Operation Tomodachi
DOE Response to the Japan Earthquake

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DOE CM – Laboratory Analysis Working Group

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Overview of the Event

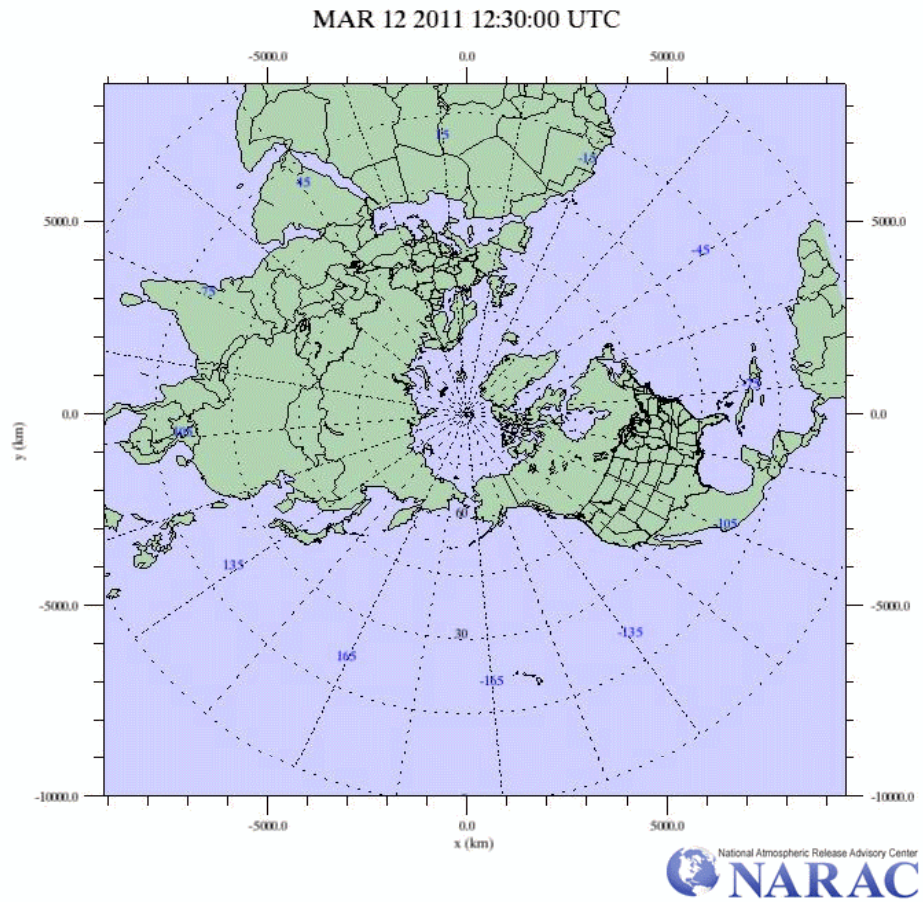
DOE/NNSA Response

- **March 11, 2011**
  - Nuclear Incidence Response Team **(NIT)** is stood up and begins 24/7 operations.
  - DOE/NNSA provides Consequence Management expertise for the U.S. Agency for International Development (U.S. AID) Disaster Assistance Response Team **(DART)** in Tokyo.
  - National Atmospheric Release Advisory Center **(NARAC)** is stood up to provide atmospheric modeling projections.
  - The Consequence Management Home Team **(CMHT)** is stood up to support data collection and analysis efforts.
  - The Radiation Emergency Assistance Center/Training Site **(REAC/TS)** in Oak Ridge, TN is stood up to provide medical advice and assistance.
  - The NNSA Administrator directs NNSA to offer assistance of NA-42 Aerial Measurements System **(AMS)** assets to the Government of Japan, U.S. Military, and the U.S. Embassy.
- **March 14, 2011**
  - Decision to deploy a Consequence Management Response Team **(CMRT)** directly to Japan.
- **Mission**
  - Monitor U.S. Bases and Consulate in Japan to ensure the safety of U.S. Citizens.

First Full Day of Operation

NARAC Provided Predictions of Possible Impacts on Japan and US Territories

- NARAC estimated arrival times and radiation dose for selected locations in the US using:
  - NOAA GFS model meteorological forecasts
  - NRC source term analyses
  - DOE Consequence Management Home Team (CMHT) dose conversion analyses
- Predictions consistent with detected plume arrival times and low levels of radiation



Particle animation of hypothetical unit release rate illustrates complexity of trans-Pacific dispersion

An Abundance of Data

- Ministry of Education, Culture, Sports, Science and Technology (MEXT)
  - Drinking Water by Prefecture
  - Monitoring Post out of 20 Km Zone of Fukushima Dai-ichi NPP
  - Environmental Radioactivity Level by Prefecture
  - Monitoring Data at Ibaraki Prefecture
- System for Prediction of Environmental Emergency Dose Information (SPEEDI)
- Tokyo Electric Power Company (TEPCO)
- US Forces Japan (USFJ) and other U.S. Military in Japan
- DOE Consequence Management Response Team (CMRT)
- Over 550,000 records in RAMS database as of September 30, 2011

Not Always Usable

福島第一（1F） 正門付近前（MP-6付近）（2号機より西南西約1．0キロ）

3月16日													
モニタリングカー	5:00	5:30	6:00	6:30	6:40	6:50	7:00	7:10	7:20	7:30	7:40	7:50	8:00
測定値(μSv/h)	918.2	868.0	884.0	848.0	837.0	815.0	808.8	670.3	661.8	651.1	644.0	636.8	627.5
中性子	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
風向	北西	北北西	北西	西	西北西	西北西	北西	北西	北西	北西	西	西	北北西
風速(m/s)	2.9	2.6	2.0	1.4	1.4	1.4	1.4	1.4	1.2	1.3	1.2	1.2	1.2

3月16日													
モニタリングカー	9:40	9:50	10:00	10:10	10:20	10:30	10:45	10:54	10:55	11:00	11:10	11:20	11:30
測定値(μSv/h)	641.8	700.6	810.3	988.5	2399.0	1361.0	6400.0	2300.0	2900.0	9391.0	2720.0	1900.0	5350.0
中性子	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
風向	西	北北西	東北東	北東	東北東	東	東北東	北東	－	北東	北北東	東北東	北東
風速(m/s)	1.6	1.5	1.8	1.5	1.4	2.2	4.9	－	－	2.0	1.9	2.3	1.6

3月16日													
モニタリングカー	13:10	13:20	13:30	13:40	13:50	14:00	14:10	14:20	14:30	14:40	14:50	15:00	15:10
測定値(μSv/h)	2536.0	2430.0	2331.0	2257.0	2182.0	2122.0	2059.0	2022.0	1937.0	1888.0	1835.0	1788.0	1752.0
中性子	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
風向	西南西	西南西	北	北西	北西	東北東	南南西	南南西	西	西北西	西南西	北西	北西
風速(m/s)	1.0	1.2	2.4	2.7	2.1	1.7	1.9	2.3	2.1	2.1	3.1	2.3	3.4

福島第一（1F） 体育館付近（MP－5東側）（2号機より西北西約0．9キロ） ※消防活動の支障になるため移動

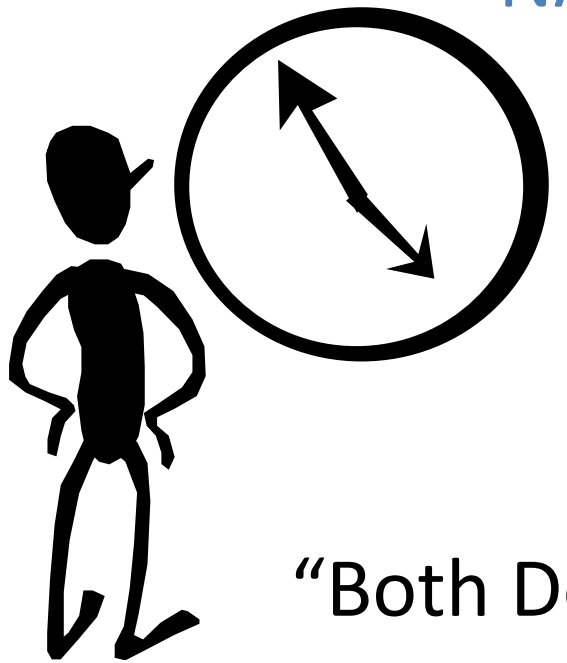
3月16日										
モニタリングカー	17:03	17:10	17:20	17:30	17:40	17:50	18:00	18:10	18:20	18:30
測定値(μSv/h)	752.0	749.3	745.6	741.3	738.2	735.0	731.0	728.0	725.9	723.3
中性子	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
風向	－	北	北西	西北西	北北西	北北西	西北西	北西	西	北西
風速(m/s)	－	3.6	3.5	3.5	4.0	4.0	4.3	3.9	3.6	3.6

Does Anyone Know What Time It Is?

"One Laptop is set for JST and the other is set for PDT!"

UTC = PDT + 7 hrs

NARAC uses UTC



UTC = JST – 9 hrs

RAMS is in PDT

PDT = JST – 16 hrs

"Both Detectives are set to JST*!*"

Review of In Situ Gamma Spectra

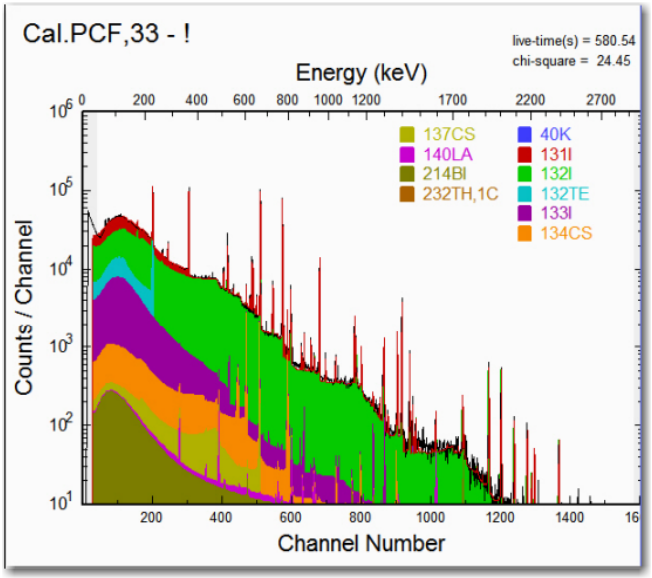
3/16 3/23 3/24 3/25 3/26 3/27 3/28 3/29 3/30 4/1

First Full Day of Operations

Data from Japan

Triage Review of In Situ Gamma Spectra and Field Spectra

- Triage Role
  - Ensure accurate identification of radionuclides
  - Quantify radionuclides
  - Resolve background and calibration issues
  - Perform QC review of laboratory gamma spectroscopy results
- Other activities
  - Provide input on sample analyses plans



Analytical Requirements

3/16 3/23 3/24 3/25 3/26 3/27 3/28 3/29 3/30 4/1

First Full Day of Operations

Data from Japan

Triage Review of In-situ Gamma Spectra

Decision to ship samples from Japan

Development of Analysis Requirements

Measurement Quality Objectives (MQOs) What's the Question?

- Are there areas where the population should be evacuated?
- Is it safe to plant and harvest a rice crop?
- Do we need to monitor milk from reindeer in Alaska?
- What are the major dose contributing radionuclides?
- Did the reactors undergo meltdown?

- What are the levels of radioactive materials present?
- What is the ratio of Cesium to Iodine?
- What is the ratio of Cesium to Strontium?
- Are actinides present?

Measurement Quality Objectives

Gross Analyses		Air	Soil
Gross Alpha		Standard Count times	Standard Count times
Gross Beta		Standard Count times	Standard Count times

Sr-89/90 Analyses		Air		Soil
Nuclide	$T_{1/2}$	uCi/mL	pCi/Sample (500 cu.ft.)	pCi/g
Sr-89	50.53 d	8.80E-12	125	3.5
Sr-90	28.79 y	5.40E-12	76	2.1

Gamma Analyses		Air		Soil
Nuclide	$T_{1/2}$	uCi/mL	pCi/Sample (500 cu.ft.)	pCi/g
Cs-137/Ba-137m	30.08 y	3.50E-10	4955	22
Ba-140/La-140	12.75/1.68 d	8.80E-12	125	2.4
Cs-134	2.065 y	3.10E-10	4389	34
Ce-144	284.9 d	1.60E-12	23	0.6
Te-132/I-132	3.20 d/2.29 h	2.00E-12	28	0.3
I-131	8.02 d	3.10E-12	44	4.2
Te-129/Te-129m	33.6 d/69.6 m	1.60E-12	23	0.4
Cs-136	13.16 d	3.50E-13	5	0.14
Xe-133	5.24 d	----	----	----
Np-239	2.36 d	----	----	----
Mo-99/Tc-99m	65.98/6.01 h	----	----	----

Preliminary Laboratory Capability Summary

			Gamma Spectroscopy			Strontium					
Lab POC	**Sample Type**	**Activity Limit (max activity acceptable)**	**# of Detectors**	**TAT**	**Capacity**	**Total Sr**	**Sr-90**	**Sr-89**	**Method**	**TAT**	**Capacity**
Laboratory A Contact Name Phone Number email (Contractor for)	Air Filters	**Alpha** - < 2 mCi/Sample **Beta** - < 100 mCi/Sample		2-days		Yes	Yes	Yes	Ppt, Sr-spec, proportional counting Chernenkov (50 pCi/sample)	**Air Filters** – Ppt, proportional counting 7 - 10 days, **Cherenkov** - 2 days, 50 pCi/sample detection limit	20/day
	Soils									**Soil** –Ppt, proportional counting 12 – 14 days **Chernekov** - 9-12 days	
Laboratory B Contact Name Phone Number email (Contractor for)	Air Filters	400 mR/hr @ surface		2 days	100/day	Yes	Yes	Yes	**Total Sr, Sr-89/90 -** Ppt, Sr-spec, proportional counting **Sr-90** - hdehp	5 days	50/day
	Soils			2 days	50/day					6 days	50/day
Laboratory C Contact Name Phone Number email (Contractor for)	Air Filters	**Alpha** < 50,000 pCi/g **Beta** < 100,000 pCi/g	6 detectors (10 total)	1 to 2-days		Yes	Yes	Yes	Sr-Spec	**Total Sr** - 4-5 days **Sr-89/90** – 18 to 20 days	20/day
	Soils	**Alpha** < 75,500 pCi/L **Beta** < 125,000 pCi/L	10 detectors (10 Total)	3-4 days						**Total Sr** - 4-5 days **Sr-89/90** – 18 to 20 days	

First Samples Received

3/16 3/23 3/24 3/25 3/26 3/27 3/28 3/29 3/30 4/1

First Full Day of Operations

Data from Japan

Triage Review of In-situ Gamma Spectra

Decision to ship samples from Japan

Development of Analysis Requirements

Preliminary List of Lab Capabilities

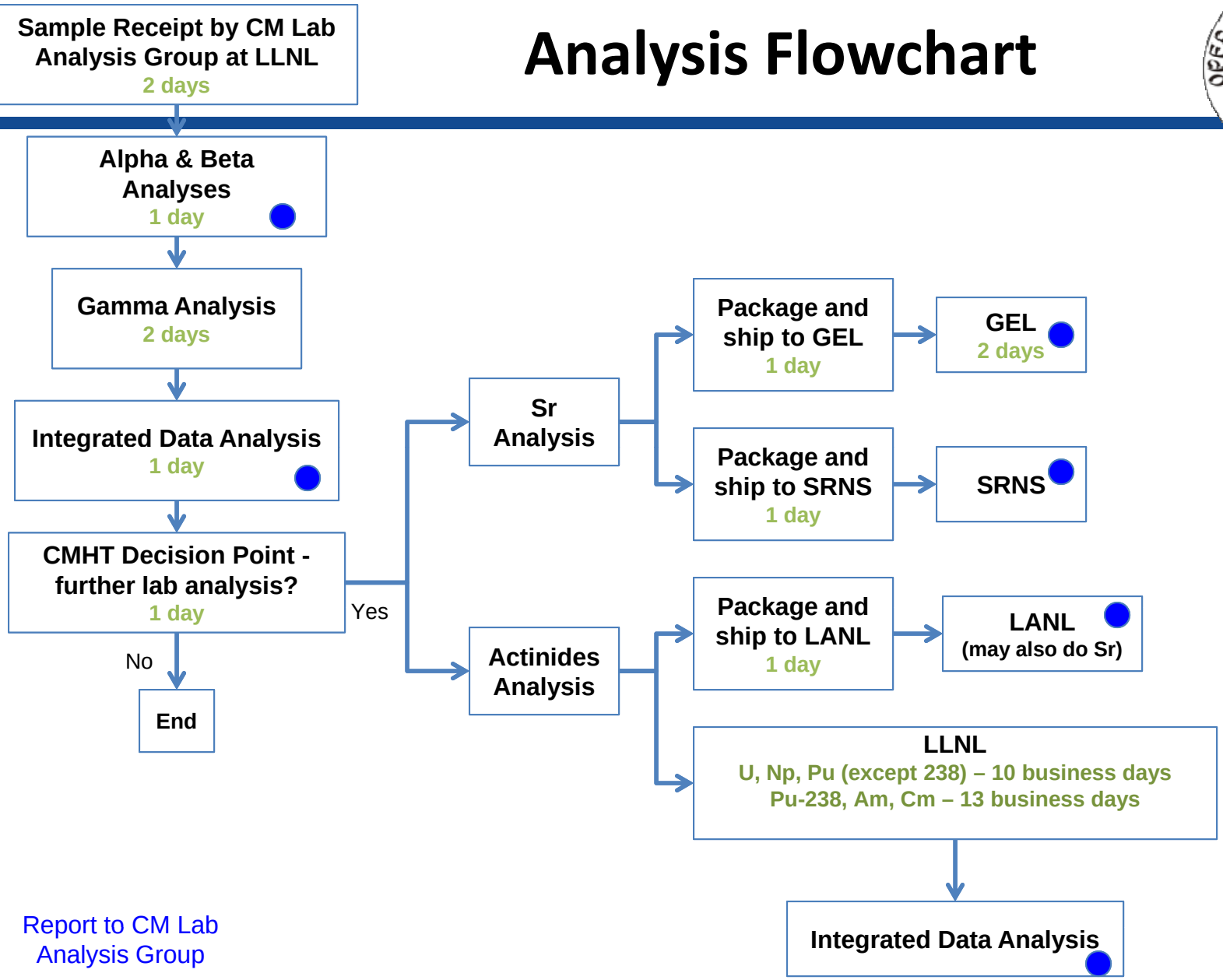
First samples received

FedEx Shipping Routes

"There will be no new samples today.

Our FedEx package got Shanghai'd, literally, the package is in Shanghai, China. ☺"

Analysis Flowchart



Report to CM Lab Analysis Group

Juggling Act

4/1 4/2 4/3 4/4 4/5 4/6 4/7 4/8 4/9 4/10 4/11 4/12

CMRT continues to monitor and collect samples

Mining data from Japan continues

Lab Analysis continues to work with Triage to resolve In Situ gamma spec analyses

Second batch of air samples shipped from Japan (Rec'd at LLNL on 4/6)

On-going work to finalize analytical requirements

Analytical Laboratories selected; funding mechanisms put in place

Samples shipped to LANL

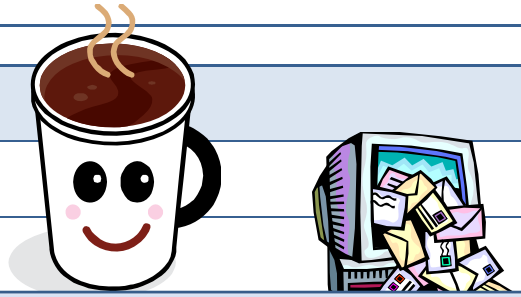
First samples shipped to commercial lab

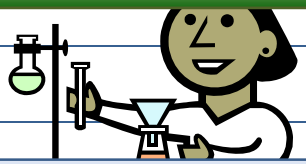
Soil samples received at SRNS
Third batch of Air Filters received at LLNL

4/13

Daily Conference Call/Meeting Schedule

PST	JST	
6:00 AM	10:00 PM	
7:00 AM	11:00 PM	
8:00 AM	12:00 AM	
9:00 AM	1:00 AM	CMHT/Bridgeline Conference Call
10:00 AM	2:00 AM	LLNL LA Conference Call
11:00 AM	3:00 AM	CM/LA Conference Call
12:00 PM	4:00 AM	
1:00 PM	5:00 AM	
2:00 PM	6:00 AM	CMHT/NIT VTC
3:00 PM	7:00 AM	LLNL LA Meeting
4:00 PM	8:00 AM	SitRep Report Due
5:00 PM	9:00 AM	Field Team Conference Call





PST	JST	
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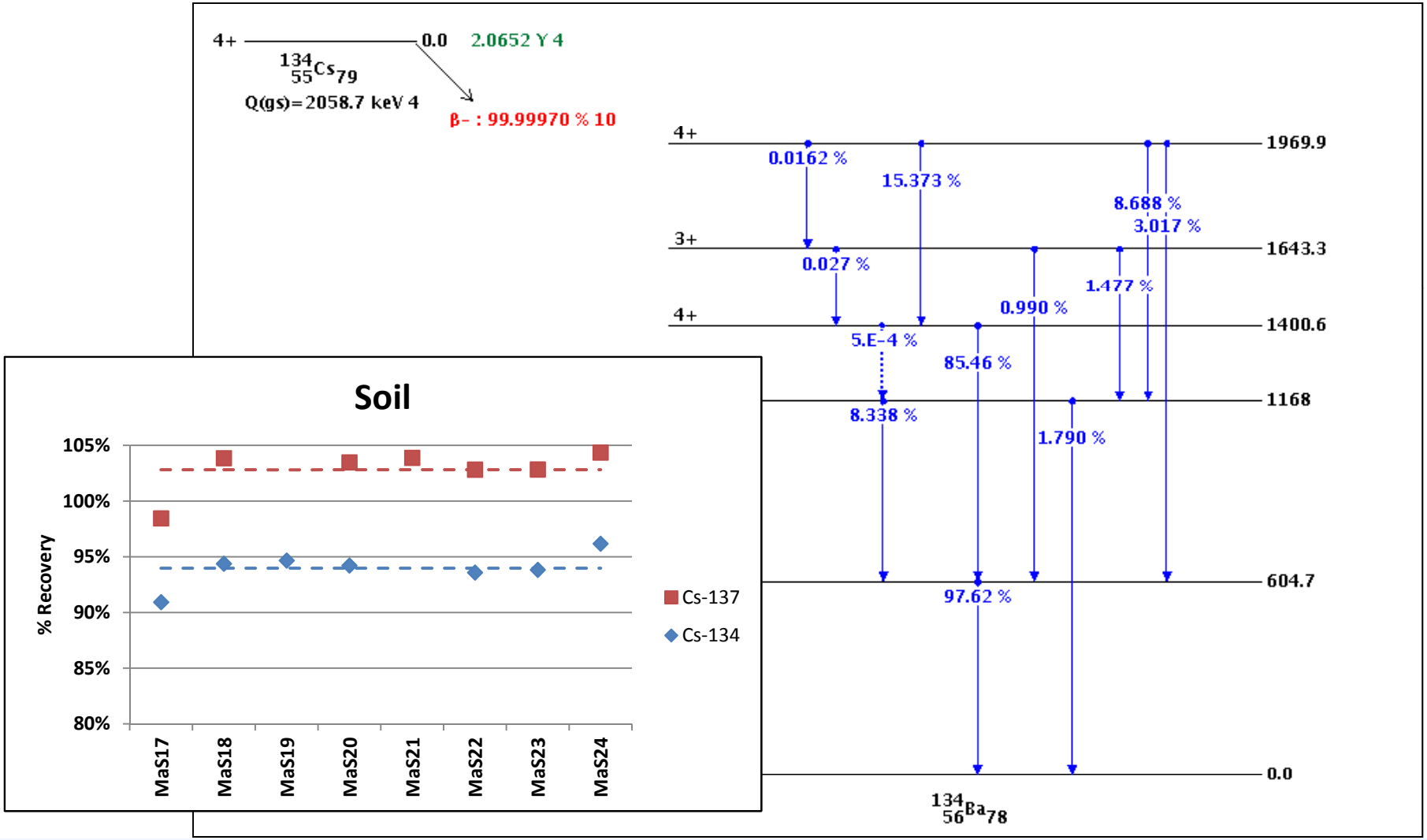
7:00 PM	11:00 AM	
8:00 PM	12:00 PM	CMHT/Bridgeline Conference Call
9:00 PM	1:00 PM	
10:00 PM	2:00 PM	
11:00 PM	3:00 PM	
12:00 AM	4:00 PM	
1:00 AM	5:00 PM	
2:00 AM	6:00 PM	
3:00 AM	7:00 PM	
4:00 AM	8:00 PM	
5:00 AM	9:00 PM	Field Team Conference Call

Not Everything Went Smoothly

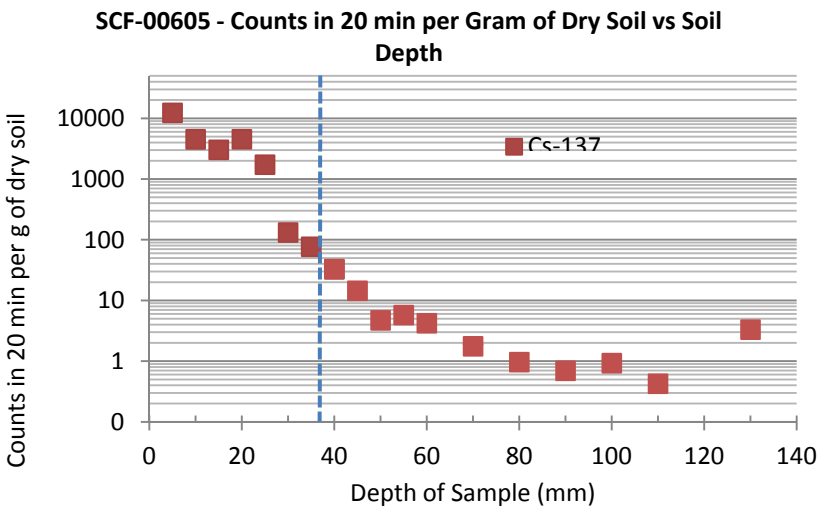
- Sample data in RAMS did not always match sample data on Sample Control Forms
- Pressure to get samples sent to laboratories for analyses
- Permits required for importation of foreign soils
- Acceptance limits for radiological material
- Shipping issues
- Coincidence Summing

Just a Coincidence?



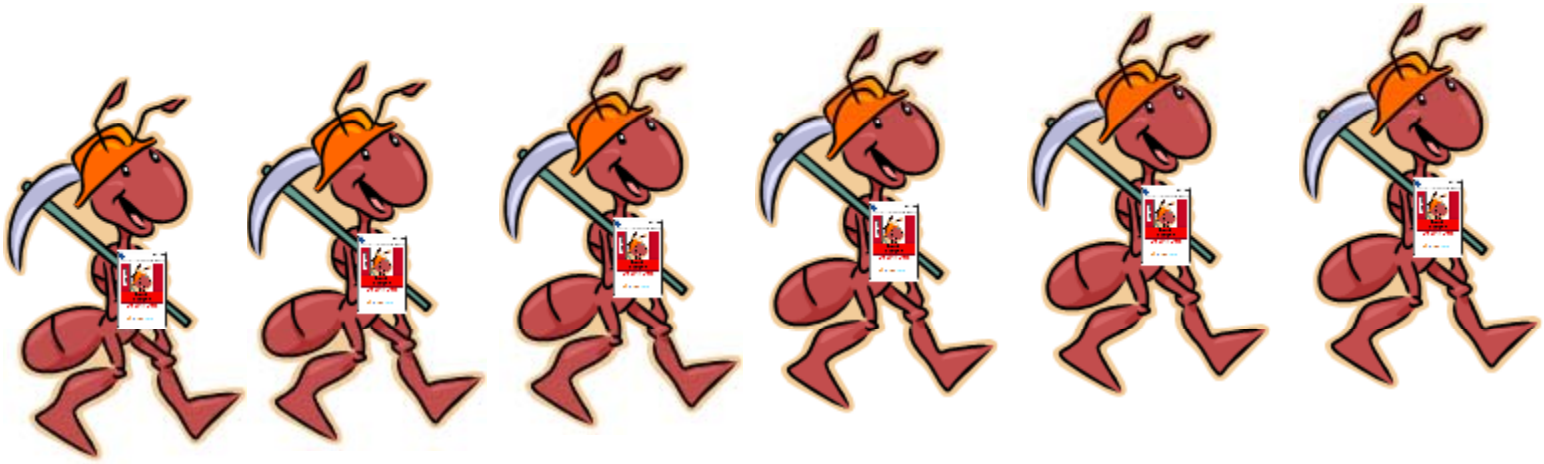
Soil – Depth Profile Studies

- Weathering and migration of radionuclides in soil could affect dose calculations
- Six soil cores collected in area with higher meter readings observed
- Cores were sub-sectioned into 20 to 26 sub-sections
- Gamma analyses for Cs-134 and Cs-137



Courtesy CMRT

Red-badged Ants



Successes

- No injuries
- Coordinated a multi-laboratory response
- Laboratories met requested MQOs and Turn-around times
- RAMS used for the first time for real-world samples
- First time Triage involved in this type of event
- 734 samples analyzed
  - 593 Air Filter Samples
  - 4 Swipe Samples
  - 131 Soils
  - 6 Soil Cores
- Gross Beta, Gamma Spec, Sr-89,90, Total Sr, Plutonium, Uranium, Americium/Curium

Lessons Learned

Quality Control	• Quality control needs to start with sample collection.
DQOs/MQOs	• DQOs/MQOs need to be clear prior to collecting and sending samples to laboratories for analyses.
Surge Capacity	• Laboratories need to have sufficient surge capacity to sustain 24/7 operations for long periods of time.
Safety Basis	• Laboratories should review their safety basis documentation and ensure they can handle samples during an emergency.
Procedures	• Laboratories will likely need to modify routine procedures to handle samples from these types of events.
Data Validation	• Appropriate QC samples need to be available to validate analytical results.
Funding	• A funding mechanism is needed to support laboratories performing analyses.

In a Perfect World

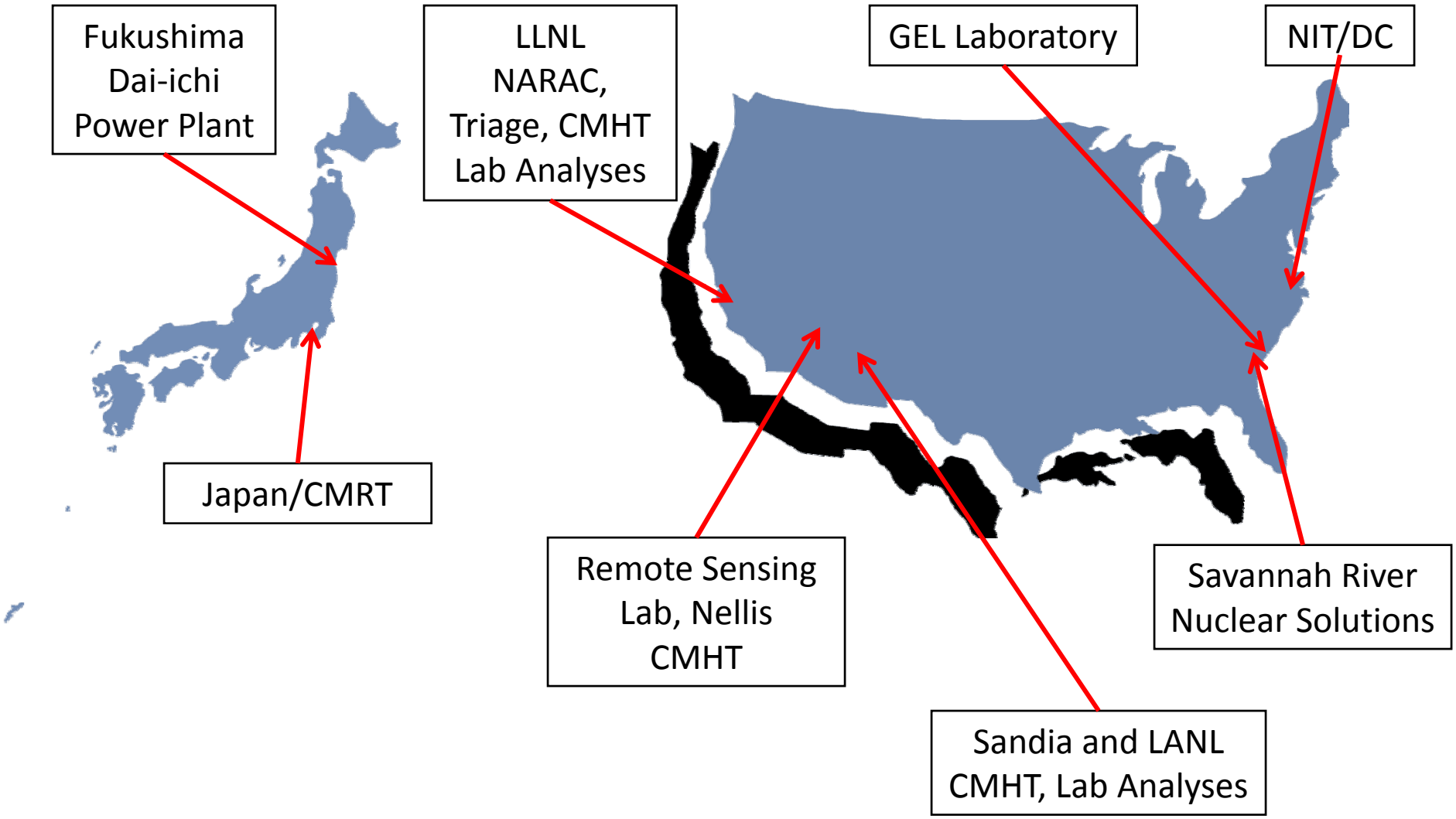
There would be…

- Predefined DQOs/MQOs
- Performance testing programs
- Network of pre-qualified laboratories
- Laboratories capability exercises

Is Your Laboratory Prepared?

- Integrated Consortium of Laboratory Networks (ICLN) www.icln.org
  - Search www.aphl.org for "Limiting Issues"
- U.S. EPA – Environmental Response Laboratory Network (ERLN), Radiation Focus Area
  - http://www.epa.gov/oemerln1/radiation.html
- Food Emergency Response Network (FERN)
  - http://www.fernlab.org
- Centers For Disease Control (CDC)
  - http://emergency.cdc.gov/radiation
- National Analytical Management Program (NAMP)
  - Search on program name
- Federal Radiological Monitoring & Assessment Center (FRMAC)
  - Search on FRMAC
  - https://cmweb.llnl.gov

Multi-Site Response



Acknowledgements

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- Sonoya Shanks

DOE/NNSA

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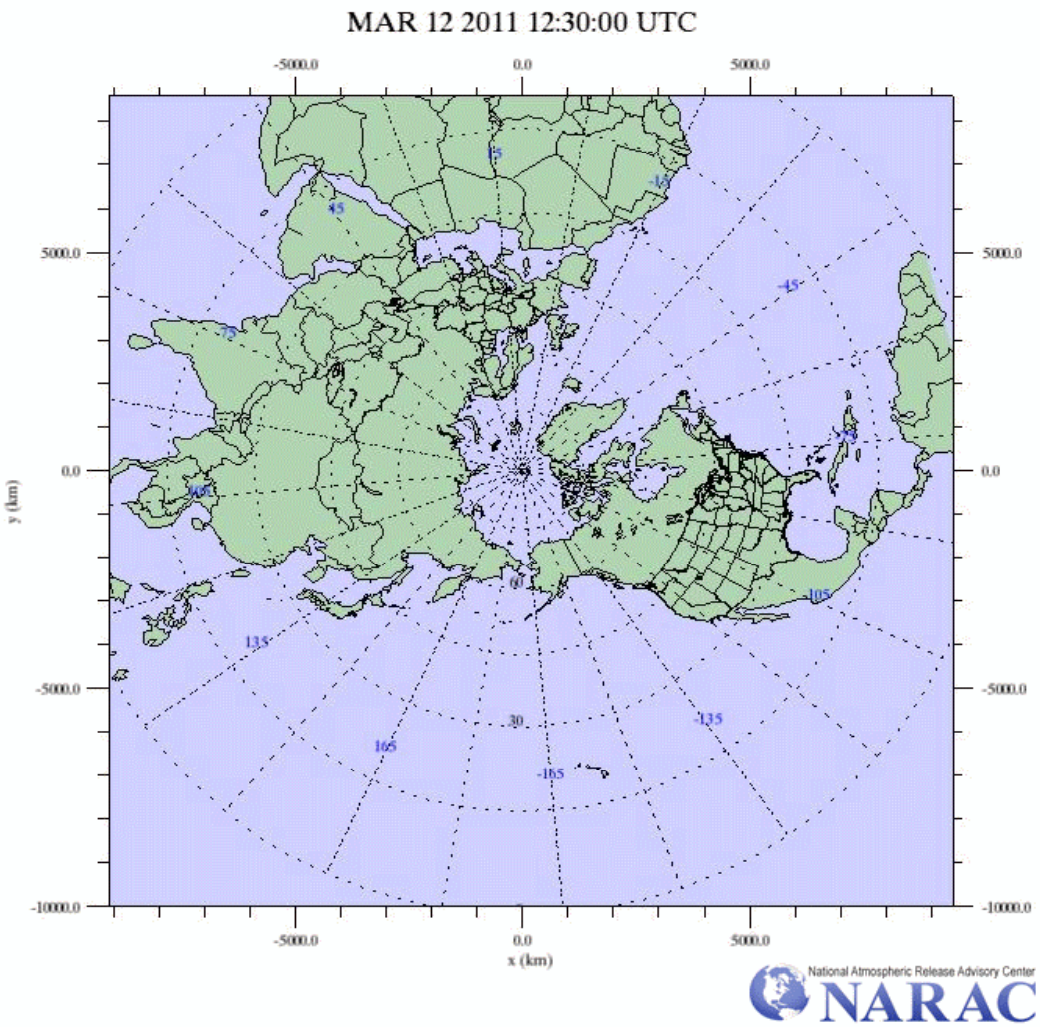
- Colleen O'Laughlin

Questions?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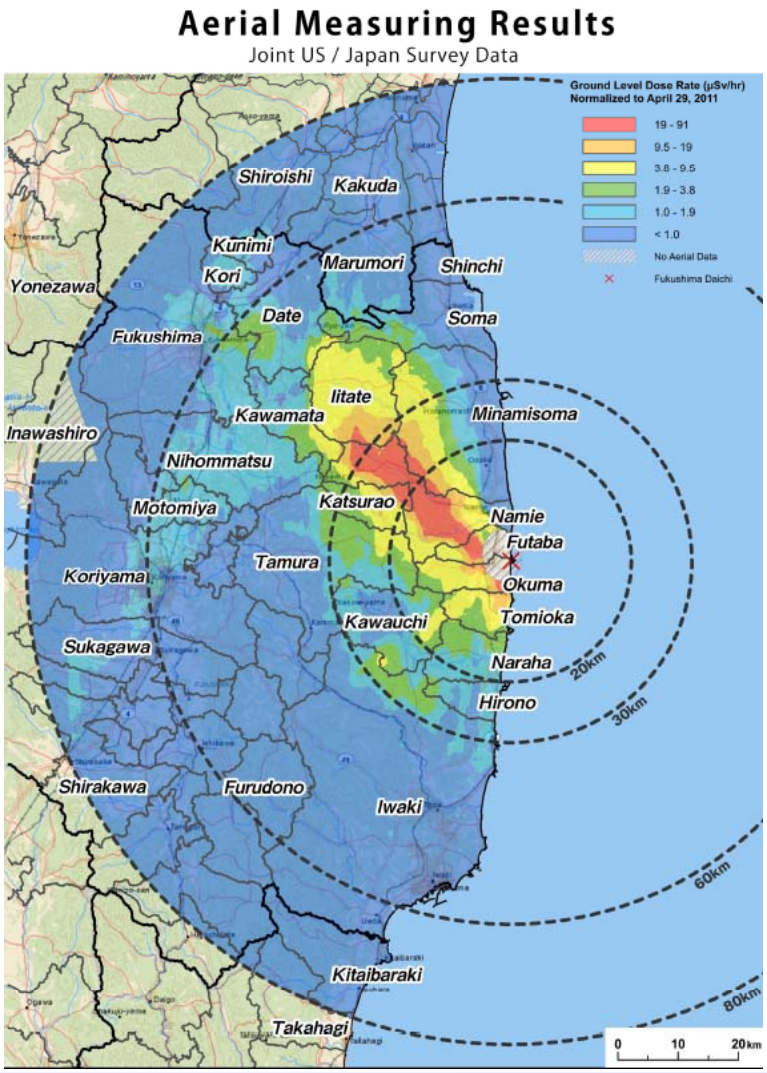
y (km)
x (km)
National Atmospheric Release Advisory Center
NARAC


Aerial Measuring Results
Joint US / Japan Survey Data
Ground Level Dose Rate (µSv/hr)
Normalized to April 29, 2011
19 - 91
9.5 - 19
3.8 - 9.5
1.9 - 3.8
1.0 - 1.9
< 1.0
No Aerial Data
Fukushima Daichi
Shiroishi
Kakuda
Kunimi
Kori
Marumori
Shinchi
Yonezawa
Date
Soma
Fukushima
Iitate
Kawamata
Minamisoma
Inawashiro
Nihommatsu
Katsurao
Motomiya
Namie
Futaba
Tamura
Koriyama
Okuma
Tomioka
Kawauchi
Sukagawa
Naraha
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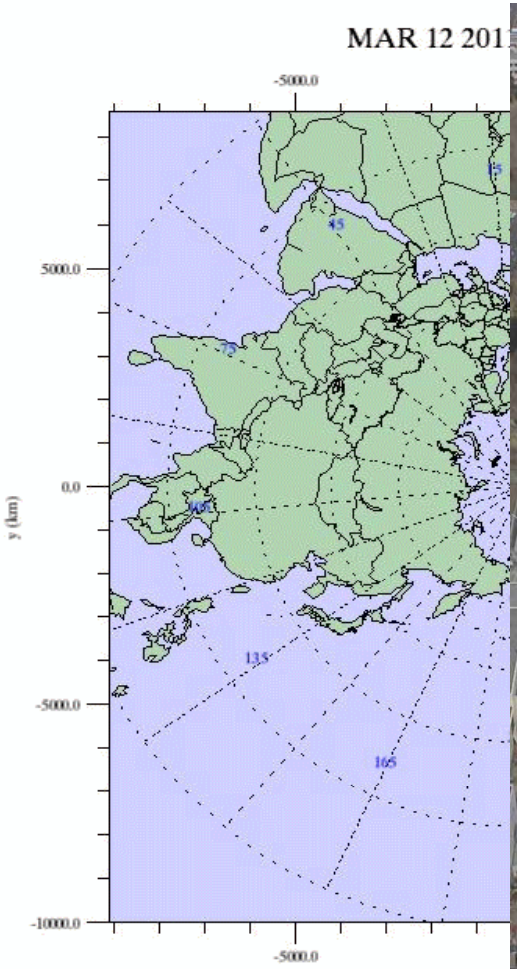
Questions?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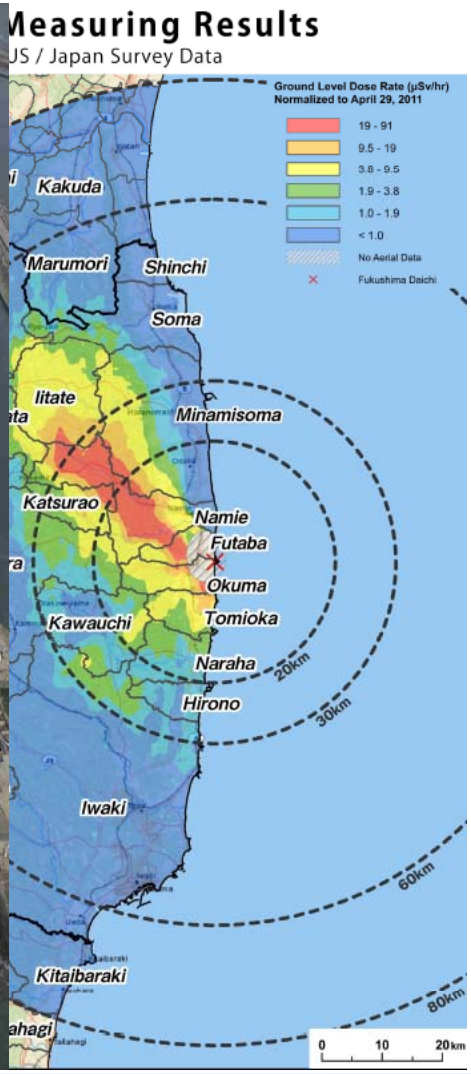
y (km)
-5000.0
45
135
165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Marumori
Shinchi
Soma
Iitate
Minamisoma
Katsurao
Namie
Futaba
Okuma
Tomioka
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Hirono
Iwaki
Kitaibaraki
20km
30km
60km
80km
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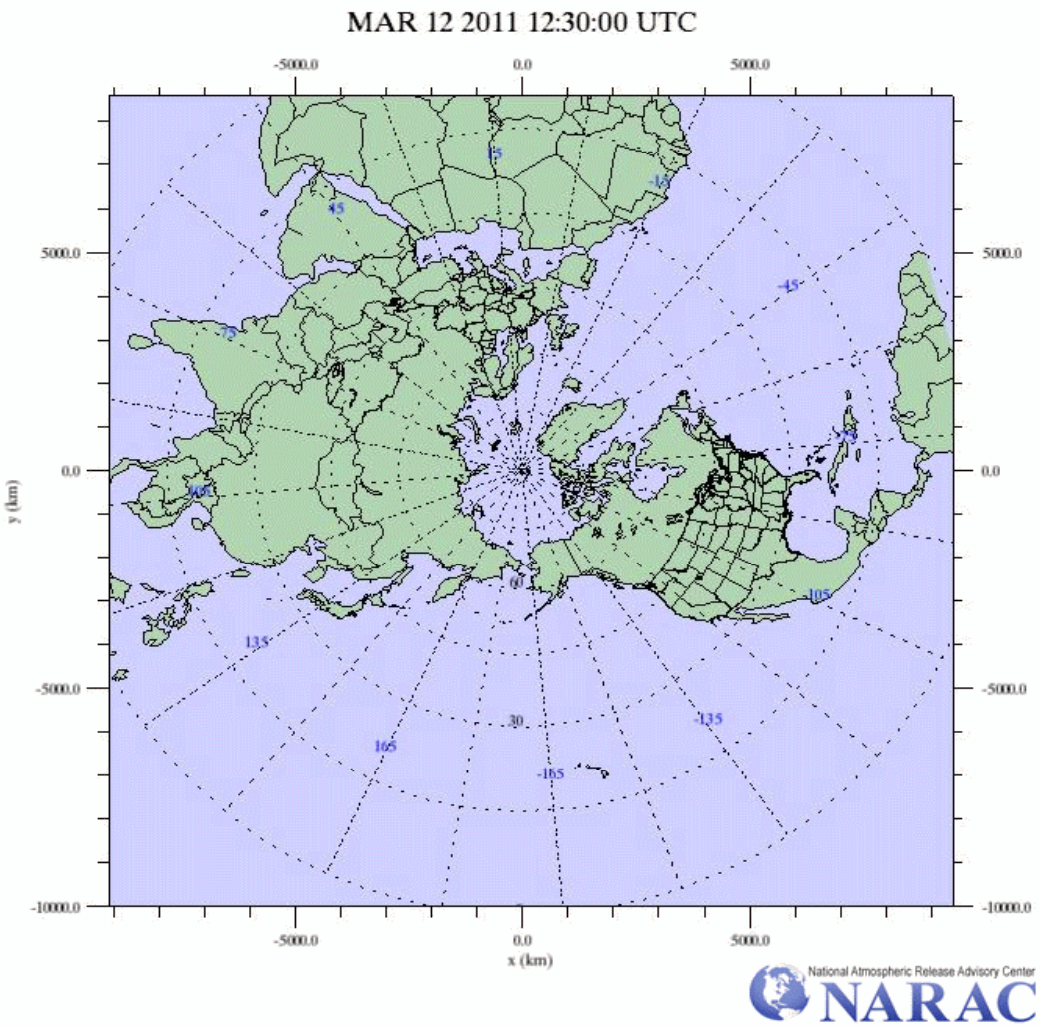
10
20km

Questions?


MAR 12 2011 12:30:00 UTC
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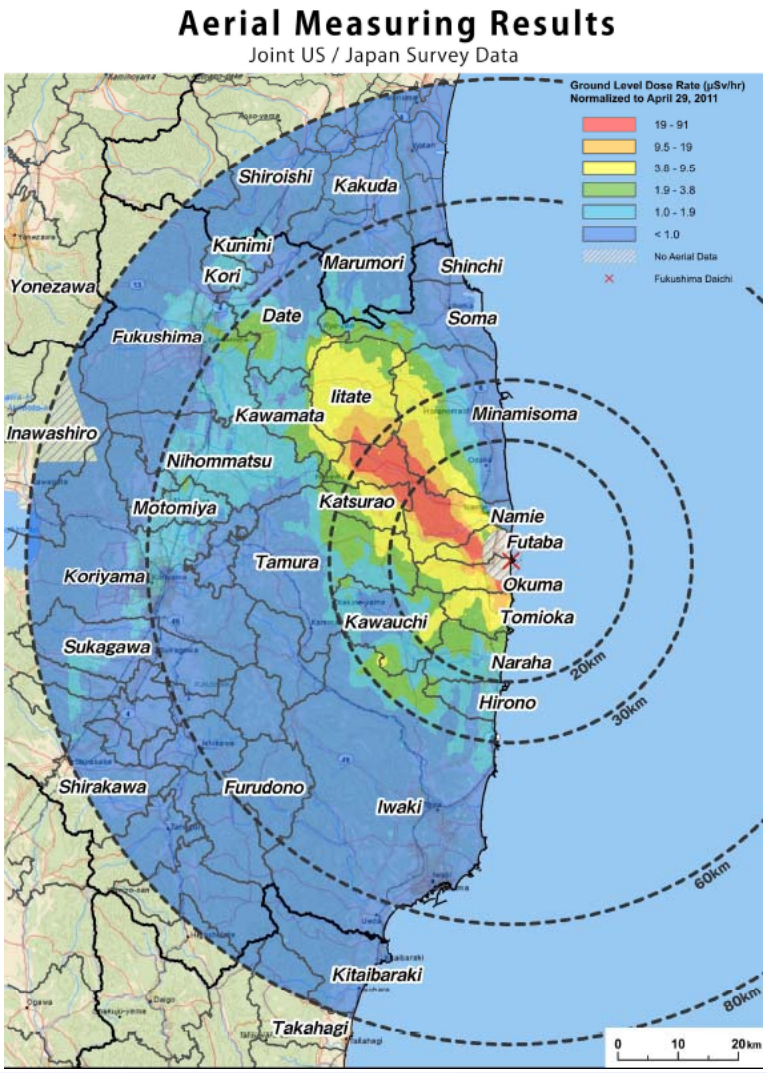
y (km)
x (km)
National Atmospheric Release Advisory Center
NARAC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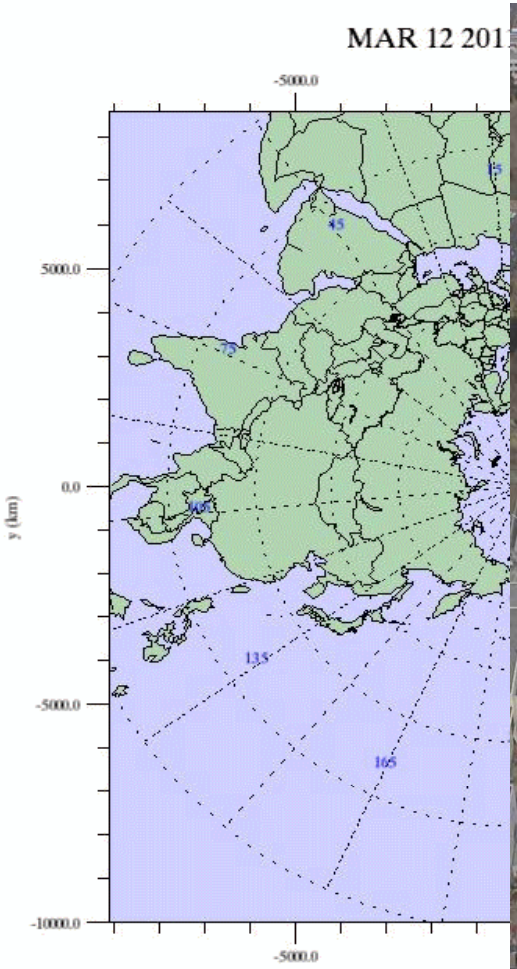
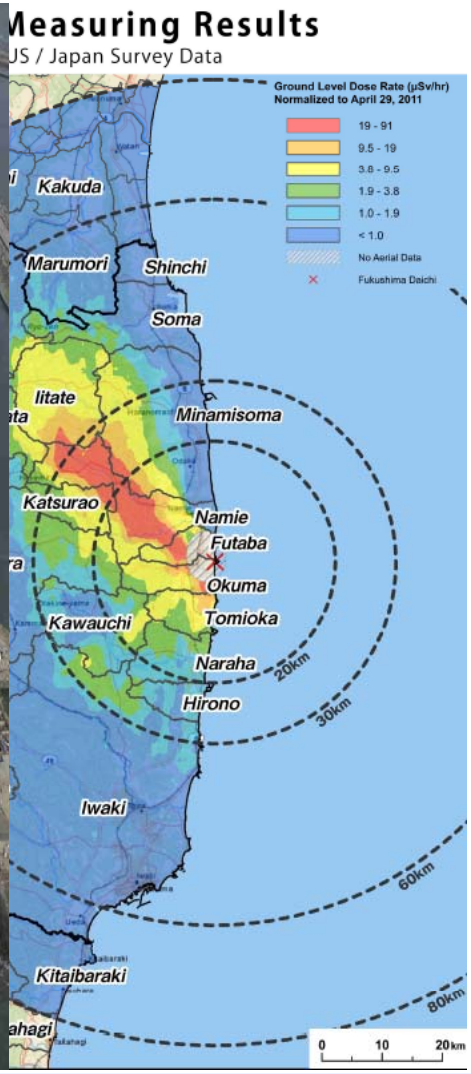
Shiroishi
Kakuda
Kunimi
Kori
Marumori
Shinchi
Yonezawa
Date
Soma
Fukushima
Iitate
Kawamata
Minamisoma
Inawashiro
Nihommatsu
Katsurao
Motomiya
Namie
Futaba
Tamura
Koriyama
Okuma
Tomioka
Kawauchi
Sukagawa
Naraha
Hirono
Shirakawa
Furudono
Iwaki
Kitaibaraki
Takahagi
20km
30km
60km
80km
0
10
20km

Questions?


MAR 12 201
-5000.0
5000.0
0.0
-5000.0
-10000.0
y (km)
-5000.0
45
75
105
135
165


Measuring Results
US / Japan Survey Data
Ground Level Dose Rate (µSv/hr)
Normalized to April 29, 2011
19 - 91
9.5 - 19
3.8 - 9.5
1.9 - 3.8
1.0 - 1.9
< 1.0
No Aerial Data
Fukushima Daichi
Kakuda
Marumori
Shinchi
Soma
Iitate
Minamisoma
Katsurao
Namie
Futaba
Okuma
Tomioka
Kawauchi
Naraha
Hirono
Iwaki
Kitaibaraki
20km
30km
60km
80km
0
10
20km