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Visual Features of the Kuroshio Eddies as Seen in the Infrared Satellite Images from NOAA-6*

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Suda (1936), Uda (1938) and Shoji (1951) have identified possible generation of the mesoscale eddies over the confluence zone of the Kuroshio and the Oyashio. Since then, synoptic descriptions about the Kuroshio eddies have been accumulated after the results of cooperative observations by several research vessels in almost simulteneous scale (Kitano, 1974; Muto et al., 1975; Tomosada, 1975). Meanwhile, the rapid developments of the space oceanography in past twenty years have been disclosed epochal new technique to observe whole feature of mesoscale oceanic eddies almost instantaneously in two dimensional spatial scale. This space survey for the oceanic eddies is especially useful to discuss the shape of eddy and the detailed structure of the boundary layers of the isolated mesoscale eddies in contrast with the surrounding waters, because it completely eliminates difficulties caused by the time lag and spatial discontinuity which are hitherto limited further detailed considerations. Already, Legeckis (1978) and Mizuno et al. (1980) have been presented several infrared satellite pictures on the Kuroshio mesoscale eddies from NOAA series satellites. NOAA-6 is launched in June 1979 as the third generation operational satellite and first NOAA funded operational satellite based on TIROS-N. The NOAA-6 has the principal sensor of AVHRR-advanced very high resolution radiometer. It covers four channels of 0.55-0.70 μm, 0.725 to 1.1μm, 3.55 to 3.93μm and 10.5-11.5μm. The AVHRR is improved over the current VHRR-very high resolution radiometer on the use of digital data and removal of panoramic distortion in the APT-automatic picture transmission mode (Sherman, 1977).

Figure 1 shows the enlargement picture of the infrared image from NOAA-6 on the mesoscale eddies over the confluence zone of the Kuroshio and the Oyashio at May 27, 1980. The darker and the light gray tone express the warm and the cold region, respectively. The most conspicuous feature is the generation of a warm eddy off Kushiro, which is located nearly in lat. 41°-42°N and long. 146°E. The shape of eddy is apparently found as elliptical form with short diameter of 190 km and large diameter of 290 km which means visual evidence on two dimensional spatial scale in the light of instantaneous observations as a whole. The elliptical shape of the mesoscale eddy was already suggested by Koshlyakov et al. (1973) and Kitano (1975) as a result of simultaneous observations by several research vessels. The narrow cold filament characterized by light gray tone is encircled on outside rim of eddy with about 30-40 km width and the warm core is found inside rim of eddy as already indicated by Hata (1974). The rather small scale warm eddy of 70 and 80 km is found in nearly lat. 39°N and long. 142°E. This warm eddy is completely surrounded by the narrow cold filament about 10-20 km in width. Figure 2 shows the enlargement picture of the infrared image of NOAA-6 at June 20, 1980. The warm eddy off Kushiro is still located almost in same site. It does not indicate any conspicuous changes in size and elliptical shape.

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The replenishment of the warm water into the warm eddy is clearly identified as already suggested by Mizuno et al. (1980). Figure 3 shows the enlargement picture of infrared image of mesoscale warm eddy off Kushiro at November 6, 1980 from NOAA-6. In reference to this set of IR images, it is clear that the warm eddy off Kushiro is moved gradually to the northeast as suggested by Hata (1974) and Kitano (1975). The size of the warm eddy considerably diminishes as a whole and the darker tone of the warm eddy is lost to a great extent because of a possible decrease of sea surface temperature.

The most conspicuous visual feature is the double frontal structure at the rim of warm eddy which consists from the encircled detailed structure of the warm core and the cold filament. That is, the double frontal structure consists usually of the cold boundary layer outside of the rim and the warm core inside of the rim. As a result, the warm eddy is totally isolated in the background of light gray tone as a whole. The typical mesoscale warm eddy is also indicated in lat. 38°N and long. 146°E in reference to Figure 3. This warm eddy is characterized by the encircled warm core with darker tone in the boundary layer. The central core of warm eddy is characterized by the rather light gray tone. There is clearly found the intrusion of narrow cold filament. This narrow cold filament is encircled outside rim of warm eddy.

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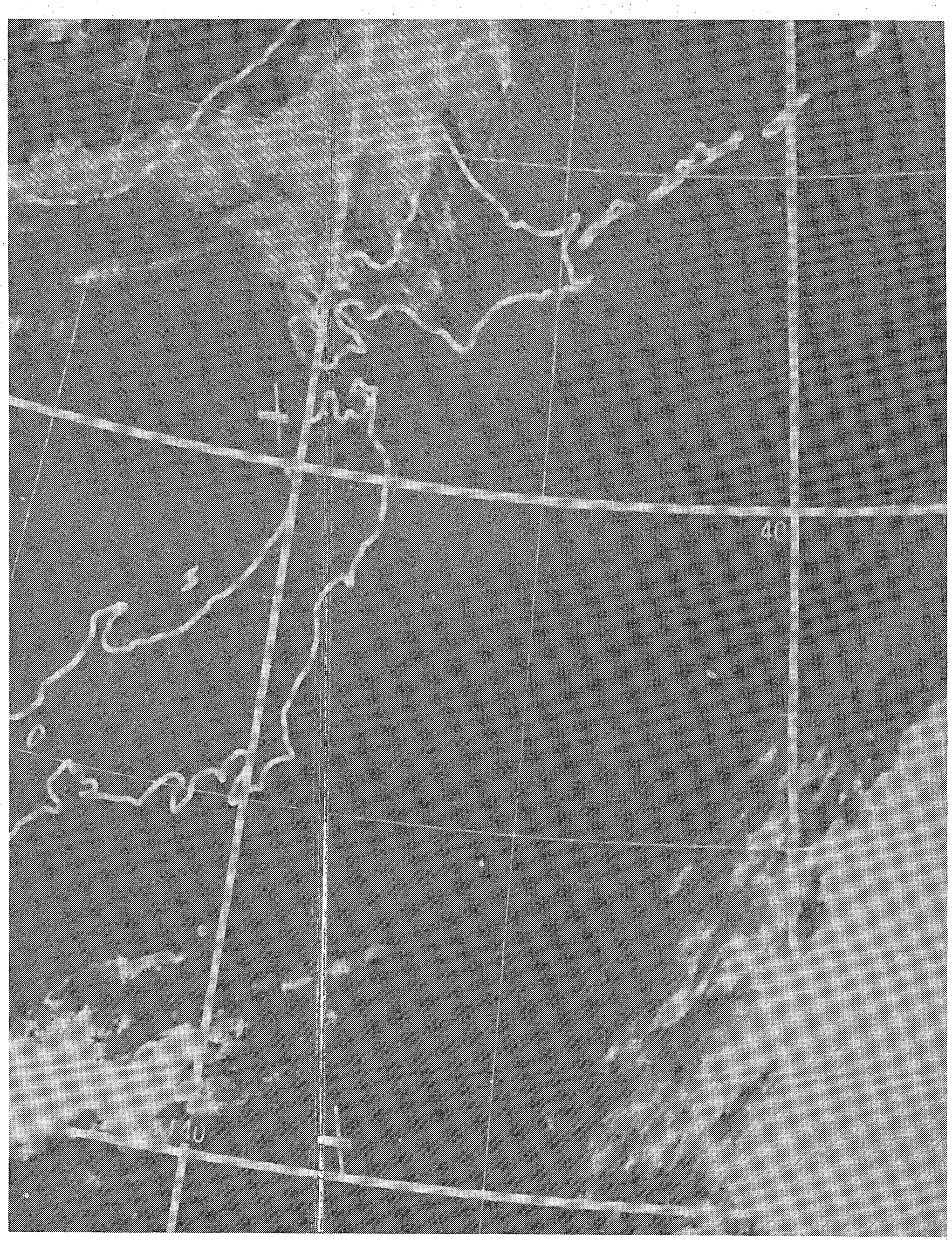

Figure 1. Enlargement picture of IR image for channel 4 from NOAA-6 at May 27, 1980.

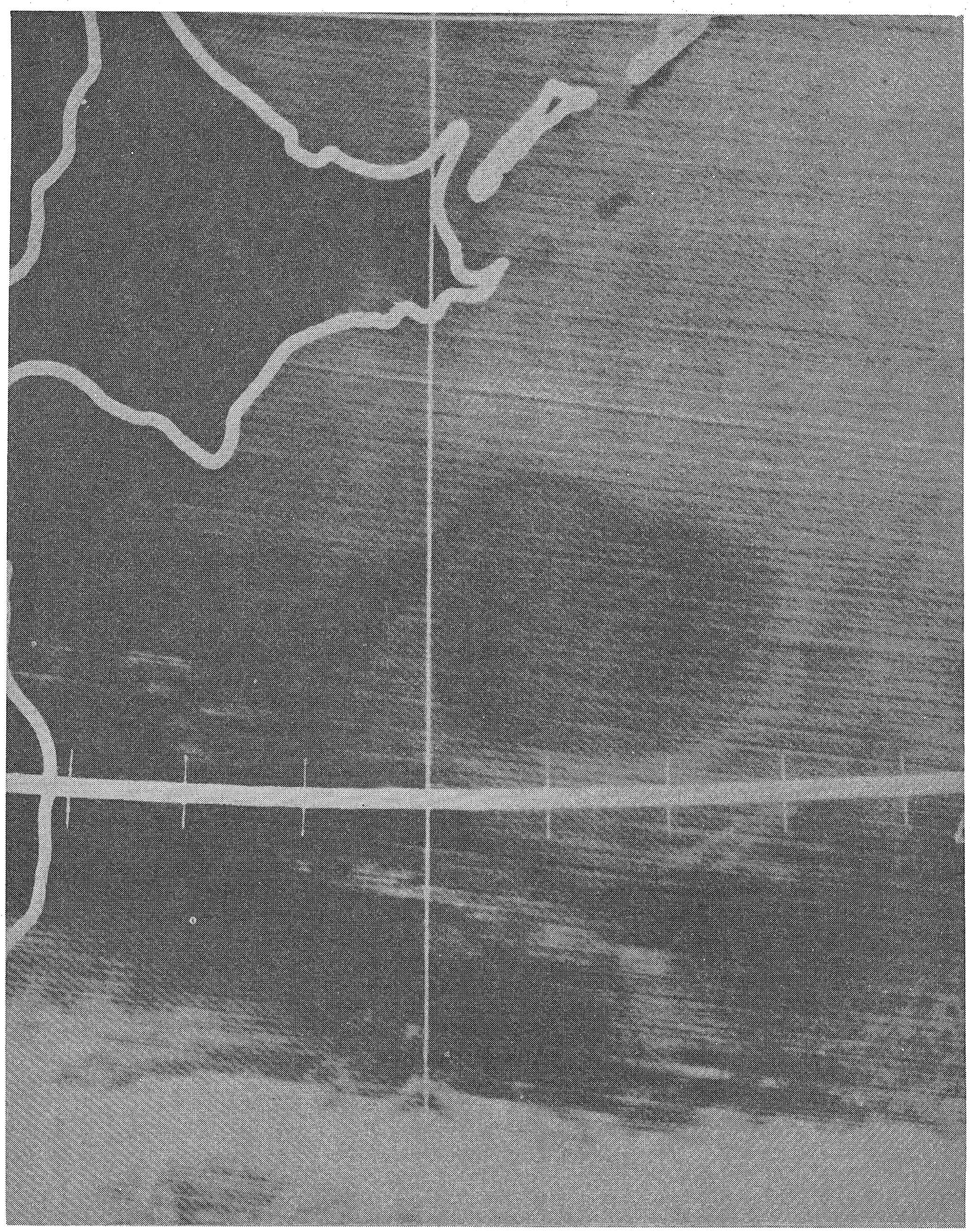

Figure 2. Enlargement picture of IR image for channel 4 from NOAA-6 at June 20, 1980.

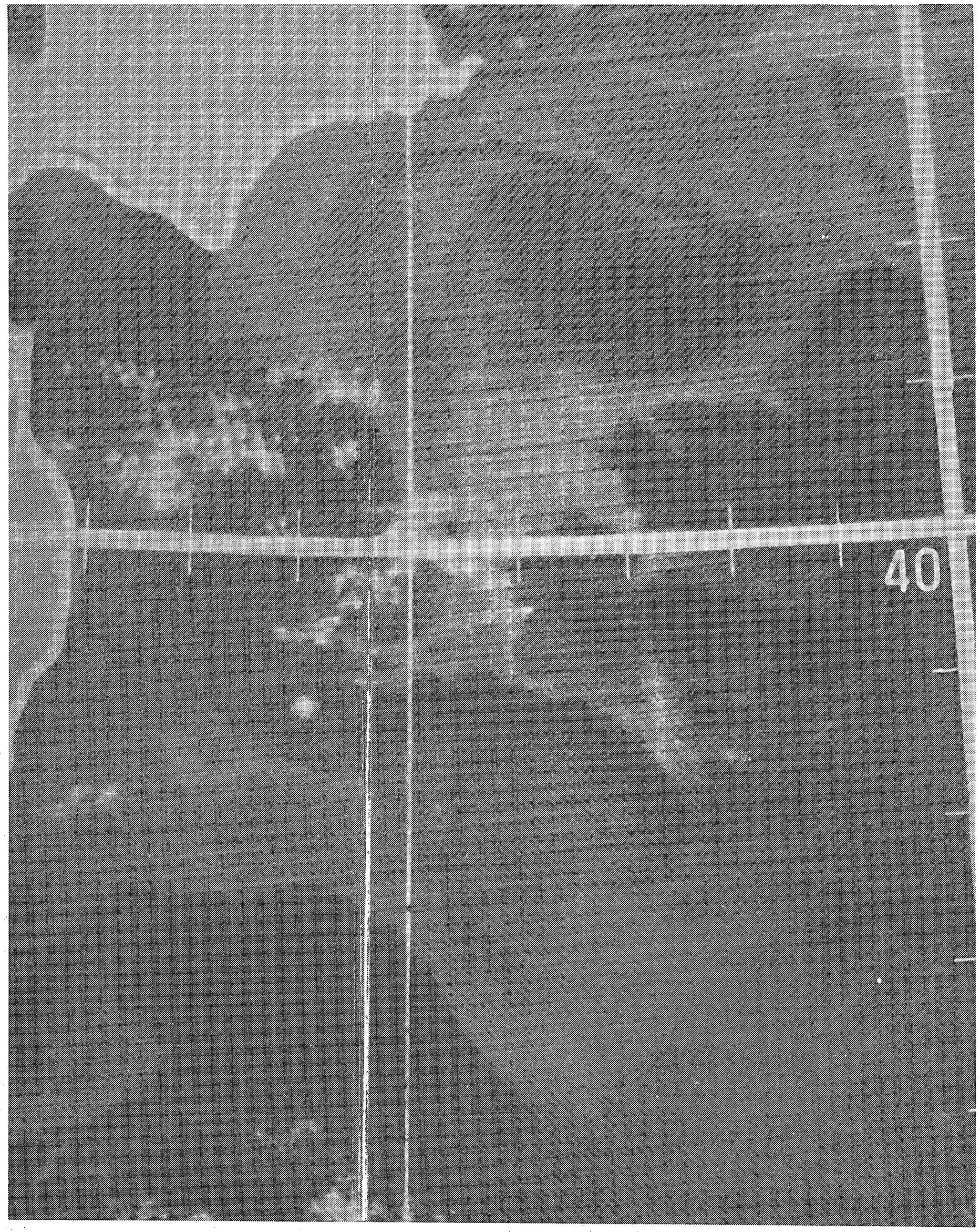

Figure 3. Enlargement picture of IR image for channel 4 from NOAA-6 at November 6, 1980.