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Operational Use of Synthetic Soundings
Derived from TOVS Data

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INTRODUCTION

At the present time meteorologists at the Pacific Weather Centre have several data sets that have not been fully integrated into the daily forecast operation. These include the TOVS and ASAP vertical soundings over the North Pacific. The reasons for the under usage are multifold and include format, access, area of interest, time considerations, and accuracy (TOVS).

However, the ASAP program now provides the opportunity to assess TOVS data over the usually data sparse northeastern Pacific. The cases presented were chosen to illustrate the degree of utility of soundings derived from TOVS data in areas of close proximity to the ASAP ship reports.

TOVS - Grid point TIROS operational vertical sounding data obtained from NESS and transmitted via AES teletype circuit.

ASAP - Automated Shipboard Aerological Program, a development program aimed at producing cost effective mobile upper air meteorological stations. A containerized complete upper air observation system is transported by a ship on a transpacific run. The data is then relayed via GOES-W.

THE APPROACH

By using available imagery (visual, IR, water vapour), the satellite meteorologist can subdivide the northeastern Pacific into similar type airmass regimes. At present times these areas are subjectively assessed because of the lack of conventional data. This often results in a degree of uncertainty regarding the changes to expect across a Pacific front or within a modifying airmass.

Temperature profiles, stability, and freezing levels can be better assessed by using available TOVS data. (Note that when looking at TOVS data we are not necessarily looking at absolute values but for differences and tendencies.)

THE TECHNIQUE

- Within the area of interest, outline regions in which the same type of atmospheric processes appear to be going on. This can be done by scrutinizing the imagery from similar cloud structure, cloud tops, and moisture regimes.

- Within these regions pick out TOVS data points. See Figure 1 for format of TOVS data. The thickness between layers can be converted into a mean layer virtual temperature Tmv (from Smithsonian tables) and the mean pressure for the layer calculated by $\bar{P} = \sqrt{P_1 P_2}$. According to R. Lee "For most practical purposes, the Tmv of a column of air can be considered equal to the mean temperature itself." (Note this may not be applicable to frontal zones.)

- The (Tmv, $\bar{P}$) are then plotted on the tephigram to produce a synthetic vertical sounding.

- The sea surface temperature is also included in the TOVS data and should be plotted for stability and available moisture considerations.

CASE STUDIES

Three cases were chosen from one transpacific run of an ASAP ship during July 1982.

Case A - Synthetic TOVS and ASAP soundings within the same cloud zone (Figures A1, A2).

Although nearly 240 nautical miles apart, the imagery shows the ASAP ship and TOVS gridpoint to lie under similar regimes as far as the cloud field is concerned, (45-50°N, 175-180°W) (Figure A1). TOVS thickness data has been converted into mean virtual temperatures Tmv, and mean pressure P for the layer computed (Figure A2 - top right hand table). Tmv, P for the available layers have been plotted alongside the ASAP sounding. The surface temperature of an independent ship (EXXN) near the TOVS point has been plotted as well.

Observations

- When Tmv, $\bar{P}$ and surface reports are joined, the resultant vertical sounding is quite close to the reliable ASAP ascent.

- As the ship lies further south, one would expect the ASAP sounding to be warmer than the TOVS.

- With only a few TOVS data points it is not possible to catch inversions between points.

- In the absence of ASAP data, the forecaster could still get an idea of the stability of the airmass especially at mid and high levels.

- The TOVS sounding would be useful in determining upstream freezing levels.

Case B - The capability of synthetic TOVS soundings to resolve discontinuities across a baroclinic zone (Figures B1, B2).

In this case two TOVS points were found to be located 300 nautical miles apart across a relatively weak looking frontal zone (Figure B1). The frontal cloud band along 50°N is poorly defined on the IR imagery and has quite warm cloud tops. The visual imagery, however, shows the frontal band much better.

The two TOVS derived soundings (Figure B2) show them to be in significantly different airmasses. At first the difference appears extreme. However ground truth ASAP data between TOVS points helps to clarify the situation. The ASAP sounding shows a well defined baroclinic zone between 920-800 mb. The airmass below the front is similar to the northern TOVS point and the airmass above the mixing zone is similar to the upper levels of the southern TOVS point. Thus the TOVS data appears to be quite reliable and also useful in discriminating between airmasses.

Case C - Assessing the temperature and stability discontinuity between the cold core of a low and the surrounding airmass (Figures C1, C2).

In this case a cold low is pushing onto the west coast of Vancouver Island (Figure C1). Cold, unstable air (as evidenced by convective buildups) covers the area between 45-50°N, 125-130°W. Just southwest of this area, the cloud becomes more extensive and more stratiform.

The ASAP RAOB (Figure C2) shows the air southwest of Vancouver Island to be very unstable to at least 600 mb given that the sea surface temperature is 13°C. On the other hand the TOVS sounding just within the more stable cloud area shows a much warmer and nearly moist adiabatic ascent.

Thus the TOVS data can serve a useful purpose in assessing temperature and stability regimes over coastal waters.

CONCLUSIONS

Synthetic TOVS soundings can be used to assess temperature regimes, stability tendencies, and freezing levels over data sparse areas of the Pacific. Confidence in and useability of these soundings can be increased when used in conjunction with other available data. (Such as ASAP soundings, and ship and buoy surface observations.)

REFERENCES

Horita, M.; A PWC Evaluation of the Automated Shipboard Aerological Program; Pacific Region Technical Note 82-015

Lee, R.; The Geostrophic Thermal Wind Equation; AES Training Course Note CIR 3069, TRA 255, July 8, 1958.

Grimes, D.; Tephigram Analysis Procedure, 1980, (internal unpublished document).

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RETRIEVAL OF TUXN DATA 3 HRS BFR AND AFT  00Z  10  JULY
  NOTE: % IS CONFIDENCE VALUE IN READINGS
        AMOUNT OF CLOUD (CL) IN %,  AVG CLOUD TOP (ACT) IN MB
        THICKNESS (THKS) IN DECAMETERS
        PRECIPITABLE WATER (PCW) IN MILLIMETERS
        SURFACE TEMP (SFT), TROPOPAUSE TEMP (TRT)

DATM      LAT  LONG    850MB  700MB  500MB  400MB  300MB  250MB  CL ACT   SFT  TRT

1002Z    62N  174W---                                             38 492
20%:THKS FM1000MB      135    293    552    715    913    033
20%:PCW  FM1000MB             013    018           019
                                                                         003  //
1002Z    49N  174W---                                              2 341
00%:THKS FM1000MB      134    292    554    719    921    041
                                                                         006  //
1002Z    50N  165W---                                              2 341
00%:THKS FM1000MB      134    292    553    719    921    041
                                                                         005  //
1002Z    55N  172W---                                              2 341
00%:THKS FM1000MB      134    291    552    717    918    037
                                                                         007  //
1002Z    31N  170W---                                             04 725
90%:THKS FM1000MB      140    303    574    745    953    079
90%:PCW  FM1000MB             024    030           032
                                                                         024  //
1002Z    32N  165W---                                             14 665
90%:THKS FM1000MB      140    303    573    743    951    075
90%:PCW  FM1000MB             023    028           030
                                                                         023  //
1002Z    36N  175W---                                              2 341
00%:THKS FM1000MB      140    302    571    741    950    075
                                                                         019  //
1002Z    37N  170W---                                              2 341
00%:THKS FM1000MB      139    300    568    737    945    069
                                                                         018  //
1002Z    39N  163W---                                             65 247
50%:THKS FM1000MB      139    300    567    735    941    065
50%:PCW  FM1000MB             024    032           034
                                                                         015  //
1002Z    42N  173W---                                              2 341
00%:THKS FM1000MB      137    297    563    732    938    060
                                                                         013  //
1002Z    42N  168W---                                             25 578
10%:PCW  FM1000MB             016    022           023
                                                                         009  //
1002Z    30N  178W---                                             03 800
90%:THKS FM1000MB      141    304    576    747    957    082
90%:PCW  FM1000MB             024    029           030
                                                                         022  //
1002Z    65N  124W---                                             62 505
50%:THKS FM 950MB      092    250    511    675    875    994
50%:PCW  FM 950MB             013    018           019
                                                                         016  //
1002Z    52N  121W---                                             30 479
90%:THKS FM 850MB             160    423    587    787    908
90%:PCW  FM 850MB             007    012           013
                                                                         016  //
1000Z    60N  150W---                                             61 500
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FIGURE 1.

Sample of TOVS data available to PWC satellite meteorologist. Data is received under a "TUXN" header and decoded into the above format.

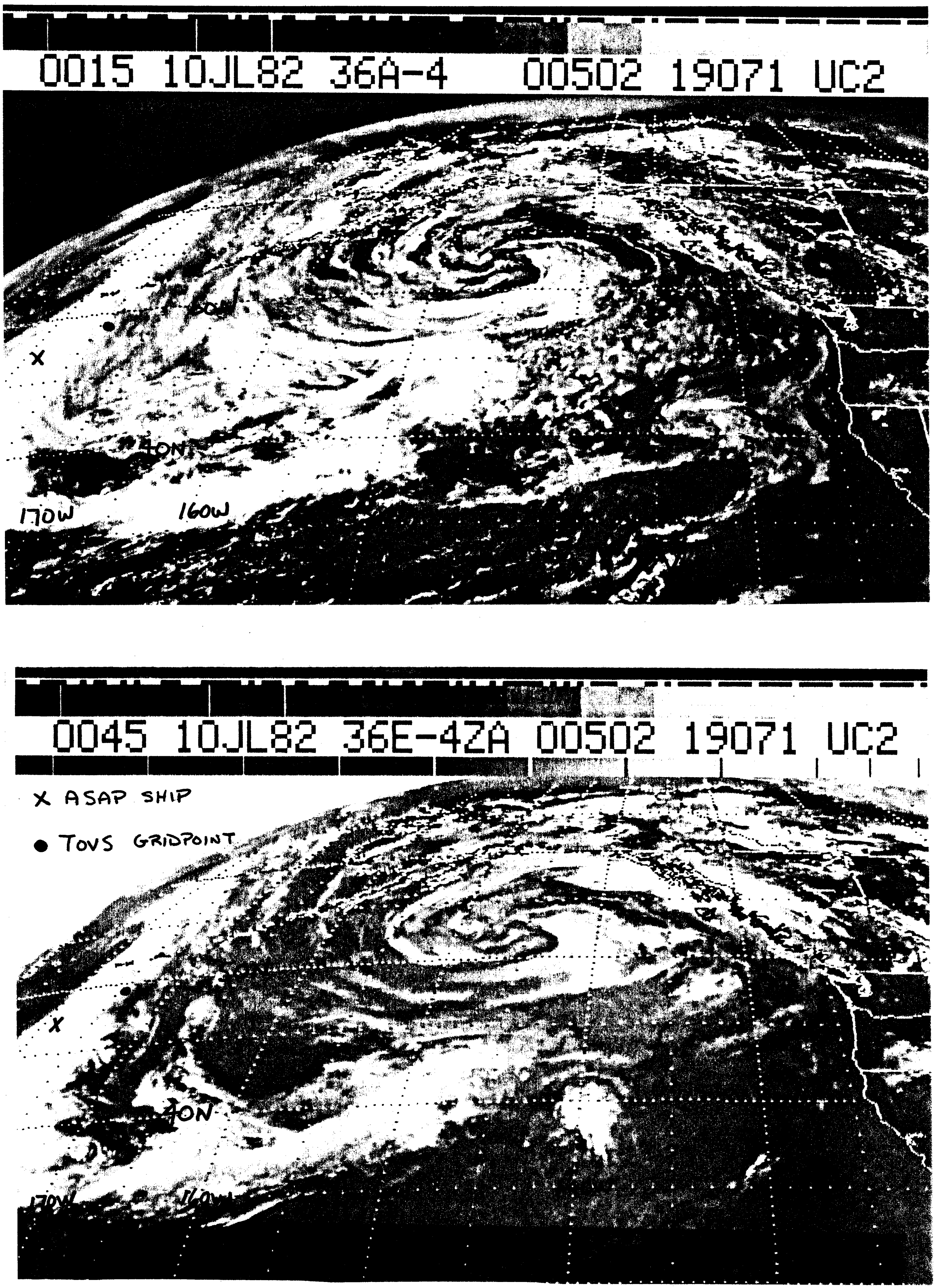
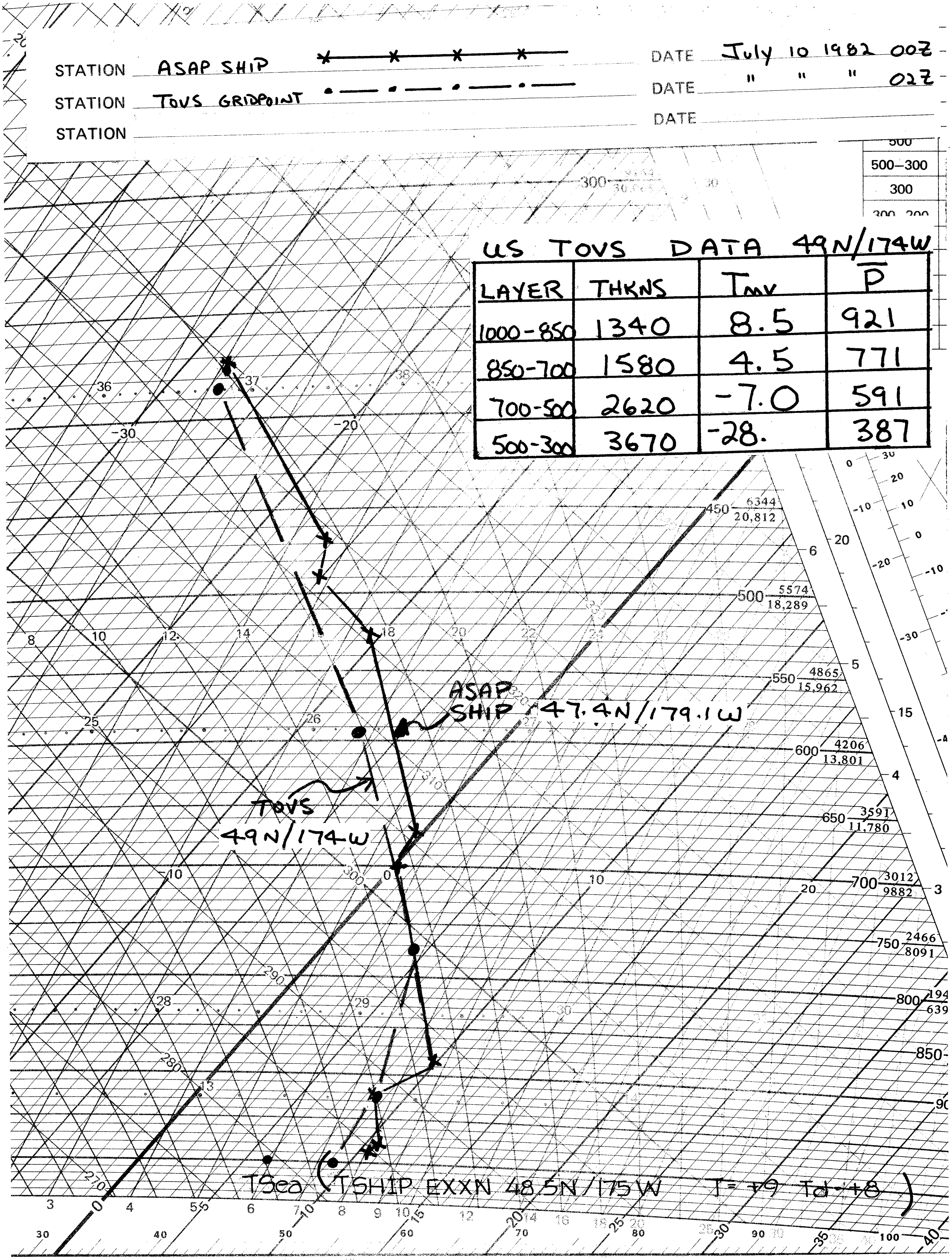
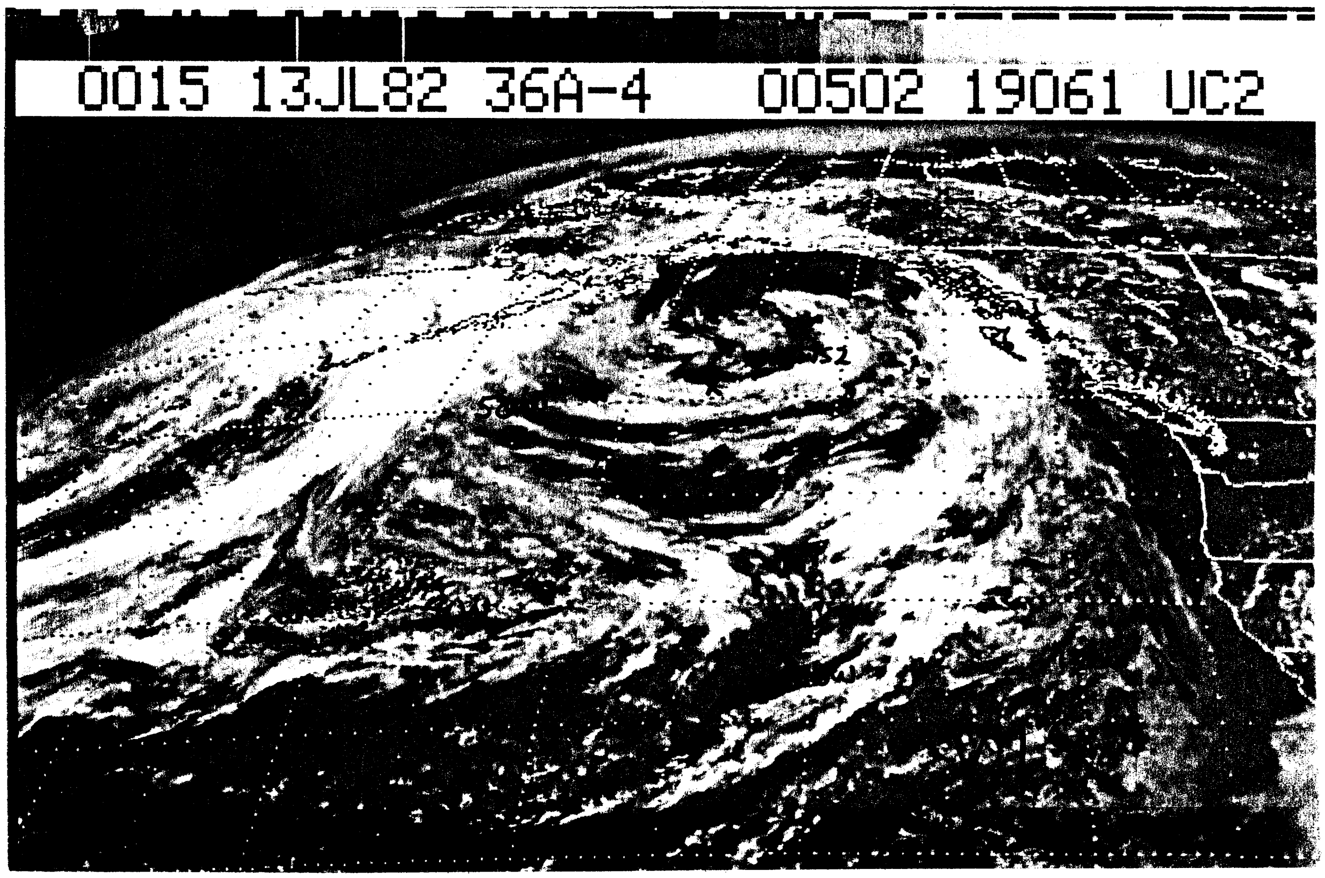

0015 10JL82 36A-4 00502 19071 UC2
40N
170W
160W
0045 10JL82 36E-4ZA 00502 19071 UC2
X ASAP SHIP
● TOVS GRIDPOINT
X
40N
170W
160W

FIGURE A1.



LAYER	THKNS	Tmv	$\overline{P}$
1000-850	1340	8.5	921
850-700	1580	4.5	771
700-500	2620	-7.0	591
500-300	3670	-28.	387

FIGURE A2


0015 13JL82 36A-4 00502 19061 UC2

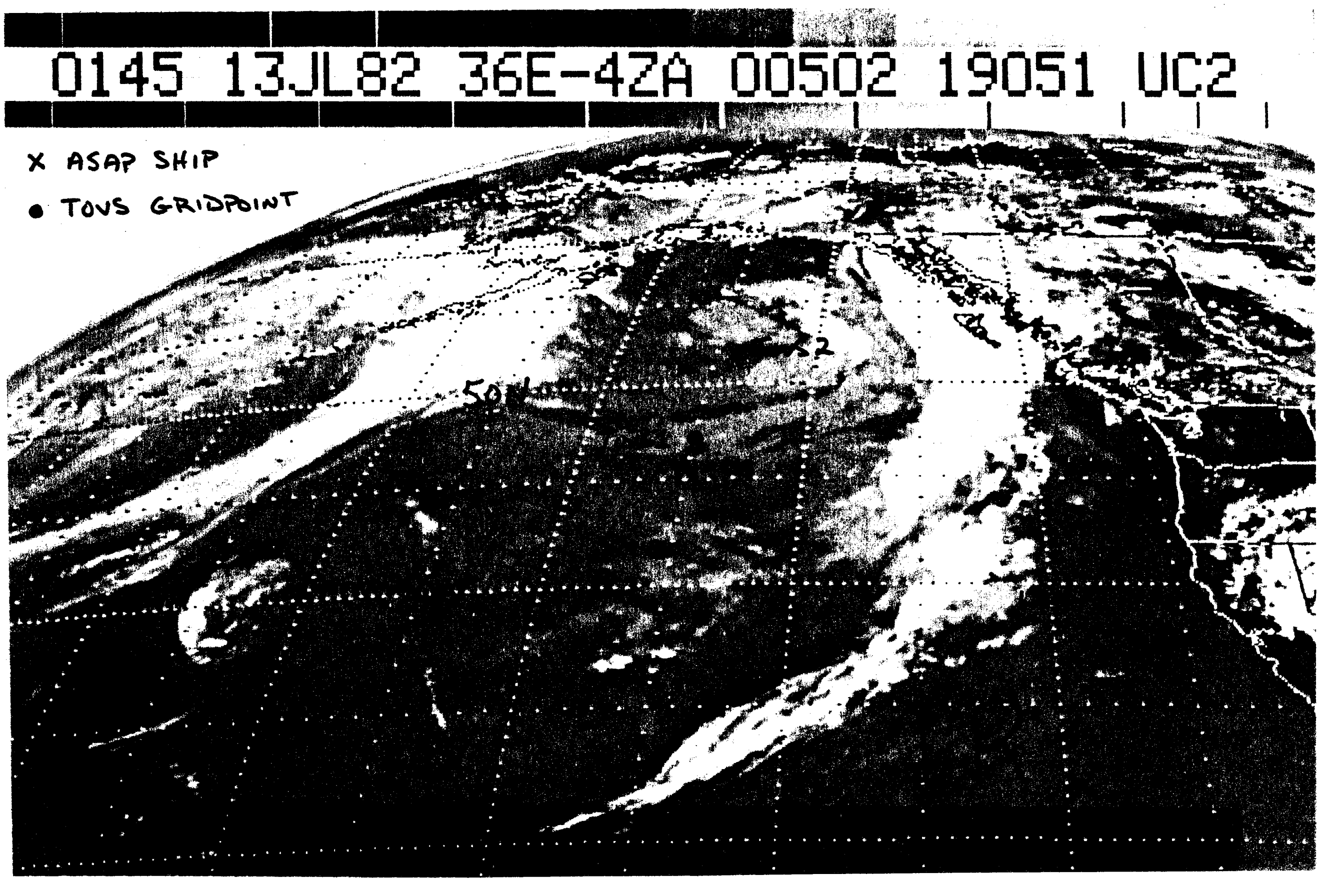

0145 13JL82 36E-4ZA 00502 19051 UC2
X ASAP SHIP
● TOVS GRIDPOINT

FIGURE B1.

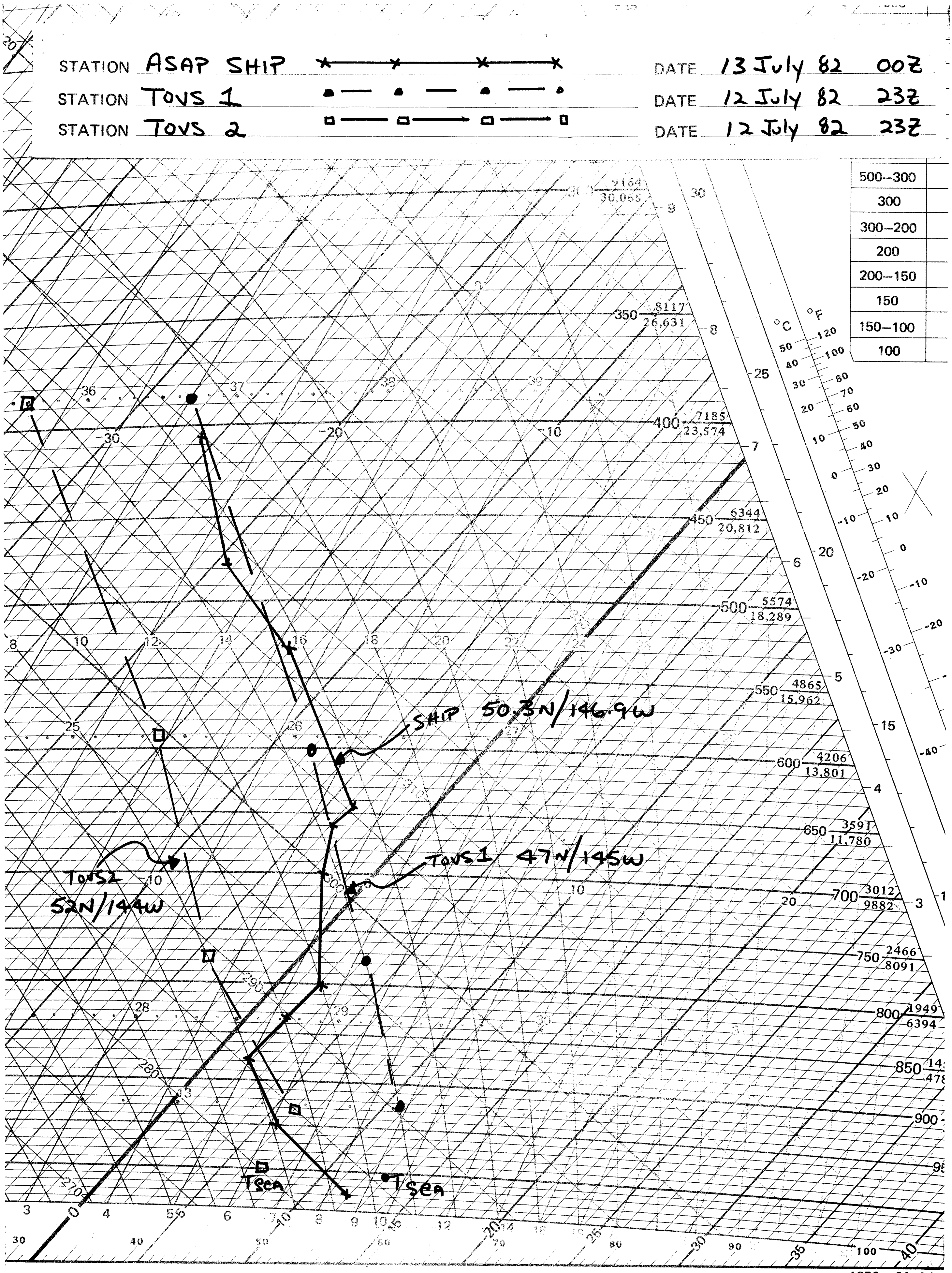

STATION ASAP SHIP
DATE 13 July 82 00Z
STATION TOVS 1
DATE 12 July 82 23Z
STATION TOVS 2
DATE 12 July 82 23Z
SHIP 50.3N/146.9W
TOVS1 47N/145W
TOVS2 52N/144W
Tsea
Tsea
500–300
300
300–200
200
200–150
150
150–100
100

FIGURE B2.

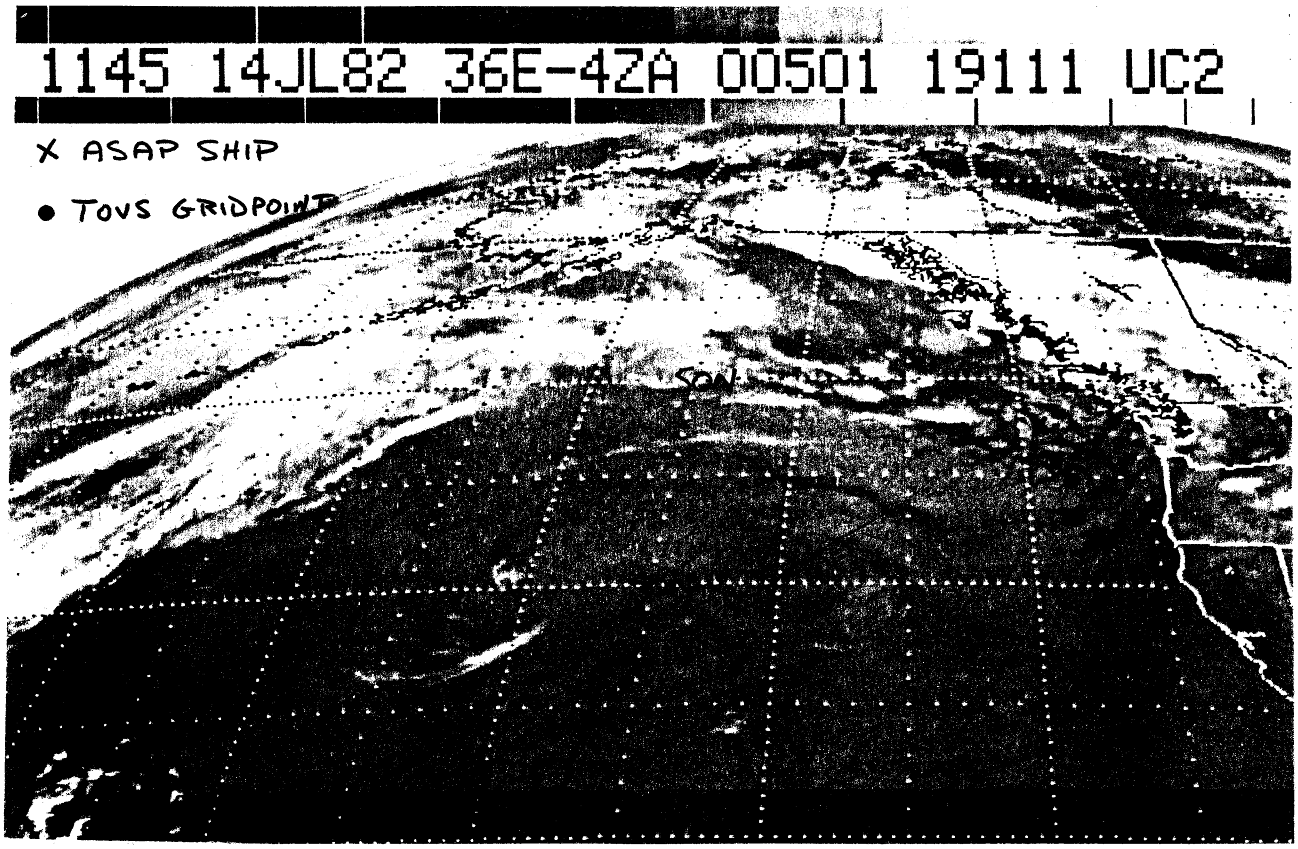

1145 14JL82 36E-4ZA 00501 19111 UC2
X ASAP SHIP
● TOVS GRIDPOINT

FIGURE C1.

STATION ASAP SHIP — DATE 14 July 12Z

STATION TOUS GRIDPOINT — DATE 14 July 12Z

STATION ________ DATE ________

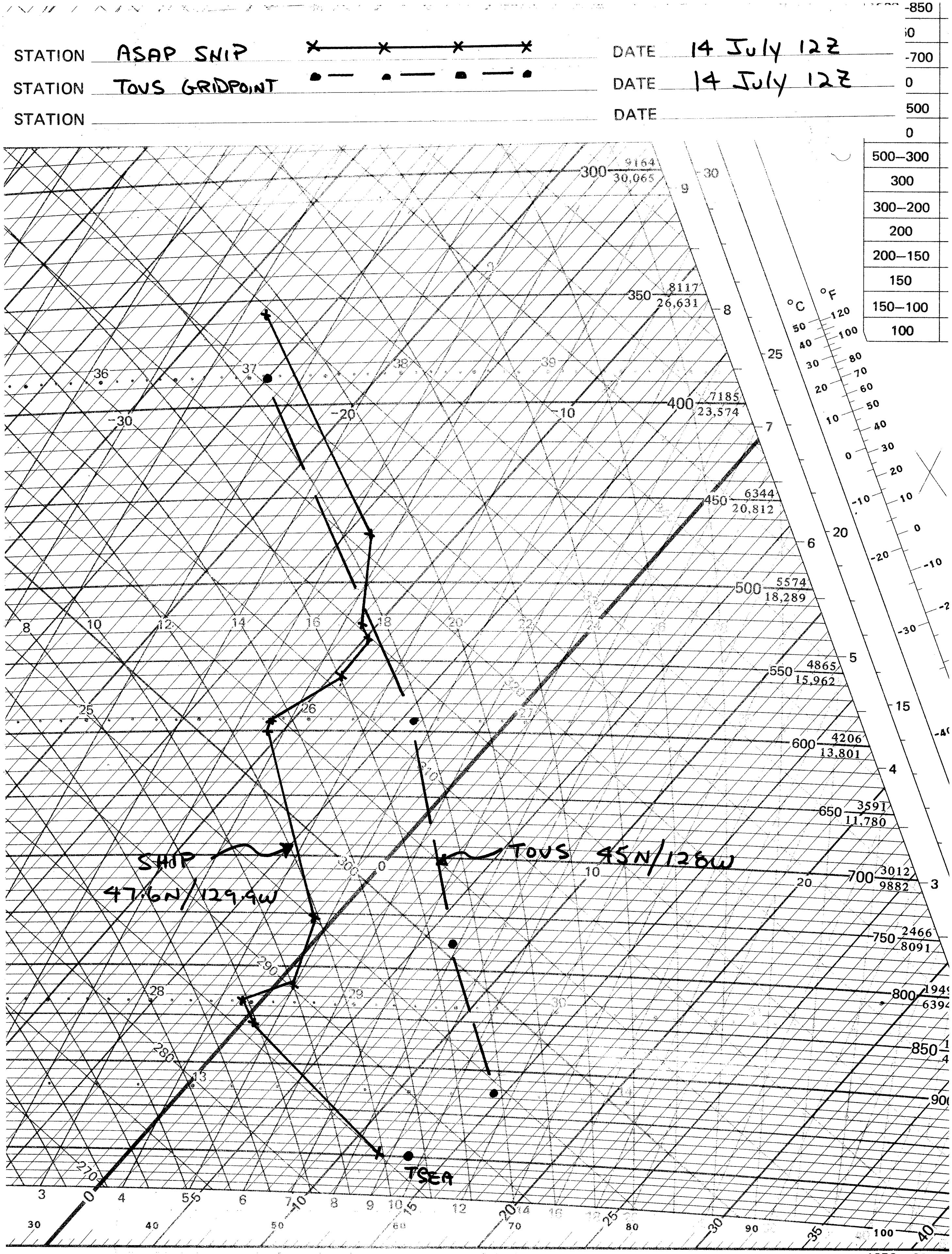


FIGURE C2.