Processing techniques for optimizing the detectability of synthetic shallow slow slip events in seafloor pressure data from the Alaska margin

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Using seafloor pressure and temperature data from the 2018-2019 Alaska Amphibious Community Seismic Experiment and sea surface height data from satellite altimetry, we evaluate the efficacy of various processing techniques to maximize the detectability of slow slip event (SSE) signals in this setting. We consider seasonal and oceanographic pressure signal proxy corrections and conduct synthetic tests to determine their impact on the timing and amplitude prediction of ramp-like signals typical of SSEs and find that subtracting out the first mode of the complex empirical orthogonal functions (CEOFs) of the pressure records on either the shelf or slope yields signal RMS reductions up to 73% or 80%, respectively. Additional correction with proxies that exploit the depth-dependent spatial coherence of pressure records provides cumulative variance reductions up to 83% and 93%, respectively. Our detectability tests show that the timing and amplitude of synthetic SSE-like ramps are best estimated by the same combination of corrections and that these ramps can be well constrained for amplitudes ≥4 cm on the shelf and ≥2 cm on the slope, using a fully automated detector. The principal limits on detectability are residual abrupt changes in pressure that occur as part of the transition to and from summer to winter conditions but are not adequately characterized by our seasonal corrections, as well as the inability to properly account for instrumental drift, which is not readily separated from the seasonal signal.

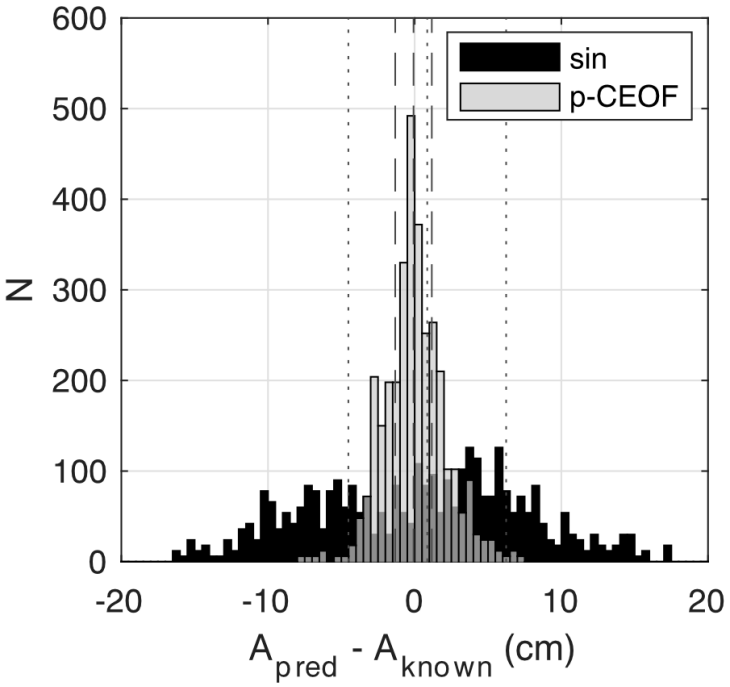

Figure 1. Summary results of detectability analysis, showing quality of ramp amplitude estimations for pressure records on the continental shelf when only with a sinusoidal seasonal correction is applied (black) versus when the data are corrected with both the first mode CEOF and differenced with a depth-matched pressure record (gray), our preferred method. Dotted vertical lines indicate the median and ±MAD for the sinusoidal case and dashed lines indicate the same for the CEOF case.