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Global propagation of ionospheric traveling ionospheric disturbances associated with the 2022 Tonga Volcanic Eruption

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In this study, we use measurements from over 4,735 globally distributed Global Navigation Satellite System (GNSS) receivers to track the progression of travelling ionospheric disturbances (TIDs) associated with the 15 January 2022 Hunga Tonga-Hunga Ha'apai submarine volcanic eruption. We identify two distinct Large Scale TIDs (LSTIDs) and several subsequent Medium Scale TIDs (MSTIDs) that propagate radially outward from the eruption site. Within 3000 km of epicenter, LSTIDs of ~1600 km wavelength are initially observed propagating at speeds of ~950 ms^{-1} and ~555 ms^{-1}, before substantial slowing to ~600 ms^{-1} and ~390 ms^{-1}, respectively [1]. MSTIDs with speeds of 200-400 ms^{-1} are observed for six hours following eruption, the first of which comprises the dominant global ionospheric response and coincides with the atmospheric surface pressure disturbance associated with the eruption, i.e. the surface Lamb wave. Further diagnostics of the event will also be discussed.

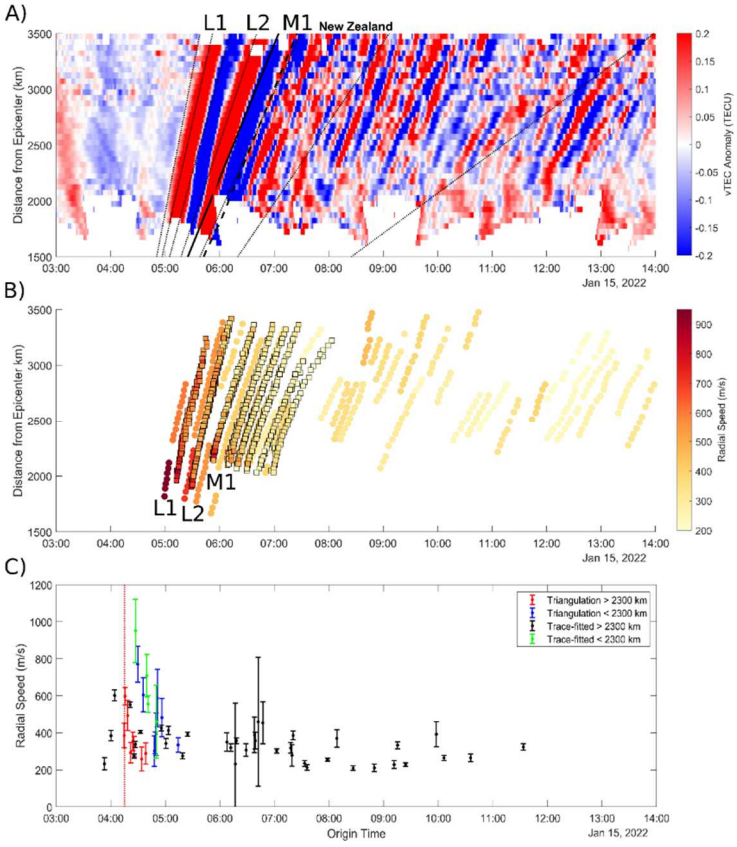

Figure 1. A) vTEC anomalies from the region surrounding New Zealand plotted against range from the volcano location and time. **B)** Traces of the leading and trailing null points of TID signatures from panel A colored by the fitted wave speed (circles), and radial distance and time of speed estimates from a triangulation method (squares). **C)** Average wave front speeds corresponding to the New Zealand regional domain plotted against estimated time of origin. The beginning of the eruption is marked with a vertical red dashed line. Speeds are color coded according to estimation method and radial distance. Error bars for the triangulation method are the standard deviation of speed estimates for each front, while error bars for the tracing method are the 1-sigma error of the least squares fit. Dotted lines represent different propagation speeds from the eruption. The left-most dotted line corresponds to propagation at 700ms^{-1}. All subsequent dotted lines correspond to increments of 100 ms^{-1} [1].

1. Themens, D. R. et al. Global propagation of ionospheric disturbances associated with the 2022 Tonga Volcanic Eruption. http://www.essoar.org/doi/10.1002/essoar.10510350.1 (2022) doi:10.1002/essoar.10510350.1.