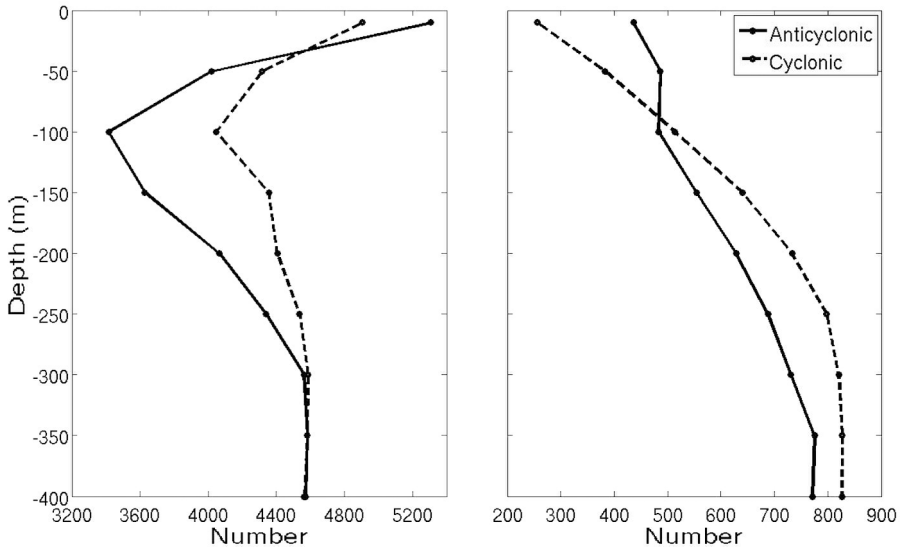

Figure 4. Vertical profiles of the number of eddies generated. (left) Number of eddies with lifetime equal to or longer than 3 days. (right) Number of eddies with lifetime equal to or longer than 20 days.

radius (R_2), and other parameters of the eddy at the level of 50 m are recorded.

[21] 3. Using the eddy center, radius, occurrence time and polarity, we check if there is an eddy with the same polarity and occurrence time at an immediately lower level (100 m) whose center is located within a circular area around the center: the circle's center is $P_2(X_2, Y_2)$ and radius is $R_2/4$.

[22] 4. Then, we repeat the above procedures until we reach the level of 400 m. Then the quantitative features of the eddy can be obtained: centers (P1, P2, …, P9), radius (R1, R2, … R9), and other parameters.

[23] By these procedures a discrete 3-D eddy data set with a vertical resolution of 50 m. Of course, if more vertical levels are extracted, the vertical structure can have a higher resolution.

4. Eddy Statistical Characteristics

4.1. Eddy Number and Lifetime

[24] With the application of the above automated velocity geometry eddy detection to the velocity anomaly fields at the 9 levels, which was introduced in section 2, we develop a 3-dimensional eddy data set in the SCB. It includes eddy location, time, polarity, and boundary at each level. Other eddy parameters, such as relative vorticity, size and lifetime, are also derived. In total, 57062 cyclonic and 46874 anticyclonic eddies are detected at the surface and 61476 cyclonic and 64873 anticyclonic eddies are found at the level of 400 m. The total numbers include repetitive counting of the same eddies through their lifetimes. If we count eddies at each time step of its lifetime as one occurrence, the total numbers of individual eddies are 12240 cyclonic and 12510 anticyclonic eddies at the surface, and 8099 cyclonic and 8049 anticyclonic eddies at the level of 400 m. Considering some uncertainties associated with the eddy detection scheme and sporadic noises in the numerical data, in the following analysis, we only count eddies whose lifetimes are equal to or longer than 3 days. Then there are 5308 cyclonic and 4906 anticyclonic eddies at the surface, and 4573 cyclonic and 4564 anticyclonic eddies at 400 m. There are about 8.0% more cyclonic than anticyclonic eddies at the surface but almost the same number for anticyclonic and cyclonic eddies at 400 m. The greater number of cyclonic eddies at the surface might be due to the prevailing positive wind curl in the area.

[25] The variation of eddy numbers from the surface to 400 m is shown in Figure 4. It indicates that the eddy number does not monotonically decrease or increase but rather has minimum number at 100–200 m where the density stratification is located. Since eddies in their lifetime are counted as one eddy, the eddy number can be used as the eddy generation number. It shows that fewer eddies are generated within the stratification layer than at the surface and even below the stratification. It implies some eddies generated either at the surface or at deep levels cannot penetrate the stratification layer. It should be noted that the vertical profile of the eddy number changes with the criteria of the life time chosen. For example, for eddies whose lifetimes are equal to or longer than 20 days, there are more eddies in deeper ocean, i.e., the eddies generated in the deeper ocean tend to live longer. An eddy's lifetime is defined by the interval between the first and last times when the eddy is detected. To exclude eddies which are advected out of and into the domain, in other words, they are not generated or terminate locally, we do not count eddies first and last found 10 grid points next to the three open boundaries, which is about the length of the mean advection scale for one day (assuming the mean velocity is about 0.1 m/s).

[26] The eddy lifetime variation with the depth is directly confirmed by a figure showing vertical profile of eddy lifetimes in Figure 5. It shows that anticyclonic eddies in the deep ocean live longer than those near the sea surface, but cyclonic eddies display the less difference between the surface and the deep water. This can be explained with the fact that the SCB is located in a positive wind curl area, which favor cyclonic eddies at the surface. To further examine the eddy lifetimes, Figure 6 shows the histogram of eddy lifetimes at four levels. The numbers of both anticyclonic and cyclonic eddies are approximately symmetric in terms of the