INTERNATIONAL COLLABORATION FOR DEVELOPMENT OF CO_2 EMISSION EVALUATION METHOD

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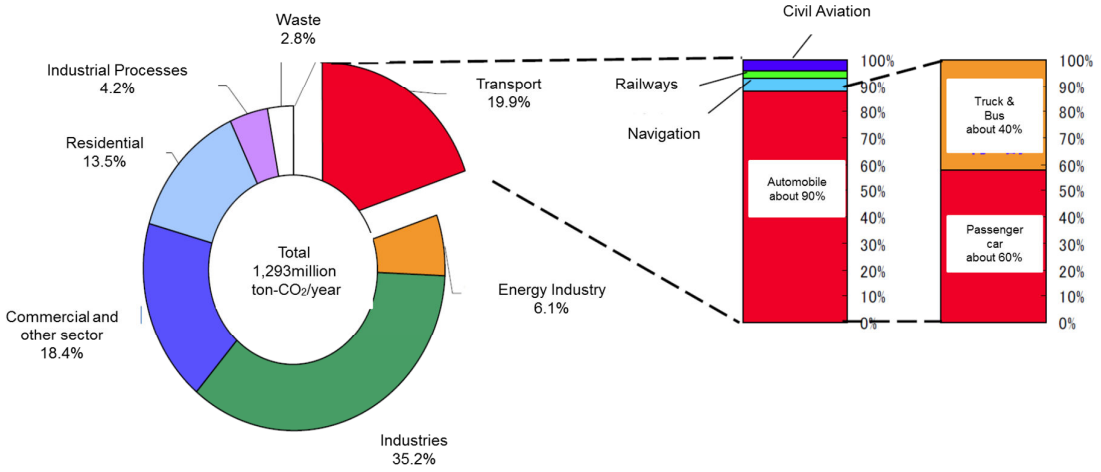
CO_2 EMISSION FROM THE TRANSPORT

<Japan>

Around 20% of CO2 emissions.

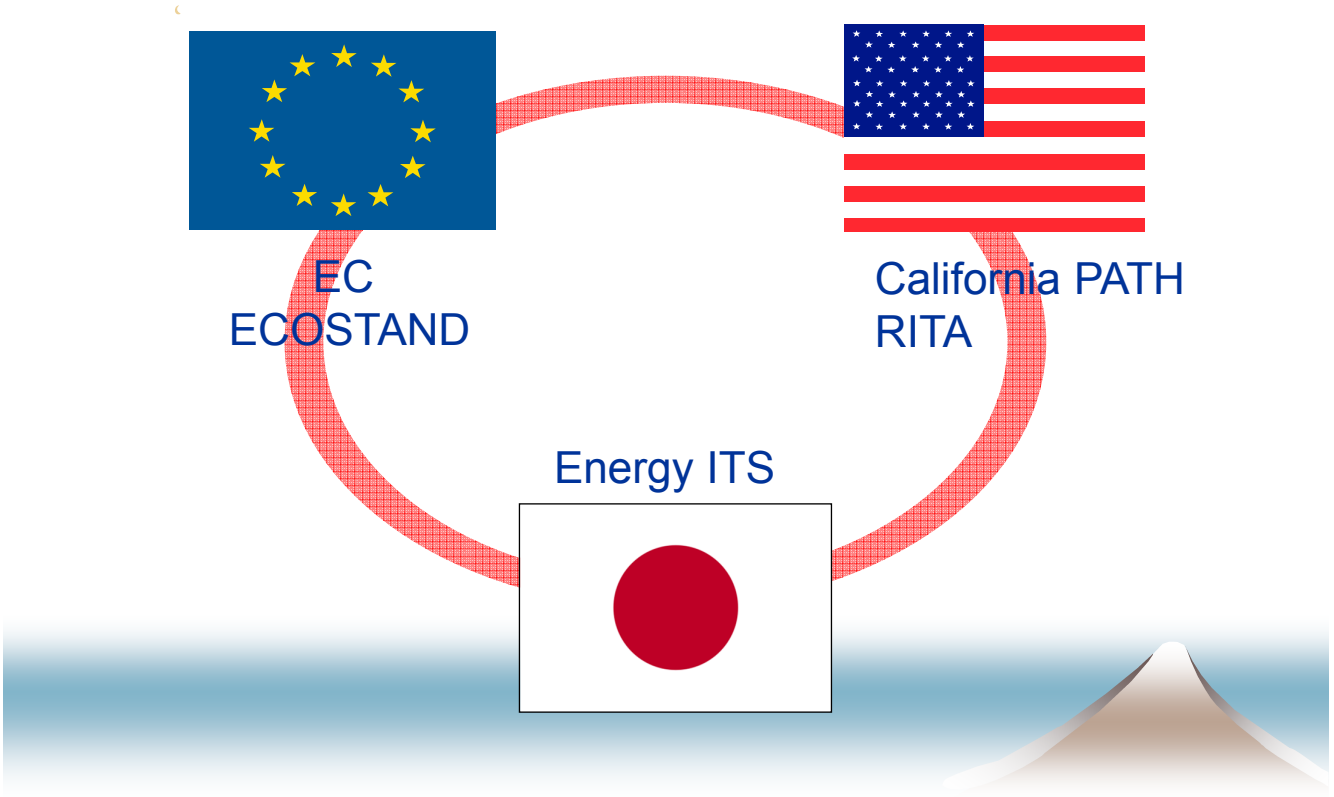
Automobiles account for around 90% of the transport sector.



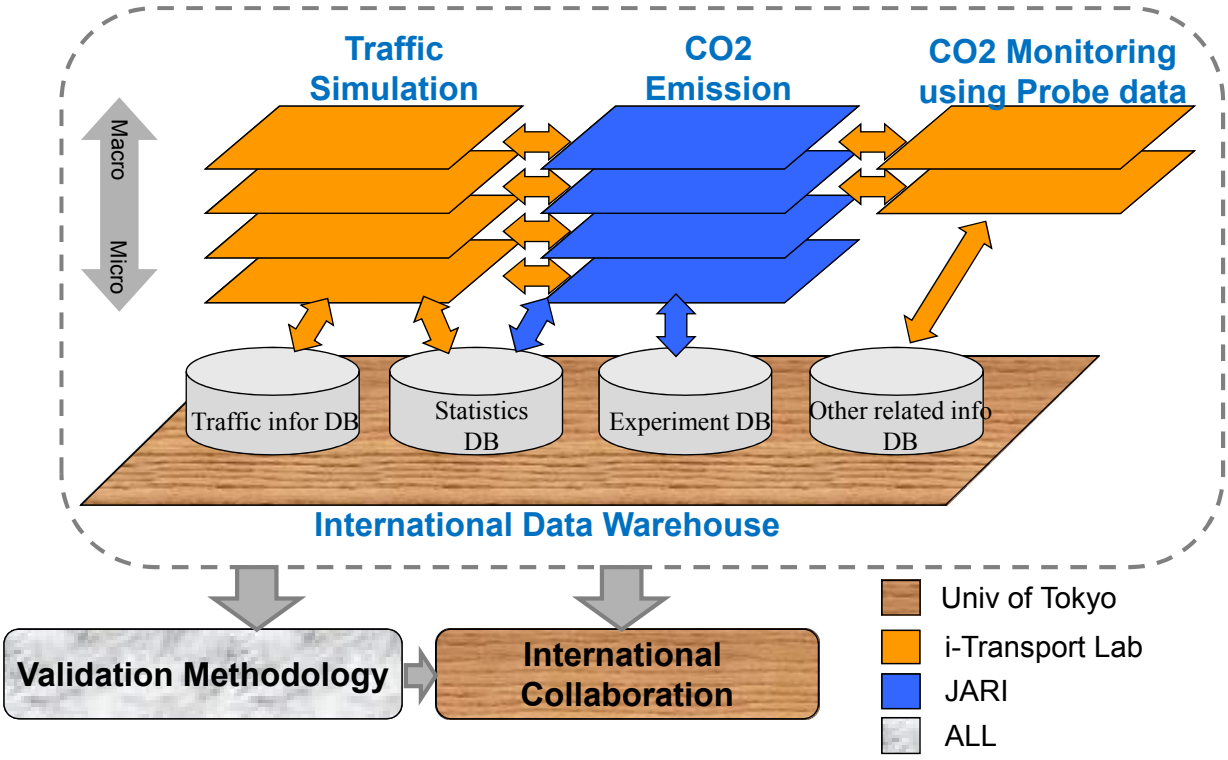
Details of CO_2 emission in each sector (FY2005)

Details of CO_2 emission in transport sector (FY2005)

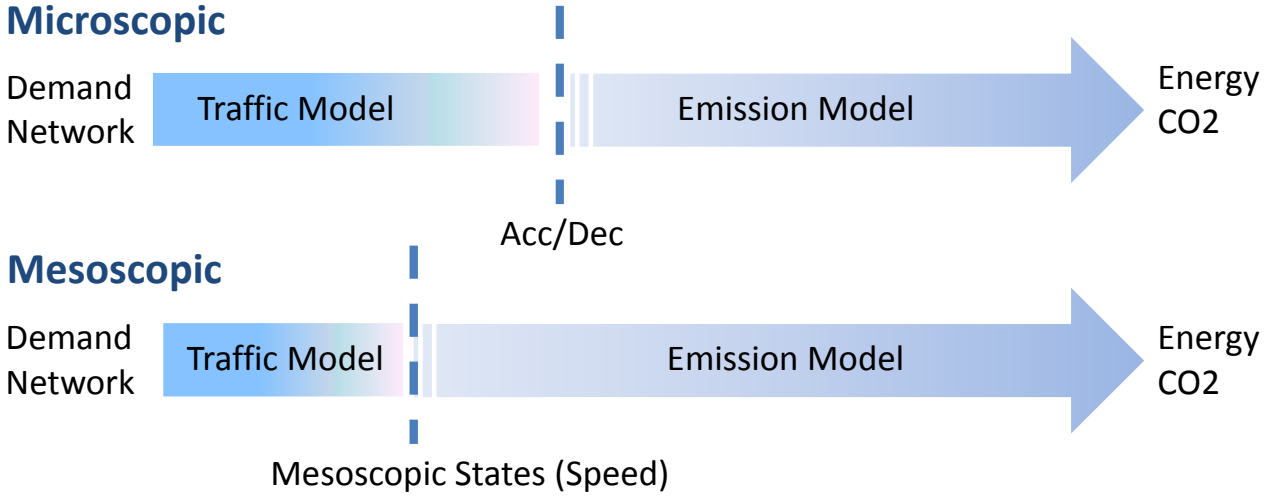
International Collaboration



Energy ITS Projects (2008-2012)



Harmonization of Traffic and Emission Models

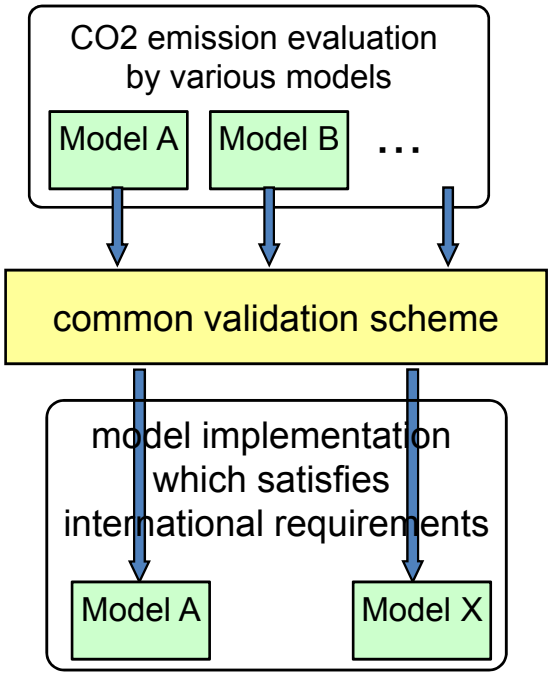


EM is basically the conversion from traffic state to the amount of emission.
You may input various different level of traffic state such as quite microscopic level like acc/dec or more macroscopic level like speed.

Model Validation - Philosophy

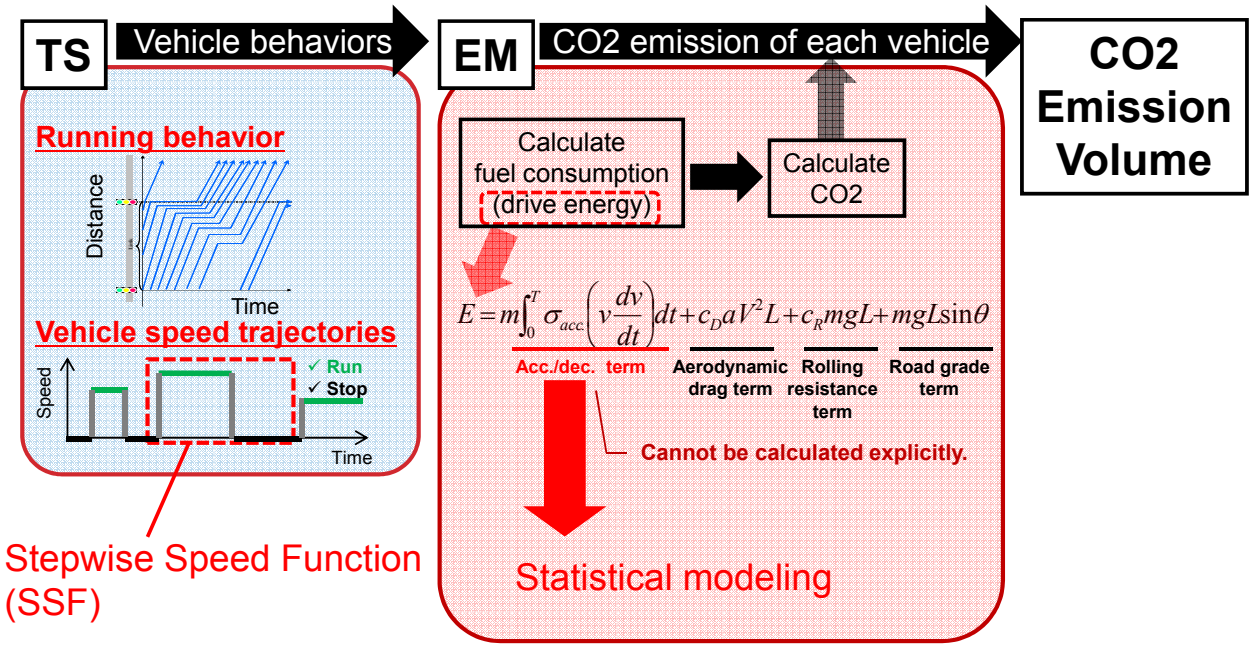
- A lot of different models exist.
- Preferences to use own models

- Models themselves can be different.
- Validation scheme should be common.
- Models should be checked by the common validation process and disclose the results.



Any kinds of models can be used as long as well validated!

CO_2 EMISSION MODEL (MESOSCOPIC)



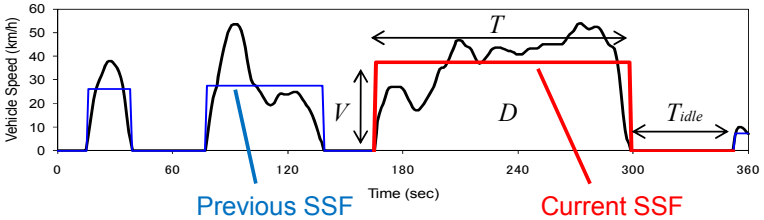
CO_2 EMISSION MODEL (MESOSCOPIC)

Vehicle drive energy: E

$$E = \underbrace{m\int_0^T \left\{\delta_{acc.}\left(v\frac{dv}{dt}\right)\right\}dt}_{\text{Acceleration term}} + \underbrace{c_D a V^2 D}_{\text{Aerodynamic drag term}} + \underbrace{c_R mgD}_{\text{Rolling resistance term}} + \underbrace{mgD\sin\theta}_{\text{Road grade term}}$$

Statistical modeling

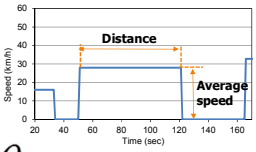
$$\begin{cases} \delta_{acc.} = 1, & when \quad dv/dt \geq 0 \\ \delta_{acc.} = 0, & when \quad dv/dt < 0 \end{cases}$$



Short trip (ST)
v : Vehicle speed
t : Time
V : Vehicle mean speed
D : Running distance
T : Running duration
θ : Mean road grade
Short stop (SS)
T_{idle} : Idling duration
Constants
m : Vehicle mass
g : Gravity acceleration
c_D : Aerodynamic drag coefficient
a : Vehicle frontal area
c_R : Rolling resistance coefficient

CO_2 EMISSION MODEL (MESOSCOPIC)

Acceleration term modeling



$$E = \underbrace{m\int_0^T \left\{\delta_{acc.}\left(v\frac{dv}{dt}\right)\right\}dt}_{E_{acc}} + \underbrace{c_D a V^2 D}_{E_{aero}} + \underbrace{c_R mgD}_{E_{rolling}} + \underbrace{mgD\sin\theta}_{E_{grade}}$$

Multiple regression analysis

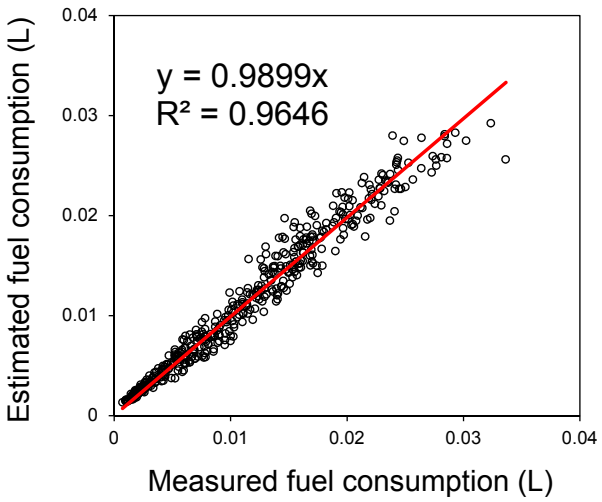
$$E_{acc.} \approx C_{dist}\cdot D_n + C_{V_n^2}\cdot V_n^2 + C_{V_n}\cdot V_n + C_{V_{n-1}}\cdot V_{n-1} + C_{grade}\cdot \sin\theta_n + C_{const}$$

D_n : Current SSF distance
V_n : Current SSF speed
V_{n-1} : Previous SSF speed
θ_n : Mean road grade of current SSF

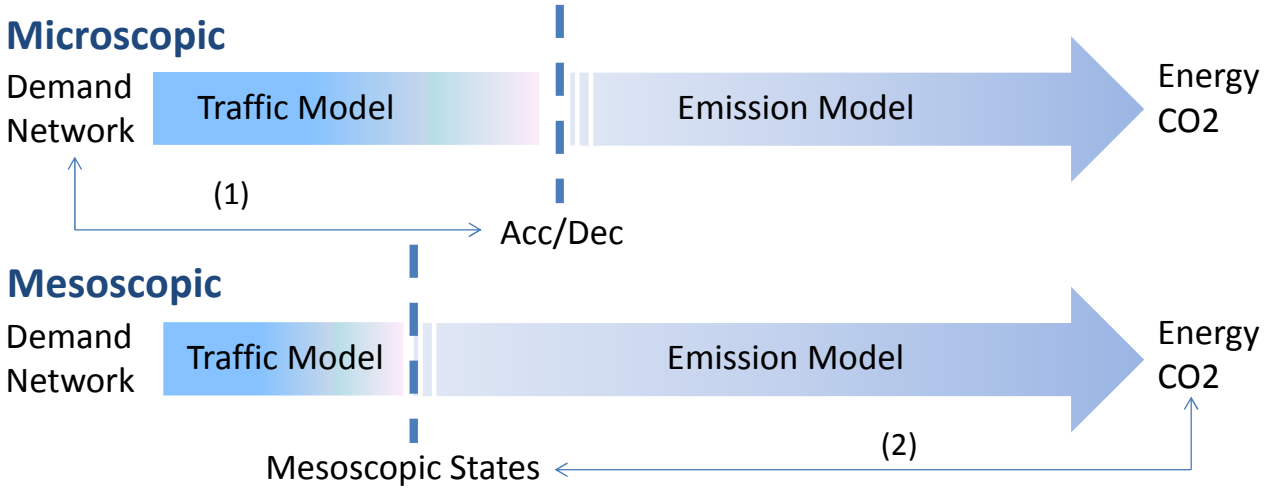
Constants	C_{dist}	Cv_n^2	Cv_n	Cv_{n-1}	C_{grade}	C_{const}
Variables	Current SSF distance (m)	Current SSF speed squared (km2/h2)	Current SSF speed (km/h)	Previous SSF speed (km/h)	Mean road grade of current SSF (deg.)	Constant
Contribution	Large				Small	—
Standardized coefficients	0.462	0.269	0.251	0.049	-0.044	—

CO_2 EMISSION MODEL (MESOSCOPIC)

$$E = \underbrace{m\int_0^T \left\{\delta_{acc.}\left(v\frac{dv}{dt}\right)\right\}dt}_{E_{acc}} + \underbrace{c_D a V^2 D}_{E_{aero}} + \underbrace{c_R mgD}_{E_{rolling}} + \underbrace{mgD\sin\theta}_{E_{grade}}$$



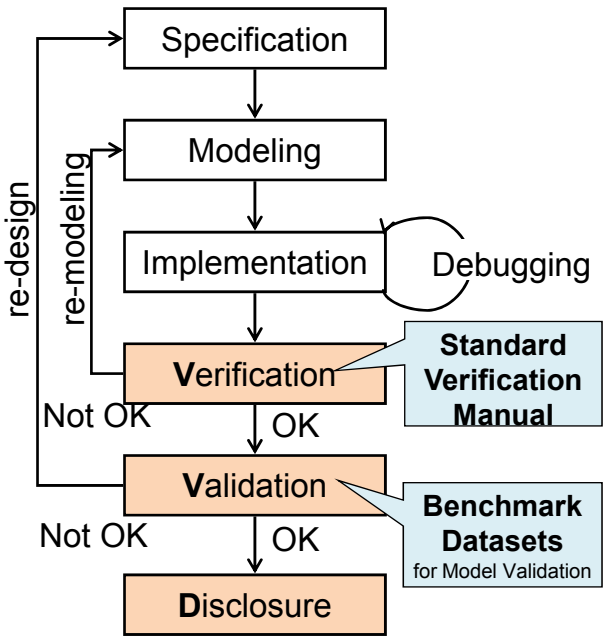
Model Validation - Key Points



(1) Traffic Model Validation
Relationship between Demand+Network and Acc/Dec is one issue to be validated.
(2) Emission Model validation
The reproducibility of emission from more macroscopic traffic condition is another validation point.

Model Validation - Process

- Verification
  - qualify tests with virtual & ideal data
  - to confirm the fundamental model functions.
- Validation
  - evaluation of validity using real world data
  - to evaluate practical applicability of the model.
- Disclosure
  - disclose the result of verification & validation on the Clearing House.



Model Validation – Benchmark Dataset

Observation at Komazawa Street, Tokyo

- Date: 1 Dec, 2010
- Time: 6:30 ~ 10:30 am
- Survey area: (1.7km)

- Measured data
  - by video
    - traffic volume, queue length, signal parameters, etc.
  - by probe vehicle
    - vehicle position, speed, fuel consumption, etc.

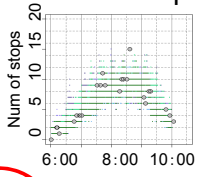
- probe vehicles

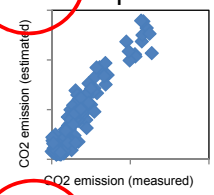
- observation

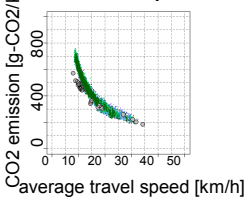
Model Validation - Items

	TS	EM
Verification	(proposed in JSTE manual) •vehicle generation •bottleneck capacity etc.	•model structure •vehicle type setting
Validation	•traffic flow •travel time •travel speed	•CO2 from EM and from probe •relationship of CO2 vs speed (optional)

•num of stops

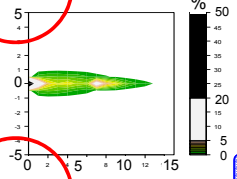






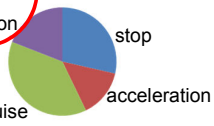
<for MicroTS>

•speed vs acceleration map

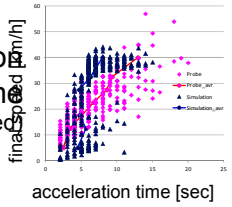


•VSP distribution

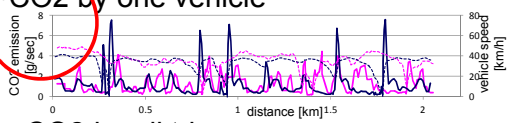
•driving modes



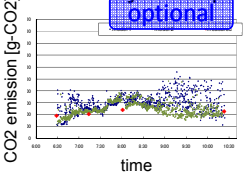
•acceleration time (optional)
(by initial speed)



•CO2 by one vehicle



•CO2 by all trips (optional)



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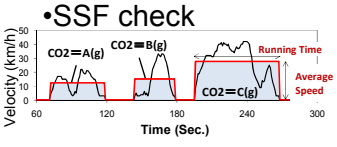
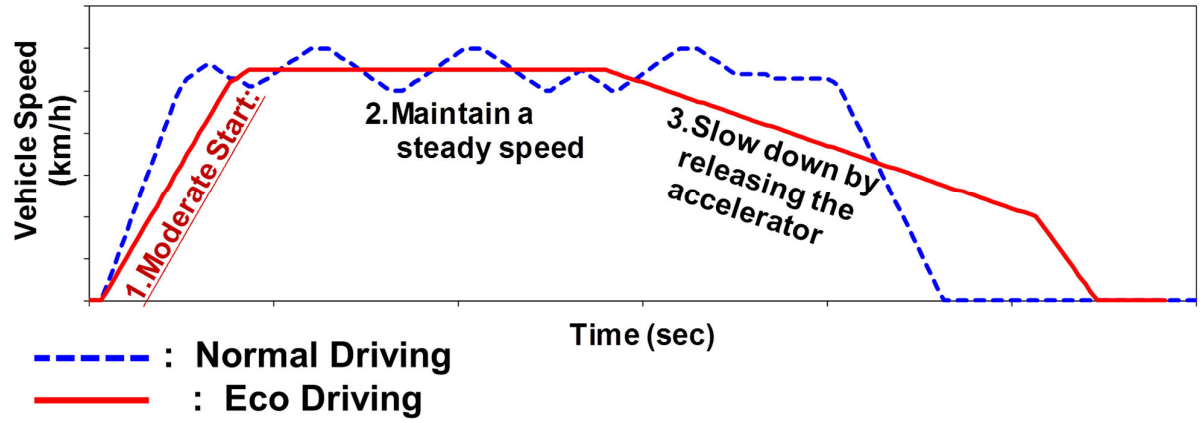
•SSF check



Applications

In the promotion of Eco-driving in Japan,
Eco-driving by changing "driving behavior":

1. Moderate start
2. Maintain a steady speed
3. Slow down by releasing the accelerator

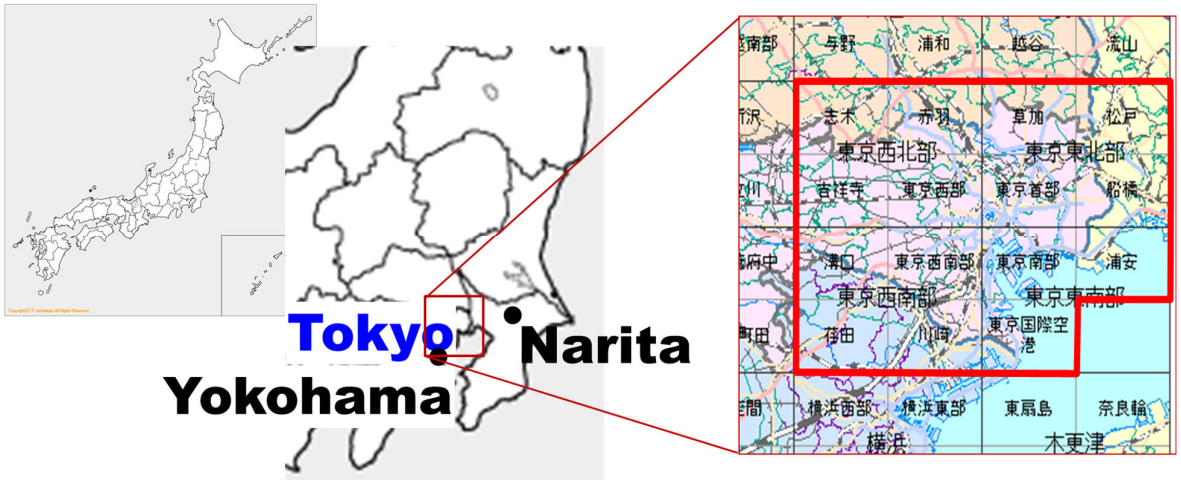


Applications

■Target Area: Tokyo Met. 23 Wards (40km x 40km)

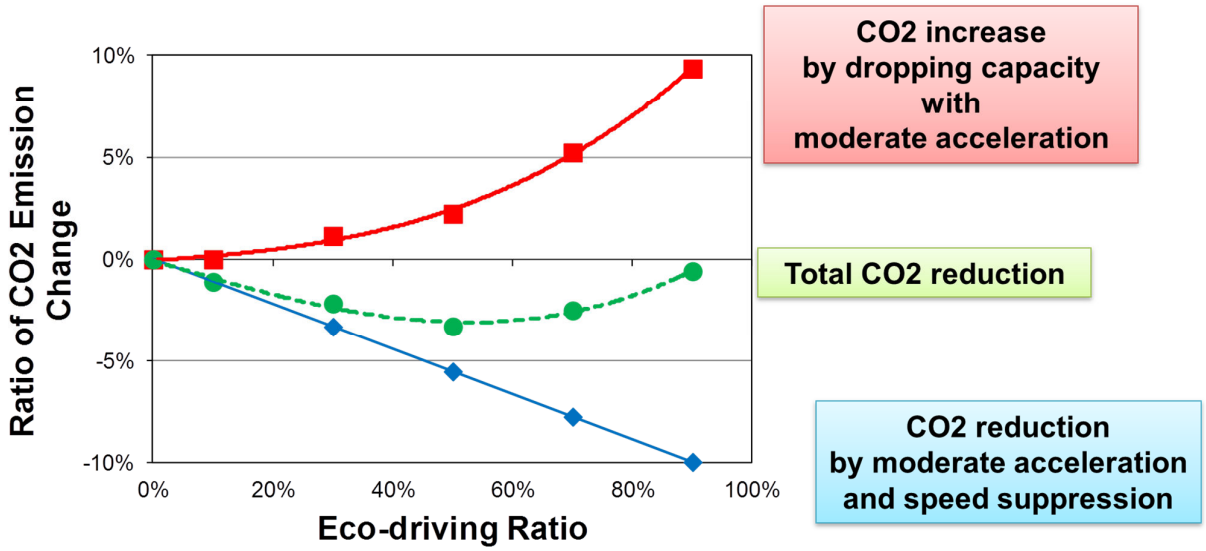
<Note> Vehicle speed in congestion:
21 km/h in Tokyo vs. 35km/h as Japanese average

■Estimation for 22 hours on weekdays

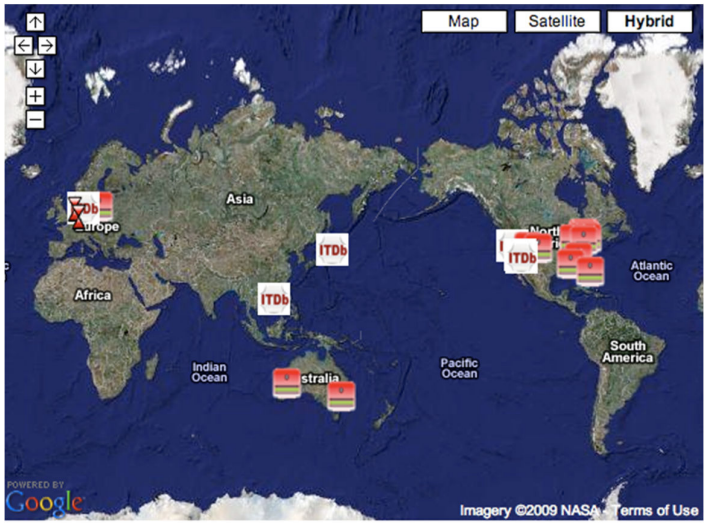


Applications

- **Too many eco-driving vehicles may cause additional congestion.**



International Traffic Database (ITDb)



Sources:

Detector Data
Video Image Data
Signal Parameters
Network Data
Project Information
Environmental Daa
Accident Data
etc.

Storage:

ITDb data: Meta information and actual data stored on ITDb server
External data: Meta information stored on ITDb server, while actual data is accessed via an external database

International Collaboration

Contents of the International technical report agreed by EU, US, and Japan

1 Introduction
- 1.1 Philosophy of the Report
- 1.2 Key points

2 Modeling of CO_2 Reduction Effects
- 2.1 Target ITS applications
- 2.2 Description of the CO_2 reduction mechanism
- 2.3 Modeling requirements
- 2.4 State-of-the-art evaluation tools
- 2.5 Possible approaches to the modeling
- 2.6 Reference models

3 Validation and Verification Processes
- 3.1 Philosophy of the verification and the validation
- 3.2 Verification process
- 3.3 Validation process
- 3.4 Benchmark dataset for validation

4 Evaluation Process of CO_2 Reduction Effects

5 Example applications
- 5.1 Japan
- 5.2 EU
- 5.3 US

1st International symposium (October, 2010)

7th International workshop (January, 2012)