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Low degree Earth's gravity coefficients determined from different space geodetic observations and climate models

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Large scale mass redistribution and its transport within the Earth system causes changes in the Earth's rotation in space, gravity field and Earth's ellipsoid shape. These changes are observed in the ΔC_{21}, ΔS_{21}, and ΔC_{20} spherical harmonics gravity coefficients, which are proportional to the mass load-induced Earth rotational excitations.

In this study, linear trend, decadal, inter-annual, and seasonal variations of low degree spherical harmonics coefficients of Earth's gravity field, determined from different space geodetic techniques, Gravity Recovery and Climate Experiment (GRACE), satellite laser ranging (SLR), Global Navigation Satellite System (GNSS), Earth rotation, and climate models, are examined. In this way, the contribution of each measurement technique to interpreting the low degree surface mass density of the Earth is shown.

Especially, we evaluate an usefulness of several climate models from the Coupled Model Intercomparison Project phase 5 (CMIP5) to determine the low degree Earth's gravity coefficients using GRACE satellite observations. To do that, Terrestrial Water Storage (TWS) changes from several CMIP5 climate models are determined and then these simulated data are compared with the GRACE observations.

Spherical harmonics ΔC_{21}, ΔS_{21}, and ΔC_{20} changes are calculated as the sum of atmosphere and ocean mass effect (GAC values) taken from GRACE and a land surface hydrological estimate from the selected CMIP5 climate models.

Low degree Stokes coefficients of the surface mass density determined from GRACE, SLR, GNSS, Earth rotation measurements and climate models are compared to each other in order to assess their consistency. The comparison is done by using different types of statistical and signal processing methods.