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SEA SURFACE TEMPERATURE OF THE COASTAL ZONES OF FRANCE

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I - INTRODUCTION

The objectives of this investigation are to map the various thermal gradients in the coastal zones of France with regard to natural phenomena and man-made thermal effluents ; to study and map the mesoscale thermal features in the English Channel, the Bay of Biscay and the North Western Mediterranean Sea ; to study and map the evolution of the thermal gradients generated by the main estuaries of the french coastal zones ; and to contribute to the modelling of diurnal heating of the sea surface and its influence on the oceanic surface layers.

The investigation is conducted by the following Dr P.Y. DESCHAMPS (Principal Investigator) and Dr M. CREPON, Mr J.M MONGET and Professor F. VERGER (Co-Investigators). Attachment A give their related organizations and addresses.

2 - TECHNIQUES

2 - 1 - Technical organization of the investigation

2.1.1 - Documents

Every document received by the Principal Investigator from NASA and concerned with the HCMM investigation is duplicated and sent to the Co-Investigators. When necessary, a feedback advice is requested from the Co-Investigators.

2.1.2 - Photographic products

2 negative transparencies are received on standing order by the Principal Investigator. One transparency is archived by the Principal Investigator at L.O.A (Laboratoire d'Optique Atmosphérique, Université de Lille) and the other one is sent and archived at ENS (Ecole Nationale Supérieure). Additional positive prints are made at ENS and sent to the other Co-Investigators.

2.1.3 - Digital products

Request orders for CCTs are done by the Principal Investigator who collects the requests of the other Co-Investigators. The received CCTs are stored by the Principal Investigator and sent to the interested Co-Investigators.

2 - 2 Photographic product techniques

There are no specific photographic product facilities used within the investigation. Interpretation is commonly restricted to the determination of the cloud free areas. Oceanic thermal features are only apparent in a very few occasions, and correspond generally to our previous knowledge. Because of the small temperature variations encountered in marine areas, most of the interpretation work has to be done on digital data after an appropriate enhancement.

2 - 3 Digital product techniques

2.3.1 - Digital product facilities

Most of the facilities of the investigation are at C.T.A.M.N (Centre de Télédétection et d'Analyse des Milieux Naturels), Ecole des Mines, where processings of remotely sensed data have been extensively developped for a variety of applications. The other investigators may alternatively use this main facility or their own smaller in house facilities.

2.3.1.1 - Digital product facility at LOA (Laboratoire d'Optique Atmosphérique), Université de Lille.

This facility is divided into the CII model IRIS 80 computer fo the University, specific terminals located at LOA, and a communication link between the two locations. Major processings are done on the IRIS-80 computer. Digital data may then be transferred and stored on floppy disks at LOA. Each floppy disk contains 6 small scenes of 256 x 256 pixels. Vizualisation of a small scene is made on a PERICOLOR system-color graphic display (256 x 256 pixels). A HP9125 A calculator allows for minor processings of the stored data. Additional outputs are done on a printer plotter fo curves, and a print out for listings of the processed data.

2.3.1.2 - Digital products facilities at C.T.A.M.N

The Centre de Télédétection et Analyse des Milieux Naturels is équiped with a self contained computer system for image processing based on two HP 21 MX minicomputers.

This system is linked to specific output device suchas :

- a VERSATEC printer/plotter with a special gray scale display software developped by C.T.A.M.N wich allows cartography of satellite data at any given scale and cartographic projection

- a BENSON ink-plotter with adequate software for mapping with various symbols and colors as well as cartographic projection

- a TEKTRONIX digitizer with associated graphics display for landmarks acquisition and input to rectification or registration software.

The main body of the C.T.A.M.N system is an interactive image processing system TRIM-CIT ALCATEL. This versatile equipment allows display and manipulation of images in a man-machine interactive loop. Image memory is 512 x 512 x 8 bits with an overlay graphical memory of 512 x 512 bits. A real-time processor allows color selection, pixel selection with cursor tracking, zooming and lateral displacement of the image.

2.3.1.3 - Digital product facility at ENS (Ecole Nationale Supérieure)

This facility is divided into :

- an IBM 370 main computer at CICE, the computer centre of CNRS (Centre National de la Recherche Scientifique) with the following specific outputs : a VERSATEC printer plotter and a BENSON color printer plotter,

- a MODCOMP CLASSIC minicomputer located at ENS is linked to CIRCE, in association with a TEKTRONIC 4013 graphic display.

2.3.2 - Digital product interpretation

The three laboratories working on the present investigation had already developped appropriate interpretation techniques for the NOAA and Landsat satellites. As they are used to cooperative programs, there are many common points between the techniques they have implemented on each of their own digital systems.

2.3.2.1 - Digital product interpretation at LOA

The Following processing techniques may be applied more or less routinely on digital data :

- radiometric calibration if necessary, e,g, VHRR of NOAA's satellites,
- resampling for uniform scaling if necessary, e, g, VHRR,
- smoothing,
- stripes filtering (see Figure 1).

As a typical scene contains 1024 x 1024 pixels, localisation and visualization are usually done by means of the following procedure.

- visualization of the whole scene reduced to 256 x 256 pixels after sampling every n pixels and every n lines, or after averaging over a n x n pixels square,

- selection of a small scene (256 x 256 pixels) and visualization at full ground resolution,

- localisation with reference to map locations and addition of coordinates on the color graphic display,

- surface isotherms, or isocountours, mapping on the printer plotter after the necessary filtering (see Figure 2).

Additional procedures allows to compute and display for a selected n x n pixels square :

- histograms,
- spatial density spectra of temperature variations (Figure 3),
- structure functions of temperature variations (Figure 4),
- spatial cross correlation function with an other n x n pixels square.

2.3.2.2 - Digital product interpretation at C.T.A.M.N

Upon receiving the HCMM data on magnetic tapes the processing is organized as follows :

- "Quick look" of available data, at a scale of 1: 2000 000, using a black and white printer plotter

- transformation of data into surface temperatures using the calibration curve

- destriping of imagery

- isotropic filtering in order to eliminate the salt and pepper noise. This algorithm is constrained to the local variance in order to leave untouched the strong gradients along the coastlines

- geometric corrections in order to rectify the imagery at a specified projection (ex. : Lambert)

- display of sea-surface temperatures as colored maps (Fig. 5).

2.3.2.3 - Digital product interpretation at ENS

The following programs are used to produce a convenient automatic cartography.

The FRALISET program performs a fast and low cost print-out visualization of a part of a given scene. The HCMR digital counts are converted in alphanumeric characters. Each printed character is associated to one or several pixels after selection by the operator. The 1/500 000 appeared to be suitable for the HCMM applications in the Bay of Biscay. Isotropic filtering of the data can be applied once or several times. The additional legend is selected by the operator. Out-put is done on the BENSON plotter and as black and white or 6 colors prints (example given in Figure 6).

2.4 - Ground truth techniques

No specific ground truth techniques have been developpped for the investigation. The collection of the necessary oceanographic and meteorological data is done either from routine observations or from dedicated oceanographic cruises, by the following organizations :

- B.N.D.O (Bureau National de Données Océanographiques) at C.O.B (Centre Oceanologique de Bretagne, Brest) of the French Oceanographic agency for oceanographic observations.

- S.M.M (Service Météorologique Métropolitain) of the French Meteorological Agency for meteorological observations.

Requests for ground truth data are supposed to be sent to those organizations after selection and first examination of the interesting HCMM scenes.

3 - Accomplishments

3 - 1 - Ground truth data collection

A part from the routine collection of observations, several oceanographic experiments have been conducted by various french organisations more or less in relation which the investigation objectives :

- LION 78 (June to September 1978) is a summer experiment in the Gulf of Lions, mediterranean sea, for the study of coastal upwellings

- a March 1979 experiment in the Ligurian Sea, mediterranean sea, to support remotely sensed data of sea surface temperature and ocean color,

- a drifting buoy experiment in the Bay of Biscay, starting February 1979, for the study of ocean dynamics,

- several cruises from March 1979 to October 1979 in the British Channel to support remotely sensed data of sea surface temperature and ocean color.

No airborne temperature measurements have been performed for the HCMM investigation as no specific request for this type of data appeared within the investigation.

The only lack of accomplishments of the ground truth data collection has been the non availability of BOHRA II, a french buoy previously anchored at a fixed station in the Mediterranean Sea, about 100 km south of Marseilles. BOHRA II had to be removed prior to the AEM.A spacecraft launch for technical reasons. BOHRA II was supposed to support the investigation by routinely reporting on the vertical thermal structure of the upper water layers. This will probably seriously affect the objective related with studies of diurnal heating of the surface layer.

3.2 - Comparison of HCMR versus VHRR

The quality of HCMR radiometric performances has been evaluated on a few digital data. Spatial and thermal radiometric resolutions correspond to the nominal performances, respectively 500 m and 0.3 K. HCMR derived temperatures are in accordance with routine observations of sea surface temperature within the accuracy of the atmospheric correction and of the routine observations.

Comparison of HCMM with VHRR performances shows a definite improvement of the quality of the restituted thermal field. On one occasion, HCMM data (11 may 1978 at 2 a m) acquired over the Bay of Biscay have been compared to VHRR data (10 may 1978 - 8 a m) allowing to evaluate the impact of such an improvement : a mesoscale thermal eddy, about 50 km wide, was clearly detected on the enhanced HCMR data (Fig. 2) while it appeared very weakly distinctable on the VHRR data. HCMR data should improve the knowledge of such mesoscale thermal features which have small thermal amplitudes (less than 1 K).

Also shown in Fig. 3 and Fig. 4 are the comparison of computed spatial spectra and structure functions for the same sampled area (64 x 64 km^2) corresponding to the previous thermal eddy, and using respectively HCMM and VHRR data. The improvement in the quality of those functions here again is noticeable, more than a factor of ten. HCMR data should particularly allow to make use of those functions for the study of small scale oceanic turbulence, without too much interference due to the radiometric noise level, which was unfeasible when using VHRR data.

3.3 - Mesoscale studies of the oceanic thermal field

The previous example of a thermal eddy detected in the Bay of Biscay gives us a strong confidence in the interest of HCMM data for the mesoscale studie of thermal features.

On several occasions HCMM photographic products have exhibited interesting thermal features or gradients in the Gulf of Lions (upwellings), on the continental shelf of the Bay of Biscay and in the western part of the English Channel (tidal mixing of the thermocline). The work on digital data is necessary to assess the impact of HCMR data for the studies of such features which have been previously detected with the coarse radiometric performances of VHRR.

3.4 - Studies of Estuarine thermal gradients

In a similar way, we cannot yet assess the impact of HCMM data on the studies of estuarine thermal gradients.

3.5 - Diurnal heating

Up to that time, examination of the received photographic products unlikely show that the few day night HCMM acquisitions within 12 hours associated with cloud-free conditions covers very small oceanic areas, even in the Mediterranean Sea. Consequently, there has been no request order for temperature differences CCTs and we did not yet start fulfilling this objective.

3.6 - Future plans for using AVHRR/TIROS-N

The AVHRR sensor of TIROS-N and the following NOAA's satellites appeared to have attractive performances for the mapping of sea surface temperature. AVHRR ground resolution of about 1 km, and thermal resolution of 0.15 K make the AVHRR radiometric performances comparable to the HCMM. Several infrared channels allow to make an atmospheric correction and improve the absolute accuracy of the thermal field.

AVHRR data over the investigation test site areas are currently available from the CMS (Centre de Météorologie Spatiale) receiving station at Lannion, France. Plans have been made to use this type of data to complement the HCMM investigation with additional AVHRR data when necessary.

AVHRR data should provide the following advantages :

- increased repeatitivity (every 6 hours) of a gieven area

- improved accuracy of the determination of sea surface temperature when using the several AVHRR infrared channels.

4 - Significant results

As previously explained, most of the investigational results are expected to come from the processed HCMM digital products up to that time, a very few CCTs have been received and processed. So that the statement of the accomplisments of some of the objectives would appear rather small at this starting point. Nevertheless during the reporting period the investigation has made an extensive use fo thermal imagery from the VHRR on NOAA's satellites. And results corresponding to some of the objective of the HCMM investigation have been obtained by this way. We finaly decided to take into account for this fact when reporting about significant results.

4.1 - Mesocale studies in the Mediterranean Sea

4.1.1 - Ligurian Sea

The Ligurian sea is an area in the Mediterranean which is limited by the Western Coast of Corsica and the Rivieras extending from Hyeres in France to Livorno in Italy.

The climatology of this area has been studied from the measurements of sea surface temperature by the satellites NOAA 3 through NOAA 5. The processing of more than a hundred satellite images from 1975 to 1978 helped in the determination of typical "seasons" through the year : a mono thermal period from February to April when the VHRR images are uniform contrasting with a summer (from July to September) and a winter periods (from October to December) when the temperature gradients are strong.

In order to improve the significance of satellite results, monthy averages of images were computed through the year 1975 to 1978 on a pixel to pixel basis after geometric rectification of the original data set within one pixel accuracy and a compensation of temperatures due to random variations of the thermal calibration of the sensors.

In winter, a stable thermal structure brings out a cold area in the center of the gulf surrounded with warm waters.

The evolution from December to January is marked by the growing of the cold center up to a uniform temperature field in February. Perturbations do occur when strong winds blow from the East (Fig.7), this causes a bending of the isotherms to the continent and the generation of periodic structures at the front between cold and warm waters.

In summer the thermal structure is globally circular, however the isotherms stretch southward and bend a little toward Corsica which may be due to a higher frequency of a strong wind (Mistral) from the West. The fig. 8 shows such a typical situation for an HCMM image.

Good statistical relationship exists between satellite results and along track ship measurements between Nice and Calvi. Though no simple relation between sea surface currents and temperatures could be found, the images are nevertheless a good representation of water dynamics in the Ligurian Sea.

4.1.2 - <u>Gulf of Lions (Golfe du Lion)</u>

VHRR data have been used to map the extent of strong and transient coastal upwellings, generated by North-Westerly winds, the Mistral and the Tramontane (Fig. 9). Satellite data have been combined with in-situ measurements to highlight the main features of wind induced summer circulation. These features comprise high spatial and temporal variabilities of the current and temperature fields, together with complex advective circulations organized like cells around the upwelling areas.

4.2 - Mesocales studies in the Bay of Biscay

HCMM data revealed on 11 may 1978 a anticyclonic thermal Eddy located at about 45 N - 4.40 EW in the Bay of Biscay (Fig. 1). This eddy would possibly be connected to the response of the oceanic upper layers to the circulation of an atmospheric disturbance over the Bay of Biscay. Similar oscillations have been obtained from theoretical modeling but more analysis is necessary to confirm this hypothesis. In any case, the small thermal contrast of this feature, less than 1 K, is only detected thanks to the improved radiometric performances of HCMM.

4.3 - Mesoscale studies in the English Channel

Summer thermal fronts in the Western part of the English Channel have been located when using VHRR data (Fig. 10). These tidal thermal fronts are produced by the destruction of the thermal stratification in the upper layer of the ocean (thermocline) under the turbulence induced by tidal currents which are of large amplitude in this area. A typical tidal front extents from Britanny, France to Cornwalls, Britain, across the British Channel, and is strongly enhanced in the vicinity of North West Britanny where colder areas appear near the coast. As a result, an experiment has been dedicated in July and September 1979 to the study of the processes associated whith this thermal front. This experiment will make an extensive use of remotely sensed data.

4.4 - Estuarine thermal gradients

About 70 images from satellites NOAA 4 and NOAA 5 were processed between July 1975 and January 1979 for the Gironde estuary off the South-west coast of France.

These images were printed on paper in black and white at a scale of 1: 2000 000 and transferred on the television screen where they were pictured on slides for documentation.

The time repartition of the documents during the studied period are not homogeneous because of had weather in winter and early spring, however interesting features of the sea surface temperature field were brougt about. The image showed on Fig. 11 covers the atlantic coast of France from "Baie de Fromentine" (A) down to the south of the Gironde estuary (B). At time of overpass it was clear weather with little wind (N, 5m/sec) with an air temperature of 12° C in Bordeaux. In the afternoon of the preceeding day similar weather was observed.

The isotherms are approximately paralell to the coast and the interval between maximum and minimum temperature is 6° C. It is interesting to note a cold surface water zone (dotted line) off the coast of Aquitaine (c) and the islands of Oleron (D) and Ré (E). This phenomena is noted frequently observed on the summer images and may be due to seasonal upwelling.

4.5 - Atmospheric correction of infrared radiometry

Theoretical modelling of atmospheric effect on the means of infrared radiometry. The atmospheric effect can be eliminated with a good accuracy, typically 0.5 K, by using a multispectral combination of such infrared channels as planned on AVHRR/TIROS-N (3.7, 11 and 12 μm). Atmospheric correction for HCMM data could also be derived from the AVHRR/TIROS-N data.

5 - Publications

MILOT,C. - Wind induced upwellings in the gulf of Lions - Oceanol. Act., 1979, 2, 3, 261 - 274.

ALBUISSON, M., MONGET, J.M., CREPON, M., MILLOT, C. Observation of transient upwellings in the mediterranean sea with the NOAA VHRR imagery - Journées de Télédétection du GDTA, St Mandé, Sept. 1977, pp. 85-95.

ALBUISSON,M. - TSS-HP Système de traitement sur mini-ordinateur des images VHRR pour la thermographie - Rapport interne, C.T.A.M.N.

MONGET,J.M, - Traitement diachronique des données NOAA - Rapport interne, C.T.A.M.N.

ALBUISSON, M., MONGET, J.M, POISSON, M., 1977.

Investigation of coastal and marine environmental change NOAA digital data - in Maritoring environmental change by remote sensing, J.L. Van Genderen and W.G. Collins Ed., 1977, pp. 41-46.

DESCHAMPS P.Y, PHULPIN T., 1978 - Atmospheric correction of infrared measurements of sea surface temperature using channels at 3.7, 11 and 12 . Presented at IURCM Colloquium "Passive Radiometry of the Ocean", Sydney, B.C, Canada, June 1978 - To be published in Boundary-Layer Meteorology.

DESCHAMPS P.Y, PHULPSIN T., TOURNIER B., 1979 - Atmospheric correction of surface temperature measurements in a 10.5 - 12.5 channel from AVHRR/TIROS-N Presented at COSPAR XXII, Gangalore, India, June 1979.

6 - Problems

6.1 - HCMM data geometry

When registering HCMM data products with map locations it appeared that the distance between lines (about 500 m) and the distance between pixels of the same line (about 450 m) are different and do not correspond to their nominal value (470 or 480 m). Appropriate correction has to be done in order to obtain a map at a given scale. e.g. missing one line every 10 lines.

6.2 - HCMM Periodic noise

Computed structure functions exhibit a small periodic signal, particularly downline. This could be possibly due to :

(i) a periodic noise on the data,

(ii) the resampling algorithm.

This small periodic signal is large enough to alterate the interpretation of small scale turbulence by means of structure functions. We would be very glad to obtain any information allowing to clear up this point, and to correct this effect if possible.

6.3 - Thermal contrast of photographic products

Standard photographic products are usually not enough enhanced to derive from the images any information over the oceanic areas where temperature variations are small. Specific enhancement of photographic products within the range of sea surface temperature would be very useful for the investigational needs, allowing to perform a first analysis of thermal oceanic features prior to requesting digital products.

7 - Image quality and delivrey

7.1 - Image quality

Image quality is good except for the periods where the noise of the thermal channels is too high. Another serious problem is the geometry of the images (see Section 6.1). A part of that, some small defects occasionally appear :

- stripes or anomalous lines,
- grid of periodic black or bright points which do not seriously affect our objectives

7.2 - Test site coverage

A list of the received data, photographic and digital products is given in the Attachment B.

As expected from the cloud cover analysis, cloudfree coverage is satisfactory over the Mediterranean sea, and very poor in the North Western Bay of Biscay. Day-Night cloudfree coverage within 12 hours rarely occurs even in the mediterranean sea : during some periods we systematically received only Day data, or only Night data.

Some data (January-Febraury 1979) located over the Southern Hemisphere were received. A few data have been labelled with an incorrect geographical location, probably due to a confusion between Day and Night (29 dec. 1978, 27 oct. 1978).

7.3 - Delivery

Timeliness of photographic products is acceptable. A few pourcentage of them is too much cloudy, or only land surfaces or too much south or north of the test site areas.

Photographic products arrive whith an erratic schedule. We still not receive some data from the first three months. Et would be preferable for our investigation planning to receive a systematic whole data set of photographic products over a couple of weeks or a month. This would permit a definite and proper selection of the request orders to be done within a given period.

Some of the digital data have been listed as sent but they were not received. It could be preferable to send directly to the intestigator the product list or a copy of the data which are sent through the mailing address within the U.S.A.

ESA (European Space Agency) notify us of the alternative possibility of ordering HCMM data through EARTHNET (the european distribution network). We did not yet make this alternate possibility. Nevertheless quick-looks of HCMM data produced by EARTHNET have been currently received by this way, for two months.

8 - Recommendations

Some recommendations have been listed below despite that we feel they are minor :

- to send directly to the Foreign investigator a copy of the product list when data are mailed to a mailing adress within the U.S.A,

- to increase the thermal contrast of infrared data within the sea surface temperature range for the specific applications to oceanography,

- to distribute the standing order photographic products on a more systematic way allowing the investigator to obtain a complete data set for a given period or notify him when the data set has been completed for this period.

9 - Conclusions

The following conclusions may be tentatively established for the reporting period :

- the quality of HCMM radiometer performances ground resolution and temperature resolution shows a definite improvement compared to the previous VHRR/NOAA radiometers for the studies of sea surface temperatures and applications to oceanography,

- because of photographic products do not provide specific enhancement of the temperature field over the ocean, extensive use fo digital products has to be done for oceanographic applications,

- repetitivity of HCMM coverage is not high enough for the continous survey of areas where cloudfree condition are not prevailing. Because of its improved repetitivity AVHRR/TIROS-N could provide a better alternative source of data for studies of ocean dynamics in those areas,

- HCMM data appear to be potentially very useful for a detailed analysis of the sea surface temperature field, particularly in the very coastal area whith making profit of the HCMM ground resolution of 500 m.

Figure 1 : Black and white visualization of HCMM digital, on a PERICOLOR system at LOA :

(1) raw data,

(2) after stripe filtering,

(3) after additional smoothing.

The 256 x 256 pixels of the example shown correspond to a 120 km square area centered at 45 N - 4.40 W and exhibit a thermal eddy in the Bay of Biscay (HCMM scene ID : A - A0015 - 02550 - 3)

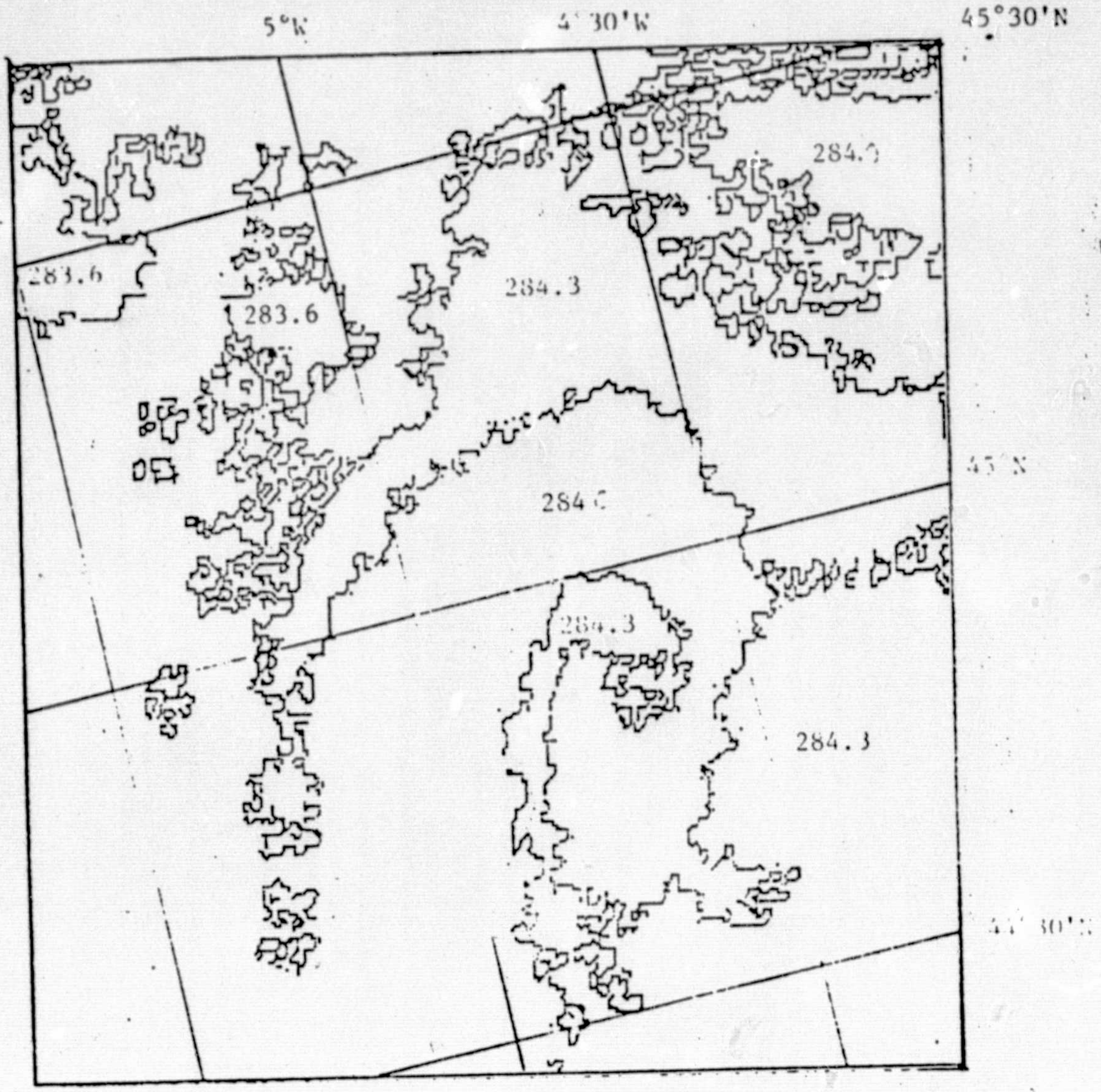


Figure 2 : Surface isotherms derived from HCMM digital data at LOA. The example given corresponds to the thermal eddy shown in Figure a (HCMM scene ID : A - A0015 - 02550 - 3 : 11/05/78) - Radiometric temperatures are given in Kelvin degrees.

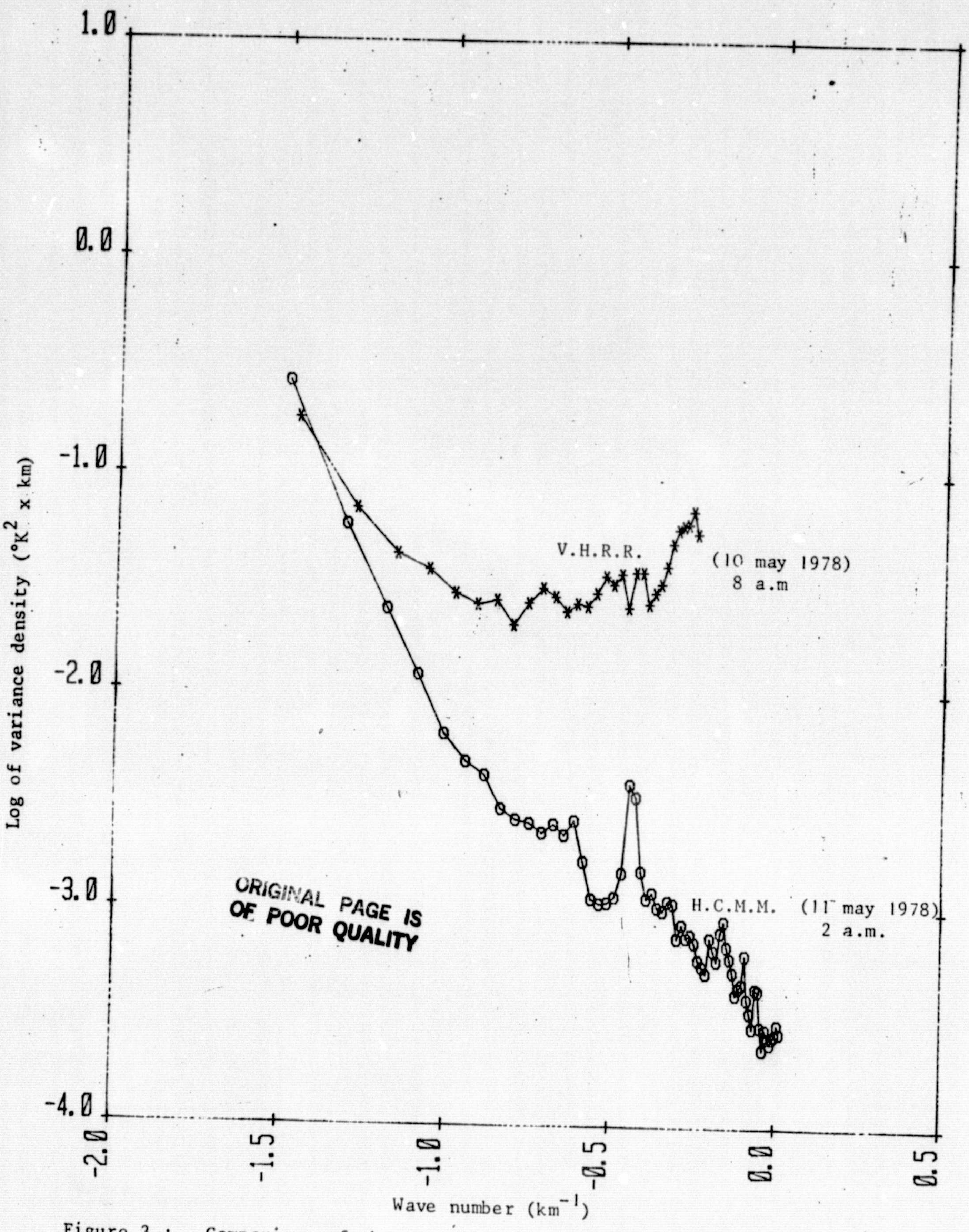


Figure 3 : Comparison of the one dimension downline spatial density spectra of temperature variations computed from HCMM and VHRR data, over the same location and about the same time.
The example given is for a 64 km square area of the thermal eddy shown in Figure 1 (HCMM scene ID : A - A0015 - 02550 - 3)

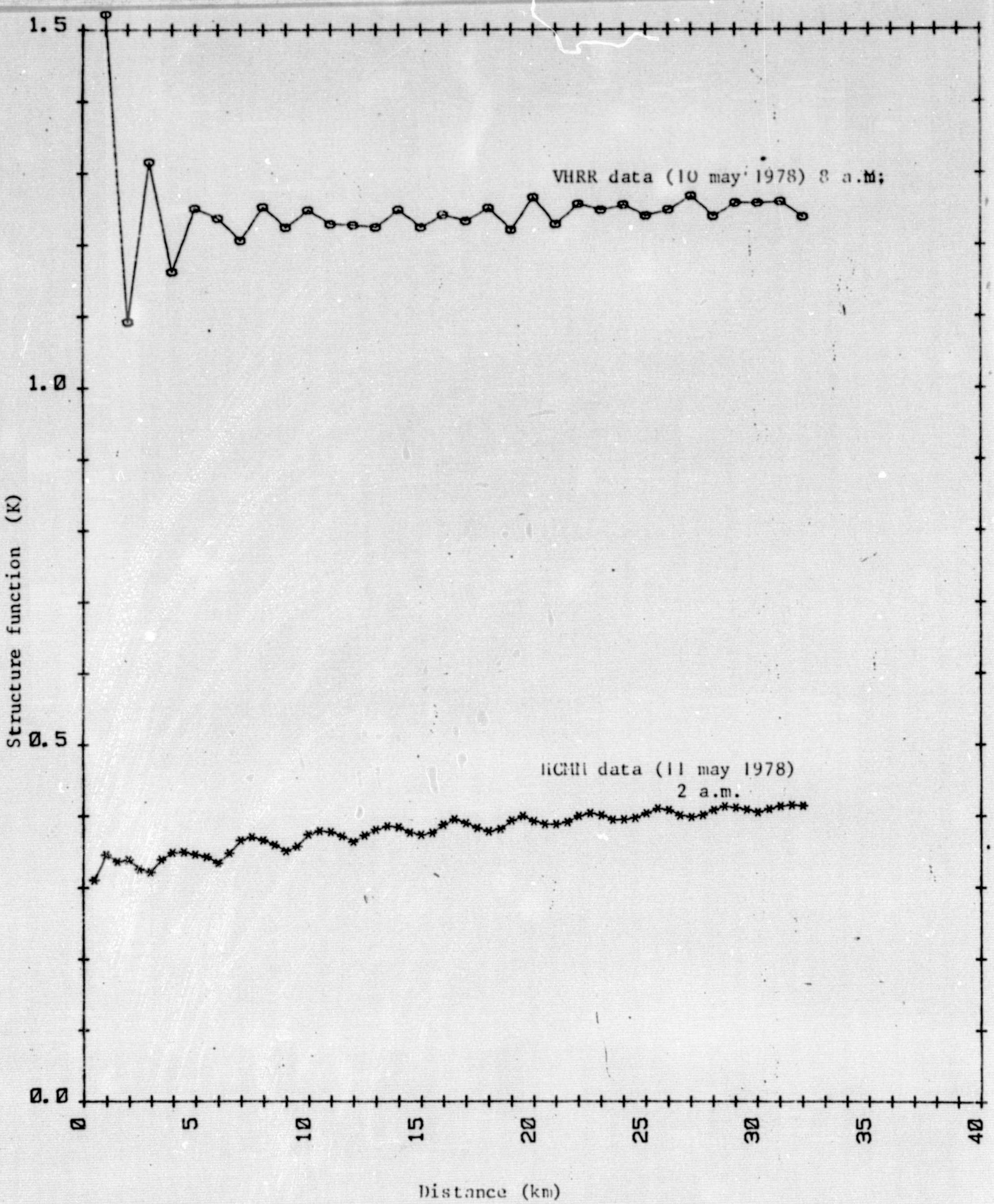


Figure 4 : Comparison of the downline one dimension structure function computed from HCMM and VHRR data, over the same location and at about the same time.

The example given is for a 64 km square area of the thermal eddy shown in Figure 1 (HCMM scene ID : A - A0015 - 02550 - 3).

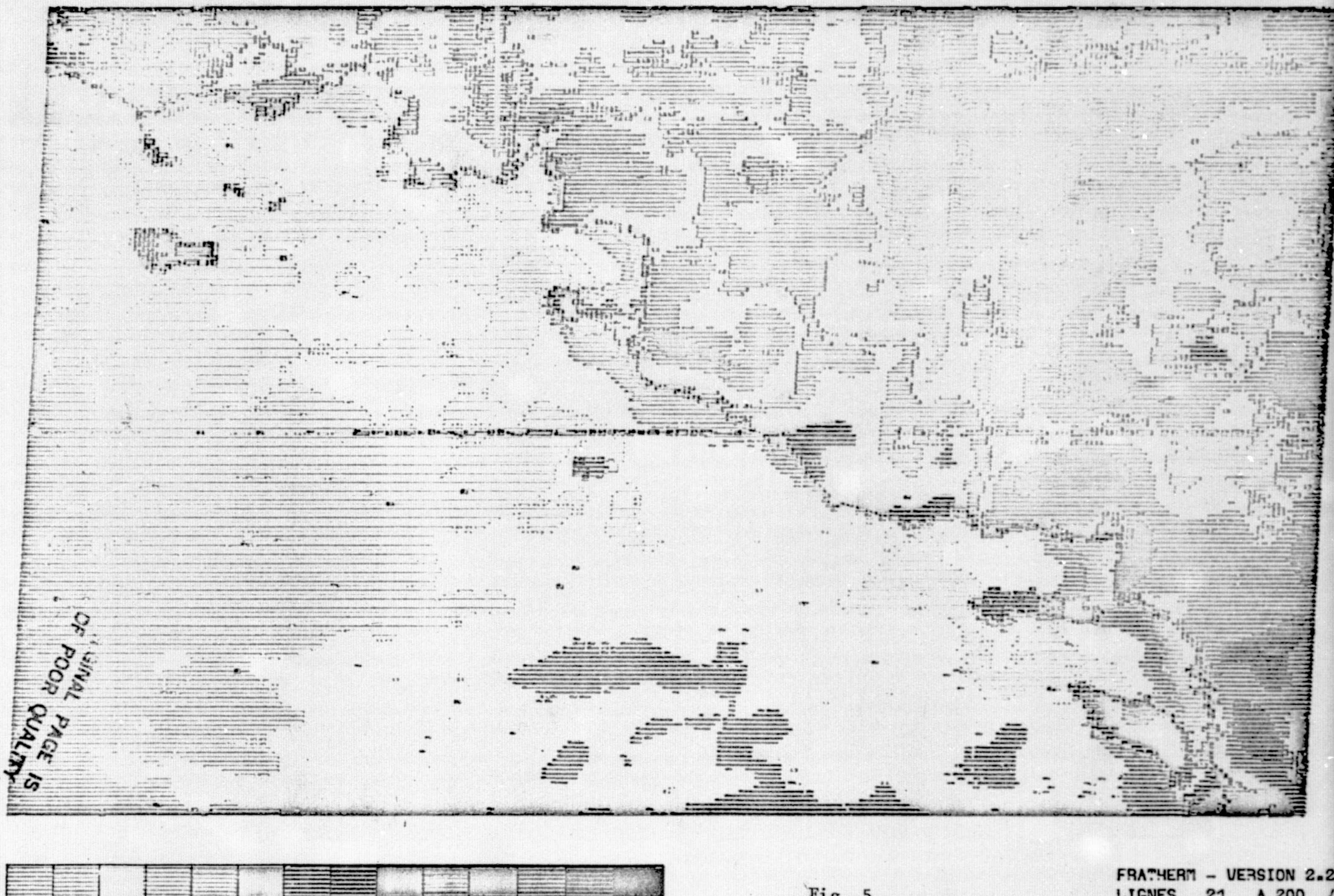


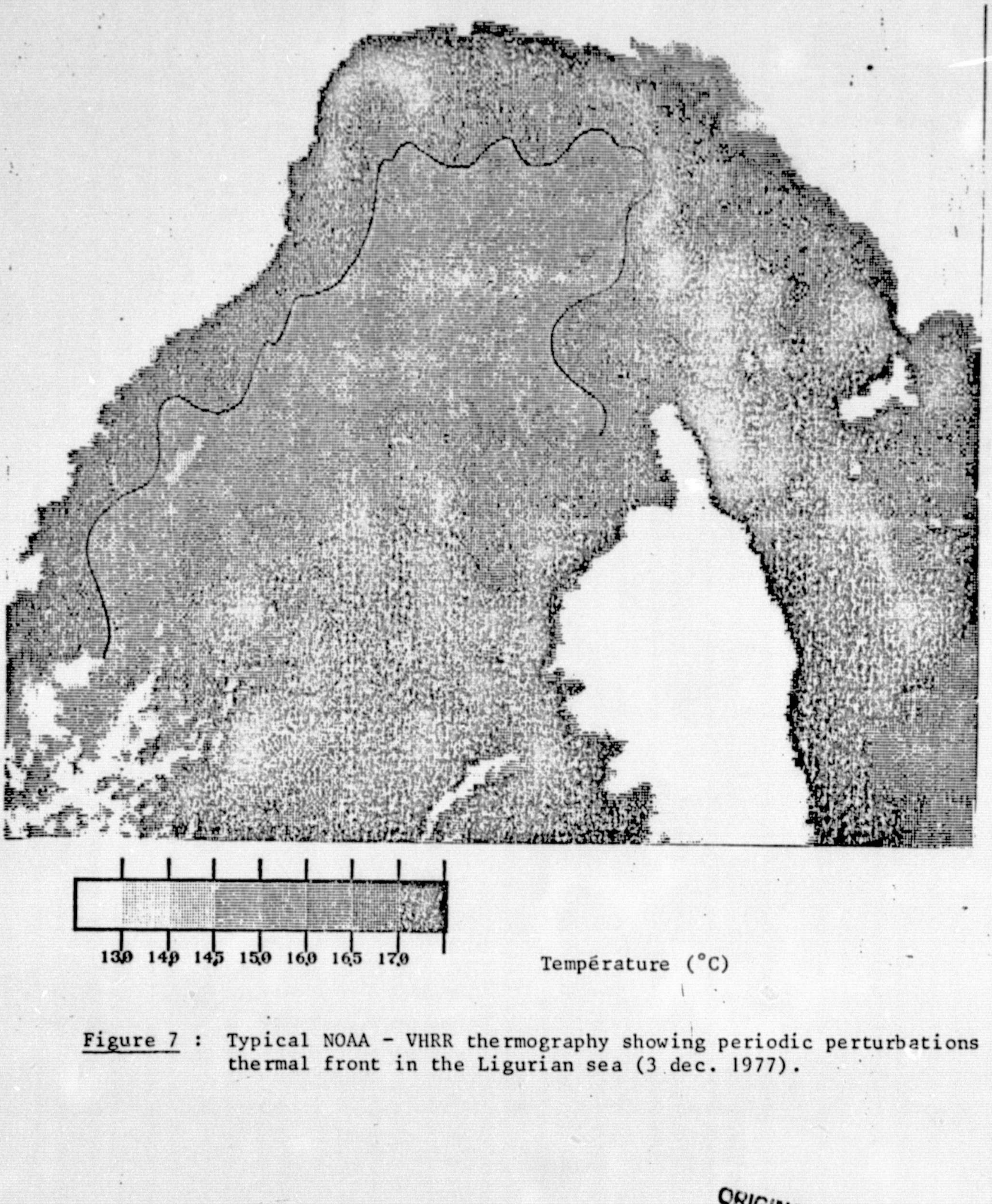
Fig. 5

FRATHERM - VERSION 2.2
LIGNES 21 A 200 /
COLONNES 51 A 320 /
ECHELLE: 1/1000000
JANVIER 1977

TEMPERATURE EN DEG. CELSIUS

THERMOGRAPHIE NOAA-VHRR. IMAGE DU 06/08/75 A 09H 30M TU
EQUIPE FRALIT (C.T.A.M.N. / ECOLE DES MINES DE PARIS)

Fig.6: FRACARTE visualisation at ENS
(same area)



<u>Figure 7</u> : Typical NOAA - VHRR thermography showing periodic perturbations along thermal front in the Ligurian sea (3 dec. 1977).

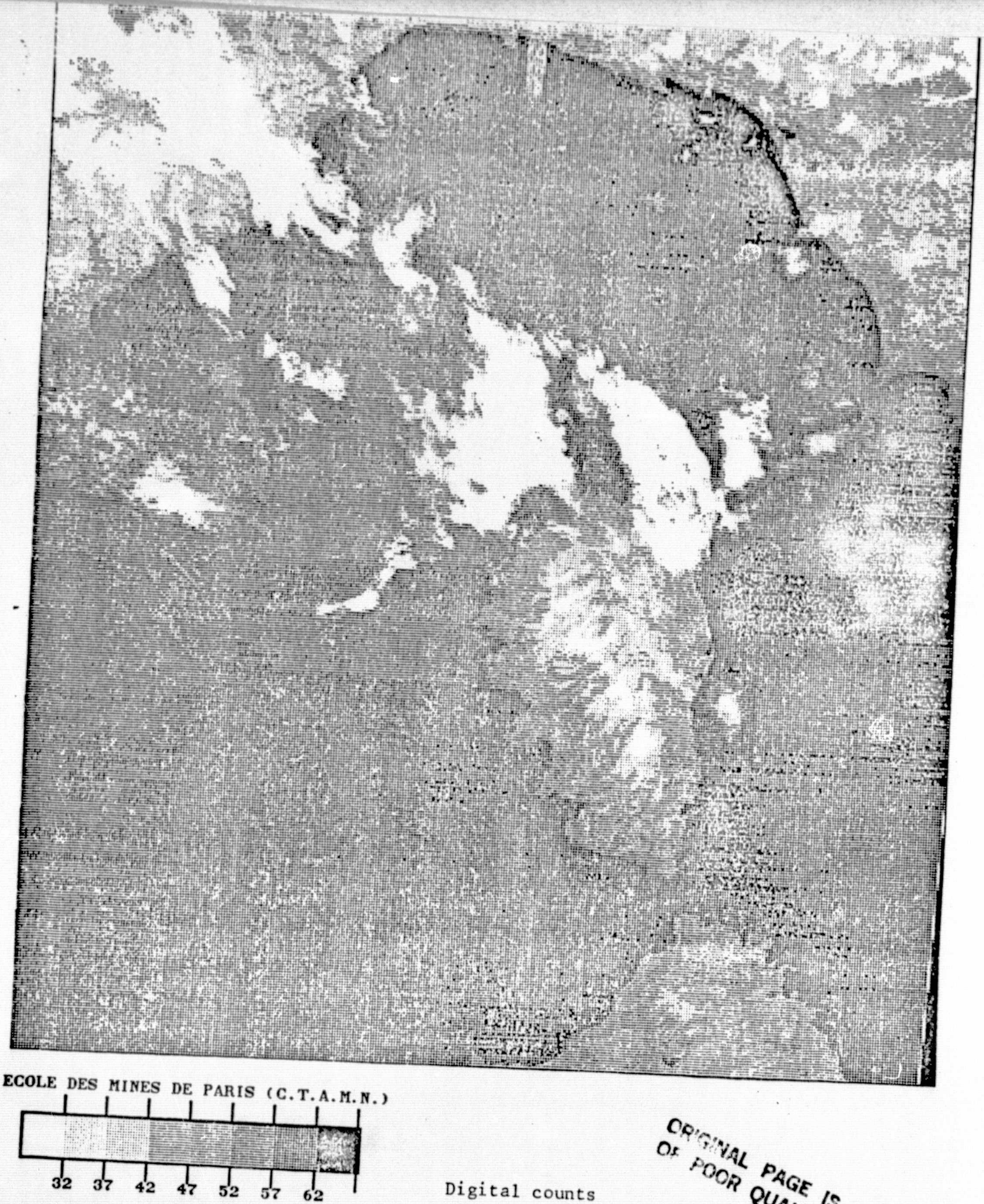


Fig. 8 : HCMM thermography on 30 June 1978 showing bending of isotherms toward Corsica under strong blowing of Mistral.

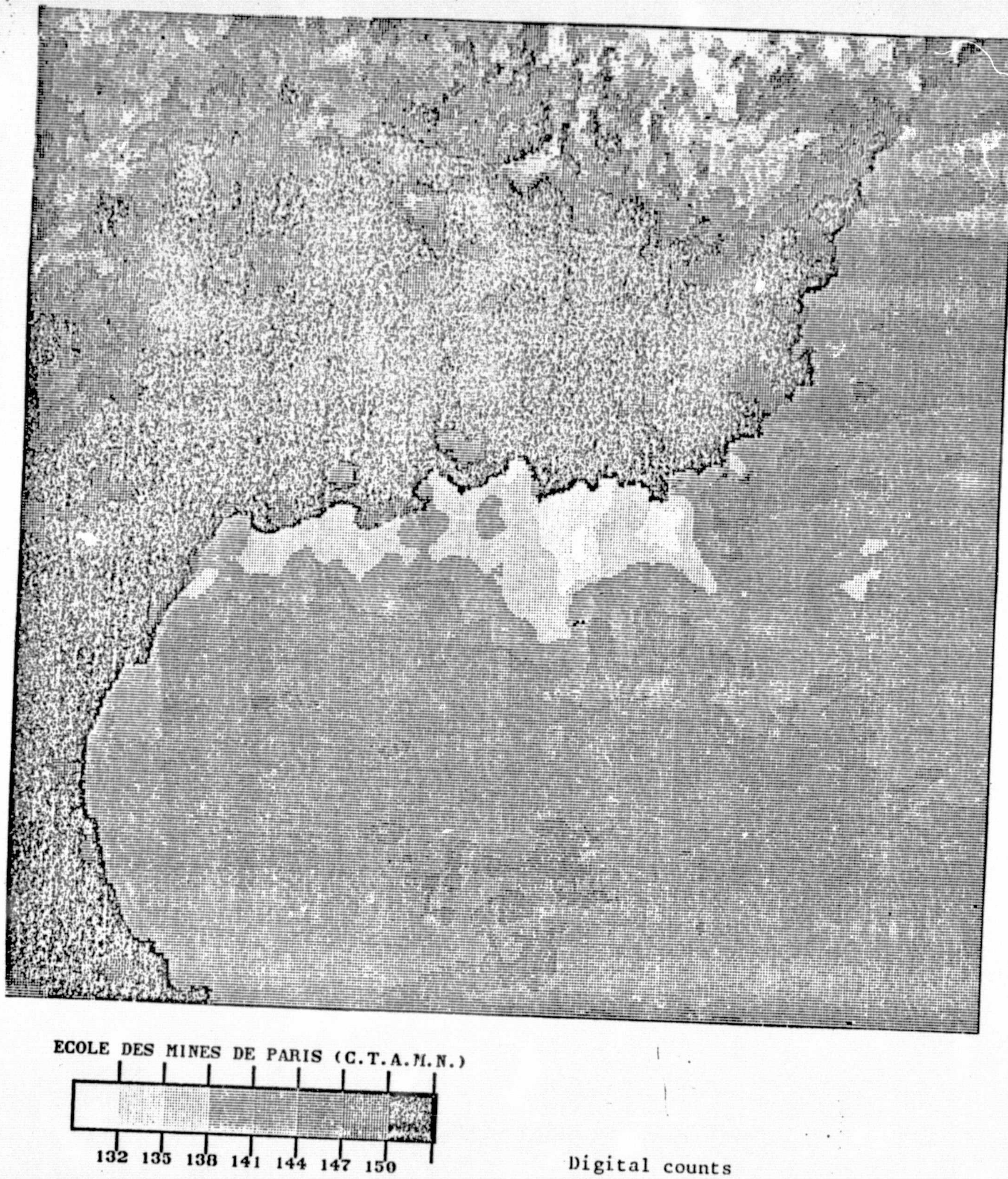


Fig. 9 : Coastal upwelling induced by Mistral in the Golfe du Lion (NOAA - VHRR thermography on July 78)

Fig. 10 : Summer thermal front in the Western part of the Channel revealed by NOAA - VHRR thermography on 30/07/75.

ORIGINAL PAGE IS OF POOR QUALITY

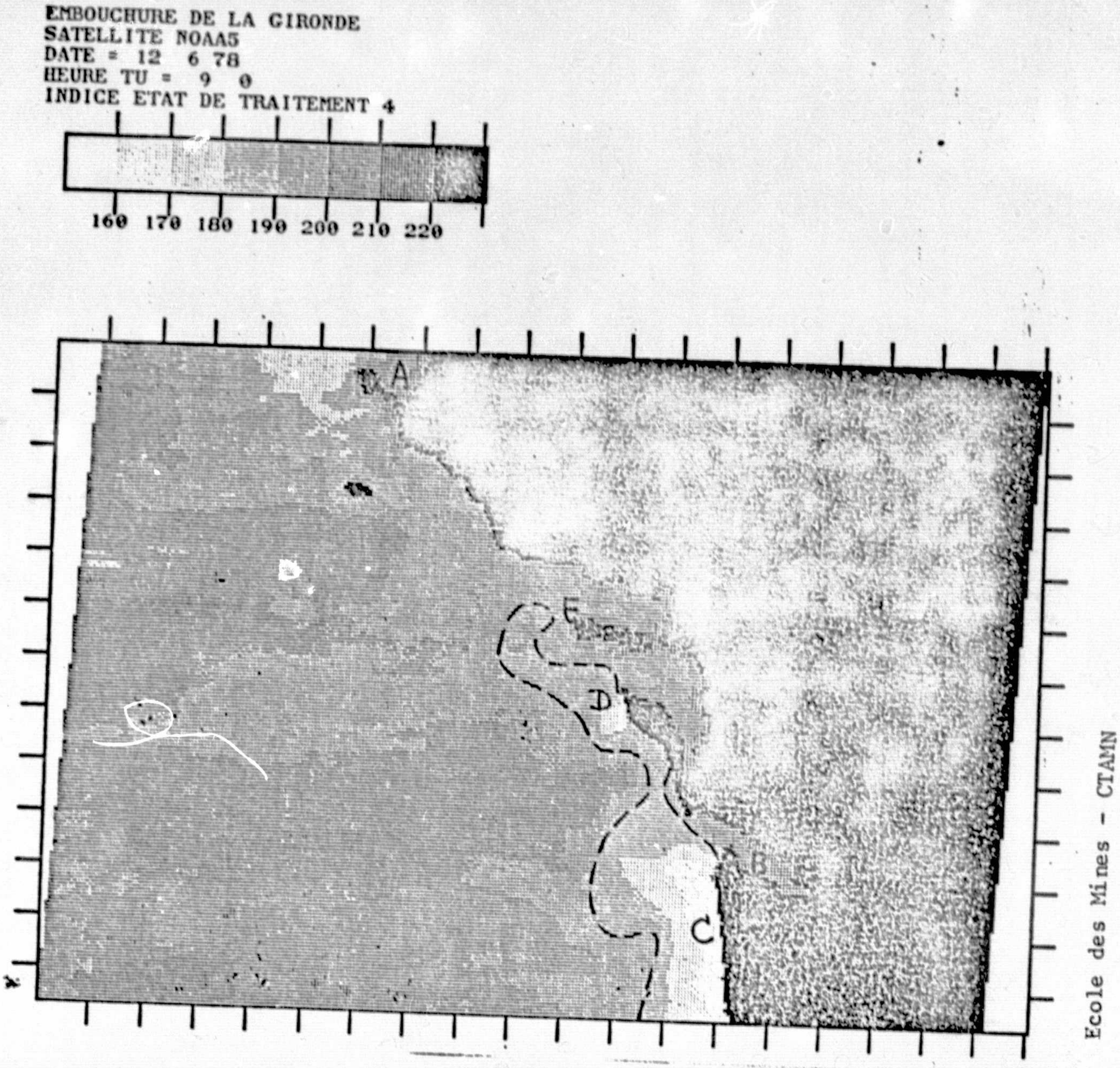


Fig. 11 : NOAA - VHRR thermography of the Gironde estuary (12/06/78).

ATTACHMENT A

Permanent addresses and organizations of the Investigators

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Ecole des Mines
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Pr. F. VERGER - Laboratoire de Géographie, Ecole Normale Supérieure
1 rue Maurice Arnoux
92410 MONTROUGE

ATTACHMENT B

List of the receided data

The images are listed using the following codes

- 0 : Date
- 1 : Type of data
  - DIR : Day IR
  - NIR : Night IR
  - DVI : Day VIS
- 2 : Scene ID
- 3 : Location of the center of image
- 4 : Remarks

0	1	2	3	4
11 may 1978	NIR	A - A0015-02540-3	53.32N-003.43 W	
	NIR	A - A0015-02550-3	47.29N-006.08 W	
	NIR	A - A0015-02560-3	47.29N-006.08 W	
	NIR	A - A0015-02564-3	41.10N-008.45 W	
	NIR	A - A0015-02570-3	41.26N-008.08 W	
	NIR	A - A0015-03000-3	32.50N-010.00 W	
20 may 1978	DVI	A - A0024-13200-1	36.32N-003.34 E	
	DIR	A - A0024-1320-2	36.32N-003.34 E	
	DVI	A - A0024-13230-1	48.40N-000.19 E	
	DIR	A - A0024-13230-2	48.40N-000.19 E	
	DVI	A - A0024-13250-1	54.40N-002.52 W	
	DIR	A - A0024-13250-2	54.40N-002.52 W	
30 may 1978	NIR	A - A0034-02120-3	50.41N-005.06 E	
	NIR	A - A0034-02140-3	44.37N-002.53 E	
11 june 1978	DVI	A - A0036-13460-1	42.00N-004.25 W	
	DIR	A - A0036-13460-2	42.00N-004.25 W	
3 june 1978	NIR	A - A0038-01490-3	41.46N-007.56 E	
	NIR	A - A0038-01510-3	35.39N-006.11 E	
8 june 1978	DVI	A - A0043-12370-1	34.45N-014.15 E	
18 june 1978	DVI	A - A0053-14030-1	46.05N-010.34 W	
	DIR	A - A0053-14030-2	46.05N-010.34 W	
	DVI	A - A0053-14050-1	52.00N-012.54 W	
	DIR	A - A0053-14050-2	52.00N-012.54 W	
19 june 1978	NIR	A - A0054-01470-3	45.45N-008.58 E	
	NIR	A - A0054-01490-3	39.40N-007.02 E	
20 june 1978	NIR	A - A0055-02030-3	52.58N-007.11 E	
	NIR	A - A0055-02040-3	52.00N-006.46 E	
	NIR	A - A0055-02050-3	45.56N-004.27 E	
	NIR	A - A0055-02050-3	46.54N-004.47 E	
	NIR	A - A0055-02070-3	39.49N-002.30 E	
	NIR	A - A0055-02070-3	40.48N-002.47 E	
24 june 1978	DVI	A - A0059-12370-1	42.34N-011.47 E	
	DIR	A - A0059-12370-2	42.34N-011.47 E	
	DVI	A - A0059-12400-1	54.41N-007.07 E	
	DIR	A - A0059-12400-2	54.41N-007.07 E	

30 june 1978	NIR	A-A0065-01500-3	54.07N-010.39 E	
	NIR	A-A0065-01500-3	45.59N-006.08 E	
	NIR	A-A0065-01550-3	35.53N-004.23 E	
2 july 1978	NIR	A-A0067-02270-3	50.36N-000.02 E	
	NIR	A-A0067-02280-3	44.32N-002.09 W	(2)
	NIR	A-A0067-02300-3	38.26N-004.01 W	
5 july 1978	NIR.	A-A0070-01460-3	42.29N-007.49 E	
	NIR	A-A0070-01460-3	43.16N-008.04 E	
	NIR	A-A0070-01470-3	37.10N-006.15 E	
	NIR	A-A0070-01480-3	36.23N-006.02 E	
	DVI	A-A0070-12410-1	43.34N-009.58 E	
	DIR	A-A0070-12410-2	43.34N-009.58 E	
	DVI	A-A0070-12450-1	55.41N-005.08 E	
	DIR	A-A0070-12450-2	55.41N-005.08 E	
6 july 1978	NIR	A-A0071-02020-3	48.26N-005.17 E	
	NIR	A-A0071-02040-3	42.22N-003.13 E	(2)
	NIR	A-A0071-02060-3	36.16N-001.27 E	
11 july 1978	NIR	A-A0076-01550-3	49.03N-007.04 E	
	NIR	A-A0076-01570-3	42.59N-004.58 E	
	NIR	A-A0076-01590-3	36.53N-003.10 E	
17 july 1978	NIR	A-A0082-02060-3	51.24N-005.02 E	
	NIR	A-A0082-02080-3	45.21N-002.47 E	
	NIR	A-A0082-02090-3	39.17N-000.53 E	
22 july 1978	NIR	A-A0087-02000-3	47.02N-004.59 E	
	NIR	A-A0087-02020-3	40.58N-003.00 E	
31 july 1978	NIR	A-A0096-03040-3	51.54N-009.34 W	
	NIR	A-A0096-03050-3	45.42N-011.52 W	
19 aug. 1978	NIR	A-A0115-02180-3	45.56N-000.42 E	(2)
	NIR	A-A0115-02200-3	39.52N-002.39 W	
24 aug. 1978	DVI	A-A0120-13060-1	40.34N-002.34 E	(3)
	DIR	A-A0120-13060-2	40.34N-002.34 E	
	DVI	A-A0120-13080-1	46.38N-000.36 E	(3)
	DIR	A-A0120-13080-2	46.38N-000.36 E	
31 aug. 1978	DVI	A-A0127-13380-1	45.05N.006.38 W	
	DIR	A-A0127-13380-2	45.05N.006.38 W	
1 sept. 1978	DVI	A-A0128-12220-1	56.23N-008.22 E	

	DIR	A-A0128-12220-2	56.23N-008.22 E	
6 sept. 1978	DVI	A-A0133-13490-1	43.30N-009.20 W	
	DIR	A-A0133-13490-2	43.30N-009.20 W	
7 sept. 1978	NIR	A-A0134-03090-3	53.38N-011.36 W	
	DVI	A-A0134-12300-1	43.29N-010.21 E	
	DIR	A-A0134-12300-2	43.29N-010.21 E	
	DVI	A-A0134-12340-1	55.32N-005.35 E	
	DIR	A-A0134-12340-2	55.32N-005.35 E	
17 sept. 1978	DVI	A-A0144-13560-1	46.05N-011.58 W	
	DIR	A-A0144-13560-2	46.05N-011.58 W	
	DVI	A-A0144-13570-1	52.08N-014.17 W	
	DIR	A-A0144-13570-2	52.08N-014.17 W	
27 sept. 1978	NIR	A-A0154-02450-3	49.29N-007.38 W	
	NIR	A-A0154-02460-3	43.25N-009.47 W	
30 sept. 1978	NIR	A-A0157-02050-3	38.10N-000.47 E	
3 oct. 1978	DVI	A-A0160-13530-1	43.29N-011.13 W	
	DIR	A-A0160-13530-2	43.29N-011.13 W	
	DVI	A-A0160-13550-1	49.32N-013.21 W	
	DIR	A-A0160-13550-2	49.32N-013.21 W	
5 oct. 1978	DVI	A-A0162-12520-1	40.38N-004.49 E	
	DIR	A-A0162-12520-2	40.38N-004.49 E	
	DVI	A-A0162-12530-1	46.43N-002.50 E	
	DIR	A-A0162-12530-2	46.43N-002.50 E	
17 oct. 1978	DVI	A-A0174-13140-1	39.54N-000.53 E	
	DIR	A-A0174-13140-2	39.54N-000.53 E	
	DVI	A-A0174-13170-1	52.04N-005.08 W	
	DIR	A-A0174-13170-2	52.04N-005.08 W	
24 oct. 1978	DVI	A-A0181-13430-1	42.10N-008.57 W	
	DIR	A-A0181-13430-2	42.10N-008.56 W	
	DVI	A-A0181-13450-1	48.15N-011.01 W	
	DIR	A-A0181-13450-2	48.15N_011.01 W	
27 oct. 1978	NIR	A-A0184-12590-3	40.45N-002.11 E	uncorrect
	NIR	A-A0184-13010-3	46.51N-000.13 E	labelling
	NIR	A-A0184-13020-3	52.55N-002.10 W	

28 oct. 1978	DVI	A-A0185-13160-1	37.49N-001.26 W	
	DIR	A-A0185-13160-2	37.49N-001.26 W	
	DVI	A-A0185-13180-1	43.56N-003.17 W	(2)
	DIR	A-A0185-13180-2	43.56N-003.17 W	(2)
	DVI	A-A0185-13200-1	50.01N-005.27 W	
	DIR	A-A0185-13200-2	50.01N-005.27 W	
30 oct. 1978	DVI	A-A0187-12170-1	44.34N-011.44 E	
	DIR	A-A0187-12170-2	44.34N-011.44 E	
	DVI	A-A0187-12180-1	50.38N.009.31 E	
2 nov. 1978	DVI	A-A0190-13090-1	40.23N-000.26 E	(2)
	DIR	A-A0190-13090-2	40.23N-000.26 E	(2)
	DVI	A-A0190-13110-1	46.29N-002.24 W	
	DIR	A-A0190-13110-2	46.29N-002.24 W	
	DVI	A-A0190-13130-1	52.33N-004.46 W	
	DIR	A-A0190-13130-2	52.33N-004.46 W	
3 nov. 1978	DVI	A-A0191-13280-1	45.13N-006.28 W	
	DIR	A-A0191-13280-2	45.13N-006.28 W	
4 nov. 1978	DVI	A-A0192-12120-1	56.49N-008.29 E	
	DIR	A-A0191-12120-2	56.49N-008.29 E	
9 nov. 1978	NIR	A-A0197-02400-3	52.53N-006.38 W	
	NIR	A-A0197-02420-3	46.52N-009.02 W	
16 nov. 1978	NIR	A-A0204-01340-3	49.53N-008.28 E	
	NIR	A-A0204-01360-3	43.50N-006.17 E	
	NIR	A-A0204-01380-3	37.46N-004.26 E	
30 nov. 1978	DVI	A-A0218-13320-1	42.13N-007.32 W	
	DIR	A-A0218-13320-2	42.13N.007.32 W	
	DVI	A-A0218-13340-1	48.17N-009.35 W	
	DVI	A-A0218-13340-1	50.46N-010.33 W	
	DIR	A-A0218-13340-2	48.17N-009.35 W	
	DIR	A-A0218-13340-2	50.46N-010.33 W	
6 déc. 1978	DVI	A-A0224-12090-1	49.58N-10.54 E	
	DIR	A-A0224-12090-2	49.58N-10.54 E	
	DVI	A-A0224-12100-1	55.49N-008.14 E	
	DIR	A-A0224-12100-2	55.49N-008.14 E	
	DVI	A-A0224-13440-1	43.20N-011.02 W	
	DIR	A-A0224-13440-2	43.20N-011.02 W	
	DVI	A-A0224-13460-1	49.24N-013.10 W	
	DIR	A-A0224-13460-2	49.24N-013.10 W	

7 déc. 1978	DVI	A-A0225-12250-1	42.01N-009.05 E	
	DIR	A-A0225-12250-2	42.01N-009.05 E	
	DVI	A-A0225-12260-1	48.05N-007.02 E	
	DIR	A-A0225-12260-2	48.05N-007.02 E	
	DVI	A-A0225-12280-1	54.07N-004.34 E	
	DIR	A-A0225-12280-2	54.07N-004.34 E	
8 déc. 1978	DVI	A-A0226-12410-1	36.38N-006.06 E	
	DIR	A-A0226-12410-2	36.38N-006.06 E	
14 déc. 1978	DVI	A-A0232-12530-1	35.27N-003.20 E	
	DIR	A-A0232-12530-2	35.27N-003.20 E	
	DVI	A-A0232-12540-1	41.33N-001.35 E	
	DIR	A-A0232-12540-2	41.33N-001.35 E	
	DVI	A-A0232-12560-1	47.37N-000.25 E	
	DIR	A-A0232-12560-2	47.37N-000.25 E	
	DVI	A-A0232-12580-1	53.38N-002.50 W	
	DIR	A-A0232-12580-2	53.38N-002.50 W	
17 déc. 1978	DVI	A-A0235-12120-1	42.37N-011.53 E	
	DIR	A-A0235-12120-2	42.37N-011.53 E	
	DVI	A-A0235-12130-1	48.41N-009.49 E	
	DIR	A-A0235-12130-2	48.41N-009.49 E	
	DVI	A-A0235-12150-1	54.42N-007.17 E	
	DIR	A-A0235-12150-2	54.42N-007.17 E	
20 déc. 1978	DIR	A-A0238-04380-2	37.20S-138.04 E	
21 déc. 1978	DVI	A-A0239-13250-1	45.08N-007.04 W	
	DIR	A-A0239-13250-2	45.08N-007.04 W	
25 déc. 1978	DVI	A-A0243-12580-1	39.57N-000.37 E	
	DIR	A-A0243-12580-2	39.57N-000.37 E	
	DIV	A-A0243-13000-1	46.01N-001.18 W	
	DIR	A-A0243-13000-2	46.01N-001.18 W	
	DVI	A-A0243-13020-1	52.04N.003.36 W	
	DIR	A-A0243-13020-2	52.04N.003.36 W	
26 déc. 1978	NIR	A-A0244-02210-3	45.24N.005.53 W	
29 déc. 1978	NIR	A-A0247-12360-3	48.43N-003.51 E	uncorrect
	NIR	A-A0247-12370-3	54.44N-001.19 E	labelling
30 déc. 1978	DVI	A-A0248-12500-1	35.55N-003.20 E	
	DVI	A-A0248-12520-1	42.01N-001.36 W	(2)
	DIR	A-A0248-12520-2	42.01N-001.36 W	
3 janv. 1979	DVI	A-A0252-18540-1	37.37N-178.21 W	out of test
	DIR	A-A0252-18540-2	37.37N-178.21 W	site areas
	DVI	A-A0252-18560-1	43.42N-179.49 E	
	DIR	A-A0252-18560-2	43.42N-179.49 E	
	DVI	A-A0252-18580-1	49.45N-177.40 E	

4 féb.	DVI	A-A0284-18500-1	36.30N-178.02 W	out of test site
	DIR	A-A0284-18509-2	36.30N-178.02 W	
	DVI	A-A0284-18510-1	42.36N-179.50 W	areas
	DIR	A-A0284-18510-2	42.36N-179.50 W	
	DVI	A-A0284-18530-1	48.40N-178.04 E	
	DIR	A-A0284-18530-2	48.40N-178.04 E	

2 - Digital data products

0	1	2	4
11 may 1978	NIR	A-A0015-02550-3	
	NIR	A-A0015-02570-3	
18 june 1978	DVI	A-A0053-14050-1	
	DIR	A-A0053-14050-2	
	DVI	A-A0053-14030-1	
	DIR	A-A0053-14030-2	
19 june 1978	NIR	A-A0054-01470-3	
	NIR	A-A0054-01490-3	
30 june 1978	NIR	A-A0065-01530-3	
			listed on the product list as sent, but not received
2 july 1978	NIR	A-A0067.02300-3	
6 july 1978	NIR	A-A0071-02040-3	
11 july 1978	NIR	A-A0076-01570-3	
	NIR	A-A0076-01590-3	