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SATELLITE IMAGERY STUDIES

The long-term mean seasonal circulation patterns off southern California have been documented in studies carried out by the California Cooperative Fisheries Investigations over the past 20 years. It is also known that large deviations from the mean pattern are generally present in the form of meanders, gyres, eddies, rings, and vertical motion; although these deviations can be important processes in the exchange of nearshore and offshore water, they have not been extensively studied. We are exploring the possibility of using remote sensing, particularly satellite imaging, to obtain additional information on the surface water circulation within the Southern California Bight.

At the present time, we are using visual and thermal infrared imagery collected by the sun-synchronous, polar-orbiting NOAA series of weather satellites. The thermal imagery reveals the temperature variations in a very thin layer at the oceans surface; however, it may be possible to infer movements within the mixed (upper) layer from these observations (Bernstein et al. 1977).

The imagery is stored on magnetic tape in digital format; the least-count thermal resolution is approximately 0.7 C, and the spatial resolution is about 1 square kilometer. This record is then computer processed ("enhanced") to display the range of thermal values and spatial averaging relevant to a particular investigation. An example of such an enhanced thermal image is shown in Figure 1 (reference points and features of interest are indicated on Figure 2). The imagery was collected on 23 June 1976 by the NOAA-3 satellite. The area shown in the enhancement is cloud-free, except for a small segment at the bottom left corner. Artificial color has been added to represent temperature changes of about 1.4°C.

Several features are evident in this "picture." As we have only examined a few such images at the present time, we can only tentatively suggest possible sources for these features. The southward-flowing, relatively and Santa Cruz Islands into the middle of the Santa Barbara Channel (Feature 2), generating a counter clock-wise gyre in the western half of the channel and a clock-wise gyre in the eastern half. Part of the clockwise gyre appears to flow between Anacapa Island and the Ventura/Oxnard area, mixing with the northward flow of the Southern California Countercurrent at a location south-east of Santa Cruz Island (Feature 3). The countercurrent is deflected westward toward the California Current and eastward toward Santa Monica Bay. At the boundary of the California Current and the Countercurrent, considerable meandering or eddy formation is evident (Feature 4). South of San Nicolas Island, a detached cold water patch can be discerned (Feature 7).

Imagery collected on 1 June indicated warm surface water between and inshore of Santa Catalina and San Clemente Islands. By 23 June, this water had apparently been displaced toward the coast by a colder water intrusion between the two islands (Feature 5). A considerable portion of the coastal surface water had lower temperature than the water 15 to 20 km offshore, suggesting coastal upwelling. This temperature depression appears to be correlated with the coastal contours and bottom topography (e.g., downstream from Palos Verdes Point, Dana Point, and Point Loma), suggesting that the near-coastal surface flow is to the south. Some additional upwelling may also be occurring in the Ventura/Oxnard area—in the 1 June image, this appeared to be an area of warm water.

As additional imagery is collected and analyzed, the sequential development and movement of the thermal patterns can be observed and the validity of these inferences can be tested. From this imagery, we hope to develop a conceptual model of the circulation of the surface water within the Bight and perhaps gain insight into the sources of the long-period fluctuations observed in nearshore shelf current meter records.

REFERENCE

Bernstein, R.L., L. Breaker, and R. Whritner. 1977. California Current eddy formations: Ship, air, and satellite results. Science 195:353-59.

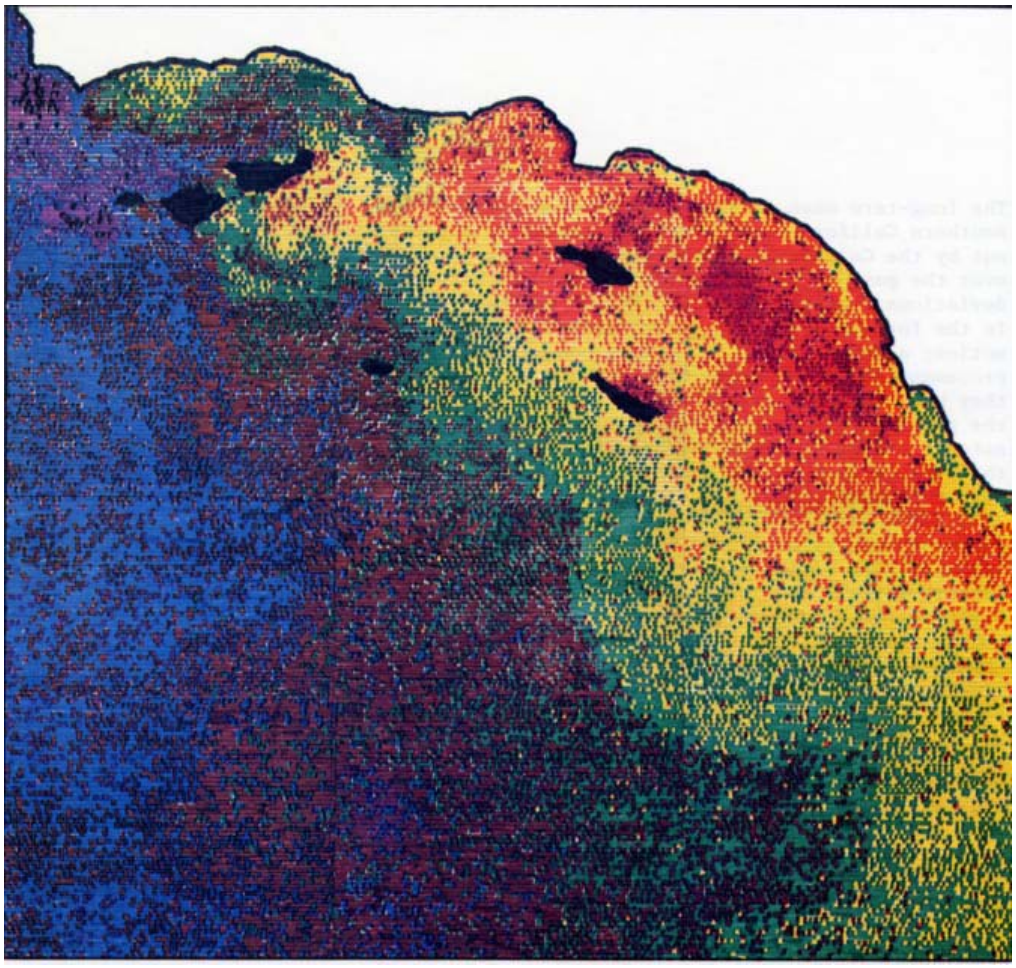

Figure 1. Thermal image of Southern California Bight taken by NOAA-3 satellite, 23 June 1976. Red areas are warmest; orange, yellow, green brown, blue, and violet indicate successive drops in temperature of about 1.4°C (a small area off Point Conception, colored black, is about 1.4° colder than the violet areas).

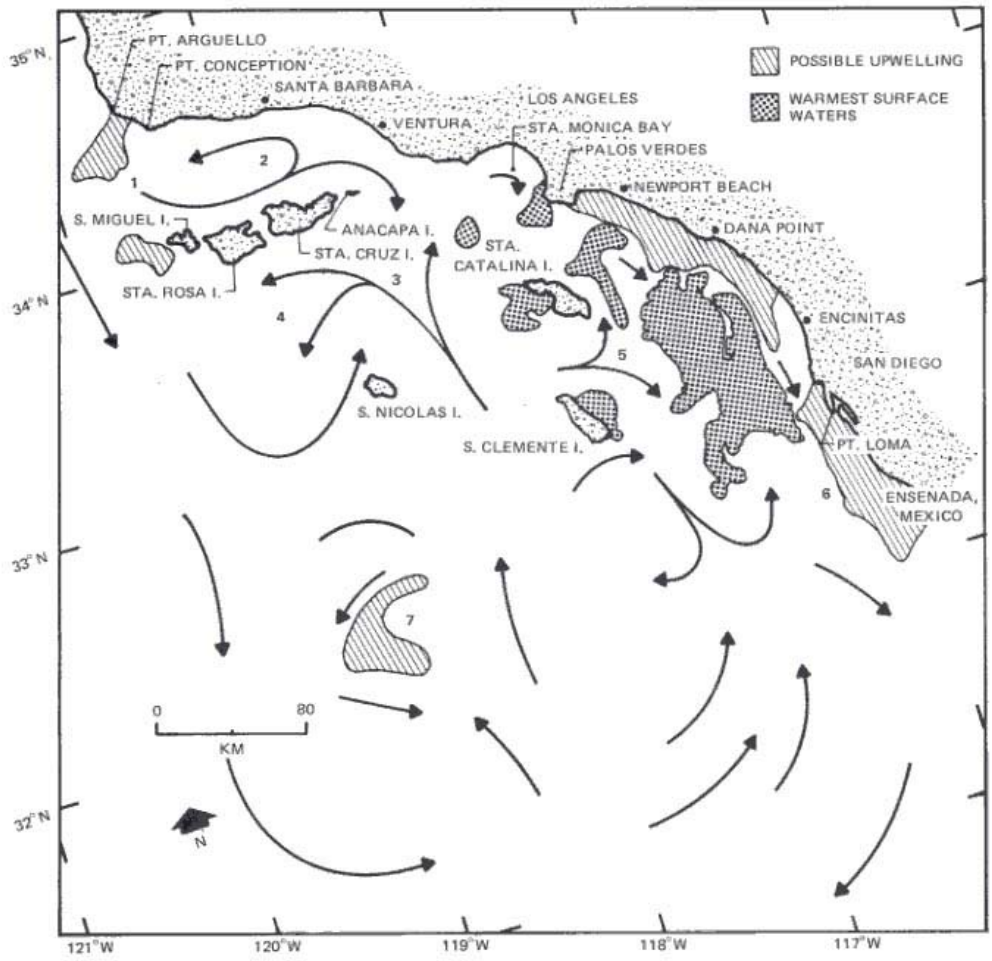

Figure 2. Guide to features on thermal image of Southern California Bight (Figure 1).