2.5   **COMPREHENSIVE AND LOCATION-SPECIFIC**
LIGHTNING INFORMATION SERVICE IN HONG KONG

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1.   INTRODUCTION

The Hong Kong Observatory (HKO) set up a lightning location system in 2005 to monitor lightning activities over Hong Kong and its neighbouring regions round the clock. Embracing both Internet and Geographic Information System (GIS) technologies, the Observatory provides on its website a near-real-time lightning location map and a lightning alerting tool. Users can select their own location of interest and the webpage will automatically send alerts when lightning strokes are detected within a 15 km range. The tool allows users to make conscious decisions based on assessment of weather situation and it has proved to be very handy for outdoor workers, hikers, swimmers, swimming pool operators and organisers of big outdoor events. The lightning information service has been well received by the public. Since its inception in 2005, the average number of visits to the lightning information webpage per year is around 1.7 million, a figure equivalent to about one-fourth of the population of Hong Kong.

2.   LIGHTNING LOCATION NETWORK

The lightning location network of the HKO has been in operation since June 2005. It comprises six lightning sensors of the IMPACT ESP model (Vaisala 2004), which are located at Chung Hom Kok, Tsim Bei Tsui and Sha Tau Kok in Hong Kong; Taipa in Macao; Sanshui and Huidong in Guangdong (Figure 1). The algorithm for locating lightning is based on a combined magnetic direction finding and time-of-arrival method (Cummins et al. 1998). The system provides lightning information including lightning stroke time,

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2-dimensional location (latitude and longitude), stroke type (cloud or cloud-to-ground), polarity and peak current.

Figure 1   Distribution of the lightning sensors (The rectangle in the inset map shows the location and coverage of the main map)

3.   COMPREHENSIVE LIGHTNING LOCATION INFORMATION SERVICE

In the past, people engaging in outdoor activities relied solely on the territory-wide thunderstorm warning issued by the HKO to decide whether they should suspend their activities to prevent strikes by lightning. However, the warning was text-based and contained limited information about the location of lightning. This sometimes caused inconvenience when lightning only affected parts of Hong Kong but the outdoor activities in other parts of the territory had to halt just because people did not know where the lightning was or how far it was away from the activity site.

After the lightning location system was introduced in 2005, a comprehensive lightning location service for the public was launched and lightning information was disseminated in different forms and through various channels to meet different user needs. The service allows user's flexibility in assessing how the weather is going to affect his/her activities and in making conscious decisions based on the assessment, instead of relying solely on the territory-wide thunderstorm warning.

The full range of lightning information services provided by the HKO are described as follows:

(a)   Lightning location map on the website

Lightning locations are displayed in graphical form on the website www.weather.gov.hk/wxinfo/llis/index.htm (Figure 2) and the Personal Digital Assistant (PDA) website at pda.hko.gov.hk/llise.htm with an update frequency of every five minutes. With the service adopting GIS technology (Lee 2008), the user can interactively zoom in to his/her area of interest and select to display a number of geographical references including major landmarks, swimming pools and country parks so as to identify more easily the location of lightning.
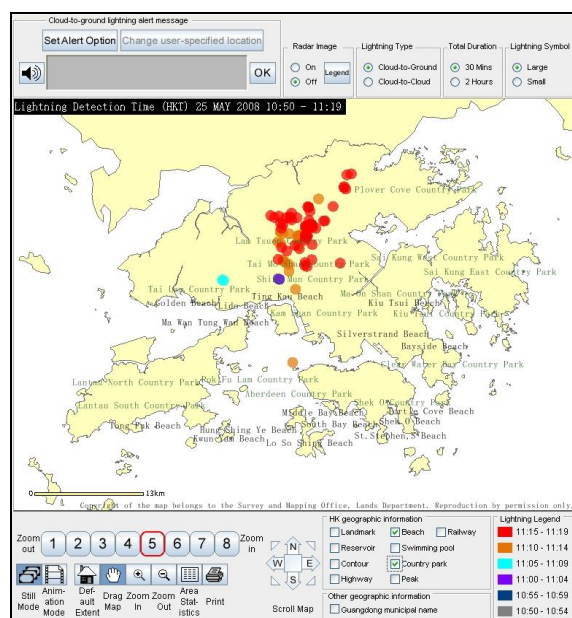

Figure 2   Lightning location map on the Observatory's website

Users can also choose to overlay radar images on the lightning location map (Figure 3) to appreciate which rain area bears lightning activities and which does not. The public can better grasp the adverse weather situation after appreciating the distribution and movement of lightning within a rain area. Animation is also available so that user can track the movement of lightning alongside rain areas and assess how the lightning develops or decays as the rain progresses.
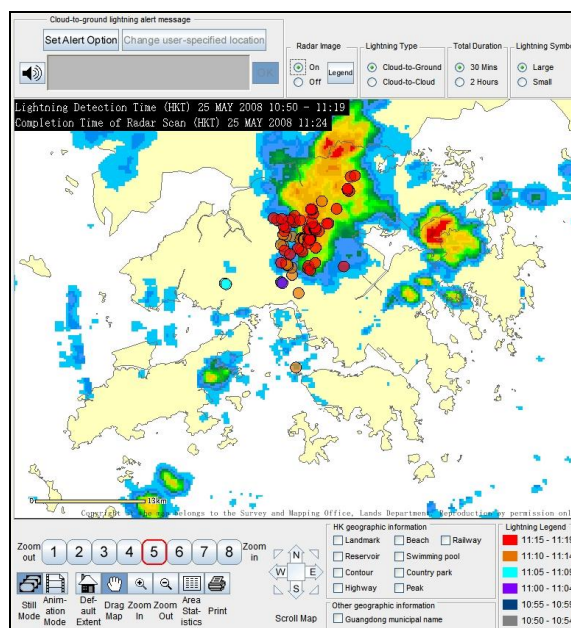

Figure 3   Lightning information overlaid with weather radar image

(b)   Statistics of lightning stroke counts

The lightning location map provides a spatial data analysis tool for the user to retrieve the total number of lightning strokes occurring in his/her selected area of interest over a period of time. Besides, the number of lightning strokes recorded each hour in Hong Kong in the current and past three days is also available in tabular form on the HKO website (Figure 4). For climatological study, lightning density map of Hong Kong is published every year (HKO 2008).

Period (HKT)	Cloud-to-ground				Cloud-to-cloud			
	11 Aug	12 Aug	13 Aug	14 Aug	11 Aug	12 Aug	13 Aug	14 Aug
00:00-00:59	0	0	125	1	0	0	93	1
01:00-01:59	0	0	9	1	1	0	27	5
02:00-02:59	0	0	0	0	0	0	1	0
03:00-03:59	4	0	3	0	7	0	10	0
04:00-04:59	0	0	3	0	0	0	42	0
05:00-05:59	0	0	0	0	0	0	5	0
06:00-06:59	0	0	0	0	0	0	0	0
07:00-07:59	0	0	0	0	0	0	0	0
08:00-08:59	0	0	0	0	0	0	0	0
09:00-09:59	0	0	0	-	0	0	0	
10:00-10:59	0	0	5	-	0	0	9	
11:00-11:59	0	0	1131	-	0	0	387	
12:00-12:59	0	0	242	-	0	0	128	
13:00-13:59	0	0	2	-	0	0	0	
14:00-14:59	0	0	0	-	0	0	0	
15:00-15:59	0	0	0	-	0	0	0	
16:00-16:59	0	0	219	-	0	0	123	
17:00-17:59	0	0	2270	-	0	1	1209	
18:00-18:59	0	935	35	-	0	218	43	
19:00-19:59	0	769	1	-	0	338	1	
20:00-20:59	0	0	1335	-	0	0	510	
21:00-21:59	0	5	2075	-	0	2	1650	
22:00-22:59	0	2362	264	-	0	632	205	
23:00-23:59	0	48	11	-	0	38	18	
Daily total	4	4119	7730	-	8	1229	4461	

Figure 4   Hourly lightning counts of the current and past three days

For those who need more detailed lightning data of the past (as described in Section 2), the Observatory also provides the data upon request on a cost-recovery basis. This service was well received by construction companies, insurance firms and academic researchers.

(c)   Simplified Regional lightning information

To cater for those who do not use computer or do not have access to the Internet, a simplified version of the lightning location service is available at the Observatory's telephone-based Dial-A-Weather System, which is a kind of interactive voice response system. For the sake of simplicity, Hong Kong is divided into four regions and a message will automatically be read out when lightning is detected in one of the regions. The same information is also included in the hourly weather bulletin for radio broadcast.

4.   LOCATION-SPECIFIC LIGHTNING ALERTING SERVICE

In 2008, the lightning information service was enhanced with the launch of a location-specific lightning alerting service. This new service allows members of the public to select their own location of interest on a lightning location map via a computer, a mobile phone or a PDA, and the webpage will automatically provide audio and visual alerts when cloud-to-ground lightning strokes are detected within 15 km of the location (Figure 5). Although this is a tailor-made service, it is offered at no charge as the purpose is to enhance public safety during outdoor activities. This makes the service the first of its kind around the globe in terms of tailor-made and free-of-charge weather alerting service for the public and operators of various facilities.
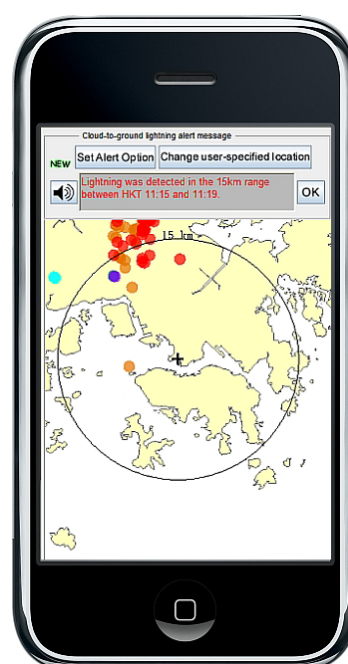

Figure 5   Alarm is triggered when lightning activities come close to the user (The "+" symbol in the centre denotes the location specified by user, and the circle denotes the pre-set 15 km-radius alert area)

Simplicity is the main concept of the webpage design. Selection of user's location of interest, i.e. centre of the alert circle, can be made by simply clicking the location directly on the lightning map. For those who may not be familiar with locations on a geographic map, the webpage provides a list of beaches, reservoirs, swimming pools, country parks and peaks for them to choose from. The user can also

enter the name of a building, estate or street and the webpage will automatically look up where it is (Figure 6). Furthermore, several sound files are available for users to select as the audio alert.

Figure 6   Selection of user's location of interest is just a few clicks or keystrokes away

The lightning alerting service enables users to make decisions based on updated lightning information. It allows them to continue their outdoor activities when lightning poses no immediate threat to them, even though the thunderstorm warning has been issued and there may be lightning affecting other parts of the territory. Examples of application abound. The beach operator can be alerted of the location and movement of lightning and keep the beach open so long as there is no threat from lightning, instead of simply closing the beach every time the thunderstorm warning is issued. Swimmers can then enjoy more leisure time in the beach. Potential users include practically every business that has to conduct its activities in the open, e.g. container terminals, ground operations at the airport, and various logistics activities. In short, the service can improve the quality of time of individuals and produce efficiency gains for the society as a whole, while at the same time mitigates damage or loss of life due to lightning and thunderstorms.

5.   LIGHTNING ALERTING SERVICE IN SUPPORT OF THE OLYMPIC GAME

In the 2008 Olympic and Paralympic Equestrian Events in Hong Kong, real-time lightning information specific to the event venues was provided to the event organizers, enabling them to better arrange the game schedule and protect spectators against the possible approach of thundery weather. In this tailor-made service, the number of selectable alert circles was increased from one to three so that the event organizers could set different alert thresholds and implement stepped preventive measures against lightning. A special tool which calculated the total number of lightning strokes in the 5 and 10 km ranges in the past 15 minutes was also tailored for the event (Figure 7). Audio and visual alert would be issued when 15 or more lightning strokes were detected within the specified range. Upon receiving the alert, the event organizers would immediate notify the responsible parties to implement the planned response actions.
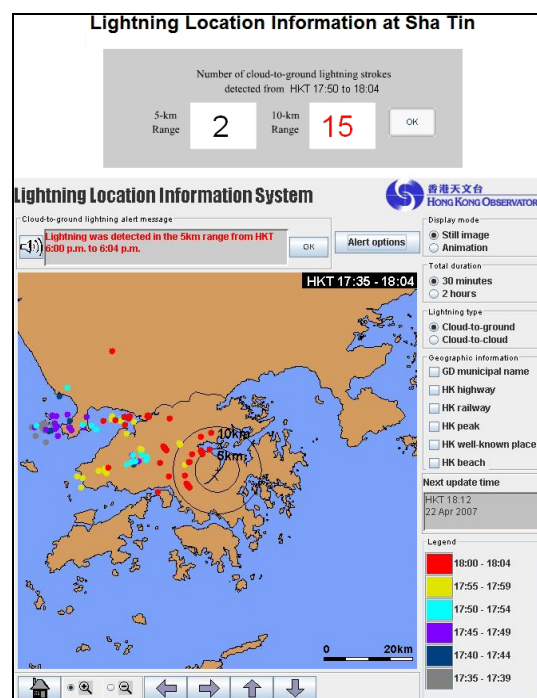

Figure 7   Lightning alerting tools tailor-made for the Olympic and Paralympic Equestrian Events in Hong Kong

6.   SUMMARY AND DISCUSSION

The Hong Kong Observatory provides a full range of lightning location information services to the

public and different sectors of the society. Combining Internet and GIS technology, the first-of-its-kind free and tailor-made lightning alerting service has been developed which empowers the public to assess the risk of lightning during outdoor activities.

Looking head, more lightning information services for mobile device users will be explored. As more and more mobile devices can determine the user's location from signals of Global Positioning System (GPS) satellites, cell phone network or Wi-Fi hot spots, it is believed that location-based weather service should become a trend in the near future.

7. ACKNOWLEDGEMENT

8. REFERENCES

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