551.506.7:551.582(512.317)

ROYAL OBSERVATORY, HONG KONG

Climatological Note No. 1

TECHNICAL NOTE NO. 59

HONG KONG UPPER-AIR CLIMATOLOGICAL SUMMARIES

1961 - 1970

by

H. C. LEONG

March, 1976

Hong Kong Upper-air Climatological Summaries

Contents

Hong Kong Upper-air Climatological Summaries

Introduction

Since 1949 tables of radiosonde and pilot/rawin data have been published annually in Meteorological Results Part II - Upper Air Observations. This summary is prepared to provide mean and extreme values of various elements observed during the 10-year period 1961-1970.

The reasons for choosing the 10-year period (1961-1970) are twofold:

(1) In Technical Publication No. 44 the World Meteorological Organization recommends that upper-air normals should be prepared for a 10-year period.

(2) 1961-1970 is the 10-year period in which most data were available at the time when the preparation of this summary began.

History

The Observatory began regular upper-wind measurements using pilot balloons in 1921. Results of the observations were published together with surface observations in the annual volumes of "Meteorological Results" until 1939. In view of the increased importance of upper-air observations, a new publication "Meteorological Results Part II - Upper Air Observations" was introduced in 1947.

Soon after the second world war, whenever the sky was sufficiently clear, balloons were released twice daily during daylight hours from the Royal Observatory and followed by a theodolite on the roof. The frequency of observations was increased to three times daily in January, 1950 and again to four times at intervals of six hours from 1951 onwards. Temperatures, pressures and relative humidities of the lower atmosphere were also measured daily by commercial aircraft. Measurements were first undertaken by aircraft of the Far East Flying Training School in January, 1949 and the Hong Kong Flying Club took over the responsibility for the meteorological flights from February, 1949 until the end of November the same year. Results of meteorological flights were published in Meteorological Results Part II - 1949.

A complete set of radiosonde equipment for determining upper-air temperatures and humidities, was received from the Meteorological Office, Air Ministry, U.K. in August, 1949. Routine observations commenced on November 1 and were made daily at 0900 h H.K. St. T. at the Royal Observatory. The launching site was surrounded by obstructions and considerable difficulty was experienced in releasing the balloons satisfactorily in windy conditions.

In 1951, a permanent radiosonde station was established at King's Park on a hill about 1 km north of the Observatory. The altitude of the floor beneath the barometer was 66 m above MSL and the position was 22°19' N, 114°10' E.

Routine radiosonde and rawin soundings were made at King's Park Meteorological Station from June 1, 1951 and January 1, 1955 respectively.

Radiosondes

From November 1949 until May 1953 Kew MK II type radiosondes were used but were replaced by Kew MK IIB sondes after June 1, 1953. These sondes are fully described in MO 577 Handbook of Meteorological Instruments Part II. An evacuated steel aneroid capsule is used as the pressure sensor. The humidity element consists of a strip of single ply unvarnished goldbeater's skin under tension. The temperature sensor is a bimetallic strip rolled into cylinder.

All the sensors are contained in polished aluminium shields and control three variable frequency audio oscillators whose output is transmitted back to the ground station at 27 MHz. The instruments weigh 885 gm and the lead-acid battery a further 350 gm.

On January 1, 1969 Vaisala RS 13 radiosondes were brought into use and, in order to comply with recommendations of World Meteorological Organization, two ascents were made each day at 0000 Z and 1200 Z. The Vaisala sensors use, a nickel alloy aneroid capsule for pressure, a bimetallic thermometer and chemically treated human hair for humidity. The sensors control the frequency of the transmitter directly between 23.6 and 26.2 MHz with no audio oscillators. The result is that the Vaisala sondes are much lighter and weigh only 280 gm.

Radars

An army radar (type A.A. Number 3 Mark VII) with a range limit of 36,000 yeards was used to follow the tetrahedral reflectors which were flown with the radiosondes after December, 1949.

In 1954, the Observatory acquired its own GL III anti-aircraft radar and from January 1, 1955 onwards, regular measurements of upper-winds were made by radar at 6-hourly intervals.

The GL III 100-mm radar was destroyed by fire in April, 1962 and replaced by a Plessey WF 2 30-mm wind-finding radar in the following month. No comparison of performance could be made as the former was unserviceable at the time the latter was commissioned.

Method of Computation

There were no major changes in the method of computation of rawin and radiosonde results during the chosen 10-year period except that correction due to instrumental lag was not applied to temperatures obtained from Vaisala sondes. Also the curvature of the surface of the earth was not taken into account in the computation of upper-winds.

Notes on Tables

The following points should be noted when using the data presented in the present publication :

No correction has been applied to temperature and humidity data obtained from Vaisala sondes in order to form a homogeneous series. However, comparison between the results obtained with these two types made by Apps (1971) indicated that temperatures, relative humidities and geopotential heights given by Vaisala sondes were generally slightly higher than those given by the Kew sondes.

Results of radiosonde ascents made at 1200 Z have not been used for the computation of means and extremes as data were not available in the first eight years of the chosen period.

Owing to the inaccuracy of the humidity observations in the higher troposphere, dew-point temperatures have not been computed at levels where the dry-bulb temperatures were lower than $-40^{\circ}C$.

In Table I, the means and extremes are taken from monthly aerological returns prepared for international exchange. Consequently, geopotential heights to the nearest metre, temperatures and dew-points to the nearest tenth of a degree Celsius are used to obtain mean values. Standard deviations of these elements are also included.

In Tables II and III the means and extremes are taken from Meteorological Results Part II in which geopotential heights are rounded off to the nearest decametre, and temperatures and dew-points are rounded off to the nearest degree Celsius. Geopotential heights for many of the supplementary pressure levels after 1969 were obtained by linear interpolation between those derived for the standard pressure levels in accordance with the recommended operational procedures for Vaisala sondes. As the variation of height with pressure is non-linear, the mean values thus obtained should always be higher than those computed from the mean virtual temperatures of the layers concerned.

In Table IV, vector mean winds were obtained from the four rawin ascents scheduled daily at 02h, 08h, 14h and 20h H.K.St.T. Only data for a 4-year period (1967-1970) were used to compute mean winds for the 2.1 km level as winds were not available at this level in the years prior to 1967.

In Table V, mean and extreme values are based on available data on the lowest tropopause only.

In Table VI, it was found that occasions on which there were two or more freezing levels in one ascent were rare during the chosen 10-year period. The highest freezing level is tabulated because of its importance to aviation.

In Table VII, results presented were computed from data recorded at the time of release of the radiosondes. The normal time of release is approximately 0730h H.K.St.T. (2330 GMT the previous day).

In Table VIII, mean lapse rates were derived by dividing the differences between monthly mean temperatures at the base and at the top of the layer concerned by the mean thickness of the layer in that month. These figures may be different from the mean of the daily values.

In Tables IX, X, XI, data were obtained from Table 9 in Meteorological Results Part II (Discontinuities of Temperature) in which only those inversions whose thickness is equal to or greater than 20 millibars are tabulated. Thicknesses of inversion layers and temperatures at the base and top of inversions have not been taken into consideration.

In Table IX, bases of inversions are classified into height intervals of 60 metres with the exception of the first layer which goes from station level (66 m) to 119 m. Such a classification ensures that there should not be more than one inversion per day in each class.

In Table X, it is interesting to note that in the 10-year period chosen, the annual total number of inversions with base at a height below 600 m has shown a marked increase. There is insufficient information to decide whether this is accidental or part of a secular trend.

References

1. Apps R.F. Technical Note No. 31, "Comparison Between the Results Obtained with the Kew MK 11B and the Vaisala RS 13 Radiosondes Under Operational Conditions in Hong Kong" Royal Observatory, Hong Kong

2. Meteorological Results Part II - Upper Air Observations, Royal Observatory, Hong Kong.

TABLE I MONTHLY VECTOR MEAN WINDS AND MEAN VALUES OF HEIGHT, TEMPERATURE AND DEW-POINT AT STANDARD PRESSURE LEVELS OVER HONG KONG. PERIOD 1961-1970

PRESSURE LEVEL (mbar)	MONTH	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	YEAR
850	Height (gpm)	1533 (9.9)	1531 (9.7)	1522 (6.9)	1519 (5.3)	1497 (4.7)	1479 (8.3)	1474 (9.3)	1477 (16.2)	1491 (9.5)	1531 (9.5)	1542 (6.2)	1539 (6.1)	1511 (25.9)
	Temperature (°C)	8.9 (1.8)	10.0 (1.5)	12.5 (0.8)	14.8 (0.7)	17.2 (0.4)	18.0 (0.5)	18.7 (0.3)	18.7 (0.2)	17.6 (0.6)	15.1 (0.7)	13.1 (0.9)	10.5 (1.5)	14.6 (3.5)
	Dew-point (°C)	1.4 (5.7)	5.3 (2.1)	7.7. (2.3)	9.9 (1.8)	12.7 (1.0)	14.6 (0.6)	14.7 (0.9)	14.6 (0.8)	13.3 (1.8)	9.9 (1.9)	7.1 (2.7)	3.3 (3.8)	9.5 (4.6)
	Wind Direction (deg)	249	210	214	198	207	203	181	149	084	076	085	088	162
	Wind Speed (kn)	2	6	8	7	7	10	8	6	9	10	8	3	4
700	Height (gpm)	3125 (16.1)	3130 (10.9)	3137 (6.3)	3147 (5.8)	3136 (6.4)	3123 (9.8)	3122 (9.6)	3123 (15.6)	3133 (8.8)	3160 (7.8)	3159 (7.0)	3141 (7.9)	3136 (13.3)
	Temperature (°C)	3.3 (1.8)	3.7 (1.7)	5.8 (0.6)	7.9 (0.8)	9.8 (0.6)	10.2 (1.1)	11.2 (0.4)	10.8 (0.3)	10.3 (0.4)	8.6 (0.7)	6.8 (0.8)	4.7 (1.8)	7.8 (2.8)
	Dew-point (°C)	-10.0 (4.6)	-7.2 (3.3)	-2.8 (2.0)	-0.4 (3.1)	2.1 (1.4)	4.4 (1.2)	3.6 (1.7)	3.8 (1.6)	2.4 (2.2)	0.6 (3.5)	-3.1 (2.5)	-6.6 (4.0)	-1.1 (4.8)
	Wind Direction (deg)	272	267	266	251	245	213	172	144	086	032	263	266	253
	Wind Speed (kn)	19	21	19	14	11	10	7	6	5	3	5	15	10
500	Height (gpm)	5801 (27.6)	5804 (23.4)	5817 (11.3)	5841 (10.1)	5857 (9.5)	5854 (12.2)	5857 (8.7)	5857 (11.7)	5862 (8.9)	5872 (7.6)	5859 (9.6)	5826 (21.1)	5842 (24.1)
	Temperature (°C)	-8.4 (3.9)	-8.6 (1.4)	-8.5 (1.0)	-7.8 (0.7)	-5.4 (0.7)	-4.2 (0.5)	-4.0 (0.4)	-4.2 (0.7)	-4.5 (0.2)	-5.9 (0.5)	-6.7 (0.9)	-8.1 (1.2)	-6.4 (1.9)
	Dew-point (°C)	-31.3 (4.8)	-29.7 (3.4)	-26.8 (2.4)	-20.8 (2.5)	-14.0 (2.0)	-12.2 (1.9)	-13.9 (1.8)	-13.3 (2.4)	-14.2 (3.0)	-17.1 (2.6)	-23.0 (3.9)	-28.3 (3.8)	-20.4 (7.1)
	Wind Direction (deg)	266	264	264	259	262	233	119	099	081	283	257	262	261
	Wind Speed (kn)	45	44	39	24	13	6	7	5	6	8	19	36	22
400	Height (gpm)	7510 (33.3)	7502 (29.4)	7515 (17.3)	7543 (14.3)	7578 (13.5)	7583 (15.2)	7585 (8.4)	7587 (11.1)	7587 (9.2)	7586 (8.5)	7568 (12.1)	7525 (29.6)	7556 (34.2)
	Temperature (°C)	-18.4 (1.3)	-18.5 (1.1)	-19.0 (1.2)	-18.3 (1.1)	-15.4 (1.0)	-14.0 (0.5)	-14.2 (0.5)	-14.1 (0.7)	-14.7 (0.4)	-16.3 (0.6)	-17.5 (1.3)	-18.5 (1.2)	-16.6 (2.0)
	Dew-point (°C)	-39.5 (3.3)	-39.5 (2.3)	-37.0 (2.2)	-31.0 (4.0)	-25.1 (2.1)	-23.4 (1.9)	-25.2 (1.9)	-24.5 (2.7)	-25.9 (2.6)	-28.3 (2.6)	-34.1 (3.7)	-38.2 (2.8)	-31.0 (6.4)
	Wind Direction (deg)	264	263	263	260	272	255	096	089	079	280	262	263	263
	Wind Speed (kn)	60	59	53	33	15	2	9	8	7	11	28	48	29
300	Height (gpm)	9589 (29.9)	9591 (30.9)	9599 (23.6)	9629 (21.2)	9629 (20.5)	9710 (17.3)	9710 (10.0)	9708 (7.9)	9706 (10.1)	9690 (11.5)	9663 (19.8)	9615 (36.9)	9659 (50.3)
	Temperature (°C)	-32.6 (0.7)	-32.2 (0.7)	-32.9 (1.4)	-33.1 (1.2)	-29.8 (1.1)	-28.3 (0.6)	-28.5 (0.5)	-28.6 (0.9)	-29.3 (0.7)	-31.2 (0.9)	-32.0 (1.0)	-32.7 (1.0)	-30.9 (1.9)
	Dew-point (°C)	-48.9 (0.8)	-49.4 (1.9)	-47.4 (1.0)	-44.3 (2.0)	-39.0 (2.9)	-37.5 (2.0)	-39.4 (1.9)	-38.2 (2.3)	-40.1 (2.5)	-42.5 (2.0)	-46.3 (1.9)	-48.1 (1.0)	-43.4 (4.5)
	Wind Direction (deg)	263	260	262	263	279	360	083	084	070	281	261	262	264
	Wind Speed (kn)	68	71	68	43	19	2	13	10	6	15	35	58	35
200	Height (gpm)	12324 (28.4)	12331 (33.9)	12334 (32.7)	12359 (33.9)	12456 (33.9)	12488 (25.5)	12489 (15.8)	12485 (14.8)	12476 (15.3)	12438 (19.2)	12402 (29.1)	12347 (44.5)	12411 (68.3)
	Temperature (°C)	-53.4 (0.7)	-52.8 (0.7)	-53.1 (1.0)	-53.2 (1.3)	-51.1 (1.0)	-50.3 (1.2)	-50.0 (0.7)	-50.2 (0.7)	-50.7 (0.8)	-52.2 (1.0)	-53.0 (1.1)	-53.6 (0.8)	-52.0 (1.4)
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	255	253	258	267	296	023	073	073	065	282	257	258	263
	Wind Speed (kn)	73	75	73	55	21	9	21	16	7	17	41	63	36
150	Height (gpm)	14120 (27.4)	14130 (37.2)	14133 (39.5)	14159 (40.9)	14268 (38.1)	14303 (32.4)	14310 (21.5)	14303 (18.8)	14293 (20.6)	14244 (25.9)	14200 (33.9)	14139 (48.0)	14217 (77.6)
	Temperature (°C)	-66.4 (1.0)	-65.9 (1.3)	-65.9 (1.2)	-65.1 (1.1)	-64.4 (0.9)	-64.7 (1.1)	-64.3 (0.8)	-64.5 (0.7)	-64.2 (0.8)	-65.6 (1.1)	-66.6 (1.0)	-66.9 (1.0)	-65.4 (1.0)
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	252	253	258	267	303	018	068	069	073	280	251	253	263
	Wind Speed (kn)	69	69	67	48	19	15	31	20	11	14	40	62	31
100	Height (gpm)	16495 (25.1)	16507 (45.0)	16535 (60.3)	16555 (45.7)	16658 (46.0)	16688 (40.2)	16698 (26.9)	16692 (26.6)	16679 (31.7)	16618 (34.7)	16563 (40.7)	16507 (47.9)	16600 (80.7)
	Temperature (°C)	-78.6 (2.1)	-78.1 (2.0)	-77.6 (1.5)	-76.7 (1.5)	-78.1 (1.3)	-78.1 (1.1)	-77.7 (1.6)	-77.4 (1.1)	-78.0 (0.7)	-79.1 (1.1)	-79.7 (1.7)	-79.2 (1.5)	-78.2 (0.8)
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	261	260	263	267	327	049	069	073	075	264	252	260	277
	Wind Speed (kn)	47	45	44	26	9	24	40	33	21	3	24	40	12

Note: Figures in brackets denote the Standard Deviations.

TABLE II MONTHLY VECTOR MEAN WINDS AND MEAN VALUES OF HEIGHT, TEMPERATURE AND DEW-POINT AT SUPPLEMENTARY PRESSURE LEVELS OVER HONG KONG. PERIOD 1961-1970

PRESSURE LEVEL (mbar)	MONTH	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1000	Height (gpm)	180	170	150	130	90	60	50	60	80	130	160	170	120
	Temperature (°C)	13	13	16	20	25	26	27	27	26	23	19	15	21
	Dew-point (°C)	7	9	13	18	22	24	25	24	22	18	14	10	17
	Wind Direction (deg)	064	077	081	091	115	183	205	164	072	063	060	059	080
	Wind Speed (kn)	8	8	9	7	4	3	5	1	7	9	10	8	5
950	Height (gpm)	610	610	580	570	540	510	510	510	530	580	600	610	560
	Temperature (°C)	11	11	15	18	22	23	24	24	23	20	17	13	18
	Dew-point (°C)	5	8	12	16	19	21	22	21	19	16	12	8	15
	Wind Direction (deg)	080	098	109	117	164	194	190	158	074	072	072	076	099
	Wind Speed (kn)	8	8	8	7	4	5	5	3	8	11	12	9	6
900	Height (gpm)	1060	1060	1040	1040	1010	990	980	980	1000	1050	1060	1060	1030
	Temperature (°C)	10	11	14	17	19	20	21	21	20	17	15	12	16
	Dew-point (°C)	4	7	10	13	16	18	18	18	16	13	10	6	12
	Wind Direction (deg)	096	134	159	152	191	198	186	151	081	076	081	085	122
	Wind Speed (kn)	5	6	6	7	6	8	7	4	9	13	12	8	5
800	Height (gpm)	2040	2040	2030	2030	2010	2000	1990	2000	2010	2050	2050	2050	2030
	Temperature (°C)	7	8	11	13	15	16	16	16	15	13	11	9	13
	Dew-point (°C)	-1	3	5	6	9	11	11	11	10	6	4	1	6
	Wind Direction (deg)	267	255	248	228	225	205	177	150	085	073	079	272	215
	Wind Speed (kn)	8	11	12	9	9	11	9	7	8	7	3	3	4
600	Height (gpm)	4360	4370	4380	4400	4400	4390	4390	4400	4400	4420	4410	4390	4390
	Temperature (°C)	-1	-1	-1	0	3	4	4	4	3	2	1	0	1
	Dew-point (°C)	-21	-18	-14	-10	-5	-3	-5	-4	-5	-7	-12	-19	-10
	Wind Direction (deg)	269	267	267	260	255	225	153	122	082	307	257	261	260
	Wind Speed (kn)	31	31	27	18	12	8	6	4	5	4	13	25	13
250	Height (gpm)	10850	10850	10860	10890	10970	10990	10990	10990	10980	10960	10930	10870	10930
	Temperature (°C)	-42	-41	-42	-42	-39	-38	-38	-38	-39	-41	-41	-42	-40
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	261	258	260	265	287	015	075	078	065	282	260	262	262
	Wind Speed (kn)	72	74	72	50	20	4	16	13	6	16	39	61	31
90	Height (gpm)	17100	17110	17120	17160	17260	17290	17310	17300	17290	17220	17170	17110	17200
	Temperature (°C)	-80	-80	-79	-78	-80	-79	-78	-77	-78	-79	-80	-80	-79
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	263	260	264	269	002	057	071	075	078	090	254	261	288
	Wind Speed (kn)	39	40	37	20	7	25	41	35	24	1	20	33	6
80	Height (gpm)	17770	17780	17790	17830	17930	17960	17980	17980	17970	17890	17830	17780	17880
	Temperature (°C)	-79	-79	-79	-78	-79	-79	-75	-74	-76	-77	-79	-79	-78
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	265	260	265	266	043	063	076	078	080	087	254	262	323
	Wing Speed (kn)	33	34	29	14	8	26	42	37	26	4	14	26	2
70	Height (gpm)	18520	18540	18550	18600	18690	18730	18760	18760	18740	18660	18590	18540	18640
	Temperature (°C)	-78	-77	-76	-75	-77	-75	-72	-71	-72	-73	-75	-76	-75
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	265	263	268	269	063	071	080	083	082	087	250	263	062
	Wind Speed (kn)	27	27	23	8	11	27	40	37	26	9	9	21	3
60	Height (gpm)	19420	19440	19460	19510	19590	19640	19680	19690	19660	19580	19490	19440	19550
	Temperature (°C)	-73	-72	-72	-71	-72	-70	-67	-67	-68	-69	-71	-71	-70
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	265	265	271	332	077	080	081	086	086	088	244	263	080
	Wind Speed (kn)	21	21	17	1	15	29	40	37	27	11	5	16	7
50	Height (gpm)	20510	20520	20550	20600	20680	20740	20780	20800	20760	20680	20590	20530	20640
	Temperature (°C)	-66	-66	-66	-66	-65	-65	-64	-63	-64	-64	-65	-65	-65
	Dew-point (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wind Direction (deg)	264	266	277	048	087	082	087	086	089	090	184	257	086
	Wind Speed (kn)	11	15	12	3	18	33	40	40	29	15	1	10	11

TABLE III   EXTREME VALUES OF HEIGHT, TEMPERATURE, DEW-POINT AND WIND SPEED AT SPECIFIED PRESSURE LEVELS OVER HONG KONG

PERIOD 1961-1970

PRESSURE LEVEL (mbar)	HEIGHT (gpm)		TEMPERATURE (°C)		DEW-POINT (°C)		WIND SPEED (kn)	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1000	260	-170	29	3	27	-14	34	0
950	680	280	27	1	26	-18	49	1
900	1130	720	25	0	23	-28	52	1
850	1600	1250	25	-3	20	-38	60	1
800	2110	1780	21	-1	18	-48	70	1
700	3210	2920	14	-5	11	-50	72	1
600	4480	4210	8	-12	5	-50	72	1
500	5930	5660	2	-16	0	-50	95	1
400	7650	7310	-7	-29	-10	-54	113	1
300	9870	9340	-19	-43	-	-	128	1
250	11160	10590	-31	-52	-	-	135	0
200	12660	12060	-43	-60	-	-	157	1
150	14500	13850	-53	-73	-	-	139	1
100	17020	16240	-65	-87	-	-	117	1
90	17630	16850	-64	-91	-	-	117	1
80	18320	17520	-61	-91	-	-	78	1
70	18980	18300	-59	-94	-	-	70	0
60	19970	19220	-55	-87	-	-	60	1
50	21380	20270	-53	-82	-	-	69	1

TABLE IV MONTHLY VECTOR MEAN WINDS AT SPECIFIED HEIGHT LEVELS OVER HONG KONG
PERIOD 1961-1970

MONTH / HEIGHT (km)	JAN		FEB		MAR		APL		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	deg	km	deg	kn	deg	kn	deg	kn	deg	kn	deg	kn	deg	km	deg	km	deg	kn	deg	kn	deg	kn	deg	kn
18.5	258	20	258	23	262	19	253	06	071	13	074	27	081	39	084	34	087	24	098	08	232	07	257	18
16.2	262	42	258	43	263	42	267	27	336	09	046	21	069	39	076	31	078	19	258	04	248	24	257	39
14.1	254	66	254	66	259	65	266	47	305	18	020	13	068	29	070	20	077	10	275	14	251	39	254	59
12.0	256	73	254	73	259	73	266	54	294	20	016	07	073	19	073	14	066	06	282	17	257	40	259	63
10.5	260	72	257	73	261	71	264	49	284	19	014	04	079	15	080	11	064	05	281	16	259	38	262	61
9.0	263	67	260	69	262	65	261	41	274	17	292	02	090	11	083	09	071	06	276	14	260	33	262	56
7.2	264	59	263	59	263	52	259	33	267	16	243	04	107	08	103	07	081	06	279	11	260	26	262	47
6.0	266	50	265	48	264	42	259	27	261	14	237	07	124	07	113	05	082	05	280	09	258	21	263	38
5.4	267	40	265	42	264	37	258	24	258	13	233	07	135	07	122	05	084	05	282	07	256	19	263	34
4.5	268	35	266	34	264	30	255	20	253	12	228	09	157	08	132	05	086	05	292	04	255	14	262	28
3.6	267	26	266	26	265	24	253	16	250	11	223	09	167	07	142	05	084	05	335	02	255	09	262	21
3.0	267	20	265	20	262	20	248	14	245	10	219	10	173	07	144	05	083	06	046	03	256	04	262	14
2.1	257	11	252	13	247	15	237	08	236	12	215	09	185	07	144	06	078	07	068	07	063	05	251	04
1.5	242	03	213	06	217	08	203	07	212	07	204	08	176	07	145	05	076	09	070	10	083	08	092	02
0.9	088	05	125	06	146	06	148	06	181	05	193	07	178	06	149	05	077	08	072	11	076	11	082	08
0.6	078	06	101	07	115	07	124	06	165	04	187	06	179	05	153	04	077	06	072	10	072	11	075	08
0.3	073	07	086	08	096	08	107	07	146	04	180	04	181	04	155	03	074	06	073	09	068	09	068	08

TABLE V TROPOPAUSE DATA FOR HONG KONG
PERIOD 1961-1970

MONTH	MEAN PRESSURE	MEAN HEIGHT	MEAN TEMPERATURE	EXTREME VALUES					
				PRESSURE (mbar)		HEIGHT (gpm)		TEMPERATURE (°C)	
	mbar	gpm	°C	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
JAN	94	16855	-81.1	143	65	18920	14300	-69	-90
FEB	95	16835	-80.8	145	57	19110	14330	-69	-92
MAR	95	16882	-79.9	149	62	19280	14020	-68	-88
APL	93	17073	-79.4	162	68	18710	13650	-63	-88
MAY	92	17166	-80.5	140	70	18850	14800	-67	-87
JUN	94	17081	-80.2	124	69	18880	15300	-71	-87
JUL	100	16747	-79.0	136	70	18810	14800	-71	-87
AUG	101	16640	-78.4	137	75	18390	14800	-69	-89
SEP	97	16900	-79.7	134	75	18440	14970	-64	-90
OCT	96	16864	-81.3	126	64	19220	15230	-73	-89
NOV	96	16858	-81.6	132	68	18830	14860	-68	-95
DEC	96	16824	-81.1	127	63	19150	14960	-73	-88
YEAR	96	16894	-80.3	162	57	19280	13650	-63	-95

TABLE VI HIGHEST FREEZING LEVEL DATA FOR HONG KONG
PERIOD 1961-1970

MONTH	PRESSURE (mbar)			HEIGHT (gpm)		
	MEAN	MAX	MIN	MEAN	MAX	MIN
JAN	622	767	516	4116	5600	2350
FEB	623	738	506	4190	5740	2650
MAR	615	688	515	4194	5550	3300
APL	597	651	550	4445	5090	3700
MAY	566	630	476	4878	6280	3970
JUN	552	615	485	5066	6050	4160
JUL	548	601	507	5133	5700	4370
AUG	550	589	510	5099	5690	4560
SEP	555	603	504	5028	5340	4600
OCT	574	642	510	4775	5700	3880
NOV	585	666	523	4622	5490	3540
DEC	603	742	506	4351	5750	2640
YEAR	583	767	476	4658	6280	2350

TABLE VII MONTHLY MEAN SURFACE DATA RECORDED AT KING'S PARK METEOROLOGICAL STATION AT THE TIME OF RELEASE OF RADIOSONDES PERIOD 1961-1970

ELEMENT / MONTH	STATION LEVEL PRESSURE (mbar)	TEMPERATURE (°C)	DEW-POINT (°C)	SURFACE WIND	
				DIRECTION (deg)	SPEED (kn)
JANUARY	1013.4	13.5	8.0	061	5
FEBRUARY	1012.3	14.1	10.7	076	7
MARCH	1009.5	16.8	13.9	084	8
APRIL	1007.0	20.8	18.2	091	6
MAY	1002.5	25.3	22.2	117	3
JUNE	999.5	26.8	24.2	188	3
JULY	998.6	27.9	24.9	183	2
AUGUST	998.9	27.5	24.7	137	2
SEPTEMBER	1001.1	26.2	22.5	065	5
OCTOBER	1007.7	23.8	18.6	063	8
NOVEMBER	1010.9	20.3	14.7	061	8
DECEMBER	1012.6	16.0	10.7	058	6
YEAR	1006.2	21.6	17.8	079	4

TABLE VIII MONTHLY MEAN LAPSE RATE IN $^{o}C\ Km^{-1}$ BETWEEN SPECIFIED PRESSURE LEVELS OVER HONG KONG (PERIOD 1961-1970)

MONTH / LAYER (mbar)	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1000-950	4.4	4.4	3.4	5.2	6.6	6.9	6.6	6.8	6.4	7.3	6.3	5.1	5.8
950-900	2.6	1.3	2.0	3.2	5.1	6.1	7.0	6.1	6.2	5.2	3.9	2.9	4.3
900-850	2.3	1.9	2.7	3.5	4.3	4.9	4.9	5.1	4.9	4.5	3.5	2.9	3.8
850-800	4.0	3.4	2.5	2.7	4.2	4.6	4.8	5.0	4.6	4.1	3.7	3.4	3.9
800-700	3.3	4.2	4.9	4.9	4.6	4.8	4.4	4.7	4.4	3.9	4.0	3.7	4.3
700-600	3.6	4.2	5.7	6.1	5.7	5.0	5.6	5.4	5.4	5.5	4.7	3.9	5.1
600-500	5.0	5.0	5.0	5.6	5.5	5.5	5.5	5.5	5.4	5.2	5.3	5.6	5.3
500-400	5.9	5.8	6.2	6.2	5.8	5.7	5.9	5.7	5.9	6.1	6.3	6.1	6.0
400-300	6.8	6.6	6.7	7.1	6.8	6.7	6.7	6.8	6.9	7.1	6.9	6.8	6.8
300-250	7.4	7.3	7.1	7.4	7.4	7.7	7.4	7.6	7.6	7.5	7.5	7.6	7.5
250-200	7.8	7.7	7.6	7.3	8.0	8.1	8.0	7.9	7.8	7.8	7.8	7.7	7.8
200-150	7.2	7.3	7.1	6.6	7.3	7.9	7.9	7.9	7.4	7.4	7.6	7.4	7.4
150-100	5.1	5.1	4.9	4.8	5.7	5.6	5.6	5.4	5.8	5.7	5.5	5.2	5.4

TABLE IX FREQUENCY DISTRIBUTION OF HEIGHT OF BASE OF INVERSIONS BELOW 600 m OVER HONG KONG (PERIOD 1961-1970)

MONTH / HEIGHT (gpm)	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	% FREQ.
SURFACE (66m) -119m	8	2	9	7	0	0	0	0	0	0	0	3	29	7.7
120-179	1	1	3	0	0	0	0	1	0	0	0	2	8	2.1
180-239	1	0	3	1	1	0	0	0	0	0	0	1	7	1.8
240-299	4	2	7	1	1	0	0	0	0	0	1	0	16	4.2
300-359	7	9	13	10	1	0	0	0	0	0	1	4	45	11.9
360-419	4	14	18	7	4	1	0	0	0	0	6	4	58	15.3
420-479	7	15	27	10	4	0	0	0	0	0	3	11	77	20.3
480-539	15	18	15	13	1	0	0	2	0	0	2	11	77	20.3
540-600	8	8	11	8	6	1	1	2	0	2	7	8	62	16.4
TOTAL	55	69	106	57	18	2	1	5	0	2	20	44	379	
% FREQ.	14.5	18.2	28.0	15.0	4.7	0.5	0.3	1.3	0	0.5	5.3	11.6		100

TABLE X ANNUAL DISTRIBUTION OF INVERSIONS WITH HEIGHT OF BASE BELOW 600 m OVER HONG KONG (PERIOD 1961-1970)

MONTH / YEAR	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1961	8	6	12	4	3	0	0	0	0	0	0	4	37
1962	3	4	6	7	0	0	0	0	0	0	1	4	25
1963	4	7	7	2	0	0	0	0	0	0	0	0	20
1964	7	6	15	1	1	0	0	1	0	0	2	1	34
1965	4	4	7	9	5	0	0	0	0	0	0	9	38
1966	3	9	7	8	0	0	0	2	0	1	1	5	36
1967	5	9	12	7	1	0	1	0	0	0	2	4	41
1968	5	6	15	3	1	0	0	0	0	0	3	0	33
1969	8	8	11	5	3	2	0	1	0	1	6	7	52
1970	8	10	14	11	4	0	0	1	0	0	5	10	63
TOTAL	55	69	106	57	18	2	1	5	0	2	20	44	379

TABLE XI FREQUENCY DISTRIBUTION OF INVERSIONS WITH BASE IN SPECIFIED PRESSURE RANGES OVER HONG KONG (PERIOD 1961-1970)

MONTH / PRESSURE RANGES	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	% FREQ.
sfc-851mb	187	207	245	145	72	17	12	15	21	63	128	183	1295	22.3
850-701mb	175	114	99	87	56	25	17	22	50	103	119	169	1036	17.8
700-501mb	137	116	80	48	10	13	11	14	9	46	77	108	669	11.5
500-401mb	19	26	13	7	5	2	2	3	4	2	9	9	101	1.7
400-301mb	6	11	8	0	0	1	1	0	0	1	2	3	33	0.6
300-201mb	0	2	1	1	0	0	0	0	0	0	0	0	4	0.1
200-151mb	1	1	0	1	0	0	0	0	0	0	0	0	3	0.1
150-101mb	16	17	28	17	9	19	45	69	41	44	21	36	362	6.2
≤100mb	184	160	198	190	198	187	202	180	204	212	194	197	2306	39.7
TOTAL	725	654	672	496	350	264	290	303	329	471	550	705	5809	
% FREQUENCY	12.5	11.3	11.6	8.5	6.0	4.5	5.0	5.2	5.7	8.1	9.5	12.1		100