Coherent ocean eddies - a global view

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A brief review is presented of a global census of coherent ocean eddies based on analysis of 18 years of sea-surface height (SSH) fields constructed by merging the measurements from two simultaneously operating altimeters. Eddies with radius scales of O(100 km) are readily apparent in these high-resolution SSH fields. An automated procedure for identifying and tracking mesoscale features based on their SSH signatures yields more than 41,000 eddies with lifetimes of 16 weeks and longer. These long-lived eddies, comprising approximately 1.3 million individual eddy observations, have an average lifetime of 32 weeks and an average propagation distance of 550 km. Their mean amplitude and a speed-based radius scale as defined by the automated procedure are 8 cm and 90 km, respectively. Essentially all of the observed mesoscale features outside of the tropical band 20°S-20°N are nonlinear by the metric U/c, where U is the maximum circum-average geostrophic speed within the eddy interior and c is the translation speed of the eddy. A value of $U/c > 1$ implies that there is trapped fluid within the eddy interior. Many of the extratropical eddies are highly nonlinear, with 48% having $U/c > 5$ and 21% having $U/c > 10$. Even in the tropics, approximately 90% of the observed mesoscale features are nonlinear by this measure. Simple quasigeostrophic models initialized with isolated Gaussian eddy structures and with random fields of Gaussian eddies reproduce quantitative aspects of the propagation characteristics of the tracked eddies and the spatio-temporal variability of the merged altimeter SSH field. Subsurface floats deployed off the west coast of the U.S. show evidence of entrainment into and subsequent trapping by altimeter-tracked eddies, consistent with inferences from the U/c nonlinearity metric. Simple kinematic models are used to infer the likely vertical structure of the presumed regions of trapped fluid in the global eddy field.