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# Enhanced Vertical Atmosphere Resolution improves Climate Model Simulation of Tropical Atlantic Sea Surface Temperature and Interannual Variability

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A long-standing problem in climate modelling is the inaccurate simulation of tropical Atlantic (TA) sea surface temperature (SST), known as the TA SST bias. Basically all state-of-the-art global climate models suffer from a reversed equatorial zonal SST gradient in the Atlantic and too warm surface temperatures in the Benguela upwelling region. These biases have far-reaching consequences for climate prediction as they go along, among others, with erroneous precipitation patterns.
We used the coupled atmosphere-ocean-sea ice Kiel Climate Model (KCM) to conduct experiments with varying atmosphere model resolutions, while keeping the ocean component unchanged. Atmosphere model resolution has been increased not only in the horizontal (from T42 to T159), but also in the vertical (from L31 to L62).
We show that the TA SST bias can be largely reduced by increasing both the atmospheric horizontal and vertical resolution. In particular, the zonal SST gradient along the equator is simulated with the correct sign. At high horizontal resolution, enhanced vertical resolution is indispensable to substantially improve the simulation of TA SST by enhancing the surface wind stress. This also reduces biases in the upper ocean thermal structure and precipitation. A major step forward is a more northward position of the Intertropical Convergence Zone.
Although enhanced horizontal resolution alone leads to some improvement in the mean climate, typical bias patterns, characterized by a reversed zonal SST gradient at the equator and too warm SST along the Benguela Coast, remain.
Notable changes in the pattern of interannual SST variability occur with increased resolution. Seasonal phase locking is captured only at high vertical resolution, although a phase lag of 2 months still exists.
Our study highlights the importance of sufficiently high atmospheric model resolution and, equally important, a consistent choice of horizontal and vertical model resolution.