Regional patterns of cropland and pasture burning: Statistical separation of signals from remote sensing products

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The use of fire in agriculture—to manage crop residues and pastoral grasses, and for clearing land—has consequences worldwide for air quality, human health, and climate. Airborne particulate matter from such burning aggravates respiratory ailments and can influence regional precipitation, while associated greenhouse gases and aerosols affect global climate. Little research, however, has focused on understanding patterns of cropland and pasture fire use with an eye towards simulation at global scales.

Previous work by these authors showed that the separate seasonal trends of agricultural and non-agricultural fire could be extracted from large-scale fire observation and land use datasets. This study builds on that research, describing the derivation and application of a statistical method to estimate both the seasonality and amount of cropland, pasture, and other fire based on observations from satellite-based remote sensing products. We demonstrate that our approach is flexible enough to allow the incorporation of alternative high-quality observations of fire and/or land use that might be available only for certain regions.

Results for a number of large regions around the world show that these two kinds of agricultural fire often differ in their extent and seasonality from each other and from burning on other land in ways that reflect known management practices. For example, we find that pasture in north-central sub-Saharan Africa tends to burn earlier than non-agricultural land; this can be attributed to pastoralists preventively burning their land early in the dry season so as to avoid severe, uncontrolled burns under more dangerous fire conditions later. Both the timing and extent of agricultural fires prove to be

regionally specific; our method allows these geographically distinct patterns to be fully appreciated.

The local and global differences in seasonality and amount of fire between different land-use types suggest that dynamic global vegetation models (DGVMs) should simulate fires on cropland and pasture fire independently from burning on other lands and take a regional approach in doing so. For example, pastoral burning dominates across large parts of the African region described above, where a fire model focused only on non-agricultural burning would therefore be inaccurate. On the other hand, in southern Africa those two types of fire more closely parallel each other. While a pure application of our analytical method is based exclusively on the relative distributions of fire activity and land use types, we demonstrate its incorporation into a more process-based fire model to capture the influence of seasonal and interannual variations in climate and ecosystem characteristics on burning. Such a model, the ultimate goal of our research, will help improve DGVM simulations—and therefore scientific understanding—of past, present, and future distributions of fire.