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Long term impacts of prescribed burns on soil thermal conductivity and soil heating at a Colorado Rocky Mountain site

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Heating any soil during a sufficiently intense wild fire or prescribed burn can alter soil irreversibly, resulting in many significant and well known, long term biological, chemical, and hydrological effects. However, much less is known about how fire affects the thermal properties and the long term thermal regime of soils. Such knowledge is important for understanding the nature of the soil's post-fire recovery because plant roots and soil microbes will have to adapt to any changes in the day-to-day thermal regime. Here we report the results of a study performed at a semiarid forest site in the Rocky Mountains of central Colorado (USA) on how fire can affect the long term (post-fire) thermal energy flow in soils.

Direct in situ measurements of soil thermal conductivity are presented that show that prescribed burns can alter the thermal conductivity of soils to a depth of at least 0.20 m without altering its bulk density and that such changes have persisted for almost 4 years after the burn. This previously unknown and presently not-well understood effect can have significant impacts on the long-term soil thermal regime that is independent of changes to surface albedo or any remnants of ash. This study also reports on a new analytical model that synthesizes the above observed data to predict the long term changes in the daily and annual cycles of soil heating and cooling that may result from fire. The model incorporates observed (linearly-varying) vertical structure of the soil thermal properties, observed changes in the surface temperatures, and the influence of any remaining ash to simulate the fire-induced effects on the long-term thermal

climate of the soil. Modeling results suggest that under the dry soil conditions, typical of the experimental forest site, the amplitudes of the daily and seasonal cycles of soil heating/cooling in the fire-affected soils will greatly exceed those in the soils unaffected by fire for several months to years following the fire and that these effects propagate to depths exceeding a meter.