INSTITUTO DOM LUIZ

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Response of the surface climate to different land surface models: WRF sensitivity to groundwater options

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Numerical Weather Prediction in Portugal 2021: Surface-Atmosphere Interactions| 11–12 November 2021

WRF Simulations

❖ Analysis of the surface climate response to different surface model options in WRF model

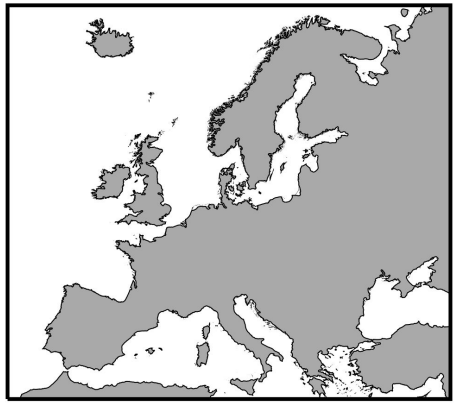
Period: 2004-2006

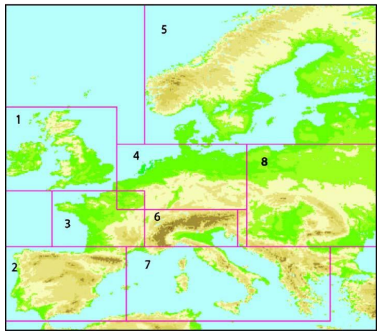
Boundary conditions from ERA5

Experiment Schemes	Noah	Noah-MP1	Noah-MP2	Noah-MP3
Radiation	RRTMG			
PBL	YSU			
Cumulus	Grell and Freitas ensemble			
Shallow Convection	GRIMS			
Microphysics	Thompson 28			
Surface layer	Revised MM5			
LSM	Noah	Noah-MP	Noah-MP	Noah-MP

NOAH-MP Options	Options		
Dynamic vegetation	Off; use input LAI; calculate FVEG		
Runoff and groundwater	Original surface and subsurface runoff (free drainage)	TOPMODEL with groundwater	Miguez-Macho & Fan groundwater scheme

EURO-CORDEX domain
EUR-11



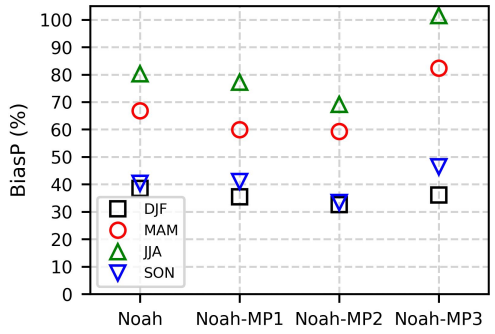


Results: Precipitation

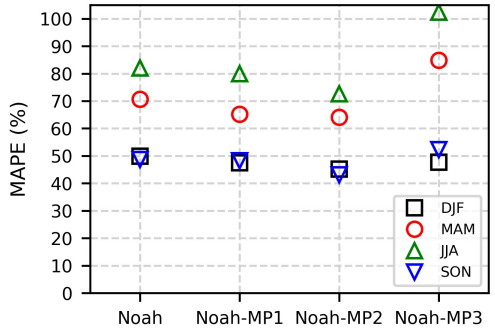
WRF Simulations against EOBs

European domain

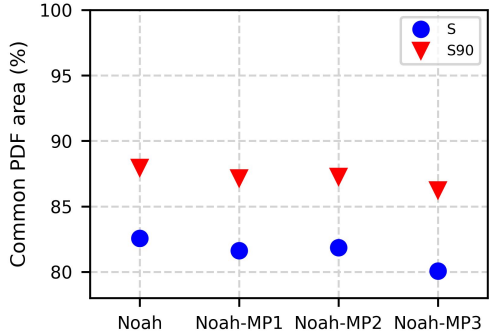
Normalized bias



Mean absolute percentual error

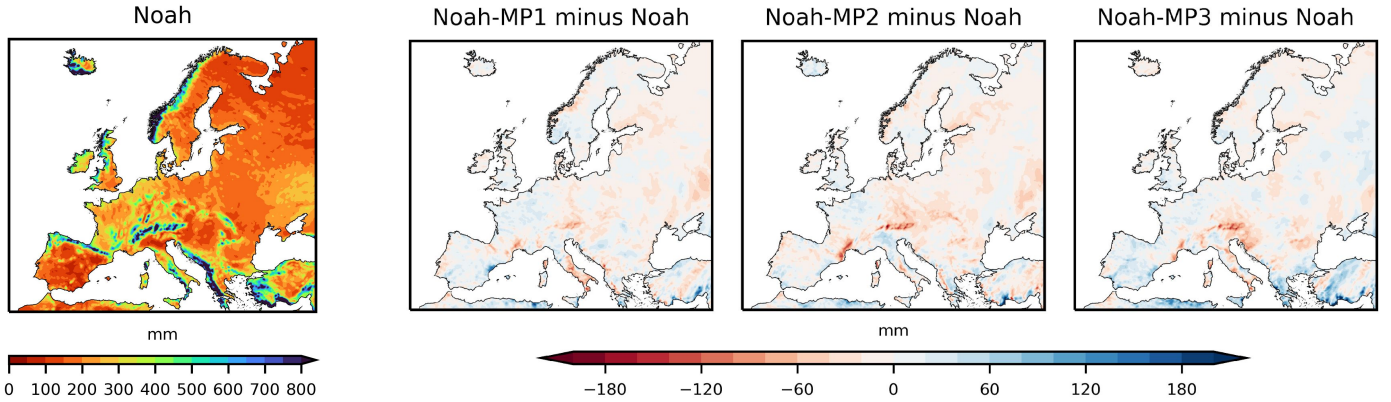


PDF matching skill scores S and S90 of daily precipitation



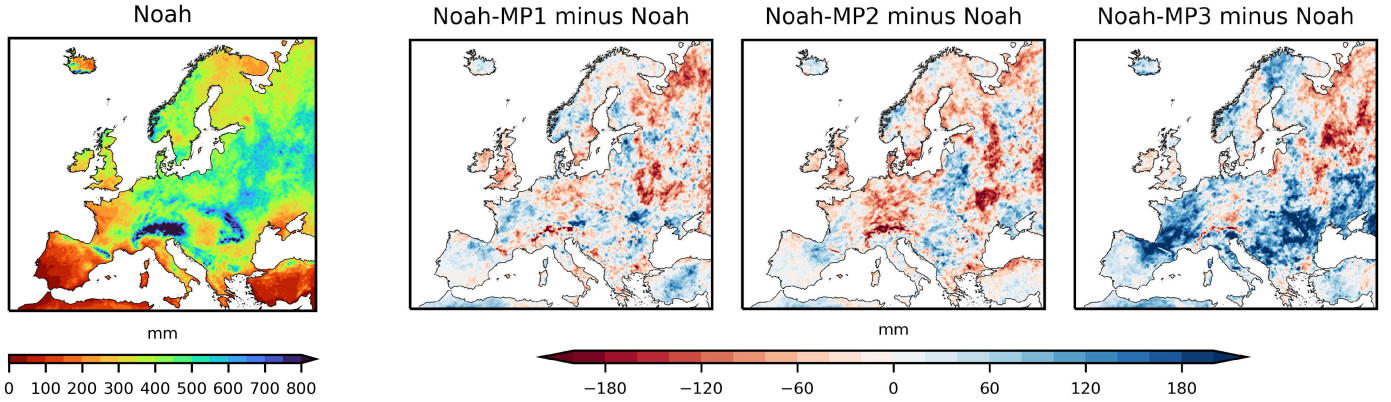
Winter (DJF)

Seasonal (DJF) precipitation from WRF with Noah scheme and its difference from WRF runs with Noah-MP schemes



Summer (JJA)

Seasonal (JJA) precipitation from WRF with Noah scheme and its difference from WRF runs with Noah-MP schemes

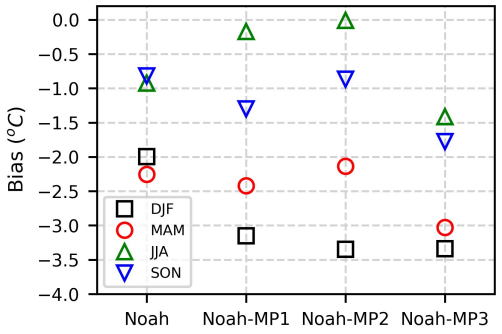


Results: 2-m Maximum Temperature

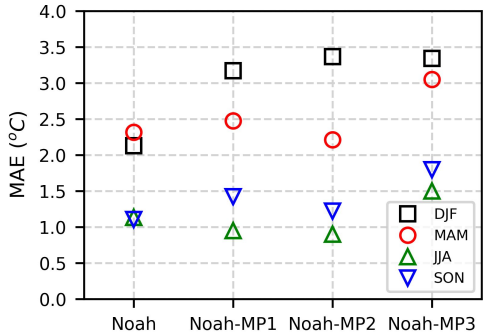
WRF Simulations against EOBs

European domain

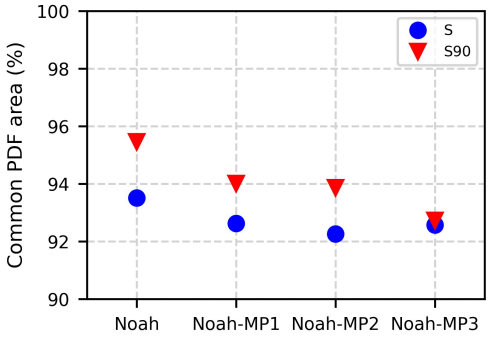
Bias



Mean absolute error



PDF matching skill scores S and S90 of daily maximum temperature



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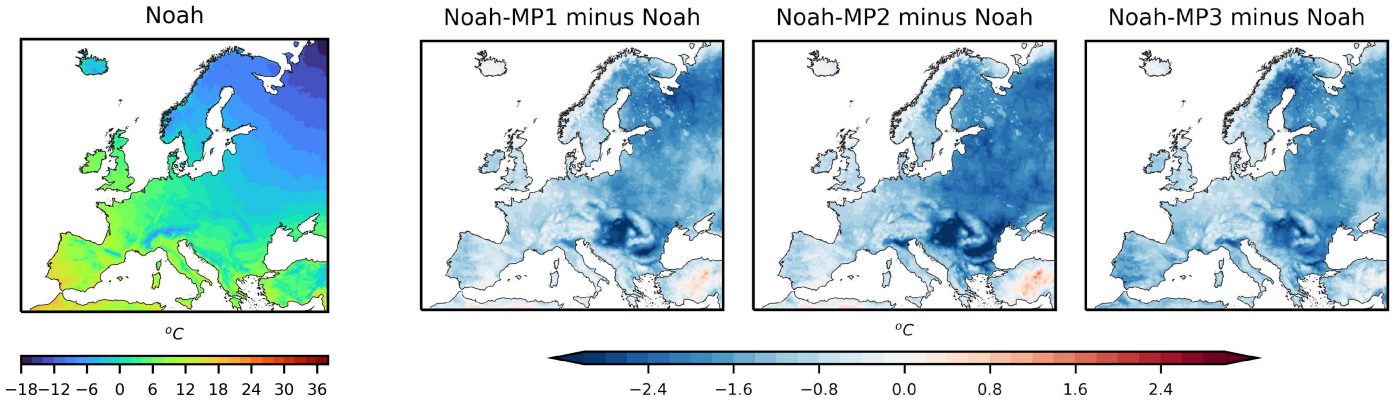
Seasonal (DJF) 2-m maximum temperature from WRF with Noah scheme and its difference from WRF runs with Noah-MP schemes



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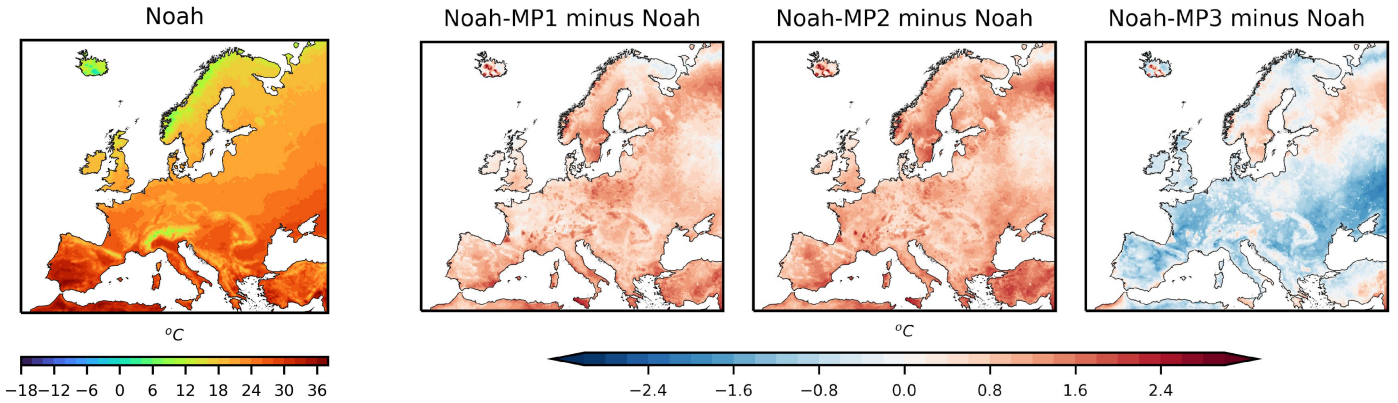
Seasonal (JJA) 2-m maximum temperature from WRF with Noah scheme and its difference from WRF runs with Noah-MP schemes

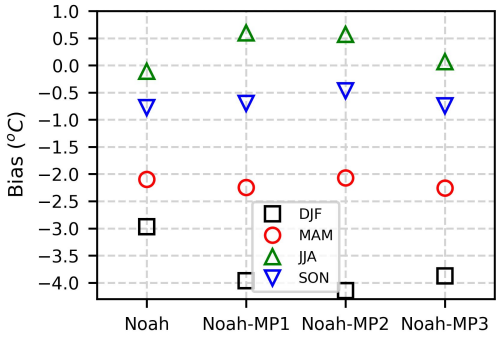


Results: 2-m Minimum Temperature

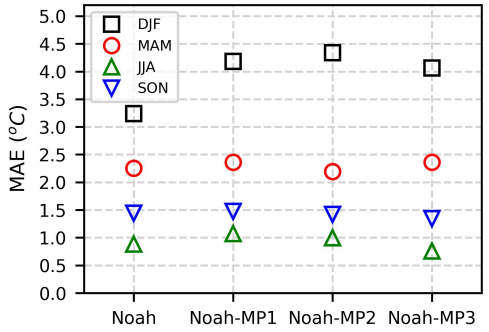
WRF Simulations against EOBs

European domain

Bias



Mean absolute error



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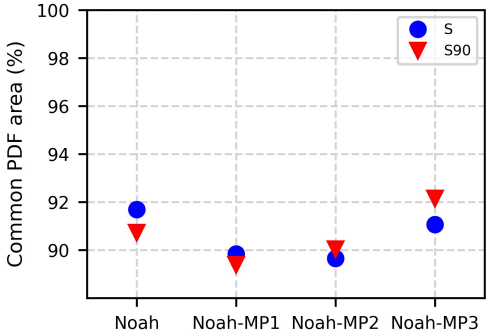

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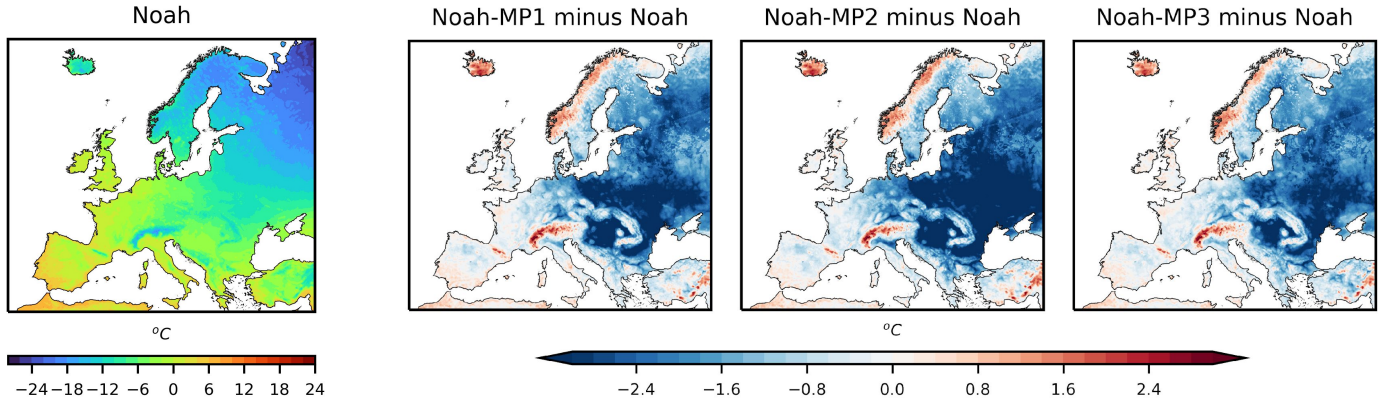
Seasonal (DJF) 2-m minimum temperature from WRF with Noah scheme and its difference from WRF runs with Noah-MP schemes



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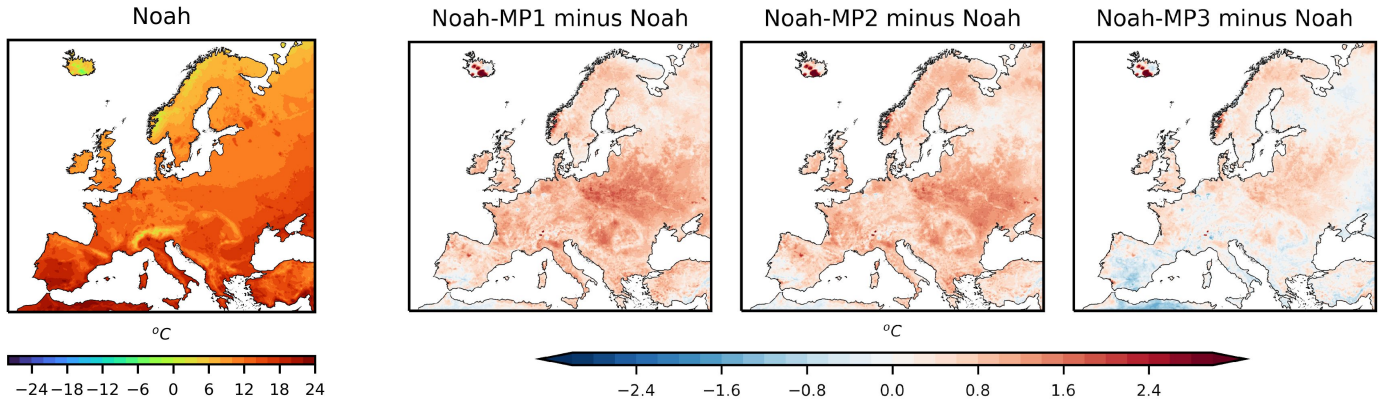
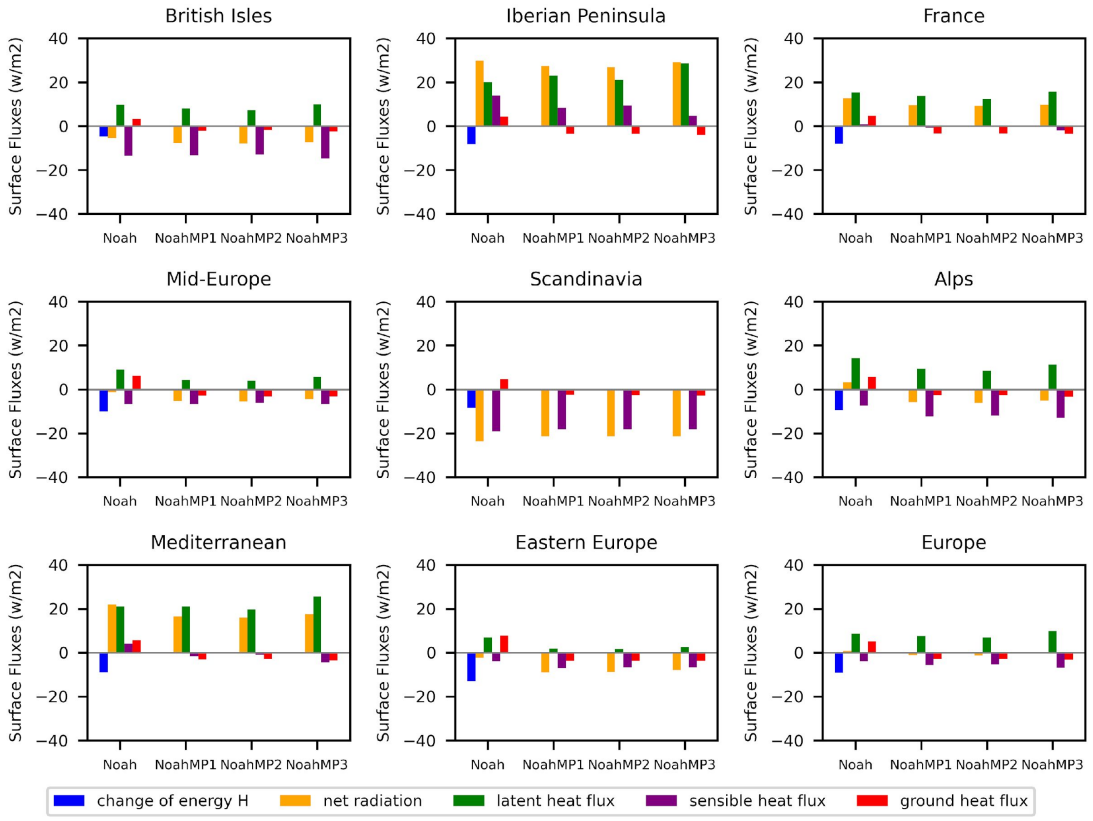


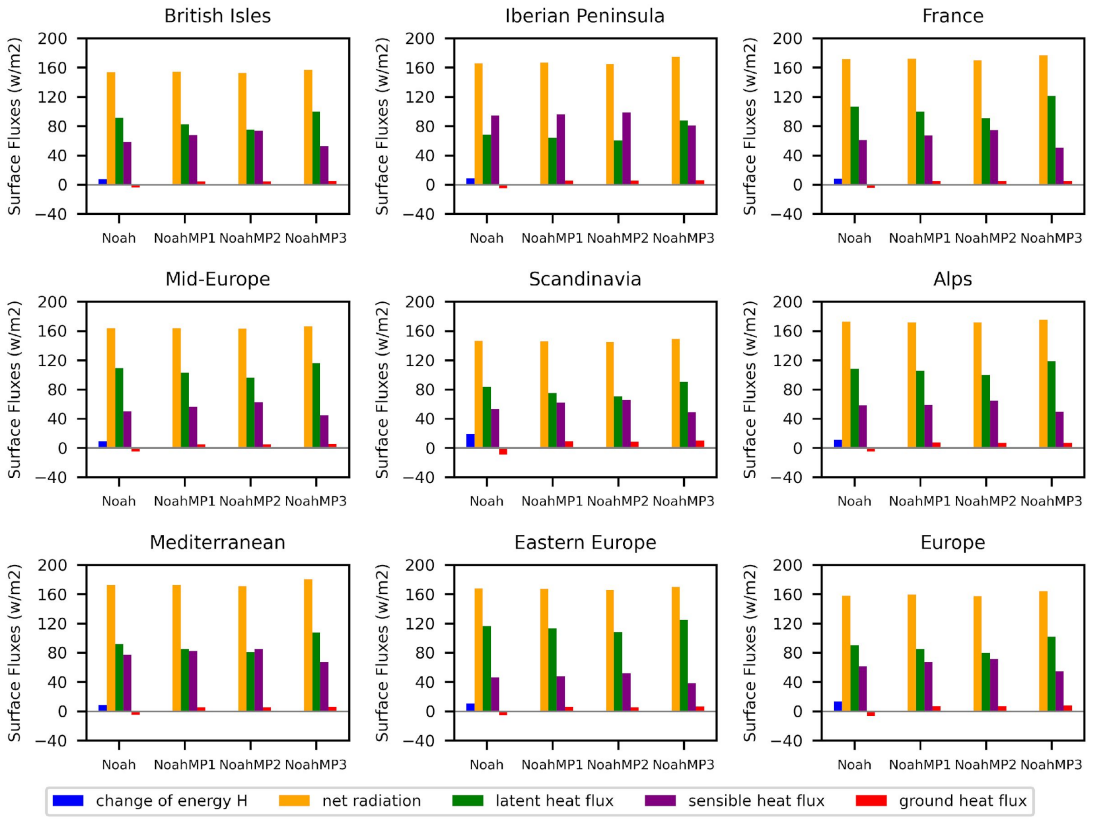
Seasonal Analysis: Land Energy Balance

$$\frac{dH}{dt} = R_n - LH - SH - G$$

Winter (DJF)

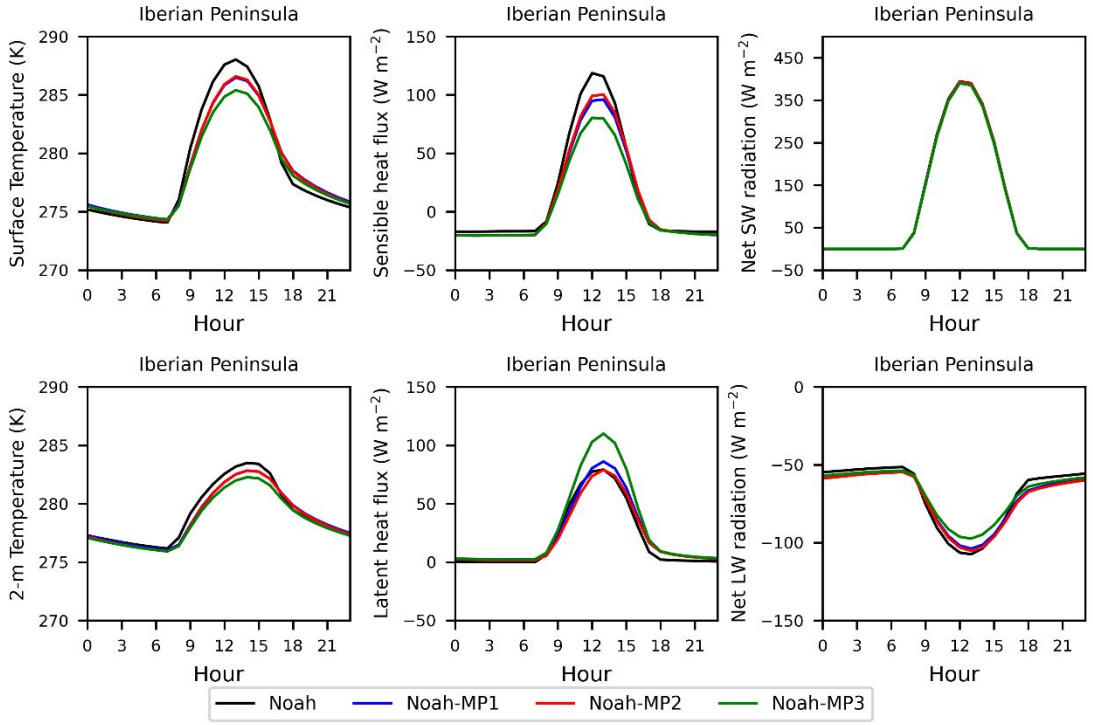


Summer (JJA)

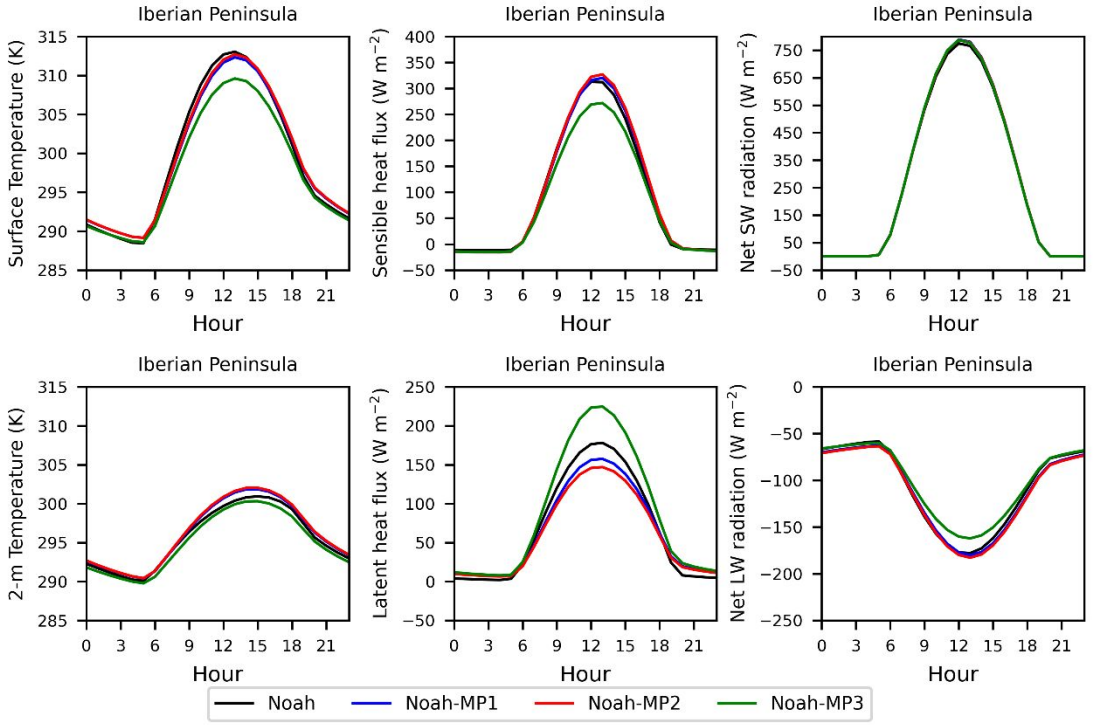


Diurnal Cycle: Land Energy Balance

Winter (DJF)



Summer (JJA)

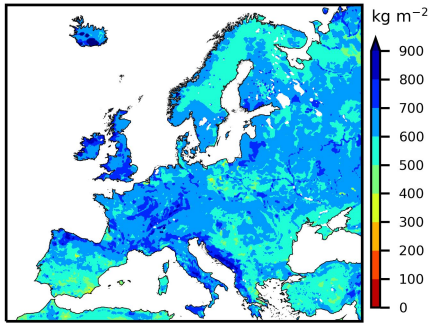


Seasonal Analysis: Soil Moisture

Total soil moisture content

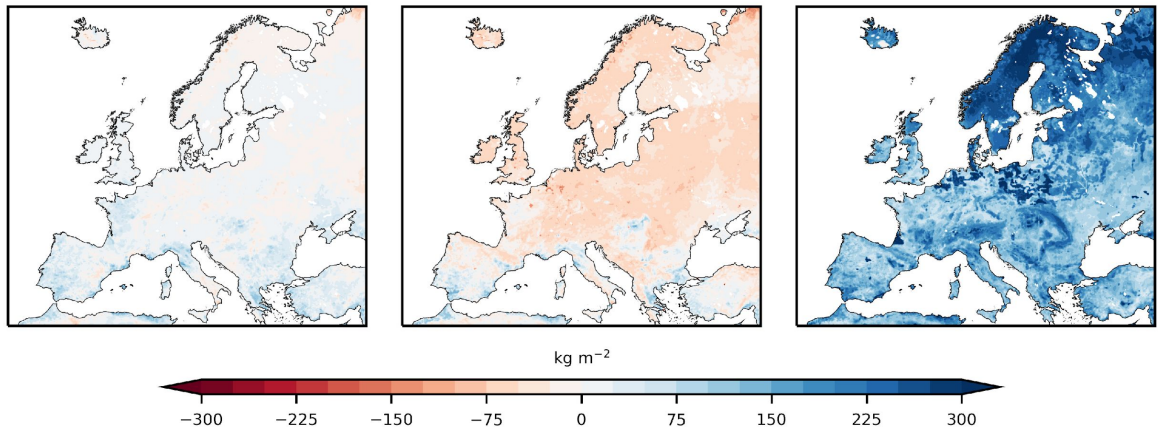
Winter (DJF)

Noah



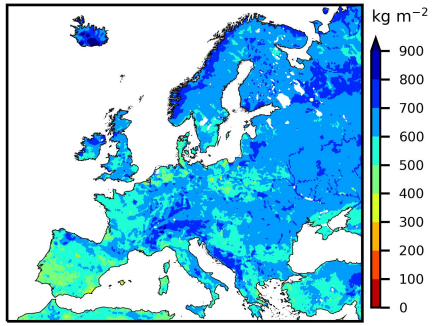
Seasonal (DJF) total soil moisture content from WRF with Noah scheme and its difference from WRF runs with Noah-MP schemes

Noah-MP1 minus Noah | Noah-MP2 minus Noah | Noah-MP3 minus Noah



Summer (JJA)

Noah



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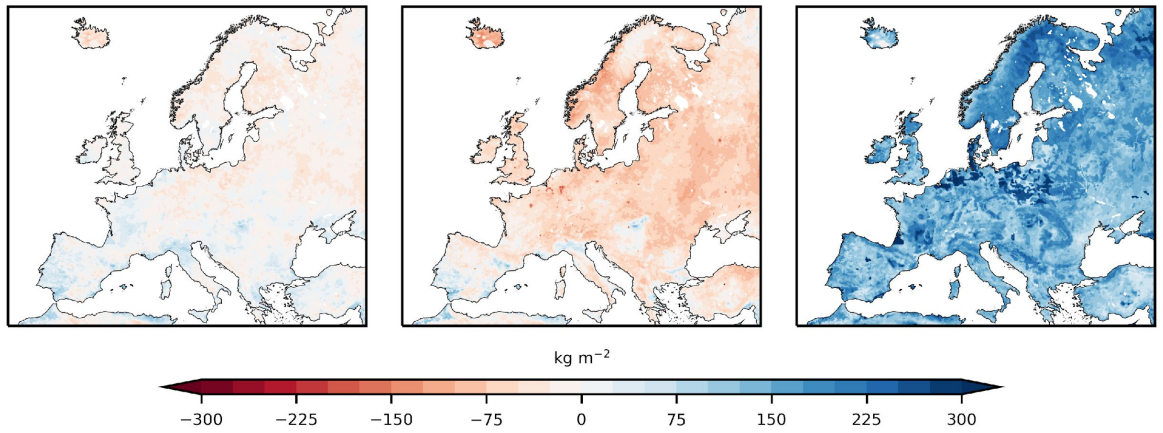
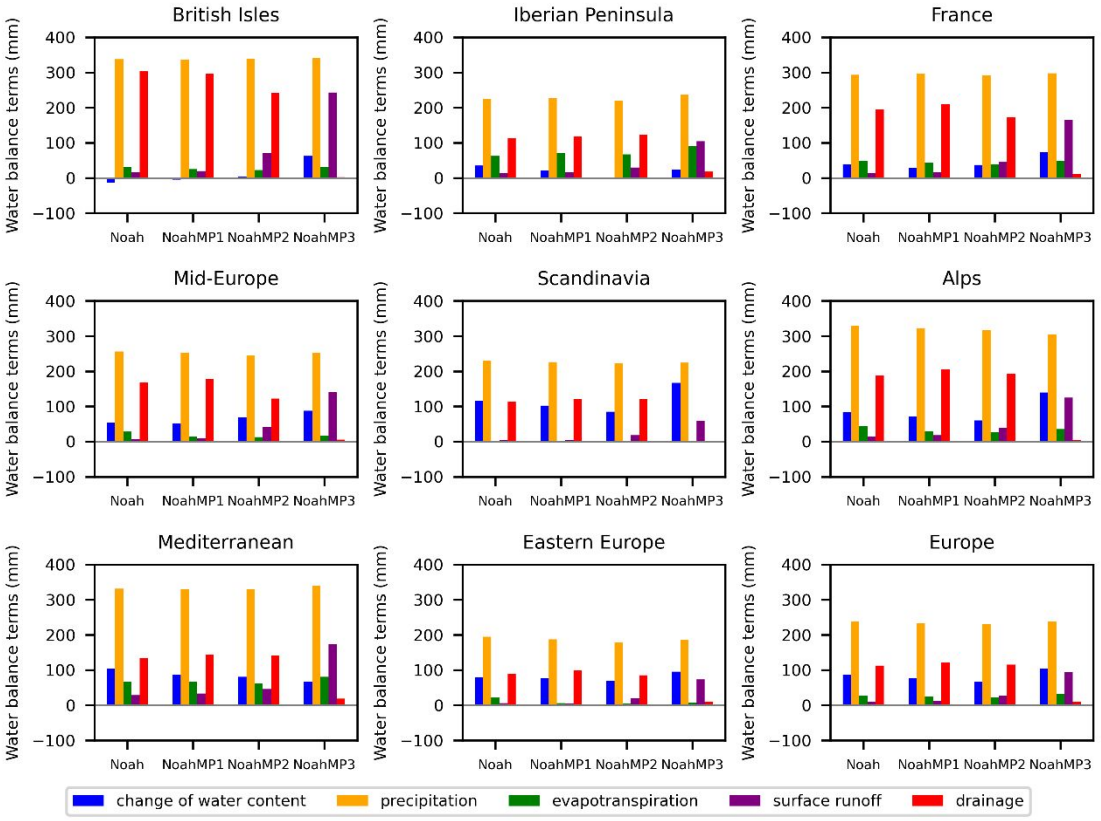


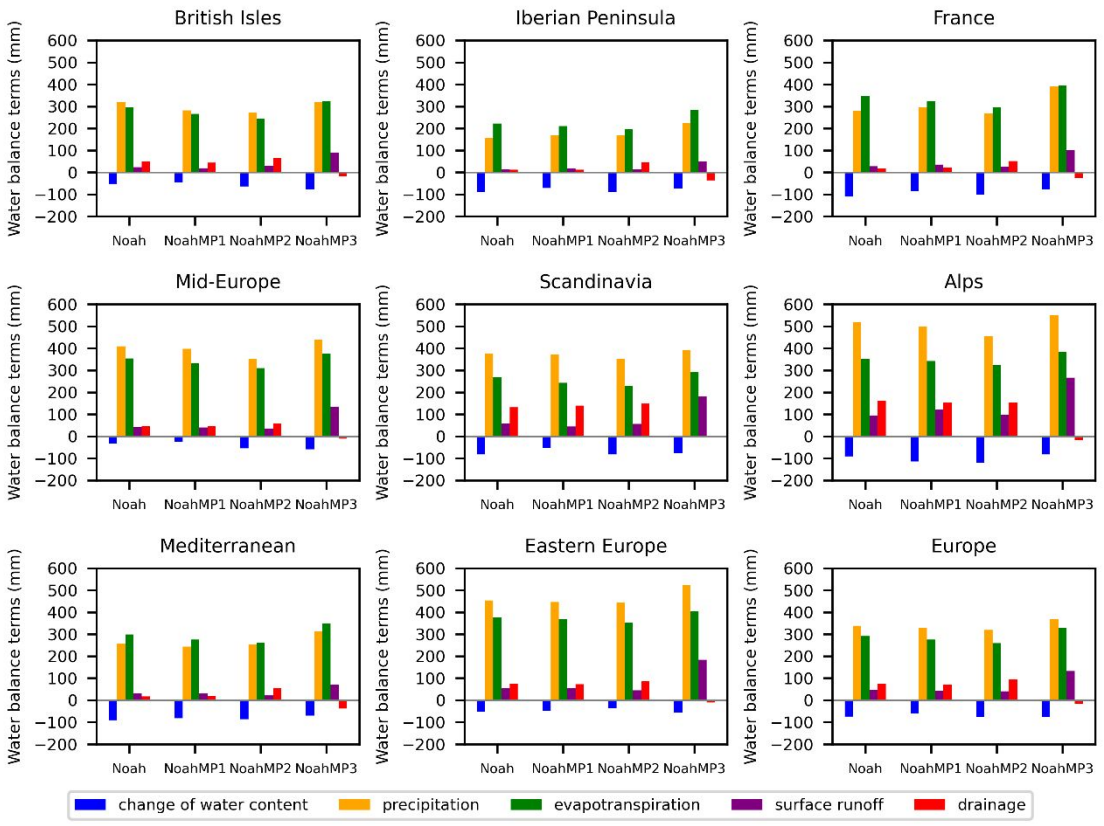
Seasonal Analysis: Land Water Balance

$$\frac{dS}{dt} = P - E - R_s - R_g$$

Winter (DJF)



Summer (JJA)



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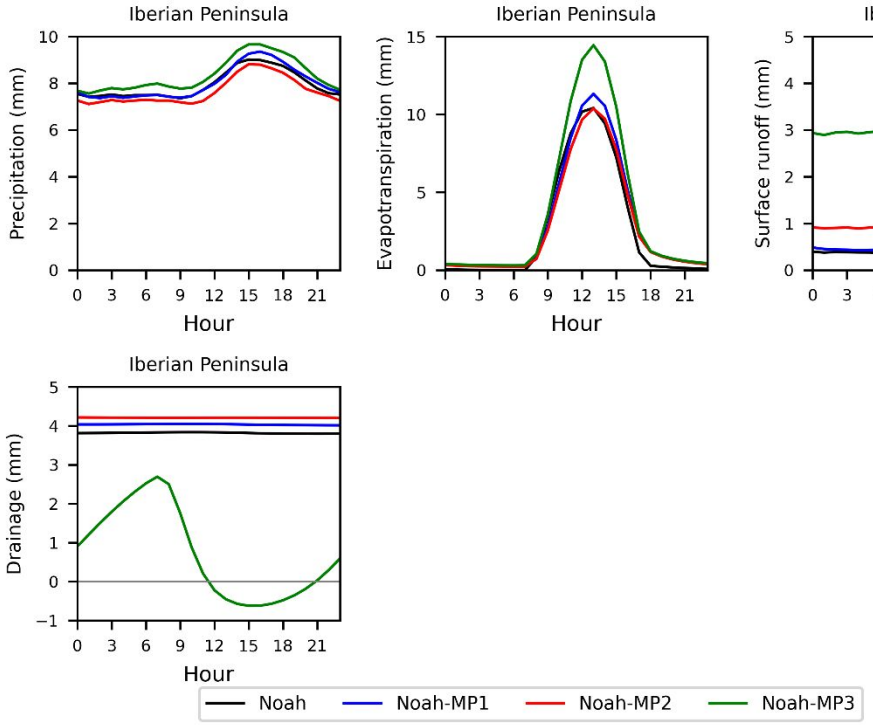

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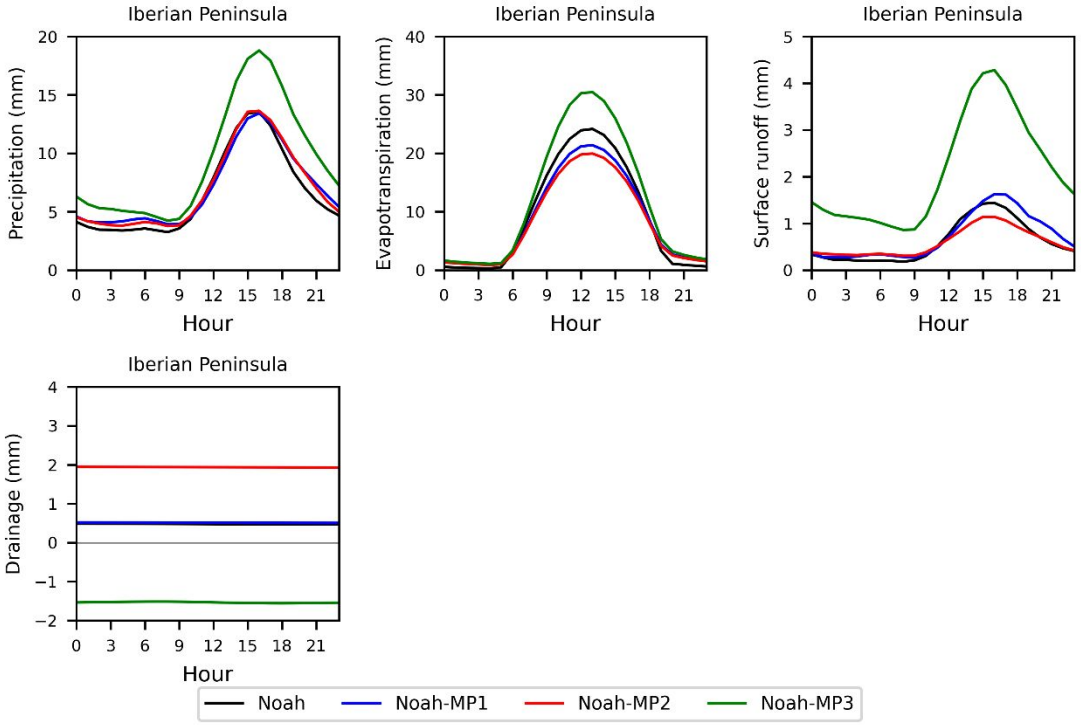

Conclusions

WRF Simulations against EOBs:

✔ All WRF runs show an overestimation in precipitation;

✔ Overall, the Noah-MP2 run shows the best result against EOBs dataset.

Land Energy Balance:

✔ For the land energy balance, differences between WRF runs are higher in summer than winter;

✔ The ground heat flux signal is opposite between Noah and Noah-MP runs.

Land Water Balance:

✔ Noah-MP3 run shows a different result in surface runoff and drainage;

✔ A deeper analysis is needed.

Future Research:

- Investigate the cloud cover and its difference between WRF runs
- Investigate the water table