Explorations of the GPS data and what can it tell us about the Ionosphere

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Objectives

Feel for GPS data

What can GPS data tell us about spatial and temporal gradients in the electron column density?

\[ \theta(\text{rad}) = \frac{40.3}{\nu^2} \cdot \nabla n_e \]

- 0.1 TECU/km ⇒ 3.5' (200 MHz)
- 0.5 TECU/km ⇒ 17' (200 MHz)

TID studies at Haystack using GPS and ISR data (Takuya Tsugawa, JSPS Fellow)

December 07, 2006, 3 receivers running at Haystack

Coordinated observing runs with the Millstone Incoherent Scatter Radar

GPS receivers provided by AFRL under the SCINDA (Keith Groves)
Line-of-sight TEC
Vertical TEC

Mapping Function

LOS TEC  →  Vertical TEC
Effect of elevation

Lesson – place the GPS antenna as close to the ground as possible with an absorber below it
Look at only the high elevation data
The Az-El distribution

Vert TEC
Spatial coverage
Spatial and temporal TEC variations

\[ TEC_Z - \langle TEC_Z \rangle, \text{ for 30min bins} \]

Largest gradient seen \(\sim 4 \text{ TECU/100 km}\)
MH ISR Electron Density (Ne) Profile

Takuya Tsugawa: Traveling Ionospheric Disturbances Observed in North America
Background Ne Profile

Background (1h run. ave.) : 2007-01-20

Takuya Tsugawa : Traveling Ionospheric Disturbances Observed in North America
Preliminary Impression

- Except at the lower edge of the band, the TEC gradients don’t seem to be large enough to cause refractive shifts of order of a beamwidth.
- The gradients involved in TIDs are of order 0.01 TEC/km, can cause significant refractive shifts by ~1/10 of a beamwidth (20°).

Work in progress
- Better calibration of the GPS data
- A more extensive look at the data
- Examination of higher time resolution data (1min vs 50ms)
- ...