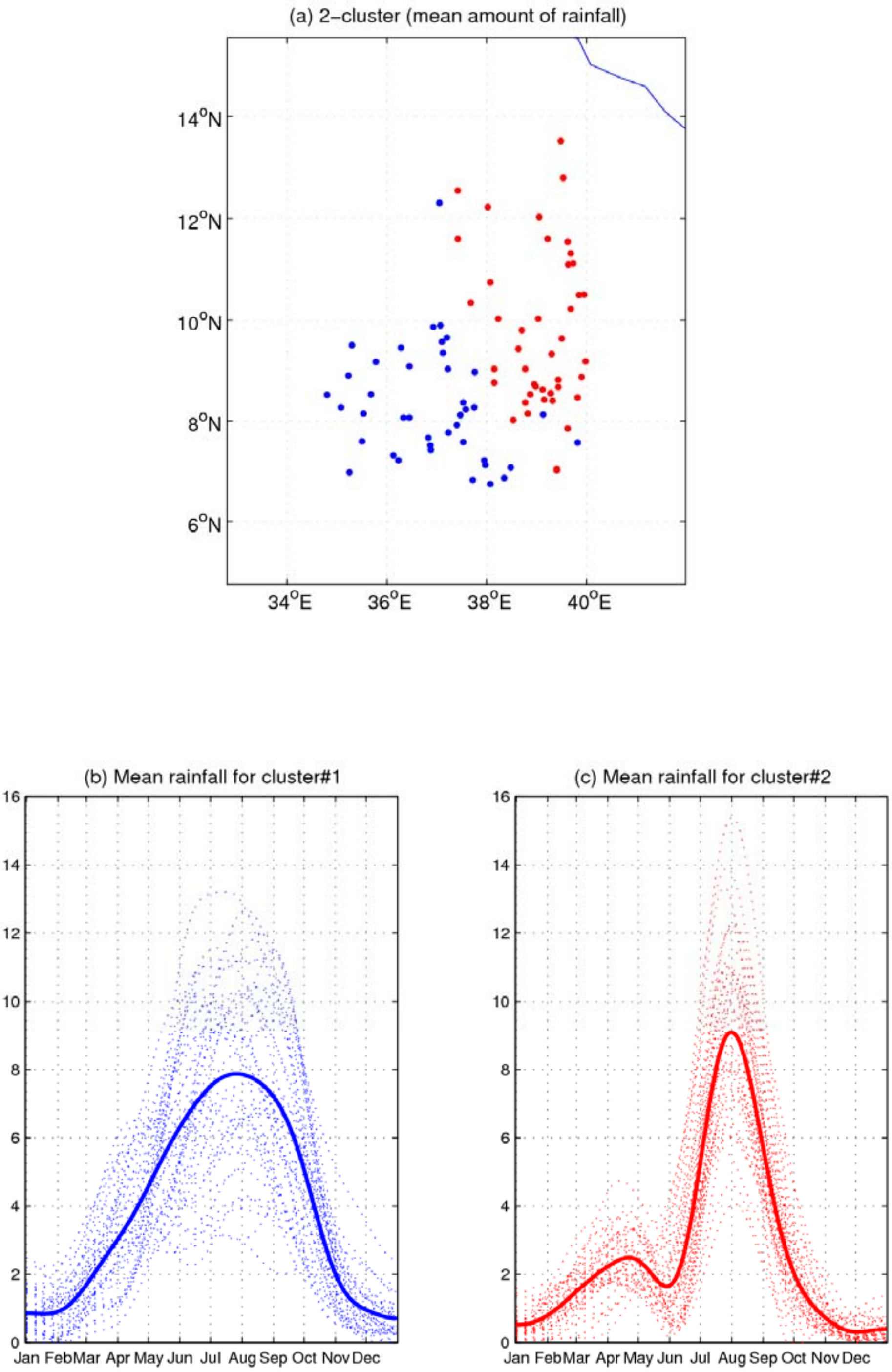
Preliminary analysis of the daily network of Ethiopia (1975-2004)

There are 84 stations with ??% of missing entries. These missing entries are replaced by a stochastic weather generator using a one-order Markov Chain for simulating dry and wet days (> 1 mm) and a gamma PDF for simulating the amount of wet days. This SWG is applied on a monthly basis for each station and does not accurately represent the interannual variability (i.e. a month that is totally missing is simulated as a "normal" sequence of dry and wet days and the amount is consistent with the climatology). This choice is simple but I don't think it really change the results.

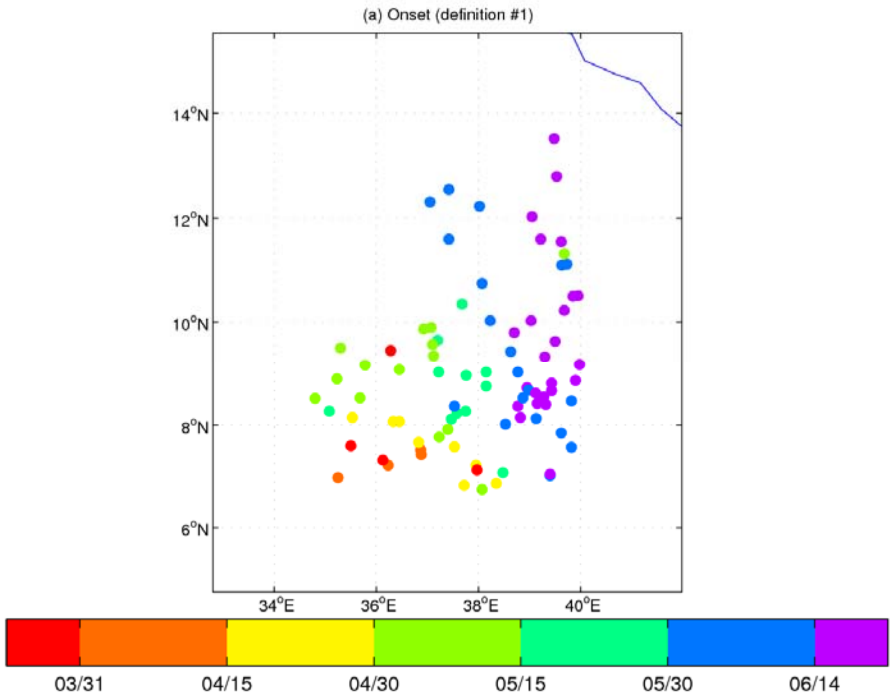
Rainfall regime (Fig. 1)



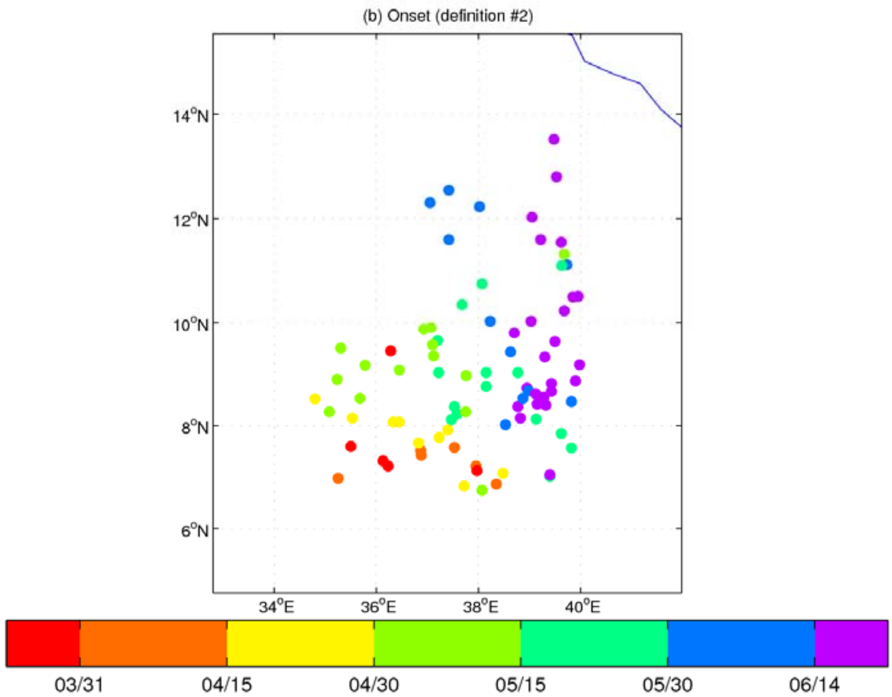
The mean seasonal cycle is computed as the daily average low-pass filtered retaining periods > 60 days and then subjected to a k-means clustering. The 2-cluster solution is perfectly robust (it does not depend on the choice on initial seeds). There is a basic distinction between eastern and western parts. The first is related to small rains during boreal spring (peak in April) and a main rainy season in July-August. The eastern part is wettest with a longer wet season, but there are large differences between the included stations (look at the dispersion between individual seasonal cycles). I think that this distinction makes sense from my (very limited on that area !) knowledge. Then I compute the onset and withdrawal of the rainy season from two definitions;

- Def#1 : onset is the first wet day of two-days > 20 mm without a 7-day dry spell < 5 mm in the following 30 days (it is the definition usually considered for Sahelian countries)
- Def#2 : same except that the amount of the initial wet spell is flexible locally (= mean maount of rainfall for 2-day > 1 mm)
- The withdrawal is computed in the same way as the onset except that the time series are reversed and the computation is thus done from December 31st instead of January 1st

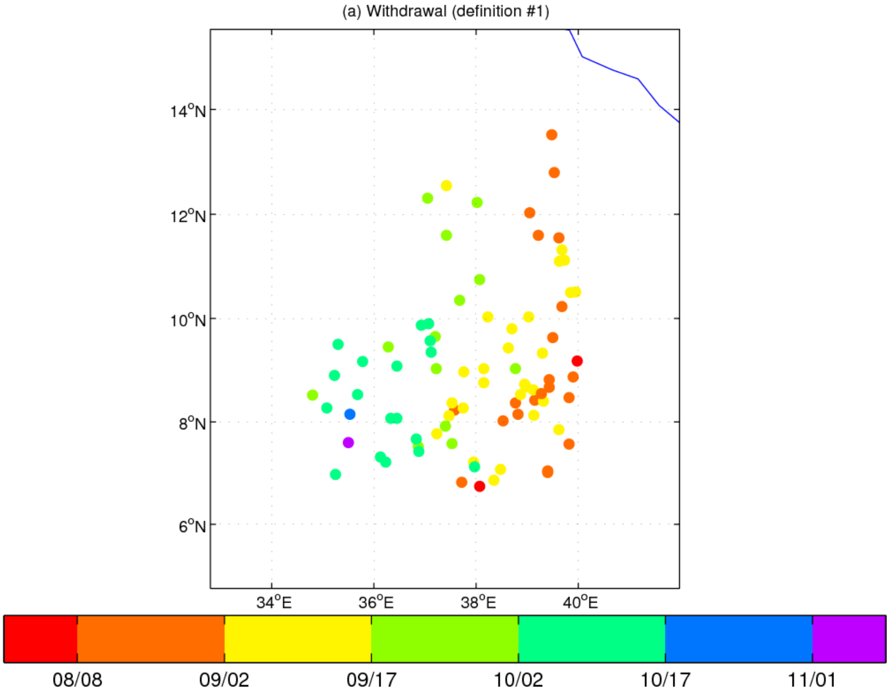
The amount as well as length could be modified. The “best” choice is tightly related to crop needs (at least for the onset; for example the amount of dry spell critical for crops is estimated to be 50% of the weekly crop requirement over Sahel, i.e. 10 mm –Omotosho, 1992—). From my experiment in other settings, the interannual variability is not really dependent on these parameters. Of course, it should also make sense from the physical point of view and the functioning of atmosphere over this area. Fig. 2 shows the mean onset date from the two definitions. It seems that the small rains in Feb-April are accurately filtered by both definitions because an earlier onset is not experienced over Eastern Ethiopia where these small rains occur. In other words, it seems that we capture with these parameters the main boreal summer monsoon onset. There is a SW-NE gradient which is close to the gradient of mean rainfall amount even if several stations could be different from their neighbors (effect of altitude ? orientation ? In the Philippines for example, the onset is bring forward for the elevated stations, probably because the orographic uplift tend to allow to cross the threshold of wet spell before the lowlands, but this effect should be minimized with definition #2). [Does these mean dates make sense for you ?]. The withdrawal dates are shown on fig. 3. The gradient is similar but the transition is sharper : the interquartile range between station averages is 26 days (vs 42 days for onset) [Does these mean dates make sense for you ?].



(a) Onset (definition #1)
14°N
12°N
10°N
8°N
6°N
34°E
36°E
38°E
40°E
03/31
04/15
04/30
05/15
05/30
06/14



(b) Onset (definition #2)
14°N
12°N
10°N
8°N
6°N
34°E
36°E
38°E
40°E
03/31
04/15
04/30
05/15
05/30
06/14



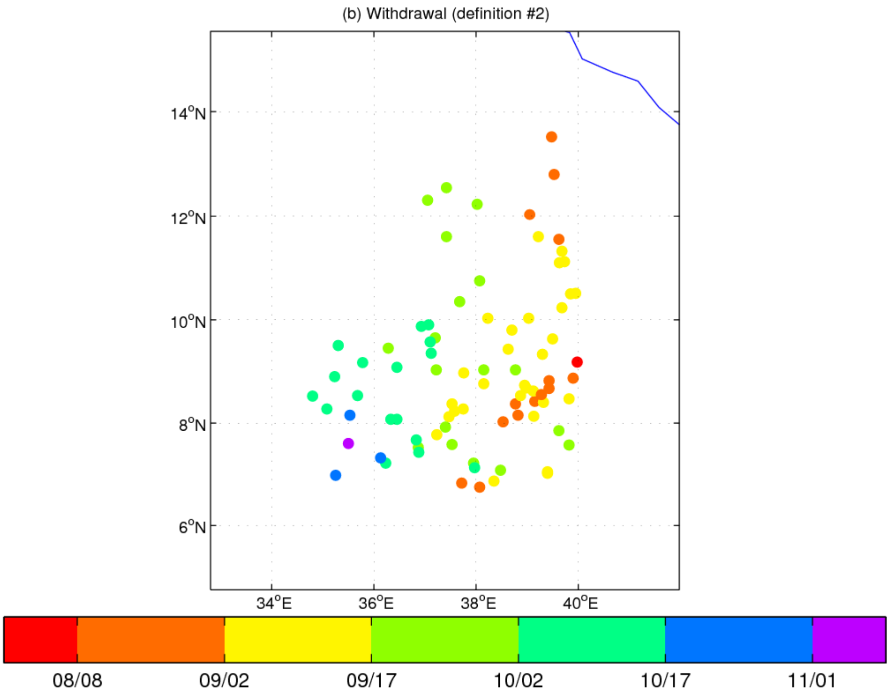
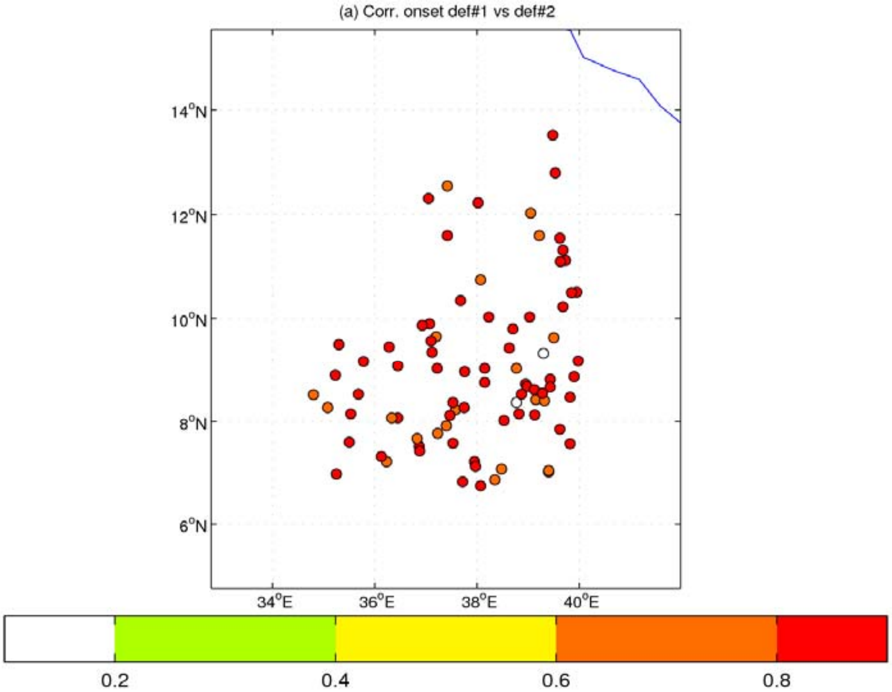


Fig. 4 is just to illustrate the similarity of both definitions of onset/withdrawal. The correlations between both dates at local-scale are close to 1 except for several scattered stations (remind that some stations have more than 40% of missing entries and we need to be cautious about them).



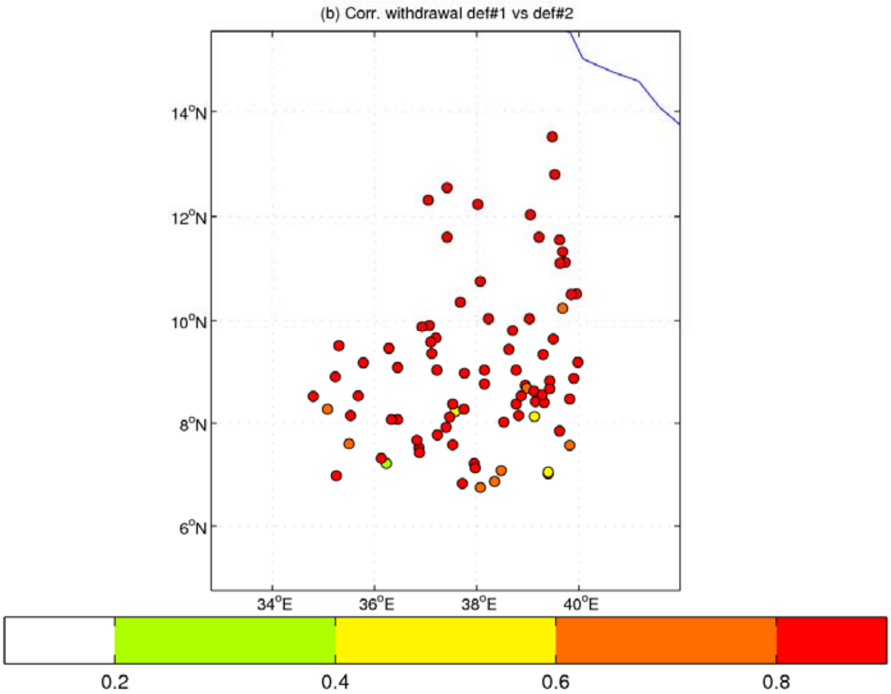
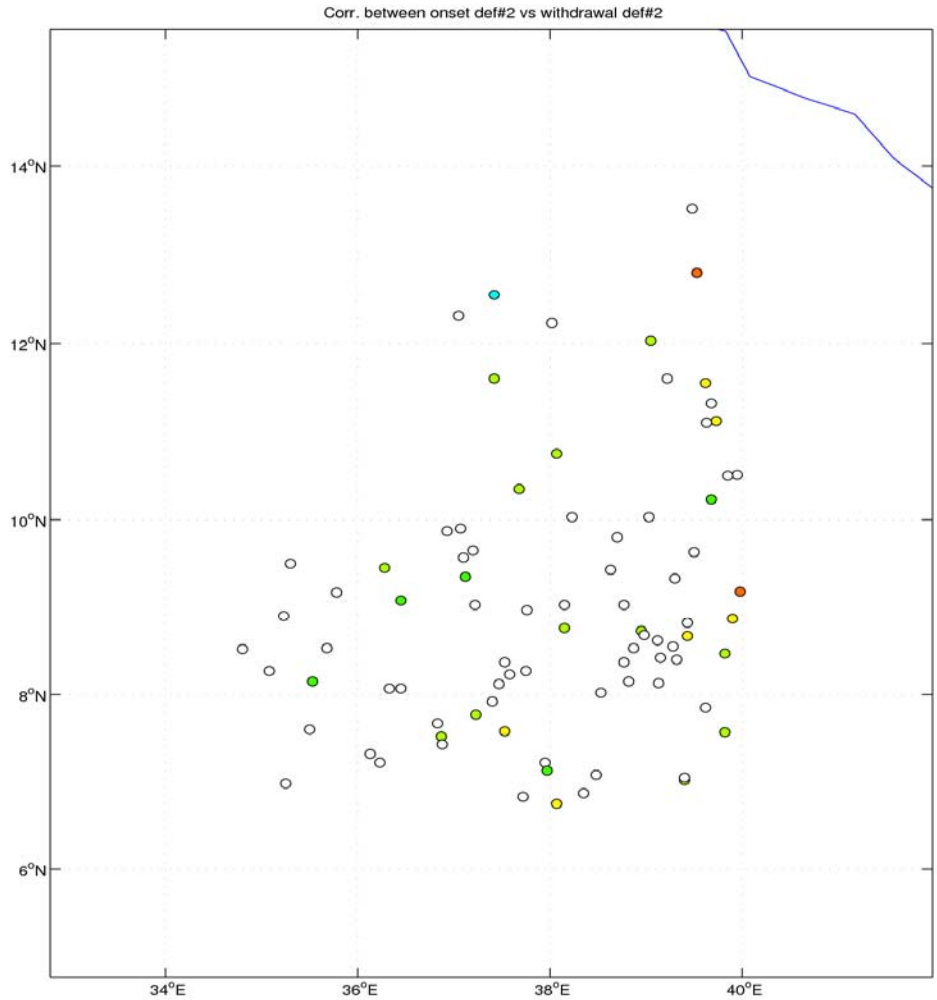
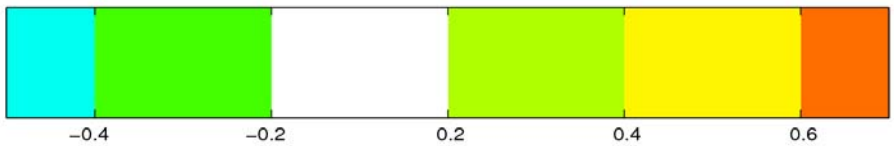
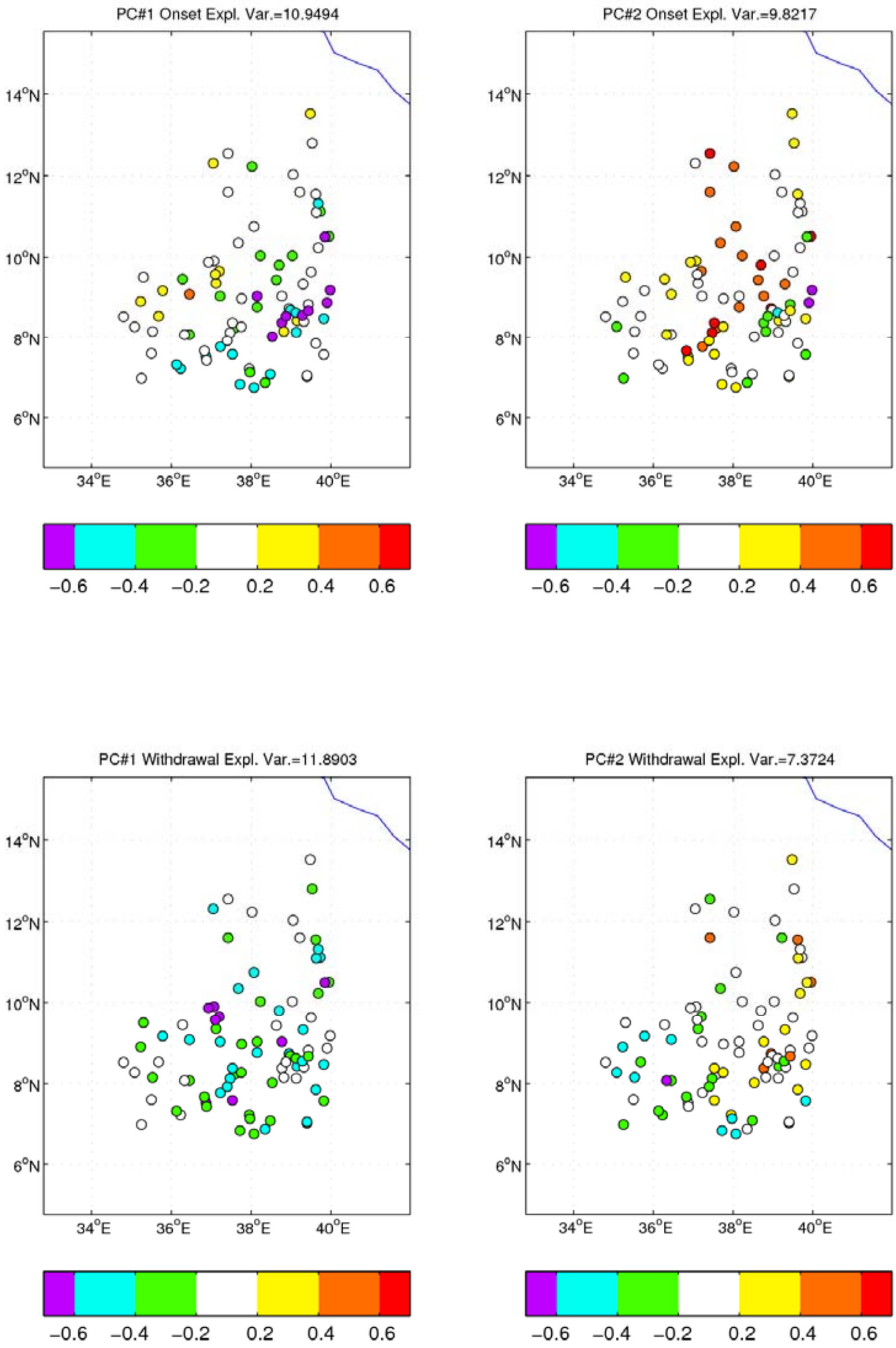


Fig. 5 shows the mean correlation between onset and withdrawal (both computed from definition #2). Most of the correlations are close to zero and the onset date does not say anything about the withdrawal dates. The values different from zero are too scattered in space to speak about the pattern.





The last figure below show the two first EOF of onset and withdrawal date (from definition #2). The amount of dispersion is large but it makes sense because the area is usually “dry” and the topography induces a large amount of complexity related to altitude and also perhaps orientation. Could we make a difference between onset and withdrawal despite the similar amount of variance explained ? it could be just an artifact but the first mode of withdrawal is a little bit more consistent than the one of onset (no values > 0.2 & 79 stations < 0 while 62 stations “only” have negative values). So there is a little chance to get a spatial coherence for the withdrawal but not for the onset (but EOF#2 shows a somewhat consistent pattern across the central area)



Following analyses

- Using CPT with March SST (for Onset) and July SST (for withdrawal)
- Re-doing EOF using only stations having less than 10% of missing entries
- Trying rotation of the leading EOF
- K-means of onset and withdrawal