Emissions from Prescribed Burning and the Effects on Air Quality in the Tahoe Basin

Tom Malamakal

L.W Antony Chen, Xiaoliang Wang, Mark Green, Steven Gronstal
Overview

- Background/history of burning around Tahoe
- Our objectives/goals
- Description of method
- Preliminary Data
  - Time series, emission factors, chemical composition
- Future Directions
  - Modeling transport
  - Spring monitoring, seasonal differences
Lake Tahoe Basin

- Lake is 22 miles long north to south, 12 miles wide.
- Roughly same size for last million years.
- Forest landscape has evolved over last 10,000 years.
- Development in basin has altered natural wildfire cycle - large buildup of fuels.
Project Objectives

• Characterize particles and gases associated with prescribed burn

• Develop source profiles

• Develop continuous and time integrated emissions factors for different burn types, fuel loading and environmental conditions (moisture content, carbon and nitrogen content)

• Assess burn emissions transport by satellite remote sensing and five air monitoring sites representative of community exposure.
Method
In-Plume System

Testo 350 CO2 Sensors PID Analyzer

Filter Packs Canister Pump for Makeup Flow Flowmeters

Deep Cycle Marine Battery Voltage Regulator

Computer CPC DRX OPC

Battery Monitor
7 acre prescribed burn - source measurements taken at Tunnel Creek near Incline Village
Calculation Method

**Emission Factor**

\[
EF_j = \frac{M_j}{M_{\text{fuel}}} = \frac{M_j}{C_{\text{ash}} + \sum_i C_i} \quad x_{c,\text{fuel}} = \frac{M_j}{\sum_i C_i} \left( \frac{\sum_i C_i}{C_{\text{ash}} + \sum_i C_i} \right) x_{c,\text{fuel}} = \frac{M_j}{\sum_i C_i} \left( x_{c,\text{fuel}} - \frac{M_{\text{ash}}}{M_{\text{fuel}}} x_{c,\text{ash}} \right)
\]

\( EF_j \): emission factor of species \( j \)
\( M_{\text{fuel}} \): mass of the fuel burned
\( M_j \): mass of the species \( j \) emitted
\( C_{\text{ash}} \): carbon mass in ash
\( C_i \): carbon mass in every combustion product \( i \) (\( \text{CO}_2 \), \( \text{CO} \), etc., including species \( j \))
\( x_{c,\text{fuel}} \) and \( x_{c,\text{ash}} \): carbon mass fraction in fuel and ash, respectively

**Combustion Efficiency**

\[
CE = \frac{C_{\text{CO}_2}}{\sum_i C_i} = \frac{C_{\text{CO}_2}}{C_{\text{CO}_2} + C_{\text{CO}} + C_{\text{HC}} + C_{\text{VOC}} + C_{\text{PM}}}
\]

(Chen et al., 2007)
Open burning in Oregon, Nevada, and California recorded by SMARTFIRE for June – November, 2011.

Fires within the 25, 50, and 250 km domain. The largest circle represents a burn area of 14,288 acres.
Known wildfires are circled in black
Time Series of Open Burning

Distance to Lake Tahoe (km)

06/01 07/01 08/01 09/01 10/01 11/01 12/01

0 20 40 60 80 100 120 140 160 180 200

Time in 2011

NDF Prescribed Burn
LTBMU Prescribed Burn
Challenges and Future Directions

- Source profiles difficult to obtain.
  - meteorology
  - access
  - coordination between multiple agencies
- Sample through spring, look at seasonal difference in burns
- Model emissions transport
Thank You

• Tahoe Regional Planning Agency
• Washoe County Air Quality Management Division
• Placer County Air Pollution Control District
• California Air Resources Board
• Nevada Division of Forestry
• California State Parks
• Lake Tahoe Basin Management Unit