PROJECTIONS OF WILDLAND FIRE EMISSIONS CORRESPONDING TO VEGETATION CHANGES DUE TO CLIMATE CHANGE

PRESENTED AT EPA EMISSION INVENTORY CONFERENCE
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Overview

- Introduction
- MC1 Model
- Data Available from Model
- Estimation of Monthly Distribution of Wildfires
- Calculating Fire Emissions
- Sample of Resulting Data
- Other Issues

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Introduction

- Objective: Estimate air emissions from wildland fire projections simulating climate change scenarios
  - Output of project to be used as input to air quality modeling
- MC1 model output provided information on fire locations, vegetation types burned, particulate matter produced by fire, monthly live carbon
- Processed MC1 data to estimate monthly fire emissions by grid cell for input to air quality model
- Reference and policy case evaluated, 5 wind initializations
  - 10-year base period (2000-2009)
  - 2 sets of 3 consecutive 10-year periods(2035-2064, 2085-2114)

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MC1 Model

- Dynamic global vegetation model with a fire sub model
- Developed by USDA Forest Service and Oregon State University
- Model documentation sparse
- Model output did not include:
  - Month or day fire started
  - Fire duration (needed for plume rise estimates)
  - Emission results other than PM
- Effort spent understanding model and variables produced by model

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Data Output from MC1 Model

- Output provided for each year from 2000 to 2114
- Data output in 0.5 degree lat-lon cells
- Covered continental US
- Data fields used (cell level data):
  - Fraction of cell burned (annual)
  - Indicator of vegetation type burned
  - Particulate matter produced by fire (g PM/m^2)
  - Total monthly live carbon

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Estimating Monthly Distribution of Fires

- Annual indicator of whether fire occurred in cell during year
  - Only one fire assumed for a given cell in calendar year
- Monthly data on live vegetation by cell
- Looked at monthly change in vegetation level
  - However, seasonal changes cause natural flux in vegetation level
- Computed average monthly change over entire 115 year period
- Developed normalized estimate of monthly change for year of interest
- Then, for every cell with a fire indicated for a given year: month with largest normalized monthly change identified as month with fire

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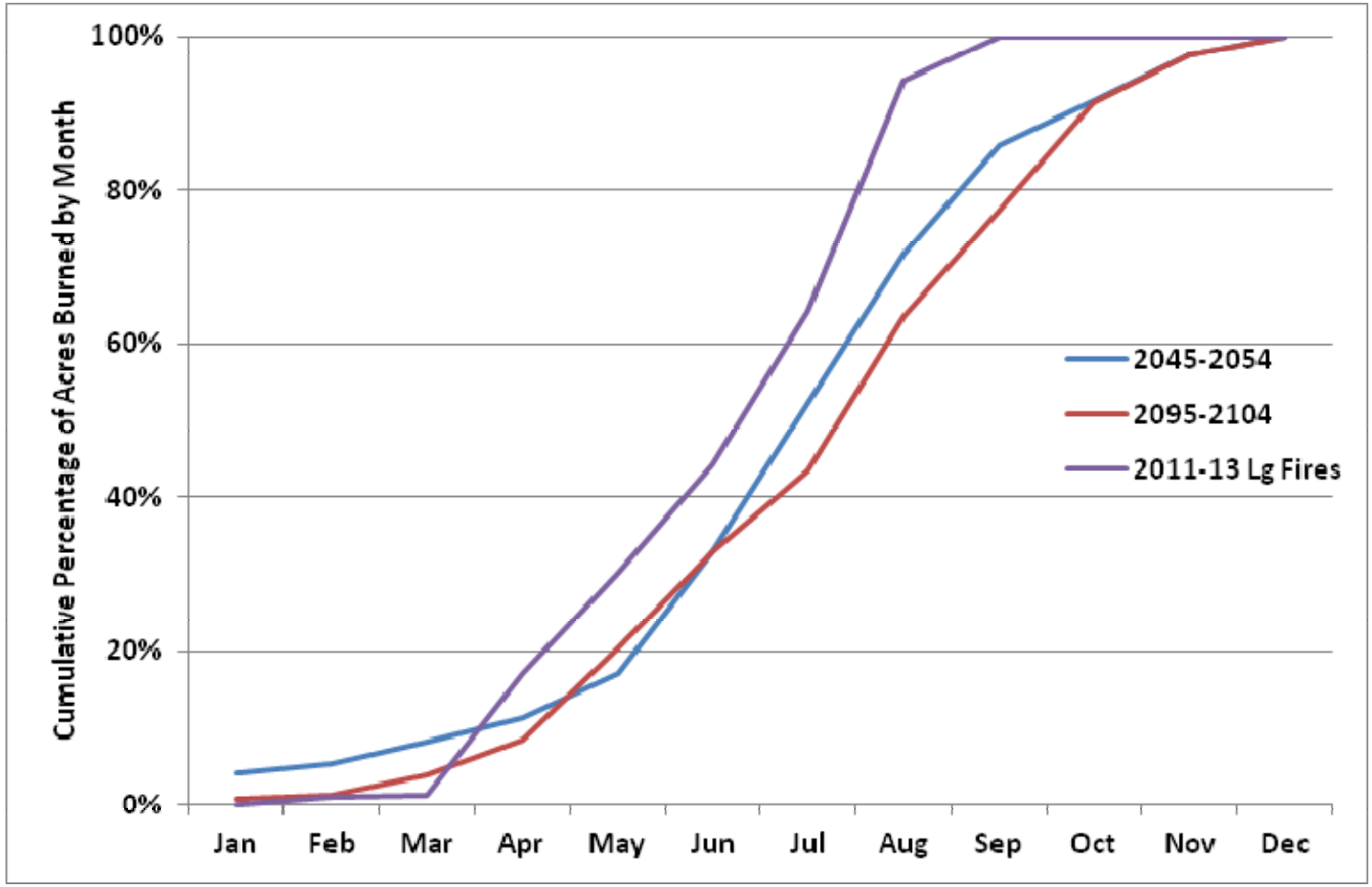
Cumulative Distribution of Acres Burned



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Calculating Fire Emissions

- Only PM emission output obtained from model
- Consume 2.1 model provides emission factors by wood/vegetation type
  - PM, PM10, PM2.5, CO, CO2, CH4, NMHC
- Scalars developed by dividing Consume 2.1 emission factors by PM emission factor for each vegetation type
- Consume model emission factors mapped to MC1 model data by vegetation type

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Emission Factor Scalars

Vegetation	PM	PM10	PM2.5	CO	CO2	CH4	NMHC
Douglas Fir	1.0	0.78	0.74	10.5	104.1	0.37	0.24
Hardwoods	1.0	0.67	0.60	6.8	82.1	0.35	0.29
Ponderosa	1.0	0.63	0.56	4.5	80.9	0.21	0.16
Mixed Conifer	1.0	0.71	0.65	6.9	109.1	0.44	0.34
Juniper	1.0	0.72	0.66	5.8	114.2	0.42	0.37
Sagebrush	1.0	0.66	0.59	4.5	69.0	0.26	0.30
Chapparal	1.0	0.59	0.51	4.5	95.5	0.17	0.31

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Calculating Fire Emissions

- Calculated cell emissions by multiplying:
  - MC1 PM emission factor, pollutant scalar, cell area
- Also calculated area of cell burned and converted to acres
  - Total cell area * PART_BURN
- Cell emissions, acres burned allocated fully to month estimated as burn month

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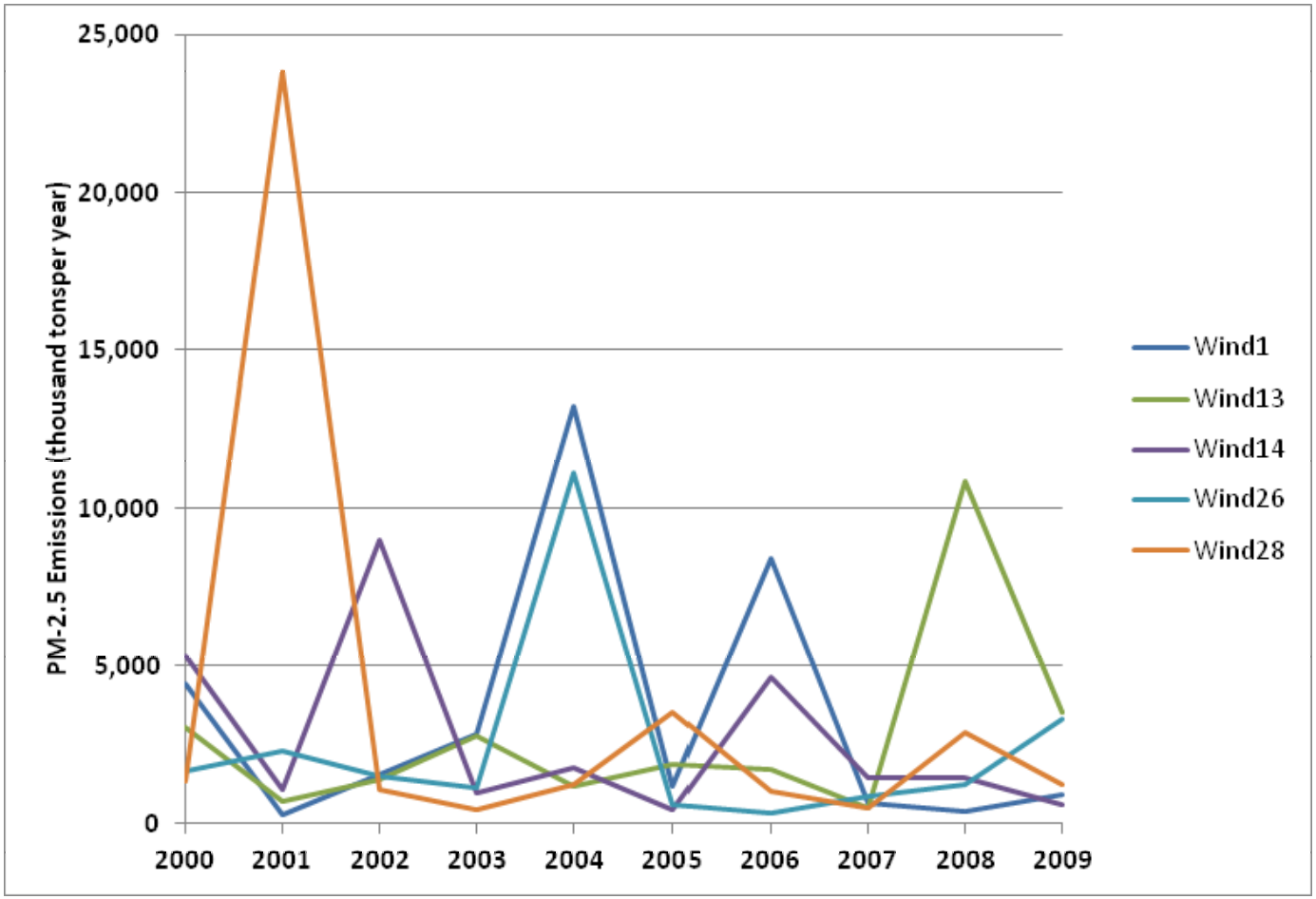
Sample of Resulting Data

Annual Emissions by Initialization for Base Period



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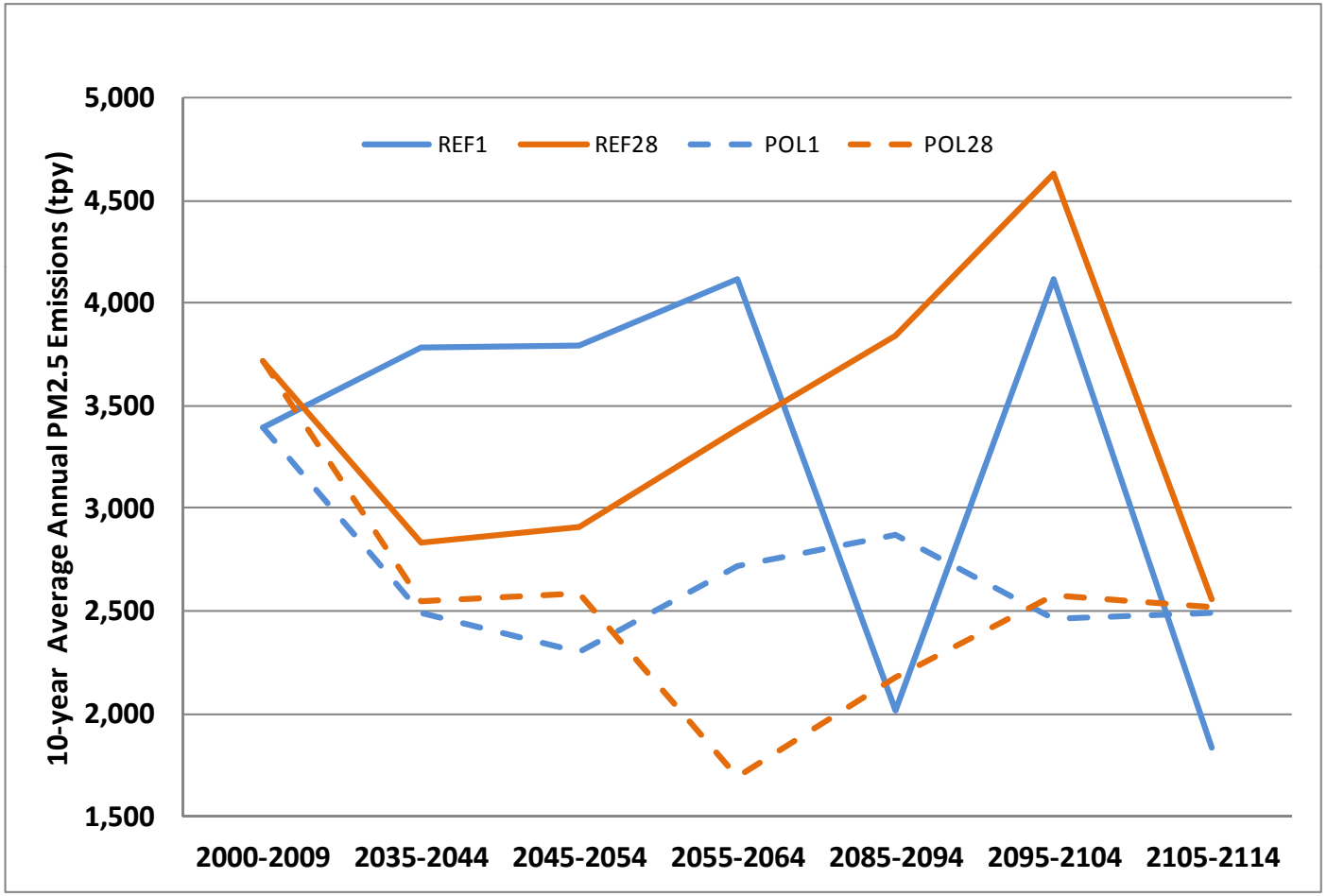
10-Yr Average Annual PM2.5 Emissions



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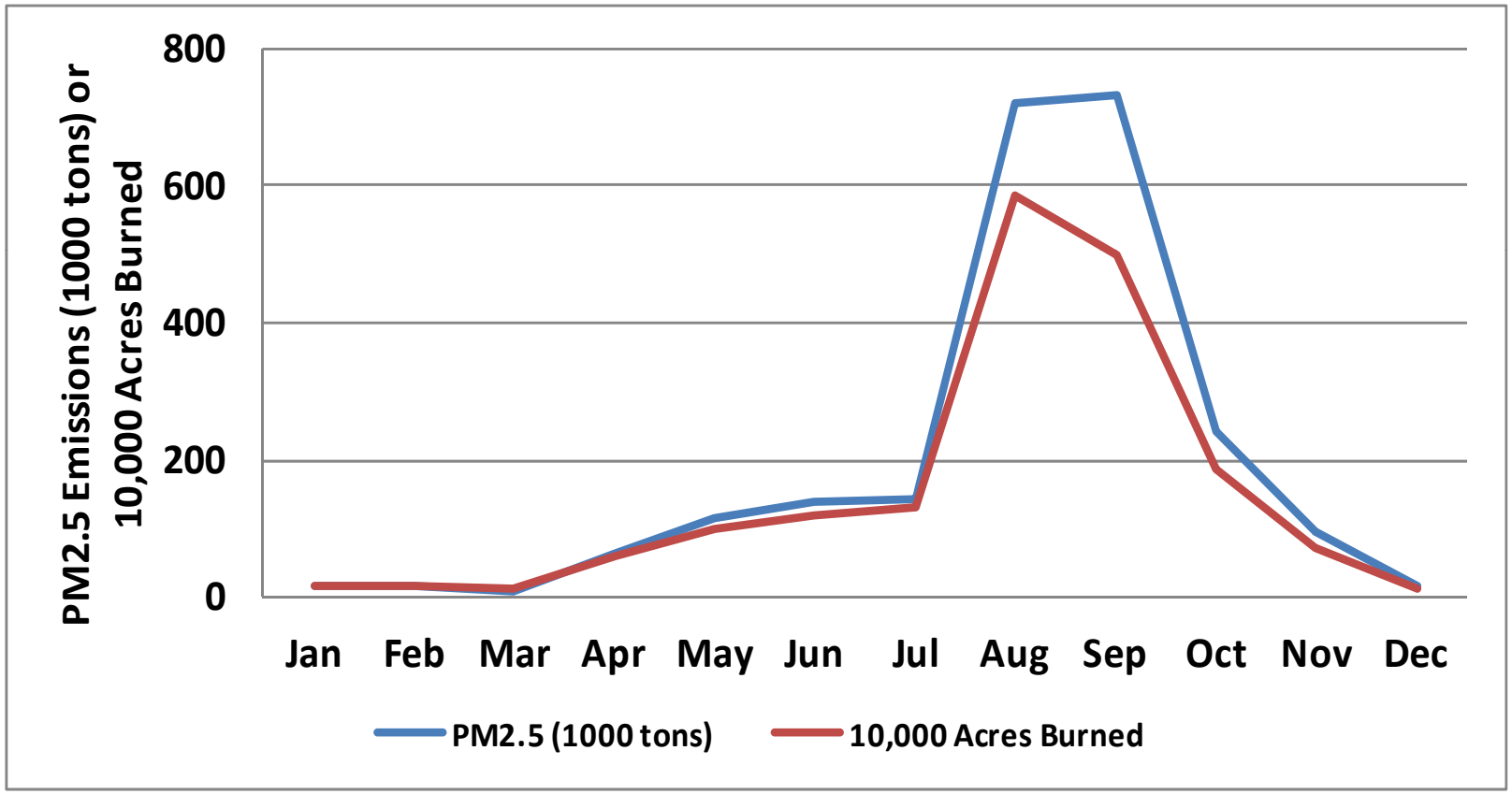
Sample Monthly Distribution (POL1 Scenario)



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Issues

- Focus on trends or changes between years, scenarios; not on absolute magnitude of emissions
- Daily temporalization
  - Recommend random start date within month
- Hourly temporalization
  - Use typical diurnal profile of US wildfire emissions
- Plume rise
  - Further study needed
- Other Emissions (BC, OC, ammonia)
  - Further study needed
- Fire duration
  - All fires assumed to be less than 1 month in duration

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