“Using Dual Frequency GPS Under Tree Canopy” (Successfully)

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Four Scenarios Will Be Reviewed

- Dual Frequency with Real time correction from Real Time Network or RTK
- Dual Frequency using Canadian Post Processing system. (8-10 min occupation)
- Dual Frequency Base Station with Single Frequency Rover (post processing)
- Collecting OPUS points with 15 minute occupations.

Definitions

- Dual Frequency – Using 2 GPS signals. L1L2
- Fixed Position – 1 to 10 cm accuracy
  - Exceptional accuracy potential
- Float Position – 10 to 45 cm accuracy
- Static Occupations – multiple minutes to multiple hours collecting data on 1 point
- Real Time Corrections – Corrections via radio link or cell phone/internet
- OPUS – Online Positioning User System

Collecting sub-50 centimeter data under trees IS NOT EASY

- Some Dual Frequency GPS units may have **less** accuracy than single frequency units designed to work under canopy
- Trees cause major interference with the L1 and L2 signals
- User must take advantage of any openings in canopy
- Use Multi-constellation GPS receivers

Current GNSS Constellations

- GLONASS - 24 operational
- Beidou – 13 Regional (2016) Plus 9
- Galileo – 8
- US GPS – 31 – w/ (12) newer IIF satellites
  - GPS III satellites coming in 2017
- Total today is 85

The Future of GNSS

- US GPS System (31 satellites-current)
  - L1, L2, L5
- GLONASS (Russia) (24 + 3 available now)
- Galileo (Europe) (27 + 3 satellites-2016)
- Beidou (China) (24 + 3 satellites-2020)

- Potential Satellites in 2020 is 106

Dual Frequency GPS With Real Time GPS Network

- Oregon Real Time GPS Network
  - Free! Must have cell phone coverage to work
  - GPS only (GLONASS Coming Soon)
- Washington State Reference Network
  - Subscription cost ($1,900/Yr); Has GLONASS
- Plate Boundary Observatory
  - Limited to western part of US
  - Single base lines only

Real Time Networks

- GLONASS helps when trees nearby
  - Less waiting for fixed position
  - We can get fixed positions when it was impossible with just GPS
- Beidou & Galileo are starting to build up their constellations.
- Major limitations
  - Cell Phone Coverage limited in remote areas
  - Trees are a major problem in real time mode

Tests With Dual Frequency Receivers

GPS Course –
Summerlake Park
Tigard, Oregon

Four Points in Open Sky

Nine Points under Tree Canopy

Test Results

- Fixed Positions at all Open Sky Points with all receivers
  - Receivers: X900+, X91+, SP80, Javad Cube
- Some Fixed Positions under canopy
  - Ave Open Sky 2 cm; Ave under canopy 85 cm

X900+ RTK

Date of test: 1/13/2015

Nail	Rebar	11445	Valve Cov	Man Hole	Root1	Root2	Root3	Root4	Bridge NE	Bridge NV	Bridge SE	Bridge SW
0.02	0.01	0.02	0.05	0.07	0.93	2.18	1.21	0.40	1.08	0.95	0.82	0.04
Average for Open Sky:			0.02						Average for Covered Canopy:			0.85
											Overall Average:	0.60

Canadian Post Processing (on-line)

- Free submission to Canadian site
- Will provide an answer when OPUS won't
  - OPUS filters out poor data
- Minimum of 3 minute occupation
  - 8 to 10 minutes = much better accuracy
- Dual Frequency Only
- www.nrcan.gc.ca/earth-sciences

Post Processing With The Base Station Within ¼ Mile

Near decimeter accuracy potential with a Sub-meter GPS unit and Post Processing.

X90-OPUS

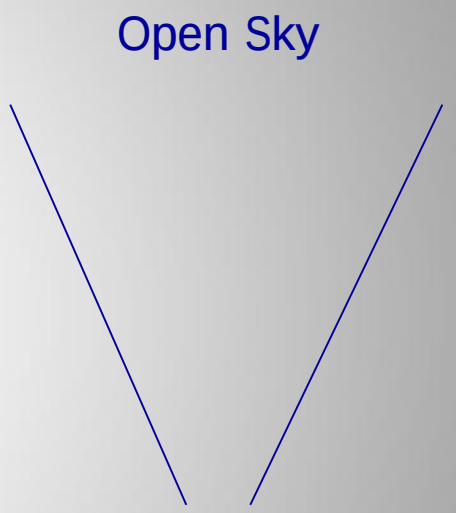
MM120 L1

Post Processing with Dual Frequency Base & L1 Rover

- Distance base to rover very short
- Post Processing operation easy & fast
- Must store RAW GPS data
- Post Processing uses Rinex File from dual frequency receiver
- Base unit can be put anywhere in the open

Using OPUS (Online Positioning User System)

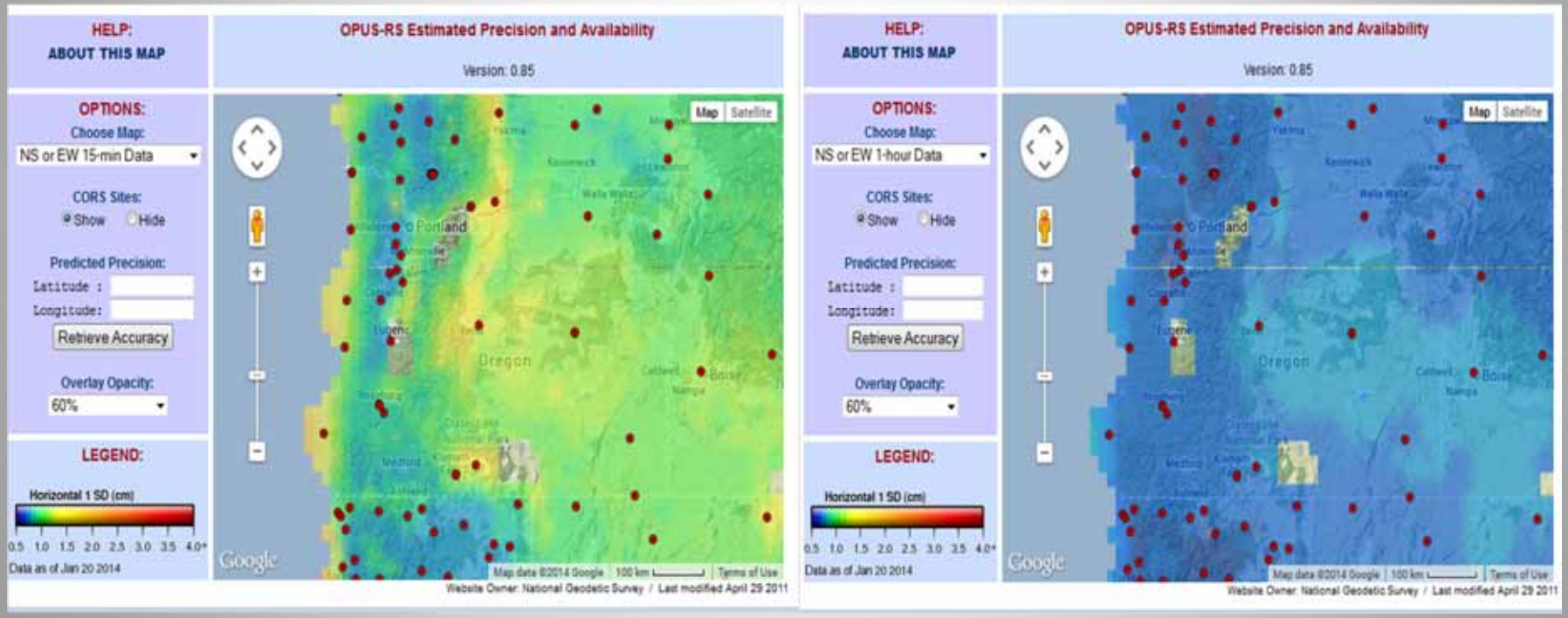
- How Much Canopy is Too Much?
  - Trees to the side OK
  - Directly overhead should be clear
  - Important to track as many satellites as possible in open sky
  - Not survey grade under trees



OPUS Occupation Times

- OPUS Rapid Static (15 min to 2 hours)
  - 30 minutes better than 15
  - Won’t work in some remote areas
  - Works fine in OR/WA except on extreme West Coast
- OPUS Static (2 hours to 48 hours)
  - Works anywhere in world

Accuracy – What Can We Expect With OPUS Rapid Static?



Submitting To OPUS:

OPUS Report:

NAD_83(2011)(EPOCH:2010.0000)

LON: 122.16340) .005(m)
EL HGT: 389(m) 0.014(m)
ORTHO HGT: 347(m) 0.014(m)

UTM COORDINATES

STATE PLANE COORDINATES

Summary: What We Know

- OPUS gives exceptional accuracy in nearly clear sky conditions
- Dual Frequency/Real Time Networks give Fixed Positions under canopy occasionally
- The Canadian System allows us to collect shorter static periods
- Post Processing can work well with longer sessions.

What We Are Hoping For:

- Full Constellations of Beidou, Galileo, GLONASS and GPS will make significant improvements in accuracy
- New Receivers will mitigate signals under canopy better
- Costs for Dual Frequency Receivers will continue to fall

Conclusion

- **It is possible to use Dual Frequency GPS units under tree canopy.**
- **Accuracy can be exceptional at times.**
- **Accuracy can be abysmal at times.**
- **Post Processing is still a viable alternative**

Thanks!

For all your GPS data collection, may your:

- **GPS never crash**
- **Batteries never die**
- **PDOP's be low**
- **Satellites High in the Sky**

Miles the GPS Dog

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