Rigorous combination of GPS and VLBI to study reference frame related issues

Forschungsgruppe Satellitengeodäsie

GEOTECHNOLOGIEN

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Introduction: The space techniques GPS, VLBI and SLR contribute in different ways to the determination of geodetic parameters, e.g station coordinates, earth orientation parameters and tropospheric parameters, and so to the realisation of global reference frames. The intensive VLBI campaign CONT02, initiated by the International VLBI Service for Geodesy and Astronomy (IVS) from 16.-31. October 2002, provides an ideal basis for combination studies. Due to a lot of common parameters for GPS and VLBI both techniques should benefit from a combination. Recently we included also SLR into these investigations.

Processing: The unconstrained daily GPS normal equations are computed at FESG with the Bernese GPS software 5.0; the VLBI normal equations are generated at DGFI with OCCAM. To avoid systematic differences between the techniques, we take much care to adopt the same models and parametrisation.

Station coordinates: For the CONT02 campaign 8 co-locations between GPS and VLBI do exist (see Fig.1). Of the 8 available local ties 7 could be used for the combination, only Kokee Park has to be excluded because of inconsistencies. The local ties are introduced as pseudo observations with an a priori sigma of 0.1mm.

Fig.1: Co-location stations

Fig.2 shows the time series of the GPS and the VLBI station in Onsala before and after the combination. For both stations a smoothing effect can be recognized due to the combination. Furthermore for GPS and VLBI heights a common time-dependent characteristic exists.

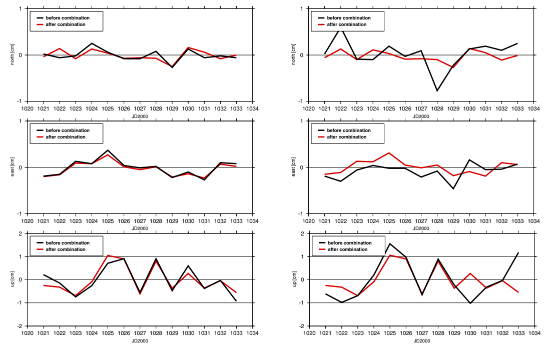

Fig.2: Station coordinate time series for GPS (left column) and VLBI (right column) station in Onsala before and after the combination.

The repeatabilities of all co-location stations are presented in Fig.3. For some of the stations the estimation of the height component improves considerably through the combination.

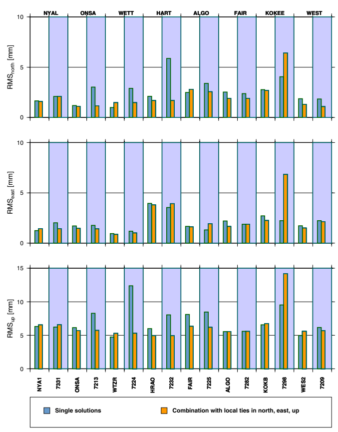

Fig.3: Repeatabilities of station coordinates before and after the combination (blue background for VLBI stations). Note that the local tie for Kokee Park was not introduced.

Troposphere parameters: Fig.4 shows the excellent agreement of tropospheric zenith path delays (ZPDs) derived from GPS and VLBI single solutions for Onsala. For the combination of ZPDs "tropospheric ties" are derived from Saastamoinen model and a standard atmosphere, to consider the height difference between the GPS and the VLBI reference point.

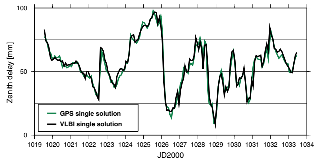

Fig.4: Zenith path delays for GPS and VLBI station in Onsala derived from single solutions

To investigate the effect of combining ZPDs we compare the correlations between station coordinates and ZPDs before and after the combination. Fig.5 shows the correlations between the station coordinates and ZPDs of the GPS and the VLBI station in Onsala.

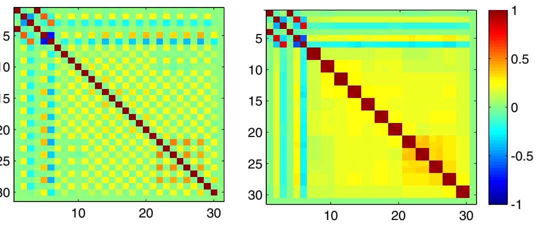

Fig.5: Correlation matrix between station coordinates of GPS and VLBI station in Onsala (in Longitude, Latidude and Height) and the tropospheric zenith path delays of both stations before (left) and after (right) the combination of zenith path delays (one-day solution).

Earth rotation parameters (ERPs): The results of 2-hourly ERPs derived from single technique and the combined solution are presented in Fig.6. The time dependent characteristics for UT1-UTC of the single technique solutions agree very well; unfortunately this is not the case for the pole coordinates. The offset of the combined UT1-UTC solution to the single solutions is caused by the local ties. This effect has to be investigated in the future.

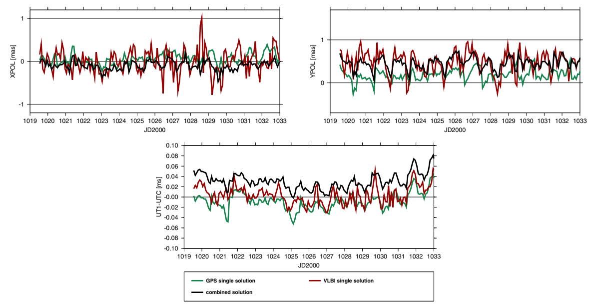

Fig.6: Earth rotation parameter estimates w.r.t. IERS C-04 derived from single GPS and VLBI and a combined solution

We started to include also a 14-day SLR solution from DGFI in the combination. Fig.7 shows the comparison of daily pole coordinates estimated from GPS, VLBI and SLR single solutions.

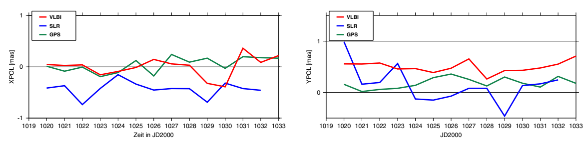

Fig.7: Daily pole coordinate estimates w.r.t. IERS C-04 from GPS, VLBI and SLR single solutions

Conclusions: The CONT02 combination of VLBI and GPS data provides promising results for various parameters common to both techniques (e.g. station positions, tropospheric path delays, ERPs). In future the influence of local ties, the offsets between ERPs, the effect of combining troposphere gradients, and the contribution of SLR within this rigorous combination has to be further investigated.

IGS Workshop, 1-5 March 2004, Berne