



Reprint 626

Scientific Background of Haze and Air Pollution in Hong Kong

C.Y. Lam & K.H. Lau *

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** Hong Kong University of Science and Technology*

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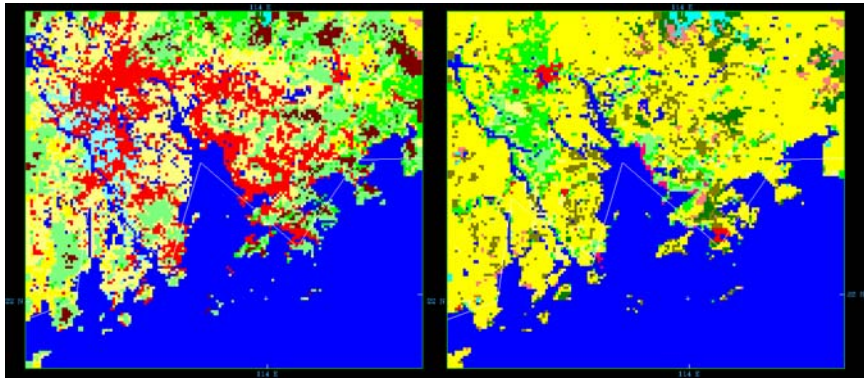
Abstract

The number of instances of reduced visibility reached a record high in 2004 and became very noticeable to Hong Kong citizens who perceived the phenomenon as related to increased air pollution. To focus on reduced visibility not due to weather *per se*, the Hong Kong Observatory (HKO) studied the statistics of instances where visibility fell below 8 km in the absence of rain, fog and mist. At the HKO Headquarters between 1968 and 1986, the percentage of time with reduced visibility rose at a rate of 0.8% per decade. Between 1986 and 2004, the corresponding rate was 5.7% per decade, which was 7 times that of the previous period.

Analyses of the synoptic situations showed that in winter and spring, reduced visibility typically occurred in association with weak northerly surges of the monsoon or when the northeast monsoon affecting Hong Kong was relatively weak. In summer and early autumn, episodes of reduced visibility often occur in northerly or northwesterly winds capped by stable subsiding air aloft, induced by tropical cyclones a few hundred kilometers to the east of Hong Kong. Taken together, it is inferred that the deteriorating visibility is associated with an increase in the strength of sources of suspended particulates inland to the north of Hong Kong. This is corroborated by the spatial distribution of aerosol optical depth (AOD) as determined by satellite observations on days of poor visibility in the region (real-time pictures available on <http://www.weather.gov.hk/wxinfo/intersat/modis/sat.html>).

Studies by the Hong Kong University of Science and Technology (HKUST) have shown that the occurrence of haze was well correlated with high air pollution levels. In addition to the increased emission of air pollutants over the Pearl River Delta (PRD) region, numerical studies suggest that the increase in the number of hazy days in Hong

Kong may also be attributed to the enhanced trapping of air pollutants by the local urban land-sea breeze circulation, which is in turn related to the rapid urbanization around the PRD region. The figures below show the extent of urbanization (in red) in the region in 2003 (left) contrasting with that in the late 1980s.



On hot days when the background winds are weak, air tends to rise over the urban areas and sink over cooler water surface nearby. Such hot air does not rise high and typically reaches an altitude of one to two kilometers and then spread out. As the Pearl River estuary is now virtually surrounded by intense urbanization, the resultant urban land-sea breeze circulation is as shown schematically in the left-hand side of the figure below. It is stronger and more widespread around the estuary compared with the more localized circulation over Hong Kong in the 1980s.



The present complex circulation mixes the pollutants from the different sources. It also implies that the trapping of the air pollutants over the region is stronger, thus requiring stronger background winds to effectively disperse the pollutants emitted within the region.

Since the background wind regime is controlled by large-scale dynamics which do not change much from year to year, the number of hazy days is expected to continue increasing in parallel with further urban and industrial development around the PRD region.

香港煙霞和空氣污染的科學背景

Scientific Background of Haze and Air Pollution in Hong Kong

林超英 C Y Lam



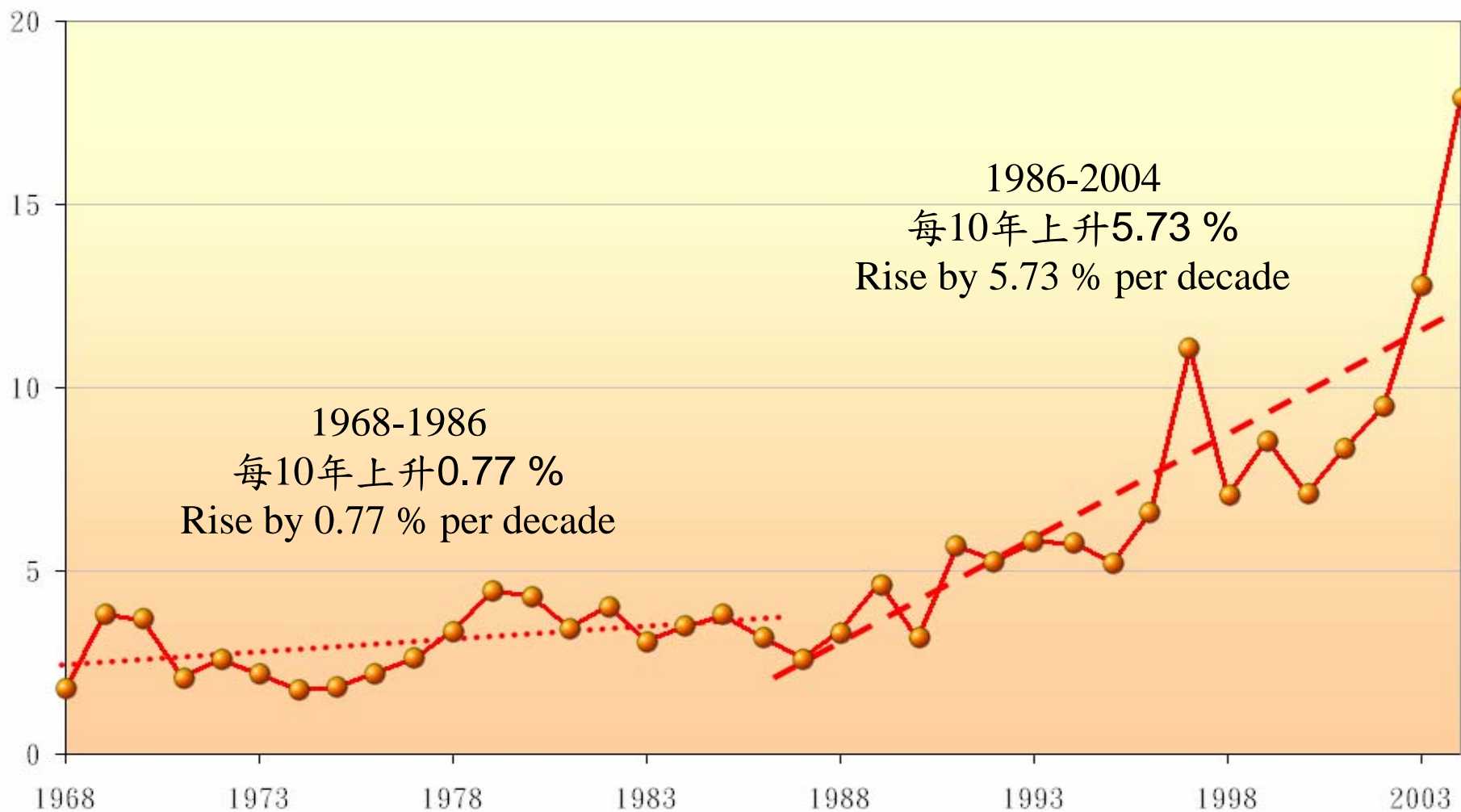
劉啟漢 K H Lau

Hong Kong University
of science & Technology

香港天文台總部能見度低於8公里（雨霧不計）

Visibility below 8 km at the Hong Kong Observatory Headquarters
(not counting rain, mist or fog)

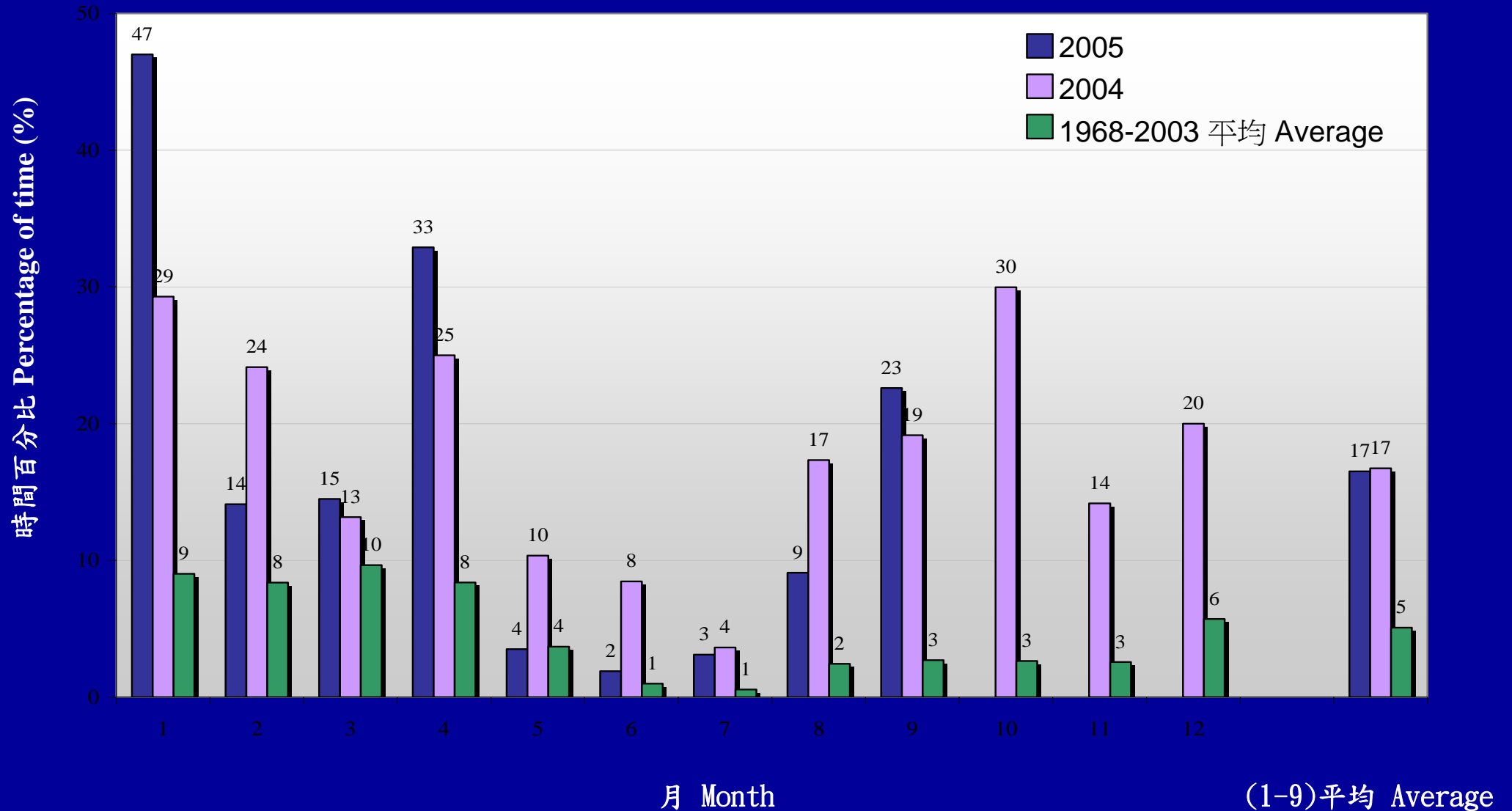
時間百分比 Percentage of time (%)



年Year

香港天文台總部出現低能見度的時間百分比(2005, 2004及1968-2003平均)

Percentage occurrence of reduced visibility at the Hong Kong Observatory Headquarters (2005, 2004 and 1968-2003 average)



甚麼東西令能見度下降？ What reduces visibility?

- 懸浮粒子把光線散射
- Scattering of light by aerosols
 - 天然 + 人為
 - Natural + Anthropogenic
 - 源頭 Sources :
 - 本地 local
 - 外地 external

低能見度天氣形勢

Synoptic situations of reduced visibility

- 冬季：微弱北風
- Winter: weak northerlies
- 夏季：颱風在香港以東，
香港吹微弱北或西北風
- Summer: weak northerlies or NW'lies
with tropical cyclones to the east

共同之處:

- 晴天
- 大氣穩定，擴散能力低
- 香港處於大陸下游

Common features:

- fine weather
- stable atmosphere, low diffusion
- Hong Kong downstream of mainland

推想：

- 懸浮粒子與光化學霧有關
- 主要源頭在內陸

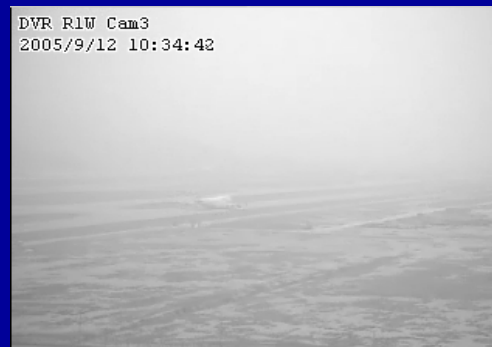
Inference:

- aerosols related to photochemical smog
- main source is located inland

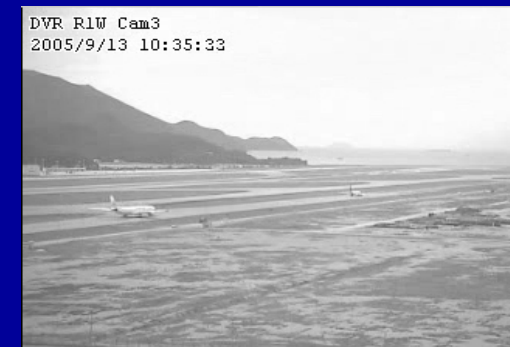
2005年9月11日至13日在機場向大嶼山方向拍攝的照片
Photos taken at the airport towards Lantau from 11 to 13 September 2005



2005年9月11日
上午10時33分
10:33 a.m.
11 September 2005

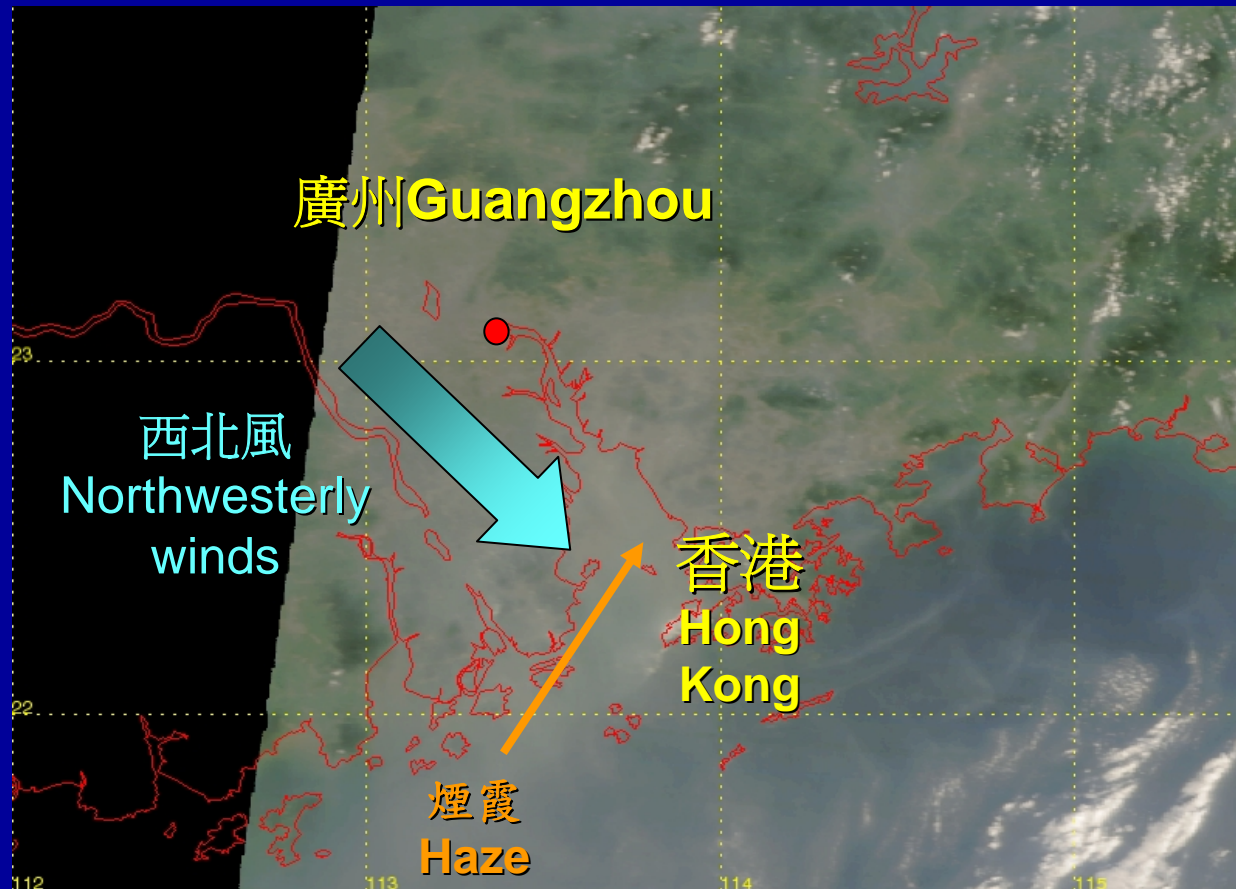


2005年9月12日
上午10時34分
10:34 a.m.
12 September 2005



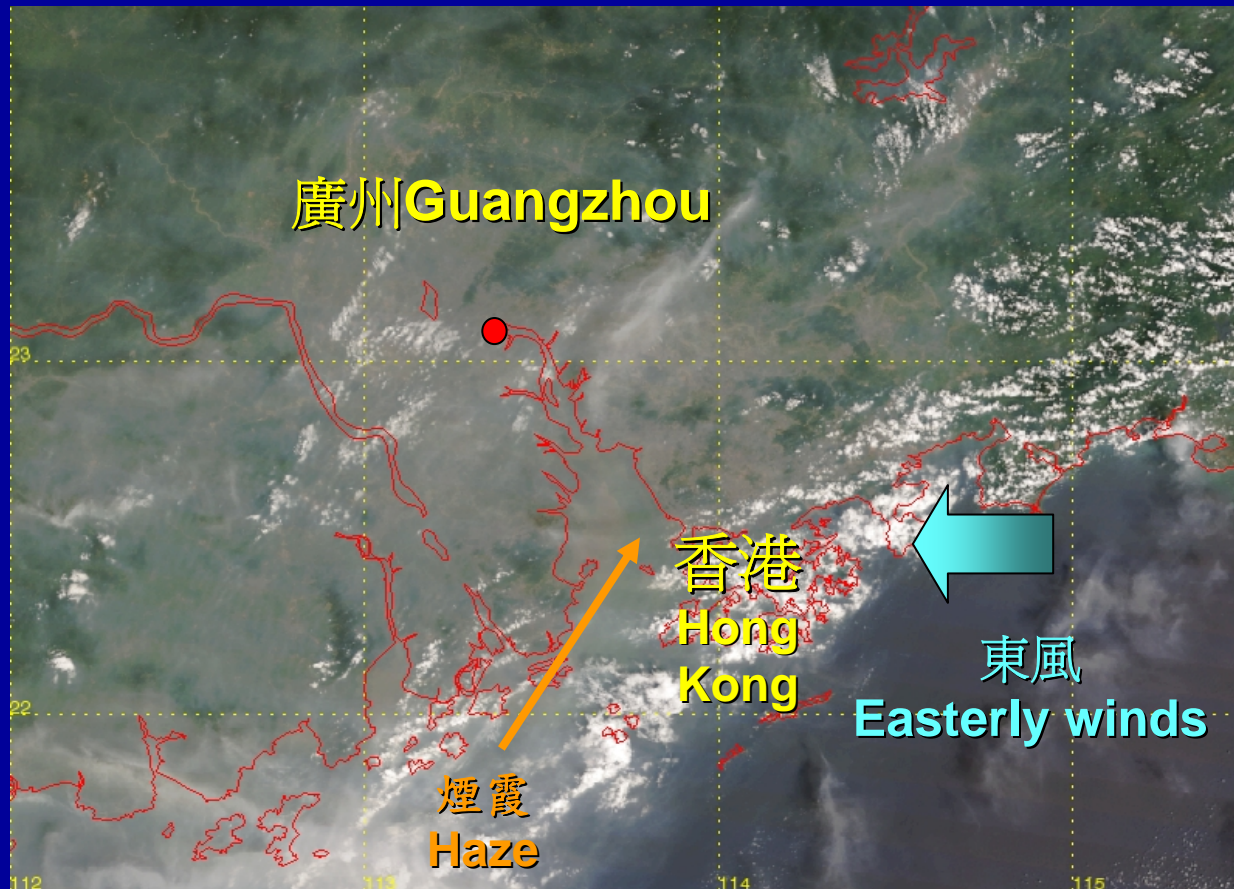
2005年9月13日
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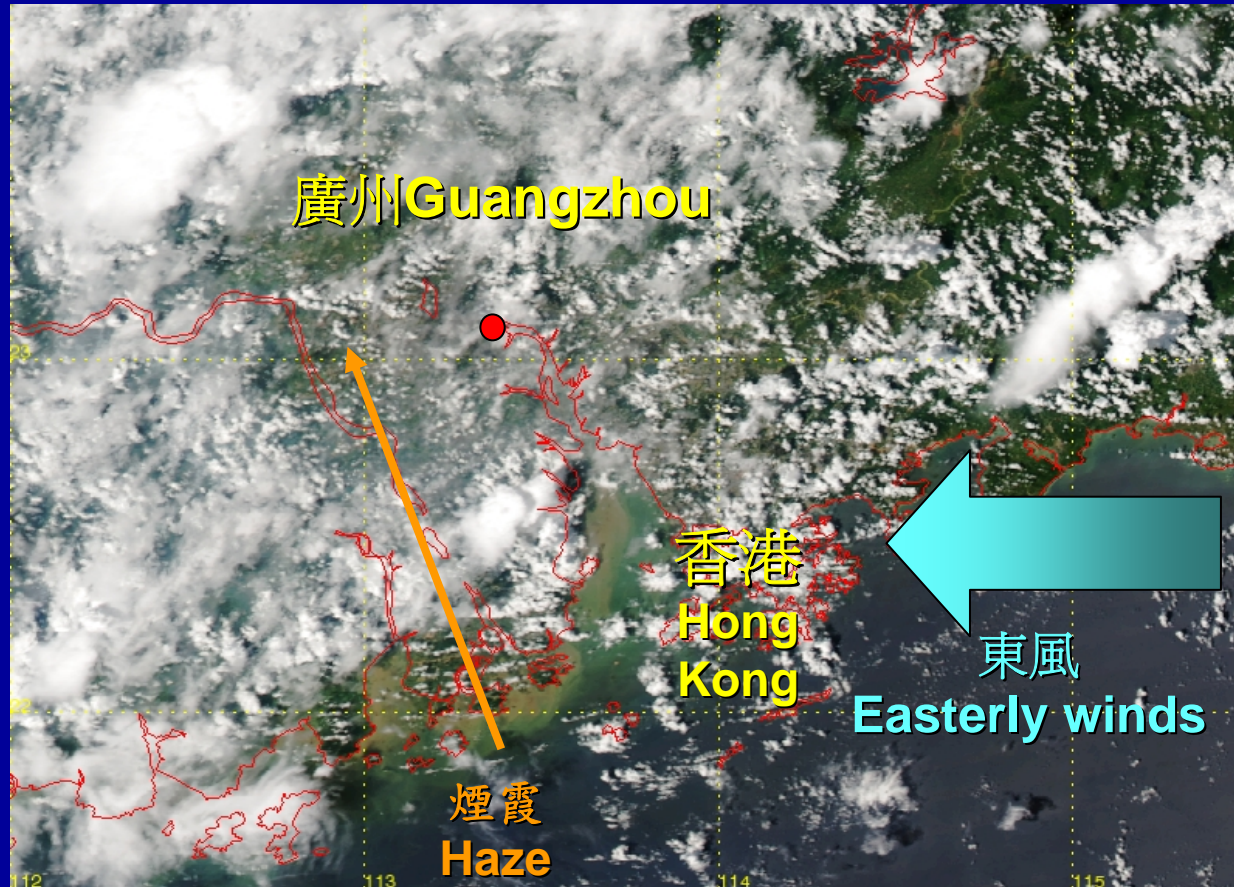
廣東沿岸吹西北風，香港被煙霞覆蓋。
Northwesterly winds prevailed over the coast of Guangdong.
Hong Kong was covered by haze.

2005年9月12日
12 September 2005



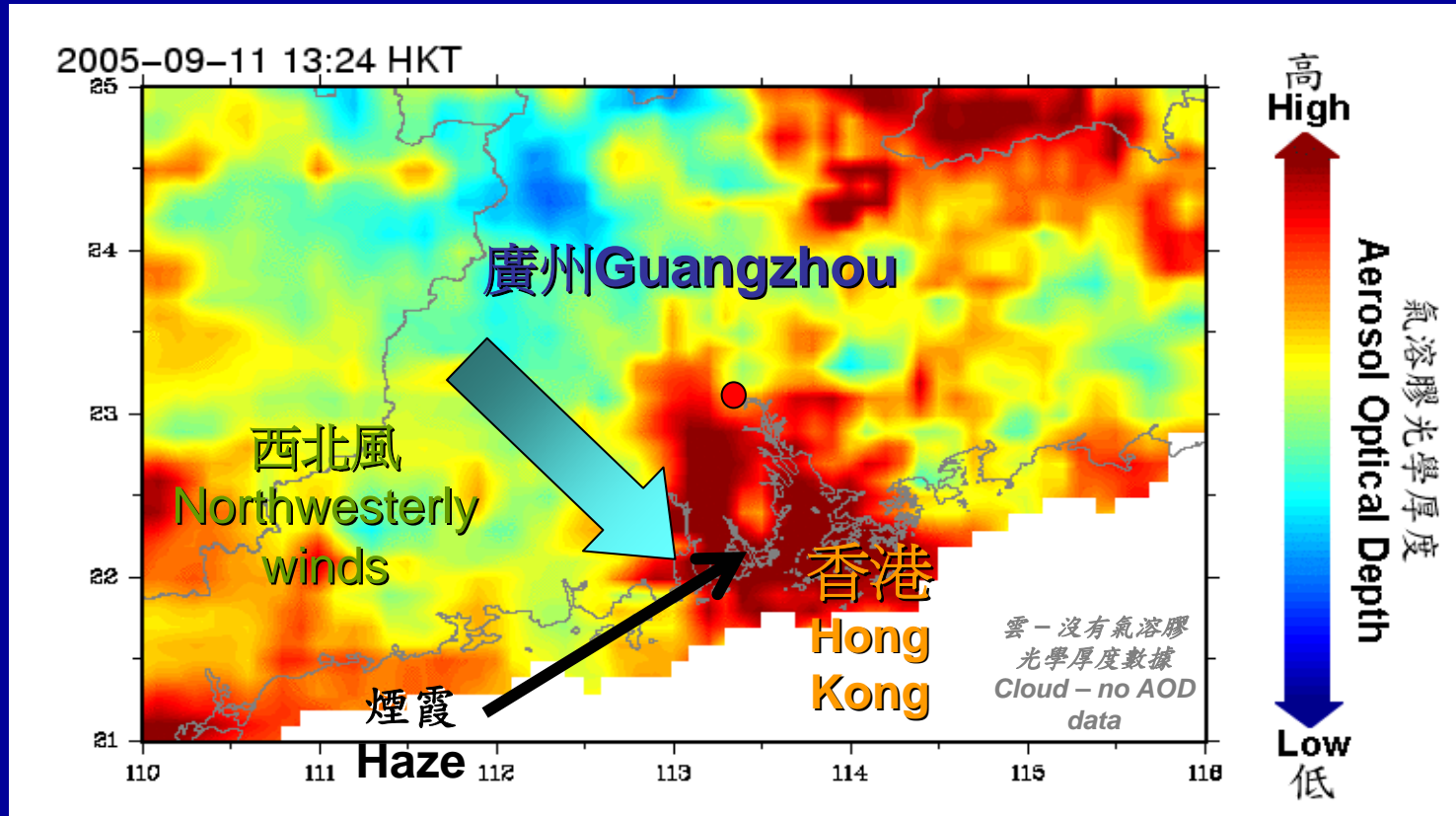
東風取代西北風，煙霞隨風向西飄，但仍影響香港。
Northwesterly winds were replaced by easterlies. Haze drifted west, but still affected Hong Kong.

2005年9月13日
13 September 2005



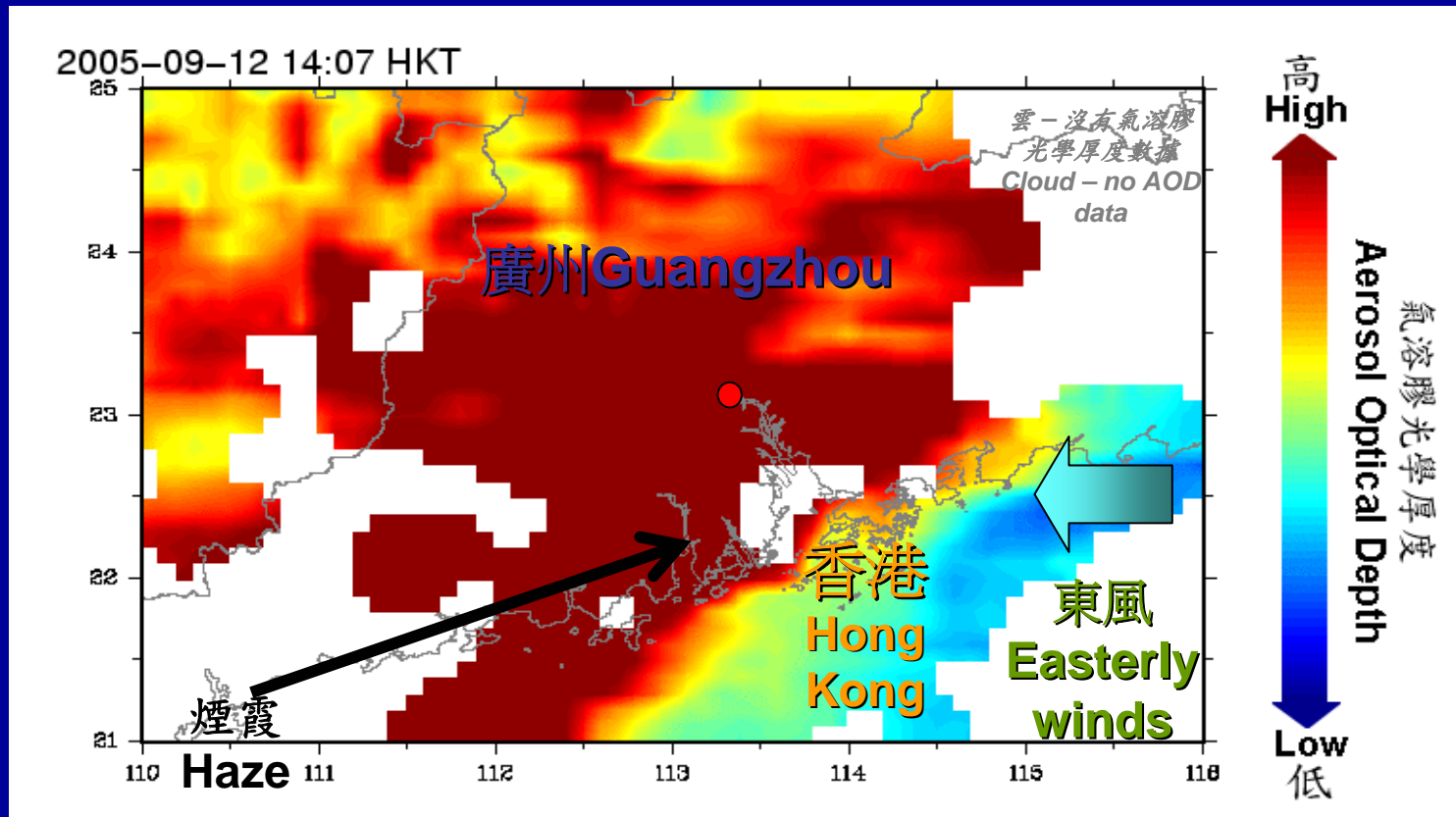
東風增強，煙霞隨風向西飄離香港。
Easterly winds strengthened. Haze drifted west away from Hong Kong.

2005年9月11日
11 September 2005



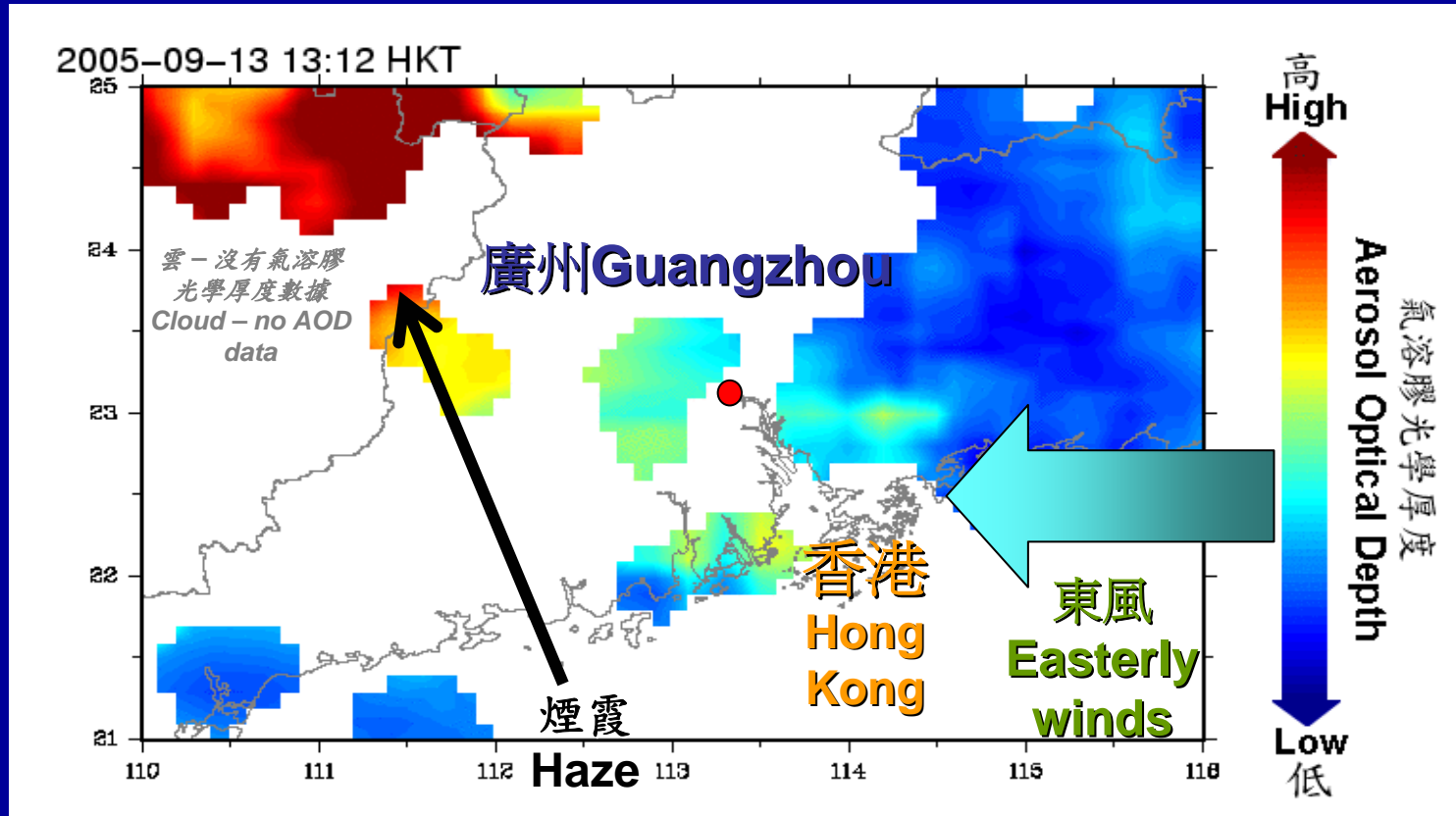
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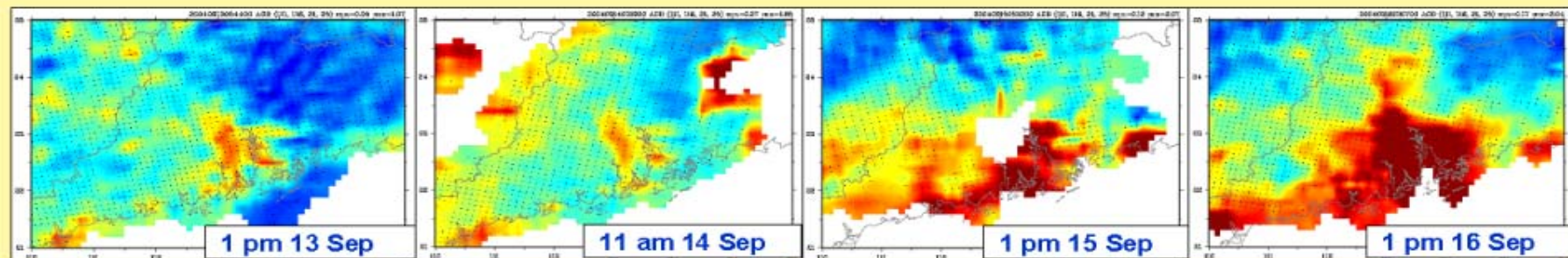
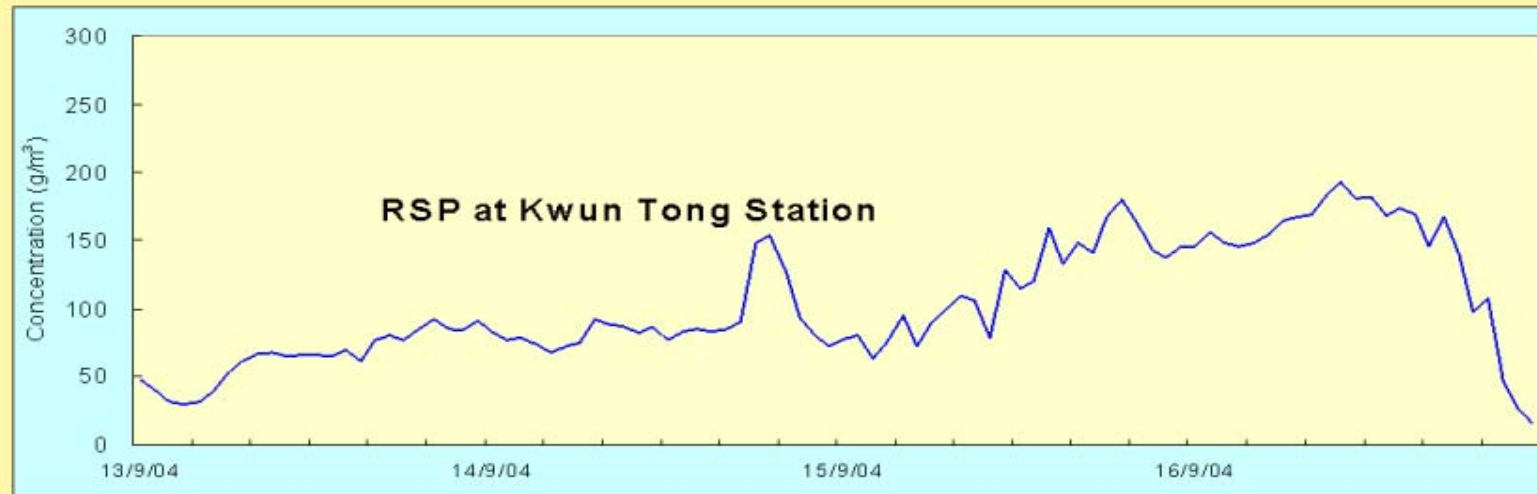


東風增強，煙霞隨風向西飄離香港。

Easterly winds strengthened. Haze drifted west away from Hong Kong.

2004年9月13日至16日污染物增多而能見度下降

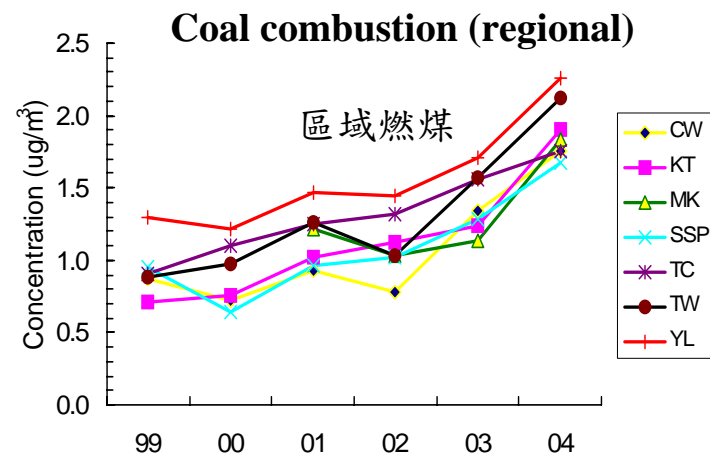
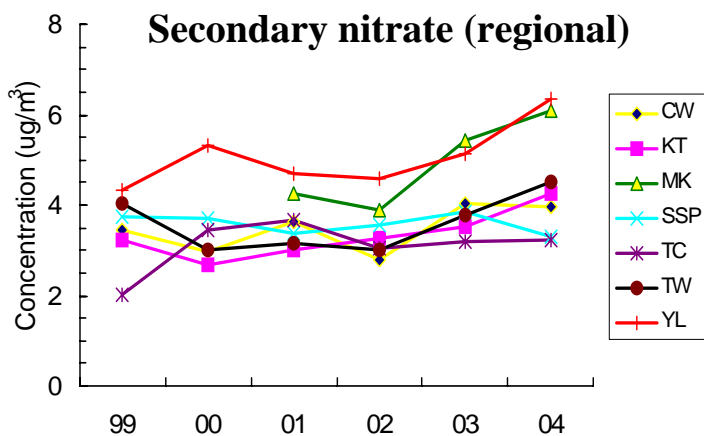
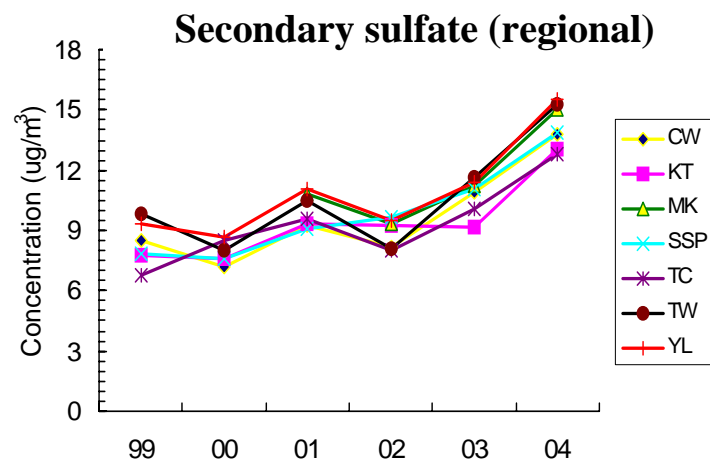
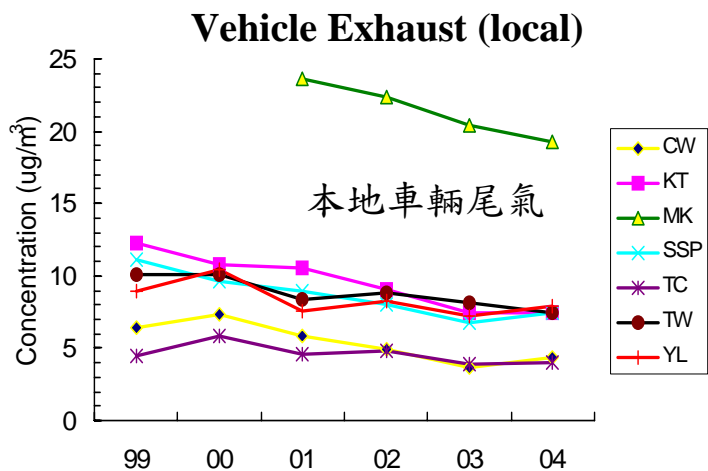
Pollution in the region increased gradually as smog activities persisted from 13 Sep to 16 Sep 2004



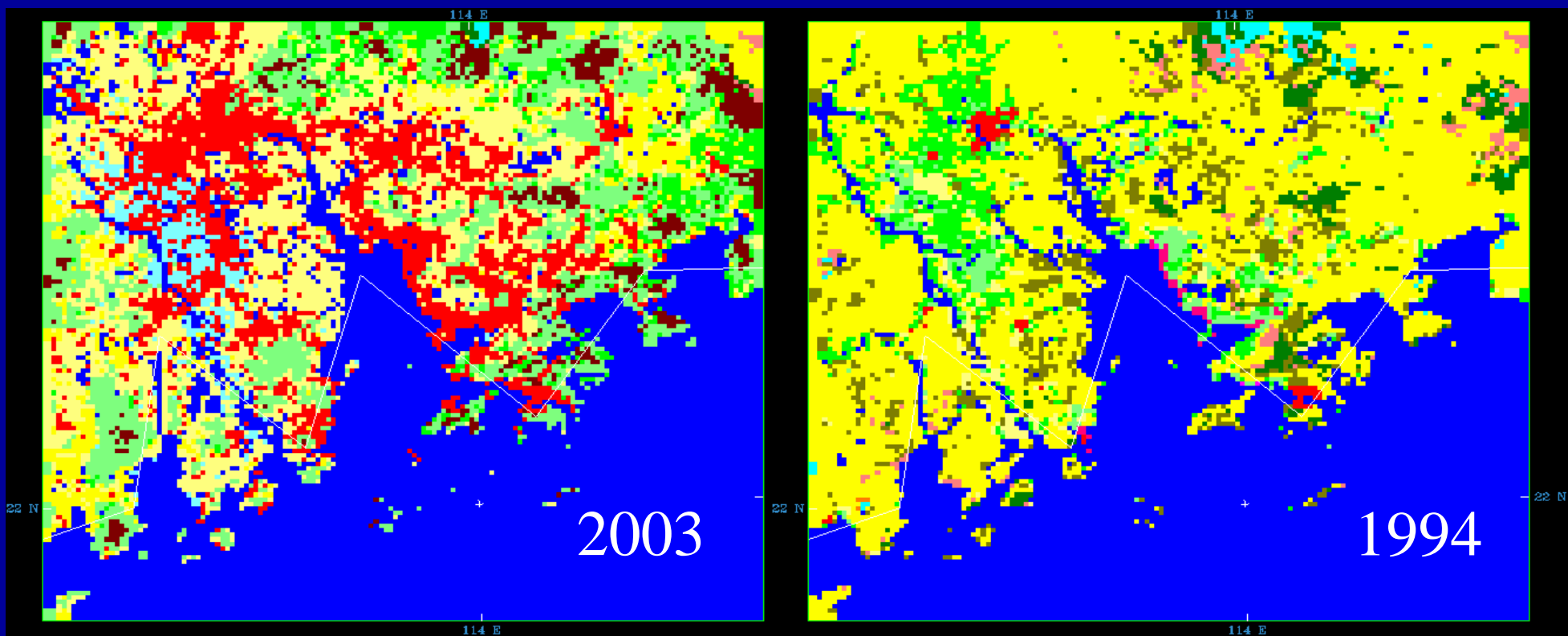
Satellite images indicated the building up of particulates over the period

主要污染物來源趨勢

Trends of major pollutant sources



珠江口周邊大規模城市化 Dramatic urbanization around Pearl River Estuary

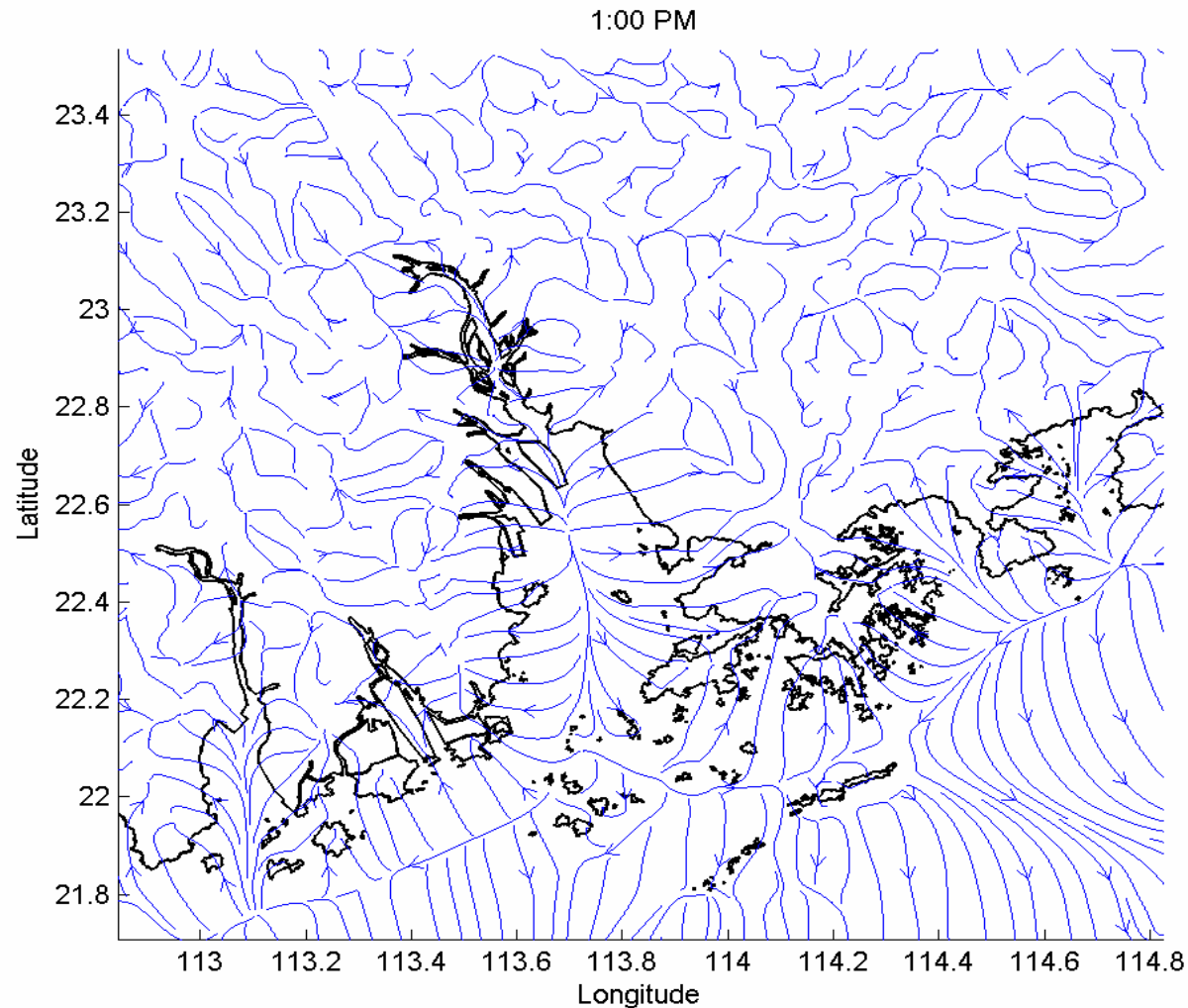


紅色代表城市

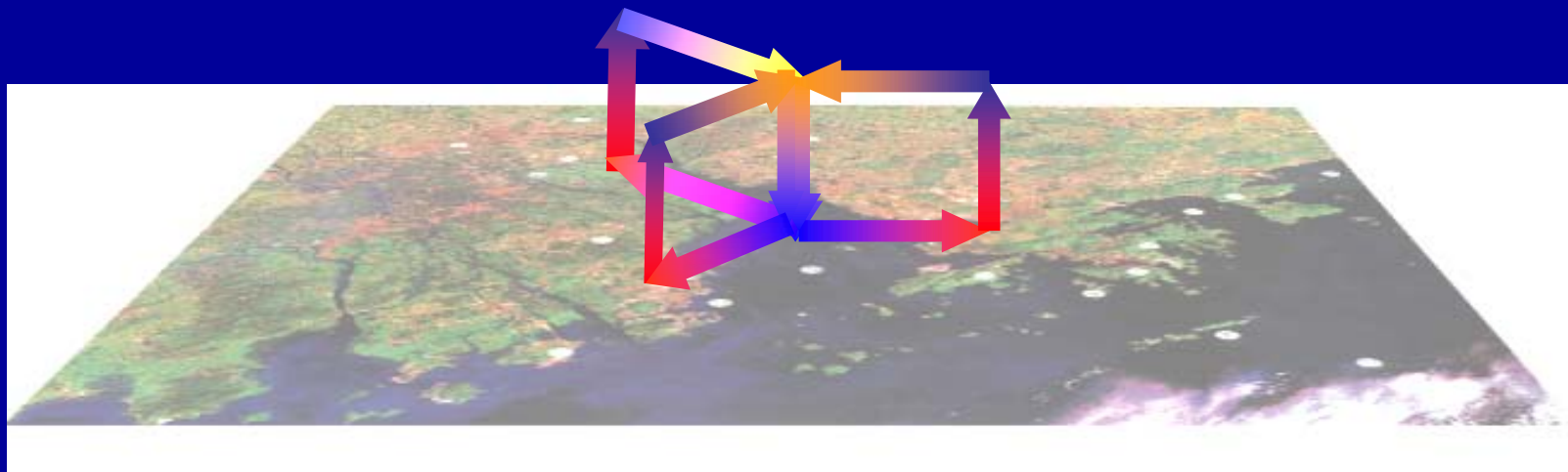
Red stands for urban areas

微弱北風背景下日間的海風環流

Day-time sea breeze circulation in weak background northerlies



環珠江口海風系統 - 鎖住和混合各地污染物
Sea breeze system surrounding the Pearl River estuary
locks in and mixes pollutants



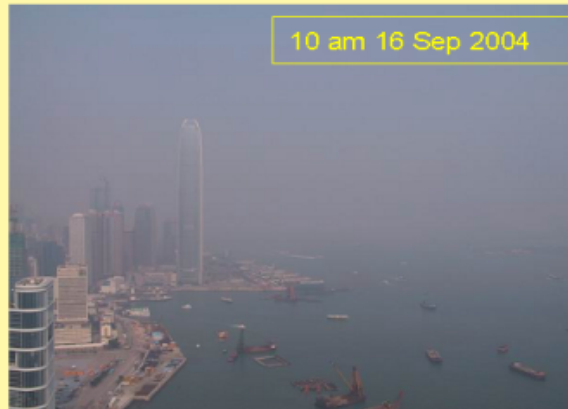
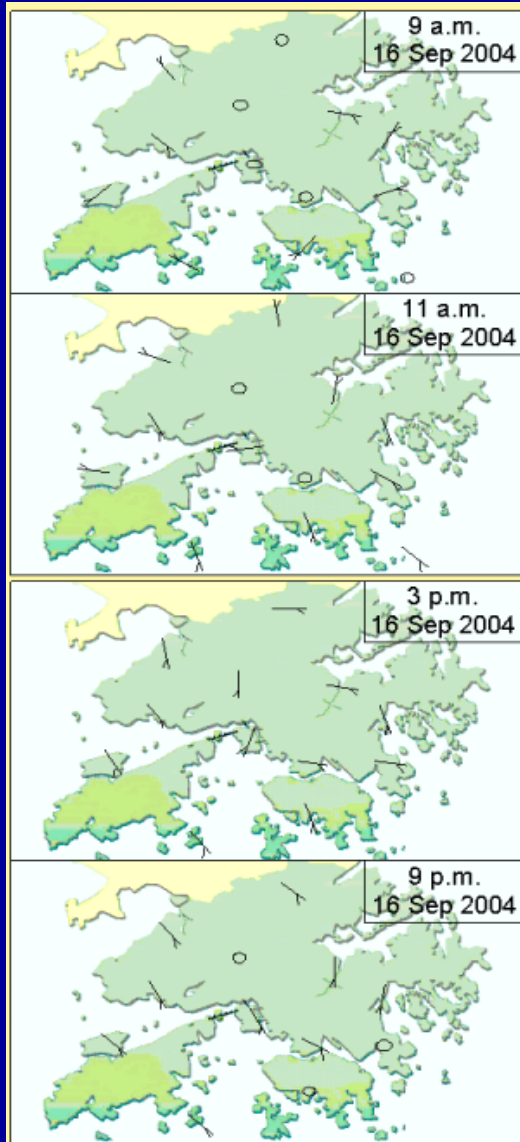
煙霞 = 污染 = 物理 + 化學

haze = pollution = physics + chemistry

有辦法解決

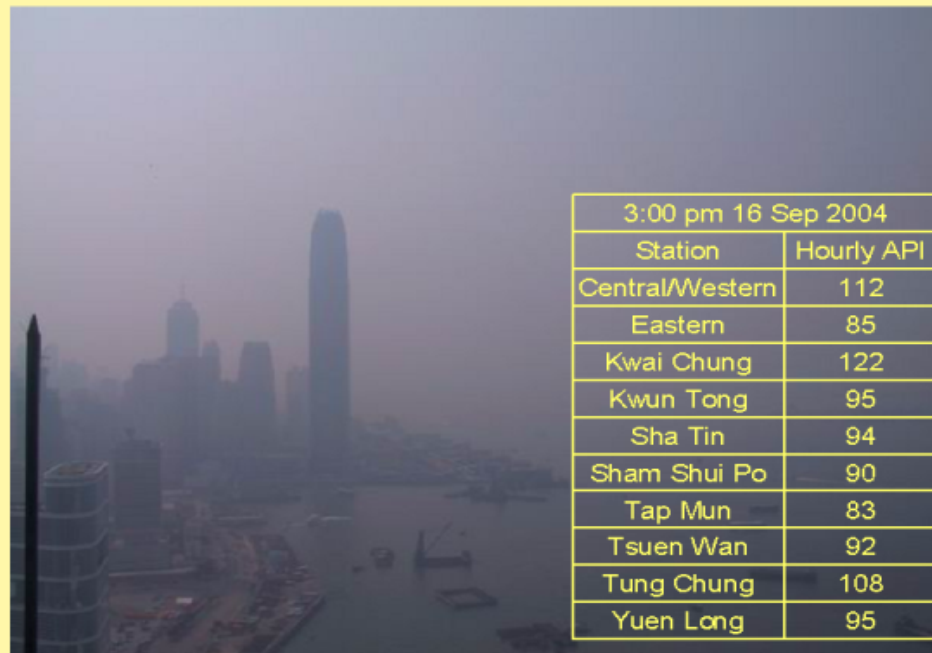
Solutions exist

煙霧迷濛 Bad haze

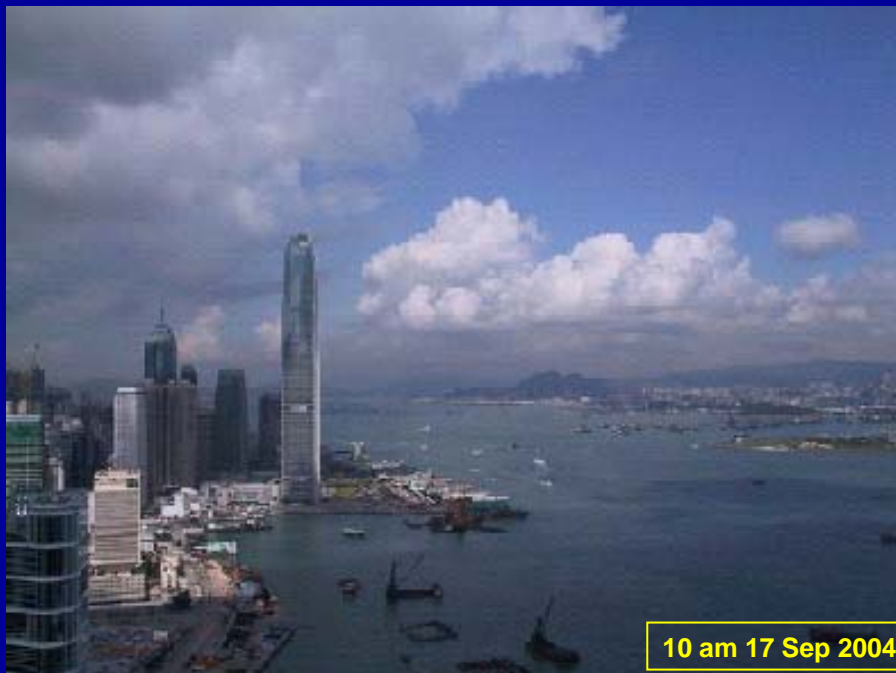


16 Sep 2004

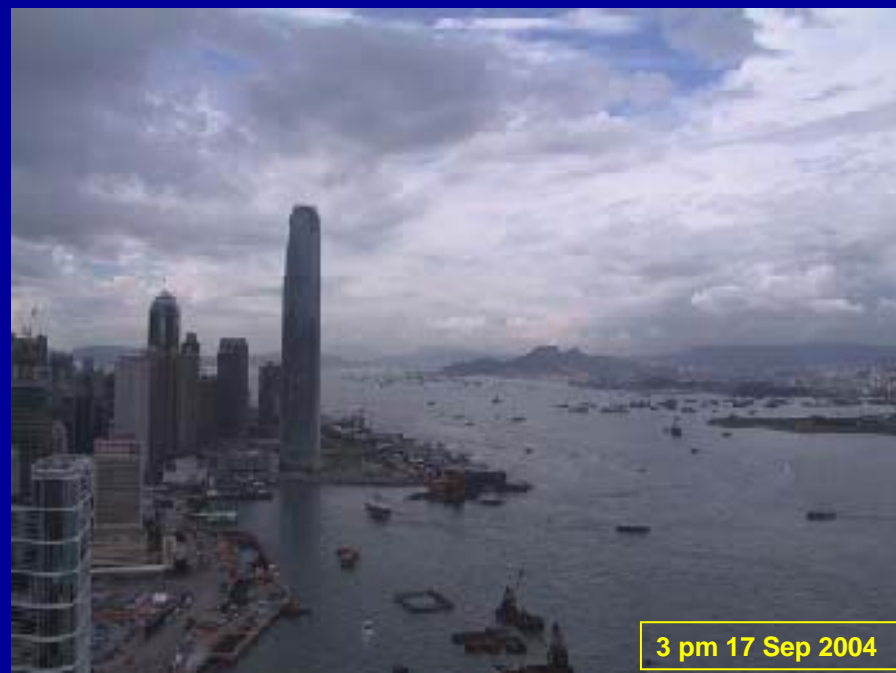
- Low visibility due to accumulation of pollution over the days
- A fresh southeast wind flushed away the smog that night



希望 - 東南風、治理源頭
Hope - south-easterlies and treating the sources.



10 am 17 Sep 2004



3 pm 17 Sep 2004

自己看問題
Seeing the problem yourself

香港天文台網頁

>氣象衛星圖片>地球觀測衛星

Hong Kong Observatory web page

> satellite imagery >EOS satellite

<http://www.weather.gov.hk/wxinfo/intersat/modis/sat.html>