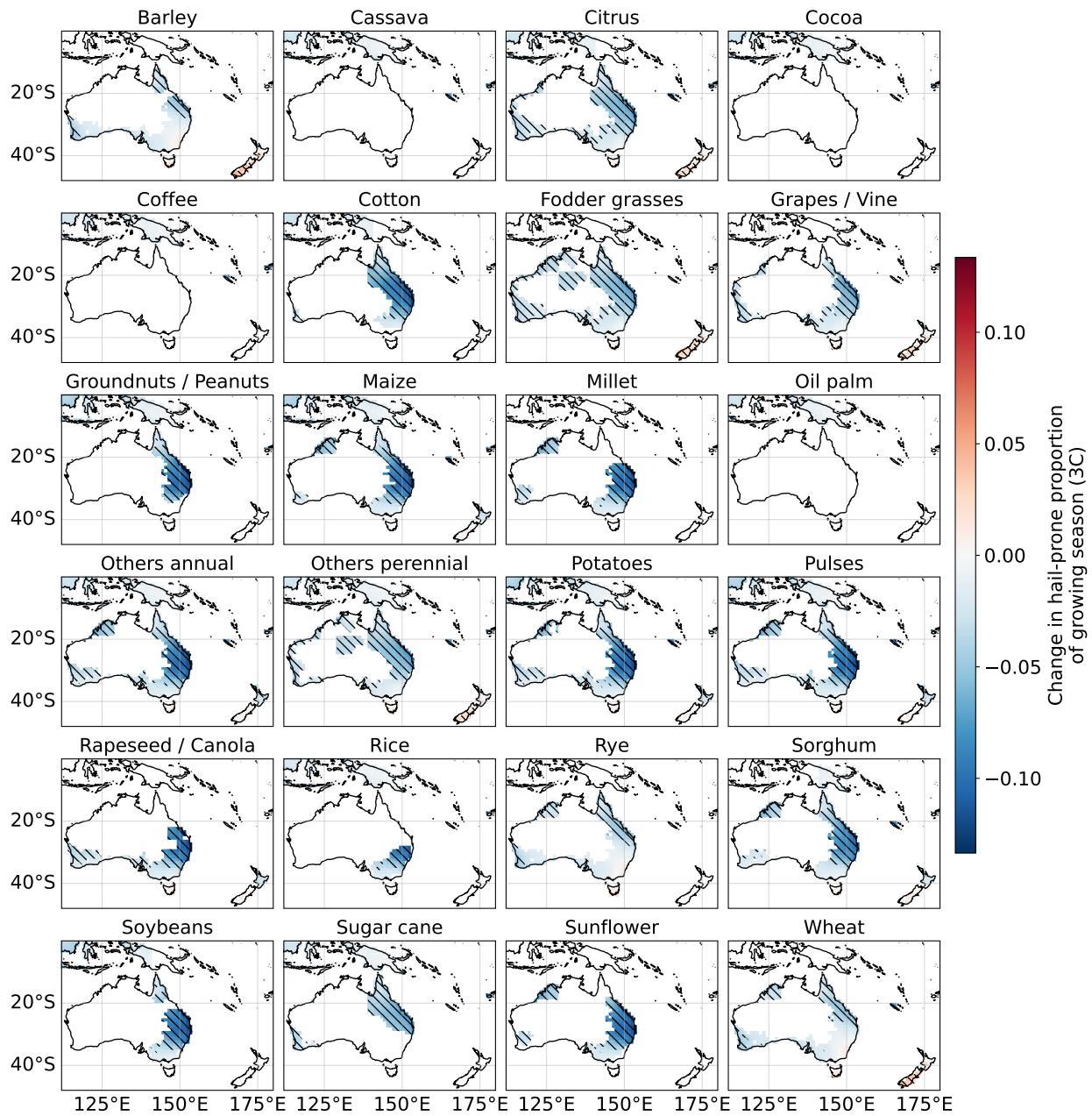
Supplementary Figure 13: As for Figure 11 but for Europe.



Supplementary Figure 14: As for Figure 11 but for central and southern Africa.



Supplementary Figure 15: As for Figure 11 but for central and southeast Asia.



Supplementary Figure 16: As for Figure 11 but for the Maritime Continent, Australia and New Zealand.

Supplementary References