

Dear Editor and Referees,

We are very grateful for your comments on the manuscript. According to your advice, we amended the relevant part of the manuscript. Following are point-by-point responses to comments in Referee #1 Report #3 and Referee #3 Report #2. All the line numbers mentioned in responses are referred to the manuscript with changes marked.

**Referee #1 Report #3:**

**Specific Comments:**

(1) L148: This sentence is confusing.

“In addition, within six hours before the start of each sample, the number of grids with CG lightning flashes records in each hour is less than 10% of the entire study region. This is to ensure that thunderstorm is ...”

Is this what your mean?

“In addition, days when flashes occur in more than 10% of the study region during any of the six-hours (06-12 UT) preceding the sample period are removed to ensure that thunderstorm activity is ...”

**Reply:** Thank you for your comment. Yes, this is what we want to express.

We have revised this sentence according to this comment. (Lines: 157-159)

(2) L184: You could argue that there is only one peak on clean days too with the peak lasting from 1700-0100 BJT. Do you believe the decrease in

flashes between the two small peaks is significant or noise?

**Reply:** Thank you for your comment. The decrease in lightning flashes between the two small peaks seems insignificant. As mentioned in this comment, these two small peaks can be regarded as one peak. We have rewritten this sentence. (Line 195)

(3) Low and Middle SHEAR –For simplicity, it might be best to use 850 to 700 hPa shear for low shear and 500 to 400 hPa shear for middle shear.

**Reply:** Thank you for your comment. We have replaced low SHEAR and middle SHEAR with 850 to 700 hPa shear and 500 to 400 hPa in the manuscript and related figure.

(4) L280: “In the afternoon, the relationship between TCLW and T may contain the above two mechanisms, which leads to an insignificant relationship between them”

Is this what you mean?

“In the afternoon, for  $TCLW < 0.1 \text{ kg m}^{-2}$ , the change in T with increases in TCLW is small as both factors are in play”.

**Reply:** Thank you for your comment. Yes, what we want to express is consistent with this comment. We have rewritten this sentence. (Lines: 297-299)

(5) 281: At night, the absence” ◇ “At night, for  $TCLW < 0.1 \text{ kg m}^{-2}$ , the absence”

**Reply:** Thank you for your comment. We have revised this sentence. (Line 297)

(6) L269-296: This paragraph is difficult to follow. Ideally, it should be rewritten – perhaps shortened.

**Reply:** Thank you for your comment. We have rewritten part of this paragraph to make it clearer.

(7) L570: I’m not sure what you mean by “Black lines represent the 1500 m contour line”. Are you simply saying that the 1500 m altitude line is shown to highlight the location of the basin?

**Reply:** Thank you for your comment. The black lines represent the 1500 m altitude line. We have revised this sentence. (Lines: 594-595, 601-602 )

### **Technical Corrections:**

**Reply:** Thank you for your patience and careful technical corrections to this manuscript. All technical errors have been corrected in this manuscript.

### **Referee #3 Report #2**

#### **Specific Comments:**

(1) Lines 12-17: The authors first claimed that “the difference in lightning flashes between the clean and polluted subset was not obvious in the afternoon”, however, the authors continued to say that “increasing AOD will lead to an increase in lightning flashes in the afternoon and night”. These two statements are contradictory. The abstract is very important for readers, and the authors are expected to write it as clearly as possible.

**Reply:** Thank you for your comment. We have revised this part to make it clearer. (Lines: 12-26)

(2) Lines 232-235: Why are the correlation coefficients between lightning flashes and temperature the same ( $R = 0.68$ ) in the afternoon and evening? The relationships in Figs. 8a and 8e are not linear relationship, but here it is called a positive relationship? Namely, “Positive relationships can be found in lightning flashes and T both in the afternoon and at night”. This description is inaccurate. Please clarify.

**Reply:** Thank you for your comment. Higher surface temperature (T) is conducive to convection and lightning both in the afternoon and at night. Therefore, the correlation between lightning activity and T is positive during the day and night. However, due to the limited number of samples, there may exist errors in the obtained correlation values, resulting in the same correlation values in this manuscript. In fact, based on the results of this manuscript, the relationship between lightning flashes and T in the

afternoon is different from that at night. The non-linear relationship between the lightning flashes and T is more obvious in the afternoon. In future research, we will use more appropriate data to investigate the relationship between them to obtain more accurate results.

We have revised the relevant content in the manuscript to make it more accurate. (Lines 242)

(3) In addition, what is the reason for the above nonlinear relationship?

**Reply:** Thank you for your comment. Higher surface temperature will increase the instability of the atmosphere, which is conducive to the generation of thunderstorms and the increase of lightning flashes. Therefore, when the surface temperature is relatively low, the number of lightning flashes is very small. But exorbitant surface temperature means that a lot of solar radiation reaches the ground without being blocked. It means that there may not be many clouds or even clear days. Therefore, when the surface temperature is too high, there will not be too strong thunderstorms. This may cause a nonlinear relationship between surface temperature and lightning flashes.

(4) Lines 255-258: The authors claimed that “The CG lightning flashes increase with the increase of TCLW when the TCLW is relatively low ( $< \sim 01 \text{ kg m}^{-2}$ ), but decrease with the rise of TCLW when its value exceeds

about  $0.1 \text{ kg m}^{-2}$ ". But the explanation given by the authors cannot convince me. Zhao et al. (2020) also discussed the relationship between these two and indicated that it was related to different regions in this region. Please discuss these two different explanations.

**Reply:** Thank you for your comment. Zhao et al. (2020) investigated the relationship between TCLW and lightning density in regions of the Sichuan Basin and the western Sichuan Plateau. Due to the different topography of these two regions, the warm clouds in the plateau area are thinner than those in the basin area. This leads to a smaller value of TCLW in the plateau area than that in the basin area. As found by Zhao et al. (2020), the lightning density is relatively large when the TCLW is equal to about  $0.1 \text{ kg m}^{-2}$ . Our result in this manuscript is similar to theirs. Zhao et al. (2020) pointed out that in the basin region, too much TLCW means robust warm-cloud processes, which are more conducive to the formation of warm rain than ice-phase processes, thereby inhibiting lightning activity. The basin TCLW values of most of their samples are larger than  $0.1 \text{ kg m}^{-2}$ . Therefore, our explanation of the negative relationship between TCLW and lightning flashes when the TCLW exceeds  $0.1 \text{ kg m}^{-2}$  is consistent with that of Zhao et al. (2020). Because the time resolution and processing method of their data is different from our research, the TCLW values of their samples in the basin area are mostly greater than  $0.1 \text{ kg m}^{-2}$ . Our research reflects the relationship between lightning and TCLW when TCLW is relatively small

( $\text{TCLW} < 0.1 \text{ kg m}^{-2}$ ). We believe that when TCLW is relatively small, it is not easy to trigger warm-rain processes. Under appropriate updraft conditions, TCLW will be transported upward to participate in the ice phase processes in the cloud to form more lightning. This principle should be similar to Zhao's interpretation of the positive correlation between lightning density and TCLW in plateau areas.

(5) Lines 279-284: The results show that “TCLW was negatively correlated with T in the afternoon and at night”. And the authors gave two different explanations for this phenomenon. Firstly, “The thicker and wider clouds will block more solar radiation from reaching the ground, thus reducing the surface temperature” (line 278). Secondly, “too much liquid water in the cloud may promote a warm-rain process, The precipitation falling to the ground will significantly reduce the surface temperature” (lines 283-284). Please provide the references for these two explanations separately. And which factor is more important?

**Reply:** Thank you for your comment. We made a mistake in this part of the article. In the afternoon, when the cloud liquid water content is relatively high, these two kinds of impacts on temperature exist simultaneously. At night, the former effect disappears due to the absence of solar radiation. We have revised the related content in the manuscript and added several references for these two explanations. We believe that these two impacts

are both important. However, the specific strength of their impact on temperature cannot be quantified in this paper. This is what we need to pay attention to and solve in our future work. (Lines: 291-305)

(6) Line 287: The authors claimed that “This may be because the ice water content in clouds is related to more factors”. Please provide these factors and the references accordingly.

**Reply:** Thank you for your comment. We have modified the explanation of the relationship between TCIW and temperature. (Lines: 305-313)

(7) Lines 331: In which region are these analyses conducted? Please clarify.

**Reply:** Thank you for your comment. We have added the specific study region in this sentence.

(8) Lines 339-340: What the authors claimed “reduce the solar radiation reaching the ground” is not the “microphysical effects” of aerosols. The usage of proper nouns should be checked in the paper.

**Reply:** Thank you for your comment. We have revised this mistake in the manuscript.

(9) I grew tired well reading the paper, which is an indication that the writing needs to be improved.



**Reply:** We apologize for the poor language of our manuscript. We worked on the manuscript for a long time and the repeated addition and removal of sentences and sections obviously led to poor readability. We really hope that the flow and language level have been substantially improved.