The 3D representation of the new transformation from the terrestrial to the celestial system

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Abstract. We offer a 3D representation of the new transformation from the terrestrial to the celestial system.

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In order to study the sky from the Earth or to use navigation satellites, we need two reference systems, a celestial reference system (CRS) without no intrinsic rotation with respect to space and a terrestrial reference system (TRS) rotating with the Earth. Additionally, we need a way to go from one reference system to the other. This transformation involves the Earth rotation rate, polar motion, and precession-nutation. It is done using an intermediate system obtained by transforming the CRS with taking into account precession-nutation. Previously, one used an intermediate system related to the equinox; the new paradigm involved a point, denoted the Celestial Intermediate Origin (CIO), which, due to its kinematical property of 'Non Rotating Origin' (NRO), allows better describing the Earth rotation angle. The use of a NRO for the point related to the TRS has also been introduced; the corresponding name of this origin is the Terrestrial Intermediate Origin (TIO). Using or not using the CIO and the TIO only affects the intermediate system used in the transformation between the TRS and the CRS. The use of the CIO allows a perfect decontamination between Earth rotation and precession nutation. The use of the TIO allows a perfect decontamination between Earth rotation and polar motion.

Several 3D animations have been performed in order to explain the definition of the NRO, the transformation between the TRS and CRS, and the conceptual advantage with using the CIO. The new paradigm for performing the transformation between TRS and CRS based on the CIO and TIO uses the small quantities s and s'. As a first step, the CIP motion in the TRS is accounted for in order to move the z-axis of the TRS to the CIP. Then, the rotation s' around the CIP is applied in order for the new x-axis to be brought on to the non-rotating origin ϖ corresponding to the TIO. The third step consists in a rotation around the CIP axis of the so-called Earth Rotation Angle (ERA) denoted θ in order to move ϖ on the celestial counterpart of the non-rotating origin, σ, corresponding to the CIO. The rotation s is then applied, still around the CIP, and finally, the celestial motion of the CIP is taken into account in order to reach the CRS (rotation around the CIO, σ, to move the CIP on to the Z-axis of the CRS). The small quantities s and s' are for contributions associated with polar motion and nutation, respectively and are easily solved for kinematically from expressions for the polar motion and precession-nutation.