

Extraordinary lightning episode during 12th and 13th of August 2015 in Canary region, was it the effect of dust aerosols?

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Introduction

The number of lightning registered in the REDRA (Red de Detección de Rayos de AEMET, AEMET Lightning Detection Network) during the 12th and 13th of August 2015 in an area that covered between 27.5 and 29.5 latitude North and between 13.0 and 18.5 longitude West (the Canary Region), was extraordinary huge, 4339 and 1446 respectively. Analysing episodes with more than 1000 lightnings in this region in the last 12 years (2006-2017), it would be observed that the day 13th occupies the sixth place of the 25 episodes, listed in the table 1, in terms of number of rays. Note also that it presents a very low mean intensity (absolute value), 7.7 kA. In addition, it is the only event of this magnitude not only in any August, but also in any summer. This “unusual” number of lightning stands out, at least in the registers of the last 12 years, as one of the most important events and also the only one with more than 1000 lightnings registered not only in August, but also in the whole summer period.

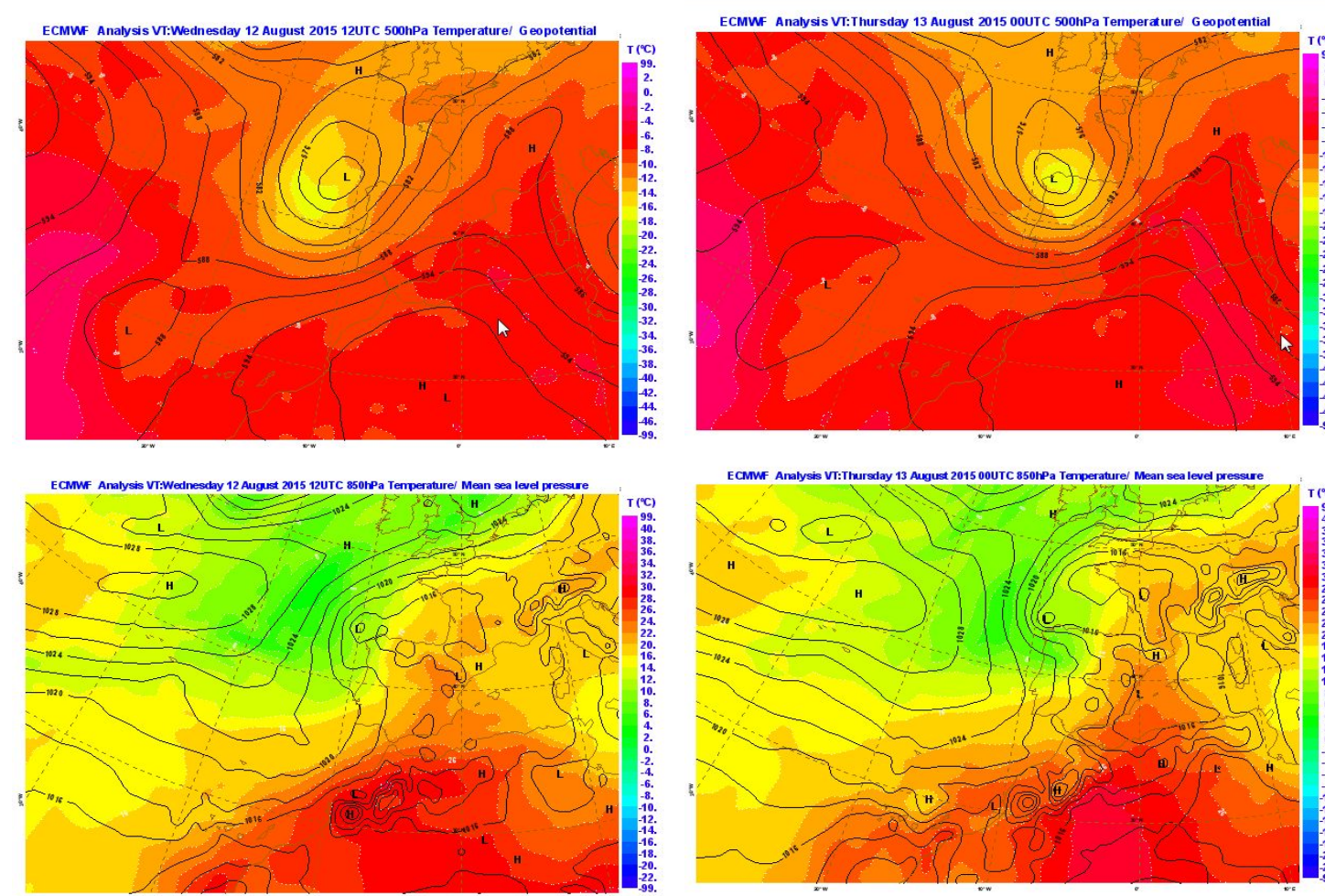
Though the background conditions were not extremely “convective/unstable”/(**did not favour convection**) and lightning models did not expect such intensification, we suspect that the presence of aerosol dust coming from Africa (directly or by recirculation), could be the key in this episode...[1],[2]

Date	Lightnings	Mean Intensity media (absolute value, kA)	Lightnings/hour	Percentage of positive rays over the total (%)
31/10/2006	3137	22.8	136.3	10.6
14/03/2007	1154	25.5	49.6	15.9
15/03/2007	2874	16.0	125.9	5.3
12/10/2007	1585	23.6	85.2	5.5
09/02/2008	3075	24.1	132.3	15.3
26/03/2009	1409	24.5	65.2	3.9
27/03/2009	3331	21.5	141.0	8.6
12/12/2009	1414	20.3	141.1	18.0
31/01/2010	1833	23.0	78.1	19.3
01/02/2010	4825	19.9	207.0	20.8
17/02/2010	3378	18.6	248.8	23.7
29/11/2010	4552	18.6	206.0	18.7
30/11/2010	10722	16.5	799.6	25.3
08/11/2012	3282	16.0	191.1	21.5
03/11/2013	1402	14.6	78.7	22.0
11/12/2013	1516	22.5	86.7	21.6
09/01/2014	13316	18.1	478.3	26.2
13/10/2014	3398	11.0	145.7	53.2
20/11/2014	7576	16.6	399.0	29.9
20/11/2014	1296	24.5	55.0	22.5
12/08/2015	4339	7.7	194.9	26.6
13/08/2015	1446	15.5	60.4	17.5
26/10/2016	1327	23.8	60.3	23.8
05/11/2016	2487	21.2	108.1	21.2
19/03/2017	1244	22.2	65.5	30.7

Table 1: Episodes with more than 1000 lightnings during 2006-2017

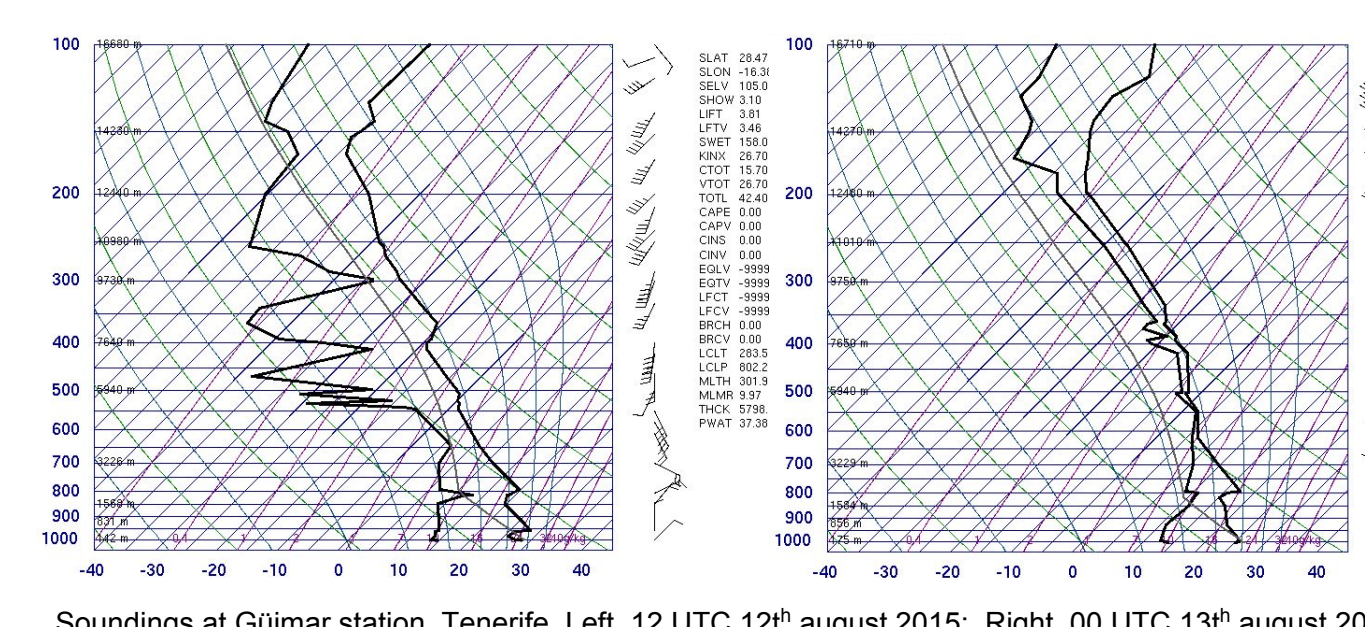
Synoptic environment

The synoptic feature is typical of the summer with a high in mid-high levels in North Africa and an isolated low at West of the Canary Islands. At low levels, there is low heat in North Africa. This type of situation favors the intrusion of dust into the archipelago in mid-high level, as well as subtropical moist air.

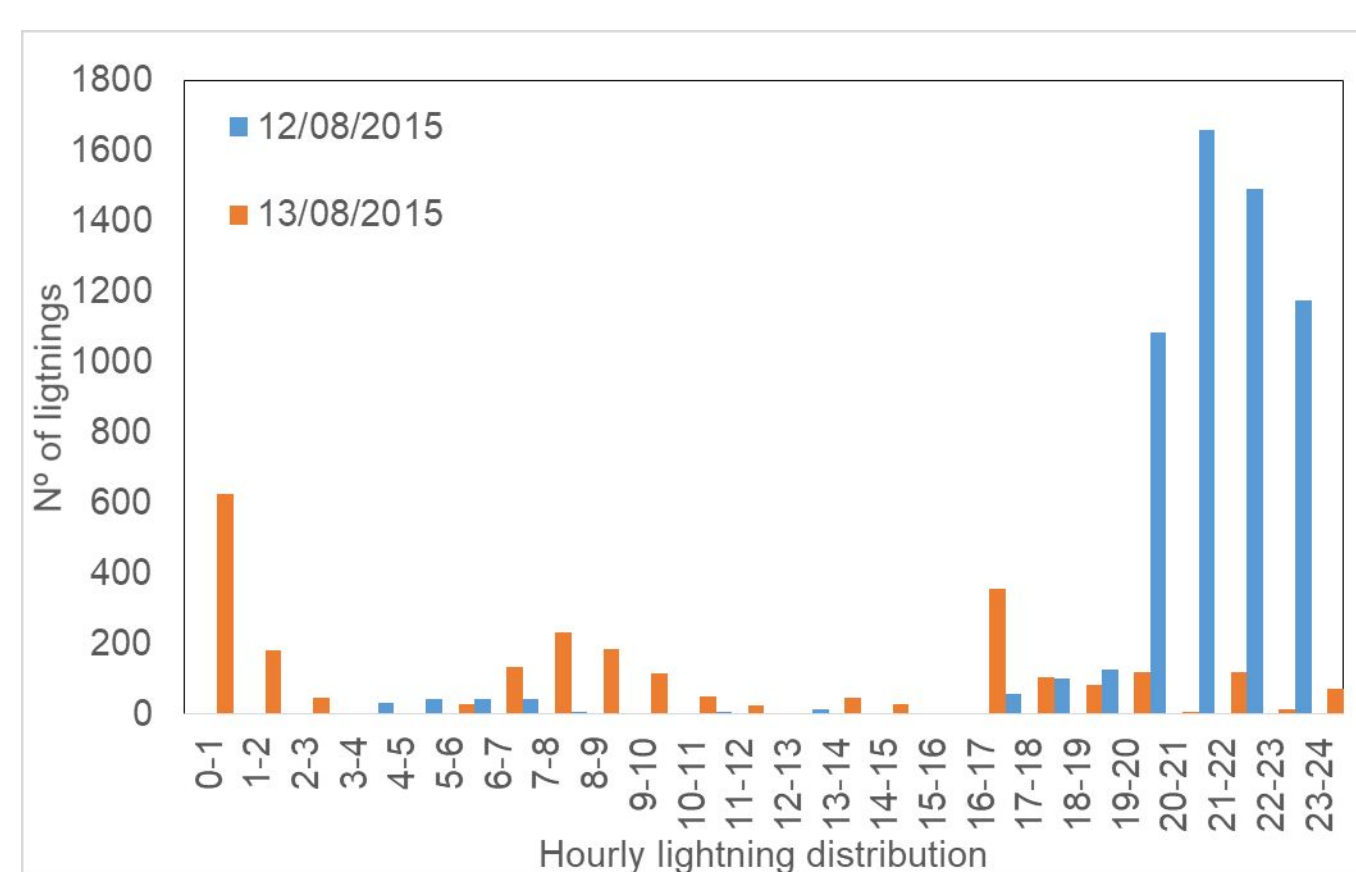


Soundings

Comparing both soundings, we can see the increase of humidity from middle to upper levels and an increase of instability in 12 hours. Although the conditions were not extremely convective / **did not favour convection**, there was a deep moist layer extended from mid-levels (650 hPa) until higher levels, as it can be seen in the right side sounding.

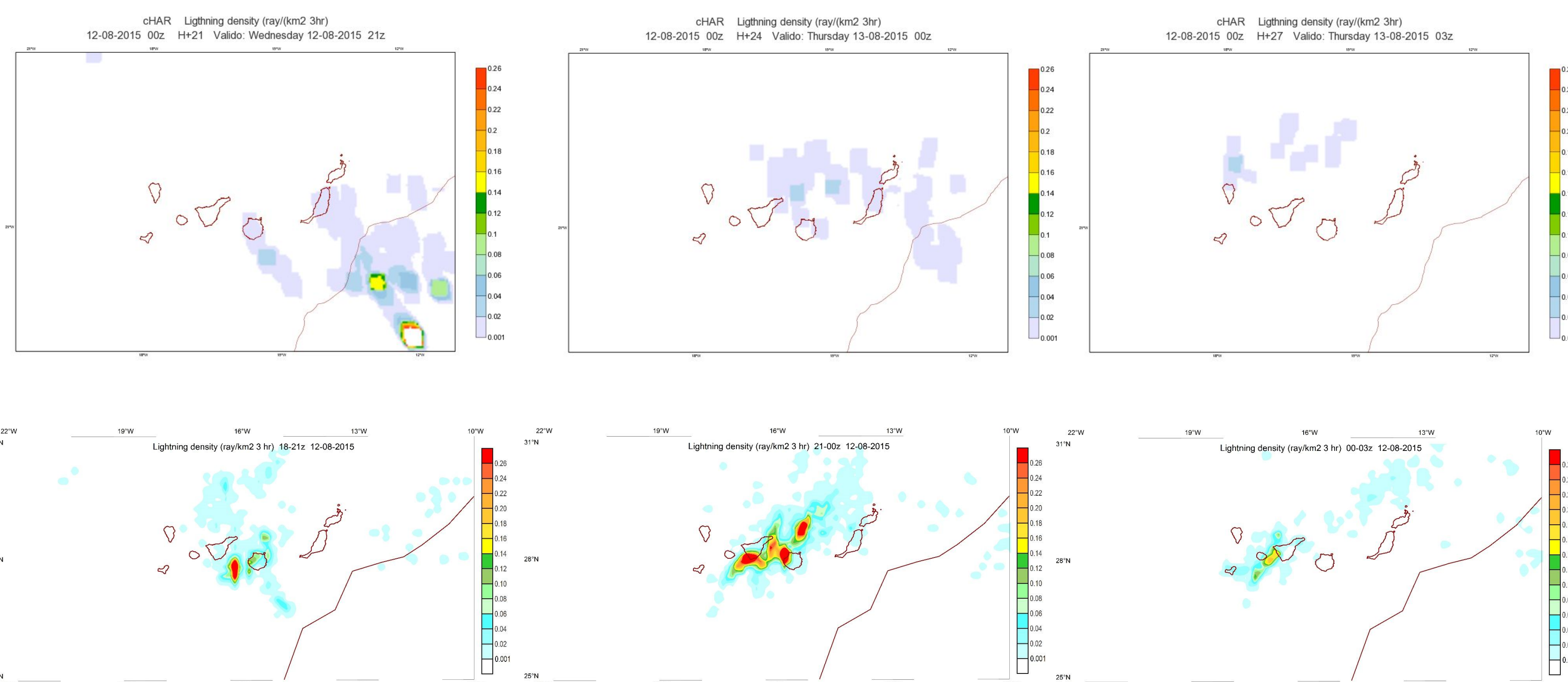


Lightning observations versus forecasting



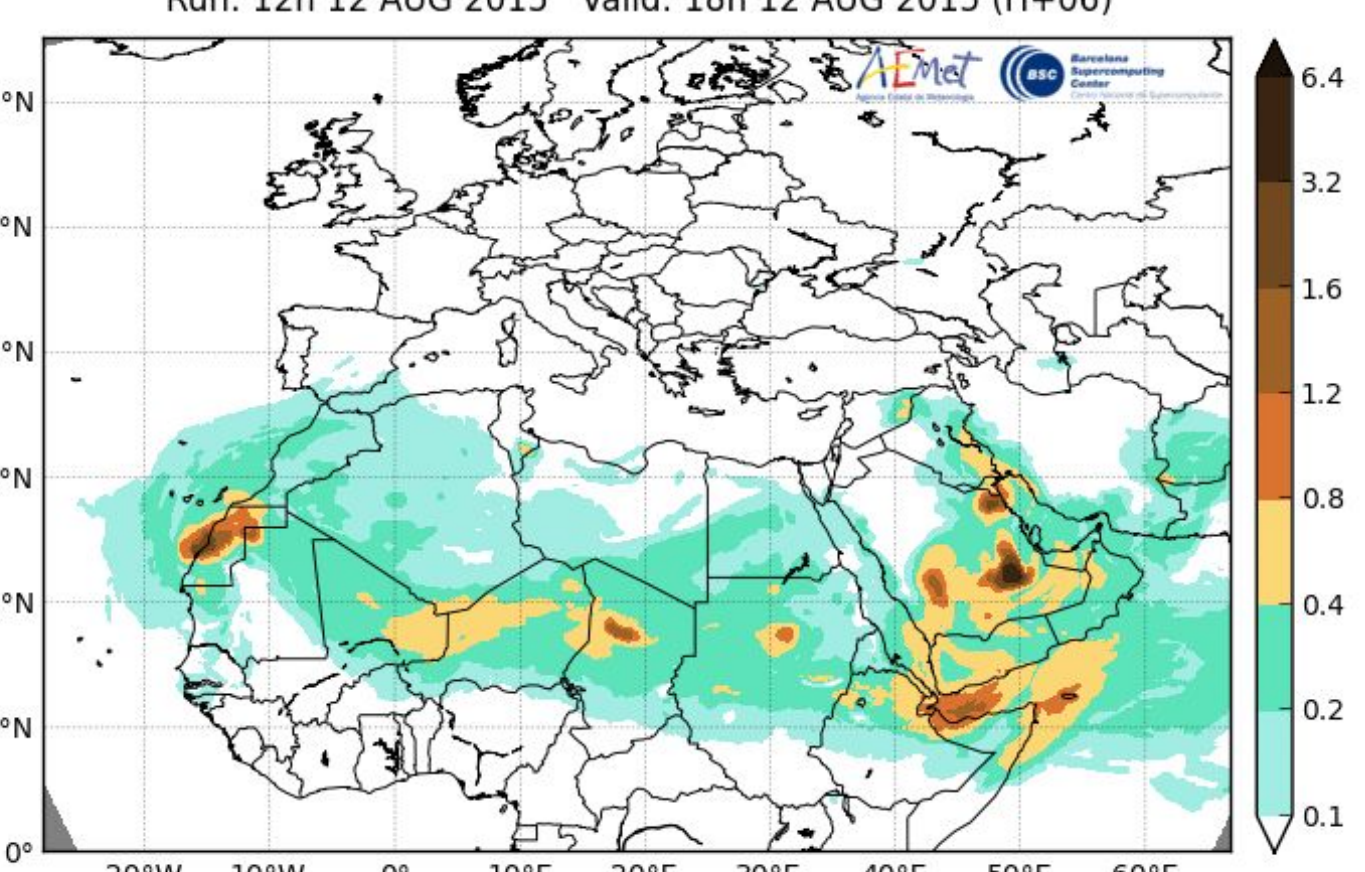
This graphic shows the hourly lightning distribution on 12th and 13th August 2015. It is evident that most of the lightnings stroke during the late afternoon and night of the 12th.

Lightning forecast is based on vertical integrated graupel following KNMI approach adapted to AEMET lightning network. Aerosol affects clouds microphysic and hence the graupel formation and growth, but it is introduced in the model as a constant and climatological value. Could be this last the reason of such discrepancy between observed and forecasted lightning density?

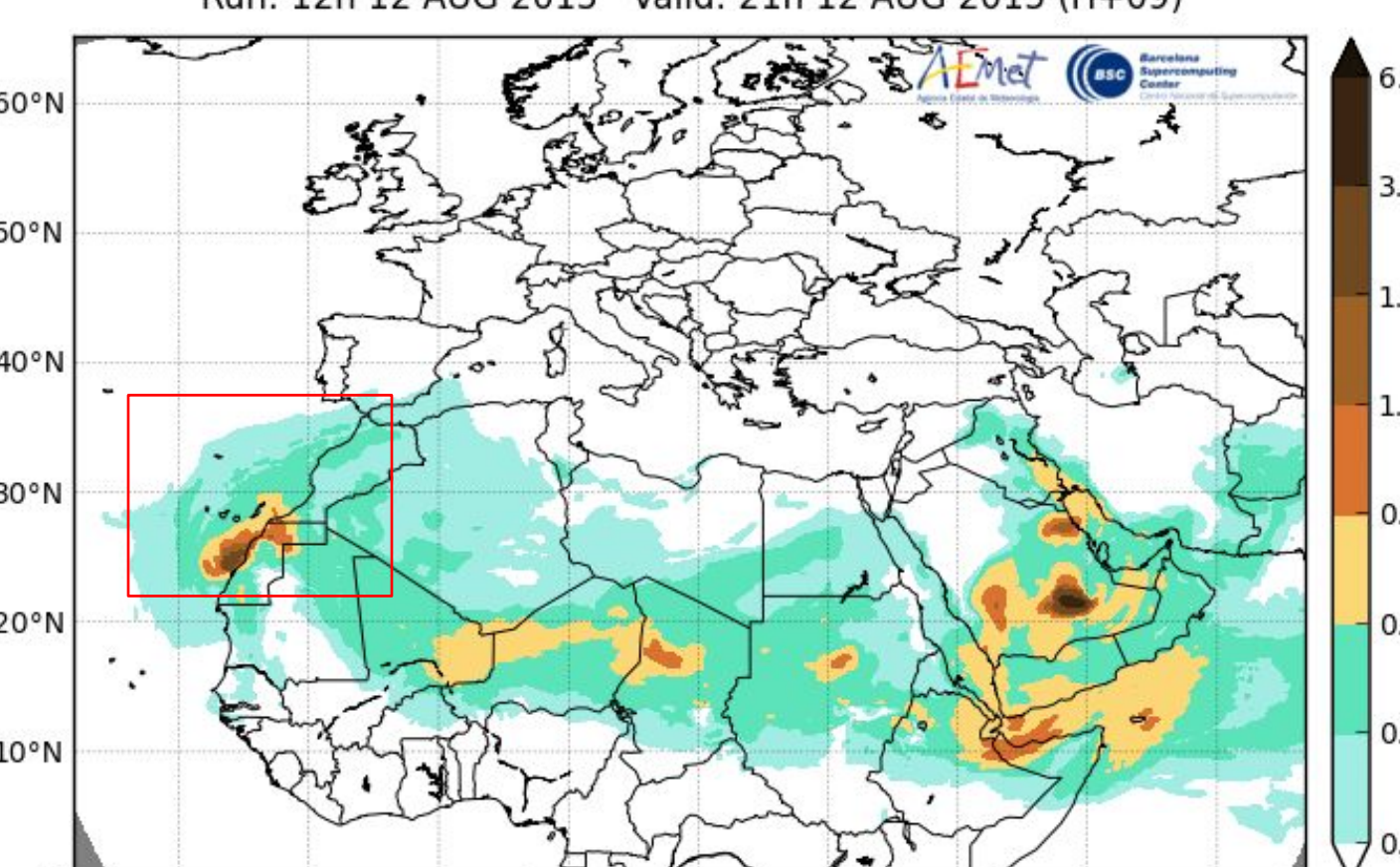


Dust forecasting versus observations

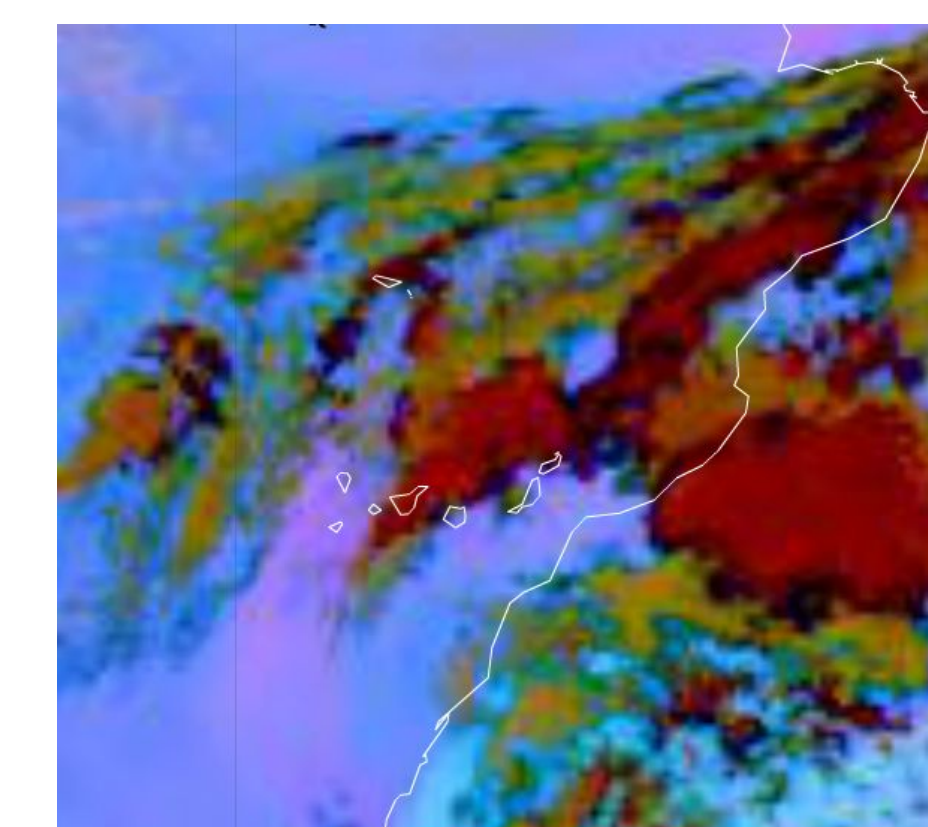
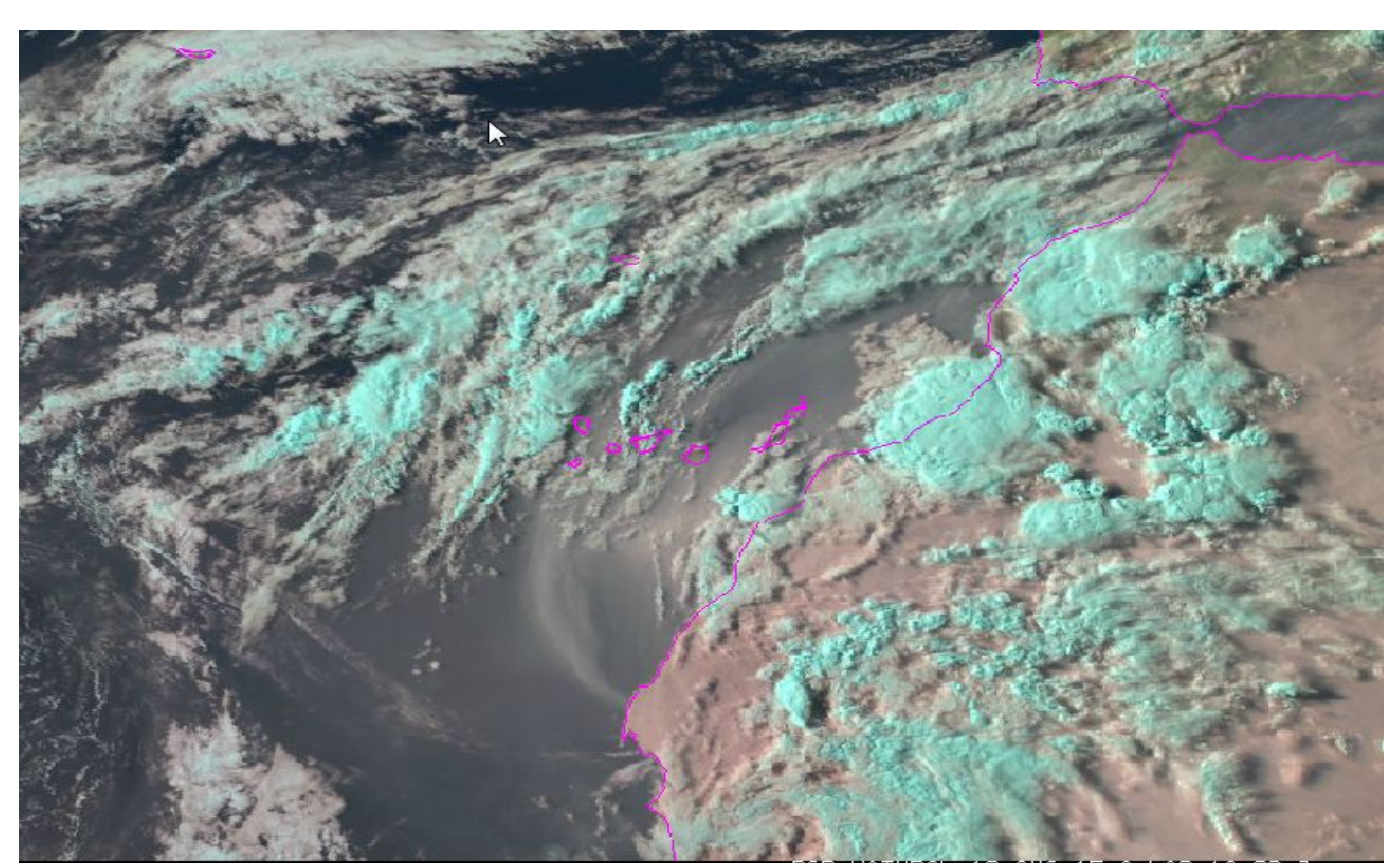
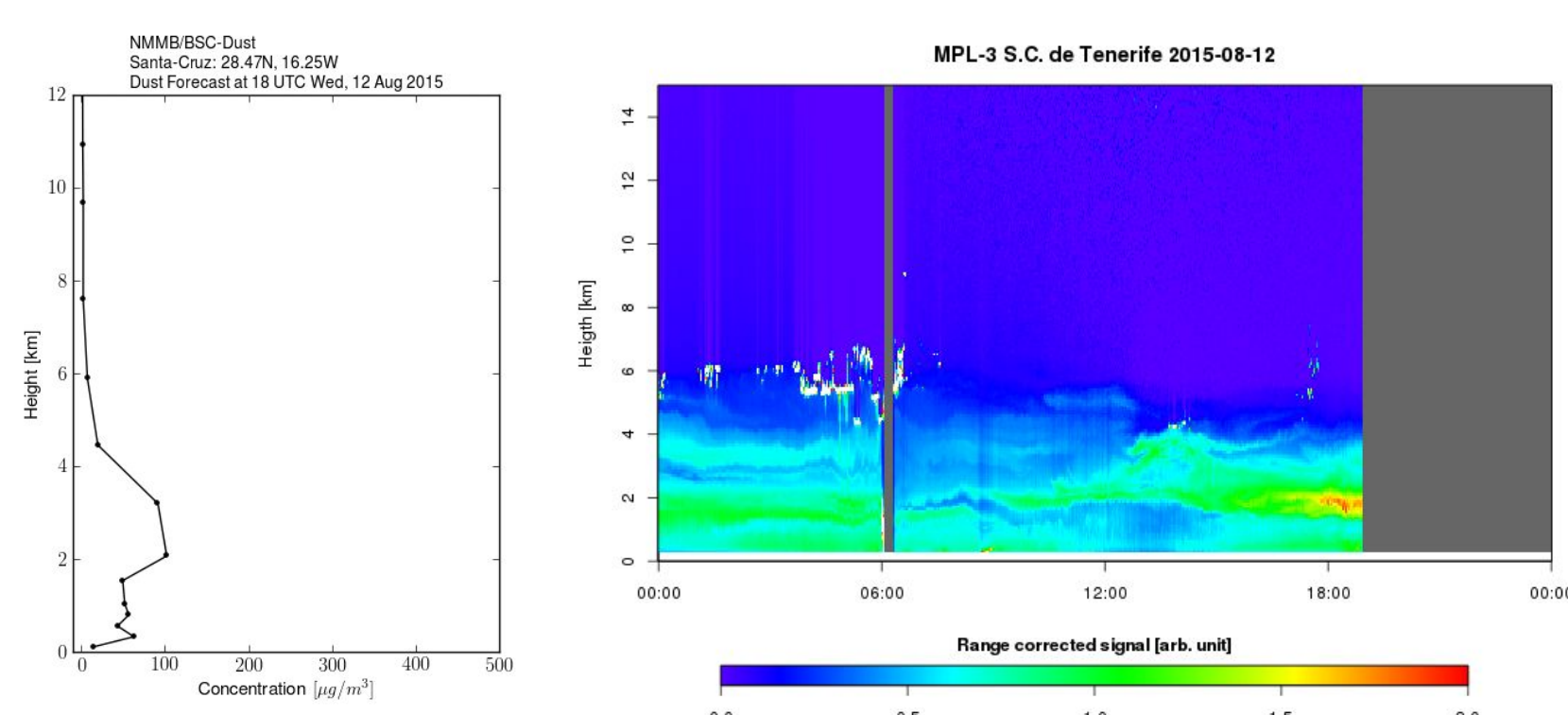
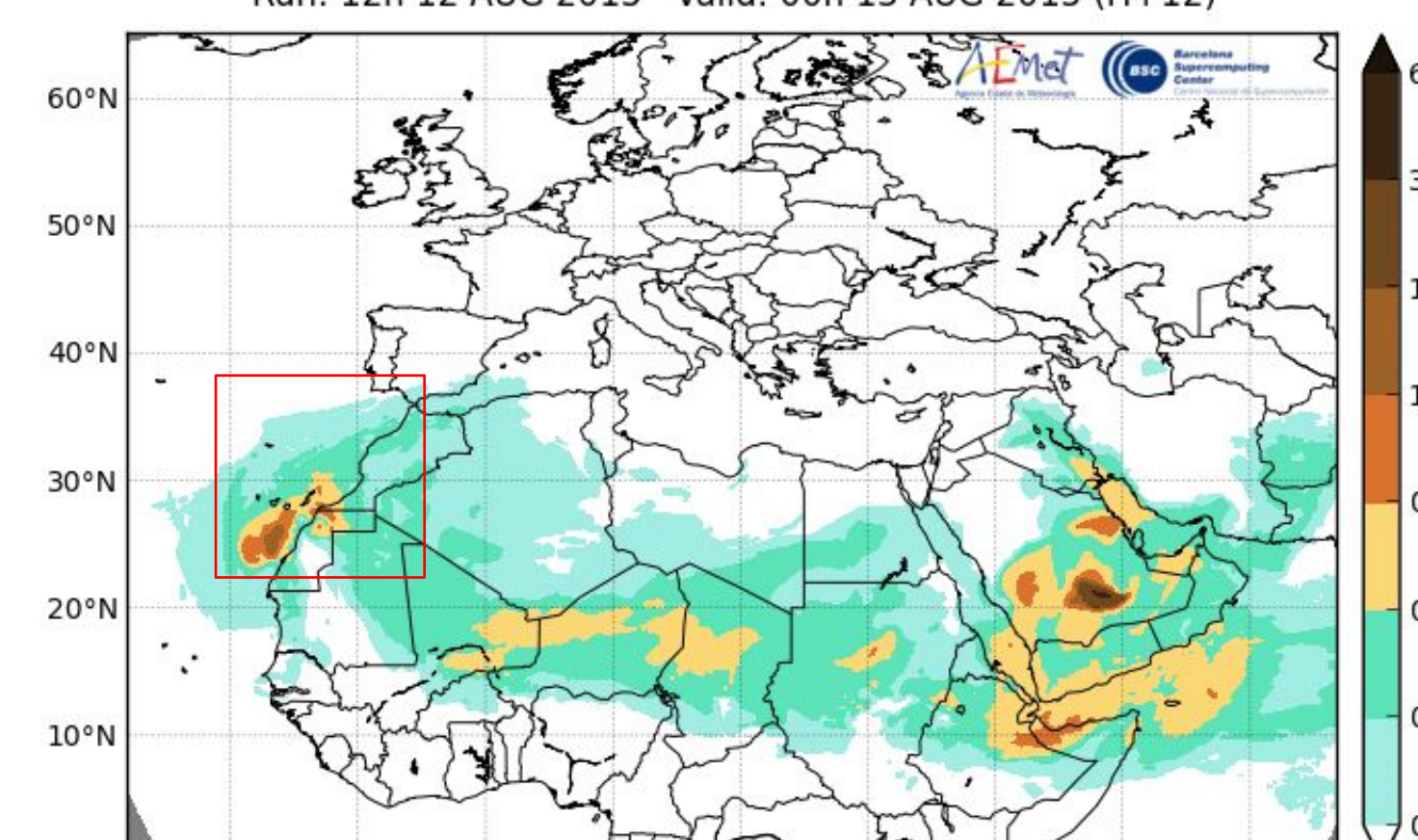
Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 12 AUG 2015 Valid: 18h 12 AUG 2015 (H+06)



Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 12 AUG 2015 Valid: 21h 12 AUG 2015 (H+09)



Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 12 AUG 2015 Valid: 00h 13 AUG 2015 (H+12)



NMMB/BSC-Dust AOD(500) forecast for 12/08/2015 at 21h (above). Natural RGB Satellite Image at 18:00 UTC of 12th August 2015, showing the dusty area (corresponding to red box in forecast map).

Dust RGB Satellite Image at 00:00 UTC of 13th August 2015, showing the dusty area (corresponding to red box in forecast map).

Summary

► This episode shows a lightning activity comparable to other autumn or winter episodes, but not to summer ones. The main difference between episodes was the presence of dust (frequent in summer in such levels).

► Could the dust enhance the electrification of clouds? For lack of sufficient quantitative observations, the relative contributions of the hypothesized aerosol effect could not be determined [3]. But although the predominant factor in lightning activity initiation is the meteorological conditions, and the aerosol, the meteorology, and the topography effects on lightning activity are not possible to separate, the observations show a possible secondary role of aerosol on this enhance, as studied also by Proestakis et al. [1] and Sassen et al. [2]

[1] Proestakis et al. *Lightning activity and aerosols in the Mediterranean region*. *Atm. Res.* 170, 66-75, doi: 10.1016/j.atmosres.2016.07.031 (2016).

[2] Sassen et al. *Saharan dust storms and indirect aerosol effects on clouds: CRYSTAL-FACE results*. *Geophys. Res. Lett.* 30, NO. 12 doi:10.1029/2003GL017371 (2003).

[3] Williams et al. *Contrasting convective regimes over the Amazon: Implications for cloud electrification*. *J. Geophys. Res.* 107, NO. D20, 8082 doi:10.1029/2001JD000380 (2002).