General answer to reviewer 1.

We thank Reviewer 1 for having carefully read our manuscript and for her/his comments. We agree on the suggestions to add material describing a) the role of the wind and b) the link to anticyclones. On this respect, we think that this review really helps improving the clarity and the quality of the manuscript. Some of these concerns/suggestions are shared by reviewer 3. Therefore, there is an overlap between our answers to the two reviewers and the new material that we present here is duplicated in our answer to reviewer 3.

Our feedback to suggestions a) and b) and answers to the request for clarifying some issues are here below. They refer to the supplement, where reviewer 1 has described her/his general concerns and provided suggestions for improving the manuscript.

Note that our study shows that in shallow areas the wind is a main factor leading to sea level anomalies (SLA). This occurs particularly at the stations (Trieste and Gabes) located in the areas where anomalies have the largest values in the Mediterranean Sea. In order to stress this, a new column is added to former figures 11 and 12 showing the composites of the surface wind fields at the time of the maximum SLA. The new column clearly shows the correspondence between wind fields and the residual SLA, which is not produced by the inverse barometer effect.

Moreover, maps describing the position of high pressures and a table documenting the frequency of their presence when large negative SLAs occur are presented. This new information shows that the link with the presence of a high pressure system is indeed present, but weaker than the connection with the presence of cyclones in the opposite part of the Mediterranean Sea for some stations.

Finally, "*we clarify that we are not denying that high pressure leads to a negative sea level. Our study clearly supports the importance of the local action of the inverse barometer effect for both positive and negative SLAs. The link between large negative SLAs and cyclones that is shown in this study does not describe a local effect, but a teleconnection, supported by a statistical analysis and explained by the large scale structure of the SLP fields. The connection between cyclone in the opposite part of the basin and negative SLAS at the station is mediated by the cross basin pressure gradient and the presence of a highpressure that locally acts according to the inverse barometer effect*". This paragraph will be added to the "Discussion and Conclusion section".

Answers to general comments 1-5 of reviewer 1

Here below our answers to the comments of the reviewer. At the same time we describe where and how our manuscript would be changed to clarify the results of our study. Slant characters denote the text to be added to the manuscript

1) The reviewer lists very interesting papers on storm tracks and modelling of surges, several of them describing impacts of climate change on sea level anomalies. Those papers are very interesting, but they do not consider the description of the link between synoptic patterns and SLAs in the Mediterranean Sea, which is the actual object of this study. Mainly they describe the results of simulations that describe evolution and change of storm surges. They do not address explicitly the link between synoptic features and SLAs.

2) We agree that to add to the manuscript some details on the used tracking algorithm is useful, "*This cyclone tracking algorithm contains features that are meant to detect the formation of cyclones inside the Mediterranean and, at the same time, to avoid the inflation of the number of cyclones, determined by considering small, short lived feature as independent systems. This is a crucial balance as a large fraction of Mediterranean cyclones are secondary lows triggered by the presence of a large system over north and central Europe The method first partitions the SLP field in depressions, which can be considered candidates for independent cyclones, by merging all steepest descent paths leading to the same minimum. The small depressions that share a boundary with a deeper depression are included in the latter to form a single cyclone. The position of the cyclone is computed as the average of the points with SLP not more than 3 hPa higher than the actual minimum to compensate for large deviation of cyclones from the circular shape. Finally, when searching for successive positions of cyclones to construct their track, the search area is shifted southeasterly with respect to the former center (see Lionello et al., 2002 and Reale and Lionello, 2013, for more details)*".

This text will be added to the manuscript. The “double back” of cyclones trajectories (mentioned by the reviewer) is not evident in any of the former applications of this method, probably because of the specific features of this method.

3) “*The link between large negative SLAs and cyclones is a statistical concept. It is not meant that cyclones are the cause of large negative anomalies, but that the synoptic condition leading to negative anomalies is frequently associated to the present of a cyclone in the opposite part of the basin.*” This clarification will be added in the conclusions, page 13, line 25.
The link between the presence of a cyclone and the cross-basin pressure gradient is described in figure 9. This figure (described in the paragraph beginning at line 31 page 10) shows the difference of MSLP between the station and the cyclone center. *“The presence of positive values, between 10 and 15hPa in the areas of the basin opposite to the station evidences that when the cyclone center is located in such areas the pressure at the station is high and the inverse barometer effect contributes to negative sea level anomalies.”* Note that almost all differences in the maps are statistically significant. We admit that this was not clearly described in the text and the sentence between quotation marks will be added the manuscript.

4) We agree to document better the relevance of the wind. Two new columns in figure 11 and 12 are meant to provide the evidence of the action of the wind (see figures below). “*The action of the wind is evident in the fourth column of figures 11and 12, which show the composites of the wind fields at the time when the SLAs are largest anomaly. In these maps, the presence of a strong wind blowing towards the coast (fig.11, positive SLAs) or offshore (fig.12, negative SLAs) is consistent with the large residuals at Trieste, Tripoli and Gabes. For positive SLAs is also present in correspondence with the residuals (which smaller than in the previous stations) at Alexandria, Iskenderun and Thessaloniki.”* These sentences will be added at the end of section 3.6.

5) A new figure has been produced to answer to this comment of the reviewer and describe the role of anticyclones. “*Figure new1 shows the centers of anticyclones at the time of negative SLAs. It is made following the same procedure that has been used for figure 6, which refers to cyclones. It reveals the location of centers of anticyclones in the areas where figure 5 shows high pressure systems. Anticyclones are actually concentrated around the stations, with the exception of Gabes and, to a lesser degree, Trieste, where the wind effect is much larger than the inverse barometer effect and anticyclones play a minor role. Therefore, negative SLAs are linked to the presence of a high pressure around the station. This is necessarily true for most stations, because of the inverse barometer effect. However (see table new1), the probability to find an anticyclone at a distance lower than 10 degrees from the reference position* at the time of negative SLAs is significantly larger than the climatological value only for three stations (Toulon, Thessaloniki, Iskenderun). On the contrary, in Gabes, the absence of an anticyclone is linked to negative SLAs (and this is justified by the dominant role of the wind at this station). The link with the presence of a cyclone in the part of the basin opposite to the station (table 3) is stronger than what shown in table new1 for anticyclones.”* This explanation will be added to the manuscript at the end of section 3.4.
Further, we will extend the sentence at lines 5-8 of the abstract as it follows: *“The inverse barometer effect produces a positive anomaly at the coast near the cyclone pressure minimum and a negative anomaly at the opposite side of the Mediterranean Sea, because a cross-basin mean sea level pressure gradient is associated to the presence of a cyclone. This often coincides with the presence of an anticyclone above the station, which causes local negative inverse barometer effect”*

We clarify that we are not denying that high pressure system lead to a negative sea level. Our study clearly supports the importance of them and of the inverse barometer effect. The fifth paragraph at the beginning of this answers has to be added to the conclusions to clarify this.

*: *The reference position is defined as the center of the 5deg wide lat-lon cell where the density of anticyclone centres (blue square in figure new1) has a maximum (same procedure that was adopted for table 2).*

Station	P_{SLA+}	P_{CLIM+}	P_{SLA+}
ALICANTE	38	40	62
TOULON	**56**	**40**	44
TRIESTE	44	37	54
DUBROVNIK	42	37	58
THESSALONIKI	**62**	**41**	38
ISKENDERUN	**51**	**31**	49
ALEXANDRIA	43	39	57
GABES	**33**	**44**	67
TRIPOLI	40	48	60

Table new1. Statistics of cyclones producing the 100 largest negative sea level anomalies in each considered station. The two columns labelled "PSLA+" and "P_{clim-}", report the probability (%) to find an anticyclone within a 10degs search radius from the reference point (denoted with a yellow square in figure new1) at the time of the event and the corresponding climatological mean value, respectively. Bold values denote differences between the "PSLA+" and "Pclim-" that are statistically significant at the 95% level.

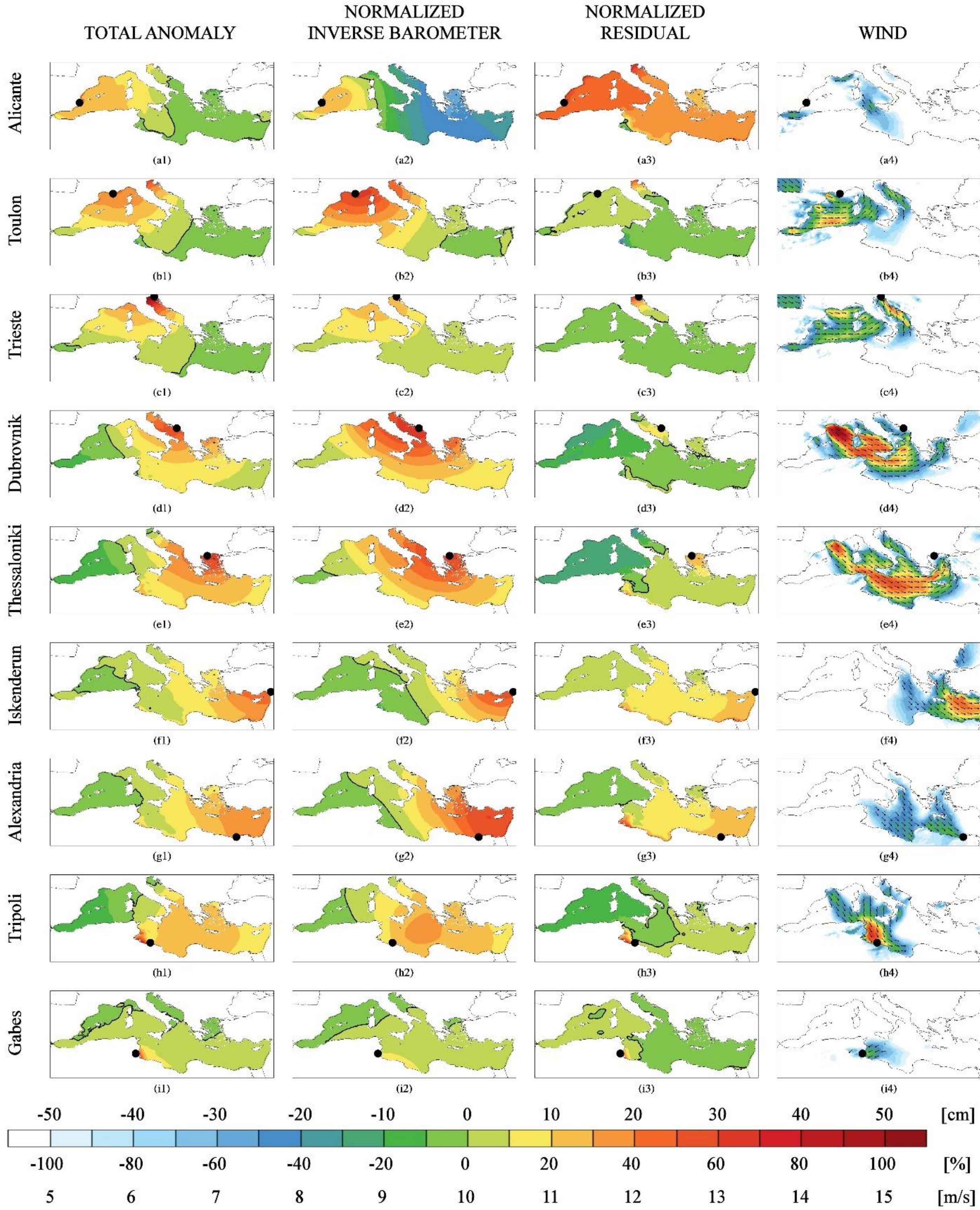


Figure 11. First three columns show the composites of sea level anomaly (cm) at the time of positive SLAs at the 9 stations considered in this study: Alicante, Toulon, Trieste, Dubrovnik, Thessaloniki, Iskenderun, Alexandria, Tripoli, Gabes (from top to bottom in this order). The left column reports the total anomaly (cm, upper annotation along the color bar), the central column the contribution due to the inverse barometer effect, the right column the residual. Values in the central and right columns are normalized with the maxima of the total SLA in the left column (%, lower annotation along the color bar). The thick black line denotes the zero level contour. The fourth column reports the wind speed (m/s bottom annotation below the color bar) and direction arrows. Arrows are plotted every degree and only where the wind speed exceeds 5m/s.

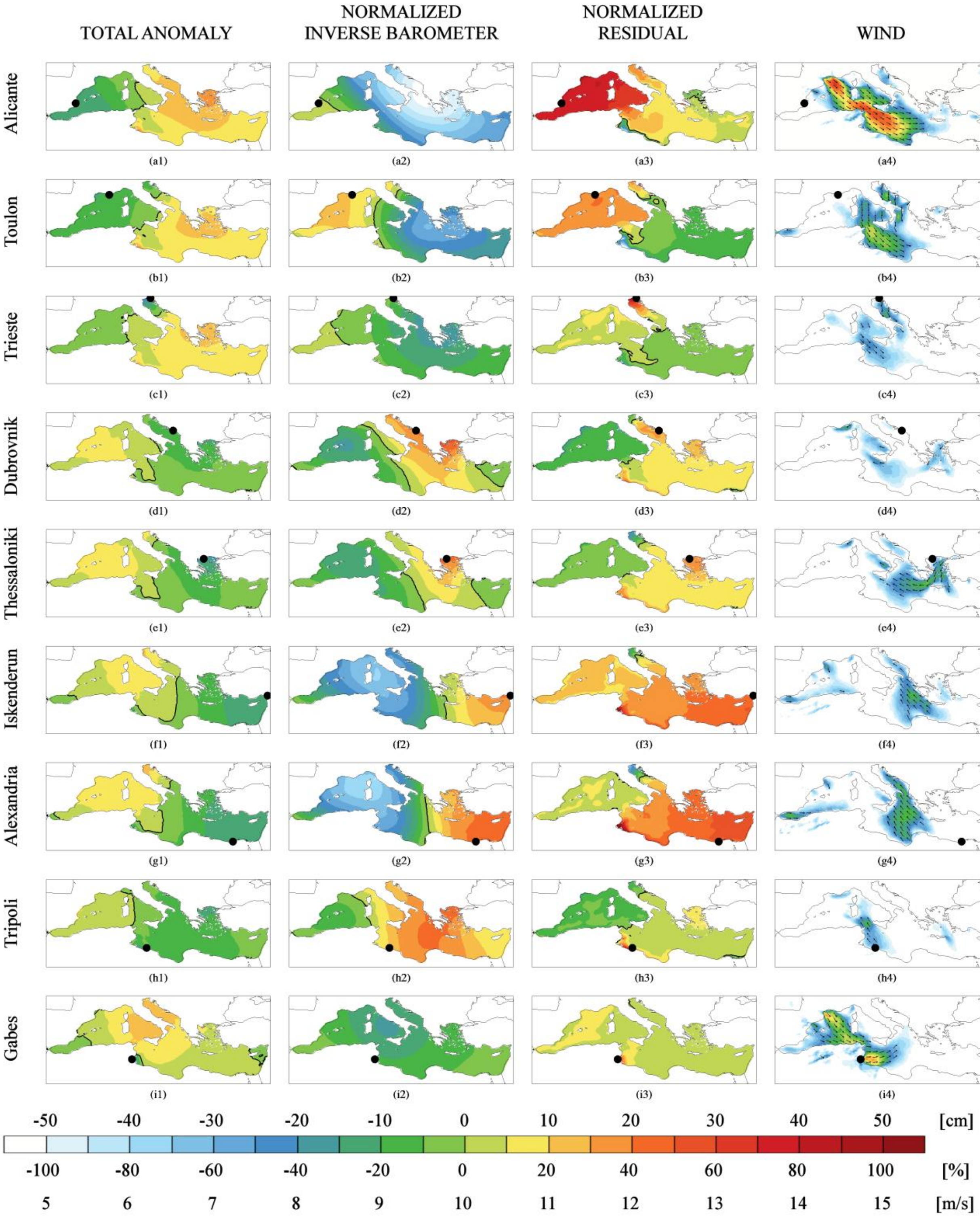
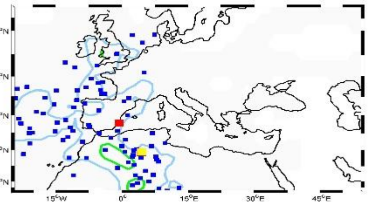
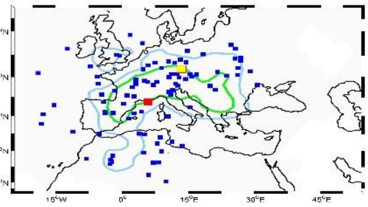


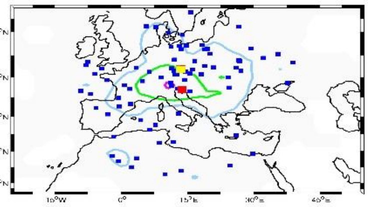
Figure 12. Same as figure 11 except negative sea level anomaly events are considered (in this case the minima of the SLA total in the left column are used for producing normalized values in the central and right column).



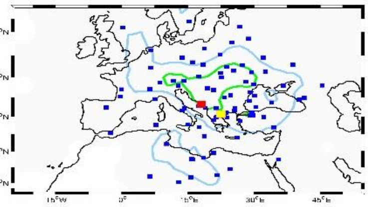
(a) **Alicante**



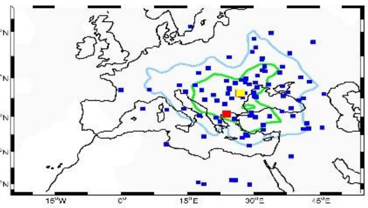
(b) **Toulon**



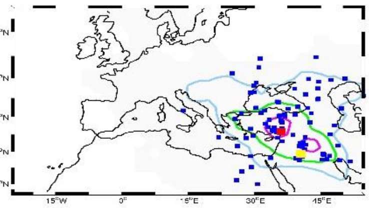
(c) **Trieste**



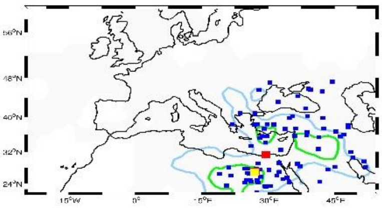
(d) **Dubrovnik**



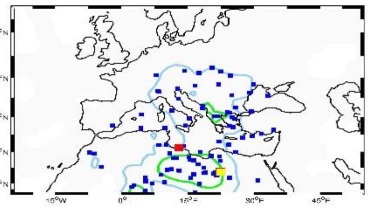
(e) **Thessaloniki**



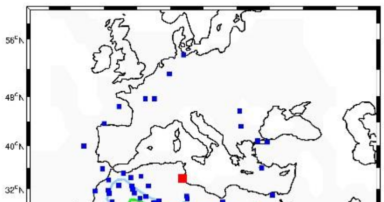
(f) **Iskenderun**



(g) **Alexandria**



(h) **Tripoli**



(i) **Gabes**

Figure new1. Track density of cyclones producing large sea level anomalies at Alicante (a), Toulon (b), Trieste (c), Dubrovnik (d), Thessaloniki (e), Iskenderun (f), Alexandria (g), Tripoli (h), Gabes (h) (locations are denoted with a red square). Blue squares show the position of the cyclone centers at the peak of the sea level anomaly. The yellow square denotes the reference position used in table new1 and subsection 3.4. A smoothing radius of 5degs is applied to the data original resolution (1.5degs). Contour lines are drawn at the .25· 10^{-7} (green line), 1·10^{-7} (magenta line) levels. Units are probability per square kilometer (blue line), 0.5· $10^{-7}{}_{-7}$

Answers to the specific comments of reviewer 1. The reviewer's comments, which have been included by the reviewer in the supplement provided, are here referred according to page and lines (following the reviewer's list)

Page 3,line 4.
The sites where surges have the largest values in the Med Sea are the North Adriatic and the Gulf of Gabes. All other sites where surges have relevant values are represented in this selection of coastal stations. See figures 5 and 6 of Conte, D., and Lionello, P. (2013) Characteristics of large positive and negative surges in the Mediterranean Sea and their attenuation in future climate scenarios, Glob. Planet. Change, 111, 159-173, https://doi.org/10.1016/j.gloplacha.2013.09.006, 2013.

Page 4 line 30
The "OBS" and "MOD" SLP composites are both based on ERA-Interim. The labels "MOD" and "OBS" do not refer to the source of SLP data, but to the criterion used for selecting the members of the samples used to build the composites, that are the time of the SLAs in the hindcast ("MOD") and in the observations ("OBS") (section 3.1, 2nd paragraph). The two samples share only a fraction of members. The similarity of the "MODS" and "OBS" composites, in spite of the small overlap between the corresponding samples, indicates that synoptic conditions leading to surges in the simulations ("MOD") are representative of those leading to the observed surges ("OBS").

Page 4, line 6-15 and page 6 line 11
See answer to general comment 5.

Page 6 line 3-7
Negative SLAs at Dubrovnik, Thessaloniki, and Tripoli differ from the others because they do not show the presence of a cyclone. The sentence from line 5-7 will be rephrased as "*The figures considering positive SLAs show the presence of a cyclone, which is consequently a permanent feature in the atmospheric circulation leading to large positive SLAs. For negative SLAs for most stations Figure 5 shows the presence of a cyclone in the basin, except for Dubrovnik, Thessaloniki and Tripoli"*

Page 6,line 21-22.
See our answer to general comment 4. The columns added to figures 11 and 12 now support the statement in these lines

Page 6 Lines 18-19:
Actually, we do not understand this comment of the reviewer. At the average speed of 32km/hour a cyclone would cover 768km in one day. This is compatible with the shift of the cyclone centers in the last 24 hours at Iskenderun and Alexandria.

Page 7 Lines 15-23:
The added columns in figures 11 and 12 support convincingly the role of a wind set-up and set-down for stations (mainly Trieste and Gabes) with a long shallow water fetch offshore

Page 7 Lines 29-31.
The sentence will be rephrased: "For example, the tracks of cyclones associated with negative SLAs in Alicante, Toulon and Trieste are similar to those associated with positive SLAs in Thessaloniki, showing that the same cyclone when moving along the main branch of the Mediterranean storm track can produce negative SLAs at the former stations and positive at the latter."

Page 10 Line 31 and Fig. 9:
We fully agree that the inverse barometer effect is mainly responsible for negative SLAs. It appears that our manuscript was misunderstood, on this respect. We think that the changes will make clear in the new version what we actually mean. We will emphasize this adding to the conclusions the new paragraph mentioned in our answer to the general comment 5 and explicitly written at the beginning of this document (paragraph 5th)

Page 11 Line 36 and Fig. 10:

Figure 10 (see the text at page 11 lines 4 to 12) is not restricted to positive or negative SLA. It shows how the intensity of cyclones is linked to SLAs (both positive and negative) at the station. "*Figure 10 provide a statistical evidence of a teleconnection linking negative SLAs to cyclones whose centers are located thousands of kilometers far away from the station. The green cells in the Iskenderun and Alexandria panels of figure 10 show that a cyclone positioned in those areas is linked to negative SLAs at these two stations. Therefore, this figure clearly shows the connection between intensity of cyclones in the opposite part of the basin and negative anomalies at Iskenderun and Alexandria* ". This paragraph will be added in section 3.5

Page 12 Lines 23-25 and Fig. 12.

The new column in figure 12 clearly shows the presence of winds blowing onshore and offshore and producing positive and negative SLAs , respectively