EGSIEM

European Gravity Service for Improved Emergency Management

WP4. Scientific Service

Validating two-year EGSIEM combined GRACE products

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HORIZON 2020

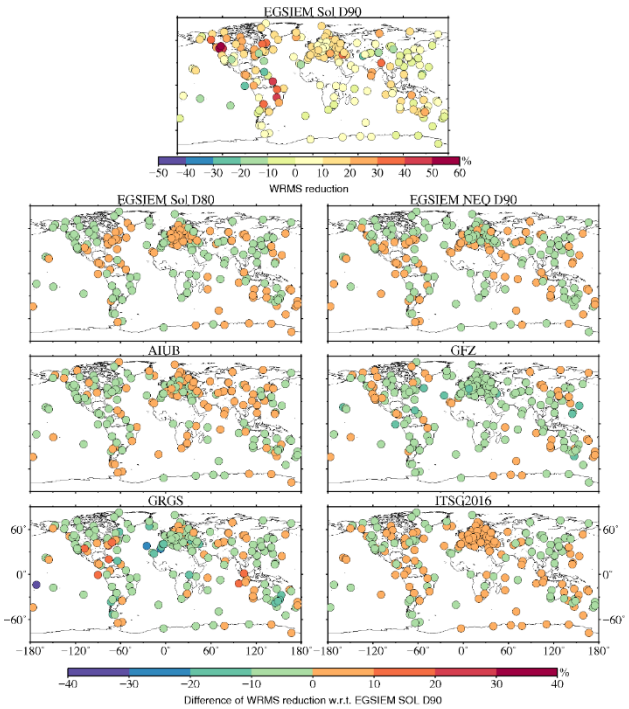
Data

- GNSS data
  - Latest daily ITRF2014 GNSS residuals (IGN)
    - Rigorously stacking the latest IGS repro2 solutions, averaged into monthly
- Gravity models
  - 4 two-year (2006&2007) GRACE gravity models from 4 ACs (AIUB, GFZ, ITSG, GRGS)
  - Latest 3 two-year (2006&2007) combined EGSIEM solutions both at NEQ level and Solution level (max degree 80&90)
  - L3 products in SHs --> no need further data processing

Monthly GRACE fields post-processing

	AIUB, GFZ, ITSG, GRGS (n=80), combined solutions (n=80/90)	L3 products in SHs of DDKx
• replace C20 from SLR	X	-
• subtract a priori GIA model	-	-
• restoring degree-1 from Swenson	X	-
• applying filtering of Gaussian 500	X	-
• adding back GAC product removed during de-aliasing	X	-
• fit & remove mean & trend	X	X
• displacement in CF	X	X

Validation at full GRACE SH spectrum



Both can not tell which degree of GRACE SH coefficients might be problematic!

	WRMS reduction [%]				Positive WRMS reduction [%]
	min	max	mean	median	
AIUB	-27.88	54.07	7.71	7.24	75.19
GFZ	-41.08	55.41	4.82	3.69	65.89
GRGS	-43.64	51.54	5.11	4.68	64.34
ITSG	-27.21	54.75	8.24	8.28	74.03
EGSIEM Sol D80	-30.91	54.12	7.85	7.52	74.42
EGSIEM Sol D90	-29.57	54.78	7.78	7.56	75.58
EGSIEM NEQ D90	-34.13	53.37	7.42	7.05	72.48

Degree WRMS reduction

- To better validate at each SH degree, I use

$$Degree\ \mathrm{WRMS}\ reduction = \frac{\mathrm{WRMS}\left[h_i^{\mathrm{GPS}}\right] - \mathrm{WRMS}\left[h_i^{\mathrm{GPS}} - h_i^{\mathrm{GRACE}^{n}}\right]}{\mathrm{WRMS}\left[h_i^{\mathrm{GPS}}\right]}$$

Degree WRMS reduction at the i^{th} GPS station

Compute GRACE-derived displacements using SH at only degree *n*

WRMS reduction is similar (or equivalent) to Relative Explained Variance used by Lea in validation using the OBP data

Accumulative Degree WRMS reduction

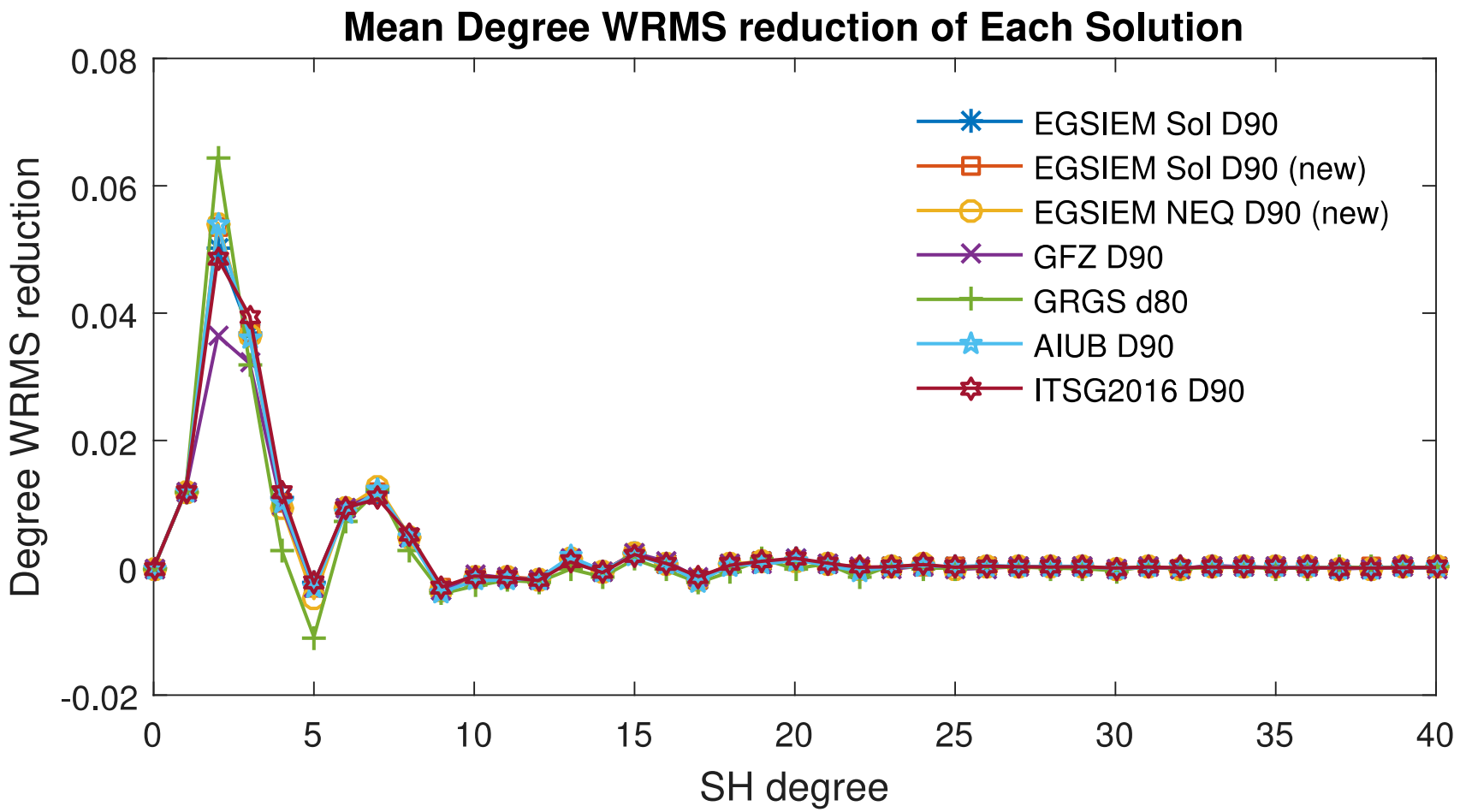
- To better validate at each SH degree, I use

$$\textit{Degree WRMS reduction} = \frac{\mathrm{WRMS}\left[h_i^{\mathrm{GPS}}\right] - \mathrm{WRMS}\left[h_i^{\mathrm{GPS}} - h_i^{\mathrm{GRACE}^{n}}\right]}{\mathrm{WRMS}\left[h_i^{\mathrm{GPS}}\right]}$$

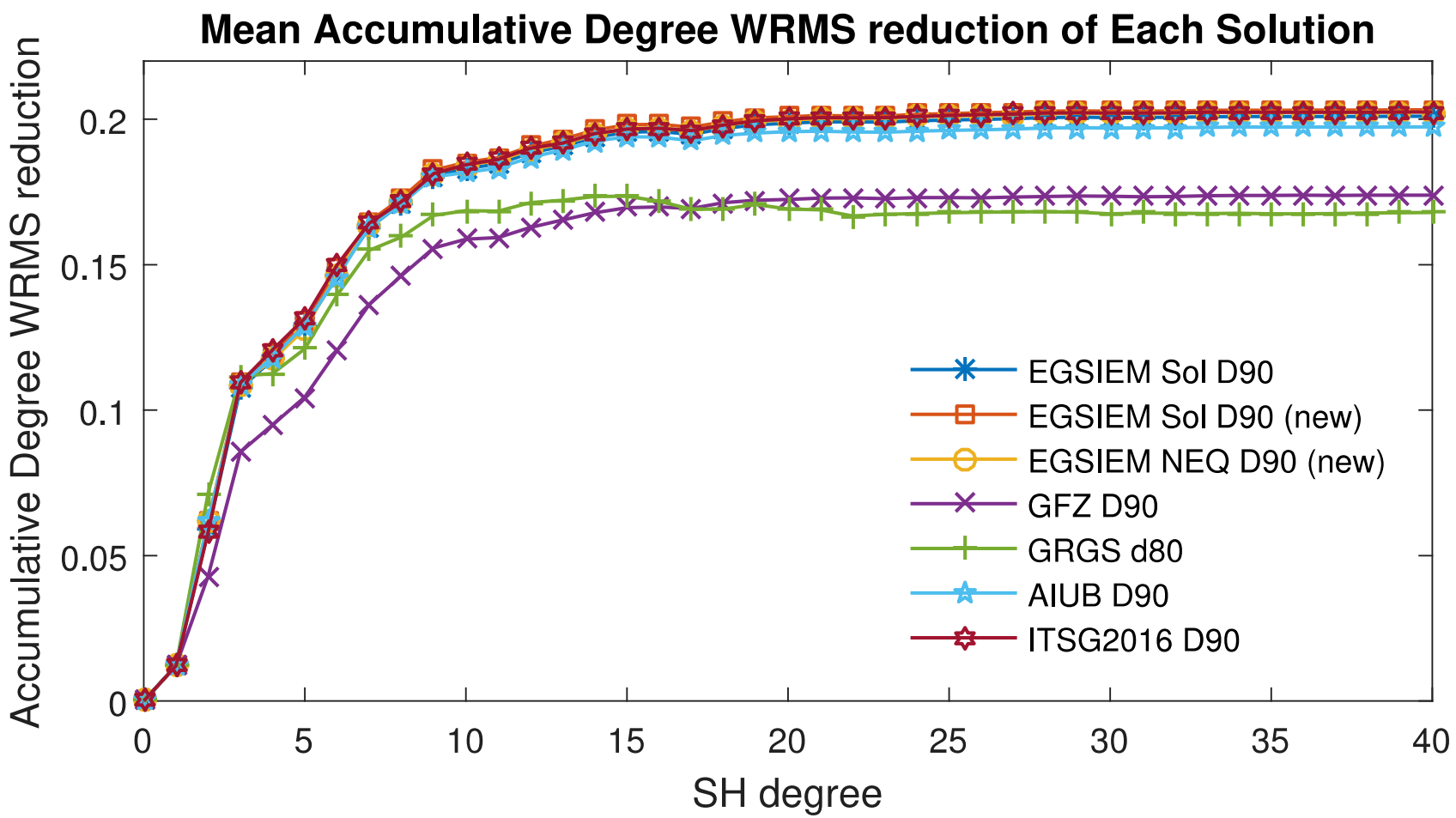
Degree WRMS reduction at the i^{th} GPS station

Compute GRACE-derived displacements using SH up to degree *n*

Mean degree WRMS reduction



Mean accumulative degree WRMS reduction



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At annual signal level

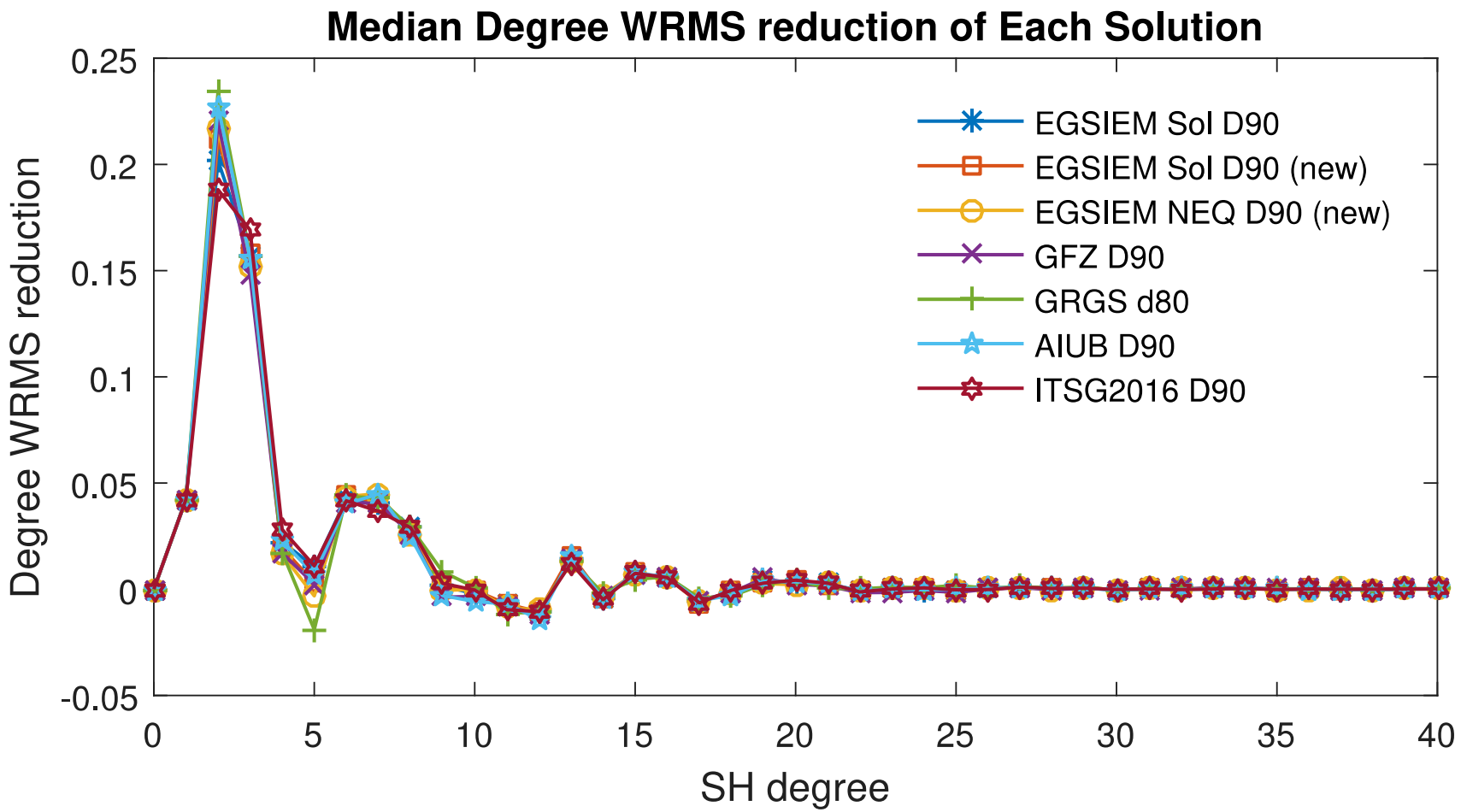
$$Degree\ Ratio_{\text{reduction}} = \frac{\text{WRMS}\left[h_i^{\text{GPS}}\right] - \text{WRMS}\left[h_i^{\text{GPS}} - h_{\text{fit},i}^{\text{GRACE}^n}\right]}{\text{WRMS}\left[h_i^{\text{GPS}}\right] - \text{WRMS}\left[h_i^{\text{GPS}} - h_{\text{fit},i}^{\text{GPS}}\right]}$$

Annual fit of GRACE

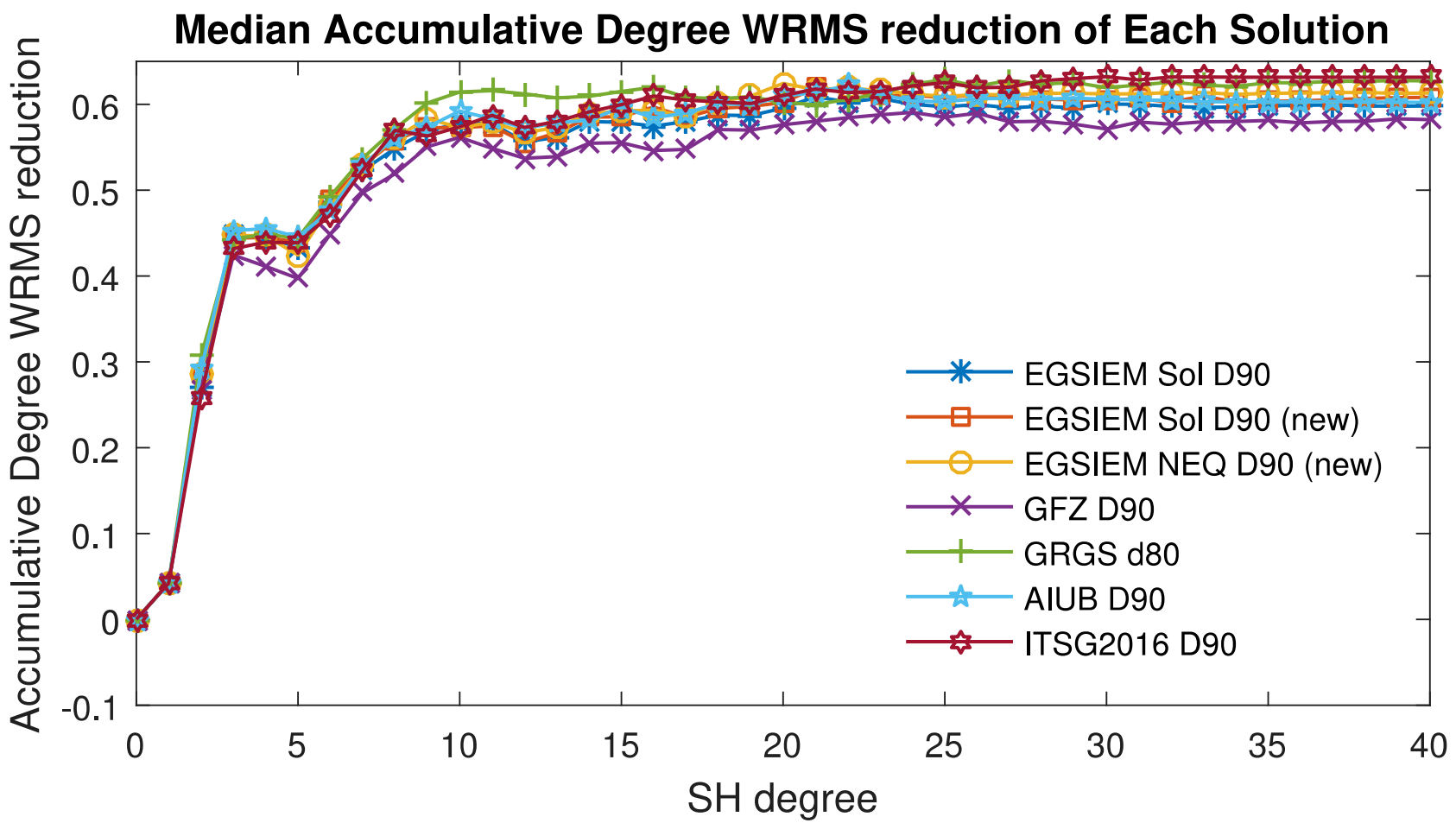
Annual fit of GPS

Ratio here to evaluate how GPS and GRACE agree at the annual signal level.

Annual signal: median degree WRMS reduction



Annual signal: median accumulative degree WRMS reduction



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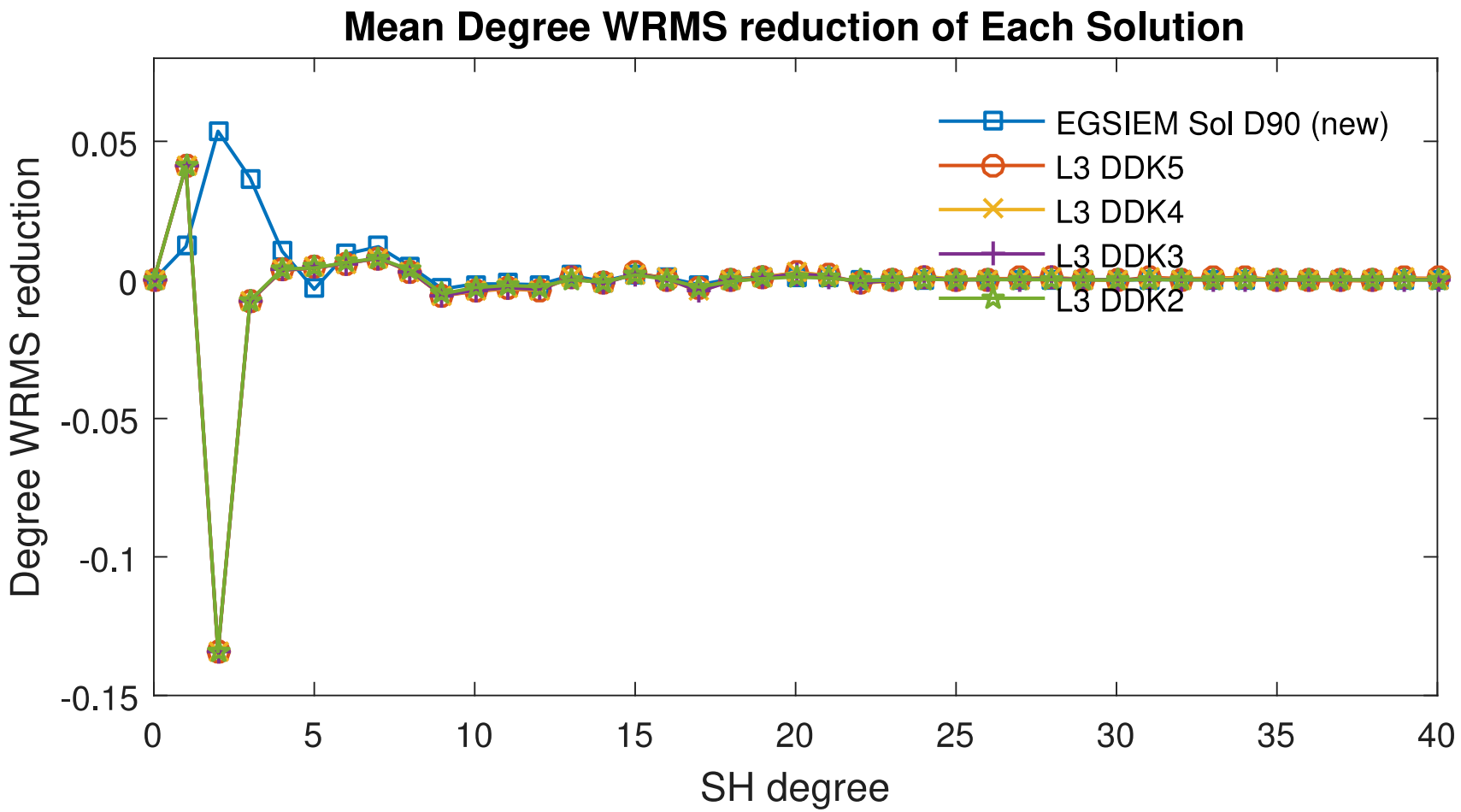
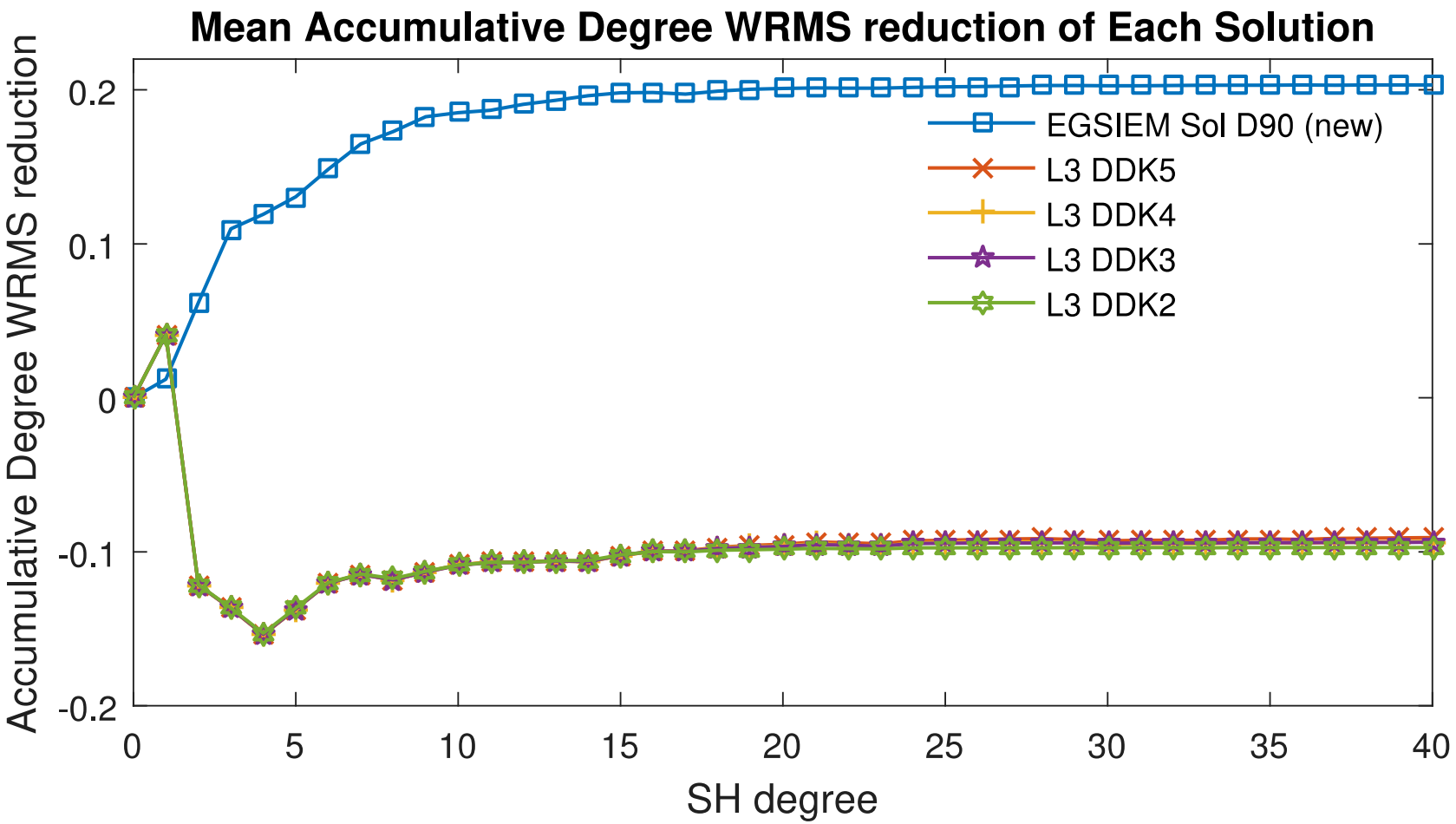
L3 products


Mean Degree WRMS reduction of Each Solution
Degree WRMS reduction
SH degree
0.05
0
-0.05
-0.1
-0.15
0
5
10
15
20
25
30
35
40
EGSIEM Sol D90 (new)
L3 DDK5
L3 DDK4
L3 DDK3
L3 DDK2

L3 products


Mean Accumulative Degree WRMS reduction of Each Solution
Accumulative Degree WRMS reduction
SH degree
EGSIEM Sol D90 (new)
L3 DDK5
L3 DDK4
L3 DDK3
L3 DDK2
0.2
0.1
0
-0.1
-0.2
0
5
10
15
20
25
30
35
40

WRMS reduction

EGSIEM Sol D90 (New)