Winter dry spells indexes in the Mediterranean Basin: variability (1951-2013) and atmospheric forcing (1979-2013)

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General Issue

What are and what would be the winter dry spells variability in the Mediterranean Basin?

Winter period = “rainy season” > September to April.

2 axes developed for the current conditions:

1. 1951-2013: define an index to describe the spatio-temporal variability of winter dry spells.

   E-OBS V10.0 daily precipitation dataset (0.25° resolution).

2. 1979-2013: focus on the Very Long Dry Spells events (VLDS):
   - detection Very Long Dry Spells events;
   - classification (HAC) into main kinds of VLDS events;
   - analyze of the main atmospheric forcings.

   E-OBS V10.0 daily precipitation dataset;
   ERA-INTERIM Reanalysis: Sea level Pressure and z500 Geopotential (1° resolution).
1.1. Evolution of Dry days/season (1951-2013)

Method:
- dry day with less than 1mm;
- linear regression on the number of dry days/season.

Overall, the number in dry days has significantly increased in the Mediterranean Basin between 1951 and 2013.
1.2. Dry spells indexes (1951-2013)

Method:

- dry spells length number of consecutive dry days ;
- unique value of dry spells length ;

- **Very Short Dry Spells**: $\text{VSDS} < 20^{th}$ centile ;
- **Short Dry Spells**: $20^{th}$ centile $< \text{SDS} < 40^{th}$ centile ;
- **Medium Dry Spells**: $40^{th}$ centile $< \text{MDS} < 60^{th}$ centile ;
- **Long Dry Spells**: $60^{th}$ centile $< \text{LDS} < 80^{th}$ centile ;
- **Very Long Dry Spells**: $\text{VLDS} > 80^{th}$ centile ;

Example:

Grid Point n°8977 (40.125°N & 21.125°E)
1.3. Dry spells spatial and temporal variability (1951-2013)

The number of Very Short Dry Spells has slightly decreased and that of Short and Medium Dry Spells has slightly increased. Long and Very long Dry Spells don’t show significant evolution.

Method:
- linear regression on the frequency of each of the 5 Dry Spells classes (frequency: number of VDSD divided by the total number of dry spells, for each season).
2.1. How to detect Very Long Dry Spells events (1979-2013)?

**Very Long Dry Spells:**
significant impacts on water resource, agriculture and vegetation.

**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 8228 days:
  - square of 6 degree of side;
  - all the 0.5° in my study’s domain;
  - sea grid point are not taken into account.

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

48 events for a total duration of 2822 days (34%)
2.2. Very Long Dry Spells classification (1979-2013)

48 VLDS events for total duration of 2822 days.

Hierarchical clustering is applied to the median days of each of 48 events.

- **North-West Mediterranean**: 6 events (49.7 days of mean duration) 10.6% of 2822 VLDS days
- **West Mediterranean**: 5 events (52 days) 14.7% of 2822 VLDS days
- **Generalized**: 19 events (40.7 days) 31.8% of 2822 VLDS days
- **North-East Mediterranean**: 5 events (37 days) 13.1% of 2822 VLDS days
- **South-East Mediterranean**: 13 events (52.6 days) 29.8% of 2822 VLDS days

Percent of events concerning each grid point.
2.3. Very Long Dry Spells atmospheric forcing (1979-2013)

Geopotential Height at 500 hPa ($z_{500}$) and Sea Level Pressure anomalies

The 3 smallest clusters

**North-West Mediterranean**
- 9.7% of the VLDS

**West Mediterranean**
- 12.9% of the VLDS

**North-East Mediterranean**
- 16.1% of the VLDS

VLDS of the North-West, West and North-East Mediterranean classes are associated with $z_{500}$ and SLP positive anomalies; anticyclonic conditions.
2.3. Very Long Dry Spells atmospheric forcing (1979-2013)

Sea Level Pressure and Geopotential Height at 500 hPa (z500)

Generalized class is also associated with slightly z500 and SLP positive anomalies (anticyclonic conditions) ;
> too much events with different localizations.

South-East class is associated with z500 positive anomalies but SLP negative anomalies ;
heat low conditions?
Perspectives

**Short term:**
- continue to explore VLDS classification, further analyze within each of the 5 classes and analyze of key events (moving events and multiple events);
- analyze other atmospheric or oceanic forcing;
- apply the same method to the Long Dry Spells.

**Medium term:**
- compare CORDEX simulations to the E-obs data.

**Long term:**
- analyze changes in the spatio-temporal characteristics of intense drought during the XXI\textsuperscript{th} century:
  - Precipitations simulated by RCMs (e.g. MEDCORDEX),
  - Large-scale atmospheric predictors of the intense events simulated by GCMs (e.g. CMIP5, RCP4.5 and RCP8.5 GES).
- Focus on one or two specific regions, with stations data, to study the impacts of intense dry spells events on local water resources and agriculture.
Thanks' for your attention.