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A stochastic coupling scheme for climate models with high ocean-to-atmosphere resolution ratio

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Atmosphere-ocean coupling is of major importance for numerical climate models. Systematic errors in surface flux computations affect both components simultaneously. As an example, surface flux variations caused by (sub-) mesoscale oceanic features and their impact on the atmospheric circulation are generally underrepresented in current models.

In the case of coupled climate models, atmospheric sub-grid scale information is in fact available at the surface, as part of it is typically resolved by the oceanic model component. We present a stochastic scheme that couples *resolved* spatial ocean (and ice) variability, previously not visible to the atmospheric model. Consequently, the resulting SST perturbations of the stochastic scheme are based on resolved dynamics, displaying a pronounced seasonality and realistic magnitude.

We apply the stochastic coupling method in the AWI Climate Model, a new multi-resolution climate model with an ocean component (FESOM) supporting unstructured triangular grids. Our specific setup features a high ocean-to-atmosphere resolution ratio in the tropics, with grid point ratios of about 60:1 (less than 25km to about 200km). Compared to the default deterministic coupling, changes are largest in the tropics, leading to an improved distribution of convective precipitation, and reductions of prominent biases of up to 50%.

The scheme does not rely on a simultaneous increase of resolution in the atmospheric component, saving computational resources. The results are also of interest to other modeling centres employing high ocean-to-atmosphere resolution ratios, as the coupling scheme could be implemented relatively easily as an additional coupling option, without a change to the model code.