

- Les modules du traitement de données

- 1 fichier de données par station et par jour qui contient les phases observées à cette station
- => fichier RINEX (receiver independent exchange format)



```

teqc 2008Feb15 20081209 09:08:12UTCPGM / RUN BY / DATE
MSXP|IAx86-PII|bcc32 5.0|MSwin95->XP|486/DX+ COMMENT
BIT 2 OF LLI FLAGS DATA COLLECTED UNDER A/S CONDITION COMMENT
-Unknown- MARKER NAME
EMAN MARKER NUMBER
Ch Vigny -ENS/CNRS - OBSERVER / AGENCY
ZE120022324 ASHTECH UZ-12 ZB00 REC # / TYPE / VERS
7118 ASH701975.01A ANT # / TYPE
1779945.8115 -5223913.1237 -3187315.9909 APPROX POSITION XYZ
0.0000 0.0000 0.0000 ANTENNA: DELTA H/E/N
1 1 WAVELENGTH FACT L1/2
5 L1 L2 C1 P1 P2 # / TYPES OF OBSERV
Version: Version: COMMENT
Project: A COMMENT
SNR is mapped to RINEX snr flag value [0-9] COMMENT
L1 & L2: min(max(int(snr_dBHz/6), 0), 9) COMMENT
pseudorange smoothing corrections not applied COMMENT
2008 11 13 17 1 0.0000000 GPS TIME OF FIRST OBS
END OF HEADER

```

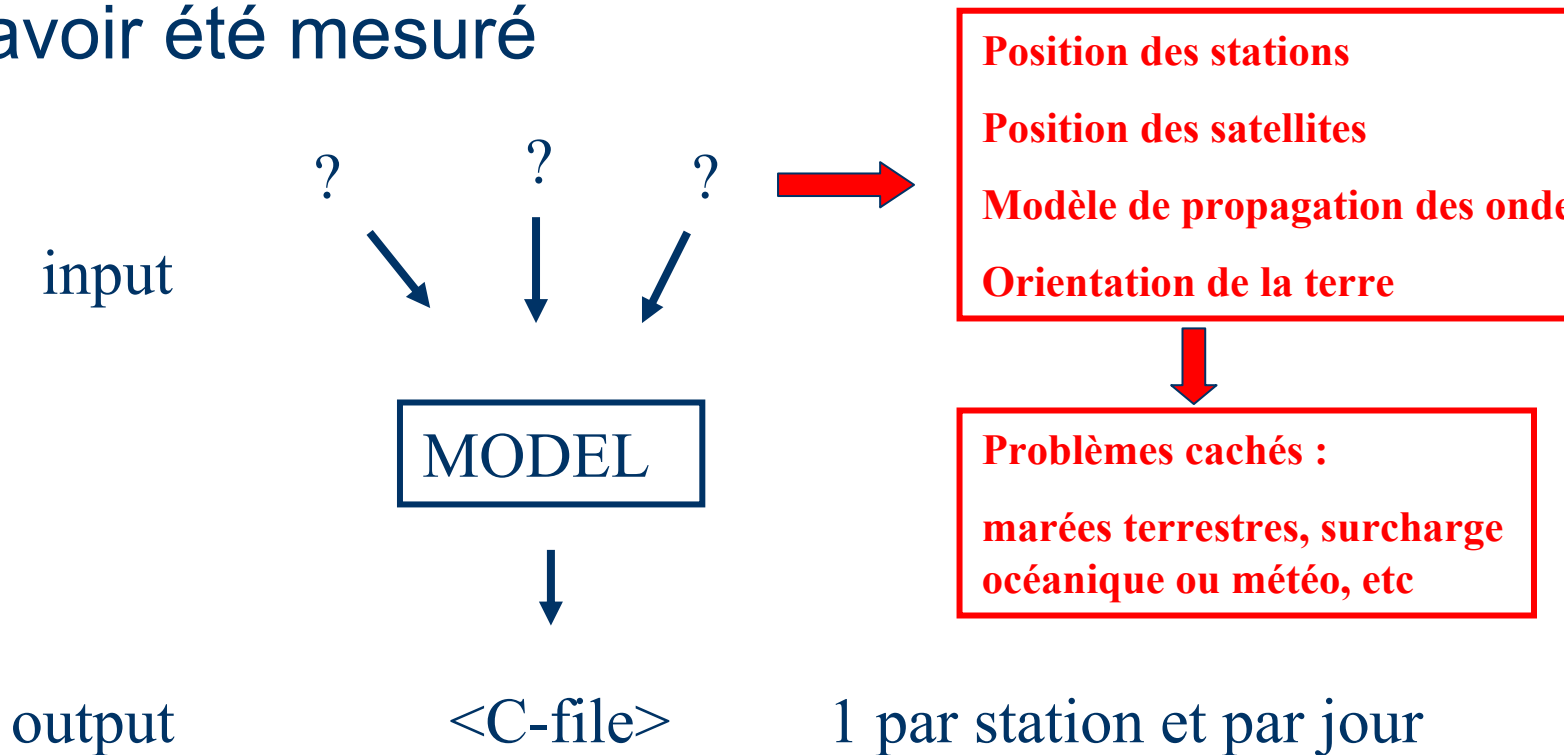
```

08 11 13 17 1 0.0000000 0 2G25G 7
-18212.80558 -13741.18957 17937857.2704 17937856.1294 17937868.8344
-95906.04058 -70080.46257 18391854.4004 18391853.9714 18391865.7714
08 11 13 17 1 30.0000000 0 3G25G27G 7
-25783.37448 -19640.33947 17936416.7604 17936415.5524 17936427.0504
-241722.04558 -176033.45057 18874497.8694 18874496.3144 18874510.0234
-137852.15248 -102765.73747 18383872.5604 18383871.6134 18383883.5414
08 11 13 17 2 0.0000000 0 4G23G25G27G 7
173460.74857 128334.27657 19609008.9814 19609007.6954 19609018.2784
-33326.69748 -25518.26147 17934981.3454 17934979.7964 17934992.1114
-318563.45448 -235909.85347 18859875.1534 18859873.8554 18859887.6474
-179821.47148 -135469.10147 18375886.1964 18375885.1814 18375897.1834
08 11 13 17 2 30.0000000 0 6G23G25G27G 4G 7G 8
11794858.92647 9183969.16147 21820487.4784 21820486.3044 21820496.4744
11516802.41948 8974582.34447 20132897.7064 20132896.1474 20132908.9524
11162143.31148 8710095.43847 21044581.2504 21044580.2634 21044593.7724
11512214.04257 8973664.25357 21467466.0864 21467465.7184 21467478.5284
11335840.88848 8837774.30447 20567243.8584 20567242.7284 20567255.1164
11356284.35657 8853148.22656 22873944.4314 22873941.3884 22873957.1774
08 11 13 17 3 0.0000000 0 7G23G25G27G 4G13G 7G 8
11851305.08247 9227953.12147 21831228.9974 21831227.9884 21831238.5814
11502475.49648 8963418.50247 20130171.5674 20130170.2304 20130182.5564
11078238.03548 8644714.72647 21028614.9124 21028612.8254 21028626.7844
11486162.87248 8953364.61947 21462509.5414 21462508.1804 21462520.9574
-961065.33358 -753689.18357 20953227.9494 20953227.0884 20953239.1284
11286991.00148 8799709.46547 20557948.0354 20557947.0144 20557959.0554
11248334.07647 8769031.18646 22853401.4464 22853399.6684 22853414.4994
08 11 13 17 3 30.0000000 0 8G23G25G27G 4G13G20G 7G 8
11907811.31447 9271983.89047 21841981.6164 21841980.8464 21841991.1334
11488722.79648 8952702.10547 20127554.5424 20127552.6844 20127565.3584
10994770.22448 8579674.89147 21012730.9274 21012730.0454 21012743.1104
11460690.87447 8933516.29147 21457661.7474 21457660.3854 21457673.4964
-937082.65147 -735001.40947 20957791.6444 20957790.6034 20957802.2174
-888265.49257 -698513.70657 22046571.4304 22046569.6774 22046583.3064

```

# 1ere étape du calcul: MODEL

- c'est à dire calcul théorique de ce qui devrait avoir été mesuré



# 1ere étape du calcul: MODEL

## Les input de MODEL

- les position “à priori” des stations : L-file
- les positions “à-priori” des satellites : T-file
- les parametres d’orientation de la Terre dans l’espace (Pole.dat, UT1.dat, leap.sec, ...)
- Un modèle de propagation (fichier météo, ionosphère, etc...) et des perturbations de la position des satellites et des stations (marées terrestres par exemple)
- Et le fichier des phases mesurées (X-file)

# 1ere étape du calcul: MODEL

Les output de MODEL (C-file)

- les phases théoriques
- les phases mesurées
- Les residus (c'est à dire la différence entre théorie et mesure) et surtout les dérivées partielles des phases (théoriques évidemment) par rapport aux paramètres du modèle
- => on sait l'influence de chaque paramètre du modèle sur la phase théorique

## 2eme étape du calcul: Autcln

- Le nettoyage des données (c'est à dire des phases mesurées) qui peuvent avoir été affectées par un peu n'importe quoi (un coup de chaleur du récepteur, un avion qui passe dans le ciel, un enfant curieux.....)
- On n'entre pas dans les détails, mais le nettoyage ne peut se faire qu'en double différence.....

## 3eme étape du calcul: SOLVE

- Le calcul de la solution, c'est à dire la minimisation (par moindre carré) de la différence entre phases mesurées et phases théoriques par l'ajustement de chacun des paramètres du modèle

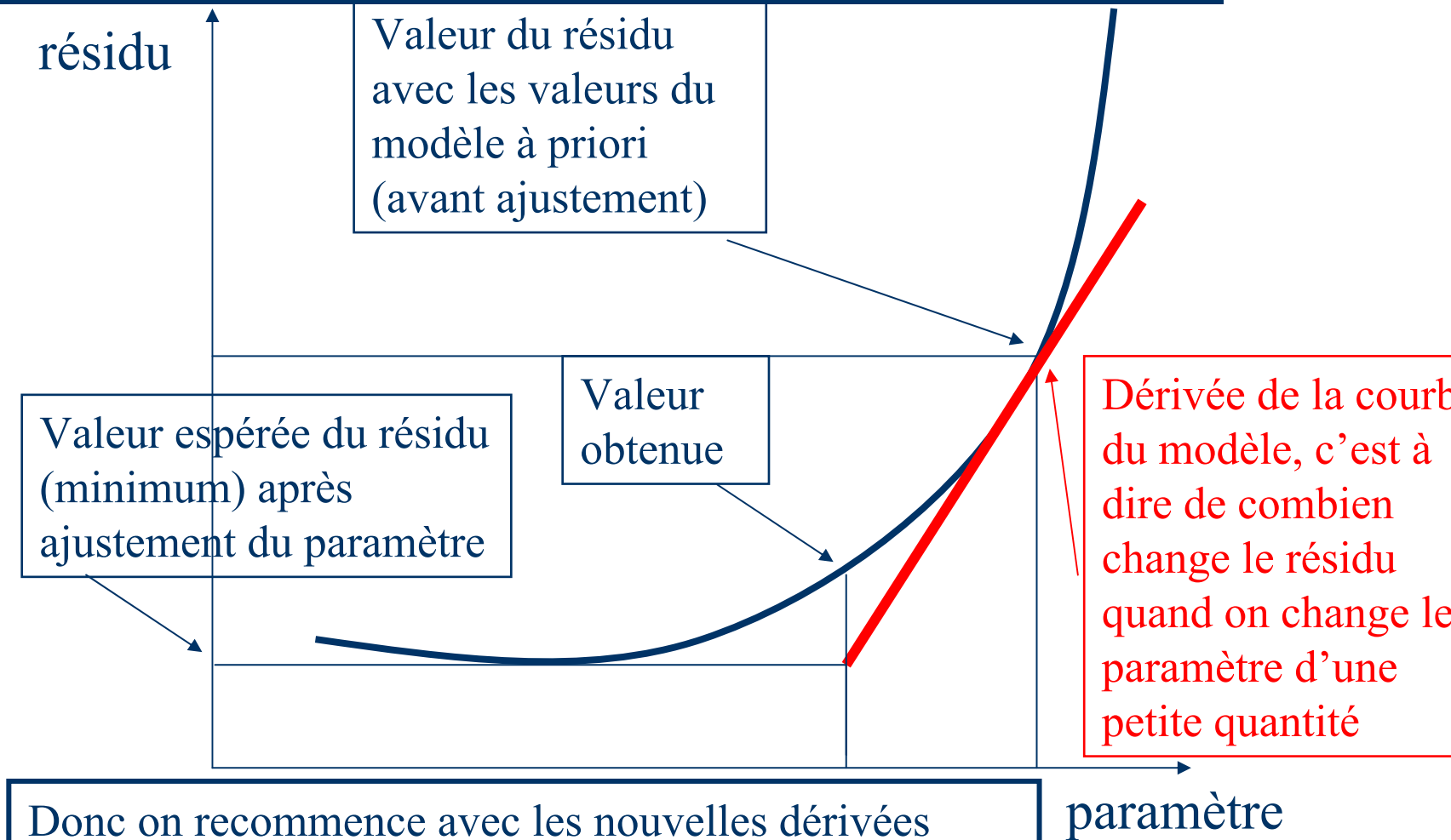


# 3eme étape du calcul: SOLVE

Les output de SOLVE

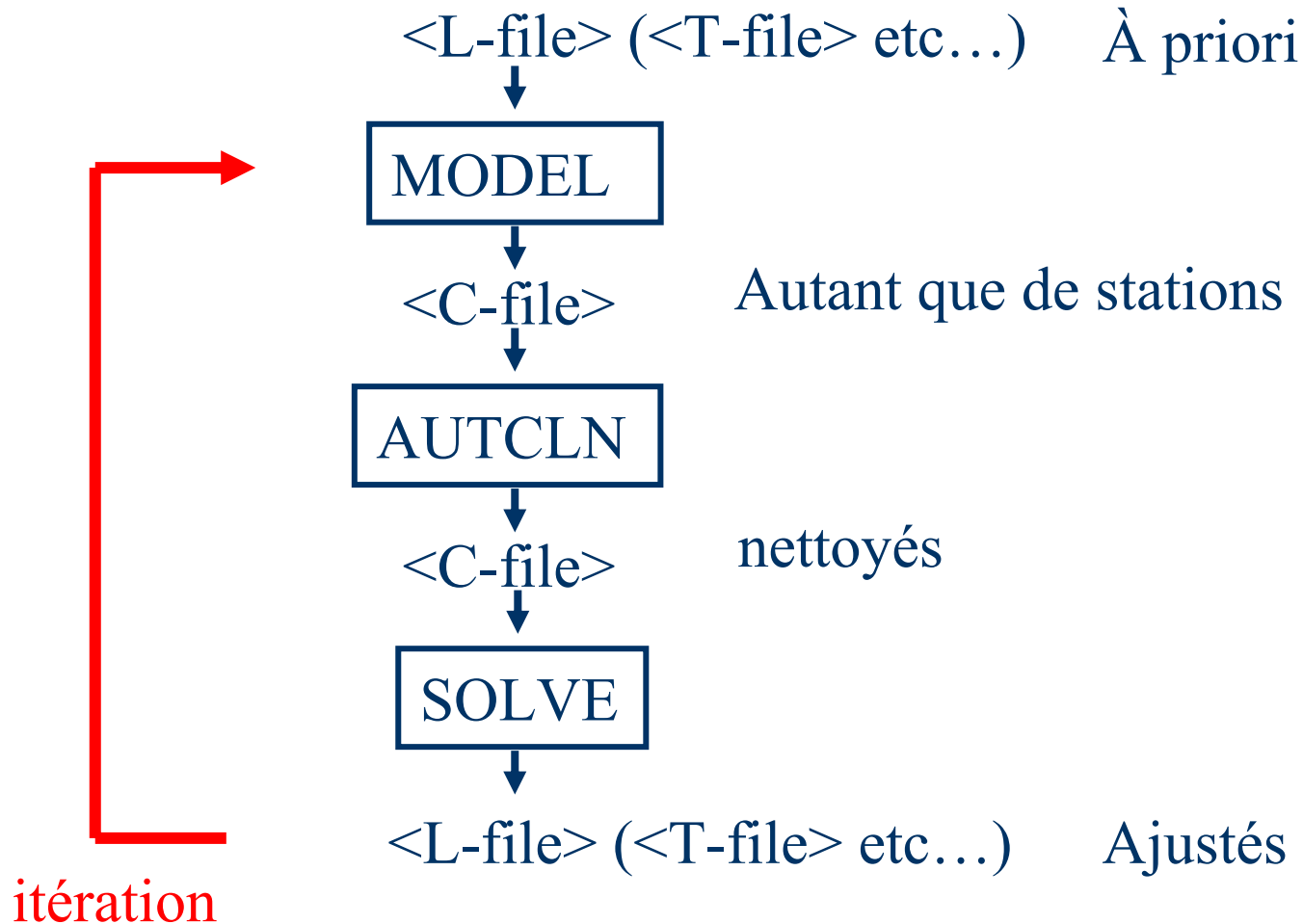
- TOUS LES PARAMETRES AJUSTES !!!!!
- Les positions de station
- Les orbites des satellites
- La position de la Terre
- Le modèle de propagation (météo par exemple)
- Mais ça fait pas mal de paramètres, donc ils sont corrects seulement si on a beaucoup de mesures...
- Et comme toutes les inversions par moindre carré: l'ajustement est approximatif, il faut donc iterer!!!

# Minimisation par moindre carré



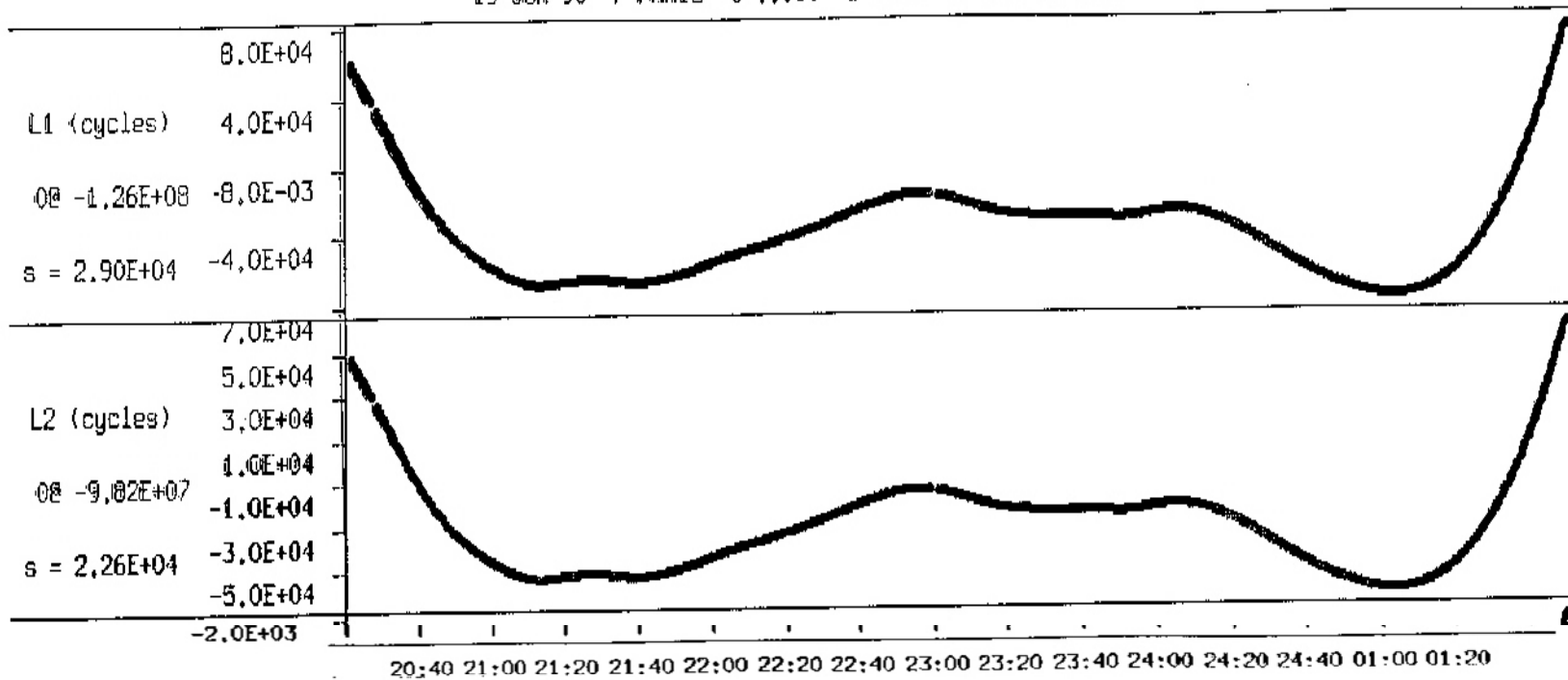
Donc on recommence avec les nouvelles dérivées partielles à l'endroit du nouveau jeu de paramètres....

# Un calcul complet d'une session de mesure



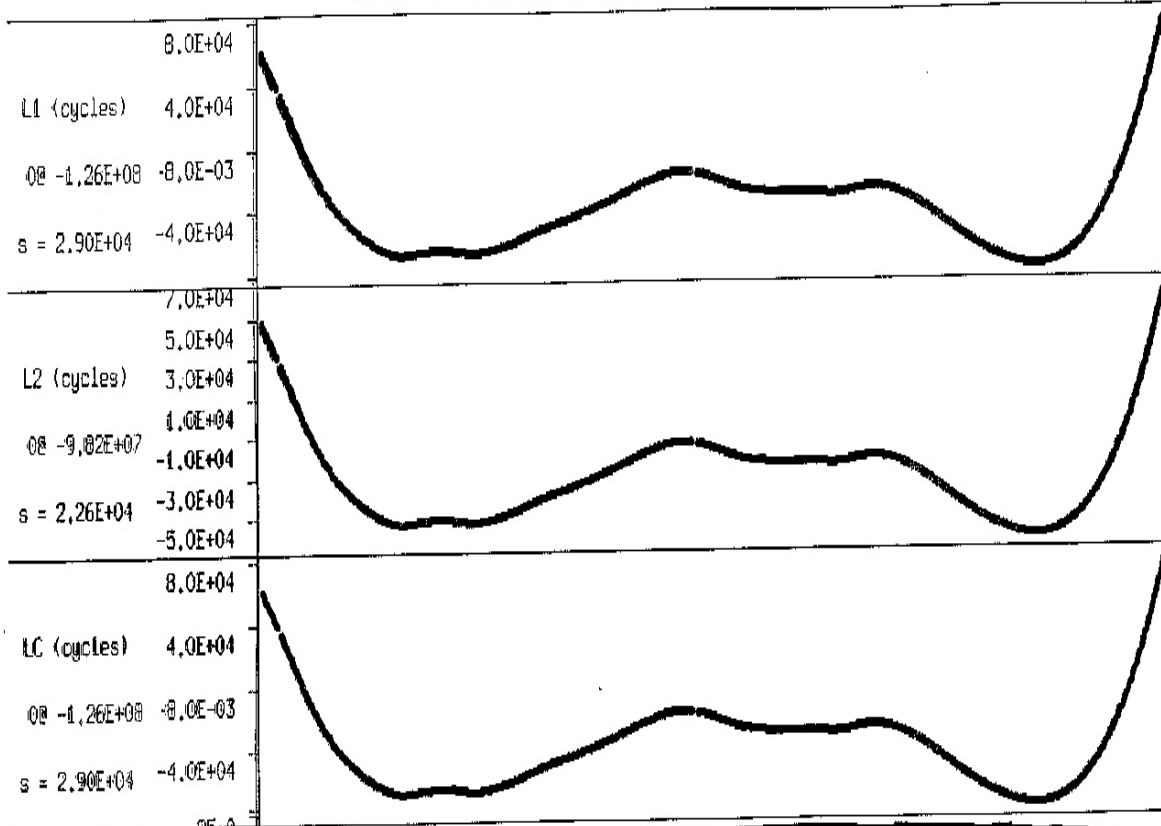
# ONE WAY

19 JUN 90 7 PRN13 0 ...00 1 TX01 0 .... NO POLY



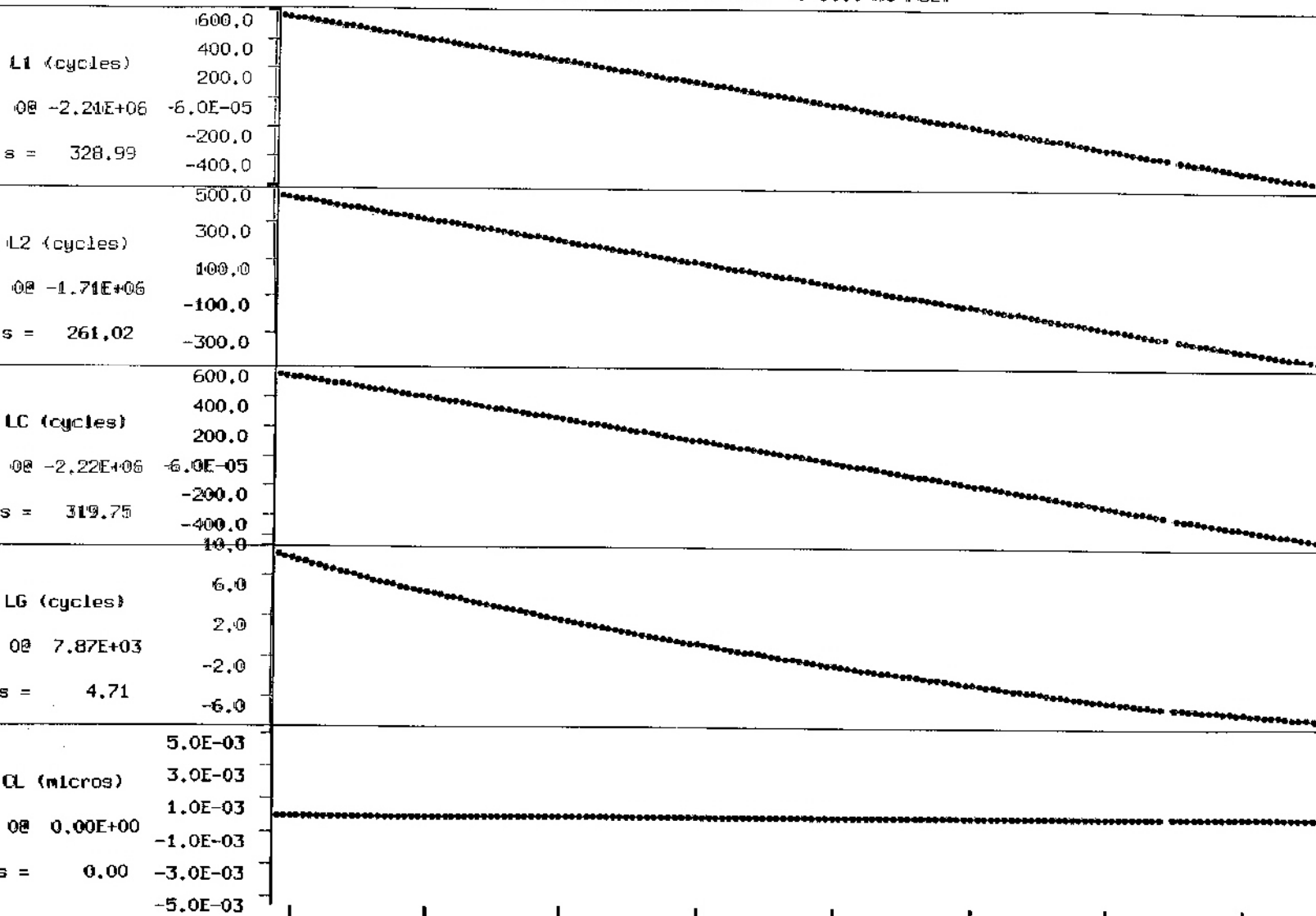
# ONE WAY

19 JUN 90 7 PRN13 0 ...00 1 TX01 0 .... NO POLY



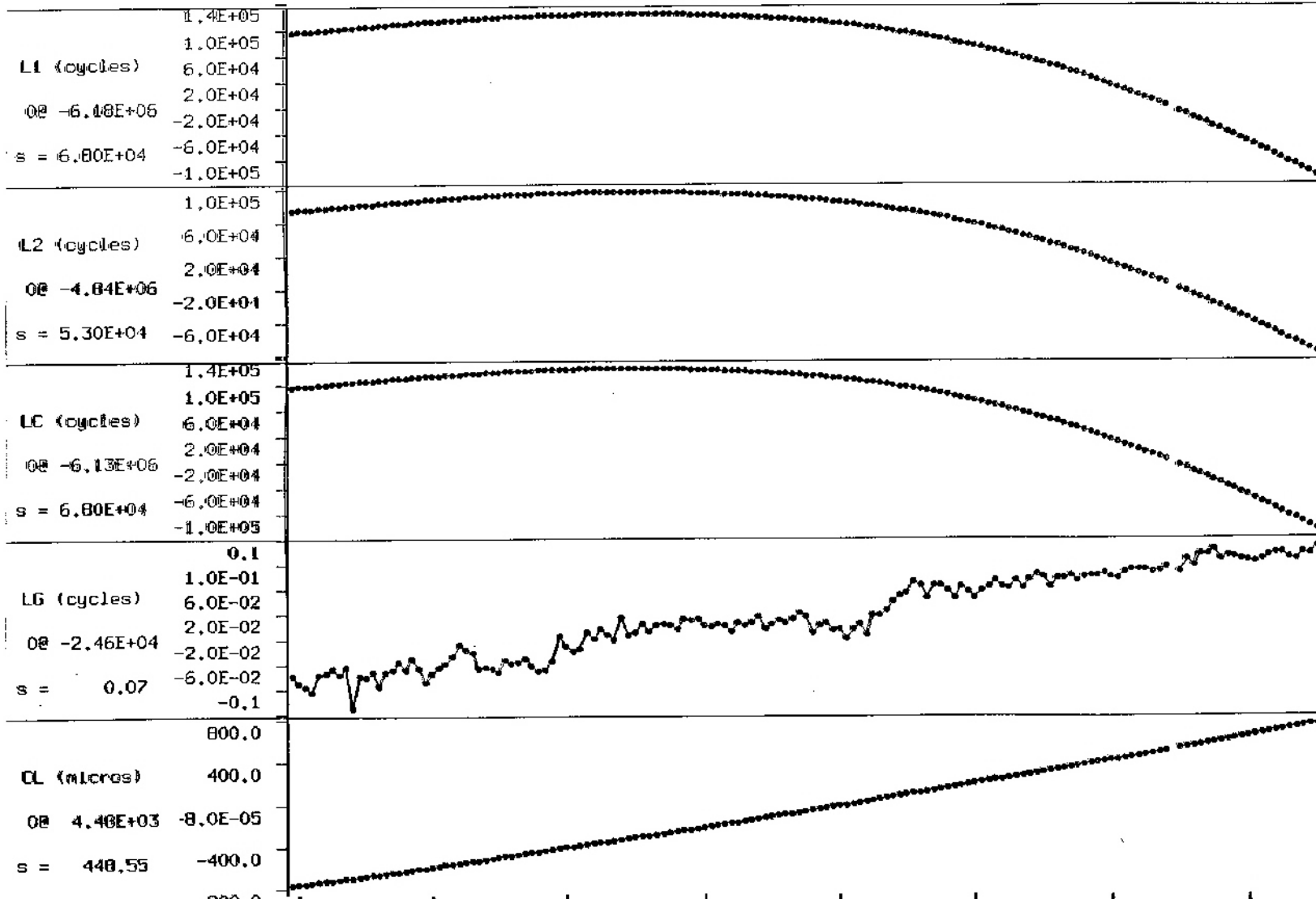
# SINGLE DIFFERENCE (between satellites)

19 JUN 90 7 PRN13 2 PRN03 1 TX01 0 .... NO POLY



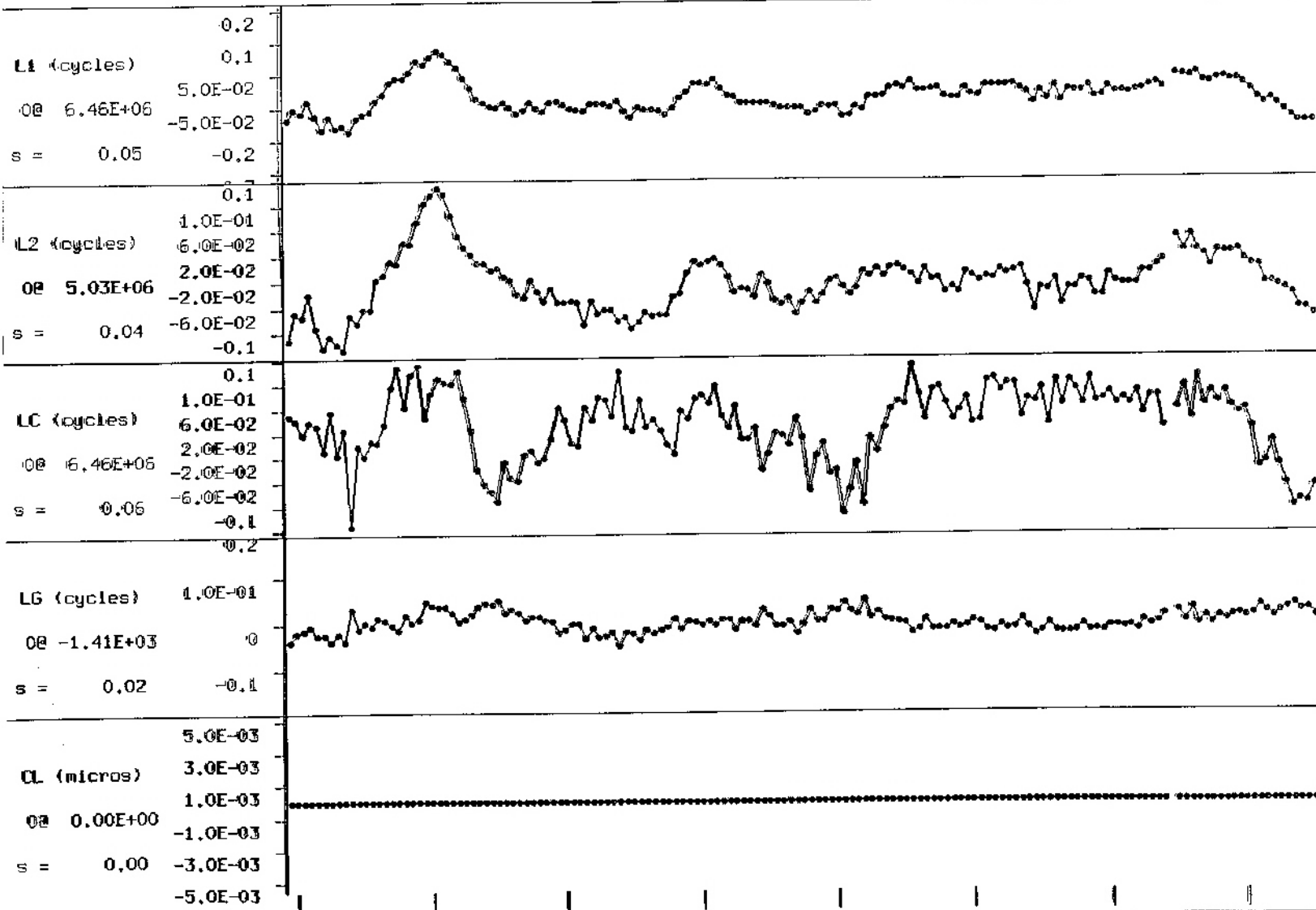
# SINGLE DIFFERENCE (between stations)

19 JUN 90 2 PRN03 0 ...00 2 TX02 1 TX01 IN0 POLY



# DOUBLE DIFFERENCE

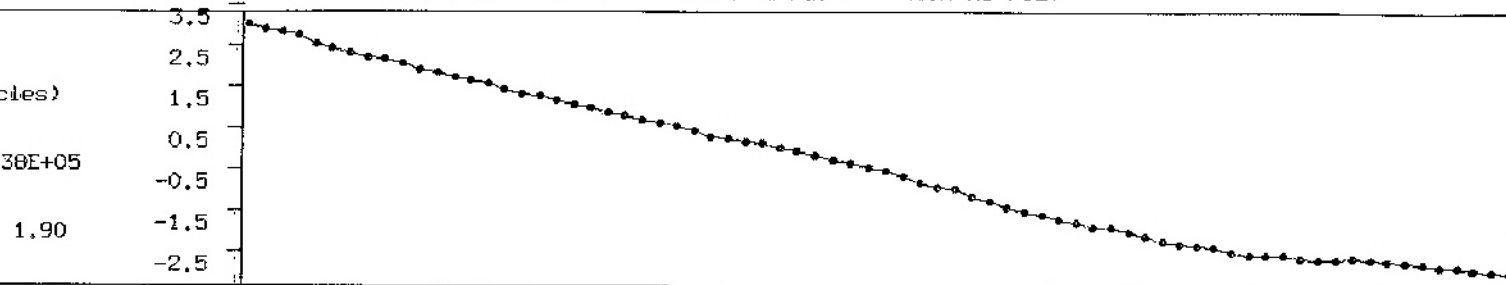
19 JUN 90 7 PRN13 2 PRN03 2 TX02 1 TX01 NO POLY



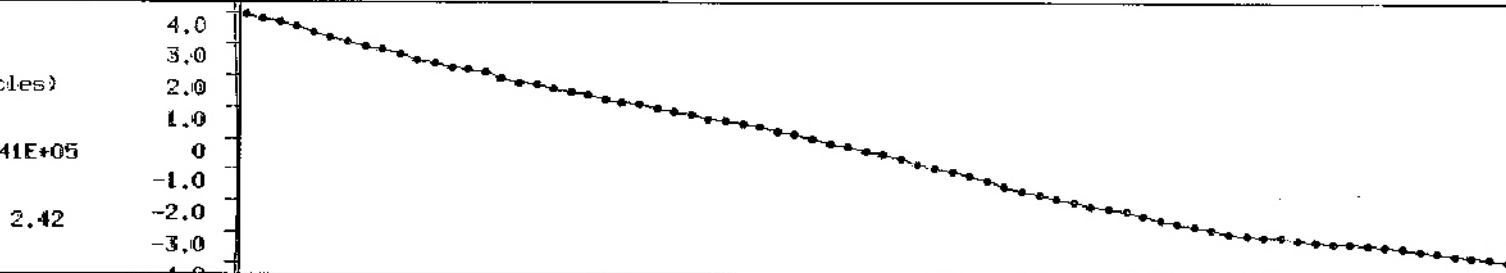


# L1, L2, LC, and LG

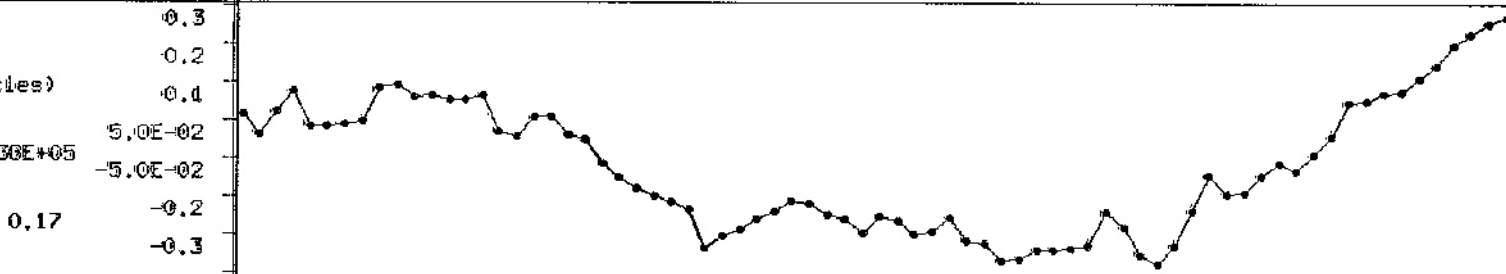
19 JUN 90 5 PRM11 1 PRM02 2 RIGM 1 MOJM NO POLY



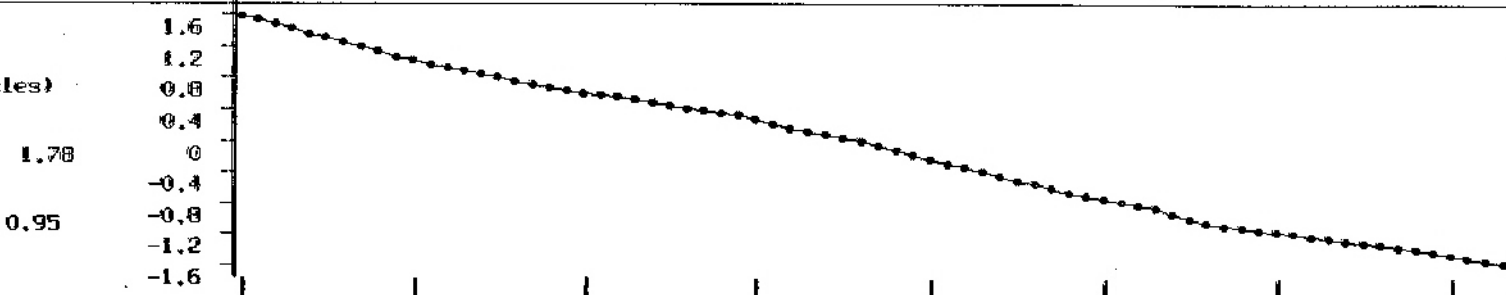
**L1 = 1575.42 MI**  
**(19 cm)**



**L2 = 1227.60 MI**  
**(25 cm)**

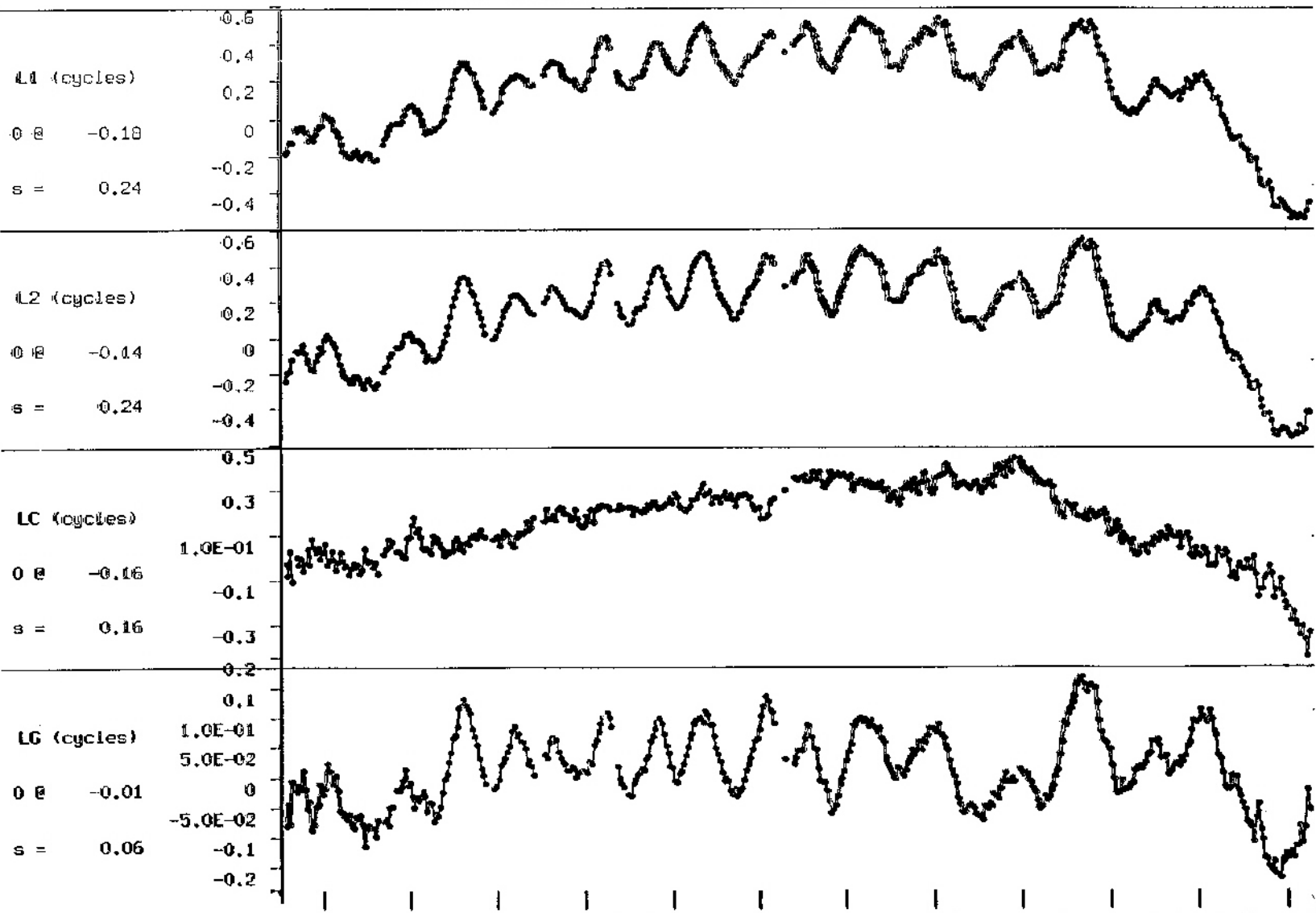


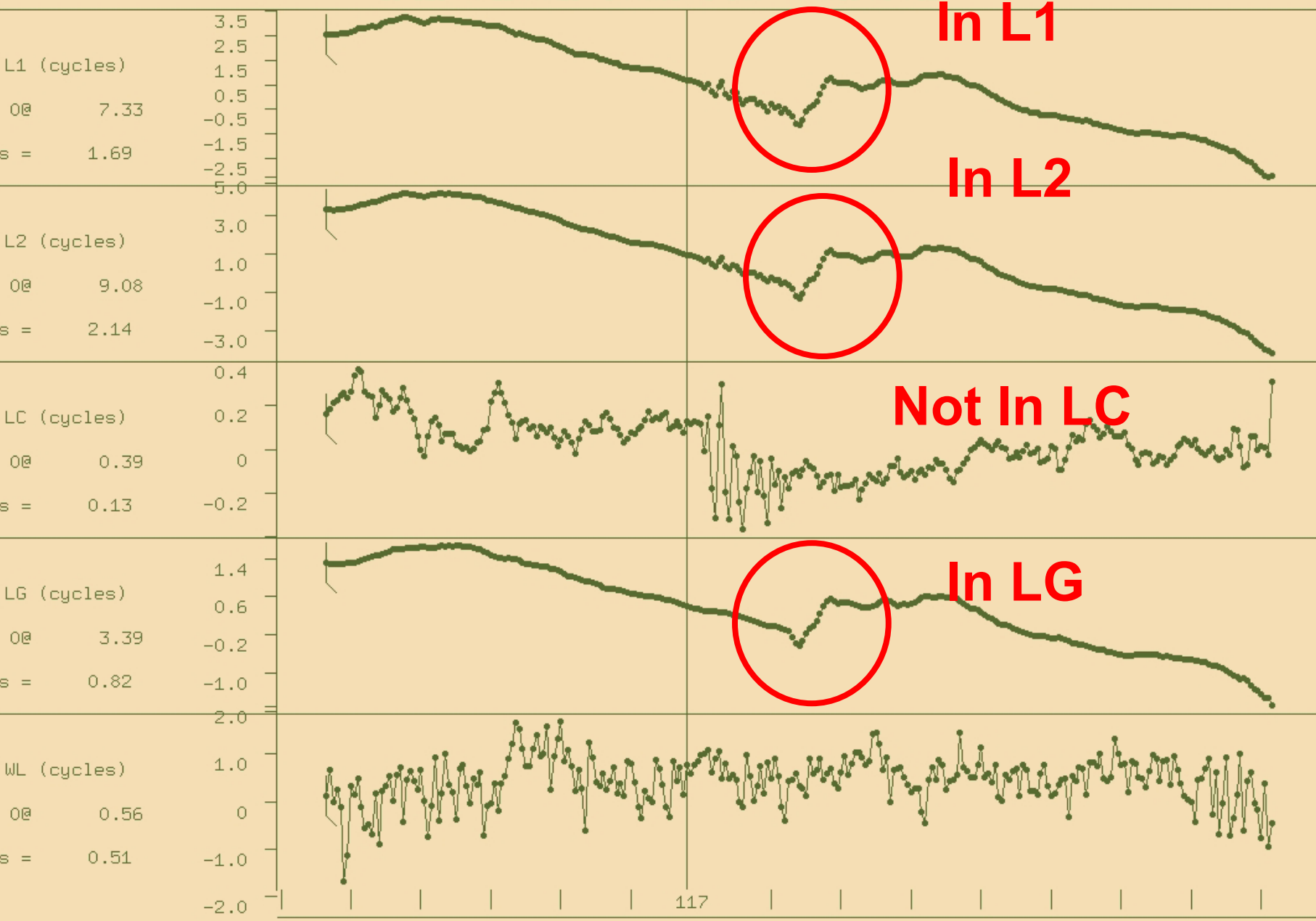
**LC = 2.546 L1**  
**- 1.984 L2**



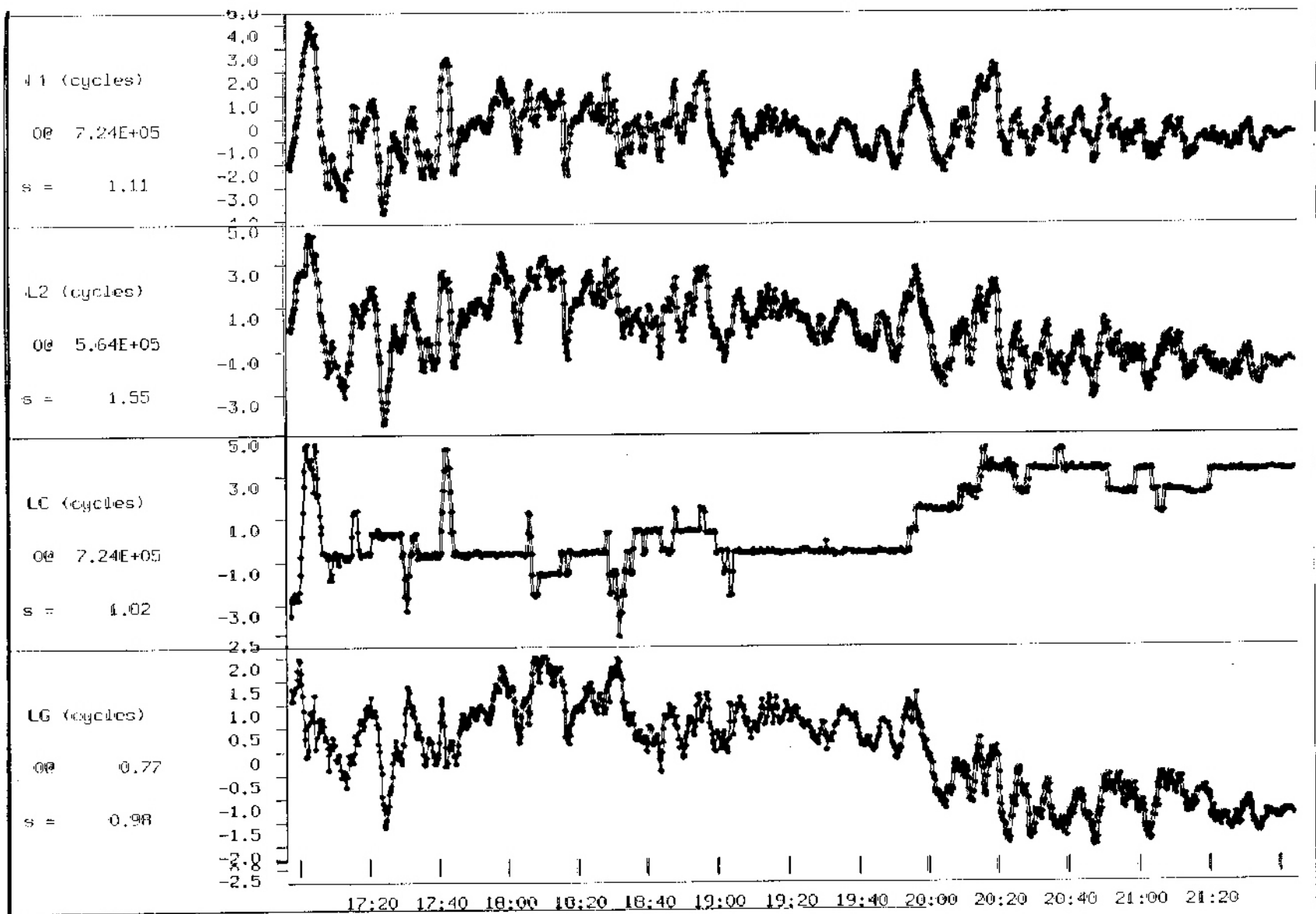
**LG = L2**  
**- 1227.60/1575.4**

13 JUN 90 6 PRN13 5 PRN12 4 TX06 2 TX04 PDLY 1

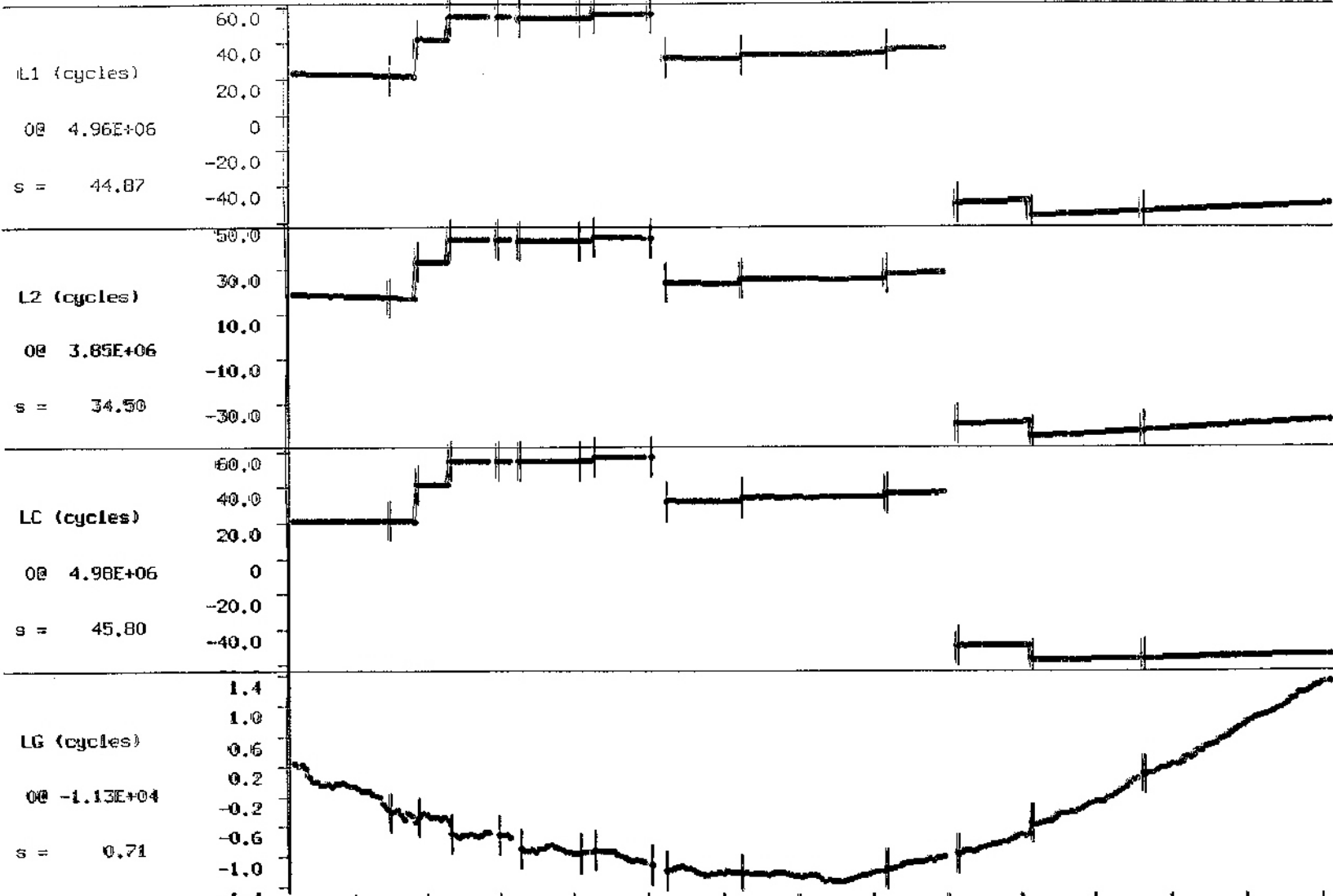




# STUFFED WITH CYCLE SLIPS !!!



9 JUN 90 7 PRN14 3 PRN09 3 TX05 2 TX04 NO IPOLY



L1 (cycles)  
0@ 4.96E+06  
s = 44.87

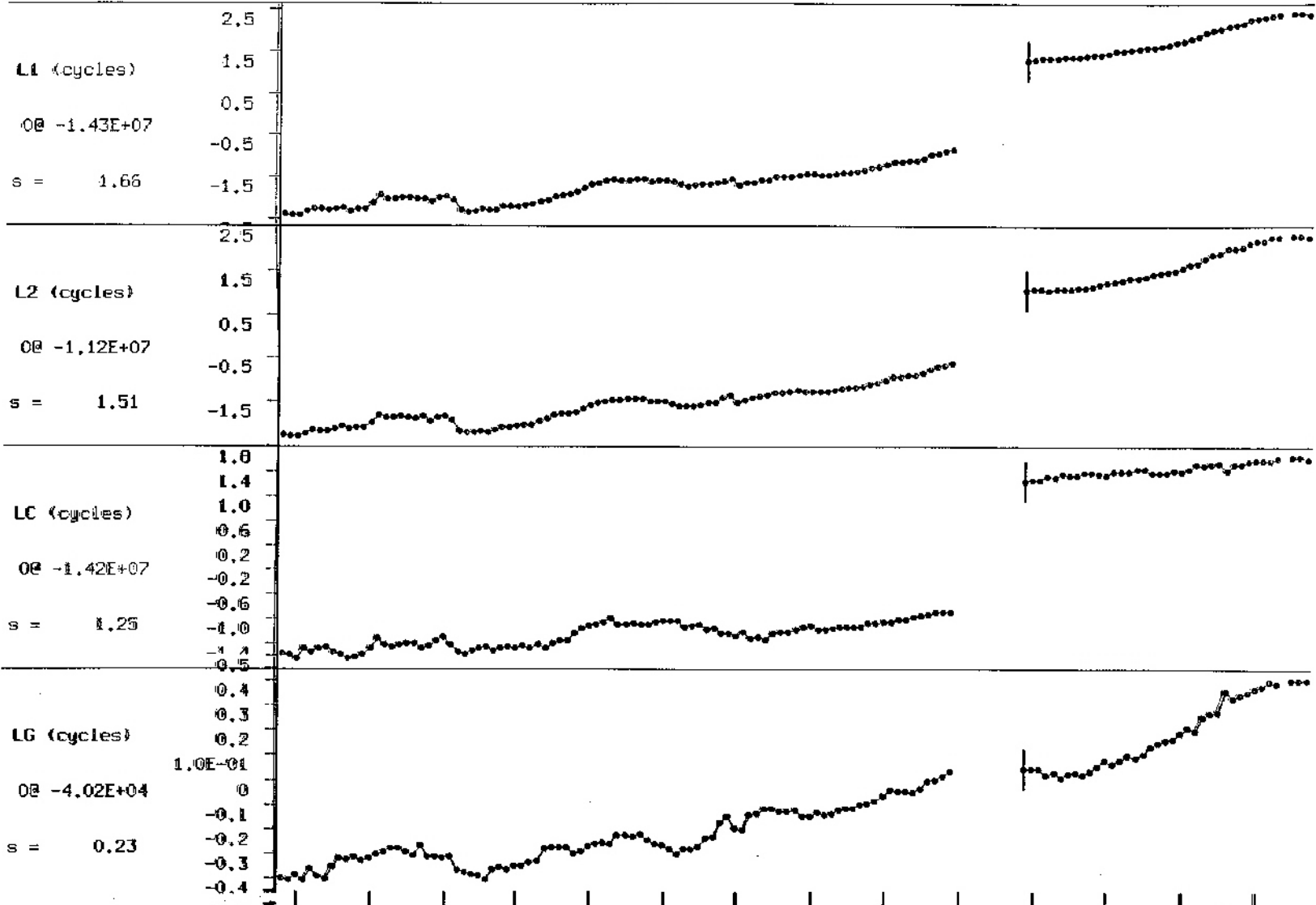
L2 (cycles)  
0@ 3.85E+06  
s = 34.50

LC (cycles)  
0@ 4.98E+06  
s = 45.80

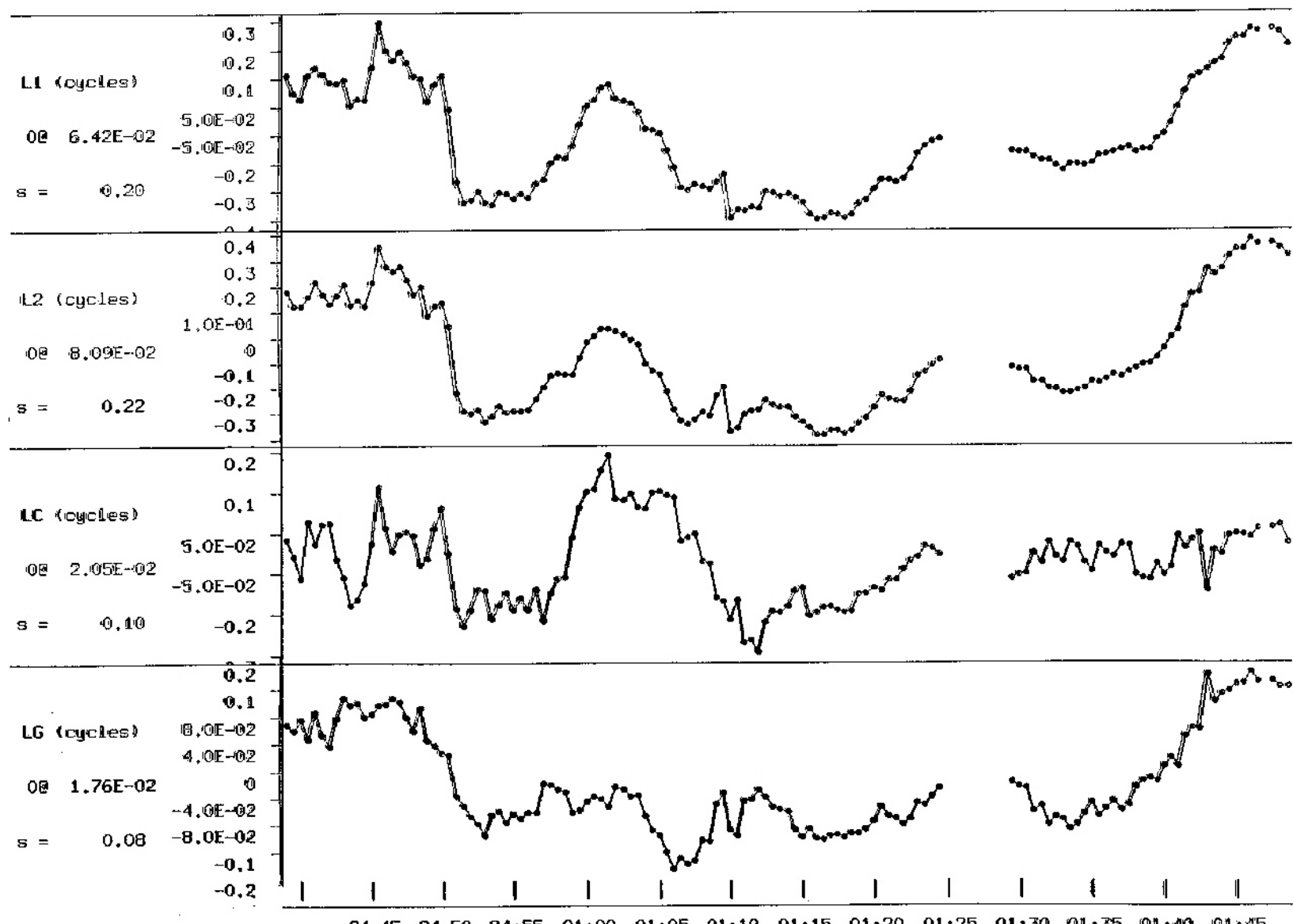
LG (cycles)  
0@ -1.13E+04  
s = 0.71

# REPAIRING CYCLE SLIPS [1]

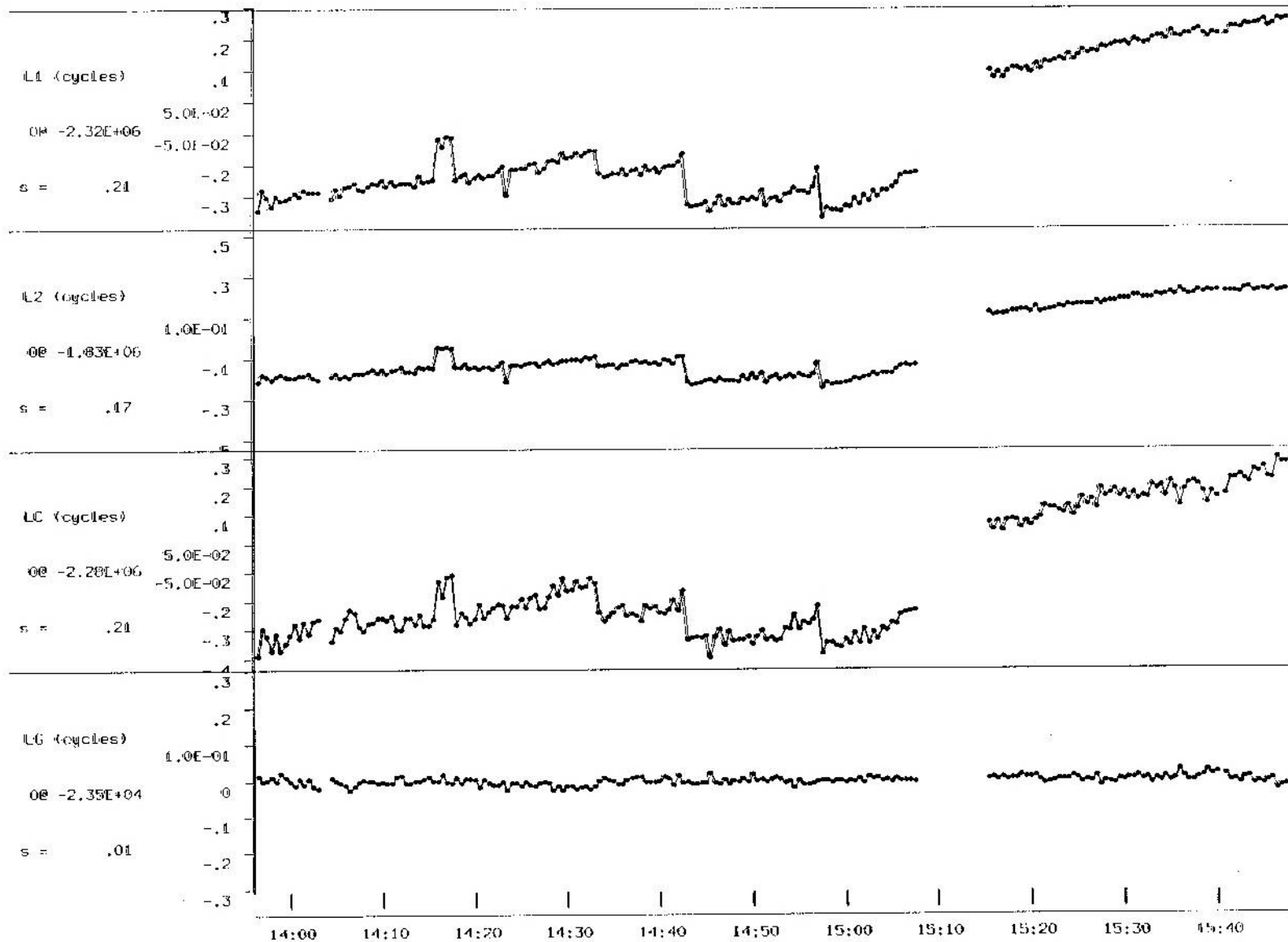
16 JUN 90 6 PRN13 1 PRN03 2 TX03 1 TX02 NO POLY



# REPAIRING CYCLE SLIPS [2]

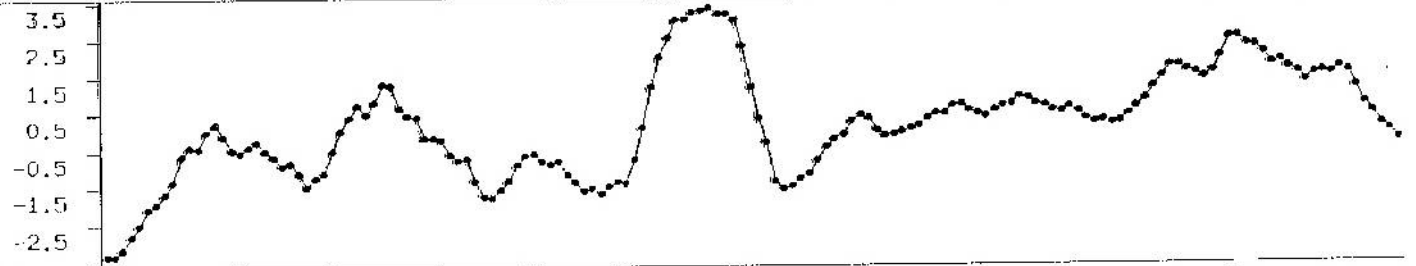


# TRIMBLE : WEIRD BEHAVIOUR !!!

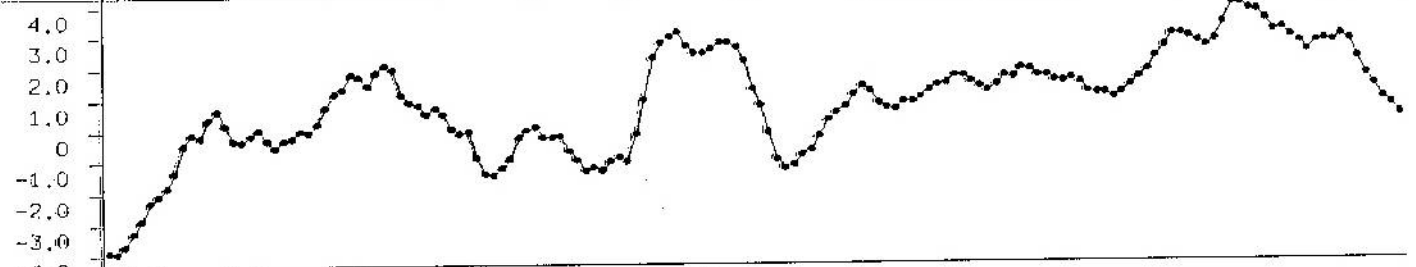




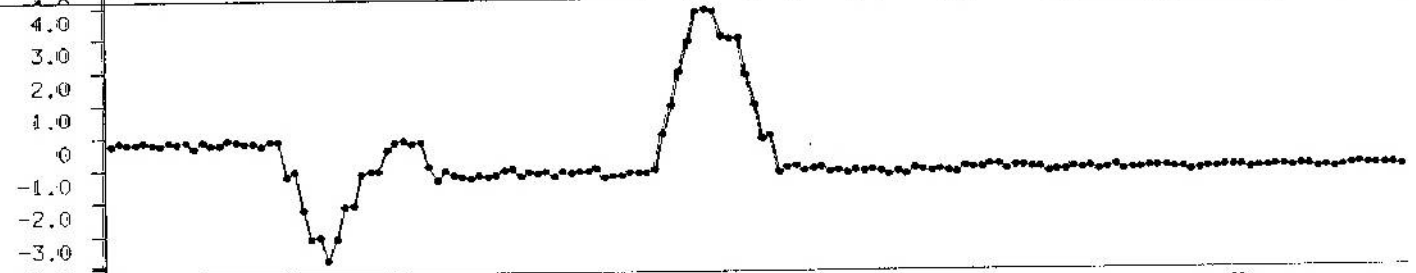
L1 (cycles)  
00 7.24E+05  
s = 1.38



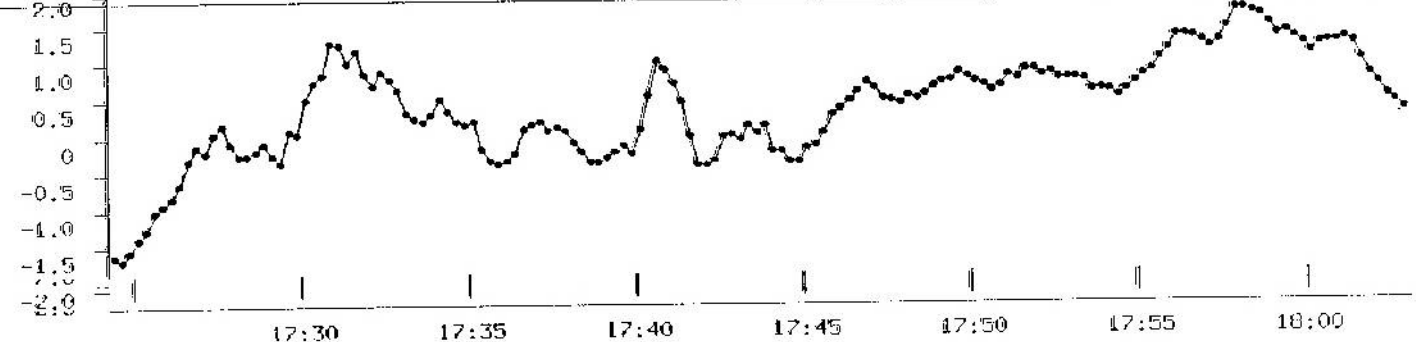
L2 (cycles)  
00 5.64E+05  
s = 1.61



L3 (cycles)  
00 7.24E+05  
s = 1.12

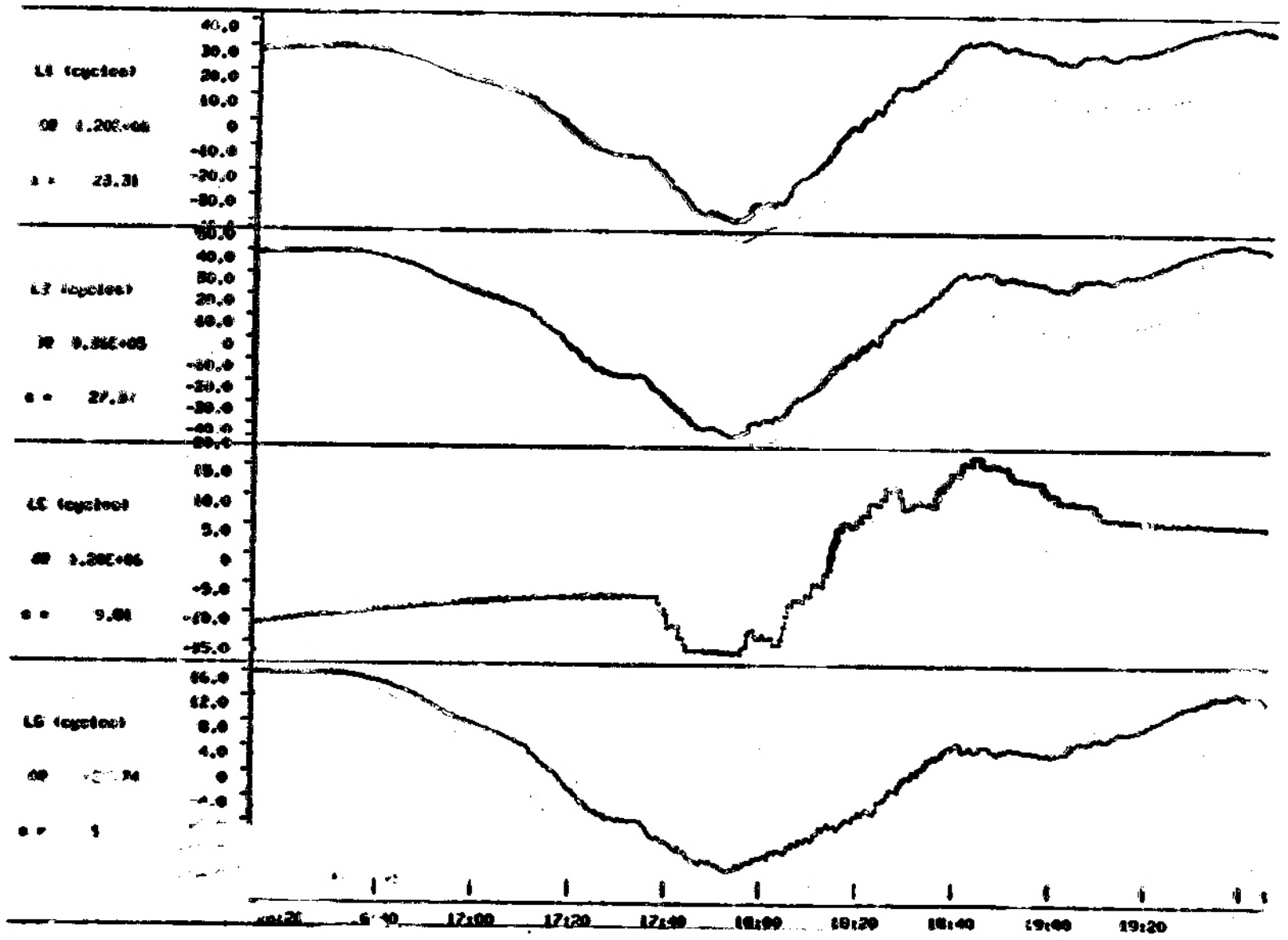


L6 (cycles)  
00 0.66  
s = 0.68



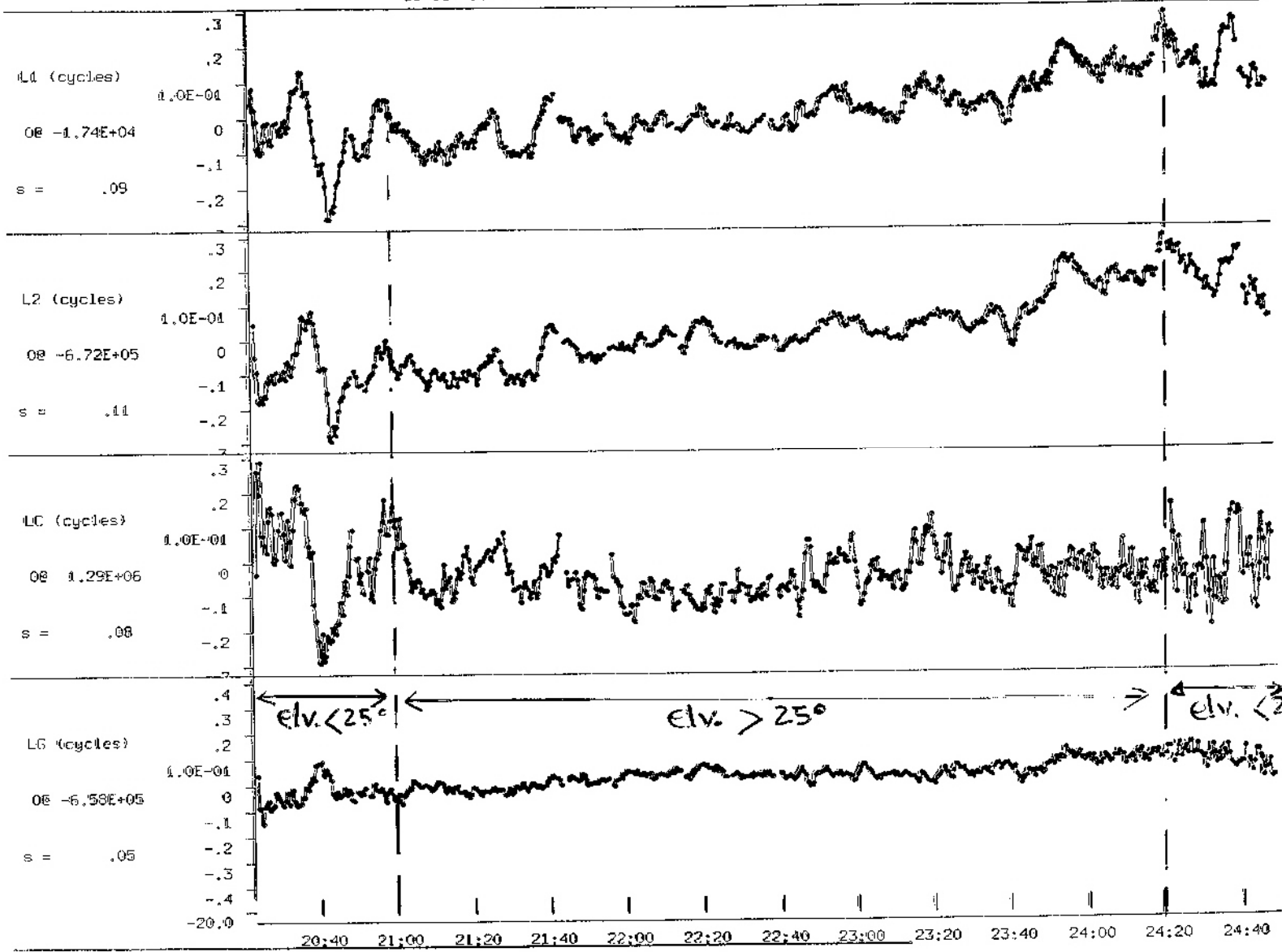
17:30 17:35 17:40 17:45 17:50 17:55 18:00

# WHAT KIND OF DATA ARE WE LOOKING AT ?



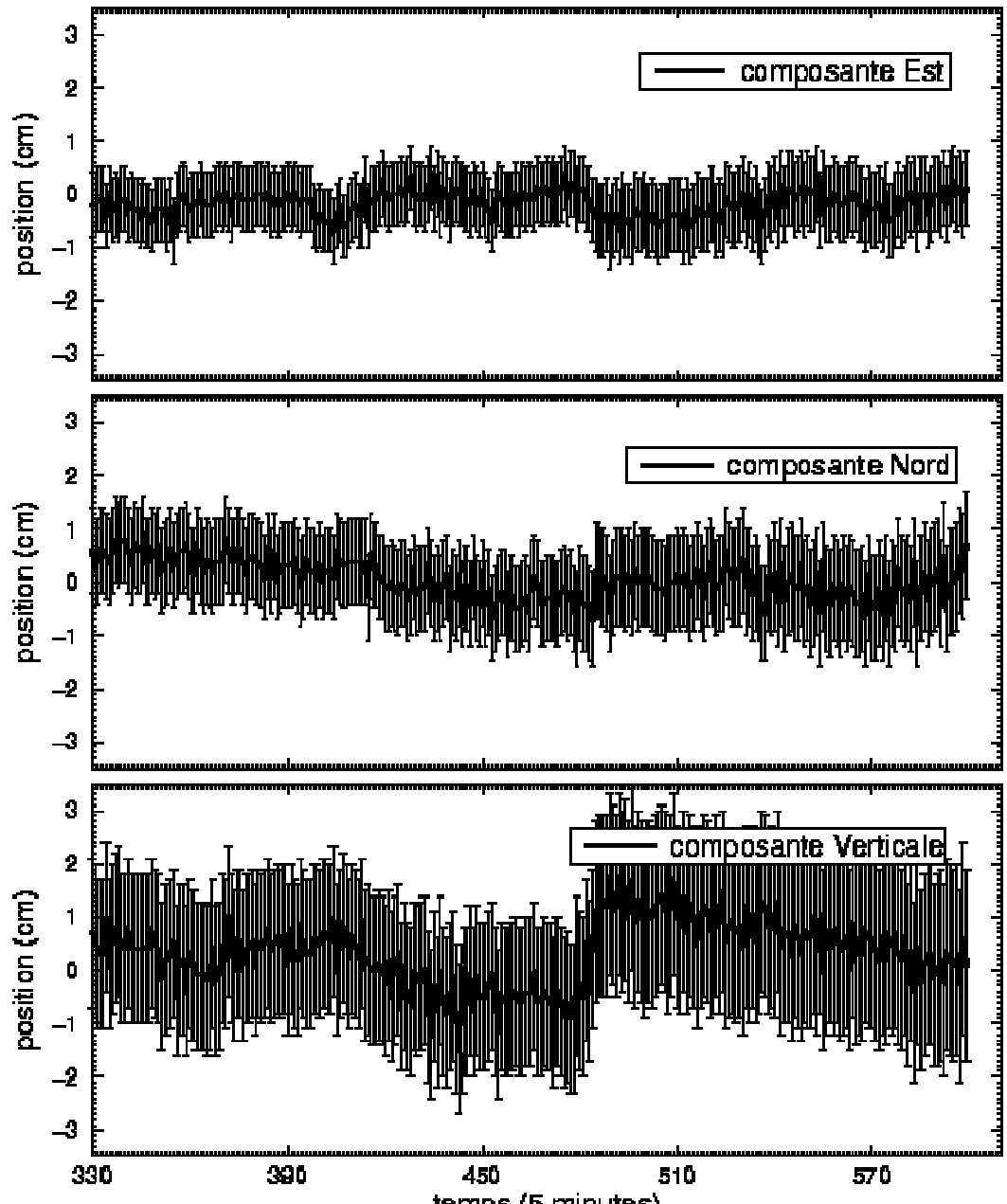
# MULTIPATH

19 JUN 90 7 PRN13 4 PRN09 6 TX08 5 TX07 NO POLY

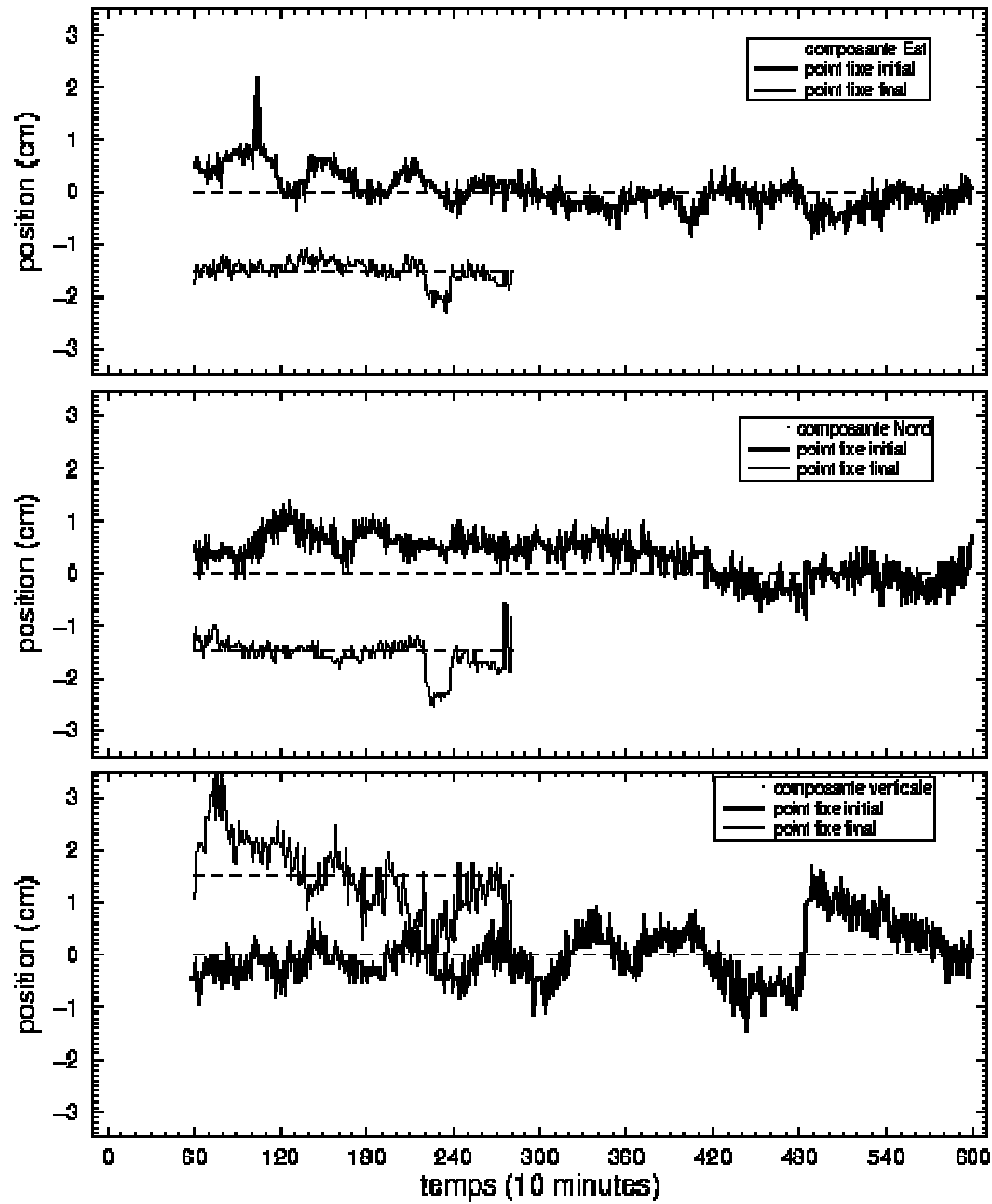


# Les dix premières minutes

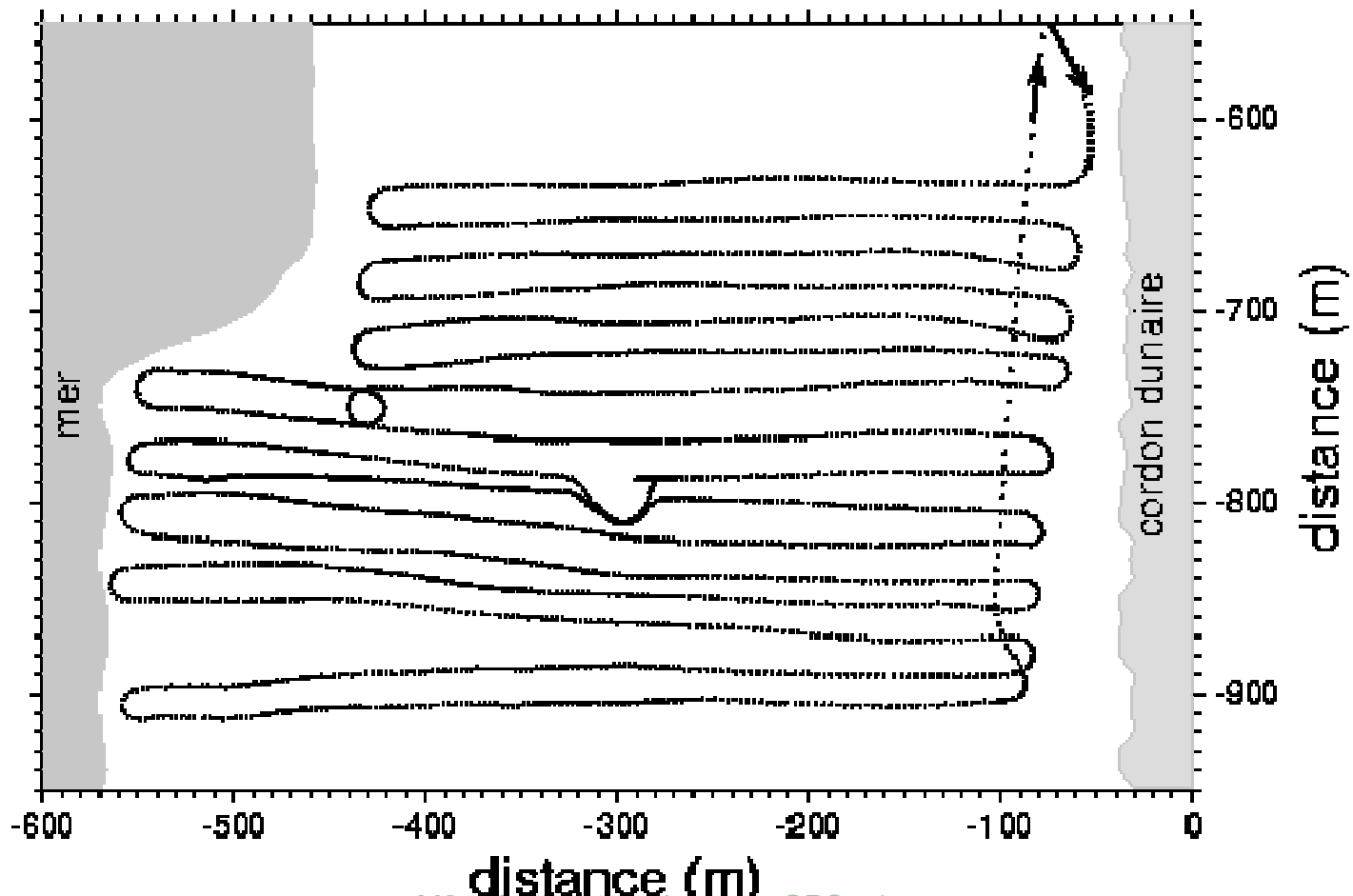
zoom apres resolution des ambiguites



### 9 minutes initiales – 4 minutes finales



## trajet du recepteur mobile



profils perpendiculaires a la plage

.1 (-636 m)

.2 (-656 m)

.3 (-670 m)

.4 (-690 m)

.5 (-705 m)

.6 (-720 m)

.7 (-740 m)

.8 (-760 m)

.9 (-785 m)

.10 (-800 m)

.11 (-815 m)

.12 (-835 m)

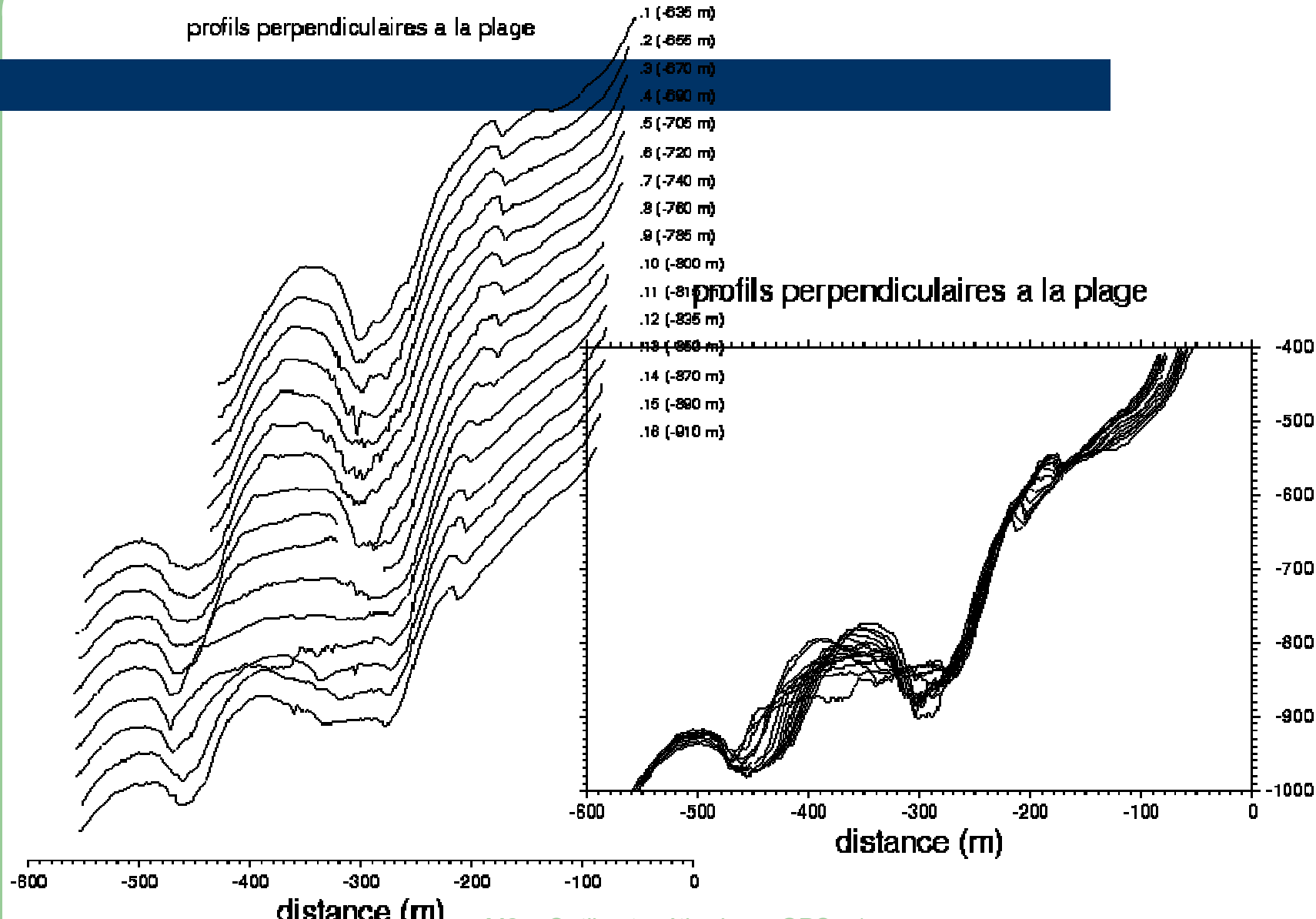
.13 (-850 m)

.14 (-870 m)

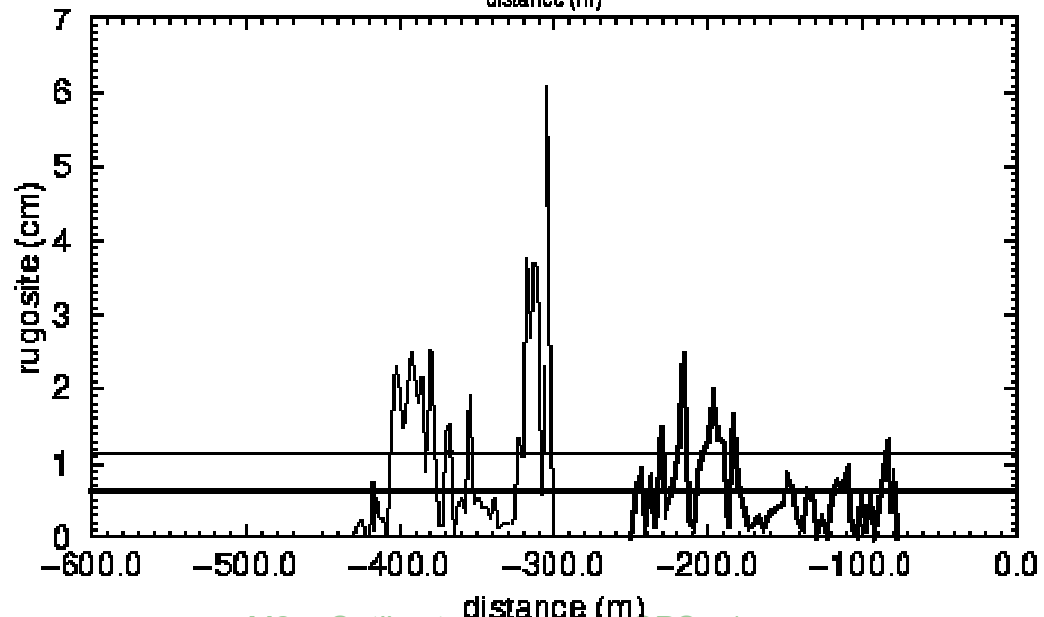
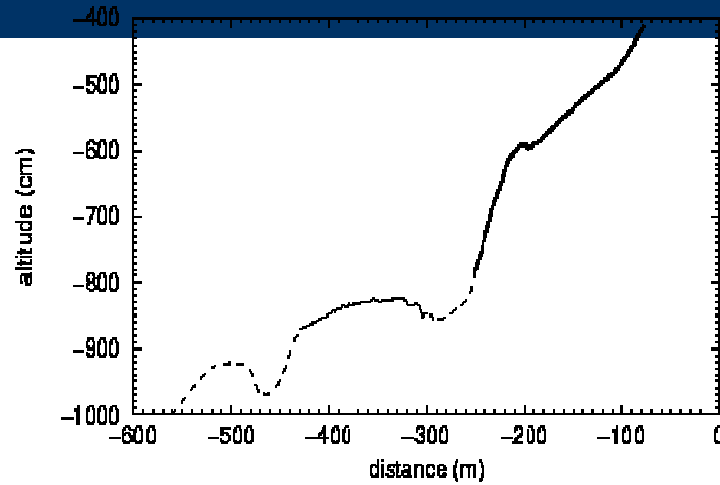
.15 (-890 m)

.16 (-910 m)

profils perpendiculaires a la plage



## rugosite du profil 11



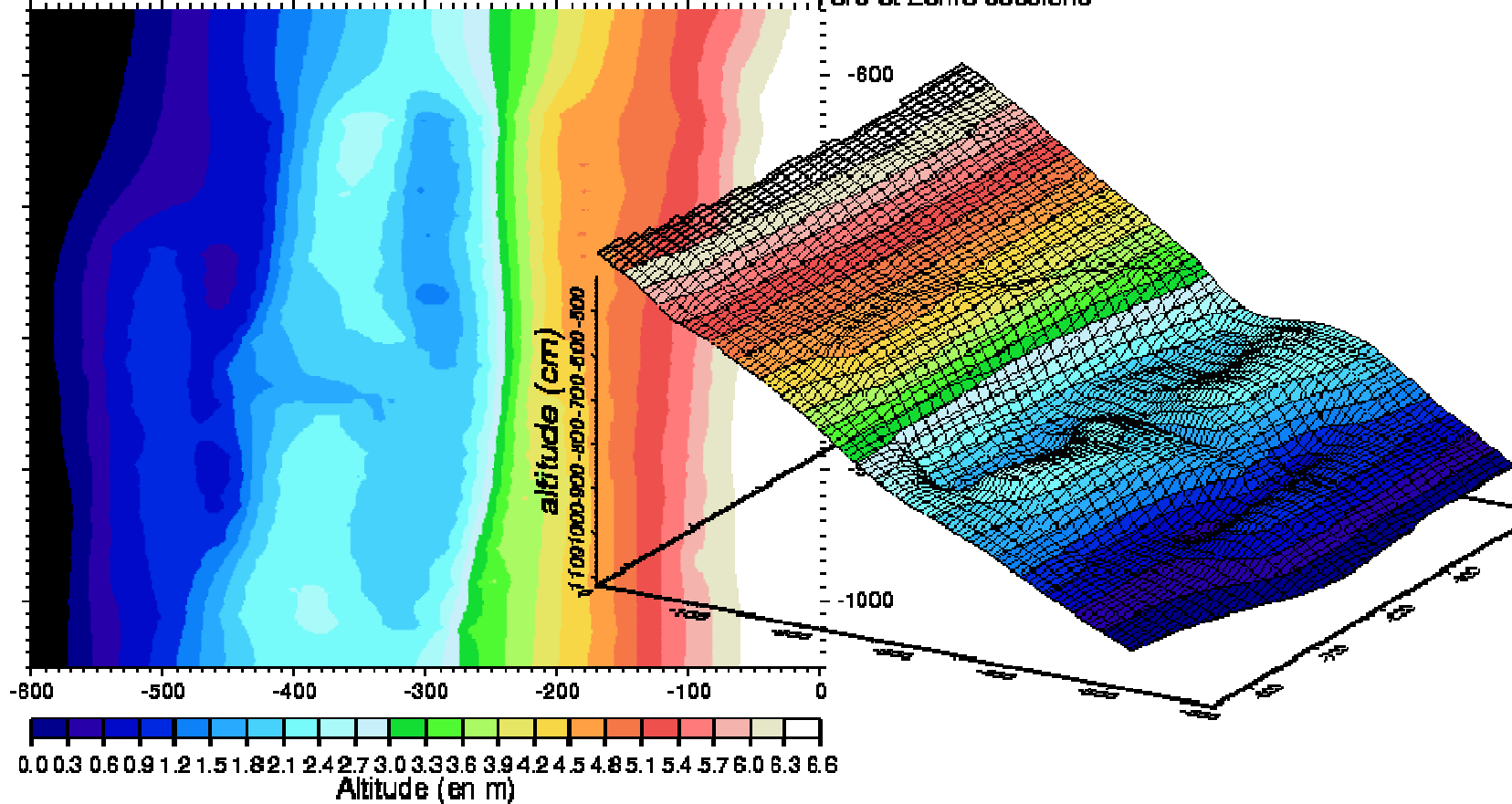


# topographie de la zone test

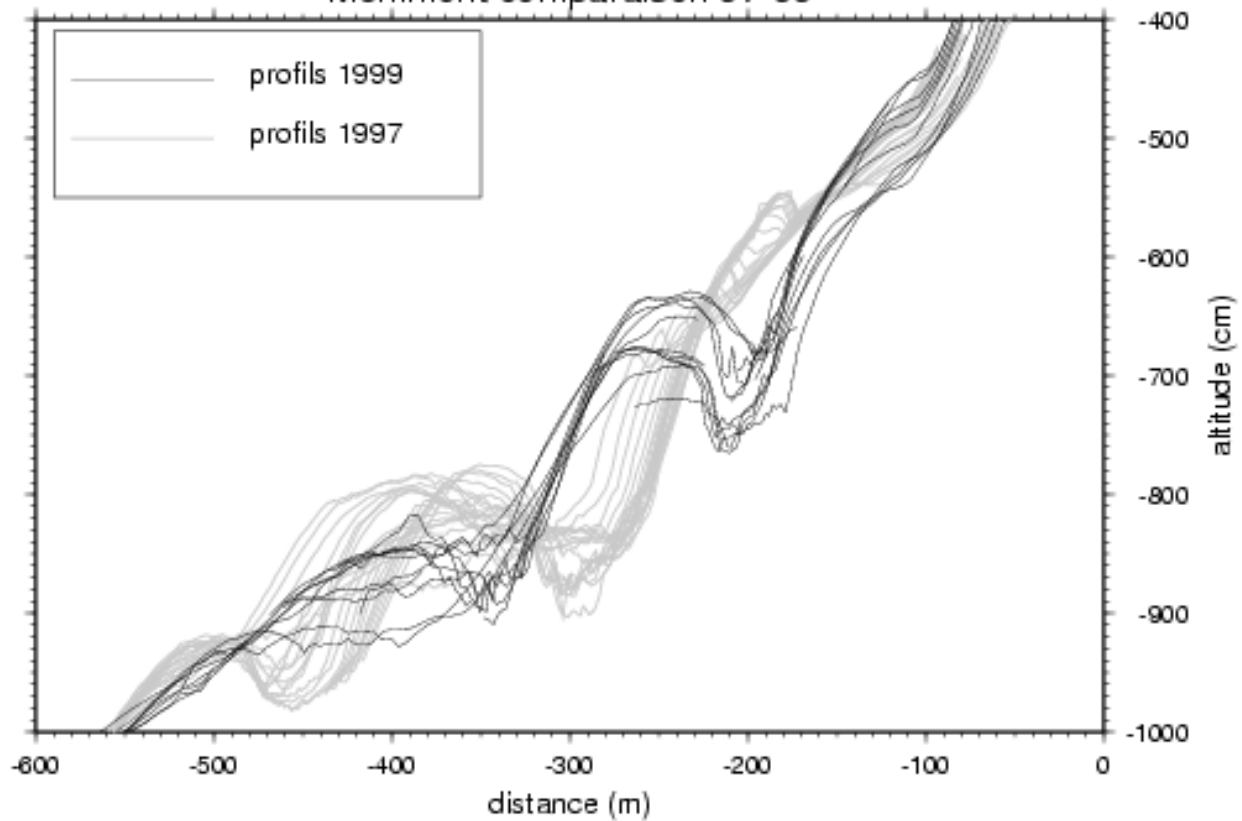
# Topographie de la zone test

1ere et 2eme sessions

1ere et 2eme sessions

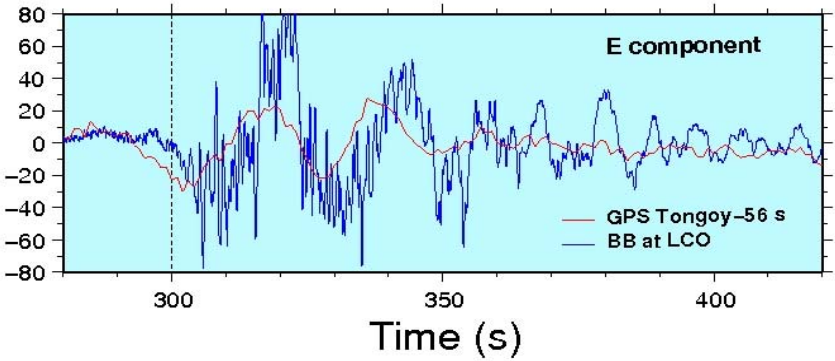
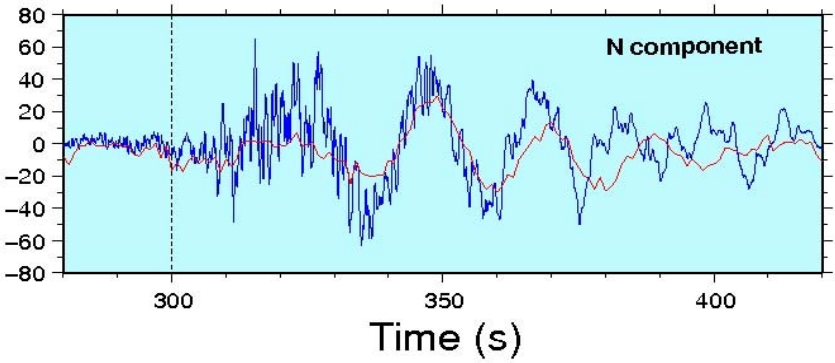
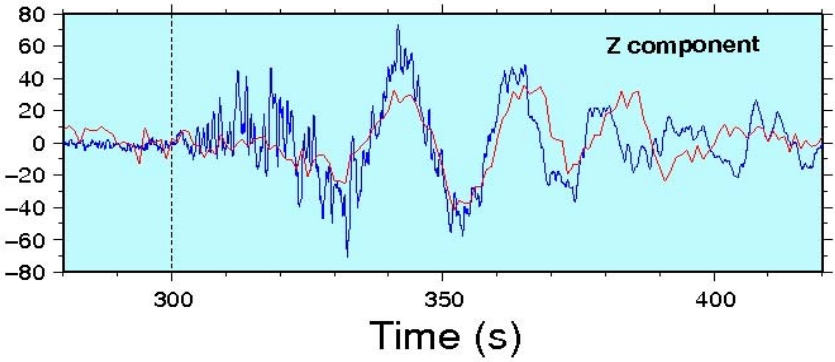


profils perpendiculaires a la plage  
Merlimont comparaison 97-99

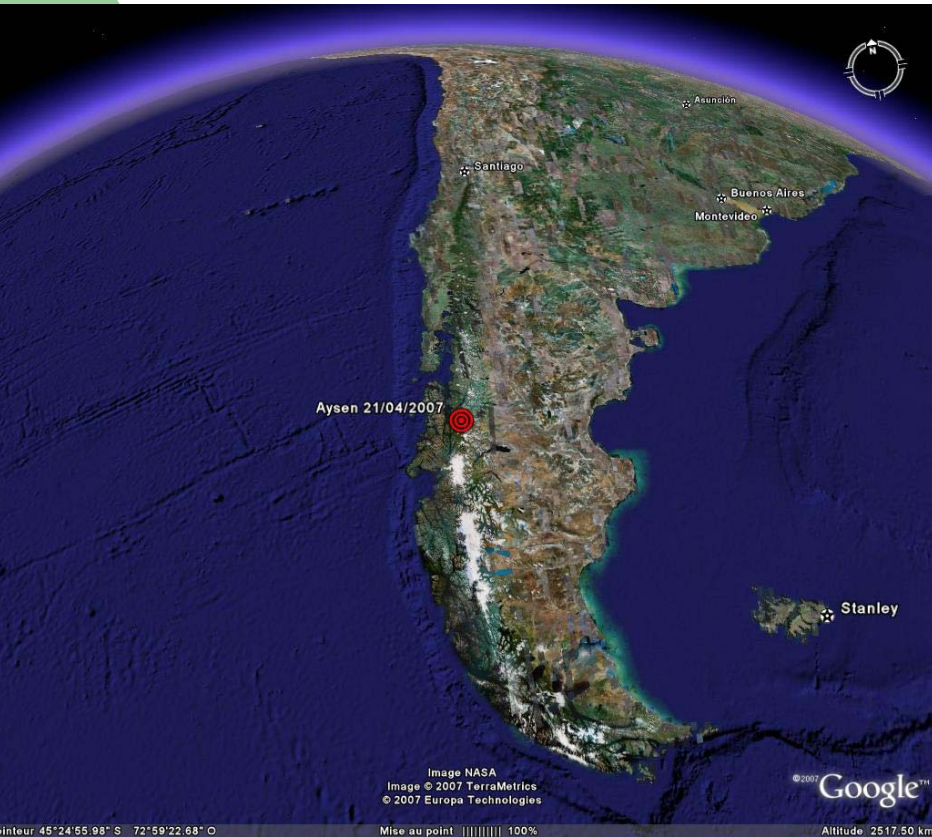


# Tocopilla (North Chile) Earthquake (14 Nov. 2007, Mw 7.7) :

Surface waves (Love: E-W, Rayleigh : N-S and Up) travelling at 4km/s measured by GPS 800 km away



# GPS in Aysen





5 seismic stations   
5 GPS units 

# GPS unit in Punta Cola



# Landslides triggered by the earthquake



# Tsunami triggered by the landslides

## Effects of the Tsunami

before



after



before



after





# Effects of the Tsunami

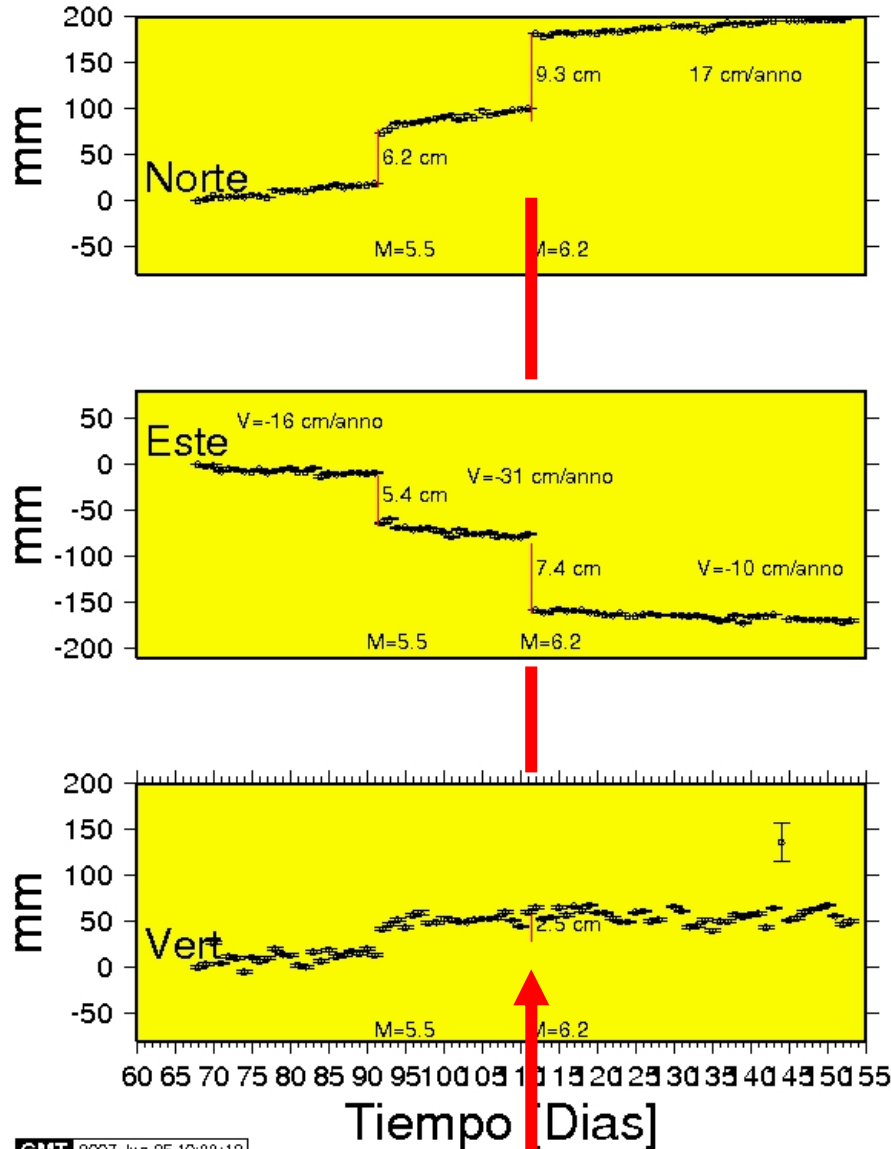
## Run up of 10-12 meters at puerto Chinconal (punta tortuga)



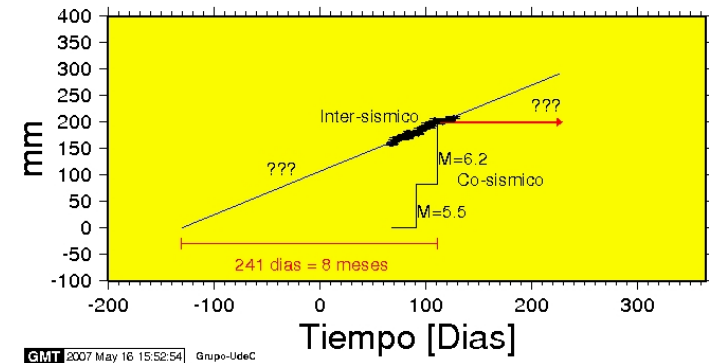
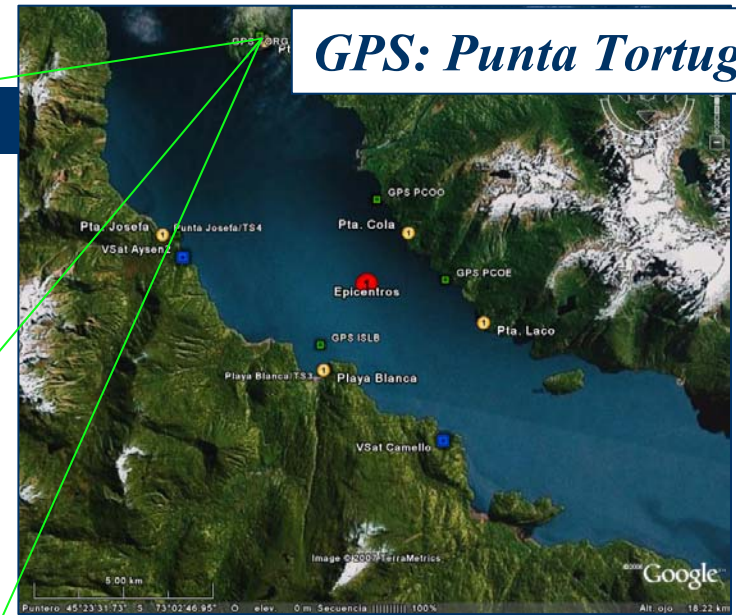
# Effects of the Tsunami.....lost instruments



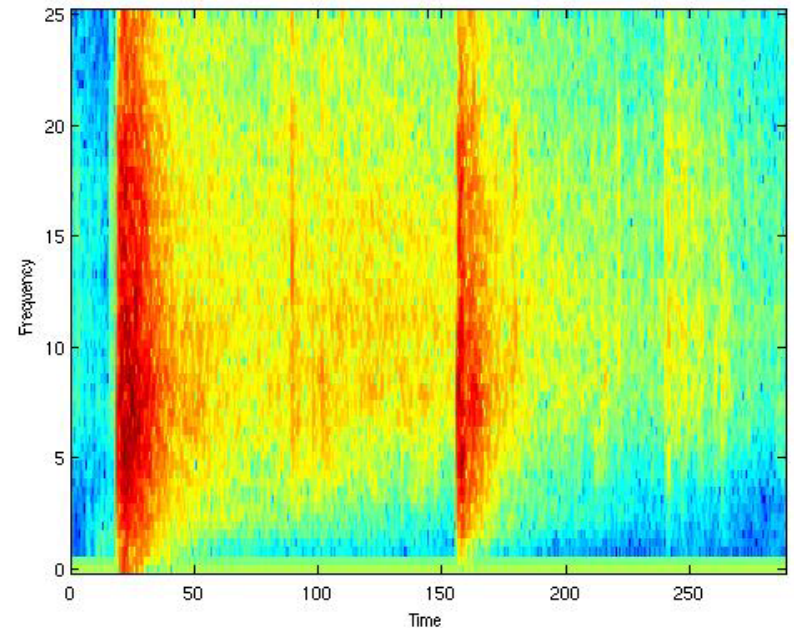
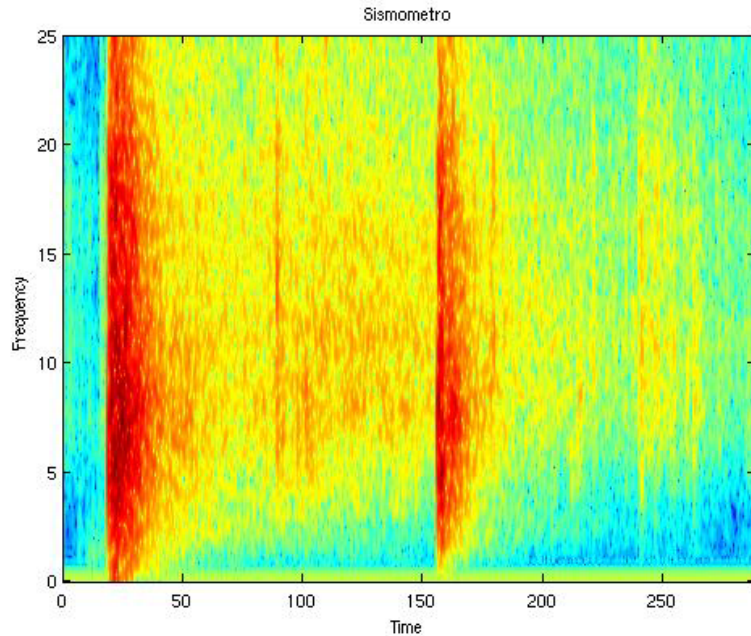
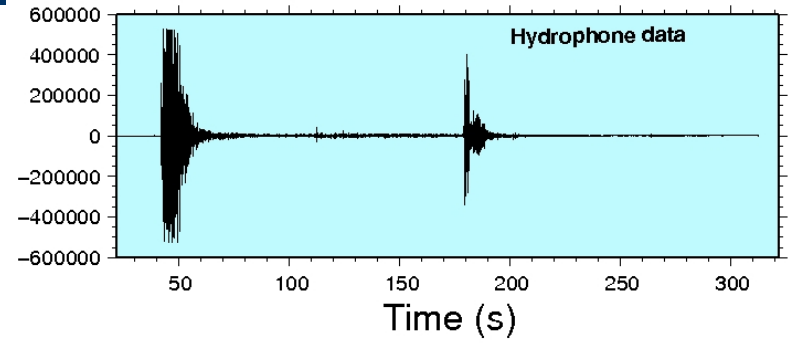
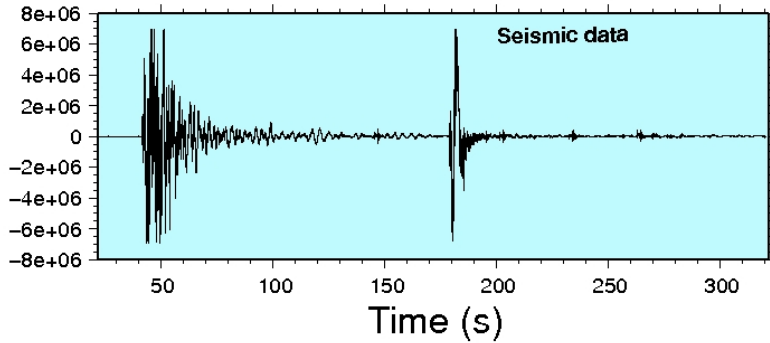
# 1 sismograph and 1 GPS survived in Punta Tortuga



**21 April**

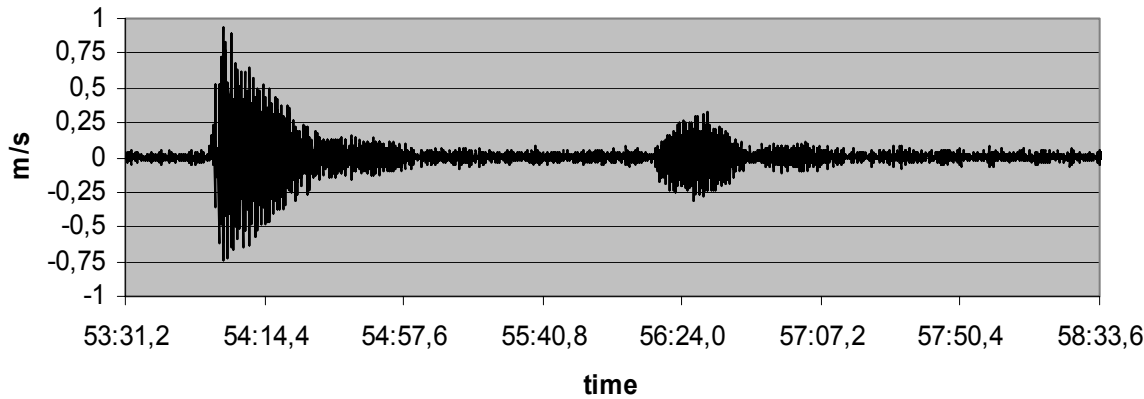


# Seismic and hydrophone data

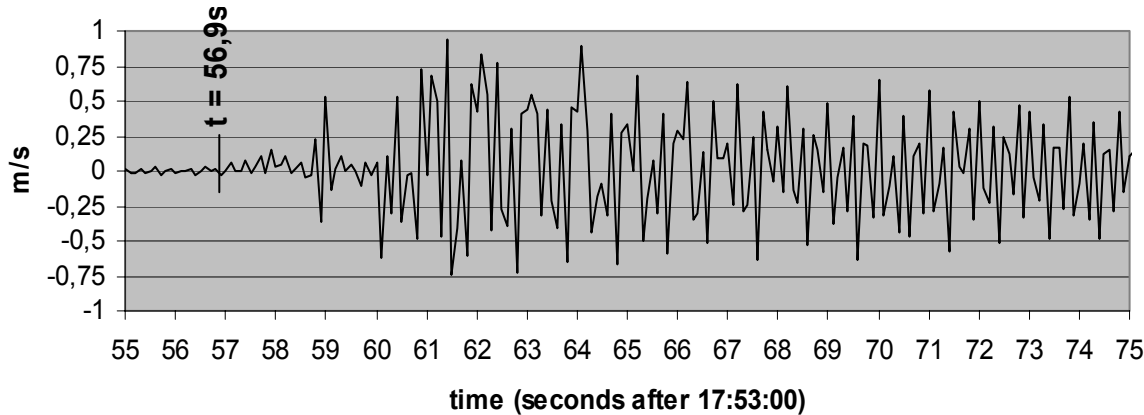


# High frequency GPS (10 Hz)

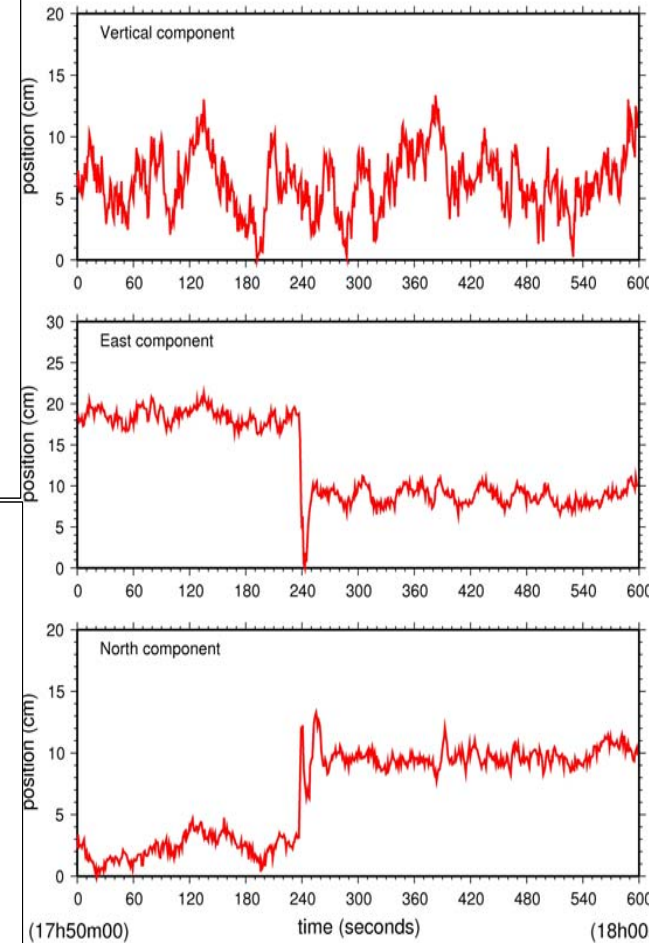
Velocity N-S



Velocity N-S



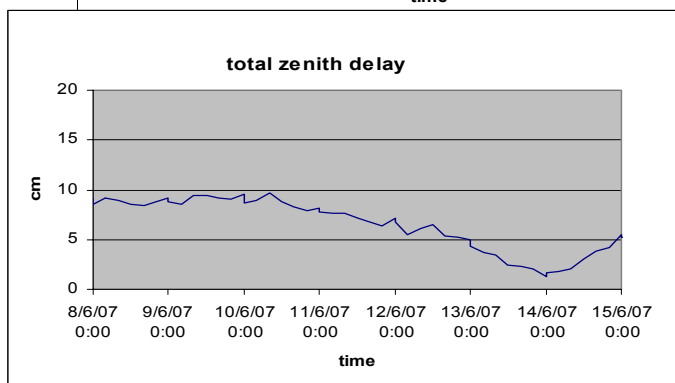
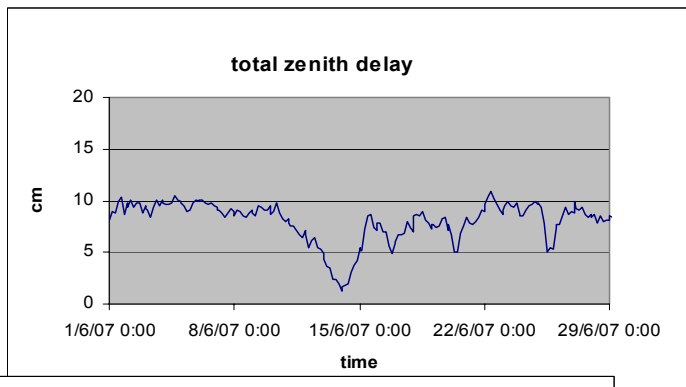
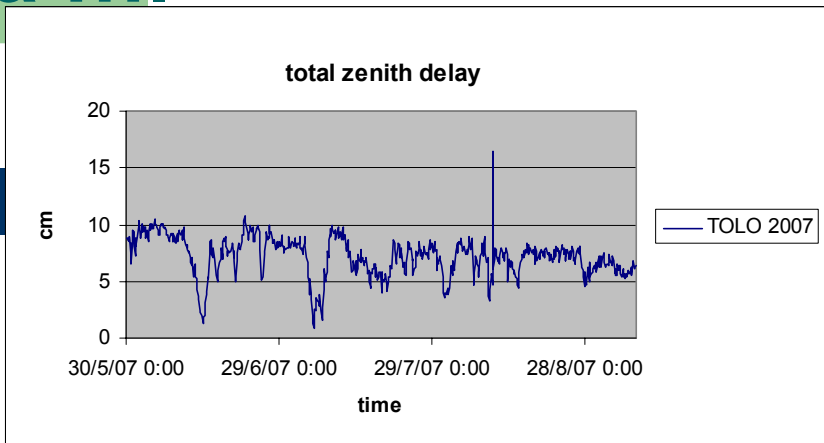
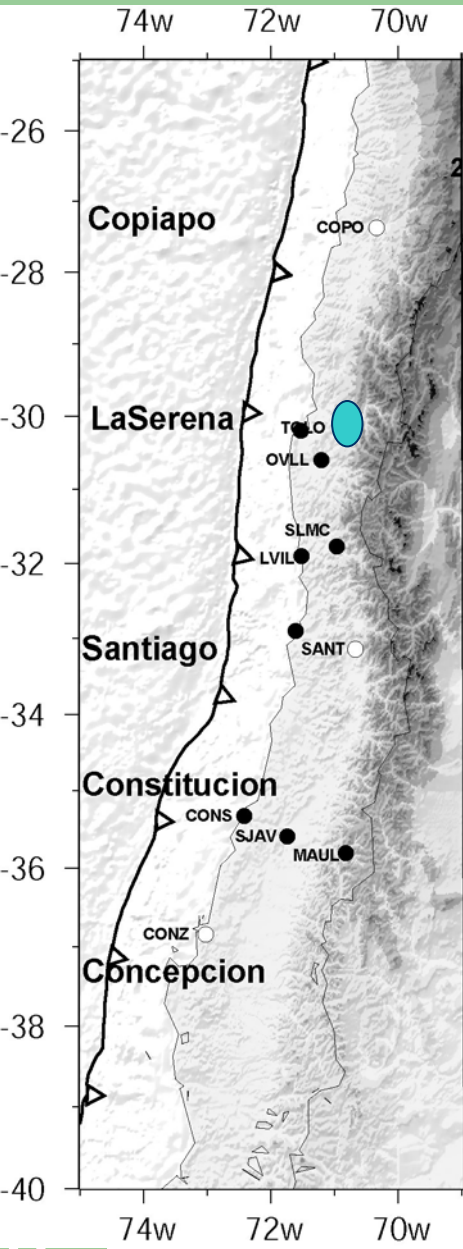
Tortuga 21 April 2007



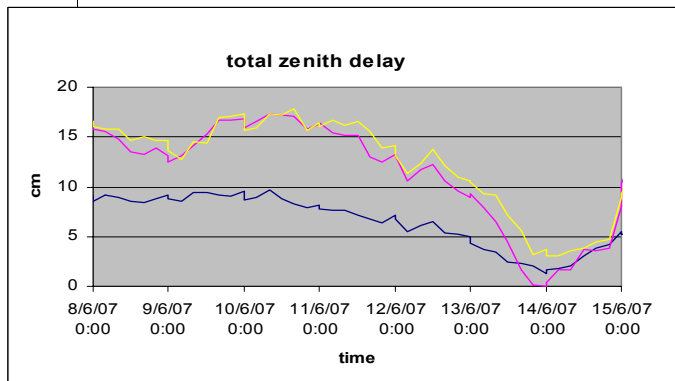
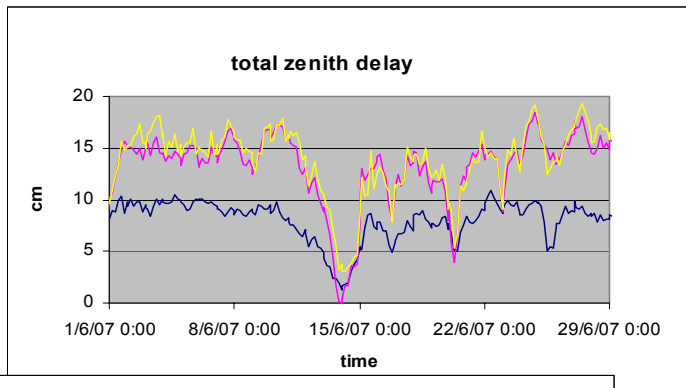
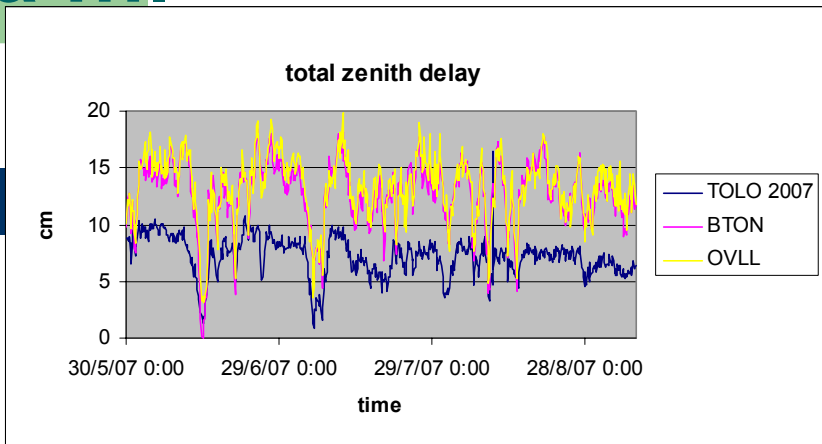
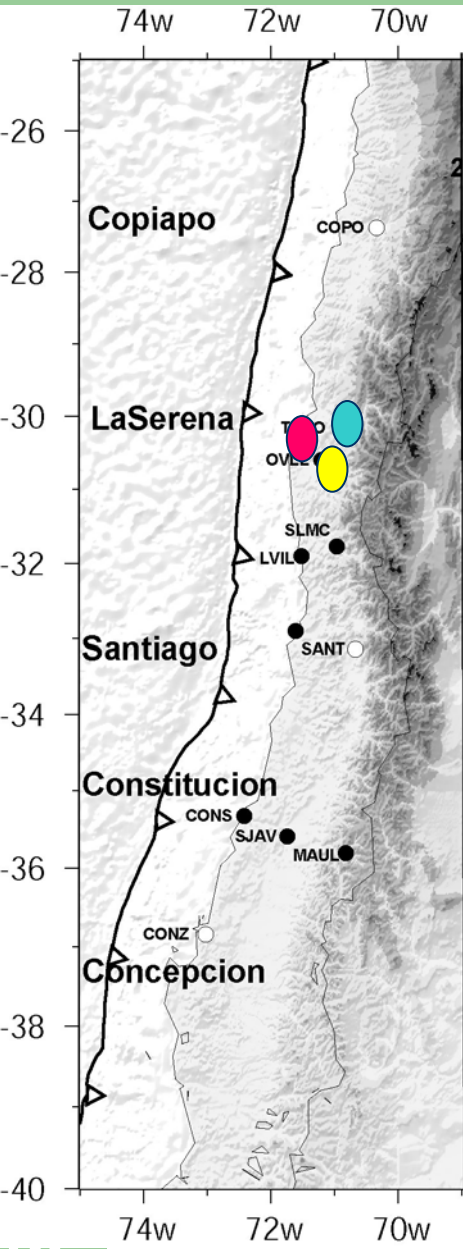


20 4 2007

# Meteo data ....



# Meteo data ....





# Meteo data ....

