In-flight measurements of high-energy radiation from lightning and thunderclouds

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Long laboratory sparks
Problem
ILDASystem

- 1 E-field sensor
- 8 window H-field sensors
- 2 X-ray detectors

- Continuous data (15 ms intervals)
- High-speed data (10 ns intervals)
D/I measurements in aircraft

- Differentiating sensor
- Transport by cable
- Integrator
- Registration in EMC cabinet

H-field window sensor
IE3 J. Sens. 11 (2011) 199
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Background

“We started every day the same way: looking at weather reports all over Europe and phoning national weather stations to try and find the right kind of storm. On the radio, we would hear other pilots asking air traffic control to guide them around storm cells. We did just the opposite: we asked to go directly into them. Those other pilots must’ve thought we were crazy.”

Emanuele Costanzo, flight test engineer
Radiation

- measured
- background (est)

X-rays, a.u.

Time, UTC

10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00

1 2 3 4 5 6 7 8 9 10
Long gamma-ray glow
Lightning interaction with an aircraft

- Aircraft-intercepted (a few percent)
- Aircraft-initiated (most often)
Aircraft-initiated lightning
Aircraft-initiated lightning
Aircraft-initiated lightning
Aircraft-initiated lightning
Lightning strike

initiation

Recoil, RS

E field [kV/m], H field [A/m]

X-ray [MeV]

Time [ms]

(a)
X-rays from negative corona
To conclude

- Ildas + 2 × x-rays operating
- X-rays linked to - initiating negative leader steps and
  - recoil processes a.o. return stroke
- 1 - 4 µs x-ray bursts immediately (< 1 µs) precede the current of the recoil processes.
- X-ray energies up to 10 MeV. Single photon?
- X-ray intensity and spectral distribution known
- Association with the current distribution….
- CDF provides weak indication for long gamma ray glow.
- New flights this month, improved x-ray part

- No positrons in our data
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