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Comparing environmental loading effects and geodetic time series: What is the natural environmental reference frame for surface mass observations?

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It is common practice when comparing geodetic data with environmental surface load models or observations, to determine the surface loading effects in a particular reference frame, e.g. the Center of the solid Earth [CE], Center of Mass (Earth + surface masses) [CM] or the Center of Figure [CF] (see Blewitt, 2002 for a thorough discussion of reference frames). However, the observations or models of the surface masses themselves may be defined in a 'natural frame' that is different from any of these classic geodetic frame definitions. For example, in the case of atmospheric pressure loading (ATML), induced deformations are determined with respect to some reference pressure, i.e. the temporal average. But is the reference pressure consistent with the ITRF? In other words, would we derive the same ITRF using geodetic data corrected for and uncorrected for ATML? Another issue is whether the models conserve total mass over time and respect the same global origin consistently.

In addition, there is the problem of providing geodetic corrections for different contributions to the total surface mass. As stated above, we can theoretically generate the loading corrections in any reference frame. But only the CE reference frame is accurate for any individual mass component as the true CM or CF depends on the total of all surface masses. Further, in practice, the geodetically observed CF or CM is dependent to some extent on the number and distribution of observing sites used to determine the frame.

In this paper we will investigate these questions and consider the errors introduced into a geodetic time series by these mismodelling effects. We will further investigate options for overcoming these problems.