Short Communication

Assessment of difference in the atmospheric surface layer turbulence characteristics during thunderstorm and clear weather days over a tropical station

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Abstract

The present study analyses the atmospheric surface layer characteristics (non-dimensionalised standard deviation of temperature and wind) during days of thunderstorm (DT) and clear weather days (CWD) during the months of pre-monsoon for years 2007, 2009 and 2010 at a tropical station Kharagpur (22°30′N, 87°20′E), India using the data sets collected by a 50-m instrumented tower. The study proposes site-specific relationships for thermal and mechanical characteristics of turbulence concerning atmospheric stability during DT and CWD during the pre-monsoon season. Although the analysis has not considered the data during the thunderstorm events (removed due to quality check), the relationships are different in CWD and DT cases. It is observed that during unstable stratification of CWD, values are less dispersed compared to the unstable region of DT. The study also reveals differences for stable stratification of DT and CWD days; even the thunderstorms are occurring during an unstable regime. The turbulence intensity for wind obeys the 1/3 power law, whereas for the unstable (stable) region of the temperature the – 1/3 (– 1) slope exists.

Keywords Atmospheric stability · Surface layer · Thunderstorm · Turbulence

1 Introduction

Dispersion of the pollutants, transfer of moisture, momentum and heat and scalars (pollutants) in the atmospheric boundary layer (ABL) are some important features based on turbulent fluctuations [18, 41]. The lowest layer in ABL is known as the surface layer. The study of atmospheric turbulence in the SL is essential to understand the transport of moisture, momentum and heat transportation from near the surface to higher levels in the atmosphere [30]. The SL has most substantial gradients near the surface, and hence, its accurate representation is crucial for the bulk transport description in the ABL [3]. To study the turbulence in SL, we need to find the relationships of the non-dimensionalised standard deviation of wind components and temperature (σ_u/u_*, σ_v/u_*, σ_u/u_* and σ_T/T_*), with the non-dimensionalised length scale, i.e. *z/L* (hereafter referred as ζ), where *L* is Obukhov length. These relationships are not universal but vary with site and season [4, 28].

The relationships between $\sigma_{u,v}/u_*$ and ζ in unstable stratification generally follow a 1/3-power law (e.g. [5, 7]). Hedde and Durand [11] found the power of 2 for unstable cases and 1.3 for neutral ranges. There are even cases of no relationship for σ_u/u_* with ζ [14]. Several studies reported the relationship of σ_w/u_* with ζ for various sites (e.g. [12, 14, 23, 36] and it is found to be proportional to (1/3) power for unstable condition and to (1) power for stable conditions. Temperature statistics are supposed to vary above horizontally homogeneous surfaces, i.e. over the vegetation or the ocean surface (e.g. [11, 19]. The relationship of the normalised standard deviation of temperature (σ_T/T_*)

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and ζ has been reported by various researchers time to time over different regions [22, 29, 36].

The deficiency of in situ fast response observational data sets over the tropical land region is a severe constraint on the study of turbulence characteristics in the atmosphere. Over the Indian region, only few studies exist, which explicitly takes into account of turbulence characteristics (e.g. [7, 23, 25, 26, 34, 36, 41, 45]. However, studies of turbulence characteristics (standard deviations of velocity and temperature) are mainly focused for establishing relationships for unstable/stable stratification and modelling validations [16, 17]. These relationships were absent over the north-eastern region of India, where the pre-monsoon season experiences severe thunderstorms, and the cyclones are making landfall over the coastal regions. The previous works are only focused on the relationship establishment and not on any difference in these relationships concerning any convective activity (thunderstorm, cyclone) occurring over the region. During thunderstorm days (DT), over the Kharagpur region, the contribution to fluxes by subgrid-scale processes is different from that of the clear weather days (CWD) [38, 39]. This result is valid even for stable conditions of these days when there is no sign of such convective activity [37], which indicates that turbulent characteristics differ for CWD to DT.

The present study aims to understand whether the mechanically and thermally induced intensity of turbulence relationships with stability parameter (ζ) differs under different atmospheric stability conditions for cases of DT and CWD, and what are the existing relationships for them. The study utilises fast response data collected for pre-monsoon months (March–May) over a tropical station Kharagpur (22°30′N, 87°20′E) located in the Eastern Indian region, where thunderstorms are frequent and devastating during pre-monsoon season [32, 33, 35]. The results maybe helpful to improve the behaviour of turbulence characteristics by improving existing parameterisation schemes in mesoscale models, which in turn will be beneficial for better prediction of such thunderstorms over the region.

2 Site and data description

The study site Kharagpur (22°30′N, 87°20′E) experiences severe thunderstorms during the pre-monsoon season, locally known as Kal-Baishakhi or Nor'westers [27]. The details about the soil texture, vegetation and local characteristics of the site are explained in the study of Tyagi and Satyanarayana [31]. We used in situ observations collected using RM Young sonic anemometer (frequency 10 Hz) installed at 10 m height on a 50 m tower. A complete description of the site and installed sensors, with their make and model, is given in the study of Tyagi and Satyanarayana [31, 38]. In the present study, half-hourly averaged standard deviations and fluxes are computed from the 10 Hz data using the eddy covariance technique. At the site, we have observed DT with the help of logbook records and information from Doppler Weather Radar (DWR) Kolkata. A thunderstorm is defined even if no rainfall occurred at the site and only thunder is heard, and we have convective cells over the station. If there is no activity for a whole day 24 h period, that day is CWD. Table 1 shows the DT and CWD cases chosen for the present study.

A thorough quality check has been performed for the data sets before using them for final analysis. The quality checks include removal of data during rain hours, spike removal, tilt angle correction, linear detrending, spectral analysis and steady state test [9, 13, 42]. The details of the procedure can be obtained from the study of Tyagi and Satyanarayana [40]. Out of a total 2064 half-hourly data sets of FRD (1104 for CWD and 960 for DT), 970 data sets have been finally considered into the analysis (561 for CWD and 409 for DT) after the quality check. The higher

Table 1 Thunderstorm and non-thunderstorm cases for the present study at Kharagpur

S. no.	Thunderstorm cases		Non-thunderstorm cases
	Date	Local time of thunderstorm event (h)	Date
1	26 April 2007	1530–1632	14 April 2007
2	27 April 2007	1703–1800	22 April 2007
3	7 May 2007	1512–1636	23 April 2007
4	8 May 2007	1533–1654	28 April 2007
5	18 May 2007	1300–1425, 1500–1603	29 April 2007
6	19 May 2007	1445–1627	30 April 2007
7	21 May 2007	1551–1742	4 May 2007
8	28 May 2007	1533–1607	14 May 2007
9	22 April 2009	1642–1724	31 May 2007
10	6 May 2009	1448–1512	14 April 2009
11	11 May 2009	1721–1809	15 April 2009
12	12 May 2009	1212–1321	1 May 2009
13	14 May 2009	1609–1654	5 May 2009
14	03 May 2010	1406–1512	7 May 2009
15	5 May 2010	1500–1615	1 May 2010
16	7 May 2010	1530–1703	2 May 2010
17	9 May 2010	1540–1700	4 May 2010
18	21 May 2010	1327–1442	8 May 2010
19	22 May 2010	1503–1554	11 May 2010
20	29 May 2010	1524–1618	12 May 2010
21	–	–	15 May 2010
22	–	–	16 May 2010
23	–	–	31 May 2010

rejections for these data sets are due to not following steady state test during the observational period.

3 Methodology

Following the Monin–Obukhov similarity theory (MOST), the standard deviation of wind components and temperature non-dimensionalised by friction velocity (u_*) or friction temperature (T_*) will serve as universal functions of ζ in the steady and horizontally homogeneous flow u_* (m/s) is given as

$$u_* = ((\overline{u'w'})^2 + (\overline{v'w'})^2)^{\frac{1}{4}}, \tag{1}$$

the mean quantity is represented by overbar and the turbulent/fluctuation value by the prime [10, 30]. The T_* (Kelvin) and length scales are given by

$$T_* = \overline{w'T'}/u_*, \tag{2}$$

$$L = -u_*^3/\left[k\left(g/\overline{T}\right)\left(\overline{w'T'}\right)\right]. \tag{3}$$

here k = von Karman constant, w = vertical velocity (m/s) and g = acceleration due to gravity (m/s^2).

The variances and standard deviation will give the information about the intensity of turbulence in the data and are essential for the accurate modelling of turbulent diffusion and transport in the surface layer. The surface layer similarity functions, e.g.σ_u/u_*, σ_v/u_*, σ_w/u_*, *and* σ_T/T_* obtained from the fast response data and relationships concerning ζ are derived separately for DT and CWD.

4 Results

The present study proposes normalised wind components and temperature turbulence characteristics relationships with stability during both DT and CWD. The results are as follows.

4.1 Normalised standard deviation of wind components

The variation of σ_u/u_*, σ_v/u_*, σ_w/u_* with stability parameter (ζ) for both stable and unstable situations during DT and CWD is studied. The existing relationships are tested and found unsuitable for the present study, which justifies establishing new relationships for the site, given second quartile values. For both stable and unstable regime, the wind components are pursuing 1/3 power law irrespective of DT or CWD. However, the DT and CWD relationships have different constant values in formulas for stable/unstable stratification, which are as follows:

For DT during unstable stratification ($-1 < \zeta \le -0.001$):

$$\sigma_u/u_* = 1.35\,(1 - 3\,\zeta)^{1/3}, \tag{4}$$

$$\sigma_v/u_* = 1.43\,(1 - 3\,\zeta)^{1/3}, \tag{5}$$

$$\sigma_w/u_* = 1.2\,(1 - 3\,\zeta)^{1/3}. \tag{6}$$

For DT during stable stratification ($0.001 < \zeta \le 1$):

$$\sigma_u/u_* = 1.35\,(1 + 3\,\zeta)^{1/3}, \tag{7}$$

$$\sigma_v/u_* = 1.43\,(1 + 18\,\zeta)^{1/3}, \tag{8}$$

$$\sigma_w/u_* = 1.2\,(1 + 3\,\zeta)^{1/3}. \tag{9}$$

For CWD during unstable stratification ($-1 < \zeta \le -0.001$):

$$\sigma_u/u_* = 1.2\,(1 - 5\,\zeta)^{1/3}, \tag{10}$$

$$\sigma_v/u_* = 1.3\,(1 - 26\,\zeta)^{1/3}, \tag{11}$$

$$\sigma_w/u_* = 1.18\,(1 - 5\,\zeta)^{1/3}. \tag{12}$$

For CWD during stable stratification ($0.001 < \zeta \le 1$):

$$\sigma_u/u_* = 1.2\,(1 + 2\,\zeta)^{1/3}, \tag{13}$$

$$\sigma_v/u_* = 1.3\,(1 + 26\,\zeta)^{1/3}, \tag{14}$$

$$\sigma_w/u_* = 1.18\,(1 + 12\,\zeta)^{1/3}. \tag{15}$$

Figure 1 shows the scatter diagram between the normalised wind components and ζ with a curve fit for the second quartiles points derived for DT and CWD at Kharagpur.

The relationships for longitudinal velocity (Fig. 1a–b) are considerably different for DT and CWD, following the same slope with DT values on higher side during both unstable and stable stratification. In the case of meridional velocity (Fig. 1c–d), the relationships are not as distinguishable different for DT and CWD as for longitudinal velocity. During unstable situations (Fig. 1c), CWD and DT relationships are close to each other in range $-0.02 < -\zeta < -0.001$ which start deviating afterwards. In the case of a stable region, values of DT are higher than CWD up to $\zeta = 0.02$, after which CWD values are little higher than DT. The values of σ_w/u_* show less scatter (Fig. 1e–f)) and almost fall in line within the stability range from -0.1 to 0.1 as noticed by Krishnan and Kunhikrishnan [14]. With instability, the σ_w/u_* increases and follow 1/3 power law as observed by previous studies [23, 29]. The difference of present relationships from the relationships given in the literature is explaining the seasonal and site-specific characteristics of such relationships in the neutral region. However, they are following similar power law for the same variables as defined in the literature. It is remarkable to note that the

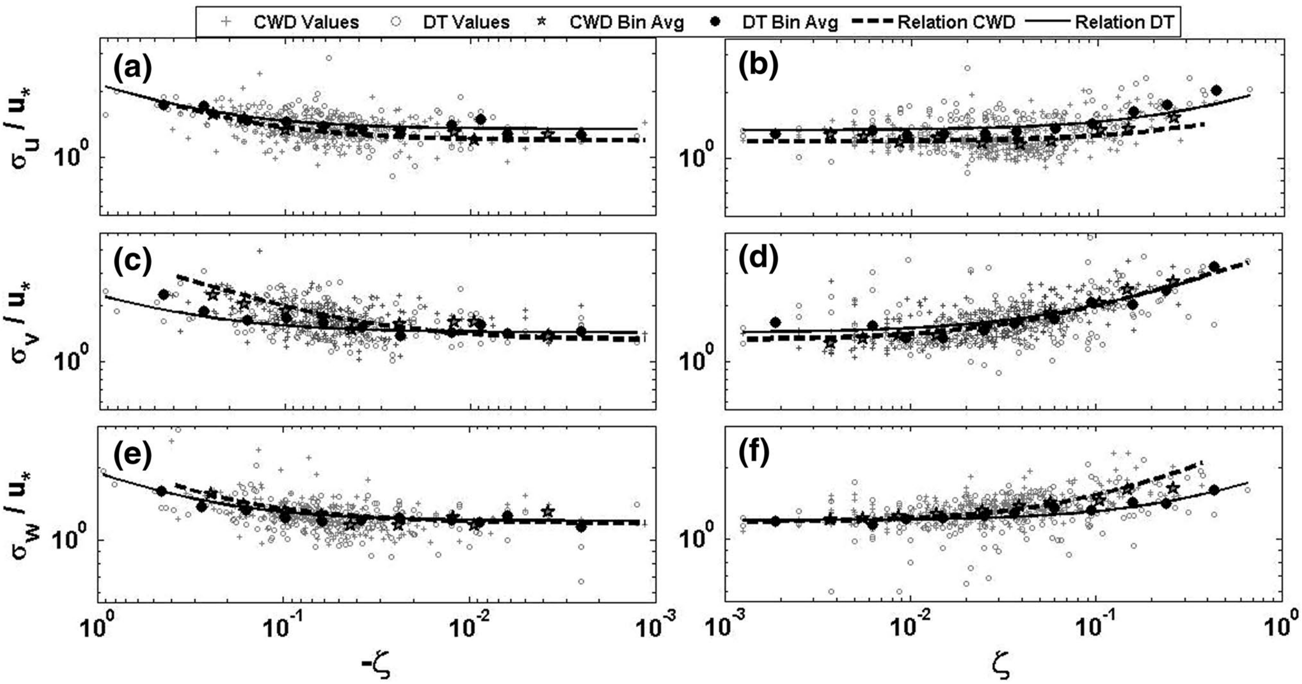

Fig. 1 Normalised turbulent intensity of longitudinal (**a**, **b**), meridional (**c**, **d**), and vertical velocity (**e**, **f**) as a function of ζ at Kharagpur, with the present study relationships fitted for bin quartile points

convective activity occurrence over the site is in the daytime (unstable stratification) for the chosen cases of study. However, the stable regions are also depicting the difference in the relationships for DT and CWD.

4.2 Normalised standard deviation of temperature

Figure 2 shows the present study fit by considering second quartile values for CWD and DT temperature deviation. The relationship for the present study in the unstable region is showing a similar trend as Wyngaard et al. [44] and Kader and Yaglom [12].

The variation of σ_T/T_* with ζ follows 1/3 power law during unstable stratification, and the observations are disseminating in DT rather than CWD where they are in the range of 0.3–0.003. For the stable stratification, σ_T/T_* decrease with increasing ζ following Bian et al. [2]. In stable stratification, the range of points is equally dispersed in both CWD and DT. DT average values are always higher than CWD in magnitude. The σ_T/T_* and ζ relationships during unstable/stable stratification for CWD and DT are as follows:

For DT:

$$\sigma_T/T_* = 0.8\,(\zeta)^{-1/3}, \quad -1 < \zeta \le -0.001 \tag{16}$$

$$\sigma_T/T_* = 3.1\,(1 + 0.67\,\zeta)^{-1}. \quad 0.001 < \zeta \le 1 \tag{17}$$

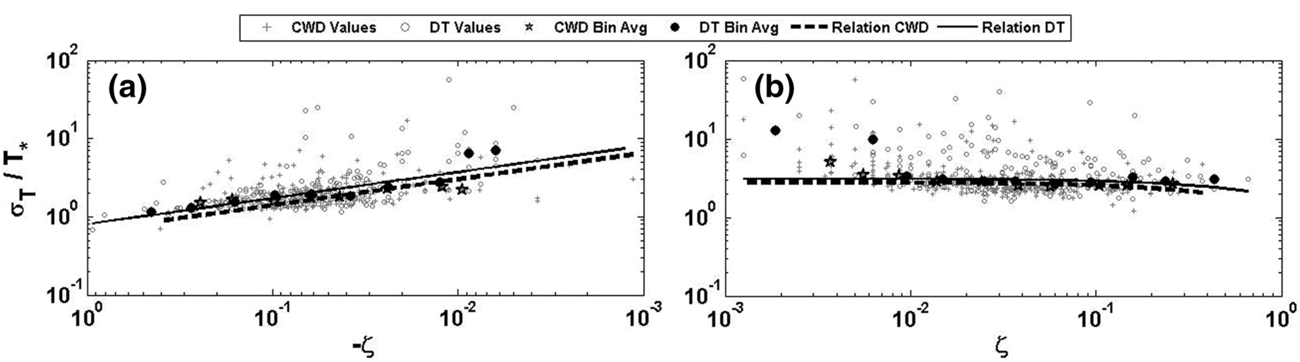

Fig. 2 Normalised turbulent intensity of temperature at Kharagpur during (**a**) unstable and (**b**) stable conditions as a function of *z* at Kharagpur with the present study relationships fitted for bin quartile points

For CWD:

$$\sigma_T/T_* = 0.65\,(\zeta)^{-1/3}, \quad -1 < \zeta \le -0.001 \tag{18}$$

$$\sigma_T/T_* = 2.8\,(1 + 0.97\,\zeta)^{-1}. \quad 0.001 < \zeta \le 1 \tag{19}$$

The neutral stratification values of non-dimensionalised wind and temperature components from the present and previously published studies are presented in Table 2.

DT mean values of normalised standard deviations (σ_u/u_*, and σ_v/u_*) are found to be higher than that of CWD in all three stabilities. The inference is based on bin average values of these normalised parameters for both DT and CWD in all three stability ranges. In the near neutral stratification, during DT (CWD) mean value of σ_w/u_* is 1.23 (1.30) is observed, which are in close agreement to the reported values (1.1–1.4) in the near neutral conditions [21, 43]. For temperature parameters, DT values are higher than that of CWD. There are some characteristic differences found between DT and CWD. The unstable region of CWD is having a definite range of values (less scatter), while the stable region is more scattered. However, for DT, both unstable and stable values are disseminating as compared to CWD, depicting the anisotropic behaviour of turbulence during DT. Table 2 shows values in neutral stability for the present study DT and CWD along with previous values from the literature. The turbulence characteristics values during DT and CWD for the present study differ with higher magnitudes of normalised longitudinal velocity and temperature during DT.

The integral turbulence characteristics at Kharagpur with respect to wind direction are shown in Fig. 3. It is clear that wind sector 0°–135° is not having much data points and variations of CWD and DT. However, in the wind sector 135°–360°, integral turbulence characteristics are significantly showing variations and difference between CWD and DT for the study period. For all three wind components, the normalised wind intensities are higher in CWD compare to DT in wind sector 135°–270°, whereas from 270°–360°, DT are having higher ranges of turbulence intensities compare to CWD. For normalised temperature variations (Fig. 3d), the DT are having higher fluctuations in values for all wind sectors compare to CWD. The differences based on stability are not very clear for DT and CWD based on wind directions as mentioned by Foken [10] and DeBruin et al. [6]. Table 3 shows functional forms for DT and CWD in the present study and widely used functional forms reported in the literature for stable and unstable conditions. It is apparent from Table 3 that the functional forms of integral turbulence statistics are varying place to place with different stability ranges.

5 Summary

The present study investigates statistics measure for the turbulent variance of mechanical and thermal characteristics, during pre-monsoon thunderstorm season over a tropical Indian site, Kharagpur. The relationships for DT and CWD [Eq. (4)–(19)] have different slopes for DT and CWD but with the same power law, revealing the varying intensity of turbulent transport of energy. The reason

Table 2 The neutral stratification values of non-dimensionalised wind components and temperature from the present and previously published studies

Study	$\frac{\sigma_u}{u_*}$	$\frac{\sigma_v}{u_*}$	$\frac{\sigma_w}{u_*}$	$\frac{\sigma_T}{T_*}$	Comments
Lumley and Panofsky [15]	2.45	1.9	1.25	–	–
McBean [18]	2.2	1.9	1.4	1.6	Grassland, British Columbia, Canada
Panofsky and Dutton [21]	2.65	2.00	1.20	–	Erie, CO (rugged Terrain)
	3.20	2.90	1.24	–	Rock Spring, PA (Rugged Terrain)
	3.50	3.80	1.24	–	Rock Spring (Mountain)
Stull [30]	2.46–2.55	1.709–2.46	1.0–1.58	2	Madison. Wisconsin, USA
Qi and Wnag [24]	2.98	2.91	1.35	–	Wudaoliang area in Tibetan Plateau
Andreas et al. [1]	2.55	–	1.20	3.2	Patchy vegetation grassland, Neutral; $z=4$ m
Pahlow et al. [20]	2.3		1.1	3.0	Stable; $z=1$–4.3 m
Krishnan and Kunhikrishnan [14]	2.32	2.29	1.37	6.5	Tropical Inland station,; $z=3$ m
Bian et al. [2] Site 1 Gerze	3.21	2.69	1.46	2.3	Southeastern Tibetan Plateau
Bian et al. [2] Site 2 Qamdo	3.45	3.15	1.30	7.2	Southeastern Tibetan Plateau
Dharamaraj et al. [7]	2.5	2.25	1.25	4	River Basin,; $z=5$ m
Present study TD	1.36	1.59	1.23	4.4	Tropical coastal station, Grassland; $z=10$ m
Present study NTD	1.27	1.62	1.30	1.34	Tropical coastal station, Grassland; $z=10$ m

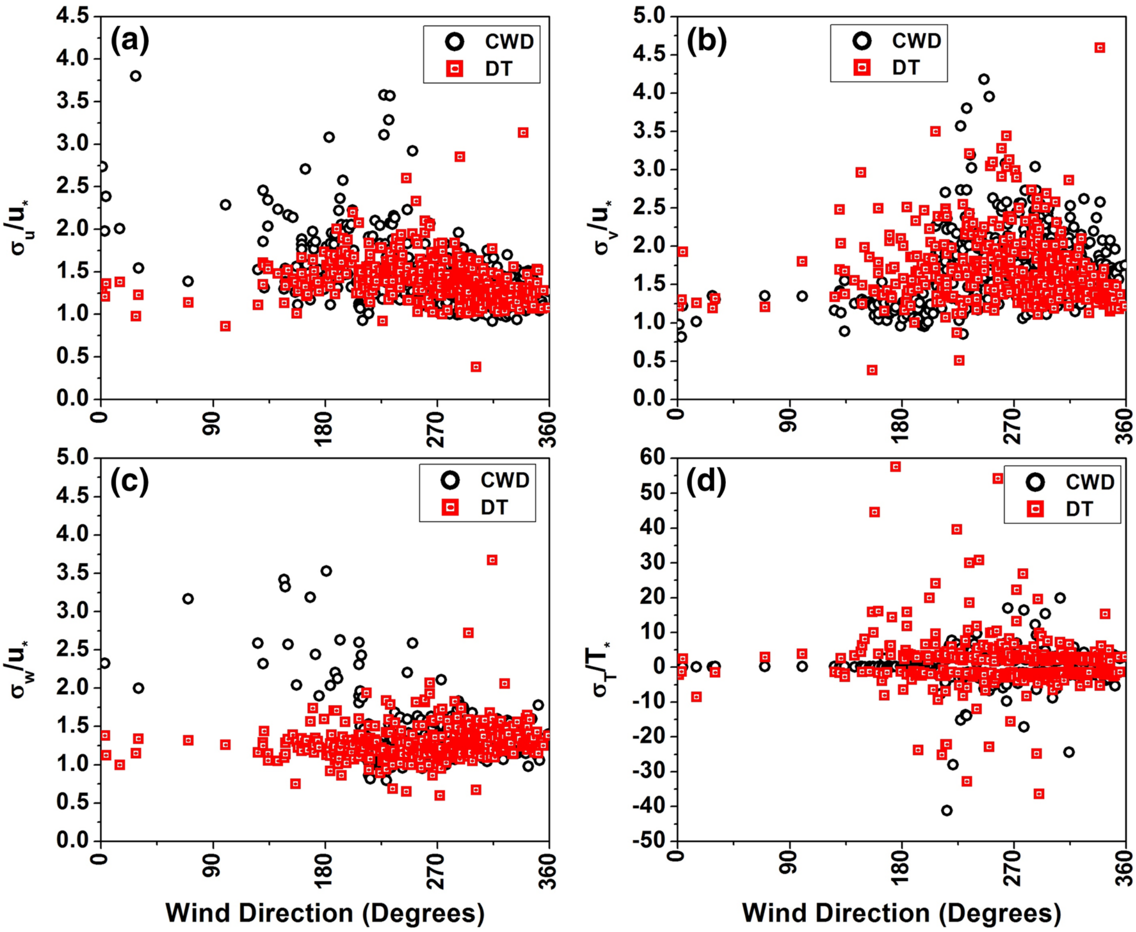

Fig. 3 Variation of normalised turbulent integral characteristics with respect to wind direction

which may be attributed to the high turbulent fluctuations is the effect of the development of mesoscale convective activity (thunderstorm), which in turn alters the surface layer characteristics. The results can be summarised as follows:

- The turbulent variance of wind components is following 1/3 power law and differs significantly for DT and CWD in the unstable region. During the stable stratification, DT and CWD relationships are different to each other for σ_u/u_* and in high stable region (0.01–1) σ_w/u_* modelling but σ_v/u_* relationships for DT and CWD are quite close to each other. The differences are present in the stable region even all the convective events considered in the present study occurred during daytime (unstable stratification).
- The turbulent variance of the temperature follows – 1/3 (– 1) power law in the unstable (stable) region. The values are disseminating in the unstable region of DT compare to CWD, indicating more turbulent nature of atmosphere during DT cases.
- σ_u/u_* and σ_T/T_* values during DT are higher than that of CWD, while for σ_v/u_* and σ_w/u_* CWD values are on the higher side to that of DT.

The neutral range of various parameters is within the range of previous universal findings. The proposed relationships will be helpful to improve the existing parameterisation schemes in the mesoscale models used for prediction over the region and will provide a better forecast for such DT.

Table 3 Functional forms of integral turbulence characteristics from the literature and present study

S. no.	Study	Location	Stability	Function
1	Wyngaard et al. [44]	Kansas, USA	Unstable ($\zeta < -0.3$)	$\sigma_T/T_* = 0.95(\zeta)^{-1/3}$
2	Foken et al. [8]	Tsimlyansk, Russia	Unstable ($\zeta < -0.032$)	$\sigma_u/u_* = 4.15(\zeta)^{1/8}$; $\sigma_w/u_* = 2.0(\zeta)^{1/8}$;
			Unstable ($\zeta < -1$)	$\sigma_T/T_* = (\zeta)^{-1/3}$
3	Sivaramakrishnan et al. [29]	Kharagpur, India (monsoon season)	Unstable ($-0.4 < \zeta < 0$)	$\sigma_w/u_* = 1.1(1+3\zeta)^{1/3}$; $\sigma_T/T_* = 5.12(1+8\zeta)^{-1/3}$
			Stable ($0 < \zeta < 0.5$)	$\sigma_w/u_* = 1.1(1+0.15\zeta)$; $\sigma_T/T_* = 8(1+0.67\zeta)^{-1}$
4	Andreas et al. [1]	The Sevilleta National Wildlife Refuge, New Mexico, USA	Unstable ($-4 < \zeta \le -0.01$)	$\sigma_u/u_* = 5.49(-\zeta)^{1/3}$
			Stable ($0 < \zeta \le 1$)	$\sigma_u/u_* = 2.55(1+0.8\zeta)$
5	Pahlow et al. [20]	California and Iowa, USA	Unstable ($\zeta \le 0.1$)	$\sigma_u/u_* = 2.3+4.3(\zeta)^{0.5}$; $\sigma_v/u_* = 2+4(\zeta)^{0.6}$; $\sigma_w/u_* = 1.1+0.9(\zeta)^{0.6}$; $\sigma_\theta/\theta_* = 0.05(\zeta)^{-1}+3$
6	Krishnan and Kunhikrishnan [14]	Ahmedabad, India	Unstable ($\zeta \le 0$),	$\sigma_w/u_* = 1.37(1-3\zeta)^{1/3}$
			and Stable ($\zeta \ge 0$)	$\sigma_w/u_* = 1.37(1+0.2\zeta)$
7	Bian et al. [2]	Qamdo, southeastern Tibetan Plateau Gerze, southeastern Tibetan Plateau	Unstable ($\zeta < 0$)	$\sigma_u/u_* = 3.45(1-3\zeta)^{1/3}$; $\sigma_v/u_* = 3.15(1-3\zeta)^{1/3}$; $\sigma_w/u_* = 1.3(1-30\zeta)^{1/3}$; $\sigma_T/T_* = 1.10(-\zeta)^{-1/3}$
			Unstable ($\zeta < 0$)	$\sigma_u/u_* = 3.21(1-4.2\zeta)^{1/3}$; $\sigma_v/u_* = 2.69(1-7.4\zeta)^{1/3}$; $\sigma_w/u_* = 1.46(1-4.7\zeta)^{1/3}$; $\sigma_T/T_* = 1.21(-\zeta)^{-1/3}$
8	Dharamaraj et al. [7]	Semi-arid region of Gujarat, India	Unstable ($-10 < \zeta \le 0$)	$\sigma_u/u_* = 2.5(1+\alpha\lvert\zeta\rvert)^{1/3}$; $\sigma_v/u_* = 2.25(1+\alpha\lvert\zeta\rvert)^{1/3}$; $\sigma_w/u_* = 1.25(1+\alpha\lvert\zeta\rvert)^{1/3}$; $\sigma_T/T_* = 4(1+\alpha\lvert\zeta\rvert)^{-1/3}$
			Stable ($0 < \zeta \le 10$)	$\sigma_u/u_* = 2.5(1+\beta\lvert\zeta\rvert)$; $\sigma_v/u_* = 2.25(1+\beta\lvert\zeta\rvert)$; $\sigma_w/u_* = 1.25(1+\beta\lvert\zeta\rvert)$; $\sigma_T/T_* = 4(1+\beta\lvert\zeta\rvert)^{-1}$
9	Present Study	Kharagpur, India (pre-monsoon season)	Unstable ($-1 < \zeta \le -0.001$)	For DT $\sigma_u/u_* = 1.35(1-3\zeta)^{1/3}$ $\sigma_v/u_* = 1.43(1-3\zeta)^{1/3}$ $\sigma_w/u_* = 1.2(1-3\zeta)^{1/3}$; $\sigma_T/T_* = 0.8(\zeta)^{-1/3}$, For CWD $\sigma_u/u_* = 1.2(1-5\zeta)^{1/3}$; $\sigma_v/u_* = 1.3(1-26\zeta)^{1/3}$ $\sigma_w/u_* = 1.18(1-5\zeta)^{1/3}$; $\sigma_T/T_* = 0.65(\zeta)^{-1/3}$
			Stable ($0.001 < \zeta \le 1$)	For DT $\sigma_u/u_* = 1.35(1+3\zeta)^{1/3}$; $\sigma_v/u_* = 1.43(1+18\zeta)^{1/3}$ $\sigma_w/u_* = 1.2(1+3\zeta)^{1/3}$; $\sigma_T/T_* = 3.1(1+0.67\zeta)^{-1}$ For CWD $\sigma_u/u_* = 1.2(1+2\zeta)^{1/3}$; $\sigma_v/u_* = 1.3(1+26\zeta)^{1/3}$ $\sigma_w/u_* = 1.18(1+12\zeta)^{1/3}$; $\sigma_T/T_* = 2.8(1+0.97\zeta)^{-1}$

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Compliance with ethical standards

Conflict of interest On behalf of all the authors, the corresponding author states that there is no conflict of interest.

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