

Supporting material for

**A novel spatial filter to reduce north-south striping noise
in GRACE spherical harmonic coefficients**

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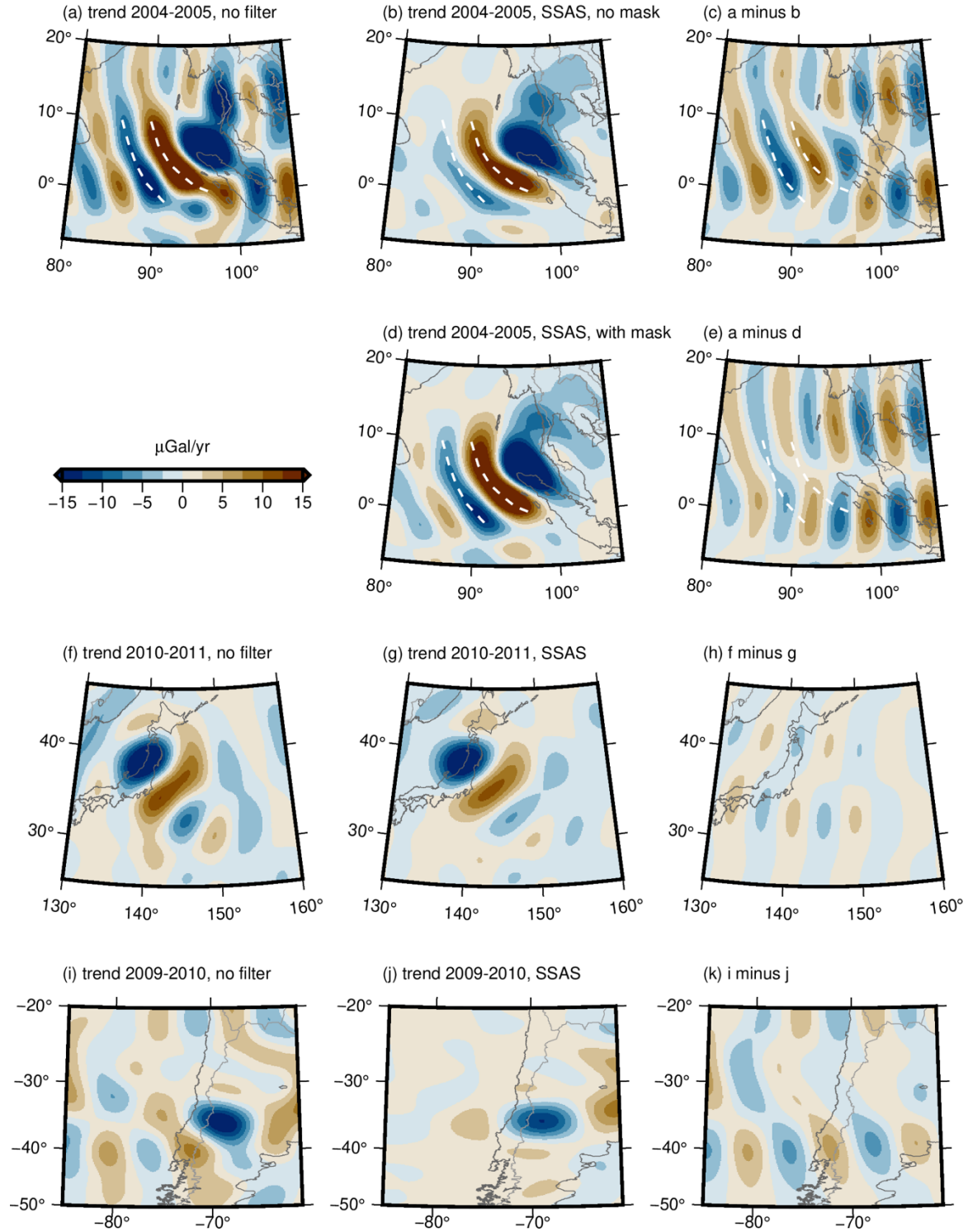


Figure S1. Examination of 2-year gravity trends in three seismic zones. Plots (a)-(e) show the necessity of the mask to maintain the signals of the 2004 Sumatra event. Plots (f)-(h) show the results for the 2011 Tohoku event. Plots (i)-(k) shows the results for the 2010 Chile event.

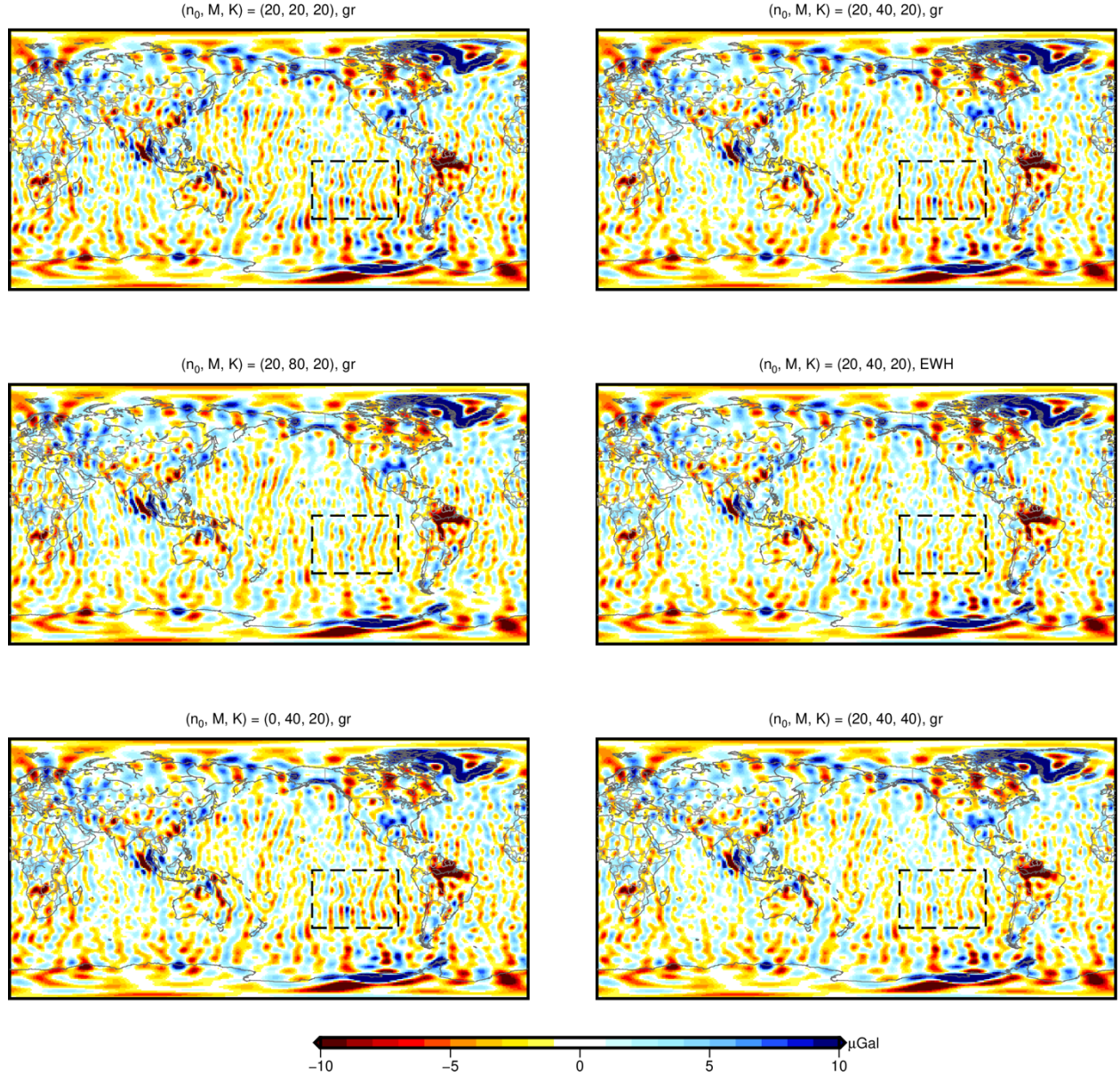


Figure S2. Testing of different combinations of parameters. ‘gr’ (‘EWH’) indicates SSAS is implemented in the form of gravity disturbance (equivalent water height). The differences are barely noticeable, while the dashed box outlines a key area with distinguishable features.

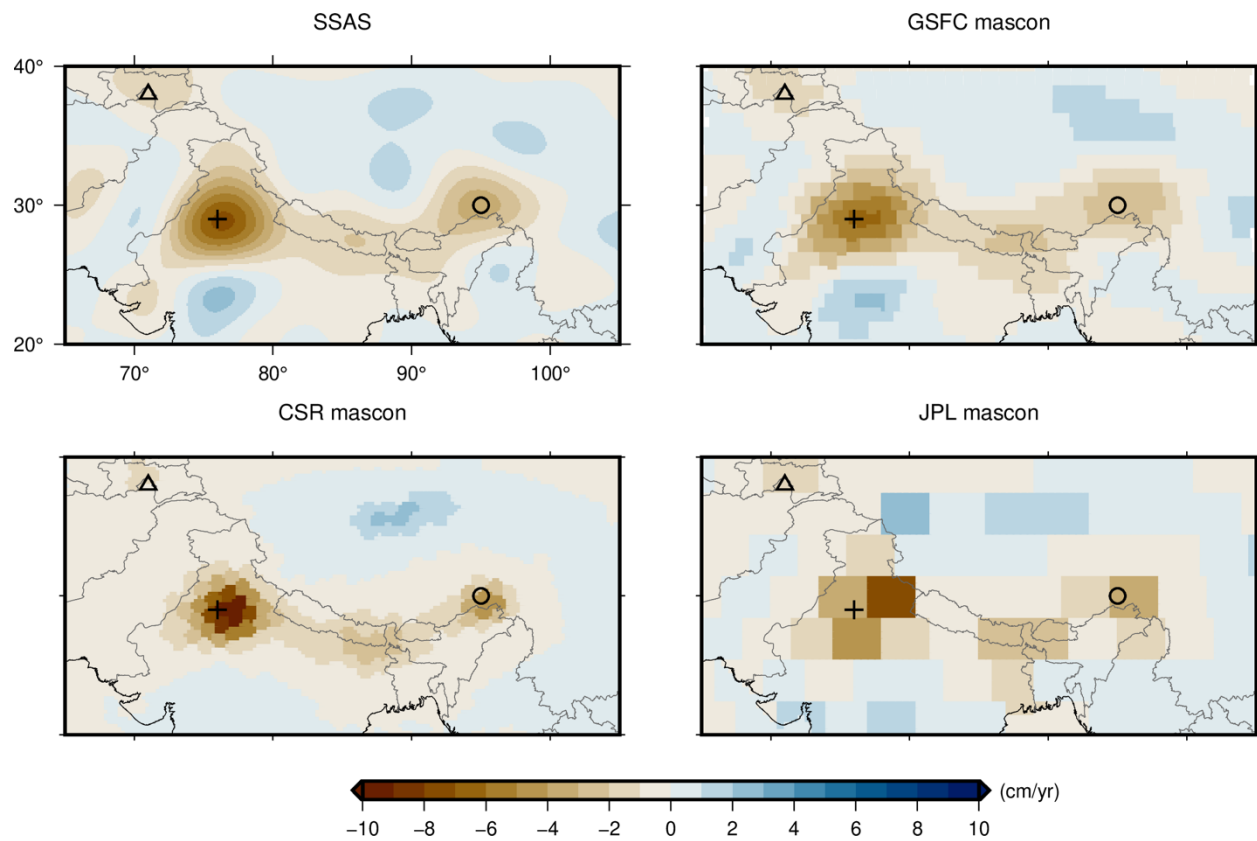


Figure S3. Trends on the Tibetan Plateau between April 2002 and August 2020 using four different GRACE products.

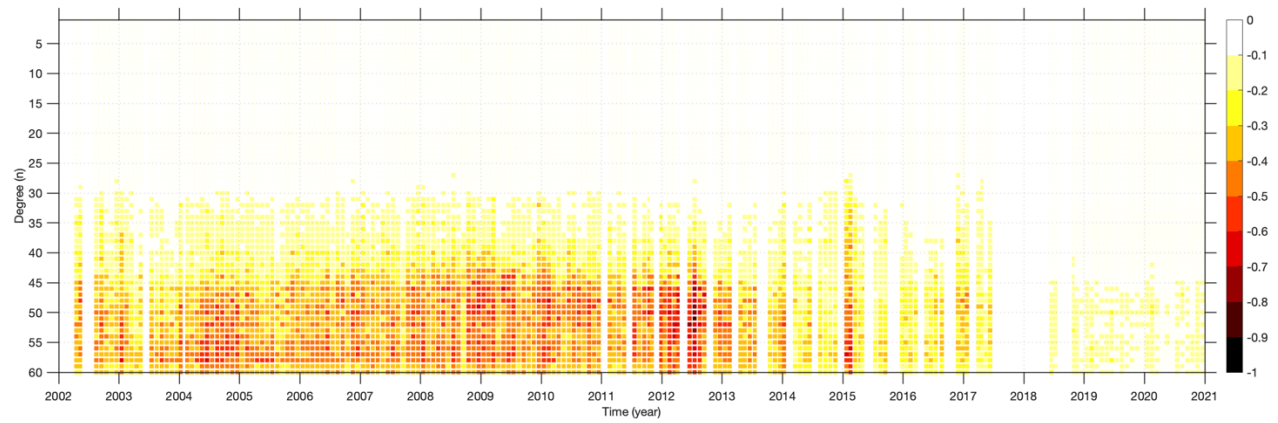


Figure S4. The ratio of the reduction in the degree variance in each monthly product by using SSAS. A value of 1 indicates the degree variance is reduced to zero and 0 indicates no change at all.

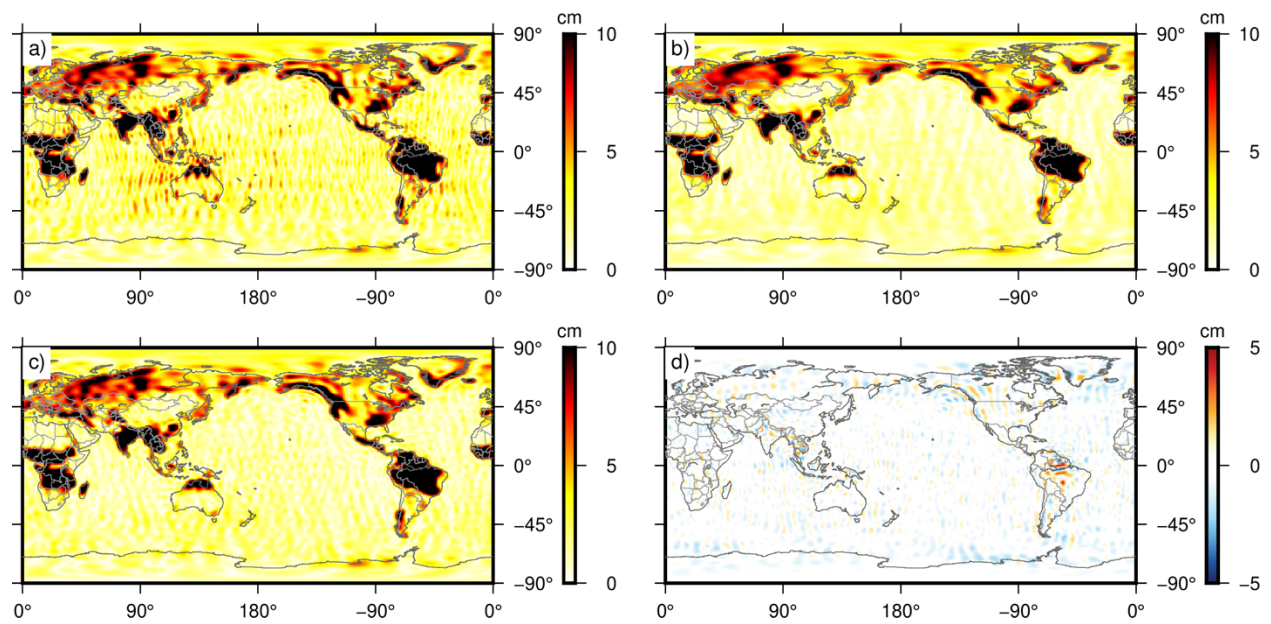


Figure S5. Annual amplitude of (a) original signals without any filter, (b) signals smoothed by DDK6, and (c) signals smoothed by SSAS. (d) The difference between (b) and (c). The results are in EWH (cm) and the time span is from 2002 to 2020.

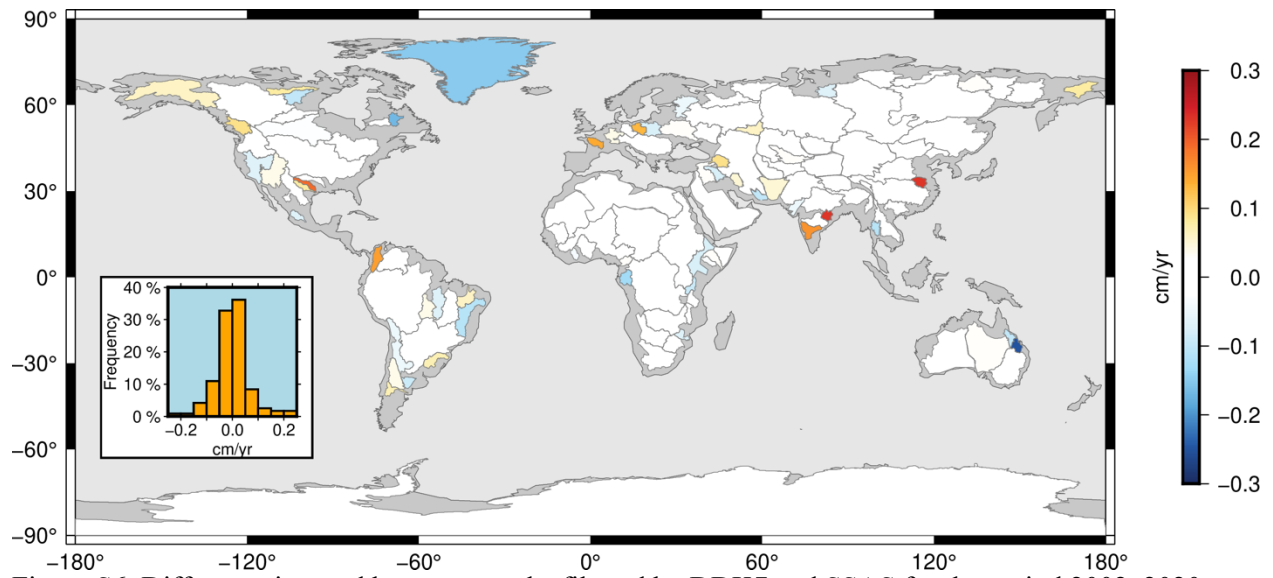


Figure S6. Difference in trend between results filtered by DDK7 and SSAS for the period 2002–2020. The inset shows the statistical distribution of the differences.

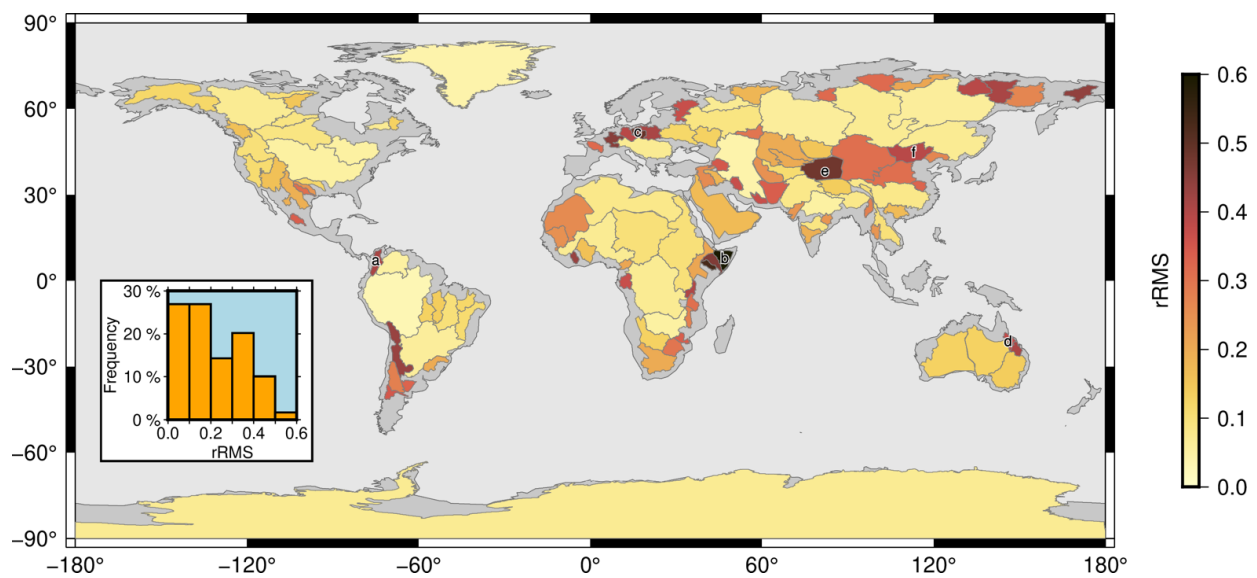


Figure S7. Relative RMS (rRMS) between 2002–2020 time series smoothed by DDK6 and SSAS, respectively. More than half of the basins have a rRMS value smaller than 0.2 (the inset). Six basins with large a rRMS value are examined in Figure S8.

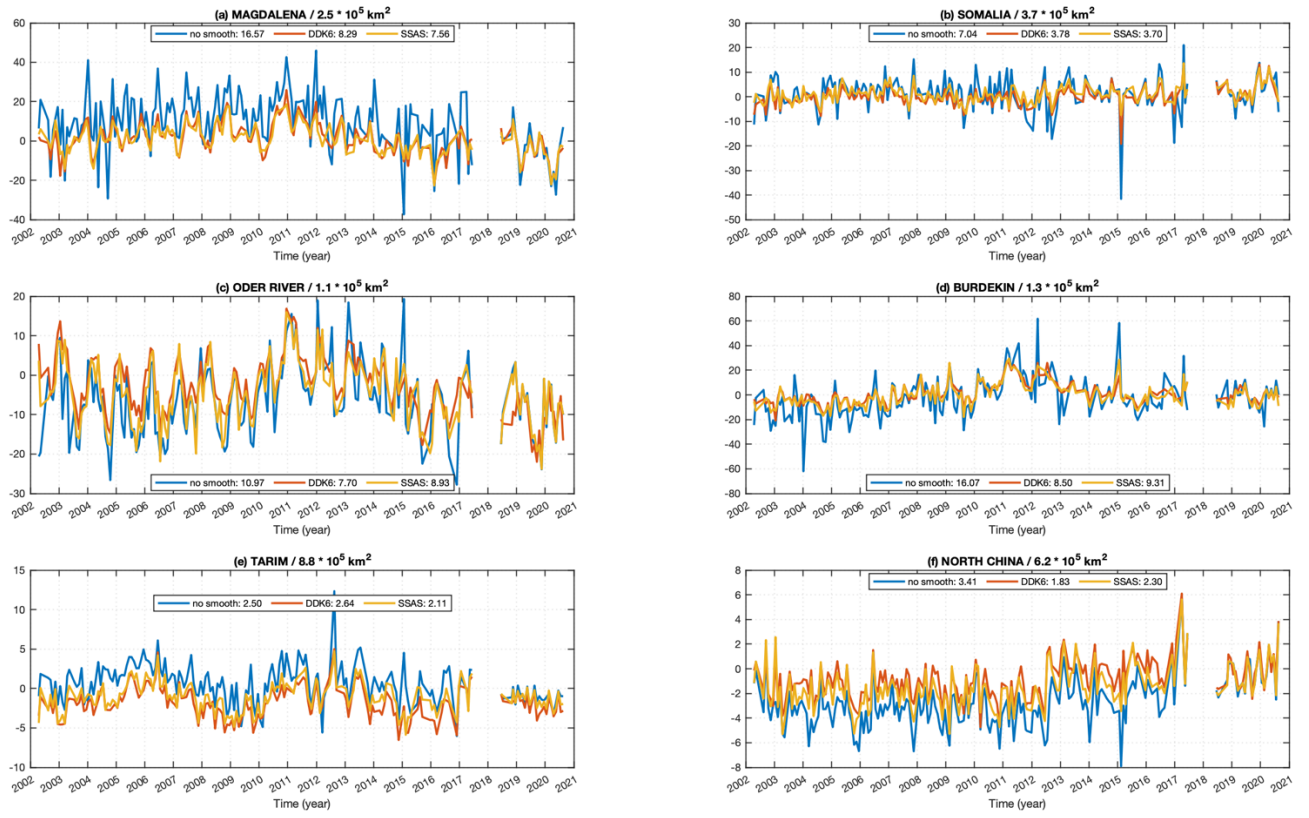


Figure S8. Comparison of time series smoothed by DDK6 and SSAS. The position of the basins is marked in Figure S7. The values in the legend show the RMS. The unit is cm. The high rRMS is mainly due to the irregular variability (weak seasonality, high noise level). It shows that both filters greatly revise the original time series, but the filtered series are mostly consistent, although these two filters are designed on completely different conceptions.

Table S1. The top 20 basins/regions with the largest difference in the trend. The unit is cm/yr. The uncertainty only reflects the 1-sigma error in the curve fit. Generally, the large discrepancies come from small basins. The Greenland has a large difference due to the weakening effect of DDK7 (at a level of 1.8%) since our method barely modified the signal in Greenland.

Basin/Region name	Area ($\times 10^5 \text{ km}^2$)	Trend by DDK7	Trend by SSAS
Fitzroy	1.27	0.74 ± 0.13	0.49 ± 0.12
Huai He	1.37	-0.95 ± 0.12	-0.71 ± 0.10
Mahanadi	1.24	-0.03 ± 0.12	0.20 ± 0.11
Brazos	1.07	-0.95 ± 0.10	-0.76 ± 0.10
Caniapiscau	1.03	4.52 ± 0.08	4.35 ± 0.09
Krishna	2.55	0.19 ± 0.09	0.35 ± 0.08
Greenland	21.48	-8.20 ± 0.08	-8.35 ± 0.08
Magdalena	2.55	-0.62 ± 0.12	-0.47 ± 0.08
Loire	1.12	-0.82 ± 0.09	-0.68 ± 0.09
Oder	1.07	-0.34 ± 0.08	-0.21 ± 0.09
Amu Darya	4.28	-0.16 ± 0.10	-0.29 ± 0.09
Loire	1.12	-0.89 ± 0.14	-1.01 ± 0.13
Kolyma	4.22	-1.58 ± 0.13	-1.69 ± 0.12
Liao he	1.64	3.50 ± 0.07	3.39 ± 0.09
Colorado	6.37	0.46 ± 0.14	0.36 ± 0.12
Kura	1.74	-1.10 ± 0.07	-1.20 ± 0.06
Huang He	9.02	-0.47 ± 0.09	-0.38 ± 0.09
Euphrates	3.28	-0.95 ± 0.08	-0.86 ± 0.06
Tigris	1.57	0.75 ± 0.13	0.66 ± 0.10
Yukon	8.20	-0.34 ± 0.15	-0.43 ± 0.15