Detection of ionospheric perturbations using dense GPS arrays

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Vertical motions of the Earth's surface are known to excite to excite atmospheric infrasonic acoustic and gravity waves that propagate laterally and upward away from the source (e.g. Blanc, 1985; Davies and Archambeau, 1998]. These perturbations eventually reach the ionospheric layers, where the coupling between neutral atmosphere and ionized plasma results in fluctuations of the ionospheric electron density. Since the atmospheric density decreases almost exponentially with altitude, energy conservation implies that the pulse amplitude increases upward as it propagates into the atmosphere. For a near-surface source, for instance, the amplification factor can reach 10^4 at ionospheric heights.

Dual-frequency Global Positioning System (GPS) data provide a straightforward means of measuring the ionospheric electron content and are now widely used to monitor variations of the ionospheric electron content at both global and regional scales (*e.g.* Manucci *et al.*, 1993; Juan *et al.*, 1997; Sylvander *et al.*, 1996). Using dual frequency GPS observations, studies have detected ionospheric disturbances caused by large earthquakes (Calais and Minster, 1995; Afraimovitch et al., 2001), by the shock wave associated with a Space Shuttle ascent (Calais and Minster, 1996), and by a 3-million pound quarry blast in the Black Thunder basin, Wyoming (Calais et al. 1998).

The development of permanent networks of densely spaced and continuously recording GPS stations provides the opportunity to investigate ionospheric perturbations and their characteristics with great detail. We show in this paper the possibilities offered by the Southern California Integrated GPS network (SCIGN), a densely spaced GPS array of 250 ground stations centered on the Los Angeles area, to detect ionospheric perturbations. We show how methods derived from seismological array processing techniques can be used to determine basic properties of the perturbation such as its propagation azimuth and velocity.

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