Mathematics of the Weather 2024





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Impact of small-scale gravity waves on tracer transport

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The large-scale transport of tracers such as ozone and water vapor is primarily governed by the Brewer-Dobson circulation. However, this transport is modified by small-scale gravity waves (GWs) and turbulence from GW breaking. Since these dynamics are not fully resolved in weather and climate models, parameterization is necessary. Tracers significantly influence the Earth's energy budget and surface climate, making accurate modeling crucial. Current GW parameterization schemes account for the indirect effects on mean meridional circulation but not the direct effects of GW tracer transport or the enhanced mixing due to GW breaking.

To address this gap, we use wave-resolving simulations to investigate how GWs affect tracer distribution. We also extend a GW parameterization scheme, a Lagrangian ray tracer, to include GW-induced tracer transport from inertial and propagating GWs. Our findings highlight the significant direct impact of GWs on tracer transport. Additionally, we may discuss the influence of turbulent diffusive mixing on tracers. Our goal is to provide a comprehensive understanding of the complex processes influencing large-scale tracer transport in the atmosphere.

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