



# ARE THE DROUGHTS BUSTERS IN IBERIAN PENINSULA ASSOCIATED WITH ATMOSPHERIC RIVERS?

# 1. Introduction

Since the begin of the century the Iberian Peninsula has been stricken by major drought events, namely the extreme events of 2004/2005 and 2011/2012.



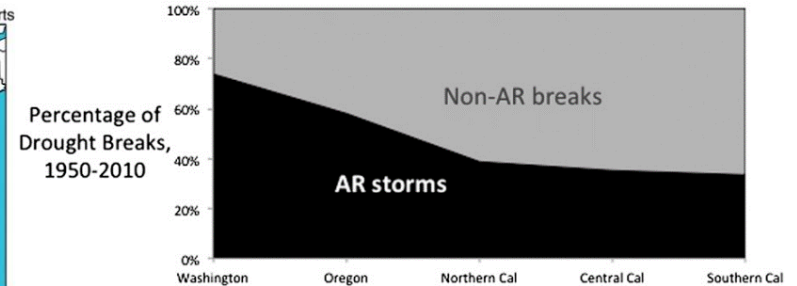
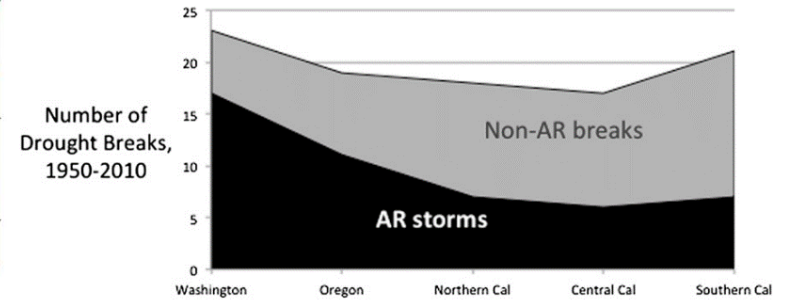
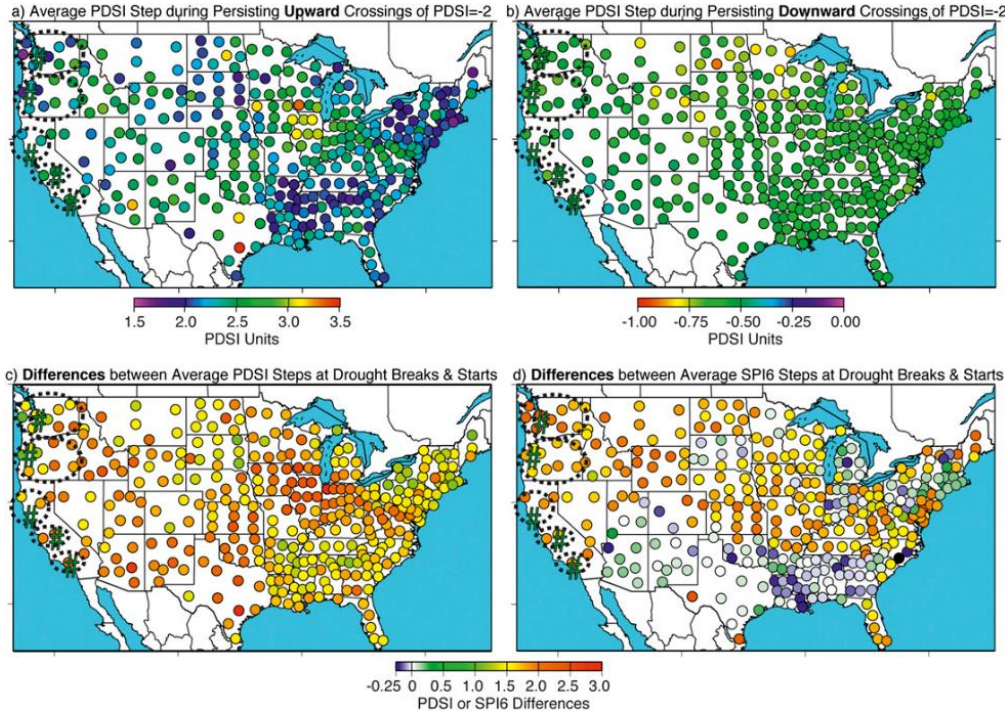
The projected increase of drought conditions in the coming decades reinforces the huge need of better understanding the frequency, duration, start and ending phases of droughts.



With the aim of better understanding the water cycle, special attention has been devoted to the role played by the horizontal moisture transport in the lower atmosphere by Atmospheric Rivers (Ralph et al., 2006).

## 2. Motivation

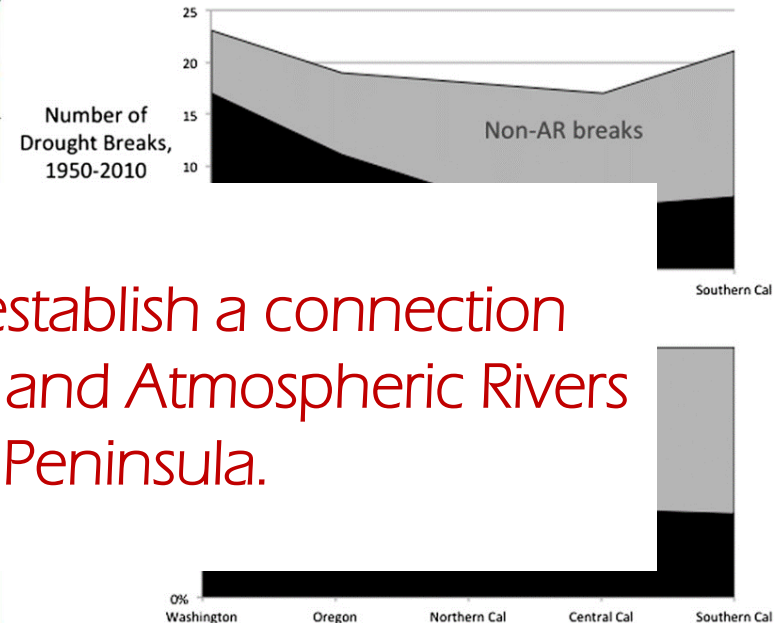
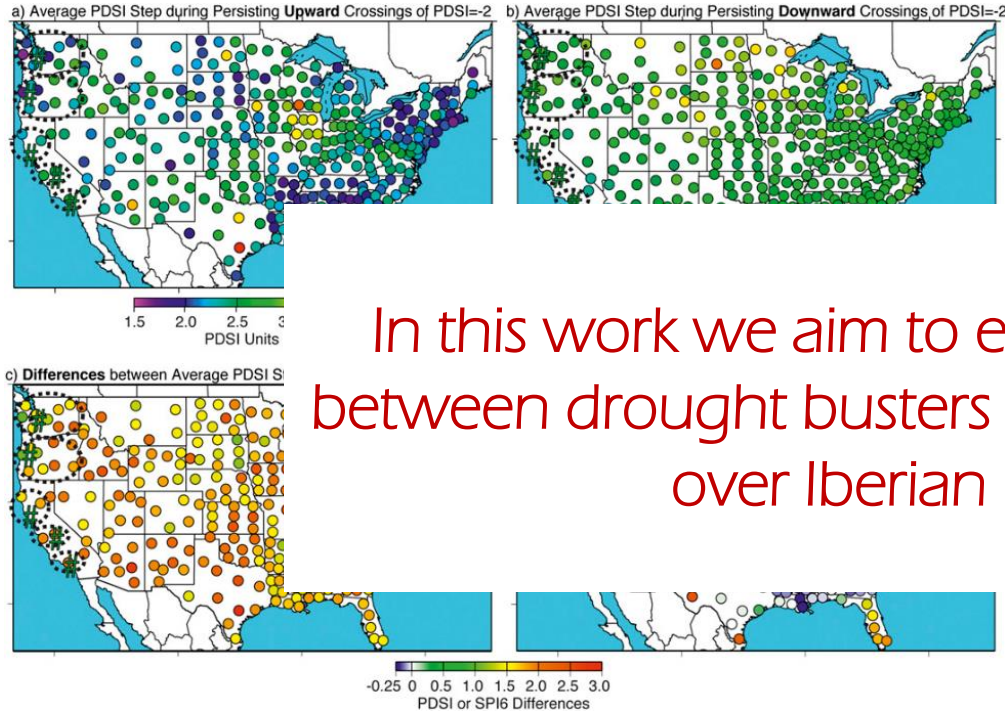
On the other hand, in **California** and in the **Pacific Coast of U.S Northwest** about **1/3** and **2/3**, respectively, of all persistent drought endings from 1950-2010 have occurred by the arrival of **ARs storms** (Detinger, 2013).



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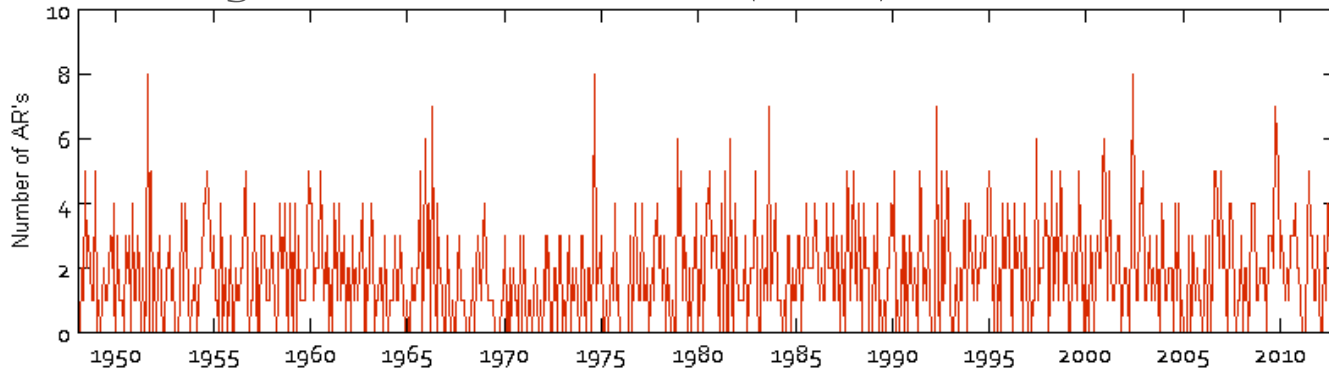


In this work we aim to establish a connection between drought busters and Atmospheric Rivers over Iberian Peninsula.

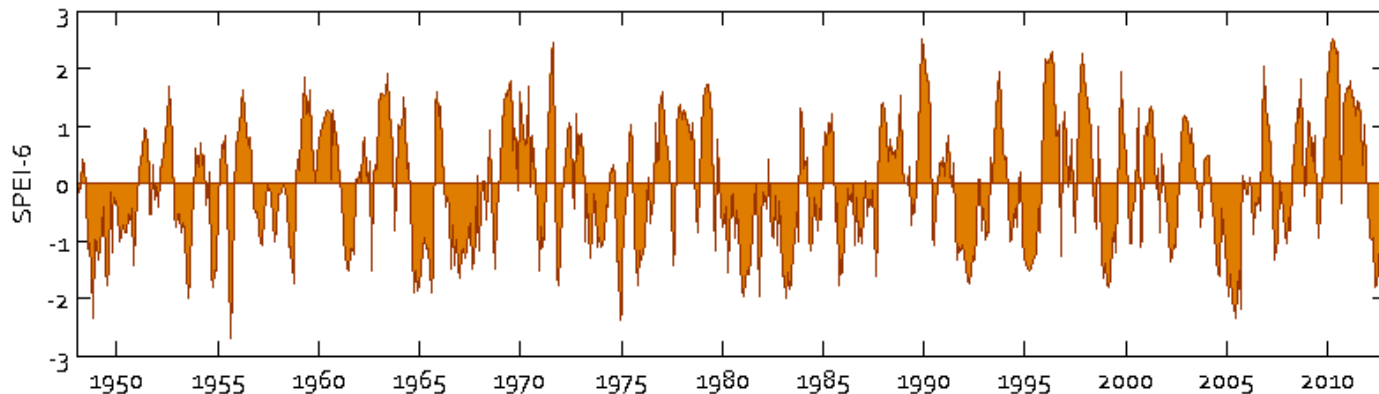
(Detinger, 2013).

## 2. Data

- ARs events and time steps that affected the Iberian Peninsula over the 1948–2012 period, obtained through the automated atmospheric rivers (ARs) detection algorithm of Ramos et al. (2015).



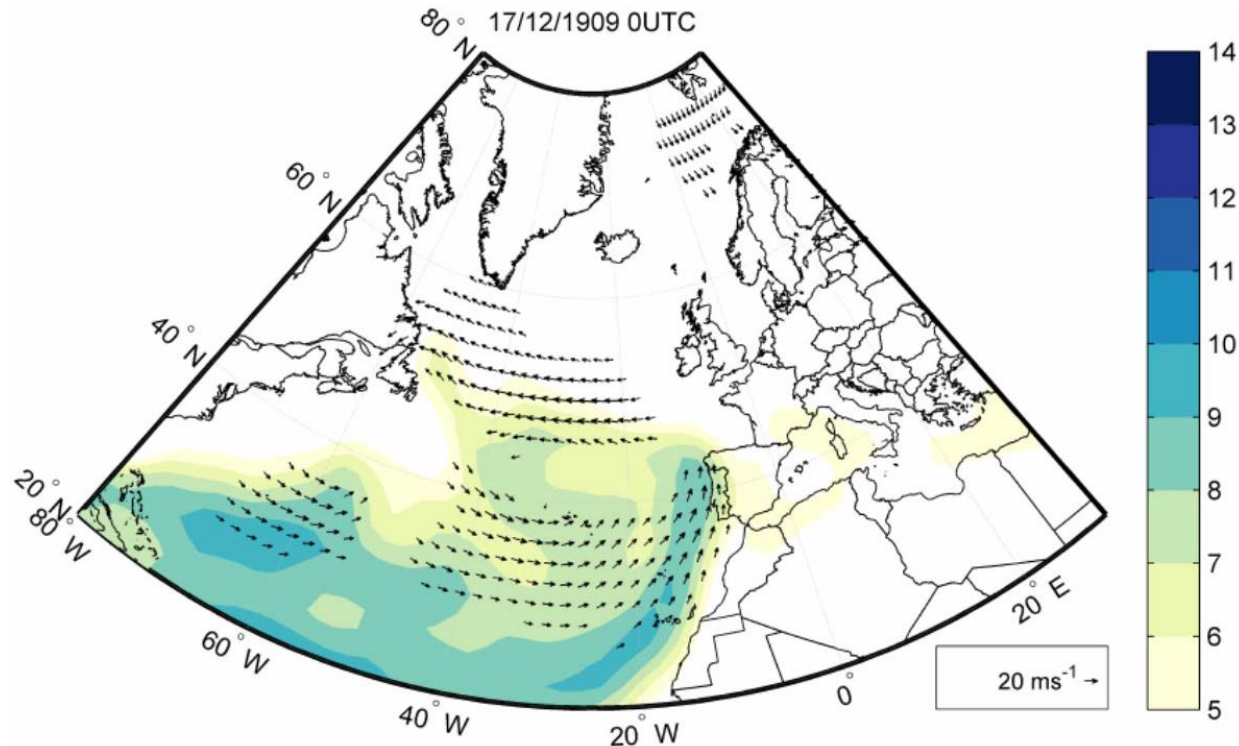
- SPEI for the time scale of 6 months, as obtained from CRU TS3.21 database between 1901 and 2012 with a spatial resolution of  $0.5^\circ$  (Russo et al, 2015). Evapotranspiration was estimated using the Hargreaves method.



# 4. Atmospheric Rivers

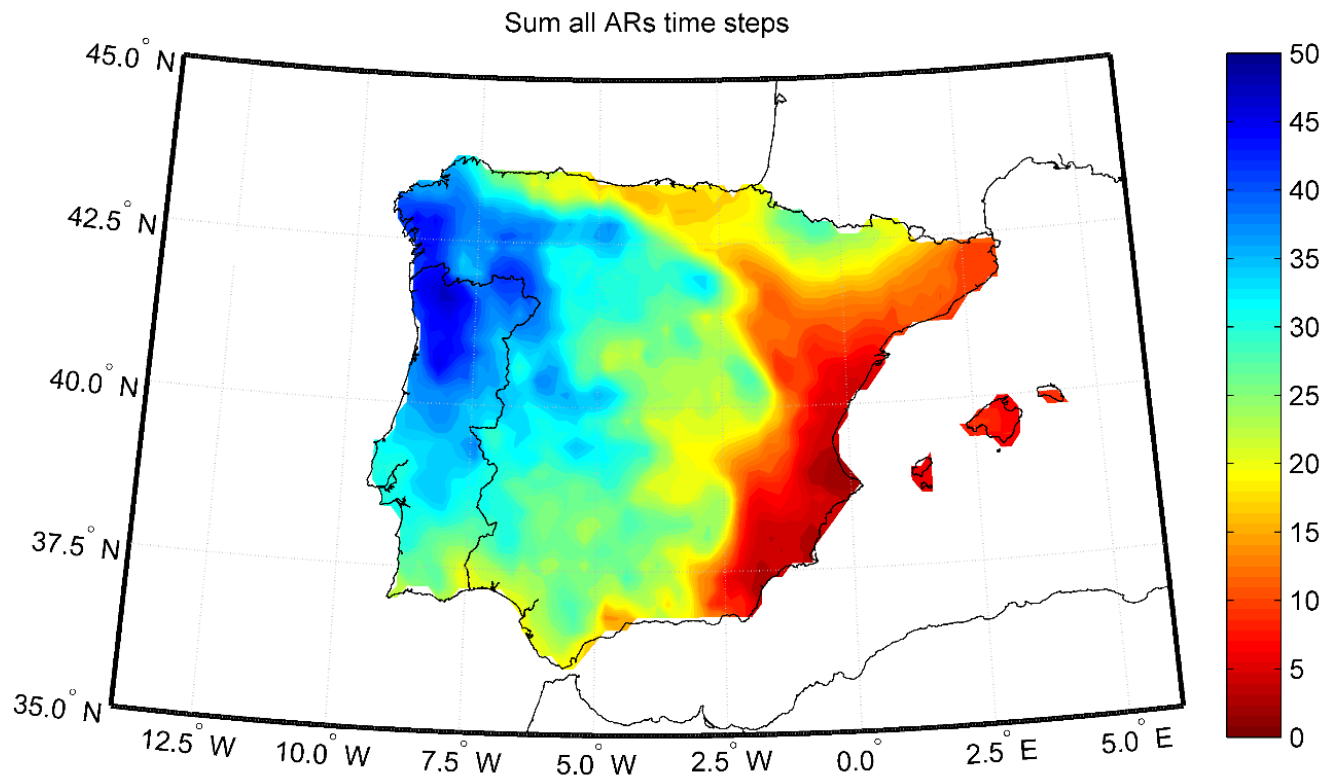
**Atmospheric Rivers (ARs)** are relatively narrow regions of concentrated Water Vapour (WV) responsible for horizontal transport in the lower atmosphere.

The large amounts of WV that are transported can lead to heavy precipitation and floods with important social economic impact.

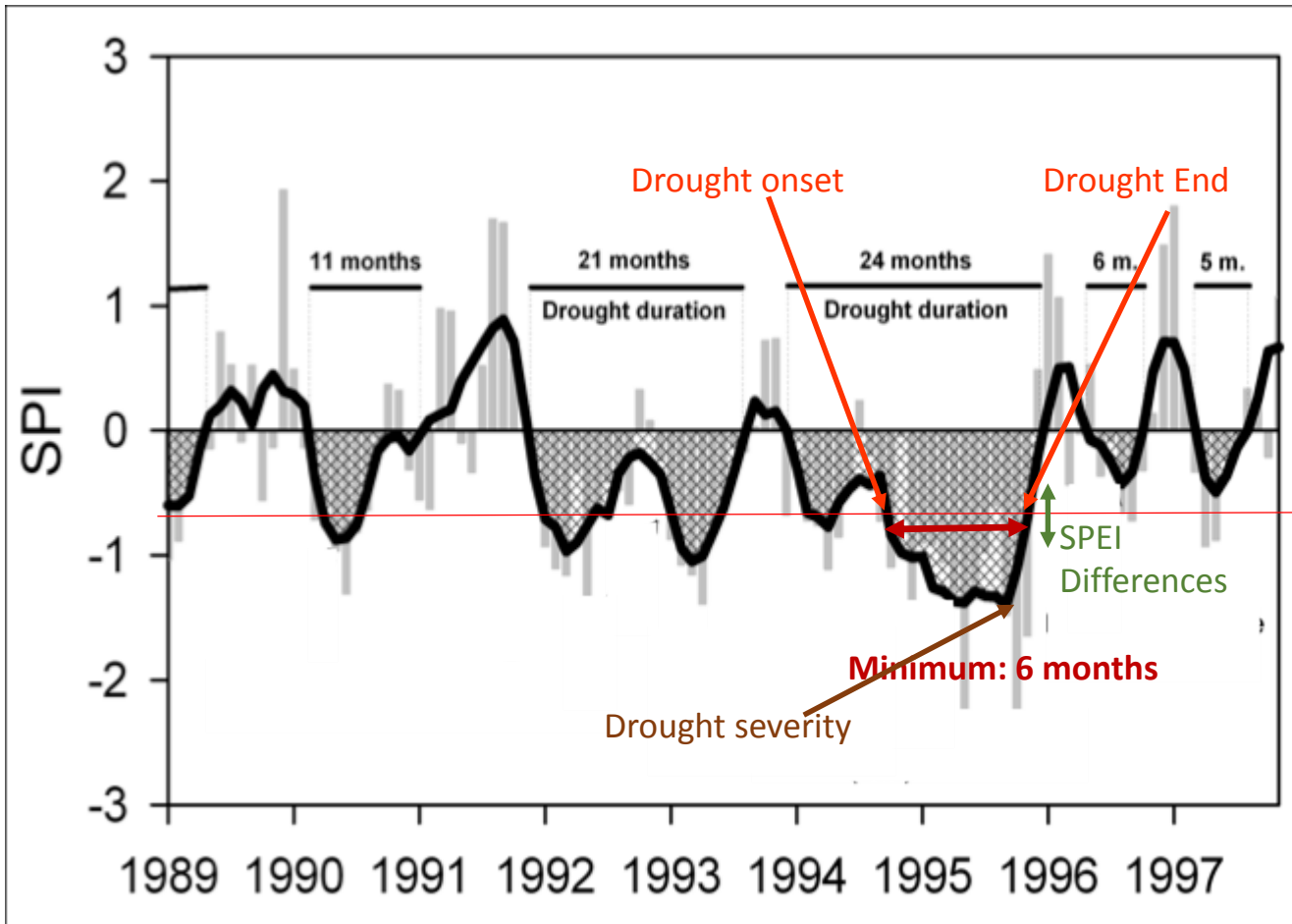


## 4. Atmospheric Rivers

Percentage of Atmospheric Rivers associated to extreme precipitation events (considering the sum of ARs for all time steps, 1948-2012).



### 3. Drought ends in Iberian Peninsula



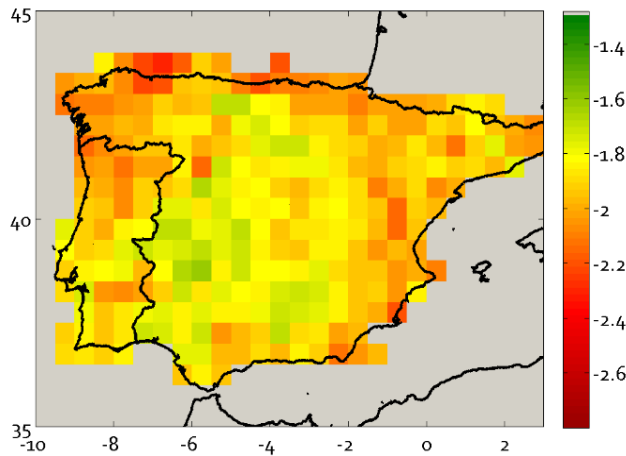
-0.84  
Moderate Droughts

(Adapted from <http://santiago.beguera.es/2013/11/spatial-temporal-analysis-of-the-1970s-sahel-drought/>)

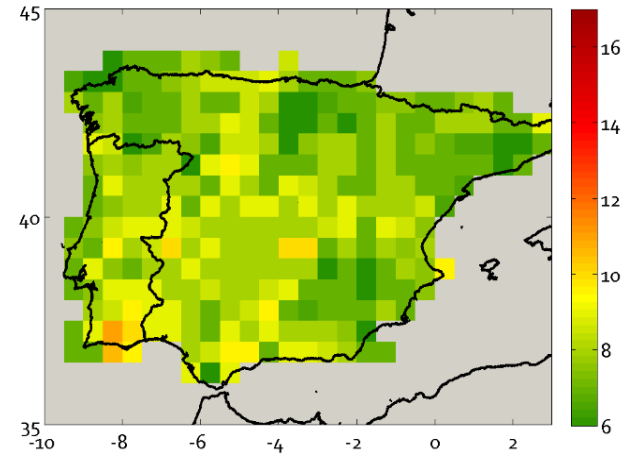


# 3. Drought ends in Iberian Peninsula

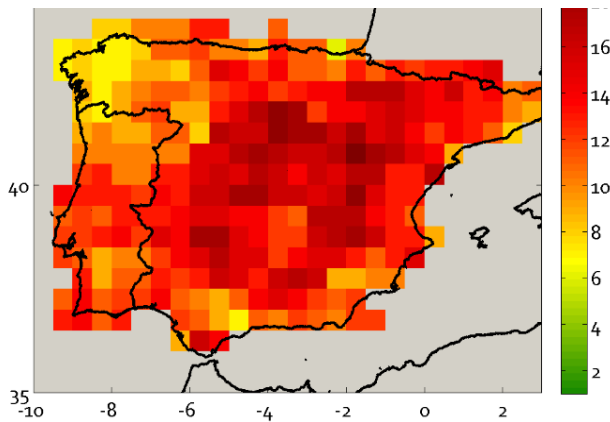
Drought severity



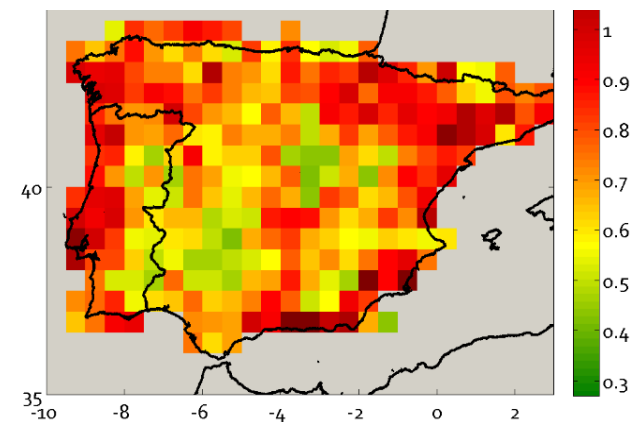
Mean drought duration



Number of drought events (>6)

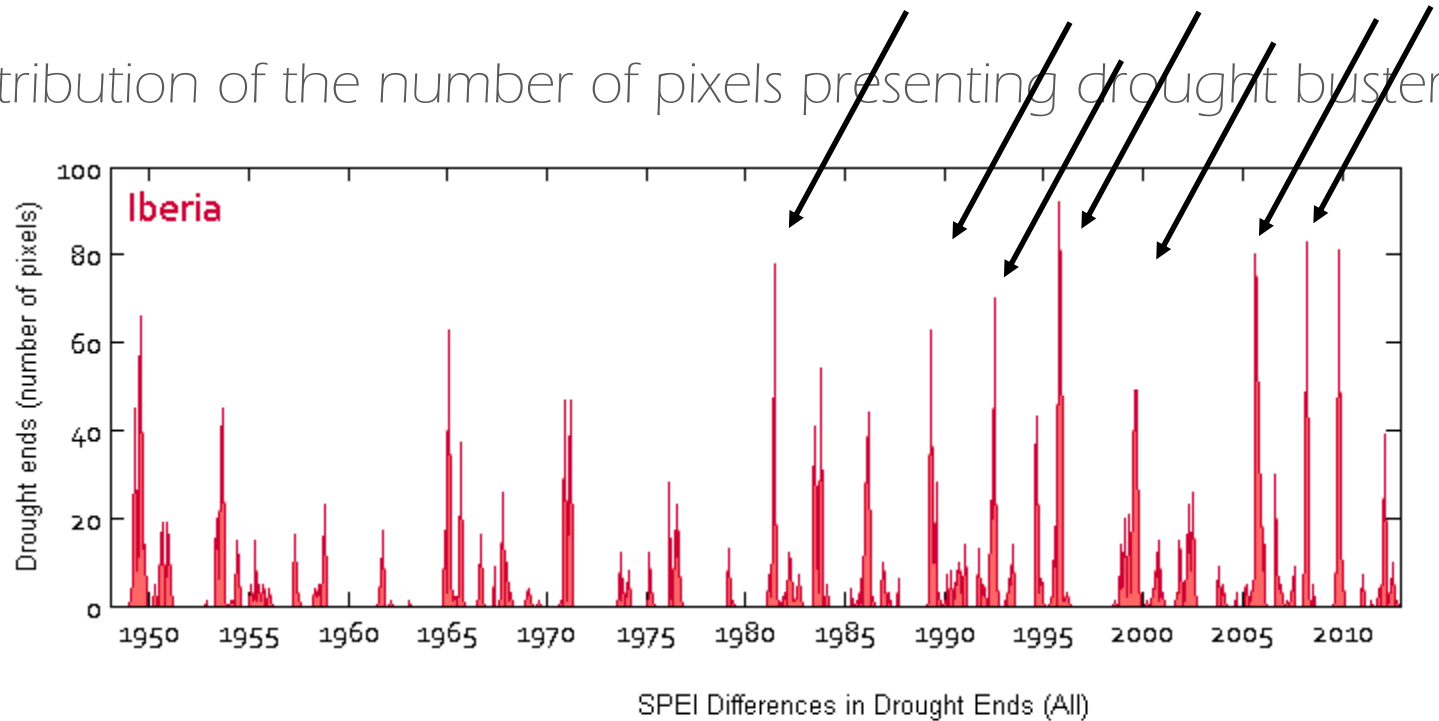


SPEI differences in Drought ends

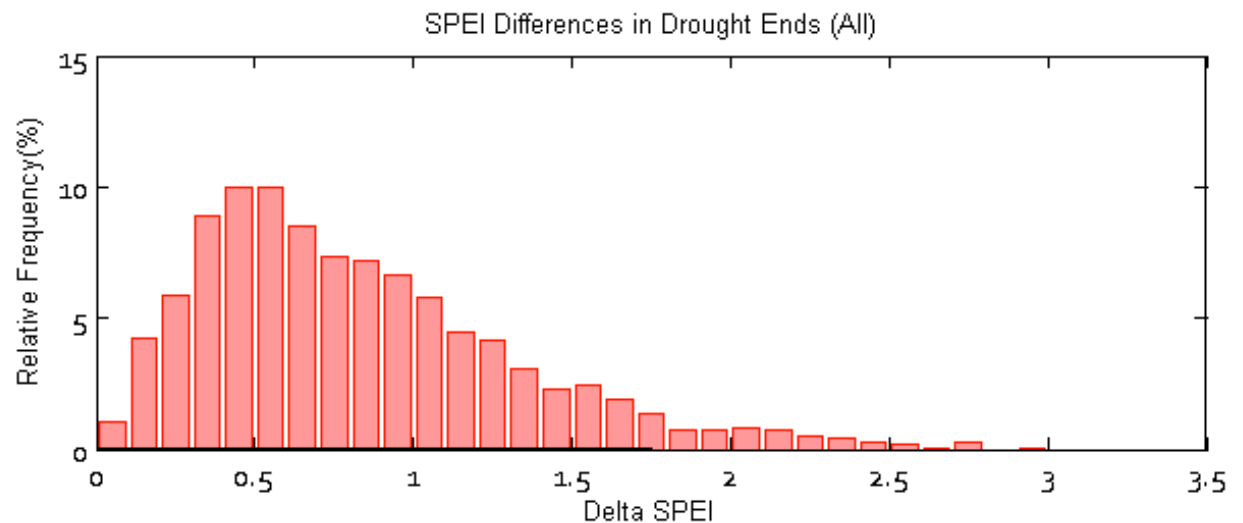


# 3. Drought ends in Iberian Peninsula

Monthly distribution of the number of pixels presenting drought busters over Iberia

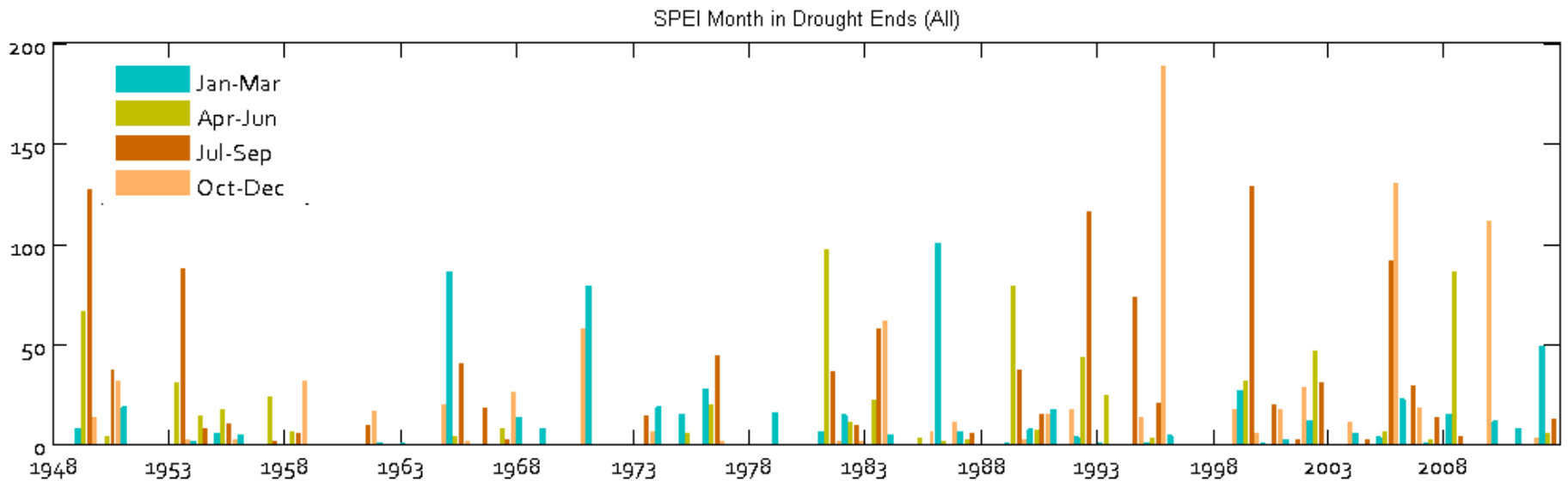


Frequency of SPEI Differences in drought busters



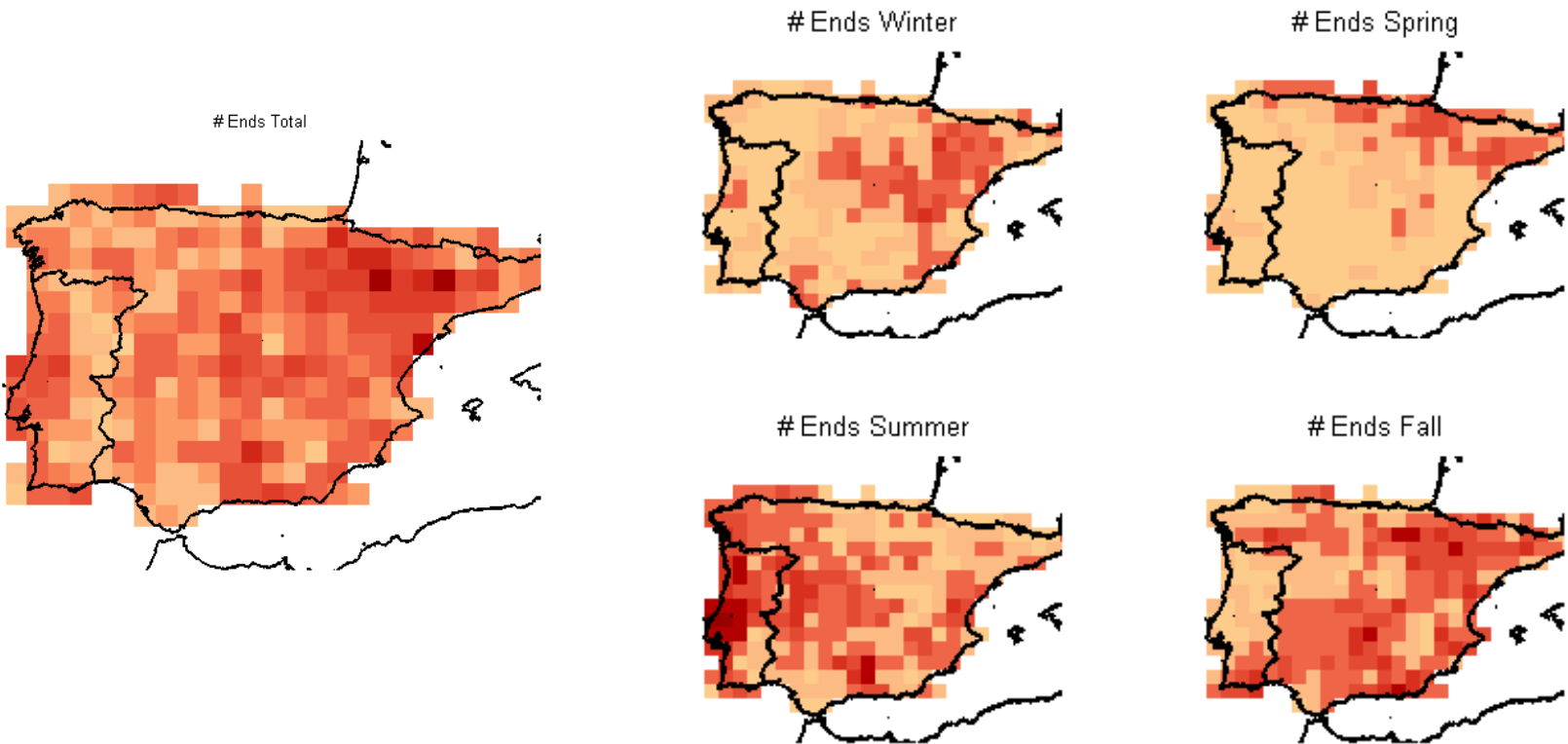
# 3. Drought ends in Iberian Peninsula

The amount of drought ends were assessed separately for each season, presenting the summer and fall high frequency of drought ends in the last period.



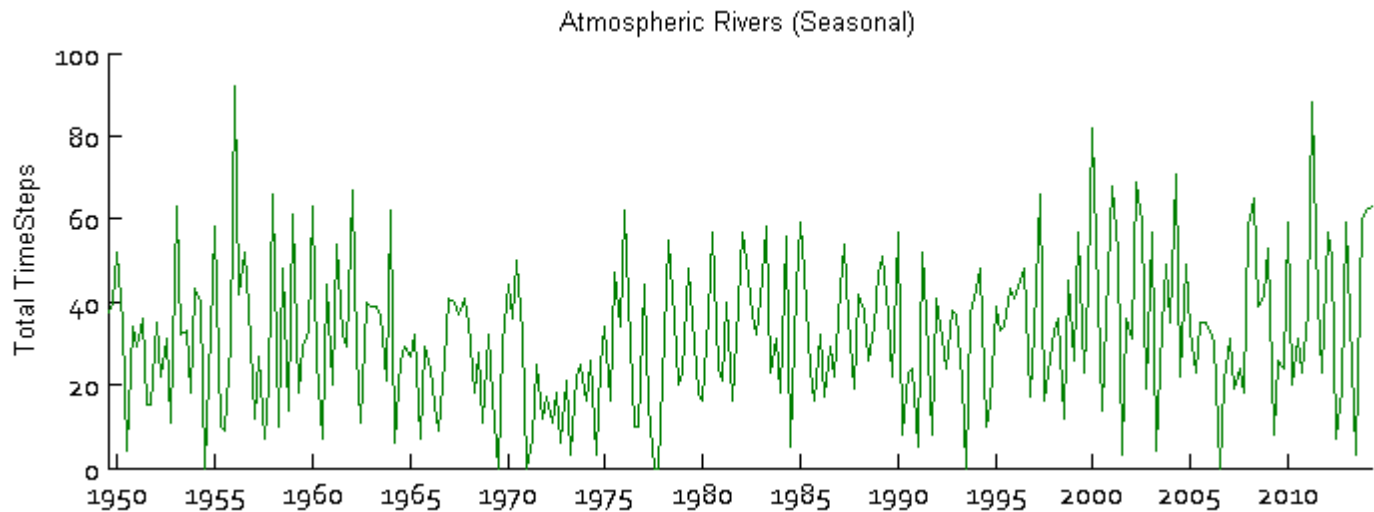
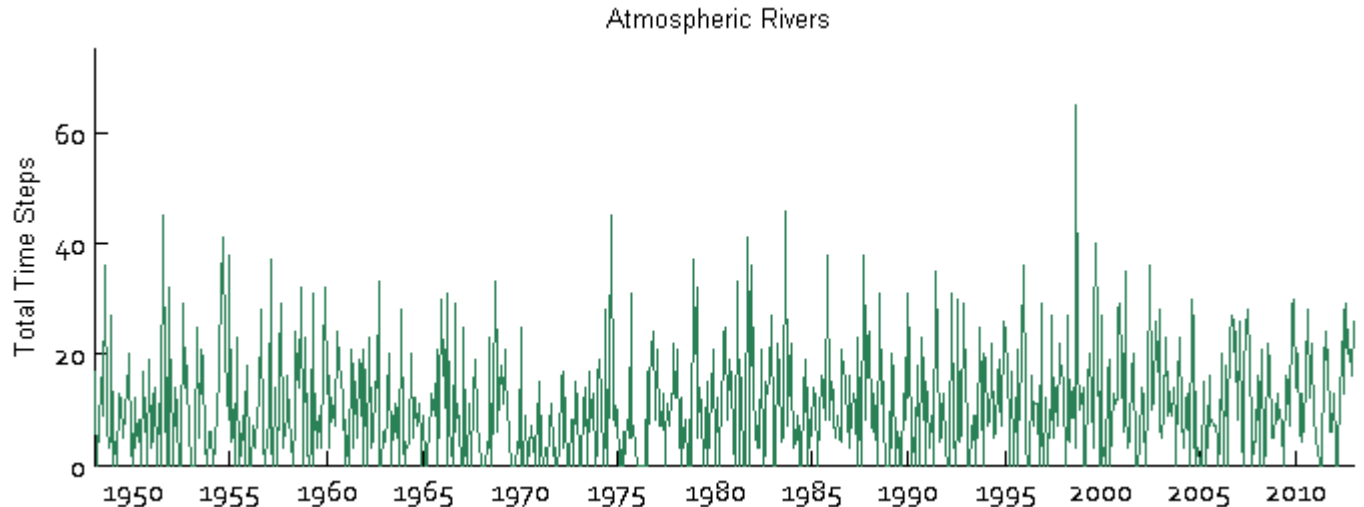
# 3. Drought ends in Iberian Peninsula

Spatial distributions of drought ends: annual and seasonal



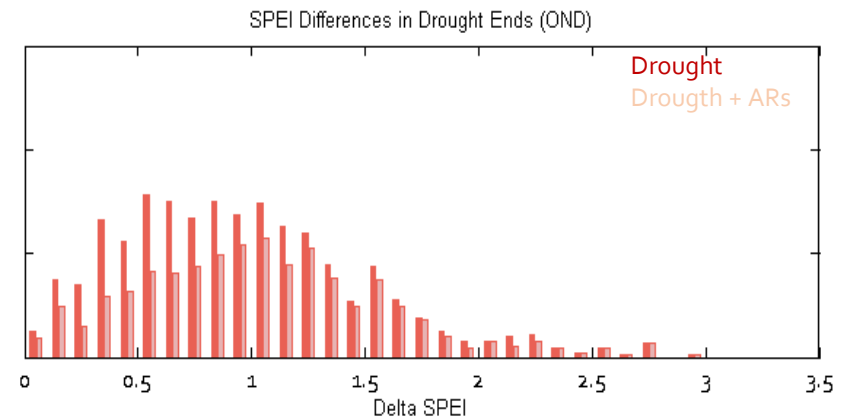
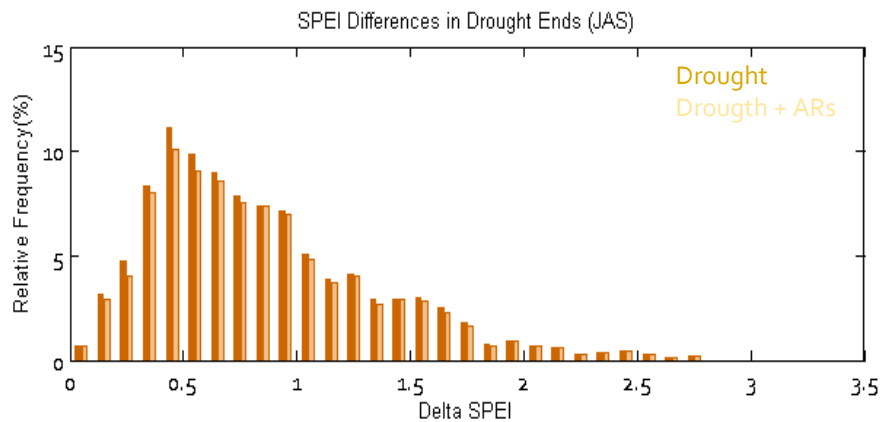
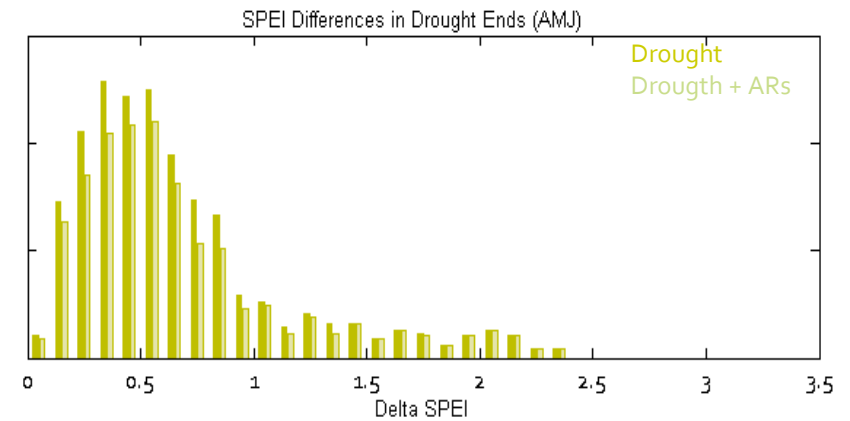
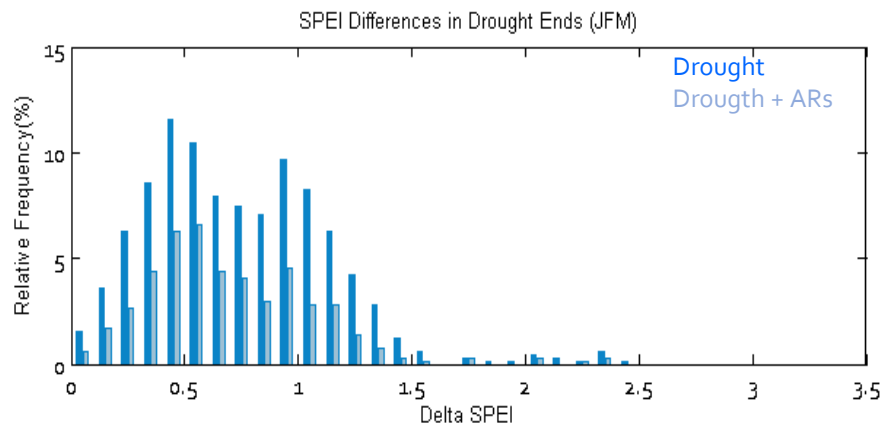
# 3. Atmospheric Rivers in Iberian Peninsula

Monthly and seasonal time series of total time steps



# 3. ARs and Drought ends in Iberian Peninsula

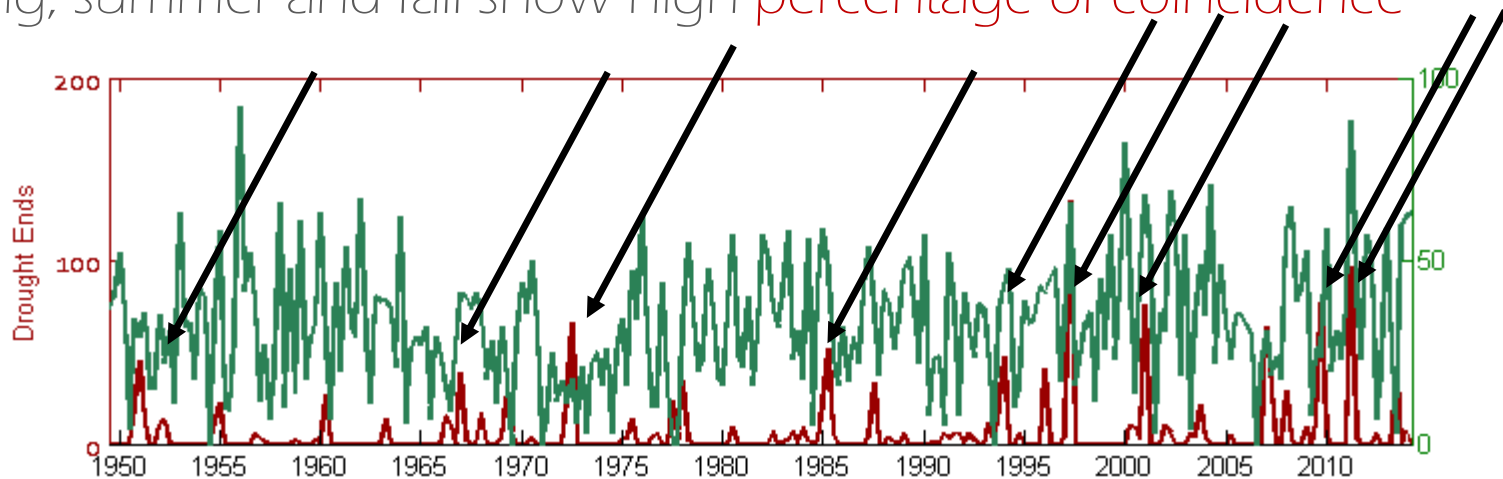
Percentage of drought ends that are coincident with ARs occurrence,



### 3. ARs and Drought ends in Iberian Peninsula

Special attention was paid to the events with *more than ten drought end pixels over Iberia*

Spring, summer and fall show high *percentage of coincidence*



Annual	Winter	Spring	Summer	Fall
97%	83%	100%	100%	100%

# 5. Discussion

- Lower number of drought events in **Northwestern Iberia**.
- **Lower SPEI differences** during drought busters in **South and Central Iberia**.
- **Higher percentage** of pixels presenting **drought busters** over Iberia in 1995, 1999, 2006, 2008 and 2010.
- Since the **begin of 1990** the higher number of drought busters occurred mainly in **summer and fall**, while in the 3 decades before there are a considerable number of **drought ends in winter**.
- The **spatial distribution of drought busters** present also a strong seasonality; during winter and spring the mainly occurred in Eastern and North sectors respectively, whereas in **summer** they are located in **west and northwest** sectors and in **fall** in **south and eastern region**.
- The **percentage of widespread drought ends** that are coincident with atmospheric rivers occurrence **are higher in spring and summer**, being the lowest occurrence observed in winter.

