Possible Impacts of Climate Change on Fermilab's Radioactive Air Emissions

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5 Minutes, 5 Slides

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Causes of Climate Change

Previously, climate change was a natural process

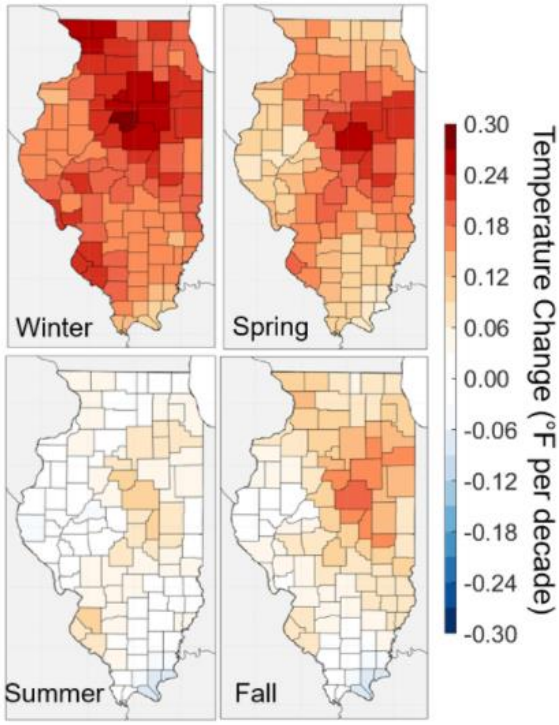
- External changes – solar radiation, volcanic eruptions, greenhouse gases (GHG), changes in Earth's orbit
  - Note: GHG like CO2 are the natural result of respiration and volcanic activity
- 800,000 years ago – Ice Age

Now, it's manmade

- Greenhouse Effect
  - More GHG -> more infrared energy absorption and reflection back to Earth's surface
- Greenhouse gases & atmospheric composition
  - Carbon dioxide – fossil fuel combustion
    - Atmospheric levels increasd by 47% since 1950s
  - Methane
    - Less abundant but more potent than CO2

Climate Change in Northern Illinois

- Temperature
  - Dependent on greenhouse gas emissions
    - Warmer weather increases ground-level ozone production
  - Rise 4-14 F by 2100
  - Decreased ice cover in the Great Lakes -> increased summer temperatures
- Increased wind speed
- Inevitable – focus on minimizing climate change and adapting to its anticipated effects



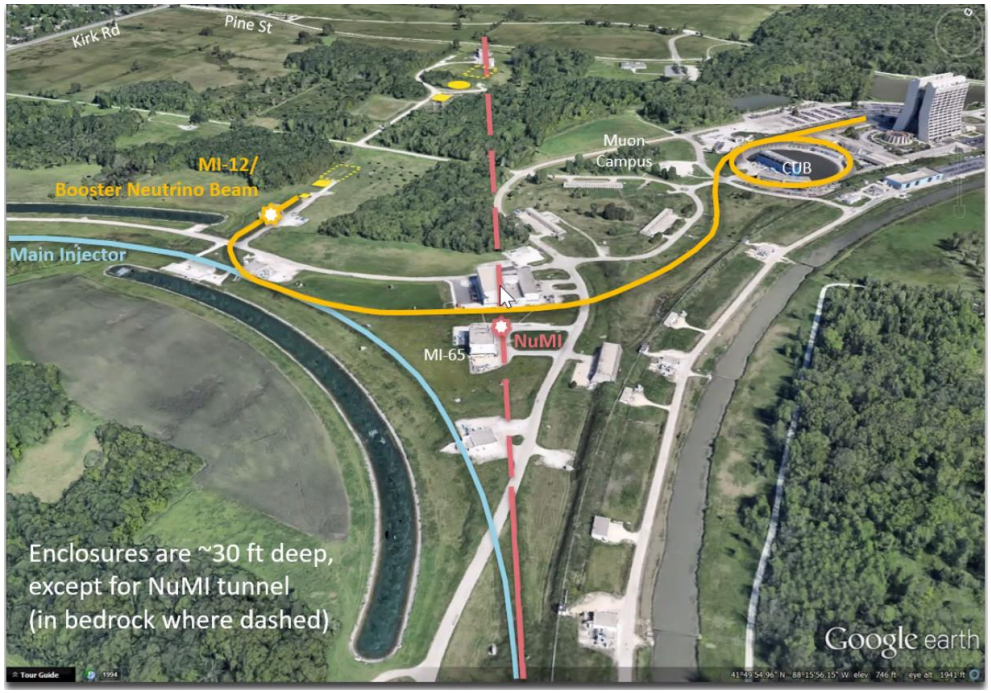
Maps show trends in daily average temperature in degrees Fahrenheit per decade by season and county in Illinois. Trends are calculated using observations between 1900 and 2020.

- Increase in extreme weather events:
  - Flooding
    - 2-in rainfall days increased by 40% since 1900
    - Average annual precipitation has increased 5% since 1900
  - Droughts
    - Higher temperatures -> increased evapotranspiration
    - Currently experiencing a severe drought in NE IL
  - Days above 95 F

Fermilab Emissions

Activated air release from all FNAL sources:	FNAL Total	46.573	Ci

- Fermilab emits radioactive air emissions while running accelerators
- Air emissions deliver doses of radioactive isotopes to people
  - Airborne doses are regulated by the US EPA
- Atmospheric conditions can affect the distribution of these airborne particles → possibly increased exposure to public and impact Fermilab operations



NuMI
^{13}N
^{11}C
^{41}Ar
^{15}O
^{76}Br
^{77}Br
^{82}Br
^{7}Be
^{97}Ru
Tritium

Importance

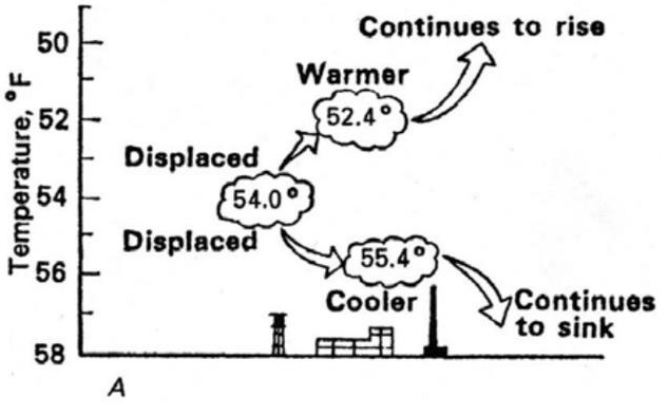
- Identifying the repercussions of climate change on radioactive air emissions
- Estimate radiation exposure the public may receive after the (possibly) altered emissions
- Possibilities
  - No change → operations not impacted
  - Increased concentrations → possibly develop controls to reduce radioactive emission operations
- 2020: Fermilab's max dose was only .14% of the EPA's limit for public dosage
- Fermilab hopes to increase accelerator power in the future
  - Accommodate potential changes in emissions with possible climate change impacts

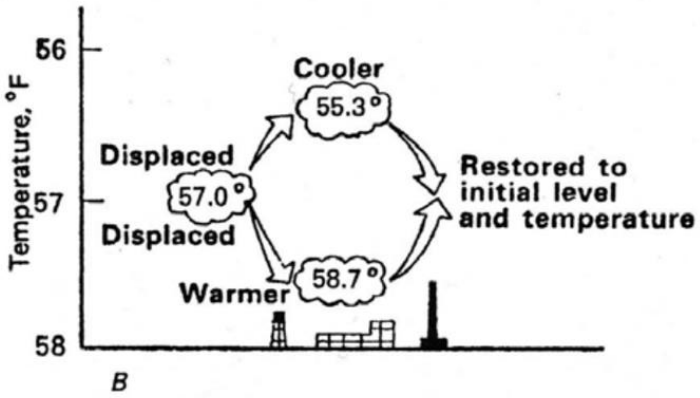
Climate Modeling

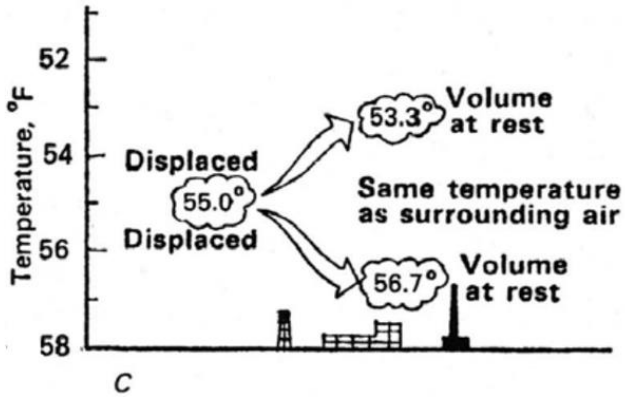
- Factors affecting air quality
  1. Emission sources – stacks
  2. Topography
  3. Atmospheric chemistry
  4. Meteorology - describe air mixing behaviors

Data to Collect

- **Population** – age, number, estimates at specified year
- **Meterological** – annual precipitation, ambient temperature, humidity, wind speed/direction
- **Sources** – stacks' heights, diameter, plume type, heat release rate
- **Agricultural** – land use, density of livestock & crop
- **Nuclides -** released, total count, type, release rate







Goal: Use climate modeling to predict future Fermilab doses from air emissions and understand global warming's impacts

Fermilab