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# Influence of external climate forcing on coastal major upwelling systems analyzed by IPCC CMIP5 MPI-ESM climate simulations -past and future

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Eastern Boundary Upwelling Systems, together with the Arabian Sea, are highly productive coastal ocean areas where nutrient rich, cold water upwells by the action of favorable winds. Observations over the 20th century and ocean sediment records have been interpreted as indicative of upwelling intensification due to stronger external climate forcing, such as increasing greenhouse gas concentrations or changes in solar irradiance. However, recent climate model studies on past and projected changes to coastal upwelling show inconsistencies in results, yielding to a debate regarding the impact of climate change on coastal upwelling.

Here, we analyze the variability and trends of upwelling in ensemble of simulations with the global climate model MPI-ESM covering the past millennium, the last 150 years and the next 100 years. The future simulations were driven by three IPCC scenarios of concentrations of anthropogenic greenhouse gases, RCP2.5, RCP4.5 and RCP 8.5.

For the past millennium and the last 150 years, coastal upwelling does not show any imprint of external forcing, with the exception of the Arabian Sea which shows the influence of orbital forcing on millennial timescales. This result undermines the connection between upwelling and external forcing that has been claimed to explain observed trends in upwelling systems, and strongly suggests that chaotic internal variability will dominate upwelling intensity in major upwelling regions over the next few decades.

For the 21st century, the analysis was limited to the Benguela upwelling system. Here, all ensemble members show a consistent intensification of upwelling in the strongest scenario RCP8.5. Weaker scenarios do not produce consistent long-term trends that are replicated in all ensemble members.

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