Reprocessing of the Global GPS Network
First Results

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Motivation

Considerable improvements in the processing strategies and modeling of global GPS solutions were achieved within the time span of ten years since the official start of the IGS in 1994. Due to the changes at the individual IGS analysis centers during these years, the resulting time series of global geodetic parameters are very inhomogeneous and inconsistent which makes a geophysical interpretation of long series difficult and questionable.

In view of these deficiencies, the Technical Universities of Munich and Dresden decided to perform a reprocessing of a global GPS network over the last ten years in a joint effort, implementing a processing scheme similar to the one used at the CODE Analysis Center of the IGS at the University of Berne. With powerful LINUX clusters available at both institutions, the processing of 9 years (out of 10) was possible in about two months.

Processing

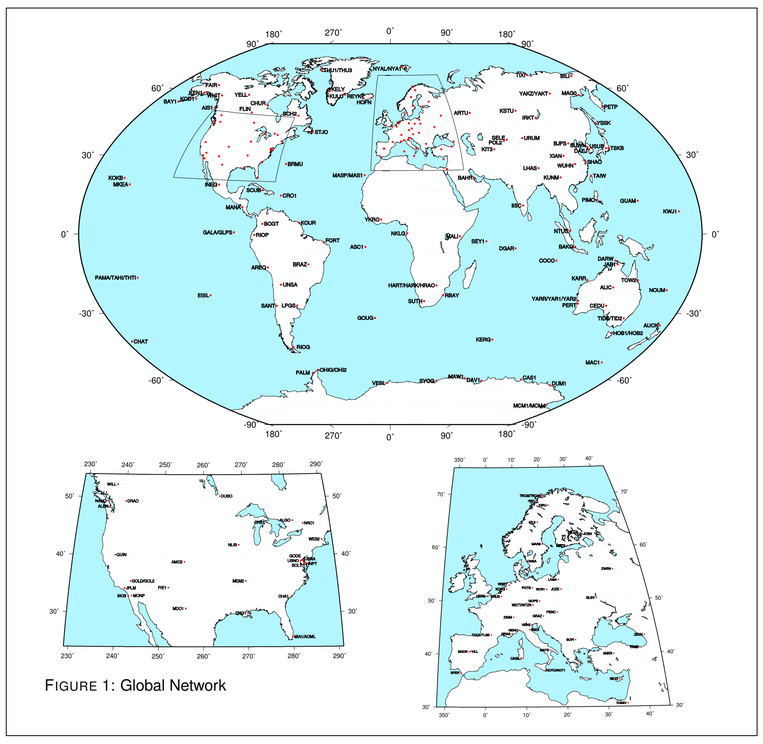

FIGURE 1: Global Network

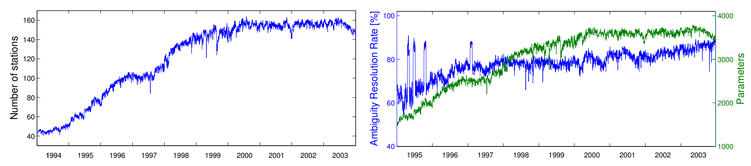

FIGURE 2: Number of stations, parameters and ambiguity resolution rate of the 1-day solutions. The peaks in the ambiguity resolution rate in 1995 and 1997 coincide with the deactivation of A/S during these time periods.

A set of nominal 192 global stations was selected primarily based on long observation time, homogeneous global distribution, and collocation with other space techniques and tide gauges. The real number of stations per day is smaller due to inactive sites and outages.

The daily normal equations (NEQs) are combined to 3-day solutions including special approaches for the estimation of subdaily Earth rotation parameters, nutation rates and geocenter coordinates. The coordinates and Earth rotation parameters of weekly solutions are introduced in the final 3-day solutions to get the final orbits and troposphere parameters.

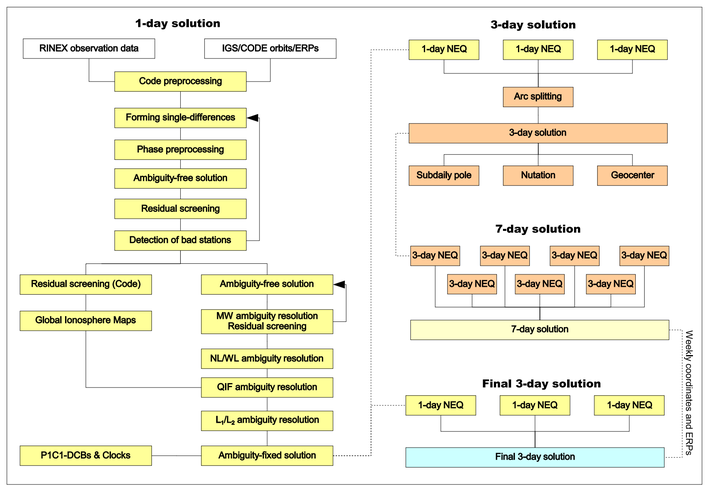

FIGURE 3: Simplified processing scheme.

The most important modifications in the CODE routine processing which are expected to significantly improve the results of the reprocessed solution are listed in Table 1.

Enhancements in orbit models and estimation	1994-2004
Elevation cut-off angle $20° \Rightarrow 10° \Rightarrow 3°$	Oct 1997/Aug 2001
Elevation-dependent weighting	Oct 1997
Estimation of troposphere gradients	Aug 2001
Refined ambiguity resolution	Mar 2002
Piecewise linear representation of the troposphere	Jun 2003

TABLE 1: Selected changes in the CODE IGS routine processing.

Results

Coordinates

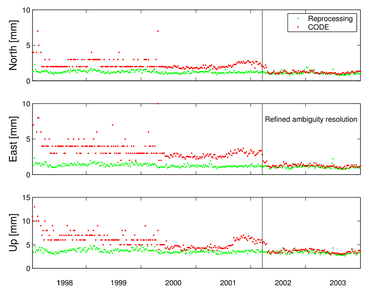

FIGURE 4: Repeatability of weekly station coordinates compared to the CODE solution.

Figure 4 shows the repeatability of the weekly coordinate solutions from CODE and the reprocessing. In March 2002 a completely revised ambiguity resolution strategy was implemented at CODE which is also used for reprocessing. Before, QIF was the only solution strategy used (baselines up to 2000 km only). Now about 80 percent of the ambiguities of baselines up to 6000 km are solved using Melbourne-Wübbena, Widelane-Narrowlane, QIF and direct solution of the L_1 and L_2 ambiguities depending on the baseline length. Starting with this week the quality of the CODE and the reprocessing solutions is at almost the same level.

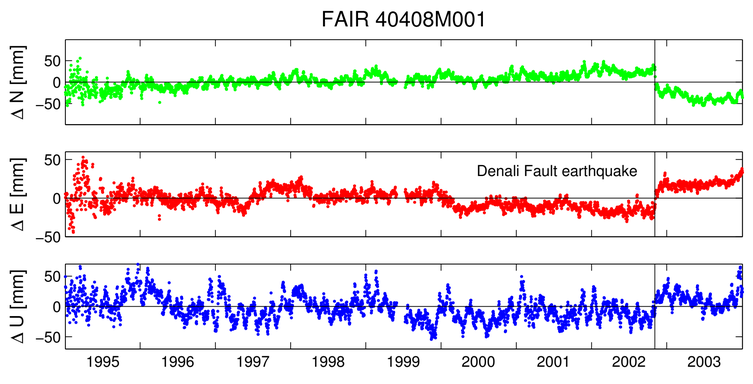

FIGURE 5: Coordinate results of a 3-day solution. The coordinates of the 99 IGS00(v2) core stations have been used to define a NNR condition. The geocenter has been kept fixed. The time series clearly shows the influence of the Denali Fault earthquake of November 2002.

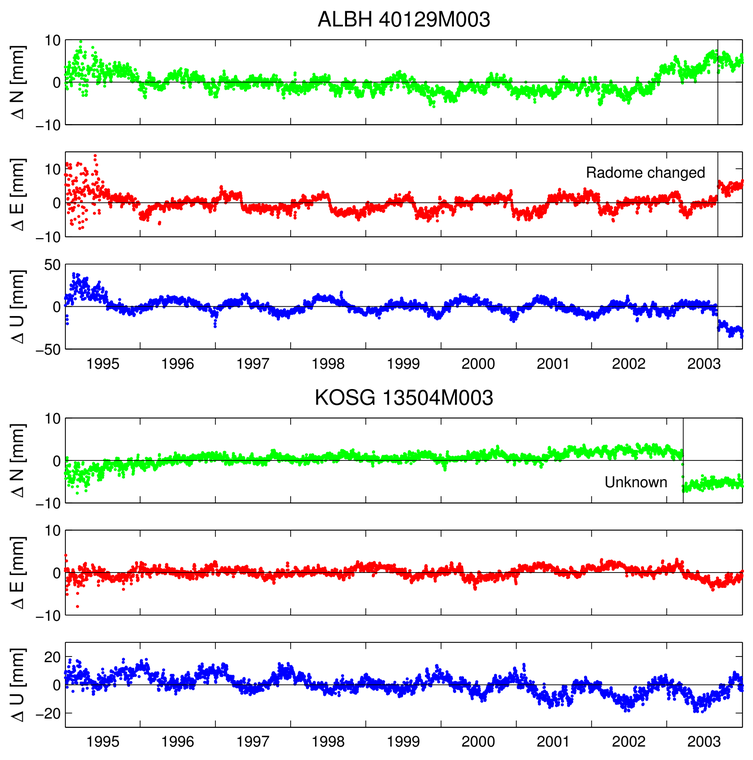

FIGURE 6: Coordinate results of the 3-day solutions. The coordinates of the 99 IGS00(v2) core stations have been constrained to their IGS00 values. The geocenter has been estimated. The displayed stations ALBH 40129M003 and KOSG 13504M003 have been estimated.

Orbits

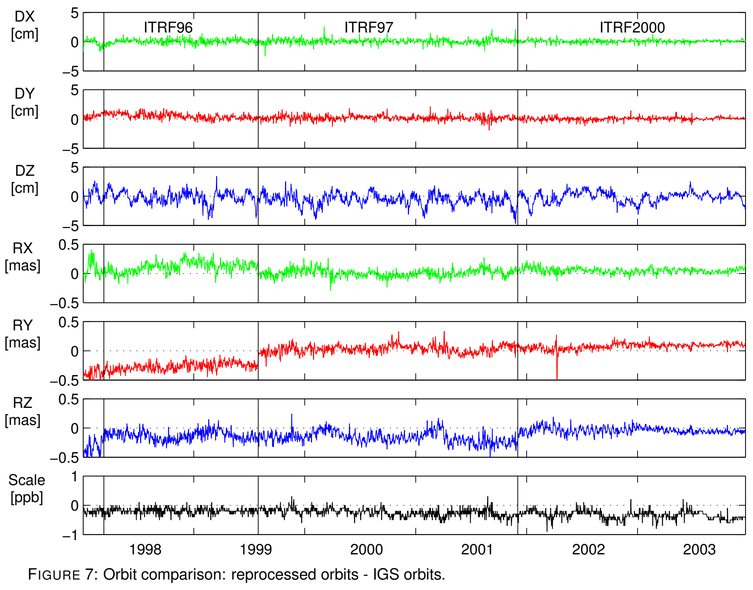

FIGURE 7: Orbit comparison: reprocessed orbits - IGS orbits.

A comparison of the preliminary 3-day orbits with the official IGS-orbits is shown in Figure 7. The mean unweighted RMS of the 7-parameter transformation is 6.6 cm. Changes in the realization of the reference frame can be clearly seen as well as an increasing consistency of both solutions. The annual oscillation in the rotation around the z-axis, vanishing with the introduction of ITRF2000, is not yet explained.

Figure 8 shows the internal orbit quality based on moving 3-day fits through 1-day orbits. PRN 13 was the first Block IIR satellite. First an offset of 1.2053 m was used by CODE resulting in a quite bad orbit repeatability compared to the reprocessed solution. In December 1998 the offset was set to 0.0000 m (based on estimates by CODE, GFZ and JPL) resulting in much better orbit fits.

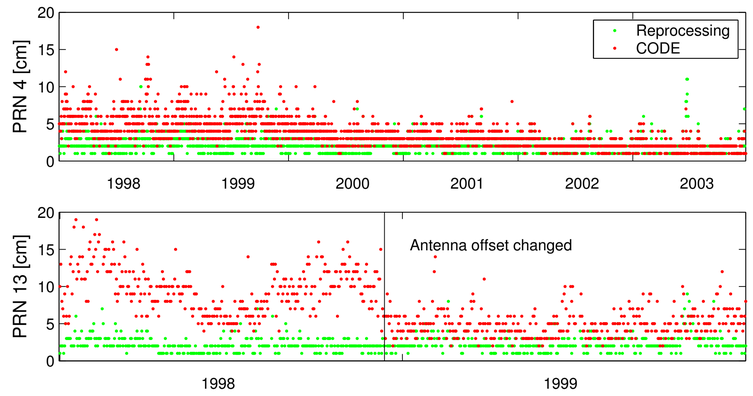

FIGURE 8: Orbit repeatability of 1-day solutions based on moving 3-day fits. The CODE solution again benefits from the improved ambiguity resolution starting in March 2002 (PRN 4). The effects of changing the Block IIR antenna offset are obvious (PRN13).

Earth Rotation Parameters

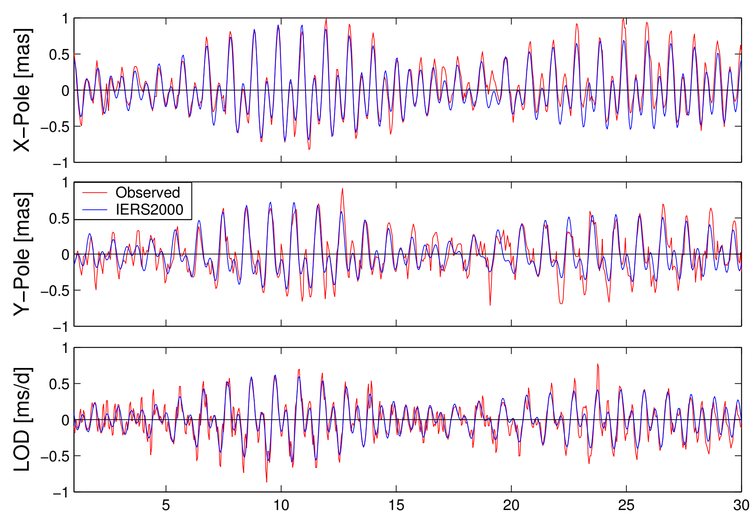

FIGURE 9: Subdaily ERP estimates for January 2001 compared to the IERS2000 model. The weekly IGS pole solution was subtracted to show the subdaily variations.

As a special part of the 3-day solution 2-hourly Earth rotation parameters are estimated. An example of one month of these data reveals a quite good agreement with the IERS2000 model (Figure 9).

The formal errors of the subdaily X- and Y-pole estimates from CODE and the reprocessing are shown in Figure 10, an annual comparison to the IERS2000 model in Figure 11.

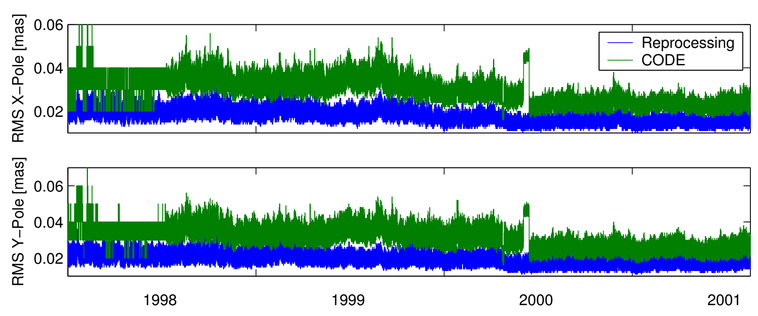

FIGURE 10: Formal errors of 2-hourly X- and Y-pole estimates (CODE and reprocessing). The peak at week 1065 in the CODE series was introduced by changing the stochastic pulses in the orbit modeling. But also the reprocessing solution contains a discontinuity: starting with May 2000 (when SA was switched off) the RMS is slightly improved.

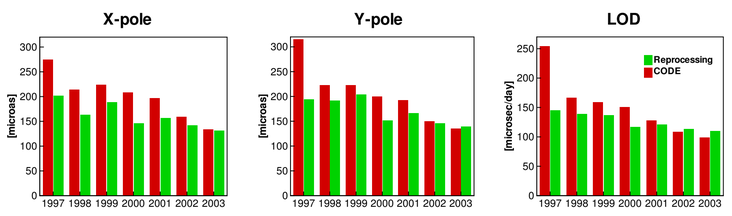

FIGURE 11: Observed - computed RMS-values for CODE and reprocessed subdaily ERP solutions with respect to the IERS2000 model.

Conclusion

The first results of the reprocessing project are encouraging: refined models and processing strategies lead to a significant improvement in the quality and homogeneity of the estimated parameters. Reprocessing is a common practice for other techniques like VLBI and SLR. Rigorous and consistent combination of space-geodetic techniques over decades as planned by the IERS requires GPS time series to be generated with homogeneous models and processing strategies. This is one of the main reasons why GPS reprocessing projects will play a major role in the near future.

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