World Meteorological Organization

EXPERT MEETING ON THE ENHANCEMENT
OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES
IN REGIONAL ASSOCIATION II (ASIA)

Jeddah, Kingdom of Saudi Arabia
29 November – 1 December 1999

Agenda item 3.2(1)

Activities of the Hong Kong Observatory and ESCAP/WMO Typhoon Committee

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1. INTRODUCTION

Hong Kong is a compact cosmopolitan city of about 1,000 square kilometers in area with a population of about 6.5 million (Figure 1). It is situated along the coast of southern China and is affected by a diversity of weather systems. Historically, extensive weather-related casualties, both on land and at sea, were mostly caused by high winds and storm surge during the close passage of tropical cyclones. But through the years, coastal engineering works and better structural designs have gone a long way in mitigating these disasters. By the 1990s, the major perennial weather hazards to be tackled are those associated with severe rainstorms and prolonged heavy rain. These result in landslips on unstable slopes, urban flooding in localized areas with poor drainage, and extensive flooding in the low-lying plain over the northern part of Hong Kong.

Hong Kong is also a very vibrant and energetic city. It is always on the move and hardly has a moment of rest. Through the years, the society as a whole has continued to evolve. The way of life changes and public expectation is never constant. In the context of social and economic development, weather warnings and services are no longer confined to the realm of public safety. They now play a pivotal role in ensuring or even improving the quality of life as well. Standards and contents of meteorological services have to keep pace with the changing needs within the local environment. And on the global scale, information technology is leaving its mark in all walks of life. Our modes of operation and methods of delivery will inevitably be affected. In many ways, it acts as a spur for the modernization of meteorological services. It is no longer a matter of finding room for improvement; there is just no room left for not improving!

At the Hong Kong Observatory, we are keenly aware of the need to adopt a proactive and progressive stance in a continuous effort to upgrade our forecasting and information services. Section 2 reviews the major efforts undertaken by the Observatory in recent years – the formulation of forecasting techniques geared towards the prediction of mesoscale systems and rainstorms, the utilization of information technology in service provision, and the technical systems developed in support of major infrastructure projects such as the new airport in Hong Kong.

Section 3 highlights the regional cooperation under the auspices of the ESCAP/WMO Typhoon Committee, in particular on the subject of tropical cyclones which is a matter of common concern and interest for countries and territories around the western North Pacific and South China Sea basins.

In the light of the Hong Kong and Typhoon Committee experiences, section 4 is an attempt to extend some ideas on service development and mutual collaboration to the RA II. By doing so, it is hoped that we may be able to deal effectively with the many challenges facing the NMHSs in the new millennium.

2. THE HONG KONG OBSERVATORY

Significant rain associated with various weather systems can affect Hong Kong for most part of the year. The most critical periods, however, are during the early summer months of May and June when the monsoon troughs are active over southern China. Short-range forecast of the evolution of intense convective cells embedded within these systems, from mesoscale downwards, remains a major challenge. The highly uneven rainfall distribution in many rainstorm cases, exacerbated by the hilly terrain and tortuous coastline of Hong Kong, renders quantitative rainfall forecasts, even for only a few hours, extremely difficult. To deal with the problem, we have to look at the available tools in state-of-the-art science and technology and to adopt a workable development strategy applicable to the local situation.

In a world of limited resources and knowledge, particularly as observation and forecasting of cloud-scale rain systems are still very much in the realm of research investigation, a practical option is to pursue an engineering approach in dealing with operational problems relating to the prediction and warning of rainstorms. First of all, we need input data from a dense local observation network.

Then in search of the forecast solution, a high-resolution numerical model and a tailor-made nowcasting system are to be our toolboxes.

2.1 Observational Systems

2.1.1 Automatic Weather Observing Network

In Hong Kong, a dense network of over 70 automatic weather observing stations comprising of rain-gauges, anemometer stations, wind profilers, and automatic weather stations (AWS, measuring wind, temperature and humidity) provides minute-by-minute real time data for forecast operation. The network is designed to be maintenance-free by using solar power and incorporating the latest technology in lightning protection and self-diagnostic software. With this network, severe weather systems on the mesoscale and local scale can be readily resolved. The network will be further expanded in the coming years in collaboration with neighbouring services in Guangdong and Macau to cover the entire Pearl River delta in southern China.

2.1.2 Doppler Radars

The Observatory operates two Doppler radars for general weather surveillance: one at Tate's Cairn and another one at Tai Mo Shan. By networking the two radars together and using advanced data processing software, forecasters are now provided with new radar products, such as dual-Doppler winds (Figure 2), composite reflectivity radar images, 3-dimensional display of storm structures (Figure 3), as well as forecast radar products based on user-defined advection vectors or forecast winds from NWP models.

2.1.3 Satellite Reception System

With the planned replacement of GMS-5 by MTSAT (Multi-Functional Transport Satellite), the Observatory intends to acquire at an appropriate time a ground reception system to receive both cloud imagery and the Low Rate Information Transmission (LRIT) from the MTSAT, which would include synoptic observations, NWP model output, tropical cyclone advisory, etc.

2.1.4 Aviation Systems

At the Hong Kong International Airport in Chek Lap Kok, the Observatory operates a dense network of weather sensors in addition to conventional observation of pressure, temperatures and rainfall (Figure 4). Minute-by-minute data are collected in support of aircraft operation.

Thunderstorm-induced windshear and microburst events are monitored by a Terminal Doppler Weather Radar (TDWR) situated about 12 kilometres from the airport. The Radar commands an entire view of both runways, and the approach and departure areas.

Terrain-induced windshear events are determined using a network of automatic weather stations to monitoring surface weather conditions in the mountainous terrain near the airport. A Windshear and Turbulence Warning System (WTWS) issues coherent alerts to air traffic controllers after reconciling data from all sources. Based on investigation of windshear events, the windshear detection algorithm is continually refined.

The Observatory will also acquire a Light Detection and Ranging (LIDAR) system to enhance detection of low level windshear and turbulence at the airport under non-rainy situations. The system makes use of the Doppler effect of laser light to detect movement of particulates in the atmosphere.

2.2 Forecast Development

2.2.1 Numerical Modeling

Driven by the need to forecast mesoscale convective systems for a small area like Hong Kong, much effort has been expended to develop a regional high-resolution numerical model. In 1997, with the kind support of the Japan Meteorological Agency (JMA), a Regional Spectral Model (RSM) was adapted for local use.

The model currently operates with two domains. An outer domain has 60-km horizontal resolution and 20 vertical levels. An inner domain is nested with 20-km horizontal resolution and 36 vertical levels. Besides conventional GTS data, the model ingests digital cloud data from the GMS for moisture bogussing. To minimize the spin-up problem, hourly rainfall amounts based on combined analysis of radar and raingauge data are incorporated through physical initialization. Whenever a tropical cyclone is in the domain, an asymmetric typhoon bogussing technique is used to improve track forecasts. Asynoptic data, such as hourly observations, will have more and more impact on model performance as the frequency of running the analysis/forecast cycle is increased. We are working with our neighbours to extend the hourly AWS coverage. We also follow closely the ATOVS data dissemination from the latest NOAA satellite with a view to incorporating the derived temperature and humidity data for more pressure levels. The model is currently running on a CRAY SV1 super-computer with 16 CPUs and a peak performance of about 19.2 GFLOPS.

Post-processing of model outputs utilizes regression techniques and Kalman filtering to improve point forecasts. Summarized weather map showing fine, cloudy and rainy areas, time series of local weather elements, automated worded weather forecasts and warnings (Figure 5) are also generated to assist the forecaster to assimilate and interpret the model results for operational reference.

2.2.2 Nowcasting System

For numerical prediction, the first two to three hours in the forecast period will always remain a blind spot because of the minimum data cut-off time and the finite computation time required even on a high speed computer. To bridge this gap, an operational nowcasting system SWIRLS (Short-range Warning of Intense Rainstorms in Localized Systems) is designed to assimilate observational data from radar, satellite and raingauges to produce short-range rainfall prediction. The first phase of SWIRLS, mostly radar-based applications, has been put into operation in April 1999. When applied to the tropical cyclone cases in 1999, the prediction of rainfall within the next couple of hours is reasonably accurate in terms of location and amount (Figure 6). The cyclone circulation is also well represented by the analyzed wind field based on movement of radar echoes, thus providing an additional tool for radar eye fix and monitoring of tropical cyclone movement.

In the future phases of SWIRLS, various options will be explored to extend the rainfall forecast validity period. For echo movement, use of wind profiler information and model winds will be investigated. More sophisticated treatments on rain intensity changes will be explored. For even longer shelf life, satellite information ultimately has to be incorporated and the relevant preparatory work is already under way. Additional products from the MTSAT are likely to play a pivotal role in the further development of SWIRLS.

2.2.3 Web-based Forecast Operations

Time has never been on forecasters' side. Given the sheer volume of information available to the forecasters these days, time is, relatively speaking, in even shorter supply. One can argue that if the information were not intelligently presented for ready digestion, then forecasters would find even less room for "thinking time" and any potential benefits of extra data would simply go to waste.

The Central Forecasting Office (CFO) in Hong Kong has chosen to solve this problem using the rapidly developing web technology. Outputs from NWP models, data from automated observation networks, web cam images for visibility monitoring, climatological data, satellite and radar images and their derived products, etc., are centralized into an intranet and are easily viewed with commercially available browsing software. The "homepage" concept, apart from providing a friendly and attractive users' interface (Figure 7), has actually brought about a more dynamic, flexible and interactive desktop working environment. New graphical tools can be readily introduced and implemented, ensuring forecasters' requirements can be met with minimal delay. Information is all set for retrieval and display at the click of a button

Should an emergency disrupt the normal forecast operations, a back-up CFO purposely set up at another location is all ready to take over. Basic operation can be maintained through Internet access to overseas data sources. All that is required is a couple of PCs equipped with forecast bulletin preparation and dissemination capabilities.

2.3 Information Dissemination

In Hong Kong, the emphasis in the past several years has been very much on the development of a comprehensive public weather service. The objective is to deliver weather warnings and messages in a timely and efficient manner direct to the users through the latest information technology. The strategy is to operate multiple concurrent information paths to recipients in multimedia formats. Slowly but gradually, a differentiated approach is emerging to meet different needs: unlimited access of information through automated enquiry systems, the mass media or Internet for the public at large; and limited access of more technical details restricted to special users through a combination of Intranet, dedicated servers and unlisted telephone hotlines.

2.3.1 Weather Warnings and Public Education

The Hong Kong Observatory operates a wide range of warnings on weather hazards, e.g. tropical cyclones, rainstorms, thunderstorms, landslip, flooding, strong monsoon, fire danger, cold snap and hot spell. A comprehensive public education programme has been developed through the years to increase public awareness. This includes information pamphlets, special press releases and articles, educational material on the web and TV, organizing visits to the Observatory and setting up a resource centre for easy access to meteorological, climatological and other geophysical information.

The mass media itself, of course, is not immune to the electronic revolution. The Observatory has developed coded warnings for transmission to various communication media. Once captured, the appropriate weather warnings can be automatically decoded, disseminated and relayed to the public in a timely and efficient manner. This transmission mode is particularly effective for the increasingly popular mobile phones and pager networks, avoiding confusion that may result from ambiguous wordings in text messages, ensuring consistency among the various networks, and in a split second getting the important warning messages literally to the hands of the end-users.

In an effort to reduce the social impact caused by inclement weather, early alerts of imminent changes in warning status and precautionary measures are also included in media broadcasts. For example, advice of health risks, navigational safety and social orderliness is spelt out in the Observatory's TV weather broadcast in hot or cold spells, reduced visibility and rainstorm situations respectively.

2.3.2 Conventional Channels

Apart from the traditional way of disseminating information through the media, a dial-a-weather service together with an interactive telephone answering system provides the public with ready access to weather information on their own initiatives. The service is a computerized operation with 200 telephone lines. Text-to-voice capability enables it to operate in three different languages and dialects, mostly in an automatic manner. A fax-on-demand service is also provided. About 25 million calls are handled each year.

2.3.3 Web-based Information Channels

Public weather services in the 1990s can no longer ignore the impact of the burgeoning Internet. Since its launch in 1996, popularity of the Observatory's homepage continues to grow rapidly (Figure 8). Apart from the standard fare of weather facts and forecasts, information can now be conveyed visually and graphically in multimedia formats. Weather information products, such as temperature readings and rainfall maps, are made available in real time.

The Observatory's homepage was recently voted the most popular Government web site. During the last 12 months, a total of 27 million pages of information were retrieved. The highest number of retrieval in a single day exceeded 2.1 million on 16 September 1999 when Typhoon York hit Hong Kong.

TV weather programmes presented by Observatory meteorologists, previously very much confined to the cable TV network, now reaches out to a much wider audience through a web version on the Observatory's homepage.

To enhance preparedness, information is regularly provided to government officials for decision-making in weather-related situations. This has also taken the electronic leap through the recent launch of a government server, again employing web technology. Information of appropriate technical content is provided for professionals and administrators.

At the airport, airline operators and flight crews can retrieve flight documentation and other information from a web-based Meteorological Information Dissemination System (MIDS). Documents are retrieved by flight number, destination aerodrome, or flight route. They have also access to aerodrome observations, forecasts and warnings, radar and satellite images, products from the World Area Forecast Centres, and tropical cyclones affecting the area.

MIDS is very popular among the users, who need only to use a dial-up telephone line connected to a PC. On average, they download over 400 megabytes of data each day with a rising trend (Figure 9). It has recently gained the recognition of the International Civil Aviation Organization as a system enabling airlines to obtain products for their operation "with minimum investment in hardware, software and training".

Our experience in recent years is a testimony to the profound impact the Internet has on forecast operations. In many respects, the forecast centre in a meteorological service is no longer an information source strictly for weather forecasts and warnings only. It now serves a much wider purpose that includes other weather-related facts and stories. Through the Internet, an interactive relationship emerges between the forecasters and the general public. Forecast and warning messages can be conveniently and directly transmitted to homes and offices; in return, the public expects more real time information on various weather aspects to be made available on their computer monitors for their use and reference. At the Observatory website, for example, the number of hits on weather readings is actually higher than the forecast itself. Through these trends, we can keep track of the public's expectation and demand; and to maintain an efficient service, our product availability and delivery should be able to meet such needs.

2.3.4 Publicity and Media Initiatives

Against a growing list of competitors, ranging from well-established private consultants to the weather enthusiast next door, it is very important for an officially designated meteorological service to uphold its authority and authenticity. If high-profile forecasts such as those in severe weather situations were correct, they would obviously help to boost the service's popularity stake. But despite the best of intention, we cannot be right all the time. If the credibility of the service hangs only on severe weather forecasts, then it would be very much a case of hit or miss. What with severe weather not likely to occur for more than a few times each year, the opportunities to enhance the profile of the service therefore really have more to do with how we interact with our customers during the prolonged "peace time" periods that cover most part of the year.

At the Observatory, we recognize the importance of making "fair weather friends" when the pressure is off, taking a proactive approach in establishing working relationship and mutual trust with the public, the media and other users.

For the public, we routinely monitor and respond to letters and comments in the newspapers, phone-in radio programmes and weather forum on the Internet. A special liaison group named "Friends of the Observatory" is now in its fourth year of operation, with membership exceeding 2,000. Regular activities, mostly talks, visits and newsletters, are organized for the members. Members are also invited to take an active role such as serving on selection panels for best TV weather presenters, providing feedback on our services, and contributing articles to the newsletter.

For the media, apart from interviews on topical issues, we also have a planned series of press information on various subjects through the seasonal cycle. For better mutual interaction, a "one-stop shop" is set up - an officer from the Observatory is designated as a focal point for liaison. An added benefit from such a vibrant relationship is that the media's professional help can also be enlisted in promoting the work of the Observatory when the opportunity arises.

3. ESCAP/WMO TYPHOON COMMITTEE

3.1 Background

The ESCAP/WMO Typhoon Committee was established in 1968. Presently, it has 14 Members: Cambodia; China; Democratic People's Republic of Korea; Hong Kong, China; Japan; Lao People's Democratic Republic; Macau; Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; the Socialist Republic of Vietnam, and the United States of America.

The purpose of the Typhoon Committee is to promote and co-ordinate efforts for minimizing tropical cyclone damage in the ESCAP region, to recommend to participating governments facilities and plans for mitigating such damage, to foster research and training among Members, and to obtain for Members the financial and technical assistance required for attaining the objective of disaster reduction.

3.2 Activities

The Typhoon Committee implements its programmes under five components: meteorology, hydrology, disaster prevention and preparedness, training and research. The Typhoon Committee has organized two large-scale experiments in the 80's and 90's - The Typhoon Operational Experiment (TOPEX) and the Special Experiment Concerning Typhoon Recurvature and Unusual Movement (SPECTRUM). These experiments resulted in improvements in the observational capabilities of all Members, better understanding of the influence of typhoon asymmetry on its movement, and enhanced cooperation among Members in the exchange of information and experience. On an annual basis, technical conferences or training seminars are organized for Members, this year being a training workshop in China on Doppler radars. Other activities of the Typhoon Committee include assignment of numbers to tropical cyclones by RSMC Tokyo – Typhoon Centre to facilitate identification, and the recent formulation of a list of tropical cyclone names for use beginning from the year 2000.

The Committee publishes a Typhoon Committee Annual Report (TCAR), which summarizes the achievements of the Typhoon Committee Members and tropical cyclone activities each year. The Committee also maintains a Typhoon Operational Manual for Members covering operational guidance information on facilities, observations, telecommunications and tropical cyclone prediction.

During the recent 32nd Session of the Typhoon Committee held in Seoul, a Typhoon Committee Research Fellowship Scheme with an objective to promote cooperative research among Members was proposed. The scheme is expected to strengthen the exchange of experience and expertise among Members as well as to contribute towards the solution of problems common to Members.

4. COOPERATION TOWARDS A BETTER FUTURE IN RA II

In Hong Kong, we are appreciative that significant development in forecasting techniques and public weather services is only possible as a result of the free and unrestricted exchange of data. For the protection of life and property against weather impact, the principle of free and unrestricted exchange of data deserves the continued and unmitigated support of all Members of RA II. This is a necessary condition to bridge the technological gap among Members and to encourage the science and services to flourish.

Looking into the future, information technology will enable the public to have ready access to a variety of information sources. But ready access may also come at a price. The public at large could well be inundated with all kinds of information – truths, half-truths as well as untruths. The likely scenario in the next millennium is for the man in the street to ask "Which weather forecast should I believe in?" rather than "What is the latest weather forecast?".

It is important that established meteorological services should maintain a high profile so that the man in the street will always know where to turn to for authentic information. In a climate of privatization and commercialization, there is a tendency to under-estimate the intangible value of an officially designated meteorological service with strong links to the government administration. An official identity serves to project an aura of authority, reliability and accountability, thereby ensuring concerted action in emergency preparedness and response. The danger is for designated meteorological services to retreat into a corner, leaving grounds for others to exploit and at the same time losing the public's trust and respect cultivated over a long period of time.

On the positive side, if we take full advantage of our well-established logistic and technical infrastructure, and as long as we remain mindful of the constant need to improve operational and service standards, NMHSs will, and should, continue to play a leading role in the millennium to come. And if such services can collectively pool their resources together, streamlining on areas of redundancy and striking out strategically at new areas of development, then the possibilities are even more exciting.

Recent advances in web-based technology provide an opportunity to make an immediate and affordable quantum jump to bridge the technological gap among Members. The web will probably become the major means for the exchange of meteorological information in the coming years, even for data or warnings on a real time basis. Although how far such technology can effectively deliver information to the general public will depend on the networking infrastructure within individual countries, there should be at least an electronic link-up among the NMHSs within and without the RA II. The web is a low-cost and effective way to exchange information, from data to graphics to software. A number of data servers should be set up at world and regional centres from which ready-to-use prognostic information, as well as a variety of forecasting tools and software, or even a selection of numerical models, with different plug-in modules for customization purposes, can be retrieved via the internet.

Another step forward in this general direction is to pool resources to make a common data set as input to numerical modeling. What we get from the GTS currently are mostly raw observational data. But for data assimilation and initialization, we need processed self-consistent gridded data and fields. We can choose to do this within our own NMHS, of course. But this inevitably will require more computing resources and also the necessary expertise. And even then, we will only have part of the picture owing to data availability problems and constraints. If a regional data analysis centre(s) can be established to collate and analyze the data, from conventional to remote sensing sources, and to provide the output products in real time or near real time for operational use, then the application of NWP techniques will no longer be the impossible dream for many, and more services will be able to run some sort of regional mesoscale models on moderate means.

Entitlement to the use of the analyzed products will simply be on the basis of raw data contribution. And the following advantages immediately become obvious:

(a) NMHSs will have the impetus to maintain a good-quality monitoring and observational network, and will be in a strong position to secure continuing support and funding from their respective governments;

(b) from the science angle, the pooling and combined analysis of data will bring about a more complete input picture and hence more quality output information can be expected;

(c) the application of input analyzed data from a common source will facilitate the inter-comparison of algorithms and models, providing useful indicators for further tuning and refinement of forecast packages;

(d) the integrity and profile of NMHSs can be enhanced against competitors from private and international sectors.

While the cost of telecommunication and computing is coming down to affordable levels, the cost of data collection is on the rise. As a result, many NMHSs have found it difficult to upkeep their observational network and equipment. We have to look for cheaper alternatives without sacrificing accuracy and reliability. In Hong Kong, our solution for surface data is a custom-built network of automatic observing stations. As part of the WMO Voluntary Cooperation Programme (VCP), the Observatory would be happy to share our experience in the design and operation of such automated observing systems. These systems will dispense with the expensive deployment of trained professionals to outstations. They are very much left alone apart from maintenance visits or, if so desired, can also be designed and set up for simple operation by personnel with no meteorological training.

We live in an age of great changes, and the millennium could not have arrived at a better time. It is a less-than-subtle reminder that we are, like it or not, stepping forward into a new era. Y2K-compliance will only get us through to the New Year. What happens after that is beyond the fiddling of numbers. The well being of NMHSs requires deep resolve and thoughtful planning on our part, and we must not fail to meet the challenge.

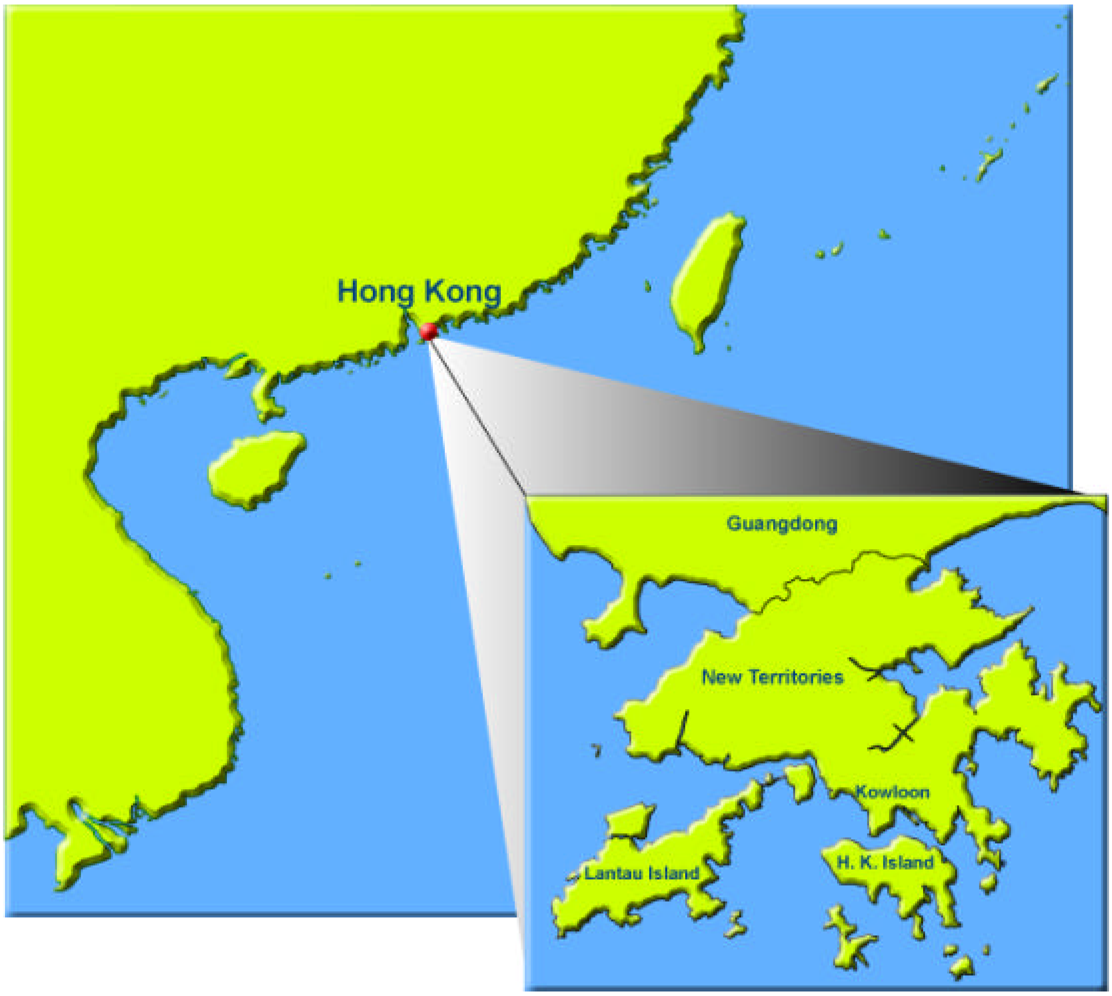


Figure 1 Hong Kong – a small city along the coast of southern China.

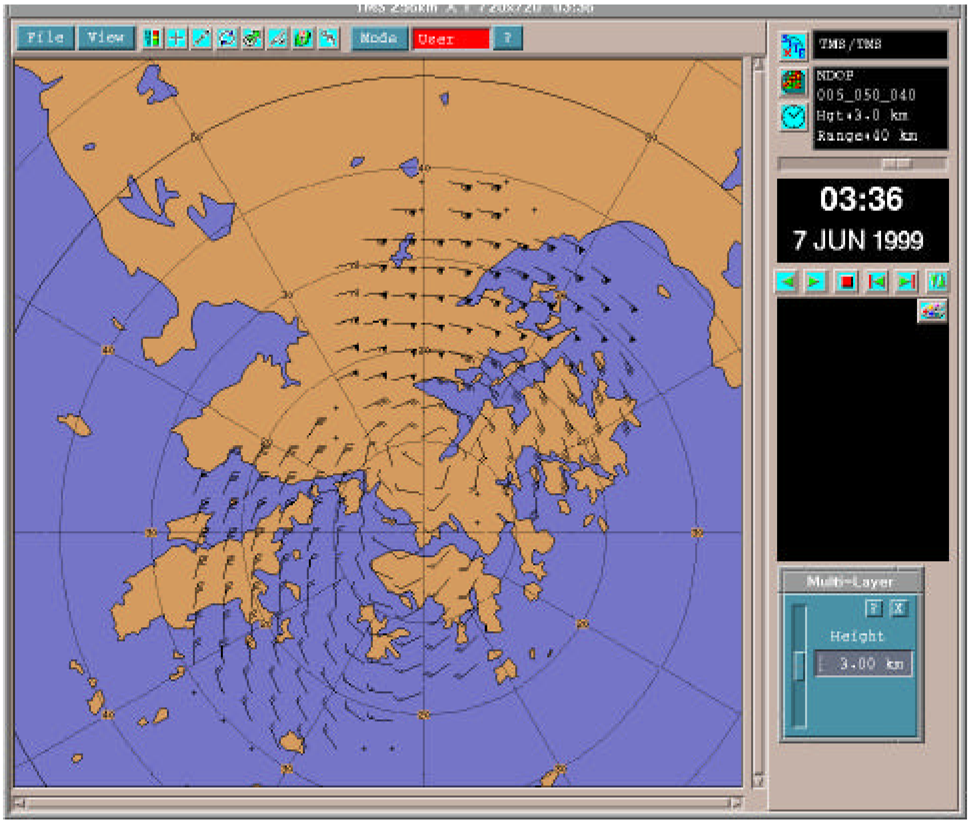


Figure 2 Dual-Doppler analysis of the wind field of Typhoon Maggie (9906) during its passage over Hong Kong at 3:36 a.m. on 7 June 1999.

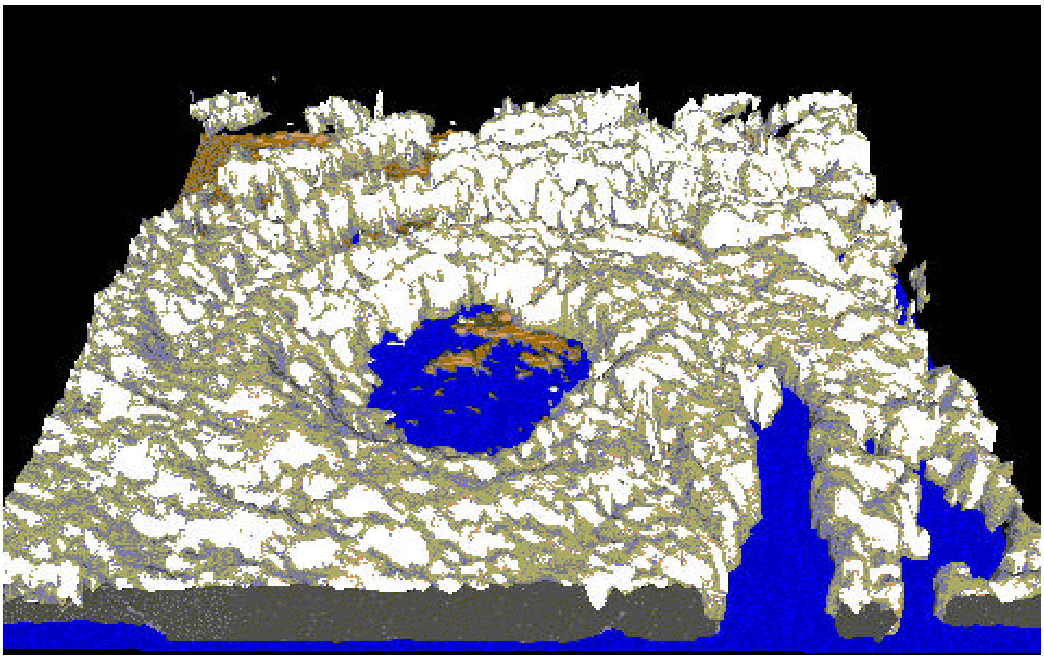
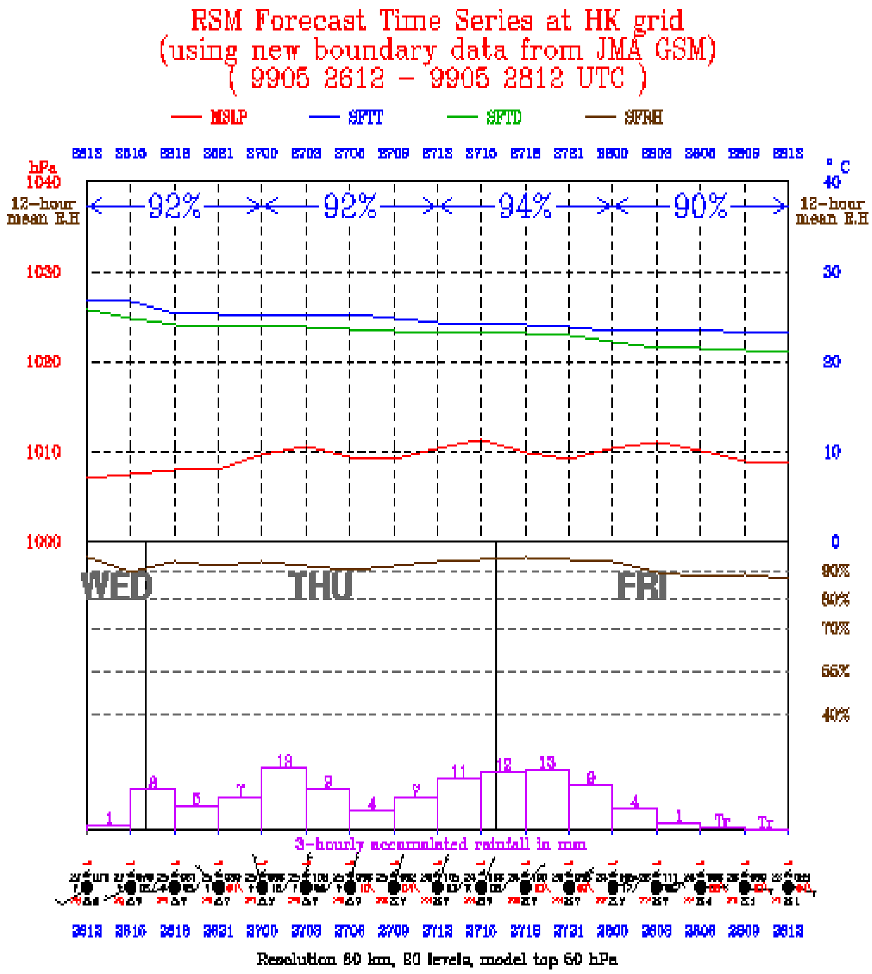


Figure 3 3-D radar image of Typhoon York (9915) with eye over Hong Kong at 10:30 a.m. on 16 September 1999.

Figure 4 Network of weather sensors for the Hong Kong International Airport.



RSM 12-HR F/C BASED ON 12 UTC 08 JUN 1998

Hours	13 14 15 16 17 18 19 20 21 22 23 00
Thunderstorm	
Rainstorm	
WIND	S/SE 3-4, OCNL 5 OFFSHORE LATER.
SKY	OVERCAST.
PPT	OCCASIONAL SHOWERS AND THUNDERSTORMS, BEC HEAVIER LATER.
VIS	NIL.
TEMP	25-26 C
RH	90-95 %

Figure 5 RSM–derived products: forecast time series at grid point near Hong Kong (upper panel) and automated worded forecasts and warnings (lower panel).

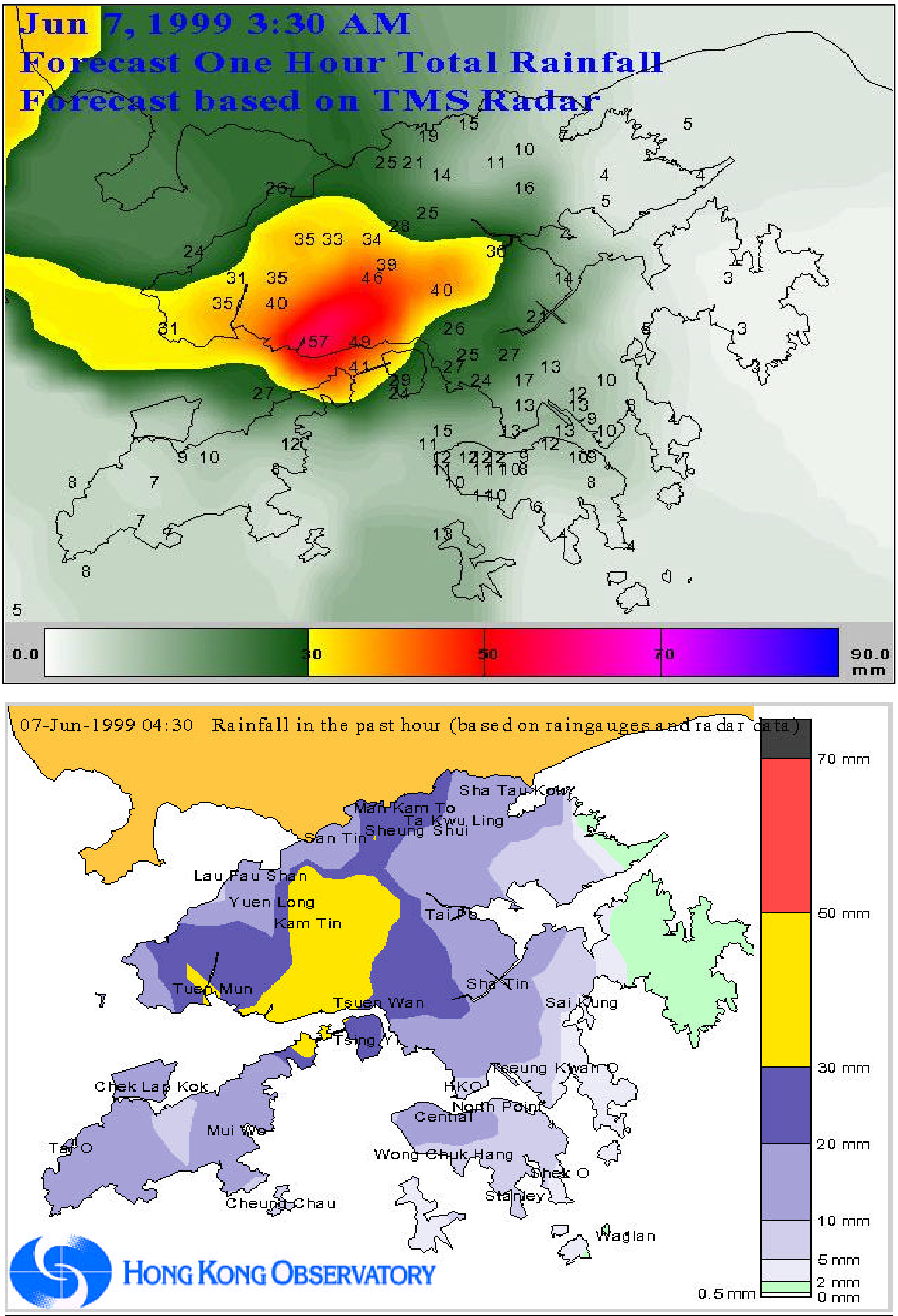


Figure 6 1-hour rainfall forecast by SWIRLS for Typhoon Maggie issued at 3:30 HKT on 7 June 1999 (upper panel) and the corresponding one hour rainfall accumulation reported by the raingauges from 3:30 HKT to 4:30 HKT on 7 June 1999 (lower panel).

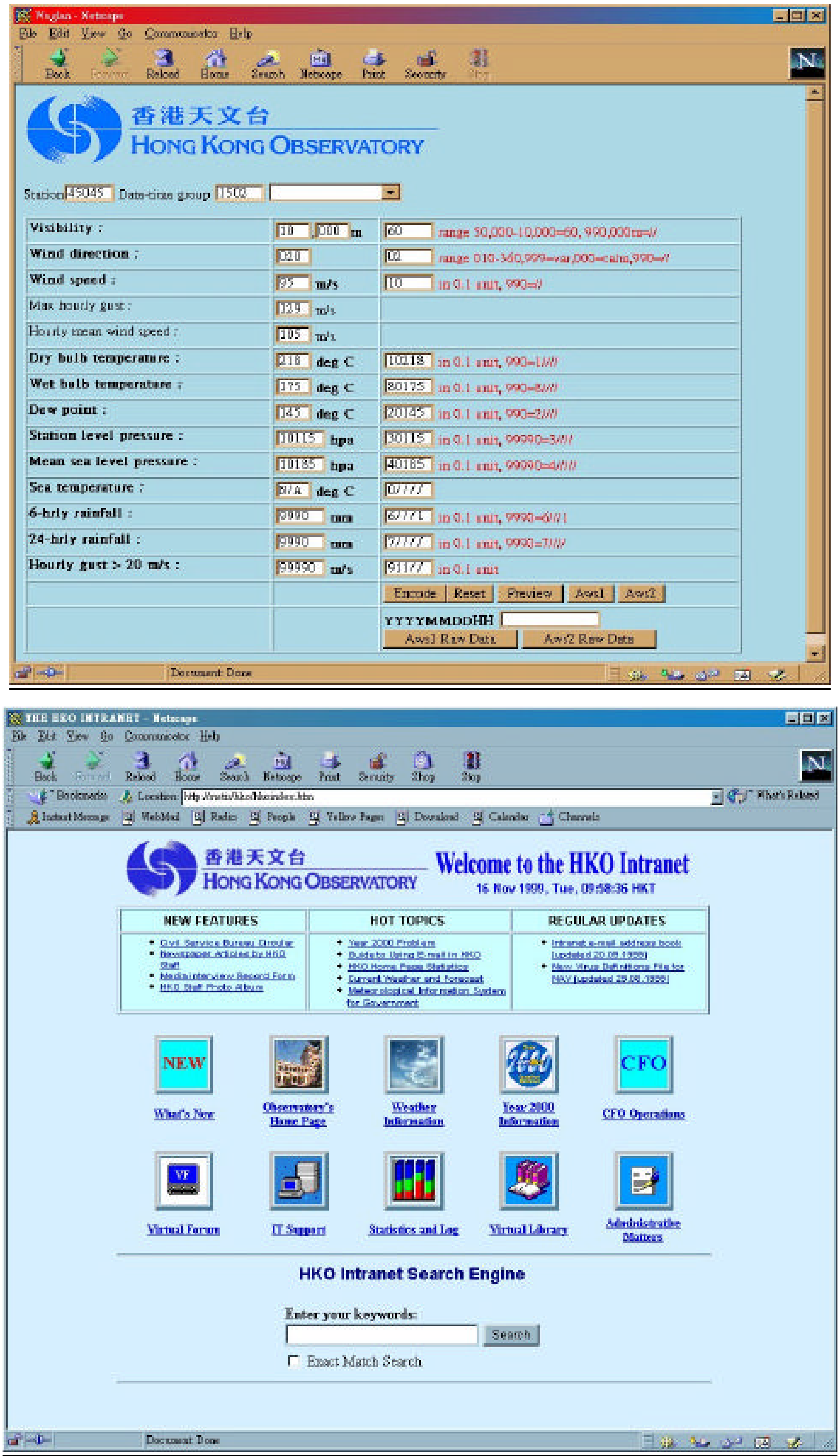


Figure 7	Synop Coding Panel on Web-based Forecast Operations System (upper panel) and Intranet Index Page (lower panel)

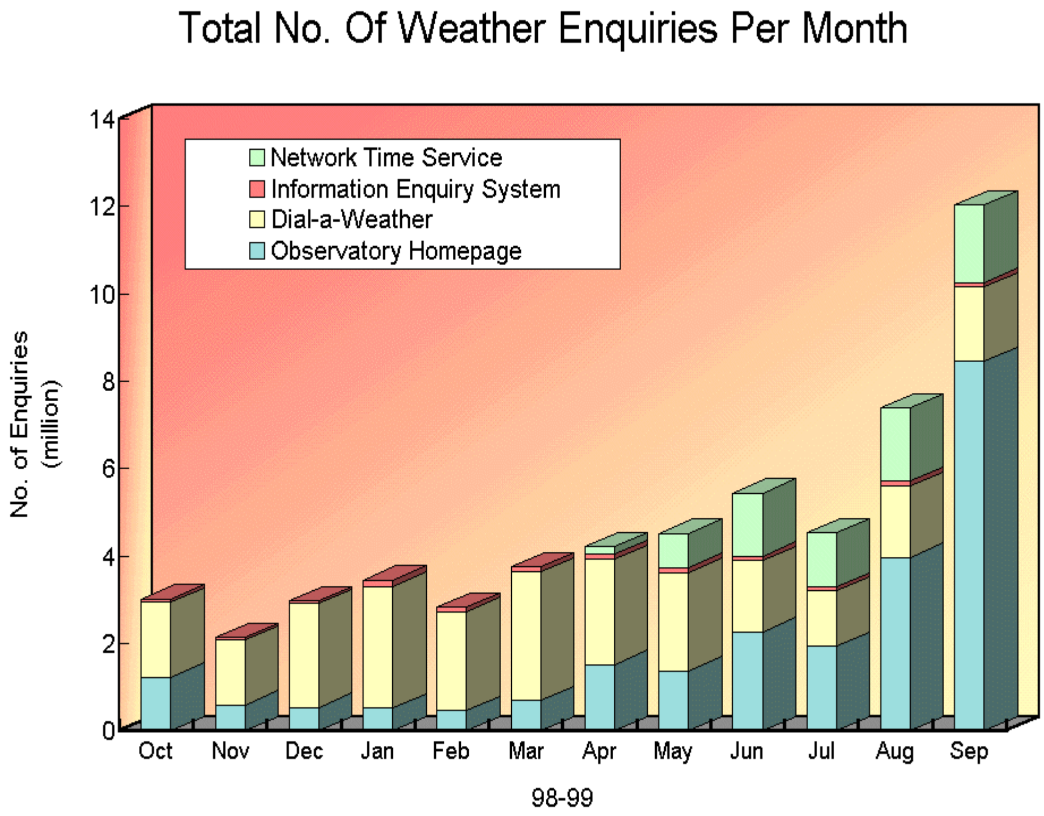


Figure 8 Significant increase in information retrieval through the Internet at Hong Kong Observatory's web page.

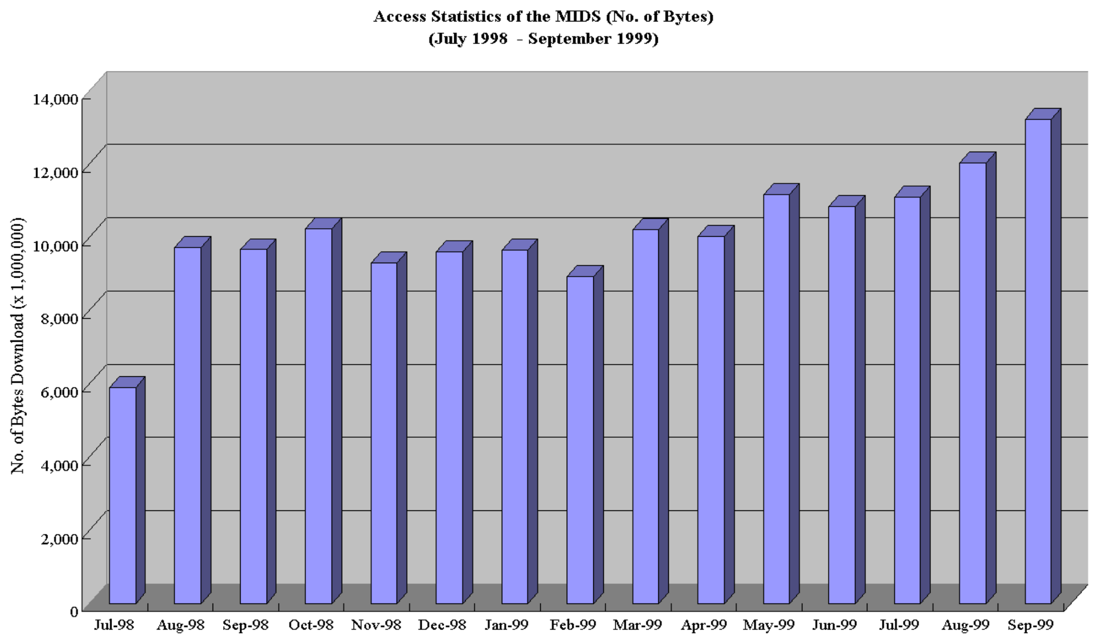


Figure 9 Trend of web-based retrieval of flight document and aviation weather information.