Observations of wet downburst during a heavy rain event in Taipei Metropolitan

Yang Kai-Shiang[1], Ben Jong-Dao Jou[2,3], Chi-June Jung[2], and Yu-Cheng Kao[4]

1. Department of Atmospheric Sciences, Chinese Culture University
2. Department of Atmospheric Sciences, National Taiwan University
3. Center for Weather and Climate Disaster Research, National Taiwan University
4. Satellite Center, Central Weather Bureau, Taiwan

40th Conference of Radar Meteorology, 23 August 2023 virtual poster

1. Introduction

On June 4, 2021, before the heavy rainstorm occurred in the Taipei metropolitan area, wet downburst was observed in the south of Taipei City. The development of convective cells changed significantly after the downburst occurred. This study analyzed data from radars and ground stations to understand the development process and characteristics of wet downburst in convective cells.

2. Environmental conditions

Upper air sounding of Taipei on 00 UTC, 4 June 2021 (Figure 1) shows

0℃ melting layer height = 5130 m

C.C.L, convective condensation level = 1194 m

$\Delta\theta_e$ difference of equivalent potential temperature between the near-ground maximum and the midlevel minimum (Atkins and Wakimoto 1991)

$\Delta\theta_e$ = 24.68 K ($\Delta\theta_e$ minimum at height 2625 m)

Wind index (WINDEX; McCann 1994)

$WI = 5[H_M R_Q(\Gamma^2 - 30 + Q_L - 2Q_M)]^{0.5}$ = 33.58 Kts

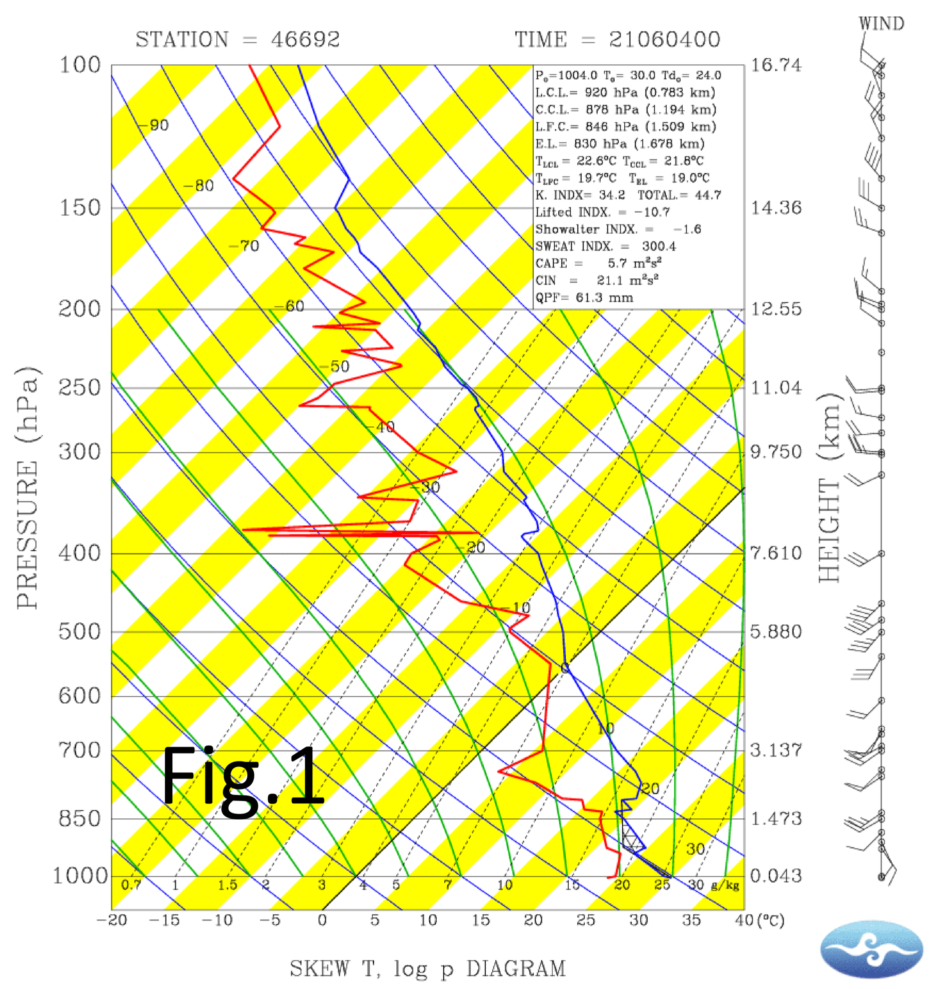
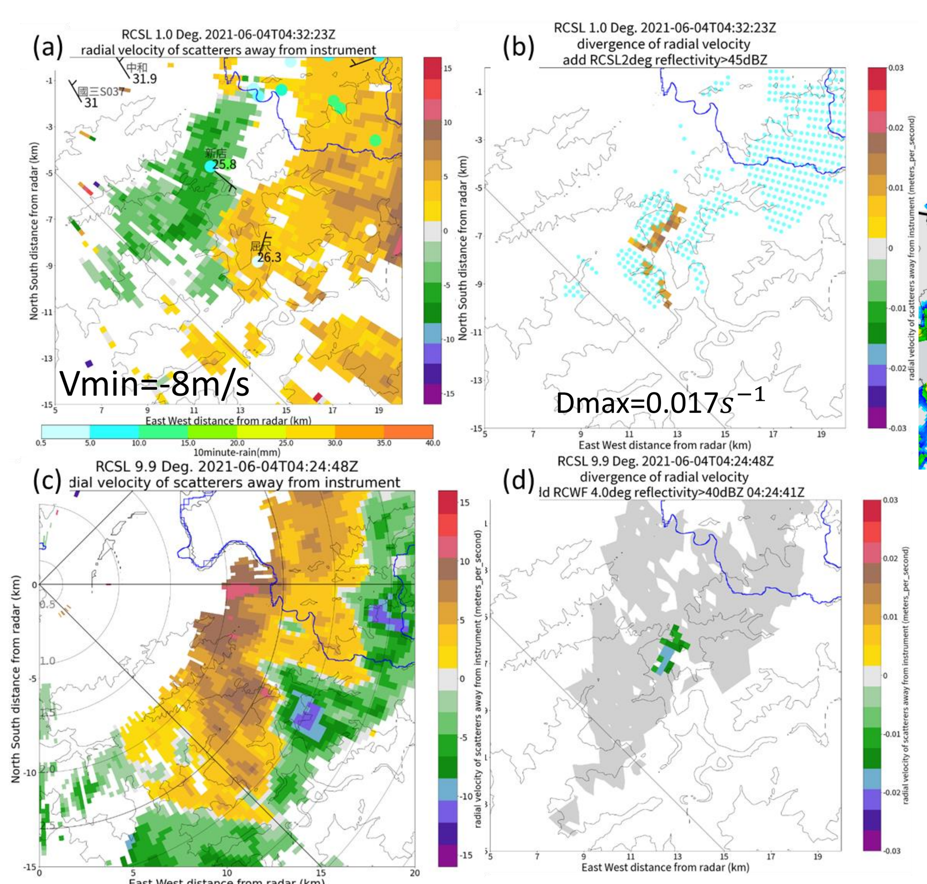


Fig.1

3. Early stage of downburst development



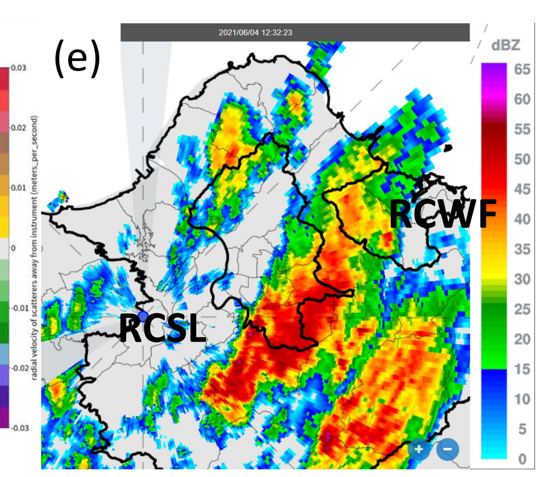


Fig. 2 (a) to (e)

Figure 2 shows

(a) 04:32 UTC RCSL 1.0 Deg. Velocity (Cool colors are moving into the radar, warm colors are leaving the radar), wind bars, dots and numbers next to the dots are surface wind speed, precipitation and temperature;

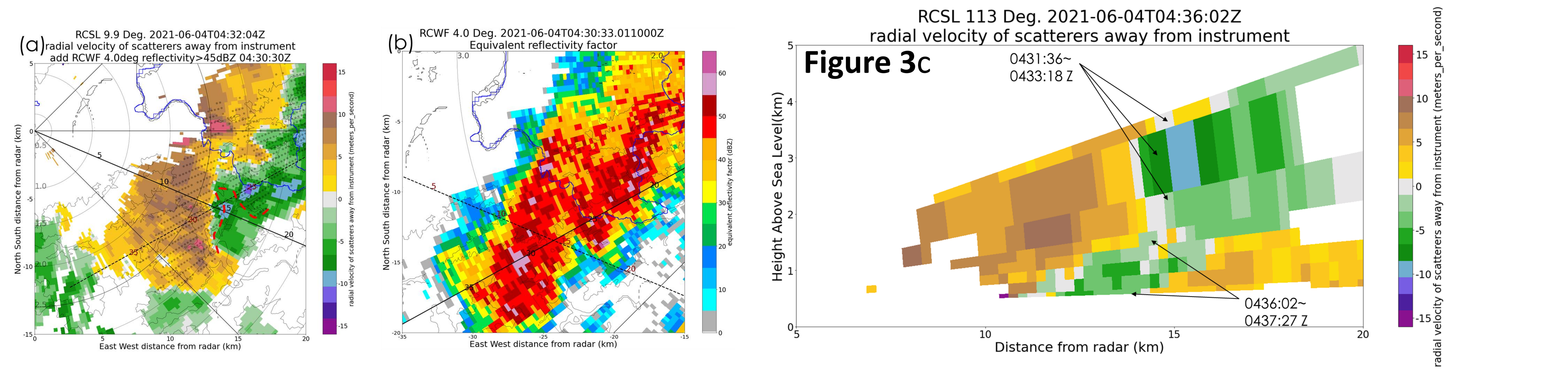
(b) 04:32 UTC RCSL 1.0 Deg. divergence of velocity $>8 \times 10^{-3} S^{-1}$ area and 2.0 Deg. ZHH > 45 dBZ area (light blue dot area);

(c) 04:24 UTC RCSL 9.9 degree radial velocity;

(d) 04:24U TC RCWF 4.0 Deg. ZHH => 45 dBZ area (gray shading) and RCSL 9.9 Deg horizontal divergence $<= -10 \times 10^{-3} S^{-1}$ area; and

(e) 04:32 UTC RCSL 1.0 - 3.0 deg composite reflectivity image.

4. Mature stage signals of downburst



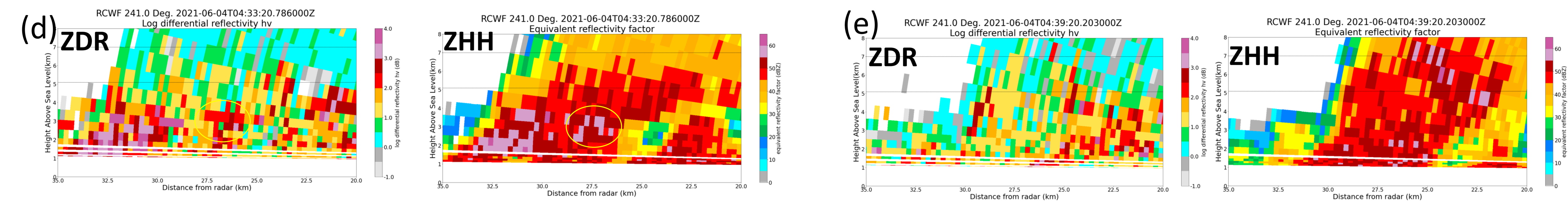


Figure 3 display (a) PPI of radial velocity at 9.9 degree elevation angle on 0432 UTC 4 June of RCSL radar (a C-band rapid scanning polarimetric radar); (b) the reflectivity field at 4.0 degree elevation angle on 0400 UTC 4 June of RCWF (a S-band polarimetric radar). The dashed red line in (a) is the echo notch from RCWF observations. (c) Composited radial velocity profile of RCSL , low-levels are 0436 ~ 0437UTC and high-level from 0431 ~ 0433 UTC. Mid-level convergence and low-level divergence signatures are observed. (d) Cross-sections of ZDR and ZH on 04:33 ~ 04:38 UTC from RCWF and yellow circle indicates location of reflectivity core; and (e) same as (d), but for 04:39~04:44 UTC 4 June 2023.The descending of the reflectivity core indicated signal of downdraft.

5. Downburst evolution and summary

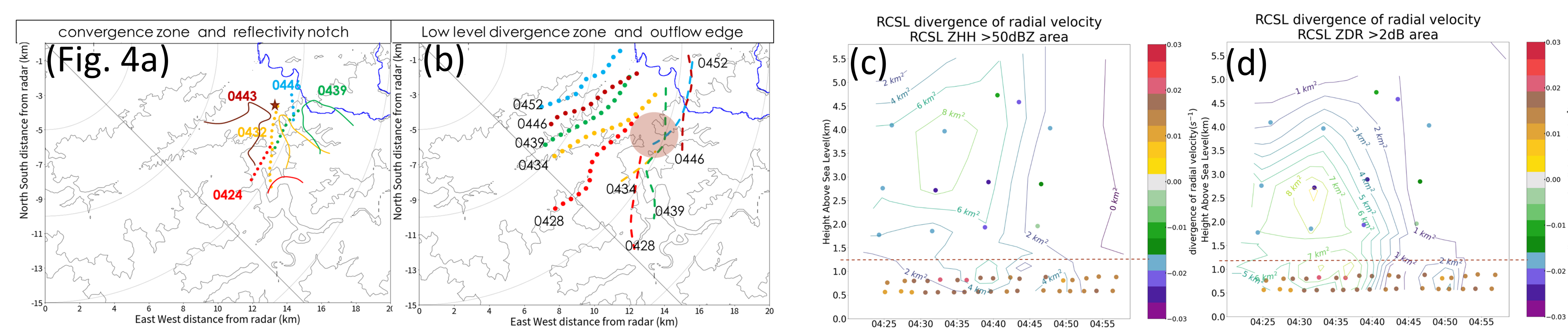


Figure 4 provide (a) midlevel convergence area (dotted line and star) and the echo notch (solid line) above the cloud base at different times); (b) Low level divergence area (long dashed line) and outflow boundary at each time precipitation core descending (brown shading circle); (c) The maximum value of divergence and minimum value of convergence near the downburst observed by RCSL and RCWF (dots) and the area of the reflectivity greater than 50 dBZ around the downburst position (contour) changes with time (UTC) and height; and (d) Same as (c), but for the area where ZDR is greater than 2dB.

6. Reference and acknowledgement

Adachi, T., K. Kusunoki, S. Yoshida, and K. I. Arai, 2016: High-Speed Volumetric Observation of a Wet Microburst Using X-Band Phased Array Weather Radar in Japan. Monthly Weather Review, 144, 3749-3765.

Atkins, R.T. and R. M. Wakimoto, 1991: Wet microburst over the southeastern United States: Implications for forecasting. Weather & Forecasting, 6, 470–482, doi:10.1175/1520-0434(1991)006,0470: WMAOTS.2.0.CO;2.

Kuster, C. M., P. L. Heinselman, and T. J. Schuur, 2016: Rapidupdate radar observations of downbursts occurring within an intense multicell thunderstorm on 14 June 2011. Wea. Forecasting, 31, 827–851, doi:10.1175/WAF-D-15-0081.1

McCann, D. W., 1994: WINDEX-A new index for forecasting microburst potential, Weather and Forecasting, 9, 532-541.

Roberts, R. D., and J. W. Wilson, 1989: A proposed microburst nowcasting procedure using single-Doppler radar. J. Appl. Meteor., 28, 285–303, doi:10.1175/1520-0450(1989)028,0285: APMNPU.2.0.CO;2

Acknowledgement: Thanks to the supports of NSTC of Taiwan *MOST 111-2119-M-002-017*.