The International Terrestrial Reference Frame: current status and future challenges

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The ability to assign accurate time-dependent coordinates to points on the Earth's surface is fundamental for many Earth observation applications. Also important is monitoring these coordinates over time in order to take into account all geophysical changes affecting the Earth's surface. Many areas of science, Earth observation, geo-referencing applications, and society at large, today depend on being able to determine positions to millimeter level precision. Point positions, to be meaningful and fully exploitable, have to be determined and expressed in a well-defined Terrestrial Reference Frame (TRF). All current global and regional reference frames rely on the availability of the *International Terrestrial Reference Frame* (ITRF), which is the most accurate realization of the *International Terrestrial Reference System* (ITRS).

The positions of the thousands of geodetic stations distributed over the Earth's surface can now be determined with a precision at the level of a few millimeters and their variation over time at the level of, or better than, 1 mm/yr in a global geocentric frame. This performance is only possible as a result of the tremendous progress made in improving the hardware of the space geodetic techniques and in the high level algorithms, models, and scientific software packages developed by the analysis centers dealing with the geodetic observations accumulated over the last three decades. However, none of the space geodetic techniques is able to provide all the parameters necessary to completely define a TRF (origin, scale and orientation). While satellite techniques are sensitive to the Earth center of mass (the point around which a satellite orbits; a natural TRF origin), VLBI is not (whose TRF origin is arbitrarily defined). The scale is dependent on the modeling of some physical parameters, and the absolute TRF orientation (unobservable by any technique) is arbitrary or conventionally defined through specific constraints. Therefore the value of the ITRF multi-technique combination is recognized not only for an accurate reference frame definition, but also as a tool for exposing technique systematic errors that need to be understood and mitigated.

The presentation will focus on the current ITRF results achieved so far and future challenges towards its refinement: improvement by a factor of 10 is needed in order to meet the science requirement of 0.1 mm/yr stability over time for confident tracking of sea level change. A particular emphasis will be given to the current status of the ITRF geodetic infrastructure, technique systematic errors as seen from the ITRF combination results and its future parameterization, taking into account and quantifying all geophysical changes and non-linear motions affecting the Earth's crust.