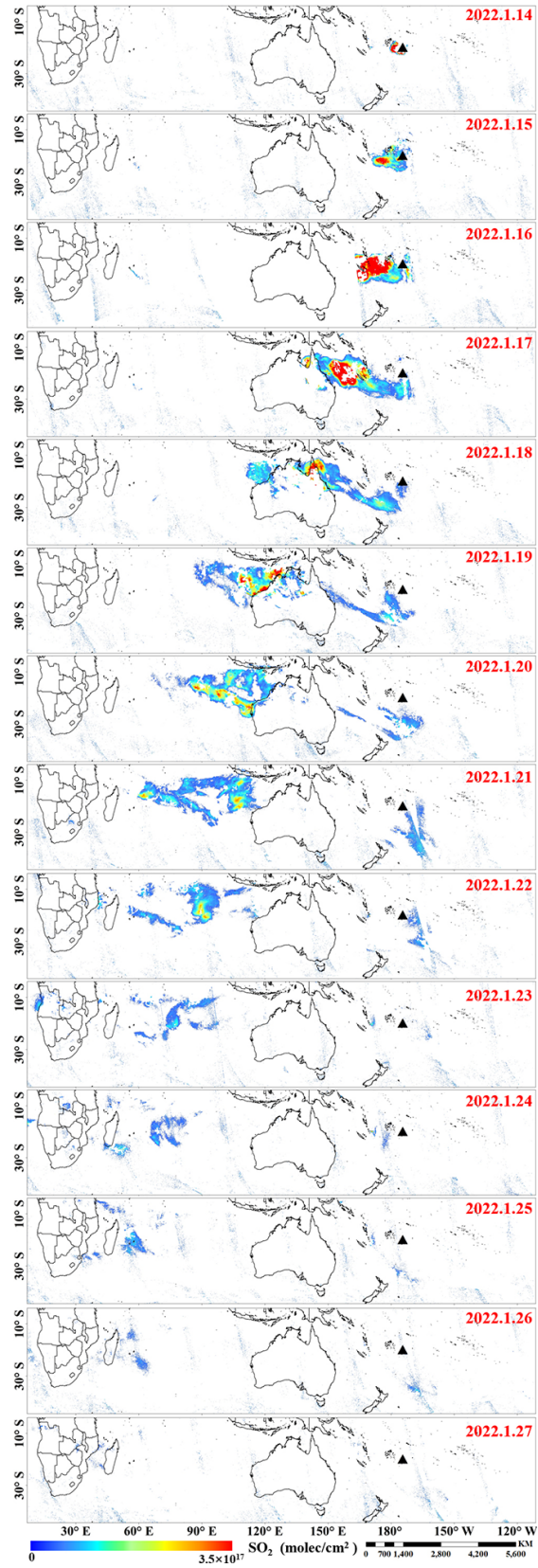
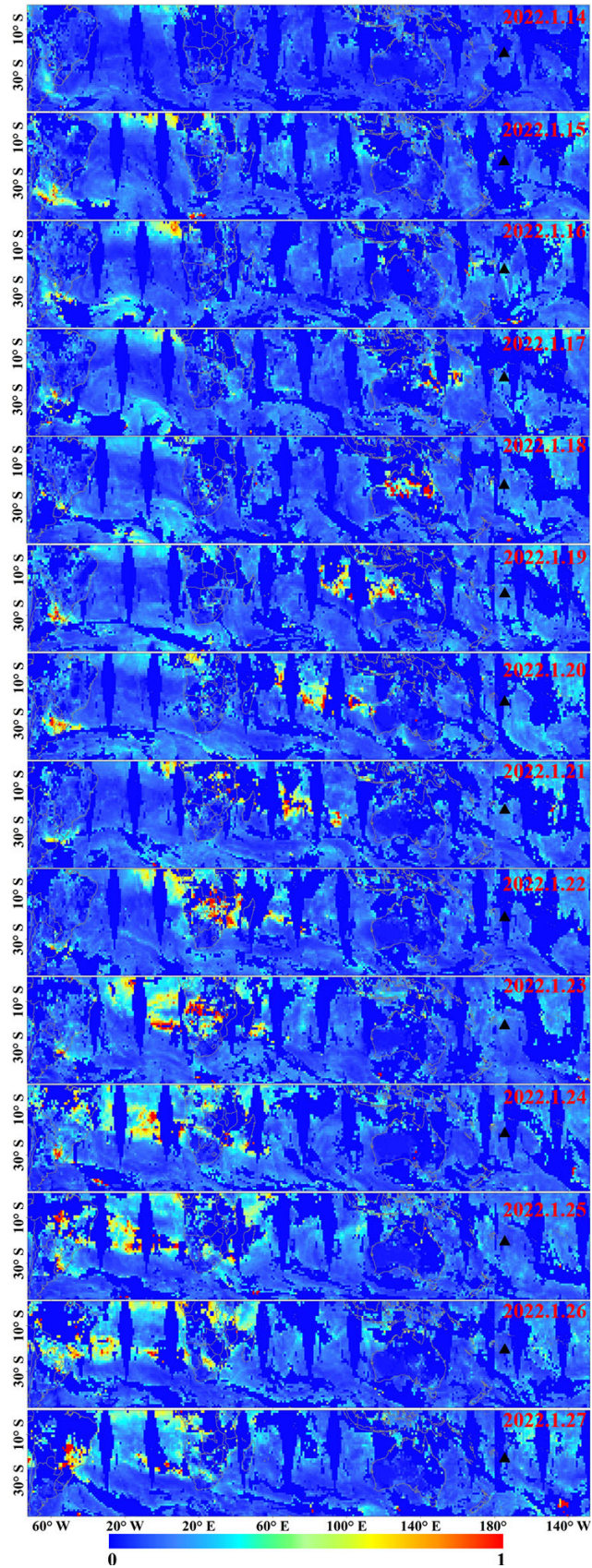


**Figure S1.** 72-hour forward and backward trajectory maps for the Tonga volcanic event during January 22 and January 27, 2022, at 10km, 20km and 25km.

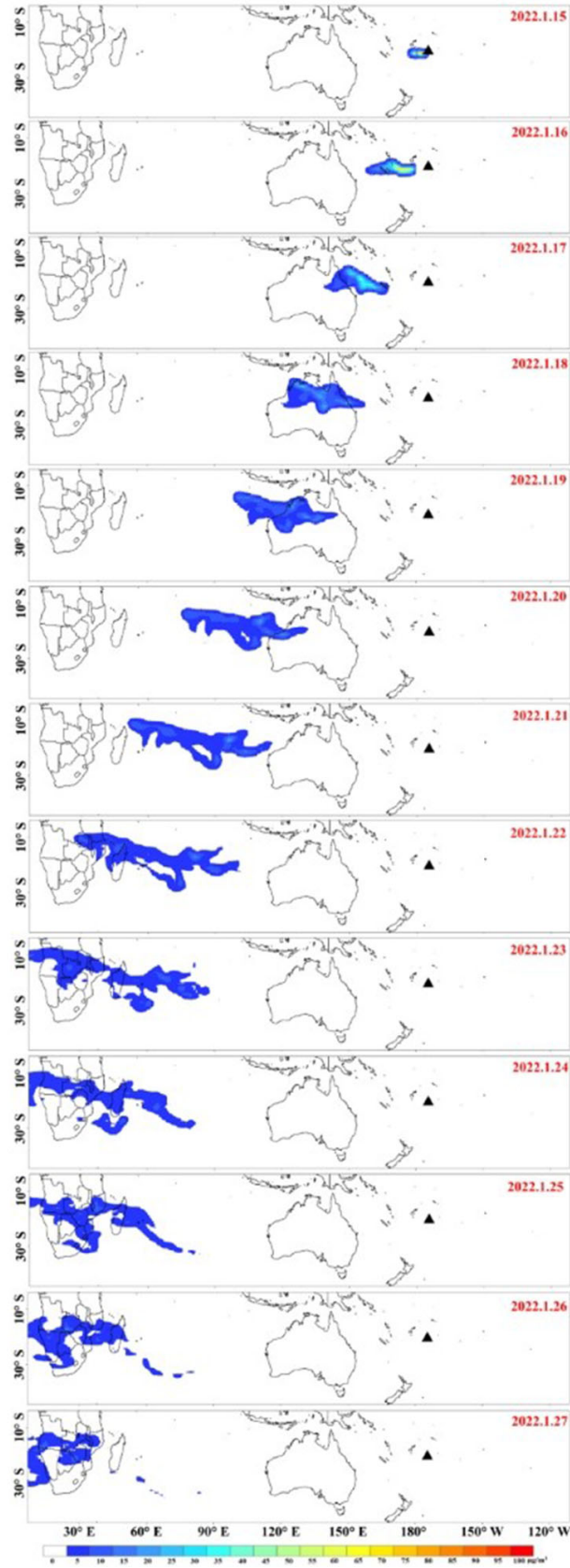


**Figure S2.** Temporal and spatial evolution results of vertical column concentration of  $\text{SO}_2$  in Tonga volcano. The black triangle represents the location of the Hunga Tonga-Hunga Ha'apai volcano.

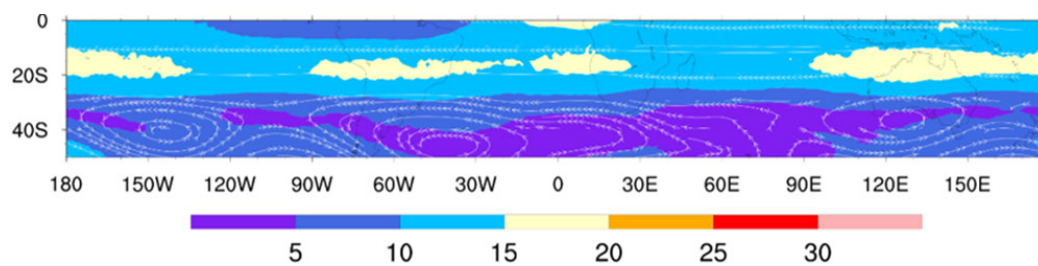


**Figure S3.** AOD spatial distribution results from January 14 to January 27, 2022. The black triangle represents the location of the Hunga Tonga-Hunga Ha'apai volcano. The data source is MODIS, which is the same as Figure 3.

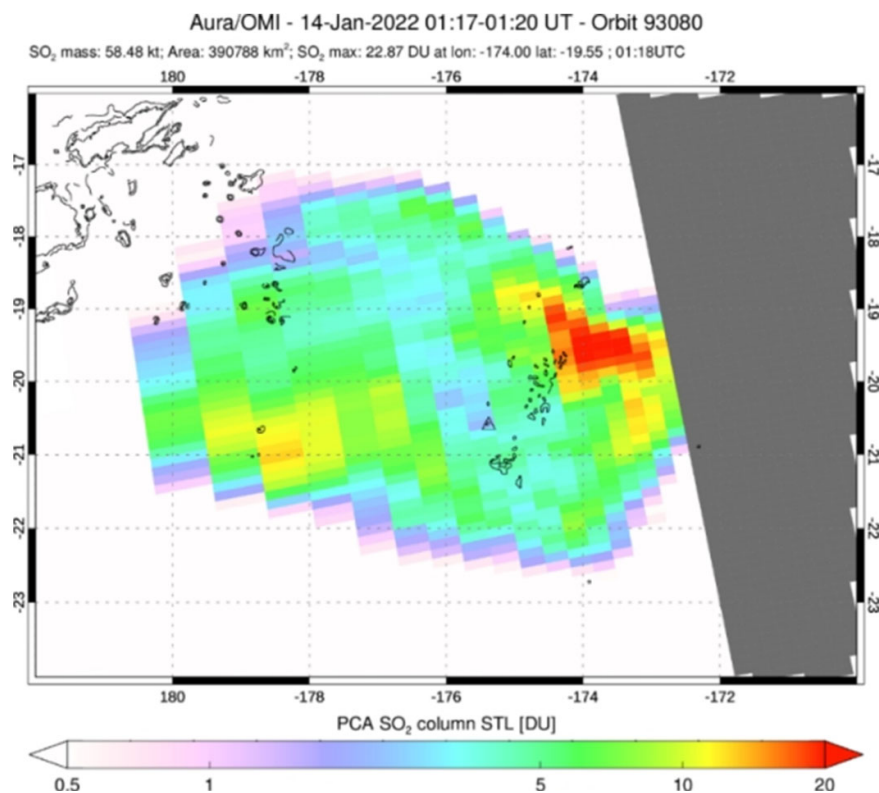




**Figure S4.** Spatio-temporal evolution results of SO<sub>2</sub> numerical simulation from January 15 to January 27, 2022.



**Figure S5.** Stratospheric wind field at about 20km (Unit, m/s).



**Figure S6.** SO<sub>2</sub> concentration values on January 14 around the satellite around the outburst from NASA website.(<https://SO2.gsfc.nasa.gov>).