Development of geospatial data and tools for wildland fire emissions modeling for the US

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Spatial datasets for modeling fire emissions:

1. Fuels map and fuel loadings

2. Burned area map

3. Fire weather data

Abstract

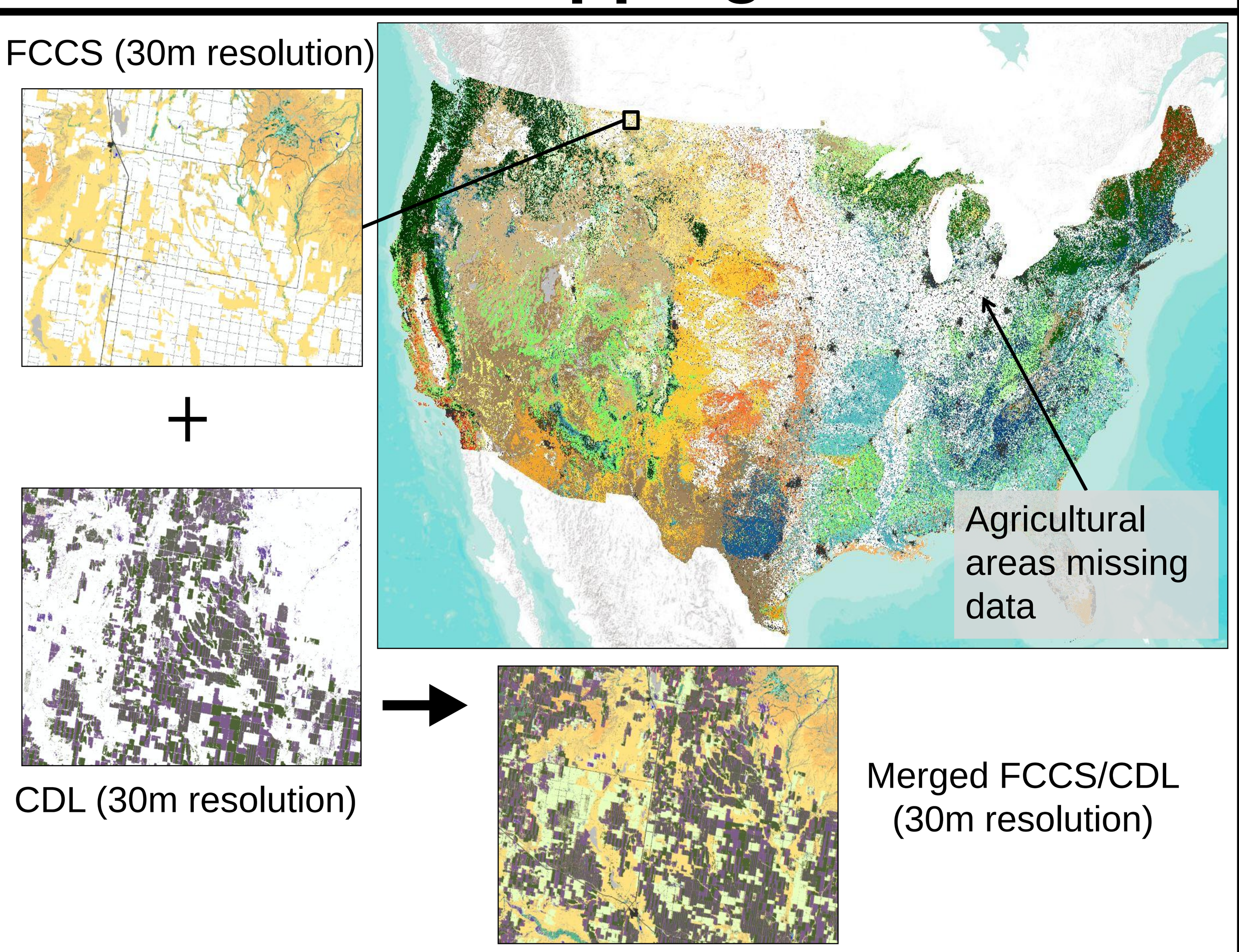
An important improvement in emissions inventory is better representations of where and when pollutant emissions occur. For wildland fire this requires development of geospatial data and analysis tools to know both temporally resolved emissions profiles (daily, monthly and annual emissions) and spatially resolved results. Efforts to map where and when fire occurs are rapidly progressing. The spatial data and systems needed to properly derive emissions quantities using improved fire records are also under development under two research projects funded by NASA in coordination with USDA Forest Service and the US Environmental Protection Agency and using data from the USDA National Agricultural Service (NAS). Our work to build national-scale geospatial fuels data, weather data and tools to use and disseminate these data is presented in this poster. The geospatial information developed originates from several sources, with satellite-derived information a very important aspect of data product development. We present geospatial data products on fire fuels (vegetation type), fuel loading (biomass), and fire weather that are used in conjunction with fire occurrence data to map and quantify wildland fire emissions, including emissions of PM, CO_2, and CO. In addition, we review the tools needed to work with these geospatial data sets including software custom-developed for these NASA-funded projects. The results of the project are presented along with a review of the gaps in our datasets and methodologies to better model and map wildland fire emissions.

1. Fuels Mapping

The FCCS (Fuel Characteristic Classification System) has been developed by the US Forest Service to provide a comprehensive description of fuel layers. FCCS fuelbeds represent fuels across the US and Mexico. They were compiled from scientific literature, fuels photo series, fuels inventories, and expert opinion. Allometric equations in the FCCS calculator produce fuel loadings, other plot-level metrics, and fire-hazard potential.
See: http://www.fs.fed.us/pnw/fera/fccs/

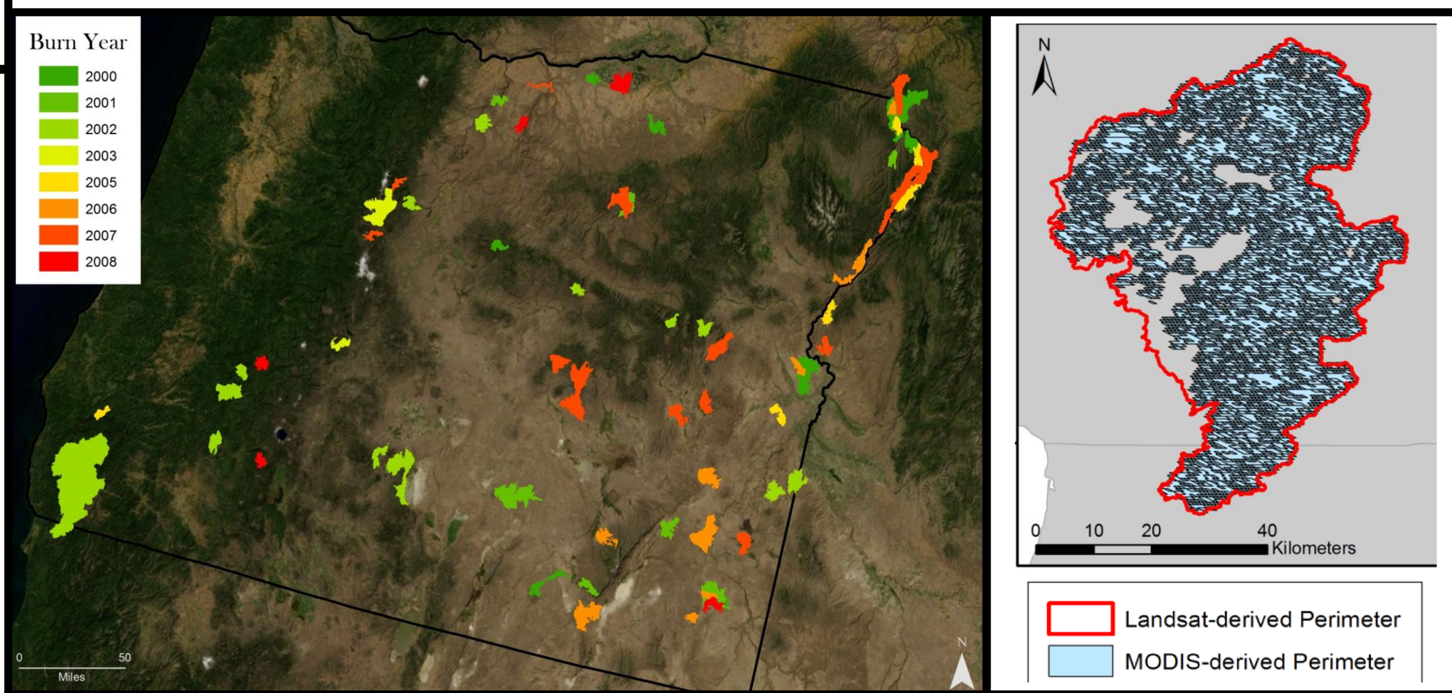
FCCS fuelbeds are used within WFEIS (Wildland Fire Emissions Information System), along with the *Consume* model (see below), to compute wildland fire emissions across CONUS. In areas where no fuelbed is indicated in the FCCS layer, fire emissions are calculated as zero. The areas with no FCCS value in the original FCCS map are urban areas, bare land, or agricultural areas. Because urban areas and bare land do not burn regularly, it is acceptable to leave those areas without an FCCS code, but agricultural areas do burn regularly both due to planned and unplanned burning. Because of this, we have integrated the annual Cropland Data Layer from the USDA NASS to fill in these important gaps in the FCCS by identifying individual crop types in each location as well as calculating the fuel loadings for each type so that the new map will be useful as a tool to compute fire emissions in agricultural areas as well as the areas previously included in the FCCS (forested areas, grasslands, etc.). The process of combining the FCCS and CDL layers is shown to the right.

Fuelbed Mapping Process



2. Burned Area

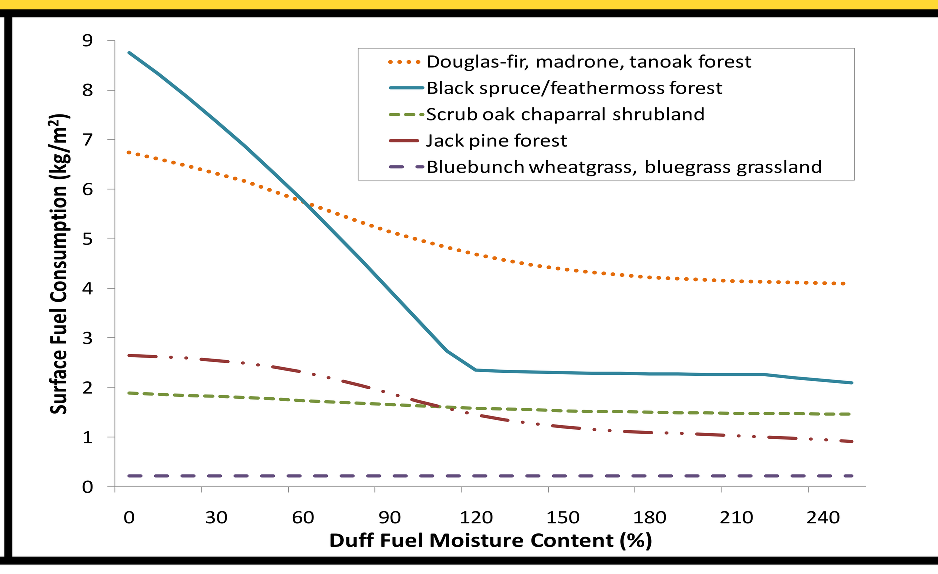
Burned area is used to model fire consumption and emissions. Sources of burned area can be: fire records, Landsat MTBS (below left), or MODIS MCD64A1 Direct Broadcast Burned Area Product



Effect of Burned Area on Carbon Emissions:
For the Biscuit fire, consumption was modeled with two burned area maps (see figure above and to the right). The area-normalized emissions are similar (3.06 and 3.07 kgC m^{-2} or 13.65 and 13.69 short tonsC $acre^{-2}$), but the total carbon emitted is higher with the Landsat-based map by about 17% (6.13 TgC or 6,757,168 short tonsC with Landsat and 5.22 TgC or 5,754,065 short tonsC with MODIS).

3. Fire Weather

Fuel consumption and emissions for wildland fire can be modeled given fuelbed and fire weather information such as duff fuel moisture.



Using weather station data and spatial statistics, daily fuel moisture (%1000-hour and duff fuel moisture) has been calculated by ecoregion (Bailey's province-level ecosystems, pictured below) so that emissions models such as *Consume* can use fuel moisture to compute fuel consumption. With mapped fuel moisture, consumption and emissions can be computed for any place and time in CONUS where fire has occurred for the last 25 years.

Mapping Fuel Moisture

Data Sources

WFEIS: http://wfeis.mtri.org
MTBS: http://mtbs.gov
MODIS burn area: http://modis-fire.umd.edu/
***Consume*:** http://www.fs.fed.us/pnw/fera/research/smoke/consume/index.shtml
Bailey's Ecoregions: http://nationalatlas.gov/mld/ecoregp.html
FCCS: http://www.fs.fed.us/pnw/fera/fccs/
CDL: http://www.nass.usda.gov/research/Cropland/SARS1a.htm

Background: Fuel Consumption Modeling

Wildland fire emissions are largely determined by the amount of biomass (fuel) consumed in the fire. Emissions models use biomass or fuels data to determine consumption and emissions. The USFS *Consume* model contians an empirically-developed set of equations based on field-collected information on fuels and fuel moisture. *Consume* imports fuels data directly from FCCS. Using mapped FCCS fuels (see above) *Consume* can be used to estimate consumption and emissions from all forest, shrub, grassland, and agricultural types in North America. It predicts fuel consumption and pollutant emissions based on fuel loading (varies by fuelbed) and fuel moisture (duff fuels and 1000-hr fuels) by using information collected through field collections. By applying the model in a spatial context, fire emissions can be mapped across the US.