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Mechanisms of Indian Summer Monsoon Change in the HAPPI 1.5 °C and 2.0 °C Future Climate Experiments

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The Indian Summer Monsoon is an important part of the tropical climate system. As millions of people are dependent on its rainfall, the need to be able to produce reliable projections of how monsoon rainfall is likely to change in a future warmer climate is clear. In this work, part of the REAL Projections project, we use data from the HAPPI (Half a Degree Additional Warming: Prognosis and Projected Impacts) project, which comprises ten-year multi-model climate simulations imposing current climate conditions, and two sets of additional ten-year simulations in a future climate that is either 1.5 °C or 2.0 °C warmer.

We compare both current climate simulations and changes in a warmer climate across five models from the HAPPI dataset. While the models agree on the general large-scale pattern of monsoon circulation and how that pattern could change, there is a great deal of disagreement in the detail. Consistency maps show that, even though the models all capture the general patterns of change, there is a disagreement in the sign and the magnitude of the predicted rainfall changes over India. We then compare the 1.5° C warmer and 2.0° C warmer scenarios and find that, in terms of monsoon rainfall and circulation strength, the extra 0.5 °C of warming generally enhances the change from the initial 1.5 °C, but not in every model. We also examine the timing of the monsoon onset and the structure of its vertical circulation, which reveals different behaviours across the models.

Next, we will investigate the changes to the Indian Summer Monsoon in more detail using the large number of ensemble members available in the HAPPI data. We will examine the ranges of interannual variability of various monsoon indices and how these change in a warmer climate. We will also examine changes in the occurrence of extreme weather events.