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Joint effects of natural variability and forcing uncertainty on observational estimates of climate sensitivity

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We explore the joint effects of natural variability and forcing uncertainty on the transient climate sensitivity (i.e, the short-term response of the surface temperature to a doubling of CO2) of the Earth. We assimilate observations of temperature in the 20th century and various estimates of the radiative forcing into a simple energy balance model using a "sigma point" Kalman filter. Use of the filter, along with estimates of natural variability and forcing uncertainty, allows us to estimate both the climate sensitivity and its uncertainty. Currently, the forcing uncertainty provides the largest source of errors in our estimates. If our knowledge of the radiative forcing were to improve we could expect to provide better estimates of climate sensitivity sometime in the future, then constrained by natural variability. We quantify this statement, providing an estimate of when in the future we will have a good estimate of climate sensitivity for given levels of forcing uncertainty and natural variability.