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Extension of a linearized Ozone scheme to include solar forcing impact

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We have extended the Linearized ozone scheme LINOZ in the ICON (ICOsahedral Nonhydrostatic)-ART (the extension for Aerosols and Reactive Trace gases) model system to include ozone loss caused by energetic particle precipitation (EPP) and changes in the rate of ozone formation due to the variability of the solar radiation in the ultraviolet wavelength range. This extension allows us to represent variable solar forcing in the middle atmosphere using a very simple ozone scheme. The LINOZ scheme is computationally very cheap compared to a full middle atmosphere chemistry scheme, yet provides realistic ozone fields consistent with the stratospheric circulation and temperatures, and can thus be used in climate models instead of prescribed ozone climatologies. To include the energetic particle precipitation indirect effect on ozone via NOy, we use LINOZ version 3 with a NOy-based tendency term only. The additional NOy is brought to the model as an upper boundary condition of NOy, parameterized using the geomagnetic Ap index, as recommended for chemistry-climate models for the CMIP6 experiments. With this extension, the model simulates realistic „tongues“of NOy propagating downward from the model top in the upper mesosphere to the mid-stratosphere in every polar winter and a corresponding ozone loss. In addition, the tabulated coefficients forming the basis of the LINOZ scheme are provided separately for solar maximum and solar minimum conditions. These coefficients are then interpolated to ICON-ART using the F10.7 index as a proxy for daily solar spectra (UV) variability to account for solar UV forcing. This solar UV forcing in the model leads to changes in ozone in the tropical and mid-latitude stratosphere consistent with observed solar signals in stratospheric ozone.

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