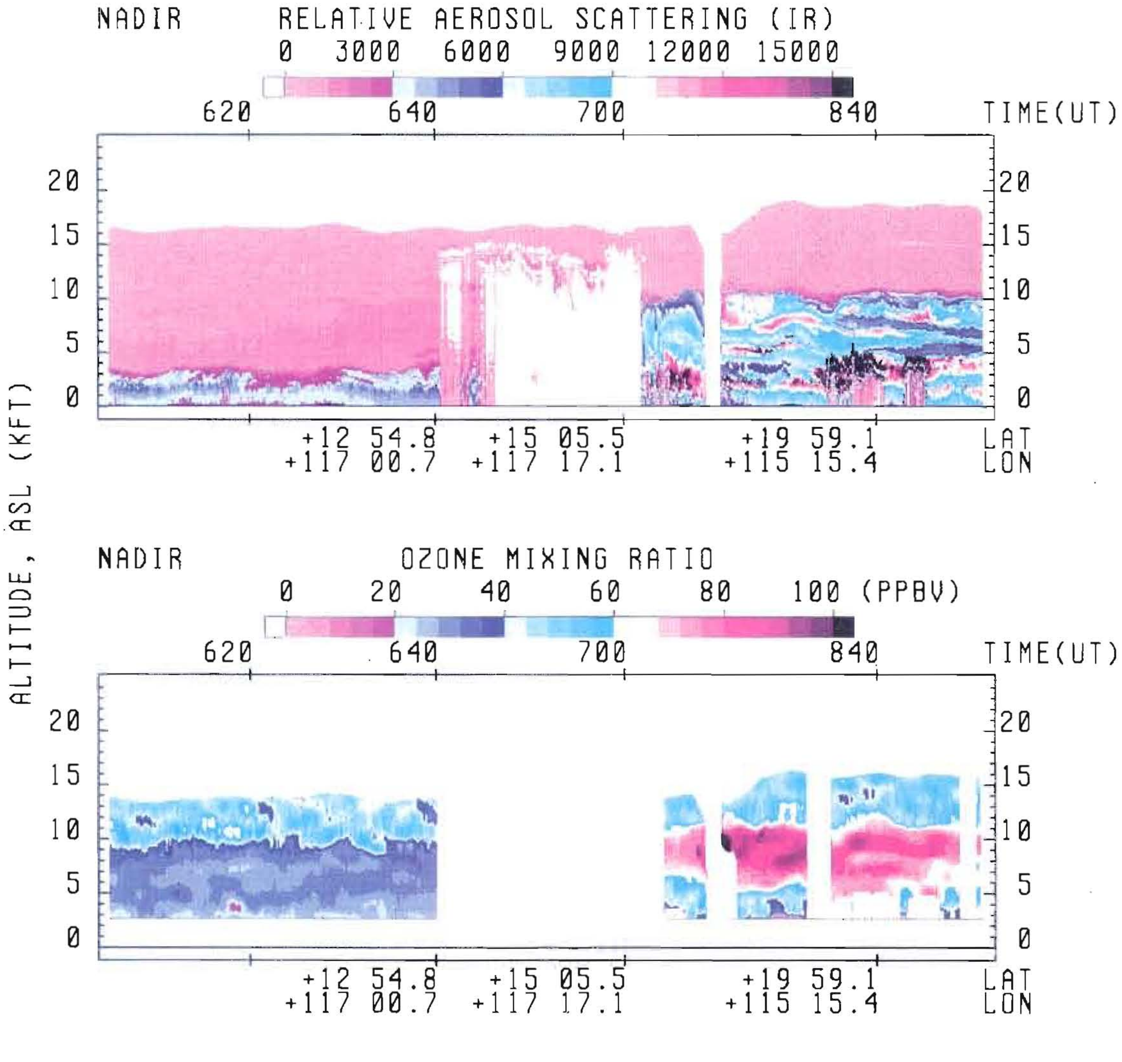
香港氣象學會
HONG KONG METEOROLOGICAL SOCIETY

Bulletin

VOLUME 6, NUMBER 1, 1996
ISSN: 1024-4468

NASA DC-8 Airborne Laboratory



ISSN 1024-4468

ABOUT THE COVER

The cover picture shows a composite image incorporating a photograph of the NASA DC-8 Airborne Laboratory and Relative Aerosol Scattering (IR) and Ozone Mixing Ratio data obtained during a Guam to Hong Kong flight during the Pacific Exploratory Mission (PEM) West-B on 21 February 1994. In this issue a paper by K.K. Yeung, W.L. Chang, Reginald E. Newell, Wenjie Hu and Gerald L. Gregory compares tropospheric ozone profiles obtained over Hong Kong as measured by ozone sondes launched from the Royal Observatory's King's Park station (*see article by Shun, C.M. & K.S. Leung, HKMetS Bulletin Vol. 3, No. 2, 21-27, 1993)* and by the nitric oxide-ozone luminescence method aboard the NASA DC-8 Airborne Laboratory operated by NASA from Hong Kong International Airport during the data collection phase of the PEM West-B mission from 21 February to 1 March, 1994.

The **HONG KONG METEOROLOGICAL SOCIETY BULLETIN** is the official organ of the Society, devoted to articles, editorials, news and views, activities and announcements of the Society.

Members are encouraged to send any articles, media items or information for publication in the **BULLETIN**. For guidance see the "**INFORMATION FOR CONTRIBUTORS**" in the inside back cover.

Advertisements for products and/or services of interest to members of the Society are accepted for publication in the **BULLETIN**.

For information on formats and rates please contact the Society secretary at the address opposite.

Views and opinions expressed in the articles or any correspondence are those of the author(s) alone and do not necessarily represent the views and opinions of the Society.

The mention of specific products and/or companies does not imply there is any endorsement by the Society or its office bearers in preference to others which are not so mentioned.

SUBSCRIPTION RATES	(Two issues per volume)
Institutional rate:	HK$ 300 per volume
Individual rate:	HK$ 150 per volume

Published by

The Hong Kong Meteorological Society

c/o Royal Observatory
134A Nathan Road
Kowloon, Hong Kong

香港氣象學會

HONG KONG METEOROLOGICAL SOCIETY

Bulletin

VOLUME 6, NUMBER 1, 1996

SINGLE COPY PRICE: HK$ 150

(for subscription rates see inside front cover)

CONTENTS

Editorial

This issue of the BULLETIN contains two papers whose main focus is the application of measurement techniques for the detection of the state of the atmosphere over Hong kong. One is concerned with approaches to the measurement of tropospheric ozone profiles while the other reports on the use of a radar acoustic sounding system (RASS) for detecting inversions and stable lapse rates in the atmosphere.

The first paper by K.K. Yeung and W.L. Chang of the Royal Observatory, Hong Kong, Reginald Newell and Wenjie Hu of the Massachussetts Institute of Technology, Cambridge, Massachussetts, U.S.A. and Gerald Gregory of NASA's Langley Research Center, Langley, Virginia, U.S.A. reports on techniques used and data collected during the NASA supported Pacific Exploratory Mission (PEM) West-B expedition from 21 February to 1 March 1994. In particular, comparison is made between tropospheric ozone profiles over Hong Kong measured by ozone sondes launched from the Royal Observatory's King's Park station and those acquired by the nitric oxide-ozone chemiluminescence method aboard the DC-8 aircraft operated by NASA from Hong Kong International Airport during the data collection phases of the mission.

In the second paper, Jay Chun-Chen, S.C. Kot and J. Mark Tepper of the Hong Kong University of Science and Technology's Research Centre report on the installation of a RASS (radar acoustic sounding system) at HKUST which provides a robust, continuous, unmanned monitoring of the lower atmosphere. Its success in detecting inversions and stable lapse rates over the territory is documented and its limitations are examined.

As in earlier editions of the BULLETIN the latest issue of *The United Nations Climate Change Bulletin* has been included to provide readers with information of a general nature concerning matters related to the subject of climate change. The remainder of the issue contains the regular features *News and Announcements* and *Hong Kong Weather Reviews.*

Readers will notice that the BULLETIN has taken on a new format after its first five years. The Editorial Board hopes that you will find it more attractive and readable than the old format and, as always, look forward to receiving any opinions, suggestions or contributions sent in by readers.

Bill Kyle, Editor-in-Chief

K.K. Yeung [1], W.L. Chang [1], Reginald E. Newell [2], Wenjie Hu [2] and Gerald L. Gregory [3]

[1] Royal Observatory, 134A Nathan Road, Kowloon, Hong Kong
[2] Massachusetts Institute of Technology, Cambridge, MA, USA
[3] NASA Langley Research Center, Langley, VA, USA

Tropospheric Ozone Profiles Over Hong Kong

ABSTRACT

Ozone profiles above Hong Kong were measured by both ozone sondes and NASA's DC-8 research aircraft during the Pacific Exploratory Mission (PEM) West-B's expedition to the territory from 21 February to 1 March 1994. Observations from the two platforms were found to compare well with each other. In particular, on one occasion both sets of data showed a large peak in ozone concentration at about 3 km above mean sea level. This peak is probably a result of long range transport. On the other hand, surface or near surface ozone levels were found to be very low. Titration by nitric oxide from heavy local traffic and a lack of vertical mixing are proposed as reasons for these low values.

1. Introduction

Between 21 February and 1 March 1994, NASA's instrumented DC-8 aircraft operated from Hong Kong's Kai Tak International Airport to make intensive observations of, amongst other trace gases, ozone and its precursors over the western North Pacific. This was in connection with NASA's Pacific Exploratory Mission (PEM) West-B programme. A description of this programme and the instruments on the DC-8 has been provided by Hoell *et al.* (1994). During this period, ozone sondes were launched by the Royal Observatory Hong Kong for cross-validation with aircraft measurements. These ozone sonde operations are part of the Royal Observatory, Hong Kong's programme to obtain ozone profile information for this part of the world where such information is limited. These data will be submitted to the World Ozone Data Centre. Further details of the Royal Observatory's ozone sounding program can be found in Shun (1993).

This note compares three ozone profiles obtained by the DC-8 and ozone sondes on 21, 25 and 27 February 1994. It describes some of the features in these profiles, and discusses the meteorological conditions associated with these features.

2. Comparison of aircraft and ozone sonde measurements

The ozone sondes used are manufactured by Vaisala of Finland. The ozone sensor is of electro-chemical concentration cell (ECC) type. The sondes are launched from the Royal Observatory's climatological station at King's Park, an urban site roughly 66 m above mean sea level. The ascent rate of the sonde is approximately 6 m s^{-1} and data is sampled once every two seconds.

Aboard the DC-8, ozone is measured via the nitric oxide - ozone chemiluminescence method. The data used in the analyses are 2 second averaged data and represent a vertical resolution of at least 15 meters when considering the nominal DC-8 takeoff and landing vertical ascent/descent rate of less than 500 m min^{-1}.

Figures 1*a*, 1*b* and 1*c* show the ozone profiles of 21, 25, and 27 February respectively, the three days when ozone profiles were made both by ozone sonde and DC-8. Measurements were made in the same air mass, albeit not necessarily at the same time. The sondes were launched at 0600 UTC (2 p.m., Hong Kong time). For the aircraft data, takeoff and landing profiles were made at 0200 UTC (10 a.m. Hong Kong time) and 0900 UTC (5 p.m. Hong Kong time), respectively.

On all three occasions, it can be said that the match between aircraft and ozone sonde profiles is generally very good. On 21 February, there is a discrepancy in the concentration near the ground as obtained from the DC-8 and ozone sonde (*see* Section 4.1 below). In the layer adjacent to the surface, the DC-8 measured concentration was about 50 ppbv on landing (no take-off value is available) while the ozone sonde sounding gives about 17 ppbv. Above this layer there is good agreement. On 25 and 27 February, aircraft and ozone sonde data show extremely low surface or near surface concentrations. The DC-8's concentrations were respectively about 4 and 7 ppbv on take-off; and 10 and 11 ppbv on landing. Values given by the ozone sonde were approximately 2 ppbv and 0.3 ppbv.

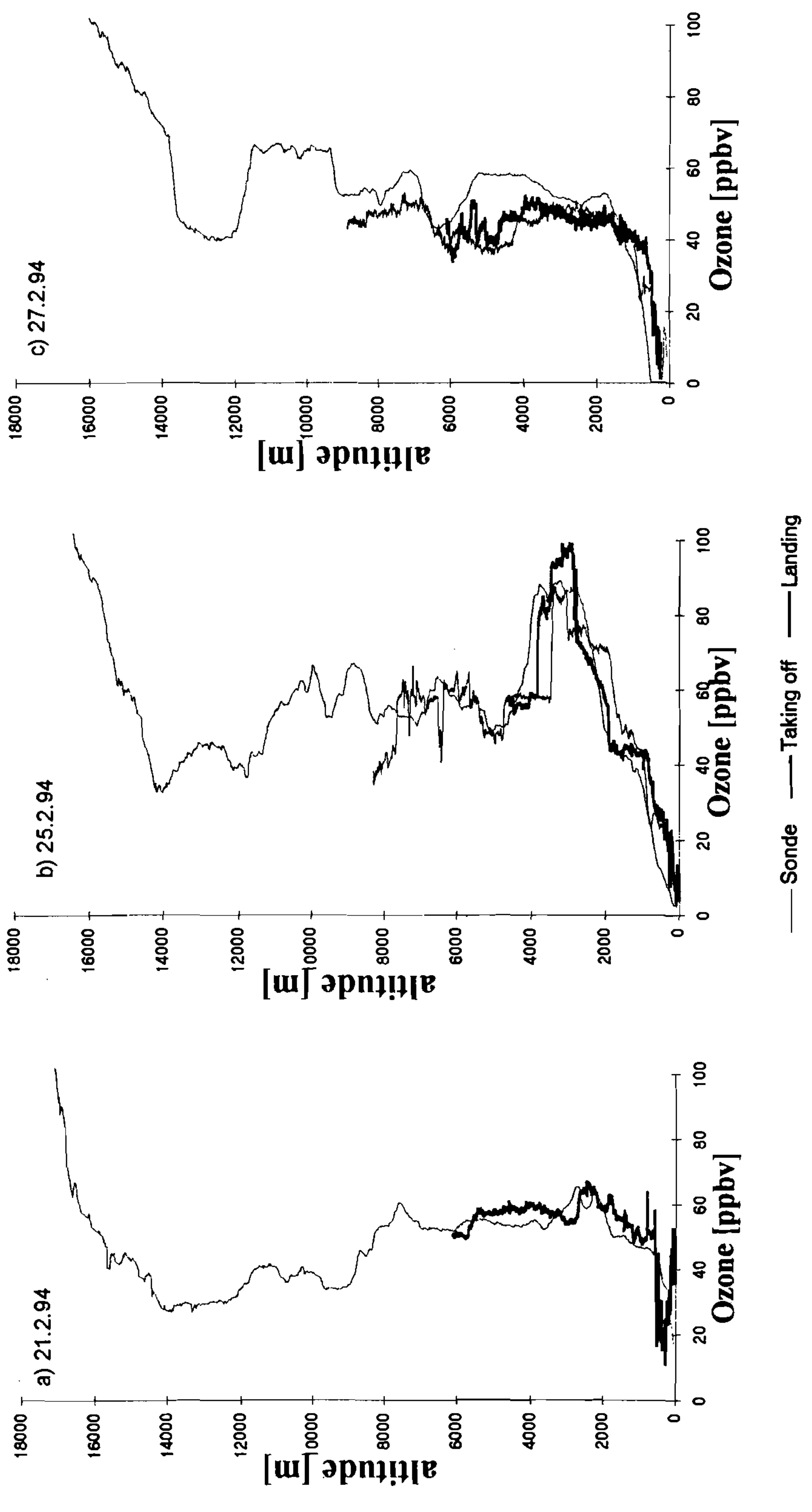
On all three days, profiles from both aircraft and ozone sonde show ozone concentrations increasing quickly from the ground and attaining maxima in the lower troposphere. The maxima is most pronounced on 25 February 1994, with the ozone concentration reaching almost 100 ppbv in a narrow layer at about 3 km. Above the maxima ozone concentrations taper off to about 50 ppbv and remain generally constant with height to about 8 km altitude, the extent of the DC-8 data in the Hong Kong air traffic control region.

3. Tropospheric ozone peak on 25 February 1994

The ozone maxima of some 100 ppbv observed on 25 February (Figure 1*b*) is reminiscent of the extraordinarily large peak, in excess of 110 ppbv, recently observed in the lower troposphere over Brazil by Kirchhoff and Marinho (1994).

Kirchhoff and Marinho (1994) associated the peak they found with biomass burning. In the present case, initially it was thought that stratospheric-tropospheric exchange processes as described in WMO (1985) might have been responsible. However, measurements by the

Figure 1. Ozone profiles measured by ozone sonde (thick line) and instrumented aircraft during take-off (medium line) and landing (thin line) on: *a*) 21 February 1994; *b*) 25 February 1994; and *c*) 27 February 1994.



DC-8 (*private communication* with G. Sachse and J. Collins) show high carbon monoxide values accompanying the high ozone values on that day. As normally low values would accompany stratospheric-tropospheric exchange, this suggests that the air in the lower troposphere was on this occasion not of stratospheric origin. This hypothesis is confirmed by the relatively high humidity mixing ratio in the lower troposphere on that day (as well as the other two days under discussion), as shown in Figure 2.

An alternative explanation would be lateral transport. The peak was observed in air behind a cold surge (Figure 3*a*). The flow at 3 km on that day (and on the previous 3 days) was westerly (Figure 3*b*) so that the air had a continental origin. Trajectory analysis may help shed light on the matter but this is beyond the scope of this research note.

4. Surface ozone

In the paragraphs below an explanation is ventured on the reasons for the very low surface ozone concentrations (17, 2 and 0.3 ppbv) measured by ozone sondes on the three days 21, 25 and 27 February 1994.

4.1 Titration effects

Nitric oxide concentrations recorded at 0600 UTC at a street level station at Mongkok, one of the busiest areas in Hong Kong in terms of traffic, were 65, 182 and 123 μgm m^{-3} (53, 148, and 100 ppbv)) respectively on the afternoons of 21, 25 and 27 February. At the same time, nitrogen dioxide levels measured at the same station were respectively 91, 86 and 63 μgm m^{-3} (48, 46, and 33 ppbv) respectively.

The high nitric oxide/nitrogen dioxide ratio (approximately 2) on 25 and 27 February suggests surface ozone destruction by the fresh injection of nitric oxide (Liu *et al.*, 1994) on these two days. The smaller nitric oxide/nitrogen dioxide ratio (0.7) and therefore lesser titration on 21 February may help account for the comparatively higher concentrations on that day.

This titration effect on urban ozone concentrations in Hong Kong can also be shown by comparing ozone sonde data with surface data from the background station at Hok Tsui. This station is operated by Hong Kong Polytechnic University (see Lam *et al.*, 1994, for a description). Figure 4 shows the comparison from which one can see that while the ozone concentrations obtained by the ozone sonde at ground level at King's Park are significantly below the surface values obtained at Hok Tsui, those at 750 m approach the background values.

The higher ozone concentration (50 ppbv) measured by the DC-8 on 21 February may also be similarly explained. Winds at the airport that afternoon were more southerly (from 148^{0} at 2 m s^{-1}) than those at King's Park (where winds were from 110^{0} at 3 m s^{-1}). The air mass at the airport was therefore fresher and more maritime with less nitric oxide for titration.

Figure 2. Humidity mixing ratio (hmr), potential temperature (θ) and equivalent potential temperature (θ_e) profiles over Hong Kong at 0600 UTC on: *a)* 21 February 1994; *b)* 25 February 1994; and *c)* 27 February 1994. The atmosphere is deemed stable/unstable if θ or θ_e, increases/decreases with height, and neutral if θ or θ_e, is constant with height.

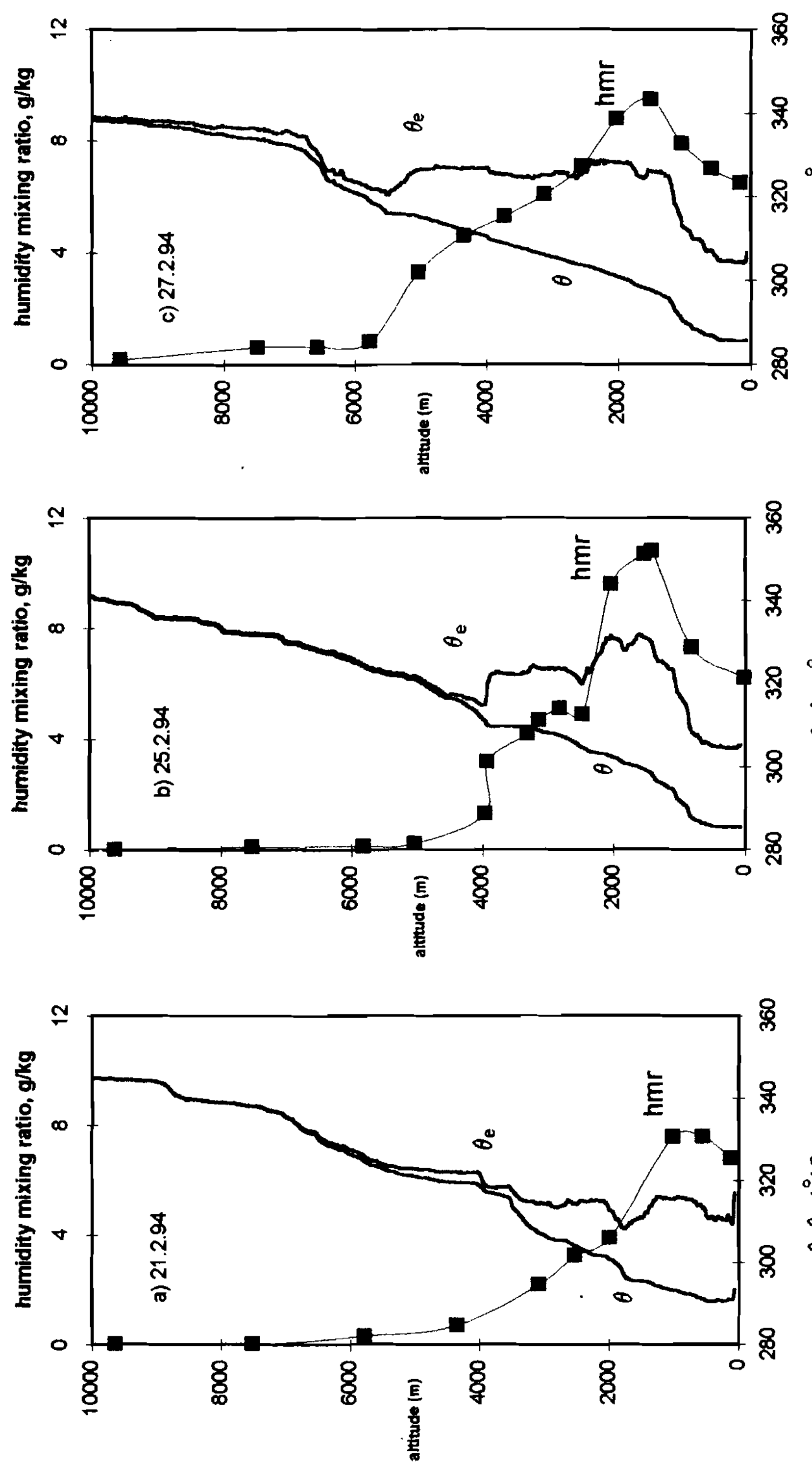
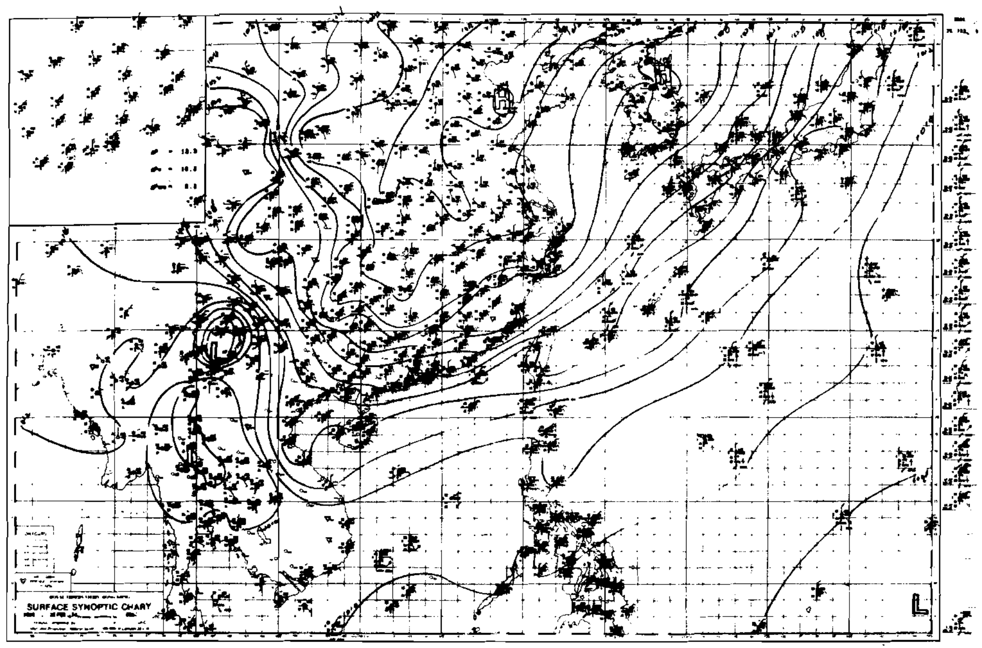


Figure 3

a. Surface pressure chart at 0600 UTC on 25 February 1994.



b. Streamlines at 700 hPa (about 3 km above m.s.l.) at 0000 UTC on 25 February 1994.

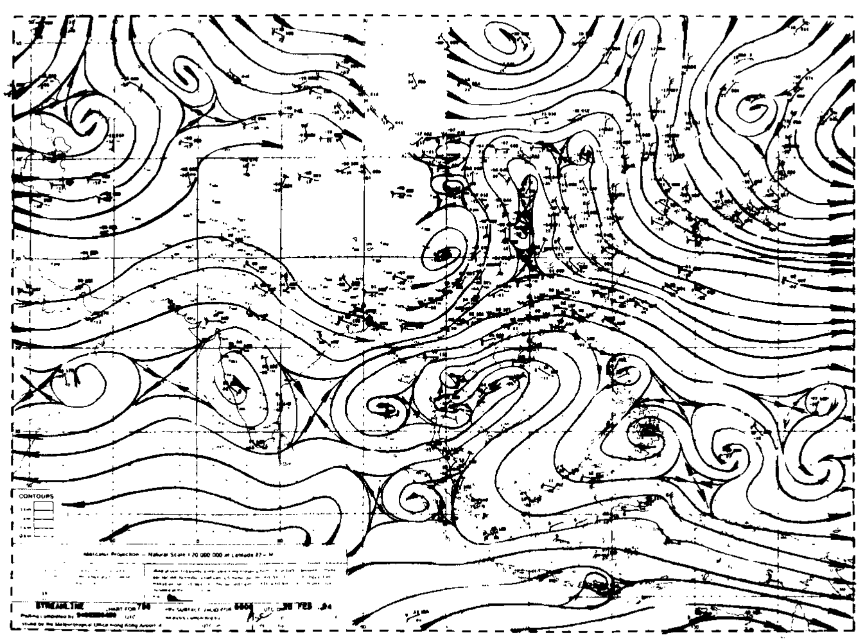
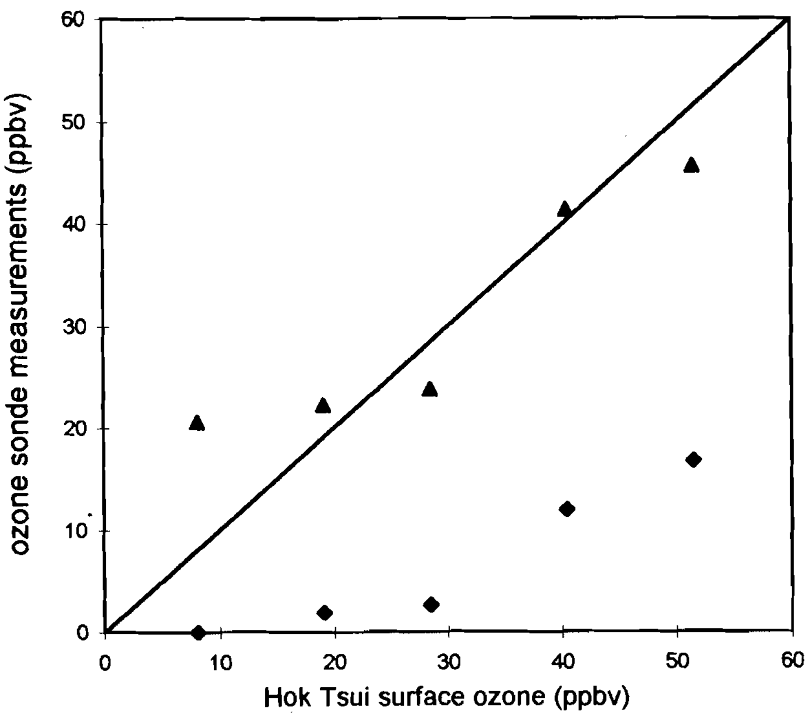


Figure 4 Comparison of ozone sonde data at 66 m (♦) and 750 m (▲) with surface ozone measurements at the background site at Hok Tsui.



4.2 Meteorological influence

In addition to titration, meteorological factors also seem to have a role to play in the very low surface ozone concentrations recorded on 21, 25 and 27 February 1994. Referring back to Figure 2, one sees that the profiles of potential temperature θ and virtual potential temperature θ_e show a stable atmosphere from about 500 m upwards on 21 February, and from just below 1 km on 25 and 27 February (refer for example, to Garratt 1992 for a description of the use of θ and θ_e to characterize atmospheric stability). The stability would have prevented the effective mixing of the ozone rich air in and above these stable layers downwards to the ground. Particularly on the 25 and 27 February when the weather was overcast (see Table 1), there was perhaps little photochemical production of ozone so that there was no opportunity for ozone depleted at the ground to be made up by either production or downward transport. The surface ozone concentrations were therefore kept very low. That the surface concentration on 21 February 1994 was higher than the other two days might be attributed to the more sunny weather on that day, a less stable atmosphere in the lower troposphere as well as less titration as mentioned in the above paragraph.

The ozone profile for 6 October 1993, further illustrates the mechanism described above. On that day surface ozone concentration, as obtained by ozone sonde, was about 50 ppbv (Figure 5*a*).

Figure 5 *a.* Ozone profile over Hong Kong at 0600 UTC on 6 October 1993. Surface ozone level is in the region of 50 ppbv, high compared with most other observations during the year.
b. Potential temperature (θ) and equivalent potential temperature (θ_e) profiles over Hong Kong at 0600 UTC on 6 October 1993.

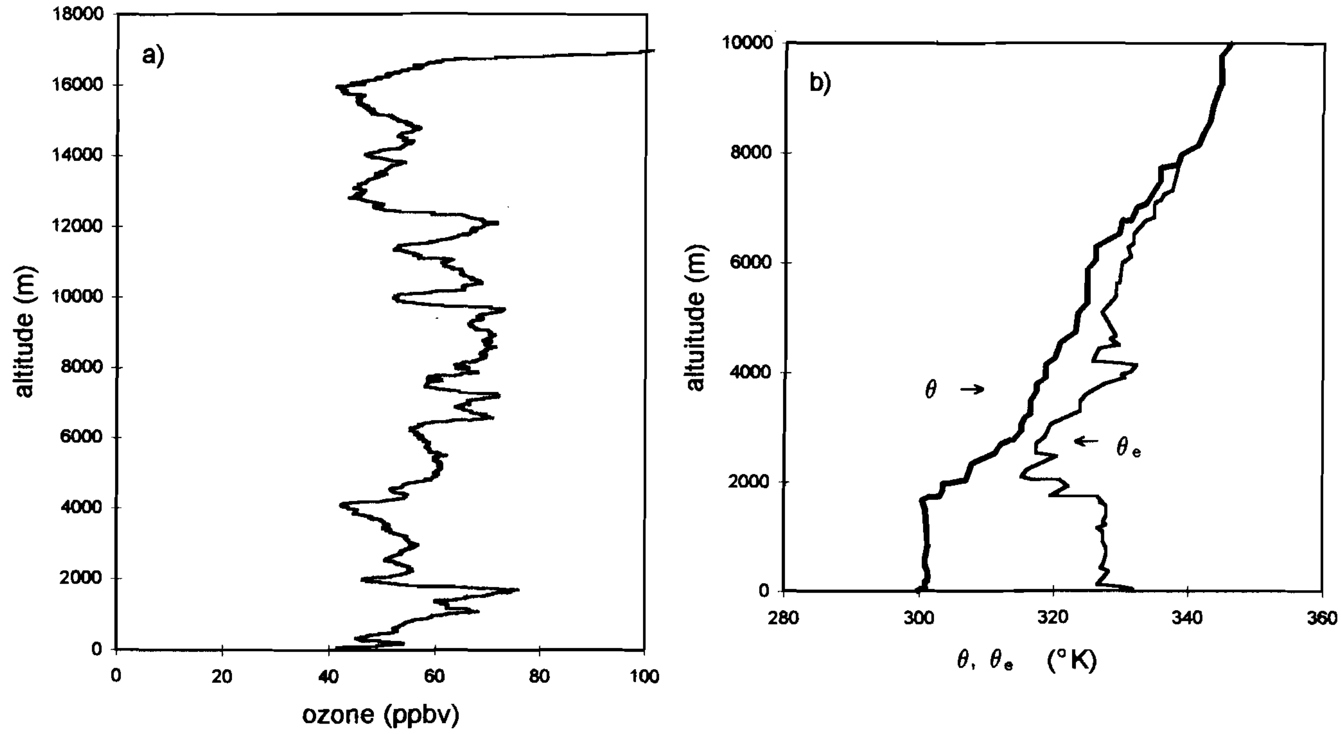


Table 1 Summary of meteorological parameters on 6 October 1993, 21, 25 and 27 February 1994.

Meteorological element	6 October 1993	21 February 1994	25 February 1994	27 February 1994
Mean cloud amount (%)	14	37	98	100
Hours of bright sunshine (h)	10.1	7.9	0	0
Daily global solar radiation (MJ/m²)	18.73	16.89	3.23	2.08

Since titration was not expected to be any less, this comparatively high surface ozone concentration may well have arisen from the sunny conditions on that day (Table 1) and the neutral layer from the ground to about 2 km (Figure 5*b*), conditions which facilitate replenishment both by photochemical production and the vertical mixing of ozone in the neutral layer.

4.3 Surface uptake

The effects of surface uptake on ozone are difficult to quantify, as estimates for a city such as Hong Kong with so much vertical surface area per unit horizontal area (from the numerous tall buildings) have not been published, although figures for vegetation, soil or water surfaces can be found, for example in Rodhe (1982).

5. Conclusions

Ozone profiles obtained by ozone sonde and NASA's DC-8 aircraft in February 1994 were found to compare well with each other. Some features of these profiles are a large peak amounting to almost 100 ppbv at about 3 km and very low near surface concentrations. It is suggested that long range transport is responsible for the former, and destruction by titration and a lack of vertical mixing for the latter.

Acknowledgements

The authors would like to thank the Director of the Royal Observatory Hong Kong and the NASA Global Tropospheric Experiment Program Manager, Dr. Robert J. McNeal for supporting this research. The authors also gratefully acknowledge NASA for providing the ozone sondes the results of which are reported here, Mr. K.S. Leung of the Royal Observatory Hong Kong for supervising the calibration and launching of the ozone sondes, Hong Kong Polytechnic University for making available ozone data from its Hok Tsui station, and the Environmental Protection Department of the Hong Kong Government for making available the nitric oxide and nitrogen dioxide data for February 1994 from its Mongkok station.

References

GARRATT, J.R., 1992 : *The Atmospheric Boundary Layer*, Cambridge University Press, 316 p.

HOELL, J.M., D.D. DAVIS, S.C. LIU, R.E. NEWELL, M. SHIPHAM, H. AKIMOTO, R.J. McNEAL, R.J. BENDURA and J.W. DREWRY, 1996 : The Pacific Exploratory Mission-West (PEM-West A): September-October 1991, *J. Geophys. Res.*, (in press).

KIRCHOFF, V.W.J.H., V.A. MARINHO, 1994 : Layer Enhancements of Tropospheric Ozone in Regions of Bio-Mass Burning, *Atmospheric Environment*, **8**, 69-74.

LAM, K.S., L.Y. CHAN and M. ANSON, 1994 : Indications of Continental and Pacific Air Mass Transport from the Measurement of Ozone and Other Trace Gases in a Remote Station in Hong Kong. Western Pacific Geophysics Meeting, 25-29 July 1994, Hong Kong.

LIU, C.M., HUANG Ching-Ya, SHIEH Shinn-Liang, and WU Ching-Chi, 1994 : Important Meteorological Parameters of Ozone Episodes Experienced in the Taipei Basin, *Atmospheric Environment*, **28**, 159-173.

RODHE, H., A. ELIASSEN, L. ISAKSEN, F.B. SMITH, and D.M. WHELPDALE, 1982 : *Tropospheric Chemistry and Air Pollution*, World Meteorological Organization Technical Note No. 176.

SHUN, C.M. and K.S. LEUNG, 1993 : The First Radioactivity and Ozone Soundings in Hong Kong, *Hong Kong Meteorological Society Bulletin*, 3, 21-27.

WORLD METEOROLOGICAL ORGANIZATION, 1985 : *Atmospheric Ozone - Assessment of Our Understanding of the Processes Controlling Its Present Distribution and Change, Vol. I*, World Meteorological Organization Global Ozone Research and Monitoring Project - Report No. 16, 151-240.

Jay Chung-Chen, S.C. Kot, J. Mark Tepper

Research Centre, The Hong Kong University of Science & Technology,
Clear Water Bay, Kowloon, Hong Kong (Internet: *http://sunsite.ust.hk/~rc*)

Detecting Inversions and Stable Lapse Rates with RASS

ABSTRACT

Inversions and stable lapse rates in the lower atmosphere impede vertical dispersion causing a detrimental effect on the dispersal of air pollution in the boundary layer. Detection of these layers have been historically made by radiosondes launched from regional meteorological offices usually twice daily near sunrise and sunset. Recently efforts have included instrumented aircraft, SODAR (acoustic radar), and tethersondes to provide extended spatial and temporal coverage. The installation of RASS (radio acoustic sounding system) at HKUST enables continuous, unmanned, and robust monitoring of the lower boundary up to 1 kilometre. Inversion and stable conditions on December 18, 1995 and January 3, 1996, respectively adversely affected the territory's air quality as noted by the Hong Kong Government's Environmental Protection Department's Air Pollution Index (API). Radiosonde and RASS measurements for these cases are studied in this paper to illustrate limitations of existing system and to propose a supplemental detection and monitoring method.

Instrumentation & Introduction

Instrumented balloons known as radiosondes measure a wide variety of meteorological parameters vertically up to the troposphere. Radiosondes are hand launched at sunrise and sunset to measure diurnal atmospheric conditions (neutral, stable and unstable) respectively. Meteorological stations process the raw radiosonde data and transmit data at the significant heights (*i.e.* surface, 1000, 925, 850 mb) over the GTS (Global Telecommunications Network) to share with the world weather community. For air pollution studies, temperature and wind vector information are most critical. Radiosondes are able to accurately measure dry bulb temperature to within +/-0.1°C, hence are commonly used as standards to compare other meteorological instruments. However, the reliability of radiosonde data is often degraded by human and environmental factors. For example, the telemetry link with the meteorological ground station is often affected by background electrical activity such as lightning, pagers, and mobile phones. The average ascent rate for a radiosonde is between 3-4 ms^{-1}, which often requires 15-20 minutes for a complete sounding between 1000 mb and 10 mb (troposphere) [Chen, Kot and Tepper, 1996]. Slow ascent rates also increase the susceptibility of serious damage by impacting airplanes and birds. [Lally, 1985]

Plate 1 Wind Profiler/RASS equipment at seafront

The commercial development of RASS (Radio Acoustic Sounding System) by a joint project between NOAA/NCAR/Radian has enabled researchers and forecasters to predict and monitor temperature profiles in near real time. A RASS has been recently deployed at the Hong Kong University of Science & Technology (HKUST) in conjunction with a 1299 MHz wind profiler atop the coastal seawater pump house (Plate 1). Arrayed loud speakers with parabolic reflectors project pseudo-random acoustic waves at +18 dBV between 2880-2998 Hz upwards to vibrate air parcels. The induced perturbation of the index of refraction scatters the incoming vertical electromagnetic beam from a collocated wind profiler back to the receiver. When the wavelength of the acoustic wave matches half the wind profiler's wavelength the acoustic waves are scattered most efficiently. This tuning method is referred to as Bragg Matching and provides the highest Signal to Noise Ratio (SNR). To guarantee matching and to conserve energy emissions, a narrow acoustic frequency range is programmed according to typical seasonal temperature extremes. The returned signals are then averaged for five minutes. The RASS is turned off between 23:00-7:00 HKT to minimize disturbance to university students. The data set is kept locally for half an hour then automatically transferred by a 14.4K modem to the Operations Centre in the main academic building for display, analysis, and archival.

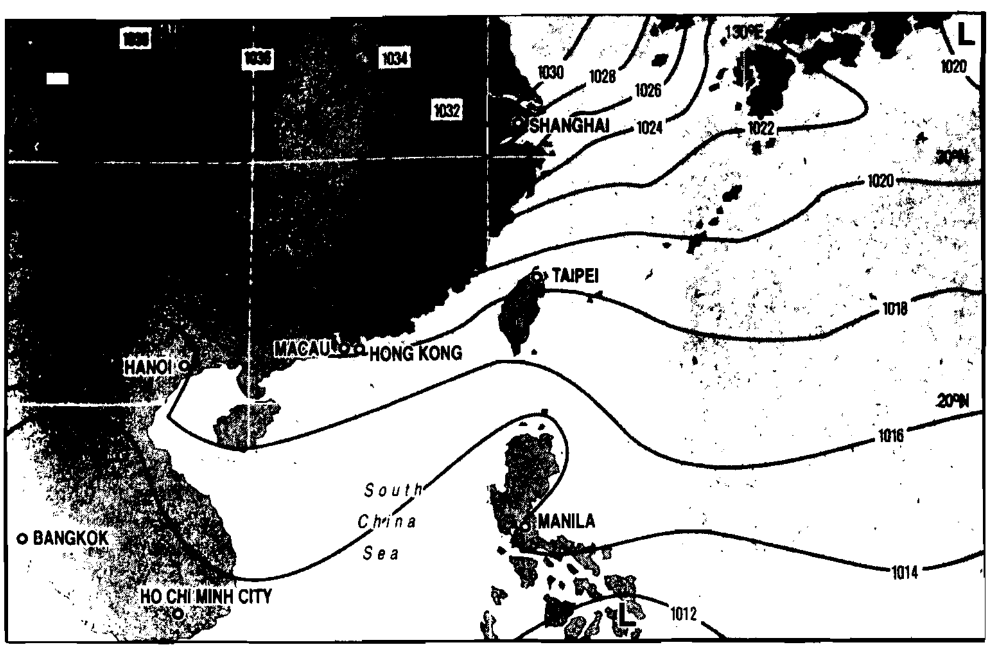
RASS measures the virtual temperature of the atmosphere accounting for the effect of water vapor in addition to the dry bulb temperature. Under low humidity at low atmospheric levels this difference is negligible. At high humidity this error may be between 1-2°C (calculated from steam tables). Researchers at NOAA compared 50 pairs of radiosonde and RASS profiles and identified a rms difference of less than 1°C [May *et al.*, 1989]. Knowledge of previous moisture profiles as measured by earlier radiosonde profiles was suggested to correct any small errors.

The stability of air parcels in the lower atmosphere are determined by the vertical temperature gradient or lapse rate (Γ). For low humidity atmospheres, a dry adiabatic lapse rate ($\Gamma_d \sim 9.8$°C km^{-1}) is utilized as a reference to determine the stability (*i.e.* $\Gamma < \Gamma_d$ the atmosphere is considered stable, vertical motion suppressed). However, for moist environments, air parcels contain water vapor. During condensation, latent heat is released and water is removed adding buoyancy to air parcel causing unstable motion. A saturated adiabatic lapse rate ($\Gamma_s \sim 4$°C /km) is therefore implemented in tropical regions to designate a conditionally unstable atmosphere when $\Gamma_s < \Gamma < \Gamma_d$ [Holton, 1992].

Results

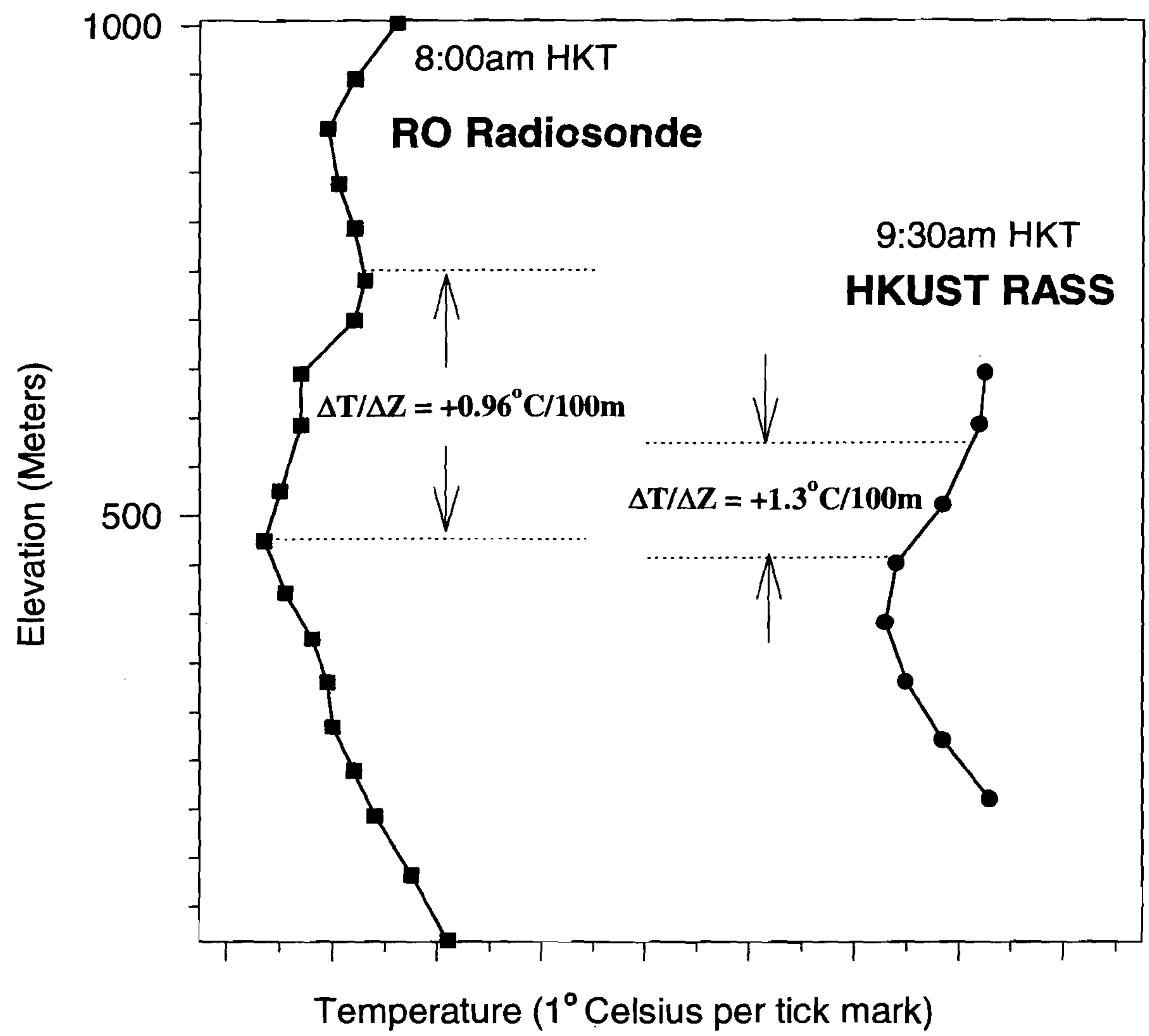
December 18, 1995 - Temperature Inversion ($\Gamma << \Gamma_s$)

Plate 2 General Situation Chart for December 18, 1995



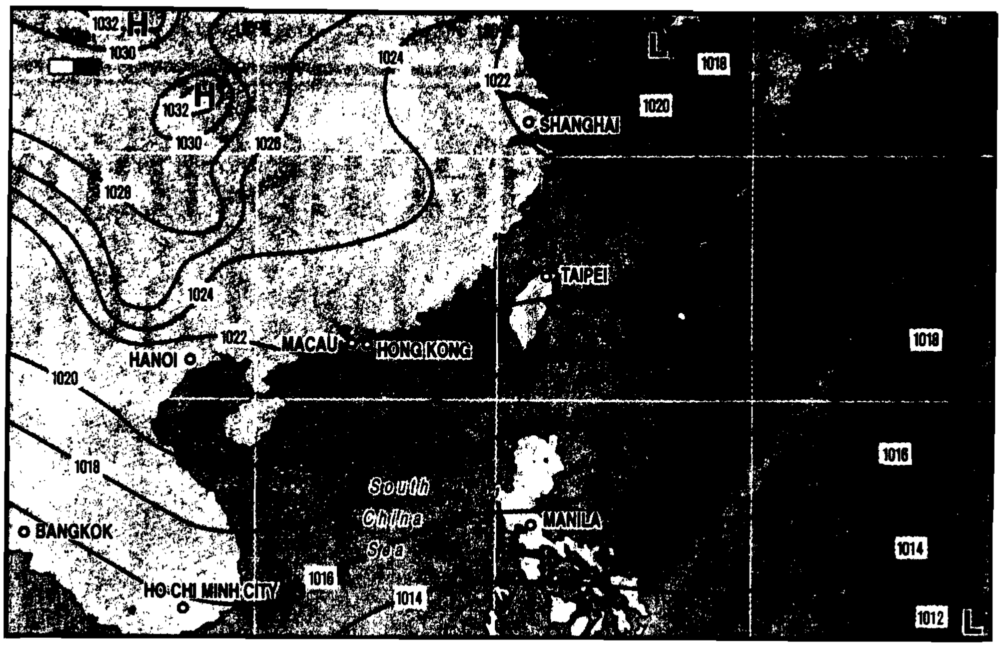
As seen in the General Situation Chart in Plate 2 a cold front entered into the region on December 17, 1995 dropping surface temperatures in the New Territories to below 15°C. The skies were overcast and patches of rain were detected by the Royal Observatory. Light northerly winds brought cool air from the mainland dramatically affecting the coastal regions near Hong Kong. On the morning of December 18, 1995 a low level inversion was detected by the Royal Observatory's 0:00 GMT radiosonde and by HKUST's RASS. Intensities of the inversion were -9.6°C km^{-1} (RO radiosonde) and -13°C km^{-1} (RASS) for elevations between 450-750 meters above sea level as shown in Figure 1. However by midday, moderate easterly winds brought fresh, moist air to the territory. Surface anemometers recorded wind speeds of 5-7 m s^{-1}. The relative humidity varied between 71-97 percent up to 2 km. Low lying clouds were detected by the radiosonde at 500 and 700 meters. The API index issued by the EPD was only 40.

Figure 1 Inversion Intensities on December 18, 1995



January 3, 1996 - Stable Condition ($\Gamma < \Gamma_s$), Conditionally Unstable ($\Gamma_s < \Gamma < \Gamma_d$)

Plate 3 General Situation Chart for January 3, 1996

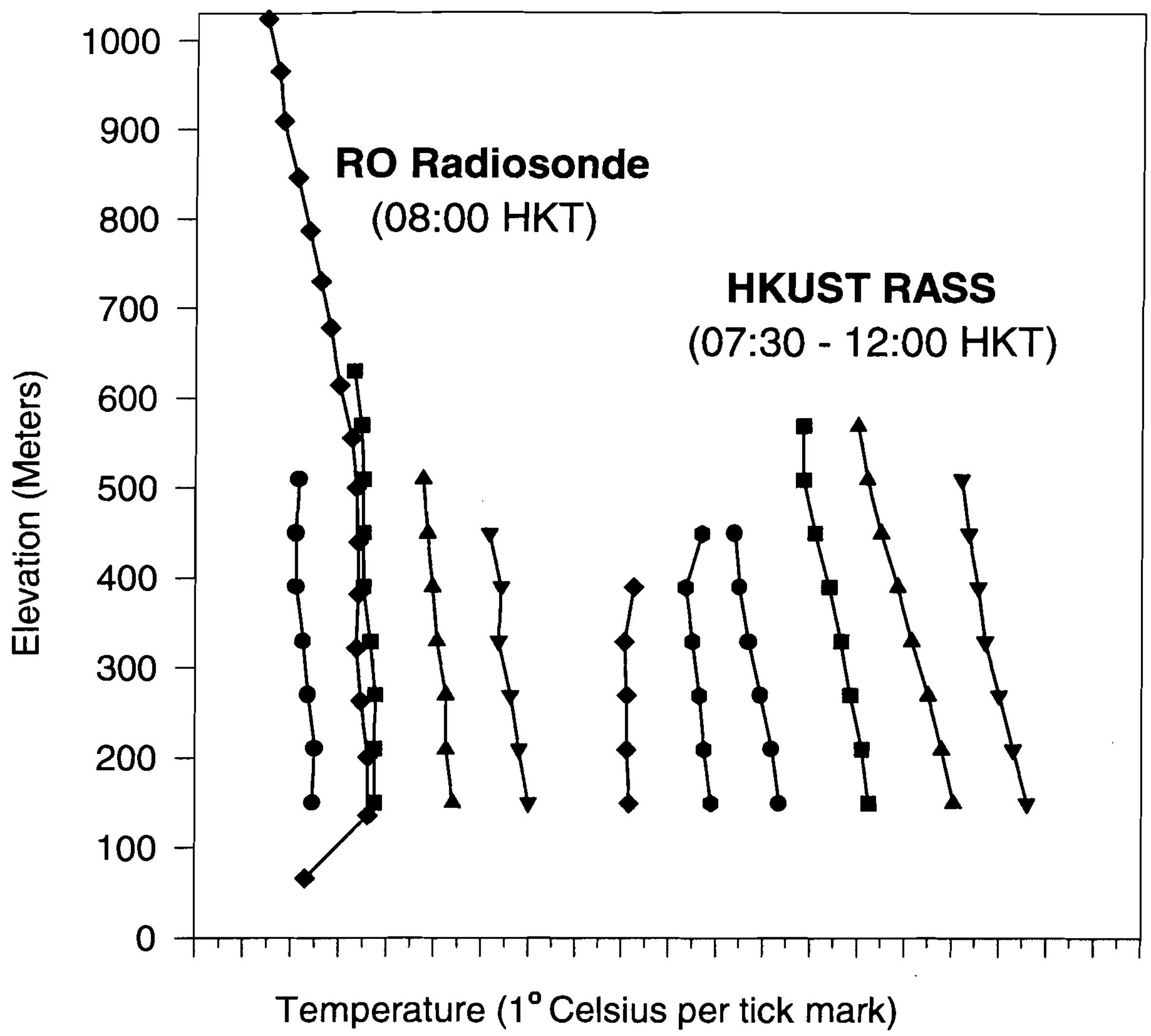


Under the influence of a northeast monsoon (Plate 3) the territory experienced sunny and dry conditions throughout the day on January 3, 1996 with light winds from 2-3 ms^{-1}. The 0:00 GMT RO radiosonde measured stable conditions (+3.1°C km^{-1}) with dry air (RH, 17-56 percent) extending upwards to 2 km. HKUST's RASS also measured stable conditions (+2°C km^{-1}) with a slight inversion at 10:00am. Levels of NO_x, a key gaseous air pollutant reached record highs by 10:00am at an air quality monitoring station at Shalowan, Lantau Island. By mid-morning the EPD revised the daily predicted API to over 120. Persons with existing heart or respiratory illnesses were advised to stay home. RASS tracked the eventual breakdown of the stable condition by 11:30am as illustrated in Figure 2 when the temperature gradient approached the standard dry adiabatic lapse rate of +9.8°C km^{-1} [Pasquill and Smith, 1983]. Strong solar radiation raised urban temperatures to 21°C by mid-afternoon.

Conclusions

A strong inversion was detected on December 18, 1995 by RO and HKUST instruments. However, it did not affect the API index substantially. Abundant moisture in the vertical column perhaps "washed out" aerosols to either adjacent clouds or deposited them on the ground with rain. In addition, moderate offshore easterly breezes mitigated the transport of mainland aerosols to Hong Kong. Conversely, on January 3, 1996 a distinctly less stable atmosphere curiously raised the API to a record breaking 120. A northerly airstream from mainland China brought dry and aerosol laden air to Hong Kong and was widely believed to be

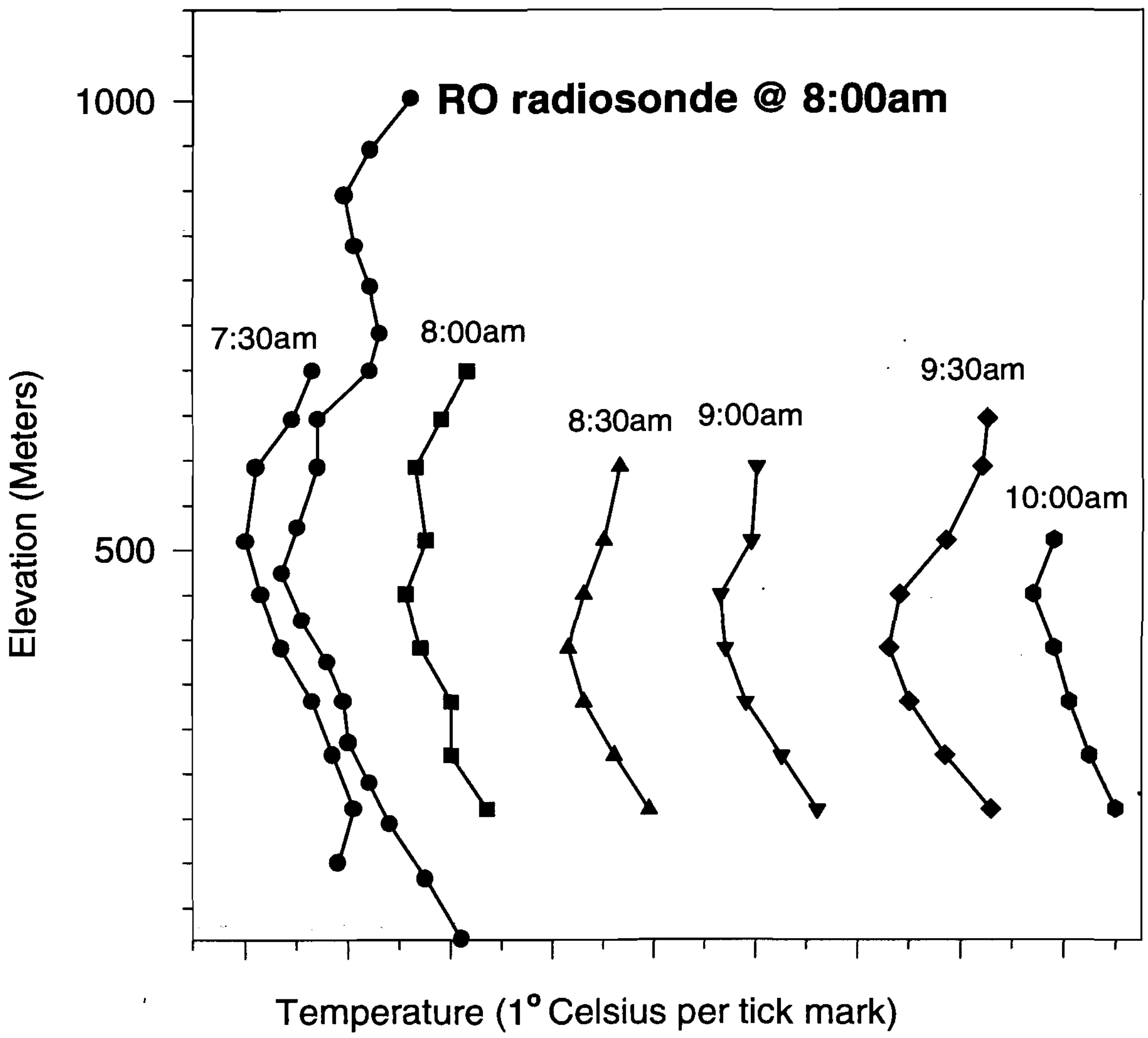
Figure 2 Inversion Intensities on January 3, 1996



responsible for the poor air quality. RASS was able to monitor the eventual breakup of the morning stable conditions at 11:30am. With RASS, pollution forecasters would be able to monitor the evolution and disintegration of inversions which may fumigate the surface layer. Hong Kong citizens could then be effectively notified of impending or diminishing health hazards.

RASS performance was enhanced during the dry event on January 3rd which agreed with studies by May *et al.* [1989]. Slight variations between the graphed temperature gradient from the radiosonde and RASS are attributed to the distance between sounding locations (~10 km between King's Park and Clear Water Bay) and differing surface conditions at launch (marine and urban). Conversely, the high moisture content on December 18th caused a 2°C deviation between radiosonde and RASS data as shown in Figure 3. Moisture content information from radiosonde releases confirms the deviation of RASS data. Fortuitously, severe air pollution events occur on dry days, when RASS data are most accurate.

Figure 3 Radiosonde and RASS Profiles on December 18, 1995



Acknowledgements

The authors wish to thank K.P. Wong, Chief Experimental Officer at Royal Observatory for the 10-second raw radiosonde data. At the Hong Kong University of Science & Technology, gratitude is extended to the Estate Management Office's Building Services section for providing space and installation support and to the Research Centre's technical support staff.

References

EASTERN EXPRESS NEWSPAPER, 1995/96 : General Situation Charts on December 18, 1995 and January 3, 1996.

HOLTON, J.R., 1992 : *An Introduction to Dynamic Meteorology 3rd Edition*, Academic Press, San Diego, 293.

LALLY, V.E., 1985 : Upper Air in situ Observing System. *In* (Ed.) *Handbook of Applied Meteorology*. John Wiley & Sons, New York, 352-360.

MAY, P.T., R.G. STRAUCH, K.P. MORAN and W.L. ECKLUND, 1990 : Temperature Sounding by RASS with Wind Profiler Radars: A Preliminary Study. *IEEE Transactions on Geoscience and Remote Sensing*, 28(1), 19-27.

MAY P.T., L.M. McMILLIN, 1991 : Prospects for Temperature Sounding with Satellite and Ground-based RASS Measurements. *Journal of Atmospheric and Oceanic Technology*, 506-513.

PASQUILL, F. and F.B. SMITH, 1983 : *Atmospheric Diffusion*, Ellis Horwood, Chichester, England, 381-384.

TEPPER J.M., S.C. KOT, and J.C. CHEN, 1995 : Comparing NOAA-12 and Radiosonde Atmospheric Sounding Profiles for Mesoscale Weather Model Initialization. *Proc. Space Remote Sensing of Subtropical Oceans Conference, Taipei, Taiwan*, Section 13B2, 6-12.

United Nations Climate Change Bulletin

CONTENTS

❶ The Geneva COP: Keep the focus on sustainable development

H.E. Chen Chimutengwende, President-designate of the Second Session of the Conference of the Parties

The United Nations Framework Convention on Climate Change is one of several international efforts undertaken during the last decade to redirect economic development towards forms of production and consumption that are more sustainable and that take into account the resilience of natural ecosystems.

The Convention was inspired by concerns that humanity's activities may be disturbing the natural climate system. The climate has changed in the past, but the pace at which greenhouse gas-induced climate change will take place in the future could be too rapid for ecosystems to adjust. It is in large part this rate of change that convinced over 150 heads of state and other senior officials to sign the Climate Change Convention at the Rio Earth Summit in June 1992.

A divided world

Four years later, as we prepare to meet in July 1996 for the Second Session of the Conference of the Parties (COP-2), some 160 countries have become Parties, the majority of them developing countries.

While there is no need to waste time casting blame on one another, all Governments must take a serious look at the policies and measures that they are adopting at the national or regional level to redress this apparent global climate trend. For without a willingness to exchange old habits for new approaches that incorporate environmental considerations, the quality of life for future generations will certainly be compromised.

It is with this understanding that I have joined the negotiation process. Developments since COP-1, which was held in Berlin last year, have demonstrated that the world continues to be divided into two: the developed (Annex I) countries on one hand, and the developing countries on the other.

To address climate change, the developing country Parties will need support to build their capacities and capabilities, strengthen existing institutions, and develop new ones. They need the transfer of technologies and know-how and of new and additional financial resources. The need for such support does not generally apply to the developed countries.

The same scarce resources that developing country Parties have available for climate change activities are also needed for national priorities such as alleviating poverty and providing basic social facilities such as health, education, housing, and security. These urgent needs must take precedence over climate change considerations. Unless it can be demonstrated that certain policies and options can simultaneously generate short- and long-term benefits for both national priorities and for global climate change, developing nations will find it extremely difficult to divert meagre resources to address the Convention.

At the same time, developing country Parties will suffer the most as a result of climate change and climate variability. In recent years African countries have experienced recurrent droughts leading to reduced water resources, poor agricultural performance, and desertification. Some Pacific and Asian countries have suffered excessive flooding as a result of severe monsoons episodes. The Americas, too, have experienced severe weather conditions. Unlike the developing nations, the developed countries have demonstrated a capacity for coping with such extreme events and conditions.

The ongoing negotiations, therefore, must seek answers not just on what needs to be done, but more importantly on how to find the means to take action. The availability of financial resources to support climate change programmes and projects is vital. So too is a change in unsustainable consumption patterns.

A new era of trust

We should work together to ensure that the process of implementing this Convention has a positive affect on all international efforts and agreements involving sustainable development. The Convention has the potential to encourage the introduction of new and innovative technologies into our industrial processes and to promote a greater harmony amongst trade and information exchange systems. It is also my hope that this process will produce numerous business opportunities for environmental technologies.

My vision of the Berlin Mandate negotiations of additional developed-country commitments is that they should pave the way for a new era of trust where Parties do their best at the national level to achieve the common good of the international community.

For such cooperation to be fully effective, the concept of sustainable development must evolve.

We need innovative and alternative development policies if sustainable development is to serve as an effective guideline for the future. All nations should join hands in designing these policies and giving development a new direction - a direction that truly takes note of environmental considerations.

Finding meaningful solutions to the problem of climate change will require input not only from governments, but from all interested parties. We can all be satisfied with the positive contributions being made by both business and environmental nongovernmental organizations (NGOs) as well as municipal leaders.

On the academic front, the role of the Intergovernmental Panel on Climate Change (IPCC) as an important source of scientific and technical information on the understanding of climate change is greatly appreciated by the negotiators. The 1995 Second Assessment Report will therefore be used as a basis for the negotiations during COP-2. The COP will welcome future updates from the IPCC. Further progress in making regional and national predictions of climate change and its impacts will be particularly important to enable Parties to respond to the challenges ahead.

Mr. Chen Chimutengwende is the Minister for Environment and Tourism of Zimbabwe

❷ Strengthening the FCCC: A mid-term review of the Berlin Mandate

Raul Estrada-Oyuela, Chairmain, Ad hoc Group on the Berlin Mandate, and Ambassador of Argentina to China

The Ad hoc Group on the Berlin Mandage (AGBM) is now half-way through its two-year task of preparing a "protocol or other legal instrument" to further the goals of the Convention. This year's COP offers an opportune moment to take stock of how far we have progressed, and of what we must still achieve in the coming year.

The AGBM

The AGBM was established by the COP's first session last year in Berlin. It will hold its fourth meeting during COP-2 and then three more before submitting its final results to COP-3 in the second half of 1997. The Berlin Mandate recognizes that the commitment of developed countries (including countries with economies in transition) to take measures aimed at returning their greenhouse gas emissions to 1990 levels by the year 2000 are not adequate. Stronger commitments for these countries are needed for the post-2000 period.

As required by the Berlin Mandate, the AGBM is considering all greenhouse gases - carbon dioxide, methane, nitrous oxide, and so on. It is elaborating policies and measures and negotiating quantified objectives for limiting and reducing emissions of these gases within specified time-frames, such as the years 2005, 2010, and 2020.

The AGBM is *NOT* introducing new commitments for developing countries, although the Berlin Mandate does reaffirm the existing ones and calls for advancing their implementation.

Tools to work with

The AGBM also draws on the inputs of other bodies. An especially important input is the 1995 Second Assessment Report from the Intergovernmental Panel on Climate Change (IPCC). For example, the IPCC finds that so-called no-regrets policies could cut emissions by 10-30% at little or no cost. It also finds sufficient rationale for going beyond no- regrets. The IPCC assessment suggests that a prudent strategy for combating climate change would address mitigation, adaptation, and research. This strategy would be adapted over time as knowledge and circumstances evolve.

Other inputs come directly from participating governments. Two key documents include a draft protocol proposal submitted by the Alliance of Small Island States (AOSIS) at COP-1 and a draft protocol outline tabled by the European Union (EU) at the second AGBM meeting.

Policies and measures

The AGBM started this complex process by first getting the various options and issues out on to the table. It then began to analyse and assess policies and measures that could be included in the future protocol. There has been a lively debate over how long and how in-depth this analysis phase should be. Nevertheless, the possibilities are now being whittled down to a more definitive list.

Many of the policies and measures that have been identified focus on controlling emissions through technological solutions. They focus in particular on renewable energy, transport, and energy efficiency. Cross-sectoral economic instruments (??) and the removal of subsidies and market distortions are also being discussed.

More specifically, at COP-2 an expert group set up by the developed countries will present the first results of its studies of possible policies and measures, including:

* emissions from road vehicles;
* removal of electricity and transport subsidies;
* energy efficiency standards for traded products;
* financing energy efficiency in CWEITs(?);
* removing barriers and improving access in energy markets;
* full-cost pricing of energy;
* taxation (carbon/energy);
* voluntary agreements with industry for demand side efficiency; and
* reducing emissions in agriculture and forestry.

Structuring the protocol

The AGBM talks are starting to address how to incorporate agreed policies and measures into the protocol or legal instrument. Parties must also determine whether policies should be internationally harmonized, and if so to what degree.

Two general approaches have emerged. There could be an agreed detailed listing, or menu, of possible policies and measures from which each developed country would choose the ones most suitable to its national circumstances.

Alternatively, the policies and measures could be catagorized, or prioritized in annexes to a protocol. Either approach raises the question of whether policies should be internationally harmonized, and if so to what degree.

Another key element for the protocol will be the "quantified emissions reduction and limitation objectives", or QERLOS, that the policies and measures will seek to achieve. The range of acceptable options and variations has become clearer, including the following:

a) a 20 per cent reduction in CO2 emissions by 2005 with reference to 1990 (the AOSIS protocol proposal);

b) a 10 per cent reduction in CO2 emissions by 2005 and a 15-20 per cent reduction by 2010, both against the base year of 1990; and

c) a 5 to 10 per cent reduction by 2010 compared to 1990.

There is a discussion on whether the objective should be uniform or differentiated (e.g. for OECD vs. countries with economies in transition). In addition, some Parties advocate that the agreed objective apply to a comprehensive, multi-gas approach; others advocate a gas-by-gas approach to identifying separate objectives.

Other ideas include creating incentives for early action. Some emphasize short- and medium-term goals (2005 and 2010) to promote early action, while others are more inclined to a longer time-horizon to optimize investment decisions.

Next steps

It should be stressed that, while the AGBM draws from scientific and technical sources, this is not a technical exercise. Clear-cut technical solutions that governments can simply verify and adjust over time do not exist for the problem of global warming.

This is a political exercise, and we are analysing, assessing, and negotiating because al Parties have different national interests. Our task is to reach a workable compromise, supported by the largest possible number of Parties, that will advance us towards the objective of the Convention. If based on an intelligent vision of the future world economy and its energy needs, such a compromise will prevail over the current anxieties of a small minority of Parties.

This effort will continue at COP-2. The AGBM meeting will continue to analyse and assess policies and measures but will also start considering features of a possible protocol. We need to advance now in both areas in order to clarify the legal and political possibilities.

During the year to come, we must further clarify options, negotiate among delegations, consult with capitals and reach agreement on a final text to be adopted by COP-3. It will not be easy. Since we have to deal now with concrete policies and measures nd with specific limitation and reduction objectives, it may require even more work and stamina that did the negotiation of the original Convention.

At the same time, in many ways we are now in a better position. We are working on the basis of an existing international agreement; the problem is better understood; the general public, particularly in developed countries, is more aware of the problem; some business sectors, including insurance and banking, are starting to take a constructive interest; and recent weather extremes - including heavy tropical storms, warmer summers, extraordinary precipitation, floods, and drought - have offered a preview of what could happen in coming decades as climate change accelerates the hydrological cycle. We are committed to the Berlin Mandate, and we will deliver.

❸ National efforts to implement Convention: A second review

Vitaly Matsarski, Manager, Review Process, Climate Change Secretariat

Now that the Convention has been in force for over two years, the process of gathering and assessing information about national greenhouse-gas emissions and climate change-related activities is gaining momentum. The first 15 national communications received from Annex I Parties (developed countries and countries with economies in transition) were reviewed in late 1994. Now the second review - based this time on information from 33 Parties - is being finalized in time for COP-2.

This Second Compilation and Synthesis Report benefits from a more complete and comprehensive set of submissions. While many methodological and practical problems remain, governments are steadily improving how they gather and present data.

In addition, information from 21 in-depth reviews, including country visits by expert teams, has been included. These reviews generate a more sophisticated understanding - both amongst the reviewers and the producers of country information.

Last year, COP-1 decided that developed and transition countries should submit their second communications by 15 April 1997. Developing countries will start submitting their first communications in 1997 as well. However, the review process is one of the major agenda items for this year's COP, and we shall soon learn what direction this critical activity will take.

Inventories and projections

Each communication contains a national inventory identifying greenhouse gas sources and sinks (e.g. forests) and quantifying the emissions and removals of each gas. Inventories are essential to understanding what the situation is today in order to measure future progress or change.

The 33 Parties reporting inventories for 1990 accounted for 63% of global carbon-dioxide emissions (inventories available for the first review accounted for just 41%). Of these, about 20 reported inventories for the years 1991 through 1994.

The inventories show carbon dioxide accounting for 80.7% of total greenhouse gas emissions, confirming CO2 as the most important gas. Fuel combustion is also confirmed as the most important CO2 source.

The largest sources for methane were fugitive fuel emissions (leaks) at 37.8%, livestock at 31.4%, and waste at 26.6%. Nitrous oxide was primarily released by the agricultural use of fertilizer (43.8%) and by industrial processes (29.9%).

Parties generally concluded that their data on CO_2 had a high confidence level (excepting land-use change and forestry). For methane the confidence level is medium for energy and livestock and low for waste and fugitive fuels emissions. For nitrous oxide confidence is medium for energy and industrial emissions and low for agriculture.

In addition to inventories, Parties provide projections through the year 2000. These projections consider policies and measures that the government has already adopted or committed itself to. For methane, all but three Parties project that their emissions will decline or stabilize over the decade. Nitrous oxide trends are not clear, although some countries project major decreases.

A comparison of carbon dioxide projections for 2000 with inventories for 1990 suggests that emissions in most developed countries will rise over the decade if additional measures are not adopted. In countries with economies in transition, CO_2 emissions declined during the first half of this decade but may start growing again while staying below earlier levels.

While this is the most comprehensive set of data ever gathered on greenhouse gas emissions from Annex I Parties, it still contains important flaws. Many countries did not follow the minimum documentation standards or provide the necessary explanations of methods and data. They departed from guidelines and used different assumptions and definitions.

Scientific uncertainty and data collection both pose serious difficulties. As a result data was not always complete for particular sectors (land-use change and forestry remains a particularly difficult sector to quantify). On the other hand, most methodological problems relate to the allocation of emissions among sectors rather than to the reliability of the actual emissions data.

More work is clearly needed, both on improving the methodologies and then on adhering to them strictly. In fact, amended guidelines containing more precise reporting instructions are likely to be adopted at COP-2. In addition, there is good will amongst all concerned for seeking improvements.

Policies and measures

Identifying effective policies and measures for developed countries to adopt after the year 2000 is key to the implementation of the Convention and to the Berlin Mandate negotiations for a protocol or another legal instrument. As revealed by the communications, a wide range of policies and measures are already being tested in practice. The ones countries choose are generally dictated by national circumstances such as political structure, overall economic situation, and social circumstances.

Many are "no-regrets" measures that have environmental or economic benefits irrespective of climate change concerns. Each of the 33 national communications indicates that improved energy efficiency is the primary means for reducing emissions while improving economic efficiency.

Five Parties report the use of specific taxes to reduce greenhouse gas emissions. In addition to regulatory and economic instruments, many Parties promote voluntary agreements with industry and public authorities. These agreements seek energy efficiency and lower CO_2 emissions. In some countries they are also used to control emissions of other gases. They range from relatively informal statements of intent to highly structured agreements. Other measures include research and development, and information and education.

The energy production and transformation sector accounts for 38.5% of total 1990 Annex I emissions and for many countries is the largest sector. The policy objective of many Parties are switching to low or no-carbon fuels for electricity generation and improved efficiency. Some of the most effective measures mentioned were regulatory reform to promote competition in energy supply and distribution, removal of subsidies on coal, and time-of-day or seasonal electricity pricing. Some Parties reported that they are in the process of reforming and liberalising their energy markets.

Industry is responsible for 20.9% of energy-related CO2 emissions and a small share of energy-related methane and nitrous oxide. Many countries expected the emissions from this sector to be stable or to decrease as a result of economic restructuring and technology modernization. They emphasized the importance of using a wide range of policy instruments, including voluntary arrangements; legislation, regulation, and standards; financial incentives; and liberalized energy prices and the removal of energy subsidies.

The residential, commercial and institutional sector contributed 13.8% of 1990 carbon dioxide emissions from reporting Parties. Here the focus is generally on energy efficiency standards for new buildings, higher energy prices, and public information campaigns. The need to encourage manufacturers and consumers to move towards more energy-efficient appliances was also mentioned.

Another key sector is transportation, responsible for 26.2% of energy-related carbon dioxide and 11.1% of nitrous oxide. While most Parties project growth in transport, relatively few measures for limiting emissions were reported, and CO2 emissions from transport are projected to rise. Those reported include measures to improve the average fuel economy of new cars, local measures to encourage the use of public transport and bicycles, and economic instruments and measures to influence vehicle design and use.

Other sectors include industrial processes (few measures reported), agriculture (reductions in herd size, decreased fertilizer use, improve waste management, research and development, etc.), land-use change and forestry, and waste management and sewage treatment (including efforts to reduce, separate, recycle, and incinerate waste).

In-depth reviews

In addition to producing the Compilation and Synthesis Report, the secretariat is also coordinating in-depth reviews of individual communications. To date 21 Parties have been visited by review teams consisting of experts from 26 countries. Each team includes at least one expert from a developing country.

The in-depth reviews are based on country visits by expert teams. So far 52 countries have nominated 192 national experts to participate. The OECD, IEA, and UNIDO have also provided experts.

These reviews provide a thorough and comprehensive technical assessment of each Party's efforts to carry out its Convention commitments. They review the information contained in the national communications in a non-confrontational and facilitative manner.

In the process they also build capacity in developing countries through the participation of their experts, increase confidence in the overall Convention process, and lead to improvements in the collection, analysis, and synthesis of data.

❹ Ministers should send a strong political message

Dr. Angela Merkel, President of COP-1, and Germany's Federal Minister

for the Environment, Nature Conservation and Nuclear Safety

Incipient global warming caused by the enhanced greenhouse effect is a warning signal for all humanity. The foreseeable consequences will considerably impair the foundations of life on earth. Global climate protection is thus one of the most important challenges for environmental policy.

I was greatly concerned when I read the 1995 Second Assessment Report of the Intergovernmental Panel on Climate Change. Based on the findings available to date, we can anticipate that human activities will have a noticeable influence on the global climate. Once again this makes clear the urgency with which more intensive measures for combating climate change are required.

If the consequences of global warming are far-reaching and complex, so too are the changes that will be essential in practically all areas of our lives if we are to stop it, or at least slow it down. Fundamental changes in economic structures and consumer habits -- particularly in the area of energy supply and consumption -- can obviously not happen overnight; they will require a continuous adjustment process.

This process was set in motion at the international level with the Framework Convention on Climate Change in Rio in 1992. The obligations contained in the Convention -- particularly the commitment of developed countries to return their greenhouse gas emissions to 1990 levels by the year 2000 -- are dynamic in nature and must be reviewed regularly.

By stating last year in Berlin that the existing commitment of the developed countries to limit emissions is inadequate, the first session of the Conference of the Parties (COP-1) set the course for the further development of the Convention. It adopted the Berlin Mandate launching new talks on a protocol or another legal instrument. This protocol, to be negotiated in time for COP-3 in 1997, shall in particular strengthen the commitments of the developed countries.

The Berlin Mandate

To date the Ad hoc Group on the Berlin Mandate (AGBM) has met three times. These meetings have dealt with the core questions in depth. The analysis and assessment of possible objectives and climate protection measures is also progressing. Thus sufficient data and background material are available for the negotiations.

However, it has also become clear that there are still considerable differences in the positions of countries and groups of countries. Great efforts are needed to bring the negotiations to a successful conclusion before COP-3. In particular, discussion of the issue of whether to have uniform limitation and reduction objectives for all developed countries, or differentiated objectives for individual Annex I Parties, is controversial. There are also varying opinions on how binding these objectives should be as well as on what specific policies and measures should be elaborated.

I consider it essential that COP-2 send out the right political signals, so that an ambitious protocol can be negotiated in the year remaining before COP-3.

Joint activities

In addition to adopting the Berlin Mandate, COP-1 also made numerous other decisions that are important for the Convention's future.

A pilot phase for activities implemented jointly (AIJ) was agreed in which all interested Parties can participate on a voluntary basis. During this pilot phase the emission reductions achieved with the pilot projects will not be credited to existing commitments of the developed countries.

The pilot phase will be comprehensively assessed before the end of the decade. At the most recent meeting of the Subsidiary Body on Scientific and Technical Advice (SBSTA), an agreement was reached on a reporting framework for AIJ projects. Thus the practical experience countries have gained can be transmitted in a comparable form, and the Convention secretariat can submit a progress report to COP-2.

In my view, AIJ could become an ecologically and economically effective instrument for taking precautionary action on climate change. I hope that many governments will play an active role in the pilot phase. Governments need to gather experience with many different kinds of project in the area of power plants, renewable energies, demand-side management, carbon sinks, and so on.

Communications

National communications are of great significance for the implementation of the Convention. COP-1 decided that the first communications of Annex I Parties are to be subjected to an in-depth review in order to monitor the implementation of the Convention.

Experience to date shows that these reviews and the related country visits by expert teams also promote the drawing up of national climate protection programmes. The information resulting from the national communications and the in-depth review reports is, furthermore, an important input for the Berlin Mandate negotiations.

The first communications of developing country Parties are to be submitted from March 1997 onwards. In order to make the communications comparable, transparent, and consistent with the provisions of the Convention, it is important for COP-2 to decide on the guidelines for these communications.

Action at COP-2

Political support for the continuing Convention process, including the Berlin Mandate negotiations, is of central importance for further progress. That is why I hope and expect that my colleagues will actively participate in the Ministerial Segment of COP-2 in great numbers on 17 and 18 July 1996 in Geneva.

I would very much welcome it if, in a far-reaching ministerial declaration, we can:

- emphasise the urgency for further action to protect the climate in the light of the IPCC findings;
- renew and strengthen our commitment to the implementation of existing Convention commitments; and

- focus the process to implement the Berlin Mandate on immediate and concrete negotiations on a protocol. Suitable proposals from various countries and groups of countries have already been submitted.

There is not much time until COP-3. We must be firm and decisive about expressing our political will for stricter international obligations and increased international efforts for climate protection.

❺ CC:TRAIN's Phase II

UNITAR, the Climate Change Secretariat, and UNDP have now launched Phase II of CC:TRAIN. The operational manuals for the programme's three Regional Partners and 17 participating countries are being drafted, workshops organized, and the CC:TRAIN workshop package updated.

The Regional Partners and participating countries for this phase are as follows: In Africa, Environement et Developpement du Tiers-Monde (ENDA) will coordinate the work of Benin, Chad, and Senegal; in Latin America and the Caribbean the Fundacion Futuro Latinoamericano (FLAA) will work with Bolivia, Cuba, Ecuador, Paraguay, and Peru; and in the Pacific, the South Pacific Regional Environmental Program (SPREP) will do the same for the Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Solomon Islands, Tuvalu, Vanuatu, and Western Samoa.

During COP-2, CC:TRAIN will host a meeting bringing together delegates from the 17 countries participating in phase II. A tentative calendar of Regional Country Studies Workshops for training professionals to prepare greenhouse gas inventories, vulnerability and adaptation assessments, and emissions mitigation analysis is available. Please contact CC:TRAIN, UNITAR, Palais des Nations, 1211 Geneva, Switzerland; tel:+41 22 788-1417 or 979-9483, fax:+41 22 733-1383, email: cc:train@unep.ch

News and Announcements

This section is intended for dissemination of news and announcements by the Society or any of its members. If members wish to relay any news or make any announcement of interest to members which is related to the aims of the Society they should email, fax or mail such information to the Editor-in-Chief along with their name(s) and membership number(s).

IPCC Second Assessment (1995) Available on Web

The Synthesis Report and two of the three Working Group "Summaries for Policymakers" For the Intergovernmental Panel on Climate Change (IPCC) Second Assessment (1995) are available for viewing/downloading from the United Nations Environment web page at:
http://www.unep.ch/ipcc/ipcc95.html

Joe Schumacher, U.S. Global Change Research Information Office, 2250 Pierce Rd., University Center, MI 48710. U.S.A.
Tel: 517-797-2730 Fax: 517-797-2622 Internet: http://www.gcrio.org

GHCN Monthly Maximum and Minimum Temperature Data Available on Internet

A beta version of mean monthly maximum and minimum temperature data from the Global Historical Climatology Network (GHCN) version 2 is now available over anonymous ftp. These data from over 5,000 long term land surface stations have been thoroughly quality controlled and adjusted for inhomogeneities. However, the metadata and documentation are still being worked on. For more information or to obtain the data connect to:

http://www.ncdc.noaa.gov/ghcn/ghcn.html

The GHCN is produced cooperatively by the National Climatic Data Center, NESDIS/NOAA, the Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, DOE, and Arizona State University.

Query the Global Change Master Directory (GCMD) for Data

The Global Change Master Directory (GCMD) is a comprehensive directory of Earth science and environmental data. Through data set descriptions and contact information, the GCMD provides the scientific community and the general public with easy access to scientific data. Currently, there are almost 4000 data set descriptions, covering the fields of meteorology, oceanography, geology, ecology, hydrology, geophysics, GIS and remote sensing. If you are on the Internet and are searching for scientific data, try querying the GCMD first. You may find important leads to archived and public-domain data.

Some features of the GCMD:

Over 650 research institutions from around the world are represented in the GCMD. These include research centers, universities, government agencies, and international programs. Direct hypertext links to data centers simplify the data access process. Supplementary descriptions provide introductory explanations of research campaigns, scientific instruments, data-collection platforms including spacecraft, and data centers. Access to the GCMD is available through the Internet via the World Wide Web and telnet:

http://gcmd.gsfc.nasa.gov telnet gcmd.gsfc.nasa.gov login: gcdir

As always, the GCMD is a free service funded by NASA in an effort to provide a comprehensive, interdisciplinary directory of Earth science and environmental data. If you have comments or questions about the GCMD, please email me Ron Vogel Global Change Master Directory, NASA Goddard Space Flight Center vogel@gcmd.gsfc.nasa.gov

Announcement: Antarctic Homepage on WWW

The Antarctic Meteorology Research Center in the Space Science and Engineering Center at the University of Wisconsin - Madison is proud to announce the Antarctic Project Home Page. The Antarctic Automatic Weather Station Project and the Antarctic Meteorological Research Center's (AMRC)home pages can be found here. The AMRC homepage offers displays of real-time meteorological and remote sensing data from and over Antarctica. In the real-time section, there is the ability to build your own Antarctic Meteorological Display. Also, information regarding the AMRC archive is on-line here as well.

The Universal Resource Locators for these new homepages are:

Antarctic Project Home Page:
http://uwamrc.ssec.wisc.edu/
Antarctic Meteorology Research Center Home Page:
http://uwamrc.ssec.wisc.edu/amrchome.html

Matthew Lazzara, Meteorologist, Antarctic Meteorology Research Center,
Space Science and Engineering Center, University of Wisconsin-Madison,
1225 West Dayton Street, Madison, WI 53706, U.S.A.
Phone: (608) 262-0436 Fax: (608) 263-6738
E-mail: mattl@ssec.wisc.edu

CALMet WWW Site Launch

This is to announce the official launch of the CALMet WWW site. Some of you may have noticed it developing for some time. The CALMet WWW site is at http://www.met.ed.ac.uk/calmet/ and it is divided into six main sections:

- Email discussion list (information about the email list)
- FTP source (WWW access to the ftp archive)
- CALMet Conferences (papers and workshops from previous conferences)
- Information sources for CAL development tools (pointers to useful information)
- Interactive showcase (examples of interactive programs using the Web)
- Inventory of Meteorology CAL Products (an on-line directory of available CAL products)

As usual, any comments, suggestions etc. please let me know.

Charles Duncan, Department of Meteorology, Kings Buildings,
University of Edinburgh, Edinburgh EH9 3JZ, United Kingdom
Tel: +44-131-650-5091 Fax: +44-131-662-4269
Email: C.Duncan@ed.ac.uk URL: http://www.met.ed.ac.uk/~cnd/

Electronic Atlas of NCEP (NMC) & GFDL Climate Data

Keywords: NMC, NCEP, GFDL, Climate data

The NOAA/ERL Climate Diagnostics Center (CDC) would like to announce two new web documents which provide real-time access to climate data:

The NCEP (NMC) Reanalysis electronic atlas allows the user to view and/or download products derived from the NCEP Reanalysis dataset located at

URL: http://www.cdc.noaa.gov/ncep_reanalysis/.

For additional information regarding these data, contact Cathy Smith (cas@cdc.noaa.gov) or Klaus Weickmann (kmw@cdc.noaa.gov). Additional information about the NCEP Reanalysis project at CDC is available at

URL: http://www.cdc.noaa.gov/cdc/reanalysis/reanalysis.shtml

or via e-mail at cdcdata@cdc.noaa.gov.

The electronic atlas of GFDL-University Consortium products

URL: http://www.cdc.noaa.gov/gfdl/

allows the user to view and/or download data which are derived from the Geophysical Fluid Dynamics Laboratory (GFDL) Rhomboidal 30 with 14 sigma levels (R30S14) General Circulation Model (GCM). For additional information regarding these data, contact gfdlatlas@cdc.noaa.gov. Both of these documents are currently hyperlinked to the CDC homepage (URL: http://www.cdc.noaa.gov/).

Julia Collins, The NOAA/ERL Climate Diagnostic Center
webmaster@cdc.noaa.gov
URL:http://www.cdc.noaa.gov/

UKMO NWP WWW Pages

The Numerical Weather Prediction Development Division of the UK Meteorological Office now has a set of pages on the WWW describing some of its current research activities. Of special interest is the development of a variational analysis system. There is also some useful background information to the numerical models run operationally. The URL is http://www.meto.govt.uk/sec5/sec5pg2.html

Clive Jones,
NWP Development Analysis and Assimilation Group,
Room 340, Meteorological Office, London Road,
Bracknell, Berkshire, RG12 2SZ, ENGLAND

voice: +44 1344 856422/0
fax : +44 1344 854026
email : cpjones@meto.govt.uk

Our Changing Planet FY 1996 now on-line

"Our Changing Planet: The FY 1996 U.S. Global Change Research Program" is now available on-line from the U.S. Global Change Research Information Office (GCRIO) at http://www.gcrio.org/ocp96/toc.html. "Our Changing Planet" is a supplement to the President's annual budget request. This report has a summary of U.S. Global Change Research Program (USGCRP) activities such as: seasonal-to-interannual climate fluctuations; climate change over the next few decades; stratospheric ozone depletion and increased UV radiation; changes in land cover and in terrestrial and marine ecosystems; and crosscutting aspects of global change research. Also included in the report are highlights of recent USGCRP research results, and budget information by agency, framework and program. Further information about the GCRIO, USGCRP and global change and environmental research is available from the GCRIO home page at http://www.gcrio.org.

Joe A. Schumacher, U.S. Global Change Research Information Office,
2250 Pierce Rd., University Center, MI 48710, U.S.A.
Tel: 517-797-2730 Fax: 517-797-262
http://www.gcrio.org

Bulletin of the Australian Meteorological & Oceanographic Society on the WWW

The Bulletin of the Australian Meteorological and Oceanographic Society now has a site on the World Wide Web. The URL is:

http://mullara.met.unimelb.EDU.AU:8080/home/blair/amos/amos.html.

The text for the February and April 1996 issues can be found there (along with parts of some previous issues). I haven't yet set the site up to include figures and illustrations.

Blair Trewin, Editor

NCEP Ocean Modelling Branch Homepages

The National Centers for Environmental Prediction, Environmental Modeling Center, Ocean Modeling Branch (NCEP/EMC/OMB) has a number of home pages open now (with more coming). The main branch page is at http://polar.wwb.noaa.gov/

Subtopics include:

Sea Ice	http://polar.wwb.noaa.gov/seaice/
Fog	http://polar.wwb.noaa.gov/fog/
Global Wave Model	http://polar.wwb.noaa.gov/waves/
Regional Wave Model	http://polar.wwb.noaa.gov/regional.waves/

All are primarily the current model or analysis output. The sea ice page includes some climate and retrospective materials (limited). Some branch publications are coming on line, with two already present (both on sea ice). Disclaimer of note: although some of the models and analyses presented are operational, web distribution is not operational. The server may be down, and files may be missing or old. NCEP used to be called NMC. EMC used to be Development Division. This is the group responsible for model development and improvement. OMB has the responsibility within EMC for ocean winds, waves, ocean fog, ice, and coastal ocean prediction.

Robert Grumbine
wd21rg@hp20.wwb.noaa.gov
5200 Auth Rd., #209 Camp Springs, MD 20746, U.S.A.

Scientists Foresee Warming's Effects on Humans

The United Nation's World Health Organization will soon be releasing a report calling global warming one of the largest public health challenges facing the world in the 21st century. The Intergovernmental Panel on Climate Change (IPCC) has already reported that "climate change is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life."

One scientist who is spreading this message of concern is Paul R. Epstein, clinician and researcher at the Harvard University School of Public Health in Boston. Epstein is a specialist in tropical public health who fears that climate change will trigger millions of cases of cholera, malaria and other scourges to areas currently free of these diseases. In addition to the spread of disease, global warming would increase the death rate from summer heat and cause starvation by reducing crop yields in the tropics.

Laurence S. Kalkstein of the University of Delaware in Newark has matched daily summertime temperatures with the mortality rates in different cities. He has concluded that increased temperatures and frequency of heat waves will lead to more heat-related deaths, particularly in the large urban centers located in the midlatitudes. The deaths in Chicago that resulted from last summer's heat wave totaled over 500. According to Kalkstein's research, Shanghai and New York would see several thousand more heatth related deaths by 2050.

However, other regions of the world would benefit. One British study suggests that although some heat waves may trigger an increase in deaths in the United Kingdom, more than 9,000 lives could be saved in England and Wales if the global temperature warms from 2 degrees Celsius (C) to 2.5 degrees C by the middle of the 21st century, according to Anthony J. McMichael of the London School of Hygiene and Tropical Medicine.

Because diseases are extremely sensitive to climate, Jonathan Patz of the John Hopkins University School of Hygiene and Public Health said climate change will lead to "shifts in the distribution of many diseases." For example, the temperatures necessary for malaria transmission exist in just 45 percent of the world, but if the IPCC-estimated warming of 3 to 5 degrees C occurs in the 22nd century, the presence of malaria could grow to 60 percent of the globe. A Netherlands study forecast an increase of one million deaths by malaria annually by 2050. Although the developed country would most likely be able to handle the spread of malaria, countries like Nairobi, Kenya, and Zimbabwe, could be particularly hard hit and the resistance of malarial strains to drugs could worsen the situation globally.

With warmer sea temperatures, cholera and harmful algal blooms will also be able to spread. A 1991 outbreak of cholera which occurred in Peru spread through waterways and to coastal cities throughout South America killing 5,000 and infecting 500,000 in its first 18 months. As if to draw the conclusions of health researchers and climatologists together, the cholera epidemic occurred while an El Nino was occurring in the Pacific.

Beyond the spread of diseases, food shortages are another concern. A recent study found that global warming could put another 40 to 300 million people at risk of hunger by 2060. The IPCC does confess its forecasts on health are uncertain, and some fear all this concern about global warming is making people lose focus on other serious issues.

Climate Impacts Unit, Greenpeace International,
PO Box 800, 4145 Surry Hills, 2010, Australia
Ph : +61 (0) 2 211 4066 Fx: +61 (0) 2 211 4123
E-mail: erwinj@peg.apc.orgAustralia. URL: www.greenpeace.org

Executive Summary:
Scientific Assessment of Ozone Depletion 1994

I'm pleased to announce that the Executive Summary and the "Common Questions about Ozone" sections of the WMO/UNEP report "Scientific Assessment of Ozone Depletion: 1994" are available on the Web. You can reach them on the NOAA Aeronomy Lab's Web site at http://www.al.noaa.gov/WWWHD/pubdocs/WMOUNEP94.html. Links to these documents have been installed on SOLIS, the Stratospheric Ozone Law, Information & Science site, at http://www.acd.ucar.edu/gpdf/ozone/. An abbreviated table of contents is appended below. Note that the Executive Summary and the Common Questions are, within the limitations of HTML, identical to the ones published in print with the full Assessment in February 1995, and so cannot, for instance, reflect research that appeared too recently to be included in the Assessment. My only part in this project was the translation to HTML, so I am not the proper recipient for substantive comments on the report's contents. Please consult the author list included in the Web version for further information. The full 1994 Assessment is not anticipated to be released on the Web.

Is the Depletion of the Ozone Layer Leading to an Increase in Ground-Level Ultraviolet Radiation?

How Severe Is the Ozone Depletion Now, and Is It Expected to Get Worse?

List of International Authors, Contributors, and Reviewers

Gregory P. Dubois-Felsmann
National Center for Atmospheric Research
<gpdf@acd.ucar.edu>

TORRO Web Pages Live

The web pages of the Tornado and Storm Research Organisation (TORRO) are, at long last, live. The pages include:- information about TORRO- information on the Journal of Meteorology (UK) (as well as contents by issue) - reports of severe ("local") weather in the UK and Europe (*i.e* tornadoes, damaging hail - ball lightning reports are also in there!) - extensive links to severe weather web sites around the world - extensive links to sites providing UK data such as observations, text forecasts, model forecasts, etc. Information is also given on TORRO's forthcoming one-day conference to be held in Oxford in early June. Presentation topics include lightning deaths and injuries, British waterspouts, storm chasing, storm worship in Britain 3,000 BC, the Met. Office's severe weather warning system .... and more. Simply point your favourite browser to:

http://www.zetnet.co.uk/oigs/torro

Please note that if you wish to contact me, a much faster response is likely if you mail me at djr.torro@zetnet.co.uk. return until the end of May.

David J. Reynolds - Tornado and Storm Research Organisation (TORRO)
Wolverhampton, Great Britain djr.torro@zetnet.co.uk
http://www.zetnet.co.uk/oigs/torro

Malaria Transmission and Climate Change in Australia

ABSTRACT: Malaria Transmission and Climate Change in Australia.
Medical Journal of Australia 1996 : 164, 345-347.

Although endemic malaria was eradicated from Australia by 1981, the vectors remain and transmission from imported cases still occurs. Climate modelling shows that global warming will enlarge the potential range of the main vector, *Anopheles farauti sensu stricto.* By the year 2030 it could extend along the Queensland coast to Gladstone, 800 km south of its present limit. Vigilance and a dispassionate assessment of risk are needed to meet this challenge.

Erwin Jackson, Greenpeace International,
PO Box 800, 4145Surry Hills, 2010, Australia.
Ph (wk): +61 (0) 2 211 4066 Fx: +61 (0) 2 211 4123
E-mail: erwinj@peg.apc.org URL:www.greenpeace.org

Climate Change and Extreme Weather Events

CLIMATE CHANGE AND EXTREME EVENTS:
Altered risk, socio-economic impacts and policy responses.
Edited by T.E. Downing, A.A. Olsthoorn and R.S.J. Tol
Institute for Environmental Studies, Vrije Universiteit, Amsterdam and
Environmental Change Unit, University of Oxford, 309 pp.

From the preface:
Predictions on the future of extreme weather cannot be given, but reasonably plausible scenarios can be derived, through which society's sensitivity can be analysed. The most crucial determinant of the impact of changes in extreme weather events appears to be adaptation. Although single events can be dramatic, the average impact of changes in the investigated hazards (river floods, extratropical storms, tropical cyclones, agricultural droughts, subsidence, heat waves and human health) can be manageable with appropriate climate change foresight and adequate implementation of adaptive measures. However, these two presumptions may not be fully met, in which case the risks to society can increase significantly. Given the many and great uncertainties, the most appropriately adapted systems are those which are robust to a range of possible futures. Reducing vulnerability requires a thorough analysis of specific systems at risk, and more investment in infrastructure and institutions then is presently the case.
The executive summary can be found on http/www.vu.nl/ivm/.

This publication can be ordered at:
V.U. Boekhandel/Uitgeverij De Boelelaan 11051081 HV
AMSTERDAM The Netherlands
Tel +31-20-444 9410Fax +31-20-646 2719
IVM-VU R96/04ECU Research Report 12 ISBN 90-5383-479-6

For further information contact the editors at xander.olsthoorn@ivm.vu.nl, richard.tol@ivm.vu.nl, or tom.downing@ecu.ox.ac.uk

Richard S.J. Tol
Institute for Environmental Studies, Vrije Universiteit,
De Boelelaan 1115, 1081 HV Amsterdam, The Netherlands
telephone: +31 20 4449 555 (direct: 503), or +31 2292 61839 (home)
telefax: +31 20 4449 553; email: richard.tol@ivm.vu.nl

1996 Atlantic Hurricane Season Forecast Press Release

Here's a press release version of the Atlantic Basin hurricane forecast for 1996. For the whole report go to: http://tropical.atmos.colostate.edu/

COLORADO STATE PROFESSOR PREDICTS ABOUT-AVERAGE HURRICANE YEAR;
'96 TO BE UP FROM RECENT INACTIVE PERIOD, DOWN FROM RECORD '95 SEASON

FORT COLLINS--For the second consecutive year, coastal dwellers will have to keep an eye out for above-average numbers of tropical storms and hurricanes--but there will be much less storm activity than last year, Colorado State University's noted hurricane forecaster said in a report released today (June 6). William Gray, a professor of atmospheric science at Colorado State, predicts the hurricane season that began June 1 will see 10 tropical storms, just above the average of 9.3 tropical storms per season. From those tropical storms, Gray and his research team predict six hurricanes will evolve, a level just above the average of 5.8 hurricanes per season. Gray also predicts two intense storms, or Andrew-type hurricanes, will form. This is just under the average of 2.3 major hurricanes per season. This forecast is a slight reduction from the April prediction but increases the overall storm activity forecast in November, Gray's first look ahead at the hurricane season.

In today's update, Gray's research team predicts the 1996 season will have a Net Tropical Cyclone Activity level of 95 percent of normal. Net Tropical Cyclone Activity is a measure of all tropical storm, hurricane and intense hurricane activity rolled into one number. The Net Tropical Cyclone Activity level in 1995 was 229 percent of the average season. "We're forecasting a season with about average activity. That means we'll see a year that is much more active than the four recent inactive years of 1991-1994, but still considerably less storm and hurricane formation than last year--one of the most active seasons ever," Gray said. "Last year, we were lucky. It was a very active season, but the number of landfalling storms was not as high as it could have been. This year will be less active, but there's no way to tell if we'll see more landfalling storms."

Gray said very active hurricane seasons statistically are usually followed by years with below-average activity. He said it is therefore significant that this season is shaping up to be about average in tropical storm and hurricane formation in comparison to the average over the last 45 years. "We've seen an incredible downturn in the major Andrew-size storms over the last 25 years or so. Eventually, we'll see a return to a period when more of these major hurricanes are being formed," Gray said. "We're not sure yet, but this could be the start of that period." Gray also says if the number of major storms increases, the potential for hurricane-spawned destruction is immense. "Because of the build-up along the coast and the many more people living in these areas, we could see hurricane destruction like we've never seen it before," Gray said. "Hurricanes, not other natural disasters, are the single biggest natural threat to the United States."

Gray and his research team use a variety of global weather factors to produce their forecast, issued four times each year in early April, early June, early August and again in November. The November forecast serves as a recap of the previous season's hurricane activity and the team's first look ahead at the next season. Although several main factors are used to come up with the prediction, Gray and research team members Chris Landsea, John Knaff, Paul Mielke and Kenneth Berry continually add to the forecast to improve it.

There are five primary factors in their forecast: the strength or weakness of El Nino; the direction of equatorial stratospheric winds at 68,000-75,000 feet; rainfall in the West African Sahel region; temperature and pressure readings in West Africa; and Caribbean Sea-level pressure readings and tropospheric winds at 40,000 feet. Gray and his team also continue to monitor and add other climatological factors into the hurricane forecasts. "We rely heavily on the El Nino and the stratospheric and tropospheric winds and the other main factors, but we also look at the globe as a whole," Gray said. "We find that the weather in Singapore, what happens in Asia, what happens in north Australia--all these things appear to influence hurricane formation because we know the globe functions as a whole. "So the fact we had a snowy East Coast this winter, the fact the North Atlantic and Pacific circulation patterns were different and the fact we've had drought out here in the West probably indicate the atmosphere is functioning a little bit differently in the last six months," Gray said. "And that has meaning for what will happen in the current hurricane season."

GRAY RESEARCH TEAM HURRICANE FORECASTS FOR 1996 SEASON

	6/96	4/96	11/95
1. Named Storms (9.3)	10	11	8
2. Named Storm Days (46.6)	45	55	40
3. Hurricanes (5.8)	6	7	5
4. Hurricane Days (23.9)	20	25	20
5. Intense Hurricanes (2.3)	2	2	2
6. Intense Hurricane Days (4.7)	5	5	5
7. Hurricane Destruction Potential (71.2) #	60	75	50
8. Net Tropical Cyclone Activity (100%)	95	105	85

1995 HURRICANE ACTIVITY AND LAST YEAR'S FORECASTS

	'95 actual	8/95	6/95	11/94
1. Named Storms (9.3)	19	16	12	12
2. Named Storm Days (46)	121	65	65	65
3. Hurricanes (5.8)	11	9	8	8
4. Hurricane Days (23.9)	62	30	35	35
5. Intense Hurricanes (2.3)	5	3	3	3
6. Intense Hurricane Days (4.7)	11.5	5	6	
7. Hurricane Destruction Potential # (71.2)	173	90	110	85
8. Net Tropical Cyclone Activity (100%)	229%	130%	140%	140%

( ) represents the number in this category that occur in a typical year.
Hurricane Destruction Potential measures a hurricane's potential for wind and ocean-surge damage.

JUNE TO SEPTEMBER RAINFALL IN THE AFRICAN SAHEL: A SEASONAL FORECAST FOR 1996

C.W. Landsea*, W.M. Gray**, P.W. Mielke, Jr.***, K.J. Berry***

* NOAA Post-Doctorate Fellow in Climate and Global Change
NOAA AOML/Hurricane Research Division
** Department of Atmospheric Science Colorado State University
***Department of Statistics Colorado State University
Internet: landsea@aoml.noaa.gov 6 June, 1996

A more detailed version of this is at the CSU WWW site:
http://tropical.atmos.colostate.edu/

The rainy season in North Africa's Sahel occurs almost exclusively during the months of June through September when the ITCZ reaches its farthest northward extension. The Sahel is defined here as the North African region between 10 and 20N. It is this area that has experienced numerous devastating droughts within the last three decades. This report provides a forecast for this year's June to September seasonal rainfall for the Sahel based upon data available through early June.

Because of rainfall variability within the region, a homogeneous index of precipitation is not utilized for the entire Sahel. Instead, two smaller subregions are organized within which precipitation shows similar within season behavior. These regions are the West and Central Sahel. The West Sahel extends from the Atlantic coast to 6W including portions of the countries of Mauritania, Senegal, Gambia, Guinea-Bissau, Guinea, and Mali. The Central Sahel is the region from 6W to 26E and includes parts of Mali, Burkina Faso, Ghana, Togo, Benin, Niger, Nigeria, Cameron, Chad, Central African Republic, and Sudan. Note that the Central Sahel is over twice the size of the West Sahel.

STATISTICAL METHODOLOGY AND 1996 FORECAST

The forecasting techniques are detailed in full in Landsea *et al.* (1993)and Gray *et al.* (1992, 1993, 1994). We use a Least Absolute Deviations (LAD) regression instead of the traditional Ordinary Least Squares (OLS) multiple regression based upon the years 1950 to 1991. LAD is selected over OLS in that LAD is based upon minimizing the absolute differences between predicted and observed values instead of the square of that difference. Thus outliers do not overly influence the prediction equations. The amount of skill is estimated by the regression applied to the whole data set with a standard degradation applied (as detailed in Mielke *et al.* 1996). In general, degradation increases with the number of predictors and decreases with the number of years under consideration. Thirteen predictors based upon the phase and magnitude of the stratospheric Quasi-Biennial Oscillation (QBO), North African surface data, and Caribbean and El Nino-Southern Oscillation (ENSO) information are utilized for the early June forecast. The individual predictors and their values to be used as input for the1996 forecast are the following:

QBO Predictors:

Zonal (U) winds at 50 mb at 10N (extrapolated for Sep 1996)	= -20 ms^{-1}
Zonal (U) winds at 30 mb at 10N (extrapolated for Sep 1996)	= -31 ms^{-1}
|U50hPa-U30hPa| (extrapolated for Sep 1996)	= 11 ms^{-1}

North African Predictors:

Aug-Sep 1995 West Sahel rainfall	= - 0.35 Std. Devs.
Aug-Nov 1995 Gulf of Guinea rainfall	= +0.09 Std. Devs.
Feb-May 1996 Sea level pressure anomaly gradient	= - 0.30 Std. Devs.
Feb-May 1996 Surface temperature anomaly gradient	= - 0.30 Std. Devs.

Caribbean and ENSO Predictors:

Apr-May 1996 Sea level pressure anomalies (Caribbean)	= + 1.0 hPa
Apr-May 1996 200 hPa zonal wind anomalies (Caribbean)	= - 0.7 ms^{-1}

Apr-May 1996 Southern Oscillation Index (SOI)	=	+0.25 Std. Devs.
Apr-May minus Jan-Feb 1996 SOI	=	- 0.20 Std. Devs.
Apr-May 1996 "Nino 3" Central Pacific SST anomalies	=	- 0.45 °C
Apr-May minus Jan-Feb 1996 "Nino 3" SST anomalies	=	+0.00 °C

Given these values for the predictors based upon information available to us at CSU by the end of May, the statistical model predicts values of:

West Sahel	- 0.11 Std. Devs. (NEUTRAL QUINTILE)
Central Sahel	+0.15 Std. Devs. (NEUTRAL/WET QUINTILE)

These various values of rainfall are due to 1) slightly unfavorable conditions for rainfall throughout the Sahel due to strong east phase of the QBO and the large vertical shear between 30 and 50hPa; 2) near average rainfall amounts in the West Sahel indicating for near average rainfall based on persistence; 3) near average rainfall occurring during last fall along the Gulf of Guinea suggests that the evaporation/evapotranspiration moisture source will be contributing to a neutral Sahel rainy season; 4) North African sea level pressure and surface temperature anomaly gradients show a slightly negative pattern that would marginally inhibit the formation of the monsoonal flow; 5) Caribbean and ENSO factors suggest a weak La Nina or ENSO cold conditions are currently occuring down from the moderately strong La Nina that peaked in the Northern Hemisphere winter of 1995-1996. Weak La Nina conditions should slightly enhance the rainfall values in the Sahel.

Overall, the combination should contribute toward the West Sahel having near average rainfall (conditions in the middle quintile "NEUTRAL", 40-60% of rainfall years) and the Central Sahel being slightly wet (conditions at the boundary between the second - "WET" 20-40% of rainfall years - and the middle quintiles- "NEUTRAL" 40-60% of rainfall years). Note that the West Sahel that has been previously shown (Landsea and Gray 1992) to be most strongly correlated with concurrent Atlantic seasonal hurricane activity; a near average West Sahel should correspond to having two or three major hurricanes this year.

The forecast that was issued in late November (Landsea *et al.* 1995) was similar to what is described here:

	Late November forecast	Early June forecast
West Sahel	+0.00 S.D. (NEUTRAL)	- 0.11 S.D. (NEUTRAL)
Central Sahel	+0.00 S.D. (NEUTRAL)	+0.15 S.D. (NEUTRAL/WET)

The amount of skill indicated in the hindcast testing of the five predictors during the years 1950 to 1991 is 56% of the variability in the West Sahel and in the Central Sahel. Note that simple use of only persistence provides just 25% and 32%, respectively. Recent tests (Mielke *et al.* 1996), however, have suggested that the true skill that would be found in independent data would be on the order of 30 to 35%. A verification of this forecast as well as an accompanying extended range outlook for 1996 Sahelian rainfall will be made by early December of this year.

REFERENCES

Gray, W.M., C.W. Landsea, P.W. Mielke, Jr., K.J. Berry, 1992: Predicting Atlantic seasonal hurricane activity 6-11 months in advance. *Wea. Forecast.*, 7, 440-455.

Gray, W.M., C.W. Landsea, P.W. Mielke, Jr., K.J. Berry, 1993: Predicting Atlantic basin seasonal tropical cyclone activity by 1 August. *Wea. Forecast.*, 8, 73-86.

Gray, W.M., C.W. Landsea, P.W. Mielke, Jr., K.J. Berry, 1994: Predicting Atlantic seasonal tropical cyclone activity by 1 June. *Wea. Forecast.*, 9, 103-115.

Landsea, C.W., and W.M. Gray, 1992: The strong association between western Sahel monsoon rainfall and intense Atlantic hurricanes. *J. Climate*, 5, 435-453.

Landsea, C.W., W.M. Gray, P.W. Mielke, Jr., K.J. Berry, 1993: Predictability of seasonal Sahelian rainfall by 1 December of the previous year and 1 June of the current year. *Preprints of* 20th Conference on Hurricanes and Tropical Meteorology, San Antonio, Amer. Meteor. Soc., 473-476.

Landsea, C.W., W.M. Gray, P.W. Mielke, Jr., K.J. Berry, 1995: June to September rainfall in the African Sahel: Verification of our 1995 forecasts and an extended range forecast for 1996. CSU Dept. of Atmospheric Sciences on 30 November, 5pp. (http://tropical.atmos.colostate.edu/forecasts/1995/sahel.long.dec95/chris96.html).

Mielke, Jr., P.W., K.J. Berry, C.W. Landsea, and W.M. Gray, 1996: Artificial skill and validation in weather forecasting. *Wea. Forecast.*, 11, 153-169.

Bill Kyle

Department of Geography & Geology, The University of Hong Kong
Pokfulam Road, Hong Kong (Email: billkyle@hkusua.hku.hk)

Hong Kong Weather Reviews

Climatological information employed in the compilation of this section is derived mainly from published weather data of the Royal Observatory, Hong Kong and is used with the prior permission of the Director.

Review of Autumn 1995

Important Climatological Events

Overall, autumn 1995 was near normal in terms of temperature and rainfall. However, this seasonal summation masks marked variability within the three month period with regard to humidity and rainfall. The seasonal total rainfall of 560.1 mm was 80.5 mm more than normal which in itself is not particularly unusual. In terms of the 1961-90 normals 62 percent of the seasonal mean precipitation falls in September, 30 percent in October, and 8 percent in November. This is consistent with the termination of the rainy season associated with the summer monsoon circulation and the onset of the drier, anticyclonic winter monsoon circulation. On a month-by-month basis in autumn 1995, September was very much drier than normal (14 percent of the seasonal total amount), October was unusually wet (85 percent of the seasonal total amount), and November was again very dry (1 percent of the seasonal total amount). Predominance of anticyclonic conditions was the primary reason for the dryness in both September and November. Although anticyclonic conditions also prevailed for most of October leading to a generally dry situation there was a period in the first week when instability dominated. This was associated with the landfall of Tropical Storm Sybil and airstream convergence and produced an abnormally rainy spell. Over 95 percent of the month's total fell in the first six days with most falling in only four days (the 2nd, 3rd, 5th and 6th. The rain which fell in this brief period more than made up for the shortfall in September.

Seasonal statistics

Mean daily maximum temperature	27.4 °C	(0.1 °C below normal)
Mean daily temperature	24.7 °C	(normal)
Mean daily minimum temperature	22.7 °C	(0.1 °C above normal)
Rainfall (provisional)	560.1 mm	(117 %)

September

September 1995 was the tenth driest since records began in 1884 with the meagre total monthly rainfall of only 81.4 mm a substantial 73 percent below the normal value of 299.7 mm. However, the previous month of August was extremely wet so that the accumulated rainfall for the first nine months of 1995 was still 13 percent above average at the end of September, with a total of 2,267.8 mm compared to the 1961-90 normal of 2,007.1 mm. The number of days with more than 0.1 mm of rain was above normal. However, generally fine weather prevailed on most days with only three days registering more than 15 mm of rainfall. The prevalence of fine weather due to anticyclonic conditions meant that the mean monthly pressure of 101.4 kPa was the seventh highest on record for September.

Typhoon Kent which affected Hong Kong during the final day of August, weakened rapidly into an area of low pressure over Guangxi on the first day of the September. The outer rainbands of Kent brought scattered heavy showers on that day, but these became less frequent on 2nd and there were sunny periods as a ridge of high pressure became established along the south China coast. A total of 29.0 mm of rain was recorded at thr Royal Observatory on the first two days of the month. The ridge of high pressure persisted along the coast and maintained fine and hot weather for the next few days leading to the recording of the month's highest temperature of 33.4 °C on the afternoon of 5th. During this spell of fine weather in the territory Tropical Depression Nina formed in the Philippine Sea on 2nd and made landfall over the Philippines two days later, before entering the South China Sea on the afternoon of 4th. Nina tracked westwards at first but turned northwestwards the next day as it intensified into a tropical storm and moved steadily over the South China Sea towards the Leizhou Peninsula. The Tropical Cyclone Stand By Signal Number 1 was hoisted at 0945 HKT on 6th when Nina was due south of Hong Kong. There was abundant sunshine on that day but squally showers associated with Nina also affected the territory giving a total of 16.2 mm of rain at the Royal Observatory. The cyclone was closest around 0500 HKT the next day when it was 380 km to the southwest. The Number 1 signal was lowered at 1015 HKT on 7th as Nina made landfall over Leizhou Peninsula. Isolated squally showers also occurred on 7th with over 30 mm of rain being recorded on Lantau Island. Thereafter, it became fine and hot for the period from 8th to 11th as generally anticyclonic conditions prevailed. The next day a strong easterly airstream reached the south China coast bringing cloudy weather to Hong Kong overnight. The winds subsided rapidly soon after daybreak and there were sunny periods during the day on 12th. The weather remained fine apart from a few brief, but heavy, showers for the next four days although there were isolated thunderstorms on the morning of 16th. Tropical Depression Ryan developed over the South China Sea about 430 km southeast of Xisha on that day but remained nearly stationary for three days mainly due to a surge of the northeast monsoon.

This brought cloudy weather to Hong Kong and temperatures began to fall from 17th to 20th. As the surge began to weaken Ryan started to move east-northeastwards on 19th, bringing it closer to the territory and resulting in the hoisting of the Tropical Cyclone Stand By Signal Number 1 at 1015 HKT that day. Ryan attained Typhoon status on 20th as it continued on the same track. Ryan's track spared the territory from gales and general strong winds although its peripheral circulation brought strong winds to hilltops and offshore areas. Local winds became generally fresh and gusty and temperatures declined to the month's recorded minimum of 22.8 °C on the early morning of 21st when Ryan was closest to the territory. The Number 1 signal was lowered at 1130 HKT that day when Ryan no longer posed a threat. The weather turned fine again on 22nd as Ryan continued to move away from the territory through the Bashi Channel and into the Western North Pacific Ocean. Re-establishment of anticyclonic conditions began a five day sunny spell with no measurable rain which lasted until 27th. With the arrival of a fresh easterly airstream the next morning rain patches developed and the weather remained cloudy with occasional light rain in the early morning for the remainder of the month.

Monthly Statistics

Extreme daily maximum temperature	33.4 °C	(on 5th)
Mean daily maximum temperature	30.1 °C	(0.2 °C below normal)
Mean daily temperature	27.6 °C	(normal)
Mean daily minimum temperature	25.7 °C	(0.2 °C above normal)
Extreme daily minimum temperature	22.8 °C	(on 21st)
Total Rainfall (provisional)	81.4 mm	(27 % of normal)
Number of Days with ≥0.1 mm rain	16	(1.63 above normal)
Number of Days with ≥25.0 mm rain	0	(3.57 below normal)
Number of Days with ≥50.0 mm rain	0	(1.63 below normal)

October

In sharp contrast to the preceding month October 1995 was the fifth wettest since records began in 1884. On three days during the first week, the 3rd, 5th and 6th, the daily rainfall exceeded 100 mm, being 73, 89 and 92 percent respectively of the monthly normal of 144.8 mm. The total monthly rainfall was 476.9 or considerably more than three times normal. As a result the accumulated rainfall for the first ten months of 1995 amounted to 2,744.7 mm or 28 percent above the 1961-90 average for the same period.

The month started fine and sunny with moderate easterly winds and the maximum temperature at the Royal Observatory reached 30.1 °C on the first day, the highest recorded during the month. Tropical Storm Sibyl, which had formed as a tropical depression two days earlier and passed across the Philippines, entered the South China Sea early on 1st resulting in the hoisting of the Tropical Cyclone Stand By Signal Number 1 at 1745 HKT that evening. However, winds strengthened and squally showers began as rainbands associated with Sibyl began to affect the territory on 2nd. The Strong Wind Signal Number 3 was raised at 1230 HKT that day as winds strengthened from the east. Sibyl attained typhoon strength that afternoon and continued to move west-northwestwards that evening. The cyclone started to turn to a north-northwest track, bringing it closer to Hong Kong, in the early hours of 3rd. Sibyl also intensified and winds were generally strong and gusty resulting in the hoisting of the Gale or Storm Signal Number 8 SE at 0510 HKT that day. However winds started to decrease later in the morning and the Number 8 Signal was replaced by the Strong Wind Signal Number 3 at 1130 HKT. Sibyl made landfall over the coast of western Guangdong that afternoon and all signal were lowered at 2045 HKT on 3rd. Torrential rain, amounting to 106.4 mm was recorded at the Royal Observatory on that day. With the dissipation of Sibyl on 4th, the weather turned sunny during the day and temperatures climbed to over 30 degrees again, equalling the high set on 1st. Convergence of airstreams over the coastal waters of Guangdong led to intense rain development near Hong Kong on 5th. The heaviest downpour occurred that night as rain clouds and thunderstorms moved across the territory. The total rainfall recorded at the Royal Observatory on 5th and 6th amounted to 261.2 mm, or 180 percent of the monthly normal on those two days alone! The rain eased off on the afternoon of 6th with the arrival of a drier airstream from the north. The weather then became fine for the next two days before winds strengthened from the east on the evening of 9th, bringing with them some rain patches. Under the influence of this easterly airstream, the weather remained cloudy with some light rain for the following few days. Meanwhile, a ridge of high pressure persisted over China maintaining fresh northeast monsoon along the coast of southeast China. Winds became strong offshore during the night of 10th and the Strong Monsoon signal was hoisted for the following two and a half days before the monsoon moderated during the day on 13th. The remnant of Tropical Storm Ted over western Guangdong brought periods of rain to the territory on 14th and 15th. However, the onset of a dry continental airstream cleared the clouds and there were long periods of sunshine the next day. As this pattern persisted weather continued fine and sunny with temperatures rising to above 30 degrees in the New Territories on 20th. Renewed intensification of the anticyclone over China led to a rather dry airstream influencing the territory on 23rd and winds turning northerly the next day and freshening in the evening. Clouds moved in bringing light rain patches on the evenings of 25th to 27th. It was during this time, on the morning of 26th, that temperatures fell to the month's low of 21.4°C. Under the resumed influence of a drier continental airstream, the clouds dispersed on 28th and the weather became fine and remained that way for the remainder of the month.

Monthly Statistics

Extreme daily maximum temperature	30.1 °C	(on 1st and 4th)
Mean daily maximum temperature	27.6 °C	(0.3 °C above normal)
Mean daily temperature	25.3 °C	(0.1 °C above normal)
Mean daily minimum temperature	23.7 °C	(0.6 °C above normal)

Extreme daily minimum temperature	21.4 °C	(on 26th)
Total Rainfall (provisional)	476.9 mm	(329 % of normal)
Number of Days with ≥0.1 mm rain	13	(4.40 above normal)
Number of Days with ≥25.0 mm rain	4	(2.67 above normal)
Number of Days with ≥50.0 mm rain	4	(3.13 above normal)

November

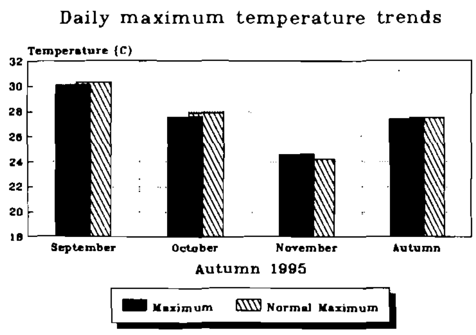
Due to the predominance of anticyclonic conditions and continental airstreams affecting the territory November was another dry month with only 1.8 mm of rainfall recorded as against a normal of 35.1 mm. Despite this low monthly total the accumulated rainfall for the first 11 months of 1995 was 26 percent above normal at 2,746.5 mm. The monthly mean relative humidity was only 64 percent, five percent below normal. A record low for the month of only 17 percent was set on the afternoon of 24th. As a result of the prevalence of dry conditions the Fire Danger Warnings had to be issued on 19 days during the month.

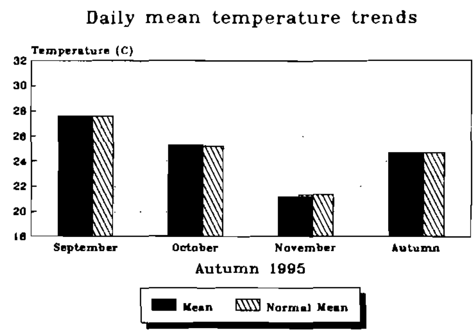
Under the influence of a continental airstream, the month started fine and dry. This fine weather continued until 5th when the outer rainbands associated with Typhoon Angela, moving westwards over the South China Sea towards Hainan Dao, began to affect local weather, bringing light rain. A dry surge arrived on the afternoon of 7th and winds strengthened from the north. The dry air gradually cleared the clouds and temperatures rose to 27.9 °C, the highest recorded during the month, on 10th. However, an easterly airstream arrived on 11th, bringing more clouds, but not much moisture to the territory. As a result the fire danger remained. A surge of the winter monsoon arrived from the north on 14th, bringing cooler air. Local winds strengthened and light rain fell during the night. Long sunny periods marked the weather between 16th and 25th. Strong northerly winds again reached the coast on 23rd and the relative humidity dropped to an all time low for November of 17 percent on the afternoon of 24th. Temperatures also fell with the temperature of 13.9 °C, the minimum recorded for the month at the Royal Observatory, being registered on the morning of the following day. Temperatures measured that morning at Ta Kwu Ling in the New Territories were even lower with a minimum recorded of just 4.5 °C. The amount of cloud increased again on 26th as an easterly airflow replaced the northerlies and gave rise to some light rain patches on both 28th and 30th.

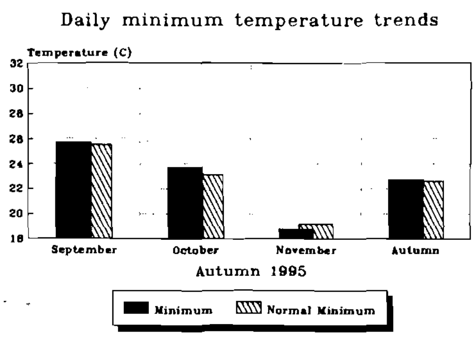
Monthly Statistics

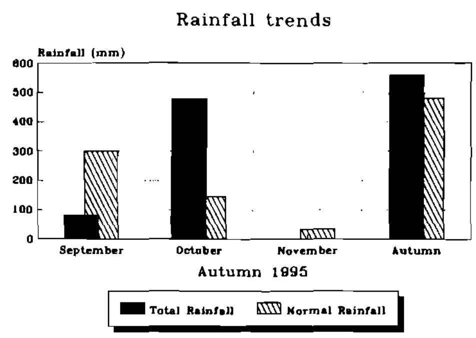
Extreme daily maximum temperature	27.9 °C	(on 10th)
Mean daily maximum temperature	24.6 °C	(0.4 °C above normal)
Mean daily temperature	21.2 °C	(0.2 °C below normal)

Mean daily minimum temperature	18.8 °C	(0.4 °C below normal)
Extreme daily minimum temperature	13.9 °C	(on 25th)
Total Rainfall (provisional)	1.8 mm	(5 % of normal)
Number of Days with ≥0.1 mm rain	4	(1.87 above normal)
Number of Days with ≥25.0 mm rain	0	(0.40 below normal)
Number of Days with ≥50.0 mm rain	0	(0.10 below normal)









Review of Winter 1995-96

Important Climatological Events

Winter 1995-96 was characterized by its unusual dryness. All three months had less than two-thirds of 1961-90 normal totals. January was particularly dry with only 1.3 mm of rain being recorded at the Royal Observatory for the whole month, 22.1 mm below the usual value. Considering the season as a whole temperatures were slightly above normal, mainly as a result of higher mean daily minimum temperatures. However, as with the case of the preceding autumn this near normality mask considerable month-to-month variation in the thermal regime. December was generally somewhat cooler than normal as the winter monsoon circulation was persistent throughout the month. This persistence faltered early in the New Year and as a result January was unusually warm with monthly mean temperatures 2.0°C above the 1961-90 normal. Colder winter monsoon conditions returned in February with mean daily temperatures for the month at the Royal Observatory 1.0°C below normal. The month was also characterized by one of the longest cold spells recorded in the territory following an intense northerly surge from a strongly developed anticyclone over China.

Mean daily maximum temperature	18.9 °C	(0.3 °C below normal)
Mean daily temperature	16.7 °C	(0.3 °C above normal)
Mean daily minimum temperature	14.6 °C	(0.3 °C above normal)
Rainfall (provisional)	36.4 mm	(37 %)

December

December was generally fine and dry, though cooler than normal, primarily as a result of the persistence of the winter monsoon circulation. The dominance of anticyclonic conditions produced a monthly mean pressure of 102.21 kPa, the sixth highest on record for December. Furthermore, the monthly total rainfall amounted to only 7.9 mm, 71 percent below the normal of 27.3 mm and the monthly mean relative humidity was only 63 percent, five percent below normal. With continuing dry weather Fire Danger Warnings had to be issued on 18 days, only one fewer than in the previous month.

The first three days of the month were fine and dry with temperatures rising to a maximum for the month of 22.8 °C on the afternoon of 3rd. Northerly winds prevailed from 4th to 8th resulting in rather dry and cool conditions. Winds turned more easterly on 9th and weather remained fine until 12th. The easterly winds strengthened on 13th and the weather became cloudier. By 15th an extensive cloud band had developed over the south China coastal regions, bringing rain for the first time in the month. Cloudy conditions with light rain patches continued for the next three days until a cold front passed the coast late on 17th. The surge of winter monsoon conditions brought cool, dry and sunny conditions. Another surge arrived on 24th and strong northerly winds brought cold, dry air to the territory. The persistent of the winter monsoon ensured that fine and clear weather prevailed until the end of the month. Temperatures at the Royal Observatory dropped to 11.6°C, the minimum for the month, on the morning of 30th. The next morning Ta Kwu Ling in the New Territories registered a low of only 1.3 °C and frost was reported at Shatin Racecourse.

Extreme daily maximum temperature	22.8 °C	(on 3rd)
Mean daily maximum temperature	19.7 °C	(0.8 °C below normal)

Mean daily temperature	17.4 °C	(0.2 °C below normal)
Mean daily minimum temperature	15.1 °C	(0.3 °C below normal)
Extreme daily minimum temperature	11.6 °C	(on 30th)
Total Rainfall (provisional)	7.9 mm	(29 % of normal)
Number of Days with ≥0.1 mm rain	1	(2.87 below normal)
Number of Days with ≥25.0 mm rain	0	(0.23 below normal)
Number of Days with ≥50.0 mm rain	0	(0.10 below normal)

January

January 1996 was very much warmer than usual with the mean temperature of 17.8 °C, being the fifth highest for January on record, and 2.0 °C above the 1961-90 normal of 15.8 °C. The mean daily minimum and maximum temperatures also ranked the fourth and eighth highest respectively recorded for the month since 1884. Although rain was recorded on 14 days, the total rainfall for the month was only 1.3 mm, 22.1 mm below normal. The month was also less sunny than normal with the total of 134.4 hours being 18 hours less than average.

The fine and cool weather which ended 1995 carried through into the first four days of the new year. However, easterly winds freshened on the night of 3rd and cloud cover gradually increased the following day. Winds moderated on 5th and a maritime airstream brought some light rain to the territory on 6th. The approach of a cold front on 7th and its passage across the south China coast on the morning of 8th brought a marked change in the weather. For the next five days, temperatures did not exceed 20 degrees. During this time winds turned easterly on 9th and freshened on the early morning of 11th bringing light rain patches. Fine weather returned on 13th but was soon followed by cloudy conditions again on 15th. Cloudy weather with occasional rain patches then characterized conditions for the next ten days although there were some sunny periods. During one spell on the afternoon of 18th temperatures rose to 24.1 °C at the Royal Observatory, the highest recorded there during the month, before the arrival of a weak replenishment of fresh, cool northerly winds again that evening. As the winds subsided on 22nd it became hazy and visibility inside Victoria Harbour fell to 2,000 m that afternoon. The arrival of a strong easterly airstream cleared the haze early on 24th. Another northerly surge of the winter monsoon brought cooler air the next day and temperatures again remained below 20 degrees for another five day period. The monthly minimum temperature at the Royal Observatory, 12.1 °C, was recorded on the morning of 27th. Temperatures fell below 10 degrees in the northern part of the New Territories on the same morning. Milder conditions then returned as clouds over the territory cleared on the last day of the month.

Extreme daily maximum temperature	24.1 °C	(on 18th)
Mean daily maximum temperature	19.9 °C	(1.3 °C above normal)

Mean daily temperature	17.8	°C	(2.0 °C above normal)
Mean daily minimum temperature	15.8	°C	(2.2 °C above normal)
Extreme daily minimum temperature	12.1	°C	(on 27th)
Total Rainfall (provisional)	1.3	mm	(6 % of normal)
Number of Days with ≥0.1 mm rain	0		(5.63 below normal)
Number of Days with ≥25.0 mm rain	0		(0.10 below normal)
Number of Days with ≥50.0 mm rain	0		(normal)

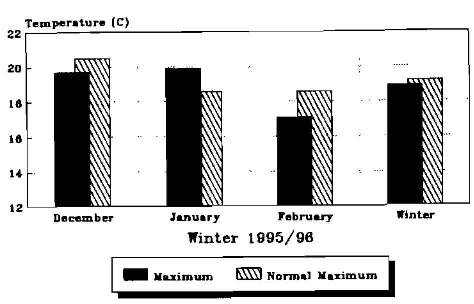
February

February 1996 was characterized by one of the longest cold spells recorded in Hong Kong. Daily minimum temperatures of below 10°C were recorded for seven consecutive days from 18th to 24th, the sixth longest on record for the month. Some media reports associated this cold spell to be directly or indirectly related to the deaths of several elderly people. As the winter monsoon dominated the major part of the month, it was colder than normal. The daily mean temperature of 6.9°C on 21st was the sixth lowest for the month. In addition, the monthly mean sea-level pressure of 102.07 kPa was the tenth highest for February. Although the weather in the latter half of the month was gloomy, the monthly mean rainfall amounted to only 27.2 mm, 43 percent below the normal figure.

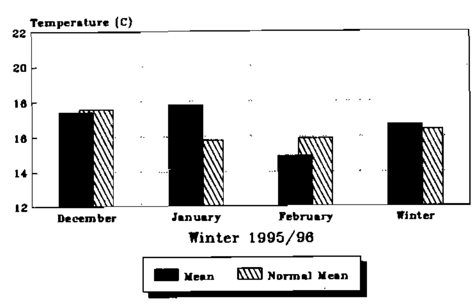
Fine and dry weather brought by the northeast monsoon prevailed during the first four days of the month. The weather turned cloudy on 5th and winds strengthened from the east that night. There were periods of rain the following day but winds weakened later on 7th. A northerly surge arrived on 9th bringing drier air and finer weather for a couple of days. Cloudy conditions returned on 12th as winds became light. The following day a warm, southerly airstream became established. This raised the temperature up to a high for the month of 26.4°C on the afternoon of 15th. However, winds turned easterly the next day and periods of rain set in which lasted for almost two weeks. Around the middle of the month an intense anticyclone over China began advancing south and a cold front crossed the coast on the night of 17th. Temperatures dropped by nearly 8°C over a period of seven hours that night as a consequence. The intense northerly surge marked the start of a prolonged cold spell of seven consecutive days when the daily minimum temperature remained below 10°C. The lowest temperature, 5.8°C, was recorded at the Royal Observatory on the morning of 21st. Temperatures fell below freezing at Tate's Cairn on 20th and frost was observed at Tai Mo Shan on the mornings of 20th and 21st. The weather remained dull and overcast for almost all of the rest of the month although the rain stopped and it began to brighten on 28th. Wind became light on the last day of the month and haze was reported with visibility falling to 1,000 metres at Waglan Island that evening.

Extreme daily maximum temperature	26.4 °C	(on 15th)
Mean daily maximum temperature	17.1 °C	(1.5 °C below normal)
Mean daily temperature	14.9 °C	(1.0 °C below normal)
Mean daily minimum temperature	12.9 °C	(1.0 °C below normal)
Extreme daily minimum temperature	5.8 °C	(on 21st)
Total Rainfall (provisional)	27.2 mm	(57 % of normal)
Number of Days with ≥0.1 mm rain	14	(5.07 below normal)
Number of Days with ≥25.0 mm rain	0	(0.43 below normal)
Number of Days with ≥50.0 mm rain	0	(0.03 below normal)

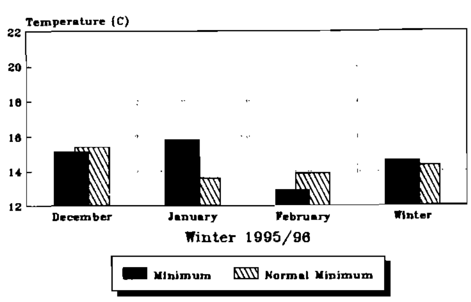
Daily maximum temperature trends



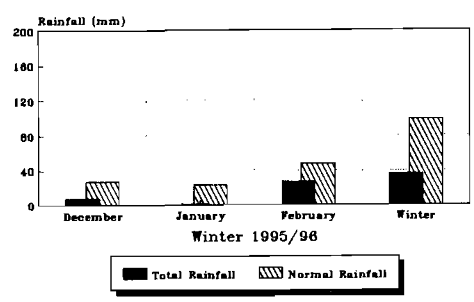
Daily mean temperature trends



Daily minimum temperature trends



Rainfall trends



HONG KONG METEOROLOGICAL SOCIETY

INFORMATION FOR CONTRIBUTORS TO THE BULLETIN

Technical or research articles, as well as reviews and correspondence of a topical nature are welcome. In general contributions should be short, although exceptions may be made by prior arrangement and at the sole discretion of the Editorial Board. Copyright of material submitted for publication remains that of the author(s). However, any previous, current, or anticipated future use of such material by the author must be stated at the time of submission. All existing copyright materials to be published must be cleared by the contributor(s) prior to submission.

Manuscripts must be accurate and preferably in the form of a diskette containing an electronic version in one of the common word processing formats. WORD is preferred but others are also acceptable. Whether or not an electronic version is submitted, two complete manuscript copies of the articles should be submitted. These should be preceded by a cover page stating the title of the article, the full name(s) of the author(s), identification data for each author (position and institution or other affiliation and complete mailing address). An abstract of about 150 words should be included. Manuscripts should be double-spaced, including references, single-side only on A4 size paper with a 2.5 cm margin on all sides, and be numbered serially. All references should be arranged in alphabetical and, for the same author, chronological order. In the text they should be placed in brackets as (Author'(s) name(s), date). In the reference list at the end the Author'(s) name(s) and initials followed by the date and title of the work. If the work is a book this should be followed by the publisher's name, place of publication and number of pages; or, if a journal article, by the title of the periodical, volume and page numbers.

Submission of electronic versions of illustrations is encourage. Originals of any hardcopy illustrations submitted should be in black on tracing material or smooth white paper, with a line weight suitable for any intended reduction from the original submitted size. Monochrome photographs should be clear with good contrasts. Colour photographs are also accepted by prior arrangement with the Editorial Board. Originals of all illustrations should be numbered consecutively and should be clearly identified with the author'(s) name(s) on the back. A complete list of captions printed on a separate sheet of paper.

All submitted material is accepted for publication subject to peer review. The principal author will be sent comments from reviewers for response, if necessary, prior to final acceptance of the paper for publication. After acceptance the principal author will, in due course, be sent proofs for checking prior to publication. Only corrections and minor amendments will be accepted at this stage. The Society is unable to provide authors with free offprints of items published in the Bulletin, but may be able to obtain quotations from the printer on behalf of authors who express, at the time of submission of proofs, a desire to purchase a specified number of offprints.

Enquiries and all correspondence should be addressed to the Editor-in-Chief, Hong Kong Meteorological Society Bulletin, c/o Department of geography & Geology, The University of Hong Kong, Pokfulam Road, Hong Kong. (*Tel. +(852) 2859-7022; Fax. +(852) 2559-8994 or 2549-9763; email: billkyle@hkusua.hku.hk or billkyle@hkucc.hku.hk.*

香港氣象學會

HONG KONG METEOROLOGICAL SOCIETY

Bulletin

VOLUME 6, NUMBER 1, 1996

SINGLE COPY PRICE: HK$ 150

(for subscription rates see inside front cover)

CONTENTS