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Impact of stochastic parametrisation schemes on the climate of the Community Earth System Model

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Stochastic parametrisations have been used for more than a decade in atmospheric models. They provide a way to represent model uncertainty through representing the variability of unresolved sub-grid processes, and have been shown to have a beneficial effect on the spread and mean state for medium- and extended-range forecasts (Buizza et al. 1999, Palmer et al. 2009). There is also increasing evidence that stochastic parametrisation of unresolved processes could be beneficial for the climate of an atmospheric model. There is evidence that including stochastic physics can reduce model biases through noise-induced drift (nonlinear rectification) (Berner et al. 2008), and that including stochastic physics enables the climate simulator to explore other flow regimes (Christensen et al. 2014; Dawson and Palmer 2014). It is also possible that, through representing the variability of unresolved sub-grid processes, stochastic parametrisation schemes could improve the internal variability of a model's climate.

We present results showing the impact of including the Stochastic Kinetic Energy Backscatter Scheme (SKEBS) and the Stochastically Perturbed Parametrisation Tendencies scheme (SPPT) in coupled runs of the National Center for Atmospheric Research (NCAR) Community Atmosphere Model, version 4 (CAM4) with historical forcing. The impact of the schemes in the coupled runs is compared to the impact in a similar set of AMIP runs. Both schemes have a beneficial impact on the model climate. The SKEBS scheme significantly reduces mean biases in several fields whereas SPPT results in a significant improvement in the variability of the modeled climate. In particular, SPPT results in a significant improvement to the representation of the El Nino-Southern Oscillation in CAM4, improving the power spectrum, as well as both the inter- and intra-annual variability of tropical pacific sea surface temperatures.

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