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Seasonal variations of gravity wave net momentum fluxes derived from high-resolution AIRS temperatures

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One of the recent main developments to make general circulation models more realistic is the improvement of the representation of small scale gravity waves in the models. This can be achieved by improving the spatial resolution of the models in order to explicitly resolve a larger fraction of the whole spectrum of gravity waves, or by improving the way in which the effect of gravity waves on the atmospheric circulation is parameterized by gravity wave drag schemes. In order to validate the representation of gravity waves in the models (either resolved or parameterized), global observations of gravity waves from satellite are required. One of the main difficulties for satellite instruments is to provide the spatial 3D information required for deriving full momentum flux vectors for each observed gravity wave.

This 3D information is available from observations of the nadir-scanning Atmospheric Infrared Sounder (AIRS) satellite instrument. We utilize high resolution 3D temperatures from a dedicated temperature retrieval that fully exploits the 3D capabilities of the AIRS instrument. Gravity wave wave vectors, amplitudes and momentum flux vectors are derived by subdividing the AIRS data into small 3D sub-volumes and applying a 3D harmonic fit algorithm (S3D). Based on this approach monthly global distributions of net gravity wave momentum fluxes and gravity wave squared amplitudes are derived. Seasonal variations of the global distributions show the importance of both the interaction of the gravity waves with the background wind and the role of specific gravity wave sources, such as orography, deep convection in the tropics and subtropics, as well as gravity waves generated by jet mechanisms. In particular, the direction of gravity wave momentum fluxes during austral winter indicates that gravity waves are refracted from both sides into the southern polar vortex, an effect that is not captured by models that parameterize the effect of gravity waves and assume that gravity waves propagate only vertically.