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Mechanisms driving seawater pCO2 spatiotemporal variability in the Canary-Iberian Upwelling System

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Upwelling systems are very productive regions of the ocean that strongly contribute to the local economies holding very different fisheries. These dynamic systems are characterized by a high degree of spatial and temporal variability of biogeochemical properties, including carbon, which is generally poorly represented in coarse-resolution global models. The importance of the marine carbon system characterizing these systems has been demonstrated in different regions from multiple perspectives. For the first time, we evaluate the drivers of the spatiotemporal variability of the seawater partial pressure of CO_2 (pCO_2) in the Canary-Iberian Upwelling System (25.5-45ºN, 5.5-20.5ºW) to better understand the inorganic carbon cycle in this highly-productive upwelling region. To do so, we first coupled a regional high-resolution ocean circulation model CROCO with the ocean biogeochemical model PISCES and run a climatological simulation. A first-order Taylor expansion was applied over this simulation to compute the contribution of four variables to the pCO_2 spatiotemporal variability: salinity-normalized dissolved inorganic carbon (sC_T), salinity-normalized total alkalinity (sA_T), temperature (T) and freshwater fluxes (FW). Modeled pCO_2 is in agreement with that of recent data-based monthly climatologies (open ocean RMSE: 5.2-10.8 µatm; coastal ocean RMSE: 7.9-18.7 µatm), measured data from the Surface Ocean CO_2 Atlas (SOCAT) (RMSE: 6.6-13.9 µatm) and computed pCO_2 from measured A_T and pH at the European Station for Time series in the Ocean Canary islands (ESTOC) (RMSE: 5.1 µatm). The spatial distribution of the pCO_2 anomalies relative to the domain mean shows two different areas with opposite anomalies: positive anomalies around the coast in the entire domain and in open ocean south of 33ºN and negative anomalies in open ocean north of 33ºN. This pattern is mainly driven by the contribution of the T component and a minor influence of sA_T and FW, with the sC_T component largely counteracting the effects of the other drivers but contributing to the positive anomaly along the Iberian coast. The seasonal variability is controlled by T and sC_T, with a minor influence of sA_T and a negligible importance of FW. The seasonal cycle shows a direct covariation between the T contribution and the δpCO2 (monthly mean minus annual mean of pCO_2) and an inverse covariation between the sC_T contribution and the δpCO_2 that counteracts the effect of T in the δpCO_2 amplitude. A decrease in the δpCO_2 amplitude was found from open ocean (depths > 200m) to coastal ocean (depths < 200m) determined mainly by a decrease in the influence of the T driver and, less significant, also by a reduction of the sC_T contribution. The general agreement

between modeled and observed contributions to pCO_2 variability at the ESTOC time-series station, in terms of both phase and amplitude, lends credibility to our deconvolution and model, which has been applied across the Canary-Iberian Upwelling System, to assess the processes behind the spatiotemporal variability of pCO_2.