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Influence of Antenna Thermal Deformations on Estimation of Seasonal Variations in Baseline Length

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Abstract

The results of analysis of baselines length variations calculated at the Institute of Applied Astronomy with the OCCAM package from all available VLBI sessions with and without modelling antenna thermal deformations are presented.

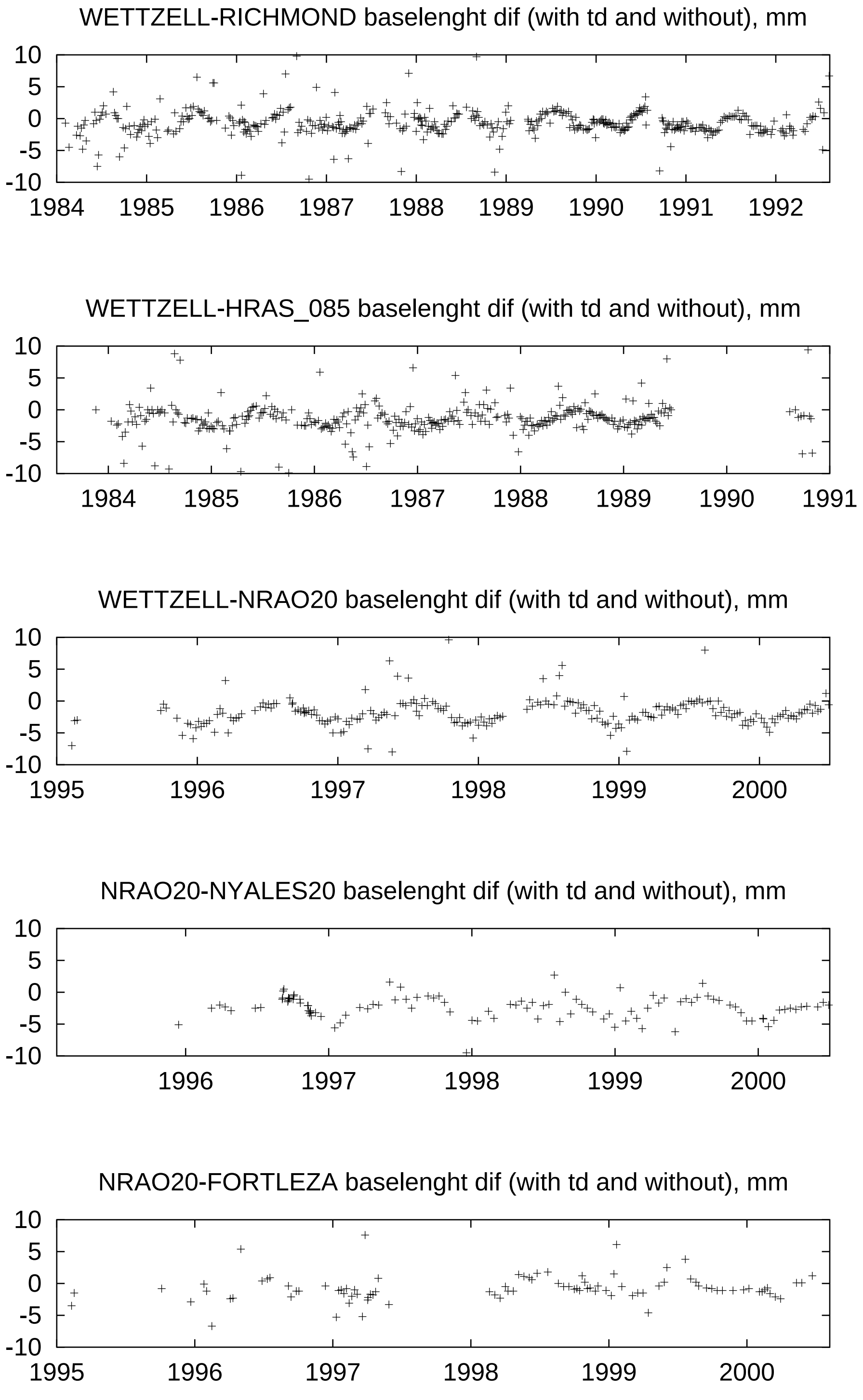
Some baseline variation time series show not only linear trend due to tectonic plates motion but seasonal variations too [2]. Antenna thermal deformations may be one of the possible reasons for this effect. The main aim of this work is to investigate what part of baseline length seasonal variations can be explained by this effect. All computation of station coordinates and baseline lengths was made with OCCAM package. Model of thermal deformations proposed in [1] was used for this computation. This model extends one recommended by IERS Conventions (2000) for all mount types.

Fig. 1 shows the differences of baseline lengths computed with and without modelling of antenna thermal deformations. Obviously thermal deformation influences baseline lengths as a combination of a bias and a periodic part with 1-year period. List of analyzed baselines is presented in Table 1. The name of a baseline consists of the first 4 letters of station names. First column of the Table 1 is values of biases and the last column is amplitudes of the year term.

As recommended in [2] baseline length time series was approximated as a combination of a linear trend and two periodic terms with annual and semiannual period. Baseline length rate was found to be practically independent of antenna thermal deformations.

Amplitudes of annual and semiannual terms are presented in Table 2 for two variants: the first column corresponds to calculation without thermal deformations modelling (Amp_1 — the amplitude of annual term), the second column contains the amplitude of the annual term for calculations with thermal deformations modelling, the third and fourth columns show the amplitudes of semiannual terms in the same order.

An unexpected consequence of this work is that seasonal variations of baseline lengths can be hardly explained by the effect of the VLBI antenna thermal deformations. Ampitude spectra of baseline length time series demonstrate that the 1-year period is not the largest period in these spectra. Some baseline lengths (HRASRICH, RICHWETT, GILCRICH, FORTNYAL, FORTWETT,FORTNYAL) have significant 2-year (or 2.25 year) periodic terms and also 1.25 and 1.7-year terms. Baseline lengths ALGOGILC, FORTNYAL, FORTWETT, NR20NYAL, NR20WETT have 1.5-, 1.7-, 2.25-year terms and baseline lengths NR20NYAL, NR20WETT have 0.75-year term. However, more detailed spectral analysis of baseline length time series and more careful approximation planned for the nearest future might specify the influence of antenna thermal deformations on estimation of seasonal variations in baseline length.


WETTZELL-RICHMOND baselenght dif (with td and without), mm

WETTZELL-HRAS_085 baselenght dif (with td and without), mm

WETTZELL-NRAO20 baselenght dif (with td and without), mm

NRAO20-NYALES20 baselenght dif (with td and without), mm

NRAO20-FORTLEZA baselenght dif (with td and without), mm

Figure 1. Influence of thermal deformation modelling on baseline length.

Table 1. Influence of thermal deformation modelling on baseline length.

Baseline	Nsess	Period	bias, mm/y	Ampl, mm
WESTWETT	872	1983.9 – 2001.7	-2.0 ± 0.09	0.8
RICHWEST	545	1984.0 – 1992.5	-0.39 ± 0.02	0.1
RICHWETT	506	1984.1 – 1992.2	-0.48 ± 0.02	0.3
KOKEWETT	496	1993.4 – 2002.0	-1.1 ± 0.07	0.4
GILCWETT	496	1984.7 – 2002.0	-1.7 ± 0.07	1.0
HRASWEST	483	1981.4 – 1990.7	-0.3 ± 0.02	0.4
GILCNR85	431	1989.1 – 1995.3	-1.7 ± 0.07	1.0
GILCKAUA	431	1984.5 – 1993.5	-0.5 ± 0.04	0.3
FORTWETT	436	1993.5 – 2002.0	-0.4 ± 0.04	0.2
FORTKOKE	411	1993.5 – 2001.9	-0.2 ± 0.05	0.2
HRASWETT	397	1983.9 – 1990.7	-0.4 ± 0.02	0.3
GILCWEST	398	1984.7 – 2001.7	-1.9 ± 0.11	1.4
MOJAWEST	378	1983.6 – 1992.5	-0.8 ± 0.05	0.9
GILCKOKE	367	1993.4 – 2001.9	-0.8 ± 0.04	1.5
HRASRICH	336	1984.0 – 1990.8	-0.1 ± 0.02	0.1
KAUANR85	267	1989.1 – 1993.2	-0.3 ± 0.04	0.6
KOKENR20	280	1995.1 – 2000.5	-1.5 ± 0.10	1.0
FORTGILC	258	1993.5 – 2002.0	-1.3 ± 0.12	0.8
NR20WETT	256	1995.1 – 2000.4	- 1.7 ± 0.10	1.3
MOJAWETT	253	1984.7 – 1992.6	-0.9 ± 0.10	0.8
GILCMOJA	244	1984.5 – 1992.6	-0.8 ± 0.05	0.8
ONSAWETT	231	1983.9 – 2001.4	-0.2 ± 0.03	0.6
NYALWETT	231	1994.8 – 2002.0	-1.2 ± 0.04	0.4
KOKENYAL	226	1994.8 – 2001.9	-2.2 ± 0.08	0.8
ONSAWEST	216	1981.8 – 2001.2	-1.6 ± 0.15	0.6
ALGOGILC	219	1984.6 – 2001.9	-2.1 ± 0.13	1.9
MOJARICH	204	1984.0 – 1992.6	0.15 ± 0.08	0.3
FORTNR20	200	1995.1 – 2000.5	- 0.7 ± 0.09	0.6
NR85WETT	187	1991.9 – 1996.6	- 1.5 ± 0.06	0.6
ALGOWETT	185	1990.5 – 2002.0	-2.2 ± 0.15	1.7
GILCKASH	139	1984.6 – 1998.7	-1.3 ± 0.13	0.3
FORTNYAL	169	1994.8 – 2001.9	-1.4 ± 0.08	0.8

Table 2. Influence of thermal deformations on estimates of amplitudes of annual and semiannual terms in baseline length variations (cont.).

Baseline	Amp_1, mm	Amp_1th, mm	Amp0.5, mm	Amp0.5_th, mm
WESTWETT	1.8 ± 0.5	2.4 ± 0.6	1.5 ± 0.5	0.6 ± 0.4
RICHWEST	0.8 ± 0.5	1.0 ± 0.5	1.5 ± 0.5	1.6 ± 0.4
RICHWETT	1.4 ± 1.1	2.5 ± 1.0	1.6 ± 1.1	1.4 ± 1.0
KOKEWETT	0.6 ± 0.5	1.8 ± 0.8	2.5 ± 0.5	2.4 ± 0.5
GILCWETT	3.5 ± 0.9	4.1 ± 0.9	1.0 ± 0.9	1.1 ± 0.9
HRASWEST	1.9 ± 0.9	2.6 ± 1.0	1.0 ± 0.8	0.9 ± 0.8
GILCNR85	2.1 ± 0.8	2.7 ± 0.8	0.8 ± 0.8	1.2 ± 0.8
GILCKAUA	1.2 ± 0.7	2.3 ± 0.8	2.8 ± 0.7	1.5 ± 0.6
FORTWETT	2.7 ± 0.7	2.6 ± 0.8	0.6 ± 0.7	0.7 ± 0.8
FORTKOKE	2.8 ± 1.3	2.8 ± 1.4	1.6 ± 1.4	2.0 ± 1.3
HRASWETT	6.3 ± 1.8	8.2 ± 2.0	2.8 ± 1.8	2.6 ± 1.8
GILCWEST	2.8 ± 0.5	3.8 ± 0.5	0.5 ± 0.5	0.5 ± 0.4
MOJAWEST	3.2 ± 0.5	4.1 ± 0.6	1.4 ± 0.5	1.4 ± 0.5
GILCKOKE	4.7 ± 0.5	4.7 ± 0.5	0.7 ± 0.5	0.7 ± 0.5
HRASRICH	1.4 ± 1.0	1.6 ± 0.9	0.2 ± 1.1	0.5 ± 1.0
KAUANR85	4.4 ± 1.0	5.4 ± 1.1	1.0 ± 1.0	1.5 ± 1.0
KOKENR20	3.2 ± 1.7	2.4 ± 1.7	2.9 ± 1.6	2.0 ± 1.6
FORTGILC	2.8 ± 1.3	3.9 ± 1.3	2.0 ± 1.3	2.3 ± 1.3
NR20WETT	2.9 ± 0.9	4.5 ± 0.9	1.7 ± 0.8	1.4 ± 0.8
MOJAWETT	3.1 ± 1.2	3.9 ± 1.2	1.4 ± 1.2	1.2 ± 1.2
GILCMOJA	4.3 ± 0.7	5.1 ± 0.7	2.0 ± 0.7	2.3 ± 0.7
ONSAWETT	1.7 ± 0.4	2.0 ± 0.5	2.7 ± 0.4	2.7 ± 0.4
NYALWETT	0.4 ± 0.5	1.3 ± 0.5	1.2 ± 0.5	0.4 ± 0.4
KOKENYAL	1.5 ± 1.1	0.7 ± 1.2	2.4 ± 1.1	2.4 ± 1.1
ONSAWEST	1.1 ± 0.6	3.1 ± 0.6	1.8 ± 0.6	1.9 ± 0.5
ALGOGILC	9.5 ± 2.2	7.2 ± 1.8	0.9 ± 2.3	8.9 ± 1.9
HARTWEST	2.8 ± 0.9	3.3 ± 0.9	0.7 ± 0.9	0.8 ± 0.9
MOJARICH	5.3 ± 2.5	4.5 ± 3.1	3.9 ± 2.5	3.6 ± 3.1
FORTNR20	4.6 ± 1.1	4.9 ± 1.2	3.1 ± 1.1	3.2 ± 1.1
NR85WETT	3.8 ± 1.0	5.1 ± 1.0	1.5 ± 1.0	1.8 ± 1.0
ALGOWETT	2.8 ± 0.8	4.3 ± 0.9	1.5 ± 0.8	1.3 ± 0.8
GILCKASH	1.0 ± 1.4	0.9 ± 1.4	2.3 ± 1.4	2.8 ± 1.4
FORTNYAL	4.5 ± 1.2	5.4 ± 1.2	1.4 ± 1.2	1.5 ± 1.2

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