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Understanding changes in the hydrological cycle with imperfect models

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Our ability to detect, attribute and predict externally driven changes in the hydrological cycle is generally considered to be much lower than our ability to predict temperature changes. Part of the reason for this is that model-simulated rainfall changes disagree with both each other and with observations, measured in terms of root-mean-square error or pattern correlation, much more than temperature changes do. The recent Fourth Assessment of the Intergovernmental Panel on Climate Change highlighted large regions over which models failed to agree on even the sign of projected rainfall changes over the 21st century. Part of the reason, of course, is that hydrological change may be intrinsically less predictable than temperature change, but a contributing factor may simply be that hydrological features are typically smaller-scale than temperature features and less closely anchored to land-ocean geography. Hence a small error in the location or seasonality in model-simulated convergence zones may, for example, reduce the correlation between simulated rainfall and rainfall changes by much more than a similar error in temperature climatology. Here we show how sophisticated image-processing software developed for the co-registration of brain imagery can be used to correct both geographical and seasonal errors in model-simulated precipitation climatology and improve both multi-model agreement in forecast precipitation changes and the prospects for detection and attribution of human influence on precipitation.