BAROCLINIC INSTABILITIES OF NONZONAL OCEAN CURRENTS WITH APPLICATION TO THE KUROSHIO EXTENSION CURRENT

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ABSTRACT

Using the TRANSPAC XBT data at a depth of 300 m, the regional variability of energy, time scales, length scales, and phase propagation of internal temperature fluctuations in the mid-latitude North Pacific was examined. The results showed that the regional variability in the eastern half of the basin is substantially different from that in the western half.

In the eastern North Pacific, the energy of the internal temperature fluctuations is very low and fairly uniformly distributed. Time and meridional length scales are distributed over broad ranges, zonal length scales are relatively small, and the direction of phase propagation is almost due west. At the eastern boundary, the opposite tendency in time and length scale distribution holds.

In contrast, the energy in the western North Pacific is high, particularly along the main axis of the Kuroshio Extension Current (KEC), and decreases towards the east. It also decreases towards the north and south, with length scales of decay of about 1000 km. Time scales are small near the western boundary and increase eastward. Both zonal and meridional length scales are large near the western boundary and decrease eastward. Phase propagation along the KEC appeared to be eastward, while that in the outer regions north and south of the KEC seemed to be westward with

poleward components to the north and south, respectively.

In an attempt to explain these observed characteristics, three independent studies of baroclinic instabilities of nonzonal currents have been conducted. First, local baroclinic instability of nonzonal currents was explored. It was found that time scales are smaller, length scales are larger, and eastward phase speeds are higher whenever there were larger vertical shears, and/or more meridional orientations of the mean flow and propagating wave, and/or a less stable stratification. Secondly, radiation of energy from a mesoscale disturbance traveling along a nonzonal current was studied to determine the length scale of decay and also to determine any differences in radiation between a zonal and nonzonal flow (cf, Pedlosky, 1977). The results showed that the region in period-wavelength space where radiation occurs is much larger in the nonzonal cases than in the zonal case. Furthermore, in the nonzonal cases, the broad ranges of periods and wavelengths of the disturbance overlap the observed ranges. Lastly, radiating instability of zonal and nonzonal currents was explored, using a more realistic flow structure than was used in the second study. This more elaborate theory extended an earlier analysis of the purely zonal case (Talley, 1982). It was found that the nonzonal cases (30° and 60° mean flows) actually show better agreement with the observations than the zonal case.