H24VLP Project 1

Environmental impact on the GNSS positioning performance

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13th February 2016

NGI

Outline

Introduction

Project Introduction I

Aim of the project is to understand the impact of the environment on positioning performance. You will study

- Positioning performance;
- Number of satellites and Signal strength;
- Multipath;

using data collected in three distinctive environments

- Open area;
- Foliage (trees);
- heavy multipath - between two buildings.

Project Introduction II

For the study we expect you to use:

- TEQC command line software;
- TEQCSPEC Matlab script visualising multipath;
- WangSEU VC++ software;

Workflow

I suggest following workflow for your analysis:

- Extract QC characteristics from RINEX data using *teqc +qc +plot data.16o*;
- Use Matlab script for initial visualisation of results;
- Use software to output relevant data into CSV file;
- Use Matlab script for initial visualisation of results;
- **Analyse data and draw conclusions.**
- Prepare and present a story about your findings.

Software

TEQC[1] allows translation, editing and quality control of collected GNSS data[2].

For example *teqc +qc +plot data.16o* will produce all outputs needed for Matlab script. Use binaries provided with Matlab script as recent ones use non-compatible COMPACT3 format [3]. Other examples are available in *TEQC_intro.pdf* introductory document by Sean Ince.

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[1] `http://www.unavco.org/software/data-processing/TEQC/TEQC.html`. Latest binaries at at bottom of page.

[2] Tutorials are available at `http://www.unavco.org/software/data-processing/TEQC/doc/UNAVCO_TEQC_Tutorial.pdf`

[3] `http://postal.unavco.org/pipermail/teqc/2013/001594.html`

This matlab script visualise *teqc qc data* using COMPACT2 files created by TEQC. We expect that you will utilise script to identify satellites to analyse. To create plots:

- run *main.m* (F5) selecting script folder as active;
- select requested teqc COMPACT2 files;
- plots 5-6 visualise multipath on skyplot;
- explore other plots;
- save plots.

Further description is available in *2006_Ogaja.pdf*, available, with scripts, at H24VLP Moodle website[4].

[4] History of changes at `https://github.com/DfAC/TEQCSPEC`.

WangSEU I

WangSEU is a software created by Denghui Wang, *visiting PhD student from Southeast University, Nanjing, China*. You will use it to output relevant characteristics from RINEX[5]. Software outputs separate CSV file for each satellite[6] with the following columns:

Epoch[s] GPS week [s] SV ID Elev[deg] Az[deg] MP1 MP2 SN1 SN2 SV lock [s]

To produce CSV output:

- start *WangSEU.exe*
- from top menu select *Read Rinex File* $\rightarrow$ *Read single station RINEX file*

Example output

Epoch,1,GPSSecond,305969,Sat, 10,Ele, 69.46,Azi,147.97,MP1,-13.4718,MP2,-23.1764,SN1,50.25,SN2,45.40,Num,1,
Epoch,2,GPSSecond,305970,Sat, 10,Ele, 69.45,Azi,147.97,MP1,-13.4753,MP2,-23.1607,SN1,50.30,SN2,45.15,Num,2,
Epoch,3,GPSSecond,305971,Sat, 10,Ele, 69.44,Azi,147.97,MP1,-13.4779,MP2,-23.1643,SN1,50.40,SN2,45.35,Num,3,
Epoch,4,GPSSecond,305972,Sat, 10,Ele, 69.43,Azi,147.96,MP1,-13.4686,MP2,-23.1767,SN1,50.45,SN2,45.35,Num,4,

[5] you need RINEX 2.11 *.??o, *.??p *.??n files.

[6] Note that $SV_{GLONASS} = SV_{ID} + 60$ to differentiate from GPS. For example SV64 is GLONASS 4 while SV4 is GPS 4.

Point coordinates (truth)

ID	$E[m]$	$N[m]$	Ht Ort [m][a]	Notes
JUB7	454 729.552	339 338.900	28.980	Open Area
JUB8	454 682.344	339 523.094	27.803	Trees
UrbanA	454 853.269	339 696.630	29.890	MP area for Group A
UrbanB	454 858.511	339 697.517	29.854	MP area for Group B

Table 1: OSGB coordinates for the Project 1

[a] Geoid undulation is 48.523m

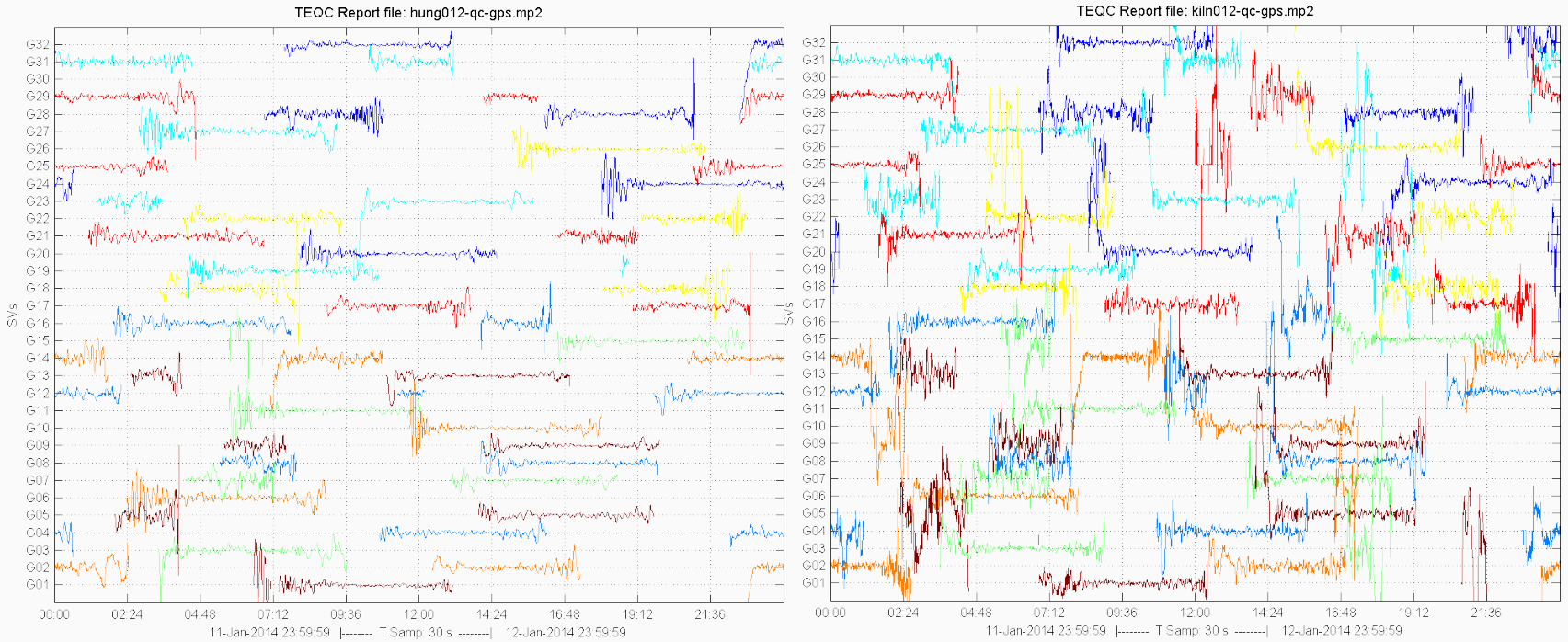
Comparison examples

Visualisations

Following examples have been carried out by PhD students at NGI and show possible visualisations of multipath:

- Sample Matlab output using OS data (Jareer Mohammed);
- Sample Denghui Wang visualisation;
- Sample Jareer Mohammed visualisation;

Matlab output I

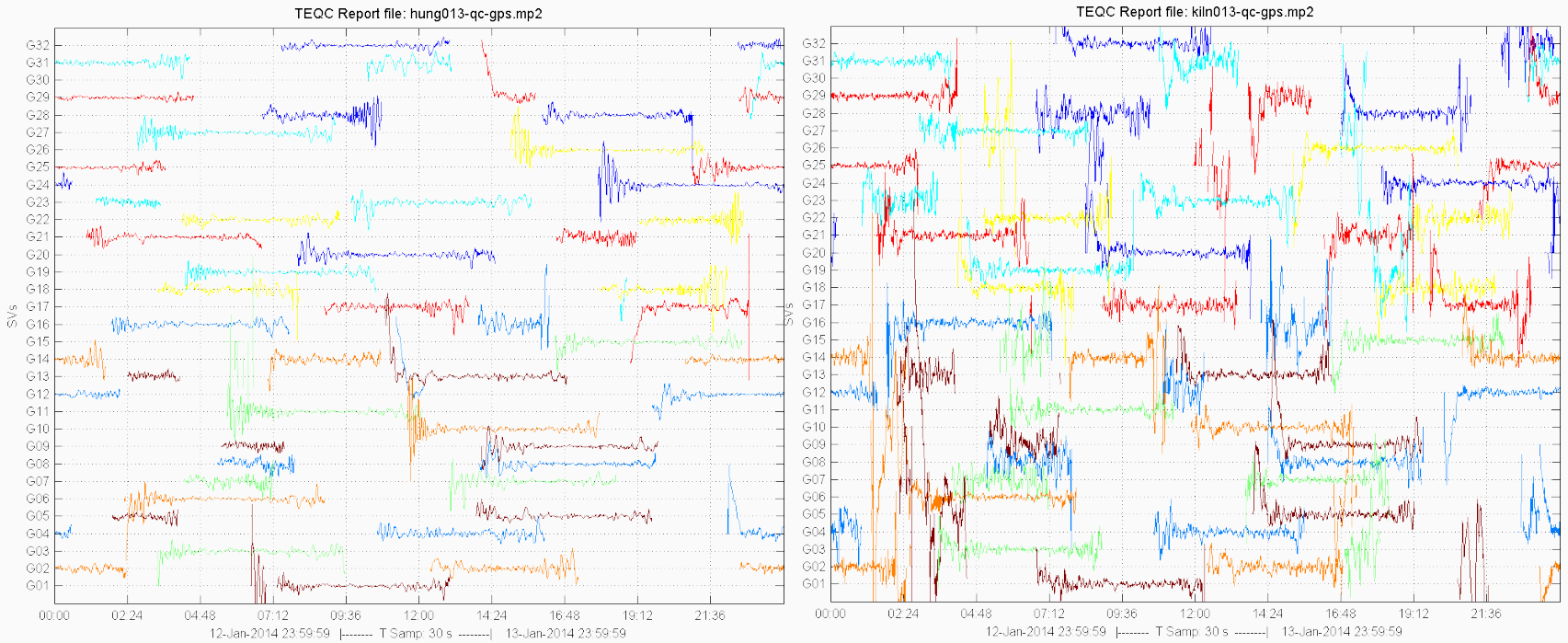


a: HUNG, no MP

b: KILN, suspected MP

Figure 2: TEQC MP2, day 1

Matlab output II



a: HUNG, no MP

b: KILN, suspected MP

Figure 4: TEQC MP2, day 2

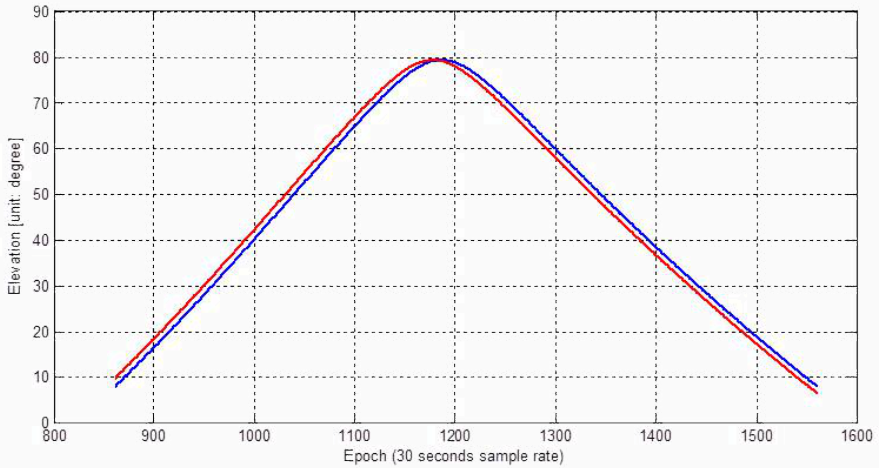
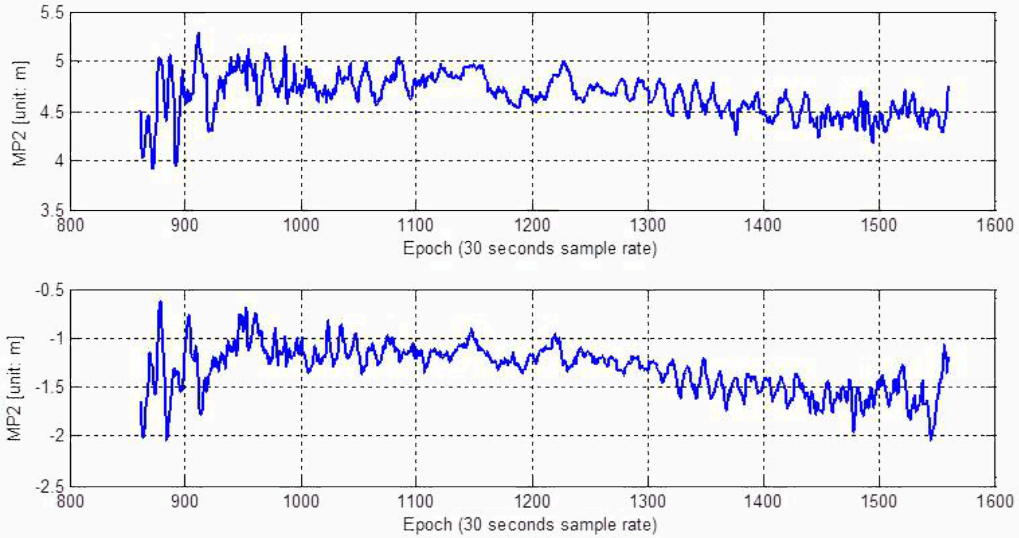
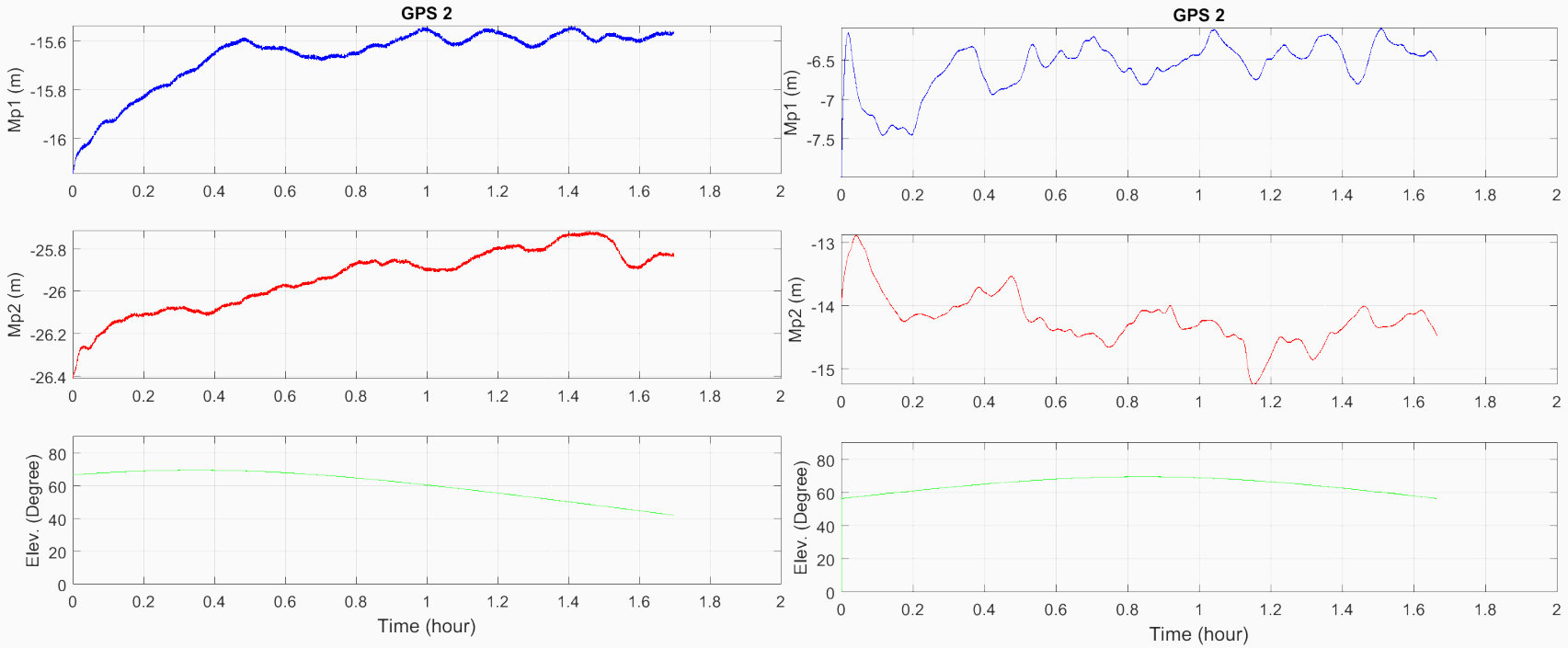


Figure 5: Visualisation





a: Open sky

b: Urban area

Figure 7: Comparison for GPS SV2

Summary

Supporting files

You will study the impact of the environment on positioning performance using software provided. We expect you to produce own graphs using outputs from the provided software. Following files can be found on the accompanying Moodle site:

H24VLP_P1_MP.pdf This presentation[7];

TEQC_intro.pdf Introduction to TEQC (Sean Ince);

teqc.zip Old teqc 64bit Windows binary to produce Matlab script inputs;

2006_Ogaja.pdf Paper describing TEQCSPEC Matlab script;

Matlab.zip TEQCSPEC Matlab script[8]. Use *main.m* to run it;

WangSEU.zip VC++ binary producing CSV files from RINEX.

[7] History of changes at `https://github.com/DfAC/TeachingSlides/`.

[8] History of changes at `https://github.com/DfAC/TEQCSPEC`.

Good luck