Winter Very Long Dry Spells over the Mediterranean Basin

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Objectives

Very Long Dry Spell events variability during the second half of the 20th century : where (location), when (seasonality), how much (frequency), how long (duration) and why (associated conditions)?

→ **Very Long Dry Spell events are considered as an object**
(spatial and temporal grid-point grouping)

→ **Winter period = "rainy season" > September to April.**

2 axes developed for the current conditions :

1. focus on the Very Long Dry Spells events (VLDS) for the 1957-2013 period :
   - detection of Very Long Dry Spells events ;
   - classification (HAC) into main regimes of VLDS events ;
   - characteristics of the main regimes of VLDS events ;
   - try to explain the Seasonality of the VLDS and LDS events.

2. capacity of the MED-CORDEX runs to reproduce VLDS events (1979-2009) :
   - the 80th centile value on models;
   - detection of VLDS events on models ;

Daily grid point data series

- 1957-2013 :
  - E-OBS v10.0 (European Climate Assessment & Dataset) daily precipitation amount (0.25° resolution).
  - NCEP-NCAR reanalysis (National Centers for Environmental Prediction-National Center for Atmospheric Research) Sea Level Pressure and Z500 Geopotential (2.5° resolution).
- 1979-2009 : MED-CORDEX runs evaluated

Platform	Resolution	RCM	Coupled	Period
CNRM	MED-44	ALADIN 52	-	1979-2011
ICTP	MED-44	RegCM4 v4	-	1979-2012
CMCC	MED-44	CCLM4	-	1979-2012
LMDZ	MED-44	LMDZ4	-	1979-2009
LMDZ	MED-44	LMDZ4	NEMOMED8	1979-2009

The MED-CORDEX resolution have been adapted to the E-OBS grid (0.25°)

1.1. How to detect Very Long Dry Spells events? (1/2)

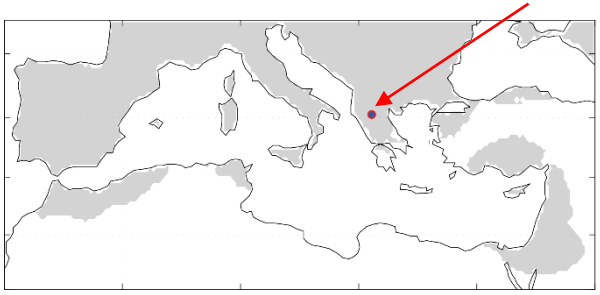
Method: **for each grid point**

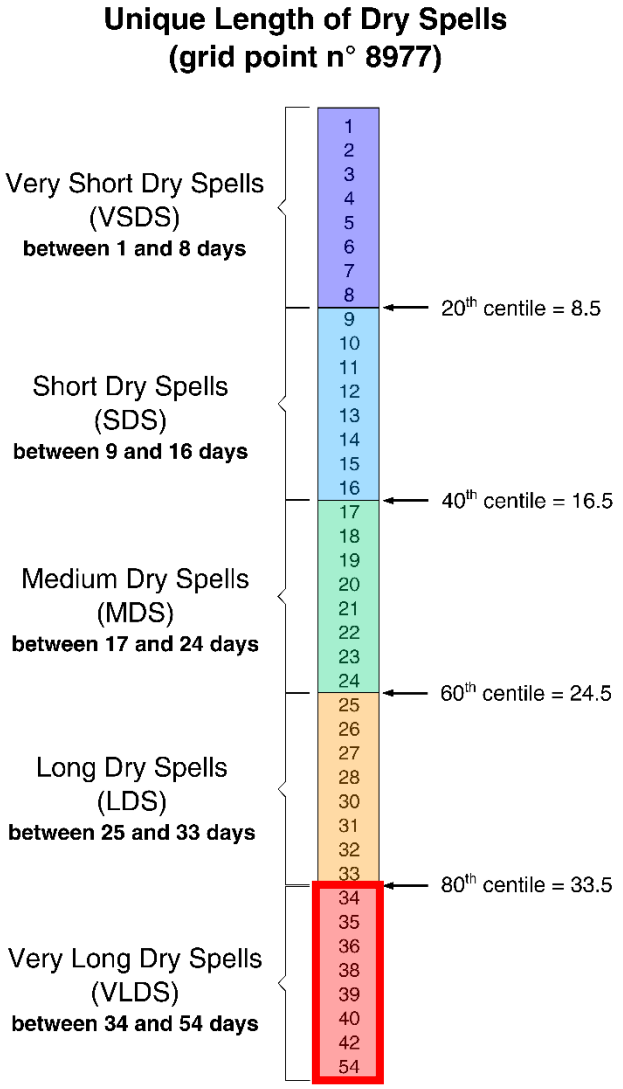
- dry spells length ⟶ number of consecutive dry days ;
- centiles are apply on the unique value of dry spells length (1979-2013 period);

- Very Short Dry Spells: **VSDS** < 20th centile ;
- Short Dry Spells: 20th centile < **SDS** < 40th centile ;
- Medium Dry Spells: 40th centile < **MDS** < 60th centile ;
- Long Dry Spells: 60th centile < **LDS** < 80th centile ;
- Very Long Dry Spells: **VLDS** > 80th centile ;

Example:

Grid Point n°8977 (40.125°N & 21.125°E)





1.1. How to detect Very Long Dry Spells events? (2/2)

Binary matrix to select VLDS:

value "0" > rainy grid points or grid points where dry spells are shorter than the 80th centile ;

value "1" > all grid points belonging to dry spells longer than the 80th centile.

Sliding scan to obtain spatially and temporally coherent events:

to the 13552 days:

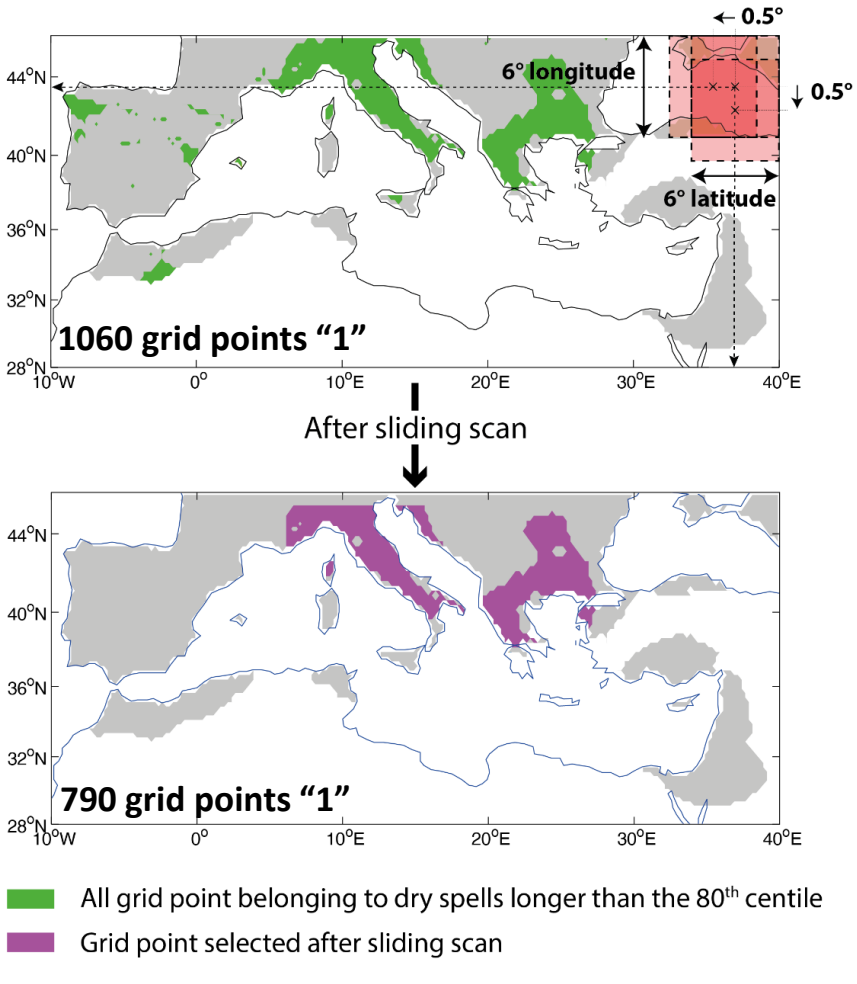
- square of 6 degree longitude/latitude ;
- sliding by 0.5° longitude/latitude increment ;
- sea grid points and grid points without data not taken into account.

VLDS day: if 90% of the grid points contained in at least one square have the value "1".

VLDS event "object" is characterized by location, spatial extension, duration and associated atmospheric conditions.

Adapted from Stefanon *et al.*, 2012

Sliding scan example (01/01/1989)



100 events for a total duration of 4423 days (32.6%)

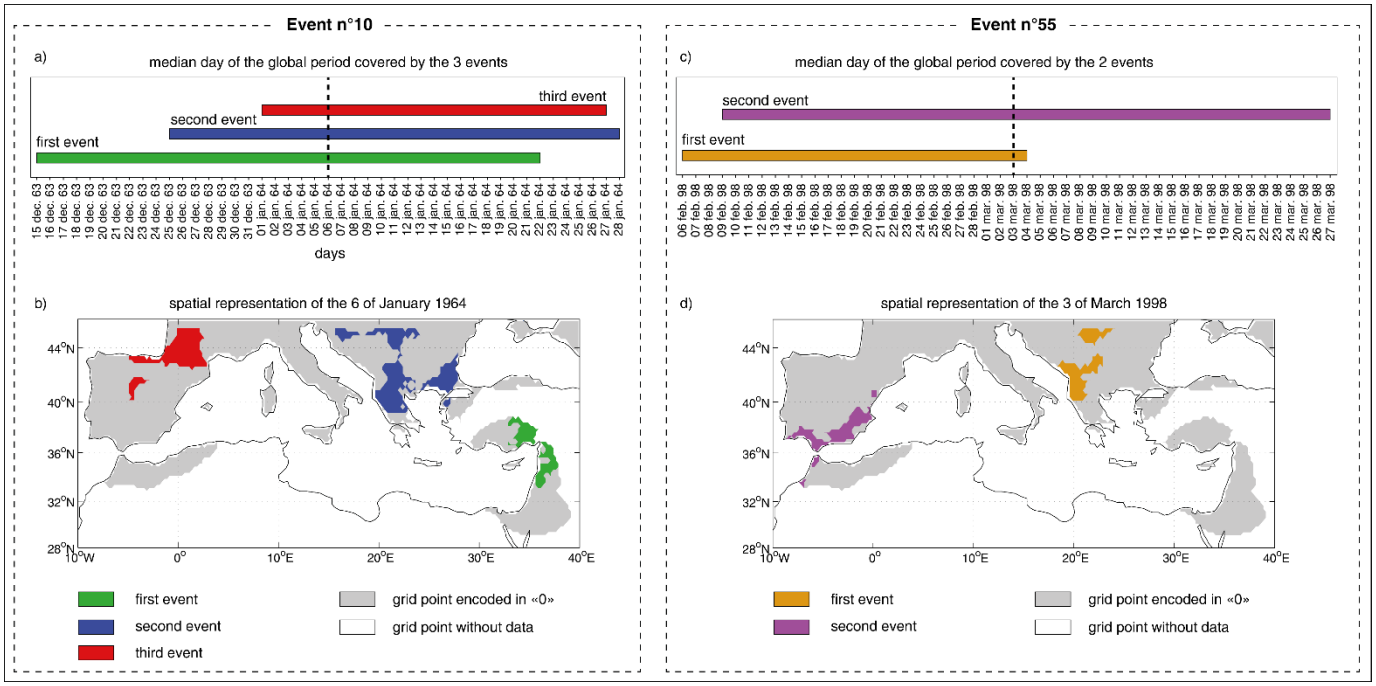
1.2. Very Long Dry Spells classification (1/2)

100 VLDS events for total duration of 4423 days :

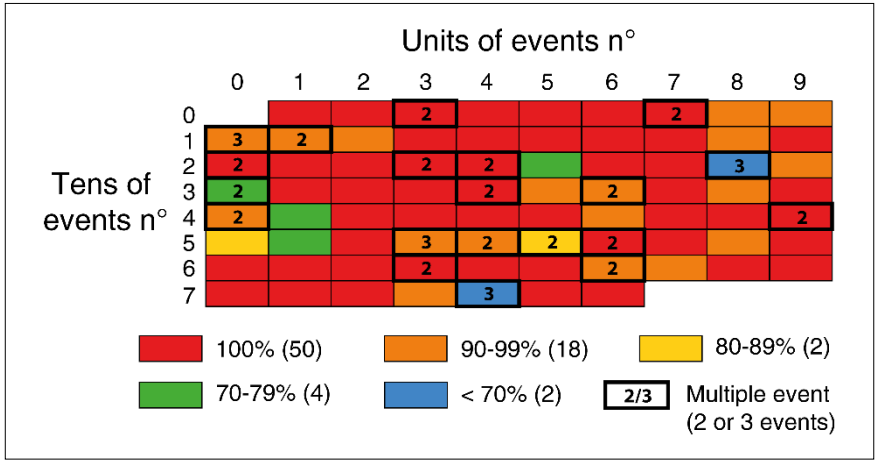
- 56 singular/simple events
(one event occurs at a time)

- 44 nonsingular events
(belong to 20 multiple events, characterized by 20 different periods where VLDS occur the same day but in different areas)

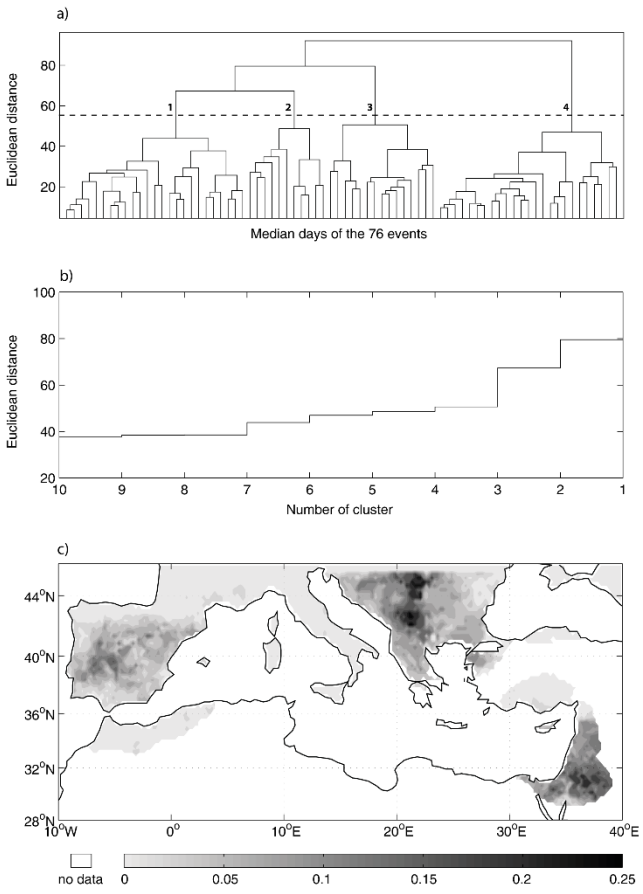
> 100 to 76 events (periods)



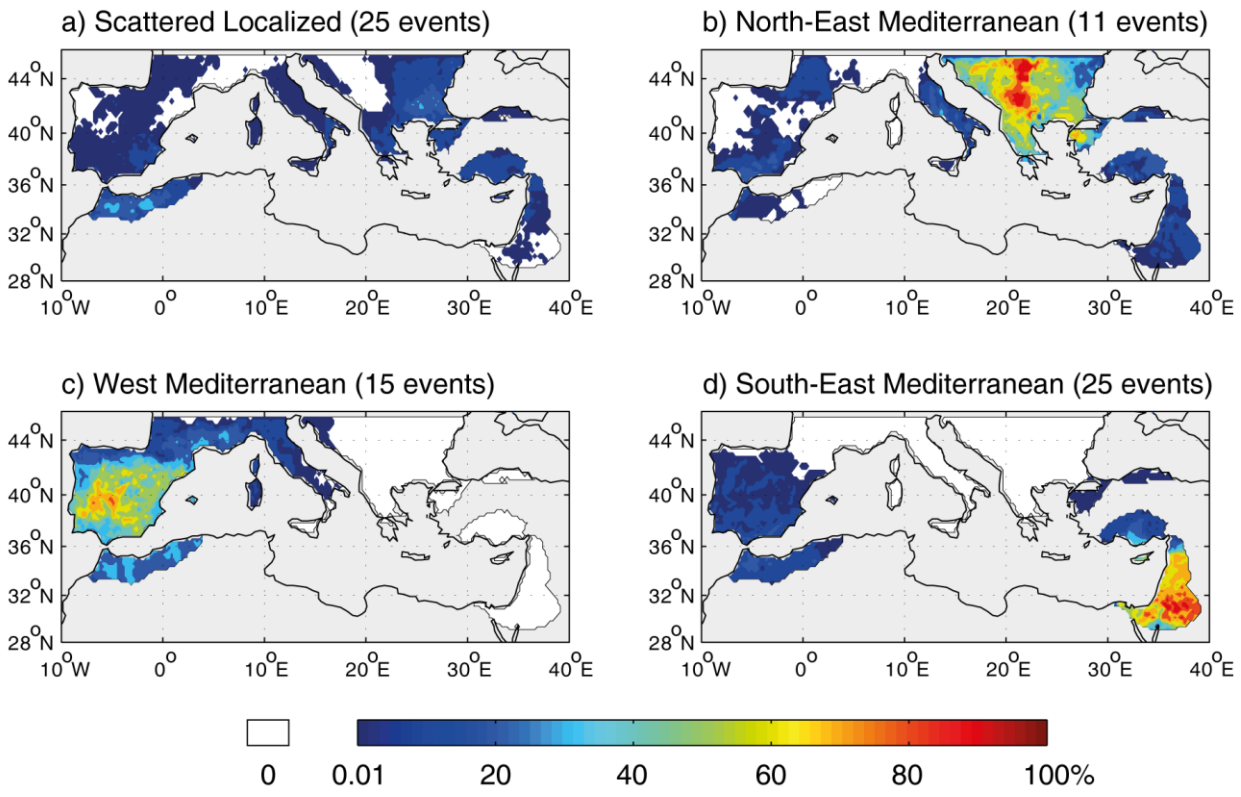
Hierarchical clustering applied to the median day of each of the 76 events (periods).



1.2. Very Long Dry Spells classification (2/2)

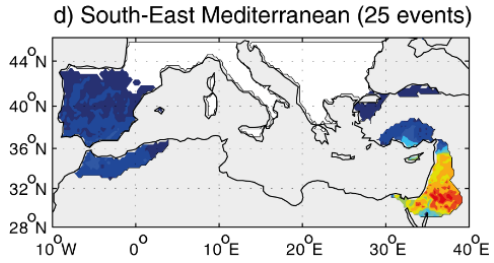


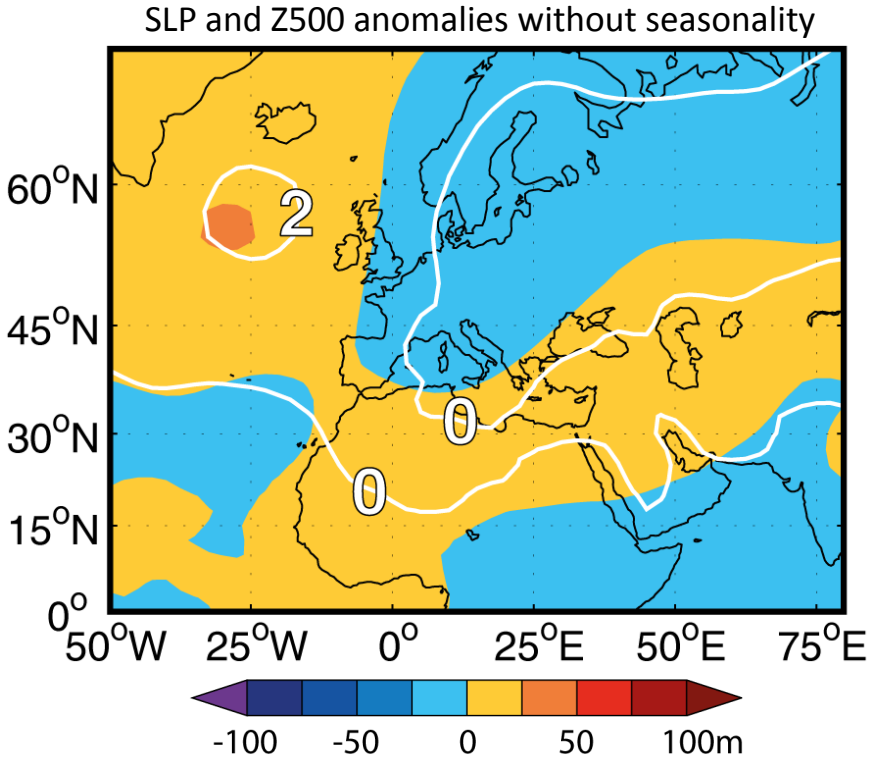
a) Hierarchical clustering tree of the HAC
b) Stairs of the HAC (intra-clusters Euclidian distance)
c) Inter-cluster variance between the four retained clusters

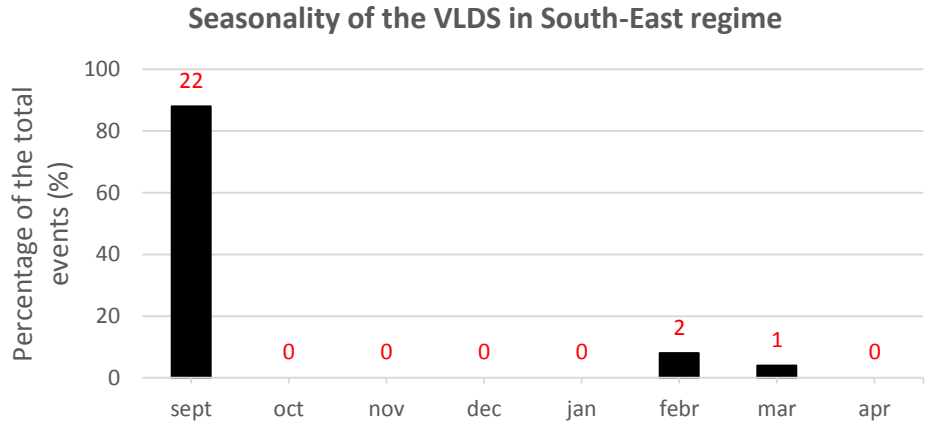


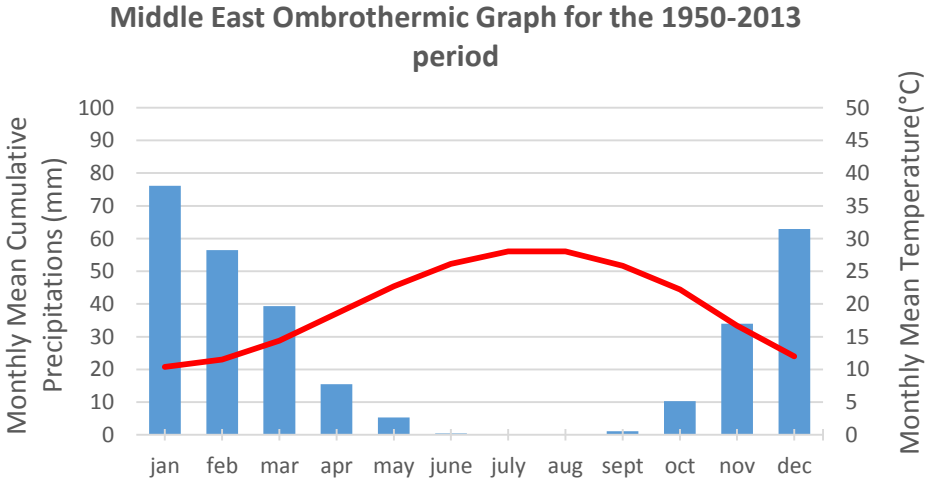
	SL	NE	W	SE
Average duration (days/event)	46.4	62.2	56.1	69.4
Average spatial extension (grid points/event)	251.1	629.2	527.4	428.4
Number of multiple events	3	6	1	10

1.3.1. South-East Mediterranean regime : Middle East region



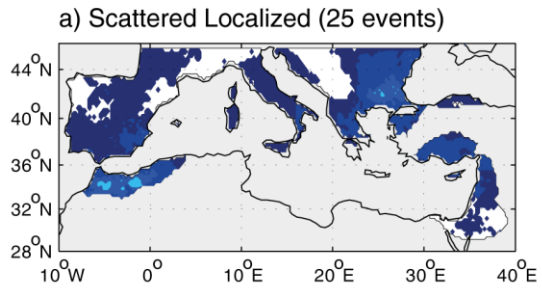




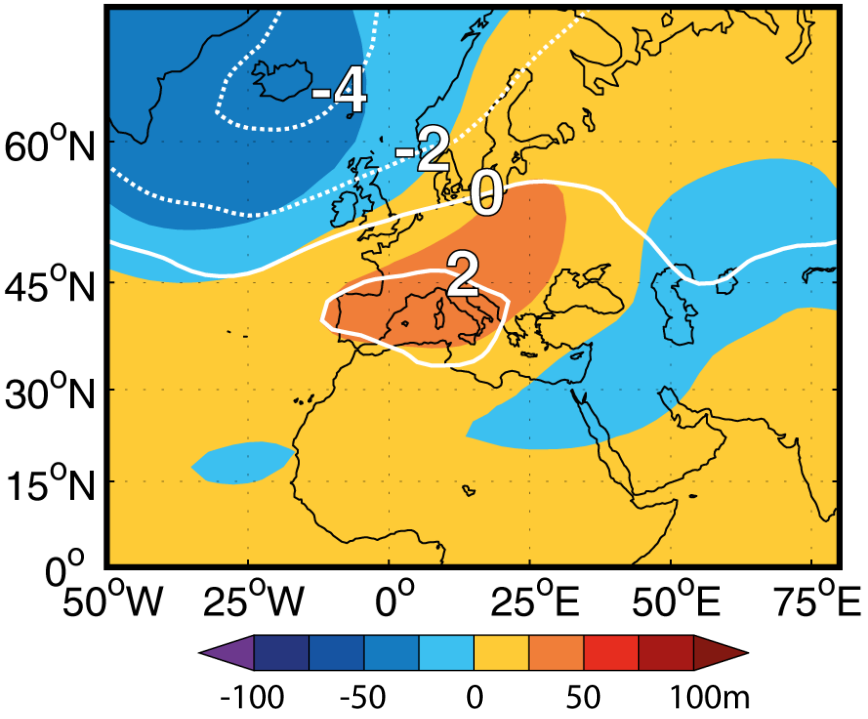


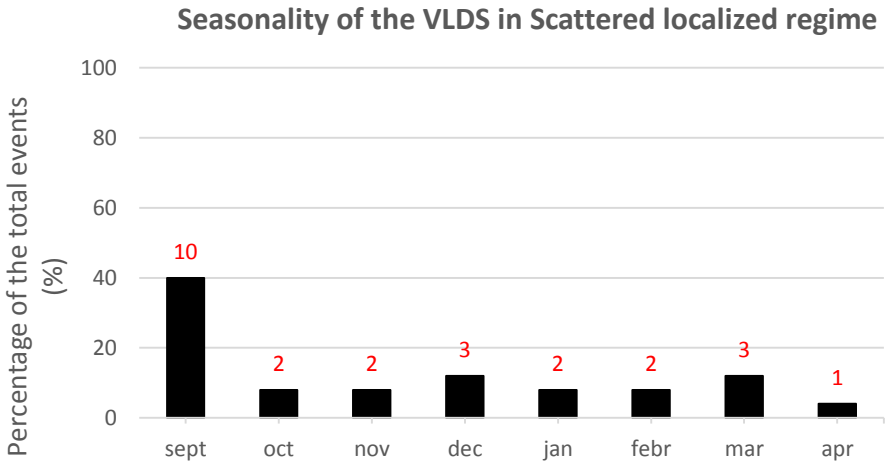
South-East regime : not Very Long Dry Spells but dry months…

1.3.2. Scattered Localized regime



SLP and Z500 anomalies without seasonality

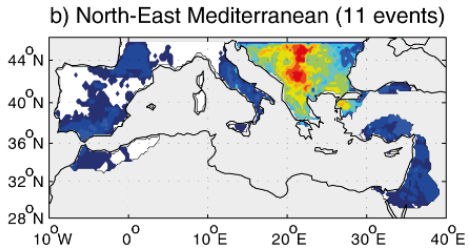




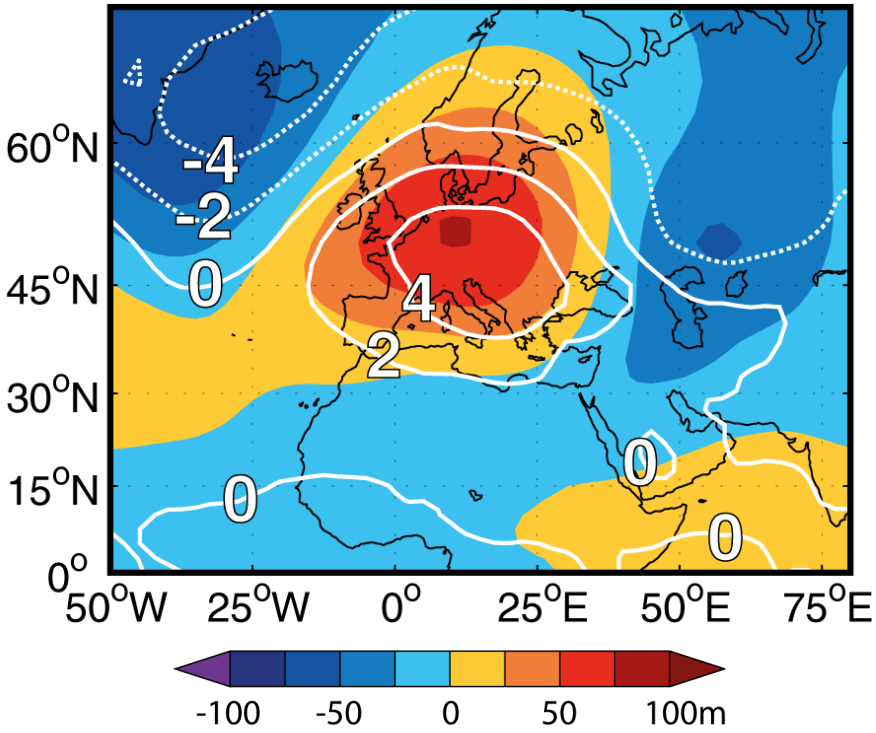
In September, 6 of the 10 events are localized in Middle East

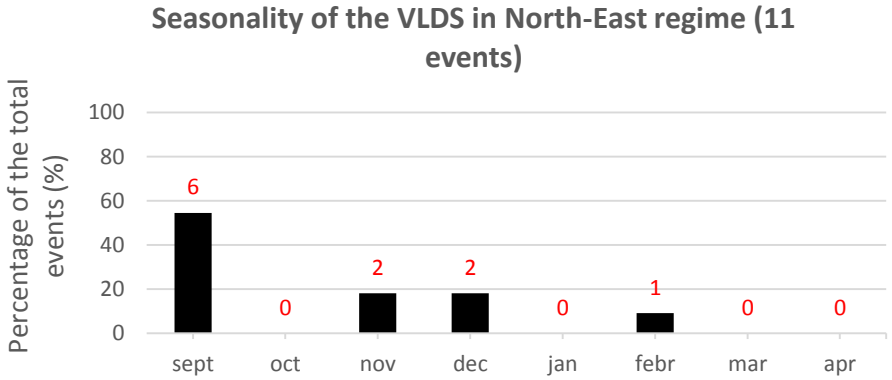
In Scattered Localized regime : associated with slightly z500 and SLP positive anomalies (anticyclonic conditions) ;
> too much events with different localizations.

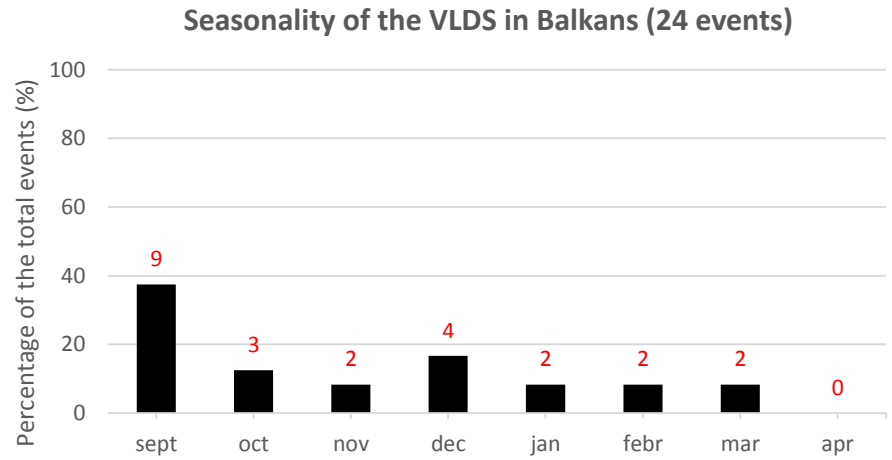
1.3.3. North-East regime : Balkans region



SLP and Z500 anomalies without seasonality

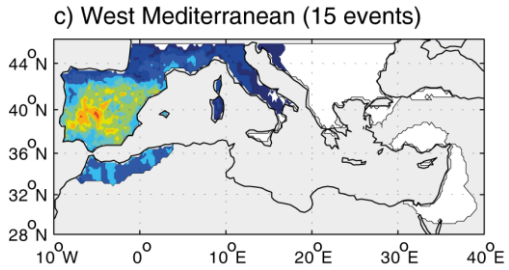




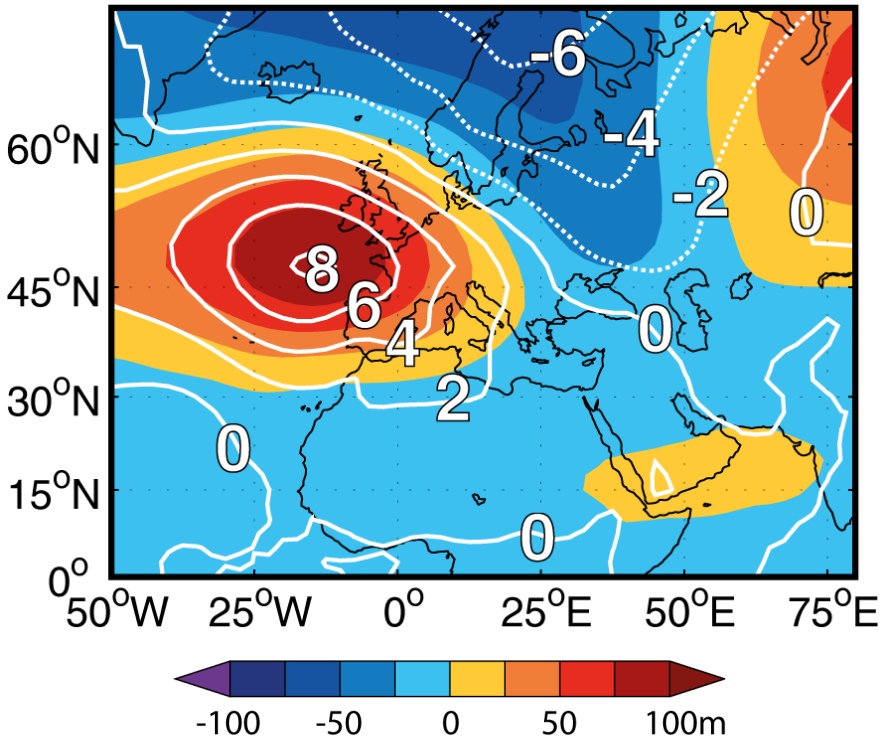


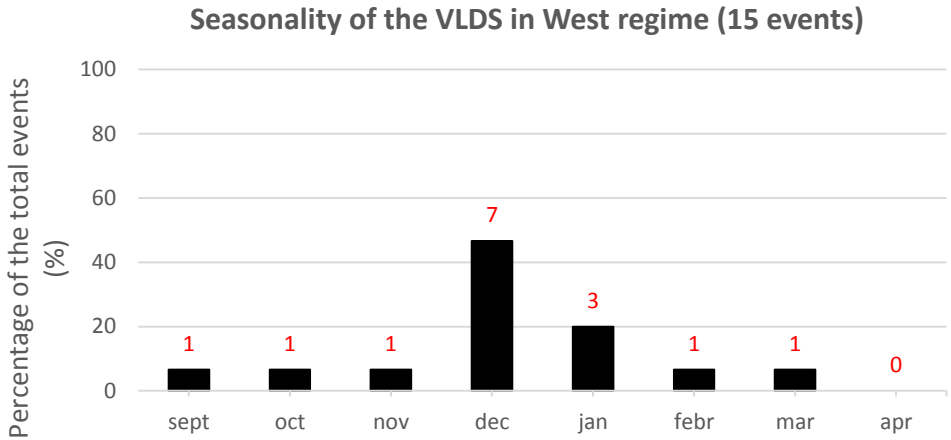
In North-East regime : anticyclonic conditions associated to the VLDS events.

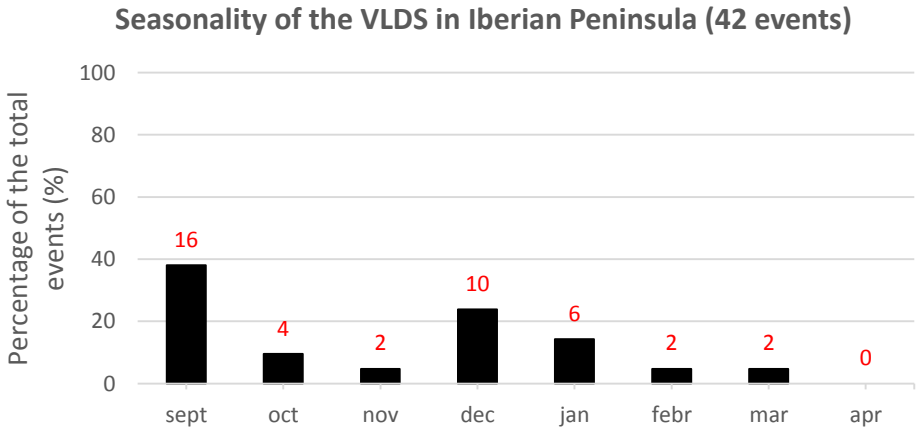
1.3.4. West regime : Iberian Peninsula region



SLP and Z500 anomalies without seasonality

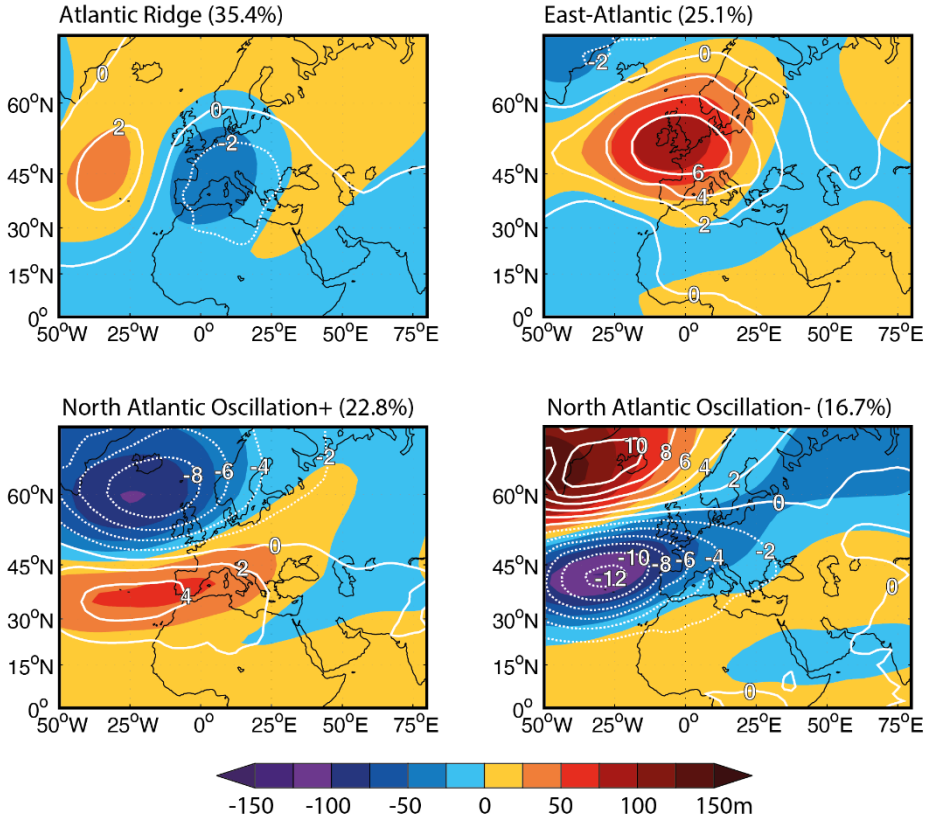




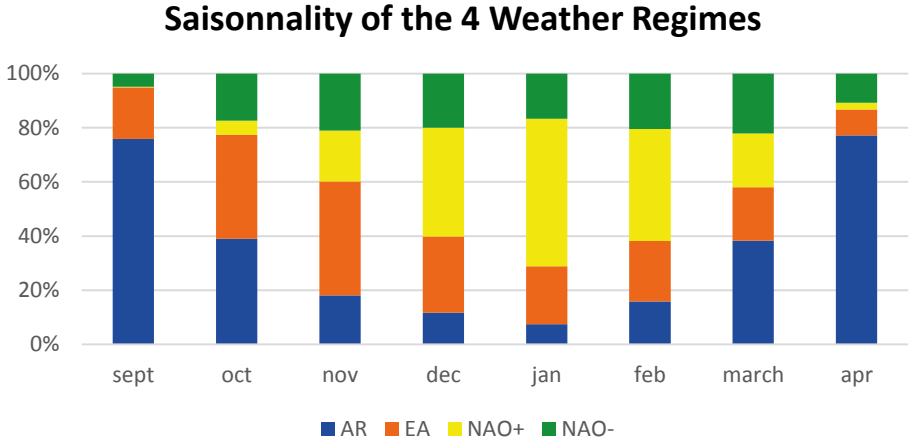


In West regime : anticyclonic conditions associated to the VLDS events.

1.4. How to explain seasonality of events in Iberian Peninsula and Balkans?

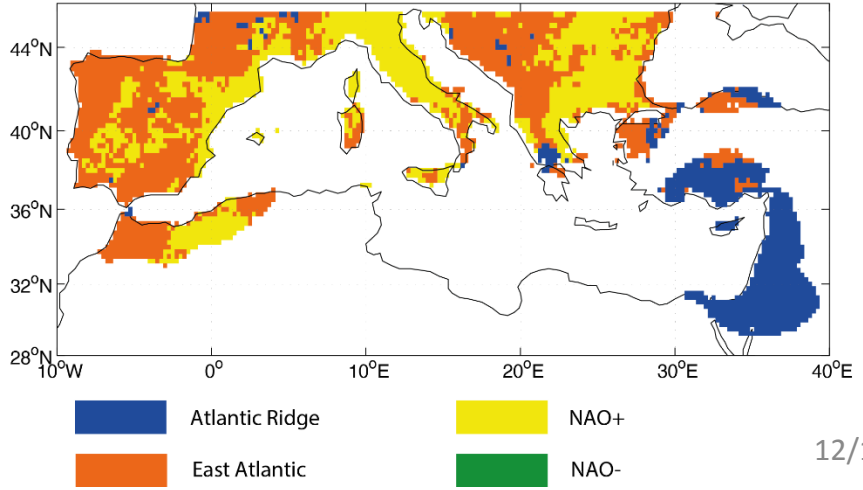


The 4 main Euro-Atlantic Weather Regimes

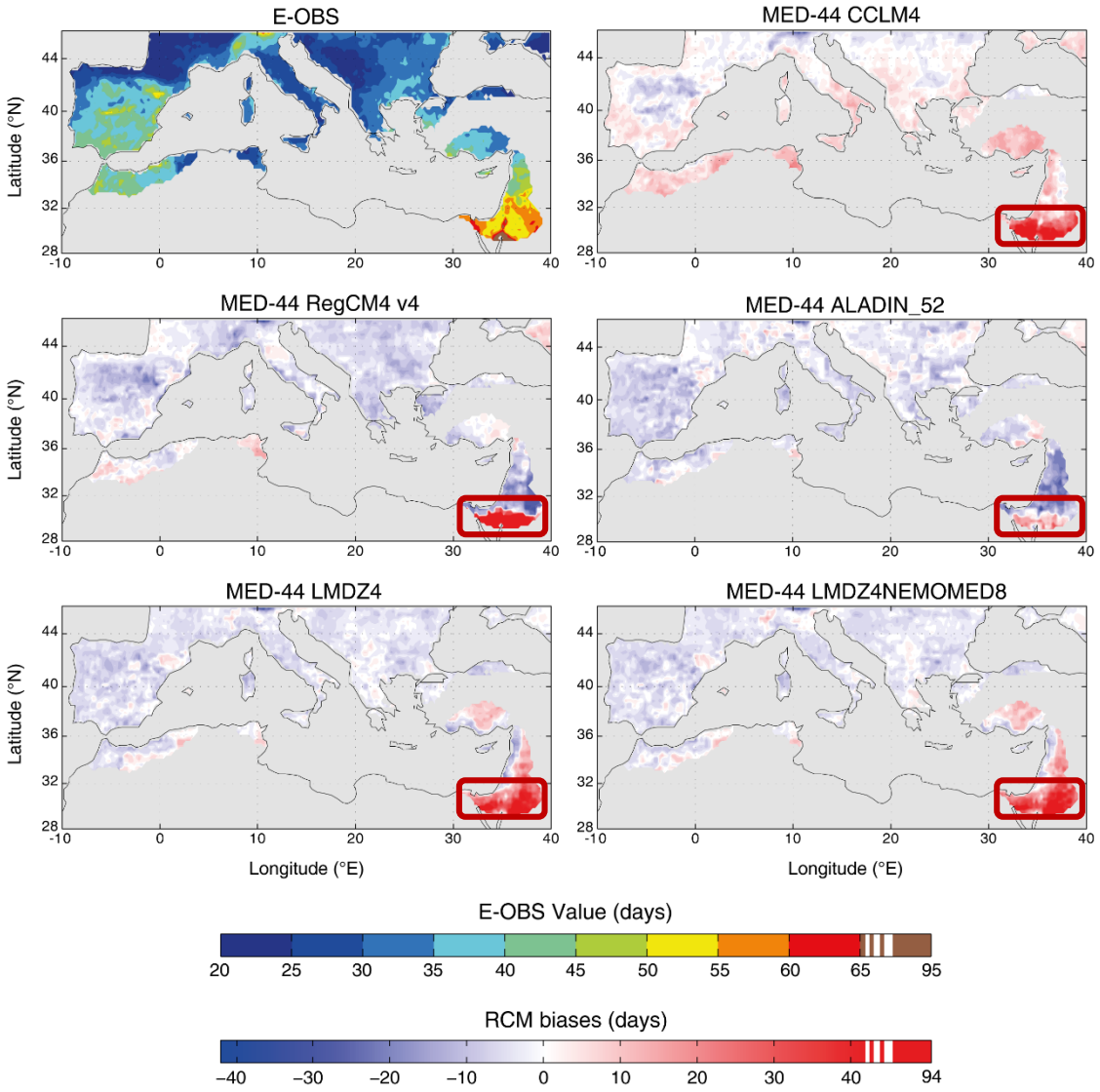


	VLDS & LDS in Iberian Peninsula	VLDS & LDS in Balkans
AR	30.1%	32%
EA	33.7%	33%
NAO+	28.7%	26.6%
NAO-	7.5%	8.4%

WR favoring emergence of events (for each grid point)



2.1. Models capacity to reproduce the 80th centile value



- rainy day: 1mm threshold ;
- 80th centile on the unique value of dry spells length.

CCLM4 slightly overestimates the 80th centile length

On the contrary, the other models slightly underestimate the 80th centile length

All models overestimate the 80th centile length in the south of Middle East: problem with the models or E-OBS data?

2.2. Models capacity to detect the VLDS events

The same methods as for the E-OBS are apply to the 5 models

	E-obs	CCLM4	RegCM4 v4	ALADIN_52	LMDZ4	LMDZ4NEMOMED8
Number of events detected	56	57	45	49	55	58
Including multiple events number	11	10	7	8	10	10
Average number of events per season	1.87	1.9	1.5	1.63	1.83	1.93
Total location of events	92	128	89	97	105	105
Average number of sub-regions affected by VLDS event	1.64	2.25	1.98	1.98	1.91	1.81

All the models overestimate the spatial extension of the VLDS events.

Mean duration of the events per Mediterranean sub-regions

	E-obs	CCLM4	RegCM4 v4	ALADIN_52	LMDZ4	LMDZ4NEMOMED8
Iberian Peninsula	54.7	59.8	53.9	47.6	50	52.4
Maghreb	57.1	62.1	60.5	55.6	52.8	57.4
France	56.7	67.6	58.9	62.7	54	45.3
Italy	48	60.4	38.7	49	35.5	38.7
Balkans	44.7	62.4	41.5	41.7	49.1	43.6
Anatolia	57.1	72.5	55.4	48.7	81	75.1
Middle East	62.3	77.1	54.5	49.1	84	79.3

56 underestimate **56** overestimate **56** within the uncertainty range

Conclusion & Perspectives

Conclusion:

- **There are little number of VLDS events detected (76 single events) for the 1957-2013 period to the E-OBS data (> difficulty to observe evolutions) but they represented 32.6% of the studied days ;**
- **Rainy season in the Middle East (from November to March) explain the seasonality of the VLDS events detected in the Eastern part of the Mediterranean Basin ;**
- **Strongly anticyclonic conditions mainly explain the VLDS events presence in almost all the Mediterranean Basin, except to the Middle-East ;**
- **East-Atlantic, NAO+ and Atlantic Ridge Weather Regime favoring events in Iberian Peninsula and Balkans ;**
- **Models strongly overestimate the length of 80th centile value in the South of the Middle East compare to the E-OBS data:**

  > CCLM4, LMDZ4 and LMDZ4NEMOMED8 strongly overestimate the duration of VLDS in Middle East and Anatolia ;

- **CCLM4, ALADIN_52 and Red_CM4 models showed "global" event, located almost to the entire Mediterranean Basin ;**
- **The 5 models overestimate the special extension of the VLDS events compare to the E-OBS data ;**

Perspectives:

- **Apply the method to the models historical runs and to the models RCP4.5 and RCP8.5 runs (daily precipitation data);**
- **Do the same work to the Long Dry Spells events (**60th centile < **LDS** < 80th centile).

Thanks' for your attention.