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Wind-driven currents and sea-level variability of the northwest European shelf

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The shelf northwest of Europe is home to subinertial fluctuations in sea level, whose peak-to-peak amplitude reach several tens of centimetres. These weekly-to-monthly shelf-wide sea-level variations feature at the coast, and therefore understanding their drivers is of prime importance for coastal adaptation. These sea-level changes have been previously hypothesized to reflect the strength of the European slope current (Chafik et al., 2017), a wind and density driven quasi-barotropic circulation lying in the region of the 500 to 1000 m isobaths (Huthnance & Gould, 1989). This interpretation has however not yet been validated by in-situ observations.

Using data from single-point current-meters and acoustic Doppler current profilers moored west of France, Ireland and Scotland, we show that the common mode of northwest European sea-level changes covaries with along-isobath currents on the shelf and on the upper part of the slope (< 400 m of water depth). However, the pattern of variability is different in the slope current and further off-shelf, , with the correlations between shelf sea levels and in-situ currents decreasing moving down-slope (> 400m of water depth). We discuss whether or not the relationship between European sea levels and shelf and slope currents emerges from momentum balance associated with the slope current existence (joint effect of winds, baroclinicity and bathymetry). We also discuss the relevance for coastal sea levels and associated coastal vulnerability.

Chafik, L., Nilsen, J. E. Ø., & Dangendorf, S. (2017). Impact of North Atlantic teleconnection patterns on Northern European sea level. Journal of Marine Science and Engineering, 5(3), 43.

Huthnance, J. M., & Gould, W. J. (1989). On the northeast Atlantic slope current. In Poleward flows along eastern ocean boundaries (pp. 76-81). Springer, New York, NY.