**Atmospheric
Measurement
Techniques**
Discussions

Interactive comment on "An overview of the lightning and atmospheric electricity observations collected in Southern France during the HYdrological cycle in Mediterranean EXperiment (HyMeX), Special Observation Period 1" *by* E. Defer et al.

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Interactive comment on "An overview of the lightning and atmospheric electricity observations collected in Southern France during the HYdrological cycle in Mediterranean EXperiment (HyMeX), Special Observation Period 1" by E. Defer et al.

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We would like to thank Dr Poelman for his constructive review. All comments have been addressed as detailed in the following document and in the revised version of the paper.

This manuscript describes the observations performed within the PEACH experiment in the framework of the HyMeX campaign, and specifically during SOP1. The different instruments used during SOP1, as well as the operational Lightning Location Systems and some results of specific observations are addressed.

The manuscript fits well within the scope of Atmos. Meas. Tech. and could be a valuable contribution to the literature. However, there are some issues that should be addressed:

Main comments: - There is an excessive use of brackets "(...)" in the text, which makes it sometimes hard to read. To improve the readability of the manuscript, most of the text within the brackets should be incorporated within the text.

Response : The brackets were originally used to concise the content of the paper. Now most brackets have been removed and the text adapted.

- Abstract: p8015 L18-L26 "A description of the different instruments ... are discussed." This text belongs to the Introduction section. The 'Abstract' should contain the results/outcome of the paper, and not just a description of the different Sections.

Response : We have replaced the following part of the abstract "A description of the different instruments deployed during the field campaign as well as the available datasets is given first. Examples of concurrent observations from radio frequency to acoustic for regular and atypical lightning flashes are then presented showing a∼rather comprehensive description of lightning flashes available from the SOP1 records. Then examples of storms recorded during HyMeX SOP1 over Southeastern France are briefly described to highlight the unique and rich dataset collected. Finally, future steps required for the delivery of reliable lightning-derived products to the HyMeX community

are discussed" by "Herein we present an overview of the PEACH project and its different instruments. Examples are discussed to illustrate the comprehensive and unique lightning dataset, from radio-frequency to acoustics, collected during the SOP1 for lightning phenomenology understanding, instrumentation validation, storm characterization and modeling."

- 1 Introduction: p8019 L14-L19: I am missing the goal of this paper. The authors could provide a small paragraph at the end of the introduction containing what the authors want to bring to the scientific community with this paper, why has it been written? This is partly described in Sect. 2, but a short description is at place at the end of the introduction.

Response : One small paragraph has been added at the end of the introduction section, just prior the brief description of the content of the paper as follows: "Lightning detection is definitively useful to monitor thunderstorms and to help improve severe weather simulations. Among the open scientific questions related to the electrical activity, are the links between microphysics, kinematics and lightning activity, the use of the lightning information in multi-sensor rainfall estimation and the lightning-flash phenomenology. In the following we describe the rationale for dedicated lightning observations to characterize the electrical properties of Northwestern Mediterranean storms during a dedicated campaign of the HYdrological cycle in the Mediterranean EXperiment (HyMeX) program (Ducrocq et al., 2013). First, the HyMeX project is briefly described in Sect. 2. The scientific questions and the observational strategy of the HyMeX lightning task team, including instruments and models, are described in Sect. 3. Section 4 presents an overview of the observations collected at flash, storm and regional scales. Section 5 then discusses the perspectives by listing out the next steps of the data analysis as well as the data and products made available to the HyMeX Community."

- 2 The HyMeX program: p8020 L8: "Super sites". Explain a bit more what these sites are. How were these chosen? What makes them different from other sites?

This is somewhat indicated in Sect. 3 L24 but could be described earlier. Response : A super site over land or the ocean gathers research instruments dedicated to the study of specific processes. We propose the following to detail a bit more the notion of super site. "Those equipments were deployed at or near super sites where dedicated research instruments are gathered to document specific atmospheric processes c."

- 3 The PEACH experiment: p8020 L20. Maybe one can start first with the goals of PEACH. For instance, part of Sect. 3.1. could be placed here to describe the scientific objectives. Response : We would prefer to keep the current structure of the paper as the two first paragraphs describe briefly the nature of the electrical activity in the Mediterranean Basin and the relevance of the lightning detection for storm monitoring over the Mediterranean Sea. Then we list the scientific objectives of the PEACH project and its observational/modeling strategy.

- p8023: LMA, EFM, SLA are all described in a designated subsection. However, this is not the case for INR. Therefore, the authors could consider to include a subsection explaining the main parameters of the INRs, as has been done for the other instruments. Response : The induction rings (INR) were built just before the field deployment and were not enough tested before their deployment and operation during the field campaign. They all failed due to non-reliable electronic chips. It is why we did not originally describe them in the paper. Notice that the INR measurements were aimed to provide some ground-truth on the actual electrical charges carried by the raindrops at the ground for a comparison and verification of simulated charge distribution at ground level provided by the cloud-resolving model MESO-NH. As suggested by the Reviewer we now include one section describing the principle of an induction ring as well as the explanation of the failure. Here is the text that has been inserted: " The electric charge carried by raindrops can easily be detected and measured by a simple apparatus commonly called induction ring. This sensor is constituted of a cylindrical electrode (the ring) on the inner surface of which induced electric charges appear by electrostatic influence when a charge raindrop enters the sensor. When the drop leaves the sensor,

the induced charges disappear. The cylindrical electrode is connected to an electrometer and the current signal induced by the passing of a charged drop (a bipolar current impulse) is sampled at a rate of 2000 Hz. It is amplified and integrated by an electronic circuitry that directly provides the charge signal. This one appears as a single pulse with amplitude and length proportional to the charge and to the velocity of the drop, respectively. The actual charge is deduced from the calibration of the sensor. If the drop collides with the induction cylinder, the pulse signal exhibits a slow exponential decay (MacGorman and Rust, 1998) that is easily recognizable in the post data processing. In this case, the raindrop charge that is fully transferred to the induction cylinder is determined by a specific calibration. The charge measurement sensitivity ranges from about $\pm$ 2 pC to $\pm$ 400 pC. Furthermore, the charge signal duration at mid height can be used to determine the size of the charged raindrops provided the relationship between size an fall velocity in function of the actual temperature and pressure (Beard, 1976). Such measurement provides key information on the electric charge carried by the rain at the ground to validate numerical modeling. It documents the spectrum of charged drops and helps deduce the proportion of charged drops within the whole drop population by comparing its spectrum with the one measured by a disdrometer. Four induction rings were built and operated during the SOP1, mainly along the South to North axis at the foothills of the Massif Central where most of high precipitating events occur. Unfortunately, only few events passed above the sensors and in these rare cases, the main electronic component of the induction rings suffered dysfunction that were not detected during the laboratory tests, so no valuable INR data are available for the SOP1."

- 3.3 Operational Lightning Location Systems: The writing style of the subsections concerning the description of the OLLS is not coherent. The authors could slightly rewrite these sections in order to converge the writing style of the OLLS subsections. Response : As suggested by the Reviewer, the subsections dealing with the description of the OLLSs have been rewritten with similar information. See the different sections describing the OLLSs.

- Concerning the description of all the OLLS: It would be worth to include some LA and DE values + references, if possible within the region/neighborhood of HyMeX SOP1. Response : Some numbers are now given in the different subsections describing the OLLSs. We would like to stress out that one of the objectives of the investigations performed with the HyMeX SOP1 data is to assess in the SOP1 region both DE and LA for all operational networks.

- 3.5 Modeling: This section is out of the scope of this paper and no further results are presented in this paper on the modeling aspects. Maybe the authors could just make a comment concerning the modeling efforts in stead of including sect. 3.5.1 and 3.5.2 in the manuscript. For instance p8034 L22-L26 can be removed to Section 5 Prospects. Response : The Authors was discussed on that question before the submission. Our strategy is to use as much instruments as possible, and models are instruments for us, to tackle the different scientific questions investigated here. So we would like to keep the Modeling section as it is now. Some modeling exercises have already been performed, but are not discussed here. s

- 4.1 SOP1 Climatology: The authors should include a bit more info on the climatology during SOP1: How many thunderstorm days were observed in the region of interest (describe Fig. 2), how many flashes have been observed during SOP1?, ... Response : We have provided some additional information on the lightning climatology. Figure 2 has now one extra panel showing the number of lightning days on the yearly basis for the SOP1 duration. No reference on actual number of flashes is given due to the successive upgrade of Météorage network. Note that we performed a set of investigations on the lightning climatology based on Météorage data that were used for the definition of the HyMeX SOP1 Implementation Plan. We propose the following text now: "The year 2012 was rather weak in terms of lightning activity over the center of the SOP1 domain. The electrical activity was mainly located in the far Northern part of Cévennes-Vivarais, and was more pronounced along the Riviera coastline and over the Ligurian Sea (Fig. 2b). About 0.3% of the 5 km x 5 km pixels of the year 2012

contribute to more than 20% of the 16-year climatology. Over the 500-km side domain plotted in Fig.2a and 2b, and for a period ranging from 5 September to 6 November, the total number of days with lightning activity in 2012 reached a value of 44 days, slightly below the average value for the 16 years of interest (Fig. 2c)."

Minor comments and proposed editorial changes:

Affiliations: Nowcast (with capital letter) and Météo-France (include hyphen) Response : nowcast has been replaced by Nowcast GmbH, Météo France by Météo-France.

Abstract: - P8015 L1: The PEACH project (Projet ...) is the ... Response : Modified.

- P8015 L7: During the HyMeX SOP1 (Special Observation Period) from 5 September to 6 November 2012, four ... Response : Modified.

- P8015 L8: (OLLSs) under which ATDNET, EUCLID, LINET, ZEUS, and the ... + I think it is 'ATDnet' and not 'ATDNET' Response : Modified.

- P8015 L23: Then, examples ... Response : Corrected.

- p8015 L24: Finally, future steps required for the delivery ... Response : Modified as suggested.

1 Introduction:

- P8016 L10: ... ice particles, temperature and liquid water content. Response : Corrected.

- P8016 L16: However, such an electric field intensity is one order ... Response : Corrected.

- P8016 L19: or hydrometeor interactions present in high electric fields ... Response : Corrected as suggested.

- P8016 L22: exceeds a threshold: threshold is of the order of? Give an idea of this. Response : of a few kV/m. Added in the text.

- P8016 L23: Hence, it is clear that the lightning activity of a thundercloud ... Response : Corrected as suggested.

- P8016 L26: occur in clouds, while ... Response : Corrected as suggested.

- P8016 L27: (positive) charge to the ground. Response : Corrected as suggested.

- P8016 L28: electromagnetic radiation when connecting to the ground. Response : Corrected as suggested.

- P8017 L2: connections to the ground (references?) Response : We proposed among others the following references: Mäkelä, A., T. J. Tuomi, and J. Haapalainen (2010), A decade of highâĂŘlatitude lightning location: Effects of the evolving location network in Finland, J. Geophys. Res., 115, D21124, doi:10.1029/2009JD012183. Orville, R. E., G. R. Huffines, W. R. Burrows, and K. L. Cummins, (2011), The North American Lightning Detection Network (NALDN)âĂŤAnalysis of Flash Data: 2001–09. Mon. Wea. Rev., 139, 1305–1322.

- P8017 L8: rephrase: 'A lightning flash then consists in a multi-scale physical process' Response : We propose "A lightning flash is then constituted of a series of multi-scale physical processes".

- P8017 L9: ... over large distances of a few km or more. Response : Corrected as suggested.

- P8017 L11: ... have been developed to detect and locate these ... Response : Corrected as suggested.

- P8017 L13: For instance, ... Response : Corrected as suggested.

- P8017 L14: ... borne sensors detect electromagnetic ... Response : Corrected as suggested.

- P8017 L21: rephrase: 'to provide the most comprehensive description for analyzing in details the lightning flashes', e.g.: provide the most comprehensive description in

order to analyze in great detail ... Response : Corrected as suggested.

- P8017 L29: Flash rates ... Response : Corrected as suggested.

- P8018 L2: Flash rates reach a peak value ... Response : Corrected as suggested.

- P8018 L9: "(IC+CG)" already defined on p8017 L27 => can be removed Response : Removed.

- P8018 L9: total lightning activity is a more ... Response : Corrected.

- P8018 L22: For instance, ... Response : Corrected.

- P8018 L24: ... in the pioneering model ... Response : Corrected.

- P8018 L25: Altaratz et al. (2005). Based on the references, it should be (2005), not (2003) Response : Corrected.

- P8019 L4: CRMs are the preferred modeling tools ... Response : Corrected.

- P8019 L8: ... and by Sounders et al. (1991). Those disagree ... (make a new sentence, original sentence is too long) Response : We propose "A key challenge in simulating cloud electrification mechanisms is the lack of agreement in the community about the relevance of each of the non-inductive charging diagrams published by Takahashi (1978) and by Saunders et al. (1991). Those diagrams disagree in some way because the protocol of the laboratory experiments was different."

- P8019 L15: ... strategy of the HyMeX ... Response : Added.

- P8019 L17: Section 5 then discusses the perspectives ... Response : Corrected.

2 The HyMeX program: - P8019 L23: ... and lead to expensive property damage. Response : Corrected.

- P8019 L24/L25: remove 'dedicated to the hydrological cycle in Meditarranean' since this is exactly what HyMeX stands for. Response : Removed as suggested.

- P8019 L26: As part of this ... Response : Corrected as suggested.

- P8019 L27: ... during 2 months from 5 September 2012 to 6 November 2012 over the Northwestern ... Response : Modified as suggested.

- P8020 L7: ... lidar, and rain gauges Response : Added as suggested.

- P8020 L10: Additionally, various Response : Added as suggested.

- P8020 L13 & L15: two times 'autumn', the last one on L15 could therefore be removed Response : Removed as suggested.

3 The PEACH experiment: - P8021 L5: ... geostationary satellites can offer ... Response : Corrected.

- P8021 L15: However, further ... Response : Added as suggested.

- P8021 L17: ... of the parent clouds ... Response : Corrected.

- P8021 L15-L20: Last sentences could be split into 2 sentences to improve readability. Response : We propose now "However, further scientific investigations are required to document the links between the lightning activity and the dynamical and microphysical properties of the parent clouds in continental and maritime Mediterranean storms. In addition it is necessary to identify the key parameters derived from OLLS records alone or in combination with other meteorological observations to provide suitable proxies for a better storm tracking and monitoring over the entire Mediterranean Basin."

3.1 Scientific objectives and observational/modeling strategy: - P8021 L21: The scientific objectives, i.e. p8021 L22 – p8022 L18, could be removed and replaced at the beginning of Sect. 3. Therefore, the title could become '3.1 observational and modeling strategy'. Thus, p8022 L19 could be the new start of Sect. Response : As mentioned earlier we would prefer to keep the current structure of the paper.

3.1. - P8021 L25: Who are member of the PEACH team, this hasn't been described yet. Response : We propose "The PEACH team, composed of the Authors of the

present article, identified five observational- and modeling-based scientific objectives in relation to HyMeX goals:"

- P8021 L26: and modeling-based scientific ... in relation to the HyMeX goals: .. Response : Corrected.

- P8022 L10: ... to HPEs and flash-floods ... Response : Corrected.

- P8022 L12: observations to improve monitoring Response : Replaced.

- P8022 L13/L14: try not to use "(...)" Response : The parentheses are removed.

- P8023 L3: (SLAs), as well as Response : Added.

- P8023 L6: Finally, ... Response : Added.

- P8023 L9: (MBA and MPA, respectively) Response : Added.

- P8023 L11: also includes a range of numerical ... + rephrase 'hosting or not a lightning/ electrification scheme' Response : We propose "The PEACH project also includes two cloud resolving models, MesoNH with its electrification and lightning scheme, and WRF."

- P8023 L21: remove ', of course,' Response : Removed.

- P8023 L23: In addition, ... Response : Added.

- P8023 L25: ... help to investigate ... Response : Corrected.

- P8023 L28: of the lightning flashes, as well as ... Response : Added.

- P8023 L29: ... tHunderclouds, allows ... Response : Corrected.

- General comment: 'in situ' or 'in-situ': be consistent throughout the paper Response : 'in situ' is used throughout the paper now.

- P8024 L2: Finally, ... Response : Added.

C3434

- P8024 L7: As a result, ... Response : Added.

- P8024 L9/L10: three times 'stage' in 1 sentence is a bit too much. Make use of synonyms. Response : Sorry for the phrasing. We propose "As a result, the HyMeX SOP1 experiment is probably the first ambitious field experiment in Europe to offer such comprehensive description of lightning activity and of its parent clouds over a mountainous area from the early stage to the decaying phase of the sampled electrical storms."

- P8024 L11: ... in conjunction with the operational network of Météo-France ... Response : Modified as suggested.

- P8024 L13: start a new paragraph with: 'In the following we ...'. However, this sentence is too long and could be split into 2 sentences: In the following we give some ... observations. Several other studies are underway to investigate the ...and rain patterns, as derived ... + However: 'in the following' is not true in this case: 'in the following' the instruments are described in Sect. 3.2, so text should be changed accordingly. Response : We propose "In this article we give some examples of only atmospheric electricity observations. Several studies are underway on the electrical properties of thunderstorms relatively to cloud properties like cloud structure, microphysics and rain patterns as derived from radar and satellite observations and in situ measurements."

3.2.1 The HyMeX Lightning Mapping Array (HyLMA): - P8025 L10: what are the errors at 300km? Response : We used the same program as the one used in Thomas et al. (2004) but with the locations of the 12 HyLMA stations and we obtained a theoretical error of location < 1 km at 200 km range.

3.2.3:MBA/MPS - P8026 L3: (MBA) and a microphone array (MPA). Response : Added.

- P8026 L10: ... has a sensitivity of a few ... Response : Corrected.

- P8026 L24: The data from each sensor of the arrays were ... Response : Modified as suggested.

C3435

3.2.4: EFM - P8027 L8: include space between 'etc. The' Response : Inserted.

- P8027 L9: ... due to the variety ... Response : Corrected.

- P8027 L11: ... irregularities, and the charge ... Response : Added.

- P8027 L17/L19: orientated -> oriented Response : Corrected.

- P8027 L15/L20: field mills / field-mills: be consistent Response : 'field mill(s)' is used throughout the paper now.

- P8027 L25: avoid "(...)" Response : We propose "The polarity of the field is positive when the field points upward and the electric field is created by negative charge overhead."

3.2.5: VFRS - P8028 L2: VRFS acronym has been already introduced earlier in the text, so no need to do this again. Response : OK. It is removed now. We propose "The VFRS instrument".

- P8028 L23: scenario, e.g. location . . .of the storms, the VRFS . . . Response : Parentheses removed.

3.2.6: Locations and status of the research instruments - P8029 L12: Finally, ... Response : Added.

- P8029 L21: distributed to the HyMeX Community. Response : Added.

- P8029 L22: Additionally, ATDnet ... Response : Added.

- P8029 L23: to the HyMeX ... Response : Added.

3.3.2: EUCLID/Meteorage - P8031 L9: As of August 2009: what is the present status during SOP1 of EUCLID/Météorage? 3.3.3: LINET - P8032 L7: remove "(total lightning)", since it looks now as if cloud strokes = TL - P8032 L8: Typical baselines - P8032 L12: is somewhat lower: any idea how much lower? 3.3.4 ZEUS - P8032 L19 : remove 'Very Low Frequency', since the VLF acronym has been introduced already earlier in

the manuscript - P8032 L22/L23: remove '(' ... ')' - P8032 L25/L26: use other word for 'major' Response : New sections describing the OLLSs were introduced in the paper, with corrections as suggested by the Reviewer. The section is now as follows:

"3.3 Operational Lightning Locating Systems

3.3.1 ATDnet

The UK Met Office VLF ATDnet (Arrival Time Differencing NETwork) lightning location network takes advantage of the long propagation paths of the VLF (frequency range) sferics emitted by lightning discharges, which propagate over the horizon via interactions with the ionosphere (Gaffard et al., 2008). The ATDnet network consists of 11 that regularly contribute to the "operational network", plus sensors distributed further afield. The waveforms of VLF sferics received at the ATDnet sensors are transmitted to a central processor in Exeter, where the waveforms are compared in order to estimate arrival time differences. These arrival time differences are compared with theoretical arrival time differences for different locations, in order to estimate the most likely source location. Current ATDnet processing requires four ATDnet sensors to detect a lightning stroke in order to be able to calculate a single, unambiguous source location. ATDnet predominantly detects sferics created by CG strokes, as the energy and polarization of Sferics created by CG return strokes can travel more efficiently in the Earth–Ionosphere waveguide, and so are more likely to be detected at longer ranges than typical IC discharges. ATDnet location uncertainties within the region enclosed by the network of sensors are on the order of a few kilometers, i.e. suitable for identifying electrically active cells.

3.3.2 EUCLID

The EUCLID network (EUropean Cooperation for LIghtning Detection) is a cooperation of several European lightning detection networks (Austria, Finland, France, Germany, Italy, Norway, Portugal, Slovenia, Spain, and Sweden) that operate state-of-the-art lightning sensors. As of August 2009 the EUCLID network employs 137 sensors, 5

LPATS III, 18 LPATS IV, 15 IMPACT, 54 IMPACT ES/ESP, 3 SAFIR and 42 LS7000 sensors (oldest to newest), all operating over the same frequency range (1 kHz -350 kHz) with individually-calibrated gains and sensitivities. Data from all of these sensors are processed in real-time using a single common central processor, which also produces daily performance analyses for each of the sensors. This assures that the resulting data are as consistent as possible throughout Europe. In fact, the Europe-wide data produced by EUCLID is frequently of higher quality than the data produced by individual country networks, due to the implicit redundancy produced by shared sensor information. Since the beginning of the cooperation the performance of the EU-CLID network has been steadily improved, e.g. with improved location algorithms, with newer sensor technology and by adapting sensor positions because of bad sites. The flash/stroke detection efficiency (DE) of the EUCLID network in the south of France was determined to be 90%/87% for negative and 87%/84% for positive discharges but for a time period where a close sensor was out of order (Schulz et al., 2014). Therefore the values should be rated as lower limits of EUCLID DE in this region. The location accuracy was determined to be 256 m but based on 14 strokes only.

3.3.3 LINET

The LINET system is a modern lightning detection network in the VLF/LF domain (5 kHz – 100 kHz) developed by nowcast GmbH (Betz et al., 2008, 2009). LINET Europe consists of more than 120 sensors placed in 25 countries. Each of them includes a field antenna, a GPS antenna and a field processor. The field antenna measures the magnetic flux produced by a lightning. The processor evaluates this signal and combines it with the accurate time provided by the GPS antenna. Compact data files are then sent to a central processing unit where the final stroke solutions are generated. Accurate location of strokes requires that the emitted signal is detected by many sensors. Reported strokes are based on reports from at least 5 sensors. Strokes are located using the Time-Of-Arrival (TOA) method. LINET detects also cloud strokes, and can distinguish between CG strokes and IC strokes. Typical baseline of LINET systems are 200

km between adjacent sensors, allowing very good detection efficiency, even for very weak strokes (< 10 kA), whereby an average statistical location accuracy of $\sim$200 m is achieved. However, in the HyMeX area in Southern France the baselines are longer and, thus, the efficiency is somewhat lower than in most other LINET network areas.

3.3.4 ZEUS

The ZEUS network is a long-range lightning detection system, operated by the National Observatory of Athens. ZEUS system comprises six receivers deployed in Birmingham (UK), Roskilde (Denmark), Iasi (Romania), Larnaka (Cyprus), Athens (Greece), Lisbon (Portugal), the latter being relocated to Mazagon (Spain). ZEUS detects the impulsive radio noise emitted by a lightning strike in the Very Low Frequency (VLF) spectrum between 7 and 15 kHz. At each receiver site an identification algorithm is executed that detects a probable sferics candidate, excludes weak signal and noise and is capable of capturing up to 70 sferics per second. Then the lightning location is retrieved (at the central station) using the arrival time difference technique. Further details on ZEUS network are given in Kotroni and Lagouvardos (2008). Lagouvardos et al. (2009) have compared ZEUS system with the LINET system over a major area of Central-Western Europe where the latter system presents its major efficiency and accuracy and found that the location error of ZEUS was 6.8 km and the detection efficiency 25%. These numbers are applicable also for the SOP1 domain. The authors found also that while ZEUS detects cloud-to-ground lightning it is also capable to detect strong IC lightning. At this point it should be stated that the statistical analysis showed that ZEUS is able, with high accuracy, to detect the occurrence of lightning activity although it underdetects the actual number of strokes."

3.4: Instrumentation during EOP and LOP - General comment: Maybe this section can be moved to Sect. 5 'Prospects' section, since this paper deals only with SOP1 observations Response : This section was placed here in order to show that the PEACH team is providing an expertise on lightning activity, mainly with the operational networks, for HyMeX EOP and LOP activities as others supersites are still running and

future local field campaigns over the Mediterranean Basin are expected. So we would like to keep that section in its current place in the paper.

- P8033 L3: For instance, ... Response : Added.

- P8033 L4: ... web site, while ... Response : Added.

- P8033 L5: are delivered to the HyMeX database. Response : Corrected.

- P8033 L6: '12 LMA': however, on p8029 L16: '11 stations' => make consistent Response : This is a new LMA network that has been installed in Corsica and has been operated since mid-July 2014. It is not the same network as the one operated during SOP1, which was borrowed to NASA Marshall Space Fight Center group. From the Reviewer comment, we have added the following precision in the former p8029 L16 "The 12th HyLMA station was online early beginning of September 2012".

4.1 SOP1 climatology - P8036 L7: Interestingly, this new ... Response : Added.

A regular IC - P8036 L12: an example of a regular Response : Added.

- P8036 L13: What is meant with #06? Response : It is the number of the IOP event. We rephrase it as follows "Figure 3 shows an example of a regular IC flash recorded by HyLMA during SOP1 Intensive Observation Period (IOP) IOP-06 on 24 September 2012".

- P8036 L16: Do not use '(' and ')', just make it into a normal sentence. For instance: 'For more information on ... the interested reader is referred to Thomas ...' Response : We propose the following "It was composed of 2510 VHF sources as reconstructed from at least 7 HyLMA stations and chi2 < 1. For more information on the definition of the parameters associated to each LMA source the interested reader is referred to Thomas et al. (2004). The VHF sources were vertically distributed between 4 and 12 km height (Fig. 3d)."

- P8036 L17: rephrase: 'and distributed between 4 and 12 km height.' Response : See

previous response.

- P8036 L19: msl? => asl? Response : "asl". Corrected.

- P8036 L23: propagated faster: as evidenced from? Response : As evidenced from the actual distances traveled by the negative leaders compared to the ones traveled by the positive leaders during the same temporal gap. We inserted the previous phrase in the paper now.

- P8037 L2: Finally, ... Response : Corrected.

A regular negative CG - P8037 L7: ... and the different OLLS, but ... Response : Corrected.

- P8037 L8: at close range of about 25 km by the VRFS instruments. VFRS has been already explained, so 'FM and video camera' can be removed. Response : Modified as suggested.

- P8037 L11: ... 1464 VHF sources derived from at least ... Response : Added as suggested.

- P8037 L17: rewrite a bit: ATDnet reported 7 events, whereas EUCLID identified 5 strokes ..., and LINET categorized 8 strokes as ... Response : Modified as suggested as follows "ATDnet reported 7 events, whereas EUCLID identified 5 strokes as negative ground connections, and LINET categorized 8 strokes as negative ground connections and 1 stroke as positive ground connection"

- P8037 L23: ... close to each other ... Response : Corrected.

- P8037 L28: remove '('...')' in the text, the same for p8038 L4 Response : Removed. And removed.

- P8038 L6: FM should become EFM as defined first on p8023 L3, also on p8038 L12/L19 Response : FM stands for the Field Measurement of VFRS. To be more precise we replace FM by Field Record at both locations pointed out by the Reviewer and

in different phrases in the manuscript.

- P8038 L12: Additionally, the noisy EFM ... Response : Added.

- P8038 L28: For instance, ... Response : Added.

- P8039 L1: for a specific type of flash, ... Response : Corrected.

- P8039 L2: time in UTC? Response : Yes. It is now indicated.

- P8039 L3: the upper discharge splits in two parts, one progressing continuously upward ... Response : Modified as suggested.

- P8039 L5: first at a constant altitude of 8 km during 50 ms before descending and ... Response : Modified as suggested.

- P8039 L6: shows clearly several branches Response : Modified as suggested.

- P8039 L10: Additionally, ... IC events a few ... Response : Corrected as suggested.

- P8039 L13: This example demonstrates ... Response : Corrected as suggested.

- P8039 L21: The HyMeX SOP1 data offers a unique opportunity to study ... Response : Corrected as suggested.

- P8039 L23: ... enough and well pronounced to be detected ... Response : Corrected as suggested.

- P8040 L5/L6: rephrase sentence: 'HyLMA suggests that ... extensive lightning flash' Response : A verb was missing in the original sentence. We propose "The temporal and spatial evolution of the successive discharges mapped by HyLMA reveals that the continuous VHF signal emanated from a single but extensive lightning flash".

- P8040 L18/L19: remove '('...')' Response : Done.

- P8040 L21 strokes/fixes into flashes Response : Corrected.

- P8040 L21: This unusual flash example demonstrates ... Response : Modified as

suggested.

- P8040 L23: Additionally, ... Response : Added.

- P8040 L24: Rephrase 'while others emanate from a single OLLSs'? What is meant here? Detected by only 1 OLLS? Response : We meant that some of the events detected by one OLLS are also detected by one, two and three other OLLSs, while sometimes some events are only reported by one single OLLS only. We rephrase as follows "Additionally, some of the events detected by one OLLS are also detected by one or more other OLLSs, while sometimes some events are reported by one single OLLS only."

Concurrent VHF and acoustic measurements: - P8041 L7: (with one composed of a few ...) Response : Added.

- P8041 L9: one composed of a few Response : Added.

- P8041 L11: one composed of a few ... Response : Added.

- P8041 L12: Point forgotten at end of sentence: ... in the domain of interest. Response : Added.

4.2.2 Storm and regional levels: - Rephrase title Response : We propose "Examples of SOP1 daily lightning activity as recorded by HyLMA".

- P8042 L5: Here we discuss some storms recorded ... Response : Modified as suggested.

- P8042 L27: in 24 h, and reached locally levels of up to 30-40 mm in Ardeche. Response : Modified as suggested.

- P8043 L8: in the evening of 23 September ... Response : Modified as suggested.

- P8043 L26: ... system progressing eastwards ... Response : Modified as suggested.

- P8044 L3: include explanation for 'while the CG flashes in the afternoon were mostly

negative'? Response : This is currently under investigation.

- P8044 L19: Additionally, ... Response : Added.

- P8044 L21: (French Riviera), which offers ... Response : Corrected as suggested.

- P8044 L23: Finally, Fig. 9F ... Response : Corrected as suggested.

- P8044 L27: in the complex located at ... Response : Added.

- P8045 L5: ... from the same flashes ... Response : Added.

5 Prospects: - P8045 L12: This task will help to refine ... (or will help refining ...) Response : Corrected according to the 1st suggestion.

- P8045 L24: Southeastern France and which will be used in ... Response : Corrected as suggested.

- P8046 L4/5: remove '('...')' Response : Removed as suggested.

- P8046 L6: should then help to identify Response : Corrected as suggested.

- P8046 L10: performed in the near future to ... Response : Corrected as suggested.

- P8046 L13: ... May 2014 for a minimum of five years. Response : Corrected as suggested.

- P8046 L14: ... fall where electrical activity ... Response : Corrected as suggested.

- P8046 L16: Finally, ... Response : Added.

Table 1: 'Météo-France' and 'MBA/MPA' Response : Corrected.

Fig. 1: - In the figure M1 and M1&M2 are not indicated correctly Response : A revised version of the figure has been provided with M1 and M1&M2 correctly indicated (see the attached figure as well as the new version of the paper provided in pdf format). See also the new figure caption "Figure 1 - Locations of PEACH instrumental sites (see Table 1 for details on site locations). M1 markers indicate VFRS locations while

M2 markers indicate the few locations where additionally a second video camera was operated at the same site; sites where VFRS recorded actual lightning flashes are labeled with an extra letter 'r'. The Cévennes-Vivrais domain is also delimited by the white polygon."

- The white star in the box which is indicated now as MBA, should this become MBA/MPA? Response : Yes. It has been modified.

Fig. 2: - Indicate a) and b) in the figures Response : Labels were already indicated in the lower-left corners of each panel. The labels have been moved to the upper-left corners with a white background.

- In the text 'a)' should be replaced: '... climatology a) in terms of days with ...' - '... as sensed by' => 'based on' Response : As one new panel has been inserted in Figure 2, a new figure caption is given, taking into account the comments of the Reviewer. Here is what we propose: "Cloud-to-ground lightning climatology in terms of number of days with at least one cloud-to-ground lightning flash recorded per day in a regular grid of 5km x 5km and cumulated over the period investigated as sensed by Météorage from 1997 to 2012 (a), contribution of the 2012 records expressed in % relative to the 1997– 2012 number of days per 5km x 5km pixel (b), and number of days per year (c) for the period September–November 2012 between over South East of France. The red solid line plotted in (c) corresponds to the average value for the 1997-2012 period. Red and dark red lines indicate 200m and 1000m height, respectively. The Cévennes-Vivarais domain is also delimited by the black polygon."

- What is written in between brackets '(about 0.3% ... climatology)' should be written in the text and not in the caption of the figure. Response : It has been removed from the caption and is now inserted in the manuscript in the paragraph describing Figure 2.

Fig. 6: - Bolt-from-the-blue Response : Corrected.

Fig. 8: - rewrite: '...recorded during between ...' Response : We removed "during".

- (g): ...'available only for EUCLID and LINET with ...': I see black stars for ZEUS as well Response : The type of strokes is only available from EUCLID and LINET. This information does not exist for ZEUS. To avoid any mis-understanding, we removed the part of the sentence "and type of detected events available only for EUCLID and LINET".
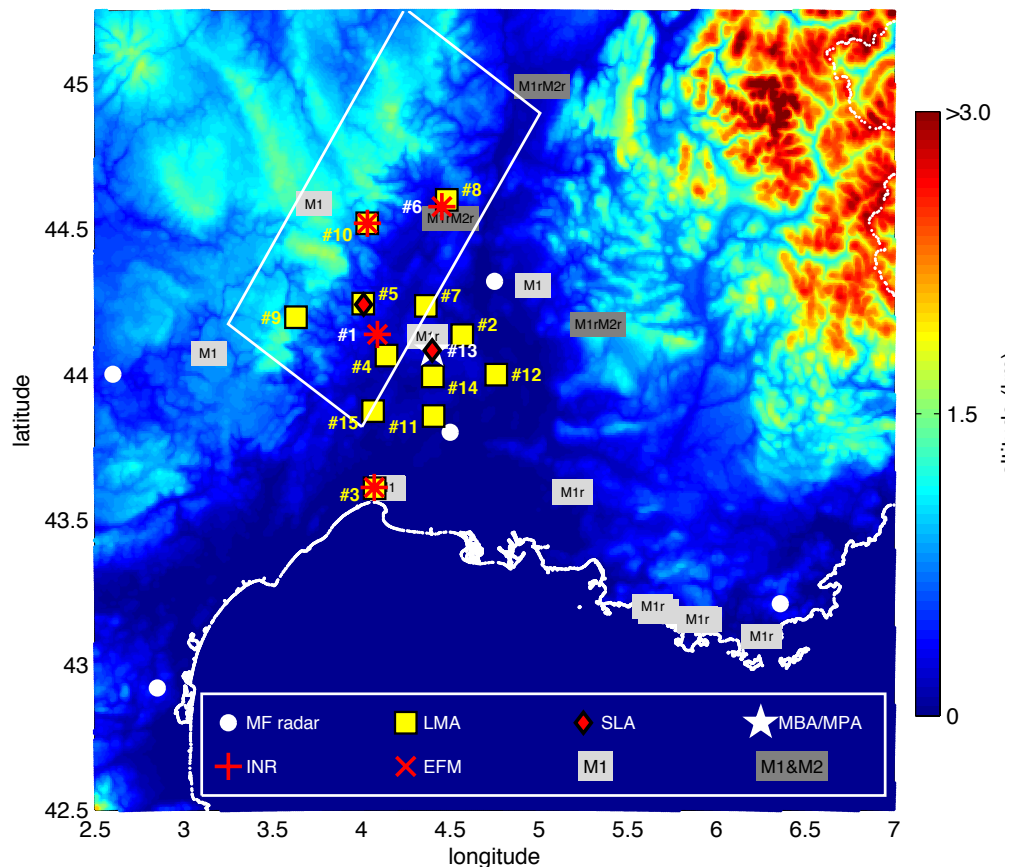
Fig. 9: Figures are too small to see Response : The figures were plotted per day and provided individually for the typesetting. The original size of daily-based figures is about the size of Figure 3.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/7/C3424/2014/amtd-7-C3424-2014-supplement.pdf
_____

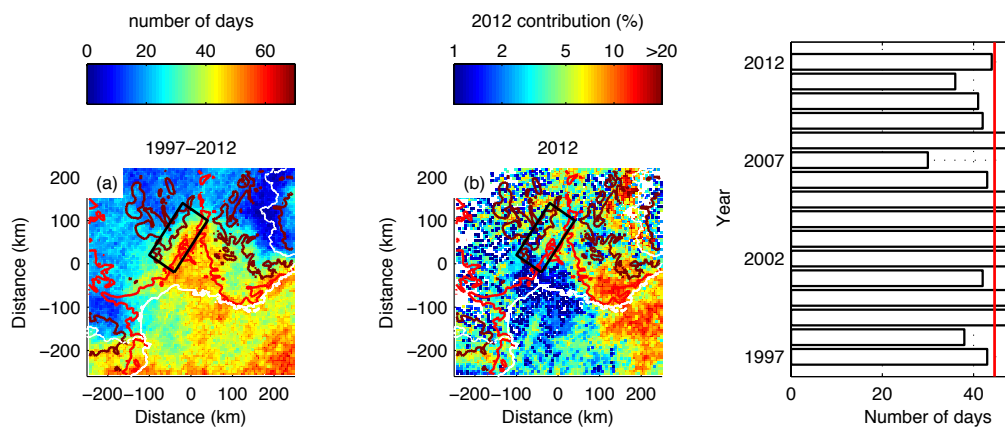Interactive comment on Atmos. Meas. Tech. Discuss., 7, 8013, 2014.

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Fig. 1. Updated Figure 1

Fig. 2. Updated Figure 2

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