Characterizing Airmass Outflow using Daily Biomass Burning Emission Inventories in Support of Flight Measurement Campaigns

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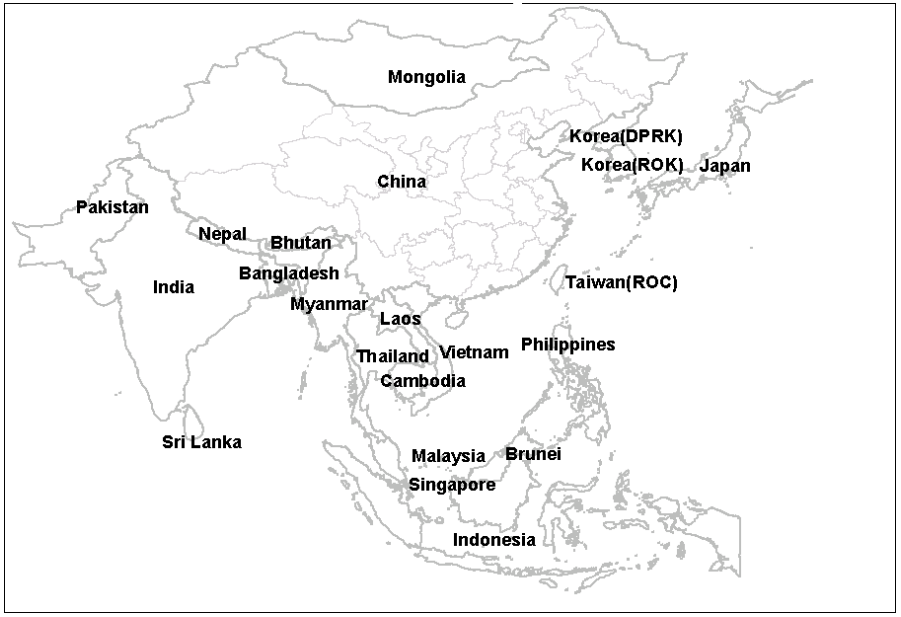
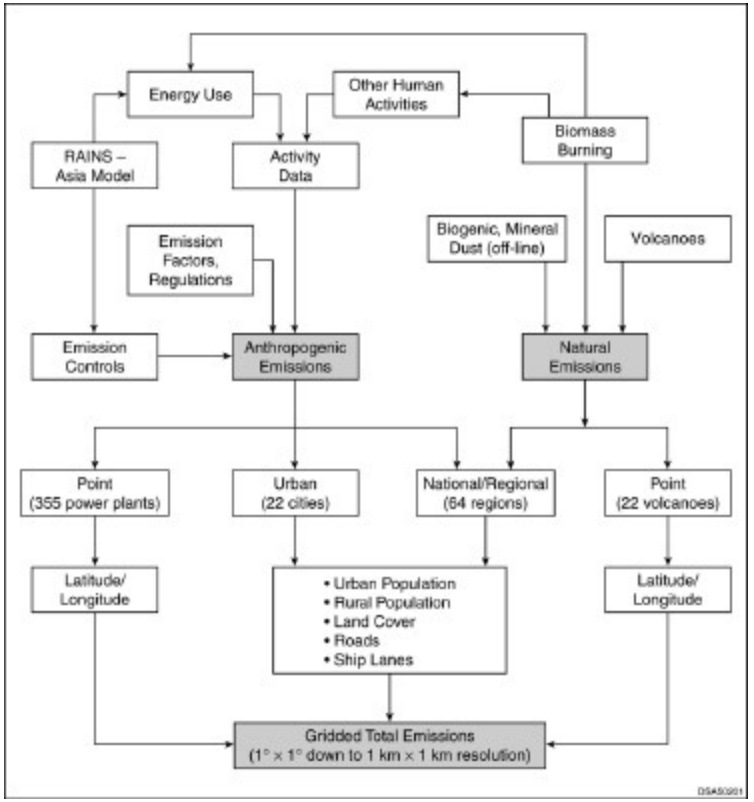
1. Emissions estimation

Research Domain





Schematic methodology for the development of Asian emission estimates

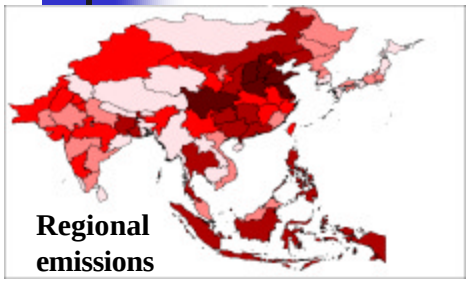
Objectives

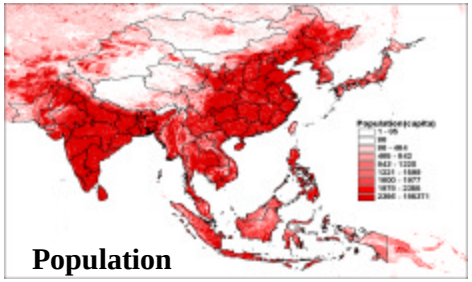
- Develop/manipulate emissions inventory that could support field measurement campaigns
- Analyze developed emissions inventory itself
- Finding airmass characteristics by integrating information from emissions, transport models, and other analysis.

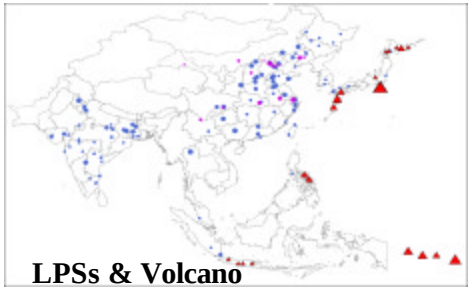
Data Sources

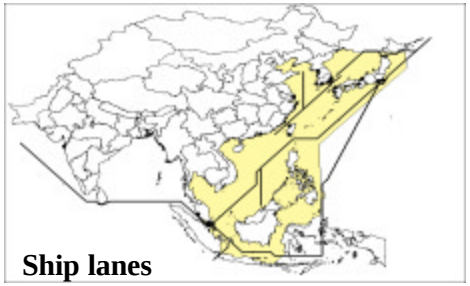
- Energy/Emission data
  - Emission by administrative boundaries : ANL (Dr. David Streets)
  - Large Point Sources(LPSs) : China-Map, Rains-Asia
  - Volcano emission data : GEIA, CRIEPI, Volcano world
- Geographical information system(GIS) data
  - Population and Landcover : ORNL
  - Admin. Boundaries, Road, Ship lanes : Digital Chart of the World (DCW), IIASA
- Remote sensing(RS) data
  - AVHRR Fire count/Cloud/Satellite coverage data : WFW
  - TOMS AI : NASA
- Other data
  - Precipitation data : NCEP
  - Oil/Gas/Mineral database : USGS

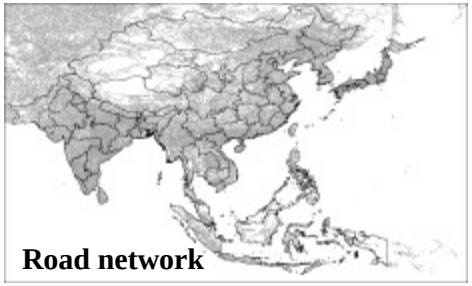
Data used for allocation



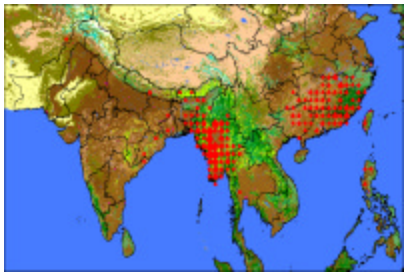


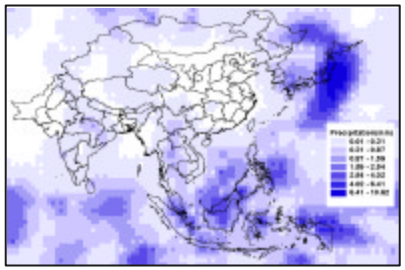


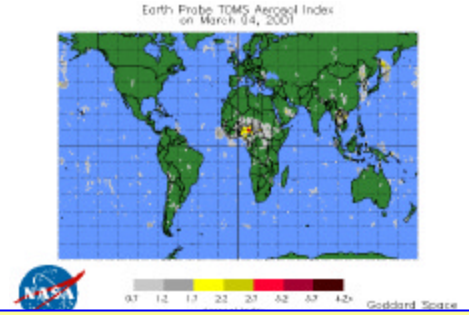




Used for Anthropogenic emissions gridding

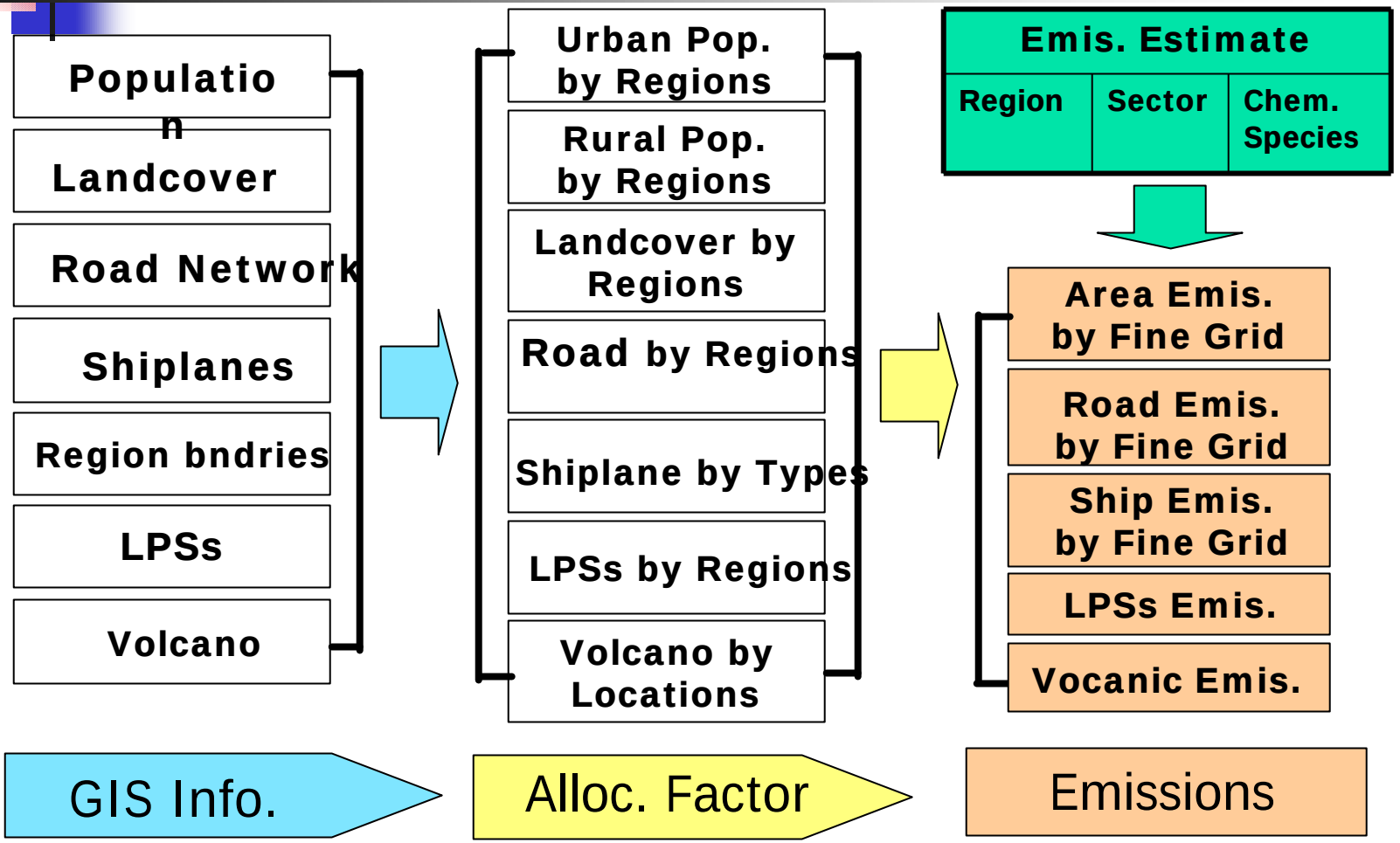






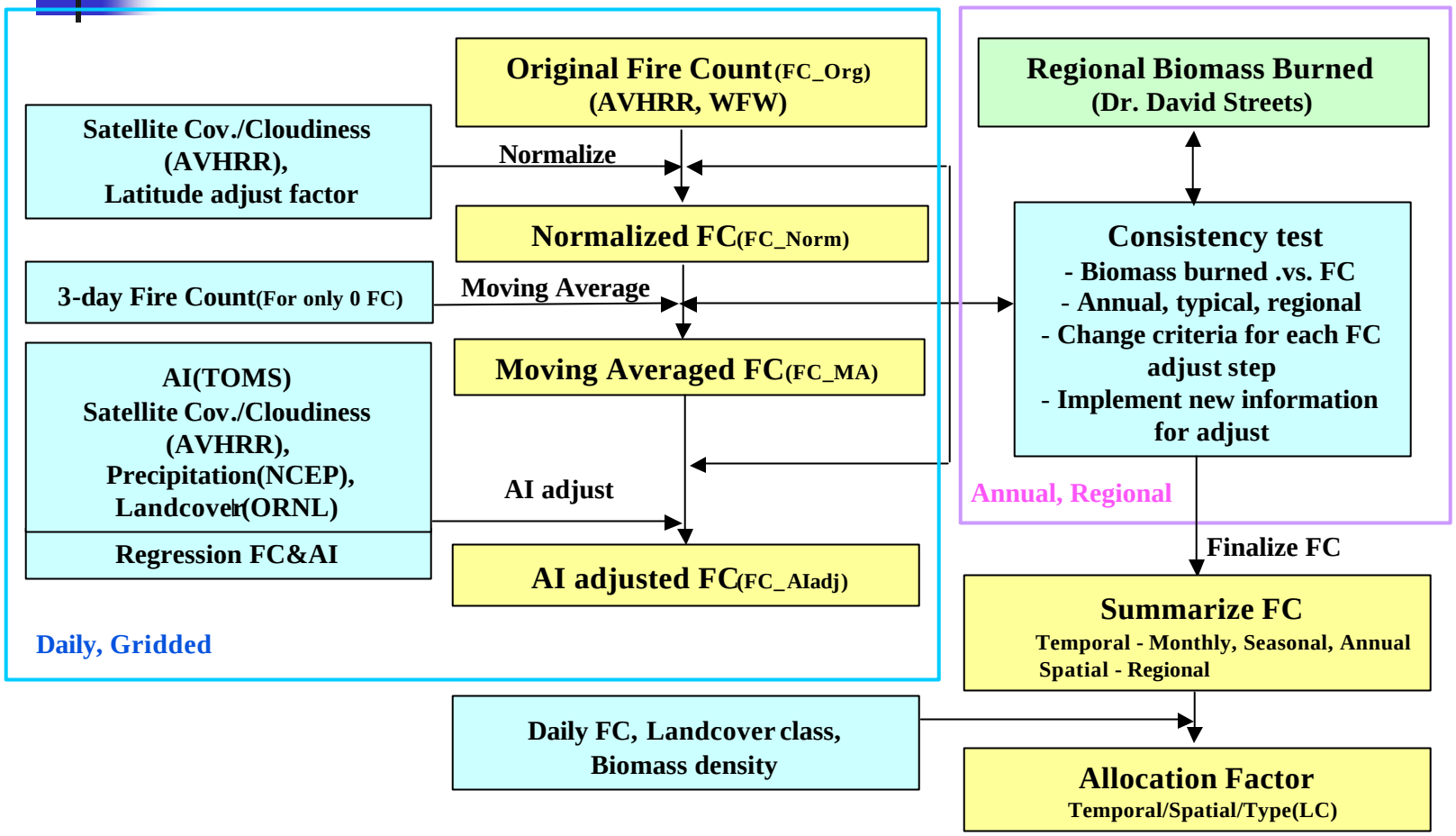
Used for biomass burning emissions allocation

Spatial allocation methodology (Anthropogenic)

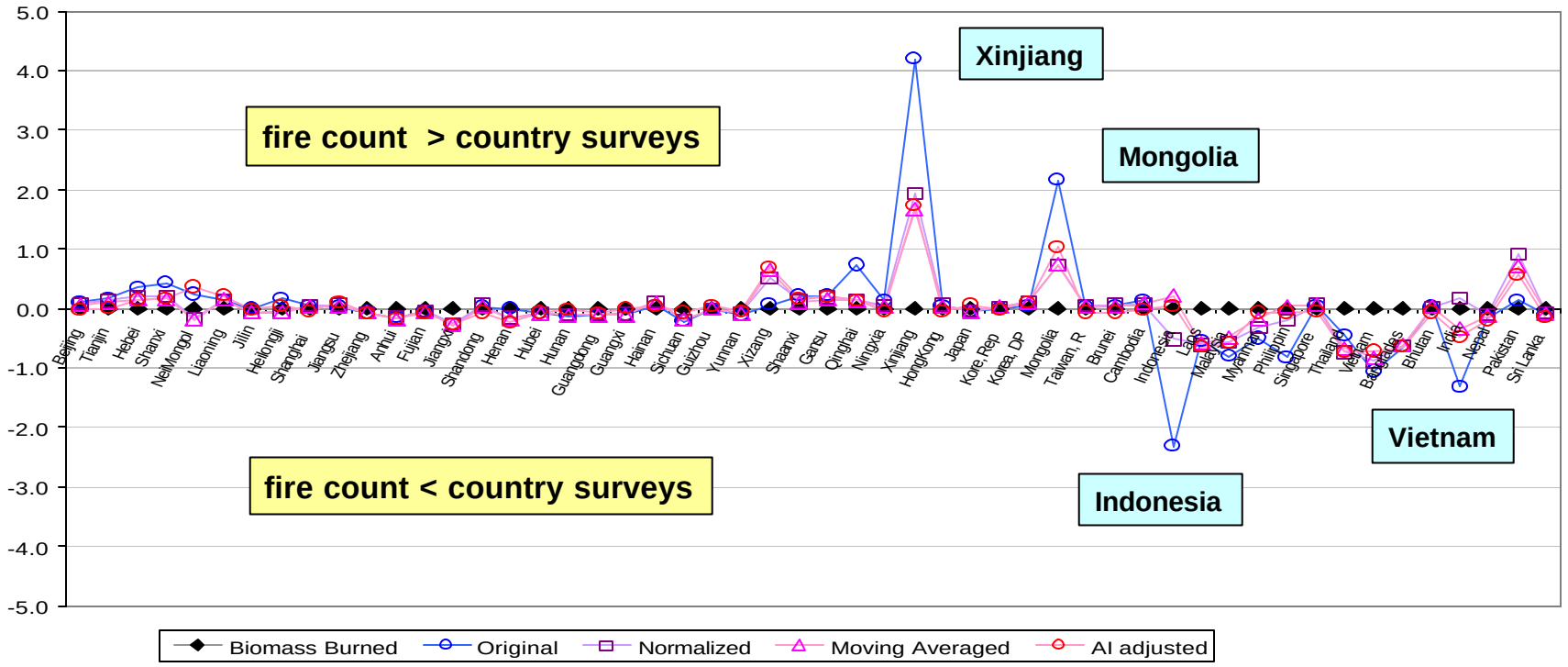


Spatial & temporal allocation methodology

(Biomass Burning, Y1999 & Y2000)

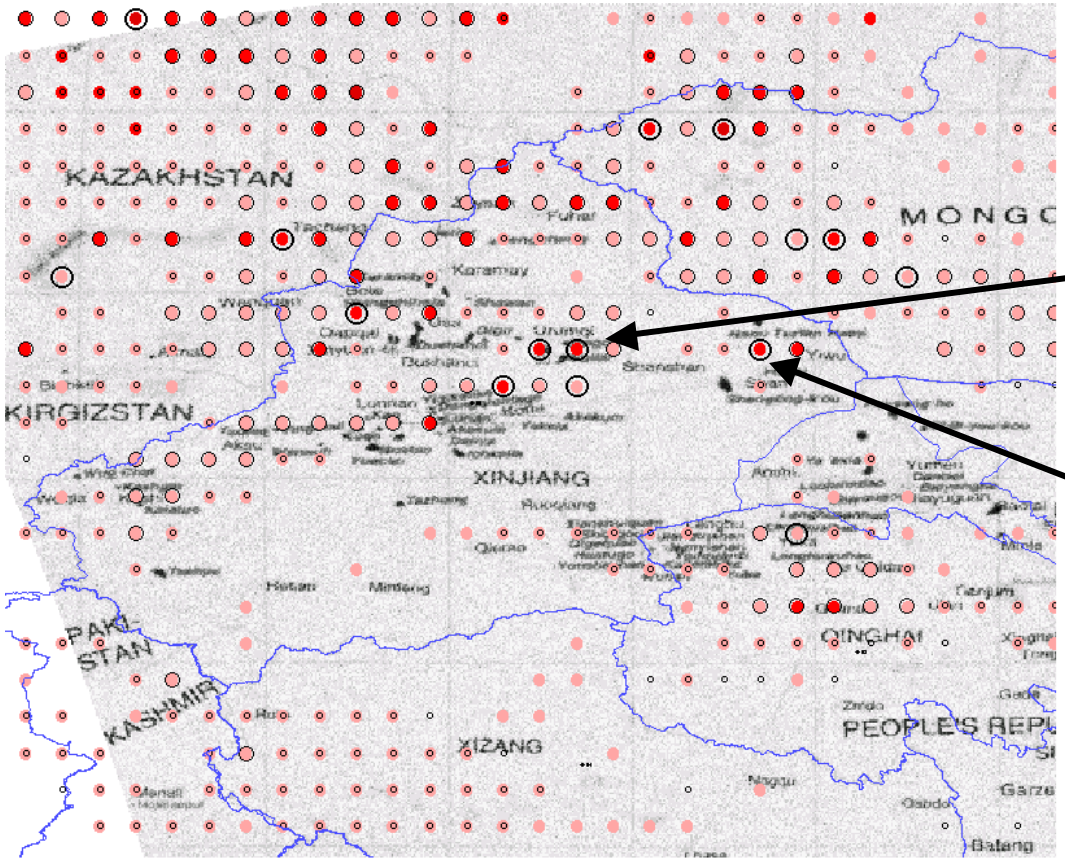


Test of Biomass burning Emissions



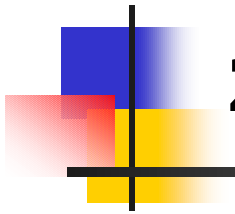
Comparison of country surveys with various AVHRR fire-count adjustments reveals problem areas for further investigation

FC from oil & gas drilling sites



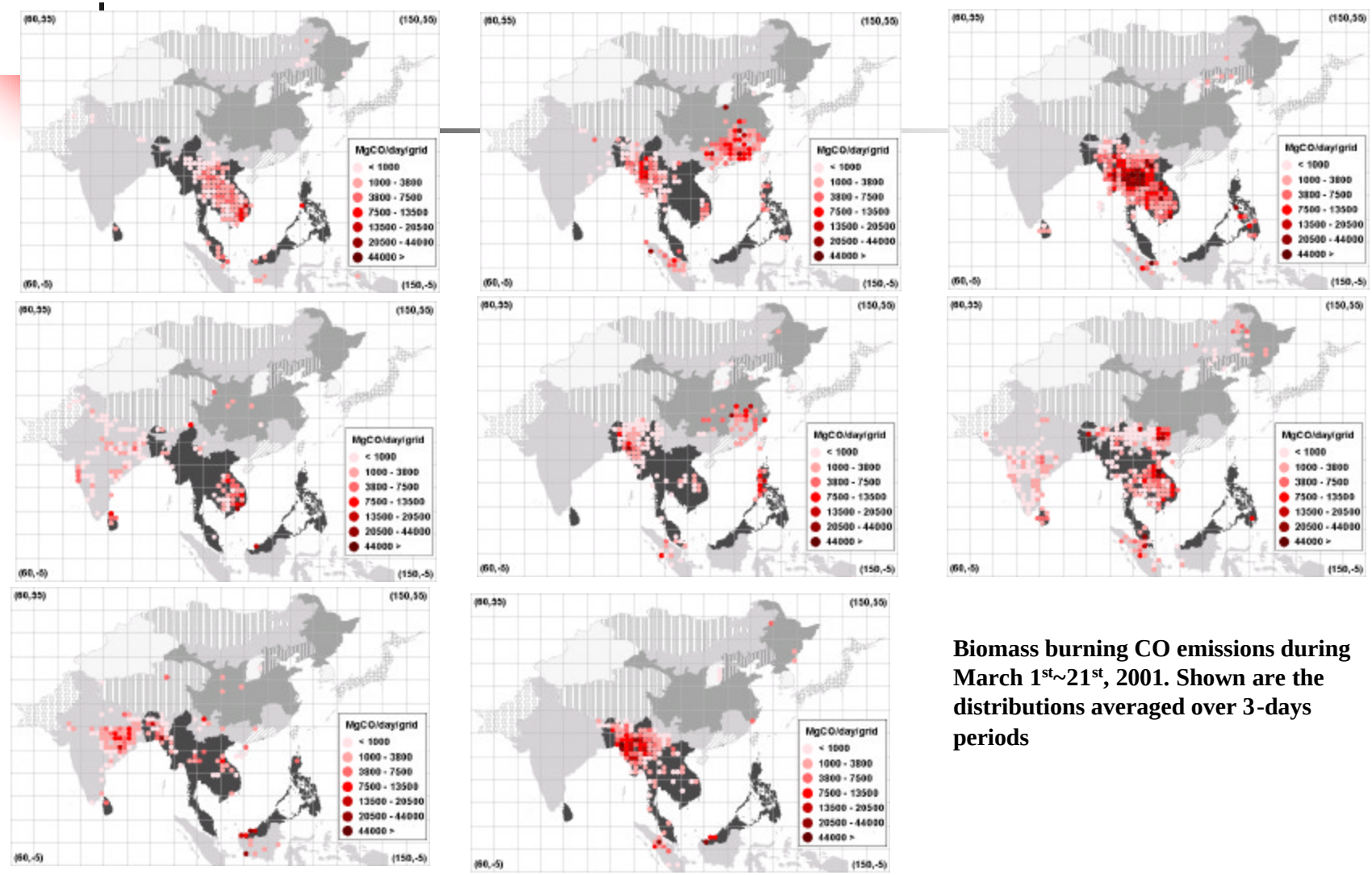
• **Fire detection from Xinjiang and Gansu province could be flares from Oil/Gas drilling site.**

• **Circle : Maximum FC>0 days in year 1999 & 2000**
• **Red dot : Maximum FC > 0 consecutive days**



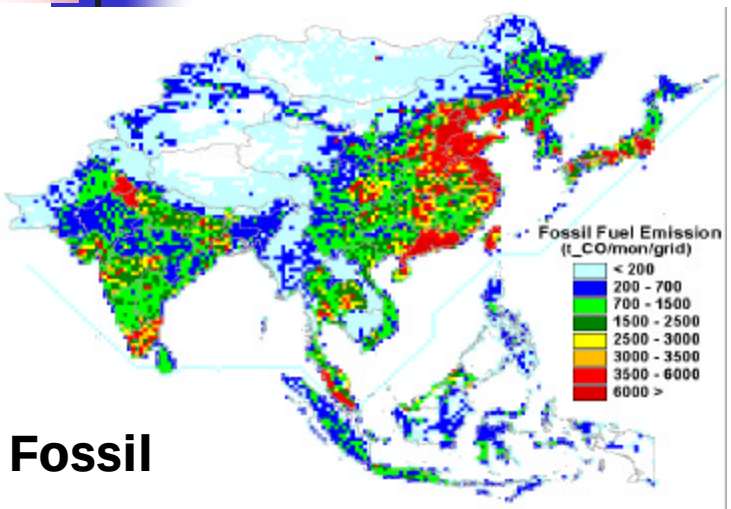
2. Inventory features

Daily biomass burning distribution

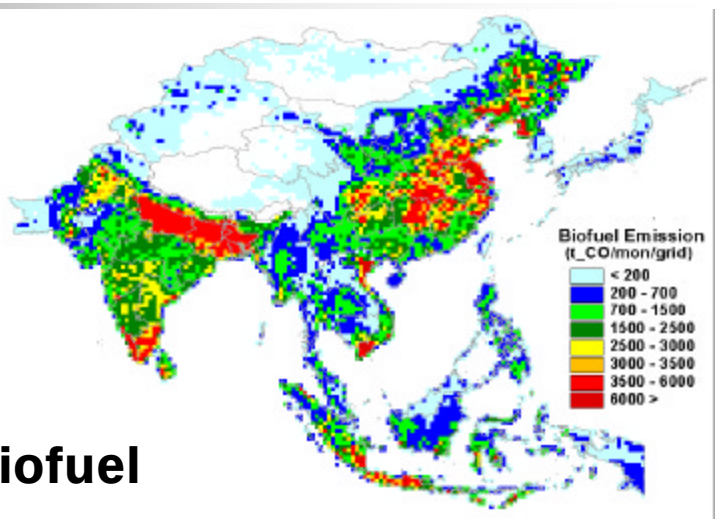


Biomass burning CO emissions during March 1st~21st, 2001. Shown are the distributions averaged over 3-days periods

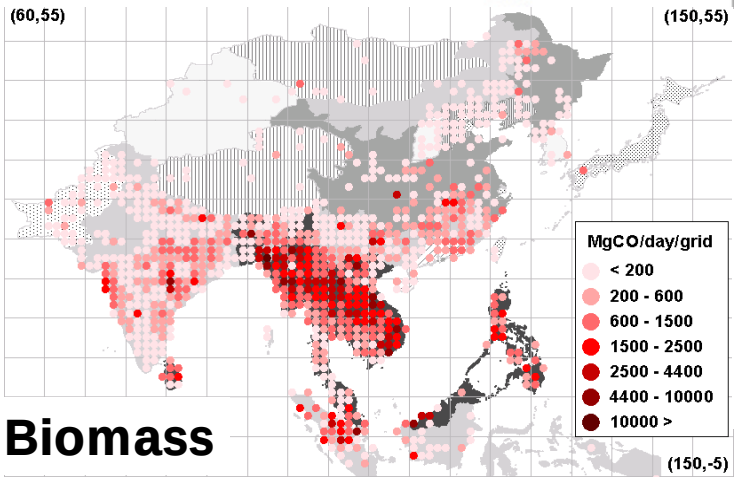
CO emissions by emission categories



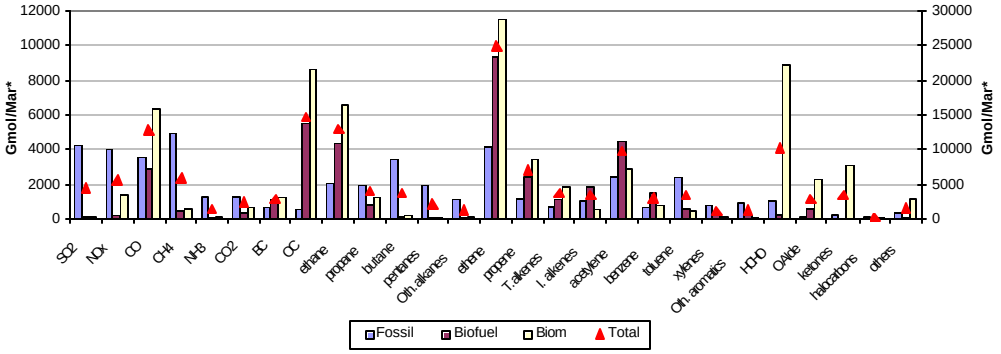
Fossil



Biofuel



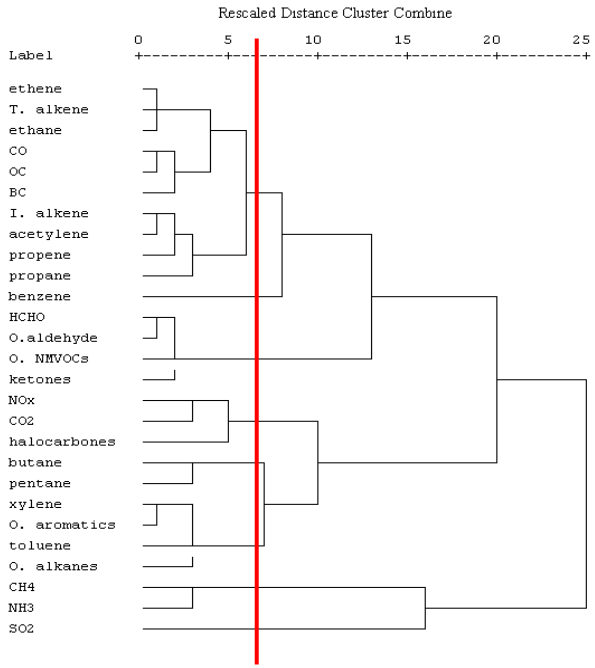
Biomass



*Note : SO2, NOx are scaled by 0.1 and CO, CH4, BC, and OC are scaled by 0.01. CO unit is Tmol/Mar

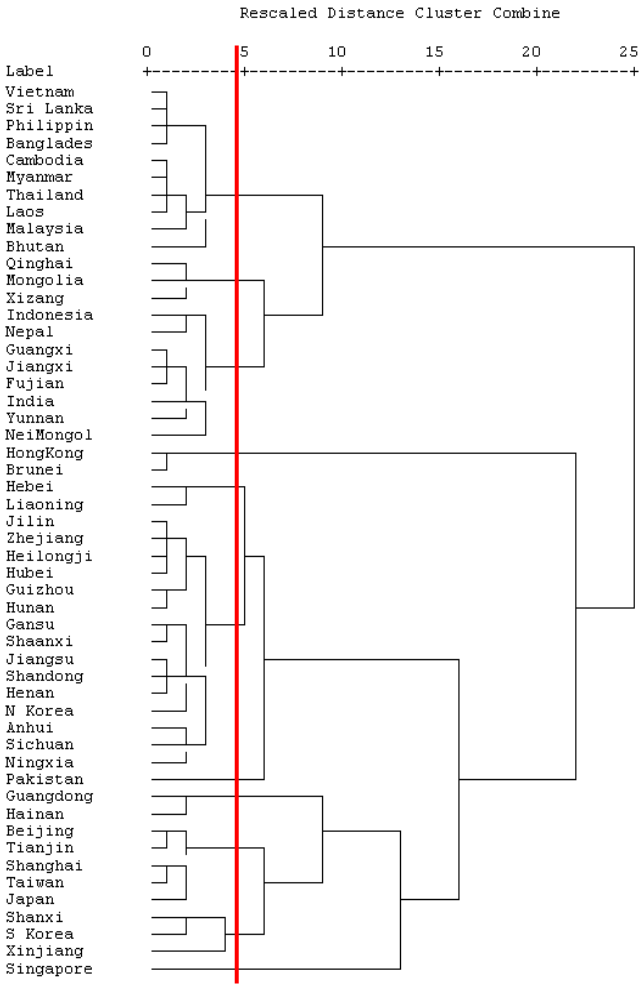
Source strength by emissions category

Cluster analysis

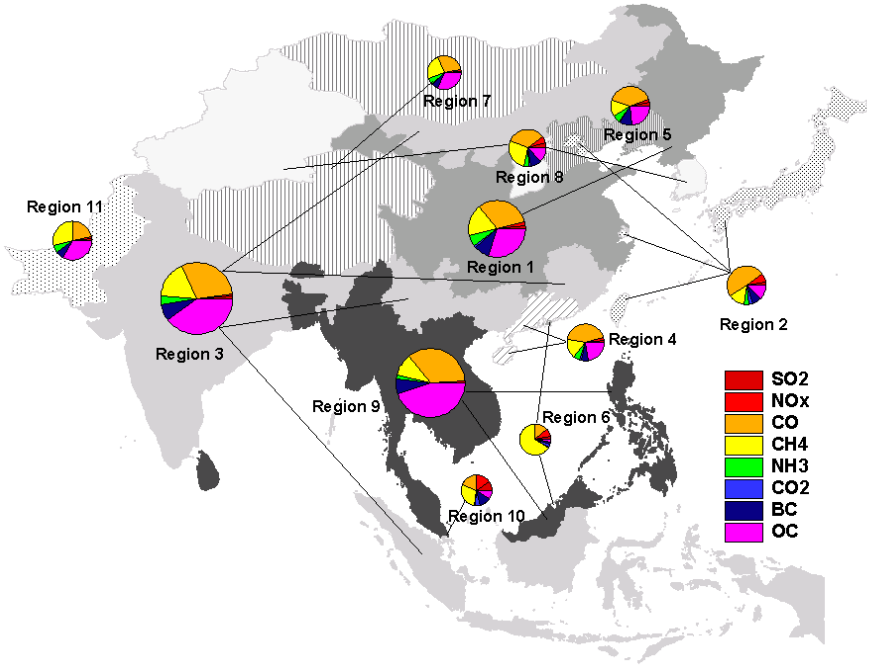


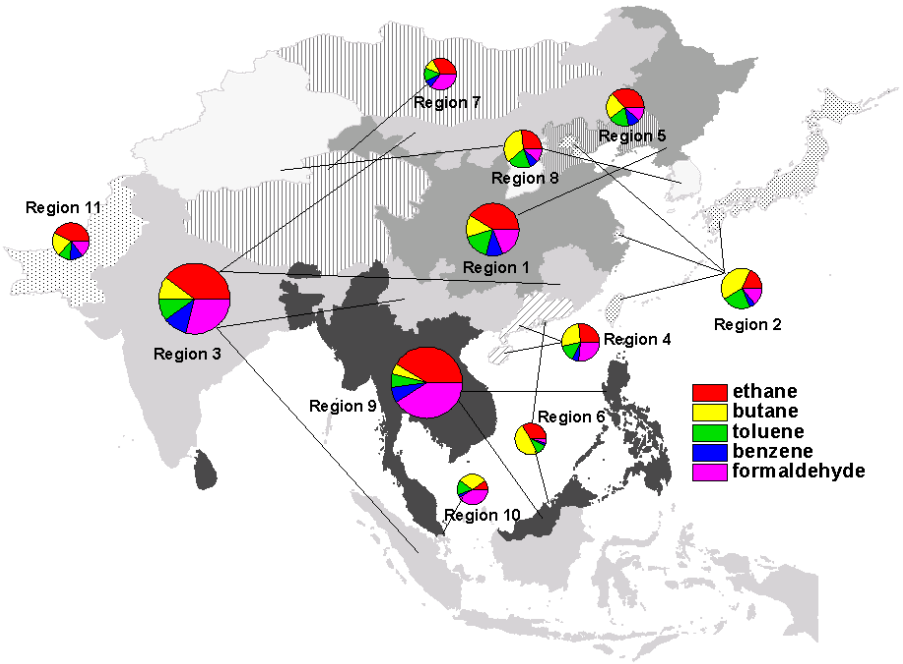
Chemical groups identified from hierarchical cluster analysis

Regional groups identified from hierarchical cluster analysis

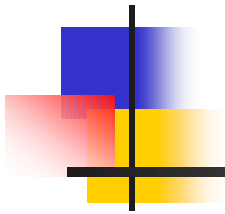


Spatial and Sectoral composition



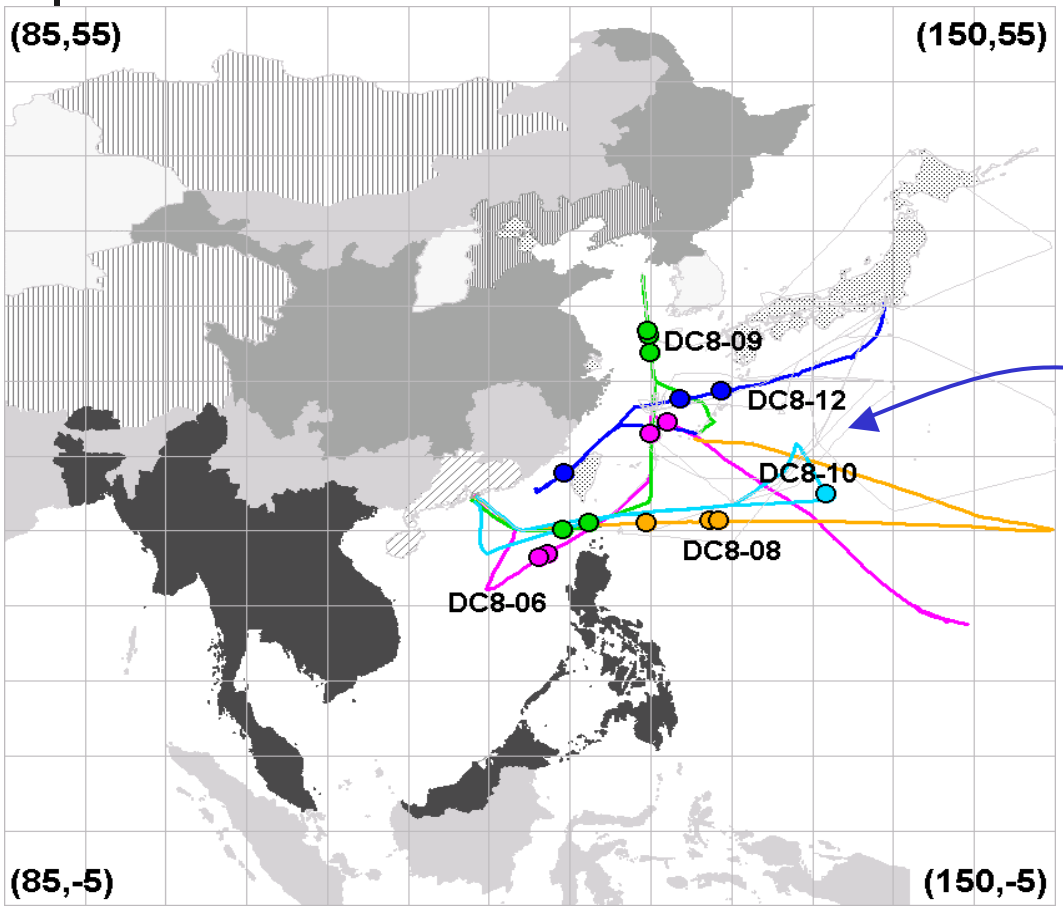


Source profiles from regional groups (left : major species, right : NMVOC species)



3. Analysis of Source Signitures

Selected flight points

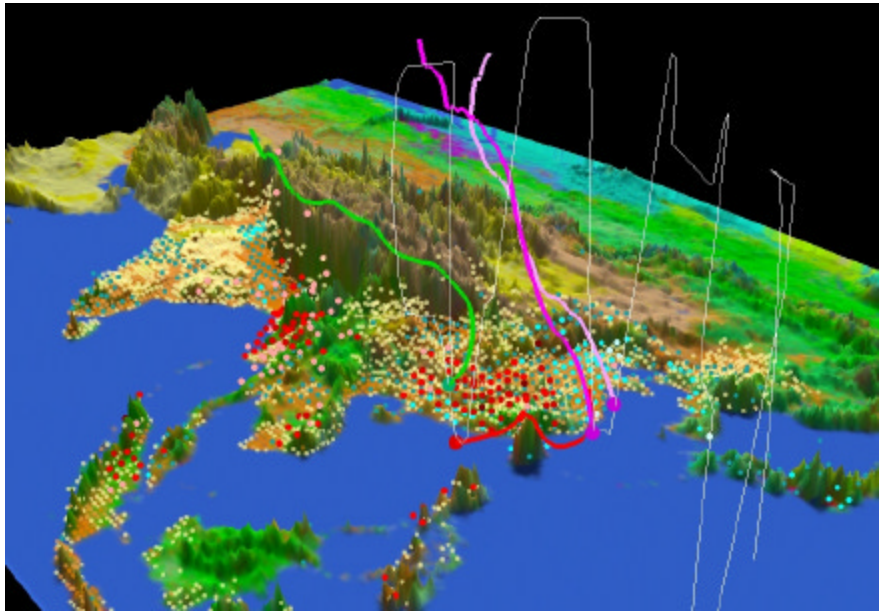


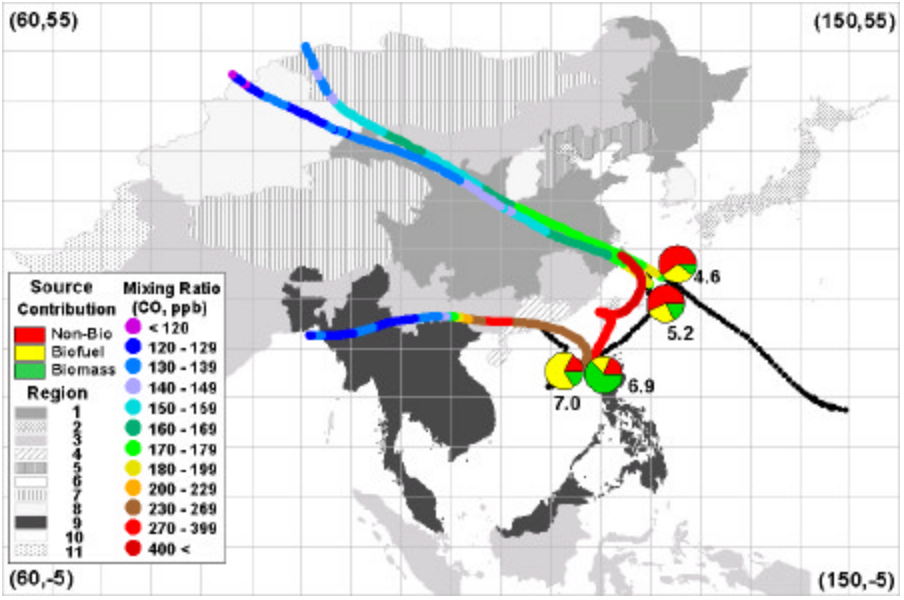
Selected 5 DC8 flights with 16 measurement points

Back trajectory and CMB * analysis

* Chemical Mass Balance Model

2-D and 3-D analysis features for DC8 flight 6 (March 4th).





Source sector contribution by CMB model and 5day 2-D back trajectories color coded by STEM-III CO concentration.

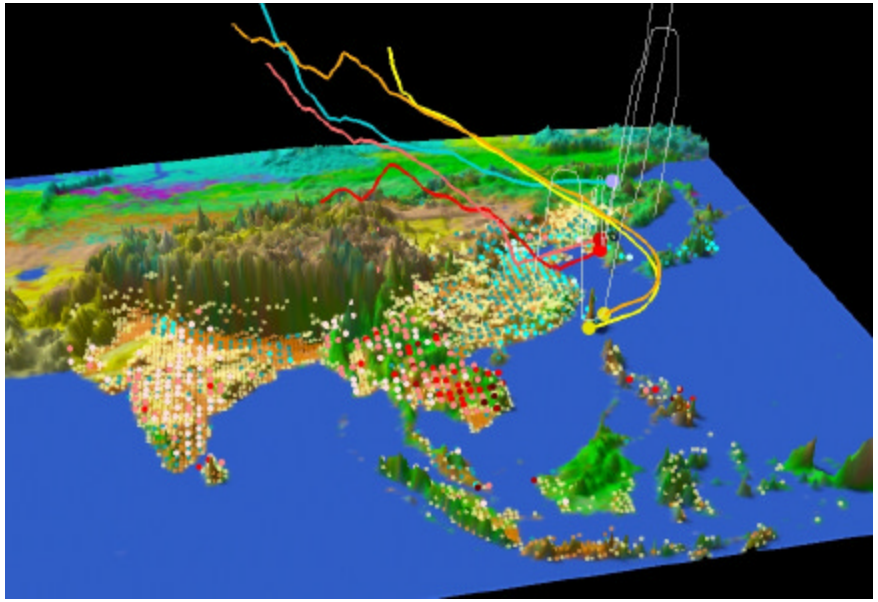
*** 3-D back trajectories (5-day) colored with measured trace gas mixing ratio (light purple line: 4.6GMT, purple line: 5.2GMT, red line: 6.9GMT, green line: 7.0GMT)**

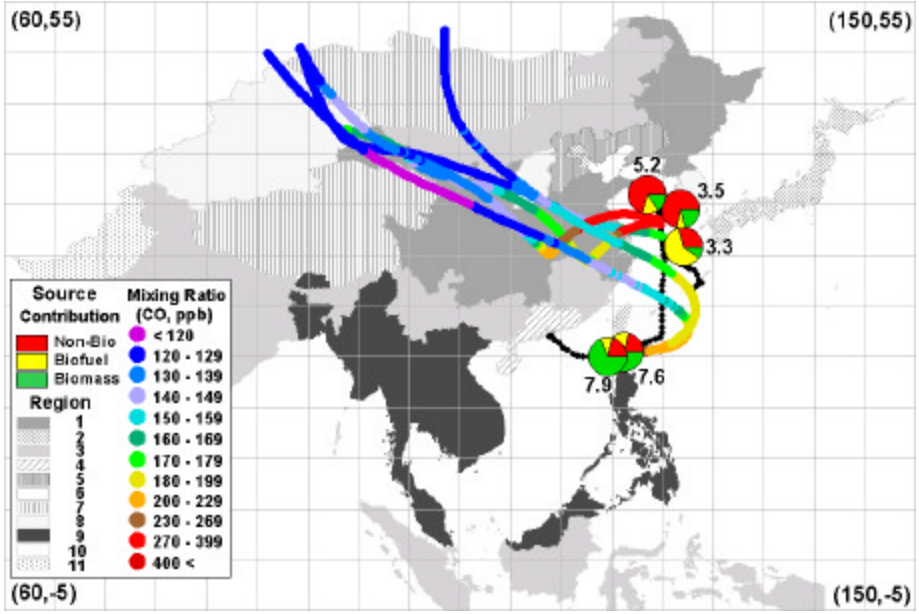
*** Emissions : fossil fuel (light blue dots), biofuel (yellow dots), biomass burning (red dots)**

*** Background map - topography colored by landcover**

Back trajectory and CMB analysis

2-D and 3-D analysis features for DC8 flight9 (March 10th)

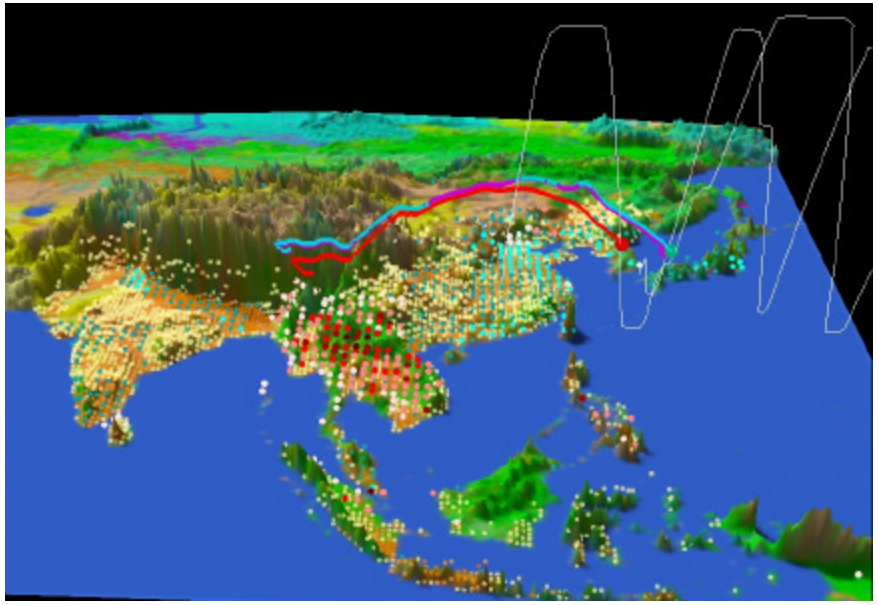


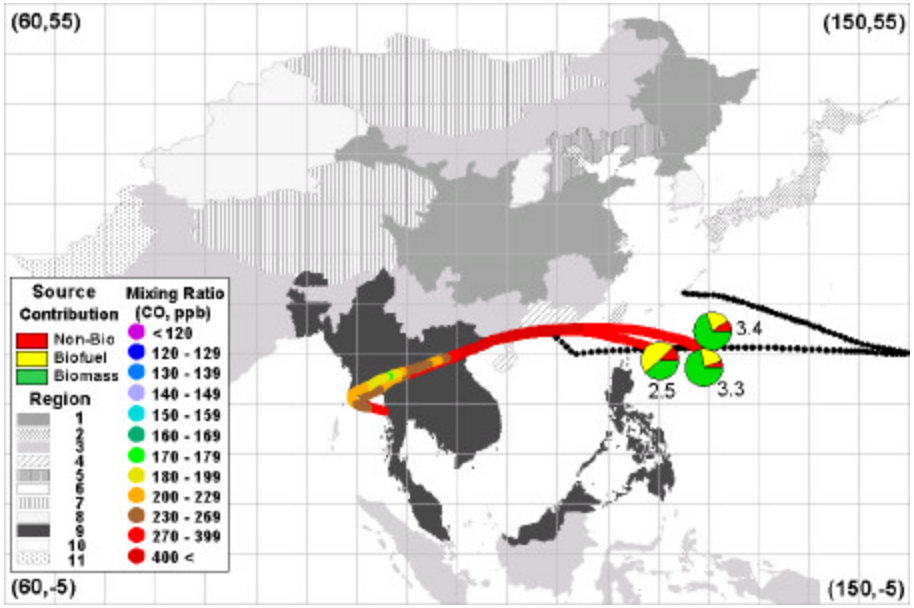


Left: same as previous figure, but (light blue: 3.3GMT, red: 3.5GMT, light red: 5.2GMT, orange: 7.6GMT, yellow: 7.9GMT), Right: same as previous figure.

Back trajectory and CMB analysis

2-D and 3-D analysis features for DC8 flight8 (March 9th)

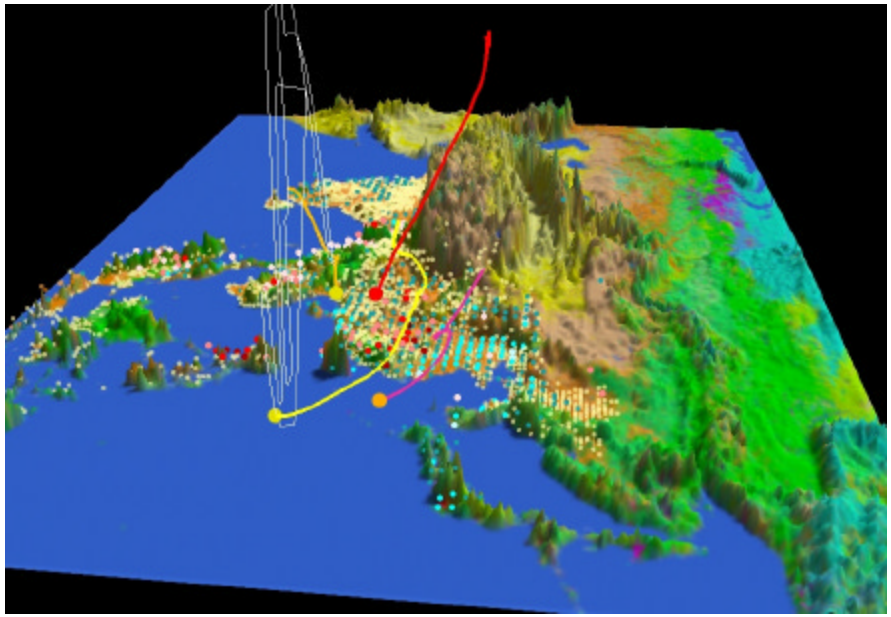


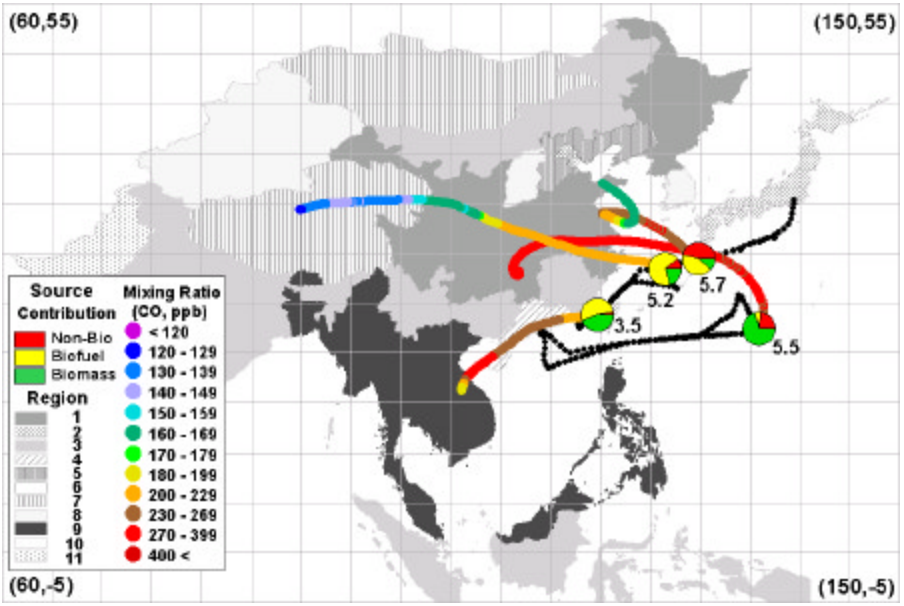


Left: same as previous figure, but (light blue: 3.4GMT, purple: 3.3GMT, red: 2.5GMT); Right: same as previous figure.

Back trajectory and CMB analysis

2-D and 3-D analysis features for DC8 flight10 (March 13th) and DC8 flight 12 (March 18th)





Left: same as previous figure, but (yellow: flight10-5.5GMT, orange: flight12-3.5GMT, red: flight12-5.2GMT, purple: flight12-5.7GMT), Right: same as previous figure.

Intercomparison with others

- **P-3B flight aerosol measurement data (dK^+/dSO_4^{2-}) [*Ma et al.*, 2003]**

- **CH_3CN/SO, SO_y/CO, and C_2Cl_4/CO ratios ratios for DC8 flight 6 (high fossil fuel source contribution) and for DC8 flight 8 (high biomass combustion source contribution)**

- **Biomass burning emission sensitivity tests using 3D chemical models (STEM 2K1, The Models-3 : CMAQ)**

Summary

- In general, Asian outflow is usually a complex mixture of biofuel, biomass and fossil sources.
- Intercomparison of AVHRR fire count with country surveys (biomass burned) has been used to analyze problem areas and thus enhance data quality for both sides.
- Biomass burning emissions could affect ambient concentration even to the distant flight track point.
- Flights in the regions at high latitudes and low altitudes were found to have a high contribution of fossil fuel emissions.
- Flights in the warm sector of cold fronts were dominated by biomass burning contributions (about 70%).
- Biofuel contributions were high (about 70%) when air masses come from central China.