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Simulation of smoke plumes from agricultural burns: Application to the San Luis/Rio Colorado airshed along the U.S./Mexico border

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Abstract

Vegetation fires emit a number of air pollutants, thus impacting air quality at local, regional and global scales. One such pollutant is the particulate matter (PM) that is known to trigger adverse health effects. In this study, the CALPUFF/CALMET/MM5 modeling system is employed to simulate PM_{10} dispersion (PM with aerodynamic diameter less than 10 μm) from agricultural fires in the Yuma/San Luis area along the U.S./Mexico border, with the aim of investigating local and regional air quality impacts of fires. To the extent possible the data collected from and observations made in the study area were employed to infer inputs to the modeling system, but insufficient information available on burning practices and input parameters, such as the duration of fire, PM_{10} emission rate and plume rise, necessitated relying on some previously published research as well as the Fire Emission Production Simulator (FEPS) model to provide necessary inputs.

Under the simulated conditions the fire plumes did not disperse much, and thus mostly affected the area near the sources. The PM impact of fires on populated (receptor) areas in Yuma/San Luis was less than 15 $\mu g/m^3$, calculated on the basis of EPA-recommended 24-hr averaged PM_{10}. If the formation of secondary particles is considered, the impacts could have been greater. In order to conduct more realistic fire plume simulations, it is imperative to have accurate fire-activity records such as the firing technique applied, fuel condition, time of burning as well as some model updates. In all, this paper presents a methodology for calculating agricultural-burns introduced PM, while identifying critical improvements that need to be made in future work.

Keywords: Agricultural fire; Particulate Matter (PM); Plume dispersion; CALPUFF; CALMET; MM5

1. Introduction

Agricultural burning (post-harvest field burning) is a long-standing vital practice that generally occurs in rural regions with low population densities. It is an inexpensive method to remove residues, control weeds and release nutrients for the next crop. Most of the U.S. states regulate agricultural burning in the form of a "permit-by-rule" system, where an agricultural burning manager establishes a set of requirements for which burning can take place. These commonly include the burner demographic information, crop type, acreage and permissible burning conditions, specified by the time of the year, time of the day, meteorological conditions and local notification. If the requirements are met, the burning is allowed without any on-site ambient monitoring. Some U.S. states require written permits, while in the others the agricultural burning

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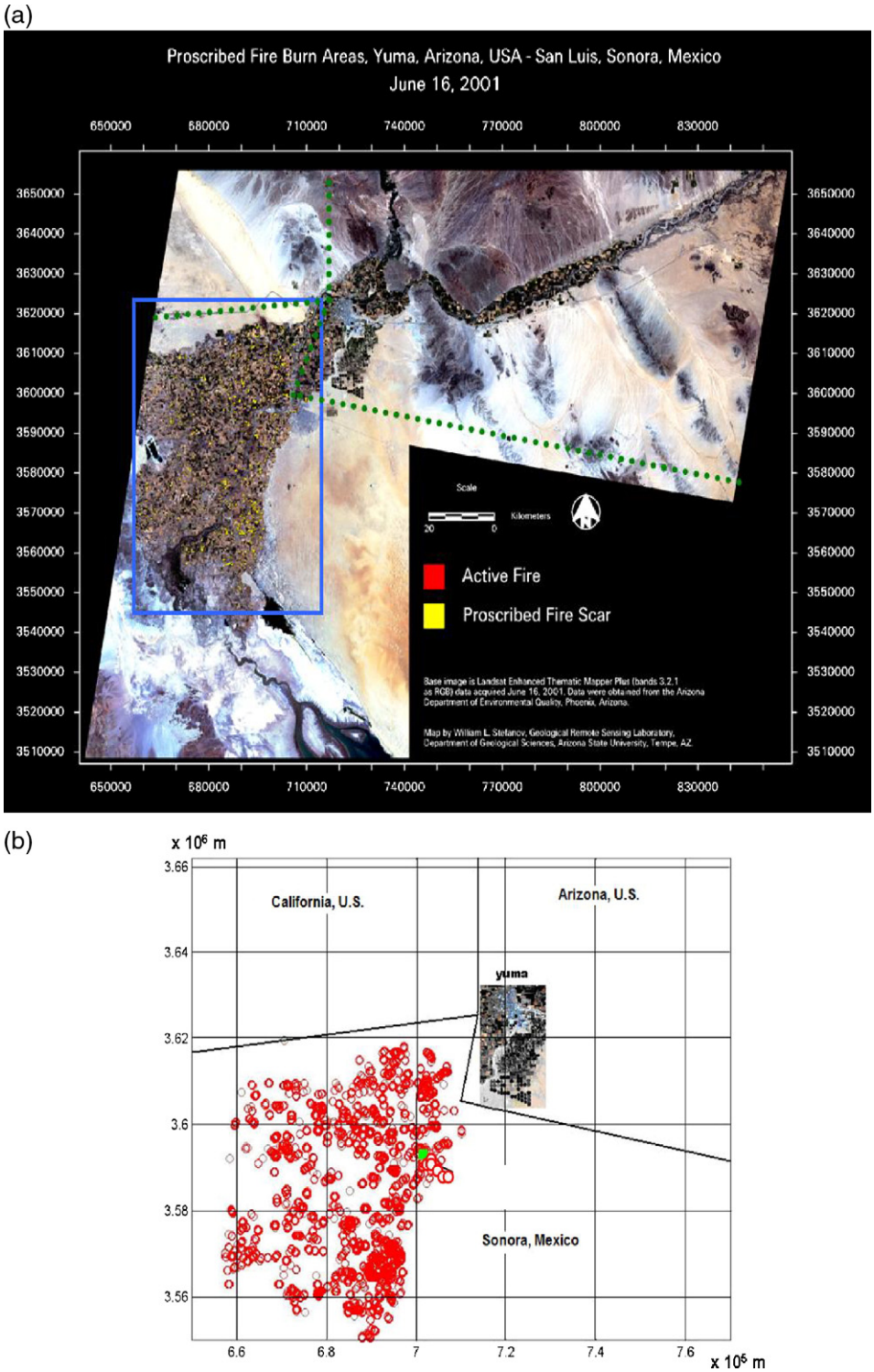

Fig. 1. (a) Fire scars in the Yuma/San Luis area on June 16, 2001, obtained by ETM+ and (b) the processed image of the boxed area using a pattern recognition technique. Maps are in UTM coordinates.