SEMINAR

專題演講

國立中央大學 太空科學與工程學系

Department of Space Science and Engineering, National Central University

Time

Thursday, July 09, 2026
10:00 – 10:50

Place

健雄館(科四館)

S4-807 教室
Room S4-807,
Chien-Shiung Building

Ionospheric Disturbances Induced by the 2022 Tonga Volcano Eruption: Observations and Numerical Simulations

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摘要：The major eruption of the Hunga Tonga–Hunga Ha'apai volcano on 15 January 2022 generated atmospheric disturbances that propagated into the upper atmosphere. Traveling atmospheric disturbances (TADs) and traveling ionospheric disturbances (TIDs) were observed globally, providing a unique opportunity to investigate atmosphere–ionosphere coupling during an extreme geophysical event. This study investigates the ionospheric responses to the eruption using ground-based and satellite observations together with numerical simulations.

Near-field observations reveal a long-lived umbrella-shaped plasma depletion during local nighttime, followed by a daytime plasma enhancement extending approximately 1650 km from the volcano. Nighttime TEC decreases by 5–10 TECU, whereas daytime TEC increases by 2–18 TECU. Numerical simulations are conducted to reproduce the observed plasma redistribution and indicate that atmospheric expansion, ionospheric uplift, and large-scale plasma transport play key roles in producing these ionospheric signatures. On the other hand, far-field observations identify a tropospheric Lamb wave propagating at 300.8 ± 3.9 m/s across the western Pacific. Two TIDs associated with thermospheric and tropospheric Lamb wavefronts propagate at 539.0 ± 22.3 m/s and 338.3 ± 4.0 m/s, causing ionospheric uplifts of 86–155 km and 50–110 km, respectively. The TIDs precede the corresponding Lamb-wave fronts by 14–39 min, indicating the presence of bow-wave structures.

These findings demonstrate that the 2022 Tonga volcanic eruption produced profound and long-lasting modifications of the thermosphere–ionosphere system. The combined observational and modeling results provide new insights into the physical processes responsible for these disturbances. This study contributes to a better understanding of atmosphere–ionosphere coupling associated with extreme volcanic eruptions.