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Yearly to decennial beach morphodynamics south the Arcachon inlet, France from satellite observations

Aurelie Dehouck (1), Nadia Sénéchal (1), Virginie Lafon (2), Rafael Almar (1), Bruno Castelle (1), and Jean-Marie Froidefond (1)

(1) EPOC, UMR 5805 CNRS, Université de Bordeaux, 33405 Talence cedex, France (a.dehouck@epoc.u-bordeaux1.fr), (2) GEO Transfert, EPOC, UMR 5805 CNRS, Université de Bordeaux, 33405 Talence cedex, France (v.lafon@epoc.u-bordeaux1.fr)

Historical shoreline oscillations along adjacent beaches south the Arcachon tidal inlet (south-west France) have been directly controled by sediment inputs carried through the inlet by the littoral drift. In parallell, field observations aiming at understanding high frequency processes governing short-term beach morphodynamics are conducted on a very few local beach sites, among them the beach of Biscarrosse located 12 km south the inlet where video cameras are implemented. It have been suggested that Biscarrosse Beach was recently affected by nearshore large-scale sandy structures propagating southward and originating from the inlet. But, basic information about the space and time dynamics of these bodies is actually missing. In addition, there is a spatial gap in knowledge concerning the hydro and morphodynamics particularities along the south-Gironde coast, i.e. between the ebb-delta and adjacent beaches which have been subject to intense monitoring and the beach of Biscarrosse. In fact, this is a complex area where beaches are dominated by channeled tidal flows on one hand, while typical swell-dominated beaches extend for several tens of kilometers on the other hand, characterized by rhythmic crescentic outer bar patterns and oblique bar-and-rip inner bar. So, large-scale observations are needed to fill the spatial gap in order to provide a comprehensive understanding of nearshore sandbar morphodynamics.

To achieve this objective, we benefited from satellite remote sensing timeseries that were recently made available by the CNES, the French Space Agency, through the Kalideos database. It encompasses SPOT high resolution (10-m and 20-m pixels) multispectral imagery from 1986 to 2009. The method is based on a semi-empirical algorithm using seawater optical properties to invert satellite reflectance at the sea level into water depth (Lee et al., 1998; Lafon et al., 2002). The algorithm was calibrated with in situ reflectance measurements collected in the nearshore shallow waters off the sandy beaches (Dehouck et al., 2008). Validation showed that the underwater morphology was perfectly reproduced up to 6-7 m deep and retrieved depths were accurate to 0.4 m (Dehouck et al., 2009). Annual bathymetric maps of the area were produced from twelve SPOT scenes spanning from 1997 to 2009 and used to analyze nearshore sandbar evolution. Sandbar morphology is a good proxy of the magnitude of sand supply along the south Gironde coast, with sandbar growth enhancing natural beach protection against severe storm waves, while sandbar deepening/narrowening is more likely conjugated to potential areas of beaches at risk.

From the satellite observation timeseries, we found evidence for :
(1) Repeted events of breaching of the Arguin sandbank causing sandbank disconnection from its main body and their travelling through the southern tidal channel until merging and feeding the Pineau Bank located along the southern coast. The Pineau Bank acts as the main ‘source’ of sediment for the downdrift coast, giving birth to a remarkable alongshore sandbar in 1997 that migrated south by 1400 m a year and then up to 400 m/yr until 2003, and feeding durably the downdrift nearshore sandbars over the period of observation;
(2) an inhibation process causing rhythmic crescentic patterns to only appear at the southern end of the Pineau sandbar where wave-induced circulation patterns can self-organize again properly;
(3) an intriguing event of nearshore sandbar merging during February 2006 storm, leading to a continuous, quasi-rectilinear nearshore sandbar from north to south, this one benefited from a strong littoral drift over the last three years explaining its persistance and growth ;
(4) the presence of two shallow south-propagating sandy bodies almost welded to the beachface, one of them

migrating along Biscarrosse Beach in the video cams field of view between 2007 and 2009, thus only provoking occasional perturbations within outer-bar dynamics.