Environmental Radiation Monitoring in the US

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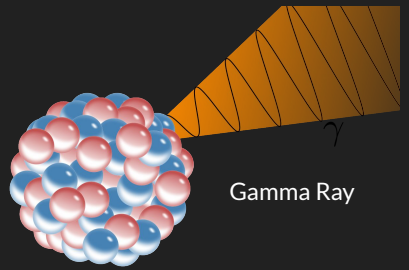
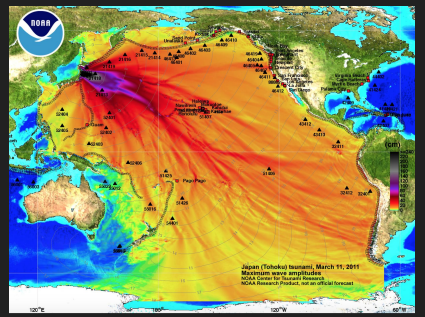
What is gamma radiation and why do we care?

- Can’t avoid
- Varies across the US
- Radiation sensitive instruments may fail
- Can be harmful at higher levels
- Difficult to detect
- Affected by human and natural events



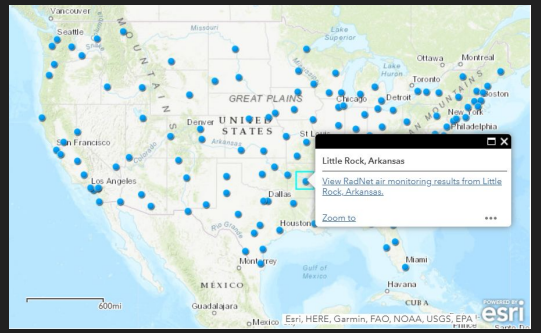


Source:
National Weather Service Heritage - vlab.ncep.noaa.gov

Motivation

- Why do we measure background radiation?
  - Potential health issues
  - Detect significant events
  - National Security
  - US Environmental Protection Agency (EPA)
    - RadNet
- Who and how can someone benefit from this?
  - Radiation professionals, scientists and engineers
  - A one stop place for radiation information
  - Quick analysis and comparisons in time and space

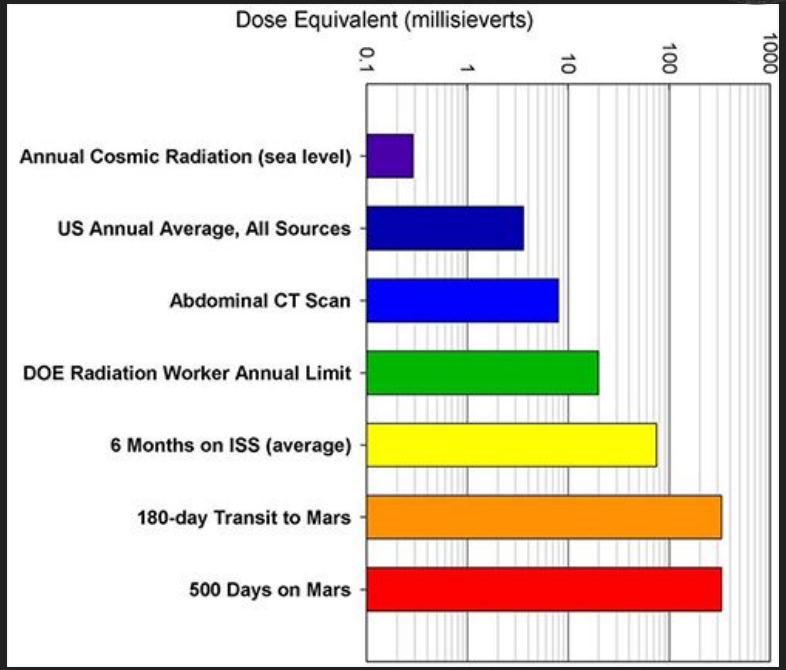
RadNet Radiation Air Monitor



RadNet Visualization of Sensors

Radiation Levels and Potential Health Effects

- How is radiation measured:
  - Units of Sieverts: Energy deposit in mass adjusted with human factors for potential health damage
  - Count rate: Number of particle interactions per unit of time
- Average Dose Rates :
  - San Diego, CA: 0.8453 mSv/year
  - Denver, CO: 12.4 mSv/year
  - Ramsar, Iran: up to 250 mSv/year
  - Fukushima City 2011: 21.9 mSv/year



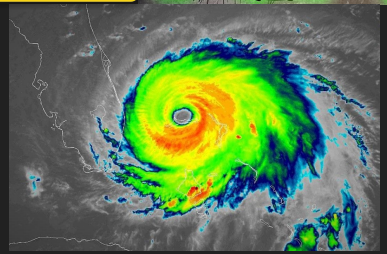
Link: Apollo Investigation, Spaceflight. Orion, the Van Allen Belts and Space Radiation Challenges by Mary Bennett. AULIS Online – Different Thinking

Dataset and Data Wrangling Overview

- Environmental Protection Agency RadNet program
  - 140 sensors across the US
  - Near real time measurements (per hour)
  - Data available from 2006 to 2020 (Gamma count only)
- EPA Dataset
  - 1,742 CSV files (>1.08GB) among all US states
  - Fields: Location Name, Time in UTC, Dose Equivalent Rate, and Gamma Count Rates (spread over 8 channels)
- Longitude, Latitude, and Elevation dataset
- Transformations
  - Aligned timestamps to local time using UTC time correction
  - Sensor location and elevation is approximated with city coordinates
  - Total gamma count rate (sum over 8 channels)

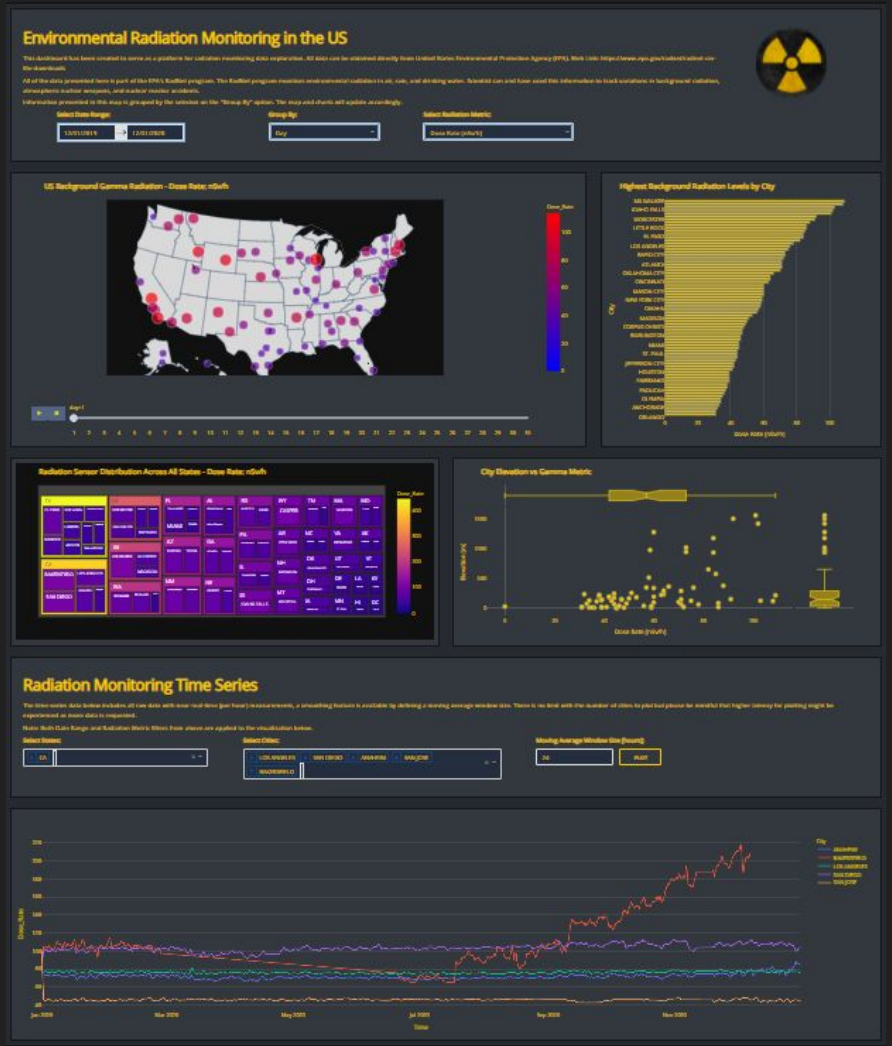
Tasks

- What parts of the country, state and city, have the highest or lowest amounts of gamma radiation? If so, at which rate?
- Do radiation patterns trend overtime? How?
- How does radiation patterns compare across cities?
- When deviated from normal levels, how does this shift compare relative to known radiological incidents?
- Can we see differences after a natural disaster occurred such as hurricanes?
- Is there a noticeable correlation between elevation and radiation levels?



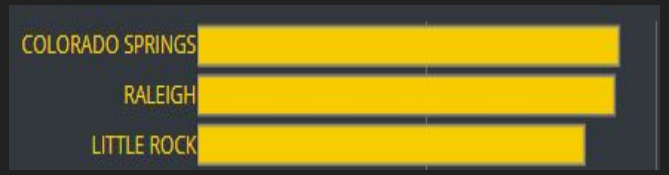
Solutions

- **Design**
  - Dark Mode
  - Components: Date Range, Dropdown, Input Field
  - Geospatial map with animation frames
  - Horizontal bar plots ordered descending
  - State-City hierarchy treemap
  - Correlation scatterplot
  - Time-series to show per city trendlines for raw data
- **Usage and Key Aspects**
  - Every element is interactive
  - Decoupled front-end and back-end
  - Data transformation on-the-fly for aggregating (by day, month, or year) and finding moving average
  - Map animation frames



Results and Findings

- Objective 1: Highest levels of naturally occurring radiation from 2010-2020
  - Count Rates



9186 cpm
9089 cpm
8435 cpm

High

1713 cpm
1677 cpm
1485 cpm

Low

  - Dose Rates

104 nSv/hr
102 nSv/hr
101 nSv/hr

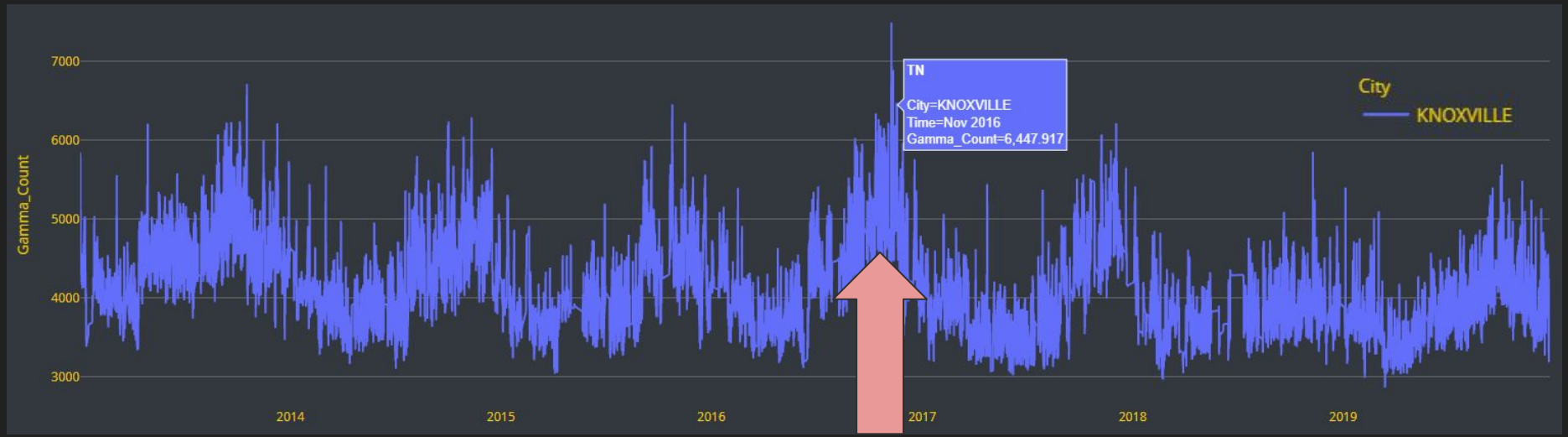
High

32 nSv/hr
32 nSv/hr
31 nSv/hr

Low

Results and Findings

- Objective 2: Natural Disaster Effects
  - November 2016 - Great Smoky Mountains Tennessee ~ 30 miles from Knoxville
  - Time Series Plot - January 2013 to December 2029 - 12 hour moving average



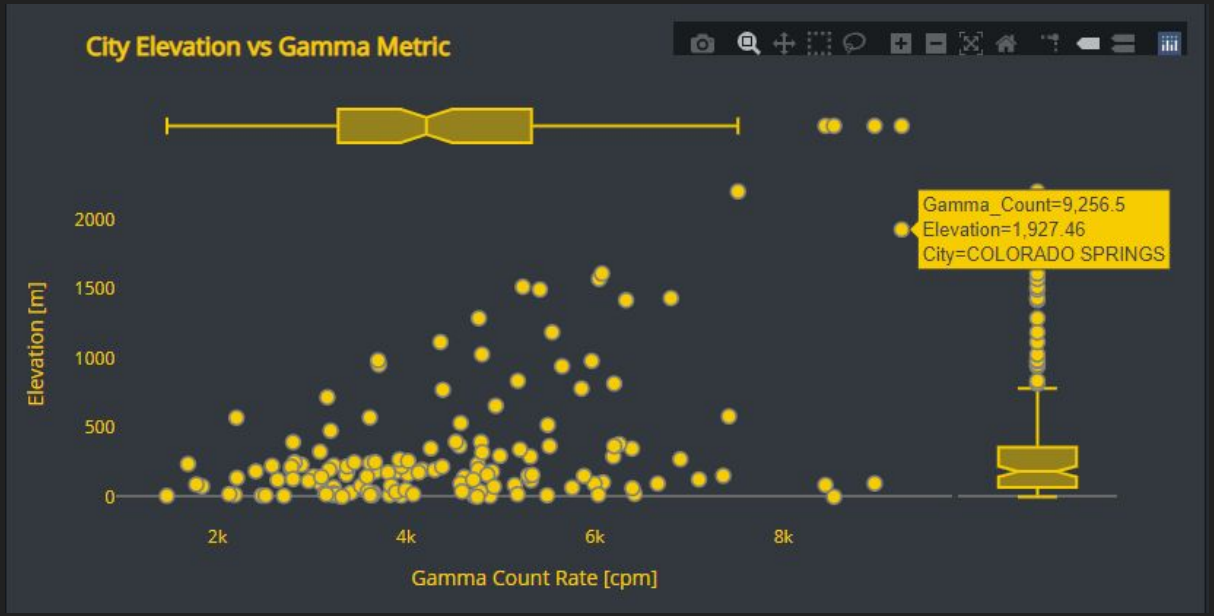
January 1st 2013

Great Smoky Mountains Wildfires

December 31st, 2019

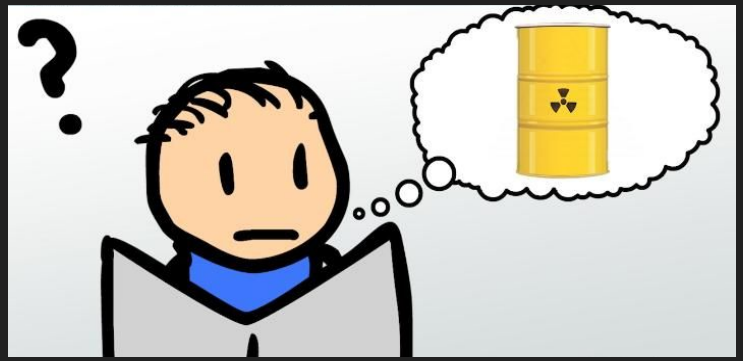
Results and Findings

- Objective 3: Elevation Effects



Average Count Rates from January 2013 - to December 2020

Q&A



Online Sources

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