

Mariners Weather Log

RADIO FACSIMILE INFORMATION TO THE TROPICAL PACIFIC TUNA FLEET

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Tuna fishermen on the high-seas fishing grounds in the eastern tropical Pacific are wary of the tropical cyclones, the chubascos, and the severe local wind conditions, such as tehuantepecers, which typically occur in the area. Accurate information on the location and intensity of these storms was not always available to the fisherman when needed. In 1970, a program was developed at the National Marine Fisheries Service (NMFS), Southwest Fisheries Center (SWFC), La Jolla, Calif., to provide the tuna fleet with information on weather and fishing conditions on a regular basis, in exchange for environmental data from the fishing grounds. Such data are needed by NMFS scientists for studying the effects of environmental fluctuations on the distribution and availability of tropical tunas, and for developing fishery-forecasting techniques applicable to the management and harvesting of fishery resources. The data are also needed for preparing the fishery advisories; consequently, it is essential that fishermen report their observations in a timely manner.

One obstacle to the recruitment of tuna vessel captains into a real-time environmental observation program was a reluctance to reveal their position to competitors. This obstacle was removed by use of an encoding scheme for transmitting data messages. The Navy's Fleet Numerical Weather Central (FNWC), Monterey, Calif., cooperated in implementing the scheme, whereby each participating vessel is furnished with its own unique encoding chart. The decoding keys are stored in the FNWC computer, which processes the coded messages, feeds the data to the Navy's analysis and predictions programs, and routes the decoded observations back to the SWFC and also to the National Weather Service (NWS) Forecast Office, Redwood City, Calif.

Participating tuna vessels, which numbered more than 70 at the start of the 1975 fishing season, are expected to make and transmit marine surface weather

observations once each day while on the fishing grounds. These include windspeed and direction, air temperature, sea-surface temperature, barometric pressure, weather, cloud cover, swell direction, and wave height. In addition, some 25 vessels are equipped with bathythermograph (XBT) systems with which subsurface temperatures can be measured and recorded. FNWC furnishes some of the XBT systems and the expendable probes through the SWFC to these vessels in exchange for data transmitted in the BATHY message format, which gives temperatures and depths down to 500 m.

In practice, tuna vessels at sea begin transmission of weather and BATHY messages about midafternoon each day, to NMFS-licensed radio station WWD, operated by the Scripps Institution of Oceanography and located at La Jolla, Calif. The messages are relayed via a data line through SWFC to the computer at FNWC, decoded and processed, and sent back to SWFC and to NWS, Redwood City, for use in preparing the daily analyses of wind and sea conditions. The processed BATHY data are also returned to SWFC on punched cards and in reconstructed computer plots of temperature-depth profiles, for research use.

At the time the program was conceived, no tuna vessels carried the special equipment necessary for radio facsimile (FAX) reception. The SWFC procured approximately 60 facsimile recorders from Government surplus and adapted them for use with shipboard radio communications equipment. These recorders were installed on selected San Diego-based tuna boats on an experimental basis beginning in 1971. They proved so valuable that more than a dozen other boats have since purchased their own facsimile recorders in order to receive the advisories.

Station WWD transmits two FAX advisory charts daily, beginning about 2300. One of the charts gives average windspeeds and directions expected during the next 24 hr, the locations and expected movements of

tropical cyclones, areas of squalls, and the configuration of the Intertropical Convergence Zone (ITCZ). Figure 1 shows the wind and weather advisory chart issued on July 16, 1974. The ITCZ was displaced north of its usual location at longitude 110°W (10° to 15°N in July), where tropical storm Francesca was approaching the tip of Baja California. Chubascos are shown near 10°N, 126°W, and 14°N, 117°W, while an incipient cyclonic circulation is indicated near 12°N, 95°W. Such disturbances can intensify suddenly; consequently, adequate forewarning can help boats avoid potentially hazardous situations.

Figure 2 shows the sea-state advisory chart for the same day. Swell directions are indicated by arrows, while predicted swell heights and wave heights are given by the plotted numbers. Sea and swell conditions are particularly important in purse seine operations because they affect deployment and retrieval of the net and safety of the crew.

In addition to the daily wind and weather and sea-state advisories, three charts depicting ocean temperatures are prepared and transmitted weekly by radio facsimile. These are a sea-surface temperature analysis (fig. 3), a mixed-layer depth analysis (fig. 4), and a sea-surface temperature difference analysis, which compares present conditions with those in the corresponding week of the previous year. These charts are prepared in order to provide to the fisherman environmental information which is deemed to be useful, and thereby enlist his cooperation in developing the potential application of such information to fishing

strategy. For example, preliminary studies at the SWFC suggest that the highest frequency of successful sets on yellowfin tuna occurs with sea-surface temperatures of approximately 80° to 83°F (26.7° to 28.3°C). Knowing this, a tuna-boat captain can use the sea-surface temperature charts as an aid in determining where to fish. The mixed-layer depth charts might be used as an aid in judging the probable success of purse seine fishing operations. Shallow mixed-layer depths are believed to favor successful sets, particularly when the vertical temperature gradient just below the bottom of the mixed layer is strong, because the fish are less likely to escape the net if it requires that they swim down through the thermocline into cold water below. The temperature difference charts, along with a fisherman's past experience, can assist him in judging the significance to fishing success of changes in environmental conditions.

Much of the present knowledge of environmental-fishery relationships is qualitative and, to some extent, speculative. The research in progress at the SWFC, based on environmental observations and catch statistics from the fleet, is aimed at defining and quantifying these relationships to a degree that will benefit both the harvesting and management of tuna resources.

The FAX advisory charts are based on environmental observations and analyses from many sources, which include fishing vessels, merchant ships, weather satellites, the FNWC, the National Environmental Satellite Service (NESS), and the NWS. Nevertheless, the eastern tropical Pacific is affected by a chronic

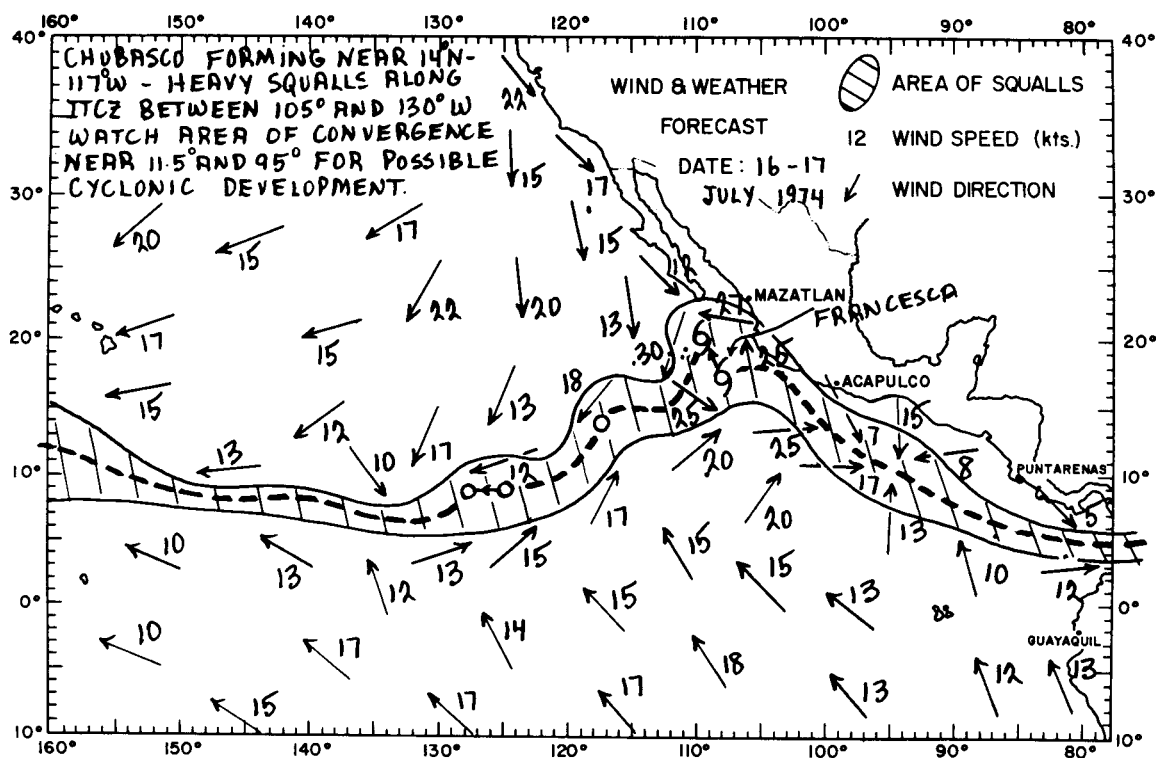


Figure 1. --Wind and weather advisory chart transmitted by radio facsimile on July 16, 1974.

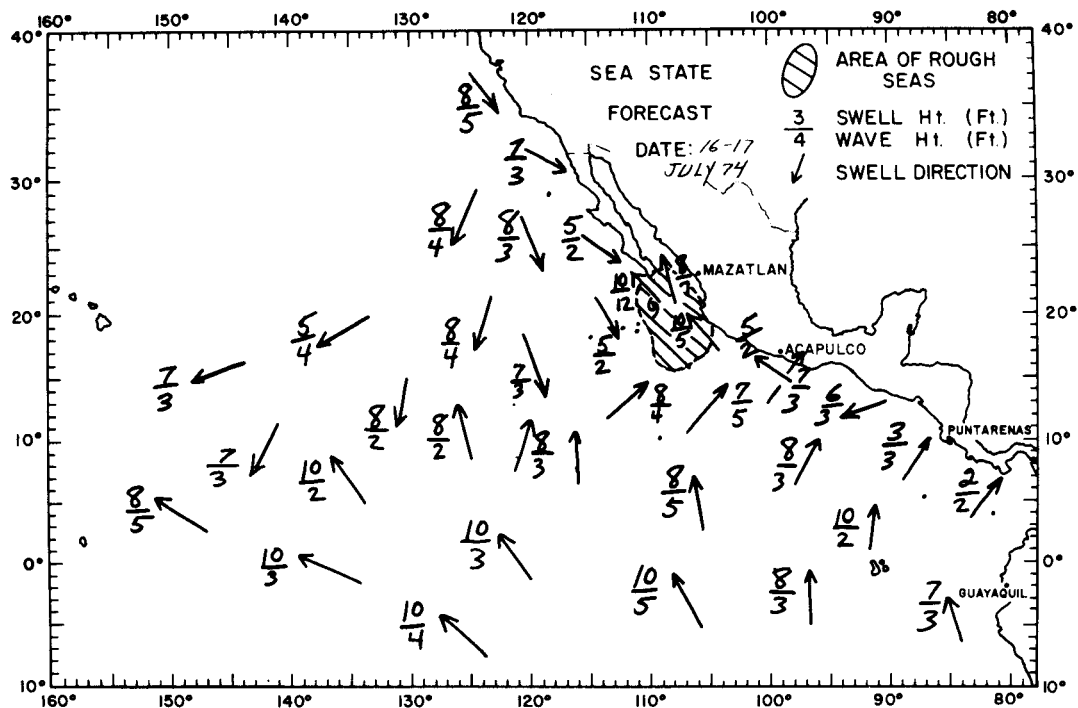


Figure 2. --Sea-state advisory chart transmitted by radio facsimile on July 16, 1974.

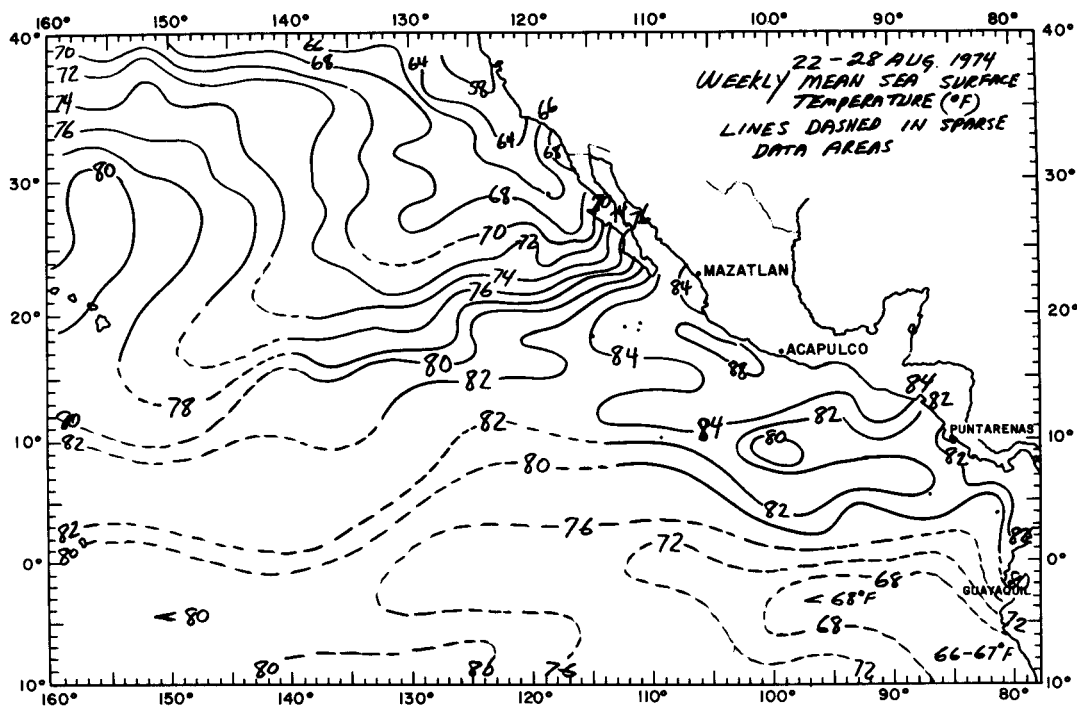


Figure 3. --Weekly sea-surface temperature chart for the period August 22-28, 1974. This chart was transmitted by radio facsimile on August 29, 1974.

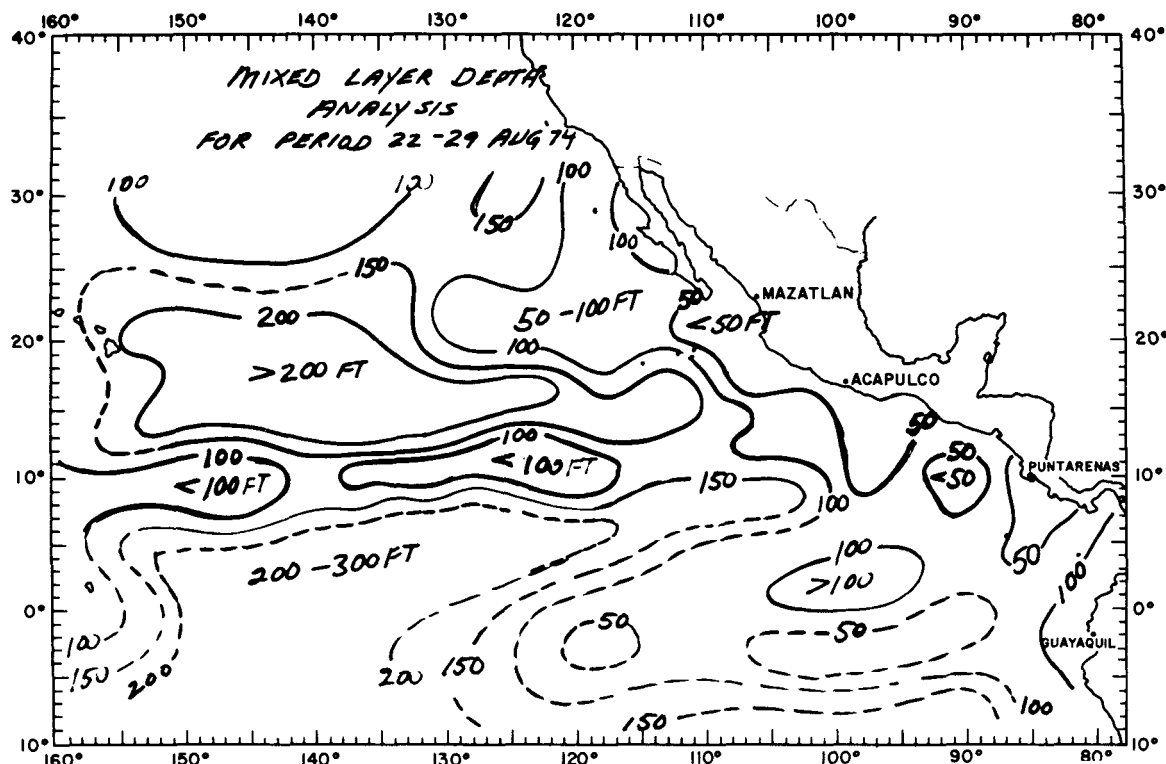


Figure 4. --Weekly mixed-layer depth chart for the period August 22-28, 1974. This chart was transmitted by radio facsimile on August 30, 1974.

deficiency of data and poses a difficult problem for marine analysts and forecasters. Consequently, in developing procedures for the preparation of wind, weather, and sea-state forecasts, emphasis was placed on the construction of a daily composite wind streamline analysis as the primary analysis tool. The streamline charts are not broadcast with the FAX charts, but enable the analyst to maintain careful day-to-day continuity, so that the course of tropical cyclone activity and other phenomena can be monitored with reasonable confidence, even when observations are sparse.

A reproduction of the streamline analysis for August 24, 1974, is shown in figure 5. The short arrows indicate observed wind directions and represent a sample of the observations reported by fishing vessels and merchant ships. The numbers plotted near the heads of the arrows give windspeed in knots. Three hurricanes (Ione, Kirsten, and Joyce) were active on this day, along with one tropical storm (Lorraine). The locations of these storms in the streamline analysis conform to those given for 1800 August 24, in the NWS San Francisco Eastern Pacific Hurricane Center Marine Advisories. The cyclonic circulation near 13°N, 101°W, detected off Costa Rica a few days earlier, became tropical storm Maggie on August 26.

The locations of the storm centers shown in figure 5 were all determined from weather satellite pictures. An excellent example is presented in figure 6, which shows hurricanes Ione (left) and Kirsten (right) at about 1750 on August 24. The picture was generated in the visible range with the very high resolution radiometer aboard the satellite NOAA-3 during a north-

to-south overpass. A portion of the subpoint track (projection of the satellite's orbit onto the Earth's surface) is indicated by the dashed line in figure 5, which can be seen to pass nearly midway between the two hurricanes. On its preceding orbit, about 2 hr earlier, NOAA-3 passed over the area just east of Joyce and Lorraine, affording good fixes on those storms.

The availability of satellite imagery with comprehensive coverage of oceanic regions is obviously of tremendous value for monitoring conditions in the marine environment. Surface observations from fishing vessels and merchant ships are still essential, however, for determining surface wind, sea temperature, sea state, and other properties, and for providing "ground truth" to support continued development of remote-sensing technology.

Since August 1974, the daily wind and weather and sea-state advisory charts broadcast from station WWD have been prepared by the NWS San Francisco Weather Service Forecast Office (WSFO). The assumption by NWS of this service reflects a strengthening of the marine program at the San Francisco WSFO, which also prepares midlatitude analyses and prognoses for the North Pacific, for radio facsimile transmission from radio station NMC, San Francisco.¹ The NWS

¹Radio facsimile transmission schedules of weather and sea conditions, along with transmission frequencies, are contained in the U.S. Department of Commerce publication "Worldwide Marine Weather Broadcasts," issued jointly by the National Weather Service and the Naval Weather Service Command.

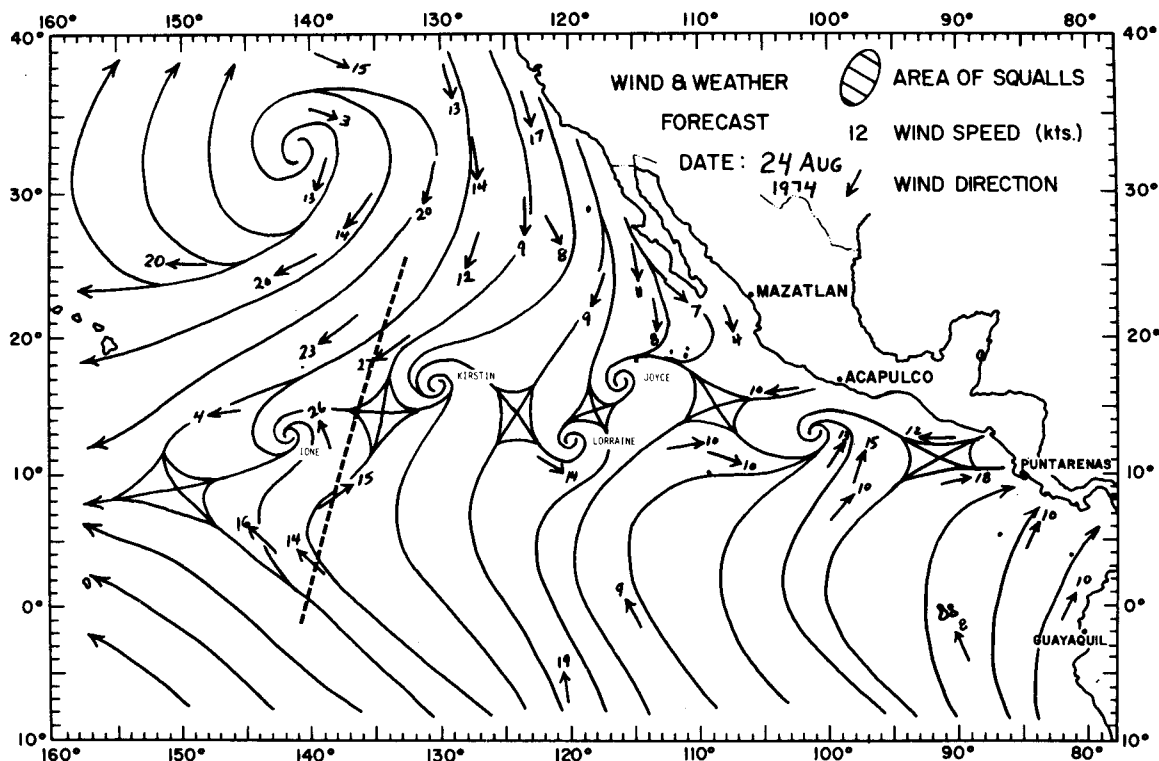


Figure 5.--Streamline analysis of the wind field on August 24, 1974. The short arrows with numbers plotted near their heads represent observations of direction and speed, in knots, reported by fishing and merchant vessels. The heavy dashed line marks a portion of the subpoint track of NOAA-3 at the time the satellite picture in figure 6 was taken.

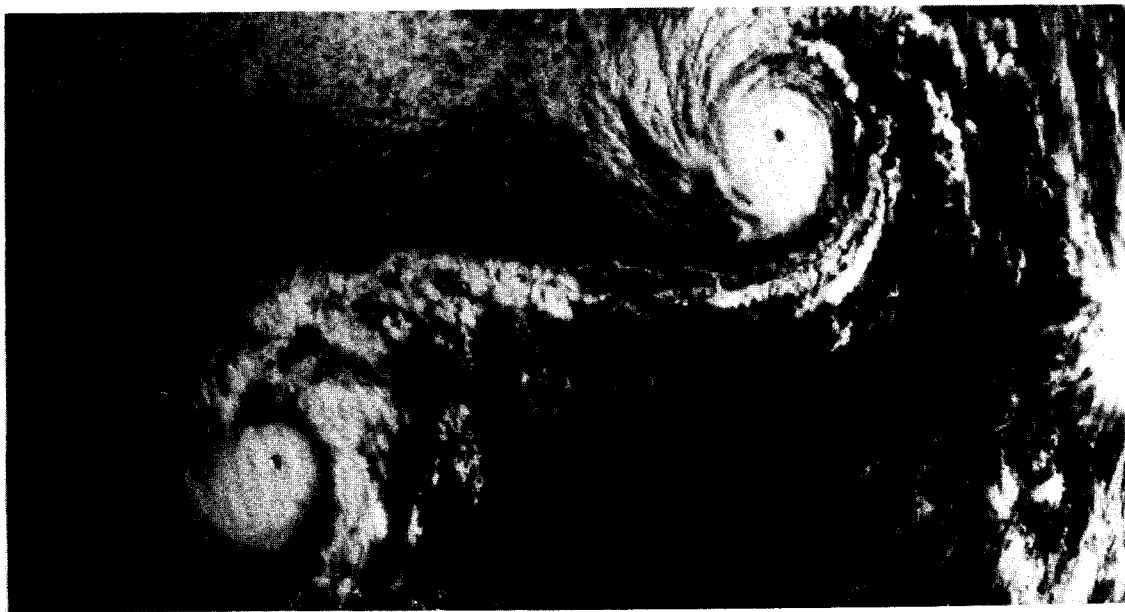


Figure 6.--Weather satellite picture taken with the very high resolution radiometer on NOAA-3, at about 1750 on August 24, 1974. The picture was received and processed at the San Francisco Satellite Service Field Station of the National Environmental Satellite Service.

FAX advisory charts for the eastern tropical Pacific are similar to those developed at SWFC (figs. 1 and 2), with some differences in format, such as the use of symbolic cloud images to denote squally areas, and streamlines instead of discrete wind arrows to denote the wind field, without an explicit delineation of the ITCZ. The NWS sea-state forecast charts also contain swell period in addition to swell height and wave height. The entry of NWS brought full 7-day coverage to the FAX advisory service, which formerly excluded weekends.

Marine forecasters at the San Francisco WSFO have the advantage of support from the NESS Satellite Field Service Station (SFSS), which is colocated with WSFO. The SFSS is equipped and staffed to receive, process, and interpret on a near real-time basis all satellite data, including output from the very high resolution radiometers (fig. 6). Thus, NWS will be assured of high-quality, up-to-date satellite imagery for use in forecasting conditions in the eastern tropical Pacific.

Radio facsimile transmission is also being used in the albacore tuna fishery investigations at the SWFC to send sea-surface temperature information to albacore fishermen. Weekly sea-surface temperature charts are prepared for the region 30° to 50°N, and seaward from the North American west coast to 140°W.

Approximately 20 albacore fishing boats are equipped with facsimile recorders and are cooperating in an experimental effort to determine the value of sea temperature information to fishing strategy. The charts are broadcast from station WWD on Friday mornings during the albacore fishing season, May to October.

The FAX program was originated to obtain environmental data for fishery research and to provide fishermen with advisory information which might be of use in their fishing operations. Favorable reaction to the program stimulated increasing participation to the extent that communications are becoming a limiting factor in the amount of real-time data the program can yield. Such data, however, are certain to become more and more valuable as a consequence of the growing concern about and attention to the ocean's role in predicting climatic changes. The scope of global environmental monitoring essential to climate prediction is such that all systems of data collection must be utilized as fully as possible, including those involving cooperating fishing vessels. The continued development of data communications systems using satellites can be expected to lead to more efficient and reliable means of providing ships at sea with environmental analyses and forecasts in exchange for observational data.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR
THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD
WEATHER OBSERVATIONS. TO US, THESE EXCELLENT OBSERVATIONS ARE PRICE-
LESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.