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Improved Hydrological Loading Models in South America: Analysis of 3D GPS Displacements Using M-SSA

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Abstract. Environmental loading, in particular from continental water storage changes, induces geodetic station displacements up to several centimeters for the vertical components. We investigate surface deformation due to loading processes in South America using a set of 247 permanent GPS (Global Positioning System) stations for the 2003–2016 period and compare them to loading estimates from global circulation models. Unfortunately, some of the hydrological components, and in particular surface waters, may be missing in hydrological models. This is especially an issue in South America where almost half of the seasonal water storage variations are due to surface water changes, e.g., rivers and floodplains. We derive river storage variations by rerouting runoffs of global hydrology models, allowing a better agreement with the mass variations observed from GRACE (Gravity Recovery and Climate Experiment) mission. We extract coherent seasonal GPS displacements in the east, north and vertical directions using Multichannel Singular Spectrum Analysis (M-SSA) and show that modeling the river storage induced loading effects significantly improve the agreement between observed vertical and horizontal displacements and loading models. Such an agreement has been markedly achieved in the Amazon basin. Whilst the initial models only explained half of the amplitude of GPS, the new ones compensate for these gaps and remain consistent with GRACE.