National Aeronautics and Space Administration

Are Co-seismic Ionospheric Disturbances Alfvénic?

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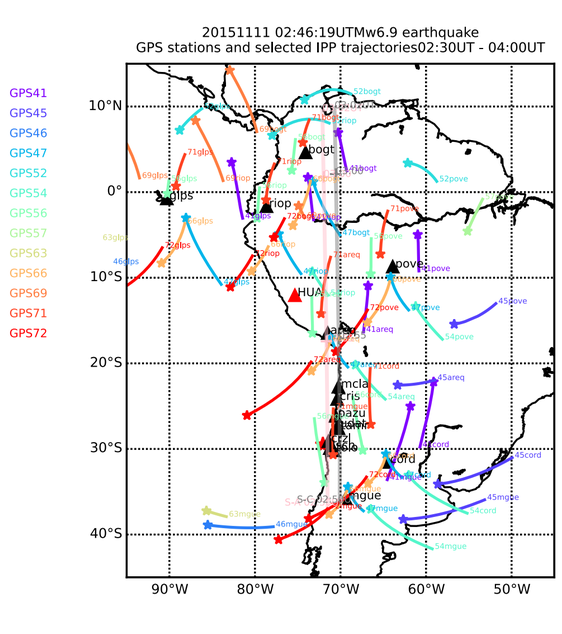
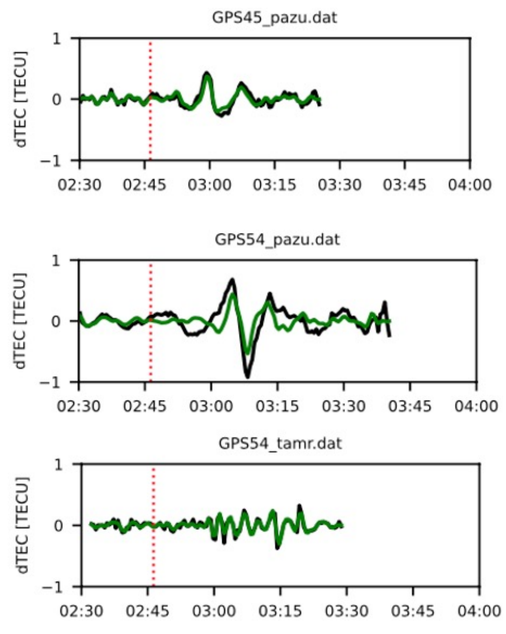
Goal: test the hypothesis -- Co-seismic ionospheric disturbances are Alfvénic.
Objectives: 1) characterize and connect the ionospheric plasma and electromagnetic field perturbations induced by earthquakes; 2) determine if the plasma and electromagnetic field perturbations are Alfvénic.

Background:
Ground displacements during earthquakes can generate upward propagating acoustic waves in the atmosphere and further induce co-seismic ionospheric disturbances, which manifest in Global Navigation Satellite System (GNSS)-derived total electron content (TEC) data timeseries as oscillations of a 3-5-minute period. Research efforts have been focusing on characterizing the observed TEC oscillations, rather than investigating the physical mechanism behind. A fundamental question remains open: How do seismically induced acoustic waves perturb the ionospheric plasma and eventually lead to observed TEC oscillations?

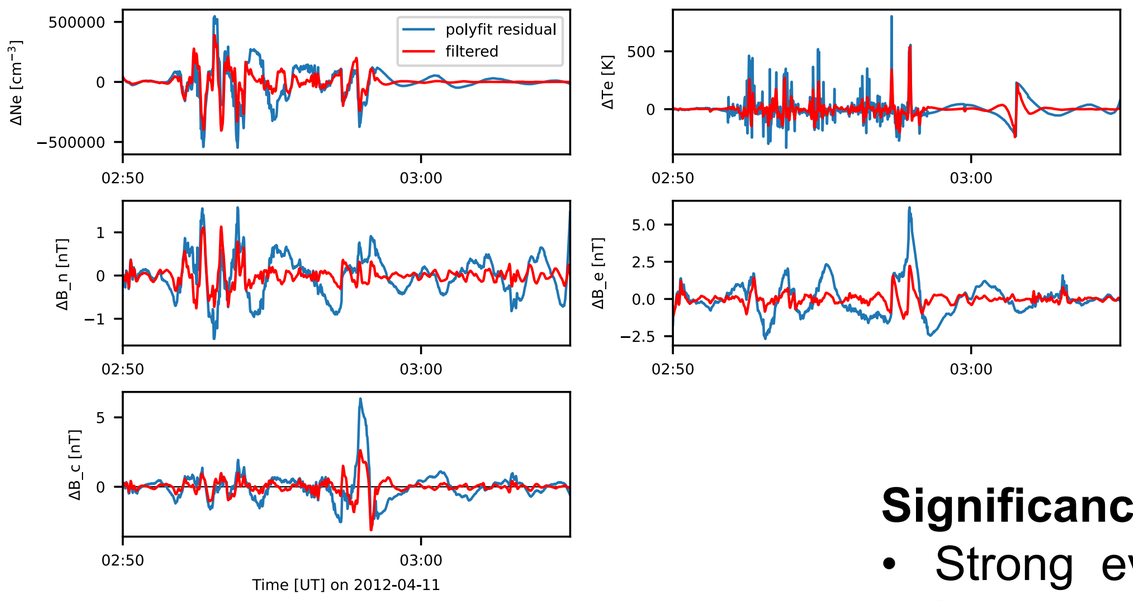
Approach and Results:

11 November 2015 Mw6.9 Chile Earthquake
Processed Data from GNSS TEC



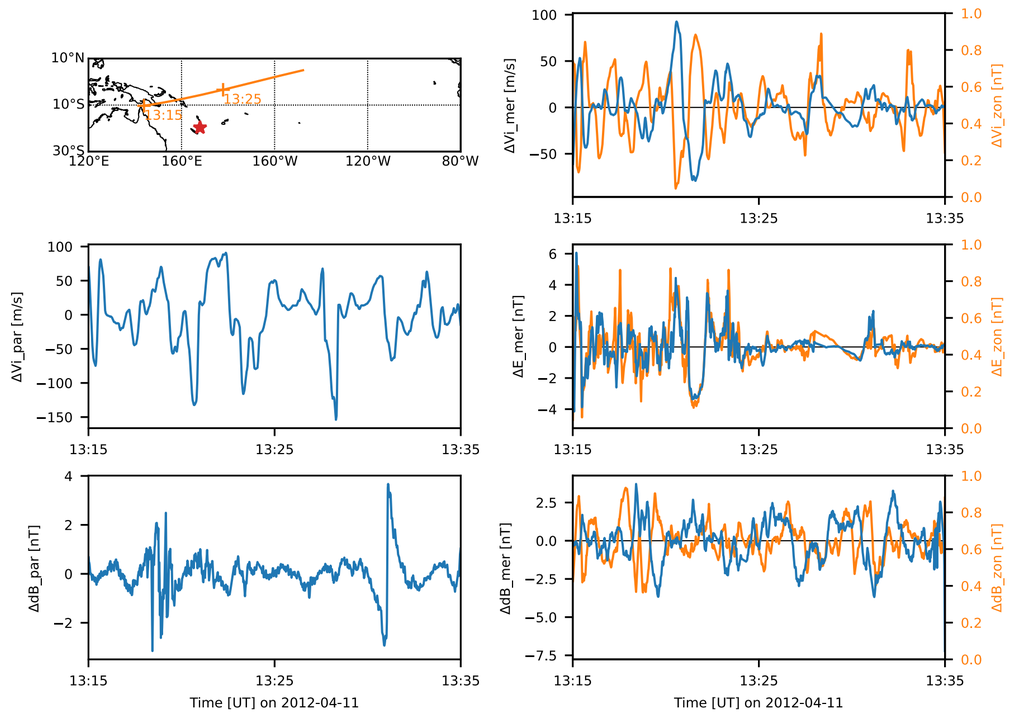


Processed Data from Swarm-C



- Survey all conjunction events with Swarm and C/NOFS satellites from 2008 to present.
- Process plasma, magnetic field and electric field data from in-situ measurements: polynomial fit to remove background and extract perturbations.

25 December 2010 Mw 7.3 Vanuatu Earthquake
Processed Data from C/NOFS



Significance/Benefits to JPL and NASA:
- Strong evidence of co-seismic ionospheric Alfvén waves for at least one earthquake is found, yet the causality relationship is unclear due to possible presence of plasma bubbles.
- Our results reveal possible electromagnetic nature of co-seismic ionospheric disturbances.
- More in-situ ionospheric electromagnetic field measurements on board of future low-Earth-orbit missions are needed for a better understanding of the earthquake-ionosphere coupling and possible ionospheric monitoring of earthquakes.

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