

INTRODUCTION & MOTIVATION

What: Overall scope of the paper is to better understand how the quality of station position time series improves, if latest high-end models are used in geodetic data analysis (if possible to judge: are they more directly interpretable in a geophysical sense?).

How: To judge if series improve, the following criteria were applied to two GPS and VLBI height time series:

- similarity of the two techniques' series concerning episodic patterns (figure 1),
- similarity of the mean GPS and VLBI annual behaviour, so that all data is assumed to be in one year (figure 2),
- similarity of annual harmonics estimated from the GPS and VLBI height series (figure 3),
- similarity of atmospheric loading coefficients estimated independently from both techniques, using homogeneous ECMWF pressure time series (figure 4).

The critical points of this investigation are:

- to find objective criteria for VLBI & GPS similarity and
- to find out if a possible improvement of VLBI & GPS similarity could directly be translated to a better "geophysical interpretability".

DATA

Geodetic data: We used GPS and VLBI height time series with daily resolution (data from 94-07):

- **Iteration 1:** Both series are fully reprocessed and the a priori models were homogenized in both softwares used (GPS: Bernese 5.1 @ GFZ, VLBI: OCCAM 6.1 @ DGFI); Nevertheless not all models were state of the art (e.g. NMF, constant a priori ZD ...).
- **Iteration 2:** Besides the efforts in iteration 1, all models were updated according to the latest state of knowledge (e.g. VMF1, apriori ZD from ECMWF, thermal deformation for VLBI, the VLBI ZD was estimated in full UTC hours as for GPS ...).

Pressure data: In order to estimate the atmospheric loading coefficients, pressure time series at each site were derived from the ECMWF (thanks to J. Boehm!) for both techniques:

$$\Delta\text{height [mm]} = \text{coefficient [mm/mbar]} * \Delta\text{pressure [mbar]}$$

RESULTS

Iteration 1:

- both series fully reprocessed
- VLBI and GPS homogenized but partially with simple models (further description see "DATA")

Iteration 2:

- same as iteration 1, but with enhanced modelling (further description see "DATA")

Fig. 1: Median smoothed GPS and VLBI height time series; the given examples are series of the stations Wettzell (upper panel) and NyAlesund (lower panel).

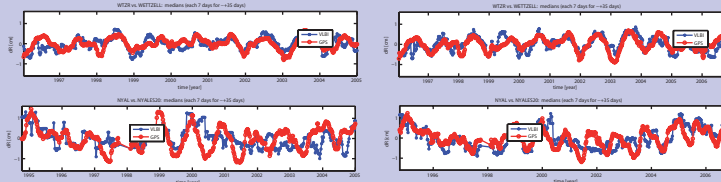


Fig. 2: Examples of median smoothed mean annual behaviour (all data assumed to be in 1 year); NyAlesund (upper left), Tsukuba (upper right), Fortaleza (lower left), Algonquin (lower right).

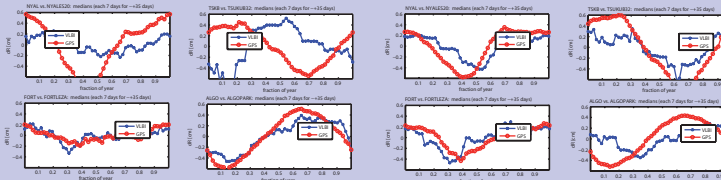


Fig. 3: Annual harmonic signals estimated from the full GPS and VLBI height time series; the arrows illustrate the estimated amplitudes and phases of all 17 stations considered to have appropriate data, grey are the corresponding formal errors.

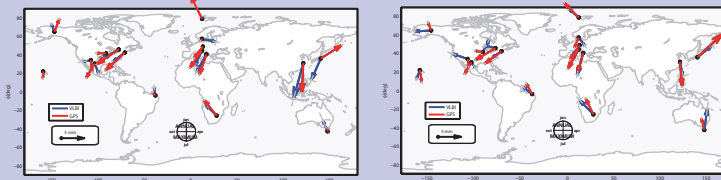
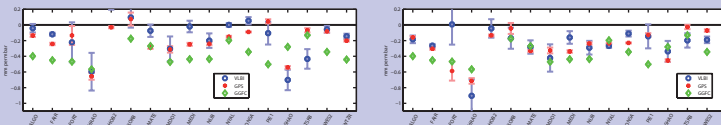


Fig. 4: Atmospheric loading coefficients: the estimated values for GPS and VLBI are given together with the coefficients published by the GGFC (all shown with their formal errors, the formal errors of the GGFC coefficients are very small).



DISCUSSION

Similarity of GPS / VLBI series concerning episodic patterns:

- The upper panel of figure 1 (Wettzell) illustrates the maximum similarity possible if the modelling is carefully adapted.
- If besides, the models are state of the art (iteration 2), episodic height changes become clear in both techniques for many stations (e.g. NyAlesund, lower panel).

Similarity of the mean GPS / VLBI annual behaviour:

Figure 2: to uncover annually repeating patterns (not necessarily harmonic), all data of one station was assumed to be in one year.

- For 8 out of the 17 sites under investigation, like NyAlesund (upper left) and Tsukuba (upper right), the advanced modelling of iteration 2 significantly improves the similarity of the GPS and VLBI signal. Especially the VLBI series is stabilized.
- The GPS-VLBI-similarity for some of the sites (5 out of 17), like Fortaleza (lower left) does not change much.
- For few sites (4 out of 17) like Algonquin (lower right), the similarity slightly degrades with iteration 2.

Similarity of annual harmonics in GPS / VLBI series:

Figure 3 illustrates the harmonic annual signals estimated from the GPS and VLBI height time series. The WRMS of the differences in phase and amplitude clearly improves with iteration 2 (iteration 1/2: WRMS amplitude 2.2 / 1.7 mm, WRMS phase 44 / 38 deg).

Similarity of GPS / VLBI estimated atmo-loading coefficients:

As shown in figure 4, the GPS- and VLBI-derived coefficients ($\Delta\text{height} = \text{coefficient} * \Delta\text{pressure}$) generally coincide much better in iteration 2. The WRMS of the GPS-VLBI differences improves from 0.13 to 0.08 [mm/mbar] from iteration 1 to 2. Additionally, most of the coefficients of iteration 2 are closer to the values published by the IERS GGFC (Global Geophysical Fluids Center).

CONCLUSIONS

- The enhanced similarity of the annual patterns in GPS and VLBI height series suggests that iteration 2 allows "better" modelling. However, this could still be induced by shortcomings of the new, homogeneously implemented correction models.
- Nevertheless, the complex pressure signal found in GPS and VLBI in iteration 2 was also more similar, which indicate the latest software updates to be steps towards an improved interpretability of geodetic station height time series.