Developing spatial and temporal allocation methodologies for TRACE-P emission and impact on the chemical modeling analysis.

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# Objectives and Outline

- **Background and Objectives**

  - To satisfy need for highly resolved level of spatial, temporal, and species-component in emission inventories that support field experiments and complex atmospheric models
  - Development of multi-resolution anthropogenic inventory
  - Estimate daily and monthly emission from biomass burning using satellite data
  - Analysis the impact of our emission allocation methodology to chemical modeling

- **Research Outline**

  - Spatial allocation methodology for anthropogenic emission data
  - Spatial/temporal allocation methodology for biomass emission data
  - STEM modeling results from nested modeling study and biomass burning consistency test .
  - Visualize/analyze some flight segments with 2D/3D back-trajectory.

Why is resolution important?

- Reduce boundary error

- Temporally variable incidents

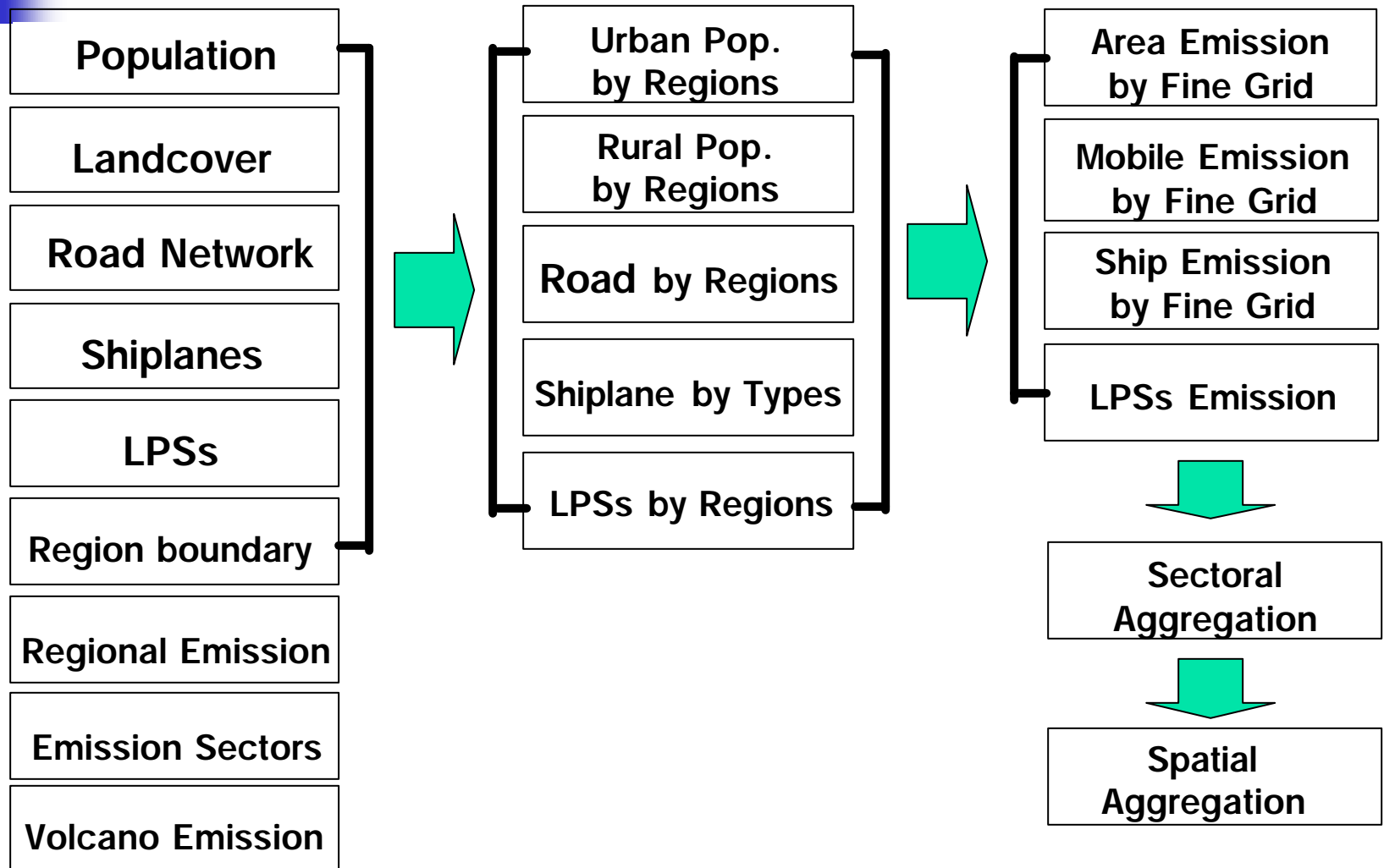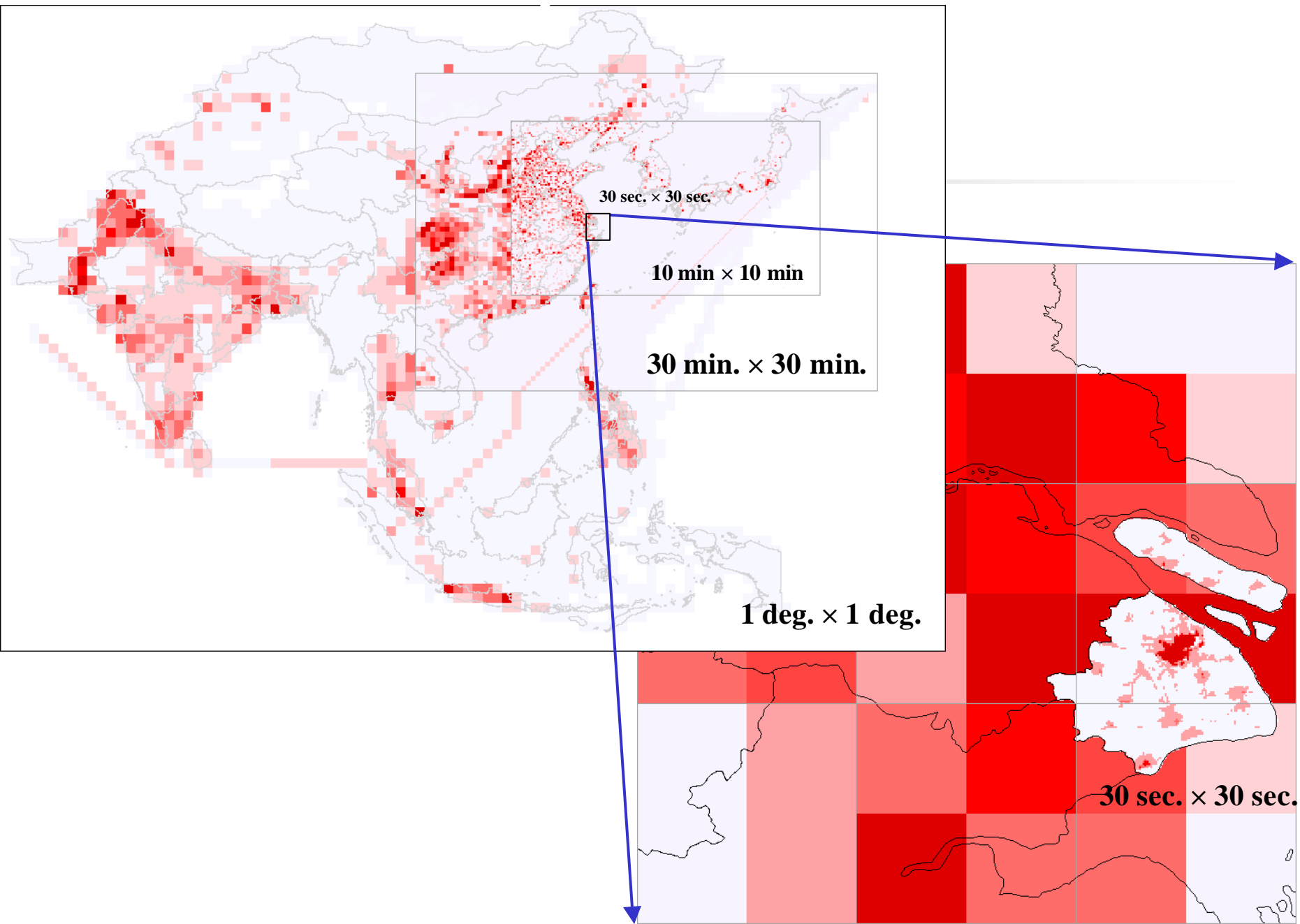- Support various domain/application

- Visualization /analysis
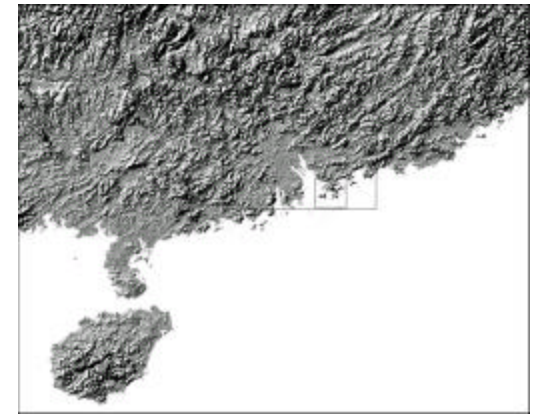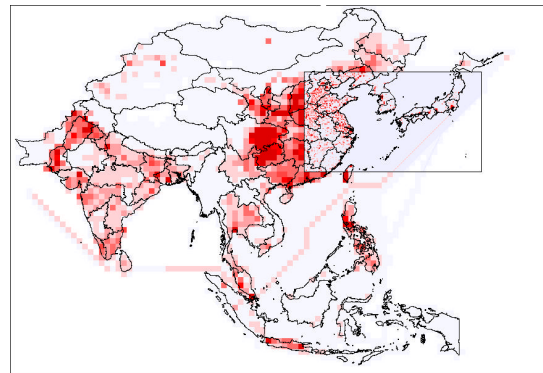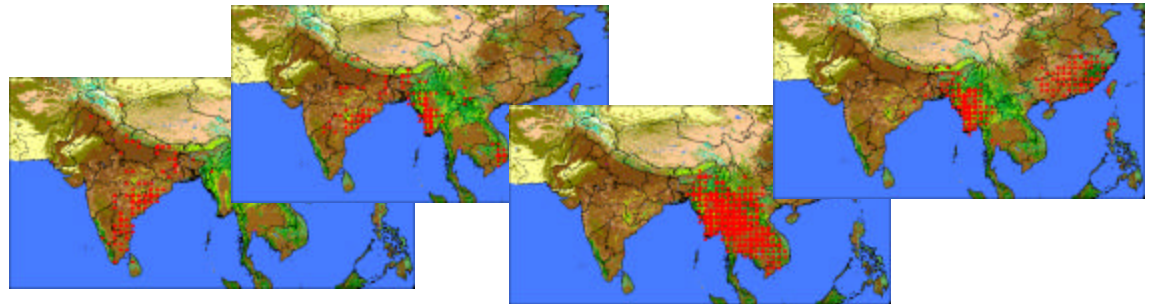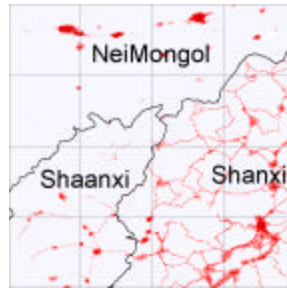
Data Sources

- **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 site map : IPE, Map book of China

Maps from data sources

Energy/ Emission

Regional Emis.

LPSs & Volcano

Ship lanes

GIS

Population

Landcover

Road network

RS/Etc

FC

AI

Precipitation

Spatial allocation methodology(Anthropogenic)

Population	**Urban Pop. by Regions**	**Area Emission by Fine Grid**
Landcover	**Rural Pop. by Regions**	**Mobile Emission by Fine Grid**
Road Network	**Road by Regions**	**Ship Emission by Fine Grid**
Shiplanes	**Shiplane by Types**	**LPSs Emission**
LPSs	**LPSs by Regions**	**Sectoral Aggregation**
Region boundary		**Spatial Aggregation**
Regional Emission		
Emission Sectors		
Volcano Emission		

Area source emission by different resolution

30 sec. × 30 sec.

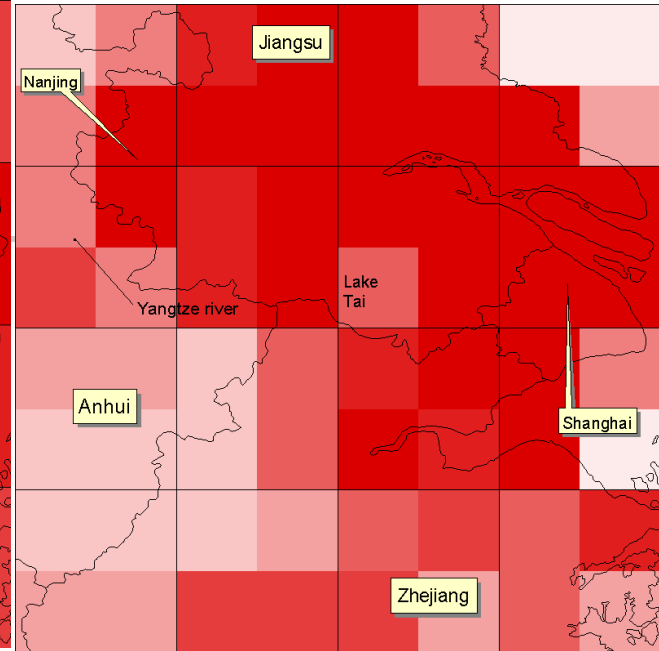10 min × 10 min

30 min. × 30 min.

1 deg. × 1 deg.

30 sec. × 30 sec.

Area emission by different resolution (Near Shanghai)
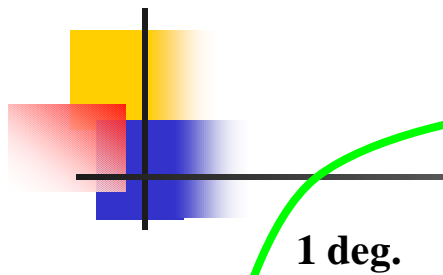
1 deg.

30 min.

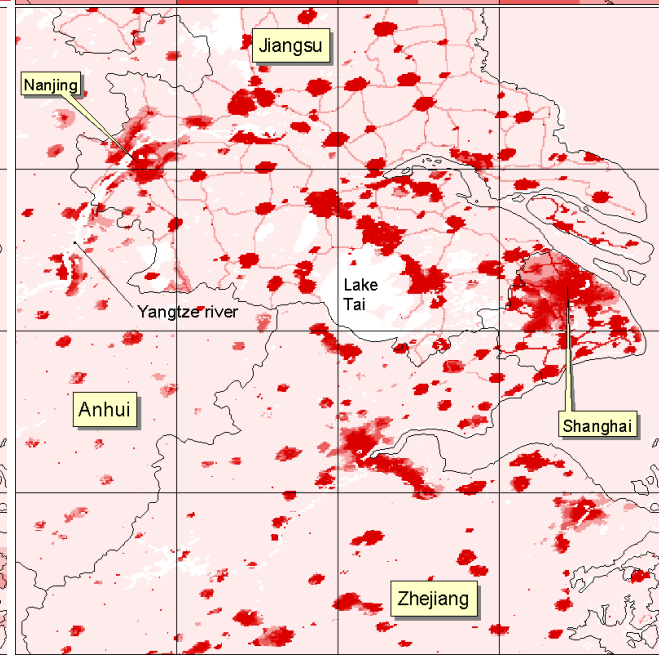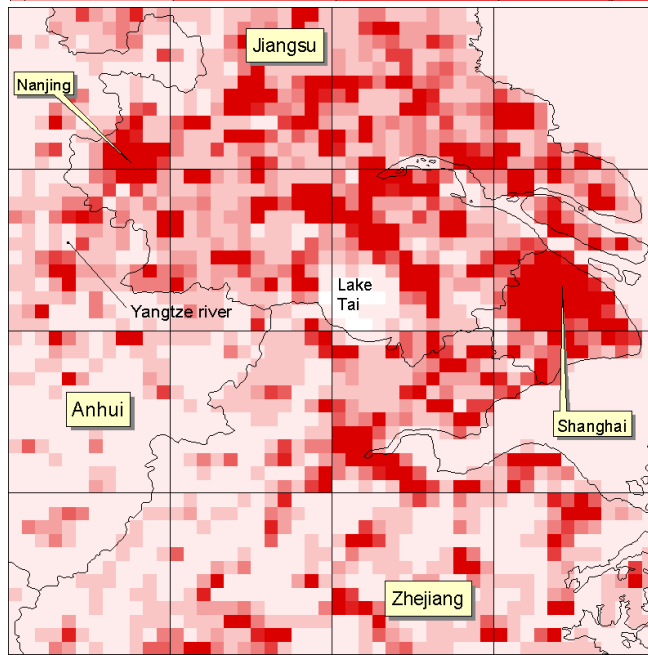**5 min.**

30 sec.

Lake Tai's effect can be seen at 30' × 30' resolution, but Yangtze River's effect cannot clearly seen even in 5' × 5' resolution.
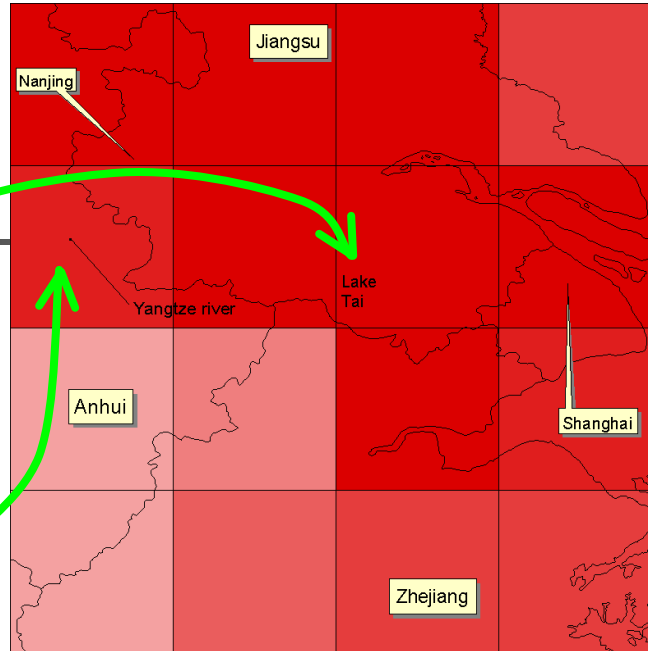
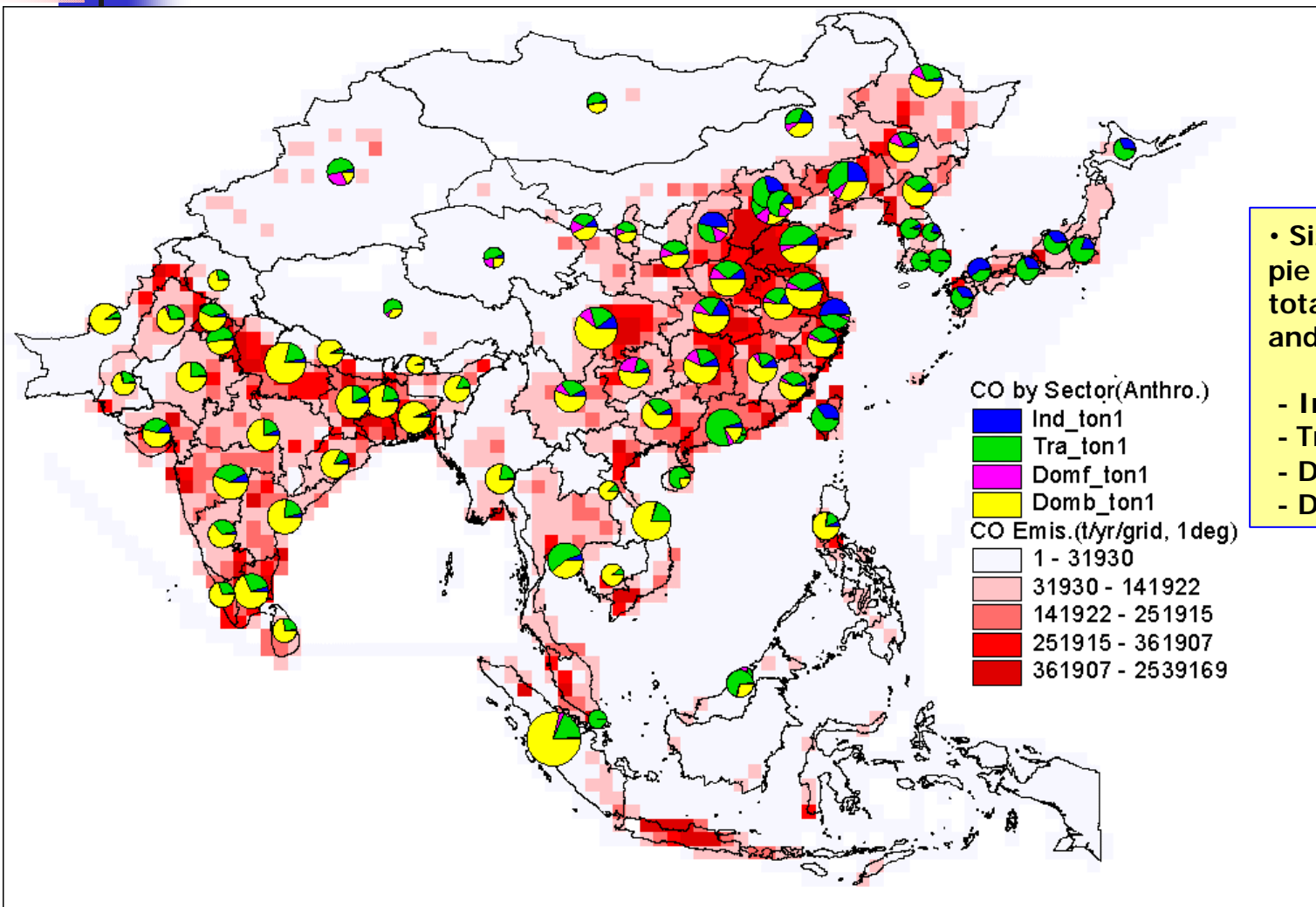# Anthropogenic CO emission by grid & sector

CO by Sector(Anthro.)
- Ind_ton1
- Tra_ton1
- Domf_ton1
- Domb_ton1

CO Emis.(t/yr/grid, 1deg)
- 1 - 31930
- 31930 - 141922
- 141922 - 251915
- 251915 - 361907
- 361907 - 2539169

• Size and fraction of pie graph stands for total emission amount and sectoral fraction.
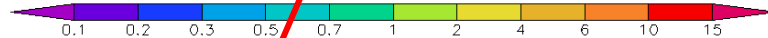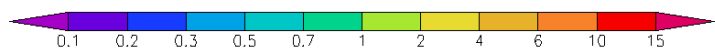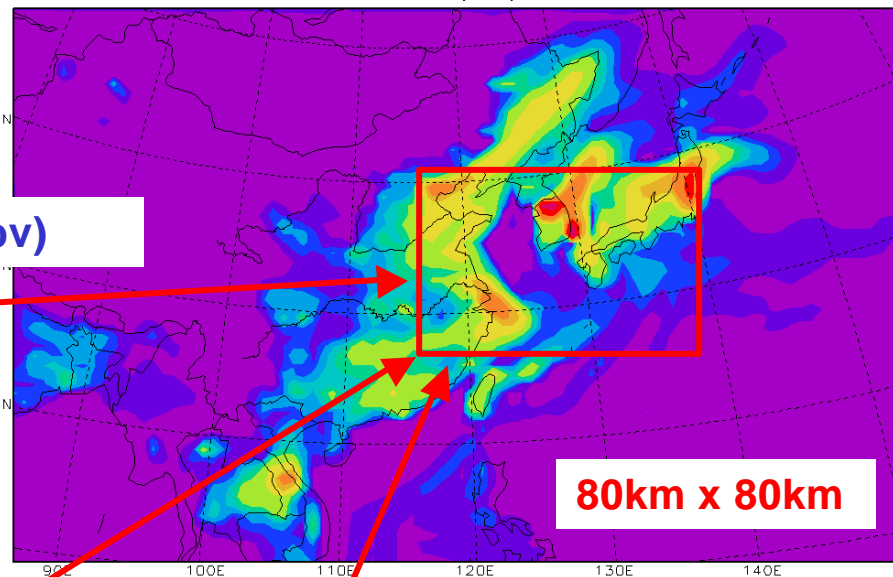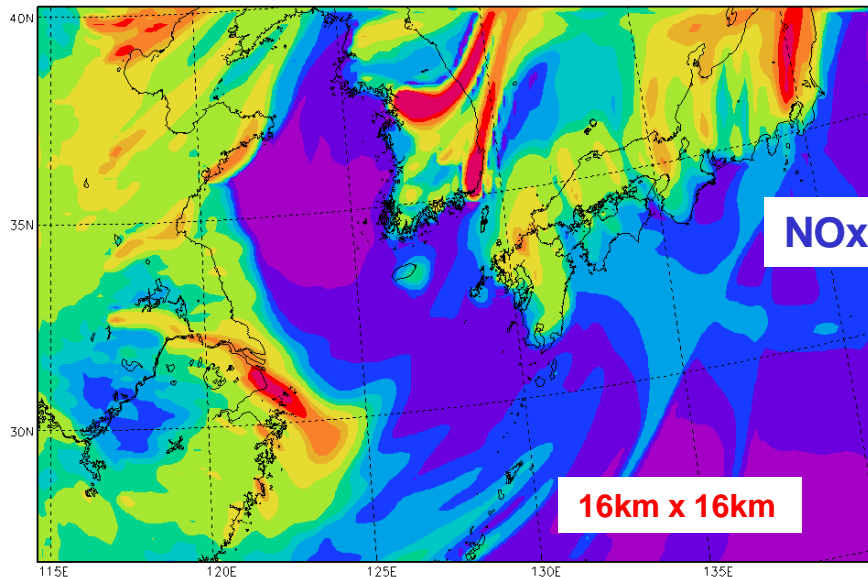
- Industrial
- Transportation
- Domestic fossil
- Domestic biofuel

Effect of emission resolution on Chemical modeling

TRACE-P DC8-11(Mar. 17th)

Nesting Simulated NOx Concentration (ppbv) in 438m Layer at 6GMT, 3/17/2001

16km x 16km

Simulated NOx Concentration (ppbv) in 438m Layer at 6GMT, 3/17/2001

80km x 80km

NOx (ppbv)

NOx(t/yr/gr)

NOx Emis(t/yr/10min_grid)
- 0.1 - 410.5
- 410.5 - 1856.7
- 1856.7 - 3302.8
- 3302.8 - 4749
- 4749 - 6195.1
- 6195.1 - 7641.3
- 7641.3 - 9087.5
- 9087.5 - 206599.3

NOx Emis(t/yr/1deg_grid)
- 1 - 14778
- 14778 - 31854
- 31854 - 48930
- 48930 - 66006
- 66006 - 83081
- 83081 - 100157
- 100157 - 117233
- 117233 - 399369
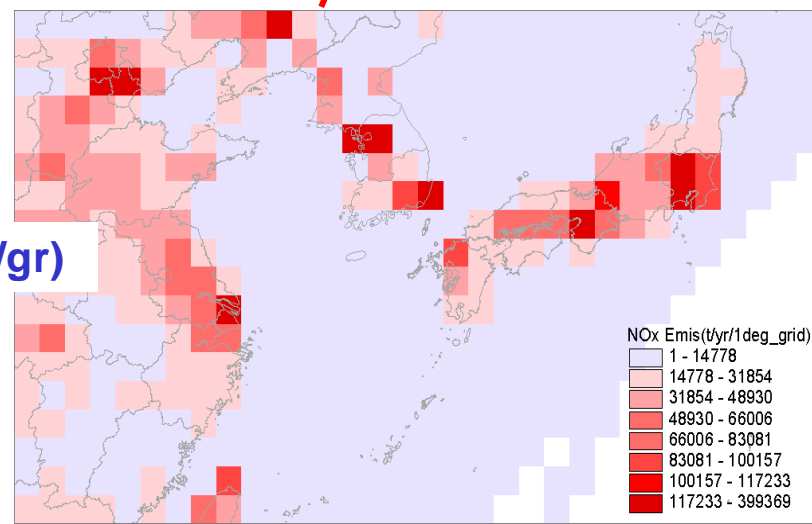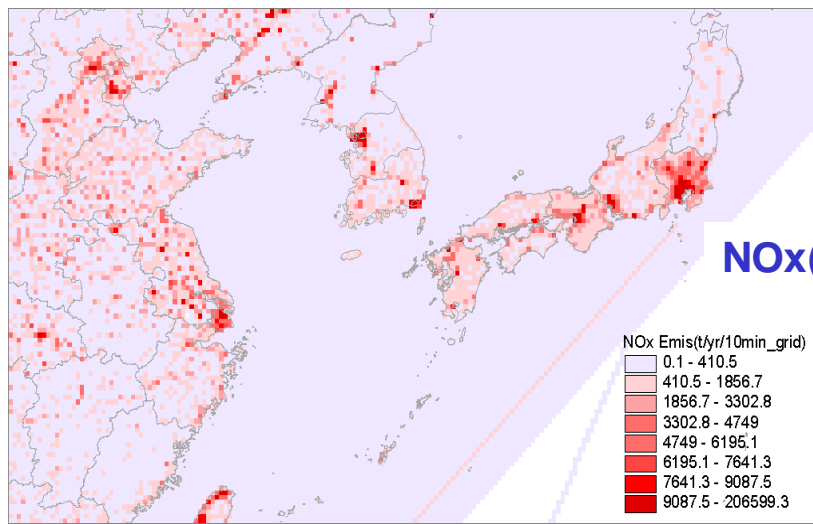
Spatial & temporal allocation methodology
(Biomass Burning, Y1999 & Y2000)

Original Fire Count(FC_Org) (AVHRR, WFW)

Regional Biomass Burned (Dr. David Streets)

Satellite Cov./Cloudiness (AVHRR), Latitude adjust factor

Normalize

Normalized FC(FC_Norm)

Consistency test
- Biomass burned .vs. FC
- Annual, typical, regional
- Change criteria for each FC adjust step
- Implement new information for adjust

3-day Fire Count(For only 0 FC)

Moving Average

Moving Averaged FC(FC_MA)

AI(TOMS) Satellite Cov./Cloudiness (AVHRR), Precipitation(NCEP), Landcover(ORNL)

AI adjust

Regression FC&AI

Annual, Regional

AI adjusted FC(FC_AIadj)

Finalize FC

Daily, Gridded

Summarize FC
Temporal - Monthly, Seasonal, Annual
Spatial - Regional

Daily FC, Landcover class, Biomass density

Allocation Factor
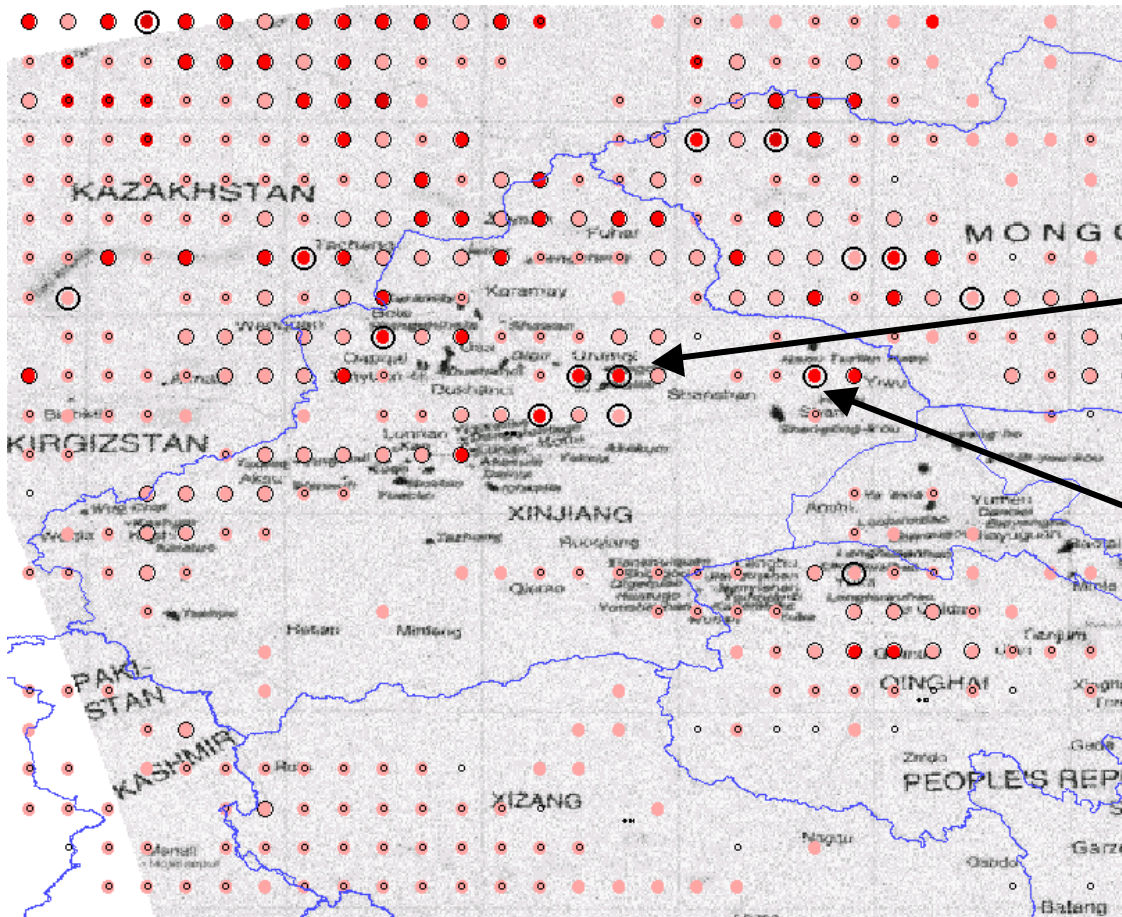Temporal/Spatial/Type(LC)

FC .vs. Biomass burned test
(Normalized difference)

Comparison of country surveys with various AVHRR fire-count adjustments reveals problem areas for further investigation
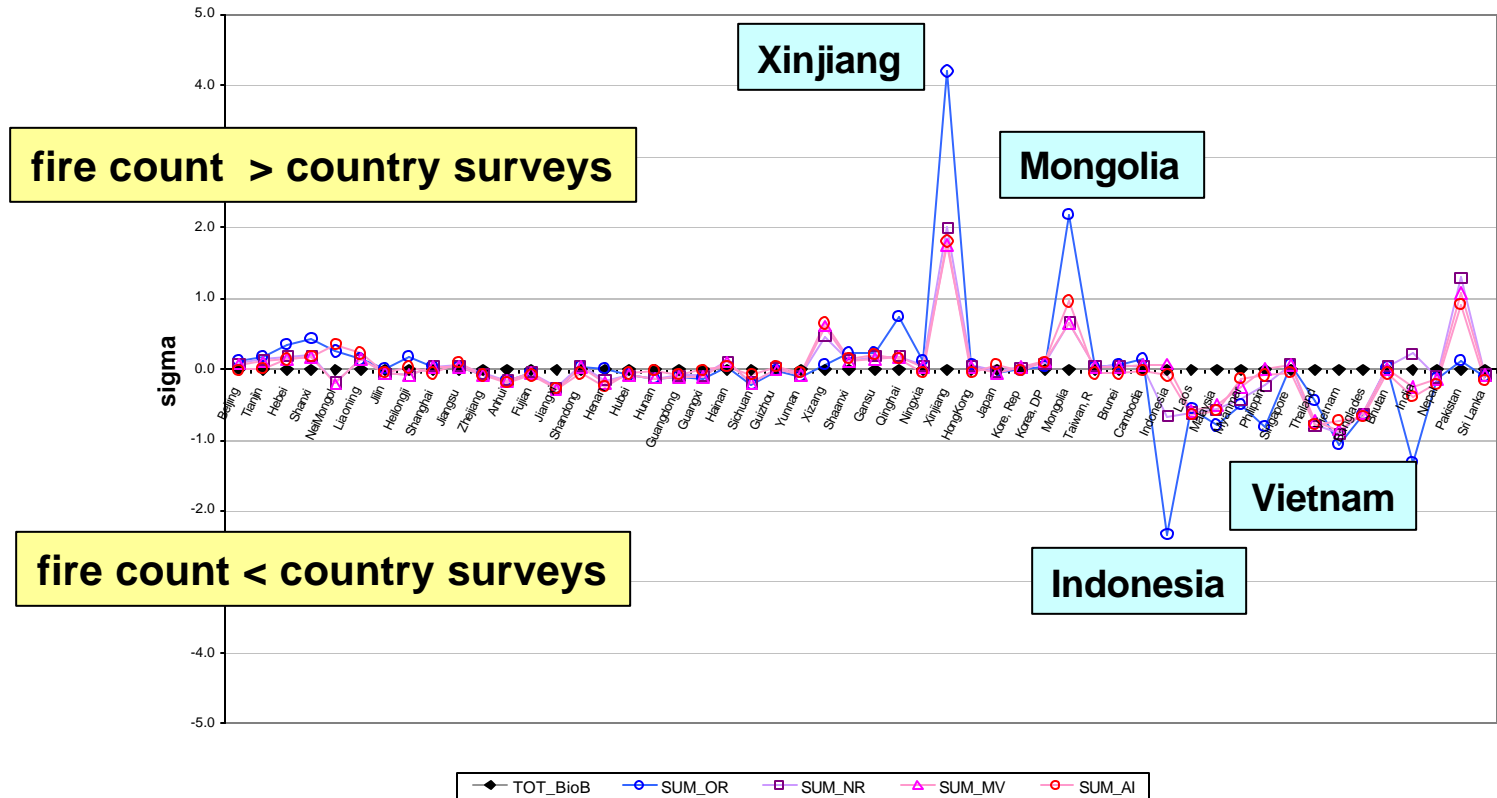
FC from oil & gas drilling sites

• **Fire detection from Xinjiang and Gansu province could be flares from Oil/Gas drilling site.**
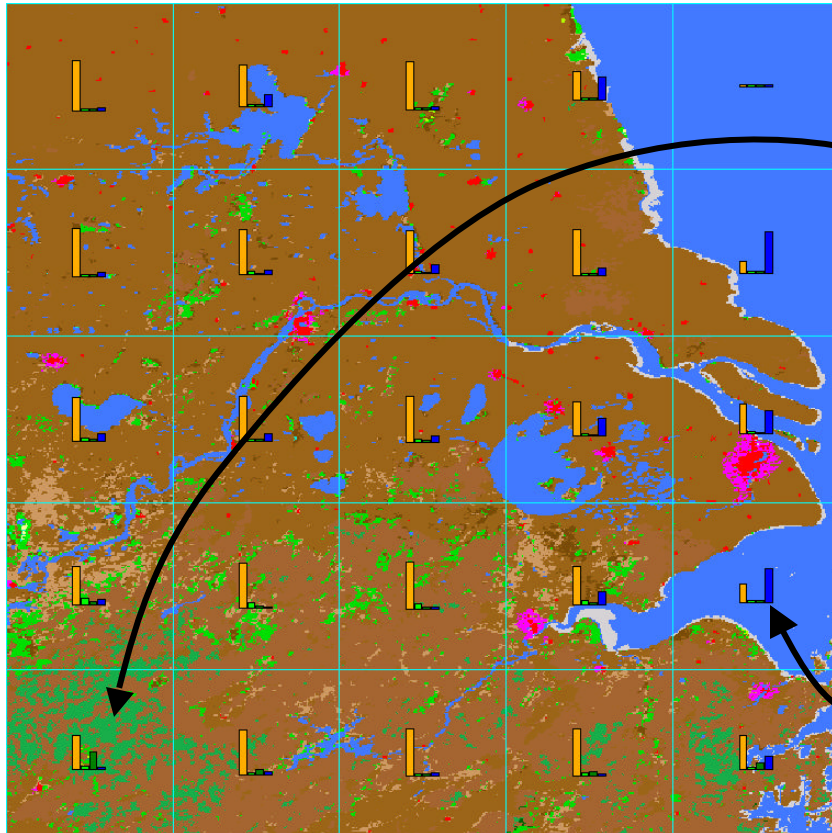
• **Circle : Maximum FC>0 days in year 1999 & 2000**
• **Red dot : Maximum FC > 0 consecutive days**

Days(FC>0)
- ° 30 - 60
- ○ 60 - 90
- ◯ 90 - 226

Con. Days(FC>0)
- 3 - 7
- 7 - 14
- 14 - 70

Landcover fraction estimation to allocate type of burning

Landcover Fraction
**(For type of burning, 1 deg.)**

1 degree grid box.

LC Fraction(%)
- Cropland
- Grassland
- Forest
- Other

Landcover
- Developed
- Dry Cropland & Pasture
- Irrigated Cropland
- Cropland/Grassland
- Cropland/Woodland
- Grassland
- Shrubland
- Shrubland/Grassland
- Savanna
- Deciduous Broadleaf Forest
- Deciduous Needleleaf Forest
- Evergreen Broadleaf Forest
- Evergreen Needleleaf Forest
- Mixed Forest
- Water
- Herbaceous Wetland
- Wooded Wetland
- Barren
- Herbaceous Tundra
- Wooded Tundra
- Mixed Tundra
- Bare Tundra
- Snow or Ice
- Partly Developed
- Unclassified
- No Data

Landcover Classes
(20+ classes)

Landcover Fraction
(Crop/Grass/Forest)

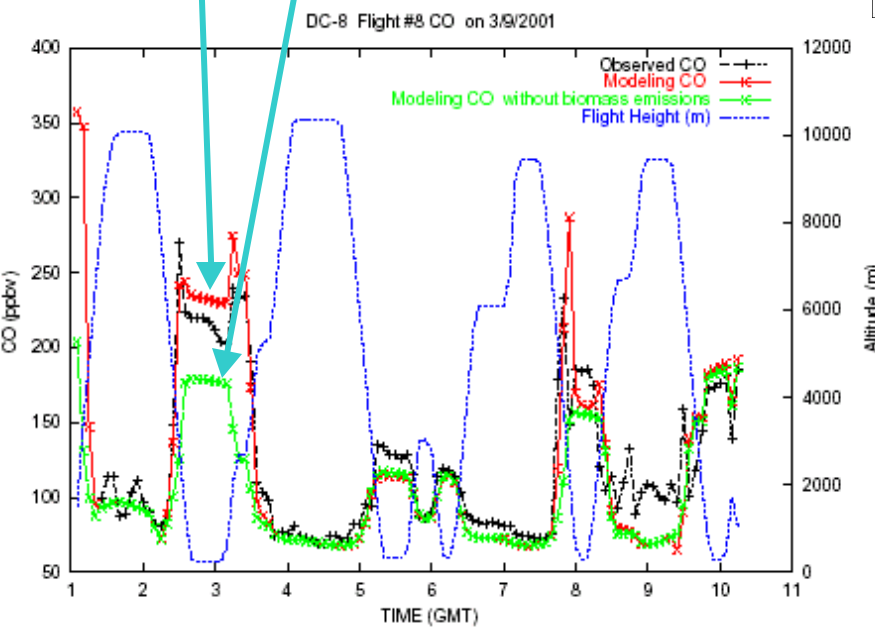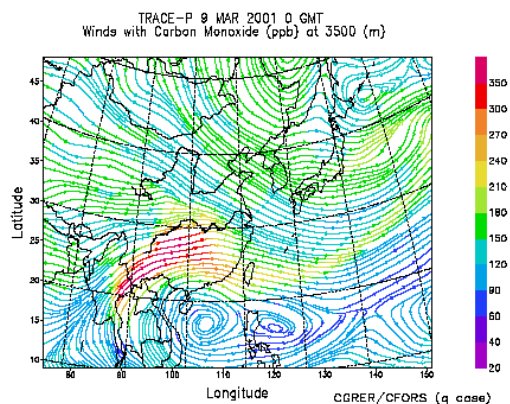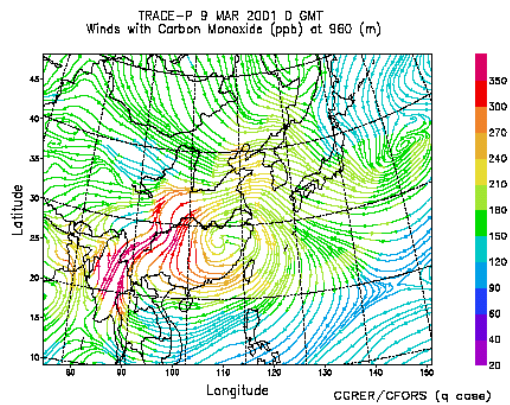# Emission & Modeling Analysis
(DC8-08, Mar. 9th , Biomass Burning, Seg. 4)
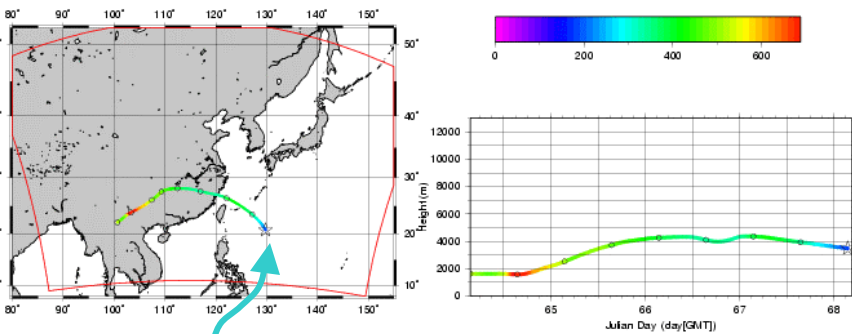
Choose a flight segment that showed big difference between with/without Biomass Burning
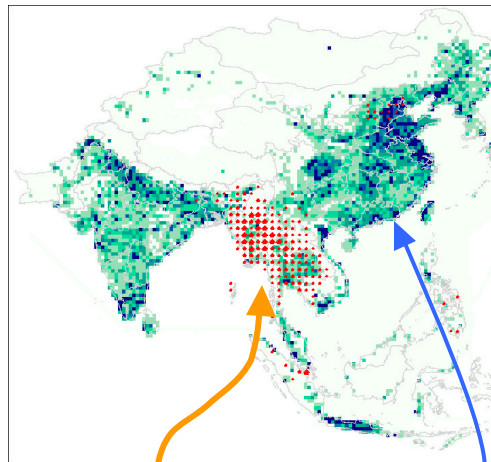
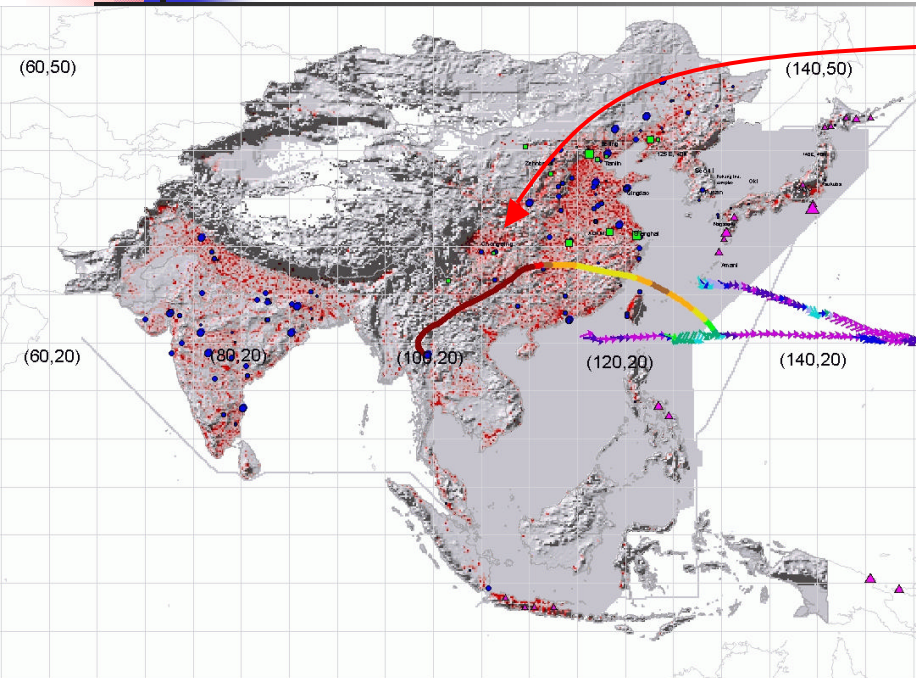**Red : Fire Count(Mar. 6th)**
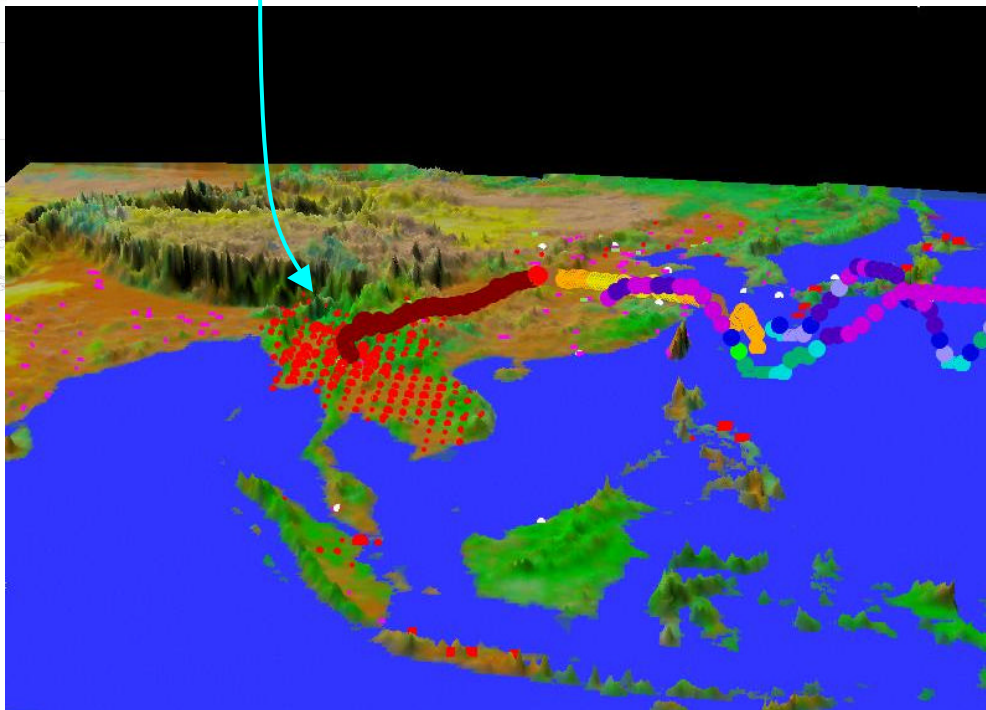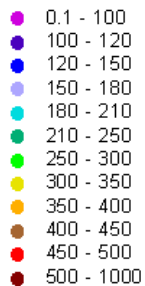**Blue : CO Emis(Anthro.)**

Emission & Modeling Analysis
(DC8-08, Mar. 9th , Biomass Burning, Seg. 4, 3D)

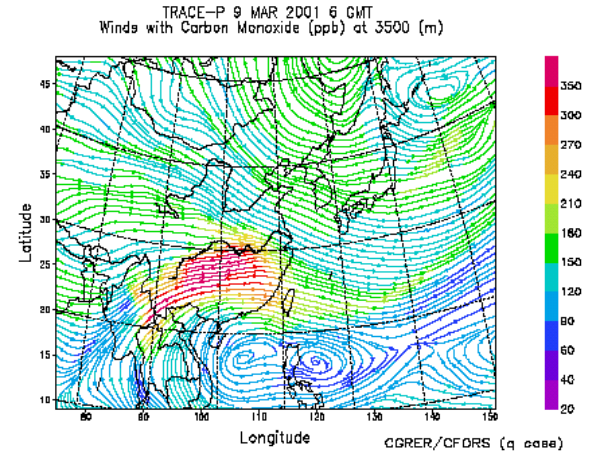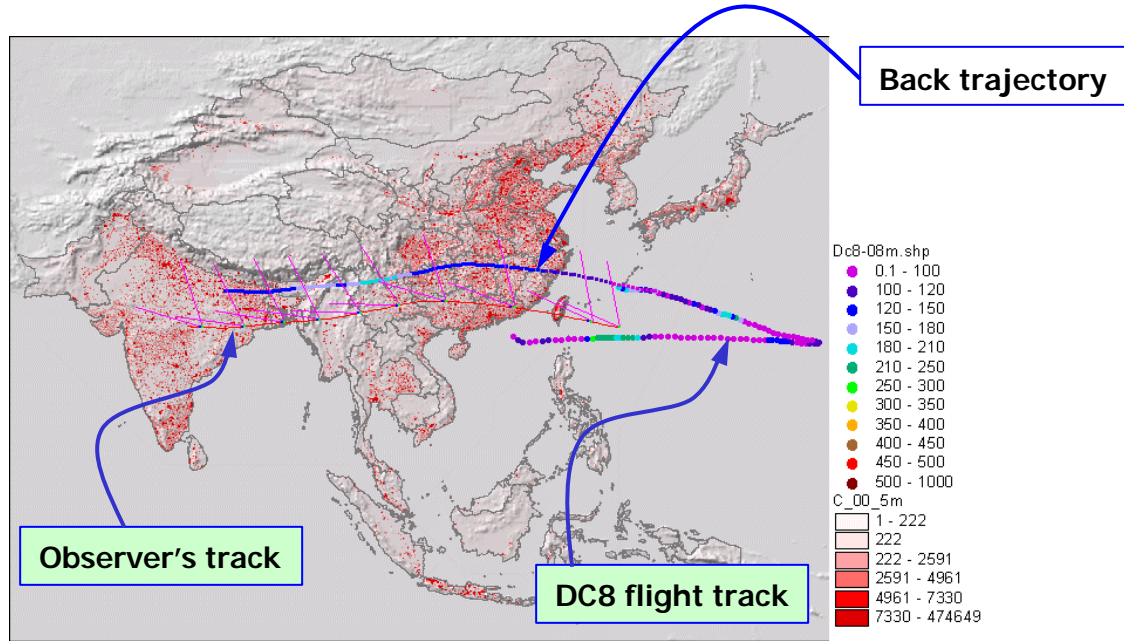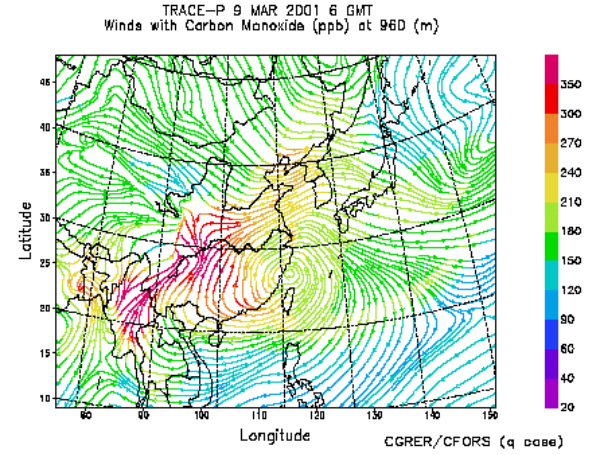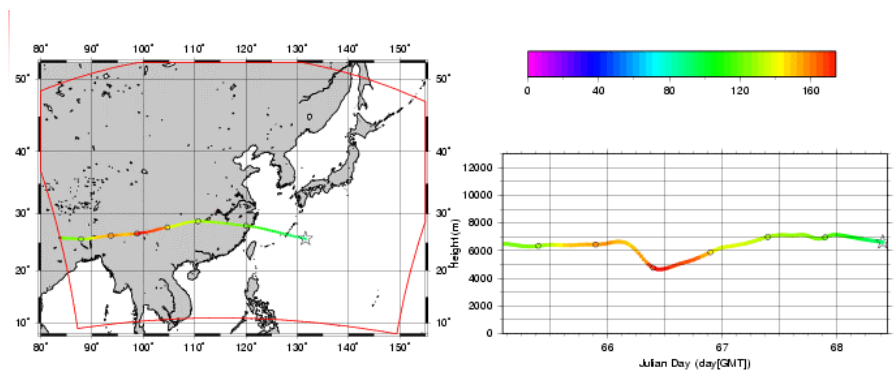High anthropogenic emission area(Chongqing) and Biomass Burning area (SE asia)

Flyby Animation

CO(ppb)
- 0.1 - 100
- 100 - 120
- 120 - 150
- 150 - 180
- 180 - 210
- 210 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 1000

Emission & Modeling Analysis
(DC8-08, Mar. 9th , Biomass Emission, flyby)

Back trajectory

Observer's track

DC8 flight track

Flyby Animation

Conclusions

- Highly resolved emissions can support various atmospheric research studies.

- Chemical modeling with higher resolution emissions shows more variability in distribution pattern, and can help detect higher peaks from dense emission areas.

- 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.

- Emission data with visualization technique could be used to analyze and understand complex air pollution processes.