A STUDY ON LOW-LEVEL ATMOSPHERIC STRUCTURE ON THE SEASIDE BORDERS TO THE WEST OF HAIKOU①

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ABSTRACT

In this paper, the observed data of low-level wind and temperature collected from western outskirts of Haikou city, Hainan Island, are analysed. Mean boundary layer structure, generation and development of ground-level inversion and inner boundary layer on the coastal area of interest, which is in China's northern tropical area, are analysed. It is found that an inner thermal boundary layer can be produced under intense insolation in both dry and rainy seasons, and the mixing layer on the coast is remarkably deeper than that of inland.

Key words: coastal area, low-level atmospheric structure, inversion superadiabatic layer

Ⅰ. INTRODUCTION

An important part of any study on the boundary layer is one that deals with the mean structure of low-level atmosphere, which is helpful in accounting for dilution and dissipation of atmospheric pollutants and exchange between the surface and air. Most of the investigation done in China is generally for the extratropic zone. There is little documentation for the southern subtropical and not any for the tropical one (Wu et al., 1991). Using low-level wind and temperature data the mean structure of the boundary layer was studied for the coastal area of the northern tropical zone where the observation was taken, revealing a number of noteworthy phenomena, which will be introduced later in this paper.

Ⅱ. ENVIRONMENT, CLIMATE BACKGROUND AND OBSERVATION

Having a maritime monsoon climate of the northern tropical belt, Haikou is generally warm in two well-defined periods of rain (May through October, frequented with typhoon activities) and drought (November through following April) without a prominent season in the year. Our central point of observation was to the south of Tianwei Village, Xinhai Town, in the western suburbs of Haikou (20°04'N, 110°19'E), 22 km to the west of the proper and 1 km away from the Qiongzhou Strait in the direction of

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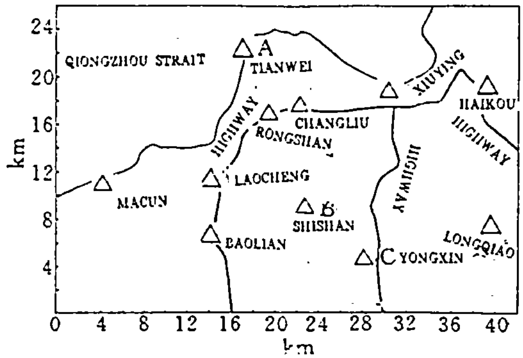

Fig. 1. Diagram of observation sites (△ cup-contact anemometer; A: mini-T-sonde, dual-theodolite anemometer, Gill UVW anemograph, Andersen particle sampler in Dec. 1989 and Jul. 1990; B: mini-T-sonde, mono-theodolite anemometer in Dec. 1989; C: mini-T-sonde, mono-theodolite anemometer in Jul. 1990).

northwest as shown in Fig. 1. The observation was carried out in two periods: the first lasts 15 days 9 through 24 December, 1989 standing for prevailing Northeast Monsoon and the second 10 days from 14 to 24 July, 1990 reflecting prime Southerly Monsoon. The field work also included observations with a mini-T-sounde, a dual-theodolite anemometer and a Gill 3-component anemograph, and with 11 cup-contact anemometers in a network of 40×25 km^2. As control, low-level sounding and anemometrographing was done in Shishan Town (dry season) and Yongxin Town (rainy season), to the southeast of the main site of observation, being 15 and 24 km away, respectively. The observation was done 6 times a day (at 00 : 00, 04 : 00, 08 : 00, 12 : 00, 16 : 00 and 20 : 00, L. S. T. , same below) in both periods, added by 2 days of intensive record for each of them at intervals of 2 hr. For the 25-day observation, 314 records of low-level sounding and winds, 198 records of 3-component anemograph speed spectra and 60 days of hourly cup-contact network wind field data, were obtained. There were two processes of enhancement of anti-cyclones following close passages of the bottoms of upper-level cold troughs, which was marked by fine days of strong winds in unaltered directions. During the observation in the rainy season, however, it was mainly fine with remarkable diurnal variation in wind direction, a reflection of the location to the southwest (or south) of the Subtropical High in the West Pacific.

Ⅲ. BOUNDARY LAYER CHARACTERISTICS

1. *Vertical distribution of air temperature*

An essential meteorological element that affects the concentration of pollutants is the structure of vertical atmospheric temperature within the boundary layer. By studying the observed results for Tianwei vs Shishan in December, 1989 and Tianwei vs Yongxin in July, 1990 (Figure omitted), one can see the contrast between the coast

(Tianwei) and somewhere inland (Shishan and Yongxin) . For the former case, temperature profiles are smooth for Tianwei and give rise to inversion just adjacent to the surface at 00:00, which is maintained till 04:00 in a shallower layer, and disappears at 08:00; there occurs a shallow superadiabatic layer in the air of deeper height due to solar heating of the underlying surface. The vertical temperature distribution for Shishan, which is 15 km away from seashore, is different mainly by the earlier onset of establishment of the inversion just next to the surface at 20:00, growing to appreciable intensity and extending to a higher depth 00:00 through 04:00 than at the coast and scarcely weakening by 08:00; the superadiabatic layer existing 12:00 through 16:00 close to the ground is also much stronger. In the meantime, relatively more complicated topographic features around the point of observation lead to inversion at low-level up to a few hundred metres above the surface, a reflection of the multiplicity in the vertical temperature distribution. As one sees from the coast observation for July, 1990, it is averagely more difficult for the close-to-surface inversion to apppear and the superadiabatic heating is stronger in the layer next to the ground 12:00 through 16:00, in addition to a noteworthy low-level inversion at a height of 100—200 m at 08:00. For the Yongxin Town 25 km away, it is similar to the case of Shishan in December 1989, where the inversion appeared at 20:00 in the layer next to the surface and was observed at 00:00 and 04:00, being less intense than that for Shishan in the dry season; there was also inversion at 100 — 200 m (MSL, same below) at 08:00 and it was much stronger than at the seashore, a fact that suggests the possibility for the inversion to appear in a much larger area. The stronger intensity of the superadiabatic layer next to the surface observed at Yongxin is mainly due to solar radiative heating and the nature of underlying surface.

By definition, any inversion with the base touching the surface or being no higher than 100 m above it is referred to as the next-to-surface inversion which is usually of radiative nature. Generally, an inversion with the base at 100—1000 m is known as low-level inversion and caused either by the lifting or topographic effect and weather systems①. It is noted that the inversion in the area of interest seems to be associated more with frontal zones of sea breezes. Inversion layers whose base at more than 1000 m are mainly linked with activities of synoptic scale systems and will not be addressed here. Tables 1 and 2 show the general characteristics of the observed inversion at the seashore and inland in dry and rainy seasons. One finds that for the dry season the opportunity for the next-to-surface inversion to occur in Shishan is higher at all time of observation (except for 12:00) than in Tianwei with greater thickness and intensity. It is reasonable as inland Shishan is associated with intense temperature fall at the underlying surface, typified by radiative inversion; for Tianwei it is regulated by the ocean, making the rise

① Wu Dui et al. , An study on flow field of close-to-surface layer and structure of land—sea breezes, to be published.

Table 1. Distribution of next-to-surface inversion in dry season.

	16:00		20:00		00:00		04:00		08:00		12:00	
	T	S	T	S	T	S	T	S	T	S	T	S
Frequency(%)	8	25	29	100	46	100	54	100	29	90	23	0
Mean thickness(m)	10	10	30	58	52	82	69	67	20	68	33	—
Max. thickness(m)	10	10	50	130	90	150	180	80	30	130	60	—
Mean intensity (°C/100m)	1.0	1.0	0.5	1.6	2.0	2.0	1.0	2.0	0.4	1.6	0.5	—

T for Tianwei; S for Shishan.

Table 2. Distribution of next-to-surface inversion in rainy season.

	16:00		20:00		00:00		04:00		08:00		12:00	
	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y
Frequency(%)	0	20	56	80	70	70	60	100	25	30	0	0
Mean thickness(m)	—	80	94	98	94	59	125	79	46	60	—	—
Max. thickness(m)	—	80	260	380	320	130	220	200	50	150	—	—
Mean intensity (°C/100m)	—	0.3	1.5	1.7	0.3	1.0	0.8	0.9	0.6	0.2	—	—

T for Tianwei; Y for Yongxin.

and fall of temperature over waters slow and lagging behind as compared with inland areas, resulting in retardation of inversion. On the other hand, there was 50% of chance for the next-to-surface inversion to occur at 04:00 before dawn in the dry season with mean thickness of about 60 m and maximum up to 180 m; the opportunity is reduced to 30% 20:00 through 08:00. In contrast, the percentage is almost 100% for this period at inland observation points with greater thickness and intensity against Tianwei.

It is different in the rainy season in which the frequency for the next-to-surface inversion to happen somewhat increases but decreases for inland Yongxin and the mean intensity reduces with it, too. Nevertheless, there is better chance for the inland observation points to have the inversion than the coastal one and with greater intensity. The next-to-surface inversion is observed 56%—70% of the time 20:00 through 04:00 with mean thickness between 94—125 m and minimum thickness of 46 m at 08:00. It should be noted that unusually strong inversion was sometimes recorded due to cooled underlying surface left behind by severe thunderstorms.

For the distribution of low-level inversion (see Tables 3 and 4), there is in the dry season more of such observation at Tianwei than at inland Shishan with mean height from dozens of m to over 100 m and mild intensity (mainly due to the low-lying clouds commonly seen over the sea for that season or with the possibility for lifting by radiative inversion). On the other hand, the low-level inversion has relatively lower height between 100—400 m at greater frequency of occurrence as compared with the dry season.

Table 3. Distribution of low-level inversion in dry season.

	16:00		20:00		00:00		04:00		08:00		12:00	
	T	S	T	S	T	S	T	S	T	S	T	S
Frequency(%)	62	38	50	56	54	0	33	22	79	50	85	80
Mean base height(m)	714	517	674	218	564	—	658	600	555	402	512	374
Mean thickness(m)	105	87	99	40	96	—	58	40	94	85	86	181
Max. thickness(m)	160	150	130	70	160	—	60	50	250	180	160	210
Mean intensity (°C/100m)	0. 3	0. 9	0. 5	0. 3	0. 3	—	0. 3	0. 0	0. 3	0. 3	0. 4	0. 4

T for Tianwei; S for Shishan.

Table 4. Distribution of low-level inversion in rainy season.

	16:00		20:00		00:00		04:00		08:00		12:00	
	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y
Frequency(%)	50	50	100	50	70	90	70	98	88	90	40	36
Mean base height(m)	272	488	392	536	270	361	350	224	129	239	340	360
Mean thickness(m)	64	116	103	110	137	118	169	114	168	126	108	85
Max. thickness(m)	110	350	190	190	210	280	280	370	280	270	180	130
Mean intensity (°C/100m)	1. 2	0. 4	0. 3	0. 5	0. 2	0. 4	0. 2	0. 5	0. 4	0. 9	0. 4	0. 5

T for Tianwei; Y for Yongxin.

There is inversion most of the day at Tianwei, being as high as 70%—100% 20:00 through 08:00. Even during the daytime 12:00 through 16:00, the frequency is 40%—50% with mean thickness between 64 and 169 m in mild intensity, reflecting the activity of sea breeze.

Fig. 2 gives a real case of the generation and development of the next-to-surface inversion. One can see that the lapse rate becomes smaller at some points in the period 22:00 through 00:00 in the rainy season and the layer of inversion begins to develop and

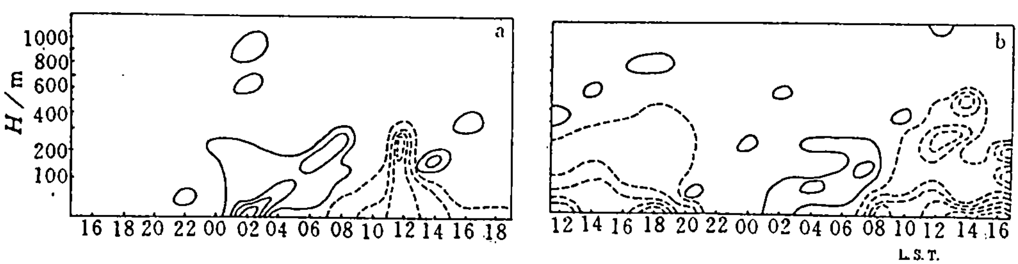

Fig. 2. Cross-section diagram of next-to-surface inversion and inner boundary layer at Tianwei and Yongxin on Jul. 23—24, 1990. Solid lines indicate the inversion layer starting from 0. 0°C/100 m at intervals of 0. 5 °C/100 m and dashed lines indicate the superadiabatic layer starting from —1. 0°C/100 m at intervals of —0. 5°C/100 m.

maintains a thickness of over 200 m until 08:00. With the increase of azimuth of solar altitude, the inversion begins lifting to form an internal thermal boundary layer which develops upward to be 350 m thick in the extreme at 12:00 with intensity more than −2.5°C/100 m. It lowers and weakens at 14:00 until around 18:00.

The inner thermal boundary layer due to radiative heating is typical of coastal areas. The superadiabatic layer for the area of observation is selected for statistic study with a critical lapse rate of 1.0°C/100 m (See Tables 5 and 6). We see that the superadiabatic layer is observed at both of the sites within the area with greater frequency of occurrence for the rainy season on the coast than for the dry season inland ; the mean thickness is generally between dozens of and 200 m and the mean intensity is in the range from -1.4 °C to -3.9 °C per 100 m; looking closely with the aid of Figs. 2 and 3, one observes that the super-adiabatic layer is relatively deeper and stronger in the rainy season than in the dry one and the earliest time of occurrence is 08:00 and lasts till 20:00 at the latest.

Table 5. Features of superadiabatic layer in dry season.

	00:00		04:00		08:00		12:00		16:00		20:00	
	T	S	T	S	T	S	T	S	T	S	T	S
Frequency(%)	0	0	0	0	36	0	50	50	57	44	0	0
Mean thickness(m)	—	—	—	—	208	—	87	180	123	130	—	—
Max. thickness(m)	—	—	—	—	530	—	160	600	320	270	—	—
Mean intensity (°C/100 m)	—	—	—	—	-1.4	—	-3.0	-2.2	-2.6	-2.6	—	—

T for Tianwei; S for Shishan.

Table 6. Features of superadiabatic layer in rainy season.

	00:00		04:00		08:00		12:00		16:00		20:00	
	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y
Frequency(%)	0	0	0	0	56	9	73	64	64	36	30	0
Mean thickness(m)	—	—	—	—	136	70	188	180	196	100	93	—
Max. thickness(m)	—	—	—	—	260	70	550	430	610	200	140	—
Mean intensity (°C/100 m)	—	—	—	—	-2.0	-3.0	-3.5	-2.3	-1.7	-3.9	-2.4	—

T for Tianwei; Y for Yongxin.

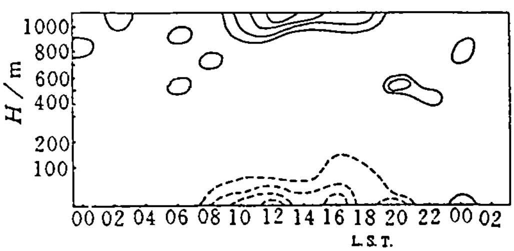

Fig. 3. Cross-section diagram of inner boundary layer at Tianwei on Dec. 18 1989. Solid lines show inversion layer starting from 0.0°C/100m at intervals of 0.5°C/100m and dashed lines show superadiabatic layer starting from −0.1 °C/100m at intervals of −0.5 °C/100m.

The mixing layer is one that has strong turbulent dissipation and vertical mixing above the surface, whose top section is often accompanied by stratification-stable inversion. Table 7 gives the variation in the mixing layer (in which $\frac{\partial T}{\partial Z} \geqslant 0.98°C/100$ m) at the sites of observation. By analysing the observed data, one finds evident diurnal variation in the thickness of the mixing layer during the insolation and the mean thickness is at the minimum at 00:00 for both seasons and maximum at 12:00 (16:00 for the dry season), and maximum thickness is 1180 m, a fact that bears similarity to the case for the Pearl River Delta (Liang et al. , 1992). The mixing layer is almost non-existant 20:00 through 04:00 at Shishan for the dry season or relatively thin at night and much different between day and night at Yongxin for the rainy season. For Tianwei, however, it is thicker than the inland sites, being 100—200 m even at night, a phenomenon that probably relates to greater winds on the coast.

Table 7. Mean mixing layer thickness at different time of the day (unit: m).

	00:00		04:00		08:00		12:00		16:00		20:00	
	T	S	T	S	T	S	T	S	T	S	T	S
Dry season	186	~0	281	~0	629	37	665	507	482	606	266	3
Rainy season	19	33	128	132	239	148	1180	1174	769	590	215	130

T for Tianwei; S for Shishan.

As the product of the thickness of the mixing layer and mean winds, the coefficient of ventilation describes the volume of air crossing a unit width of cross-section of the mixing layer which is normal to the mean direction in any unit time, by which the capacity for the near-surface atmosphere to dilute and dissipate pollutants is comprehensively expressed. As table 8 shows, the dissipative condition is much better at Tianwei than at the inland sites , especially during periods without insolation when the coefficient of ventilation maintains between 68—1441 m^2/s in the rainy season and rises to 1116—2181 m^2/s in the dry season, much larger than in the northern mainland China and coastal areas of Guangdong Province (Xiang, 1986).

Table 8. Ventilation coefficient for dry and rainy seasons (unit: m^2).

	00:00	04:00	08:00	12:00	16:00	20:00	Mean
Tianwei(Dec. 1989)	1116	2051	5284	6118	4434	2181	3531
Tianwei(Jul. 1990)	68	755	1673	6608	4768	1441	2552
Shishan(Dec. 1989)	0	0	133	4259	4606	8	1501
Yongxing(Jul. 1990)	89	620	710	4931	3363	650	1727

2. *Vertical distribution of winds*

The spatial and temporal variations in the speed of winds are studied with Fig. 4 which plots mean speed of winds for the surface, 25, 75, 175, 275 and 550 m in the area of observation. A pattern of single peak vs valley is recognised for the diurnal variations in the dry season for Tianwei, where the peak appears in the day and the speed reduces

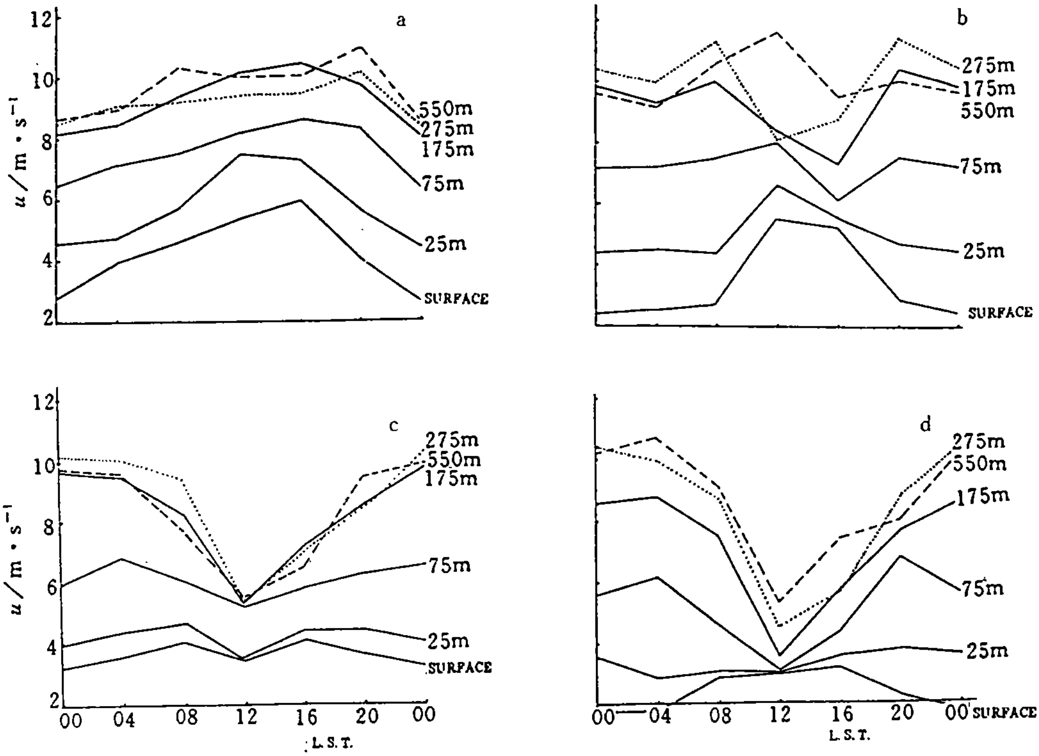

Fig. 4. Time cross-section diagram of mean winds at different layers. a. Tianwei in Dec. 1989; b. Shishan in Dec. 1989; c. Tianwei in Jul. 1990; d. Yongxin in Jul. 1990.

to the minimal at 00:00; with increasing height, the peak value somewhat deviates to the right and the growth of wind speed is rapid from the surface to 175 m but quite mild from 175 to 550 m. Analysing profiles with different values of stability at varying times, it is found that the maximum winds layer generally occurs between 200 and 600 m 12:00 through 00:00 or between 800 and 1000 m at 04:00 and 08: 00; the wind speed for Stability E and F is genernally smaller than that for Stability D while for 16:00 it is larger for Stability B and C than Stability D and slightly smaller than that for Stability D for 12:00.

In Shishan, from which the coast is far away, the diurnal variation for the dry season is a pattern of single peak vs valley for the lowest level with the peak at 12:00. Another pattern of twin peaks vs valleys is recognised for the layer 75—550 m with the only similarity of light nocturnal winds to the lowest level, added with minimal values at 12:00 or 16:00 and maximal values at 08:00 (or 12:00) and 20:00, an allocation much different from Tianwei for the same season, probably due to the geographical difference between Tianwei, which lies on the south coast of the Qiongzhou Strait in exposure to prevailing northeast monsoon, and Shishan, which is an inland site complicated by the adjacency of two hills within 2 km from where the observation was made. From the wind profile of Shishan for the dry season (Figure omitted), one finds that the curve runs smoothly from 20:00 to 08:00 the next day with the maximum winds between 200 and 600 m and it goes dramatically from 12:00 to 16:00 in association with topographic effect and daytime solar radiative heating.

For the rainy season, Tianwei (coast) is similar to Yongxin (inland)with respect to the temporal and spacial variation of wind speeds. Typical patterns of single peak vs valley are found at all heights of the lowest level with the minimum at 12:00 and maximum at 00:00 accompanying rapid growth in the layer against mild change from 175 to 550 m. Especially for 12:00, the whole gradient is small. The allocation of the two sites of observation and striking similarity are sharply different from the case of the dry season, probably due to light mean winds in the rainy season and well-defined diurnal variation of vertical wind distribution by radiation. In addition, the mainly southeasterly in the rainy season also makes Tianwei characteristic of inland nature, accounting for the good resemblance between Yongxin and Tianwei; on the other hand , the prevalence of strong northeast monsoon in the dry season travels over the ocean or dozens of km on land before reaching Tianwei or Shishan, resulting in large difference between the two.

Studying the wind profile (Figure omitted) for Tianwei and Yongxin in the rainy season, one sees that the maximum winds occur at about 200 m, sometimes with one more such layer at 800 — 1000 m, being characteristic of stronger winds and variable curves. The profile is relatively smooth at night for Yongxin with the maximum winds at about 400 m. It can also be variable 12:00 through 16:00 because there may be layers of strong winds at both 200 and 800 m, a fact that is accountable by the effect of radiative heating and the development of land and sea breezes.

Wind profiles are in comformity with the logarithmic law in neutral stratification while simply matching the exponential law in non-neutral stratification (Li et al., 1985) . The value of p is determined by curve fitting with observed low-level wind gradient data using the method of least squares. As shown in Table 9, p increases roughly with stability except for Stability E and F for Yongxin in July 1990, possibly due to insufficient and less representative data. In addition, it should be noticed that the value of p in the season inland is larger than in Tianwei.

Table 9. Exponent p of wind profile indexes in areas of observation.

Place	Time/Stability	B、C	D	E、F
Tianwei	Dec. 1989	0.114	0.125	0.167
Shishan	Dec. 1989	0.124	0.189	0.231
Tianwei	Jul. 1990	0.093	0.152	0.227
Yongxin	Jul. 1990	0.208	0.238	0.222

Frictional velocity U_* and roughness Z_0 are determined with observed wind speed at two heights which follow logarithmic profiles and then turbulent exchange coefficient K_m (Li et al. , 1985) is obtained. Based on the wind speed averaged between 25 and 75 m with neutral stability, Z_0, U_* and K_m are obtained as in Table 10. One sees that for either coastal Tianwei or inland sites of observation, U_* is smaller but Z_0 is larger in the rainy season than in the dry season; for the inland sites U_* is slightly larger but Z_0 is almost twice as large as on the coast, a fact that is related with the existance of spreaded hills of 100—200 m in height around the two sites of observation. In approximation, K_m suggests that the condition for dissipation is better in the dry season than in the rainy season. The observation that Z_0 is generally large for all of the sites is associated with the widely grown tall arborous species in that area.

Table 10. Roughness Z_0, frictional velocity U_* and exchange coefficient K_m in the observed area.

	Tianwei Dec. 1989	Tianwei Jul. 1990	Shishan Dec. 1989	Yongxin Jul. 1990
Z_0	97(cm)	142(cm)	180(cm)	313(cm)
U_*	67(cm/s)	54(cm/s)	70(cm/s)	58(cm/s)
Km	0. 23z(m^2/s)	0. 19z(m^2/s)	0. 25z(m^2/s)	0. 20z(m^2/s)

Six heights of 25, 125, 225, 350, 550 and 1050 m are selected to plot a rose distribution of wind direction frequency. From what is presented in Fig. 5a for Tianwei in December 1989, one sees that due to the strong Northeasterly the direction is concentrated within the 45° range from E to NE, and over the layer from 350 to 550 m, the concentration is reduced to the narrower 22. 5° range from E to ENE, with ENE being the most frequent direction from 25 to 550 m, a reflection of the steadiness of the monsoon. In fact, no evident diurnal change can be found in terms of the surface direction of wind other than changes in the intensity of winds. As it goes to the height of 1050 m, which is basically in the free atmosphere, the directon is distributed over a range of 67. 5° from ESE to NE. Fig. 5b gives a rose distribution of wind direction at different heights for Shishan locating 15 km away from Tianwei at the coast. A picture similar to the case of Tianwei is recognised, in which the directions are gathering in a range of 45 ° from E to NE over a layer of 25 through 225 m, the frequency at ESE increases from 350 to 550 m with the dominant direction remaining at ENE; the frequency at E prevails at 1050 m. The phenomena suggest that the topographic effect produced by the northern coast of the South China Sea and the Qiongzhou Strait enhances the northeast monsoon (observed mainly at Tianwei) to the height of over 500 m. Fig. 5c gives the result for the rainy season in July 1990. The maximum frequency occurs at SSE for the lowest level, S for 225 through 350 m and SSE for 550 through 1050 m. The fan in which significant frequency of wind direction prevails is wider in the rainy season, spanning about 90° at the lowest level and 135° from 350 to 550 m and 157.5° at 1050 m, a clockwise change with increasing height. Generally, the frequency range is quite concentrative as compared with the results for mainland China. Fig. 5d presents the case of Yongxin which is 24 km away from the coast, in which one sees a different picture from Tianwei : SSE is the dominant direction from 25 to 550 m, paralleled by the easterly; SW has a high rate apart from 1050 m, with the fan wider than that for Tianwei, reflecting local circulation contributed by land-sea distribution.

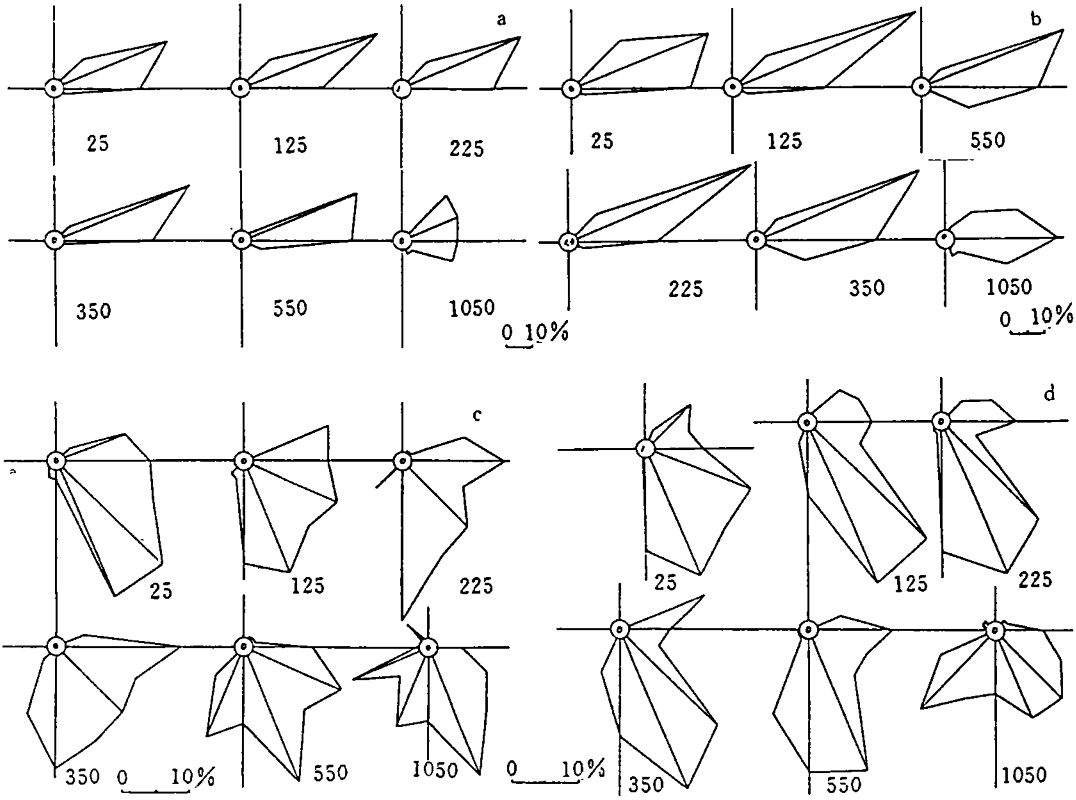

Fig. 5. Rose distribution of wind direction frequency at different heights.
a. Tianwei in Dec. 1989; b. Shishan area in Dec. 1989;
c. Tianwei in Jul. 1990; d. Yongxin in Jul. 1990.

Ⅳ. CONCLUDING REMARKS

a. Although there is generally less chance for the next-to-surface inversion to occur on the coast than in the inland area, it is observed 50% and 70% of the time for the dry and rainy seasons, respectively, with the mean intensity at about 100 m. There is usually weak low-level inversion from 500 to 700 m in the dry season while the chance increases with lowered height.

b. An internal thermal layer is formed in intense insolation for both dry and rainy seasons, with the latter season marked by greater frequency of occurrence (70%) and thickness (from dozens of m to over 200 m).

c. The coastal mixing layer is obviously deeper than inland areas and maintains a certain range of thickness throughout the day with the largest thickness up to 2000 m and more. Added with higher ventilation coefficient, the coastal area has relatively better condition for dissipation in both of the seasons due to better dissipative dilution of pollutants in the vertical.

d. The direction of wind is stable at low level in the dry season in association with strong northeasterly monsoon while it is marked by significant diurnal change due to the activities of land-sea breezes.

e. The temporal and spatial distribution resembles each other between the coastal and inland sites in the rainy season by having the minimal winds for all layers at 12:00 and the maximum winds 00:00 through 04:00 while remarkably departing from each other in the dry season by having the maximum winds for all levels at around 16:00 for the coast, for the surface and 25 m 12:00 through 16:00 and for 75 through 275 m around 08:00 and 20:00, for the inland sites.

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