Where in the World? Tracking Radionuclide Dispersal

James Slaton
Alabama Agricultural and Mechanical University
Research Alliance in Math and Science
Computational Sciences and Engineering Division, Oak Ridge National Laboratory
Mentor: John A. Turner

Background and Purpose

- After the Fukushima nuclear power plant disaster, public concern about the negative effects of radiation exposure has risen.
- To fully grasp the scope of the effects from this event, the radionuclide pathways and concentration need to be examined to determine if the concentration will have any effects on the global population and environment.

Research Objectives

- Investigate the pathways of the released radioactive particles
- Determine the concentration of the particles as they move away from the source
- Examine if the concentration will have any effects on the global population and environment

Types of Radiation

- Non-ionizing
  - Does not produce charged ions
  - May produce burns
- Ionizing
  - Does produce charged ions
  - Comes in three types
    - Alpha Particles
    - Beta Particles
    - Gamma Rays
  - May cause tissue damage

Isotopes Released from Fukushima Daiichi Accident

- Iodine-131 (^{131}I)
- Half-life of approximately eight days
  - Fission product of Uranium, Plutonium, and Thorium
- Notable for causing mutation and death in cells through beta decay
- Cesium-137 (^{137}Cs)
  - Half-life of 30 years
  - Emits beta and gamma radiation
  - Poses risk of burns, cancer, and death

Methods

By using the National Oceanic and Atmospheric Administration Air Resources Laboratory's Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model on a Dell Inspiron 1420 notebook, various radionuclides, such as ^{137}Cs and ^{131}I, can be traced from the initial source and determine the pathways by using archived atmospheric data from March 14 to March 31, 2011, in three-day intervals.

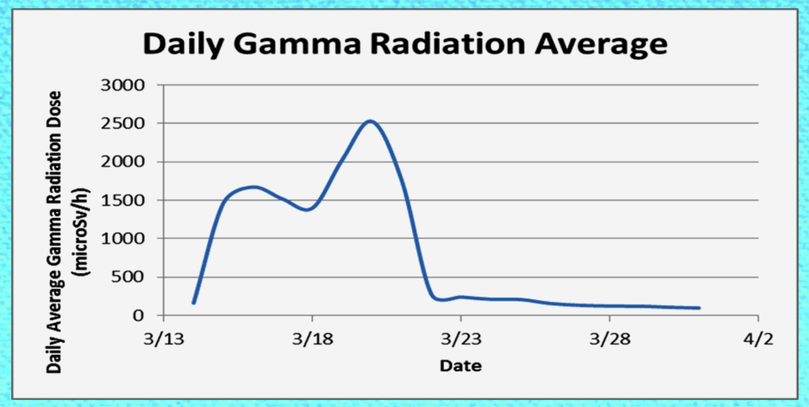

Figure 1. The daily average of gamma radiation dose in the month of March, starting after the natural disasters. Data to compute the daily averages is provided by Tokyo Electric Power Company (TEPCO).

Results and Verification

- Radionuclides traveling away from Japanese shoreline toward the Parific ocean
  - Increasing chances of oceanic contamination
  - Especially closer to the nuclear power plant
- Comparison reveals similarities
  - Direction which the radionuclides will travel
  - How the plume disperses the particles as it travels away from the source

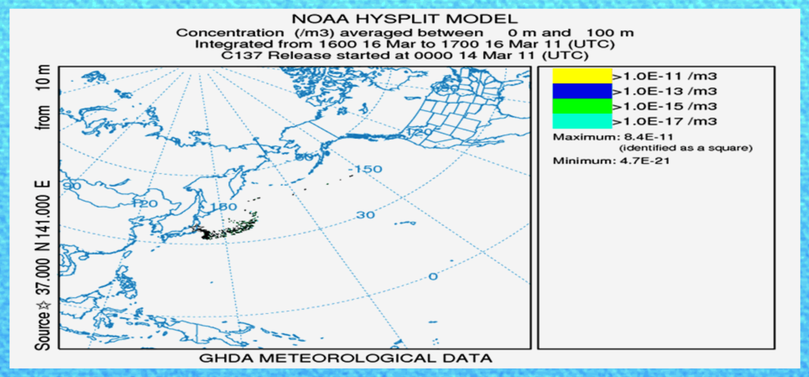

Figure 2. Concentration of ^{137}Cs particles on March 16, 2011.

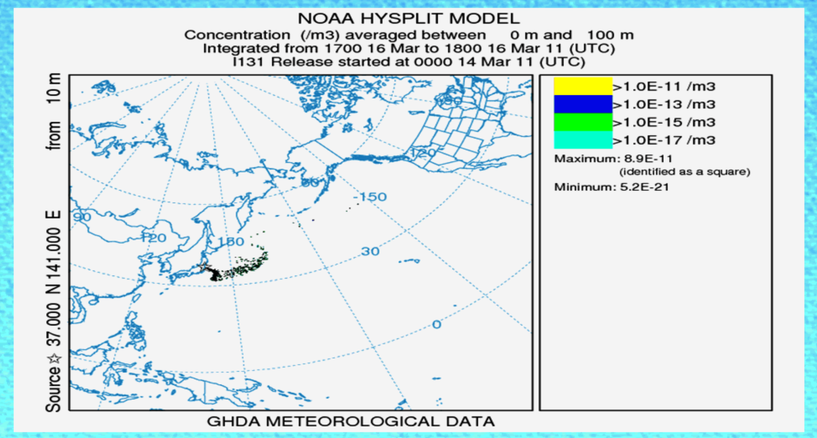

Figure 3. Concentration of ^{131}I particles on March 16, 2011.

Conclusions

Based on the limited information regarding Fukushima Daiichi, a rough computer simulation of radionuclide dispersal from the nuclear power plant can be used to roughly determine the general direction of the particles and how far the plume will spread in any direction.

Future Research

- Obtain more Fukushima Daiichi data to refine simulation further
  - Limited amount of information hinders accuracy of simulation
- Reassess the situation by running additional simulations
  - Future data
    - Will reflect conditions during aftermath of natural disasters
    - May cause significant changes to plume concentration in simulation
    - Will quantify any errors that will arise from unknown variables

References

- *Air Resources Laboratory - HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model*. (2011). Retrieved 2011, from National Oceanic and Atmospheric Administration Air Resources Laboratory: http://www.arl.noaa.gov/HYSPLIT_info.php
- *Radiation dose measured in the Fukushima Daiichi Nuclear Power Station. (2011, June). Retrieved June 2011, from Tokyo Electric Power Company: http://www.tepco.co.jp/en/nu/fukushima-np/f1/index-e.html*

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