



Radionuclide Concentrations in Food and the Environment

Kathryn Higley, PhD, CHP

Professor and Head

Nuclear Engineering & Radiation Health Physics

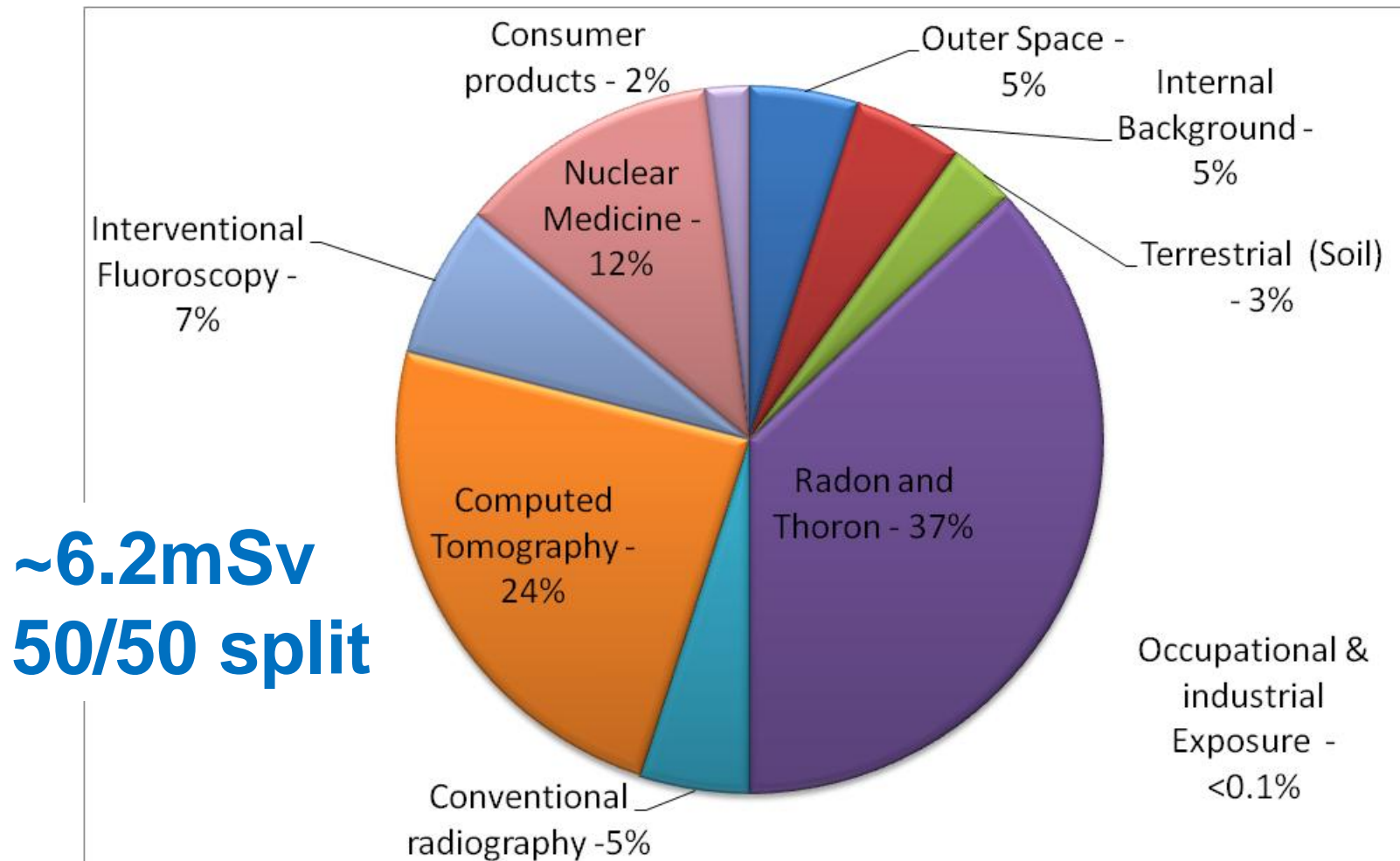
Presented at the 20th Annual Meeting of the Council on Ionizing Radiation
Measurements and Standards

Public Perception of Ionizing Radiation

Outline

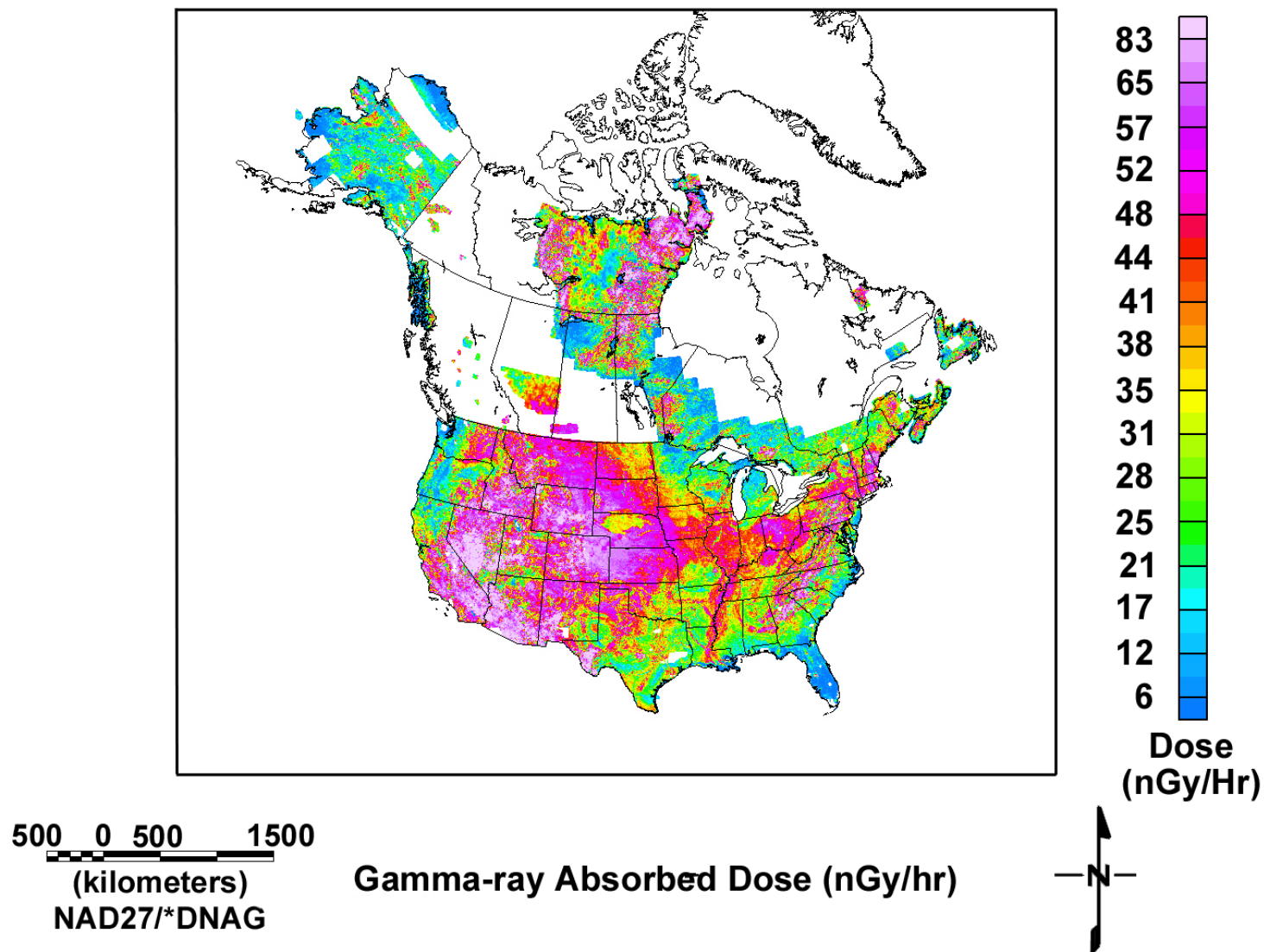
- Review sources of radiation/radionuclides
- Examine concentrations and resultant doses
- Put in context of current events
- Where to go for more information

Sources of Radiation Exposure in the US

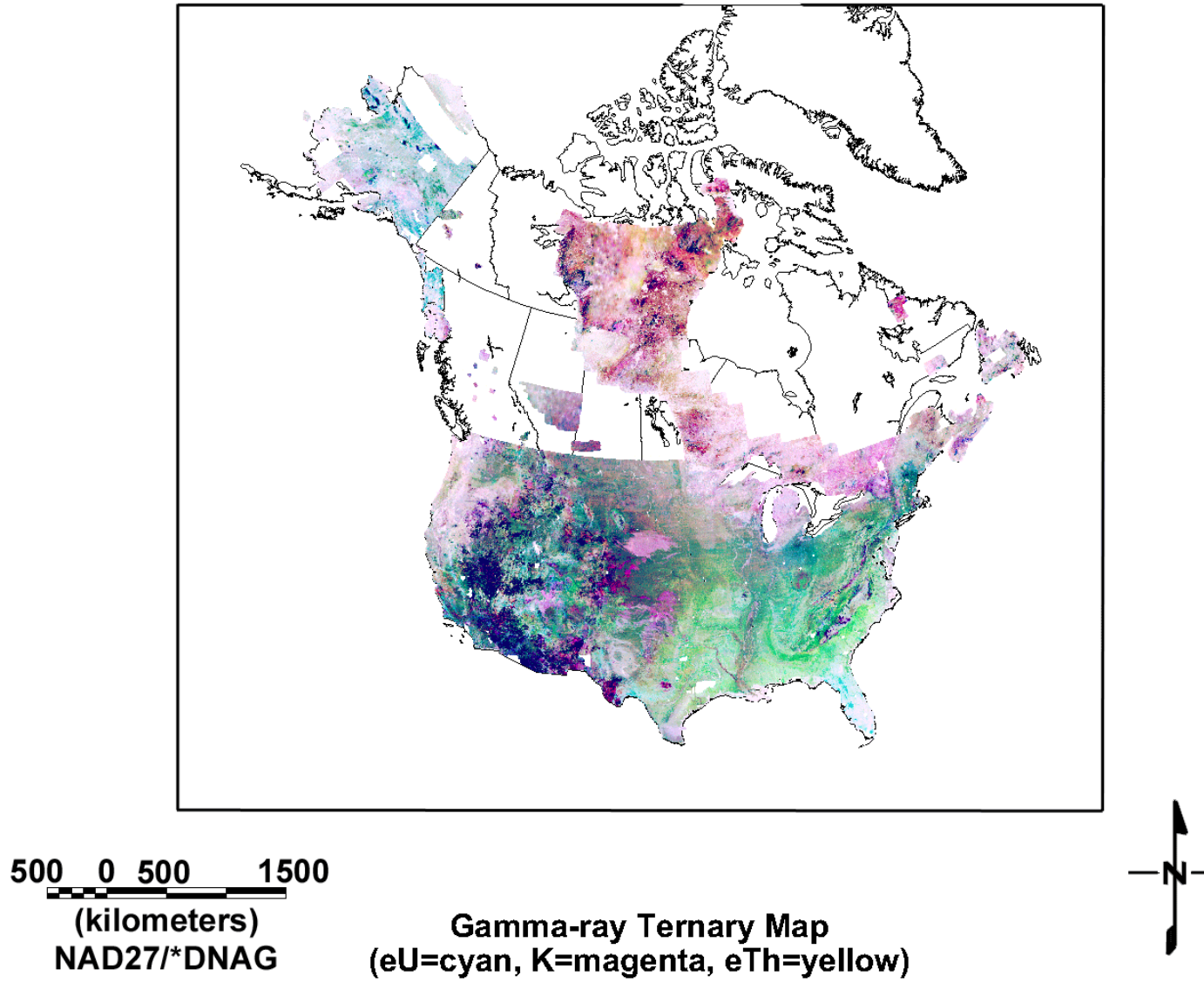


Source NCRP Report 160, 2009

Terrestrial Distribution of Absorbed Dose



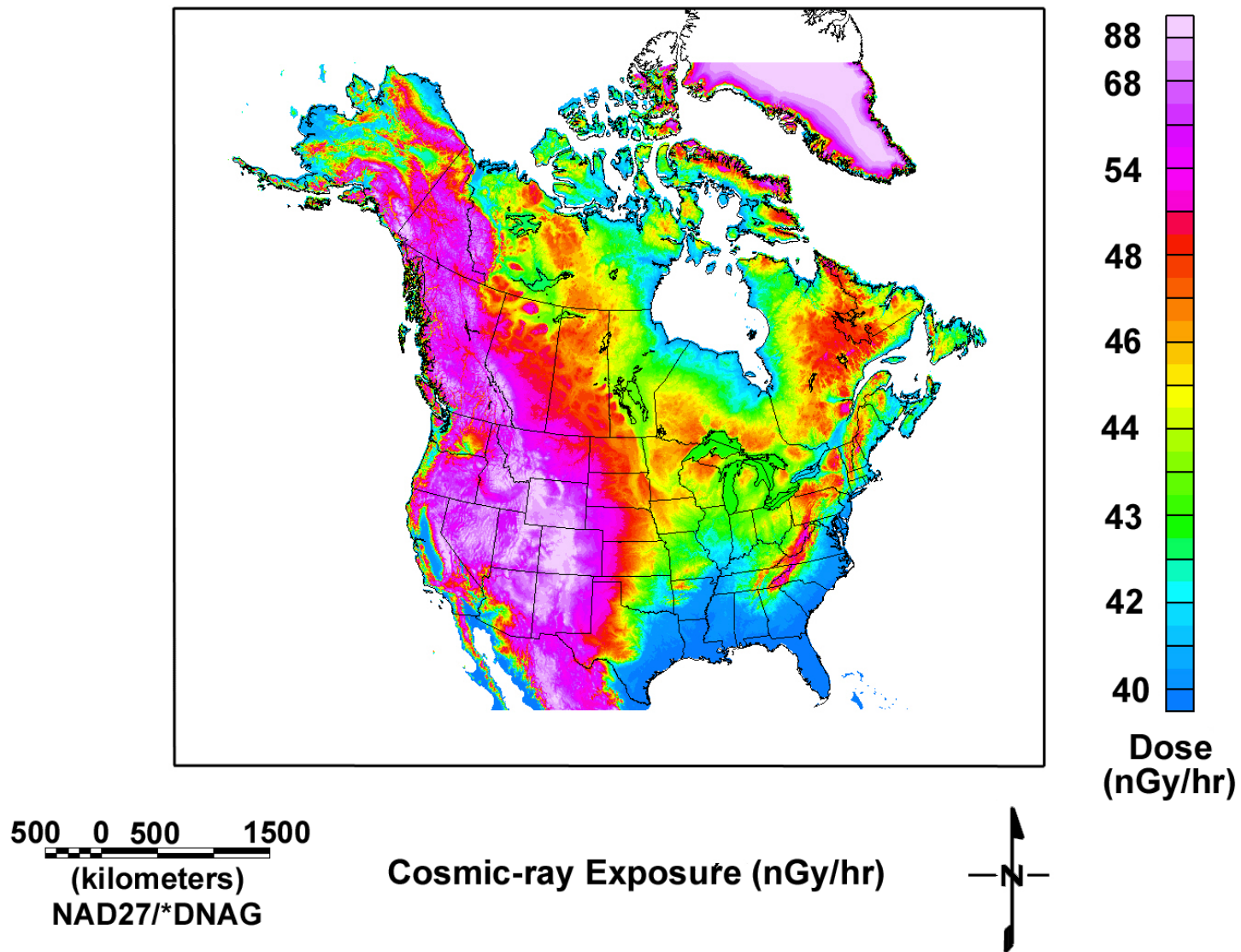
Contributors to Gamma Exposures



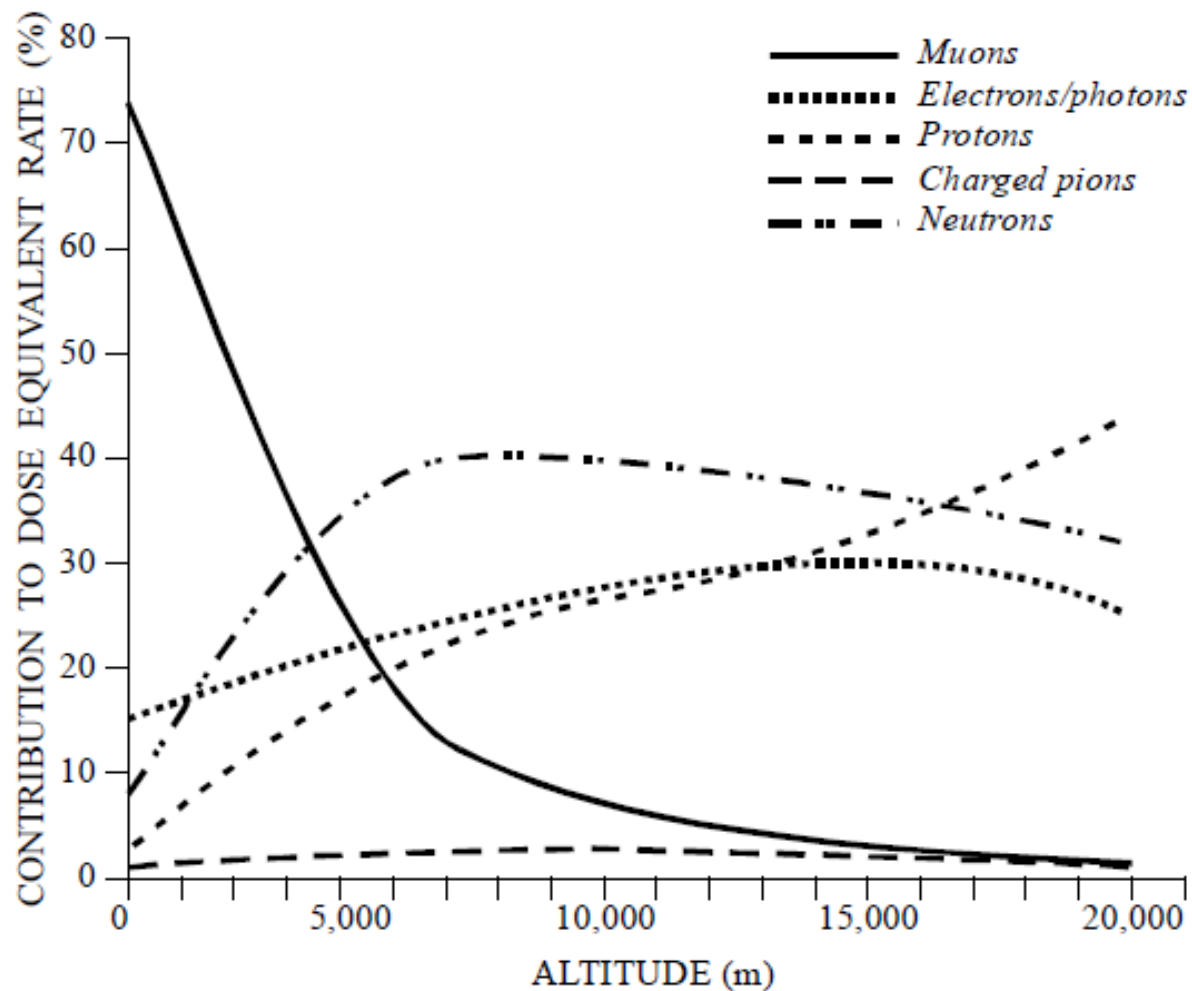
Natural Radionuclide Content in Soil and Resultant External Dose

Radionuclides	Concentration in soil (Bq kg ⁻¹) ^a	Absorbed dose rate in air (nGy h ⁻¹) ^a
⁴⁰ K	420	18
²²⁸ U series	33	15
²³² Th series	45	27
Total		60 ^a
^a Population-weighted value		

Cosmic Ray Exposures

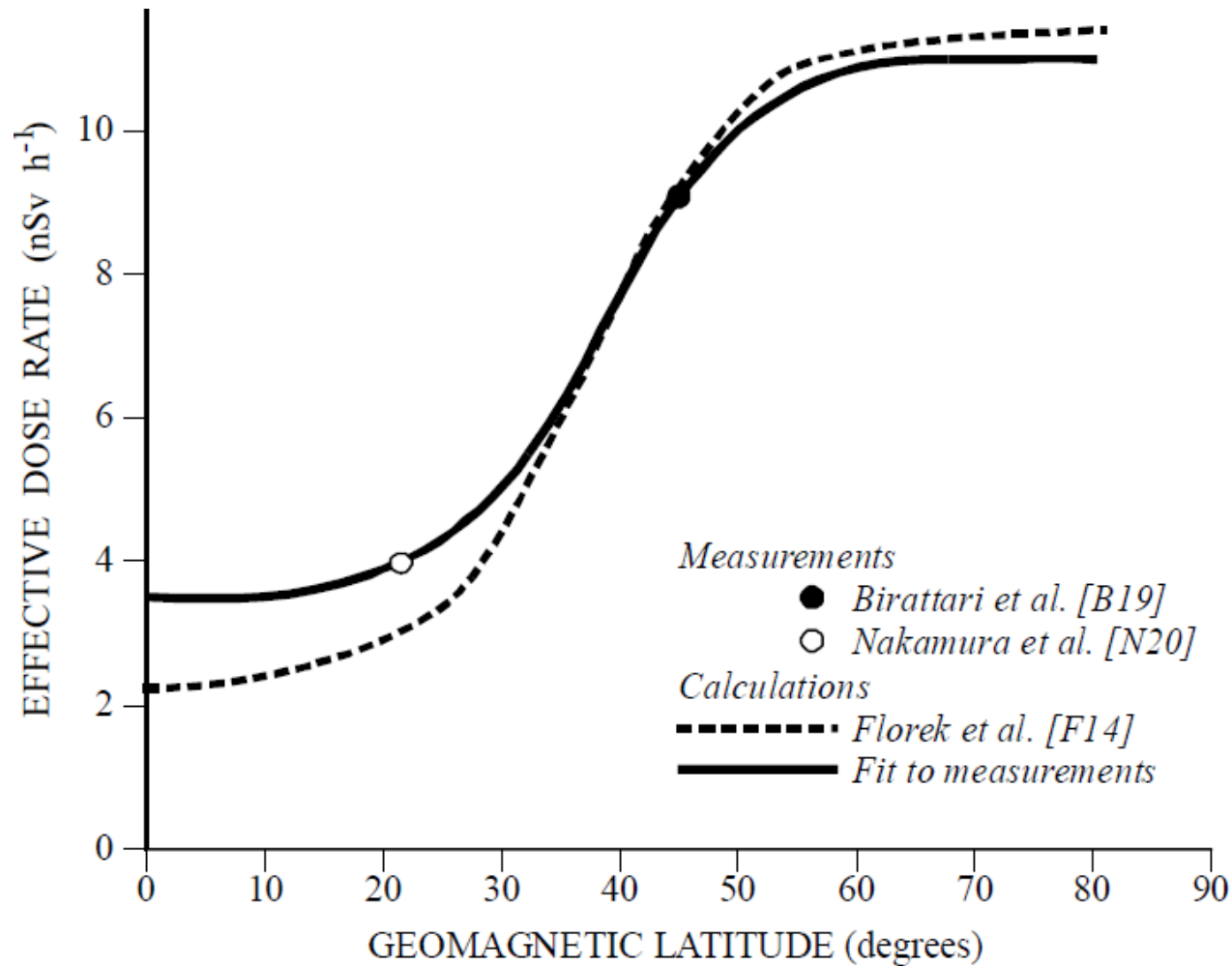


Altitude Effects on Cosmic Dose Rate

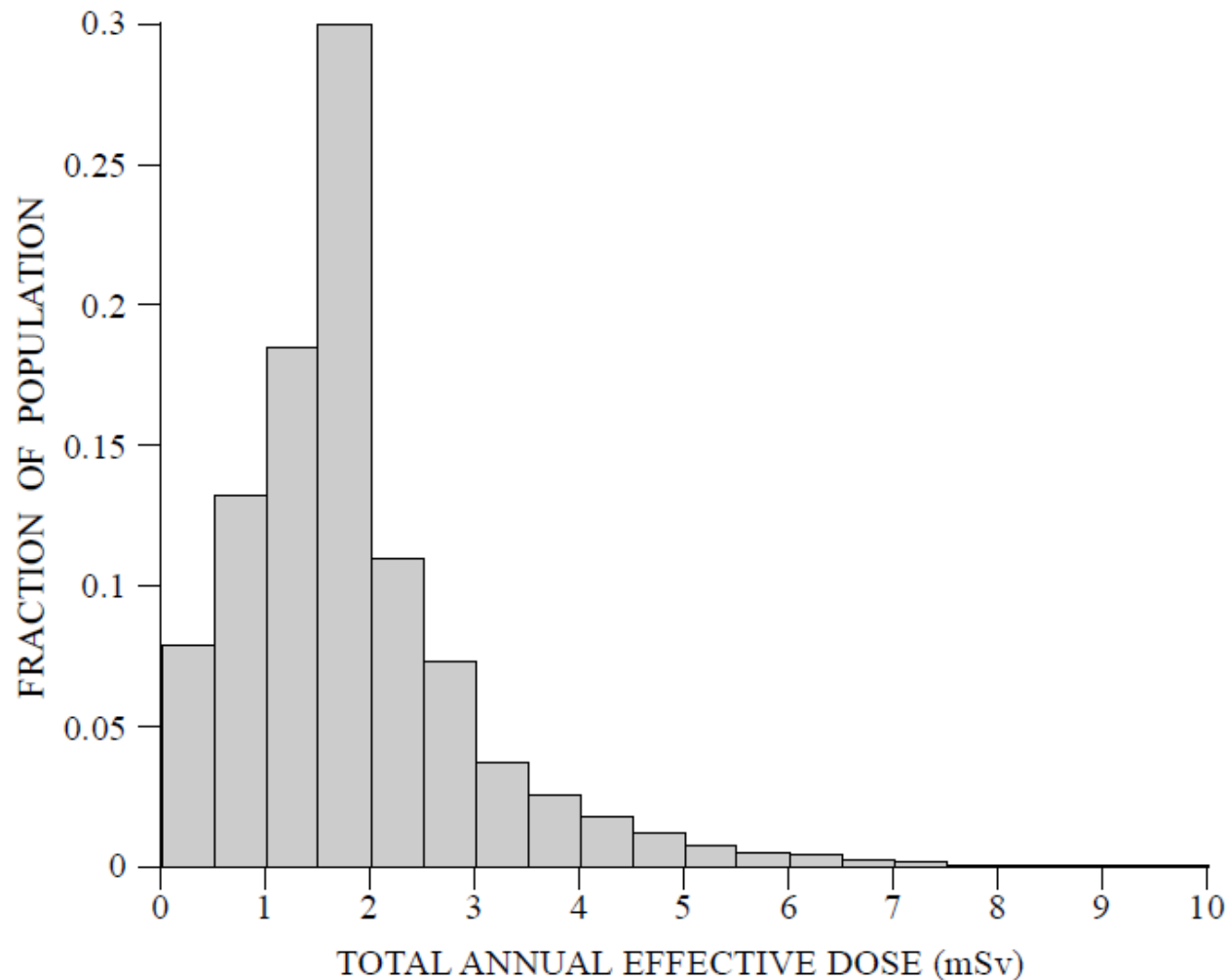


UNSCEAR, 2000 , Annex B, Exposures from natural radiation sources

Latitude Variation in Dose Rate



Net effect: distribution of total annual effective doses (15 countries).

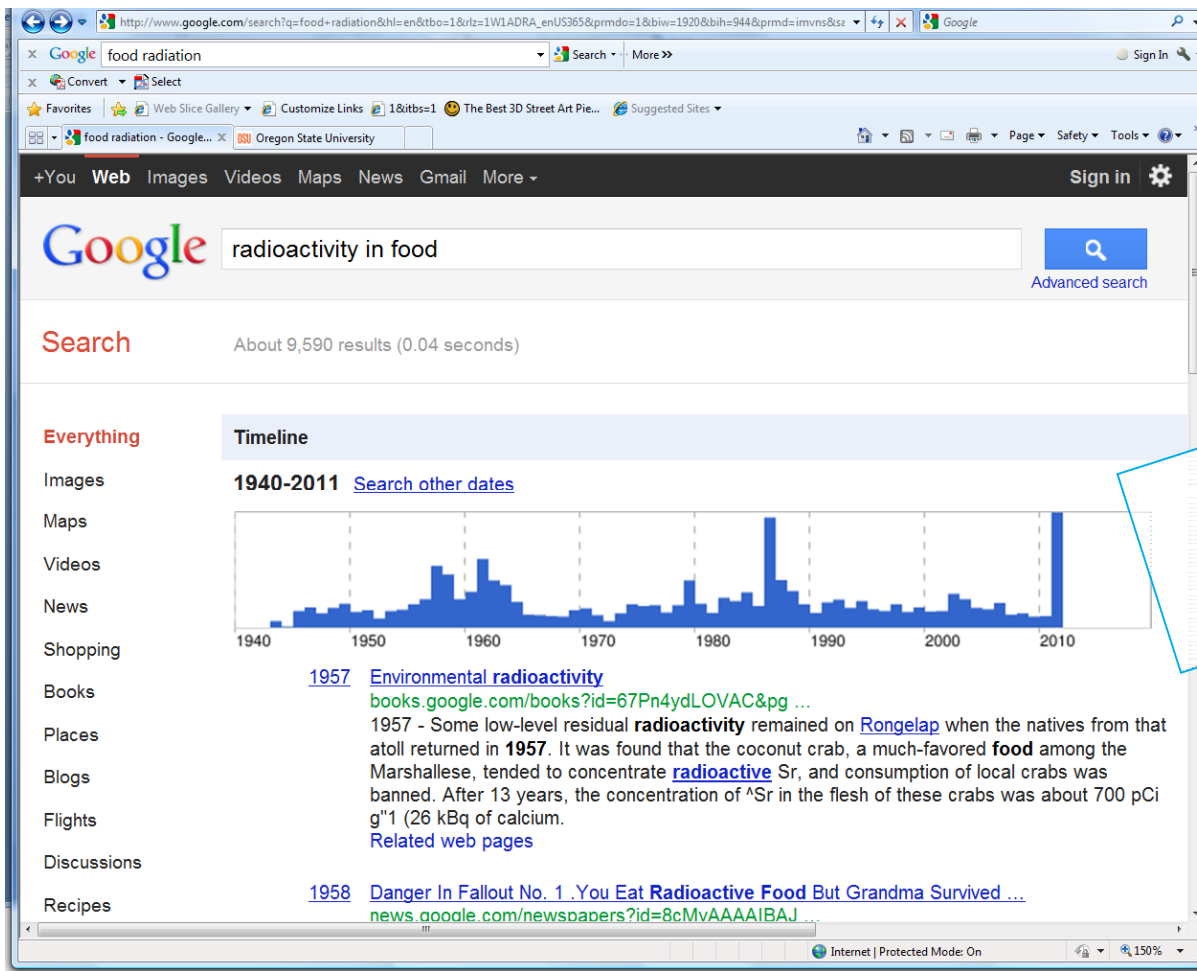


UNSCEAR, 2000 , Annex B, Exposures from natural radiation sources

Intermission with Musings

- 8 months ago
- In the context of “Public Perception of Radiation”
- This would have been an extremely ~~boring~~ dry talk.
 - Educational
 - Largely academic interest

What could pique anyone's interest in radioactivity in food or the environment?



Go to:

Google

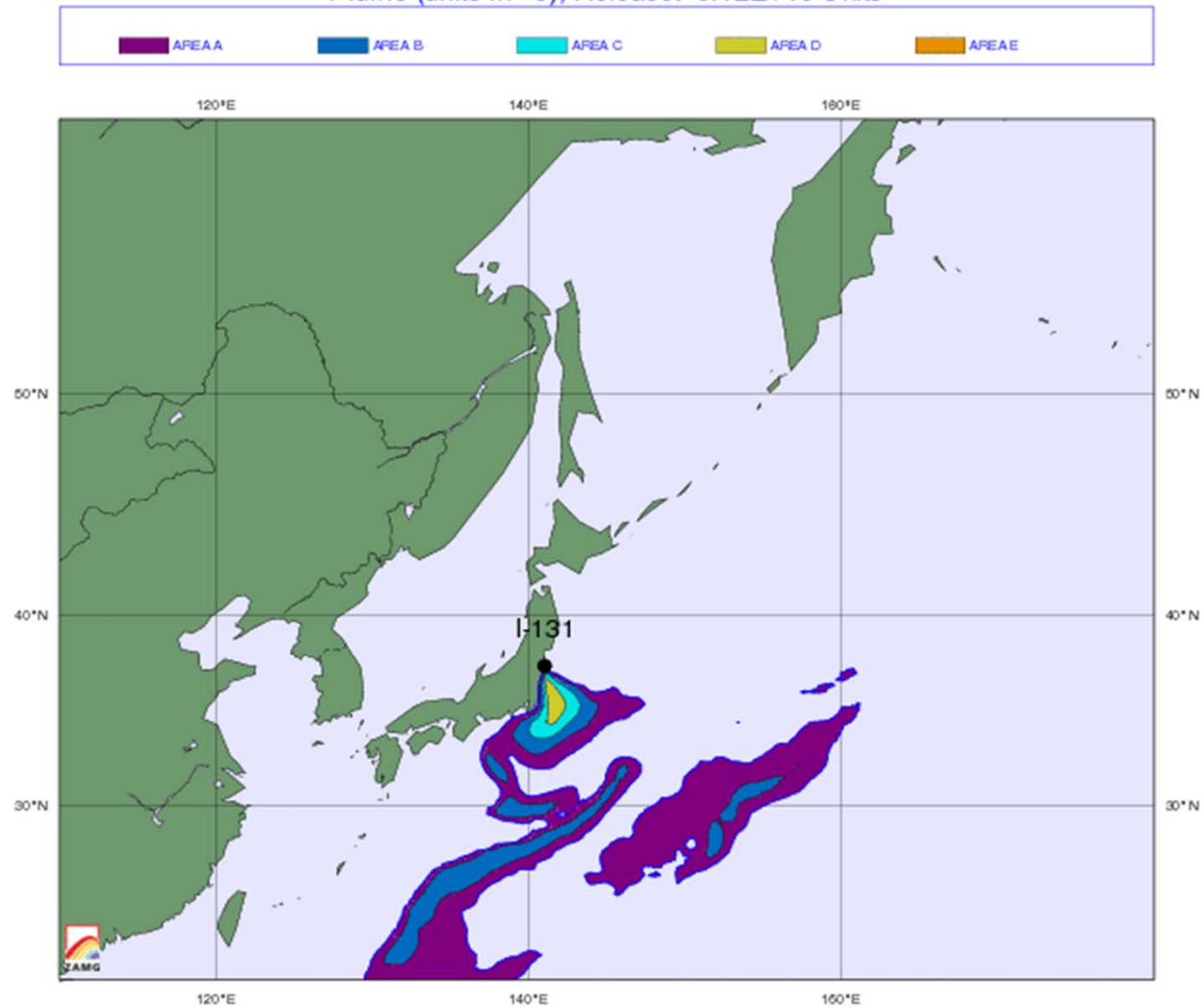
One word: **Fukushima**



AKW_FUKUSHIMA-I-131

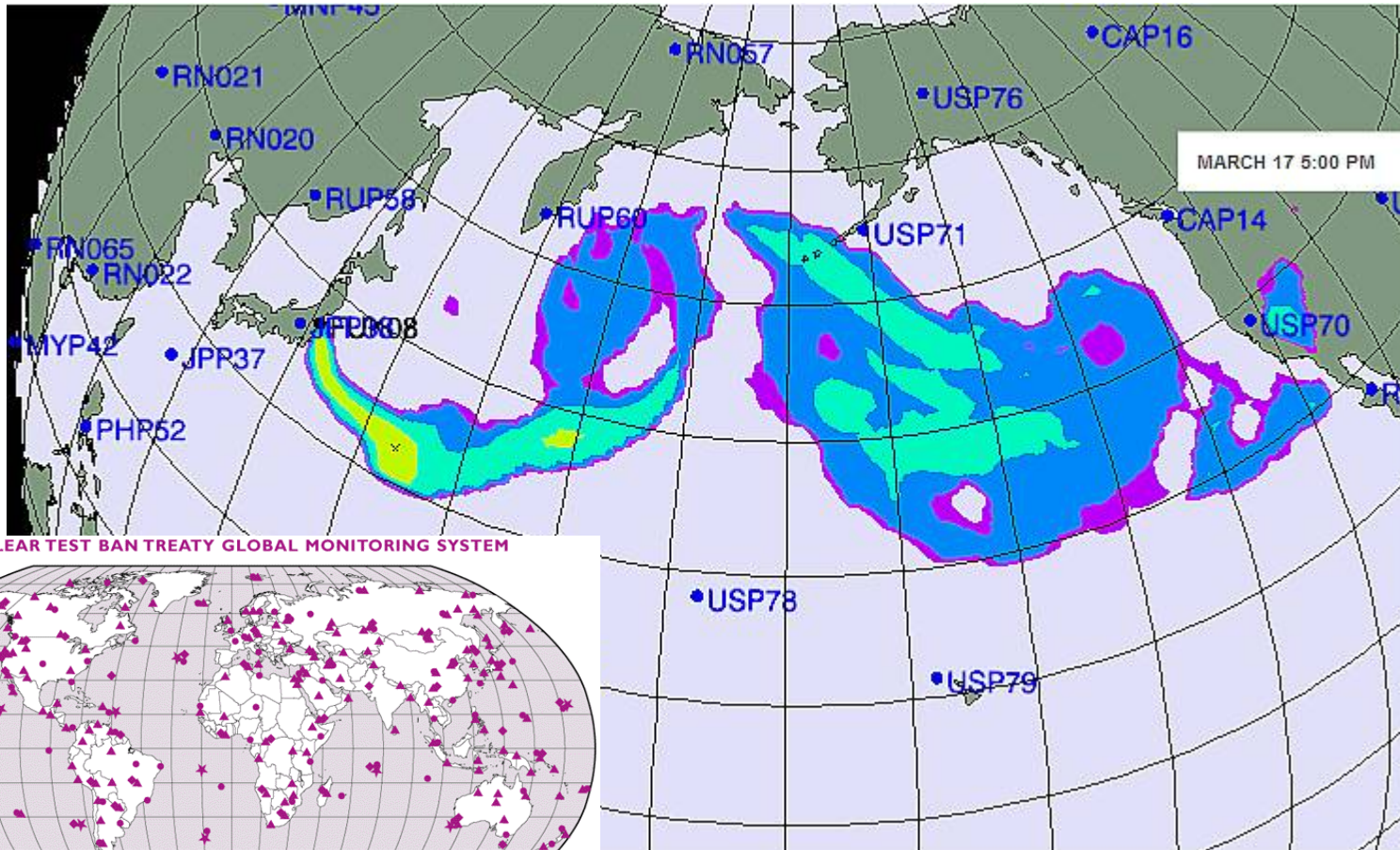
20110404-000000

Plume (units m^{-3}), Release: $0.12\text{E}+19$ Units

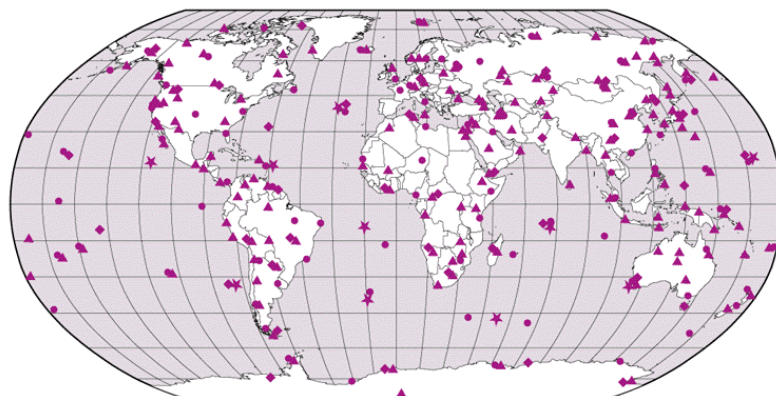


http://www.zamg.ac.at/pict/aktuell/20110404_fuku_I-131.gif

Comprehensive Test Ban Treaty Sites



NUCLEAR TEST BAN TREATY GLOBAL MONITORING SYSTEM



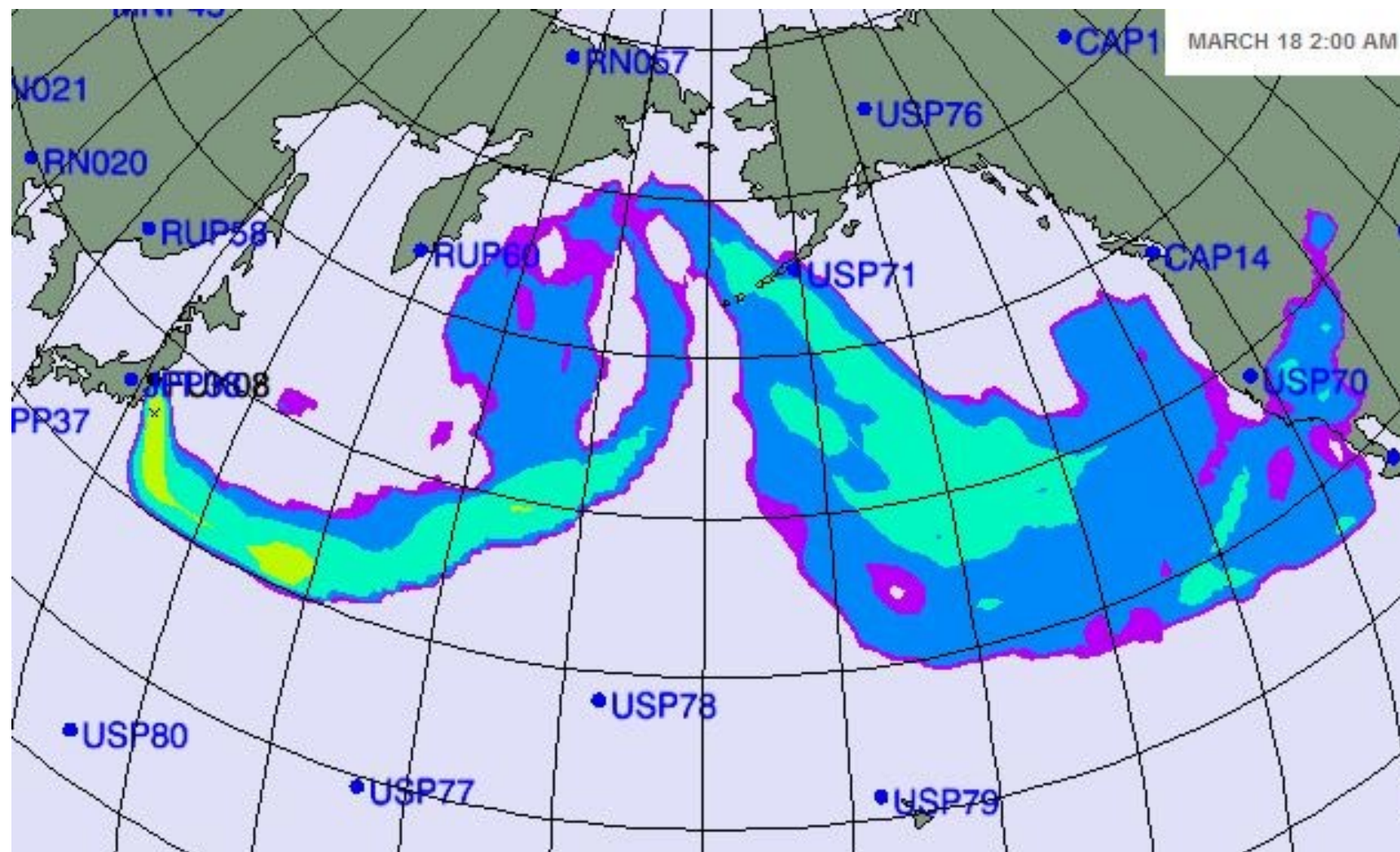
▲ Seismic ● Radionuclide ★ Hydroacoustic ◆ Infrasound

Worldwide, the International Monitoring System will consist of 321 monitoring facilities to help detect possible violations to the comprehensive nuclear test ban treaty. Approximately one-third of the planned monitoring stations are currently operational.

Sources: Coalition to Reduce Nuclear Dangers; US Department of Defense

Oregon State
UNIVERSITY

<http://www.ctbto.org/press-centre/newsletters/newsletters/the-11-march-japan-disaster/>



MONDAY, APRIL 11, 2011

“Radiation Detected In Drinking Water In 13 More US Cities”



“Radiation Detected In Drinking Water In 13 More US Cities”

by Jeff McMahon

“Radiation from Japan has been detected in drinking water in 13 more American cities, and cesium -137 has been found in American milk—in Montpelier, Vermont—for the first time since the Japan nuclear disaster began, according to data released by the Environmental Protection Agency late Friday. Milk samples from Phoenix and Los Angeles contained iodine-131 at levels roughly equal to the maximum contaminant level permitted by EPA, the data shows. The Phoenix sample contained

Japan Radiation Contaminates Food Sent Beyond Affected Area



(ABCNEWS.com)

<http://abcnews.go.com/Health/Wellness/japan-radiation-food-contamination/story?id=13185149>

SCIENCE -- March 22, 2011 at 10:20 AM EDT

Radiation in Japan's Food Supply: Dangerous or Benign?

BY: JENNY MARDER

 Like 27



The Japanese government reported on Sunday that it had halted some food shipments to prevent tainted samples of milk and spinach from reaching consumers.

Iodine 131 was found in milk samples in Kawamata, a town in Fukushima prefecture, where the reactor sits, at levels five times the limit set by law. In

ENTRIES FROM ...



Gwen Ifill



Paul Solman



Judy Woodruff



David Chalian



Hari Sreenivasan



Ray Suarez



Gwen Ifill



Betty Ann Bowser



Tom Bearden

FDA halts imports of dairy, produce from Japan

Seafood will still be sold, but will be screened first

Jump to discuss

242 total comments

Below: Video Discuss Related

Recommend 3

Tweet 1

Share

msnbc.com staff and news service reports
updated 3/23/2011 9:19:02 AM ET

Print Font: A A + -

The Food and Drug Administration said Tuesday it will halt imports of dairy products and produce from the area of Japan where a nuclear reactor is leaking radiation.

The FDA said those foods will be detained at entry and will not be sold to the public. The agency previously said it would just step up screening of those foods.

Other foods imported from Japan, including seafood, still will be sold to the public but screened first for radiation.

On Wednesday a spike in [radiation in Tokyo tap water](#) caused new worries about food safety. Broccoli was added to the list of contaminated vegetables.

Japan's Fukushima Dai-ichi nuclear complex has been



Tyrone Siu / Reuters

A woman shops for fruit at a Japanese department store in Hong Kong March 21. The World Health Organization said that radiation in food after an earthquake damaged a Japanese nuclear plant was a "serious situation."

Series radionuclides in food and drinking water, mBq/kg


	²³⁸ U	²³⁰ Th	²²⁶ Ra	²¹⁰ Pb	²¹⁰ Po	²³² Th	²²⁸ Ra	²²⁸ Th	²³⁵ U
Milk Products	1	0.5	5	15	15	0.3	5	0.3	0.05
Meat Products	2	2	15	80	60	1	10	1	0.05
Grain Products	20	10	80	50	60	3	60	3	1
Leafy Vegetables	20	20	50	80	100	15	40	15	1
Root Vegetables & Fruits	3	0.5	30	30	40	0.5	20	0.5	0.1
Fish Products	30	10	100	200	2000	10		100	
Drinking Water	1	0.1	0.5	10	5	0.05	0.5	0.05	0.04

Effective Dose from Ingestion of Uranium and Thorium Series Radionuclides, μSv

Radionuclide	Infants	Children	Adults	Age – weighted
^{238}U	0.23	0.26	0.25	0.25
^{234}U	0.25	0.28	0.28	0.28
^{230}Th	0.42	0.48	0.64	0.58
^{226}Ra	7.5	12	6.3	8
^{210}Pb	40	40	21	28
^{210}Po	180	100	70	85
^{232}Th	0.26	0.32	0.38	0.36
^{228}Ra	31	40	11	21
^{228}Th	0.38	0.3	0.22	0.25
^{235}U	0.01	0.012	0.012	0.011
Total	260	200	110	140

Radionuclides Routinely Measured

 U.S. Department of Health & Human Services

 U.S. Food and Drug Administration

A-Z Index

Search

go

Home | Food | Drugs | Medical Devices | Vaccines, Blood & Biologics | Animal & Veterinary | Cosmetics | Radiation-Emitting Products | Tobacco Products

Food

Share Email this Page Print this page Change Font Size

Home > Food > Food Safety > Food Contaminants & Adulteration

Food Safety

Food Contaminants & Adulteration

Total Diet Study

Total Diet Study - Study Design

Total Diet Study - Market Baskets

Total Diet Study - Analytes and Analytical Methods

Total Diet Study - Analytical Results

CFSAN/Office of Food Safety*
April 2001; Updated July 2008 and January 2011†

All TDS foods (with the exception of some infant/toddler foods) are analyzed for all [elemental analytes](#) (other than mercury) and radionuclides. For other analytes (pesticide residues, industrial chemicals, and mercury) only selected foods are analyzed. Refer to the [food/analyte matrix](#) to determine which TDS foods are analyzed for each analyte group.

TDS foods are analyzed for elements, pesticides residues and industrial chemicals in each market basket (MB); radionuclides are measured in only one MB each year. Each MB is designated by the fiscal year and the specific collection (1 through 4) for that year (e.g., MB 02_2 is the second market basket in 1992).

FDA market basket study values, 2006

Nuclide	# Results	Not Detected	Mean (Bq/kg)	Std Dev (Bq/kg)	Min (Bq/kg)	Max (Bq/kg)	Median (Bq/kg)
⁴⁰ K	3295	2253	38	52	0	506	0
¹³⁷ Cs	3522	3521	0.002	0.028	0	6.7	0
⁹⁰ Sr	2443	1937	0.04	0.094	0	2.43	0

<http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/TotalDietStudy/ucm184293.htm>

Since Fukushima, Increased US Monitoring

Radionuclide Concentrations in Food and the Environment.pptx - Microsoft PowerPoint

Japanese Nuclear Emergency: EPA's Radiation Monitoring | US EPA - Windows Internet Explorer

http://www.epa.gov/japan2011/

Google

Search

More >>

Convert Select

Favorites

Web Slice Gallery

Customize Links

1&itbs=1

The Best 3D Street Art Pie...

Suggested Sites

US EPA Japanese Nuclear Emergency: EPA's Radiation M...

Page Safe

EPA United States Environmental Protection Agency


LEARN THE ISSUES | SCIENCE & TECHNOLOGY | LAWS & REGULATIONS | ABOUT EPA

ALL EPA THIS AREA Advanced Search

SEARCH

Japanese Nuclear Emergency: EPA's Radiation Monitoring

Share



This site contains information and data from March 11, 2011 to June 30, 2011. EPA has returned to routine RadNet operations. This site will continue to be available for historical and informative purposes.

For real-time air monitoring data, please visit the EPA RadNet website and Central Data Exchange. To view both current and historical laboratory data, please visit our Envirofacts database.

June 30 Statement

In response to the Japanese nuclear incident, EPA accelerated and increased sampling frequency and analysis to confirm that there were no harmful levels of radiation reaching the U.S. from Japan and to inform the public about any level of radiation detected.

RadNet Data

- Data Summaries
- EPA's RadNet Data
 - Real-Time Monitoring Data

Looking for the regular EPA Radiation home page?

About Radiation

- Understanding Radiation
- Sources of Radiation Exposure
 - Radon
- Radiation Doses in Perspective

Overview of EPA's Radiation Monitoring Experience

- Monitoring Radiological Incidents
- EPA's Radiation Response History

Common Power Plant Radionuclides

- Cesium
- Iodine
- Strontium

Done, but with errors on page.

Internet | Protected Mode: On

US EPA RadNet Measured Data

March – June 2011

Radio-nuclide	Maximum	Average	US Average	Units	Medium	EPA Target Risk Range Concentration
Iodine-131	15.6	3.17	0.725	Bq/L	Precipitation	
Iodine-131	0.0285	0.00356	0.0232	Bq/L	Pasteurized milk	14.8 Bq/L to 0.148 Bq/L
Iodine 131	0.00858	0.0023	0.00559	Bq/L	Drinking Water	
Cesium-137	1.35	0.124	0.0175	Bq/L	Precipitation	
Cesium-137	ND	0	0.0129	Bq/L	Pasteurized milk	

FROM FDA

- “As of Wednesday, October 12th, FDA import investigators had performed 26, 318 field examinations for radionuclide contamination. FDA had tested 1091 samples, 167 of which were seafood or seafood products. 1090 samples had no Iodine-131, Cesium-134, Cesium-137, or other gamma-ray emitting radionuclides of concern. 1 sample was found to contain detectable levels of Cesium, but was below the established **Derived Intervention Level (DIL)** and posed no public health concern”

FDA Derived Intervention Levels

All components of the diet		
Radionuclide Group	Limits, Bq/kg	Limiting Group
Sr-90	160	15 year old
I-131	170	1 year old
Cs-134 + Cs-137	1200	Adult
Pu-238 + Pu-239 + Am-241	2	3 months
Ru-103 + Ru-106	$[(C3 / 6800) + (C6 / 450)] < 1$	3 months

- The DIL for each radionuclide group is applied independently.
- Each DIL applies to the sum of the concentrations of the radionuclides in the group at the time of measurement

<http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/Radionuclides/ucm078341.htm#level98>

FDA DILS

- The FDA uses the principles in the general guidance provided by ICRP in 1984 for the immediate response to a major radiation accident, recognizing that at later stages, after the local situation is stabilized and more clearly defined, the longer-term intervention for food can be modified based on more detailed evaluation of local conditions by local authorities.
- Therefore, the PAGs for the ingestion pathway at the onset of an accident are **5 mSv committed effective dose equivalent** or 50 mSv committed dose equivalent to an individual tissue or organ, whichever is more limiting.

FDA DIL calculation

- $\text{DILs (Bq/kg)} = [\text{PAG (mSv)}] / [f \times \text{FI (kg)} \times \text{DC (mSv/Bq)}]$
- Where:
 - DC = Dose Coefficient; the radiation dose received per unit of radionuclide activity ingested (mSv/Bq)
 - f = Fraction of the food intake assumed to be contaminated
 - FI = Food Intake; the quantity of food consumed in an appropriate period of time (kg)
- DILs assume 10% contamination of the diet which is then multiplied by a factor of three.
- For infants, (i.e., the 3-months and 1-year age groups) 100 % contamination of the infant diet is assumed
- The Protective Action Guides (PAGs) used are 5 mSv committed effective dose equivalent, or 50 mSv committed dose equivalent to individual tissues and organs, whichever is more limiting.

International Generic Action Levels for Foodstuffs

Radionuclides	Foods destined for general consumption, kBq/kg	Milk, infant foods, and drinking water, kBq/kg
^{134}Cs ^{137}Cs ^{103}Ru ^{106}Ru ^{89}Sr	1	1
^{131}I	1	0.1
^{90}Sr	0.1	0.1
^{241}Am , ^{238}Pu , ^{239}Pu	0.01	0.001

(from CODEX Alimentarius Commission guidelines for radionuclides in food moving in international trade following accidental contamination.)

Calculation of Guideline Level

$$GL = \frac{IED}{M \text{ ipf } e_{\text{ing}}}$$

- Where
 - IED = Intervention Exemption Level of Dose (mSv/yr)
 - M = Mass of food consumed (kg/yr)
 - ipf = import to production factor (fraction)
 - e_{ing} = ingestion dose coefficient (mSv/Bq)
- ***IED was set at 1 mSv/yr***
- 550 kg of food is consumed per year by an adult
- 220 kg of food and milk is consumed by an infant
- 10% of the diet is imported (and contaminated food)
- Guidelines apply to each of the food groups independently

Determination of Guideline Level (GL)

GL is defined as *“The maximum level of a substance in a food or feed commodity which is recommended by the CAC to be acceptable for commodities moving in international trade.*

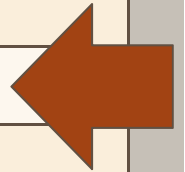
When the GL is exceeded, governments should decide whether and under what circumstances the food should be distributed within their territory or jurisdiction”.

Anecdotal Radioactivity Reported in Japanese Foodstuffs

- Spinach – 15 k Bq/kg ^{131}I (~15 x adult GL)
- Milk -1.510 kBq/kg ^{131}I (~15 x infant limit)
- Rice grains 0. 500 kBq/kg ^{137}Cs (~1/2 adult limit)
- Tea 2.720 kBq/kg ^{137}Cs (~3 x adult limit)
- Saitama products had between 0.800 and 1.530 kBq/kg ^{137}Cs (~1- 1.5 adult limit)
- *These are single measurements*
- *Not representative of sustained consumption levels*

Radiation Doses and Expected Effects

Dose	Time span	Effect
0-0.1 Sv	Acute or chronic	No observable effect
0.1-0.5 Sv	Acute or chronic	No observable effect, possible cancer risk
0.5-1 Sv	Chronic	Increased cancer risk
	Acute	May see changes in blood cells, but the blood system quickly recovers
1–2 Sv	Chronic	Increased cancer risk.
	Acute	Nausea and fatigue
2–3 Sv	Acute	Nausea and vomiting within 24-48 hours. Medical attention should be sought
3–5 Sv	Acute	Nausea, vomiting, and diarrhea within hours. Half of people exposed at high level will die if they receive no medical attention.
5-12 Sv	Acute	Likely lead to death within a few days
>100 Sv	Acute	Death within a few hours.



Radiation Risks in Japan

Short term whole body dose , Gy	Acute Symptoms (nausea and vomiting within 4 hr) , (%)	Death (acute) even with medical intervention %	Excess Lifetime Risk of Fatal Cancer due to Short-term Radiation Exposure %
0.1	0	0	0.8
0.5	0	0	4
1	5-30	0	8
1.5	40	<5	12
3	75	15-30	24
6	100	50	>40
10		>90	>50

Japanese workers

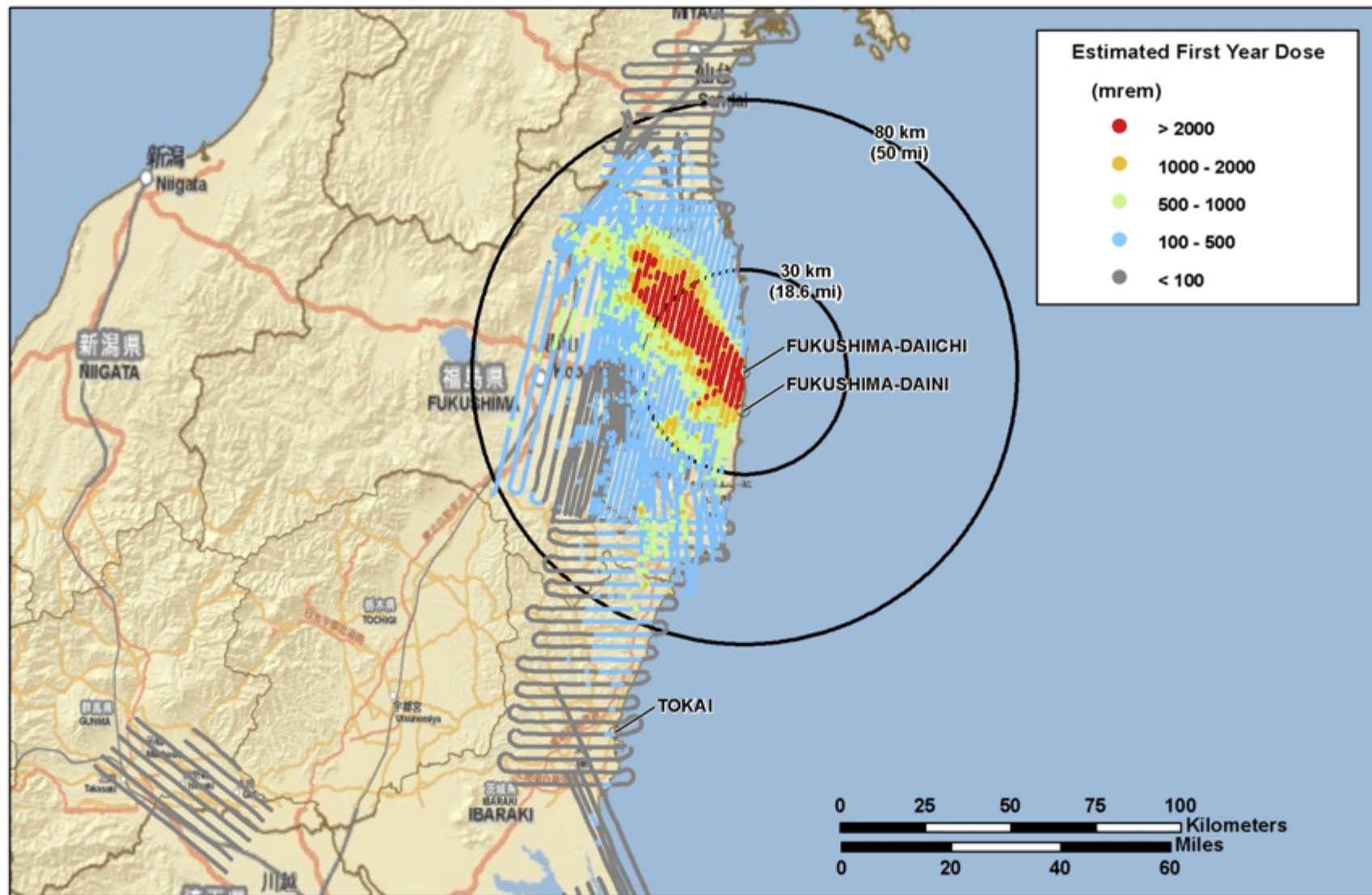
Short-term is radiation exposure during the initial incident.
 Lifetime risk of fatal cancer is approximately 24 %.
 Applies to individuals surviving the acute radiation syndrome.



First-Year Dose Estimate

Dose Commencing March 16, 2011 for 365 Days

FUKUSHIMA DAIICHI
JAPAN



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

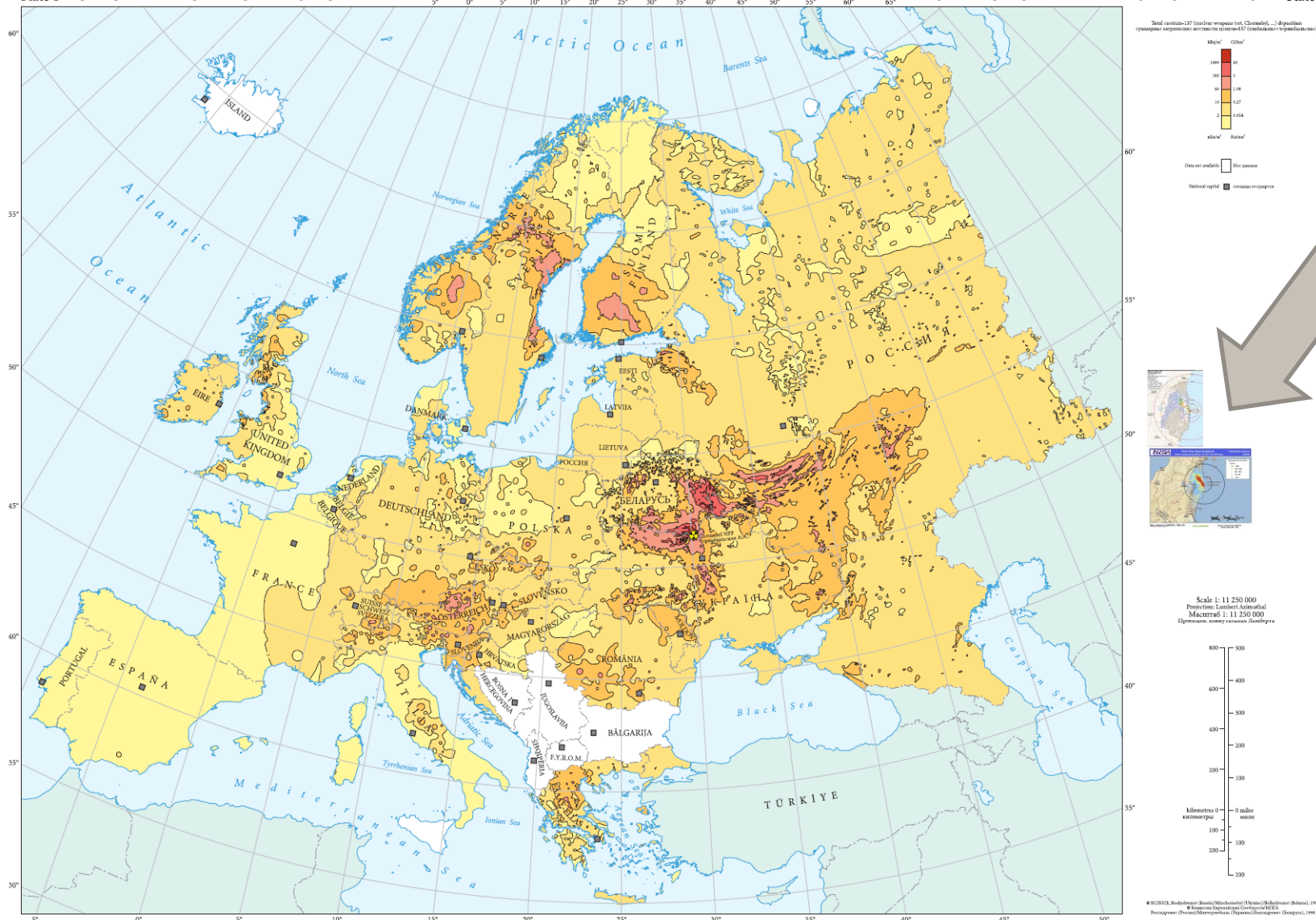
UNCLASSIFIED

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



Plate 1 European map of caesium-137 deposition - Европейская карта загрязнения цезием-137

Европейская карта загрязнения цезием-137 - European map of caesium-137 deposition Plate 1



From the atlas of caesium deposition on europe

Summary and Conclusions

- Radionuclides are present in our environment
 - Naturally
 - Not-so naturally
- Systems in place to
 - Measure them
 - Limit total dose

Great Sources of Data and Information

- Ongoing monitoring
 - EPA RADNET
 - FDA
- Overviews
 - UNSCEAR
 - IAEA
 - Other
 - USGS



Thank you – Questions?