

Environmental Measurements in an Emergency: *This is not a Drill*



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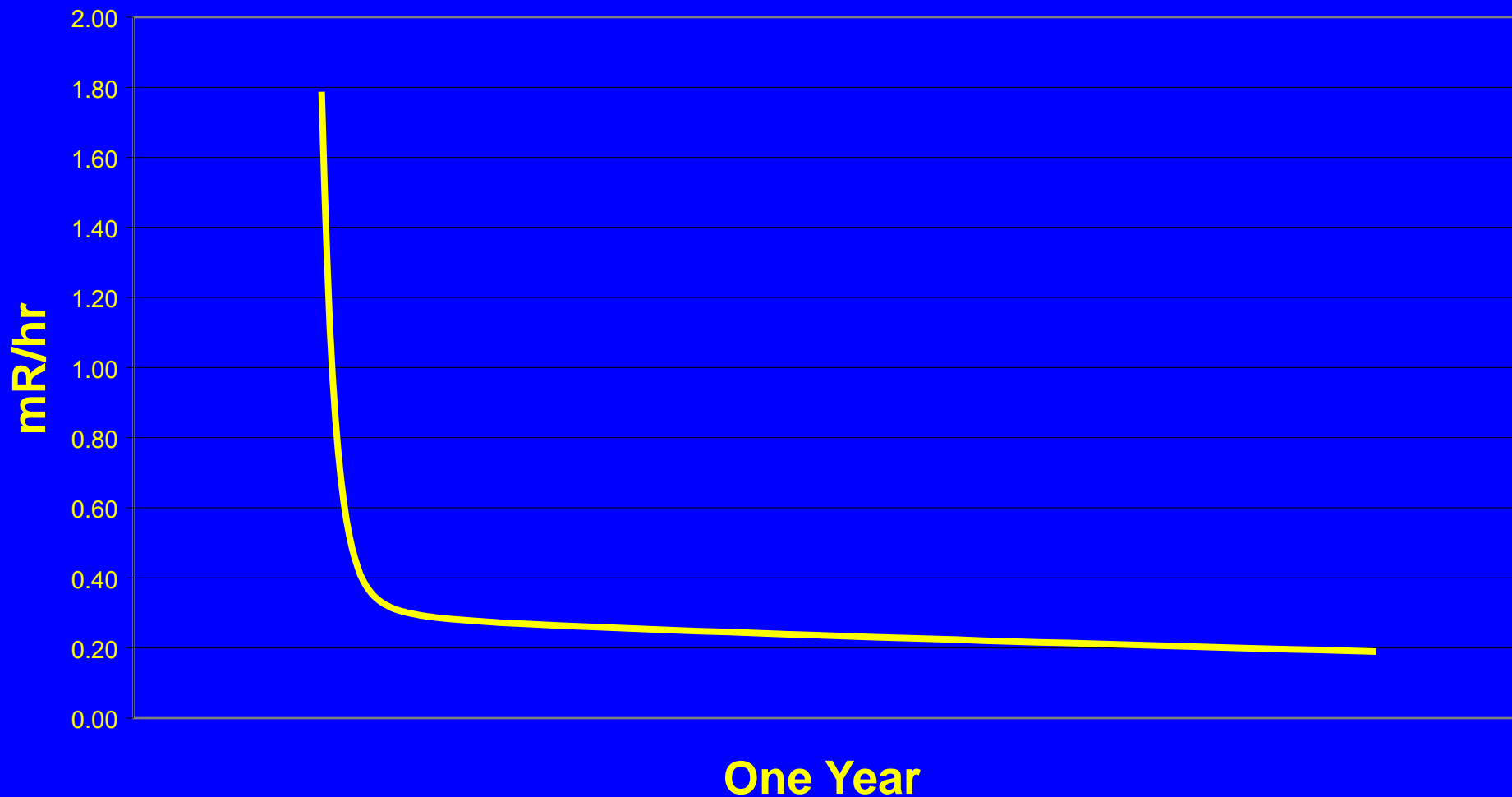
Harvey Clark, Wendy Pemberton, Thomas McCullough

Remote Sensing Laboratory

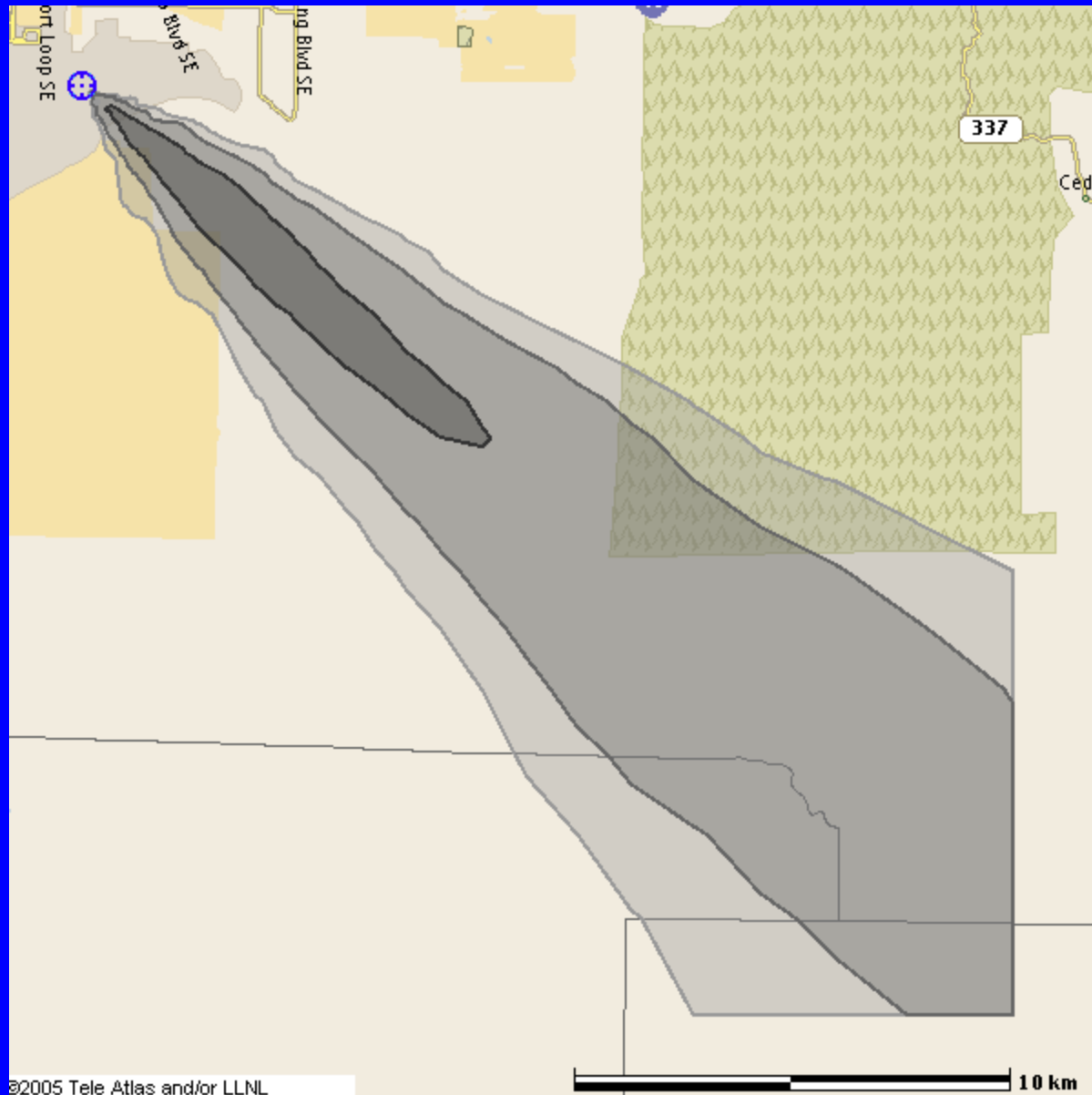
Drills and Exercises

- Data are generated from models
 - National Atmospheric Release Advisory Center (NARAC)
 - TurboFRMAC – Calculates a Derived Response Level from a radionuclide mix

Exposure Rate Derived Response Level (DRL) for Avoidable Dose

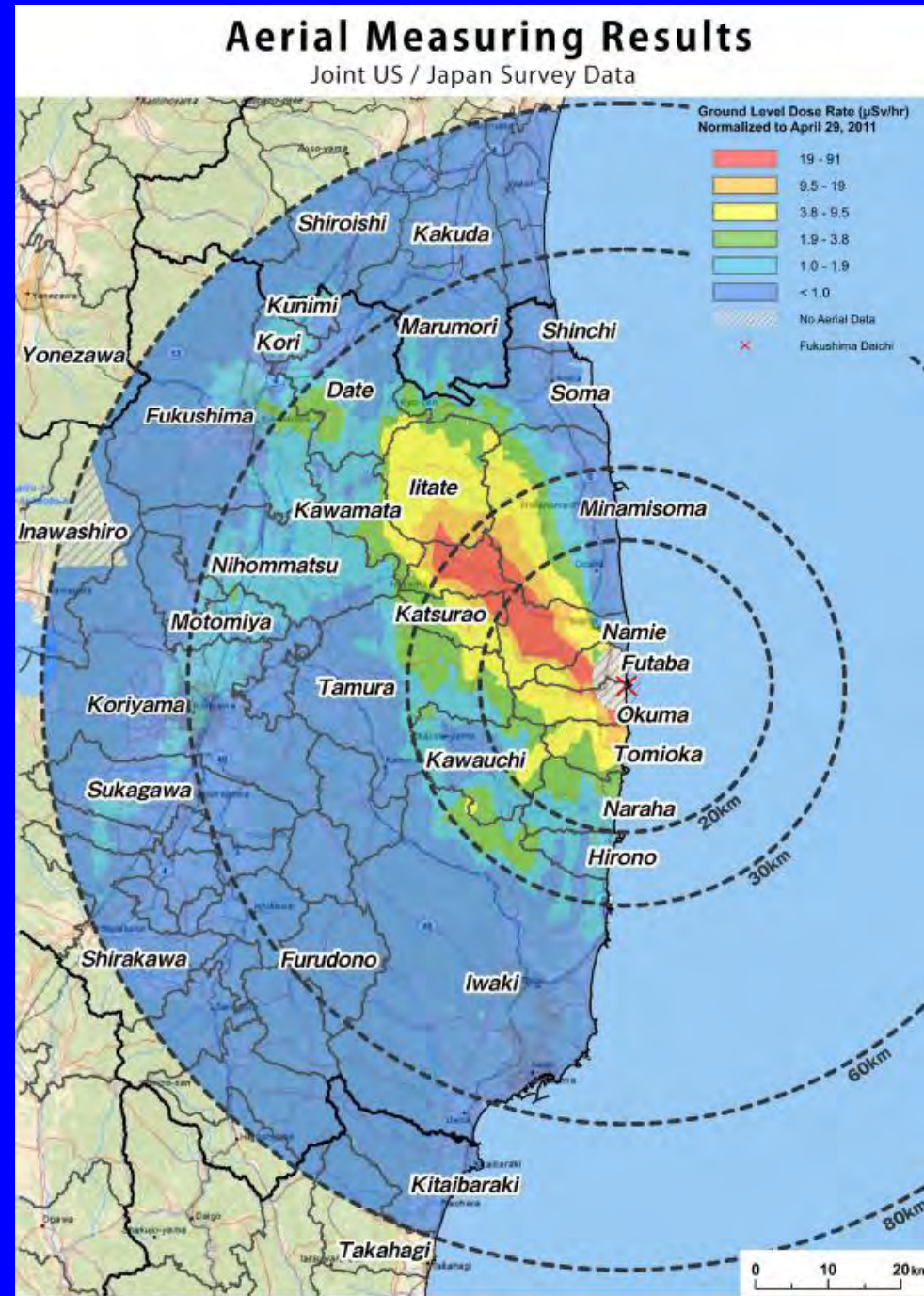


The World View

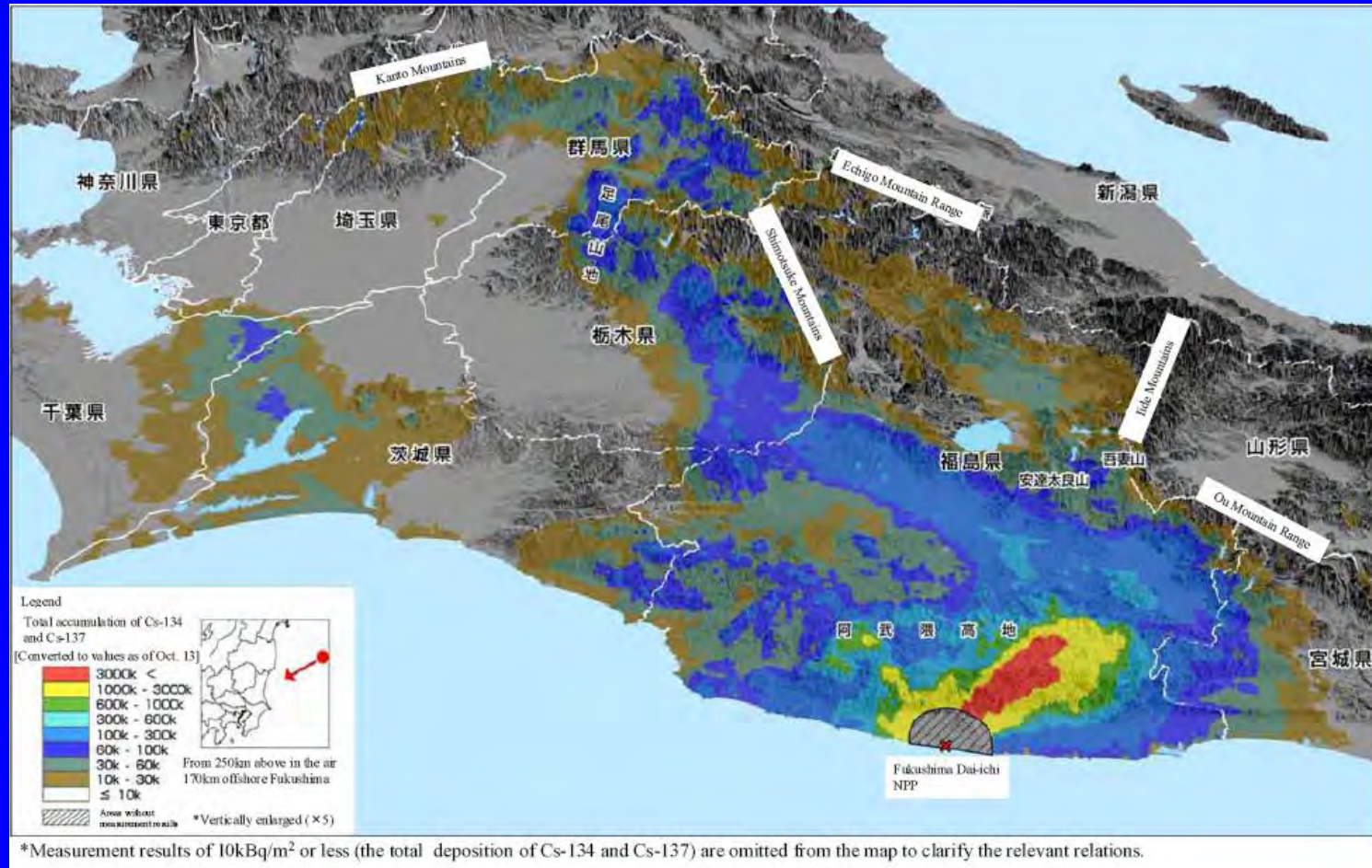


Japan Was Not Quite Gaussian

- Multiple source terms released over an extended period
- Complex terrain and micro-meteorology
- Wide range of weathering variations



The Terrain Got a Vote



Three examples of real life issues
encountered by the
Assessment Scientists

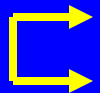
(in a World that's not Gaussian)

1. Air Sampling Data Scattered

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Date	Type	Exposure	Iodine			Cs-134	Cs-137
		Rate (uR)	I-131 (uCi)	I-132 (uCi)	I-133 (uCi)	(uCi)	(uCi)
3/20/2011	Paper	17	3.07E-03	9.23E-04	0.00E+00	8.21E-04	0.00E+00
3/20/2011	Charcoal	17	4.46E-04	1.99E-04	1.52E-04	0.00E+00	0.00E+00
3/20/2011	Paper	17	3.47E-03	1.81E-04	1.83E-04	5.15E-04	0.00E+00
3/20/2011	Paper	21	2.39E-03	2.55E-04	0.00E+00	2.78E-04	0.00E+00
3/20/2011	Charcoal	21	2.34E-03	1.63E-04	0.00E+00	4.09E-04	0.00E+00
3/20/2011	Paper	21	1.52E-02	5.96E-04	1.30E-04	7.17E-04	0.00E+00
3/20/2011	Paper	20	9.36E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3/20/2011	Charcoal	20	7.97E-03	0.00E+00	0.00E+00	9.04E-03	0.00E+00
3/20/2011	Paper	600	2.31E-03	2.41E-04	0.00E+00	5.20E-04	0.00E+00
3/20/2011	Charcoal	600	2.21E-03	4.32E-04	0.00E+00	0.00E+00	1.70E-04
3/20/2011	Paper	300	2.48E-03	5.40E-04	0.00E+00	3.26E-04	0.00E+00
3/20/2011	Charcoal	300	2.79E-03	4.29E-04	0.00E+00	0.00E+00	0.00E+00
3/20/2011	Paper	165	3.29E-03	4.70E-04	1.24E-04	0.00E+00	0.00E+00
3/20/2011	Charcoal	165	0.00E+00	4.65E-04	0.00E+00	0.00E+00	0.00E+00
3/20/2011	Charcoal	NA	5.89E-03	5.26E-04	0.00E+00	6.43E-04	2.44E-04
3/20/2011	Paper	NA	2.49E-03	5.16E-04	0.00E+00	7.46E-04	0.00E+00

1.2 mrem



Confounding Issues



- High background due to actual air activity
 - No shielding on the spectrometer
- Short count time for sample throughput
 - Immediate assessments needed
 - No time for Sr analysis
- Variability in analytical results
 - Filter paper and charcoal separated
 - Blank counted with each sample
 - Variable background subtraction



Operational health physics not regulatory compliance

2. Ground-Truth Measurements to Corroborate Aerial Data Did not Agree!

Aircraft

C-12 Huron



UH-60 Blackhawk

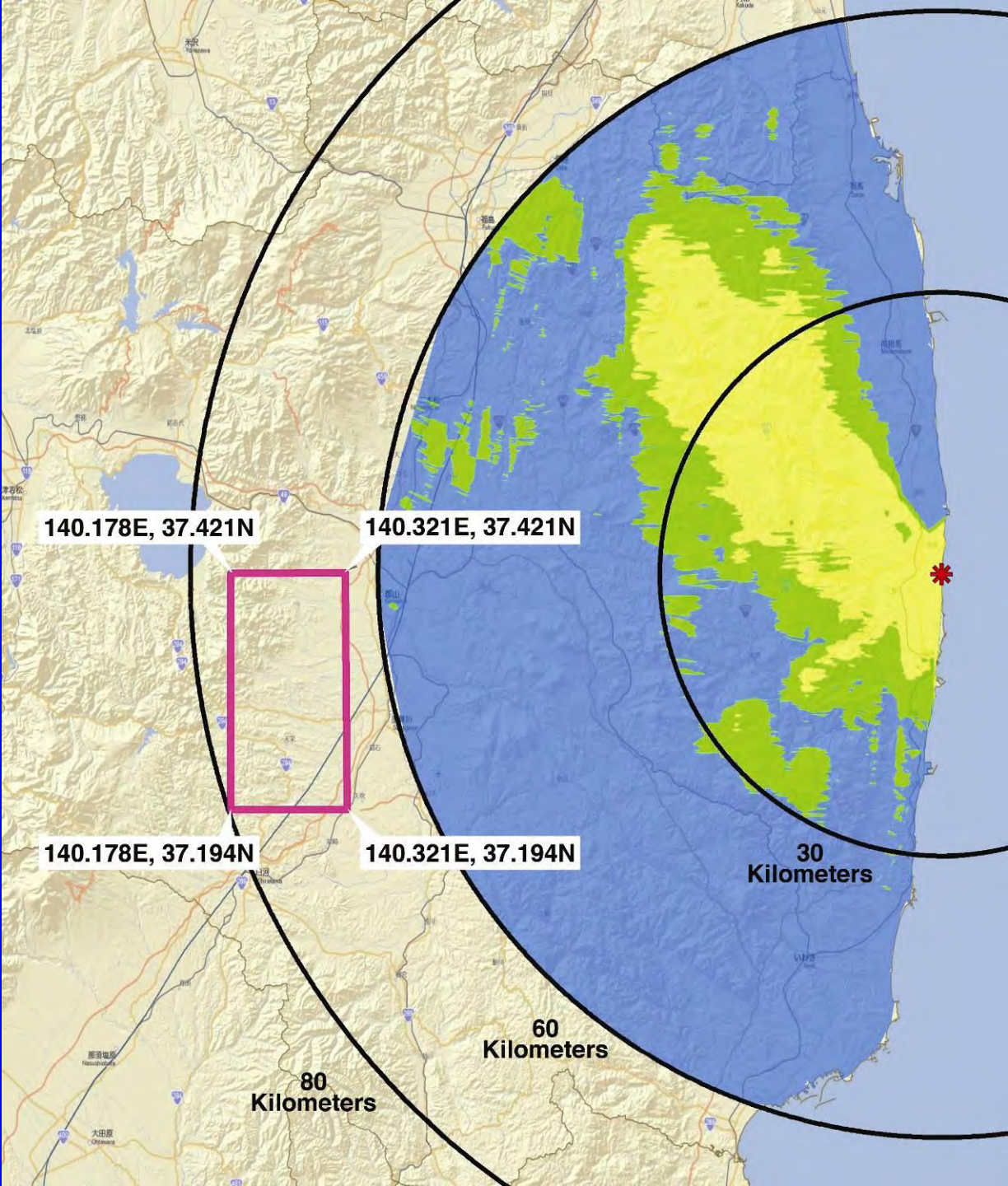


UH-1 Iroquois

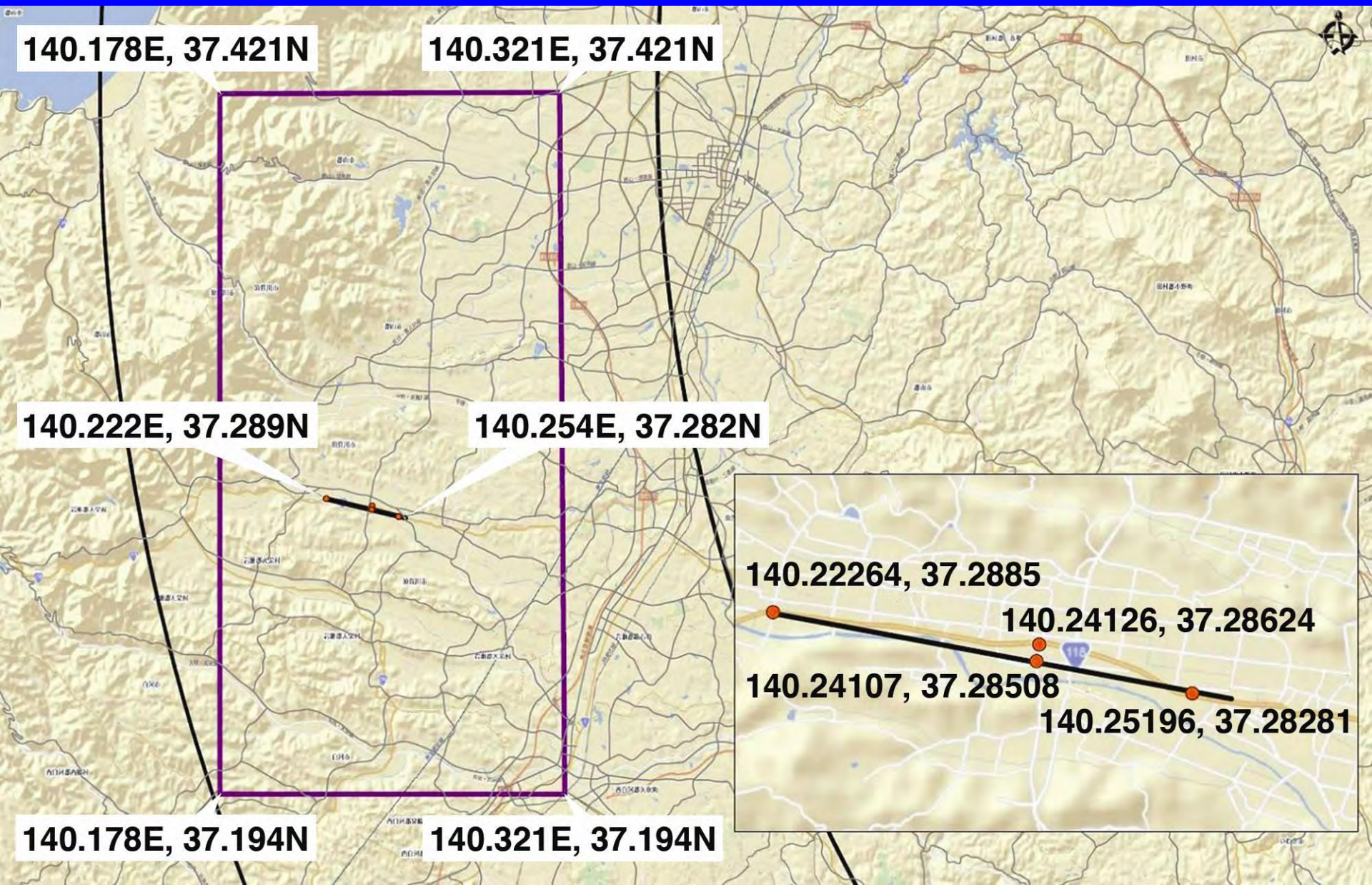
View from the Aerial Measuring System



Joint U.S. & Japan Flight Area & Test Line



Joint U.S. & Japan Flight Area & Test Line



2. Ground-Truth Measurements to Corroborate Aerial Data Did not Agree!



- Insitu spectrum on the Test Line converted to the Derived Response Level (DRL)
- Pressurized Ion Chamber on the Test Line was two times higher!!
- So what?

Two Views on Uncertainty

A. Comparison

- Measured exposure rate with the Pressurized Ion Chamber
- Exposure rate inferred from the isotopic mixture from *In situ*

Estimated uncertainty +/- 75%

B. Major sources of error

- Altitude correction +/- 30%
- Ground truth exposure rate +/- 20%
- DCF factors in calculation +/- 10%
- Radionuclide mix +/- 5%
- Deposition date +/- 2%
- Counting statistics +/- 1%

Estimate of quadrature sum of uncertainties +/- 40%

Not all representative of what aircraft “see”



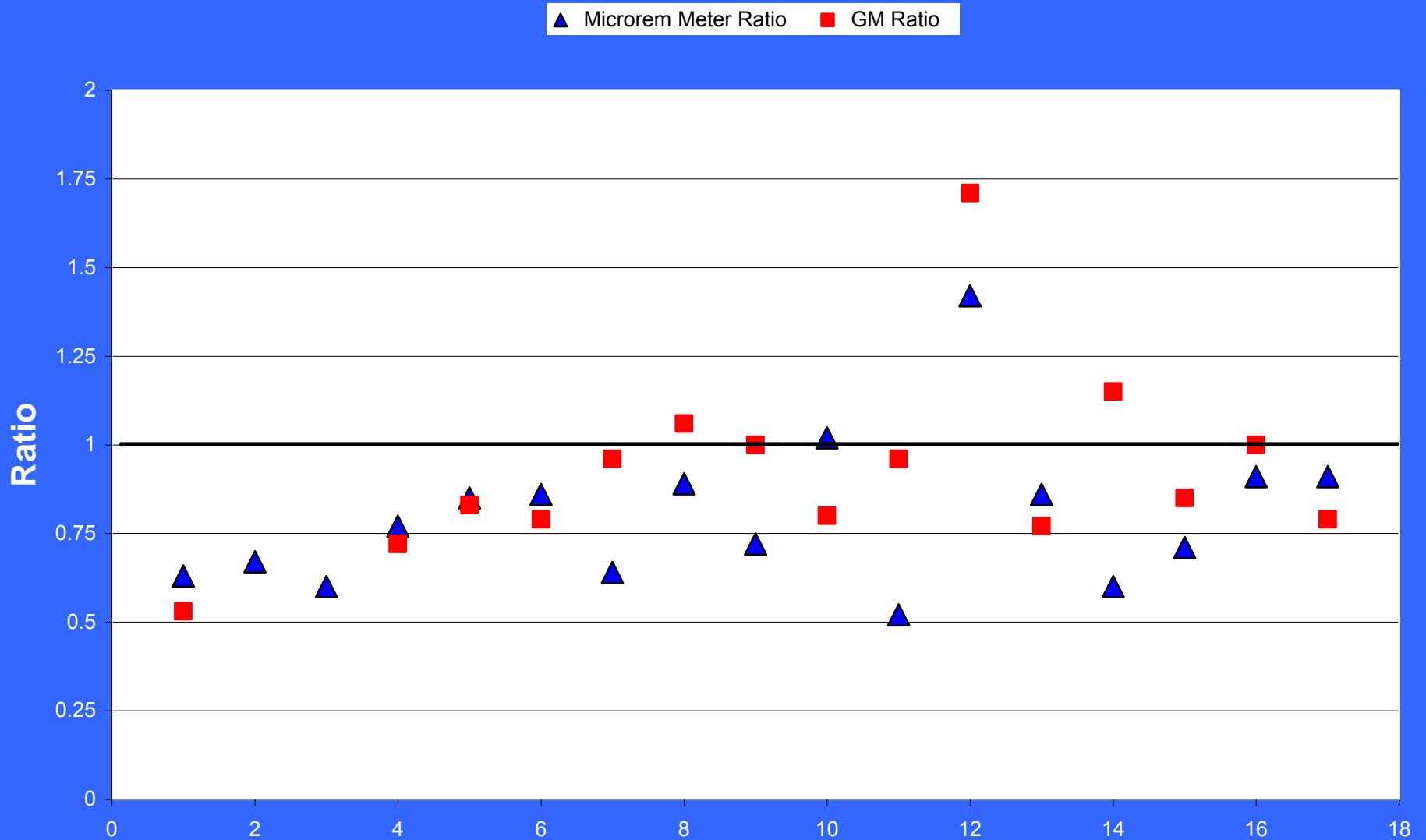
View from the Aerial Measuring System





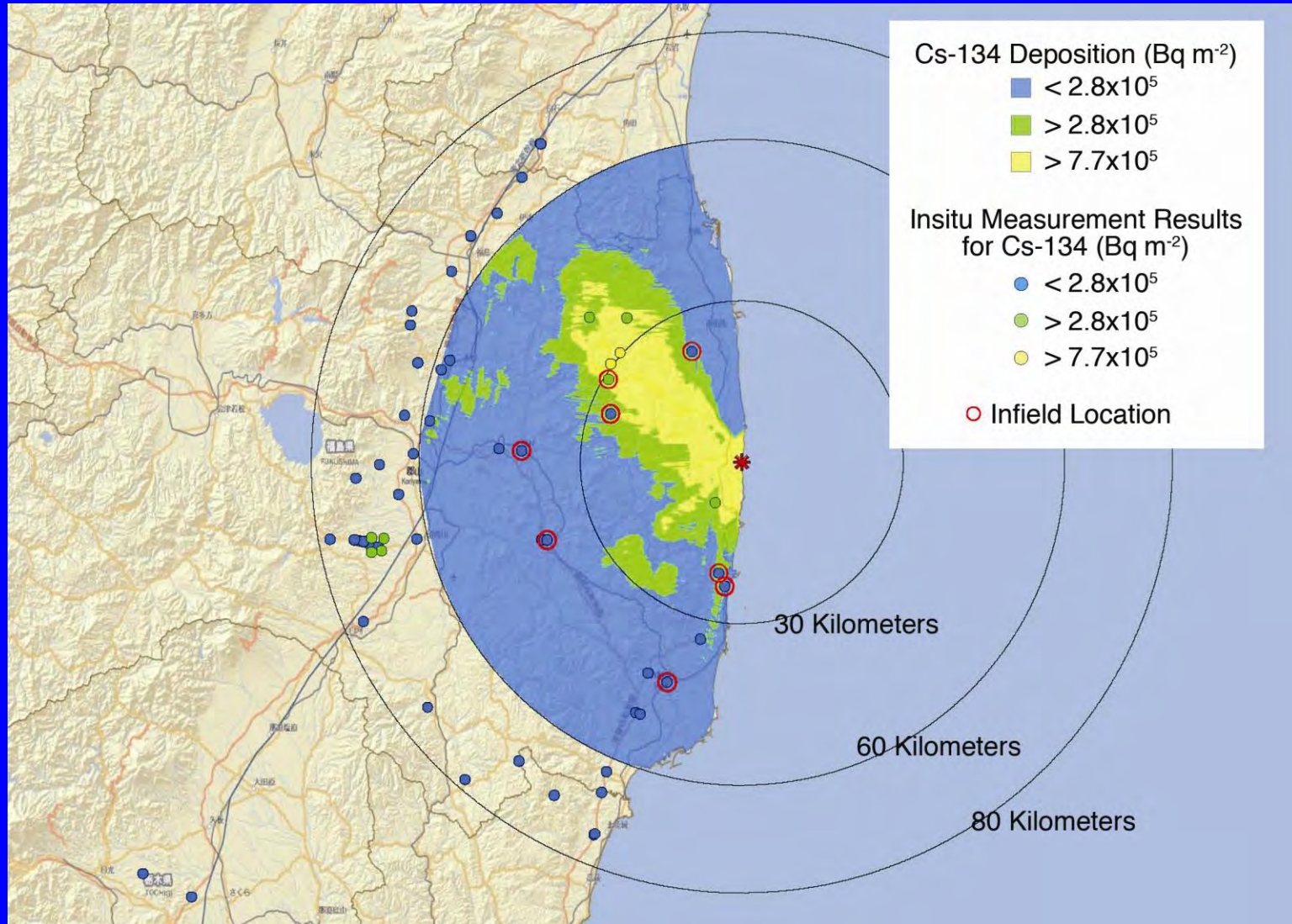


Ratio of Pavement to Undisturbed Vegetated Area

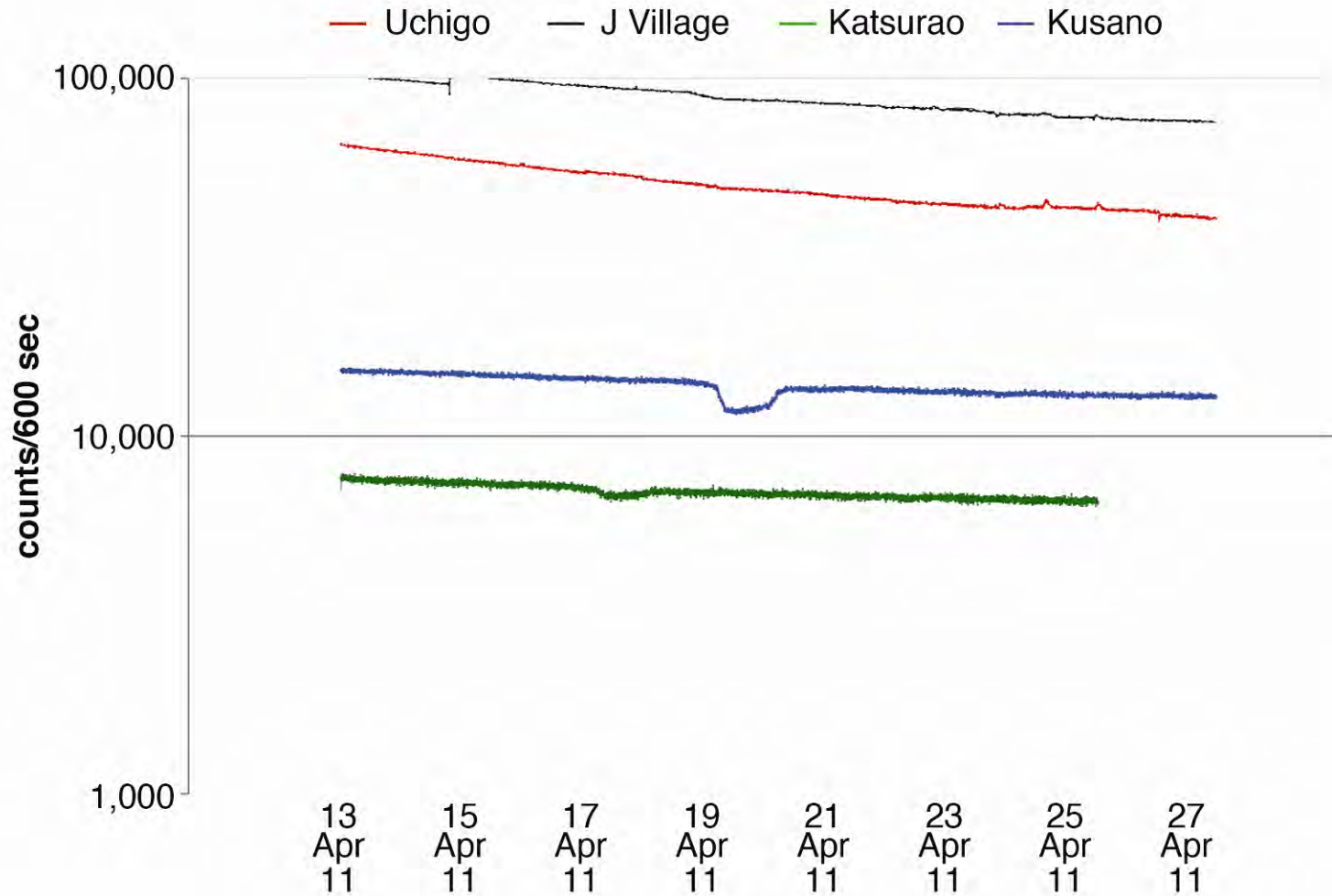


3. Rapid Decay at Fixed Monitors?

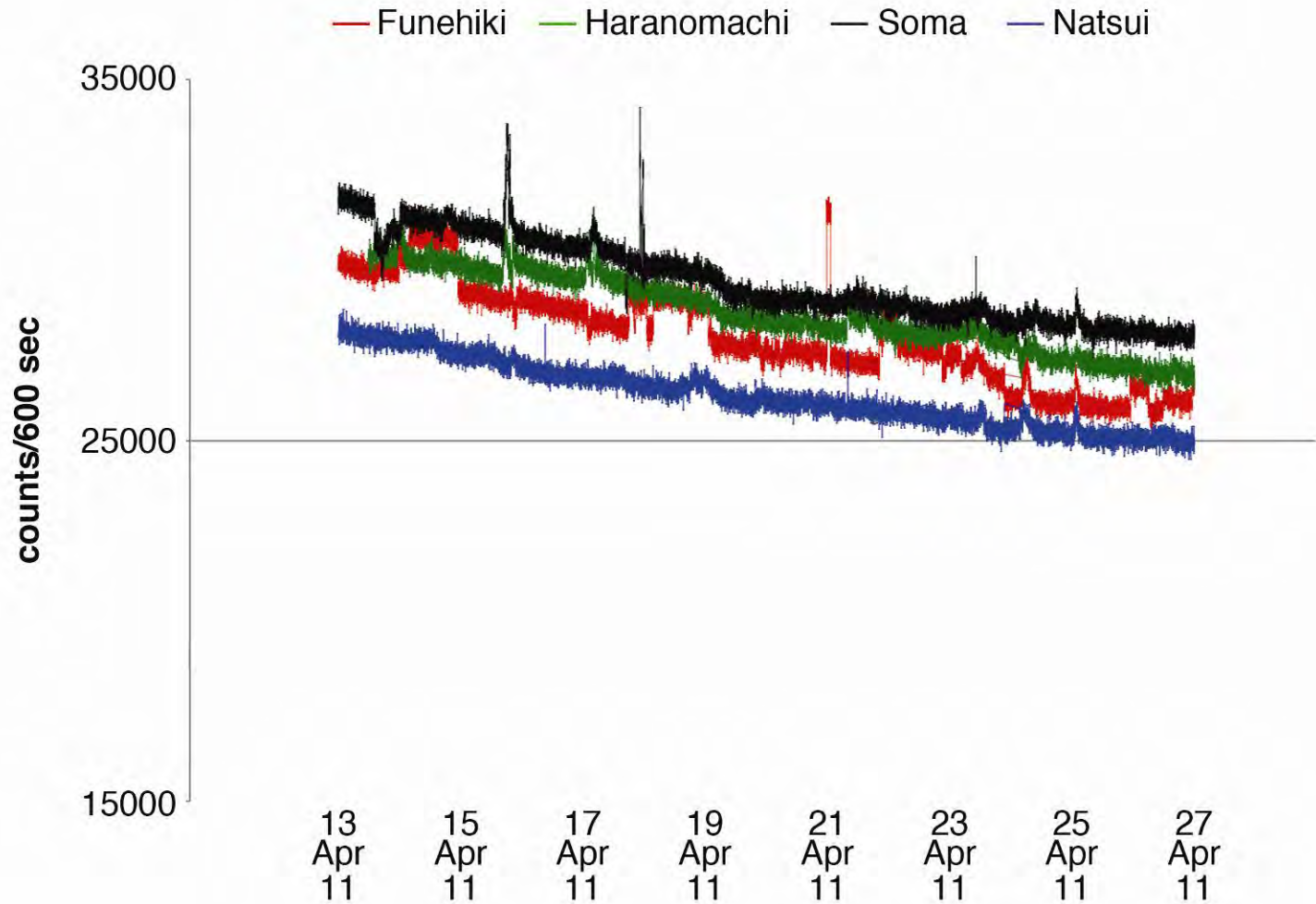
Fixed Monitors for Early Warning



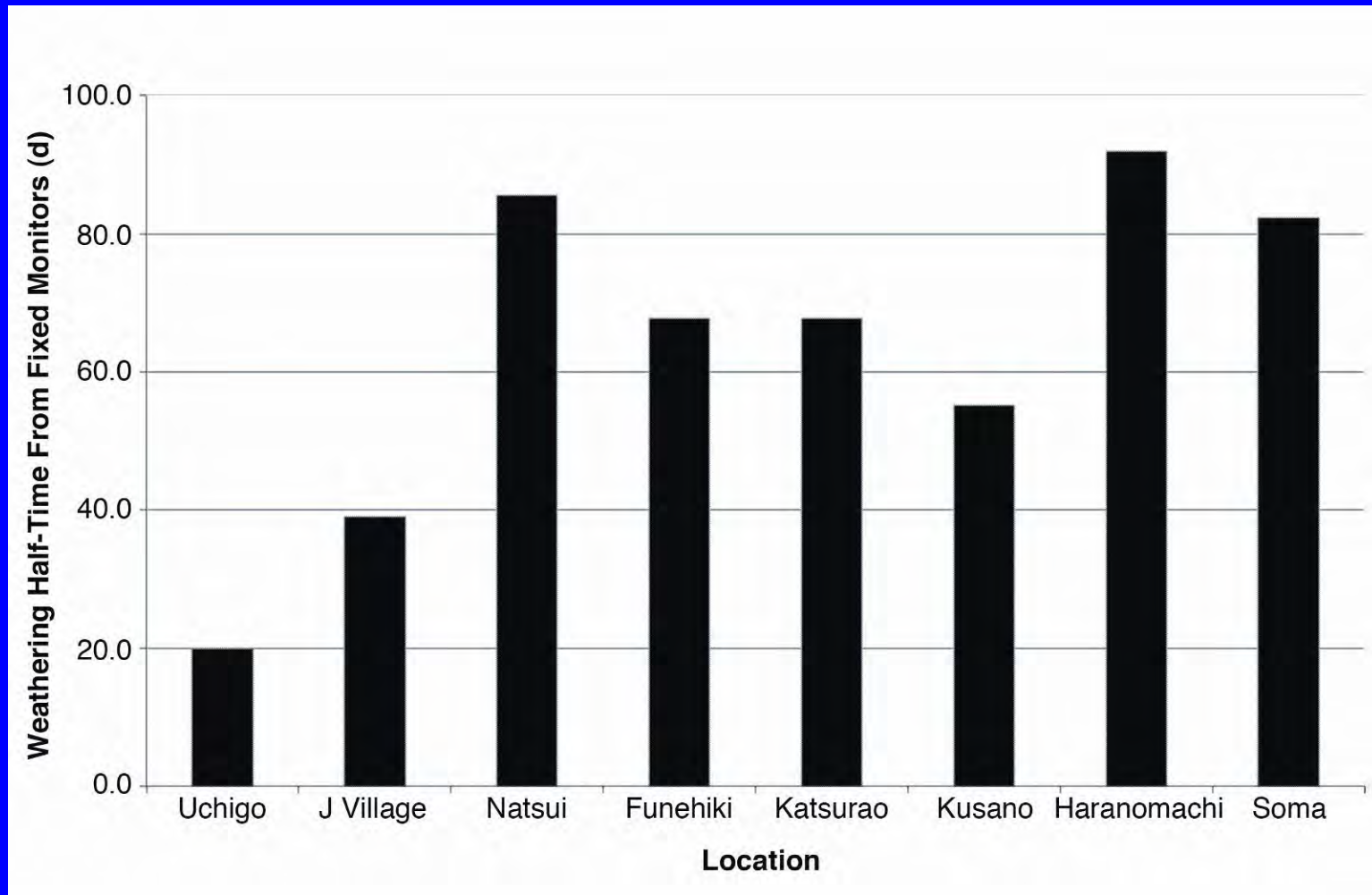
Rapid Decay?



Rapid Decay?



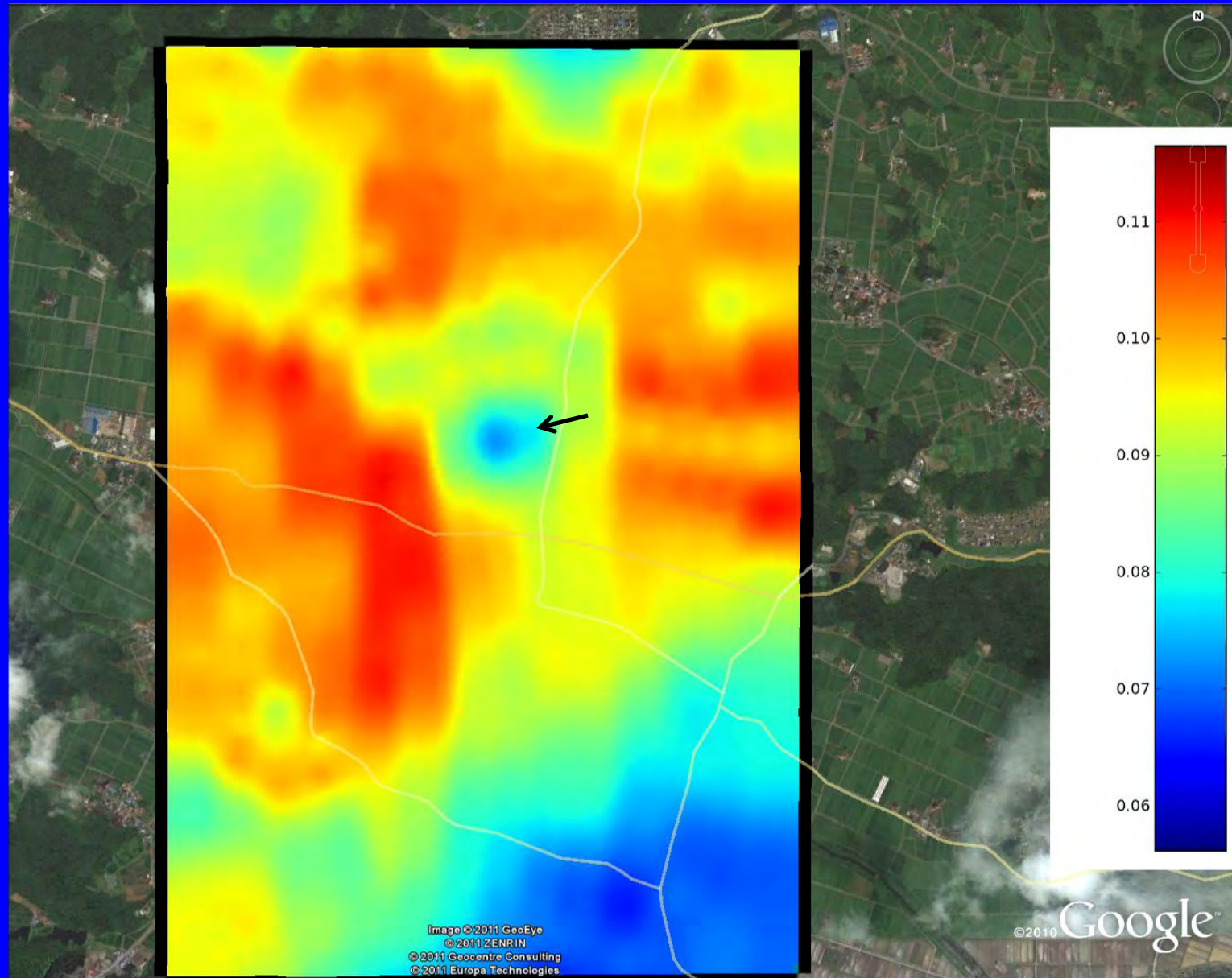
Weathering Half-times



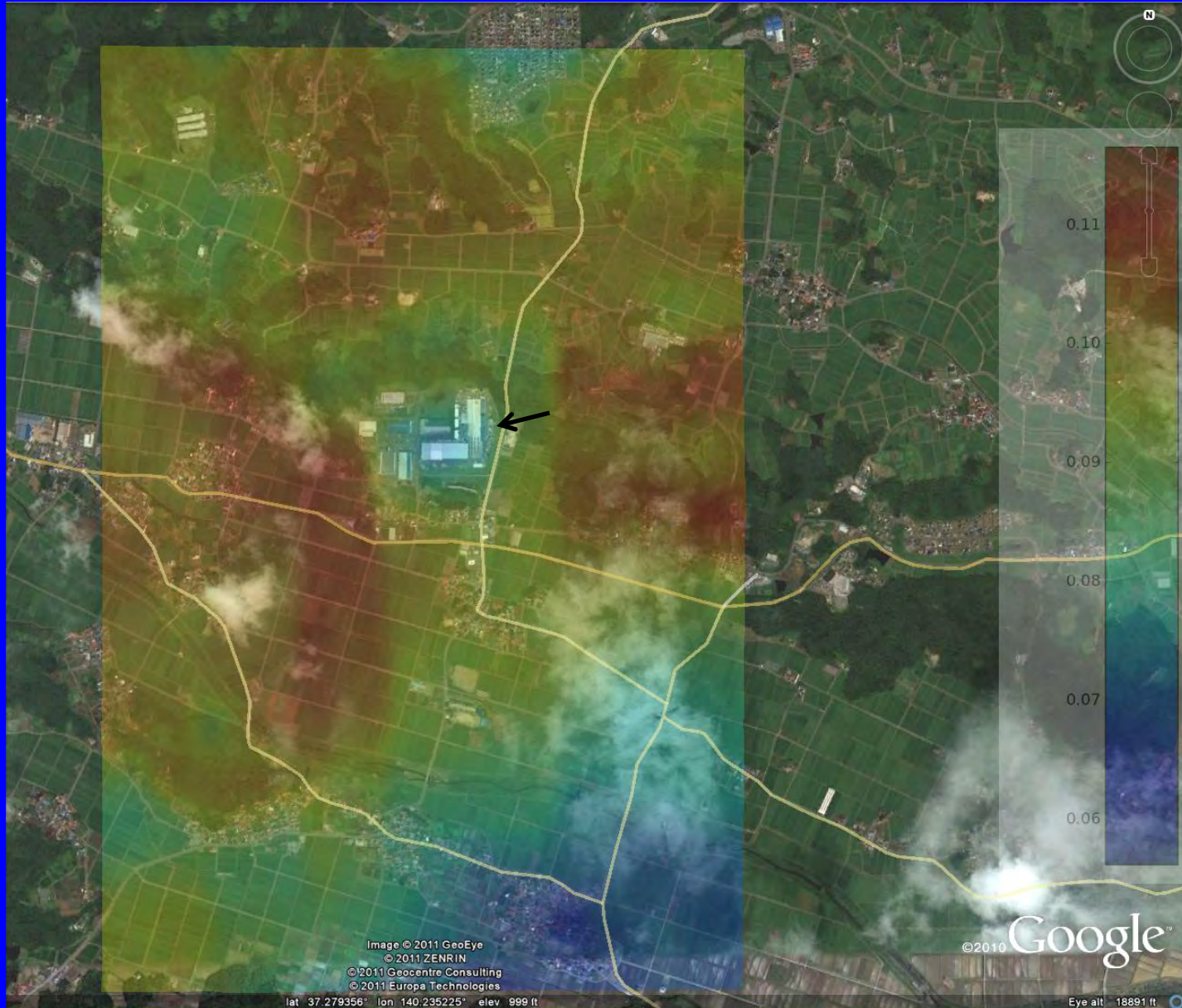
Detectors “see” Weathering



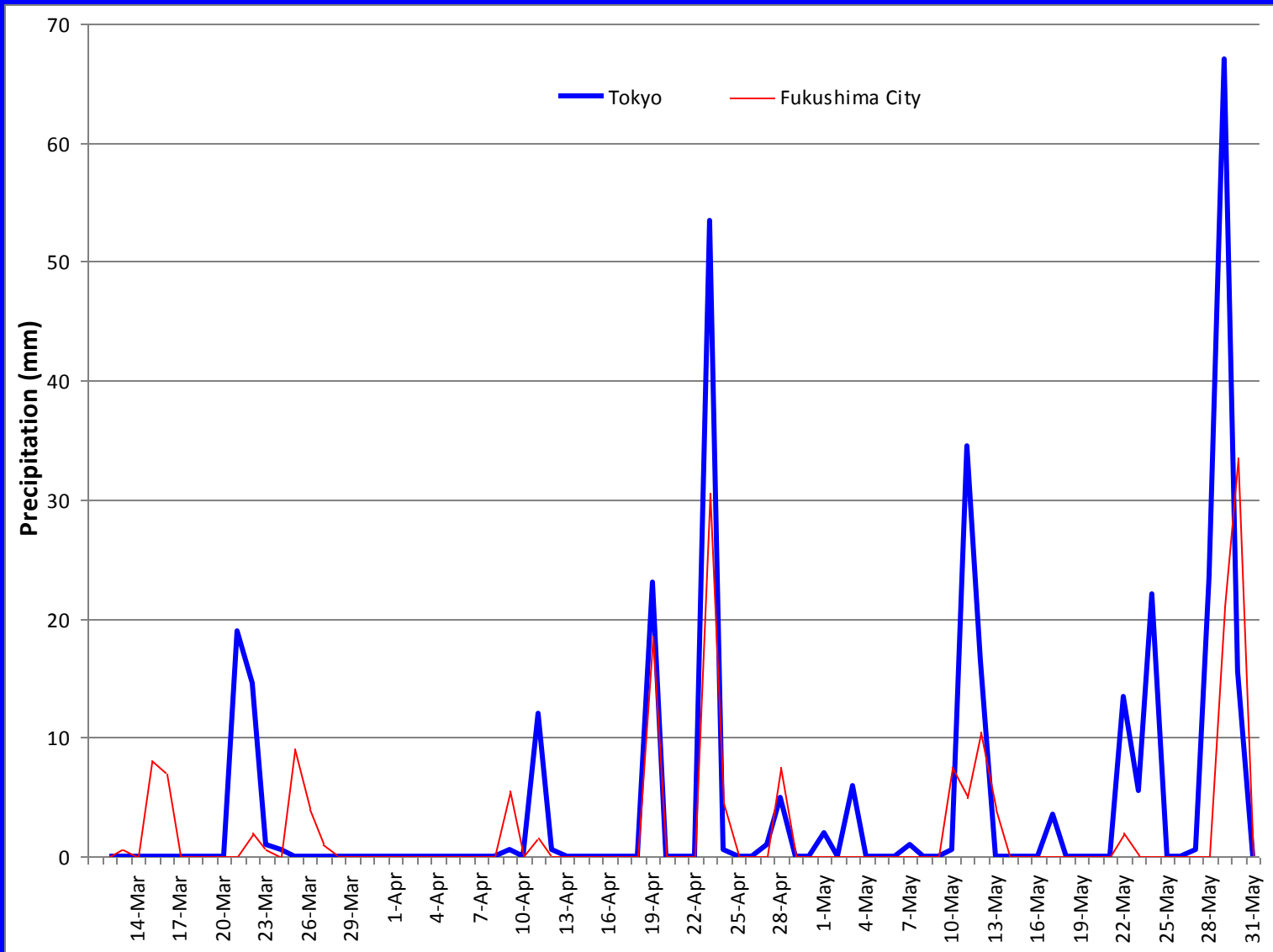
Real World Variation



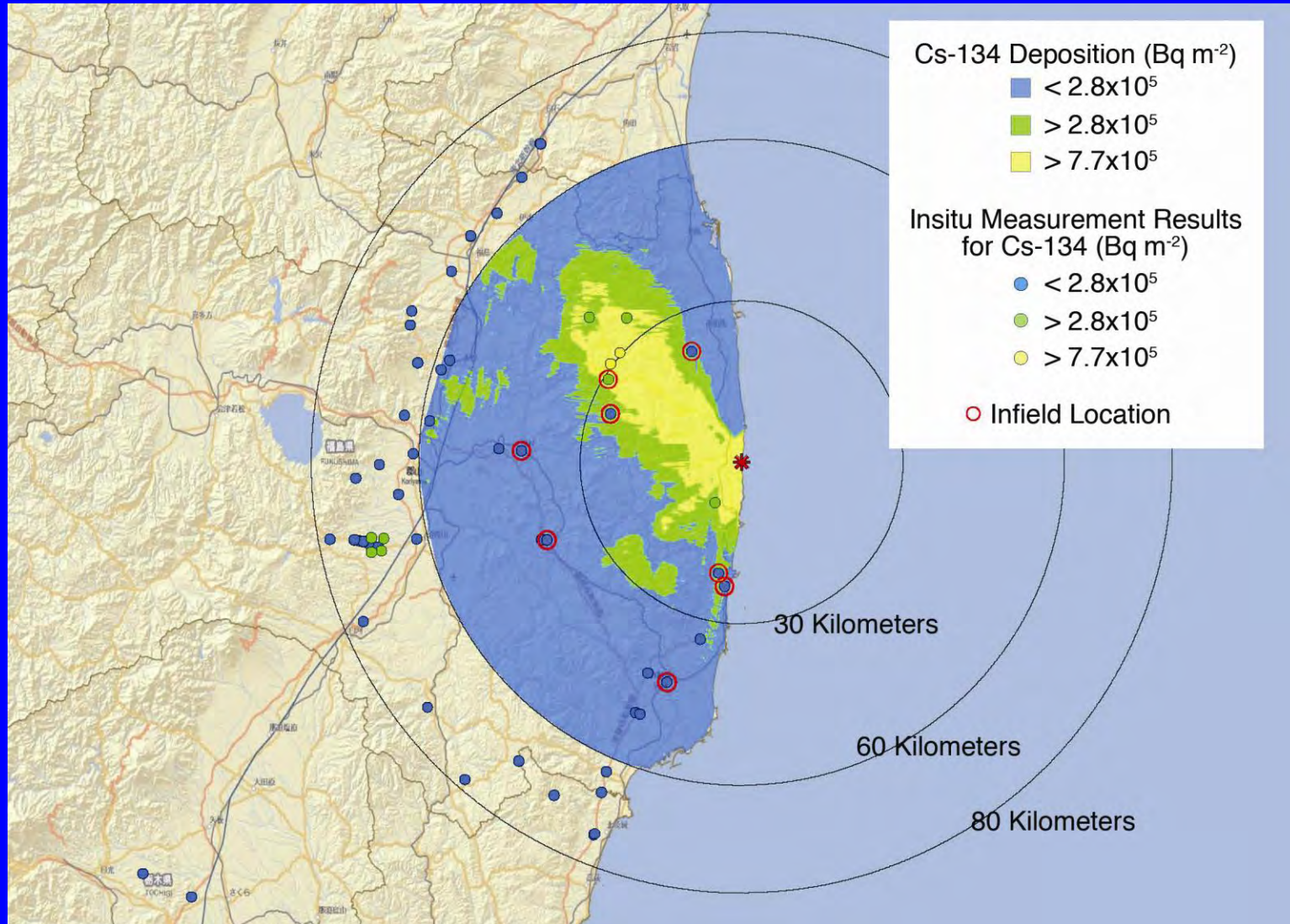
Real World Variation



Precipitation



Real World Variation



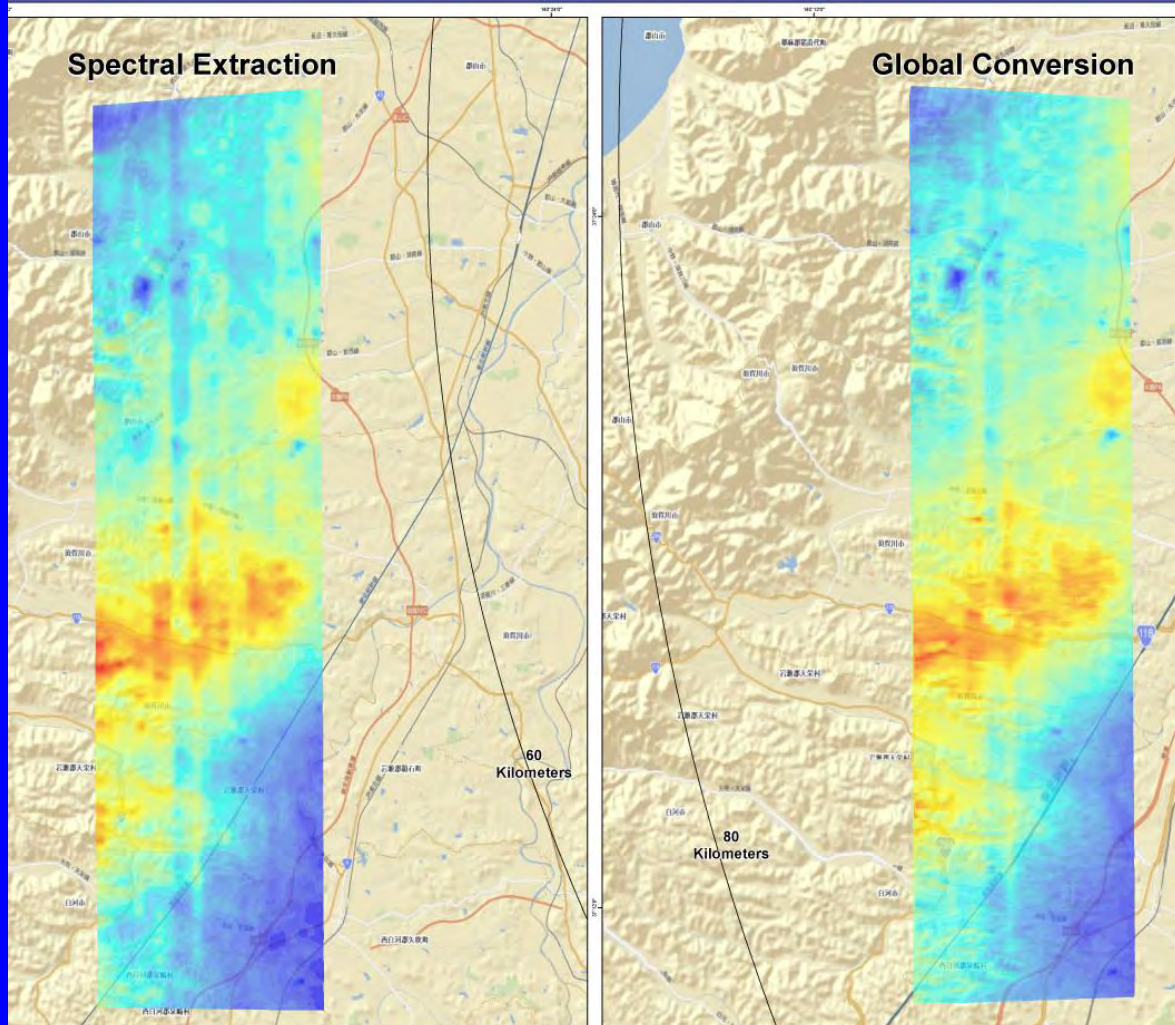
Data Validation

Test Box

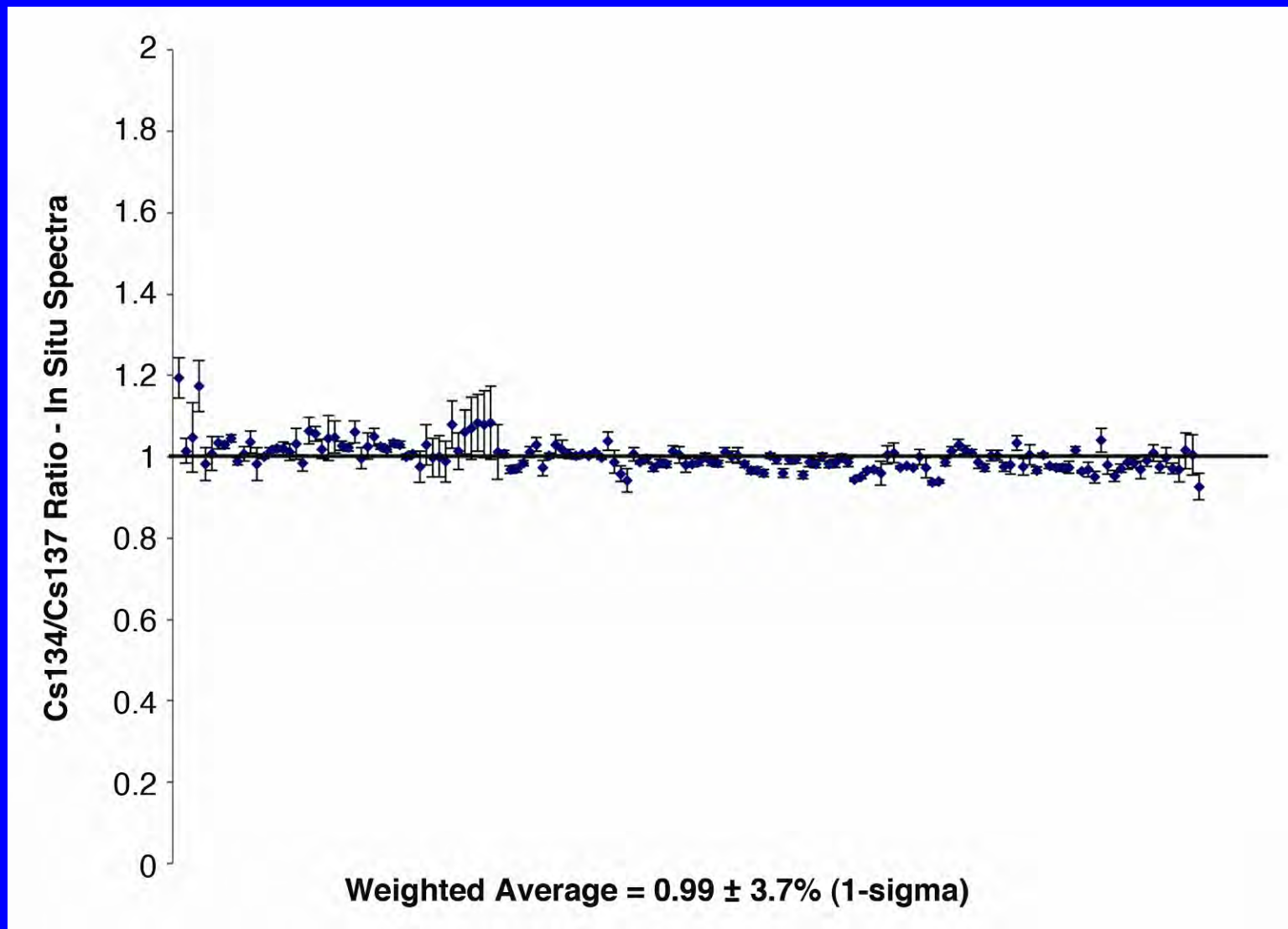
Spectral Extractions vs. Wide Window

Covert Spectrum to deposition

Calibrate spectrum with in situ



$^{134}\text{Cs}/^{137}\text{Cs}$ Ratio – In Situ Spectra



$^{134}\text{Cs}/^{137}\text{Cs}$ Ratio – Air Filters

