

# Long Term Rayleigh Lidar and Satellite Observations of Gravity Wave Activity above the Southern Tip of South America

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Gravity wave (GW) activity is analyzed using temperature ( $T$ ) data retrieved from a Rayleigh lidar at Río Gallegos, Argentina (51.6° S, 69.3° W). GW characteristics are derived from 302 days of observations providing more than 1018 h of high-resolution lidar data between 20 km and 56 km height from August 2005 to December 2015.  $T$  measurements are carried out by a Differential Absorption lidar (DIAL) instrument. This lidar was the southernmost outside Antarctica until the end of 2017. Río Gallegos is an exceptional place to observe large amplitude GW. Every lidar measurement is classified according to its relative position to the polar vortex. The lidar measurements are compared with collocated SABER and GPS-RO data. The different instruments show different spectral windows of the GW spectrum, providing complementary observations. In general, the geometric mean of the specific GW potential energy ( $PE$ ) is larger during winter and spring than during summer and autumn. The largest geometric mean of  $PE$  is found inside the vortex and decreases monotonically at its edge, outside it and when there is no vortex. The same behavior is found with satellite data. On average, it can be seen that lidar observations provide larger  $PE$  values than limb sounding measurements. From a Morlet continuous wavelet transform analysis, 3 distinct modes are captured from SABER and from GPS RO data at the upper and lower stratosphere, respectively. In particular, a systematic 3.5-4 years oscillation, possibly related to El Niño–Southern Oscillation (ENSO) and minimum / maximum  $PE$  values during September is observed from GPS RO / SABER data. Stationary and non stationary GW possible sources are discussed in detail.

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