Characteristics of Warm Season Convection over Pearl River Delta, China

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Abstract

Characteristics of convection over Pearl River Delta during warm season were studied using Guangzhou Ground-based Doppler radar data between 2007 and 2009. Like previous works, our results indicate that most storms initiated over the windward side of low-level prevailing wind and along coastline (fig.1). This distributive pattern is much clearer for bigger/deeper storms and did not change dramatically after we excluded days with strong synoptic force (front, typhoon). Spatial distribution of three years' warm season accumulative rainfall also exhibited two clear maxima over windward side of northeast mountainous area and along coastline.

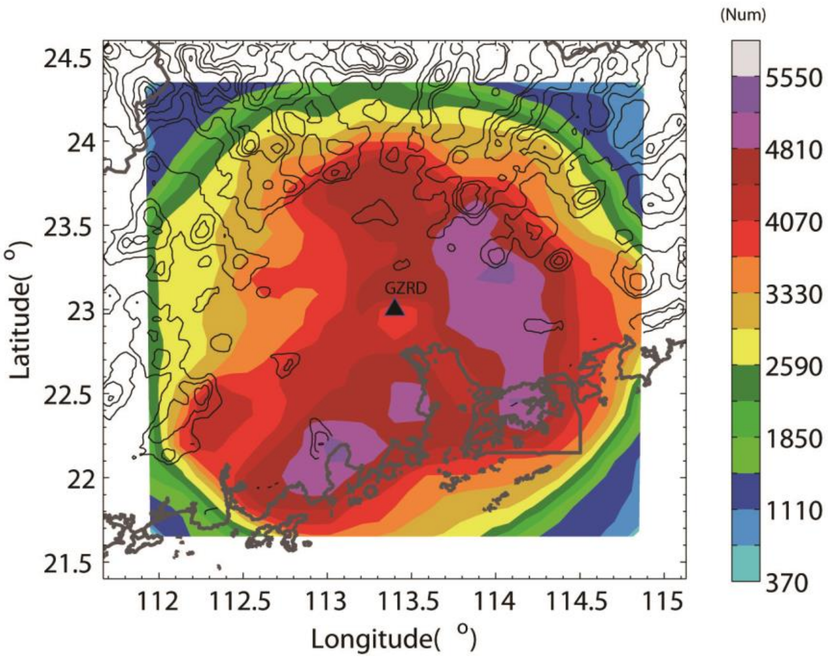

Figure1. The 3-yr (2007-2009) distribution of convection occurrence frequency during warm season

During warm season, storms happened mostly in early afternoon due to solar heating effect. While with the changing of weather pattern and atmospheric condition, Inter-monthly changes of storms' diurnal cycle and strength were dramatically. From early summer to middle summer diurnal cycle became increasingly clear and convection became stronger. Analysis results indicate that August had the most obvious single peak diurnal cycle feature and the strongest extreme storms, while September had a double peak feature and the weakest extreme storms.

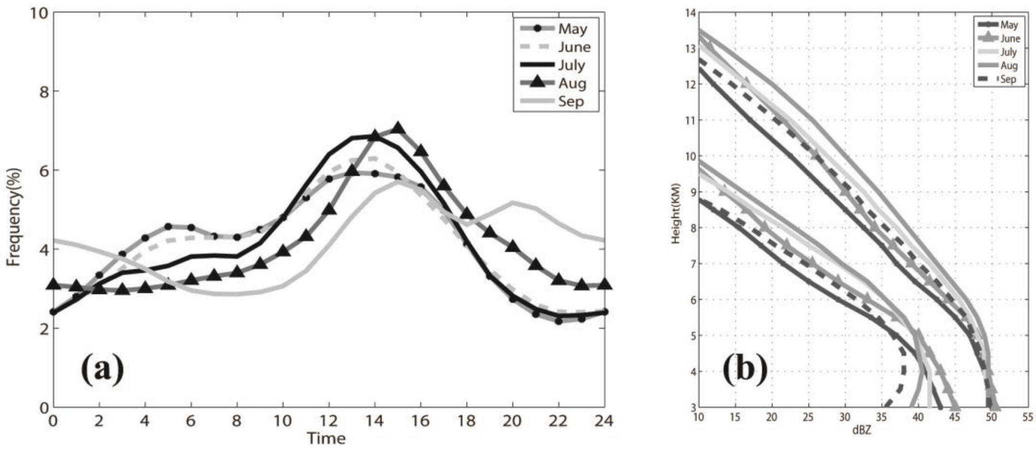

Figure 2. Characteristics of warm season convection: (a) diurnal cycle of convective features and (b) vertical profiles (60th and 90th percentile) of maximum radar reflectivity of convective features during different month.

VAD wind data of Guangzhou Doppler radar makes it possible to study the characteristics of LLJs over our research region. The criteria we used to identify LLJ incidences is similar with Chen[*Chen et al.*, 2004] : (1) maximum wind speed ≥ 12.5 ms^{-1}; (2) direction of maximum wind between 180° to 270° (southerly to westerly); (3) vertical shear below and up wind maximum ≥ $1.0 * 10^{-3}s^{-1}$.

Different with LLJs in Shanghai and Taiwan, we found LLJs in Pearl River Delta had has only one peak of LLJ incidences on 2300m altitudes (Figure3). Following previous study, we believe this incidences peak was closely related to synoptic-system-related LLJs (SLLJs) which influence South China every summer. The disappearance of Barrier-layer jets (BLJs) around 500m altitudes over this delta may due to the flatten landscape around GZRD. Orographic blocking on prevailing air flow at a low Froude number (Fr) flow regime can often produce BLJs inside PBL below 1km and this phenomenon can be found around the world [*Smith and Grubišić*, 1993; *Georgelin et al.*, 1996; *Douglas et al.*, 1998; *Igau and Nielsen-Gammon*, 1998; *Li and Chen*, 1998; *Skamarock et al.*, 1999; *Chelton et al.*, 2000]. While, there has no topographical features within a radius of 50km of GZRD. So, no obvious LLJ incidences peak can be found within 1km above the surface due to the absence of orographic blocking effect.

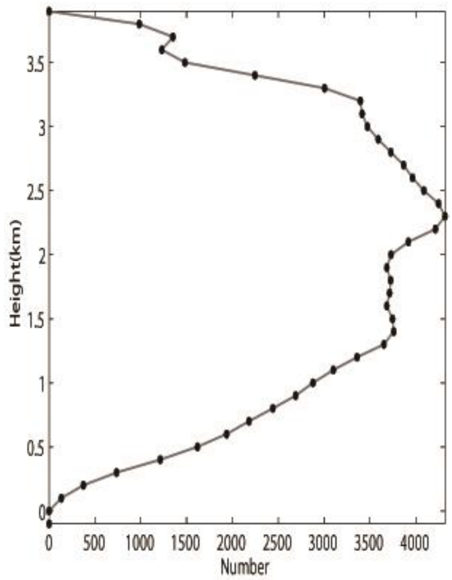

Figure3. Vertical profiles of the occurrence of frequency of LLJ for the 3-year warm season record

Storms initiated over windward slope were results of orographic lifting effect. While for storms along coastline, we found they related to low level jet (LLJ) closely with the help of VAD results and sounding data. VAD results showed LLJ influenced Pearl River Delta mostly was on 2300 m height. Based on the sounding observation on this level, we divided 3-yr warm season into LLJ days which with LLJ on 2km and no-LLJ days which without LLJ influence. We also excluded the days which were influenced by typhoon and front. It showed that coastal convective center could only be found during LLJ days. This phenomenon can be explained as synthetic effects of increasing velocity convergence along coastline, lifting effect of boundary layer and coastal front during LLJ days.

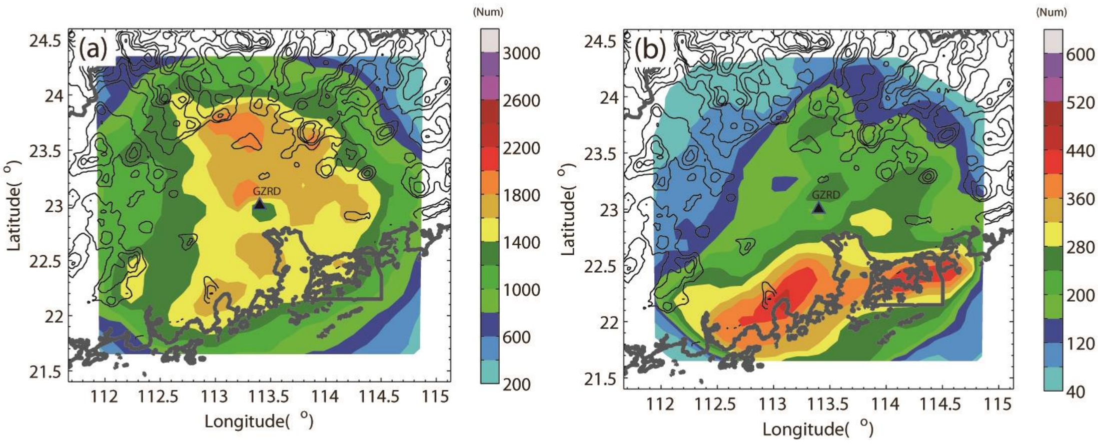

Figure4. Spatial distribution of convection occurrence frequency in (a) No-LLJ days and (b) LLJ days. Orography is superimposed on the figure in black contour with 150m interval.

We also used automatic weather station (AWS) data to investigate the difference in boundary layer conditions between SLLJs days and No-SLLJs days. We divided all automatic stations near coastline into seaside and landside sub-regions (figure 5a). Then the diurnal cycles of offshore wind speed, temperature on surface in two sub-regions and precipitation are studied.

Diurnal changes of surface temperature and offshore wind during no-SLLJs days are much more prominent than changes of SLLJs days. The early afternoon surface temperature peak is weaker in SLLJs days due to the cooling effect of stronger coastal precipitation in these days. Velocity convergence effect along coastline (the solid black line minus the dashed black line) in SLLJs days was much stronger than the convergence in no-SLLJs days. The coastal convection may relate to velocity convergence on coastline most closely.

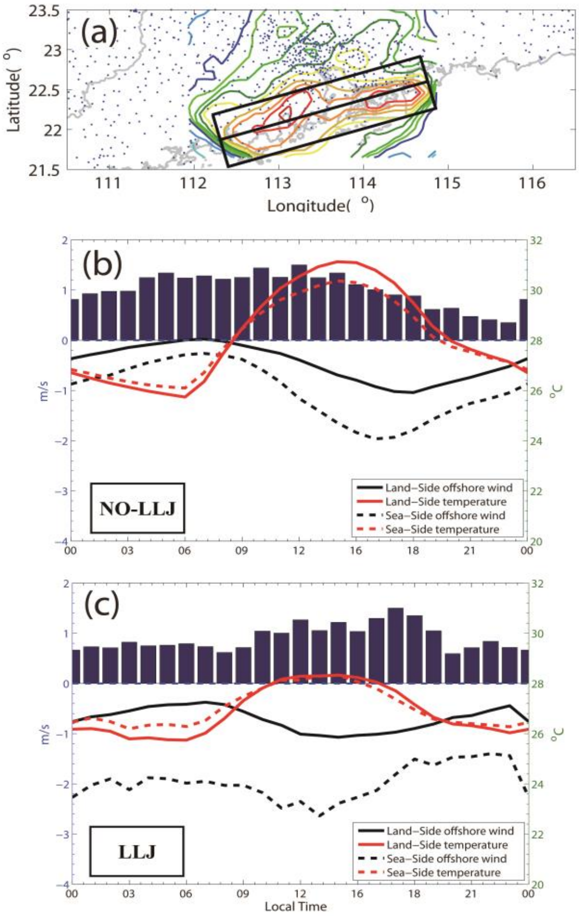

Figure5. (a) Spatial distribution of auto weather stations, color contour is convection occurrence frequency in LLJ days and the black boxes are two sub-regions along coast. Diurnal change of surface temperature (read line), off-shore wind (black line) and precipitation (blue bar) in No-LLJ and LLJ days are shown in figure b and c.