Abstract: Gravity Recovery and Climate Experiment (GRACE) satellites, launched 17.03.2002 from Plesetsk, provide a set of monthly Earth’s gravity field observations. They present a big interest for hydrological studies. Gravity data reflect changes, related to the groundwater redistribution, ice melting, and precipitation accumulation. However, de-striping/filtering is required to use the GRACE data products. We apply Multichannel Singular Spectrum Analysis (MSSA, or extended EOF) technique to filter GRACE data and separate the principal components (PCs) of different periods. We performed data averaging over the large river basins of Russia. Winter 2012-2013 was the most snowy winter in Russia since 1960s. Melting of this snow induced large floods and river levels increase. The exceptional maxima are seen in the curves obtained from GRACE. Next spring and summer 2014 were much less snowy. Long-periodic climate-related changes were separated into PC 1. Gravity field increase in Siberia, Black sea, and decrease around Caspian sea are seen.

Data: We used JPL Level-2 RL05 monthly GRACE spherical harmonic data since 01.2003 till 09.2015 with coefficients complete to degree 60. 13 files (06.03, 01.11, 06.11, 05.12, 10.12, 03.13, 08.13, 09.13, 02.14, 12.14, 02.12, 05.15, 06.15) were cubically-interpolated (overall N=153 files). $C_o$ coefficients were replaced by SLR-derived. Average field over 10 years was subtracted. GIA effect according to Poulson 2007 model was removed. Results are presented in form of equivalent water height (EWH) level (cm) maps.

**Fig 1.** Vertical “stripes” manifest as high-frequency correlated errors dominates each of the monthly temporal gravity field solutions. Initial data contains mostly stripes, and illustrates constant (geographically-correlated) spatial behavior. MSSA can be used for de-striping.

**Fig 2.** Sum of MSSA PCs 1-10 ($L=8$) represent main signal variability (energy). Stripes are mostly removed (they go to larger PCs). Simulated Topological Networks (STN-30p) database is used to constrain the region of study to the basins of 15 large Russian rivers (left). The map for 06.2014 is presented (below).

**Fig 3.** $C_o$ coefficients are badly estimated from GRACE and should be replaced by those, obtained from Stellate Laser Ranging (SLR) -- Fig 4. Results of averaging over the basins of large Russian rivers. Black curve is sum of SNs 1-10. Purple curve - initial data (sum of all SNs). Trend (PC 2) is shown in blue. It increases until 2009, then reaches a plateau.

**Fig 4.** Singular numbers for MSSA with parameter $L=8$.

**Fig 5.** Difference between 2014 and 2003 for the trend component (PC 1).

**Fig 6.** Sum of PCs 1-10 for particular rivers basins. Different trends’ behavior for European and Siberian rivers is seen.

**Fig 7.** MSSA sum SN 1-10 and initial GRACE data for big seas and lakes of Russia. Regions were selected as rectangles with coordinates shown in the label.

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**Mass anomalies over Russia from GRACE**

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