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Controls on surface ozone pollution in the province of Nova Scotia, Canada

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Surface ozone (O_3) is an air pollutant that is notoriously difficult to regulate due to its non-linear production that is dependent on emissions of precursor gases (NO_x , VOCs) and meteorological conditions. As a small, but expanding, province, containing the largest urban centre in Atlantic Canada, Nova Scotia does not experience concentrations of ozone and its precursors that are characteristic of megacities. However, elevated levels of surface ozone are observed on some days and the chemistry and meteorology behind these events are not well characterized.

This study examines long-term (2000-2021) observational ozone and precursor gas data, as well as associated local emissions inventories, in order to define trends and explain changing ambient levels of ozone in the province. For example, provincial local emissions have been consistently decreasing but ozone concentrations are beginning to rise in recent years and the cause of this rise is investigated. Although it is known that transboundary pollution is present on some days, the significance of this transported pollution to annual trends was unknown prior to this research.

We introduce and apply a spatial correlation algorithm as a novel method to diagnose transported pollution events that cause high ozone across the province and are able to estimate the proportion of transported pollution in the province over the study period. We find transported pollution to account for 45-63% of the elevated ozone days. We then identify source regions of this transported pollution as well as changes in source regions over time based on results from HYSPLIT model runs. Vertical ozone concentrations obtained from model forecasts are examined during high ozone events in the province to determine the processes that bring pollutants to the surface from above the boundary layer.

Our results clarify the sensitivity of surface ozone levels in Nova Scotia to changing levels of precursor emissions in upstream areas like NE USA, which have seen an increase in recent years following decades-long reductions. This research has significance for policy-makers working to manage risks from air pollution in growing cities subject strong upstream pollution sources under a changing climate.