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Rationale for sub-millimetre per year ITRF accuracy for long-term sea level studies

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Vertical land movements arise from a wide range of natural and anthropogenic processes. They affect most coastlines and can significantly increase (or decrease) the rates of sea level rise expected from the sole climatic contributions of ocean thermal expansion and land-based ice melting, magnifying (or reducing) the impacts of sea level rise on the coast. Their knowledge represents a key step toward identifying the forcing factors contributing to sea level change at a particular coast, correctly quantifying their relative importance, and improving our understanding of the causes for robust predictions and full assessment of coastal vulnerability by sea level rise. Poor knowledge on land movements may profoundly hamper sea level rise projections, and ultimately lead to expensive mistakes in coastal management policies. Hence, high-quality measurements of vertical land movements have been given considerable attention over the past two decades. However, the accurate determination of these has remained a fundamental though elusive goal. The application is demanding. Sea level is estimated to have risen globally at around 1.7 mm/year over the past century. To be useful for long-term sea level trend studies, vertical land movements should be estimated with standard errors of one order of magnitude less. In this presentation, we will show that despite the remarkable advances made recently in the reanalysis of Global Positioning System (GPS) data, we are aiming at a level of performance where serious consideration of the reference frame and its long-term stability need to be addressed. Vertical velocity is a reference frame-dependent quantity, which is very sensitive to the origin and scale of the frame. The accuracy of its origin and scale is thus one of the main factors limiting the determination of accurate vertical velocities today, and subsequently the estimates of vertical land movements and geocentric sea level trends at the coast. A terrestrial reference frame accurate and stable at the sub-millimeter per year level is required.