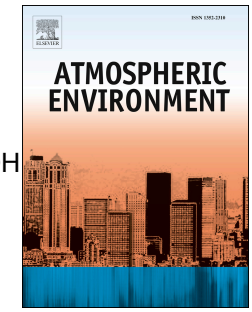
Accepted Manuscript



Impact of aromatics and monoterpenes on simulated tropospheric ozone and total OH reactivity

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PII: S1352-2310(17)30561-7

DOI: 10.1016/j.atmosenv.2017.08.048

Reference: AEA 15518

To appear in: *Atmospheric Environment*

Received Date: 12 May 2017

Revised Date: 18 August 2017

Accepted Date: 20 August 2017

Please cite this article as: Porter, W.C., Safieddine, S.A., Heald, C.L., Impact of aromatics and monoterpenes on simulated tropospheric ozone and total OH reactivity, *Atmospheric Environment* (2017), doi: 10.1016/j.atmosenv.2017.08.048.

Impact of aromatics and monoterpenes on simulated tropospheric ozone and total OH reactivity

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Abstract

The accurate representation of volatile organic compounds (VOCs) in models is an important step towards the goal of understanding and predicting many changes in atmospheric constituents relevant to climate change and human health. While isoprene is the most abundant non-methane VOC, many other compounds play a large role in governing pollutant formation and the overall oxidative capacity of the atmosphere. We quantify the impacts of aromatics and monoterpenes, two classes of VOC not included in the standard gas-phase chemistry of the chemical transport model GEOS-Chem, on atmospheric composition. We find that including these compounds increases mean total summer OH reactivity by an average of 11% over the United States, Europe, and Asia. This increased reactivity results in higher simulated levels of O_3, raising maximum daily 8-hour average O_3 in the summer by up to 14 ppb at some NOx-saturated locations.

1 Introduction

Volatile organic compounds (VOCs) play a critical role within the Earth's troposphere, affecting the global climate, controlling the formation of common pollutants, and influencing the lifetimes of other key atmospheric compounds. VOCs are emitted from both natural and anthropogenic sources, including combustion and industrial production processes (Piccot et al., 1992), as well as natural emissions from trees and other plant life (Guenther et al., 2012). The accurate representation of these compounds within atmospheric models is a key goal of the atmospheric chemistry community, largely because they are direct precursors of ozone (O_3) and fine particular matter ($PM_{2.5}$), known pollutants which can also influence the global climate (Jenkin and Clemitshaw, 2000). VOCs also have major impacts on other key atmospheric species, including the hydroxyl radical (OH), one of the key contributors to the oxidation capacity of the atmosphere.

Tropospheric O_3 is an EPA criteria pollutant responsible for an estimated 200,000 premature mortalities worldwide each year (Lim et al., 2013). Ozone concentrations are typically highest on hot, stagnant days in the presence of abundant nitrogen oxides (NO_x) and VOCs. While there has been some success in reducing the magnitude of extreme summertime O_3 events across the United States and Europe, especially in urban areas (Guerreiro et al., 2014; Simon et al., 2015), difficulties in predicting and reducing global tropospheric O_3 levels remain (Cooper et al., 2014). Among the causes of these difficulties are uncertainties surrounding the emissions, chemistry, and removal of VOCs and other O_3 precursors, especially due to the non-linearity of the relationship between precursor concentrations and O_3 production. Understanding spatial and temporal variability in atmospheric oxidative capacity, O_3 formation rates, and other consequences of VOCs will require that gap to be closed, both in ambient observations of the atmosphere and within the models used to represent it. Many studies have reported a gap