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Climate response to ozone as a function of latitude and altitude

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Global and regional surface temperature response is sensitive to the latitude, altitude and nature of the underlying radiative forcing mechanism, in addition to the dynamics and the feedbacks of the climate system. A first systematic investigation of the regional climate response to the latitude and type of forcing by Shindell and Faluvegi (2009) showed that in particular mid- and high-latitude climate is quite sensitive to the location of the forcing. The resulting relationships between latitudinal forcing and response have been further used to establish a regional climate metric concept, which in turn has been applied in several studies to provide first-order estimates of the regional temperature response to regional forcing from various emission sources, without full climate model simulations. However, these forcing-response relationships have so far only been derived by a single climate model. Furthermore, they are specific to a given vertical profile of radiative forcing. For several atmospheric species, such as ozone and black carbon, the surface temperature response can depend considerably on the altitude where the forcing is exerted. Increased knowledge if such vertical sensitivity is important for understanding regional climate responses, as well as for further application of regional climate metrics.

Focusing on ozone, we build on the framework of Shindell and Faluvegi (2009) and investigate the climate response to ozone concentration perturbations in different latitude bands using the NCAR Community Earth System Model (CESM1.2). We also move one step further by systematically imposing these perturbations at different altitudes within each of the latitude bands. The model is run in fixed SST and slab-ocean configurations to extract the effective radiative forcing and surface temperature response, respectively, and the resulting regional temperature per forcing is examined.