# Processing of GPS Data from a Regional Continuous Monitoring Network

C. Shen and R. B. Langley

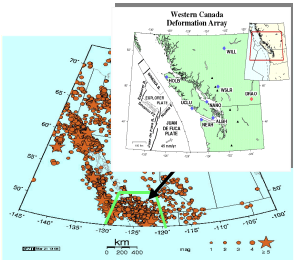
**Introduction:** The Western Canada Deformation Array (WCDA), as part of the Canadian National Earth Hazards program, is a regional continuous GPS network for monitoring the crustal deformation in western Canada. Since the rate of crustal deformation in the region is of the order of 1 cm per year, high precision processing software is required to extract the deformation signals. We have initiated a project to further enhance accuracy of UNB's DIfferential POsitioning Program (DIPOP) in ord er to process WCDA data and yield position results with the requisite accuracy.

**ENV #17** - Understanding Earthquakes

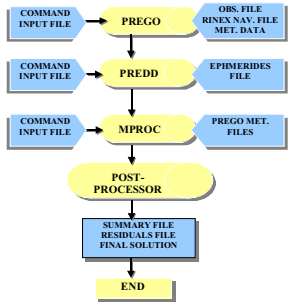
- Deformation in western Canada: the order of 1 cm per year.
- GPS Technique: relative precision of $10^{-8}$ to $10^{-9}$.

**WCDA :** operated by the Geological Survey of Canada since 1991. The purpose of the array is to monitor crustal deformation and to provide evidence for assessment of seismic hazard.

- Location: spanning the most seismically active and the most densely populated region in western Canada.
- WCDA Network: 8 permanent GPS tracking stations providing dual-frequency data daily .



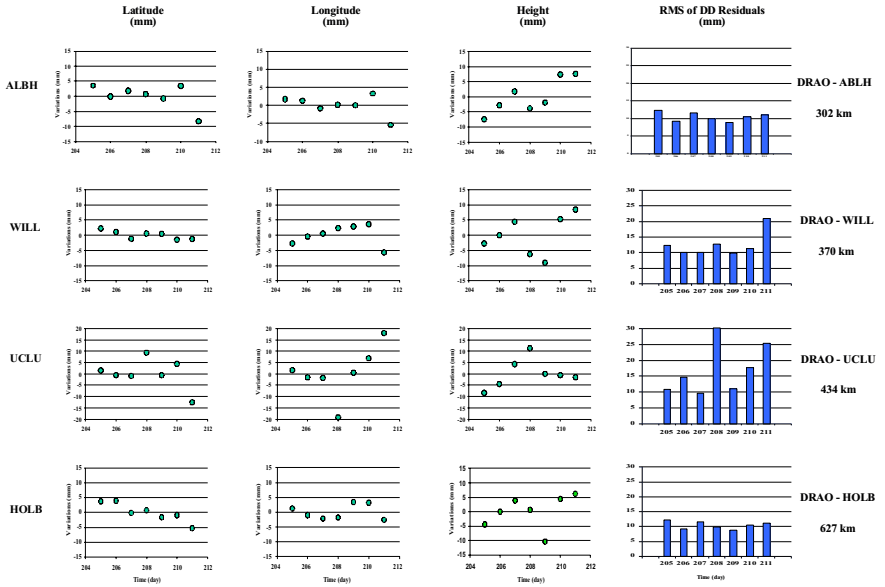

Earthquakes in western Canada (1996/03/22 - 2001/03/21)
<http://www.pgc.nrcan.gc.ca/>




DIPOP FLOW CHART

**DIPOP :** a software package developed by the Department of Geodesy and Geomatics Engineering, University of New Brunswick. The current version is running in the shell environment of the UNIX operating system.

- Preprocessors - PREGO and PREDD: scanning for gaps, eliminating bad observations and fixing cycle slips.
- Main Processor and Postprocessor - MPROC and PPROC : carrying out sequential least squares adjustment in baseline or network mode and giving final solutions and statistics information in output files.




**Solutions from DIPOP:** The first three columns of above plots show variations of daily coordinate solutions for 4 selected GPS stations of WCDA. The plots of the last column show RMS of double difference residuals for the 4 stations with respect to the reference station DRAO during 7 days respectively.

**Data Processing Strategy:**

Processed Data: WCDA data on 7 baselines ( 254 km - 627 km ) from 23 to 29 June 2000.
Reference Station: DRAO
Stations adjusted: ALBH, HOLB, NEAH, NANO, UCLU, WILL, WSLR .
Analysis Model: sequential LS adjustment in baseline mode for each 24hr data set.
Satellite Orbits: IGS precise orbit (fixed).
Solution Type: L3 carrier phase.
Elevation Angle Cutoff: 15 degrees.
Tide Corrections: solid Earth tide, ocean tide loading, and pole tide.
Tropospheric Zenith Delay (ZD) Estimate: in a 100 min interval using Saastamoinen ZD models and Niell mapping functions.
Parameters Estimated: coordinates, tropospheric ZD delay and ambiguities (not fixed).

**Table a**

| Site | Difference | | |
|---|---|---|---|
| | dx(mm) | dy (mm) | dz (mm) |
| ALBH | 13.6 | 12.4 | -9.2 |
| WILL | -6.8 | 6.3 | 7.3 |
| UCLU | 12.9 | -13.8 | -15.4 |
| HOLB | -7.9 | 6.1 | -0.5 |

**Table b**

| Baseline | DL (mm) | RDL (0.01ppm) |
|---|---|---|
| DRAO-ALBH | 13.9 | 4.61 |
| DRAO-WILL | 1.6 | 0.43 |
| DRAO-UCUL | -27.6 | 6.36 |
| DRAO-HOLB | 9.8 | 1.56 |

**Table a:** Comparison of coordinate solutions from DIPOP and GPS coordinate solutions published by IERS (ITRF97). dx, dy and dz denote differences between the two sets of solutions in x, y, and z axis directions respectively. **Table b:** Comparison of baseline lengths of the 4 stations with respect to reference station DRAO. DL represents a difference between the two sets of length solutions. RDL is a relative difference of DL in parts per 0.01ppm.

**Conclusions:** The preliminary solutions suggest that the consistency of coordinate solutions is better than 2 cm for the horizontal components except for the site UCLU. The variation of the height components is less than 25 mm. RMS of double difference residuals is within a range of 8 mm to 30 mm. The RMS average of residuals from 49 sessions ( 7 baselines for 7 days ) is 14.6 mm. The comparison of 4 baseline lengths from DIPOP solutions to GPS solutions published by IERS (ITRF97) shows a mean scale difference of 3.24 parts per 0.01ppm.

Department of Geodesy & Geomatics Engineering