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Impact of changes in atmospheric and ocean model resolution on modes of variability in historical coupled model simulations

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We use historical simulations from coupled general circulation models (GCMs) participating in the EU H2020 project PRIMAVERA, to assess the impact of changes in ocean and atmospheric model resolution on different coupled modes of variability. In an inter-model comparison across different atmospheric and ocean model resolutions, we analyse differences on the representation of spatial patterns, intensities and frequencies of El Nino Southern Oscillation (ENSO), the Atlantic Multidecadal Oscillation (AMO), the Pacific Decadal Oscillation (PDO), the North Atlantic Oscillation (NAO) and the Pacific North America pattern (PNA) compared with observations and reanalysis.
Regarding the ENSO spatial pattern, we found that with higher ocean or atmospheric model resolution the GCMs tend to show warmer Sea Surface Anomalies (SST) in the eastern equatorial Pacific. However, we did not find a clear improvement on the ENSO cycle, and on the ENSO power spectra with increased resolution. SST anomalies related to PDO are in general underestimated by all GCMs and there is no clear improvement with increased model resolution. In contrast, with increased resolution most of the GCMs show an improvement of the AMO related SST pattern, with some biases over the north Atlantic.
The atmospheric response to ENSO tends to be weaker in all GCMs compared to the reanalysis, showing a systematic weaker Aleutian low response to ENSO with increased model resolution. However most of the GCMs show an improvement in the precipitation anomalies related to ENSO with increased resolution, particularly over North America. Weaker sea level pressure anomalies associated to NAO and PNA are found systematically across models with increased resolution, only NAO (as ENSO) shows an improved representation of its associated precipitation with increased resolution.