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Detection and attribution of the ocean warming to provide anthropogenic contribution to the future thermosteric sea level rise and constraints on the effective climate sensitivity due to anthropogenic forcing

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The ultimate warming due to the net energy imbalance in the climate system is difficult to estimate from the present-day observations due to the large uncertainty spread of the radiative forcing estimate. The global ocean is the primary heat sink that stores more than 90% of the energy reaching the earth's surface. While previous studies have shown that changes in the ocean warming are detectable and distinct from the internal variability of the climate system, an estimate of separate contributions by individual anthropogenic forcings (such as greenhouse gases and aerosols) in a formal detection and attribution framework remains outstanding. Here we investigate the contribution of different forcings affecting ocean warming to provide an estimate of anthropogenic contributions to future sea level rise by the year 2100, and derive an estimate of the effective climate sensitivity range due to anthropogenic forcing. By applying regularized optimal fingerprinting techniques, we show that ocean warming in the historical period is detectable and attributable to contributions from the aggregate anthropogenic forcing as well as greenhouse gas forcing alone in Earth System Models from the Fifth Coupled Climate Model Intercomparison Project (CMIP5). Our results suggest that estimated anthropogenic contributions to future sea level rise projections support the multimodel mean projection range, with slightly stronger support for the central and lower part of the distribution. We then apply such detection and attribution framework to the blended global mean temperature, which combined with the ocean heat content results used in the forcing-feedback framework provide anthropogenic constraints on the uncertainty range of the effective climate sensitivity.