Supplement 2: Examples of horizontal eddy structure

Here we present examples of Doppler velocity images to describe the horizontal structure of the strongest eddies in the convective boundary layer during the afternoon, when buoyancy flux is strongest, and during the night. Plan-view images of the Doppler radial velocity component anomaly from 1° elevation scans show horizontal velocity structures from 30-70 m elevation. The 1° radial velocity is nearly horizontal. The radial wind component of the mean vector is subtracted from the radial component anomaly. The radial velocity does not completely describe the eddy wind field. Nevertheless, the differences between night and afternoon cases is informative.

Two scans from the afternoon (Nov 13 07:29 and Nov 14 08:49 UTC) show velocities that are twice as strong as at night (Nov 13 17:09 and Nov 14 13:41). Fig. 2 shows the dissipation profiles, SST, wind speed, and buoyancy flux at the 4 times of the images, as indicated by crosses near the axes of Fig. 2c and 2d of the main text.

Radial velocities alternate towards and away from the lidar, resembling counterrotating convective boundary layer rolls (e.g. LeMone 1973). Convective rolls longitudinally oriented slightly to the left of the wind are instabilities of the mean shear (Brown 1970, 1972). Though these rolls transport turbulent kinetic energy upward from the surface, they generate little turbulence themselves, compared to the buoyancy flux (LeMone 1976).

The mean wind is so weak in our examples that the ocean currents strongly affect the direction of the surface wind stress, so we compare the orientation of the eddies to the direction of the ocean current-relative 10 m wind (Fig. S2). We observe that the strongest eddies in the afternoon cases (Fig. S2a,b) are aligned with the current-relative wind with a 1 km wavelength. There are also longer-wavelength eddies transverse to the wind.

The radial wind anomalies are weaker and of smaller scale at night, showing very little preferred directional structure. Only the 1 km eddies northwest of the ship are aligned with the wind at Nov 13 17:09 UTC (Fig. S2c). The scalloped line of convergence wrapping north of the ship suggests a gust front spreading northward. The vertical velocities above the ML are disturbed at this time, with dissipation greater than 10^{-5} m^2 s^{-3} extending to 1.3 km, the highest level where it is diagnosed, and well above D = 420 m. The current-relative wind is 0.1 m s^{-1} on Nov 14 13:41 UTC. Eddies at that time are strongest at 1 km scale and have no clear orientation (Fig. S2d).

The dominant scale of the eddies in the examples is close to that of the mixed layer depth D. Table S2 shows D from vertical profiles of the turbulence. The 1 km eddies in the afternoon are on the order of the mixed layer depth (770 m on Nov 13 and 970 m on Nov 14); the transverse eddies are about twice the mixed layer depth. The nocturnal scans have smaller D (42 and 500 m) and smaller-scale eddies.

Table S2. Times and mixed layer depths *D* of the plan-view images in Fig. S2.

date	time (UTC)	*D* (m)	SST (°C)	*B*(0) ($m^2\,s^{-3}$)
Nov 13	07:29	770	31.7	4.65
	17:09	420	30.3	1.90
Nov 14	08:49	970	31.3	4.43
	13:41	500	30.1	1.53

Figure

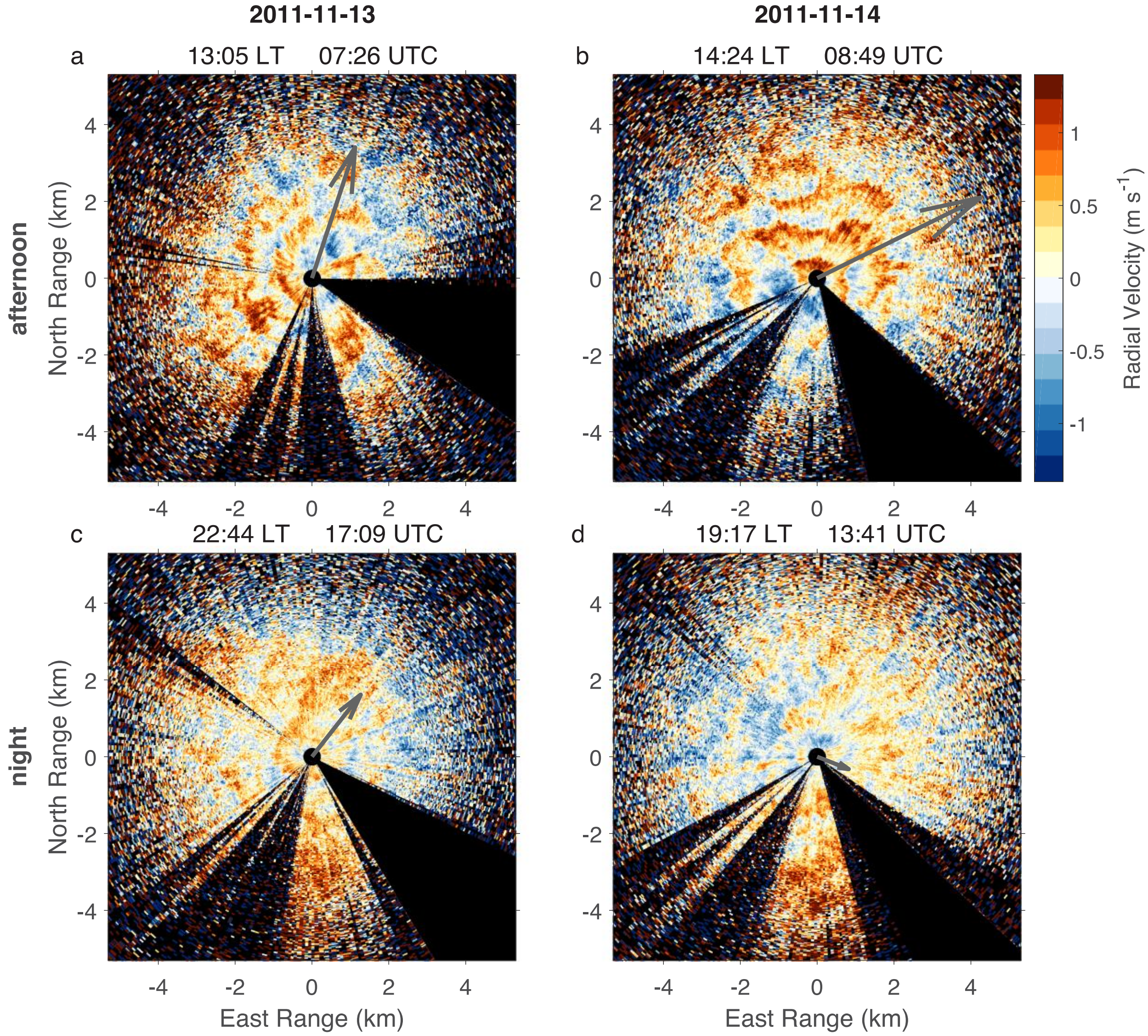

Figure S2. Examples of convective structures during daylight and night. 1° elevation angle scans from (a) afternoon Nov 13 07:29, (b) afternoon Nov 14 08:49, (c) night Nov 13 17:09, and (d) night Nov 14 13:41 UTC. Vectors show current-relative 10-m mean wind, multiplied by 3 m s^{-1}. Roll are spaced about 2 times farther apart along the axis of the mean wind.

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