Moisture recycling in Europe: analysis and impact on the precipitation in a changing climate

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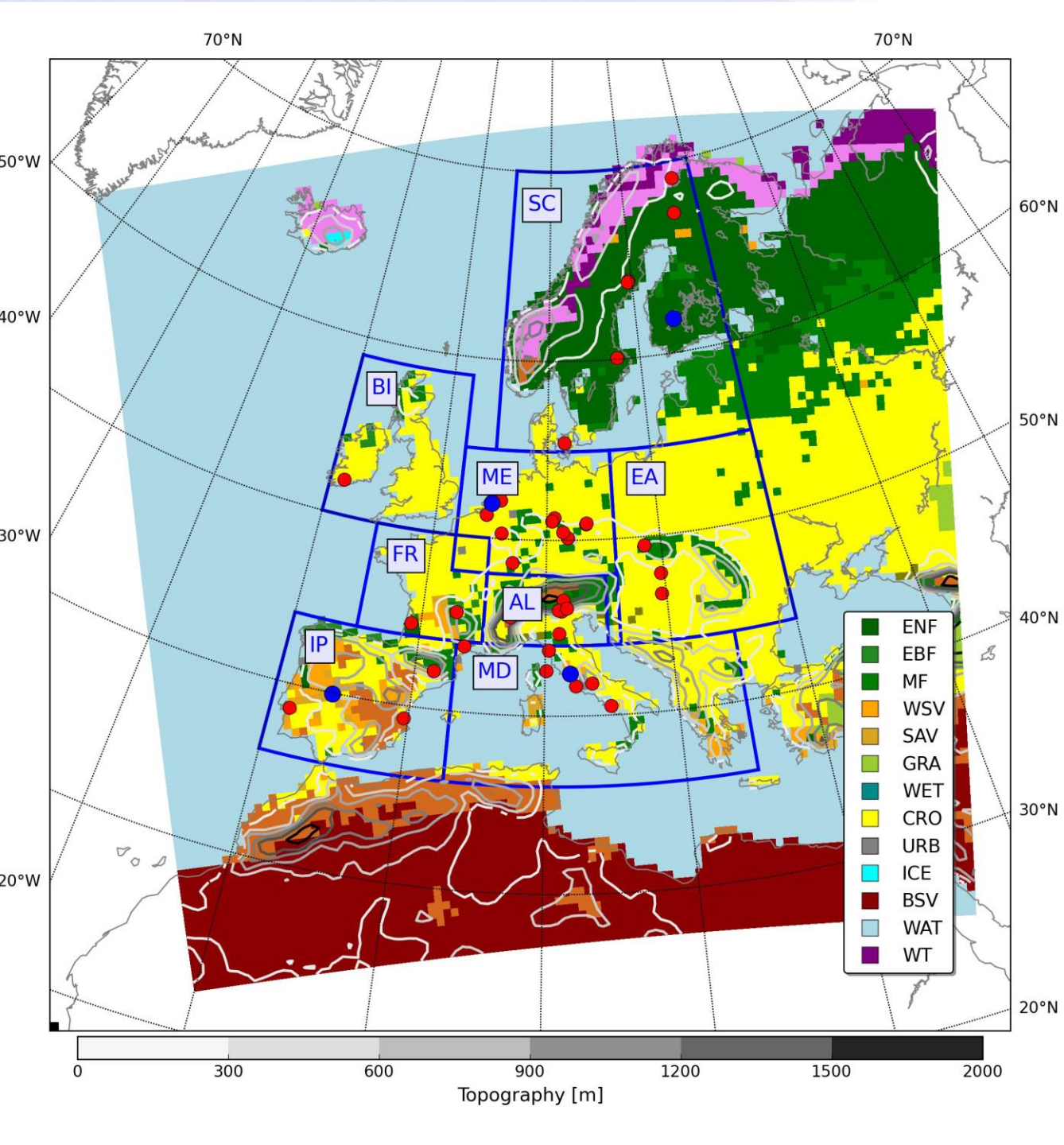
Moisture recycling refers to the contribution of local evapotranspiration fluxes to precipitation.

The recycling ratio ρ is the fraction of precipitation coming from ET.

It can be an indication of the degree of control of local processes on precipitation dynamics in a region.



EURO-CORDEX domain

and

Prudence regions

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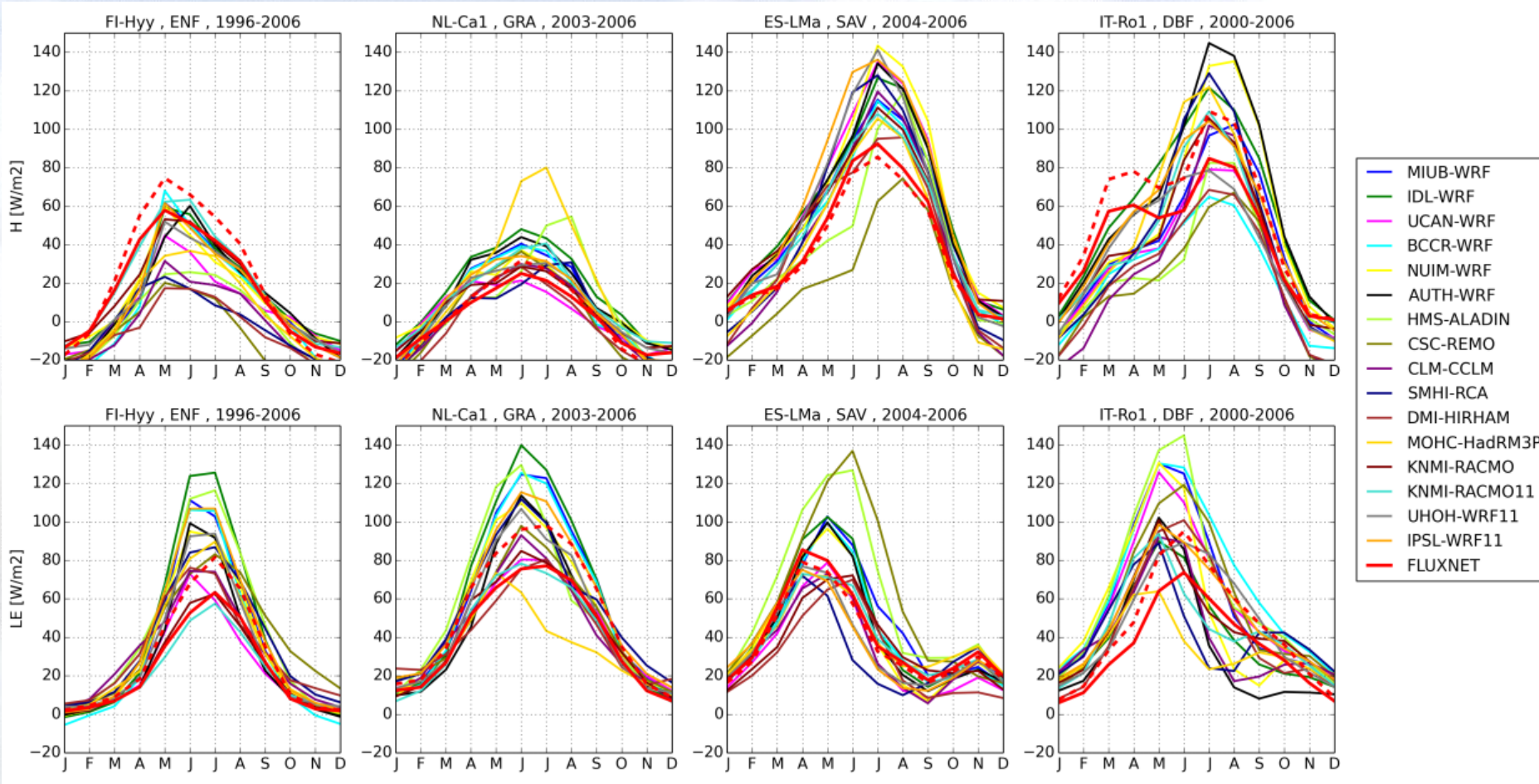
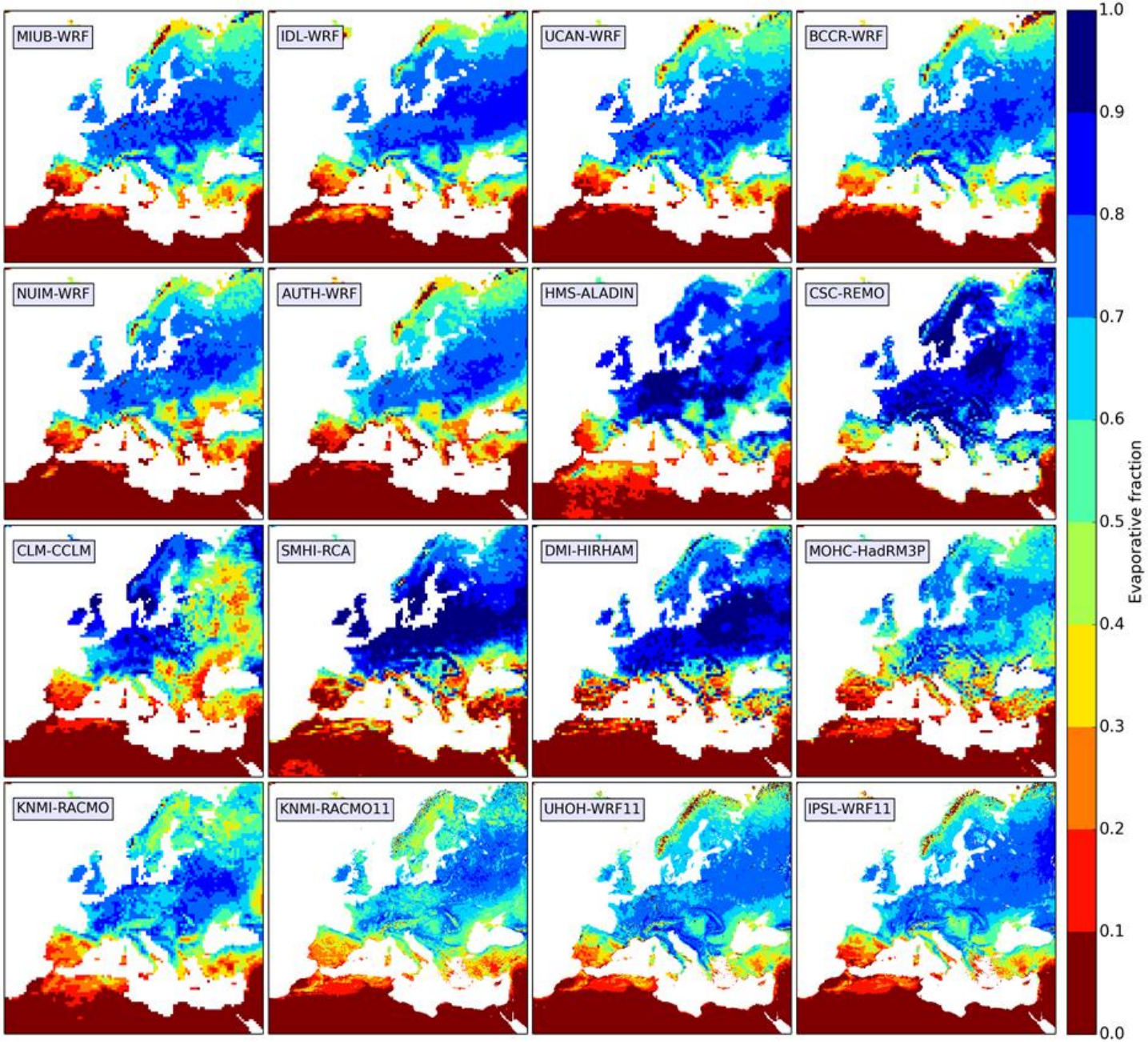
EURO-CORDEX models

Institution	Reference	Model	Forcing Model	Acronym	Resolution
Climate Limited-area Modelling Community	Rockel et al. (2008)	CCLM4-8-17	MPI-M-MPI-ESM-LR	CLM	0.44º
Danish Meteorological Institute	Christensen et al. (2006)	HIRHAM5	ICHEC-EC-EARTH	DMI	0.11º /0.44º
Instituto Dom Luiz	Skamarock et al. (2008)	WRFV350D	IDL-EC-Earth	IDL	0.44º
Institut Pierre Simon Laplace and Institut National de l Environnement industriel et des RISques	Skamarock et al. (2008)	WRF331F	IPSL-IPSL-CM5A-MR	IPSL	0.11º/0.44º
Koninklijk Nederlands Meteorologisch Instituut	van Meijgaard et al. (2008)	RACMO22E	ICHEC-EC-EARTH	KNMI	0.11º/0.44º
Swedish Meteorological and Hydrological Institute	Samuelsson et al. (2011)	RCA4	CNRM-CERFACS-CNRM-CM5	SMHI1	0.44º
			ICHEC-EC-EARTH	SMHI2	0.44º
			IPSL-IPSL-CM5A-MR	SMHI3	0.44º
			MPI-M-MPI-ESM-LR	SMHI4	0.44º
			CCCma-CanESM2	SMHI5	0.44º
			CSIRO-QCCCE-CSIRO-Mk3-6-0	SMHI6	0.44º
			MIROC-MIROC5	SMHI7	0.44º
			NCC-NorESM1-M	SMHI8	0.44º
			NOAA-GFDL-GFDL-ESM2M	SMH9	0.44º

Mean annual cycles of monthly mean of sensible (top) and latent (bottom) heat flux at four representative FLUXNET stations (thick red line)



Knist, S. et al. 2016: Validation of soil moisture and surface fluxes in EURO-CORDEX simulations as part of land-atmosphere coupling analysis. *Submitted to JGR Atmospheres*



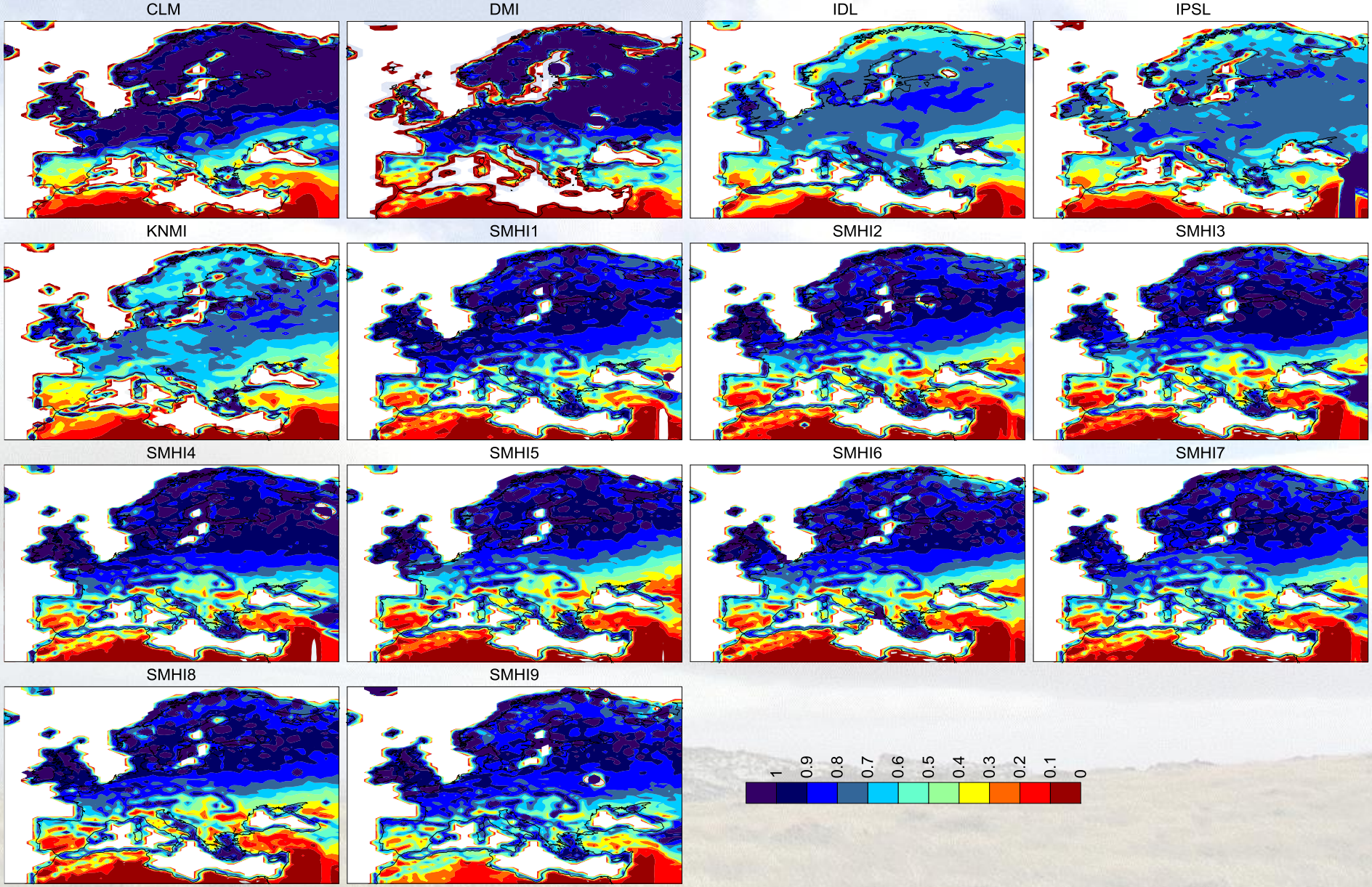
ERA-Interim (1990-2008)

Evaporative fraction

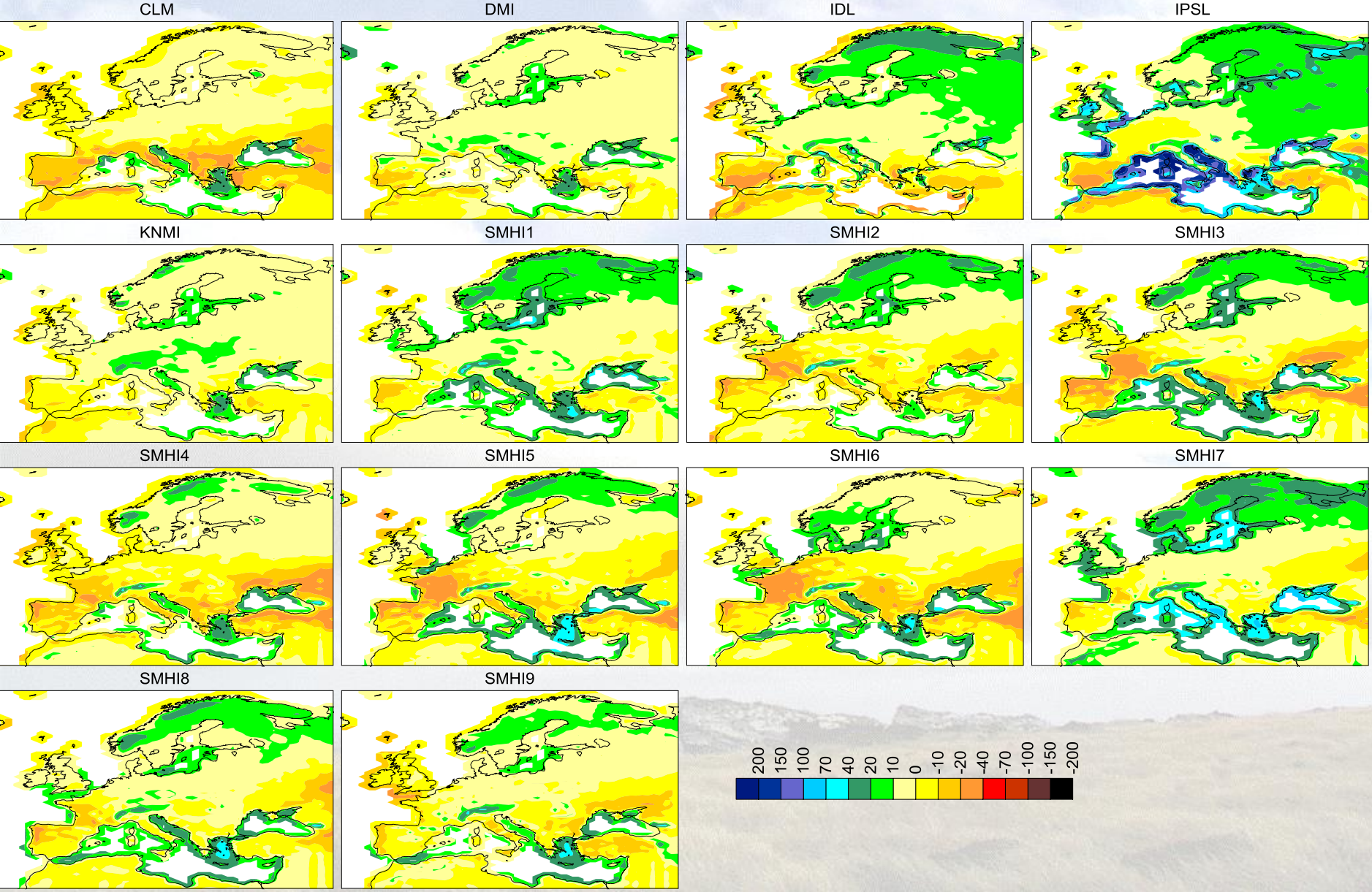
$$\frac{LE}{H + LE}$$

Knist, S. et al. 2016: Validation of soil moisture and surface fluxes in EURO-CORDEX simulations as part of land-atmosphere coupling analysis. *Submitted to JGR Atmospheres*

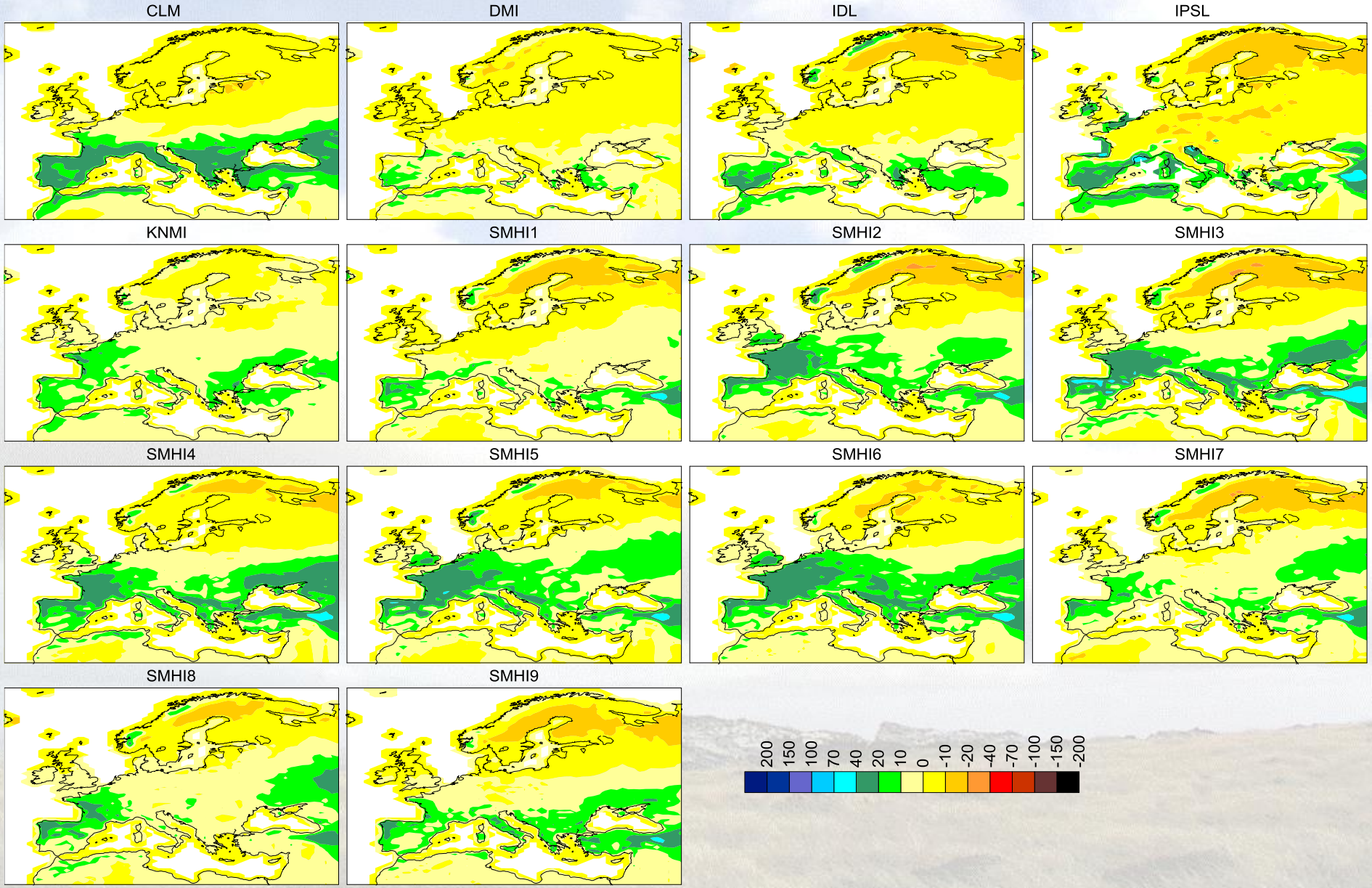
Summer Evaporative Fraction 1971-2000



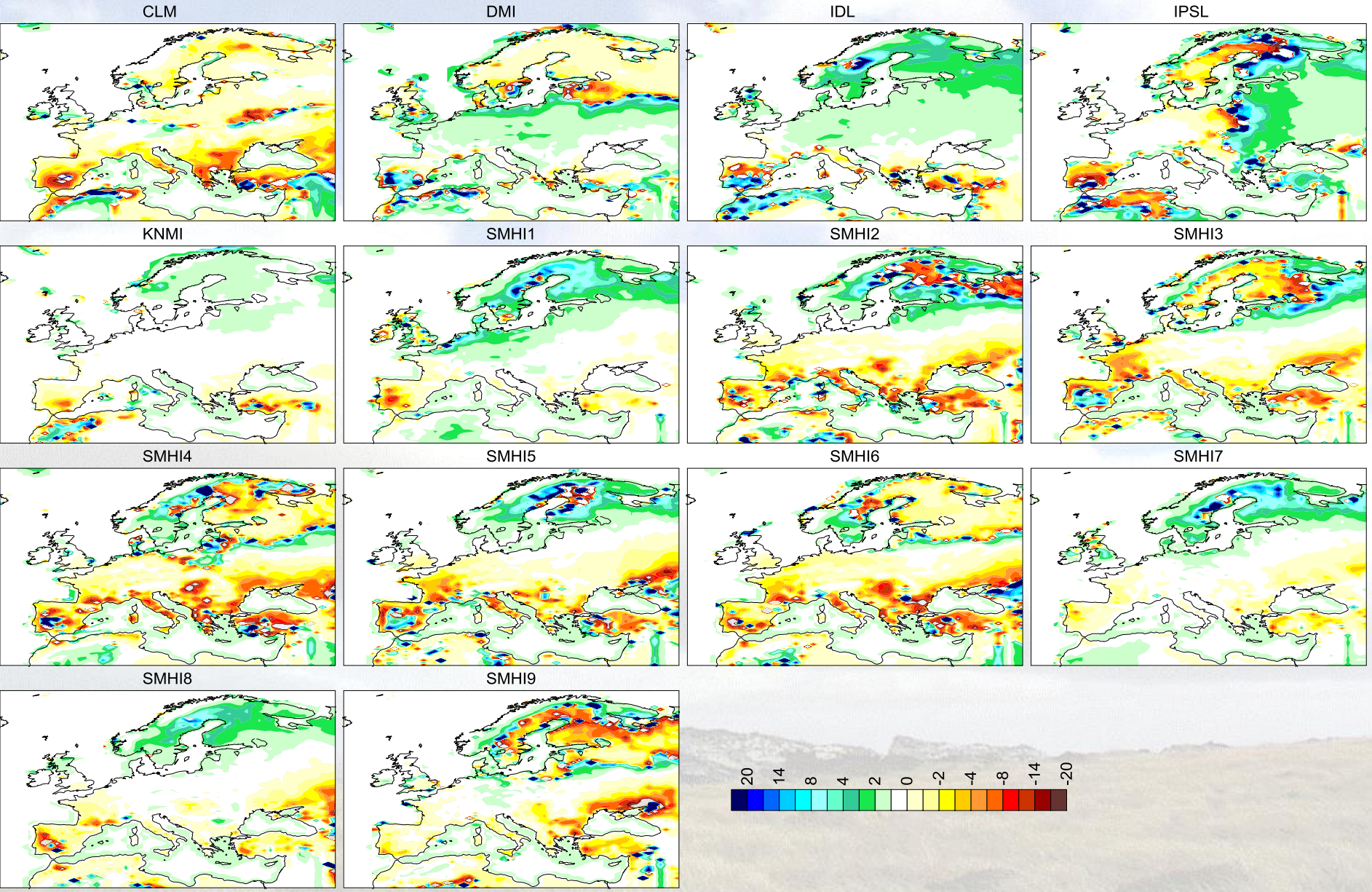
Summer mean Latent Heat Flux anomalies
Fut (2071-2100)–Hist (1971-2000)

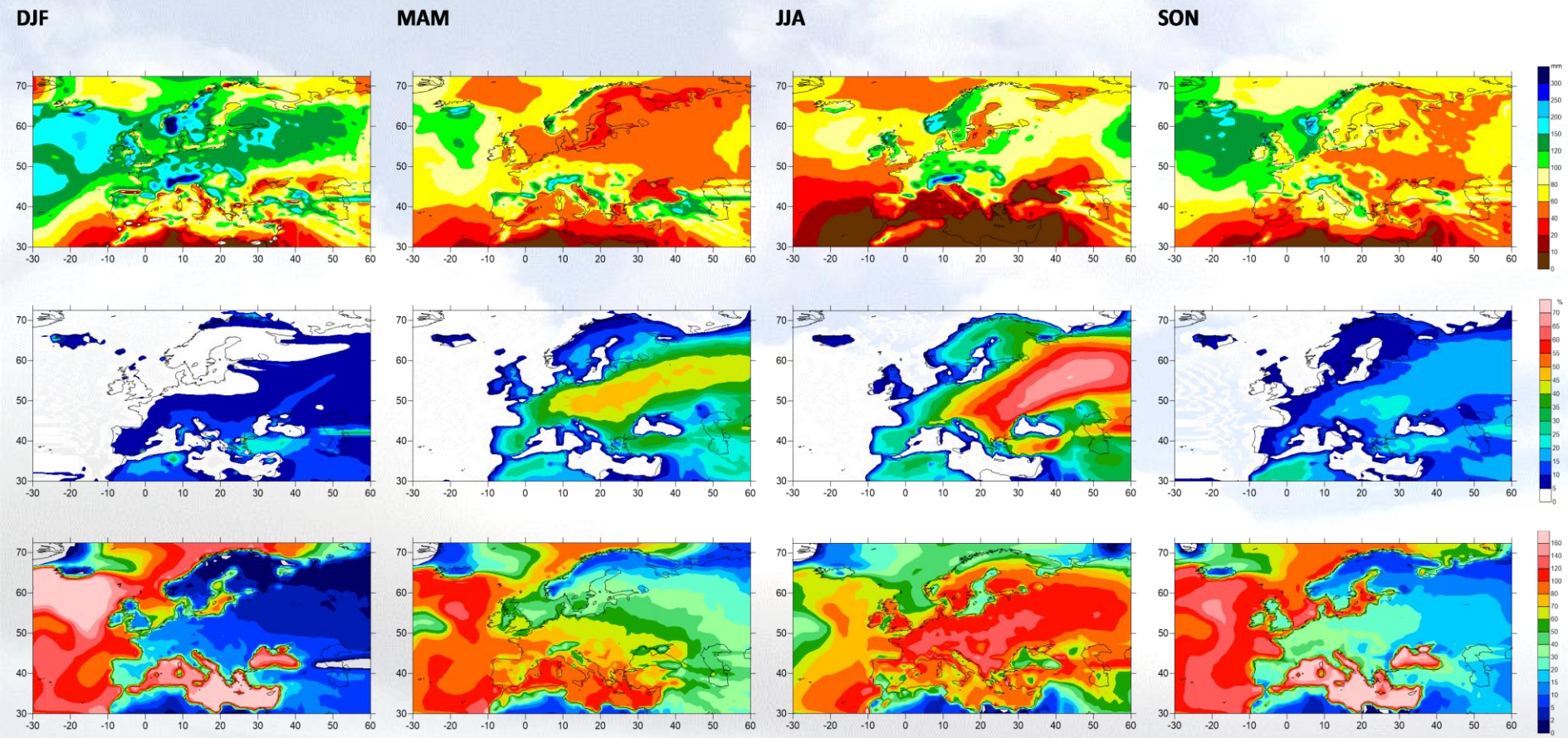


Summer mean Sensible Heat Flux anomalies
Fut (2071-2100)–Hist (1971-2000)



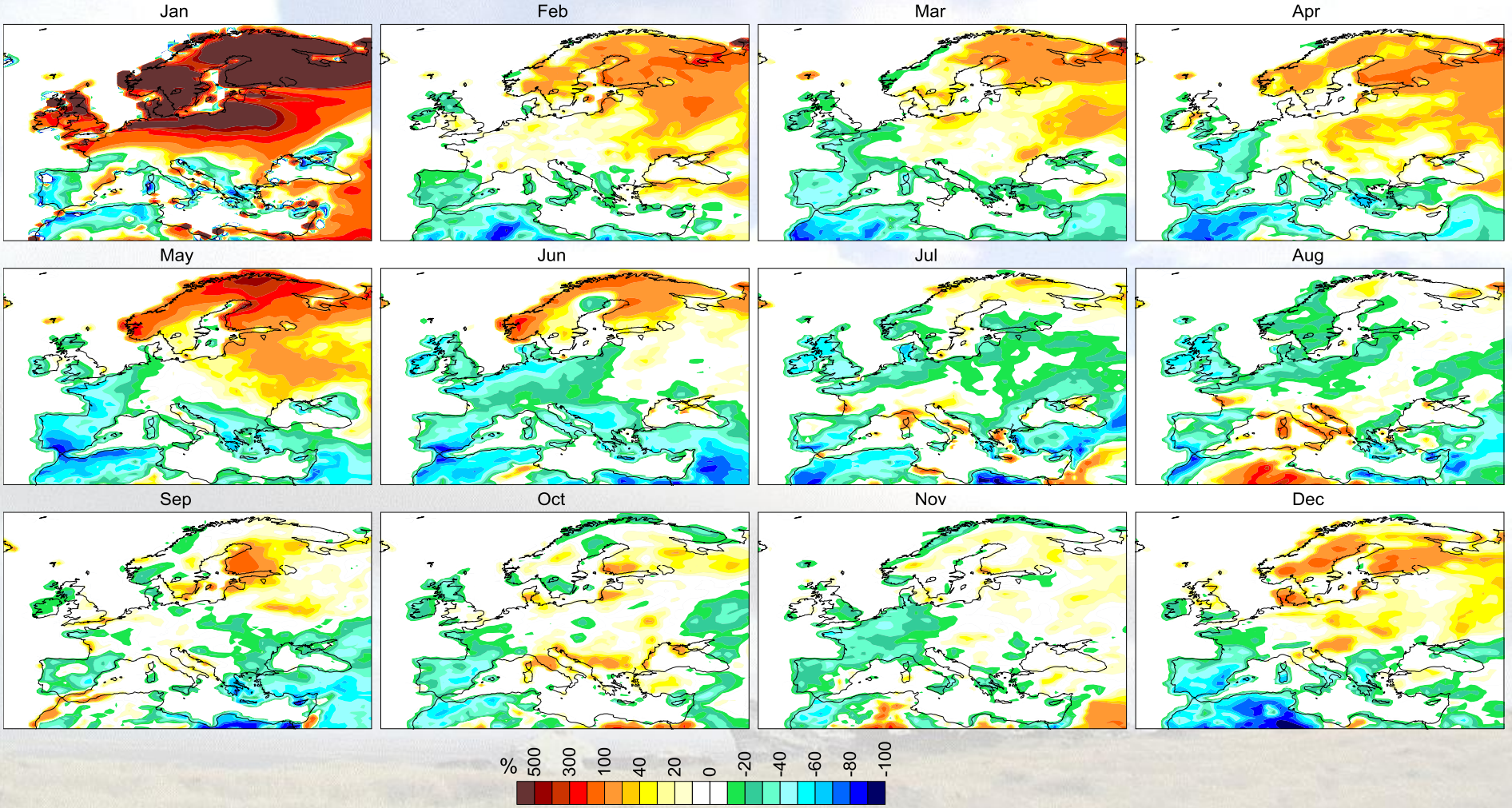
Summer mean Evaporative Fraction anomalies
Fut (2071-2100)–Hist (1971-2000)



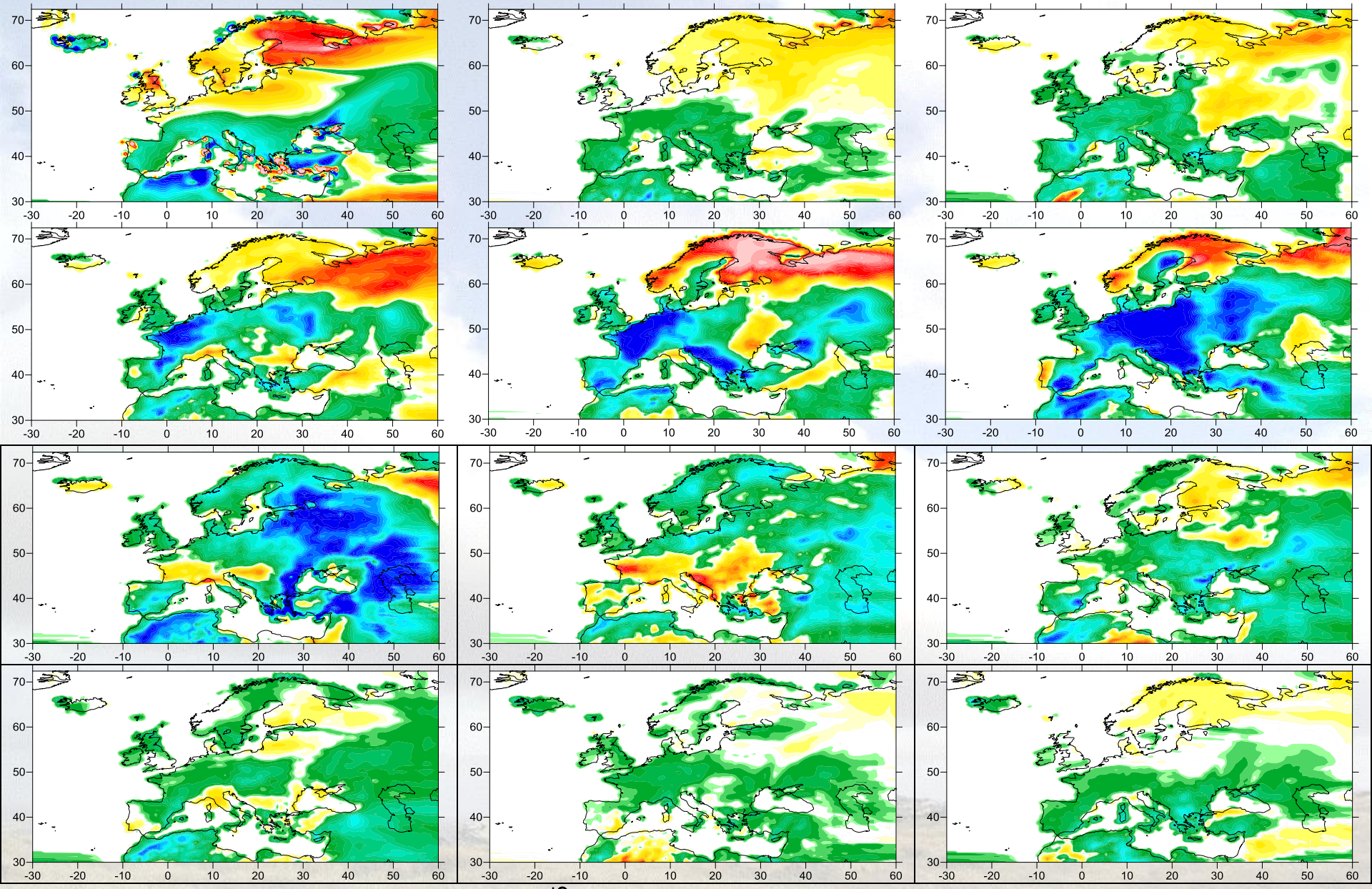


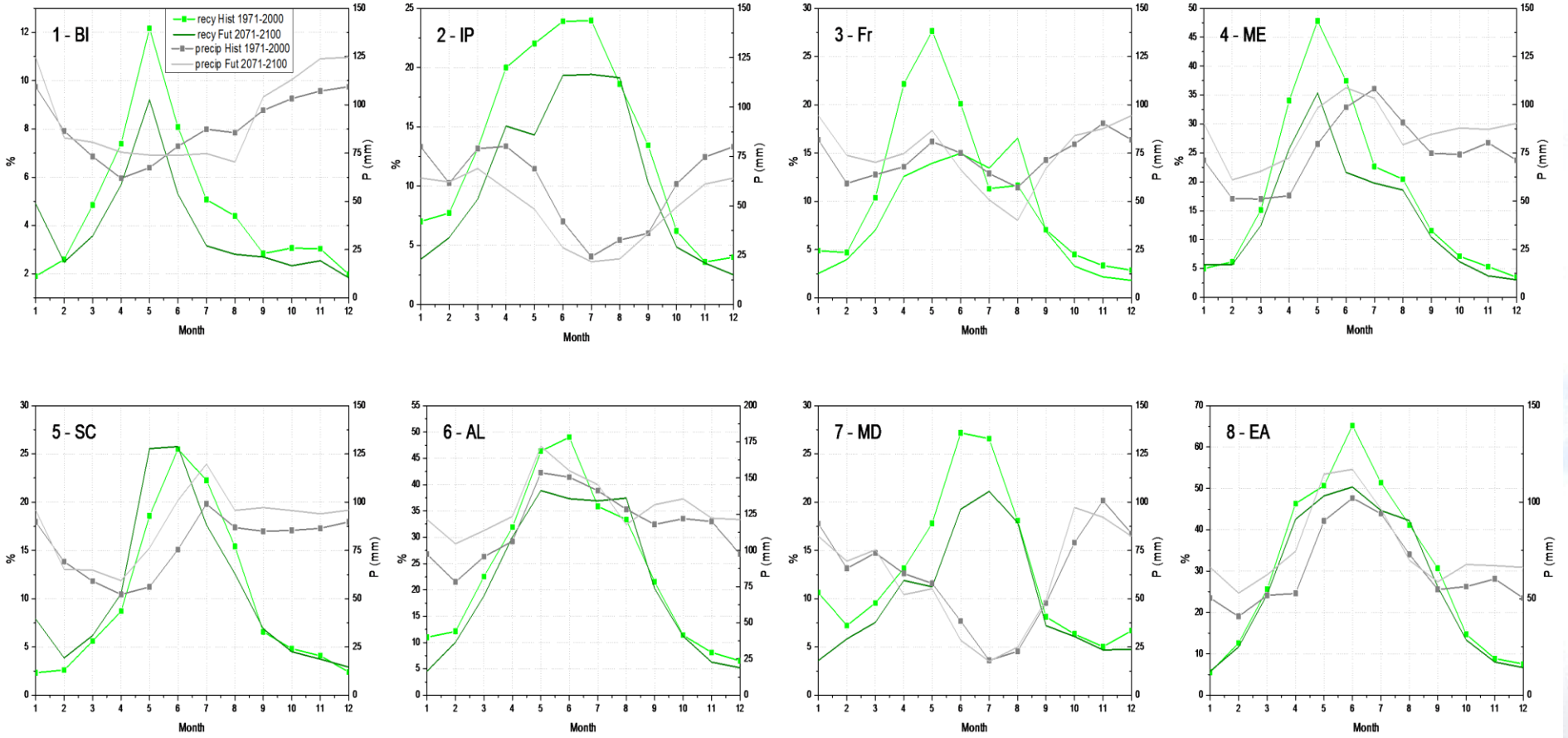
Seasonal mean precipitation (top row), recycling ratio (center), potential evapotranspiration (third row) for the period 1971-2000

Monthly mean evapotranspiration anomalies
Fut (2071-2100)–Hist (1971-2000)



Monthly mean recycling ratio anomalies Fut (2071-2100)–Hist (1971-2000)





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Discussion

- The Euro-CORDEX models have a large spread in terms of the distribution in LE and H between models. This is also reflected in the evaporative fraction;
- The changes in the heat fluxes and EF between 2071-2100 and 1971-2000 also show a large spread. The majority of the models forecast an increase in EF in Scandinavia and a decrease in the Mediterranean and Iberia
- The highest recycling ratio occurs in central and eastern Europe in late Spring and Summer; where the percentage of precipitation from evapotranspiration is higher than 50%;
- Although some areas experience an increase in future precipitation, this occurs mostly during the winter and late autumn, when recycling ratios are lowest. Thus this increase is mostly due to the advection of moisture associated to the trajectory of frontal systems;
- With the exception of Scandinavia and the Alps in August, the recycling ratio suffers a reduction in the future.

Summer Precipitation anomalies
Fut (2071-2100)–Hist (1971-2000)