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Intermittency of gravity-wave momentum flux in the stratosphere

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Atmospheric gravity waves transfer energy and momentum from the troposphere to upper layers of the atmosphere. They significantly contribute to forcing the global-scale Brewer Dobson circulation in the middle atmosphere, and to driving the stratosphere out of radiative equilibrium. As most of the gravity waves are not explicitly resolved in current climate models, their effects on the general circulation must be parameterized. Strong assumptions are generally used in such parameterizations, like for instance constant and homogeneous non-orographic gravity-wave sources. In this study, we challenge this latter hypothesis, and use long-duration balloon- and space-borne observations as well as mesoscale numerical simulations to characterize the intermittency of gravity waves in the lower stratosphere above Antarctica. This is achieved through working on the gravity-wave momentum-flux probability density functions (pdfs) obtained with these three datasets. The pdfs consistently exhibit long tails associated with the occurrence of rare and large amplitude events. We provide a measure of the contribution of these events to the total gravity-wave momentum flux, and show that only a small fraction of the wavepackets are responsible for most of the momentum transport during the winter regime of the stratospheric circulation. On the other hand, the wave intermittency significantly decreases when stratospheric easterlies develop in late spring and summer. With the exception of mountainous areas in winter, the momentum-flux pdfs furthermore tend to behave like lognormal distributions. We find that this behaviour can result from the propagation of a wave spectrum into a varying background wind field that generates the occurrence of frequent critical levels.