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## Seasonal and Latitudinal Variations of High-Frequency Gravity Waves in the Lower Stratosphere

Gravity waves play an important role in upper tropospheric and stratospheric dynamics but are largely unresolved in GCMs. Instead, the effects of gravity waves of small scales and high frequencies in models are parameterized. Small scale, high-frequency gravity waves in the lower stratosphere can be observed in superpressure balloon (SPB) flights, but SPB studies have traditionally been able to launch no more than a few (order dozen) balloons at a time. The temporal and global extents of SPB observations are therefore limited. However, Project Loon has been flying SPBs in the lower stratosphere since 2013 in an effort to provide worldwide Internet coverage. The flights record variations in location, temperature, pressure and horizontal wind at a frequency of 60 seconds. Here we use observations from Project Loon during the years 2014 through 2018 to characterize high-frequency gravity wave variability in the lower stratosphere. The dataset includes over 800 individual balloon flights that exceed two days in length, with the longest flights approaching 200 days. These flights are divided into 6840 two-day segments, with each segment capable of resolving waves of periods ranging from two minutes to one day. The segments cover the full seasonal cycle at latitudes ranging from 60S to 60N. We investigate gravity wave amplitudes and spectral slopes in the midlatitudes and tropics, and find seasonal variations in all regions. Our results provide unprecedented global and seasonal estimates of gravity wave variability, and can be used to constrain gravity wave parameterizations in climate models.

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