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The Relationship between Ozone and Temperature in Greater Kuala Lumpur, Malaysia

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ABSTRACT

A positive relationship between temperature (T) and the pollutant ozone (O_3) has been widely reported. Increases in T linked to anthropogenic climate change could promote increases in O_3, but the importance of this "ozone-climate penalty" has received little attention in tropical regions. Here we add to available evidence from the tropics by analysing the O_3-T relationship in Greater Kuala Lumpur (GKL), Malaysia. We focussed on observations from three Malaysian Department of Environment air quality monitoring sites, covering the 10-year period 2007–2016. We identified consistent patterns across the sites, with high T and O_3 year-round, modest seasonality, and a year-round positive O_3-T relationship. We quantified this relationship using regression slopes, which varied across the three sites between 2.8–4.0 ppb $°C^{-1}$ for 50th percentile O_3 and between 5.6–6.7 ppb $°C^{-1}$ for 95th percentile O_3. Over the study period, we found that O_3 in fixed T bins, and O_3-T slopes, were tending to decline, but that counteracting increases in T appear to result in little change in overall O_3 levels. This is an indication of an "ozone-climate penalty" in GKL. We also characterised increases in O_3 during a period of exceptionally high T in 2016. Our findings of a strong positive O_3-T relationship, of indications of a declining sensitivity of O_3 to T, and of co-occurring extremes of O_3 and T are broadly consistent with literature covering cities in other regions, though these features are relevant year-round in GKL. Further work is required to understand the influences of chemistry, emissions and other meteorological conditions associated with high T on O_3 and the O_3-T relationship in this region. Such an understanding would inform further controls on emissions of O_3-precursors in GKL, which appear to be critical to achieving improvements in future O_3 air quality under ongoing warming.

Keywords: Ozone, Climate change, Regional air quality

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1 INTRODUCTION

Meteorological variations play an important role in influencing air quality (Jacob and Winner, 2009). One widely observed meteorology-air pollution relationship is between temperature (T) and ozone (O_3), a pollutant which affects both human and plant health (Monks *et al.*, 2015). Especially in polluted urban areas there is typically a positive O_3-T relationship, with higher T associated with higher levels of O_3. This relationship has been linked to several underlying mechanisms: higher T assists O_3-forming chemical reactions, promotes precursor emissions, can weaken O_3 deposition, and is typically correlated with other meteorological conditions—such as calm, sunny, dry periods—