Ionospheric Modelling for WADGPS at Northern Latitudes

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ION-GPS-98
September 15th - 18th, 1998

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Introduction

- **Objective** - to investigate the suitability of the currently proposed WAAS ionospheric modelling scheme for use in Canadian airspace
  - Work sponsored by Nav Canada

- **Research objectives**
  - Assess the WAAS ionospheric grid model for Canadian operational use over the full range of solar activity intensities
  - Identify “interesting” periods of ionospheric activity in historical data and assess the associated performance of the WAAS model
    - derivation of some *ad hoc* indicator of geomagnetic activity [cf. Skone and Cannon, 1997]
  - Recommend possible densification of permanent GPS tracking sites in Canada
  - Recommend any improvements needed to the WAAS ionospheric modelling technique
Ionospheric delay mitigation techniques in WAAS

- Network of continuously operating reference receivers provides dual frequency carrier phase and pseudorange measurements
- Line of sight ionospheric delay values estimated from each receiver to each satellite
- Vertical ionospheric delay values at each of a series of ionospheric grid points (IGPs) are estimated along with an error bounding value (GIVE)
- Corrections to user line of sight delays, and a user error bounding value can then be created

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IGPs in Canadian airspace

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NSTB and NRCan Station Locations

- NRCan
- NSTB

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IPPs from current NSTB stations

Sampling rate = 15 minutes
Time interval = 12 hours
Elevation cut off = 5°
IPPs from NRCan stations

Sampling rate = 15 minutes
Time interval = 12 hours
Elevation cut off = 5°
IGP Availability in Canada using NSTB sites

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IGP availability in Canada using Canadian IGS sites

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Rate of change of ionospheric delay plotted with total Geomagnetic field variation, 4 May, 1998.

Note that the TurboRogue receiver located at Yellowknife continued to track through this period of significantly enhanced geomagnetic activity (Kp = 9o).
Interpolated Ionospheric Delay Surface

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Issues

• Potential ionospheric limitations on WAAS use over the Canadian landmass
• Ability of currently proposed grid structure to adequately model large scale gradients in the auroral and polar cap ionosphere
• Magnitude and frequency of occurrence of “significant” scintillations in the auroral and sub-auroral zone
  – identification of potentially problematic periods for tracking of GPS and/or WAAS signals
  – prediction of effects of increasing solar activity
• Implementation of WAAS in Canada requires careful consideration of ionospheric effects
• Validation of WAAS ionospheric grid model a primary task
• Outline system and methodology to monitor operational WAAS/CWAAS ionospheric modelling performance
• Contingency plan if current WAAS model proves to be insufficient