**Supplementary material**

**Figure. S1.** Topographic map of the Luzon Strait (LZ) and the South China Sea (SCS) areas with locations where *Prochlorococcus* were observed in the mesopelagic waters (Square) and the locations where solitary waves were monitored year round (Star). Refer to Table 1 for detailed information of the stations.

**Figure. S2.** The sea level anomalies observed by satellite altimeters on April 21, 2010 showing a typical case of meso-scale eddies occurring year-round in the Luzon Strait areas.

**Figure. S3.** Demonstration (cartoon movie) of the vertical transport process of material particles driven by the soliton of March 31, 2010 at the Luzon Strait area (21°00'N, 119°00'E), which is computed as  where z is the time-varied depth of water particle at starting depth Z0, obtained by integrating the vertical velocity w from the initial time to time T. In this model, material particles in the water column from 100 m to 400 m are indicated by a series numbers of 1 to 9 to show the displacements by the soliton.