A Radiation Estimation Method for use in the Initial and Intermediate Stages of a Nuclear Accident

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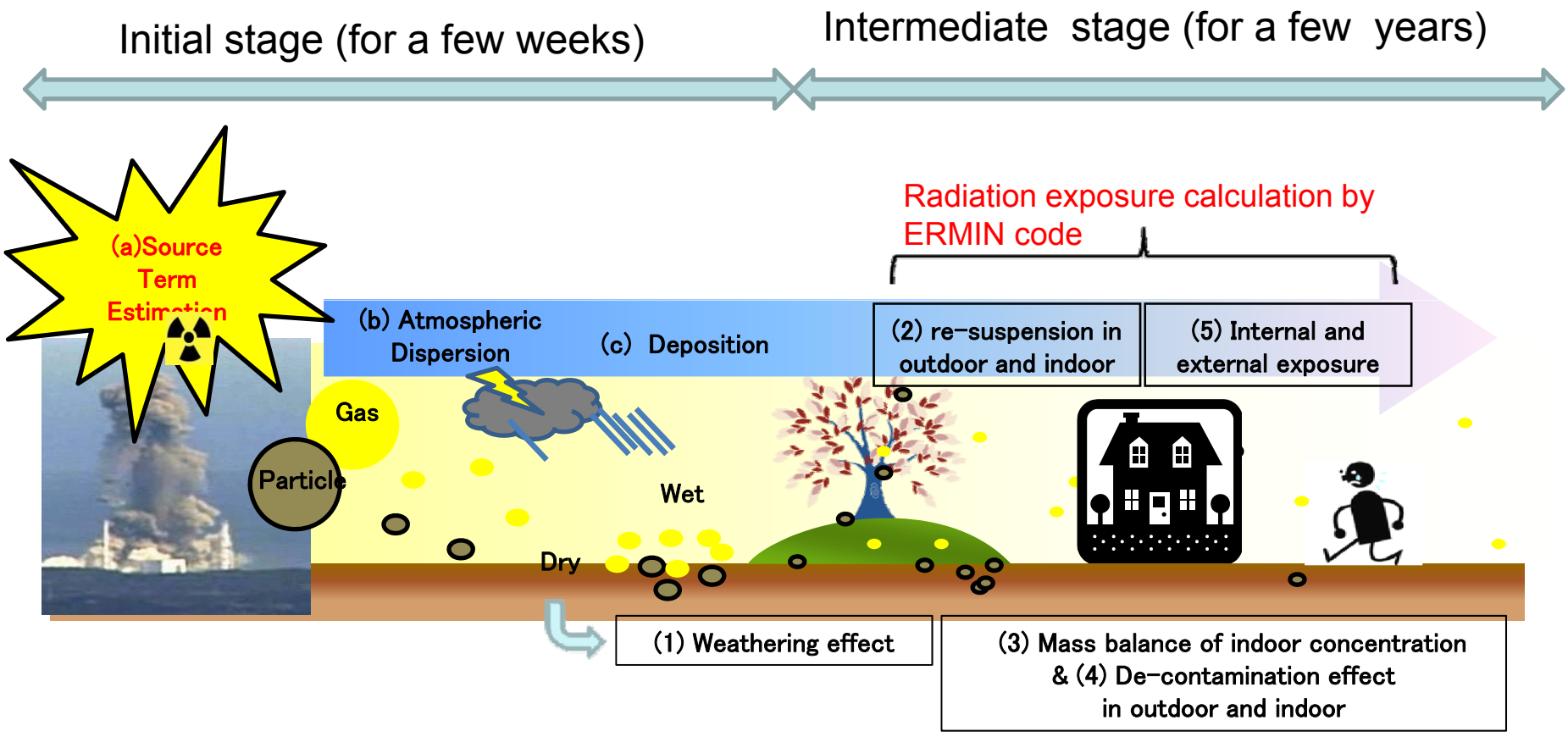
Today's main topics
1. Introduction of the MEXT 2012-2014 project
2. Verification and Validation study of STE method

MEXT: Ministry of Education, Science, Culture, Sports and Technology
STE: Source Term Estimation

Initial and Intermediate stages of nuclear accident



ERMIN: European Model for Inhabited areas code, developed by EU, after Chernobyl accident

References: Emergency response system of EU/ARGOS （integration system of STE and Decontamination ）

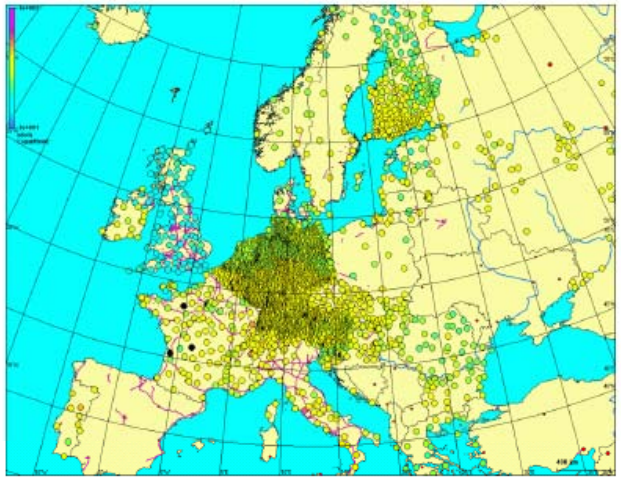


Figure 16. ARGOS showing imported nuclear measurements from European stations.

Figure 22. ARGOS has support for managing measurement routes.

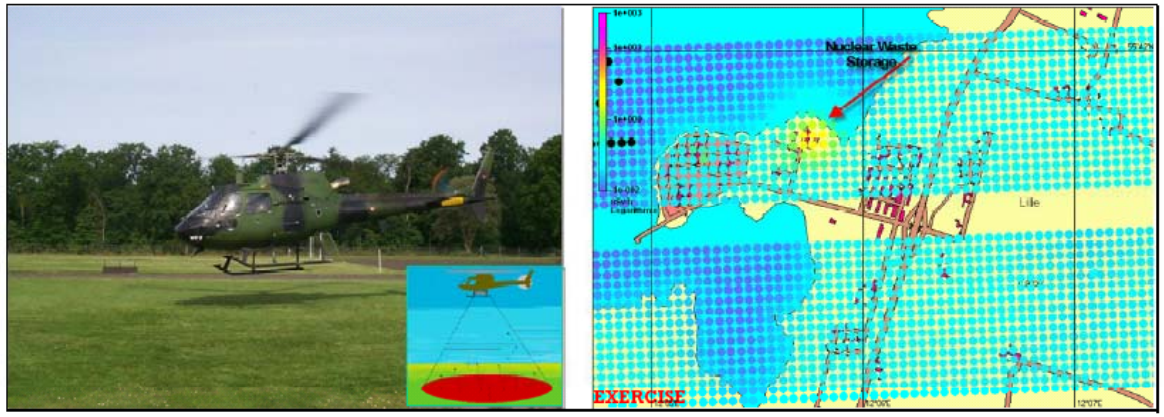


Figure 19. AGS Monitoring: 1) Left, monitoring helicopter and diagram showing monitoring principle. Normal measuring height is about 100 m. 2) Right, results from AGS monitoring survey of Risø DTU, which is the only site in Denmark that had a nuclear installation.

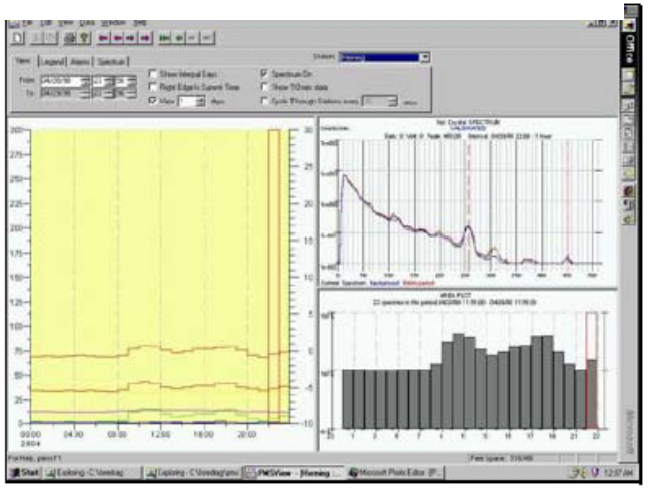
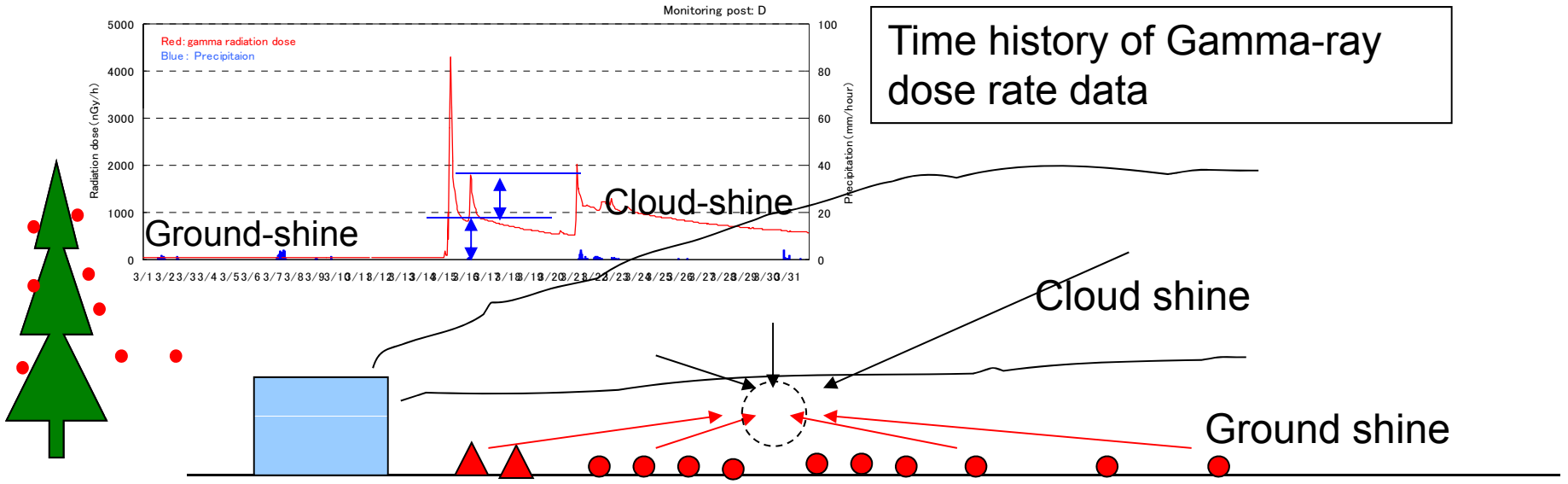
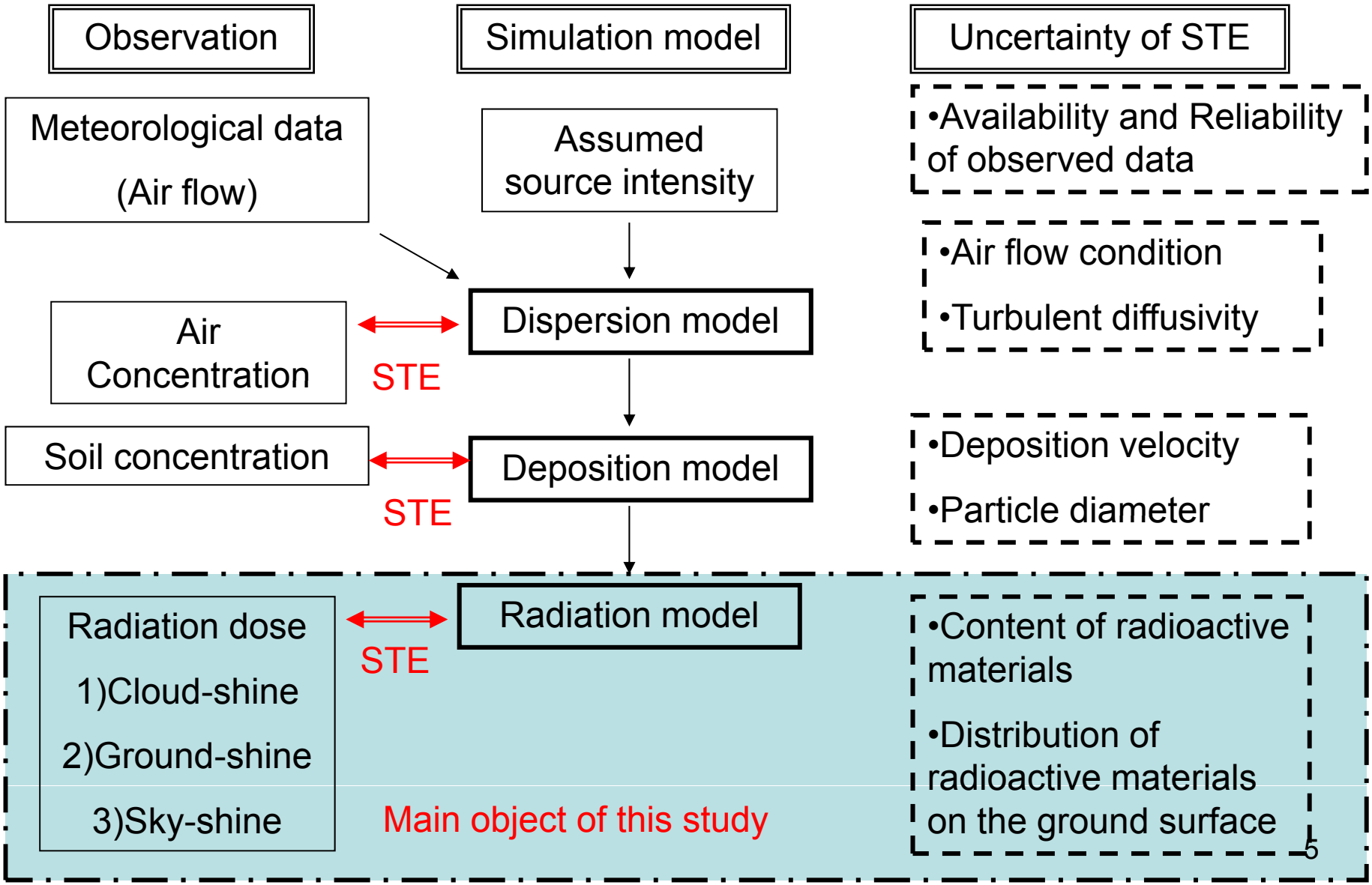


Figure 18. Inspecting the data on a monitoring station.

Difficulties	Developed technologies
Shortage of monitoring data	Application of mobile monitoring by car and airplane
Unsteady wind and release conditions	Operational Source Term Estimation method
Separation of cloud and ground shines	Data filtering technique



Flow Chart of Source Term Estimation (STE)



Operational STE method using the Transfer Coefficient Matrix(TCM) DataBase

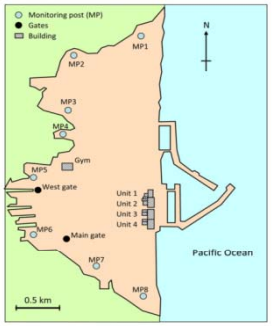
Assumption of application

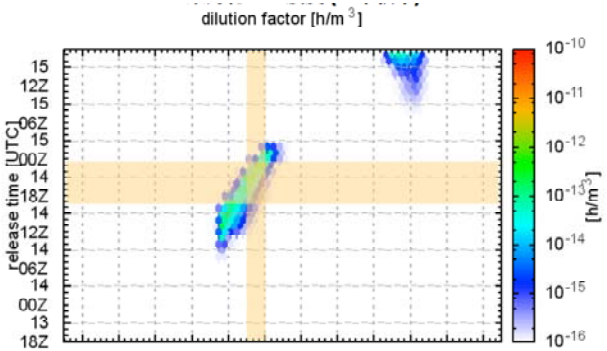
1)Steady state of meteorological condition

2)Short time release (< few hours)

3)Nearfield monitoring points(< few kms)

Example of monitoring points &TCM in Fukushima





Input typical meteorological conditions
(Ex. 16 wind directions &
3 atmospheric stabilities = 48 cases)

Calculation of air field and dispersion under unit release rate

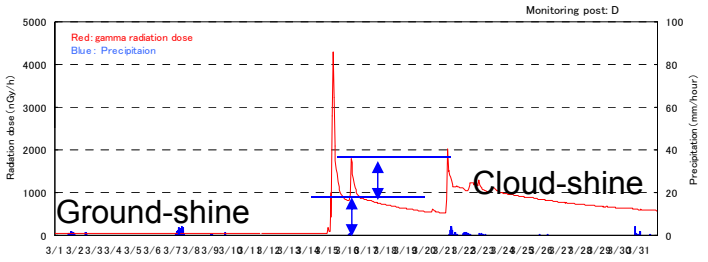
DataBase of TCM

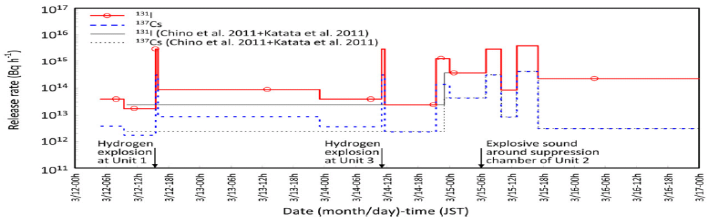
Before accident

Monitoring data of gamma radiation dose

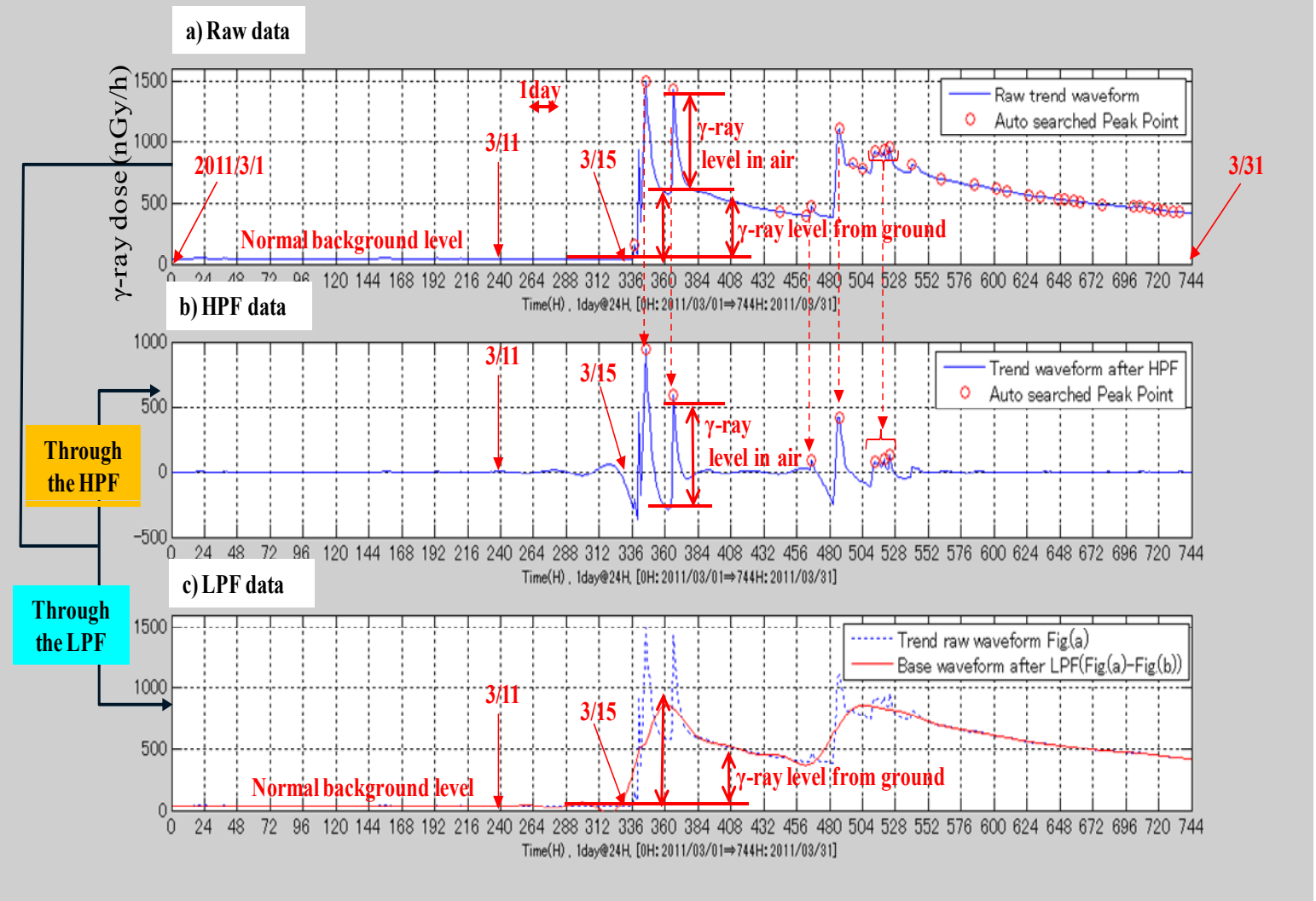
STE using TCM DB

After accident



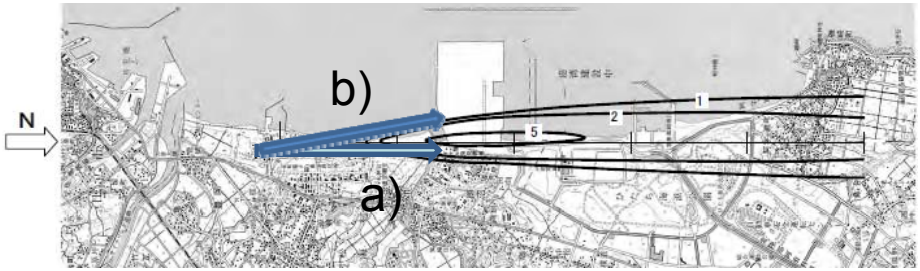


Data filtering technique of Gamma dose rate to obtain just the cloud-shine

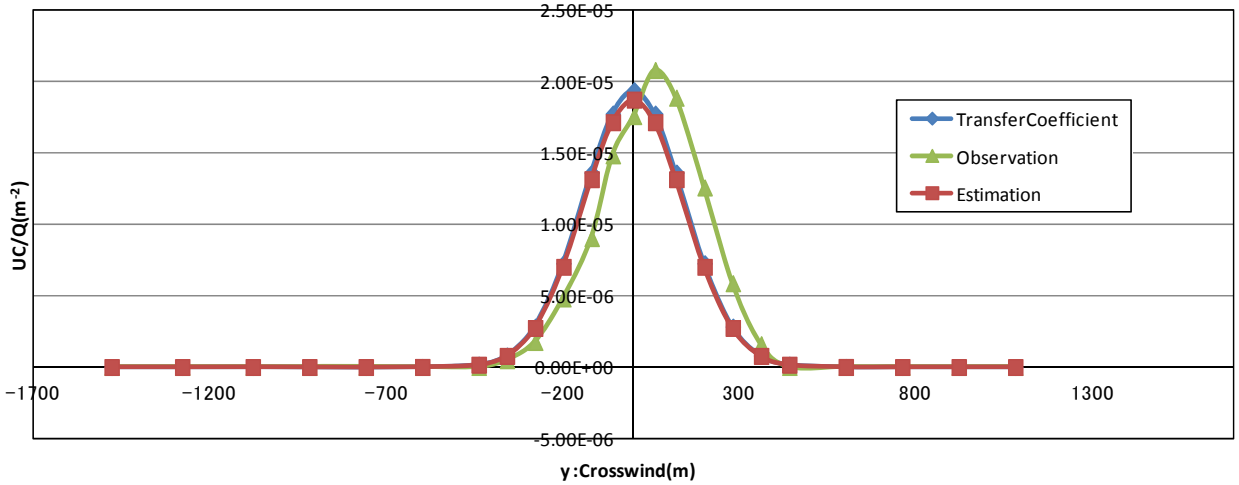


Verification & Validation Study of STE based on the Wind Tunnel data (1st step)

・Observed data：W/T data (concentration)
・TCM：Gaussian Plume model （fitting with W/T data）



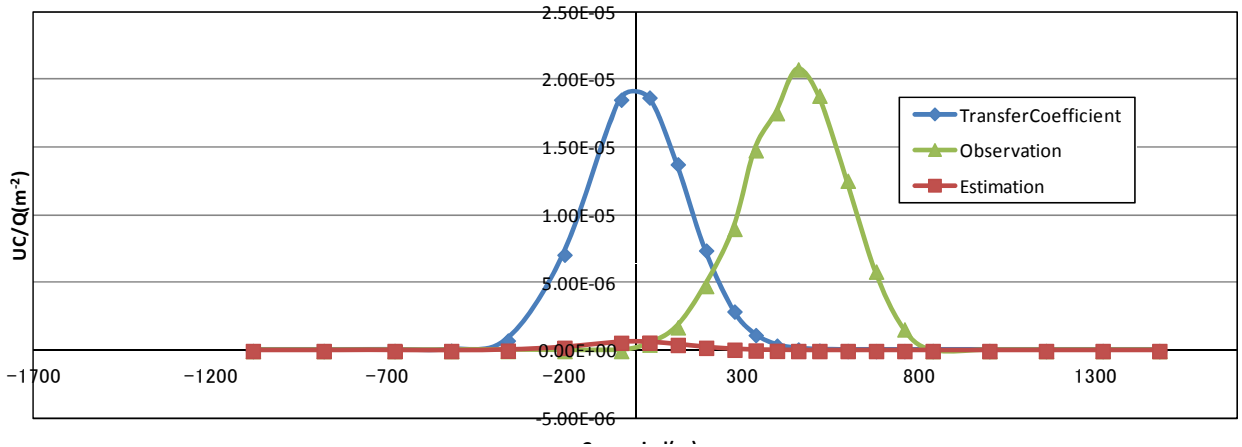
Concentration Distribution at a Distance of 2000m Downwind



a) Wind direction: N
Accuracy of estimated Source rate：97%

Uncertainty factor of wind direction

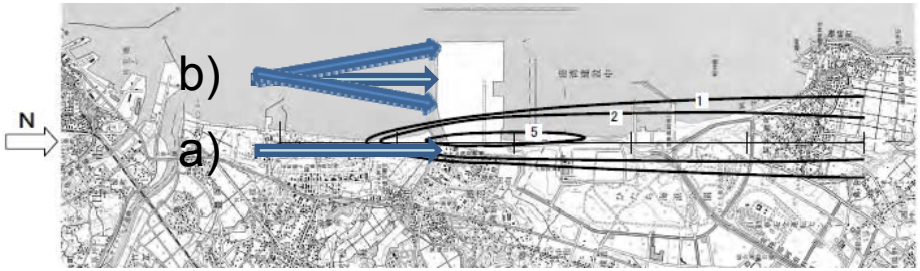
Concentration Distribution at a Distance of 2000m Downwind



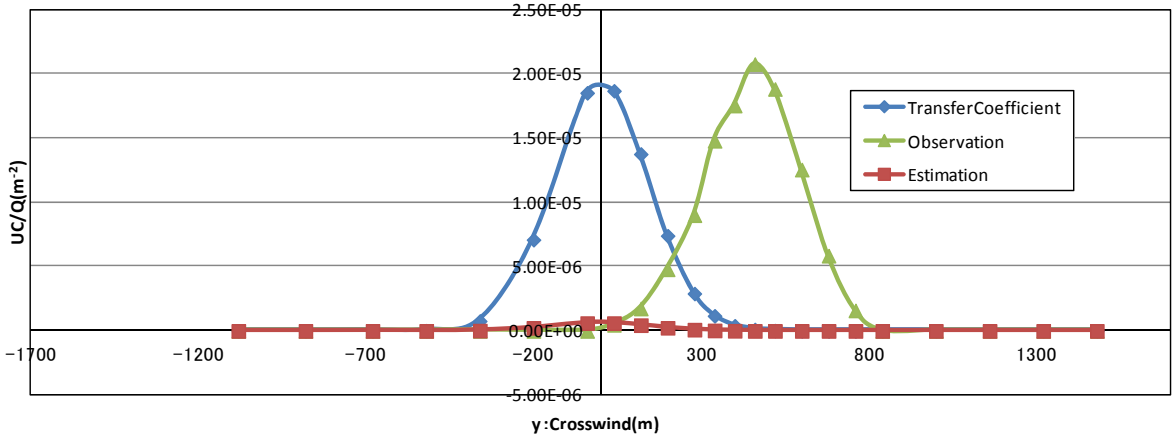
b) Wind direction: N +11.25 deg
Accuracy of estimated Source rate：3%

Verification & Validation Study of STE based on the Wind Tunnel data (1st step)

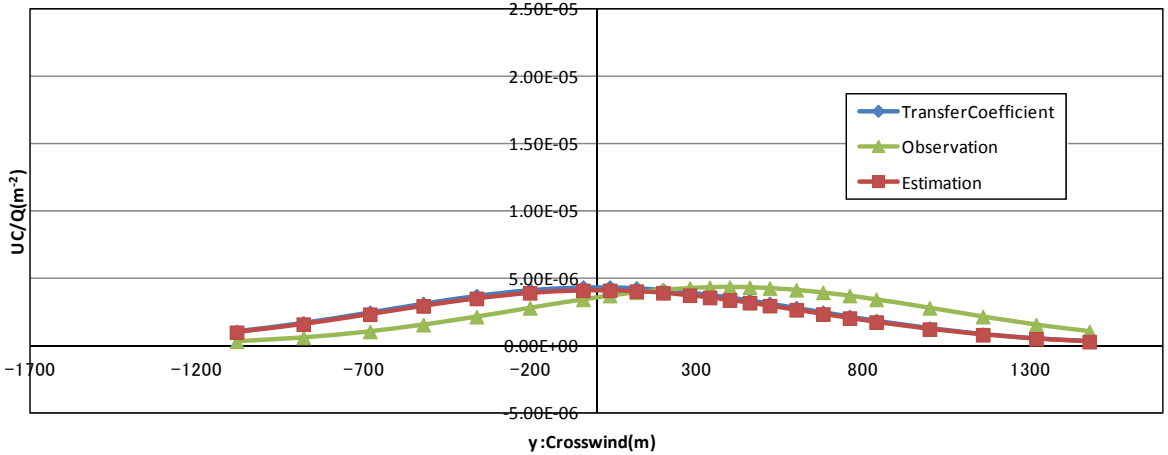
・Observed data：W/T data modified by the meandering factor of 1 hour
・TCM：Gaussian Plume model
（fitting with W/T data and modified by the meandering factor of 1 hour）



Concentration Distribution at a Distance of 2000m Downwind



Concentration Distribution at a Distance of 2000m Downwind



a) Wind direction: N+11.25 deg without meandering factor
Accuracy of estimated Source rate：3%

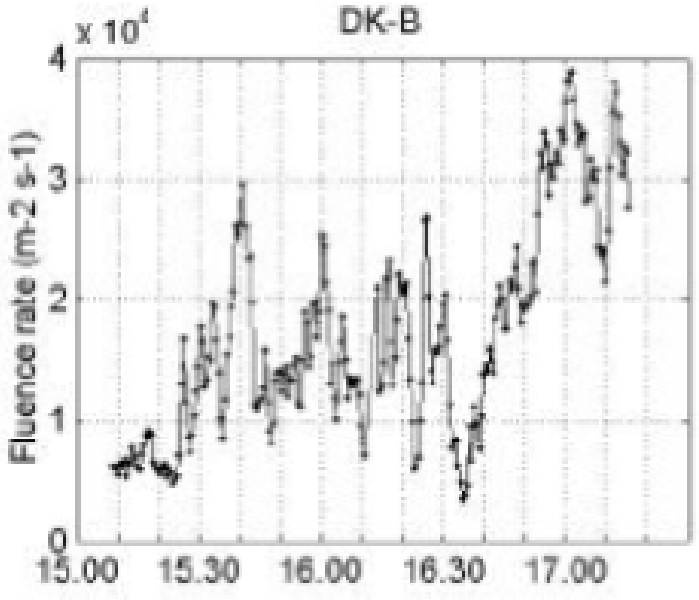
Uncertainty factor of wind direction with meandering

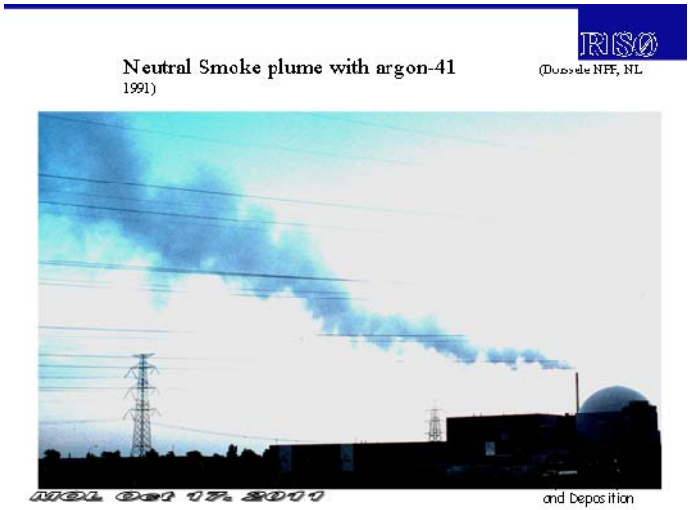
b) Wind direction: N +11.25 deg with meandering factor of 1 hour
Accuracy of estimated Source rate：94%

1 hour averaged data are desirable for STE

Verification & Validation Study of STE based on the Field test data (2nd step under preparation)

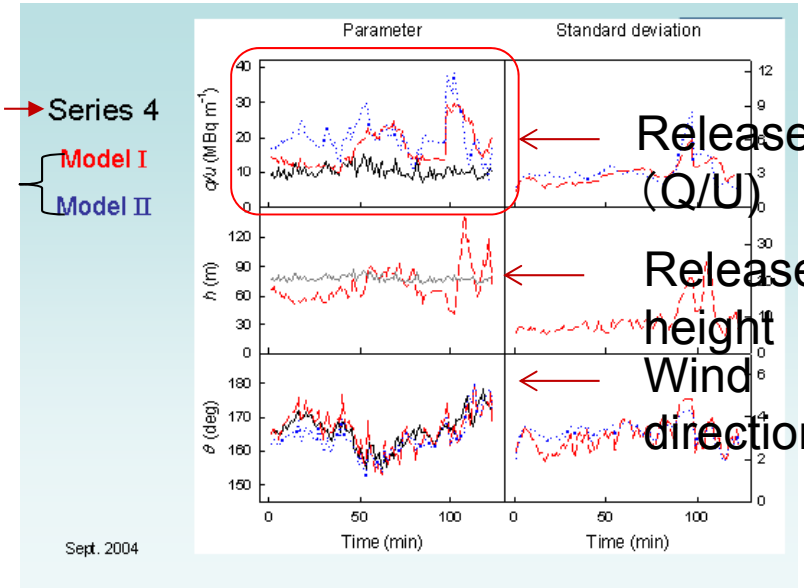
Test site: MOL test reactor in Belgium
- Released gas: Ar41(2001.10.)
- Observed data: Gamma dose





Obs. data

Est. data by RISO



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Long term radiation exposure model

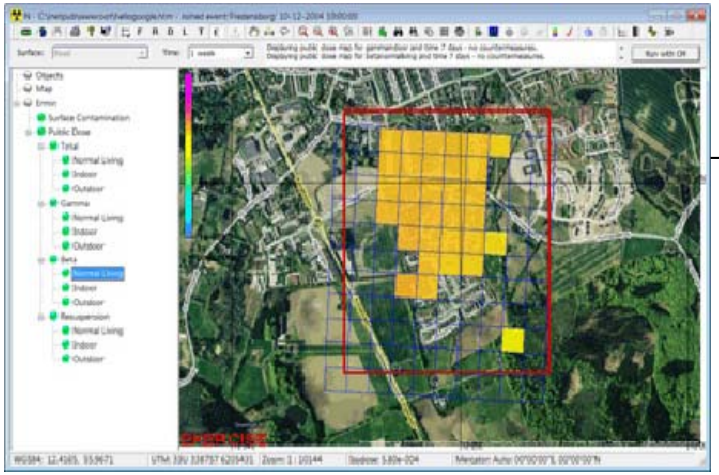
Target：to improve the ERMIN(European Model for Inhabited areas) code

Input data

・Ground Surface condition

・Soil contamination

・De-contamination measures



Output data

・Long term exposure

（External and internal）

・Effect, cost and waste amount

of de-contamination

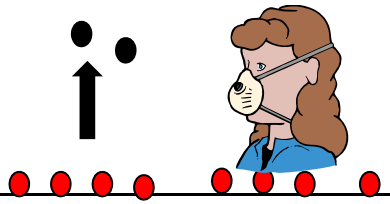
Tasks of 2012

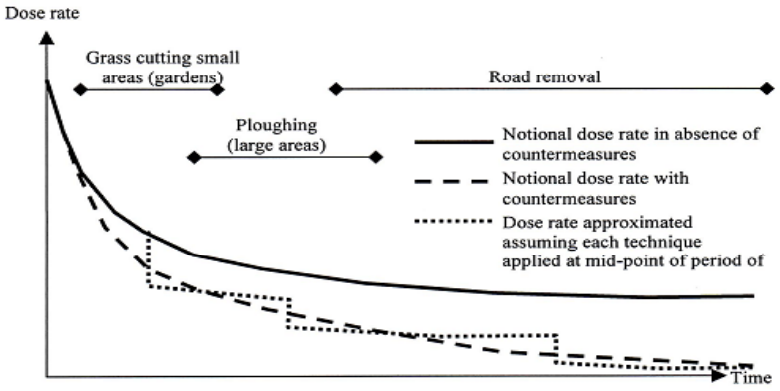
・Analysis of re-suspension coefficient

・Analysis of weathering factor

・Installment of Japanese database

Re-suspension coeff.(m-1)
= Soil contamination (Bq/m2)
/Air concentration (Bq/m3)

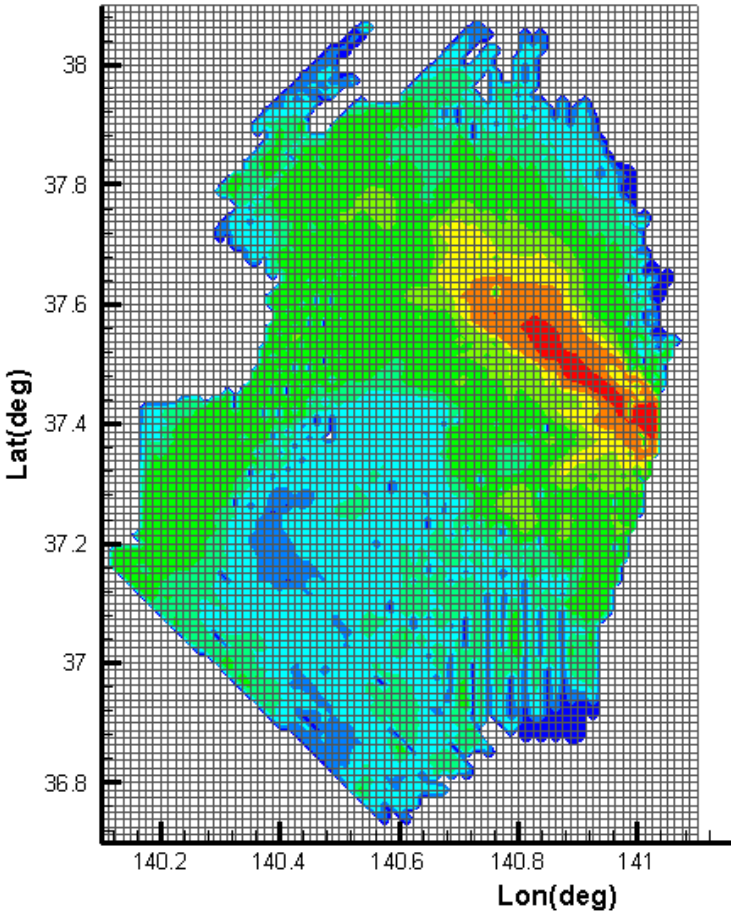




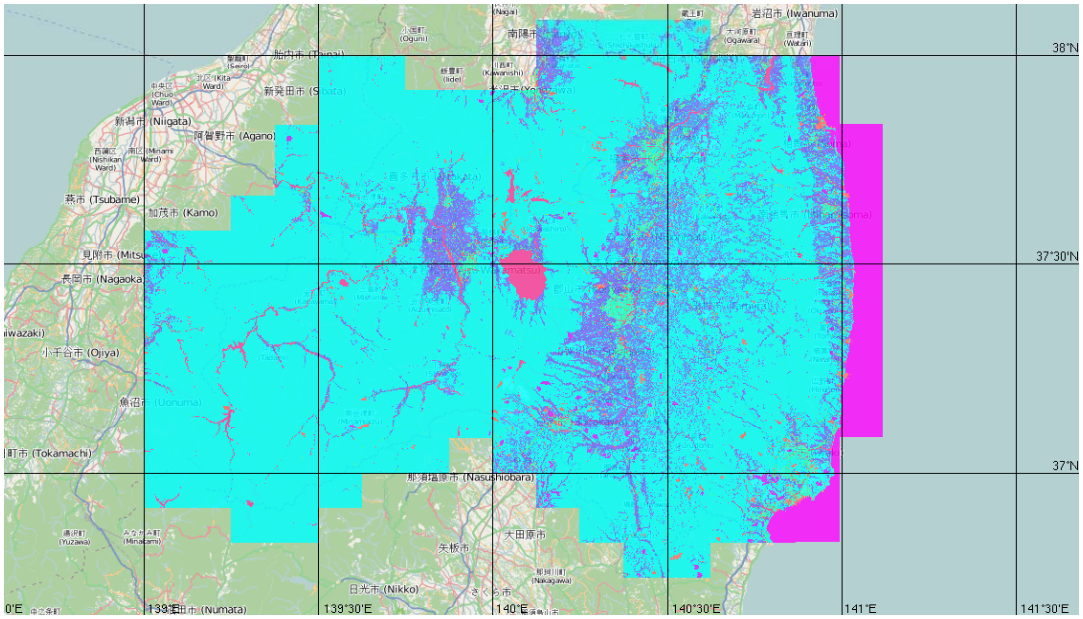
Weathering factor(washout effect et al.）

Database installed into ERMIN code

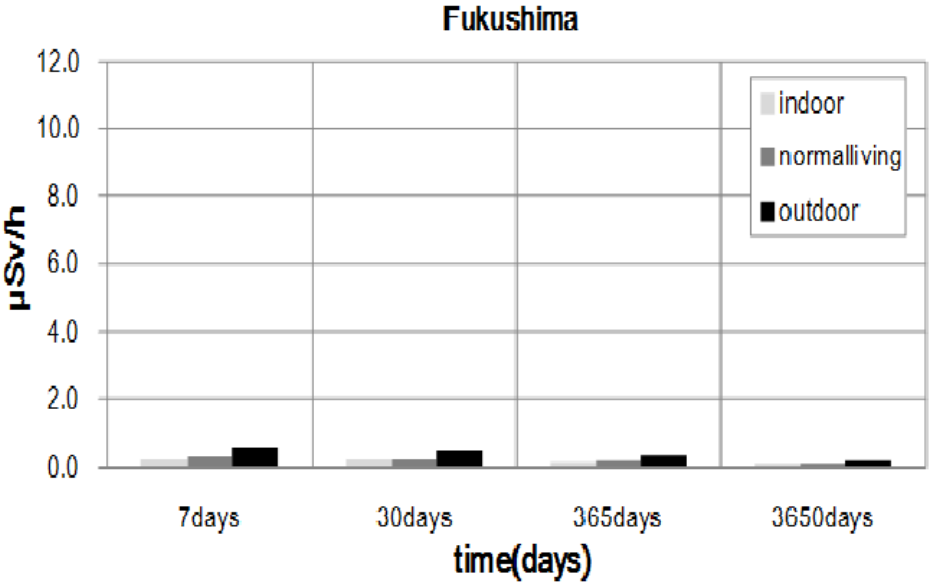
Soil contamination map

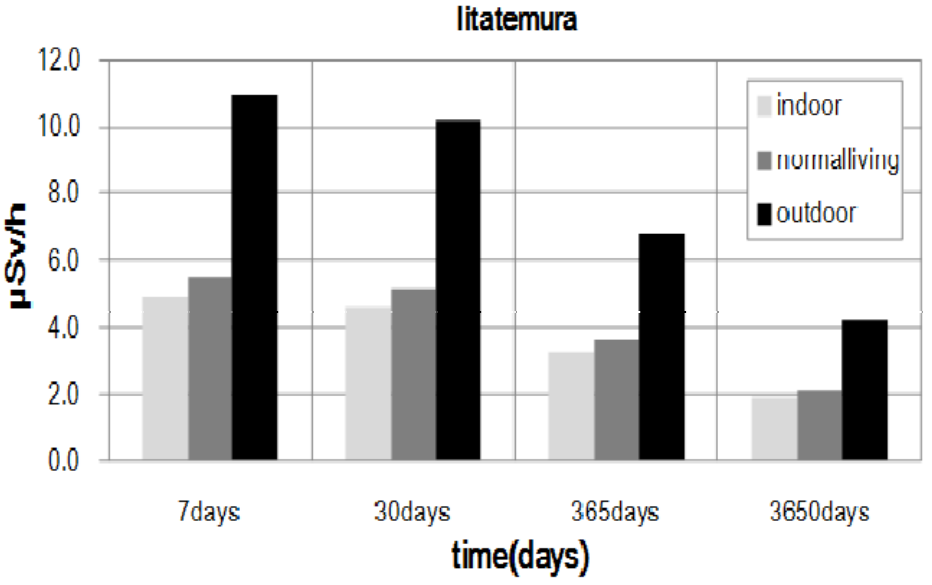


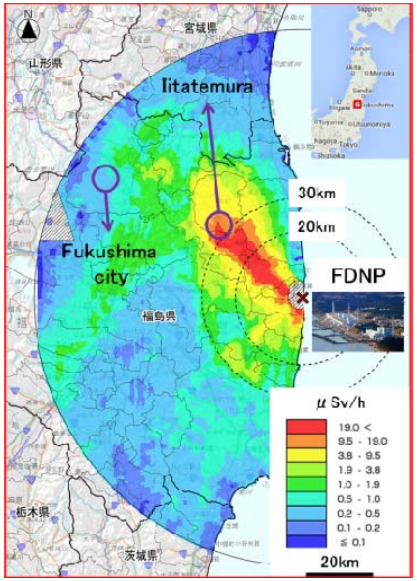
Ground surface categories in Fukushima



Calculated results by ERMIN code

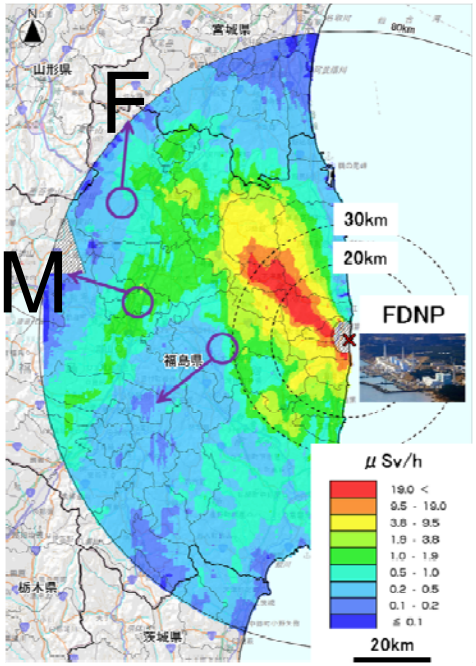


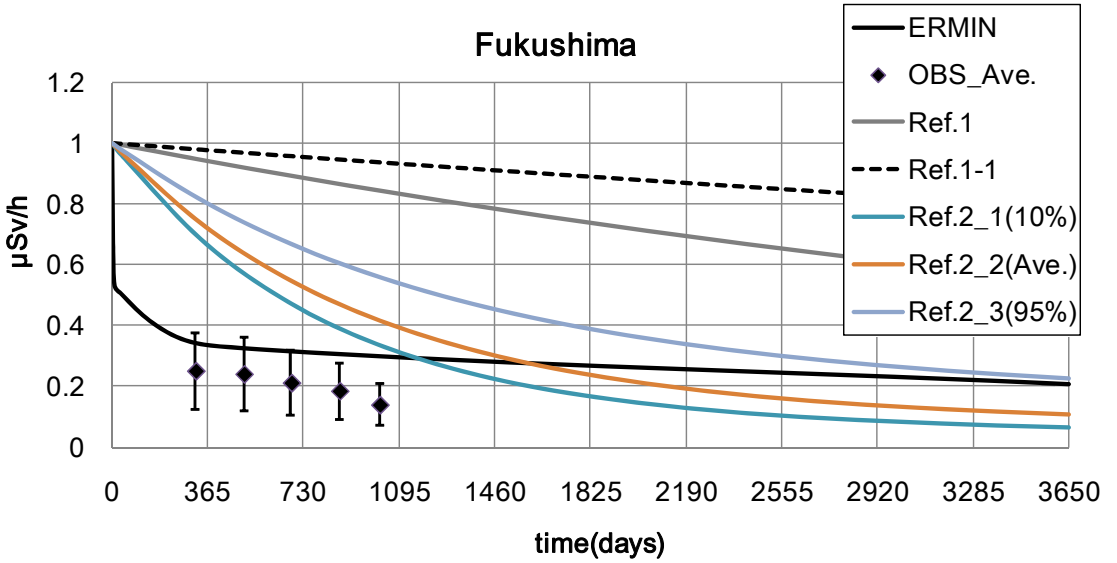


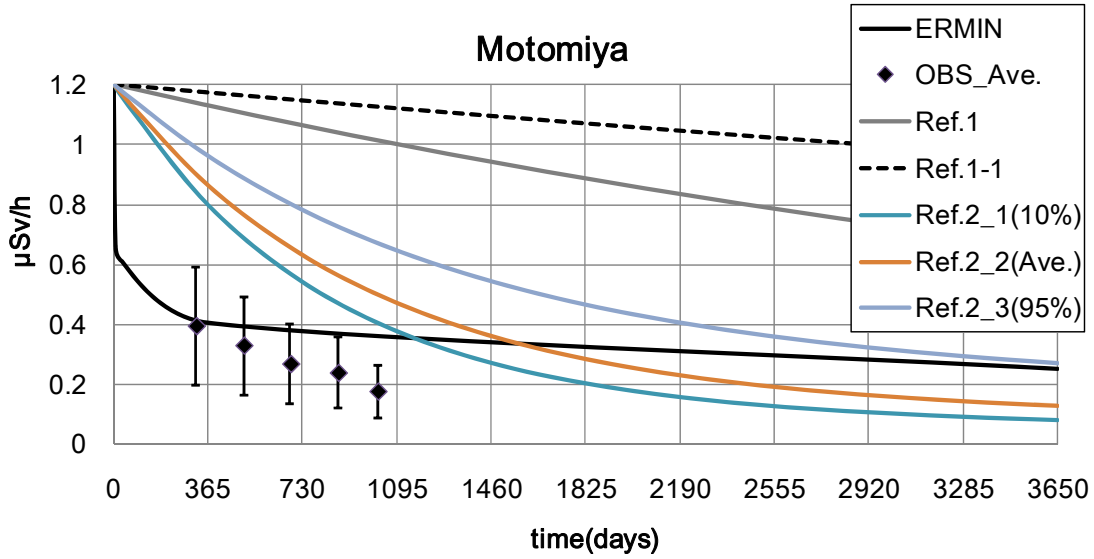


・Calculated results decrease with the passed time and the living time inside a house.
・More calculations are planned to check the effect of the ground surface, house and de-contamination conditions.

Validation of ERMIN code with Fukushima data







Ref.1 : $D_t(t)=D_i(0)\cdot\exp(-\ln 2/\tau_w \cdot t)\cdot\exp(-\lambda_i \cdot t)$, Ref.1_1: $D_t(t)=D_i(0)\cdot\exp(-\lambda_i \cdot t)$
τ_w: Weathering factor (^{137}Cs:18.4 Years, Komamura(2006)), λ_i: Radioactive decay factor (^{137}Cs:0.0231), Ref.2: Golikov(1993)

Summary

1. The operational Source Term Estimation method was developed using the database of the Transfer Coefficient Matrix based on the wind tunnel data.
2. Verification & Validation study of STE method was conducted using the wind tunnel data
3. EU-ERMIN code was applied for the estimation of long term radiation dose in Fukushima area.

Annual schedule of each subjects

Subjects	FY2012 (Development of fundamental tech.)	FY2013 (Validation test)	FY2014 (System integration)
(1)Source Term Estimation (Tokyo Univ.)	Programing	Validaiton test	System integration
(2)Data pre-processing （MHI）	Programming	Installing input data	Integration test
(3)Long term exposure	Data analysis	Improvement of ERMIN code	Estimation of Long term radiation dose
International collaborations	a)Kick-off meetings b)Invitations from LLNL and NCAR	a)Visiting at RISO b)Participation into international conf.	a)Closing meetings

Initial Stage (Few Weeks)

Late Stage (Few years)