Inter-Scan Correlation

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Uncertainty of Geodetic Parameters

1. In least squares the uncertainty of an estimated parameter goes like:

$$\sigma_{est}^2 \approx \frac{NumEst}{NumObs}\sigma_{meas}^2$$

where σ_{meas}^2 is the measurement error and σ_{est}^2 is the error in the estimate.

2. The total number of observations in an experiment is roughly equal to the number of scans times the number of baselines. The number of baselines is Nstat*(Nstat-1)/2 (where Nstat is the number of stations).

3. The number of parameters grows linearly with the number of stations. Hence

$$\sigma_{Geo}^2 \approx \frac{1}{Nscan}\left(\frac{\sigma_{meas}^2}{Nstat}\right)$$

Table 1. Residuals for Source 1418+546 @ 2004-12-01-18:06:59

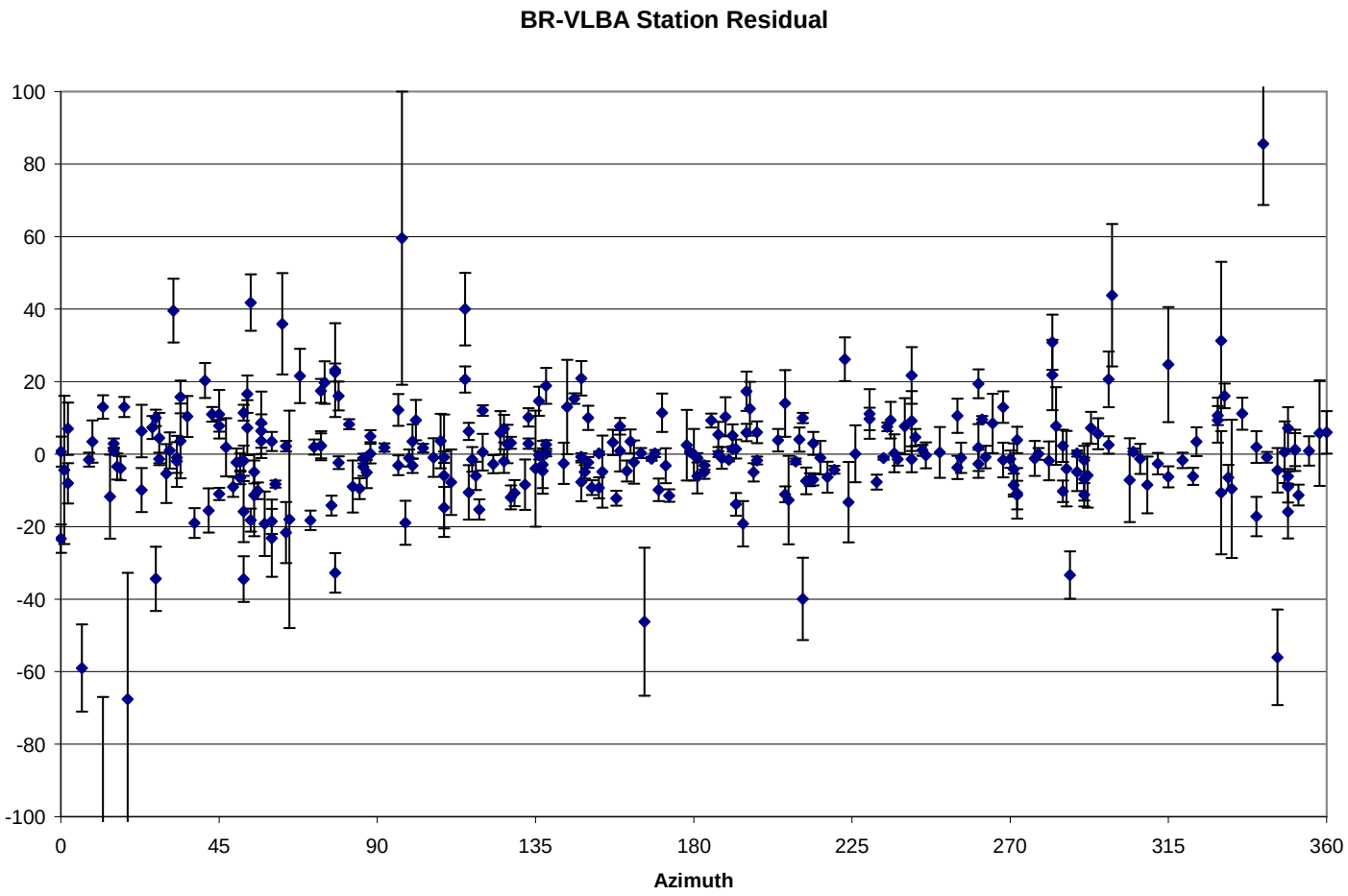
#	Name	AZ	EL	BR-V	FD-V	HN-V	KP-V	LA-V	NL-V	OV-V	PIET	SC-V	WEST	MEDI	ONSA	TSUK	#GD	AVG	SIG	AVG/ SIG
1	BR-VLBA	322	82	-	-5	31	-20	-18	1	12	-21	8	36	-19	-11	-8	12	-6.14	2.37	-2.59
2	FD-VLBA	331	60	5	-	31	31	14	22	15	7	16	2	4	-39	-3	12	14.09	2.07	6.82
3	HN-VLBA	308	52	-31	-31	-	-6	-29	-6	-5	-22	-12	2	-12	-63	-31	12	-17.21	3	-5.73
4	KP-VLBA	338	65	20	-31	6	-	10	1	-45	-3	20	-11	-	-	46	10	-1.24	3.63	-0.34
5	LA-VLBA	327	66	18	-14	29	-10	-	2	-14	-3	-11	-22	-24	12	-24	12	-2.78	2.05	-1.36
6	NL-VLBA	310	63	-1	-22	6	-1	-2	-	-11	-14	20	-8	-17	-39	-17	12	-7.77	1.92	-4.05
7	OV-VLBA	341	71	-12	-15	5	45	14	11	-	14	-24	0	8	16	-36	12	-1.34	2.27	-0.59
8	PIETOWN	331	65	21	-7	22	3	3	14	-14	-	20	11	-21	16	-3	12	6.2	1.77	3.49
9	SC-VLBA	323	29	-8	-16	12	-20	11	-20	24	-20	-	6	4	64	23	12	-3.11	2.86	-1.09
10	WESTFORD	308	52	-36	-2	-2	11	22	8	0	-11	-6	-	34	-	32	11	0.24	4.34	0.06
11	MEDICINA	337	15	19	-4	12	-	24	17	-8	21	-4	-34	-	55	-28	11	2.81	4.31	0.65
12	ONSALA60	336	26	11	39	63	-	-12	39	-16	-16	-64	-	-55	-	-62	10	-13.56	11.95	-1.13
13	TSUKUB32	41	28	8	3	31	-46	24	17	36	3	-23	-32	28	62	-	12	13.88	3.45	4.02

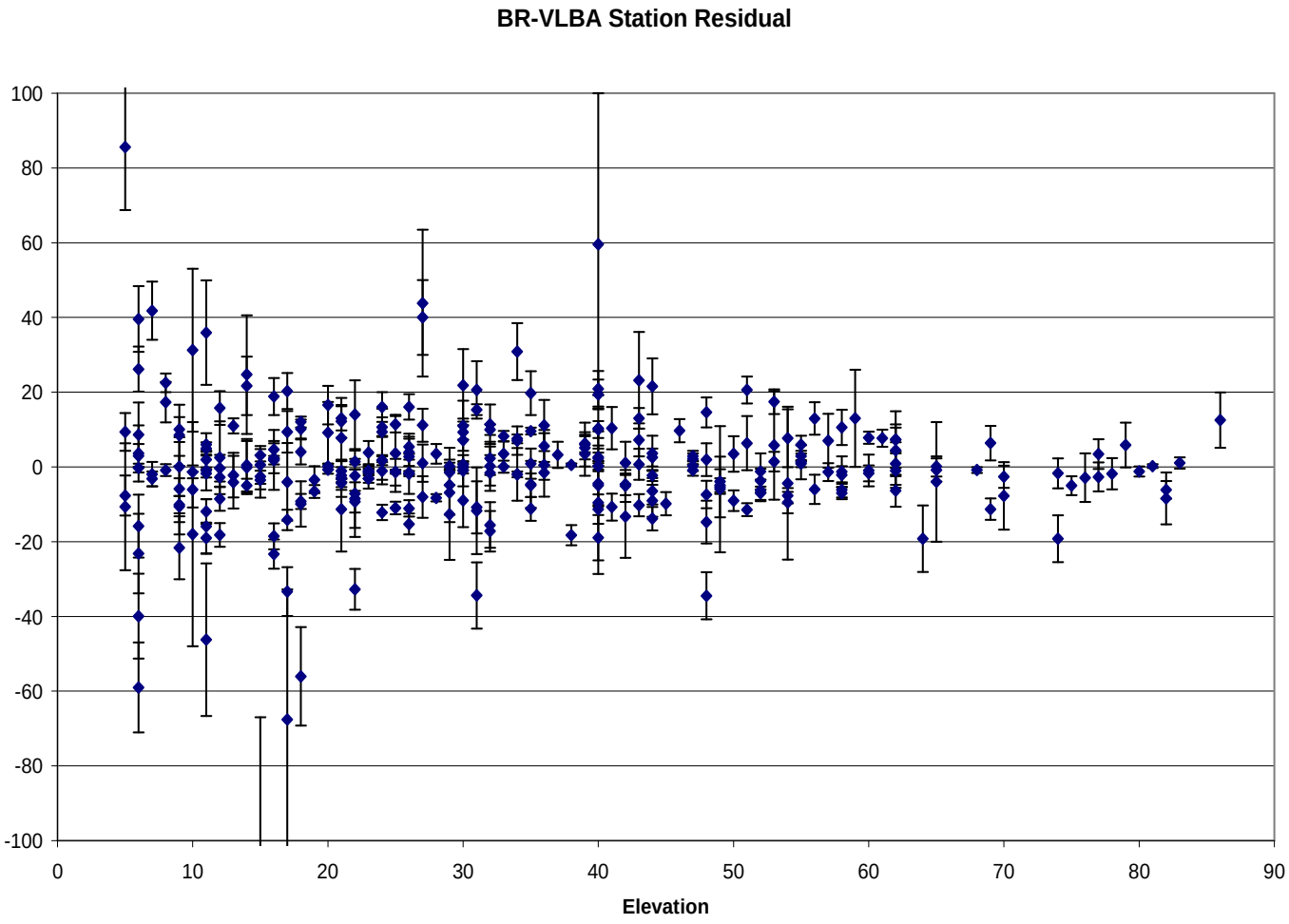
Table 2. Uncertainties in Delay Measurements for Source 1418+546 @ 2004-12-01-18:06:59

#	Name	AZ	EL	BR-V	FD-V	HN-V	KP-V	LA-V	NL-V	OV-V	PIET	SC-V	WEST	MEDI	ONSA	TSUK	#GD
1	BR-VLBA	322	82	-	7	11	12	6	6	8	5	10	16	13	38	10	12
2	FD-VLBA	331	60	7	-	8	11	6	5	5	5	7	12	13	37	11	12
3	HN-VLBA	308	52	11	8	-	17	9	7	8	8	11	14	20	55	17	12
4	KP-VLBA	338	65	12	11	17	-	9	9	14	7	17	26	-	-	21	10
5	LA-VLBA	327	66	6	6	9	9	-	5	7	4	8	13	14	40	11	12
6	NL-VLBA	310	63	6	5	7	9	5	-	6	4	8	11	13	39	10	12
7	OV-VLBA	341	71	8	5	8	14	7	6	-	6	8	12	13	38	9	12
8	PIETOWN	331	65	5	5	8	7	4	4	6	-	7	11	12	34	9	12
9	SC-VLBA	323	29	10	7	11	17	8	8	8	7	-	16	16	47	15	12
10	WESTFORD	308	52	16	12	14	26	13	11	12	11	16	-	31	-	27	11
11	MEDICINA	337	15	13	13	20	-	14	13	13	12	16	31	-	36	10	11
12	ONSALA60	336	26	38	37	55	-	40	39	38	34	47	-	36	-	29	10
13	TSUKUB32	41	28	10	11	17	21	11	10	9	9	15	27	10	29	-	12

Table 3. Corrected Residuals for Source 1418+546 @ 2004-12-01-18:06:59

#	Name	AZ	EL	BR-V	FD-V	HN-V	KP-V	LA-V	NL-V	OV-V	PIET	SC-V	WEST	MEDI	ONSA	TSUK	#GD	AVG	SIG	AVG/ SIG
1	BR-VLBA	322	82	-	15	20	-15	-15	-1	17	-9	11	42	-10	-18	12	12	1.05	2.37	0.44
2	FD-VLBA	331	60	-15	-	0	16	-3	0	0	-1	-1	-12	-7	-67	-3	12	-2.3	2.07	-1.11
3	HN-VLBA	308	52	-20	0	-	10	-15	3	11	1	2	19	8	-59	0	12	0.67	3	0.22
4	KP-VLBA	338	65	15	-16	-10	-	8	-6	-45	4	18	-10	-	-	61	10	0.32	3.63	0.09
5	LA-VLBA	327	66	15	3	15	-8	-	-3	-13	6	-11	-19	-18	1	-7	12	0.48	2.05	0.24
6	NL-VLBA	310	63	1	0	-3	6	3	-	-5	0	25	0	-6	-45	5	12	1.35	1.92	0.7
7	OV-VLBA	341	71	-17	0	-11	45	13	5	-	22	-26	2	12	4	-21	12	1.15	2.27	0.51
8	PIETOWN	331	65	9	1	-1	-4	-6	0	-22	-	11	5	-24	-4	5	12	-1.75	1.77	-0.99
9	SC-VLBA	323	29	-11	1	-2	-18	11	-25	26	-11	-	9	10	54	40	12	0.72	2.86	0.25
10	WESTFORD	308	52	-42	12	-19	10	19	0	-2	-5	-9	-	37	-	46	11	-0.84	4.34	-0.19
11	MEDICINA	337	15	10	7	-8	-	18	6	-12	24	-10	-37	-	39	-17	11	1.77	4.31	0.41
12	ONSALA60	336	26	18	67	59	-	-1	45	-4	4	-54	-	-39	-	-35	10	2.17	11.95	0.18
13	TSUKUB32	41	28	-12	3	0	-61	7	-5	21	-5	-40	-46	17	35	-	12	-0.59	3.45	-0.17


BR-VLBA Station Residual
100
80
60
40
20
0
-20
-40
-60
-80
-100
0
45
90
135
180
225
270
315
360
Azimuth



There is some indication that the station-delay depends on the elevation.

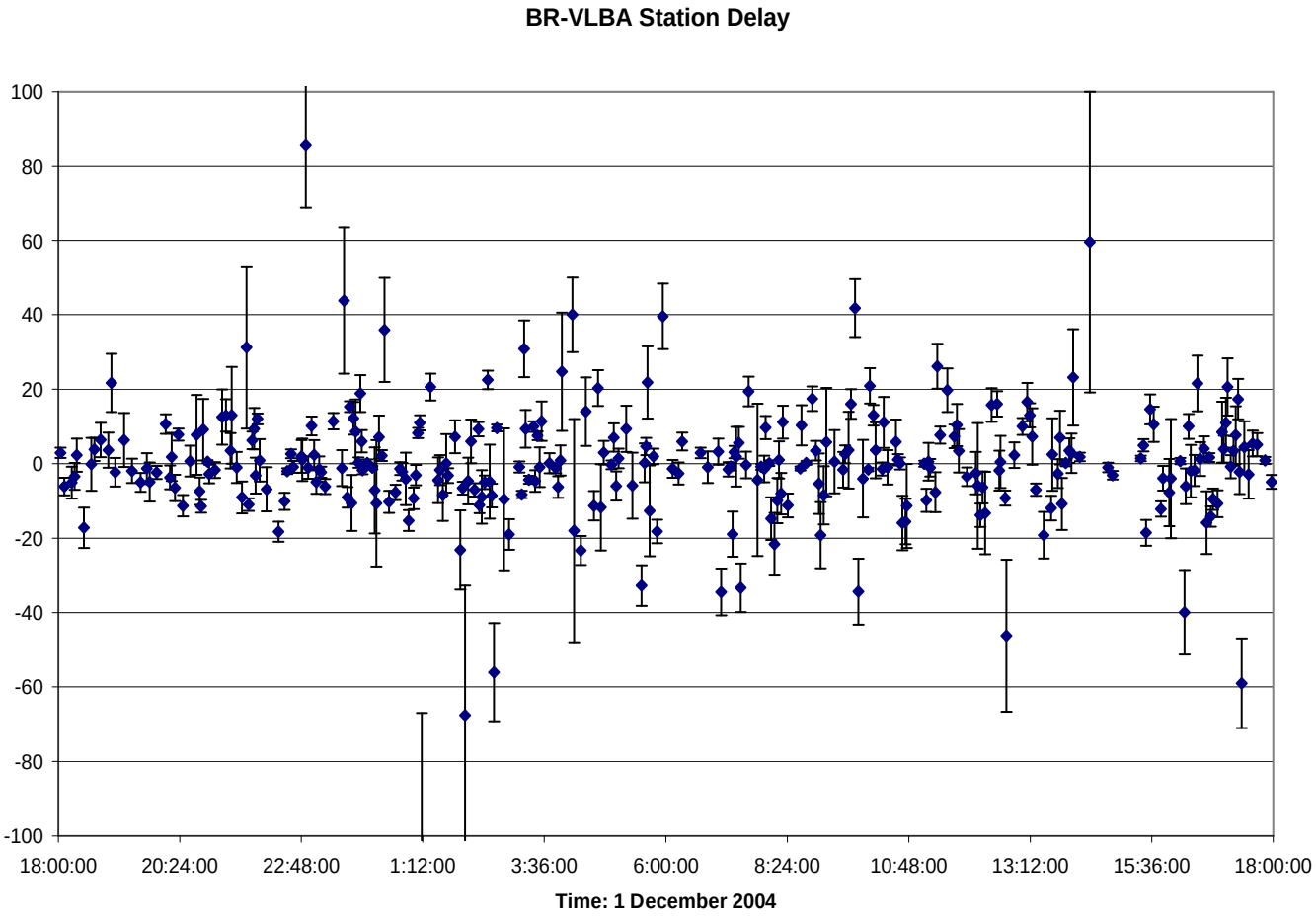

BR-VLBA Station Delay
100
80
60
40
20
0
-20
-40
-60
-80
-100
18:00:00
20:24:00
22:48:00
1:12:00
3:36:00
6:00:00
8:24:00
10:48:00
13:12:00
15:36:00
18:00:00
Time: 1 December 2004

Table 4. RMS Variation of Station Dependent Delay:
RDV48
December 1, 2004

	Station	# Scans	Wt RMS	RMS
1	BR-VLBA	292	8.6	16.3
2	FD-VLBA	301	8.6	20.5
3	GILCREEK	215	27.7	74.4
4	HARTRAO	152	31.8	56.8
5	HN-VLBA	248	13.5	27.0
6	KP-VLBA	294	6.2	10.2
7	LA-VLBA	301	7.2	11.7
8	MEDICINA	243	16.1	40.9
9	MK-VLBA	296	10.8	37.4
10	NL-VLBA	279	7.0	12.6
11	ONSALA60	162	18.2	43.3
12	OV-VLBA	295	7.6	14.0
13	PIETOWN	244	5.4	7.7
14	SC-VLBA	258	14.5	34.3
15	TSUKUB32	290	23.9	62.5
16	WESTFORD	221	17.7	26.7

Table 5. RMS Variation of Station Dependent Delay:
RDV50
April 28, 2005

	Station	# Scans	Wt RMS	RMS
1	ALGOPARK	173	5.6	23.5
2	BR-VLBA	83	5.8	12.1
3	FD-VLBA	229	6.8	12.9
4	GGAO7108	35	11.2	27.2
5	GILCREEK	146	11.8	40.4
6	HN-VLBA	189	6.7	31.2
7	KOKEE	171	11.3	23.1
8	KP-VLBA	225	7.6	15.4
9	LA-VLBA	220	8.7	18.5
10	MK-VLBA	190	8.0	21.0
11	NL-VLBA	221	6.0	21.6
12	OV-VLBA	214	7.0	26.3
13	PIETOWN	223	7.1	16.9
14	SC-VLBA	181	9.7	30.8
15	TIGOCONC	52	15.2	33.8
16	WESTFORD	157	8.4	31.1
17	WETTZELL	90	9.4	44.7

How to Treat Correlation:

Introduce Nuisance Parameters.

Also need to introduce constraint.

Assume standard deviation σ_L

If all the measurement uncertainties are the same AND all baselines are observed in every scan, then can show that:

$$\sigma_{Geo}^2(new) = \sigma_{Geo}^2(orig)\left\{1 + \left(\frac{\sigma_L^2 * Nstat}{\sigma_{meas}^2}\right)\right\}$$