Characteristics and Formation of a Synoptic Situation Causing Sudden Turning of Mesoscale Convective Systems over South China

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The rainfall of the pre-flood rainy season (April–June) contributes more than 40% of the annual rainfall for South China, and warm-sector mesoscale convective systems (MCSs) have been indicated as the principal systems causing heavy or extreme rainstorms in this rainy season [1–4]. Compared to frontal rainfall systems, warm-sector MCSs are harder to predict [5], owing to difficulties in accurately capturing their initiation, development and motion. In contrast to the initiation and development, the motion of MCSs over South China has seldom been investigated, especially for those with complex motion.
In the present study, the characteristics and formation of a synoptic situation that causes a sudden turning motion of warm-sector mesoscale convective systems (MCSs) over South China are described, based on the collection and investigation of associated cases during April–June 2011–2017 using high-resolution observational data and ERA (ECMWF Re-Analysis)-Interim data. The results show that the blocking of a marked low-level high over eastern China (eastern high) on a strengthening low-level trough over southwestern China (southwestern trough) results in significant enhancement of southerly winds ahead of the trough, which produces a strong southeastward vertical wind shear at low levels near western Guangdong province. This low-level vertical wind shear results in sudden southeastward turning motion for the warm-sector MCSs entering into Guangdong province from Guangxi province. The formation of the eastern high is mainly attributable to the strong cyclonic wind anomaly over the northwestern Pacific Ocean, which continuously brings cold air from higher latitudes to eastern China, where high synoptic-scale transient anomaly of geopotential height (SSTA-GH) forms. This cyclonic wind anomaly is induced by a low SSTA-GH, which travels from the north and south sides of the Tibetan Plateau to the northwestern Pacific Ocean and develops significantly as a result of a strong upper-level low SSTA-GH coupling with it or approaching it. On the other hand, the high SSTA-GH over eastern China blocks the eastward extension of the low SSTA-GH originating from the Tibetan Plateau. Consequently, this low SSTA-GH turns to extend or move southeastward/southward to southwestern China, leading to intensification of the southwestern trough.

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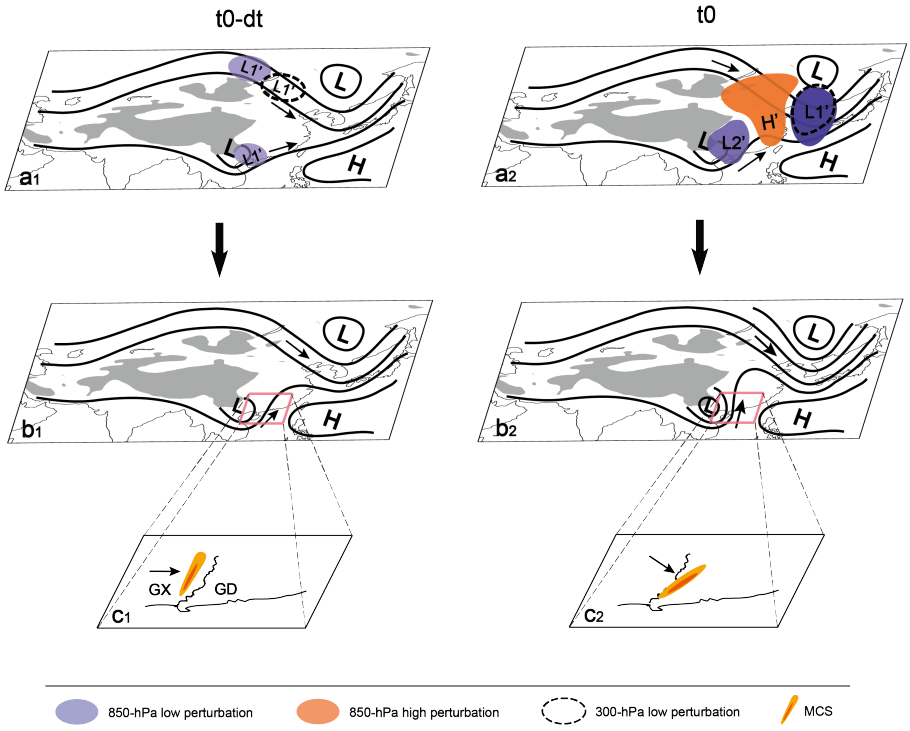

Schematic illustration of how (a1 − a2) the evolution of SSTA (color-shaded) and climatic average (contours) of geopotential height impact (b1 − b2) that of the complete geopotential height field (contours) at low levels, which promoted warm-sector MCSs to move suddenly from (c1) eastward/northeastward to (c2) southeastward when they entered Guangdong (GD) province from Guangxi (GX) province. “L” and “H” indicate the low and high value centers of geopotential height, respectively, while “L1’/L2’” and “H’” indicate the low and high SSTA-GH, respectively. The arrows indicate the (a1 − a2 and b1 − b2) flows or (c1 − c2) MCS motion directions.

