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Application of deformation–induced topographic effect in interpretation of 2013–2016 spatiotemporal gravity changes at Laguna del Maule (Chile)

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The accurate deformation-induced topographic effect (DITE) should be used to account for the gravitational effect of surface deformation when analyzing residual spatiotemporal (time-lapse) gravity changes in volcano gravimetric or 4D micro-gravimetric studies, in general. Numerical realization of DITE requires the deformation field available in grid form. We compute the accurate DITE correction for gravity changes observed at the Laguna del Maule volcanic field in Chile over three nearly annual periods spanning 2013–2016 and compare it numerically with the previously used free-air effect (FAE) correction. We assess the impact of replacing the FAE by DITE on the model source parameters of analytic inversion solutions and apply a new inversion approach based on model exploration and growing source bodies. The new inversion results based on the DITE correction shift the position of the mass intrusion upwards by a few hundred meters and lower the total mass of the migrated fluids to roughly a half, compared to the inversion results based on the local-FAE correction. Our new Growth inversion results indicate that vertical dip-slip faults beneath the lake, as well as the Troncoso fault play active roles in hosting migrating liquid. We also show that for the study period, the DITE at Laguna del Maule can be accurately evaluated by the planar Bouguer approximation, which only requires the availability of elevation changes at gravity network benchmarks. We hypothesize that this finding may be generalized to all volcanic areas with flatter or less rugged terrain and may alter interpretations based on the commonly used FAE corrections.