An Overview of HyMeX SOP1 Atmospheric Electricity Observations

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1 – ST-Lightning Objectives

Provide HyMeX community record and analysis of the lightning activity as reported by research and operational lightning locating systems (LLSs) over SOP, EOP and LOP.

Multi-scale and multiple-year lightning detection for observational- and modeling-based multi-disciplinary investigations in the frame of HyMeX with emphasis on

> Links between kinematics, microphysics, electrification, aerosols and lightning occurrence and characteristics,

> Electrification processes and charge structures inside clouds over sea and land, and during sea-to-land and land-to-sea transitions,

> Climatology of the lightning activity over the Mediterranean Basin,

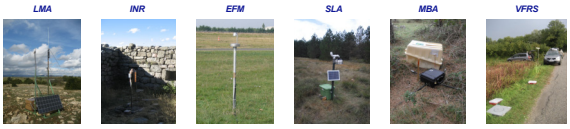
> Comparison of lightning observations from different LLSs,

> Use of lightning detection in assimilation and nowcasting.

2 – ST-Lightning Instrumentation

Four operational LLSs :	ATDnet (UKMO), EUCLID, LINET (nowcast), ZEUS (NOA)
One research LLS :	HyLMA (NMT)
Auxiliary ground sensors :	Induction rings (LA) Electric field mills (LA) Barometer array (CEA) Video & Field Record System (OVE)
CRM models :	MESO-NH (LA) WRF (NOA)

Research and operational radars, in-situ microphysics probes



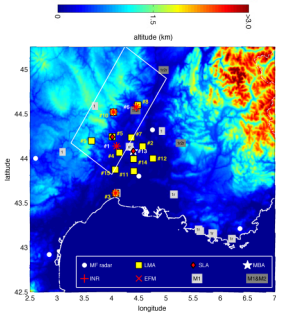


Fig-2.1. Top : locations of the different ST-Lightning research instruments (VFRS locations are indicated by M1 markers while M2 markers indicate the few locations where a second video camera was operated); Left : pictures of the instruments with LMA station at Mont Aigoual, induction ring (INR) at Mont Perier, electric field mill (EFM) at Candillargues, slow antenna (SLA) at Uzès airfield, micro-barometers (MBA) at Uzès airfield, and VFRS deployment on 26 September 2012 with M1 and M2 measurements).

3 – ST-Lightning Observations during HyMeX-SOP1 (5 September 2012 to 5 November 2012)

Storm activity sensed during the SOP1 period

- Lightning activity mainly located in the far Northern part of the HyLMA network and along the Riviera coast (Fig-3.1)
- But several convective systems over SOP1 domain well documented with all lightning sensors as well as ground- and air-based research radars (Fig-3.2)
- Large range of storm systems recorded during the 6-month HyLMA operation (Fig-3.3)

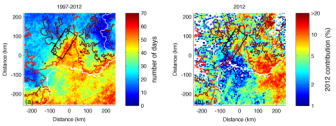


Fig-3.1. Météorage CG lightning climatology in terms of number of days with at least one cloud-to-ground lightning flash recorded per day in a regular 5-kmx5-km grid from 1997 to 2012 (a) and contribution of the 2012 records expressed in % relative to the 1997-2012 number of days per 5x5-km pixel (b) for the period September-November. Red and dark red lines indicate 200 m and 1000 m height, respectively.

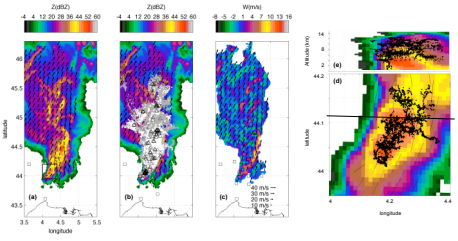


Fig-3.2. (a) reflectivity and horizontal wind at 5 km amsl from 3D Multiple-Doppler wind and reflectivity analysis from 0215-0230 UTC on 24 Sep 2012, (b) overlay of lightning activity as recorded by LMA (in grey along the depth of the 500m reflectivity layer; in white over the entire atmospheric column) and EUCLID (-CG strokes as triangles; +CG strokes as circles) during 15 minutes, (c) vertical velocity, (d) zoom in the domain drawn in (a) with lightning observations collected at 02:29:06-02:29:16 where 7 flashes were recorded by the LMA including one -CG flash in the considered domain, and (e) vertical distribution of the VHF sources along the black line in (d).

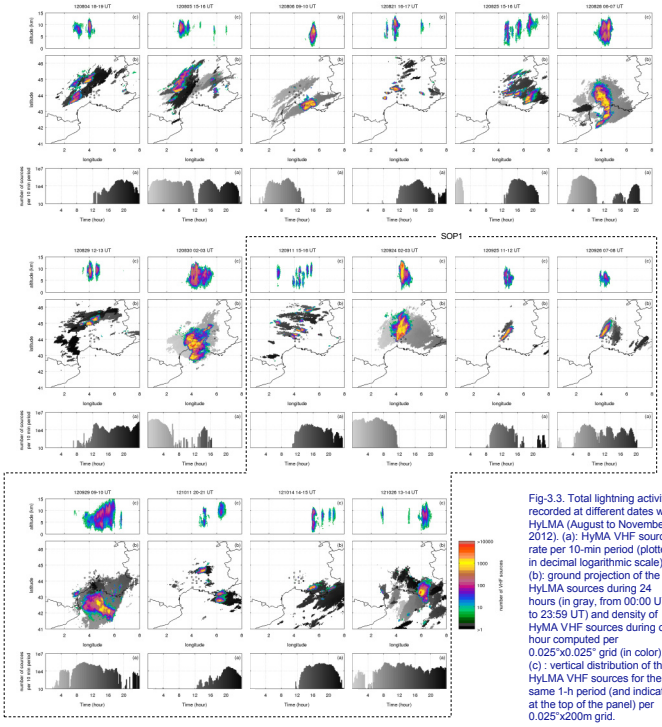


Fig-3.3. Total lightning activity recorded at different dates with HyLMA (August to November 2012). (a): HyMA VHF source rate per 10-min period (plotted in decimal logarithmic scale); (b): ground projection of the HyLMA sources during 24 hours (in gray, from 00:00 UT to 23:59 UT) and density of HyMA 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.

Concurrent observations at the flash scale

- Comprehensive description of all types of lightning flash (Fig-3.4 to 3.8) with instruments sensitive to the different processes occurring during the flash life to
  - Study the different flash processes and their physical properties for a better understanding and modeling,
  - Identify the flash processes that are actually recorded by the different Op. LLSs for a better operational use and for an objective assessment of both detection efficiency and location accuracy.

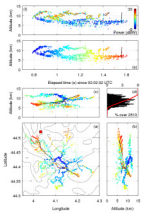


Fig-3.4. Regular IC flash 24/09/12 02:02:32 UTC. [HyLMA]

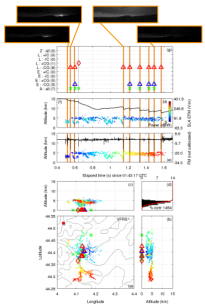


Fig-3.5. Negative CG flash 24/09/12 01:43:17 UTC. [HyLMA, Op. LLSs, VFRS, SLA]

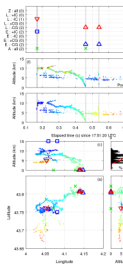


Fig-3.6. Bolt-from-the-blue flash 05/09/12 17:51:20 UTC. [HyLMA, Op. LLSs.]

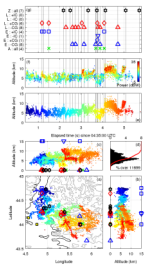


Fig-3.7. 6-s hybrid flash 30/09/12 04:35:00 UTC. [HyLMA, Op. LLSs]

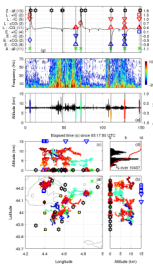


Fig-3.8. 2.5-min of lightning activity starting at 24/09/12 05:17:50 UTC. [HyLMA, MBA/MPA, Op. LLSs, SLA]

Data and products to deliver to HyMeX participants

Type	Δt	Δx	Parameter	SOP	EOP	LOP	Applications
3D & 4D maps	sec. to days	100's of m to 100's of km	Flash and storm locations and density maps	X	X	X	real time display, storm tracking/monitoring, assimilation, climate
	sec. to few hours	few 10's of km	Charge layer structures in parent clouds	X	-	-	storm monitoring and analysis
Time series	sec. to days	100's of m to 1000's of km	Flash rate, IC/CG ratio, flash duration, maximum of flash density…	X	X	X	real time display, storm monitoring and analysis
	sec. to few hours	few 10's of km	Charge layer structures in parent clouds	X	-	-	storm monitoring and analysis

Current investigations

- Observational and modeling-based analysis underway
  - Flash level : lightning physics, instrument validation [HyLMA, Op. LLSs, VFRS, SLA, MBA/MPA]
  - Storm level : dynamics, microphysics, electrification, lightning [HyLMA, Op. LLSs, EFM; radar; satellite; MESO-NH, WRF]
  - Regional level : climatology [HyLMA, Op. LLSs; satellite]

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