# Introduction to AIM/Enduse[Air]

AIM APEIS TWS in NIES

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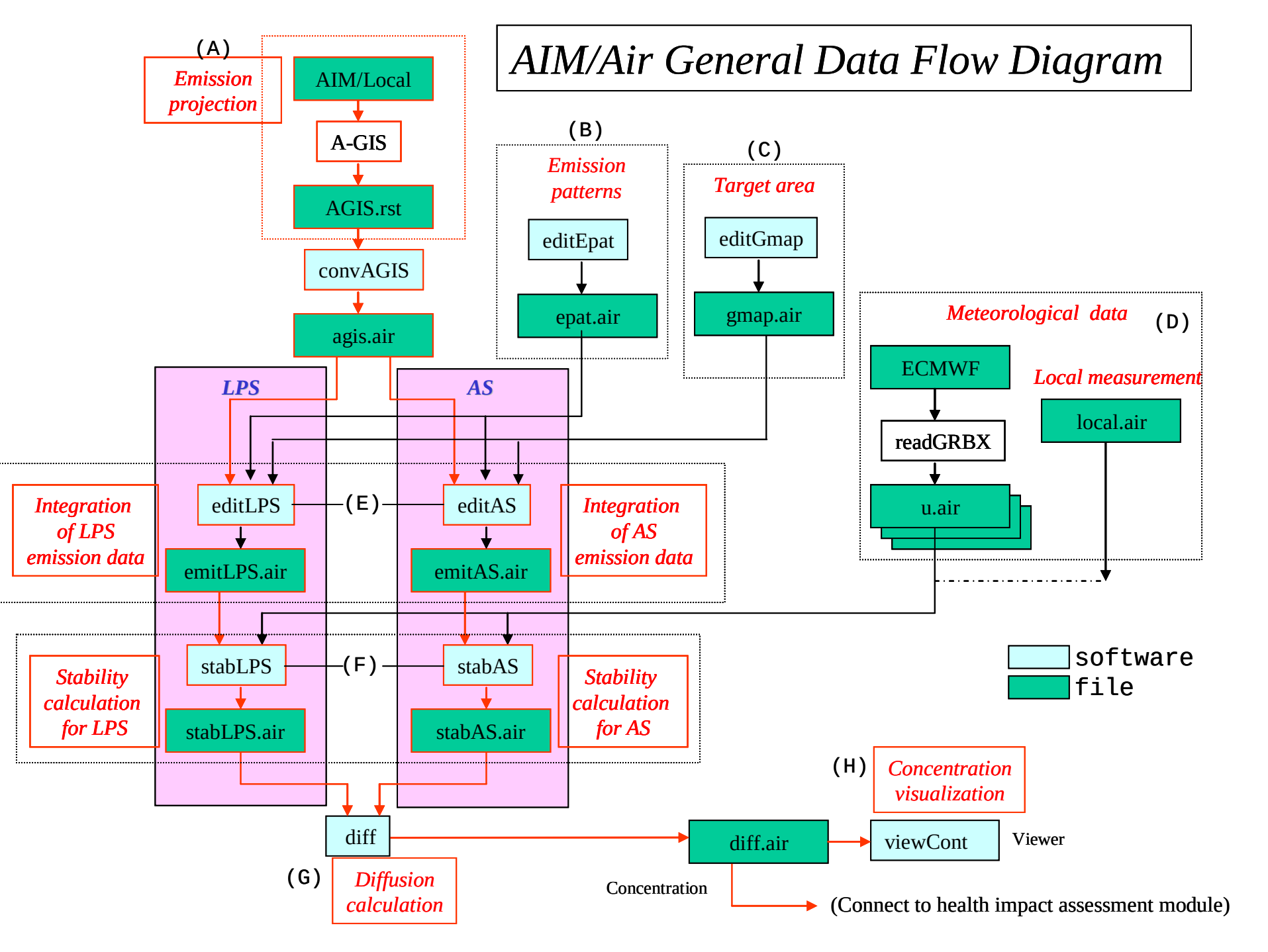
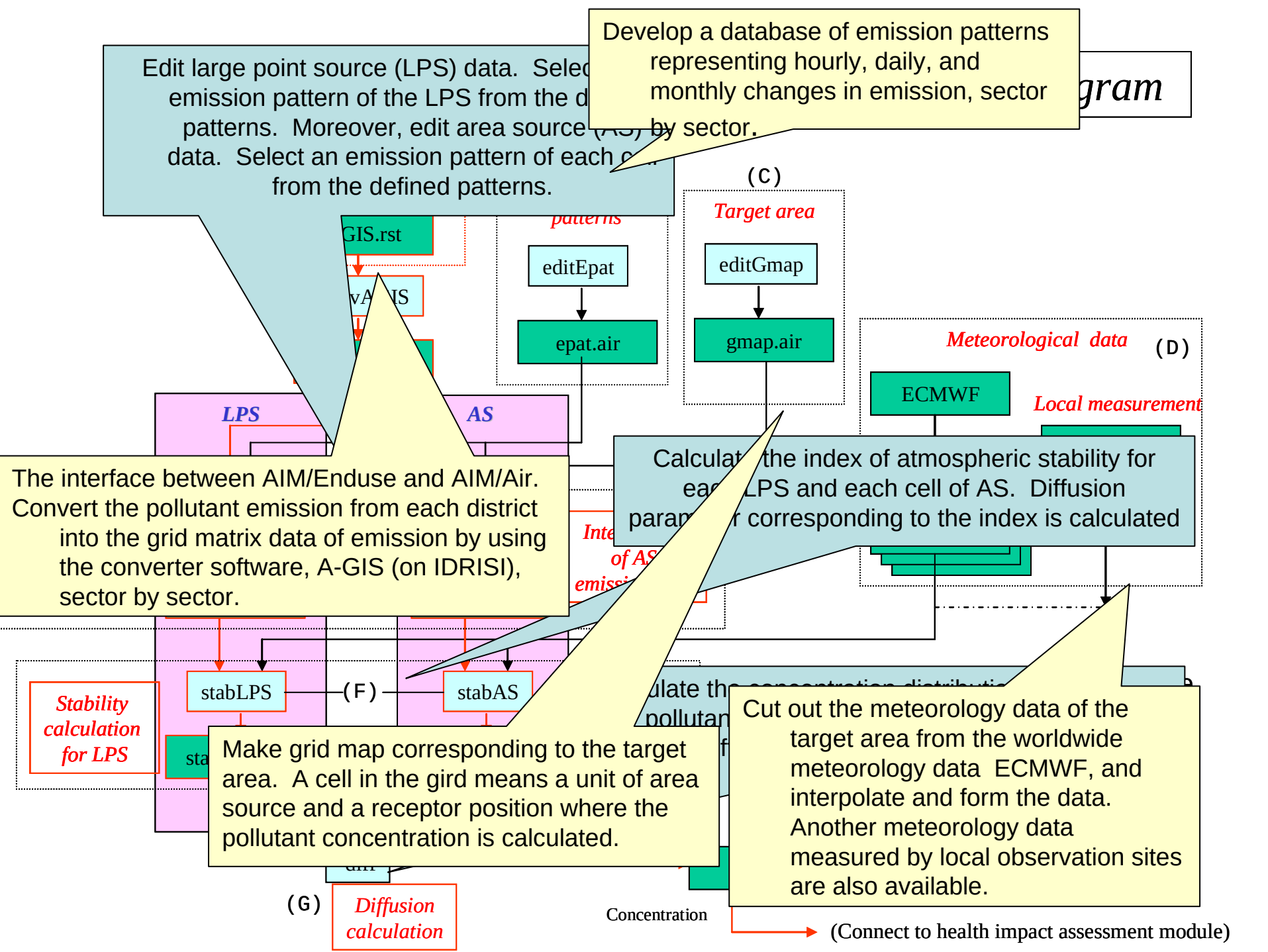
# Purpose

- To calculate diffusion of air pollutant emitted from three kinds of sources:
  - LPS: emission from large point source which has a tall stack, such as power plant, boiler or reactor in factory, waste incinerator, and so on.
  - AS: area source having a lower emission point, such as factory having a low stack, transporters, houses, fields, and so on.
  - LS: line source such as traffic road.

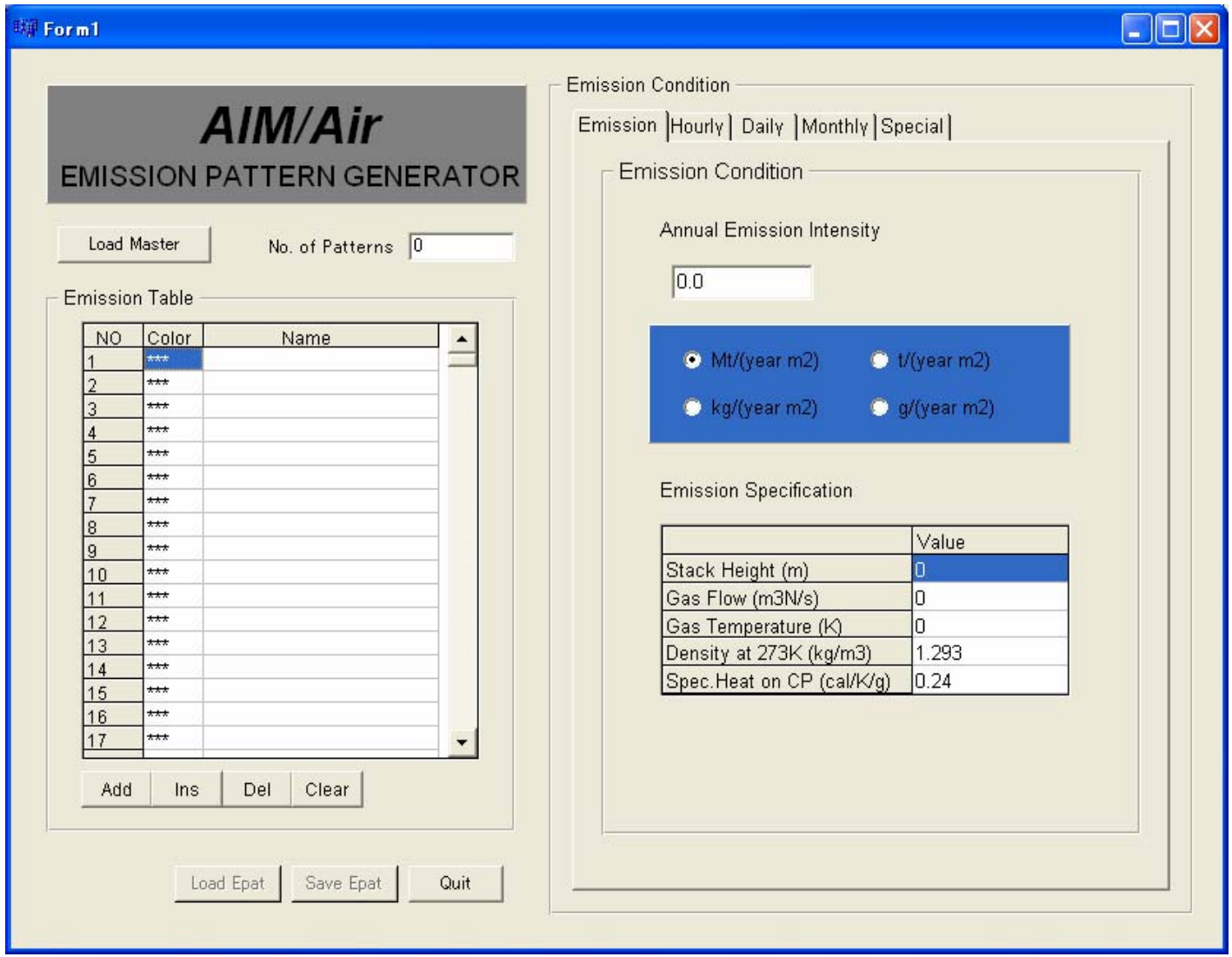
# Characteristics

- Air quality modeling in the framework of AIM family
- One of supplementary models of AIM/Enduse
- SO2, NOx, are target pollutants.. (SPM is the third target of pollutant)
- Pollutant concentration in every hour during specified period is calculated.
- Evaluation of health risk related to energy use through calculation of air pollutant concentration.


AIM/Air General Data Flow Diagram
(A)
Emission projection
AIM/Local
A-GIS
AGIS.rst
convAGIS
agis.air
(B)
Emission patterns
editEpat
epat.air
(C)
Target area
editGmap
gmap.air
Meteorological data
(D)
ECMWF
readGRBX
u.air
Local measurement
local.air
LPS
AS
Integration of LPS emission data
editLPS
(E)
editAS
Integration of AS emission data
emitLPS.air
emitAS.air
Stability calculation for LPS
stabLPS
(F)
stabAS
Stability calculation for AS
stabLPS.air
stabAS.air
software
file
(H)
Concentration visualization
diff
diff.air
viewCont
Viewer
(G)
Diffusion calculation
Concentration
(Connect to health impact assessment module)

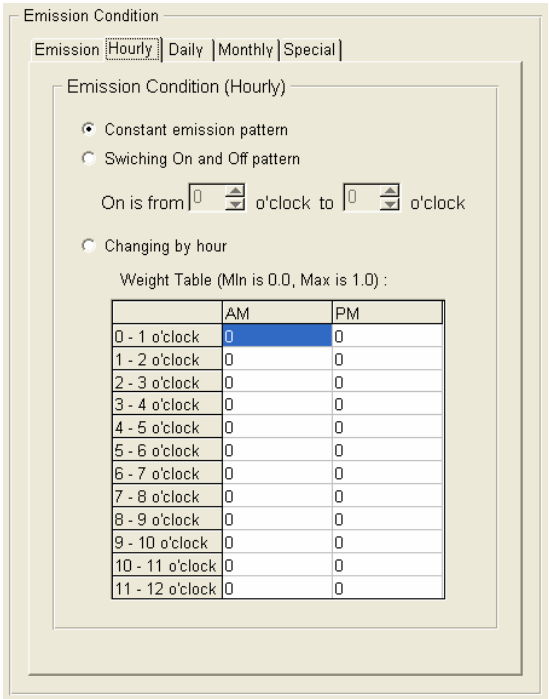

Edit large point source (LPS) data. Selec
emission pattern of the LPS from the d
patterns. Moreover, edit area source (AS) by
data. Select an emission pattern of each c
from the defined patterns.
Develop a database of emission patterns representing hourly, daily, and monthly changes in emission, sector by sector.
gram
(C)
Target area
editGmap
gmap.air
editEpat
epat.air
GIS.rst
Meteorological data
(D)
ECMWF
Local measurement
LPS
AS
The interface between AIM/Enduse and AIM/Air. Convert the pollutant emission from each district into the grid matrix data of emission by using the converter software, A-GIS (on IDRISI), sector by sector.
Calculat the index of atmospheric stability for ea LPS and each cell of AS. Diffusion param r corresponding to the index is calculated
Stability calculation for LPS
stabLPS
(F)
stabAS
Make grid map corresponding to the target area. A cell in the gird means a unit of area source and a receptor position where the pollutant concentration is calculated.
Cut out the meteorology data of the target area from the worldwide meteorology data ECMWF, and interpolate and form the data. Another meteorology data measured by local observation sites are also available.
(G)
Diffusion calculation
Concentration
(Connect to health impact assessment module)

# Emission pattern generator (1)

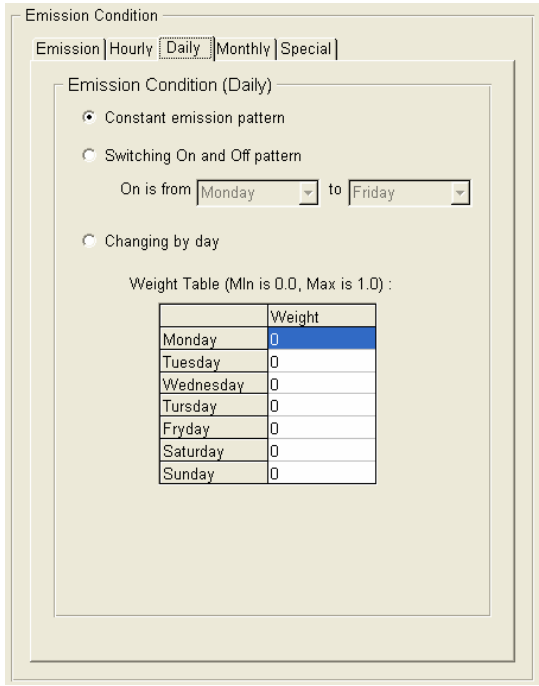


# Emission Pattern generator (2)

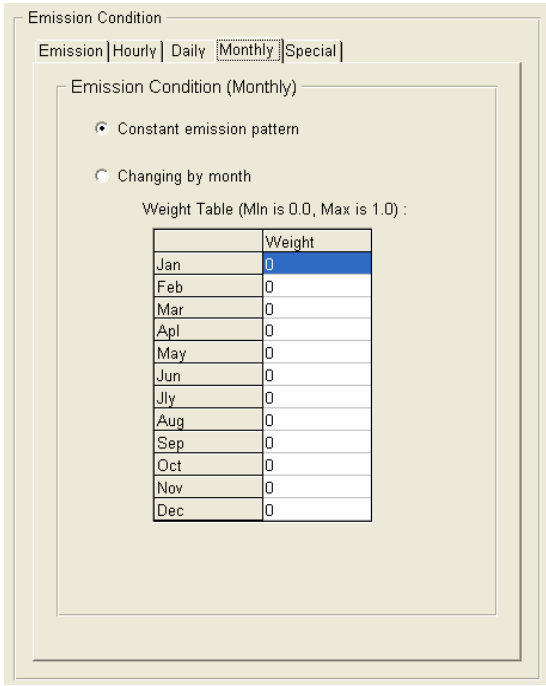
GUI to input emission pattern.




Hourly pattern



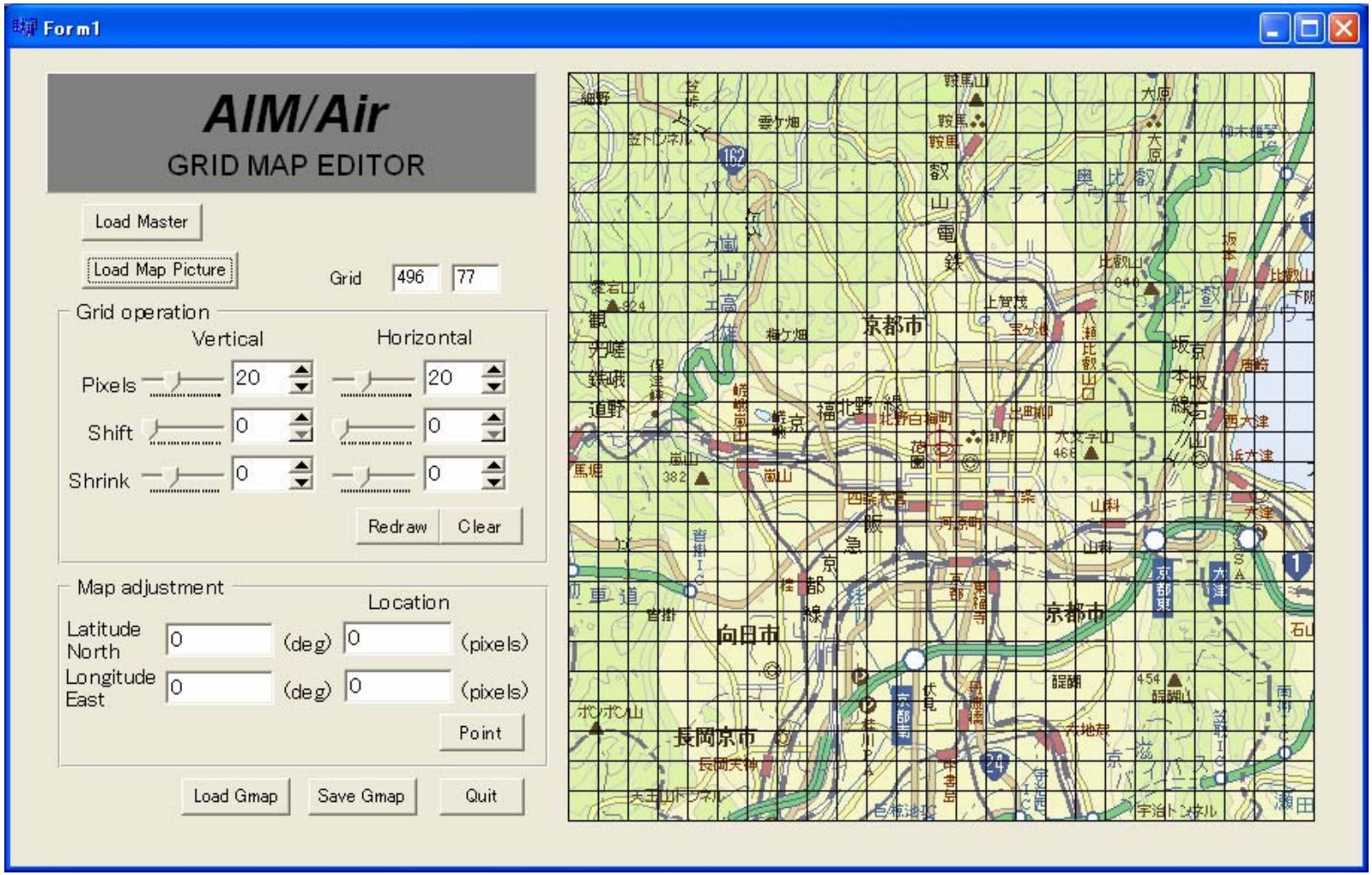

Daily pattern



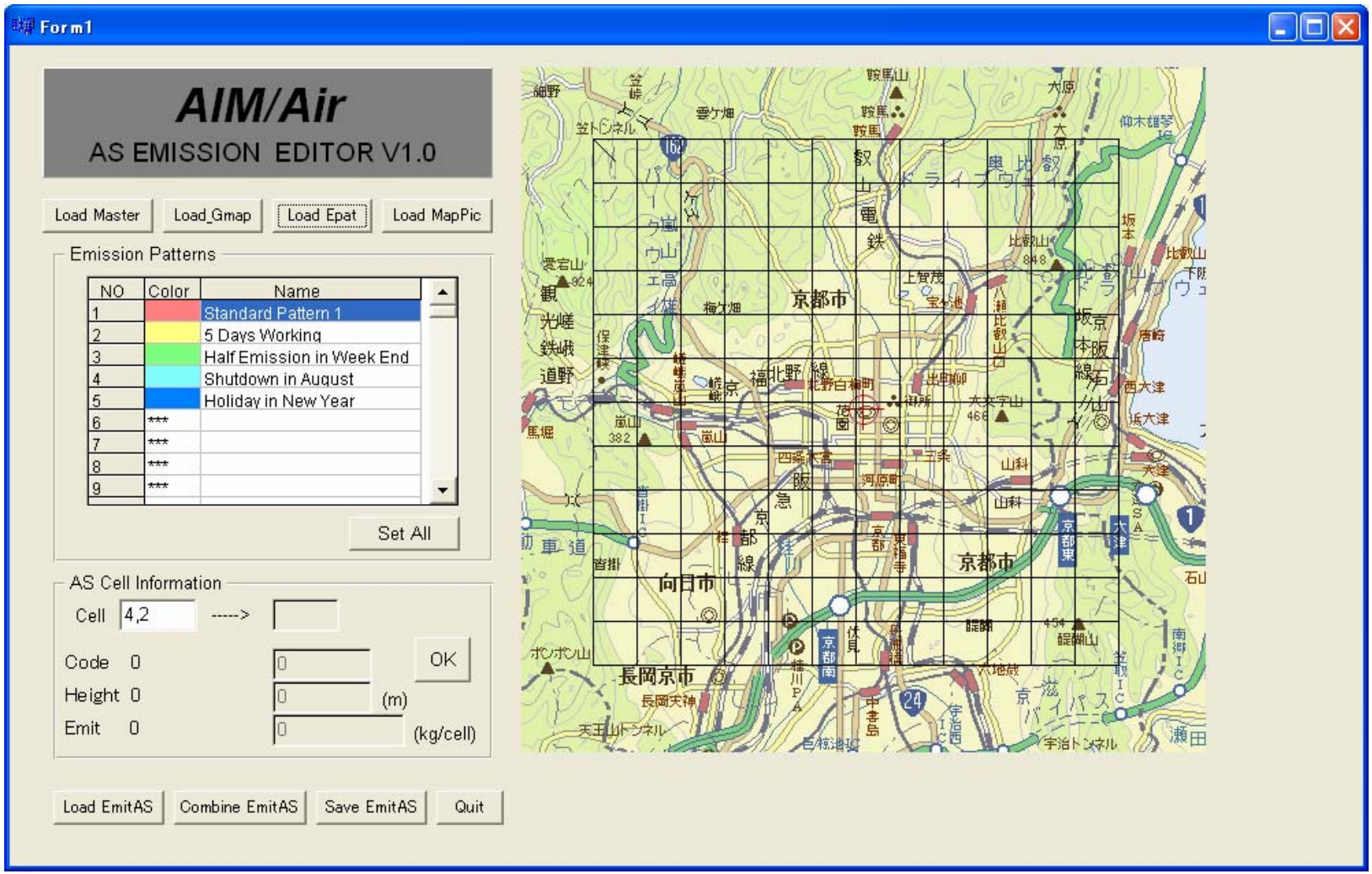

Monthly pattern

Note: Term of special holidays is also taken into account.

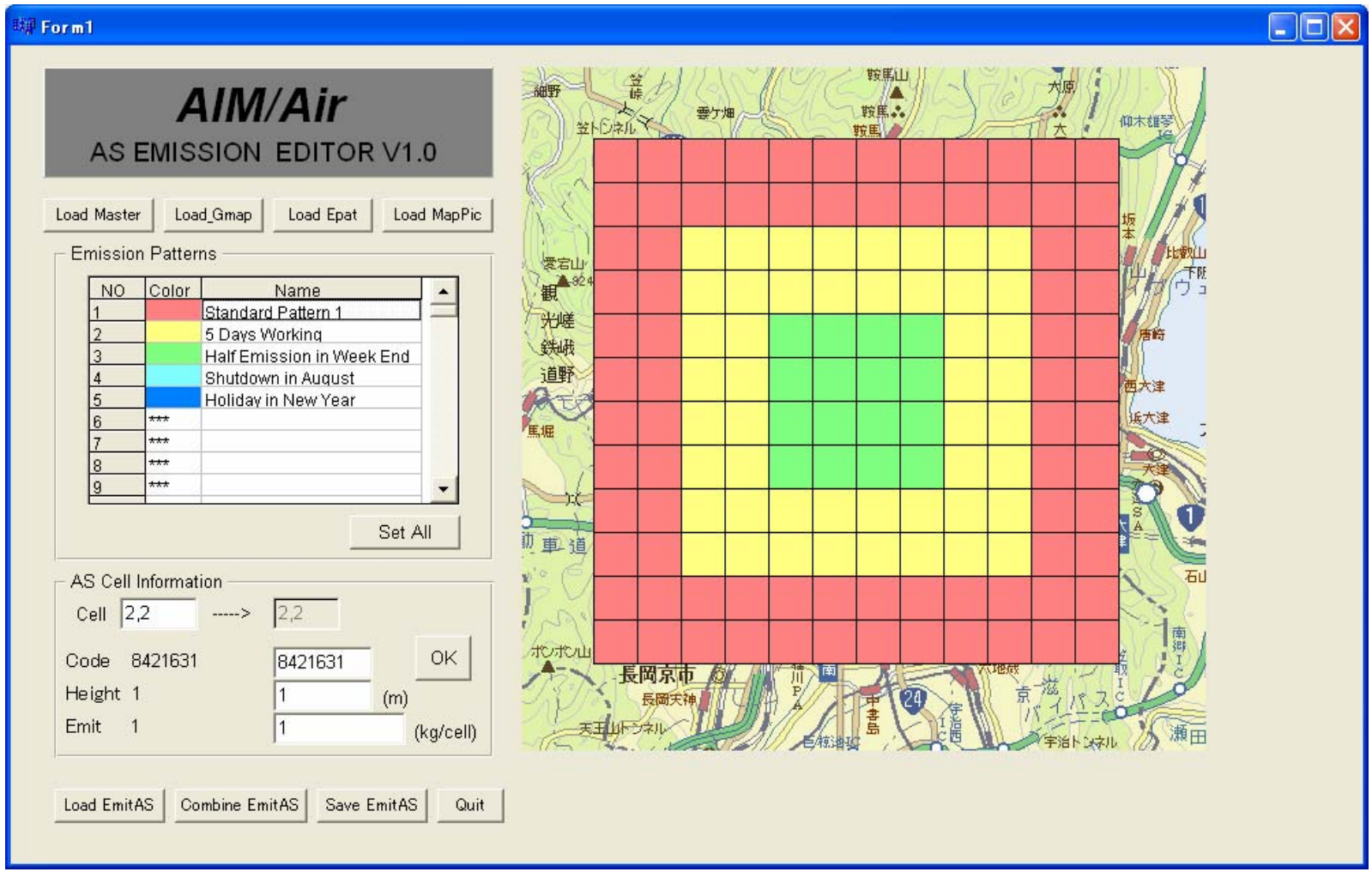
# Grid map editor



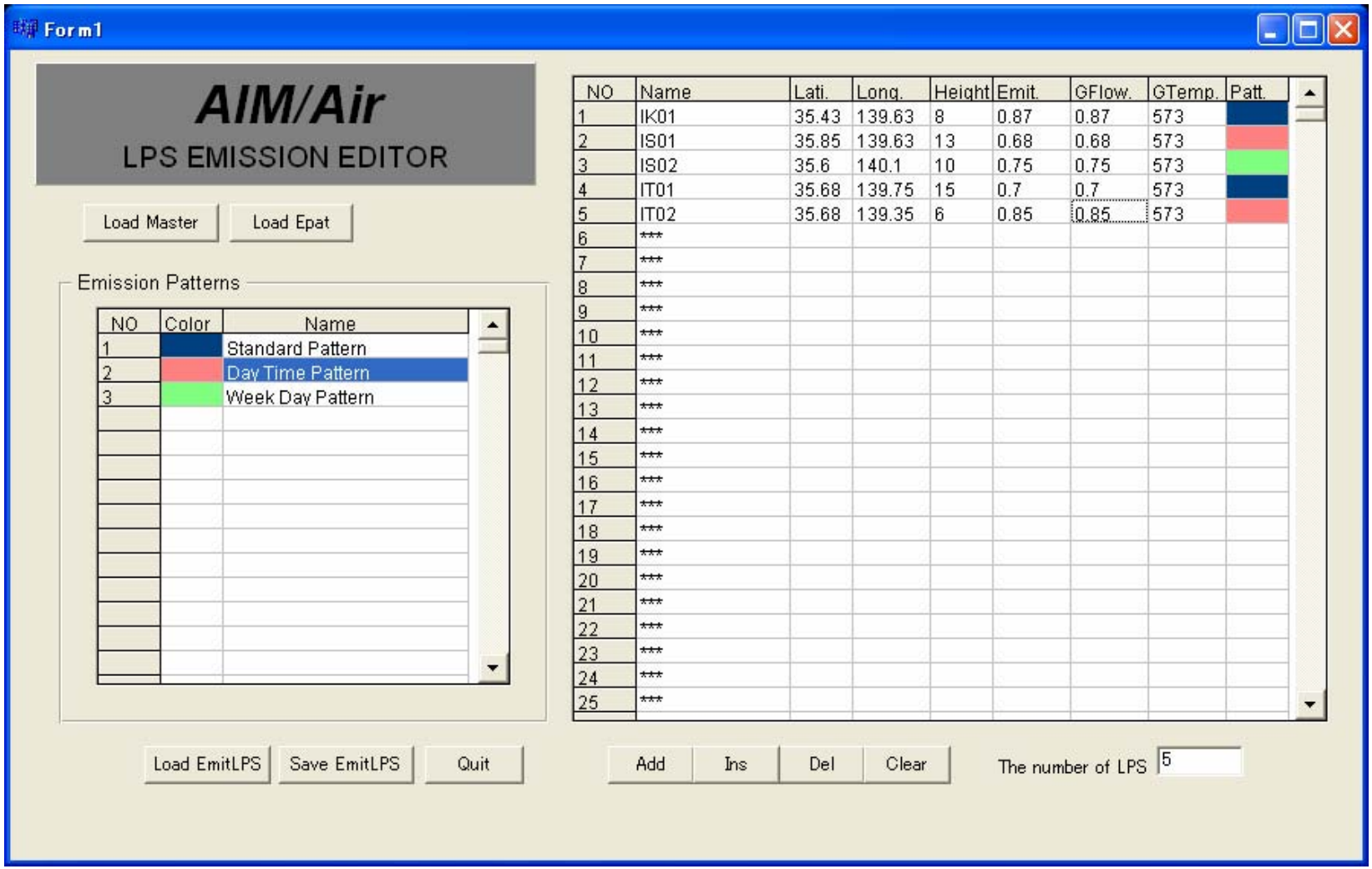
# AS Emission Editor (1)



# AS Emission Editor (2)



# LPS Emission editor



# Specification of AIM/Air software

- Grid size: fineness of the gird is restricted by the limitation of CPU power and memory size.
  - Ex 1) the size of the target area is 100km x 100km, and cell size of the grid is 1 km x 1 km
  - Ex.2)the size of target area is 10km x 100km, and cell size of the grid is 100m x 100m. The balance of the target size and cell size are flexibly adjustable.
- Emission pattern of LPS should be designed according to the actual operation schedule in the factory. That of AS cell should be designed by considering land use, several kinds of industrial area, residential area, traffic path, agricultural field, and so on.
- Hourly, weekly and monthly change in emission intensity can be defined.
- The meteorology data locally corrected at observation sites are available for the diffusion calculation.
- Pollutant concentration in every hour during specified period is calculated.
- Effective computational algorithm to calculate plume-type diffusion from AS cells is implemented.
- GUI is available on PC computer, and software can run on both PC and Linux.

# Plume model

This diffusion equation is used when the wind velocity is more than 1(m/s).

$$C(x,y,z)=\frac{Q_P}{2\pi\sigma_y\sigma_z u}\exp\left(-\frac{y^2}{2\sigma_y{}^2}\right)\exp\left\{\left(-\frac{(z-H_e)^2}{2\sigma_z{}^2}\right)+\left(-\frac{(z+H_e)^2}{2\sigma_z{}^2}\right)\right\}$$

*x*: downstream coordinate, *y*: horizontally transverse coordinate, *z*: vertical coordinate (representative height=1.5m), *Qp*: emission from point source (kg/year), *u*: wind velocity (m/s), $\sigma y$, $\sigma z$ : diffusion coefficients of coordinate y and z (m)

Diffusion parameters

$$\sigma_y=\gamma_y\cdot x^{\alpha_y},\ \sigma_z=\gamma_z\cdot x^{\alpha_z}$$

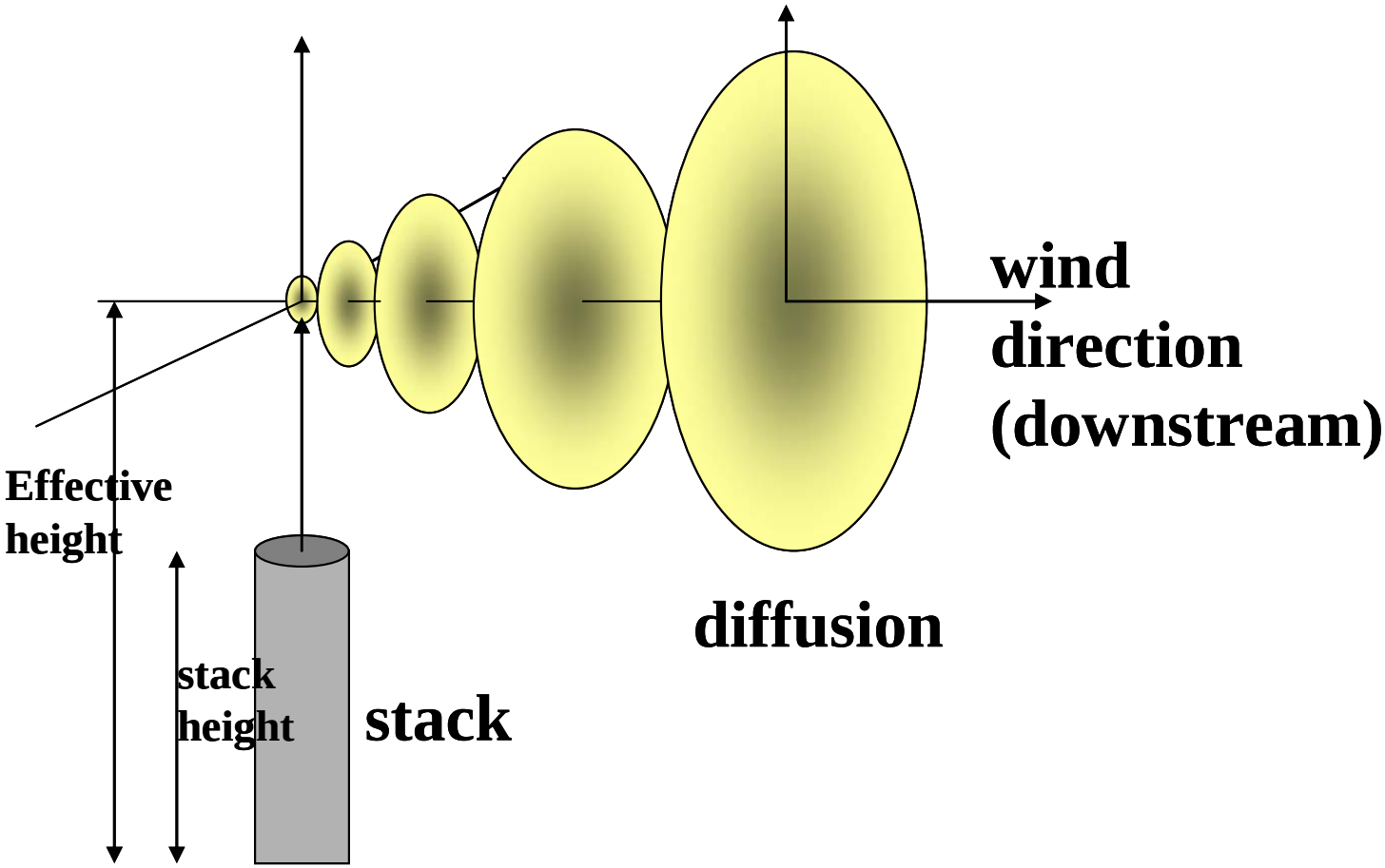
Effective stack height

$$H_e=H+\Delta H$$

$$\Delta H=0.175Q_H{}^{1/2}u_h{}^{-3/4}$$

$$Q_H=\rho C_p q_g\left(T_g-T_0\right)$$

# Image of plume diffusion



# Puff model

This diffusion model is used in the case of no wind or very weak wind.

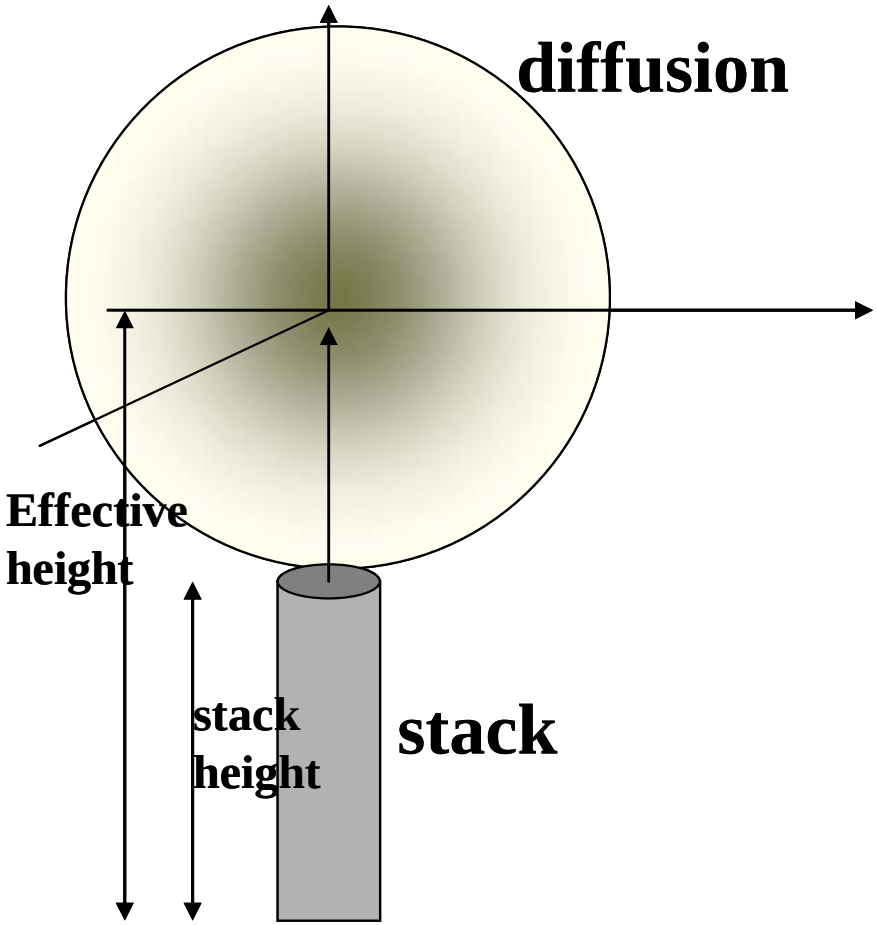
$$C(x,y,z)=\frac{Q_P}{(2\pi)^{3/2}\gamma}\exp\left(-\frac{u^2}{2\alpha^2}\right)\left[\frac{1}{\eta_-^2}\left\{1+\frac{\sqrt{\pi/2}\cdot ux}{\alpha\eta_-}\exp\left(\frac{u^2x^2}{2\alpha^2\eta_-^2}\right)\operatorname{erfc}\left(-\frac{ux}{\sqrt{2}\alpha\eta_-}\right)\right\}+\frac{1}{\eta_+^2}\left\{1+\frac{\sqrt{\pi/2}\cdot ux}{\alpha\eta_+}\exp\left(\frac{u^2x^2}{2\alpha^2\eta_-^2}\right)\operatorname{erfc}\left(-\frac{ux}{\sqrt{2}\alpha\eta_+}\right)\right\}\right]$$

$$\eta_-^2=x^2+y^2+\frac{\alpha^2}{\gamma^2}(z-H_e)^2$$

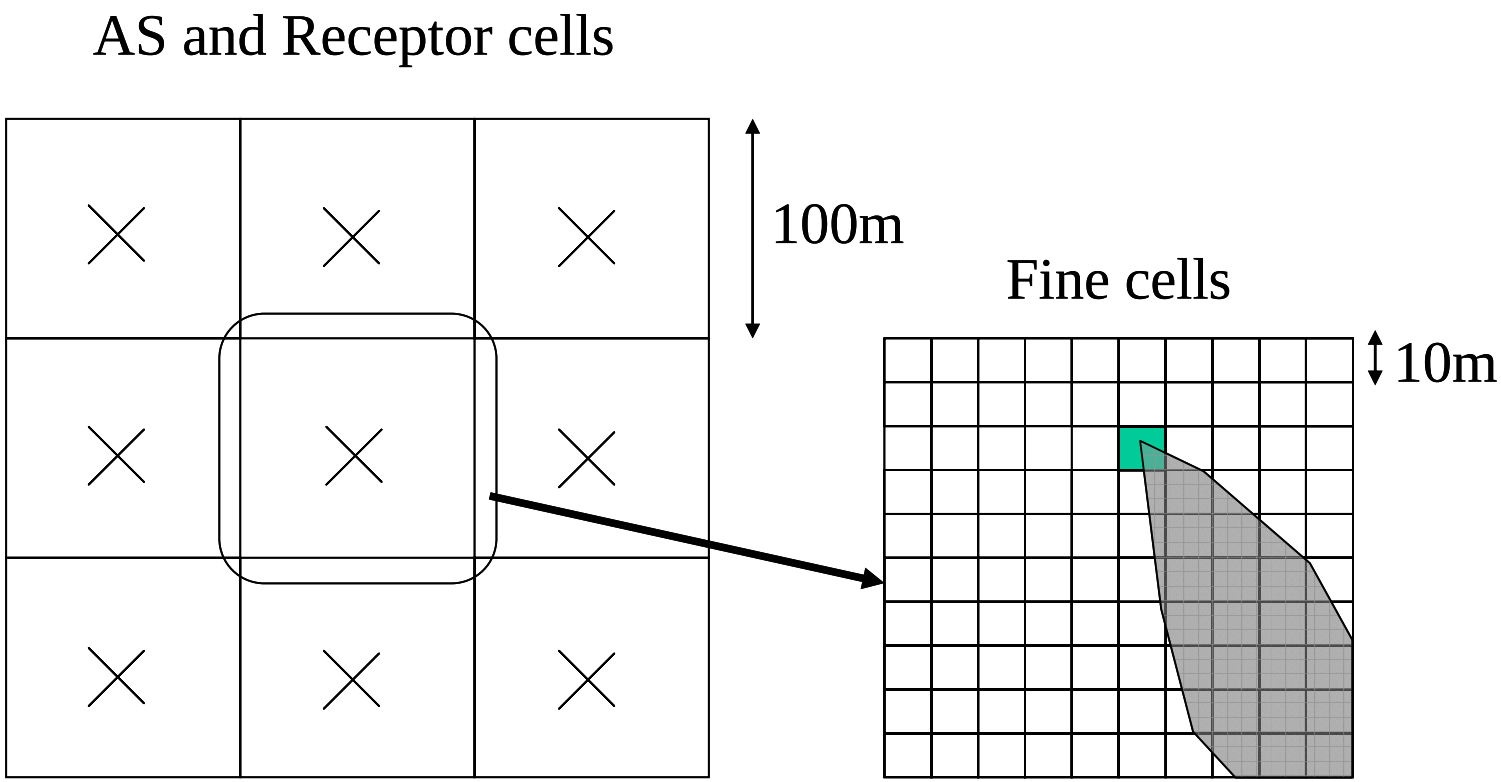
$$\eta_+^2=x^2+y^2+\frac{\alpha^2}{\gamma^2}(z+H_e)^2$$

$$\operatorname{erfc}(W)=\frac{1}{\sqrt{\pi}}\int_W^\infty e^{-t^2}dt$$

# Image of puff diffusion



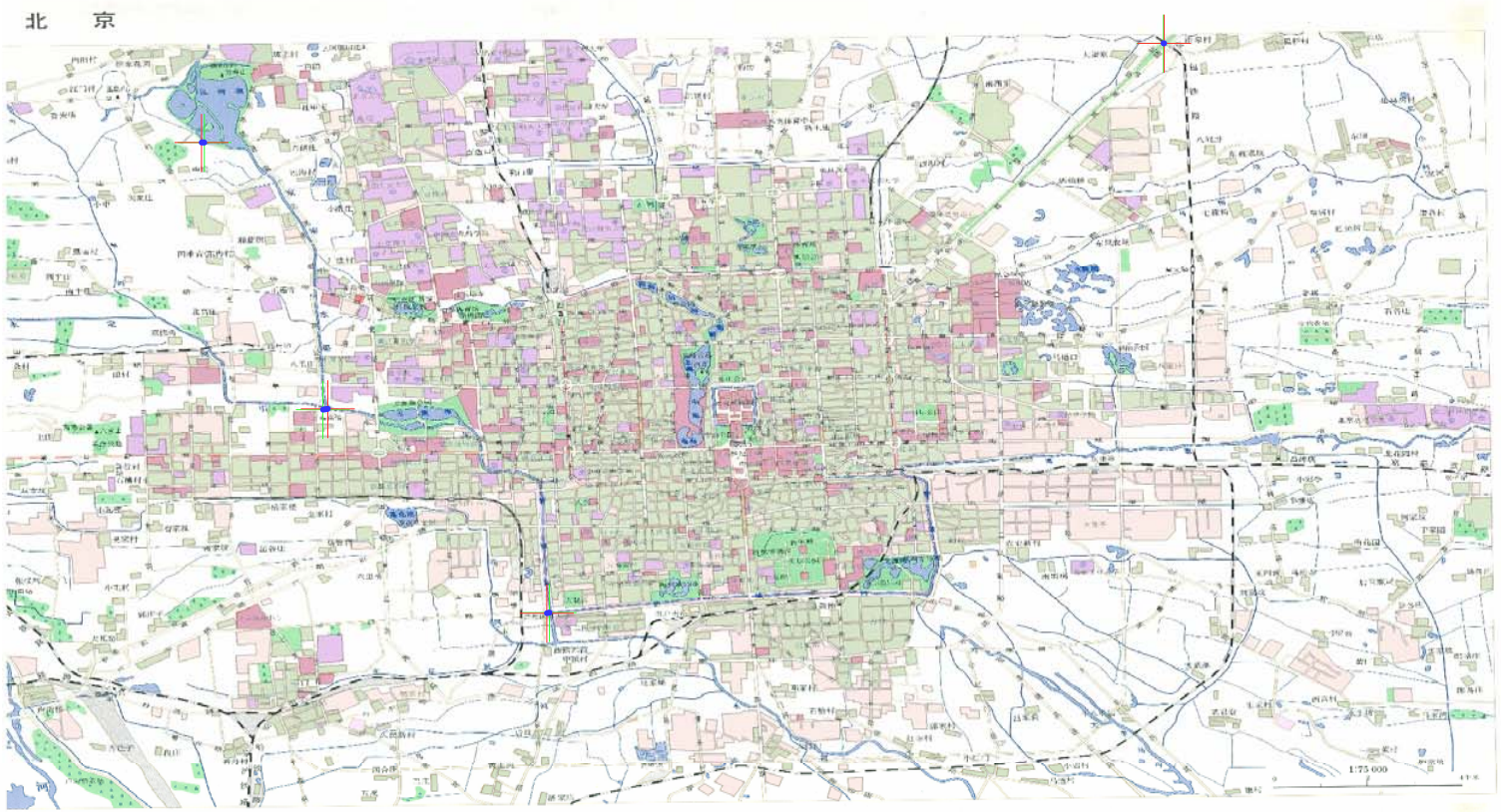
# Method for AS



# Required data in AIM/Enduse[Air]

| | |
|---|---|
| Emission quantity | Annual quantity (kg/year), sector by sector, output from Enduse model. |
| Emission pattern | daily, weekly, and monthly change in emission, sector by sector |
| LPS | location (latitude and longitude), stack height, gas(flow, temperature, specific heat) |
| AS | land-use map, emission height, gas(flow, temperature, specific heat) |
| LS | road map, traffic volume by transporter-type, emission factor (kg/m) by transporter-type |
| Meteorology data | wind direction and velocity, air temperature, solar radiation, cloud cover |

# Land use in Beijing city




Public building area

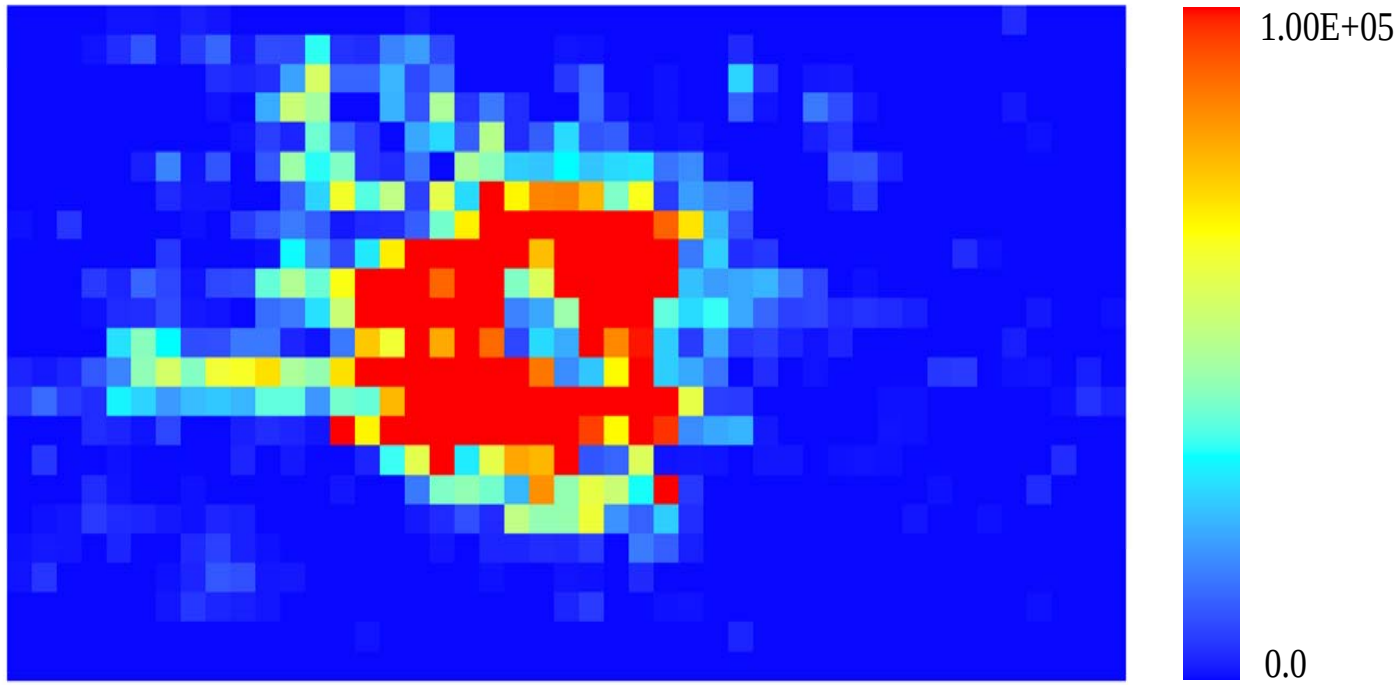
Commercial area

School & Hospital area

Residential area

Industrial area & Warehouse

# Emission from residential area (grid map data)



# Contribution to Air Pollution in Beijing