Analysis of GPS Data from An Antarctic Ice Stream

R. Dach, G. Beutler and G.H. Gudmundsson

Abstract Temporal variations in the flow of an active ice stream are analyzed using GPS data collected over a period of two months at six different locations. The diameter of the network is about 60 km. The ice stream moves with a velocity of about one meter per day. The kinematic data are processed using three different strategies: zero-difference network solution, Precise Point Positioning, and double-difference network solution with resolved carrier phase ambiguities.

The solutions are compared with regard to the quality of the resulting coordinate time series. Special attention is paid to the positional accuracy as a function of temporal frequency for these different analysis methods as the overall aim of the measurements is to estimate temporal variability in ice flow.

Keywords GPS · GNSS · Kinematic positioning · Ambiguity-fixing · Precise point positioning

1 Introduction

To process GNSS data we usual distinguish zero- and double–difference processing schemes. Both are mathematically equivalent. The zero-difference method allows to solve for the receiver and satellite clock corrections, in the double-difference approach we have access to the integer nature of the carrier phase ambiguities. Integer carrier phase ambiguities may also be introduced as conditions of sum (or by adequate technologies) to a zero-difference solution.

Resolving the integer phase ambiguity parameters is essential for obtaining optimal results (e.g., in the repeatability of station coordinate estimation). Recent studies at the AIUB (Jäggi et al., 2008) concerning the gravity field recovery have shown that not all GNSS applications benefit from the introduced integer ambiguities. In that study, the orbits of the two GRACE satellites were generated once with real valued ambiguities and once with resolved integer ambiguities. On one hand, the relative validation of the orbits using K–band measurements between the two satellites clearly demonstrated the benefit of introducing the integer ambiguities. On the other hand, the gravity fields obtained from both orbits were nearly identical. For a more detailed description of this experiment we refer to Jäggi et al., (2008).

This result may be surprising at first sight, but can be explained by the fact that the epoch–to–epoch coordinate differences are dominated by the noise of the carrier phase measurements, which is identical for both solutions. Hence, only the long-term characteristics become more stable as the carrier phase ambiguities are fixed. Here we focus on the impact that resolving the carrier phase ambiguities has on the accuracy as a function of temporal frequency.

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2 Description of the Dataset

Six GPS stations were installed on the Rutford Ice Stream, West Antarctica, from end of December 2003 until February 2004 (see Fig. 1):

- One of the receivers, C − 20, was located on the (freely floating) ice shelf some 20 km down-stream from the grounding line.
- A second one, station C + 00, was at the grounding line marking the division between the grounded ice steam and the floating ice shelf.
- Four more stations C + 10, C + 20, C + 30, and C + 40 were located at increasing distances of 10, 20, 30, and 40 km, respectively, upstream from the grounding line.

Yet another receiver (FLET) was placed at the top of a nearby ice dome (Fletcher Promontory) where little ice movement is to be expected. The nearest tracking station of the International GNSS Service (IGS) with coordinates available in the IGS05 reference frame — the IGS realization of the ITRF2005 considering the corrections between relative and absolute antenna phase center variation modeling (Schmid and Rothacher (2003); Ferland (2006)) – is O'Higgins (station ID's OHI2 and OHI3).

Most of the sites were equipped with LEICA SR530 receivers and LEIAT502 antennas. The station C + 30 on the ice stream was occupied with a TRIMBLE 4000SSE receiver and a TRM22020.00+GP antenna. None of the antennas were covered by a radome. The two IGS stations in O'Higgins (OHI2/OHI3)

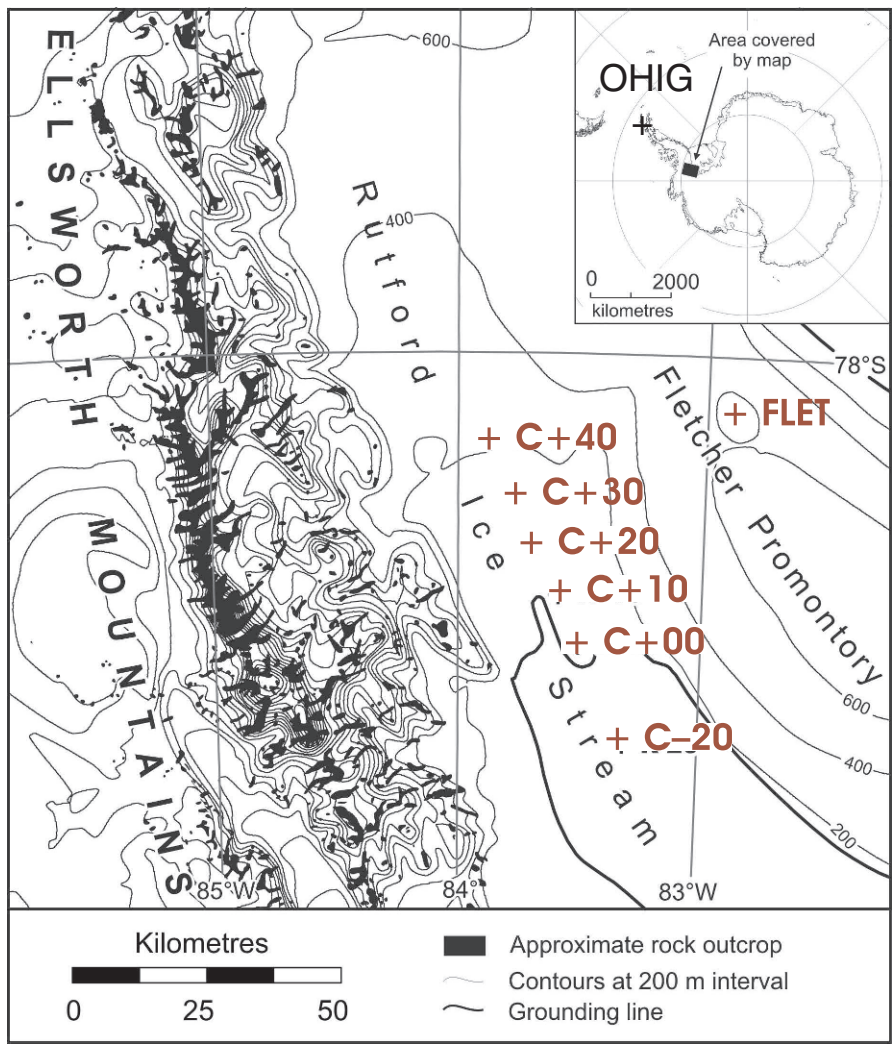

Fig. 1 Location of the GPS sites on the Rutford ice stream