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On spatial patterns of heat waves and cold spells from a large deviations perspective

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We analyse persistent temperature events, like heat waves or cold spells, by applying large deviation theory (LDT), and show that events with a long duration have also a substantial spatial extension. We point out that by using LDT one finds typical spatial patterns related to the persistent temperature extremes. Based on the output of a state-of-the-art climate model, we define the climatology of persistent heatwaves and cold spells in some key target regions of the planet by constructing empirically the corresponding rate functions for the surface temperature, and we assess the impact of increasing CO₂ concentration on such persistent anomalies. In particular, we notice the increasing hazard associated to heatwaves in a warmer climate. We show that two 2010 high impact events - summer Russian heatwave and winter Dzud in Mongolia - are associated with extended atmospheric patterns that are exceptional compared to the typical ones, but typical compared to the climatology of extreme events.