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On internal gravity waves convectively forced in the atmospheric residual layer. 2-μm Doppler and 0.5-μm backscatter lidars investigation.

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Observations using 2-μm Doppler and 0.5-μm backscatter lidars and a linear theory are used to examine the occurrence of gravity waves in the residual layer during the morning transition on 10 and 14 June 2005. Comparison between the thermal forcing frequency estimated by lidar measurements and Brunt-Vaïsala frequency calculated by sounding profiles explain the three different cases observed: no wave, evanescent wave and propagating wave. The results illustrate the necessary condition of a statically stable and stratified residual layer to generate convectively forced gravity waves and that an horizontal wind shear which exceeded 5 10-3 s-1 in both days is not sufficient. In the case of wave propagation, the results confirm numerical studies that the phase lines are tilted upstream and against the wind shear. Typical horizontal wavelength and line phase direction are measured: 2 km and 30°, respectively. The vertical change in the horizontal wind is seen to produce a refraction of the wave with altitude so that the phase lines become quasi-vertical close to residual layer – free troposphere interface. Wave trapping is seen as a possible mechanism to explain differences between the theoretical vertical group velocity (1.6 m.s-1) and the wave velocity anomalies (< 1 m.s-1) measured by the lidar. These waves are shown to be important because they generate a mixing between the convective layer and the free troposphere beyond the entrainment zone and affect the fluxes of momentum and scalar across the residual layer.