HUMID

'HUMID': Hydrological Understanding and Modelling of Iberian Drought

Local patterns compose the balance of interactions between rainfall, evapotranspiration and soil moisture in the semi-arid Ebro basin

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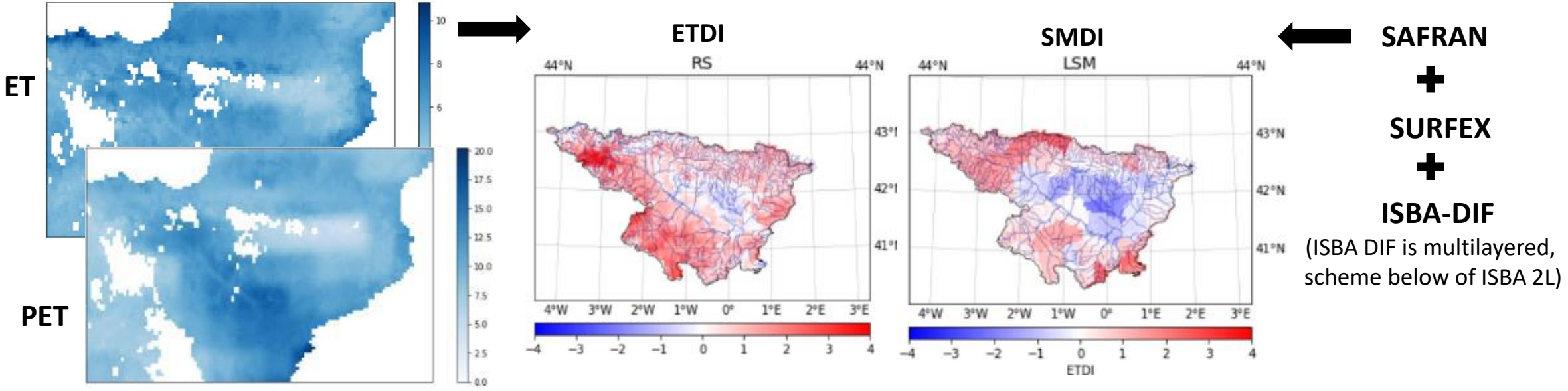
EGU 2022_7782
24 May 2022 18:10h
- HS7.9: The atmospheric water cycle under change: feedbacks, land use, hydrological changes and implications

AIMS OF THE STUDY (Ia): IDENTIFY *R – ET - SM* ANOMALIES

- Analyze anomalies of key variables of the water balance of the land-surface system: rainfall (R), evapotranspiration (ET) and soil moisture (SM) with individual drought indices:
  - **SPI (McKee et al., 1993) non-parametric formulation (Farahmand and AghaKouchak, 2015)**
  - **ETDI (Evapotranspiration deficit index) (Narasimhan & Srinivasan, 2005)**
  - **SMDI (Soil moisture deficit index) (Narasimhan & Srinivasan, 2005)**
- Using remote sensing (RS) and land-surface model (LSM) data :

RS
- **Soil moisture SMOS1km (DisPATCh) (Merlin et al., 2012, RSE, Escorihuela et al., 2012)**
- **Evapotranspiration MOD16A2 ET (Mu et al., 2011, RSE; Running et al., 2019).**

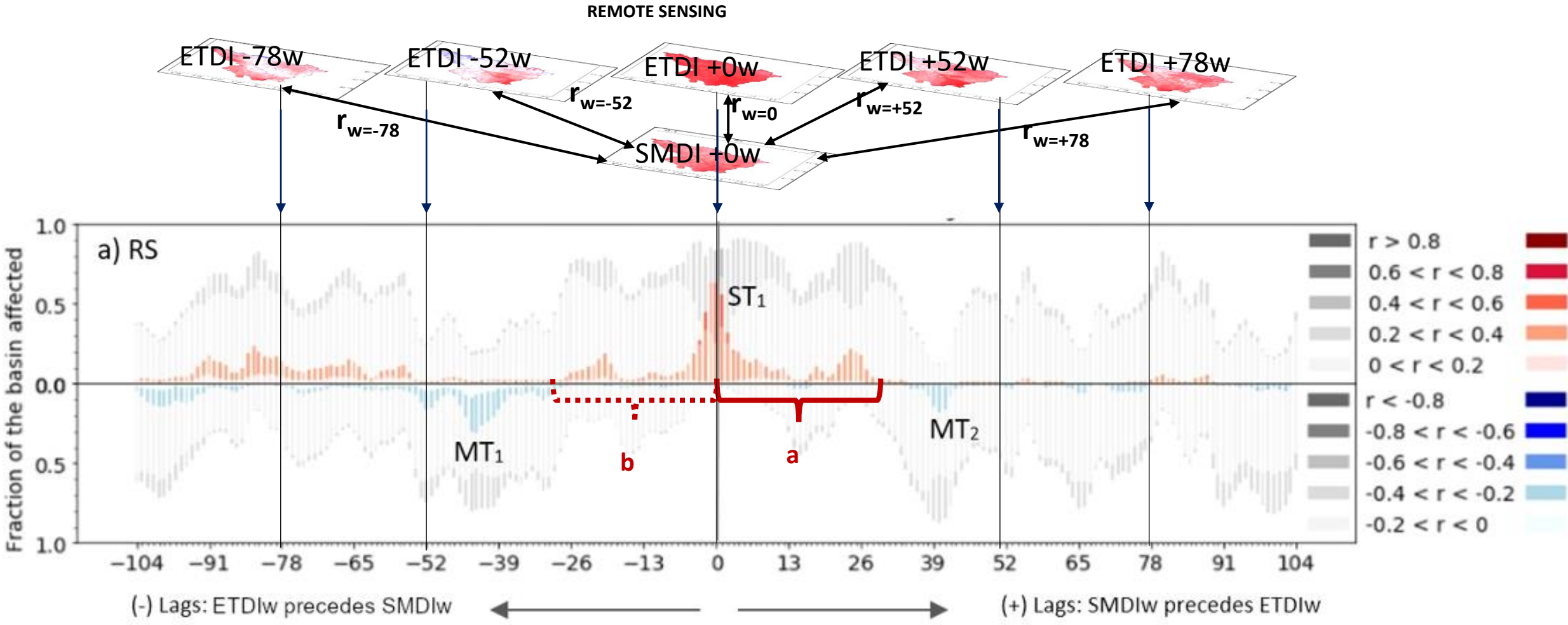
LSM
- **SURFEX (Le Moigne, 2009; Mason et al., 2013; Running et al., 2019).**
  - **+ ISBA (Noilhan and Planton 1989; Habets et al., 1999a; Boone et al., 1998).**



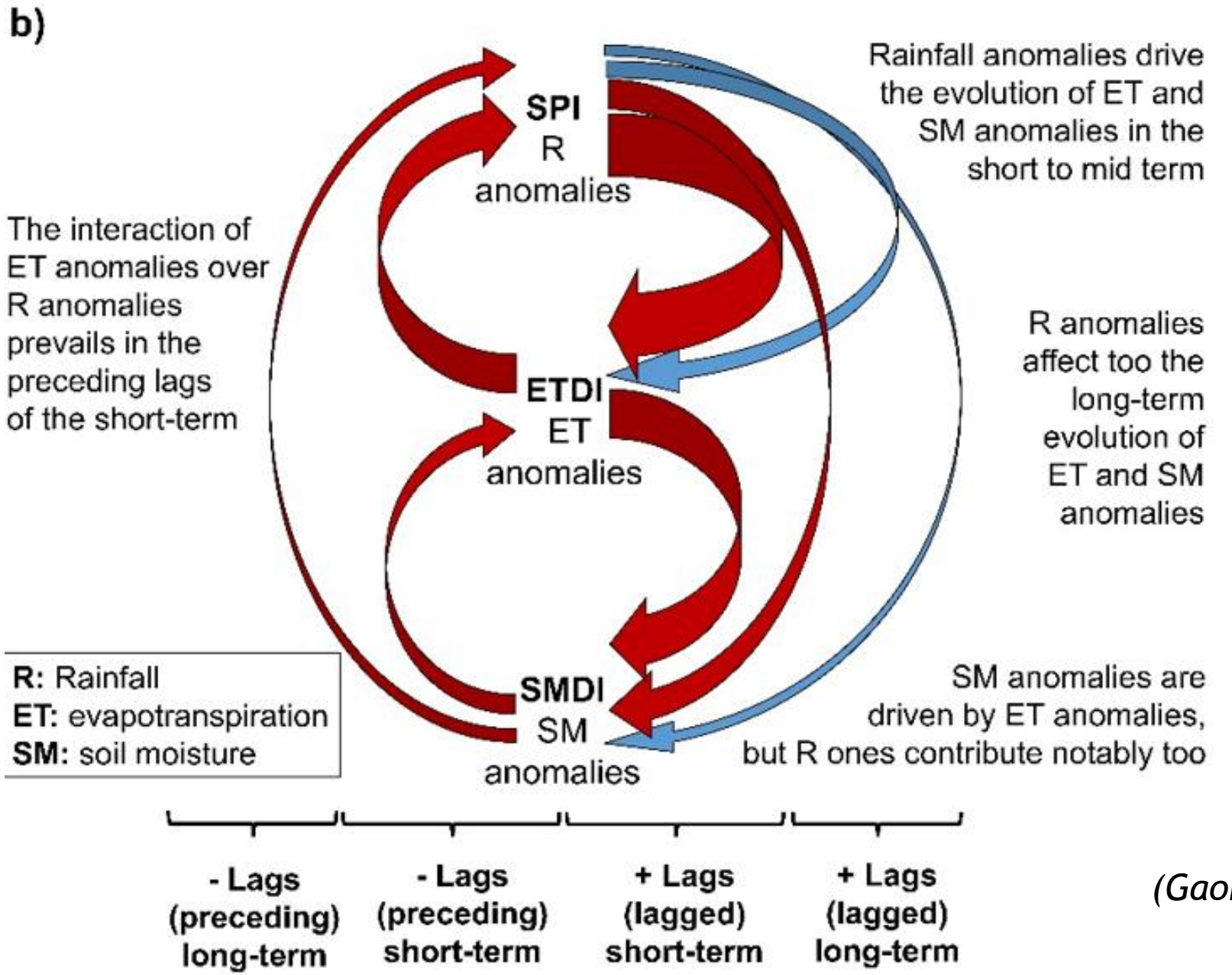
AIMS OF THE STUDY (IIIa): EXPLORE *R - ET - SM* INTERACTIONS

→ **Temporal lags analysis describes the interactions between anomalies**

- **The method provides a time display of the precedent and lag influences between water anomalies**
- **Precedent influences represent a significant portion of the interactions, also beyond annual scales**



LAG ANALYSIS(I): Summary of *R – ET - SM* INTERACTIONS

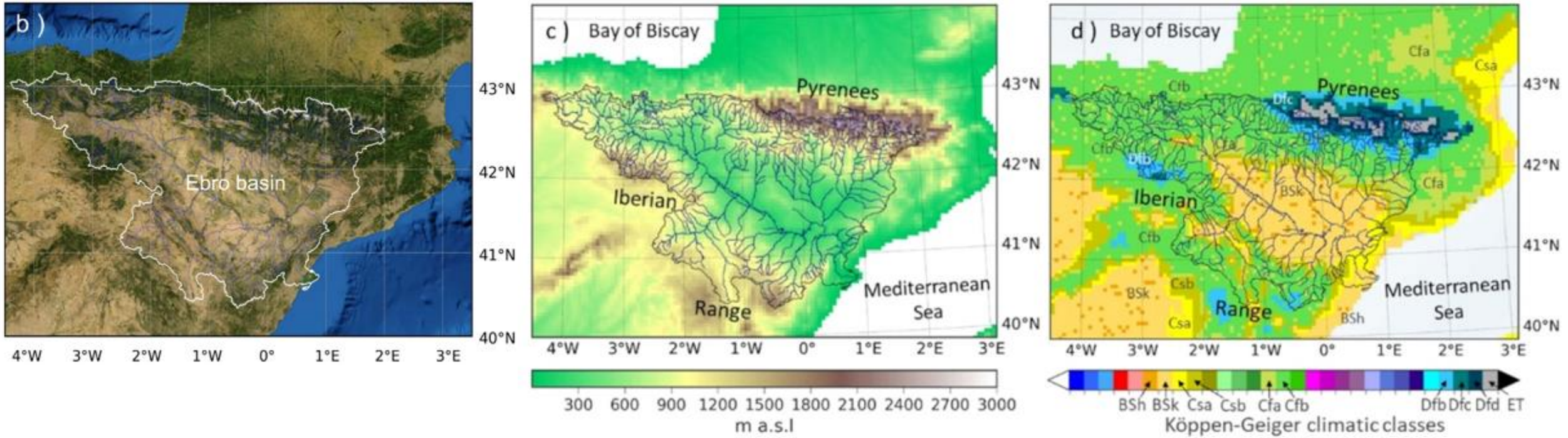


(Gaona et al., 2022, NHESS) (under review)

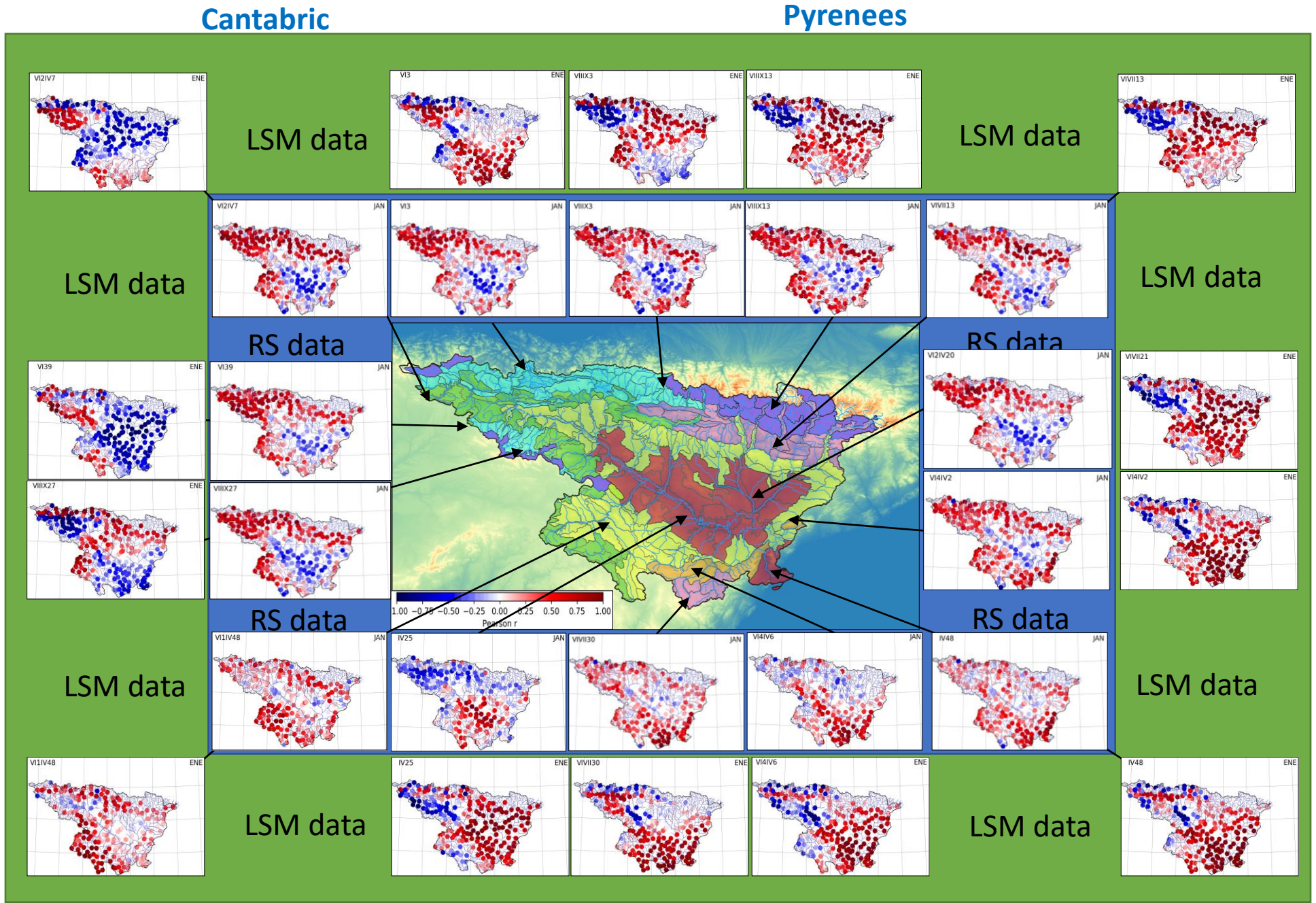
AIMS OF THE STUDY (II): ASSESS SPATIAL PATTERNS OF INTERACTION

→ Evaluate the spatio-temporal interactions between indices of rainfall (SPI), evapotranspiration (ETDI index) and soil moisture anomalies (SMDI index) to identify characteristic patterns of the water cycle at regional scale: the **EBRO river basin**

Ebro Basin in NE Iberian Peninsula is advantageous for hydrometeorological analysis due to:
- geographic characteristics (topographic, land cover, climatic, geologic),
- the intense human intervention (land cover, water use: irrigation, hydropower…),
- and the high availability of hydrometeorological and water management data.



AIMS OF THE STUDY (IIa): ASSESS SPATIAL PATTERNS OF INTERACTION



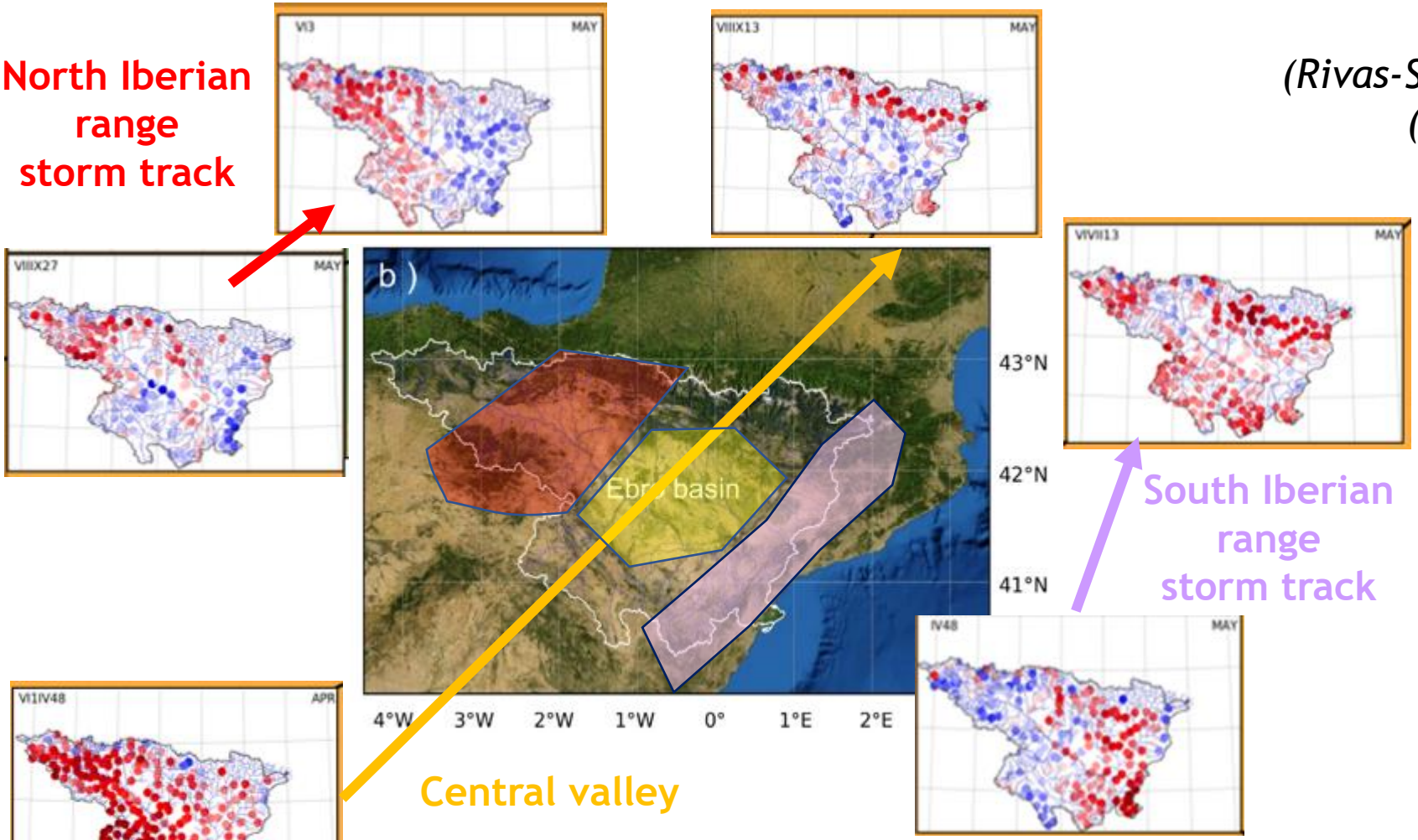
AIMS OF THE STUDY (IIb): ASSESS SPATIAL PATTERNS OF INTERACTION

Spatial correlations of ETDI and SMDI may indicate local patterns of climatic dependency

In the Ebro basin, the North-Iberian and South Iberian ranges generate relevant storm tracks

(Castro et al., 1992)
(Rivas-Soriano and de Pablo, 2002)
(Azorín-Molina et al., 2015)

North Iberian range storm track



South Iberian range storm track

Central valley

The analysis of temporal interactions between R, ET, SM anomalies (lags) can explore the alteration of local R-ET-SM interactions due to of storm tracks.

LAG ANALYSIS (I): Alteration of R-ET-SM interactions at local scale

- Exploring lags over areas requires invariant combinations to limit other factor's influence

Each combination is compared between storm-track areas and non-storm track area:

CLIMATE (Köppen-Geiger)

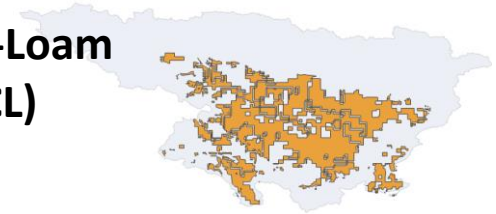
SOIL TEXTURE (USDA)

(two most common textures)

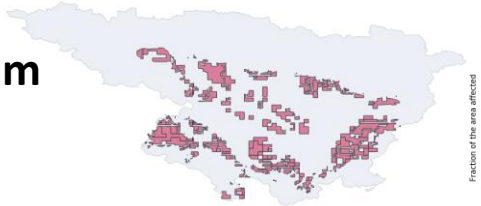
(contrasting climates)

Bsk

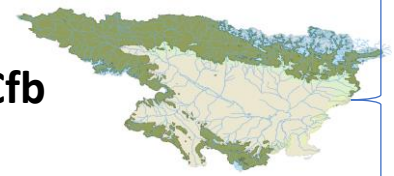
Clay-Loam (CL)



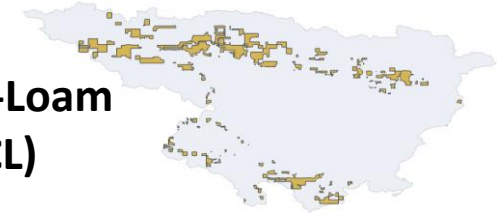
Loam (L)



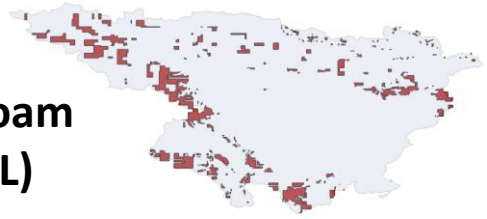
Cfb



Clay-Loam (CL)

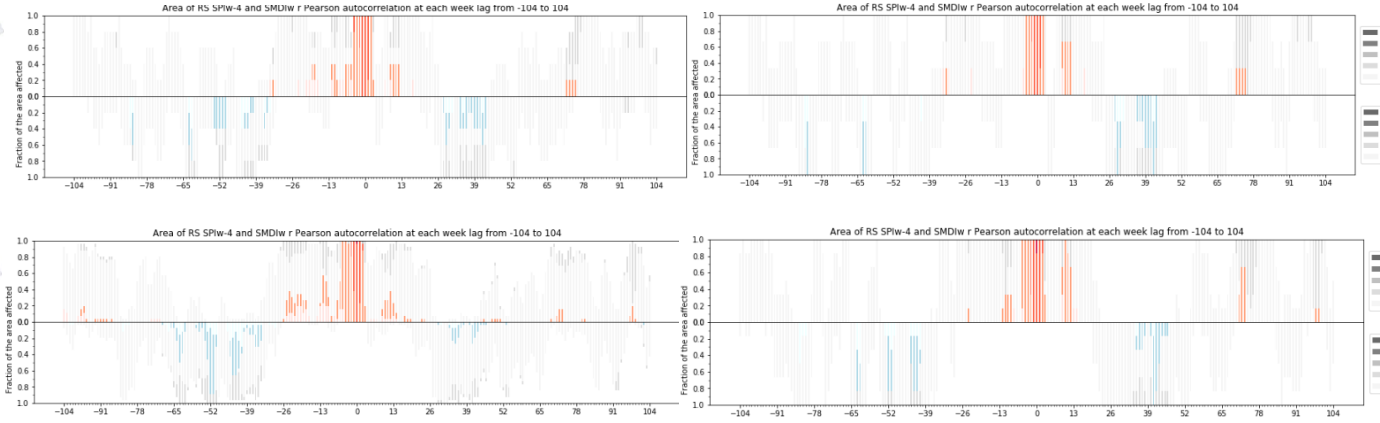


Loam (L)

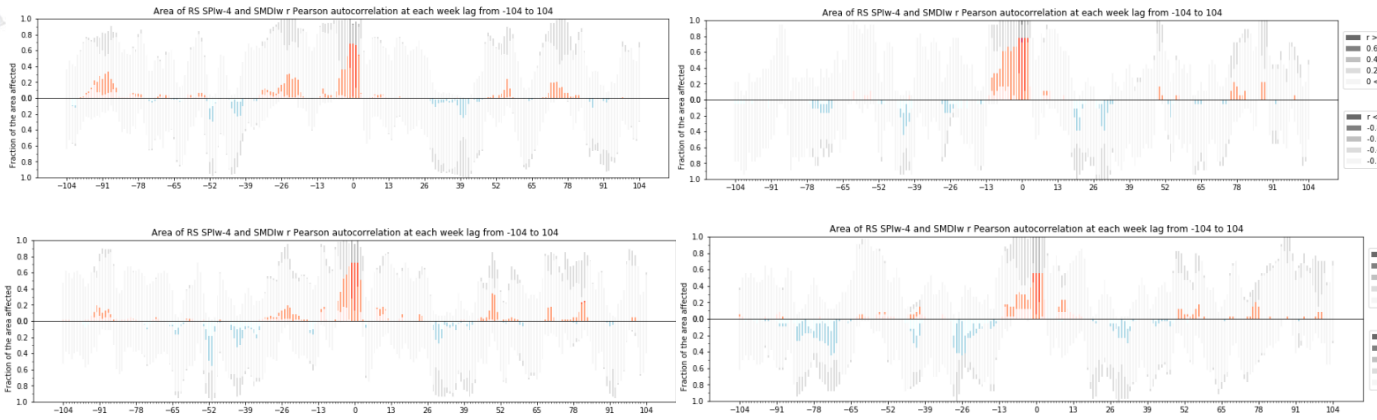


STORM TRACKS AREAS

Storm track area (e.g. North Iberian range) **VS.** **Non storm track area** (e.g. Central valley)

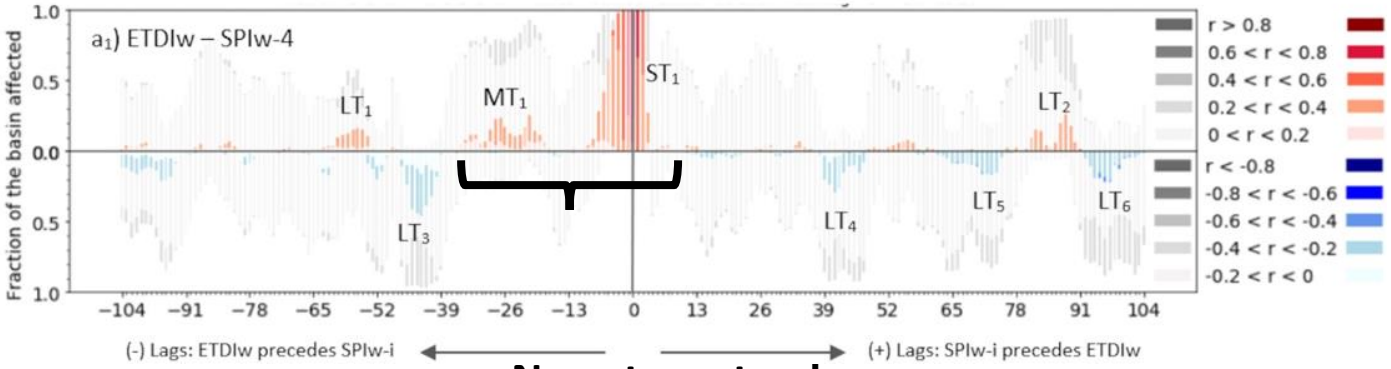


Lags differ with climate, and storm tracks more than by soils

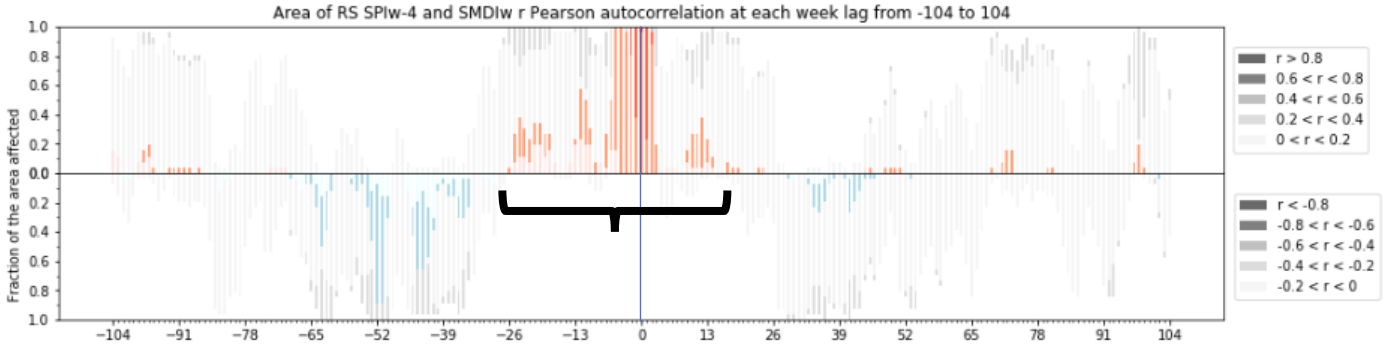


LAG ANALYSIS (II): Interpretation of alterations of interactions (I)

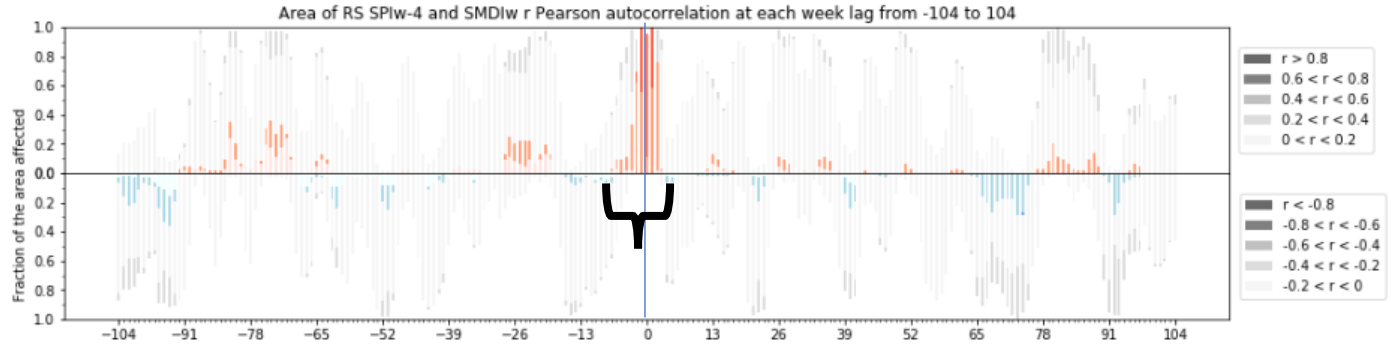
Whole basin



Non storm tracks



Storm tracks



INTERACTION SPI-ETDI

Results suggest a notable shortening of the interaction in areas under convective storm tracks:

The overly leading influence of ET on R anomalies decreases significantly while the one of R on ET remains without much change.

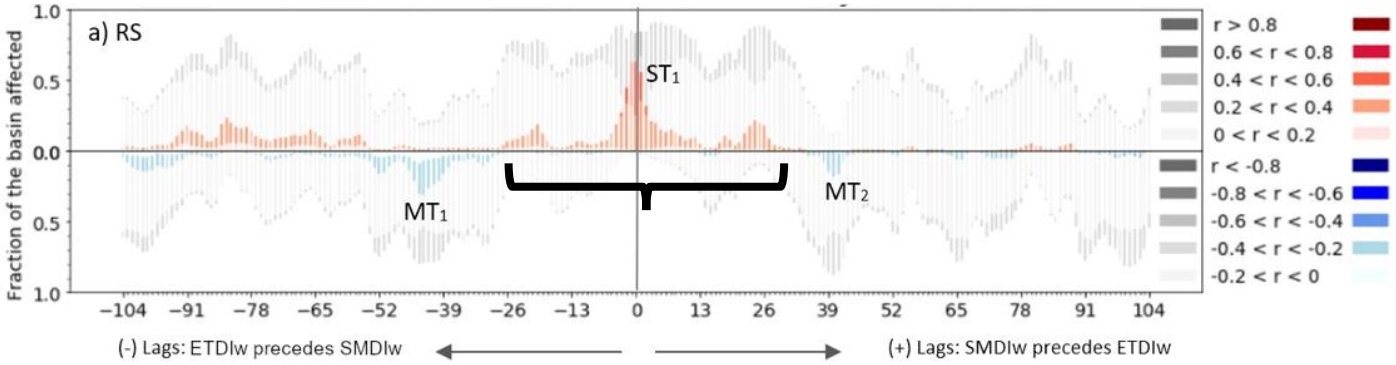
→ The long-term ET influence on rains was discussed of likely oceanic influence. Results disabling long-term anomalies may indicate a local origin of the trigger of rains under storm tracks areas.

The influence of SPI on the following ETDI anomalies also decreases

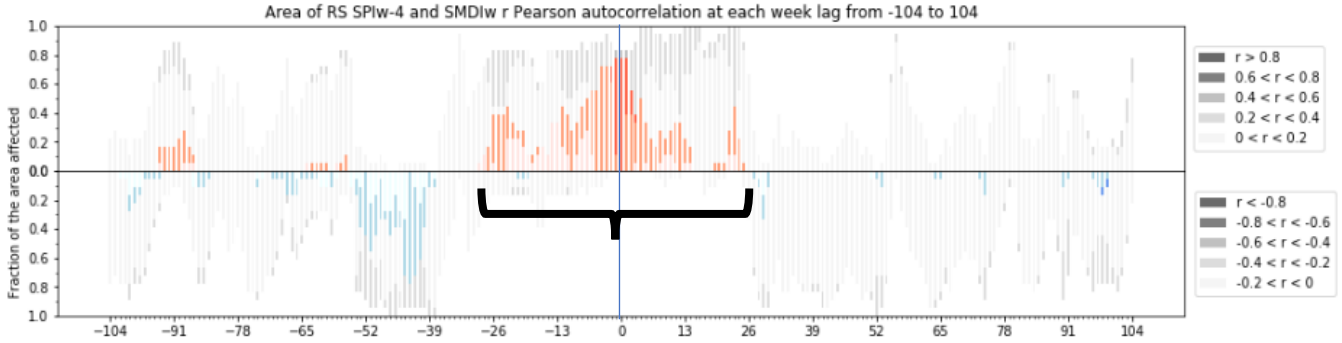
→ This result suggests ET depends less on mid to long term conditions of SPI than in other areas of the basin, where convective activity is less prevalent.

LAG ANALYSIS (II): Interpretation of alterations of interactions (II)

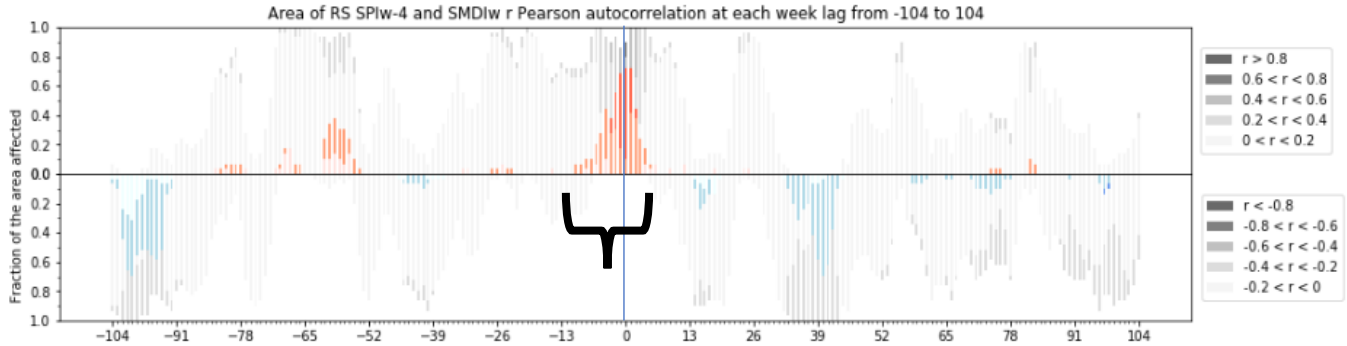
Whole basin



Non storm tracks



Storm tracks



INTERACTION ETDI-SMDI

Results suggest a notable shortening of the interaction in areas under convective storm tracks:

The leading influence of ETDI on SMDI decreases from half a year to barely a 12/6 weeks

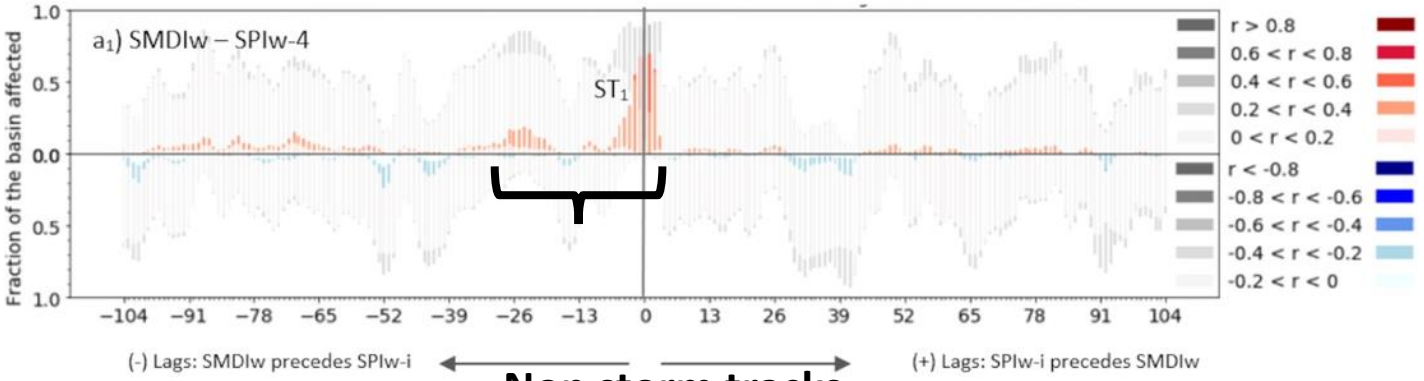
→ This result may indicate SM under storm tracks mostly depends on the short-term evolution of ET anomalies instead of on the long-term ET contribution

The influence of SMDI on the following ETDI anomalies decreases even more notably

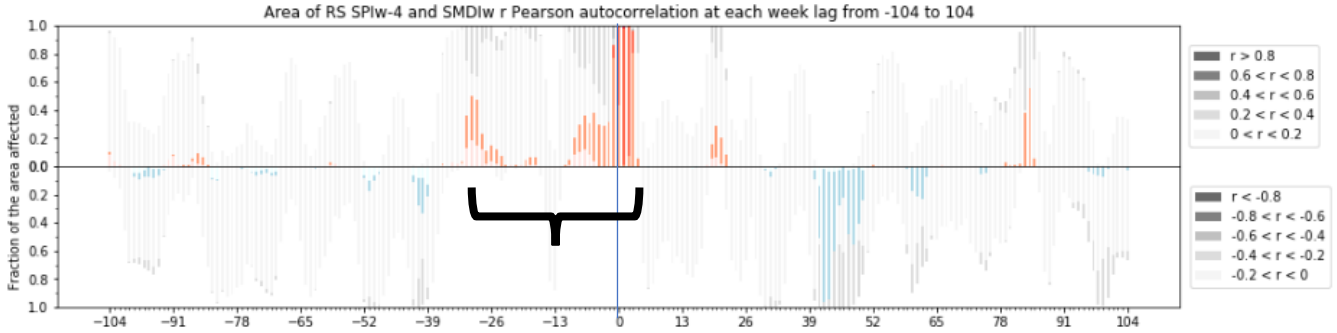
→ This result suggests precedent SM barely determines ET anomalies beyond a few weeks. The long-term dependence is lost except on the inhibiting correlation at around 8-9 months.

LAG ANALYSIS (II): Interpretation of alterations of interactions (III)

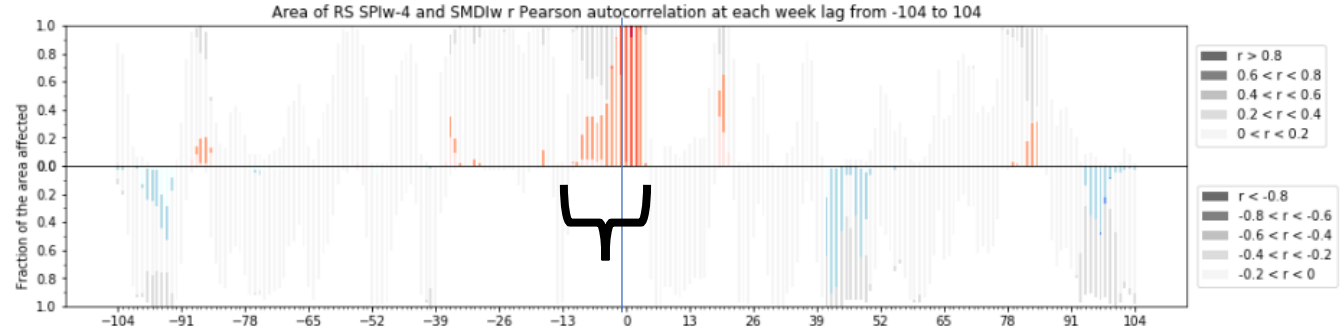
Whole basin



Non storm tracks



Storm tracks



INTERACTION SPI-SMDI

The changes observed on R-SM interactions under storm areas evidence a clear shortening of the interaction compatible with often short-term events:

The leading influence of SMDI on SPI decreases notably in duration, but not in magnitude

→ SM influence on R under storm tracks is enhanced in the few weeks around present time.

Few changes on the influence of R on subsequent SM: the interaction remains strongly asymmetrical

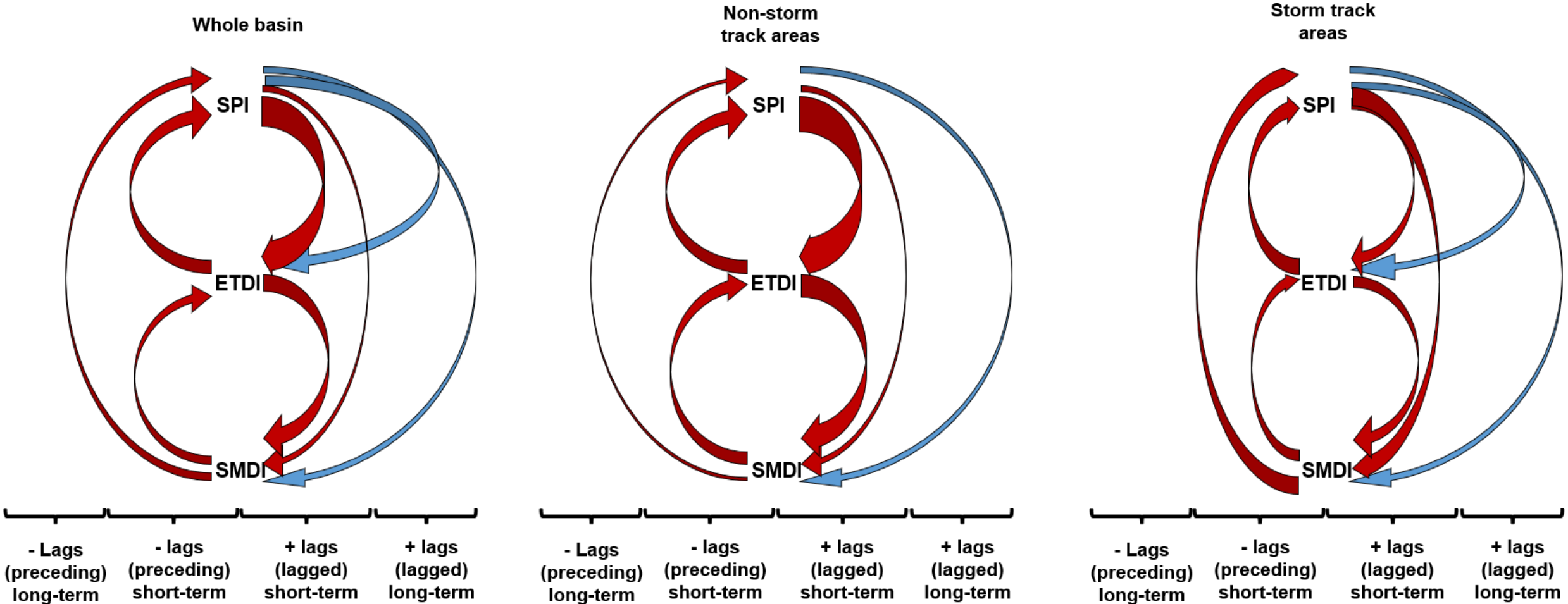
→ Result indicate the influence of SM on R remains short, barely for a few weeks. We expected a lengthening of the SM influence on R over areas of storm tracks due to local recycling.

CONCLUSIONS: Local patterns compose basin's *R-ET-SM* interactions

Lag analysis is a powerful tool to explore the balance between interactions of key variables of the land-surface

Local patterns such as convective storm tracks may shorten the duration of interactions, which is compatible with the short-term nature of these local events. Areas outside tracks remain of similar lags to those of the basin

The general scheme of interactions of a basin is a balance of that of local patterns → It is worth + exploration



Questions?...

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