

*Satellite Informatics System for  
Surface Particulate Matter Distribution*

<http://envf.ust.hk/itf-si>

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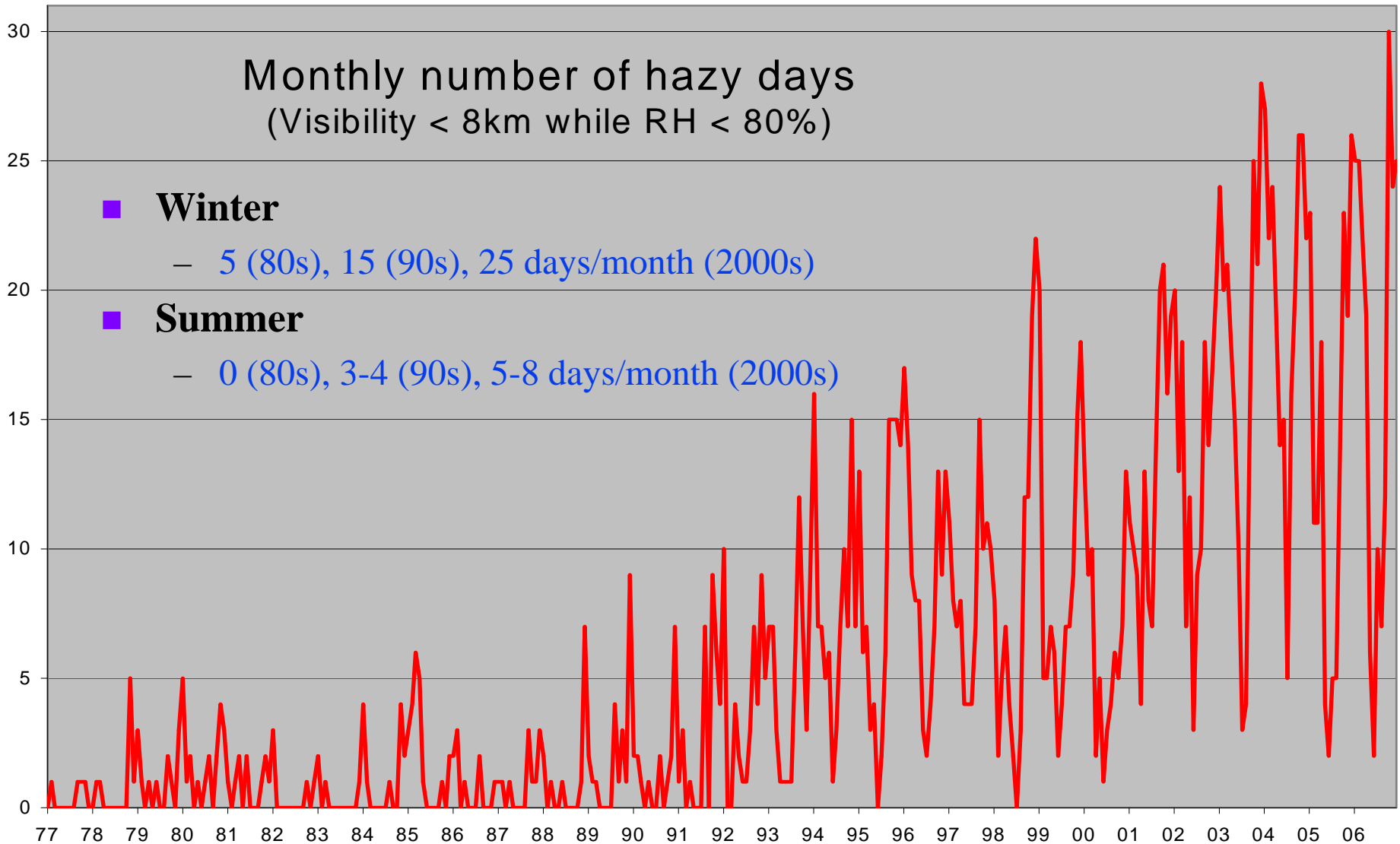
*Urban Heat Island,  
Coastal Landsea Breeze, and  
Regional Air Quality*

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# # of Hazy days per month (1978-2006)



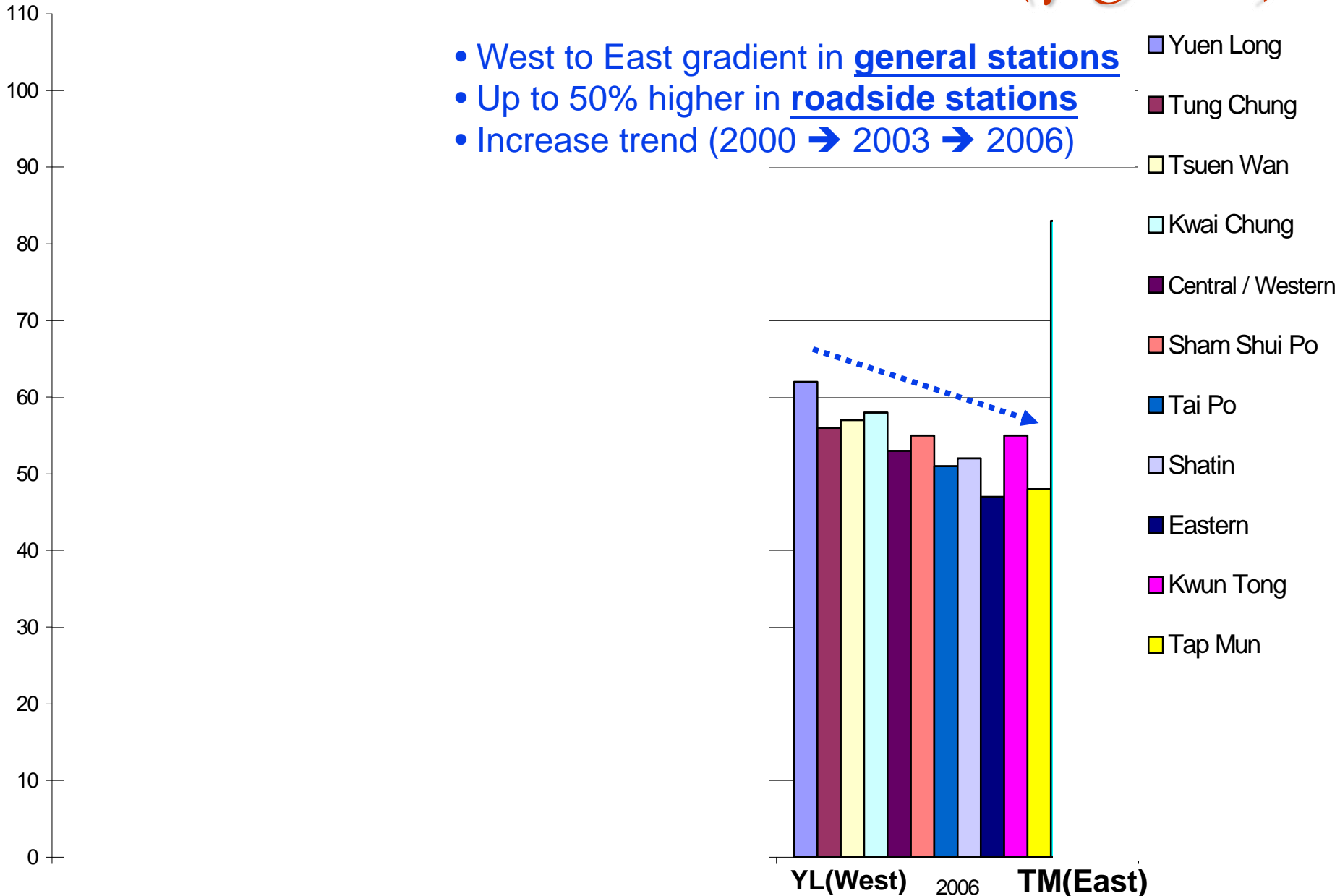
# *PM information currently available in HK*



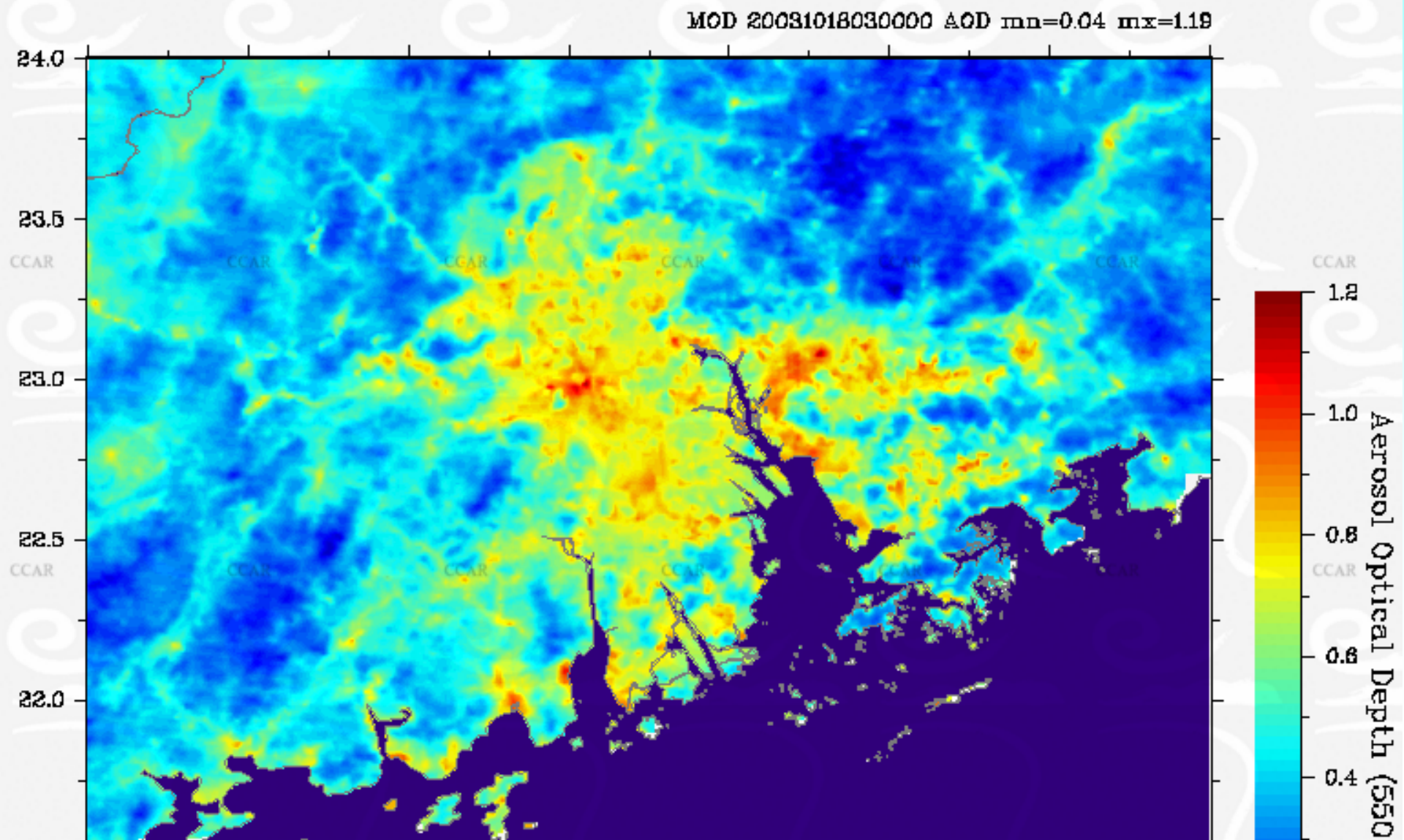


# PM10 Annual Concentration ( $\mu\text{g}/\text{m}^3$ )

- West to East gradient in general stations
- Up to 50% higher in roadside stations
- Increase trend (2000  $\rightarrow$  2003  $\rightarrow$  2006)



# Single Snapshot AOD - to ID sources

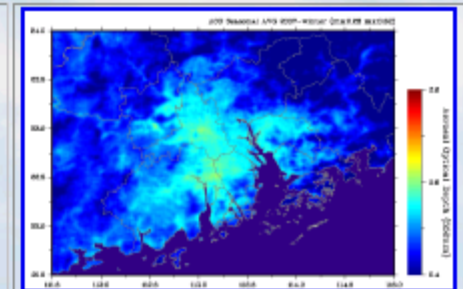
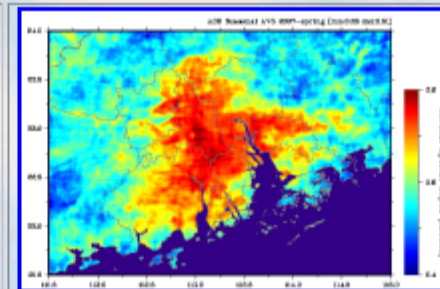
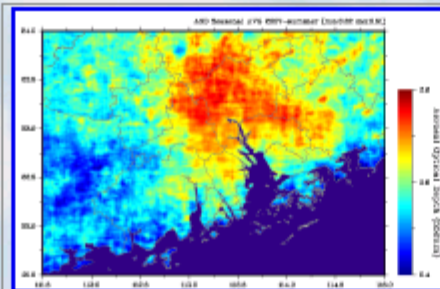
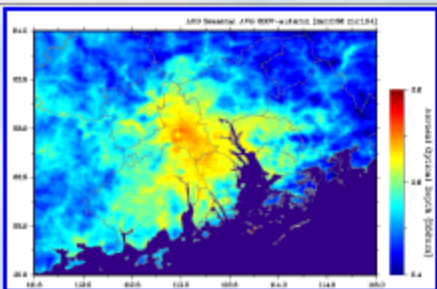


# *Problem with AOD to study air quality*

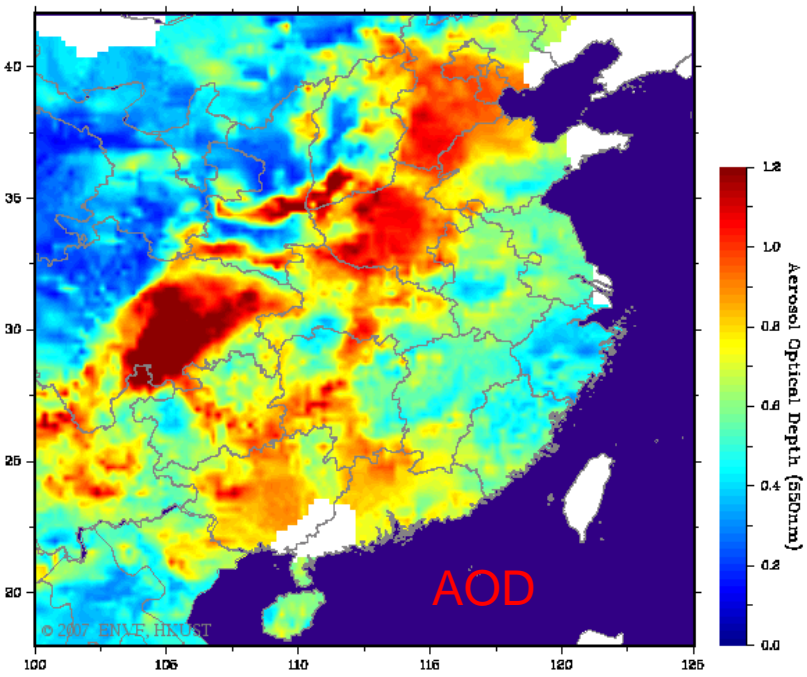
- **AOD is a vertically integrated measure**
  - we are mainly interested in ground level air quality
- **Moisture has significant impact on AOD**
  - Summer AOD is higher than winter but we know that summertime air quality is much better

Aerosol Optical Depth ( 1 km res.)

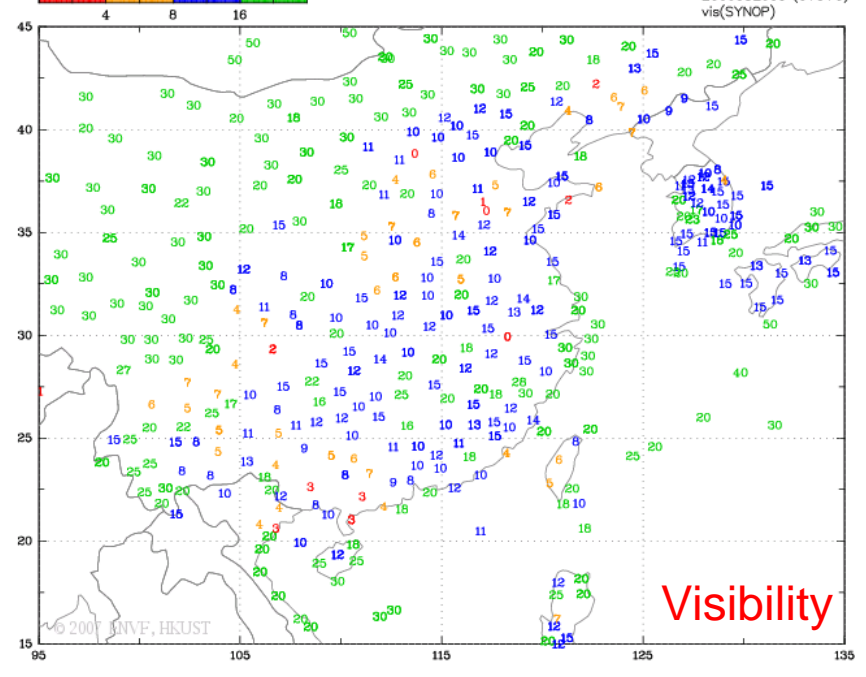
Time Scale: Seasonal Average    Region: Pearl Delta Area    Category: AOD    Search  
Year: 2007    Season: winter    No. of Seasons: 4    Interval: 1



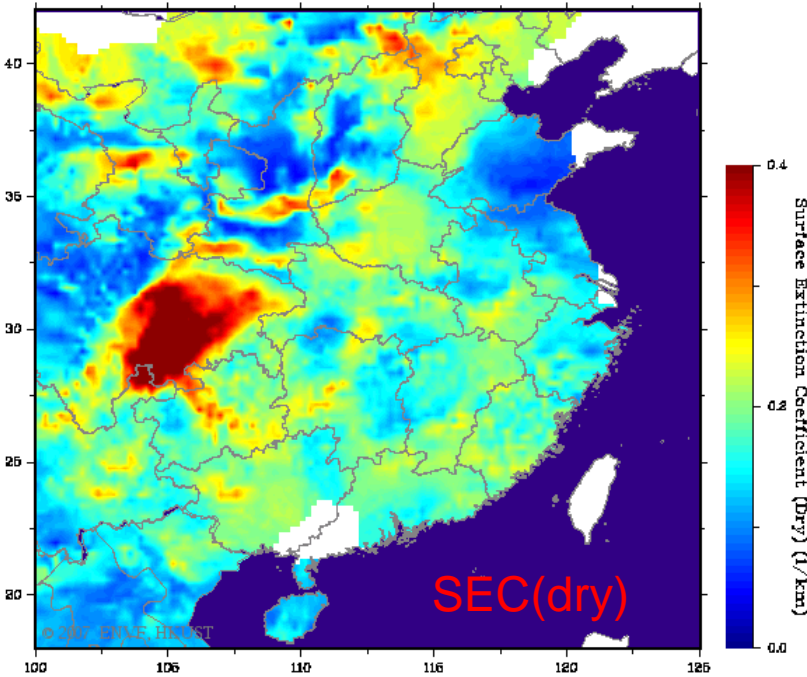
AOD 20060826032500 (max:1.12 min:1.57)



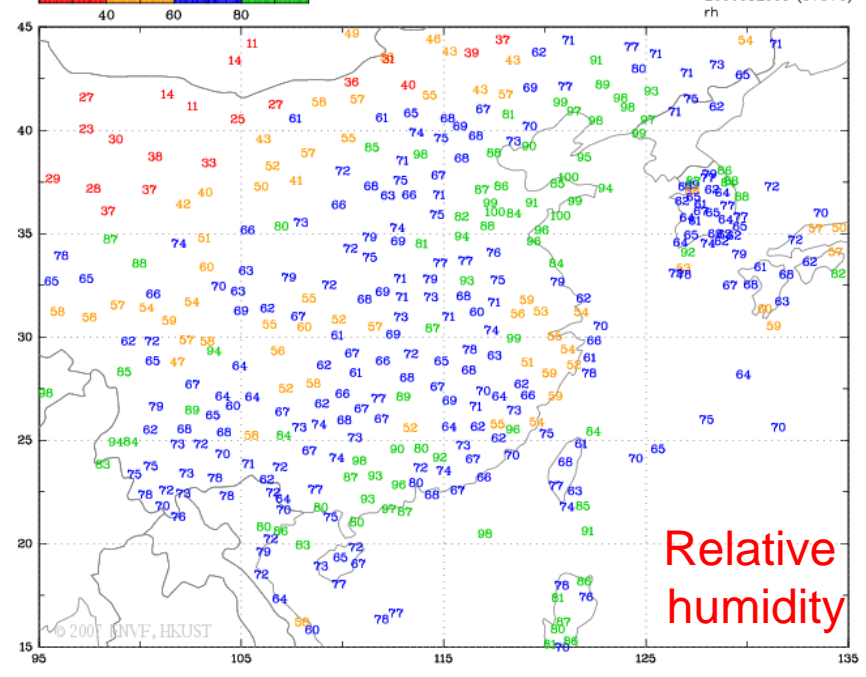
4 8 16



SEC(Dry) 20060826032500 (max:0.04 min:0.53)



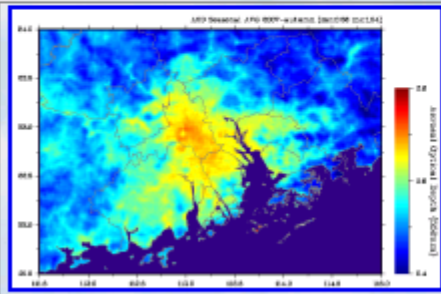
40 60 80



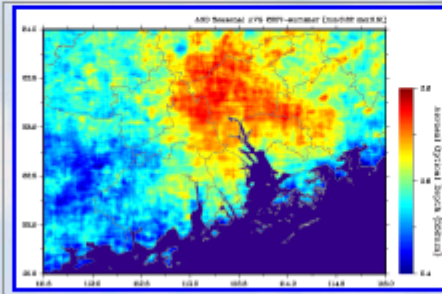


# Aerosol Optical Depth ( 1 km res.)

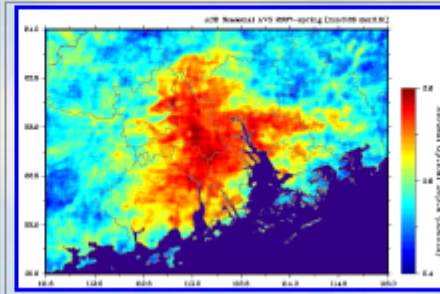
Time Scale: Seasonal Average Region: Pearl Delta Area Category: AOD  
Year: 2007 Season: winter No. of Seasons: 4 Interval: 1 Search



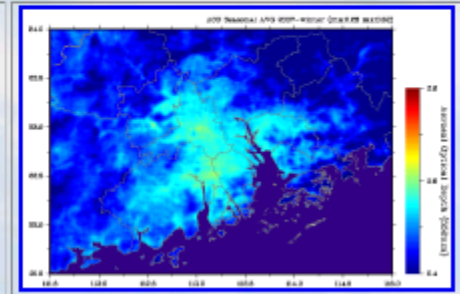
2007-autumn



2007-summer



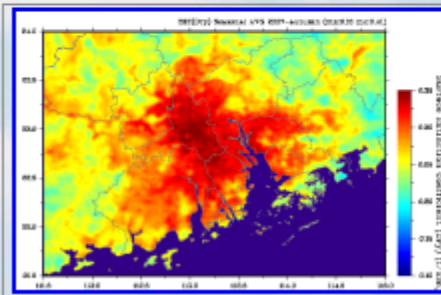
2007-spring



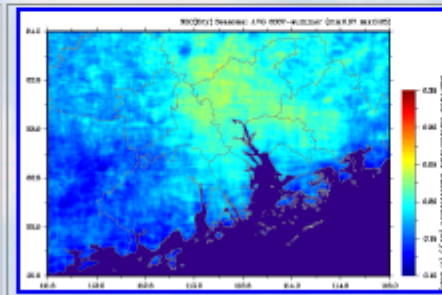
2007-winter

# Surface Extension Coefficient (Dry) 1 km res.

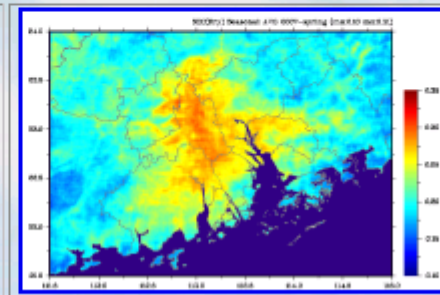
Time Scale: Seasonal Average Region: Pearl Delta Area Category: SEC(Dry)  
Year: 2007 Season: winter No. of Seasons: 4 Interval: 1 Search



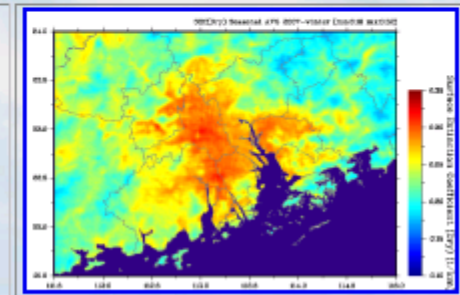
2007-autumn



2007-summer

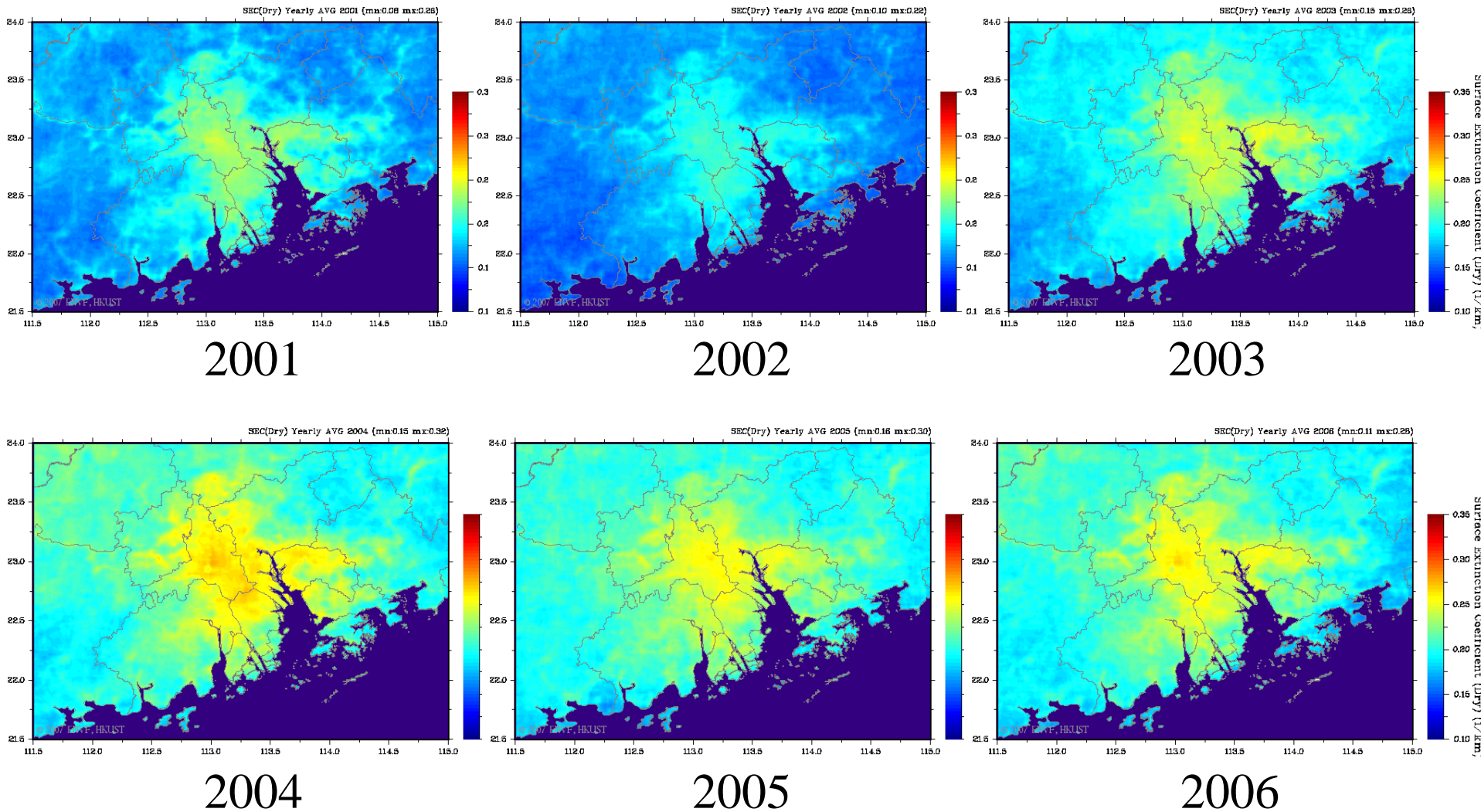


2007-spring



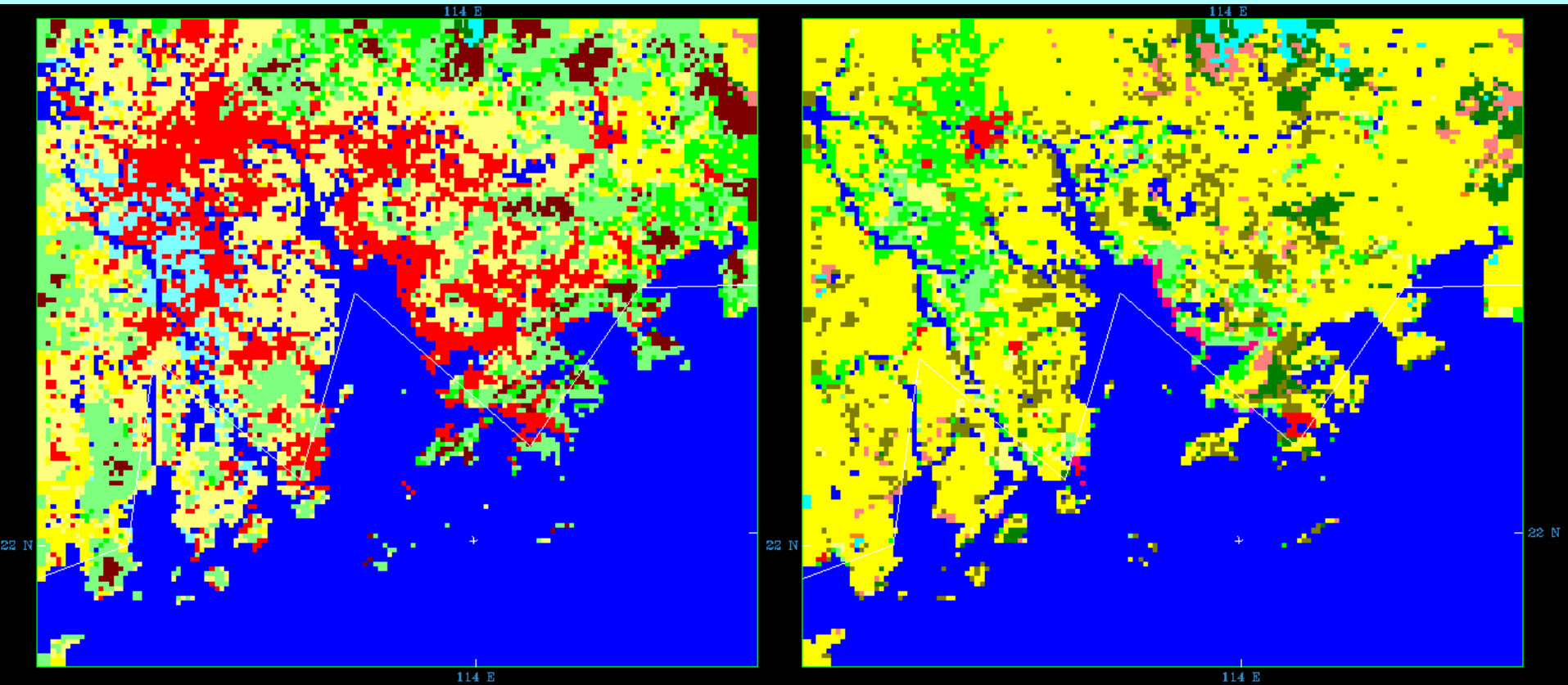
2007-winter

# Proxy for annual averaged surface PM level



- Clear deterioration of air quality since 2003

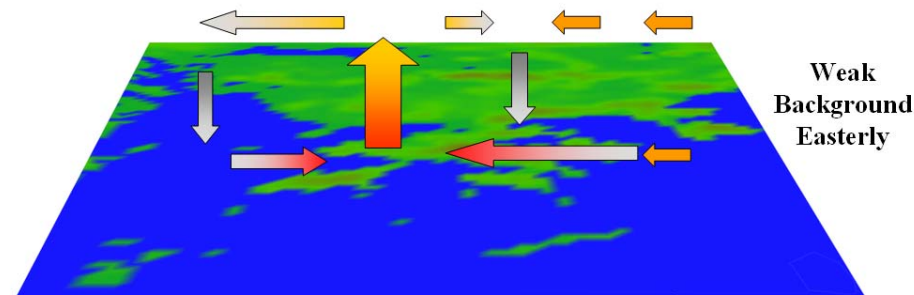
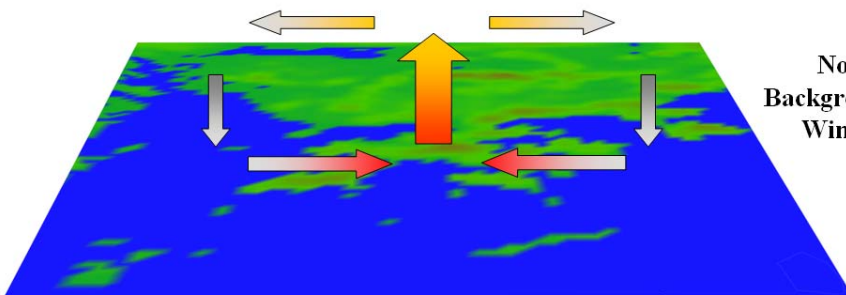
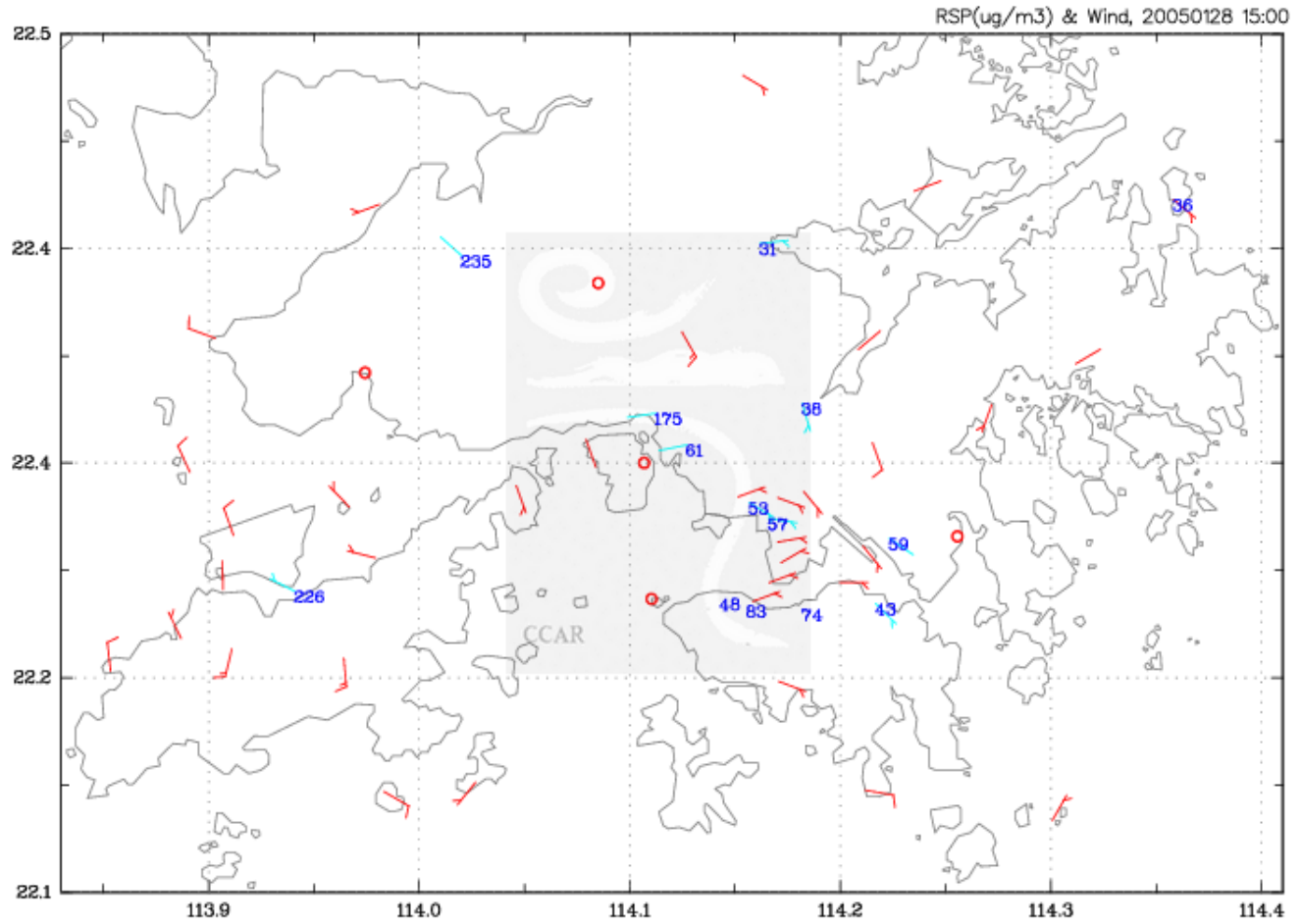
# *Land Use Map ( RED : Urban )*



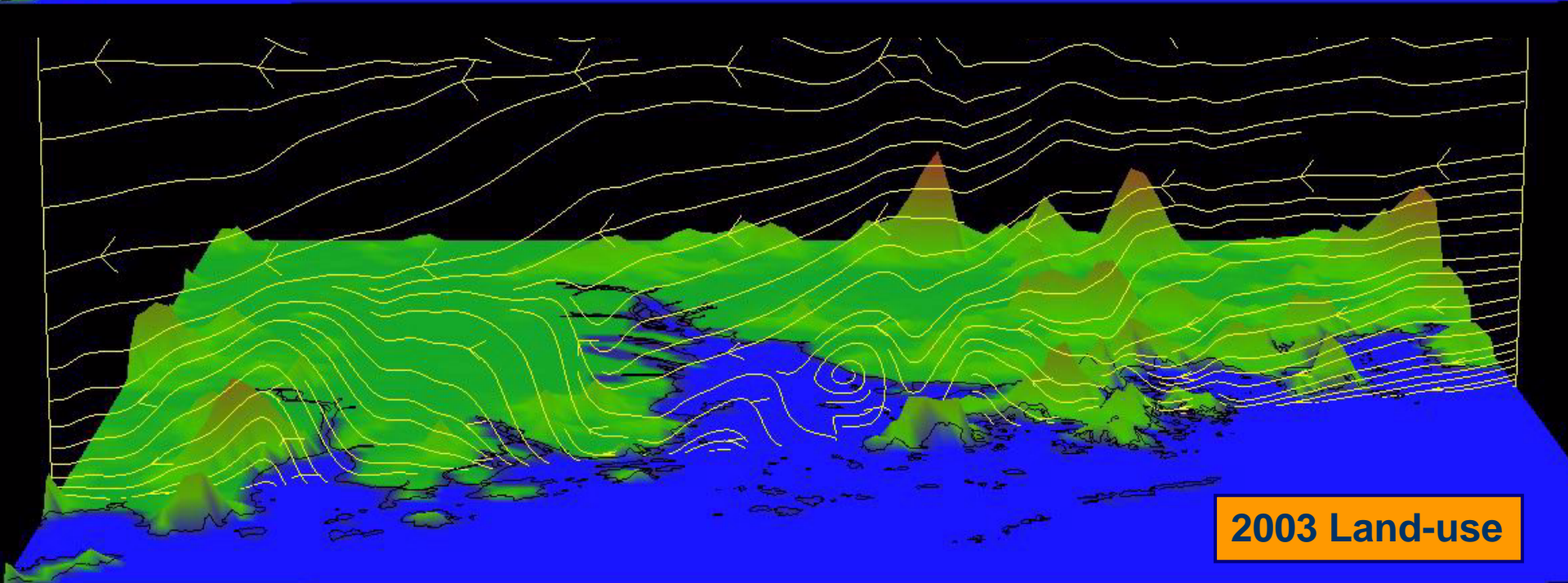
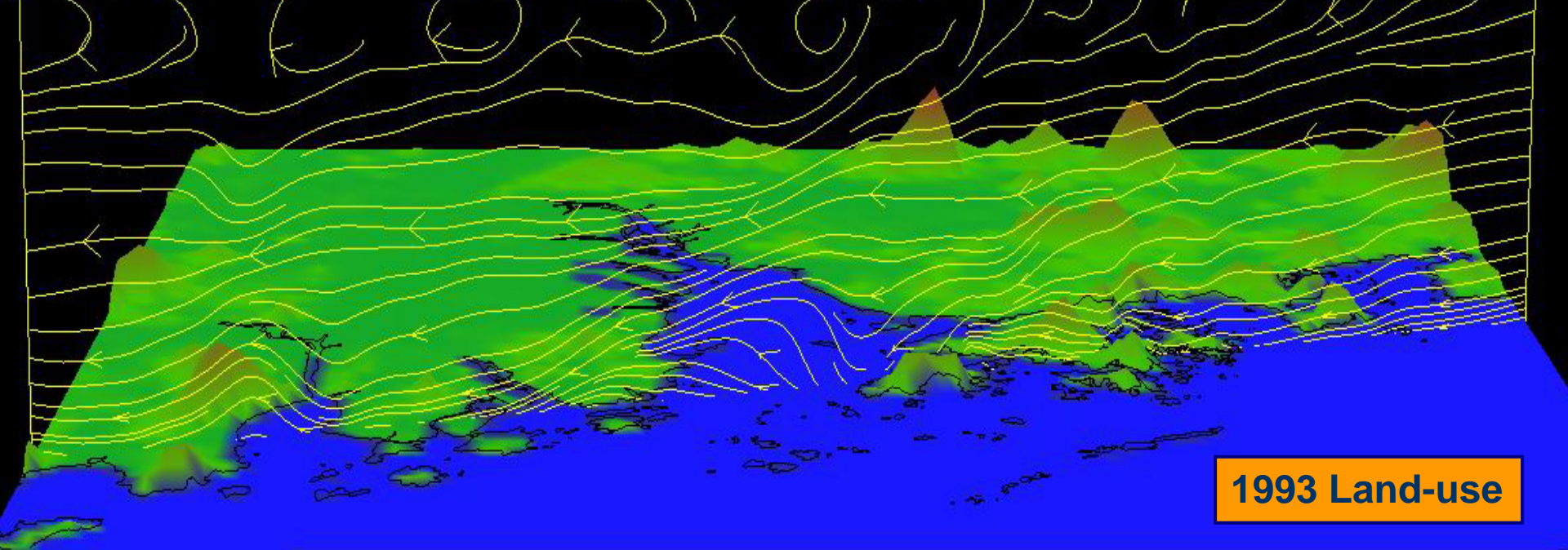
**2003 Landuse**

**1993 USGS**

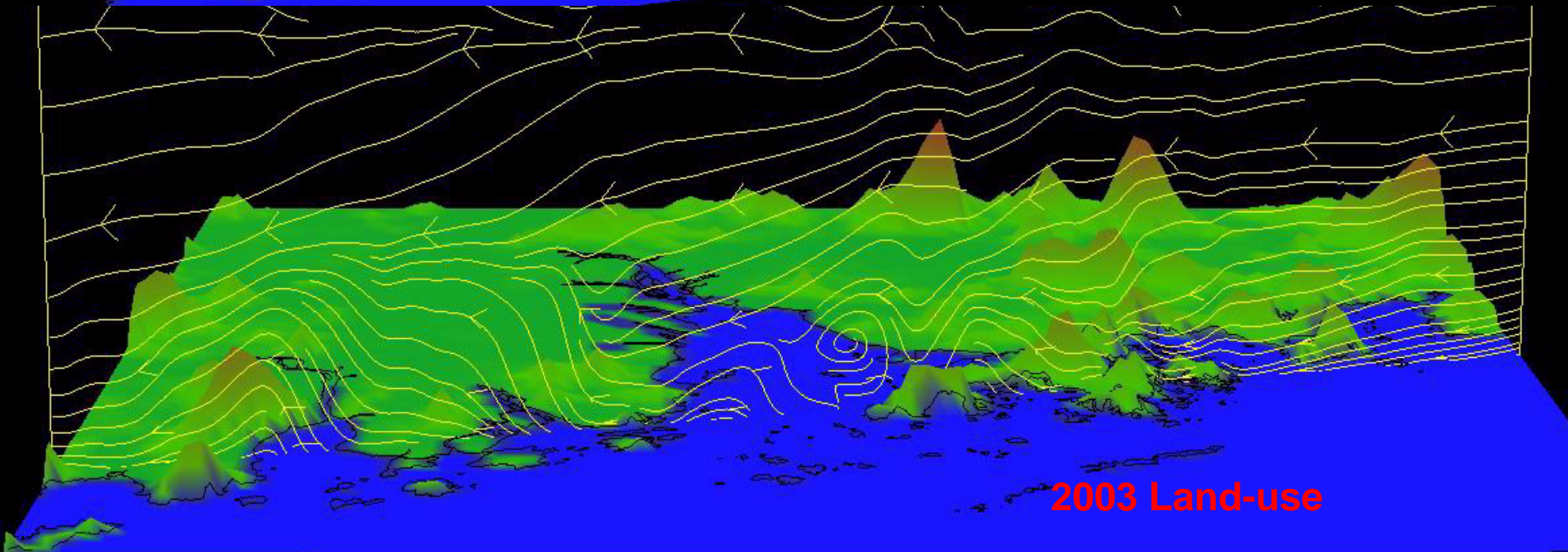
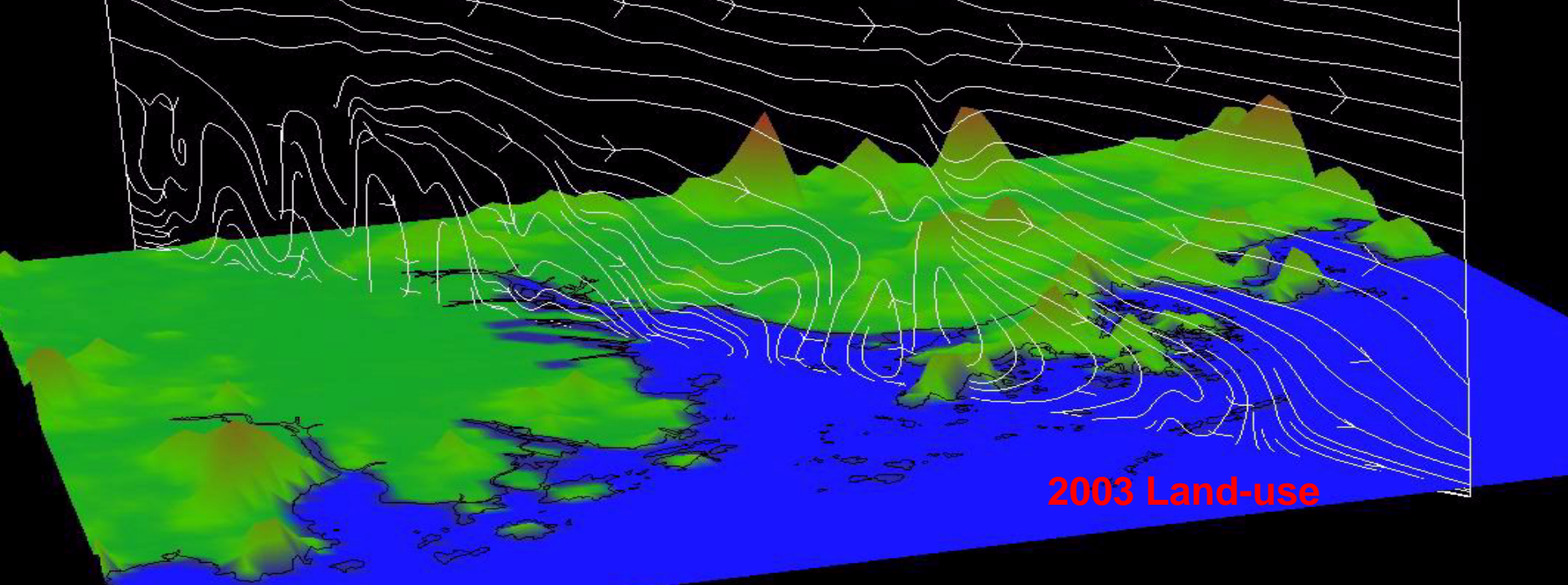
**Local land-sea breeze winds tend to push air pollutants to the western side of the city**



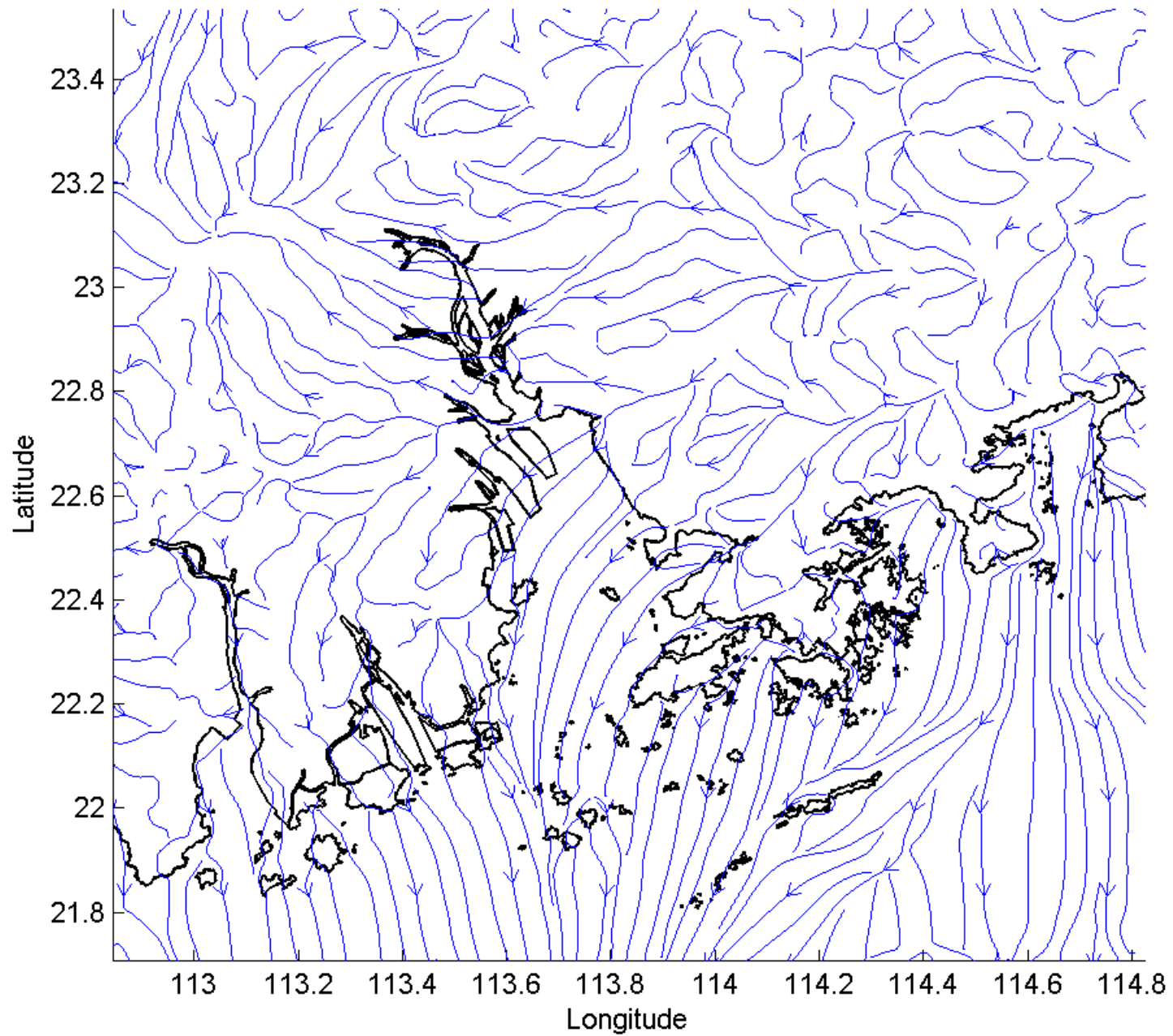




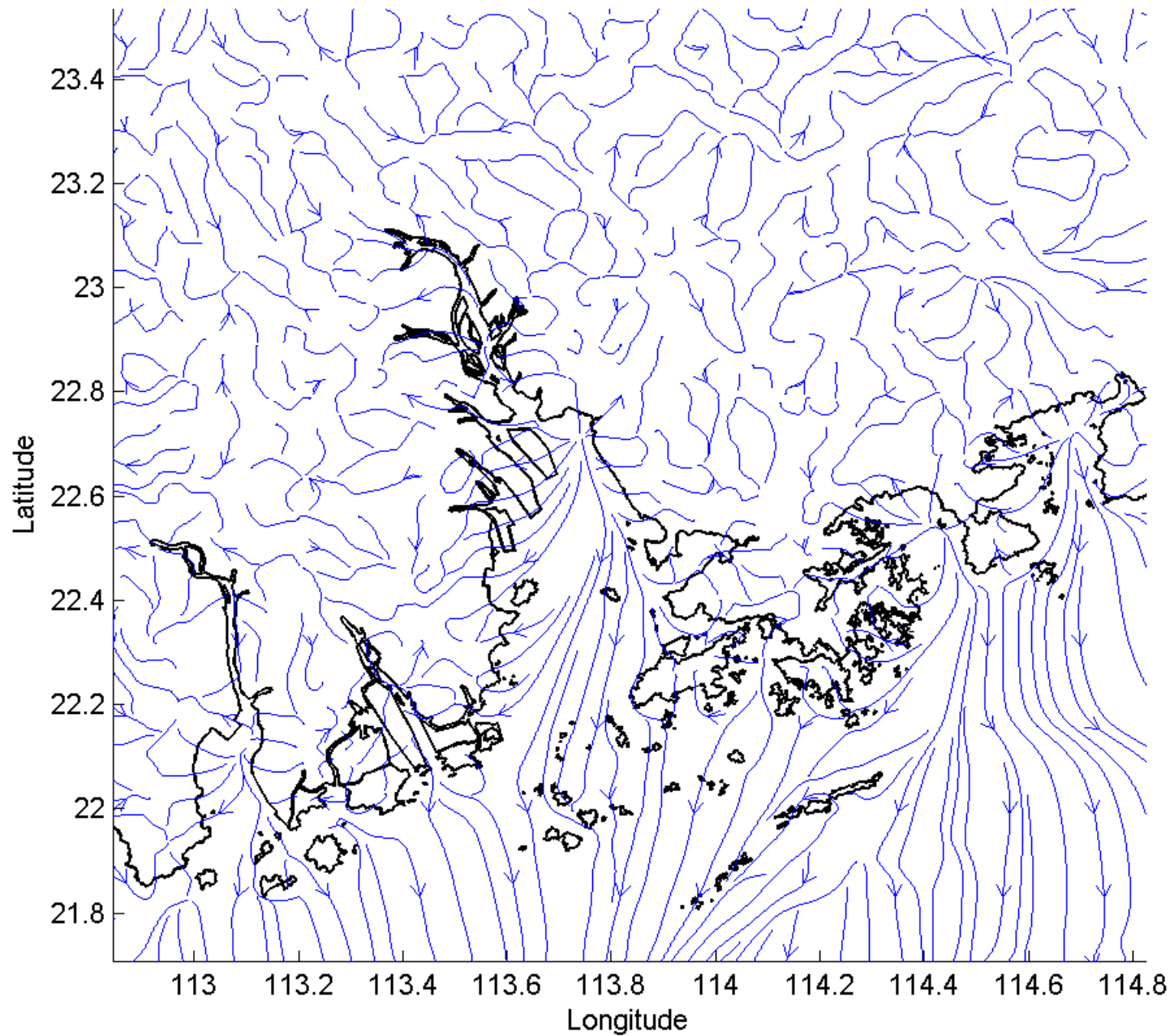




10:00 AM

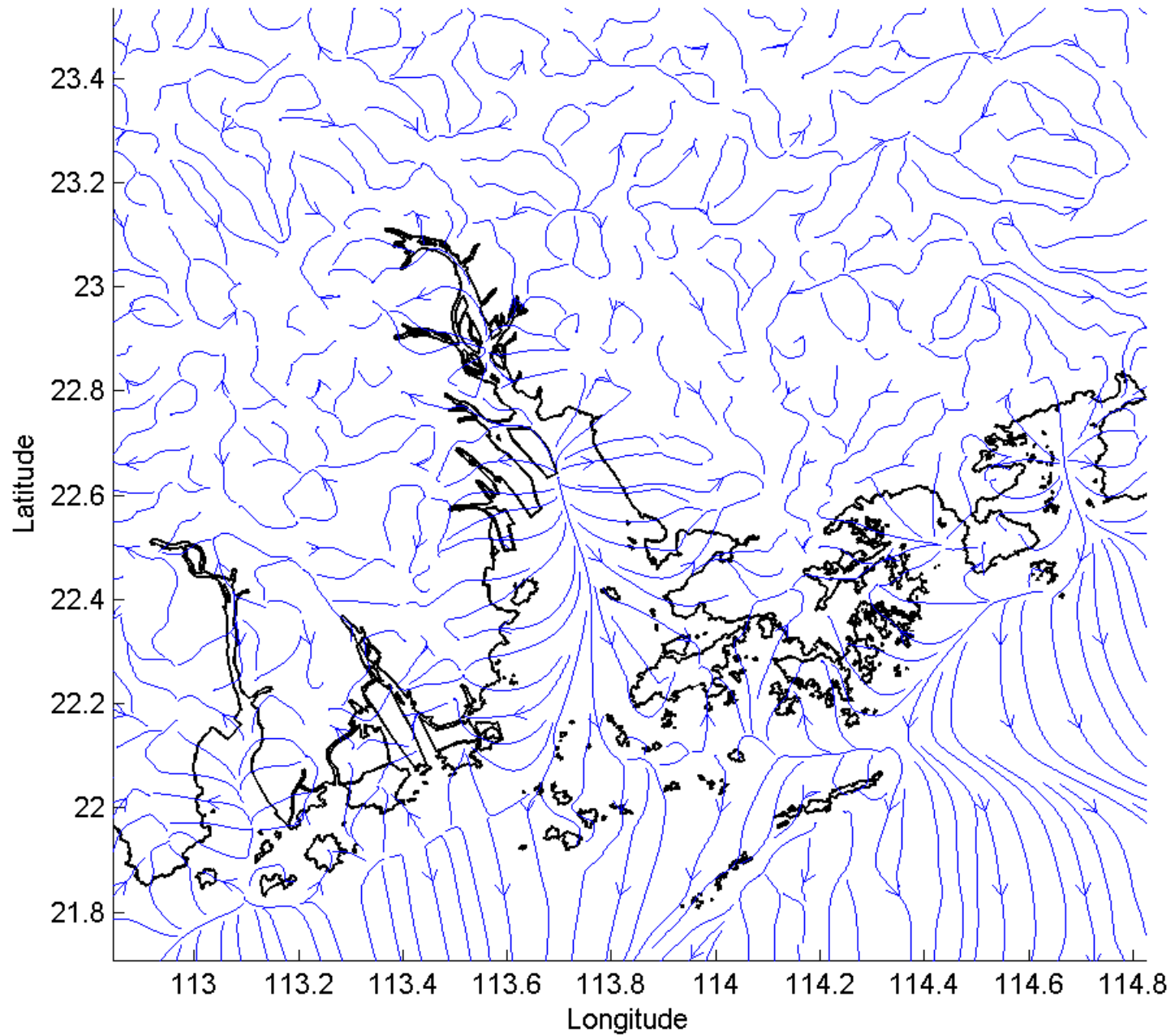


11:00 AM

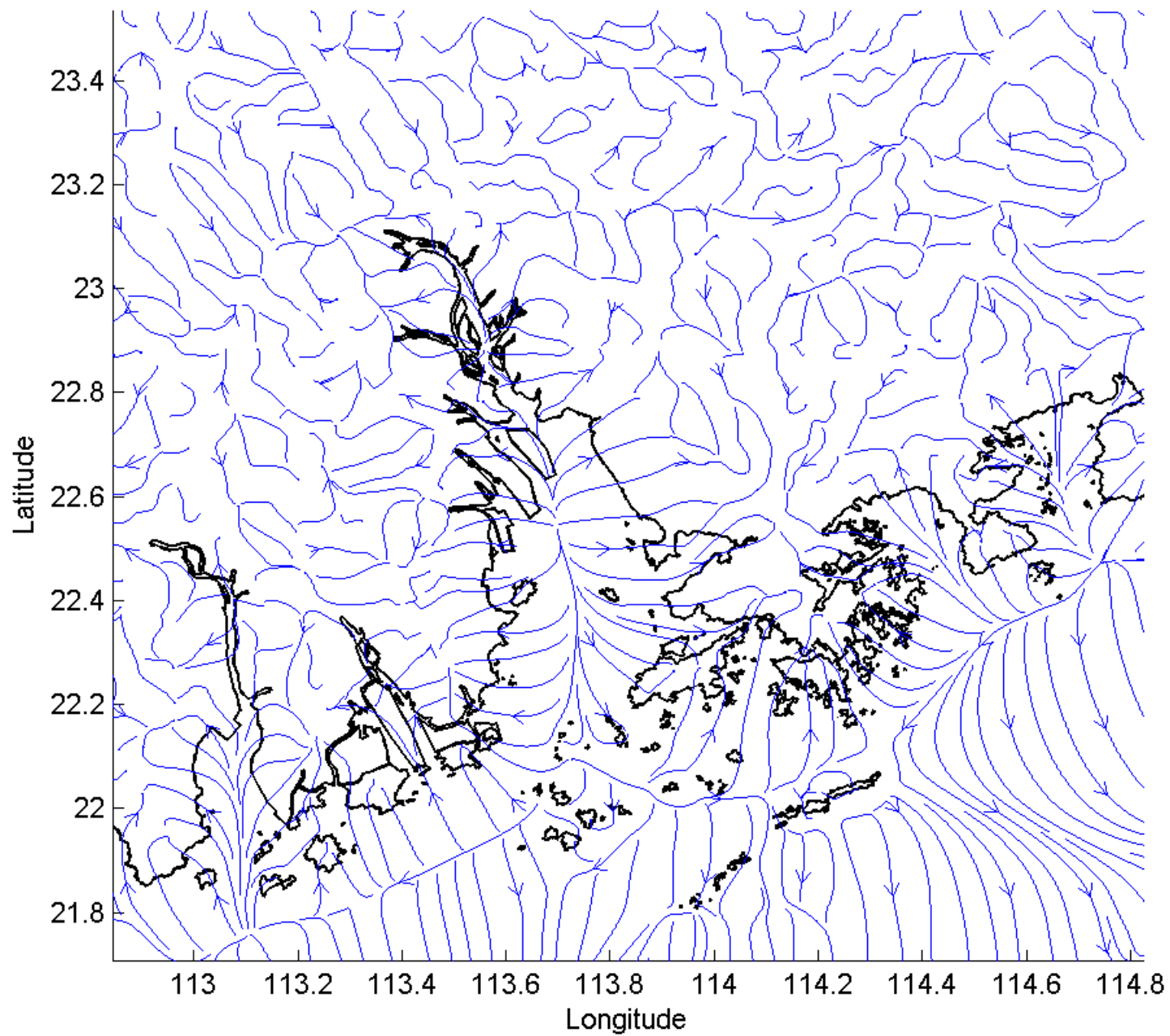




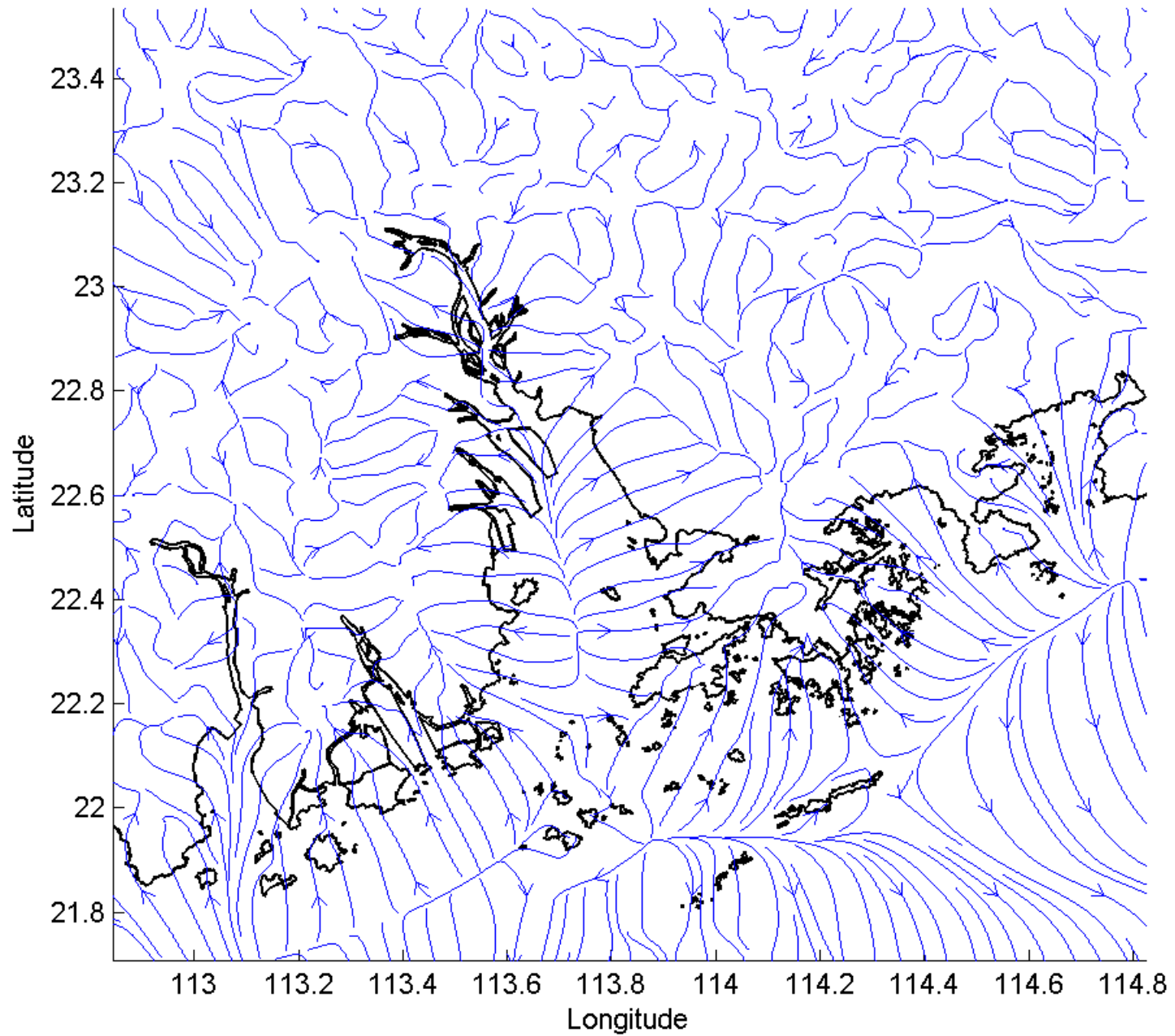
12:00 PM



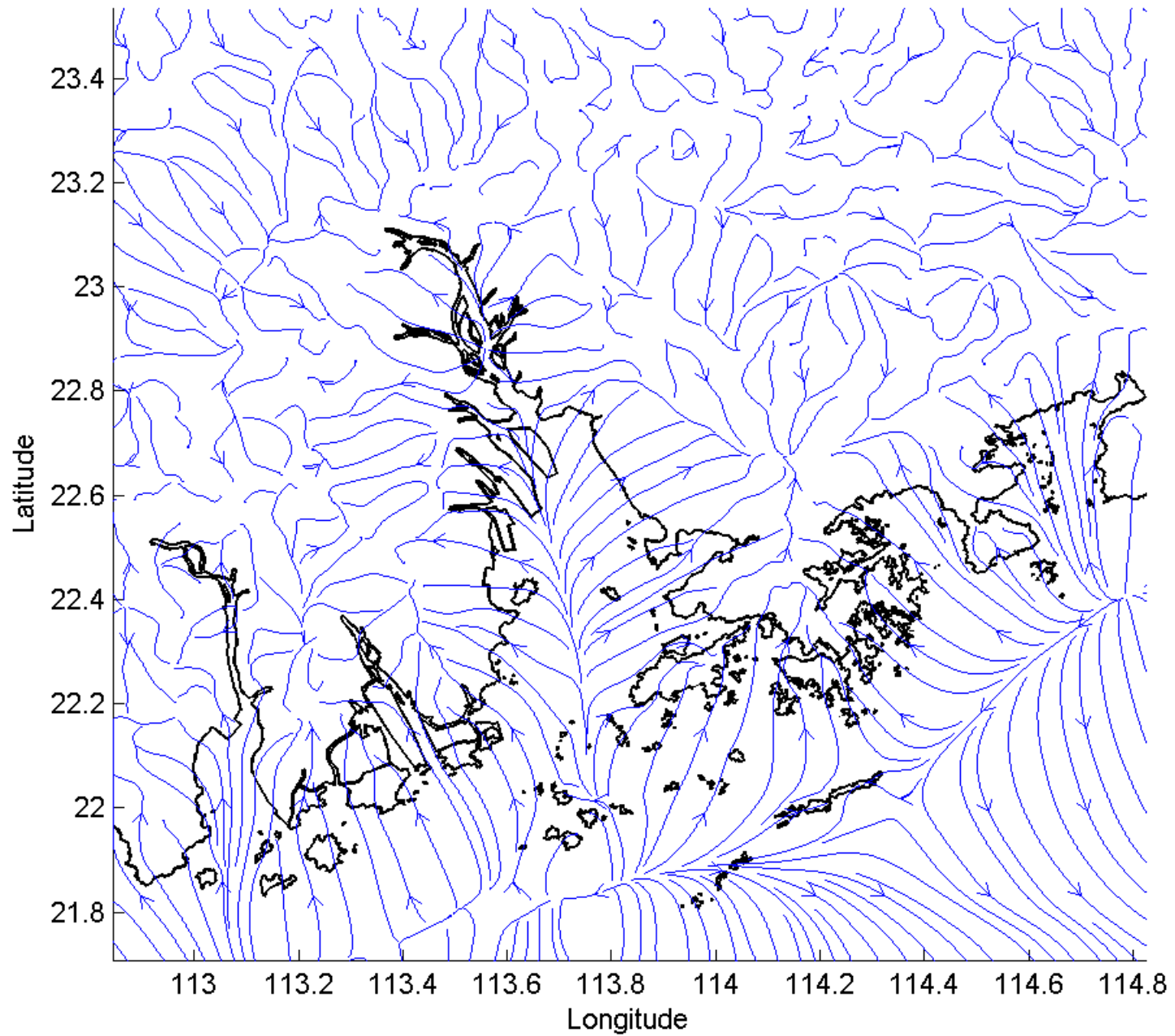
1:00 PM



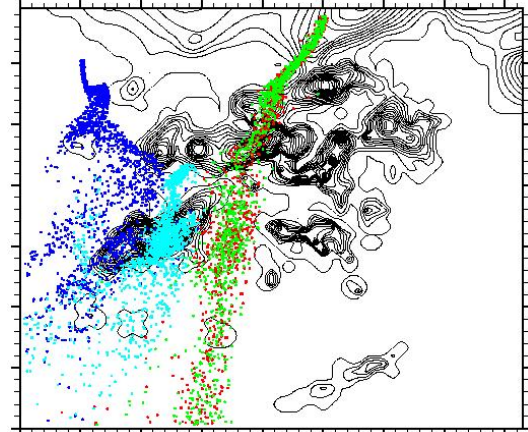
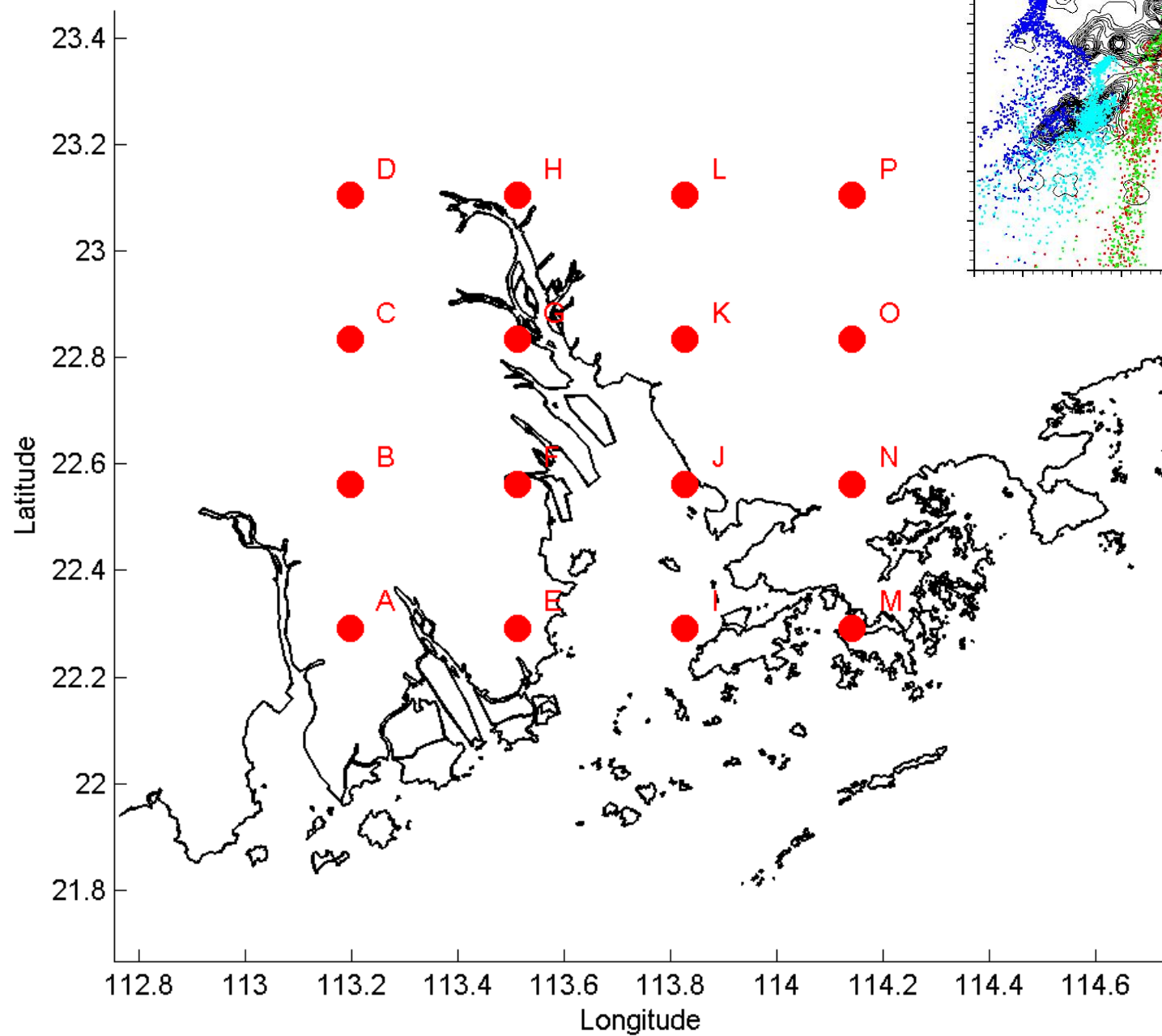
2:00 PM



3:00 PM

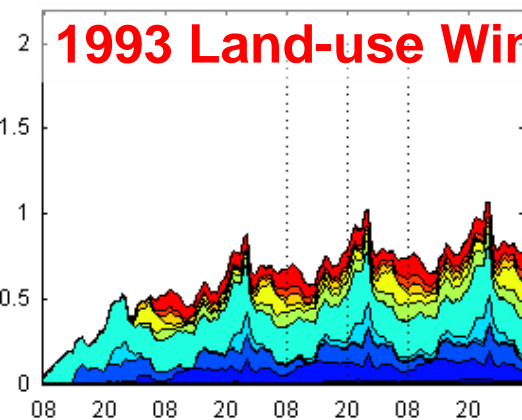




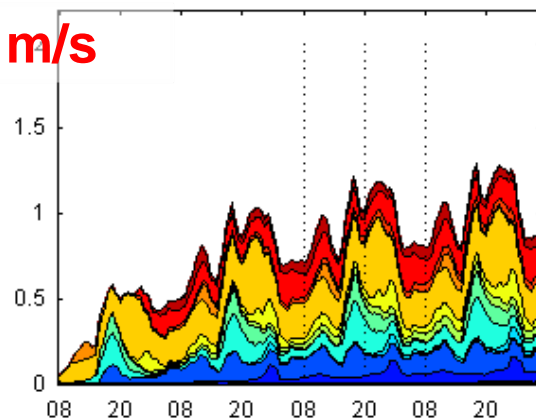


z3

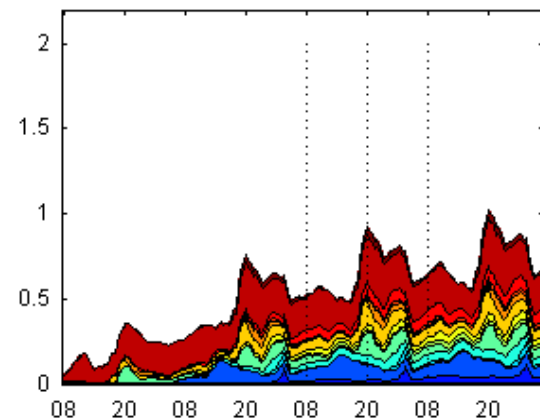
1993 Land-use Wind 3 m/s



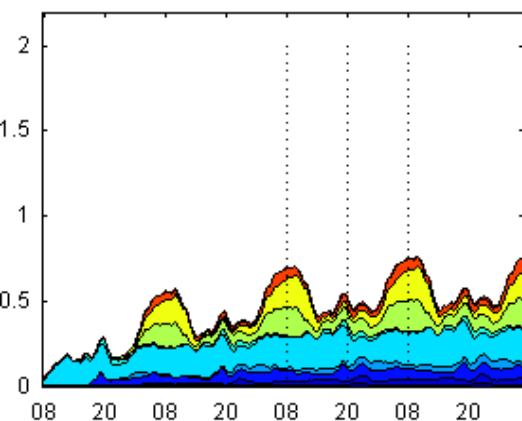
z6



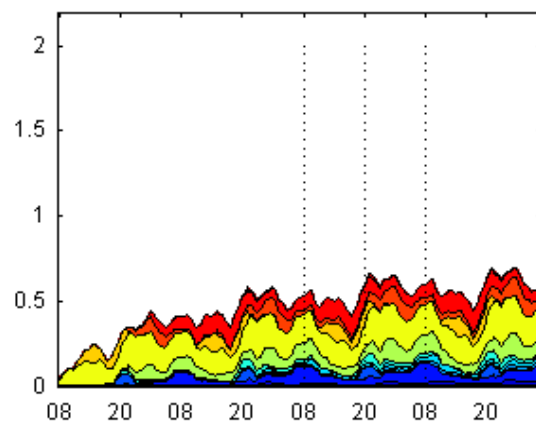
z9



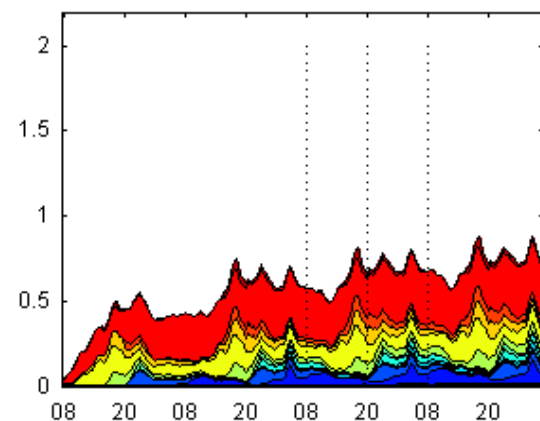
z2



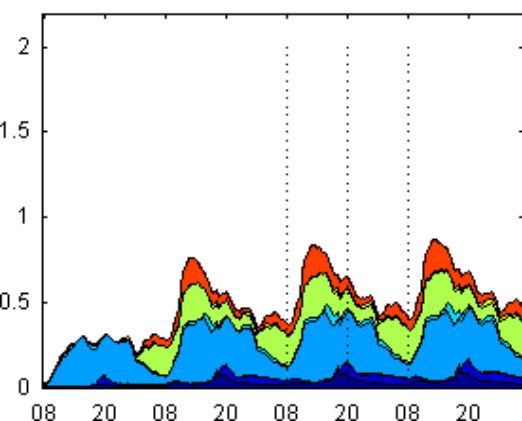
z5



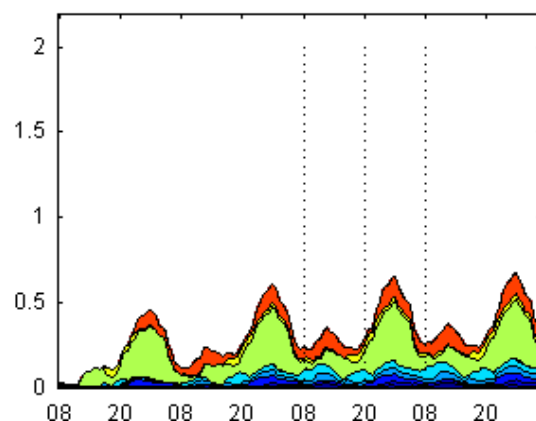
z8



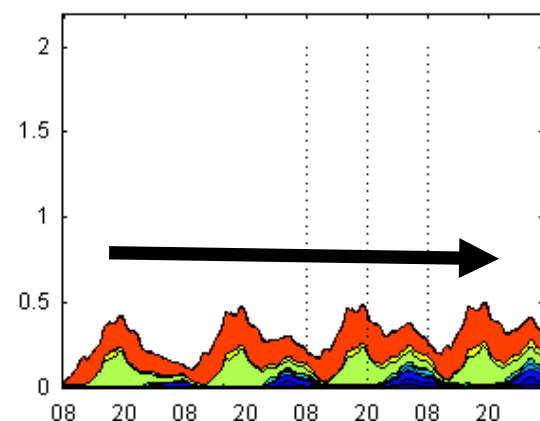
z1



z4

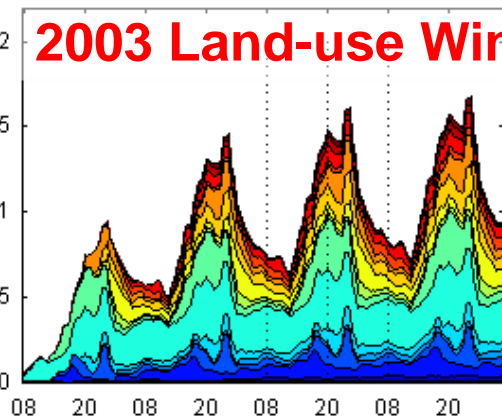


z7

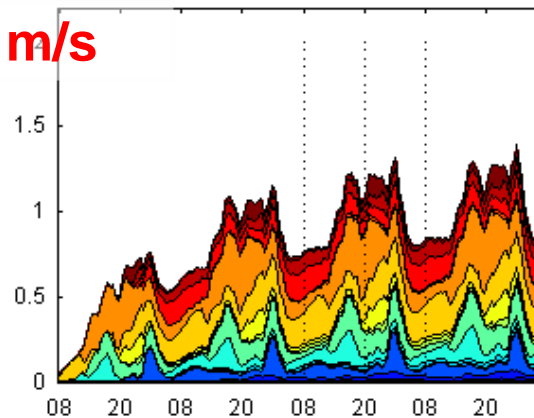


z3

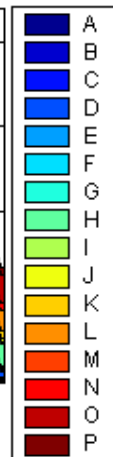
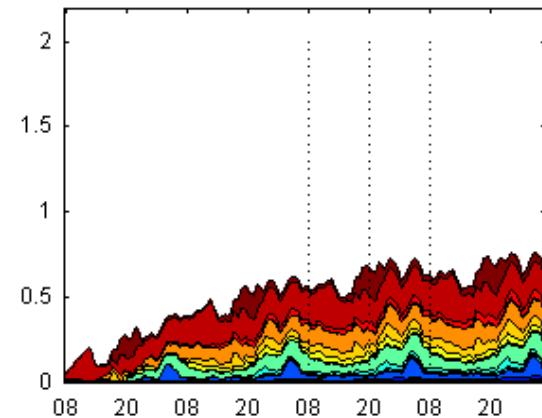
2003 Land-use Wind 3 m/s



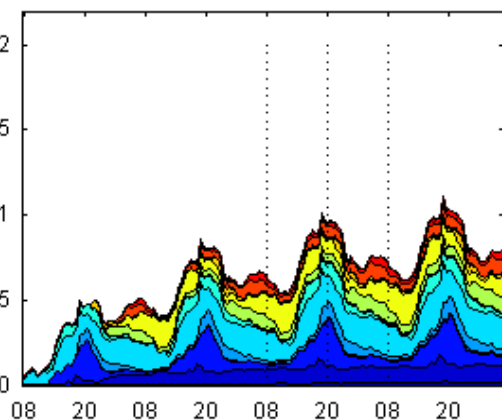
z6



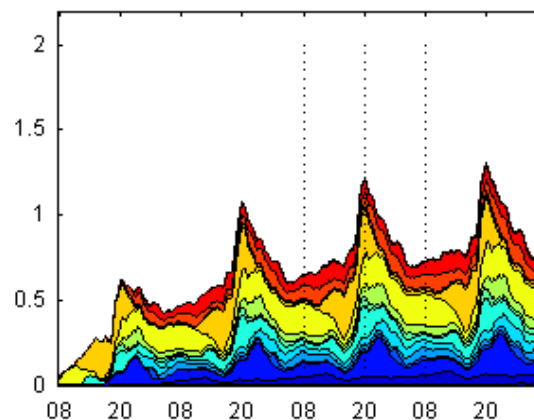
z9



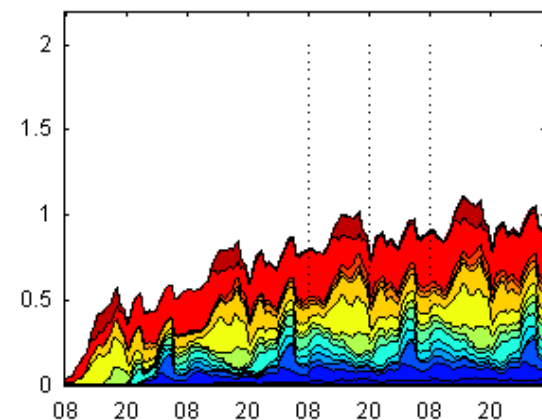
z2



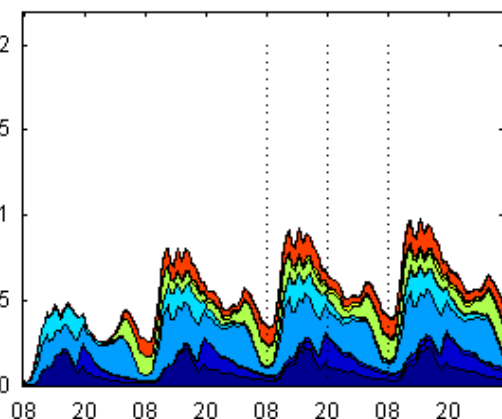
z5



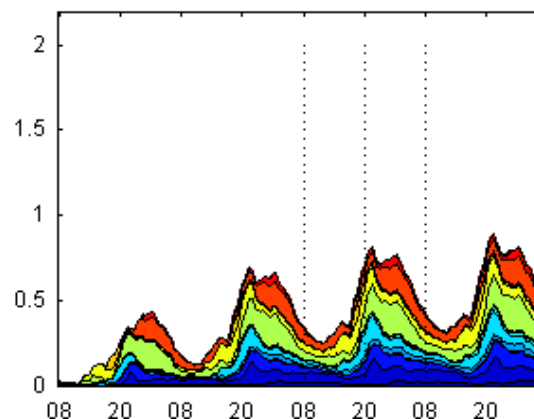
z8



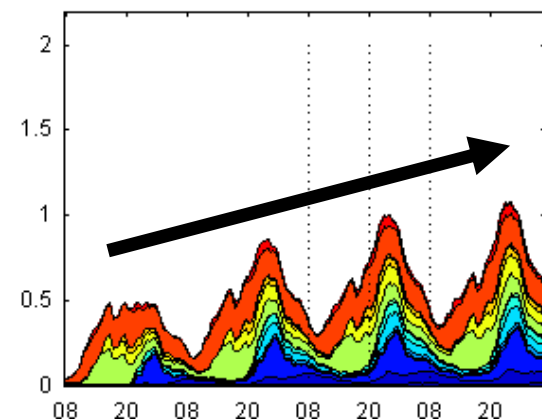
z1



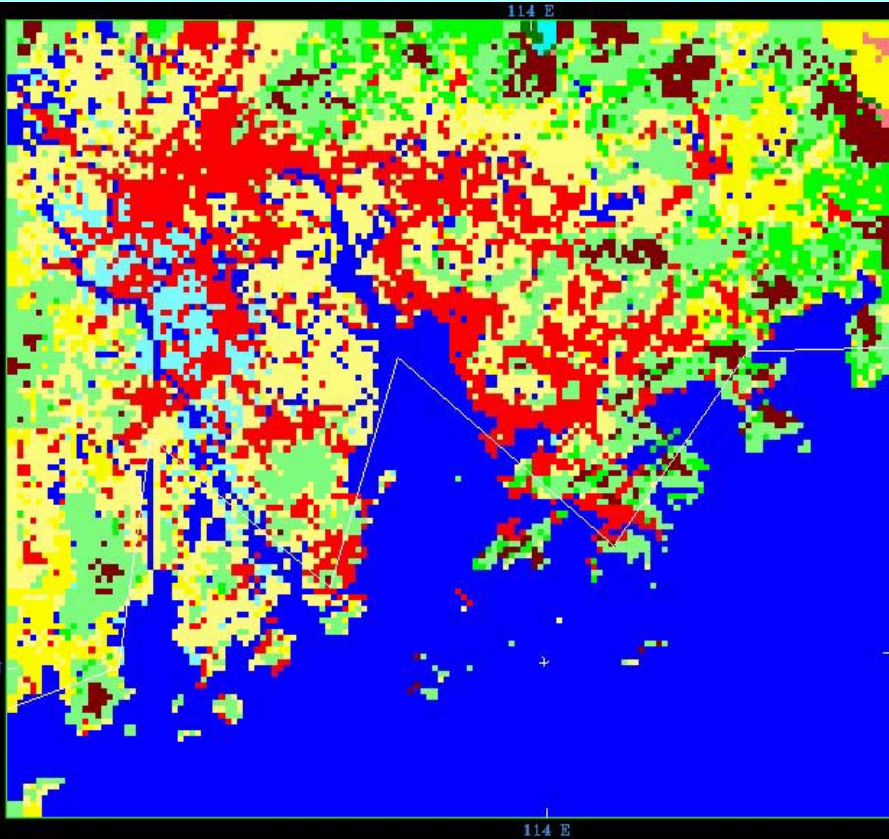
z4



z7



# Urban landsea-breeze circulation led to enhanced trapping of pollutants over the PRD



Pearl River Delta Regional Air Quality Map  
2006. 03. 16



Percentage contribution for HK	Regional sources	Local sources
Ambient PM	~ 70 %	~ 30 %

*An Extreme Regional  
Air Pollution Event*



Visibility 25 km

12/10/2003 2:15pm  
@TC: PM10 20  $\mu\text{g}/\text{m}^3$   
PM2.5 12  $\mu\text{g}/\text{m}^3$



**Visibility 12 km**

**30/10/2003 2:15pm**  
**@TC: PM10 113  $\mu\text{g}/\text{m}^3$**   
**PM2.5 83  $\mu\text{g}/\text{m}^3$**





**Visibility 8 km**

**31/10/2003 2:15pm**  
**@TC: PM10 129  $\mu\text{g}/\text{m}^3$**   
**PM2.5 98  $\mu\text{g}/\text{m}^3$**





**Visibility 5 km**

**01/11/2003 2:15pm**  
**@TC: PM10 190  $\mu\text{g}/\text{m}^3$**   
**PM2.5 148  $\mu\text{g}/\text{m}^3$**



**Visibility 1.5 km**

**02/11/2003 2:15pm**  
**@TC: PM10 342  $\mu\text{g}/\text{m}^3$**   
**PM2.5 295  $\mu\text{g}/\text{m}^3$**

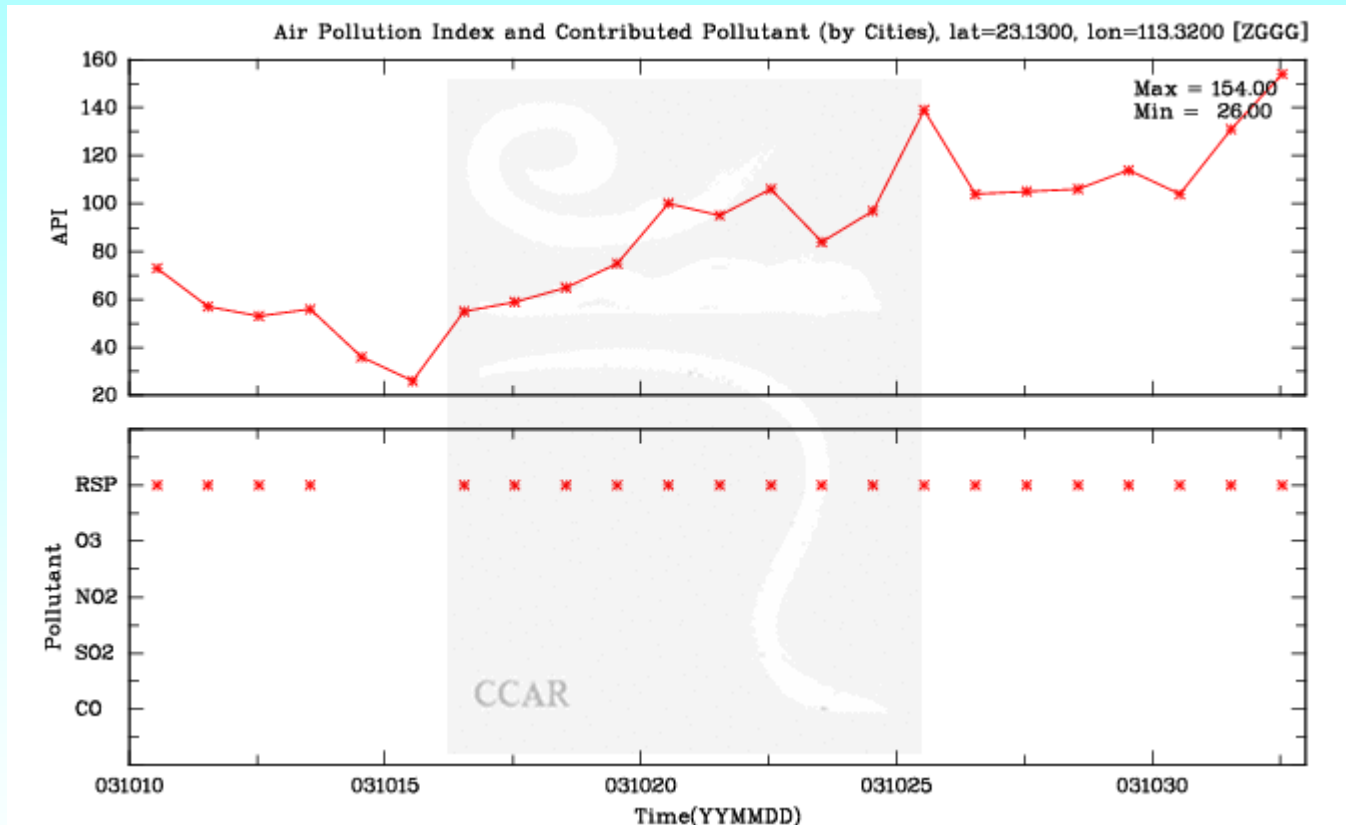


**Visibility 16 km**

**03/11/2003 2:15pm**  
**@TC: PM10 100  $\mu\text{g}/\text{m}^3$**   
**PM2.5 57  $\mu\text{g}/\text{m}^3$**



# Air Pollution Index for Guangzhou



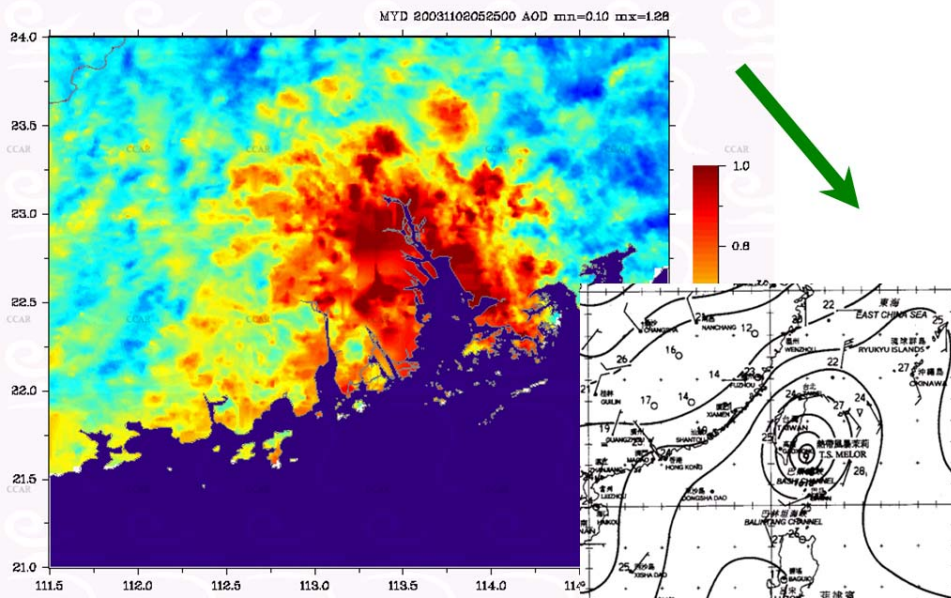
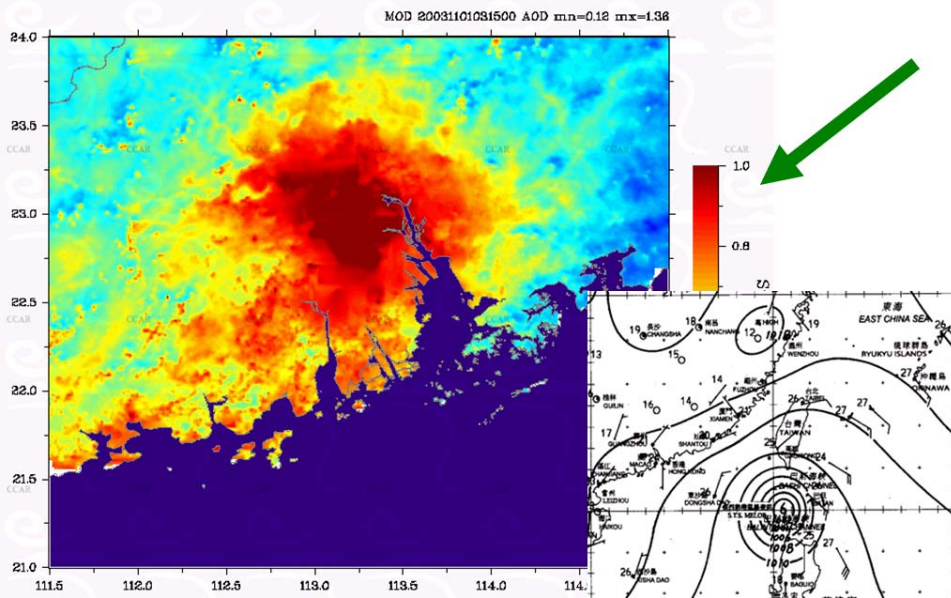
API of Guangzhou shot up to **303** on 02/11/2003 (max over the city: 431)

Accumulation of pollutants in GZ started since the relax of the cold front on 16 October!





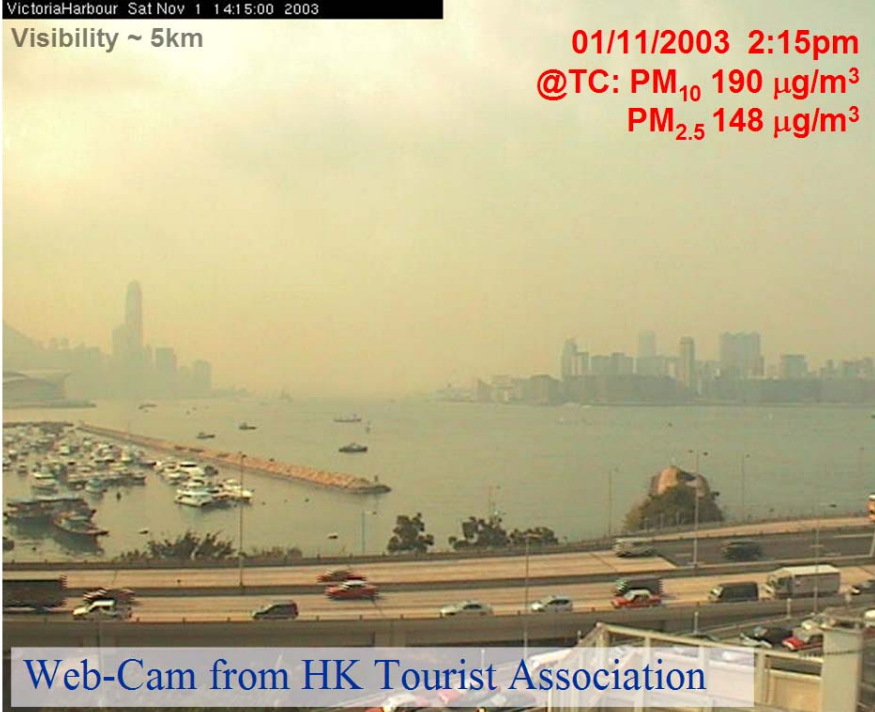
# MODIS plot 11am 1st November 2003    MODIS plot 11am 2nd November 2003



VictoriaHarbour Sat Nov 1 14:15:00 2003

Visibility ~ 5km

**01/11/2003 2:15pm**  
**@TC: PM<sub>10</sub> 190 µg/m<sup>3</sup>**  
**PM<sub>2.5</sub> 148 µg/m<sup>3</sup>**



Web-Cam from HK Tourist Association

VictoriaHarbour Sun Nov 2 14:16:03 2003

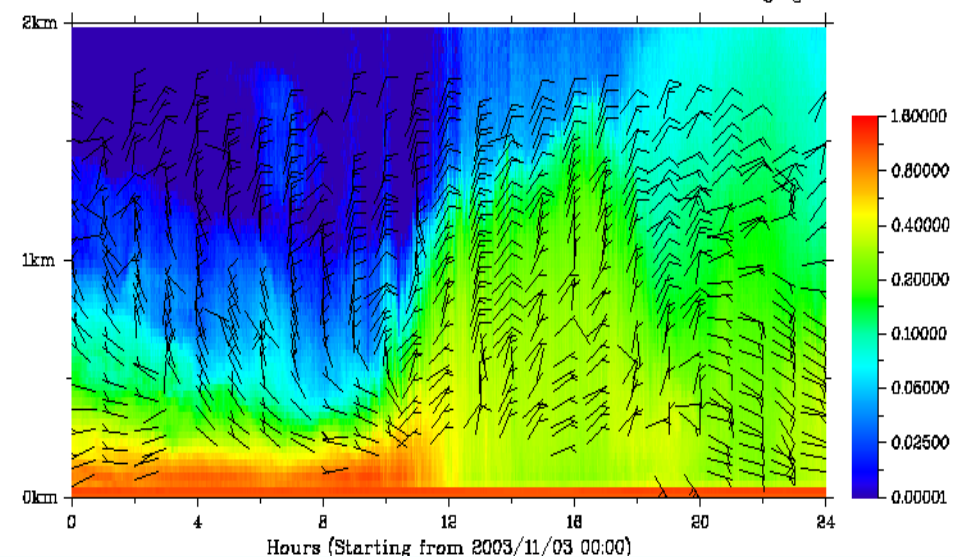
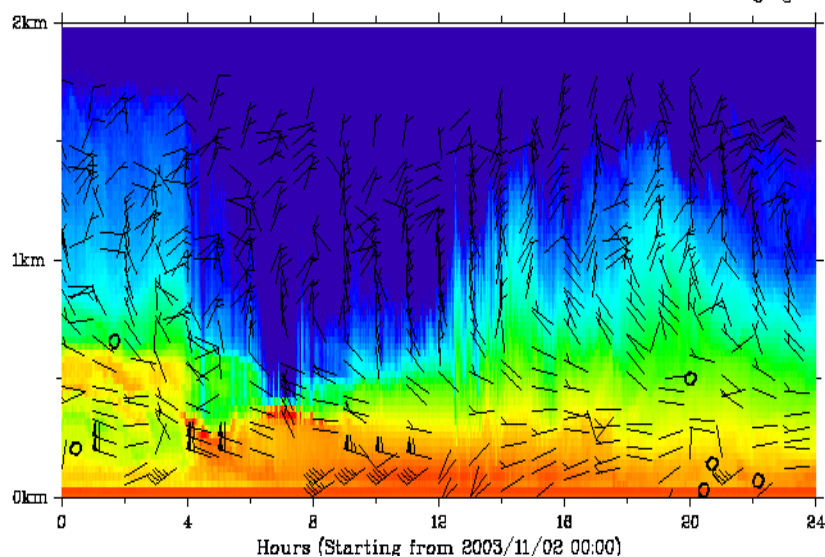
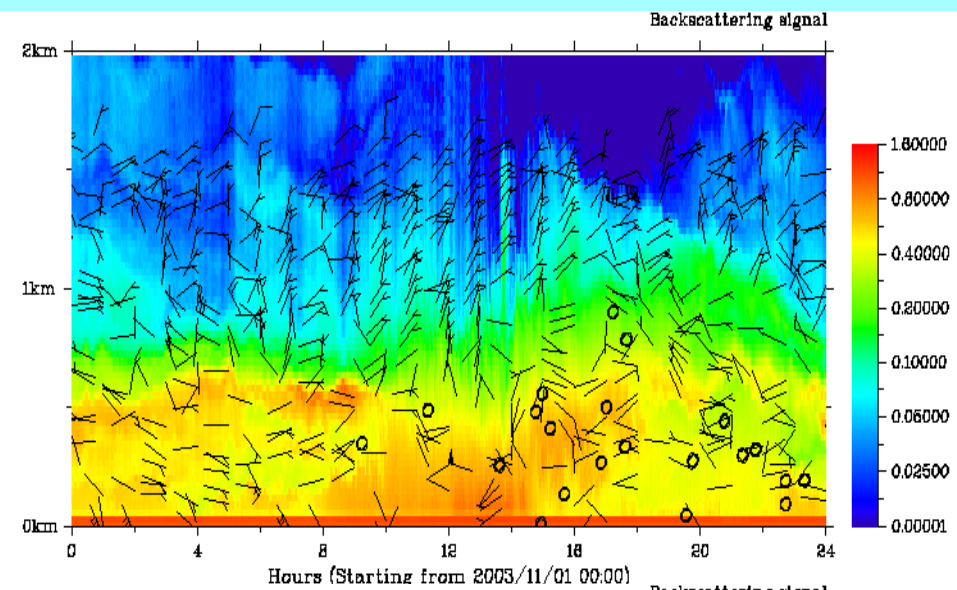
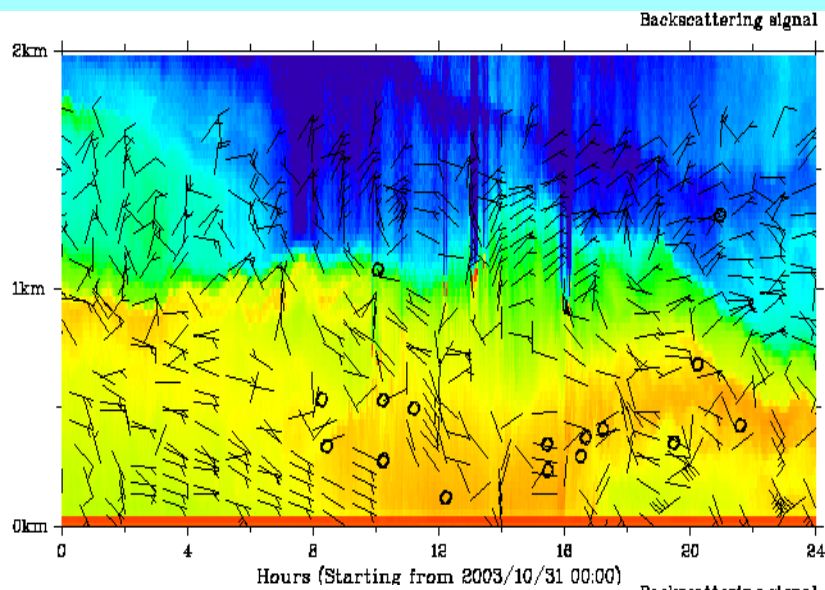
Visibility ~ 1.5km

**02/11/2003 2:15pm**  
**@TC: PM<sub>10</sub> 342 µg/m<sup>3</sup>**  
**PM<sub>2.5</sub> 295 µg/m<sup>3</sup>**



Web-Cam from HK Tourist Association



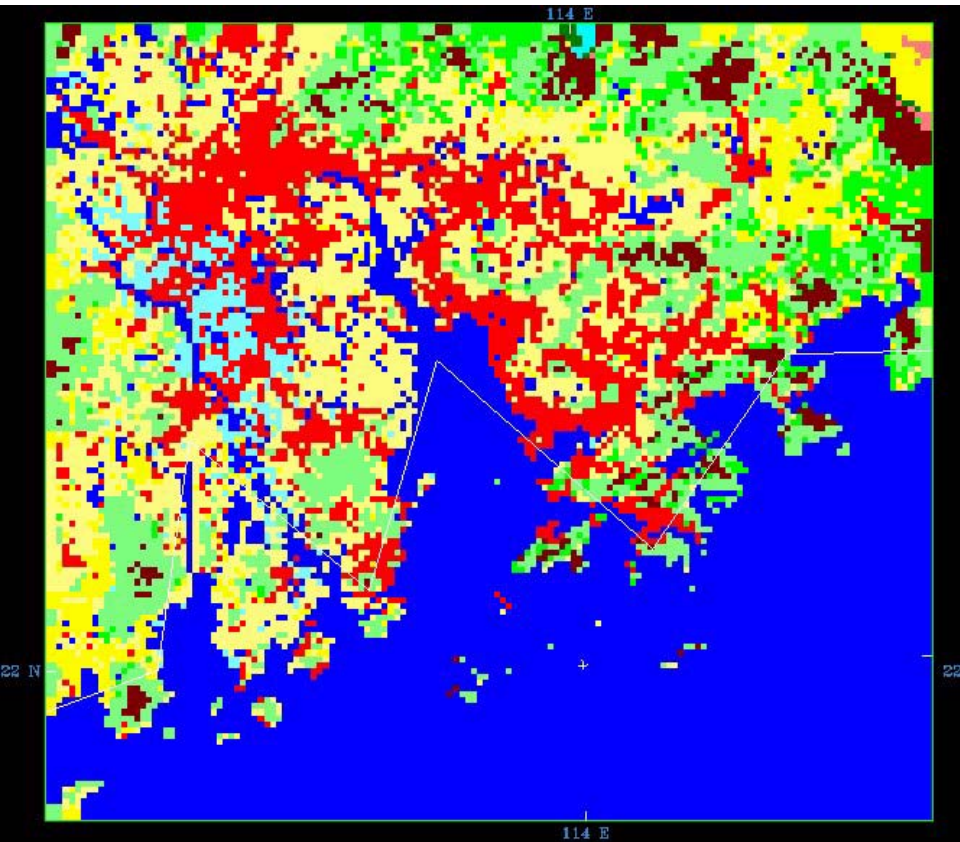


Winds in the lowest layers switched to NW  
Boundary layer height decreased (subsidence effect)

# *Event Summary*

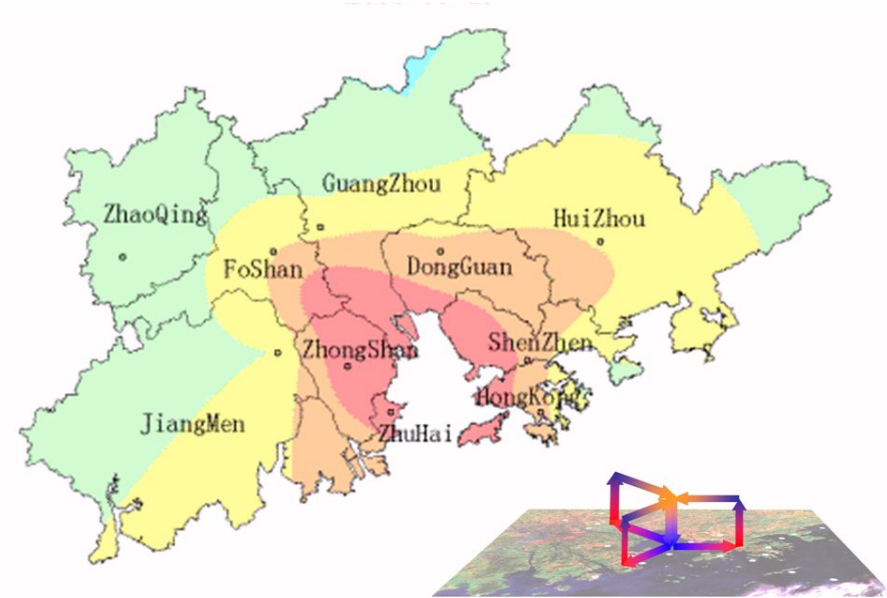
- This is a **regional** air pollution event.
- **Reason 1:** Accumulation – AQ over PRD has been severe for sometime (seen from regional API ) because of weak background winds.
- **Reason 2:** The systematic change of the surface wind from an easterly to a northwesterly direction over HK (and the PRD). That brought in the pollutants through northwesterly transport.
- **Reason 3:** Subsidence related to the tropical cyclone lowered the boundary layer and acted to increase the pollutant concentration.





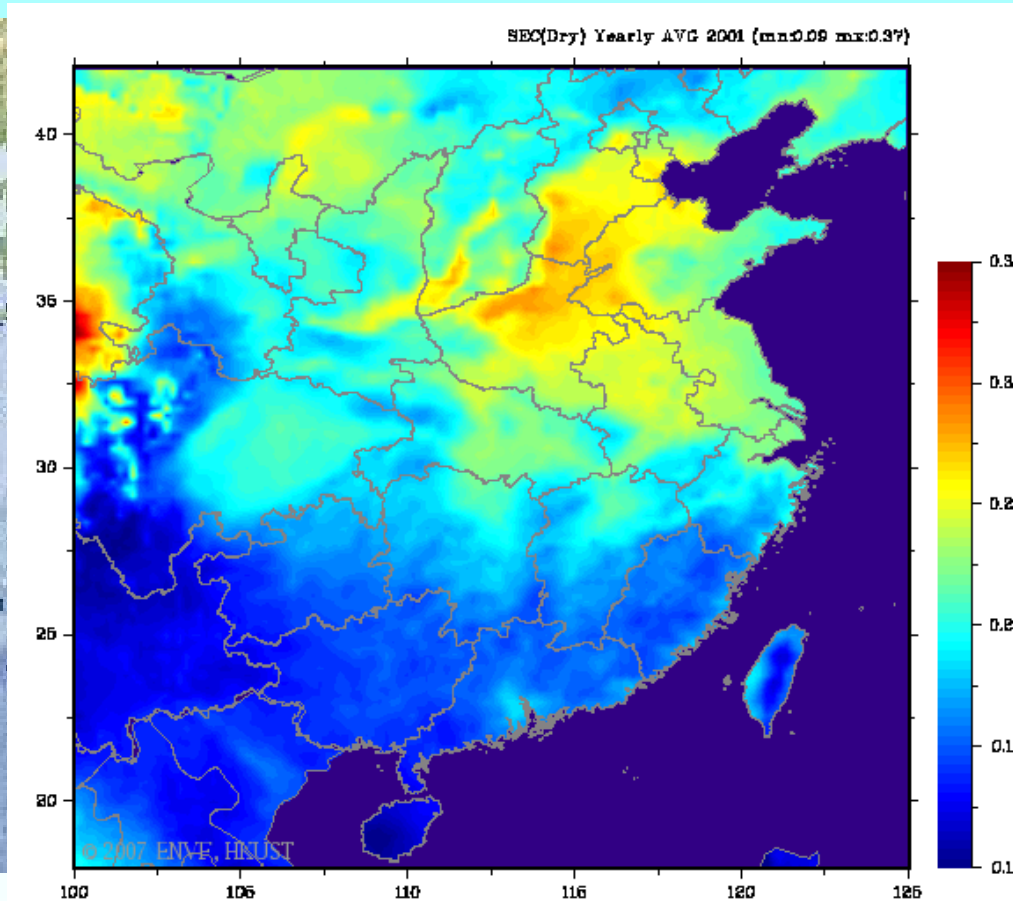
3. Same coastal land-sea breeze circulation also leads to **enhanced trapping** of pollutants over the PRD

2. Regional / coastal land-sea breeze circulation tends to push air pollutants to the **western side** of HK



4. Moist subtropical condition allows **rapid transformation** of gases pollutants (SO<sub>2</sub>, NO<sub>x</sub>) to secondary particulates (photochemical smog)

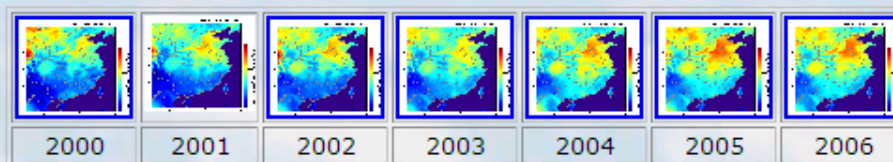
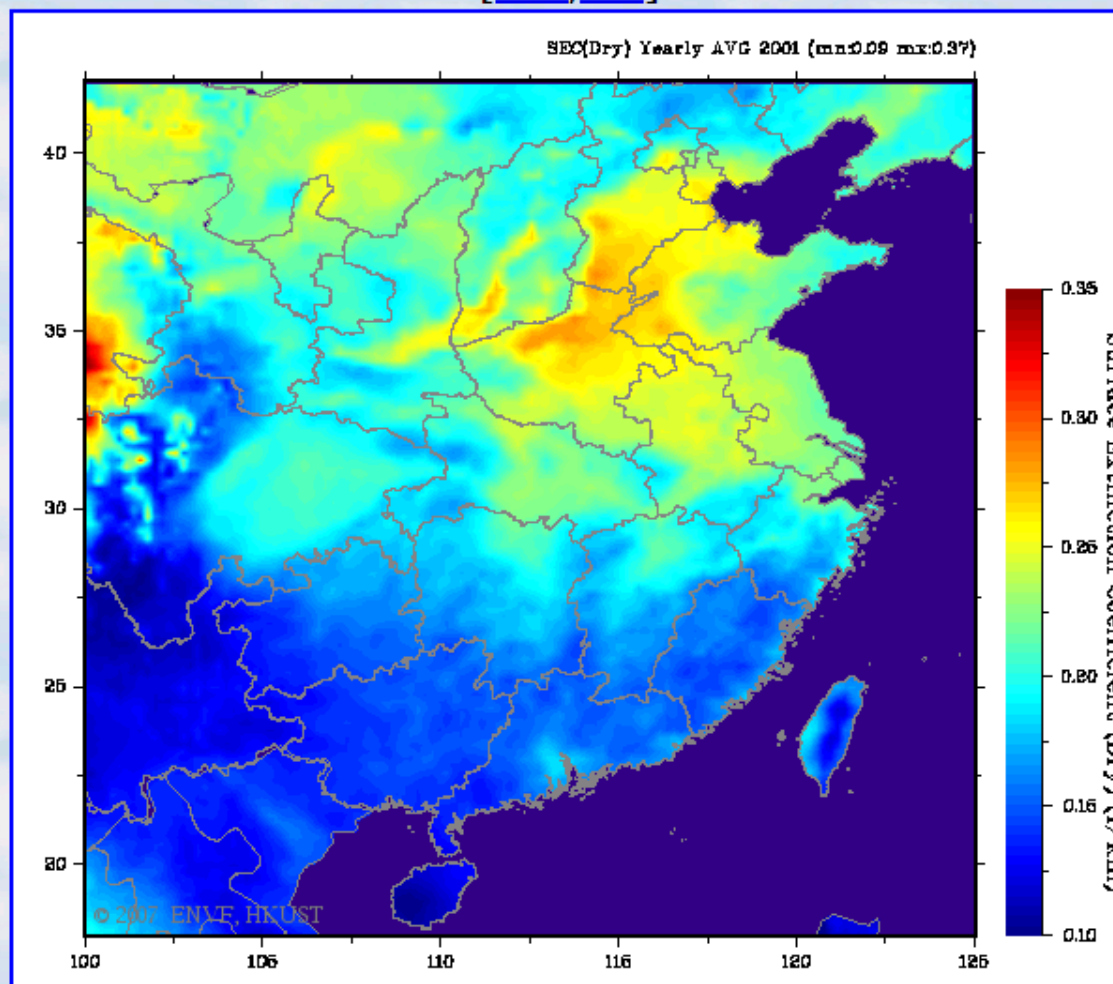
# Air Quality Problem for China and PRD



- Thanks to the presence of the Nan Ling mountains, **the particulate pollutant problem for HK is mostly local and regional (PRD), transport from north of the mountains are much less important !** Compare with other cities like Shanghai or Beijing, it is easier to manage AQ in the Pearl River Delta and HK

## SEC(Dry) Yearly Averaging Image Display - 2001 (Fixed Color Scale)

[\[AOD,SEC\]](#)



# *Acknowledgement*

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- **Innovation Technology Commission, HKSAR**
- **Cinotech Consultants Limited**
- **Maunsell Environmental Management Consultants Ltd**
- **The Real Estate Developers Association of Hong Kong**
- **Environmental Protection Department, HKSAR**
- **Hong Kong Observatory, HKSAR**
- **National Aeronautics and Space Administration, USA**



*THANK YOU*