On-site meteorological instrumentation
and data base
for an air pollution dispersion model
of an air shed

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1. INTRODUCTION

The Air Pollution Meteorology Research Unit (APMRU) of the Hong Kong Royal Observatory was created recently to conduct meteorological studies of various air sheds in the territory. The broad objective is to characterize the air pollution dispersion potential in areas where large scale engineering projects are planned which have a potential of generating air pollution. Knowledge of the existing air quality can be combined with conclusions drawn from a meteorological study of the air shed to make an assessment of the future additional air pollution burden that can be tolerated in the area, without causing an exceedence of acceptable air quality levels. Furthermore, this information is valuable for determining guidelines for land use planning.

The first selected air shed is presently being investigated at Junk Bay, where a potential New Town is being planned for a target population of up to 300,000 people in the mid-1990's. The study period for Junk Bay is for a full year commencing in late 1982. It is expected that this will form the first in a series of studies of various regions in Hong Kong.

The aims of this paper are to:

(a) present meteorological instrumentation and parameters recommended elsewhere for similar purposes;

(b) describe the meteorological instrumentation being used in the Junk Bay air shed study; and

(c) outline the meteorological data base thus obtained in Junk Bay for input into an air pollution dispersion model.
2. METEOROLOGICAL REQUIREMENTS FOR AIR POLLUTION DISPERSION MODELS

(a) Parameters of primary meteorological data

Continuing development of a wide variety of air pollution dispersion models to simulate atmospheric dispersion processes has necessitated reviews and updates on input requirements. It is generally regarded that the two main site-specific requirements of variables needed for a model are (i) emission source/load characteristics and (ii) meteorological data. Selected reviews on requirements for the latter are addressed in the following paragraphs.

(1) The U.S.A. Nuclear Regulatory Commission (NRC) issued guidelines on requirements for "On-site Meteorological Programs" in the Safety Guide 1.23*, first published in February 1972. The objective for such requirements was to lay down guidelines to provide a knowledge of meteorological conditions in the vicinity of nuclear reactors so that effects of potential radiation doses from routine or accidental gaseous release of radioactive materials to the atmosphere may be assessed. These requirements are outlined in Table 1 below.

<table>
<thead>
<tr>
<th>Meteorological parameter</th>
<th>Height(s) of instrumentation</th>
<th>Accuracy of instrumentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind direction</td>
<td>At a minimum of 2 levels on at least one tower/cast. Mandatory level at 10 m with upper set at height of release of radioactive material but should be positioned not less than 30 m above the lower sensor set and preferably at 60 m height, the latter of which coincides with most routine release levels of LRs.</td>
<td>±5° for instantaneous recorded values</td>
</tr>
<tr>
<td>Wind speed</td>
<td></td>
<td>±0.5 mph (0.22 m/s) for averaged values with start speed of ≤1 mph (0.45 m/s)</td>
</tr>
<tr>
<td>Ambient air temperature</td>
<td></td>
<td>±0.5°C for averaged values but ±0.1°C for averaged values of temperature difference</td>
</tr>
<tr>
<td>Dew point temperature</td>
<td>At 10 m</td>
<td>±0.5°C for averaged values</td>
</tr>
</tbody>
</table>

Table 1. Meteorological parameters recommended by the U.S.A. NRC

* Subsequently in September 1980, a Proposed Revision to Regulatory Guide 1.23, "Meteorological Program in support of Nuclear Power Plants" was issued by the Office of Standard Development in September 1980. It is understood that this document is still being circulated for comments.
The length of a meteorological study for evaluation of air pollution effects is also a subject for consideration. The Safety Guide 1.23 recommended that the "minimum amount of meteorological data needed for evaluation is considered to be that amount of data gathered on a continuous basis for a representative consecutive 12 month period. Two full annual cycles of data are desirable".

(2) In the U.S.A. Environmental Protection Agency (EPA) Guideline on Air Quality Models (1979), it is emphasized that meteorological data used in a model must be representative of the transport and dispersion conditions in the vicinity of the source that the model is attempting to simulate. Minimum requirements included "wind direction, wind speed, atmospheric stability, mixing height or related indicators of atmospheric turbulence and mixing." It was pointed out that "site-specific data are preferable to data collected off-site" and that the availability of such micro-meteorological data collection could vastly improve model estimates. Multi-year data base is also recommended but the use of one year of data might be justified if climatological representativeness of data can be demonstrated.

(3) More details on data requirements have been discussed in a "Workshop on On-site Meteorological Instrumentation Requirements to Characterize Diffusion from Point sources", which was held in North Carolina, U.S.A. in January 1980. Based on expert consensus of this Workshop, recommendations were made on specific measurement techniques and accuracies required of meteorological data. These recommendations were intended to help the modeler choose variables relevant to models generally, rather than any specific model. On-site measurements were again encouraged.

Meteorological variables were divided into three Priority Classes: 1) Essential, 2) Desirable, and 3) Helpful. The basic measurements required for the "Essential" Priority Class together with instruments specification are presented in Table 2 below.
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Height</th>
<th>Accuracy</th>
<th>Resolution</th>
<th>Sample averaging time</th>
<th>Response Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal wind speed (u)</td>
<td>10 m, source</td>
<td>0.2 m/s ±5%</td>
<td>-</td>
<td>1-5 s</td>
<td>distance const. ≤5 m</td>
</tr>
<tr>
<td></td>
<td>plume</td>
<td>0.5 m/s</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Horizontal and vertical wind direction</td>
<td>10 m,</td>
<td>absolute 50°</td>
<td>-</td>
<td>1-5 s</td>
<td>distance const. ≤5 m</td>
</tr>
<tr>
<td></td>
<td>source</td>
<td>relative 1°</td>
<td>-</td>
<td>-</td>
<td>damping ratio ≥0.4</td>
</tr>
<tr>
<td>vertical temperature difference (∆T)</td>
<td>2-10 m</td>
<td>0.1°C</td>
<td>0.02°C</td>
<td>30 s</td>
<td>1 min</td>
</tr>
<tr>
<td>height of convectively mixed layer (H_C)</td>
<td>50-2000 m</td>
<td>50 m</td>
<td>10 m</td>
<td>-</td>
<td>10 s</td>
</tr>
<tr>
<td>height of mechanically mixed layer (H_m)</td>
<td>0-200 m</td>
<td>10-50 m</td>
<td>10 m</td>
<td>-</td>
<td>10 s</td>
</tr>
<tr>
<td>dew point temperature (T_D*)</td>
<td>source,</td>
<td>1.5°C</td>
<td>0.1°C</td>
<td>≥ 1/2 of response time</td>
<td>1-30 min</td>
</tr>
<tr>
<td></td>
<td>plume</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dry bulb temperature (T)</td>
<td>2 m, source</td>
<td>0.5°C</td>
<td>0.1°C</td>
<td>30 s</td>
<td>1 min</td>
</tr>
<tr>
<td></td>
<td>plume</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Required only when cooling tower plumes are modeled


(b) Treatment of primary data for archival

(1) The NRC recommends that data of wind and temperature should be averaged over a period of at least 15 minutes for each hour. The reduced data should be compiled into monthly/seasonal and annual joint frequency distributions of wind speed and direction (i.e. "wind roses") and by stability class (i.e. "stability roses"). It is also suggested that stability classification should be compiled by the measured temperature gradient between two selected height levels. Stability classification by angular fluctuation of horizontal wind direction over periods of 15 minutes to an hour may also be conducted as a secondary method.
(2) The "Workshop on Wind Climate" held in North Carolina, U.S.A. in 1979 was aimed at a wide variety of users for wind data for engineering applications and research needs. For research on pollution dispersion, surface wind measurements were recommended at 10 m above ground and obtained in 20 minute intervals continuously for at least a year. Wind speed and direction, as well as standard deviation of wind fluctuation for an average time of 20 minutes are recommended for archiving.

(3) The "Workshop on On-site Meteorological Instrumentation Requirements to Characterize Diffusion from Point Sources" gives detailed recommendations for computations of variables in the "Essential" Priority 1 list. Archival of hourly averages are at Table 3 below.

<table>
<thead>
<tr>
<th>Meteorological data for archival*</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| (i) mean horizontal wind speed ($\bar{u}$) and direction ($\theta$) at 10 m | 1. Both the scalar mean ($\bar{u}$) and the resultant vector mean ($\bar{u}_v$) should be reported.  
2. Sample frequency should be 1 to 5 s |
| (ii) mean horizontal wind speed ($\bar{u}$) and direction ($\theta$) at source and plume heights | (see Remarks for (i)) |
| (iii) harmonic mean wind speed ($1/\bar{u}$) between source and plume heights | 1. This is sometimes preferred for use in calculation of initial dilution and plume rise. |
| (iv) Standard deviations of horizontal and vertical wind fluctuations ($\sigma_u$, $\sigma_v$) at 10 m | 1. These parameters should be calculated directly and not by a range estimation.  
2. For sufficient accuracy, computation should be based on digital or mathematically equivalent analog techniques. |
<p>| (v) temperature ($\bar{T}$) at 2 m | 1. This requirement is consistent with WHO standards for ambient measurements. |</p>
<table>
<thead>
<tr>
<th>Meteorological data for archival*</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| (vi) temperature difference \( \Delta T \) between 2 and 10 m | 1. This requirement gives the vertical temperature gradient in an unobstructed surface layer.  
2. Ideally, high accuracy \( 0.05^\circ \)C and resolution \( 0.01^\circ \)C of temperature sensors are needed to detect this minute gradient in order to derive parameters based on it.  
3. It is however recognized that greater accuracy and resolution than practically available is needed to enhance the usefulness of this measurement |
| (vii) Heights of the convectively mixed layer \( H_c \) and mechanically mixed layer \( H_m \) | 1. Mixed layers may be maintained either convectively by surface heating, or mechanically by wind generated turbulence.  
2. A monostatic and a bistatic acoustic radar can be used to directly and continuously measure \( H_c \) and \( H_m \) respectively.  
3. Free-flying and tethered radiosondes can be used as a supplement or comparison to 2. |

Table 3. Computed hourly values of "Essential" (Priority 1) meteorological parameters recommended by "Workshop on On-site Meteorological Instrumentation Requirements to Characterize Diffusion from Point Sources", North Carolina, U.S.A. (1980)

Depending on results of the primary computed data collected (see Table 3), derivation of the following commonly used parameters are often found to be useful:

- surface roughness length \( (Z_0) \)
- friction velocity \( (U_w) \)
- bulk Richardson number \( (RIB) \)
- Monin-Obukhov length scale \( (L) \)
- turbulent heat flux \( (H_P) \)
- convective velocity scale \( (W_c) \)

In addition to providing guidelines for data suitable for input into air pollution dispersion models, the 1980 Workshop also provides advice on quality assurance, archival and retrieval of primary data.
3. LOCATION AND TOPOGRAPHY OF THE JUNK BAY AIR SHELD

The nominated study area for the Junk Bay New Town lies about 8 km due east of the highly urbanized area of Kowloon Peninsula (see map in Fig. 1). The air shed consists of Junk Bay together with its adjacent headlands. The area extends about 4 km in the east-west direction and about 8 km in the north-south direction. The southern limits of the Junk Bay air shed are set by Lei Yue Mun and Junk Island. Hills rise quite steeply from the narrow natural coastal plains of the Bay towards the east, north and west. The ridge bounding the area towards the north is the highest and extends up to 432 m at Razor Hill. The line of hills to the east are generally about 200 m to 340 m high except for a low saddle about 60 m high lying between Hang Hau Town and Silverstrand a beach in Fort Shelter. The ridge on the western bound of the study area rise up to about 350 m. A photograph showing the Junk Bay air shed is at Fig. 1a.
4. SITING CRITERIA FOR METEOROLOGICAL INSTRUMENTATION
IN THE JUNK BAY AIR SHED

Siting for meteorological instruments is a complicated subject
because of the multitude of factors that need to be considered. It is
difficult to generalize and each case should be considered on its own
merits.

From a meteorological point of view, the ideal site for
instrumentation is one that is suitably exposed to be representative of
the overall meteorological regime of the entire air shed. The World
Meteorological Organization Guide to Meteorological Instrument and Observing
Practices recommended "a plot of level ground covered with short grass and
about 9 m by 6 m in size ...... for outdoor temperature and humidity sensing
instruments ..... It should be away from the immediate influence of
(physical obstacles such as) trees and buildings and should, as far as
practicable, not be sited upon, or close to steep slopes, ridges, cliffs
or hollows". Siting in the vicinity of any heat source or sinks is not
desirable.

Land/sea breeze effects may be expected in the Junk Bay valley,
particularly in the summer months. The instrumentation should therefore be
located near the shoreline so that it is within the thermal internal boundary
layer to be representative of the land/sea influences. Vertical profiling
instrumentations are also used and a coastal station near mean sea level
is well-suited to enable data acquisition from the lowest possible level of
the boundary layer. It may also be desirable to establish supplementary
sites further up the valley so that drainage effects of the hilly conditions
up the valley may be assessed. However, this is regarded as of secondary
importance only because the broad land use planning emphizes development
of coastal and reclaimed plains.

Physical and operational constraints also play a large part in
siting of meteorological instrumentation. Some of the restrictions are
considered in the following paragraphs:
(1) The use of airspace is severely limited for the Junk Bay air shed – The whole area is no more than a few kilometres away from the Hong Kong International Airport and lies within the Hong Kong Aerodrome Traffic Control Zone. Moreover the general wind regime of Hong Kong is such that the air shed is expected to be upwind of the Airport for as much as 70% of the time on average. As a result, only limited use of free-flying or tethered radiosondes are permitted by the aviation authority. At an early stage in the planning it was also learnt that a tall instrumented tower would not be acceptable.

(2) Sound levels of the site – One of the instruments selected is an acoustic radar, which operates by transmitting audible sound pulses into the atmosphere and receiving the back-scattered echoes from aloft. This system therefore needs to be sited in a fairly quiet environment. A noise survey was therefore carried out at the potential sites. Account was taken of possible new sources of noise that could arise in the vicinity during the study period, such as traffic noise from new roads or construction noise from nearby sites, etc. Most importantly, the impact of noise from the sound pulses generated by the acoustic radar or the inhabitants near the site was evaluated.

(3) Electricity supply needs to be available at the site. Both the acoustic radar and the micro-processor associated with the surface meteorological station utilize electric power.

(4) Security at the site is of utmost importance. The chances of vandalism may be reduced by choosing protected sites within governmental property.

(5) All systems should be sited and operated with protection against lightning and other severe environmental conditions.
For the Junk Bay study, the management of a private hospital, the Haven of Hope Sanatorium, kindly permitted the use of a rooftop in their grounds (see Fig. 2a). An acoustic radar system and a surface meteorological station with an air-conditioned enclosure for electronics equipment are thus sited at the approximately 6 m by 20 m roof. It is estimated that the site is about 150 m inland of the west coast of Junk Bay and is about 30 m above mean sea level.

Permission was also obtained from proprietors of Leung Fung Shipyard, for the use of a nearby and presently undeveloped shoreline plot. This grassy area is about 50 m to the north of the Haven of Hope Sanatorium and is the platform for release of free-flying and tethered radiosondes. (see Fig. 2b).
5. **METEOROLOGICAL INSTRUMENTATION FOR THE JUNK BAY AIR SHED**

The three major components used are described in this section:

(a) A monostatic acoustic radar system

A basic AeroVironment monostatic acoustic radar is used to remotely and continuously monitor the stability pattern of the lowest kilometre of the atmosphere. The system is designed so that echo returns due to thermal structures are optimised and height levels of the convectively mixed layer (or the inversion height), if present, can be obtained. The acoustic radar is generally regarded as one of the most effective common tools used for air pollution dispersion studies.

The system configuration used in the Junk Bay air shed is shown in Fig. 3a and photographs are at Fig. 3b. The acoustic antenna (Model 302) is a single vertically pointing parabolic dish with a speaker mounted on a horn, all housed within a dense acoustic enclosure. The central component of the system is the Model 300C transceiver-display unit which includes both the processing and chart display function boards. The acoustic radar operates at 1,600 Hz with a pulse repetition rate of once every 15 s at 100 watts power. The pulse length is 200 ms providing a height resolution of 35 m and the maximum detectable range is 1,000 m.

In addition to recording on charts at the site in an air-conditioned instruments shelter, the resulting signal is also telemetered via a pair of telephone wires to another chart recorder (Model 322A) at the APMRU offices at the Royal Observatory Headquarters. This latter output device has proved to be invaluable for monitoring instrument status and detecting system malfunction. Data capture since installation in July 1982 has been within 90 to 95% despite frequent interruptions to power supply at site.

(b) A tethered and a free-flying radiosonde system

A Tethersonde™ Model TS-2A is a micro-processor based, portable ground station which both receives and process signals from either a tethered or a free-flying radiosonde.
A tethered radiosonde system ready for flight is shown in Fig. 4a. The helium-filled tethered balloon is aerodynamically shaped so that it generally heads into wind. It has a design volume of 4.25 m$^3$ and provides the lift for a sensor package, which samples pressure, dry and wet-bulb temperatures, wind speed and direction. An electric winch controls the ascent and descent rates of this assembly. Sensed values of the meteorological parameters are transmitted to the ground station through an FM telemetry channel using a frequency designated for meteorological use at 403.5 MHz. This data channel carries continuous frames of data by using a time multiplex format and can cater for from one to eight operator-selected variables. The ground station processes the signals and yields both analogue and digital outputs. Analogue records are in the form of a small dot matrix strip chart and also recorded in real time directly to an analogue cassette recorder. Digital output is in three modes: in real time display or LED of a programmable HP-97 desk calculator or as a hard copy in reduced frames; or in non-real time by playing back the cassette recorder to the HP-97 for all data frames. A typical frame is shown in Fig. 4b.

The Airsonde$^\text{TM}$ is a disposable radiosonde flown on a free-flying balloon (see Fig. 4c). Transmitted measurements of pressure, dry and wet bulb temperatures are received and processed by the same Tethersonde$^\text{TM}$ ground station (Model TS-2A).

Output of the complete tethered and free-flying radiosonde system is permitted up to a maximum of ten operation days per month, starting in late October 1982 under restrictions laid down by the civil aviation authority. Each operation is also subject to meeting certain of weather minima conditions. Prior approval needs to be obtained from the Air Traffic General Manager for each operation day at least two days ahead of time. For each day, up to two flights each of Airsonde$^\text{TM}$ and Tethersonde$^\text{TM}$ may be operated. It is unfortunate that the Tethersonde$^\text{TM}$ may be operated in Junk Bay to only 150 m above mean sea level, as compared to the design nominal flight altitude if 1 000 m which can be attained elsewhere in less restricted airspace. The minimum rate of ascent to be attained by the Airsonde$^\text{TM}$ is 8 m/s thus yielding greater height intervals between data frames than could have been obtained with a slower ascending rate.
Nevertheless, this system provides a useful means for measuring the temperature and wind profiles of the Jurk Bay study area. By measuring a representative number of data frames of wind direction at constant height, it may be possible to compute values of mean and standard deviation of wind fluctuation at approximately fixed levels. However, it is realised that the size of the tethered balloon would necessarily limit its response to only larger scales of turbulence. Usefulness of such results would therefore need to be assessed when data becomes available.

(c) A surface meteorological station

The data requirement and instrumentation specification of this purpose-designed surface meteorological station are quite distinct from those of a conventional station meeting WMO recommendations for weather forecasting.

Wind measurements at on top of a 10 m mast are made with a sensitive Gill u-v-w propeller anemometer mounted on booms. The low threshold speed, high accuracy and a suitable damping ratio ensure that representative turbulent properties of wind fluctuations are measured. The drawback of such an anemometer is that it is not as rugged and can only tolerate speeds of up to 30 m/s. Rate of replacement of the polypropelene propellers is expected to be quite high. Sampling of the three orthogonal wind components are made at one second intervals to directly compute the quantities of wind speed and direction as listed in Table 4.

Properly shielded and aspirated temperature measurements are made at heights of 2 and 10 m on a mast. Dew point temperature is also measured at the 2 m level. The measurements at 2 m are consistent with WMO standards for ambient temperature measurements.

Solar radiation is measured with a solarimeter installed on a one-metre high concrete pedestal. The thermopile sensor is shielded with a double hemispheric glass dome and is sited so that it is free from any shadow cast by nearby structures. Hourly values of solar radiation is one of the key inputs to classifying the atmospheric stability by the frequently-used Pasquill-Turner-Gifford scheme.
A schematic of the acquisition of the surface meteorological parameters is shown at Fig. 5. Sensor-generated voltage signals are translated directly onto chart recorders. Analog signals are also fed into a specially constructed data acquisition system where raw data is pre-processed before recorded on a digital cartridge recorder at site. Data sampled at one second intervals is initially validated and computed to yield 10-minute and hourly averages. These values are expected to provide sufficient detail for subsequent processing. A video display unit and printer for both program modification and trouble-shooting complete the system at the Junk Bay site. A telemetry link to a printer at the AMRU office yields a real-time hard copy of the same data for immediate interpretation and also provides warning for system malfunction. In this way, a reliable digital summary of surface meteorological data is compiled and interpretation of recorder charts is only necessary for quality assurance and supplementary back-up during power failures.

Up to time of preparation of this paper, the surface meteorological station at Junk Bay was not fully implemented and delivery for some sensors was awaited. The solarimeter is shown at Fig. 6a. The 10-m mast ready for installation of 2- and 10-m sensors is in the foreground of Fig. 3b. The data acquisition system, video display unit and printer to be put in an air-conditioned enclosure at the site is shown at Fig. 6b.
6. METEOROLOGICAL DATA BASE FOR THE JUNK BAY AIR SHED

The meteorological programme for the Junk Bay air shed was planned with reference to relevant reviews on need for air pollution modelling. A list showing all the archived meteorological variables is at Table 4. With the exception of measurements at plume and source heights, which are deemed not of primary use to the specific model to the developed for Junk Bay, essentially all recommended parameters are measured. Furthermore, solar radiation, which is a Desirable (Priority 2) measurement recommend by the 1980 "Workshop on On-site Meteorological Instrumentation Requirements to Characterize Diffusion from Point Sources", is taken.

Data archived directly in the data acquisition system at site include some of the commonly used inputs for air pollution dispersion modelling, e.g. the standard deviation of the horizontal and vertical wind fluctuation. The system is also modular in design so that additional parameters and alternative algorithms can be programmed in if need arises in the future.
<table>
<thead>
<tr>
<th>Sensor</th>
<th>Archived meteorological parameter</th>
<th>Height</th>
<th>Sampling frequency of primary data</th>
<th>Sample averaging time of archived data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monostatic acoustic radar (AeroVironment)</td>
<td>convective mixing height (H&lt;sub&gt;o&lt;/sub&gt;)</td>
<td>-</td>
<td>-</td>
<td>1 hr</td>
</tr>
<tr>
<td>Free-flying and tethered radiosonde system</td>
<td>upper wind and temperature profiles</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(Ambient Air, Inc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gill u-v-w anemometer (Climatronics)</td>
<td>scalar mean horizontal wind speed (u&lt;sub&gt;s&lt;/sub&gt;)</td>
<td>10 m</td>
<td>1/s</td>
<td>10 min 1 hr</td>
</tr>
<tr>
<td></td>
<td>vector mean horizontal wind speed (u&lt;sub&gt;v&lt;/sub&gt;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>resultant mean horizontal wind direction (θ)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mean vertical wind (ω)</td>
<td></td>
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<td></td>
<td>standard deviation of horizontal wind fluctuation (σ&lt;sub&gt;uw&lt;/sub&gt;)</td>
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<td></td>
<td>standard deviation of vertical wind fluctuation (σ&lt;sub&gt;vw&lt;/sub&gt;)</td>
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<tr>
<td>Surface Meteorological Station</td>
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<tr>
<td>Platinum resistance thermometer in aspirated shields (Climatronics)</td>
<td>temperature (T)</td>
<td>2 m</td>
<td>1/s</td>
<td>10 min 1 hr</td>
</tr>
<tr>
<td></td>
<td>temperature difference (AT)</td>
<td>2-10 m</td>
<td></td>
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<tr>
<td>Lithium chloride dew point sensor in aspirated shield (Climatronics)</td>
<td>dew point temperature (TD)</td>
<td>2 m</td>
<td>1/s</td>
<td>10 min 1 hr</td>
</tr>
<tr>
<td>Solarimeter (Kipp-Zoner)</td>
<td>solar radiation (S&lt;sub&gt;T&lt;/sub&gt;)</td>
<td>1 m</td>
<td>1/s</td>
<td>10 min 1 hr</td>
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Table 4. Meteorological data base for air shed study at Junk Bay
7. CONCLUDING REMARKS

A review of relevant literature on meteorological instrumentation specification and data requirements for air pollution dispersion modelling is made in this paper. Considerations of siting constraints are presented for the Junk Bay air shed study. The instrumentations used are described and an outline of data to be archived is presented. Such data is expected to be useful for basic micro-meteorological research and will also be used as input into a state-of-art air pollution dispersion model to be applied to the Junk Bay air shed.
FIG. 1  MAP SHOWING THE JUNK BAY AIR SHED
Fig. 1a A photograph of the Junk Bay air shed taken from the northern headland of the bay near Pak Shek Wo. The view is towards the south-southeast.

Fig. 2a A photograph of the rooftop of the Hansen Building at the Haven of the Hope Sanatorium.
Fig. 2b Photographs of the grassy site at Leung Fung Shipyard
(i) A tethered radiosonde is operated from the site. The orange balloon is visible
(ii) Closer view of the site
Fig. 3a  Configuration of the Acoustic Radar System at Junk Bay air shed.
Fig. 3b (iii)

Fig. 3b (iv)

Fig. 3b Photographs of the monostatic acoustic radar system used for the Junk Bay air shed study, showing
(i) Acoustic enclosure;
(ii) Antenna dish with speaker and horn assembly inside the enclosure;
(iii) Transceiver display unit at Junk Bay;
(iv) Supplementary chart recorder in the ADMT office.
Fig. 4a The tethered radiosonde system operated at the Junk Bay air shed.

(i) Helium filled balloon with suspended sensor package. The tether line is attached to the front end of the balloon. The electric winch is also shown. A red and white pennant is attached as a visible marking to air-space users.

(ii) The system in operation.

(iii) Microprocessor based ground station.

(iv) Electric winch.
2.5300 ***  elapsed time (hh. mmsa)
1016.7 ***  barometric pressure (mbar)
24.2 ***  temp (deg C)
17.9 ***  height above station level (m)

69.4 T  relative humidity (%)
13.1 Z  mixing ration (g/Kg)
335.3 Y  true wind direction (deg)
 4.0 X  wind speed (m/s)

295.8 ***  potential temp (deg K)
 12.7 ***  battery voltage (V)

Fig. 4b  A typical data frame of the tethered radiosonde system
Fig. 4c (i)

Fig. 4c (ii)

Fig. 4c A free-flying radiosonde operated at the Junk Bay air shed
(i) A 100 g free-flying balloon with radiosonde attached
(ii) Closer view of the radiosonde
Fig. 5 A schematic of the acquisition of parameters from the surface meteorological station.
Fig. 6a A solarimeter at the Junk Bay air shed
(i) Sited at the highest point on the rooftop
(ii) Closer view of sensor
Fig. 6b Some components of the data acquisition system to be sited at the Junk Bay air shed including:
(i) a video display unit
(ii) line printer