Air-conditioning adoption and electricity demand highlight climate change mitigation–adaptation tradeoffs

Objective

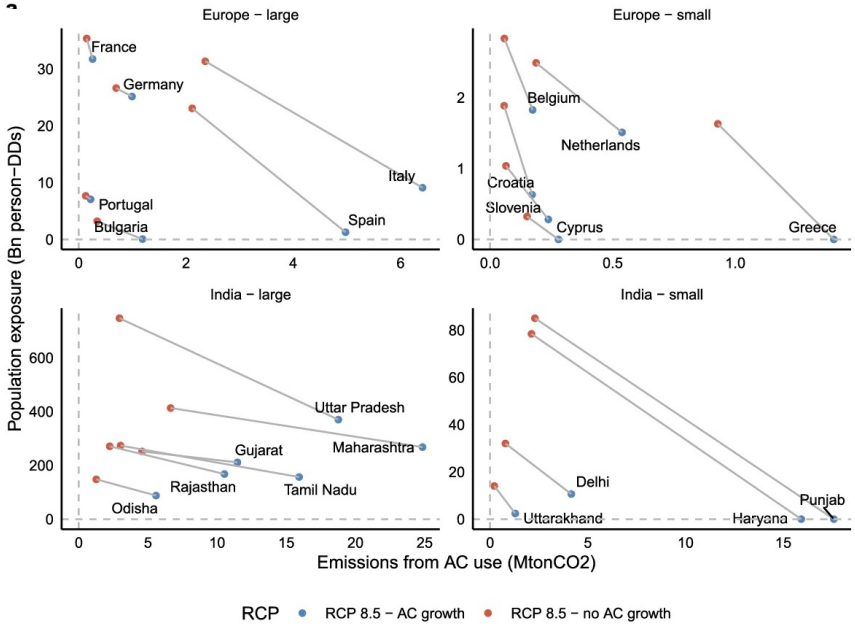
Air conditioning (AC) is a mature and widely available technology to shield indoor environments from ambient high temperatures. Given projected future growth in cooling demand and AC ownership worldwide, we quantify how climate change-driven increases in ambient temperatures could amplify future cooling demand, and increase electricity consumption and associated greenhouse gas (GHG) emissions.

Approach

Empirical models of the coupled adoption of residential air-conditioning (AC) and use of electricity are estimated using a pooled dataset of relatively richer, but cooler, European countries, and relatively poorer and hotter Indian states. Fitted models are coupled with outputs of 29 global climate models to assess the cost of increased future emissions associated with the benefit of moderation of rising future heat exposures.

Impact

Rising temperatures and income drive both AC and electricity use. The adaptation benefits are substantial offsets to rising population heat exposures due to climate warming. The costs are amplification of summer peak demands in southern Europe (20-30%) and in northwest India (35%). Cooling adaptation increases power sector GHG emissions growth of 2% in Europe and 15% in India, mitigation of which would need electricity intensity of GDP declines of 2% in Europe and 9% India, or 5-30% higher carbon prices.



Annual exposed population and carbon emissions under alternative AC prevalence scenarios circa 2050: annual power sector CO_2 increases and person-degree days (PDDs) of exposure to >24 °C daily maximum temperatures, with (blue) and without (red) projected growth in AC and associated electricity consumption increases. Panel grouping: "small" = annual PDDs < 3 billion in Europe, <100 billion in India.

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