



Synergy Grant GRACEFUL and Repercussions for Society.

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Improving and standardizing Earth's reference frames to achieve an accuracy of 1 millimeter (mm) and a long-term stability of 0.1 mm/year, as mandated by United Nations Resolution 69/266, is critical for numerous scientific and societal applications. For instance, precise determination of geocenter motion and satellite orbits is essential for accurately quantifying sea-level changes using satellite altimetry. Similarly, monitoring tectonic movements and crustal deformations for geophysical research demands this level of precision. Achieving such accuracy is vital for advancing our understanding of Earth's dynamic processes, improving natural hazard assessments, and supporting civilian applications such as navigation, positioning, and geospatial data geo-referencing.

A deep understanding of Earth's rotation, including periodic orientation changes known as nutations, underpins these goals. The current nutation model, adopted internationally in 2000, requires updating to incorporate the latest scientific insights. The GRACEFUL ERC Synergy Grant seeks to enhance our understanding of Earth's core dynamics, a key driver of reference frame and Earth rotation modeling. By integrating cutting-edge geophysical knowledge, refining computational techniques, leveraging insights from GRACEFUL, and utilizing recent Very Long Baseline Interferometry (VLBI) data, we propose significant improvements to these models.

Additionally, we will benefit from the upcoming ESA GENESIS mission, scheduled for launch in 2028. This mission will co-locate four geodetic techniques, enabling a more precise realization of reference frames. The integration of new Earth rotation models and the unprecedented accuracy expected from GENESIS will allow for the determination of geophysical observables with unparalleled precision, addressing the pressing societal needs outlined above.

In parallel, the GRACEFUL ERC Synergy Grant facilitated the discovery of a 6-year cycle in the entire Earth system, contributing to significant advancements in our understanding of Earth system's complex dynamics.