UNIVERSITI TEKNOLOGI MARA

RELATIONSHIP BETWEEN TEMPERATURE INCREASE AND PRECIPITATION EXTREMES IN PENINSULAR MALAYSIA BASED ON REGIONAL CLIMATE MODELS

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ABSTRACT

Study on the change of precipitations under changing climate is of interest because of their large impact on society. Clausius-Clapeyron (CC) relationship, which governs how moisture behaves with temperature, expected extreme precipitation to intensify by 7% per degree of warming. Research in climatology usually involves two methods: using climate models and statistical properties of historical observations. Although historical observations are often used in guiding the stakeholders in their decisions, climate models are usually used to provide future projections of climate. The coarse resolution of General Circulation Model (GCM) is insufficient in showing how extreme precipitation will affect local climate and thus lead to a scaled down Regional Climate Model (RCM). However, RCM tends to underestimate extreme rainfall when compared with historical observations. This research explores the metrics used to assess climate models and apply them on three RCM available for Peninsular Malaysia. The research starts by first establishing the relationship between observed extreme precipitation with temperature, where decreasing trend was observed in Peninsular Malaysia regardless of location or time investigated, in contrast with CC relationship expectation. The observed trend at 99th percentile of daily rainfall intensity is found to be decreasing as much as −35% per degree of warming. Next, the ability of EC-EARTH (R1), CM5A-LR (R2) and ESM-MR (R3) GCM, scaled down under RegCM4-3, in simulating historical observations were assessed where R2 was found to performs the best among the RCM assessed. Hence, R2 was chosen to investigate future changes of extreme rainfall − focused at the 2060-2084 period under RCP8.5 scenario − from the present-day climate. R2 projected no significant change in the future monthly cycle or seasonality of extreme rainfall with historical simulations. Further, the mean annual maximum of daily rainfall is also projected to increase across many areas in Peninsular Malaysia, with some coastal area of Pahang, Perak and Kedah will experience an increase of over 70% of the present-day mean, while the coastal area around Kelantan will experience a decrease between 10 to 30% of the present-day mean. However, a small area, especially in the inland area of Peninsular Malaysia, is expected to show no significant changes to the mean annual maximum in the 2060-2084 period from the present-day value. Last, the response of extreme precipitation with temperature is expected to change in the future, thus render historical scaling invalid for future climate. The findings may benefit climatology where CC relationship can improve the performance of climate models to simulate Earth climate, especially to make better predictions of future climate.

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CHAPTER ONE
INTRODUCTION

Climate change affects globally, including Malaysia. The latest report published by Intergovernmental Panel on Climate Change (IPCC) used the word “unequivocal” to describe the warming trend of the Earth (IPCC et al., 2013). In the report, anthropogenic increases in greenhouse gases concentration in the atmosphere are expected to cause changes in mean conditions of climate, with extreme weather are expected to be more frequent and/or severe. The increasing threat of climate change driven by human activities (IPCC et al., 2013) hence demands a deep understanding of its effects on the local climate system, for example, how anthropogenic warming influences extreme rainfall in Malaysia.

Therefore, assessment of the changes in extreme weather events such as storms and heavy rain are paramount to stakeholders for management of the potential risk of such weather events, such as flooding, under changing climate. This is crucial to stakeholders, especially when drawing key policies relating to climate change (Sillmann et al., 2017).

1.1 Background and Motivation of Study

Nurul Nadrah Aqilah & Sobri (2011) and Mohamad Hamzah et al. (2017) found that the temperature in Malaysia shows an upward trend in the last decade in line with IPCC et al. (2013) report. In terms of precipitations, IPCC et al. (2013) highlighted the increasing trend of heavy on land precipitations over many regions. On a regional scale, such trend has been observed in various studies (Alias et al., 2016; Mayowa et al., 2015; Muhammad et al., 2016; Suhaila et al., 2010; Syafrina et al., 2015), where the extreme rainfall events are becoming more severe.

Min et al. (2011) provide the initial insights into human influence on the daily extreme rainfall intensification. After, Westra et al. (2014), in their review of the current outlook of precipitation extremes, noted evidence of intensification of extreme daily rainfall and their frequency over most continents. Westra et al. (2014) also noted that there is evidence of anthropogenic climate change’s influence towards extreme weather events or an increase in their occurrence. An increasing trend of extreme rainfall may