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Mechanisms of decadal sea level variability in the Eastern North Atlantic and the Mediterranean Sea

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Understanding the forcing mechanisms of the decadal variability in sea level measurements from tide gauges is critical to understand whether the significant upturn in the rate of global mean sea level rise since 1993 is unique, or whether it reflects a natural climate variation. Here we relate decadal sea level variations in the Mediterranean Sea and the European Atlantic coasts during the second half of the 20th century to large-scale atmospheric forcing in the North Atlantic. We find that during periods of low sea level at the tide gauge sites, there is a much larger region of negative wind stress curl (WSC) that extends all the way to the eastern boundary of the North Atlantic. To explore the mechanisms of the wind forcing, we use a simple baroclinic Rossby wave model forced by only wind stress to simulate sea level changes throughout the basin, and find that much of the observed decadal variability can be explained. The model shows that low values of sea level at the eastern boundary of the North Atlantic coincide with increased zonal sea level gradients at the latitudes of the tide gauges, which reflects the geostrophic balance due to intensification of the southward transport associated with an expansion of the sub-polar gyre. When the region of negative WSC is reduced, the gyre shrinks, southward transport on the eastern side is reduced, and the sea level in the Mediterranean and European Atlantic coast increases to maintain geostrophic balance.