



Reconsidering the role of soil moisture in summer seasonal predictability

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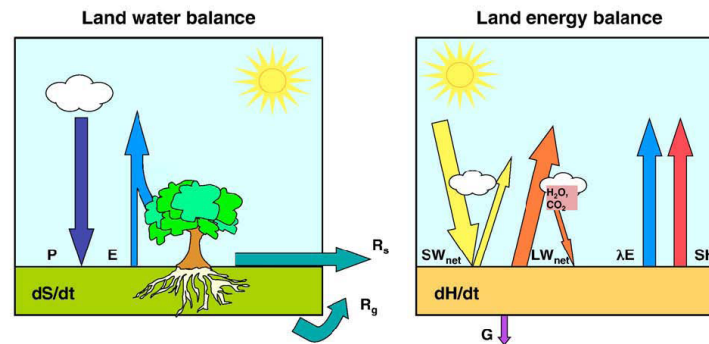
Acknowledgments :

M. Déqué, L. Batté (CNRM)

B. van den Hurk, E. van Meijgaard (KNMI)

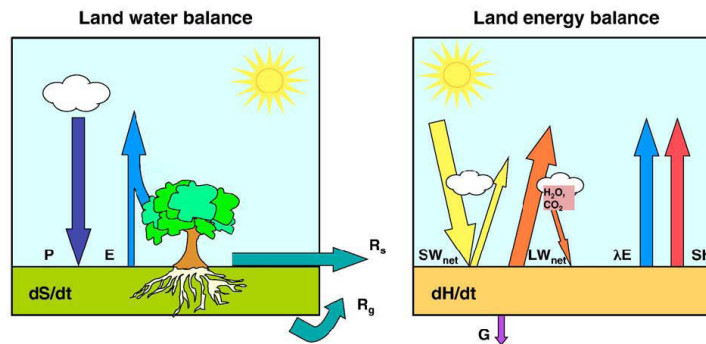
Introduction (1/2)

- Seasonal predictability => Imprint on the atmosphere of slow components
- Soil moisture potentially plays a major role on surface climate...

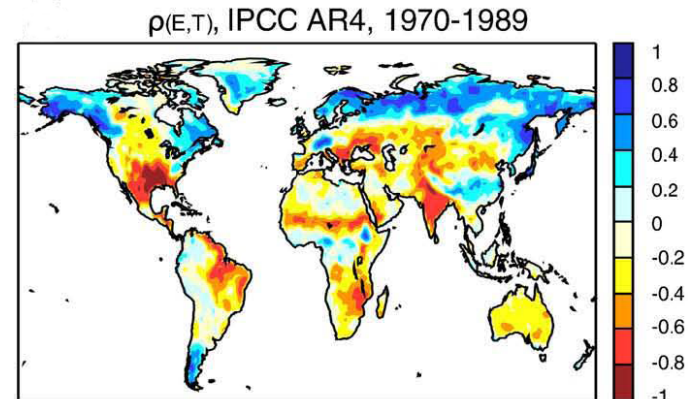
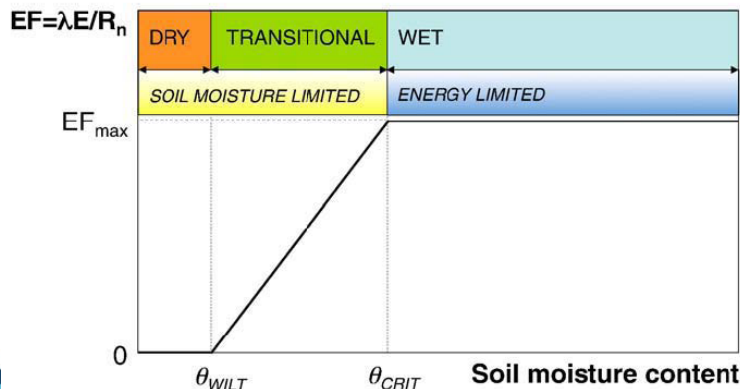


Introduction (1/2)

- Seasonal predictability => Imprint on the atmosphere of slow components
- Soil moisture potentially plays a major role on surface climate...

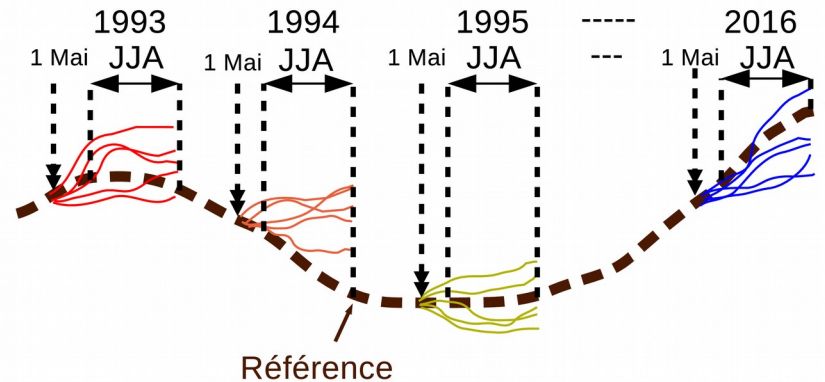


- ... under certain conditions (Seneviratne 2010, Miralles et al 2012)



Introduction (2/2)

- Seasonal prediction assessment
 - Principle: Ensemble re-forecast with a coupled GCM



- Goal: Capture the interannual seasonal variability of T° , precipitation...
- Improved soil moisture initial conditions => better predictive skill?
 - Hypothesis partially confirmed for t_{2m} (Koster et al. 2010, Prodhomme et al. 2016)
 - Model biases alter the added-value of refined initialization (Ardilouze et al. 2017)
- => Idealized experiments with prescribed soil moisture

Soil moisture nudging in Surfex (ISBA-DF)

Reference : Douville et al. 2016

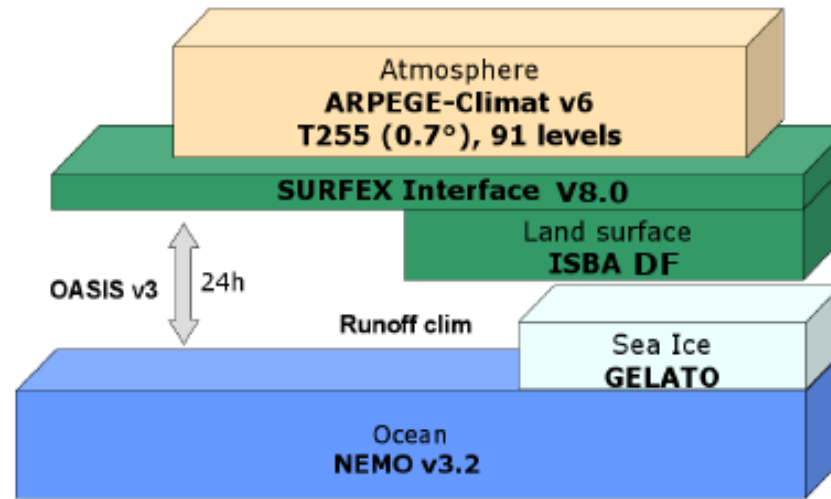
- Let X be the soil water content for Layer l and Patch p

$$\frac{\partial X_{l,p}}{\partial t} = M(X_{l,p}) + \sigma_l \frac{X_{l,p}^{ref} - X_{l,p}}{\tau}$$

- $M(X)$ is the tendency term for prognostic variable X
 - X is relaxed towards $X_{l,p}^{ref}$ daily reference value
 - σ_l is a vertical profile factor , with $0 \leq \sigma_l \leq 1$
 - τ is a characteristic relaxation time
- Here, X^{ref} is derived from **ERA-Land** (Balsamo et al. 2015), hence does not vary with p (Land Surface Model \neq Surfex)
 - Here, $\tau = 24h$ and $\sigma_l = 1 \quad \forall l$

Experimental Setup (1/2)

- 15-member 4-month re-forecast (MJJA) over 1993-2012



Short Name	Description
G-REFM	CNRM-CM initialized with ERA-Land (TI255I91r)
G-SOILM	CNRM-CM with soil moisture nudged (daily) towards ERA-Land

Experimental Setup (2/2)

GLOBAL

Short Name	Description
G-REFM	CNRM-CM initialized with ERA-Land (T1255I91r)
G-SOILM	CNRM-CM with soil moisture nudged (daily) towards ERA-Land

REGIONAL
(EUROPE)

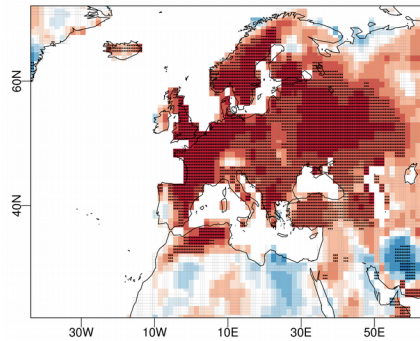
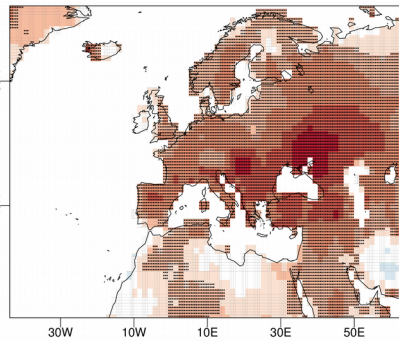
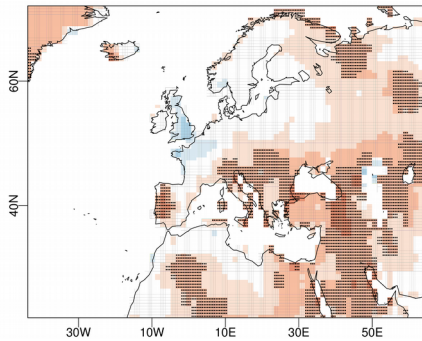
R-REFM	ALADIN boundary forced by G-REFM, resolution 0.2
R-SOILM	Same as R-REFM with soil moisture nudged (daily) towards ERA-Land
R-REFK	RACMO boundary forced by AMIP EC-EARTH v3.0 Euporias run (resolution T1255I91), resolution 0.2
R-SOILK	Same as R-REFK with soil moisture replaced (daily) by ERA-Land



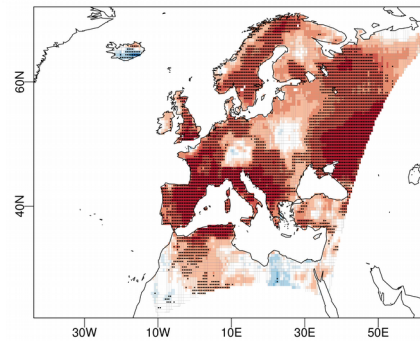
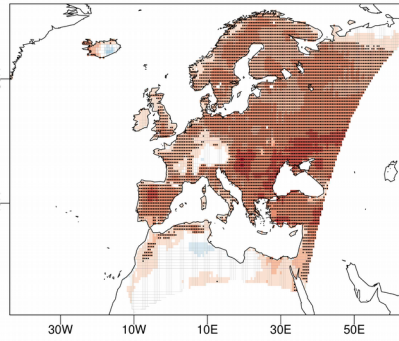
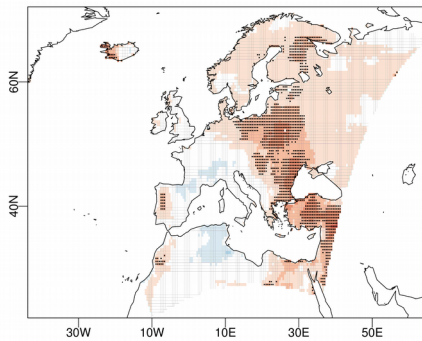
JJA Max 2m Temperature : Anom. Correlation

Reference CRU TS3 (Harris et al. 2014)

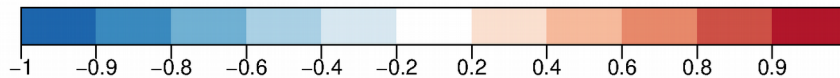
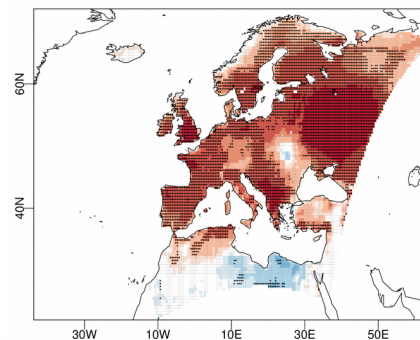
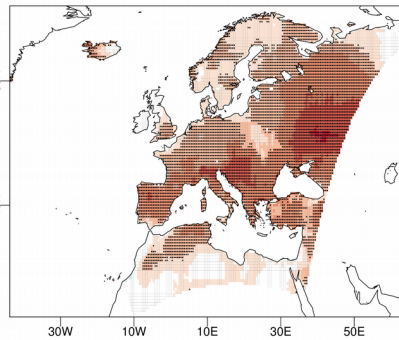
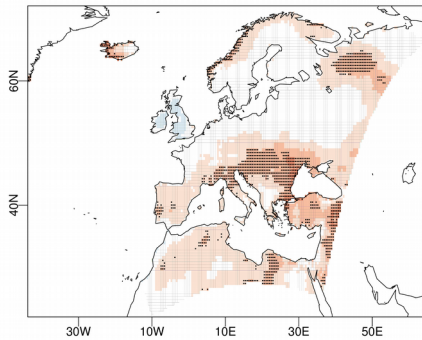
CNRM-CM



ALADIN



RACMO



REF

SOIL



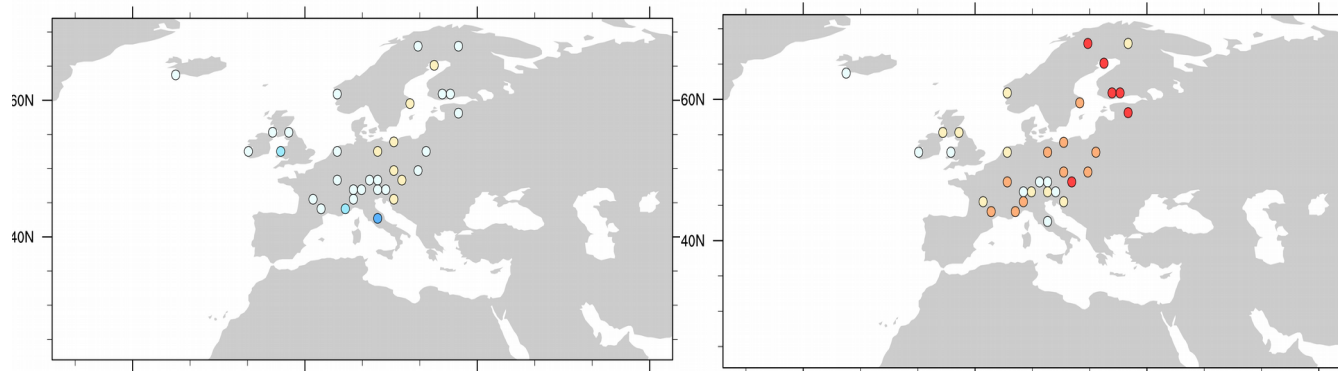
Δ (SOIL-REF)



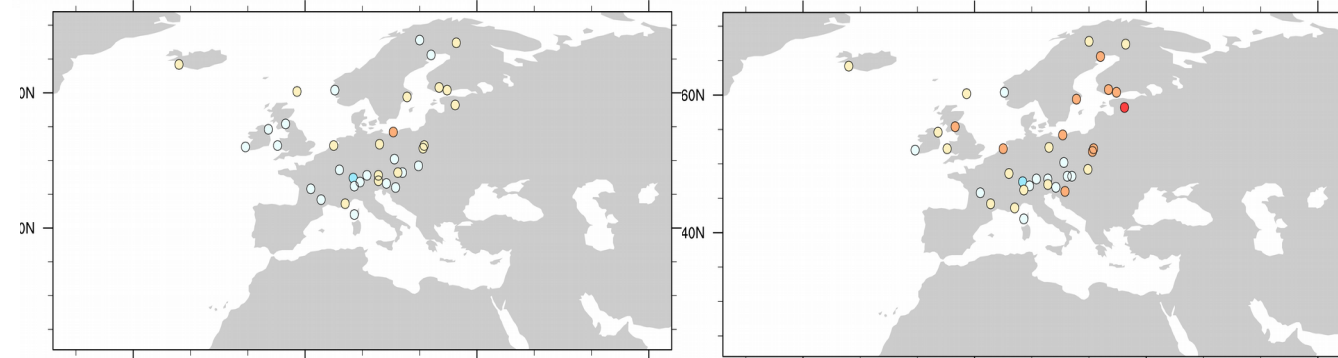
JJA Downward surface sw radiation : Anom. Correlation

Reference : GEBA (Sanchez-Lorenzo et al. 2015)

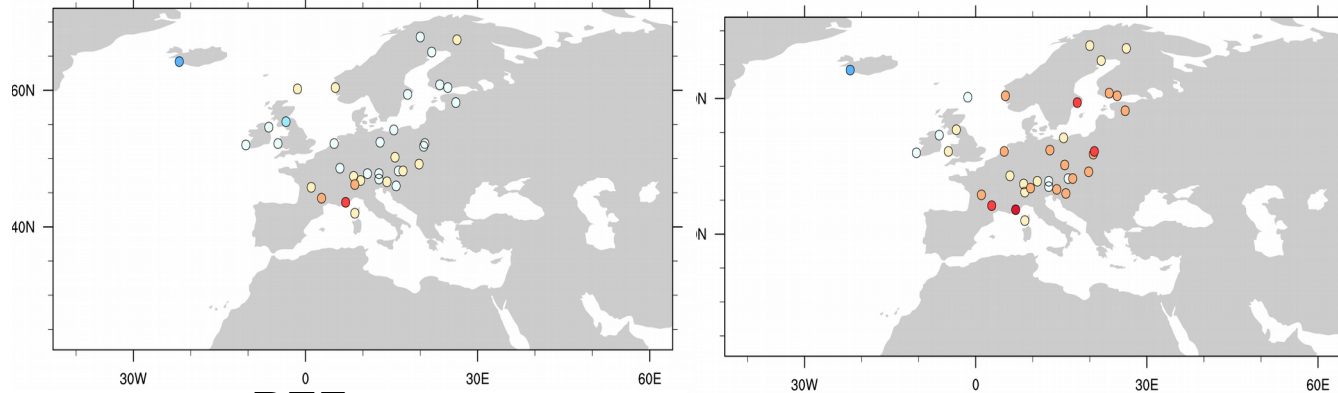
CNRM-CM



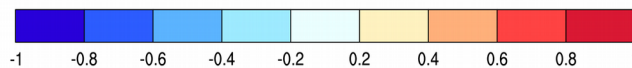
ALADIN



RACMO



REF



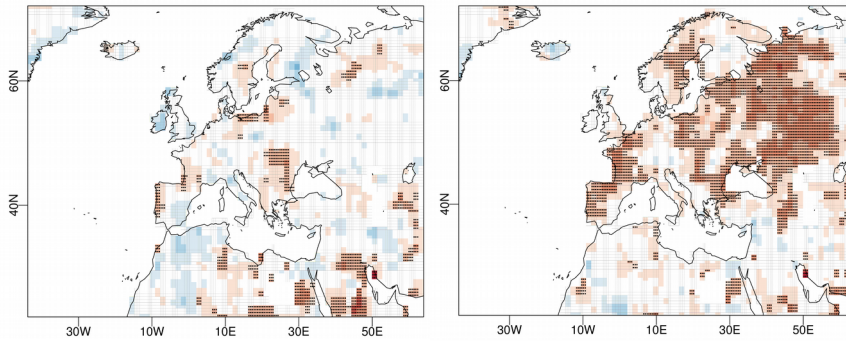
SOIL



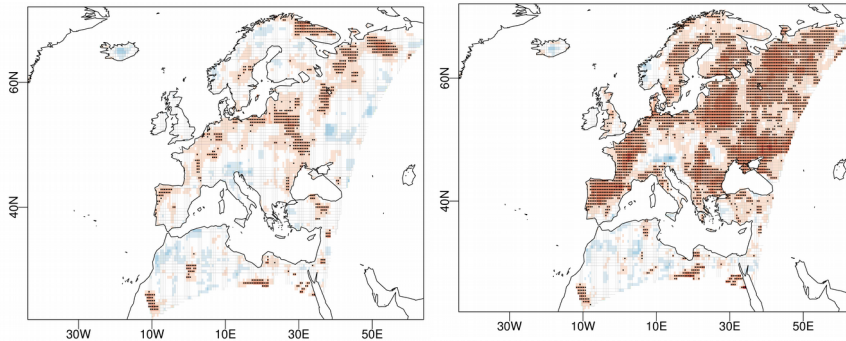
JJA Precipitation : Anom. Correlation

Reference : GPCC (Schneider et al. 2008)

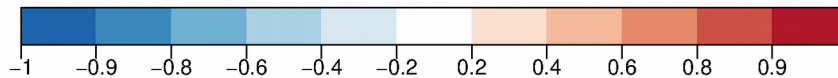
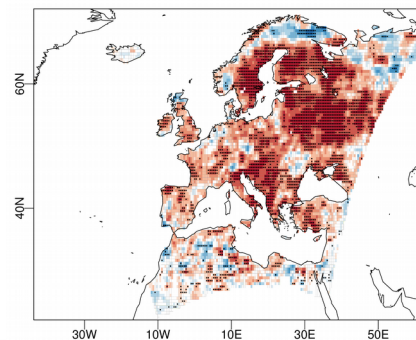
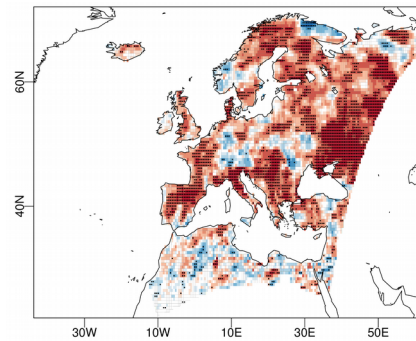
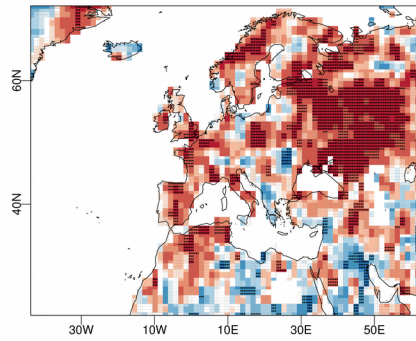
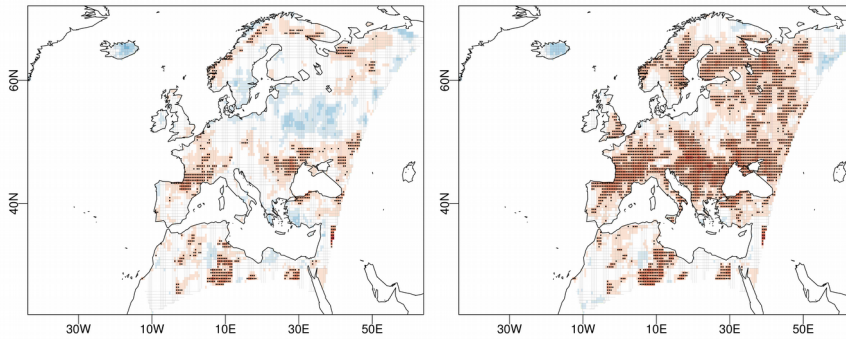
CNRM-CM



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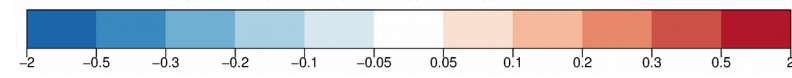


RACMO



REF

SOIL

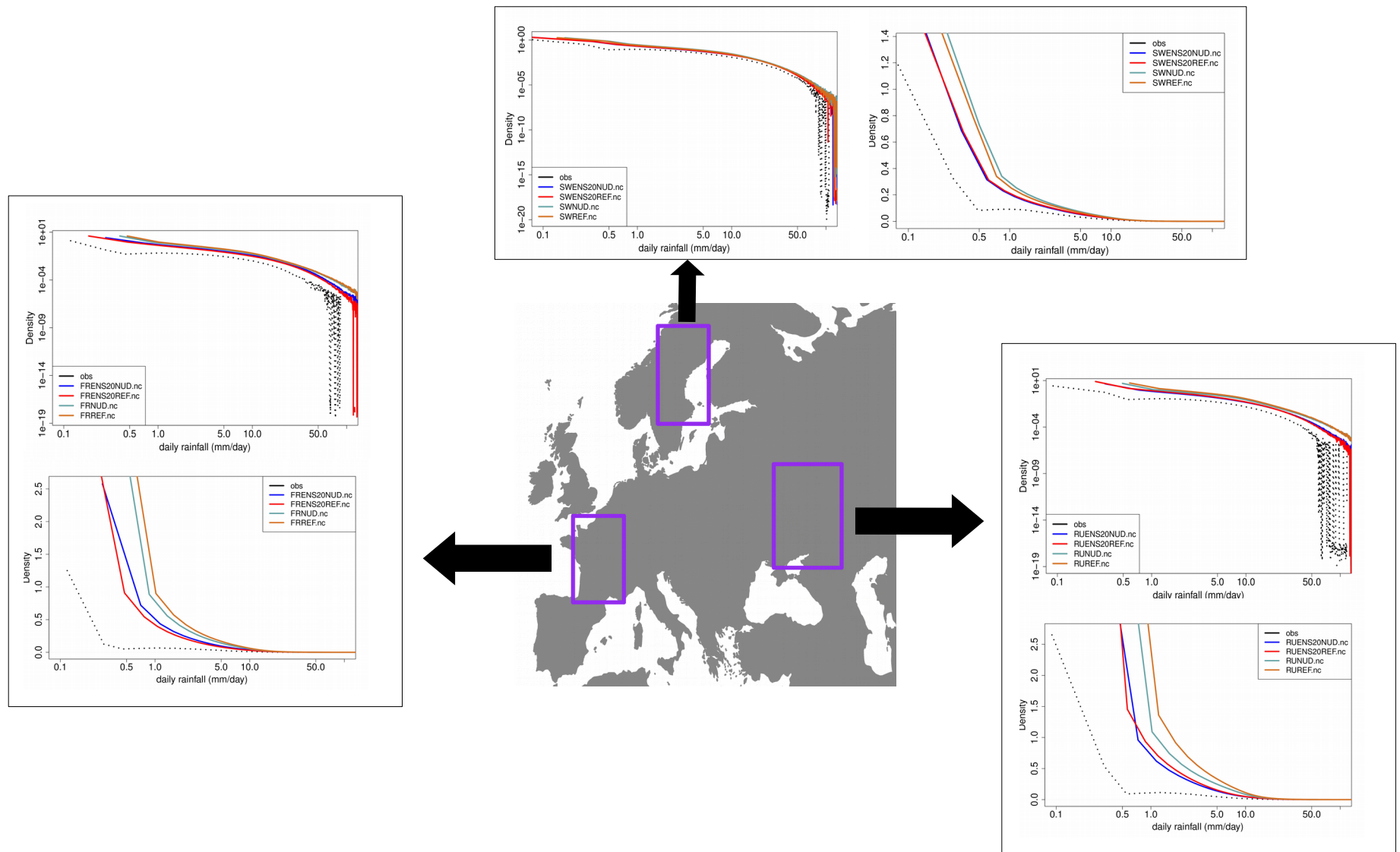


Δ (SOIL-REF)

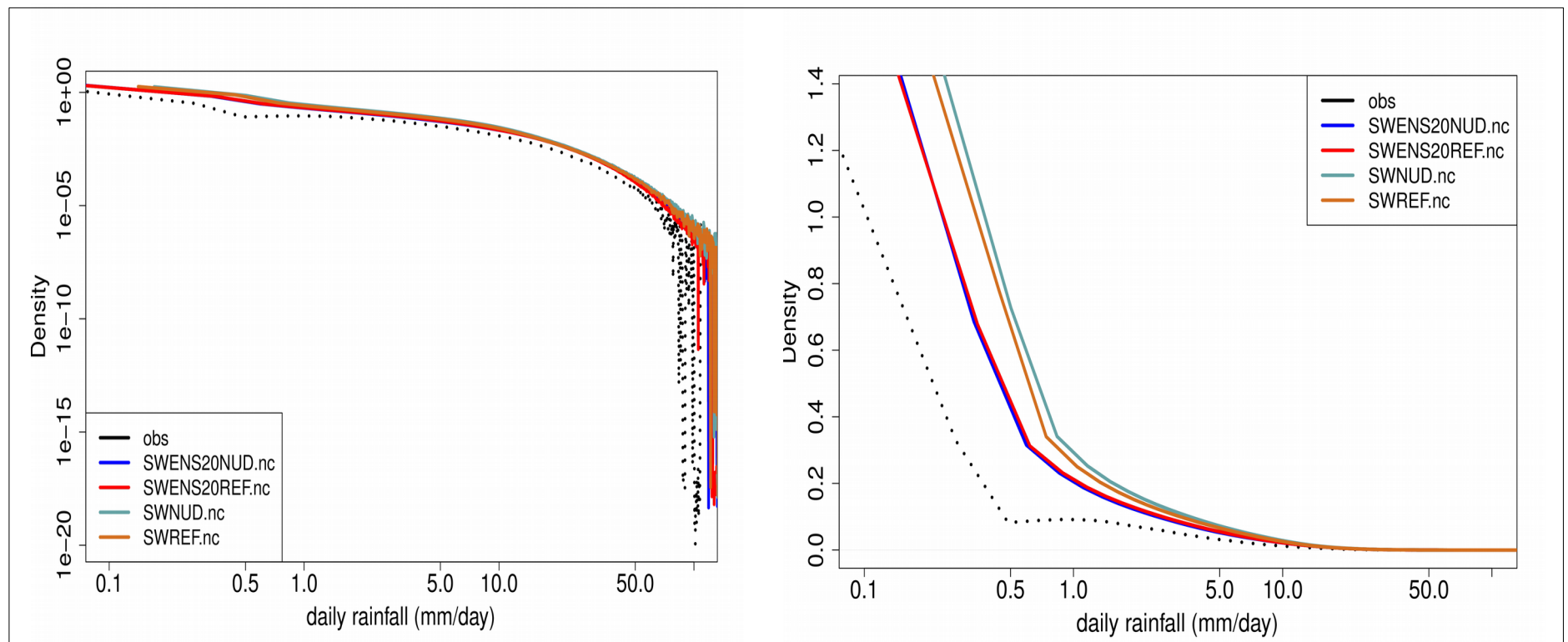


Impact on precipitation distribution

Reference : E-OBS (Haylock et al. 2008)



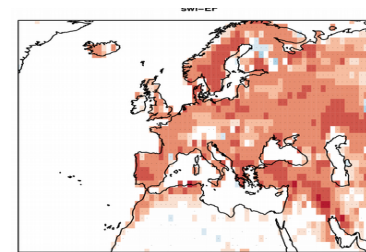
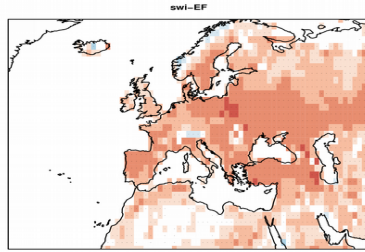
Precipitation distribution : zoom in over Sweden



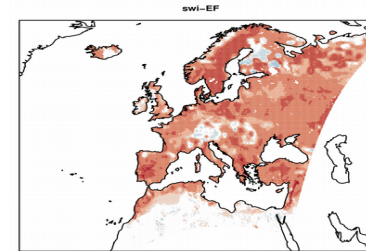
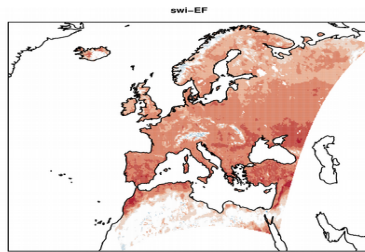
Correlations of summer 10-day averages (model)

Soil Wetness Index vs. Evaporative fraction (= $LE/(LE+H)$)

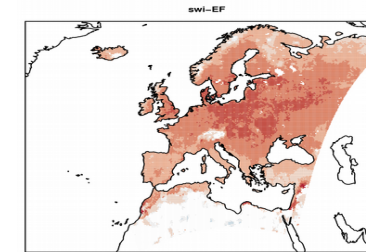
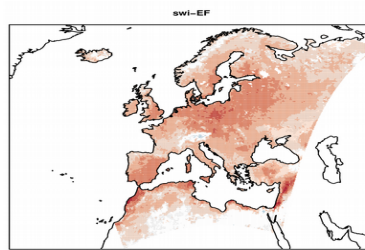
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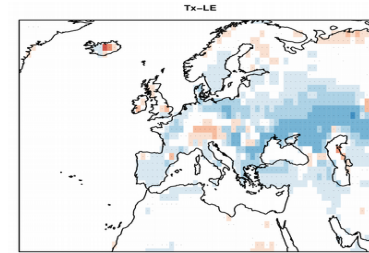
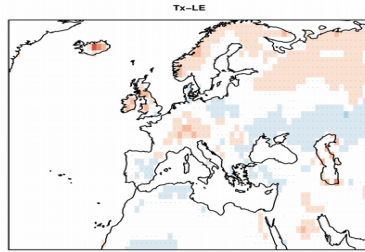
SOIL



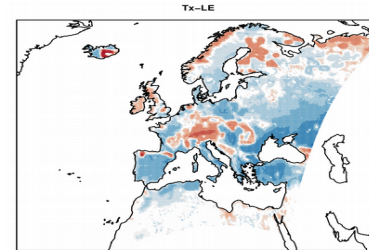
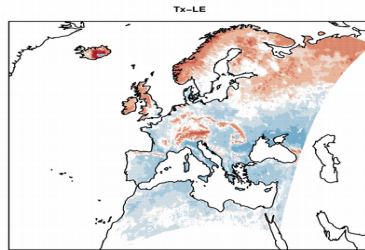
Correlations of summer 10-day averages (model)

Tmax vs. Latent Heat Flux

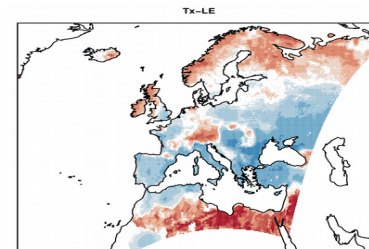
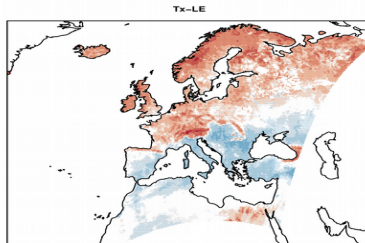
CNRM-CM



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REF

SOIL



Conclusions and perspective

- Soil moisture : a key factor for predictability in summer, **beyond the well-known hotspots** of land-atmosphere coupling
- Impacts on precipitation not straightforwardly explained
- Limitation of idealized experiments : how to disentangle the impact of realistic soil moisture from that of artificially suppressed feedback ?
 - Observational study (GLEAM dataset, Martens et al. 2016)
 - Additional experiment
- Any further suggestion is more than welcome

Thank you ! Any questions ?



Correlations of summer 10-day averages (model)

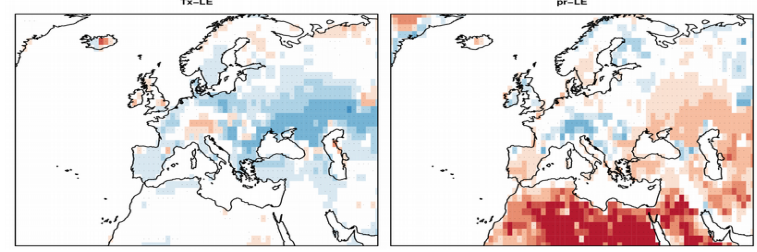
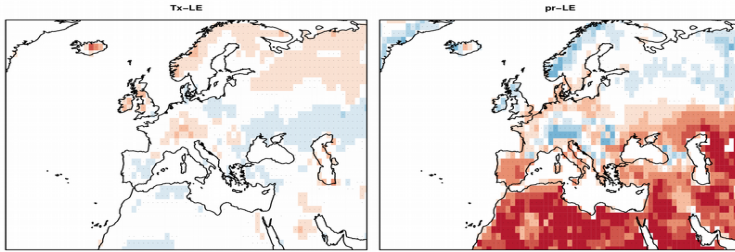
CNRM-CM

Tx vs. LE

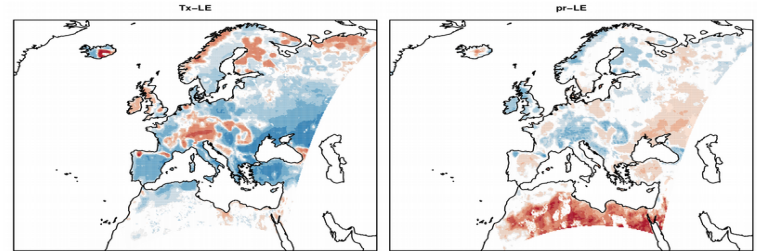
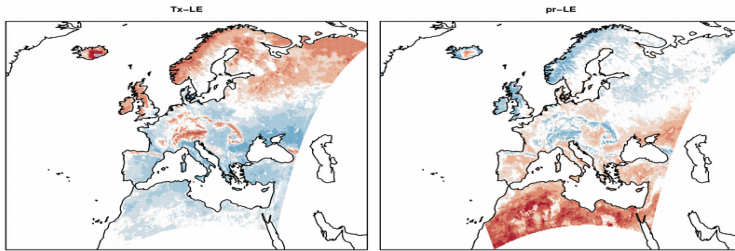
Precip vs. LE

Tx vs. LE

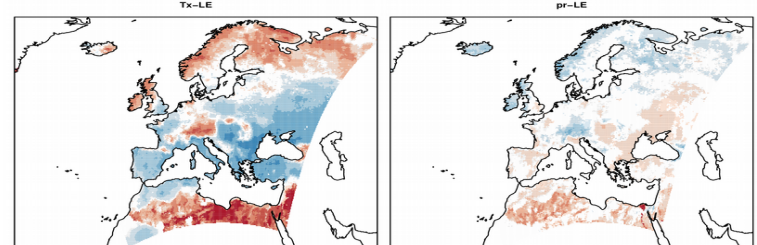
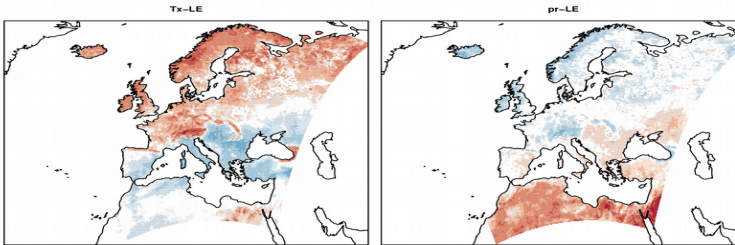
Precip vs. LE



ALADIN

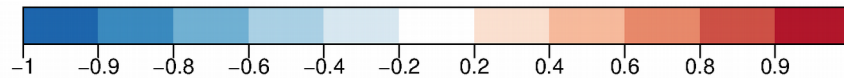


RACMO



REF

SOIL



Gain of correlation with prescribed vs. Free running SST

