Superstatistical analysis of sea surface currents in the Gulf of Trieste, measured by HF Radar, and its relation to wind regimes

Sofia Flora1,2,3, Laura Ursella1, and Achim Wirth3
1Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS, Italy (sflora@ogs.it)
2University of Trieste, Dipartimento di Matematica e Geoscienze, Trieste, Italy
3Univ. Grenoble Alpes, CNRS, Grenoble INP, LEGI, 38000 Grenoble, France

In this study, two years (2021-2022) of High Frequency Radar (HFR) sea surface current data (30 min time resolution) and modelled near-bottom wind data (1 h time resolution) in the Gulf of Trieste (Northern Adriatic Sea) are analysed through a superstatistical (a superposition of different statistics) approach.

Three distinct main wind forcing regimes are present in the Gulf of Trieste: Bora, Sirocco and low wind. Bora and Sirocco are strong winds whose characteristics are different: the Bora is a cold wind that blows in gusts from the East-North-East with a short fetch, the Sirocco is a warm wind that blows from the South with a fetch along the entire Adriatic.

The currents in the Gulf of Trieste are forced and highly dependent on such variable wind conditions. It results in a succession of different sea current dynamics on different time scales, asking for a superstatistical analysis of the sea surface current data. From the oceanic signal it is possible to extract two different time scales: a relaxation time \( t \), the time the system spends to reach the local equilibrium and a larger timescale \( T \), the time for which the signal is locally gaussian. This permits extracting a slowly varying \( \beta(t) \) strictly connected to the original time series' local variance \( \sigma^2 = \beta^{-1} \). Neither \( \beta \) nor \( \sigma^2 \) show well known PDFs and have algebraic tails. Contrary to what one might expect, they show a universal behaviour with respect to the different wind regimes blowing over the Gulf of Trieste.