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Missing centre of mass values for old LAGEOS data

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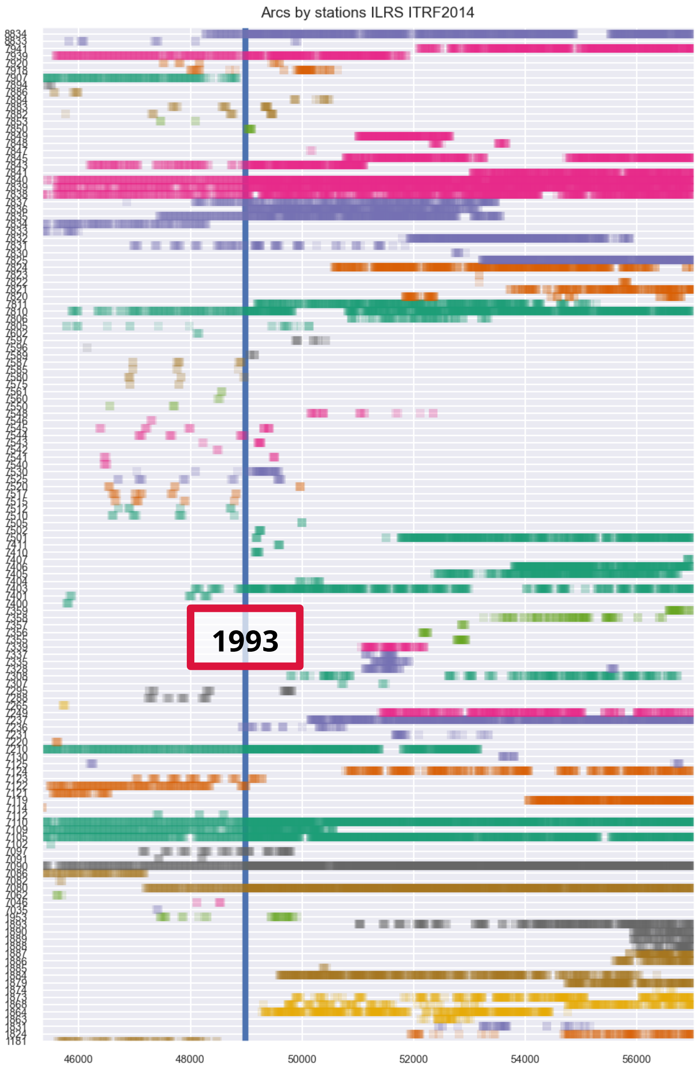
- The centre of mass corrections adopted by the ILRS ASC for its various solutions are those derived from the modelling described in Rodríguez et al, JoG:2019
- These solutions include the routine daily and weekly products, the final run of the PP on systematic errors, and the first batch of REPRO2020 solutions (1993–2020)
- The version of the centre of mass tables adopted was 2020.06.08
- The ASC has been asked to deliver solutions for the earlier period (1983–1993), as those are deemed valuable for the computation of the alternative global reference frame solutions (IGN, DGFI)
- For this period, the centre of mass tables released do not contain values for the majority of stations present
- I detail here what the situation is and provide values for some missing stations that, together with the existing ones, cover most of the data that realistically has an impact in the solutions



The ILRS contribution to ITRF2014 contained data from 139 stations

In the 1983–1993 period the number of stations was 75

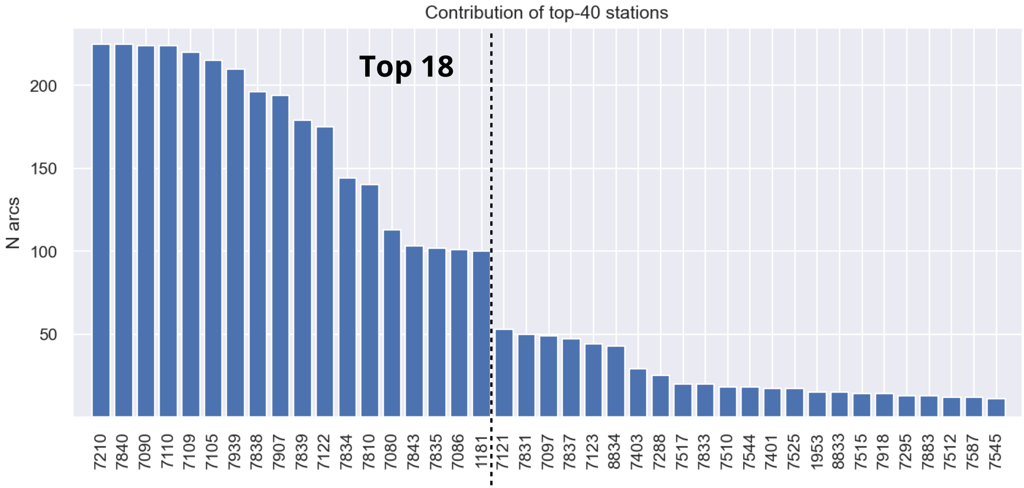
Most of those stations did not provide a sustained contribution that can be employed for the long-term definition of global parameters

Additionally, the data quality during this period is, save for a few honorable exceptions, unquestionably lower than that available from the second decade of the reprocessing

During 1983–1993, 18 stations contributed 100 or more 15-day arcs

There is a drop in data yield for the next 6 stations, which provided about 45 15-day arcs each

Beyond these 24 stations the data available is very sparse



Missing stations

For the top 24 stations in the 1983–1993 period, 8 are missing from the centre of mass tables, due to overlooking some data sources in their preparation:

id	name	system	period	# arcs
7109	Quincy	MOB-8	1983.10/1997.06	220
7907	Arequipa	SAO-2	1983.10/1992.08	194
7122	Mazatlan	MOB-6	1983.03/1991.04	175
7834	Wettzell		1983.02/1991.02	144
7086	McDonald	MLRS	1982.10/1988.02	101
7121	Huahine	MOB-1	1983/1986	53
7097	Easter Island	TLRS-2	1987.11/1995.03	49
7123	Huahine	TLRS-2	1987.08/1992.08	44

Missing stations

- Fortunately, most of the HW employed in these stations are known NASA systems for which centre of mass corrections have been computed already

- The proposal is to adopt average CoM values from other similar stations. This is justified on these grounds:
  - Similar, standard systems
  - No information available to take return rate into account
  - Poorer quality data throughout with much lower precision than current systems

- For 7834 Wettzell, some information had been obtained from the station engineers, and a CoM value computed but wrongly assigned to station code 8834 for 1989–1991. This is the value proposed here

Similar systems

LAGEOS CoM entries already present in the tables up to 1993:

7090 MOB-5: 244.6, 244.6, 243.6, 243.6, 243.6, 245.9, 245.6. Mean=244.65 mm

7105 MOB-7: 242.9, 245.2. Mean=244.1 mm

7110 MOB-4: 243.6, 245.6. Mean=244.6 mm

7403 TLRS-3: 246 mm

7110 TRLS-4: 243.6, 245.6. Mean=244.6 mm

7080 MLRS: 244.4, 243.3, 243.6. Mean=243.8 mm

7939 SAO Matera: 246.6 mm

8834 Wettzell: 244.7 mm

Proposed values

- Average of the values available for similar systems, grouped by station.
- Wettzell value computed for 1989 system

7109	Quincy	MOB-8	244.5
7907	Arequipa	SAO-2	246.6
7122	Mazatlan	MOB-6	244.5
7834	Wettzell		244.7
7086	McDonald	MLRS	243.8
7121	Huahine	MOB-1	244.5
7097	Easter Island	TLRS-2	245.3
7123	Huahine	TLRS-2	245.3

- All these values are within 1.6 mm of the default CoM computed as the average of the LAGEOS entries (245.4 mm)
- They fall close to the middle of the range of the historically adopted LAGEOS values (240 and 251 mm)

Limitations

- The accuracy of these values is limited, far lower than what the number of significant figures would suggest
- In general, the agreement between simulations performed for the computation of CoM values and the empirical data was poorer before 2000 (see Fig. below from Rodríguez et al 2019)
- Several factors contribute to this situation, which is unlikely to change substantially with future potential refinements

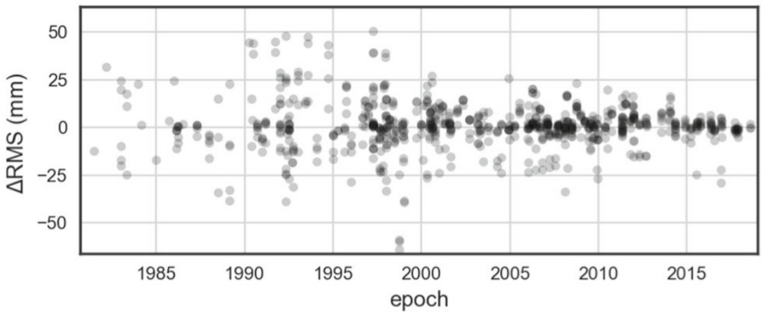


Fig. 5 Differences between the RMS of modelled NP distributions and empirical data for all satellites and system configurations, plotted against the standard deviation of the NP RMS (top), and as a time series (bottom)

Notes

- The advantage of using CoM corrections derived from the same modelling for the two analysis periods is the avoidance of discontinuities in the estimated RB time series
- Any future retrospective analysis of these biases, perhaps for comparison with engineering data, will benefit of the use of consistent sets of corrections
- The effect of the corrections on the geodetic parameters themselves is very limited, if anything at all, due to the co-estimation of biases
- Still, there is value in apportioning correctly the estimated biases to their underlying causes. For instance, in the 1993–2020 period, most of the scale change can be said to be caused by changes in the CoM values for many stations, as opposed to inherent errors in the SLR technique (biases: bad; model improvements: good)
- As it is found in many cases in more recent data, the biggest features seen in the RB time series for LAGEOS 1983–1993 are not caused by errors in the CoM values, but must be caused by changes at the station level (hw, operational)