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Atmospheric feedback uncertainty dominates ocean heat uptake uncertainty for the transient climate response

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By absorbing heat and carbon the world ocean acts to slow the transient rate of climate change and to a great extent determines the magnitude of warming given a fixed budget of carbon emissions. The projected magnitude of future ocean heat uptake (OHU) varies substantially between the climate model simulations stored in the CMIP5 archive. In this study analytical and statistical methods, in addition to climate model simulations with an intermediate complexity climate model are used to partition the uncertainty in future OHU in CMIP5 models into uncertainty in radiative forcing, the climate feedback parameter, ocean surface wind fields, and the structure of ocean models. We estimate that if only uncertainty in ocean model structure remained then the uncertainty in OHU would be reduced by 61%, and if only uncertainty in ocean surface wind field remained then OHU uncertainty would be reduced by 87%. The regression method used to simultaneously estimate radiative forcing and the climate feedback parameter from climate model output leaves these parameters with anti-correlated uncertainty. If only uncertainty in radiative forcing and the climate feedback parameter remain then the uncertainty in OHU would be reduced by 9%. These results suggest that most of the uncertainty in OHU seen in CMIP5 models originates in uncertainties in how the atmosphere will respond to anthropogenic increases in greenhouse gas concentrations. Therefore, efforts to improve the representation of the ocean in climate models will have only a limited effect on reducing the uncertainty in the rate of transient climate change unless concurrent improvements are made in constraining atmospheric feedbacks.