Remotely Observing River Discharge on Shelf - A Case of Wind-provoked Extrusion of Po Waters

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Remote sensing of marine environment offers unsurpassed opportunity of synoptic and frequent assessment of its various properties. Colour of the sea is unique among them in offering, to remote sensing, information from below the surface. Optical properties of near surface waters could be profoundly changed under the influence of river discharges rich in nutrients and/or loaded with dissolved and suspended material. This makes river discharges particularly suitable for remote detection by optical sensors. The fresh water runoff also supplies low salinity waters whose eventual fate is often, to various degree, influenced by prevailing wind regime. MULLER-KARGER *et al.* (1989), for example, have found that the largescale distribution of pigments in the Caribbean Sea seems to be controlled by wind stress, flux of water through the basin and river discharge; the Orinoco river plume dispersal was found tightly coupled to variation in the wind.

The Northern Adriatic into which the Po River discharges offers a case of pronounced river discharge into shallow, coastal waters. Although not nearly comparable to the rivers of previous example (Amazon and Orinoco) Po does supply the largest discharge into the Adriatic. Within the last decade the area was object of several remote-sensing related studies. These studies often dealt with retrieval algorithm development, but remote sensing was also used to aid oceanographic work. BARALE *et al.* (1986), for example, used a time series of Coastal Zone Colour Scanner (CZCS) scenes for the years 1979 and 1980 to study the surface colour field and circulation patterns on monthly and interannual scales, distinguishing coastal and open sea water masses via different pigment levels. It is interesting to note that, on the considered scales, the authors found the wind ineffective regarding the pigment distribution. CLEMENT *et al.* (1987) reported two types of pigment patterns observed on the Adriatic shelf, suggesting also their seasonal behaviour. One type is elongated, trapped along the Italian coastline, and found in winter, whereas the another is wide, irregularly spreading into the basin interior, and appearing in summer. Studying further this dichotomy STURM *et al.* (1992) have recently shown that the two patterns are not necessarily seasonally restricted, i.e. both may occur in summer and winter.

The case of offshore spreading in winter is the one previously reported by KUZMIC (1991) and further considered in present paper. Namely, in winter, as number of papers confirm, the Northern Adriatic is well mixed along vertical and river-affected waters remain confined to the western Adriatic coast. Apparently, this situation can change if certain conditions are met. In particular, is has been suggested and partially empirically verif ied (see e.g. KUZMIC and ORLIC, 1987) that spatially heterogeneous bura wind, known to blow in the area, spins up a cyclonic gyre which carries upwind (towards northeast) the waters from the southwestern coastal strip. Since that is the area into which the Po waters are discharges the gyre could be a mechanism to extrude the turbid and nutrient-rich waters into the basin interior. In order to explore this hypothesis previously developed hydrodynamical model has been augmented with a simple two-dimensional dispersion model. The extension facilitated comparison of model simulations with the remotely sensed data, avoiding at the same time *ab initio* modelling of the near field interactions. Selected CZCS scenes were processed to yield derived field of pigment concentration as well as total suspended matter. Atmospherically uncorrected fields of composite reflectances (the first three CZCS channels) and histogram equalized original channels were also analysed. Rather imperfect infra-red information in channel 6 was consulted when available. The comparison of model-generated and sensor-collected information suggests that the heterogeneous bura wind is indeed capable of provoking Po-water extrusions into the Northern Adriatic interior.

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X