

**Near-Real-Time analysis of the ionospheric response to the 15 January 2022  
Hunga Tonga-Hunga Ha'apai volcanic eruption**

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**Contents of this file**

Figures S1, S2, S3 and Captions  
Tables S1 and Caption

**Introduction**

The supplementary material consists of Figures S1 - S4 and Table S1.

Figure S1 illustrates the difference between dTEC/dt parameters obtained from 30-sec and 1-sec data. 1-sec dTEC/dt signal has larger amplitudes and is more disturbed than 30-sec one.

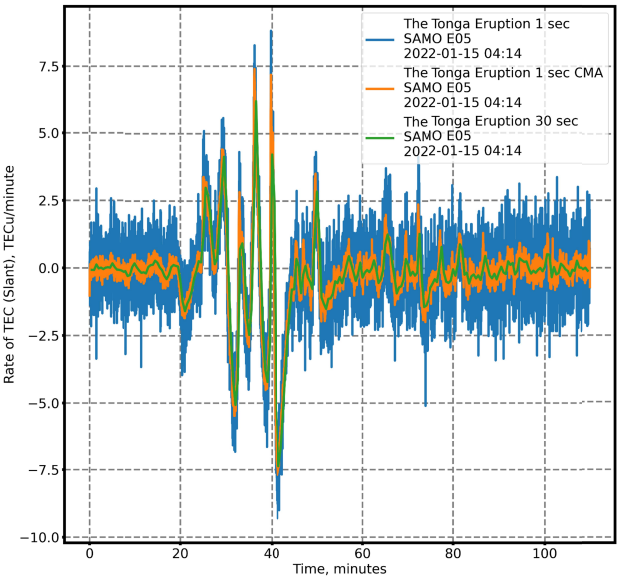
Figure S2 shows dTEC/dt signatures generated by different sources. The biggest peak-to-peak disturbance amplitude corresponds to the 2011 Great Tohoku-Oki earthquake, however the response to the Tonga volcanic eruption has a similar amplitude, which emphasizes the unprecedented response to this eruption. Signature pick-to-pick disturbance amplitudes due to the Tonga Eruption outscore the one of the 2015 Calbuco Eruption by a factor 2.5.

Figure S3 demonstrates the sound speed profile of the 15<sup>th</sup> of January 2022 that was used to compute weighted average velocity, and the scheme summarizing the

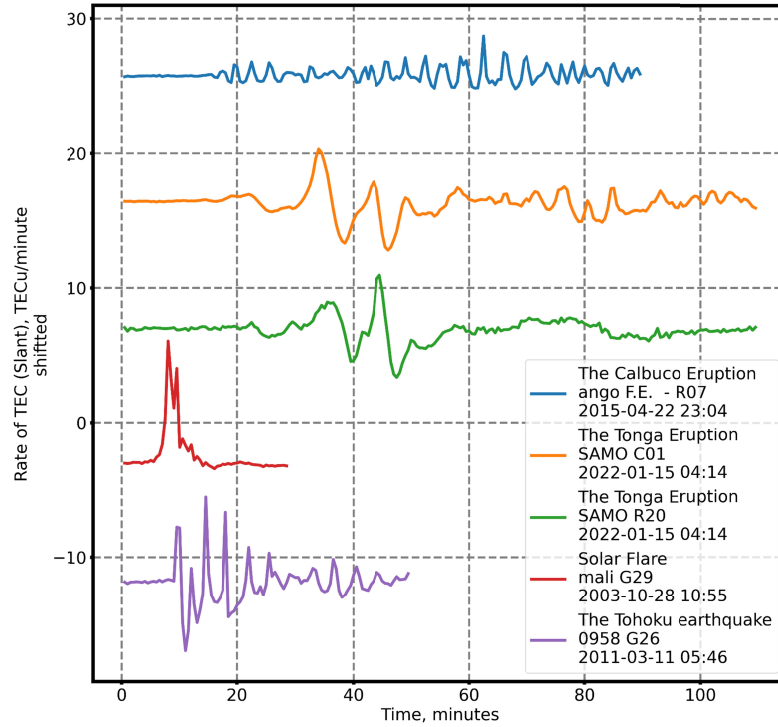
assumptions used to compute the on-ground onset time of the eruption. We use this vertical velocity to estimate the on-ground onset time of the sub-eruptions.

Table S1 presents comparison of the eruption onset time between non-ionospheric methods and our estimation based on velocities of the co-VID.

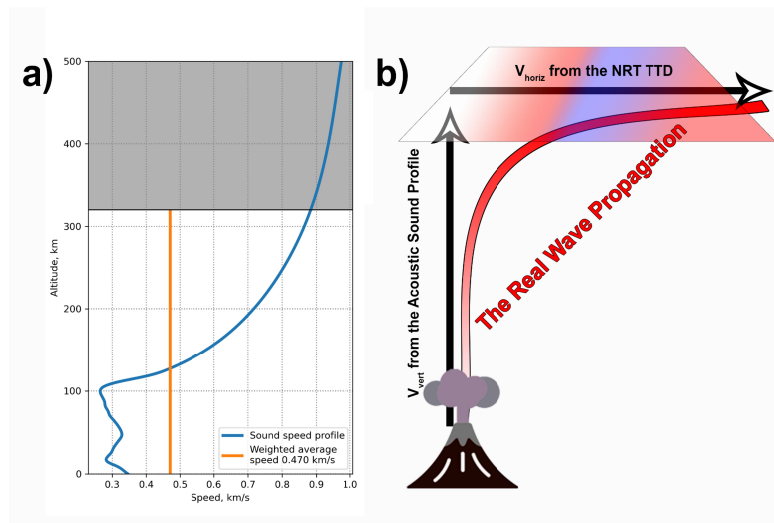
**Figures**



**Figure S1.** Comparison of dTEC/dt parameters with different data cadences. The blue line is 1-sec data; the orange line is 1-sec data after applying a centered moving average filter (5-sec window); the green line is 30-sec data.



**Figure S2.** Comparison of  $d\text{TEC}/dt$  responses generated by different sources. Time starts from the event onset.



**Figure S3. (a)** The sound speed profile for the 15 January 2022 and at the time and location of the eruption; **(b)** The scheme explaining approximations to compute on-ground onset time using vertical and horizontal components of the disturbance's

velocity. Horizontal velocity is obtained from “D1-GNSS-RT” and/or NRT TTD. Vertical velocity is obtained from an acoustic sound profile.

Event Number	Onset USGS	Onset Poli & Shapiro (2022)	Onset Wright et. al. (2022)	Onset raw VTEC Astafyeva et al. (2022)	Onset dTEC/dt NRT TTD current study
1	04:14:45	04:16:00.07	04:28±2	04:08:43	04:08:26
2	-	-	04:36	04:20:00	04:31:03
3	-	-	05:10	04:48:30	05:02:09
4	-	-	05:51	04:55:21	05:04:54

**Table S1:** Time onsets (UT) of 4 main HTHH volcano eruptions as estimated from on-ground techniques (USGS - column 2; Poli & Shapiro, 2022 - column 3; Wright et. al, 2022 - column 4), and from the ionosphere (by using raw VTEC (Astafyeva et al., 2022) - column 5, by using the dTEC/dt NRT TTD - column 6)