Method and Data Used in Wildfire Emission Estimation

Introduction

California Air Resources Board (CARB) staff have developed methods for estimating quantities of pollutants emitted to the atmosphere by wildfires that occur in California. These estimates are derived using the First Order Fire Effects Model (FOFEM) developed by the U.S. Forest Service (USFS) together with Geographic Information System (GIS) records of fire perimeters published by the California Department of Forestry and Fire Protection (CAL FIRE).

Sources and Methods

Emissions are estimated using GIS format data on fire perimeters, alarm and containment dates, natural vegetation fuel type (fuel component size class), fuel loads (tons/acre), fuel moistures and burn severity. The geospatial data are used to develop inputs to a wildland fire emission model (FOFEM version 6.7). Modeled emissions in flaming and smoldering phases (lbs/acre) by fuel type are integrated over the areas of each vegetation fuel type associated with each wildfire. Flaming and smoldering emissions are summed for reporting and include every fire reported and mapped for the calendar year.

The magnitudes of emissions are proportional to the amount of fuel consumed, and various pollutants are generated in the flaming and smoldering phases of combustion. Fuel moisture influences the proportions of fuel consumed in flaming versus smoldering phases. Forest and woodland vegetation types contain greater fuel loads than vegetation types dominated by shrubs, herbaceous plants, or grasses. Large fires often extend across a variety of vegetation types. Vegetation fuel maps based on the Fuel Characteristic Classification System (FCCS, Ottmar et al. 2007) are developed for specific years by the LANDFIRE.GOV consortium. For all other years, CARB staff use FCCS-based vegetation fuel maps developed by researchers at the University of California at Berkeley. Fuel loads for FCCS vegetation types are defined in FOFEM. Fuel moistures (Abatzoglu 2013, gridMET) are obtained from the Climate Engine consortium. Pollutant emissions associated with fuel consumption in the smoldering phase include PM_{10}, $PM_{2.5}$, CO, CH_4 and total non-methane hydrocarbons (TNMHC). Emissions associated with the flaming phase include NOx, CO_2, and N_2O.

Uncertainty

Uncertainties associated with mapped vegetation fuel types, fuel loading (tons/acre by fuel size category), fuel moisture, burned area, modeled fuel consumption in flaming and smoldering phases, and emission factors (mass of pollutant species per unit mass fuel consumed) contribute to large uncertainties in emission estimates. Emission estimates reported by CARB may have an uncertainty of between a factor of 2 to 3. The CARB wildfire

emission estimates are developed using sources and methods that are independent from those used for the statewide Natural and Working Lands (NWL) inventory of ecosystem carbon stocks and stock-change.

References

Abatzoglou, J. T. (2013) Development of gridded surface meteorological data for ecological applications and modelling. International Journal of Climatology (33), 121-131.

CARB (2021) California Wildfire Emission Estimates. *https://ww2.arb.ca.gov/wildfire-emissions*

Climate Engine: Cloud Computing of Climate and Remote Sensing Data. *https://clim-engine.appspot.com/climateengine*

Fire perimeters: A multi-agency statewide database of fire history. Fire and Resource Assessment Program, California Department of Forestry and Fire Protection. ***https://frap.fire.ca.gov/mapping/gis-data/***

First Order Fire Effects Model (FOFEM) *https://www.fs.usda.gov/ccrc/tools/fofem*

Fuel Characteristic Classification Fuelbeds (FCCS) *https://www.landfire.gov/fccs.php*

Gridmet: A dataset of daily high-spatial resolution surface meteorological data covering the contiguous US from 1979 to yesterday. *http://www.climatologylab.org/gridmet.html*

Ottmar, R. D., D. V. Sandberg, C. L. Riccardi, and S. J. Prichard (2007) An overview of the Fuel Characteristic Classification System - Quantifying, classifying, and creating fuelbeds for resource planning, Can. J. For. Res.-Rev. Can. Rech. For., 37(12), 2383-2393, doi:10.1139/x07077

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