How GNSS Signals are Impacted by Environmental Factors

MSPS 61st Annual Meeting
Bloomington Minnesota
February 8, 2013
Objectives

• Identify Negative Environmental Factors
• Useful Tools to Stack the Deck in Your Favor
• Use Your GNSS Equipment with More Confidence
Agenda

• Error Sources in GNSS Measurements
• Satellite Blockage
• Solar Activity
• But it’s Still Fixed!
  • Initializations vs. Precision Based GNSS
  • Is that good enough
Error Sources in GNSS

- PDOP (Satellite Geometry)
  - <6.0
- Atmospheric Delays
  - RTK baselines of 10km or less
- Human Error
  - Checking your work
- Multipath
  - High RMS
Error Sources in GNSS

• There is error in every GNSS Measurement
  • How do I reduce that error
  • How do I know when my measurement is in error
  • Do we have control over any of these errors
  • Where is the “backsight check” button
Error Sources in GNSS

- PDOP (Satellite Geometry)
  - <6.0
- Atmospheric Delays
  - RTK baselines of 10km or less
- Human Error
  - Checking your work
- Multipath
  - High RMS
Error Sources in GNSS

• There is error in every GNSS Measurement
  • Multipath or high RMS
  • Double Stub RTK Vectors (Radial Surveys)
  • Initialization Checks
  • Use the Right Tool for the Job
Multipath

- There is multipath error in every GNSS measurement
  - Tree’s, Building’s, Vehicles, Environment
  - What is a good Multipath (RMS <30)
- Report the RMS
- Avoid Multipath
- Pull out a Total Station

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Loss of Satellites

• Satellite Blockage
  • Buildings
  • Canyons
  • Trees
  • High PDOP
  • Base Location

• Loss of Initialization

• High Precision’s
Initialization

OTF Initialization

Loss of Lock!

$#@%!
Initialization

• On the Fly
• Known Point
• Precision Based GNSS
  • No Initializations performed
  • Example, Trimble R10
  • More robust and reliable

RTK:Fixed H:0.010m V:0.014m RMS:015

RTK H:0.008m V:0.010m
Solar Activity

• What does High Solar Activity Mean
• Should I be concerned
• How can I deal with High Solar Activity
• Where can I get more Information
Solar Flares

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High Solar Activity

• According to Wikipedia, a Solar Flare is a sudden brightening observed over the Sun with an enormous energy release followed by a large coronal mass ejection that releases ions, atoms, and electrons into space that affect all layers of the solar atmosphere of earth.
High Solar Activity

• If the Solar Flare is large enough, it has a direct negative impact on the incoming GNSS signals from Space. This impact can virtually blind the GNSS signal from being received properly by your GNSS receiver. Solar Flares are also know to disrupt power grids and other communication technologies.
Solar Flares

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Solar Flares

- www.spaceweather.com
- Solar Cycle every 11.1 years or so
- Solar Maximum at the top of that Cycle
- 2007-08 was the end of our Solar Minimum
- 2013 considered on the Solar Max Upswing
- Older Receivers Impacted More
Solar Flares

• During times of High Solar Activity
• Without Warning
  • Example: 2 Days of static observations lost due to High SA
• http://www.spaceweather.com
  • Classification of Solar Flares
    • C-Class – Small with relatively no earth consequence
    • M-Class – Medium size, brief radio blackouts, polar regions
    • X-Class – Major Events, global radio blackouts
Solar Flares

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Monitor Solar Activity During Solar Maximum

- [www.spaceweather.com](http://www.spaceweather.com)
  - Monitor High Solar Activity
  - Sign up for their *SpaceWeatherNews*
- [www.swpc.noaa.gov](http://www.swpc.noaa.gov)
  - 3 Day Forecast
  - Space Weather Alerts
- [www.solarmonitor.org](http://www.solarmonitor.org)
Base Station - OPUS

• How does this affect my Base or OPUS?
  • Base is Free and Clear
  • Pre-Planning
  • Review CORS Site Time Series
    • Short Term
  • Understand OPUS Report
Review Agenda

• Error Sources in GNSS Measurements
• Satellite Blockage
• Solar Activity

• But it’s Still Fixed!
  • Fixed does not mean a good GNSS Observation
  • You should always question the fixed position in challenging environments
Summary

• Multipath and Solar Flares are largest negative Environmental factors not in your control
• Watch/Report RMS
• Monitor Solar sites
• Survey in Challenging Environments Smarter
• Survey with Confidence
Questions

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