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Locality and dynamics shaping the global scaling pattern of hourly precipitation extremes

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According to thermodynamics, as the climate gets warmer under climate change the water holding capacity of the air increases at a rate of 7%/^{o}C (Clausius-Clapeyron; CC). This implies that in the absence of severe changes in relative humidity, precipitation extremes (PEx) will increase likewise. Would this relationship prove to be globally robust, then ground temperature predictions could be used as an indicator for predicting future PEx intensification under climate change. This could be a helpful tool, given the well-documented discrepancies of climate models in simulating PEx and the increased confidence in temperature projections. However, studies based on observational and modelled data have revealed contradicting behaviours regarding the scaling rate of PEx with ground temperature. In this study we use hourly data from weather stations (1,461 sites), two convection permitting models and 40 years of climate reanalysis in order to reveal the global scaling pattern of PEx with ground air and dewpoint temperature at fine spatial and temporal scales based on a robust methodology. Our results suggest that a robust ~CC scaling with both air temperature and dew temperature occurs in high- and mid-latitudes. In the tropics and extra-tropics scaling with temperature ranges from negative up to >CC rates, while scaling with dewpoint is strongly positive with >CC values. An investigation of the emerging global pattern reveals that exhibited divergence from CC is linked to the dynamics of deep atmospheric convection in the tropics and extra-tropics. Topography, larger-scale weather patterns and their associated mechanisms shape the scaling pattern in high- and mid- latitudes and seem to disengage ground measurements from activity at the cloud level. In this study we also prove that non-convection permitting models fail to capture the observed behaviour in regions with strong topographic features and/or distinct deep convection. We show that in such regions convection permitting models which capture those features make more reliable estimations.