Characteristics of atmospheric wave-induced laminae observed by ozonesonde at the southern tip of South America

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We have performed ozonesonde measurements at Punta Arenas (53.14˚S, 70.88˚W) in Chile and Río Gallegos (51.61˚S, 69.29˚W) in Argentina since 2014 to investigate vertical structures in the edge region of polar vortex as well as to validate ozone profiles measured by a differential absorption lidar and a millimeter-wave radiometer located at Río Gallegos. In such a southern part of South America (Patagonia area), the National Meteorological Service of Argentina also has made regular ozonesonde measurements at Ushuaia (54.85˚S, 68.31˚W) in Argentina since 2008. In these ozone concentration profiles, small-scale fluctuations of the ozone volume mixing ratio with a layer of a few kilometers are frequently found. The lamina structure is formed by vertical displacement of isopleths due to gravity waves and by isentropic advection of a filament of vortex air due to Rossby wave breakings. In the Patagonia area, notable gravity waves are generated on the leeward of the Andes. The polar vortex could contribute to both the generation of the gravity waves by a spontaneous adjustment mechanism and the formation of large meridional ozone gradient associated with lamina due to the horizontal advection. To distinguish between the effects of the vertical displacement and the horizontal advection, we investigated correlation between the ozone and potential temperature fluctuations [Pierce and Grant, GRL, 1998; Thompson et al., JGR, 2011], which were obtained by applying a high-pass filter of 3 km to the ozone and temperature profiles. Monthly fractions of the ozone fluctuation resulting from the gravity waves and Rossby waves were derived for the altitude ranges of tropopause height to 15 km, 15–20 km, and 20–25 km. Additionally, we investigated the effects of the ozone fluctuation on total ozone column for the outer side, the edge region, and the inner side of the polar vortex.

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