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Advances in the determination of a global unified reference frame for physical heights

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Abstract. Measuring, studying, and understanding global change effects demand unified geodetic reference frames with (i) an order of accuracy higher than the magnitude of the effects to be observed, (ii) consistency and reliability worldwide, and (iii) long-term stability. The development of the International Terrestrial Reference System (ITRS) and its realisation, the International Terrestrial Reference Frame (ITRF), enable the precise description of the Earth's geometry by means of geocentric Cartesian coordinates with an accuracy at the cm-level and with global consistency. An equivalent high-precise global height reference system that provides the basis for the consistent determination of gravity field-related coordinates worldwide, in particular geopotential differences or physical heights, is missing. Without a conventional global height system, most countries are using local ones, which have been implemented individually, applying in general non-standardised and non-uniform procedures. It is proven that their combination in a global frame presents discrepancies at the metre level. Therefore, a core objective of the international geodetic community is to establish an international standard for the precise determination of physical heights. This standard is known as the International Height Reference System (IHRS). Its realisation has been a main topic of research during the last years. Recent achievements concentrate on (1) compiling detailed standards, conventions, and guidelines for the IHRS realisation, (2) evaluating computational approaches for the consistent determination of potential differences, and (3) designing an operational infrastructure that ensures the maintenance and long-term stability of the IHRS and its realization. This contribution summarises advances and current challenges in the establishment, realization and sustainability of the IHRS.