The Abdus Salam
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Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

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Workshop on Aerosol Impact in the Environment: from Air Pollution to Climate Change

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Seasonal and diurnal variations of carbonaceous aerosols in Bangkok

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Seasonal and diurnal variations of carbonaceous aerosols in Bangkok

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Relevant manuscripts

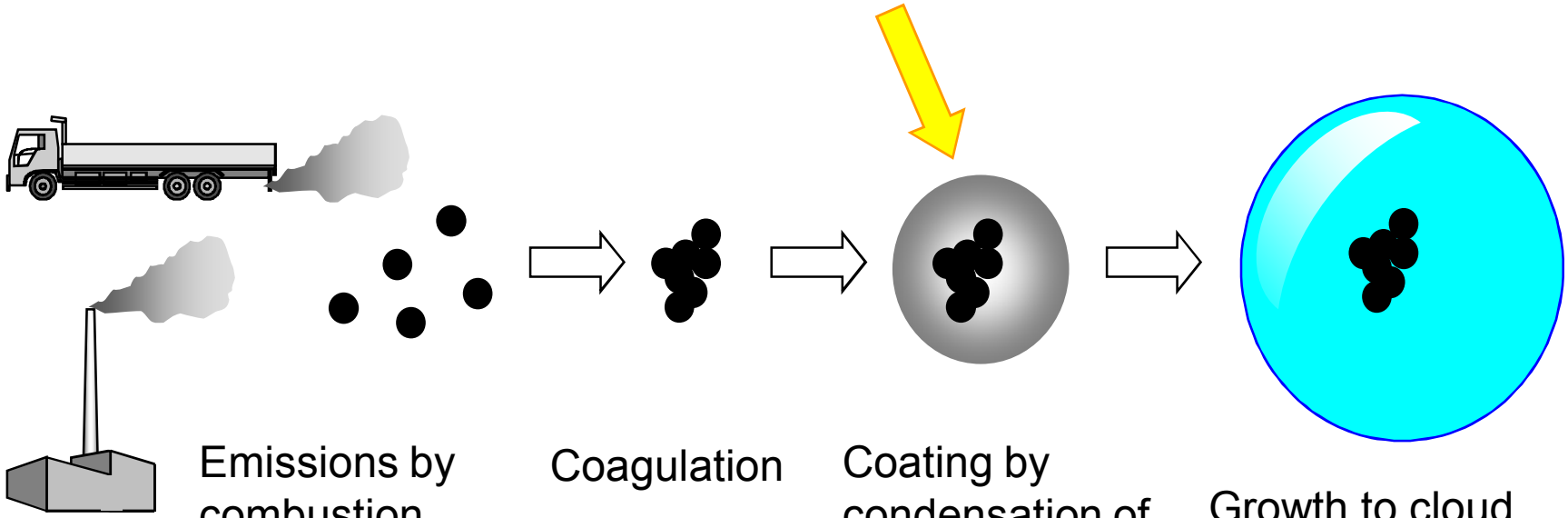
Kondo et al., 2010, AST
Sahu et al., 2011, JGR

Asia-Pacific Network for Global Change Research

ICTP: Workshop on Aerosol Impact in the Environment: from Air Pollution to Climate Change

Atmospheric processes of BC in the Atmosphere

Light absorption by BC is amplified by coating (Lens effect)



Emissions by combustion (nano-particles)

Coagulation

Coating by condensation of oxidized gases

Growth to cloud droplets (BC removal)

Understanding on these processes are insufficient due to difficulties of BC observations ⇒ Uncertainty in the prediction of radiative impact/climate change

Instruments widely used for measurements of BC mass concentration

(A) Filter Transmittance method:

- Particle soot absorption photometer (*PSAP*)
- Aethalometer
- Continuous soot monitoring system (*COSMOS*)

(B) Laser-induced incandescence (LII) method:

- Single particle soot photometer (SP2)

(C) Filter Transmittance and Reflectance method:

- Multi-Angle Absorption Photometer (MAAP)

(D) Thermal–optical transmittance (TOT)

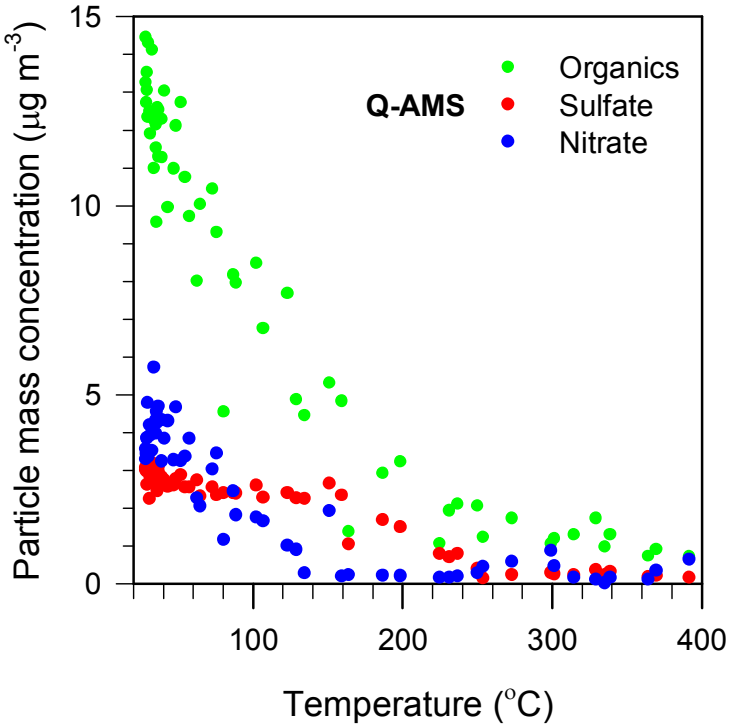
- EC and OC analyzer

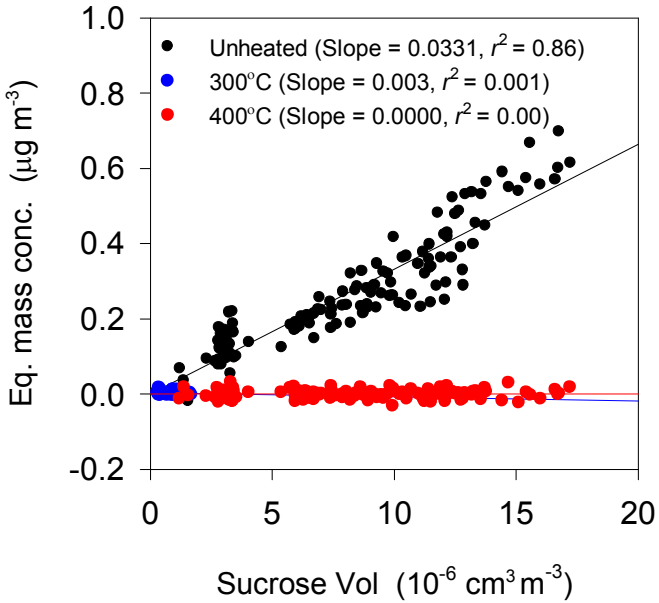
(E) Photo acoustic spectrometer (PAS)

BC Mass using filter based photometers: Challenges

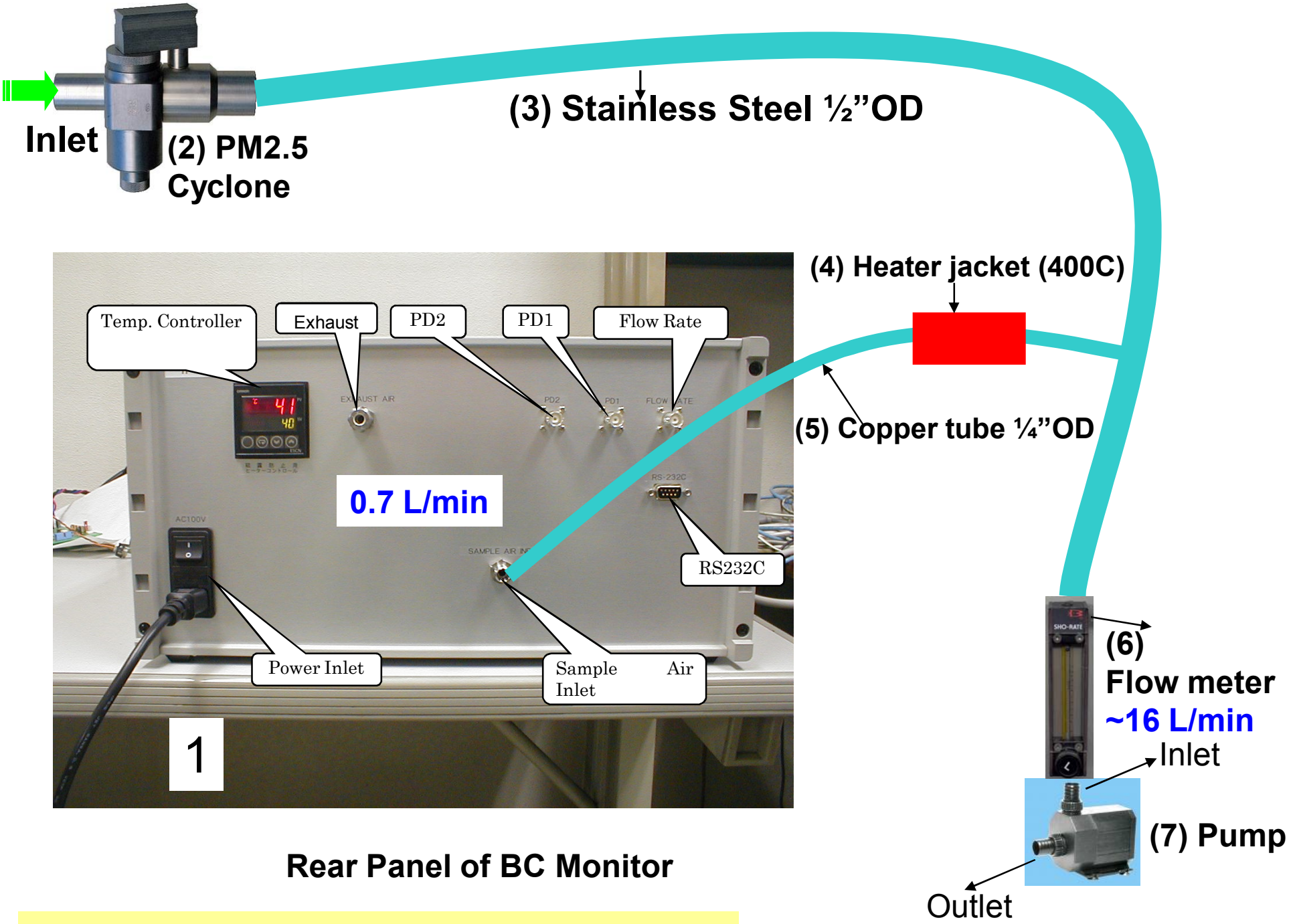
Mass absorption cross section (σ_{abs}) of BC is unstable.
Causes: external mixing (multiple scattering) and internal mixing (enhanced absorption, lens effect)

→ Evaporate light scattering particles





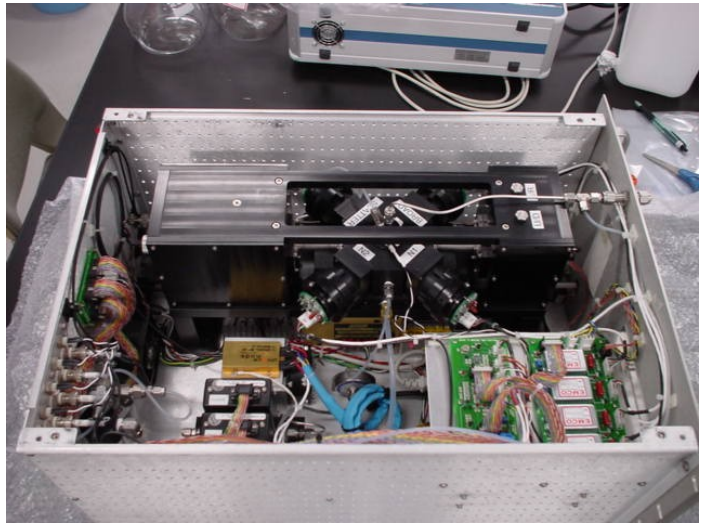
Using heated inlet measurements, σ_{abs} was stable to within ~10% at 6 sites in Asia (Kondo et al., 2009, AST)

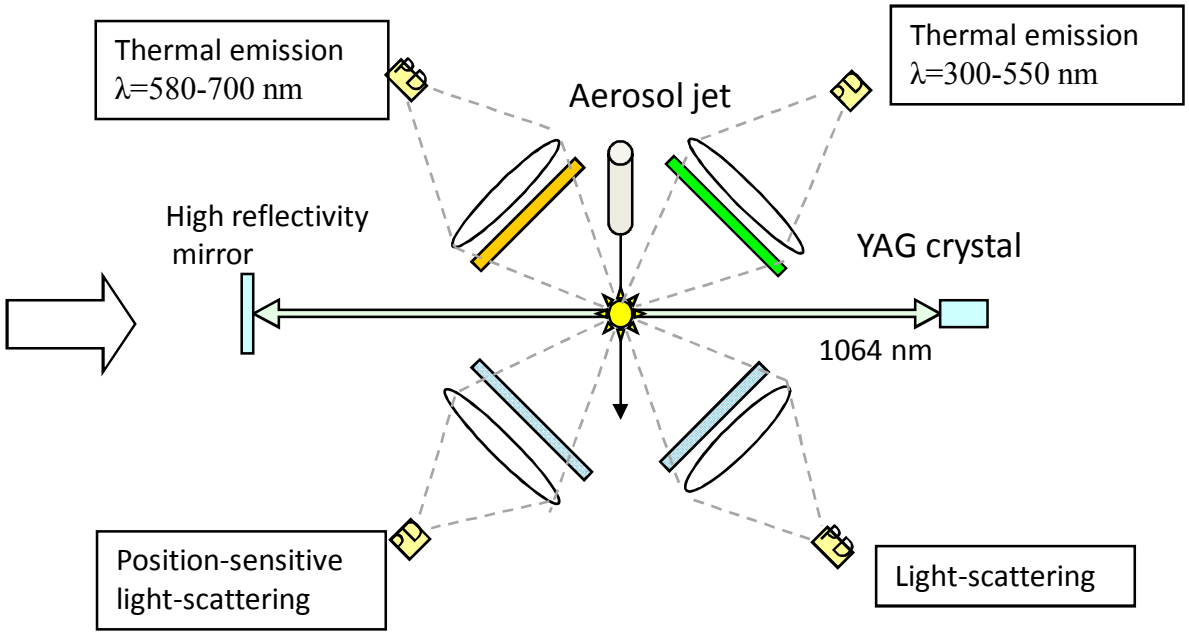


Rear Panel of BC Monitor

Setup of filter based photometers (COSMOS)

Single particle soot photometer (SP2)



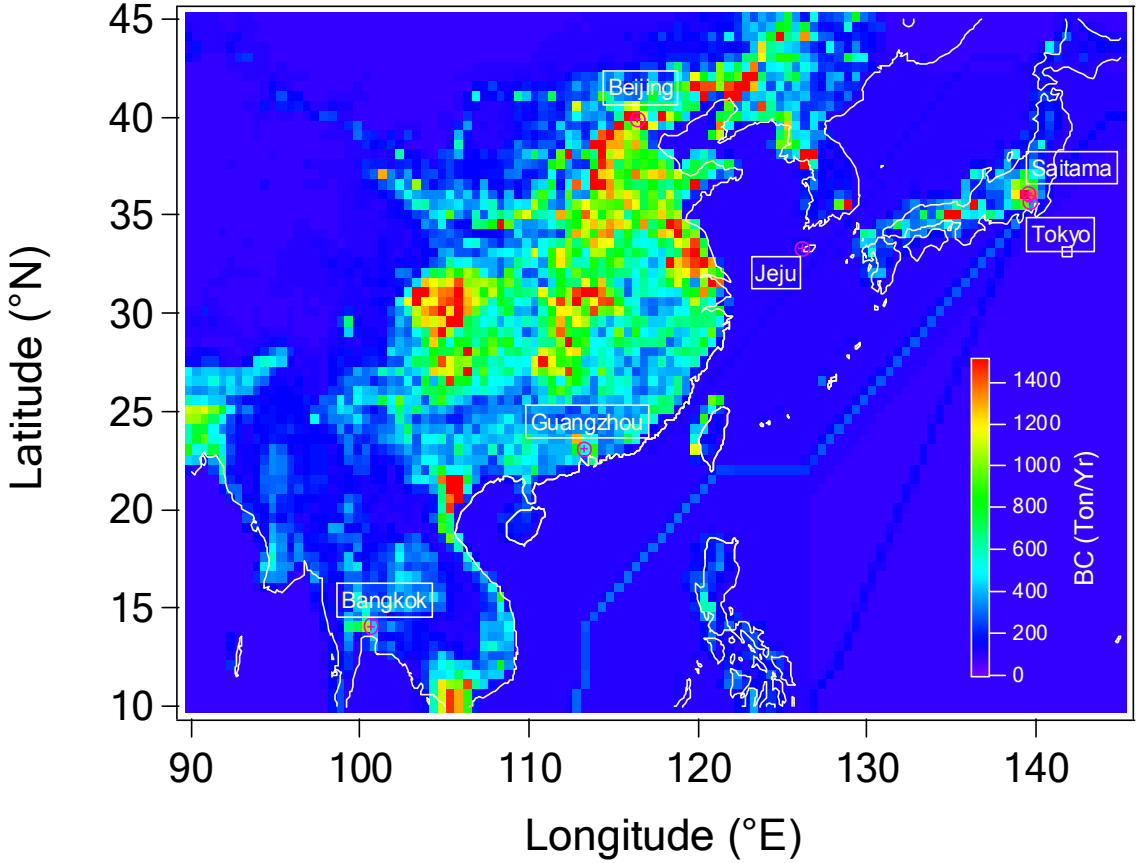


Measurements of the masses of individual BC particles laser-induced incandescence (LII) technique.

The detection of BC mass by SP2 has been shown to be unperturbed by internal mixing of BC.

It is not influenced by the coexistence of other types of aerosols, including organic aerosols (OA).

Emissions of BC



Anthropogenic emissions of BC aerosols for year 2000

The emission from fossil fuel combustion is year-round in large urban areas whereas Biomass burning varies with season.

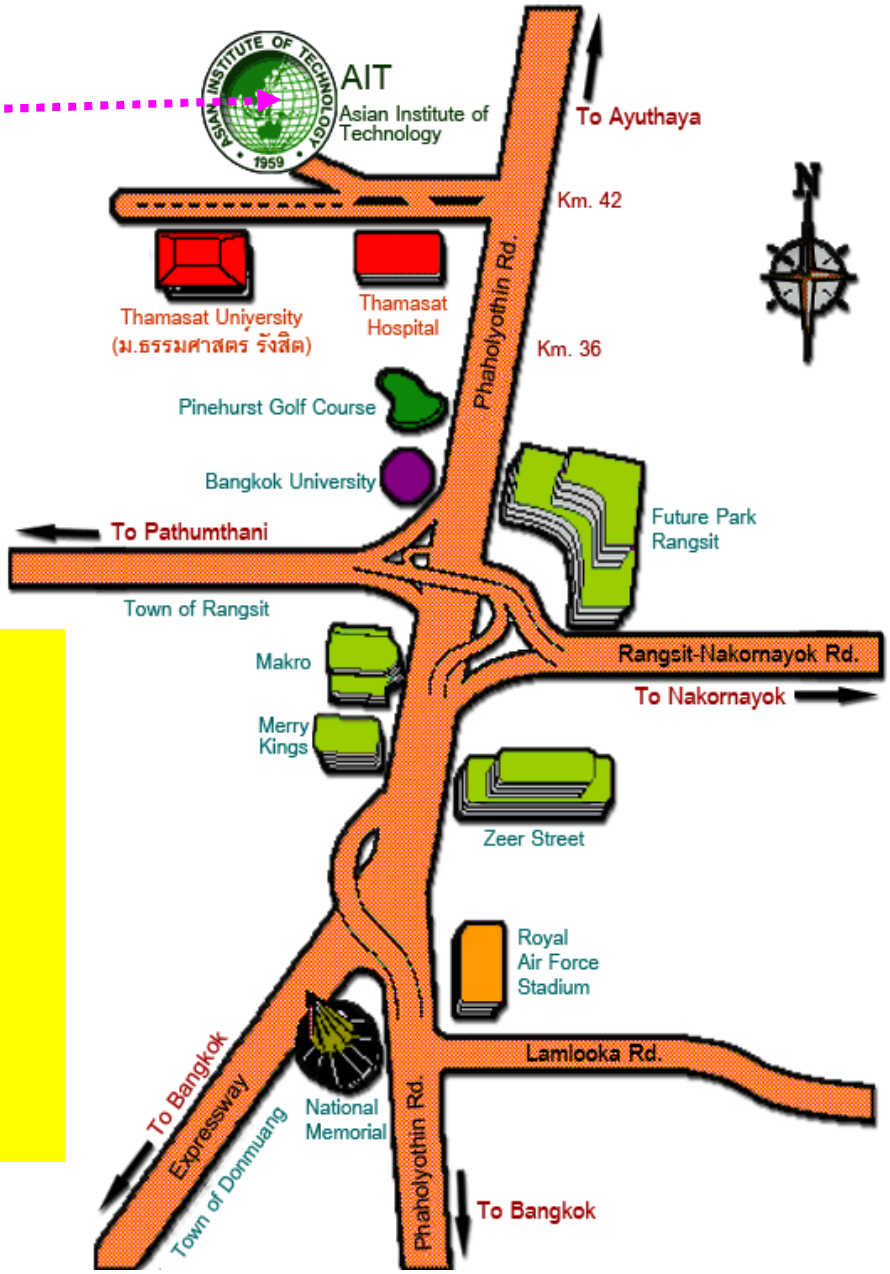
Thailand has highest number of motor vehicles in SE Asia, next is Indonesia.
Fuel use and vegetation Burned : Indonesia has highest followed by Thailand.

Streets et al. 2003, JGR

Measurement Site in Bangkok

(Campus of Asian Institute of Technology)

The Observation Site



The Measurements

Mass Cons. of EC and OC aerosols

Optical BC

Mixing ratio of CO

Met data

April 2007- August 2008.

Bangkok in Details:

- Bangkok is located in southwest Thailand on the eastern bank of the Chao Phraya River near the Gulf of Thailand.
- Population of Bangkok is > 7.0 Million.
- Bangkok is one of the top cities of Southeast Asia, economically.
- Climate: A tropical site (13.45 N, 100.35 E), Bangkok is the hottest city of the world (WMO).

The vehicular traffic

2-wheeler motorcycle (gasoline, 40% of total),

Cars (gasoline/LPG/CNG, 37%),

Taxi (LPG/CNG/gasoline, 1.6%),

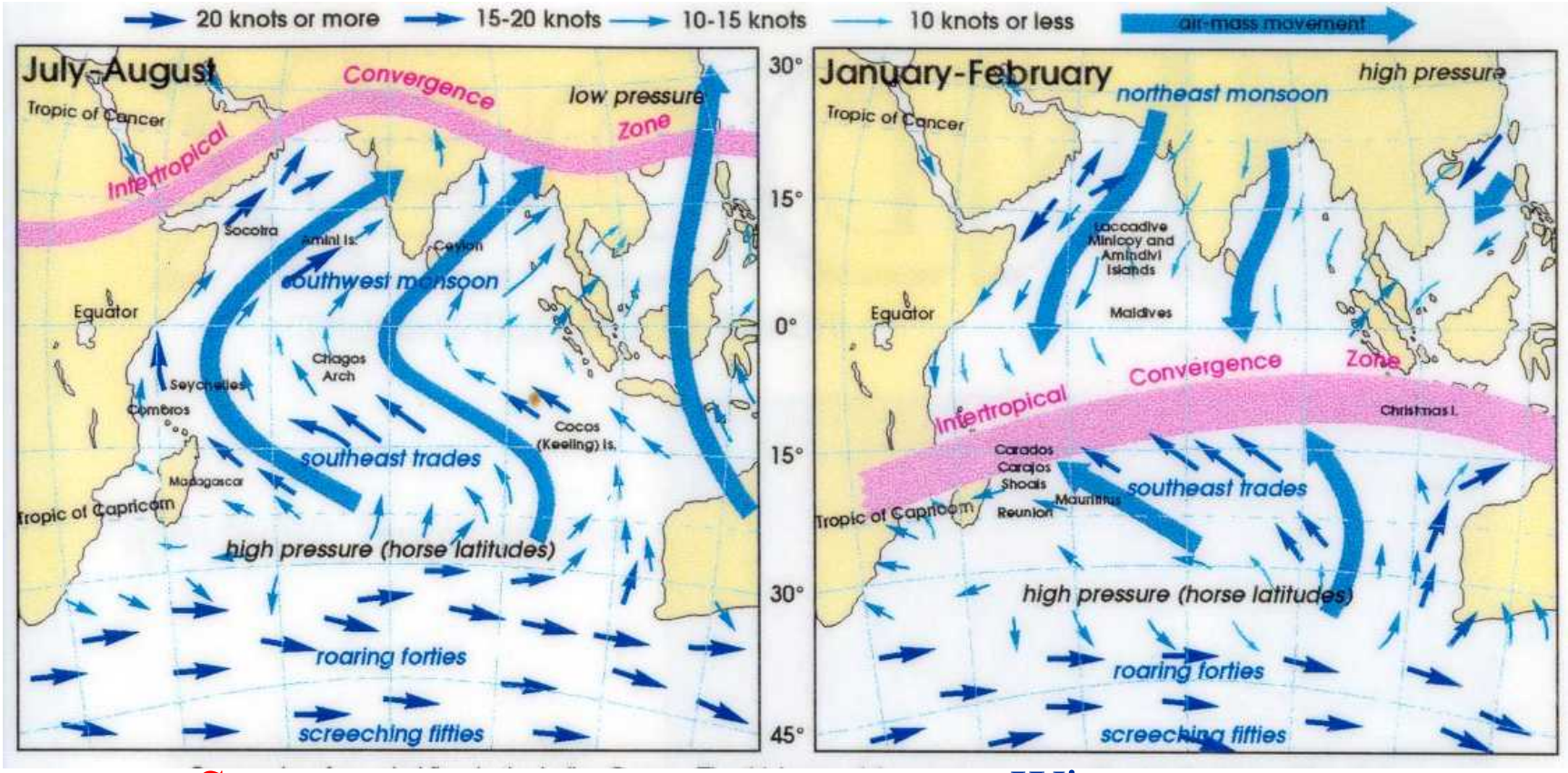
Pick-up van (diesel/CNG, 18%),

Bus (diesel/CNG, 0.6%) and truck (diesel/CNG, 1.8%)

3-wheeler or ‘tuktuk’ (LPG, 0.2%)

Transport over Thailand and surrounding regions

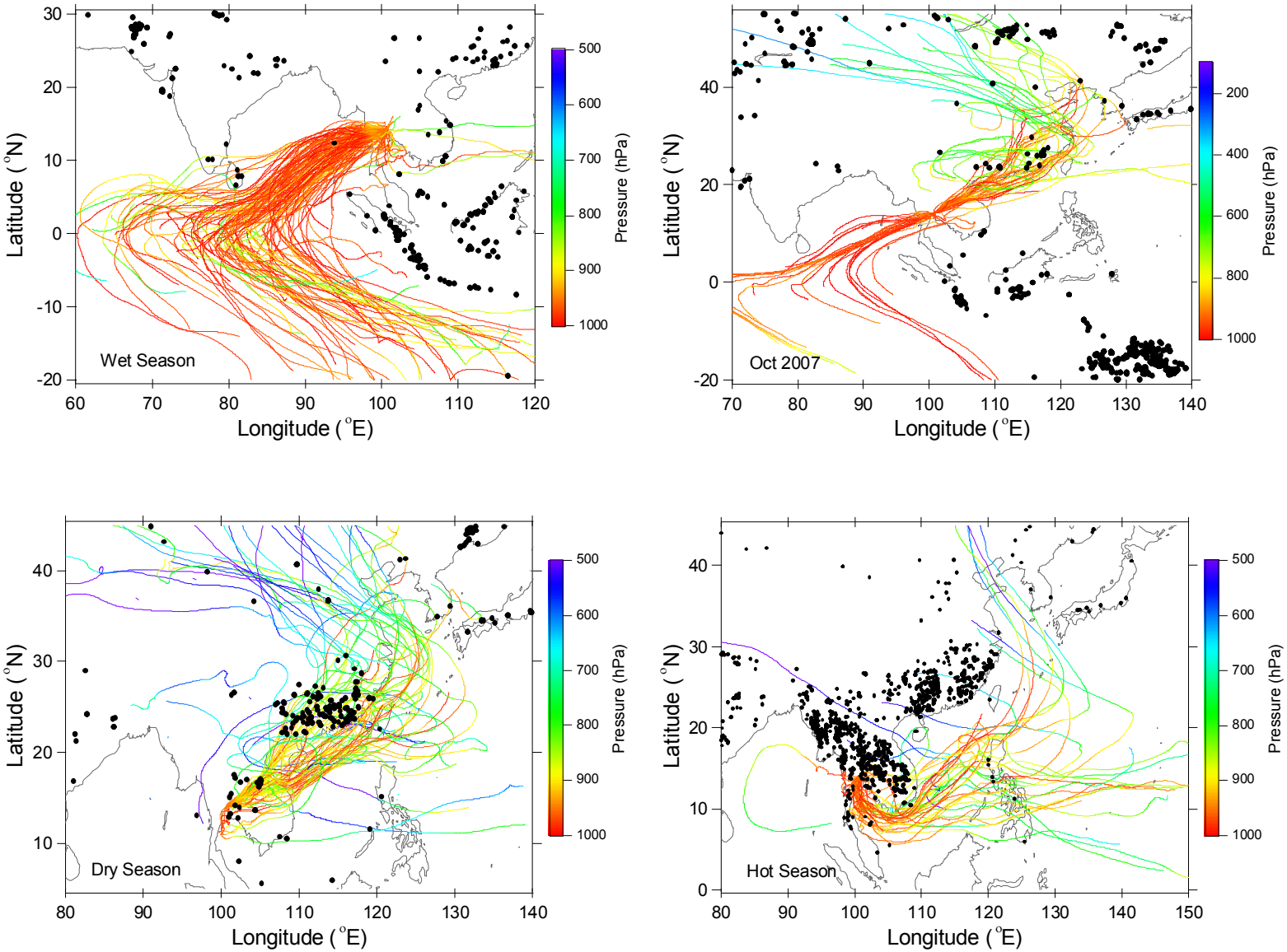
Inter Tropical Convergence Zone (ITCZ)



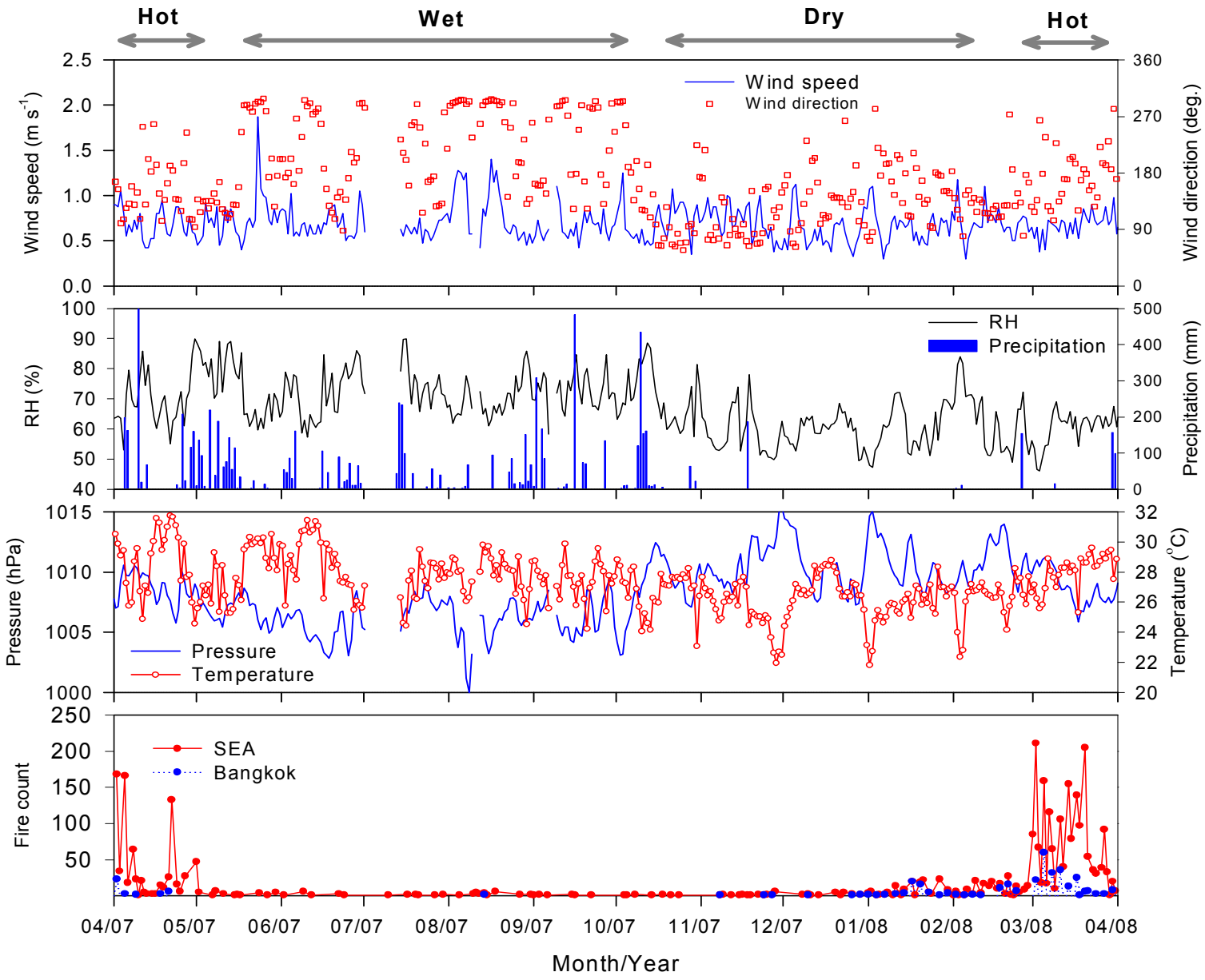
Summer monsoon

Winter monsoon

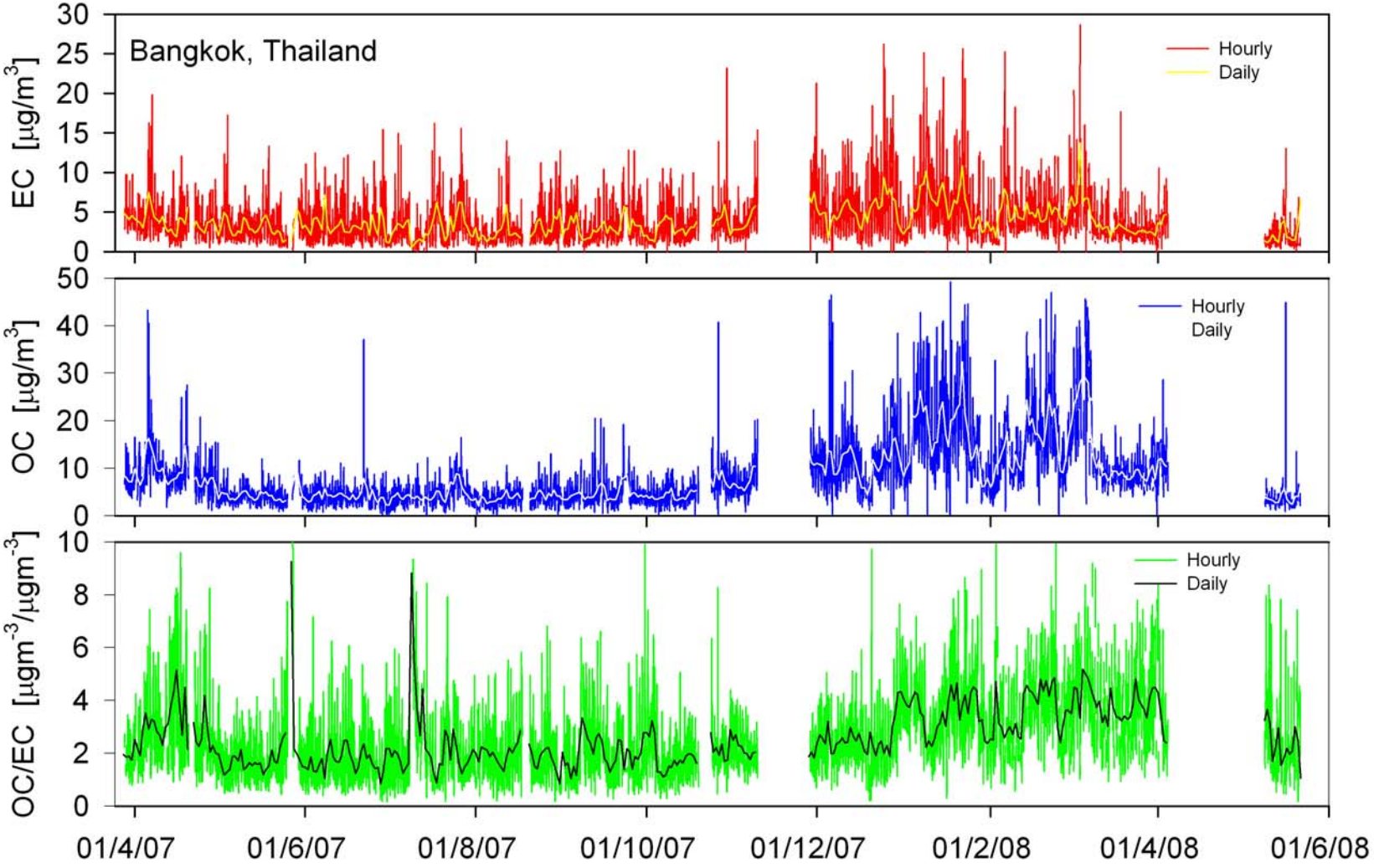
Impacts of long-range transport and biomass burning emissions



Time series variations of met parameters

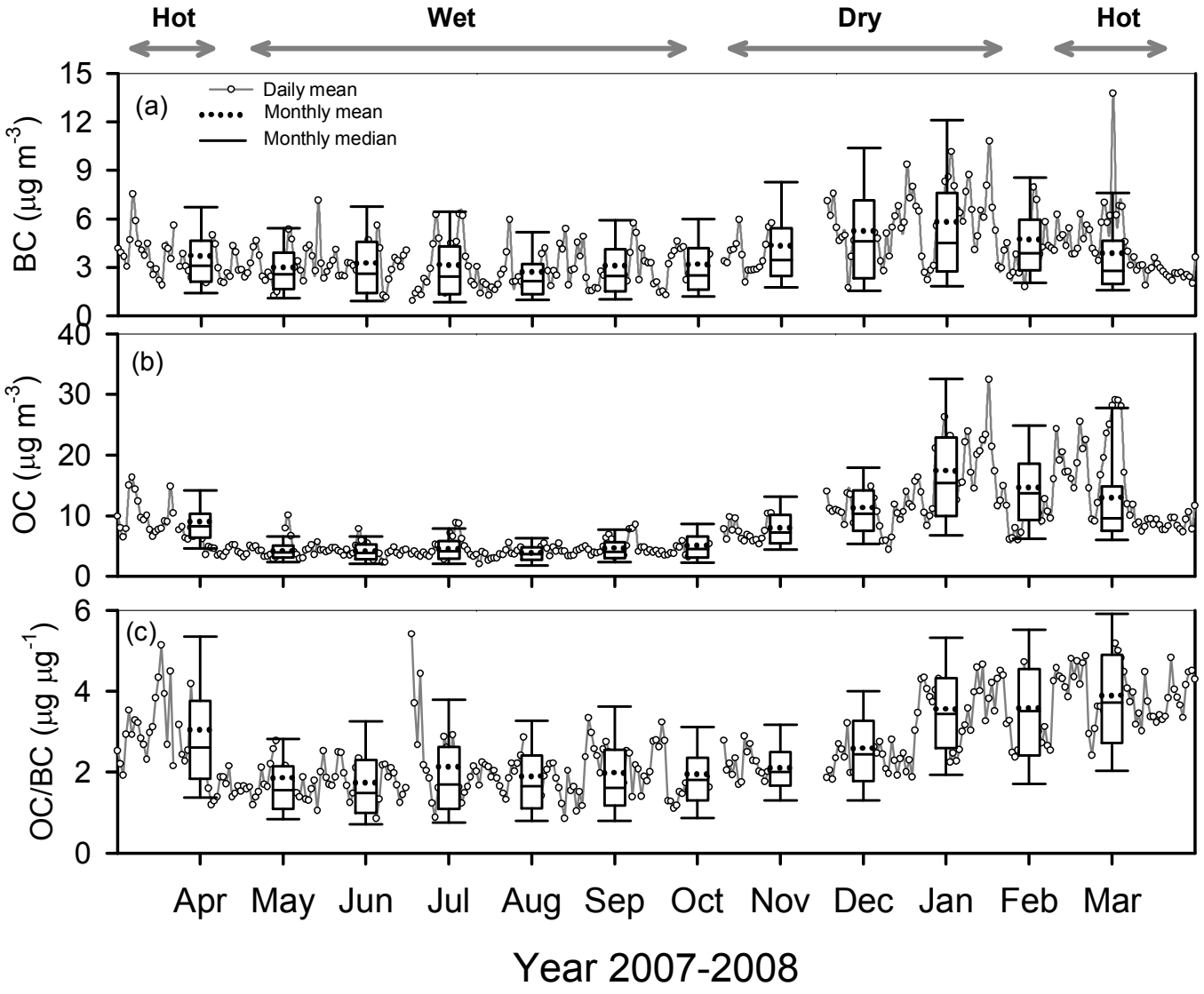


Time series variations of Aerosols



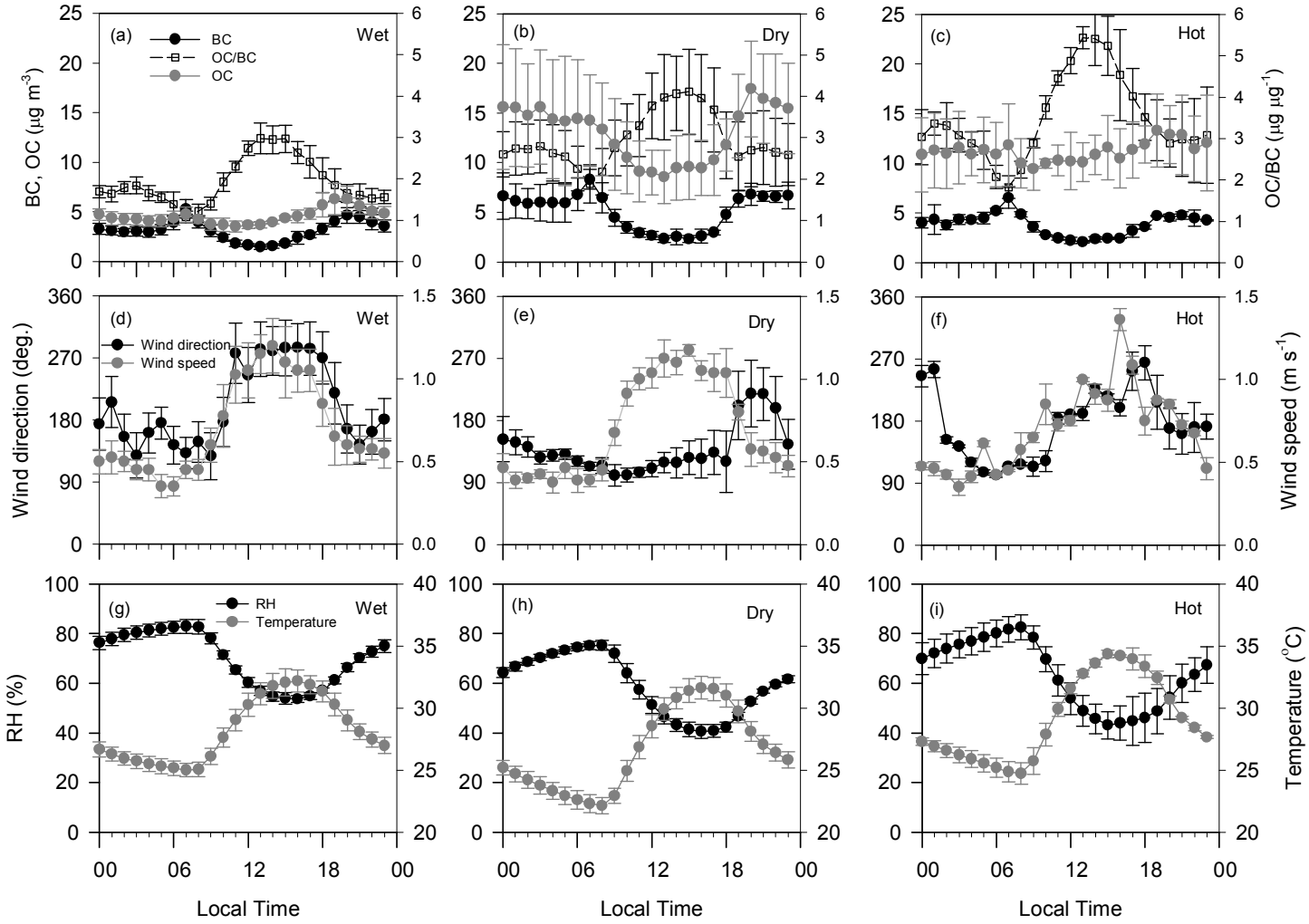
EC+OC in Bangkok exceeds the standard for PM2.5 in Europe!

Seasonal variations of BC and OC aerosols



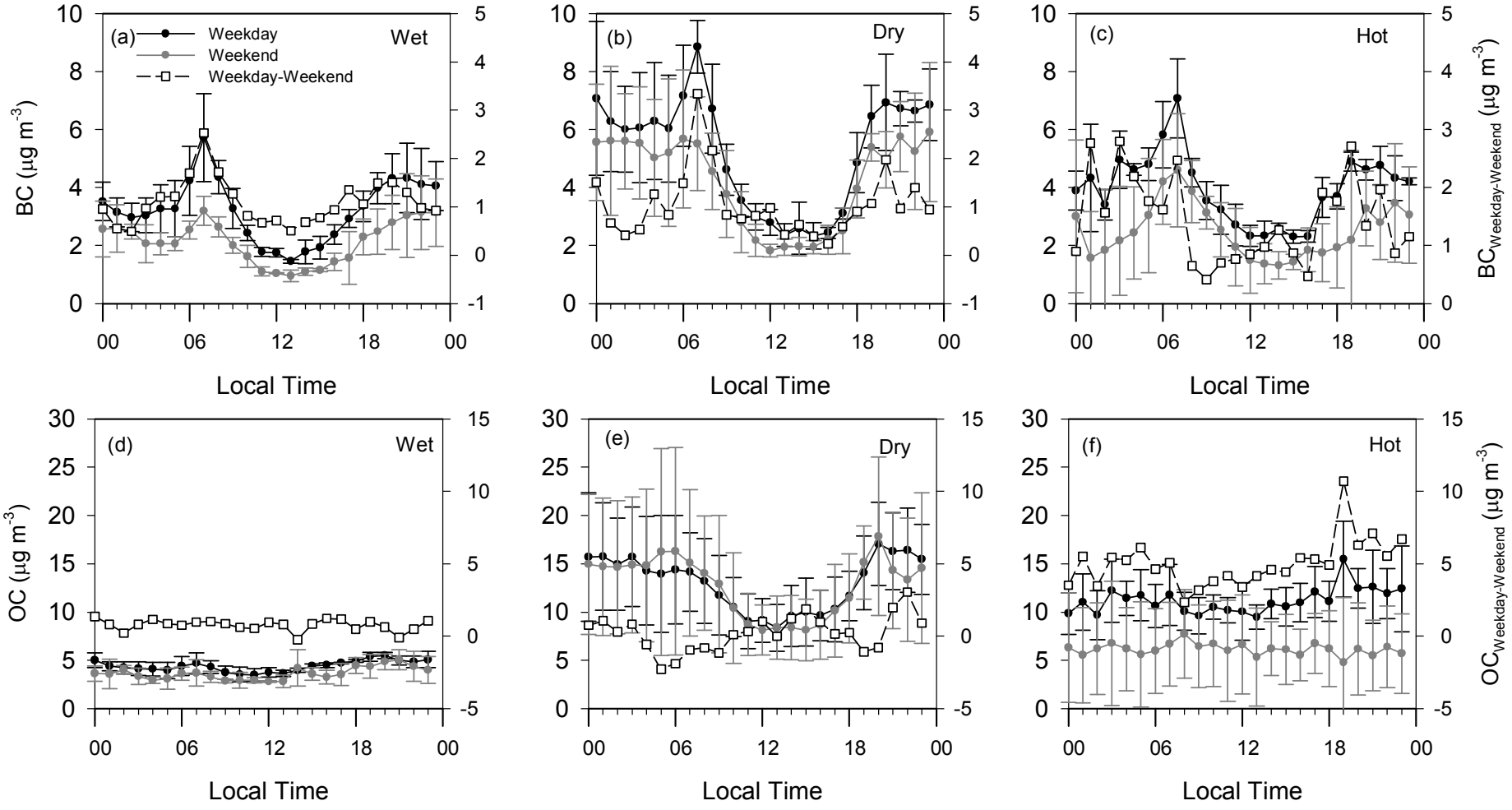
EC and OC maxima in January, but the most extensive biomass burning is during Feb-March, why?

Diurnal variations of BC and OC



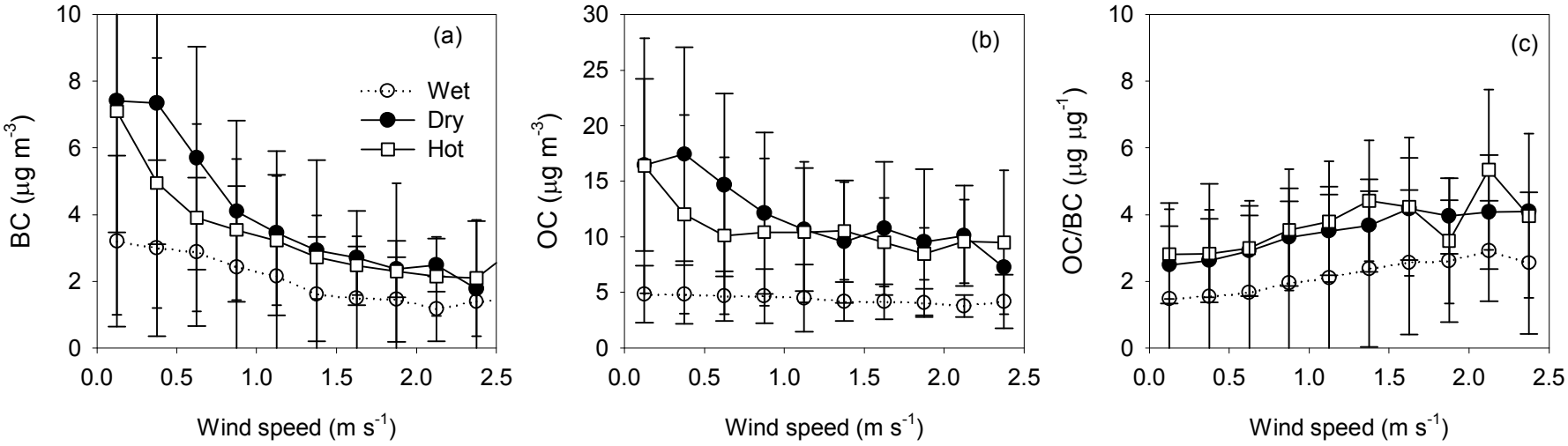
The lowest concentrations in the afternoon hours could be due to deeper planetary boundary layer (PBL, >3 km in hot season) and reduced traffic.

Weekend effect on the concentrations of BC and OC



The weekend effects in the concentrations of both BC and OC are significant. Therefore, stricter abatement in vehicular emissions could substantially reduce pollution.

Dependencies of aerosols on wind speed

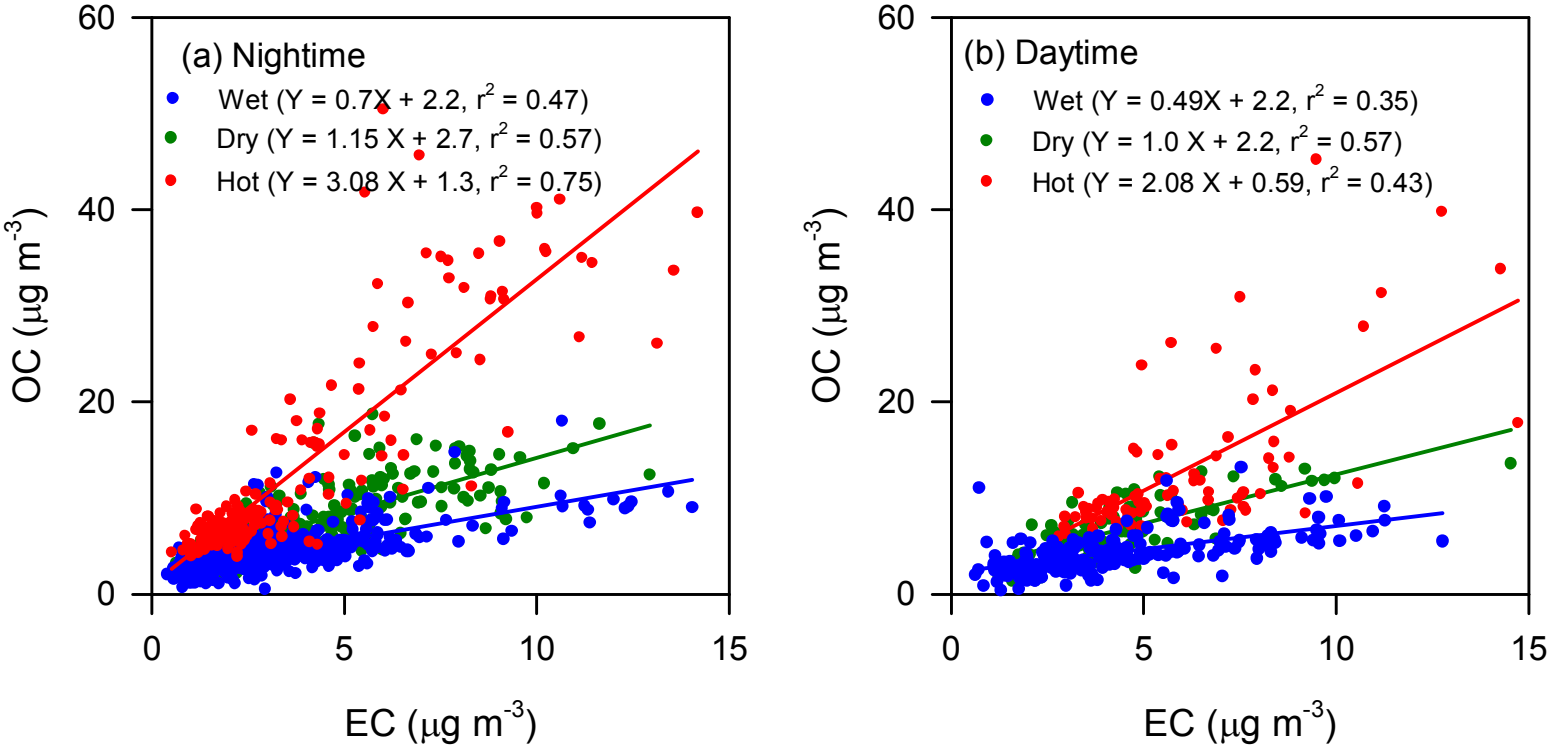


The concentrations decrease with the increase in wind speed and were particularly sensitive in the lower wind flow regime (< 1.0 m s-1).

The seasonality in the relationships could be due to the transport of air masses with different background levels of aerosols.

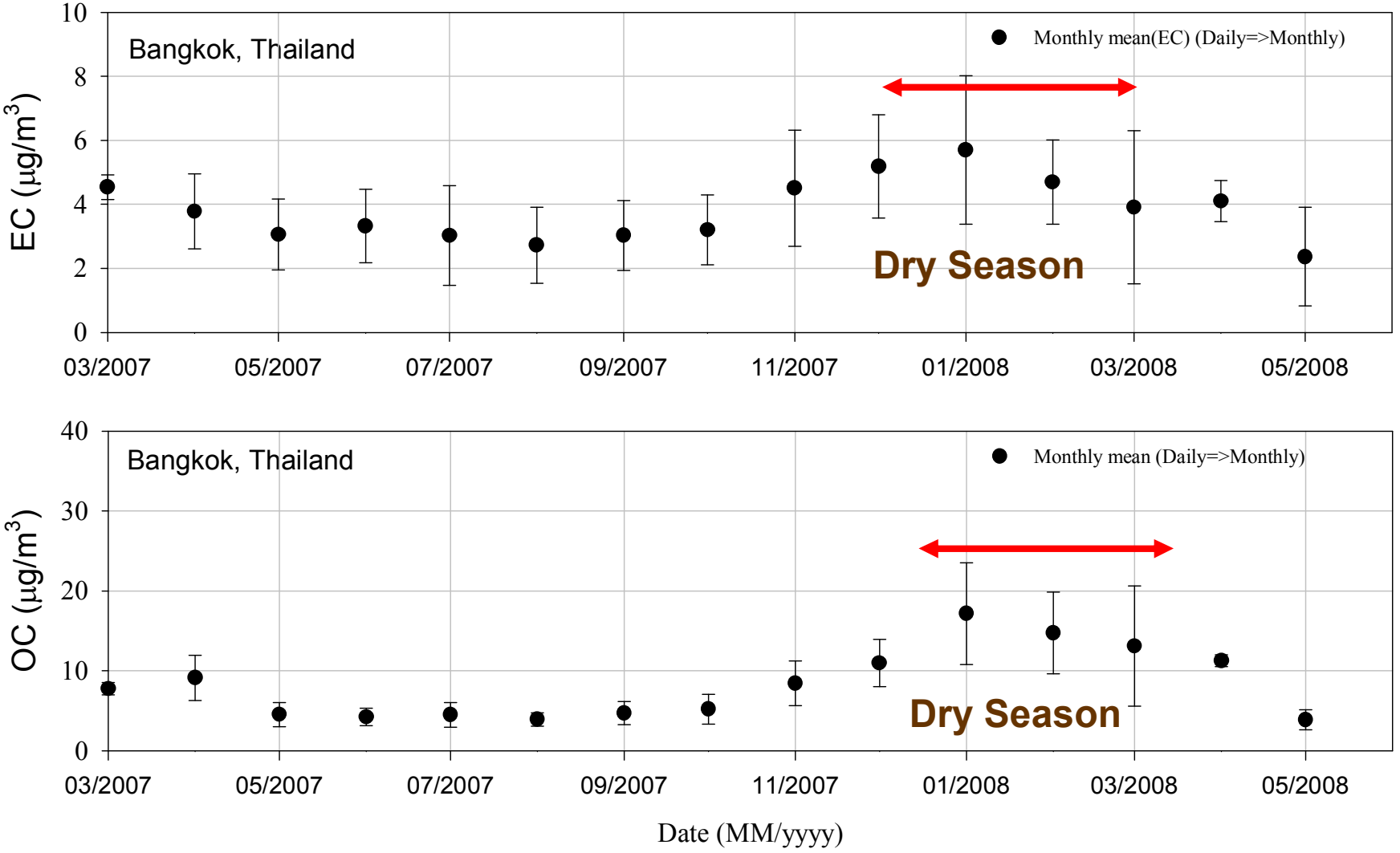
The sharp declines in the concentrations of BC and OC were observed during rainfall in Bangkok due to wet scavenging of aerosols in the wet season.

Seasonality in relationship between OC and EC



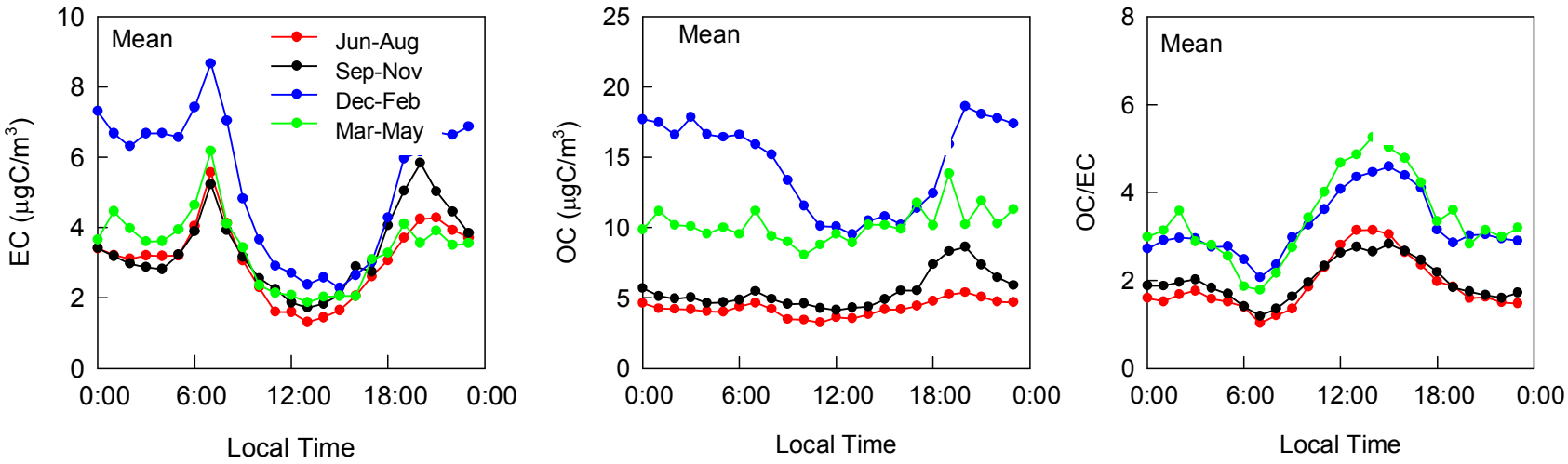
Thank you

Annual Variations of BC and OC in Bangkok: Year 2007- 08



The peaks fall in January month, but the most extensive biomass burning is during March?

Diurnal Variations of EC, OC and OC/EC, Year 2007-08



- EC shows strong diurnal variation in all the seasons with a primary peak in the morning hours and lower values in the afternoon ours.

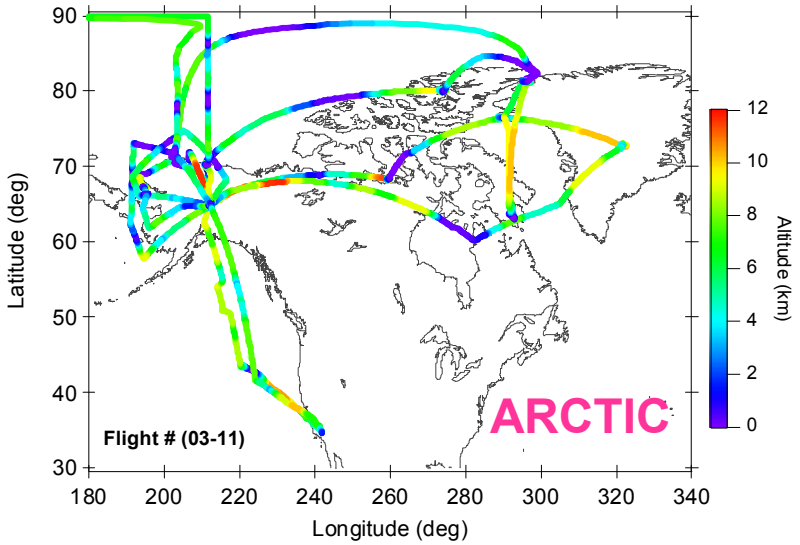
- OC variation is significant in the winter months but not noticeable in other seasons.

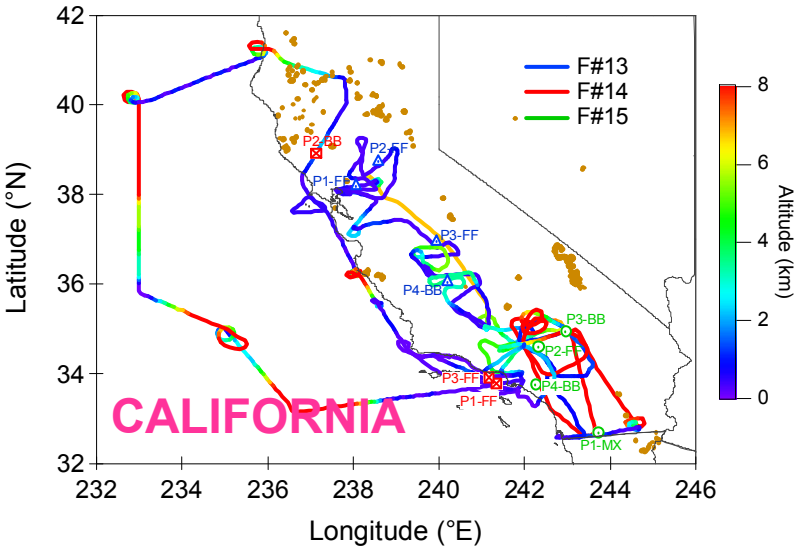
- OC/EC ratio show similar variations in all the months with a morning hour minimum and peak in the afternoon hours

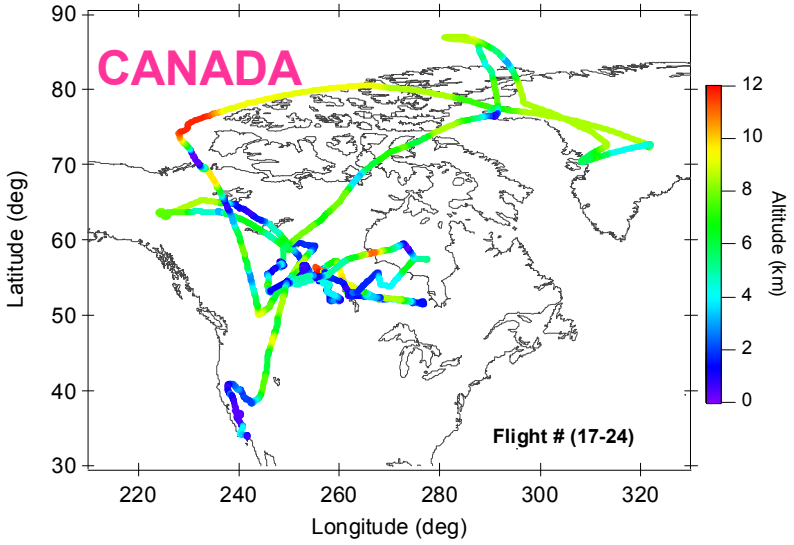
NASA Campaigns: ARCTAS (A, B) and CARB, 2008

Arctic **R**esearch of the **C**omposition of the **T**roposphere from **A**ircraft and **S**atellites

California **A**ir **R**esources **B**oard







DC-8, 24 Flights

~250 species (aerosols and trace gases)

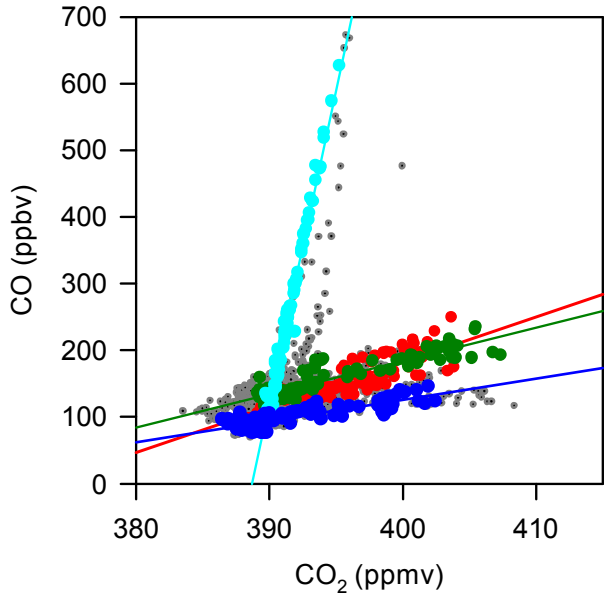
Single Particle Soot Photometer (SP2)
ARCTAS/CARB

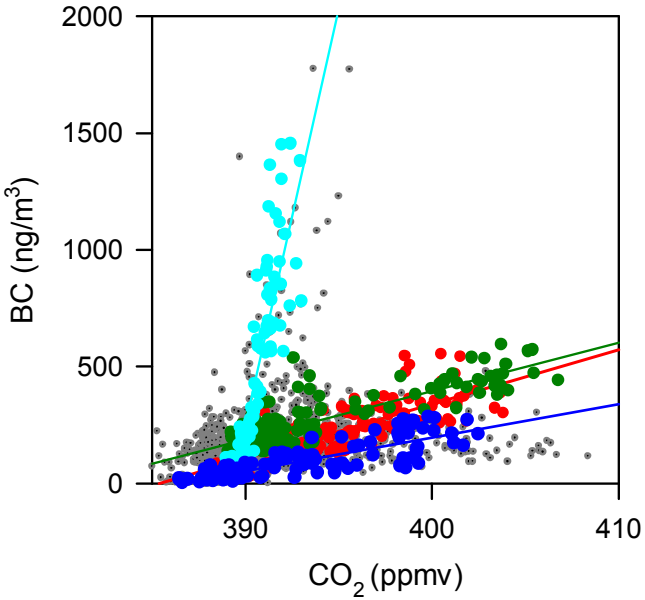
1. Scattering Number _Num, #/cm^3 @ 1013hPa, 273K
2. BC Number, #/cm^3 @ 1013hPa, 273K
3. Scattering Volume , μm^3/cm^3 @ 1013hPa, 273K
4. BC Volume, μm^3/cm^3 @ 1013hPa, 273K
5. BC Mass Conc., ng/m^3 @ 1013hPa, 273K
6. BC Median Shell/Core Ratio (170-300 nm), none

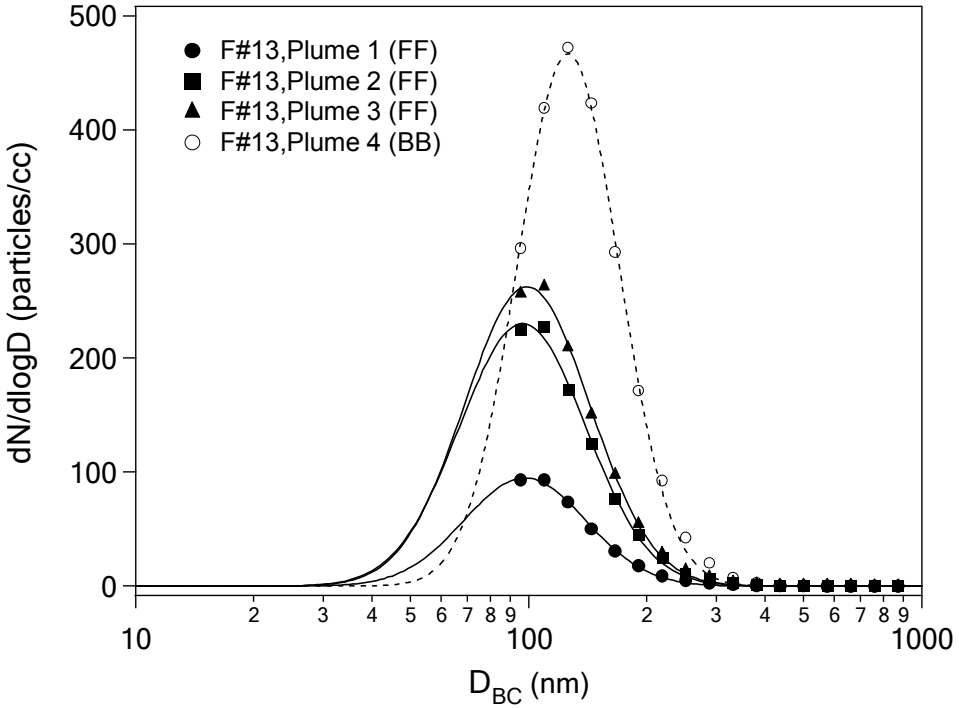
PLATFORM: DC-8, BASE: PALMDALE

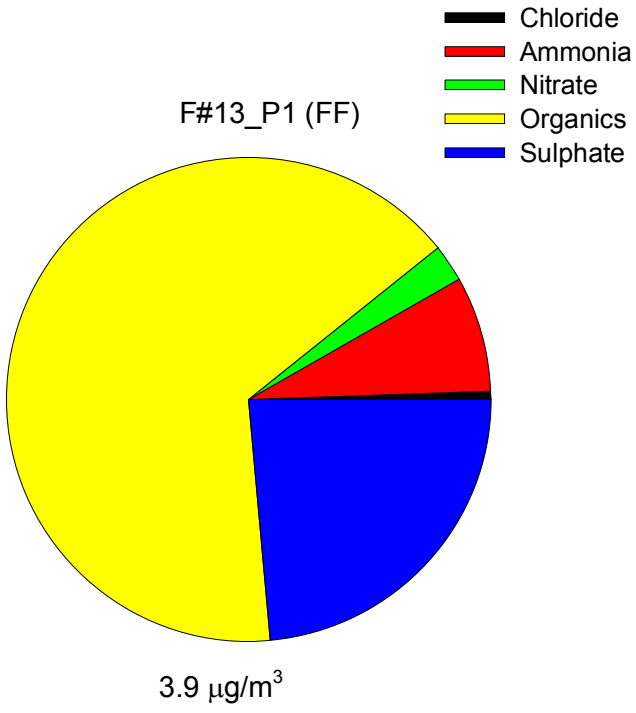
CARB Results Anthropogenic (FF) vs. BB

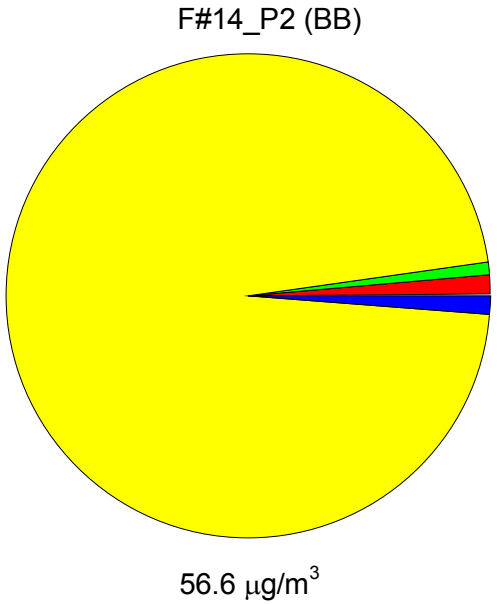
P1: Stockton (FF)
P2: Sacramento (FF)
P3: Fresno (FF)
P4: Fire (BB)








Chloride
Ammonia
Nitrate
Organics
Sulphate
F#13_P1 (FF)
3.9 μg/m3


F#14_P2 (BB)
56.6 μg/m3