EC/OC Emissions in China: Current Understanding & Relevant Issue

ZHANG, Xiao-Ye; Qiu, J H; Gong, S L; Cao, G L; Zhou, L X; Sun, J Y; Wang, H; Wang, Y Q; Xu, D; Zhang, H; Ma, J Z; Liu, Y; Li, Yang; Che, H; Ding, Y

Centre for Atmosphere Watch & Services (CAWAS), CMA
Emission Inventory of EC & OC in China
Carbonaceous aerosol emission source
Fuel types considered in this work

**Residential**
- Agriculture residues
- Fuelwood
- Rural residential-coal
- Rural residential-oil
- Urban residential coal
- Urban residential-oil

**Biomass burning**
- agriculture waste
- Forest fire
- Grassland fire

**Industry**
- Urban industry-coal
- Urban industry-oil
- Rural industry-coal
- Rural industry-oil
- Biofuel

**Power Plant**
- Coal
- Oil

**Transportation**
- diesel
- gasoline
Methodology

Fuel-use data (NBSC, coal, oil, biofuel) at province level

Database of forest fire and grassland fire (time, position, area)

Emission from Biomass burning

Crop-to-residue ratios

Porportion of open burnt in field

Emission from industry, domestic, transport and power plant

Fuel-use data distribution at country level

Census data

Life level

Economic level

Output database of crop at country level

Output database of crop straw at country level

Crop-to-residue ratios

Porportion of open burnt in field

Fuel load

EF

Estimated BC and OC emissions
Estimated BC emission for the year 2000 in China by CAWAS

Total 1.6 Tg
Estimated OC emission for the year 2000 in China by CAWAS

Total 4.5 Tg
Regional BC Sources

![Bar Chart showing emissions from various regions]

- Biomass burning
- Power plant
- Transport
- Industry
- Residential (Gg)
Monthly fractions of total BC emission

Open burning of agriculture waste
Monthly fractions of total BC emission

Open burning of agriculture waste
Emission inventory Comparisons (China)

<table>
<thead>
<tr>
<th></th>
<th>BC (Fossil fuel only)</th>
<th>OC (Fossil fuel only)</th>
<th>OC/BC: (\sim 3)</th>
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<td>Cooke 1996</td>
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<td>Novakov 1998</td>
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- Biomass burning
- Power plant
- Transport
- Industry
- Residential
- Total (Gg)
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- Biofuel

Power Plant
- Coal
- Oil

Transportation
- diesel
- gasoline
Some OC-EC Observations in China
CO, Waliguan
Ozone

地基臭氧总量在瓦里关山的观测

臭氧垂直分布的变化(从地面到18公里)
Column Ozone (surface to 18 km)
(7 July – 3 August 1996, Xi-Ning)

(对流层臭氧, 位温在天气尺度的垂直演变过程)
GHGs, Waliguan
Some BC (EC) & OC Results
2003年9月13日至2004年4月30日西安（总观测日223天）
13 Sept. 2003 – 30 April 2004 XiAn (Total observation days: 223)
图3-1 2003年9月13日-2004年4月30日每5分钟的BC浓度变化序列图
（BC浓度单位µg m⁻³）
(5 min-averaged BC variations at XiAn (13 Sept., 2003) – 30 April, 2004)
EC vs BC
(XiAn, Fall of 2003 to Spring of 2004)

BC = 1.00EC + 3.24, R = 0.81, n = 49

BC = 1.43EC + 2.15, R = 0.70, n = 112

BC = 1.15EC - 0.02, R = 0.69, n = 57

BC = 1.31EC + 1.37, R = 0.72, n = 218
OC-EC (Shang-Dian-Zi)

Comparisons between daily-mean SSA from AERONET (Nakajima’s method) and SSA from BRM (Qiu et al.’s method)

Deviation of total-mean SSAs: 0.006!
OC-EC-Sulfate-Nitrate (LinAn)

Julian Day (LinAn, 3 March - 3 Nov 2004)

Sulfate, µg m⁻³

Nitrate, µg m⁻³

OC/EC

Mean

OC, µg m⁻³

EC, µg m⁻³

Julian Day (LinAn, 3 March - 3 Nov 2004)
CMA Aethalometer Network (2005)

中国气象局微粒吸收计网

全球本底站（1个）
已建区域本底站（3个）
拟建区域本底站（3个）
沙尘暴一级站点（10个）
中韩合作沙尘暴站点（4个）
新建站点（9个）
OC-EC-Sulfate-Nitrate (Yulin)

Julian Day (Yulin, 8 March 2003 - 5 Nov 2004)
CMA Aethalometer Network (2005)

中国气象局微粒吸收计网

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全球本底站（1个）
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拟建区域本底站（3个）
沙尘暴前期站点（10个）
中韩合作沙尘暴站点（4个）
新建站点（9个）
太阳光度计网
(Sunphotometer Network)

太阳光度计站点
(Sunphotometer Stations)
• Total mean SSA: **0.864**
• **Beijing**: **0.872**
• **Shenyang**: **0.815**; **Urumqi**: **0.777**
• Small SSA during winter over some sites such as Shenyang
图11：6个辐射站10年平均气溶胶光学厚度分布图

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<td>AOD</td>
<td>0.363</td>
<td>0.336</td>
<td>0.320</td>
<td>0.354</td>
<td>0.341</td>
<td>0.331</td>
<td>0.339</td>
<td>0.364</td>
<td>0.338</td>
<td>0.345</td>
</tr>
</tbody>
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16-site-mean yearly-mean AOD (750nm): 0.32～0.36

Qiu et al., 2001
The distribution of yearly mean (1961-1990) aerosol optical depth over China

Luo et al. (2001)

The linear trend *10 (yr⁻¹) of AOD over China mainland

Aerosol optical depth is increasing

cooling
Long-range climate effects of Aerosols

Based on measurements during the inter-monsoon period over India (South-west coast) (Moorthy et al. 2005).

Hansen and Nazarenko (2004)

(Koch and Hansen, 2005)
OC model performance

Model vs annual average surface concentration:

*Model low by > factor of 2*

Source: Dorothy Koch
Questions on Aerosol Issues

- Climate issue
- Environmental issue
- Secondary aerosol formation
- Natural and Anthropogenic Sources
Thank you!