

Gravity Modeling Changes for the ILRS Reanalysis for ITRF2020

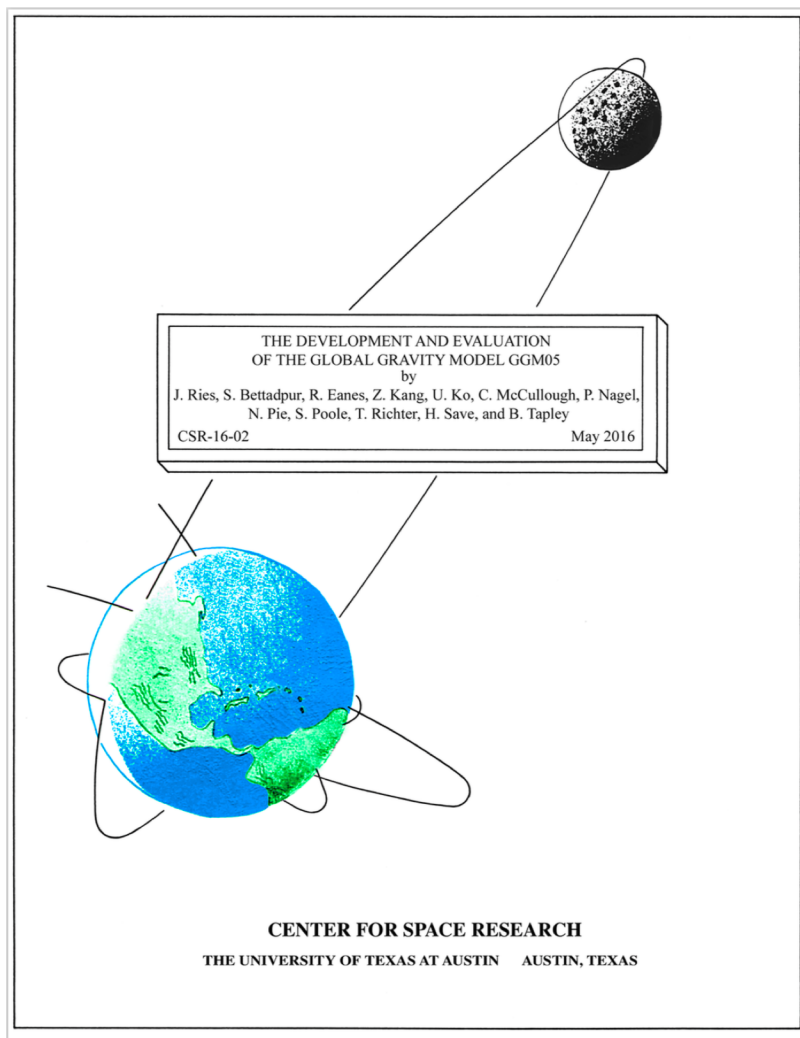
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JCET/UMBC, Baltimore, MD, USA &
NASA Goddard/61A

IGS Analysis Workshop 2019
Potsdam, Germany
April 15-17, 2019

- ITRF2020 reanalysis will start before the end of 2019
- New ILRS improved models implementation
 - New static gravity & TVG modeling
- New tidal model for orbits and ocean loading at stations
- Secular Pole model of IERS adopted (consistent with gravity)
- New CoM offset correction model
- Station data quality monitoring & systematic error modeling

- New static gravitational model adopted by all ACs:
 - **GGM05C**
- A consistent set of additional terms with significant temporal variation, derived using GGM05C as the static part and with the same standards from analysis of SLR tracking of multiple geodetic satellites by Minkang Cheng (CSR/UT):
 - $C_{(2,0)}$ & $C/S_{(2,1)}$ from CSR's 15^d series, interpolated/evaluated at mid-arc epoch of our 15^d arcs (1983 - 1992) and our 7^d arcs (1993 – present)
 - The nominal zonal terms' values for degree 3-6 for our use come from CSR's GGM05C, their rates however come from SLR (Cheng et al., 1997)
 - We can also provide DAILY values of these series (we use them for our operational product)

Documents on the development of the GRACE & GOCE model GGM05C



**GRACE 327-742
(CSR-GR-12-xx)**

GRAVITY RECOVERY AND CLIMATE EXPERIMENT

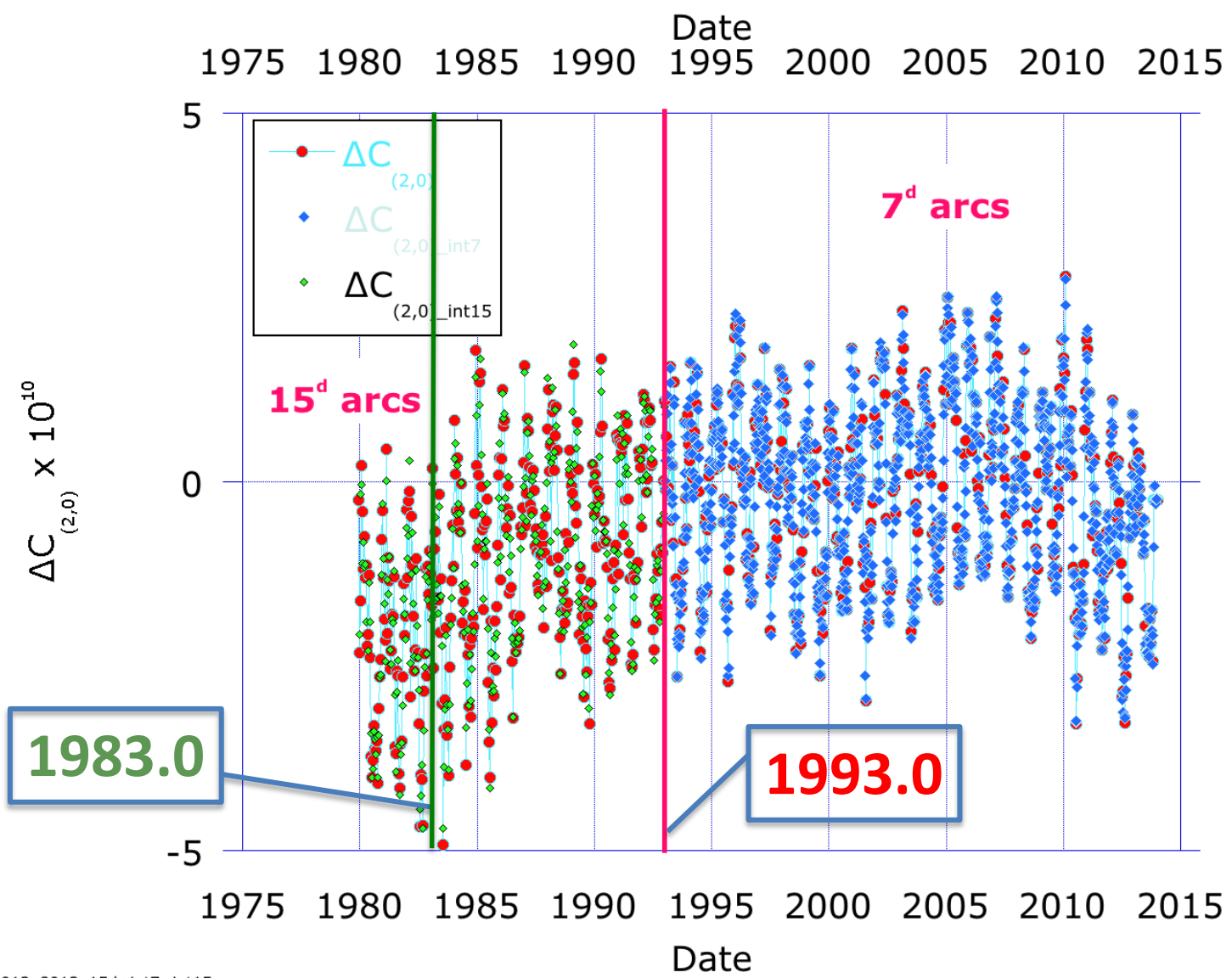
UTCSR Level-2 Processing Standards Document

(Rev 5.0 Apr 18, 2018)

(For Level-2 Product Release 0006)

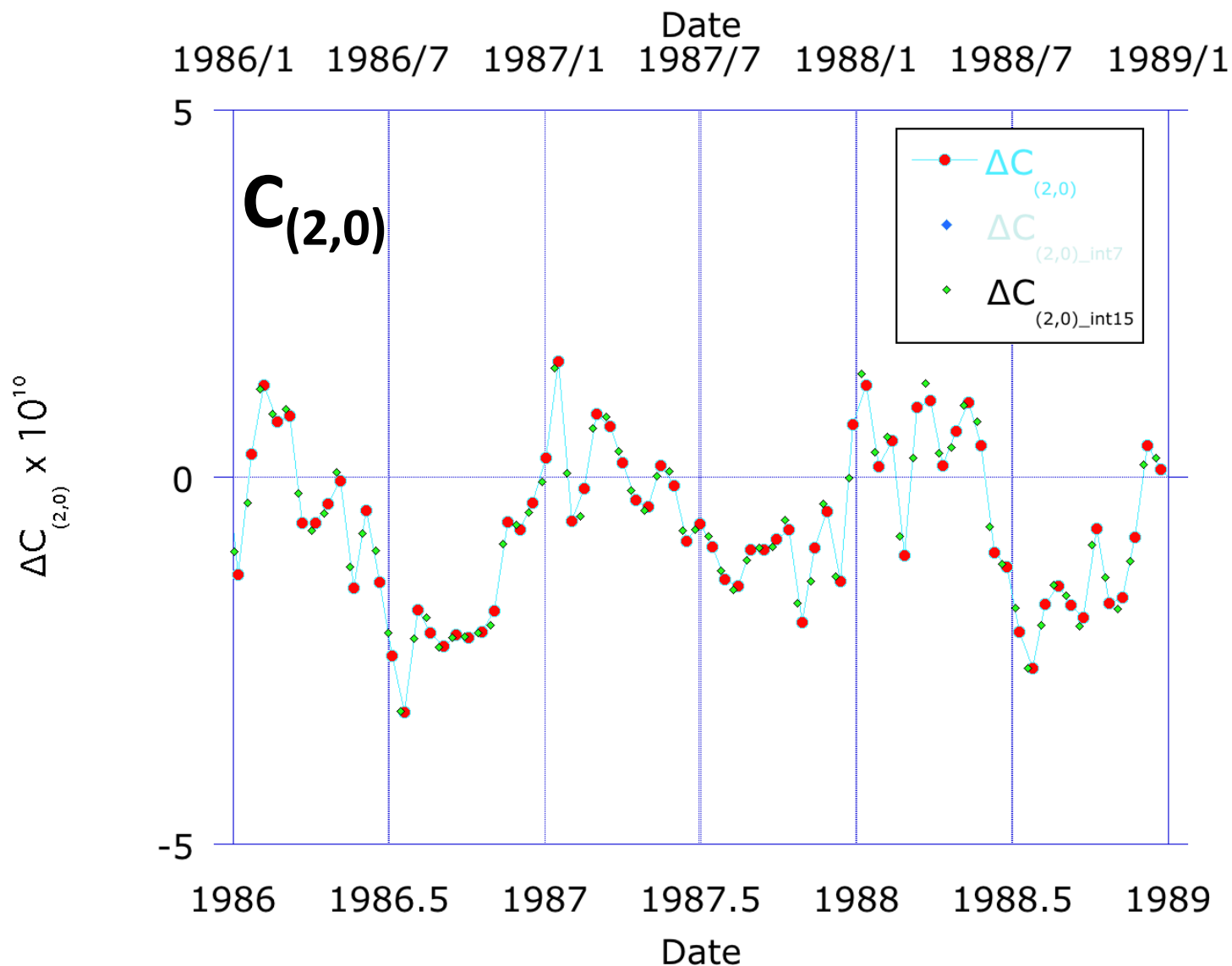
Srinivas Bettadpur
Center for Space Research
The University of Texas at Austin





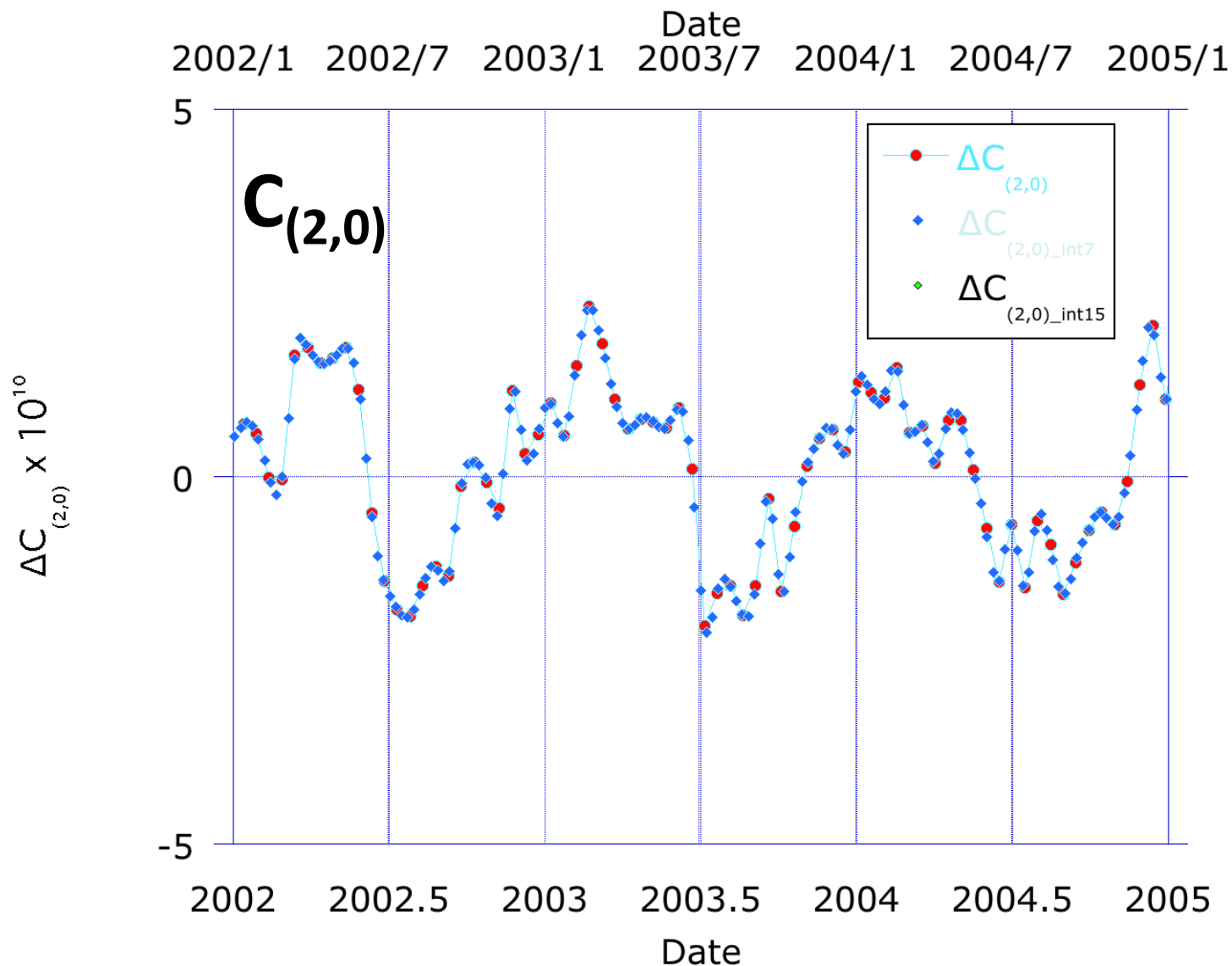
CS2012_8013_15d+int7+int15

$C_{(2,0)}$ Interpolation 15^d arcs

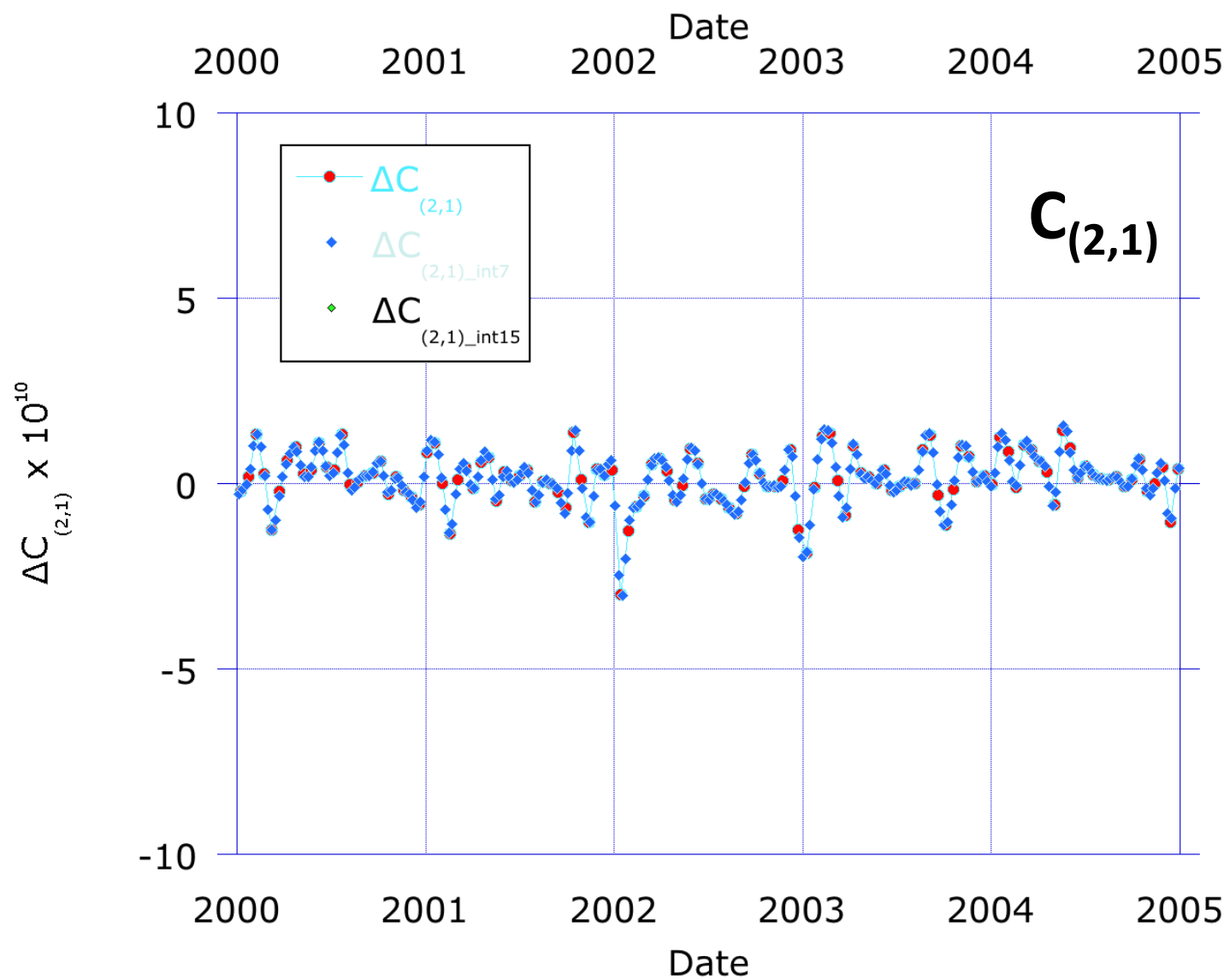


CS2012_8013_15d+int7+int15

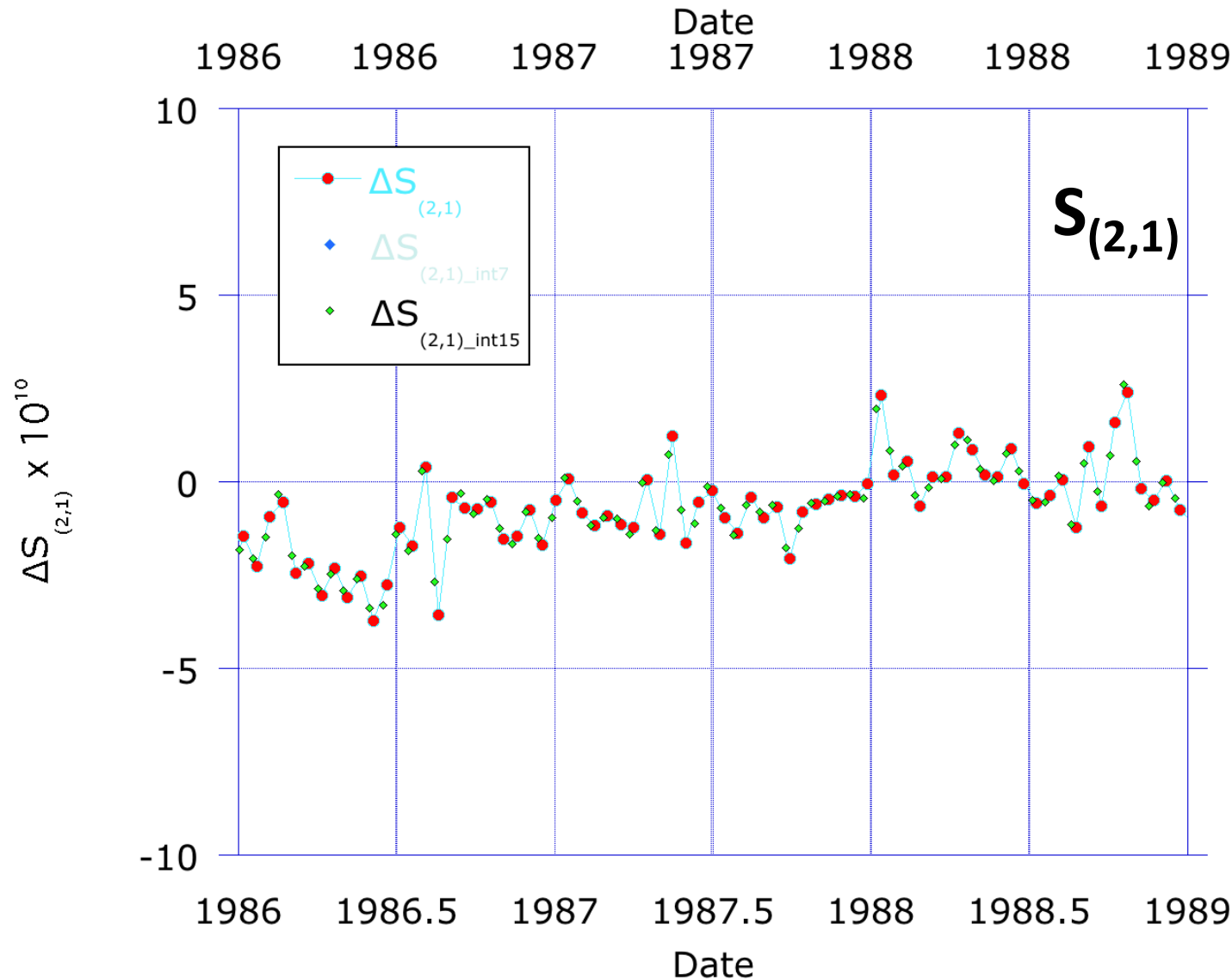
$C_{(2,0)}$ Interpolation 7^d arcs



CS2012_8013_15d+int7+int15



CS2012_8013_15d+int7+int15

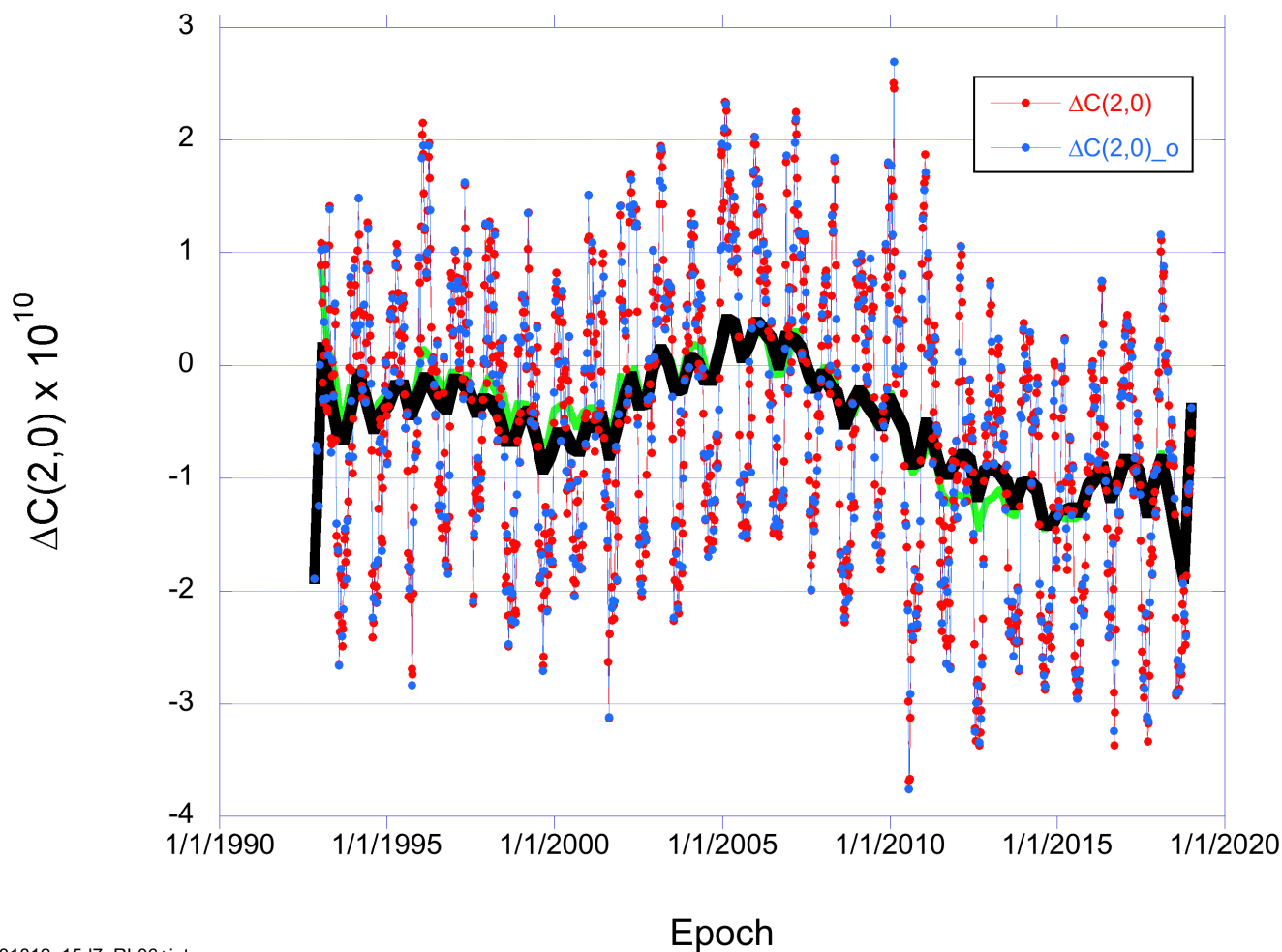


CS2012_8013_15d+int7+int15

$\Delta C_{(2,0)}$ Relative to:

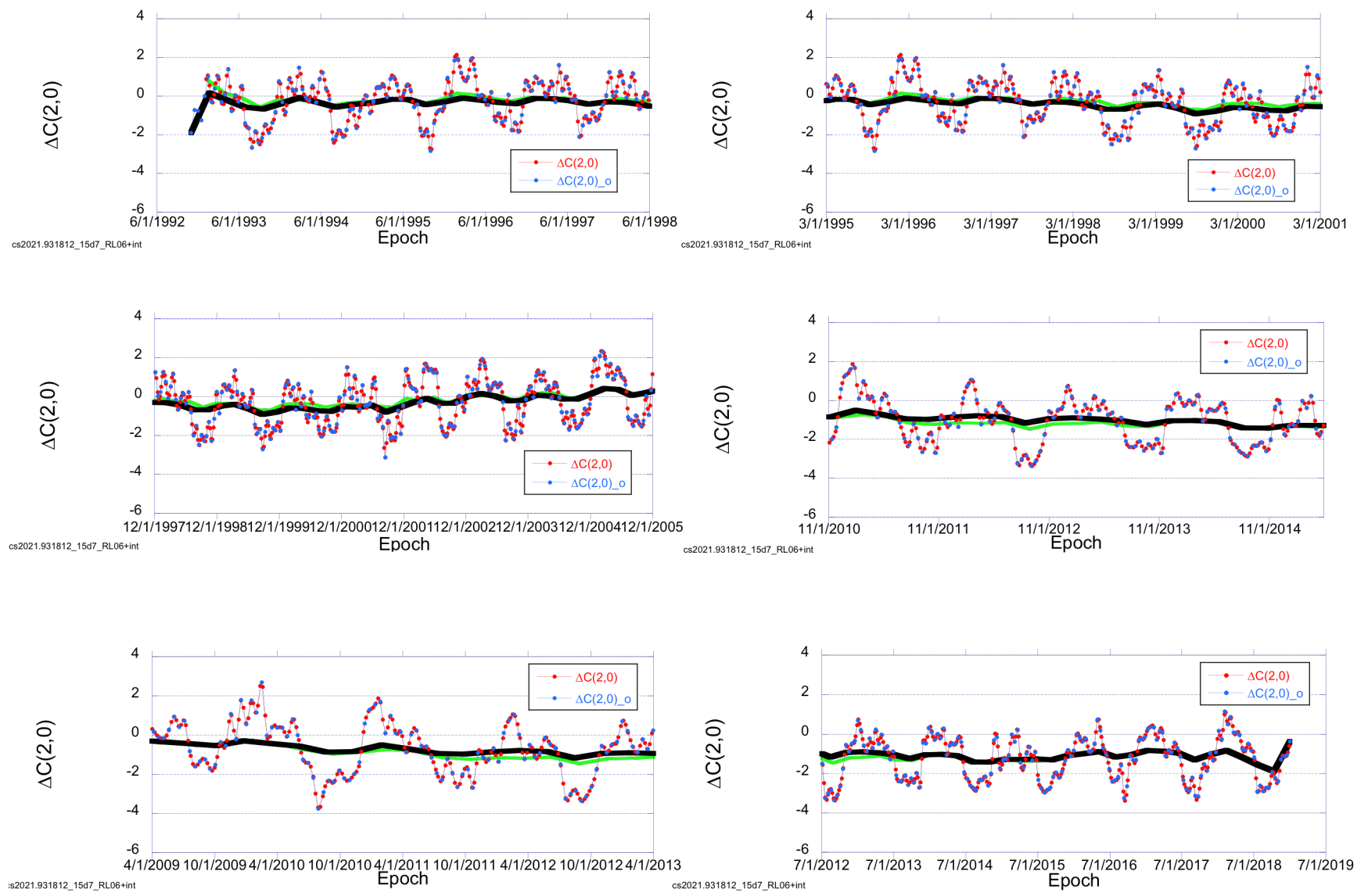
GGM05C $C_{(2,0)}$: $-0.48416945732 \times 10^{-3}$ (Zero-Tide)

GGM05C $C_{(2,0)}$: $-0.48416525732 \times 10^{-3}$ (Tide-Free)

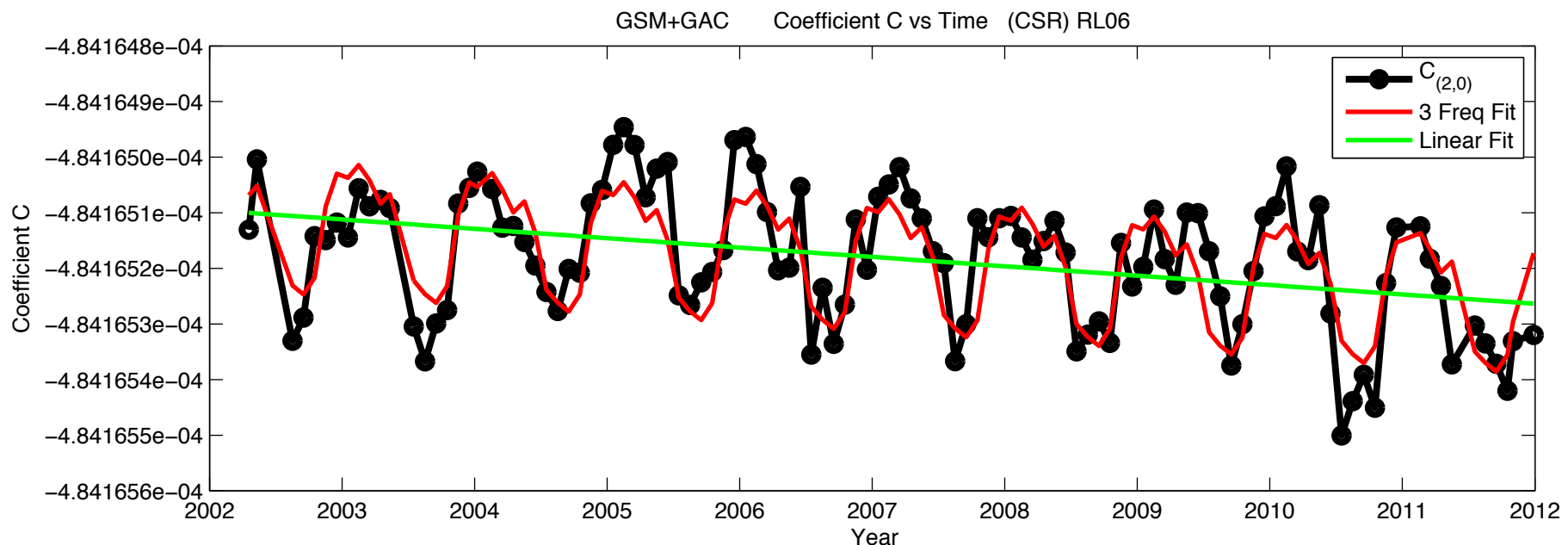


cs2021.931812_15d7_RL06+int

SLR $C_{(2,0)}$ Interpolated: 1993 - present

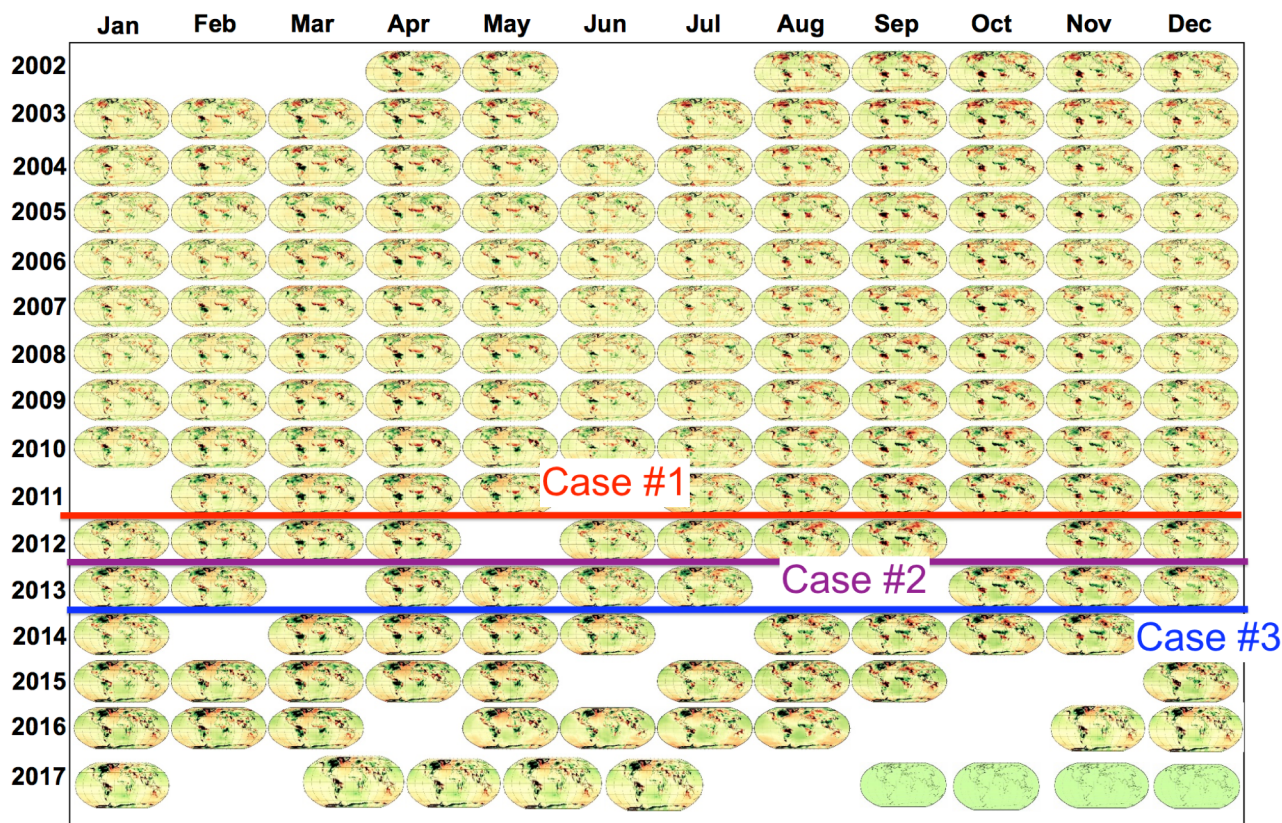


- JCET has been using the monthly GRACE solutions to derive a TVG model that is updated with each additional monthly solution, derived from a weighted LS fit to a linear plus annual (1 cpy), semi-annual (2 cpy) and seasonal (4 cpy) term model.
- These TVG 4-term models can be provided to IGS on a regular basis for degree/order 2 to 60.



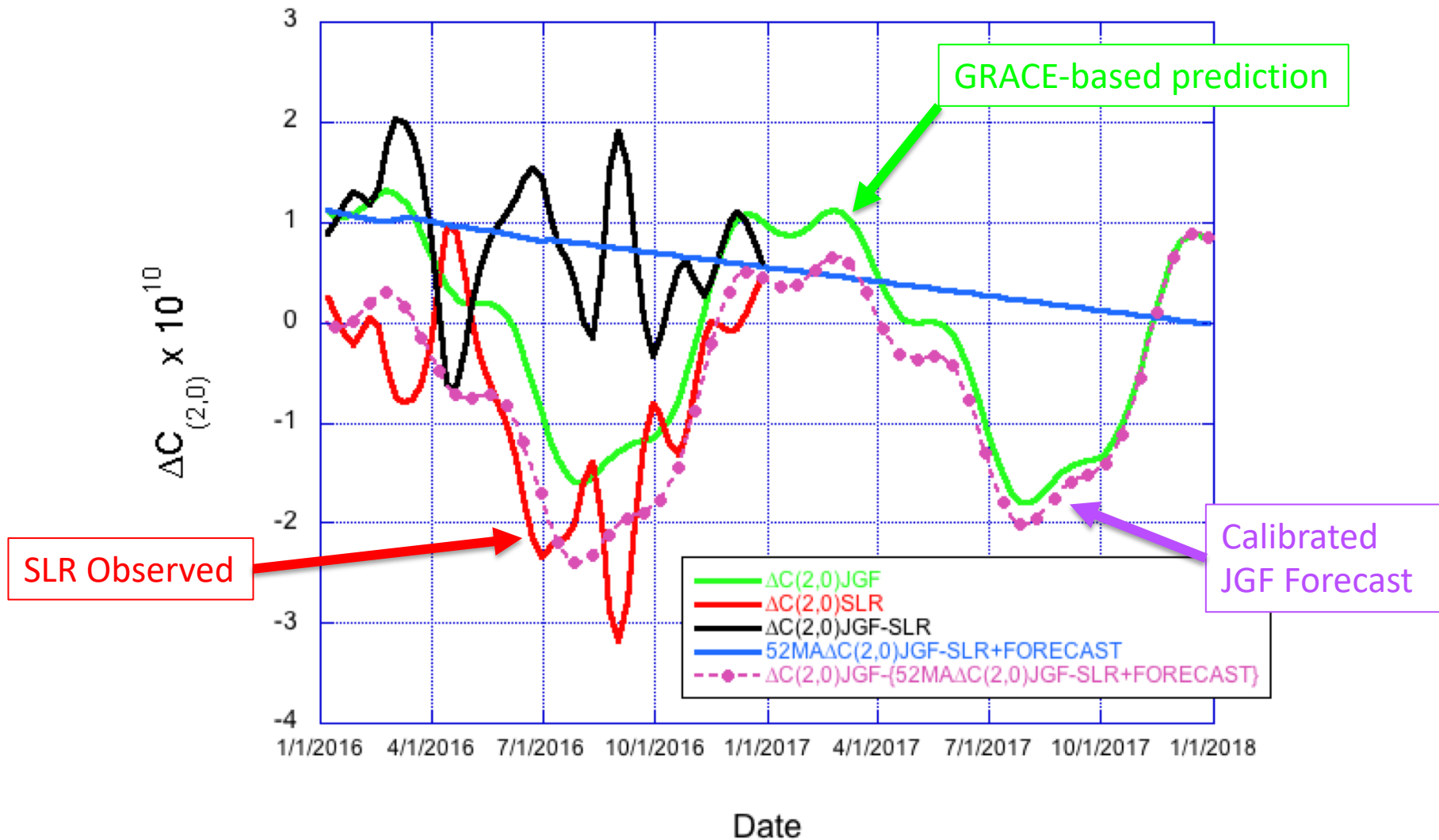
Minor degradation in SLR results when using TVG from GRACE solutions beyond 2011

Over 15.5 Years in Orbit – 163 Global Gravity Solutions



We adopted the 2003.0 – 2012.0 period as the one to be used for predicting past 2012.0

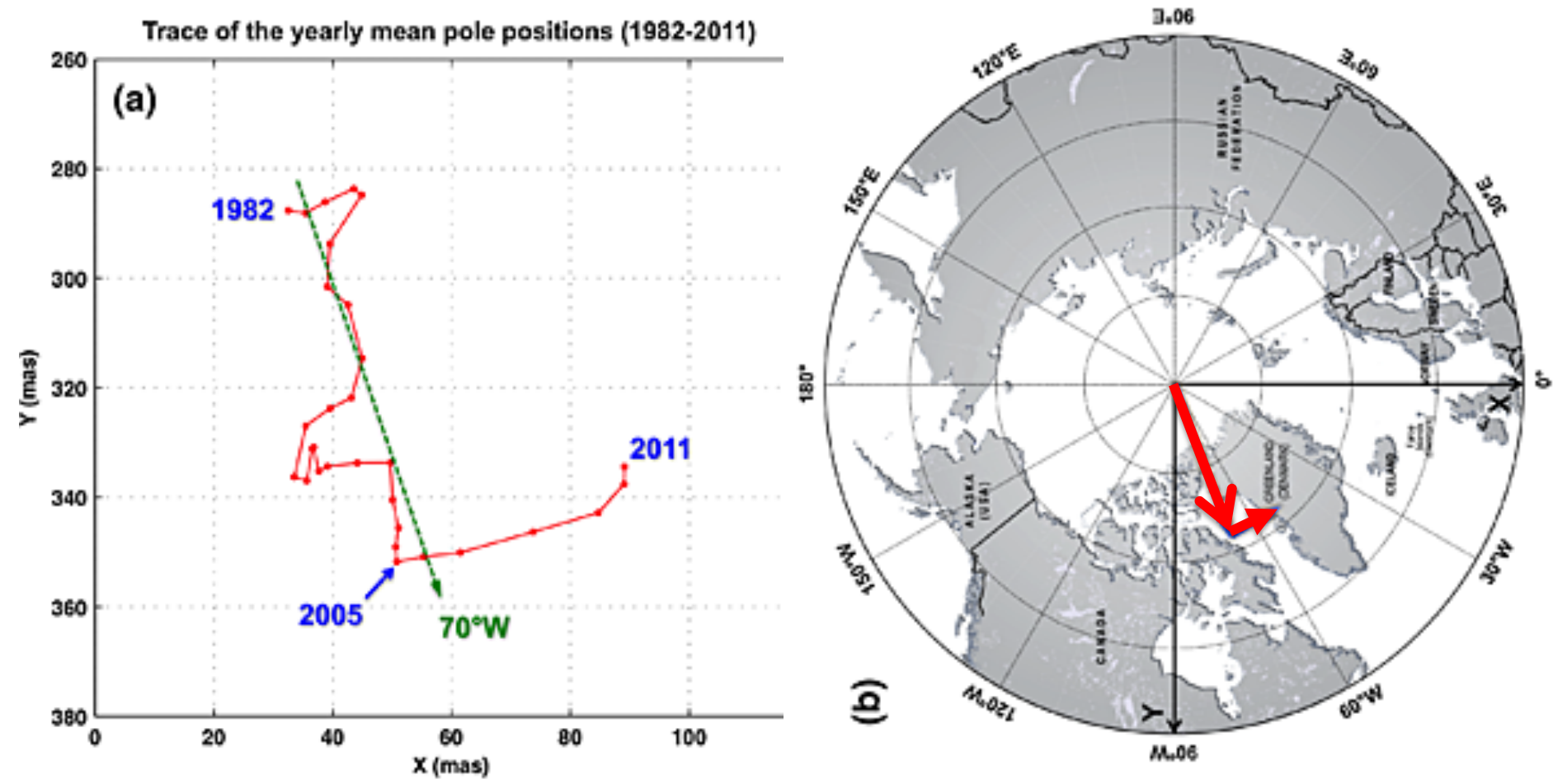
$\Delta C(2,0)$ Based on JGF Forecast Series



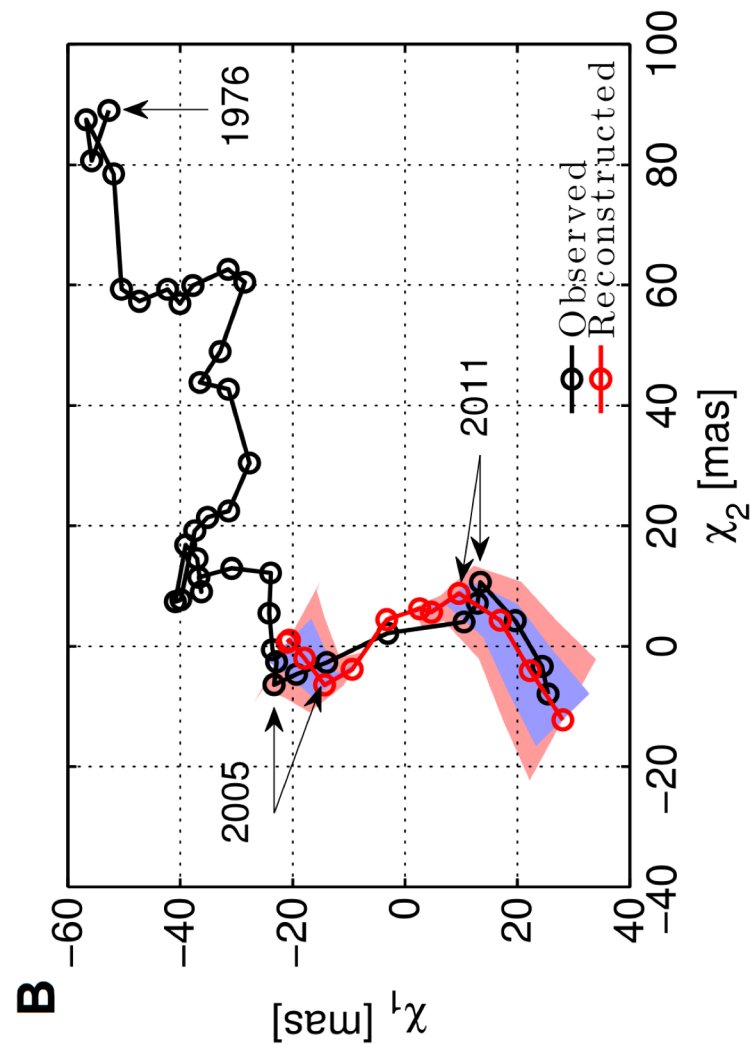
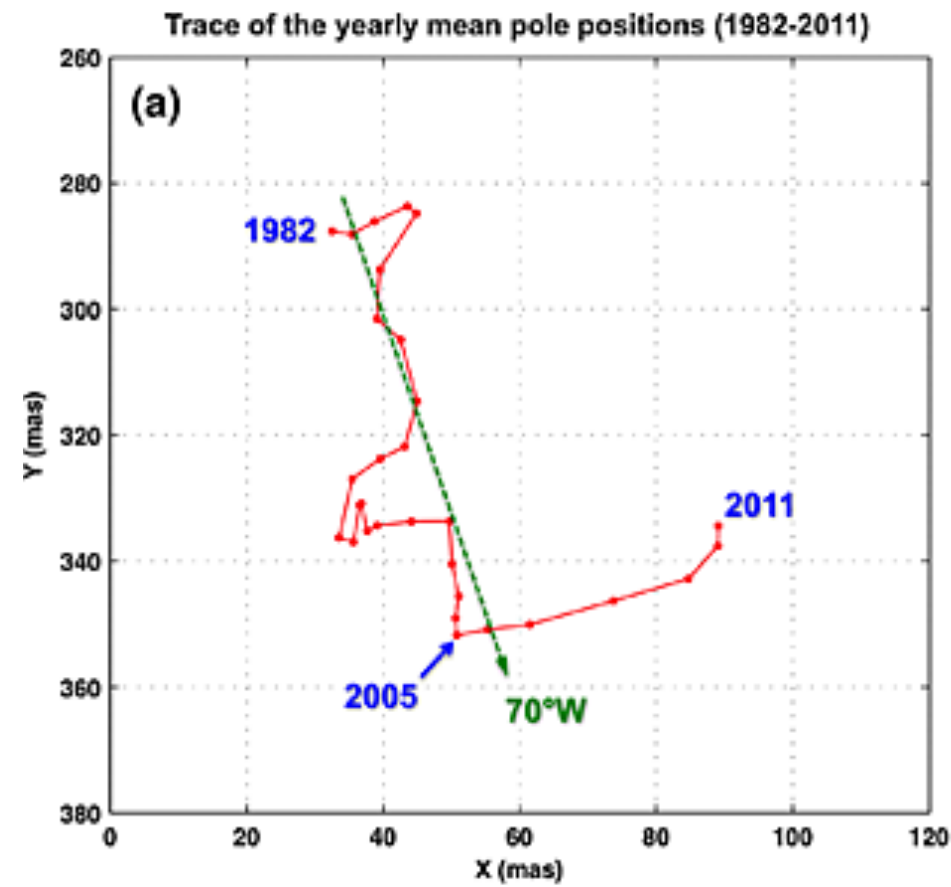
- The IERS adopted a **Secular Pole** model in place of the "Mean Pole" that was confusing, incorrect and highly dependent on IERS C04 that was often changed without notice (since a year ago, following the UAW 2017 recommendations)
- The new model is a simple linear fit to the definitive IERS C01 series, with little dependence on which portion of the series is used to derive the fit (see UAW 2017 proceedings for details)
- The change was done in time for the last reanalysis of the complete GRACE data set, resulting in release 6 (RL06) from which obtained the mean field we adopted, GGM05C, a combination of GRACE and GOCE data, and the TVG part, based on the monthly GRACE fields from RL06.
- Similarly, the companion solution for the degree-2 terms that comes from multi-SLR-target analysis and replaces the GRACE-derived harmonics, was also completed using the new Secular Pole model and GGM05C (thus fully compatible)
- For ITRF2014 we used the model GOT4.7 from NASA Goddard (T/P based). We have adopted the slightly updated version GOT4.10c for ITRF2020 (Jason based and center-of-mass referenced). Comparisons to FES2014 show that for POD purposes they are fully compatible (as other similar models are too).

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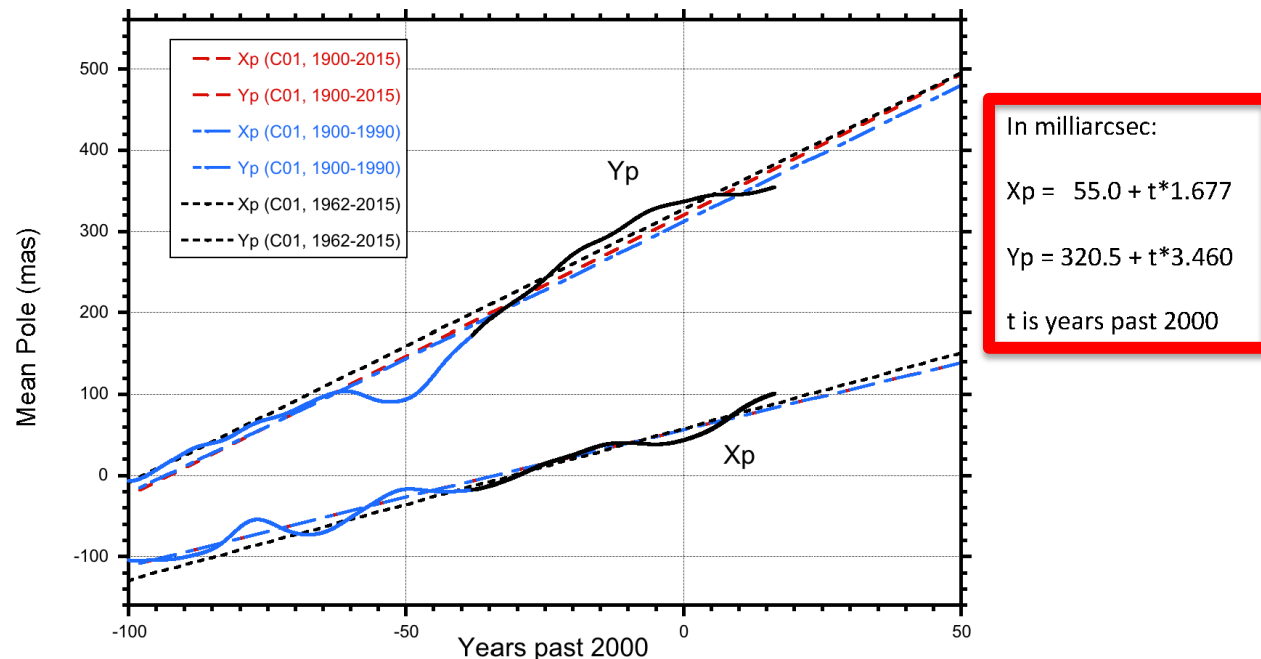
DOI: 10.1002/grl.50552



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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

- New models implemented and systematic error adjustment rules strictly adhered to by all ACs
 - ILRS will accept and use the HFEOP model adopted by the IERS WG (IGS)
- All SLR data in the period 1993 to present will be re-analyzed under the new standards and SINEX submitted by seven (7) ACs
- Re-analysis of the 1983 to 1992 data set and the corresponding SINEX series will be also delivered (maybe by fewer ACs)
- Test combination series will be developed at ASI and JCET to identify/correct any issues with individual AC contributions
- These preliminary products will be delivered to ITRS in early 2020
- Assuming no catastrophic events, final complete delivery should be at ITRS before the end of February 2021

- The ILRS ASC has implemented new models and data screening for the development of the ITRF2020 reprocessing
- We can provide the same interpolated products that we use for the 2nd-degree terms to IGS (or you can obtain them directly from the GRACE Project in their original resolution – 15-days).
- The JCET TVG 4-term models can be provided to IGS on a regular basis for degree/order: 2 to 60.
- We can also provide the IGS with the “forecast” for these terms with a daily resolution for up to a year, shortly after the last delivered GRACE/GRACE-FO solution.
- The static model compatible with the above series is GGM05C and can be obtained from the ICGEM archives (<http://icgem.gfz-potsdam.de>)
- The model we use for ocean tides (GOT4.10c) can be obtained from Richard Ray (@ NASA .GSFC .gov).