First- and second-order multi station statistics of mesospheric and lower thermospheric winds over South America related to the 2022 Hunga Tonga–Hunga Ha'apai eruption

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The dynamics of the ocean, atmosphere and ionosphere were significantly perturbed during the January 2022 Hunga Tonga–Hunga Ha'apai eruption. This eruption is one of the most explosive volcanic events of the modern era and the most observed one. A variety of atmospheric perturbations with different temporal and spatial scales traveling around the World have been observed in the lower atmosphere and the ionosphere [1]. Accompanying the eruption different Tsunami-related atmospheric waves were generated, some of them propagating with the initial acoustic perturbation and some of them delayed by a few hours [2]. Atmospheric perturbations in the mesosphere and lower thermosphere (MLT) region (between 70 and 110 km) have not been widely reported. In this work we combined the line-of-sight MLT wind velocities from three multi-static specular meteor radar (MSMRs) systems located in close to the west coast of South America, specifically two in Peru (5°S and 12°S) and one in Chile (30°S) (see Figure 1). Compared to conventional monostatic SMRs, the MSMRs allow the detection of much more meteor counts (therefore more independent line-of-sight winds) and more importantly observations over the same volume from different viewing angles [3]. A standard analysis would provide mean winds over each station averaged over a radius of ~200 km at 90 km altitude with a temporal and altitude resolution of 1 hour and 2 km, respectively. Therefore, only slowly propagating large-scale horizontal structures (more than 500 km) would be identified with the standard analysis. To go after faster phase fronts with smaller horizontal scale structures, we have taken advantage of the location of these systems (almost aligned with the phase fronts of Tonga waves), their multiple viewing angle observations and their relatively long distance to characterize the MLT dynamics after the Tonga eruption between 12 and 22 UT on January 15, 2022 over the west coast of South America. Besides first-order statistics, second-order statistics [4] within each site and among the three different sites are explored. The latter is aimed at identifying structures with scales of a few thousand of kilometers. Preliminary results indicate that indeed the MLT over South America was perturbed by fast and short-scale fronts as well as slower and large-scale fronts.

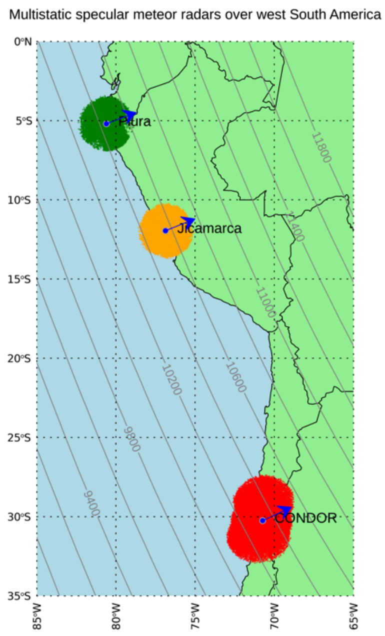

Figure 1. Multistatic radar detections. Gray lines indicate distance with respect to Tonga eruption.

References

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