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Determination of hydrological signal in polar motion variations from gravity field models obtained from kinematic orbits of LEO satellites

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Earth Orientation Parameters (EOP), that describe the rotation of our Planet, are required for a number of applications, including pointing of astronomic instruments, communication with deep space objects and precise positioning and navigation of the objects at the Earth's surface with the use of Global Navigation Satellite Systems (GNSS). Polar motion represents two out of five EOP that link the terrestrial reference frame with the corresponding celestial frame. The temporal variations of polar motion are caused by gravitational impact of other celestial bodies together with disturbances in mass redistribution of Earth's surficial fluids (atmosphere, oceans and land hydrosphere).

Throughout the past 15 years, the Gravity Recovery and Climate Experiment (GRACE) mission has given an unprecedented view on global surface mass variations that affect Earth's rotation. Assessment of the impact of land hydrosphere on polar motion has been conducted successfully using GRACE temporal models. However, the mission is over and the data gap between GRACE and its continuation (GRACE Follow-On) will exceed 2 years. For this reason, many scientists have proposed ideas to fill this gap using alternative sources of gravimetric data. For this purpose, observations from low Earth orbit (LEO) satellites can be used.

In this presentation we will present the usefulness of several temporal gravity field models determined from kinematic orbits of selected LEO satellites in designating polar motion variations. To do this, we will use available models based on Swarm, Jason, MetOp, TanDEM-X and TerraSAR-X satellite data. However, while GRACE mission, solely dedicated to Earth's gravity field measurements, is based on low-low satellite-to-satellite tracking (ll-SST) concept, the other LEO-based models were developed with the use high-low satellite-to-satellite tracking (hl-SST) observations. As a consequence, they describe only the long-wavelength part of gravity field. Nevertheless, the polar motion variations analysed here are proportional to low-degree spherical harmonic coefficients of Earth's gravity potential.

Our investigations are focused on assessment of hydrological polar motion excitation functions obtained from models determined on a basis of kinematic orbits of LEO satellites. We will consider different oscillations: seasonal, non-seasonal and interannual. We will present the agreement between obtained series and hydrological signal in observed geodetically polar motion excitation derived from precise measurements of pole coordinates. The comparison with the newest releases of Level-2 GRACE data (RL06) will be also included.

Our conclusions, supported by analyses conducted, indicate discrepancies between particular solutions that are mainly the result of differences in orbital height. Of course, neither of considered missions provide full agreement with GRACE-based hydrological excitations of observed ones. However, the combination of few solutions improves these results.