Analyzing ILRS Network Tracking Profiles and Statistics

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Introduction

In 2011 a comparison of normal point data provided by the EURROLAS Data Center (EDC) and the Crustal Dynamics Data Information System (CDDIS) was made (1). Missing and double entries of normal points were found in the provided Quick look files. In 2012 the International Laser Ranging Service (ILRS) introduced the new Consolidated Range Data (CRD) file format for normal points. In theory the observation data found in both repositories should be identical. However inconsistencies are existing.

Inconsistencies in Data Centers

By comparing the normal point files of the years 2010-2015 (until end of September) from both, the EDC and CDDIS data center, non-matching numbers of total available normal points indicate small discrepancies in the provided sets of data. More detailed analysis lead to two kinds of problems between the files.

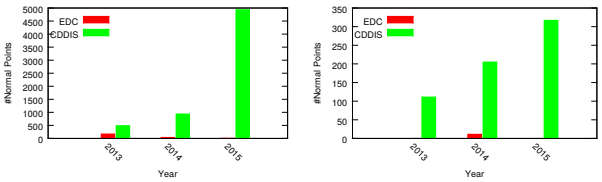


Figure 1: Number of multiple entries of the same normal point total (left) and for GNSS satellites only (right).

Multiple listing of the same observations occurs in both data centers, however significantly more often in CDDIS. This may happen due to technical issues or when updated observation information is released and the old data is not replaced. The CRD format provides a special flag to indicate the type of data release. (0=first release, 1=first replacement of the data, ...). In EDC observation data with higher release flag replaces the older release. In CDDIS files this is not always the case (see Figure 4).

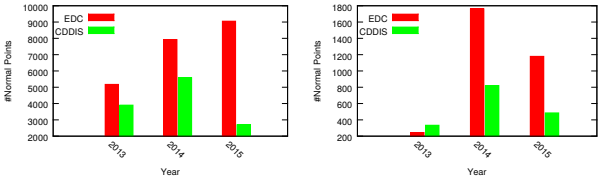


Figure 2: Number of normal points missing in one data center total (left) and for GNSS satellites only (right).

M This implies that the vast majority of normal points "missing" in EDC data files stem from a double listing in the corresponding file in the CDDIS data center.

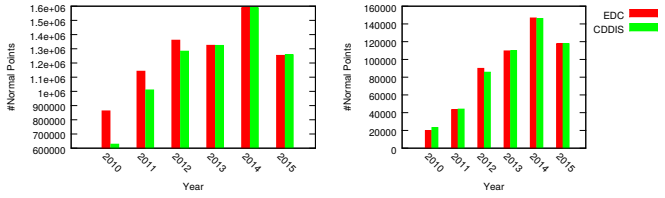


Figure 3: Number of normal points and difference between data centers total (left) and for GNSS satellites only (right).

Missing observations correlate strongly with the multiple entries and account for 0.5-1% of normal points in the years 2013-2015. However in 2010, 2011 and 2012 54%, 14% and 6.6% of the data in EDC is missing compared to CDDIS, whereas only 10%,1.3% and 0.6% of EDC data is not given in the files provided by the CDDIS data center. The biggest part of those normal points come from updated observation data, when more than one realease is given (see Figure 4)

```
h1 CRD  1 2014  5 25 13
h2 WETL       8834 10  1  4
h3 jason2       803201 1025    33105 0 1
h4  1 2014  5 25 12 25  9 2014  5 25 12 29 52  0 0 0 0 1 0 2 0
[...]
h1 CRD  1 2014  5 26  9
h2 WETL       8834 10  1  4
h3 jason2       803201 1025    33105 0 1
h4  1 2014  5 25 12 25 53 2014  5 25 12 29 31  1 0 0 0 1 0 2 0
[...]
```

Figure 4: Double listing of identical observation.

```
H1 CRD  1 2015  9 15 20
H2 CHAL       7237 19 01  4
H3 glonass125  1100901 9125    37372 0 1
H4  1 2015  9 15 18 57  4 2015  9 15 19  4 43  0 0 0 0 1 0 2 0
C0 0    532.000  std  CL1  CD1  CT1
C1 0  CL1 RG30-L        1064.00    1000.00       1.50   10.0 92.82    0
C2 0  CD1 CSPAD         532.000  20.00   5.0  60.0 TTL          0.0  1.70   0.0   0.0 none
C3 0  CT1 Meridian             Meridian            ET-A032              003309          0.0
60  std 8 2
40 68100.000000000000 0  std  3797  2885  3.699  184889.0   0.0  24.6  0.000  0.000  0.0 2 0 0
20 68686.000000000000  988.40 289.60  88. 0
11 68301.696000999218  0.145751449142  std 2  300.0  150  206.2  0.103 -1.290  369.1  0.0 0
11 68550.797000991122  0.144949246721  std 2  300.0  205  181.9  0.247 -1.107  380.0  0.0 0
50  std  191.0   0.261  -1.154  387.4 0
H8
H1 CRD  1 2015  9 15 20
H2 CHAL       7237 19 01  4
H3 glonass125  1100901 9125    37372 0 1
H4  1 2015  9 15 18 57  4 2015  9 15 19  4 43  0 0 0 0 1 0 2 0
C0 0    532.000  std  CL1  CD1  CT1
C1 0  CL1 RG30-L        1064.00    1000.00       1.50   10.0 92.82    0
C2 0  CD1 CSPAD         532.000  20.00   5.0  60.0 TTL          0.0  1.70   0.0   0.0 none
C3 0  CT1 Meridian             Meridian            ET-A032              003309          0.0
60  std 8 2
40 68100.000000000000 0  std  3797  2885  3.699  184889.0   0.0  24.6  0.000  0.000  0.0 2 0 0
20 68686.000000000000  988.40 289.60  88. 0
11 68301.696000999218  0.145751449142  std 2  300.0  150  206.2  0.103 -1.290  369.1  0.0 0
11 68550.797000991122  0.144949246721  std 2  300.0  205  181.9  0.247 -1.107  380.0  0.0 0
50  std  191.0   0.261  -1.154  387.4 0
H8
```

Figure 5: Double listing of identical observation.

Overall there are more observations in CDDIS due to the same normal points listed multiple times. This is in general not the case for EDC data files (below 0.01% of total amount of normal points), however between 0.1% and 0.6% of total normal points appeared twice in the CDDIS data files of the years 2012-2015 and even up to 11% in 2010/2011.

Network Activity Profile

To better understand when and how specific satellites are tracked, as well as how the tracking priorities depend on the region of the station, a geographic analysis was performed. Special attention was given to stations producing data while other stations could not perform measurements due to bad weather or restricted observation time due to shared infrastrucure with other projects. In general, the tracking activity increased in the years 2010-2015.

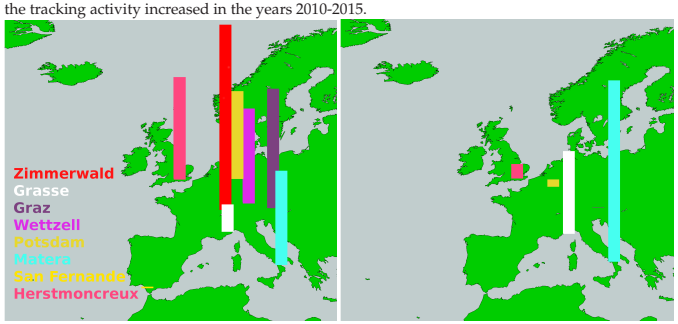
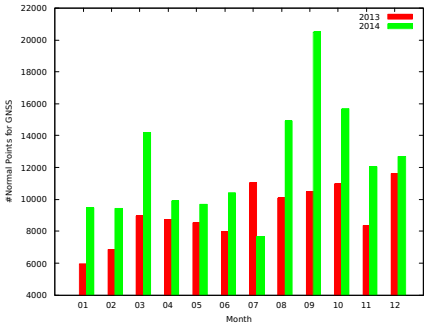


Figure 6: (left) shows the monthly average amount of normal points for the most active stations in Europe accounting for the majority of measured normal points. (right) displays a period of days in July 2014 when neither of the Stations Zimmerwald (ZIML), Graz (GRZL) and Wettzell (WETL) could provide any observations, however Matera (MATL) and Grasse (GRSM) were active above average.

The amount of SLR observations for GNSS satellites show a significant drop in July 2014 due to a longer bad weather period over middle Europe (see Figure on the right).



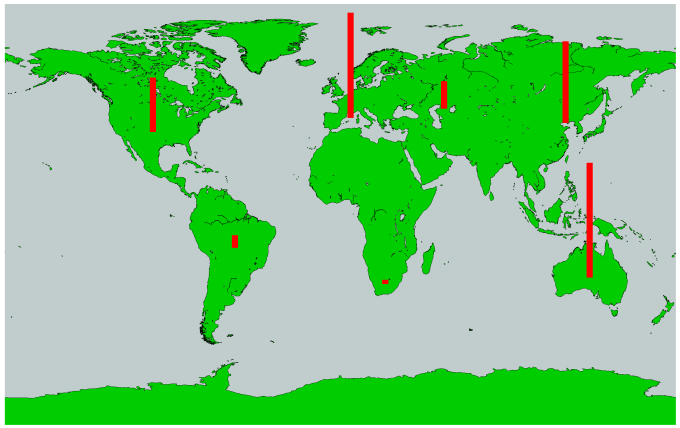


Figure 7: Average activity over 5 Years per region.

As seen in Figure 6 two stations in Australia managed to outperform the remaining stations. There were only a few months when European stations could produce more normal points.

Conclusions

Data Center Integrity: The difference in data between EDC and CDDIS normal point files clearly decreased with beginning of the year 2013. This is due to changing to the new CRD format in March 2012. and not entirely converting the observations available from previous years. The quality of the normal points files increased compared to the Quick Look format files investigated (1). However, a more rigorous management of multiply submitted normal points or updates to existing observations should be introduced.

Network Analysis: First results suggest that a better tracking coverage could be achieved if tracking priorities and schedules of stations within the same region could be adjusted to the availability of other stations around in case of longer down-times or disability to track satellites (weather, other project duties). This could increase the number of normal points for specific satellites and result in more normal point data.

References

[1] K.Sosnica (2011) Availability of SLR Normal Points at ILRS Data Centers, Poster presented at the 17th Workshop on Laser Ranging, Bad Kötzing, Germany, May 16-20,2011

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