A high-accuracy HF technique to measure E layer heights

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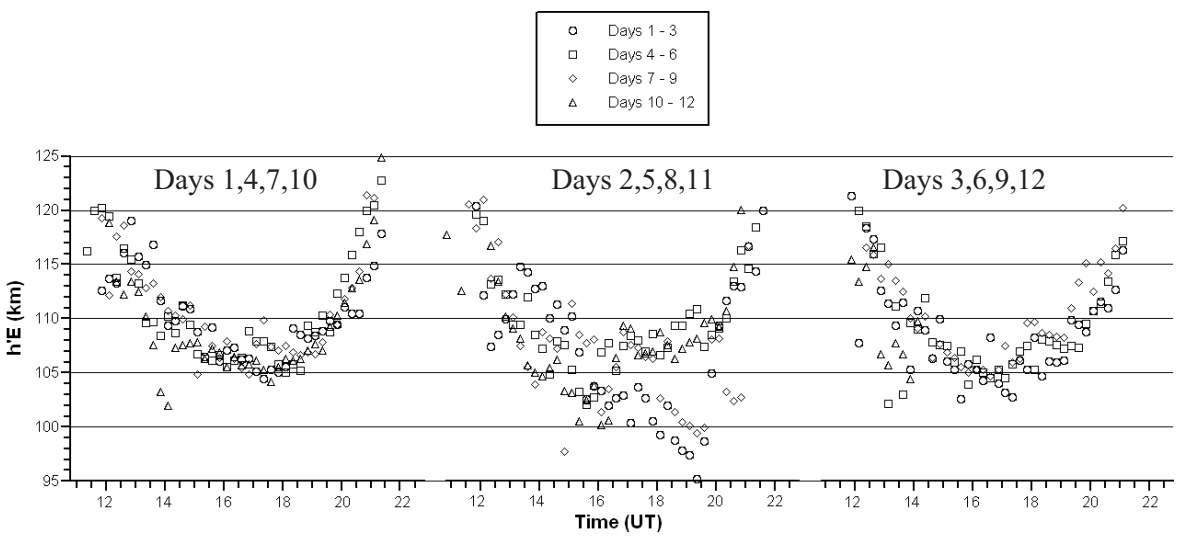
The conventional method of measuring the virtual heights of ionospheric layers in ionograms is usually not better than 3-5 km. Digisondes use phase measurements at closely spaced frequencies to determine h′(f) with an accuracy of ~0.5 km. The phase of the received signal is

$$\phi_{rec}(\omega) - \phi_0 = \int_{h0}^{h_R(\omega)} k dh = \frac{2}{c} \int_{h0}^{h_R(\omega)} \omega n(h,\omega) dh$$

leading to the well known relationship

$$\left.\frac{d\phi_{rec}}{d\omega}\right|_{\omega} = \frac{2}{c} h'(\omega)$$

To apply this phase technique the instrument must transmit the different frequencies with identical phase. If the frequencies are spaced by 5 or 10 kHz, they are physically reflected at different altitudes and the height difference depends on the vertical electron density gradient. We will demonstrate that this technique produces accurate and unambiguous results for typical gradients observed in the E and F layers. Extended observations at Millstone Hill demonstrate the robustness and reliability of the technique. We present the analysis of the E region height variations that reveal an interesting pattern of the lower ionosphere dynamics suggesting a link to tidal and planetary wave activities.



The figure indicates the existence of a 3-day oscillation of the E-layer virtual height that could not be detected with regular conventional ionosondes. At this point we only speculate about the possible mechanisms producing the observed oscillations, and we suspect (Zhou, Q. H., Two-day oscillation of the electron concentration in the lower ionosphere. J. Atmos. and Solar-Terr. Phys., 60, 1669-1677, 1998) that such variations can be induced by modulation of the metallic ion transport from sporadic E layers below regular E layer.