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Nonlinear gravity waves in the atmosphere

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The majority of gravity waves in the atmosphere are excited in the lowest 10 km where the waves are effectively described by linear theory since their amplitudes are small. They grow in amplitude as they propagate upwards due to the decreasing background density. Some of the waves reach far into the "deep" atmosphere where their amplitudes cannot be considered small anymore. Here, nonlinear wave theory governs the dynamics.

The governing equations for our theoretical analysis are modulation equations that result from nonlinear WKB asymptotics of the Navier-Stokes equations. Their traveling wave solutions possess counterintuitive properties that are available neither in linear nor weakly nonlinear theory. For instance, the group velocity, as defined usually by the derivative of the dispersion relation, may not relate to the wave's actual envelope velocity. We are in particular concerned with the stability of the wave solutions as those are relevant for applications such as subgrid-scale parametrisations in weather and climate models.