Authors' response

We would like to express our true appreciation to the referees' efforts and to thank them for their constructive and helpful remarks. In this document we have addressed the two reviewers' comments. Below we answer the comments point by point.

Answer to Referee #1

General Comments:

1. The Authors present the analysis of six years of lightning occurred in Eastern Mediterranean as detected by the Israeli Lightning Location System (ILLS). The successful strategy of the paper was to group the thunderstorms in 4 different synoptic categories occurring in that region, and to explain the statistical results on the basis of the corresponding thermodynamic conditions of each synoptic system. The result is an interesting and exhaustive analysis that should represent an example of how to organize a paper describing lightning datasets in the meteorological context.

Answer: We are happy that the reviewer found the paper interesting and well organized. We thank her/him for the comments and suggestions.

Specific Comments:

1. The heterogeneity of the ILLS sensors makes it interesting detailing the approach used in the detection algorithm. In page 3659, row 1, it could be added a specific reference, or as an alternative it could be included a description of the algorithm.

Answer: The detection algorithm, like in others LPATS based networks, is based on a combination of two detection methods: time of arrival and the magnetic field direction techniques. The two papers by Cummins et al. (1998a, b) provide detailed information about the algorithm. Additional full description of the method is given by Rakov and Uman (2006) in sections 17.2 and 17.3.

The 3 references were added to the revised text: “The detection algorithm is based on the time of arrival and magnetic field direction techniques (Cummins et al., 1998a, b; Rakov and Uman, 2006) to retrieve information on the peak current intensity, polarity, location and time of impact of ground strokes".

2. A question from Figure 1: Why the Detection Efficiency of ILLS network is better for lower longitudes and higher latitudes (namely over Mediterranean Sea)? Perhaps the previous comment on ILLS detection algorithm could help to explain also this one.

Answer: The higher occurrence frequency of lightning at lower longitudes and higher latitudes, in WCL days (as shown in figure 1) is caused mainly by the meteorological conditions. It is nicely shown in figure 5a (in the revised manuscript) presenting the strokes density at WCL days. At lower longitudes, over the sea, there are better conditions for thunderstorms development, mainly due to the convergence of the eastern land breeze and the western synoptic winds. The lower density over higher longitudes (moving to the east) is a result of rain-shadow effect downwind from the north-south mountain ridge, located parallel to the Israeli coastline, approximately between 35°E and 35.5°E. The higher strokes density at higher latitudes is due to the favorable conditions for lightning production across the central and northern parts of the Israeli coast. There is less lightning activity across the southern coast.

A remark about this point was added to the revised manuscript: “Note that the preferred occurrence of strokes at lower longitudes and higher latitudes is related to the meteorological (thermodynamic) conditions, a key factor that shapes the spatial distribution of lightning over the region (see section 1 and 3.2.2)”.

3. Discussing the dependence of positive strokes’ fraction on wind-shear (page 3667,row 28), you do no not show the results obtained using the GDAS database. Why?

To visualize this piece of information in a figure would help the reader, even because the “tilted dipole” hypothesis is very important in explaining the statistical results.

Answer: Based on this comment and comment # 7 of reviewer # 2 we reexamined the dependence of positive strokes’ fraction on wind-shear. The new analysis method included:

- The strokes data was selected for a smaller region bounded between 32°-33°N and 34°-35°E, similar to the region used to estimate the GDAS wind-shear data (instead of area bounded in radius of 250 km from the center of the study region).
- The time frame for selection of strokes was changed from 24 hours to 00:00 UTC ±2 hours.

The reduced volume of data proposes no significant correlation between fraction of positive strokes and wind-shear. For that reason we have decided to omit the discussion on wind-shear from the revised manuscript (in sections 3.2.4 and 4).

Technical Corrections:

4. page 3658, row 9: replace “Mackarres” with “Mackerras”

Answer: The reference was corrected.

5. page 3667, row 9: replace “Hojo” with “Hojo et al.”

Answer: The reference was corrected.

6. page 3673, row 28: replace “Dmweniza” with “Darveniza”

Answer: The reference was corrected.

Answer to Referee #2

General Comments:

1. This paper presents an interesting analysis of lightning over the area of Israel, as a physical continuation of previous studies over the same region. The paper presents interesting results and deserves publication, there are however many aspects that have to be reconsidered before publication. I tried to provide detailed remarks that are listed in the following.

Answer: We are glad that the reviewer liked the paper and we thank him for his comments that helped us clarify the paper.

2. Title: I believe that the reference to Eastern Mediterranean is rather misleading, since only a very small part of East Med. Sea is covered. I would suggest changing to "Israeli coasts" or "Crusade".

Answer: Based on this comment the title of the revised manuscript was changed to describe the study of region more accurately. The new title is: "Lightning Characteristics over the Eastern coast of the Mediterranean during Different Synoptic Systems"

3. Page 3656, line 10: why stroke density is provided per units of stroke per 25km^2? Comparison with previous studies would be easier if the units were simply per km^2.

Answer: Thank you for this comment. The revised manuscript provides the mean values of stroke density in units of km^2: "The average density of strokes per km^2 per day in the 250 km radius is 1.1 (WCL), 1.3 (FCL), 1.4 (RST-CL), and 1.1 (RST)".

These values are provided in figure 5 caption as well: "The average density of strokes in the 250 km radius is 1.1 km^{-2} day^{-1} (WCL), 1.3 (FCL), 1.4 (RST-CL), and 1.1 (RST)". For improved visualization the grid boxes in figure 5 are 5X5 km.

4. a. Page 3659, line 5: Are there any days without data during the analyzed period?

Answer: We don't know about specific days that the ILLS system was not operational. Nevertheless as we analyze only specific days that meet our criterions regarding synoptic conditions and significant electrical activity, it doesn't have much significance. Below in answer no. 6 you can find details about the number of analyzed days for each synoptic system.

This issue is mentioned in in the manuscript: "Only days that precisely meet the above criteria (see table 1) are selected for the analysis".

b. Moreover how the authors believe that the results are influenced by the absence of one sensor for a 4-year period?

Answer: The addition of a new detector in 2008 (marked in yellow in the figure 1 below) in the Golan Heights (near Pik Airfield) in a height of 370 meters above sea level improved the detection efficiency mostly over the northern part of the study region. Due to significant inter annual variability in the frequency and location of thunderstorms we cannot quantify this increase in the detection efficiency.

However, we can demonstrate it qualitatively. Figure 1 below shows the spatial coverage of strokes detected under synoptic conditions of WCL, before and after the last detector was added, i.e.: for the data collected during 2004-2007 (cyan) and 2009-2010 (black). The area bounded by the ellipse shows that during 2009-2010 (black) the network could retrieve data few tens of kilometers further to the north. Similar expansion of detection area was observed under synoptic conditions of FCL.

Thanks to this comment, this point is explained in the revised manuscript: "The added detector increased the detection efficiency of the system mainly over the northern edge of the study region. However, due to the big inter-annual variability in the frequency and location of thunderstorms we cannot quantify the impact of the improved detection efficiency on our results".

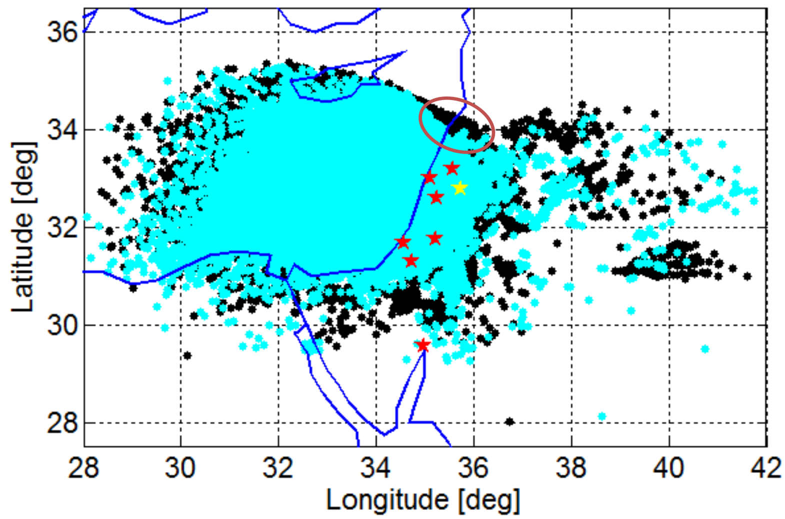

Figure 1. Spatial distribution of strokes detected under WCL system between 2004-2007 (cyan) and between 2009-2010 (black). Red stars mark the location of the ILLS detectors. The last added detector (in 2008) is marked in yellow. The area bounded by the ellipse marks the expansion in the spatial coverage of the ILLS network to the north. The data of 2004-2007 includes 87,141 strokes detected during 80 days, and for 2009-2010 it includes 54,903 strokes detected during 41 days.

5. Page 3660, line 11: The limit of 20 strokes per day seems rather subjective. How this number was selected? Why these days are excluded? Do you believe that these few strokes are noise from the sensors? How many days are therefore excluded?

Answer: Thank you for this comment that helped us clarify this point. The motivation of this research is to present the general characteristics of lightning strokes properties and their link to the thermodynamic conditions under four main synoptic systems. Accordingly, this study is focused on days when the conditions supported significant electrical activity. We believe that exclusion of days with low number of detected strokes refines the differences in the characteristics of the electrical activity and thermodynamic conditions in each synoptic system.

Accordingly, to obtain sufficient statistics, on one hand, and to expose the differences between the systems, on the other hand, a threshold value of 20 strokes per day was selected. Table 1 below shows that the part of the data that was removed for each synoptic system (due to low number of strokes) in the study region (radius of 250 km) is only between 0.11 and 0.46%. The total number of strokes removed in the four systems is only 183, i.e.: only 0.07% of the data. From the statistical point of view, the exclusion of less than a fraction of the data is expected to have negligible impact on the results.

Thanks to this comment, this issue is clarified in the revised manuscript: "…in order to sharpen the differences between the synoptic systems we filter out days with insignificant electrical activity. Days with less than 20 detected strokes are excluded from the dataset. The part of the data removed in each synoptic system due to low number of stroke is less than 0.5%".

Table 1: Number of days, number of strokes and the percent of strokes removed from the dataset in days with low number of strokes (<=20) in the study region.

Synoptic System	# of days	# of strokes	% of strokes
WCL	10	109	0.11
FCL	5	31	0.04
RST-CL	3	19	0.03
RST	3	24	0.46

6. a. Page 3660, lines 19-23: First of all, I would like to point out that a resolution of 1x1 degree is rather poor and that many interesting meteorological patterns are filtered at such a coarse resolution. The authors should comment on that.

Answer: The purpose of this analysis using GDAS data was to define the prevailing synoptic system over the eastern Mediterranean coastal region. The maps produced by the GDAS model are detailed enough to enable synoptic systems identifications even though there is a possibility of filtering out small scale meteorological patterns. In cases were there was a doubt about the synoptic system we used additional information to support the analysis like satellite images of that day. There were very few days where the determination of the synoptic system was not clear and they were removed from the dataset.

b. Moreover, how many vertical levels are used? Since later on you calculate variations of temperature and wind on the grid column, it is necessary to know the vertical resolution of the used dataset.

Answer: The GDAS model is based on 26 vertical pressure levels between 1000 hPa and 10 hPa with variable resolution between 10 and 50 hPa. Additional level is designated for the surface. Table 2 below provides detailed information regarding the pressure levels and the corresponding vertical resolutions.

Thanks to this comment, the revised manuscript includes detailed information about the vertical and temporal resolution of the model: "The GDAS data, in spatial resolution of 1×1°, is provided in 26 pressure levels, between 1000 and 10 hPa (with vertical resolution between 10 and 50 hPa). Additional level is designated for the surface. Data is provided for 00:00, 06:00, 12:00 and 18:00 UTC"

Table 2: Pressure levels [hPa] and vertical resolution [hPa] of GDAS

Pressure Height [hPa]	Vertical Resolution [hPa]
1000-900	25
900-100	50
100-70	30
70-30	20
30-10	10

c. Finally, I cannot understand how you combine data at 00 and 12 UTC with lightning strokes, do you select a time-window (how many hours?) around each synoptic time for which GDAS data are available?

Answer: The timing of the electrical activity along the day determined which synoptic map should be examined for determination of the synoptic system. If the lightning activity lasted for more than half a day the two relevant maps for that day were examined. This could be done due to the strong relation between the formation of thunderstorms over the study region and the location or passage of the synoptic systems. Accordingly, the strokes data was used to follow the location of the synoptic system in high temporal and spatial resolution.

Thanks to this comment, this issue is clarified in the revised manuscript: "GDAS data are examined with respect to the timing of the detected strokes. Since the formation of thunderstorms over the study region is strongly related to the location and passage of synoptic system, one can follow the location of the synoptic system, via the stroke data. Accordingly, the classification to specific synoptic system is based on examination of the GDAS data at 00:00 or 12:00 UTC combined with the relevant stroke data around this time".

7. Page 3661, line 6: The 17% of the days omitted in the analysis correspond to what kind of synoptic settings?

Answer: To clarify the volume of the data omitted from the analysis, the revised manuscript includes a new table (table 3, below and table 2 in the revised manuscript) that specifies the exact number of analyzed days and analyzed strokes as well as their fraction per each synoptic condition. Note that unspecified days (when the determination of the synoptic system was not clear) are not included in table 3.

The numbers in table 3 below represent the ratio between the total number of detected strokes per synoptic system and the number of strokes after removing (1) weak peak currents strokes, (2) strokes in distance >=250 km, and (3) days with low number of strokes.

In the revised manuscript we state the following: “Table 2 specifies the number and fraction of analyzed days and strokes per synoptic system”.

Table 3: Number and percentage of days and strokes used in the analysis. The percentages are calculated based on the difference in the data volume after neglecting strokes with absolute peak currents <=10 kA, strokes located in radius >=250 km from the center of the study region and days when the remaining number strokes in this radius <=20 day^{-1}.

Parameter	**WCL**	**FCL**	**RST-CL**	**RST**
Number of analyzed days	128	51	15	12
Percent of analyzed days [%]	92.8	87.9	83.3	70.6
Number of analyzed strokes	98963	80861	56994	5118
Percent of analyzed strokes [%]	63.8	70.9	71.5	37.8

8. Page 3663, lines 1-10: I have doubts about the correct use of CAPE on your analysis. First of all, you refer to “daily CAPE” which is a rather misleading term; CAPE is an instantaneous value at the time of sounding or model analysis. CAPE values are then compared against daily strokes (within the whole domain?). I believe that a more correct approach would be to combine CAPE values (at let say 1200 UTC) within each 1x1 GDAS grid with the number of strokes within each grid and for a short time-window around 1200 UTC. This approach assures that the thermodynamic conditions inferred by CAPE are correctly associated with strokes, both in space and time.

Answer: Following this comment, we changed the analysis method for this part. The number of strokes was re-analyzed for smaller spatial domain and shorter time period, combined with the relevant GDAS CAPE value for this time window:

- The area was selected for the region bounded between 32°-33°N and 34°-35°E, similar to the grid box that the CAPE represents.

- The time frame was changed from 24 hours to four time windows per day (of 4 hours each), around 00:00, 06:00, 12:00 and 18:00 UTC, (±2 hours).

The new results (presented in figure 2 below) show a general trend of an increase in the number of strokes together with CAPE. The highest correlation between the two variables was acquired for conditions of FCL, around 00:00 (R= 0.58) and 06:00 (0.68), and for WCL, around 12:00 (R = 0.31) and 18:00 (R = 0.54). All R values are significant for level of 0.05.

Figure 2 below (and figure 3 in the revised manuscript) shows the combined four time windows per synoptic system. The highest correlation in the combined dataset of the four times is for conditions of FCL (R = 0.49). The combined datasets of WCL, FCL and RSDT-CL forms a regression line (marked in gray) with regression coefficient R=0.41. The above R values are significant for confidence level of 95%.

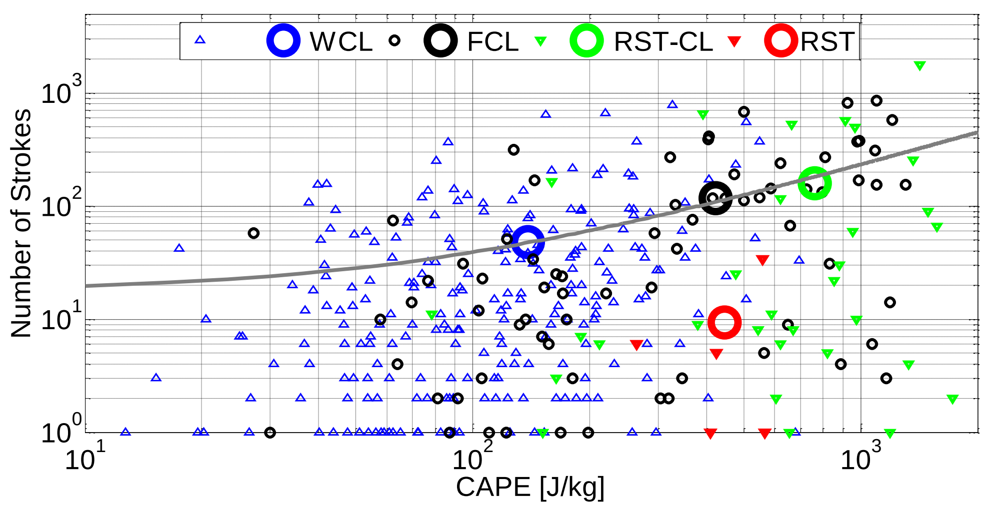

Figure 2. Number of strokes as a function of CAPE according to the four synoptic systems. The CAPE is taken from the GDAS dataset. Both variables are estimated for the area between 32°-33°N and 34°-35°E. The CAPE is estimated at 00:00, 06:00, 12:00 and 18:00 UTC, and the number of strokes is estimated for a time windows of ±2 hours around these times. Centroids for the four subsets are marked by circles. A linear fit for WCL and FCL and RST-CL is shown in grey.

9. Page 3663, line 26 and Page 3670, lines 8-10: The explanation provided by the authors at both instants concerning IC flashes is a hypothetical assumption, that it is not supported by the available data. Can the authors confirm this assumption based on data?

Answer: Unfortunately our dataset cannot be used to confirm this hypothesis and we need to use references of previous works to support it. The explanation provided for the low number of detected ground strokes in respect to the relatively high CAPE value in RST conditions is related to the likelihood for ground strokes as a function of the altitude of the charge centers in the cloud.

The development of clouds under RST conditions, at relatively high altitudes (as shown in figure 2 in the paper), is related to a source of moisture at mid troposphere. This issue is discussed in details in Kahana et al. (2002), Krichak, et al. (1997), and Ziv et al., (2001) that are cited in the revised manuscript. We also refer a previous study by Yair et al., (1998) that reported a maximum in the IC to CG ratio in the autumn and under RST conditions while using different system for lightning detection.

The revised part in the paper: "A possible explanation for this contradiction is higher relative fraction of IC flashes (Yair et al., 1998) that are not detected by the ILLS. The IC flashes can be attributed to the relatively higher-altitude of the mixed phase region in the clouds during the RST days due to the high-level source of moisture (Kahana et al., 2002; Krichak, et al., 1997; Ziv et al., 2001). Clouds located higher in the atmosphere, as implied by the higher level of the 0ºC isotherm in figure 2, are expected to produce higher ratio of IC to CG flashes (Pierce, 1970; Prentice and Mackerras, 1977; Yair et al., 1998)."

10. Figure 3 and related discussion: Do the authors believe that the pattern seen on RST could be related to the small number of events? Looking into the days of RST (red crosses) a large dispersion of data is obvious and therefore the calculation of the centroid (red bold circle) is, at least, questionable. The dispersion can be related to the small number of events, but in any case, I do not believe that the results and the

explanation provided by the authors can hold for such a small dataset showing such a large dispersion.

Answer: Thank you for this comment. Based on this comment and on comment no. 7 above we changed the method of analysis (i.e.: selection of strokes within shorter time windows and in smaller spatial domain, similar to the one used for the CAPE data), the dispersion of the data reduced significantly.

The above figure 2 (and figure 3 in the revised manuscript) shows that now the RST data is centered around the centroid. The relative position of the centroid remains below the linear fit that connects the centroids of the WCL, FCL and RST-CL systems (marked in grey).

We believe that the clustering of the RST data, despite the large reduction in the volume of the RST data, due to implementation of referee's comment #7, strengthens our assumption that the low number of detected strokes could be related to physical causes. We are aware of the small size dataset of the RST days and it is pointed out in the discussion: "However, there is some uncertainty with these results due to the small dataset measured for this synoptic system". But nevertheless we think this analysis' results are meaningful.

11. Moreover, the equations shown in the upper-left part of the Figure are merely a statistical result with no practical physical meaning (e.g. they provide lightning with 0 CAPE) and therefore I suggest removing them. Taken into account my previous comment #7 on daily CAPE and this comment, I believe that the authors have to modify Figure 3, based on the aforementioned remarks.

Answer: Figure 3 was modified based on comment #7 and in addition the equations were removed.

Minor Remarks:

1. Page 3656, line 23: The sentence "timing of frontal system" is not clear.

Answer: This issue is clarified in the revised manuscript: "…as it relates to the random passage timing of the frontal systems over the study region."

2. Page 3657, line 21: Which is the meaning of a "low-level trough"?

Answer: Yes, we define the synoptic conditions of RST.

3. Page 3661, line 20: A reference to MODIS data is necessary.

Answer: Kilpatrick et al. (2015) was added as a reference to MODIS SST product.

4. Page 3664, line 7: How the authors define a "thunderstorm day" and for which area? Moreover, since the authors exclude days with less than 20 strokes, how this exclusion can affect the correct calculation of thunderstorm days over the area?

Answer: Thunderstorm days are defined in the manuscript as days with more than 20 lightning strokes in the study region (radius < 250 km) that are determined per synoptic system based on the criteria in section 2.2 (in the manuscript).

To discuss the general characteristics of strokes under the four typical synoptic systems we focused on days with substantial amount of lightning, as stated in the response to comment #4 above. Figure 3 below shows the inter-annual monthly average thunderstorm days for the four synoptic systems. Results are calculated with (red) and without (blue, similar to figure 4 in the manuscript) days with low number of strokes. As expected, the exclusion of these days slightly reduces the inter-annual monthly average number of days over the study region.

We estimate that days with low number of strokes do not represent well the four typical synoptic conditions nor the general characteristics of lightning parameters under these conditions and therefore should not be included in such analysis.

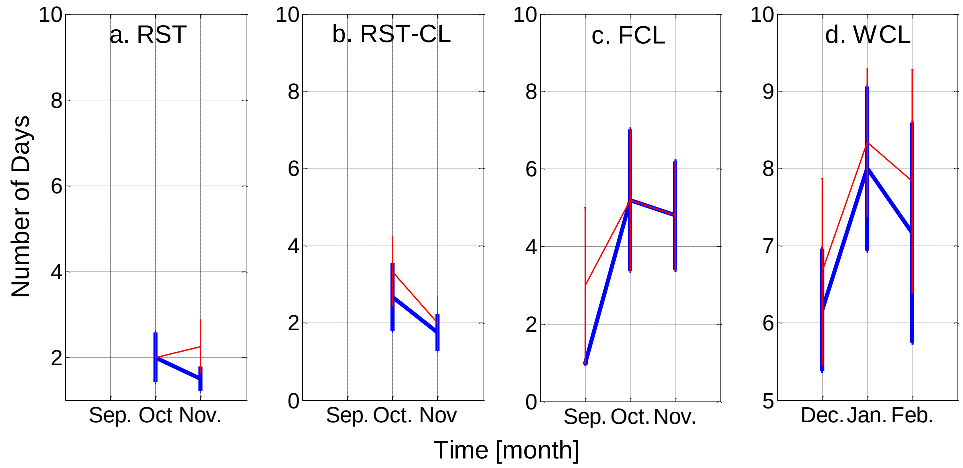

Figure 3. Inter-annual monthly average thunderstorm days for the four synoptic systems. Results are calculated with (red) and without (blue, similar to figure 4 in the manuscript) days with low number of strokes. The error-bars indicate standard errors.

5. Page 3665, lines 15-17: I agree that sea is source of moist and heat, but I believe that this effect is more pronounced during fall season, when SST reaches its yearly maximum, especially in September.

Answer: We agree with the reviewer that the SST is maximal at September. The main focus of this sentence in the paper is the differences in magnitude of instability between land and sea during the winter. Due to thermal differences between land and sea-surface the instability is greater over the sea. The significant thermal contrast between the sea and the air above it (in the winter) creates substantial sea fluxes (see Shay-El and Alpert 1991). In order to clarify this point the revised manuscript was modified: "Under conditions of WCL, the higher strokes density is detected over the sea and near the coast (figure 5a). This location of stronger electrical activity over the sea, can be associated with larger instability over the sea (compared to over land) during the winter, as the sea is a source for moisture and heat (Shay-El and Alpert, 1991)".

6. Page 3665, lines 25-26: It is of interest your statement for the position of trough axis, do you believe that you can further support this by using GDAS data?

Answer: To better support our statement the revised manuscript includes additional references (Zangvil and Druyan, 1990) that discuss the link between the position of the trough's axis and the development of thunderstorm over the study region. Additional support for this link using the GDAS data (although it is very interesting) is beyond the scope of this paper and will be studied in future studies.

7. Section 3.2.3: The authors use in some places the term "significant", I wonder if this term is used from a statistical "point of view", please clarify.

Answer: The term "significant" was not used in the text from a statistical point of view. To avoid ambiguity it was replaced with other terms along this part.

8. Page 3670, line 5: The reference to 515±615 J/kg looks strange, it would be better to refer to the confidence interval of the values.

Answer: The revised calculations of CAPE values at 00:00, 06:00, 12:00 and 18:00, based on the comment #7 above, reduced the referred standard deviation. The updated value of the standard deviation is 444.8±124.4 J kg^{-1}, and it appears in the revised text.

9. Figure 1: the center of ILLS shown with arrows on the Figure is not the same as the center written in page 3659, line 26.

Answer: Thank you for this comment. The location was corrected in figure 4 below (figure 1 in the revised manuscript).

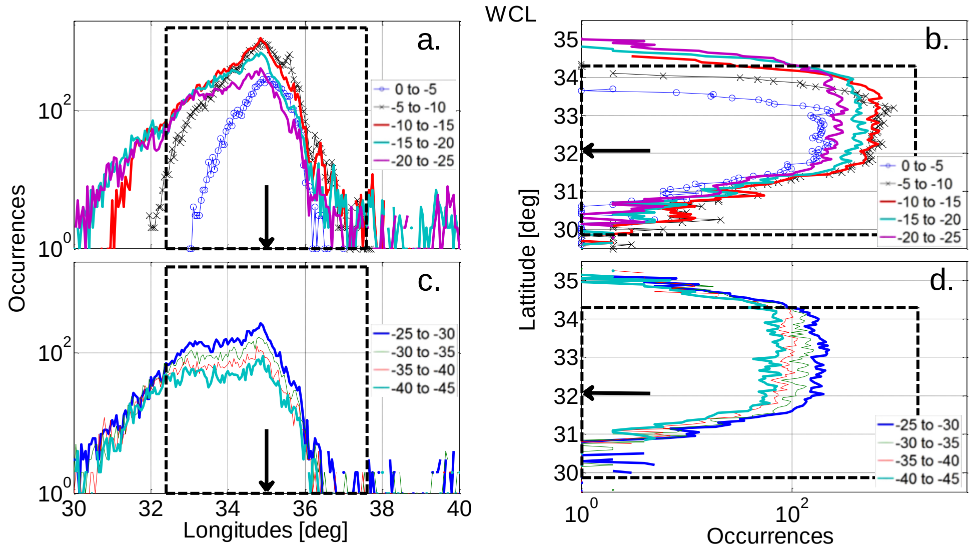

Figure 4. Distribution of peak currents during WCL system [#/25 km^2]. Data is plotted as a function of longitudes (a and c) and latitudes (b and d). Distributions are calculated for steps of 5 kA in peak current intensities. Figure a and b are for peak currents between 0 and -25 kA and figure c and d present the range between -25 and -45 kA. Black boxes mark a distance of 250 km from the center of the study region which is marked by black arrows. Absolute currents larger than 45 kA are not shown.

10. Figure 5: only 7 sensors are shown on the Figure.

Answer: Thanks to this comment the location of the sensors was highlighted with larger symbols (see figure 5 below and figure 5 in the revised manuscript).

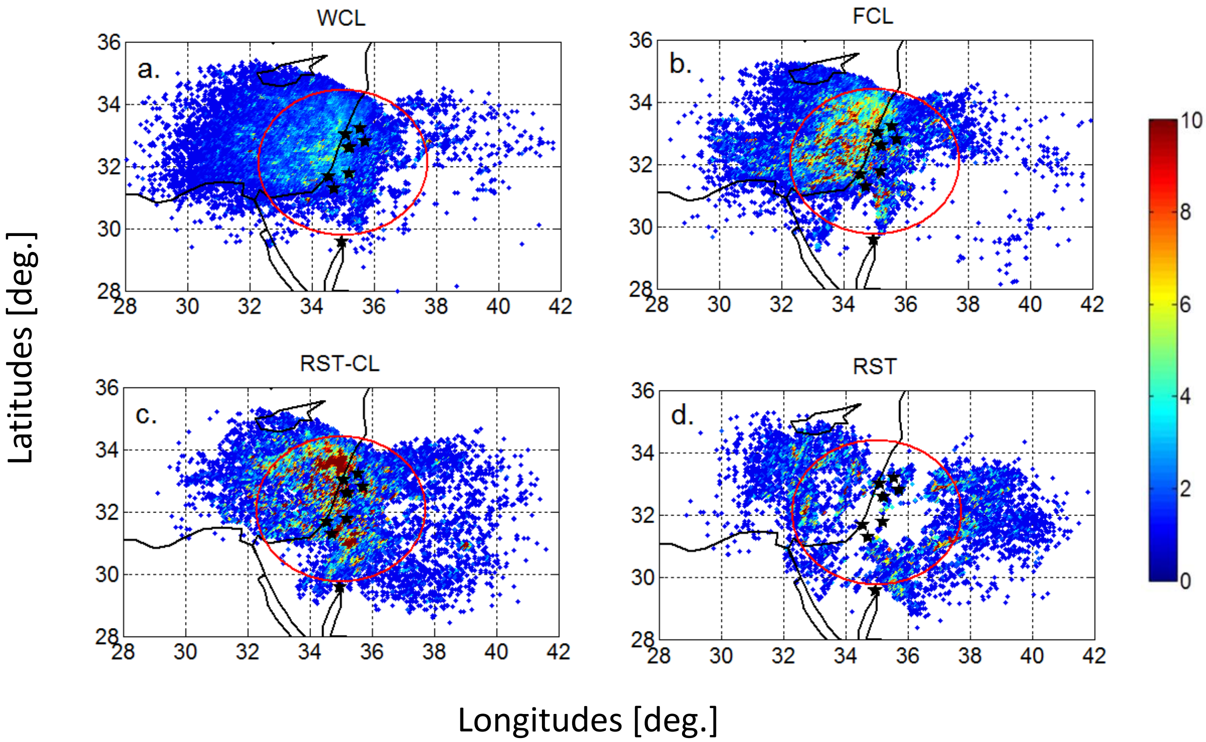

Figure 5. Strokes density per 25 km^2 per day according to the four synoptic systems. To highlight spatial features and to compare between all systems a similar color-bar is used (maximum values per 25 km^{-2} day^{-1} are 37 in WCL, 54 in FCL, 33 in RST and 131 in RST-CL). Red circles mark the study region. Black stars mark the location of the ILLS detectors. The average density of strokes in the 250 km radius is 1.1 km^{-2} day^{-1} (WCL), 1.3 (FCL), 1.4 (RST-CL), and 1.1 (RST).

References

Cummins, K. L., Murphy, M. J., Bardo, E. A., Hiscox, W. L., Pyle, R. B. and Pifer, A. E., A combined TOA/MDF technology upgrade of the U.S. National Lighting Detection Network, J. Geophys. Res., 103, D8, 9035–9044, doi: 10.1029/98JD00153, 1998a.

Cummins, K.L., Krider, E.P., and Malone, M.D., The US National Lightning Detection NetworkTM and applications of cloud-to-ground lightning data by electric power utilities, IEEE Trans. Electromagn. Compat., vol. 40, no. 4, pp.465-480, doi: 10.1109/15.736207, 1998b.

Kahana, R., Ziv, B., Enzel, Y. and Dayan, U., Synoptic climatology of major floods in the Negev Desert, Israel, Int. J. Clim., 22, 867–822, doi: 10.1002/joc.766, 2002.

Kilpatrick, K.A., Podestá, G., Walsh, S., Williams, E., Halliwell, V., Szczodrak, M., Brown, O.B., Minnett, P.J., and Evans R., A decade of sea surface temperature from MODIS, Remote Sensing of Environment, 165, 27–41, doi:10.1016/j.rse.2015.04.023, 2015.

Krichak, S. O., Alpert, P., and Krishnamurti, T. N., Interaction of topography and tropospheric flow — A possible generator for the Red Sea Trough?, Meteorology and Atmospheric Physics, 63, 3-4, doi: 10.1007/BF01027381, 1997.

Pierce, E. T., Latitudinal Variation of Lightning Parameters. J. Appl. Meteor., 9, 194–195, doi: http://dx.doi.org/10.1175/1520-0450(1970)009<0194:LVOLP>2.0.CO;2, 1970.

Prentice, S. A. and Mackerras, D., The Ratio of Cloud to Cloud-Ground Lightning Flashes in Thunderstorms, J. Appl. Meteor., 16, 545–550, doi: 10.1175/1520-0450(1977)016<0545:TROCTC>2.0.CO;2, 1977, 1977.

Rakov, V. A. and Uman, M. A.: Lightning: Physics and Effects, 687 pp., Cambridge Univ. Press, Cambridge, UK, 2006.

Shay-El Y. and Alpert P., A diagnostic study of winter diabatic heating in the Mediterranean in relation to cyclones, Q. J. Roy. Meteorol. Soc. 117: 715-747, doi: 10.1002/qj.49711750004, 1991.

Yair Y., Levin Z. and Altaratz O., Lightning phenomenology in the Tel-Aviv area from 1989 to 1996, J. Geophys. Res., 103, 9015-9025, doi: 10.1029/98JD00087, 1998.

Zangvil, A., and Druyan, P., Upper air trough axis orientation and the spatial distribution of rainfall over Israel. Int. J. Climatol, 10, 57–62, doi: 10.1002/joc.3370100107, 1990.

Ziv, B., A subtropical rainstorm associated with a tropical plume over Africa and the Middle-East, Theoretical and Applied Climatology 69, 91–102, doi: 10.1007/s007040170037, 2001.