COASTAL RADARS FOR SURFACE CURRENT MONITORING: THE VENICE AND ISTRIAN COAST EXAMPLES

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1) Shore-based coastal radars have been used since 2001 in the Northern Adriatic Sea area with the aim of studying the evolution of sea surface currents over a variety of temporal and spatial scales. Meaasurements collected with hourly time step over a regular grid provided a detailed comprehension of the coastal circulation in the Venice Littoral area ([1],[2]).

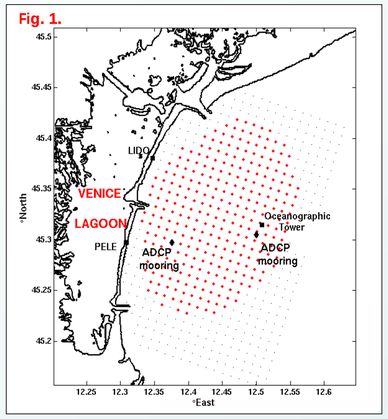


Fig. 1. The study area for the Venice Lagoon area, showing the domain of Coastal Ocean Doppler Radar (Codar) measurements. Squares show the location of the antennas at Lido, Pellestrina and the Oceanographic Tower. Thin black dots show the grid with the three antenna configurations. Red dots represent grid points with 80% data return. Black diamonds show the location of the ADCP currentmeter used for validation of HF surface current measurements.

2) Moored current meter data were used to validate radar measurements ([3],[4]). Typical RMS differences ranged between 8 - 14 cm / s at radial velocity level (correlation .37 to .84), with 1° - 12° errors in bearing angle determination. The average angular offset between surface radar currents and near surface currents was 6°. Large differences between the HF radar and surface ADCP currents can be explained in terms of random errors affecting the measurement technique and "geophysical noise".

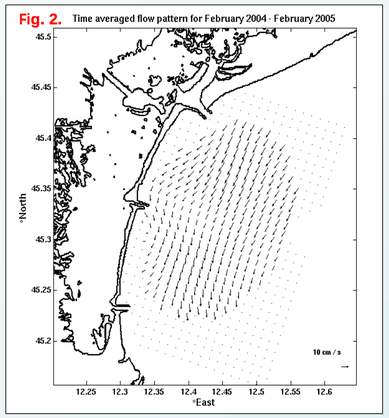
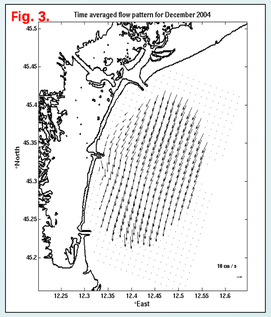
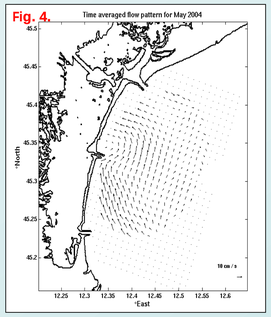


Fig. 2.
Mean circulation pattern in front of the Venice Lagoon area for the period February 2004 - February 2005.

The mean circulation pattern.

The long-term mean flow (Figure 2) is oriented southwestwards, typical magnitudes reaching 10 - 18 cm / s. Meanders and eddy-like structures are found close to the coast, where the coastal currents interact with tidal jets at the Lagoon inlets. Currents follow the Adriatic basin-wide cyclonic circulation pattern at 5-km distance from the coast.





Figg. 3, 4.
Monthly mean circulation pattern in the Venice Littoral area for December 2004 and May 2004, showing inversion from the expected NE-SW circulation scheme.

On a monthly time scale, surface currents track the long-term scheme with intensification related to the meteorological forcing during winter season (Figure 3). Temporary inversion in the circulation pattern is observed during late spring when southerlies were prevalent (Figure 4).

3) Tidal currents in the open sea are weak and contribute less than 20% to total current field variance. Tidal energy is maximum at the Lagoon's inlets and quickly dissipates within 4-5 km range from coast.

Wind Forcing.

Surface circulation patterns in the area are mostly driven by prevalent local and remote wind forcing [5].

A strong southward jet is present in the averaged current field under *Bora* wind regime (Figure 5). A flow reversal in the southern part of the domain occurs with *Scirocco* wind, with a submesoscale dipole-like structure in front of *Malamocco* inlet (Figure 6). A spatially heterogeneous current field with relatively weak currents is present with calm conditions and wind regimes other than *Bora* and *Scirocco.*

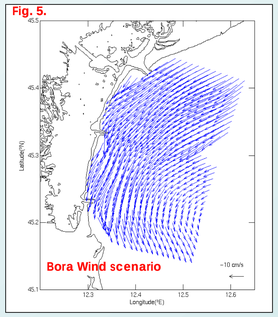


Fig. 5. Long-term circulation forced by *Bora* wind regime (occurrence 17%).
Maximum speed exceeds 30 cm / s

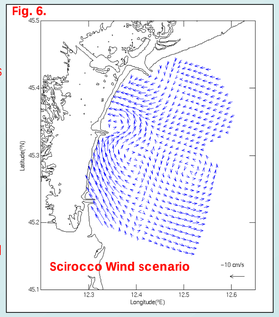
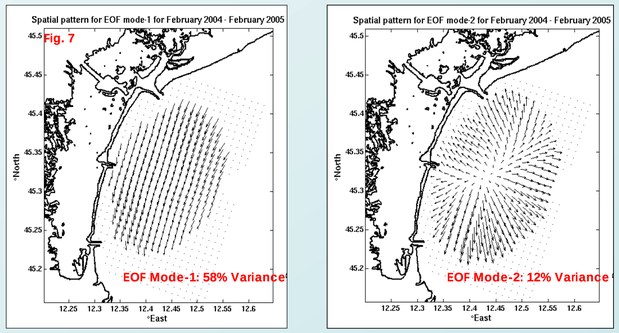


Fig. 6. Long-term circulation forced by *Scirocco* wind regime (occurrence 1%).
Maximum speed ~20 cm / s



4) A modal decomposition, performed on the surface current flow, extracts the dominant modes of variability and their typical time scales (Figure 7).

Mode-1 (58% expl.variance) contains both the tides and the low-frequency, along-shore current variability. Mode-2 (12% expl.variance) has energy in the inertial-to-diurnal frequency band, related to diurnal sea-breeze wind variability. Together with low-energy higher-order modes, Mode-2 contribute explaining the presence of small-scale structures.

Fig. 7. Spatial patterns associated with the first leading EOF mode (Left panel) and the second EOF mode (Right panel).

The NASCUM PROJECT: MONITORING SURFACE CURRENTS IN THE NORTHERN ADRIATIC SEA

A new project started in 2007 for monitoring surface current structures in the Northern Adriatic Sea. A network equipped with 4 standard range High Frequency radars will be monitoring the area along the Istrian and Italian coast for the period 2007-2008.

The project involves OGS in Trieste and CNR-ISMAR in Venice, together with the Institute of Oceanography and Fisheries (IZOR), Split, and the Center for Marine Research (CMR), Rovinj.

To date, three systems are already running and provide unique pictures of the surface flow. An example a snapshot of surface currents showing the complexity of the flow pattern in the area is presented in Figure 8.

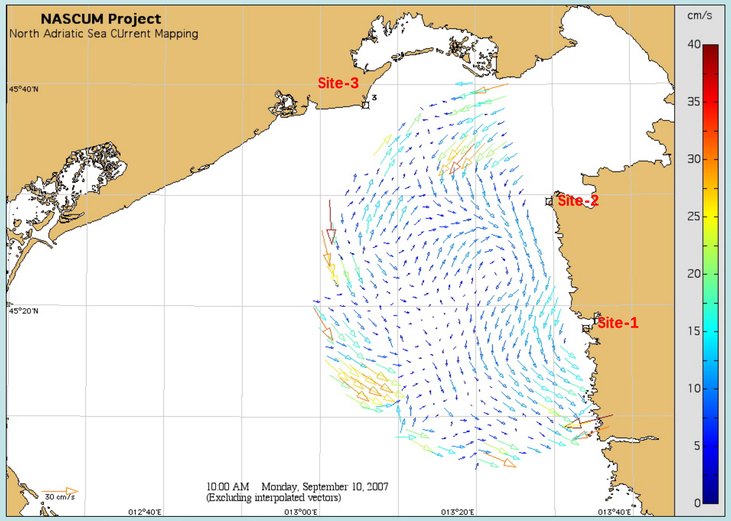


Fig. 8
Snapshot of surface circulation as derived from coastal radars deployed along the Istrian and Italian coastline showing presence of a small-scale (5km radius) eddy in front of Istrian peninsula.

References

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