Electronic Supplementary Material to Characteristics of Pre-summer Daytime Cloud Regimes over Coastal South China from the Himawari-8 Satellite*

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ESM to: LI, M. X., Y. L. Luo, and M. Min, 2022: Characteristics of pre-summer daytime cloud regimes over coastal South China from the Himawari-8 satellite. *Adv. Atmos. Sci.*, **39**(12), 2008−2023, https://doi.org/10.1007/s00376-021-1148-1.

The supporting information contains one paragraph of text (Text S1) and fourteen figures (Figs. S1 to S14). Test S1 is a detailed description of the cluster method utilized for the CR identification. Figures S1 to S10 show the results of K-means tests with different cluster numbers (4, 5, 6) and different random numbers used to initiate the analysis for a cluster number. Figures S11 to S14 show the examples of the CRs in this study.

Description of the cluster method utilized for CR identification.

The six cloud regimes (CRs) presented in the main text are obtained using the K-means algorithm combined with some subjective judgment. Following Rossow et al. (2005), a small number of clusters (starting from four clusters) are first tested repeatedly with 20 different random numbers. Results from three of the tests are shown in Figs. S1–S3 (other tests produced similar results).

In Fig. S1, the optically thin-to-moderate cloud mixture (CR1), optically thin warm clouds with cirrus (CR2), optically thick warm clouds (CR3), and convective clouds in different stages (CR4) are identified. In Fig. S2, the optically thin-to-moderate cloud mixture and the optically thin warm clouds with cirrus are merged into one cluster. Meanwhile, a CR with extreme, deep convective clouds (CR3 in Fig. S2) is identified which can be regarded as a CR separated from the convective clouds in different stages subset. Figure S3 shows optically thin warm clouds (CR4) with very small samples (about 0.31%). The above analysis suggests that K-means results are not stable when using four clusters.

When increasing the cluster number to five, there are only two main results shown in Figs. S4 and S5 (other tests produce similar results). The two tests both show reasonable CR patterns but are still unstable.

When increasing the cluster number to six, the K-means procedure begins to produce similar patterns with very large- or small-size group numbers within one test (Figs. S6–S9). Although all the COT-TBB patterns within one test have low pattern correlations (usually <0.6), some patterns are similar in terms of physical meanings. For example, CR4 and CR6 in Fig. S7 both represent optically thin warm clouds with a very small sample size. CR2 and CR6 in Fig. S8 both represent optically thick warm clouds with CR6 only accounting for 0.67% of all the samples. Figures S6 and S9 produce similar patterns as well. Tests 6−5 (Fig. S10) show different patterns but still have a very large sample size of CR5 (accounting for 41.2% of all the cloud samples), meaning that the convective clouds in different stages are not well separated. The above results show that increasing the cluster number to six produces COT-TBB patterns with similar physical meanings and cannot separate the populous convective clouds in different stages well.

Therefore, considering that CR4 in Fig. S1 represents convective clouds in different stages which are hard to separate by increasing the cluster number and the physical meanings of these clusters, results of test 4−1 (Fig. S1) is first selected and the obtained convective clouds in different stages subset (CR4) is further classified into three clusters to separate these convective clouds in various states. The final results are shown in Fig. 2 of the manuscript.

*The online version of this article can be found at https://doi.org/10.1007/s00376-021-1148-1.

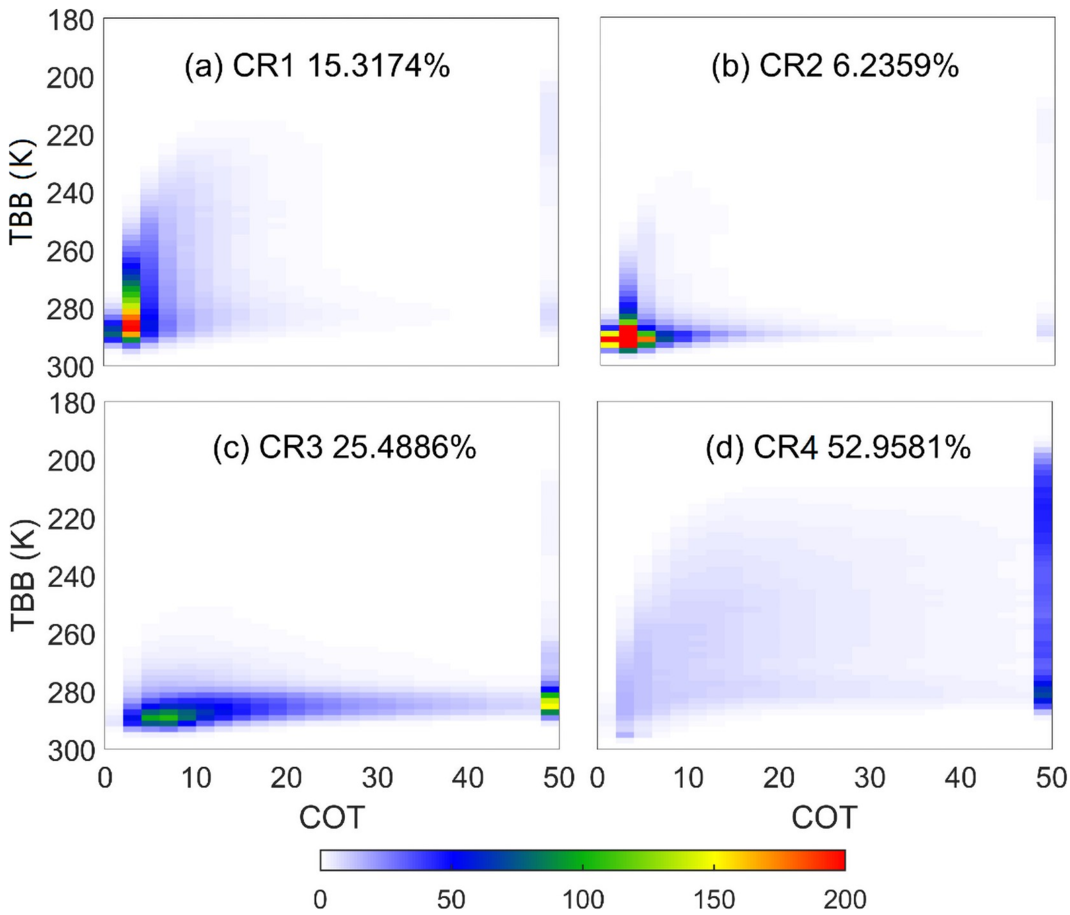

Fig. S1. The COT-TBB joint frequency distributions of the centroids of the four CR patterns for test 4–1 (4 represents the number of the subset, 1 donates the first test).

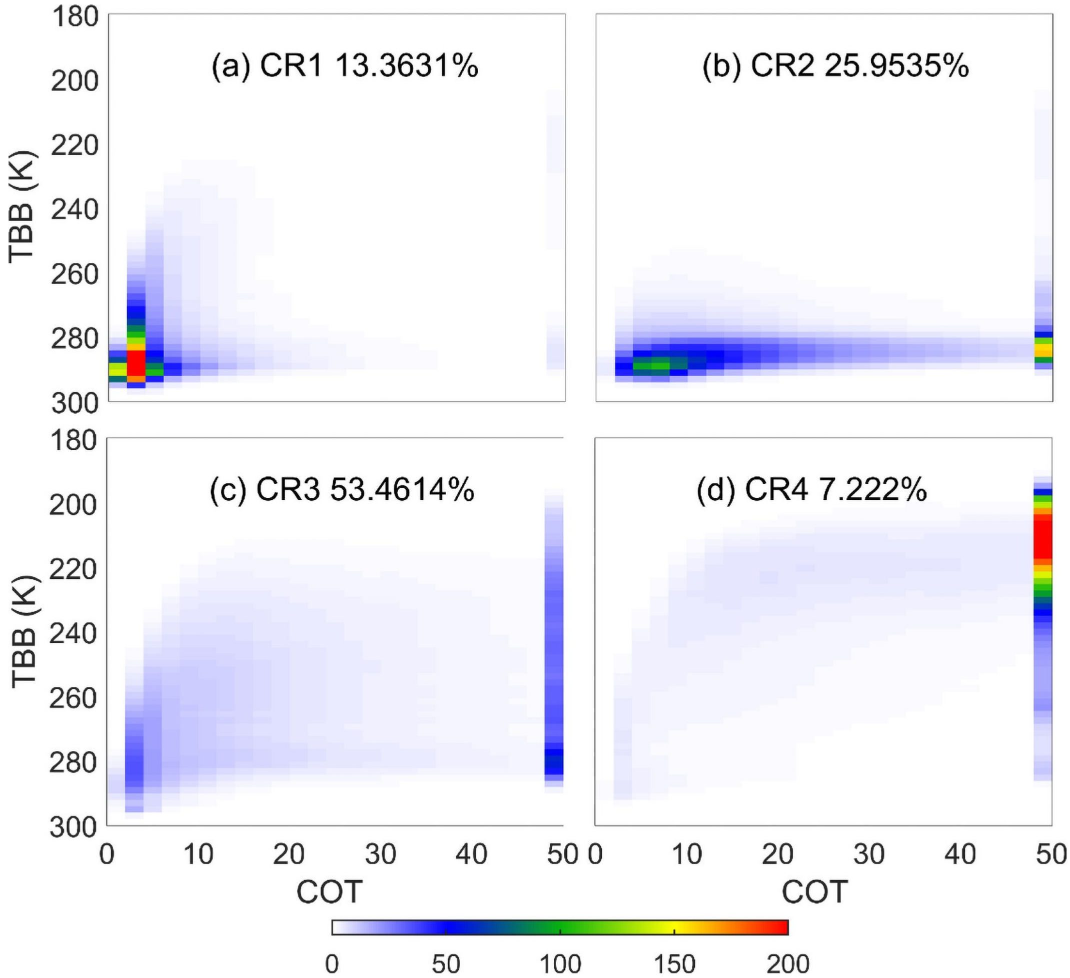

Fig. S2. Similar to Fig. S1 but for test 4−2.

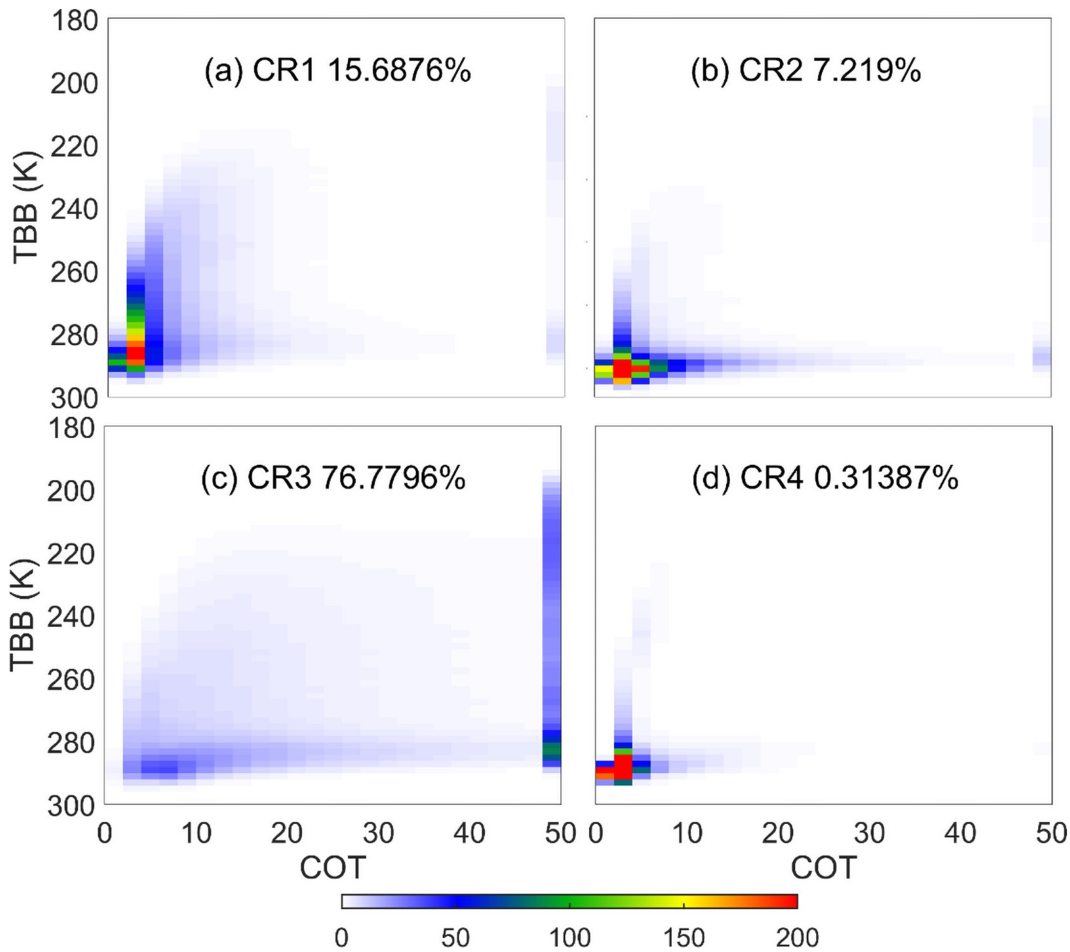

Fig. S3. Similar to Fig. S1 but for test 4−3.

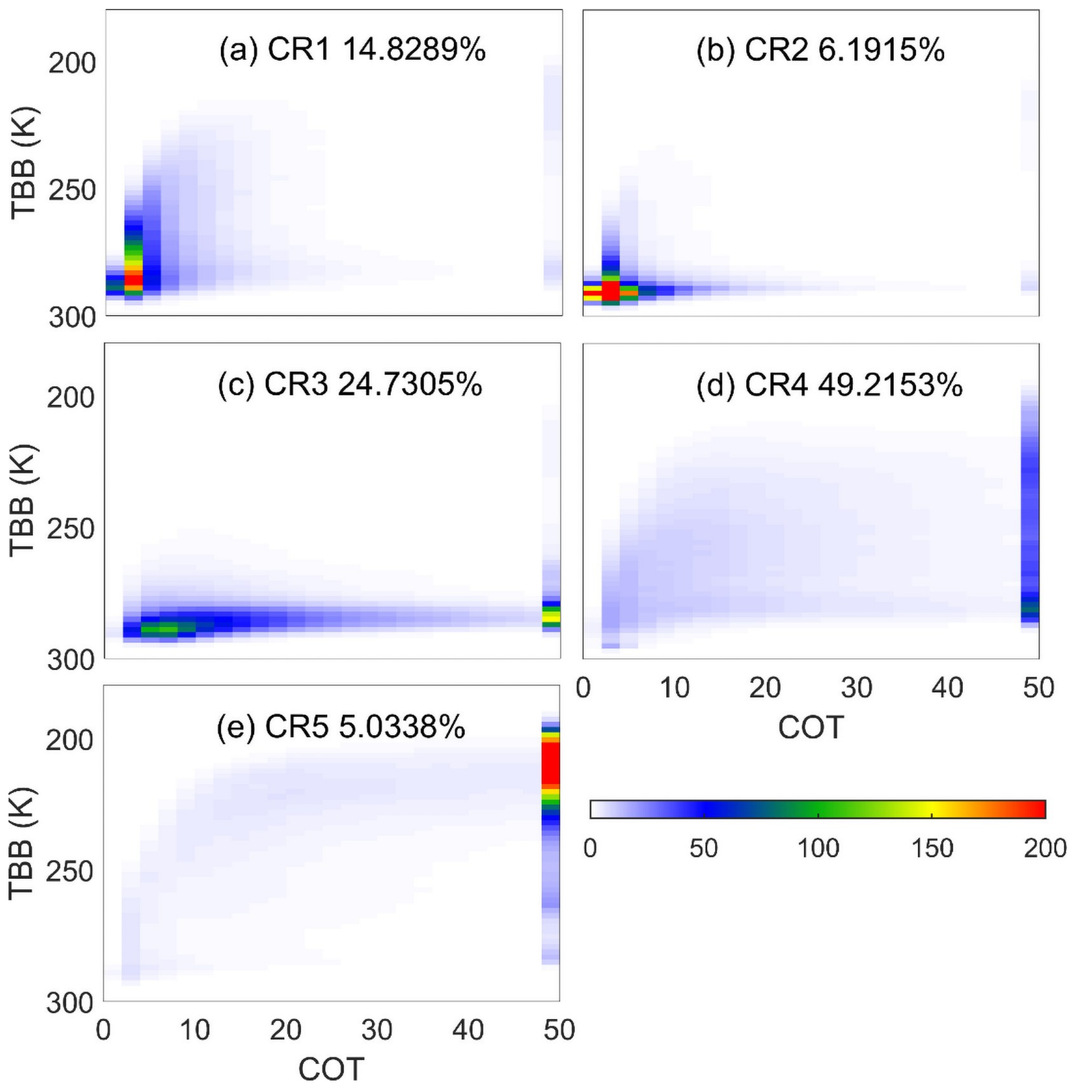

Fig. S4. Similar to Fig. S1 but for test 5−1.

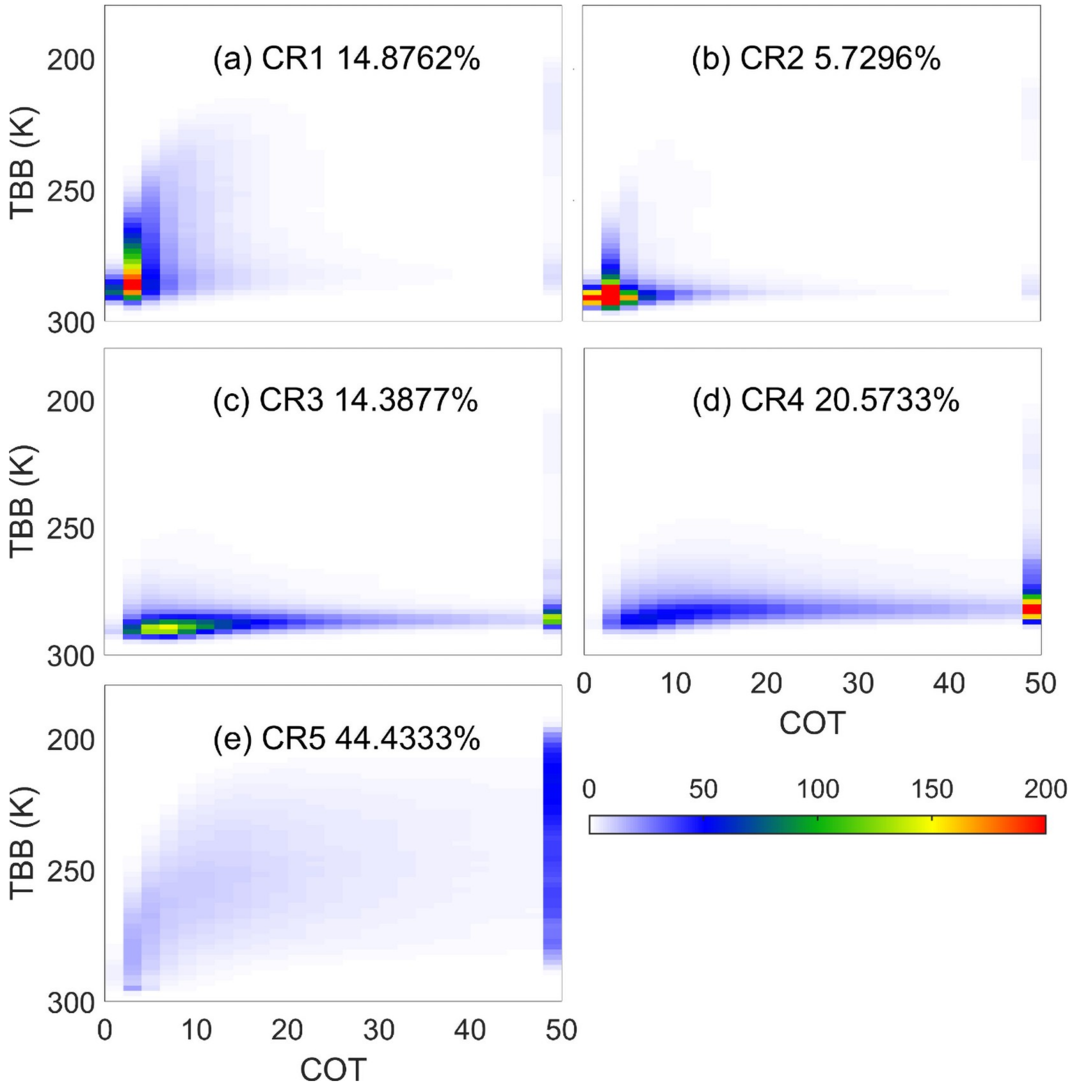

Fig. S5. Similar to Fig. S1 but for test 5–2.

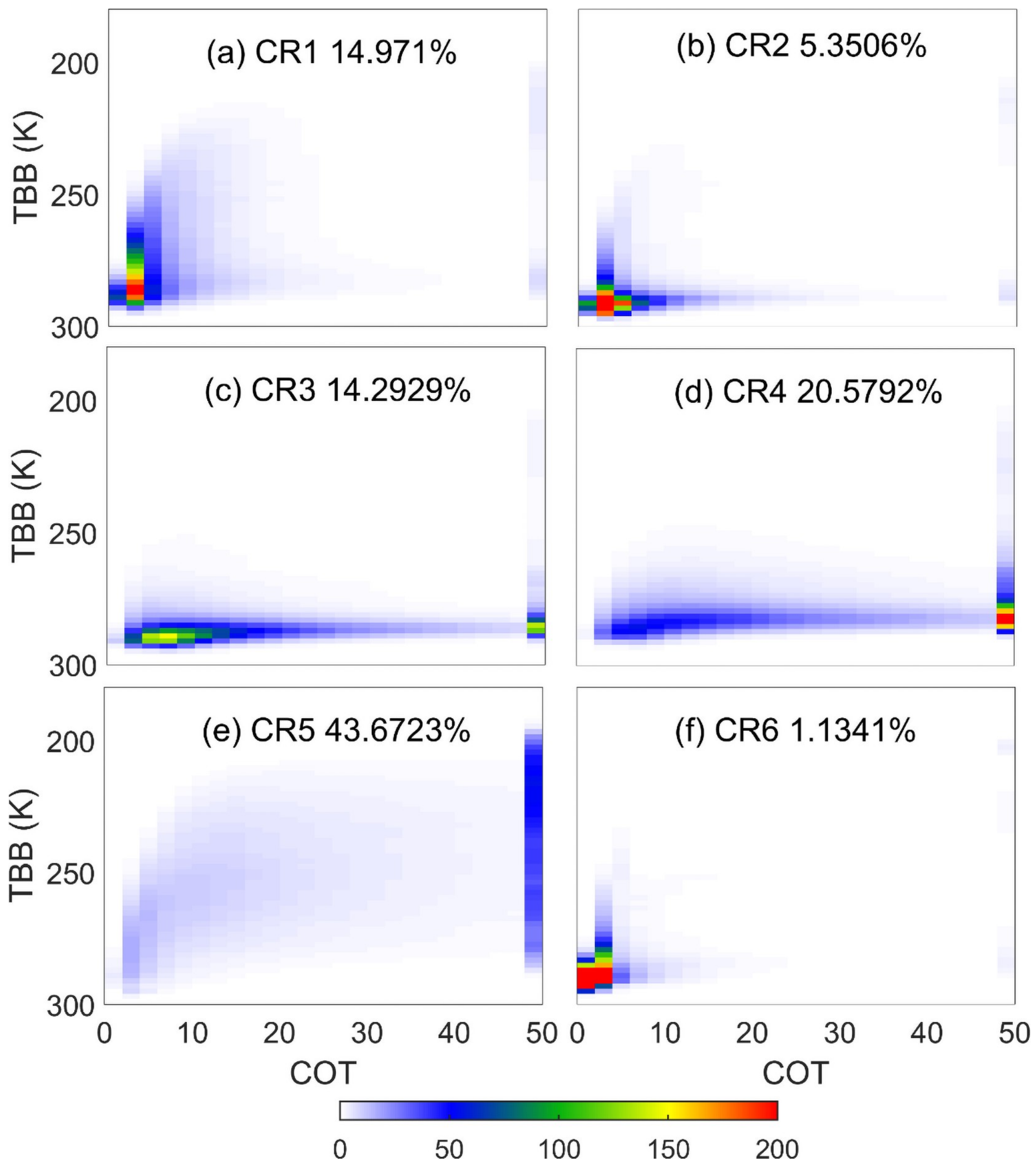

Fig. S6. Similar to Fig. S1 but for test 6−1.

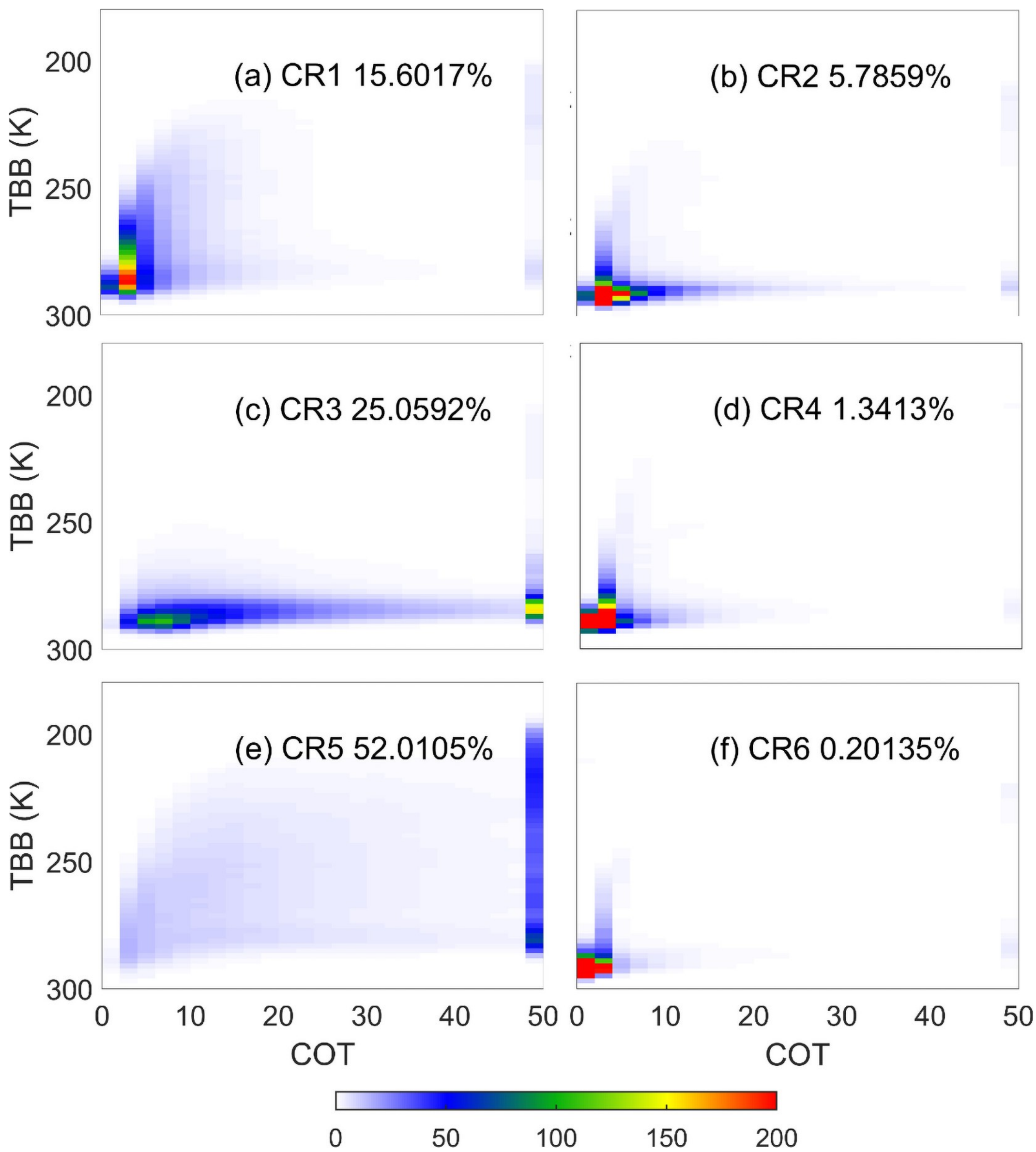

Fig. S7. Similar to Fig. S1 but for test 6–2.

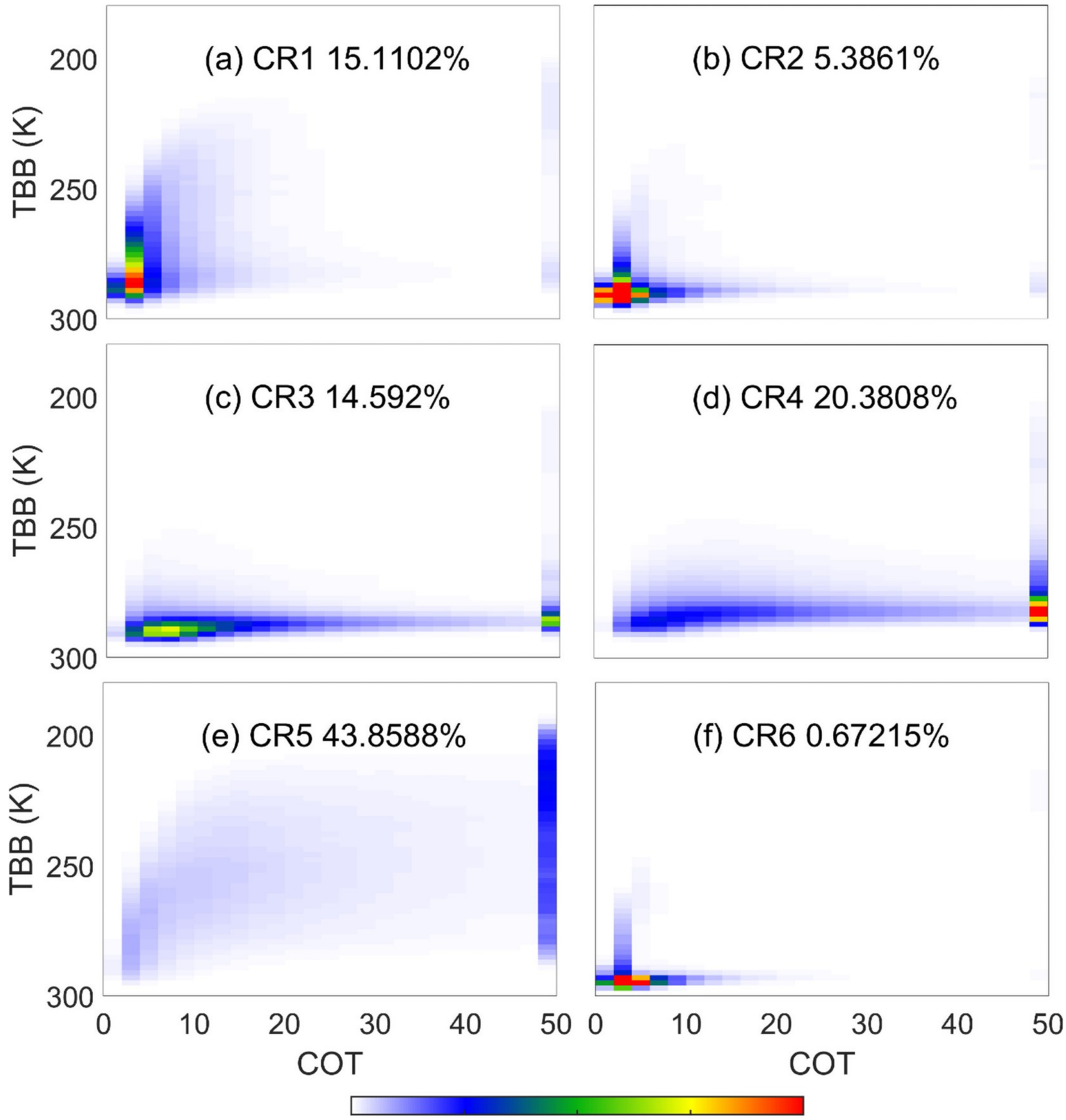

Fig. S8. Similar to Fig. S1 but for test 6–3.

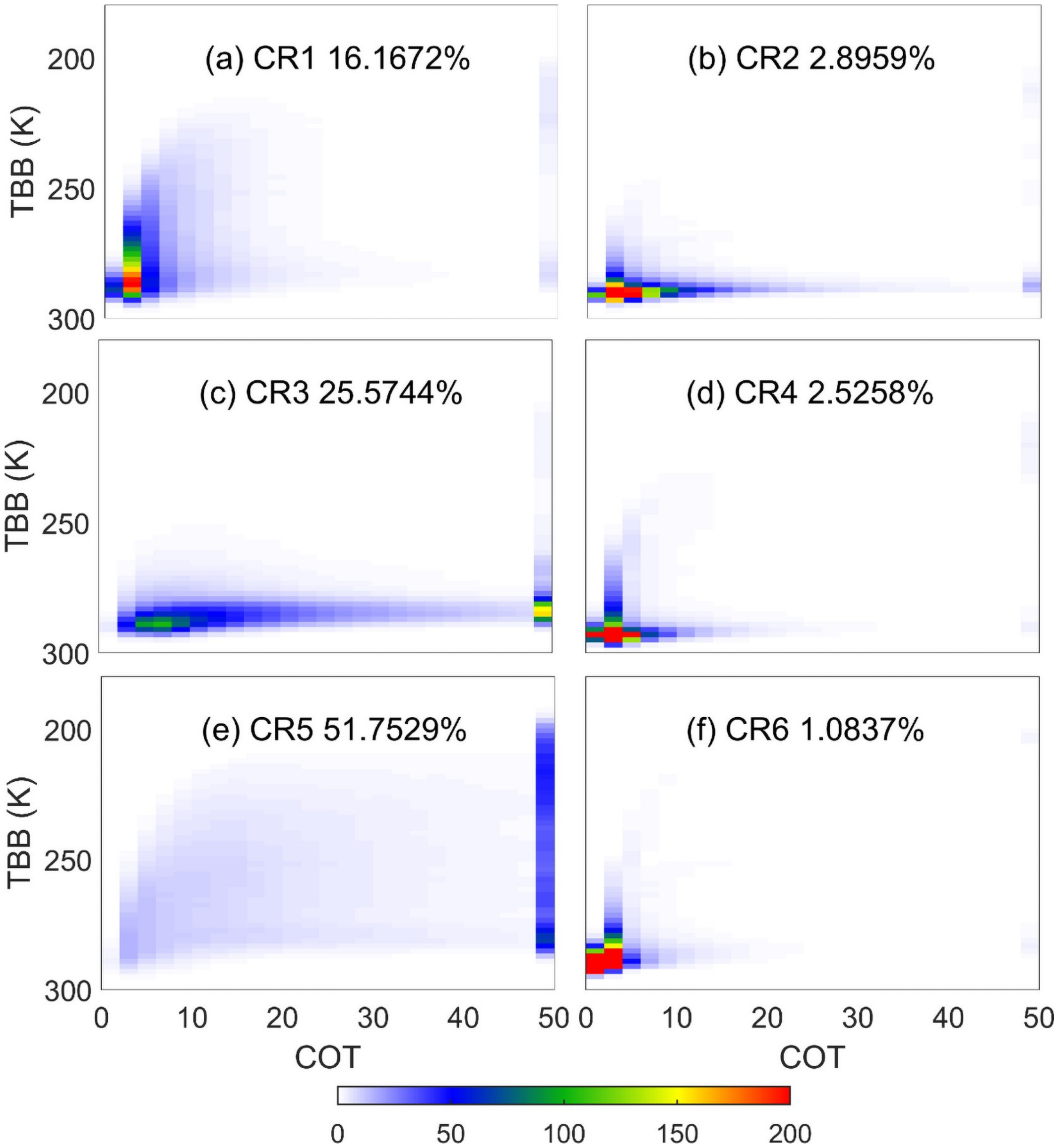

Fig. S9. Similar to Fig. S1 but for test 6–4.

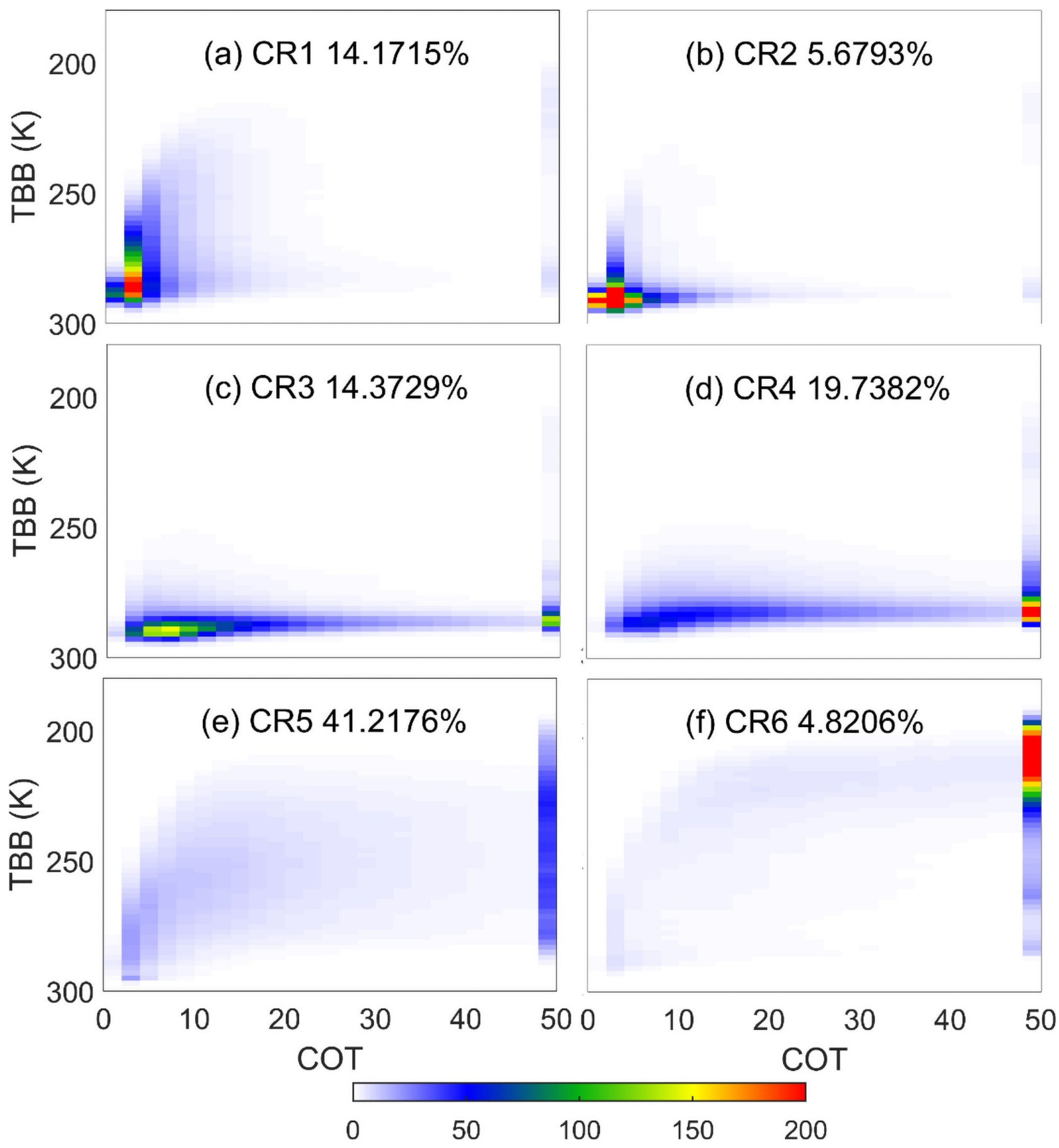

Fig. S10. Similar to Fig. S1 but for test 6–5.

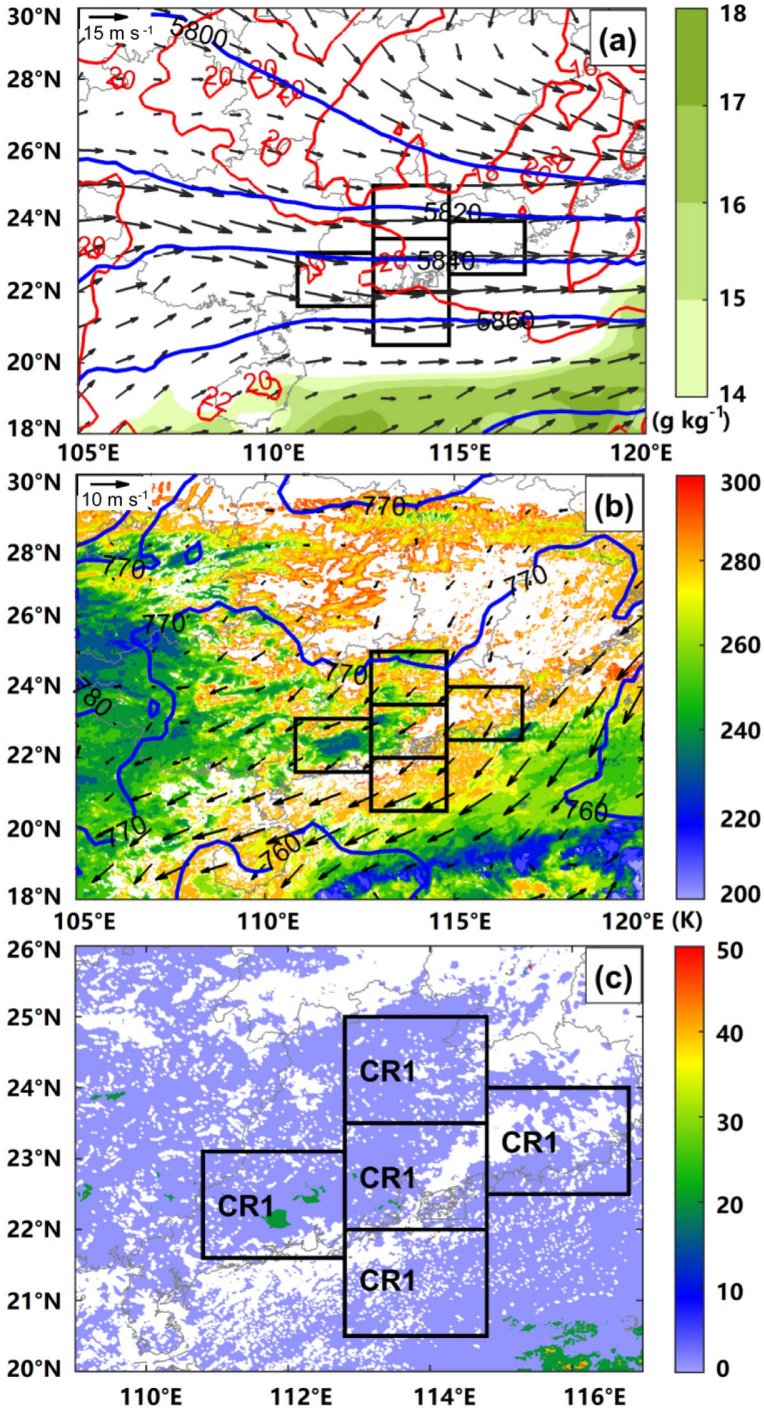

Fig. S11. Example of CR1 at 0940 LST 17 May 2017 and the synoptic background at 0900 LST the same day. (a) 500 hPa GPH (blue contour every 20 gpm) and horizontal wind (black vector), 925 hPa temperature (red contour every 2°C), and water vapor mixing ratio (shading). (b) Cloud top TBB (shading), 925 hPa GPH (blue contour) and horizontal wind vector (black vector). (c) COT (shading) over a smaller region than (a) and (b), with the CRs being labeled in the boxes that denote the subregions in the targeted area. A reference vector of 15 m s^{-1} and 10 m s^{-1} are labeled in the left-top corner of panels (a) and (b), respectively.

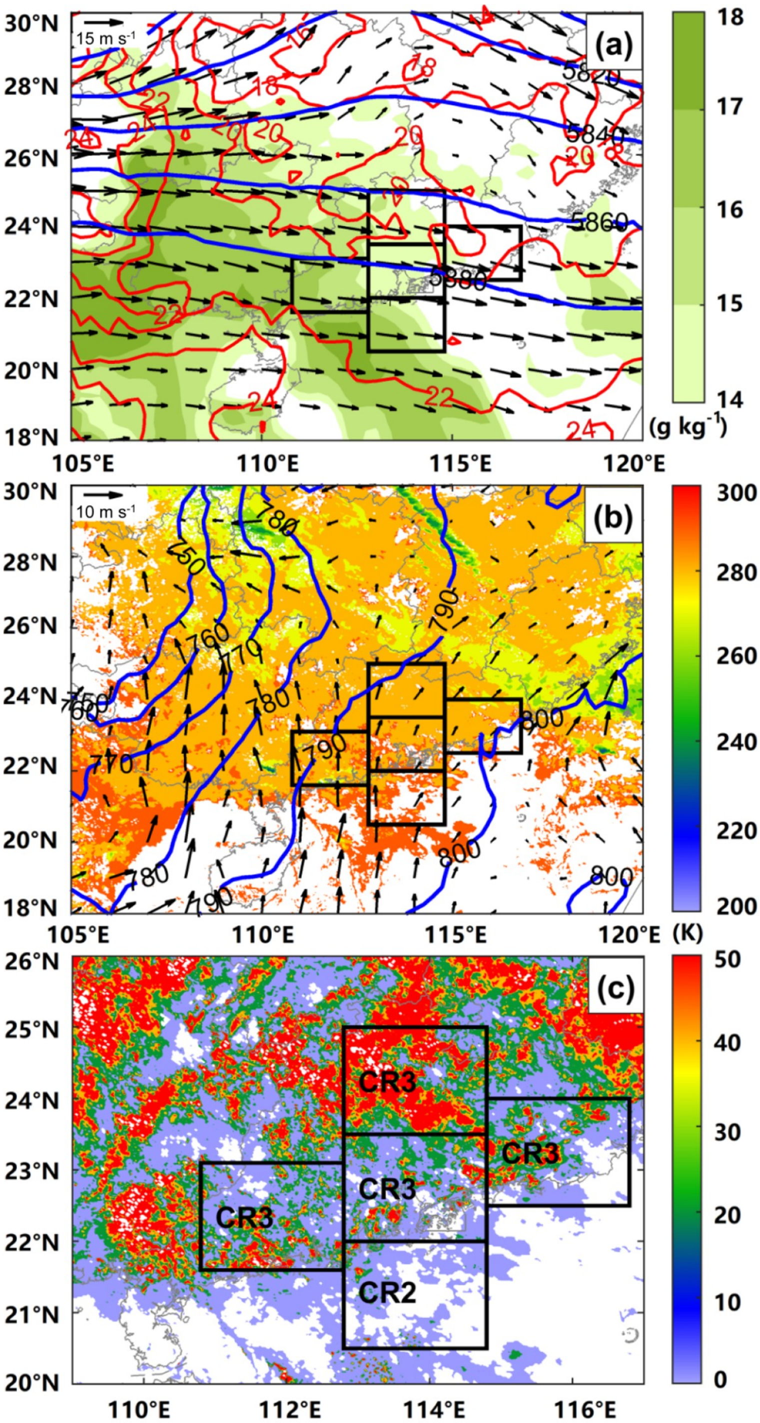

Fig. S12. Similar to Fig. S11 except for CR2 and CR3 at 1010 LST on 2 May 2017 and the synoptic background at 1000 LST the same day.

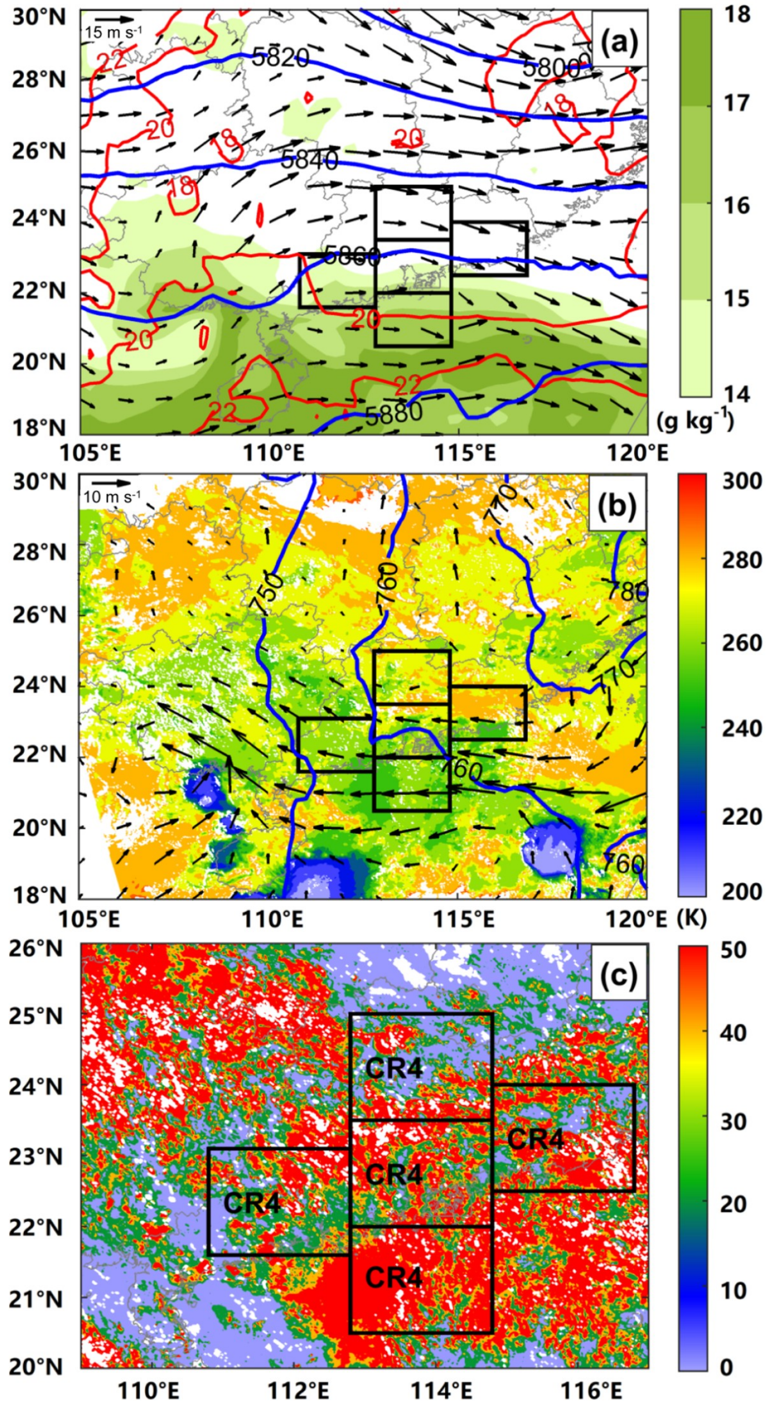

Fig. S13. Similar to Fig. S11 except for CR4 at 0900 LST on 20 May 2017 and the synoptic background at the same time.

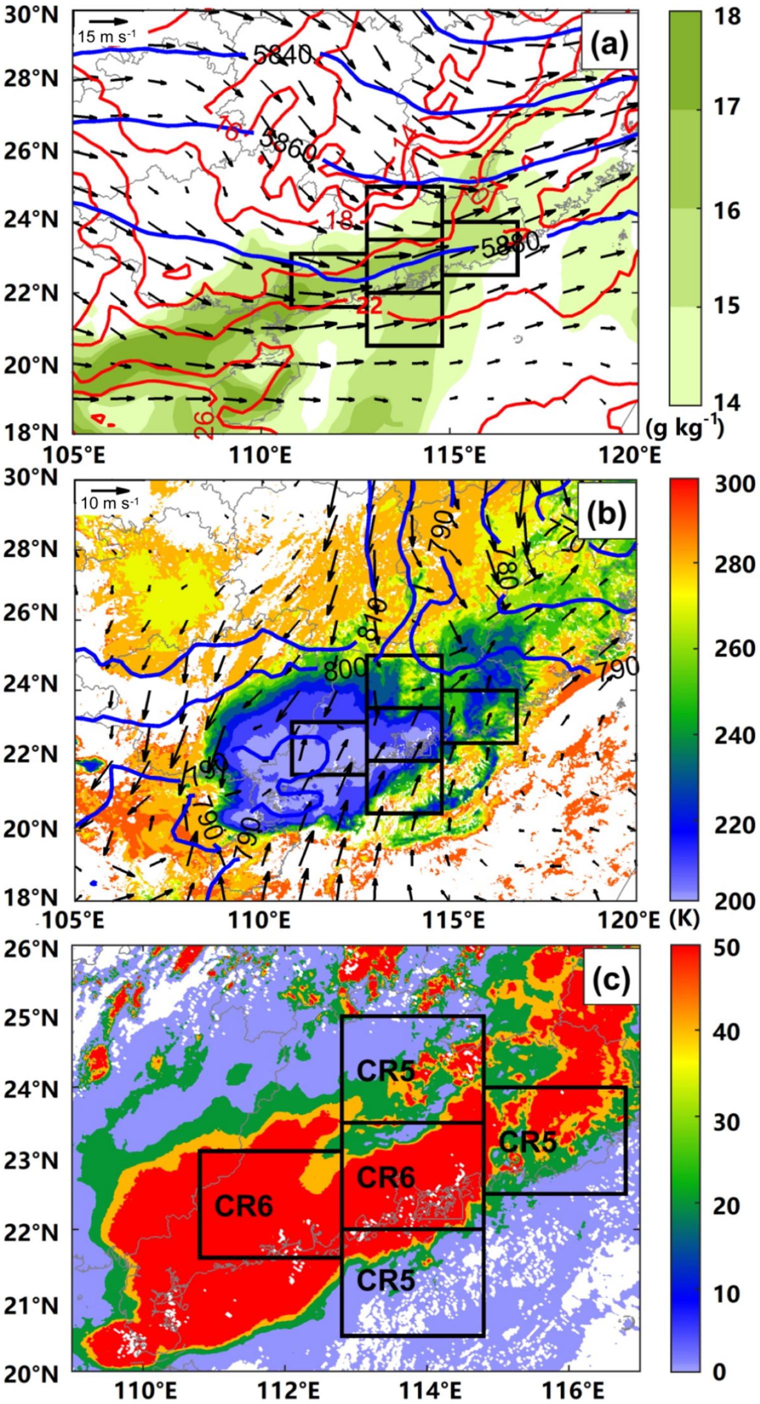

Fig. S14. Similar to Fig. S11 except for CR5 and CR6 at 1030 LST on 4 May 2017 and the synoptic background at 1000 LST the same day.