The Impact of Climate Change on Meteorological Conditions Promoting Extreme Air Pollution in Malaysia

Matthew J Ashfold

University of Nottingham Malaysia, Malaysia

Author list (excluding presenting author)

Ahmad Mirza Mokhtar

Abstract

Climate change is broadly expected to increase the likelihood of meteorological conditions that promote air pollution. In Malaysia, recent examples of extreme air pollution events, including high levels of particulate matter (PM) during 'haze' episodes during regional dryness, and high levels of ozone (O3) during 'heatwave' conditions, underscore the importance of meteorological conditions for air quality. In this work we seek to understand the impacts of climate change, both historical and future, on meteorological conditions that promote air pollution in Malaysia. We first obtained historical nationwide observational and model-derived air pollution and meteorological data to generate a coherent 13-year (2004-2016) dataset suitable for statistical analyses. We organized analyses into six main meteorologically-coherent regions of Malaysia, and two overarching seasons mapping to summers in northern (April-October) and southern (November-March) hemispheres. To determine key meteorological drivers of the air pollutants PM10 and O3, for each region and season, we deployed descriptive statistics, correlation and exceedance analyses, and multiple linear regression analyses. To assess changes with time, we obtained further historical meteorological data, covering a longer 60-year period (1960-2020), and obtained both historical and future meteorological data from the CMIP6 archive of climate model simulations. As has been found globally, our comprehensive nationwide analyses suggest climate change is impacting meteorological conditions that promote air pollution across Malaysia. Most importantly, we find increasing temperatures have a wide-ranging influence in promoting higher levels of both O3 and PM10 pollution. We also identified important influences of other meteorological variables, such as winds and recirculation patterns, in contributing to variations in air pollution in different regions and seasons, though there are fewer significant climatic trends in these further meteorological variables. Overall, the influence of a changing climate in promoting air pollution in Malaysia implies additional reductions in emissions would be needed to improve air quality.

Early Career Scientist

NO, I am not an early career scientist.

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