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Atmospheric rivers cause warm winters and extreme heat events

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Abstract

Atmospheric rivers (ARs) are narrow regions of intense water vapour transport in the Earth's atmosphere. These transient phenomena carry water from the subtropics to the mid-latitudes and polar regions[1,2], making up the majority of polewards moisture transport[3,4,5] and exerting control on the precipitation and water resources in many regions[6,7]. In addition to transporting moisture, ARs also transport heat, but the impact of this transport on global near-surface air temperatures has not yet been characterized. Here we show that seasons with more frequent ARs also have warmer than average temperatures in many mid-latitude regions, and that AR events are associated with temperature anomalies of 5–10 °C above the climatological mean. This is due to anomalous horizontal transport and convergence of sensible heat and moisture in the lower atmosphere, which increases both downward sensible heat flux and downwelling long-wave radiation at the surface. On an hourly timescale, over 70% of extreme warm-temperature anomalies occur within ARs in large portions of the mid-latitudes, and ARs are associated with moist and compound heatwaves in many regions worldwide, suggesting that consideration of ARs may improve predictive capability for certain extreme heat events. Our results demonstrate that ARs significantly impact air temperatures on a wide array of timescales, and that they may play a wider role in global energy transport than previously recognized.