

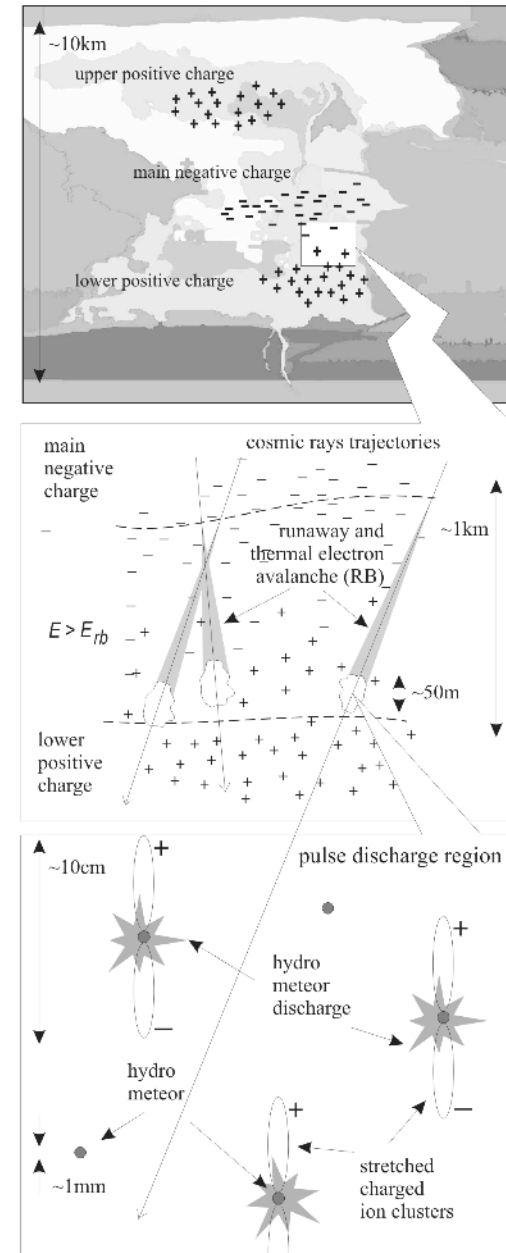
Lightning & Cosmic Rays

LICORNE Meeting

LICORNE - KoM - Nancy

RC and Lightning Initiation

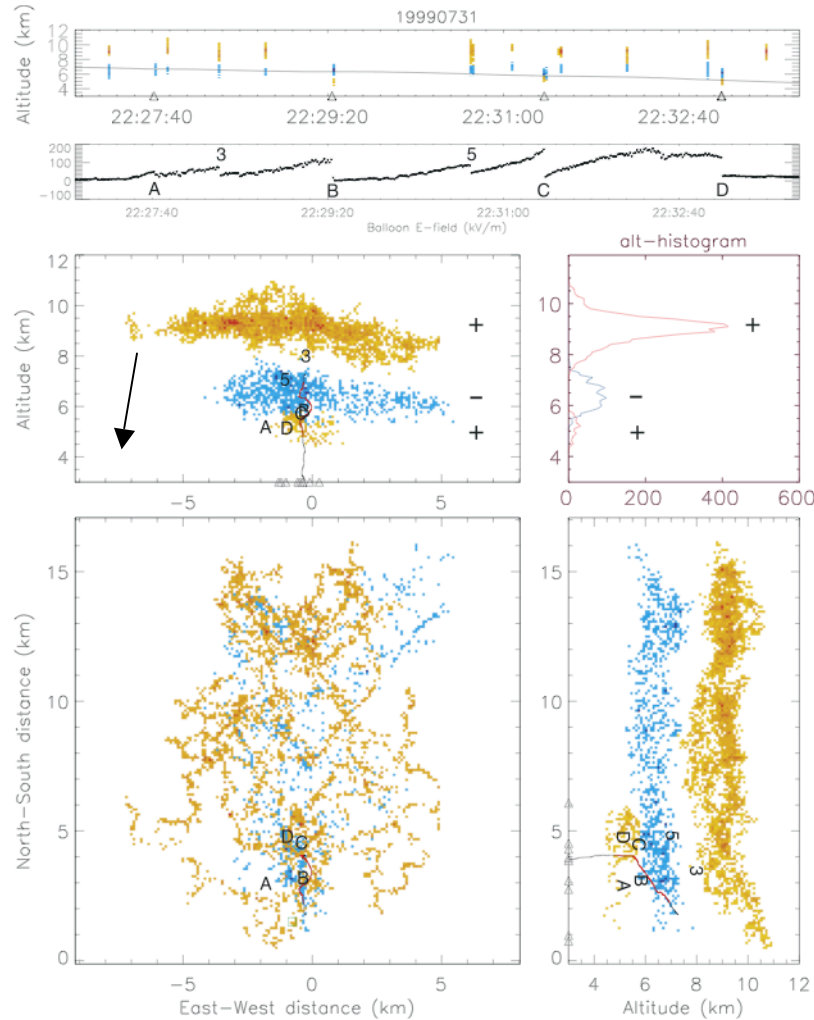
- Conventional breakdown threshold at sea level is about 2.6 MV/m
- In presence of hydrometeors, the threshold is reduced to 1-1.4 MV/m depending upon size and shape of the hydrometeors
- Observed E in thunderstorms are generally too weak to initiate the electrical breakdown
- Runaway breakdown (RB) = avalanche
- Seed for RB in thunderstorm : high energy secondary electrons in air showers
- Where $E > E_c$, the number of runaway electrons increases exponentially
- Ionization of the air, which creates a large concentration of slow electrons that generates a strong bipolar radio pulse (400-700 ns)
- The RB occurs in a complex medium and multiple micro-discharges can be triggered in the hydrometeors simultaneously in a rather limited area



(from Gurevich and Karashtin)

Observed electric fields associated with lightning initiation

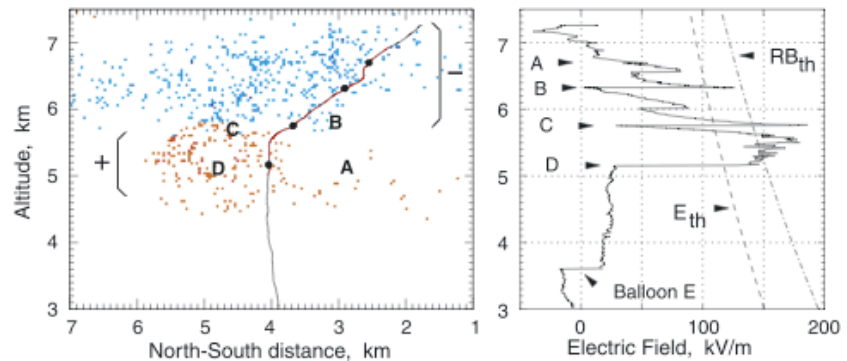
Marshall et al. GRL, 2005



- characteristic length for an avalanche to develop (Gurevich et al, 1992) $N_{re} = N_0 \exp(\Delta z/\lambda)$

- Dwyer (2003) proposes $\lambda = 7200 \times (E - 275)^{-1}$ for 430 kV/m, $\lambda = 45$ m

- The data analysis suggests :
 - i) a large volume (1-4 km³) of 1000 m vertical depth in which E exceeded RB_{th}
 - ii) λ was less 100 m
 - iii) For flashes B-D, the runaway breakdown avalanches could have initiated the flashes



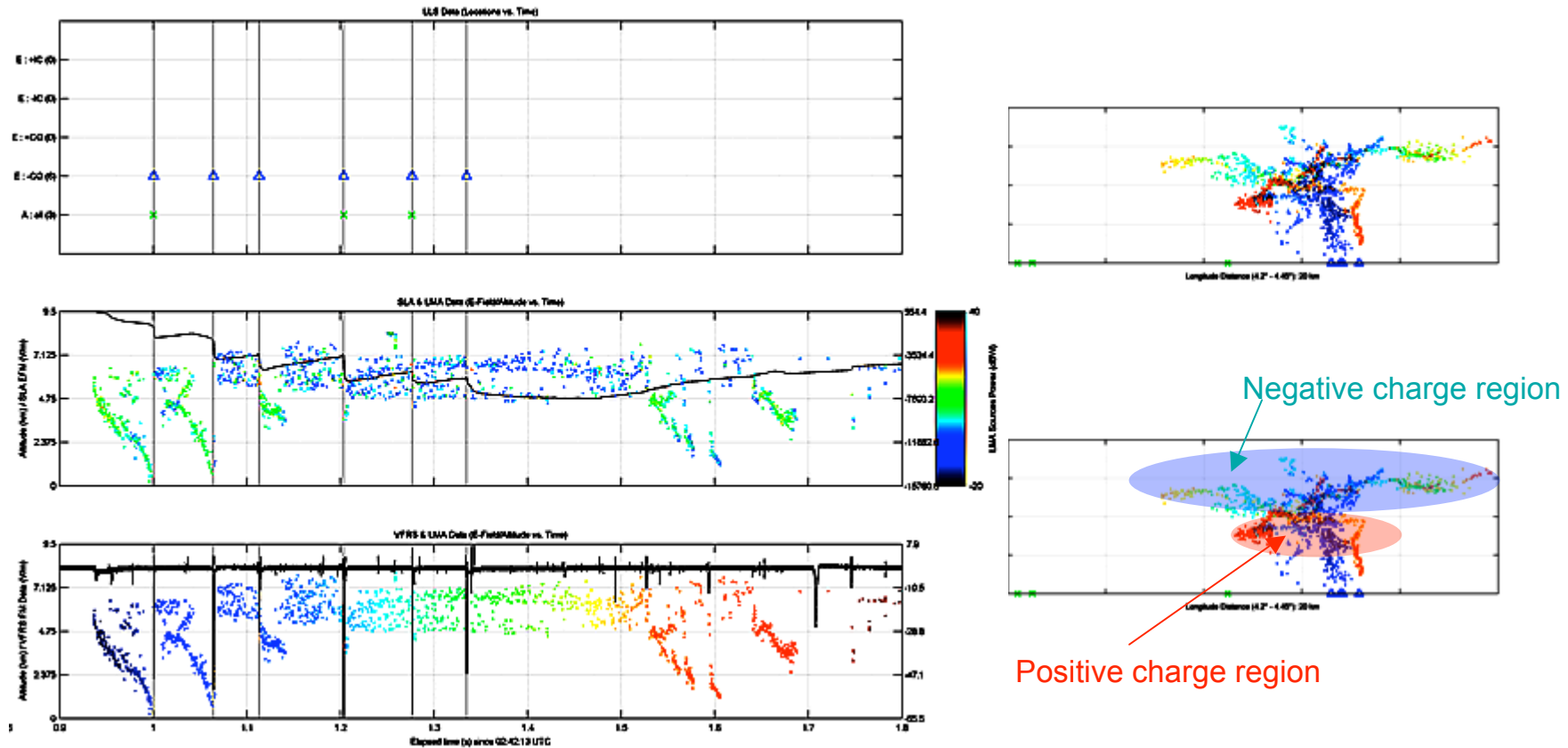
-Balloon E meter up 220 kV/m with error < 10%
 -In the case here E field mainly vertical

-RB_{th} : runaway breakdown threshold

Properties of the lightning flashes (1/3)

HyMeX SOP1 data

A -CG Flash (20120924 – 024213 UTC)

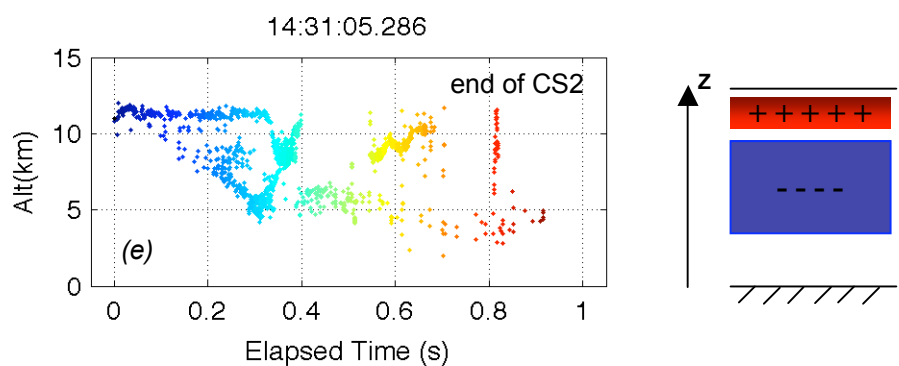
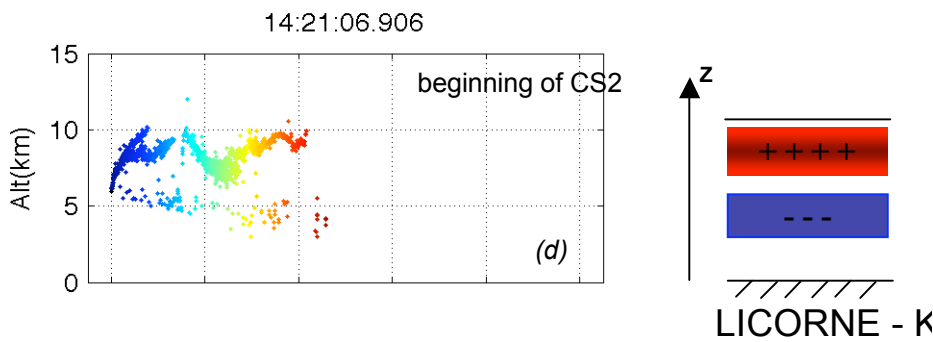
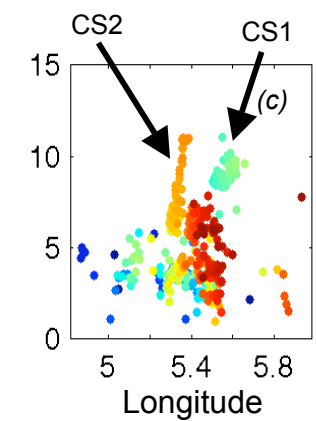
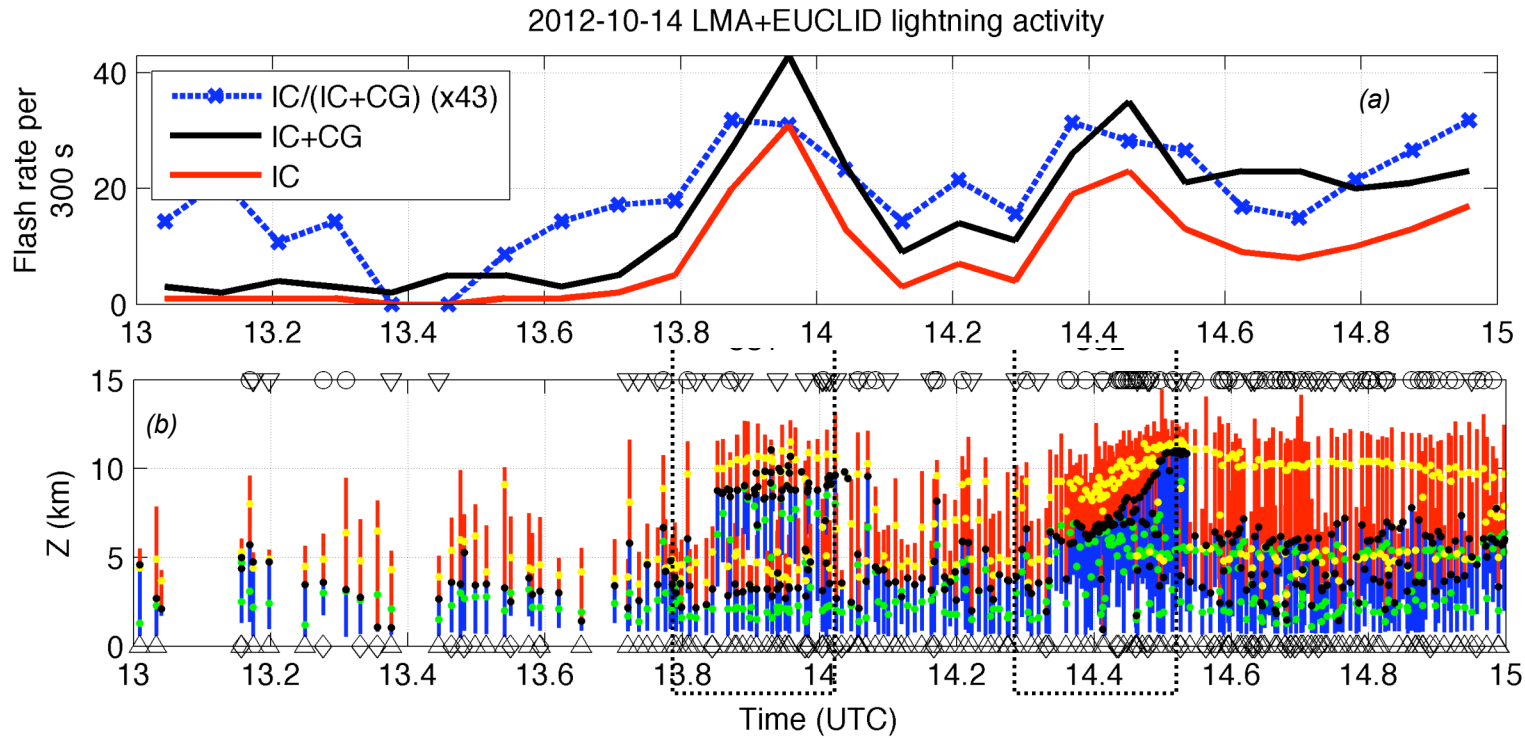


Properties of the lightning flashes (2/3)

HyMeX SOP1 data - Tornado case



© Nicolas Giusti



Properties of the lightning flashes (3/3)

HyMeX SOP1 data - Flash properties

- Flash duration of (studied) flashes ranged from 0.150 to 2 s
- VHF radiation recorded between 5 and 25% of the flash duration
- Vertical flash extension from ground level to 12 km
- CG flashes mainly triggered around 5 km height
- Triggering altitude of IC flashes increased as deepening of convection occurred
- Triggering altitude of IC flashes closer to the cloud top suggesting an upper positive charge region rather thin compared to the negative charge region

