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The Influence of Pyrogenic, Biogenic and Anthropogenic Emissions on Ozone Production Downwind from Boreal Forest Fires

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Boreal forest fires emit pollutants that can have a strong influence on downwind surface ozone concentrations, with potential implications for exceeding air quality regulations. The influence of the mixing of pyrogenic, biogenic and anthropogenic emissions on ozone is not well understood. Using the nested 0.5˚ latitude x 0.667˚ longitude GEOS-Chem chemical transport model we track biomass burning plumes in North America. We identify the changes in key chemical reactions within these plumes as well as the sensitivity of ozone to the different emission sources. We illustrate the importance of this method using a case study of a multi-day forest fire during the BORTAS aircraft campaign over eastern Canada during summer 2011. We focus on emissions from the fire on the 17th of July and follow the plume for eight days. After the initial 24 hours of pyrogenic emissions the main source of VOCs is biogenic with increasing emissions from anthropogenic sources including outflow from Quebec City and Newfoundland. Using a Lagrangian framework, we show that the ozone production efficiency (OPE) of this plume decreases steadily as it moves away from the fire but increases rapidly as the plume reaches the east coast of Canada. Using a Eulerian framework we show that ozone mixing ratios of a east coast receptor region increase by approximately 15% even though the ozone tendency of the regional air mass is negative, which we find is due to the arrival of ozone precursors in the plume. We also consider the contribution of anthropogenic outflow over Nova Scotia that originates from the eastern seaboard of the United States to the local chemistry. Using these sensitivity model runs we generate a chemical reaction narrative for the plume trajectory that helps to understand the attribution of observed ozone variations.