Review of PhD thesis by Beata Latos

The role of equatorial waves in triggering weather extremes in the Maritime Continent

Overall this is an excellent thesis and contribution to knowledge of extreme weather in the tropics. I enjoyed reading the thesis and the text had good structure and grammar. Below, I have made comments about each chapter and then summarised my overall thoughts at the end.

Introduction

I am unsure what the expected structure is for an introduction for a thesis of this kind. I found it quite repetitive – it appeared to state what is in the subsequent chapters a number of times, yet the key unknowns/gaps in the literature are not conveyed in much detail at all.

An example is the last paragraph of page 9. It would be good to make a statement with references about the fact that models struggle to represent the propagation of an MJO event across the MC, although more recent models have shown improvements better e.g.

Ahn, M.-S., Kim, D., Kang, D., Lee, J., Sperber, K. R., Gleckler, P. J., et al. (2020). MJO propagation across the Maritime Continent: Are CMIP6 models better than CMIP5 models? Geophysical Research Letters, 47, e2020GL087250. https://doi.org/10.1029/2020GL087250

Kim, H., D. Kim, F. Vitart, V. E. Toma, J. Kug, and P. J. Webster, 2016: MJO Propagation across the Maritime Continent in the ECMWF Ensemble Prediction System. J. Climate, 29, 3973–3988, https://doi.org/10.1175/JCLI-D-15-0862.1.

There are other places where more information could be added.

Paper #1 Social-media and newspaper reports reveal largescale meteorological drivers of floods on Sumatra

This paper presents a comprehensive analysis of flood observations from different sources and an investigation of the co-occurrence of floods with equatorial waves and the Madden-Julian Oscillation (MJO). The work is highly novel for two reasons. Firstly, the use of social media posts alongside data from an official disaster database to create flood 'observations' provides a solution to a key issue for any analysis of floods. It is difficult to know where and when floods occurred as there aren't direct, comprehensive observations. Secondly, the analysis of linking atmospheric circulation to floods, rather than just extreme rainfall is novel. A key result is that equatorial waves are a more important driver of Sumatran floods than the MJO. Prior to this paper there was very little in the literature linking waves to flooding, either in the Maritime Continent, or elsewhere in the tropics. This work has motivated a number of further studies over the Maritime Continent by the international community to further understand equatorial waves as a driver of extreme rainfall, evaluate equatorial waves in weather forecast models and to develop statistical forecasts of extreme rainfall based on the existence of equatorial waves. The paper states that nearly half of Sumatran flooding periods had a well-defined dynamical precursor at least two days before flood onset, which means there is a strong potential for the development of better early warning systems. The methodologies around observing floods and linking to atmospheric drivers is novel and could easily be transferred to other regions such as Africa.

Overall, a novel study in a high impact journal.

Paper #2: Equatorial Waves Triggering Extreme Rainfall and Floods in Southwest Sulawesi, Indonesia

This paper investigates the role of equatorial waves in driving extreme rainfall and floods in SouthWest Sulawesi, located in the Maritime Continent. The candidate is the lead author of the paper, which

contains a significant amount of novel and in-depth analysis. The initial analysis of the January 2019 case study is comprehensive, with significant work going into identifying the circulation and rainfall due to the different drivers (CCKW, CCEKW and MJO), identifying not just extreme rainfall events, but the floods that rainfall can cause. The paper also includes a generalisation of the results and summary through a schematic diagram. The generalisation of results over a 10 year period is a great addition to the case study and means the analysis is highly novel for not only Sulawesi, but the Maritime Continent and globally across the tropics. Another key conclusion is that the fact that the flood events were not caused by storms purely driven by the diurnal cycle of rainfall, rather the large-scale circulation plays a major role and intensifies any diurnal forced convection. I am not aware of other studies about equatorial waves and floods/rainfall with this level of mechanistic understanding.

One question would be why social media observations for floods were not used in this study even though they were over Sumatra in Paper #1. It would also be nice to know whether the overall results (in Fig 17) could be generalised for a larger part of the Maritime Continent. I suspect they could be. This is probably beyond the scope of the paper but would further strengthen the impact of the work. The conclusion that although the MJO is important, equatorial waves increase the predictability of extreme weather, is important for improving weather forecasts of such events. It might also have been nice to see some thought or discussion as to how that could be achieved.

Overall I found the evidence for equatorial waves as a driver of floods in this region compelling and it showcases the candidate's knowledge of the discipline and her ability to conduct research independently.

Paper #3 The role of tropical waves in the genesis of Tropical Cyclone Seroja in the Maritime Continent

This paper investigates the reasons for the formation of Tropical Cyclone Seroja in southeast Indonesia. Tropical cyclones this close to the equator are very rare but this event brought historic flooding to the region.

Unlike Papers #2 and 3, this study focuses almost completely on this single event. It quite rightly focuses on the cyclogenesis (formation) of the storm because this is the part which is challenging to represent in weather models and is thus a major source of poor forecast skill. The results show that a perfect storm of warm sea surface temperatures, equatorial waves and MJO co-occurrence was present during this unique event. This work is entirely novel because tropical cyclones in this region are so rare. The study is in depth and the consideration for detail is impressive. I also like the schematic at the end, which draws together the results and communicates the key points very clearly.

The work is put into a wider perspective by finding that the co-occurrence of warm sea surface temperatures, equatorial waves and the MJO occurs approximately once per year, although the Tropical Cyclone Seroja event was particularly exceptional because the anomalies of the waves were more than 2 standard deviations above the mean. It would not have been possible to generalise the results more in this study because there are no other events to look at, however, it may have been possible to look at tropical cyclones and low pressure systems in other parts of the Maritime Continent to build up the sample size.

Overall, there is plenty of evidence from this study to show independent work, knowledge of the subject area and novel findings by the candidate.

Summary of review

This PhD dissertation undoubtedly contains a sufficient amount of high quality, novel work for the award of a PhD and the work has already been published in top international journals. I have provided

evidence for that in the sections above. My only concern is the quantity of the independent work. The candidate's contribution to papers #2 and #3 are clear – she led the analysis and writing with help from her supervisors and co-authors. The candidate's contribution to paper #1, however, was only 10% of the total work required for the paper and was limited to the processing of the rain gauge data and Indonesian disaster data, processing and analysis of the ERA5 data and some (small?) contribution to the writing. I don't think paper #1 demonstrates much leadership or much evidence of independent thinking. In my home country paper #1 wouldn't really be admissible as part of her PhD, but perhaps the use of non-lead author papers is more common in Poland? Having said that, it is impressive that the candidate has two lead author papers already published, which demonstrates a large quantity of novel work.

It would have been nice to see a 3rd lead-author study, even if not published, perhaps on generalising the findings from the case study in paper #3 over a larger area of the Maritime Continent. It would have also been nice to see some thoughts on the limitations of the studies and some discussion of potential areas of future work, particularly around using the research to develop improved Early Warning Systems for floods and tropical cyclones.

Overall, I would definitely recommend the candidate for public defence of the PhD. I think there is sufficient novel work, evidence of knowledge and demonstration of independent thinking to warrant it. Well done.

Prof Cathryn Birch, University of Leeds

C. E. Birch.