SINGLE RECEIVER GPS POSITIONING IN SUPPORT OF AIRBORNE GRAVITY FOR EXPLORATION AND MAPPING

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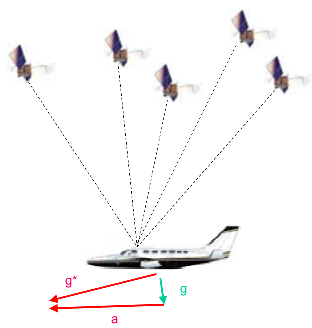
Introduction

Accurate determination of aircraft acceleration is necessary for airborne gravity data processing in support of varied applications such as geoid determination, and mineral and fossil fuel exploration. To meet the accuracy requirements, carrier-phase GPS measurements in differential mode are typically used and conventional relative processing techniques applied. The purpose of our research is to investigate a single-receiver approach for airborne positioning, therefore avoiding the use of additional equipment and data processing. We have compared this technique with the relative processing technique.

Airborne Gravimetry Method



g* Total acceleration measured by accelerometers.
Total acceleration is composed of: **g** - the earth's gravity field and **a** - acceleration due to the motion of the aircraft derived at a point in the aircraft from GPS position estimates.

Methodology

Single Receiver GPS Positioning

Combination of ionosphere-free pseudorange and carrier-phase observations in a UNB-developed processor.

Relative GPS Positioning

Ionosphere-free carrier-phase and pseudorange, ambiguity-fixed kinematic processing with a commercial software package. Results provided by KMS Denmark, and used as reference solution.

Differentiation for Velocity and Acceleration

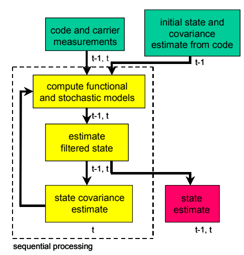
Third-order central difference of the Taylor series approximation.

Single Receiver Versus Relative GPS Comparison

Compare determined position, velocity and acceleration.

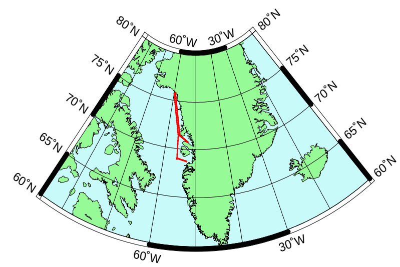
UNB Point Positioning Software

Simultaneously utilize *code* data to compute aircraft *position,* and *carrier* data to compute aircraft *position change*. Primary inputs: dual-frequency code and carrier measurements from aircraft receiver, precise GPS constellation ephemerides, and precise GPS constellation satellite clock offsets from GPST.



Data Description

Flight Path

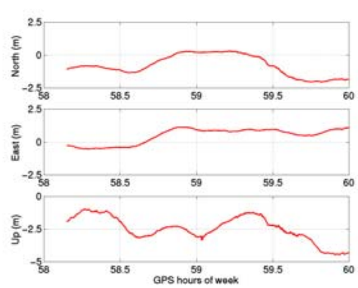


Data Availability and Data Quality

Observations start : 10:04:04 22 Aug 2000
Observations end : 16:26:35 22 Aug 2000
Observation interval : 1 second
Number of observations : 209251

Position, Velocity and Acceleration Comparisons: (Reference) Relative Solution Minus (UNB) Single Receiver Solution

Position Difference



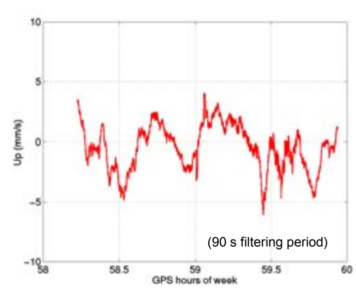
Statistical Analysis

	Mean [m]	r.m.s. [m]	std. dev. [m]
North	-0.80	1.12	0.79
East	0.47	0.75	0.58
Up	-2.47	2.65	0.96

Comments

- Processed first two hours after aircraft ascent.
- Mean flight velocity of 70 m/s and flying height of 230 m.
- Bias in up-component caused by unmodelled residual tropospheric delay in point solution and by datum difference.
- Reference relative position solution provided with 50 cm component accuracy.

Velocity Difference



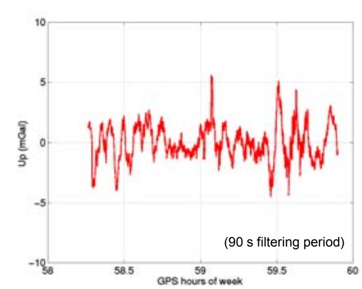
Statistical Analysis

Filtering Period	Mean [mm/s]	r.m.s. [mm/s]
30 s	-0.4	2.3
60 s	-0.4	2.1
90 s	-0.5	2.0

Comments

- Velocity obtained by numerical differentiation of position solution.
- 30, 60, 90 s are typical filtering periods used in airborne gravity processing.

Acceleration Difference



Statistical Analysis

Filtering Period	Mean [mGal]	r.m.s. [mGal]
30 s	-0.04	6.1
60 s	-0.03	2.3
90 s	-0.03	1.5

Comments

- Acceleration obtained by numerical differentiation of velocity estimates.
- Difference between the two methods at 2 mGal-level for 30 and 90 s filtering periods.
- Variations are within noise level of airborne GPS-observed vertical acceleration.

Conclusions

- Equivalence of point and relative positioning acceleration estimates indicates that for the data tested our point positioning technique can be used for airborne gravity determination.
- Accuracy of the gravity disturbances is a function of GPS and accelerometer errors. Influence of the second subsystem also has to be considered.
- The advantages of this technique will be found in many aspects such as cost of equipment and baseline length constraints.

Acknowledgements

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RES#47

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