A Case Study of Transverse Jets in Coastal Upwellings from a Lagrangian Transport Perspective

NICOLE DELPECHE-ELLMANN[1], TARMO SOOMERE[1]

[1] *Laboratory of Waves Engineering, Department of Cybernetics, School of Science, Tallinn University of Technology, Estonia*

Wind-driven coastal upwellings are a common mechanism that are known to bring cooler nutrient laden bottom waters up to the surface layer. This in effect plays a key role in replenishing euphotic zone with nutrients, vertical exchange of water masses and creating of frontal zones. They however can also known to trigger harmful cyanobacterial blooms. In the Baltic Sea upwellings frequently occur during summer and autumn months and due to the prevailing westerly winds this indicates that northern coastal areas are more prone that the southerly. Strong upwellings however can occur near the southern coastal areas and the due to changing wind patterns frequency of upwellings can also be affected. This study presents a case study of the evolution of strong easterly winds that triggered upwellings in the eastern section of the Baltic Sea. Unlike their classical signature of cooler upwelled water hugging the coastline satellite observations show the jets of cooler upwelled waters taking the form of transverse jets that extend dozens of kilometers from the coastline at distinct locations. As a result, two important aspects are examined: (i) quantifying the Lagrangian transport and mixing properties and (ii) determining the source depth of upwelled waters.

The evolution of the upwelling process was monitored using a synergy of data sources (satellite sea surface temperature (SST), in-situ Lagrangian surface drifters, bathymetry data and meteorological and hydrological measurements) along with statistical and mathematical models. Results, show that during the active phase the transverse jets not only transported cooler nutrient laden bottom water to the surface but their presence decreased the average speed of surface currents in surrounding waters. For the relax phase intense mixing occurred and presence of filaments and eddies were observed. These transverse jets were found to favour steeper slopes (>0.0075) and originated from intermediate water masses rather than the bottom layer. In these intermediate water masses phosphorous nutrients was most likely to originate and an excess of phosphorus is often also one of the major sources for the formation of cyanobacteria blooms.

The changing wind patterns of the region may affect the intensity and duration of upwellings and this may significantly affect the ecosystem by shift of the feeding area of fish and associated wildlife and the occurrences of cyanobacterial blooms.