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Co-benefits between LCS policies and Air Pollution Issues.

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Background

- Co-benefit is one of the most important factors to implement LCS policies to the developing countries.
- Target of the co-benefits:
  Air Quality / Water Quality / Human Health / poverty etc.
- Especially, air pollution issue is directly connected to the use of primary energy (Coal / Oil / Biomass).
- GAINS (IIASA) is one of the powerful tool to asses the co-benefit related to air pollution.
- However, we would like to develop own co-benefits analysis tool working within AIM framework.

Objective (1)

It is necessary to estimate the Co-Benefit of the LCS policy to the air pollution issue as accurate as possible.

It is required to estimate health impact, ecological impact and agricultural impact of air pollution.

Scale is different

Climate Change (GHG emission)

- Global scale
- Long lifetime

Air Pollutant (SOx, NOx, SPM, VOC …)

- Local Scale
- Short Lifetime

Co-benefit is not proportion to the reduction of CO_2….

Reduce Dirty CO_2 or Clean CO_2

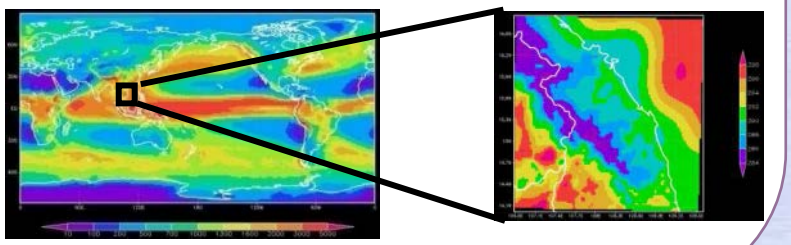
Reduce Urban CO_2 or Rural CO_2

Downscaling

Downscaling of Climate Change Scenario

GCM →
Regional Climate Model

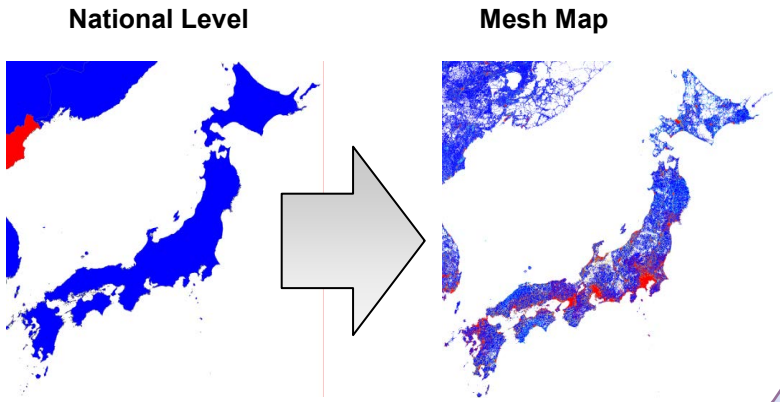
- Evaluate regional impact of climate change (Temperature/Precipitation)
- Drive the air quality model under the climate change scenario



Downscaling of Emission inventory

Country-level emission
→ Mesh map

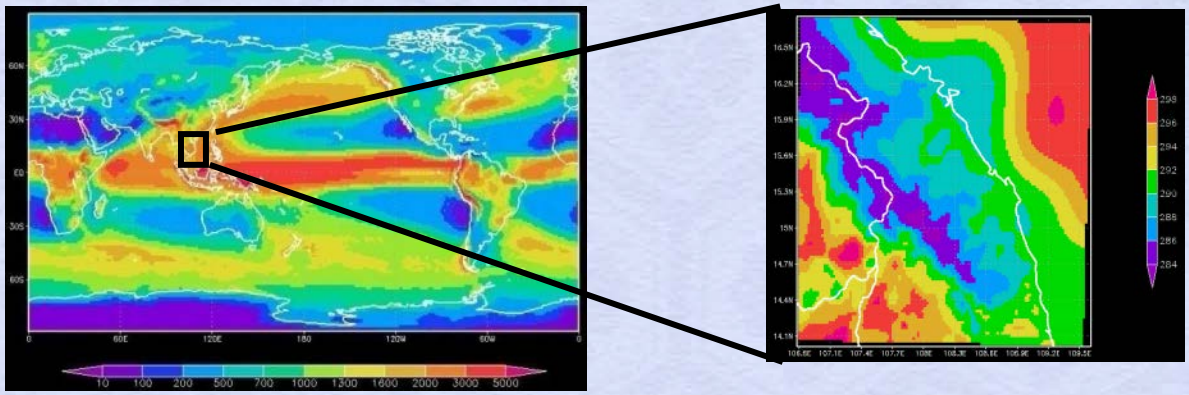
- To use as an input data for air quality modeling.
- (…….)



How to make Regional Climate Scenario ?

- Downscaling
  - Statistical Downscaling

    Create a statistical function between GCM output and local surface variables
    - Weather typing
    - Weather generation
    - Regression method
  - Regional Climate Modeling



Downscaling by Regional Climate Model

- AOGCM .. MIROC 3.2 (High resolution version)

  Developed by Univ. of Tokyo / NIES / Frontier Res. Cent. for Global Change

  - Atmosphere: 1.1° x 1.1° 59 layers Top=40km
  - Ocean : 0.2° x 0.3° 47 layers
  - SRES A1B scenario

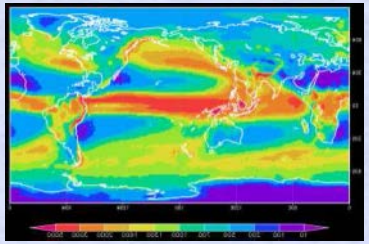
- Regional Climate Model

  WRF / MM5 / NCAR RegCM / RAMS / RCM20 ....

Pennsylvania State Univ. / NCAR
Mesoscale nun-hydrostatic meteorological model
- Cumulus Parameterization
- PBL Schemes
- Cloud Microphysics Schemes
- Radiation schemes.
- Land Surface / Soil Schemes
- One-way / Two-way nesting

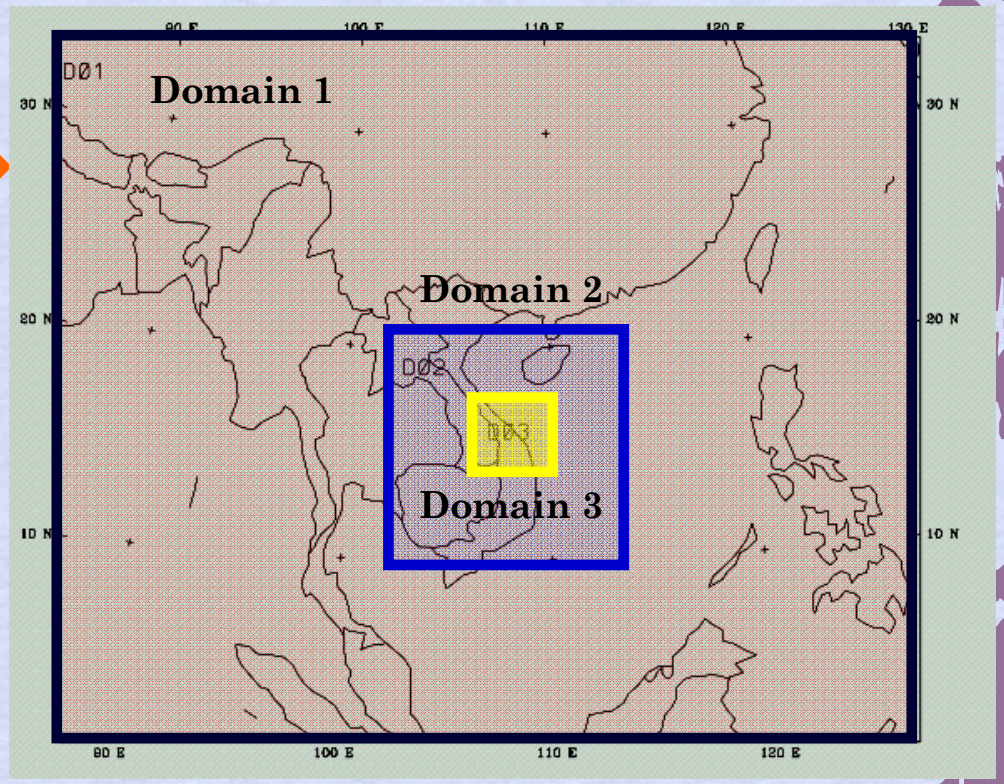
Downscaling by Regional Climate Model

Case-Study to make a Regional Climate Scenario in Danang, Vietnam.



GCM
(MIROC3.2 Hires A1B)

2030 – 2039
every 6 hour
u, v, RH, T, Tg, SST, P…..



110 km x 110km → **45 km x 45km** 88 x 73

→ **15 km x 15km** 61x 61

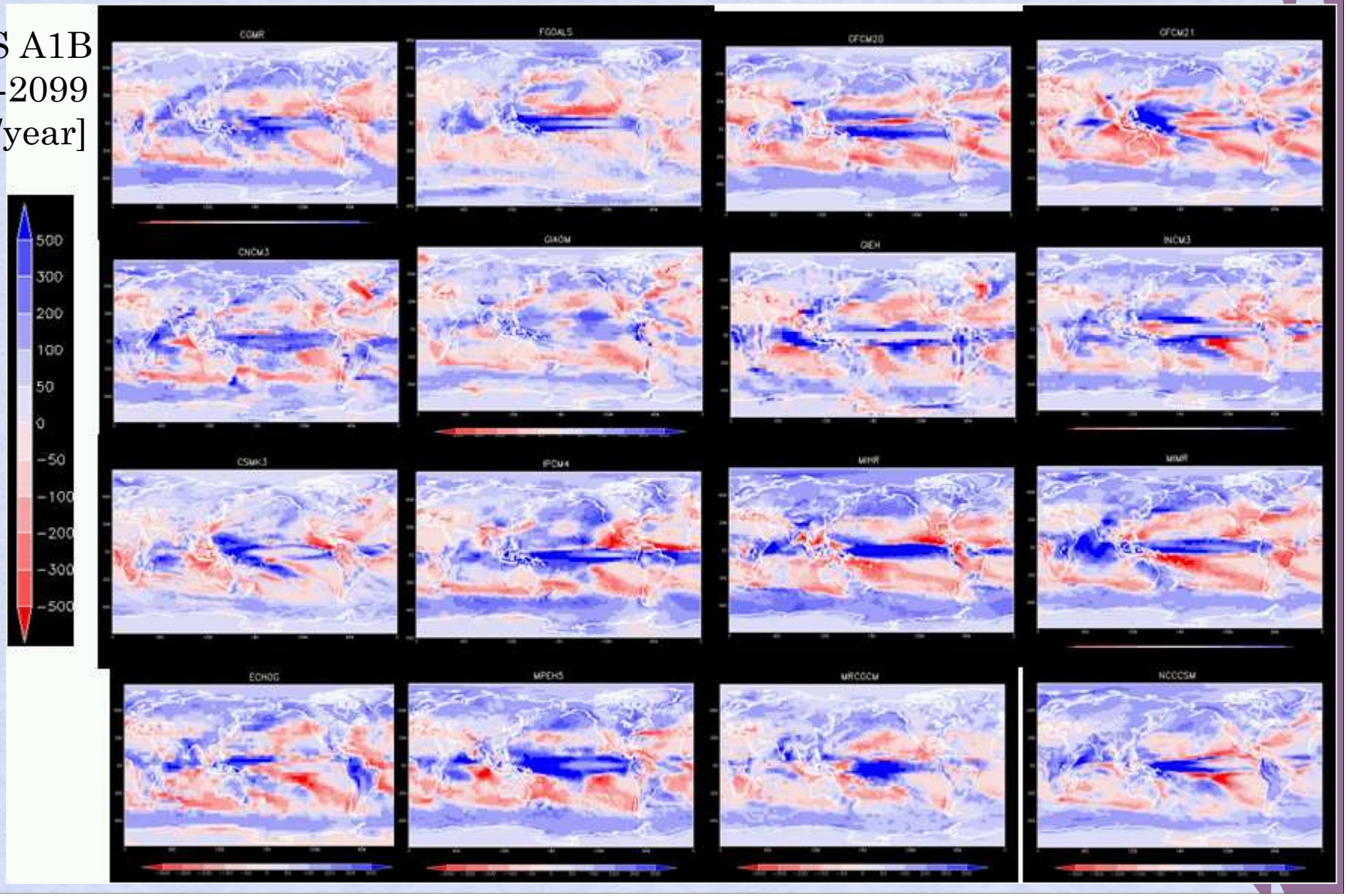
→ **5 km x 5 km** 61 x 61

Model Inter-comparison Precipitation anomaly (Global)

(IPCC, 2007)

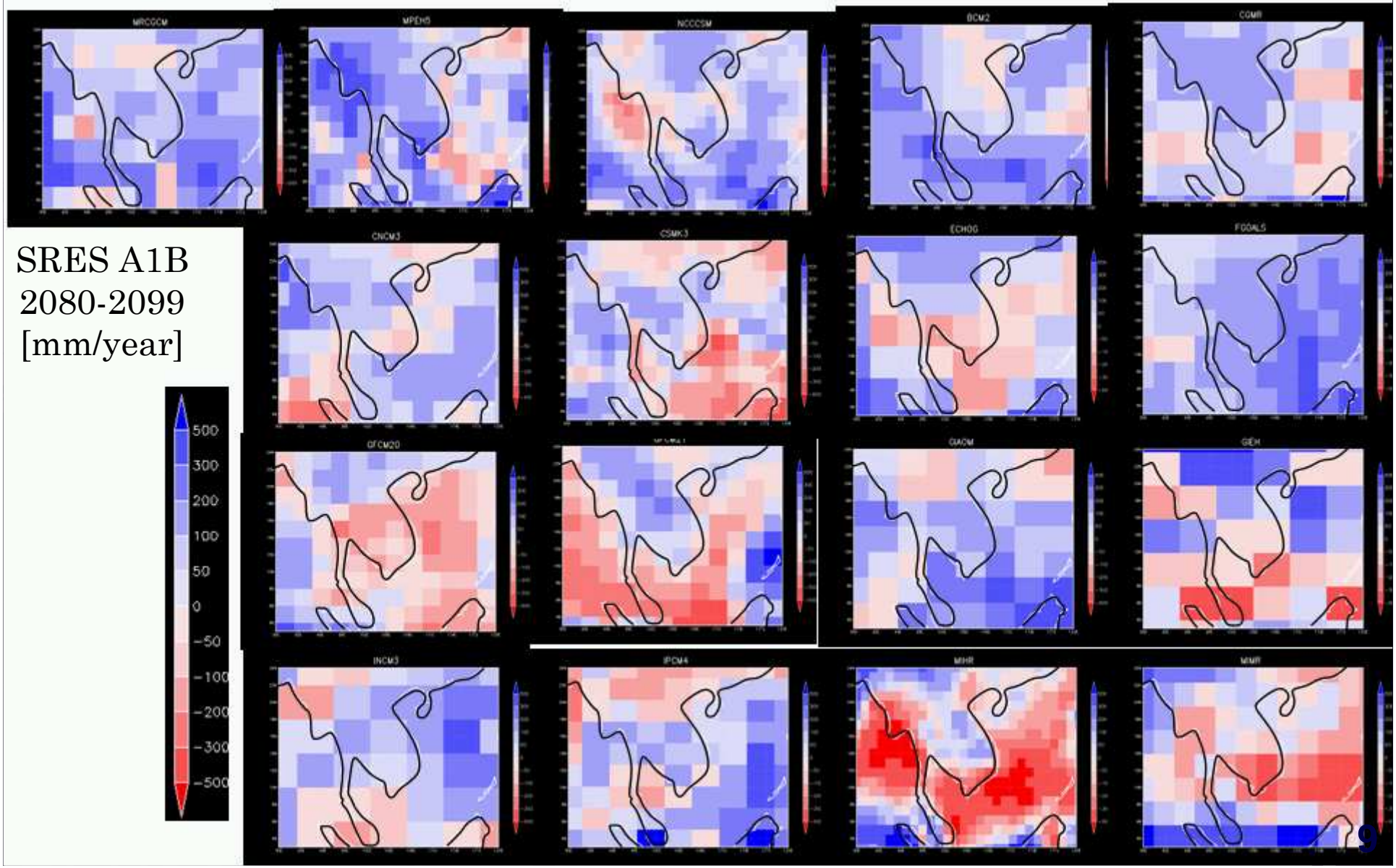
To check the model consistency.

SRES A1B
2080-2099
[mm/year]



Model Inter-comparison
Precipitation anomaly (Indochina)

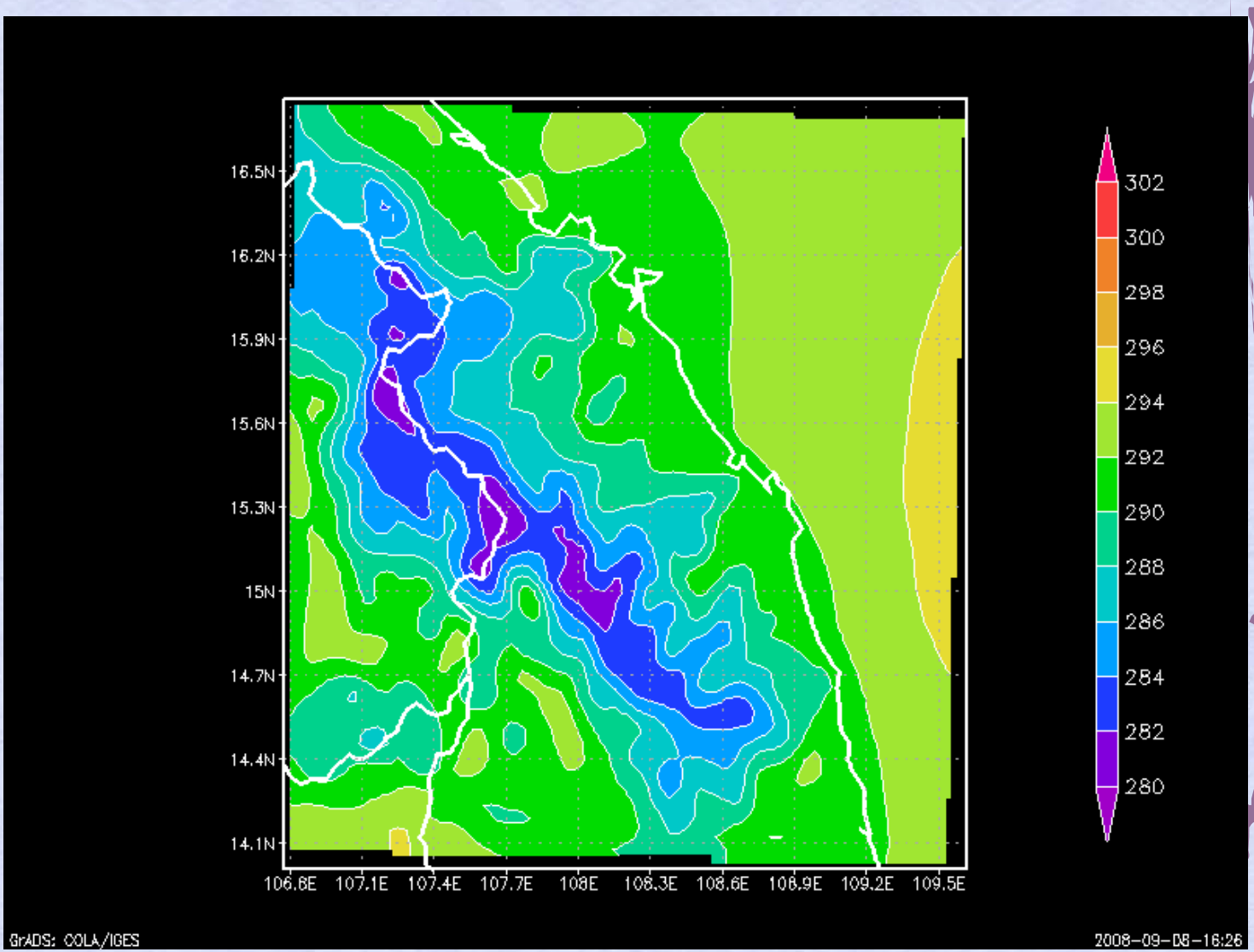
(IPCC, 2007)



SRES A1B
2080-2099
[mm/year]

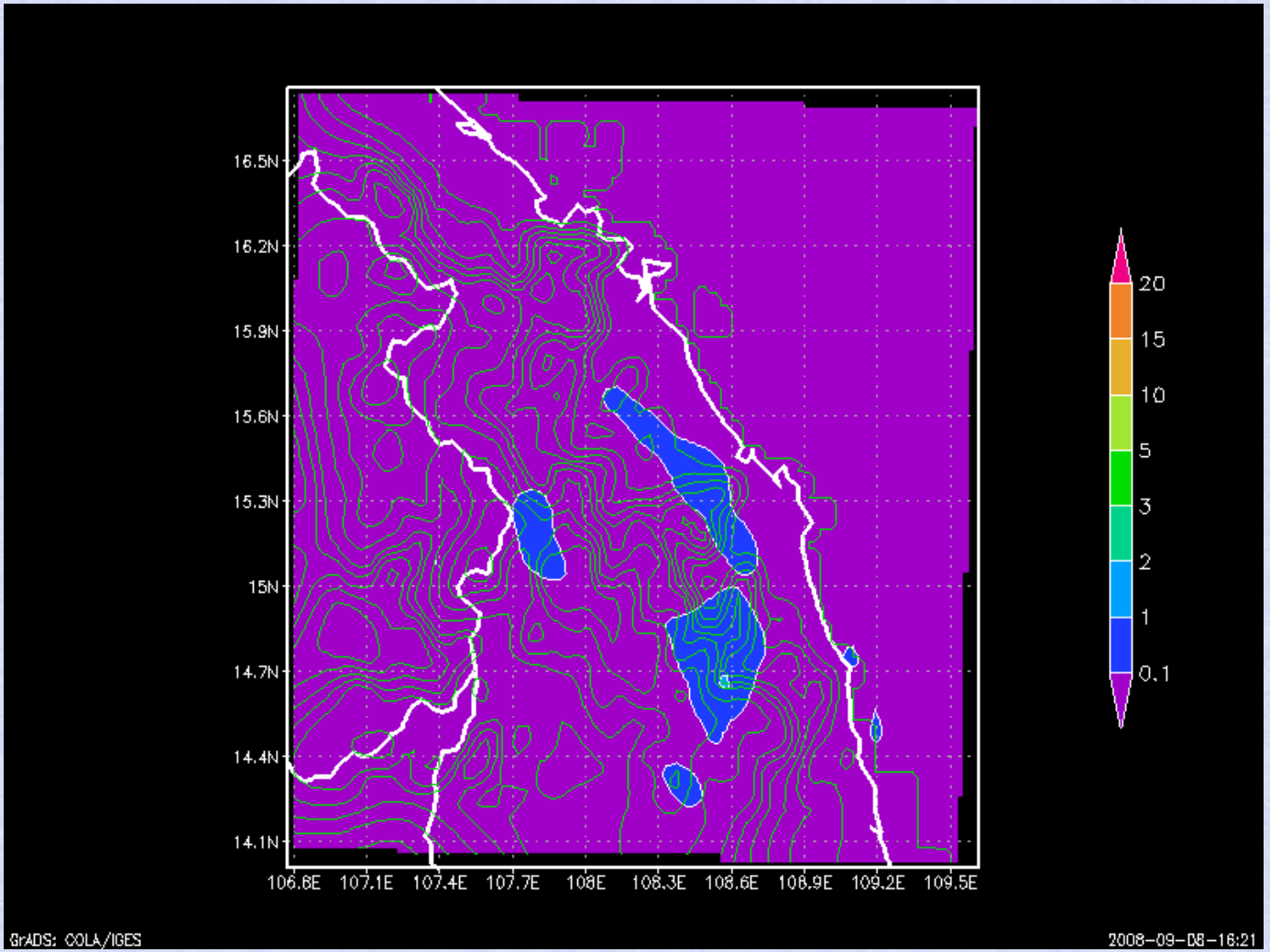
Annual Animation of RCM result

MIROC3.2 Hires (A1B) –MM5 Domain3
Temperature at 03z January 1st – December 31st , 2030



Annual Animation of RCM result

MIROC3.2 Hires (A1B) –MM5 Domain3
Daily Rain fall (mm) January 1st – December 31st , 2030



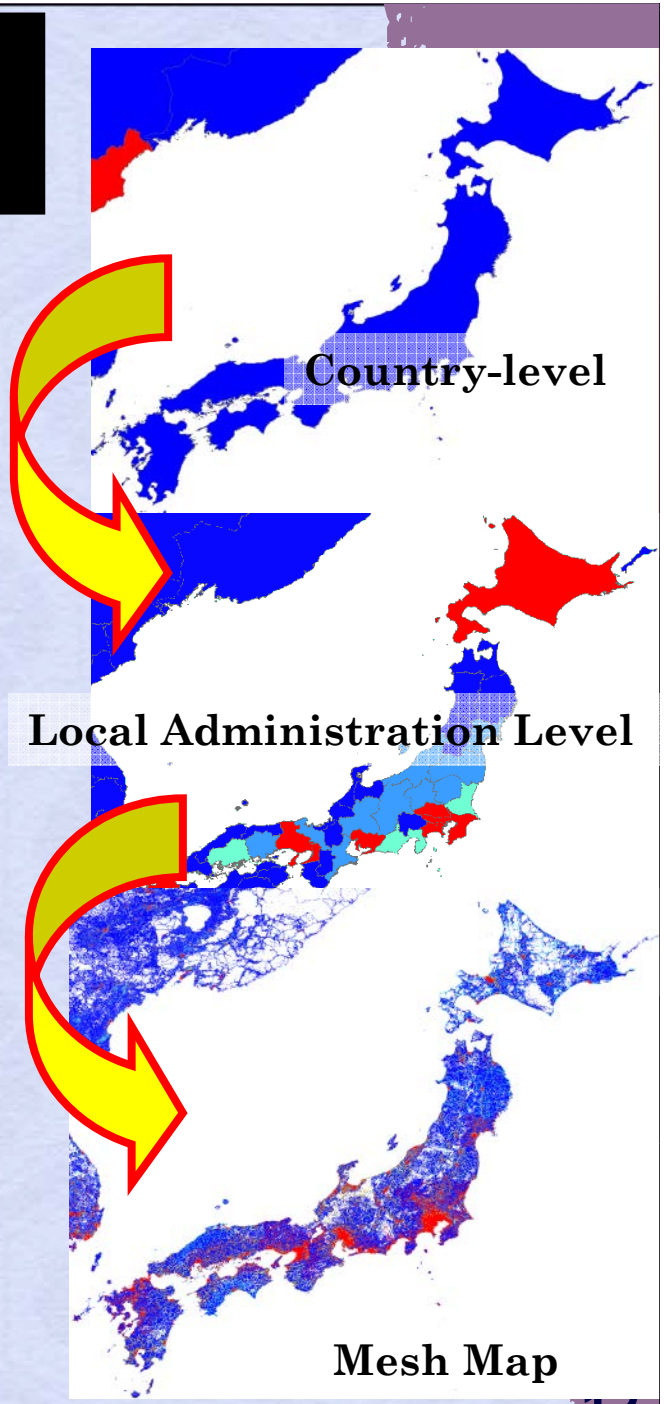
Downscaling of Emission Inventories

Country-level emission is mainly used for the policy making for reduction of GHG.

However, it is too coarse to be used for air quality modeling. Because, the spatial scale of air pollution problem is much smaller.

Downscaling

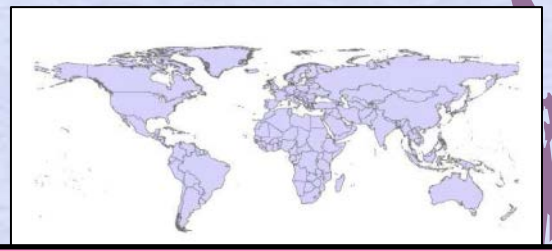
- **Two step downscaling**
  - **National level**
    - **→ Local Administration level**
      - **→ Mesh level**
- **Visualization by GIS tool**
- **Air Quality Modeling**
- **Impact estimation**



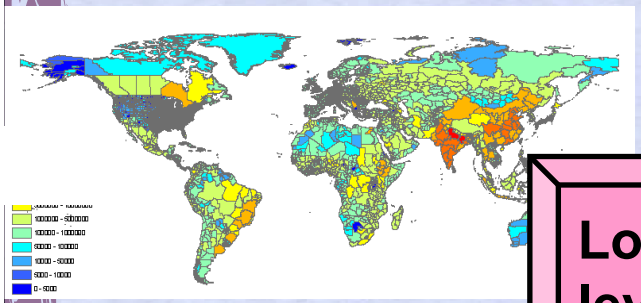
Outline of the Downscaling of Emission inventories

Air Pollutant Emission (Country-level / each Sector)

- **Industry**
- **Domestic**
- **Transportation**
- **Power Generation**



Boundary(polygon)Data

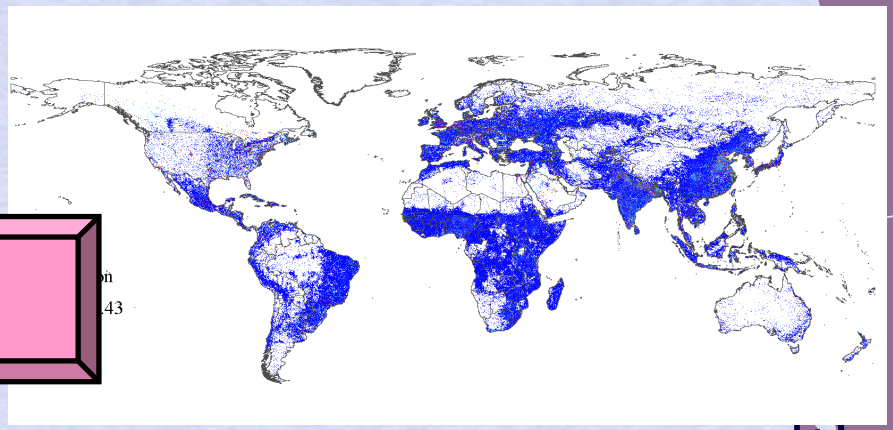


Local administration level emission data

Allocation index for local administrative district level (Population, GRDP)

Population Mesh
Land use Mesh

Emission Mesh Data



Country-level Emission of Air Pollutants

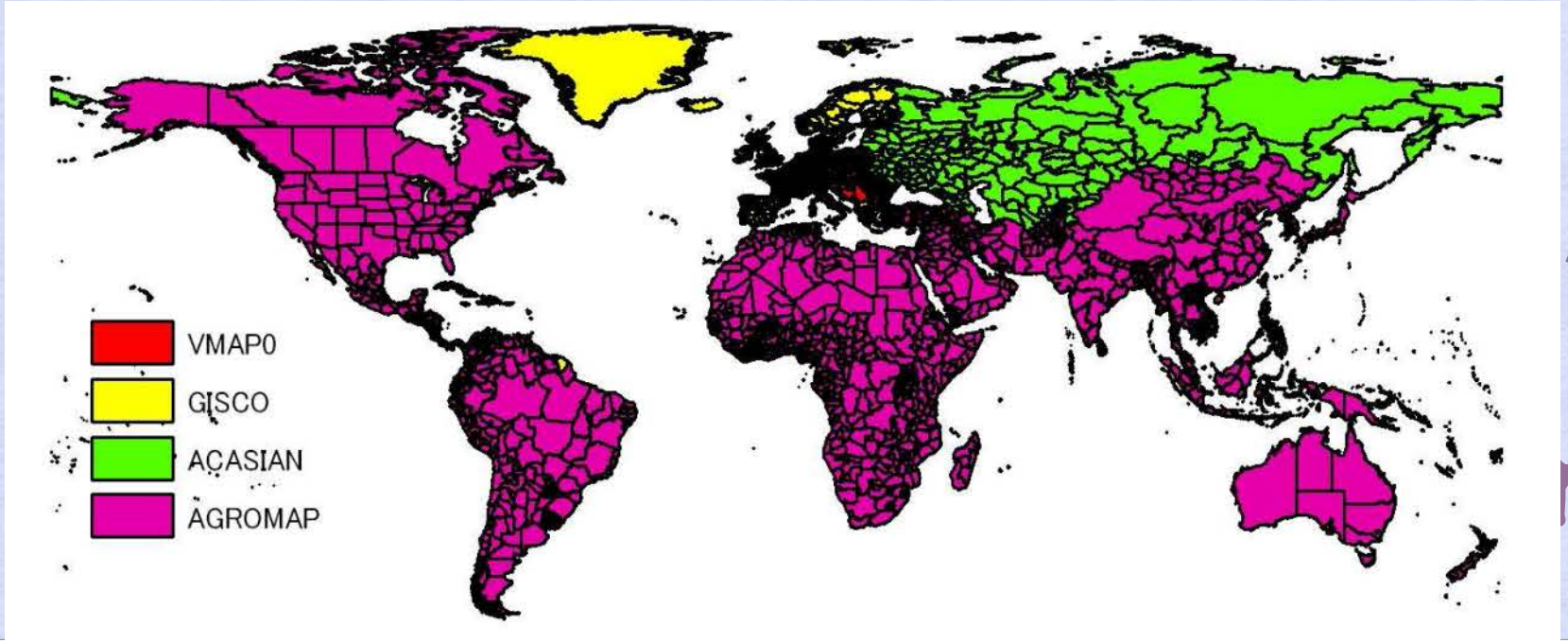
- The Downscaling system was developed to use original estimation of country-level air pollutant emission. (not yet implemented)
- For current calculation, country-level emission from EDGAR Fast Track 3.2 (Olivier *et al*., 2005)

  [CO_2、CH_4、N_2O、HFC、SF_6、CO、NO_x、NMVOC、SO_2]

  [Biomass fuel, fossil fuel, industrial process, Agriculture]

Development of secondary administrative boundary data

Region	Boundary Data	Source	Code
Asia	AgroMap	FAOSTAT	ISO3166-2
Oceania			
N/S America			
Africa			
East Europe	VMAP0	NIMA	ISO3166-2
West Europe	GISCO	Eurostat	NUTS3
Former USSR	ACASIAN	ECAI	ISO3166-2



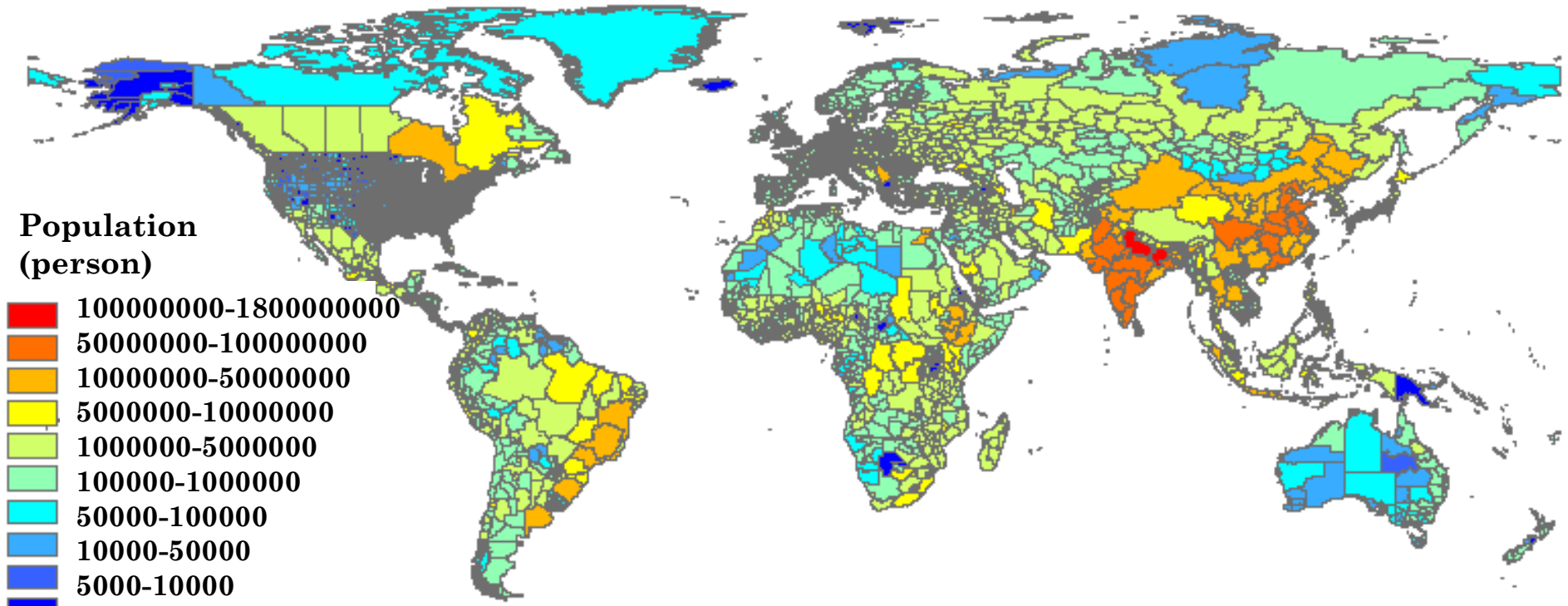
Data to allocate the emission to secondary administrative district and detail mesh.

- Model is prepared to use proper index for each sector / each country.
  - Industry: Energy consumption、Added values of secondary manufacturing
  - Transportation: Total travel distance for each type of veicle
- Currently, we use following index for allocation.

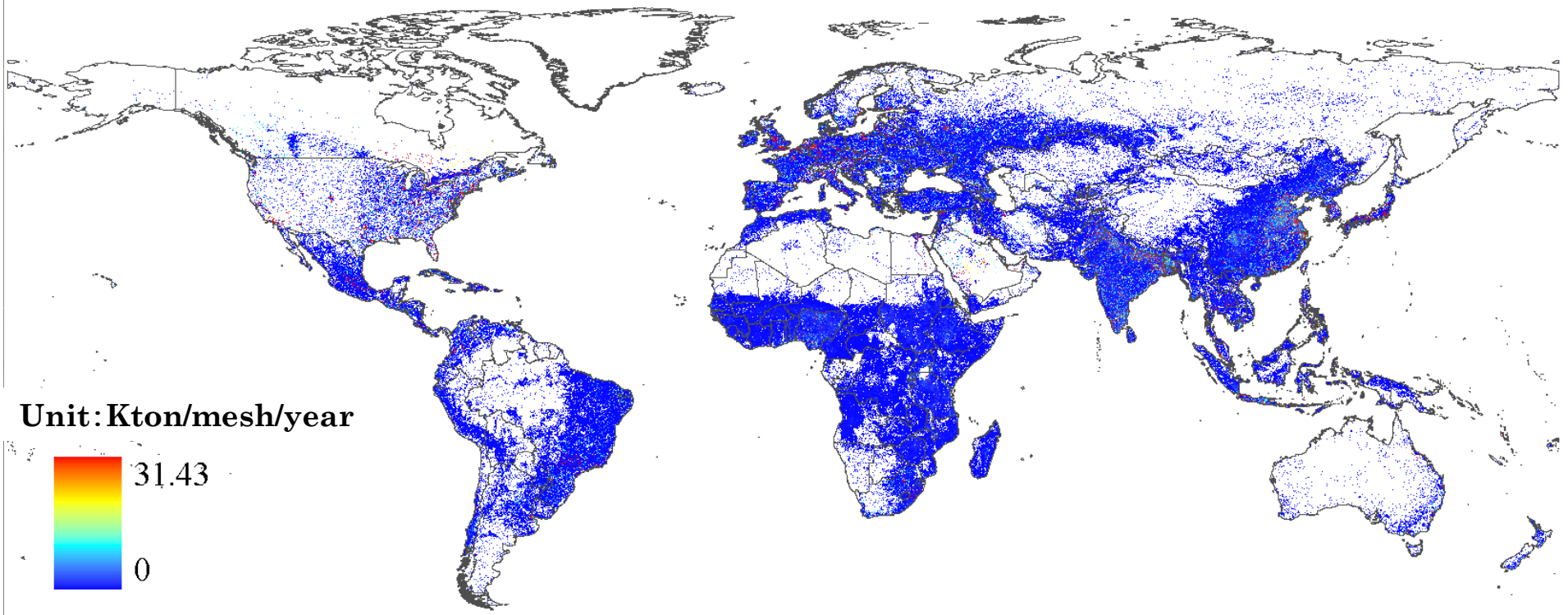
Sector	Secondary Administration Allocation Index	Mesh allocation index	Source
Industry	GRDP	Population	Landscan
Domestic	Population	Population	Landscan
Transportation	Population	Road network	VMAP0
Power Generation	GRDP	Population	Landscan

Only for Japan and China, we used added-value of secondary industries as

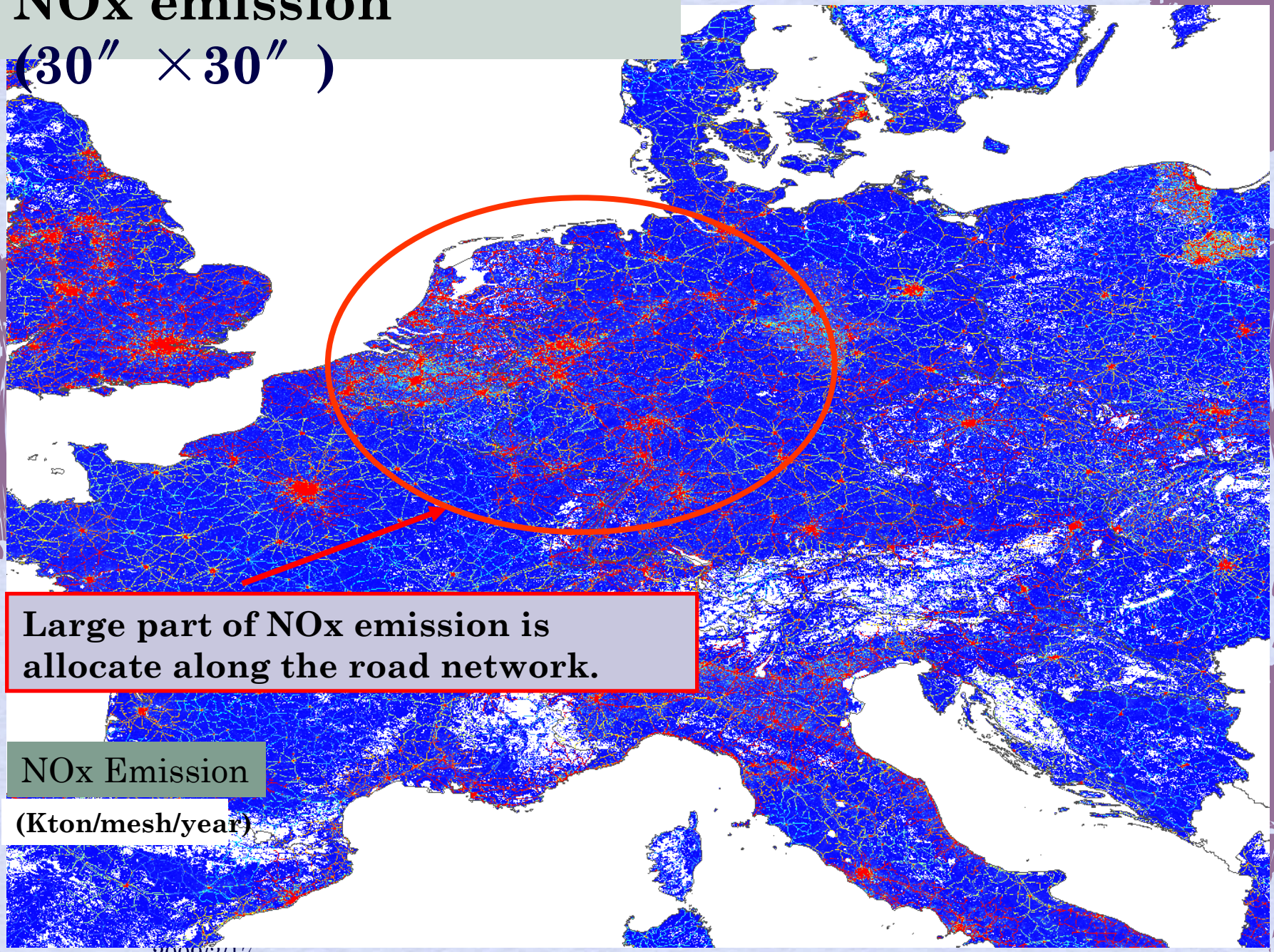
Population of Secondary Administrative district



NOx emission (30″×30″)



NOx emission (30″ ×30″)

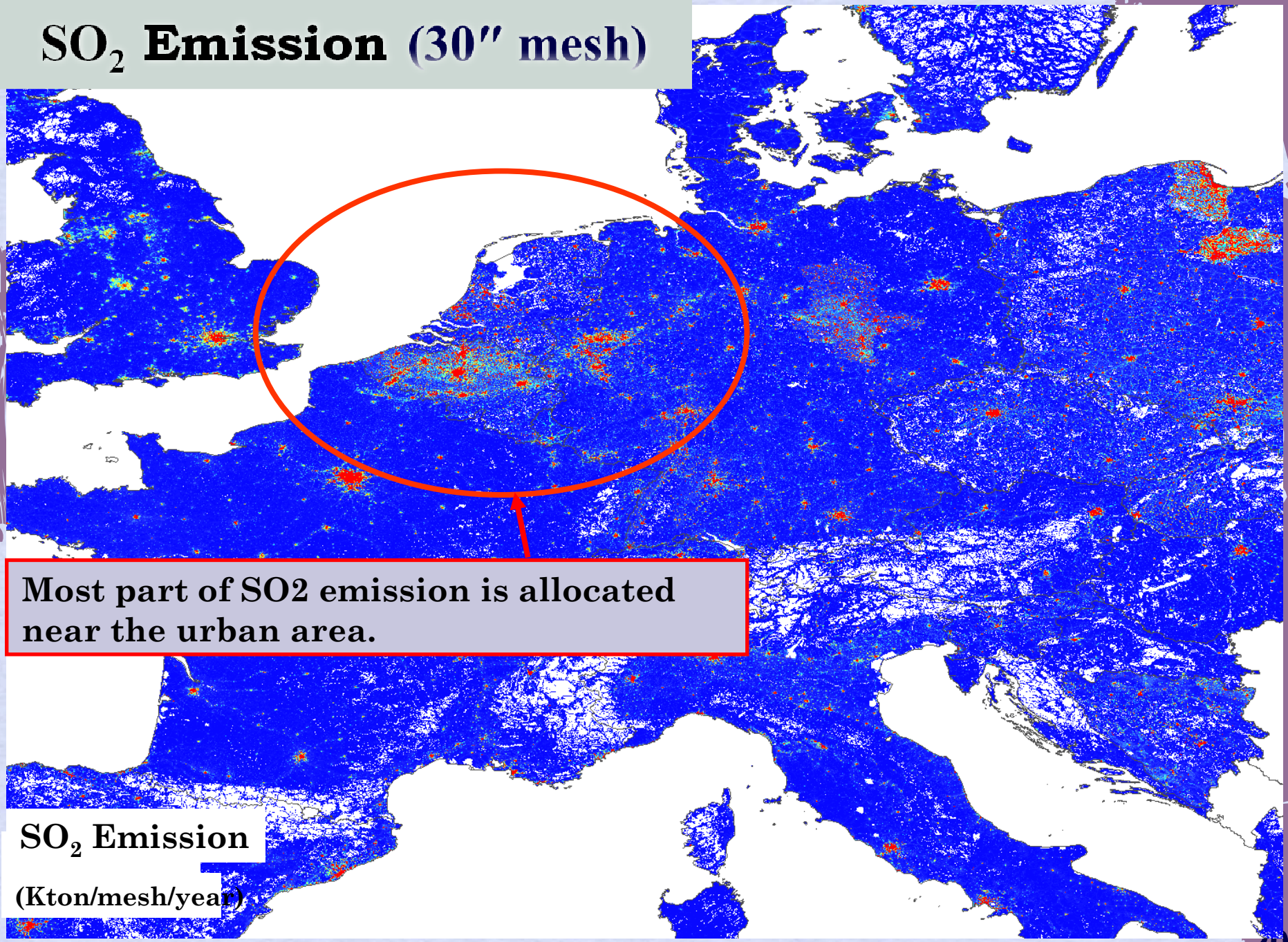


Large part of NOx emission is allocate along the road network.

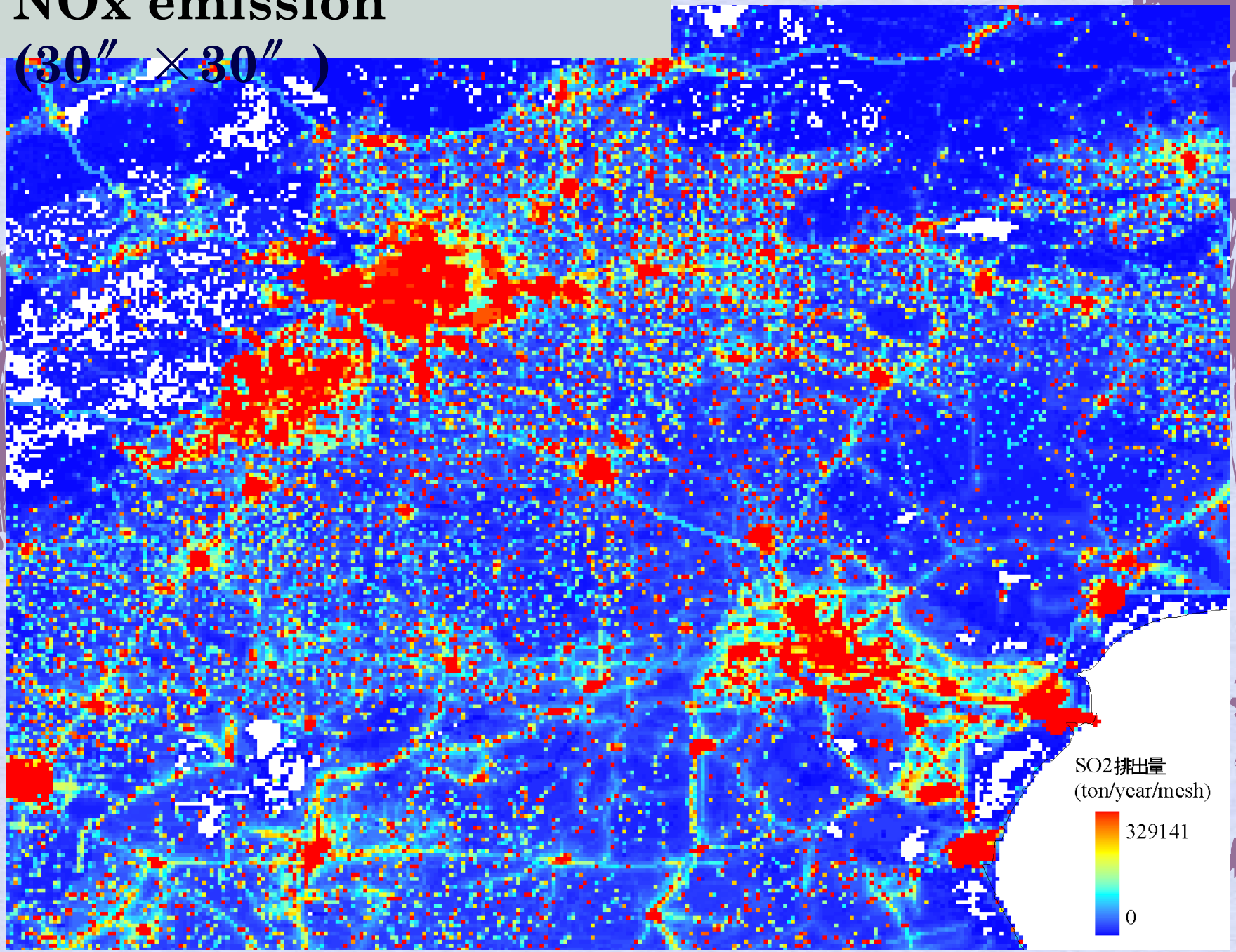
NOx Emission

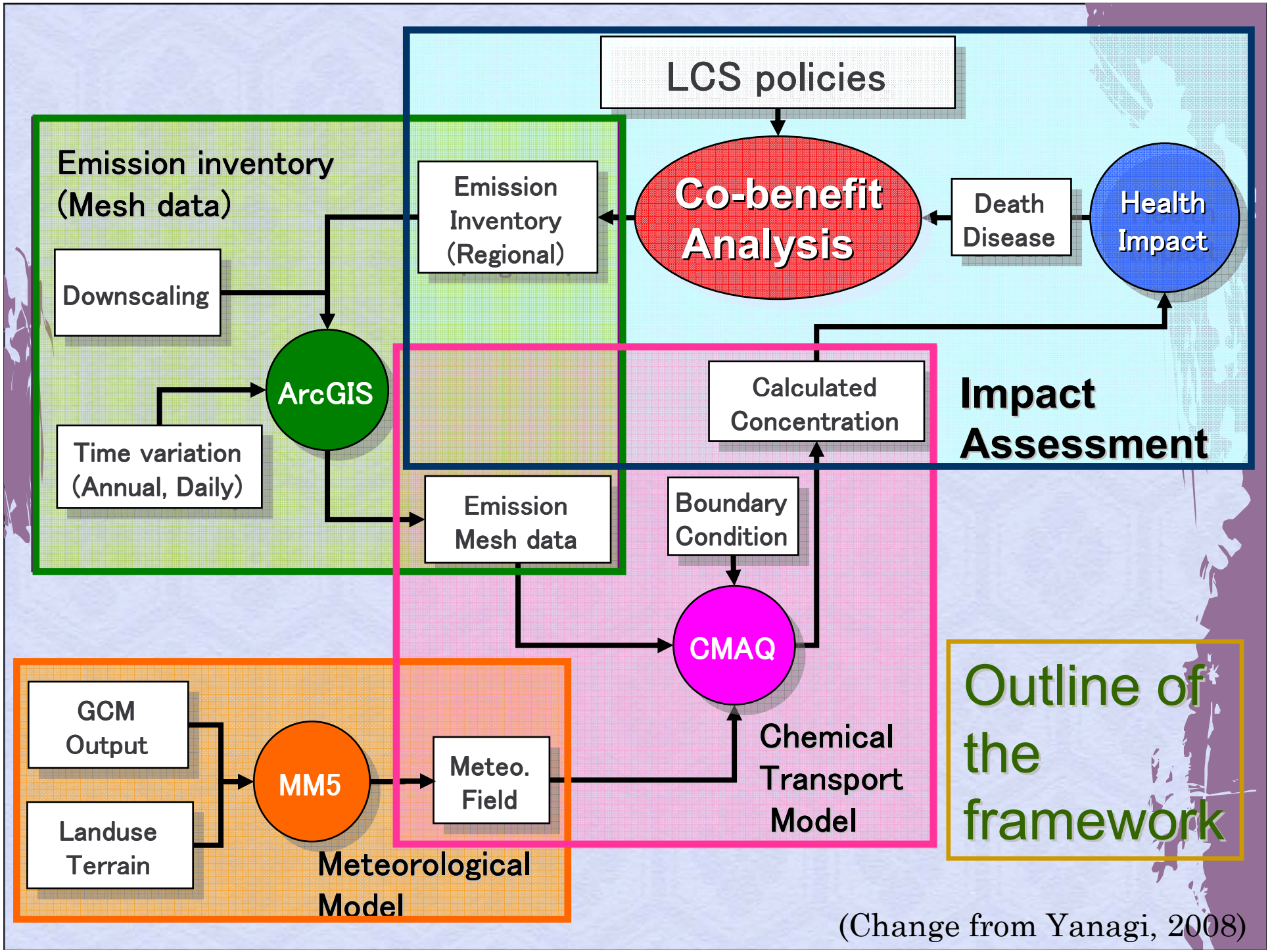
(Kton/mesh/year)

SO_2 Emission (30″ mesh)



NOx emission (30″×30″)





(Change from Yanagi, 2008)

SUMMARY

- Downscaling technique is essential to asses a co-benefit between LCS policies and air pollution reduction.
- We developed the downscaling system of Climate scenario which can be used to derive air quality model.
- We also developed the downscaling system of emission inventory to use as an input of air quality modeling.

Future Direction

- Complete the development of the co-benefit analysis system.
- Some air pollution impact is due to in-door or very small scale (road-side). CMAQ cannot treat such a small scale. We need additional model to estimate such a small scale effect.