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Division of Environment, HKUST

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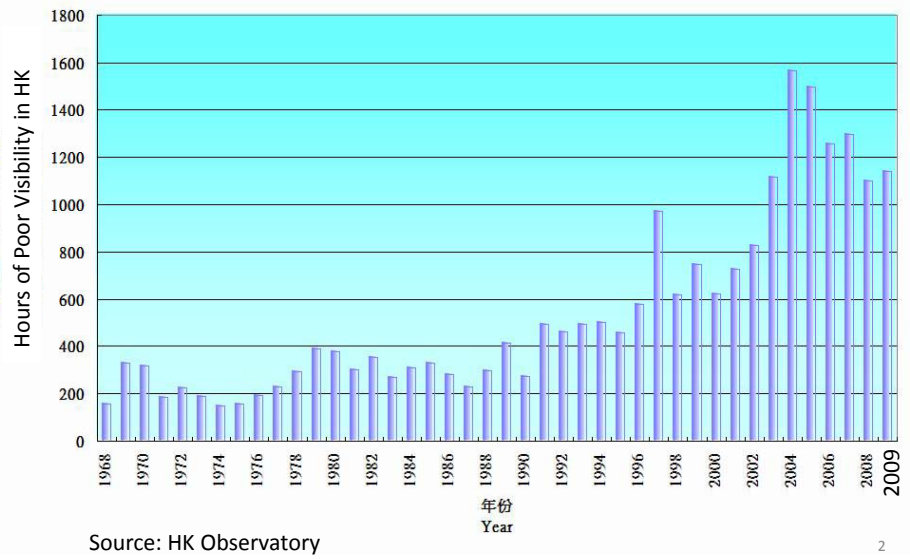
Air Pollution on the rise ..

Poor visibility is due to haze/particulate matter in the atmosphere



Source: HK Observatory

2

Visibility degradation – the most visible impact of air pollution

1st, Jul., 2008, RSP: 20-40 µg/m3

28th, Jul., 2008, RSP: 50-250 µg/m3

RSP: respiratory suspended particles;
RSP conc. from ENVF website, HKUST

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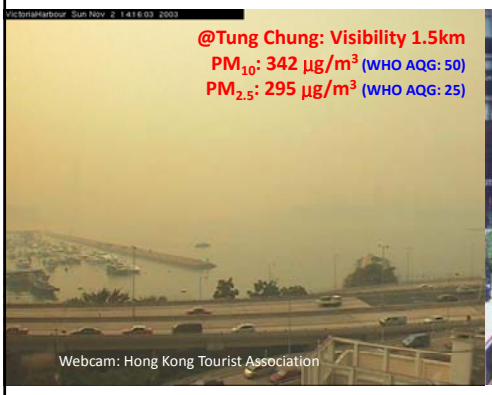
If We Can't Breathe, Nothing Else Matters. (American Lung Association)

Two distinct Outdoor air quality problems



Regional Haze / Smog
(Secondary Pollutants: PM, O_3)

Local, Urban and Roadside
(PM, NO_x, Black Carbon, SO_2)

Similar problems for all major Chinese cities

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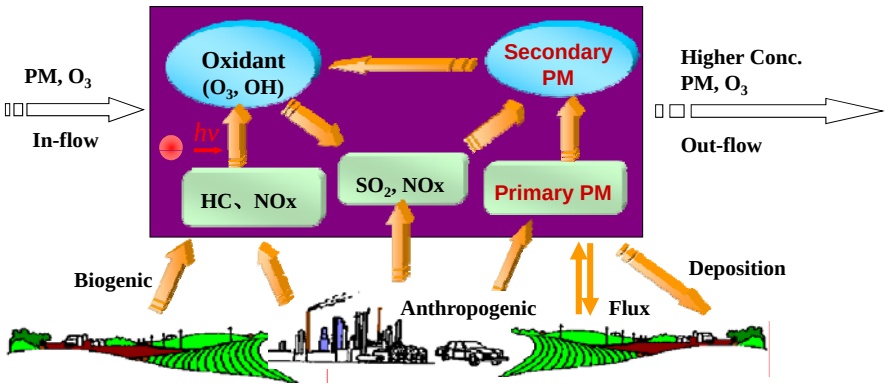
Urban Air Pollution

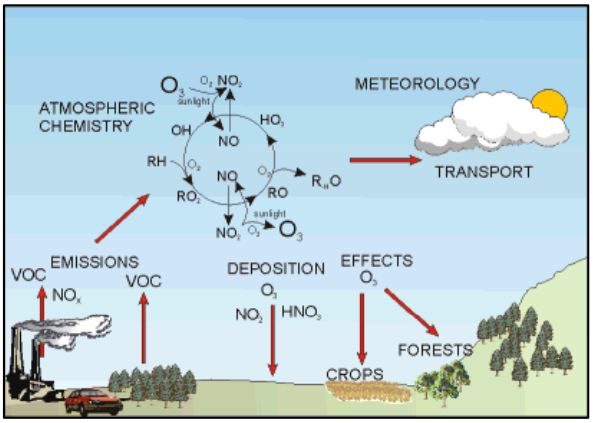


Atmosphere as a giant chemical reactor

- Transport
- Physical/Chemical Transformation
- **Secondary Pollution**

Xiaoyan Tang, 2006

Ozone



- regional problem
- potent oxidant
- VOC/NOx/light
- AVOC & BVOC

VOC = Volatile Organic Compounds

揮發性有機物

From: http://www.globalchange.umich.edu/gctext/Inquiries/Inquiries_by_Unit/Unit_9.htm

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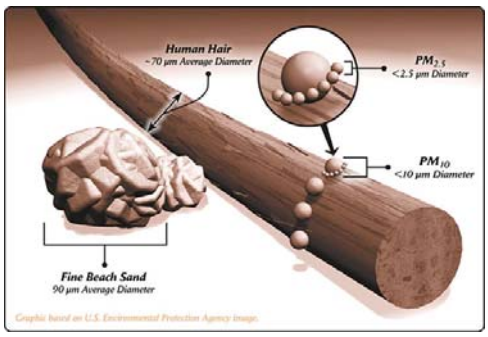
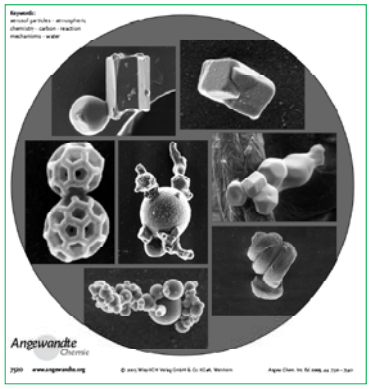
Particulate Matter



From http://www.sbcapcd.org/sbc/pollut.htm



Poschl , 2005

- Size: from molecule clusters (10^{-9} m) to fast-settling sand (10^{-4} m).
- Shape: as weird as you can imagine; depends strongly on composition and formation processes.

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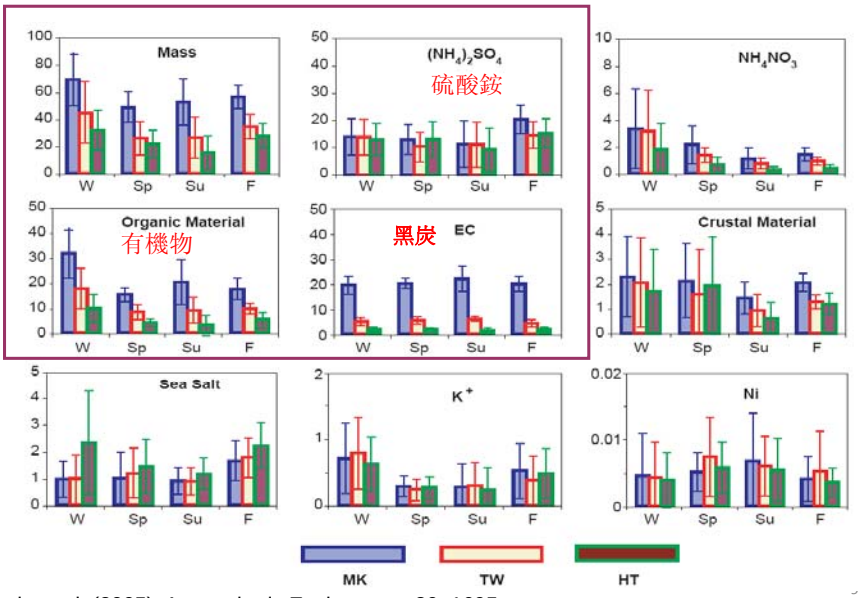
PM2.5 in Hong Kong



Louie et al. (2005), Atmospheric Environment 39, 1695.

PM observations – current status in Hong Kong

- Currently, mostly based on filter-based measurements, which are typically collected over hours or days, and analyzed off-site in labs.
- Limitations
  - **Not timely** – the time between sample-taking and availability of compositional data is routinely a few months
  - **Not continuous** – often miss significant or episodic atmospheric events
  - **Low time resolution** – cannot resolve the *fast* interactions of *transient* species which are critical for basic understanding of the dynamics and interactions among various aerosol components in the in-situ heterogeneous system

Supersite

- Use state-of-the-art instruments to make integrated and comprehensive air quality measurements.
- It offers **continuous real-time** measurements
  - with better time resolutions, some in order of seconds,
  - lower detection limits and
  - more observables on the physical and chemical properties of pollutants

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HKUST Supersite

- The facility faces Port Shelter and Sai Kung, which is a clean rural area with little residential and commercial development on the east coast of Sai Kung.
- Being at the upwind position of Hong Kong most of the time, it is the ideal place to study the background air quality and the transportation of pollutants into Hong Kong.

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HKUST Supersite

- The facility has a total floor area more than 1,000 m^2.
- It includes an automatic weather station tower and 10 outdoor plinths for samplers and equipments,
- and a 72 m^2 weather-proof air-conditioned modular house with multiple sample inlets and a sky-window for instrumentation.

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HKUST Supersite

- HKUST's Air Quality Research Supersite, with its focus on air quality research, **also serves as an education platform for the public and a training facility for students and researchers** to help develop local expertise and provide career opportunities in the area.
- **It promotes collaborations among stakeholders** in Hong Kong and the Pearl River Delta region including regulatory agencies, industries, other institutions and HKUST.

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UGC Supported SEG Equipment
(> $9M SEG + > $2M HKUST matching)

Module Name	Component
Physical Characterization System	Polarization Lidar
	Scanning Mobility Paticle Sizer System
	Fast Mobility Particle Sizer Spectrometer
	Cloud Condensation Nuclei counter
	Humidified tandem differential mobility analyzer (HTDMA)
Chemical Characterization System	Real-time EC/OC analyzer
	Real-time Particle-Into-Liquid Ion Chromatography
	Real-time VOC analyzer
	High resolution aerosol mass spectrometer

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Examples of unique instruments

#	Equipment (儀器)	Parameter measured (量度參數)	Applications and Analysis (應用及分析)
1	High-resolution Aerosol Mass Spectrometer (高分辨飛行時間氣溶膠質譜儀)*,A	Chemical composition and mass concentration of PM (顆粒物化學成分及質量濃度)	Source analysis; Particle formation (顆粒物來源及形成分析)
2	Micropulse Polarization Lidar (微脈衝偏振激光雷達)*,B	Vertical profiles of PM and moisture in atmosphere (顆粒物及水氣的垂直空間分布)	PM and water content (顆粒物和水的含量)
3	Real-Time VOC Analyzer (實時揮發性有機物分析儀)*,C	VOC concentration (揮發性有機物濃度)	Source analysis; Corroborative data for ozone and PM formation analysis (源分析;臭氧及顆粒物形成的綜合分析)

See details of all instruments in handouts.

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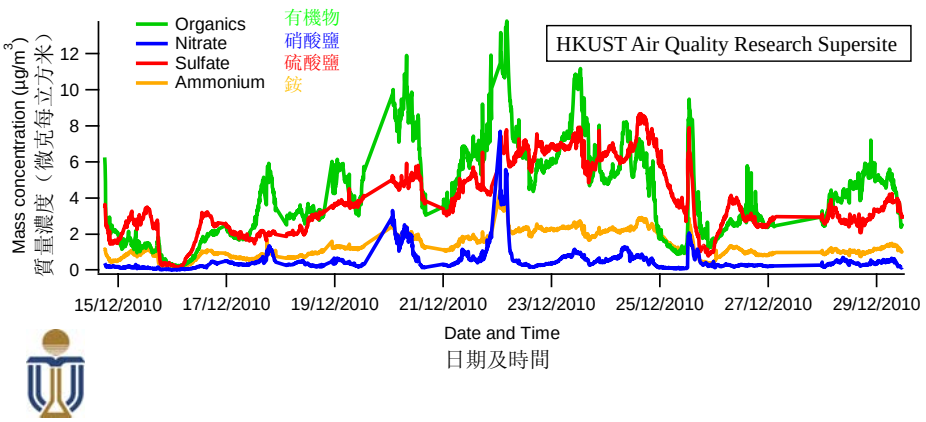
High-Resolution Time-of-Flight Aerosol Mass Spectrometer
高分辨飛行時間氣溶膠質譜儀

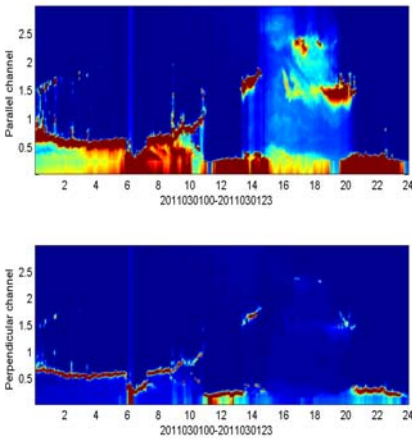
– **To measure the chemical composition of fine particles in air (測量大氣中細粒子的化學成分)**



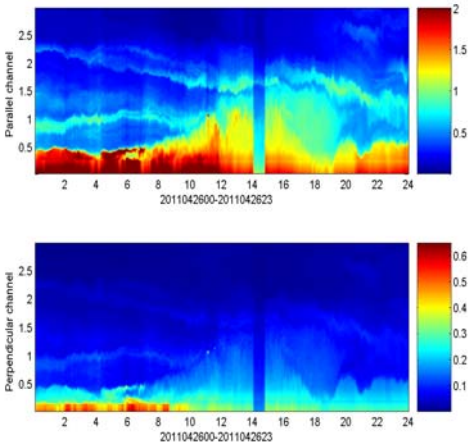
Micropulse Polarization Lidar
微脈衝偏振激光雷達

– **To measure the vertical distribution of moisture and aerosol in the atmosphere (測量顆粒物及水氣的垂直空間分布)**

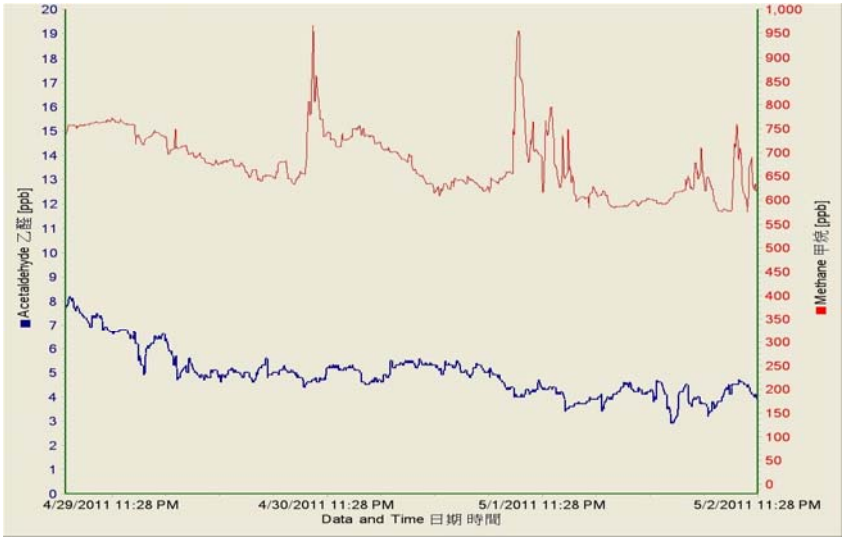
1 March 2011 – lots of low clouds



26 April 2011 – surface fog but no cloud



Real-Time VOC Analyzer
(實時揮發有機物分析儀)



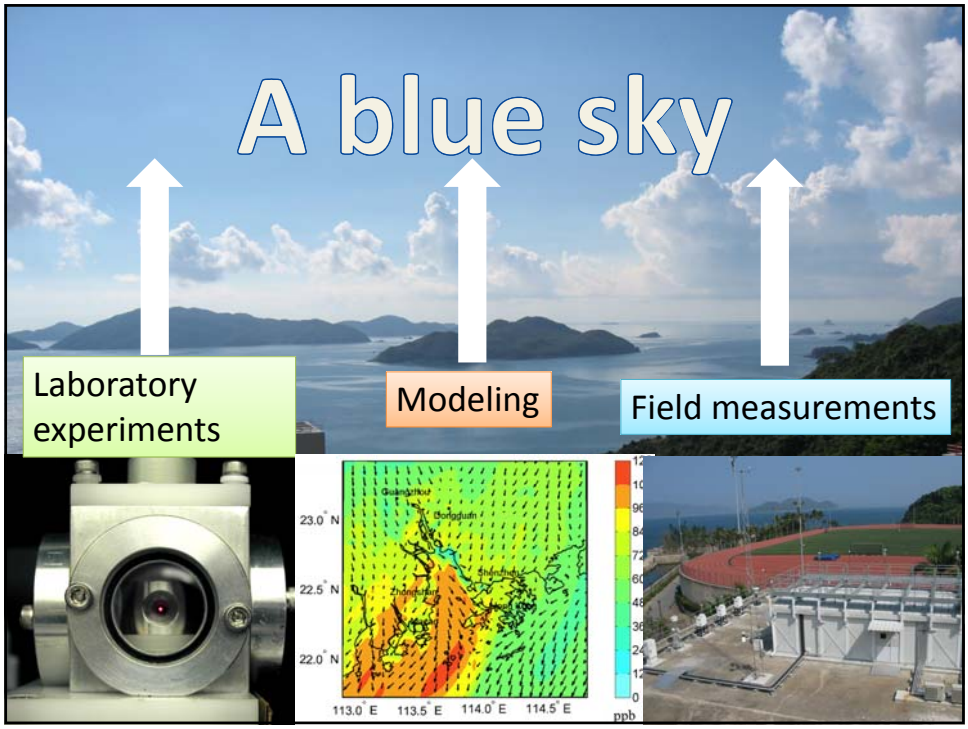
Air quality in Hong Kong: A supersite program for real-time characterization of Particulate Matter (PM) in Hong Kong's air

Sponsor:
Environment and Conservation Fund (> $6M)

Partner:
Hong Kong Environmental Protection Department,
Hong Kong Polytechnic University

ECF project on PM Supersite

- What are the sources of PM?
- What controls the abundance and the formation of PM spatially and temporally?
- What are the levels of exposure by the public to traffic-related PM?
- How does PM affect visibility over the South China region?


A blue sky
Laboratory experiments
Modeling
Field measurements
23.0° N
22.5° N
22.0° N
113.0° E
113.5° E
114.0° E
114.5° E
ppb