

## **USE OF DIFFERENTIAL GPS FOR CORRELATING SPOT IMAGERY IN NEW CALEDONIA**

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### **1. INTRODUCTION**

New Caledonia is proud to possess the largest lagoon in the world. Making a bathymetric and topographic survey of this lagoon represents a task of considerable magnitude but was facilitated by using the data from the "SPOT" earth-observation satellite. The images provided must, however, be correlated geographically and corrected for geometric distortions, which requires the existence of "on site" measurements in order to position the reference points.

Since points rising above sea level in New Caledonia are rare (Fig. 1 ) or even non-existent on certain images, new methods based on various means (Differential GPS, survey launch, helicopter, pedestrian) have had to be sought to fix the position of such reference points.

### **2. USE OF DIFFERENTIAL GPS**

The images provided by the SPOT satellite are composed of pixels, each of which represents a square with sides of 10 or 20 metres (according to the image mode: panchromatic or multi-spectral) on the earth's surface .

The correlating of an image requires knowledge of the position of several such pixels, distributed evenly over the SPOT imagery.

To satisfy this requirement, the positioning system used must fulfil several criteria:

- to be able to fix the position of any point, even if out of sight;

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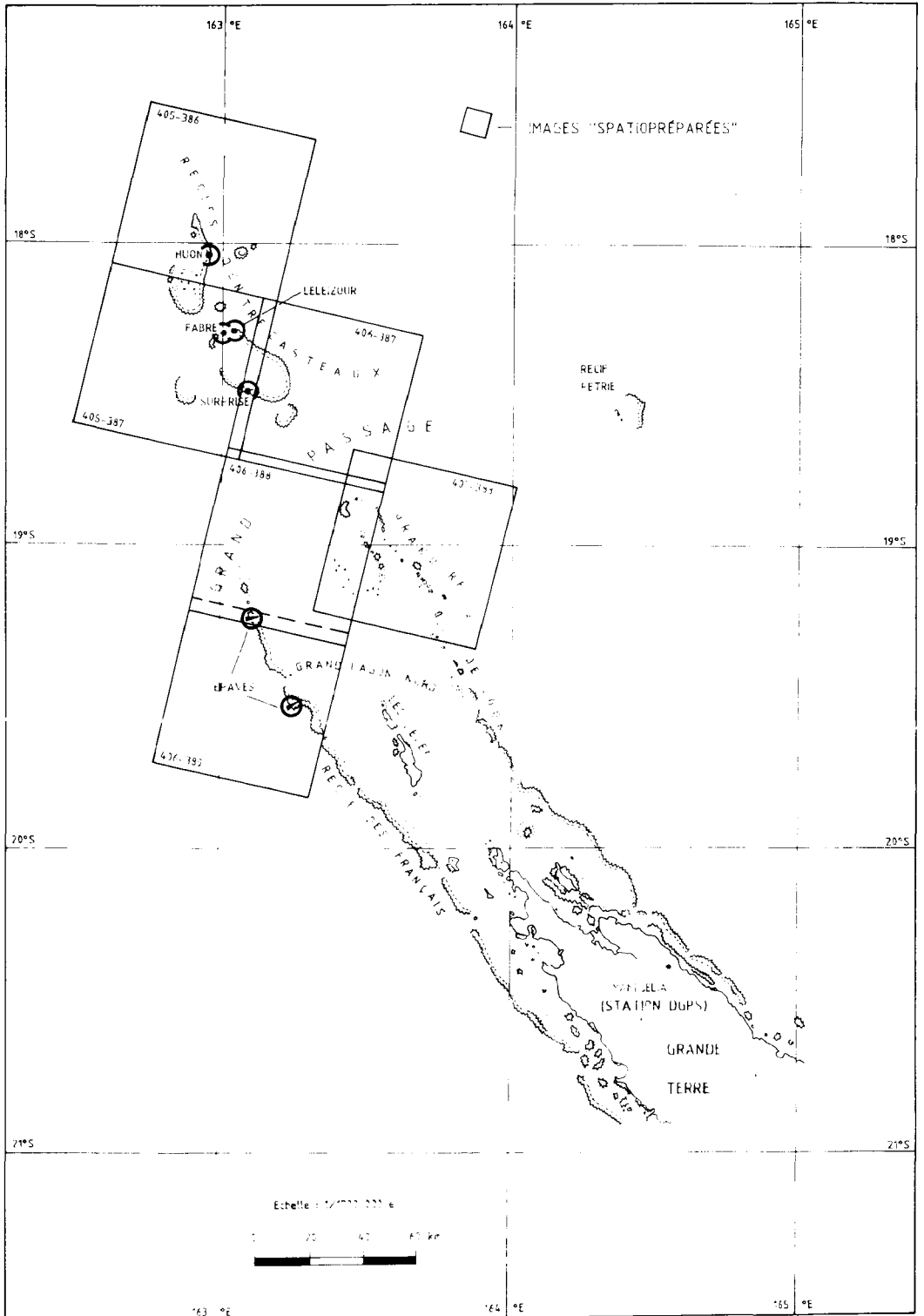


FIG. 1.- New Caledonia.

- to be able to take measurements from a mobile platform (launch, helicopter);
- to be able to obtain a position, with accuracy relative to the size of the pixels, in a very short time (approximately one minute when hovering in a helicopter).

The use of Differential GPS, with a reference station promulgating corrections in HF, made it possible to achieve these objectives. The reference station, set up at Mandjelia, in the north of Grande Terre (Fig. 1), had a theoretical range of 500 km, which made it possible to receive corrections as far as the d'Entrecasteaux reefs. Fixed-point measurements by Differential GPS on the islets of Surprise (Fig. 2) and Huon were compared with position fixes by static GPS. The accuracy of Differential GPS was estimated to be as better than 3m at 95% confidence level.



FIG. 2.- Islet of Surprise.

### 3. TRAVERSE ON LAND

The SPOT images of the reefs of d'Entrecasteaux did not generally provide pixels that were easily identifiable on the islets. Most of the islets, in fact, have contours of rounded shapes, with no well-defined angles, and are evenly covered with unvarying vegetation. When well-marked sandy points exist, these do not, however, represent reliable landmarks, as they are subject to change in this region where tropical cyclones are frequent.

Being unable to pick out a particular point, it was therefore necessary to locate a shape. The method used consisted in walking around the islet, following as closely as possible the outer limit of the vegetation, and using the Differential GPS receiver and a portable computer to record the positions. The rate of acquisition of fixes was set (every 10 seconds, or less) so as to give a true picture of the track followed.

The demarcation between vegetation and sand appears clearly on the SPOT images, these two areas having different spectral responses. Superposing this limit on the zoom of the SPOT image with the outline of the track followed, at the same scale (assessed from the size of the zoom pixels) thus provides an accurate position correlation and eliminates the risk of any error of identification.

### 4. POSITIONING THE PIXELS FROM A LAUNCH

The scarcity of islets in the region made it necessary to position the pixels corresponding to submerged coral pinnacles. The pinnacles chosen ranged in size from one metre to tens of metres and had to be sufficiently far away from the coral barrier reef to facilitate their identification at sea. Their approximate positions, obtained by exploiting the satellite image, the coordinates of the corners and centre of which are known to within about a hundred metres, then makes it possible to find them again rapidly.

On small-sized coral pinnacles, the launch stopped at the point estimated to be the centre and recorded the position by Differential GPS (points 1 and 2 of Fig. 3). On larger-sized massifs, covered by several pixels, the launch made a traverse of the outer contour. The method is equivalent to that used on the islets: the outline of the track followed by the launch around the massifs of coral enabled the position of the corresponding pixels to be determined.

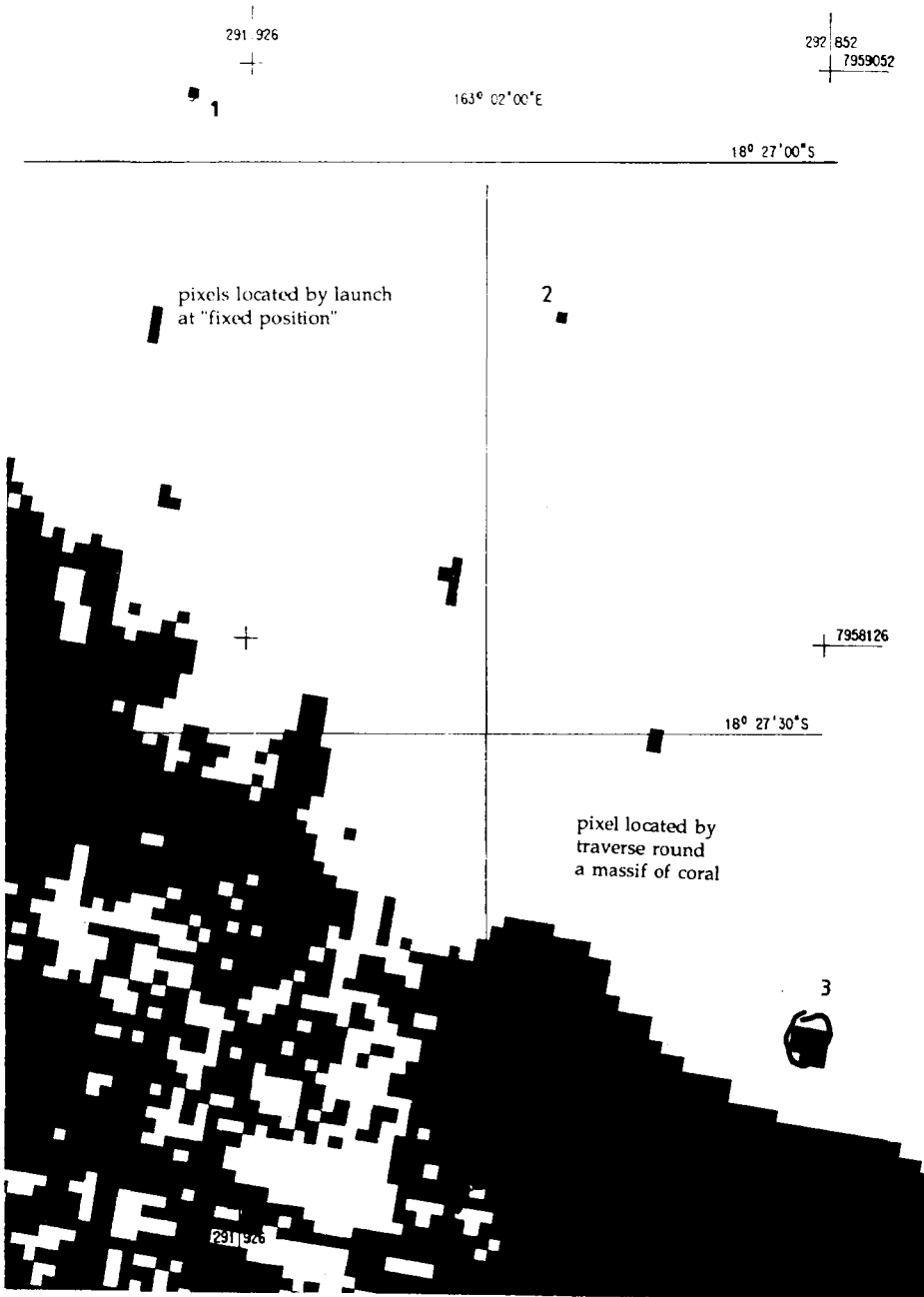


FIG. 3.- Positioning from a launch of pixels corresponding to submerged clumps of coral.

## 5. POSITION-FIXING FROM A HELICOPTER

Certain areas in New Caledonia still remain inaccessible for all navigation as they have not been surveyed. This is the case of the Great Northern Lagoon, which, moreover, does not have any land rising above sea level in its northern part. The only possible means for fixing the position of the pixels, therefore, is the helicopter.

### 5.1 Position-fixing by helicopter

The installation of Differential GPS aboard a PUMA-type helicopter did not present any major problem. The antenna for receiving the differential corrections was fixed to the outside step by a simply-devised system. The GPS antenna, taped to the front of the pilot's compartment, was nevertheless partially hidden. The helicopter thus had to endeavour to hold a constant course during the position fixing so as not to miss certain satellites.

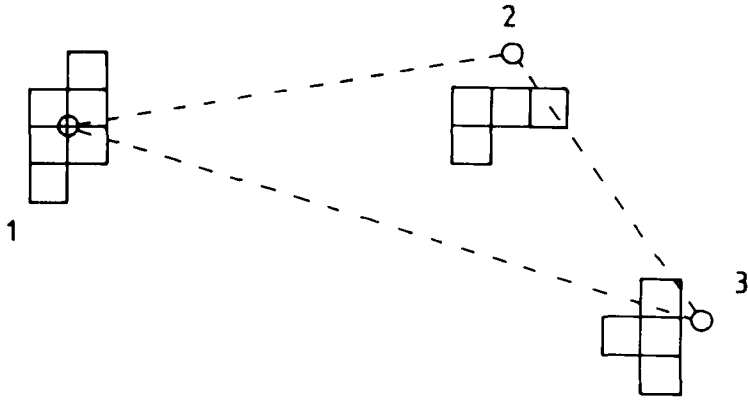
### 5.2 Acquiring of position fixes

For position-fixing from a launch, the selected pinnacles were located on the basis of approximate coordinates. The altitude enables pinnacles to be identified more easily than from a launch. Two wrecks lying on the reefs and detected on the XS2 channel of the satellite image were also identified.

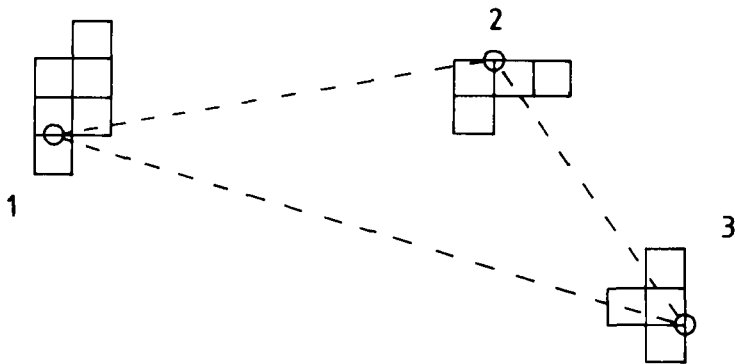
As the helicopter had to hold a constant course, measurements by traverse were not possible. It therefore hovered at about ten metres above the recognized point for a length of time sufficient to allow several fixes to be made (approximately one minute). For each station, the fixes acquired by Differential GPS were situated in a circle whose radius was less than 5 m. The coordinates adopted were those of the mean fixes.

## 6. MULTIPLICITY OF MEASUREMENTS

Selecting one coral pinnacle among others was not always easy, particularly from a launch, where identification remains very much restricted by reflections of the surface of the sea, by the depth at which the pinnacles are submerged and by the lack of landmarks. A doubt may sometimes exist and an error of identification leads to an error of position that may exceed several tens of metres. In order to reduce this uncertainty, one or more secondary pixels, near to the one being sought, were also positioned (Fig. 3). Their relative positions thus make it possible to confirm the identification (Fig. 4), thereby eliminating the gross errors, but also improving the accuracy of the position fixing, by graphically fixing the set of positions in an optimal fashion.



A single position is fixed (No. 1).  
Its position is estimated at the centre of the pixels.



Three positions are fixed (Nos 1, 2 and 3).  
Their relative distances being known, an optimal solution is adopted. This leads to readjusting Position No. 1.

FIG. 4.- Relationship of pixels to selected points.

## 7. CONCLUSION

In a region where pixel identification is difficult and where position reference points are rare, use of GPS by various carriers (pedestrian, launch, helicopter) has made it possible to acquire positions rapidly with sufficient accuracy for the geographic correlation of SPOT images.

This rapidity has, moreover, been exploited to increase the number of measurements and thus to eliminate errors in identifying pixels, through relative position fixing, at the same time improving the final accuracy.