

# Radionuclide and Carbonaceous Emissions from Prescribed Burns of Forest Biomass in New Mexico

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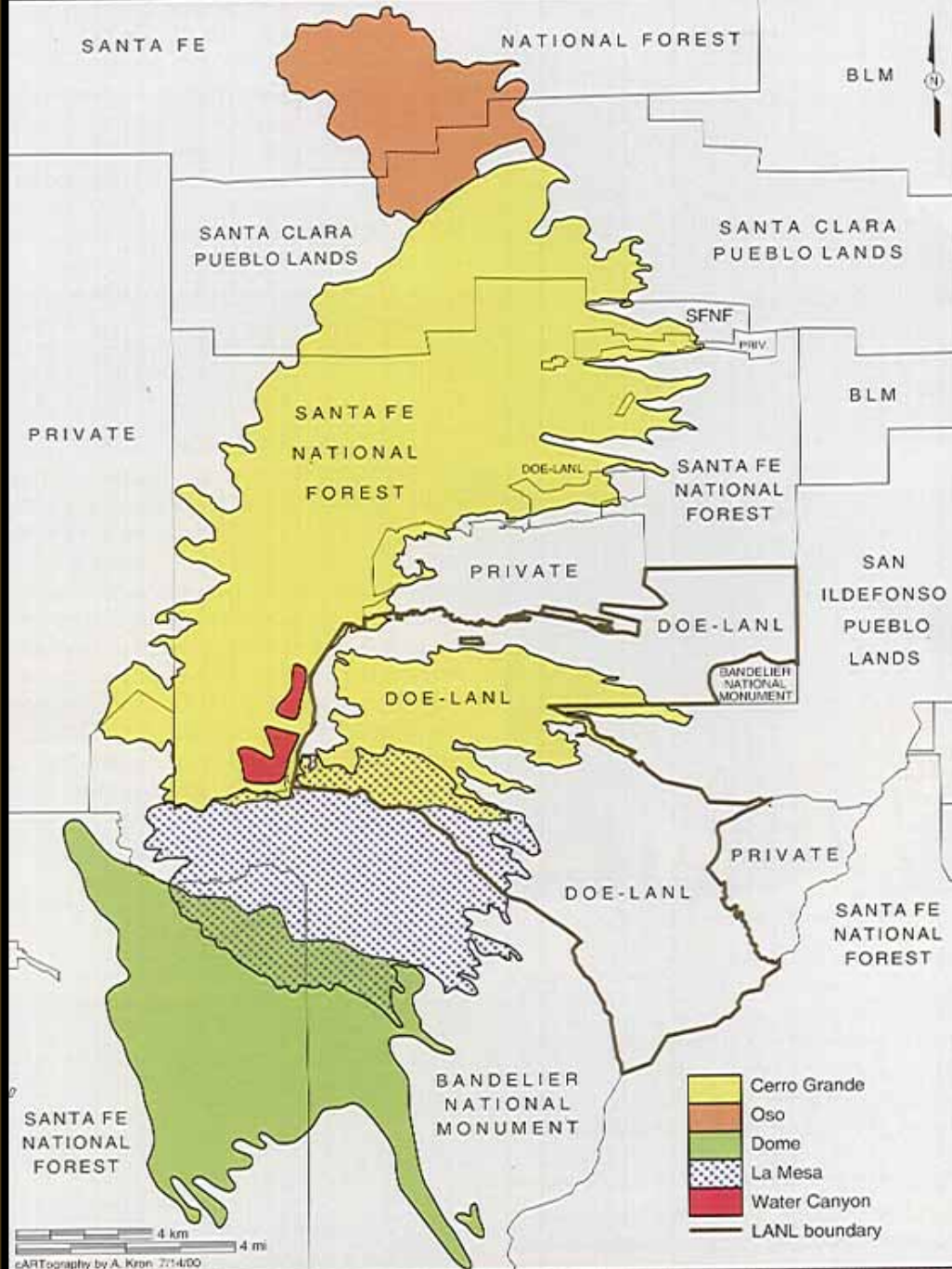
Los Alamos National Laboratory: Los Alamos, NM



# LANL Radiological Air Monitoring Network (AirNet)

- 43 stations on and near laboratory reservation and City of Los Alamos
- 6 additional Regional Monitors in Northern New Mexico
- Surveillance system for gross alpha, gross beta and key isotopes (including americium, plutonium, uranium and tritium)
- Normally observes radioisotopes associated with radon, resuspended soil, and known Los Alamos emission sources
- Cerro Grande fire in May, 2000 raised concerns





cARTography by A. Kron. 7/14/00

*Location of five major wildfires in the Los Alamos National Laboratory region.*





Colorado

Kansas

Oklahoma

Los Alamos

Española

New Mexico

Texas

May 11, 2000



# Ambient Network During Fire

- Filter overloading—cut PM sample durations from two-week to 1-7 day integration periods; 24-hr avg. over  $300 \text{ mg/m}^3$  PM<sub>10</sub> via TEOM
- Concern about fire mobilizing historical contamination from nuclear activities—  
Environmental Stewardship mission of public notification in the event of radiological hazards
- Rapid turnaround of gross measurements and isotopic analyses, communication of results

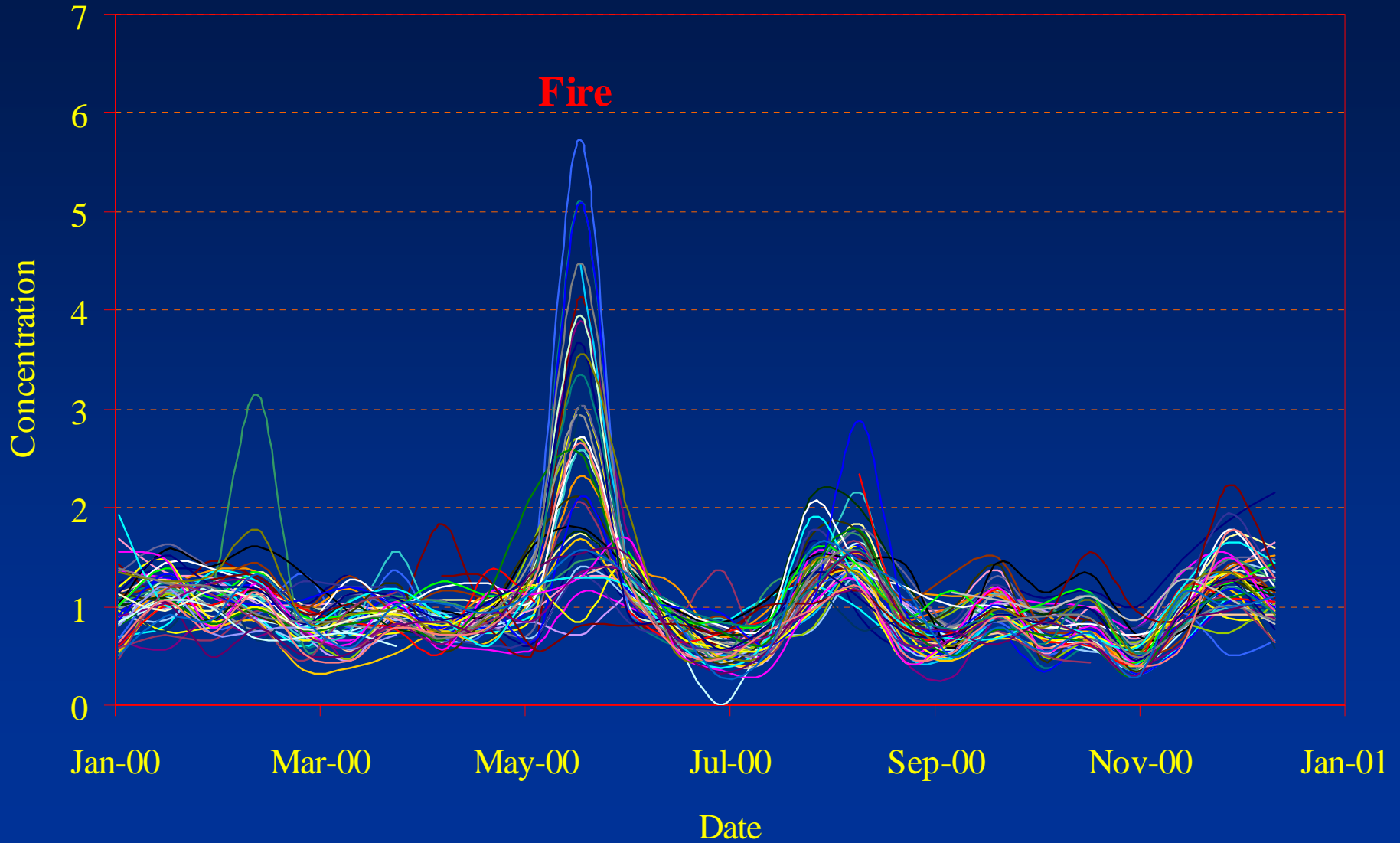


# LANL AirNet Observations




- In public-access areas (off-lab property), gross alpha and gross beta elevated in ambient air
- Only natural uranium isotopes present in most public-access areas; slight enriched uranium impact at 1 site
- Plutonium and americium not elevated in public-access areas—detectable at expected samplers within lab boundary
- Radon decay products lead, polonium and bismuth were elevated—expected due to literature on fire smoke
- Human dose estimates range up to 0.2 mRem for residents in smoke during 60 hour period of fire before evacuation (compare with 1 mRem from 2-hr air travel)



# 2000 Biweekly Gross Alpha Measurements



# Uranium-238 Decay Series

- Uranium-238  Terrestrial - 4.5 billion year half-life
- ↓
- Uranium-234  Terrestrial - 246 thousand year half-life
- ↓
- Radon-222  Released to the atmosphere as a gas - 3.8 day half-life



# Radon-222 Decay

- Short-lived decay products



• Lead-210



• Bismuth-210



• Polonium-210

↻ Gas to solid  
short half-lives - decayed by  
analysis time

↻ 22-year half-life  
accumulates over years

↻ 5-day half-life  
equilibrates in weeks

↻ 138-day half-life  
equilibrates in ~3 years

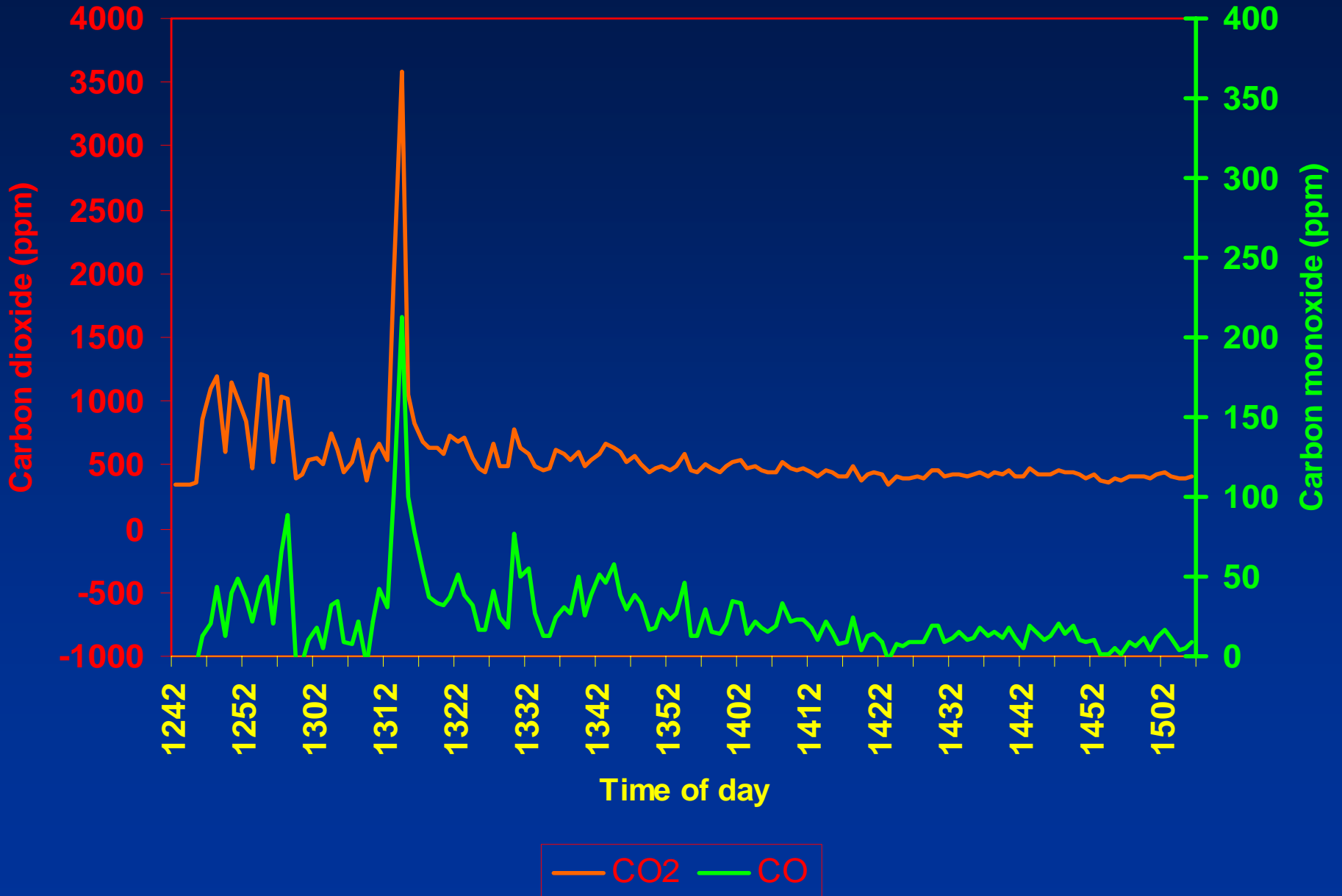
# Are radionuclides in smoke from normal New Mexico prescribed burns similar to Cerro Grande observations?

- Measure particulate (and radioactive) emissions
  - By HiVol and MiniVol, with rad analysis of filters
- Measure CO, CO<sub>2</sub>, CH<sub>4</sub> and NMHC to develop emission factors
  - NDIR and Byron GC-based analyzer
  - Main carbon mass balance species
- Test Locations
  - Two remote prescribed burns at El Rito National Forest—La Madera and Petaca-Las Tablas: far from LANL
  - Two air curtain destructor burns of Ponderosa thinning debris at LANL: material from uncontaminated areas





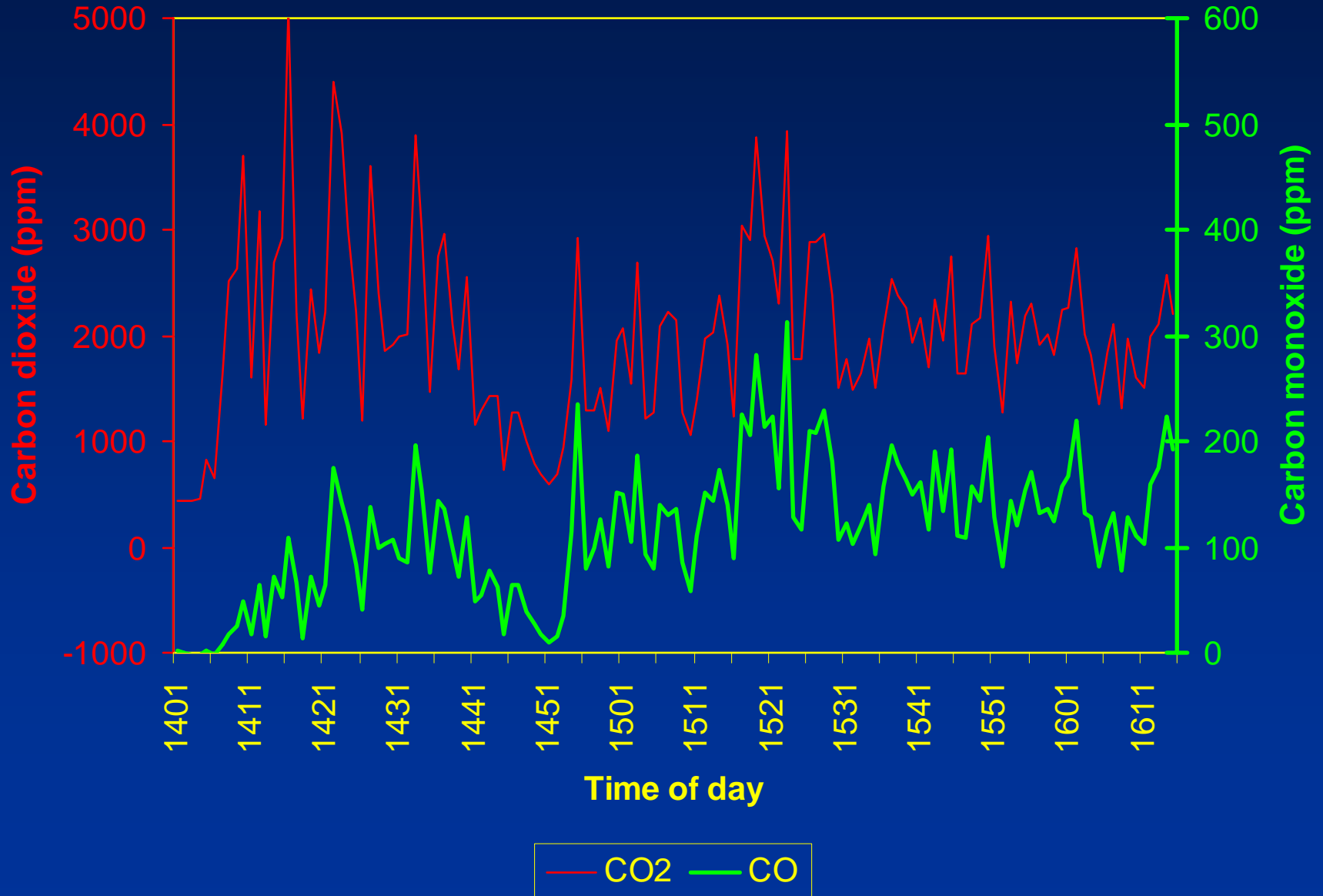
# La Madera Rx Burn







# Petaca-Las Tablas Rx Burn





# Carbon Emission Factors

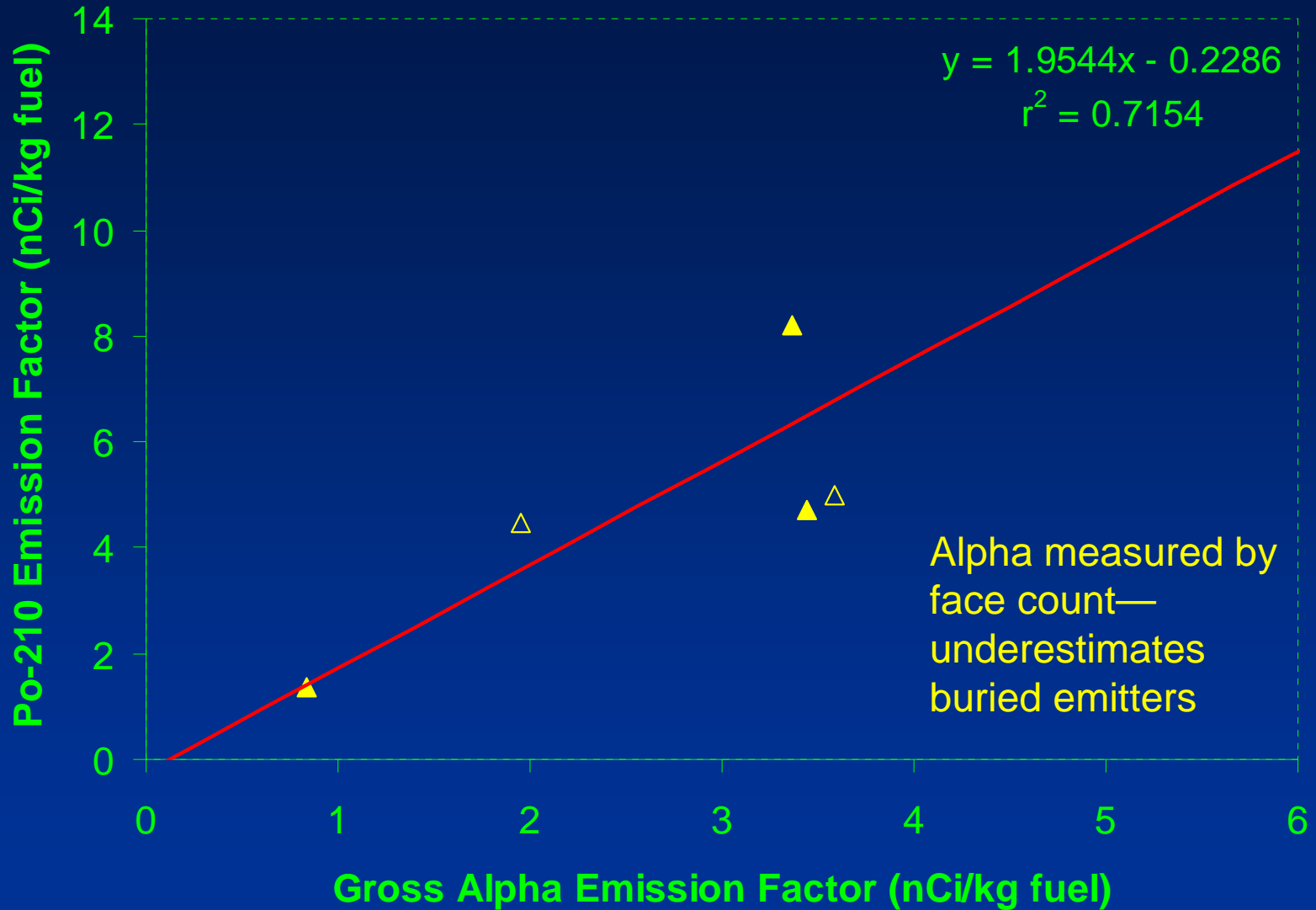
| Burn Name, Date   | Fire Phase | Combust Efficy (percent) | Measured Emission Factors (g emission/kg fuel) |                 |                 |      |      |                  |
|---|------------|--------------------------|--|-----------------|-----------------|------|------|------------------|
|   |            |                          | CO   | CO <sub>2</sub> | CH <sub>4</sub> | NMHC | PM   | PM <sub>10</sub> |
| <ul style="list-style-type: none"> <li>• Petaca–Las Tablas</li> <li>• 9/25/2001</li> </ul>        | F          | 92.5                     | 29.3   | 1697            | 7.3             | 12.5 | NA   | 12.6             |
|   | S          | 85.9                     | 83.7   | 1577            | 11.9            | 19.0 | NA   | 13.7             |
| <ul style="list-style-type: none"> <li>• La Madera</li> <li>• 10/10/2002</li> </ul>               | F          | 87.6                     | 84.3   | 1607            | 1.9             | ND   | 35.3 | 26.5             |
|   | S          | 81.3                     | 136  | 1491            | 4.3             | ND   | 46.5 | 43.8             |
| <ul style="list-style-type: none"> <li>• Air Curtain "Xena"</li> <li>11/13/2002</li> </ul>        | F          | 98.6                     | 10.0   | 1809            | 0.2             | 1.6  | 1.9  | 0.3              |
|   | S          | 96.8                     | 33.2   | 1776            | 0.2             | 0.9  | 1.4  | 1.2              |
| <ul style="list-style-type: none"> <li>• Air Curtain "Green Pondo"</li> <li>11/13/2002</li> </ul> | F          | 93.3                     | 70.5   | 1712            | 0.3             | 1.7  | 2.1  | 2.9              |
|   | S          | 94.7                     | 53.1   | 1738            | 0.4             | 1.9  | 2.4  | 3.2              |

# Radionuclide Emission Factors

| Burn Name                | Fire phase | Measured Emission Factors (emission per kg fuel) |     |                  |     |                  |      |                  |      |                  |     |                  |     |                  |     |
|--------------------------|------------|--|-----|------------------|-----|------------------|------|------------------|------|------------------|-----|------------------|-----|------------------|-----|
|                          |            | Gross Alpha (nCi)                                |     | Gross Beta (nCi) |     | Pb-210 (nCi)     |      | Po-210 (nCi)     |      | U-234 (pCi)      |     | U-235 (pCi)      |     | U-238 (pCi)      |     |
|                          |            | PM <sub>10</sub>                                 | PM  | PM <sub>10</sub> | PM  | PM <sub>10</sub> | PM   | PM <sub>10</sub> | PM   | PM <sub>10</sub> | PM  | PM <sub>10</sub> | PM  | PM <sub>10</sub> | PM  |
| Petaca—Las Tablas        | F          | 3.4  | NA  | ND               | NA  | ND               | NA   | 4.7              | NA   | ND               | NA  | ND               | NA  | ND               | NA  |
|                          | S          | 0.8  | NA  | ND               | NA  | ND               | NA   | 1.4              | NA   | ND               | NA  | ND               | NA  | ND               | NA  |
| La Madera                | F          | ND   | 3.6 | ND               | 1.4 | ND               | 0.9  | 10               | 5    | ND               | ND  | ND               | ND  | ND               | ND  |
|                          | S          | 3.4  | 2.0 | ND               | 0.6 | ND               | 0.6  | 8.2              | 4.5  | ND               | ND  | ND               | ND  | ND               | ND  |
| Air Curtain "Xena"       | F          | 3.0  | ND  | 7.9              | ND  | ND               | 0.04 | ND               | 0.06 | ND               | 5.3 | ND               | ND  | ND               | 3.7 |
|                          | S          | ND   | ND  | ND               | 0.2 | ND               | 0.02 | ND               | 0.03 | ND               | 1.2 | ND               | 0.4 | ND               | 1.4 |
| Air Curtain "GreenPondo" | F          | ND   | ND  | ND               | 0.2 | ND               | 0.1  | 0.6              | 0.04 | ND               | 1.8 | ND               | ND  | ND               | 1.3 |
|                          | S          | ND   | ND  | ND               | 0.2 | ND               | 0.03 | ND               | 0.02 | ND               | ND  | ND               | ND  | ND               | 1.0 |

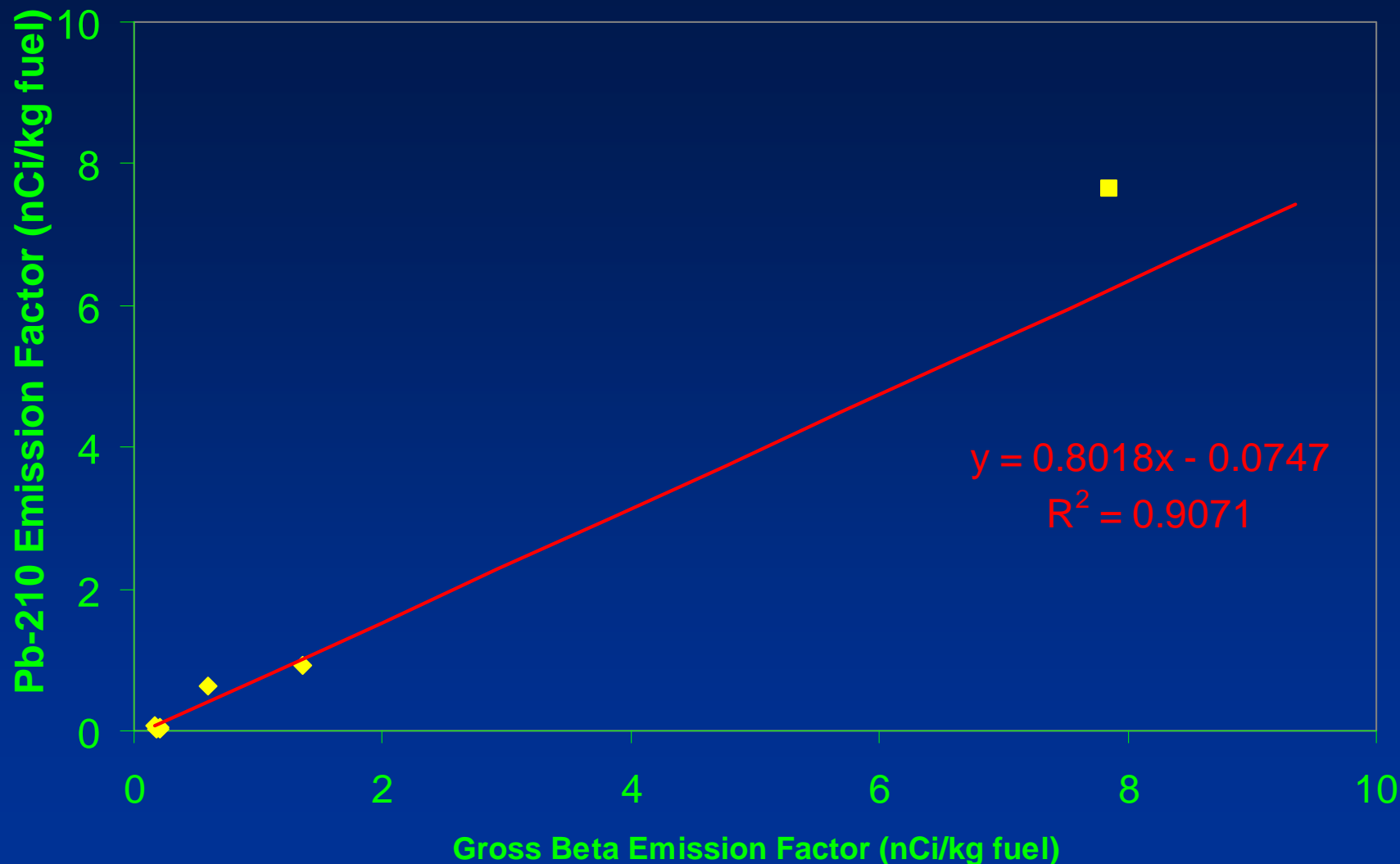
Uranium isotopes likely due to soils, and mostly below detection limits  
 No detectable americium-241, plutonium 238 or plutonium 239

# Po-210 vs. Gross Alpha (all burns)



▲ Both detected    △ Both detected:TSP    — best fit to detected PM10 data

# Pb-210 vs. Gross Beta (all burns)



◆ Both detected    ■ Both detected:PM10    — Linear (Both detected)

# Conclusions:

- Confirms literature and Cerro Grande ambient air data: naturally-occurring radioactivity is mobilized in New Mexico fires
- Emissions from uncontaminated remote sites are comparable to the gross alpha, beta and isotope mix during the Cerro Grande fire
  - Spike in gross alpha from Po-210 (alpha underestimated by face count method)
  - Gross beta from Pb-210 (method really measuring Bi-210, proportional to Pb-210 but a higher-energy emitter)
- Longer sample durations for improved detection limits
- Our emission factors for criteria pollutants were comparable to AP-42 and other researchers
- Radionuclide emission factors are first we find in literature—may be useful to global budget estimates and emission modelers
- Thanks for cooperation of U.S. Dept. of Energy and USDA-Forest Service