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Rapid 20^{th} century cooling in a northwest African alkenone-SST record

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Coastal upwelling areas are important for biological productivity and are of economic significance due to the large commercial fisheries in these regions. There is some evidence that upwelling is being impacted by increases in greenhouse gases. through changes in land-sea temperature gradients increasing the strength of upwelling-favourable, alongshore winds. However, with most evidence based on short instrumental records and very few long, high-resolution records from upwelling regions it is difficult to assess the extent of this trend, and the likely impact of further increases in atmospheric CO_2. This study investigates upwelling variability off the Moroccan coast, in the heart of the Cape Ghir upwelling system, using the alkenone sea surface temperature (SST) proxy, measured in samples from near-decadal resolution sediment cores spanning 2500 years BP through to the 1990s. The most recent part of the two alkenone records overlap with the instrumental period for the last 100 years, and, taken together, they show a steady cooling trend of approximately 1.2˚C over this time. This result is consistent with wind-stress observations for the latter part of the 20^{th} century that show pronounced upwelling intensification in the Canary Current region. The last 100 years of the GeoB6008 alkenone records, when viewed in the context of the gravity core record for the last 2.5 millennia, shows that the strong decrease in SST observed for the last century is larger and more rapid than any other change seen in the entire record. The alkenone SST records are anti-phased compared to Northern Hemisphere temperature reconstructions for the last 2000 years. This suggests that the forcing factors for the Northern Hemisphere temperature anomalies affect winds controlling NW African upwelling. For the 20^{th} century, we hypothesise that the cool-

ing trend in the alkenone SST record could be due to anomalous CO_2 warming of the northwest African landmass relative to the ocean causing changes in land-sea pressure gradient that control upwelling-favourable alongshore winds. Prior to the 20^{th} century, with minimal CO_2 forcing, we propose that changes to the strength and/or direction Azores High-related alongshore winds could be responsible for the anti-phasing.