A Wildland Fire Emission Inventory for the Western United States -Uncertainty Across Spatial and Temporal Scales

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Emissions of trace gases and aerosols by biomass burning (BB) have a significant influence on the chemical composition of the atmosphere, air quality, and climate. BB emissions depend on a range of variables including burned area, fuels, meteorology, combustion completeness, and emission factors (EF). Emission algorithms provide BB emission inventories (EI) which serve as critical input for Chemical Transport Models (CTM) employed in atmospheric sciences in a wide array of studies. Many different BB EI are commonly used and agreement among these EI is often poor. In general, the sensitivity of the emission estimates to the algorithm components is not well characterized and the performance of most algorithms have not been examined across the scales they are used. Understanding the sensitivity of EI to algorithm component uncertainties is crucial for assessing their impact on CTM simulations. We examine the spatial and temporal sensitivity of BB emission estimates of CO to uncertainties in mapped fuel loading, fuel consumption, burned area and emission factors. The study focuses on wildland fire in the western United States(2003 - 2008). Two fuel loading maps and 2 fuel consumption models provided 4 fuel load consumption emission scenarios with identical burned area and meteorology. The burned area used in the study was mapped using a MODIS burn scar algorithm. The emission algorithm was run at 1-day and 1-km2. Each of the 4 EI was aggregated across multiple spatial (dx= 10 - 200km2) and temporal (dt= 5day - 1yr) scales to evaluate the algorithm sensitivity to scale. At each (dx, dt) the native scale EI of the 4 scenarios were averaged to provide a 'best estimate' EI. The uncertainty associated with fuel load consumption (Uflc) was taken as half the range of emissions predicted by the 4 scenarios at each (dx, dt). Estimated uncertainties for the burned area (Ua) and EF (Uef) were combined with Uflc to provide the CO emissions uncertainty (U). The sensitivity of U to scale was assessed using the emission weighted uncertainty (Uw). Our emission algorithm estimates that from 2003 to 2008 annual CO emissions from wildland fire across the western U.S ranged from 0.432 to 3.38 tg with an uncertainty of 40 - 60%. The uncertainty in CO emissions increased with decreasing temporal and spatial scale. At dx=100 km2, Uw increased from 60% to 80% as the dt decreased from 1 yr to 5 days. At 10km2, Uw increased from 85% at 1 yr to 100% at 5 days. The variation in Uw across spatial and temporal scales was largely driven by uncertainty associated with the burned area mapping algorithm. While the burned area mapping component drives the variability of algorithm uncertainty with scale, Uflc makes a large contribution to Uw at all scales. Uflc is the dominant source of uncertainty for dx >= 25 km2 and dt >= 1 month. The emission factors for CO (EFCO) are well characterized for the fire activity pertinent to this study. The relatively small uncertainty in EFCO results in only a minor contribution to the overall uncertainty in the CO emission estimates. This is not the case for species with less well characterized emission factors like 'black carbon' and even total PM2.5.

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