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TIDE AND WIND COUPLING IN A SEMIENCLOSED BAY DRIVEN BY COASTAL UPWELLING

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Abstract: The Ría de Vigo is a semi-enclosed bay in which tidal residual currents are associated with coastal upwelling events. Both upwelling and downwelling favourable winds generate a bidirectional exchange flow with the shelf – a two-layer circulation with surface waters leaving (entering) the ria and a compensating inflow (outflow) through the bottom layer under upwelling (downwelling) conditions. This vertical circulation changes the vertical density structure inside the ria. In the ria, the tide is mainly semidiurnal (M_2, S_2 and K_2), with some energy in the diurnal band (K_1). Our velocity observations show that the vertical structure of the tidal currents in the ria do not exhibit a classic barotropic profile with a bottom boundary layer beneath uniform "free-stream" flow as the tidal bottom boundary layer is affected by stratification. This links tidal circulation to the wind-driven residual circulation, since the latter also greatly helps to control the stratification. We quantify this effect by fitting tidal ellipses to observed velocities through the water column. In addition to this indirect coupling through stratification, there is a direct interaction in which velocities in the upper and bottom layers are best correlated with winds while the mid-water velocities are best correlated with tides. These wind-tide interactions are expected to play a key role in the resuspension and transport of nutrients and phytoplankton in the Ria.

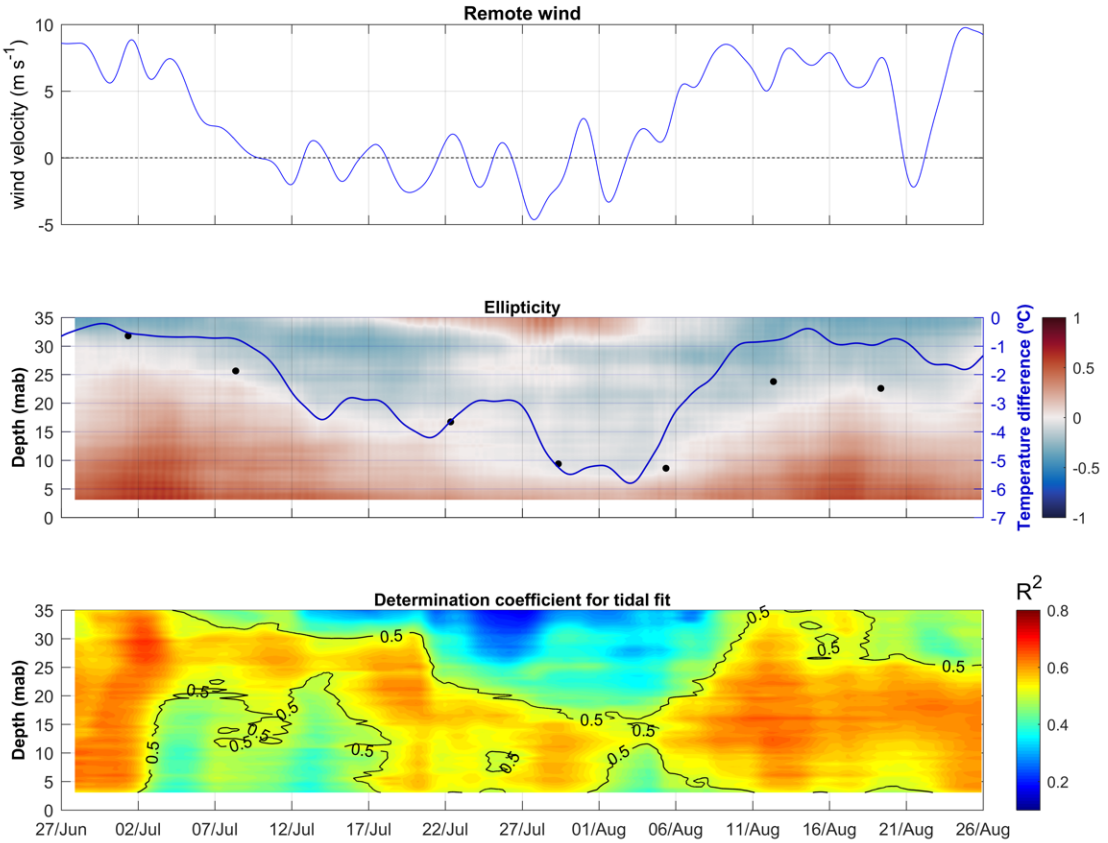

Figure 1. a) Main direction, 193° (east of north), component of the subtidal-filtered remote wind recorded at Silleiro Buoy (Puertos del Estado). b) Filled contour plot with the time demodulated ellipticity calculated applying T_Tide layer by layer in running windows of 15 days to ADCP currents recorded in the middle of the Ría de Vigo, the blue line is the subtidal-filtered vertical difference of two StarOddi temperature loggers (1.5 mab – 32 mab), the vertical position of the base of the pycnocline was calculated for selected days with INTECMAR-CTD casts taken nearby the ADCP mooring and have been placed as black solid circles on top of the plot. c) Filled contour plot for the R^2 of the ADCP velocity tidal fits (T_Tide) with the same time-window demodulation as in b).

Key words: Upwelling bay, Wind Currents, Tidal Currents, Stratification, Coastal Upwelling

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