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The terrestrial reference frame and surface mass loading

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The terrestrial reference frame is maintained by monitoring the motion of a network of crust fixed sites relative to each other and to an origin at the Earth center of mass. This network is perturbed by surface mass loading which causes global-scale Earth deformation and geocenter motion. The current ITRF realisation procedure does not incorporate a model for either of these effects; although tentative proposals have been made a practical approach has yet to be developed. We 1) investigate the effects on the ITRF of ignoring surface mass loading at both the realisation and user attachment level, and 2) discuss possible approaches to mitigating these effects which may include using external models and/or incorporating loading parameters into the geodetic observation model.

Given the underlying physical process it is possible to build a consistent theoretical framework that unifies expected changes in geodetic observables such as surface displacement and geo-potential via an Earth model. In this way it is possible to build a stronger frame procedure that exploits relationships between a number of geodetic observables rather than site coordinates alone. Such a unified approach allows a contribution to frame definition from techniques that are not directly sensitive to station displacements (such as gravity measurements) or alternatively allows techniques that are not sensitive to gravitational aspects of frame definition (e.g. VLBI) to contribute to the origin definition via observations of relative site motion. This is particularly pertinent for the ITRF, while GPS can exploit good spatial coverage and provide low

inter-site baseline precision the center of mass determination is much less precise. SLR on the other hand has this precise center of mass determination but lacks extensive spatial coverage. This theoretical framework also highlights and enforces consistency when applying loading models generated from pressure and hydrology data assimilation to geodetic measurements.