Supplement of Lightning-ignited fires and long-continuing-current lightning in the Mediterranean Basin: Preferential meteorological conditions

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1 Introduction

In the main part of this manuscript we have extensively discussed the most relevant meteorological variables in fire-igniting lightning and LCC-lightning flashes. This supplement includes further meteorological analysis of fire-igniting lightning and LCC-lightning flashes that can be useful for the community but that is not part of the main conclusions of our study.

2 Further analysis of the upper troposphere in fire-igniting lightning flashes

2.1 Vertical profile of the specific snow water content and the specific cloud liquid water

Fig. S1 and Fig. S2 show the vertical profiles of the specific snow water content and the specific cloud liquid water content for the CG lightning and the fire-igniting lightning climatologies during May and September in, respectively, the Iberian Peninsula and Greece. The main features of the specific snow water content and the rain water content are similar to the main features of, respectively, the specific cloud ice water content and the the specific rain water content shown in the manuscript.

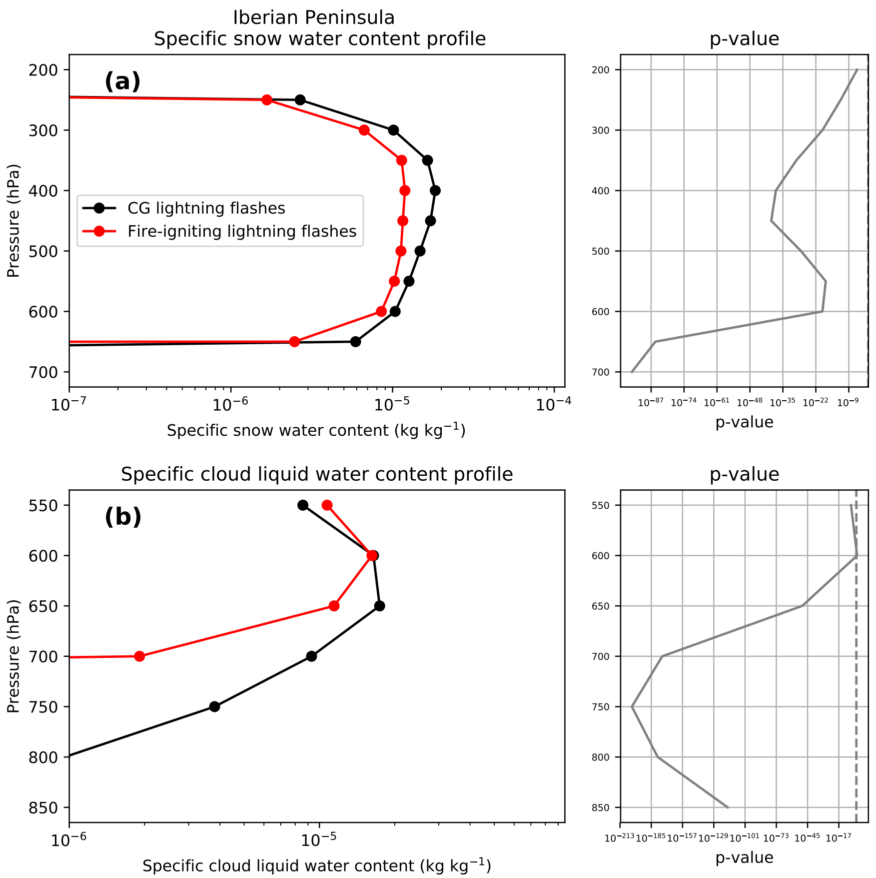

Figure S1. First column shows the vertical profiles of the specific snow water content and the specific cloud liquid water content for the CG lightning and the fire-igniting lightning climatologies during May and September in the Iberian Peninsula between 2009 and 2015. Second column shows the $p - value$ (solid line) for each vertical level representing the probability of equal average between both distributions and a mark showing the limit at 0.05 (dashed line).

2.2 Cloud Top Height map of a fire-igniting thunderstorm

Fig. S3 shows the CTH map derived from MSG satellite for one fire-igniting thunderstorm taking place in the Mediterranean coast of the Iberian Peninsula in June 17, 2014 at 14:15 UTC.

2.3 Flash frequency over coniferous and mixed forest around the time of ignition

Fig. S4 shows the cumulative number of flashes occurring over coniferous and mixed forest for the selected cases 1400 minutes around the ignition of lightning-ignited fires. Ignitions tend to occur at the moment when the lightning activity just starts to increase from the regimen with the lowest lightning activity to the regimen with the highest lightning activity.

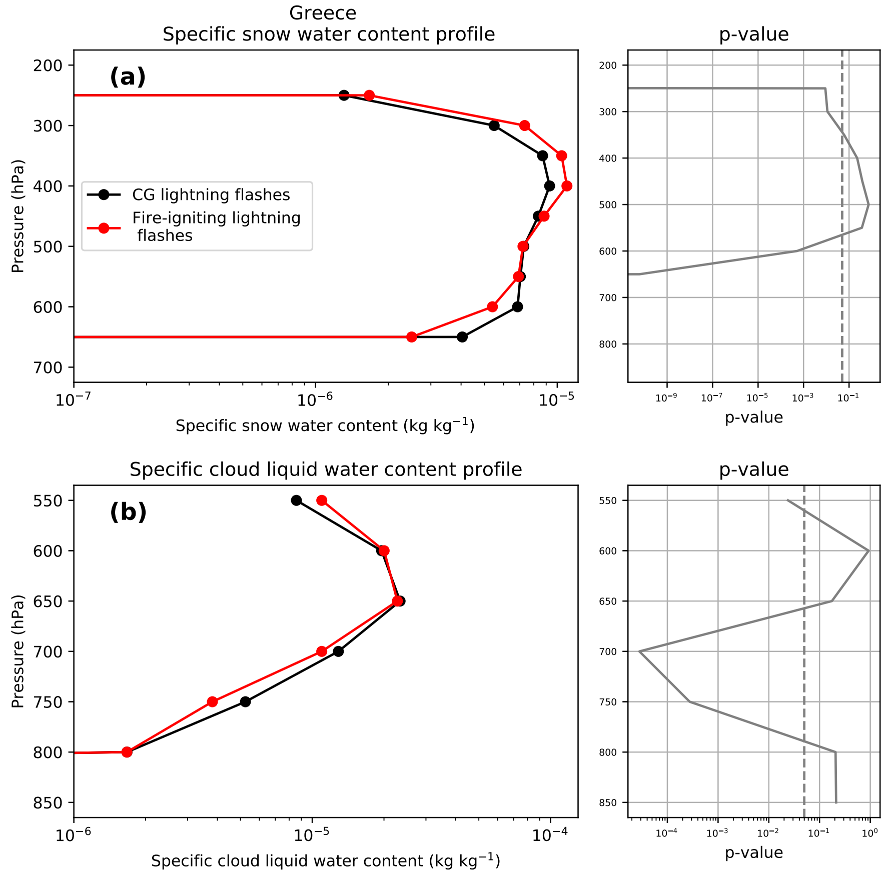

Figure S2. First column shows the vertical profiles of the specific snow water content and the specific cloud liquid water content for the CG lightning and the fire-igniting lightning climatologies during May and September in the Greece between 2017 and 2019. Second column shows the $p-value$ (solid line) for each vertical level representing the probability of equal average between both distributions and a mark showing the limit at 0.05 (dashed line).

3 Further analysis of the meteorological conditions of LCC-lightning flashes

3.1 Lower-troposphere meteorological conditions of all LCC-lightning flashes

We plot in Fig. S5 the frequency distribution of some meteorological variables for normal lightning and LCC-lightning flashes. Fig. S5(a) shows that the median value of CAPE of the thunderstorms producing LCC-lightning flashes is lower than the median value of CAPE associated with normal lightning flashes. Panel (b) suggests that LCC-lightning flashes tend to occur in dry thunderstorms, as the mean hourly accumulated precipitation is lower for thunderstorms producing LCC-lightning flashes than for all thunderstorms. However, the large value of the p-value indicates that differences are not statistically significant. Finally, panels (c) (d) and (e) shows that there are not significant differences in the median relative humidity at 850 hPa level,

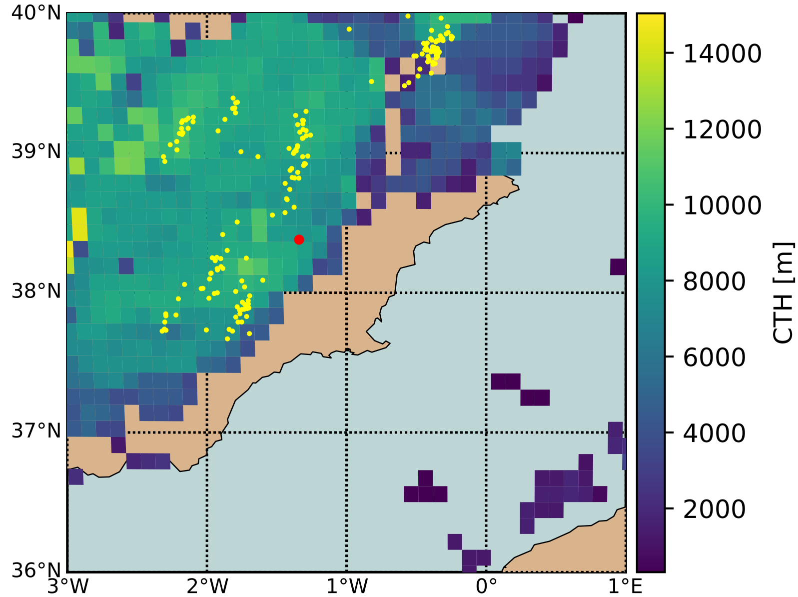

Figure S3. Cloud Top Height map of a fire-igniting thunderstorm taking place in the Mediterranean coast of the Iberian Peninsula on June 15, 2015 at 14:15 UTC. Yellow dots correspond to the lightning discharges taking place 30 minutes around the ignition, while the red dot indicates the position of the lightning candidate for the ignition.

in the temperature at 2 m altitude and at 850 hPa between both samples of data. We show the analysis of the vertical content of moisture in the supplement.

The p-values included in Fig. S5 for the comparison of the distributions of CAPE, RH at 850 hPa and temperature at 2 m altitude and at 850 hPa pressure level are below 0.05, indicating that differences in averages of the showed distributions are statistically significant.

3.2 Vertical profile of the content of moisture

Fig. S6 shows the vertical profiles of the specific cloud water content, the specific snow water content, the specific cloud liquid water content and the specific rain water content for the three samples of lightning flashes together with the p-values. The lower mean specific cloud ice and snow water contents for altitudes above the 300 hPa level (panels (a) and (b)) in thunderstorms suggests that LCC-lightning flashes tend to occur in thunderstorm with a lower CTH value than the climatological value. For larger pressures, the p-value indicates that the differences are not statistically significant. Panel (c) shows that LCC-lightning flashes tend to occur in dry thunderstorm with low specific rain water content, while panel (d) suggests that the median specific

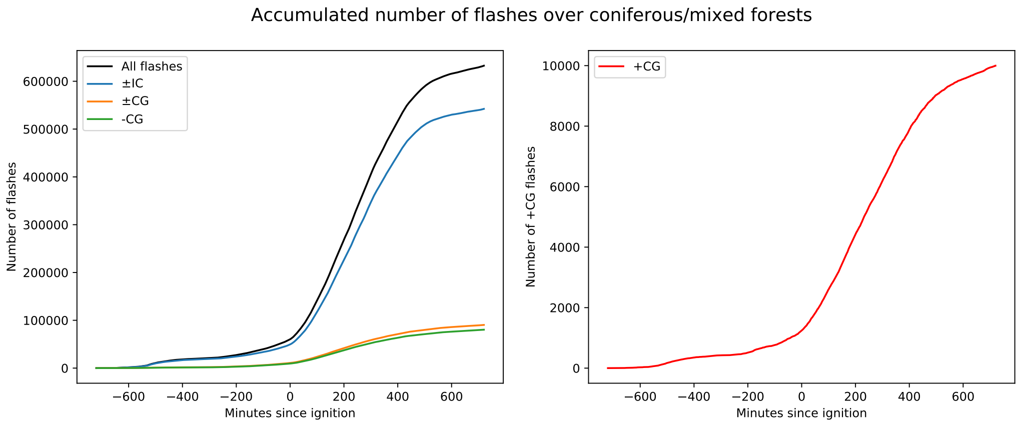

Figure S4. Cumulative number of flashes occurring in 77 fire-igniting thunderstorms 1400 minutes around the ignition of a fire-igniting lightning flash. We only include includes flashes taking place over coniferous and mixed forests. We plot all flashes, all IC flashes (±IC), all CG flashes (±CG) and -CG flashes in the right panel. We plot +CG flashes in the left panel.

cloud liquid water content profile at an altitude above 700 hPa level of thunderstorms producing LCC-lightning flashes is lower than in typical thunderstorms.

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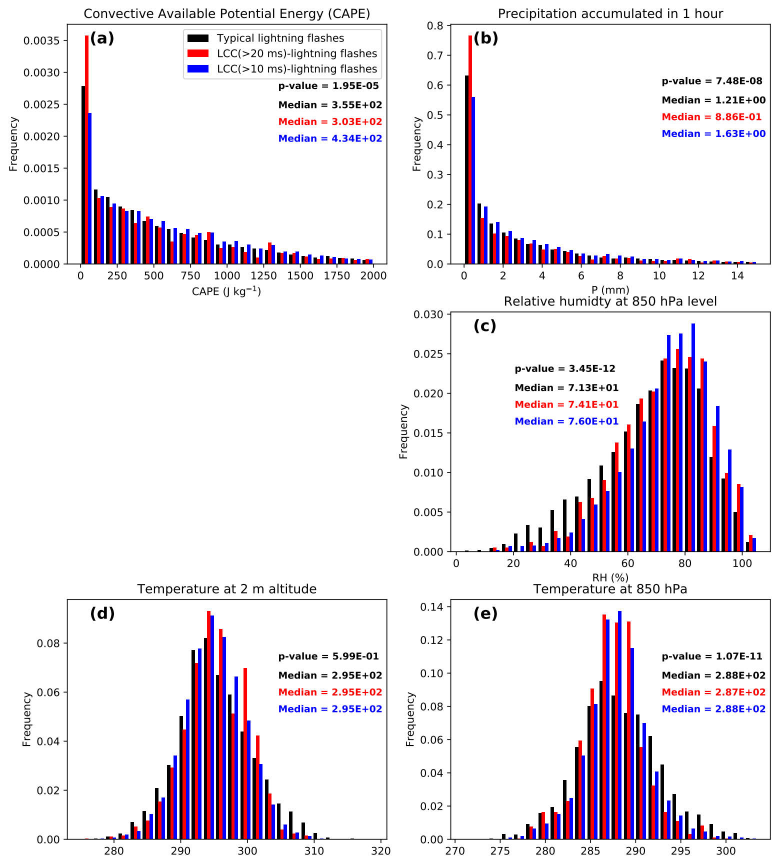

Figure S5. Frequency distribution of the Convective Available Potential Energy (CAPE), the hourly accumulated precipitation, the horizontal wind, the relative humidity at 850 hPa level and the air temperature at 2 m and at 850 hPa levels for normal lightning, LCC(>20 ms)- and LCC(>10 ms)-lightning flashes reported by ISS-LIS over land in Europe between May and September 2017-2020.

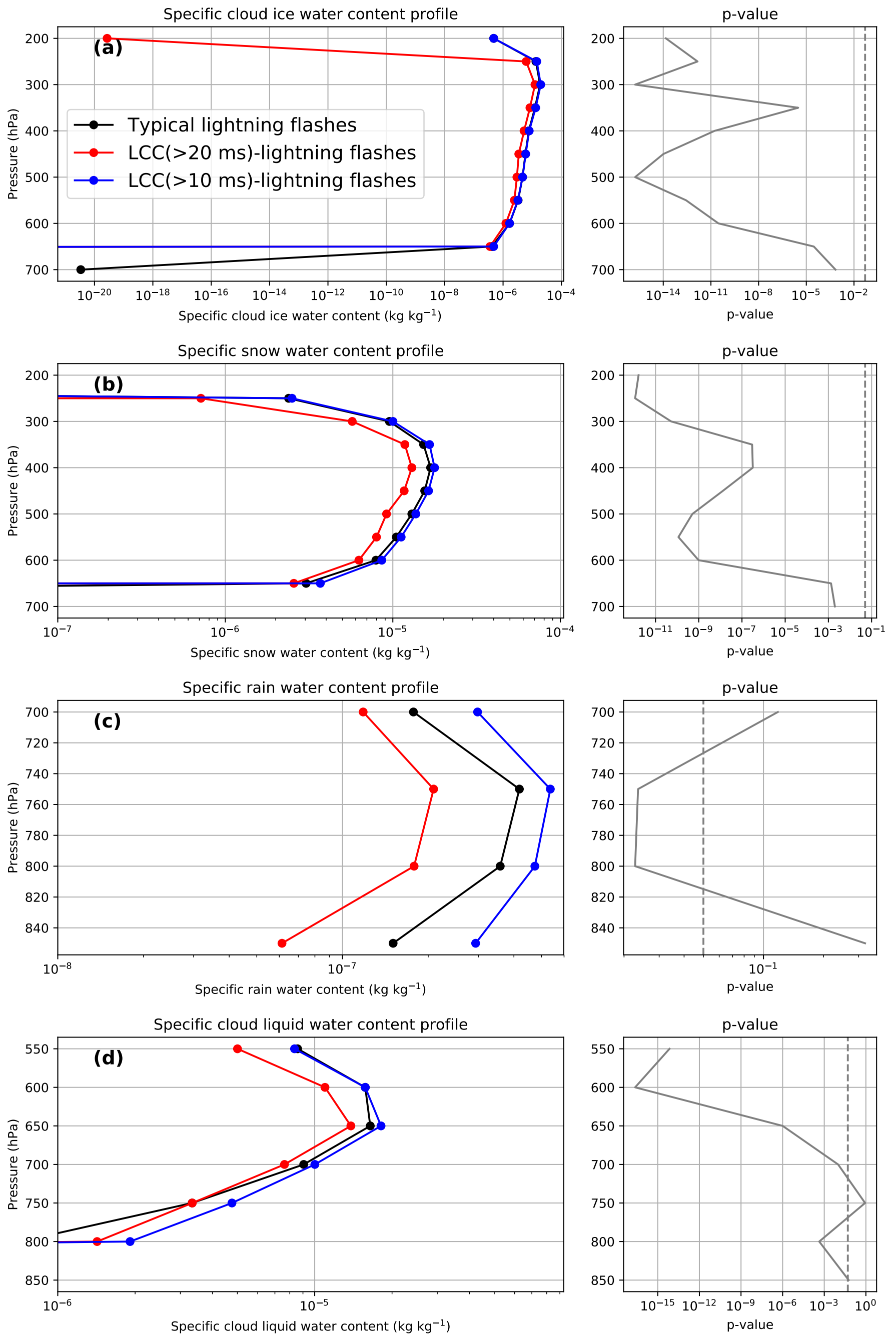

Figure S6. First column shows the vertical profiles of the specific cloud water content, the specific snow water content, the specific cloud liquid water content and the specific rain water content for normal lightning and LCC-lightning flashes over land in Europe between May and September in 2017-2020. Second column shows the $p-value$ (solid line) for each vertical level representing the probability of equal average between both distributions and a mark showing the limit at 0.05 (dashed line).