

New Products at the EPN TimeSeries SP

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WHAT'S NEW? – AN OUTLINE

- NEW SOFTWARES
- OUTLIER & OFFSET DATABASE IN SINEX
- MONTHLY UPDATED CRD & VEL SOLUTION
- NOISE ANALYSIS
- ANALYSIS OF SEASONAL SIGNAL
- NEW PLOTS

NEW SW TOOLS

- **CATREF** (Altamimi et al – IGN, France)
 - *minimum constraint approach*
 - *SINEX cleaning,*
 - *stacking of the EPN combined weekly SINEX files,*
 - *velocity estimation*
- **CATS** (Williams, SD. – Proudman OL, UK)
 - *maximum likelihood approach*
 - *noise analysis - independent estimation of velocity uncertainties*
 - *estimation of (annual) periodicity*

WHAT happened earlier?

- Time series monitoring for outlier and offset identification/elimination
- Database of the outliers and offsets are maintained and available at the EPNCB website
- The SP contributes to ITRF2005

NEW OUTLIER DATABASE

Status: 2006:051

Station_ID	GPSweek	Estimated outlier value(*)			explanation
-----from--to		-----North-----	-----East-----	-----Up-----	
ACOR_13434M001	1027 1028	-4	-6	-3	station_start
ACOR_13434M001	1029 1043	[-6,-9]	x	[4, 8]	station_start
ACOR_13434M001	1141 1141	-4	x	33	single outlier
ACOR_13434M001	1177 1255	x	x	[-10,-25]	antenna_malfunction
AJAC_10077M005	1125 1129	-4	3	[15]	antenna_malfunction?
ALAC_13433M001	1292 1292	x	-4	-16	s_o
ALME_13437M001	1102 1103	x	x	11	s_o
ALME_13437M001	1116 1121	-4	5	-12	station_start
ALME_13437M001	1136 1136	x	x	31	s_o
AMMN_22201M001	1158 1164				station_rejected
ANKR_20805M002	0865 0865	x	x	-23	s_o
ANKR_20805M002	0985 0985	x	x	23	s_o
ANKR_20805M002	1023 1040	[-3,3]	[0,8]	[-15, 0]	Izmit EQ
ANKR_20805M002	1054 1054	-8	x	66	s_o
ANKR_20805M002	1266 1281	x	x	[15, 55]	antenna_malfunction?
BOGO_12207M002	0860 0898	x	x	[-5,-15]	station_start
BOGO_12207M002	1123 1125	[8,21]	x	x	s_o
BOR1_12205M002	0943 0944	x	x	[-14,-22]	s_o
BOR1_12205M002	1307 1307	x	x	13	s_o
BORK_14268M001	1212 1221	3	x	[-8,-23]	antenna_malfunction
BORK_14268M001	1222 1224	x	x	5	temporary_antenna

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OUTLIER DATABASE in SINEX

+SOLUTION/DISCONTINUITY

*CODE	PT	SOLN	T	DATA	START	DATA	END	M	A	COMMENTS
ACOR	A	1	P	99:255:00000	99:269:00000	X	-	station_start		
ACOR	A	2	P	99:269:00000	00:009:00000	X	-	station_start		
ACOR	A	3	P	01:322:00000	01:329:00000	X	-	single_outlier		
ACOR	A	4	P	02:209:00000	04:032:00000	X	-	antenna_malfunction		
AJAC	A	1	P	01:210:00000	01:245:00000	X	-	antenna_malfunction?		
ALAC	A	1	P	04:284:00000	04:291:00000	X	-	single_outlier		
ALME	A	1	P	01:049:00000	01:063:00000	X	-	single_outlier		
ALME	A	2	P	01:147:00000	01:189:00000	X	-	station_start		
ALME	A	3	P	01:287:00000	01:294:00000	X	-	single_outlier		
AMMN	A	1	P	02:076:00000	02:125:00000	X	-	station_rejected		
ANKR	A	1	P	96:217:00000	96:224:00000	X	-	single_outlier		
ANKR	A	2	P	98:326:00000	98:333:00000	X	-	single_outlier		
ANKR	A	3	P	99:227:00000	99:353:00000	X	-	Izmit_EQ		
ANKR	A	4	P	00:079:00000	00:086:00000	X	-	single_outlier		
ANKR	A	5	P	04:102:00000	04:214:00000	X	-	antenna_malfunction?		
BOGO	A	1	P	96:182:00000	97:089:00000	X	-	station_start		
BOGO	A	2	P	01:196:00000	01:217:00000	X	-	single_outlier		
BOR1	A	1	P	98:032:00000	98:046:00000	X	-	single_outlier		
BOR1	A	2	P	05:023:00000	05:030:00000	X	-	single_outlier		
BORK	A	1	P	03:089:00000	03:159:00000	X	-	antenna_malfunction		
BORK	A	2	P	03:159:00000	03:180:00000	X	-	temporary_antenna		

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-SOLUTION/DISCONTINUITY

OFFSET DATABASE

Sitename & DOMES number	isol	Offset date	N_offs	E_offs [mm]	U_offs

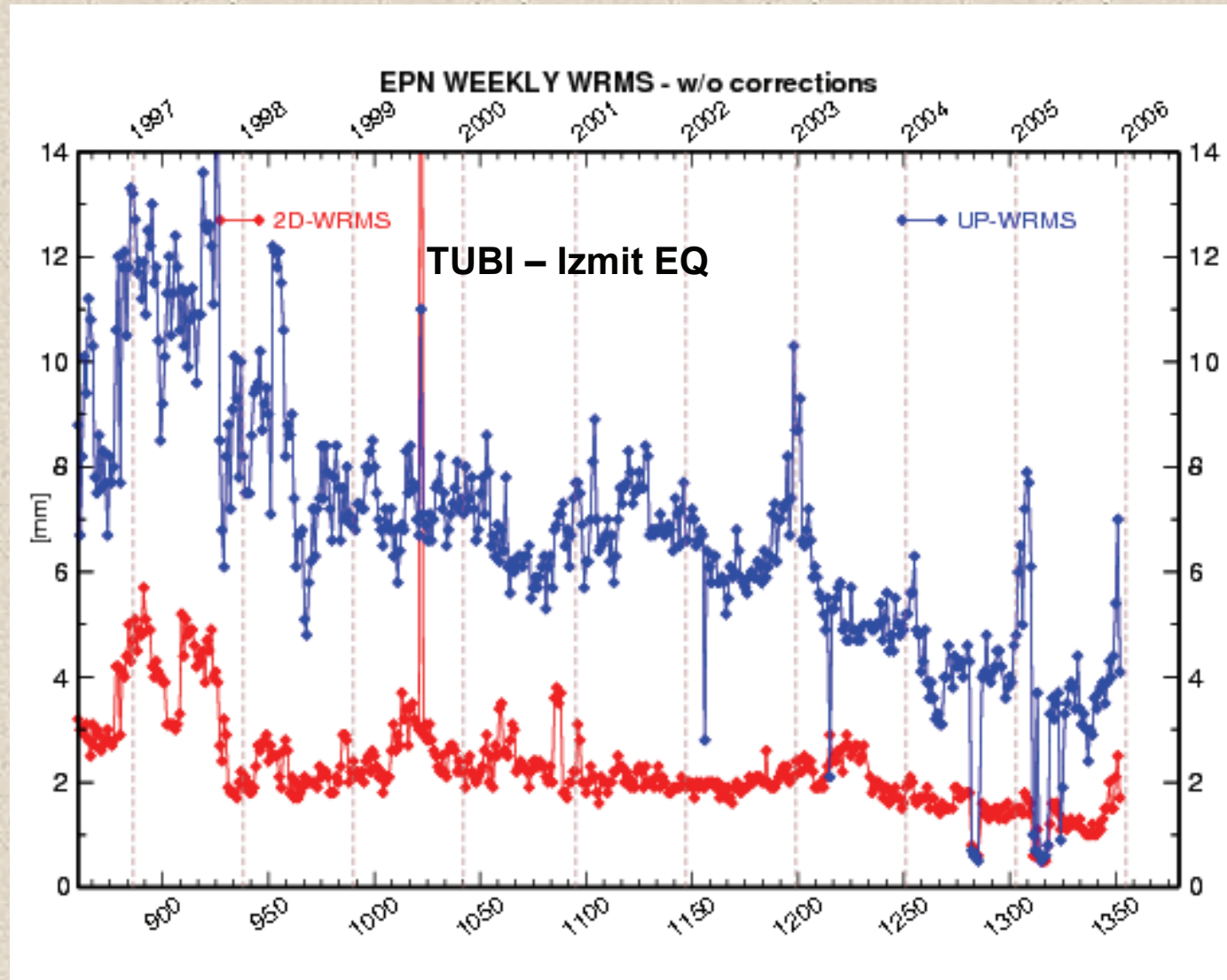
ANKR_20805M002	1	99:229:00000	11	-25	30
BOGO_12207M002	1	01:229:00000	3	1	-2
BOR1_12205M002	1	99:151:00000	0	3	-3
BRUS_13101M004	1	00:118:00000	-4	1	3
BZRG_12751M001	1	00:334:00000	-1	1	-28
CAGL_12725M003	1	01:196:00000	1	6	-13
CAME_12754M001	1	03:348:00000	0	2	10
CEUT_13449M001	1	05:016:00000	8	-2	-7
COMO_12761M001	1	05:352:00000	-2	-2	95
CREU_13432M001	1	01:098:00000	2	-6	-0
CREU_13432M001	2	03:215:00000	-8	-8	-20
DELF_13502M004	1	00:205:00000	2	-1	12
DENT_13112M001	1	00:023:00000	3	-4	-4
DENT_13112M001	2	02:069:00000	-2	-1	7
DENT_13112M001	3	05:289:00000	-2	-11	3
DOUR_13113M001	1	01:280:00000	1	4	5
DRES_14108M001	1	03:019:00000	5	-4	29
DUBR_11901M001	1	05:240:00000	7	5	2
.....					

OFFSET DATABASE in SINEX

+SOLUTION/DISCONTINUITY

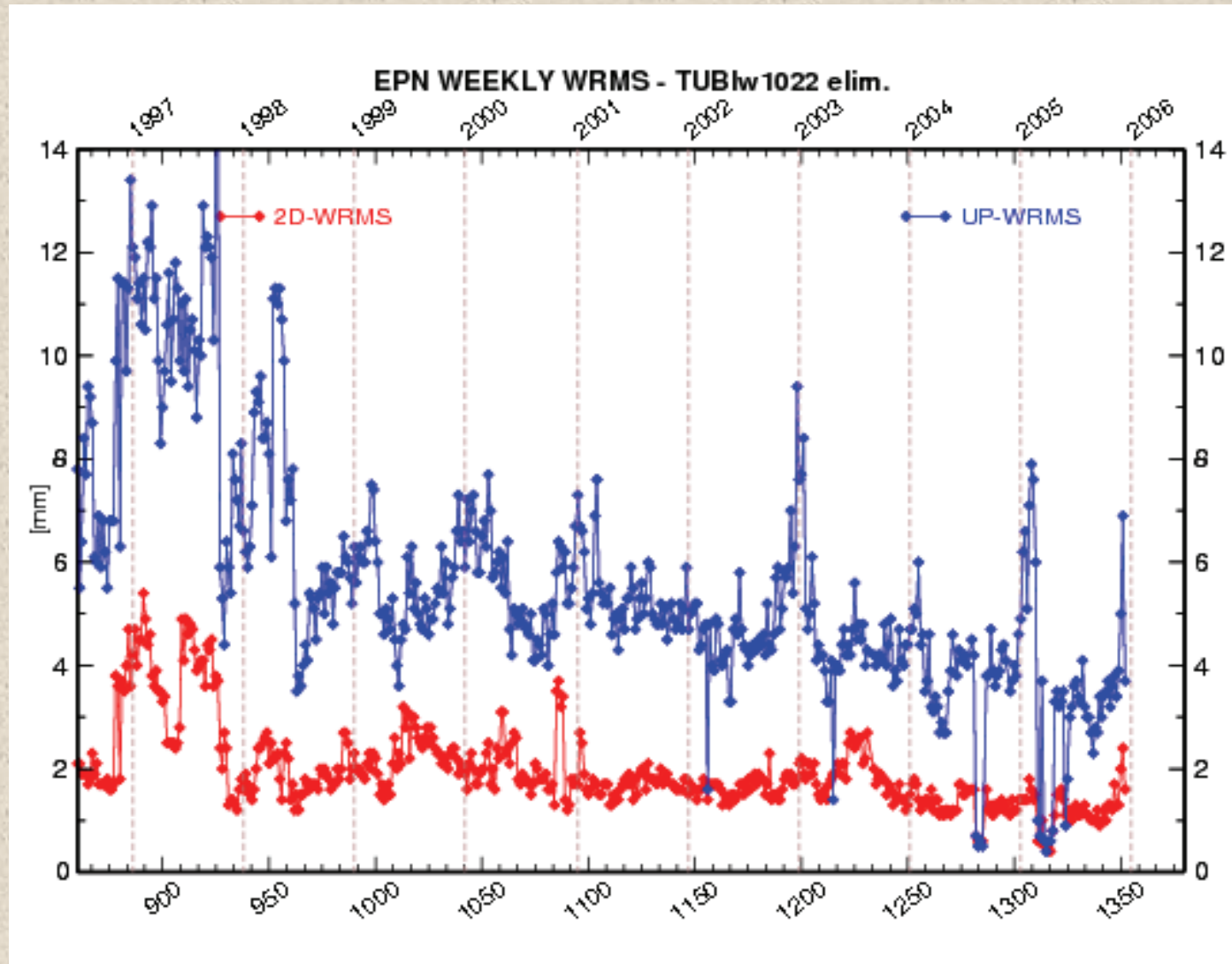
*CODE	PT	SOLN	T	DATA START	DATA END	M	A	COMMENTS
ACOR	A	1	P	00:000:00000	00:000:00000	P	-	
ACOR	A	1	P	00:000:00000	00:000:00000	V	-	
AJAC	A	1	P	00:000:00000	00:000:00000	P	-	
AJAC	A	1	P	00:000:00000	00:000:00000	V	-	
ALAC	A	1	P	00:000:00000	00:000:00000	P	-	
ALAC	A	1	P	00:000:00000	00:000:00000	V	-	
ALME	A	1	P	00:000:00000	00:000:00000	P	-	
ALME	A	1	P	00:000:00000	00:000:00000	V	-	
ANKR	A	1	P	00:000:00000	98:259:00000	P	-	IGS: Antenna Change
ANKR	A	1	P	98:259:00000	99:229:00000	P	-	IGS: Izmit Earthquake
ANKR	A	2	P	99:229:00000	00:000:00000	P	-	
ANKR	A	1	P	00:000:00000	99:229:00000	V	-	IGS: Izmit Earthquake
ANKR	A	2	P	99:229:00000	00:000:00000	V	-	
AQUI	A	1	P	00:000:00000	00:000:00000	P	-	
AQUI	A	1	P	00:000:00000	00:000:00000	V	-	
BELL	A	1	P	00:000:00000	00:000:00000	P	-	
BELL	A	1	P	00:000:00000	00:000:00000	V	-	
BOGI	A	1	P	00:000:00000	00:000:00000	P	-	
BOGI	A	1	P	00:000:00000	00:000:00000	V	-	
BOGO	A	1	P	00:000:00000	01:229:00000	P	-	IGS: Antenna re-installed
BOGO	A	2	P	01:229:00000	00:000:00000	P	-	
BOGO	A	1	P	00:000:00000	00:000:00000	V	-	
BOR1	A	1	P	00:000:00000	99:151:00000	P	-	IGS:Antenna change
BOR1	A	2	P	99:151:00000	00:000:00000	P	-	
BOR1	A	1	P	00:000:00000	00:000:00000	V	-	
BORK	A	1	P	00:000:00000	00:000:00000	P	-	
BORK	A	1	P	00:000:00000	00:000:00000	V	-	
BRST	A	1	P	00:000:00000	00:000:00000	P	-	IGS
BRST	A	1	P	00:000:00000	00:000:00000	V	-	
BRUS	A	1	P	00:000:00000	00:118:00000	P	-	IGS: Antenna change

IMPORTANCE OF OUTLIER REJECTION



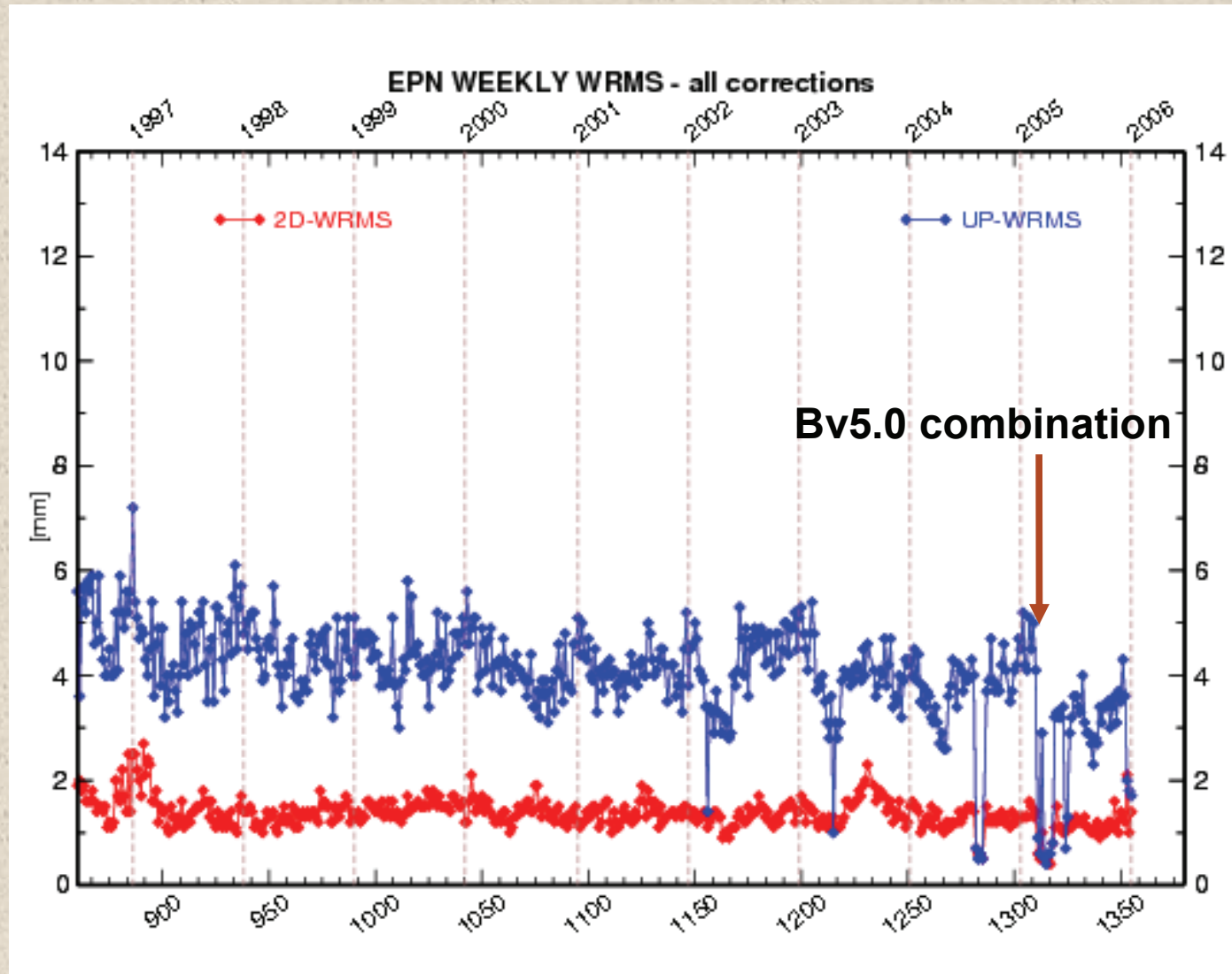
STACKING WITHOUT ANY CORRECTION (sig=2.5)

IMPORTANCE OF OUTLIER REJECTION



OFFSETS AND TUBI OUTLIER APPLIED (sig=1.8)

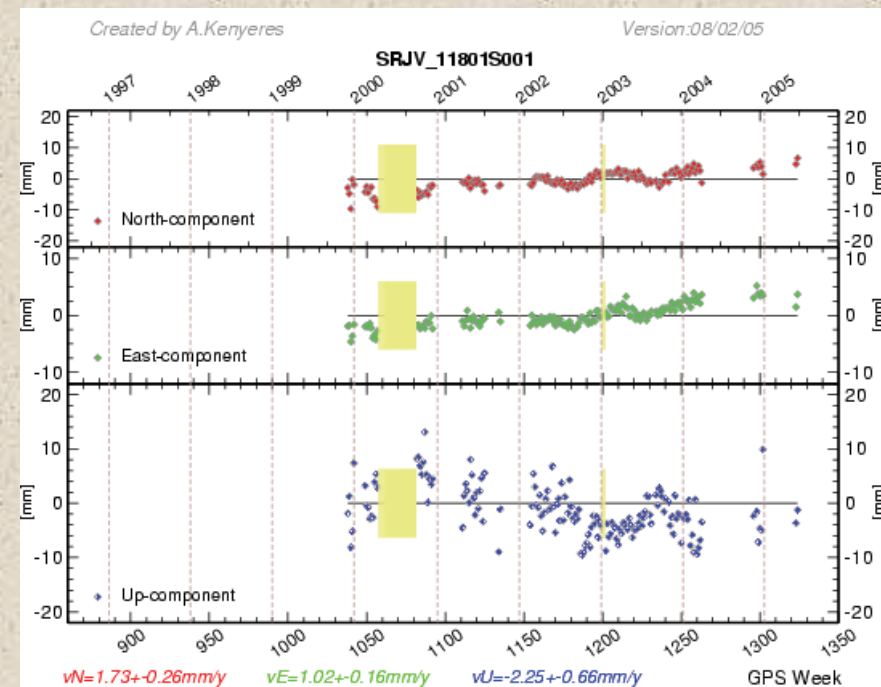
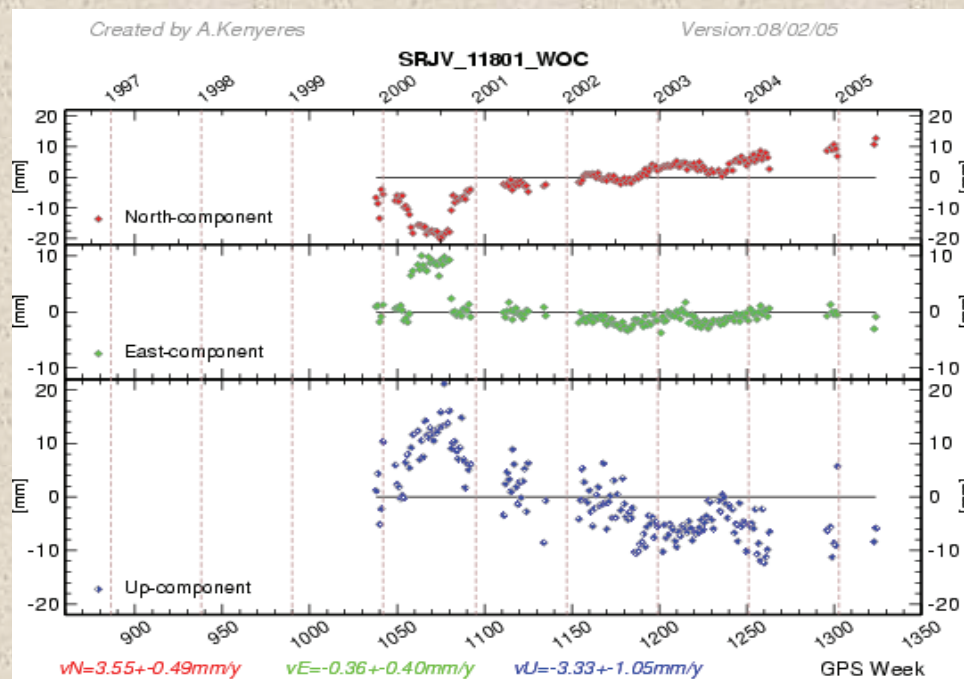
IMPORTANCE OF OUTLIER REJECTION



OFFSETS AND ALL OUTLIERS APPLIED (sig=1.4)

IMPORTANCE OF OUTLIER REJECTION

EVEN SHORT OUTLIER SEQUENCES CAN BIAS THE VELOCITY ESTIMATION !



AN OUTLIER AND OFFSET DATABASE FOR THE EPN STATIONS IS BEING MAINTAINED AND PROVIDED FOR THE **ITRF2005** SOLUTION.

NEW PRODUCT

MONTHLY UPDATED COORDINATE AND VELOCITY SOLUTION computed by CATREF

ITRF2000, EPOCH1997.0 COORDINATES [m]/VELOCITIES [m/y] OF THE EPN STATIONS:

MINIMUM CONSTRAINED SOLUTION BY CATREF GPSWEEKS [0860 - 1355]

STATION ID	solution validity	X vX	Y vY	Z vZ	dX dvX	dY dvY	dZ dvZ
ACOR_13434M001		4594489.7392	-678367.8594	4357066.0831	0.0004	0.0002	0.0005
		-0.0090	0.0234	0.0092	0.0001	0.0001	
AJAC_10077M005		4696989.4917	723994.4020	4239678.4888	0.0004	0.0002	0.0004
		-0.0147	0.0193	0.0094	0.0001	0.0001	
ALAC_13433M001		5009051.2324	-42072.2723	3935057.6796	0.0004	0.0002	0.0004
		-0.0112	0.0201	0.0108	0.0001	0.0001	
ALME_13437M001		5105220.1311	-219278.5957	3804387.0698	0.0006	0.0002	0.0005
		-0.0087	0.0191	0.0111	0.0001	0.0001	
ANKR_20805M002		4121948.5392	2652187.9358	4069023.6943	0.0021	0.0014	0.0021
		-0.0120	-0.0028	0.0032	0.0004	0.0007	
ANKR_20805M002	99:229	4121948.5661	2652187.9230	4069023.7216	0.0006	0.0003	0.0006
		-0.0088	-0.0042	0.0057	0.0001	0.0001	
AQUI_12757M001		4592507.6359	1089876.2925	4276392.9369	0.0007	0.0003	0.0007
		-0.0182	0.0189	0.0105	0.0001	0.0002	

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NEW INVESTIGATION:

NOISE ANALYSIS WITH CATS

$$P_n(f) = P_o \left(\frac{f}{f_o} \right)^{\kappa}$$

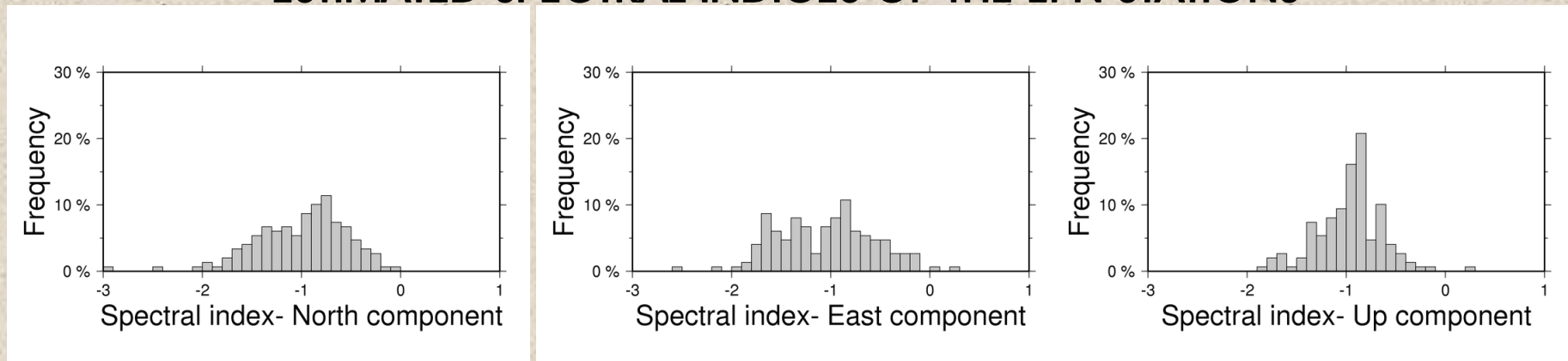
κ - spectral index

0 : white noise

-1 : flicker noise

-2 : random walk

ESTIMATED SPECTRAL INDICES OF THE EPN STATIONS

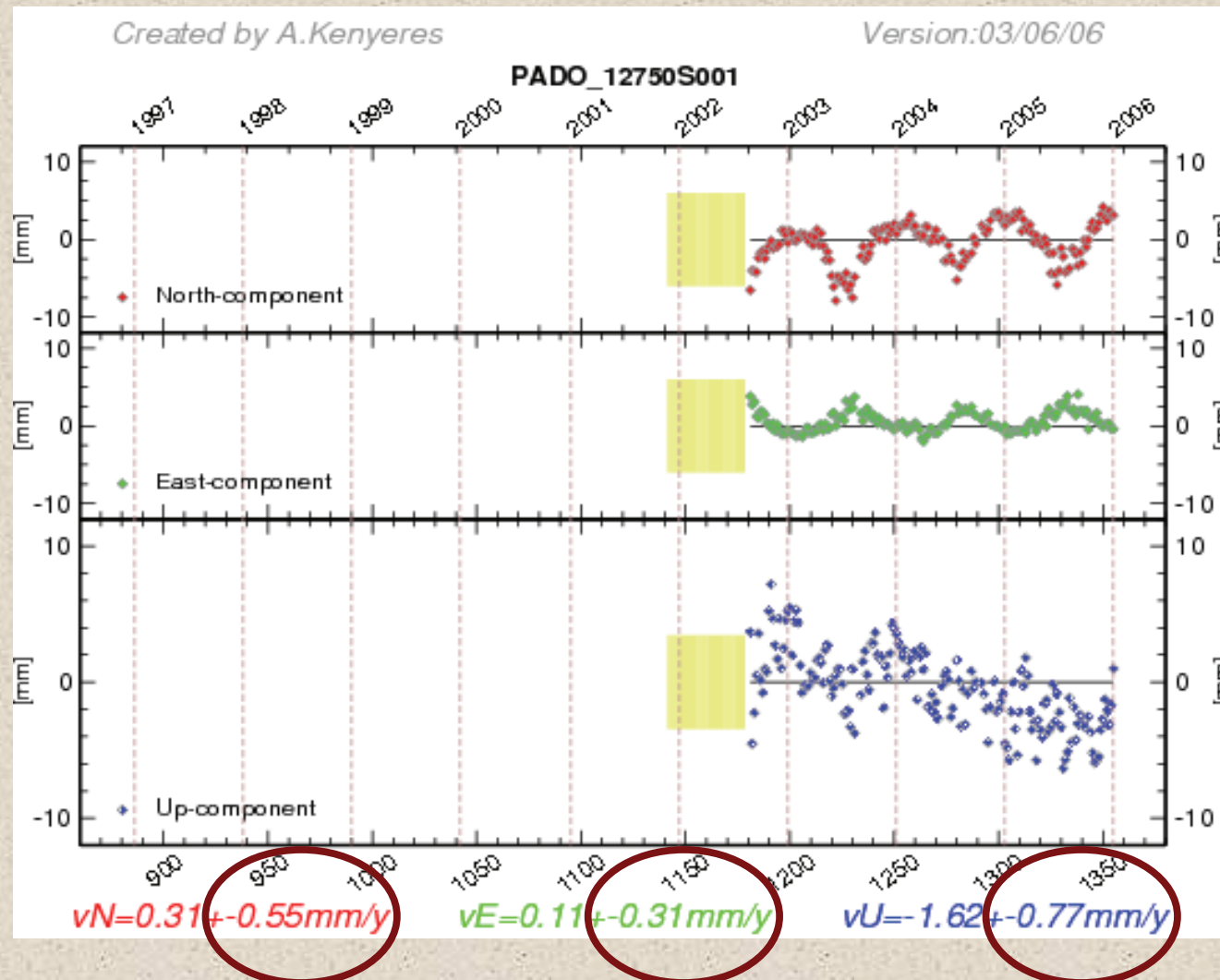


- COLORED NOISE IS PRESENT IN THE EPN TIME SERIES
- NO INDICATION IN THE NOISE FOR THE MONUMENT INSTABILITY

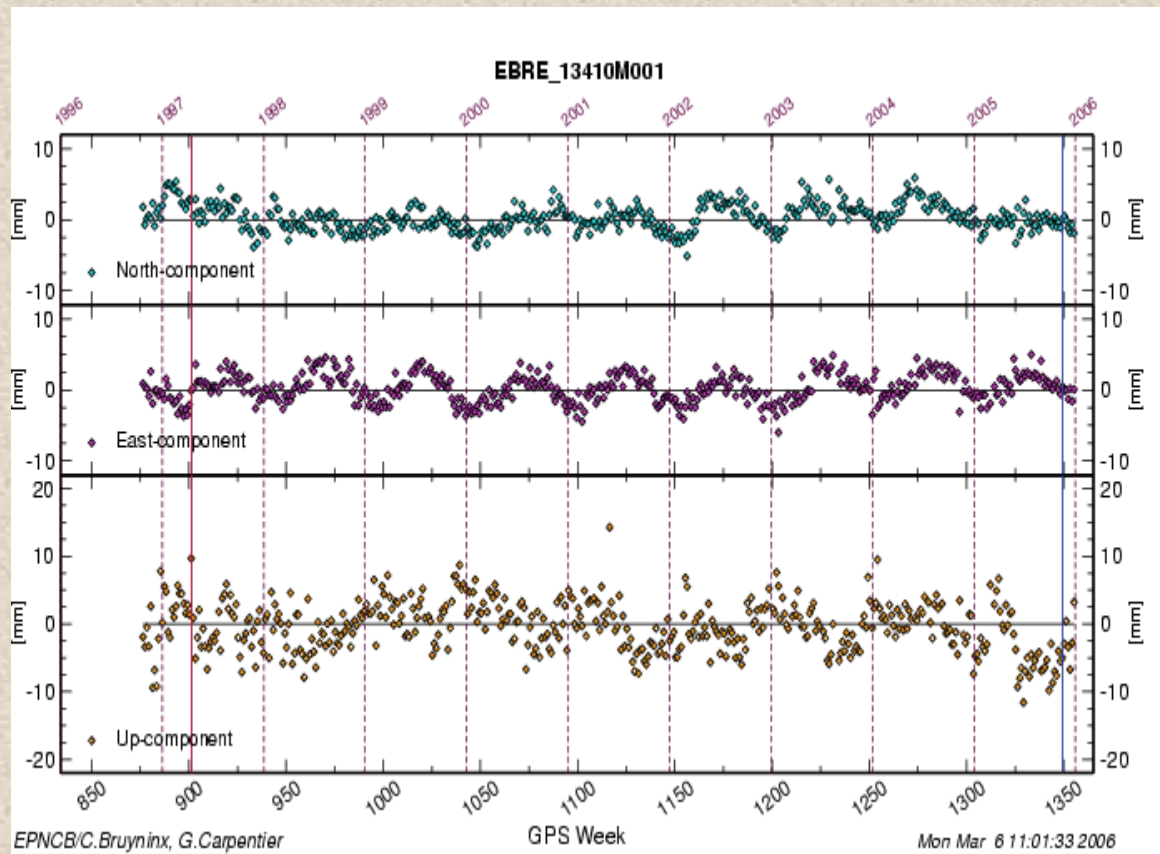
Assuming flicker noise the velocity uncertainties are 4-10 larger than with the white noise model

NEW INVESTIGATION:

NOISE ANALYSIS WITH CATS



ANNUAL PERIODICITY



ARTIFICIAL

- mismodeling (PCV, tide ...)
- noise (multipath, cycle slip ...)

- ...

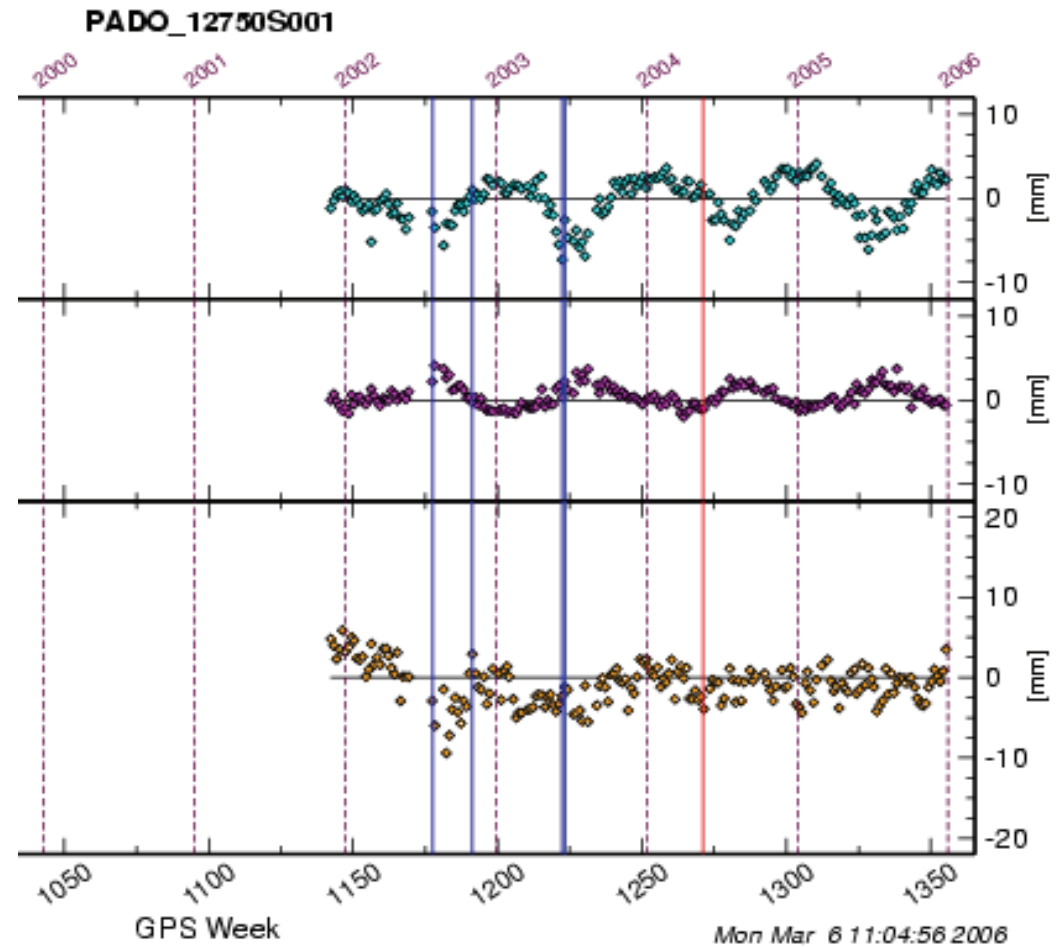
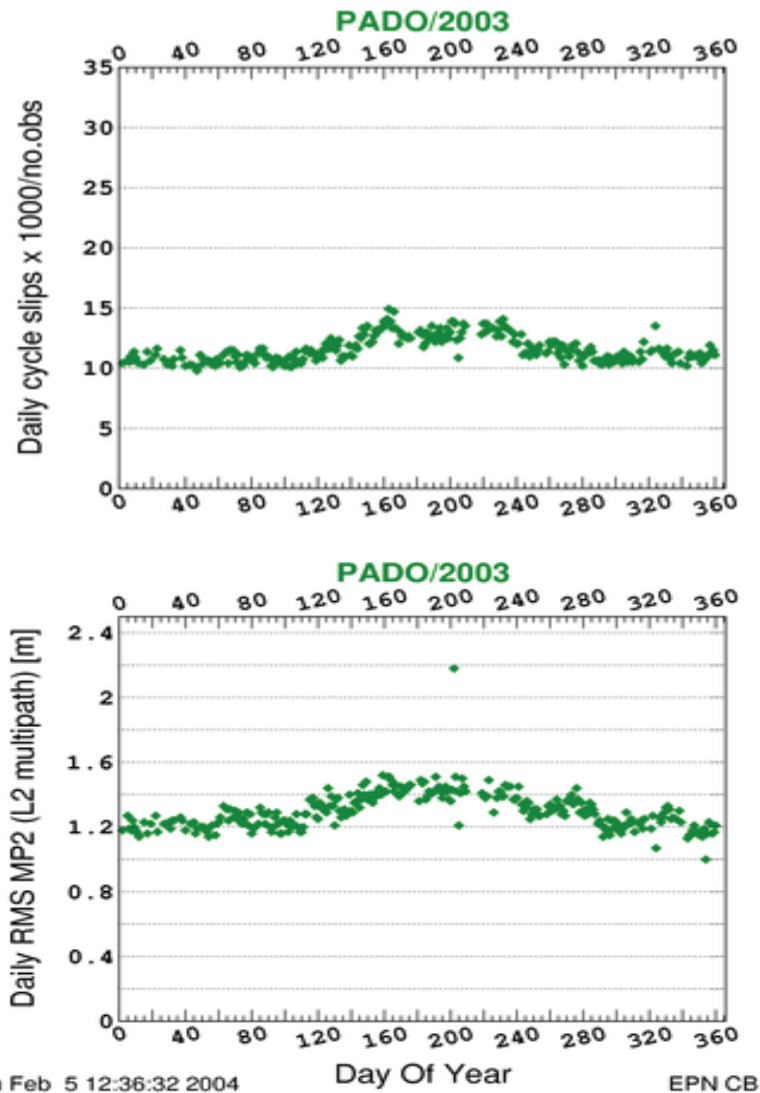
REAL PHYSICAL VARIATION

- monumentation
- soil moisture
- thermal processes

- ...

INDEPENDENT INVESTIGATIONS SHOWS THAT THE ANNUAL TERM FROM GPS DO NOT CORRELATE WITH GEOPHYSICAL MODELS AND MEASUREMENTS.

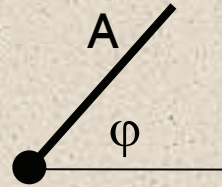
ANNUAL PERIODICITY



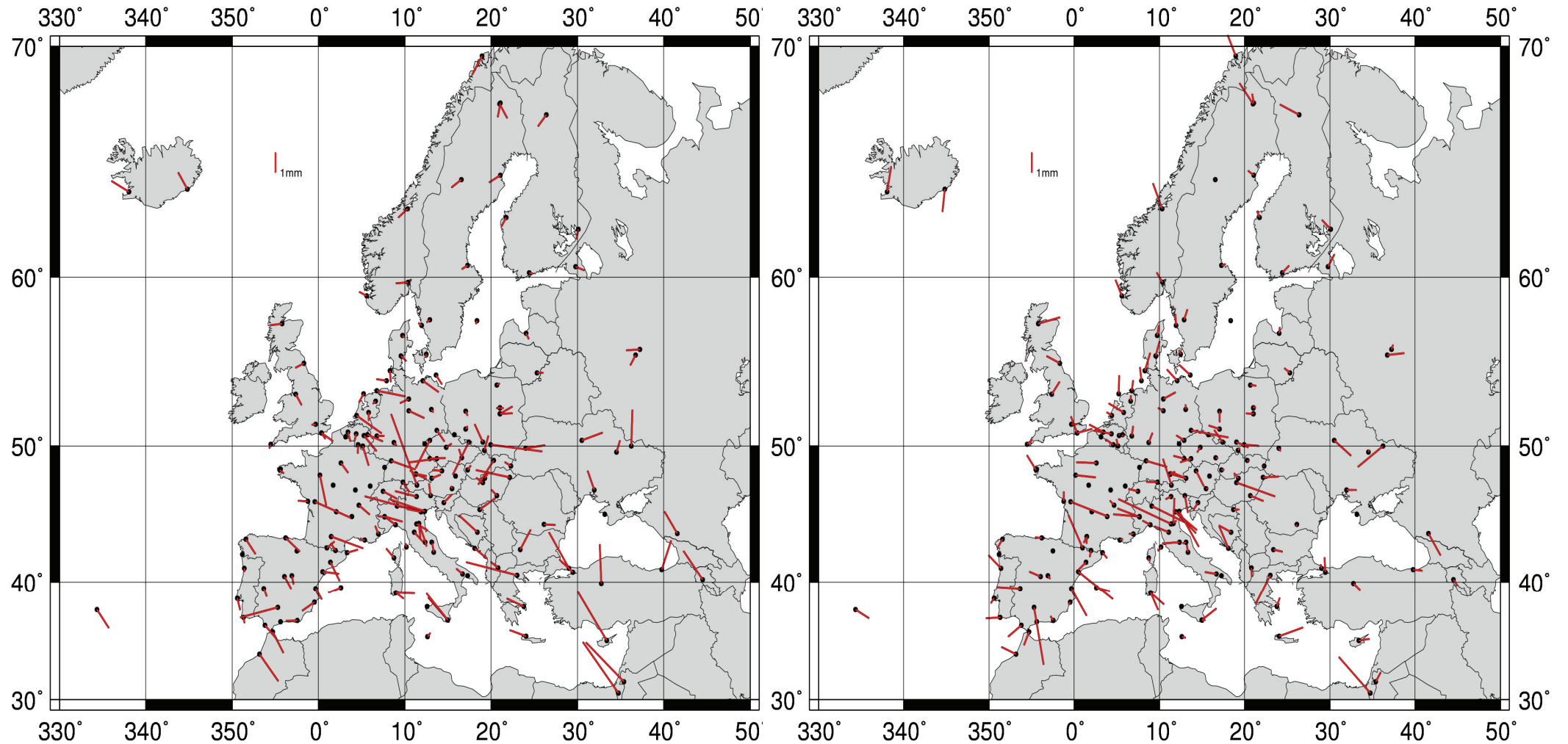
ANNUAL PERIODICITY

horizontal components

NORTH

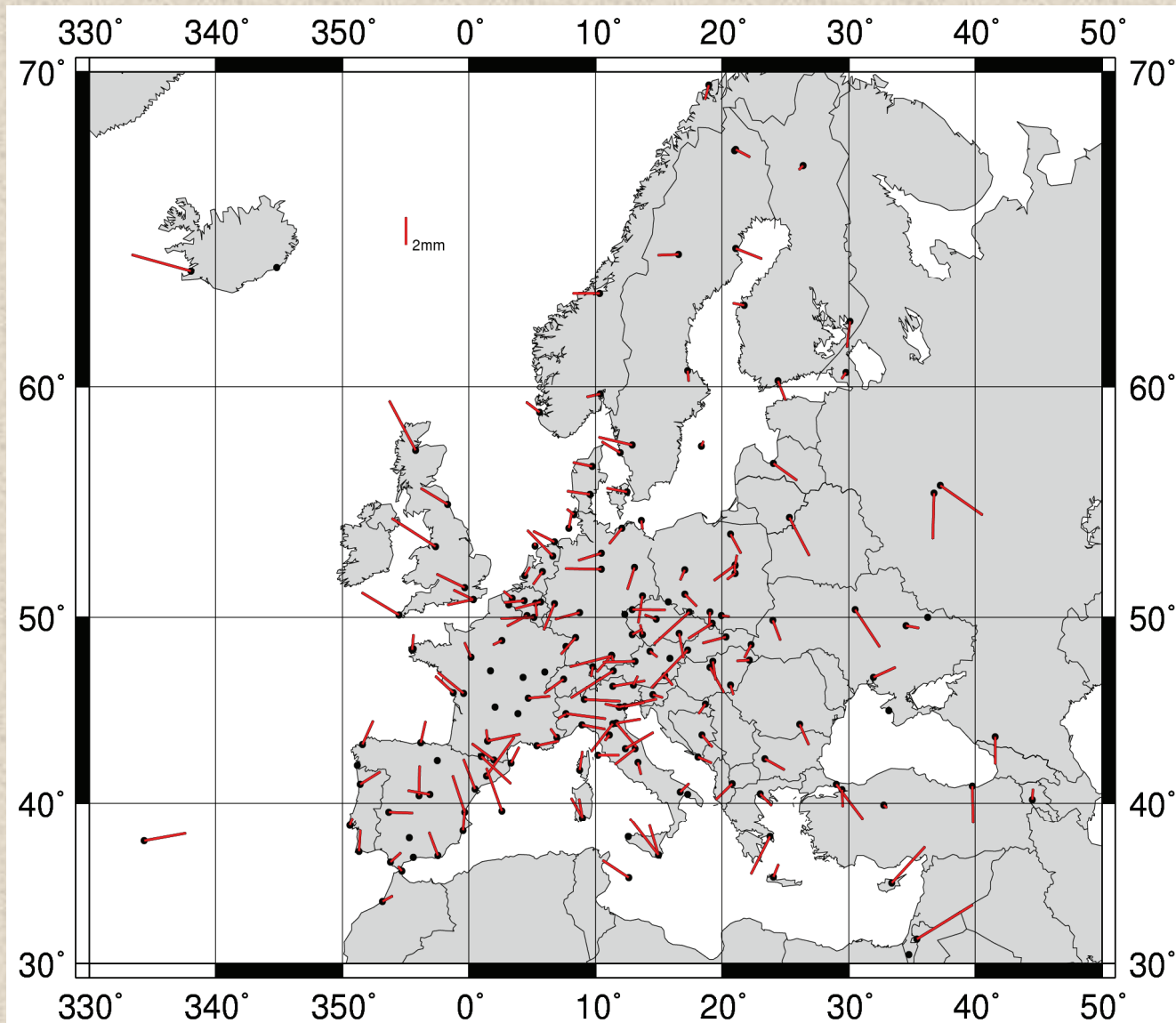


EAST



ANNUAL PERIODICITY

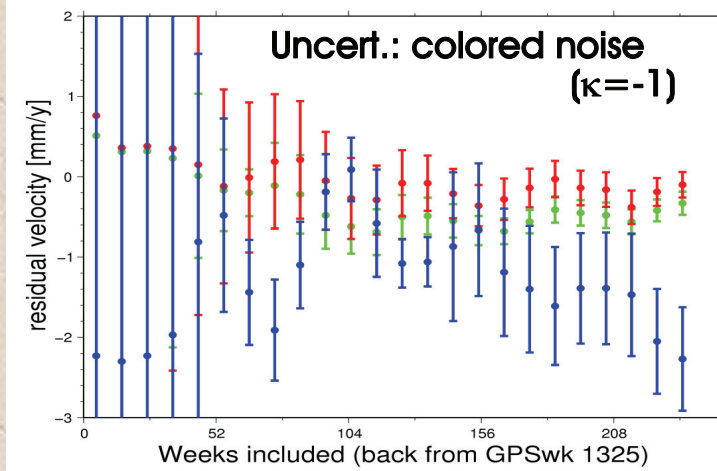
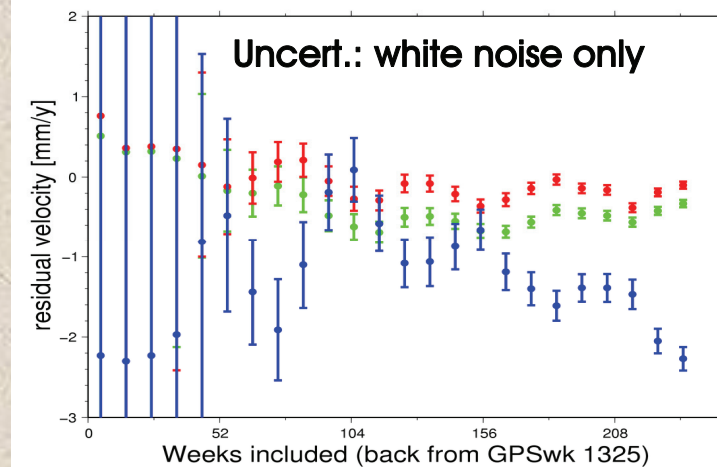
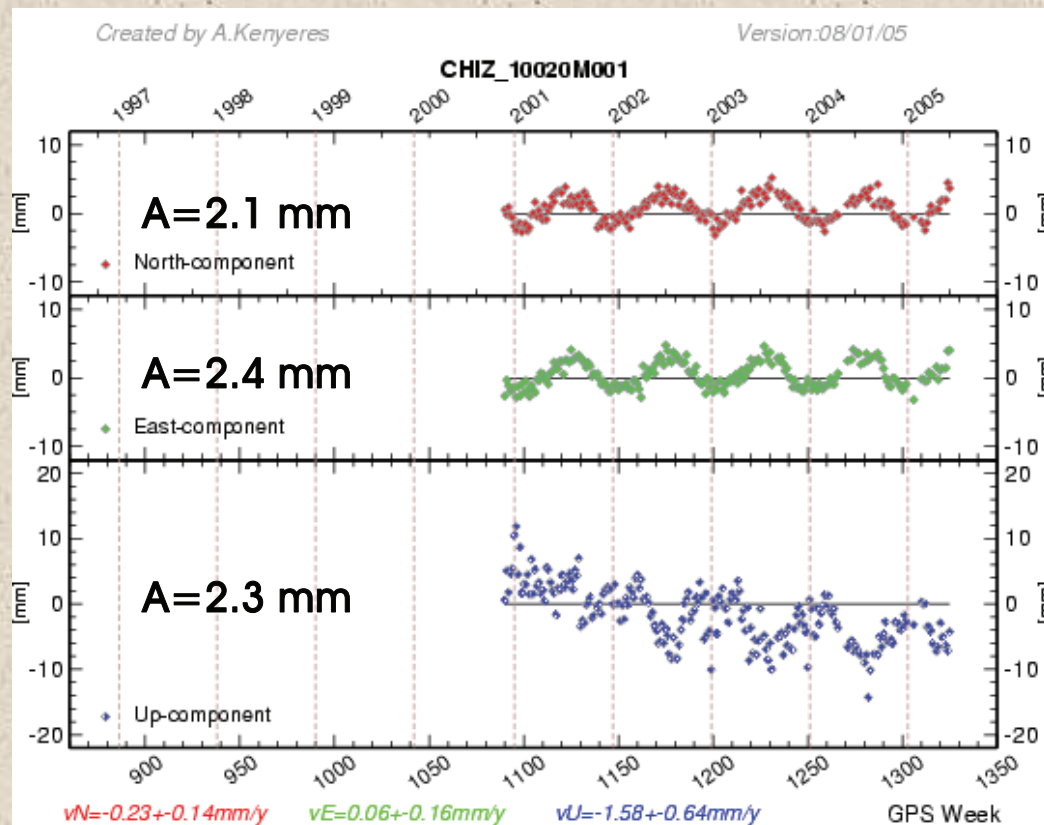
vertical component



VELOCITY ESTIMATION: dependence on the length of time series

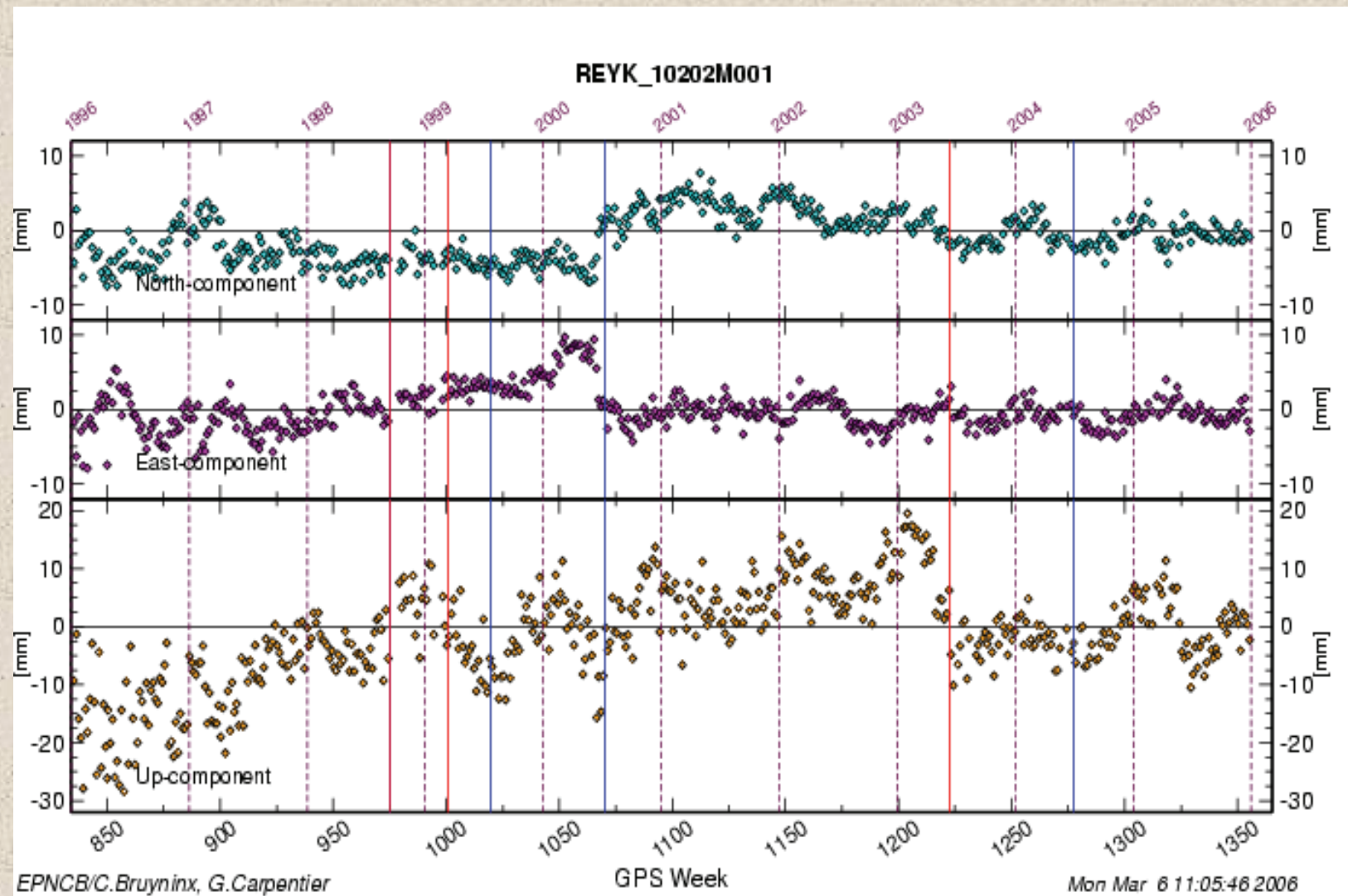
(Blewitt, Lavallee, JGR 107/B7,2002)

A stepwise growing sequence of CHIZ data was eliminated from the EPN SINEX



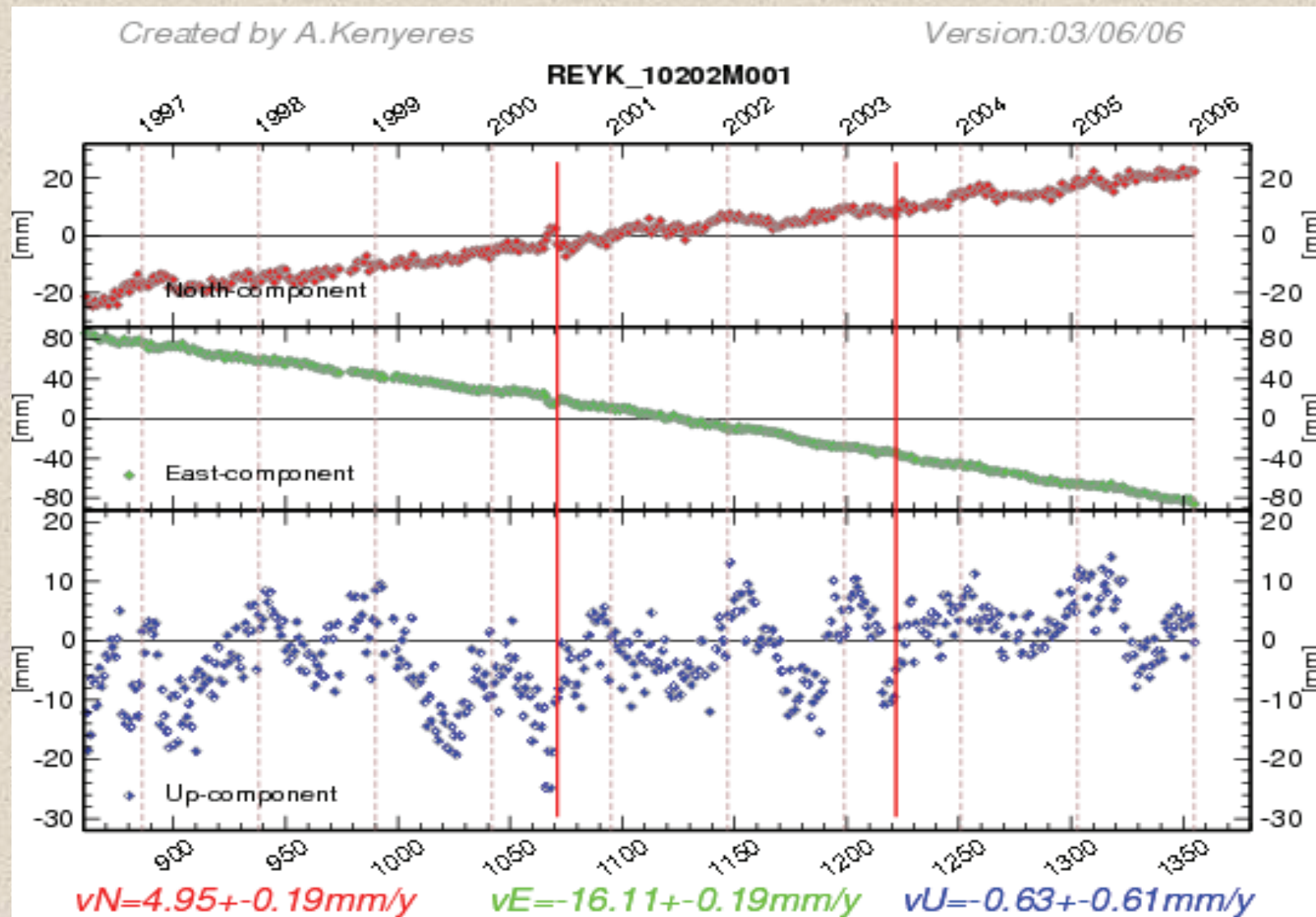
TIME SERIES PLOTS

RAW by EPNCB



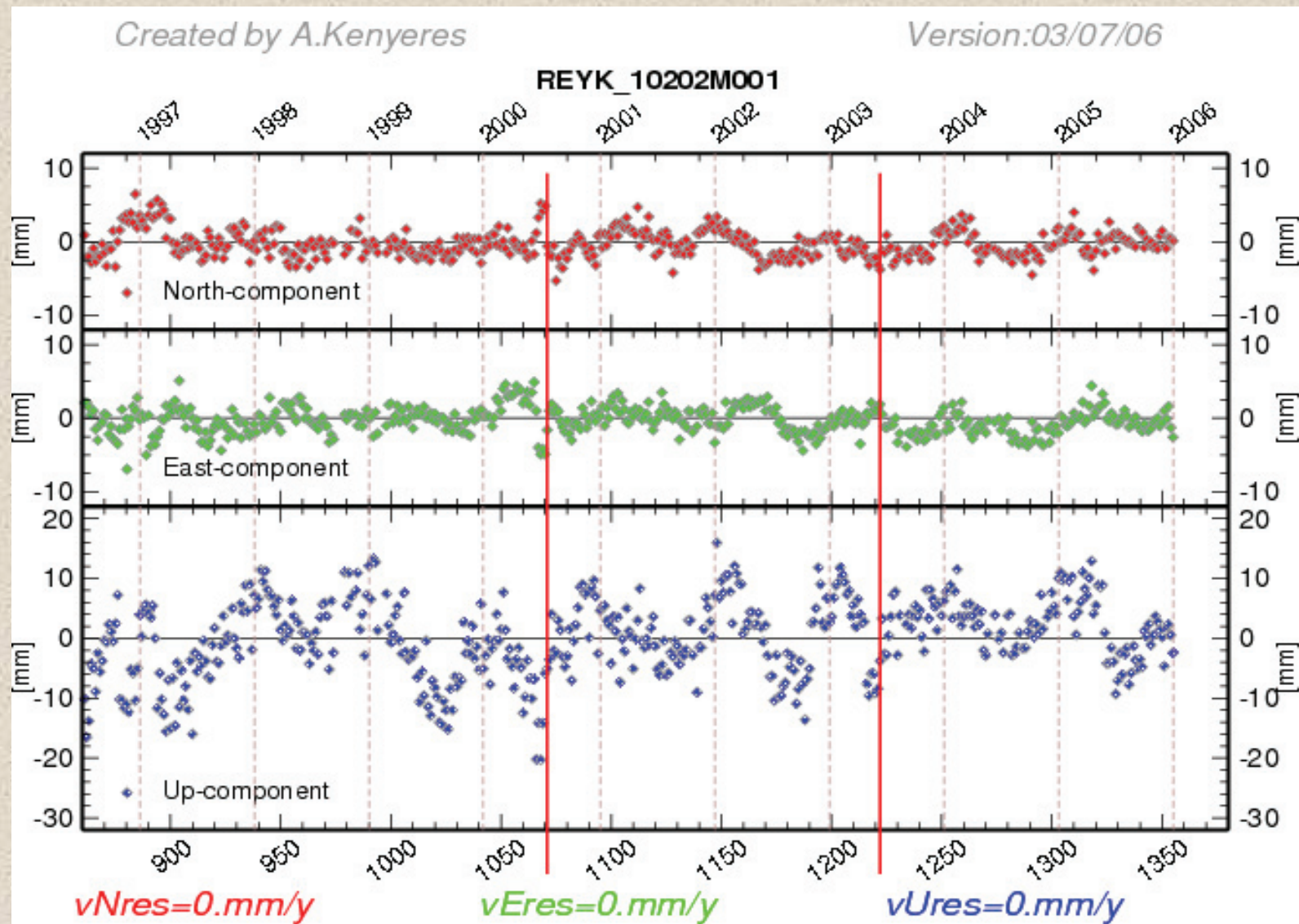
TIME SERIES PLOTS

CLEANED by TSSP



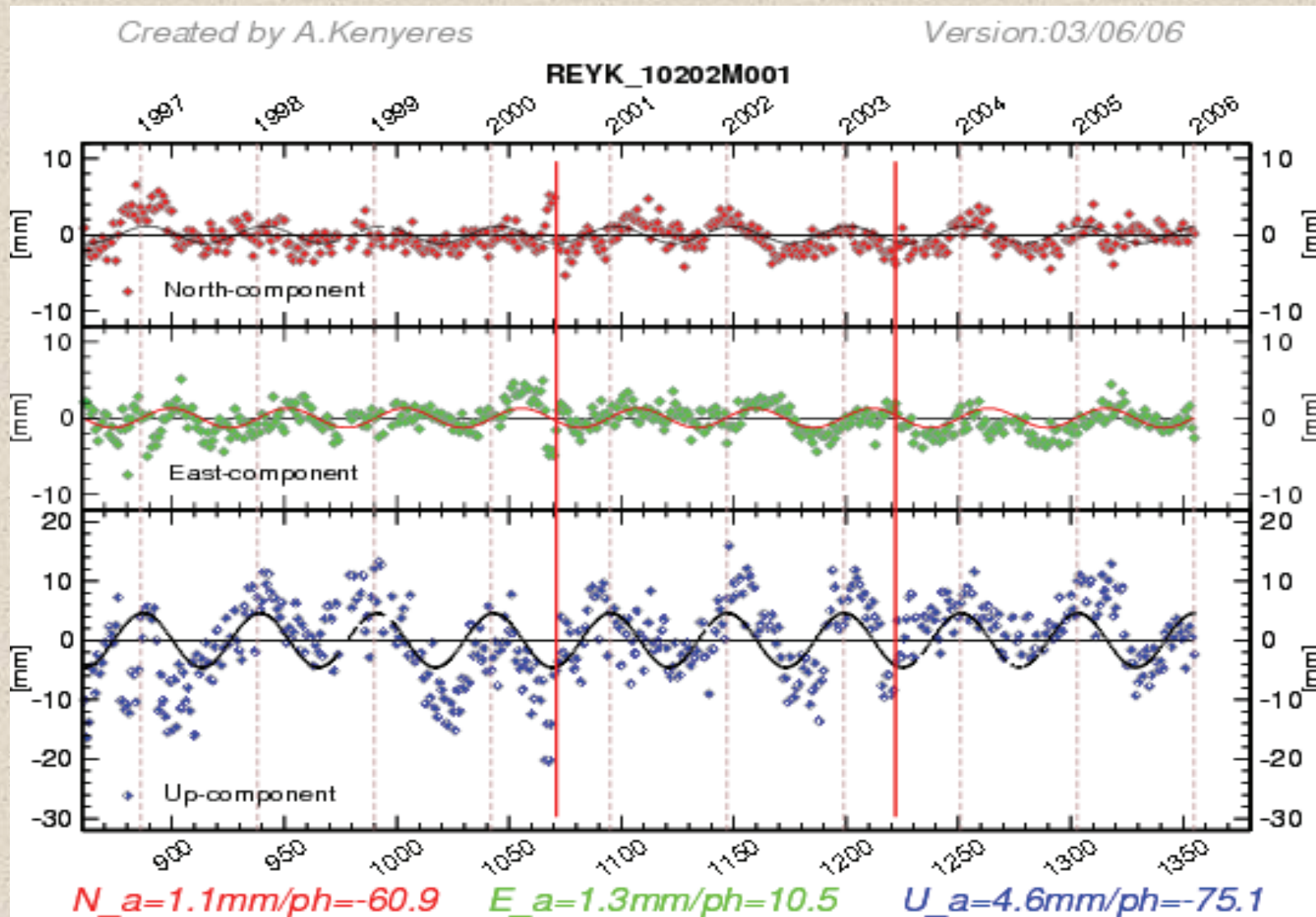
TIME SERIES PLOTS

DE-TRENDED-CLEANED



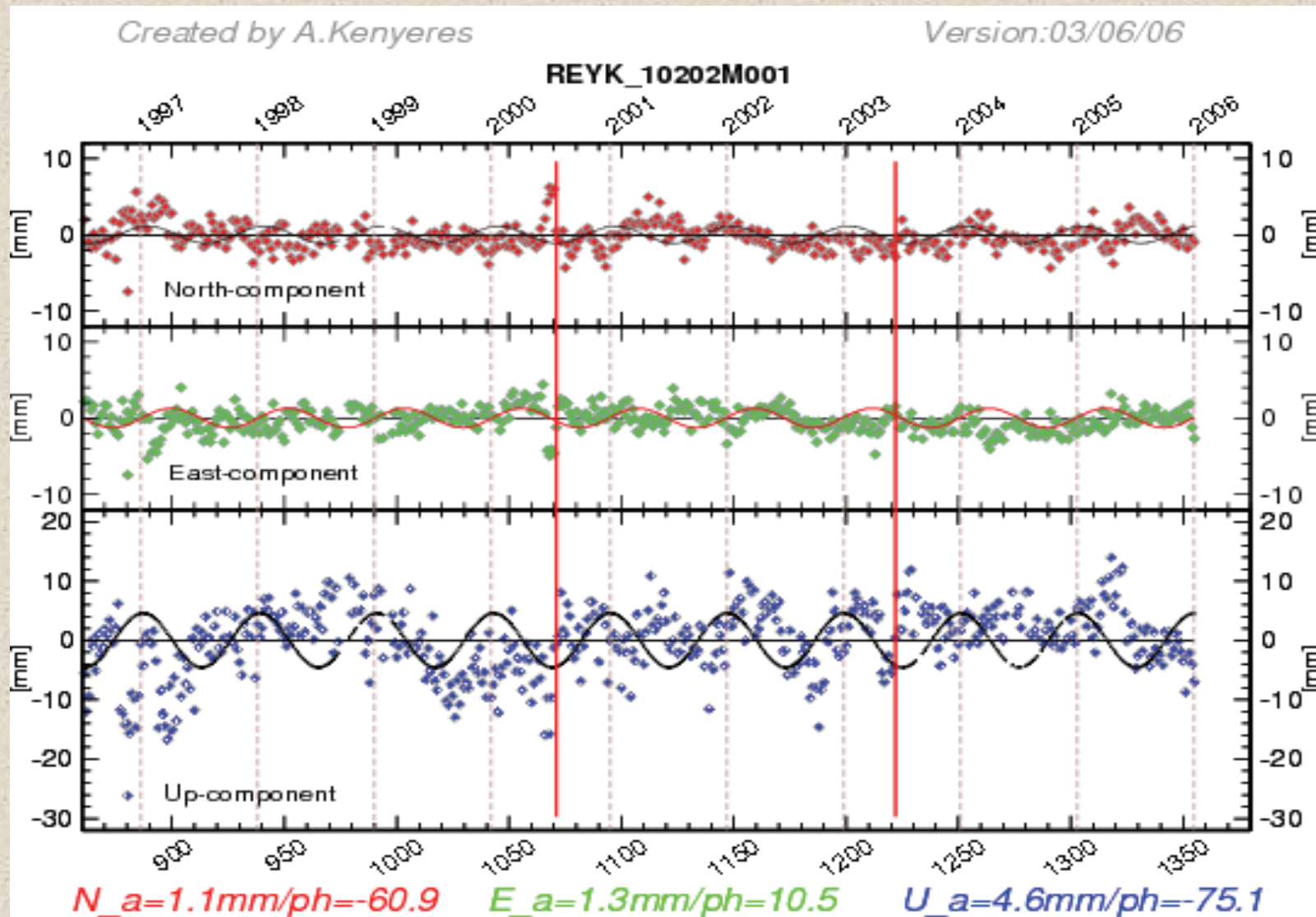
NEW TIME SERIES PLOTS

DE-TRENDED CLEANED WITH SEASONAL SIGNAL

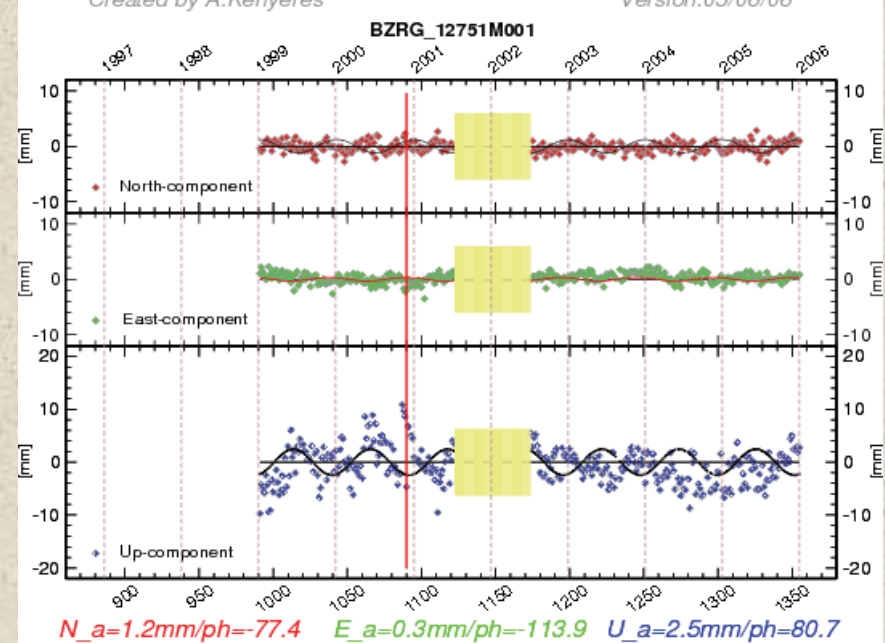
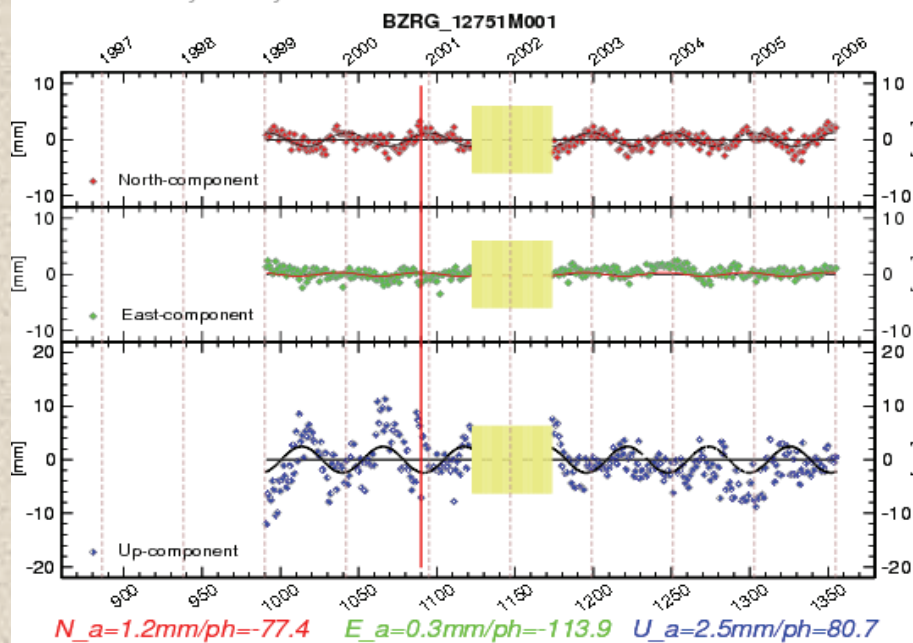
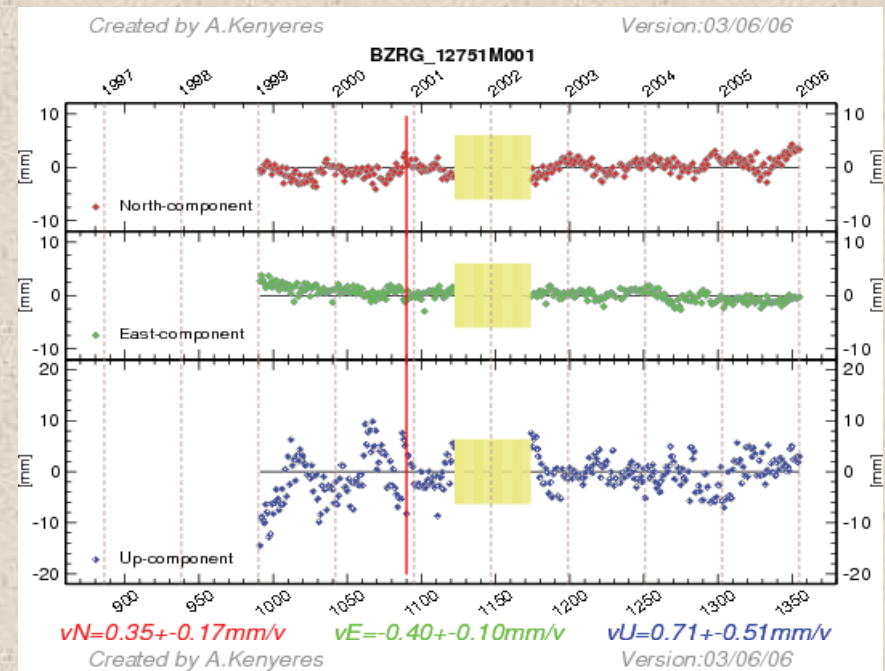
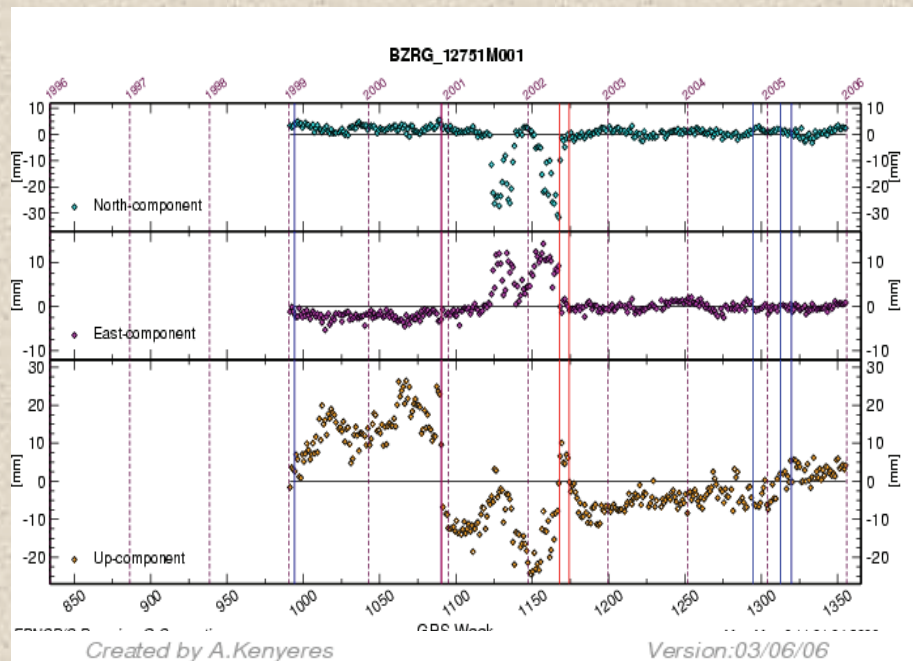


NEW TIME SERIES PLOTS

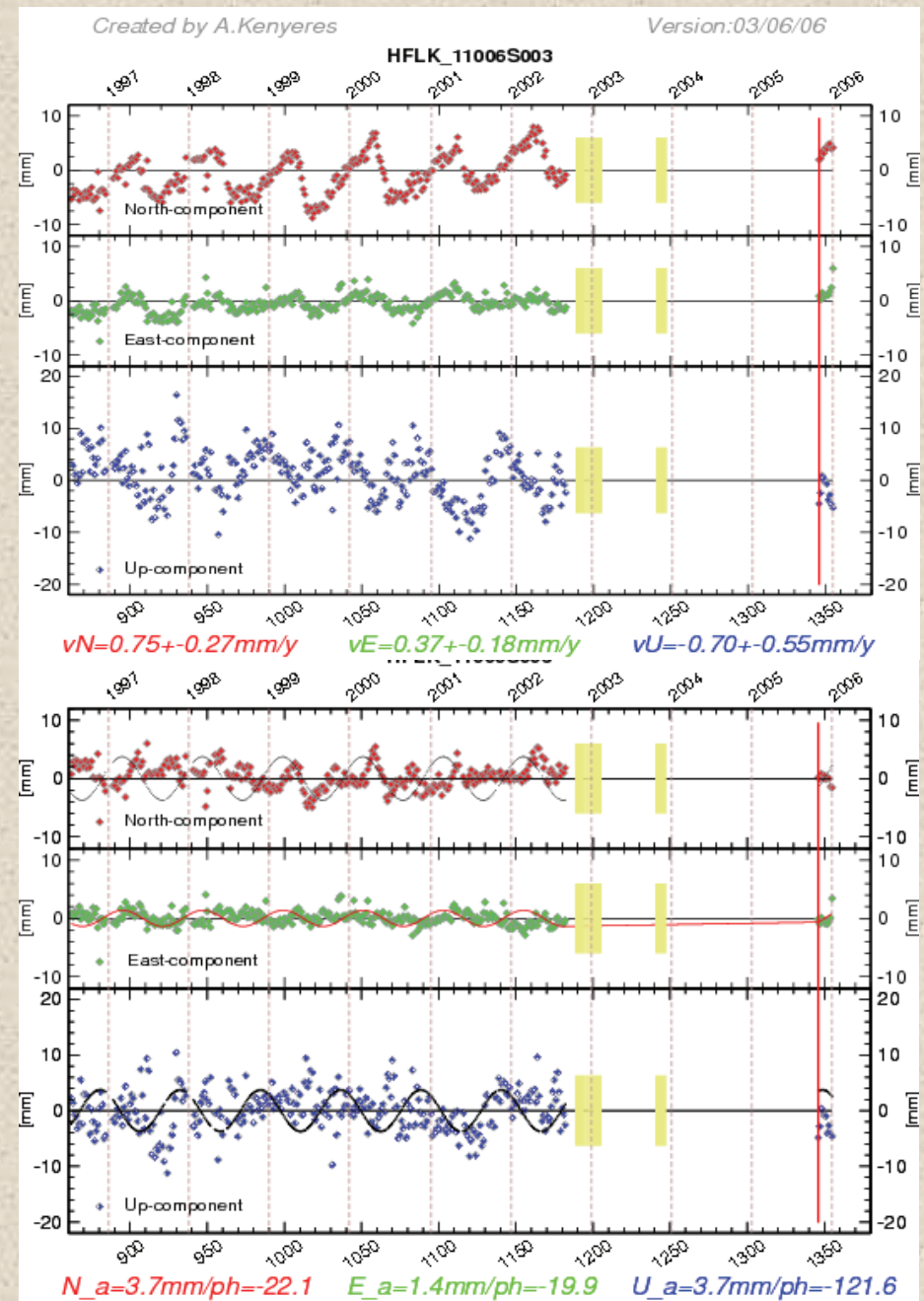
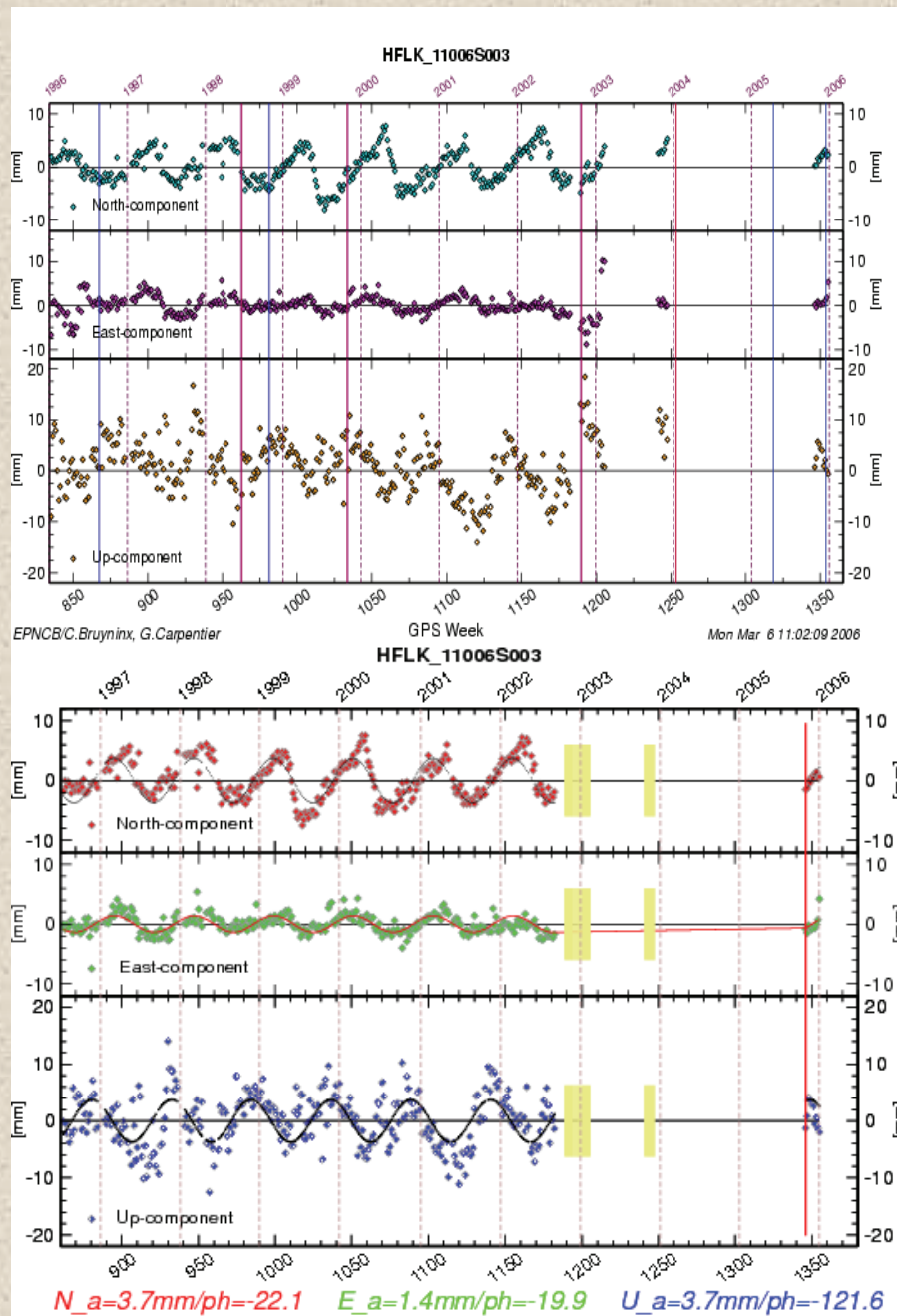
DE-TRENDED CLEANED, SEASONAL SIGNAL REMOVED



EXAMPLES



EXAMPLES



EXAMPLES

