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Evaluation of common-mode errors in global multi-year frames: A case study in the ITRF solution series

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Abstract. The quality assessment of global multi-year frames is essential for verifying their compliance with stringent accuracy standards imposed by scientific user needs for Earth science applications. This task is usually engaged in a relative framework through comparisons with other independently (or semi-independently) derived frame solutions from the same and/or different space geodetic techniques. However, in order to acquire a complete view of the quality of global multi-year frames, it is also important to assess their internal accuracy at coordinate system level (origin, orientation, scale, and their time evolution) which is reflected in the estimated solution and its full covariance matrix for the frame positions and their predicted secular/non-secular changes. This is essentially an inverse "error mapping" problem without a single straightforward solution, aiming to infer, in a statistical sense, the common-mode errors of translational, rotational and scaling type that commonly occur in multi-year frame solutions. Such errors are always hidden in the correlated part of the total estimation error of any frame solution, and they dictate the intrinsic accuracy of the coordinate system which is inherited to users by the respective solution. The aim of this paper is to expose the key aspects of the aforesaid evaluation scheme for quantifying the (internal) common-mode errors in global multi-year frames, and to present the results from its implementation in the historical series of ITRF solutions, including the latest release of ITRF2020.