USFS Cooperative Agreement: *Modeling Potential Fire Impacts with Landscape Vegetation Scenarios and Changing Climate for the Sierra Nevada and Other Areas in the Western U.S.*

Supplemental Analysis to the Final 2015 Report: Changing fire, fuels and climate in the Sierra Nevada

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Scenario analysis for fuels treatment effects on changing C emissions from wildfire under a GFDL climate change scenario.

Here we apply emissions factors used in Hurteau et al (2014) to fire simulations for Sierra Nevada forests generated by Westerling in collaboration with USFS Region 5 (See April 6, 2015 report). We apply fuels treatment scenarios from Region 5 generated by administrative units, with 0%, 15%, 30%, 60% and 100% treatment of 30m pixels in each grid cell considered for treatment. Treatment is assumed to restore fuels conditions to FRCC 1. Climate is simulated using the GFDL global climate model run for the A2 global emissions scenario, and downscaled to a 1/8 degree grid using the Bias Corrected Constructed Analogues statistical downscaling method (Maurer and Hidalgo 2008), as in Westerling et al 2011. See the April 6, 2015 report for fire modeling details and data description.

Three coupled fire severity and fuel type scenarios are assessed here, as in Hurteau et al (2014). For a low estimate of wildfire emissions, we allocate burned area preferentially to lower carbon content fuel types and assume mixed fire severity fuel types burn at low severity. For a central estimate of wildfire emissions, we allocate burned area uniformly across existing vegetation types, and assume mixed severity fuel type burn at moderate severity. For a high estimate of wildfire emissions, we allcoate burned area preferentially to high carbon content fuel types and assume mixed severity fuel types burn at high severity.

We find that while GFDL-simulated climate by mid-century produces dramatic increases in wildfire, more than doubling emissions of C as CO2 and CO, fuels treatments could potentially reduce mid-century C emissions to near or even below historic levels if they could be implemented across a large fraction of the landscape considered for treatment (Figure 1). Furthermore, if fuels treatments also result in reduced fire severity by mid-century, the reduction in C emissions from wildfire could be larger (Table 1). For example, if GFDL-simulated climate resulted in higher severity burns concentrated in forest (i.e. high carbon content) fuel types by mid-century, C emissions could more than double to between 1701 and 1835 Gg. A 60% fuel treatment scenario that did not reduce fire severity might still limit C emissions to 842-908 Gg, while if treatment also resulted in a reduction in severity this might further limit C emissions to 718 - 842 Gg, close to levels simulated for historic climate at moderate severity.

This scenario analysis assumes that treatments can be effectively applied at the desired scale, without considering the inherent challenges. Furthermore, the treatments are implemented in one step, not phased in over time. Finally, this analysis does not account for the carbon removed or released by fuels treatment. A comprehensive assessment of the net C benefit from fuels treatments must consider tradeoffs between emissions from treatments versus reduced emissions from wildfire.

Hurteau, M.D., A.L. Westerling, C. Wiedinmyer, B.P Bryant 2014: "Projected Effects of Climate and Development On California Wildfire Emissions through 2100," Journal of Environmental Science and Technology, 48 2298-2304.

Maurer EP, Hidalgo HG (2008) Utility of daily vs. monthly large-scale climate data: an intercomparison of two statistical downscaling methods. Hydrology and Earth System Science 12:551–563

Westerling, A.L., B.P. Bryant, H.K. Preisler, T.P. Holmes, H. Hidalgo, T. Das, and S. Shrestha 2011: "Climate Change and Growth Scenarios for California Wildfire" Climatic Change, 109(s1):445-463.

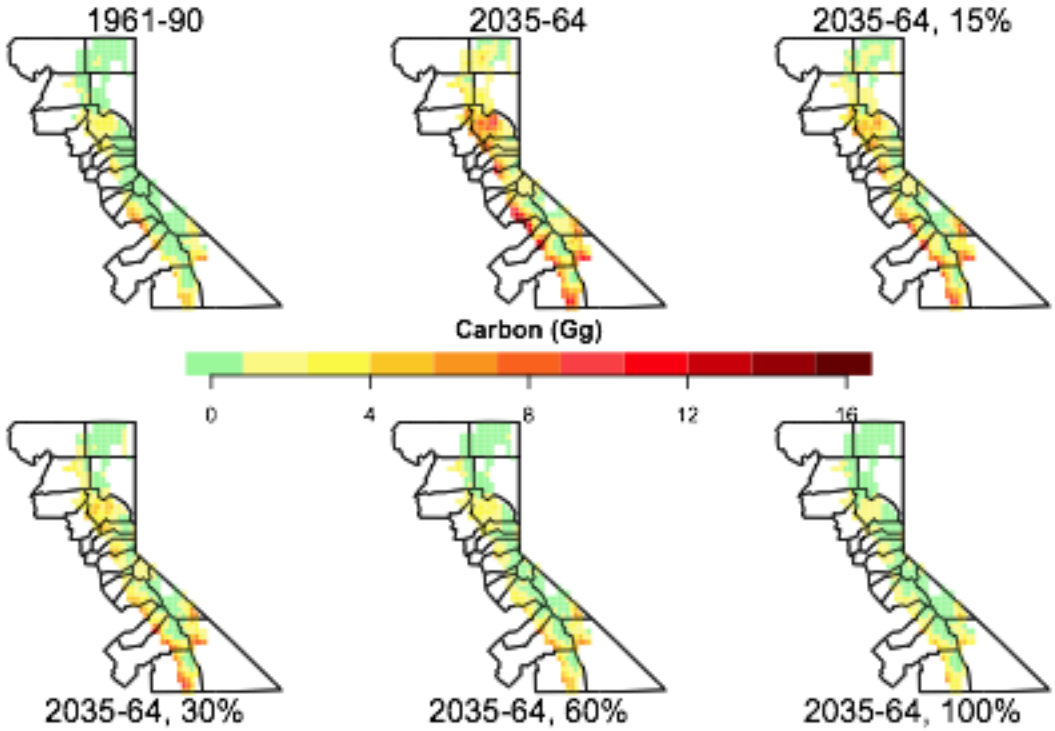

Figure 1: Emissions of C in Gg from CO2 and CO emitted by wildfires for historic climate simulated by GFDL and GFDL future climate with 0%, 15%, 30%, 60% and 100% fuels treatments from the Administrative unit fuels treatment scenarios provided by USFS Region 5. Assumes mixed severity fuel types burn with moderate severity, area burned is allocated uniformly across existing vegetation types in each grid cell.

Table 1: Carbon emissions in Gg from CO2 and CO emitted by wildfires for historic climate simulated by GFDL and GFDL future climate with 0%, 15%, 30%, 60% and 100% fuels treatments from the Administrative unit fuels treatment scenarios provided by USFS Region 5 (columns). Three severity scenarios (rows) are: 1) burned area allocated to lowest carbon fuels first, and mixed severity fuel types are assumed to burn at low severity; 2) burned area allocated uniformly across existing vegetation types, and mixed severity fuel types burn at moderate severity; 3) burned area allocated to highest carbon fuels first, and mixed severity fuel types are assumed to burn at high severity.

year (treatment)	**1961-90 (0%)**	**2035-64 (0%)**	**2035-64 (15%)**	**2035-64 (30%)**	**2035-64 (60%)**	**2035-64 (100%)**
low severity/low carbon veg	615	1447	1120	966	718	564
moderate severity/uniform veg	723	1701	1314	1134	842	662
high severity/high carbon veg	780	1835	1416	1221	908	713