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Surface circulation patterns in the Gulf of California derived from MODIS Aqua 250 m

G. Martínez-Flores (1), F. Salinas-González (1), G. Gutiérrez de Velasco-Sanromán (2), and L. Godínez-Orta (1)

(1) Interdisciplinary Research Center of Marine Science, National Polytechnic Institute, La Paz, BCS, Mexico (gmflores@ipn.mx, 6121225322), (2) Ensenada Center for Higher Education Scientific Research , La Paz, BCS, Mexico (ggutierr@cicese.mx, 6121213031)

The Gulf of California (GC) is a marginal elongated and semi-enclosed sea located at northwest of Mexico, between the Peninsula of Baja California and the mainland Mexico. The considered area average 150 km in width and 1500 km in length, from the mouth of the Colorado River to Cabo Corrientes, Jalisco. It has a maximum depth of 3600 m at the southern inlet and the northern region average 200 m in deep. The study of superficial circulation patterns in the GC is of interest because its relevance to the mechanisms of transport for distribution of a variety of materials -plankton, contaminants, microalgae, etc.- and its association with areas of sedimentary deposits, zones where there is a higher probability for fishing or related to the presence of certain species of marine life. Recent studies explain the circulation of the GC as a result of the Pacific Ocean's forcing, wind, heat fluxes on the sea surface and the interaction between the flow produced by these agents and bathymetry. The objective of this work was to obtain evidence of the patterns of surface circulation using a spatial resolution of 250 m over a period of two to seven days (depending on cloud cover), which offered images from the MODIS Level 1B. This essay is an attempt to contribute with more information to the understanding of the regional dynamics of the GC and its local influence on the zones bordering the coast. Thus, MODIS Aqua 250 m data was used, to which algorithms were applied in order to enhance the contrast of reflectance levels of these bands (0.620-0.670 and 0.841-0.876 μm) within the marine environment. The results are associated with suspended particulate matter (SPM), which we used as tracers of the surface circulation, using a sequence of images from January 2004 to December 2008. Algorithms for dust and cloud detection were used and incorporated with thermal band images, in which zones of terrigenous contribution by eolian transport were identified.
Furthermore, pluvial precipitation data were analyzed in the drainage area of the GC to consider the potential fluvial sedimentary contribution. The precipitation data was obtained from the TRMM (Tropical Rain Measuring Mission) satellite, and the digital elevation model for the drainage area was generated by use of the SRTM (Shuttle Radar Topography Mission) elevation data. Additionally, thematic cartography 1:250000-scale was used to show the relationship between the type and use of land-cover contrasted against the possible types of sediments entering the GC, wherein gradients of fluvial sedimentary contribution were identified. The terrigenous contribution via resuspension, eolic and fluvial discharges from the drainage basin of the GC is such that makes possible to monitor the surface circulation structures using remote sensors by means of the SPM-like tracers, which also allows us to infer transportation vectors and potential end-deposition of particulates. In order to validate the results of the images, the lagrangian trajectory data collected by researches from CICESE (Ensenada Center for Higher Education Scientific Research) was used. This data was collected by means of distributed drifting buoys throughout the GC. In general, the trajectories of the buoys agree with the structures identified by the images, although the images demonstrate transportation flows from the continental coast towards the peninsular one, especially from the mouth of the River Fuerte whose soils are used for agriculture, so that could transport large concentrations of pesticides across the GC. The gyres detected in the northern portion of the GC along with drifting of the buoys, were also examined in the MODIS images, and their spatial resolution showed several small-scale gyres located throughout the coastal region of Baja California.