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COMPARISON BETWEEN VARIOUS METHODS FOR DETECTING PHASE SPEED OF WAVES IN THE OCEAN USING SATELLITE BORNE ALTIMETER

Abstract

Observations of sea surface height (SSH) fields using satellite borne altimeters were conducted starting in the 1990s in various parts of the world ocean. Analyses of these observations showed a ubiquitous and pronounced westward migration of small amplitude (order of a few centimeters) SSH anomalies (SSHA). These observations were interpreted as a surface manifestation of Rossby waves that propagate westward in the ocean thermocline. The basis for estimating the speed of westward propagation of SSHA is time-longitude (Hovmöller) diagrams of the SSHA field at fixed latitude. In such a diagram the westward propagation is evident from a left-upward tilt of constant SSHA values (i.e., same value contours) and the angle between this tilt and the ordinate is directly proportional to the speed of westward propagation. The common (objective) method for estimating this slope (angle) is the application of Radon transform to the time-longitude diagram, which is a common transform used in image processing for detecting structures on an image. However, this method works (i.e. yields reasonable estimation for the phase speed) only in very particular cases. An alternative method is the application of 2D Fast Fourier Transform (2D FFT) to the time-longitude diagram to yield a frequency-wavenumber diagram and finding its maximum amplitude and this method, too, is not applicable in all cases. We suggest a new algorithm that constitutes an adaptation of Radon transform to cases where the sought structures are phase contours. Instead of looking for structures of same value we identify structures of minimal variance in the image. We calculate the variance of SSHA values along a straight line oriented at a specific angle relative to the ordinate and located at some distance from the origin (located at the center of the image). At each angle, we find the mean of the variances along different lines located at different distances from the origin and the angle where the mean of the variances attains its minimum is the most accurate estimate for the angle that characterizes the speed of westward propagation of the contours on the time-longitude diagram. The application of this new algorithm to observations in different latitudes, yields more accurate estimations of the phase speed than the other two prevailing algorithms.