Towards GNSS-Based Upper Atmospheric Real-time Disaster Information and Alert Network Using GDGPS Measurements

Léo Martire[1, 2]; S. Krishnamoorthy[1]; P. Vergados[1]; X. Meng[1]; L. J. Romans[1]; B. Szilágyi[1]; A. W. Moore[1]; A. Komjáthy[1]; Y. E. Bar-Sever[1]; A. B. Craddock[1]

[1] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

[2] leo.martire@outlook.com

Natural hazards (earthquakes, tsunamis, volcanic eruptions, *etc.*) often have devastating human and economic consequences. Early detection and characterization of such threats lead to timely evacuations, which are critical for significantly reducing casualties and economic cost. However, traditional warning systems (*e.g.*, seismometers or ocean buoys) are challenging to deploy and maintain in remote areas and in the open ocean, leading to limited spatiotemporal coverage.

Mechanical coupling allows large perturbations at the Earth's surface to propagate in the atmosphere under the form of low-frequency atmospheric waves. Eventually disrupting the ionosphere, those waves can be observed through ground-based Global Navigation Satellite Systems (GNSS) receivers. Those measurements can therefore be a valuable and inexpensive augmentation to existing natural hazards early warning systems.

Our team at the Jet Propulsion Laboratory is developing a prototype early warning system: the GNSS-based Upper Atmospheric Real-time Disaster Information and Alert Network (GUARDIAN). Using dual-frequency GNSS data from JPL's Global Differential GPS (GDGPS) network, its architecture computes total electron content time series in near-real-time. The number of multi-GNSS stations around the Pacific Ring of Fire and in selected maritime areas around the world was increased to ~100, and new additions to the network are on-going. The resulting data stream is output with minimum latency to a user-friendly public website (https://guardian.jpl.nasa.gov/), benefitting both the general public and scientific community.

We present the latest developments on the GUARDIAN system, including the deployment of geographically-binned power spectral densities. We describe the data flow from station to server, the current algorithm and implementation, as well as advantages and limitations. We provide validation cases, demonstrating that the quality of our near-real-time stream is comparable to post-processing methods. We address issues of spatial coverage around the Pacific Ring of Fire. We provide example science cases through historic examples (*e.g.*, Haida Gwaii, Tonga, and a geomagnetic storm).