



The global reach of gravity waves at the stratospheric speed limit from the 2022 Hunga Tonga volcanic eruption

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At around 04:14 UTC on the 15th January 2022, a major volcanic eruption began beneath the Tongan islands of Hunga Tonga and Hunga Ha'apai (175.4W, 20.5S). Located under only a shallow depth of water, the volcano rapidly launched a plume of super-heated ash and vapourised water upwards into the atmosphere. Over the next few hours, satellite observations reveal unprecedented large-scale concentric waves in the mid-stratosphere (near 40km altitude) radiating away from the eruption across the entire Pacific Ocean. In this presentation, we show brightness temperature perturbations in the 4.3 micron bands of the AIRS/Aqua, CrIS/Suomi-NPP and CrIS/JPSS-1 instruments that reveal three groups of atmospheric waves of special interest. First, an initial concentric wave is found travelling near the stratospheric speed of sound, likely to be an acoustic compression wave. There then follows a gap, which corresponds to phase speeds not permitted by theory, then a second group of waves likely to be gravity waves. These gravity waves are shown to be travelling near the maximum phase speed permitted, and there is a suggestion that some may travel the whole way around the globe in the tropics. Third, we observe small-scale gravity waves that pervade many thousands of kilometres across almost the entire Pacific Ocean, suggesting an extremely consistent heating source. All three of these wave observations are unprecedented in more than 20 years of stratospheric satellite observations, and this eruption may potentially have produced the first observations of an acoustic wave in the mid-stratosphere that can be measured from space. Now that we have space-borne instruments to observe it, this volcanic eruption provides a unique test of theoretical predictions of atmospheric wave phase speeds on some of the largest scales possible.