HyMeX

ST-Lightning

What We Have Learned So Far From the HyMeX ST-Lightning Observations

MISTRALS

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➲ OBSERVATIONAL STRATEGY

Comprehensive description of the electrical properties of the thunderstorms over the SOP1 CV domain based on the deployment and operation of dedicated research instruments with the support from Operational Lightning Locating Systems (OLLSs)

Learning from the SOP1 observations, expending to EOP and LOP records

SOP1 :	HyLMA, SLA, MBA/MPA, EFM, INR, VFRS, TLE cameras, *ATDnet*, *EUCLID*, *LINET*, *ZEUS*
EOP :	SAETTA, *ATDnet*, *EUCLID*, *ZEUS*
LOP :	*ATDnet*, *EUCLID*, *ZEUS*

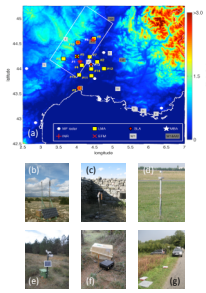

Fig-1. (a) locations of the ST-Lightning research instruments; (b) HyLMA station at Mont Aigoual; (c) induction ring (INR) at Mont Perier; (d) electric field mill (EFM) at Candillargues; (e) slow antenna (SLA) at Uzès airfield; (f) micro-barometers (MBA) at Uzès airfield; (g) VFRS deployment on 26/09/2012.

➲ LIGHTNING ACTIVITY OVER SOP1 CV

Lightning activity mainly in the north part of the SOP1 CV domain and along the Riviera coast (Fig-2)

But several convective systems well captured over the SOP1 CV area

Different types of storm systems mapped during Jun-Nov 2012 (Fig-3)

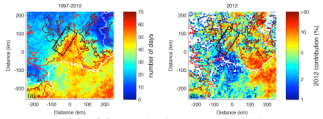

Fig-2. (a) Météorage cloud-to-ground (CG) lightning climatology (number of days with at least one CG flash recorded per day) in a regular 5 km x 5 km grid from 1997 to 2012 for the period September-November; (b) contribution of the 2012 records expressed in % relative to the 1997-2012 climatology (Defer et al., 2015).

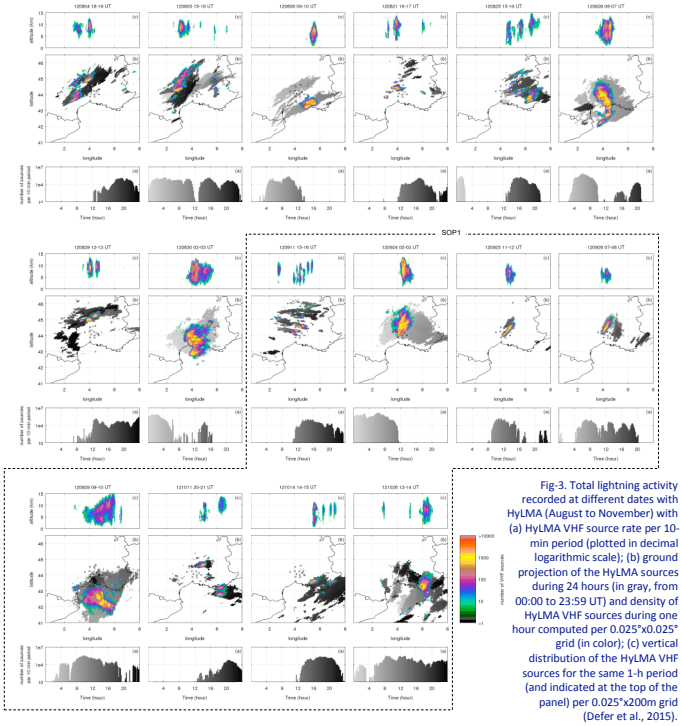

Fig-3. Total lightning activity recorded at different dates with HyLMA (August to November) with (a) HyLMA VHF source rate per 10-min period (plotted in decimal logarithmic scale); (b) ground projection of the HyLMA sources during 24 hours (in gray, from 00:00 to 23:59 UT) and density of HyLMA VHF sources during one hour computed per 0.025°x0.025° grid (in color); (c) vertical distribution of the HyLMA VHF sources for the same 1-h period (and indicated at the top of the panel) per 0.025°x200m grid (Defer et al., 2015).

➲ SOME OF THE RESULTS…

Large variety of flashes recorded with large variety of component properties: from basic CG flashes to constant altitude IC flashes, from compact discharges to >100 km long flashes [I]

No inverted polarity storms found so far in SOP1 records

Importance of the "lightning altitude" information as proxy of storm development

High-temporal resolution of the lightning information brings insights on cloud dynamics compare to operational radar (e.g. convective surges, tornado cell, transport of ice particles in the stratiform area)

Demonstration of the capability to reconstruct the 3D structure of flashes up to 25-km range with acoustics measurements [II]

Maximum amplitude of acoustics signal comes from cloud-to-ground return strokes [II]

Acoustics signal recorded during intra-cloud flashes emanates from vertical channels [II]

Verification and validation of the OLLSs [I, III]

IC detection demonstrated with potential operational applications [I, III]

Dynamics and microphysics temporal and spatial evolution impacts the properties of the lightning activity (e.g. flash rate, cloud regions traversed by lightning flashes) [IV]

Further investigations with additional records of the SAETTA network in Corsica [V]

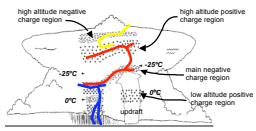

Fig-4. Electrical charge regions in a thundercloud (adapted from Stolzenburg et al., JGR, 1998)

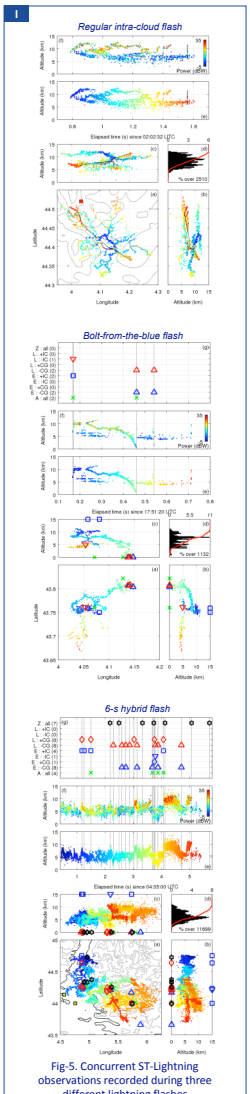

Fig-5. Concurrent ST-Lightning observations recorded during three different lightning flashes

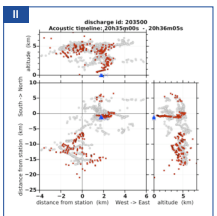

Fig-6. Acoustics sources (red dots) overlaid on HyLMA VHF sources (gray dots) reconstructed during a cloud-to-ground flash. The blue triangles locate the ground connection reported by EUCLID (Gallin, 2014).

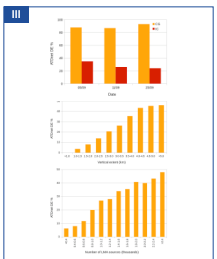

Fig-7. ATDnet performance assessment based on SOP1 records (Enno et al. Met Office reports, 2015)

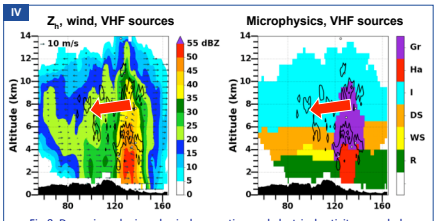

Fig-8. Dynamic and microphysical properties, and electrical activity recorded during the SOP1 IOP-06 case along a West-East vertical cross section with on the left radar reflectivity (colors), wind (arrows) and density of discharges (black contours) and on the right the microphysics species deduced from the radar measurements (colors) and density of discharges (black contours). R, WS, DS, I, Ha and Gr stand for rain, wet snow, dry snow, ice, hail and graupel (Ribaud, 2015).

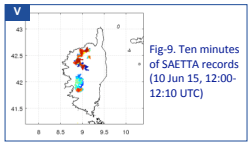

Fig-9. Ten minutes of SAETTA records (10 Jun 15, 12:00-12:10 UTC)

Acknowledgments

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References

Buguet, M., Activité d'éclairs et paramètres physiques issus de l'observation radar dans les orages : application au projet HyMeX, Thèse de Doctorat, Université de Toulouse, France, 2012.

Defer, E., *et al.*: 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, Atmos. Meas. Tech., 8, 649–669, 2015.

Gallin, L.-J., Caractérisation des éclairs d'orage par mesure acoustique, Thèse de Doctorat, Université Pierre et Marie Curie, Paris, France, 2014.

Lagouvardos, K., et al., Study of a heavy precipitation event over southern France, in the frame of HYMEX project: Observational analysis and model results using assimilation of lightning, Atmospheric Research 134 (2013) 45–55, 2013. http://dx.doi.org/10.1016/j.atmosres.2013.07.003

Ribaud, J.-F., Etude tridimensionnelle de l'activité électrique, microphysique et dynamique d'une ligne de grain observée pendant la campagne HyMeX, Thèse de Doctorat, Université de Toulouse, France, 2015.

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