Air Quality perspectives from Japan and Response/impact of the recent Earthquake/Tsunami

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Contents

Part 1. Air quality forecast in Japan
Part 2. Response/impact
of the Earthquake/Tsunami/Nuclear accident this Mar.

The background of the air quality forecast in Japan

photochemical oxidant:

- rise of concentration (particularly in western Japan) in decades and extension of high concentration area recently
- possible cause = long-range transport

$PM_{2.5}$:

- air quality standard for PM2.5 was enacted in 2009 — 35μg/day, 15μg/year (only SPM standard before that since 1973)

public concern about environment (including non-atmosphere):

- 1st priority now = radioactive materials in life, possibly food etc. already negligible in the atmosphere, though
- except for that, public concern about air quality has been increasing

Also, local governmental officers

need information to issue warnings (due to difficulty with increasing influence of long-range transport)

Abstract of air quality forecast in Japan

Active research institutions:

Kyushu University

JAMSTEC(Japan Agency for Marine-earth Science and TECnology)

NIES(National Institute for Environmental Studies)

MRI(Meteorological Research Institute)

Government offices:

Ministry of education, culture, sports, science and technology

Ministry of the Environment

JMA(Japan Meteorological Agency)

Brief history of operational AQ forecast in Japan

2000 CFORS by I. UNO = pioneer in Japan

2002 Chemical weather forecast by Frontier Research Center of Global Change

2008 collaboration started between Ministry of the Environment and JMA(Japan Meteorological Agency) about AQ forecast etc.

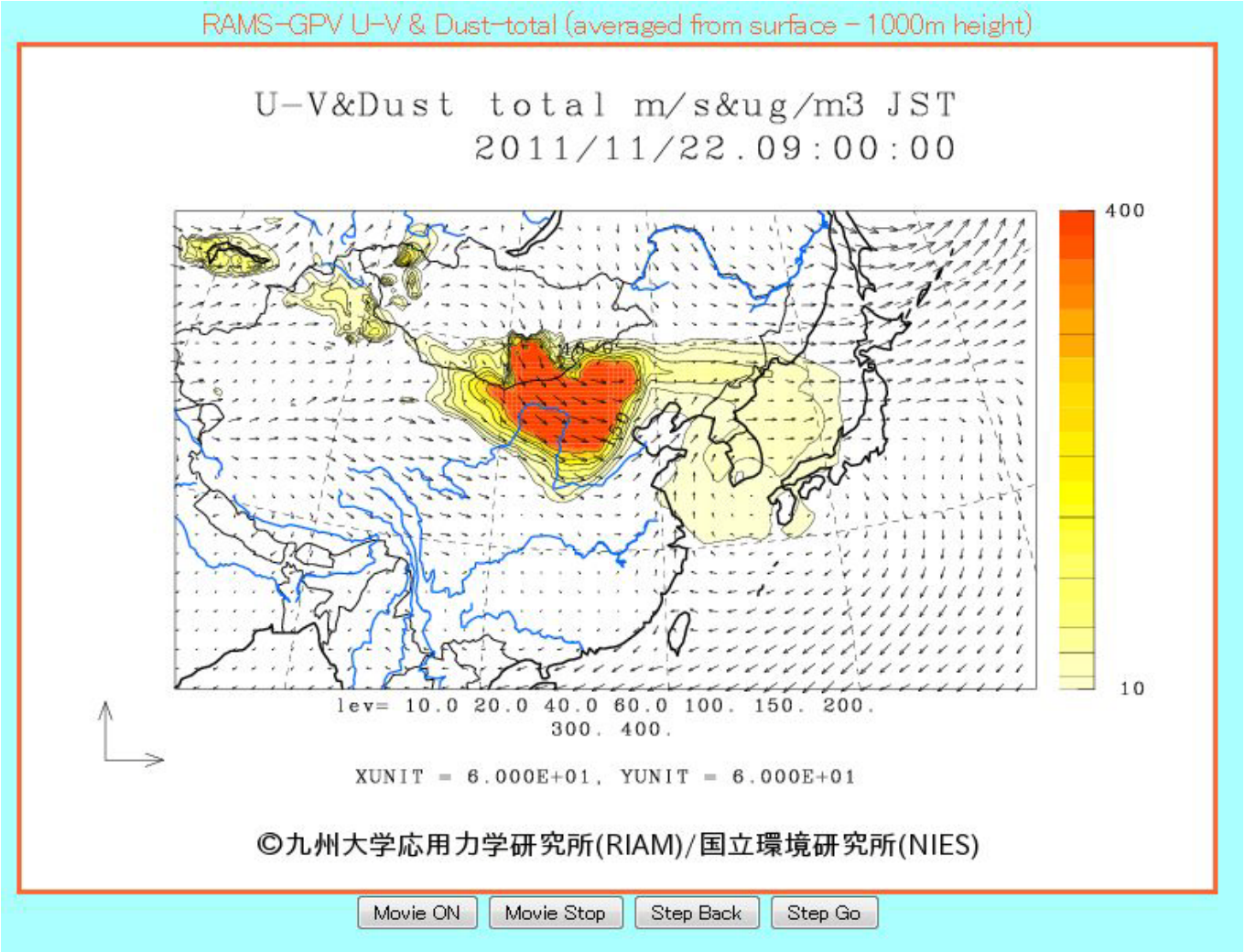
Headline of this topic

In transition from individual researches to officially projects

Active institute 1. Kyushu University (1/2)

Prof. Itsushi Uno

CFORS (Chemical weather FORecast System)

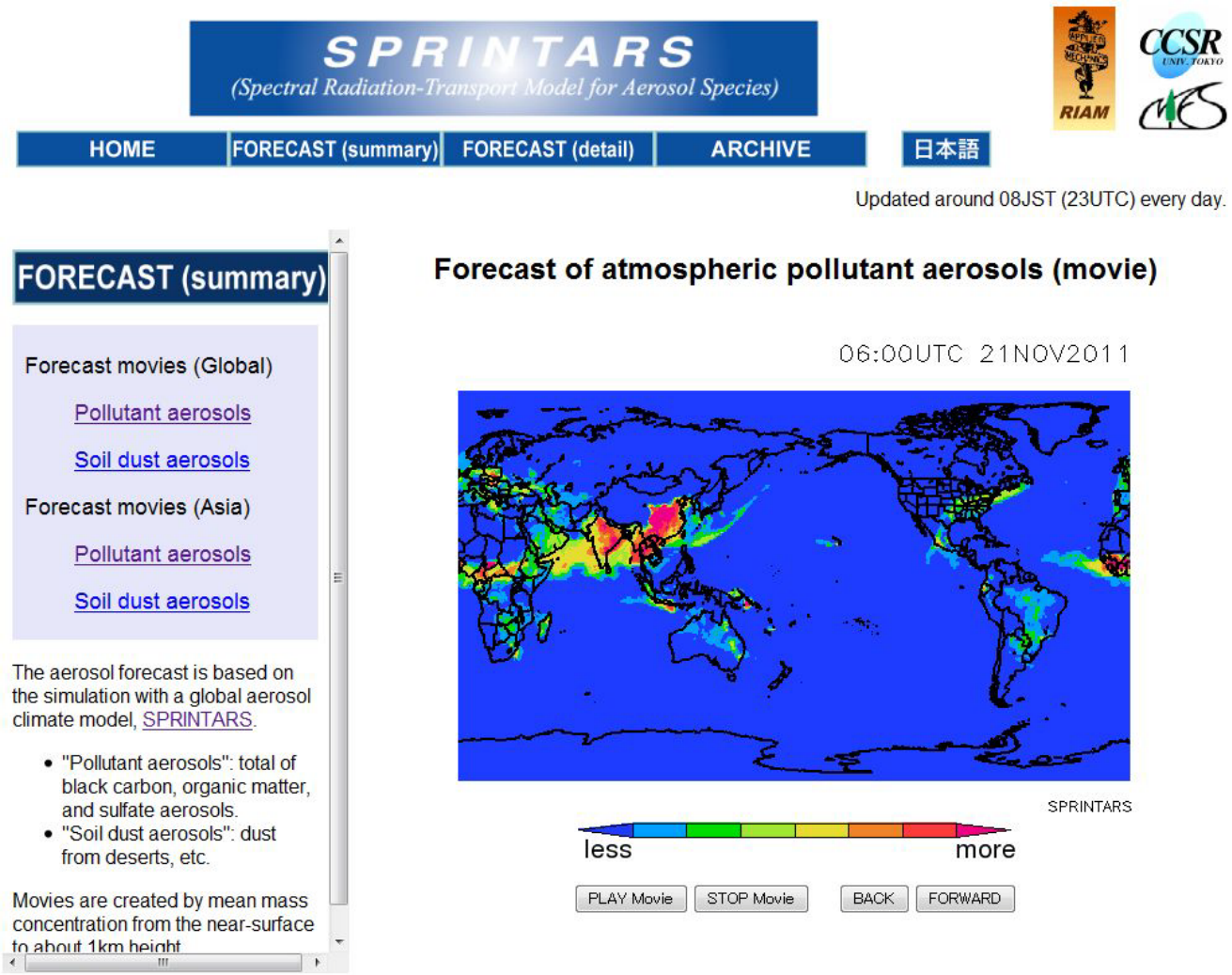


Public release: 2000
Core: RAMS online tracer transport
Species: dust & sulfate aerosols
resolution: 40km
Emission:
period: 4 day

Active institute 1. Kyushu University (2/2)

Dr. Toshihiko Takemura

SPRINTARS(Spectral Radiation-Transport Model for Aerosol Species)



Originally developed: 2000

Public release: 2008

Core: SPRINTARS (GCM based aerosol transport model)

Species: dust, BC, OC, sulfate

Resolution: T213 ≒0.5degree mesh

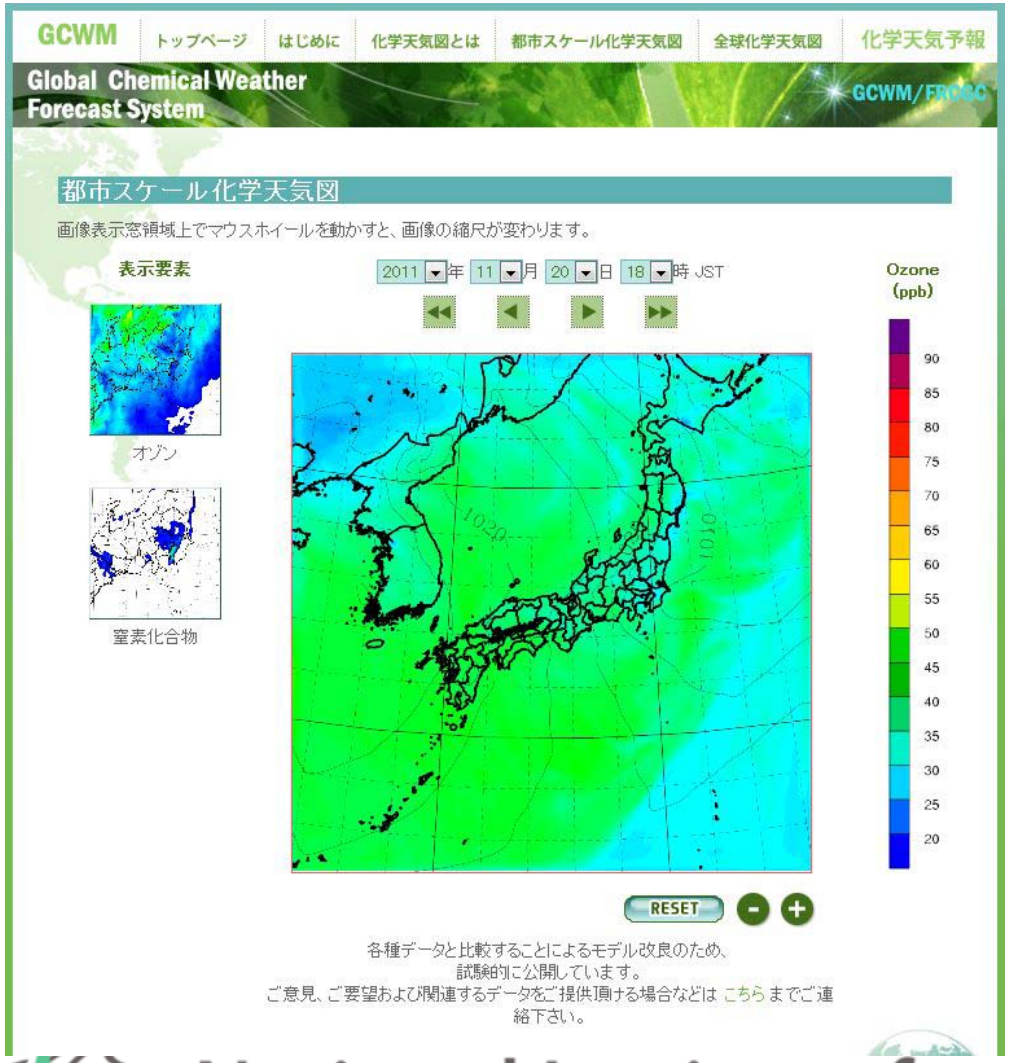
Period: 7 day

Active institute 2. JAMSTEC

(Japan Agency for Marine-Earth Science and Technology)

Prof. Hajime Akimoto (↑former "Frontier Research Center for Global Change)"

Dr. Masayuki Takigawa



Global Chemical Weather Forecast System

Public release (global ver.): 2002

Public release (regional v.): 2008

Core: CHASER (GCM based chemistry climate model) + WRF/Chem

Species: 56 species, 142 reactions
O_3 and NO_x for public

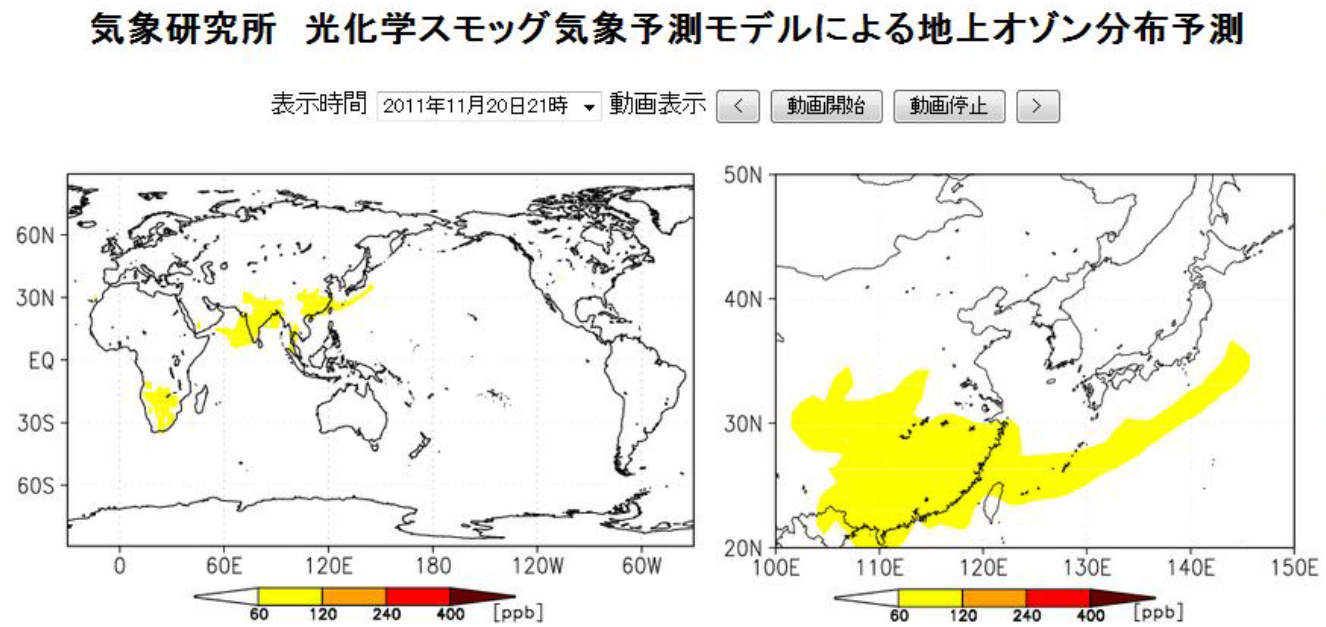
Resolution: 5km (greater Tokyo)
15km (other Japan areas)
T42 ≒2.8 degree mesh

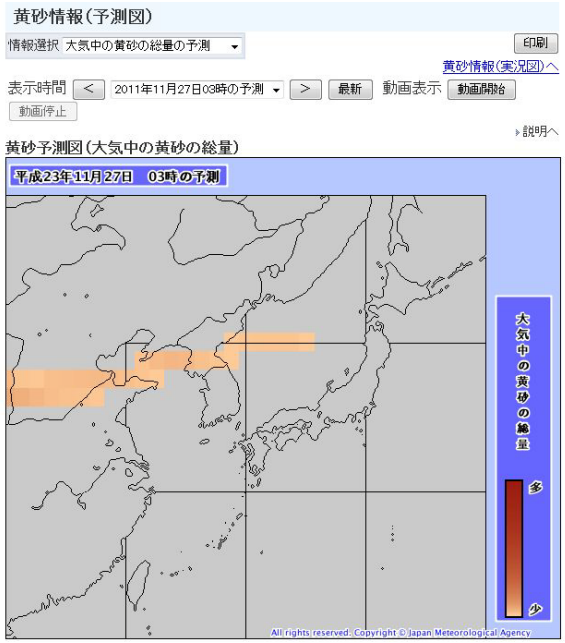
Emission: JCAP & EAGRID2000

Period: 1 day

Active institute 3. Meteorological Research Institute

Photochemical smog–weather forecast & Dust forecast





ppb（parts per billion）とは、濃度を表す単位で「10億分の1」のことです。

Public release: 2008
Core: MOZART (global chemistry climate model)
Species: surface O_3 for public
Resolution: about 100km
Emission: REAS
Period: 3 day

Public release: 2004
Core: MASINGAR
(global model)
Species: dust and other aerosols
Resolution: about 100km
Period: 4 day

becoming deeper in regional modelers

Active institute 4. NIES (National Institute for Environmental Studies)

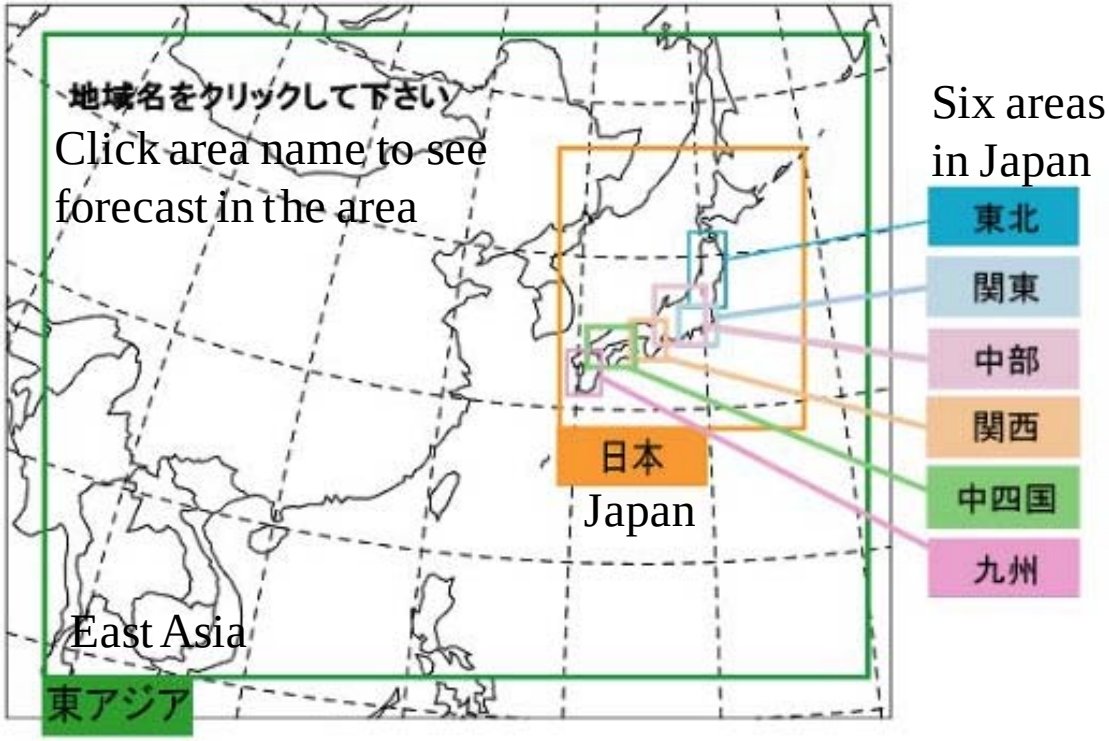
Dr. Toshimasa Ohara, Dr. Seiji Sugata and colleagues

VENUS (Visual atmospheric Environmental Utility System)

大気汚染予測システム（愛称 VENUS）

VENUS=Visual atmospheric ENvironment Utility System

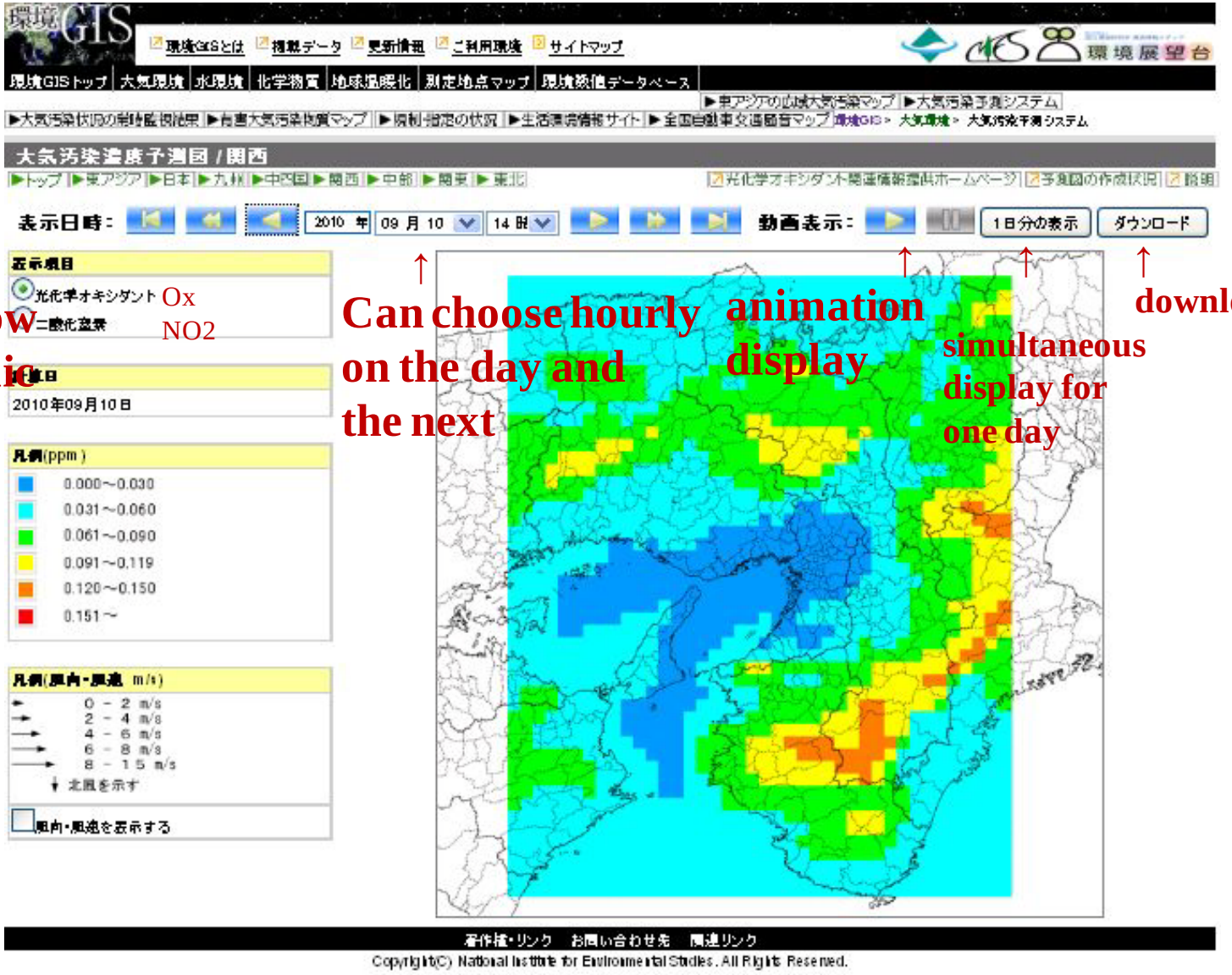
国立環境研究所では大気汚染予測モデルの開発を進めています。そのモデルを用いて、光化学オキシダント及び二酸化窒素の大気汚染濃度の予測を行い、東アジア（100kmメッシュ）、日本（25kmメッシュ）、九州、中四国、関西、中部、関東、東北地域（5kmメッシュ）の 各地域の予測図を提供しています。予測図は、毎日1回、午前9時に、当日と翌日分が掲載されます。



Six areas in Japan

Public release: 2008
Core: RAMS + CMAQ
Species: O_3 and NO_2 for public
Resolution: 5km (areas),
25km (Japan),100km(E Asia)
Emission: EAGRID (Japan)
& REAS(other)
Period: 2 day

Example of area page (greater Osaka area)



Species for public is now photochemical Ox and NO2. Sulfate aerosol after next spring

Can choose hourly on the day and the next

animation display

simultaneous display for one day

download

Features and Specification

- Core: Combination of **RAMS** + **CMAQ**
- Nudging: simply with GPV weather forecast data by JMA
- Emissions: **EAGRID** (in Japan) and **REAS**（others in Asia）
- Domain: **3 level nesting** to cover East Asia to urban areas in Japan
  East Asia **100km**⇔ Japan **25km** ⇔ each local area **5km**
- Species: hourly **Ox** and **NO2** on the day and the next day
- Schedule: update every 9 o'clock in the morning (local time)
- Computer: NIES supercomputer system (scalar system)

Core: Coupling of **RAMS** + **CMAQ**

development history

Idea: Prof. Itsushi UNO and Dr. Daewon Byun in mid 1990s

first release of the interface (MCIP for RAMS) : in 1999
when I stayed EPA/NERL for 1 year (1998-99) to develop it
with supervised by Dr. Byun

MCIP for RAMS has been developed:
up to RAMS 4.4 and CMAQ 4.4
but no update recently → VENUS

VENUS development: since 2004

↓ internal use/test

Public open 2008

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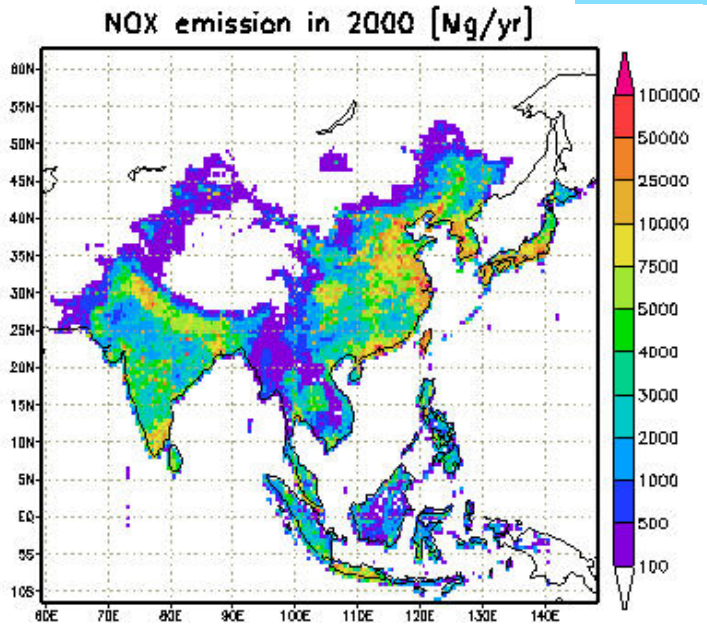
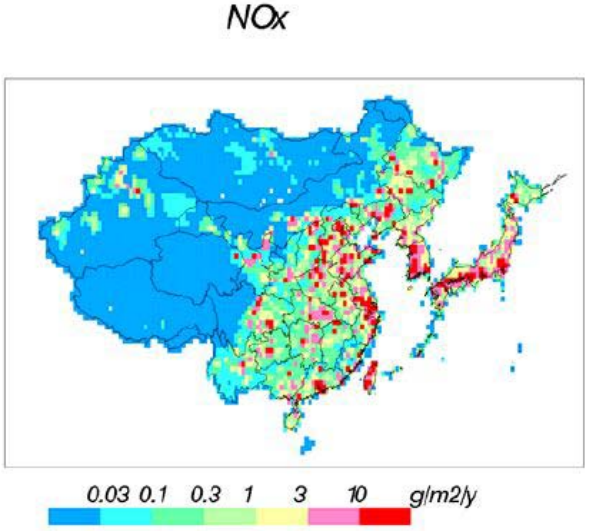
Emission



REAS(Regional Emission inventory in ASia)
By JAMSTEC, NIES etc.
base year: 1995,2000 &1980-2010, 2020
resolution: 0.5 degree
species: NO_x, SO_2, CO, CO_2, N_2O, NH_3,
BC, OC, CH_4, NMVOC

EAGrid2000(East Asian air pollutant emission GRID database)
By Drs. Kannari, Tonooka, Murano etc.
base year: 2000
resolution: 1km (Japan), 0.5 degree (others)
species: NO_x, SO_2, CO, NH_3,
PM_{10}, Hg, NMVOC



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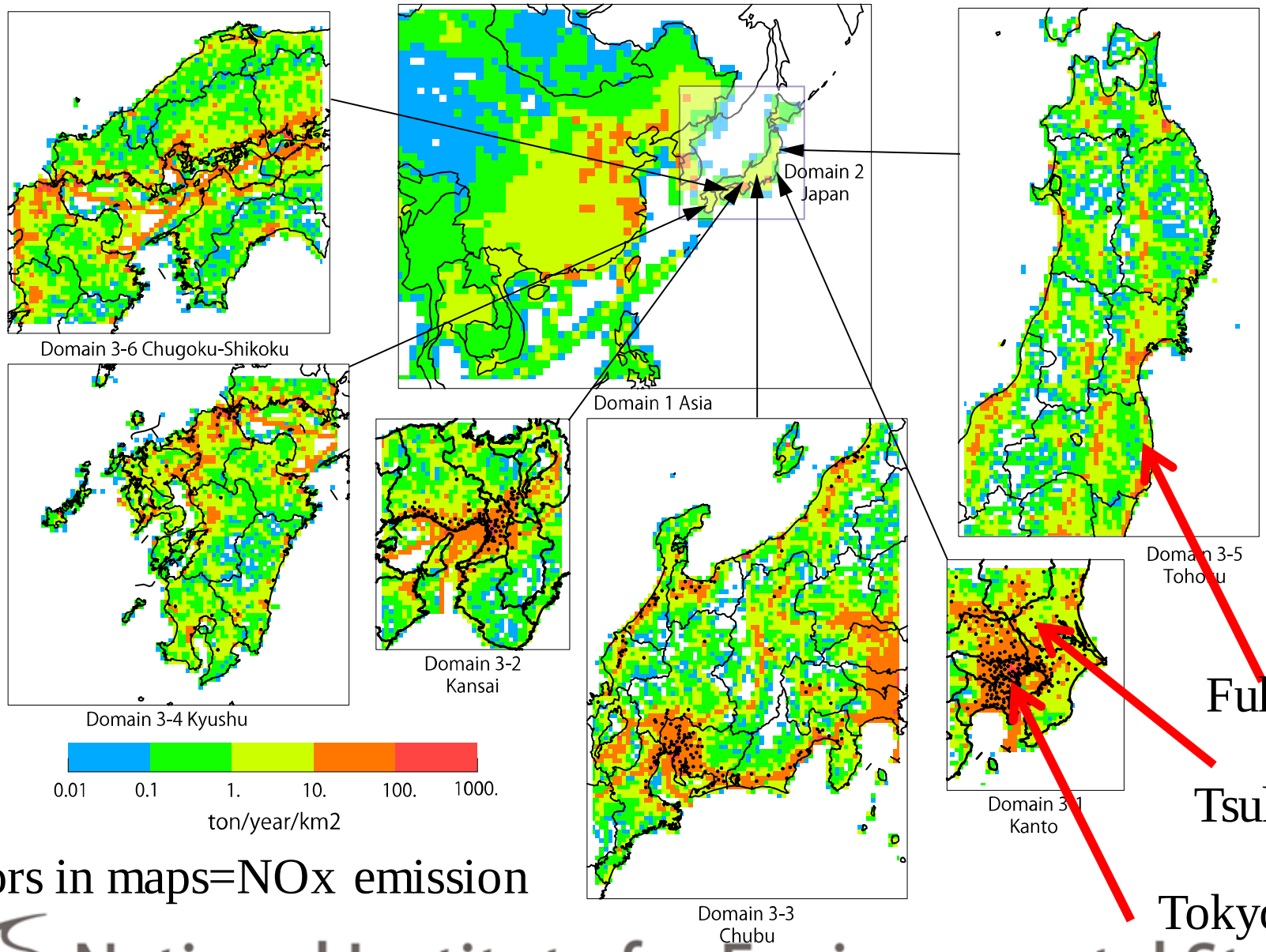
3 level nested domain: Asia (100km)–Japan (25km)–Each area (5km)



Colors in maps=NOx emission

Features and Specification

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Evaluation of VENUS

by comparing Ox in May and Aug. 2009

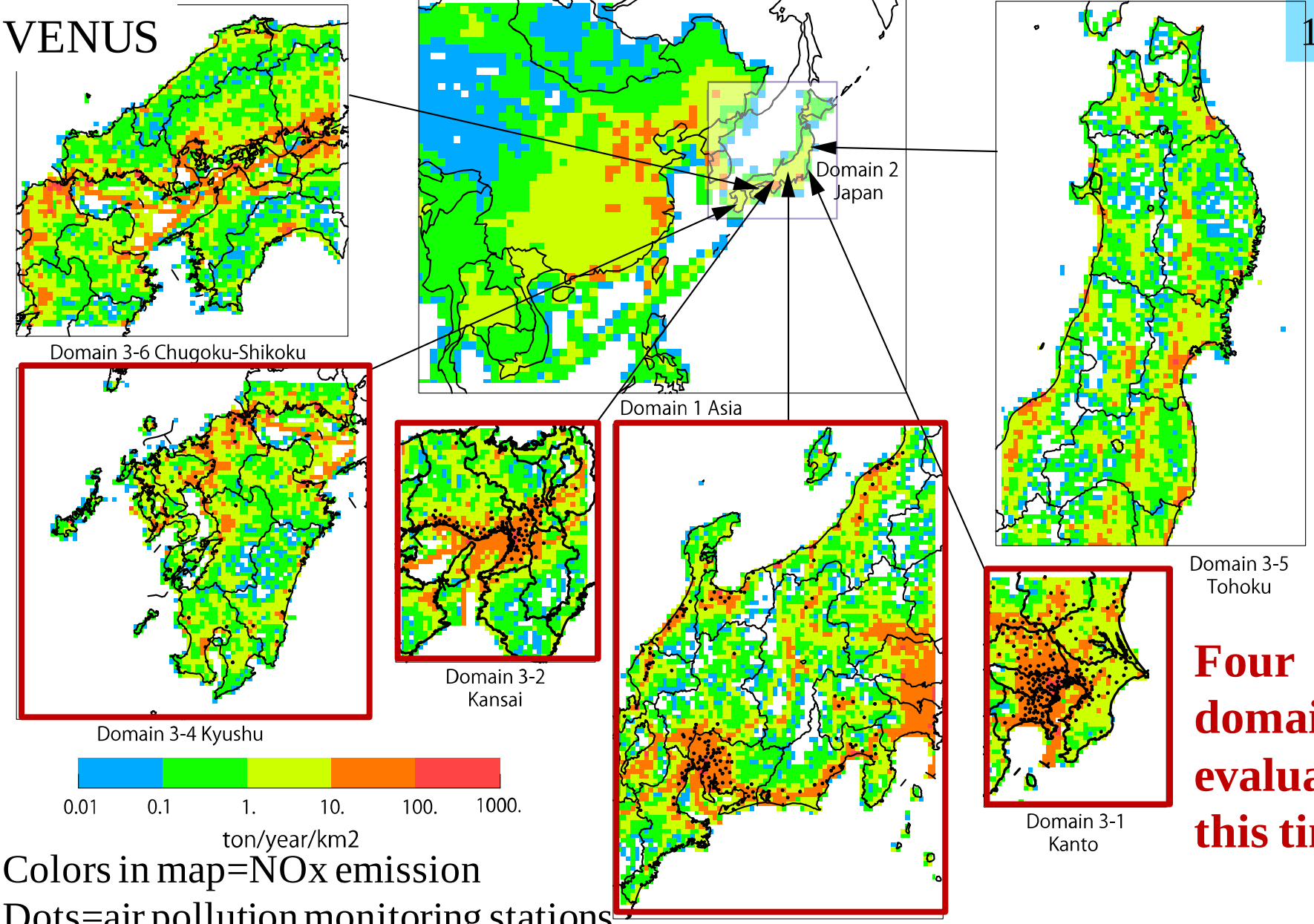
between the result of VENUS
and the observation data at air pollution monitoring stations

Comparison is made for the following three cases

	Japan25km mesh	Local 5km mesh
May 2009	○	×
Aug. 2009	○	○

for four local domains in Japan

VENUS



Four domains evaluated this time

Colors in map=NOx emission

Dots=air pollution monitoring stations

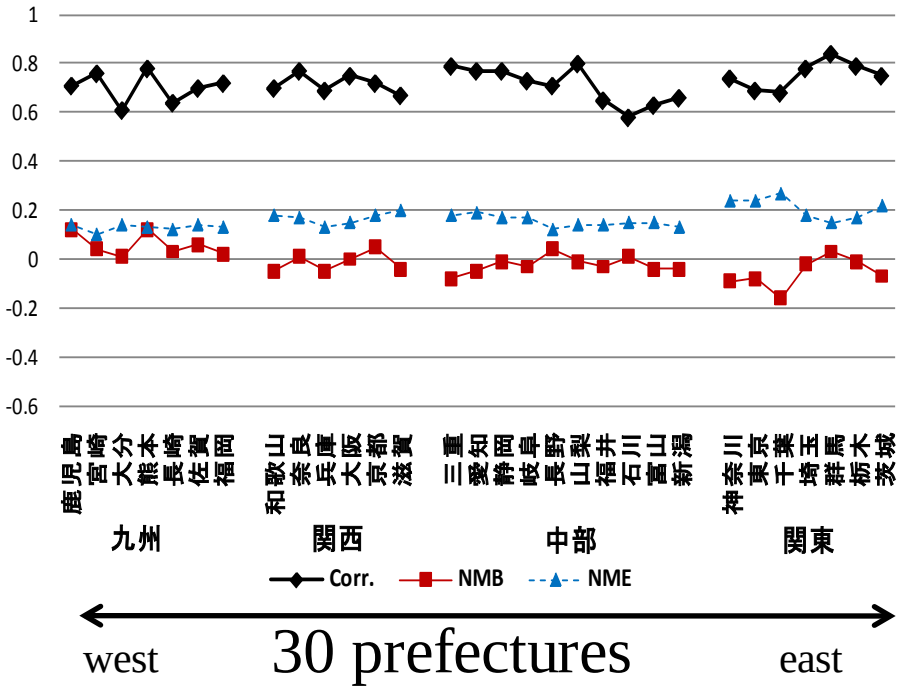
Monitoring time for NO,NO2,Ox > 90%

NO/NOx≦0.2

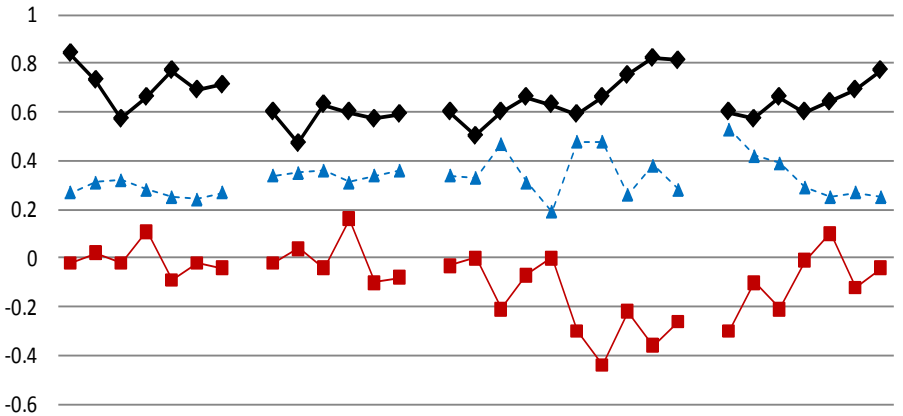
VENUS Evaluation

Skill scores for prefecture daily 95 percentile Ox between obs. and VEN

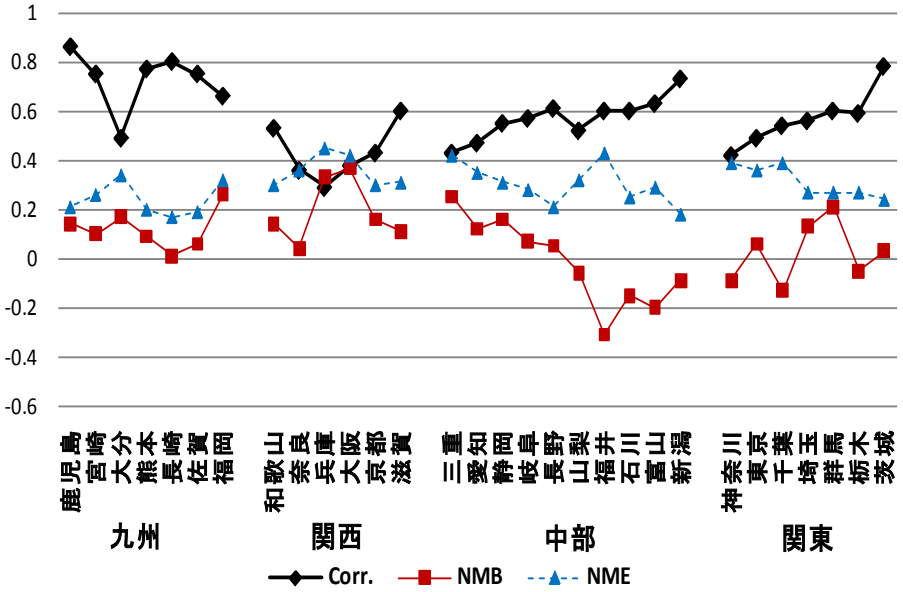
Japan domain (25km) May 2009



Japan domain (25km) Aug. 2009



Local domain (5km) Aug. 2009



Black:Correlation coefficient

Red: NMB（obs. - cal.）

Blue: NME

Summary of VENUS

- VENUS: air pollution forecast system developed by NIES and colleagues

Jointly developed by
- Ministry of the Environment
- Central Res. Inst. of Electric Power Industry
- local government environ. institutes

Assisted by
- Fujitsu FIP corporation
- Japan Weather Association

- Evaluation about Ox:
  good for daytime high concentration
  poor for low concentration at night
- Next step:
  Fully update or change to WRF+CMAQ before evaluation

Lessons learned about AQ forecast in Japan,

- Original emission inventories, original GCM and CTM
  But no original regional models
- Small (or no) official support for the AQ forecast so far with no or small funded (～$100,000?)
- Not by team but by individual researcher
  like handicraft industry
  ⇒ these are problems.

One good news is
collaboration of MOE and JMA since 2008

Before that, bureaucratic sectionalism like
"forecast" is under JMA, "environment" is under MOE…

Examples of collaboration of MOE and JMA

環境省 Ministry of the Environment　　気象庁 Japan Meteorological Agency

Information homepage for oxidant

光化学オキシダント関連情報提供ホームページ

環境省 Ministry of the Environment　気象庁 Japan Meteorological Agency

このホームページは、地方公共団体等における、光化学オキシダント関連情報の研究及び利活用の促進を目的として、環境省と気象庁が共同で関係機関の有する情報を提供するものです。

現在の状況 present observation

大気汚染物質広域監視システム（愛称そらまめくん）
（環境省では、全国の大気汚染状況（光化学オキシダントなどの大気汚染物質濃度の1時間ごとの測定値）と光化学オキシダント注意報等の発令状況をリアルタイムで提供しています。

今後の見通し **forecast**

気象情報（スモッグ気象情報と全般スモッグ気象情報を含む）
光化学スモッグの発生しやすい気象状況（晴れて、気温が高く、風が弱い等）が予想される場合、担当する気象台はスモッグ気象情報を発表します。また、翌日に広い範囲で光化学スモッグの発生しやすい気象状況が予想される場合、気象庁本庁は全般スモッグ気象情報を発表します。
気象情報の中から、スモッグ気象情報はご覧になりたい地方を、全般スモッグ気象情報は全国を選択することで、それぞれ発表状況を確認できます。

※解説　スモッグ気象情報と全般スモッグ気象情報

JMA & Met. Res. Inst.

気象研究所の光化学スモッグ気象予測モデルによる予測
気象研究所では光化学スモッグ気象予測モデルの開発を進めています。そのモデルを用いて、世界、東アジアを対象として、明後日までの光化学スモッグ（地上オゾン濃度）等の予測情報を試験公開しています。

国立環境研究所による大気汚染予測（環境GIS「大気汚染予測システム」）
国立環境研究所では大気汚染予測モデルの開発を進めています。
そのモデルを用いて、東アジア、日本域及び各地域（九州、中四国、関西、中部、関東、東　と翌日の光化学オキシダントなどの大気汚染の予測情報を試験公開しています。

NIES

海洋研究開発機構による大気汚染予測（化学天気予報）
海洋研究開発機構では、全世界および日本域、関東域を対象として、当　光化学オキシダントなどの大気汚染物質の予測情報を試験公開しています。

JAMSTEC

九州大学による大気汚染予測（SPRINTARS）
九州大学では、全世界及び東アジア、日本域を対象として、当日から1週間先までの浮遊粒子状物質（光化学オキシダントと同様に、主に人間活動によって生成され呼吸器等に悪影響を及ぼします）による大気汚染の予測情報を試験公開しています。

Kyushu University

Information homepage for Asian dust

黄砂情報提供ホームページ

環境省 Ministry of the Environment　気象庁 Japan Meteorological Agency

このホームページは、黄砂の状況を広く国民の皆様へお知らせするために、環境省と気象庁が共同で情報を集めて提供するものです。

現在の状況 present observation

黄砂の観測

人（目視）による観測（気象庁）
気象台などで目視による観測を行っています。

ライダー装置による観測（環境省）
レーザー光線を利用した観測装置（ライダー）で地上から上空の黄砂飛来量を測定しています。
※「用語の解説」ライダーとは？

浮遊粉じん（黄砂を含む）の観測

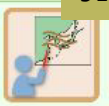
SPM観測（環境省）
国内の浮遊粉じんの観測結果です。リンク先の日本地図で見たい地域をクリックし、表示項目「浮遊粒子状物質」を選んでご覧下さい。

PM-10観測（韓国環境省/英語表記）
韓国環境省の浮遊粉じんの観測結果です。リンク先ページ中央上部の韓国の地図をクリックし、左側の「Particulate matter(PM-10)」を選んでご覧下さい。
※「用語の解説」SPMとは？　PM-10とは？

今後の見通し **forecast**

JMA

黄砂の予測（気象庁）
数値予測モデルで計算した黄砂予測図です。黄砂予測図の更新は毎日午前5時頃に行います。



黄砂に関する気象情報（気象庁）
日本の広範囲で黄砂を観測し、その状態が継続すると予測した場合に、「黄砂に関する気象情報」を発表します。「地方」「府県」を選んでご覧ください。

お問い合わせ先
環境省：〒100-8975　東京都千代田区霞が関1-2-2　中央合同庁舎5号館　代表電話：03-3581-3351　（内線）6547
気象庁：〒100-8122　東京都千代田区大手町1-3-4　代表電話：03-3212-8341　（内線）4162

このページについて
リンク先からこのページに戻るには、このページへのリンクを利用するか、ブラウザーの戻るボタンを利用してください。

著作権・リンク・利用上の注意について（免責事項）

For the next fiscal national budget:
MOE submitted about three million dollar
to develop a national AQ modeling system,
which is actual detail are not decided,
based on VENUS for regional scale?
and on JMA models for larger scale?

I don't know whether it works
but their positions are positive

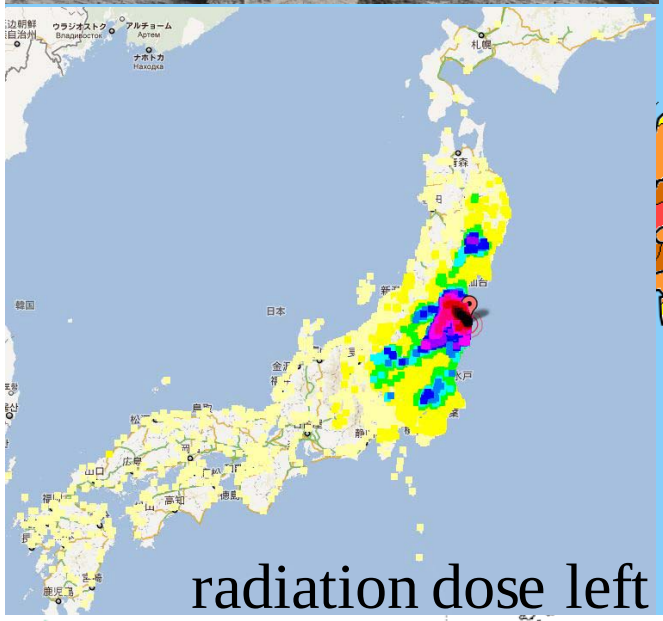
AQ forecast in Japan
will hopefully go to the next stage soon!?

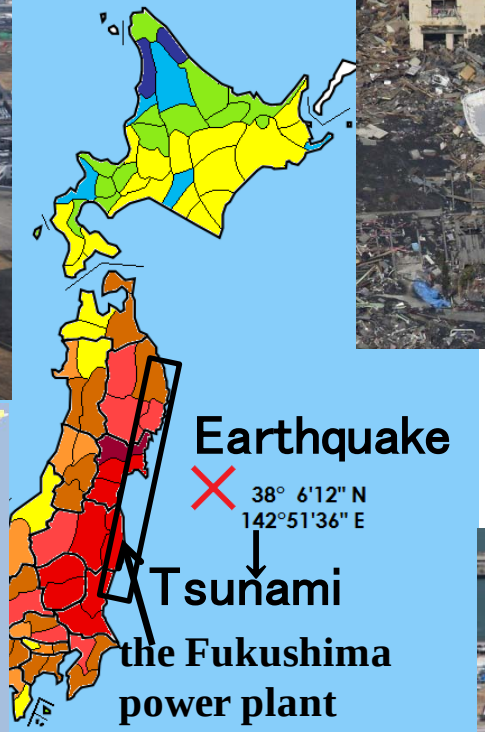
Part 2.
Response/Impact to
The Tohoku earthquake and tsunami
(March 11, 2011)

Part 2. The Tohoku earthquake and tsunami (March 11, 2011)

photos from
NY times, USA today, etc.

# of deaths=15840
missing= 3611
(official data on Nov.24)





My personal affairs related to the earthquake

Mar. 11 2:46 p.m.: The largest quake I ever experience, hard to stand a little

Cell phone didn't work at all (mobile e-mail worked, I realized later)

About 30 mins later: Went home. No one home.

Went to the elementary school to pick up my kids. Met my family

Damages: just many plates in the kitchen. No human injured including friends

At the night: electricity outage. Went to bed on 8 p.m. without knowing tsunami

For a few days: no water supply

With the news of the plant accident (about 100 mile apart):

let my kids go to school with flu mask. some of classmates evacuated.

About a week: almost no food and bottle water at stores

About two weeks: gasoline shortage=over 1 mile line of cars for gas stands

About 2 months: polluted tap-water

For several months, even now: hundreds of aftershocks

Newest publication says

meltdown at the plant occurred after 5 hours from the earthquake

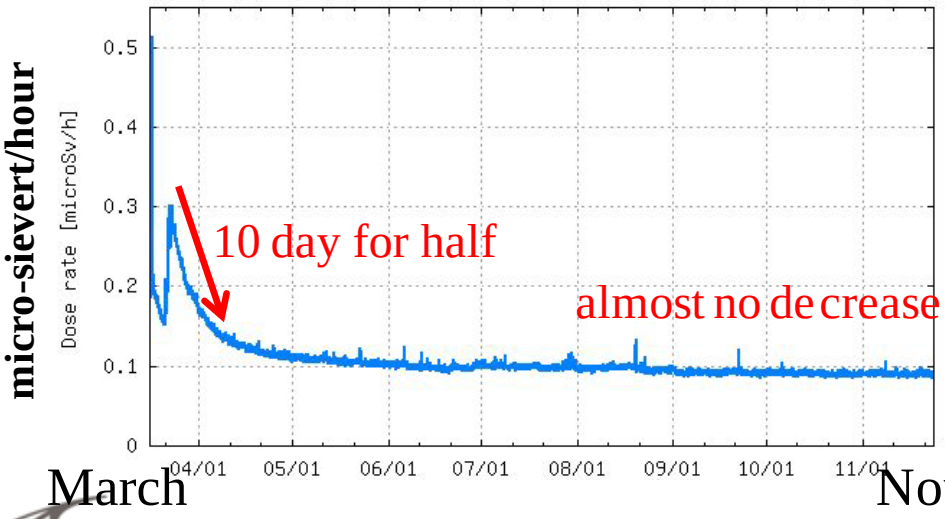
Total emitted radioactive material is

~ several hundreds of thousands tera-becquerel

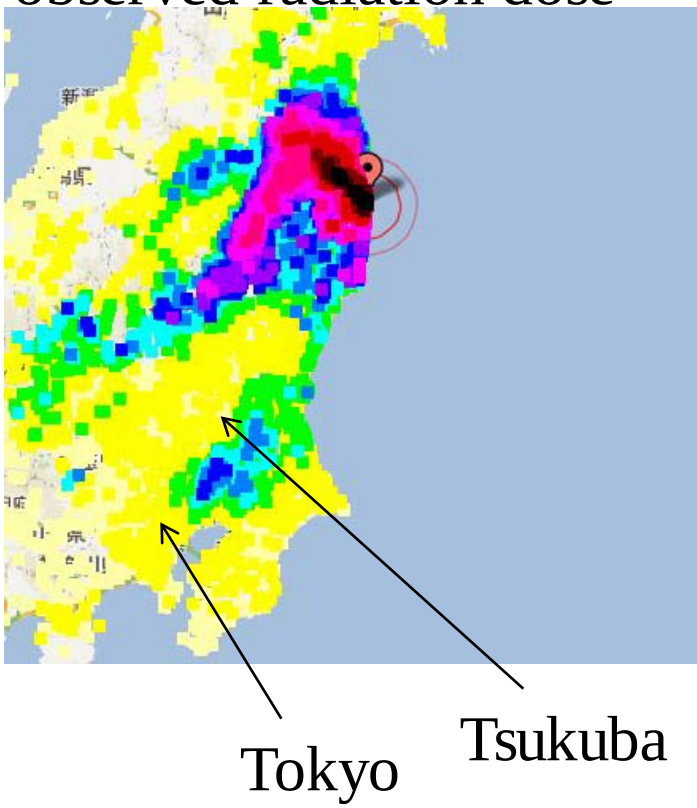
Bad materials in the larger emission order

Species	Half-life
I-131	8 day
Cs-134	2.1 year
Cs-137	30 year

hourly radiation dose in Tsukuba (including natural)



observed radiation dose



How much bad is radiation dose in Japan?

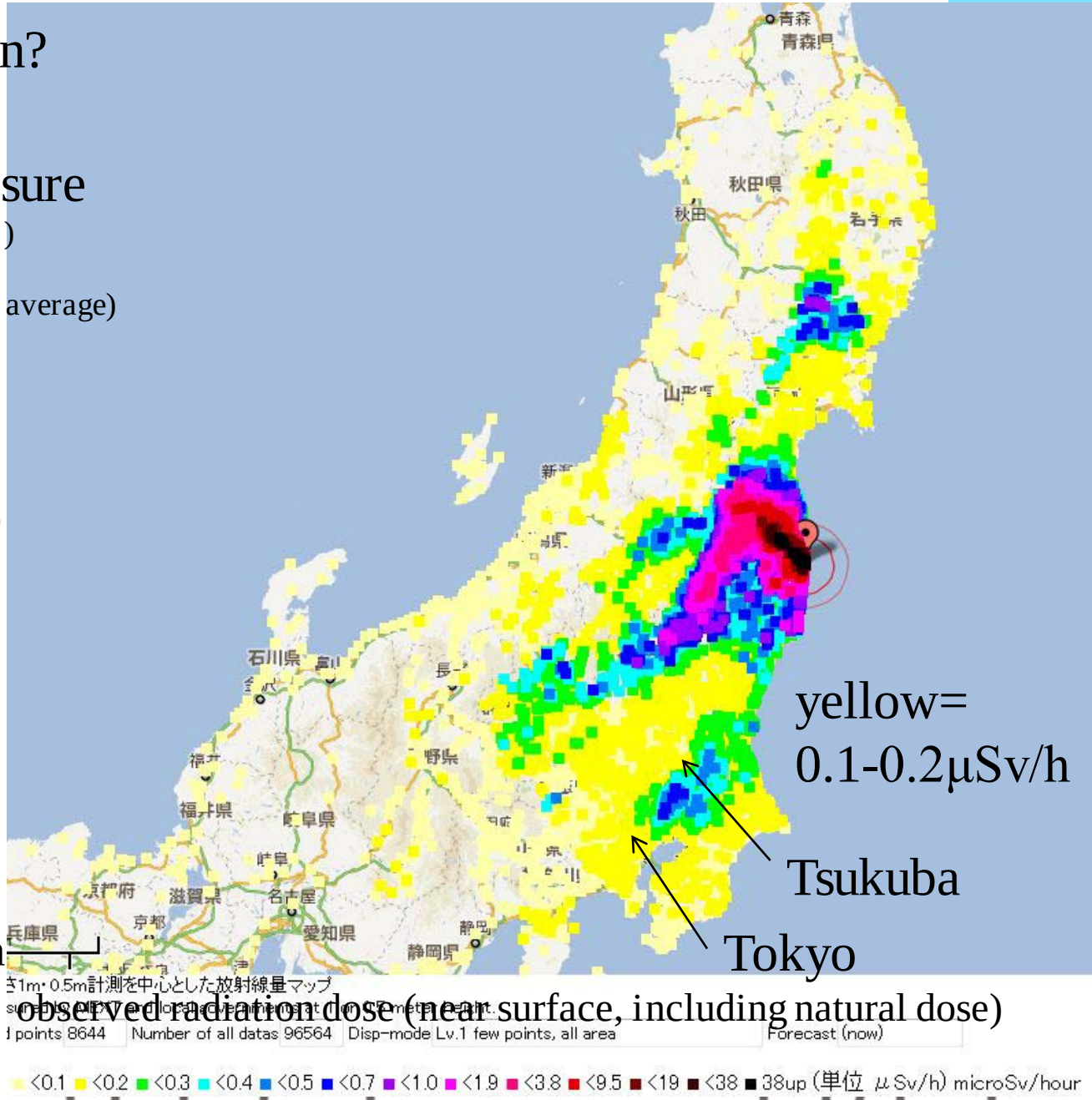
natural radiation exposure
(from space, earth, food, atmosphere)

～2400 μSv/year (world average)

US-EPA yearly limit on radiation exposure to a single member of the public
= 1000 μSv

yellow area
～300-1200 μSv

is almost no problem.
Just need to pay attention to internal exposure



observed radiation dose (near surface, including natural dose)

Present state and damage after the earthquake

From earthquake and tsunami damage: reestablishing

Fukushima power plant: manage to control
no longer large leakage toward atmosphere and ocean

Air and tap-water: Free of radioactive materials now

Soil: polluted by Cesium-134&137
only surface to 5cm depth (cesium tends to unite with clay)

→ food (animals and plants)
dry grass & pruned branch ⇒ garbage incinerators

Problems:

for public= Food safe

for regional government = Management of accumulated radioactive materials
Decontamination of soil etc.

for Japan = money for recovery, reconsideration of energy policy

for travelers = no problem at all unless you go to Fukushima

How was the distribution of the radiation dose in eastern Japan determined?

I'd like to introduce one study by my colleagues.

GEOPHYSICAL RESEARCH LETTERS, VOL. 38, L00G11, doi:10.1029/2011GL048689, 2011

Atmospheric behavior, deposition, and budget of radioactive materials from the Fukushima Daiichi nuclear power plant in March 2011

Yu Morino,[1] Toshimasa Ohara,[1] and Masato Nishizawa[1]

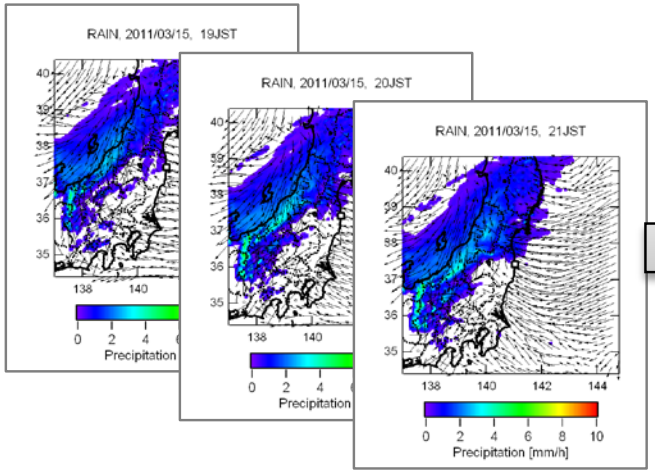
Received 27 June 2011; revised 2 August 2011; accepted 11 August 2011; published 15 September 2011.

[1] To understand the atmospheric behavior of radioactive materials emitted from the Fukushima Daiichi nuclear power plant after the nuclear accident that accompanied the great Tohoku earthquake and tsunami on 11 March 2011, we

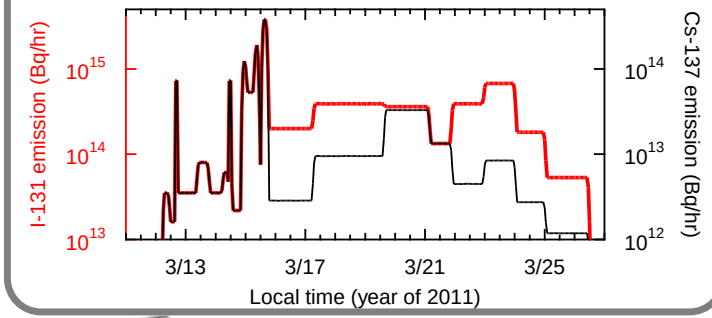
many numerical simulations were conducted after the Chernobyl nuclear accident in 1986 [*Albergel et al.*, 1988; *Hass et al.*, 1990; *Wheeler*, 1988], and these simulations helped to clarify the atmospheric behavior of the radioactive

Methodology

Meteorological model (WRF)

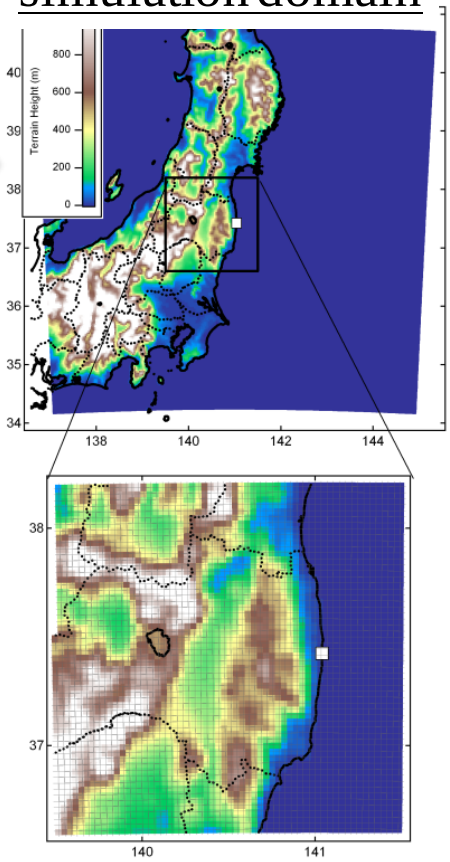


Emission of I-131, Cs-137 (hourly, by JAEA)

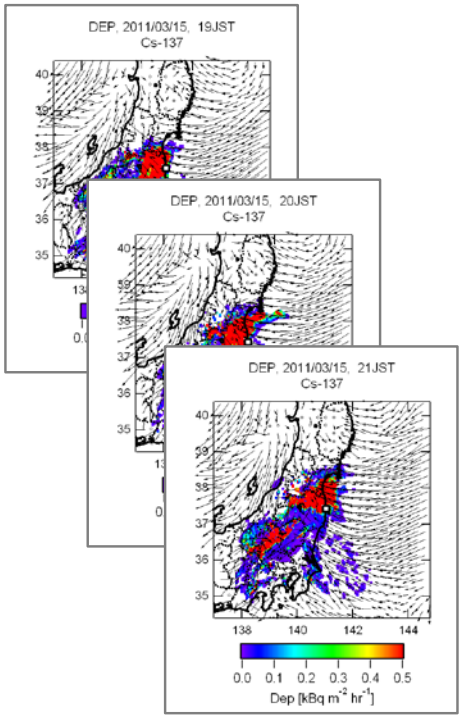


Chemical transport model (CMAQ)
emission, transport, deposition calculation

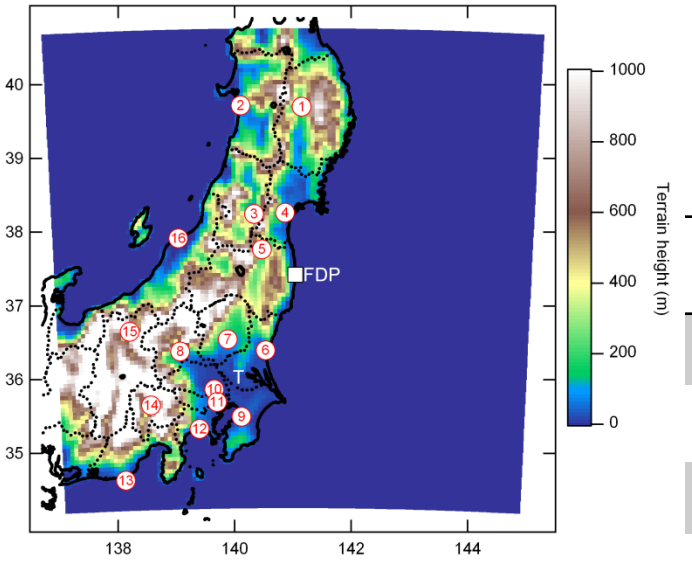
simulation domain



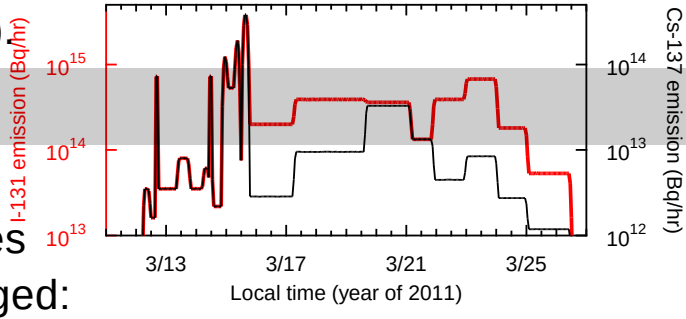
Results I-131,Cs-137 concentration,deposition



Model settings (1/2)



Meteorological model	WRF v3.1 (JMA, MSM)
Chemical transport model	CMAQ v4.6
Domain settings	237 x 237 x 34 grids ⇒
horizontal resolution	3 km
Target species	I-131 and Cs-137 (parameters are given in the next slide)
Emissions	Updated version of Chino et al. (2011): (Nagai, personal communication, 2011, Figure ⇒).
Period	10-30 March 2011
Configuration in CMAQ	✓Tracer calculation (TRC). ✓No chemical/aerosol processes ✓Programs in Table 2 are changed: ✓Process Analysis was used for the budget analysis.



 # Emission data and Horizaontal resolution are updated from Morino et al. (GRL, 2011).

Model settings (2/2)

	I-131	**Cs-137**
Radioactive decay	8.02 days	—
Gas-particle ratio	0.8:0.2	All particles
Particulate diameters	1 μm	
Dry deposition	Same as "SO_2" for gas	—

Evaluation by comparing with observation

1. MEXT aircraft monitoring

MEXT=Ministry of Education, Culture, Sports, Science and Technology

(May-Oct. 2011 in eastern Japan)

→evaluation of Cs-137 deposition distribution

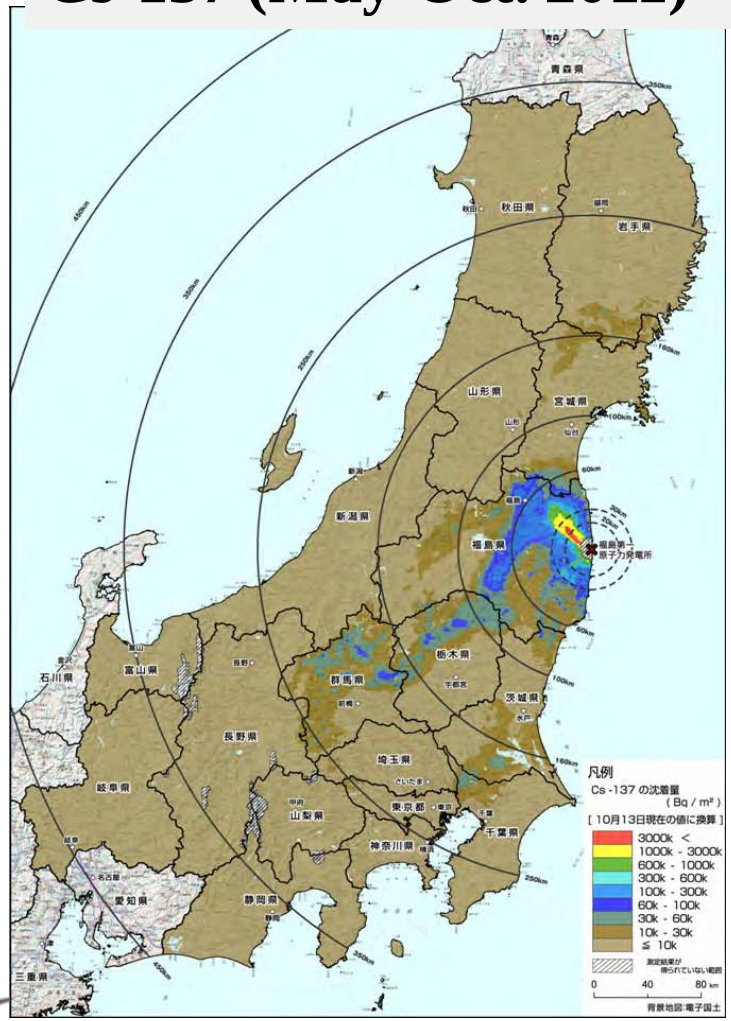
2. MEXT scheduled deposition monitoring

(since Mar. 18、one place in each prefecture, every 24 hour sampling)

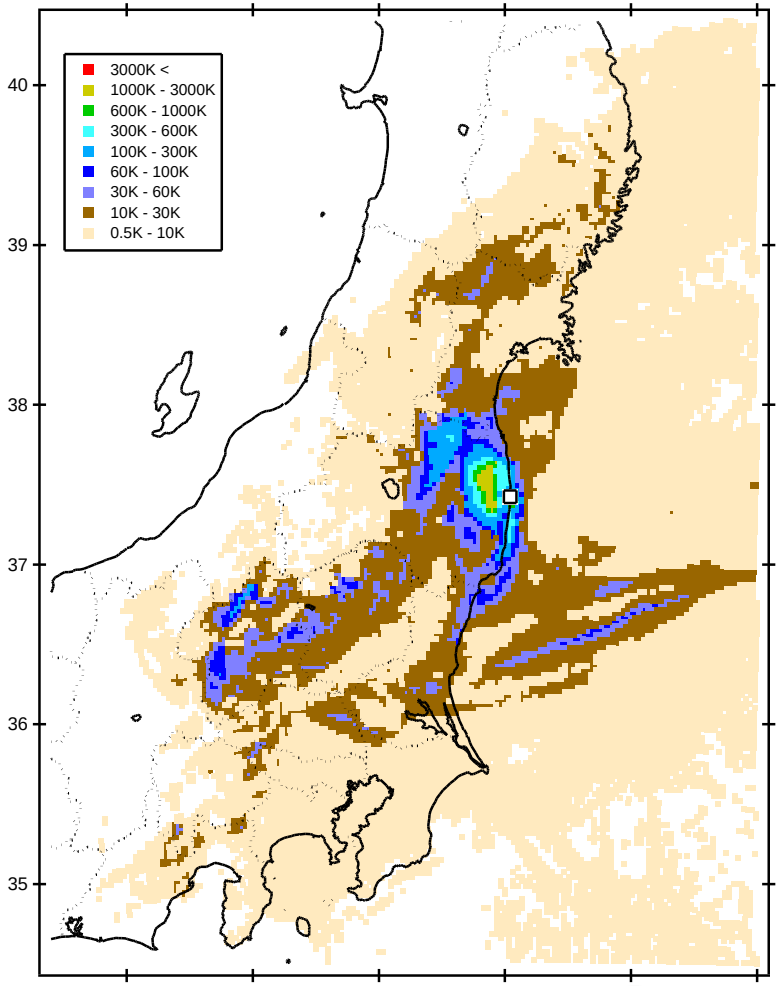
→evaluation of I-131 & Cs-137 deposition temporal variation

Aircraft monitoring —evaluation of horizontal distribution

Observed deposition of Cs-137 (May-Oct. 2011)



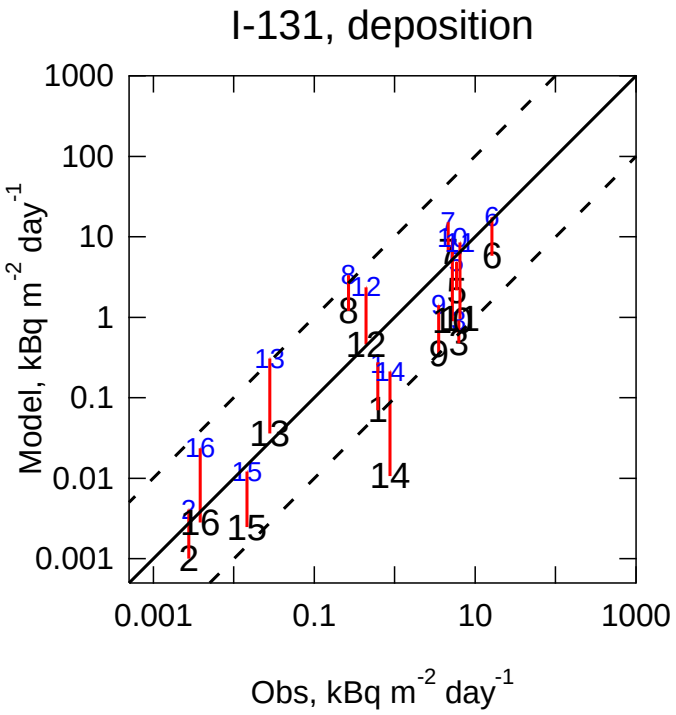
Simulated deposition of Cs-137 (-Mar. 30, 2011)

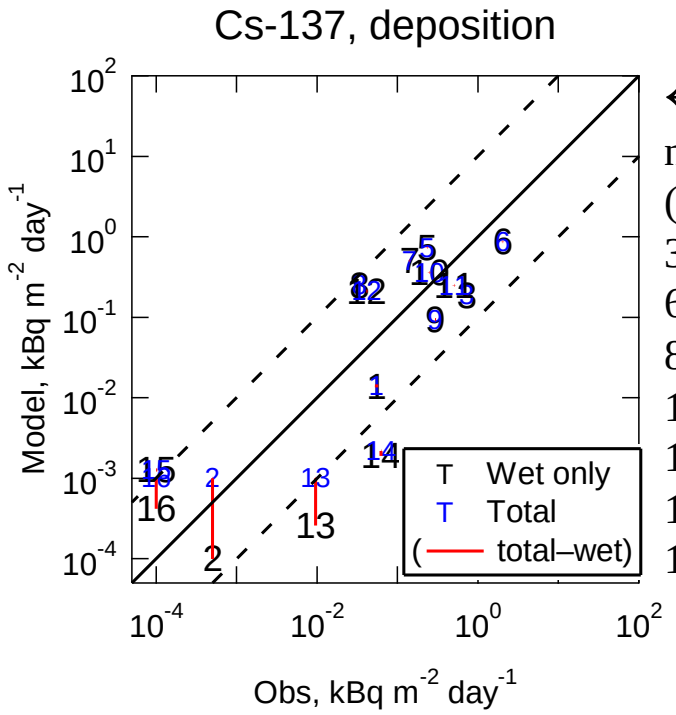


Evaluation of reproducibility of deposition

MEXT scheduled deposition monitoring

↓

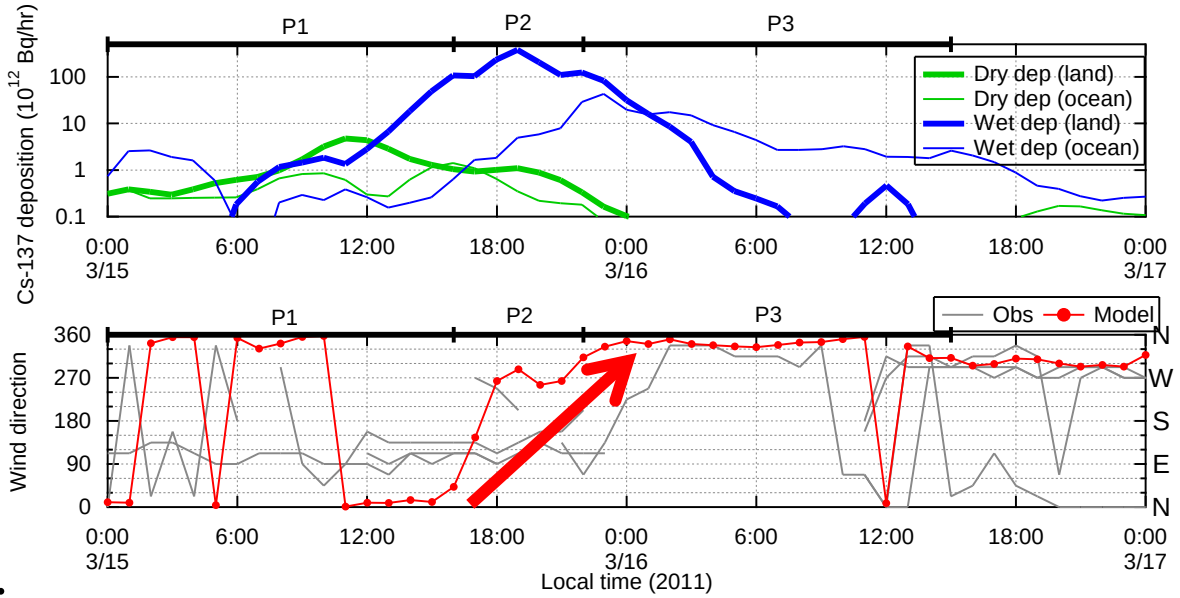




←For Mar. 18-29
numbers are prefecture names
(1, Iwate; 2, Akita;
3, Yamagata; 5, Miyagi;
6, Ibaraki; 7, Tochigi;
8, Gunma; 9, Chiba;
10, Saitama; 11, Tokyo;
12, Kanagawa; 13, Shizuoka;
14, Yamanashi; 15, Nagano;
16, Niigata)

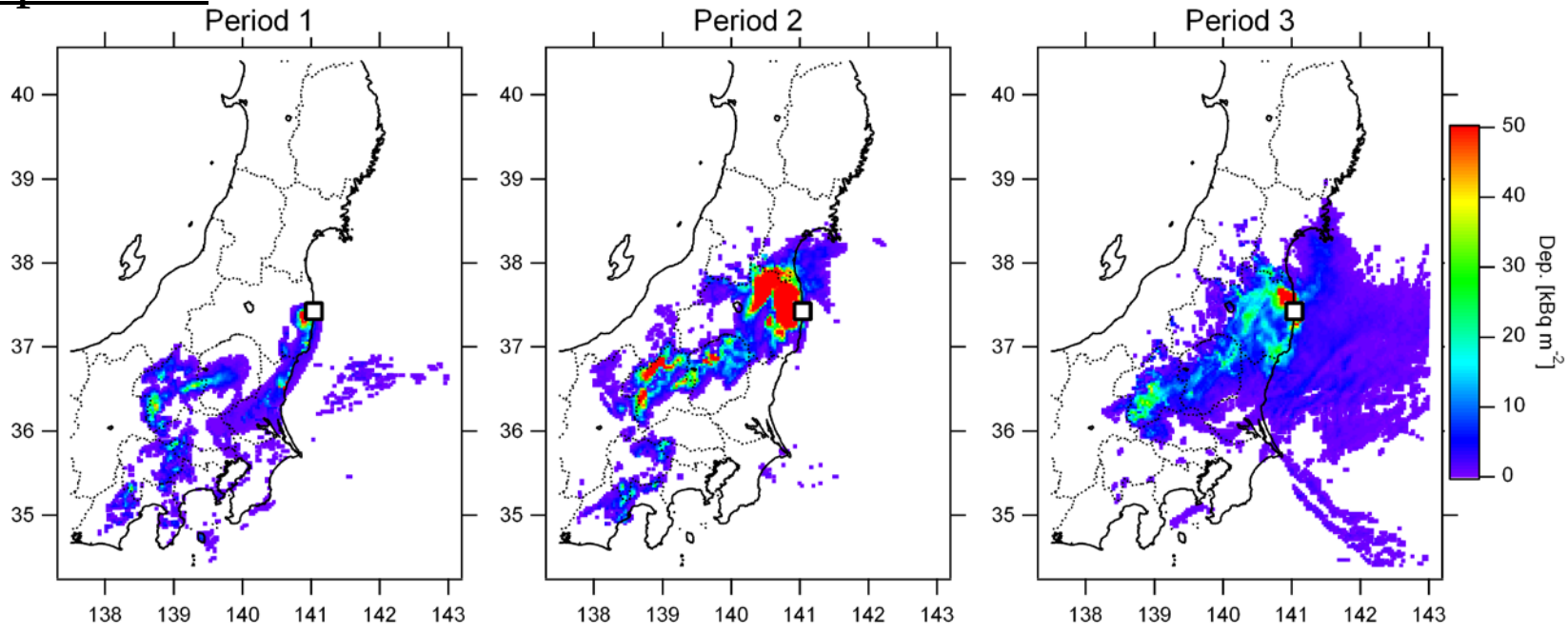
Event analysis① －March 15-16

Cs-137Deposition (all domain)



Wind direction (Fukushima)

Cs-137 deposition

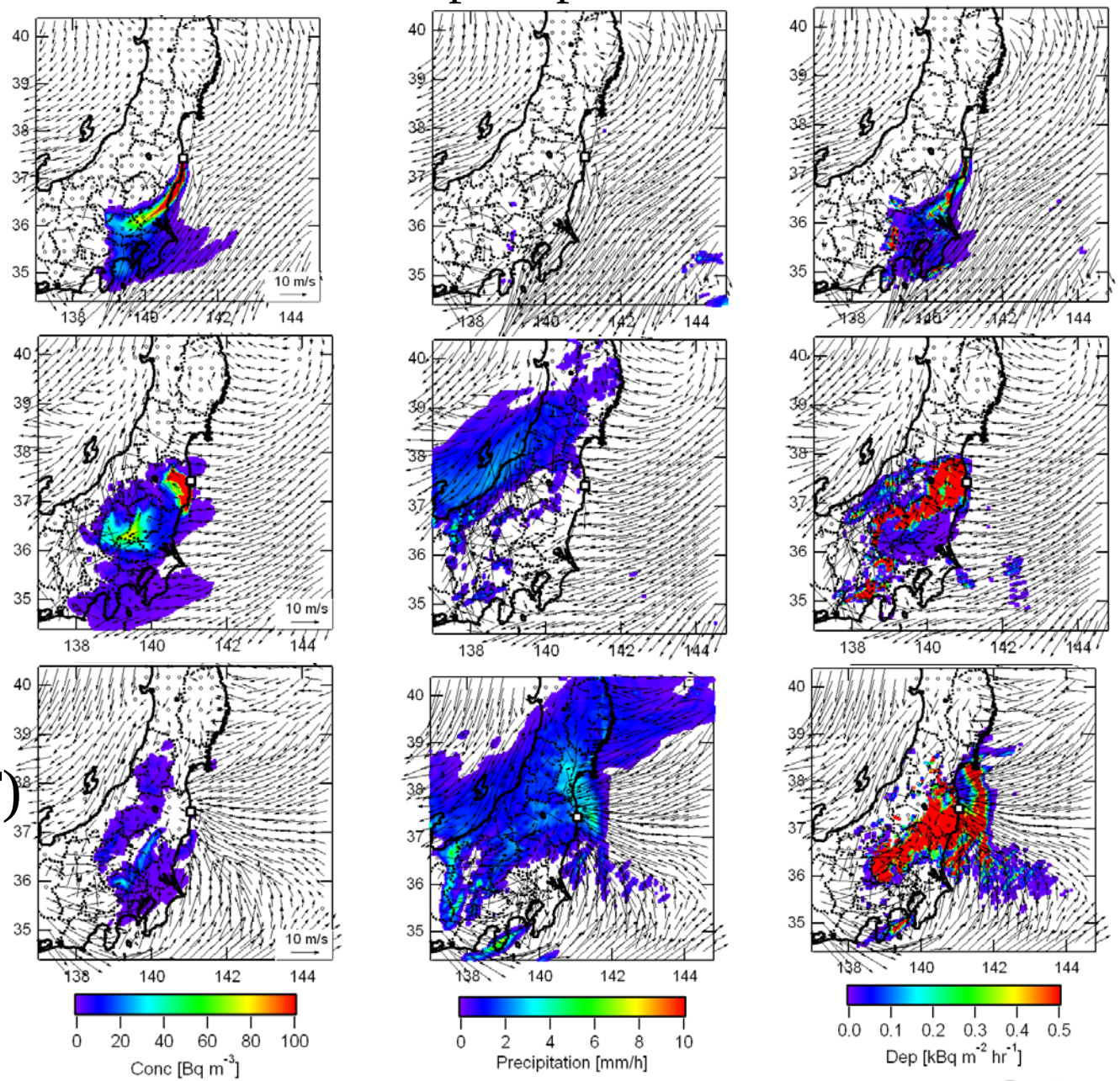


Cs-137conc. surface precipitation Cs-137 deposition

Mar. 15
9a.m.(LT)

Mar.15
6p.m. (LT)

Mar.15
12p.m. (LT)



I brought their poster presentation here, so you can see it in the poster session.

Thank you for your attention