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HETEROGENEOUS WARMING AGENTS AND WIDENING OF THE TROPICAL BELT

Observational analyses have shown the width of the tropical belt increasing in recent decades as the world has warmed. This expansion is important because it is associated with shifts in large-scale atmospheric circulation and major climate zones. Although recent studies have attributed tropical expansion in the Southern Hemisphere to ozone depletion, the drivers of Northern Hemisphere expansion are not well known and the expansion has not so far been reproduced by climate models. Here we use a climate model with detailed aerosol physics to show that increases in heterogeneous warming agents—including black carbon aerosols and tropospheric ozone—are noticeably better than greenhouse gases at driving expansion, and can account for the observed summertime maximum in tropical expansion. Mechanistically, atmospheric heating from black carbon and tropospheric ozone has occurred at the mid-latitudes, generating a poleward shift of the tropospheric jet, thereby relocating the main division between tropical and temperate air masses. Although we still underestimate tropical expansion, the true aerosol forcing is poorly known and could also be underestimated. Thus, although the insensitivity of models needs further investigation, black carbon and tropospheric ozone, both of which are strongly influenced by human activities, are the most likely causes of observed Northern Hemisphere tropical expansion.