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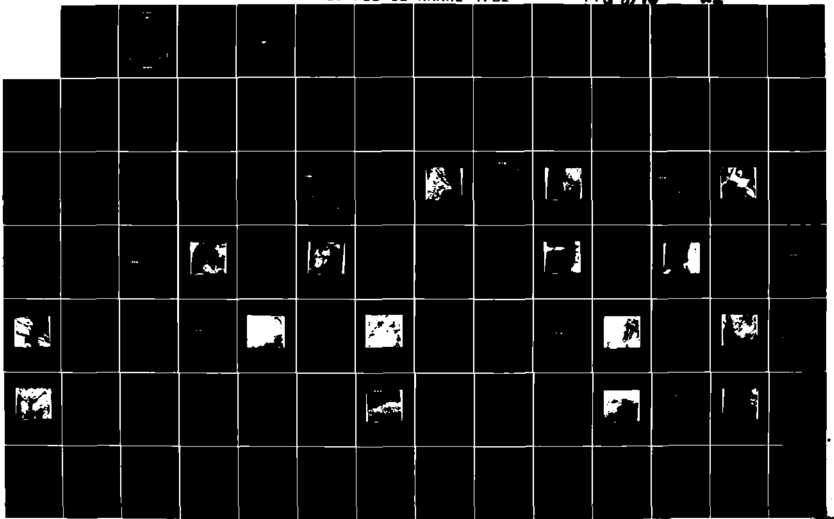

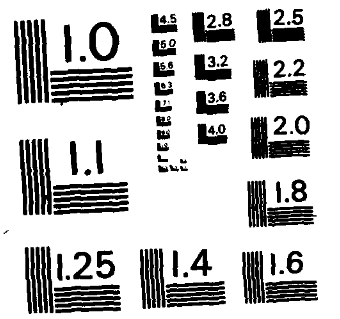

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EDGECLIFF, N.S.W.

RANRL REPORT No. 1/82

HIGH RESOLUTION SATELLITE OBSERVATIONS OF MESOSCALE OCEANOGRAPHY IN THE TASMAN SEA 1978-79
FINAL REPORT PROJECT HCM-051

BY

C.S. NILSSON, J.C. ANDREWS, M. HORNIBROOK,
A.R. LATHAM, G. SPEECHLEY & P. SCULLY-POWER

COPY No. 29

FEBRUARY 1982

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HIGH RESOLUTION SATELLITE OBSERVATIONS OF MESOSCALE OCEANOGRAPHY IN THE TASMAN SEA 1978-79

FINAL REPORT PROJECT HCM-051

C.S. NILSSON, J.C. ANDREWS[1], M. HORNIBROOK[2], A.R. LATHAM, G. SPEECHLEY AND P. SCULLY-POWER[3].

ABSTRACT

This report covers progress on NASA Project HCM-05I to 31 Mar 1981. Nearly 1000 standard infra-red photographic images have been received and of these, 273 images have been received on computer-compatible tape (CCT). It proved necessary to digitally enhance the scene contrast to cover only a select few degrees K over the photographic grey scale appropriate to the scene-specific range of SST. 178 images have been so enhanced. Comparisons with sea truth are made and we conclude that SST, as seen by satellite, does provide a good guide to the ocean currents and eddies off East Australia, both in summer and winter. This is in contrast, particularly in summer, to SST mapped by surface survey, which usually lacks the necessary spatial resolution.

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1. AIMS OF PROJECT HCM-051

The primary aim of this experiment is to determine whether the Heat Capacity Mapping Mission (HCMM) satellite infra-red (IR) imagery shows sufficient correlation with oceanographic sub-surface structure in the western Tasman Sea to provide a method of mapping the major currents in the area. There are two parts to this : firstly, the imagery must adequately show the sea surface temperature (SST); secondly, it is necessary to show that the SST adequately shows the major currents such as the East Australian Current (EAC) and Tasman Front.

A number of studies elsewhere (e.g. La Violette, Stuart and Vermillion, 1975) have shown that small changes in the grey shadings in infrared imagery do represent actual variations in SST. There were some serious doubts about the second part of this aim, however, particularly in summer when the interaction between the deep structure and SST can be hidden by newly warmed water. Further, past classical studies had indicated that there was little correlation between SST and deep structure (e.g. Hamon, 1968; Hamon, 1965).

Associated aims of this experiment, dependent on the primary aim being achieved, are to study the formation and evolution of mesoscale ocean eddies and to obtain a time series picture of the principal ocean fronts off East Australia over the period May 1978 - May 1979. The area covered by HCMM imagery for this project is shown in Fig. 1.

2. SATELLITE STANDARD PRODUCT IMAGE DATA RECEIVED TO DATE (31 MAR 81)

An edited list of data for which standad (un-enhanced) images have been received is given in Apendix C. The list is subdivided on the basis of image priority and status of computer-compatible tape (CCT) orders. A total of 952 standard IR photo. images have been filed, of which 140 have been classified as of no use to this project (priority "0") and a further 91 images are repeats, leaving 721 images of all useful priorities (AA, A and B). Assessment of image priority is discussed in Appendix A. Fifty eight of these images have been classified as of "low yield" (marked "R" for reject in the priority column) because of the small useful area of ocean surface visible, leaving a total of 663 IR (non-repeat) useful images of adequate quality to warrant further processing. The list of 717 images in Appendix C excludes the priority "0" images, but includes 21 of the repeats and 33 "low yield" images.

The distribution of these 663 images throughout the period May 1978 - May 1979 can be shown in an array of satellite cycle number (1-25) versus reference day (0-15 within each 16 day cycle). This is given in Table 1, where the number in each location is the number of useful IR images for that day. The intervals marked ... correspond to periods in which sea truth data were obtained. (See Table 2).

3. THE NEED FOR CONTRAST ENHANCEMENT

In some cases, for example sceme 124-1507-3 which is shown enhanced as Fig. 9 (images are shown positive, that is cold is white, warm is black), the oceanographic SST structure can be seen reasonably adequately in the standard product imagery . In other cases, for example scene 097-1504-3, no SST structure at all can be determined from the standard products. That scene is shown as standard and also enhanced in a previous report (Plates 2 and 3 in HCM-051 Progress Report to 31 Aug 80, Nilsson et al., 1980b). The crux of the problem lies in the manner in which the photographic grey scale is assigned. According to the HCMM User's Guide (Second Revision October 1980 p 86), a radiance histogram is determined for the whole scene and upper and lower radiance values are obtained at the 99.5% and 0.5% cumulative values. A linear contrast stretch (lower limit = 0, upper limit = 255) is applied to the data before image generation. Now, with reference to the original

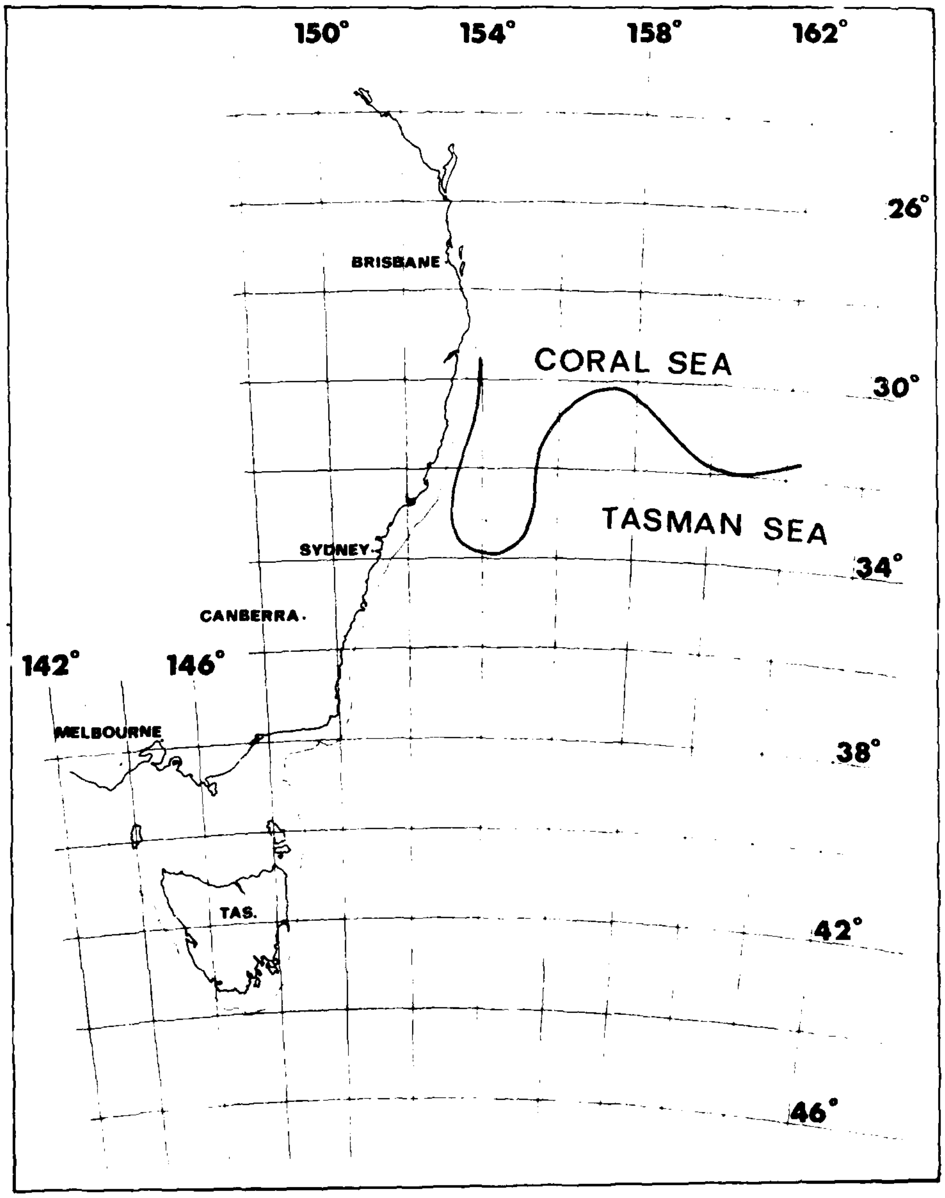

Fig. 1. The area covered by Project HCM-051.

SATELLITE REFERENCE DAY

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1															1	2
	2	2	3	1	1				1	1	2	7	4	2		2	6
	3	4	2				1		1	2	2	1	2	2	2	2	
	4	1	1		2	1		4		2	1	1	1		2	2	
	5	1	1	1		7	3	2	4	2	1	5	3	3	1		3
S	6	6	3	1	2	1	3	2	2	4	5	6	4	3	2	3	6
A	7	3	3	1		4				1	4	3	4	3		4	5
T	8	4	2		1	5	4	3	2			4	3	3			
E	9	2				3	2	3	1			1	2	3		2	5
L	10	3	1		3	2	6	4	2	3	3	6	[illegible]	3	1		4
L	11	3	5	1	3	5	5	4			3	7	3	[illegible]			4
I	12	2	1				4	2	4			4	3	2			
T	13	2	2		1		2		1		3	3	5	1	1	[illegible]	4
E	14	6	5	1	2	5	6	1		2	2	2	[illegible]	2		1	4
	15	2	4			1	1	1	1		1		2	3		4	1
C	16				3	3		2	2	1	3	7	6	1		3	2
Y	17	5	4	2	3		[illegible]	4	4	2	2	[illegible]	3	2	1		5
C	18	5	4	1		3	4	4	2		4	4	4	3	1		1
L	19		3		2	2	[illegible]				2	3	3	1		[illegible]	5
E	20	3	2			2											
	21						3	2			2	1	1			[illegible]	
	22		1			2							3	2		[illegible]	3
	23	3									2	1				1	1
	24	1	1		3	2	1				1						
	25																

....INDICATES GROUND TRUTH MAY BE AVAILABLE.

Table 1. The distribution of 663 useful standard product images as a function of satellite cycle and reference day. Cycle 1 Ref. day 0 is 27 April 1978.

CRUISE IDENT	HCM DAYS	LAT RANGE	EAST LONG.
SP 08/78	026-041	-34-40	155
SP 09/78	043-054	-30-35	157
SP 10/78	085-100	-31-34	155
K 14[illegible]/78	092-100	-30-34	155
SP 11/78	101-114	-26-34	162
AXBT 01	125-126	-30-35	162
DM 6A/78	131-138	-30-34	171
DM 6[illegible]/78	140-145	-28-34	173
SP 12/78	142-149	-34-43	153
SP 13/78	150-165	-44-53	151
SP 14/78	170-176	-34-40	152
SP 15/78	205-217	-25-37	153
SP 16/78	218-226	-34-37	153
SP 17/78	227-229	-32-35	154
AXBT 02	231-231	-30-35	160
AXBT 03	288-288	-25-34	160
K 5A/78	291-296	-27-34	158
K 148/78	299-309	-27-34	155
DM 02/79	316-321	-33-34	150
SP 02/79	322-325	-34-34	154
SP 03/79	326-336	-23-34	155
SP 04/79	337-350	-31-32	153

Table 2. Sea truth data obtained wholly or partly in support of Project HCM-051. The cruises prefixed with "SP" are CSIRO cruises using R.V. SPRIGHTLY. The western boundary of each cruise area is assumed to be the east coast of Australia; "EAST LONG" is the approximate eastern boundary of the cruise or survey areas.

adian values 0-255, if the image contains appreciable cloud, as is generally the case, the lower limit will often be close to 0 (HCM temperature 260.0 K). For images of use to this project, the upper limit will be set by the warmest SST. Typically this will be 285 K, being warmest for the northernmost images. The grey scale is uniformly divided into sixteen steps between the upper and lower limits. For scene 097-1504-3 (no SST structure visible) the standard image was spread across 1-66 (260.5 - 286.1 K), that is across 25.6 K, whereas for scene 124-1507-3, the cloud was apparently lower and the 0.5% limits were 11-59 (264.9 - 283.6 K). Thus the grey scale covered a temperature range of 18.7 K. Obviously, the smaller this range, the more chance of seeing SST structure in the standard product. This therefore depends on the latitude of the image, the intensity of the oceanographic fronts and the presence or otherwise of high level cloud. Even in favourable circumstances, the best one can hope for is about 1 K per grey scale step (i.e. 1/16 total range).

Having seen something in the image, one then faces the problem of communicating this to other people. Ultimately, this involves reproducing the image, generally through a half-tone to some final printing/copying process. One is luckly to end up with 4-6 discernable tones in the finished product. At this level, the standard images will only (on reproduction) shows fronts of at least 4 K, which is insufficient by about a factor of 4. Our present understanding of the oceanography of the EAC area is such that one needs to see down to 0.3 K and be able to reproduce for widespread viewing changes of 1 K.

The images reproduced in this report have all been enhanced at 0.33 K per grey scale step. The useful portion of the grey scale at the time the enhanced image is studied covers about 10 steps. The reader may decide for him/herself how many separable steps have survived the reproduction process in this document.

4. DEVELOPMENT OF ENHANCEMENT METHODS

Enhancement at 0.33 K per step seems reasonable for HCMM imagery. The nominal noise figure for the data (incl. telemetry) is 0.4 K. Allowing for the fact that the eye will integrate over a number of pixels, so reducing the apparent noise level, one should be able to enhance down to or below the nominal noise figure. Noise can be seen across the prinicpal eddy (eddy J) in Fig. 14, but it is not obtrusive. At any given latitude, the spread of SST across the 800 km of image width is typically about 3-4 K. Thus a black and white image can be generated with about 9-12 grey scale steps (between black and white) at 0.33 C per step covering that range of SST. The picture is complicated by the fact that SST varies with latitude and a HCMM image covers a little more than 6 latitude. In the EAC area, the SST might change up to 5 K with this latitude change. To accommodate this change with latitude, superimposed on which there is the 3-4 K mesoscale variation, most of the images enhanced early in the project were done at 0.5 K per grey scale step. That is, for each image a suitable mid-range temperature (MRT) was obtained from the CCT and the image was digitally enhanced such that 10 = MRT-7.0 K and 255 = MRT +2.5 K. Details of this procedure were given in the first HCM-051 Progress Report (Nilsson et al. pp 28-30, 1980a). Such a process resulted in the useful portion of the grey scale covering about 10 steps over the range (at 0.5 K per step) MRT ±2.5 K. It was apparent, however, that even higher constrast was needed for successful reproduction of many of the SST features of interest. For example, in Section 8 we discuss eddy F, visible in Fig. 14 as a ring of slightly warmer water about 250 km diameter centred about 36:30 S 152 E. This ring was only barely visible to the trained eye when the image was first enhanced at 0.5 K per step, but becomes moderately clear at 0.33 K per step.

The best mid-range temperature (MRT) to use will generally decrease with increasing latitude for any given image. It is not a rapid function - about 0.6 K per degree of latitude would be typical. Fig. 2 shows the mean temperatures in August down 160 E at 25m and 250m depth. At 25m (say SST), the mean temperature drops 9 C in 15 latitude. Note that apparent HCMM temperatures will be about 10 C less than these, because of the 5.5 C calibration offset and about 4 C loss through atmospheric absorbtion (Barnes and Price, 1980).

If we consider the HCMM images in their 'uncut' form, that is, as a continuous 800 km wide swath from 25 S to 45 S, it is clear that no single MRT value will accommodate the necessary contrast enhancement. The solution is to allow the MRT value to vary continuously with latitude - this is simply the equivalent of removing the overall trend in temperature with latitude and leaving, for enhancement, the mesoscale anomalies. The first crude approximation of this is to use separate but constant MRT values for each image (decreasing with higher latitude) which at least leaves each separate image with a grey scale that is the equivalent of an absolute temperature scale. At 0.33 K per grey scale step, however, as we have seen, each image covers too much latitude for the dynamic range of a black and white photographic image. Also, if we attempt to recreate the original uncut image (2200 x 800 km) by placing successive enhanced images together, the grey scales will not match at the boundaries. If, however, we allow MRT to vary continuously with latitude, these problems are solved. Consider the pair of scenes 125-1523-3 (Fig. 10) and 125-1525-3 (Fig. 11). In scene 125-1523-3 the MRT value has varied linearly from 9.3 C (HCMM temperature) at the top of the image down to 7.7 C at the bottom. The next scene, 125-1525-3 (Fig. 11) has been enhanced around a MRT value which varied from 7.7 C at the top of the image (to match the boundary with the preceding image) down to 5.3 C at the bottom. By doing this, note that both images show the SST variations within a useful part of the grey scale both at the

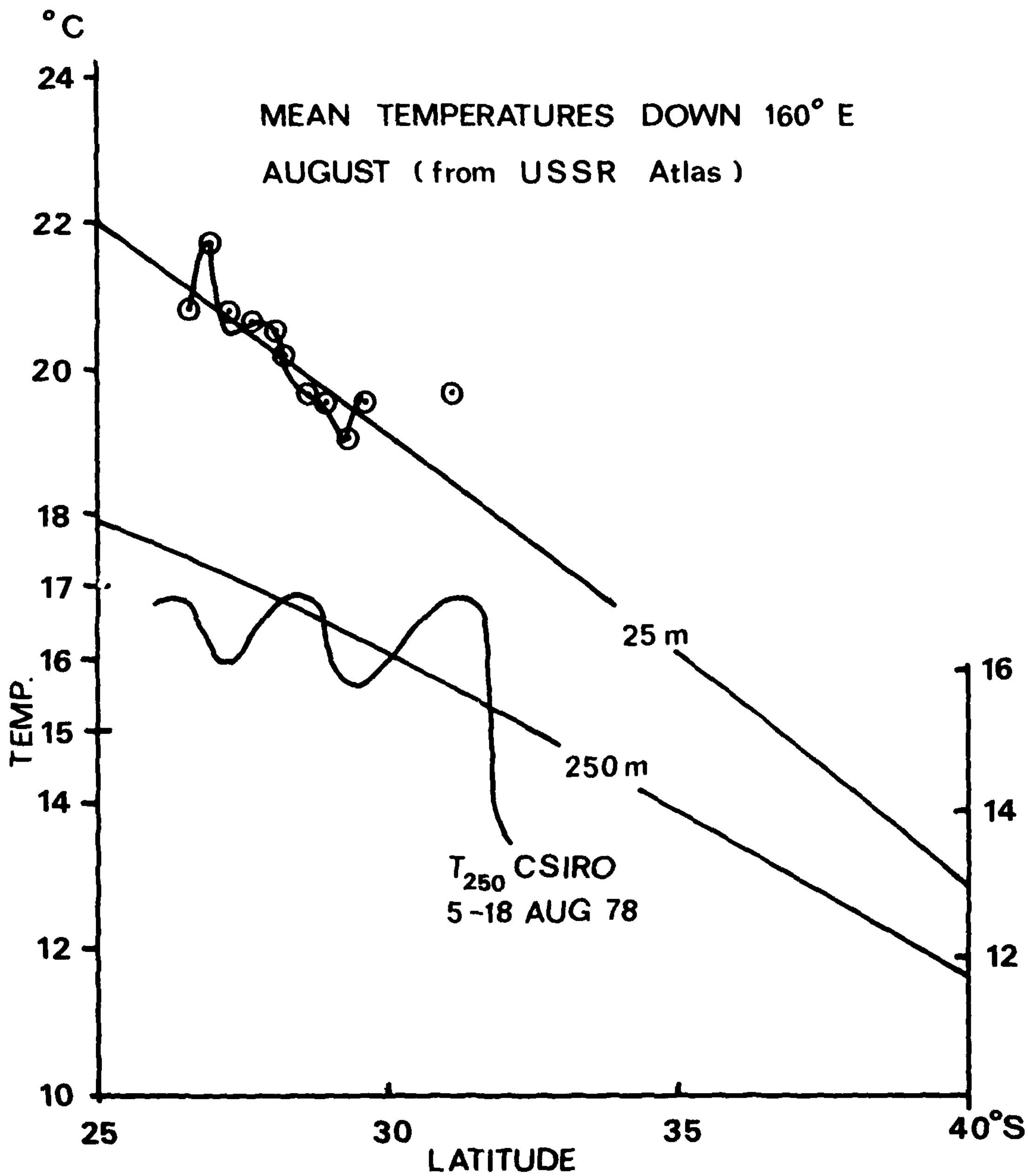

Fig. 2. Temperature variations with latitude down 160°E (from USSR Atlas). Data from CSIRO Cruise SP 11/78 are superimposed. Note the high value of T_{25} followed by the sharp drop in T_{250} at about 32°S as the Tasman Front is crossed.

top and bottom of the images. The price of this technique is that the grey scale no longer represents a simple absolute temperature range, but rather one that varies with latitude. The image is no longer a simple representation of absolute temperature, but rather one of temperature anomaly.

Images so enhanced have the caption reading "mrt varying from... to...deg". The power of this technique to show the SST structure down the whole image is illustrated well by Fig. 7, which utilises a change of 3.3 K in MRT. Even a change in MRT of 5 K from top to bottom of one image is only a change of 0.0035 K per line. We have stepped the MRT value every 20 lines, which, for such a change, amounts to steps of only 0.07 K. These steps are obviously not visible on the resultant images.

As outlined above, the MRT value is constrained to a constant gradient with latitude down each image, generally changing gradient at the north/south boundaries of each image. While the real variation of mean temperature with latitude can quite reasonably be approximted in a piecewise linear manner, the changes of gradient in general will not best be made at the arbitrary boundaries of each image. For example, in Fig. 11, the warmest SST occurs in the eddy about half-way down the image. The result of allowing the MRT value to decrease linearly from the bottom value of the preceding image (Fig. 10), that is 7.7 C, to the bottom value of the image in question (Fig. 11), that is 5.3 C, is to have an MRT value of about 6.4 C in the vicinity of the eddy, which is too low. The image has saturated in the vicinity of the eddy in this scene, causing loss of detail, particularly near the coast north of the eddy. Images are now enhanced by allowing the MRT value to vary in a piecewise linear manner with latitude as before, but its value is specified at the top, bottom and at some intermediate line number down the image. Thus changes in MRT gradient (although always keeping MRT monotonic with latitude) are allowed at an intermediate line number. In

Fig. 11 for example, a break point in the gradient should have taken place halfway down the image, not at the top. We are presently studying more thoroughly the way in which SST - as observed by HCMM - varies with latitude so that the enhancement parameters can be related in a regular manner with latitude and time of year. This is beyond the scope of this report.

5. THE AVAILABLE DATA SET

Table 1 listed the 663 potentially useful HCMM scenes over the period May 1978 - May 1979 for which CCTs could usefully have been ordered. However, that number proved too many for either NASA/GSFC to deliver or for us to process. Hence, although this number was not known to us at the start of CCT processing, it was quickly apparent that a priority system would have to be applied. Late in 1979, when only a small portion of the standard products had been received, it was simply a matter of classifying images as "good" or "bad". CCTs were ordered for "good" images. There were no real guidelines for how many CCTs could be ordered or processed. Most of the early images processed subsequently came to be assessed as priority B, the lowest and marginally most common rating. Early in 1980, when the number of CCTs likely to be ordered was seriously questioned on both sides, the present three-level priority system (AA, A and B) was quickly developed. Since then, no more priority B images have been ordered as CCTs. The highest priority was assiged on the basis of potential comparison with sea truth data, as is explained more fully in Appendix A. Such comparisons were held to be the most important aspect of the project. Standard product data seemed to arrive in more or less random groups. The same comment applies to CCT data. Attaching priorities to pieces of a jigsaw puzzle of unknown size and content that are appearing randomly is a very chancy matter. One is never quite sure what will turn out to be important.

This is not meant as a project criticism, rather it is a note of explanation of the factors that determined the data set of enhanced images available for this report. The emphasis is on comparison with sea truth rather than following the most exciting events that we happened to see.

All 178 images enhanced to date are listed in an array of satellite cycle v. satellite reference day in Table 3. Cycle 1 day 0 is 27 Apr 80. The periods marked ... indicate when sea truth data were obtained somewhere. The table has no provision for geographical location, so in many cases coincidence of position is lacking for comparison with sea truth.

Table 4 shows the distribution of the 117 useful standard product images that contain the position 33 S, 153 E which is just offshore of Sugarloaf Pt. It is in this vicinity that the EAC most often leaves the coast (Godfrey et al., 1980), so these images are of particular interest. Because of the position constraint, one can see that certain reference days are favoured (e.g. ref. 9,10,11) and for others the ground path does not allow an image (e.g. 7,8). The periods of sea truth marked in the table have now been selected on the basis of the survey area containing the position in question, namely 33 S 153 E. Thus, with respect to the aim of observing the EAC, Table 4 shows the pertinent standard product data set. If we now confine ourselves to those images in Table 4 that have been enhanced, the list becomes restricted to 38 images distributed according to Table 5. Thus, we have enhanced about one in three of the relevant images and, on the average, there is one relevant image (sufficiently cloud-free to be useful) every three days. The enhanced set presently consists of about one image every nine days distributed preferentially towards the periods when sea truth is available. Ten of the images reproduced in this report are from this set.

```
                          SATELLITE REFERENCE DAY

             0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15
    1
    2          1                   ......................
    3   ...........................   ....2..1..2..2.....
    4   .1..1............. 4           1  1     2  2
    5    1     1     4     1           2
S   6    1     1    ....3..1..1..1..2..4..2...........7.
A   7   .2..1........1..............1..3...........'..2.
T   8   .1..2.    1  5  3  3           4  2 .5....
E   9         ..........2..2.......... 1 ..........2..3.
L  10   ................4..1..2..2.....3.....1........2.
L  11   ....3..........            ..........1........2.
I  12    2              2  2  1        3  1
T  13                               4  4    .1..1..'.....
E  14   ..........2........1.....2.....2...........1....
   15   ....1.......... 1 .1.                5
C  16
Y  17
C  18                                           1    .1.
L  19       3 ....2..2...........     .2.....1.....2..2.
E  20   .3...........1.                   ...............
   21   .................................................
   22   ...........................................
   23
   24
   25

           ....INDICATES GROUND TRUTH MAY BE AVAILABLE.
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Table 3. The distribution of the 178 enhanced images as a funtion of satellite cycle and reference day. Cycle 1 ref. day 0 is 27 April 1978.

```
                    SATELLITE REFERENCE DAY

         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15
     1
     2      1                       1  1  1           1
     3   1                          1 .1..1........1....
     4  .1..1........1.... 1                       1
     5   1           1     1           1     1
S    6   2  1       ................1..1..1........1..1.
A    7  .2..1........1..............1.....1..1.....1..1.
T    8  .1..1.             1           1  1 .1....
E    9        .............1..........   .............1.
L   10  .1.             1  1        1  1  2  1        1
L   11      1        1  2  1       .1..1.....1........1.
I   12   1              1  1
T   13                              1     1 ............
E   14  .1..1........1..1.......... 1     1        1  1
    15   1  1 .........   ...       1     1  1     1
C   16                     1        1  1  1        1
Y   17      1              1        1     1           1
C   18   1  1        1  1           1  1  1          .1.
L   19      1 .......1..........    1 .1..1..1........2.
E   20  .............1.                  ...............
    21  ...            .1...........1..1...........1....
    22               1                 1              1
    23
    24                              1
    25

         ....INDICATES GROUND TRUTH MAY BE AVAILABLE.
```

Table 4. The distribution of the 117 useful standard images that contain the position 33°S, 153°E as a function of satellite cycle and reference day.

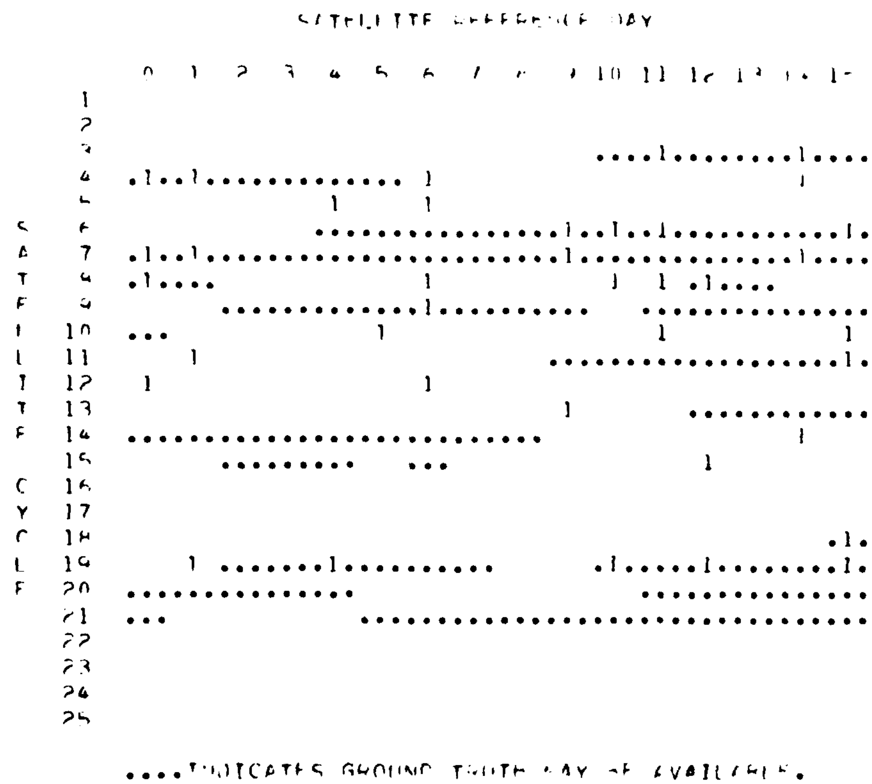


Table 5. The distribution of the 38 enhanced images that contain the position 33°S, 153°E as a function of satellite cycle and reference day.

SATELLITE REFERENCE DAY

SATELLITE CYCLE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1																
2				1					1	1	1				1	1
3	1					1								1	1	
4	1			1					1		1			1	1	
5	1				1	1			1					1		1
6	1			1	1				2		1			1	1	1
7	1				.1.	.	.	.	.	.1.	.1.	.	.	.	.1.	.1.
8	.1.	.	.	1		2					1		.	.		
9			.	.	.	.	.	.	.	.		.	.	.	.1.	.2.
10	.1.			1	1	1			1	1				1		
11				2		1					1					1
12						1					1					
13										1	1				1	1
14	1			1	1	1			1	1					1	1
15	1				1		.								1	1
16				1						1	1				1	1
17				1		1			1	1	1	1				
18	1					1				1						.
19				1						1					1	
20					1							.	.	.	.	.
21	.														[illegible]	
22															1	
23																
24				1												
25																

....INDICATES GROUND TRUTH MAY BE AVAILABLE.

Table 6. The distribution of the 97 useful standard images that contain the position 33°S, 159°E as a function of satellite cycle and reference day.

SATELLITE REFERENCE DAY

SATELLITE CYCLE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1																
2																
3														1	1	
4	1										1			1	1	
5																
6									1		1					1
7					•1•	•••	•••	•••	•••	•1•	•1•	•••	•••	•••	•1•	•1•
8	•1•	•••		1		1					1		•••	•••		
9			•••	•••	•••	•••	•••	•••	•••	•••		•••	•••	•••	•1•	•1•
10	•••					1			1							
11																
12						1					1					
13										1	1				1	
14				1					1						1	1
15							•••									
16																
17																
18																•••
19				1											1	
20												•••	•••	•••	•••	•••
21	•••															
22																
23																
24																
25																

....INDICATES GROUND TRUTH MAY BE AVAILABLE.

Table 7. The distribution of the 33 enhanced images that contain the position 33°S, 159°E as a function of satellite cycle and reference day.

If we consider an area further east, say 33 S 159 E, there are 97 useful scenes distributed as shown in Table 6. It is in this area that we would look to track the Tasman Front away from land. Again, about one in three of these have been enhanced, namely 33 scenes distributed as shown in Table 7. Note that the sea truth is much more limited than that closer to land. Table 6 shows the distribution of scenes that we might hope to use to map the Tasman Front, Table 7 indicates that we presently hold an insufficient number for a useful time series.

6. THE OCEANOGRAPHIC ENVIRONMENT EAST OF AUSTRALIA.

The oceanography of the western part of the Tasman Sea, adjacent to thee south-eastern coast of Australia, is dominated by the East Australian Current (EAC) and intense warm-core mesoscale eddies. The formation and evolution of several of these eddies were closely studied over the period August 1976 - February 1978 by Nilsson and Cresswell (1980) using satellite-tracked buoys and ship surveys. The pattern of eddy formation observed is illustrated in Fig. 3. Three eddies, labelled A, B and C, formed by three poleward meanders of the EAC pinching off over an eighteen month period. Eddy A appeared to escape to the south-east from the system, but eddy B coalesced with the EAC after about eleven months of mostly independent existance and eddy C only survived as a separate entity for a few months at the most. The Tasman Front marks the boundary between the Coral Sea and the cooler Tasman Sea.

Stanton (1976) studied the relationship between the Mid-Tasman Convergence (since called the Tasman Front by Denham and Crook (1976)) and the winter circulation near the Norfolk Ridge. He states "A strong zonal flow along the Mid-Tasman Convergence was observed which in many ways supports Warren's (1970) hypothesis of a zonal jet connecting part

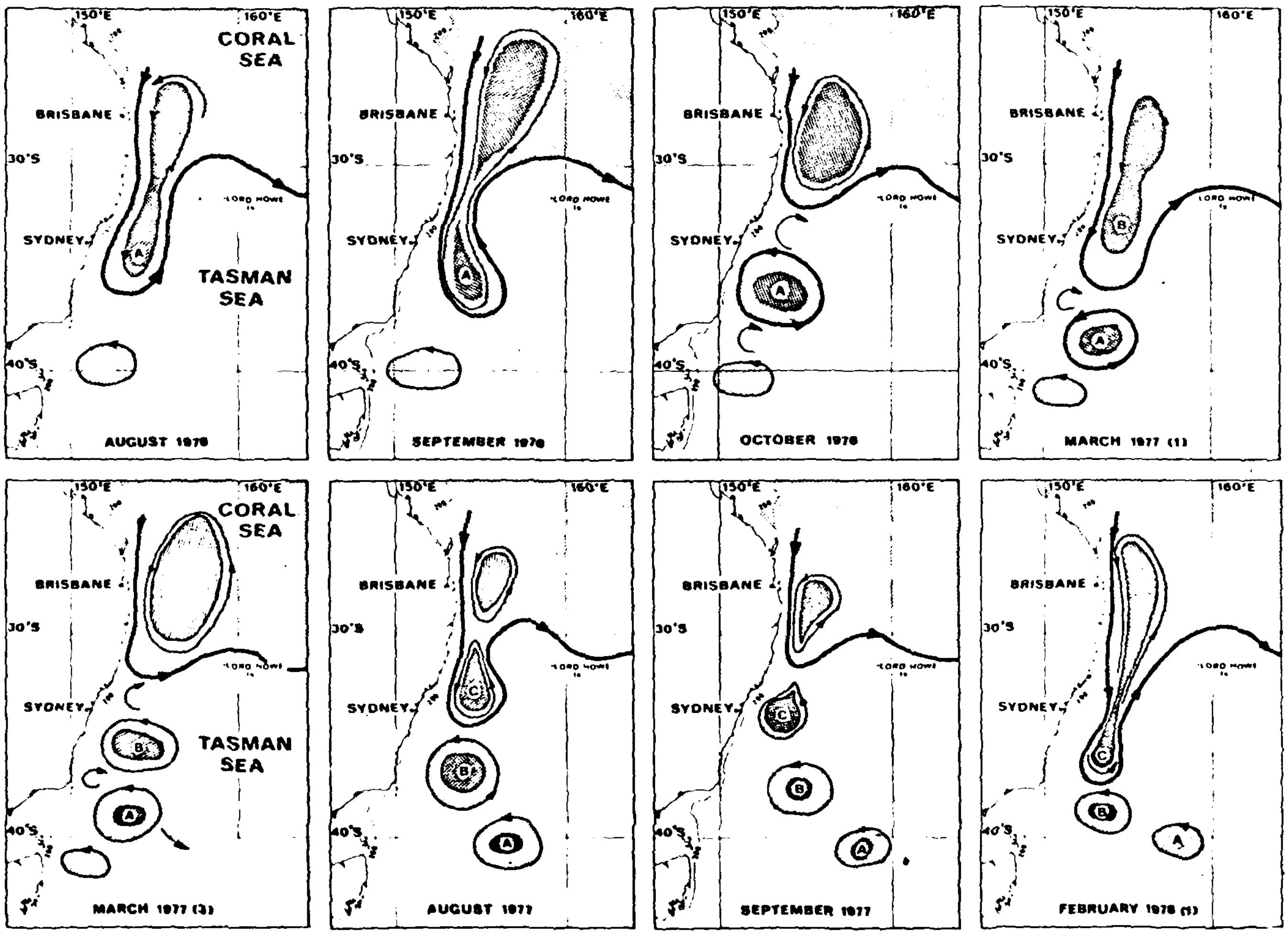
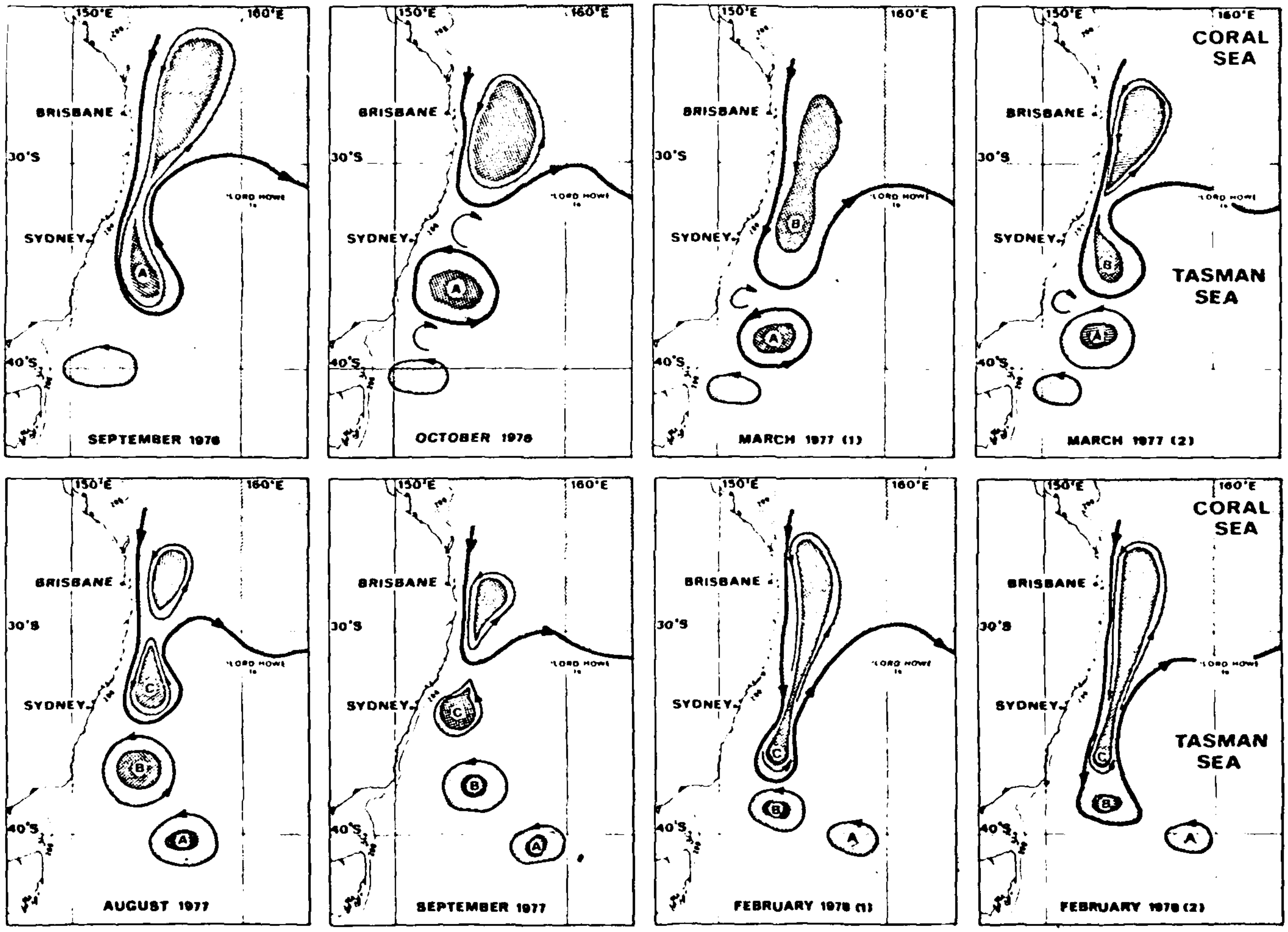


Fig. 3. A summary of the observations of eddies A, B and C over the period August 1976 through February 1978. The heavy line marks the division between the Coral Sea water (T_{250} > 15 C) and Tasman Sea water (T_{250} < 15 C). The most heavily shaded areas represent the regions of highest dynamic height (T_{250} > 17 C). From Nilsson and Cresswell, 1980.



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ea water ($T_{250} > 15$ C) and Tasman Sea water ($T_{250} < 15$ C). The most
shaded areas represent the regions of highest dynamic height ($T_{250} > 17$ C).
lsson and Cresswell, 1980.

of the East Australian Current to the weaker western boundary currents off the east coast of New Zealand." Recent work by Andrews, Lawrence and Nilsson (1980) shows that indeed part of the EAC flow meanders east around 30-34 S to north of New Zealand and forms the Tasman Front. Stanton examined the front in terms of barotropic Rossby wave theory and, using the dispersion relationship of Longuet-Higgins (1964) calculated a theoretical westward phase velocity component of 2.8 cm s-1 at latitude 33 S. He compared that value favourably with an estimated westward frontal movement of 3.3 cm s-1 found from a short period of observations. However, there was nothing to suggest that the observed frontal movement was anything but baroclinic, hence the comparison was not strictly valid.

Andrews, Lawrence and Nilsson looked at the Tasman Front in terms of a linear baroclinic wave model. The westward phase speed at 35 S was calculated to be about 1.6 cm s-1, but they concluded that non-linar processes were important in any dynamical interpretation of the Tasman Front, so the calculated phase speed could be in error. The importance of non-linearity near the East Australian coast has also been stressed by Godfrey (private communication, 1979). Motions of the EAC front near East Australia have frequently been observed in various directions, particularly south, at speeds up to 15 km day-1 (e.g. during the formation of both eddy A and eddy B).

Stanton (1976) found an average meander wavelength of 240 km. Andrews et al. found the zonal wavelength to be about 370 km. If we accept about 300 km for a mean wavelength and assume a westward propagation speed of 2.0 cm s-1 we find a mean period for the westward propagation of about 170 days, that is, about the period observed for eddy formation 1976-78.

A simple picture of eddy formation off East Australia along these lines is shown in Fig. 4. Referring to that figure, the westward phase

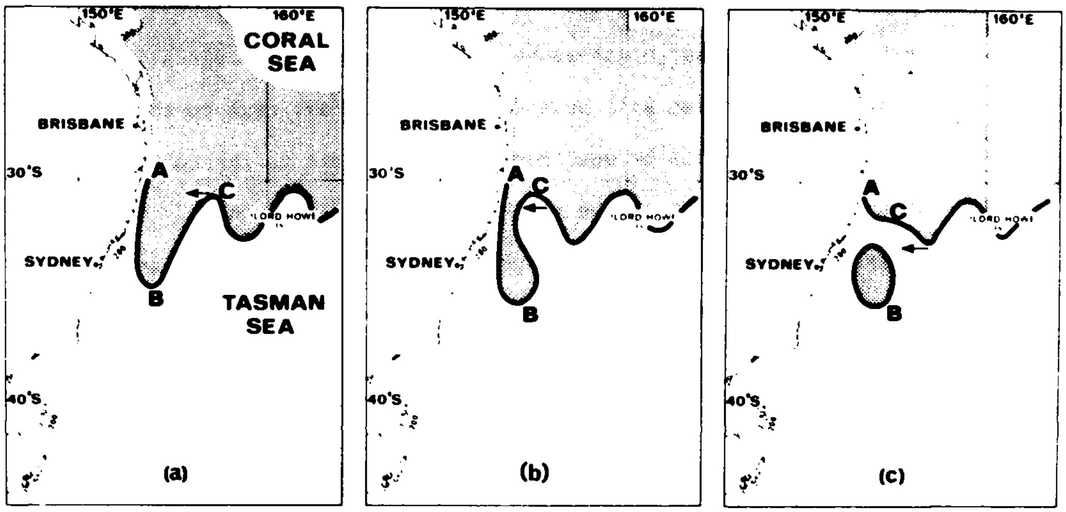


Fig. 4. An illustration of how the westward propagation of the Tasman Front might control the flow of the EAC and cause warm-core eddies to pinch off. From Nilsson and Cresswell, 1980.

propagation of the baroclinic wave is constrained by the East Australia boundary. The wave crest C propagates westward to cause the meander B to pinch-off and form a closed and separate eddy. The EAC front AC reforms north of the eddy and the process begins again. Occasionally northerly currents are reported along the shelf edge (e.g. Pearce, 1978) around latitude 32 S and such reverse currents could well be manifestations of phase reversal following the eddy pinch-off. Furthermore, as the phase of the wave near the East Australian coast is largely restricted to a near north-south flow, one can easily visualize that the most intense eddies will be those that pinch-off next to the coast. The wave motion will be most non-linear adjacent to the coast and the production of eddies can be regarded as a result of that non-linearity, somewhat analogous to waves breaking. Further eastward the waves are free to move westward and so, if eddies do separate from the wavefront, they will be of lesser intensity. Also as only warm closed eddies appear to form next to the coast, there will be a tendency for cool cyclonic eddies to form half a wavelength further out.

We expect the EAC and its continuation, the Tasman Front, to appear as a surface temperature front all year round because warmer water is being moved southward and eastward into cooler surrounds. It has also been shown that, due to heat loss to the atmosphere, the core regions of separated eddies will show a positive surface temperature anomaly in winter of as much as 3 C (Nilsson and Cresswell, 1980). We would thus expect to see these quite clearly in the HCMM data. In summer, however, new surface heating will tend to hide sub-surface oceanic structure. The ability to determine sub-surface structure from surface thermal data basically depends on the degree to which the surface interacts with the deep structure. Non-advective interaction is stronger in winter in a cooling situation (convective mixing) than in summer (surface heating). However, changes in deep temperature structure will give rise to associated currents that result in advection. This in turn will generally give rise to changes in surface temperature regardless of the season. It is a historical fact, however, that in the EAC area surface temperatures have not been regarded as a good guide to dynamic topography (e.g. Hamon, 1968).

7. COMPARISON OF HCMM IMAGERY AND SEA TRUTH

Six oceanographic surveys by ships in the Tasman Sea in support of HCM-051 were undertaken by the Australian Defence Science and Technology Organisation (DSTO). Four surveys by Royal Australian Air Force Orion aircraft in direct support of HCM-051 using air expendable bathythermographs (AXBTs) were carried out, three of these successfully (Lawrence, 1980). In addition, the Commonwealth Scientific and Industrial Research Organization (CSIRO) carried out twelve research cruises during the HCMM period to study the Tasman Front and its associated warm-core eddies. These surveys are listed in chronological order in Table 2.

In the following presentation, the results of sea truth surveys are shown in the form of overlays to the appropriate HCMM images. In each case the sea truth data have been plotted to the same scale as the HCMM images, namely Hotine Oblique Mercator. Fig. 5a. shows the dynamic topography D(0/1300) ascertained from the CSIRO cruise SP9/78 over the period 8-19 June 1978. As in the case of an atmospheric isobaric contour map, the strength of the geostrophic flow (current) is proportional to the gradient of the dynamic height and is parallel to the contours. Historically, the main axis of the EAC is reckoned to be in the neighbourhood of the 190 dyn cm level, which corresponds approximately to the contour where the temperature at 250m depth T250 = 15 C.

HCMM image 047-0347-2 for 12 Jun 78 is shown as Fig. 5b. As with all the images shown here, cold is white and warm is dark. Clouds are completely white; a night-time image (GMT 1400-1530) generally has the cooler land enhanced to white whereas for a daytime image (GMT 0300-0430) the land is generally warmer than the sea and usually is enhanced to black. To avoid confusion, unless otherwise stated, temperatures referred to will be HCMM apparent temperatures which, over the sea, are about 10 C cooler than the true sea-surface temperatures (SST). This difference is comprised of a nominal 5.5 C instrument offset on the cool side (Barnes and Price, 1980) and usually more than 4 C atmospheric absorbtion.

Fig. 5 shows that the dynamically high area (D >190 dyn cm) correlates well with the tongue of warmer Coral Sea water (dark) extending south into the cooler Tasman (light). Eight days later on 20 Jun 78 (Fig. 6b) the warm tongue of water still correlates closely with the same cruise data. In this instance, it appears that the tongue was mainly stationary over the period 12-20 June and the cruise data are reasonably synoptic.

Fig. 7a shows the SST plotted from XBT data from CSIRO cruise SP11/78 5-18 Aug 78. The data were obtained by Hamon and Golding (private communication) and contoured by us quite independently of the dynamic topography (Fig. 7b). Thirteen days is too long for the data to be termed synoptic; however in the past oceanographers have had little choice but to contour the data as if they were. In this case, Fig. 7a suggests a tongue of warm water adjacent to the shelf and extending south in the vicinity of 30 S 156 E . The dynamic heights, however, present a somewhat different picture . Fig. 7b shows the topography contoured by Hamon and Golding and presented by Boland and Church (1981). These contours show a strong EAC turning eastward at about 31 S, 155 E. The flow appeared to split at about 30 S, 158 E and there appears to be some flow to the north while the remainder meanders eastward. The shaded area indicates the flow of warm surface water, but

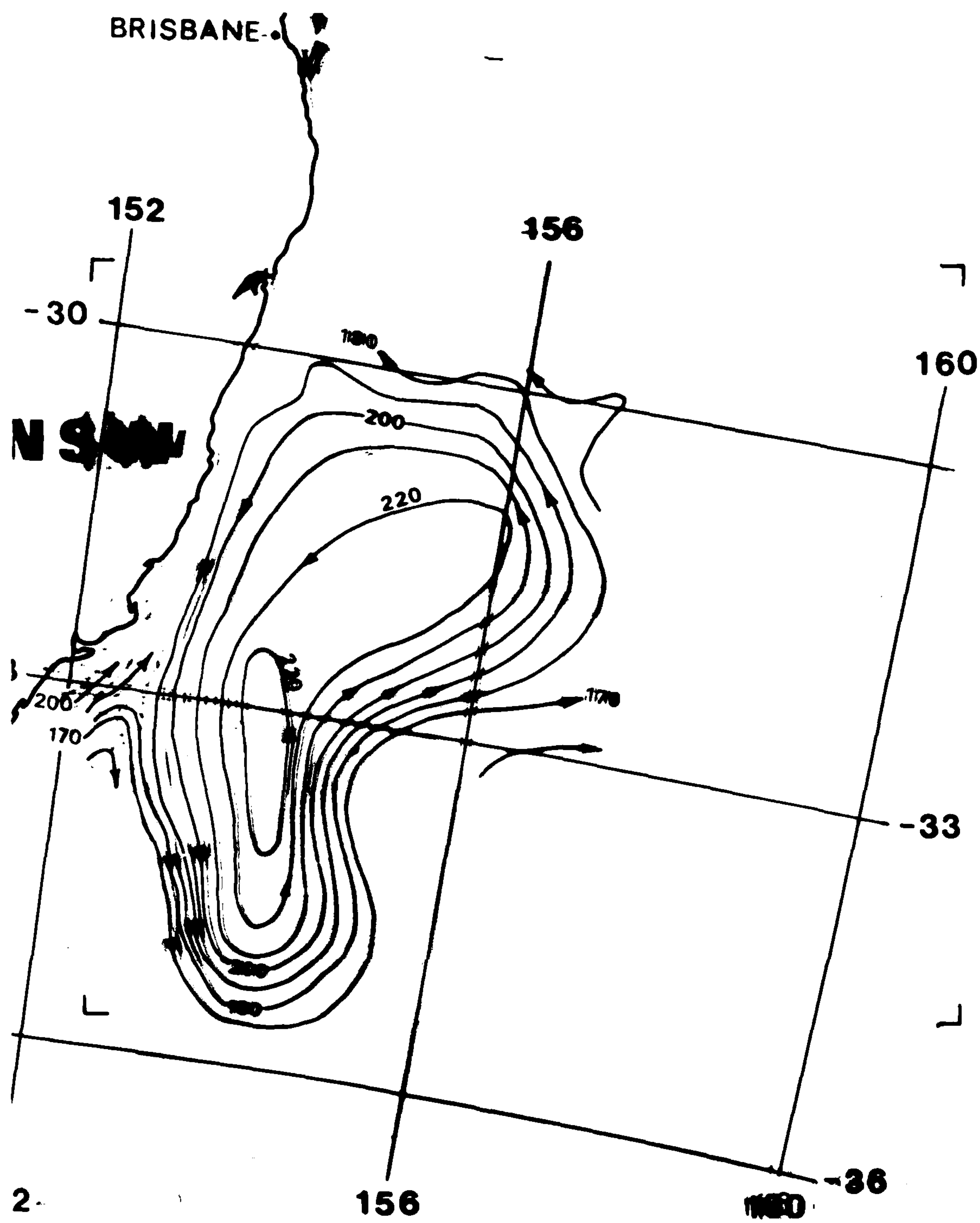


Fig. 5a. [illegible]namic topography 0(0/1300) dyn cm from CSIRO Cruise SP 9/78 8- 19 June 1978. From Boland and Church, 1980.

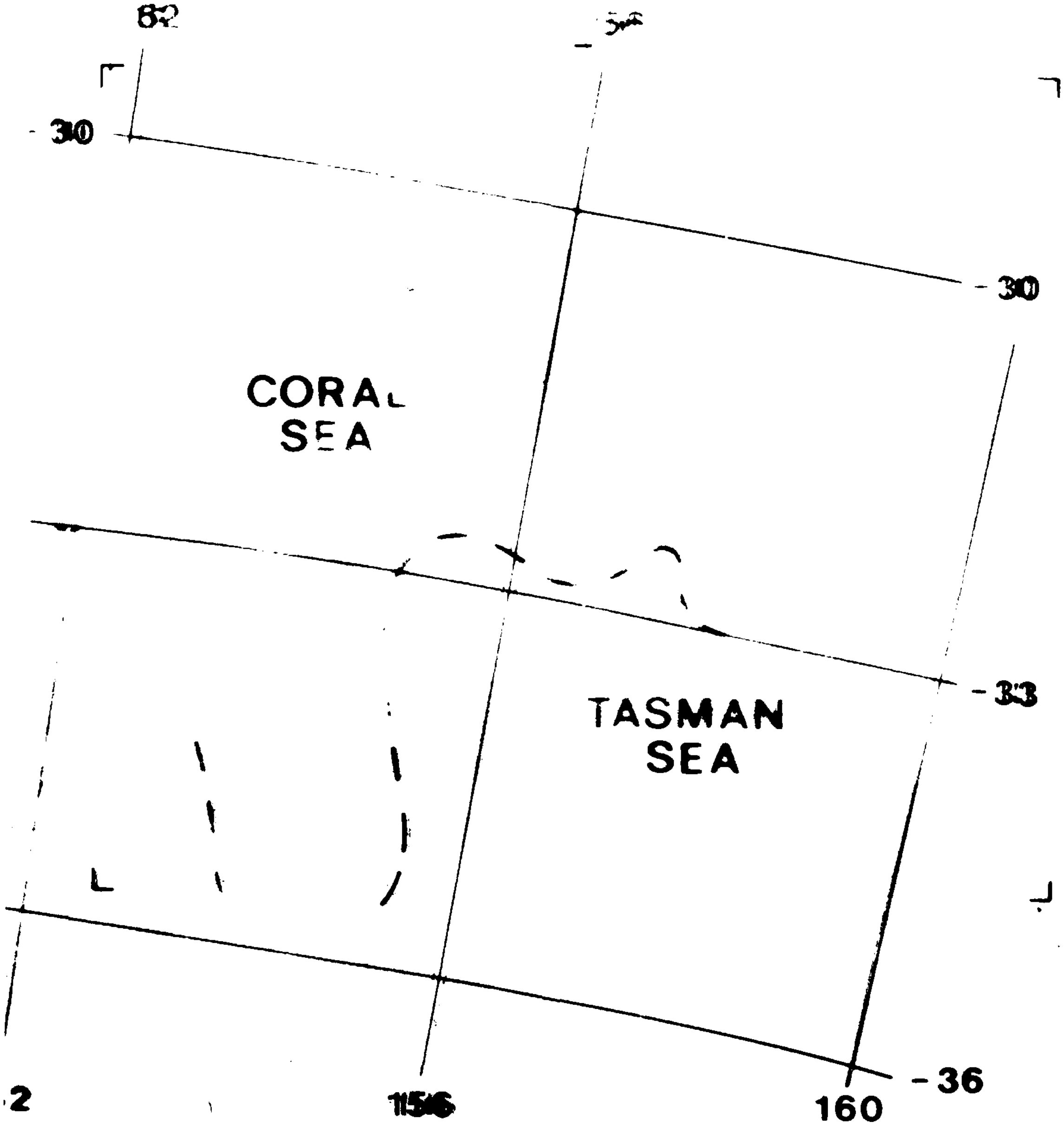


Fig. 15. [illegible] surface [illegible] Tasman Sea water [illegible]
determined [illegible]

Overb [illegible]
[illegible]


MRT VARYING FROM 10.50 TO 12.50 DEG.

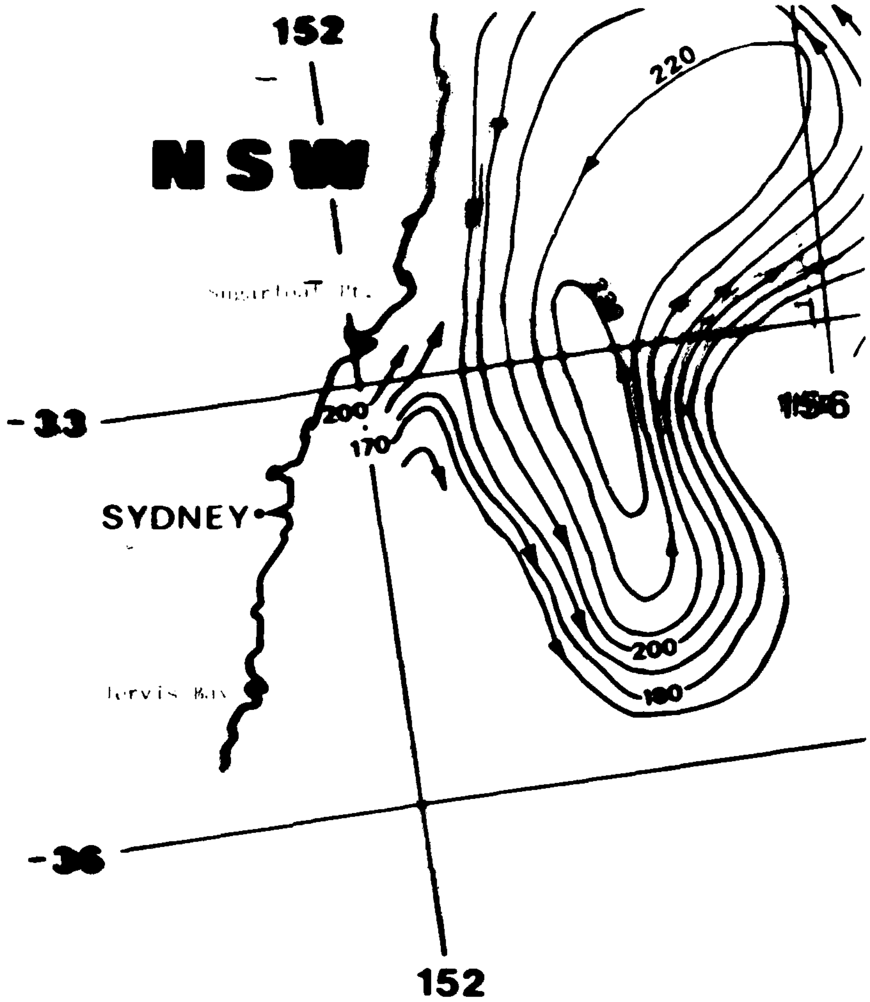
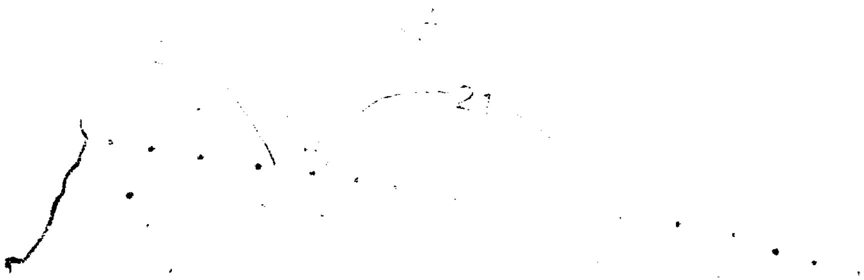


Fig. 6a. Dynamic topography D(0/1300) dyn cm from CSIRO Cruise SP 9/78
8- 19 June 1978. From Boland and Church, 1980.

Fig. 6b (Over). Enhanced image HCM 055-1525-3 for 20 June 1978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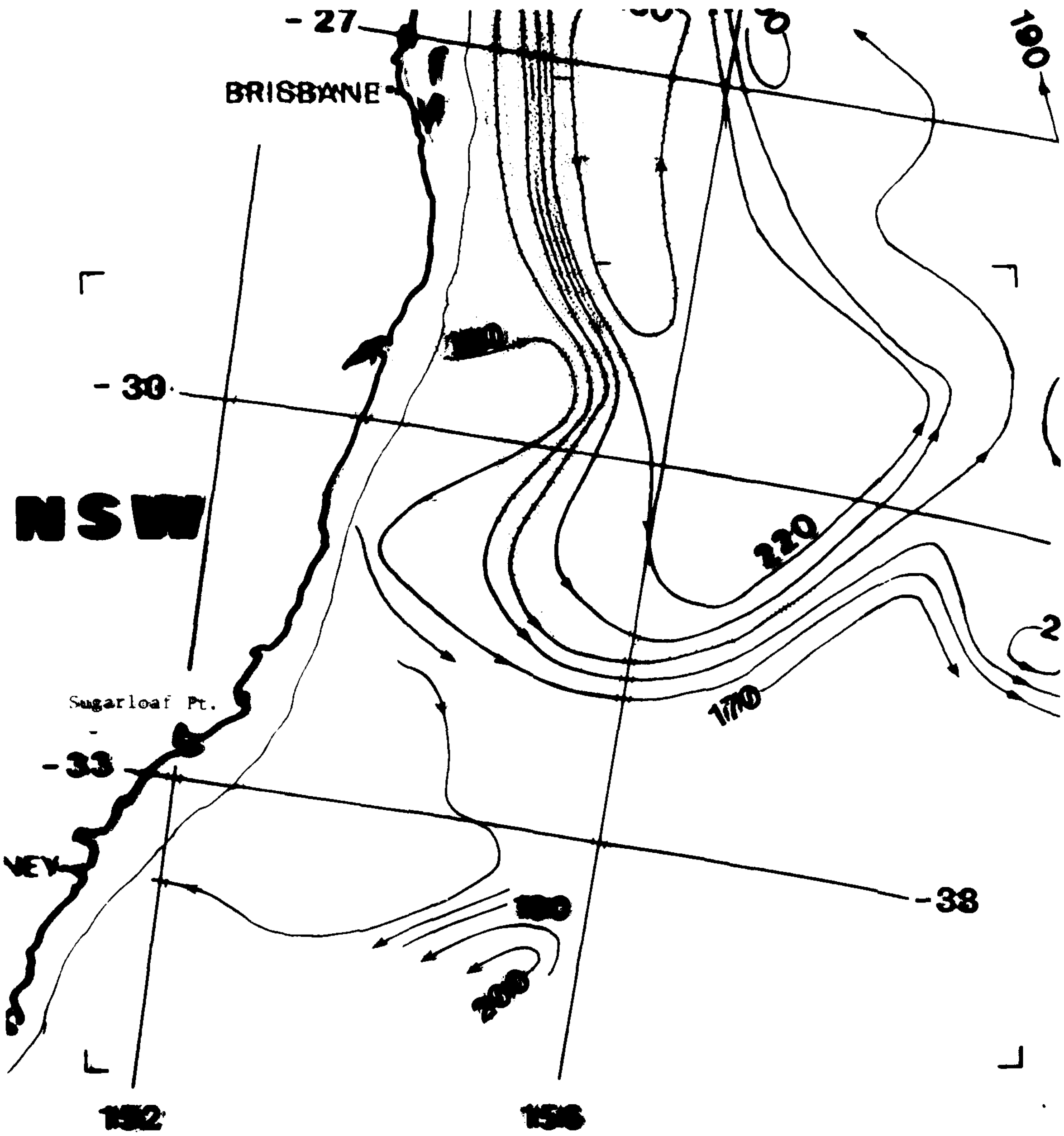


Fig. 7b. Dynamic topography D(0/1300) dyn cm from CSIRO SP 11/78 5 -18 Aug 1978. The stippled area shows warm surface water. Courtesy Hamon and Golding (publ. Boland and Church, 1980).

Fig. 7c (Over). Enhanced image HCM 106-0343-2 for 10 Aug 1978.

10AUG78 C S32-41/E155-16 D A-A0106-03430-2 MRT VARYING ROM 10.00 TO 13.33 DEG.
CSIRO - MINERAL PHYSICS - 19- 3-81 11.17

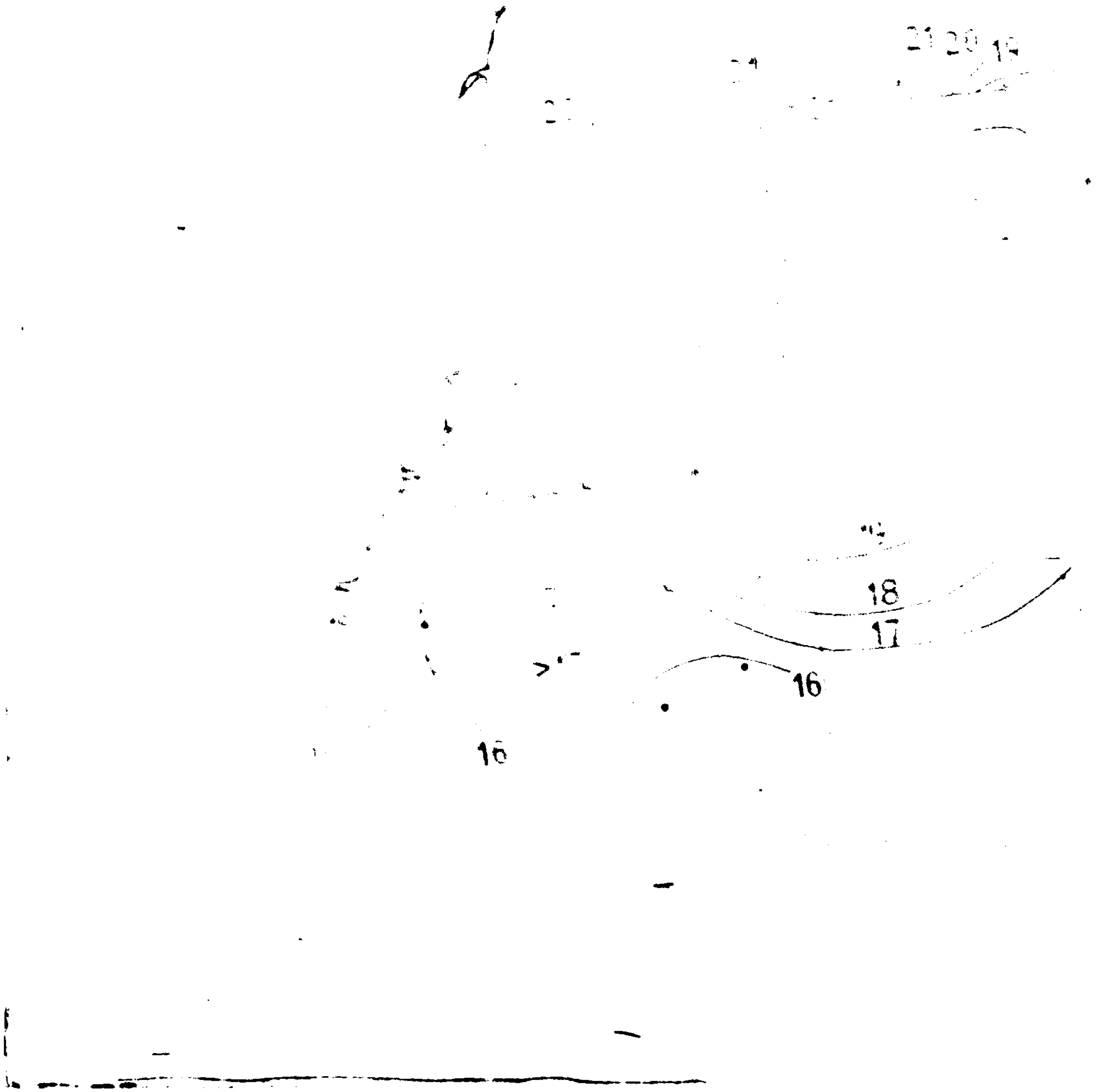
it can be seen that this area does not correspond very well to the contours drawn only from the SST XBT data in Fig. 7a. In particular, the SST map contoured by us does not show the warm (>22 C) water extending south of the E-W section along 31 S. Both the dynamic topography and the warm water are shown by Hamon and Golding as extending south of that latitude as does the HCMM image for 10 Aug shown in Fig. 7c. According to this image, the EAC appears as a meandering stream flowing much as depicted in Fig. 7b. Bearing in mind that the data in Fig. 7b are far from synoptic and limited in coverage and that a stream of this nature would be likely to shift around over the period 5-18 Aug, one can conclude that the flow depicted in Fig. 7b really matches the HCMM image quite well. The likely explanation for the mismatch between Fig. 7a and Fig. 7b is that only XBT data were used in the former, whereas Hamon and Golding presumably had the benefit of continuously recording thermosalinograph (TS) data when tracing out the warmer surface flow in Fig. 7b.

The maximum recorded XBT temperature along latitude 31 S is 21.4 C, recorded in each case between the two 21 C isotherms shown as points B and C in Fig. 7a. Now, the HCMM image shows that the mainstream of warm surface water is as narrow as 24 km in places, that is, only half the spacing between XBT stations along 31 S. We conclude that the XBT sampling was insufficient spatially to properly resolve this flow and the actual maximum surface temperature was likely higher than 21.4 C. Thus our hatching of the >22 C water in Fig. 7a gives rise to a slightly misleading picture. The southernmost extent of the >22 C water, marked as A, corresponds quite well to the pool near the top of the HCMM image but not to the mainstream of the EAC. The points that emerge from this example are quite important. Firstly, a reasonable pictorial representation (Fig. 7a) of discrete SST samples, obtained and presented in a time-honoured manner, gives an inadequate not to say misleading impression of the true flow. Secondly, the addition of some continuous data along the ship's track plus, presumably, some consideration of the dynamic height data, led Hamon and Golding to depict the essential features of the warm surface flow (Fig. 7b) in a much better manner than we did at a later date from surface XBT temperatures alone. This is the type of difference that will arise in practice between contours drawn as objectively as possible (without all the data) and those drawn by skilled oceanographers on the spot. Thirdly, we note that the dynamic topography obtained from the XBTs alone correlates far better with the true (HCMM) picture than the pattern of SST also obtained from the same XBT data. We shall return to this point later.

In the preceding discussion we have not so far questioned the idea that the HCMM image does indeed accurately reflect the true pattern of SST. In the course of studying all the comparative HCMM data, the evidence that this is so is extremely strong. Other studies at similar or reduced resolution support the same conclusion, for example Legeckis, Legg and Limeburner, 1980.

A RAAF aircraft made an AXBT survey of the EAC area 29-30 Aug 78. These instruments perform much as a ship-borne XBT, except the accuracy of the final temperatures is reduced to about ± 0.5 C absolute. Also, the probes do not generally record deeper than 350 m, so the calculated dynamic heights are also not as accurate as those from a 450 m XBT. Fig. 8a shows the positions where the probes were launched and the resultant SST map. The great advantage over a survey by ship is that the data are synoptic.

The SST contours show a clearly marked front leaving the coast in the vicinity of Sugarloaf Pt and sweeping SE to 34 S before turning north. This front can be seen in the images of Fig. 8 and Fig. 10 at about 19 C. A warm patch lies just offshore from Sydney and a closed cool pool is evident at about 31 S 158 E. This pattern correlates well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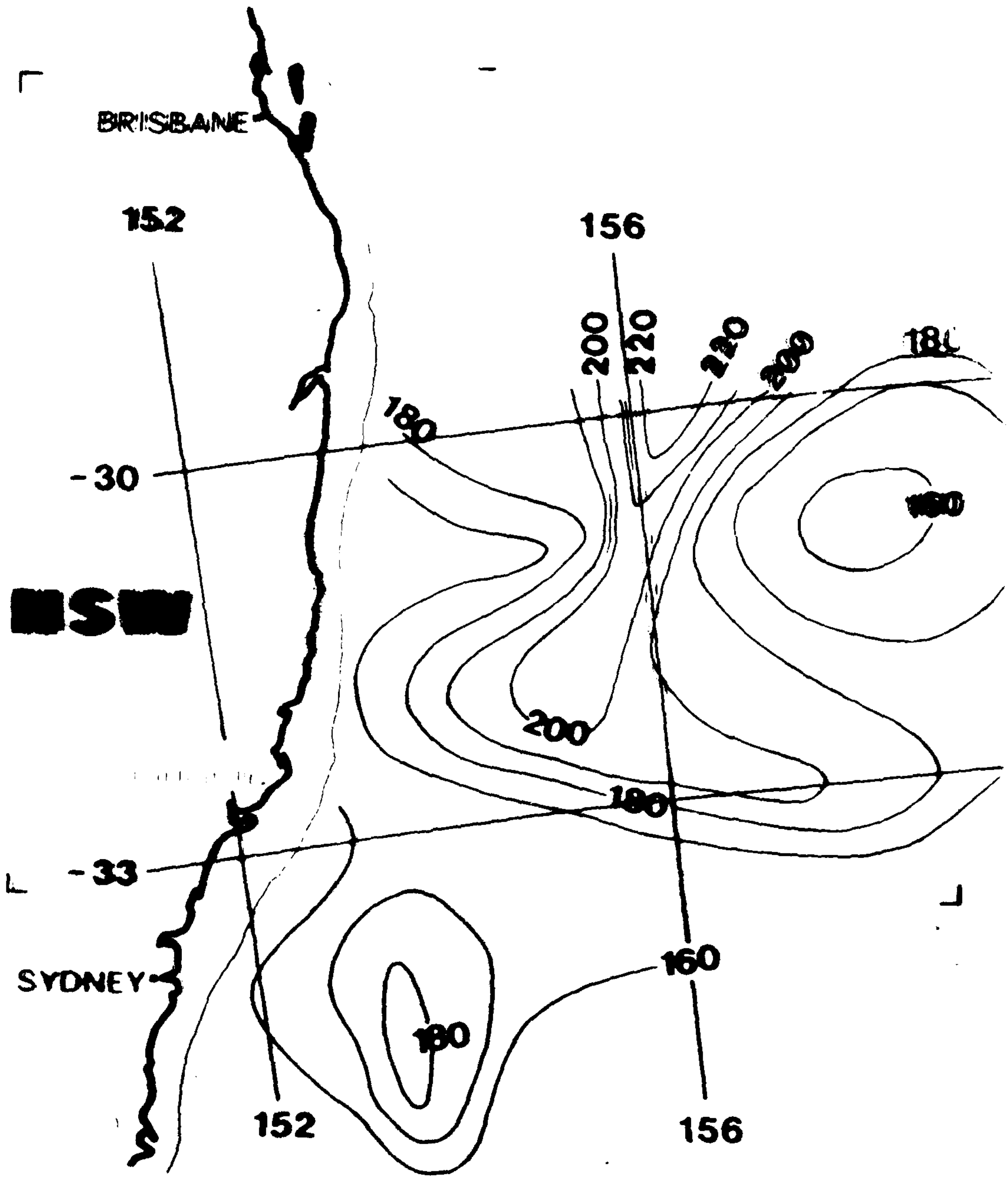


Fig. 8b. Dynamic topography DCH([illegible]/300) dyn cm from AXBT survey No. 1 29-30 Aug 1978.

Fig. 8c (Over). Enhanced image HCM [illegible] for 28 Aug 1978.

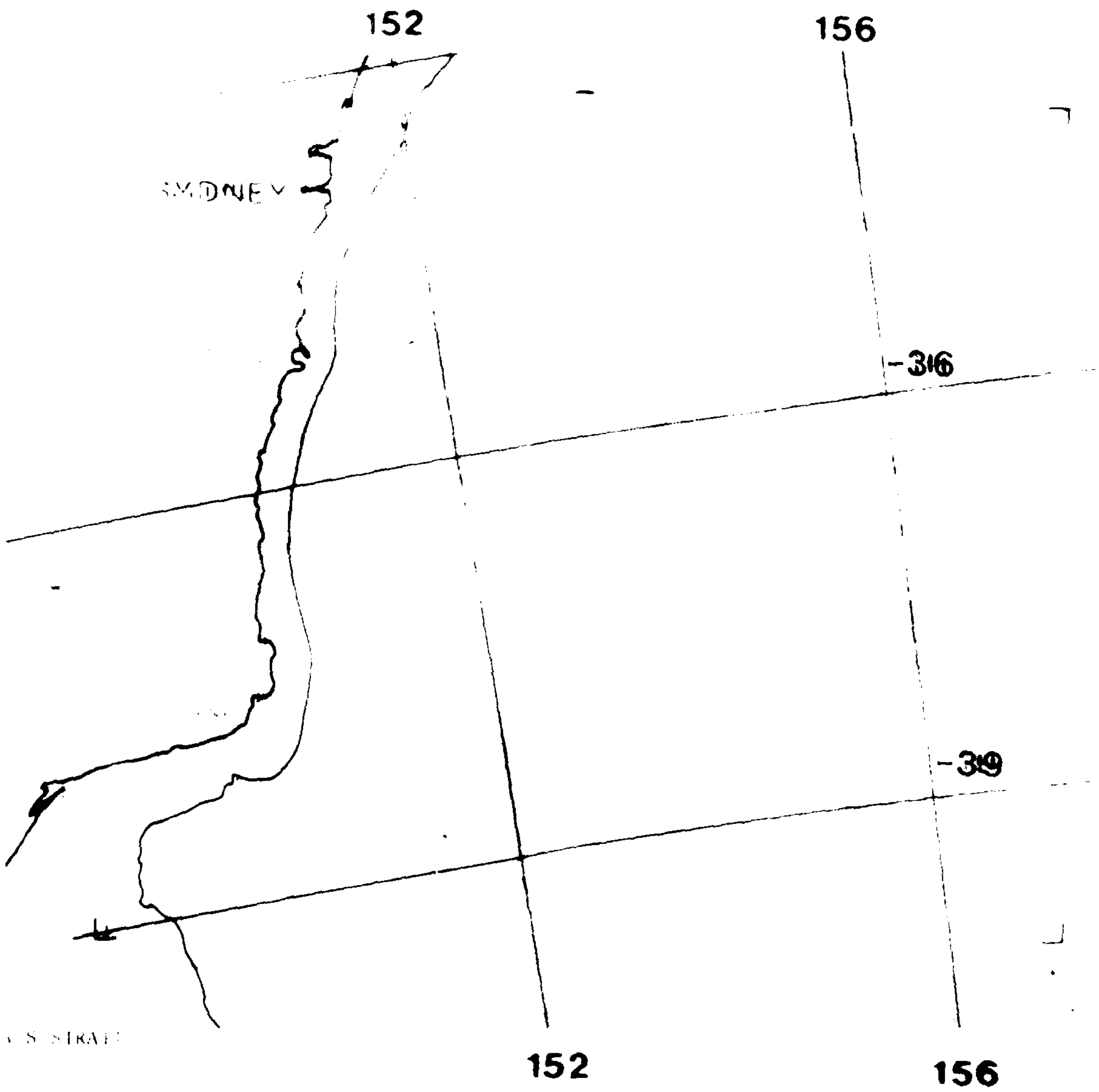


Fig. 9 (overlay). Enhanced image [illegible] for 28 Aug 1978.


VARYING FROM 6.00 TO 9.00 DEG.
11.32

with the dynamic topography shown in Fig. 8b. There is a tongue of dynamically high (warm sub-surface) Coral Sea water protruding into the Tasman Sea and spreading towards the SE. The main front in Fig. 8a does seem to come significantly further south than the 190 dyn cm dynamic height contour; however the same general shape is evident in both patterns. The cool patch around 31 S 158 E is associated with a dynamic low and the warm patch around 35 S 153 E is associated with a dynamic high. This being the time of winter cooling, these correlations are expected and reassuring (Nilsson and Cresswell,1980).

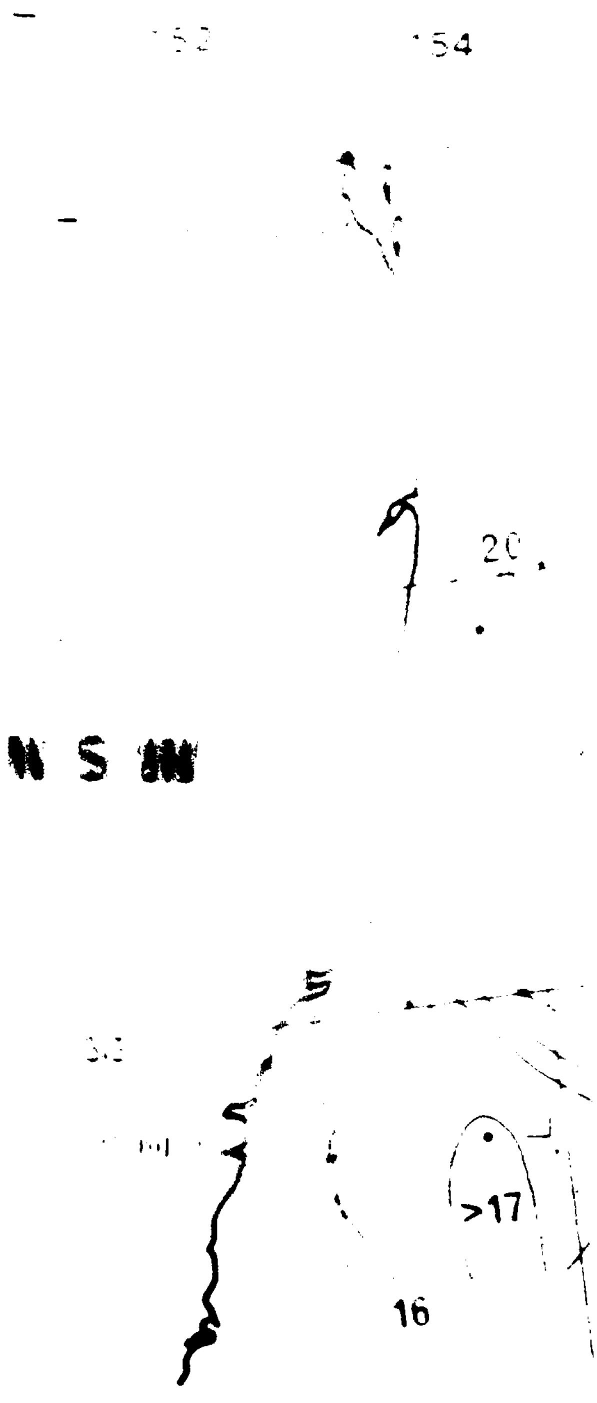
The warm eddy around 35 S 153 E can in fact be seen in the neighbouring HCMM image to the south, 124-1507-3, in Fig. 9 (offshore from Jervis Bay). This eddy was referred to by Boland and Church as eddy F. Fig. 8 and Fig. 9 confirm all the main features we had expected to see from satellite images in winter, namely the EAC front and warm and cool eddies. The oceanography in the area at this time has been discussed by Andrews, Lawrence and Nilsson (1980).

Smaller scale features are also visible in the satellite imagery. Fig. 9 (124-1507-3) shows cold surface water continuous with that in Bass Strait forming a front normal to the coast at about 37 S. This front appears to have been outflanked by warmer water coming south-west from about 37 S 153 E and curling around into Bass Strait. The complex advective patterns can be seen more clearly the next day on image 125-1525-3 (Fig. 11). The plume of warm water south of Cape Howe has moved closer to the coast, showing that these features are stable at least over a few days and can be traced from day to day. It also appears that this complex of warm water emanates from the eastern edge of a warm-core eddy that lies close to the edge of the shelf at about 37 S. This eddy can also be seen, but not so clearly, in Fig. 9. It can be identified with eddy E, surveyed by Church (Boland and Church, 1981) 15-22 Sep 78.

Now consider another AXBT survey of the EAC area, this time in summer, on 8 Feb 1979. SST contours, along with AXBT positions, are shown in Fig. 12a. By placing a backing sheet under this figure to hide parts b and c, the reader may care to try to deduce the likely flow pattern from these data alone: there appears to be a strong front coming off the coast just south of Sugarloaf Pt., based only on the southernmost AXBT, and there is a warm patch of water around 33 S, 155 30'E, also based entirely on a single AXBT datum. Thus the two principal features are each based on solitary data points, which must call for some caution in interpretation. Whatever one deduces from Fig. 12a, we suggest that the interpretation is not obvious and certainly the actual flow pattern does not immediately spring to mind.

Now, if we turn our attention to the map of dynamic topography obtained from the same set of AXBT data, the situation is quite different. A ridge of very high dynamic height (>260 dyn cm) extends southward from 30 S along 155 E. The contours are closely spaced, suggesting strong currents. One would expect a strong southward flow offshore in the neighbourhood of the 153 E meridian. There is clearly a return northward flow around 156 E that swings NE at 32 S 156 E and turns again to the SE at 30 S 158 E. The only reasonable interpretation of this pattern is that the EAC makes a U-turn from southward flow to northward flow somewhere south of 34 S; this corresponds to a typical intrusion of Coral Sea water into the Tasman Sea that apparently occurs with some regularity around February each year (Nilsson and Cresswell, 1980). On past behaviour, we would expect the neck of warm (sub-surface) water that is at its narrowest around 32 S to pinch off and form an eddy.

Now consider the HCMM image Fig. 12c. In this instance we have a synoptic survey taken on the same day, 8 Feb, to compare with the IR image, so both sets of data are synoptic and coincident within a few



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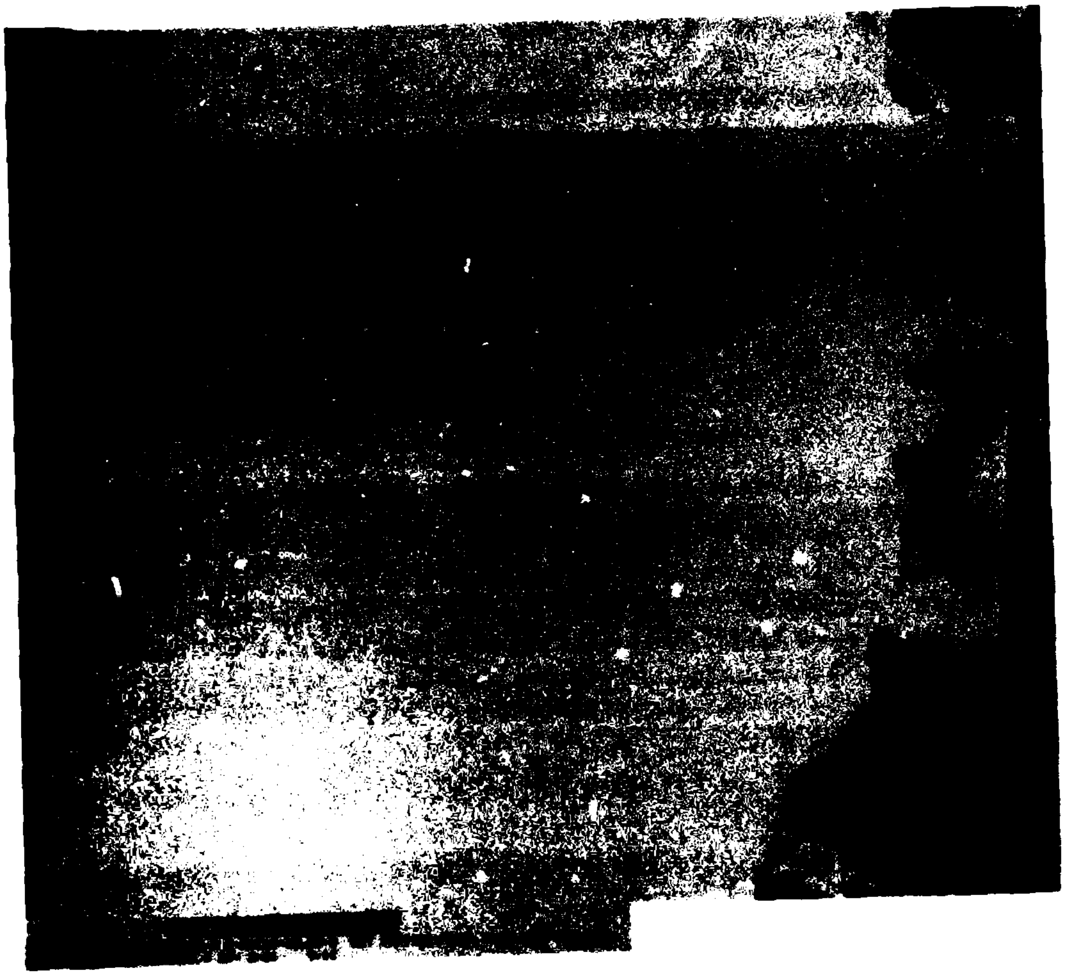

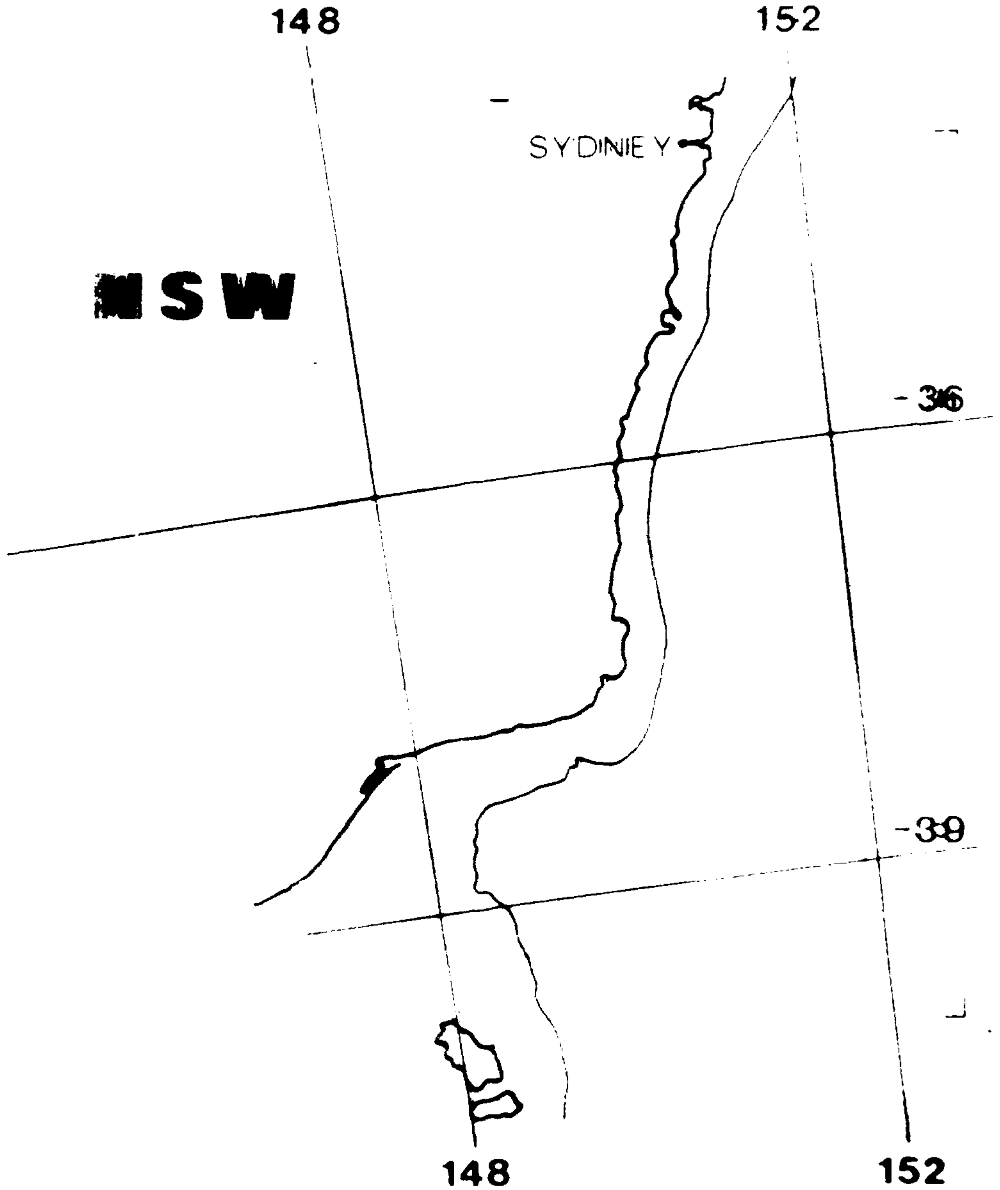
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SYDNEY
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-36
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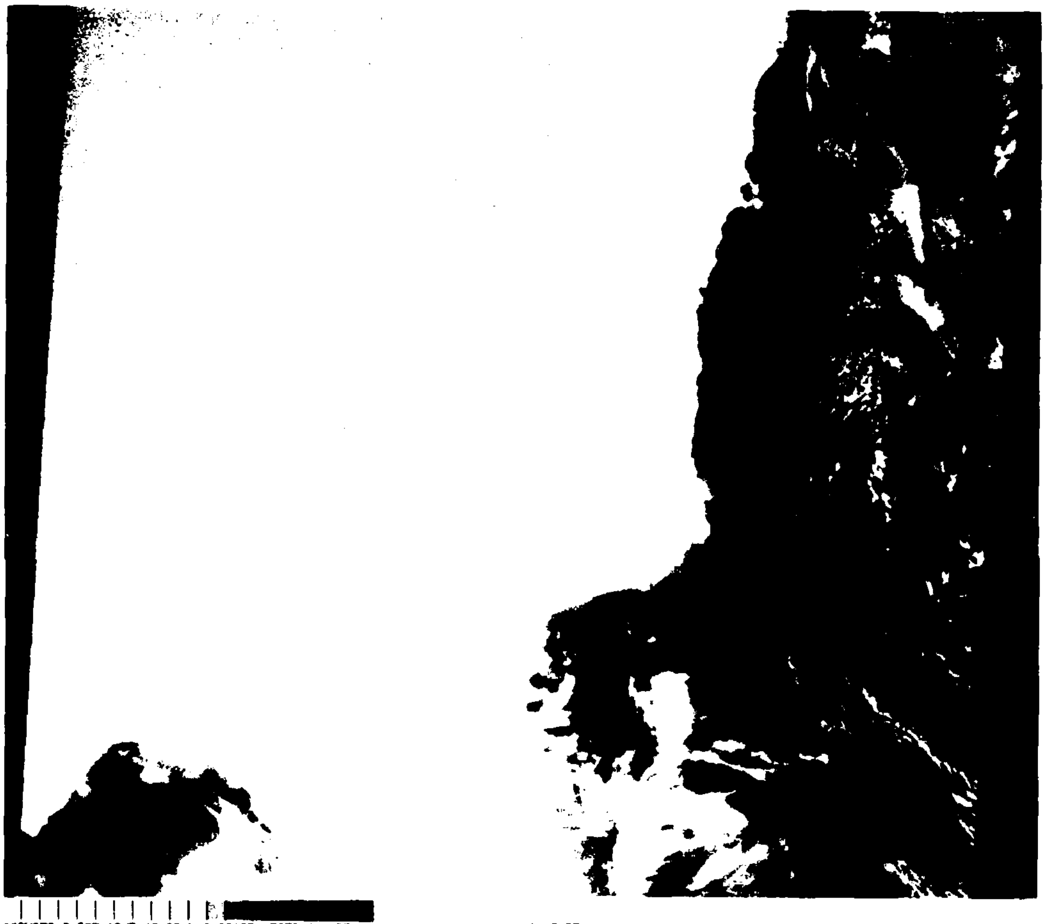

29AUG78 C S37-19/E148-29 N A-A0125-15250-3 MRT VARYING FROM 5.33 TO 7.67 DEG.
SIRO - MINERAL PHYSICS - 26- 2-81 9.44

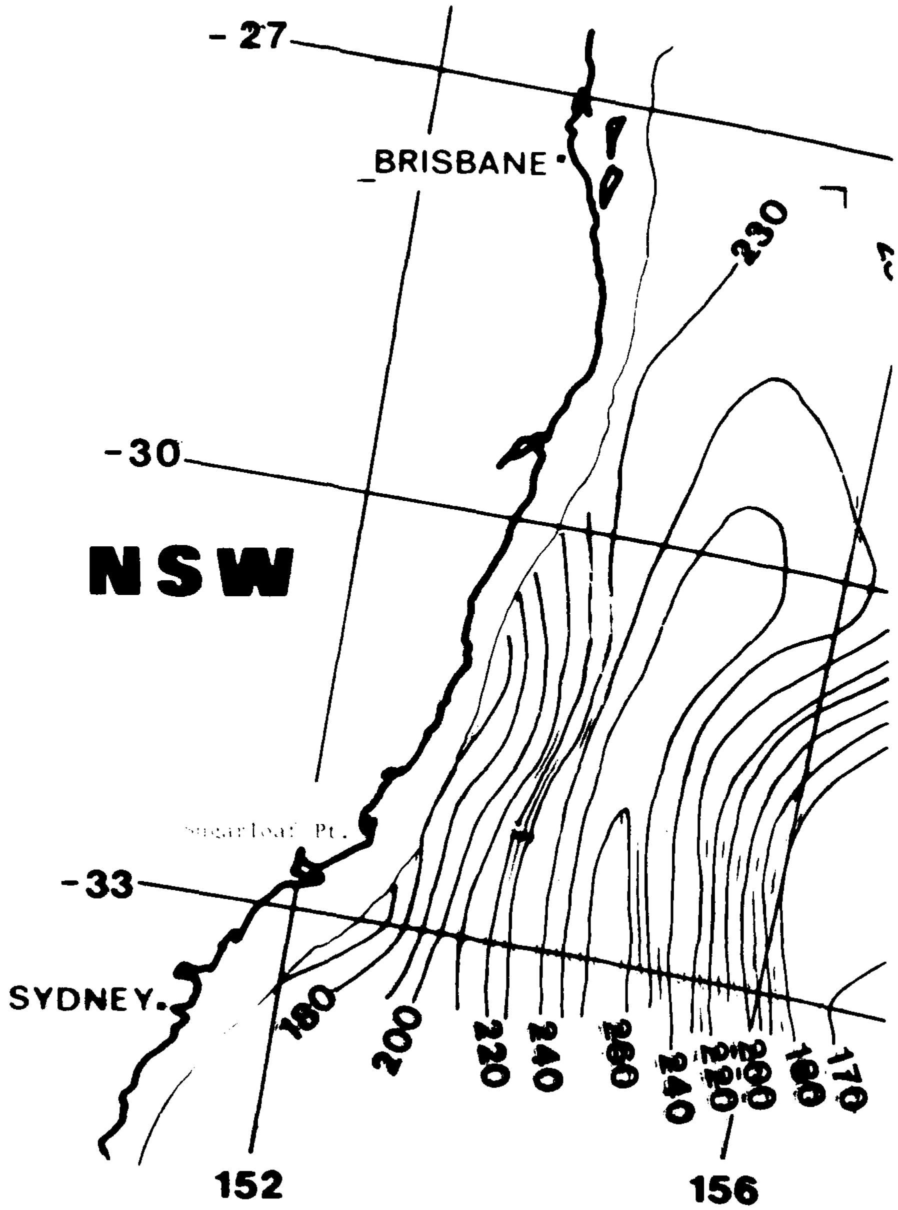
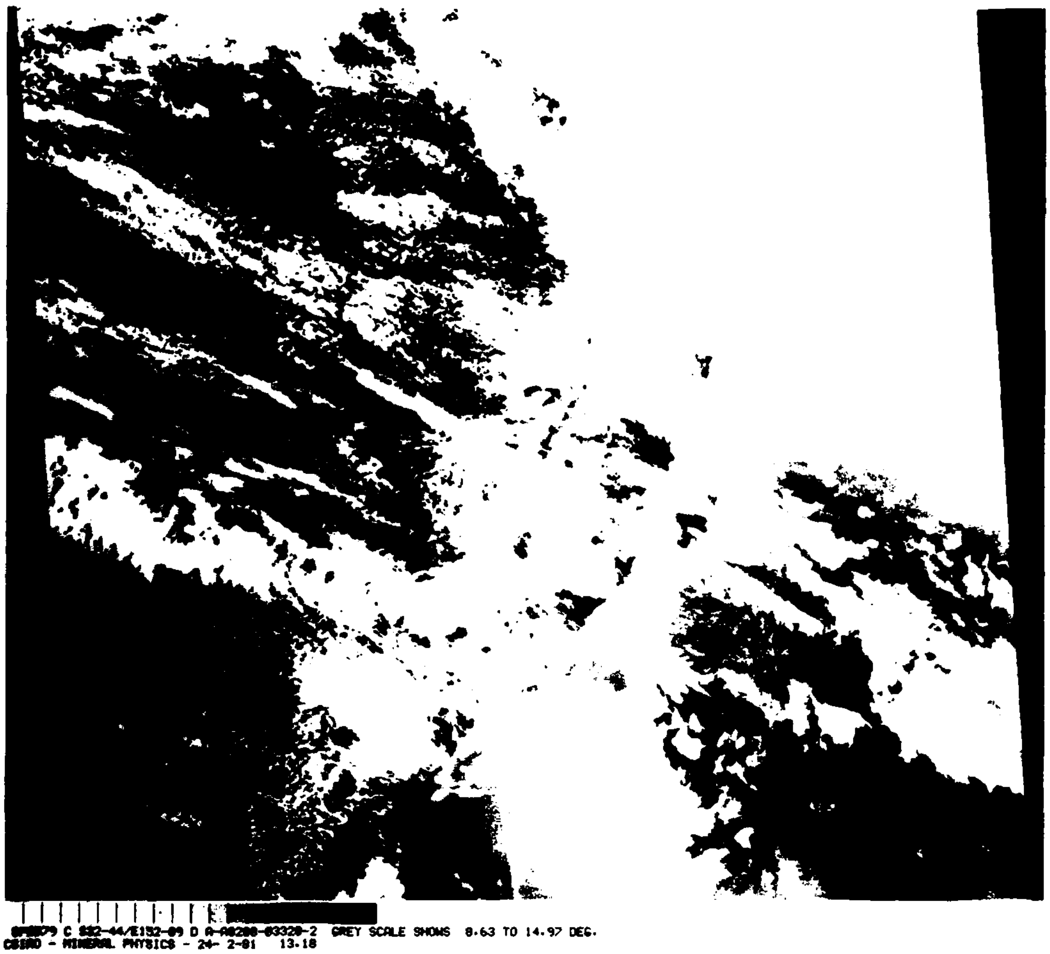


Fig. 12b. Dynamic topography D(0/1300) dyn cm from AXBT survey No. 3 8 Feb 1979.

Fig. 12c (Over). Enhanced image MCM 288-0332-2 for 8 Feb 1979.


GREY SCALE SHOWS 8.63 TO 14.97 DEG.
MINERAL PHYSICS - 24- 2-81 13.18

hours. The main southward stream seems to be in the vicinity of the 220-240 dyn cm contours, rather than the usually accepted value of about 190 dyn cm. The ridge is exceptionally warm (dynamica y high) and the surface flow does seem to correspond to the centre of the region of high dynamic gradient, as one might expect. The return northward flow seems to be at a slightly lower dynamic height (200-220 dyn cm), indicating some cross-contour flow and the warm surface water appears to pool at about 32 S, 155 E, rather than follow the dynamic contour towards the NE.

There appears to be a conflict here with the AXBT data. The HCMM image clearly indicates that the SST at point C should be close to that within the stream at point B, namely ~ 26.8 C. Yet the recorded AXBT value at point C is 24.9 C. A check on the recorded data reveals no obvious error in reduction. By way of comparison, the AXBT temperature at point A is 26.1 C and the value in between A and B in the cooler water is 24.7 C. This sequence of values along 33 S, namely 26.1, 24.7 and 26.8 C from A to B agrees quite well with the relative values shown by the HCMM image. In fact, the AXBT point C is just under the cloud that partly obscures the warm pool in that vicinity, so we cannot say for certain that there is no cooler surface water within the periphery of that pool, nor can we say for certain that no stream of warm water is leaving the pool under cover of the cloud, although both possibilities look unlikely.

Again, we can see that the dynamic height contours correlate better with the flow as seen by HCMM than does the sea truth SST pattern. Putting this another way, we conclude that the actual current flow shows up well in actual SST and IR imagery, even in summer, despite the relatively weak interaction between deep structure and SST in this season. We also conclude that the spati . sampling and resultant contouring at 1 C intervals used to pro uce Fig. 12a are inadequate to represent the real SST structure in this region.

5 OBSERVED FORMATION OF A WARM-CORE EDDY AND FURTHER COMPARISONS WITH SEA TRUTH

The U-shaped flow of the EAC shown in Fig. 12 can be seen again five days later in Fig. 13. Whereas in Fig. 12 there is no apparent NE flow out of the pool at 32 S,, 155 E on 8 Feb 79, as we might expect from the dynamic height contours, this flow does show up on 13 Feb in the HCMM image. Indeed, after the U-turn, the NE flow in the latter image corresponds well to the contours around 200 dym cm obtained on 8 Feb. The HCMM image now shows a pronounced kink in the flow as it turns from NW to NE. This flow pattern looks very much like that illustrated in Fig. 4b, being a prelude to eddy pinch-off.

Sea truth data were obtained at this time. Some surface temperatures obtained along the ship's track are shown in Fig. 13a. Temperature turning points have been annotated with values. The relevant section of ship's track is the eastward leg out of Sydney 11-13 Feb. The two maxima of 26.1 C and 25.7 C correspond well with the EAC flow observed by HCMM and the intervening minima also are consistent with the image.

Fig. 14 shows on 24 Feb the eddy that has formed from this flow pattern. The eddy was subsequently the object of considerable physical and biological reseach by CSIRO and was named eddy J. This image has been enhanced to 0.33 C per grey scale step and the mid-range temperature (which corresponds to the 14th step) has been linearly varied from 14.3 C at the top of the image down to 12.7 C at the bottom. Reference should also be made to the image 304-0330-2 immediately to the north, recorded at the same time and shown as Fig. 15. This image has been enhanced to a similar degree; in this case the reference temperature varies from 15.3 C (top) to 14.3 C (bottom), so providing visual continuity with Fig. 14 (Scene 304-0328-2).

Thus the EAC flows down the coast (Fig. 15) and it would appear

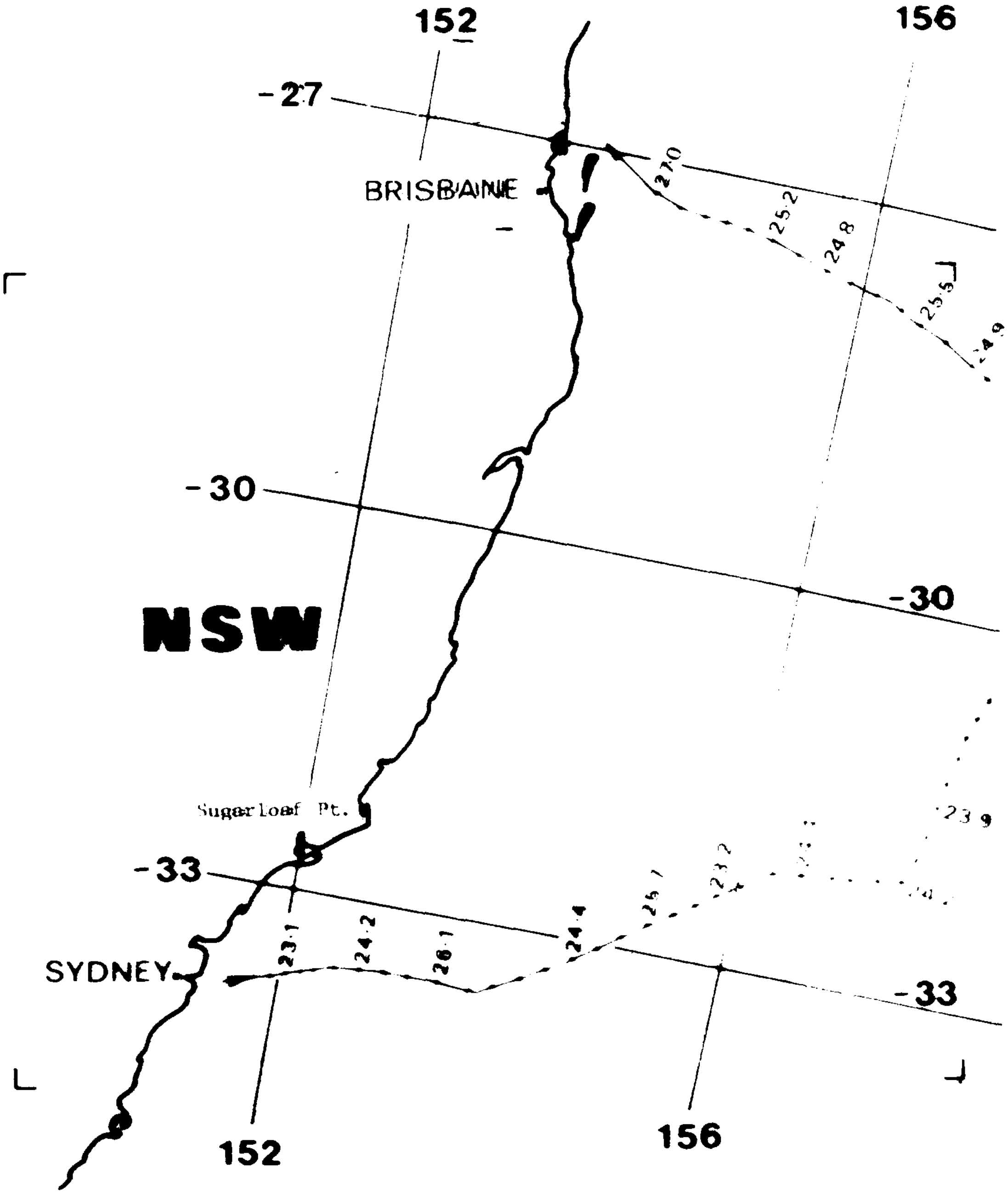
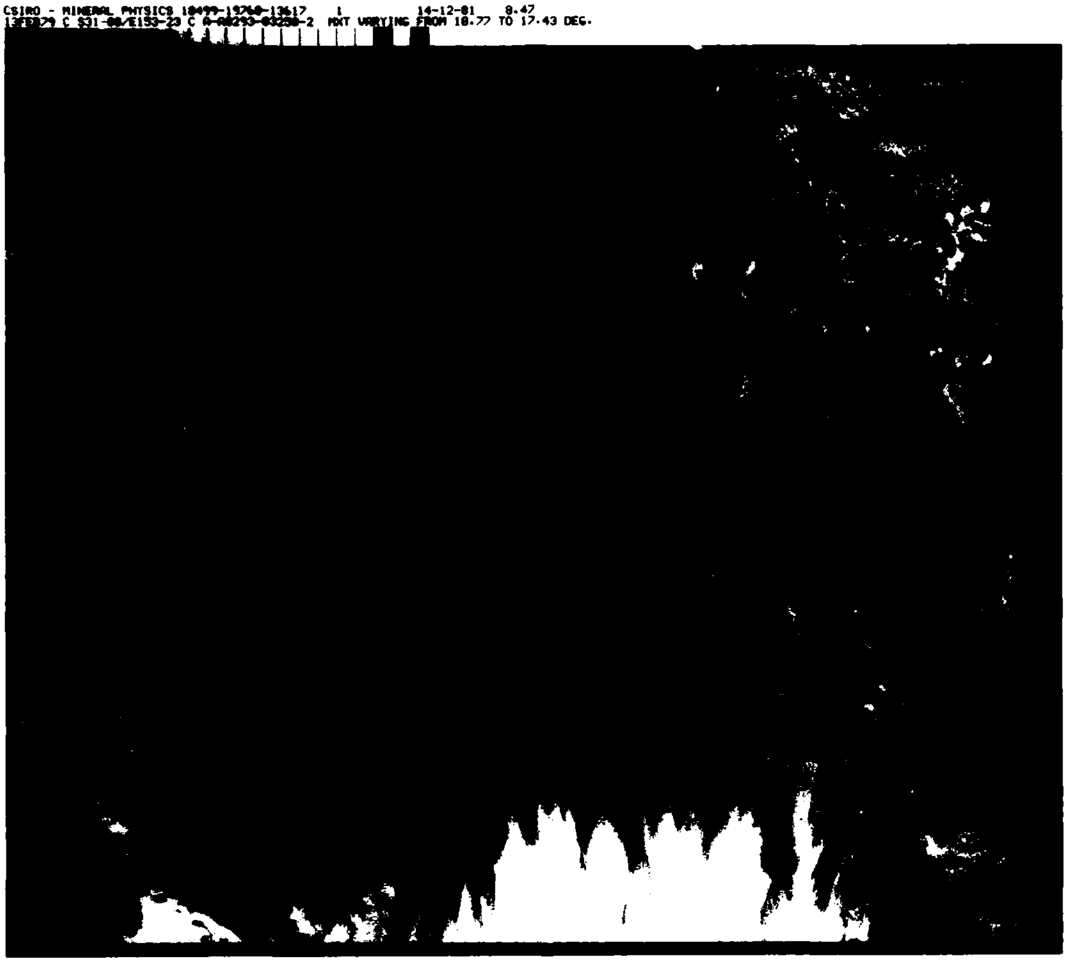
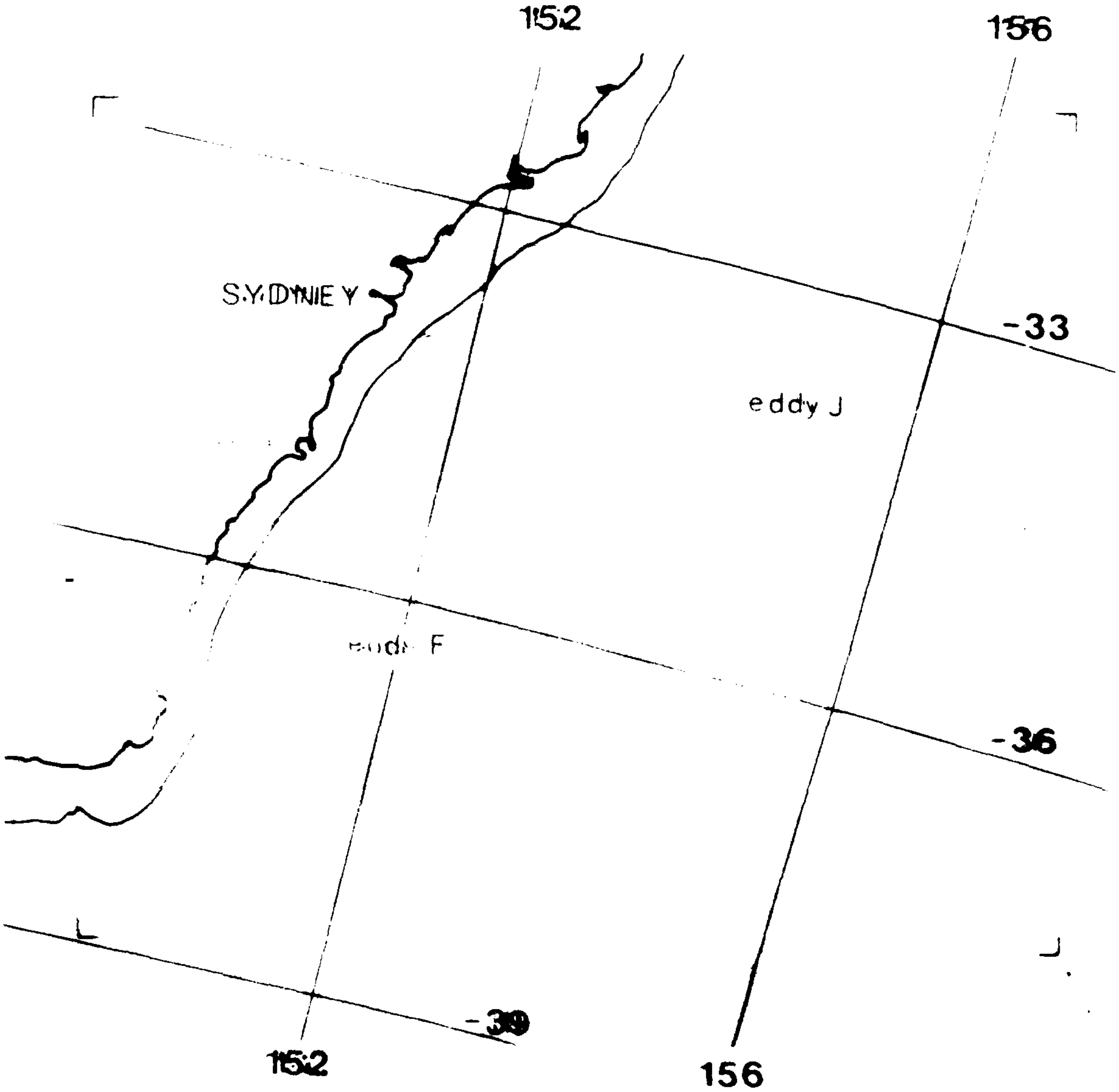


Fig. 13a. **Ship's track and some values (mainly maxima and minima) of SST for Cruise K 5m/78 11-17 Feb 1979.**

Fig. 13b **(Over).** **Enhanced image HCMM 288-0325-2 for 13 Feb 1979.**


CSIRO - MINERAL PHYSICS
14-12-81 8.47
TO 17.43 DEG.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156
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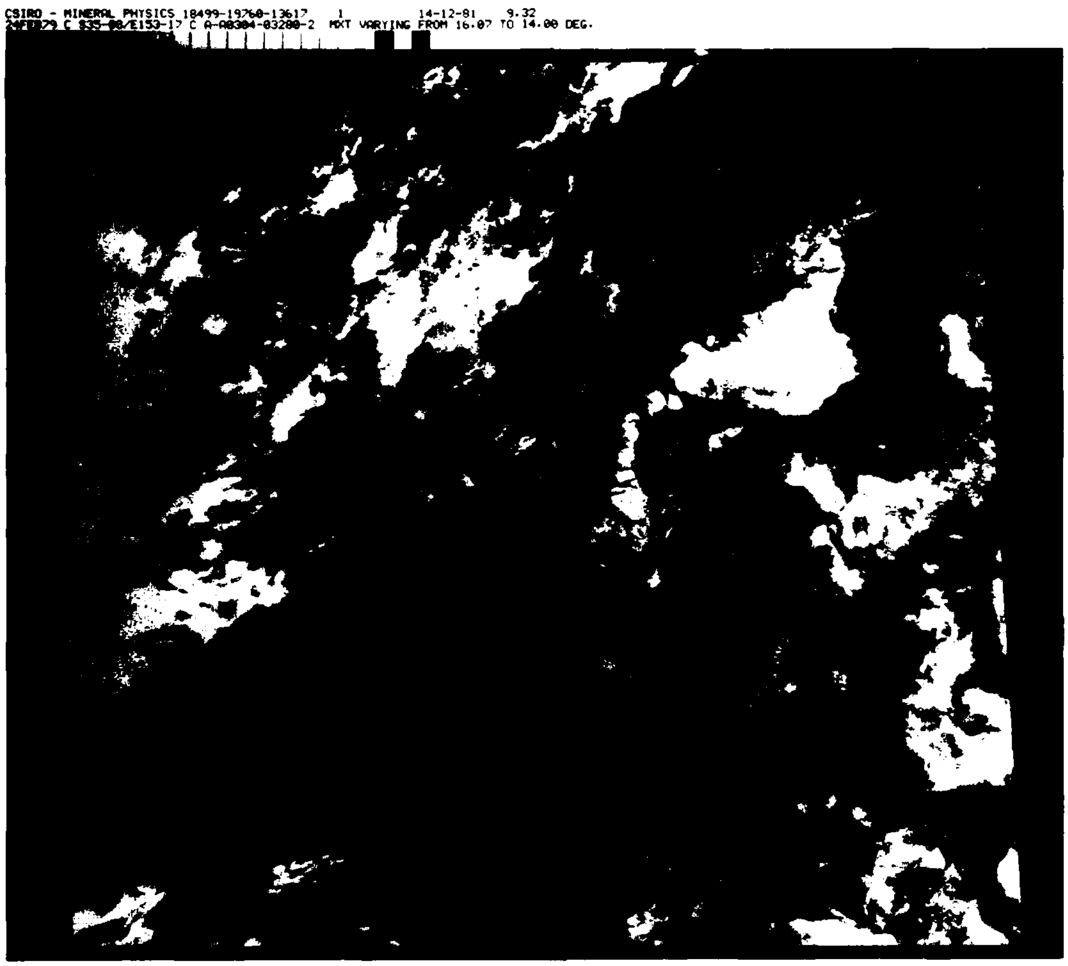
152
156


CSIRO - MINERAL PHYSICS 18499-19760-13617 1 14-12-81 9.32
24FEB79 C S35-08/E153-17 C A-A0304-03200-2 MXT VARYING FROM 16.07 TO 14.00 DEG.

that some of this flow makes a sharp turn to north-east before the constriction (neck) visible at the top of Fig. 14. The principal flow around eddy J is counter-clockwise in the vicinity of the main boundar so clearly delineated in this figure. It is difficult to imagine the northward flow (on the eastern edge of the eddy) making a turn from westward to northeastwad at the neck as sharply as Fig. 14 would seem to require, hence the conclusion that the north-eastward flow indicated at the bottom of Fig. 15 is probably the result of part of the southward EAC flow turning prior to or at the neck . However in this regard we note the ship's track 25-27 Feb shown in Fig. 17a as an overlay to the image 305-1435-3. The three current vectors shown off Sugarloaf Pt were determined on about 27 Feb. The easternmost vector has been labelled as point E on Fig. 17a. Although the current was measured three days after the HCMM image Fig. 14b, it is surprising that there is no sign of any eastwards component in the measured vector. Perhaps the region of the eddy neck moved a little further south during the period 24-27 Feb, so placing that vector in the southward flow.

The circumferential flow around the eddy (probably ~1 m sec-1) appears to have entrained cooler water from the south into the eastern section of the eddy. Note that this cool water tails off into a point. This seems to be a characteristic of such entrainment. There is an interesting structure to the south of eddy J that seems to be connected, both at the bottom of eddy J proper (about 35 S, 155:30 E) and by a long stream of warm water on the eastern edge of both structures. It is necessary to keep in mind that a constant density on the HCMM image shown here does not imply constant absolute surface temperature, as the enhancement reference temperature has decreased 1.7 C from top to bottom of the image. One can also discern a ring of slightly warmer water ~250 km across centred about 36:30 S, 152 E. This is characteristic of a closed eddy and the counter-clockwise current associated with it (which indicates a warm-core closed eddy) can be inferred from the stream of cooler water entrained by the NW flow in the vicinity of 36 S, 154 30 E. Thus in this vicinity there is NW flow and 50 km to the north there is SE flow. Between the two, one can see a small clockwise meander of warm water marking the main shear zone.

According to the summary of observations of the EAC during 1978 presented by Boland and Church (1981), the southernmost eddy can probably be identified with the eddy F that was observed by Scott (1981) at about 36 30'S, 151 40'E in early December 1978. Boland and Church report that around 10-13 December warm surface water was present on the northern and western edges of eddy F. Such water would quickly be carried around the eddy (at about 100 km day^{-1}) to form a warm ring such as that in Fig. 14. It should be noted that this ring is only clearly visible at that degree of contrast enhancement. At 0.5 C/step it is only marginally visible. However the image taken on the next day, 25 Feb, shown in Fig. 16 (at 0.33 C/step around a lower reference temperature) clearly shows eddy F off Cape Howe apparently as a pool of warm water. Further study of the apparent surface temperatures across the eddy is need to explain this change of appearance.

Fig. 17b shows the HCMM image of the western Tasman Sea from about 26 S to 32 S on 25 Feb 79. The track for cruise K14B/78 (25-27 Feb 79) is given on the overlay Fig. 17a. The cruise track from Brisbane to Sydney between points C and F was directed to follow the main flow of the EAC. A Geomagnetic Electric Kinetograph (GEK) was towed to measure the current velocity, which at times reached 2.0 m sec-1. It can be seen that this track mostly coincides with the western edge of the visible stream of warm water shown in Fig. 17b. Some measured values of SST are shown along the track. Although the image and the sea truth are not quite coincident in time, the flow along that section of the coast above the neck of eddy J has appeared to be fairly

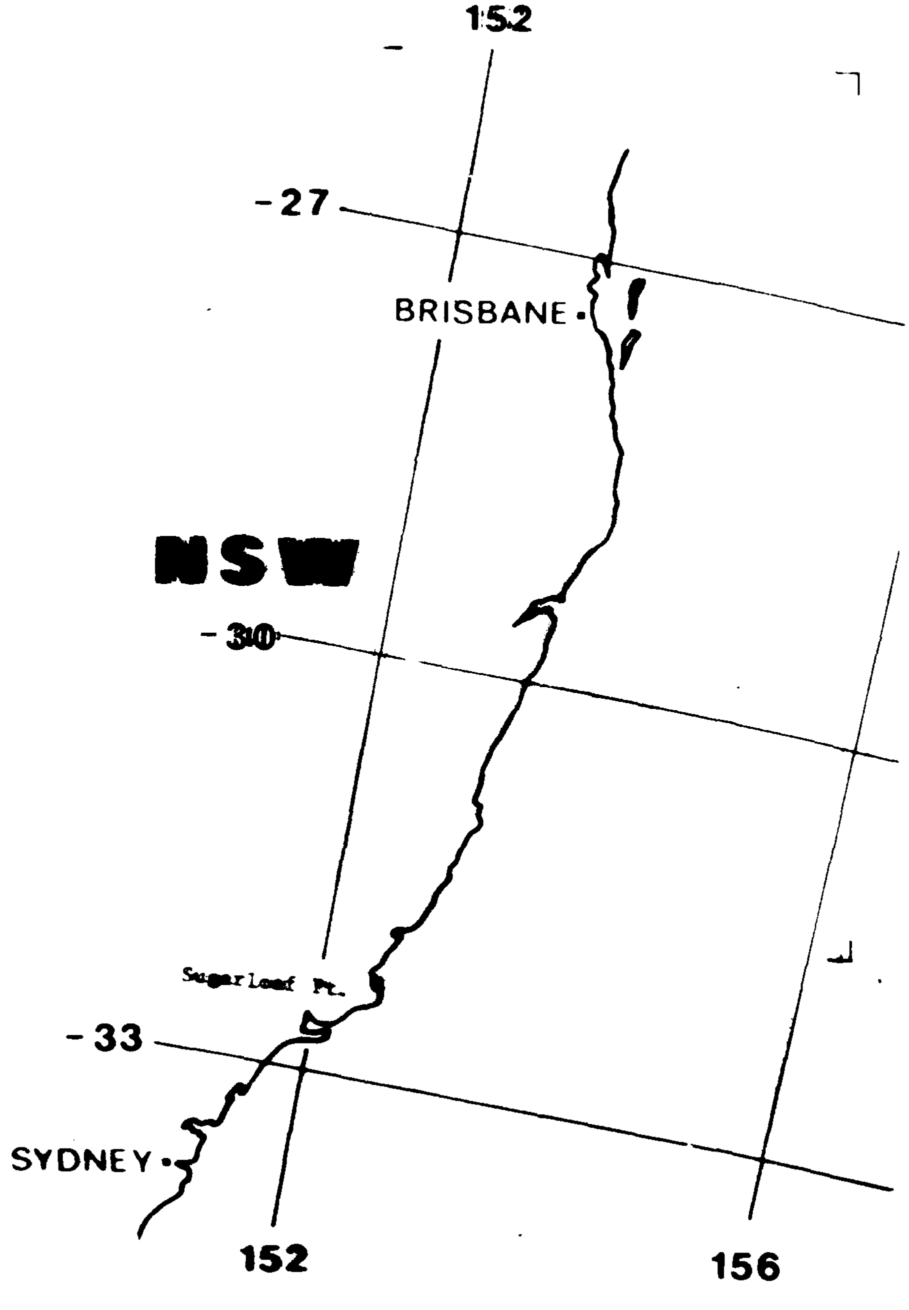
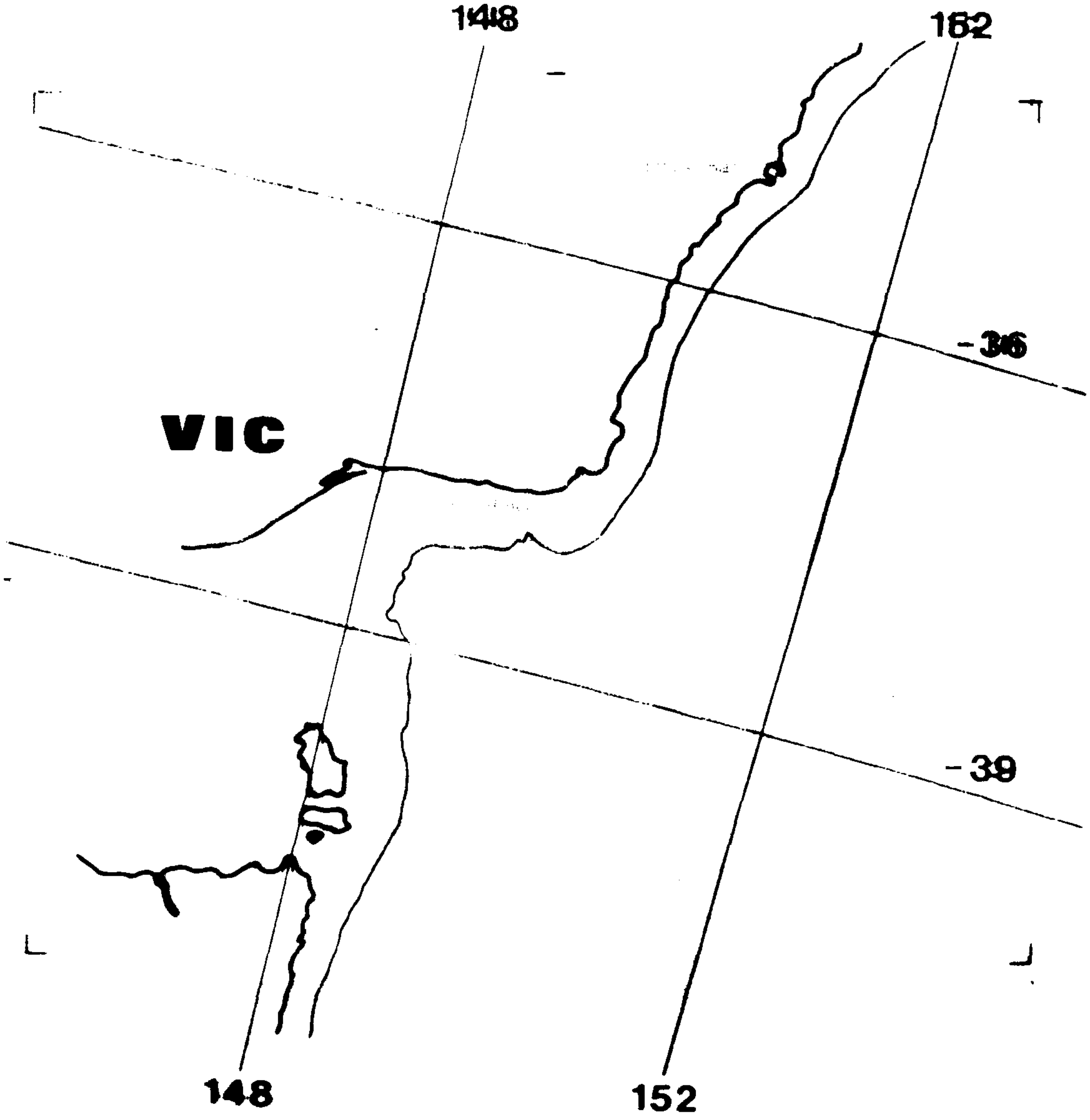
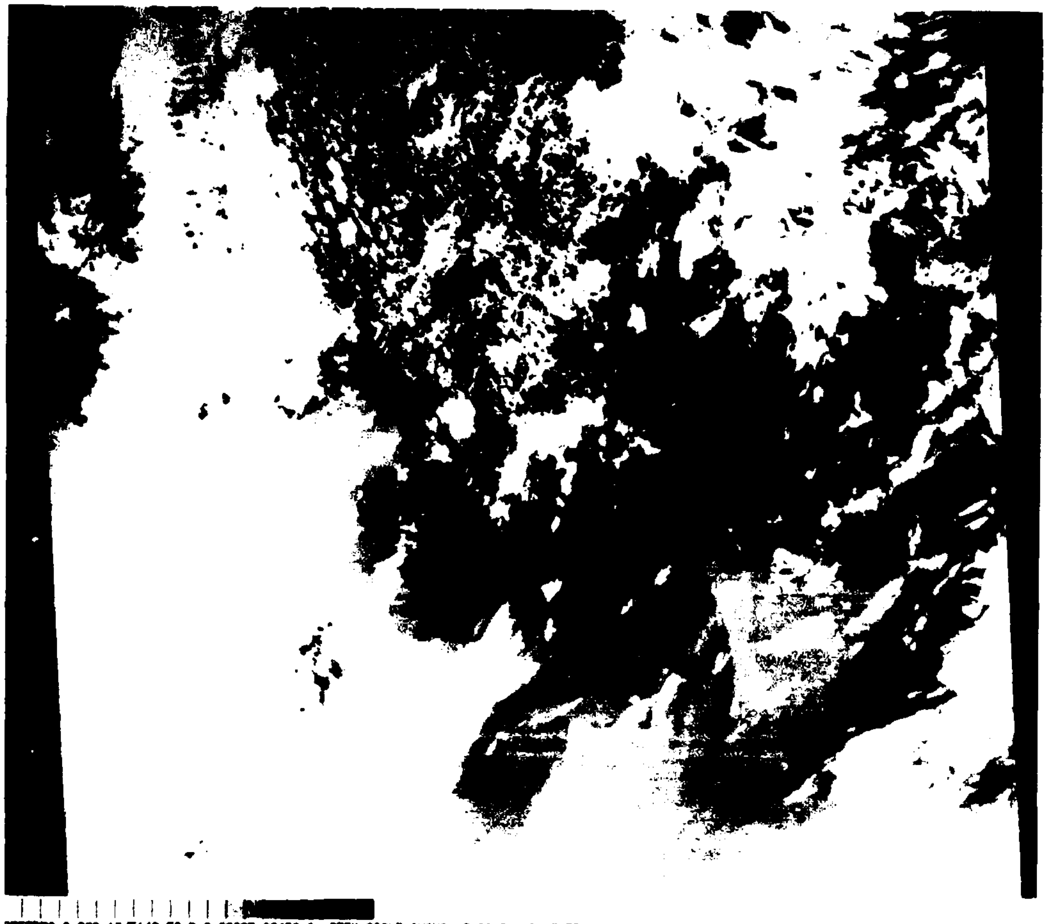


Fig. 115 (Over). Enhanced image HCM 304-0880-2 for 24 Feb 1979.



... image ... for 25 Feb 1979.
[illegible]



25FEB79 C S30-10/E149-52 D A-A0305-03450-2 GREY SCALE SHOWS 7.33 TO 13.67 DEG.
CSIRO - MINERAL PHYSICS - 24- 2-81 14.10

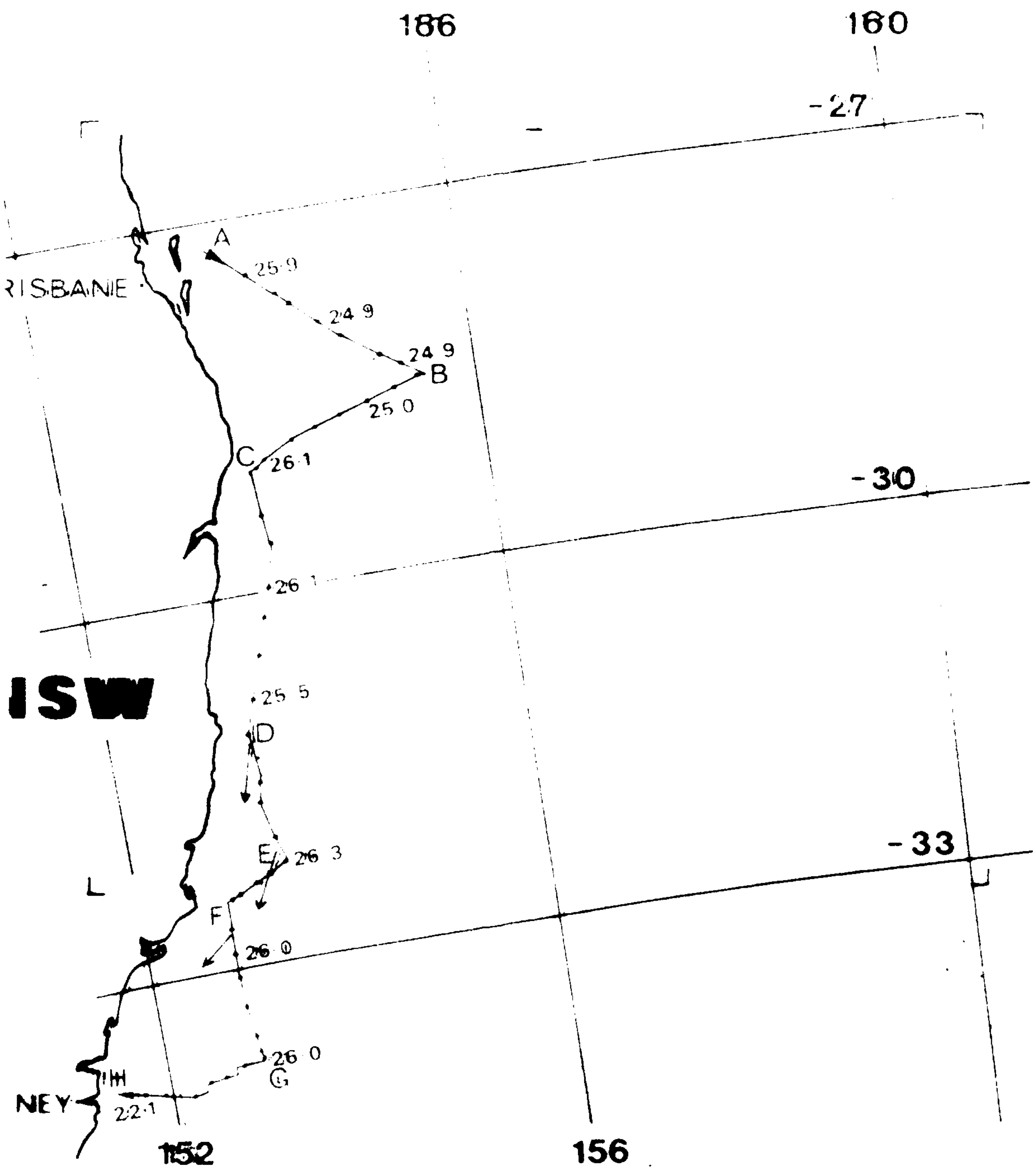
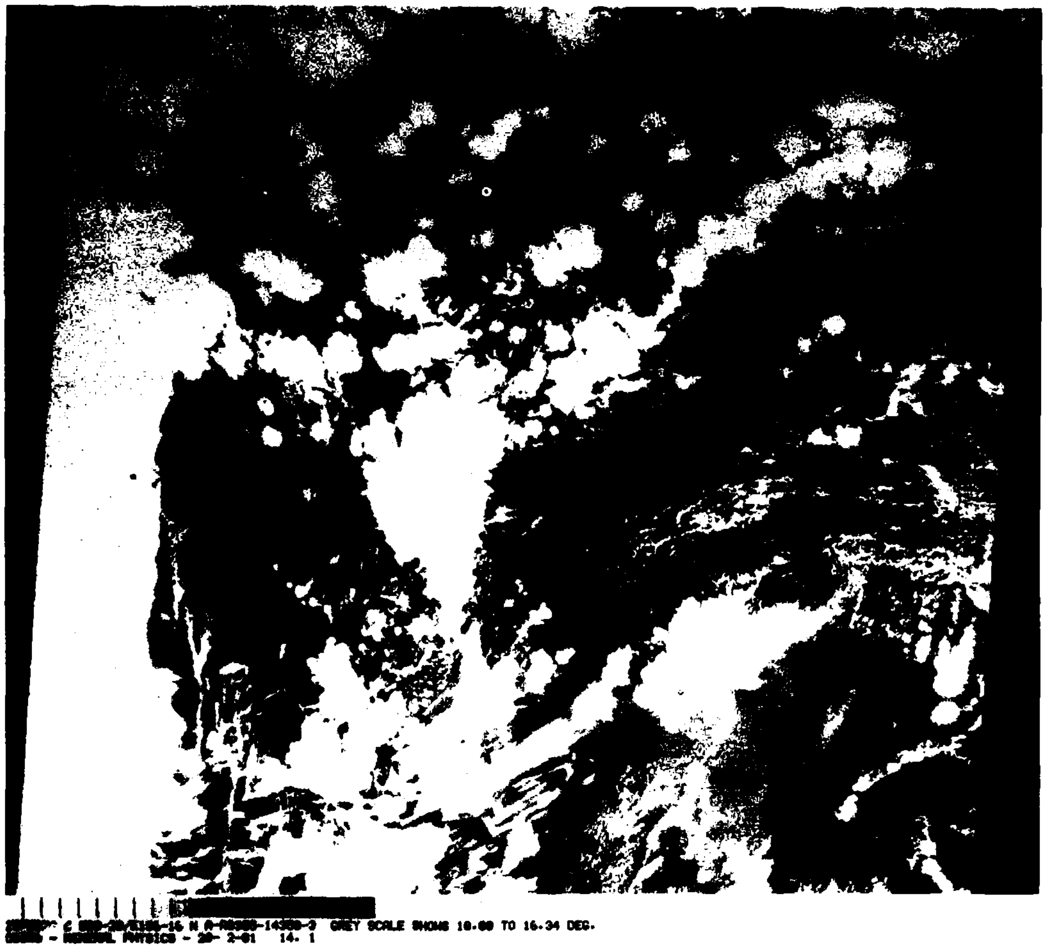


Fig. 17a. Ship's track and some values of SST for Cruise K 14b/78 25–27 Feb 1979. The section CF stayed within the main southward flow of the [illegible] Three GEK current vectors are shown.

Fig. 17b (Over). Enhanced image HCM 306-1435-3 for 25 Feb 1979.


GREY SCALE SHOWS 10.00 TO 16.34 DEG.

stable, at least over the period 13-25 Feb, as an overlay of Fig. 13 and Fig. 17 show. Therefore Fig. 17 provides a reasonable direct comparison of a measured current stream (the EAC) and a HCMM image in summer.

9. HCMM COMPARISONS WITH MEASURED SEA-SURFACE TEMPERATURES

Table 8 lists 10 comparisons of recorded HCMM temperatures with measured values of sea-surface temperatures (SST). It is clear from the foregoing presentation that a much larger number of comparisons could be made; for example a series of comparisons is available along the outgoing easterly leg of cruise K 5A/78 (Fig. 13) or, to a lesser accuracy, from the AXBT data in Fig. 8a and image 124-1505-3 (1 day apart). Also several points are available clear of cloud from the AXBT data in Fig. 12a and image 288-0332-2 (same day). However, further comparisons are unlikely to change the main conclusions already apparent from Table 8.

IMAGE-ID	-DATE	SURVEY	-DATE	T_h	T_s	ΔT
047-0347	12 Jun 78	SP 9/78	~12 Jun	12.8	21.0	8.2
055-1525	20 Jun 78	SP 9/78	~17 Jun	12.0	21.0	9.0
124-1505	28 Aug 78	AXBT 01	29 Aug	10.4	18.7	8.3
125-1523	29 Aug 78	AXBT 01	29 Aug	9.4	20.0	10.6
288-0332	08 Feb 79	AXBT 03	08 Feb	15.6	26.8	11.2
288-0332	08 Feb 79	AXBT 03	08 Feb	13.1	23.0	9.9
290-1457	10 Feb 79	K 5a/78	11 Feb	13.5	23.2	9.7
290-1457	10 Feb 79	K 5a/78	11 Feb	15.4	25.5	10.1
293-0325	13 Feb 79	K 5a/78	13 Feb	15.4	24.2	8.8
305-1435	25 Feb 79	K14b/78	25 Feb	14.8	25.0	10.2

Table 8. A comparison of HCMM temperatures (uncorrected for atmospheric absorbtion) T_h with sea truth T_s. ΔT is the difference.

Firstly if we write

$$T_s = T_h + \Delta T \qquad \ldots(1)$$

where T_s is temperature (sea truth) and T_h is temperature (recorded by HCMM), then a simple regression gives

$$\Delta T = 9.6 + 0.23(T_s - 22.8) \pm 0.7 \text{ C} \qquad \ldots(2)$$

It should be emphasised that no allowance has been made for atmospheric absorbtion. Unfortunately we did not know at the time how desirable it would be to obtain the atmospheric data to make these absorbtion calculations. However, our crude comparisons do show that the original 5.5 C offset to the cold side was not needed and that, on the average, about 4-5 C must be allowed for atmospheric absorbtion. It is also clear that there is no evidence for a change in HCMM sensor calibration of 4.2 C between June and October 1978, as has been suggested (Price, private communication, 1980). The relationship (2) also indicates a postive correlation between ΔT and T_s, as might be expected. Higher SST values should result in more water vapour in the atmosphere resulting in greater absorption. More comparisons could refine this correlation to advantage, particularly if it could be done separately for different seasons and latitude bands. One can obtain an estimate of the mean atmospheric transmittance from (2), namely (in this case) $\tau = 0.77$. This results in an effective decrease in the observed gradient of an oceanographic front, as has been pointed out by Maul, Webb de Witt, Yanaway and Baig (1978).

Referring again to HCMM image 304-0328-2 shown in Fig. 14, note the large areas of relatively uniform SST, in particular across the two eddies. Compare this with the much more complex situation over land. In order to calibrate the satellite sensor, it would seem that making use of SST across features such as mesoscale eddies would offer considerable advantages. The diurnal variation, except perhaps under very calm conditions, is likely to be below the noise level (< 0.3 K) and the truth area available at constant temperature is enormous by land standards. With advance notice, one can obtain the necessary meteorological data from a ship just as well as from a land station.

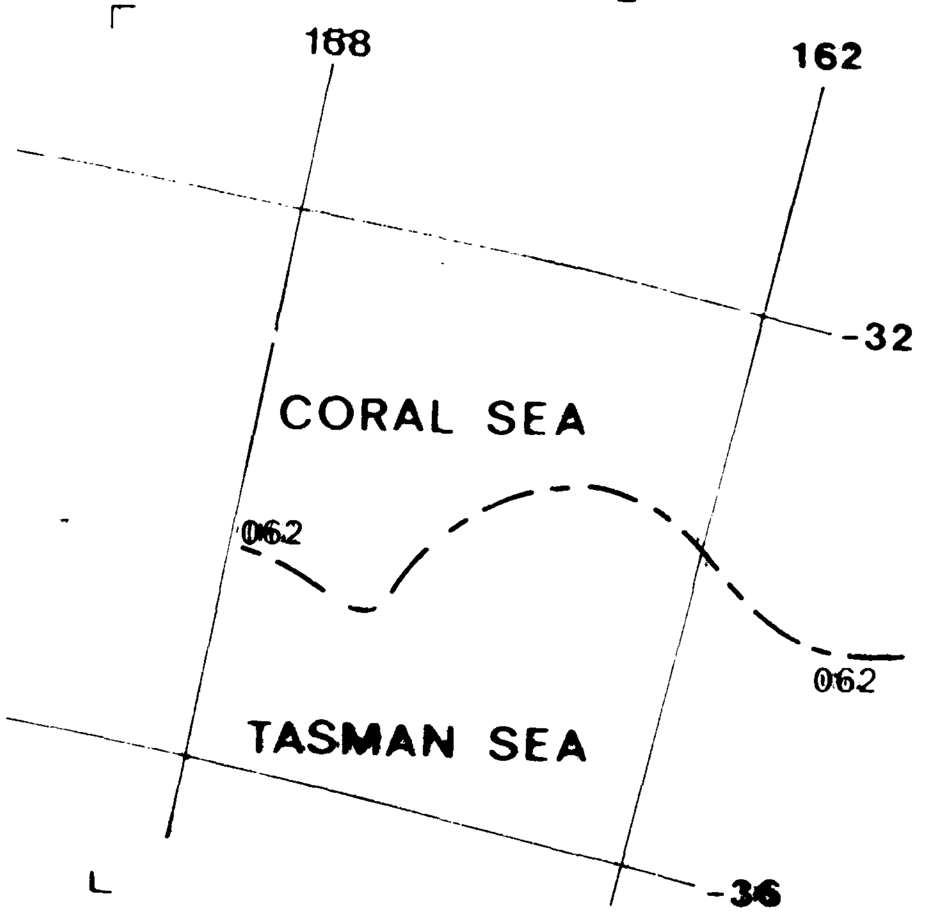
10. OBSERVATIONS OF THE TASMAN FRONT

The correspondence between the dynamic topography obtained by ship and aircraft survey in the EAC area and the warm water patterns visible in the HCMM imagery has been amply illustrated in the preceding sections. In many, but not all cases, we can delineate the Tasman Front from the HCMM images. Image 047-0347-2, shown as Fig. 5c, is a case in point. Fig. 18b shows the Tasman Front clearly visible through considerable cloud cover 15 days later, illustrating the value of the high spatial resolution of HCMM data. The visible boundary between the Tasman and Coral Sea water in this image has been delineated on the overlay and labelled according to the image (HCM) day number, namely 062. We can compare the positions of the front in this manner from three images around this time, (HCM days 047, 059 and 062). This is shown in Fig. 19. Indeed the Tasman Front does seem to exhibit some westward movement with time. Fig. 20 however, shows a front apparently moving eastward from HCM day 143 to day 153. We conclude that more such synoptic data are needed before many conclusions are drawn on this subject. An approach along the lines of that used by Maul, Webb de Witt, Yanaway and Baig (1978) would be appropriate. They performed spectral analyses of Gulf Stream meanders as they advected past a fictitious wave-staff, thus determining the dominant periods, amplitudes and phase-velocities of the wavelike meanders. These data were obtained from more than two years of GEOS observations. Unfortunately, the HCMM data are probably insufficient for this task (Maul et al. had more than 700 days of data) and furthermore, the analyses are beyond the scope of this project. We have seen however that we might expect finally to enhance from the HCMM data set about one image every three or four days covering the western section of the Tasman Front, so continued processing should produce a more useful time series that will be sufficient for an initial study of frontal movements.

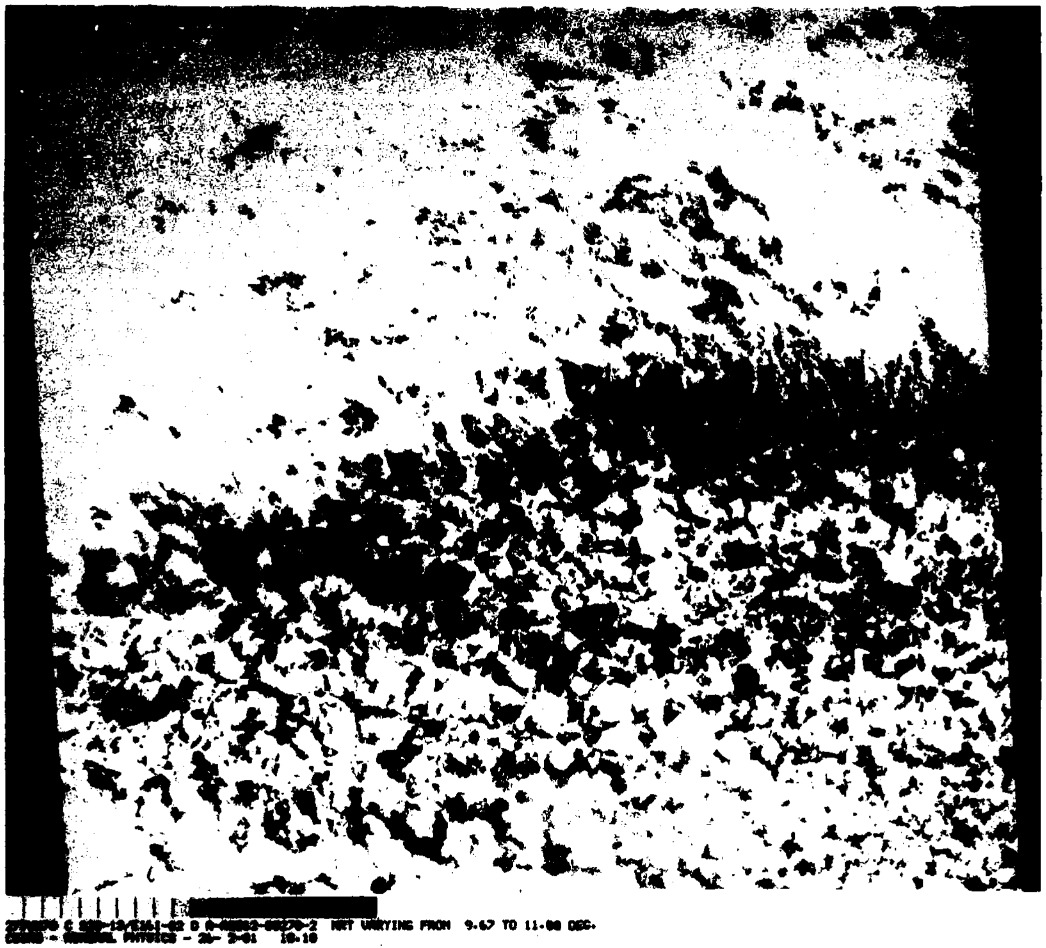
11. OTHER OBSERVATIONS

Fig. 21 shows an atmospheric cold front apparently moving eastwards, visible in the upper left of the scene. The front is preceeded by a line of thunderstorms. There is cooler, dryer air immediately behind the front, so one might expect to see an apparent enhancement of the SST due to decreased atmospheric aborbtion. This appears to be the case, particularly in a 10 km (2 mm in Fig. 21) band immediately behind the northern half of the visible front. It is noticeable that the atmospheric front looks like an atmospheric front and should not be easily confused with a genuine ocean SST front, even though the latter may be weak. Their appearances are quite different. For this reason it would appear preferable not to attempt to remove clouds by smart processing for this type of analysis - the presence and nature of the clouds serve as a warning of changes in the atmosphere that may give rise to apparent changes in radiance from the sea surface. The high resolution of the data is of great assistance in these conditions. The individual clouds can be recognised and often the SST can be read between them. In a situation of scattered cloud, a simple analysis shows that the proportion of pixels contaminated by cloud (i.e. radiance intermediate between cloud-free and total cloud) increases directly with the pixel length.

Fig. 22 (Scene 157-1523-3) shows cyclonic circulation of cool water between the anti-cyclonic flow of what appears to be the main EAC front (at about 35 S) and the detatched eddy off Cape Howe to the south. The flow around the latter warm-core eddy is clearly marked by a circumferential band of warm surface water. Satellite-tracked buoys and other current measurements have previously shown such a clockwise flow to be set up in similar circumstances (Nilsson and Cresswell, 1980) and it is indicated in Fig. 3. The point of note about this image is that it immediately gives a strong visual impression of this flow.



168
162
-32
CORAL SEA
062
062
TASMAN SEA
-36


VARYING FROM 9.67 TO 11.00 DEG.

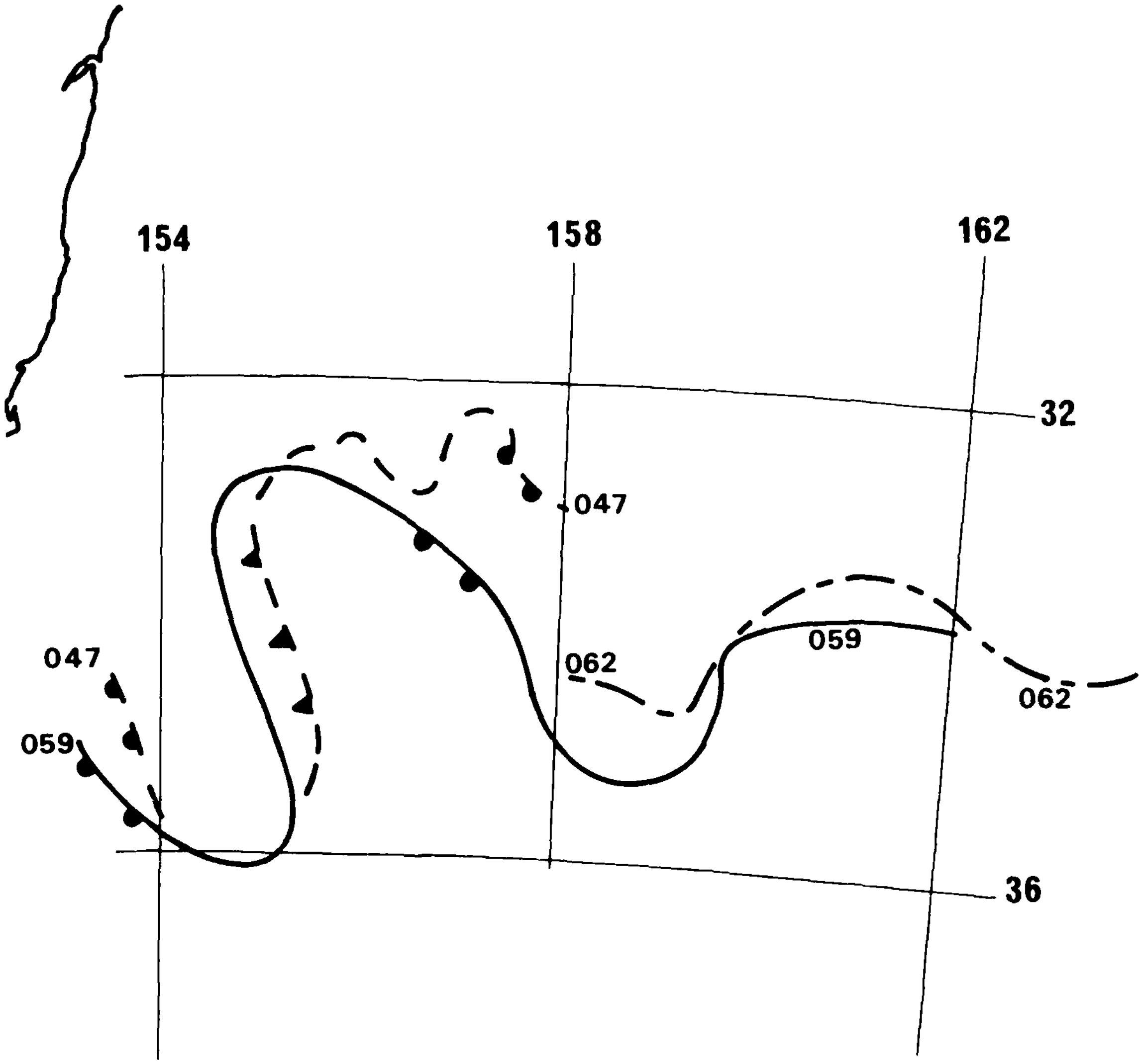


Fig. 19. The positions of the Tasman Front on 12 Jun 78 (day 047), 24 Jun 78 (day 059) and 27 Jun 78 (day 062).

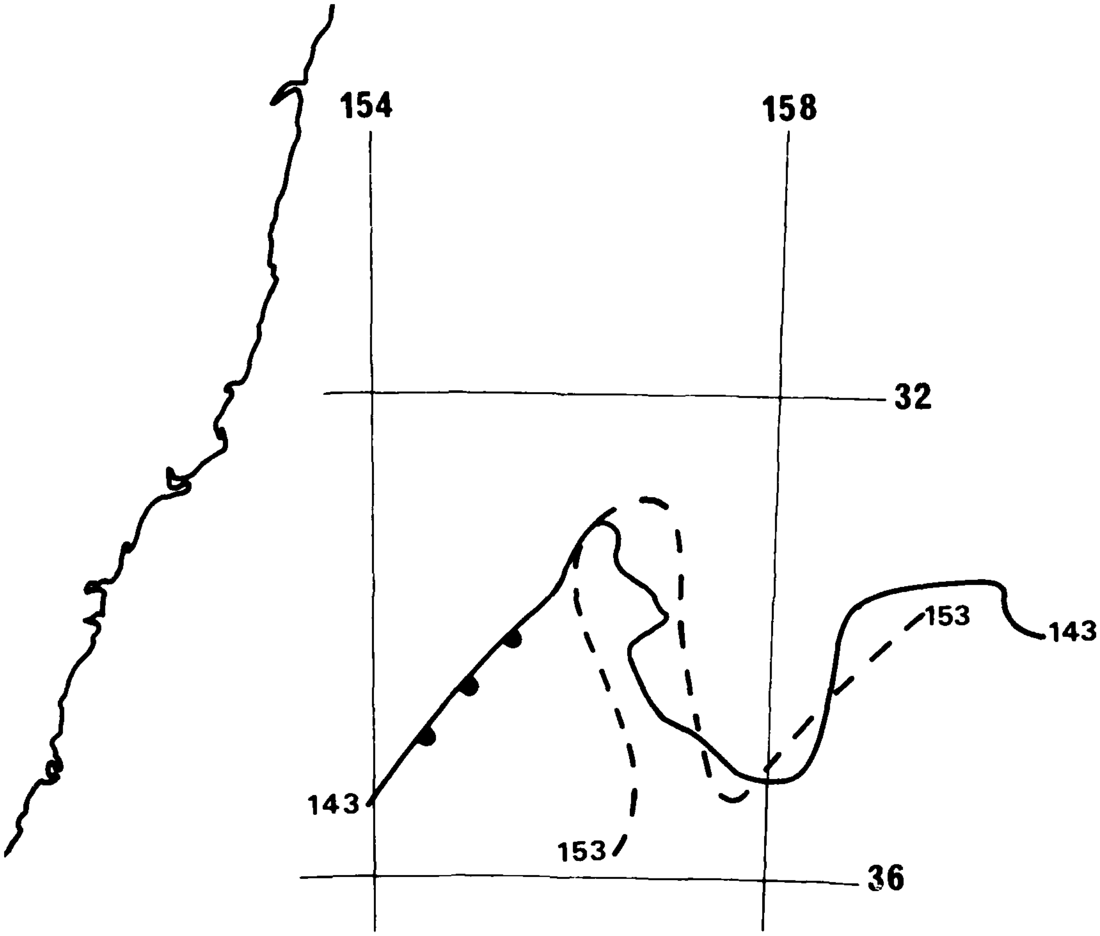


Fig. 20. The positions of the Tasman Front on 16 Sep 78 (day 143) and 26 Sep 78 (day 153).

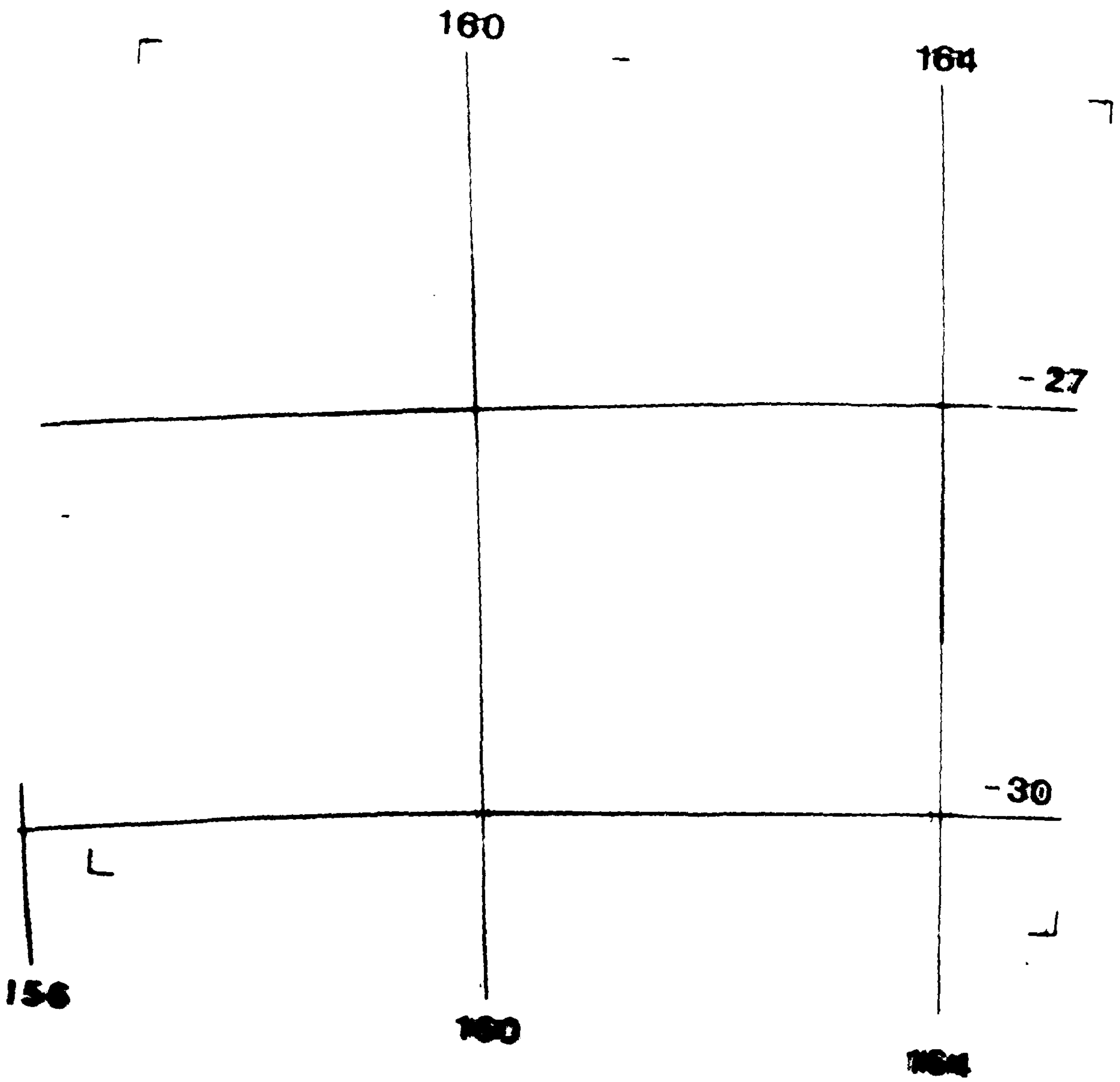
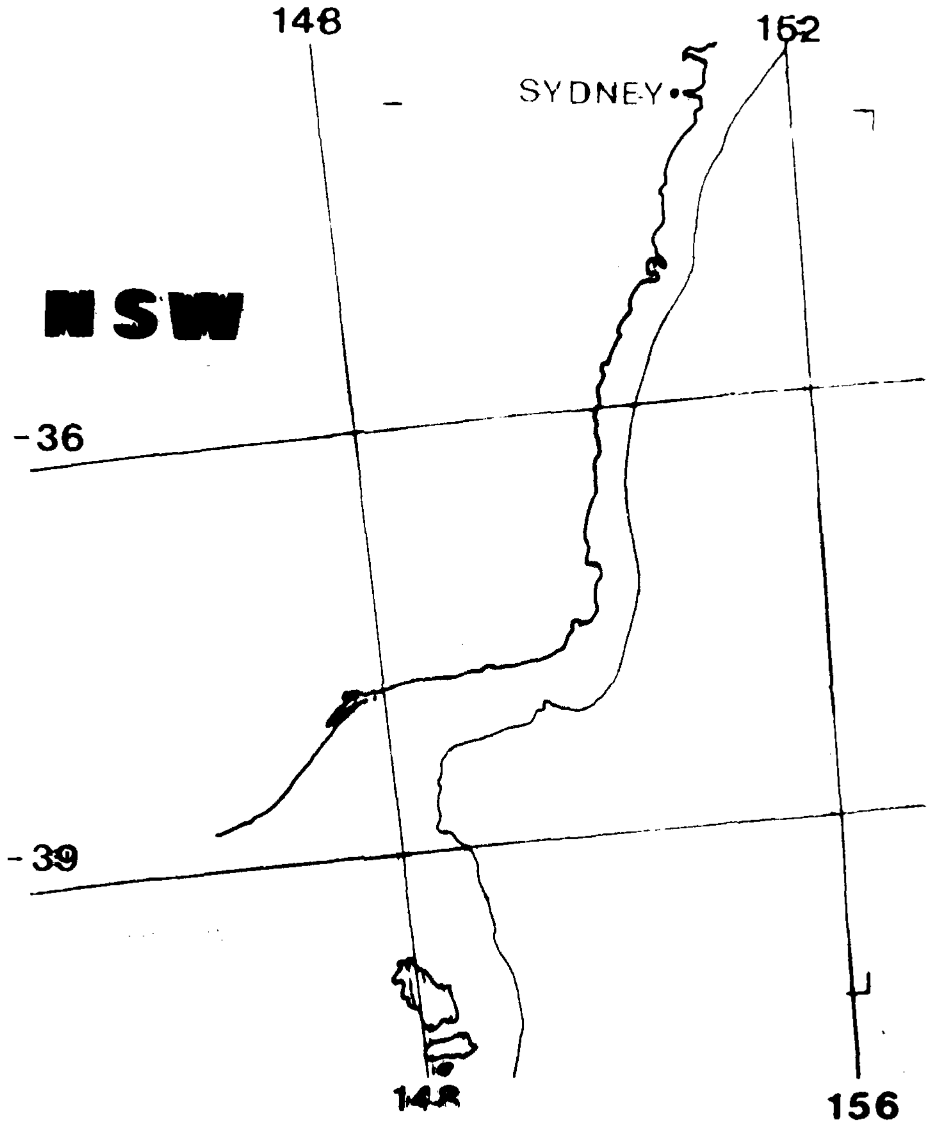
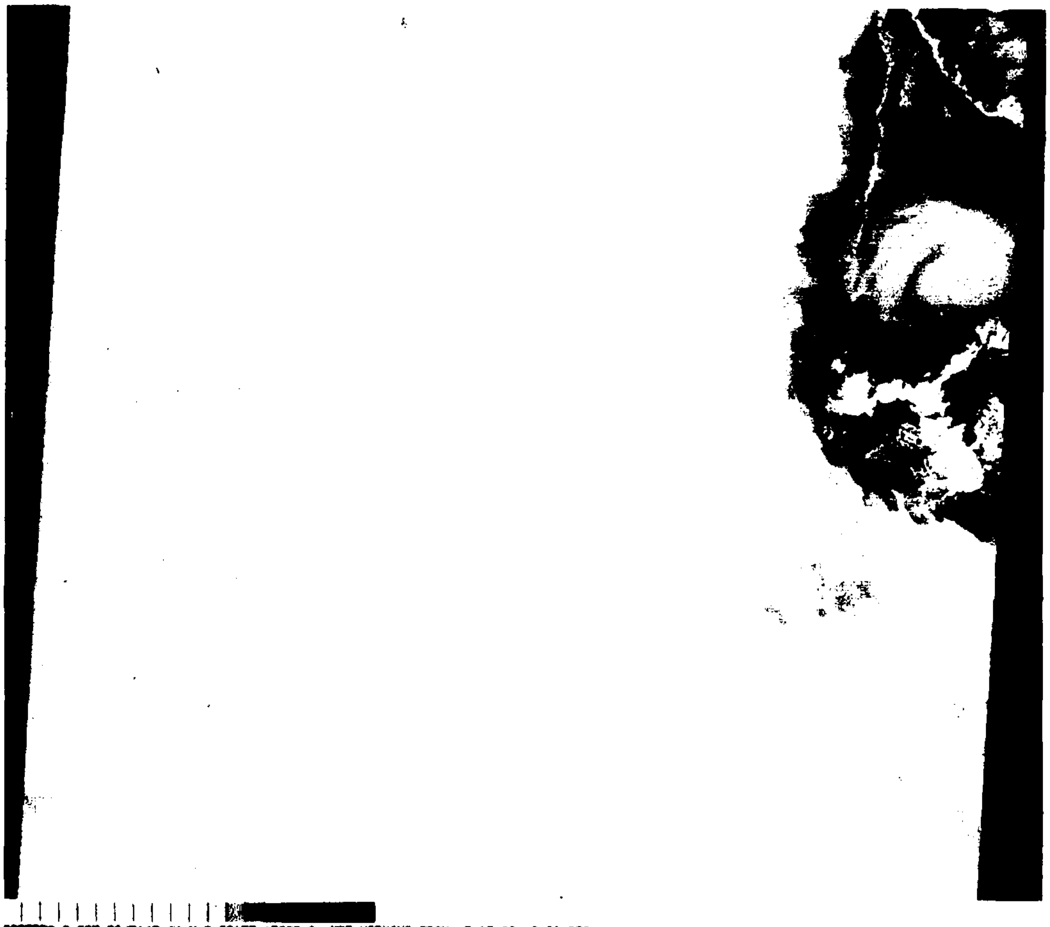


Fig. 21 (Over). Enhanced image HCM 144-1439-3 for 17 Sep 1978. An atmospheric cold front can be seen around 26°S, 158°E.


17SEP78 C S27-36/E161-05 N A-A0144-14390-3 GREY SCALE SHOWS 8.03 TO 14.37 DEG.
CSIRO - MINERAL. PHYSICS - 17- 2-81 10.17



... for 30 Sep 1978. Cyclonic ... between the EAC and a warm-core



30SEP78 C S37-23/E147-44 N A-A0157-15230-3 MRT VARYING FROM 7.67 TO 9.33 DEG.
CSIRO -'MINERAL PHYSICS - 24- 2-81 15.43

Furthermore, even if one did not know from other data, the image specifically shows that the direction of water movement between the front and southern eddy is clockwise. Thus the flow around the southern eddy must be anti-clockwise, that is, it is a warm-core eddy.

Now, if one can determine these things visually, it would be possible to program a computer to do likewise. For example, admitting for the moment an ambiguity of 180° in direction, the direction of current is given by the direction in which the SST gradient is a minimum. In practice, it would probably better be defined as normal to the maximum SST gradient. In the case of this clockwise circulation, the flow has entrained a small stream of warmer water which tapers off to a point. We have previously noted this feature as an indicator of direction of flow (Fig. 14 for example). Such indications could also be programmed to define the sense of the current.

12. SUMMARY OF SIGNIFICANT RESULTS

We have outlined in this report the development of an enhancement technique that crudely removes the variation of sea surface temperature (SST) with latitude and utilises the full grey scale for display of mesoscale oceanographic structure. In so doing we have learned and demonstrated that enhancement to at least 0.3 C per resolveable step in the grey scale is necessary in many cases to see the SST structure in the West Tasman Sea.

In Section 9 we determined a simple regression of observed atmospheric absorbtion against actual oceanographic (surface mixed layer) temperature. After allowing for a 5.5 K instrument offset, we have

$$\Delta T = 4.1 + 0.23(T_s - 22.8) \pm 0.7 \text{ C}$$

where $\Delta T = T_s - T_h$; T_s is sea-truth temperature and T_h is apparent temperature at the satellite.

The measured uncertainty (±0.7 K) is less than might have been expected and compares favourably with multi-channel analyses from NOAA-AVHRR data, for example. It could be that the Tasman Sea area is simpler to work with in this respect than is the North Atlantic Ocean.

Given suitable enhancement, we have shown that the images reflect current flow in summer as well as in winter, as shown, for example, by Fig. 12 and Fig. 13.

There are some HCMM images that we have not shown which contain SST structure that we do not yet understand. That is only to be expected, indeed hoped for, given the new nature of the data. However, all the comparisons of sea truth and HCMM data that we have had time to make have been presented and no evidence has emerged that the apparent SST structure as seen by HCMM is misleading in any significant way. On the contrary, the HCMM data show the SST structure clearly and in a way that mostly is easily interpretable, which statement cannot be made for classic oceanographic sampling of SST.

It is clear that the principal aim of Project HCM-051 has been achieved. Relatively simple enhancement techniques applied to the computer-compatible tape (CCT) data show the sea surface temperature (SST) structure adequately in the area off east Australia. Through comparisons with extensive sea truth data we have shown that the SST shows the flow of the East Australian Current (EAC), the Tasman Front and the circumferential currents around eddies.

With reference to future IR satellite operations, we note the usefulness of large areas of near-uniform SST obtainable in mesoscale eddies for the purposes of ground (sea) truth and instrument calibration.

13. FURTHER CONCLUSIONS

We expected SST to reflect dynamic topography in winter, but not in summer, in accordance with past ship data. However, the HCMM data show that SST also reflects dynamic topography in summer. One of the surprises of this project has been the closeness of the correlation in visual imagery. Past difficulties in interpretation of summer data appear largely to have been due to inadequate spatial sampling and, to a lesser extent, lack of synopticity. As a corollary to this finding, we conclude that spatial sampling that is sufficient to determine dynamic topography may be insufficient to resolve SST structure. This has important consequencies for the gathering and interpretation of oceanographic data that is not supported by satellite IR coverage.

Previous incorrect conclusions concerning the relation of SST to dynamic topography have also in part been caused by a rather naive approach to the question of correlation between the two. For example, in Fig. 5 we see that the Coral Sea water that forms an intruding tongue into the Tasman Sea is dynamically high and is characterised by warm SST across the whole tongue. Dynamic height and SST would be s mply correlated in this instance. However, on other occasions, for example in Fig.12, there is a narrow geostrophic flow of warm water that (basically) follows the contours of dynamic height and within which there is an open core of cooler surface water. Thus a simple attempt at correlating SST with dynamic height would produce a null or negative result. Again, in Fig. 22 we can see a closed eddy with a ring of warm surface water circulating around a cooler core. The visual interpretation is reasonably obvious and the pattern signals the pressence of a dynamically high body of water, but an attempt to correlate SST with dynamic height in a simple correlation exercise involving coarse spatial sampling would fail.

The high resolution of HCMM imagery has enabled us to see much fine structure that otherwise would not have been apparent, for example the detail in the plume of warm surface water intruding onto the continental shelf south of Cape Howe visible in Fig. 11. The velopment of this and other features can be followed from day to day, as is supported by the image of the previous day, Fig. 9. The western edge of the southward flow of the EAC seen in Fig. 7 has the same 'serrated' appearance due to minor back eddying as the Gulf stream in the description by Maul et al. (1978). Not only does the EAC sometimes override the continental shelf but often these secondary effects of the principal offshore currents penetrate onto the continental shelf and are responsible for perturbations to that regime. Thus high resolution IR imagery is particularly important to those concerned with nearshore water movements.

The HCMM data set, while incomplete, has shown that the Tasman Front is more complex than we might have hoped. More data are needed to establish whether or not the front as a whole propagates westward and if so, at what rate. HCMM data have, however, confirmed the broad outline of eddy formation through pinch-off of an EAC meander shown in Fig. 4 (From Nilsson and Cresswell, 1980). The HCMM images over the period 8-24 Feb 79 (Fig. 12 - Fig. 14) show this very clearly.

From the viewpoint of oceanographic studies of the EAC area, the above conclusions must cause us to rate this project as a significant success. The HCMM mission, with its emphasis on the measurement of diurnal temperature variations of the land, was primarily oriented towards land-use and geological studies. This project, dealing as it has with the deep ocean, has not made use of this important feature of HCMM. A sun-sychronous orbit was not necessary for these studies, except in so far as it is helpful to have land temperatures either significantly cooler or warmer than SSTs. However, the fact remains that Project HCM-051 represents the first opportunity Australian oceanographers have had of obtaining adequate IR coverage continuously over a substantial period. In particular, it was essential to have the CCT data to produce enhanced images. Now that the potential of these data has been demonstrated in conjunction with rigorous comparisons with sea truth, there will be increased support for the systematic use of high resolution IR imagery from other satellite systems, for example th NOAA-NESS series with AVHRR sensors. From a local viewpoint, this may prove to be the most significant long term accomplishment of this project.

Finally, the surveys giving rise to all the sea truth listed in Table 2 represent a most intensive period of oceanographic research in the EAC area. As we have shown in Section 5, the enhanced images that we presently hold represent only about one third of the total data set. Given time, it would be most valuable from a scientific viewpoint to build up as complete a coverage as is possible for this rather special twelve month period. Tracking the Tasman Front is still an important and unfinished aim. Thus we hope that the work with HCMM CCT data discussed in this report will continue.

14. PUBLICATIONS

Apart from some seminars, talks and Progress Reports, various aspects of HCM-051 data have also been presented in the following:

Nilsson, C.S. (1981) Enhanced satellite images of the Tasman Sea, Landsat 81: Proceedings of the second Australasian Remote Sensing Conference, Canberra, September 1-4, 1981, 7.7.1.

Nilsson, C.S. (1982) HCMM satellite observations of the formation of eddy J, Warm-Core Rings Workshop, Wellington, New Zealand, 18-22 January 1982, sponsored by the U.S.-Australia Cooperative Science Program and the U.S.-New Zealand Cooperative Science Program, to be published.

Acknowledgements - The Authors wish to acknowledge NASA/GSFC for the HCMM project and the supply of data for this project HCM-051. In particular, the support of Locke M. Stuart, J.C. Price and R. Murphy is gratefully acknowledged. We also wish to acknowledge the officers and crew of the reseach ships HMAS KIMBLA and R.V. SPRIGHTLY and members of RAAF 11 Squadron who flew the AXBT surveys, along with M. Lawrence who reduced the AXBT data. S. Ball did much of the HCMM image computer work prior to 1981. Defence Reseach Centre, Salisbury provided essential computing facilities and the use of CSIRO Division of Mineral Physics image processing facilities under the direction of A. Green is gratefully acknowledged.

The work was directly supported by the Australian Department of Defence (DST Task 80/006).

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Nilsson, C.S., Andrews, J.C. Lawrence, M.W., Ball, S. and Latham, A.R. (1980a) Heat Capacity Mapping Mission Project HCM-051 Progress Report to 30 April 1980. RAN Reseach Laboratory Technical Memorandum No. 3/80, 66pp.

Nilsson, C.S., Andrews, J.C., Scully-Power, P., Ball, S., Speechley, G. and Latham, A.R. (1980b) Heat Capacity Mapping Mission Project HCM-051 Progress Report to 31 Aug 1980. RAN Research Laboratory Technical Memorandum No. 5/80, 36pp.

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APPENDIX A. ASSESSMENT OF IMAGE PRIORITY

Standard product images are initially assessed as they arrive for general interest and suitability. If the image is clearly of no forseeable use, it is given a priority of zero and is listed as such on the master file. An image that only includes a relatively small area of useful ocean surface has a priority prefix of "R" assigned. It would not normally be ordered as a CCT, but remains in the processing stream in case subsequent analysis of neighbouring images suggests that the "R" image may be needed. This is as far as grading by quality is taken. Subsequent grading is based on day of observation and location. Thus the next step is performed by computer. Each record of image data on the update file is compared with the list of sea truth to determine (to the nearest day and lat/long degree) if time and location overlap with sea truth boundaries. If so, the priority assigned is "3". If not, but the image overlaps with the latitude band of interest to mapping the Tasman Front (25-36 S), the priority assigned is "2". South of that latitude limit and not coincident with the small amount of sea truth at higher latitudes, the priority given is "1". The priority thus assigned is given in the Appendix C in the column headed "PP".

The priorty used for ordering CCT data "PR" is based on "PP", but is not identical. In general, the top priority PR = AA corresponds to PP = 3, PR = A corresponds to PP = 2 and PR = B corresponds to PP = 1. However, special periods other than sea truth periods may be raised in priority. For example, all data for which PP >1 in the period 8 Jul 78 to 18 Aug 78 (HCM days 073-114) have been raised to PR = AA. This period is from HCM cycle 5 ref. day 8 to HCM cycle 8 ref. day 1 and was chosen for special attention. Cycle 6 is unique in that each of the 16 reference days has at least one image of sufficient priority. Also, there are good sea truth data available from cruises SP 10/78, K 14A/78 and SP 11/78 over the period 20 Jul 80 to 18 Aug 80 (cyc 6/4 to cyc

8/1). Thus on first inspection this period seemed particularly suitable for ascertaining whether or not it is possible to track the Tasman Front from day to day using HCMM data. We have received 42 CCT images for this period, 33 of which have been enhanced.

If the priority PP is prefixed by an "R", the priority PR associated with CCT orders is reduced one level from the usual transformation, for example, "R3" becomes "A" instead of "AA".

APPENDIX B. STATUS OF HCM-051 IMAGE PROCESSING

B1. Current situation.

It can be seen from the data in Appendix C that we have received a total of 273 images in CCT form, of which 43 are priority B and some are repeats. Of the total, 178 separate images have been digitally enhanced using procedures discussed in this and previous reports.

Final enhancement of recently received images has temporarily been suspended pending the completion of this report and further studies into an improved enhancement procedure, along the lines outlined in Section 4. We are developing a completely new version of the "STATS" program (See Progress Report 30 Apr 80) that will provide a plot of radiance distribution (within the SST range) against line number in blocks of 80 lines. Line number (half-way across the image) can be equated directly with latitude, so that, to a sufficient aproximation, such a plot will provide the relevant radiance distribution as a function of latitude.

Because CCT data have arrived in non-chronological order and because until recently it has been necessary to process these data as quickly as possible, there has been little or no opportunity to review and improve the processing procedures. In particular, images have been enhanced as separate scenes without regard of those that are neighbours in time or space. Only recently, for example, have we been able to start using a variable mid-range temperature (MRT) that has a common value at the boundary between two successive images. Although the patterns may change, the range of SST at a given latitude does not vary strongly from day to day. Our new "STATS" program will provide data in a convenient form on the range of SST as a function of latitude and date. It is desirable that some cognizance be taken of these data as a total set before MRT v. latitude functions are assigned to individual scenes. We may still end up having to assign MRT values according to each individual scene, but alternately, it may be possible to sensibly enhance using mean values of MRT as a function of date and latitude that give some absolute continuity from one image to the next.

B2. Assigned location of images.

As can be seen from the the data under the column headed "POS ERR" (Position Error) in Appendix C, the location of the centre of the image initially assigned by NASA/GSFC is sometimes in error by up to 200 km (the errors are listed in deg.min). Early in the project we developed a procedure for assigning a new fix to the image in those cases where land was visible. It is now clear that this procedure, whilst providing considerable improvement, needs revision. Our latitude scale does not match as it should with the images. This can be noticed when comparing the sea truth overlays with the HCMM images. If the datum fix is near the bottom of the image, for example, the mismatch along the coast line becomes clear by the middle of the image. This has only recently started to cause trouble, when successive images in a given sweep are joined together. Also, the task of deriving MRT as a function of latitude is complicated by this problem. We have not made use of the fact (and neither, apparently, has NASA/GSFC) that the latitude span of each image off East Australia is $6^{\circ} 24'$ to a very good approximation. There are 220 lines per degree of latitude. Thus, if an image can be located, all the neighbouring images from that swath are also located. Again, this lapse has come from dealing with individual images in non-chronological order. Had complete swaths been studied (generally 3-4 images for HCM-051), such details could have been corrected earlier.

APPENDIX C. IMAGE PROCESSING LISTS

THE FOLLOWING LISTS SHOW THE PROCESSING OF HCM-051 DATA AS OF 31 MAR 81.

THE DATA ARE LISTED UNDER THE FOLLOWING HEADINGS:

"B" IS THE INCOMING STANDARD IMAGE BATCH NUMBER; THE LARGER THE NUMBER, THE MORE RECENTLY THE PHOTO IMAGE HAS BEEN RECEIVED. DUPLICATE IMAGE IDENTS ARE DIFFERENTIATED BY DIFFERENT BATCH NUMBERS.

"FR" IS THE IMAGE FRAME NUMBER.

"LAT" AND "LONG" ARE THE IMAGE CENTER COORDINATES AS SUPPLIED BY NASA.

"DAY" AND "HHMM" CONSTITUTE THE HCM TIME (DAYS, HOURS AND MINUTES) PART OF THE IMAGE IDENT AND "T" IS THE IMAGE TYPE (-2 FOR DAYLIGHT IR, -3 FOR NIGHT IR), WHICH COMPLETES THE IMAGE IDENT CODE.

"PP" IS THE IMAGE PRIORITY WITH RESPECT ONLY TO IMAGE TIME AND LOCATION SET AGAINST THE AIMS AND PRIORITIES OF HCM-051. IMAGE QUALITY IS NOT A GRADED QUANTITY EXCEPT INSOFAR AS A USELESS IMAGE IS GIVEN PRIORITY PP =0. IMAGES FOR WHICH PP =0 ARE EXCLUDED FROM THESE LISTS. HOWEVER, IF PRIORITY PP IS PREFIXED BY AN "R", THE IMAGE ONLY INCLUDES A SMALL AREA OF USEFUL DATA AND WILL BE DOWNGRADED WHEN IT COMES TO ORDERING C/C TAPES. PP =3 IS THE TOP PRIORITY.

"PR" IS THE PRIORITY FOR ORDERING C/C TAPES. MOSTLY, BUT NOT ALWAYS, THE TOP PRIORITY "AA" CORRESPONDS TO PP =3, PRIORITY "A" CORRESPONDS TO PP =2 AND PRIORITY "B" TO PP =1. HOWEVER, SOME PRIORITY 2 IMAGES IN SELECTED TIME PERIODS HAVE BEEN RAISED TO PRIORITY AA AND A "R" ("REJECT") PREFIX AUTOMATICALLY LOWERS THE C/C TAPE ORDERING PRIORITY BY ONE GRADE. FURTHER INFORMATION ON EACH PRIORITY "PR" IS GIVEN WITH THE DATA LISTS.

"STATUS" REFERS TO OUR PROCESSING STATUS AS OF 31 MAR 81. DETAILS OF THE BREAKDOWN OF THIS WORD ARE GIVEN IN THE DATA LISTS.

"POS ERR" IS THE DIFFERENCE (OUR'S -NASA'S) IN IMAGE CENTER COORDINATES GIVEN IN DMM (DEGREES, MINUTES) FOR LATITUDE AND LONGITUDE BETWEEN NASA S VALUES AND THOSE WE HAVE DETERMINED FROM KNOWN LANDMARKS (WHERE VISIBLE).

"OB" IS THE OUTPUT PROCESSING BATCH NUMBER.

"MRT" IS THE APPARENT "MID-RANGE TEMPERATURE" OF THE SURFACE WATER AS DETERMINED FROM THE CCT IMAGE (USING THE "STATS" PROGRAM). IT IS ACTUALLY ESTIMATED TO THE NEAREST 0.5 C FROM THE MAXIMUM MEAN TEMPERATURE LESS ABOUT 2.5 DEGREES C OF ALL APPROPRIATE 20X20 PIXEL AREAS OF WATER SURFACE. THE UNITS ARE TENTHS OF DEGREES C.

"TRUTH" COMES LAST AND IS THE IDENT OF THE CRUISE OR OTHER (E.G. AXBT) GROUND TRUTH DATA AND IS APPLICABLE ONLY TO IMAGES FOR WHICH PRIORITY PP =3.

PRIORITY AA

THESE IMAGES ARE NEEDED FOR THE PRINCIPAL AIMS OF HCMM-061 AND IMMEDIATE COMPARISON WITH EXISTING GROUND TRU[illegible] TESTING OF DAY-TO-DAY CONTINUITY OF APPARENT FRONTS.

IMAGE STATUS DATA ARE DIVIDED INTO THREE [illegible]OUPS FOR THIS PRIORITY. THESE GROUPS ARE FOR CCT DATA WHICH (1) [illegible]E NOT YET BEEN ORDERED. (2) HAVE BEEN ORDERED BUT NOT YET RECE[illegible] AND (3) HAV[illegible] BEE[illegible] RECEIVE[illegible]. STATUS DATA CAN BE INTERPRETED AS FOLLOWS: "G"= GRID MADE. "O"= CCT ORDERED BY US. "C" IN COL 2 INDICATES ORDER BY CSIRO CRONULLA. "R"= CCT RECEIVED. "/" IN COL 3 INDICATES CCT UNAVAILABLE. "S"= IMAGE STATISTICS OBTAINED. "E"= IMAGE ENHANCED DIGITALLY. "C" (IN COL 6)= CSIRO ENHANCED PHOTO. IMAGE GENERATED. "P"= ENHANCED PHOTO. PRINTED. THE ABSENCE OF APPROPRIATE LETTERS INDICATES THE NEGATIVE.

GROUP(1). C/C TAPES HAVE NOT YET BEEN ORDERED FOR THE FOLLOWING IMAGES:

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS ERR OF MRT	TRUTH
16	105	210578	-3100	15935	025-03360-2	3	AA	G		SP088
16	206	220578	-3722	15640	026-03530-2	3	AA	G		SP088
16	204	220578	-3116	15504	026-03540-2	3	AA	G		SP088
22	142	230578	-3226	15841	027-15020-3	3	AA	G		SP088
22	143	230578	-3834	15702	027-15030-3	3	AA			SP088
16	238	240578	-4335	14920	028-04270-2	3	AA			SP088
16	236	240578	-3731	14732	028-04290-2	3	AA			SP088
10	124	[illegible]50578	-4116	14402	029-04460-2	3	AA			SP088
16	226	270578	-3548	15737	031-03470-2	3	AA	G		SP1[illegible]
16	250	280578	-3820	15344	032-04040-2	3	AA			SP088
16	248	280578	-3214	15207	032-04060-2	3	AA	G		SP088
16	241	280578	-3344	15945	032-14560-3	3	AA			SP088
16	242	280578	-3950	15803	032-14570-3	3	AA			SP088
20	018	290578	-3332	14752	033-04240-2	3	AA			SP088
16	266	290578	-3626	15426	033-15150-3	3	AA			SP088
15	364	300578	-4131	14531	034-04400-2	3	AA			SP088
16	258	300578	-4343	14741	034-15350-3	3	AA			SP088
2	168	160778	-3007	15540	081-15080-3	2	AA	G	14 06	
2	169	160778	-3611	15405	081-15090-3	2	AA	G	35 -09	
2	027	210778	-2957	15717	086-15010-3	3	AA	G		SP108
4	158	180878	-3626	15013	114-15200-3	3	AA	G	34 -0[illegible]	SP118
4	033	170978	-2707	16112	144-14390-3	3	AA	G		[illegible]
19	123	061278	-3230	15159	224-03400-2	3	AA	G	55 -04	SP168
19	138	071278	-3738	14848	225-03570-2	3	AA			SP168
10	171	081278	-4046	14509	226-04140-2	3	AA			SP168
5	345	081278	-3504	15003	226-15070-3	3	AA	G	22 -04	SP168
22	226	270379	-3548	15744	335-03050-2	3	AA	G		SP039

NUMBER OF IMAGES PRIORITY AA, GROUP(1) = 27

GROUP(2). C/C TAPES HAVE BEEN ORDERED BUT NOT RECEIVED AS OF 31 MAR 81 FOR THE FOLLOWING IMAGES:

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS ERR OF MRT	TRUTH
10	256	240578	-3700	15254	028-15210-3	3	AA	GO	36 -01	SP088
21	030	080678	-3325	15041	043-04110-2	3	AA	GO	44 00	SP098
8	006	170678	-3317	15806	052-03400-2	3	AA	GO		SP098
19	082	080778	-3120	15904	073-03320-2	2	AA	GO		
20	004	100778	-3301	15024	075-04080-2	2	AA	GO	49 -03	

PRIORITY AA GROUP(2) CONTINUED

R	FP	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OH	MPT	THLT
14	106	110778	-3505	14622	076-04250-2	2	AA	0					
9	465	120778	-3131	14913	077-15330-3	2	AA	0					
20	122	130778	-3105	16034	078-03250-2	2	AA	GO					
13	014	150778	-3241	15933	080-14500-3	2	AA	0					
9	077	160778	-3604	14811	081-04180-2	2	AA	0					
12	168	160778	-3007	15540	081-15080-3	2	AA	0					
12	169	160778	-3611	15405	081-15090-3	2	AA	0					
9	431	170778	-3125	15048	082-15260-3	2	AA	0					
12	004	180778	-2852	16134	083-03190-2	2	AA	GO	00	00			
10	058	190778	-3704	15909	084-03350-2	3	AA	0					SP108
15	125	200778	-3339	16054	085-14440-3	2	AA	0					
2	436	240778	-3623	16033	089-03280-2	2	AA	GO					
13	604	280778	-2529	15055	093-15280-3	2	AA	0					
10	606	280778	-3740	14750	093-15320-3	3	AA	0					SP108
14	141	290778	-3452	16139	094-03210-2	2	AA	GO					
14	139	290778	-2844	16006	094-03230-2	2	AA	GO					
16	306	300778	-3632	15734	095-03390-2	3	AA	GO					SP108
16	304	300778	-3025	15558	095-03400-2	3	AA	GO					SP108
12	041	010878	-3001	15602	097-15040-3	3	AA	0					SP108
12	042	010878	-3606	15428	097-15060-3	3	AA	0					SP108
19	026	050878	-3607	15432	101-03490-2	3	AA	GO	39	07			SP108
19	024	050878	-2959	15257	101-03510-2	3	AA	GO	102	00			SP108
10	016	100878	-2633	15346	106-03450-2	3	AA	0					SP118
19	014	120878	-3107	5428	108-15080-3	3	AA	0					SP118
11	039	130878	-37[illegible]	[illegible]4819	109-15280-3	3	AA	0					SP118
10	046	160878	-3231	15220	112-03540-2	3	AA	GO	32	07			SP118
10	044	160878	-2622	15051	112-03560-2	3	AA	GO	101	-03			SP118
9	036	170878	-3631	15443	113-15020-3	3	AA	0					SP118
18	015	170978	-4514	15543	144-03480-2	3	AA	0					SP128
18	013	170978	-3910	15349	144-03490-2	3	AA	0					SP128
18	009	170978	-2700	15037	144-03530-2	3	AA	GO	54	-02			SP128
8	194	290978	-4220	15050	156-15060-3	3	AA	GO	18	-06			SP138
5	216	031078	-4519	15536	160-03460-2	3	AA	GO					SP138
20	010	041078	-4728	15149	161-04040-2	3	AA	0					SP138
21	056	141078	-4347	15338	171-03510-2	3	AA	0					SP148
21	054	141078	-3744	15147	171-03520-2	3	AA	0					SP148
21	052	141078	-3133	15010	171-03540-2	3	AA	GO	54	-06			SP148
19	066	141078	-3855	15531	171-14450-3	3	AA	0					SP148
21	036	151078	-3659	15231	172-15020-3	3	AA	0					SP148
21	037	151078	-4304	15042	172-15040-3	3	AA	0					SP148
21	040	161078	-3146	14922	173-15190-3	3	AA	0					SP148
21	041	161078	-3751	14744	173-15210-3	3	AA	0					SP148
21	042	161078	-4355	14553	173-15220-3	3	AA	0					SP148
11	016	161178	-3553	14723	204-04040-2	3	AA	0/					SP158
20	116	211178	-3105	15602	209-14480-3	3	AA	0					SP158
20	117	211178	-3711	15426	209-14500-3	3	AA	0					SP158
21	204	251178	-2618	15214	213-03360-2	3	AA	0	114	-14			SP158
19	147	261178	-3052	15727	214-14420-3	3	AA	0/					SP158
19	148	261178	-3658	15551	214-14440-3	3	AA	0/					SP158
19	144	071278	-3101	15540	225-14480-3	3	AA	0					SP168
5	232	180279	-3500	15621	298-03170-2	3	AA	GC					K1488
5	230	180279	-2853	15449	298-03190-2	3	AA	GO	46	-35			K1488
13	040	200279	-3151	15441	300-14430-3	3	AA	C					K1488
13	041	200279	-3755	15304	300-14450-3	3	AA	C					K1488
10	074	260279	-3746	14514	306-04030-2	3	AA	C					K1488
5	140	010379	-3624	15519	309-03200-2	3	AA	GC					K1488

PRIORITY AA GROUP(2) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MRT	TRUTH
15	157	180379	-3223	14922	326-03380-2	3	AA	C					SP[illegible]
19	368	220379	-3631	15626	330-03120-2	3	AA	GC					SP039
19	366	220379	-3025	15451	330-03140-2	3	AA	GC	36	03			SP039
5	318	230379	-3530	15136	331-03300-2	3	AA	GC	31	11			SP039
11	132	270379	-3208	15647	335-03060-2	3	AA	GC	35	12			SP039
22	224	270379	-2942	15611	335-03070-2	3	AA	GC	54	-03			SP039
11	130	270379	-2602	15519	335-03080-2	3	AA	GC	48	00			SP039
15	033	020479	-3155	15423	341-03170-2	3	AA	GC	101	-38			SP049
15	204	080479	-3233	15113	347-03270-2	3	AA	C					SP049
19	039	120479	-3228	15726	351-03020-2	3	AA	C					SP049

NUMBER OF IMAGES PRIORITY AA, GROUP(2) = 71

GROUP(3), C/C TAPES HAVE BEEN RECEIVED FOR THE FOLLOWING IMAGES:

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MRT	TRUTH
9	494	230578	-3834	15231	027-04100-2	3	AA	GORS	00	00			SP088
9	492	230578	-3249	15052	027-04120-2	3	AA	GORS	41	-02			SP088
22	076	070678	-3742	15624	042-03520-2	3	AA	ORS					SP088
22	074	070678	-3147	15447	042-03540-2	3	AA	GORS	109	-05			SP088
9	615	090678	-3102	15407	044-15190-3	3	AA	ORSF			12	125	SP098
9	616	090678	-3708	15231	044-15200-3	3	AA	ORSF			12	110	SP098
3	123	100678	-3711	14755	045-15380-3	3	AA	GORSECP	26	-11	6	90	SP098
3	018	110678	-3138	16048	046-03290-2	3	AA	GORSFCP			6	105	SP098
3	309	120678	-3307	15637	047-03470-2	3	AA	GORSECP			6	125	SP098
3	307	120678	-2701	15508	047-03480-2	3	AA	GORSFCP	125	-17	6	120	SP098
3	036	140678	-3131	15526	049-15120-3	3	AA	GORSFCP	56	03	6	115	SP098
3	069	150678	-3238	15032	050-15310-3	3	AA	GORSFCP	47	00	6	105	SP098
9	638	180678	-3147	15310	053-03590-2	3	AA	GORS	54	-06			SP098
8	242	200678	-3004	15241	055-15240-3	3	AA	GORSFCP	52	05	5	110	SP098
8	243	200678	-3611	15107	055-15250-3	3	AA	GORSFCP	32	-07	5	100	SP098
9	415	160778	-2937	15547	081-15080-3	2	AA	ORSFC			7	115	
9	416	160778	-3542	15413	081-15090-3	2	AA	ORS			11	95	
2	004	180778	-2852	16134	083-03190-2	2	AA	GORSFCP			5	115	
10	056	190778	-3057	15732	084-03360-2	3	AA	GORS	40	02			SP108
11	130	210778	-3001	15716	086-15010-3	3	AA	GORSFC	44	03	4	125	SP108
11	131	210778	-3606	15541	086-15020-3	3	AA	GORSFCP	00	00	2	90	SP108
2	012	220778	-2940	15250	087-15190-3	3	AA	GOR	53	10			SP108
11	028	220778	-3035	15236	087-15190-3	3	AA	ORSFCP	56	12	5	135	SP108
9	047	230778	-3636	14632	088-15380-3	3	AA	ORSFC			8	80	SP108
12	436	240778	-3623	16033	089-03280-2	2	AA	GORS					
2	434	240778	-3016	15858	089-03290-2	3	AA	GORSFCP			5	125	SP108
12	434	240778	-3016	15858	089-03290-2	3	AA	GORS					SP108
9	004	250778	-3154	15450	090-03470-2	3	AA	ORSFC			7	130	SP108
9	002	250778	-2546	15321	090-03490-2	2	AA	ORSFC			8	130	
10	037	260778	-3651	15131	091-04040-2	3	AA	GORSFC	19	07	7	90	SP108
10	035	260778	-3044	14955	091-04050-2	3	AA	GORSFC	33	06	7	105	SP108
10	040	260778	-2644	15942	091-14530-3	2	AA	GORSFC			9	130	
10	041	260778	-3250	15812	091-14540-3	3	AA	GORSFC			9	95	SP108
10	039	270778	-3057	15408	092-15120-3	3	AA	GORSEC	44	09	7	125	SP108
10	040	270778	-3702	15232	092-15130-3	3	AA	GORSFC	36	27	7	80	SP108
10	311	310778	-3215	15154	096-03580-2	3	AA	GORSFC	30	06	8	110	SP108
10	309	310778	-2607	15025	096-03590-2	2	AA	GORSFC	102	-03	8	120	
10	152	310778	-2723	16114	096-14460-3	2	AA	GORSFC			9	125	
10	153	310778	-3330	15943	096-14470-3	3	AA	GORSFC			9	100	SP108
2	041	010878	-3001	15602	097-15040-3	3	AA	GORSFCP	53	04	2	110	SP108

AD-A128 225 HIGH RESOLUTION SATELLITE OBSERVATIONS OF MESOSCALE OCEANOGRAPHY IN THE TASMAN SEA 1978-79(U) ROYAL AUSTRALIAN NAVY RESEARCH LAB EDGECLIFF

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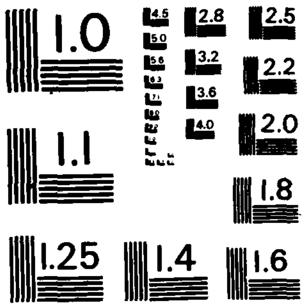
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PRIORITY AA GROUP(3) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MPT	TRUTH
2	042	010878	-3606	15428	097-15060-3	3	AA	GORSFCP	34	-12	2	80	SP108
10	073	020878	-3646	14946	098-15240-3	3	AA	GORSFC	48	00	9	80	SP108
18	009	030878	-3613	14523	099-15420-3	3	AA	ORS					SP108
23	064	050878	-3017	15302	101-03510-2	3	AA	GORS	106	-03			SP108
11	221	050878	-3540	16042	101-14410-3	3	AA	GORSF	00	00	10	80	SP118
10	003	090878	-2600	15810	105-03270-2	3	AA	GORS					SP118
10	018	100878	-3241	15516	106-03430-2	3	AA	GORSFC	56	01	7	125	SP118
10	049	110878	-2632	16009	107-14490-3	3	AA	GORSF			12	125	SP118
10	050	110878	-3239	15840	107-14510-3	3	AA	GORSE			12	105	SP118
11	038	130878	-3111	14956	109-15260-3	3	AA	GORS	45	00	11	120	SP118
11	230	150878	-3748	15817	111-03340-2	3	AA	GORSFC			7	85	SP118
11	228	150878	-3141	15640	111-03360-2	3	AA	GORSFC	106	00	7	115	SP118
11	226	150878	-2532	15511	111-03380-2	3	AA	GORSEC	108	-05	7	115	SP118
9	014	160878	-2715	16137	112-14420-3	3	AA	ORSEC			8	130	SP118
9	015	160878	-3322	16006	112-14440-3	3	AA	ORSEC			8	100	SP118
9	035	170878	-3025	15618	113-15010-3	3	AA	ORSFC			8	110	SP118
11	003	180878	-3637	15010	114-15200-3	3	AA	ORSEC			4	65	SP118
10	013	280878	-3109	15442	124-15050-3	3	AA	GORSEC	45	00	9	100	AXBT1
10	014	280878	-3716	15305	124-15070-3	3	AA	GORSEC	36	-06	9	85	AXBT1
4	015	290878	-3112	15005	125-15230-3	3	AA	GORSECP	45	-04	2	85	AXBT1
4	016	290878	-3719	14829	125-15250-3	3	AA	GORSECP	34	-06	2	65	AXBT1
10	046	080978	-3047	15256	135-15110-3	3	AA	GORSFC	44	04	9	105	DM6A8
10	047	080978	-3654	15120	135-15130-3	3	AA	GORSFC	34	-05	9	75	DM6A8
17	032	140978	-2927	15004	141-15220-3	3	AA	GORS	55	-01			DM6B8
17	033	140978	-3534	14830	141-15240-3	3	AA	GORS	30	-03			DM6B8
17	034	140978	-4141	14644	141-15260-3	3	AA	ORS					SP128
4	056	160978	-3546	15725	143-03320-2	3	AA	GORSEC			6	95	DM6B8
4	054	160978	-2940	15552	143-03340-2	3	AA	GORSFC	58	-09	6	130	DM6B8
18	011	170978	-3305	15208	144-03510-2	3	AA	GORS	41	03			DM6B8
4	034	170978	-3314	15941	144-14100-3	3	AA	GOR					DM6B8
11	053	170978	-2736	16105	144-14390-3	3	AA	GORSEC			6	120	DM6B8
11	054	170978	-3344	15934	144-14410-3	3	AA	GORSFC			6	95	DM6B8
11	055	170978	-3950	15752	144-14420-3	3	AA	GOR					SP128
14	510	180978	-4419	15050	145-04060-2	3	AA	ORS					SP128
19	004	180978	-3034	15547	145-14580-3	3	AA	ORS					DM6B8
19	005	180978	-3641	15411	145-15000-3	3	AA	ORS					DM6B8
11	008	190978	-4058	14513	146-04250-2	3	AA	ORS					SP128
17	125	230978	-4529	15240	150-03590-2	3	AA	ORS					SP128
17	123	230978	-3926	15045	150-04010-2	3	AA	ORS					SP128
4	145	230978	-3323	15631	150-14520-3	3	AA	GORSEC			6	95	SP128
4	146	230978	-3930	15450	150-14540-3	3	AA	GORSFC			6	65	SP128
4	147	230978	-4535	15254	150-14560-3	3	AA	GORSEC			6	30	SP128
10	119	240978	-4147	14654	151-04180-2	3	AA	ORS					SP138
5	038	240978	-4249	14915	151-15130-3	3	AA	GORS	20	00			SP138
4	233	250978	-4243	14238	152-04360-2	3	AA	GORSEC			6	45	SP138
8	046	280978	-4607	15422	155-03520-2	3	AA	GORSEC			6	5	SP138
11	011	280978	-4334	15330	155-03530-2	3	AA	RSEC			6	50	SP138
11	022	290978	-4242	15043	156-15070-3	3	AA	GORSEC	18	-07	6	50	SP138
19	099	290978	-4301	15037	156-15070-3	3	AA	RSE			12	50	SP138
19	064	041078	-4133	14949	161-04050-2	3	AA	ORS					SP138
8	190	051078	-4613	14648	162-04220-2	3	AA	GORSEC			6	30	SP138
19	118	091078	-4411	15319	166-14530-3	3	AA	ORS					SP138
17	146	131078	-3831	15634	170-03340-2	3	AA	ORS					SP148
17	144	131078	-3226	15454	170-03360-2	3	AA	GORS	40	02			SP148
11	442	151078	-4300	14851	172-04090-2	3	AA	ORS					SP148
8	042	161078	-4150	14356	173-04270-2	3	AA	GORSEC	19	19	6	50	SP148

PRIORITY AA GROUP(3) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MRT	TRUTH
8	023	191078	-3332	15217	176-03460-2	3	AA	GORSECP	29	03	6	110	SP148
8	034	201078	-3607	15423	177-14550-3	3	AA	GORSECP	44	02	6	120	SP148
19	016	161178	-3050	15446	204-14540-3	3	AA	ORS					SP158
19	017	161178	-3656	15310	204-14560-3	3	AA	ORS					SP158
6	092	171178	-3038	15013	205-15120-3	3	AA	GORSEC	59	08	6	135	SP158
6	135	191178	-3235	15701	207-03220-2	3	AA	GORSEC			6	125	SP158
6	133	191178	-2628	15531	207-03240-2	3	AA	GORSEC			6	140	SP158
21	114	211178	-4041	15005	209-03570-2	3	AA	ORS					SP158
21	112	211178	-3435	14822	209-03580-2	3	AA	GORS	37	01			SP158
14	534	221178	-4014	14522	210-04150-2	3	AA	ORS					SP158
22	056	221178	-2558	15240	210-15050-3	3	AA	ORS					SP158
22	057	221178	-3204	15111	210-15070-3	3	AA	ORS					SP158
22	058	221178	-3810	14934	210-15080-3	3	AA	ORS					SP158
22	045	231178	-3643	14522	211-15260-3	3	AA	ORS					SP158
6	114	241178	-2545	15643	212-03180-2	3	AA	GORSEC			6	145	SP158
21	209	251178	-3832	15523	213-03330-2	3	AA	ORS					SP158
21	206	251178	-3226	15344	213-03350-2	3	AA	GORS	51	-01			SP158
21	306	261178	-3842	15052	214-03510-2	3	AA	ORS					SP158
21	304	261178	-3235	14911	214-03530-2	3	AA	ORS					SP158
5	083	271178	-4017	14644	215-04090-2	3	AA	GORSEC	15	16	6	85	SP158
6	518	271178	-4019	14645	215-04090-2	3	AA	G RS	19	14			SP158
19	066	301178	-3253	15514	218-03280-2	3	AA	GORS	53	01			SP158
19	064	301178	-2646	15343	218-03300-2	3	AA	GORS	115	-13			SP158
6	037	011278	-3915	15224	219-03450-2	3	AA	GORSEC			6	105	SP168
23	022	021278	-4053	14819	220-04030-2	3	AA	ORS					SP168
23	020	021278	-3447	14635	220-04040-2	3	AA	GORS	39	04			SP168
19	057	021278	-3624	15249	220-14550-3	3	AA	ORS					SP168
20	048	031278	-4023	14335	221-04210-2	3	AA	ORS					SP168
7	114	051278	-3301	15644	223-03220-2	3	AA	GORSEC	51	01	6	135	SP168
5	145	080279	-3244	15209	288-03320-2	3	AA	GORSEC			9	120	AXRT3
5	008	100279	-3118	15142	290-14570-3	3	AA	GORSEC	111	-25	9	135	K 5A8
5	009	100279	-3723	15005	290-14580-3	3	AA	GORSEC	36	-35	9	135	K 5A8
5	029	120279	-3429	15913	292-03060-2	3	AA	GORSEC	43	-25	9	160	K 5A8
5	027	120279	-2823	15741	292-03080-2	3	AA	GORSEC	259	-43	9	160	K 5A8
10	204	130279	-3155	15400	293-03250-2	3	AA	GORSEC	46	-37	8	165	K 5A8
10	202	130279	-2549	15231	293-03270-2	3	AA	GORSEC	105	-44	8	155	K 5A8
10	022	190279	-3211	15105	299-03360-2	3	AA	GORSEC	51	-41	9	120	K1488
10	095	210279	-3039	15000	301-15010-3	3	AA	GORSEC	-06	-21	8	140	K1488
10	054	230279	-3301	15728	303-03110-2	3	AA	GORSEC	16	-17	8	140	K1488
10	052	230279	-2653	15558	303-03120-2	3	AA	GORSEC	32	-28	8	150	K1488
11	242	240279	-3544	15340	304-03280-2	3	AA	GORSEC	22	-23	7	140	K1488
10	043	240279	-3252	15255	304-03290-2	3	AA	GORS	31	-32			K1488
10	041	240279	-2645	15124	304-03300-2	3	AA	GORS	119	-41			K1488
11	240	240279	-2938	15205	304-03300-2	3	AA	GORSEC	45	-35	7	140	K1488
10	063	250279	-3020	15616	305-14350-3	3	AA	GORSEC	43	02	8	140	K1488
10	064	250279	-3626	15441	305-14370-3	3	AA	GORSEC	23	-14	8	130	K1488
5	138	010379	-2917	15346	309-03220-2	3	AA	GORSEC			8	130	K1488

NUMBER OF IMAGES PRIORITY AA, GROUP(3) = 143

NUMBER OF IMAGES PRIORITY AA= 241

PRIORITY A

THESE IMAGES ARE NEEDED FOR THE PRINCIPAL AIMS OF HCM-051.

IMAGE STATUS DATA ARE DIVIDED INTO THREE GROUPS FOR THIS PRIORITY. THESE GROUPS ARE FOR CCT DATA WHICH (1) HAVE NOT YET BEEN ORDERED, (2) HAVE BEEN ORDERED BUT NOT YET RECEIVED AND (3) HAVE BEEN RECEIVED. STATUS DATA CAN BE INTERPRETED AS FOLLOWS: "G"= GRID MADE, "O"= CCT ORDERED BY US, "C" IN COL 2 INDICATES ORDER BY CSIRO CRONULLA, "R"= CCT RECEIVED. "/" IN COL 3 INDICATES CCT UNAVAILABLE. "S"= IMAGE STATISTICS OBTAINED, "E"= IMAGE ENHANCED DIGITALLY, "C" (IN COL 6)= CSIRO ENHANCED PHOTO. IMAGE GENERATED, "P"= ENHANCED PHOTO. PRINTED. THE ABSENCE OF APPROPRIATE LETTERS INDICATES THE NEGATIVE.

GROUP(1). C/C TAPES HAVE NOT YET BEEN ORDERED FOR THE FOLLOWING IMAGES:

R	FR	DATE	LAT	LONG	DAY HHMM TPP	PR	STATUS	POS	ERR	OH	MRT	TRUTH
15	168	140578	-2647	15245	018-15310-3 2	A						
15	169	140578	-3255	15115	018-15320-3 2	A						
16	327	160578	-3019	15804	020-03430-2 2	A	G					
9	490	230578	-2642	14923	027-04140-2 2	A						
22	144	230578	-2618	16011	027-15000-3 2	A	G					
16	224	270578	-2942	15603	031-03490-2 2	A	G					
16	246	280578	-2608	15038	032-04080-2 2	A	G					
16	240	280578	-2736	16116	032-14540-3 2	A						
16	265	290578	-3018	15602	033-15130-3 2	A						
3	006	030678	-3622	15002	038-04170-2R3	A						SP088
18	112	030678	-3059	15716	038-15070-3 2	A	G	00	00			
22	216	050678	-2549	14922	040-15420-3 2	A						
22	035	060678	-2532	15755	041-03370-2 2	A	G					
3	037	140678	-3737	15349	049-15140-3R3	A						SP098
3	025	180678	-3012	16145	053-14470-3R3	A						SP098
3	026	180678	-3619	16010	053-14490-3R3	A						SP098
3	041	190678	-3037	15704	054-15060-3R3	A						SP098
3	042	190678	-3643	15528	054-15070-3R3	A						SP098
8	063	050978	-3249	15825	132-03270-2R3	A						DM6A8
8	036	170978	-4526	15606	144-14440-3R3	A						SP128
8	253	180978	-4157	15005	145-04070-2R3	A						SP128
4	138	280978	-4419	15447	155-14490-3R3	A						SP138
8	174	031078	-4526	15555	160-14420-3R3	A						SP138
4	158	051078	-4526	14647	162-15190-3R3	A						SP138
8	025	191078	-3937	15358	176-03450-2R3	A						SP148
8	035	201078	-4211	15237	177-14570-3R3	A						SP148
8	128	301078	-3220	15847	187-14390-3 2	A	G					
	000	141178	-3311	15552	202-03280-2 2	A	SEC			6	115	
7	154	061278	-3926	15758	224-14320-3R3	A						SP168
7	011	191278	-2552	15047	237-15090-3 2	A	G	100	01			
7	012	191278	-3200	14917	237-15110-3 2	A	G	43	04			
10	124	010179	-3559	15604	250-03230-2 2	A	G	40	01			
10	122	010179	-2953	15430	250-03250-2 2	A	G	56	-09			
11	022	020179	-3157	15029	251-03430-2 2	A	G	46	-05			
10	289	020179	-2638	15953	251-14300-3 2	A	G					
10	290	020179	-3247	15823	251-14320-3 2	A	G					
10	010	030179	-3555	14659	252-03590-2 2	A						
10	015	030179	-2603	15532	252-14400-3 2	A						
10	016	030179	-3211	15402	252-14500-3 2	A	G					
10	038	060179	-3255	15654	255-03170-2 2	A	G	31	04			
10	036	060179	-2649	15523	255-03190-2 2	A	G	46	-04			

PRIORITY A GROUP(1) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OB	MRT	TRUTH
10	029	070179	-3014	16042	256-14240-3	2	A	G					
19	104	080179	-3316	14756	257-03530-2	2	A	G	25	12			
19	035	090179	-2655	15259	258-14590-3	2	A						
19	036	090179	-3303	15128	258-15010-3	2	A						
10	137	110179	-3241	15902	260-03100-2	2	A	G					
10	135	110179	-2635	15732	260-03110-2	2	A	G	52	-41			
10	033	130179	-2701	15914	262-14330-3	2	A	G					
10	034	130179	-3308	15742	262-14350-3	2	A	G					
15	311	140179	-3023	15352	263-14520-3	2	A						
15	312	140179	-3630	15216	263-14540-3	2	A						
9	057	160179	-3156	16036	265-03020-2	2	A	G	00	00			
9	055	160179	-2550	15907	265-03040-2	2	A	G	00	00			
19	059	170179	-3059	15552	266-03200-2	2	A	G	51	-36			
10	048	180179	-2714	16056	267-14260-3	2	A	G					
10	049	180179	-3321	15924	267-14270-3	2	A						
19	151	190179	-3612	14813	268-03550-2	2	A	G	23	-26			
10	116	190179	-3027	15537	268-14440-3	2	A	G					
10	444	210179	-2943	16142	270-02560-2	2	A	G					
11	230	230179	-3311	15249	272-03310-2	2	A						
11	228	230179	-2705	15120	272-03330-2	2	A						
18	036	230179	-2719	16149	272-14200-3	2	A						
18	043	240179	-3638	14910	273-03490-2	2	A	G	31	09			
18	049	240179	-3025	15624	273-14390-3	2	A						
18	050	240179	-3632	15449	273-14400-3	2	A						
20	137	250179	-3028	15149	274-14570-3	2	A						
20	138	250179	-3634	15014	274-14590-3	2	A						
14	109	310179	-3650	14649	280-15110-3	2	A						
5	130	020279	-2646	15355	282-03210-2	2	A	G	134	-24			
9	088	030279	-2647	14919	283-03390-2	2	A						
10	062	050279	-3637	14818	285-15050-3	2	A						
5	189	190279	-3129	15917	299-14250-3R3		A						K1458
5	190	190279	-3734	15741	299-14270-3R3		A						K1488
15	202	080479	-2626	14944	347-03290-2	2	A	G	105	-08			
19	037	120479	-2623	15559	351-03040-2	2	A						
19	051	130479	-3549	15343	352-03190-2	2	A						
19	049	130479	-2944	15209	352-03210-2	2	A						
19	087	140479	-3239	14812	353-03390-2	2	A						
14	045	230479	-2750	15354	362-03110-2	2	A	G					
14	043	240479	-3620	15126	363-03270-2	2	A	G					
11	012	280479	-2708	15458	367-03060-2	2	A						
14	036	030579	-3253	15736	372-02590-2	2	A	G					
14	034	030579	-2649	15607	372-03010-2	2	A	G					
10	278	040579	-2616	15126	373-03190-2	2	A						
11	014	090579	-3034	15346	378-03120-2	2	A	G					

NUMBER OF IMAGES PRIORITY A. GROUP(1) = 85

GROUP(2). C/C TAPES HAVE BEEN ORDERED BUT NOT RECEIVED AS OF 31 MAR 81
FOR THE FOLLOWING IMAGES:

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OB	MRT	TRUTH
10	255	240578	-3052	15430	028-15190-3	2	A	GO	39	06			
19	074	040778	-2827	16205	069-14450-3	2	A	GO					
19	075	040778	-3433	16033	069-14470-3	2	A	GO					
4	121	220878	-3054	15752	118-14530-3	2	A	GO					
19	067	210978	-3250	15805	148-03260-2	2	A	GO	00	00			

PRIORITY A GROUP(2) CONTINUED

B	FR	DATE	LAT	LONG	DAY HHMM	TPR	PR	STATUS	POS	ERR	OR	MRT	TRUTH
8	042	280978	-3400	15043	155-03560-2	2	A	GO	35	04			
21	088	011078	-3117	16038	158-03140-2	2	A	GO/					
5	155	051078	-2710	15154	162-15140-3	2	A	GO	114	11			
19	052	061078	-2908	16138	163-03080-2	2	A	O/					
19	042	071078	-3133	15740	164-03250-2	2	A	GO/					
19	084	081078	-3443	16038	164-14330-3	2	A	O					
21	064	091078	-3335	14906	166-04010-2	2	A	GO	32	04			
21	074	101078	-2559	15343	167-15060-3	2	A	O					
21	075	101078	-3206	15213	167-15080-3	2	A	O					
19	064	141078	-2642	15941	171-14420-3	2	A	O/					
19	065	141078	-3249	15811	171-14430-3	2	A	O/					
21	039	161078	-2539	15051	173-15170-3	2	A	O					
21	095	191078	-3114	16012	176-14360-3	2	A	O/					
8	127	301078	-2614	16017	187-14370-3	2	A	GO					
21	107	061178	-3654	15023	194-15080-3	2	A	O					
23	037	201178	-2741	16129	208-14290-3	2	A	O/					
23	038	201178	-3347	15958	208-14310-3	2	A	O					
23	002	111278	-3406	16054	229-14240-3	2	A	O					
19	060	161278	-3114	15437	234-03270-2	2	A	GO/	42	01			
19	051	181278	-3110	15402	236-14520-3	2	A	O/					
19	014	271278	-2619	15159	245-03330-2	2	A	GO/	113	-09			
19	104	291278	-3135	15229	247-14570-3	2	A	O					
10	084	280179	-3251	15404	277-03260-2	2	A	GO					
19	164	290179	-3346	14943	278-03440-2	2	A	GO	28	08			
15	013	290179	-3101	15734	278-14330-3	2	A	O					
11	145	300179	-3632	15132	279-14530-3	2	A	O					
5	132	020279	-3252	15523	282-03200-2	2	A	GO	109	-02			
9	090	030279	-3253	15050	283-03380-2	2	A	GO	56	-01			
10	090	040279	-3011	15432	284-14450-3	2	A	GO					
10	091	040279	-3617	15258	284-14470-3	2	A	O					
15	031	020479	-2547	15255	341-03190-2	2	A	GC	104	-36			

NUMBER OF IMAGES PRIORITY A, GROUP(2) = 36

GROUP(3), C/C TAPES HAVE BEEN RECEIVED FOR THE FOLLOWING IMAGES:

B	FR	DATE	LAT	LONG	DAY HHMM	TPR	PR	STATUS	POS	ERR	OR	MRT	TRUTH
8	021	150578	-3617	14546	019-15520-3	2	A	GORSFC	20	-20	4	65	
3	016	110678	-2531	15921	046-03310-2	2	A	GORSECP			6	135	
9	090	220678	-3307	15931	057-03340-2	2	A	GORS	00	00			
9	088	220678	-2700	15802	057-03350-2	2	A	ORS					
3	153	240678	-3359	15743	059-15000-3	2	A	GORSECP			6	105	
3	147	250678	-2959	15410	060-15170-3	2	A	GORSEC	53	07	4	115	
8	105	270678	-3313	16102	062-03270-2	2	A	GORSFCP			3	95	
8	103	270678	-2706	15932	062-03290-2	2	A	GORSECP			3	115	
3	089	280678	-3320	15631	063-03450-2	2	A	GORSECP			3	100	
3	087	280678	-2714	15501	063-03470-2	2	A	GORSFCP	114	-14	3	125	
3	079	300678	-3028	15533	065-15100-3	2	A	GORSFCP	56	04	3	115	
8	027	020778	-2649	16100	067-03220-2	2	A	GORSECP			3	125	
2	205	040778	-3341	15334	069-03560-2	2	A	GORSFC			3	120	
2	203	040778	-2734	15204	069-03580-2	2	A	GORSECP			3	120	
19	140	050778	-3037	15702	070-15040-3	2	A	GORS					
5	051	060778	-3612	15102	071-15230-3	2	A	GORSE	32	-06	10	90	
10	061	200878	-3008	15757	116-03290-2	2	A	GORSFC			9	115	
4	135	210878	-3623	15502	117-03450-2	2	A	GORSFC			4	95	
4	133	210878	-3016	15326	117-03470-2	2	A	GORSFCP	103	-01	1	125	

PRIORITY A GROUP(3) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	EPR	OR	MRT	TRUTH
11	136	220878	-3123	15744	118-14540-3	2	A	GORSECP			5	110	
4	176	230878	-3021	15328	119-15110-3	2	A	GORSECP	55	04	5	105	
4	177	230878	-3628	15153	119-15130-3	2	A	GORSE	33	-06	5	90	
10	226	240878	-2542	15002	120-15280-3	2	A	ORS					
10	061	270878	-3200	15053	123-03580-2	2	A	GORSEC	105	-02	7	105	
10	068	270878	-2714	15014	123-14460-3	2	A	GORSEC			9	100	
10	069	270878	-3322	15844	123-14470-3	2	A	GORSEC			9	100	
11	008	020978	-3630	14850	129-04090-2	2	A	ORS					
19	065	210978	-2645	15636	148-03280-2	2	A	GORS	54	-07			
19	075	220978	-3454	16041	149-14350-3	2	A	ORS					
4	144	230978	-2716	15802	150-14510-3	2	A	GORSEC			6	120	
5	036	240978	-3037	15239	151-15100-3	2	A	GORSE	53	11	12	105	
5	037	240978	-3644	15103	151-15110-3	2	A	GORS	34	05			
4	238	250978	-3655	14625	152-15300-3	2	A	GORSEC	20	-05	6	65	
4	244	260978	-3234	15928	153-03200-2	2	A	GORSEC			6	100	
4	242	260978	-2628	15758	153-03220-2	2	A	GORSEC			6	130	
17	140	270978	-3307	15502	154-03380-2	2	A	ORS					
17	138	270978	-2701	15333	154-03400-2	2	A	ORS					
14	057	280978	-2607	15945	155-14440-3	2	A	ORS					
8	192	290978	-3008	15413	156-15030-3	2	A	GORSEC	57	09	6	100	
11	020	290978	-3030	15407	156-15030-3	2	A	GOR	57	11			
8	193	290978	-3615	15237	156-15050-3	2	A	GORSEC	35	01	6	95	
11	021	90978	-3637	15231	156-15050-3	2	A	GOR	35	-01			
11	025	300978	-3117	14921	157-15220-3	2	A	ORS					
5	212	031078	-3312	15201	160-03490-2	2	A	GORSE	36	05	10	125	
5	210	031078	-2707	15030	160-03510-2	2	A	GORSEC	104	04	10	135	
19	062	041078	-3529	14804	161-04070-2	2	A	GORS	35	08			
5	156	051078	-3317	15023	162-15150-3	2	A	GORSE	52	08	12	95	
22	075	081078	-3243	15327	165-03430-2	2	A	GORS	25	07			
22	073	081078	-2637	15156	165-03440-2	2	A	GORS	51	-02			
19	116	091078	-3201	15648	166-14500-3	2	A	ORS					
17	142	131078	-2619	15324	170-03380-2	2	A	GORS	52	-06			
8	021	191078	-2726	15045	176-03480-2	2	A	GORSECP	57	-05	6	135	
8	033	201078	-3001	15558	177-14530-3	2	A	GORSECP	51	06	6	120	
17	118	251078	-3249	14913	182-03570-2	2	A	ORS					
8	015	251078	-3047	15728	182-14460-3	2	A	GORSECP			6	125	
8	016	251078	-3653	15552	182-14480-3	2	A	GORSECP			6	115	
8	030	261078	-3122	15248	183-15040-3	2	A	GORSEC	109	08	6	125	
19	251	271078	-2626	14928	184-15210-3	2	A	ORS					
11	106	301078	-2650	16008	187-14380-3	2	A	RSEC			6	120	
11	107	301078	-3257	15838	187-14390-3	2	A	GORSEC			6	105	
11	101	311078	-2632	15543	188-14550-3	2	A	ORS					
19	097	011178	-3646	14837	189-15160-3	2	A	ORS					
19	268	051178	-3620	15501	193-14500-3	2	A	ORS					
20	020	081178	-2913	15807	196-03170-2	2	A	GORS					
17	129	101178	-2655	15904	198-14410-3	2	A	ORS					
1	138	141178	-2704	15422	202-03300-2	2	A	GORSEC	118	-14	6	155	
6	120	151178	-2625	16027	203-14350-3	2	A	GORSEC			6	150	
6	121	151178	-3231	15857	203-14360-3	2	A	GORSEC			6	120	
6	116	241178	-3153	15812	212-03170-2	2	A	GORSEC			6	140	
23	198	251178	-3554	16045	213-14250-3	2	A	ORS					
6	007	291178	-3646	16052	217-03090-2	2	A	GORSEC			6	125	
6	005	291178	-3039	15915	217-03110-2	2	A	GORSEC			6	135	
19	056	021278	-3017	15423	220-14540-3	2	A	ORS					
19	121	061278	-2623	15028	224-03420-2	2	A	GORS	113	-13			
7	152	061278	-2713	16109	224-14280-3	2	A	GORSEC			6	135	

PRIORITY A GROUP(3) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OB	MRT	TRUTH
7	153	061278	-3320	15938	224-14300-3	2	A	GORSFC			6	125	
5	344	081278	-2858	15137	226-15050-3	2	A	GORSF	52	04	10	135	
3	301	121278	-2607	15819	230-14400-3	2	A	GORSFC			6	170	
11	058	191278	-2622	15040	237-15090-3	2	A	GORSFC	102	02	6	160	
11	059	191278	-3229	14910	237-15110-3	2	A	GORSFC	44	01	6	125	
19	011	211278	-3215	15627	239-03200-2	2	A	ORS					
19	011	211278	-2608	15457	239-03220-2	2	A	GORS	45	-02			
23	046	221278	-3352	15928	240-14280-3	2	A	ORS					
23	016	261278	-3252	15808	244-03130-2	2	A	GORS					
23	014	261278	-2646	15637	244-03150-2	2	A	GORS	109	-05			
19	039	301278	-3358	14722	248-15150-3	2	A	ORS					
10	068	060279	-2856	16022	286-02560-2	2	A	GORSFC			7	145	

NUMBER OF IMAGES PRIORITY A, GROUP(3) = 87

NUMBER OF IMAGES PRIORITY A= 208

PRIORITY B

THESE IMAGES ARE DESIRABLE FOR LONG TERM AIMS OF HCM-051.

IMAGE STATUS DATA ARE DIVIDED INTO THREE GROUPS FOR THIS PRIORITY. THESE GROUPS ARE FOR CCT DATA WHICH (1) HAVE NOT YET BEEN ORDERED, (2) HAVE BEEN ORDERED BUT NOT YET RECEIVED AND (3) HAVE BEEN RECEIVED. STATUS DATA CAN BE INTERPRETED AS FOLLOWS: "G"= GRID MADE, "O"= CCT ORDERED BY US, "C" IN COL 2 INDICATES ORDER BY CSIRO CRONULLA, "R"= CCT RECEIVED, "/" IN COL 3 INDICATES CCT UNAVAILABLE, "S"= IMAGE STATISTICS OBTAINED, "E"= IMAGE ENHANCED DIGITALLY, "C" (IN COL 6)= CSIRO ENHANCED PHOTO. IMAGE GENERATED, "P"= ENHANCED PHOTO. PRINTED. THE ABSENCE OF APPROPRIATE LETTERS INDICATES THE NEGATIVE.

GROUP(1). C/C TAPES HAVE NOT YET BEEN ORDERED FOR THE FOLLOWING IMAGES:

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OB	MRT	TRUTH
15	180	110578	-3832	15833	015-03460-2	1	B						
16	024	120578	-3734	15911	016-14570-3	1	B						
16	025	120578	-4340	15721	016-14590-3	1	B						
15	165	130578	-4334	15113	017-04210-2	1	B						
15	163	130578	-3729	14924	017-04230-2	1	B						
15	170	140578	-3902	14935	018-15340-3	1	B						
15	233	200578	-4151	14251	024-04520-2	1	B						
22	144	230578	-4439	15509	027-15050-3	1	B						
10	126	250578	-4720	14602	029-04450-2	1	B						
20	022	290578	-4541	15125	033-04210-2	1	B						
15	366	300578	-4734	14731	034-04380-2	1	B						
22	039	060678	-3743	16059	041-03340-2	1	B						
10	151	100678	-4058	14357	045-04450-2	1	B						
3	221	210678	-3638	14625	056-15430-3	R2	B						
3	148	250678	-3605	15236	060-15190-3	R2	B						
8	022	290678	-3122	15952	064-14520-3	R2	B						
10	208	010778	-4023	14447	066-04370-2	1	B						
8	122	030778	-3130	15734	068-03390-2	R2	B						
19	076	040778	-4037	15850	069-14480-3	1	B						
9	482	050778	-3722	15001	070-04130-2	1	B						
19	142	050778	-4246	15338	070-15070-3	1	B						
2	050	060778	-3007	15237	071-15210-3	R2	B						
5	052	060778	-4216	14916	071-15250-3	1	B	G	26	00			
22	557	070778	-4213	14220	072-04480-2	1	B						
18	058	070778	-3724	14610	072-15420-3	1	B						
18	059	070778	-4328	14420	072-15430-3	1	B						
19	084	080778	-3726	16041	073-03300-2	1	B						
21	139	090778	-4325	15929	074-14420-3	1	B						
20	008	100778	-4513	15357	075-04040-2	1	B						
20	006	100778	-3908	15204	075-04060-2	1	B						
18	110	110778	-4715	15007	076-04220-2	1	B						
18	108	110778	-4111	14806	076-04240-2	1	B						
17	409	120778	-4047	14326	077-04420-2	1	B						
9	467	120778	-4339	14546	077-15360-3	1	B						
19	015	150778	-3845	15754	080-14520-3	1	B						
19	016	150778	-4448	15601	080-14540-3	1	B						
9	417	160778	-4146	15227	081-15110-3	1	B						
9	429	170778	-4550	14638	082-04330-2	1	B						
9	433	170778	-4333	14722	082-15290-3	1	B						
9	037	220778	-4203	14659	087-04270-2	1	B						
9	048	230778	-4240	14444	088-15400-3	1	B						

PRIORITY B GROUP(1) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PP	STATUS	POS ERR OR MRT TRUTH
9	008	250778	-4407	15819	090-03440-2	1	B		
9	006	250778	-3801	15628	090-03450-2	1	B		
16	032	250778	-4257	15949	090-14390-3	1	B		
10	039	260778	-4257	15319	091-04020-2	1	B		
10	042	260778	-3855	15632	091-14560-3	1	B		
10	027	270778	-4230	14838	092-04200-2	1	B		
10	041	270778	-4306	15044	092-15150-3	1	B		
10	607	280778	-4344	14600	093-15330-3	1	B		
16	308	300778	-4238	15921	095-03370-2	1	B		
10	154	310778	-3935	15803	096-14490-3	1	B		
10	068	020878	-4050	14511	098-04310-2	1	B		
10	074	020878	-4250	14759	098-15260-3	1	B		
19	027	050878	-4213	15619	101-03480-2	1	B		
10	022	100878	-4453	15849	106-03400-2	1	B		
10	020	100878	-3848	15655	106-03410-2	1	B		
19	210	120878	-4804	15010	108-04150-2	1	B		
21	017	120878	-4242	15114	108-15110-3	1	B		
19	016	120878	-4318	15103	108-15120-3	1	B		
11	040	130878	-4323	14630	109-15300-3	1	B		
11	232	150878	-4353	16008	111-03330-2	1	B		
9	031	170878	-4211	15032	113-04090-2	1	B		
9	037	170878	-4237	15255	113-15040-3	1	B		
4	159	180878	-4231	14826	114-15220-3	1	B	G	19 -06
4	117	210878	-4025	15947	117-14380-3	1	B	G	
10	015	280878	-4321	15116	124-15080-3	1	B		
11	010	02097[illegible]	-4235	15038	129-04070-2	1	B		
8	061	050978	-2642	15655	132-03290-2	P2	B		
10	017	060978	-4521	15730	133-03420-2	1	B		
10	029	060978	-4632	15735	133-14390-3	1	B		
10	048	080978	-4300	14932	135-15140-3	1	B		
10	003	090978	-3858	14609	136-15310-3	1	B		
19	073	130978	-4708	15023	140-04120-2	1	B		
19	071	130978	-4105	14823	140-04130-2	1	B		
19	0[illegible]9	210978	-3855	15944	148-03250-2	1	B		
19	076	220978	-4100	15857	149-14360-3	1	B		
17	142	270978	-3911	15642	154-03360-2	1	B		
4	136	280978	-3208	15817	155-14460-3	P2	B		
5	214	031078	-3916	15341	160-03480-2	1	B	G	
8	171	031078	-2709	16101	160-14370-3	P2	B		
8	172	031078	-3316	15930	160-14390-3	P2	B		
5	157	051078	-3922	14843	162-15170-3	1	B	G	43 09
19	044	071078	-3738	15918	164-03230-2	1	B	G	
22	079	081078	-4450	15700	165-03390-2	1	B		
22	077	081078	-3847	15507	165-03410-2	1	B		
19	085	081078	-4047	15855	165-14340-3	1	B		
21	066	091078	-3940	15047	166-03590-2	1	B		
19	117	091078	-3807	15510	166-14520-3	1	B		
21	076	101078	-3812	15035	167-15100-3	1	B		
21	077	101078	-4416	14843	167-15110-3	1	B		
19	067	141078	-4458	15437	171-14470-3	1	B		
21	096	191078	-3720	15835	176-14370-3	1	B		
10	266	211078	-4029	14509	178-04210-2	1	B		
17	120	251078	-3854	15053	182-03560-2	1	B		
19	253	271078	-3837	14620	184-15240-3	1	B		
19	254	271078	-4441	14[illegible]28	184-15260-3	1	B		
8	129	301078	-3825	15709	187-14410-3	1	B	G	

PRIORITY B GROUP(1) CONTINUED

B	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS ERR	OR MET TRUTH
8	137	311078	-3038	15444	188-14560-3	R2	B			
11	103	311078	-3843	15234	188-14590-3	1	B			
8	139	311078	-4247	15121	188-15000-3	1	B	G	24	-01
19	098	011178	-4250	14649	189-15180-3	1	B			
19	269	051178	-4225	15315	193-14520-3	1	B			
21	108	061178	-4258	14835	194-15100-3	1	B			
17	132	101178	-4509	15401	198-14460-3	1	B			
8	016	111178	-3005	15341	199-15000-3	R2	B			
6	017	111178	-3611	15206	199-15010-3	R2	B			
22	039	121178	-3733	14707	200-15200-3	1	B			
11	018	161178	-4159	14910	204-04020-2	1	B			
19	018	161178	-4300	15123	204-14570-3	1	B			
23	039	201178	-3952	15817	208-14320-3	1	B			
23	040	201178	-4556	15621	208-14340-3	1	B			
21	116	211178	-4646	15205	209-03550-2	1	B			
20	118	211178	-4315	15237	209-14510-3	1	B			
14	536	221178	-4619	14720	210-04130-2	1	B			
22	059	221178	-4414	14743	210-15100-3	1	B			
23	199	251178	-4159	15859	213-14270-3	1	B			
21	308	261178	-4447	15245	214-03500-2	1	B			
19	149	261178	-4302	15403	214-14450-3	1	B			
6	033	011278	-2701	14912	219-03480-2	R2	B			
23	024	021278	-4658	15020	220-04010-2	1	B			
19	058	021278	-4229	15102	220-14570-3	1	B			
19	094	031278	-4310	14614	221-15150-3	1	B			
7	112	051278	-2653	15513	223-03240-2	R2	B			
5	346	081278	-4110	14819	226-15080-3	1	B	G	13	-05
19	129	141278	-4156	14225	232-04260-2	1	B			
19	052	181278	-3717	15225	236-14540-3	1	B			
7	013	191278	-3807	14739	237-15120-3	1	B	G	30	-01
19	013	211278	-3821	15805	239-03190-2	1	B			
23	018	261278	-3858	15948	244-03120-2	1	B			
19	020	271278	-4435	15701	245-03280-2	1	B			
19	018	271278	-3831	15508	245-03300-2	1	B			
7	008	271278	-3407	16058	245-14210-3	R2	B			
19	105	291278	-3743	15052	247-14580-3	1	B			
19	040	301278	-4004	14539	248-15170-3	1	B			
23	055	311278	-3817	16113	249-03050-2	1	B			
10	126	010179	-4203	15750	250-03220-2	1	B			
11	026	020179	-4407	15357	251-03390-2	1	B	G	00	00
11	024	020179	-3802	15206	251-03410-2	1	B	G	33	01
10	291	020179	-3853	15643	251-14340-3	1	B			
10	292	020179	-4459	15449	251-14350-3	1	B			
10	012	030179	-4200	14844	252-03580-2	1	B			
10	017	030179	-3818	15222	252-14510-3	1	B			
10	018	030179	-4423	15029	252-14530-3	1	B			
10	098	040179	-4104	14356	253-04160-2	1	B			
10	040	060179	-3900	15834	255-03150-2	1	B	G		
10	031	070179	-4226	15720	256-14270-3	1	B			
19	108	080179	-4525	15131	257-03500-2	1	B			
19	106	080179	-3921	14937	257-03510-2	1	B			
19	111	080179	-3708	15422	257-14440-3	1	B			
19	112	080179	-4313	15234	257-14450-3	1	B			
19	037	090179	-3910	14947	258-15020-3	1	B			
19	038	090179	-4515	14752	258-15040-3	1	B			
10	126	100179	-4231	14204	259-04260-2	1	B			

PRIORITY 8 GROUP(1) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR MRT TRUTH
10	131	100179	-3829	14528	259-15200-3	1	8				
10	139	110179	-3846	16041	260-03080-2	1	8				
10	066	130179	-3746	15124	262-03440-2	1	8				
11	430	140179	-4005	14733	263-04010-2	1	8				
15	313	140179	-4236	15028	263-14560-3	1	8				
10	068	150179	-4717	14523	264-04170-2	1	8				
10	066	150179	-4114	14325	264-04190-2	1	8				
9	051	150179	-3735	14727	264-15120-3	1	8				
9	052	150179	-4340	14537	264-15140-3	1	8				
19	061	170179	-3704	15728	266-03190-2	1	8				
10	045	180179	-4413	15506	267-03350-2	1	8				
10	043	180179	-3810	15316	267-03360-2	1	8	G	22	-25	
10	050	180179	-3928	15742	267-14290-3	1	8				
19	153	190179	-4216	14959	268-03530-2	1	8				
9	019	200179	-3826	14855	269-15050-3	1	8				
9	020	200179	-4431	14702	269-15070-3	1	8				
11	234	230179	-4519	15623	272-03280-2	1	8				
11	232	230179	-3916	15429	272-03300-2	1	8				
18	045	240179	-4242	15057	273-03470-2	1	8				
18	051	240179	-4237	15302	273-14420-3	1	8				
5	126	250179	-3932	14523	274-04060-2	1	8	G	11	16	
20	139	250179	-4238	14827	274-15000-3	1	8				
19	151	260179	-4158	14402	275-15180-3	1	8				
10	088	28017 /	-4500	15735	277-03220-2	1	8				
10	086	280179	-3856	15543	277-03240-2	1	8				
19	168	290179	-4554	15318	278-03400-2	1	8				
19	166	210979	-3951	15123	278-03420-2	1	8	G	18	-03	
14	010	3001 9	-4655	14903	279-03580-2	1	8				
14	008	300179	-4052	14705	279-04000-2	1	8				
11	146	300179	-4237	14946	279-14540-3	1	8				
14	110	310179	-4255	14502	280-15130-3	1	8				
5	136	020279	-4501	15855	282-03160-2	1	8	G			
5	134	020279	-3857	15702	282-03180-2	1	8	G			
9	094	030279	-4502	15421	283-03340-2	1	8				
9	092	030279	-3858	15229	283-03360-2	1	8	G	39	-05	
10	143	040279	-4306	14908	284-03530-2	1	8				
10	092	040279	-4222	15112	284-14480-3	1	8				
10	057	050279	-4126	14402	285-04120-2	1	8				
10	063	050279	-4241	14631	285-15070-3	1	8				
10	218	140279	-3849	15118	294-03410-2	1	8	G	-08	-15	
10	026	190279	-4422	15435	299-03330-2	1	8				
19	042	200279	-4400	15113	300-14470-3	1	8				
10	056	230279	-3907	15908	303-03090-2	1	8				
11	244	240279	-4150	15526	304-03260-2	1	8				
10	076	260279	-4350	14705	306-04020-2	1	8	G	18	-37	
15	161	180379	-4434	15252	326-03340-2	1	8				
15	159	180379	-3829	15101	326-03360-2	1	8				
14	134	190379	-4628	14858	327-03520-2	1	8				
14	132	190379	-4023	14701	327-03540-2	1	8				
21	008	240379	-4201	14856	332-03470-2	1	8				
5	105	300379	-4017	14524	338-03580-2	1	8	G	18	01	
15	206	080479	-3838	15250	347-03260-2	1	8				
15	220	090479	-4620	15047	348-03410-2	1	8				
15	218	090479	-4016	14850	348-03430-2	1	8				
19	041	120479	-3833	15904	351-03000-2	1	8				
19	053	130479	-4154	15528	352-03180-2	1	8				

PRIORITY B GROUP(1) CONTINUED

B	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MRT	TRUTH
19	091	140479	-4447	15143	353-03350-2	1	B						
19	089	140479	-3844	14950	353-03370-2	1	B						
14	049	230479	-4001	15705	362-03080-2	1	B						
5	152	290479	-4131	15411	368-03200-2	1	B	G					
5	148	290479	-2922	15054	368-03240-2P2		B						
5	162	300479	-4012	14910	369-03390-2	1	B	G	15	12			
19	006	010579	-3828	14404	370-03580-2	1	B						
14	038	030579	-3859	15916	372-02570-2	1	B						
10	284	040579	-4429	15622	373-03140-2	1	B						
9	163	050579	-4228	15109	374-03330-2	1	B						

NUMBER OF IMAGES PRIORITY B, GROUP(1) = 219

GROUP(2). C/C TAPES HAVE BEEN ORDERED BUT NOT RECEIVED AS OF 31 MAR 81 FOR THE FOLLOWING IMAGES:

B	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MRT	TRUTH
8	008	170678	-3922	15945	052-03390-3	1	B	GO					
8	113	230678	-4650	15820	058-14450-3	1	B	GO	00	00	4	65	
10	048	160878	-3837	15359	112-03520-2	1	B	GO	22	13			
10	015	060978	-3917	15536	133-03440-2	1	B	GO					
4	246	260978	-3839	16108	153-03180-2	1	B	GO					
8	044	280978	-4004	15225	155-03540-2	1	B	GO	22	-09			

NUMBER OF IMAGES PRIORITY B, GROUP(2) = 6

GROUP(3). C/C TAPES HAVE BEEN RECEIVED FOR THE FOLLOWING IMAGES:

B	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OR	MRT	TRUTH
3	267	200678	-4014	14619	055-04330-2	1	B	GORSECP			6	65	
8	244	200678	-4216	14920	055-15270-3	1	B	GORSECP	12	-07	5	70	
2	209	040778	-4550	15710	069-03530-2	1	B	GORSEC			4	25	
2	207	040778	-3946	15514	069-03550-2	1	B	GORSECP			3	70	
2	003	100778	-3940	15609	075-14590-3	1	B	GORSECP			3	65	
2	004	100778	-4543	15413	075-15010-3	1	B	GORSEC			4	35	
11	132	210778	-4210	15355	086-15040-3	1	B	GORSEC			9	55	
10	313	310778	-3822	15332	096-03560-2	1	B	GORSEC	24	10	8	90	
2	043	010878	-4211	15241	097-15080-3	1	B	GOR	13	-12			
10	051	110878	-3845	15701	107-14520-3	1	B	GORSE			12	85	
11	004	180878	-4242	14822	114-15220-3	1	B	GORSEC	20	-05	4	30	
4	137	210878	-4228	15649	117-03440-2	1	B	GORSEC			4	45	
14	130	210878	-4044	15941	117-14380-3	1	B	ORSECP			5	55	
4	118	210878	-4630	15749	117-14400-3	1	B	GORSECP			5	25	
		220878	-3730	15607	118-14550-3	1	B	RSECP			5	50	
4	123	220878	-4306	15426	118-14570-3	1	B	GORSEC			4	35	
4	178	230878	-4234	15005	119-15150-3	1	B	GORSECP	23	-03	5	35	
10	228	240878	-3756	14656	120-15310-3	1	B	GORS	39	-07	11	65	
10	063	270878	-3805	15231	123-03560-2	1	B	GORSEC			7	75	
4	017	290878	-4325	14639	125-15270-3	1	B	GORSEC	15	-06	4	40	
4	235	070978	-4517	15253	134-04000-2	1	B	GORSECP			5	45	
4	241	070978	-4258	15407	134-14560-3	1	B	GORSECP			5	35	
4	012	120978	-4143	15552	139-14490-3	1	B	GORSECP			5	60	
4	035	170978	-3921	15801	144-14420-3	1	B	GORSEC			6	60	
11	009	280978	-3731	15140	155-03550-2	1	B	RSEC			6	105	
8	151	300978	-3720	14744	157-15230-3	1	B	GORSEC	31	02	6	85	
11	026	300978	-3723	14744	157-15230-3	1	B	GOR	29	-01			

PRIORITY B GROUP(3) CONTINUED

R	FR	DATE	LAT	LONG	DAY HHMM	TPP	PR	STATUS	POS	ERR	OB	MRT	TRUTH
5	148	051078	-4010	14451	162-04240-2	1	B	ORSFC			6	55	
8	031	261078	-3728	15111	183-15060-3	1	B	GORSFC	40	-01	6	115	
8	041	271078	-4206	14249	184-04310-2	1	B	GORSFC			6	70	
11	108	301078	-3902	15658	187-14410-3	1	B	ORSFC			6	60	
11	104	311078	-4447	15042	188-15000-3	1	B	ORSFC			6	40	
6	142	141178	-3917	15733	202-03270-2	1	B	GORSFC			6	75	
6	122	151178	-3837	15719	203-14380-3	1	B	GORSFC			6	105	
1	084	181178	-4317	16441	206-03010-3	1	B	GORSFC			6	130	
6	137	191178	-3842	15841	207-03210-2	1	B	GOR					
7	039	111278	-4520	15419	219-03430-2	1	B	GORSFC			6	60	
7	510	131278	-4423	14746	231-04070-2	1	B	GORSFC			6	50	
11	060	191278	-3836	14731	237-15120-3	1	B	GORSFC	32	00	6	95	
5	159	100279	-4046	14549	290-04050-2	1	B	GORSFC	26	-21	9	120	
10	024	190279	-3817	15243	299-03340-2	1	B	GORSFC	24	-21	9	115	
10	045	240279	-3858	15434	304-03270-2	1	B	GORS	21	-22			
10	057	250279	-3818	14952	305-03450-2	1	B	GORSFC	20	-30	9	115	

NUMBER OF IMAGES PRIORITY B, GROUP(3) = 43

NUMBER OF IMAGES PRIORITY B= 268

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002-695	RANRL - R - 1/82	FEB 82	DST 80/006

4. Title	5. Security a. document	6. No Pag	7. No Refs
High Resolution Satellite Observations of Mesoscale Oceanography in the Tasman Sea 1978-79 Final Report Project HCM-051.	UNCLASSIFIED; b. title U/C; c. abstract U/C	89	18

8. Author(s)	9. Downgrading Instructions
C.S. Nilsson, J. C. Andrews (AIMS) M. Hornibrook (CSIRO), A.R. Latham, G. C. Speechley, P. Scully-Power (NUSC)	N/A

10. Corporate Author and Address	11. Authority (as appropriate) a. Sponsor b. Security c. Downgrading d. Approval
RAN Research Laboratory P.O. Box 706 DARLINGHURST NSW 2010	a. DSTO b, c. GHOS d. W.F.Hunter, Director RANRL. W F Hunter

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16. Abstract

This report covers progress on NASA Project HCM-051 to 31 Mar 1981. Nearly 1000 standard infra-red photographic images have been received and of these, 273 images have been received on computer compatible tape (CCT). It proved necessary to digitally enhance the scene contrast to cover only a select few degrees K over the photographic grey scale appropriate to the scene-specific range of SST. 178 images have been so enhanced. Comparisons with sea truth are made and we conclude that SST, as seen by satellite, does provide a good guide to the ocean currents and eddies off East Australia, both in summer and winter. This is in contrast, particularly in summer, to SST mapped by surface survey, which usually lacks the necessary spatial resolution.

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