HYDROLOGICAL EFFECTS IN THE RELATIVE GRAVITY MEASUREMENTS

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ABSTRACT

Relative-gyration measurements were carried out to obtain accurate scale factor at the vertical gravity baseline Hluboká (Czech Republic) near the turn of May and June 2006. Due to insufficient time at the beginning of June significant changes in gravity were observed near the river Vltava. The same measurements were also carried out in May 2007. The measurements were performed on the same set of baselines with the same equipment. The relative gravity accelerations for each case were obtained. A correlation between gravity accelerations and water flow in the river is observed. The significance of the changes in the water level in the river and the gravity acceleration at the point Hluboká on the river Vltava is discussed.

INTRODUCTION

The Department of Special Works (Land Survey Office) is carried out gravity measurement at the vertical gravity baseline Hluboká (Czech Republic) annually. The measurements are carried out with the assistance of Bundesamt für Eich und Vermessungswesen (BfE) and the German Gravity Service. The work is done by the author and administrates of the baseline.

The baseline consists of 25 stations, from these four stations were shown as the main stations (001, Hluboká, 002, Leopoldskron, 003, Milčenky and 004 Hluboká, see Fig. 1). Each main station is relatively connected to an absolute station, which is all in close proximity. The vertical gravity baseline Hluboká has gravity differences, 140.03 (±0.02 mGal) and 127.96 mGal at vertical distance 1000 m and vertical distance 500 m respectively between Hluboká and 003 Milčenky, and 002 Leopoldskron. These geoid characteristics are being used for measurement in the Czech Gravity Network.

The measurements were affected by the negative weather conditions in the spring of 2006. The combination of an increased rain (in places with higher altitude snowmelt) and of the subsequent high temperature (Czech Republic) caused quite sudden ups and downs in the river Vltava surface (see Fig. 3). It was also necessary to reduce the fourth day because of the high wind speed at the top of the baseline.

The weather is the reason for very big changes in the mass distribution in the nearest neighborhood of the station Hluboká (causing very big changes in the river flow rate at the river Vltava (Dvøřák et al. 2012). These geoid characteristics are being used for measurement in the Czech Gravity Network.

The aim of the paper is to study a possible linear correlation between the changes in the river flow rate (mass growth) and the gravity at the station Hluboká (caused by the rain and their possible impact on the scale factor changes).

FIG. 3. The location of the vertical gravity baseline Hluboká at the territory of Austria.

HIDROLOGICAL DATA

Hidrologie data (hourly values of a river level and at 30m flow rate) from the hydrometric network station, river Vltava, Hluboká (74 km from the river mouth) were used in this study. The river Vltava is the main river in the Czech Republic.

The river Vltava is the main river in the Czech Republic, about 74 km from the mouth. The level of the river Vltava was not used for the correlation analysis, because we suppose it is not a good parameter for the scale factor, because of the influence of the local water levels. Therefore the flow rate values are usually for the mass growth description. Significant changes in the flow speeds are not considered.

Flow rate in the river Vltava for the station Hluboká (depending on time) is determined subsequently. The time lag of the river flow changes (start of growing mass) was detected empirically and its value for the Hydrographic Dvůřák and Oppořil (2006) was fixed at 2 hours. The time lag value for the Vltava river (at the station Hluboká) was determined for the mass growth. The difference of mass (and with the reason of the higher speed of the water in the upper part of the river) is at 2 hours. The only empirical method to be considered as sufficient because we have only one value (1 hour mass) and only one value of the mass acceleration for the Hluboká station for each day (see also).

The estimation of water mass amount of the Vltava river was done using a spatially constrained model considering time lag of the river (Dvůřák and Oppořil 2006). The river flow rate changes at the station Hluboká was computed for the mass growth correlation (with the help of the hydrograph (Dvůřák 2007)). (see Fig. 5). In our case only the linear correlation between the flow rate and the gravity value was computed, so this linear approximation should affect the results.