Development of Emission Factors of Nanoparticles ($PM_{0.1}$) from Solid Biomass Combustion

Worradorn Phairuang[1,2],
Hisam Samae[1], Perapong Tekasakul[1],
Surajit Tekasakul[1] and Masami Furuuchi[2]

[1]Prince of Songkla University, Thailand
[2]Kanazawa University, Japan

Background and objective

Many investigations of

- Chemical composition of TSP, PM_{10} and $PM_{2.5}$
- Number concentration and size distribution down to nanoparticles

Very few information of

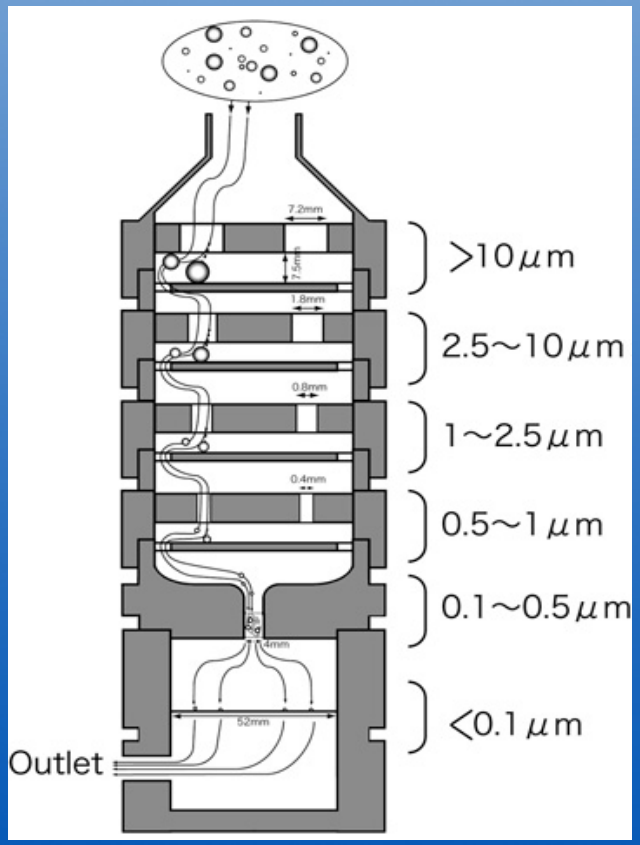
- Mass concentration and chemical composition of nanoparticles
- The lack of data both of activity level and corresponding Emission Factor (EF) would lead to large uncertainty inventory

Objective

1. To measure emission factors of nanoparticle ($PM_{0.1}$) from solid biomass combustion
2. To investigate the solid biomass burning in laboratory chamber

Nano-sampler developed in Kanazawa University, Japan

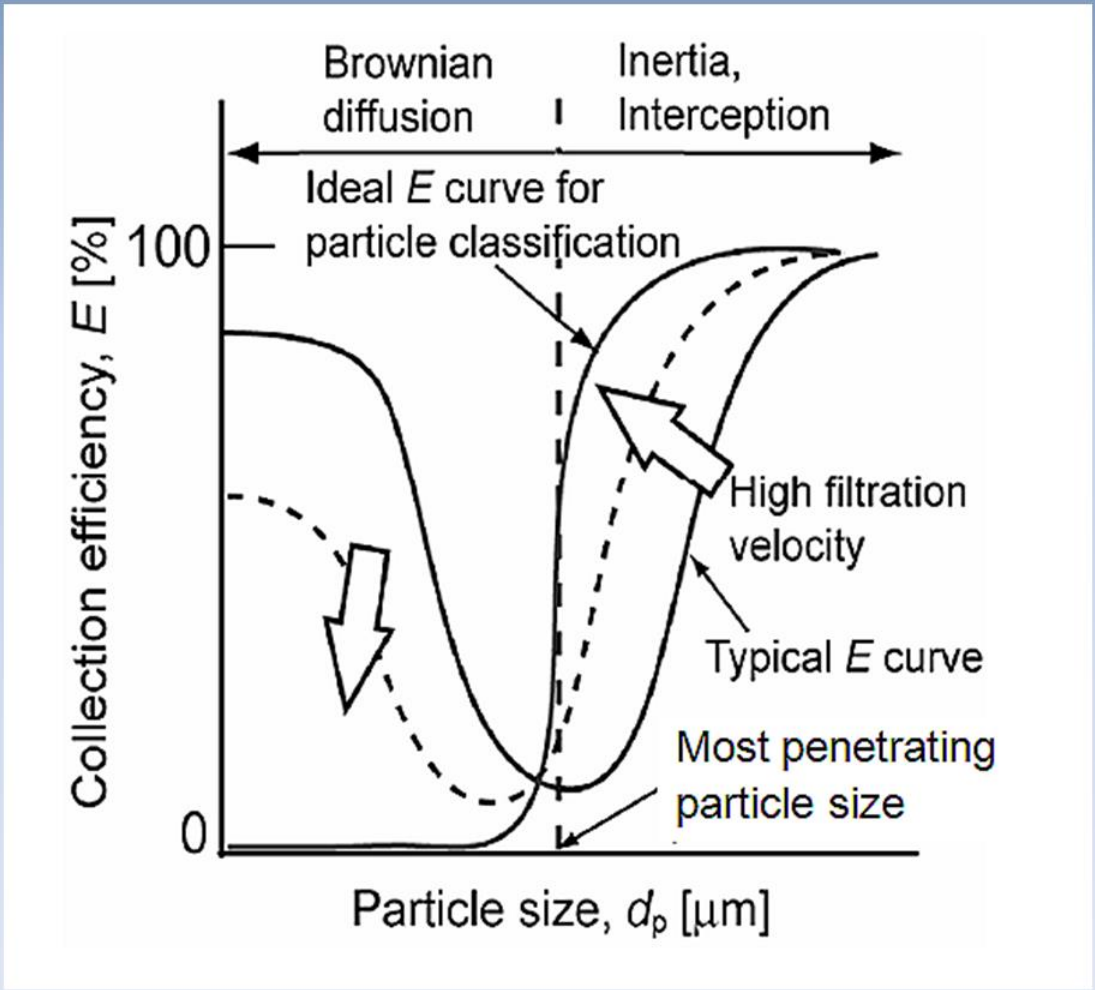
Ambient nano-particle sampling



Chemical analysis

1. Carbon analyzer capable of analysis of elemental carbon (EC including information of char-EC and soot-EC) and organic carbon (OC)
2. Integrated Sphere Method (IS) for Brown Carbon (BrC)
3. Ion chromatography to determine major ion components of Cl^-, NO_3^{2-}, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}
4. TOC analyzer to determine water soluble organic carbon (WSOC)

Inertial filter technology: key technology for nanoparticle classification developed in Kanazawa University

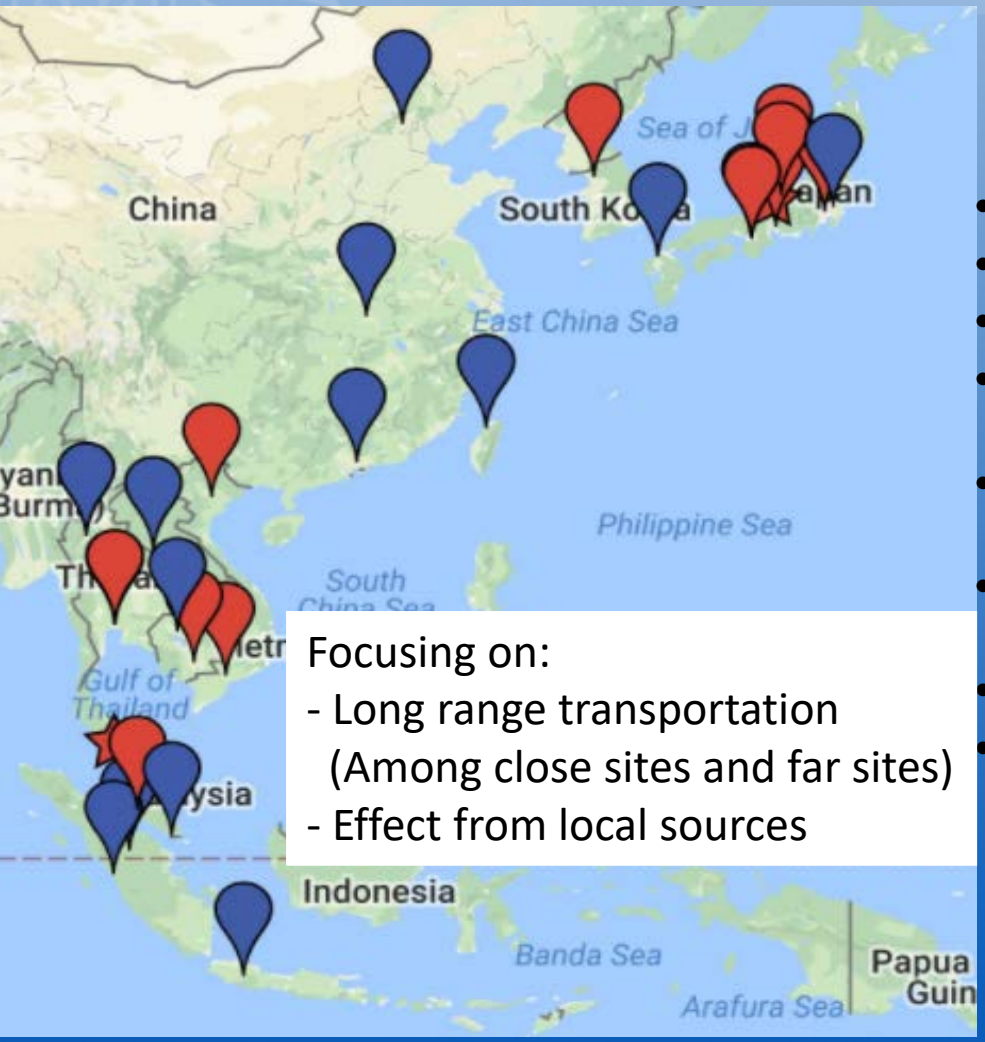


The total pressure drop of the sampler (referred to as a *"Nanosampler"*) was ~30kPa at a flow rate of 40 L/min

- Rather large filtration velocity (10 ~ 50 m/s)
- Fine fiber (5~15 μm)

Large inertial effect even for ultrafine range particles with moderate pressure drop through filter

East Asia Nanoparticle Monitoring Network (EA-Nanonet)



Focusing on:
- Long range transportation
  (Among close sites and far sites)
- Effect from local sources

Sites in SE Asia

- Cambodia-Phnom Penh
- Vietnam-Hanoi
- Vietnam-Ho Chi Minh City
- Thailand - Bangkok (3 sites)
- Thailand - Songkhla (PSU)
- Thailand Chiang Mai (CMU)
- Malaysia-Bangi
- Indonesia-Riau

Sites in Japan

- Kanazawa
- Toyama
- Suzu
- Nagoya
- Osaka
- Saitama

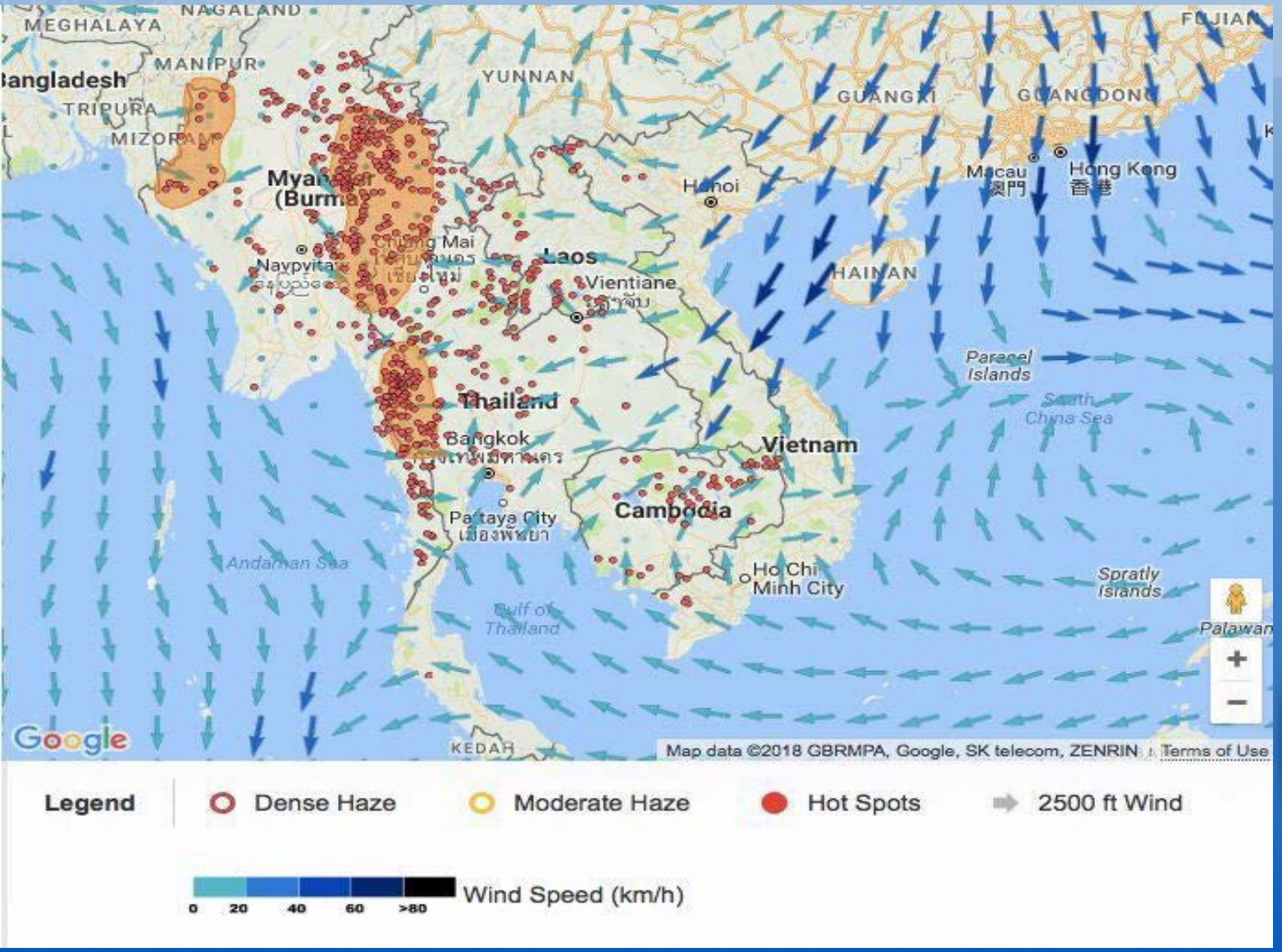
1st term: 3/28-4/19, 2016
2nd term: Indonesia Forest Fire 2017
3rd term: Chiang Mai Forest fire 2018

For What? (Objectives of EA-Nanonet)

- Evaluation of status of nano-aerosol ($PM_{0.1}$) in East Asian region
- Discuss local emission sources of $PM_{0.1}$
- Discuss transboundary influences
- Discuss possible health risk of ambient $PM_{0.1}$
- *Discuss $PM_{0.1}$ emission factor and corresponding inventory*
- Development and application of new tools for $PM_{0.1}$ measurement
- Build and strengthen an international network which many useful knowledge on $PM_{0.1}$ are provided.

ACTIVE FIRES (1 MONTH - TERRA/MODIS)
March 2018

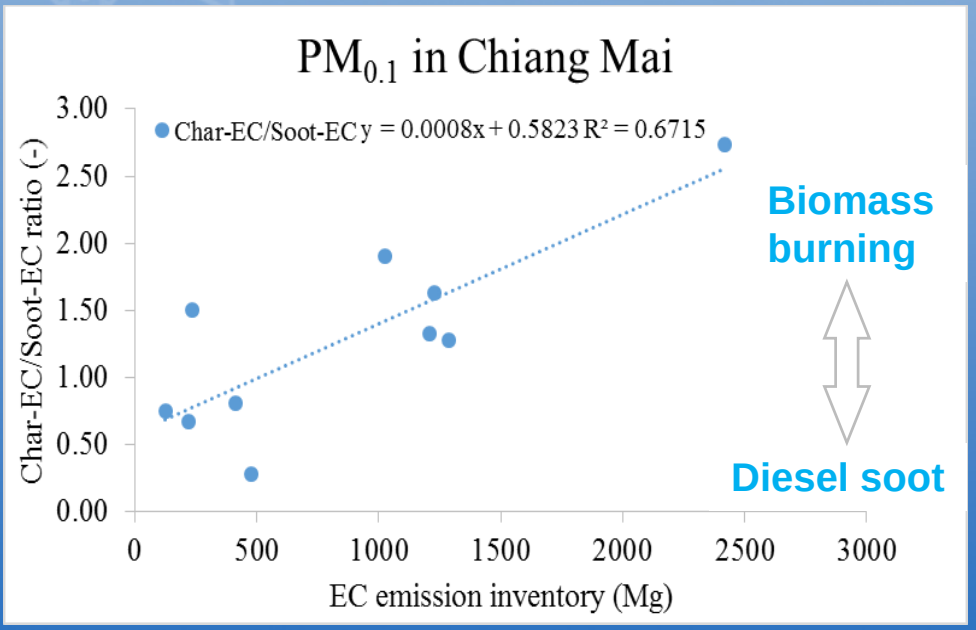
Haze Situation in Southeast Asia

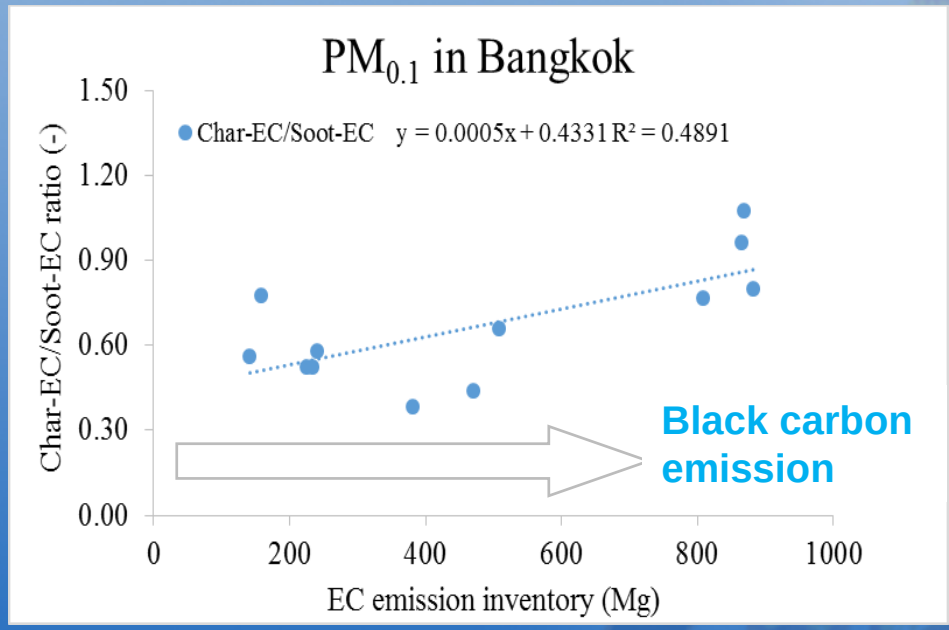


20 March 2018

http://asmc.asean.org/asmc-hotspot#Hotspot

Influence of biomass burning on carbons in nano-aerosol





Carbon index of biomass burning in $PM_{0.1}$ is very sensitive to carbon emission from agricultural residue burning

Methodology

Solid biomass fuel

6 types including;

Palm Kernel

Rice Straw

Sugarcane Leave

Corn stem

Bagasse

Rubber Wood

Para-rubber fuelwood in agroindustry, Thailand


Palm Kernel


Rice Straw


Sugarcane Leave

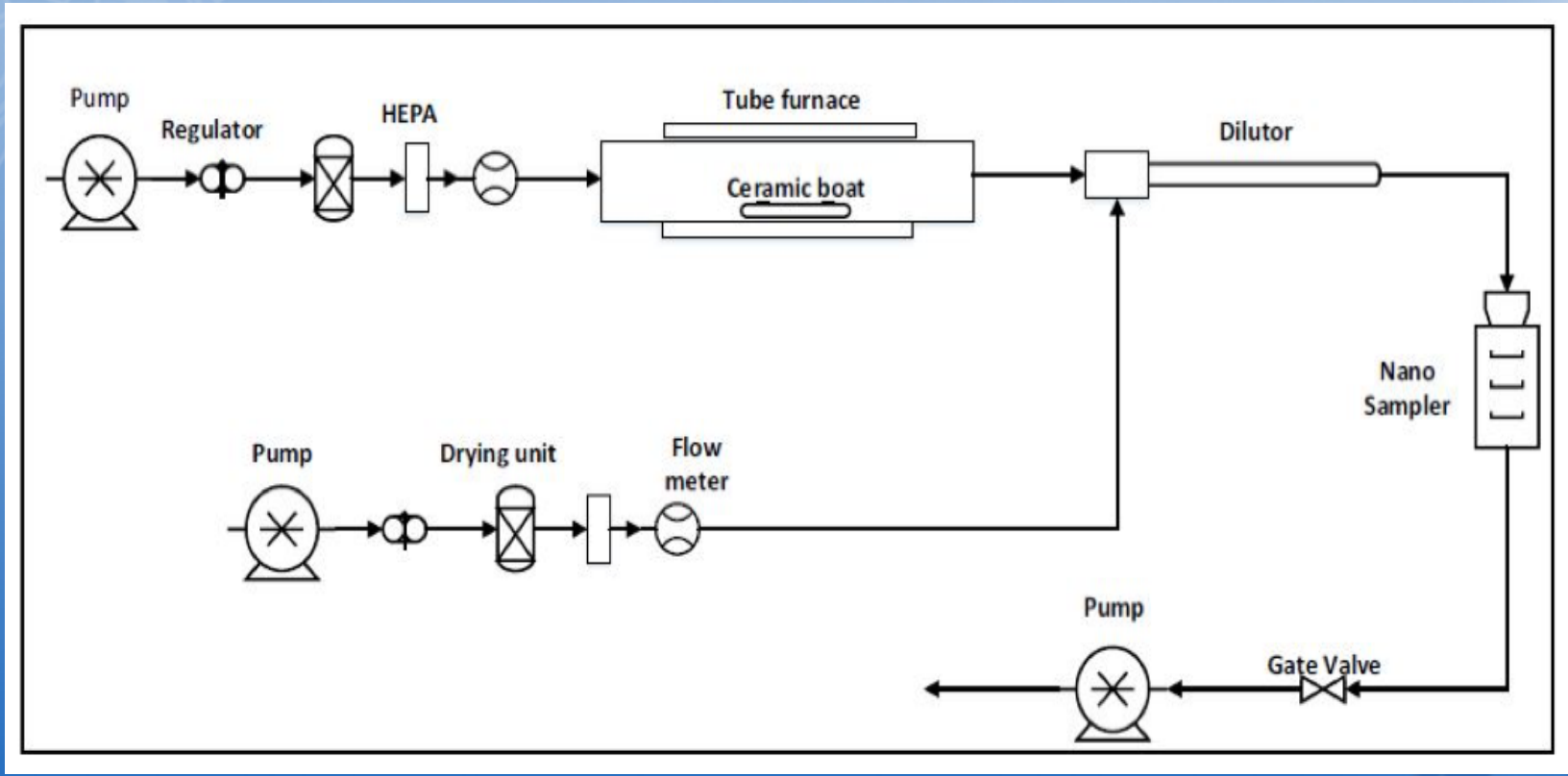

Corn stem


Bagasse


Rubber Wood

- Select saw dust as biomass geometry to deduce influences of geometry and better (uniform) adjustment of moisture content

Combustion Experiment



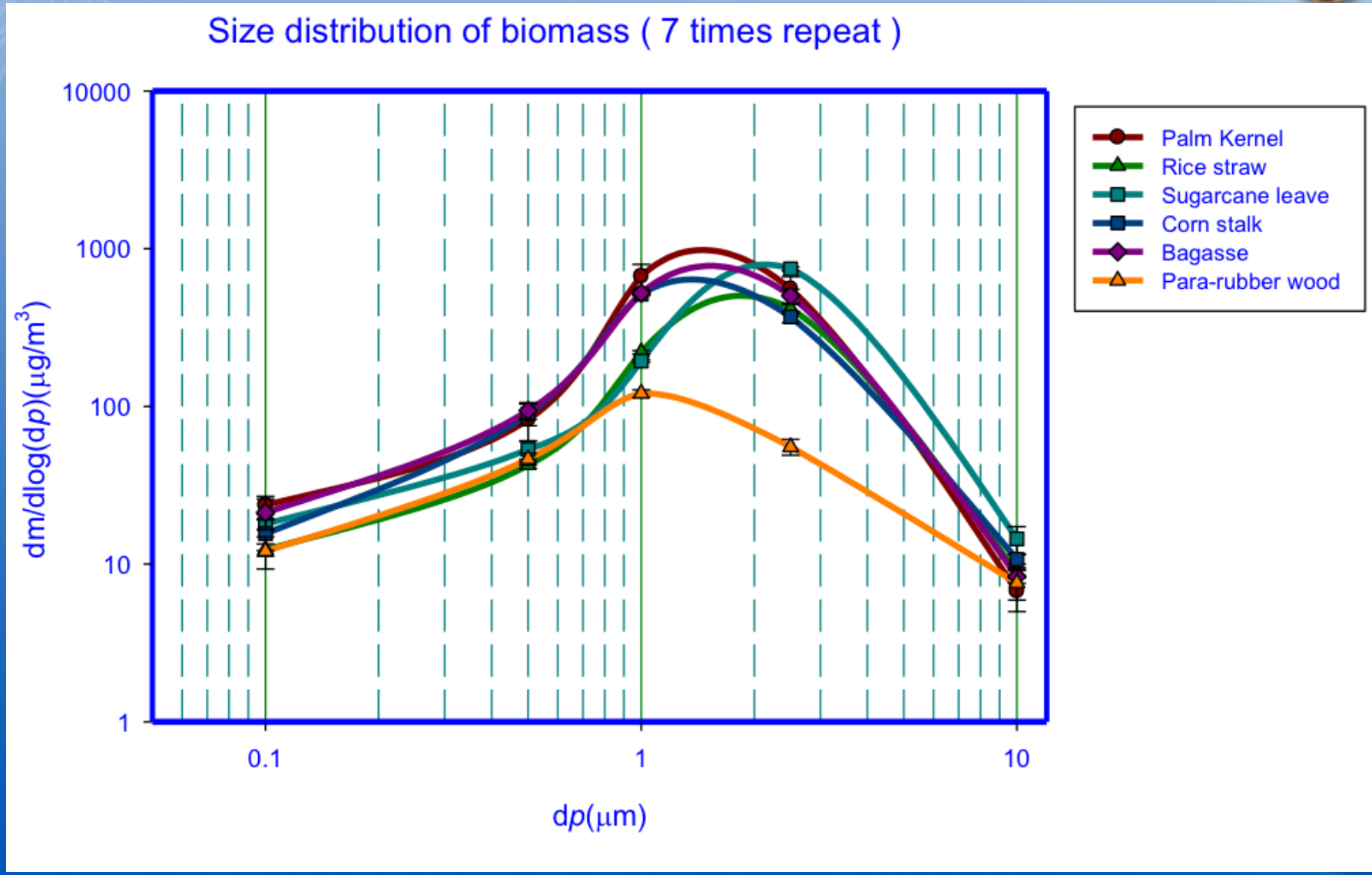
- The solid biomass burned in a horizontal tube furnace with an inserted quartz column.
- Dry clean air approximately 1.6 L/min is purged into the furnace to combust the solid biomass sample.
- dilutor (OD = 35 mm and L = 800 mm) include a mixing tube (L = 70 mm) by the dry clean air

Emission Factors (EFs) Calculation

Emission factors (EFs) of $PM_{0.1}$ from the burning experiment will calculate based on the flow rate of the Nano-sampler and particulate matter concentrations using Equation [1]
(Kim Oanh et al., 2011).

$$[1] \quad EF = \frac{\text{Concentration } (mg * m^{-3}) * \text{Flowrate } m^3h^{-1} * \text{Sampling time (h)}}{\text{biomass burned (kg)}}$$

Results and Discussions



Results and Discussions

- The size distributions of the smoke particles indicates a single-mode behavior.
- They contained major particles in an accumulation mode (0.1 μm < particle size < 2.5 μm)
- The results display that the combustion of solid biomass emits a large fraction of fine particles.
- Around 20% of the six types of the smoke particles has a mass that fell within a range of < 100 nm.

Results and Discussions

Measured $PM_{0.1}$ Emission Factors ($g.kg^{-1}$) for Solid Biomass

Biomass type	Excess air ($Lmin^{-1}$) *	Heating rate ($°Cmin^{-1}$)	Maximum temperature(°C)	$PM_{0.1}$ Emission Factors (g/kg)
Palm Kernel	0.25	5	575	0.17
Rice Straw	0.16	5	575	0.11
Sugarcane leave	0.15	5	575	0.11
Corn stem	0.16	5	575	0.14
Bagasse	0.14	5	575	0.22
Rubber wood	0.13	5	575	0.15

*excess 130% air

Conclusions

- The Emission Factors (EFs) values for six types of solid biomass burning in the laboratory experiment range from 0.11 to 0.22 g/kg.
- The highest EFs come from Bagasse (0.22 g/kg), the minimum EFs derive from rice straw and sugarcane leave (0.11 g/kg).
- The EFs are important for the development of strategies for pollution control and decrease the biomass burning.
- EFs of $PM_{0.1}$ will be discussed in detail based also on other chemicals (mainly; BC, BrC and OC).

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References

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Thank you for your attention

Hat Yai atmosphere, September 2015