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Constraints on Climate Sensitivity from the Observed Seasonal Cycle

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Estimates of impacts as well as adaptation and mitigation strategies related to anthropogenic climate change require a precise understanding of the anticipated changes as well as the uncertainties associated with it. Long-term uncertainty in future warming is dominated by the uncertainty in climate sensitivity. The range of climate sensitivity was based on expert opinion only for many years, and only recently a few new methods were suggested to objectively quantify its uncertainty. Here we use a multi-thousand member ensemble from climateprediction.net, a distributed computing experiment where versions of a general circulation climate model are run with multiple parameter perturbations. We apply a neural network to establish a relation between climate sensitivity and the amplitude of the seasonal cycle in regional temperature. Most models with high sensitivities are found to overestimate the seasonal cycle compared to observations. A probability density function for climate sensitivity is then calculated from the present day seasonal cycle in observational and reanalysis datasets. Subject to a number of assumptions on the models and datasets used, we find that climate sensitivity is very unlikely to be either below about 2 K or above about 6 K, with the best agreement found for sensitivities between 3 and 3.5 K. This range is narrower than most probabilistic estimates derived from the observed 20th century warming. The current generation of general circulation models are within that range but do not sample the highest values.