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Realistic and Efficient Gravity-Wave Modelling

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The Multi-Scale Gravity-Wave Model (MS-GWaM) in the weather and climate code ICON is the first gravity-wave parameterization that takes wave transience and horizontal propagation into account (Achatz et al 2023, JMP; Voelker et al 2024, JAS). It predicts the development of the spectral gravity-wave field by a Lagrangian approach following gravity-wave rays parallel to the wave group velocity, while the predicted momentum and entropy fluxes couple back to the flow resolved by ICON. Using MS-GWaM in ICON, one can demonstrate that wave transience and horizontal wave propagation significantly modulate or even cause the momentum-flux intermittency observed in stratosphere and mesosphere, and that they modify the distribution of the wave fluxes. Moreover, horizontal gravity-wave propagation has a leading-order effect on the period and structure of the quasi-biennial oscillation (Kim et al 2024, ACP), and it makes a significant difference in the simulated middle-atmosphere residual circulation as well as zonal-mean zonal winds and temperature. While being costlier than conventional gravity-wave parameterizations, MS-GWaM outperforms them in realism and thereby provides an efficient alternative to capturing gravity-wave effects by explicitly resolving those waves in high-resolution codes.

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