OLG Monitoring of the Balkan mountains and the Eastern Mediterranean area

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1. Introduction

The EUREF special project of Time Series Analysis divided the whole network into six regions. OLG AC has taken over the task of monitoring the region VI, Balkan and Anatolia. In fact at the European side the stations to be monitored (BUCU, ISTA, SOFI) allow only to monitor the Balkan mountains and not the whole peninsula. At the Asian side, a few stations (ANKR, TRAB, TUBI, perhaps also NSSP) are situated at Anatolia, the remaining ones (AMMN, DRAG, NICO, RAMO, ZECK) are outside that region. The current distribution can be seen in figure 1. For keeping reference and to have at least one station in the stable part of the Eurasian plate GRAZ was added to the network. The network ("MON" products are named with MN_wwwwd.xxx) is computed for each week according to the EPN guidelines. The monitoring started in 2001 with presently 60 weeks of investigation.

2. Receiver/antenna problems

Beginning with 1997 the stations have been established or included into the EPN in that region. Not many changes of receivers and antennas occurred and only at RAMO a jump in the coordinates can be seen. The correction values in North/East/Up of –6/-18/5 mm are given in the log sheet. Additionally some stations seem to have problems related to receiver, antenna or the downloading program. An overview is given below.

2.1 ANKR

At some days, the latest ones are day 225 of 2001 (GPS week 1127) and day 101 of 2002 (GPS week 1161), only four to five satellites per epoch are observed the whole day long. With files of 24 hours length the coordinates remain stable, however. This feature is most probably related to the Rogue receiver type, because both days mentioned are observed by different receivers of the same type.

2.2 DRAG

Since GPS week 1137 frequently strange discrepancies appear which are classified as "ionospheric cycle slips" by the program teqc of UNAVCO, regarding the code (figure 2.). In

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a similar way the Bernese software reacts in the phase domain, removing those values because of a misalignment between L1 and L2. The effect is a removal of values up to 90% of the total, which gives frequently biased coordinates. Because the effect is varying from day to day, the “surviving” results can be combined into a weekly solution, where it cannot be seen anymore. Not any other Ashtech receiver or antenna seems to show that problem, a replacement of the equipment is strongly recommended, therefore.

2.3 TRAB

At several days no or not correct (e.g. 0.0043) code values are found in the RINEX files. The GPS weeks 1115, 1156, 1157 and 1158 are affected by the feature. It is assumed that it is related to the Ashtech receiver type, because this feature occurs sometimes also at other EPN stations (e.g. SODA and VAAS).

3. Possible station-related problems

3.1 RAMO

Since the replacement of the antenna in GPS week 1071 the station coordinates seem to change in all three components (North, East, Up). Inspecting the time series of the EPN (`http://www.epncb.oma.be/series_sp/RAMO.html`), the amplitudes seem to reach ±10 mm or more. The frequency, best seen at the East component, seems to be semiannual with highs in summer and lows in winter. Additionally there are small jumps in the range of 10-15 mm during many weeks. It is too early to find an explanation, because there may be several reasons for this movement (moisture within the dome, monumentation, local ground movements).

3.2 SOFI

The daily coordinates of this station show movements within one or two weeks, especially in the East component (figure 3). The amplitude is about 10-15 mm, no stable frequency could be found up to now. Starting to observe this phenomenon since GPS week 1036 the time difference between the movements varies from 10 to 20 weeks. Because of its high frequency of few days the weekly solutions tend to smooth out that feature. No reasonable explanation was found at present.

4. Station velocities

Starting with GPS week 1107 the weekly results of MON were combined until week 1163, using the normal equations and the Bernese Software. As a reference the coordinates and NUVEL1A-velocities of GRAZ have been chosen. The velocities of all stations were estimated with a priori values from NUVEL1A. In table 1 the results are compared to the corresponding ones of NUVEL1A, ITRF97 and ITRF2000. It should be kept in mind that the MON time series is a little bit longer than one year and that stations which were new in ITRF97 and ITRF2000 may have a short observation length. Therefore all those station velocities should be neglected for comparisons. Especially the values of AMMN in MON, BUCU, DRAG and TRAB in ITRF2000, NICO, NSSP, SOFI and ZECK in ITRF97 should not be compared. For the reasons mentioned in 3.1 RAMO is not very well estimated in MON and the older estimations of ITRF2000 are still representative. The few remaining comparisons can be summarized as follows:

- A common bias of some millimetres in the east direction for stations being on the stable part of the Eurasian plate is also confirmed by ITRF2000,
- Whichever value is taken, DRAG and RAMO seem to have own velocities, belonging neither exactly to the Arabian nor to the African plate,
- The three station ANKR, NICO and NSSP do not belong to the stable part of the Eurasian plate and do not confirm the existence of a common plate (e.g. Anatolian).

The residual velocities between the MON and the NUVEL1A estimates are shown in figure 4. It is clearly seen the large deviations at ANKR, NICO and NSSP. In the figure the differences at DRAG and RAMO are related to the African plate.

It is expected that velocity estimations will improve with time. However, without new stations EPN sites can only be used to prove some theories of plate kinematics and not to establish new theories.

STATION	V_N MON	V_N NUVEL	V_N ITRF97	V_N ITRF2000	V_E MON	V_E NUVEL	V_E ITRF97	V_E ITRF2000	V_U MON	V_U ITRF97	V_U ITRF2000
GRAZ	13.6	13.0	13.5	14.5	22.0	18.6	21.9	22.1	0.0	-1.5	-2.3
AMMN ARAB	17.7	27.7			35.1	19.4			24.4		
ANKR	11.3	9.5	15.2	10.5	1.6	24.1	5.3	2.8	9.6	21.0	-2.5
BUCU	10.2	10.9		6.5	27.2	23.0		29.2	0.8		9.5
ISTA	8.1	10.3			30.3	23.6			2.7		
DRAG ARAB	25.9	27.3		18.9	25.4	19.7		29.8	16.4		-16.6
DRAG AFRC		19.3				24.8					
NICO	19.6	9.3	15.0	13.4	21.6	24.2	19.1	19.0	8.4	-9.9	5.0
NSSP	16.0	6.5	21.7	17.2	30.3	25.1	47.9	28.7	-4.2	27.7	5.9
RAMO ARAB	24.7	27.0	27.0	15.6	24.8	20.3	20.3	23.4	9.4	0	2.8
RAMO AFRC		19.5				24.9					
SOFI	10.3	11.5	9.8	10.6	27.0	22.8	24.0	23.7	3.8	6.1	-0.7
TRAB	10.1	7.7		11.3	27.7	24.7		19.8	1.5		23.6
TUBI	7.2	10.2			27.8	23.6			6.6		
ZECK	10.4	7.2	7.9	9.5	29.1	24.7	25.7	26.1	5.8	0.2	2.9

Table 1. Yearly station velocities in MON, NUVEL1A, ITRF97 and ITRF2000
North, East, Up components in mm/year

Figure 1. Stations of the OLG monitoring network

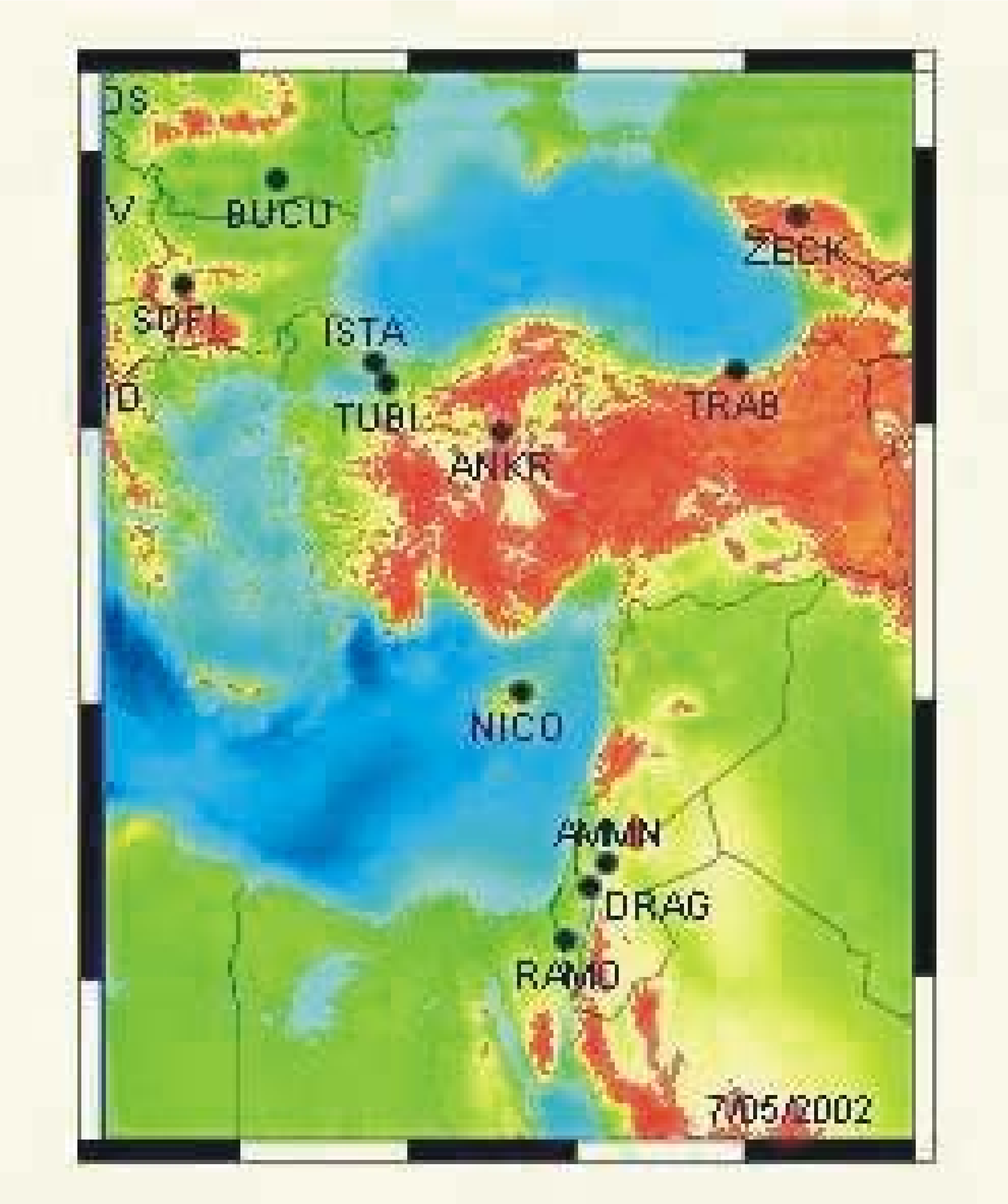

Figure 2. teqc-plot of DRAG, day 083 of 2002, with frequent “ionospheric cycle slips”

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SV+----------------------------------------------------------------------+ SV
 1|+_                                            _+oIIIoooooIIIIIImIMIIom|  1
 2|_                              __IIooIIIooo2m_       _++omIIIImmIImI++|  2
 3|                               _++IoomIIoooIIIIooI+_            ______|  3
 4|        _++IoIIoI1oII--_                              _-oIImIIImImII^_|  4
 6|               ++1IIm-ImMmImIMooooMIMom+_                             |  6
 7|^+oo1ooIIIoIoI1oo2+_                              ___m++++_          _|  7
 8|ooooIooIIIoI+_                                            _mIIImIIIIoI|  8
 9|      _+IIoIommoI1oII-Imom+_                                          |  9
10|ooooMooII+_        _^-ImomImmoMm++                              _MIIoI| 10
11|                                         __+IIIooIIImoooooIII+_       | 11
13|oooo1_                                            _IIooooIIIIIImIIIIoI| 13
14|               ___+I++___          _+IIIooomIIIooIIIm+_               | 14
15|                      _mImmmoooooomMomIIoooII+_                       | 15
17|                    _-momImIooooooIoMmmIMM++_                         | 17
18|       ______            _^mooooooIoomIIoooo+_                        | 18
20|                                            _+IooIIImoooomImIMIm1M+_  | 20
21|                             ++ooMIoomIIoooIIIIooI+_                  | 21
22|                          __Moooo1IoomIIoo++_        _++oo1ImIImm+    | 22
23|__Io1ooIII++_        _+1mmImooooo1Imom+_                              | 23
24|_         _++IooI1oII-Imommm_                             __IMImI1II++| 24
25|                    __MMmmmmMMo++__        _+IIoooIIIoooooI+_         | 25
26|__-o1oooIIoIoIIoo1+_         __++omo++__                              | 26
27|oooo1ooI+_                                            _IIIIImIImIIIIoI| 27
28|oooo1ooIIIoIoI+_                                               _+;IIoI| 28
29|         _-IoI1oo1oII+__       _^+moomIIoooIIII+                      | 29
31|oo++_                               __IIoooIIIIooIIIm+_         _mIIom| 31
 5|        _++IommoI1oII-ImomMmmmo+_                                     |  5
30|           _^+oo1oII-ImomMImMmooo1_                                   | 30
-dn|                                                                      |-dn
+dn|  1     c  1 5     3ccc3 c21c1    c2 96c 1   4    541     17c716 1 55 c|+dn
+10|7798877768888889978777 8aaa89aaaa9bbbbaaaaa9878788667656999889999aaa97|+10
Pos|oooo     o oo ooooo  o o^^^  ^ooooo  oo                               |Pos
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   +--------|--------|--------|---------|--------|--------|--------|--------+
00:01                                                                  23:59
2002 Mar 24                                                      2002 Mar 24
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Figure 3. example of daily coordinate changes at SOFI, GPS weeks 1155-1157

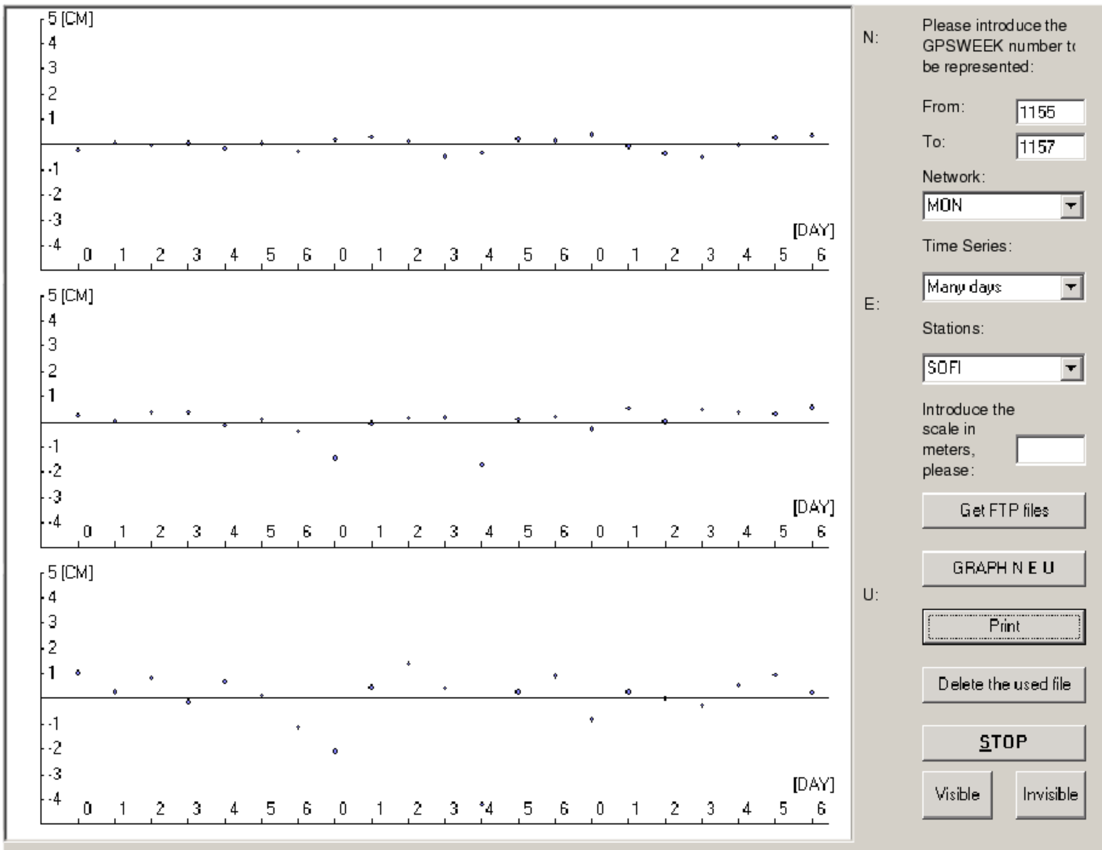

Figure 4. residual station velocities MON - NUVEL1A