



**HAL**  
open science

## Rainfall event analysis in the north of Tunisia using the self-organizing map

Sabrina Derouiche, Cécile Mallet, Zoubeida Bargaoui

► **To cite this version:**

Sabrina Derouiche, Cécile Mallet, Zoubeida Bargaoui. Rainfall event analysis in the north of Tunisia using the self-organizing map. 9th International Workshop on Climate Informatics, Oct 2019, Paris, France. insu-02314163

**HAL Id: insu-02314163**

**<https://insu.hal.science/insu-02314163>**

Submitted on 11 Oct 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



# RAINFALL EVENT ANALYSIS IN THE NORTH OF TUNISIA USING THE SELF-ORGANIZING MAP

## 0. Introduction

The rainfall pattern in the Mediterranean is characterized by an important spatial and temporal variability.

→ This variability is mainly due to its position (between 30°N and 45° N) which is directly influenced by subtropical high pressures and low mid-latitude pressures.

In Tunisia, the studies of rainfall patterns are often based on sample analysis with a fixed time step (annual, seasonal or monthly).

Since precipitation is an intermittent phenomenon that appears in the form of events. It is proposed in this study to analyze the rainfall variability using event concept using a daily rainfall time series.

→ The main objective of this study is to analyze the rainfall event of a single one season (December -January- February) in the north of Tunisia using the Self Organizing Map SOM over 50 years.

## 2. Rainfall event definition

The time series in rain gauge stations is broken down into a separate rain event by a dry period called **Minimum Inter event Time MIT**.

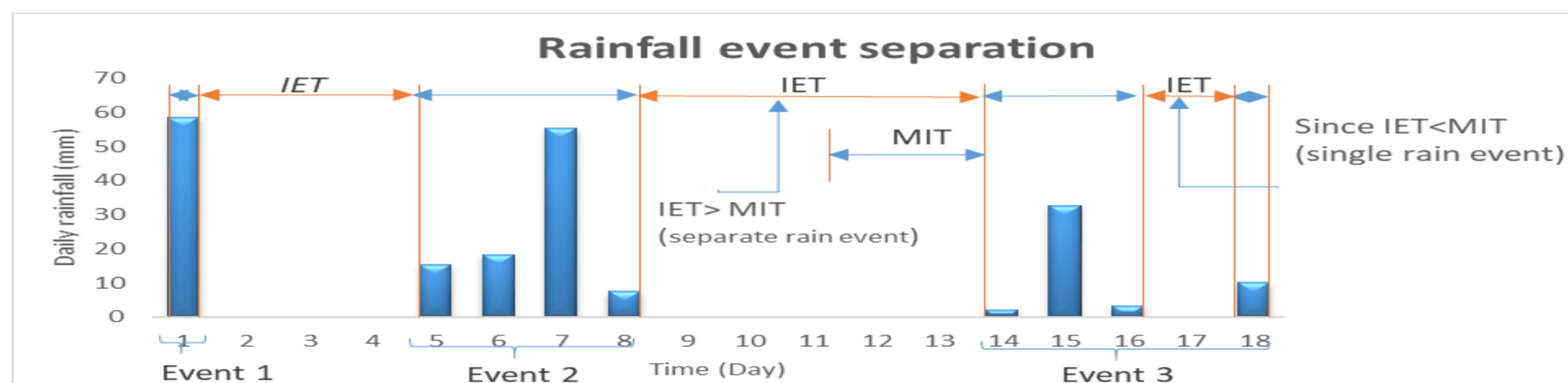


Fig.2: Rainfall event separation

**Autocorrelation analysis method** : The MIT is defined as the lag time where the autocorrelation coefficient of daily rainfall converge to zero.

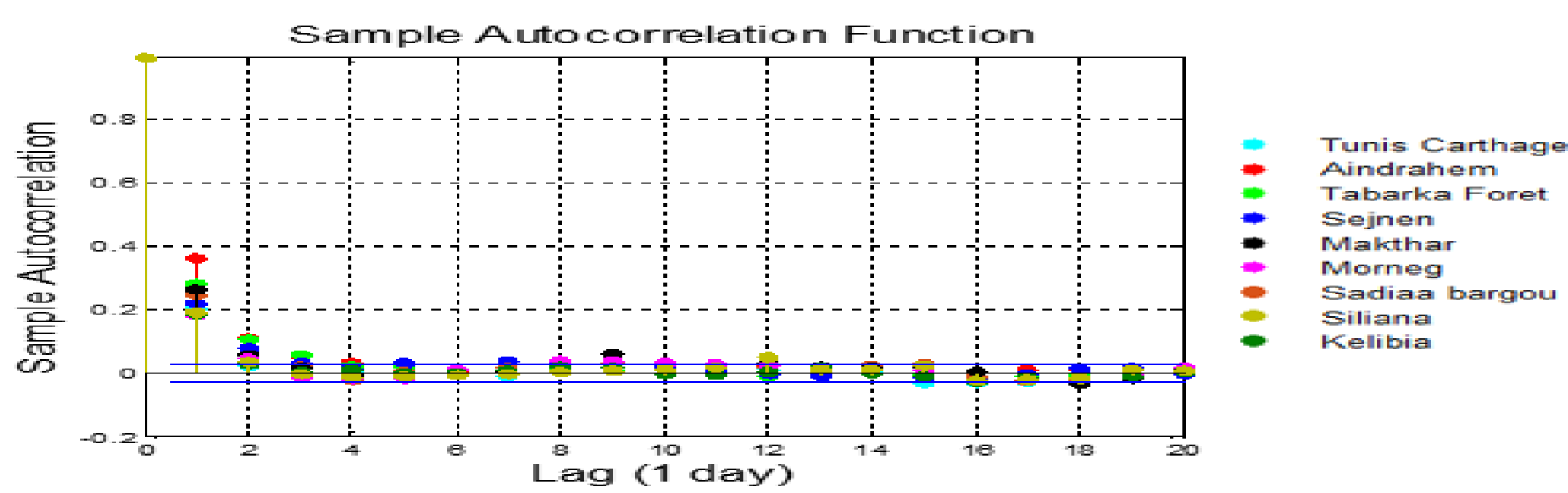


Fig.3: Autocorrelation Analysis for 9 representative stations

→ The daily rainfall time series are decorrelated after two days (MIT = 2 days)

## 4. SOM and HAC results and clusters identification

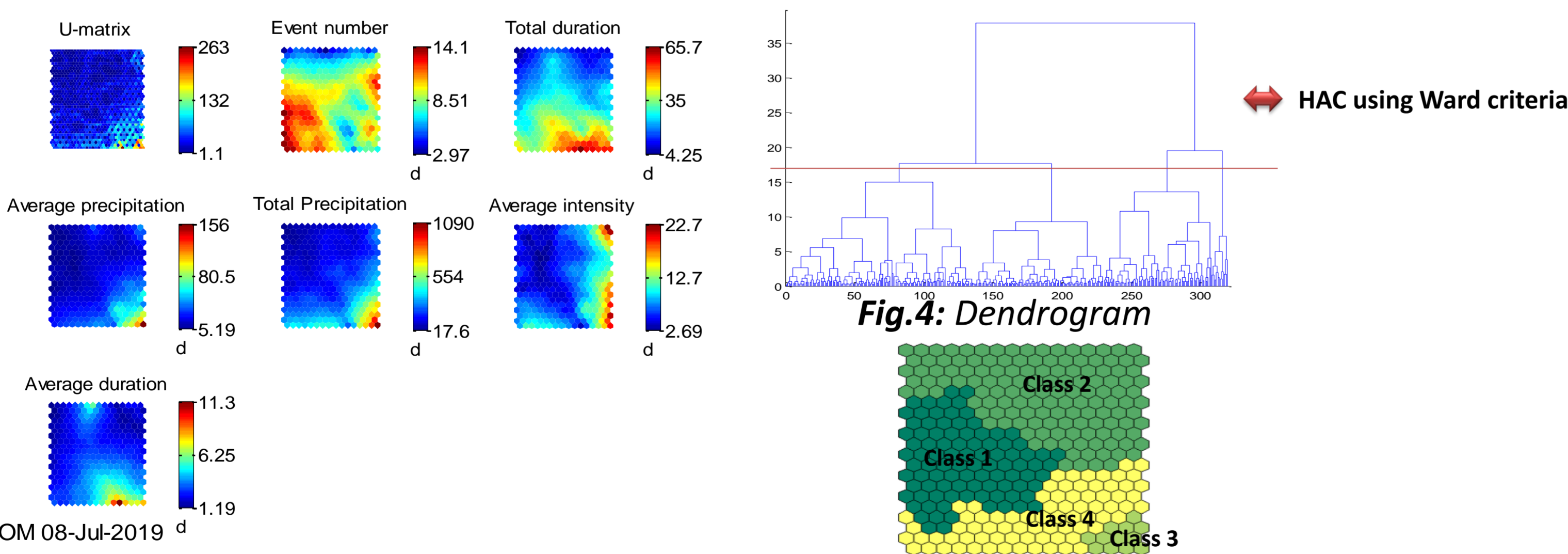


Fig.5: Variables projection in topological Map

Fig.6: Clusters delimitation in topological map

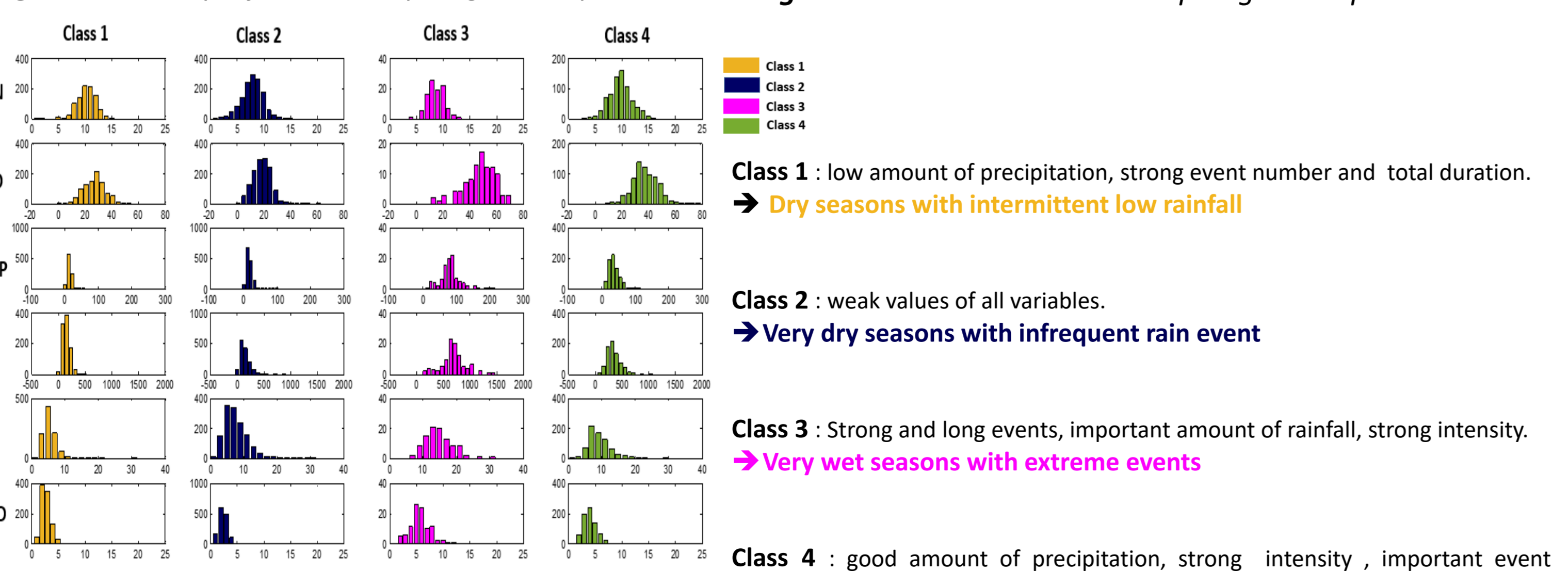


Fig.7: Histogram of six seasonal rain event variables corresponding to the obtained clusters

## 1. Data

**Data:** daily rainfall database from 1959 to 2008 distributed over 70 rain gauge stations in Northern of Tunisia.

**Source:** General Direction of Water Resources of Tunisia

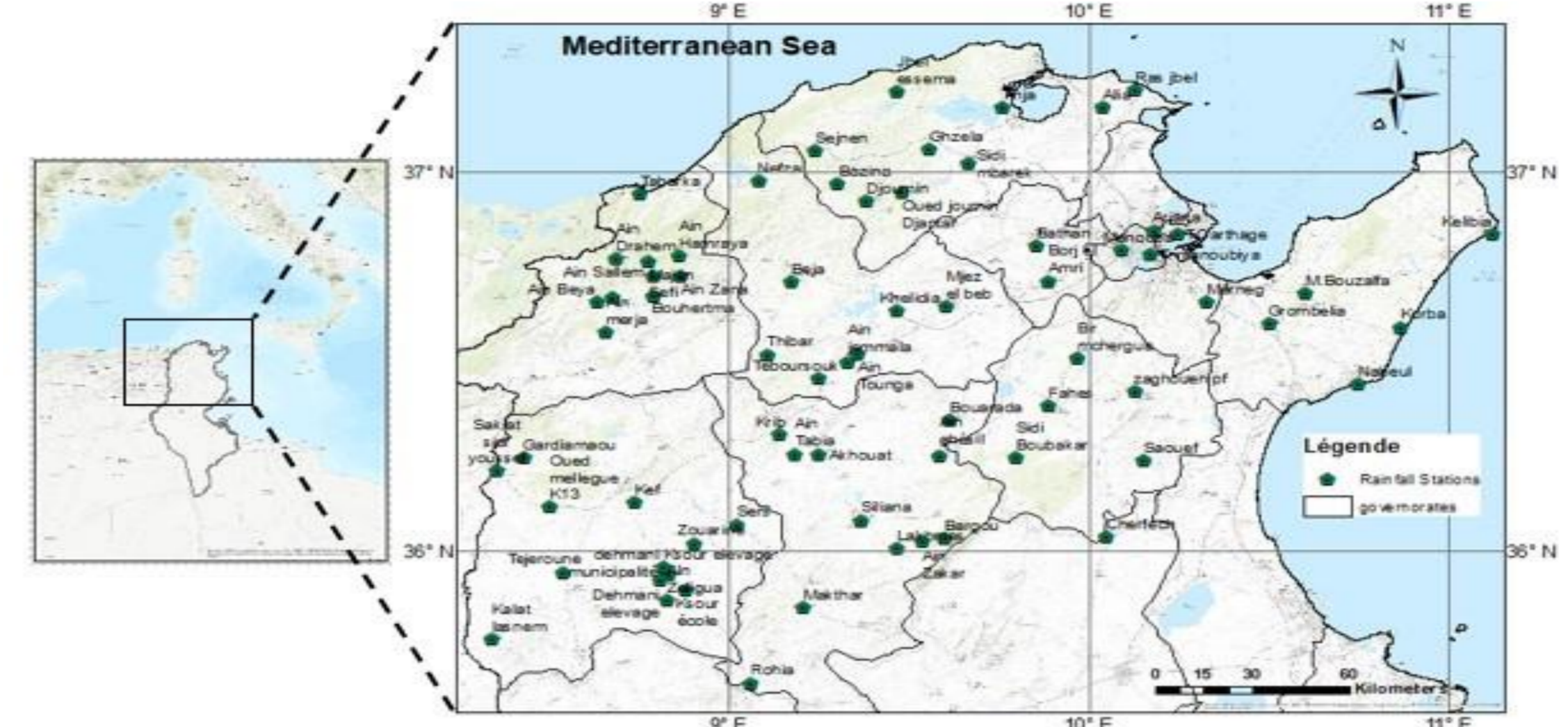


Fig.1: Rainfall stations distribution

## 3. Variables characterizing seasonal rain event DJF and SOM parameters

Tab.1: Variables are characterizing seasonal rain events (DJF)

Nom	Symbol	Unit	Formula
Event number	EN	Events	
Total duration	TD	days	$TD = \sum_{i=1}^{N.E} TD_i$
Precipitation	P	mm	
Average precipitation	MP	mm/event	$MP = \frac{P}{EN}$
Average duration	MD	days/event	$MD = \frac{TD}{EN}$
Average intensity	MI	mm/day	$MI = \frac{P}{TD}$

Tab.2: SOM parameters

parameters	
Neuron number	320
Map dimension	(20 * 16)
Grid	Hexagonal
Neighborhood function	Gauss
Neighborhood radius	$\sigma(t) = \sigma_{max} \left( \frac{\sigma_{min}}{\sigma_{min} + t} \right)^2$
<b>Rough tuning</b>	
Epoch number T	1000
Initial and Final radius of training	[8 3]
<b>Fine-tuning</b>	
Epoch number T	5000
Initial and Final radius of training	[3 0.5]



The training of Kohonen map is done starting from the matrix of input data constituted of 3500 (50 years \* 70 stations) Observations and the six seasonal rain event variables.



## 5. Conclusions and perspectives

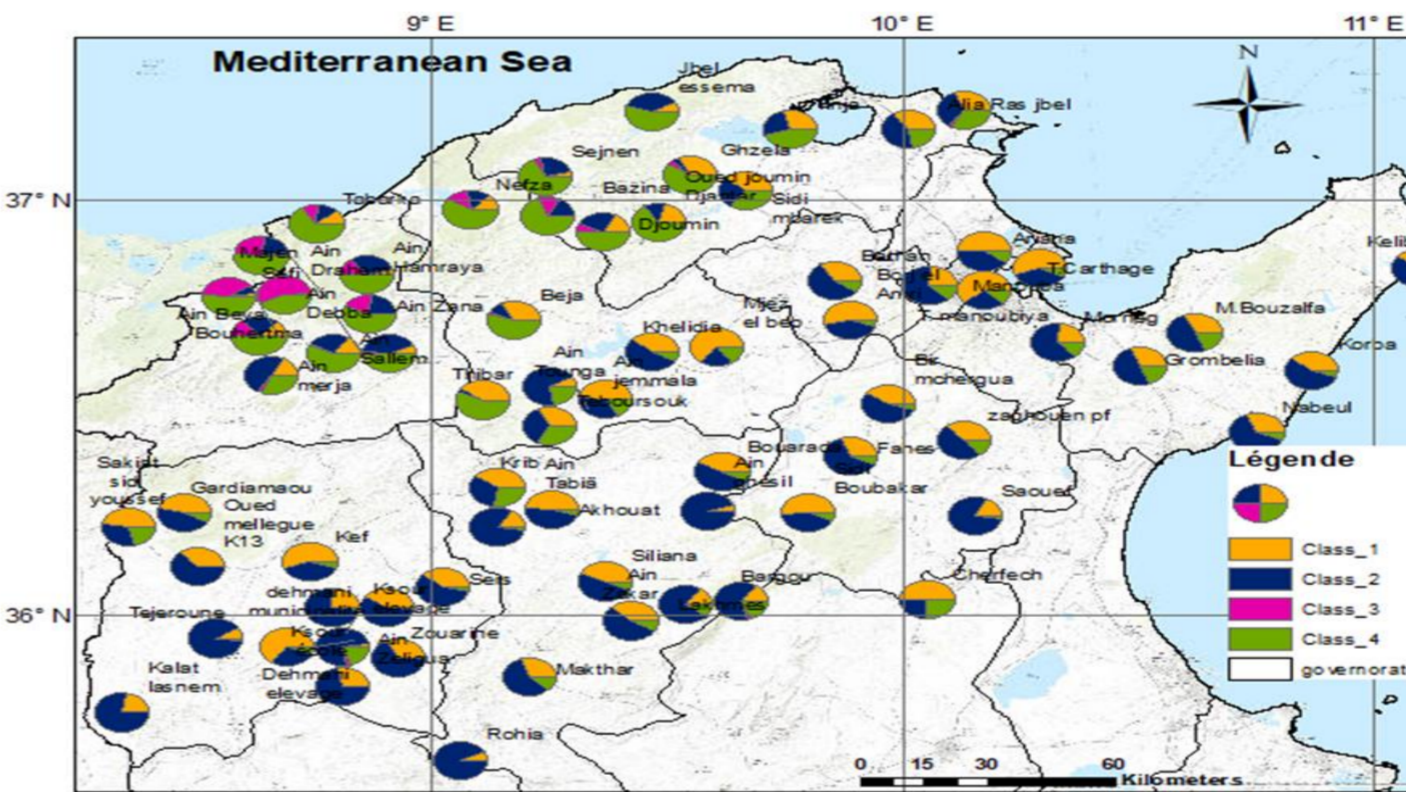


Fig.8: Spatial distribution of classes

The wet seasons, classes 3 and 4, are located in the northern part of the region.

→ influenced by North West flux coming from the Atlantic during the winter season.

The dry seasons, classes 1 and 2, are located in the southern part of the study area.

→ warm desert climate

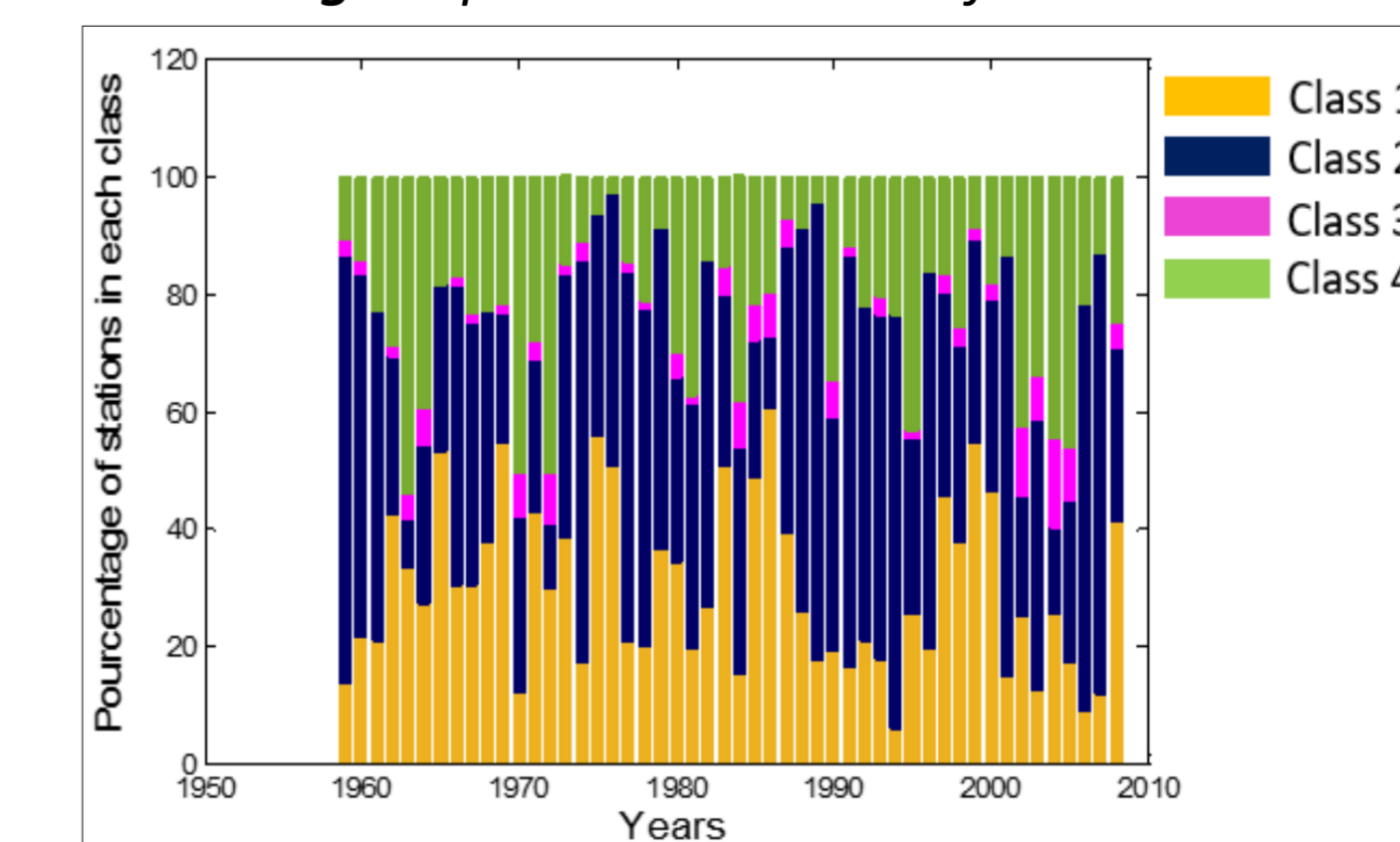


Fig.9: Temporal distribution of classes

Exceptional wet seasons: 1963, 1970, 1973, 2002, 2003, 2004 and 2005.

→ predominance of class 3 and 4.

Very dry seasons: 1975, 1976, 1988 and 1989

→ predominance of class 1 and 2 for more than 90 % of stations

The objective of this classification is to study the links between the temporal structure of seasonal precipitations and climate indices that influence the rainfall in the Mediterranean.

## 6. References

- A. Sharad Parchure, S. Kumar Gedam. "Precipitation Regionalization Using Self-Organizing Maps for Mumbai City, India". Journal of Water Resource and Protection, 10, 939-956. DOI: 10.4236/jwarp.2018.109055,2018.
- D.Dilmi,C.Mallet, L.Barthès, A.Chazottes. Data-driven clustering of rain events: microphysics information derived from macro-scale observations Atmospheric Measurement Techniques, European Geosciences Union, 10 (4), pp.1557-1574. (10.5194/amt-10-1557-2017) - insu-01410090, 2017.
- F.Murtagh, P. Contreras, Methods of hierarchical clustering. Comput.Res.Repository.abs/1105.0121(2011).http://arxiv.org/abs/1105.0121, 2011.
- J-F Rysman, S. Verrier, Y. Lemaître, E. Moreau. "Space-time variability of the rainfall over the western Mediterranean region: A statistical analysis". Journal of Geophysical Research: Atmospheres, American Geophysical Union, 118 (15), pp.8448-8459, 2013.
- J.Vesanto, J.Himberg, E.Alhoniemi and J.Parhankagas. SOM Toolbox for Matlab 5, Report A57. http://www.cis.hut.fi/projects/somtoolbox/, 2000.
- N. Akrou, A. Chazottes, S. Verrier, C. Mallet and L.Barthes . Simulation of yearly rainfall time series at microscale resolution with actual properties: Intermittency, scale invariance, and rainfall distribution, Water Resour. Res., 51, 7417–7435, doi:10.1002/2014WR016357, 2015
- T.Kohonen, "Self-Organizing Maps". Third Edition, Springer, Berlin. https://doi.org/10.1007/978-3-642-97610-0, 1995.