

Other issues related to emission inventory

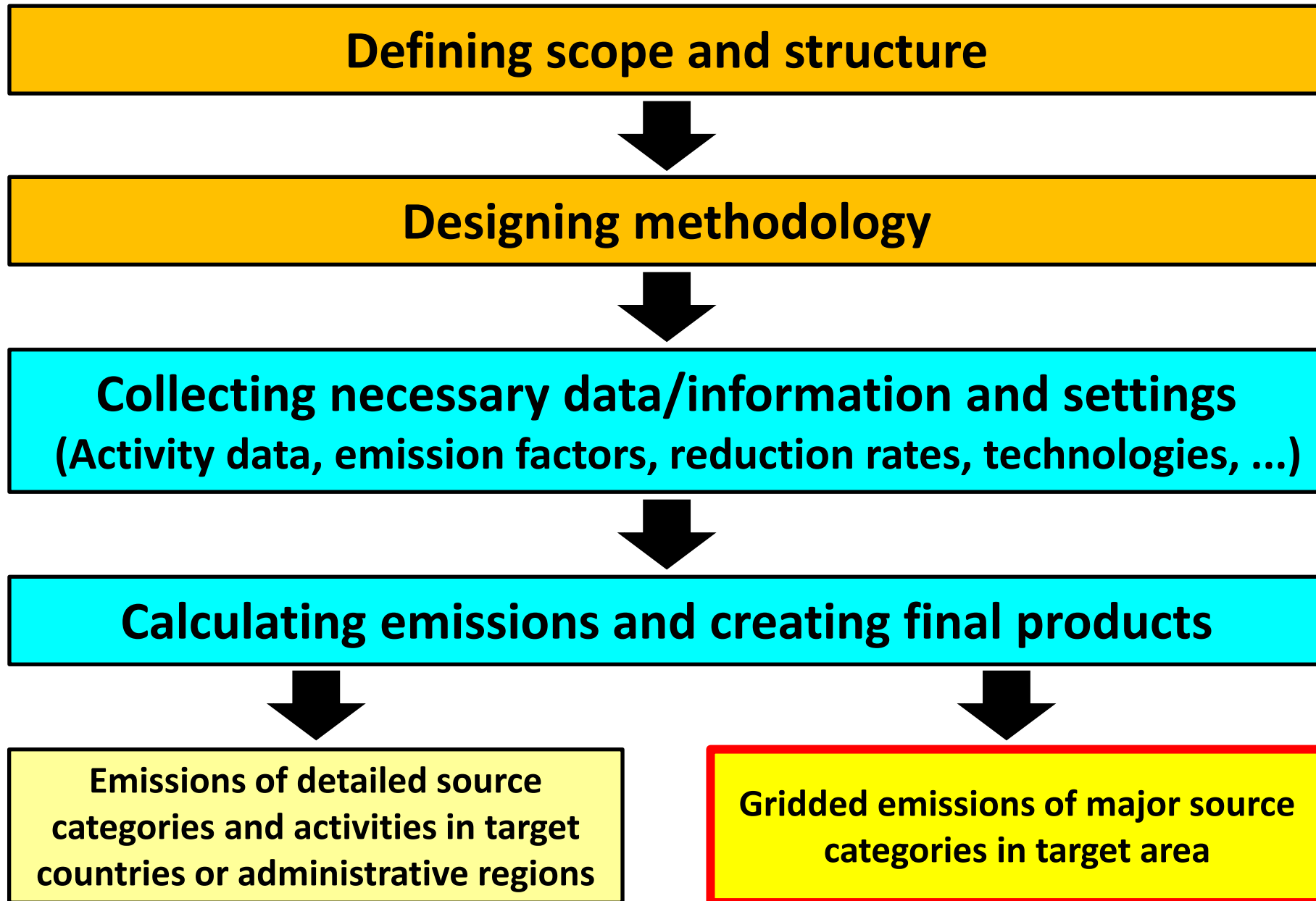
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Asia Center for Air Pollution Research, Japan

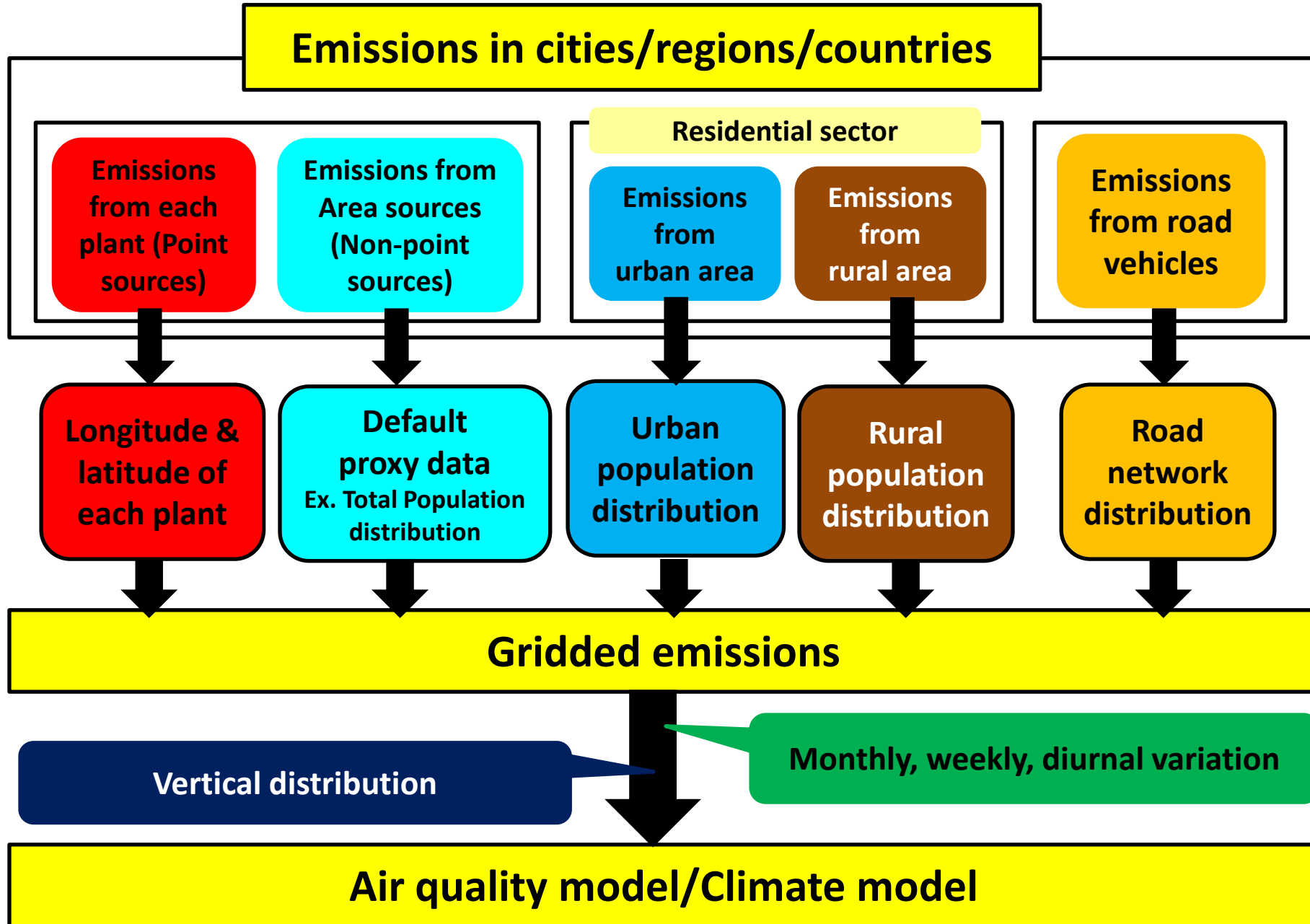
The Network Center of EANET



Process flow of developing Emission Inventory

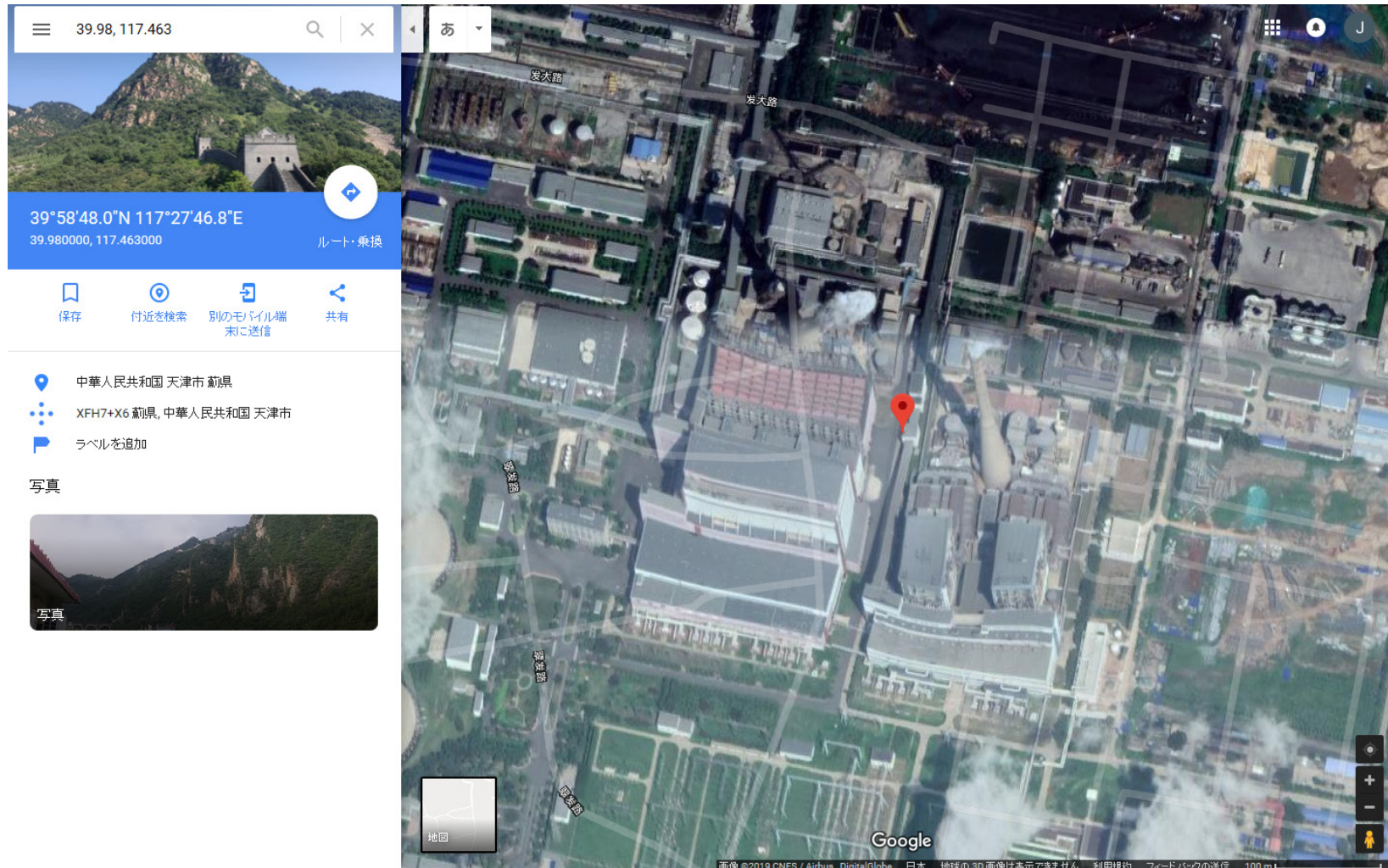


Development of gridded emissions



Grid Allocation

Point Sources



- Longitude and latitude of each point source (power plants, etc.)
- Stack height and temperature of emission gas for estimation of vertical profile.

Grid Allocation

Area Sources

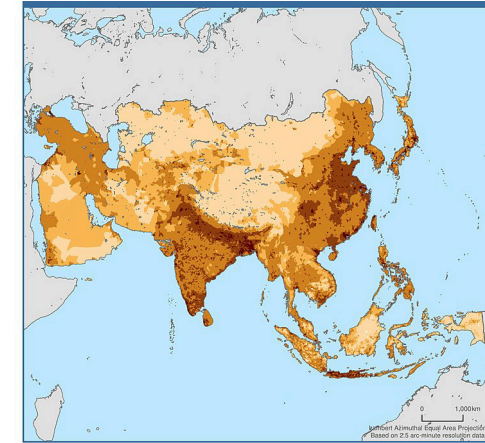
- Select appropriate proxies for grid allocation such as total/urban/rural population map for each sector
- Allocate total emission amounts to grid cells using the proxies as weighting factors

12	15	11
22	20	5
8	7	3

$R(i,j)$

$$EM(i,j) = EM(\text{Total}) \times [R(i,j) / \sum_{i,j} R(i,j)]$$

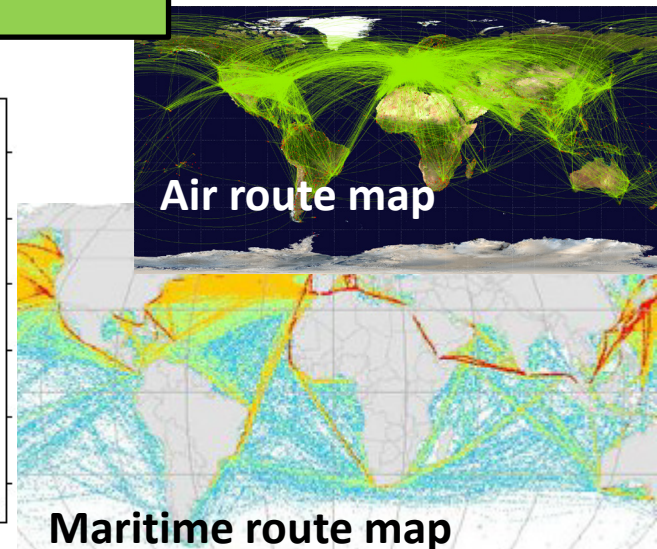
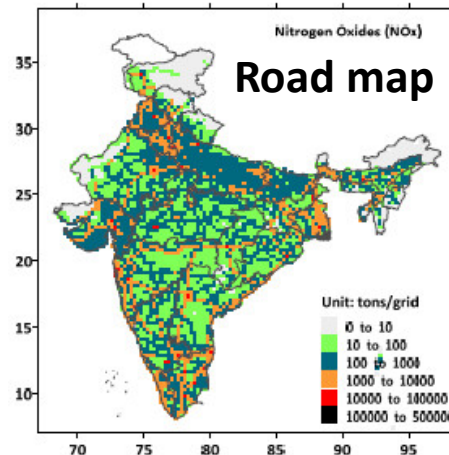
0.12	0.15	0.11
0.21	0.19	0.05
0.08	0.07	0.03



Population map

Mobile Sources

1. Allocate total emission amounts to grid cells using corresponding routes as proxies
2. Prepare activity data such as fuel consumption or traffic volume on corresponding routes and then estimate emissions



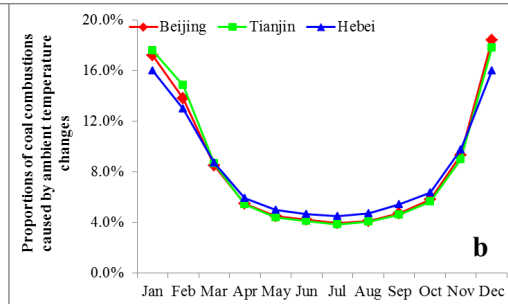
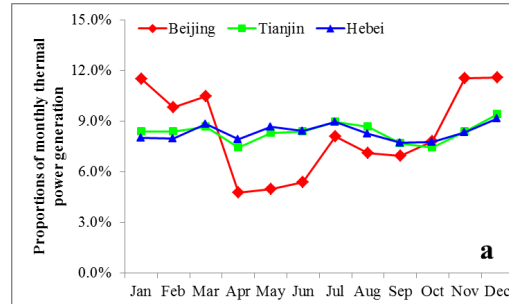
Air route map

Maritime route map

Temporal Variation

Monthly variation of emission drivers

Monthly power generation

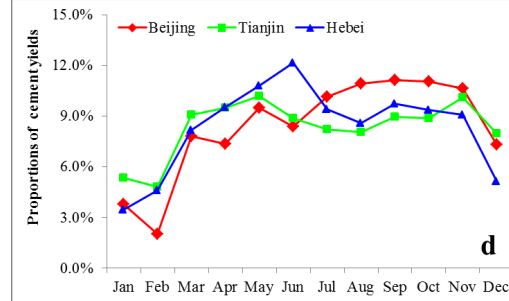


Monthly Temperature



Proxy for monthly variation of emissions from combustion for heating and cooking in residential sector

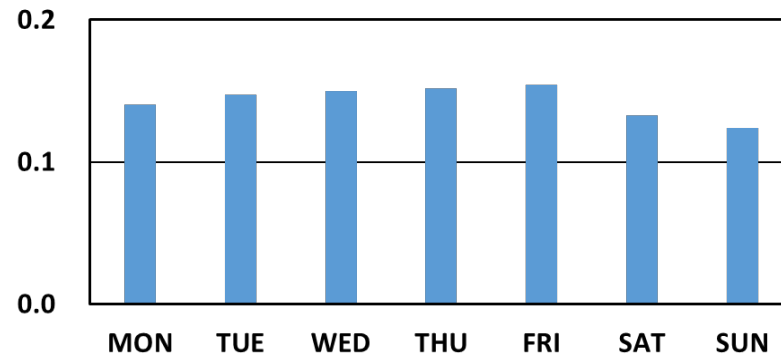
Monthly production amount of Cement



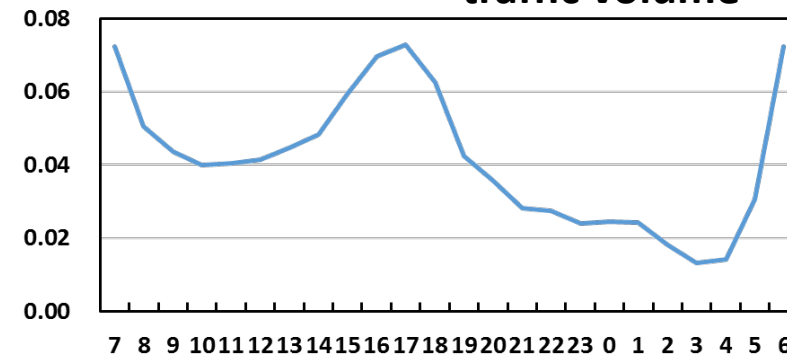
When monthly activity data are not available, annual emissions of each sector are distributed to each month base on monthly proxy data.

Weekly and diurnal factors of Road

Ratios of weekly traffic volume

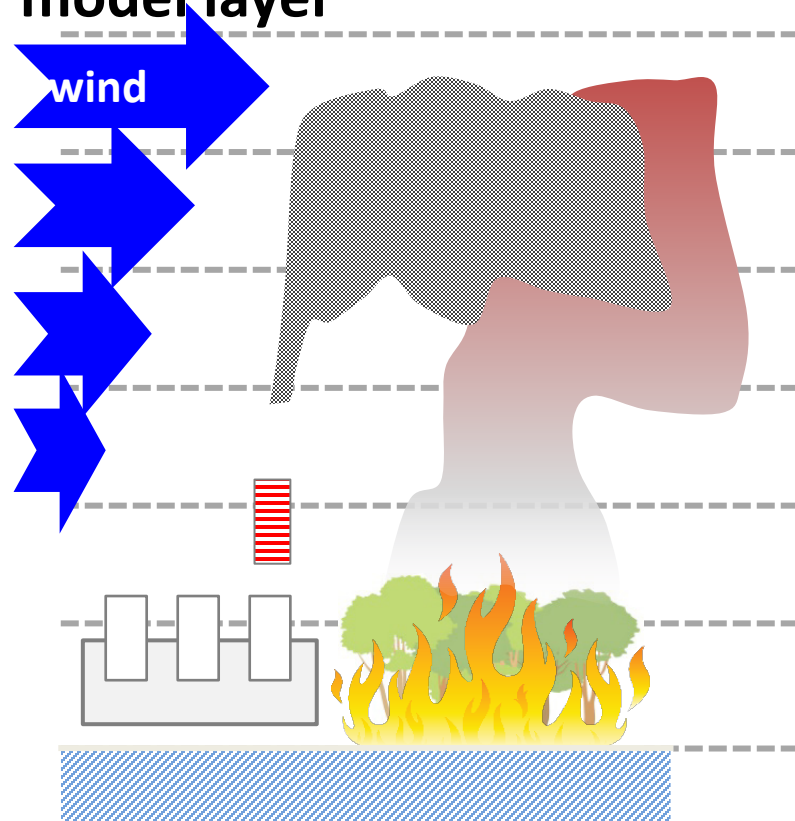


Diurnal variation of traffic volume



Vertical distribution

Cautions when applying emission data to the model model layer



Emission should be input into these model layers (not into the 1st layer only)

Long range transport



Slight air pollution near emission source

Short range transport



Severe air pollution near emission source

- Small industrial plants
- Residential combustion
- Small scale biomass burning

- Large power plants and industrial plants with high stack
- Large scale biomass burning

Information of vertical distribution of emissions is limited and has large uncertainty.

Emission Inventory and Air Quality Model

Emissions are just flux of species and to evaluate atmospheric environment (concentrations of air pollutants and their effects) in different emission structures, simulations by air quality model are essential.

Gridded Emission Inventory
(Usually unable to be used on an “as-is basis”)



- Convert Emission Inventory to “model-ready input data”**
- Speciation of NMVOC and PM species based on chemical mechanism and target species of air quality model
 - Conversion of coordinate system from that of Emission Inventory (Longitude/Latitude) to that of air quality model (Lambert etc.)



Air Quality Model

Causes of uncertainties in Emission Inventory

$$EM_{i,j,y} = A_{i,j,y} \times EF_{i,j,y} \times (1-R_{i,j,y})$$

Gridded Emission Data

A (Activity data)

- Uncertainties in statistics
- Assumption using proxy information (lack of direct activity data)
- Timing of publication of statistics

Grid allocation

- Uncertainties in regional distribution and information of point sources
- Uncertainties and lack of proxy data for grid allocation for area sources and vertical distribution

EF (Emission factors)/ R (Removal efficiencies)

- Lack of country and technology specific information
- Uncertainties in penetration rates for technologies

Temporal distribution

- Uncertainties and lack of proxy data for monthly/weekly/diurnal variation
- Lack of information which controls the temporal variation of emissions

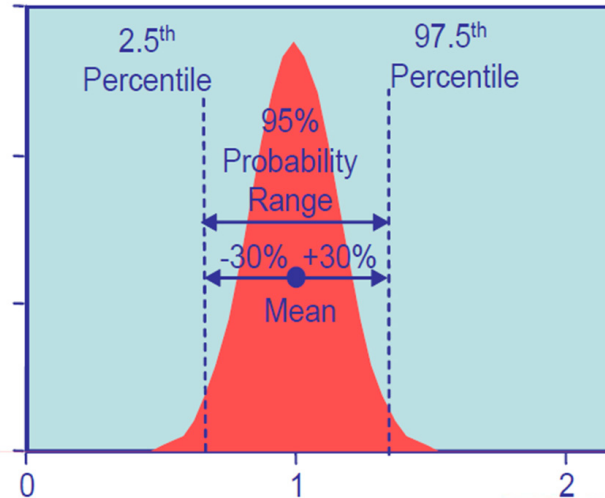
Improvement of Emission Inventory

- Evaluation of uncertainty of emission inventory
- Validation of emission inventory
 - Comparison with other inventories
 - Comparison with monitoring and modeling results (including inverse modeling)

Uncertainties in estimated emissions

Necessities/Benefits of estimating uncertainties

- Users of emission inventories need to know how reliable the numbers are and information to consider risks in policy making, scientific results, etc.
- Uncertainty analysis give insights and suggestions to improve emission inventories.
- Uncertainties of emissions are necessary information of inverse modeling.



Simple procedures to evaluate uncertainties of emissions by error propagation

Uncertainties of activity data or emission factors

half the 95 percent confidence interval

| activity data or emission factors |

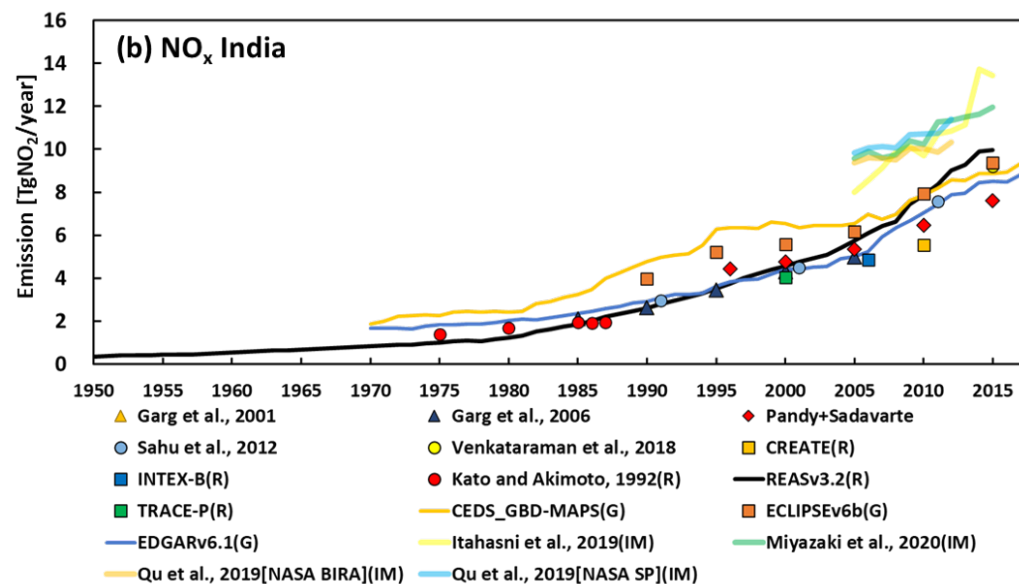
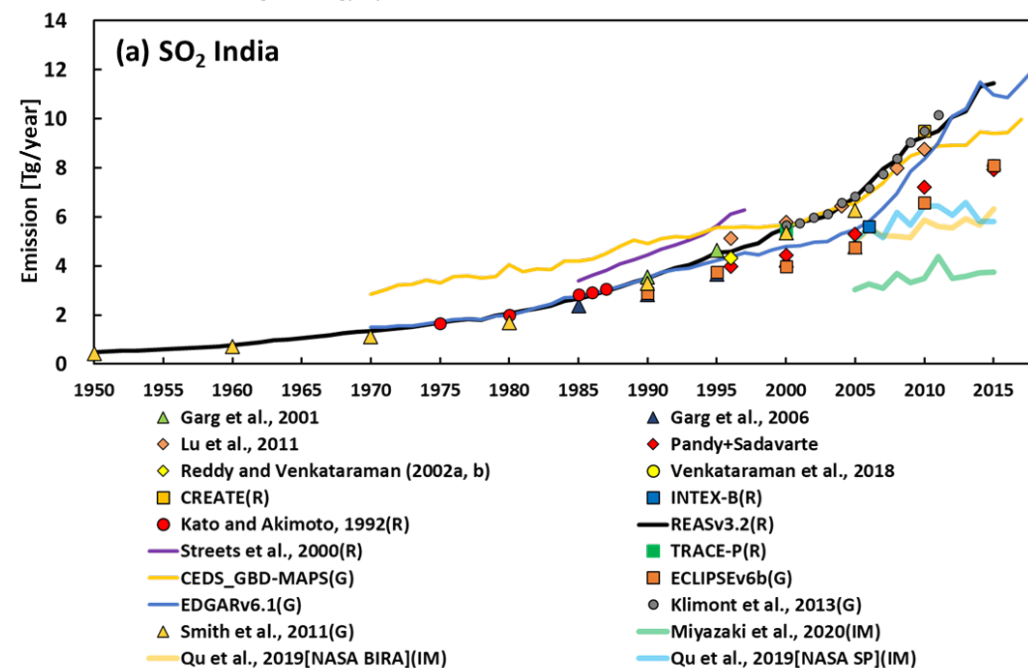
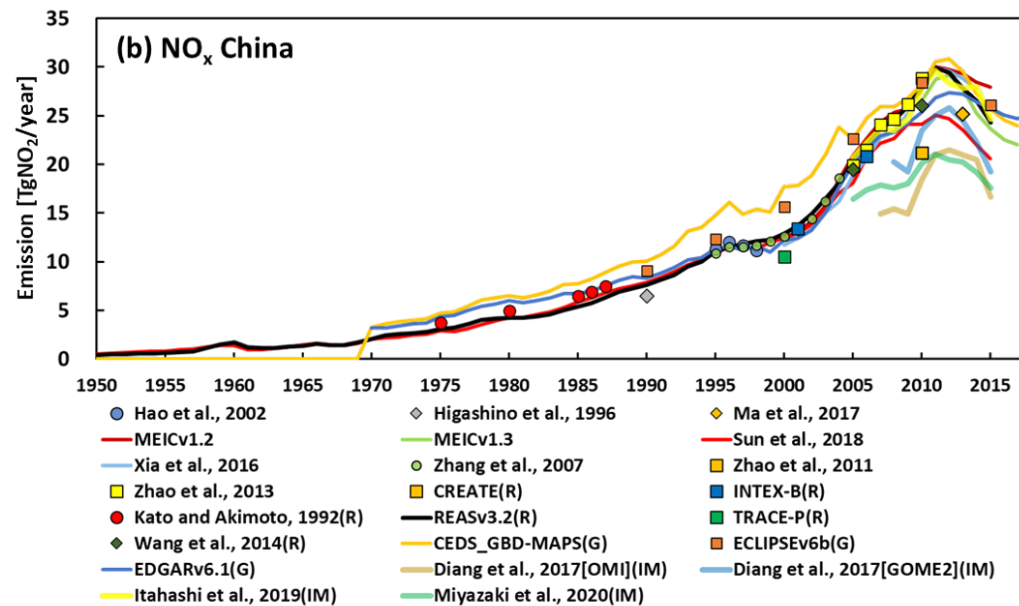
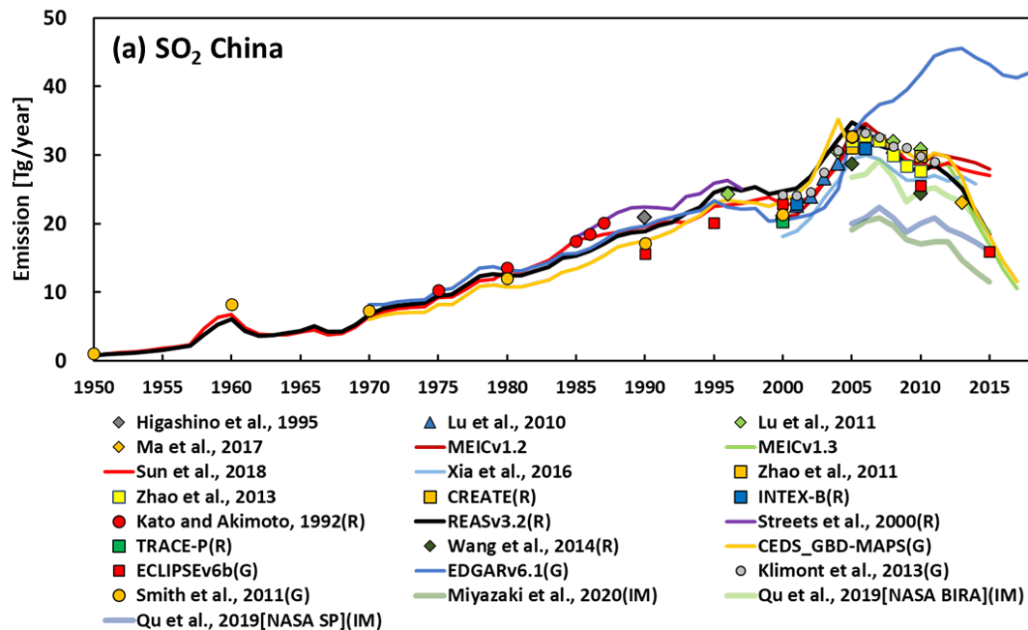
$$U_i = \sqrt{U(A_i)^2 + U(EF_i)^2}$$

U_i Uncertainties of emissions
 $U(A_i)$ Uncertainties of activity data
 $U(EF_i)$ Uncertainties of emission factors
i Sector categories

$$U_{total} = \frac{\sqrt{\sum_i (U_i \times EM_i)^2}}{\sum_i EM_i}$$

U_{total} Uncertainty of total emission
 U_i Uncertainties of emissions in sector categories *i*
 EM_i Emissions of sector categories *i*

Intercomparison of Emission Inventory



GEIA (Global Emissions Initiative)

Mission GEIA is a community initiative that builds bridges between environmental science and policy, by bringing together people, data, and tools to *create* and *communicate* the highest quality information about *emissions*.

Goals GEIA aims to be a key forum for emissions knowledge serving stakeholders and decision-makers in a rapidly evolving global society.



ECCAD-GEIA portal (<https://eccad.aeris-data.fr/>): provides access to global and regional inventories in a consistent format and to ancillary information used to produce these data sets, along with easy-to-use visualization and analysis tools.

Two approaches to estimate emissions

Estimating emissions of air pollutants

Bottom-up

Emission Inventory (EI)

- Emissions are estimated based on activity data and emission factors with unavoidable uncertainties
- Detailed information of emission structures can be obtained.
- It is fundamentally impossible to estimate real time emissions.

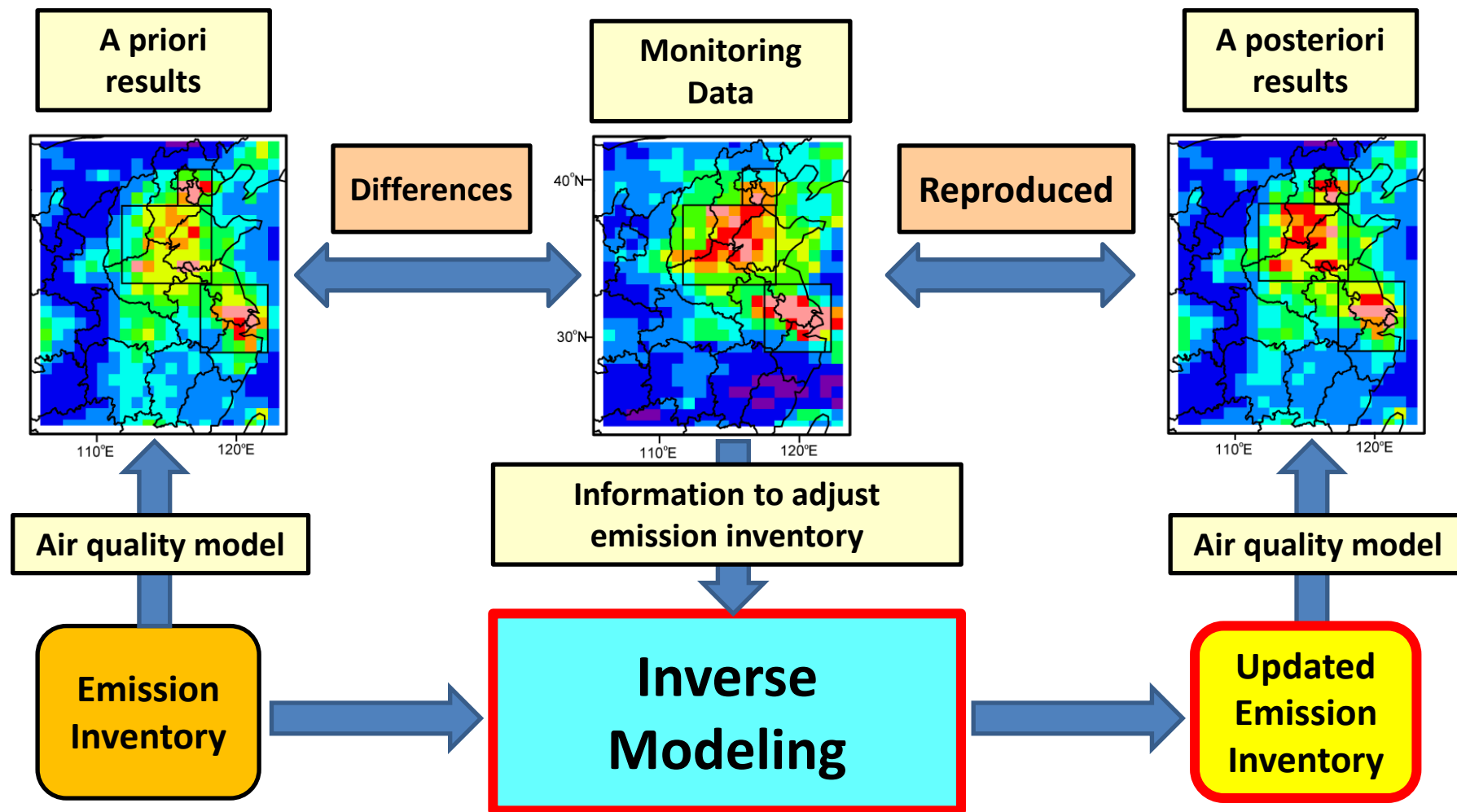
Inverse Modeling (IM)

- Emissions are calculated using monitoring data, air quality model, and numerical algorithms.
- No need for activity data and EFs.
- It is difficult to estimate emissions in each sector.
- Quasi-real time emissions can be obtained.

Top-down

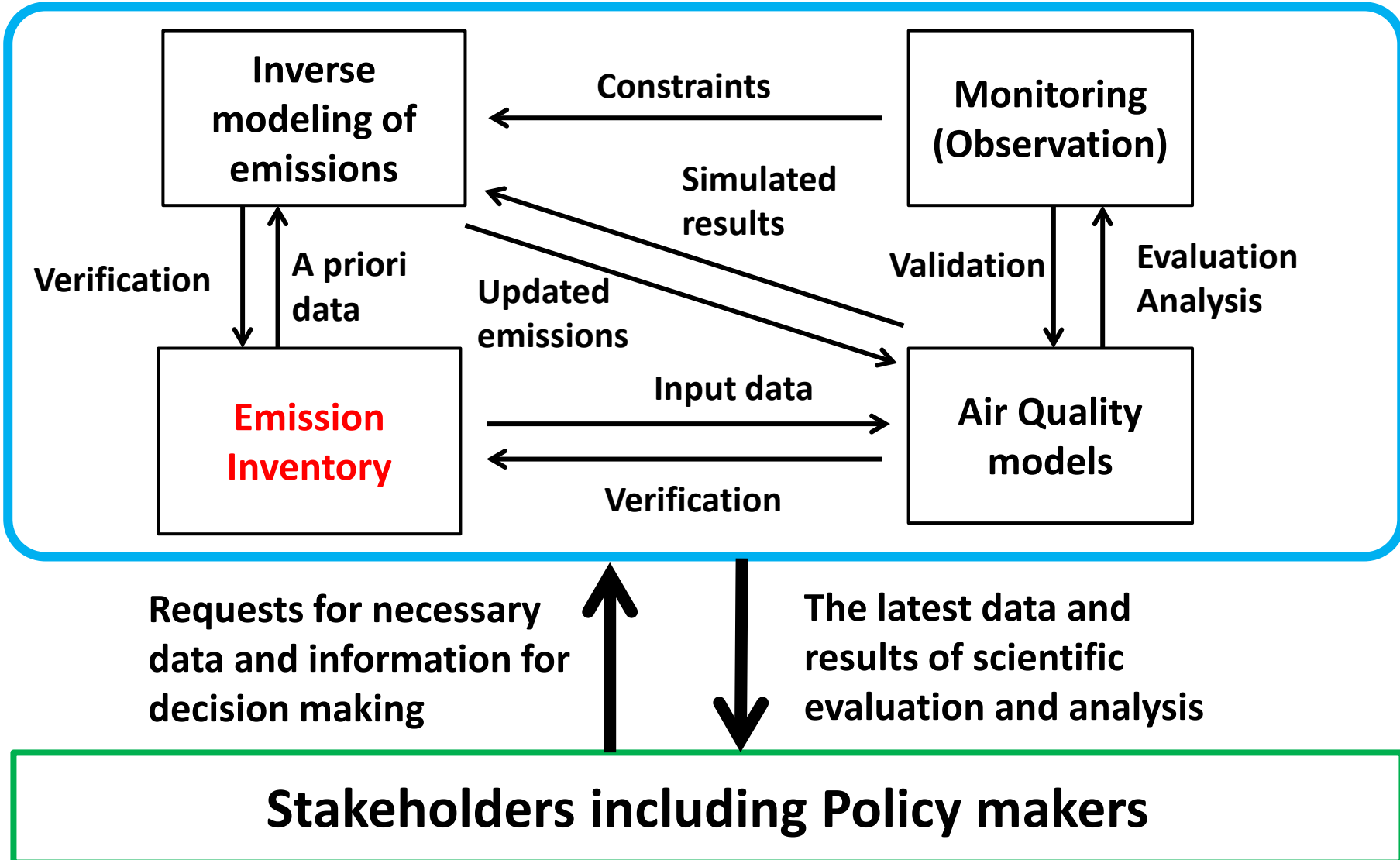
Combining EI and IM is becoming more and more important for verification of Emission Inventory.

Basic idea of Inverse Modeling



Methodology to adjust parameters (-> emissions) to reduce differences between monitoring data and model simulated results utilizing numerical algorithms.

Relationships among emission inventory, monitoring, modeling and stakeholders including policy makers



Thank you for your attention!