Modeling Revisions for Improved Reprocessing for ITRF2020

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Outline

- A reanalysis for ITRF2020 will be initiated in late 2019
- Newly adopted Secular Pole model from IERS
- Implementation of new models to start in early 2019
  - New gravity modeling, static and TVG
  - New tidal model and corresponding ocean loading model
- New satellite CoM offset correction model – to be delivered soon
- Station data quality monitoring & systematic error modeling based on the outcome of the 2-year SSEM PP

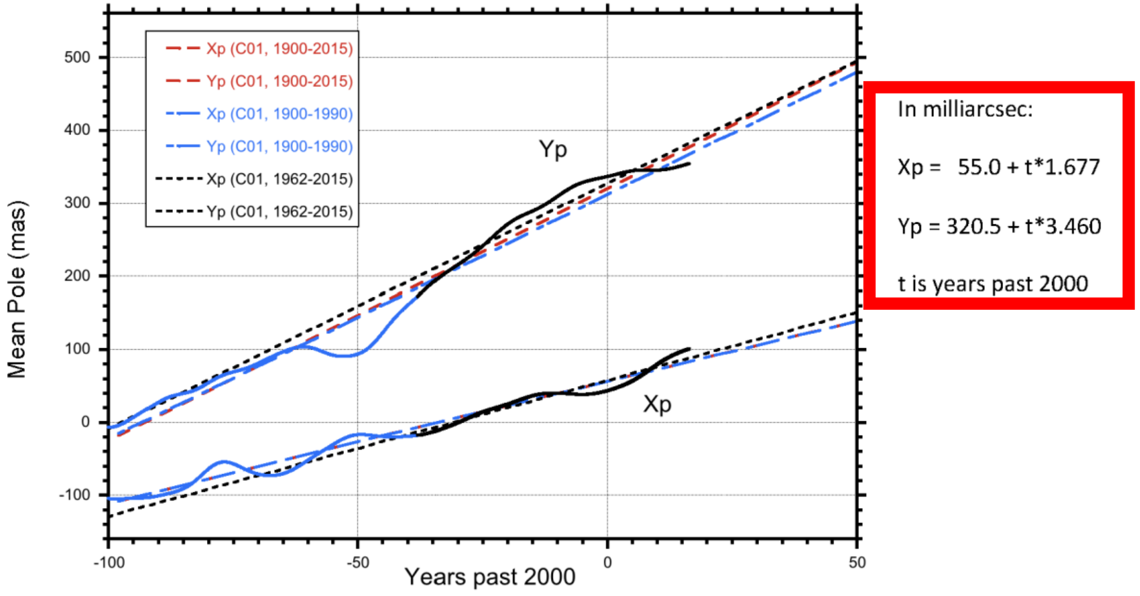
Reanalysis Kick-off: Late 2019

- A reanalysis effort in response to the anticipated ITRF2020 solicitation is now planned by the ILRS ASC with a kick-off set to late 2019
- It was agreed to implement several new models and to have them validated before the reanalysis for the ITRF submission
- The reanalysis will start with 1983, as with ITRF2014, and it will eventually end at the end of 2020
- Considerable time and effort is required from each AC / CC to develop the final ITRF delivery product:
  - The ACs will need 1-3 months to complete the development of the weekly SINEX files
  - Following the delivery of these SINEX series the CCs will need 6 to 8 months to complete the combination phase

What’s New in Terms of Modeling - I

- New secular pole model adopted by IERS last year:

Determining an appropriate linear mean pole (2)



Any of these fits to C01 seem reasonable and internally consistent, though the span of 1900-2015 provides the longest baseline for a linear (presumably GIA-dominated) mean pole

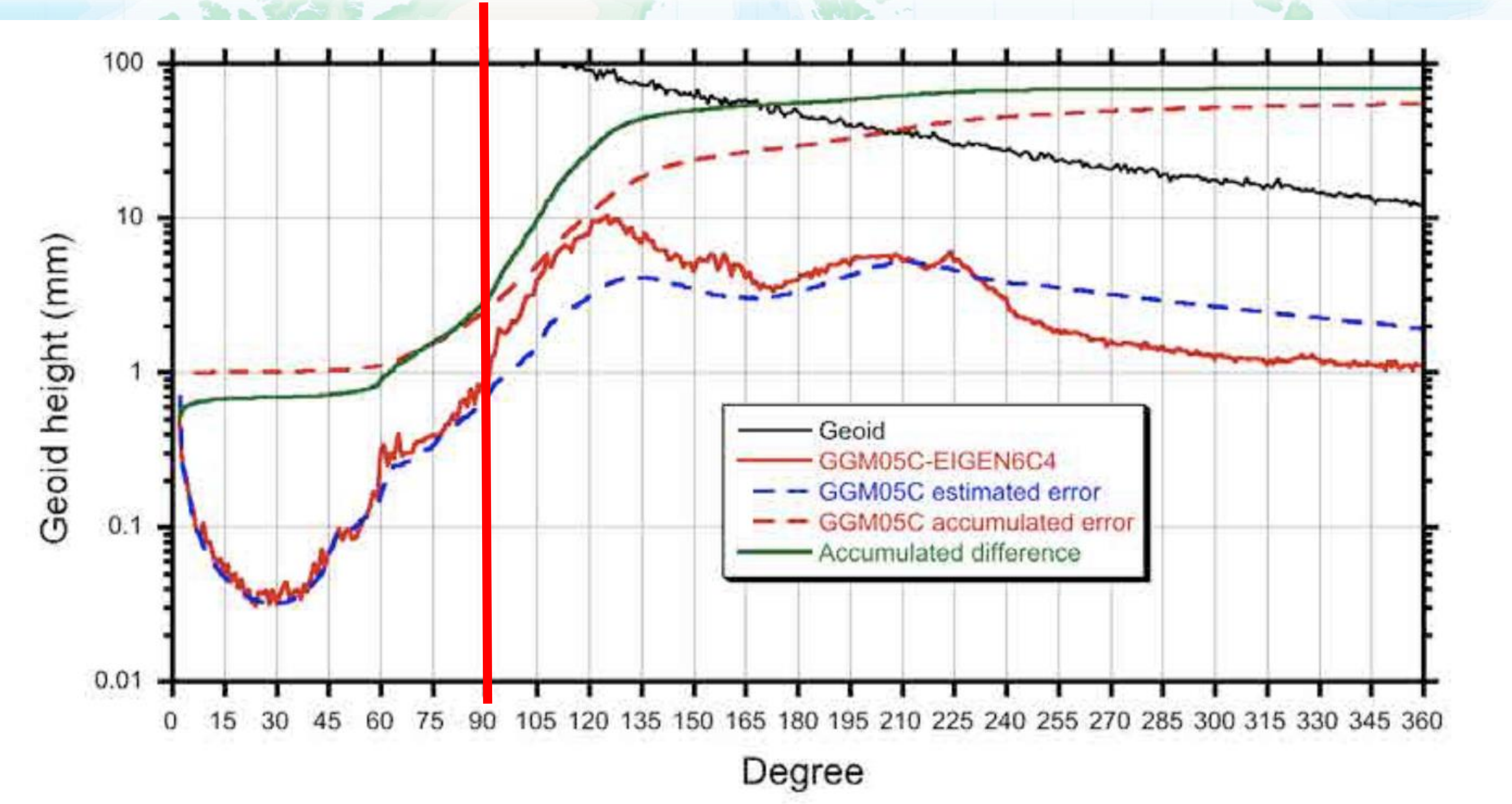
More important, even if we cannot be sure this represents the true effect on the mean pole due to GIA, it is likely to best represent the future linear trend of the IERS polar motion, and that variations about this are the variations we wish to preserve in the pole tide model

CSR

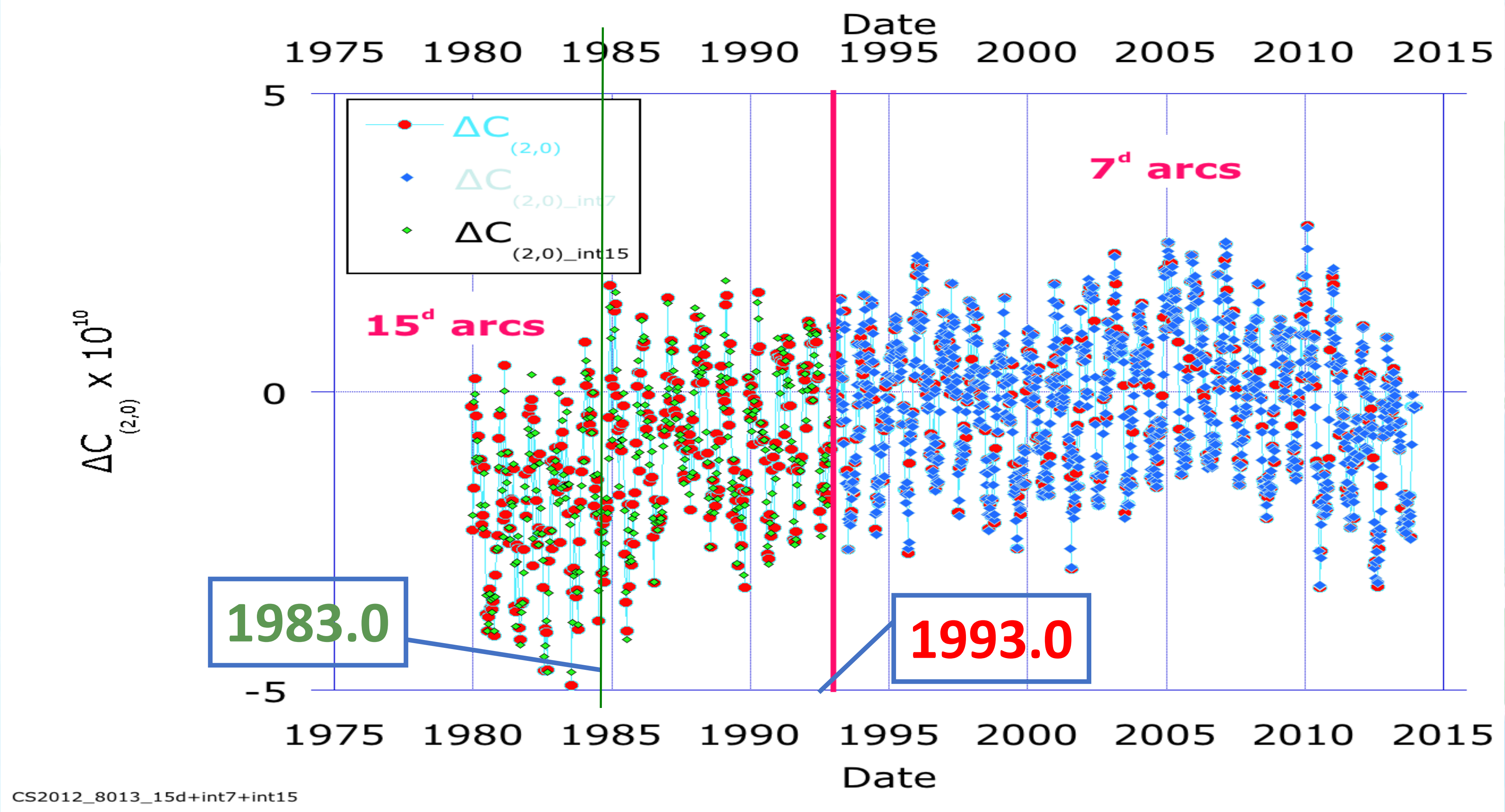
What's New in Terms of Modeling - II

- A new static gravitational model was developed from the recent reanalysis (RL06) of the GRACE mission data using the new definition of the secular pole;
- Subsequently, a complete reanalysis of the SLR data to several satellites were repeated at CSR using the newly defined secular pole;
- A new series of 15-day ΔJ_2 / $\Delta C_{(2,0)}$ are now available, consistent with the new secular pole and the new static gravity model that RL06 produced;
- A combination of that GRACE model with GOCE data and surface gravity data produced the model that we will adopt, GGM05C [Ries et al., 2016]

Gravitational Model GGM05C



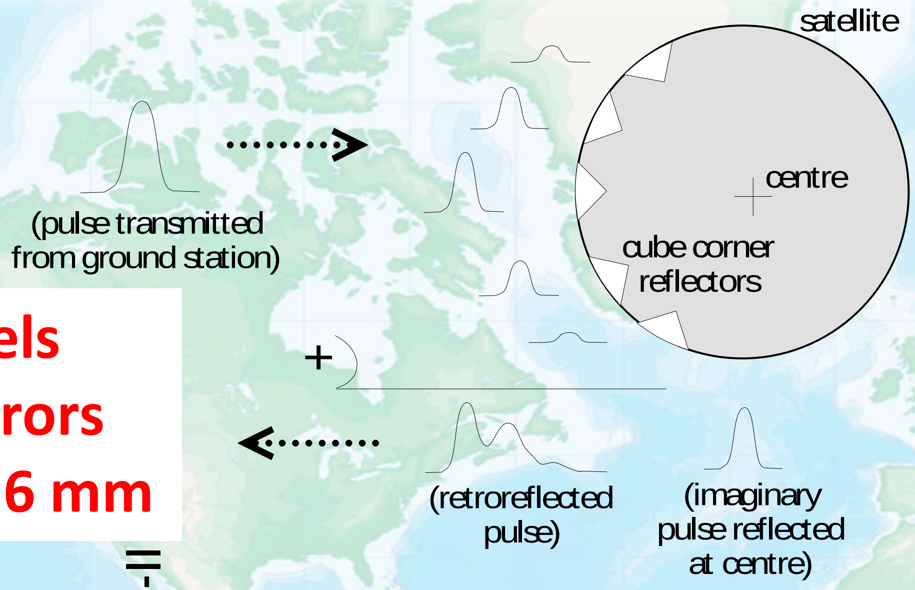
$C_{(2,0)}$ Gravitational Modeling



What's New in Terms of Modeling - III

- ILRS adopted a new model to account for the optical response of each target to different systems and modes of operation: the so-called "CoM offset"
    - It depends on:
        - The geometry and optical properties of the LRA on the s/c being tracked,
        - The ranging system installed at each site,
        - The data preprocessing parameters, and
        - The mode of operation of the system
- i.e. the application of the "CoM" correction is now time-dependent and applied by s/w using look-up tables that often need updates for new sites

Current Target Signature Model Errors



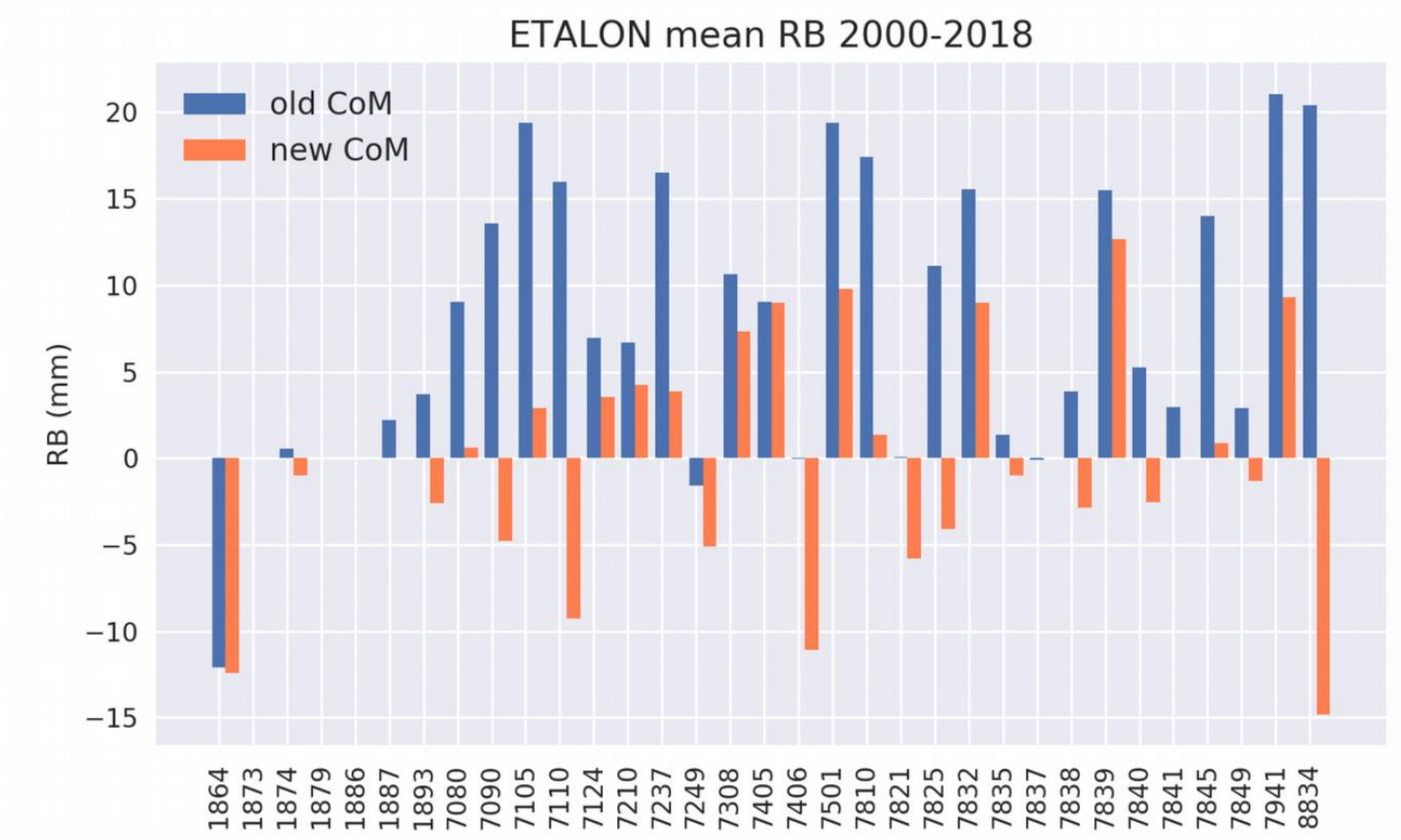
New models suggest errors as high as 6 mm

Stn pad ID	Name	Pulse length (ps)	Detector	Regime (single, few, multi)	Editing Level (×σ)	Calib. St. error (mm)	LAGEOS St. error (mm)	LAGEOS CoM range (mm)	LAGEOS CoM ADOPTED (mm)
1873	Simeiz	350	PMT	No CNTL	2.0	60	70	248-244	246
1879	Altay	150	PMT	No CNTL	2.5	20	36	254-248	251
1884	Riga	130	PMT	CNTLD s->m	2.0	10	15	252-248	250
7080	McDonald	200	MCP	CNTLD s->m	3.0	8.5	13	250-248	249
7090	Yaragadee	200	MCP	CNTLD f->m	3.0	4.5	10	250-248	249
7105	Greenbelt	200	MCP	CNTLD f->m	3.0	5	10	250-248	249
7110	Mon. Peak	200	MCP	CNTLD f->m	3.0	5	10	250-248	249
7119	Haleakala	200	MCP	CNTLD f->m	3	4.5	10	250-248	249
7124	Tahiti	200	MCP	CNTLD f->m	3.0	6	10	250-248	249
7237	Changchung	200	CSPAD	CNTLD s->m	2.5	10	15	250-245	248
7249	Beijing	200	CSPAD	No CNTL, m	2.5	8	15	255-247	251
7355	Urumqui	30	CSPAD	No CNTL	2.5	15	30	255-247	251
7358	Tanegashima	50	MCP	No CNTL	3	1.3	5	252-248	250
7405	Conception	200	CSPAD	CNTLD s	2.5	15	20	246-245	246
7406	San Juan	40	CSPAD	No CNTL	2.5	8	15	246-255	250
7501	Harteb.	200	PMT	CNTLD f->m	3.0	5	10	250-244	247
7806	Metsahovi	50	PMT	?	2.5	15	17	254-248	251
7810	Zimmerwald	300	CSPAD	CNTLD s->f	2.5	20	23	246-244	245
7811	Borowiec	40	PMT	No CNTL f	2.5	16	23	256-250	253
7824	San Fernando	100	CSPAD	No CNTL s->m	2.5	30	25	252-246	249
7825	Stromlo	10	CSPAD	CNTLD s->m	2.5	4	10	257-247	252
7832	Riyadh	100	CSPAD	CNTLD s->m	2.5	10	15	252-246	249
7835	Grasse	50	CSPAD	CNTLD					
7836	Potsdam	35	PMT	CNTLD					
7838	Simosato	100	MCP	CNTLD					
7839	Graz	35	CSPAD	No CNT					
7839	Graz kHz	10	CSPAD	No CNTL					
7840	Herstmonceux	100	CSPAD	CNTL					
7840	Hx kHz	10	CSPAD	CNTL					
7841	Potsdam 3	50	PMT	CNTLD s->f	2.5	10	18	254-248	251
7941	Matera	40	MCP	No CNTL m	3.0	1	5	252-248	250
8834	Wettzell	80	MCP	No CNTL f->m	2.5	10	20	252-248	250

Formal σ ≈ ±2 mm

Center of Mass Offset Correction 2018:

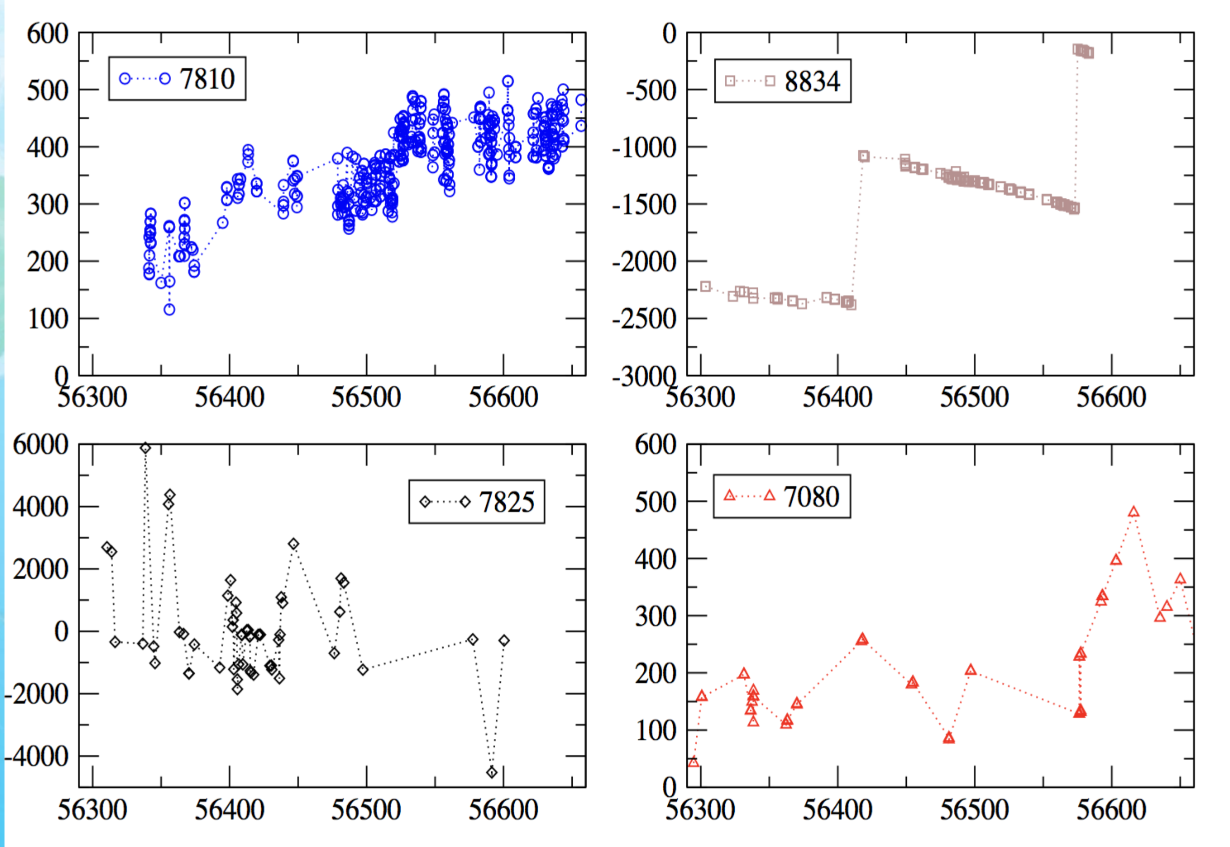
- Newly developed NERC model improves CoM correction for all satellites, although the change is more significant for the Etalons:



Graham Appleby, José Rodríguez, NERC 2018

NERC results presented at ASC meeting 11/04/2018

Epoch Time Errors at SLR Stations



nanosec

1-year process: 2013

Long-term SLR clocks

microsec

Table 10: Huge time biases per period (MJD) and main phase jumps (unit in μs).

Station*	Dates	Time bias	Jump
7090	56296-	-1.0	
	56786-	+1.2	-1.2
	56834-	+1.0	-1.0
7105	57216-227	+14.6	
7124	57286-372	+8.3	
	57408-429	+16.0	
	57456-555	+8.0	
7237	57413-414	+26.1	
	57318-371	- 0.6	
7403	56824-998	+2.1	
7501	56226-785	-4.0	
	56786-992	-6.0	
	57041		+6.0
7810	57209-210	-2.6	
7838	56552-667	-7.0	
	56672-744	-14.	
7845	56811-820	-1.4	
	56974-982	-61.1	
7941	55773	-13.5	
	55777-778	-13.0	
8834			
	56417	-29.0	
	56418-573	< -1.0	
	56575		+1.4
	56576-7203	< -1.0	
	57204		+4.0

*For the dates, XXXXX-XXX means that TB can be considered constant on that period

Time Interval Counting Errors

- Results from all sites undergone replacement so far:
  - Event Timer calibration data single shot RMS is improved over those with TIU
  - Event Timer measured stability is better than TIU
- Event Timers S/N’s 010 and 009 tested vs TIU S/N 2510A01271 at Greenbelt station (7105):
  - Tracking offset of ~4 mm observed (for all satellite groups)
- Event Timers S/N’s 011 and 010 tested vs TIU S/N 2740A02007 at Yarragadee (7090):
  - Tracking offset of ~0 mm observed (for satellite groups +GEO)
    - Some difference noted between satellite groups
- Event Timer S/N 012 tested vs TIU S/N 2332A0509 at TLRS-4, Haleakala (7119):
  - Tracking offset of ~0 mm observed (for LEO & MEO satellite groups)

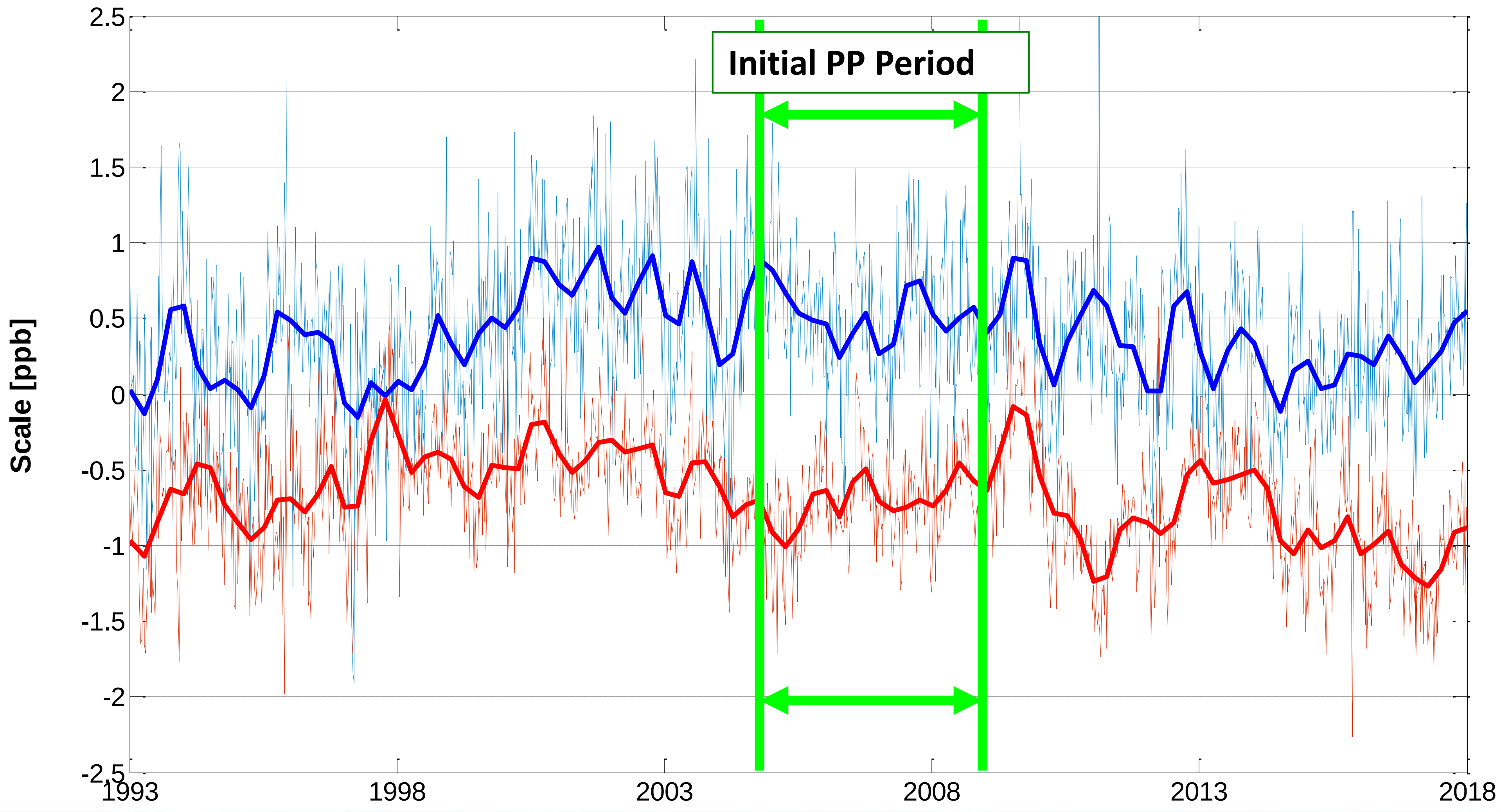
– Event Timer replaced the current TIU very recently at Hartebeesthoek, (7501):
  - Tracking offset of ~0 mm observed (for satellite groups +GEO)

ASC Activities to Control Systematic Errors

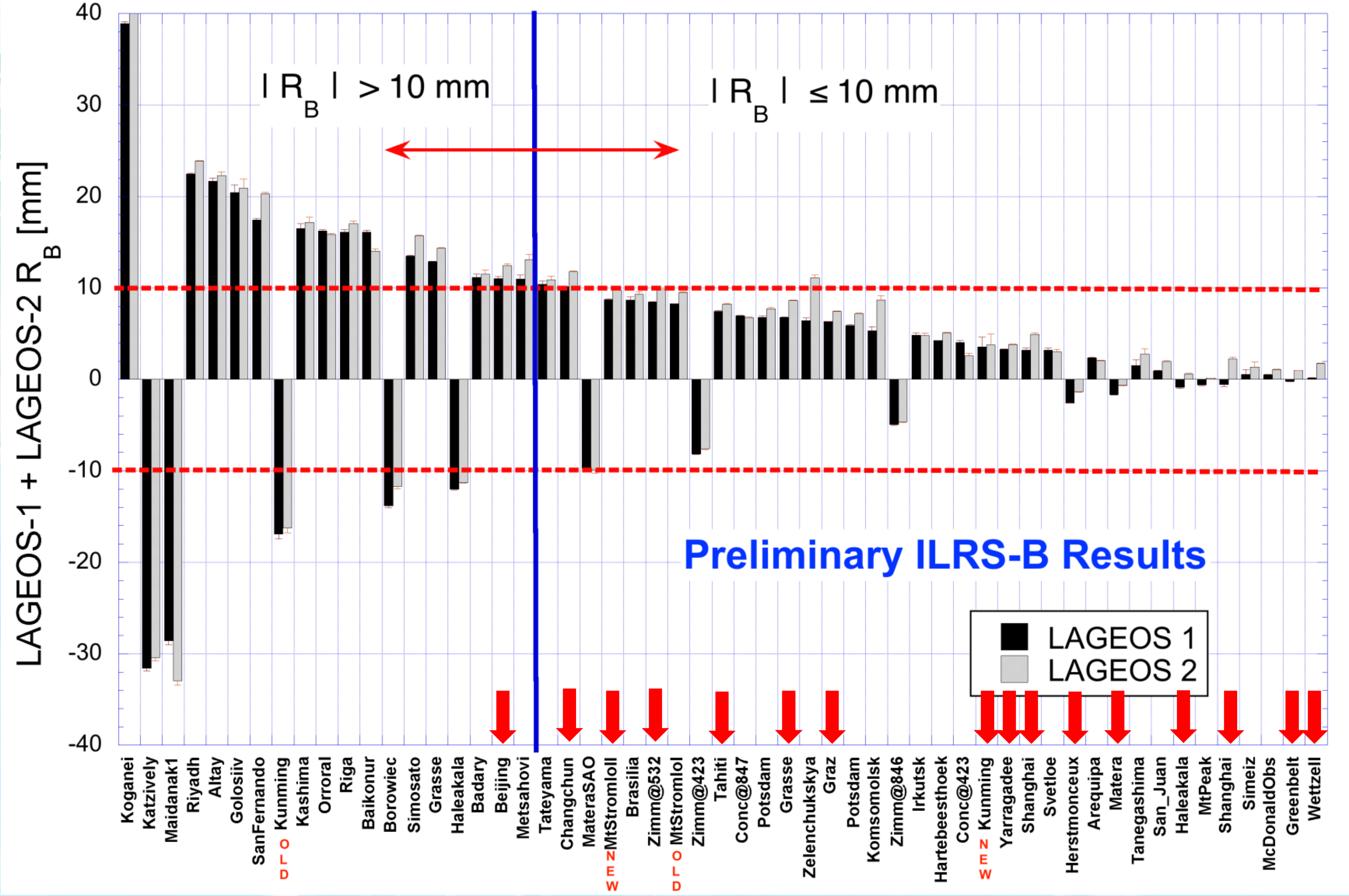
- Daily analysis for quality control (QC) - range and time biases
- Dedicated Pilot Project for an operational service to monitor the long-term performance of stations at the mm level
- Use of externally provided independent information for testing the quality of SLR data (e.g. GNSS and DORIS orbits)
- Monitoring the station clock performance with T2L2 on Jason-2
- Developing improved target signature models (CoM correction)
- Investigating alternative approaches in generating the Normal Point (NP) data from Full Rate (FR) data (e.g. Dave Arnold's correlation approach)
- Improved data accuracy by replacement of time-interval counter units (TIU) with event timers (ET)

ASC Activities to Control Systematic Errors

SSEM PP resulted in a significant change in the scale of the SLR network which is now much closer to that of the VLBI network.



Preliminary Results on Systematic Error Control



Summary

- The ILRS ASC is implementing new models and data screening;
- The adoption of these changes are necessary in order to take advantage of improved geophysical models and improved data modeling;
- Final version of the systematic error model is expected in early 2019;
- Once this model is available a complete reanalysis will produce the ILRS input to the development of the next ITRF2020;
- Monitoring systematic errors in the network will become a routine operational product and continue indefinitely;
- New events at the stations, once identified, will introduce changes in the error model and require appropriate handling

Thank you!