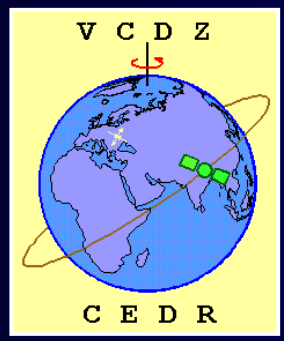
Stability of CZEPOS and VESOG sites from daily *LAC-GOP* EPN solutions

Vratislav FILLER
Geodetic Observatory Pecný

8th Czech-Polish Workshop on recent geodynamics of the Sudeten and adjacent areas,

Boguszyn, Poland, 29.-31.3.2007



Motivation

- EUREF Local Analysis Centre GOP is processing routinely more than 90 permanent GPS sites, producing daily & weekly coordinates
- 33 sites in Czech Republic, where min. one-year long time series of normal equations are available
- Time series of normal equations allow to make combination:
  - providing precise site coordinates *(not actual aim)*
  - checking stability of sites:
    - finding possible outliers and coordinate shifts
    - detecting periodical and linear movements
  - getting velocities relative to current ETRS realisation
- Aim: Stable sites may be used in geodynamics

LAC GOP processing

Processed sites:

	Network \ Purpose	EU REF	CZE POS	Processed by LAC GOP	Other
Czech sites	VESOG (Research and Experimental Network for Observations with GNSS)	2	4	**6**	
	CZEPOS (Czech Network of Permanent DGPS Stations), core stations		23	**22**	
	GEONAS (IRSM Geodynamic Network)	5		**5**	6
	Other networks (TOPNET, etc.)				~15
	Total :	*7*	*27*	*33*	
Outside	EUREF - LAC GOP			**42**	
	EUREF - other processed sites			**19**	
	Total :			*94*	

Actual products:

- **EUREF contribution (GOP subnetwork, weekly, daily SINEX)**
- **CZECH selection (constrained to 5 nearby IGS sites):**
  - ***weekly, daily SINEX***
  - ***ITRS, ETRS coordinates***
- **Troposphere postprocessing product**

Networks included in the solution

EPN/ITRS

- *Reference frame definition (fixed sites here)*

CZEPOS

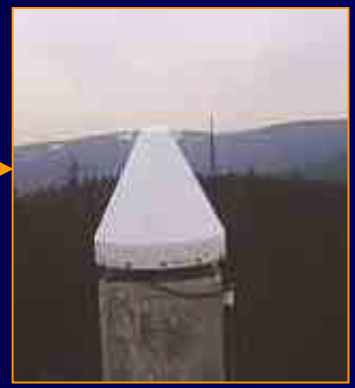
- *Built up by Czech Office for Surveying, Mapping and Cadastre*
- *Designed for providing realtime corrections (NTRIP, DGPS)*
- *Sites on cadastral office buildings*
- *Iron mounts (possible instability)*

VESOG

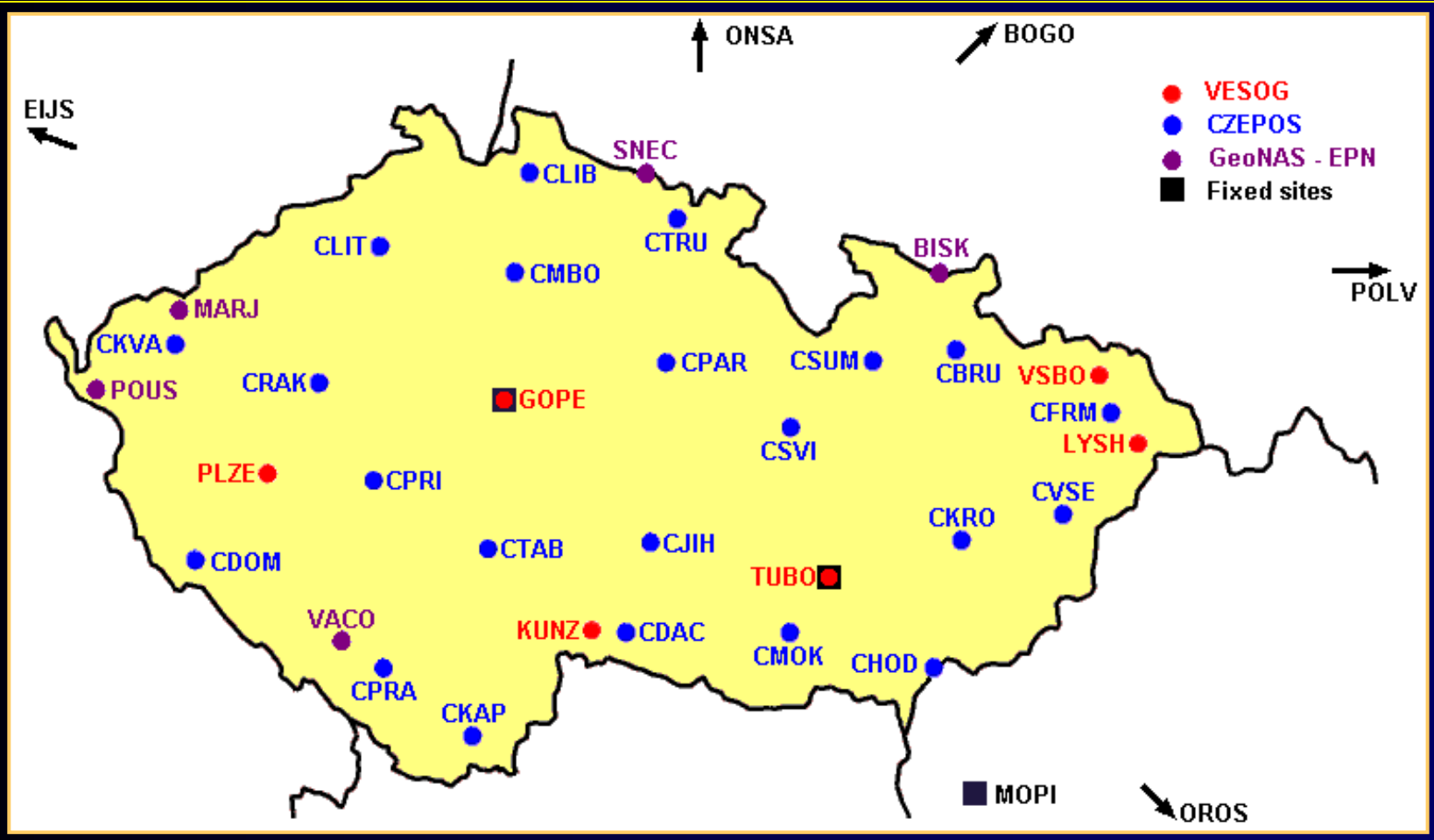
- *Research network*
- *Sites on buildings supposed to be stable*

GeoNAS *(EPN part)*

- *IRSM Geodynamic network*
- *Thoroughly stabilised sites (connected with bedrock)*



Processed sites



- **Estimation:** **31 sites (CZEPOS, VESOG, GEONAS-EPN)**
- **Fixing:** **7 EPN sites (5 IGS/EPN outside Czech Rep; GOPE, TUBO)**
  (sites without antenna change during period of interest; GOPE & TUBO need estimate coordinate slips)

Calculation I - input, preprocessing

Time span

- **whole interval: 82 weeks (10.4.2005 - 5.11.2006)**
- **last added sites: 52 weeks (6.11.2005)**

Software

- **Bernese GPS software 5.0 installed in LAC GOP.**

Input

- **566 daily NEQ files from LAC GOP (2Q variant)**
  - ***Loose constraint***
  - ***Relative Phase Centre Variation model***
- **"EPN Time series" IGS-00 coordinates and velocities for fixed sites**

Preprocessing

- **Create tiny daily NEQ files to shorten time of the calculation**
  - ***Elimination of all non-coordinate parameters and redundant sites***
  - ***Time consumption decreased ~300 times***

Calculation II - processing

Processing scheme:

1. **Outlier detection on fixed sites**
   - ***Free network solution***
   - ***Till limit 8, 8, 25 mm***
2. **Final coordinates of fixed sites**
   - ***Estimation of coordinate shifts on GOPE & TUBO***
3. **Outlier detection on estimated sites**
   - ***Partially manual ('snowed' intervals, etc.)***
   - ***Iterative procedure, till limit 8, 8, 25 mm***
   - ***Free network solution***
4. **Estimation of final coordinates and velocities**
   - ***Fixed sites constrained***
   - ***Velocities on estimated sites free in horizontal direction***
5. **Obtaining residuals to check stability of sites**
   - ***Fixed sites and velocities on all sites constrained to apriori values***
   - ***Residuals shall show also velocity change***

Results I - Coordinate products

Coordinate shifts

- *On sites GOPE and TUBO, coordinate shifts in mm level were estimated*
- *On site CMBO, an unannounced coordinate shift was detected at Jun 3., 2006.*

Velocities

- *IGB (apriori on estim. sites) and EPNTS (on fixed sites) velocities differ by ~ 1.6 mm/yr in North and -0,8 mm/yr in East - reduction necessary*

Repeatabilities

- **Solution 0**: *Raw residuals, outliers excluded till 15-15-45 mm, free network*
- **Solution 1**: *Final residuals, outliers excl.8-8-25 mm, fixed sites constraint*
- **Solution 2** : *Free network solution on all sites to minimise repeatabilities*

Solution	Average Repeatability			Lowest repeatablitiy			Highest repeatability*		
	N	E	U	N	E	U	N	E	U
0	2.07	2.31	7.56	CMOK 1.34	CVSE 1.13	VSBO 5.50	BISK 2.52	CJIH 2.37	KUNZ 14.65
1	1.72	1.88	6.22	PLZE 1.30	CKRO 1.22	VSBO 4.04	BISK 2.21	CJIH 2.60	LYSH 8.90
2	1.40	1.61	4.88	CMOK 0.84	CTAB 0.85	CKRO 3.81	BISK 1.98	CJIH 2.34	LYSH 8.54

*) except SNEC

Site stability detection I - strategy

Strategy : Detecting shift and annual periodicity from time series of residuals

Method:

- Used solution with fixed apriori velocities: there residuals express also velocity
- Only horizontal residuals are processed
- Used Least Squares Estimation of trend (B) and amplitude (a):

$$y_i = A_0 + B\,t_i + a\,\sin(t_i + \omega) + v_i \qquad \Sigma v_i v_i = min.$$

$$m_0 = \Sigma v_i v_i/(n-3) \qquad m_B = m_0\,\sqrt{1/\Sigma t_i t_i} \qquad m_a = m_0\,\sqrt{2/n}$$

- Significance of estimated values is statistically tested (relevance 95%)
- Minimum accepted values are 1 mm/yr trend and 1 mm amplitude

Solved problems:

- Inexact apriori velocities on estimated sites spoil trends
  - *Solved by reducing residuals in every epoch by epoch's average*
  - *Getting 'detrended' overall residuals*
- Too short time span for reliable separation of trend and amplitude:
  - *For span < 0,8 years, only trend is estimated*
  - *For span (0,8 yr. ≤ span < 1,3 yr.), only amplitude is estimated*

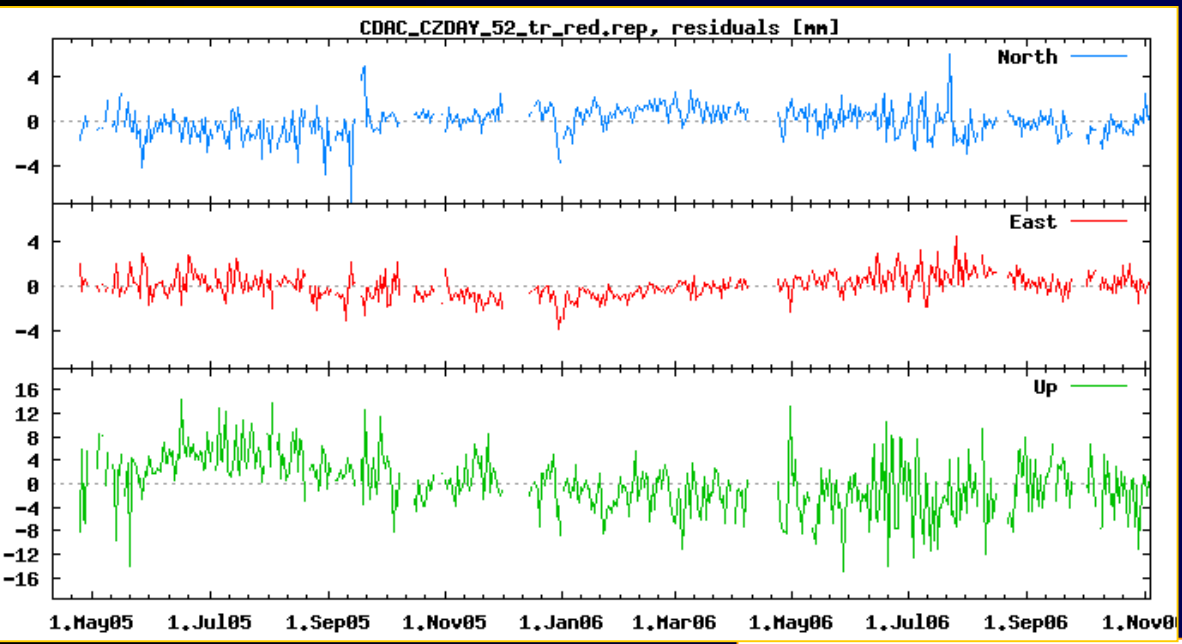
Site stability detection II - kinds of sites

Stability of estimated sites

- 5 groups of sites distinguished by detected stability:
  - Stable sites
  - Stable sites with frequent outliers
  - Sites with unsure trend or periodicity
  - Unstable sites - prevailing trend
  - Unstable sites - Prevailing annual periodicity

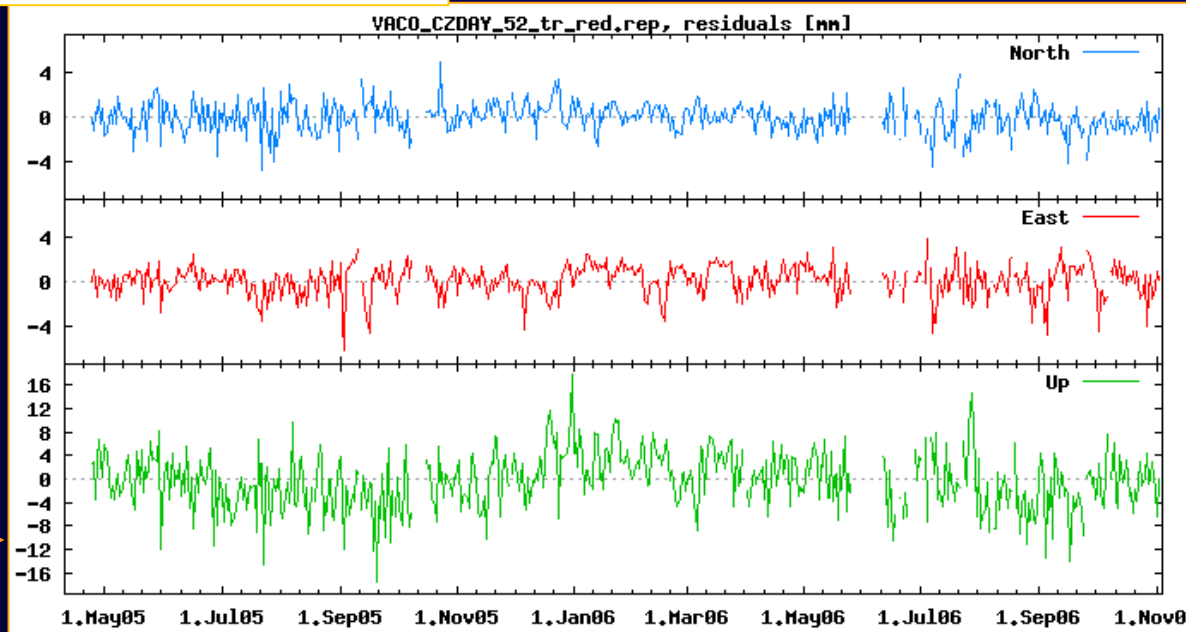
Category	Description	CZE-POS	VES-OG	Geo-NAS	to-tal
OK	No trend or amplitude detected	8	-	1	9
Outliers	Long intervals with outliers, usually connected with snow. Trend/amplitude caused by fully unremoved outliers	0	2	2	4
Unsure	Weak trend or amplitude (<1,5 mm, <1,5 mm/yr) or/and short period (1-1.3 yr)	7	1	1	9
Trend	Trend in some coordinate component > 1,5 mm/yr (weaker periodicity may occur)	2	-	-	2
Periodicity	Periodicity > 1,5 mm/yr (weak trend may occur)	5	1	1	7

Site stability detection III - stable sites

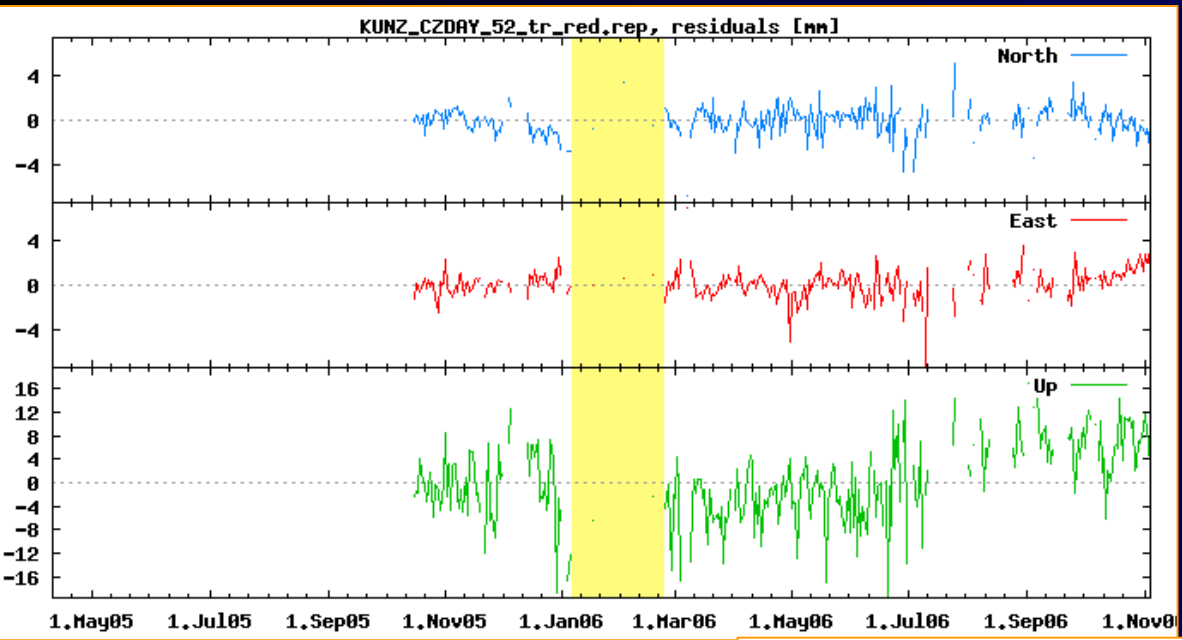


- No significant trend or amplitude detected
- About 1/3 sites

- 8 / 22 core CZEPOS sites:
  - CDAC, CFRM, CKRO, CLIB, CPAR, CRAK, CSVI, CTAB
- 0 / 4 estim. VESOG sites
- 1 / 5 GeoNAS-EPN sites:
  - VACO

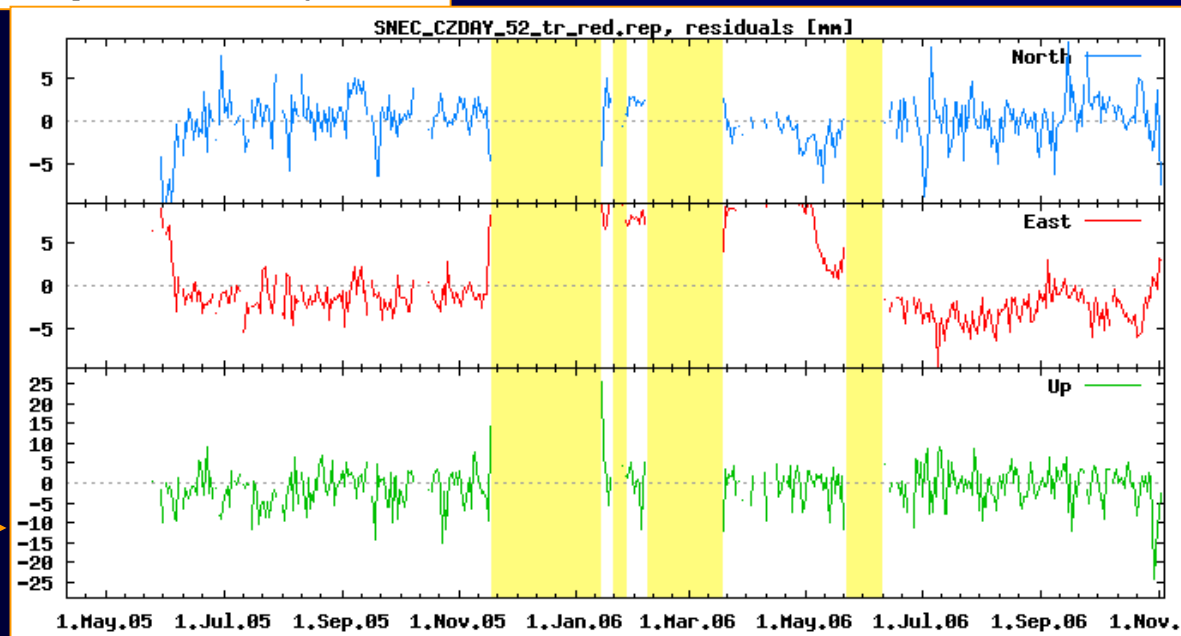


Site stability detection IV - outliers

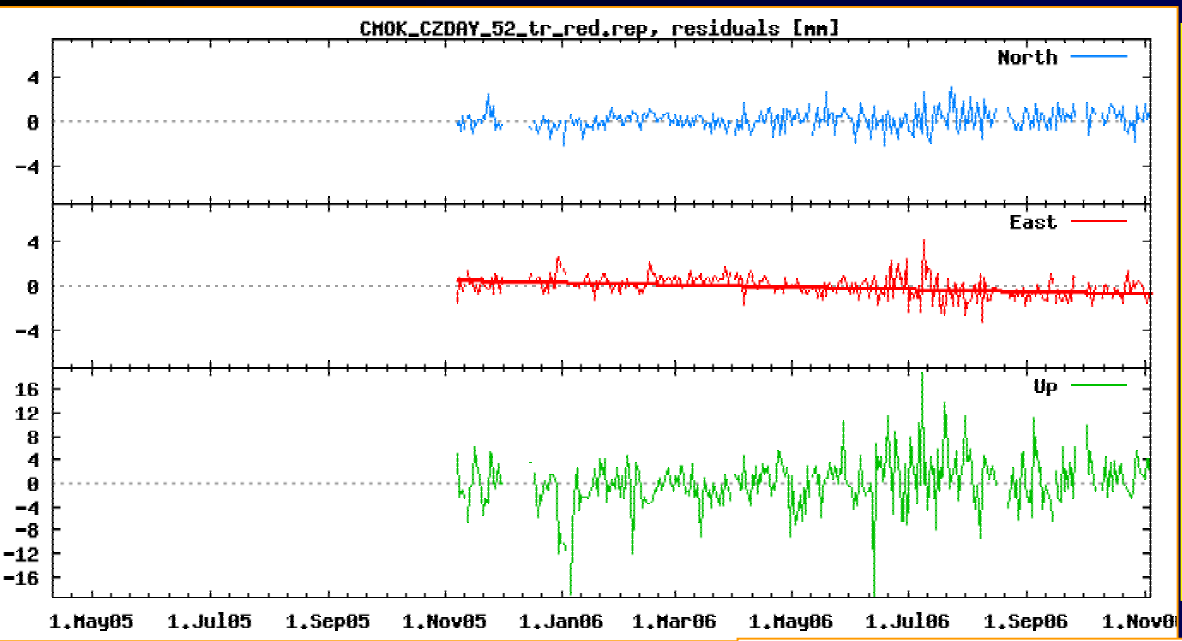


- About 1/8 sites (*high positioned*)
- Intervals with outliers were eliminated from the solution
- SNEC - strongest case:
  - *snow outliers on dm level*
  - *problematic detection of trend & periodicity*

- 0 / 22 core CZEPOS sites
- 2 / 4 estim. VESOG sites:
  - **KUNZ** *(snow outl.)*
  - **LYSH** *(outls.+weak trend)*
- 2 / 5 GeoNAS-EPN sites:
  - **BISK** *(snow -> N ampl.)*
  - **SNEC** *(very strong)*

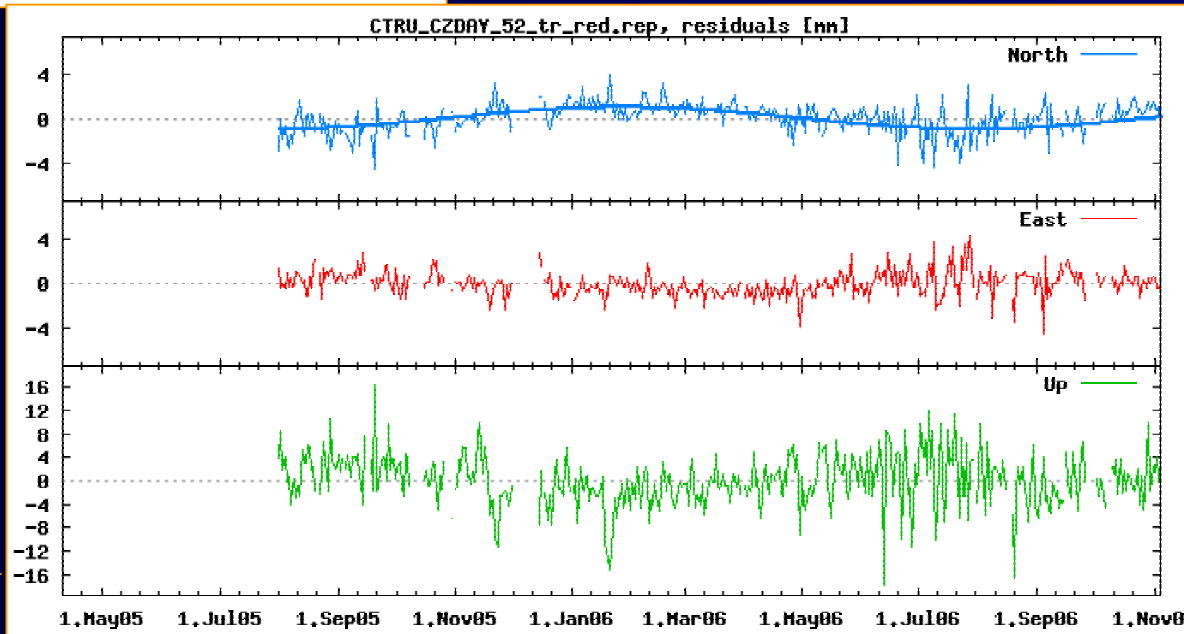


Site stability detection V - unsure/weak cases

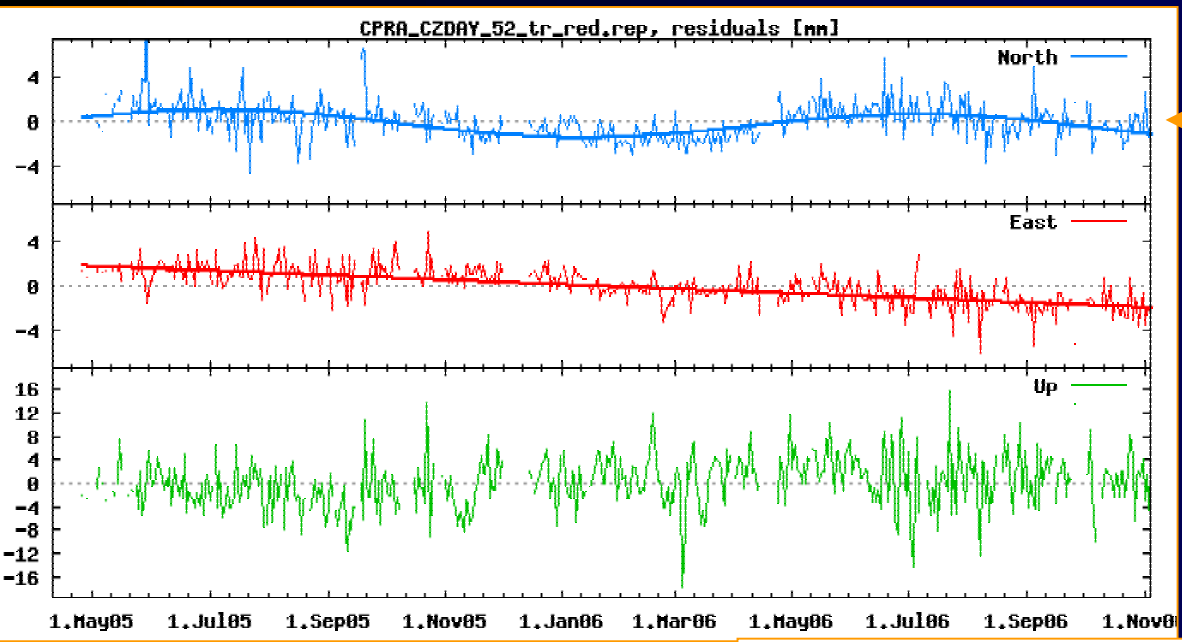


- About 1/3 sites
- on the border of reliability:
  - trends < 1,3 mm/yr
  - periods < 1,3 mm
  - time span < 1,3 yr
- 7 / 22 core CZEPOS sites
- 1 / 4 estim. VESOG sites
- 1 / 5 GeoNAS-EPN sites

Site	trend [mm/y]	ampl. [mm]	span [year]
VSBO	E -1,1	-	1,1
POUS	N 1,1	-	1,1
CBRU	N,E 1,3	-	1,0
CDOM	-	E 1,2	1,5
CKVA	-	E 1,1	1,5
CMBO	-	E 1,1	1,4
CMOK	E -1,3	-	1,0
CSUM	-	N 1,1	1,1
CTRU	-	N 1,0	1,3

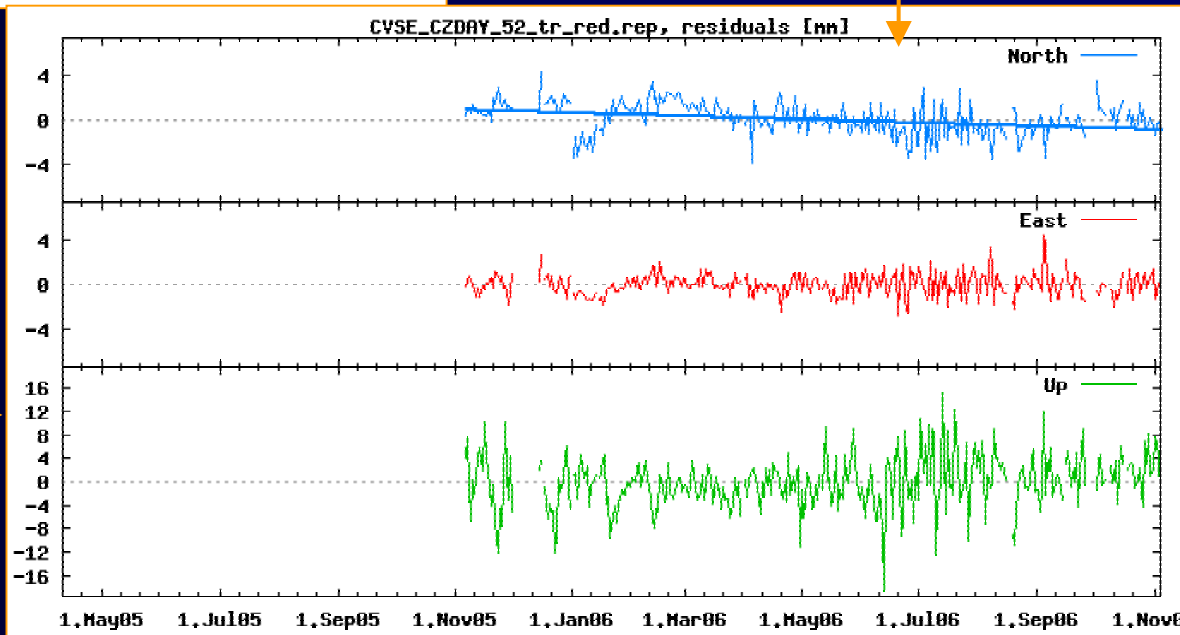


Site stability detection VI - trends

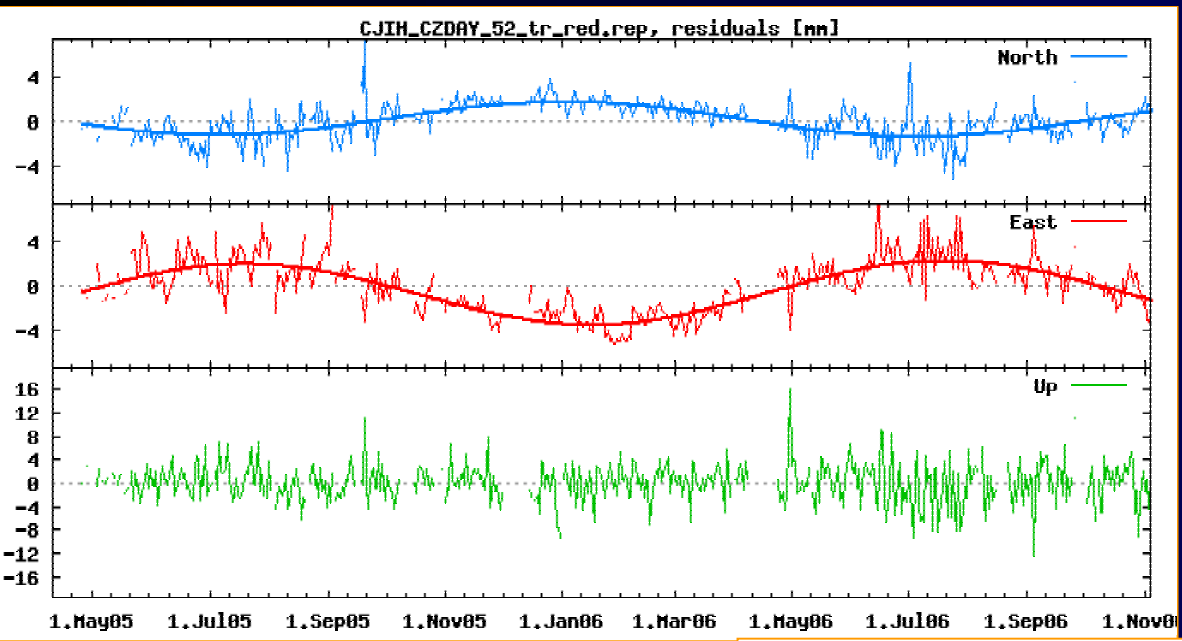


Major trends only on 2 sites

- **2 / 22 core CZEPOS sites**
  - **CPRA** *(E -2.5 mm/yr, additionally weak periodicity)*
  - **CVSE** *(N -1.8 mm/yr, but 1.0 year time span)*
- **0 / 4 estim. VESOG sites**
- **0 / 5 GeoNAS-EPN sites**

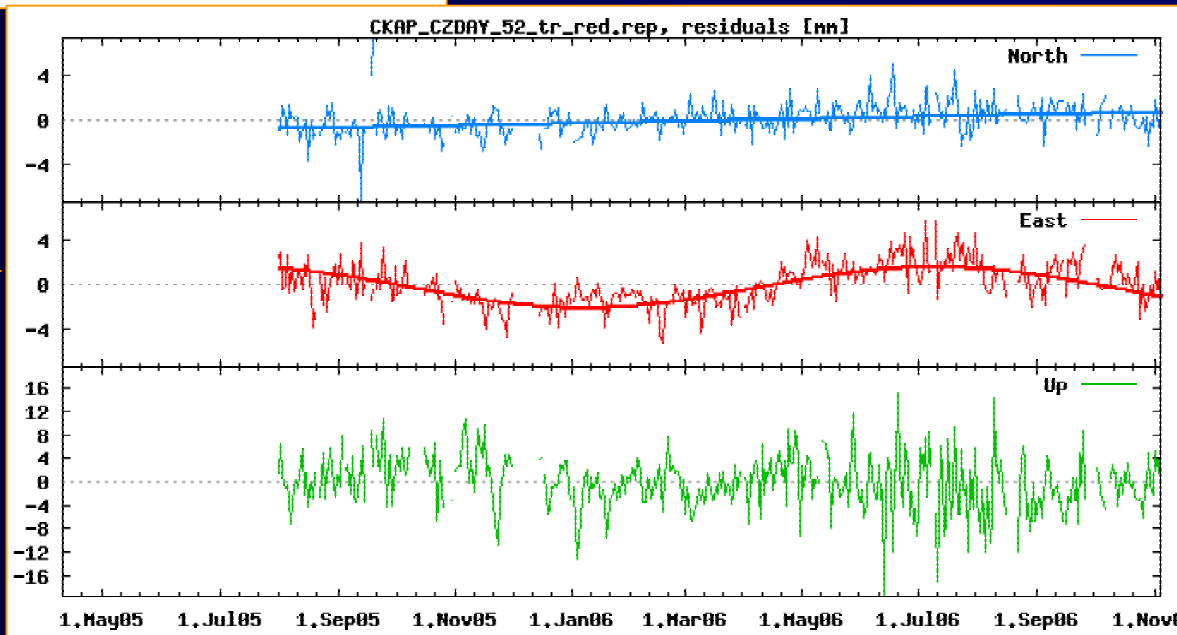


Site stability detection VII - periodicity



- About 1/4 sites
- 5 / 22 core CZEPOS sites
- 1 / 4 estim. VESOG sites
- 1 / 5 GeoNAS-EPN sites
- *CJIH: Period in both components, with common phase: swing axis in SW-NE direction*

Site	trend [mm/y]	ampl. [mm]	ampl. max.	span [year]
CHOD	N -1.1	E 2.0	Jul	1.1
CJIH	-	SW 3.3	Jul	1.5
CKAP	N 1.2	E 1.9	Jun	1.3
CLIT	-	SW 2.1	May	1.3
CPRI	-	E 2.4	Jun	1.5
MARJ	-	N 1.5	Jun	1.5
PLZE	-	W 1.8	Jul	1.0



Site stability overview - 1

Ampl.	BISK	N		1.01 mm	(1.5 yr)
Trend	CBRU	N	1.28 mm/yr		(1.0 yr)
Trend	CBRU	E	1.39 mm/yr		(1.0 yr)
Ampl.	CDOM	E		1.20 mm	(1.5 yr)
Trend	CHOD	N	-1.12 mm/yr		(1.1 yr)
Ampl.	CHOD	E		2.04 mm	(1.1 yr)
Ampl.	CJIH	N		1.55 mm	(1.5 yr)
Ampl.	CJIH	E		2.86 mm	(1.5 yr)
Trend	CKAP	N	1.22 mm/yr		(1.3 yr)
Ampl.	CKAP	E		1.86 mm	(1.3 yr)
Ampl.	CKVA	E		1.13 mm	(1.5 yr)
Ampl.	CLIT	N		1.07 mm	(1.3 yr)
Ampl.	CLIT	E		1.78 mm	(1.3 yr)
Ampl.	CMBO	E		1.08 mm	(1.4 yr)
Trend	CMOK	E	-1.27 mm/yr		(1.0 yr)
Ampl.	CPRA	N		1.15 mm	(1.5 yr)
Trend	CPRA	E	-2.51 mm/yr		(1.5 yr)
Ampl.	CPRI	E		2.37 mm	(1.5 yr)
Ampl.	CSUM	N		1.10 mm	(1.1 yr)
Ampl.	CTRU	N		1.00 mm	(1.3 yr)
Trend	CVSE	N	-1.82 mm/yr		(1.0 yr)
Trend	LYSH	N	-1.20 mm/yr		(1.1 yr)
Ampl.	MARJ	N		1.54 mm	(1.5 yr)
Ampl.	PLZE	E		1.87 mm	(1.0 yr)
Trend	POUS	N	1.09 mm/yr		(1.1 yr)
Trend	VSBO	E	-1.10 mm/yr		(1.1 yr)

Site stability - overview 2

Category	CZEPOS	VESOG	GeoNAS	total
Stable	8	-	1	9
Outliers	0	2	2	4
Unsure	7	1	1	9
Periodicity	5	1	1	7
Trend	2	-	-	2

Conclusion

Stability of CZEPOS:

- more than 1/3 of sites seems stable (trend & amplitude < 1 mm)
- many unsure sites due to short time span (1 - 1.1 year)
- 2 sites with clear trend > 1.5 mm/yr (CPRA, CVSE)
- 5 sites with 1 year-amplitude > 1,5 mm (*even > 3 mm*)

Stability of CZEPOS sites responds to method of mounting on iron angles on buildings' roofs. Two sites with trend shows that long time millimetre stability is not generally achievable.

VESOG:

- Tough winter 2005/6 shown effect of snow on LYSH and KUNZ
- Despite short span, PLZE seems to have amplitude ~2 mm

GeoNAS:

- Confirmed known problems with snow outliers on SNEC and BISK
- Surprising 1,5mm N-S amplitude on MARJ site (building?)
- No reliable trends observed on GeoNAS sites - it verifies good stability of sites, necessary for geodynamic network

Outlook

Future combinations and processing

- New (longer) combination shall be carried out
- complication caused by PCV model and reference system in GPS week 1400 (short solution after 'break' fails on singularity)
- Other sites located in Czech could be joined

Usability for geodynamics

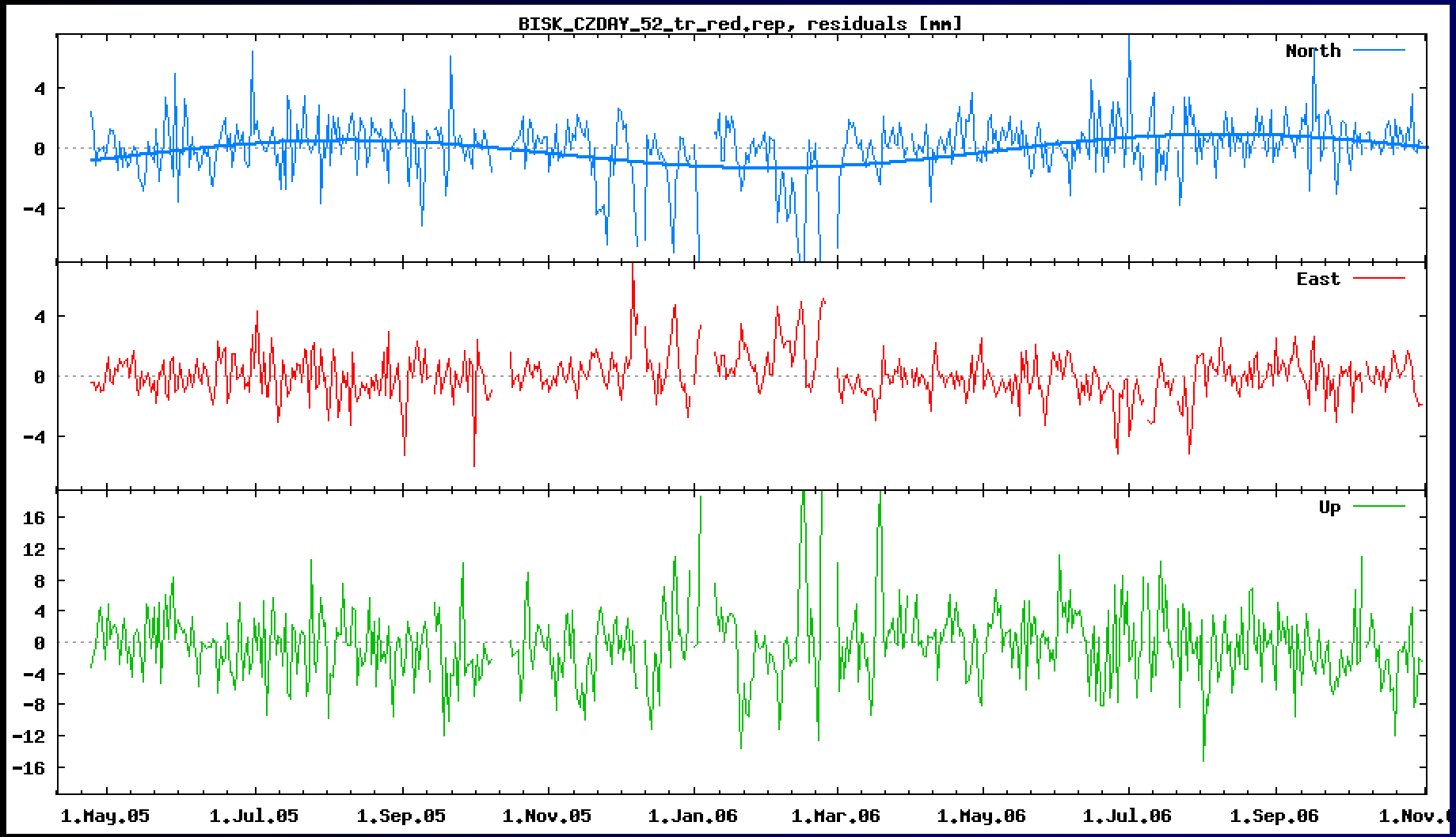
- Selected sites of VESOG may be used for geodynamic purposes
- Unfortunately, CZEPOS is rather unfit for this purpose

(in)stability of CZEPOS in future

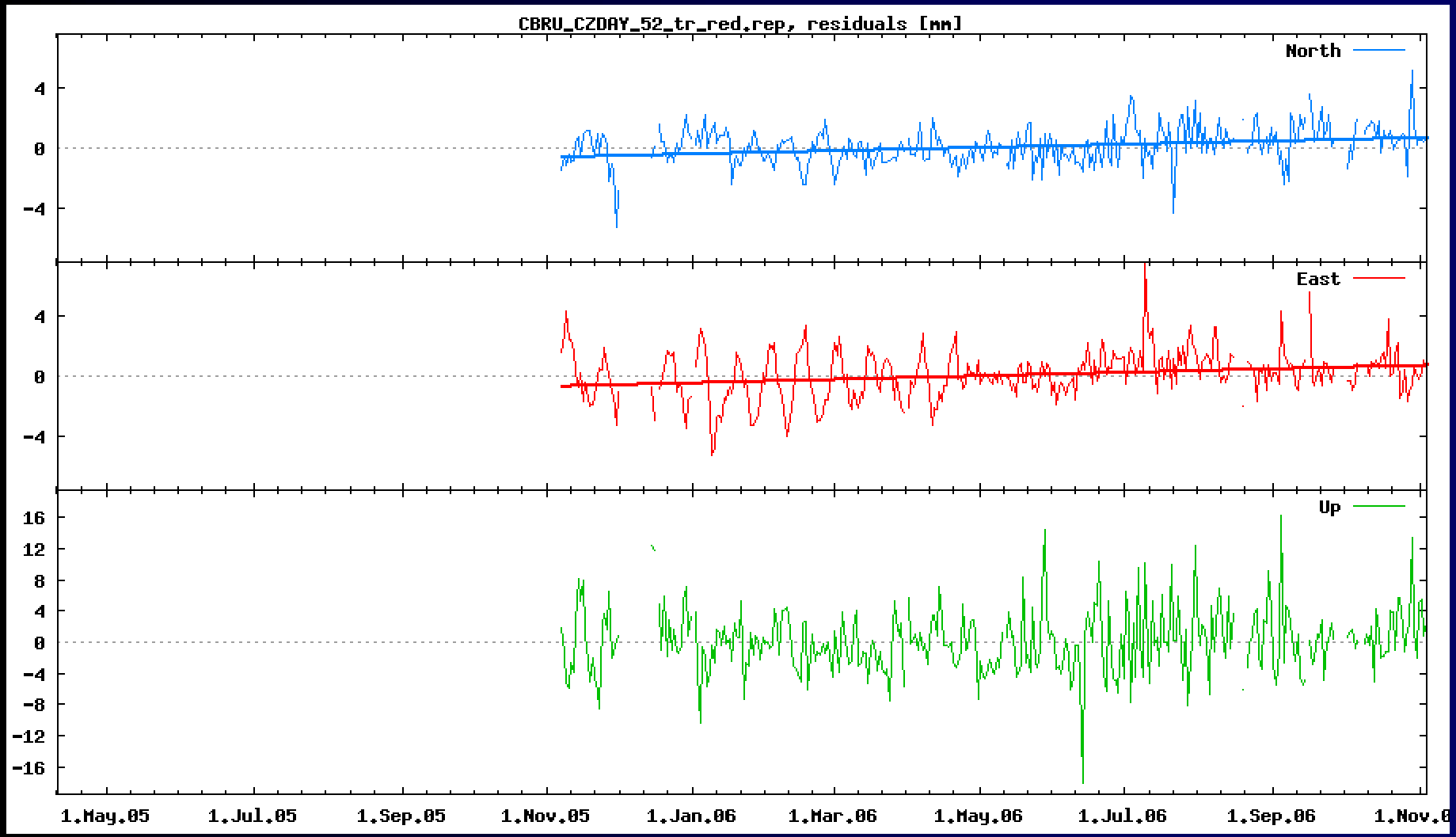
- There is intention to include CZEPOS into official geodetic fundaments in Czech Republic. Detected swings or trends on about one half of sites warn that stability of CZEPOS will stay on ~0.5 cm level (horizontal) - until an estimation of precise velocities (and also amplitude of annual periodicity) from several years long time series is available.


Thanks for your attention...

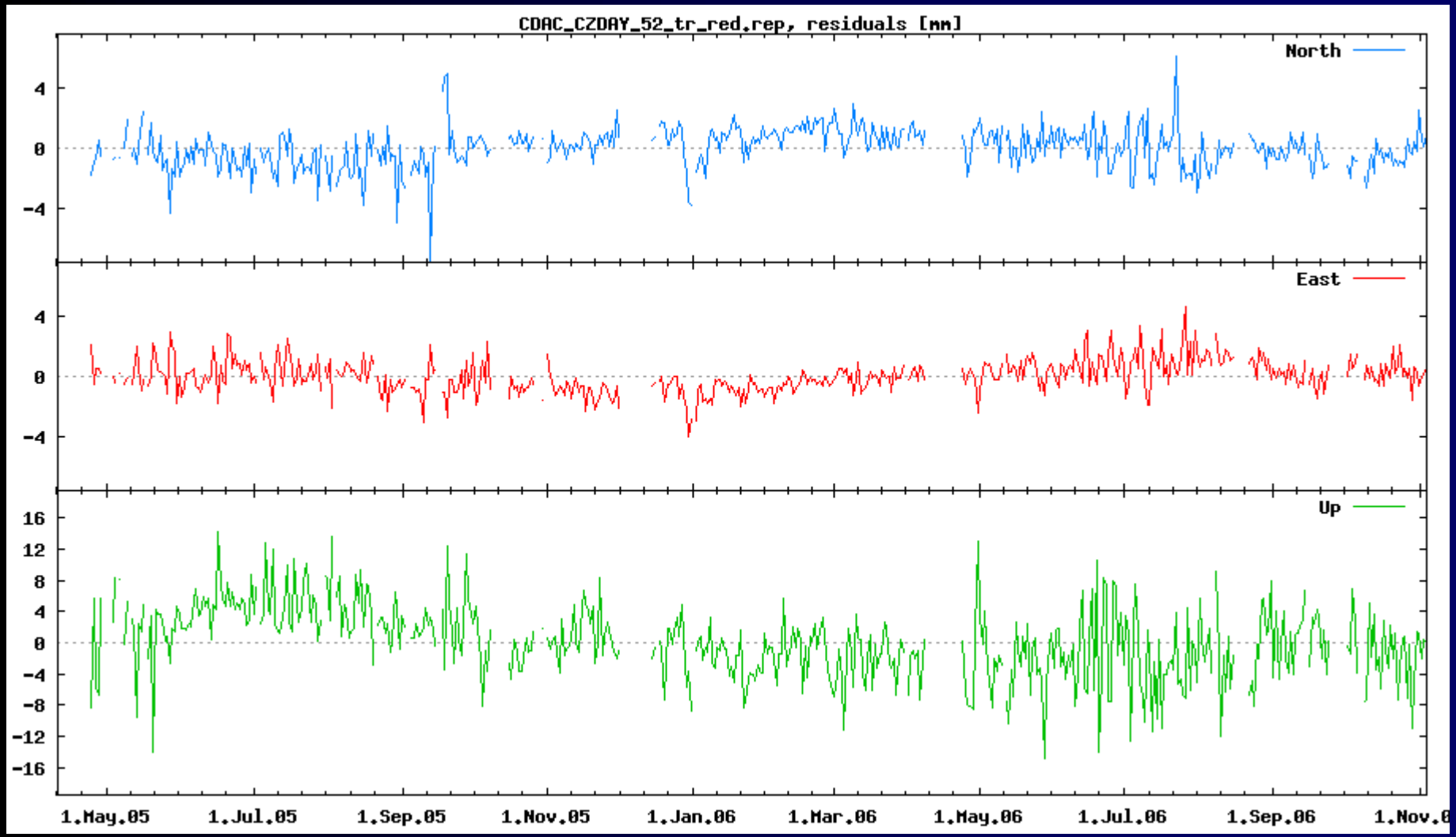
BISK


BISK_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

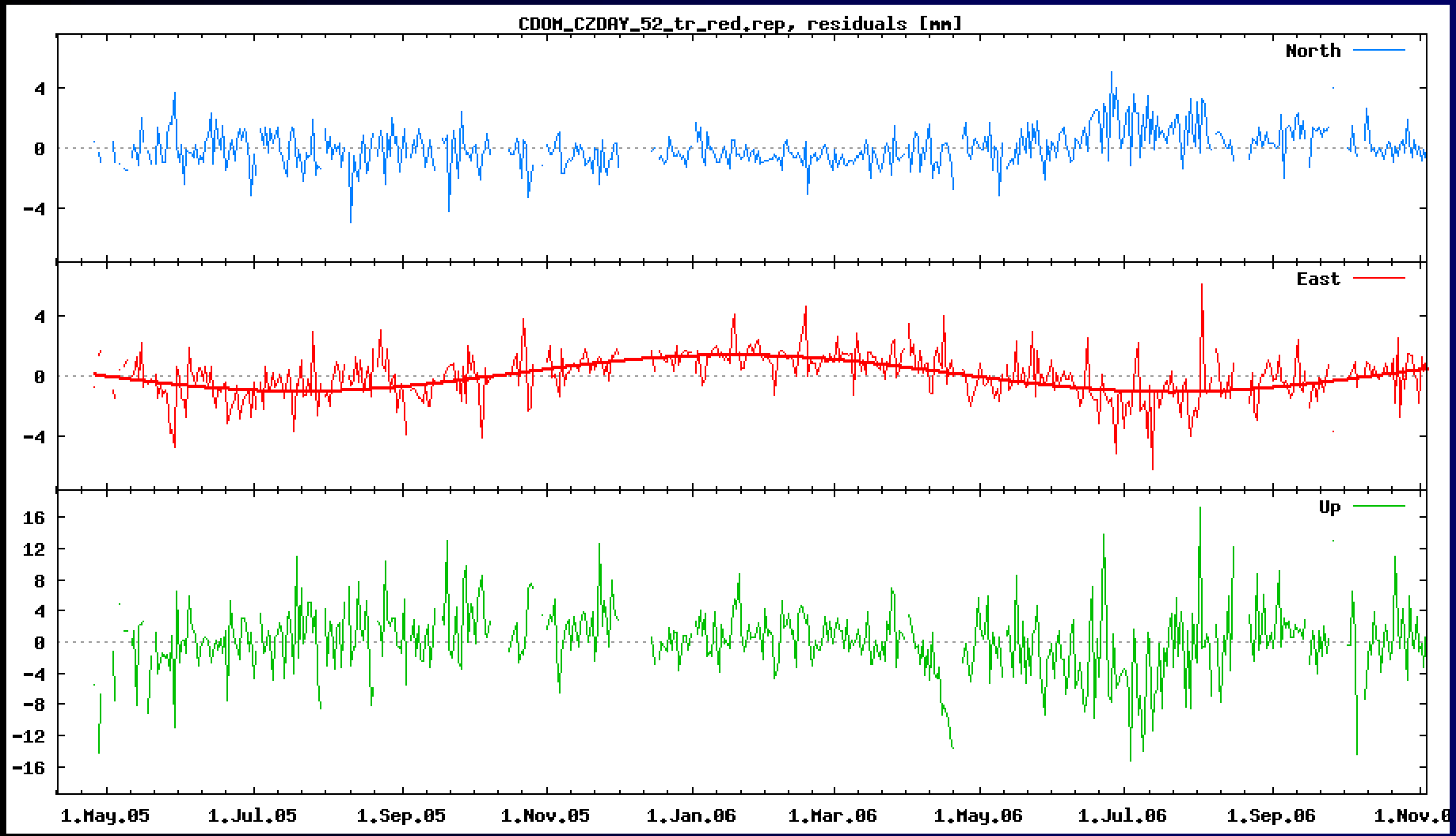
CBRU


CBRU_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

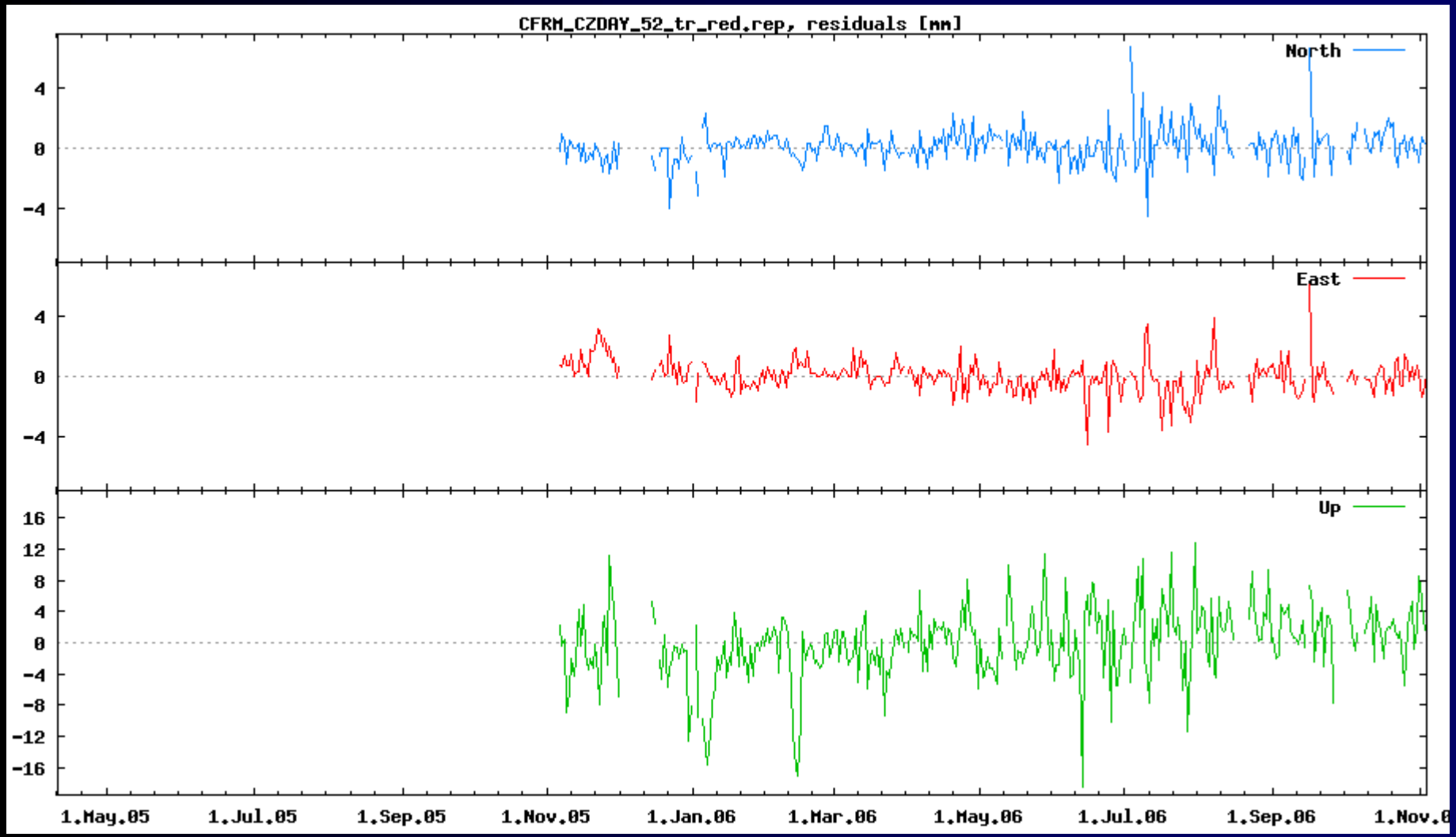
CDAC


CDAC_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

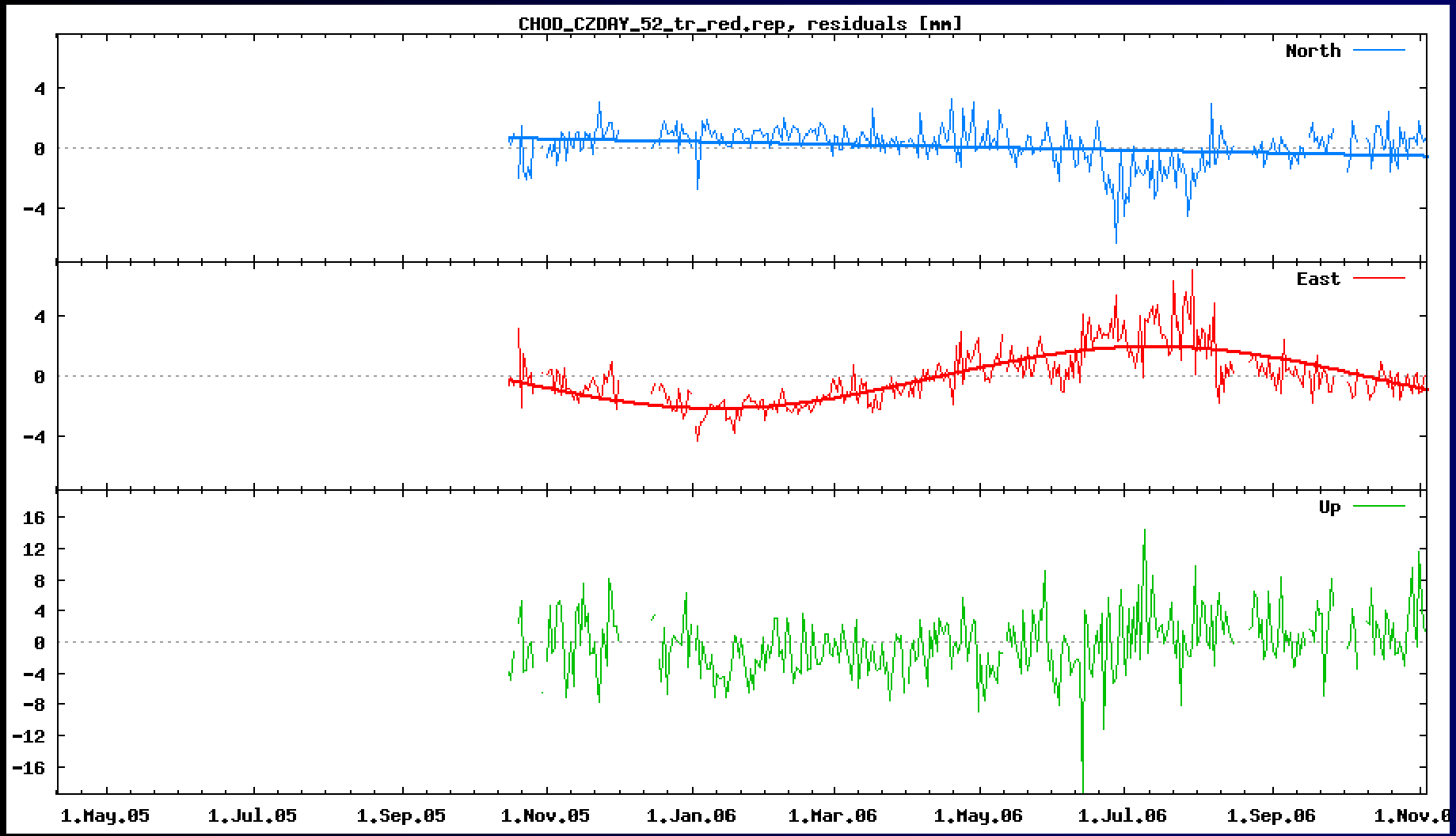
CDOM


CDOM_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

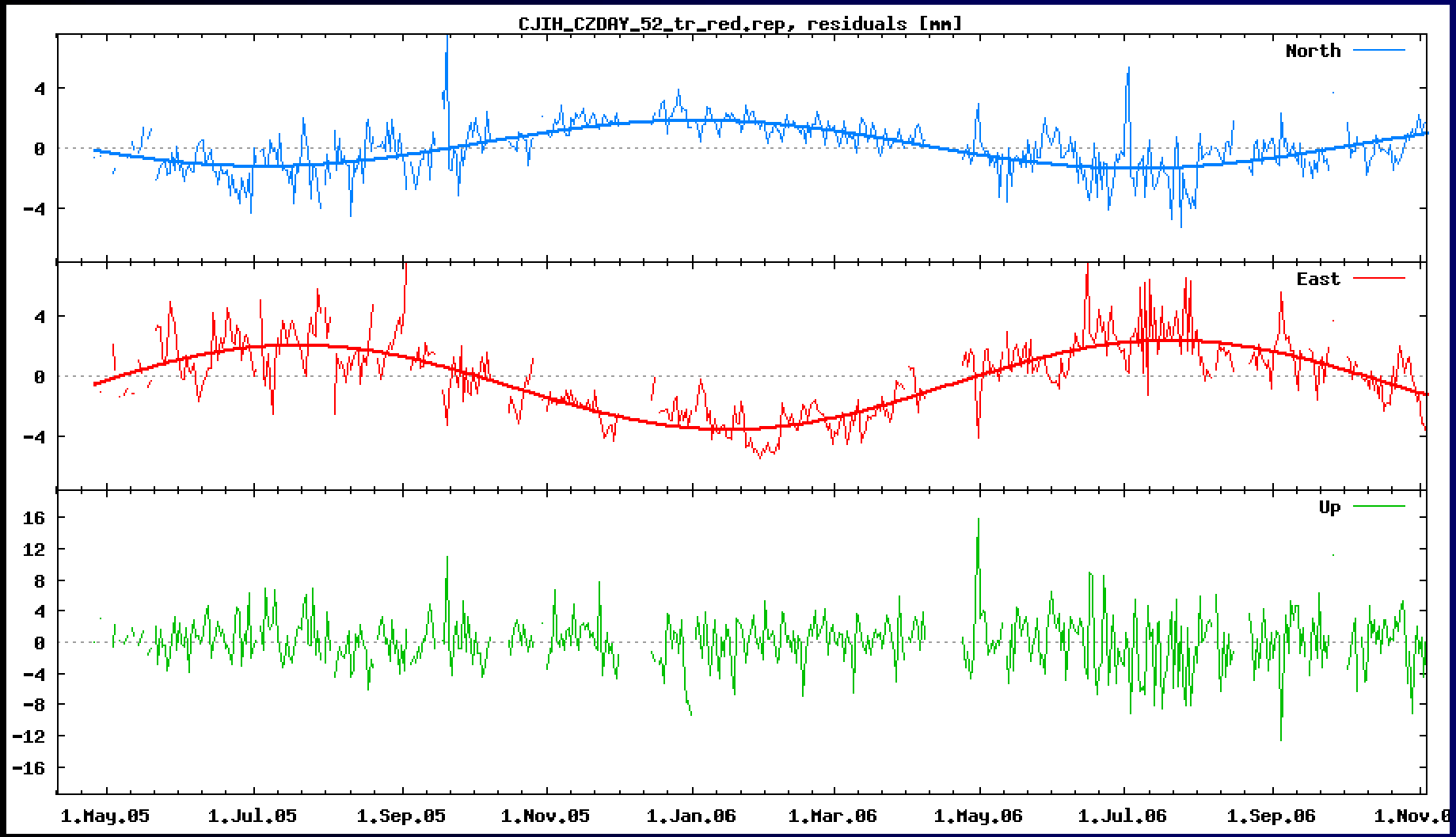
CFRM


CFRM_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

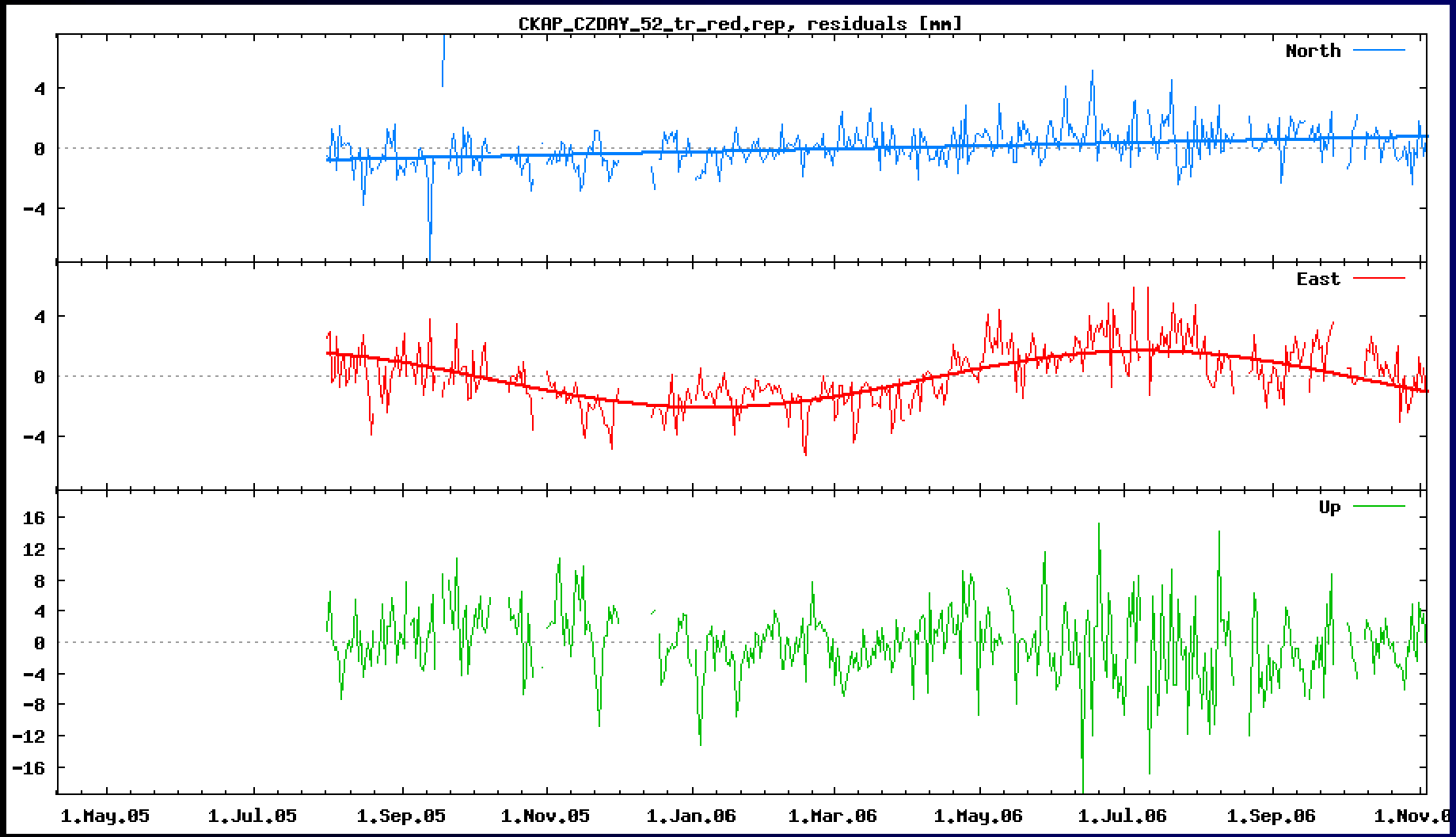
CHOD


CHOD_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

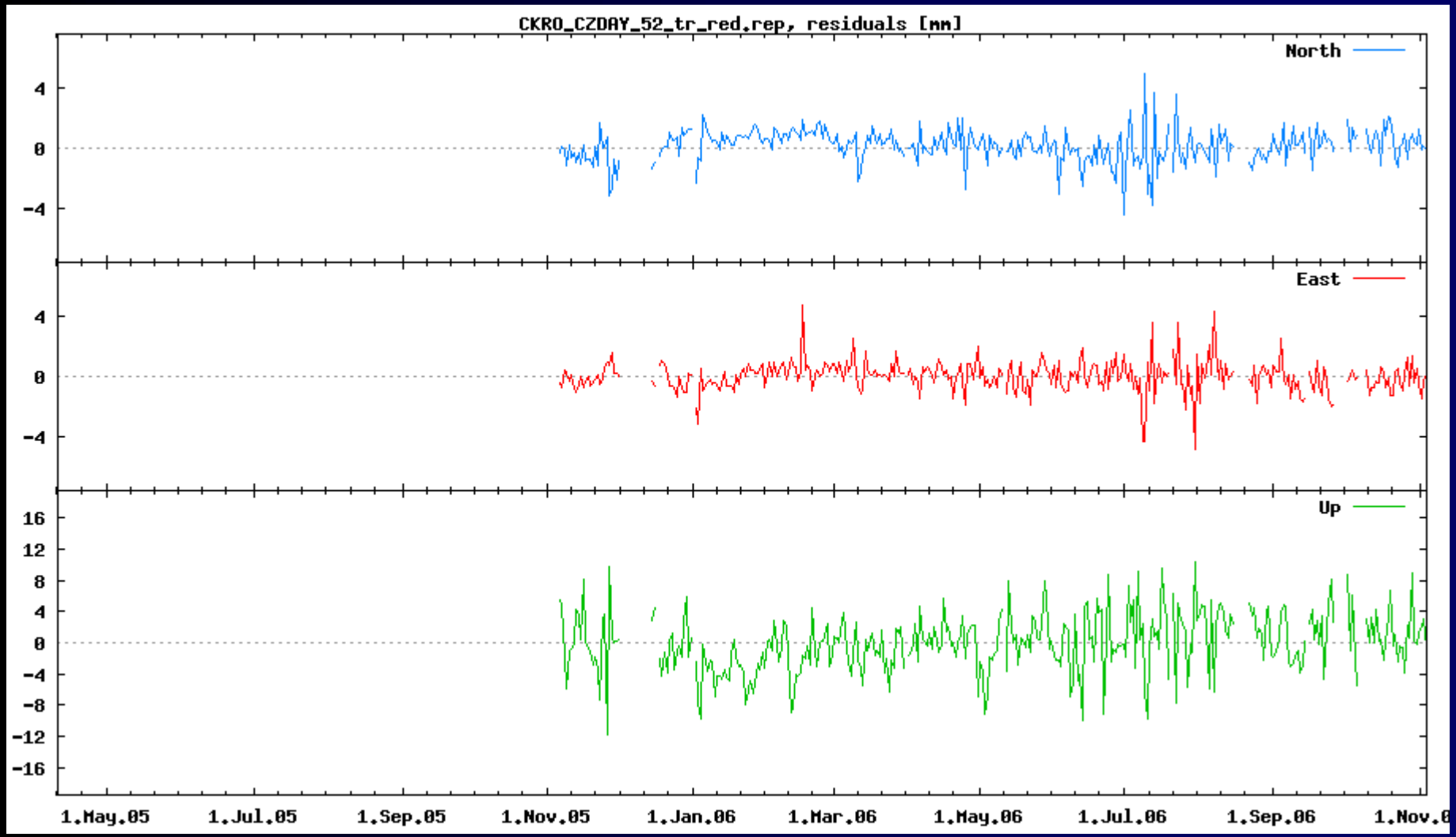
CJIH


CJIH_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

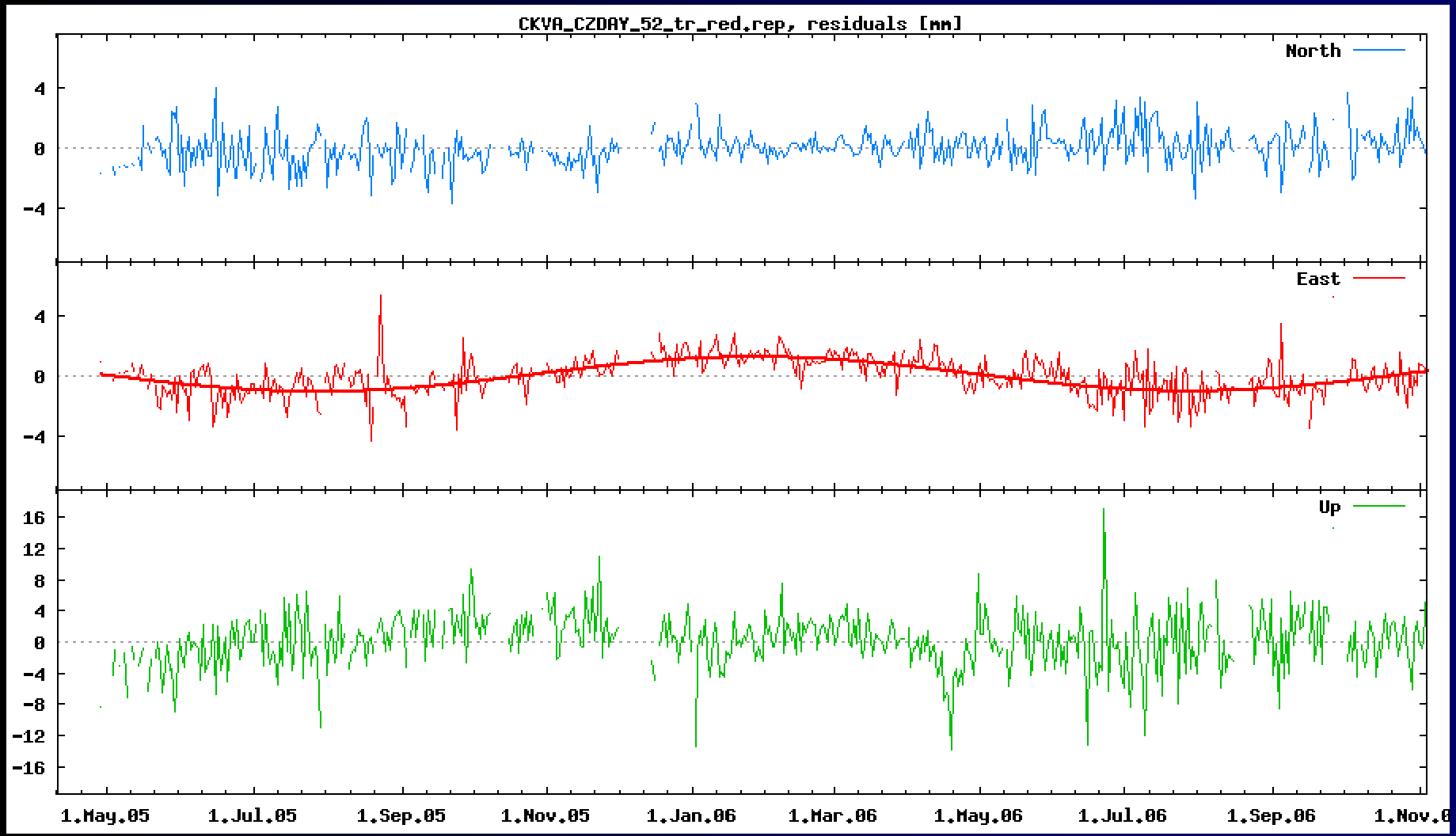
CKAP


CKAP_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.06

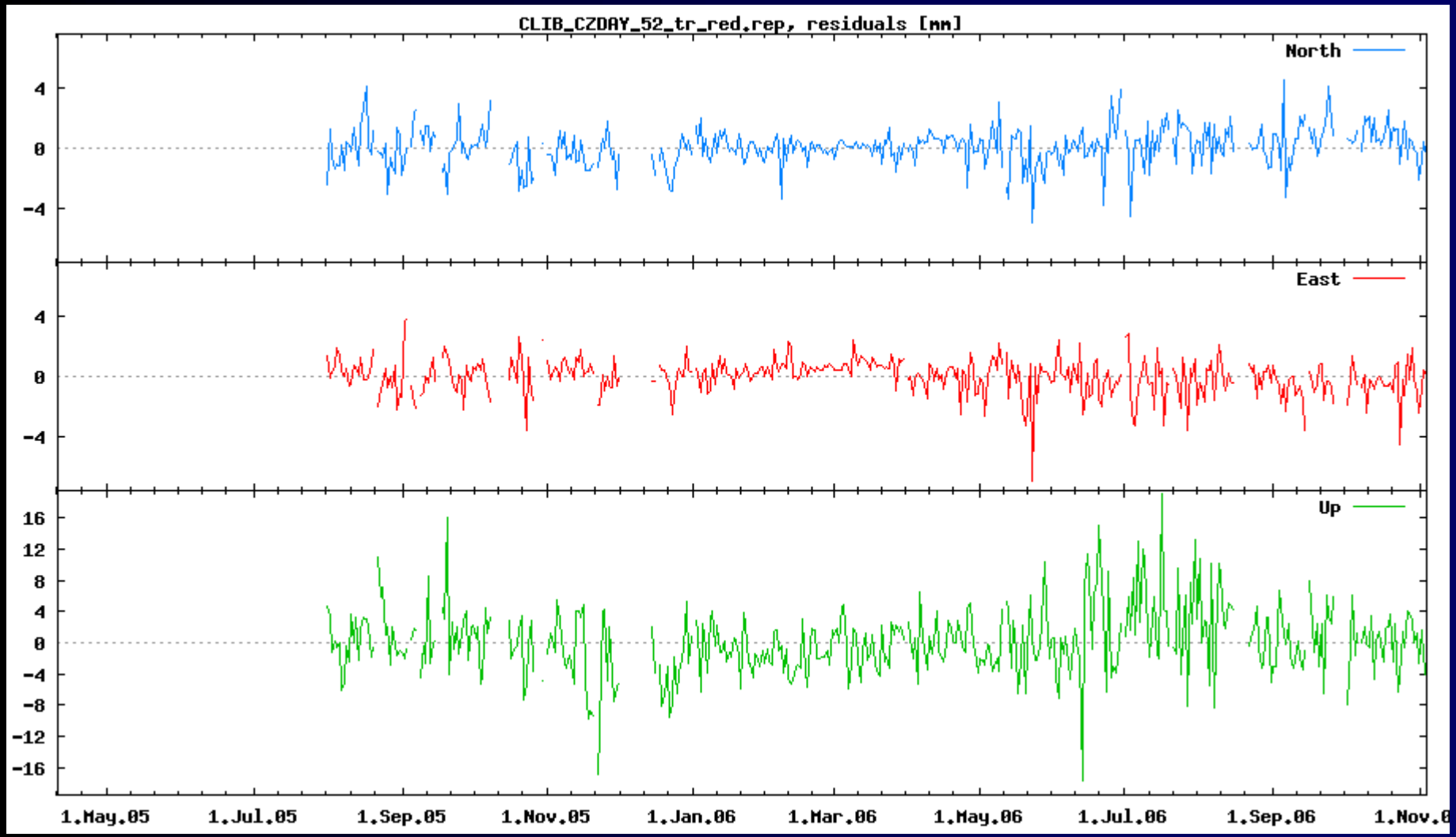
CKRO


CKRO_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.06

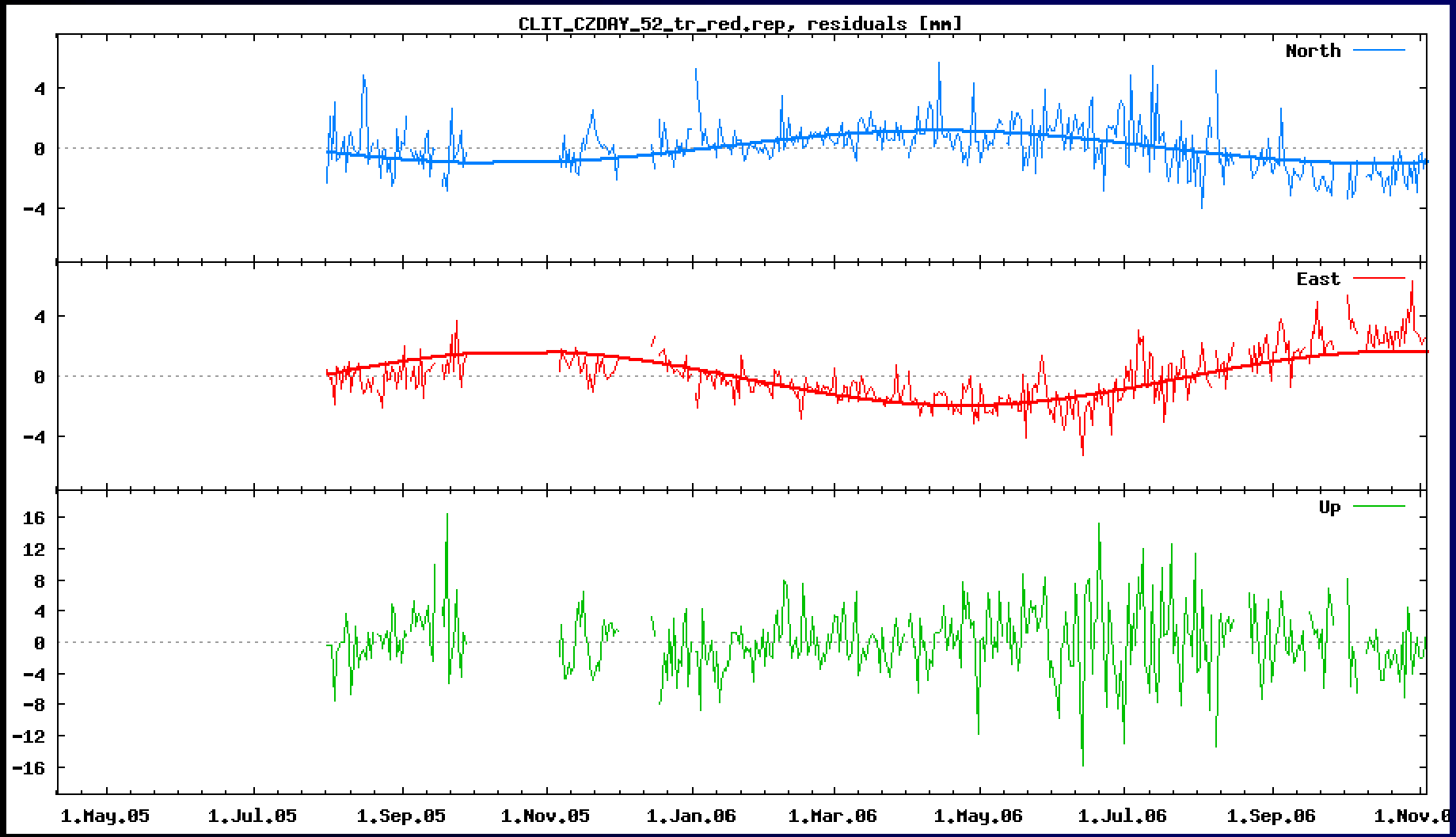
CKVA


CKVA_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

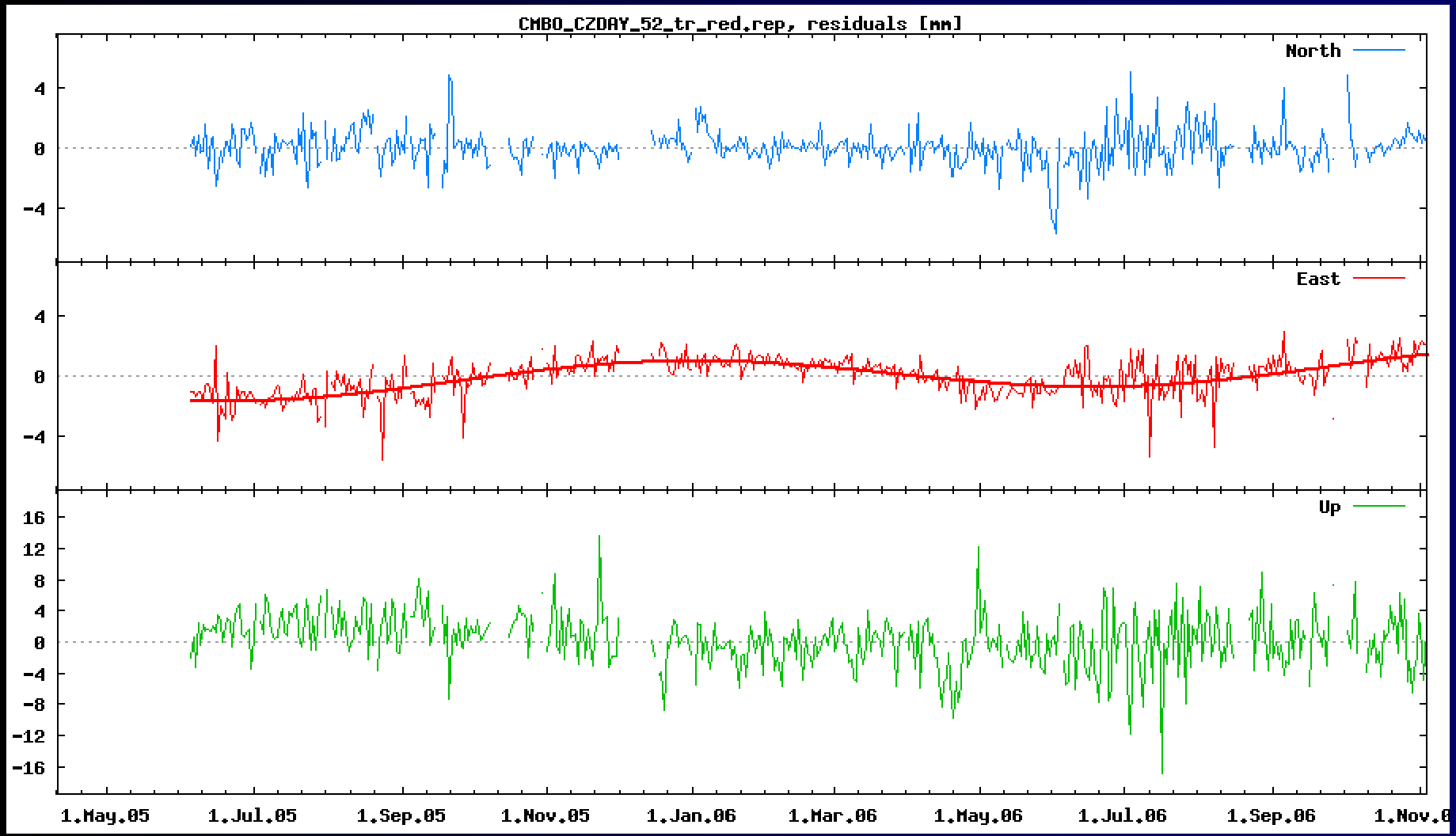
CLIB


CLIB_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

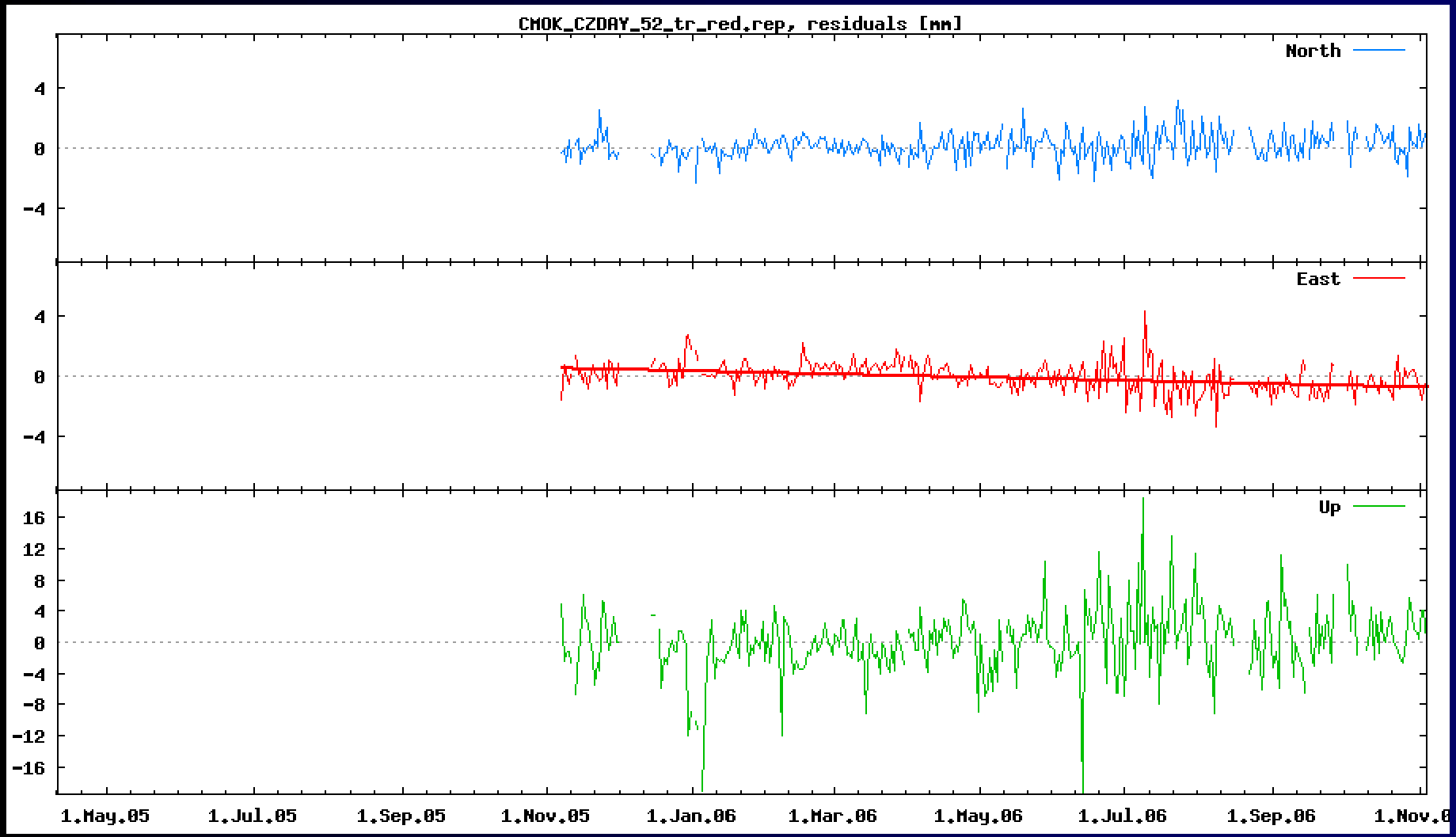
CLIT


CLIT_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

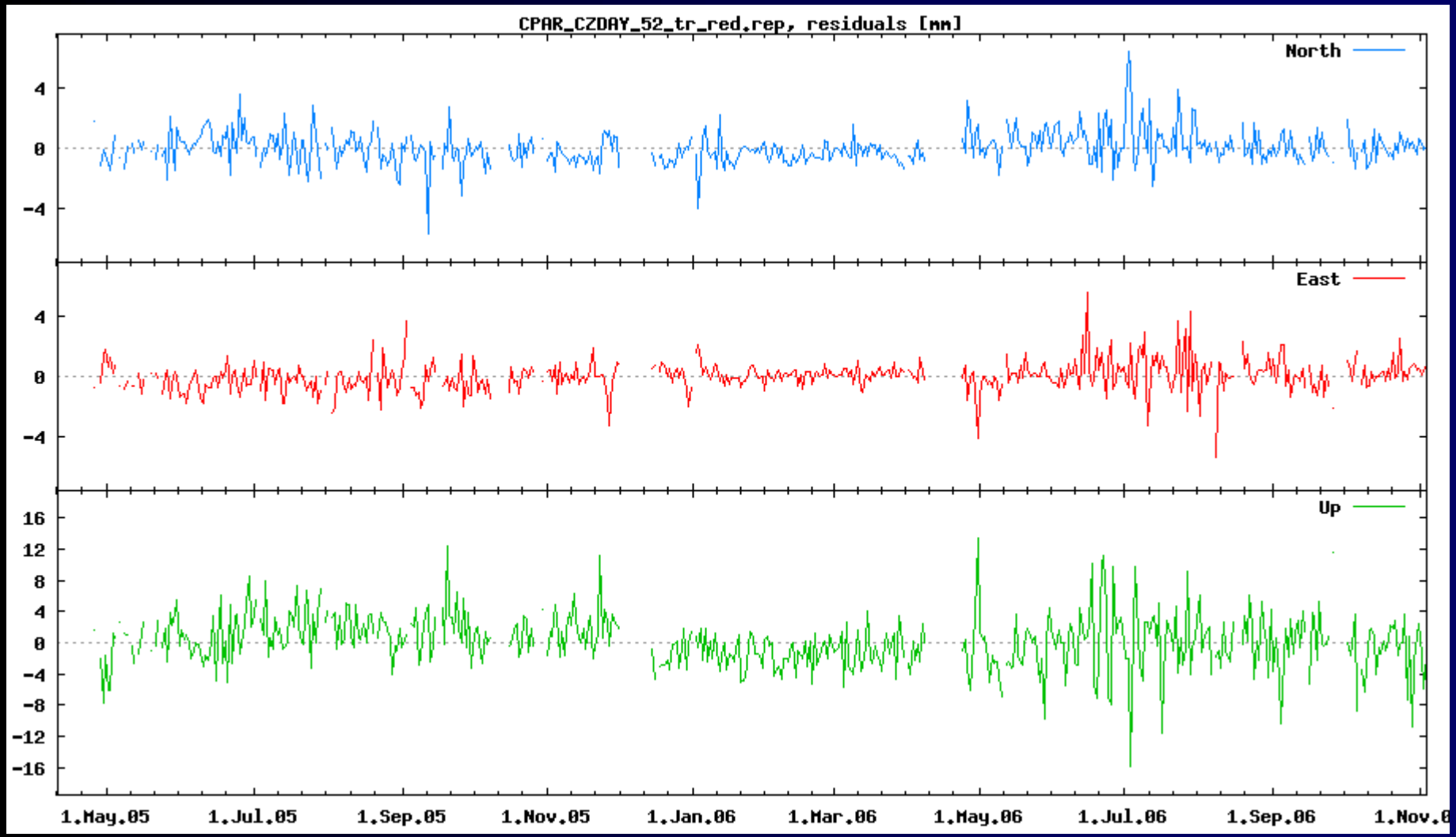
CMBO


CMBO_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

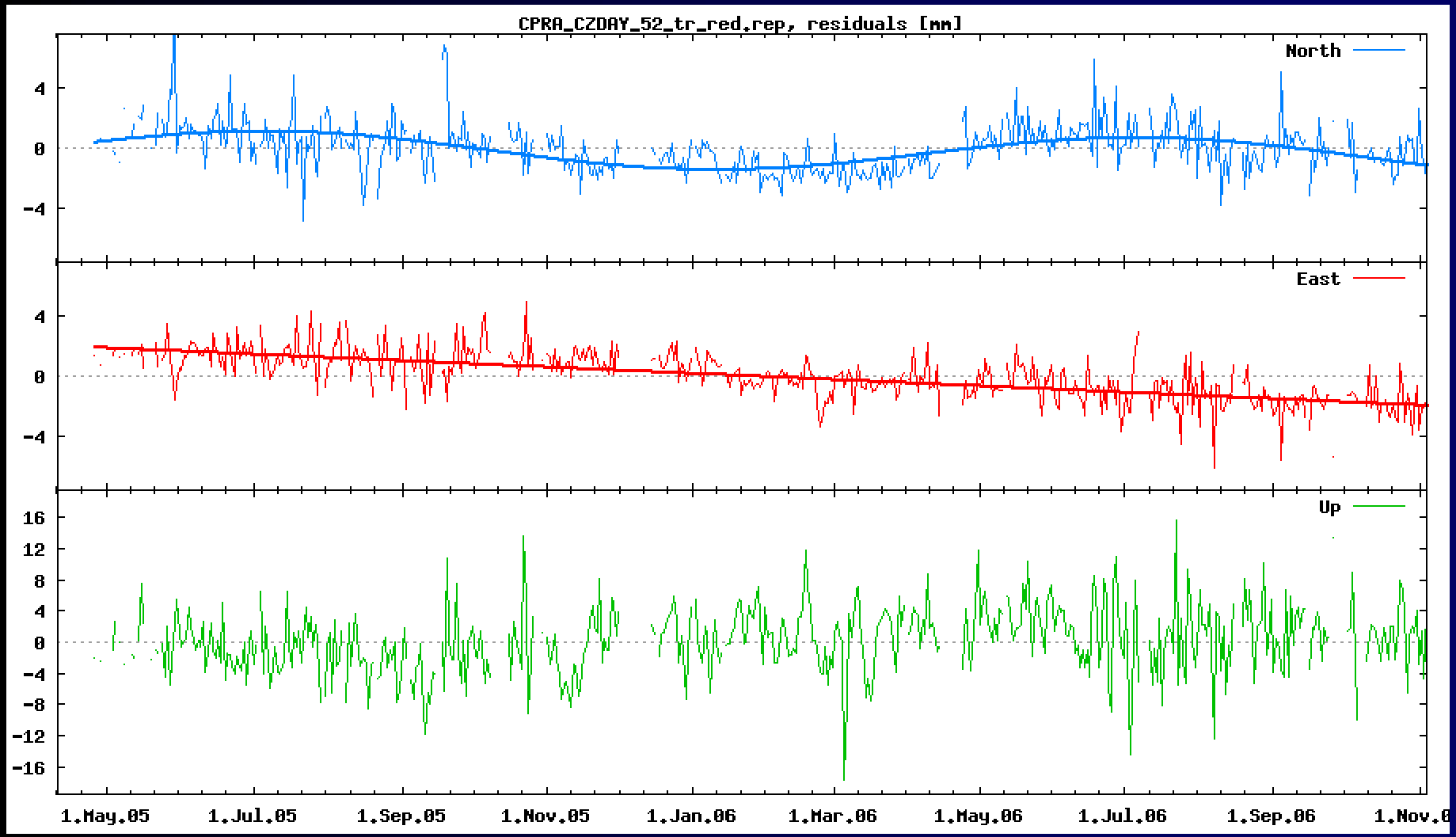
CMOK


CMOK_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

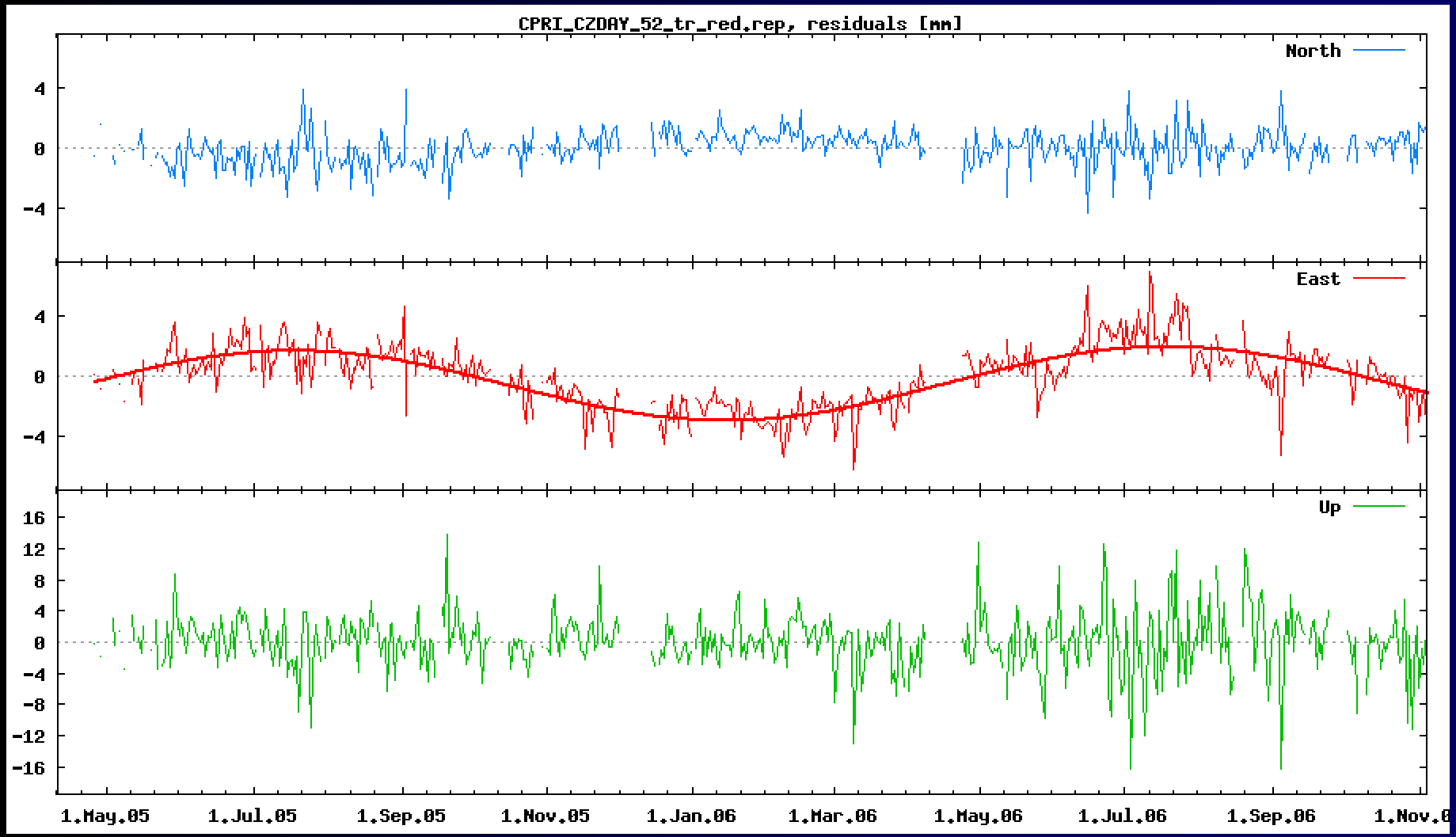
CPAR


CPAR_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

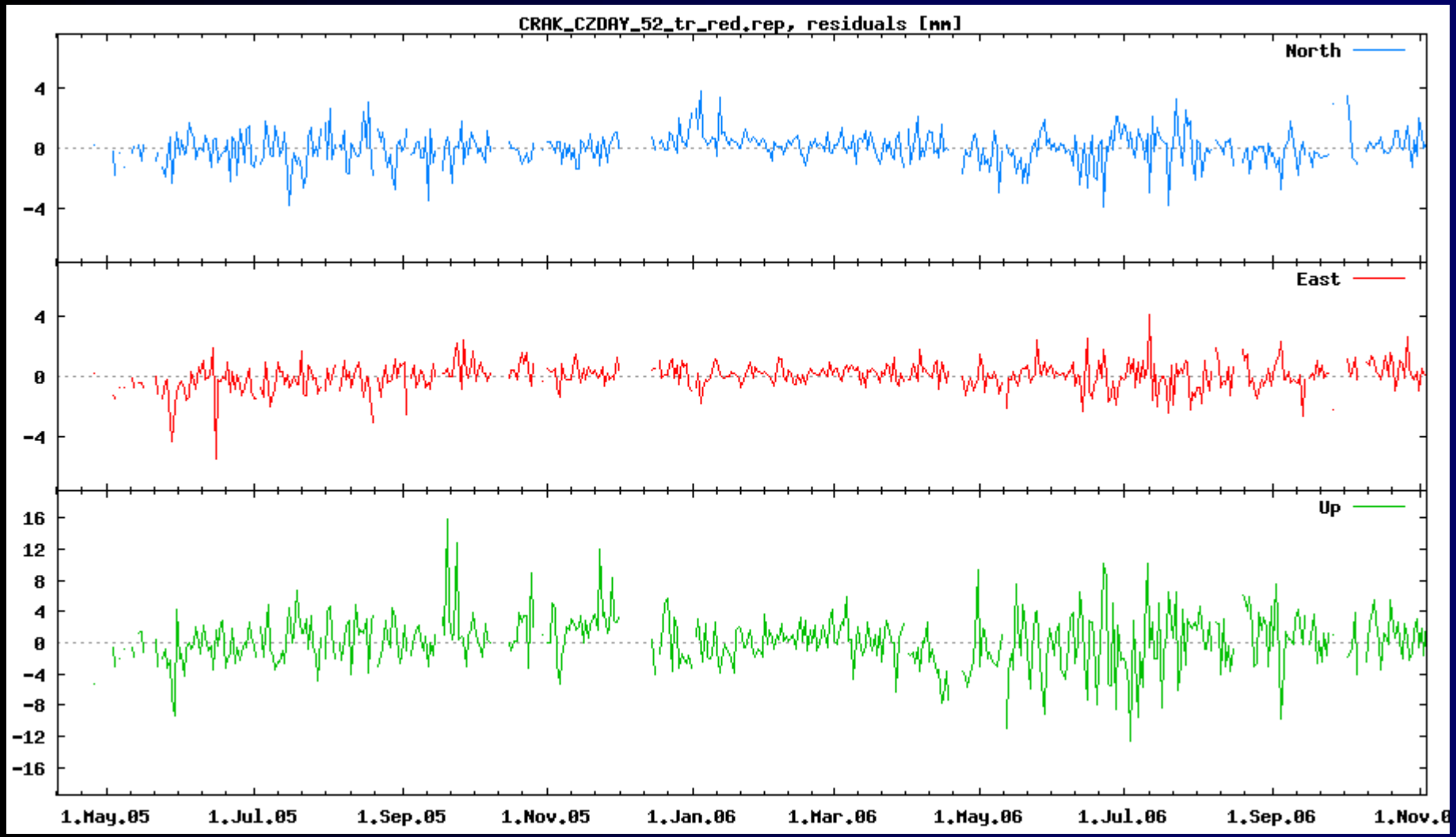
CPRA


CPRA_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

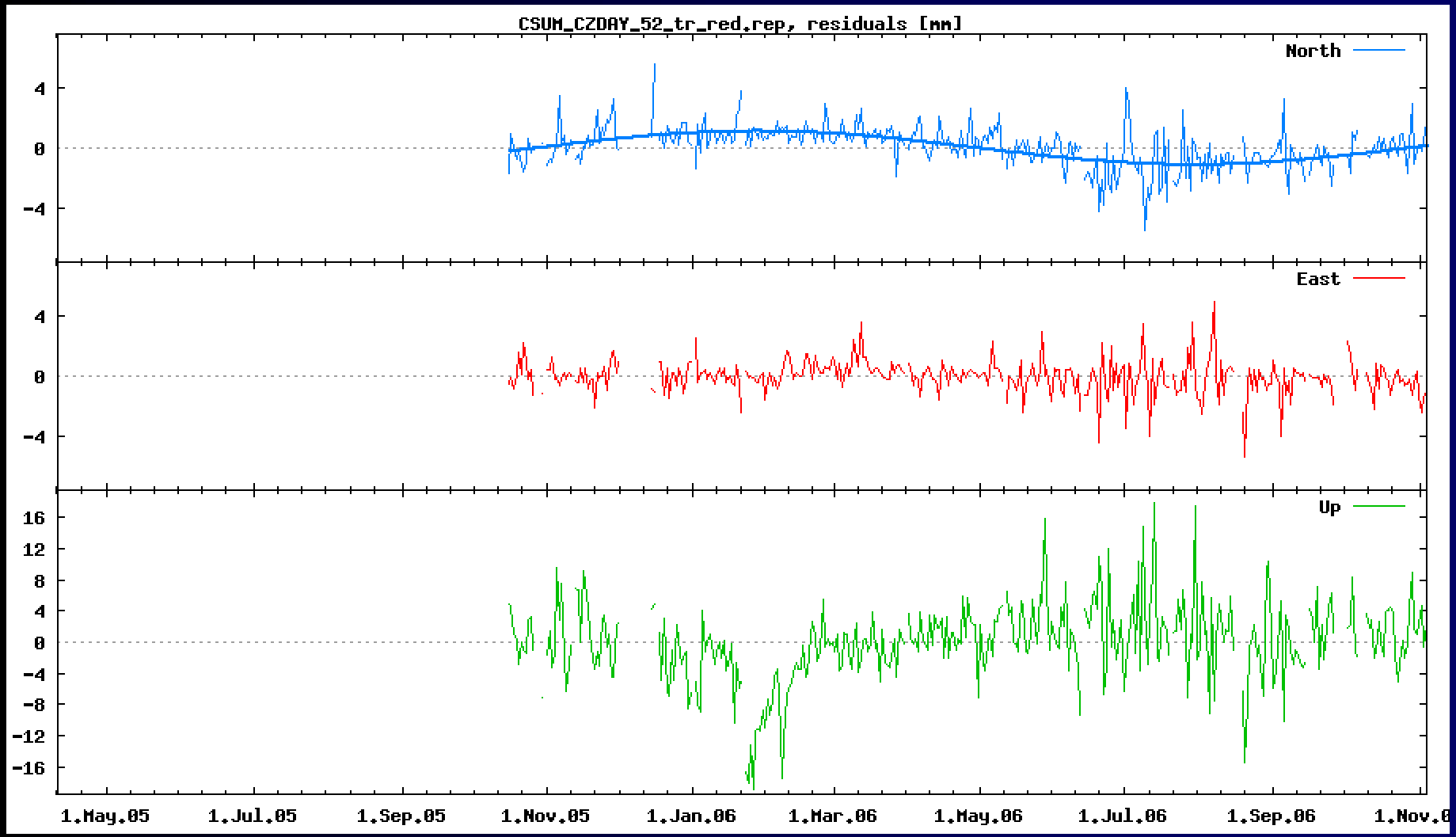
CPRI


CPRI_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

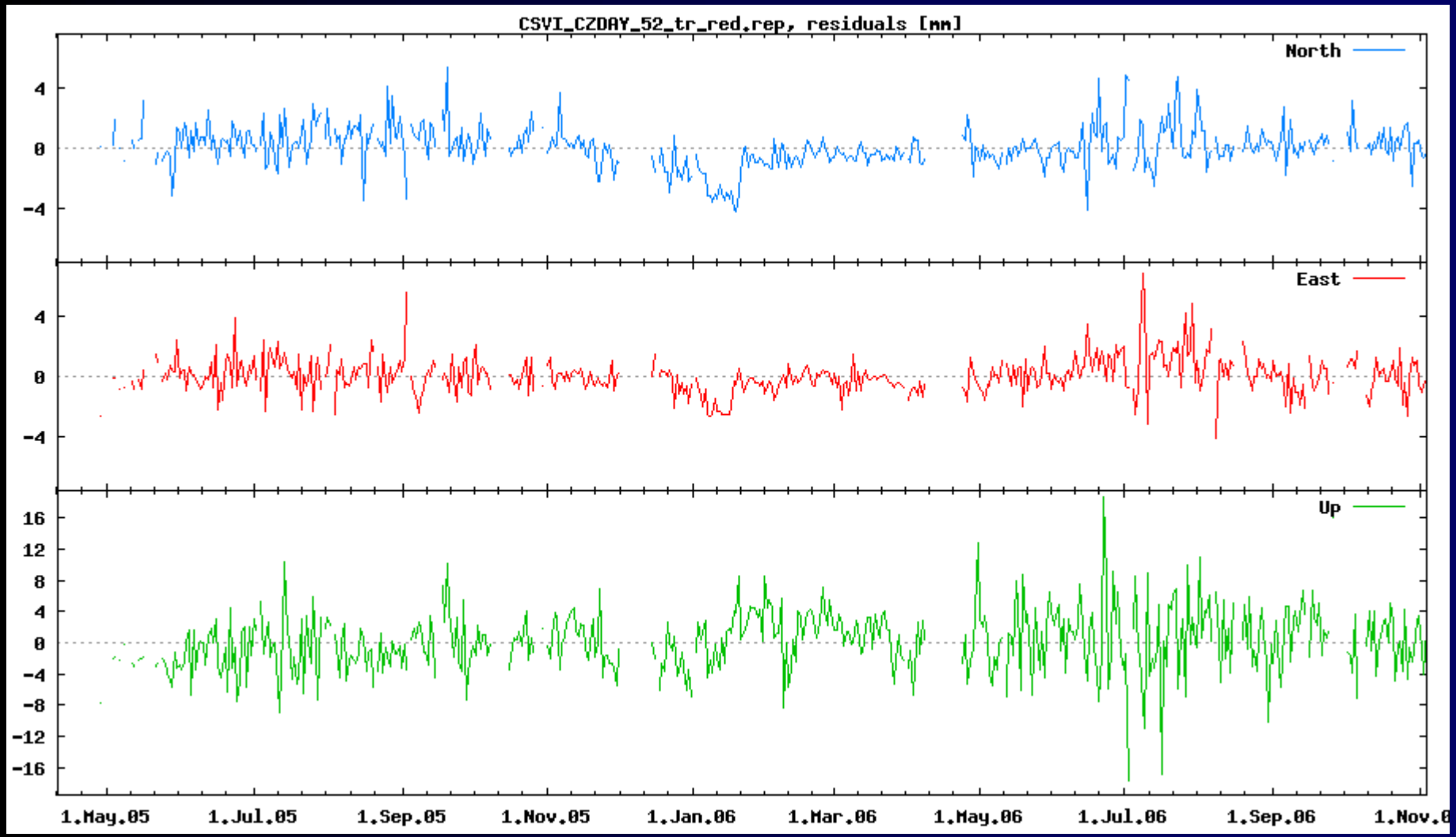
CRAK


CRAK_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.06

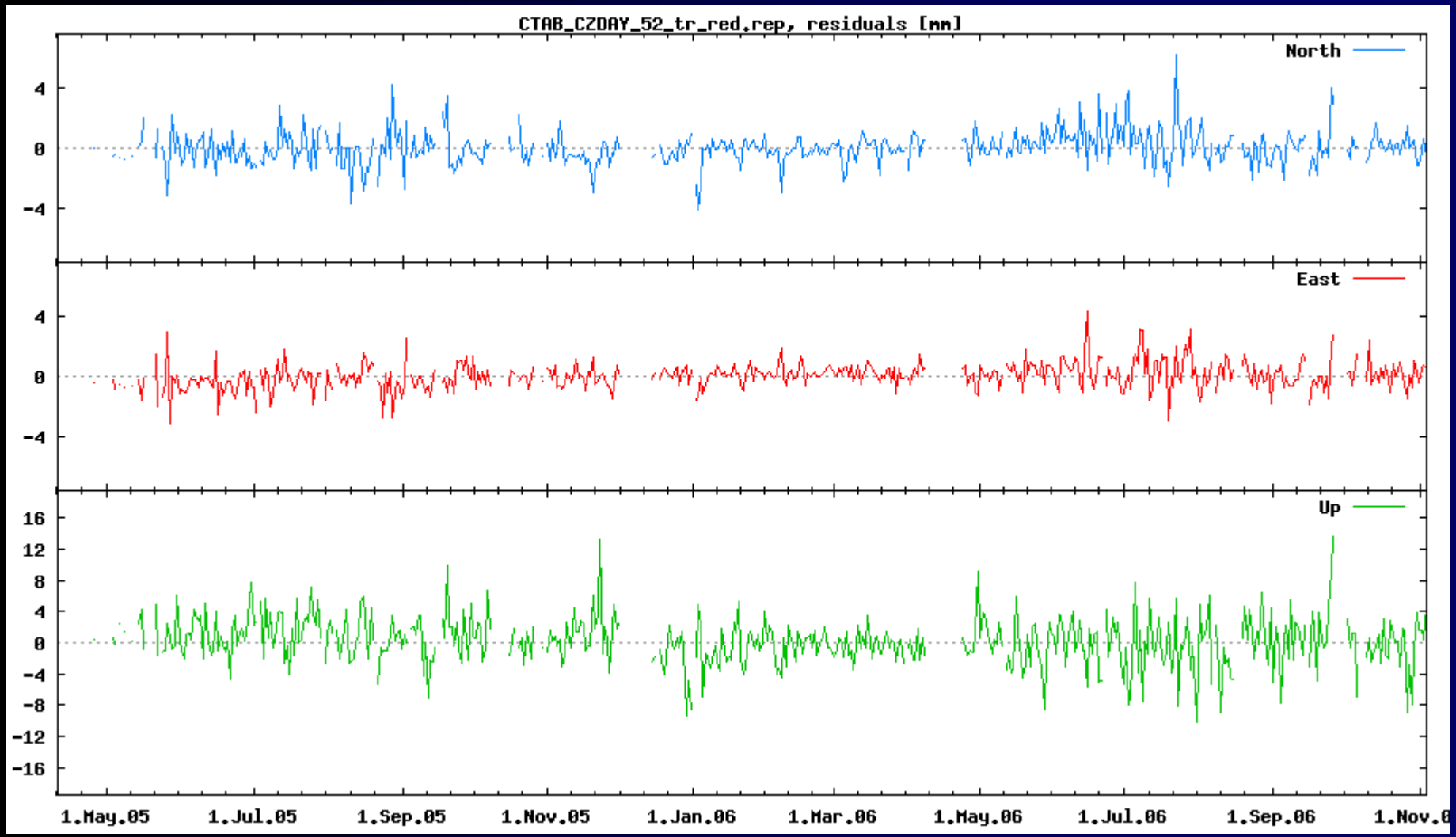
CSUM


CSUM_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

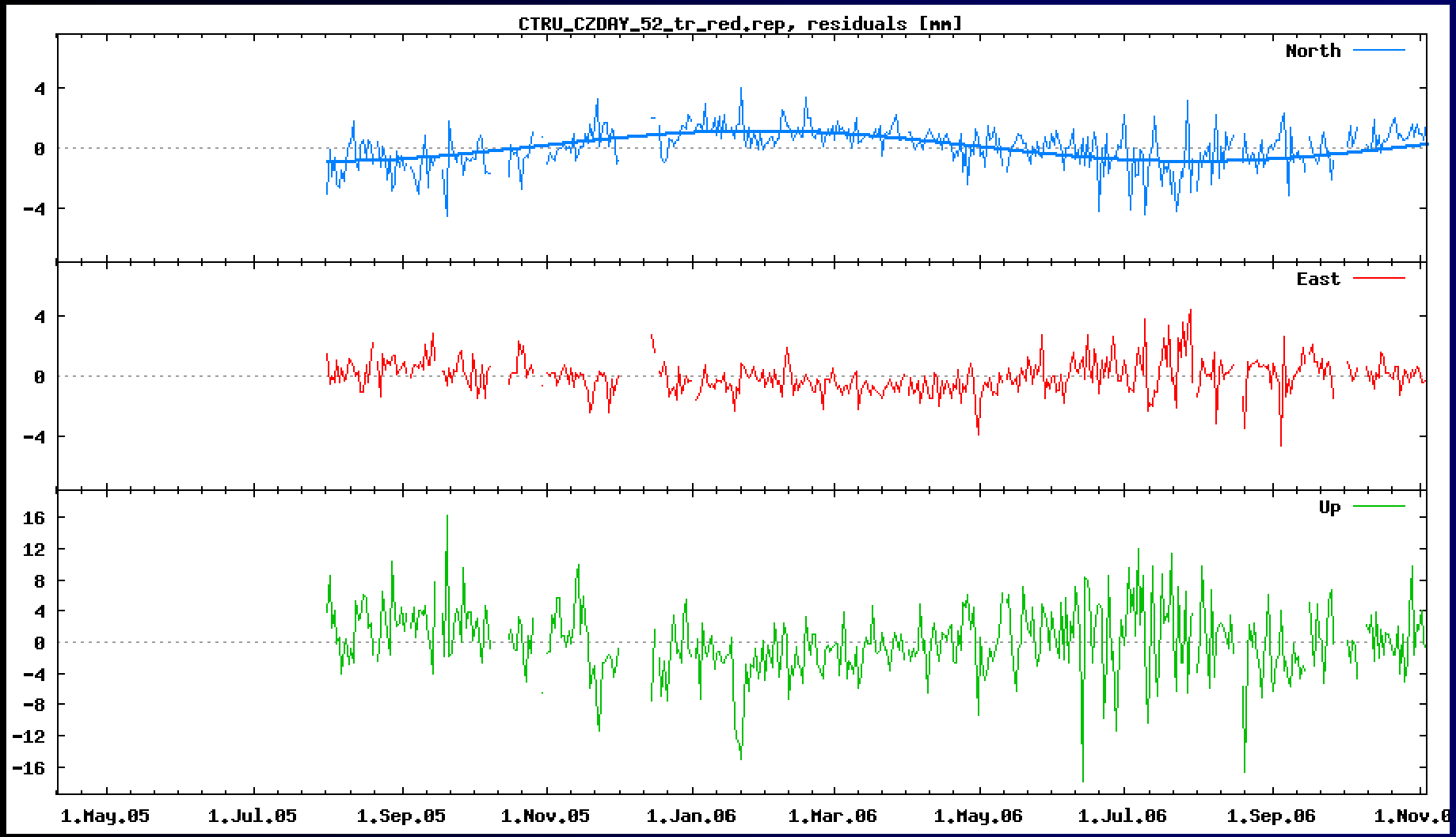
CSVI


CSVI_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

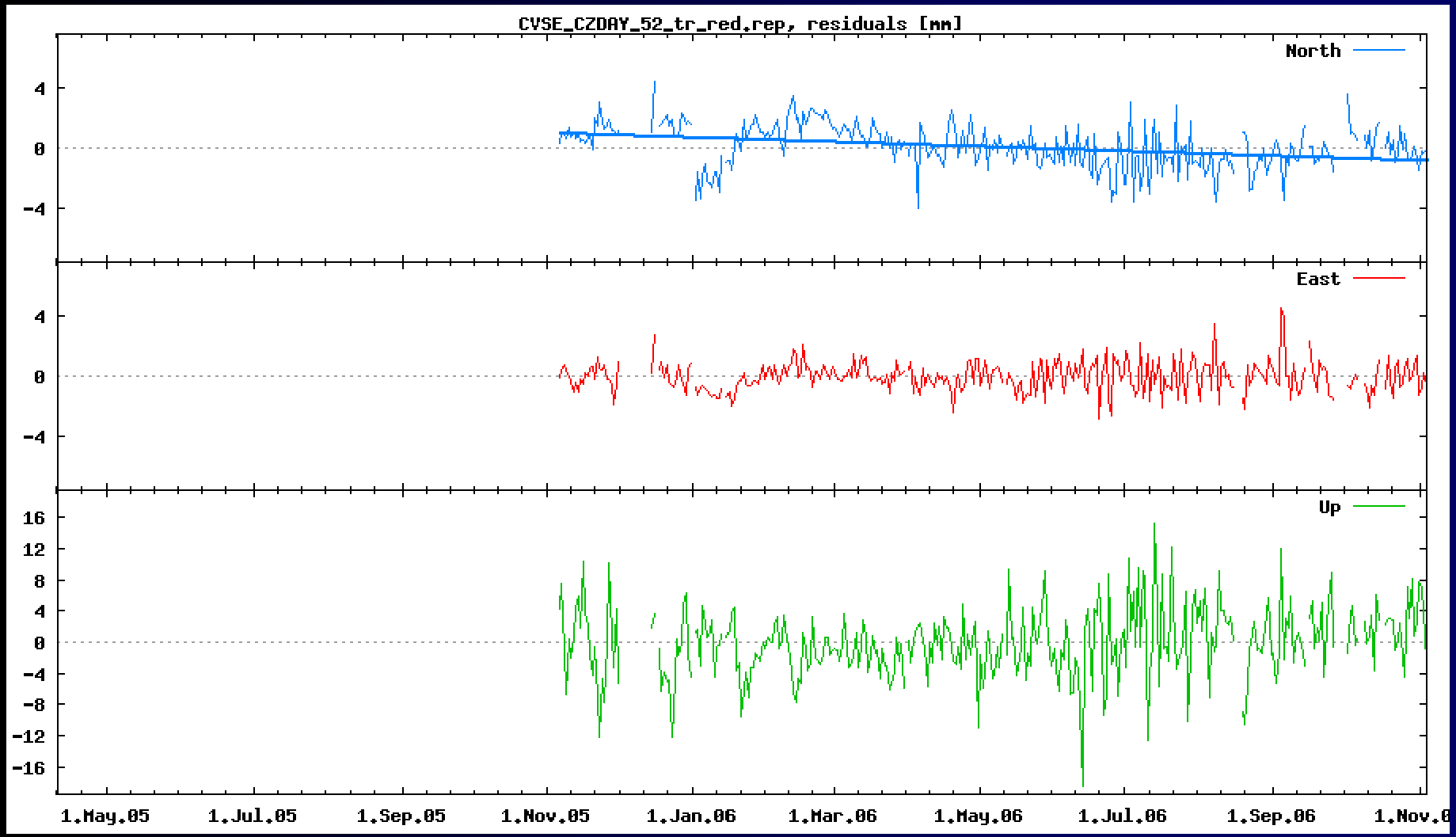
CTAB


CTAB_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.06

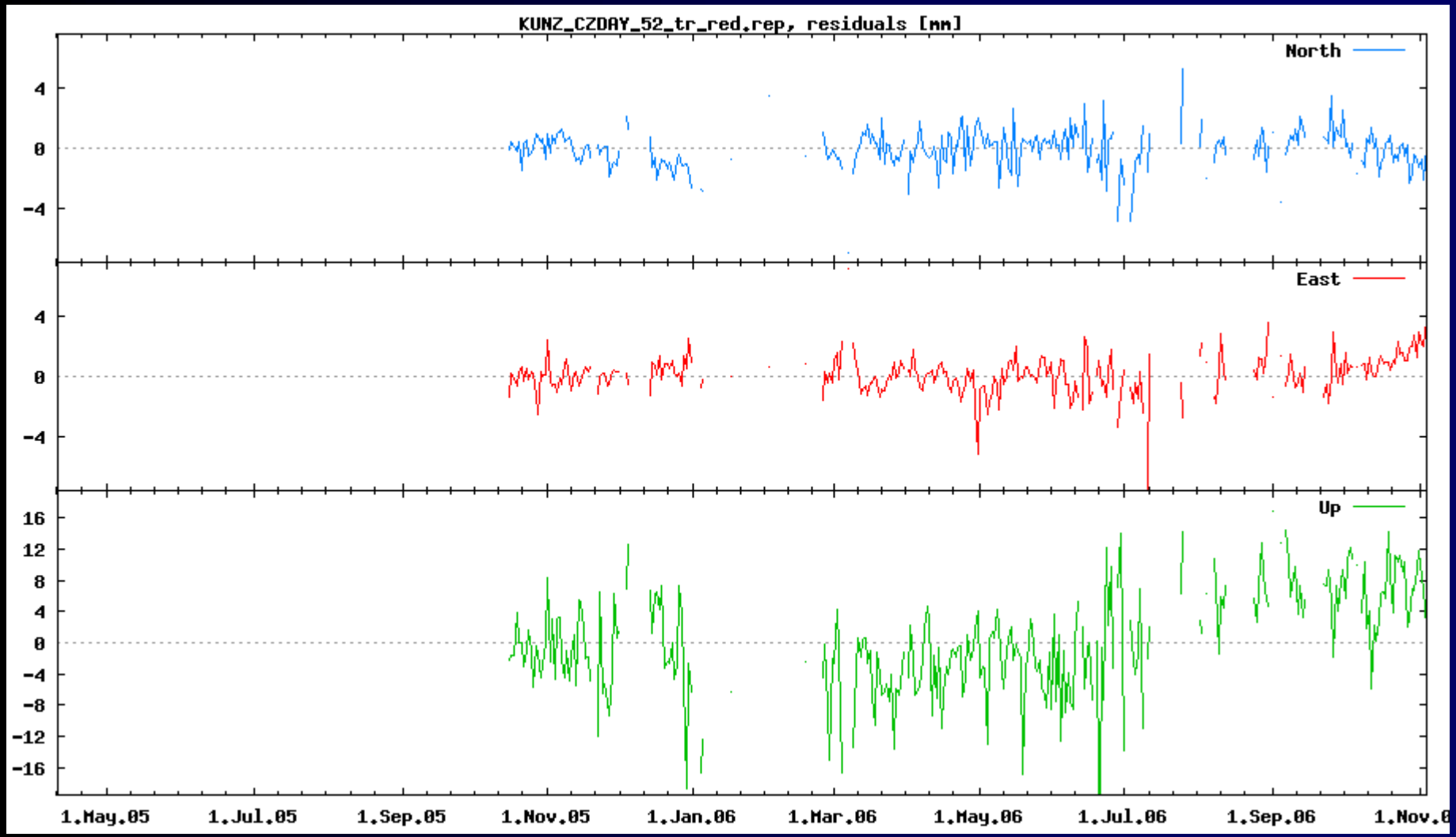
CTRU


CTRU_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

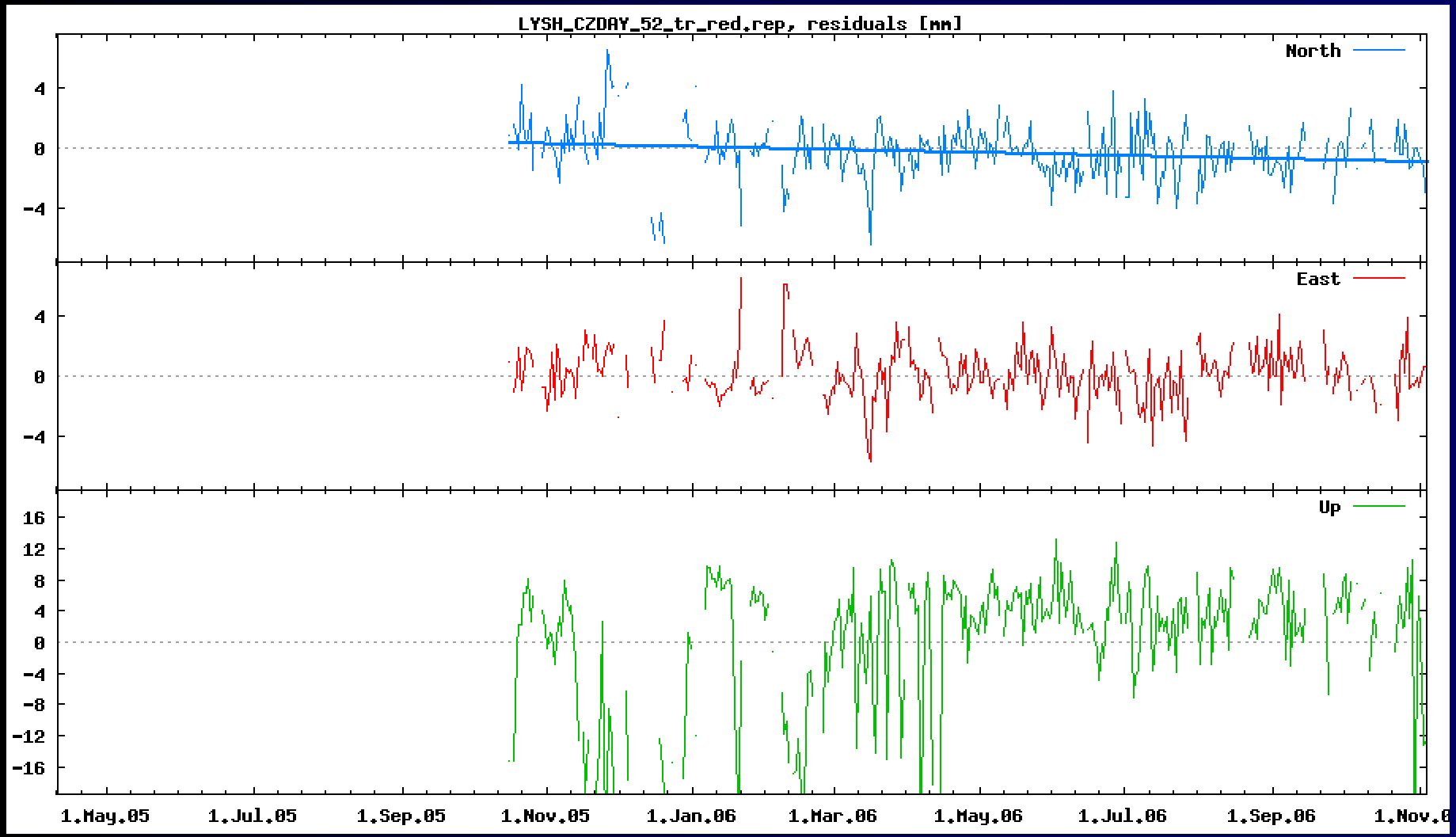
CVSE


CVSE_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

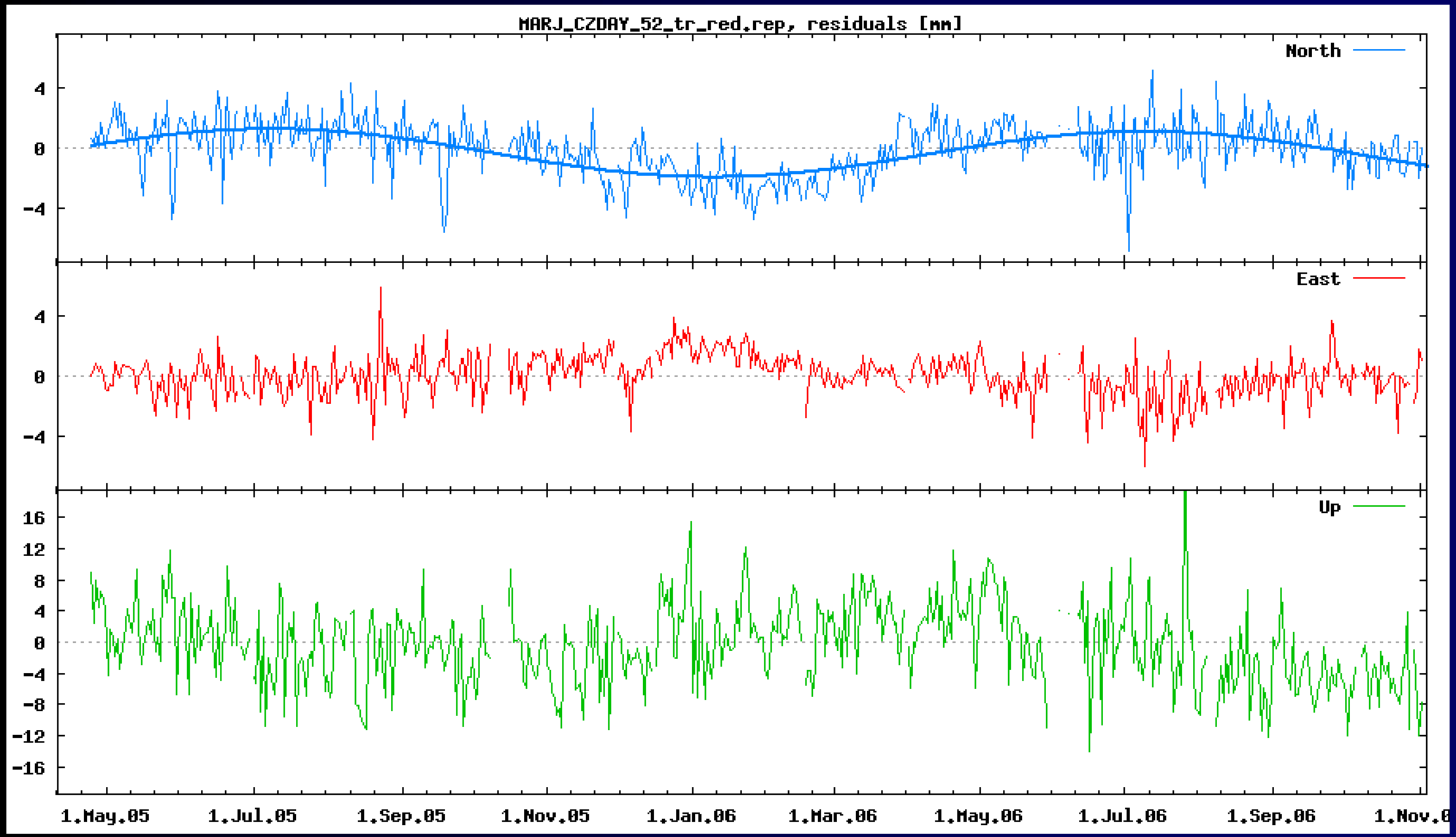
KUNZ


KUNZ_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.06

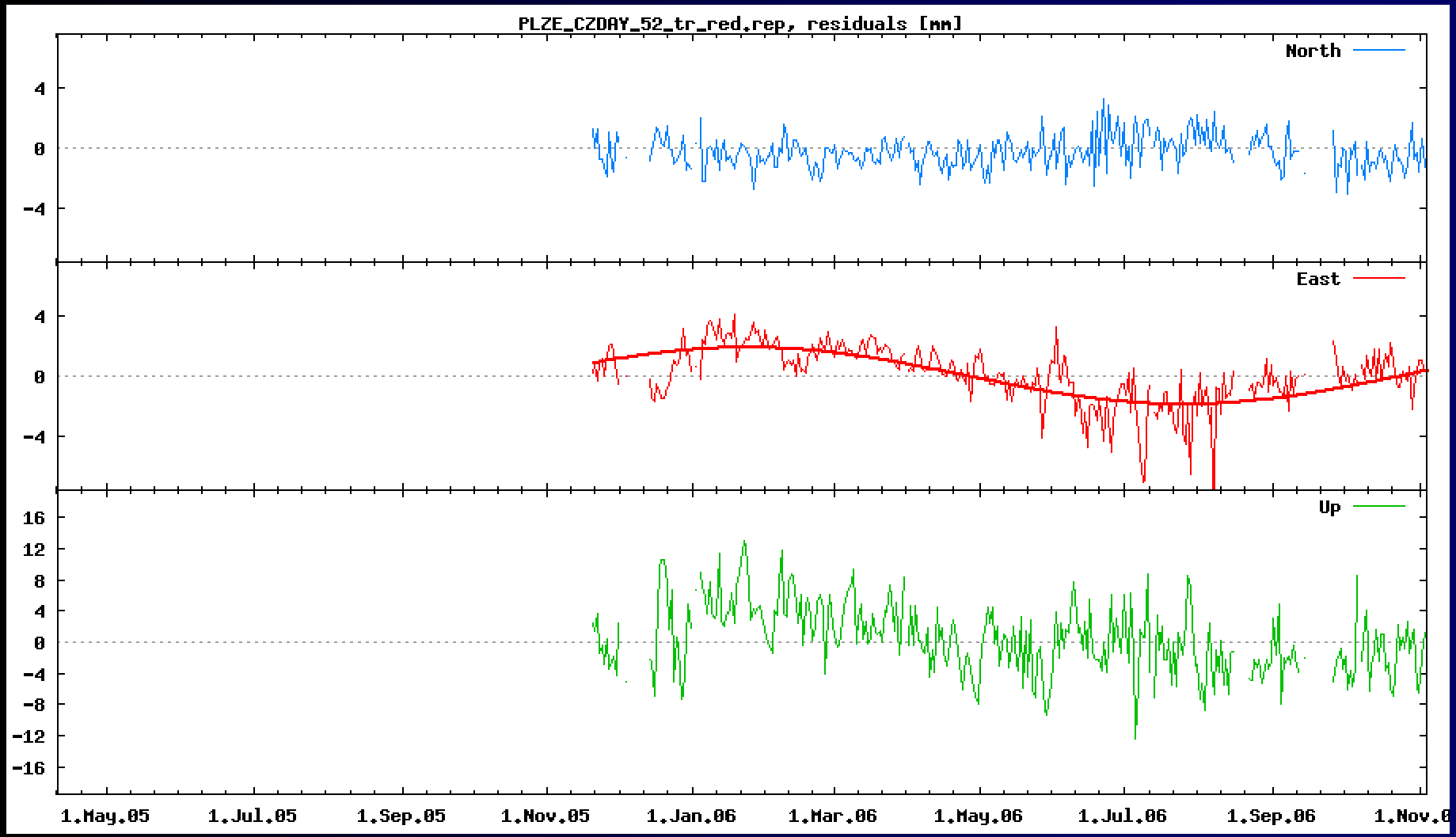
LYSH


LYSH_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

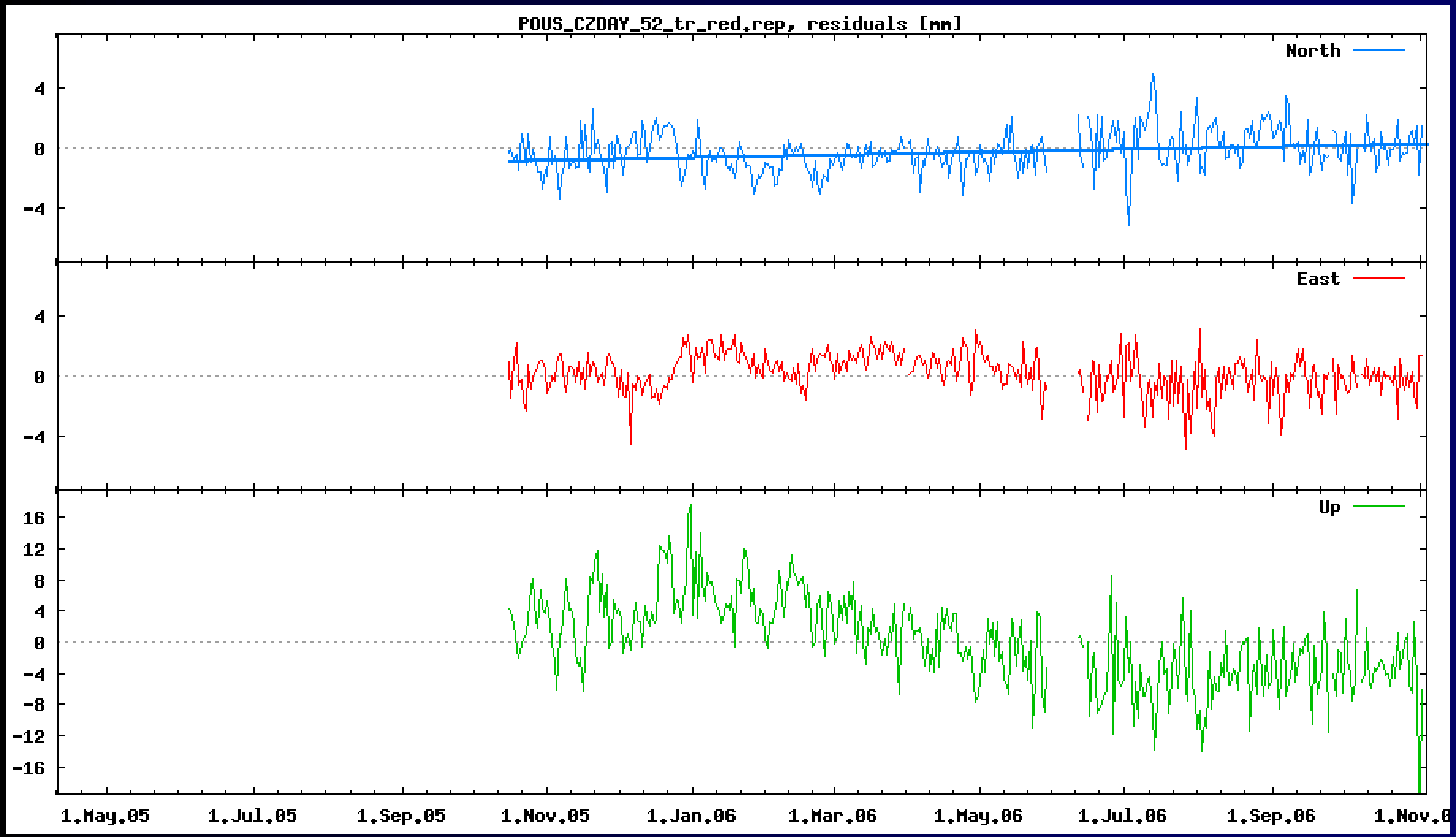
MARJ


MARJ_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

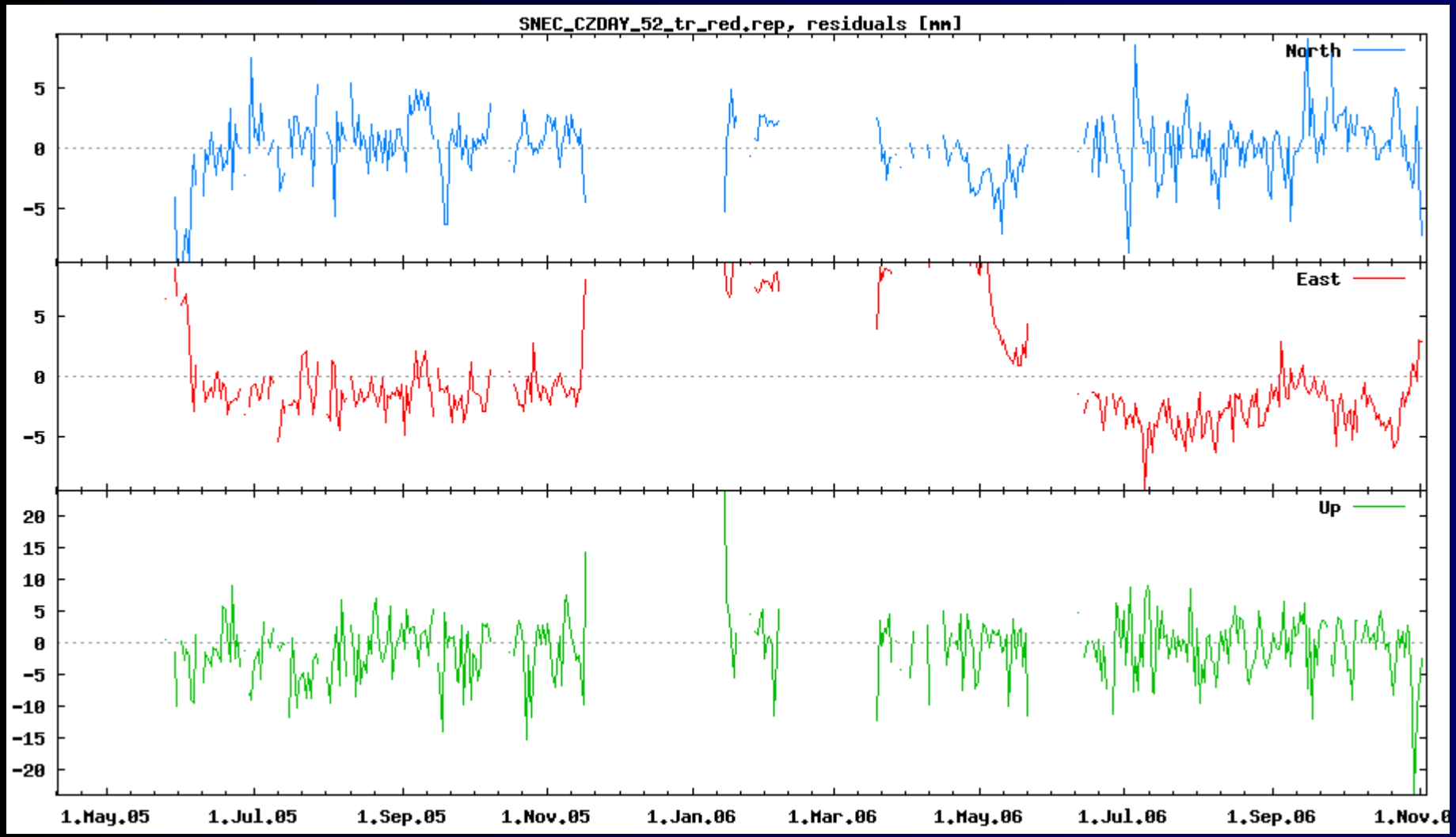
PLZE


PLZE_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

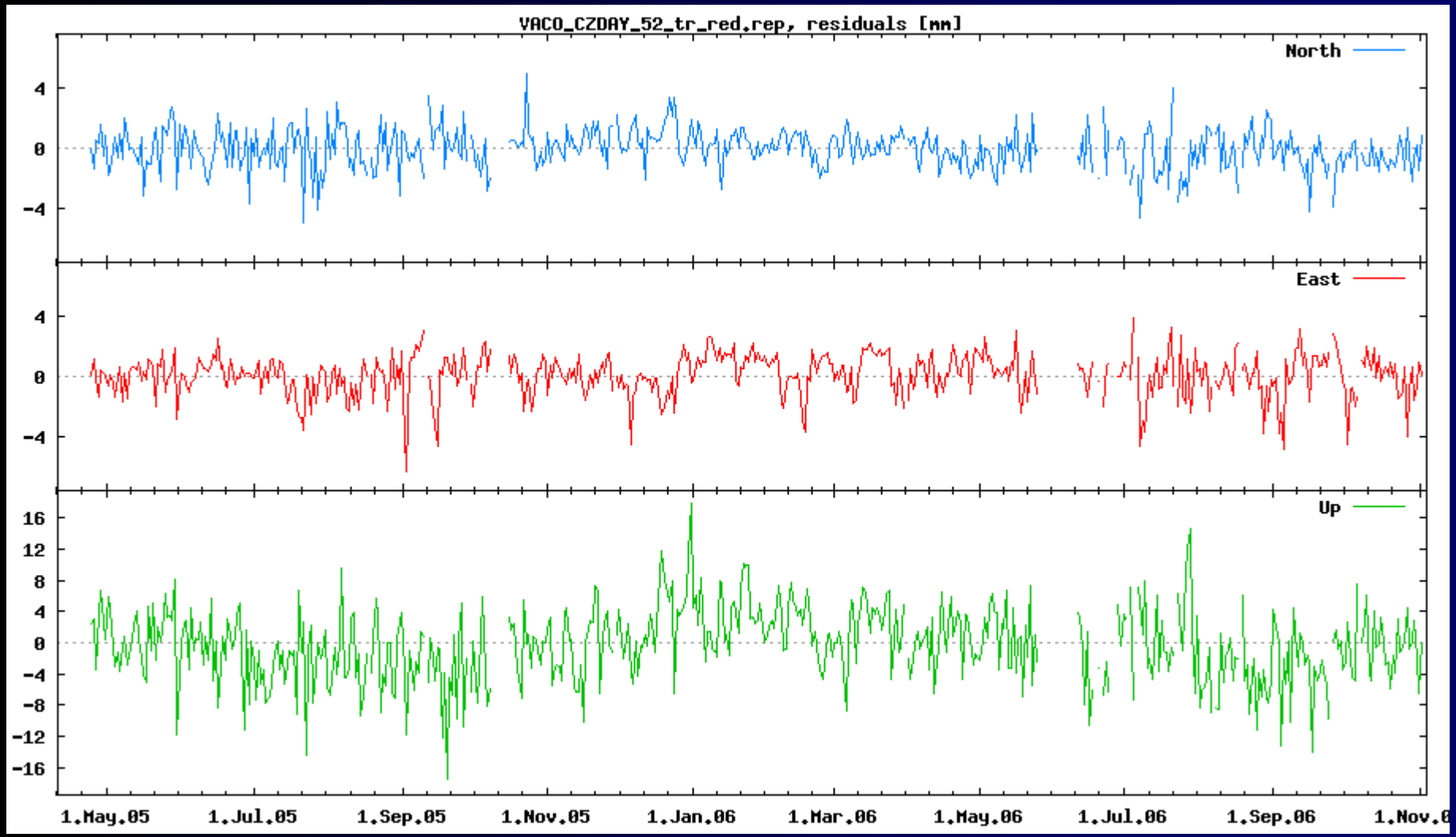
POUS


POUS_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0

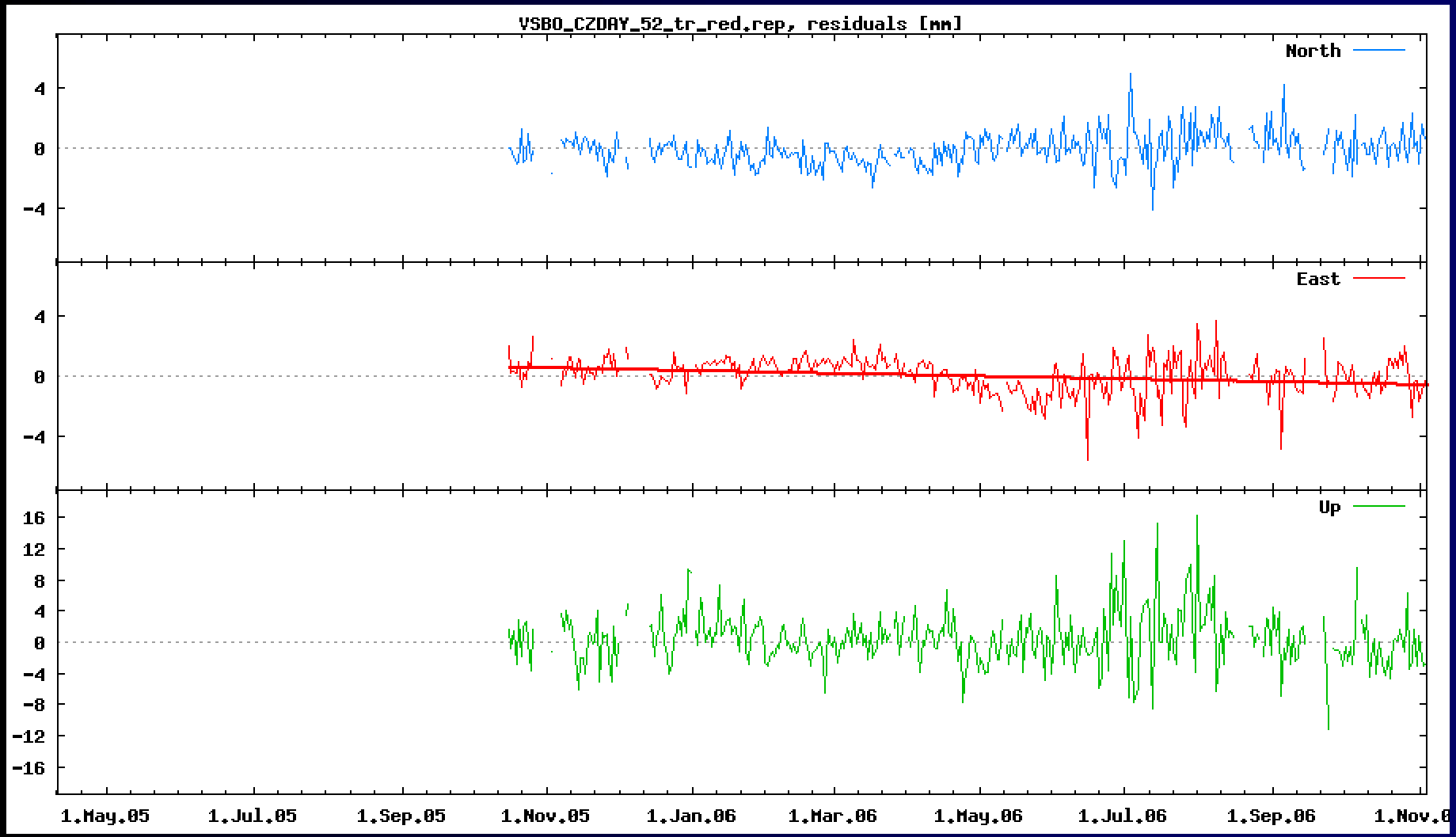
SNEC


SNEC_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
5
0
-5
20
15
10
-10
-15
-20
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06

VACO


VACO_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.06

VSBO


VSBO_CZDAY_52_tr_red.rep, residuals [mm]
North
East
Up
4
0
-4
16
12
8
4
0
-4
-8
-12
-16
1.May.05
1.Jul.05
1.Sep.05
1.Nov.05
1.Jan.06
1.Mar.06
1.May.06
1.Jul.06
1.Sep.06
1.Nov.0