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Atmosphere - Ocean interactions: The effect of mountain uplift on eastern boundary currents and upwelling systems

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All major eastern boundary upwelling systems are driven by low-level atmospheric jets that are strengthened by the presence of coastal mountains and have likely intensified during the Miocene/Pliocene. Model simulations demonstrated that Benguela upwelling intensified due to African uplift (Jung et al., 2014). Here we perform simulations, using the Community Climate System Model Version 3 (resolution: T85 (atmosphere)/$\sim$1° (ocean)), to compare those results with California and Humboldt upwelling responses to uplift of the North American Cordillera and the Andes, respectively.
The model results demonstrate that mountain uplift is important for upper-ocean temperature of all eastern boundary upwelling systems. The California upwelling zone shows, as the Benguela region, a strengthening of the low-level coastal jet, and an intensification of oceanic upwelling due to mountain uplift. The extended upper ocean cooling of over 2°C instead seems also to be related to horizontal heat advection and cloud-radiative feedbacks. Peru upwelling shows a weakening of Ekman pumping velocities of around 25% despite an observed cooling (up to 1.5°C) of sea surface temperature. In the Chile upwelling zone, a strengthening of coastal jet and Ekman pumping is accompanied by upper-ocean warming ($\sim$2°C). These two counterintuitive findings can mainly be explained by wind-driven oceanic horizontal heat advection, cloud-radiative feedback processes and changes in surface heat fluxes.
The weight of the different feedbacks/mechanisms depends on the region (e.g. mountain elevation, ocean stratification), but might be also influenced by model resolution (e.g. underestimation of upwelling intensity).

Reference:

Jung, G., Prange, M., & Schulz, M. (2014). Uplift of Africa as a potential cause for Neogene intensification of the Benguela upwelling system. Nature Geoscience, 7(10), 741-747.