PACIFIC REGION TECHNICAL NOTES

85-006

November 19, 1985

# PWC SATELLITE-MARINE PRODUCTS

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## INTRODUCTION

The lack of various types of data over the data-sparse eastern Pacific Ocean can be overcome, to some extent, through full utilization of GOES satellite imagery. Over the past few months a number of products have been developed at the Pacific Weather Centre (PWC) to mitigate the effects of the scarcity of this data. This paper will discuss three of them, one of which has been routinely produced operationally and transmitted to the field for several months, and two of which have been developed and are currently being tested. The three products are: a Sea Surface Temperature Analysis (SST Chart), Surface Wind Estimates over Offshore Areas (MARSAT Wind Chart), and a depiction of Areas of Fog and Low Cloud (SAT-FOG Chart).

### SST Chart

This product depicts an up-to-date analysis of surface temperatures over the eastern Pacific. This information is required by both the Department of National Defence (DND), and by operational forecasters at the Pacific Weather Centre. Sea surface temperature (SST) analyses are presently received at PWC from the (U.S.) National Weather Service and from CFB Esquimalt. The NWS analysis is global, and though comprehensive is considerably smoothed with relatively little detail over B.C. coastal waters and the Gulf of Alaska. The analyses from Esquimalt are more detailed, but gaps in conventional data availability have led to requests from Esquimalt that PWC supplement this data with satellite information.

Detailed SST analyses are required by DND to support anti-submarine activities in the Pacific. Accurate analyses are also helpful to forecasters attempting to predict fog and stratus formation, and in producing temperature forecasts.

The PWC SST analysis is produced twice-weekly. Input to the product now consists mainly of estimates of surface temperature from the Tiros Operational Vertical Sounder (TOVS) aboard NOAA polar orbiting spacecraft. This data is available with sufficient density and accuracy over the eastern Pacific to permit quite detailed composite SST analyses to be produced twice weekly. This analysis is done on the GOES projection, and is stored into a METDAS graphics file using a graphics tablet. It is then

transmitted to Esquimalt directly over the high-resolution facsimile circuit, with a copy produced at PWC for local use. An example of this type of product is shown in figure 1.

MARSAT Wind Chart

Reports of wind velocity over the eastern Pacific from conventional sources are frequently inadequate to supply the Marine Forecaster with the information required to produce accurate marine forecasts. This data, in the form of ship and buoy reports, does not have the spatial resolution necessary for the determination of maximum wind speeds; the ship data lacks temporal resolution as well (i.e. storms frequently deepen 6 or more millibars between synoptic hours).

Hourly GOES images can be used to supplement the above reports as a source of surface wind information. The velocities of low level cloud elements, which persist from hour to hour on the imagery, can easily be determined using the PWC satellite Meteorological Data Analysis System (METDAS); then wind vectors corresponding to these velocities can be overlaid on the imagery using a digital pad. The level in the atmosphere at which the wind velocity is being measured must be taken into account, and the estimate of surface wind velocity adjusted accordingly. In order to do this, the concept of the Ekman spiral must be understood (Holton, 1972), and the estimated stability of the airmass (which affects momentum transport down to the surface) taken into account. In an unstable airmass over the sea, (as a first approximation) the surface winds can be assumed to back 20 to 30 degrees from the direction of winds at the level of the cloud base, and to decrease in velocity by about 20 percent.

A major limitation of the above procedure is that velocity estimates cannot be made through layers of middle or high clouds. These cloud layers usually accompany developing baroclinic disturbances, and mask low level winds over critical areas. If speed estimates are to be made in these areas, the Satellite Meteorologist must rely on the increasing flow of cold air behind the system (where low cloud elements are almost always clearly visible), and the signature of the cloud system as a whole (a cloud system changes shape as the circulation around the low increases) to estimate surface wind speeds in the overcast areas.

An example of this type of product is given in figure 2, while the corresponding PWC surface analysis is given in figure 3.

SAT-FOG Chart

A determination of areas of low cloud and fog in real time is a requirement at PWC. Low level moisture advects along the B.C. coast (as well as through interior valleys), and so must be monitored closely by forecasters. Cloud associated with this moisture frequently expands in area during early morning hours because of nocturnal cooling. Darkness over the area makes obtaining comprehensive observations difficult, even by satellite.

An up-to-date knowledge of areas of low cloud and fog is required by the Aviation Forecaster, but is also necessary information at the Marine and Public desks.

Due to the limited hours of daylight during fall and winter, IR imagery must be relied upon much of the time for information concerning low cloud and fog during these seasons. Using the capability of the METDAS system to permit interactive modifications to enhancement curves, new curves can be readily developed and modified to best resolve low clouds. High resolution spectral analysis can also be performed on areas in question, and the histogram of the radiances from an area compared with typical low cloud hodographs, or spectral "footprints". In this way questionable areas may be resolved into cloud/no cloud regions. Knowledge of surface temperatures and diurnal surface radiating changes (Maturi & Holmes), can help the meteorologist define the areas of low cloud and fog from IR imagery.

For an example of this type of output, and some typical histograms of various types of radiating surfaces, refer to figures 4 and 5.

## CONCLUSIONS

This paper has discussed ways in which satellite data is being used at PWC to compensate for "shortcomings" in the conventional database. In particular it appears that the satellite information will prove useful in measuring sea surface temperatures, in complementing surface wind observations over data-sparse areas, and in helping to define areas of stratus and low cloud where no surface observations are present.

## REFERENCES

Holton, J.R., 1972: "An Introduction to Dynamic Meteorology", Academic Press Inc., 111 Fifth Avenue, New York, N.Y. 10003 pp 86-88.

Maturi, I.M., and Holmes, S.J., 1985: Monthly Infrared Imagery Enhancement Curves: A Tool for Nighttime Sea Fog Identification off the New England Coast, NOAA Technical Memorandum NESDIS 12, Satellite Applications Laboratory, NESDIS, NOAA, USCD.

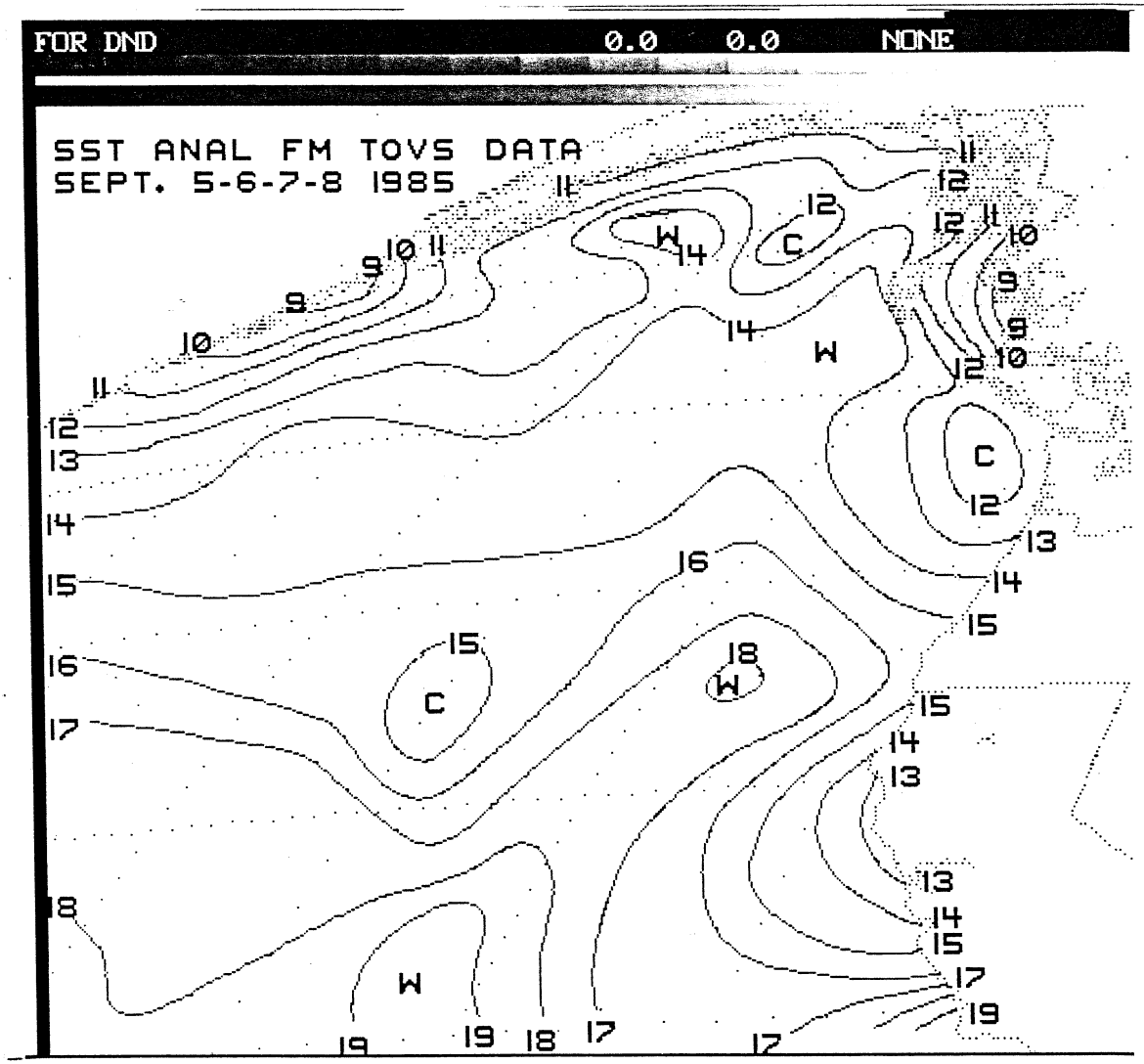



FIGURE 1.

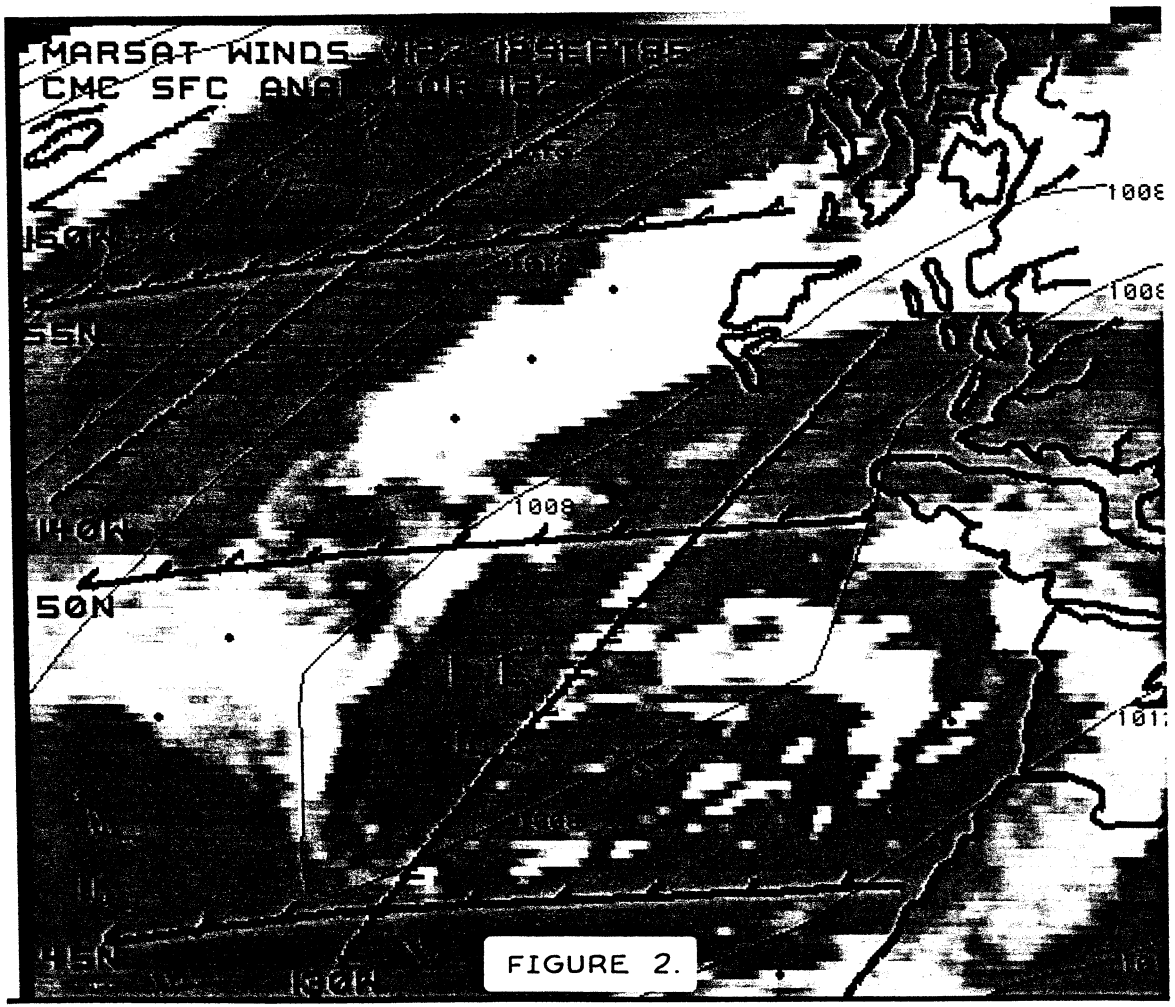
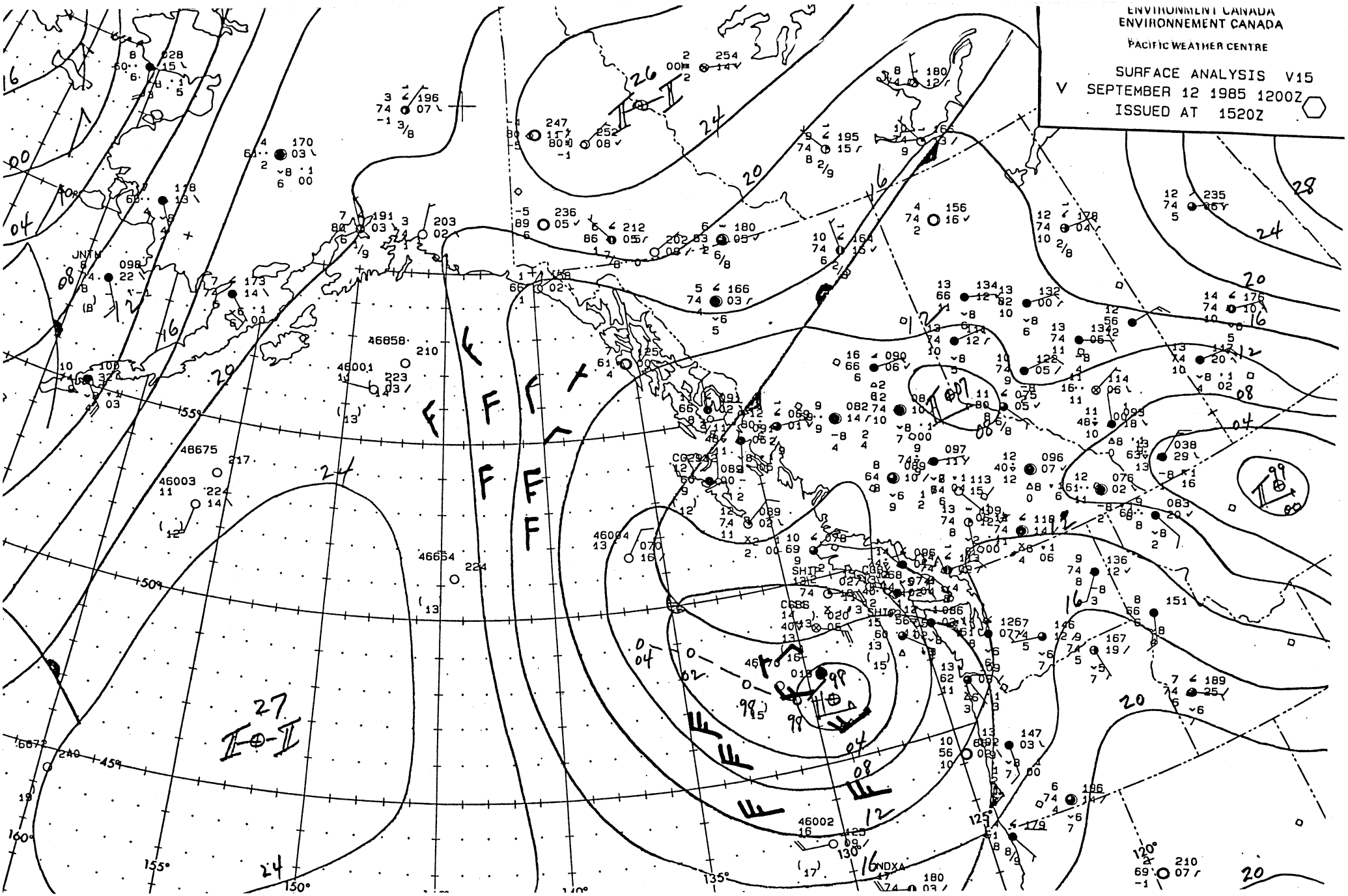



FIGURE 2.


ENVIRONMENT CANADA
ENVIRONNEMENT CANADA
PACIFIC WEATHER CENTRE
SURFACE ANALYSIS V15
SEPTEMBER 12 1985 1200Z
ISSUED AT 1520Z
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46001
46675
46003
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46654
46002
JNTN
SHIP
CNDXA

FIGURE 3.

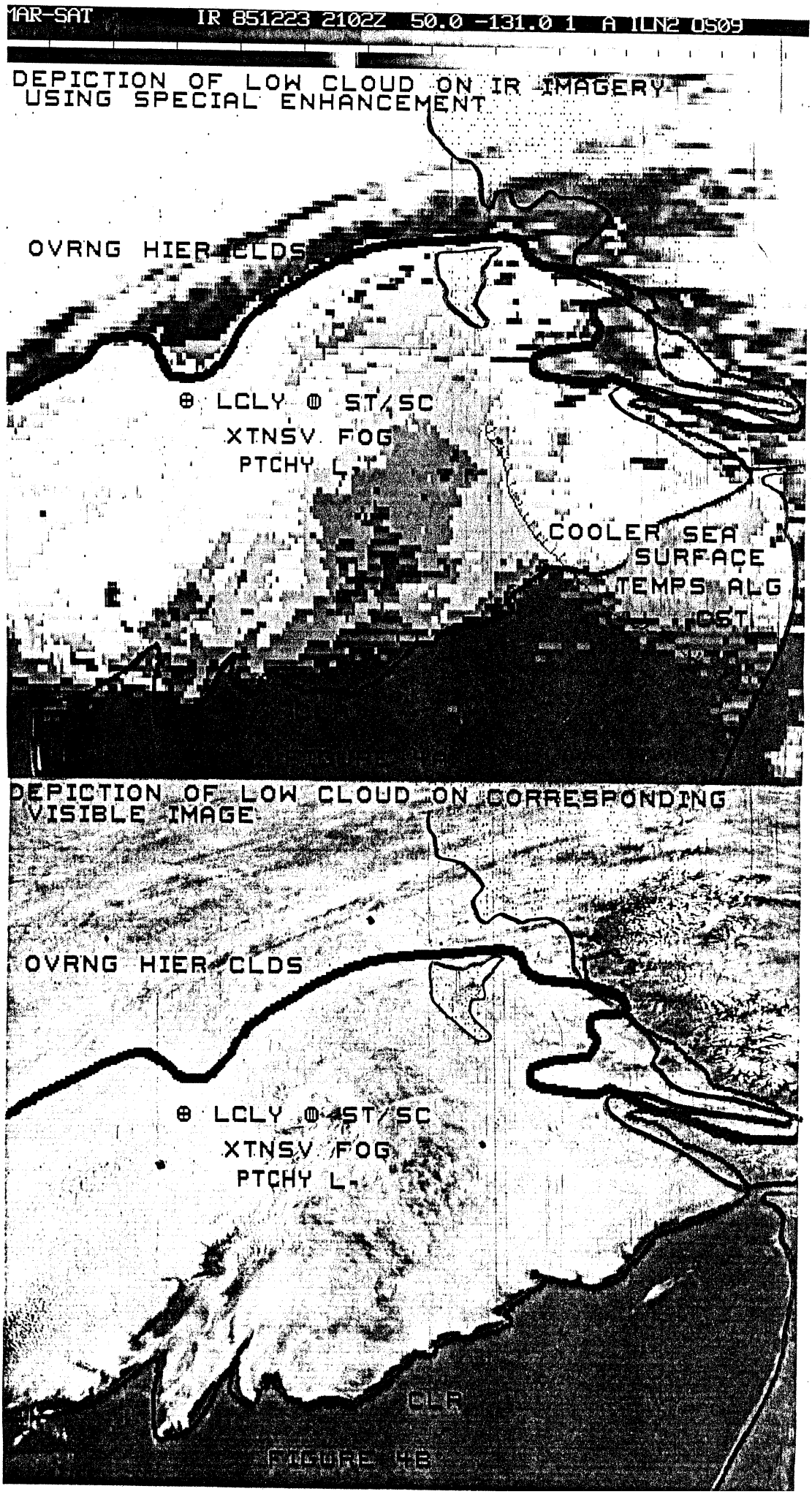
MAR-SAT IR 851223 2102Z 50.0 -131.0 1 A ILN2 0509
DEPICTION OF LOW CLOUD ON IR IMAGERY
USING SPECIAL ENHANCEMENT
OVRNG HIER CLDS
⊕ LCLY ◍ ST/SC
XTNSV FOG
PTCHY L.T.
COOLER SEA
SURFACE
TEMPS ALG
DEPICTION OF LOW CLOUD ON CORRESPONDING
VISIBLE IMAGE
OVRNG HIER CLDS
⊕ LCLY ◍ ST/SC
XTNSV FOG
PTCHY L.
CLR

FIGURE 4B

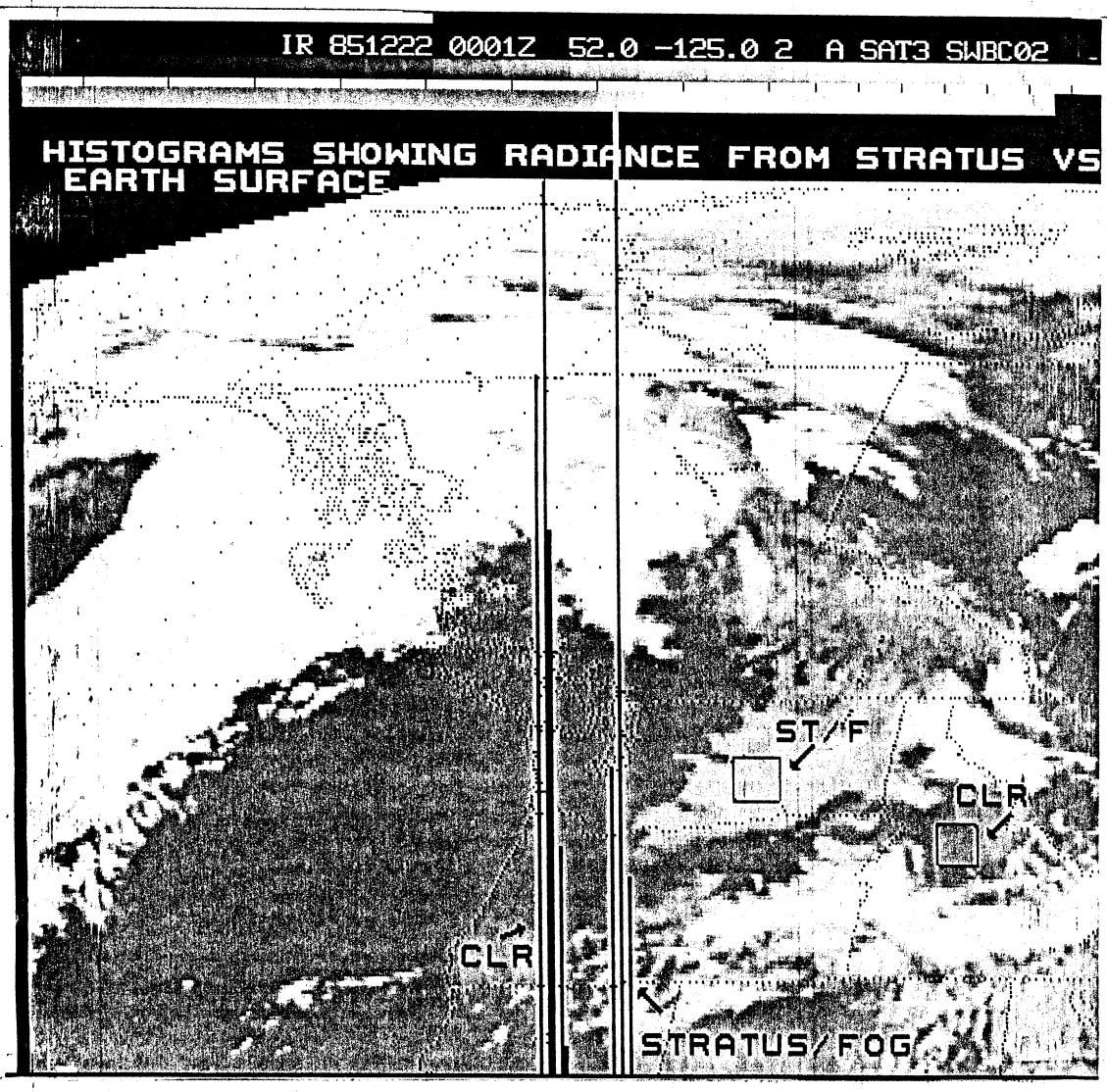


Figure 5

Fog and stratus decks often display a smaller range in IR radiance than does the ground surface (also, the standard deviation is smaller for stratus decks). This is especially true when comparing varying terrain to flat stratus decks. However this is not generally the case when comparing the sea surface or very uniform ground surfaces to stratus cloud.

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* ODIT Unit Status Reports are issued every 4 months.