

Land-surface feedbacks on temperature and precipitation in CMIP6-LS3MIP projections

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Outline

- Aim of LS3MIP
 - assess the role of land-atmosphere feedbacks on climate change
 - isolate the impacts of the soil moisture changes on temperature and precipitation climate change
- LS3MIP-LFMIP experiments setup
- Land surface feedbacks in EC-Earth3
- The LS3MIP-LFMIP MME
- Conclusions

LS3MIP LFMIP (land feedback) experiments

Experiment name	Description	#years (tot: 484)
amip-LFMIP-pdLC f1	GLACE-type CMIP6 SSP1-2.6 scenario with prescribed 1980-2014 climatological soil moisture from historical. SST and Sea-Ice from the fully coupled SSP1-2.6 experiment (first member).	1980-2100 (121)
amip-LFMIP-pdLC f2	GLACE-type CMIP6 SSP5-8.5 scenario with prescribed 1980-2014 climatological soil moisture from historical. SST and Sea-Ice from the fully coupled SSP5-8.5 experiment (first member).	1980-2100 (121)
amip-LFMIP-rmLC f1	GLACE-type CMIP6 SSP1-2.6 scenario with prescribed 30-years projected soil moisture running mean from scenario. SST and Sea-Ice from the fully coupled SSP1-2.6 experiment (first member).	1980-2100 (121)
amip-LFMIP-rmLC f2	GLACE-type CMIP6 SSP5-8.5 scenario with prescribed 30-years projected soil moisture running mean from scenario. SST and Sea-Ice from the fully coupled SSP5-8.5 experiment (first member).	1980-2100 (121)

- tier-1 simulations switched from coupled to amip, coupled simulations (if any) now tier-2

→ ***all tier-1 EC-Earth LFMIP experiments completed by ENEA***

→ ***data published on NSC ESGF node***

EC-Earth3

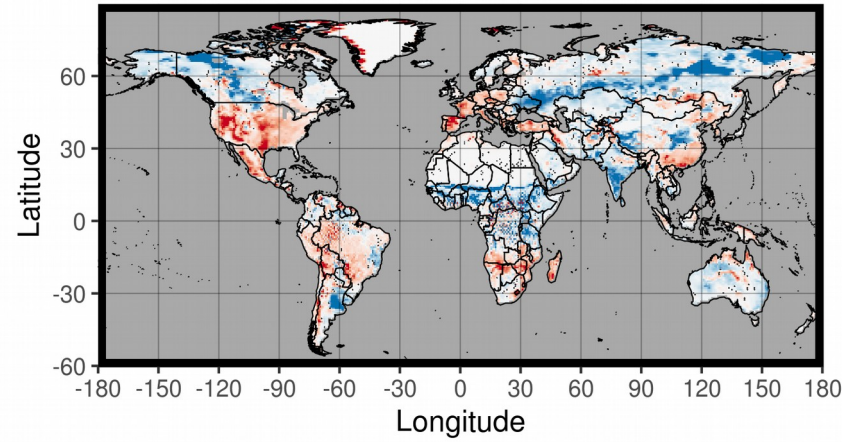
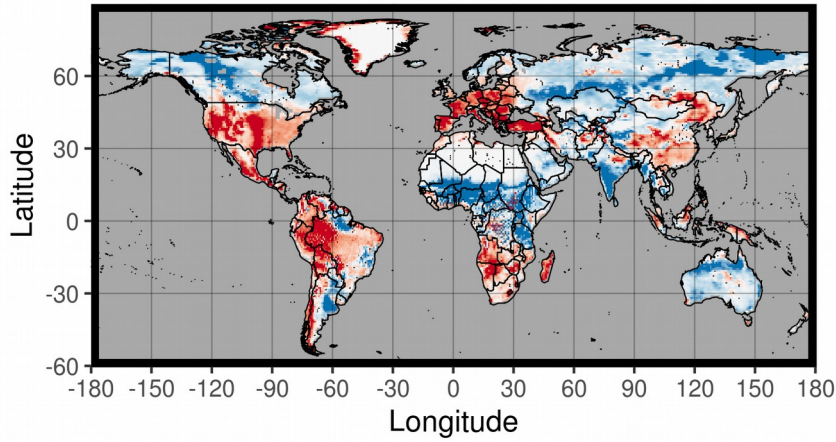


rmLC-pdLC climate change sensitivity (2071-2100 minus 1985-2014)

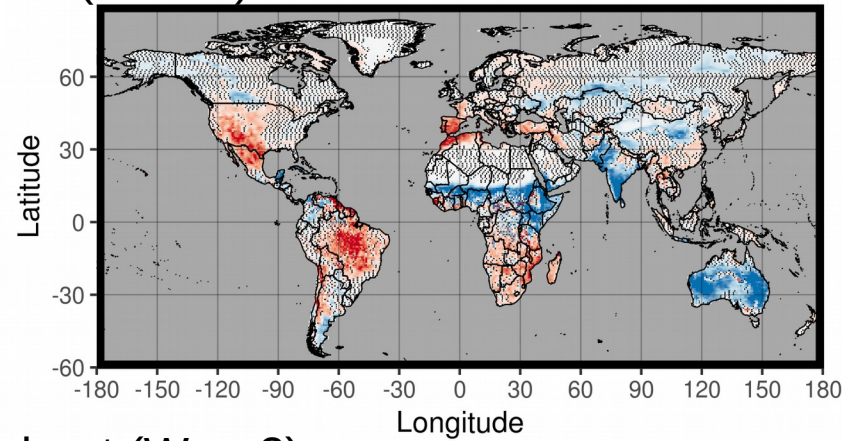
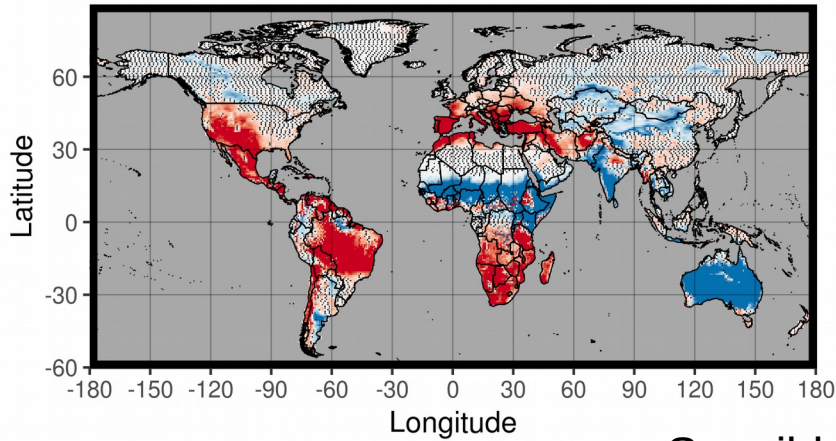
SSP5-8.5

Soil moisture (mm)

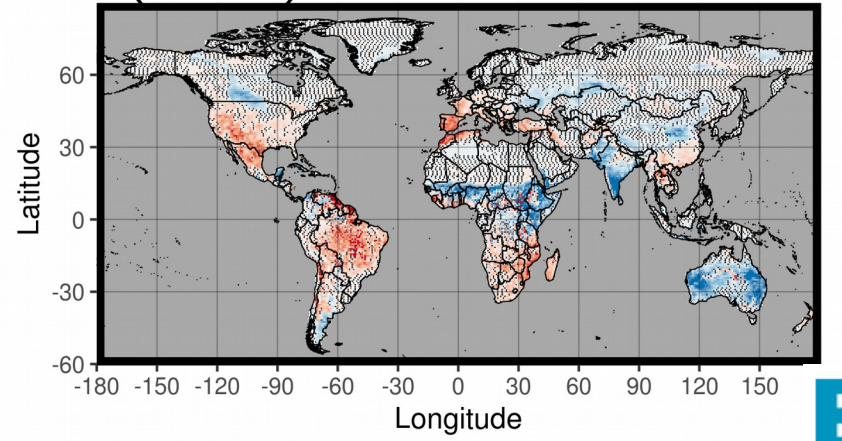
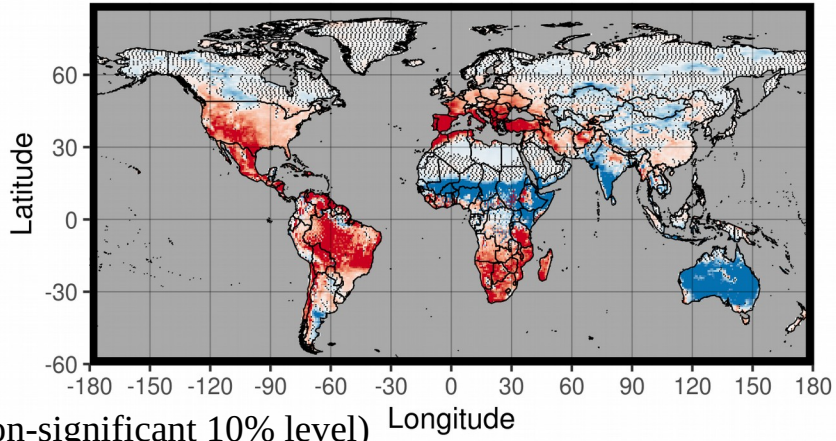
SSP1-2.6



Latent heat ($W m^{-2}$)



Sensible heat ($W m^{-2}$)



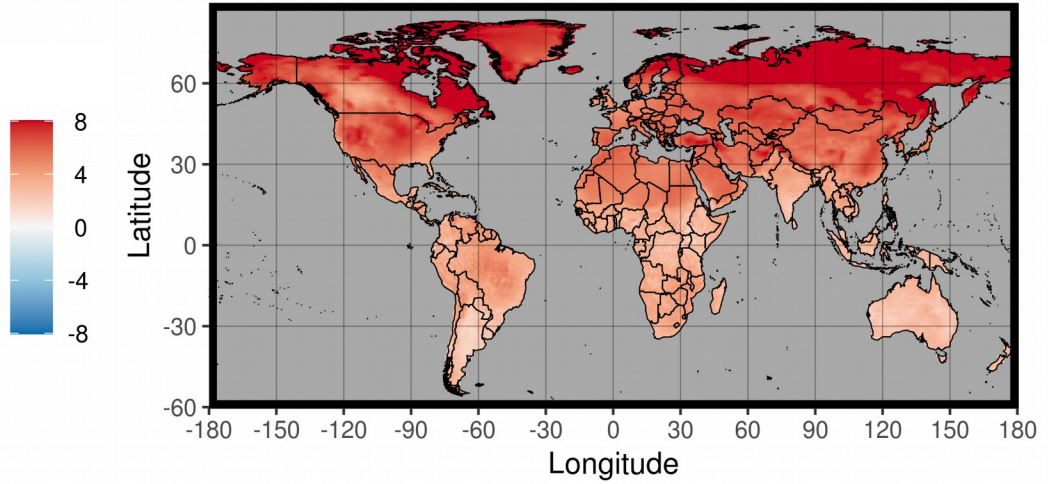
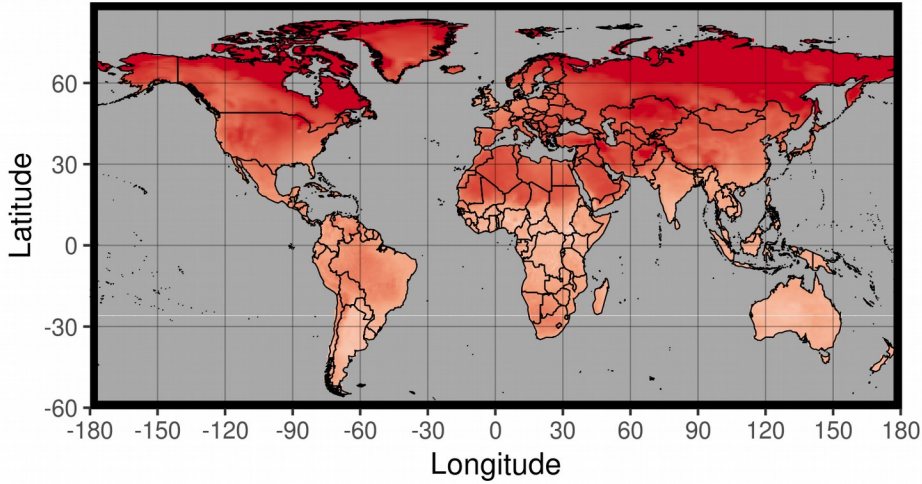
(dotted: non-significant 10% level)

2m-temperature change and sensitivity (2071-2100 minus 1985-2014)

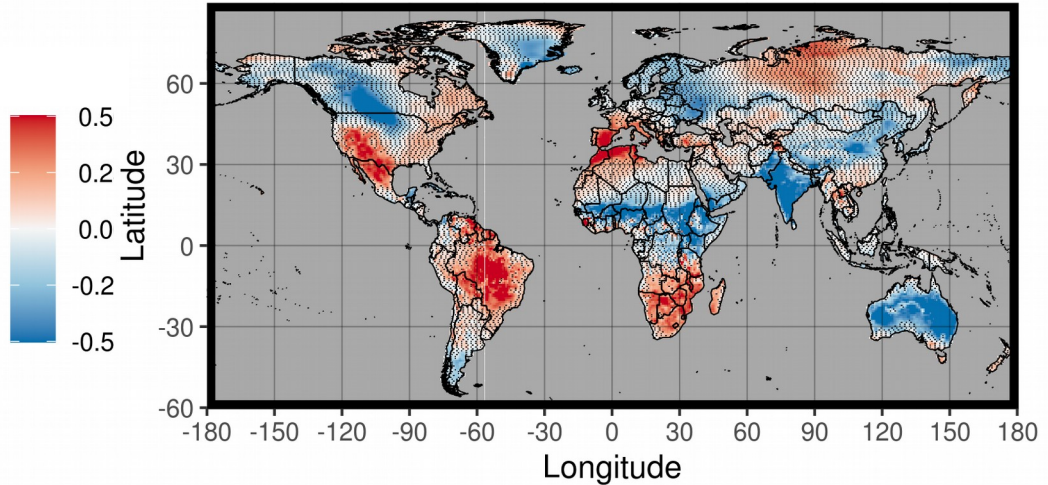
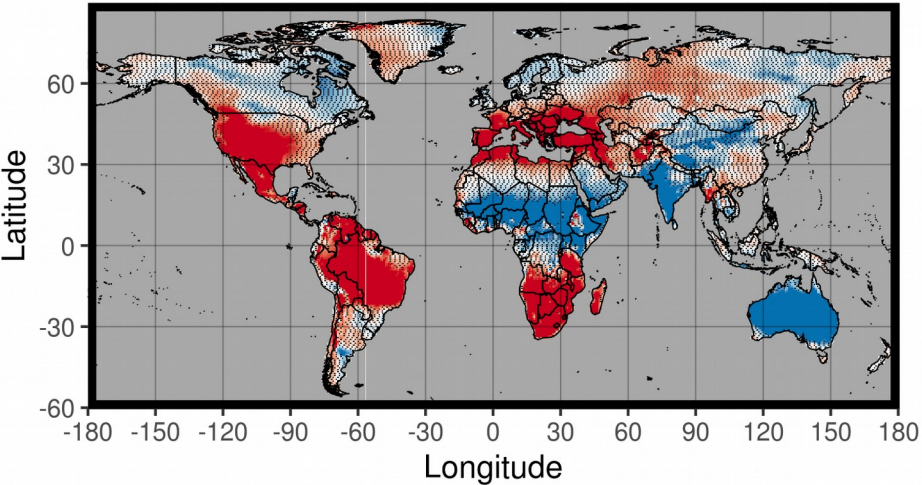
SSP5-8.5

SSP1-2.6

21st century change (K)



rmLC-pdLC sensitivity (K)



(dotted: non-significant 10% level)

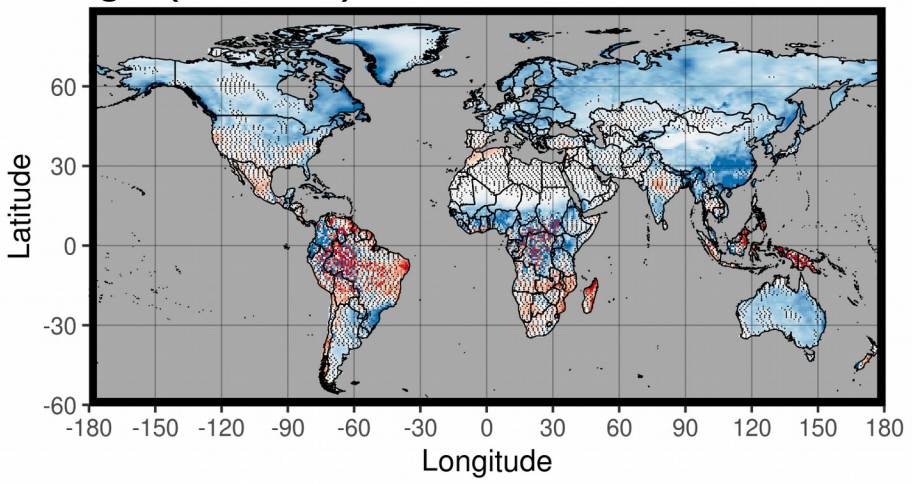
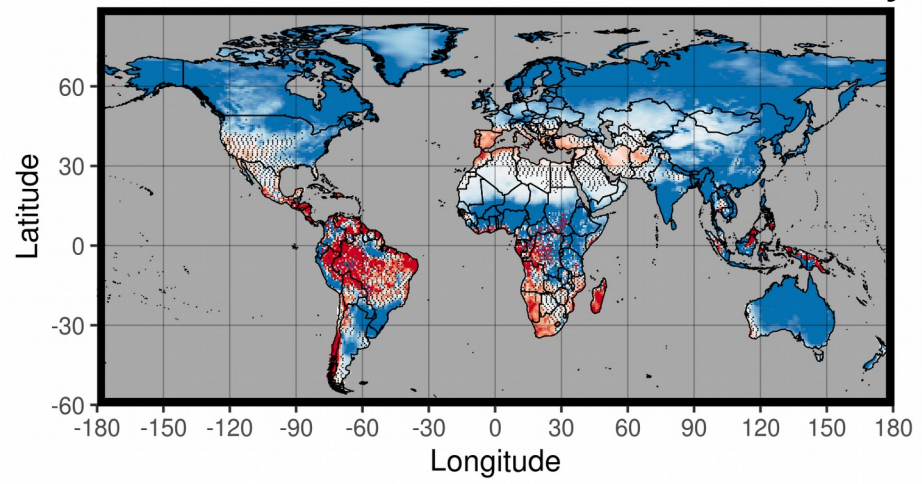


Precipitation change and sensitivity (2071-2100 minus 1985-2014)

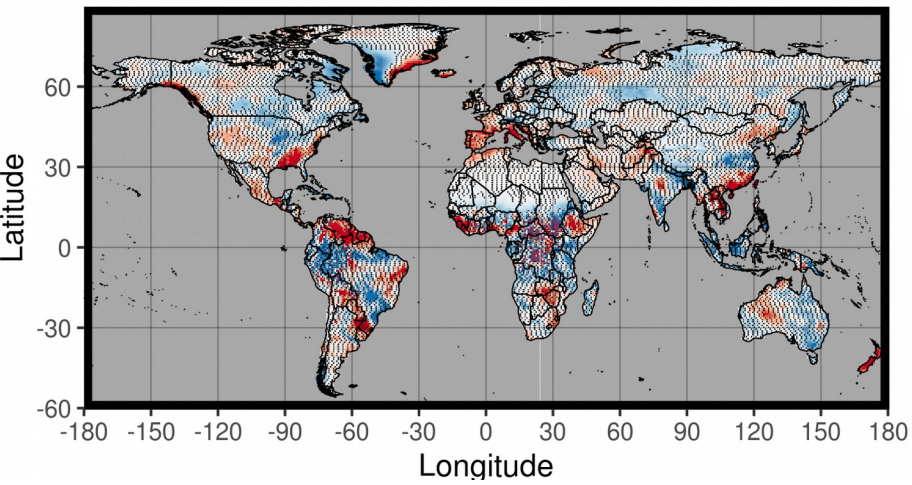
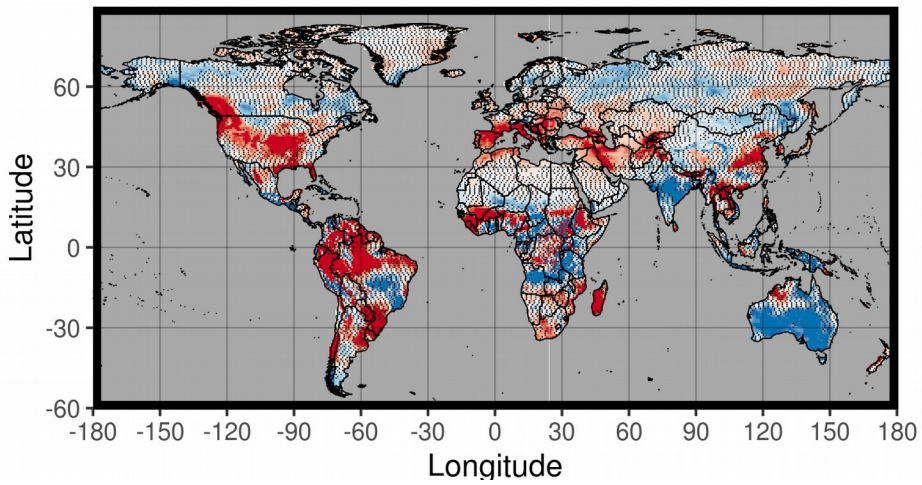
SSP5-8.5

SSP1-2.6

21st century change (mm d-1)



rmLC-pdLC sensitivity (mm d -1)



(dotted: non-significant 10% level)

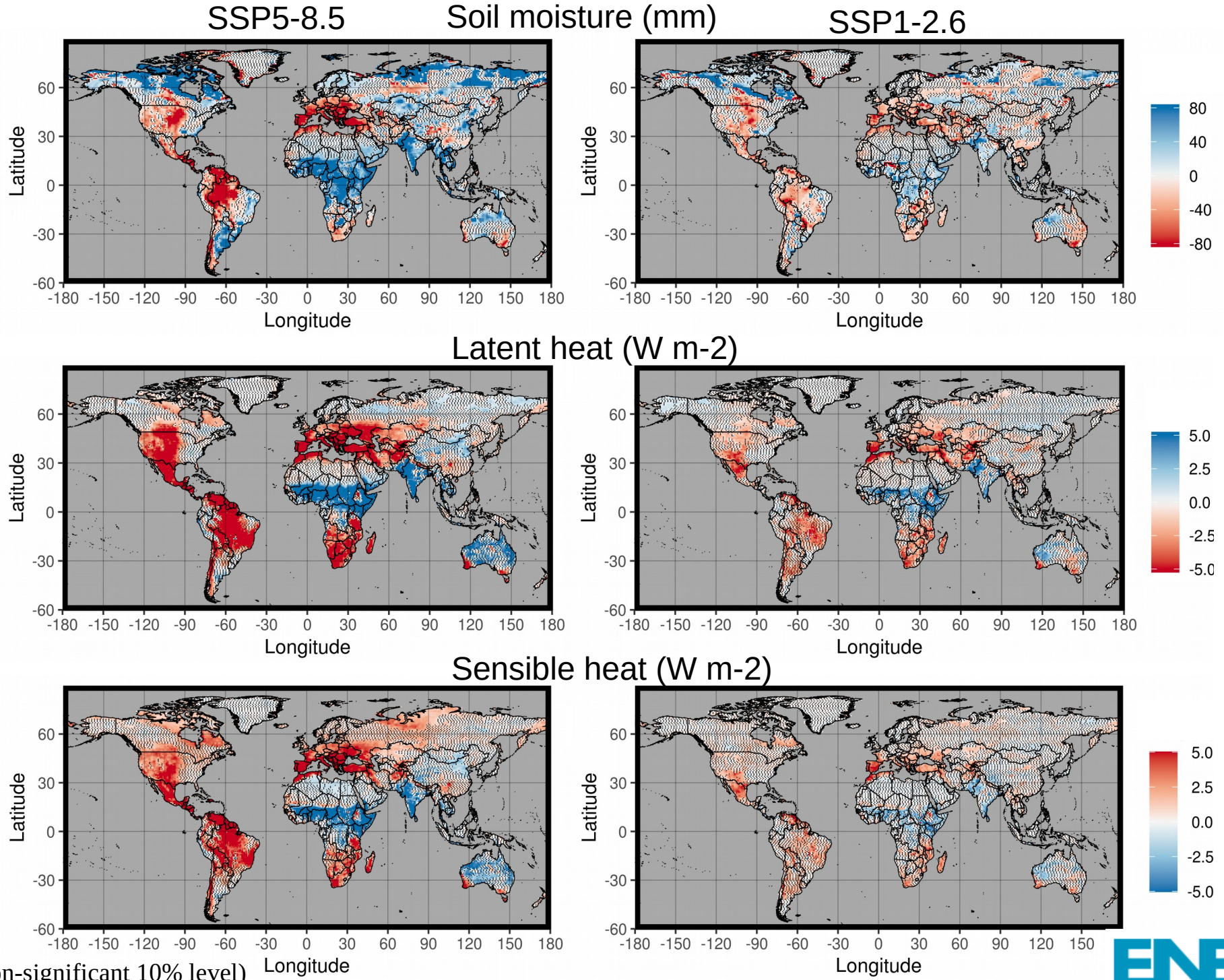


The LS3MIP-LFMIP Multi Model Ensemble

5 Earth System Models:

institute	ESM	Atmosphere model	Land model	resolution
EC-Earth consortium	EC-Earth3	IFS cycle 36r4	HTESSEL	T255 L91 (256 x 512 lat/lon)
NCAR	CESM2	CAM6	CLM5	F09 L32 (192 x 288 lat/lon)
IPSL	IPSL-CM6A-LR	LMDZ6A	ORCHIDEE	N96 L79 (143 x 144 lat/lon)
MPI-M	MPI-ESM1-2-LR	ECHAM6	JSBACH3	T63 L47 (192 x 96 lat/lon)
CNRM-CERFACS	CNRM-CM6-1	ARPEGE6	ISBA-CTRIP	T127 L91 (128 x 256)

rmLC-pdLC climate change sensitivity (2071-2100 minus 1985-2014)



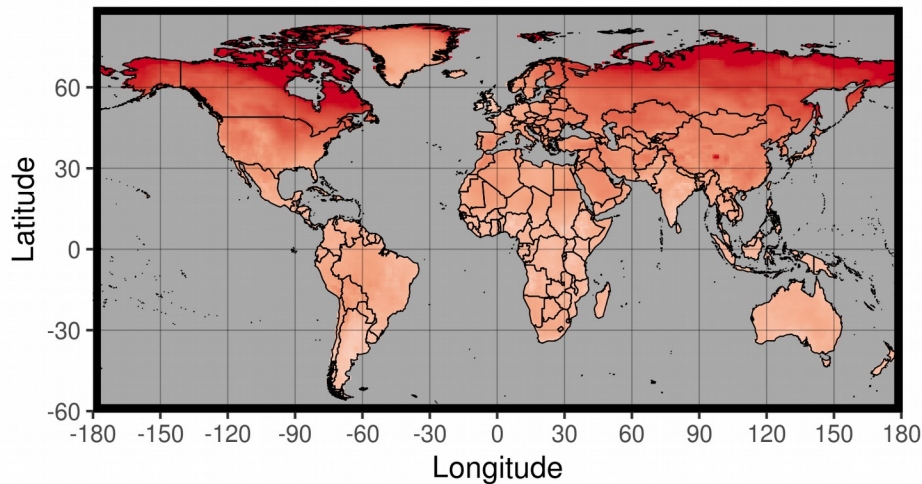
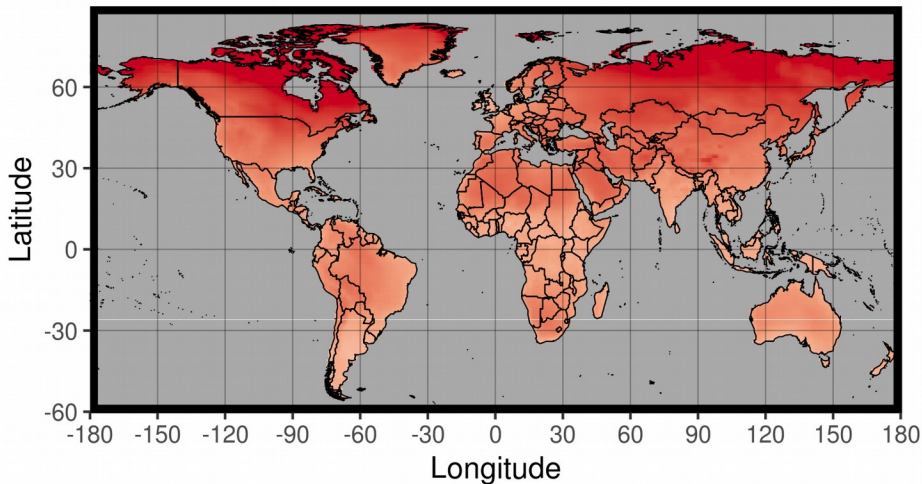
(dotted: non-significant 10% level)

2m-temperature change and sensitivity (2071-2100 minus 1985-2014)

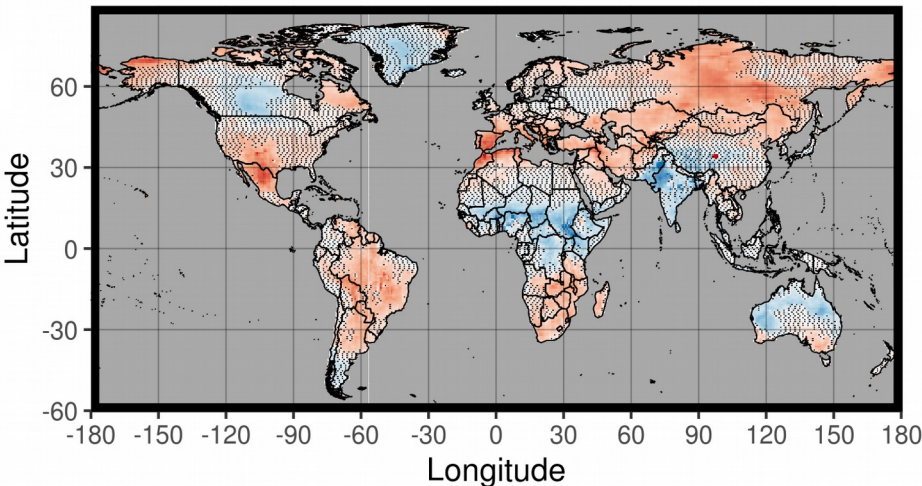
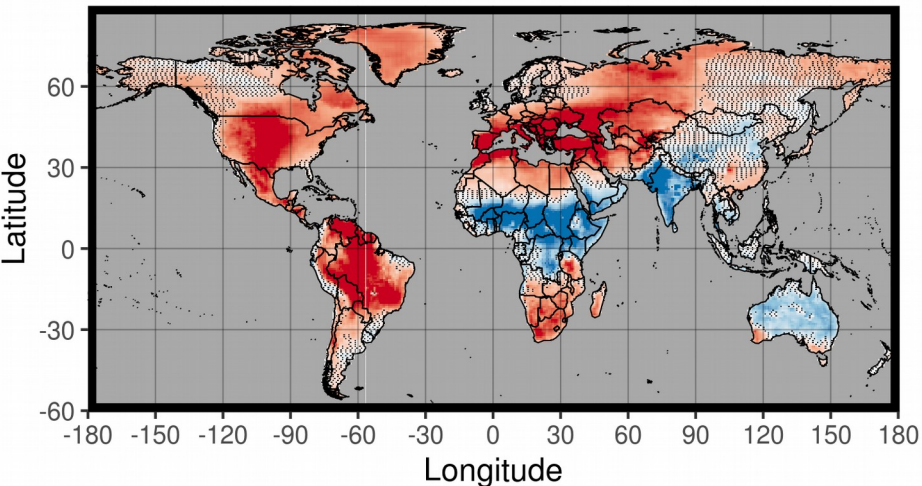
SSP5-8.5

SSP1-2.6

21st century change (K)



rmLC-pdLC sensitivity (K)



(dotted: non-significant 10% level)

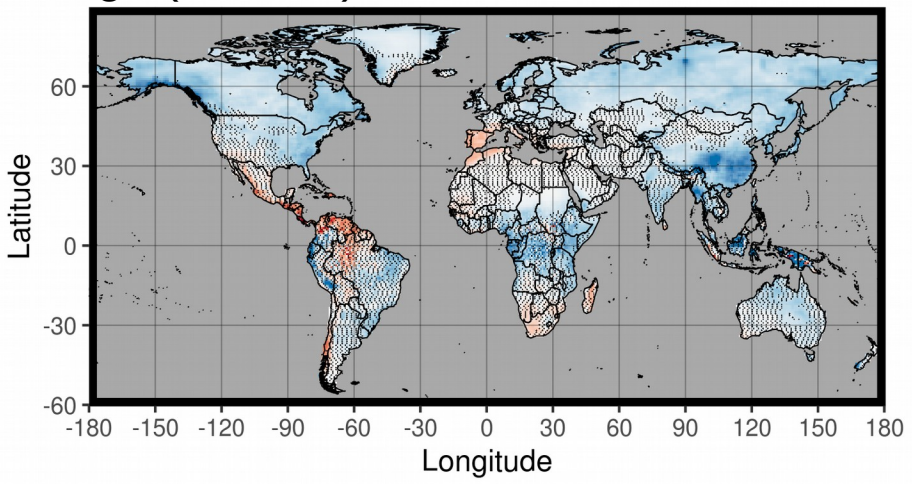
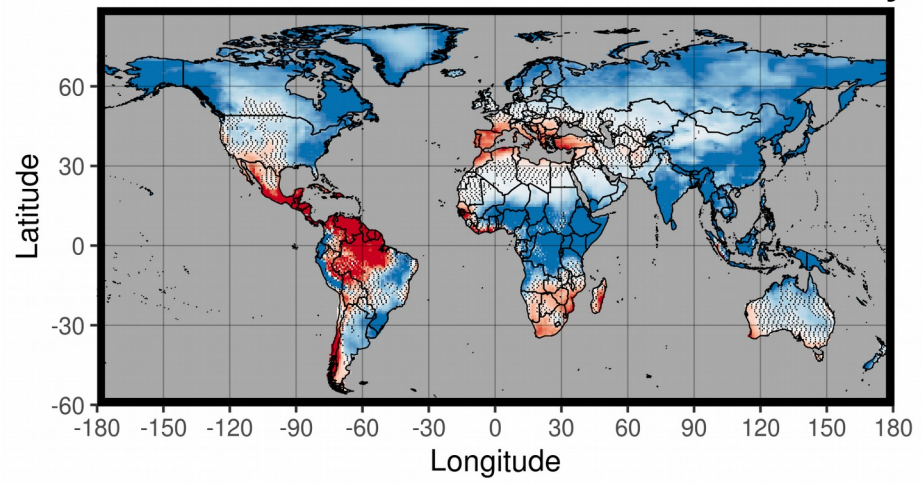


Precipitation change and sensitivity (2071-2100 minus 1985-2014)

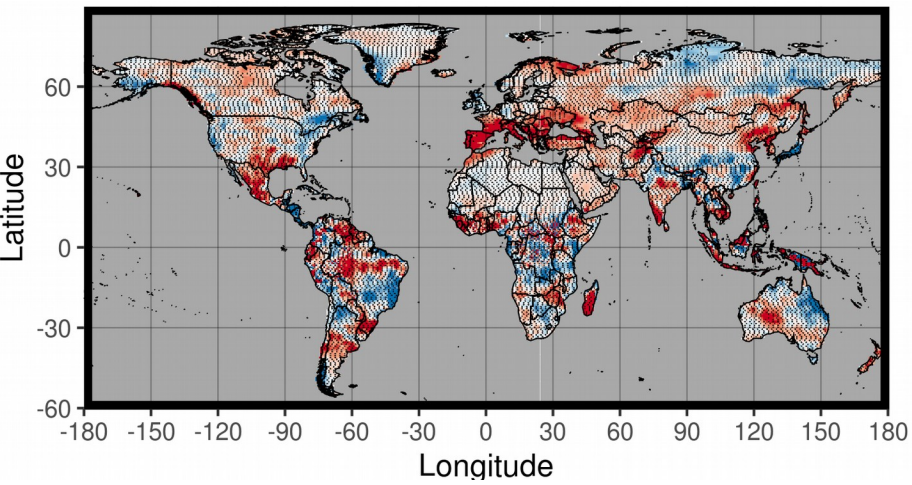
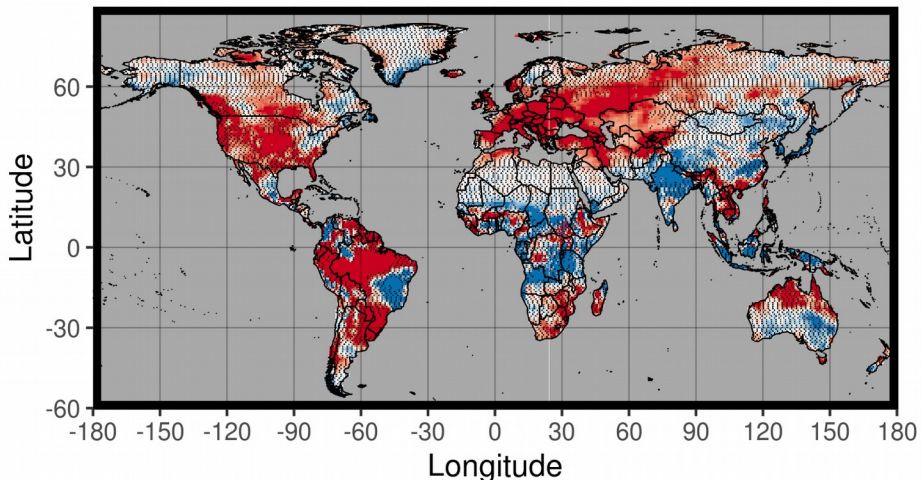
SSP5-8.5

SSP1-2.6

21st century change (mm d-1)



rmLC-pdLC sensitivity (mm d -1)



(dotted: non-significant 10% level)



Conclusions

- ✓ First results of the land-surface feedbacks on temperature and precipitation changes in LS3MIP-LFMIP experiments in CMIP6:
 - EC-Earth results are overall consistent with LS3MIP-LFMIP MME
 - The (2071-2100) minus (1985-2014) temperature change is positive everywhere over land and the climate change signal of precipitation displays a clear intensification of the hydrological cycle in the Northern Hemisphere.
 - Over the regions with negative soil moisture change, the 2m-temperature increases significantly while the cooling signal is not significant over all the regions getting wetter.
 - In agreement with Catalano et al. (2016), the larger effects on precipitation due to soil moisture forcing occur mostly over transition zones between dry and wet climates, where evaporation is highly sensitive to soil moisture.
 - The sensitivity of both 2m-temperature and precipitation to soil moisture change is much stronger in the SSP5-8.5 scenario.