SAND2011-3983C

Challenges in Determining the Isotopic Mix from the Fukushima Daiichi Accident

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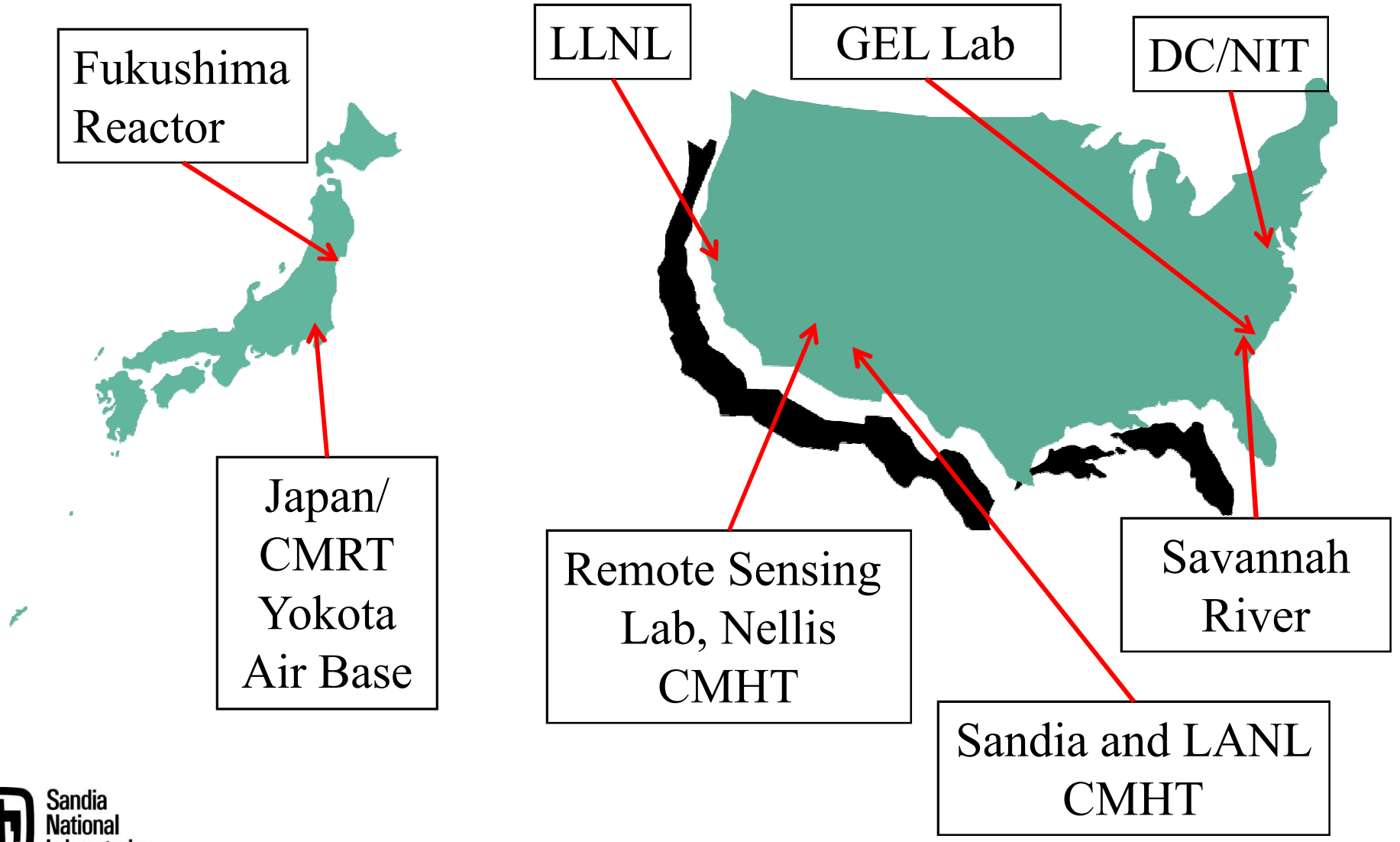
The Objective

- Assess the dose to individuals including a dose per day analysis and in relationship to the PAGs.
- Using:
  - Field Measurements
  - Aerial Measurements
  - Model Results
  - In-situ Measurements
  - Field Samples followed by Lab Analysis

- Need the mixture to assess doses.

Lab Analysis Resource Activated
CM Laboratory Response



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The First Weeks

- Reactors Failing
- Hydrogen Explosions
- Huge Pressure for Information

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The First Weeks

Releases continues for weeks

Fortunately most of the time the winds went out to sea.

Physical damage is significant.

The First Weeks

The First Weeks

- DOE Teams Deploying and Establishing Operations.
- Beginning Field Operations.

The First Weeks

- NRC Evaluating Worst Case Releases
  - Create 4 Potential Source Terms called Supercore, Melcore Reactor, Melcore Spent Fuel, and Melcore Combined

- White House Requesting Dose Impacts in Japan, West Coast, Hawaii, Guam, and Alaska

- DOE Dose Assessment Teams begin modeling various releases to each location updating each day as mixture decays/in-grows.

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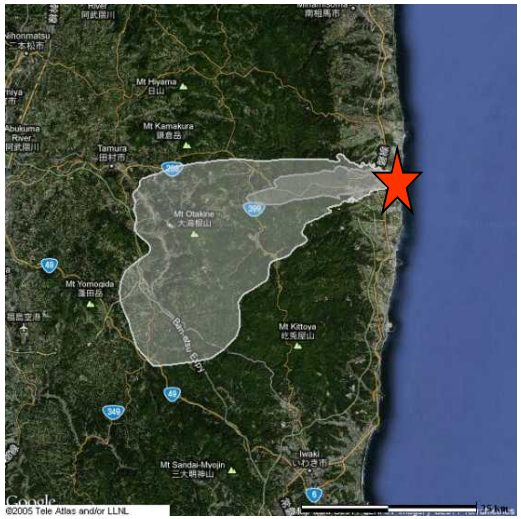
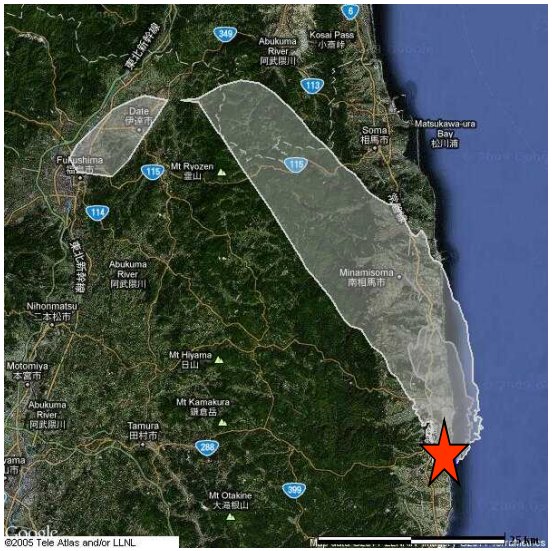
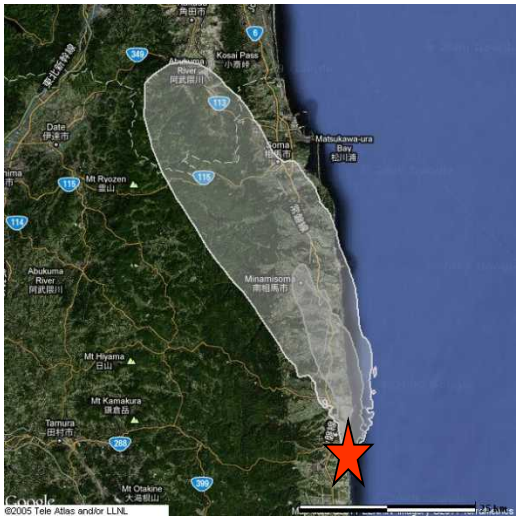
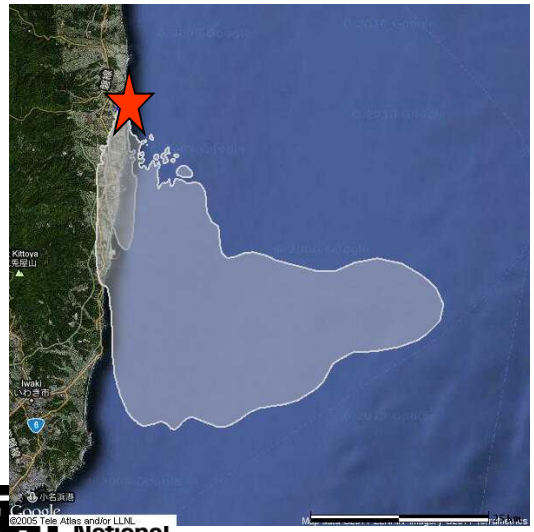
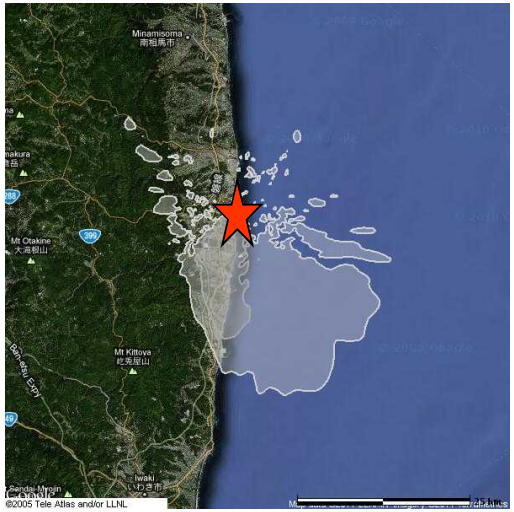
Complication of Plume Behavior During One Day (March 20)

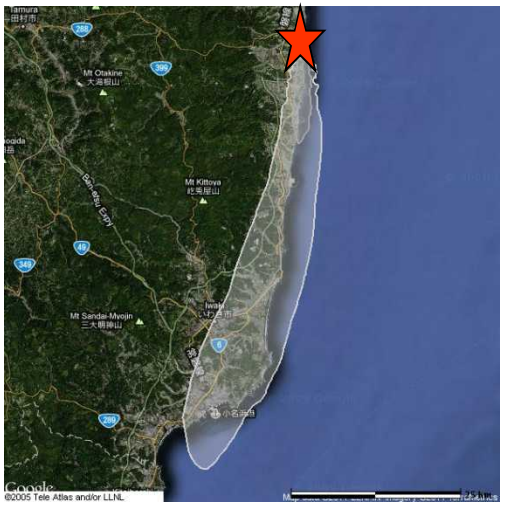












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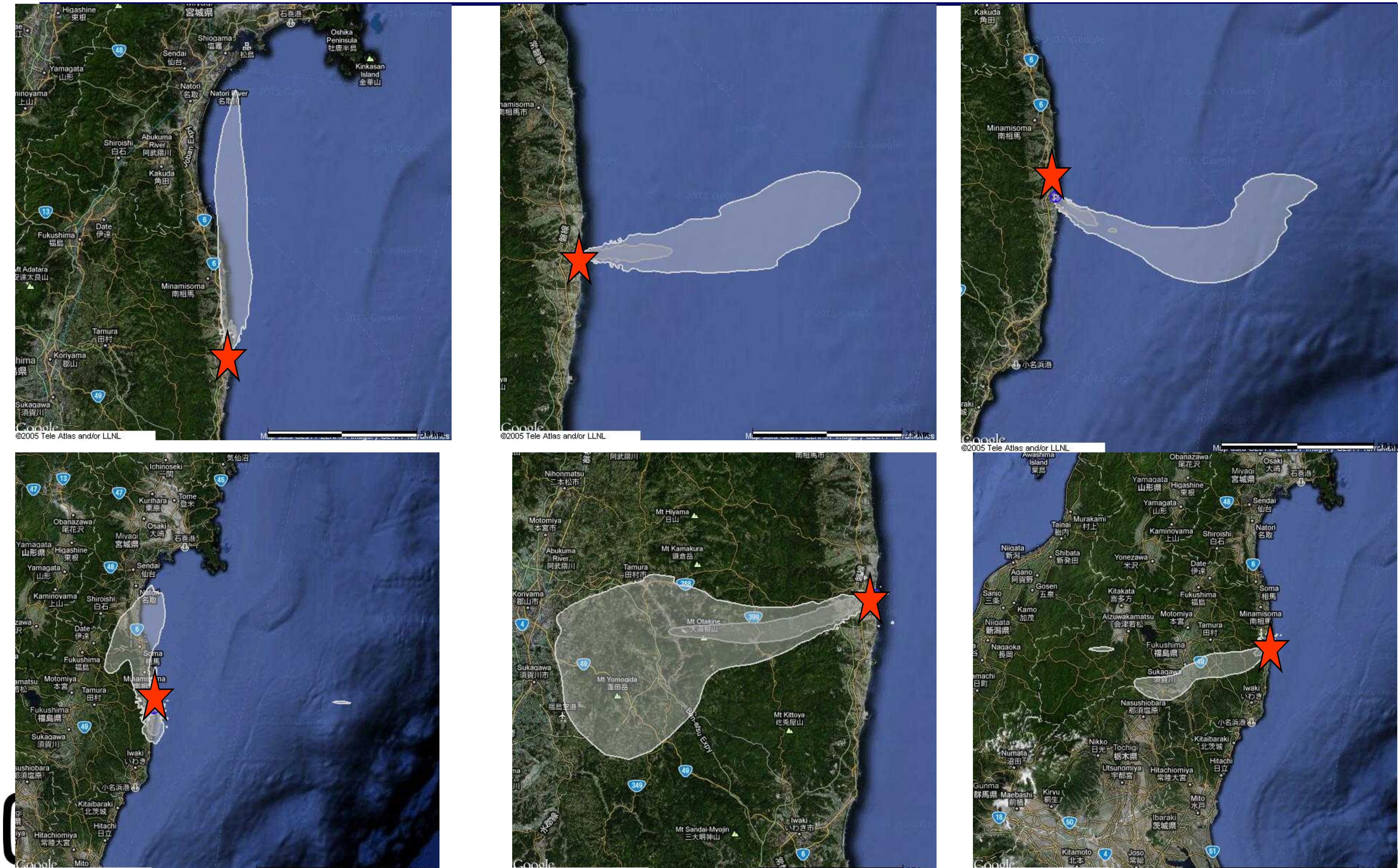
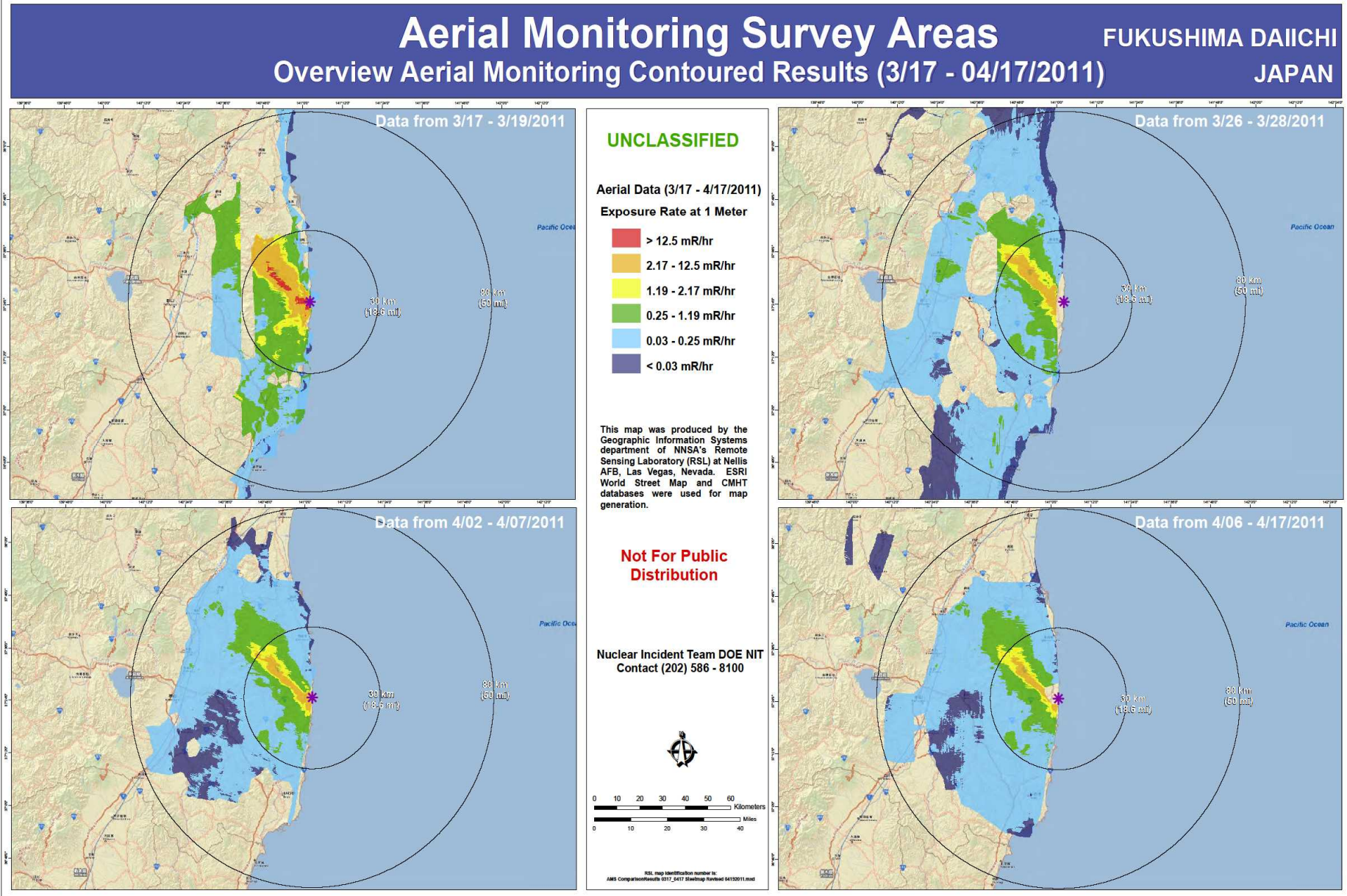
Complication of Plume Behavior During One Day (March 24)



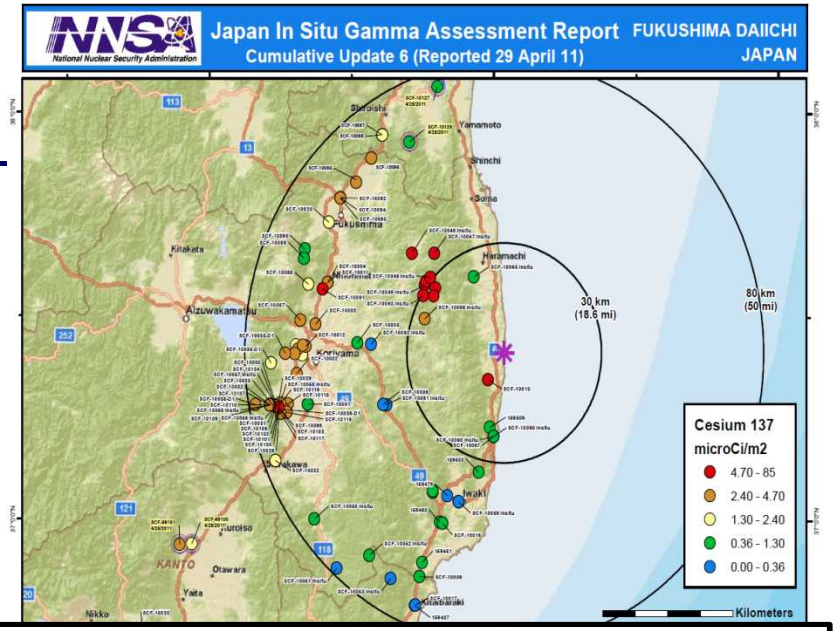
Plume Also Changed Over Time Through Decay

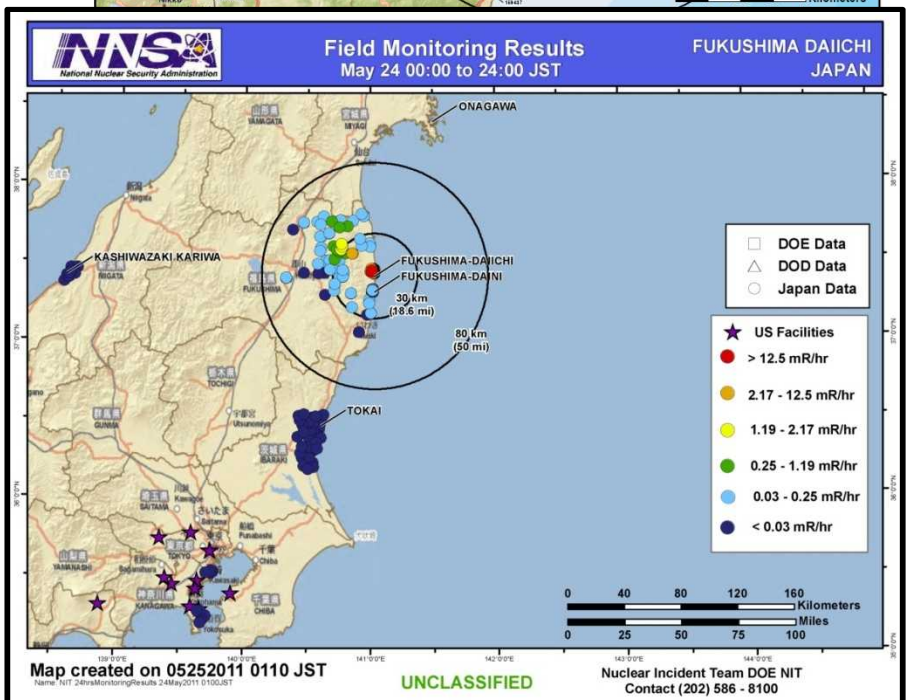


Field Measurements

- Large Numbers of Field Readings and In-situ measurements
- Well over 100K Data Points
- Measurements Mapped
- Developing the Footprint

- Using measurements to characterize the footprint, but things continue to change with several releases and a decaying mixture.





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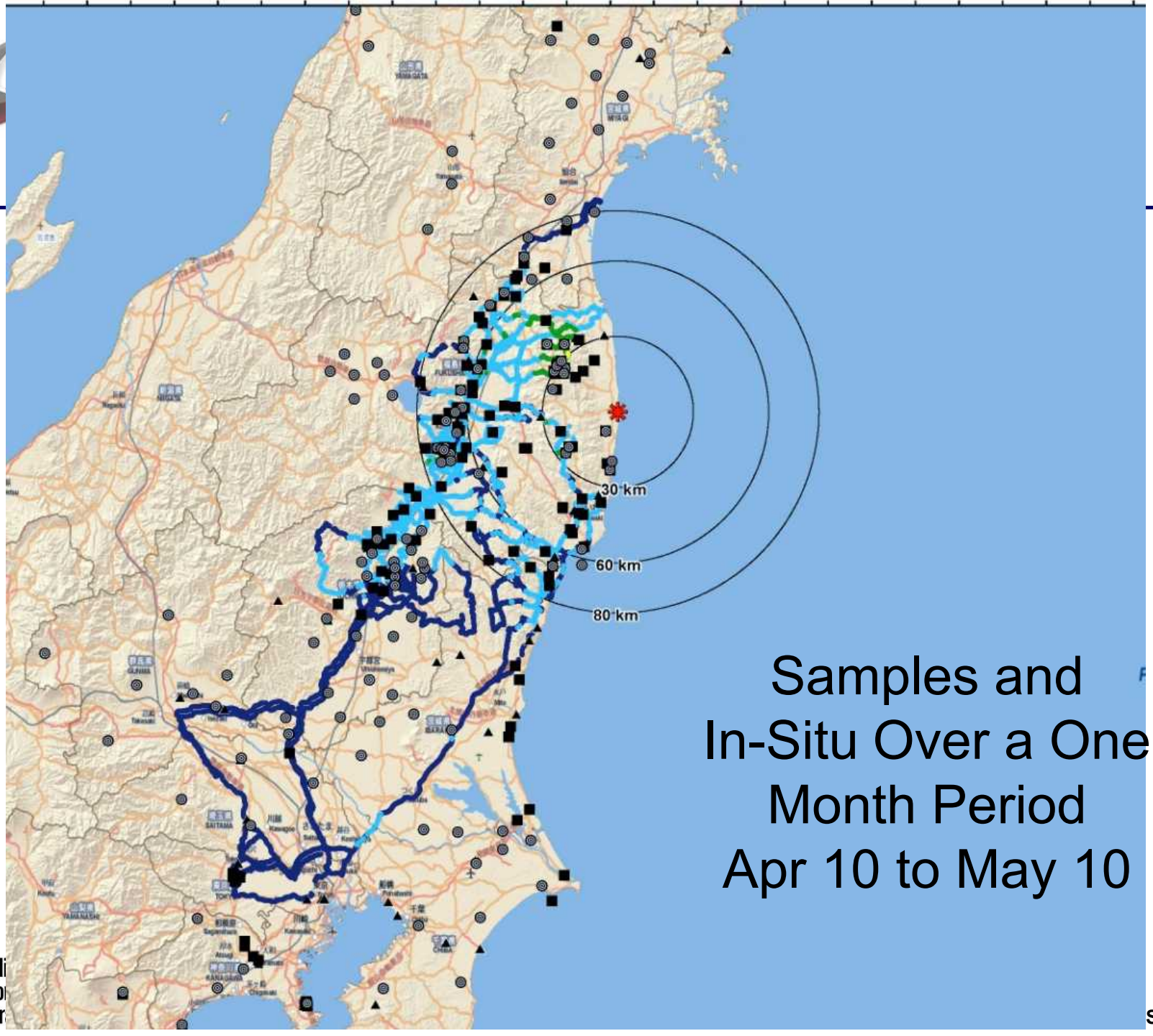

Samples and In-Situ Over a One Month Period Apr 10 to May 10

Air Filter Samples

- Collected daily to assess real-time risk to personnel located at US Facilities.
- Field counted and then submitted to laboratory for additional analysis.
- Over 580 samples collected
- Challenges
  - Field counting presented challenges as background in the counting area varied significantly
  - Could not get a Strontium numbers for few weeks.

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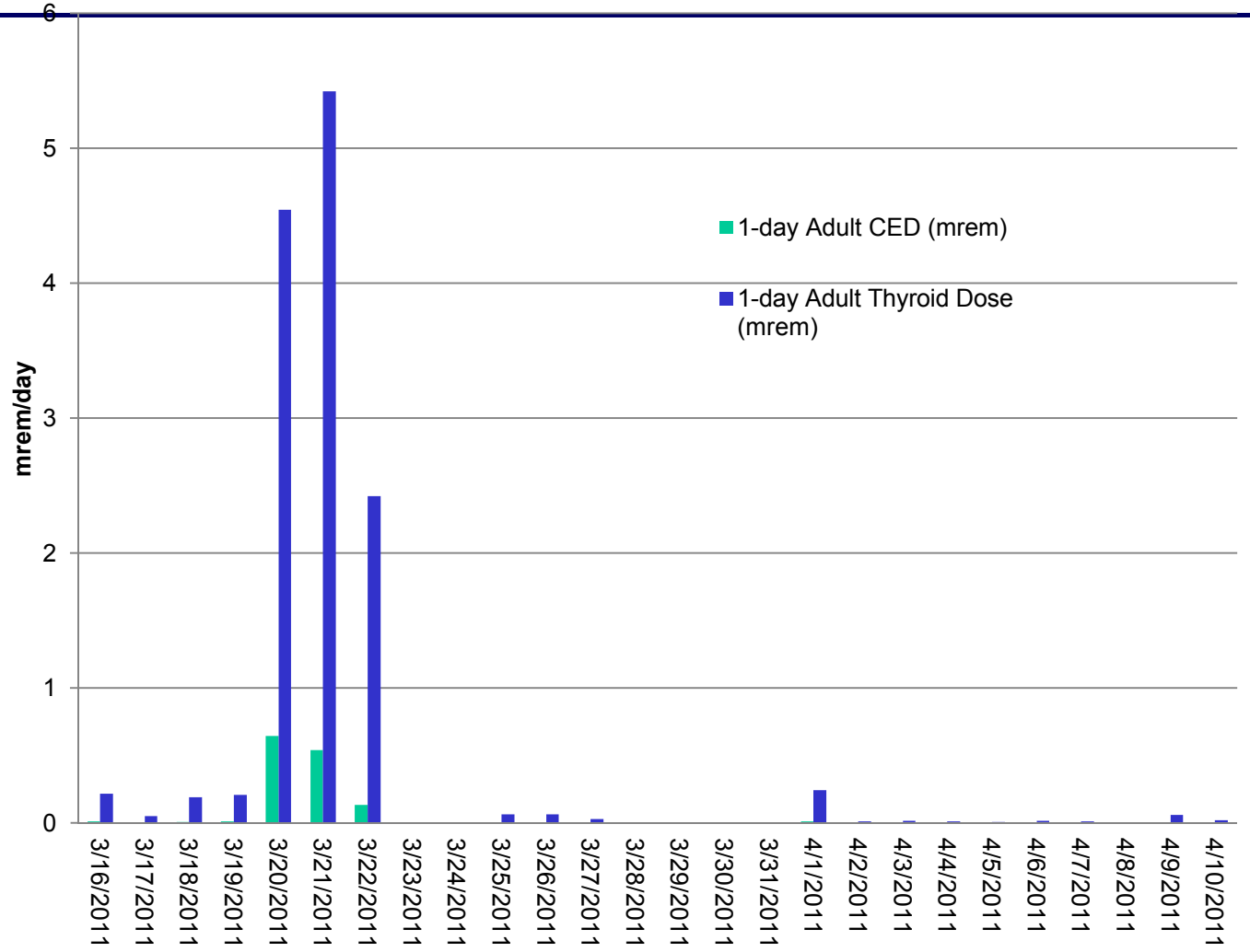
Daily Inhalation Dose at Bldg 1503 (upper bound)



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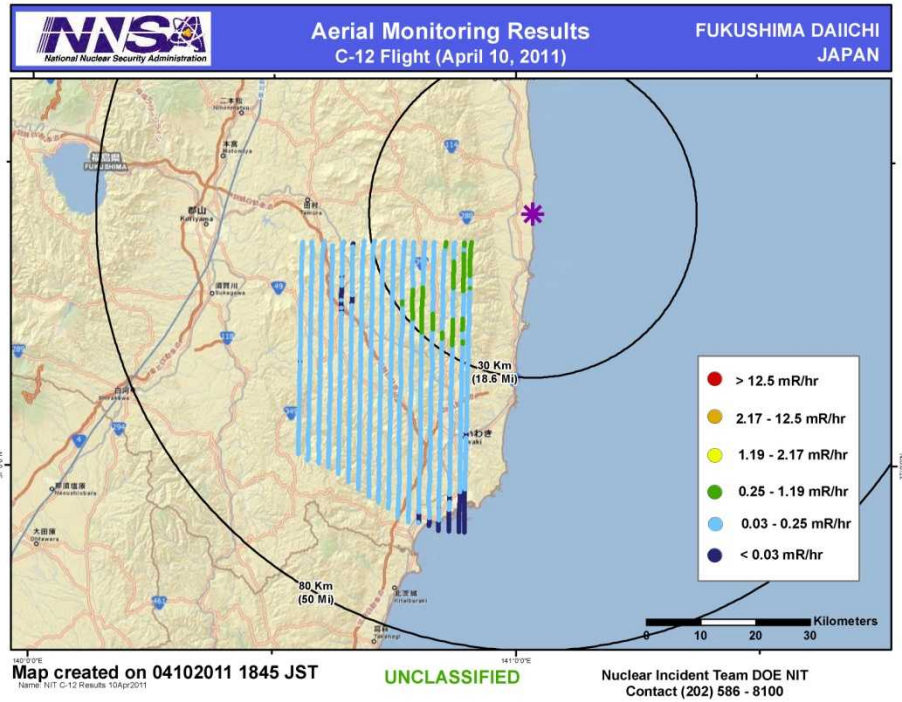
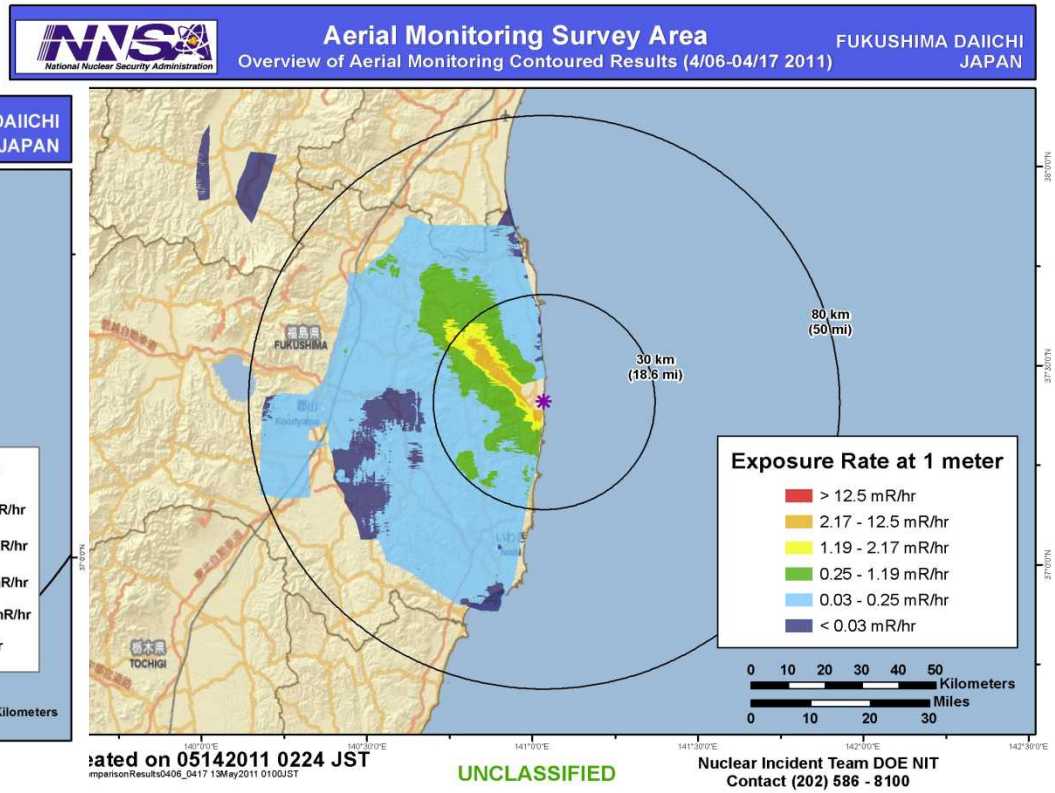
AMS Measurements

- Large Number of flights and data mapped and compared to ground measurements the help build the overall footprint.





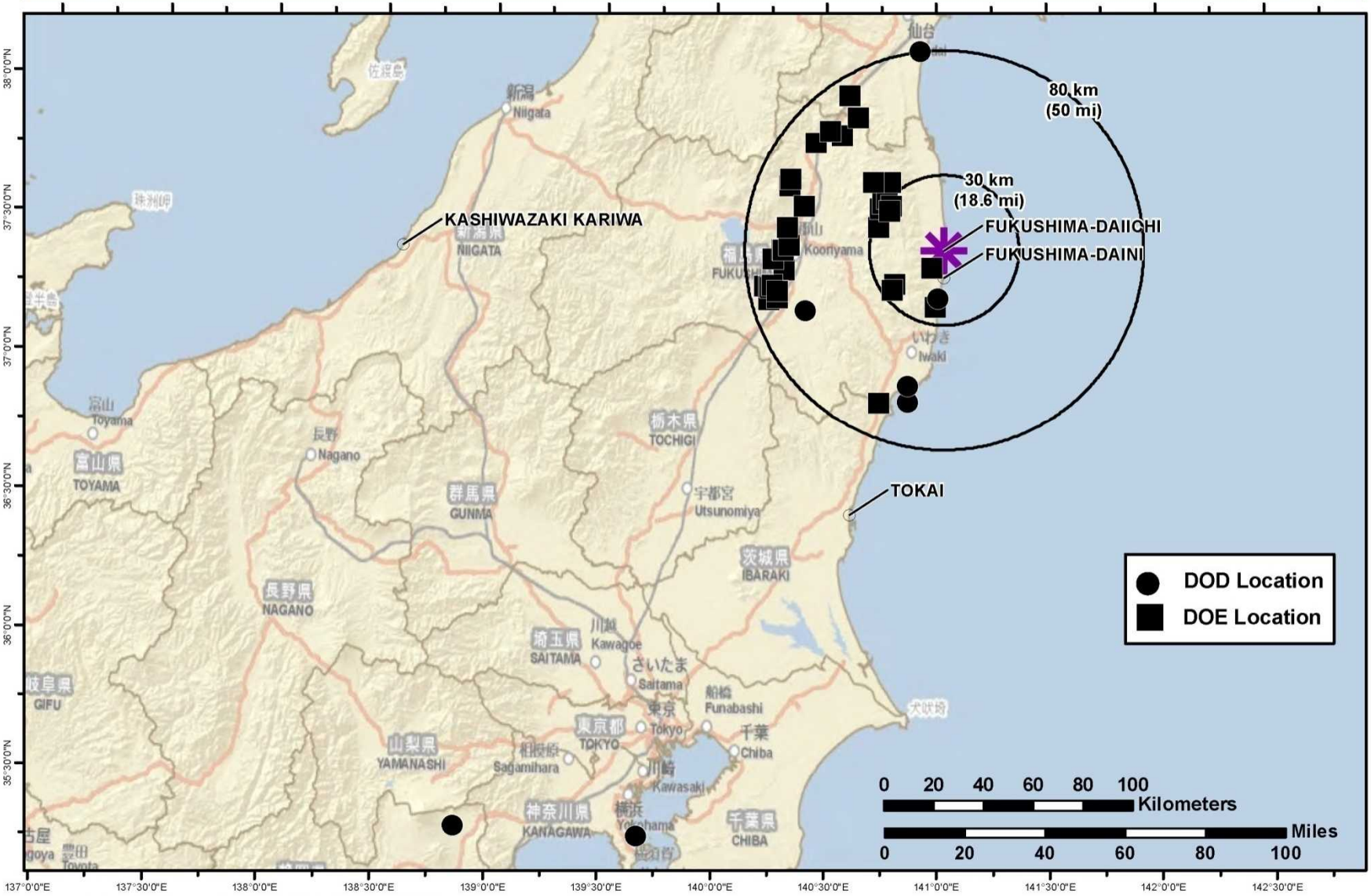
Soil Samples

- First Soils were from the Government of Japan – 89 samples
- AFRAT collected an additional 6 samples, 4 from near the reactor
- DOE collected 35 samples from higher levels areas
- DOE collected 6 soil cores to measure how deep Cs was migrating.

Soil Sample Locations

FUKUSHIMA DAIICHI
JAPAN

National Nuclear Security Administration



Map created on 05272011 0800 JST

Name: CMHT Soil sample locations

Nuclear Incident Team DOE NIT
Contact (202) 586 - 8100

Gov of Japan Soil Samples

- Gov. of Japan sent 89 soil samples to the US for Radiochemistry analysis.
- There was specific interest in Sr-89 and Sr-90.

Challenges:

- US did not know the surface area these samples represent.
  - Not able to calculate doses from these samples
  - Not able to asses how they related to a DRL or an ingestion DRL
  - These did help provide relative concentrations of radionuclides.
- Activity on these samples was low and as a results the Sr to Cs rations varied widely from 1 to 1 to 2000 to 1. The fact that they were all near detection level was causing this varibility.

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Soil Samples

- US collected 35 Surface Soil Samples and 6 Soil Cores.
- Soil Core was to determine penetration of contaminates
- US Sampled Higher Activity Locations
  - Trying to get samples that would be well above detection level
  - We cannot asses how they related to a DRL or an ingestion DRL
  - These only provide relative concentrations of radionuclides.

Soil Core

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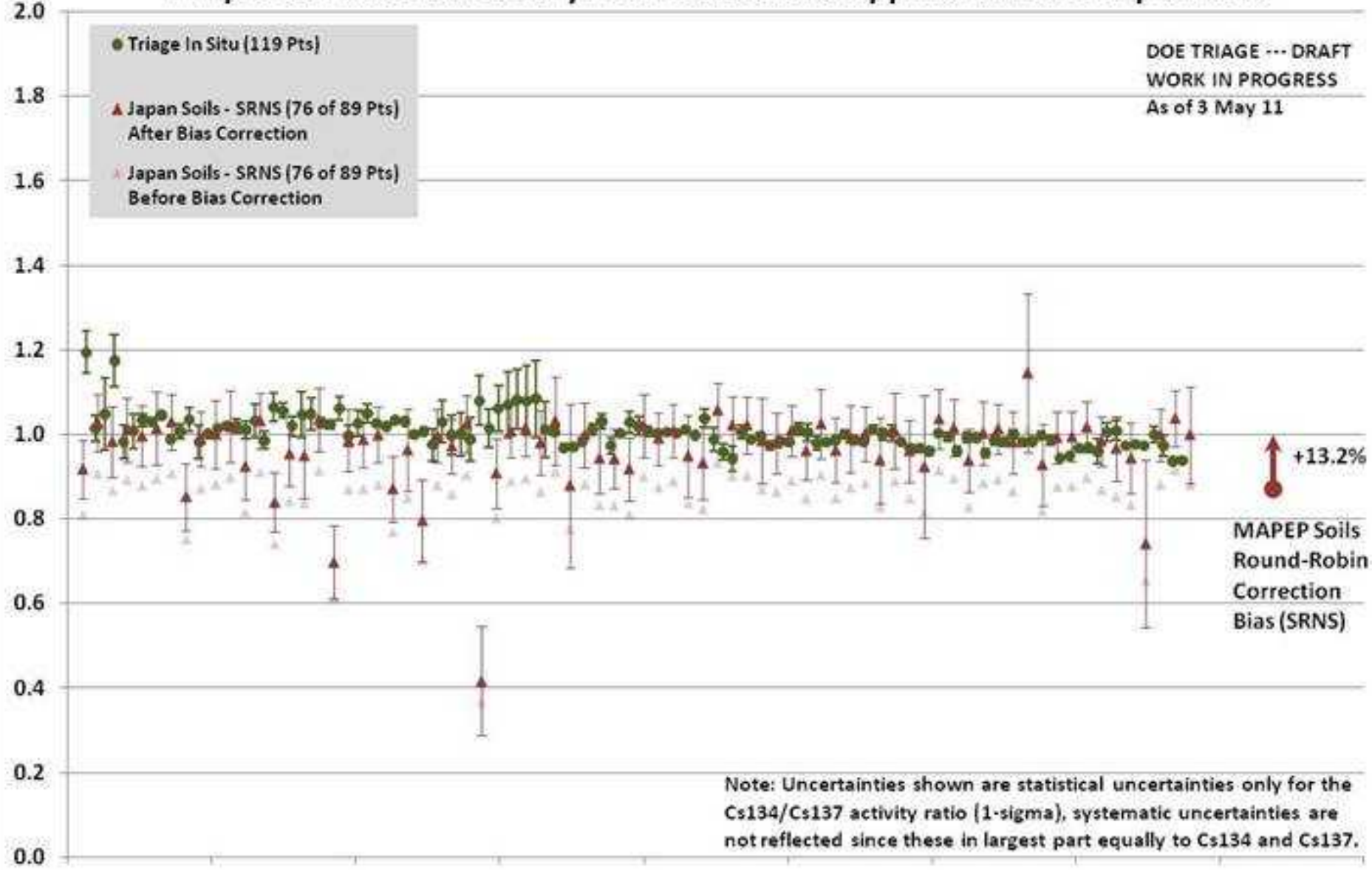
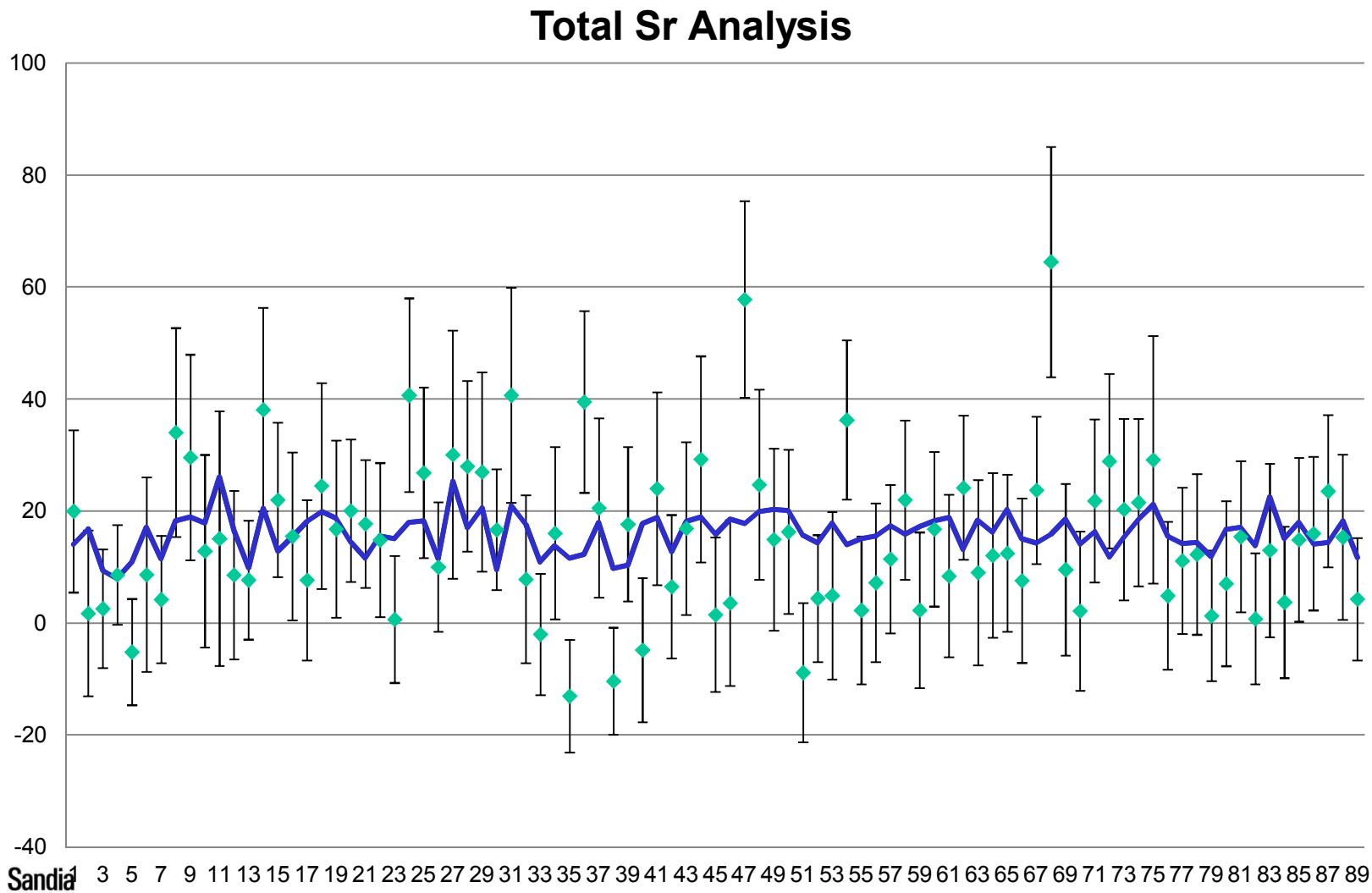
Overall Soil Sample Challenges

- It took time to get the samples to the US. The short-lived nuclides were decaying away over this time.
- USDA requires to Sterilization of the samples before any analysis. This involved heating so there was concern that the Iodines and Cesiums (i.e., Volatiles) would be driven out of the samples.
  - Were able to show this was not an issue based upon required temperatures and gamma counts before and after sterilization.
- Sr concentrations in early samples was very near detection levels so could not accurately determine the Sr to Cs ratio.
- Discovered that labs were not correcting for a peak summing issue that exists for nuclides like Cs-134 with cascade decay schemas. Caused a 13% bias between In-Situ and Samples, correcting for the summing occurred.
- Cs-137 to Cs-134 ratios was observed to be changing over the 3 month period causing a 2% variation over the time period.
  - Cs-134 with its 2.06 year half-life could not be ignored over this time frame.

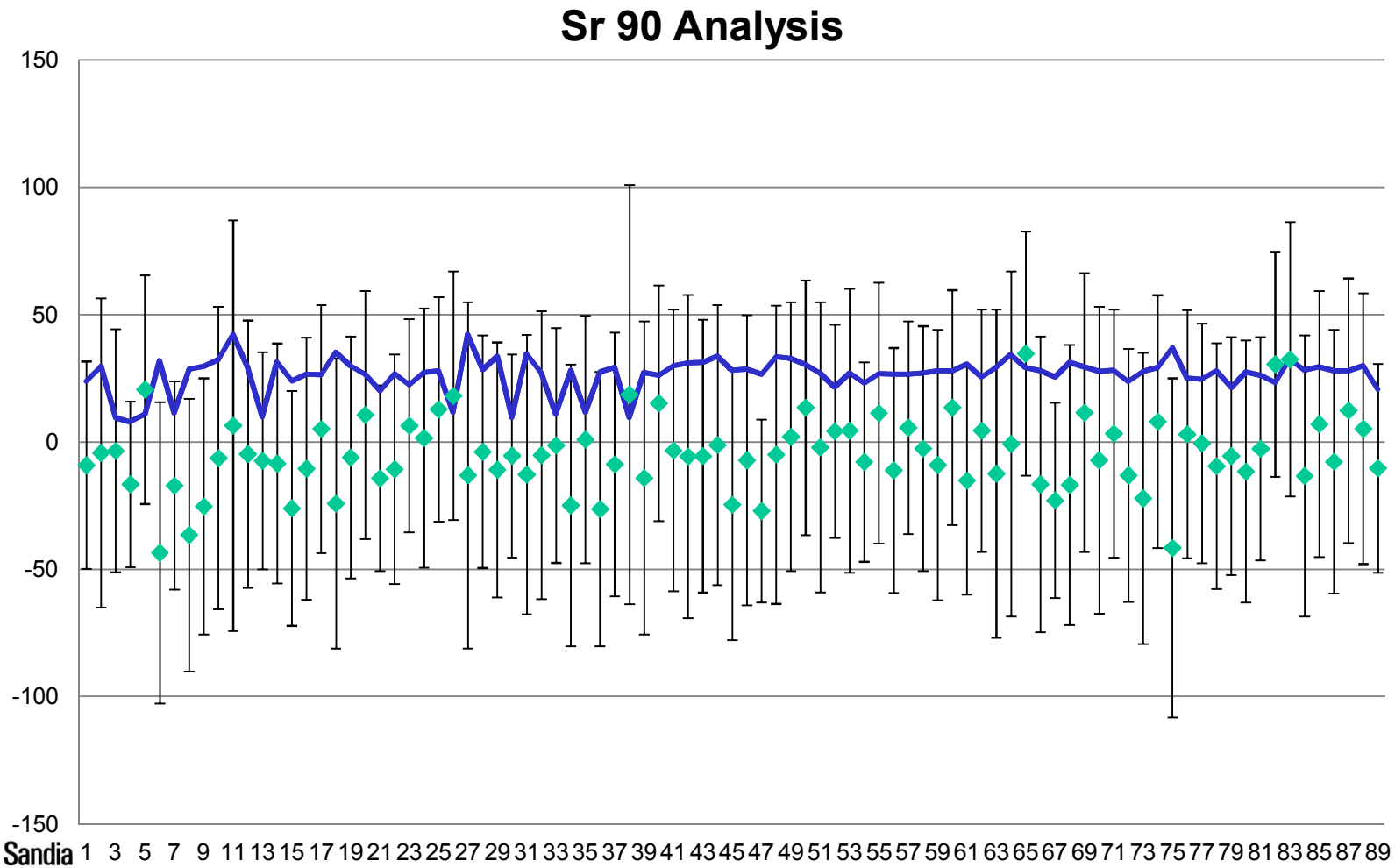
Comparison of Cs134/Cs137 Ratio: DOE In Situ / Soils -- Proposed Fixed Laboratory Bias Corrections Applied to SRNS Japan Soils



Total Strontium Compared to MDA



Sr-90 Compared to MDA



Other Issues

- US Personnel can not drive in Japan
- Note the Road Condition

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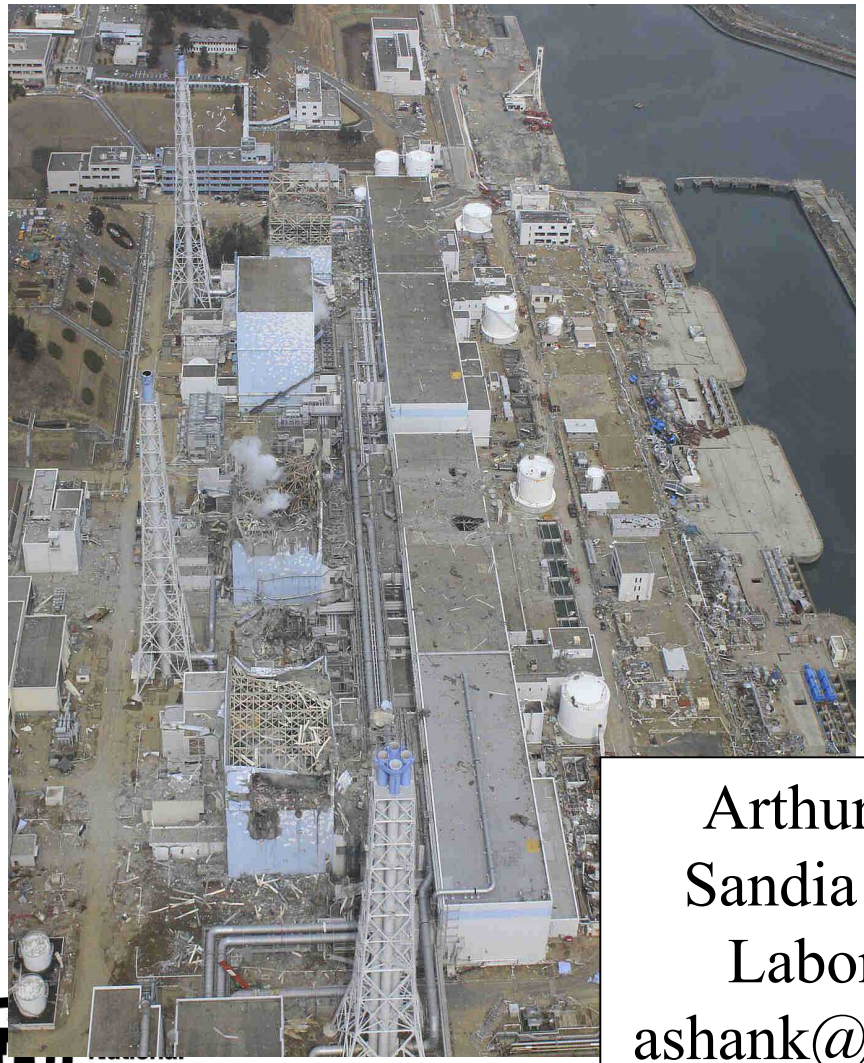
Biggest Lessons Learned

- Sample results will take a long time and they won't be definitive
  - Everyone will want answers yesterday
- MDA's are vital at the very early phases.
  - This will be one of the first question that needs to be answered for the labs and if you choose the wrong answer this will hurt in the long term.
- Need to ensure proper information is recorded for samples or you will not be able to use the results as intended.
- Sampling is far more involved than normally played in exercises.
- Everyone will be giving their assessments and you will need to be prepared to not only work on your assessment but also to address their assessments
- If the release and response occurs for weeks (like it will) you will need significantly more people resources than one would expect because they just wear out.

Questions



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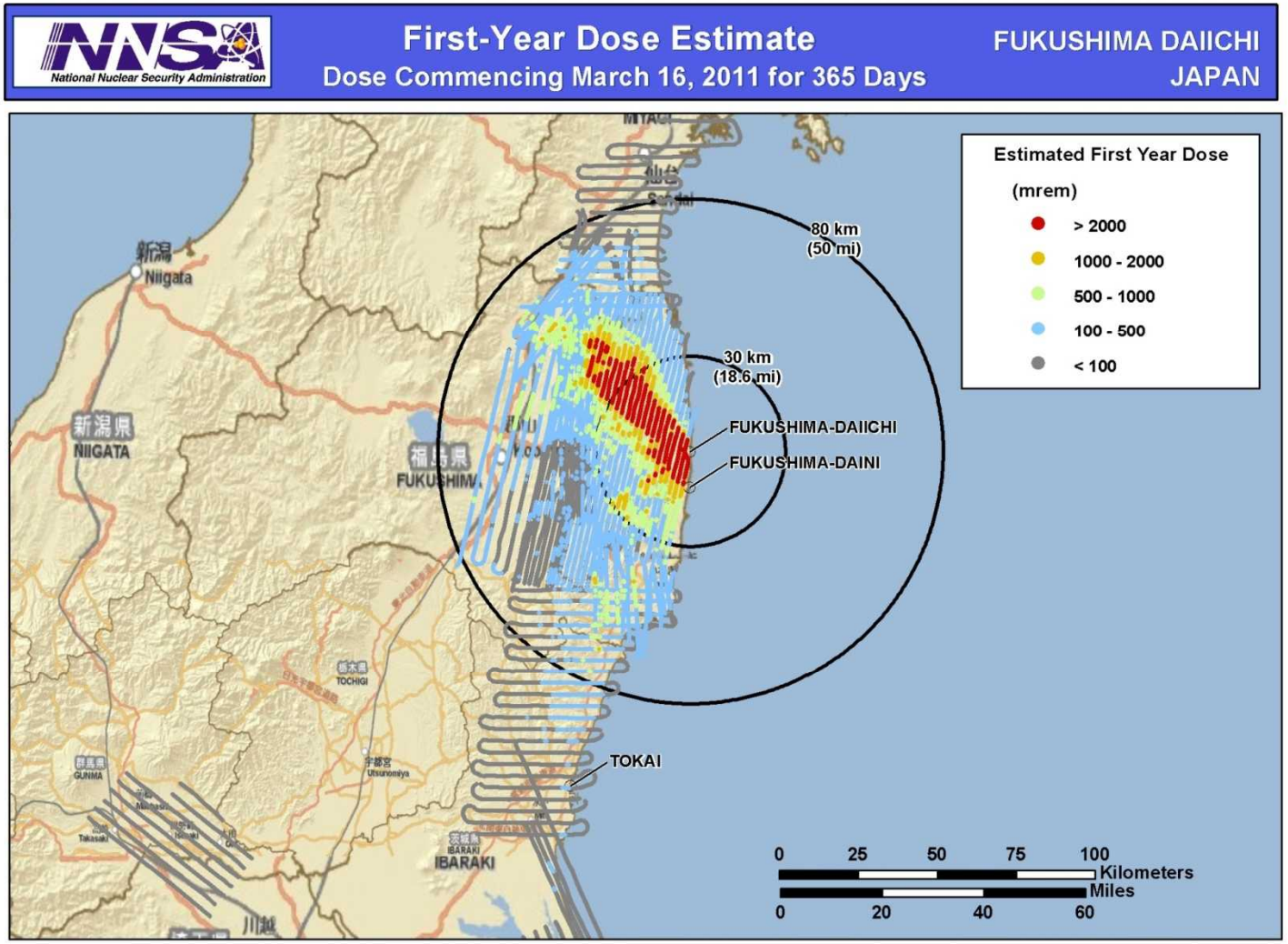
Dose Assessment



Map created on 04092011 1300 JST
Name: CMHT A 1stYrDoseEst 08Apr2011

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National Nuclear Security Administration

Fukushima Daiichi Long-term Dose Contributing Radionuclide Composition
Cs134/Cs137 Ratio: Lab Soil, Lab Air Filter, and In Situ Field Assays are consistent

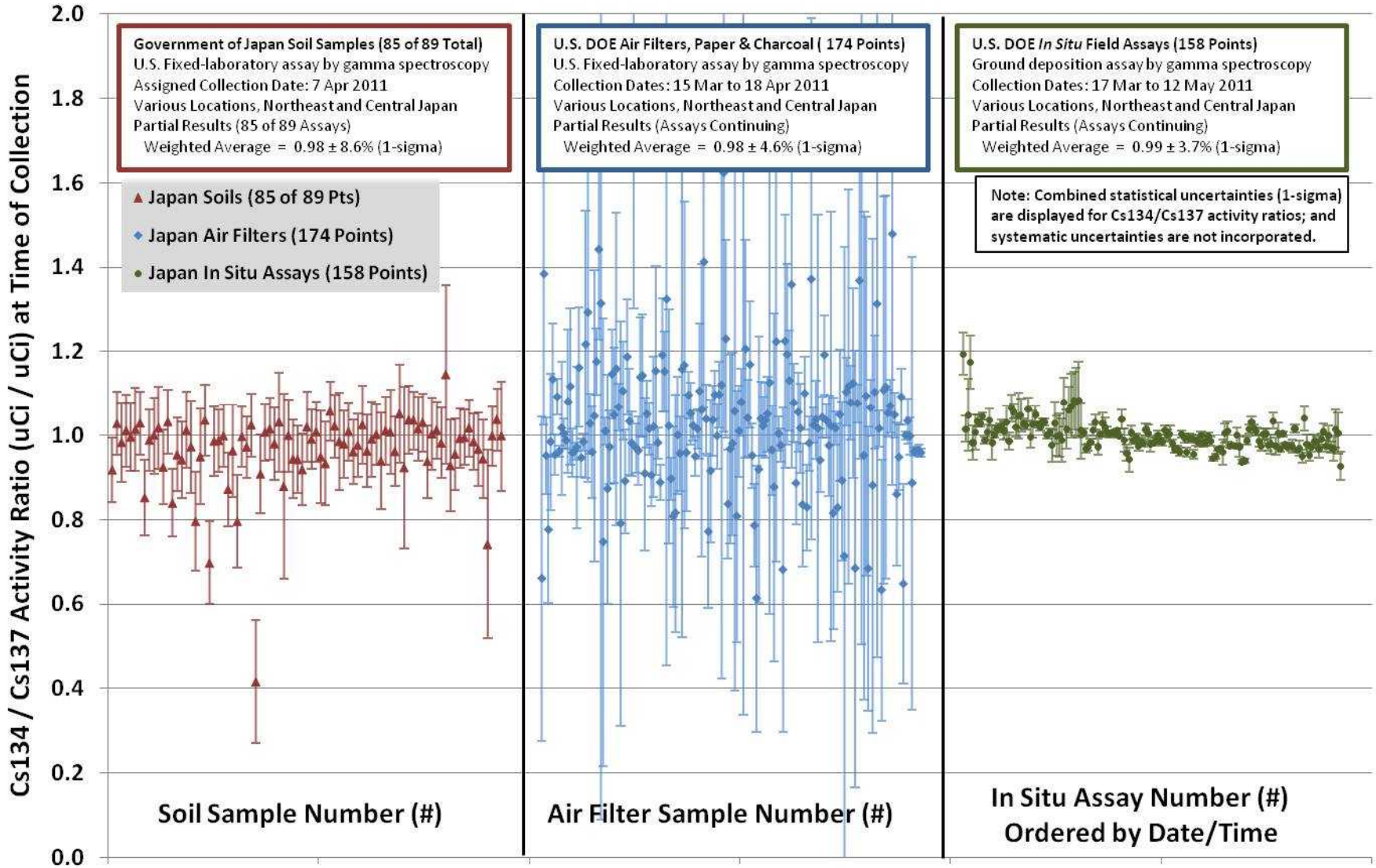

Chart Created on: 17 May 2011 (Version 1)

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