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A stochastic parameterization of gravity waves due to convection: formalism and impact

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A formalism is proposed to parameterize the gravity waves due to convection in general circulation models with a stratosphere. It is based on a stochastic approach, where a large ensemble of monochromatic gravity waves is built up by launching a few waves at each time step, and by adding the effect of these waves to that of the waves launched before during the same day. The frequency and horizontal wavenumbers of each wave are chosen randomly with fixed probability distribution, but the wave amplitude is directly related to precipitation, which is converted into heating rates. Linear theory is then used to predict the gravity waves generated by the heating rate. Off-line tests are carried out using re-analysis and global precipitation data. These tests demonstrate that the scheme launches gravity wave momentum fluxes that are much more erratic in amplitude than when uniform sources are considered. Consequently, the scheme tends to produce momentum flux deposition at lower levels than for the case when uniform sources are considered. We verify that the parameterization, when included in a general circulation model with vertical resolution in the stratosphere near 500m, is able to produce a quasi-biennial oscillation, without being detrimental to other aspects of the model climatology, like the semi-annual oscillation and the behaviour of the extra-tropics.