PICTURE OF THE MONTH

Shear Line Weather Regime Over Hawaii

ROBERT N. LARSON

National Environmental Satellite Service, NOAA, Honolulu, Hawaii 96819

5 December 1975 and 17 March 1976

The period of 1–4 October 1975 marked the arrival of the first frontal shear line into Hawaiian waters following (and providing some respite from) this year's unusually dry summer season.

At the surface, cold air masses reaching the Hawaiian Islands have passed over vast distances of relatively warm ocean. As a result the surface temperature discontinuity along the front is weak or even non-existent. In addition, that portion of a front under the influence of a trailing high pressure area may also have its density discontinuity aloft destroyed through the action of adiabatic heating produced by subsidence. Eventually fronts moving southward near Hawaii reach a point where the surface winds on both sides of the front become northeasterly. Essentially most frontal characteristics cease to exist, with only a more persistent zone of low-level cyclonic wind shear and convergence, the shear line, remaining.

Such a transformation, from cold front to shear line, was observed with the aid of half-hourly pictures from the Synchronous Meteorological Satellite (SMS-2). The National Environmental Satellite Service's (NESS) Field Services Station at Honolulu, established in August 1975, was able to supply the collocated National

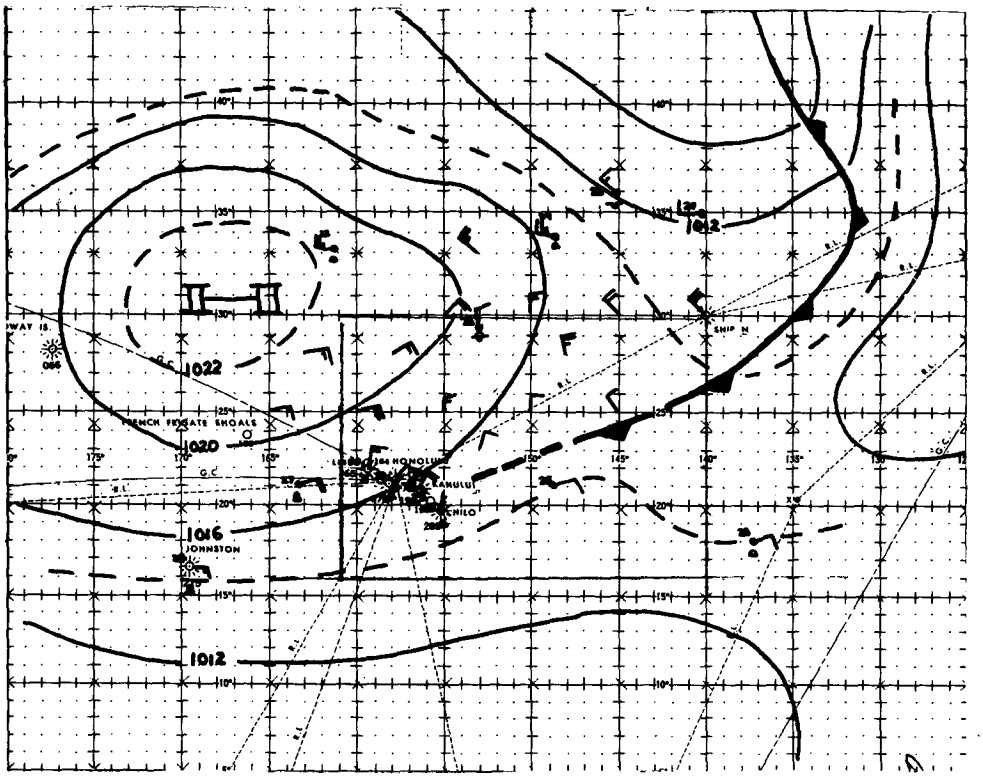

FIG. 1. Surface pressure analysis for 0000 GMT 2 October 1975. Wind reports without surface temperature or reported clouds are satellite-derived wind vectors for low-level cloud motions.

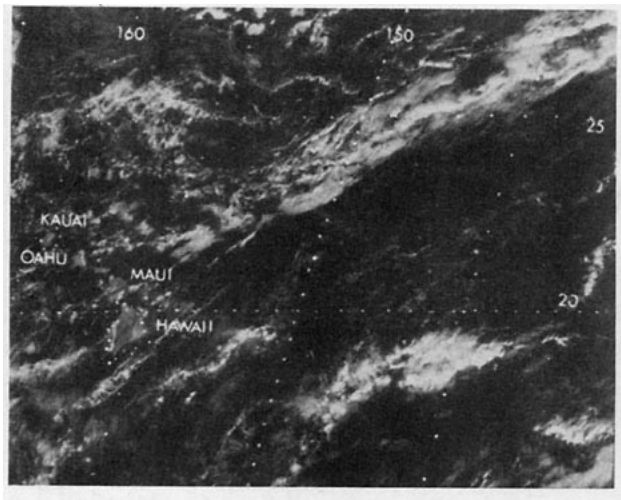

FIG. 2. SMS-2 B-scale (2 km resolution at subpoint) enlargement, taken in visible range of spectrum at 1947 GMT 1 October 1975. Note Hawaiian Islands in lower left corner.

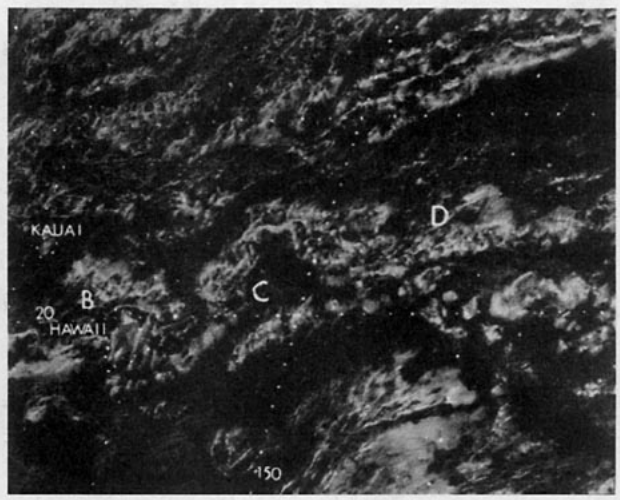

FIG. 4. As in Fig. 2 for 1948 GMT 3 October 1975.

Weather Service Forecast Office with 24 h satellite coverage of the shear line by means of imagery from the SMS-2 IR channel and from the visible channel during daylight hours.

At 0000 GMT 2 October (Fig. 1), island and ship reports were still indicating NNE to NE surface winds north of the cloud band and ENE surface winds to the south. The modification into a shear line was then already well underway as seen in Fig. 2, which shows the frontal band, consisting of cumuliform clouds with tops generally below 3 km, extending southwestward from near 26°N, 143°W to near 21°N, 155°W, just northeast of Hawaii. Within 24 h the surface winds became NE on both sides of the cloud band, its southward progression ceased, and a series of organized cloud systems A–C (Fig. 3) showing positive vorticity induced by cyclonic shear in the low-level trade wind flow formed along it.

An intensification of the low-level northeasterlies in the islands, perhaps in response to deeper vertical mixing and an increasing surface pressure gradient induced by the shear line, led to the issuance of small-craft advisories for Hawaiian waters during the morning of 2 October. The combination of increased NE trade winds and an influx of showers embedded in the first cloud system A (Fig. 3) along the shear line began to wet the windward slopes of the island of Maui during the morning hours of 2 October. The 24 h rainfall totals for the period ending 0800 HST (1800 GMT) 2 October reveal that several windward stations on Maui received amounts of 7–12 mm, while the other islands were generally dry. Time-lapse movie loops revealed that the first cloud system moved southwest with the prevailing 8 m s^{-1} speed of the northeast low-level trade wind flow and brought showery weather to the island of Maui and the northeast coast of the island of Hawaii through the afternoon of 2 October before dissipating. A review of

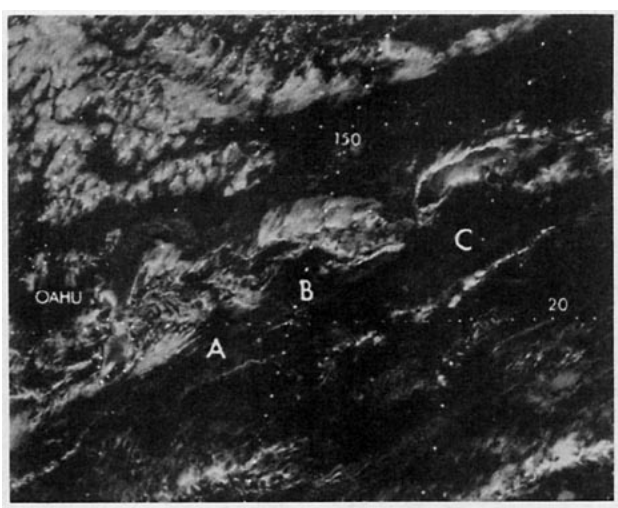

FIG. 3. As in Fig. 2 for 1948 GMT 2 October 1975.

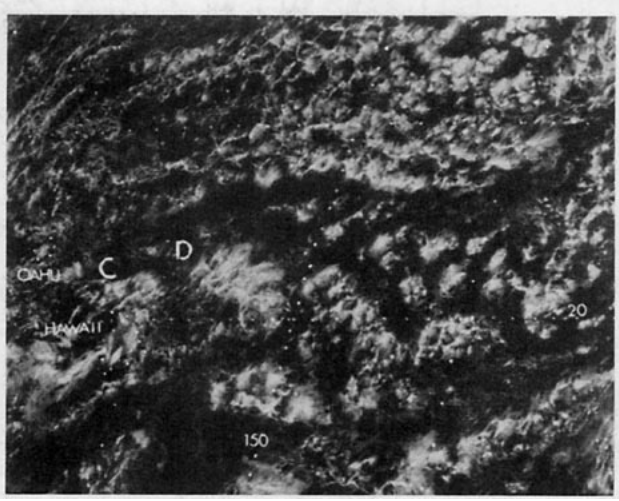

FIG. 5. As in Fig. 2 for 1948 GMT 4 October 1975.

24 h rainfall totals ending at 0800 HST 3 October 1975 reveals amounts frequently in excess of 6 mm with a maximum of 49 mm reported at one location on the eastern slopes of Mt. Haleakala on Maui. The two major islands to the north, Oahu and Kauai, remained virtually dry except for a few light trade wind showers.

The second cloud system B (Figs. 3 and 4) along the shear line moved into the island chain during the morning hours of 3 October, increasing shower activity further north to Oahu. The pattern continued with the advection of two additional cloud systems C and D (Figs. 3–5) into the islands of Maui and Hawaii during the morning and evening of 4 October, again producing 6 to 12 h periods of shower activity over the windward sections.

The nearly continuous surveillance provided by the SMS-2 satellite enabled weather forecasters to ascertain which, and during what time periods, portions of the Hawaiian Islands would be affected by the shear-line induced weather. This particular weather episode illustrates some of the variability possible within the mesoscale which currently can be revealed through satellite observation.