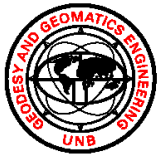


UNB - Nav Canada

Atmospheric Investigations for WAAS

Ionosphere

Peter Stewart and Richard Langley

Presentation to the

Ionospheric Working Group

Denver, Colorado

June 3rd, 1998

Geodetic Research Laboratory, Department of Geodesy and Geomatics Engineering, University of New Brunswick.

Introduction

- Nav Canada contract held by UNB to investigate atmospheric effects on WAAS in Canadian airspace
  - Both tropospheric and ionospheric effects are being investigated
- UNB ionospheric investigations *specific to WAAS* are at an early stage
- Nonetheless, UNB has extensive experience in ionospheric effects modelling at local, regional and global scales

Previous Ionospheric Research at UNB

- Ionospheric effects on precise geodetic relative positioning
- Regional ionospheric modelling for single frequency GPS users
- Local ionospheric delay estimation for improved OTF ambiguity resolution
- Global and regional TEC maps produced using dual frequency GPS data from a network of IGS sites, validated with TOPEX / Poseidon-derived TEC data
- Suggested improvements to the International Reference Ionosphere 1995 using GPS-derived TEC data

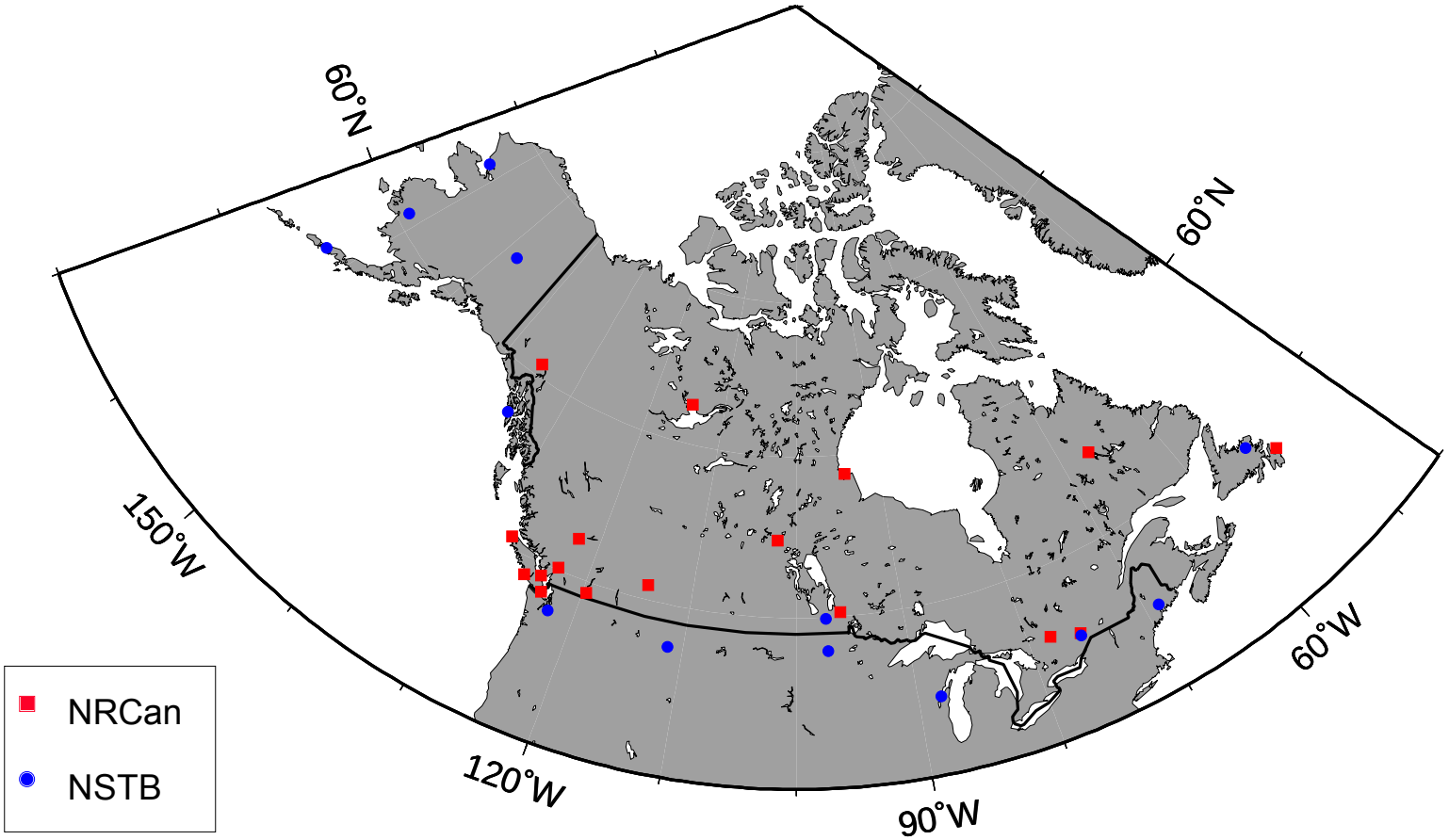
Contract Requirements

- 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
- Recommend possible densification of permanent GPS tracking sites in Canada
- Recommend any improvements needed to the WAAS ionospheric modelling technique

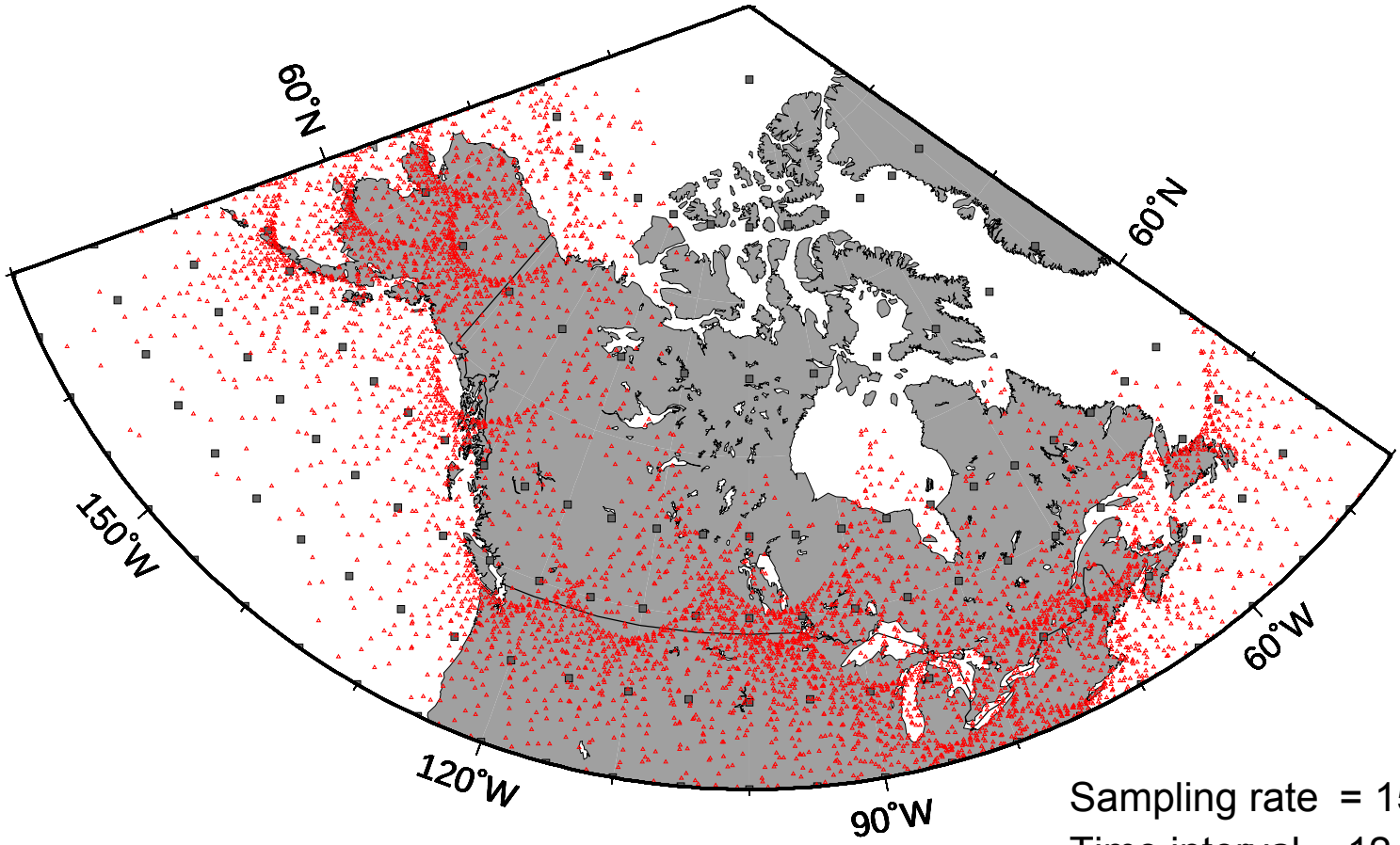
Methodology

- Literature review to ensure that work is not being duplicated (this does not preclude validation of others results)
- Identification and documentation of available data sources
  - WAAS corrections from FAATC
  - GPS data from IGS / CACS / NSTB
  - Dynamic GPS data collected from various “aircraft of opportunity”
  - Data format issues
- Comparison of user ionospheric delays interpolated from WAAS grid model and those obtained from independent GPS data
- Comparison between WAAS grid model and UNB derived ionospheric model(s)

NSTB and NRCan Station Locations

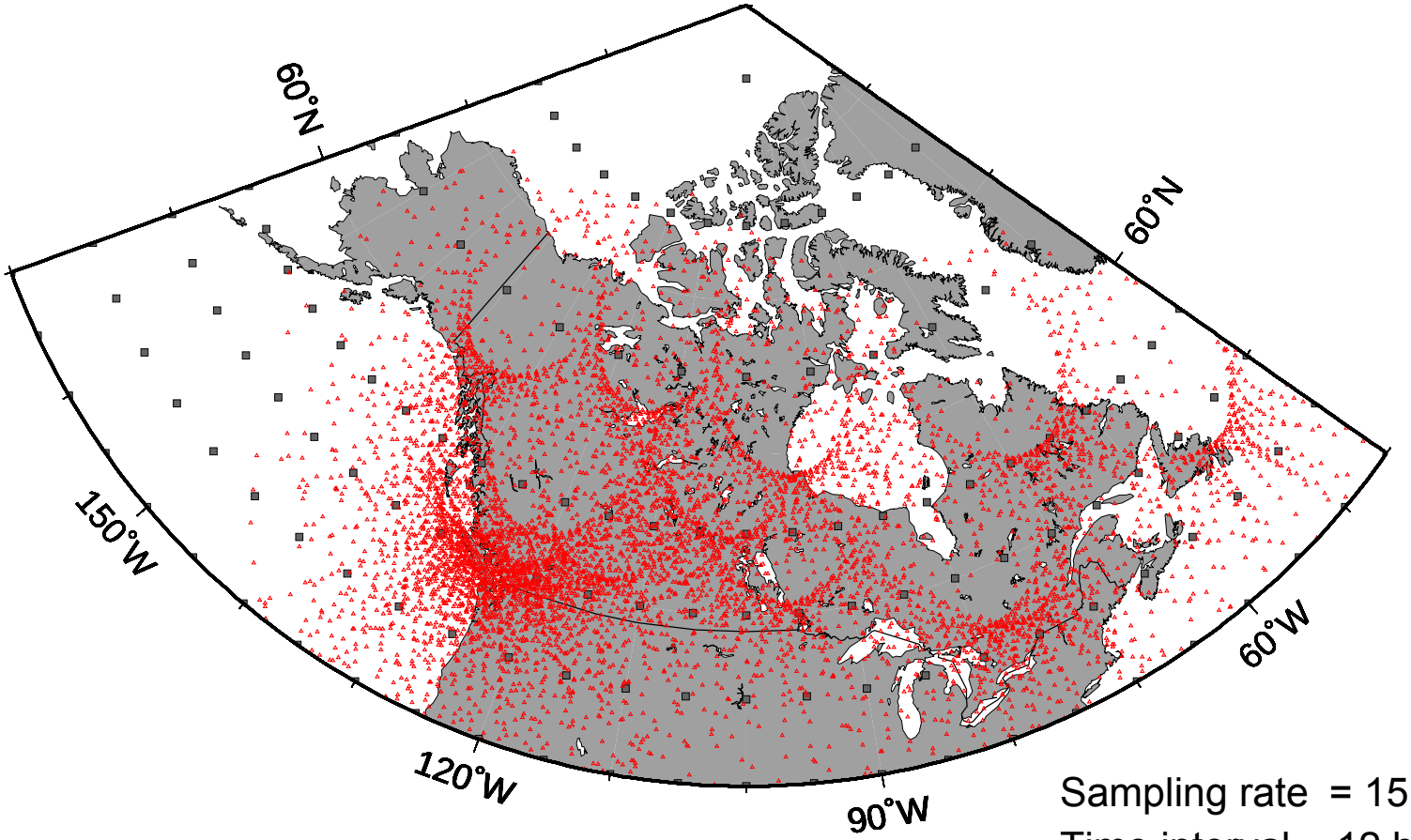


IPPs from current NSTB stations



Sampling rate = 15 minutes
Time interval = 12 hours
Elevation cut off = 5º

IPPs from NRCan stations

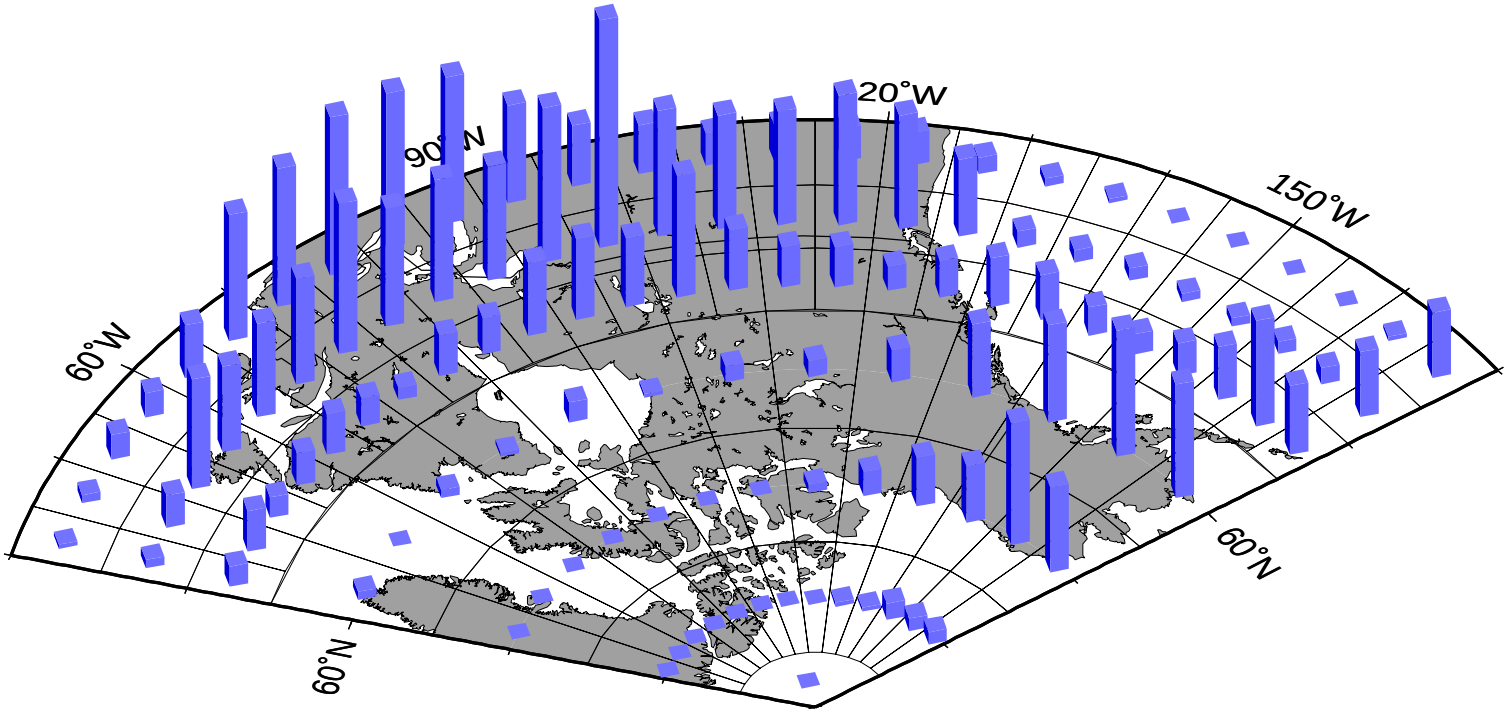


Sampling rate = 15 minutes
Time interval = 12 hours
Elevation cut off = 5°

Ionospheric Pierce Point Density

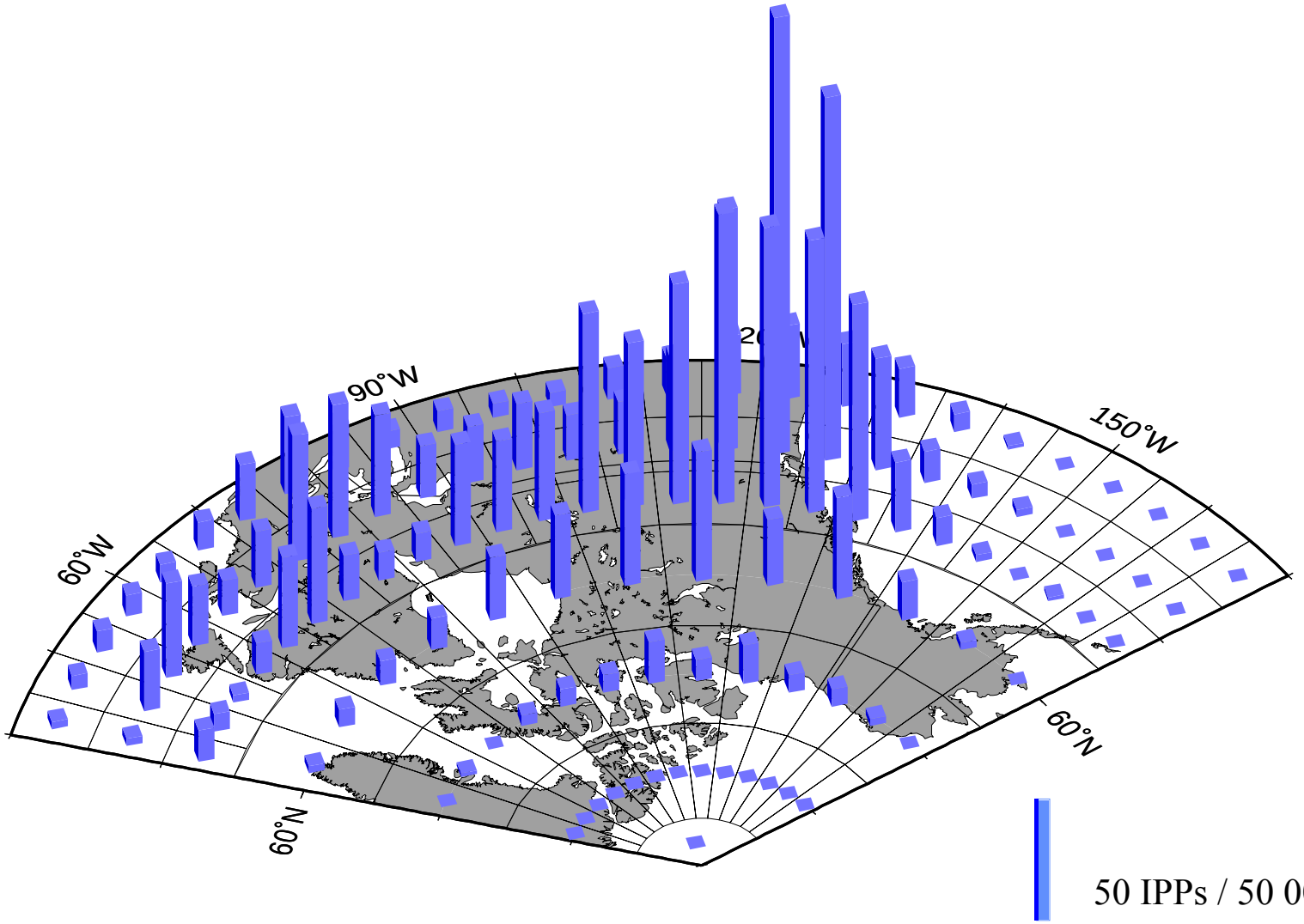
- Increase in grid square size and decrease in longitudinal extent with increasing latitude
  - This is taken into account in the following graphics by approximating the area of each grid square and providing a representation of density of pierce points per 50 000 square kilometres

IPP density from current NSTB network

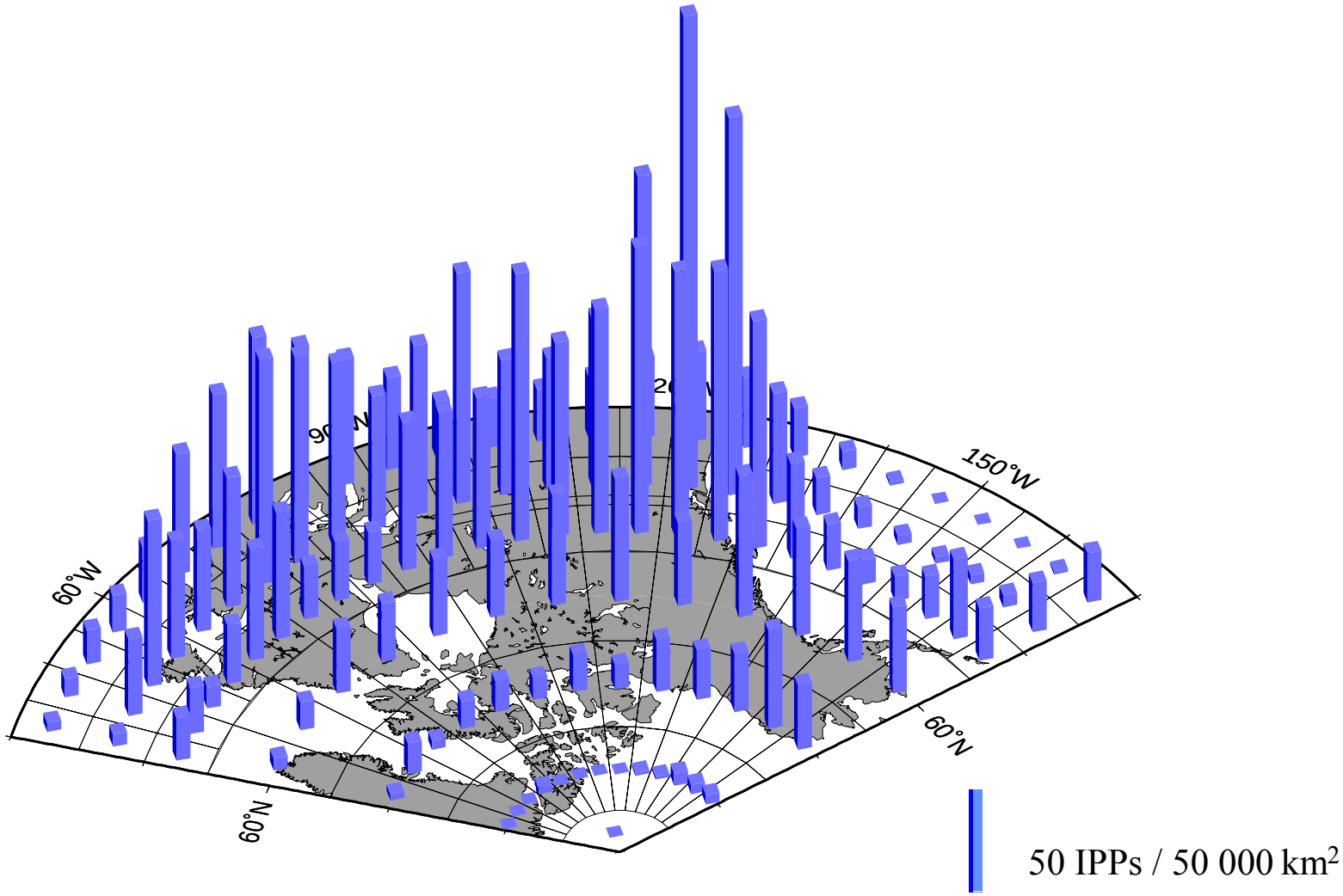


50 IPPs / 50 000 km^2

IPP density from NRCan stations



IPP density from NRCan, NSTB stations + Iqaluit



Issues

- Potential ionospheric limitations on WAAS use over the Canadian landmass
- 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

Summary and Future Work

- 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