Intensification of short-duration extreme precipitation over Greater Sydney: Observations and climate projections

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Abstract: Short-duration extreme precipitation events (≤1 hour) are intensifying more rapidly than longer-duration events (Ayat et al., 2022; Jayaweera et al., 2023), amplifying flash flood risks and threatening urban infrastructure and communities (Ramezani et al., 2023). Yet, regional-scale analyses of such events remain limited. The present study investigates sub-hourly to hourly extremes using data from 16 automated weather stations (AWS) (https://reg.bom.gov.au/climate/data/stations/) across the rapidly urbanising Greater Sydney region, New South Wales, Australia. Observations reveal stronger increasing trends in extreme precipitation (99th percentiles) at 5–10 minute scales compared with hourly events. Furthermore, we evaluated five NARCliM2.0 regional climate model simulations (https://geonetwork.nci.org.au/geonetwork/srv/eng/catalog.search#/metadata/f2795_8238_4580_6260). The results indicate that the models capture the upper tail of precipitation distributions reasonably well, although they slightly overestimate the frequency of extreme events. Projected changes were assessed by comparing 99th percentile intensities across three periods: historical (1951–2014), near future (2015–2057), and far future (2058–2100), under SSP126, SSP245, and SSP370 scenarios. Results indicate a consistent intensification of extremes, with a pronounced upward shift in the top 1% of events, particularly under SSP370. Notably, models also project a reduction in total wet hours, suggesting a transition toward fewer but more intense precipitation events. Despite inter-model variability and spatial heterogeneity, all simulations show increasing extreme precipitation trends except under far-future SSP126. These findings underscore the urgent need to account for short-duration extremes in urban planning and adaptive stormwater infrastructure design to mitigate escalating flood risks under climate change.

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