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Study on combination approaches for hydrological angular momentum determined from climate data

Jolanta Nastula[1], Tomasz Kur[1], Justyna Śliwińska[1], Małgorzata Wińska[2], and Aleksander Partyka[1]
[1]Centrum Badań Kosmicznych Polskiej Akademii Nauk (nastula@cbk.waw.pl)
[2]Warsaw University of Technology, Faculty od Civil Engineering

Geophysical interpretation of polar motion (PM) and finding the sources of its excitation is an important but challenging task that takes place on the boundary between geodesy and geophysics. Especially the role of hydrological signals in PM excitation is not yet fully understood, mainly because of the lack of agreement between estimates of hydrological angular momentum (HAM) computed from different data sources (e.g., land surface models, global hydrological models, satellite gravity measurements).

The recently observed climate changes affect the global distribution and transport of continental water mass, which may also influence the HAM. Projections of past and future changes in the physical and chemical properties of the atmosphere, ocean, and hydrosphere caused by climate change are delivered by climate models, which are collected and made available to the public in the frame of the sixth phase of the Coupled Model Intercomparison Project (CMIP6). Such models provide many of variables, including variations in soil moisture and snow water storage, which are necessary for HAM computation. However, CMIP6 models differ in terms of initial conditions, physical properties of atmosphere, oceans, hydrosphere, and climate forcing. Such divergences obviously contribute to the differences between various CMIP6-based HAM series.

In this study, we investigate various groups of models according to providing institute, mean of selected models and more sophisticated combinations determined using different methods like e.g., variance components estimation, three cornered hat method. The obtained series are analyzed and evaluated in several spectral bands. The goal of such study is to check whether grouping or combining the models could improve the consistency between CMIP6-based HAM and hydrological signal in geodetically observed PM excitation. To evaluate the combined CMIP6-based HAM series, we compare them with geodetic residuals (GAO) obtained from geodetic angular momentum reduced by atmospheric and oceanic signals, as well as with HAM computed from data from Gravity Recovery and Climate Experiment (GRACE) mission. Generally, the analyses confirm the results obtained from previous studies (Nastula et al. 2022). It is possible to find grouped CMIP6 models that provide HAM series as or more compliant with GAO than HAM determined from GRACE.