The climate response of regional air pollution changes

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Emissions of aerosols and their precursors have due to air quality regulations drastically decreased at northern hemisphere mid-latitudes during the latest decades. At the same time, emissions in the tropics and subtropics have increased e.g. as a consequence of the strong economic growth in East Asia. Using the fully coupled ocean-atmosphere climate model NorESM, we assess the influence of these regional emission changes on the climate in different parts of the world, in particular the Arctic. Different mechanisms that couple the localized forcing with the corresponding temperature response are also suggested. Focusing on the European emission reductions of SO_2 that have taken place since the 1980's, a disproportionally large effect on the Arctic climate compared to the rest of the northern hemisphere is seen. Locally, the warming due to the decreased SO_2 exceeds 1K. The primary reason for this strong remote temperature response is an increased poleward dry-static heat transport, which is initiated by the enhanced meridional temperature gradient. The localized forcing from the reduced particulate sulfate at mid-latitudes also induces a shift in the stationary wave pattern, which promotes the increased northward energy transport. The results question the assumption that Arctic climate feedbacks are similar when subjected to an inhomogeneous forcing from aerosols as compared with a homogeneous forcing from greenhouse gases.