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Examining the role of bottom topography on coastal upwelling jets using a synergy of in-situ, satellite and model data in the Gulf of Finland, Baltic Sea

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This study examines the role of the nearshore bottom slope on the generation of cross-shore upwelling jets near the southern Gulf of Finland, Baltic Sea. Unlike classical upwelling jets that usually hugs the coastline in a longitudinal direction, these coastal jets during a mid-phase of the upwelling event instead takes the form of transverse jets that extend dozens of kilometers from the coastline at distinct locations. Interestingly these transverse jets act not only as transporters of cooler nutrient laden bottom water to the surface layer but their presence supersedes the classic Ekman-type drift of the surface layer and in effect slowed down the average speed of surface currents in the surrounding waters. Thus understanding the possible trigger of these jets with respect to their location and formation plays an important role in the transport and mixing properties of nutrients and heat and their possible link to the onset of cyanobacteria blooms of the study area.

To accomplish this, we employ a synergy of various data sets that includes high resolution bathymetry data, satellite derived sea surface temperature data (SST, obtained from the MODIS Aqua satellite), in-situ data (surface current drifters, properties of water masses at sampling stations, hydrodynamic model data along with the TRACMASS Lagrangian trajectory model (that models the pathways of the water particles during the upwelling event). Using statistical techniques and a simple mathematical model, a method is derived the quantify the role of the bottom slope and the possible source of the cooler upwelled waters (intermediate or deeper layers). Results indicate that the cross-shore jets originate from shore sections with steeper slopes (>0.0075) than in the rest of the study area. Thus indicating that the steep bottom slopes plays a contributing role in the development of the transverse jets. In addition, results of the mathematical models and in-situ data confirm that the cooler water most likely originates from intermediate water masses at depths between 15–30 m. The Lagrangian pathways during the upwelling event also show reasonable comparison. Thus a synergy of different data sets and methods have allowed a more detailed understanding of the dynamics and pathways during the upwelling event. To our knowledge, this is the first detailed co-examination of the dynamics of an upwelling using satellite SST information together with high-resolution bathymetry and in-situ drifters complimented by a Lagrangian trajectory model in the Gulf of Finland.