Comparison between GIPSY OASIS 6.0 and BERNESE 5.0 time series for long term GPS stations in Denmark

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Abstract. We study influence of software on determination of secular uplift rates. For this purpose we process GPS data for three long term permanent GPS stations, SMID, SULD, and BUDP, all located in Denmark (fig 1). To process the GPS data, we use the GIPSY OASIS 6.0 software and the Bernese 5.0 software. For both software, we use the Precise Point Positioning (PPP) strategy and all parameters, including the data time span, are held constant. To make the solutions comparable, we use the same orbit products, oceans load model, antenna phase center offsets model. Our results suggest small difference in uplift rates at SMID and SULD between the GIPSY and the Bernese solutions, however, the differences of ~0.10 mm/yr are within the estimated uncertainty of ~0.17 mm/yr.
At BUDP we obtain a slightly larger difference (0.19 mm/yr) between the GIPSY and the Bernese solutions, however, the difference is almost within the estimated uncertainty of 0.18 mm/yr.

Keywords. GPS, Uplift, data processing technique

1. Introduction

The National Survey and Cadastre (KMS) is responsible for the geodetic definition of the reference network in Denmark. Permanent GPS stations play an important role in the monitoring and maintenance of the geodetic network. During 1998 and 1999 KMS established three permanent GPS station in Denmark, SMID, SULD and BUDP (see figure 1). Using 10 years of continuous data from the Danish stations, we analyze the daily GPS solutions to determine secular vertical rates. The purpose is to compare with predicted deformations caused by glacial isostatic adjustment (GIA) (Khan et al, 2005). However, studies have shown that estimated GPS rates depend on e.g. which orbits, elevation cut-off angle or software is used for data processing. Here, we compare secular rates obtained using the GIPSY OASIS 6.0 software and the Bernese 5.0 software. For both tests, we use the Precise Point Positioning (PPP) strategy and all parameters, including the data time span, are held constant. To make the solutions comparable, we use the same orbit products, oceans load model, antenna phase center offsets model.

2. GPS Data Analysis

To estimate site coordinates, we use the GIPSY OASIS 6.0 software package (Zumberge et al., 1997) developed at the Jet Propulsion Laboratory (JPL). The orbit products we use were released in 2010 by IGS (repro1 products) and include satellite orbits, satellite clock parameters, and earth orientation parameters. The new orbit products take the satellite antenna phase center offsets into account. Receiver clock parameters are modeled, and the atmospheric delay parameters are modeled using the Global

Figure 1. Location of long term GPS stations in Denmark

Mapping Function (GMF) (Boehm et al., 2006), with an elevation cut-off angle of 10 degree. Corrections are applied to remove the solid earth tide and ocean tidal loading. The amplitudes and phases of the main ocean tidal loading terms are calculated using the online program provided by H.-G. Scherneck and M. S. Bos (website: http://www.oso.chalmers.se/~loading)
applied to the FES2004 ocean tide model. Site coordinates for each day are obtained using the GIPSY OASIS 6.0 Precise Point Positioning (PPP) strategy. The site coordinates are computed in the non-fiducial frame and transformed to the ITRF2005 frame (Altamimi et al., 2007). Figure 2 show 30-day vertical GPS averages and their errors at SMID, SULD and BUDP obtained using GIPSY (black). Also shown are the best fitting linear trends (solid red curves).
Next we process all data using the Bernese software. We use the Precise Point Positioning (PPP) strategy and all parameters, including e.g. the data time span, ocean load model, satellite orbits, satellite clock parameters, and earth orientation parameters are held constant. The blue curve in figure 2 shows 30-day vertical GPS averages obtained using the Bernese 5.0 software.

3. Results

Our method of determining secular trends in the GPS data is similar to that described by (Khan et al., 2010). We simultaneously fit annually, semi-annually, and secular varying terms to the 30-day averages. For SMID, SULD, and BUDP, we obtain secular uplift rate of 1.27± 0.16 mm/yr, 1.72 ± 0.17 mm/yr and 1.06 ± 0.18 mm/yr, respectively, when using GIPSY time series. When using the Bernese time series, we obtained slightly larger uplift rates 0.1-0.2 mm/yr (see table 1 below).

4. Conclusions

Using about 10 years of continuous data from the Danish GPS stations, we analyze the daily GPS solutions to determine secular vertical rates. We perform a text using two different software packages, GIPSY 6.0 and Bernese 5.0. We use the Precise Point Positioning (PPP) strategy of both software and held all parameters, including the data time span and orbit products constant. Our results suggest small difference in uplift rates at SMID and SULD between GIPSY and Bernese solutions, however the differences of ~0.10 mm/yr is within the estimated uncertainty of ~0.17 mm/yr.
At BUDP we obtain a much larger difference (0.19 mm/yr) between GIPSY and Bernese solution, however the differences is within the estimated uncertainty of ~0.18 mm/yr.

Table 1: Observed uplift rates (and their uncertainties) in mm/yr obtained using the GIPSY and the BERNESE software.

Site	GIPSY OASIS 6.0	BERNESE 5.0
	mm/yr	mm/yr
SMID	1.27 ± 0.16	1.37 ± 0.16
SULD	1.72 ± 0.17	1.85 ± 0.16
BUDP	1.06 ± 0.18	1.25 ± 0.17

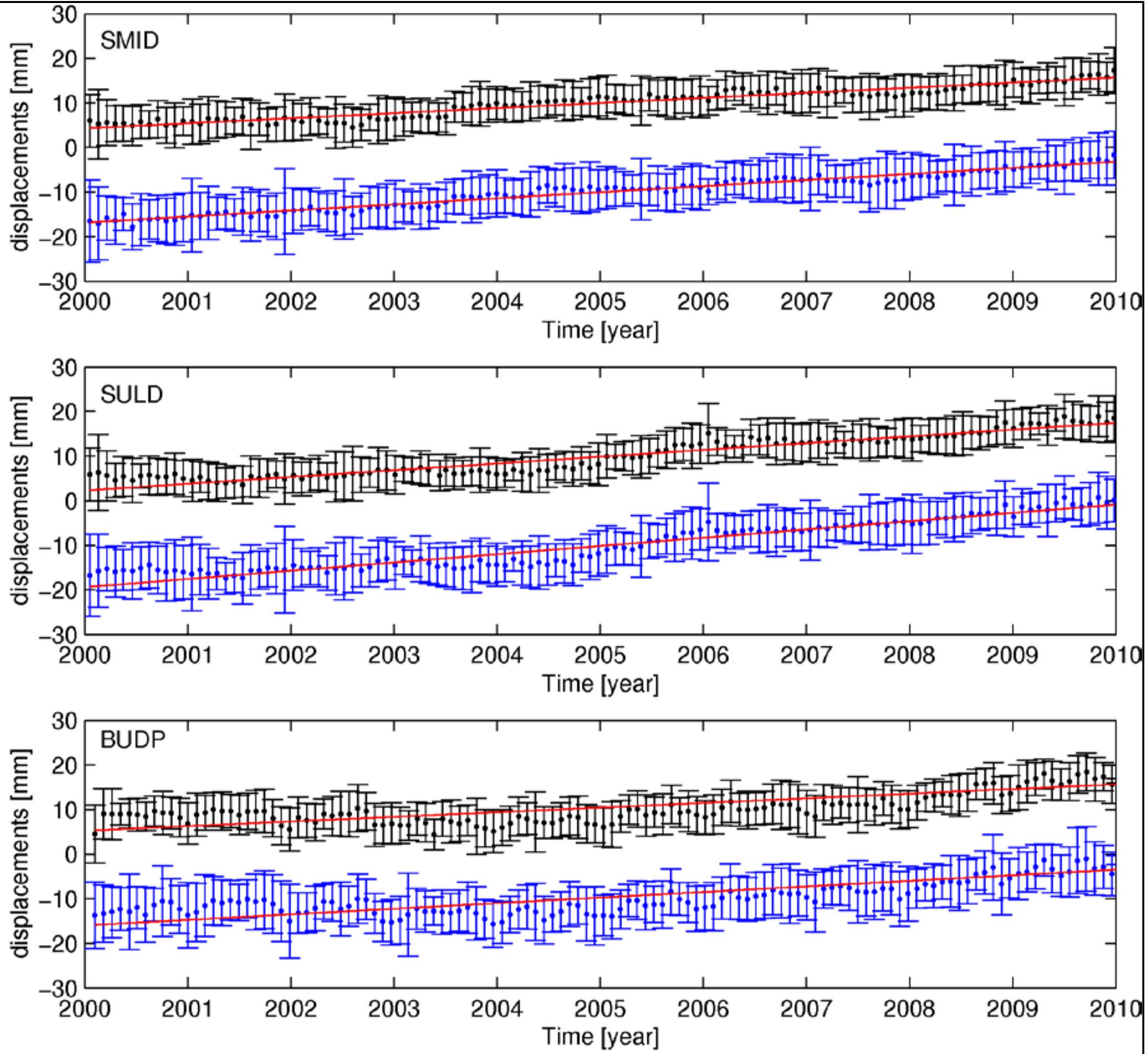

Figure 2. 30-day vertical GPS averages at SMID (top), SULD (middle) and BUDP (bottom) and their errors, obtained using GIPSY (black) and Bernese (Blue curve). Also shown are the best fitting linear trends (solid red curves). Note, the annually, semi-annually term is removed.

5. References

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