Use of remote sensing technology and geographic information systems in coastal management

# Sub-mesoscale Eddies Seen By Spaceborne Radar

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It is well known that mesoscale eddies are essential in forming hydrological and biological structures in coastal areas of marine basins. In particular, eddies can cause bimodal current conditions in the coastal zone. At second, they greatly participate in the cross-shelf water transport and thus contribute to coastal water mixing and self-cleaning processes. At third, eddies affect phytoplankton productivity in marine ecosystems. Spiral, or sub-mesoscale, eddies with a diameter less than the baroclinic Rossby radius of deformation (about 20 km for the eastern Mediterranean and Black Sea) are also considered to play a significant role in this respect, though this still needs to be clarified. Despite the fact that spiral eddies on the sea surface were first seen from space more than 40 years ago, there is still a lot of uncertainties concerning their origin, distribution, and lifetime. In the present study, synthetic aperture radar (SAR) imagery was used to derive statistics on spiral eddies in the eastern Mediterranean and Black Seas. Due to their high spatial resolution, their wide swath of observation, and their independence of cloud cover and sunlight conditions, satellite-borne SAR sensors are an effective tool to gain more information on spiral eddies, particularly in coastal waters. It is known that eddies can be seen in SAR imagery due to the accumulation of surface films and due to wave/current interaction. The dataset used consists of more than 1000 medium resolution Envisat ASAR and ERS-2 SAR images obtained in 2009-2011. In order to reveal possible mechanisms of eddy generation, in some particular cases multisensor approach was applied and additional data from satellite radiometers and scatterometers were used. Special attention was paid to generation of eddies in the near-coastal zone. A comprehensive analysis of the eddy occurrence in SAR imagery was performed, thus providing insight into the eddies' spatial and temporal distribution and the eddy 'density', i.e. the number of eddies per square unit. The analyses of the temporal variability of the derived above-mentioned statistical parameters revealed their strong seasonality, whose main reason is suggested to be the seasonal variability of the encountered wind speed. In order to check this hypothesis, wind fields were retrieved from every SAR image, and for every eddy detected the corresponding wind speed was derived. The results obtained are used to define the upper wind speed limit, at which eddies can be seen in SAR imagery, i.e. about 6 m/s for eddies visualized due to surface film accumulations and about 12 m/s for eddies visible as a result of wave/current interaction. These results were used to

improve our eddy statistics. The corrected parameters still show a clear seasonality in the number of eddies visualized by surface films: most eddies were detected during late summer and autumn, which apparently is due to favorite conditions for the generation and visualization of eddies during this period, particularly in coastal areas.