Edition No. 52, Fall 1995
Édition No. 52, Automne 1995

ISSN 0711-5628

Lighthouse

JOURNAL OF THE CANADIAN HYDROGRAPHIC ASSOCIATION
REVUE DE L'ASSOCIATION CANADIENNE D'HYDROGRAPHIE

Edition/Édition 52 **LIGHTHOUSE** Fall/Automne 1995

JOURNAL OF THE CANADIAN HYDROGRAPHIC ASSOCIATION
REVUE DE L'ASSOCIATION CANADIENNE D'HYDROGRAPHIE

LIGHTHOUSE is published twice yearly by the Canadian Hydrographic Association and is distributed free to its members. A membership application form can be found on page 52 of this issue. Yearly subscription rates for non-members are $20 for Canadian residents, and $25 for non-residents. Please make cheque or money order payable in Canadian funds to the Canadian Hydrographic Association.

La revue LIGHTHOUSE est publiée deux fois par année par l'Association canadienne d'hydrographie et distribuée gratuitement à ses membres. Une formule d'adhésion se trouve en page 52 de cette édition. Les tarifs annuels d'abonnement pour les non-membres sont de 20$ au Canada et de 25$ hors Canada, payable par chèque ou mandat-poste en devises canadiennes à l'ordre de l'Association canadienne d'hydrographie.

All Lighthouse correspondence should be sent to:
Adressez toute correspondance au:

Editor, Lighthouse
Canadian Hydrographic Association
867 Lakeshore Road
P.O. Box 5050
Burlington, Ontario
CANADA L7R 4A6

Telephone/Téléphone: (905) 336-4812
Fax/Télécopieur: (905) 336-8916

Advertising Rates/Tarifs publicitaires
For a rate card and mechanical specifications see the rate card printed on page 67 of this issue.

Pour les tarifs et les spécifications publicitaires, se référer à la page 68 de cette édition.

Back issues of Lighthouse/Éditions antérieures de Lighthouse
Back issues of Lighthouse, Editions 24 through 51 are available at a price of $10 per copy. Please write to the Editor.

Les éditions 24 à 51 de la revue Lighthouse sont disponibles au coût de 10$ par copie en écrivant au rédacteur en chef.

Contents/Contenu

Regular Features/Chroniques

Closing dates for articles / Date de tombée des articles

Spring Issue	March 1/1er mars	Édition du printemps
Fall Issue	October 1/1er octobre	Édition de l'automne

Printed by/Impression par The Sinclair-Smith Press

1995 CHA Academic Award

Canadian Hydrographic Association:

I wish to thank the Canadian Hydrographic Association for acknowledging me as worthy of receiving the third annual award.

Your financial support for myself and other students is truly appreciated. This scholarship will help me a great deal towards my degree in Geomatics Engineering. Hydrographic surveying will be a part of my studies this year.

I look forward to any future involvement with the Canadian Hydrographic Association and your members.

Sincerely,

David Scovill
Geomatics Engineering
University of Calgary

1994 Lighthouse Awards

Best Technical Paper:

Nicholas A. Doe
White Rock, British Columbia

"Captain Vancouver's Assessment of Kendall's Chronometer K3 1791/1792"
(Fall 1994)

Best Non-Technical Paper:

R. W. Sandilands
CHA Pacific Branch

"Royal Navy Hydrographers Honoured"
(Spring 1994)

Index of Advertisers / Index des annonceurs

Message from the National President
Mot du Président national

Our Association continues to cover vast stretches of water. Activities continue to be wound down while others are gearing up. These wide-ranging activities benefit not only the immediate membership but also lay a fine keel for those future "web-footed" folks who are just awakening to the sounds of a ship's bell, the smell of a cartographer's ink or the splendours of a bottom grab sample.

CHA will be 30 years old in 1996 with all the exuberance and aspirations that being "three-oh" provides. It's perhaps appropriate that, as we celebrate our collective anniversary, we consider 1996 as a year to introduce someone new to our fine association or rekindle some of our own activities for which CHA has served us so well in the past.

Reminiscing by the foc'sle, in good company, can do wonders for the spirit.

The "passing of the watch" to Ken McMillan, who commences his term as CHA President in 1996, and the Branch Directors signals another opportunity for the winds to take our association on a new tack to provide us with many benefits and different opportunities.

It has been a great personal joy to have had the opportunity to work with CHA and I very much appreciate and gratefully acknowledge the assistance and friendship of the many people who have provided support to CHA over the past six years.

I look forward to continuing our voyage together,

Regards,
Dave

Editor's Note / Note du redacteur

Terese Herron

As many of you may have noticed, there was a change in the Editorship of Lighthouse beginning with Edition 51. Bruce Richards stepped down as Editor after taking the journal through five successful years (1990-1994). During his term as Editor, Bruce made significant contributions and upheld the professional nature of the journal. One of the major changes Bruce made was to divide out the tasks involved in producing Lighthouse to transform the production process into several manageable units.

Allow me to take a moment to introduce myself. My name is Terese Herron and I am the new Editor of Lighthouse. I have been involved with the production of the journal since 1991 as the Feature Editor and have also been actively involved in Central Branch of the CHA since 1986, as an executive member, as Secretary-Treasurer and as Branch Vice-President. I begin my third and final term as Branch V-P in January 1996.

In 1984 I graduated from the University of Waterloo with a Bachelor of Environmental Studies degree in Geography. At present I am employed by the Canadian Hydrographic Service (Central and Arctic Region) in the Field Surveys Division. I was hired on as field hydrographer in 1985 and have been involved in hydrographic surveys throughout the Great Lakes and the high Arctic.

As you can see from the last edition, Lighthouse is changing with the times. The last edition saw a new look and with this edition we are almost completely digital. I look forward to working with the Lighthouse team and hope to maintain the editorial standards set by my predecessors. Any comments and feedback on these changes would be most welcome.

The production of Lighthouse depends on the efforts of a dedicated editorial team, without whom the journal would not be published. We rely on the continued support of Lighthouse by CHA members and others in the Canadian and International hydrographic community. We welcome your input through the submission of reports, advertising, letters and comments.

Lastly, I would like to thank Paola Travaglini for putting up with the growing pains of going digital with the entire layout, and the sometimes exasperating requests of a new editor.

Abstracts / Résumés

Developing Hydrographic Applications Using Relational Technology and Multi-Dimension Codes

by

The CHS Source Data Base Team

The management of large volumes of spatial information with a Relational Data Base Management System (RDBMS) has not been well supported. A spatial data structure called helical hyperspatial code (HHCode), developed by the Canadian Hydrographic Service (CHS) and implemented in a commercial RDBMS can resolve the problems associated with the management of very large data bases (VLDB) containing spatial information.

This paper outlines the conceptual design of a spatio-temporal source data base for the CHS. The data base will consist of terabytes of bathymetric information integrated with point and line data sets. The design includes the temporal status of the data to ensure its uniqueness within the RDBMS. The design is generic to allow incorporation of different data models in anticipation of changing requirements.

Page 7

Développement d'applications hydrographiques en utilisant la technologie relationnelle et les codes multidimension.

par

L'équipe base de données sources du SHC

La gestion de grands volumes de données à références spatiales n'a pas été bien soutenu par les systèmes de gestion de bases de données relationnelles (SGBDR). Une structure de donnée géométrique nommée code hélicoïdal hyperspatial (abréviation anglaise: HHCode), développée par le Service hydrographique du Canada (SHC) et implantée dans un SGBDR commercial peut résoudre les problèmes associés à la gestion des très grandes bases de données contenant de l'information à référence spatiale.

Cet article expose les grandes lignes de l'architecture conceptuelle d'une base de données sources spatio-temporelle pour le SHC. La base de données consistera en des tera-octets d'information bathymétrique intégrés avec des données ponctuelles et linéaires. L'architecture comprend le statut temporel des données pour assurer leur unicité dans le SGBDR. Dans une prévision de besoins de changements, l'architecture est générique et permet l'introduction de différents modèles de données.

Page 7

Precise GPS Shipborne Positioning Experiments With Code and Semicodeless Receivers

by

G. Lachapelle, H. Sun, M. E. Cannon and C. McMillan

The objective of this paper is to investigate the level of performance achievable in shipborne differential GPS mode using code technology and in single point (stand-alone) positioning shipborne mode using semicodeless receiver technology. The specific receiver types selected are the NovAtel GPSCard™ 3951 which measures C/A code pseudorange and carrier on L1 and the Ashtech Z-12 which measures pseudorange and carrier phase on both frequencies under Anti-Spoofing. The sea trials were conducted on a 70 m vessel off the coast of Vancouver Island in November 1994. The GPS measurements were made in differential mode and the distance between the shore-based reference station and the ship exceeded 100 km. The integer carrier phase ambiguities were successfully resolved for both pairs of receiver and cm level reference trajectories for the ship were obtained to assess less accurate solutions. The DGPS measurements were thereafter processed using a float ambiguity and a carrier phase smoothed approach. An analysis of these solutions shows that the float ambiguity method is accurate to 10 cm (rms) in each coordinate component while the corresponding accuracy of the carrier phase smoothed solution is of the order of 1 m. The single point solutions, calculated using NRCan precise post-mission orbits and satellite clock corrections, were found to be accurate at the 1-2 m level using ionospherically corrected codeless measurements. The effect of the ionosphere on single frequency measurements is shown to bias the single point solution by a few metres.

Page 13

Expériences de positionnement GPS précis embarqué avec des récepteurs à code et à demi-code

par

G. Lachapelle, H. Sun, M. E. Cannon et C. McMillan

L'objectif de cet article est d'examiner le niveau de performance réalisable à bord d'un navire en mode différentiel GPS lorsqu'on utilise la technologie code, et en mode absolu ("single point") en utilisant la technologie d'un récepteur à demi-code. Les types de récepteur sélectionnés sont les NovAtel GPSCardTM 3951 lequels mesurent la pseudodistance du code C/A et l'onde porteuse sur L1 et les Ashtech Z-12 qui mesurent la pseudodistance et la phase de l'onde porteuse sur les deux fréquences avec l'anti-leurrage (Anti-Spoofing¨). Les essais furent réalisés sur un navire de 70 m au large de l'Ile de Vancouver en novembre 1994. Les mesures GPS ont été effectuées en mode différentiel et la distance entre la station de référence terrestre et le navire dépassait les 100 km. Les ambiguïtés sur le nombre entier de la phase de la porteuse ont été résolues avec succès pour les deux paires de récepteurs et des trajectoires du navire au centimètre ont été obtenues pour évaluer des solutions moins précises. Les mesures GPS furent ensuite traitées en utilisant 2 méthodes, l'ambiguïté libre et le lissage du code de la phase de l'onde porteuse. Une analyse de ces solutions montre que la méthode d'ambiguïté libre est précise à 10 cm (écart quadratique moyen) pour chacune des coordonnées tandis que la précision de l'autre solution, le lissage du code de la phase de l'onde porteuse, est de l'ordre de 1 m. Les solutions en mode absolu, calculées en utilisant les orbites précis en mode différé de Ressouces Naturelles Canada et les corrections de l'horloge satellitaire, se sont avérées être exactes à 1-2 m en utilisant des mesures à demi-code précises (correction ionosphérique). L'effet de l'ionosphère sur les mesures d'une seule fréquence démontre que cela biaise la solution en mode absolu de quelques mètres. **Page 13**

GPS Positioning with Pseudorange Filtering and Smoothing

by

R. Santerre, É. Roy and D. Parrot

In this paper are presented the algorithms for pseudorange filtering and smoothing with carrier phase measurements. The difference between filtering and smoothing is explicitly presented along with the advantages and disadvantages of both approaches. The comparison

Positionnement GPS avec des mesures de pseudodistance filtrées et lissées

par

R. Santerre, É. Roy et D. Parrot

Dans cet article sont présentés les algorithmes de filtrage et de lissage des mesures de pseudodistance avec les mesures de phase des ondes porteuses. La distinction entre le filtrage et le lissage est clairement explicitée ainsi que les avantages et les désavantages de chacune de ses between filtering and smoothing results are presented for about ten vectors with different lengths (0 - 175 km) from 3 different receiver types. Results from a kinematic test are also included. These results have been produced with the software called POSICIEL developed at the Centre de Recherche en Géomatique at the Université Laval. As expected, the smoothing algorithms provide better results than filtering. In general, the results analysis indicates that smoothing algorithms provide root sum square errors (rss) of ±10-20 cm into horizontal components and about ±20-30 cm, in altitude.

Page 21

Upgrading Nautical Charts in Canada's Arctic Using Landsat Thematic Mapper (TM)

by

G. Tomlins, P. Wainwright and M. Woods

A study was undertaken to investigate the use of satellite imagery to provide control and derive a coastline in poorly controlled areas of the High Arctic. The area corresponding to Canadian Hydrographic Service Chart 7083 (that is known to have significant errors) was chosen for investigation. Two-dimensional rectification of the imagery was performed using the best available ground control. Overall root mean square (RMS) errors were 17 m East-West, and 18 m North-South. Maximum errors were less than 50 m in both directions. The study concluded that a 4-band data set consisting of TM bands 1, 2, 4 and 7 provided the optimum data set for coastal classification. Supervised classification and single-band thresholding methods were investigated using recent LIDAR survey data to test the classification results. The results of single-band thresholding method were superior to those from supervised classification. In the test area 97.9% of the coastline from thresholding was within 50 m of the actual coastline *vs.* 84.2% from the supervised classification. In both cases some manual editing was necessary.

Overall it was concluded that this approach produced a coastline and control that was well suited for hydrographic chart production at scales of 1:100 000 or less. This approach compares quite favourably to the cost of conventional survey methods. The classification also provided an additional benefit by identification of potential shallow-water hazards which were previously unreported. Similar features in the imagery corresponded to known shallow-water hazards.

Page 31

A Mission Off The Boston Coast (Massachusetts Bay), An Example Of International Partnership

by

R. Sanfaçon, a.f.

For the CHS, 1994 saw one of the largest bathymetric survey projects in terms of partnership with private enterprise, universities and a foreign government. The zones to be surveyed were off the Boston coast in Massachusetts Bay and the top of Stellwagen Bank, to be exact. Stellwagen Bank, a new marine park of 638 nautical square miles, was also the main work zone, which is slated to be covered in three stages of about one month each. During our mission, which lasted one month, we completed 5126 kilometres of sounding and covered 976 square km (about 280 nautical square miles) or 44% of the zone. There were considerable challenges and stakes for all parties involved. The mission was a great success and the CHS duly impressed the international scene with its multibeam sonar.

Page 41

approches. La comparaison entre les résultats du filtrage et du lissage est présentée pour une dizaine de vecteurs de différentes longueurs (0 - 175 km) provenant de 3 types de récepteurs différents. Les résultats d'un test cinématique sont également inclus. Ces résultats ont été produits avec le logiciel POSICIEL développé au Centre de Recherche en Géomatique de l'Université Laval. Tel qu'attendu, les algorithmes de lissage produisent de meilleurs résultats que ceux du filtrage. Règle générale, l'analyse des résultats indique que les algorithmes de lissage donnent des erreurs (rss) de ±10-20 cm, selon les composantes horizontales et de ±20-30 cm, en altitude.

Page 21

Mise à jour des cartes nautiques de l'Arctique canadien avec le Landsat Thematic Mapper(TM)

par

G. Tomlins, P. Wainwright et M. Woods

Une étude a été entreprise pour vérifier l'usage de l'imagerie satellitaire pour fournir le "contrôle" et délimiter les lignes de côtes dans les régions peu "contrôlées" de la Haute Arctique. La région représentée par la carte 7083 du Service hydrographique du Canada (connue pour ses erreurs significatives) a été choisie pour l'expérience. La rectification bi-dimensionnelle de l'imagerie a été faite en se servant des meilleurs points de "contrôle" disponibles. L'erreur (Root Mean Square, RMS) est de 17 m. Est-Ouest et 18 m. Nord-Sud. L'erreur maximum est moins de 50 m. dans les deux directions. L'étude a démontré qu'un ensemble de données des quatre bandes TM 1, 2, 4 et 7, fournissait l'ensemble de données optimum pour la classification côtière. La méthode de classification dirigée et celle de seuil à bande unique ont été expérimentées en se servant de données LIDAR d'un levé récent pour vérifier les résultats de classification. Les résultats de la méthode de seuil à bande unique ont été supérieurs à ceux de la méthode de classification dirigée. Dans la zone étudiée 97.9 % de la ligne de côte de la méthode de seuil se situait à l'intérieur de 50 m. de la ligne de côte actuelle versus 84.2 % pour la classification dirigée. Dans les deux cas, des interventions manuelles ont été nécessaires.

Dans l'ensemble, il a été conclu que cette approche a produit une ligne de côtes et des repères qui conviennent bien à la production de cartes hydrographiques à des échelles de 1:100 000 ou moins. Cette approche se compare très favorablement aux coûts des méthodes de levé conventionnels. La classification a aussi donné des avantages additionnels en identifiant des dangers potentiels dans les eaux peu profondes, lesquels n'avaient pas été rapportés auparavant. L'imagerie a montré des objets similaires qui correspondaient à des dangers connus en eau peu profonde.

Page 31

Une mission au large de Boston (Massachusetts Bay), un exemple de partenariat international

par

R. Sanfaçon, a.f.

Pour le SHC, l'année 1994 a vu se concrétiser un des plus importants projets de relevés bathymétriques en terme de partenariat avec l'entreprise privée, le secteur universitaire et un gouvernement étranger. Il s'agissait de zones à relever au large de Boston, plus précisément dans la Baie Massachusetts et sur le Banc Stellwagen. À ce dernier endroit se trouve la principale zone de travail, soit un nouveau parc marin de 638 milles marins carrés qu'il est prévu de couvrir en 3 étapes d'environ 1 mois chacune. Lors de notre mission qui a duré un mois, nous avons parcouru 5126 kilomètres de sondage et couvert 976 kilomètres carrés (environ 280 milles marins carrés) soit 44 % de la zone. Les défis et les enjeux étaient de taille pour toutes les parties impliquées. La mission fut un très grand succès et le SHC a fait une entrée remarquable sur la scène internationale dans le domaine du sondage multifaisceaux.

Page 41

If You Can't Put Your Finger On What's Different About The GPS 45...

...We Suggest You Try Your Thumb.

Form becomes functional with GARMIN's GPS 45. With the touch of your thumb you can operate a full-featured, differential-ready GPS while cradling an easy-to-read display in the palm of your hand.

The GPS 45 is packed with features you expect from GARMIN. Plus, its unique rockerpad lets you access a world of information. Mark a waypoint, take a position or plot a course using just one hand—one thumb, in fact. The GPS 45 offers better mapping features than units twice its size, weight and price, and makes a GPS pro out of any boater, single-handedly. Built to take Mother Nature's worst in stride, the GPS 45's rubber-armored housing and dry nitrogen-filled case will take a beating—even a dunking.

The GPS 45—it's not just different, it's better. Pick one up today and put the power of GARMIN GPS under your thumb.

GARMIN offers the first ergonomically correct GPS.

9 ounces, 2 x 6.15 x 1.23 inches
Weatherproof, dry nitrogen-filled case
Rugged, rubber-armored housing
Up to 20 hours of use on just 4 AA batteries
EL backlit LCD display for nighttime viewing
250 waypoints, 20 reversible routes of 30 waypoints each
Patented MultiTrac8™ technology for accurate positioning
One button GOTO feature and MOB mode
Built-in simulator & user prompts
Interface capabilities
Removable antenna

TECHNICAL SUPPORT and
REPRESENTED IN CANADA by:

McQUEST
MARINE SCIENCES LIMITED
489 Enfield Road, Burlington, Ontario L7T 2X5
Tel.: (905) 639-0931 • FAX: (905) 639-0934

GARMIN
9875 Widmer Rd.
Lenexa, Kansas 66215

Developing Hydrographic Applications Using Relational Technology and Multi-Dimension Codes

The CHS Source Data Base Team

Introduction
Advances in hydrographic surveying technology now provide the hydrographer with tools to obtain a complete coverage of the ocean bottom. The development and implementation of new, accurate navigation systems are creating a strong demand for digital navigation information [4] with much greater accuracy, at larger scales, and with real time water level corrections [3]. The practice of navigation is moving away from older, visually based techniques. Digital replicas of traditional paper charts cannot meet these new demands-new products are required.

This technological push is forcing hydrographic offices to completely rethink the ways in which they manage data, as well as how they design, produce and distribute products. This includes the Canadian Hydrographic Service (CHS) which is now redefining its roles in several fundamental areas, including the management of source data and products in a distributed environment. This is being done with the cooperation of industrial sector partners who, through their alliances, are furthering the development and implementation of new tools, methods and infrastructure to achieve these goals, and to give clients easier access to the CHS information. A few of the related projects are:

i) Source Data Base Project: Based upon Oracle MultiDimension, a new RDBMS extension for managing large volumes of spatial data, this project will build a networked system for managing survey data across the CHS.

ii) Object Manager: A CARIS based tool for building electronic charts according to new object based international standards.

iii) Product Data Base: Although the CHS would prefer to include the management of products in the Source Data Base itself, this is not feasible in the foreseeable future although it will remain a longer term goal. Many of the CHS's current digital products are obtained from digitizing paper charts and must still be managed in a separate system. Furthermore, even though these initiatives will change the navigation chart, and probably allow charts to be derived directly from and integrated into the source data base, these changes will be evolutionary and take years to happen.

iv) Geostatistical surface modelling project: Traditionally, a surveyed seafloor surface model has been portrayed to navigators by means of discrete depth contour lines that were visually interpolated between the punctual sounding data and drawn onto the chart as part of the cartographic process. Future bathymetric products must take a more sophisticated approach to surface modelling based on numerical surface modelling of the digital survey data . Analytically interpolating a densely gridded seafloor model from relatively sparse survey data will often be expedient in areas not deemed critical enough to warrant swath data collection. CHS has developed geostatistical surface modelling software which fills this modelling requirement and operates in conjunction with OracleMultiDimension. Called "Hydrostat", this software package is based on a statistical rather than geometrical interpolation algorithm and this approach permits two gridded surfaces to be modelled for entry into the database: - a "bathymetric surface" model which describes the continuous seafloor and - a "stochastic surface" model which estimates the spatial fidelity of every grid node in the seafloor model. By combining these two surface models, numerous Quality Control and data visualization capabilities can be realized which were heretofore impossible using graphical data structures and techniques.

v) ChartNet: Done in cooperation with industry, this is a CANARIE funded project to develop the tools and infrastructure to enable the CHS to manage and distribute its products over the InterNet. It will also provide clients with the ability to search catalogues, view sample products, and then download them [8].

vi) Updating Project: International standards for electronic chart navigation systems are expected to be approved in 1995. This includes standards for the electronic charts, as well as the updates that must be distributed whenever new information affecting the safety of navigation is available. The goal for this project is to help build the new infrastructure needed to support the new products.

vii) Pilot Project Phase II: The very successful first phase of this project [6] publicized the value of electronic chart navigation systems for safer and more economic navigation. It was based upon available technology and data formats. Phase II will focus on the testing and evaluation of standards developed by the International Maritime Organisation (IMO) and the International Hydrographic Organisation (IHO).

Figure 1 shows, in a highly simplified form, how the CHS must deal with at least 3 types of data bases. A "Source DB" to manage the growing volumes of hydrographic survey data, a Product DB to manage the growing number of electronic products as well as the existing paper chart base, much of which now exists in a digital form, and the auxiliary DB's (e.g. Navigation Aids, Tides and Current data, etc.) needed to support the surveys, chart productions and external clients.

Characteristics of the Data Bases

The underlying requirements for building the data bases in the Canadian Hydrographic Service are:

i) Single RDBMS Architecture: Use of a commercial RDBMS package seems obvious, but until 1995 it has not been feasible to use such products to manage the large volumes of spatial data. On March 28, 1995, Oracle Corporation announced a new product - Oracle MultiDimension which incorporates a new HHCode data structure to solve the problems of dealing with very large volumes of spatial data. Over the past year the CHS has been testing and evaluating alpha versions of this product. This technology will be described in more detail in the next section. Figure 2 illustrates the transition from the current hybrid solution to the integrated architecture that has become feasible with Oracle MultiDimension.

ii) Standard Query language: SQL is important for easy and flexible access of multi- and uni-dimensional data. This is not generally available with current GISs.

iii) Seamless data base: Where feasible, the CHS is attempting to move away from the older chart file schemes and management approaches in order to be able to provide a data base that will better support electronic navigation. Furthermore the IMO/IHO standards for such systems uses a cell based approach for the distribution, management and use of electronic navigation data.

iv) Multiple/Easy Access: Users, across Canada and internationally, must be able to get the information they need quickly and without extensive training.

v) Security/Data Integrity: It is required to insure the integrity of the data and to prevent access by unauthorized users.

vi) Client-Server/Distributed Access: The CHS has six offices across Canada and although most clients are in Canada, the InterNet will allow access to clients in any part of the world.

vii) Backup/Recovery: With the integrated architecture, portrayed in Figure 2, comes the inherent backup and recovery facility available in an RDBMS.

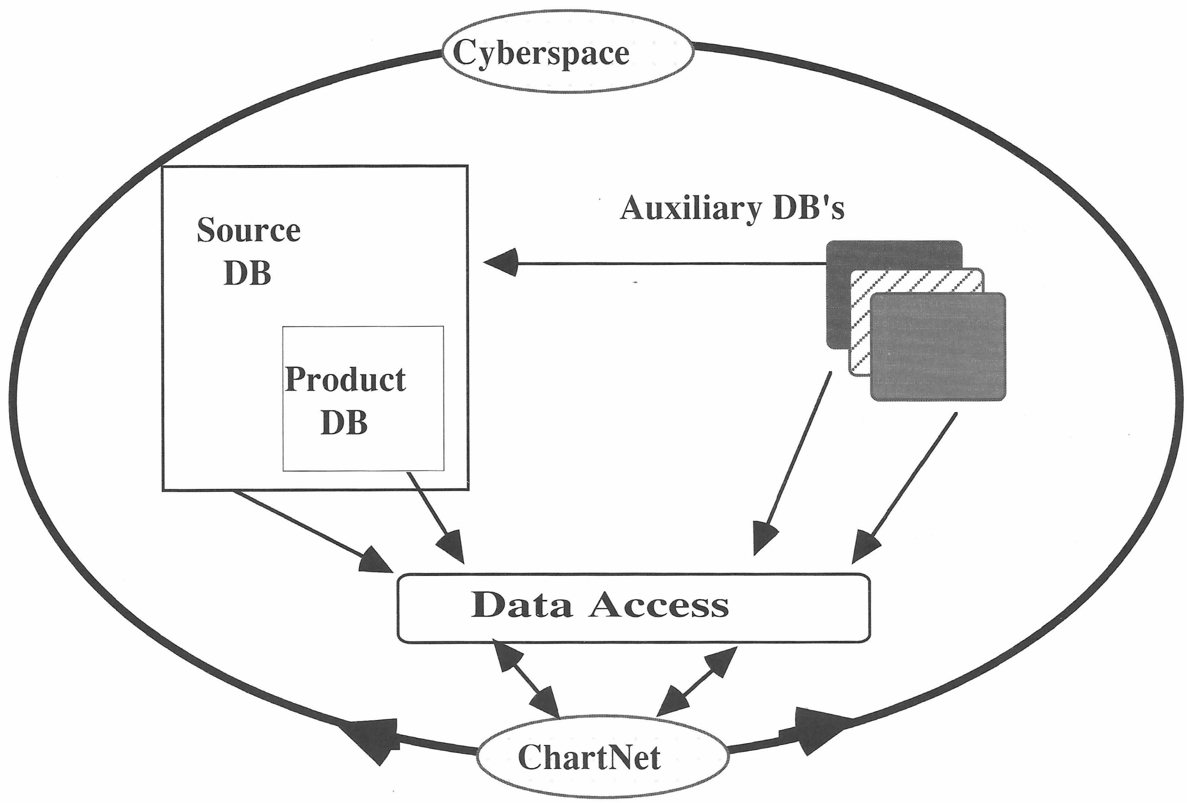


Figure 1: CHS Data Bases

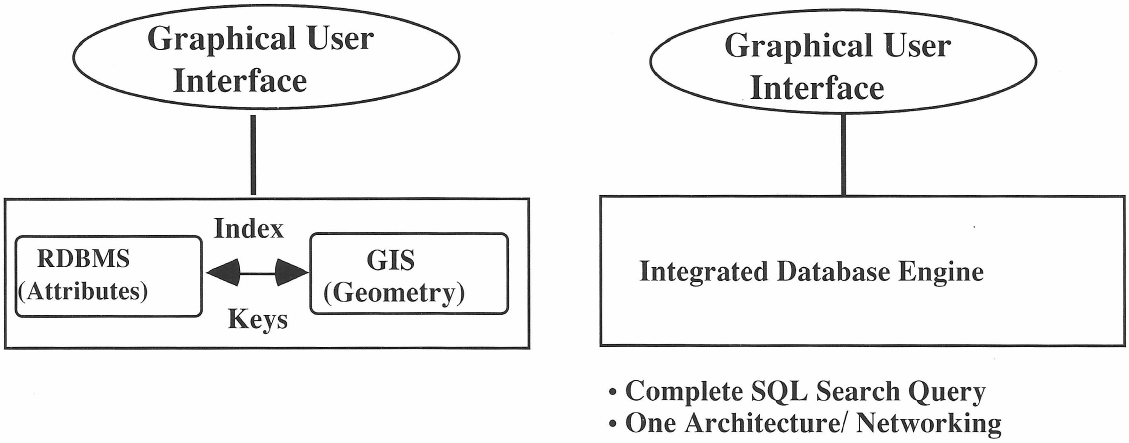


Figure 2: Transition to An Integrated DBMS Solution

viii) Volume/Response: Figure 3 illustrates the difficulties of managing large spatial data bases with relational data base systems. A minimum of two indexes or tables (holding X and Y coordinates) makes such systems extremely inefficient for spatial information access. The solution is to use a one-dimensional index that provides access to multi-dimensional data. For this purpose the Helical Hyperspatial Code (HHCode) was developed [9] and, through an agreement with Oracle Canada, has been implemented into the Oracle RDBMS. Extensive testing [5] has shown that with the HHCode implementation, a linear response is realized.

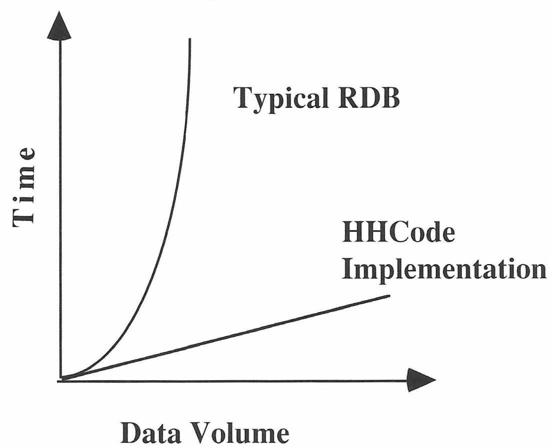


Figure 3: RDBMS Query Response Test Results with spatial data

HHCode: The Key for Managing Spatial Data:
In 1990, the Canadian Hydrographic Service proposed a new data structure [9] called the Helical Hyperspatial Code. Although the underlying concepts had been in use for many years for 2-dimensional data, as the "quad tree", Herman Varma and his colleagues at the CHS proposed extending the concept to N-Dimensions and then convinced Oracle Canada to investigate the feasibility of adding such a new data type to Oracle DBMS. The studies were highly positive and resulted in the development of the Oracle MultiDimension Product [7].

The HHCode is a generic data type that enables a uni-dimensional number to represent the intersection point of multiple dimensions. It maintains the inherent spatial organisation of data without a separate data structure. As implemented in Oracle MultiDimension the HHCode creates "buckets" of spatial data of multidimensional data (e.g. squares in 2 dimensions and cubes in three dimensions). This approach enables a powerful partitioning of the data which provides fast and efficient data access and linear loading, neither of which degrade with the size of the data base.

Data Base Design
Using Oracle Methodology and Case Tools:
The hydrographic source data base project was initiated to address the large volumes of source information collected and accessed by the CHS. This information includes bathymetry from conventional hydrographic surveys, large volume sweep and swath surveys, and the associated information collected by the CHS, other survey agencies and industry. These data sets may be broadly classed as points and lines with large volume bathymetric surveys contributing the majority of the point information. The volume of data contributed through this collection method alone is substantial. A vessel operating a Simrad EM1000 swath system can collect tens of millions of bathymetric data points per 24 hour period, not including attributes and the associated bottom imagery captured by the system. The requirement to verify and integrate this data with existing information for the production of hydrographic products is alone an arduous file management problem. To continually update the data archive, audit the changing status of data as new data is acquired and guarantee data integrity is virtually impossible in a file management system, particularly when only portions of data within a file are superseded or determined to be incorrect.

Fortunately these high volume data acquisition systems have been used by CHS in a production environment for only the last four years; therefore, our data stores are now growing rapidly but are still manageable. The need for effective management of this data is growing rapidly. Oracle MultiDimension with its spatial data management capabilities and the integration of Oracle MultiDimension with Geographic Information Systems applications will help resolve the technical issues which have hampered the management of large volumes of spatial information in the relational data base environment.

In June of 1994, the decision was made to begin the CHS Source Data Base project with a core group of CHS personnel (the Source Data Base Team) under the auspices of the Hydrographic Information Network (HIN) which funds and supports projects directly related to data management within the CHS. The scope of the project was deliberately limited to point and line data with the emphasis placed on delivering a system which could initially address the management of large volume of bathymetric information and its attributes. The line information will be addressed simultaneously but will be a later deliverable as an implemented portion of the system.

The system development includes the endorsement and use of international data standards as related to data cataloguing and data modelling. The defined system requirements address areas of data access, security, offline management of data, data browsing, audit trails, data quality and data archival. Links to other external data repositories managed by CHS, or repositories managed by other organisations will be included in the design to take advantage of distributed relational data base technology which is required to access CHS data sources to produce CHS products and services. In addition, the implementation of Application Programming Interfaces (API) by GIS vendors to take advantage of the unique spatial addressing provided by Oracle MD, would allow CHS and other agencies using this technology to develop applications which interface directly to this data structure for their specific data processing requirements.

The HIN endorsed the use of Oracle CASE*Method methodology to provide a structured approach to the project. This will provide a systematic approach to defining tasks, deliverables, standards and quality assurance for the project life cycle. This methodology is documented in three CASE*Method publications; CASE*Method Tasks and Deliverables, CASE*Method Entity Relationship Modelling [2], and CASE*Method Function and Process Modelling [1] .

In recent years, CASE (Computer-Aided System Engineering) technology has matured and the Oracle methodology is now supported by and integrated with Oracle CASE Tools. The team adopted the CASE tools as an integrated solution to support the development of the Source Data Base. These tools provide the user with a full development suite including CASE Dictionary as the repository, CASE Diagrammer for entity relationship modelling, function hierarchy modelling, data flow diagrams and matrix diagramming. CASE Generator will provide a 4thGL approach to generating the applications using Oracle MD as the relational data base engine. This allows the analyst, designers and developers to quickly generate and test prototype models at all phases of the project, from analysis to the implementation and production steps. The tools provide project documentation, graphical presentation of models, definition and description of entities and attributes, application constraints, and automatic code generation for integrated product quality assurance.

The distinct phases of the methodology are defined as Strategy, Analysis, Design, Build, User Documentation, Transition and Production. The Strategy and Analysis phases define the scope of the project and within that scope what functions the organisation carries out to reach its mandate. These are the current phases being addressed by the Source Data Base Team and involve interviews, and the use of CASE tools to capture and document our business. The Design stage addresses how these functions are carried out and targets technology and development of applications to meet specific requirements. The remaining stages address the building, testing and implementation of applications to meet production requirements.

It is anticipated that to complete and implement the bathymetry portion of the project will take approximately one year. More accurate resource requirements and time schedules for specific phases of the project are Strategy and Analysis phase deliverables. Additional deliverables at the Analysis phase include an accepted detailed function hierarchy, an accepted detailed entity relationship diagram, constraints, and an agreed approach to the subsequent system Design and Build stages. The implementation of the bathymetric management system will provide a real production model for users and developers to understand the implications of using Oracle MultiDimension to handle large spatial data sets in excess of 100 million data points.

System Development

Figure 4 summarizes the system development occurring within the CHS. The mapping tools used in the organisation are based upon CARIS and are being extended in cooperation with the supplier and hydrographic offices in other countries to enable the CHS to move from its hybrid feature coded implementation to a single architecture based upon international feature/object catalogues. The "Object Manager" is shown in 3 phases. Phase 1 represents the current system where a transition from the older tools exists. Phase 2 shows the integration of various modules into a unified desktop solution and Phase 3 is a solution integrated with Oracle MultiDimension. A prototype CARIS MultiDimension (MD) tool was built in 1994 and is expected to be the basis of our future application tools.

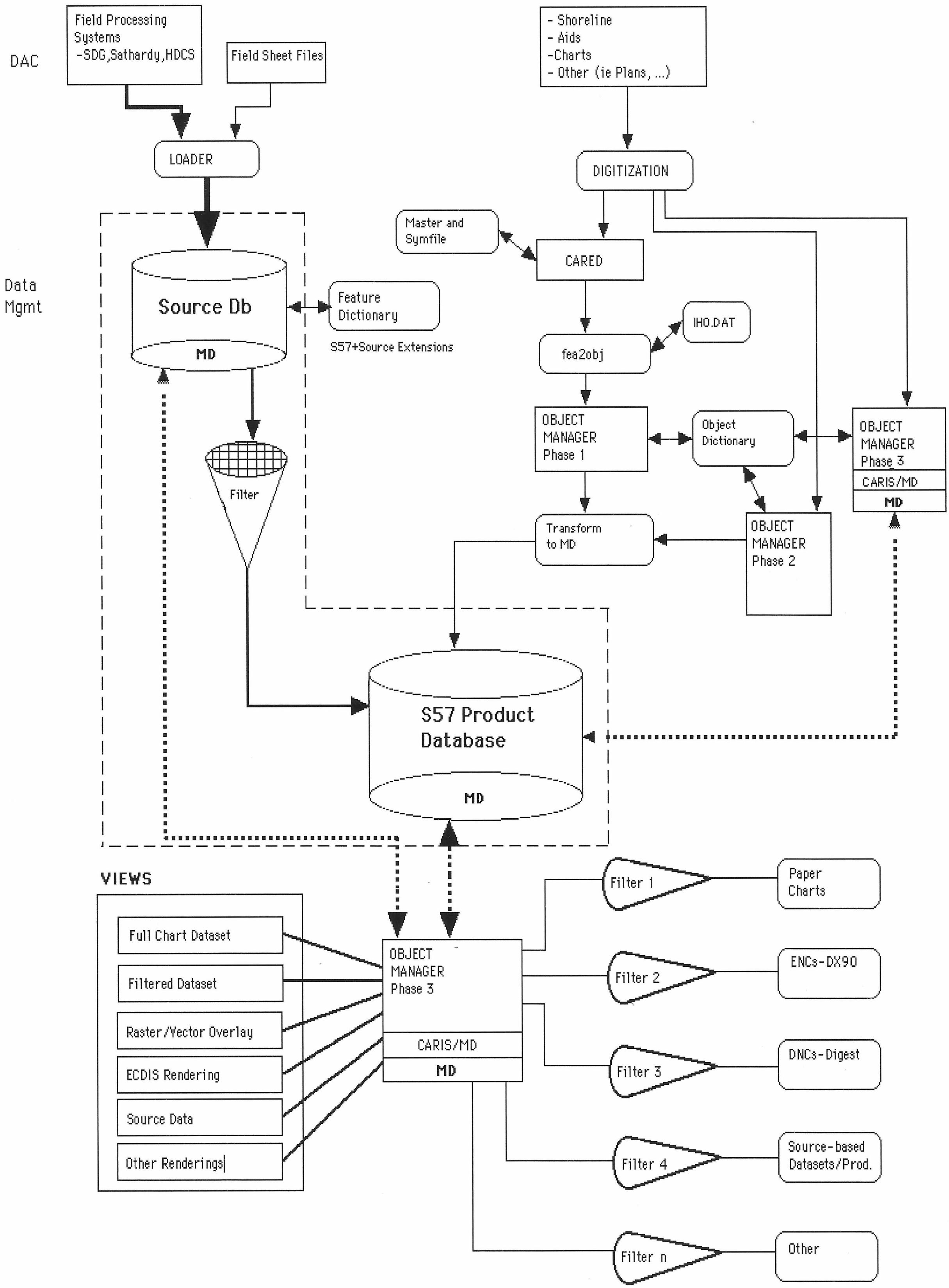


Figure 4: Proposed CHS System

Initial evaluation of CARIS MD is demonstrating that the use of HHCoded tiles for ocean bottom modelling is enabling hydrographers to use a new, and potentially much more useful area paradigm. The tiles are easier to process and generalize for use at smaller scales than the point and contour model used in the past and will more readily support the use of real time presentations for electronic chart navigation.

Conclusions

Organisations have been trying to manage increasingly larger databases by using more and more powerful computer engines. The use of a new data type, the HHCode, embedded in a RDBMS is a much better approach and indications are that it will now provide hydrographers with the flexibility and power to properly manage their growing data banks and provide the information urgently needed for navigational and other scientific purposes. When combined with other evolving database tools for qualitative and dynamic use of statistical techniques for evaluating the quality and validity of sounding data, it is clear that we are entering a new era in hydrography. Furthermore, this technology facilitates new approaches for generating perspective views of surface images over geographic areas which could result in substantial savings of processing time. Such more realistic surface depictions are valuable not only in the simulation of 3-D scenes for representing digital terrain models, but for statistical portrayal over a geographic area. These new database mechanisms also provide powerful simplifying tools for visualization and such imagery can be extremely useful in depicting the sea floor and performing data analysis. The potential of using this new database technology in conjunction with the new graphic engines will undoubtedly provide the framework for a new era in spatial data management and accessibility.

Acknowledgments

This research could not have progressed without the aid of Oracle Canada Corporation.

References

1. Baker, R. and Longman, C., "CASE*Method - Function and Process Modelling", Addison Wesley Publishing Co., 1990.

2. Barker, R., "CASE*Method - Tasks and Deliverables", Addison Wesley Publishing Co., 1992.

3. Bédard, J., "Moving from Artwork to Network", HYDROCOMM, Canadian Hydrographic Service Symposium, Ottawa, February 15, 1995.

4. Pace, Captain J., "Electronic Charts: The Course to Go", HYDROCOMM, Canadian Hydrographic Service Symposium, Ottawa, February 15, 1995.

5. The Canadian Hydrographic Service - Source Data Base Team, "A New Tool for Managing Very Large Volumes of Hydrographic Data", The US Hydrographic Conference, Norfolk, Va., April 19, 1994.

6. Goodyear, J., "Reaping the fruits of the Labour: Learning to Cope?", HYDROCOMM, Canadian Hydrographic Service Symposium, Ottawa, February 15, 1995.

7. Oracle Corporation, Oracle MultiDimension Product Announcement, GIS 95, Vancouver, March 28, 1995.

8. Nautical Data International, "ChartNet - Phase 1. Information Sheet", January, 1995, St. John's, Newfoundland.

9. Varma, H.P. and Prime, W., " A Data Structure for Spatio-Temporal Databases", International Hydrographic Review, Monaco, January, 1990.

The CHS Source Data Base Team:

Tim Evangelatos

Steve Forbes
Don Vachon
Bob Burke
Jennifer Campbell

Herman Varma
Lynn MacDonald
Caralea Day-Power
Dennis St. Jacques

Mark Journault
Geof Thompson
Paul Holroyd
Sherman Oraas

For more information please contact:
Canadian Hydrographic Service
Department of Fisheries and Oceans,
615 Booth St. ,Ottawa,
K1A 0E6

Precise GPS Shipborne Positioning Experiments With Code and Semicodeless Receivers

G. Lachapelle, H. Sun,
M. E. Cannon and C. McMillan

Introduction

The objective of this project was to test the accuracy performance achievable in DGPS and single point (SP) shipborne modes using a Narrow Correlator™ spacing C/A code receiver type, namely the NovAtel GPSCard™ 3951 [15] [2], and a semicodeless receiver type, namely the Ashtech Z-12 [1]. The GPSCard™ 3951 receivers were equipped with the Multipath Elimination Technology (MET) designed by NovAtel to reduce multipath [14]. The semicodeless technology is described in detail by Van Dierendonck [16]. The Z-12 uses the semicodeless technique to measure the code and carrier phase on the encrypted Y1/Y2 and the code technique to perform L1 C/A code measurements.

The advantage of the semicodeless techniques is that it yields measurements on L2, allowing the formation of widelane observables to resolve the integer ambiguities more easily when such a solution is required in DGPS mode. If the Single Point mode is used, the effect of the ionosphere can be estimated using the dual-frequency method. Its disadvantages are a higher receiver cost and measurements potentially more sensitive to signal interference, as shown by Sluiter & Haagmans [13].

The DGPS and SP methods tested herein are as follows:

DGPS

- Fixed integer ambiguity using widelane (L1 - L2) and L1 observables: This approach is known to provide the highest level of positioning accuracy, namely better than 10 cm, usually at the cm-level. The double difference carrier phase ($\Delta\nabla\Phi$) observables can be written as:

$$\Delta\nabla\Phi = \Delta\nabla\rho + \lambda\Delta\nabla N + \varepsilon(\Delta\nabla\Phi). \quad (1)$$

  The double difference ambiguities ($\Delta\nabla N$'s) are resolved as integer values using an ambiguity search method and disappear from the estimation process which is then reduced to three unknowns, namely the relative tridimensional coordinates. The ambiguity search method used here was the FASF method implemented in FLYKIN™ [3].

- Float ambiguity solution: This approach is less accurate than the fixed integer approach but is more robust, can be used over longer reference-remote station separations and requires only un-encrypted L1 data. The use of semicodess data is therefore not necessary. The ambiguities of equation (1) are estimated and updated on an ongoing basis as real numbers and remain stochastic quantities. The number of unknowns is 3 (relative coordinates) + (n-1) ambiguities, where n is the number of satellites observed.

  Both the fixed and float ambiguity approaches can be implemented in real-time using RTCM message types 18-21.

- Carrier phase smoothed solution: This solution is also robust, easy to implement in real-time using RTCM message types 1, 2 and/or 9.

SP (Post-Mission)

- Use of NRCan post-mission precise orbits and 30 s satellite clock correction files to remove the effect of Selective Availability (S.A.) and many other satellite-related errors from the observed code measurements [12]: The δ-effect of S.A. alone can result in satellite clock error variations of up to 30 cms^{-1}. Post-mission precise orbits are now available with an accuracy of 10-20 cm and satellite clock corrections with an accuracy better than 1 ns [5].

  Post-mission orbits and satellite clock corrections are available in the ITRF (International Earth Rotation Service Terrestrial Reference Frame) which is compatible with WGS84 at the 10-20 cm level [10].

  Depending on the receiver noise and the use of dual-frequency measurements to account for the ionospheric effect, an accuracy level of 1 - 2 m horizontally and 2 -4 m vertically can be achieved with this method in instantaneous positioning mode as demonstrated previously [8],[9].

Measurement Campaign

The measurements were made in November 1994 off the coast of Vancouver Island using a 1,600 tonnes research vessel of the Canadian Department of National Defence. The antenna set-up on the ship is shown in Figure 1. The reference antennas were located on top of a 9 m tower located on the roof of a building at CFB Esquimault, Victoria, B.C., as shown in Figure 2.

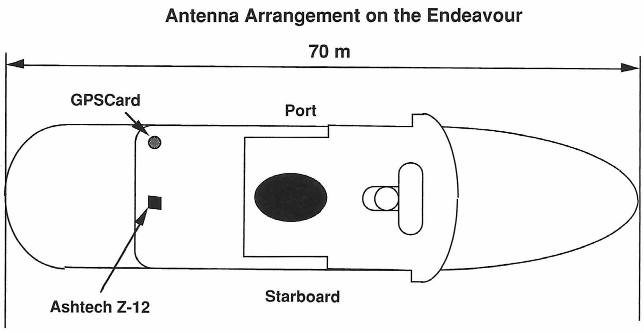


Figure 1. Antenna Configuration on Ship

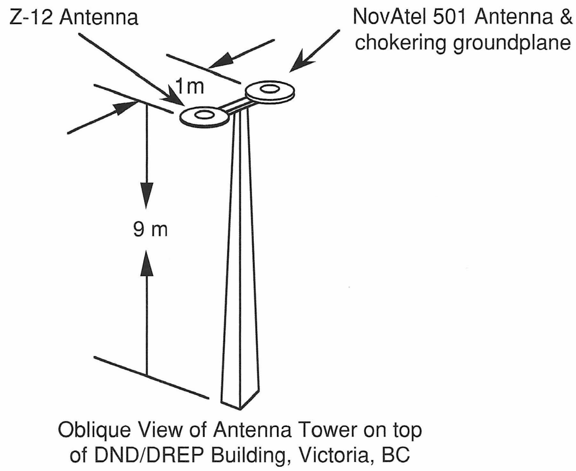


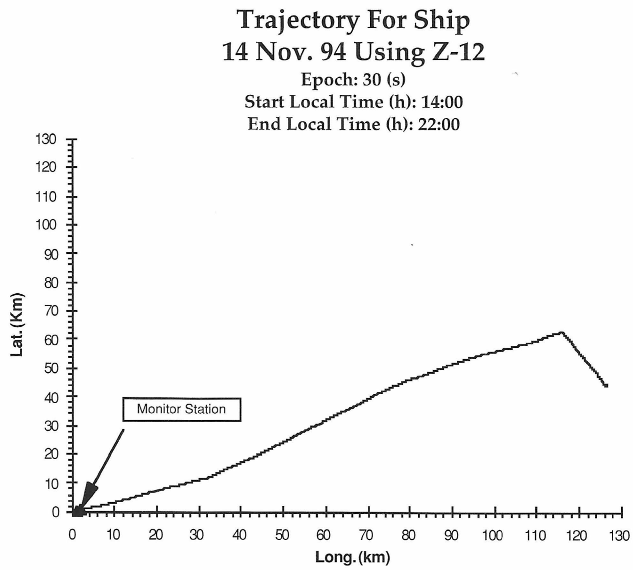
Figure 2. Reference Station Antenna Configuration

The two ship trajectories retained for the analysis presented herein are shown in Figure 3. The maximum distance of the ship from the reference station exceeded 100 and 80 km, respectively. During the observation periods, up to eight satellites above a mask angle of 10° were available. The number of SVs available on November 18 and corresponding HDOP and VDOP are shown in Figure 4. A cutoff angle of 10° was used for the data reduction.

Results And Analysis

Fixed integer ambiguity solutions

These solutions were computed using the Kalman filter-based FLYKIN™ software package [6], [3]. When dual-frequency measurements are used, the widelane observables are used to resolve the integer ambiguities on-the-fly (OTF). The position solution obtained is then used to resolve the L1 ambiguities and obtain a yet more accurate solution. If only L1 measurements are available, the integer ambiguities can still be resolved directly but success strongly depends on the distance between the reference station and the moving platform (e.g. [7]). Several methods are available to verify that the fixed ambiguity solution is correct. In the present case, the trajectories obtained with each receiver pair were free from cycle slips and repeated solutions along the trajectories should result in the same integer ambiguity solutions. This was found to be the case indeed. In addition, the double difference carrier phase observable residuals were plotted to examine if any long-term biases occurred. Three sets of such residuals for the Z-12 receiver pair are shown in Figure 5 for the November 18 trajectory. The rms fit is of the order of 1 cm and no long-term biases are visible. If the integer ambiguity solution was off by only one cycle, a systematic trend in one or several of the double difference residual sets would be seen due to the effect of the changing satellite geometry over such a long period (several hours). The short-term biases seen in Figure 5 commonly occur and are due to either multipath and/or atmospheric irregularities.



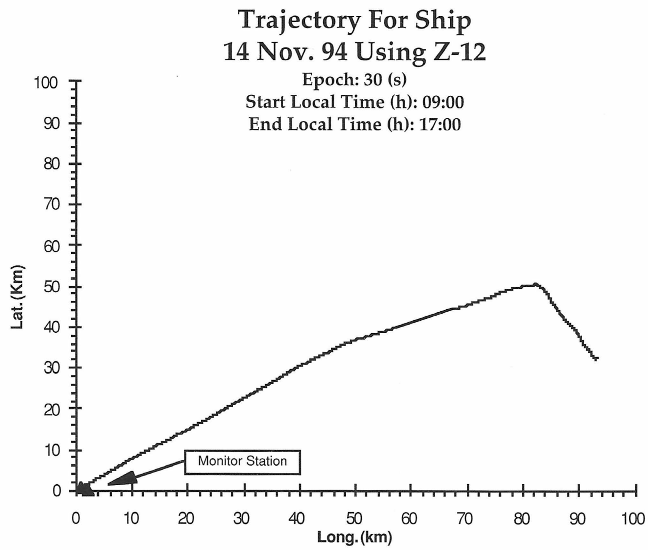


Figure 3. Ship Trajectories Used

An integer ambiguity solution was obtained with the GPSCard™ 3951 receiver pair for the November 18 trajectory. Since the Ashtech and NovAtel antennas on the ship are separated by a fixed and known distance (4.7 m), the instantaneous 3-D difference between the two fixed integer ambiguity solutions calculated at each epoch should yield the known distance. The differences be-

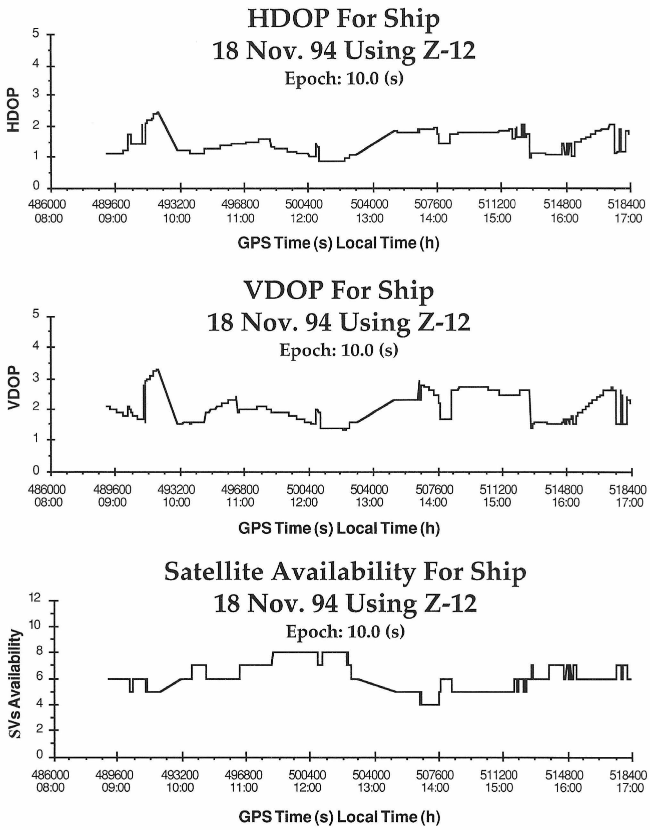


Figure 4. Number of SVs, HDOP and VDOP, November 18

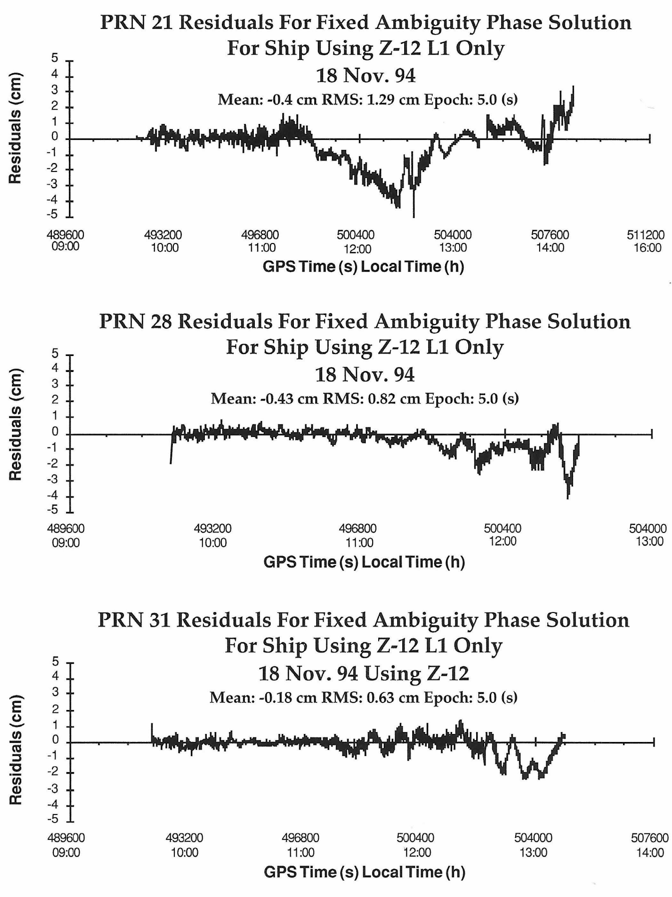


Figure 5: Fixed Integer Ambiguity Solution Double Difference Carrier Phase Residuals

tween the distance calculated at each epoch using the fixed integer solutions and the known distance are shown in Figure 6 for a 3 hour period. These differences do not exceed | 4 cm | and the rms is 1.1 cm. This shows beyond doubt that both the Z-12 and GPSCard™ 3951 solutions are correct.

The actual height of the ship as obtained from one of the fixed integer ambiguity solutions is shown in Figure 7. The height is relatively constant when the ship leaves the harbour. As it progresses toward the open sea, the 2 m effect of the waves become clearly visible. The 50 cm long term trend is due to tidal effects.

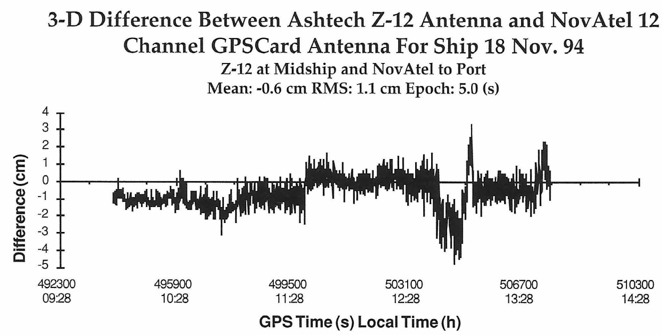


Figure 6. Differences Between Known Antenna Distance and Difference Between Ashtech and NovAtel Fixed Integer Ambiguity Solutions

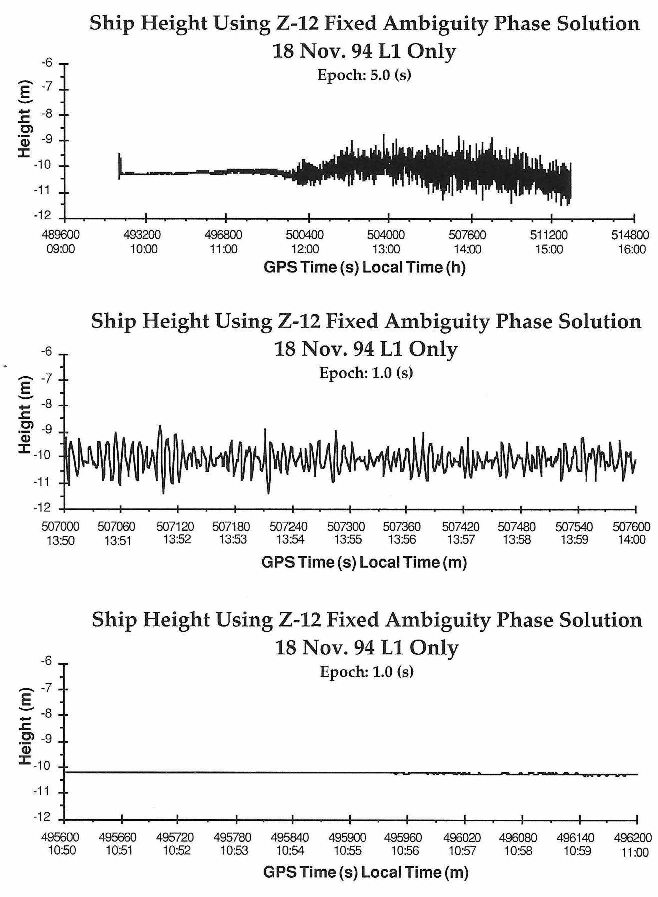


Figure 7: Ship Height Obtained from Fixed Integer Ambiguity Solution

Float ambiguity solutions

These solutions were computed using FLYKIN™ in float ambiguity mode. As described in the Introduction, the real number double difference ambiguities remain part of the estimation process and are updated at each epoch. The code and carrier phase measurements are combined in an optimal Kalman filter solution. During the convergence stage, the accuracy of the solution is expected to be poorer as it is largely based on the lower accuracy code measurements.

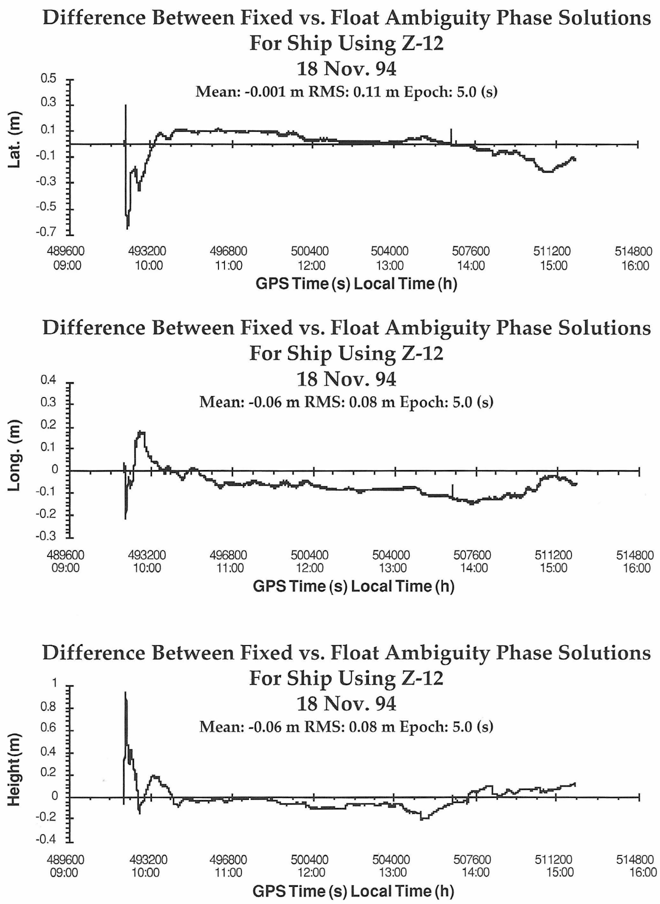


Figure 8. Differences Between Z-12 Float and Fixed Ambiguity Solutions (Cycle Slip Free Sequence of Measurements)

The accuracy of the ambiguity float solutions is best analysed by comparing them to the corresponding fixed integer ambiguity solutions which are expected to be accurate to a few cm. In the case of the Z-12 receivers, the Y1 pseudorange and carrier phase measurements were used. The coordinate differences between the two solutions are shown in Figure 8 for the Z-12 pair and in Figure 9 for the GPSCard™ 3951 pair. After a convergence period of several minutes, the float solutions agree with the fixed solutions to better than 10 cm. Both receiver pairs yield comparable solutions. Similar results were obtained for the November 14 trajectory. The measurement sequences of several hours were free of cycle slips; this is why the float solutions are uniformly good after the initial convergence period. In order to analyze the

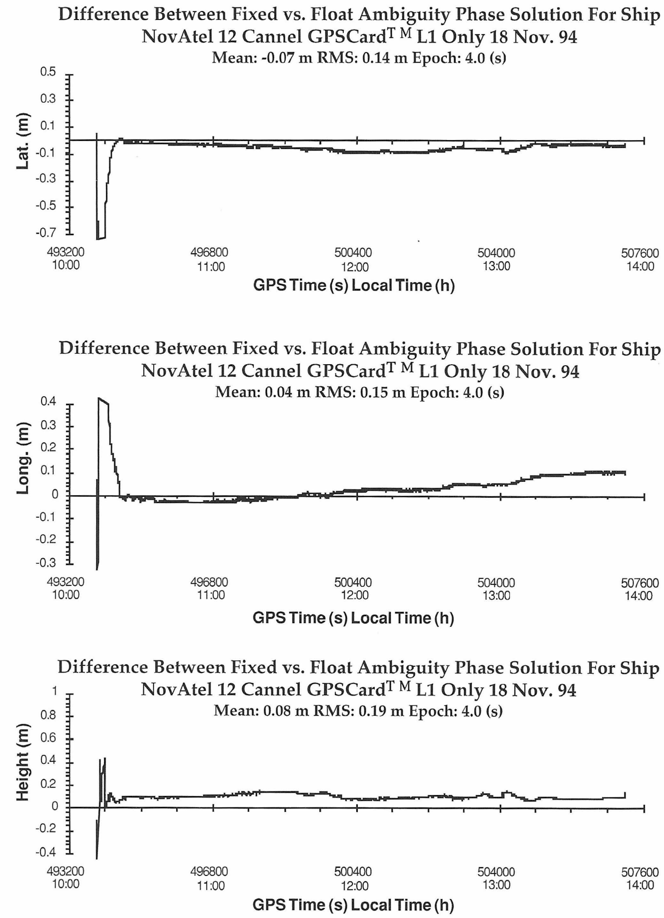


Figure 9. Differences Between GPSCard™ 3951 Float and Fixed Ambiguity Solutions (Cycle Slip Free Sequence of Measurements)

effect of cycle slips during a measurement sequence, cycle slips on all SVs were simulated at 12:45. The differences between the resulting float solution and the fixed solution are shown in Figure 10. The effect of the cycle slips is to re-initialize the filter and the consequences on the coordinate accuracy are the same as for the beginning of the measurement sequence, as expected. The lower accuracy at the beginning of a measurement sequence could be improved in post-mission using a back-filtering approach.

The double difference carrier phase residuals corresponding to the float solution shown in Figure 8 are plotted in Figure 11. A comparison with the residuals obtained for the corresponding fixed solution (Figure 5) is interesting. The residual rms fit of the float solution is better than that of the fixed solution and the short term biases are reduced significantly. This is because the number of unknowns is larger, the redundancy is consequently lower, and parts of the measurement errors are absorbed by the unknowns. The fact that the residuals are smaller does not indicate that the solution is better in this case.

The accuracy of the float ambiguity solution to estimate ship height variations over a period of several minutes

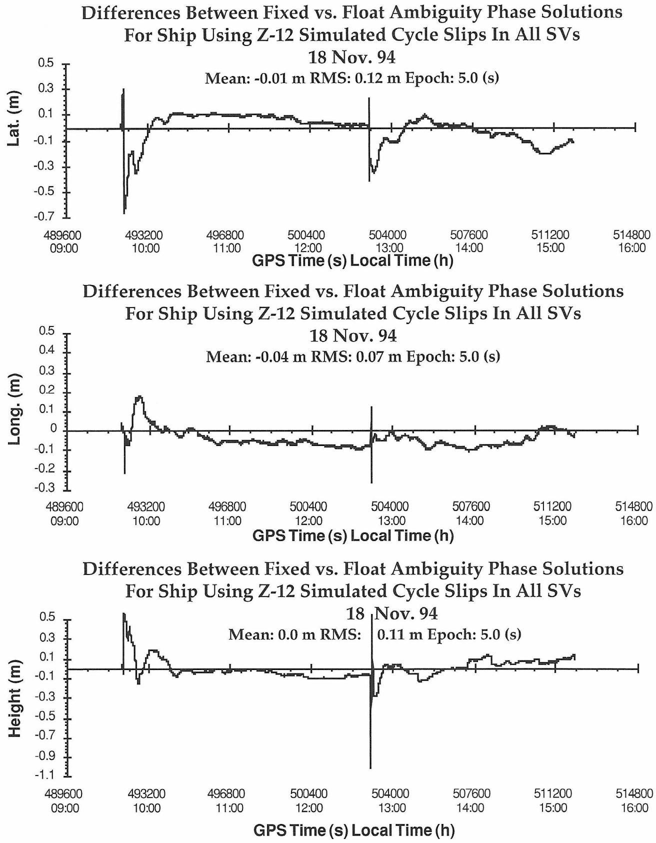


Figure 10. Differences Between Z-12 Float and Fixed Ambiguity Solutions (Cycle Slips Introduced in Measurement Sequence)

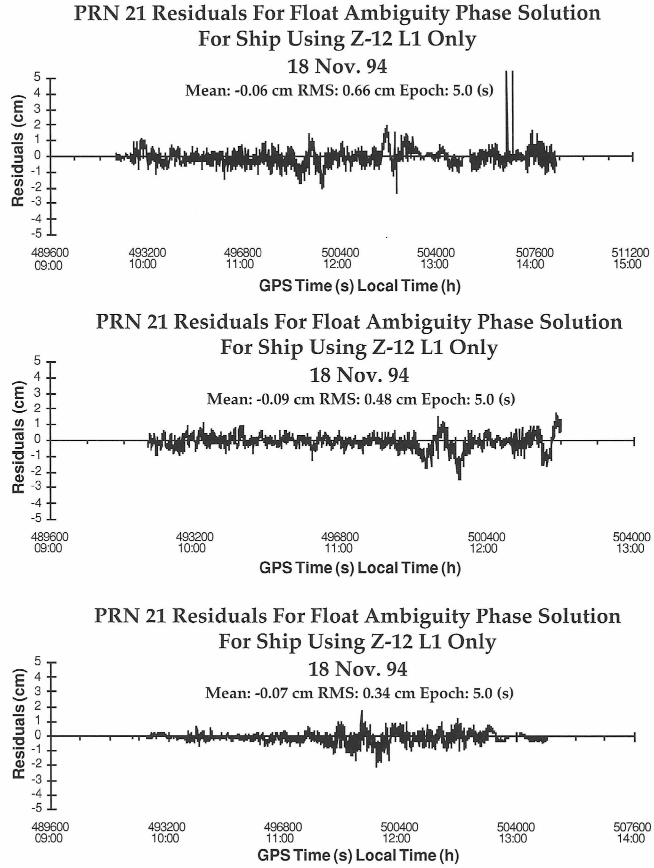


Figure 11. Float Integer Ambiguity Solution Double Difference Carrier Phase Residuals

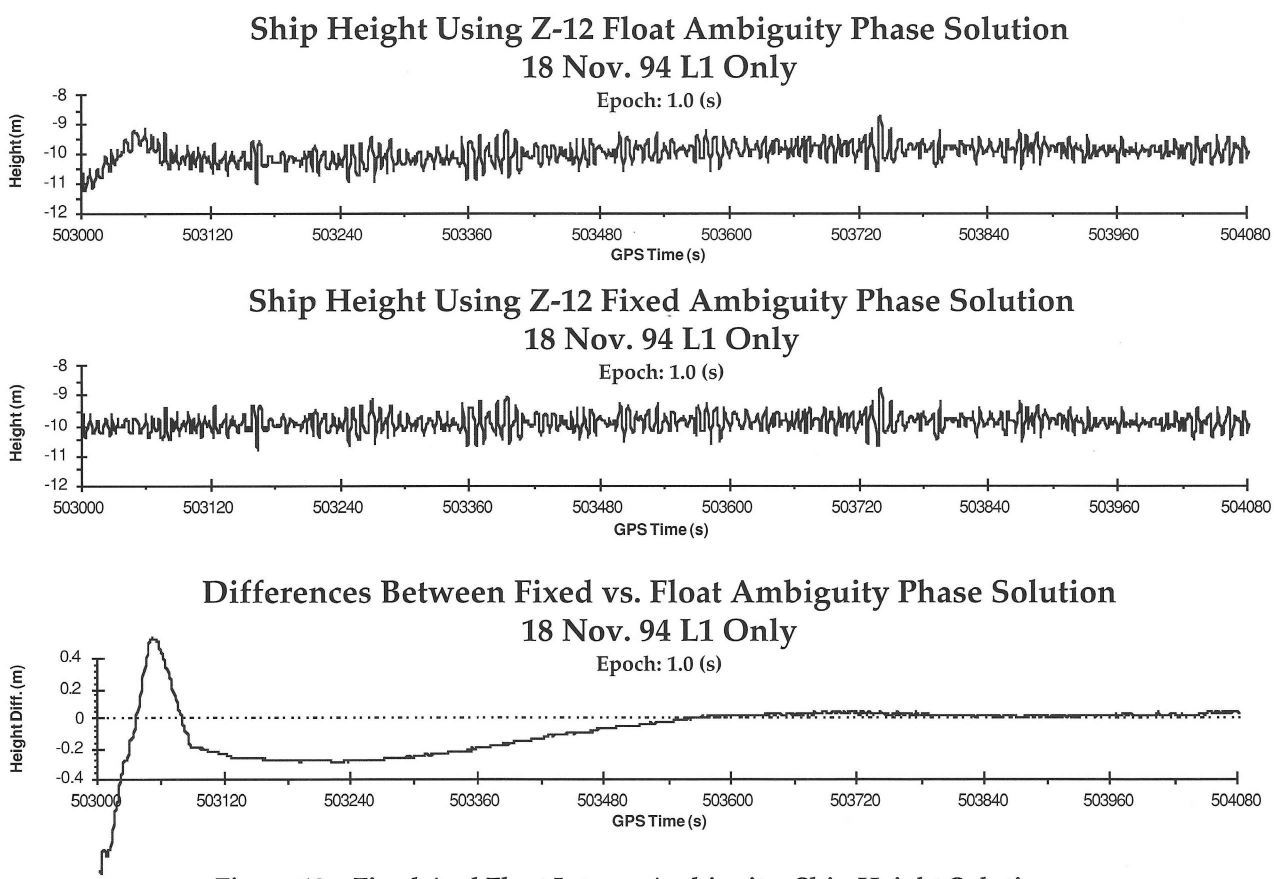


Figure 12. Fixed And Float Integer Ambiguity Ship Height Solutions

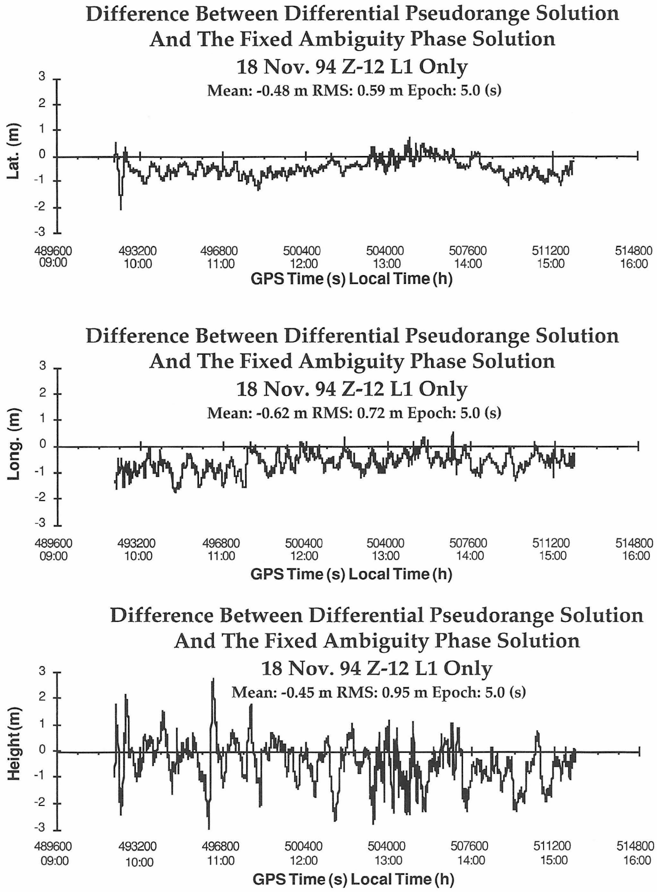


Figure 13. Carrier Phase Smoothed Versus Fixed Ambiguity Solutions

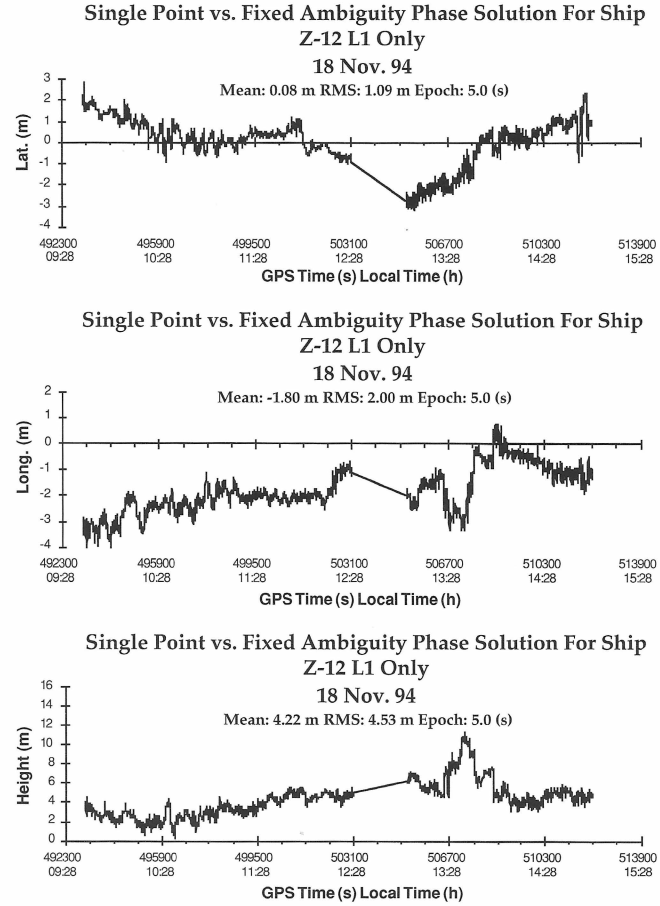


Figure 14. Single Point L1 Versus Fixed Ambiguity Solutions

can be assessed by comparing it to the more accurate fixed integer solution, as shown in Figure 12 for an 18-minute data sequence collected some 50 km from the reference station on November 18. Again, after an initial convergence period of a few minutes, the float solution is accurate to a few cm over periods of a few minutes, with longer term variations of up to 20 cm.

Carrier Phase Smoothed Code solutions

For the sake of completeness, these solutions were calculated to determine their level of agreement with the fixed and float solutions. They were computed using C³NAV™ [2]. Again the Ashtech Y1 pseudorange and carrier phase measurements were used. The November 18 solution is compared with the corresponding fixed ambiguity solution in Figure 13. Similar results were obtained for the November 14 trajectory. The rms agreement is better than 1 m in each coordinate component. The solution is not as good however as the float solution. In real-time, the carrier phase smoothed solution is however easier to implement using RTCM type 1, 2 and/or 9 messages, which are less demanding in term of data transmission than the corresponding type 18-21 messages required for the float solution.

Single Point solutions

These solutions were computed using a newly modified version of C³NAV™ (e.g., [8]). The post-mission data required for this type of solution are usually available from NRCan a few days after the mission. Two Ashtech solutions were derived, namely a L1 and a L1/L2 (ionospherically corrected) solution. The Y1 and Y2 pseudoranges were carrier phase smoothed to reduce the measurement noise. The agreement of these two solutions with the fixed ambiguity solution is shown in Figures 14 and 15, respectively. The rms agreement of the L1 solution is of the order of a few metres but systematic effects (4.2 m in the height component) affect the solution. These effects are much reduced for the L1/L2 solution and the differences are much more random. Dual-frequency codeless technology is therefore effective to reduce the effect of the ionosphere. An intrinsic weakness of a L1/L2 solution is the receiver noise and multipath amplification which occurs due to the linear combination of the L1 and L2 measurements. Receiver noise and multipath reduction are therefore of prime importance in this case to preserve the advantage of an ionospherically corrected solution.

Attitude Determination

During the experiment, an array of four NovAtel GPSCard™ sensors was also used to determine the attitude of the ship. A Mk-29 Inertial Navigation System was available to assess the GPS-derived attitude parameters.

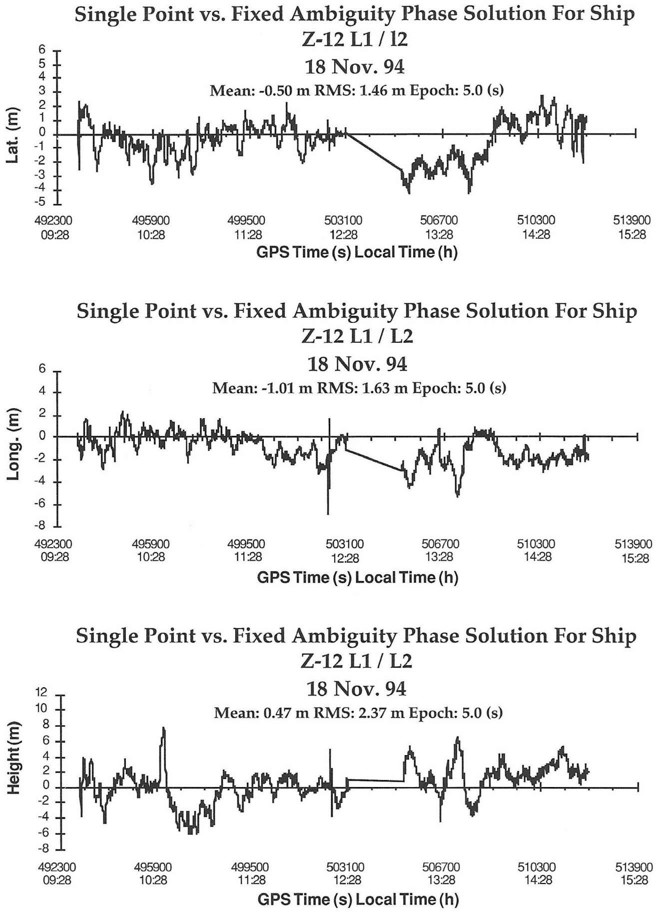


Figure 15. Single Point L1 /L2 (Ionospherically Corrected) Versus Fixed Ambiguity Solutions

The results obtained are similar to those reported for an earlier test [11]. A set of 54,600 data points measured at 10 Hz were used to derive statistics. The 68th percentiles are 0.036° (2.2 arcmins) in heading, 0.036° (2.2 arcmins) in pitch and 0.069° (4.1 arcmins) in roll.

Conclusions

The fixed integer ambiguity solution provides the highest level of accuracy (a few cm) for the tridimensional trajectory of the ship. The ambiguity float solution is a viable robust alternative for dm-level accuracy. Over periods of minutes, the relative trajectory accuracy can reach a few cm. Single frequency C/A code and carrier phase measurements are sufficient in this case. The method can also be implemented in real-time using using RTCM type 18-21 messages (e.g., [4]). The single point approach with post-mission orbits and satellite clock corrections is capable of 1-2 m (rms) accuracy but requires dual-frequency measurements to deal with the effect of the ionosphere. The linear combination is also very sensitive to receiver noise and multipath amplification.

Acknowledgments

The assistance of Mr. Geoff Cox, graduate student, with the data reduction and preparation of the figures is acknowledged.

References

1. Ashjaee, J., and Lorenz, R., "Precision GPS Surveying After Y-Code", Proceedings of GPS-92, The Institute of Navigation, Alexandria, VA, pp. 657-659,1992.

2. Cannon, M.E., and Lachapelle, G., "Analysis of a High Performance C/A Code GPS Receiver in Kinematic Mode", **Navigation**, Vol. 39, No. 3, The Institute of Navigation, Alexandria, VA, pp. 285-299, 1992.

3. Chen, D., and Lachapelle, G., "A Comparison of the FASF and Least-Squares Search Algorithms for Ambiguity Resolution On The Fly", **Navigation**, Journal of The Institute of Navigation, Vol. 42, No. 2, Alexandria, VA (in press), 1995.

4. Ford, T., and Neumann, J., "NovAtel's RT20 - A Real Time Floating Positioning System", Proceedings of GPS-94, The Institute of Navigation, Alexandria, VA, pp. 1067-1076, 1994.

5. Kouba, J., and Popelar, P., "Modern Reference Frames in Precise Positioning and Navigation", Proceedings of International Synopsium of Kinematic Systems in Geodesy, Geomatics and Navigation - KIS94, Dept. of Geomatics Engineering, The University of Calgary. pp. 79-85, 1994.

6. Lachapelle, G., Cannon, M.E., and Lu, G., "Ambiguity Resolution On The Fly - A Comparison of P Code and High Performance C/A Code Receiver Technologies", Proceedings of GPS-92, Institute of Navigation, Alexandria, VA , pp. 1025-1032, 1992.

7. Lachapelle, G., Liu, C., Lu, G., Townsend, B., Cannon, M.E., and Hare, R., "Precise Marine DGPS Positioning Using P Code and High Performance C/A Code Technologies", **Geomatica**, Canadian Institute of Geomatics, Ottawa , Vol 47, No. 2, pp. 117-128, 1993.

8. Lachapelle, G., Klukas, R., Roberts, D., Qiu, W., and McMillan, C., "One-Meter Level Kinematic Point Positioning Using Precise Orbit and Timing Information", Proceedings of GPS-94 (Salt Lake City, September 21-23), The Institute of Navigation, Alexandria, VA, pp. 1435-1443, 1994.

9. Lachapelle, G., Cannon, M.E., Qiu, W., and Varner, C., "An Analysis of Differential and Absolute GPS Aircraft Positioning", Proceedings of ION National Technical Meeting (Anaheim, January 18-20), pp. 701-710, 1995.

10. Malys, S. and Slater, J.A., "Maintenance and Enhancement of the World Geodetic Sytem 1984", Proceedings of GPS-94 (Salt Lake City, September 21-23), The Institute of Navigation, Alexandria, VA, pp. 17-24, 1994.

11. McMillan, J.C., Arden, D.A.G., Lachapelle, G., and Lu,G., "Dynamic GPS Attitude Performance Using INS/GPS Reference", Proceedings of GPS-94 (Salt Lake City, September 21-23), The Institute of Navigation, Alexandria, VA, pp. 675-682, 1994.

12. NRCan "Canadian Active Control System Products", Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, August, 1994.

13. Sluiter, P.G., and Haagmans, M.E.E., "Comparative Test Between Geodetic Y-Code GPS Receivers - Susceptibility to Radio Frequency Interference", Geomatics Info Magazine, International Journal for Geomatics, Vol. 9. No. 8 (August), pp. 35-41, 1995.

14. Townsend, B., and Fenton, P., "A Practical Approach to the Reduction of Pseudorange Multipath Errors in a L1 GPS Receiver", Proceedings of GPS-94 (Salt Lake City, September 21-23), The Institute of Navigation, Alexandria, VA,pp. 143-148, 1994.

15. Van Dierendonck, A.J., Fenton, P., and Ford, T., "Theory and Performance of Narrow Correlator Spacing in a GPS Receiver", **Navigation**, Journal of The Institute of Navigation , Vol. 39, No. 3, pp. 265-283, 1992.

16. Van Dierendonck, A.J., "Understanding GPS Receiver Terminology: A Tutorial on What those Words Mean", Proceedings of KIS94, Dept. Geomatics Engineering, Univ. of Calgary, pp. 15-24, 1994.

About the Authors / À propos des auteurs

Dr. G. Lachapelle *is Head and Professor, Department of Geomatics Engineering, The University of Calgary, where he is responsible for teaching and research related to positioning, navigation and hydrography. He has been involved with GPS developments and applications since 1980 and is the author of numerous papers on the subject.*

Mr. H. Sun *is a Research Associate in the same Department where he received an MSc in late 1994. He also holds a BSc (1987) and an MSc (1990) in Geodesy from the Wuhan Technical University of Surveying and Mapping. He won a Best Student Paper Award at GPS-94.*

Dr. M. Elizabeth Cannon *is an Associate Professor in the same Department. She has been involved with GPS research since 1984 and is the authur of numerous papers and software related to GPS positioning.*

Mr. Chris McMillan *is Head of the Airborne Radar and Navigation Section at DND/DREO and his areas of activities include integrated navigation systems and special applications of navigation sensors.*

For more information please contact:
Dr. G. Lachapelle
2500 University Drive N.W.
Calgary, Alberta
T2N 1N4

Positionnement GPS avec des mesures de pseudodistance filtrées et lissées

R. Santerre, É. Roy et D. Parrot

Introduction

La précision du positionnement GPS (Global Positioning System) est fonction de la géométrie de la distribution des satellites dans le ciel lors de la collecte des données et de la précision des mesures effectuées. Le premier facteur quantifié par les facteurs DOP (Dégradation de Précision, en anglais Dilution Of Precision) est fonction de la configuration des satellites GPS à un site et à un moment donné. La précision des mesures dépend du type d'observations recueillies et de la résolution des mesures effectuées par les récepteurs. De plus, les erreurs inhérentes au système GPS influencent également (si elles sont mal modélisées) la qualité du positionnement. Le premier facteur est en grande partie hors du contrôle de l'utilisateur. Cependant, l'amélioration de la précision des mesures est à la portée de l'utilisateur par le choix des équipements, des modèles mathématiques et des logiciels appropriés.

Une approche efficace permettant de réduire le bruit associé aux mesures de pseudodistance est de les filtrer ou mieux encore de les lisser avec les mesures de phase des ondes porteuses. La technique de filtrage est bien documentée dans [Abidin, 1993] et [Hatch, 1982]. L'avantage du filtrage est que les algorithmes peuvent être utilisés en temps réel et que les observations n'ont pas à être emmagasinées. L'avantage du lissage est qu'il permet d'obtenir des résultats potentiellement aussi précis dès les premières époques d'un parcours, contrairement au filtrage où un certain laps de temps est requis, en début de parcours, afin de permettre à ces algorithmes d'être efficaces. Cependant, le lissage ne peut se faire qu'en post-traitement.

Des algorithmes de filtrage et de lissage des mesures de pseudodistance avec les mesures de phase des ondes porteuses ont été développés et codés (en langage C) dans le logiciel POSICIEL (logiciEL de POSItionnement CInématique) du Centre de Recherche en Géomatique (CRG) de l'Université Laval.

Les algorithmes utilisés sont décrits dans la prochaine section. Le positionnement relatif GPS est obtenu du traitement des mesures de pseudodistance traitées en mode différence simple. Par la suite, des résultats permettant de comparer le traitement des mesures de pseudodistance brutes, filtrées et lissées sont présentés, pour des vecteurs de différentes longueurs, de différentes durées d'observations et avec des récepteurs de fabricants différents.

Filtrage Et Lissage Des Mesures De Pseudodistance

Une pseudodistance est une mesure de la distance entre la position d'un satellite (calculée au temps de transmission du signal) et la position d'un récepteur (calculée au temps de réception du signal). Une erreur d'horloge (du récepteur et du satellite) provoquera une erreur dans la quantité mesurée (pseudodistance) par rapport à la distance vraie récepteur-satellite. Les mesures de pseudodistance peuvent être effectuées sur les codes C/A et P (ou Y). Notons que les délais ionosphérique et troposphérique affectent aussi directement les mesures de pseudodistance.

Quant à elle, la mesure de phase de battement de l'onde porteuse est essentiellement une mesure de différence de phases, entre la phase générée par le récepteur (au temps de réception) et la phase générée par le satellite (au temps de transmission) et reçue par le récepteur (au temps de réception).

On reconnaît l'analogie entre les observations de phase et de pseudodistance, cependant il existe certaines distinctions: 1) l'ordre de grandeur de la résolution des mesures de phase est de quelques millimètres, celle des mesures de pseudodistance avec le code P (ou Y) est de quelques décimètres et de quelques mètres pour le code C/A; 2) la propagation des ondes dans l'ionosphère affecte différemment la vitesse de groupe et la vitesse de phase (les pseudodistances mesurées sont trop longues et les distances mesurées avec les phases de l'onde porteuse sont trop courtes); 3) les mesures de phase sont très précises mais ambigües (le nombre entier de longueur d'onde contenu dans la distance récepteur-satellite à l'époque initiale d'observation n'est pas mesuré).

On peut donc interpréter les mesures de phase soit comme une mesure précise de distance contenant une ambiguïté ou comme une mesure précise de la variation de la distance récepteur-satellite depuis une époque initiale. En d'autres mots, la mesure de phase même si elle est ambigüe contient de l'information précise sur le déplacement d'un mobile entre deux époques.

Dans le contexte du présent article, les mesures de phase ne sont pas directement exploitées pour déterminer la position des récepteurs. Elles servent à filtrer ou à lisser (à amoindrir) le bruit associé aux mesures non-ambiguës de pseudodistance.

Une précision s'impose ici afin de faire la distinction entre les techniques de filtrage et de lissage. Les algorithmes de filtrage utilisent toutes les mesures de phase recueillies jusqu'à l'époque courante pour réduire le bruit des observations de pseudodistance. Dans la littérature anglaise, cette technique est appelée "carrier-aided smoothing". À notre avis le mot "smoothing" (lissage) est improprement utilisé puisque la technique de lissage fait appel à toutes les mesures recueillies avant, après, ainsi qu'à l'époque à laquelle la mesure de pseudodistance est lissée. En d'autres termes, la valeur de pseudodistance filtrée ne sera égale à la valeur de pseudodistance lissée qu'à la toute fin de la session d'observations. Dans la technique de filtrage, la réduction du bruit est plus grande à mesure que le temps s'écoule. Tandis qu'avec la technique de lissage, la réduction du bruit est théoriquement semblable à toutes les époques. La figure 1 illustre schématiquement la distinction entre les techniques de filtrage et de lissage. La description de ces algorithmes est présentée dans les prochains paragraphes.

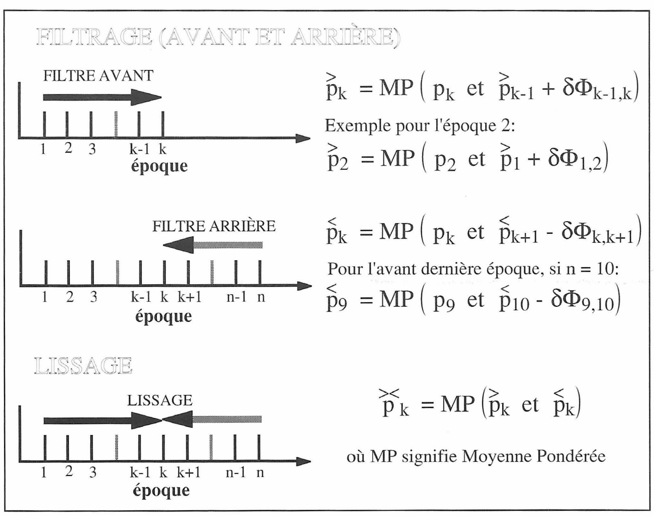


Figure 1: Filtrage et lissage des mesures de pseudodistance.

Filtrage avant

Les algorithmes de filtrage avant, présentés dans cette sous-section, ont été extraits de la thèse de doctorat de Abidin [1993, pp. 229-231] qui lui-même s'est inspiré de Hatch [1982]. La notation a été légèrement modifiée afin de ne pas confondre les algorithmes de filtrage et de lissage.

Les algorithmes servent essentiellement à calculer une moyenne pondérée. Si à une époque k, les pseudodistances observées et filtrées sont dénotées p_k et $\overset{>}{p}_k$ et que la différence de phase entre les époques k-1 et k est dénotée $\delta\Phi_{k-1,k}$ et en ignorant la corrélation mathématique entre les observations, la relation séquentielle suivante peut être établie pour la mesure de pseudodistance filtrée (dénotée par le symbole: >) et sa variance.

$$\overset{>}{p}_k = \left(\frac{W_p}{W_p + W_{\overset{>}{p}}}\right) p_k + \left(\frac{W_{\overset{>}{p}}}{W_p + W_{\overset{>}{p}}}\right)\left(\overset{>}{p}_{k-1} + \delta\Phi_{k-1,k} + 2\,\delta dion_{k-1,k}\right)$$

$$\sigma^2(\overset{>}{p}_k) = \frac{1}{W_p + W_{\overset{>}{p}}} \quad ; \quad W_{\overset{>}{p}_k} = W_p + W_{\overset{>}{p}}$$

dans lesquelles,

$$W_p = \frac{1}{\sigma^2(p_k)}$$

$$W_{\overset{>}{p}} = \frac{1}{\sigma^2(\overset{>}{p}_{k-1}) + \sigma^2(\delta\Phi_{k-1,k}) + 4\,\sigma^2(\delta dion_{k-1,k})}$$

Le sens de l'opérateur $\delta\Phi_{k-1,k}$ est égal à $\Phi_k - \Phi_{k-1}$.

Le poids $W_{\overset{>}{p}_k}$ sert à construire la matrice $P_{\Delta p}$ dans les multiplications suivantes:
$(A^T P_{\Delta p} A)$, $(A^T P_{\Delta p} \Delta W)$ et $(\Delta V^T P_{\Delta p} \Delta V)$
Ces multiplications matricielles sont utilisées dans la compensation par moindres carrés lorsqu'un positionnement avec les mesures de pseudodistance filtrées avant est désiré. Ici le terme ΔW représente le vecteur de fermeture décrit à la prochaine section.

Le filtrage des mesures de pseudodistance se fait séparément pour chaque paire récepteur-satellite et sur chaque fréquence individuellement (e.g., C/A , P1 ou Y1, P2 ou Y2).

Le terme "$2\delta dion_{k-1,k}$" est introduit afin que la valeur de $\overset{>}{p}_k$ soit affectée par le même délai ionosphérique que la mesure brute p_k. En fait, ce terme tient compte de la divergence du délai ionosphérique, puisque l'effet de la réfraction ionosphérique sur la mesure de phase et de pseudodistance est de même magnitude mais de signe opposé. Le terme "$2\delta dion_{k-1,k}$" est évalué avec les mesures de phase bi-fréquence.

Le procédé de filtrage débute en prenant la première pseudodistance et sa variance comme étant la première valeur filtrée. La pseudodistance filtrée est obtenue en calculant la moyenne pondérée de la pseudodistance observée (brute) et la mesure de pseudodistance prédite, avec un poids variable avec le temps. Ce procédé affecte la magnitude des erreurs qui ont un caractère dispersif (fonction de la fréquence), telles que le bruit et les multitrajets, mais non le délai ionosphérique si le terme "$2\delta dion_{k-1,k}$" est évalué. Les autres erreurs qui n'ont pas un caractère dispersif, telles que le délai troposphérique, les erreurs d'orbite et d'horloge sont les mêmes pour les pseudodistances brutes ou filtrées. Puisque la variance de la pseudodistance filtrée diminue avec le temps, après un certain laps de temps, le niveau de bruit de la pseudodistance filtrée deviendra beaucoup plus petit que celui de la pseudodistance brute. L'effet des multitrajets (s'ils sont existants) devrait être aussi réduit grâce au filtrage.

Lorsqu'un saut de cycle se produit entre 2 époques d'observations, un biais est introduit dans le terme "$\delta\Phi_{k-1,k}$" qui ne peut plus être utilisé dans le processus de filtrage. Le filtre doit donc être ré-initialisé. La précision associée à la prochaine mesure de pseudodistance (brute) est donc moindre que la précision d'une valeur filtrée, d'où une dégradation du positionnement qui en découlera. Les sauts de cycle non-détectés (de quelques cycles ou plus) corrompent aussi le processus de filtrage.

Les algorithmes de filtrage (avant) peuvent être utilisés en temps réel. Cependant, si l'on désire lisser les mesures de pseudodistance (en post-traitement), le filtrage avant n'est que la première étape des calculs. Les pseudodistances filtrées (avant) et leurs variances respectives calculées à chaque époque d'observations doivent alors être sauvegardées. Dans la pratique, et lorsque le positionnement relatif est effectué, ce sont les valeurs de pseudodistance en différence simple qui sont sauvegardées, c'est à dire:

$$\Delta\overset{>}{p}_k = (\overset{>}{p}_k) - (\overset{>}{p}_k)_{réf}$$

$$\sigma^2(\Delta\overset{>}{p}_k) = \sigma^2(\overset{>}{p}_k)_{réf} + \sigma^2(\overset{>}{p}_k) \;;\; W_{\Delta\overset{>}{p}_k} = \frac{1}{\sigma^2(\overset{>}{p}_k)_{réf} + \sigma^2(\overset{>}{p}_k)}$$

L'indice "réf" indique qu'il s'agit de la station de référence utilisée en positionnement relatif.

Filtrage arrière
Les algorithmes de filtrage arrière sont similaires à ceux du filtrage avant, sauf qu'ils ne peuvent être utilisés en temps réel. Les algorithmes de filtrage arrière (dénotés par le symbole: <) sont [Santerre et al., 1994]:

$$\overset{<}{p}_k = \left(\frac{W_p}{W_p + W_{\overset{<}{p}}}\right) p_k + \left(\frac{W_{\overset{<}{p}}}{W_p + W_{\overset{<}{p}}}\right)\left(\overset{<}{p}_{k+1} - \delta\Phi_{k,k+1} - 2\,\delta dion_{k,k+1}\right)$$

$$\sigma^2(\overset{<}{p}_k) = \frac{1}{W_p + W_{\overset{<}{p}}} \;;\; W_{\overset{<}{p}_k} = W_p + W_{\overset{<}{p}}$$

dans lesquelles

$$W_p = \frac{1}{\sigma^2(p_k)}$$

$$W_{\overset{<}{p}} = \frac{1}{\sigma^2(\overset{<}{p}_{k+1}) + \sigma^2(\delta\Phi_{k,k+1}) + 4\,\sigma^2(\delta dion_{k,k+1})}$$

Comparativement au filtrage avant, on a:

$$\delta\Phi_{k,k+1} = \Phi_{k+1} - \Phi_k$$

$$\delta dion_{k,k+1} = dion_{k+1} - dion_k$$

$$\sigma^2(\delta\Phi_{k,k+1}) = \sigma^2(\delta\Phi_{k-1,k})$$

$$\sigma^2(\delta dion_{k,k+1}) = \sigma^2(\delta dion_{k-1,k})$$

Si un saut de cycles s'est produit entre les époques k et k+1, le filtrage arrière est ré-initialisé.

Le poids $W_{\overset{<}{p}_k}$ sert à construire la matrice $P_{\Delta p}$ dans les multiplications suivantes:
$(A^T P_{\Delta p} A)$, $(A^T P_{\Delta p} \Delta W)$ et $(\Delta V^T P_{\Delta p} \Delta V)$, si un positionnement (calculé par moindres carrés) avec les mesures de pseudodistance filtrées arrière (à rebours) est désiré.

Lissage
La combinaison des mesures de pseudodistance filtrées avant et filtrées arrière (à rebours) permettent d'obtenir (en post-traitement uniquement) des valeurs de pseudodistance lissées. Cette procédure, la plus performante en terme de précision est décrite dans les paragraphes qui suivent. Plus de détails peuvent être retrouvés dans [Santerre et al., 1994]. Le désavantage du lissage est qu'il ne peut pas être utilisé en temps réel et que les observations recueillies doivent être emmagasinées pour le post-traitement.

La moyenne pondérée des valeurs des pseudodistances filtrées avant et filtrées arrière, correspondant à l'époque k, donne une mesure de pseudodistance lissée (dénotée par le symbole: ><).

$$\overset{><}{p}_k = \frac{W_{\overset{>}{p}_k}\,\overset{>}{p}_k + W_{\overset{<}{p}_k}\,\overset{<}{p}_k}{W_{\overset{>}{p}_k} + W_{\overset{<}{p}_k}}$$

$$\sigma^2(\overset{><}{p}_k) = \frac{1}{W_{\overset{>}{p}_k} + W_{\overset{<}{p}_k}}$$

$$W_{\overset{><}{p}_k} = W_{\overset{>}{p}_k} + W_{\overset{<}{p}_k}$$

dans lesquelles,

$$W_{\overset{>}{p}_k} = \frac{1}{\sigma^2(\overset{>}{p}_k)} \;,\quad W_{\overset{<}{p}_k} = \frac{1}{\sigma^2(\overset{<}{p}_k)}$$

Le poids $W_{p_k}^{><}$ sert à construire la matrice $P_{\Delta p}$ dans les multiplications suivantes:
$(A^T P_{\Delta p} A)$, $(A^T P_{\Delta p} \Delta W)$ et $(\Delta V^T P_{\Delta p} \Delta V)$, si un positionnement (calculé par moindres carrés) avec les mesures de pseudodistance lissées est désiré.

Détection des sauts de cycle
Dans les équations précédentes, la différence des mesures de phase entre 2 époques consécutives est utilisée. Si un saut de cycle se produit entre ces 2 époques d'observations, il est clair que ce biais faussera la procédure de filtrage et de lissage. Un saut de cycle est égal à un nombre entier de longueur d'onde de la porteuse. Par exemple sur la fréquence L1, une valeur de $\delta N = 1$, représente une erreur de 20 cm! D'où l'importance de détecter les sauts de cycle. Lorsqu'un saut de cycle se produit le processus de filtrage (avant ou arrière) doit être ré-initialisé uniquement pour le récepteur, le satellite et la fréquence en cause. S'il n'y a pas eu de sauts de cycle, l'ambiguïté de phase initiale à l'époque k est la même que celle de l'époque k-1.

Lorsque des mesures de phase bi-fréquence sont disponibles, il est possible de détecter la présence de sauts de cycle en effectuant la différence entre celles-ci (les mesures de phase étant exprimées en mètres). La quantité qui en résulte ne contient que la différence de délai ionosphérique (à une constante près, puisque les mesures de phase sont ambigües) entre les fréquences L1 et L2. La variation dans la différence de délai ionosphérique étant habituellement régulière, tout saut de cycle sera détecté par la cassure qu'il produit dans la série temporelle.

Lorsque les mesures de phase ne sont recueillies que sur la fréquence L1, les sauts de cycle sont détectés en comparant la mesure de phase à l'époque k à sa valeur prédite. La mesure de phase prédite est évaluée à partir de la mesure de phase mesurée à l'époque k-1 et de la variation de phase entre les époques k-1 et k. Cette variation étant évaluée avec les mesures de fréquence Doppler instantanée recueillies aux époques k-1 et k (notons que ces mesures Doppler ne sont pas affectées par les sauts de cycle). Si la différence entre les valeurs de phase mesurée et prédite excède une certaine tolérance, il y a lieu de croire qu'un saut de cycle est présent.

Ces techniques de détection de sauts de cycle sont d'autant plus efficaces que le taux d'échantillonnage est élevé.

Positionnement cinématique GPS
La principale particularité qui distingue le positionnement cinématique du positionnement statique est que 3 nouvelles coordonnées (correspondant à la nouvelle position occupée par le récepteur) doivent être déterminées à chaque époque d'observations. De plus, un paramètre représentant l'erreur d'horloge du récepteur doit être déterminé à chaque époque d'observations autant en mode statique qu'en mode cinématique. Donc, afin de pouvoir résoudre ce problème, le nombre d'observations doit être égal ou supérieur au nombre de paramètres à résoudre qui est de 4 (3 coordonnées et l'erreur d'horloge du récepteur), et ce pour chaque époque d'observations.

Une autre particularité du positionnement cinématique est le taux d'échantillonnage élevé des observations. Un échantillonnage serré permet d'obtenir une plus grande densité de points décrivant plus en détail la trajectoire du récepteur mobile. De plus, la détection et la résolution des sauts de cycle sont facilitées par un haut taux d'échantillonnage.

Tel qu'énoncé plus haut, pour obtenir une solution instantanée (à chaque époque d'observations), un minimum de 4 observations de pseudodistance sont requises. Avec 4 observations, une solution unique est obtenue. Avec plus de 4 observations, la solution est obtenue par une compensation par moindres carrés.

L'équation normale de la compensation par moindres carrés (méthode de variation de paramètres) s'écrit de la façon suivante:

$$\hat{X} = (A^T P_{\Delta p} A)^{-1} \; (A^T P_{\Delta p} \Delta W)$$

$$\hat{\hat{X}} = \overline{X}^0 + \hat{X}$$

La matrice A est la matrice des dérivées partielles des équations d'observations de pseudodistance par rapport aux paramètres inconnus (3 coordonnées et erreur d'horloge). Le vecteur de fermeture DW est obtenu en soustrayant à la valeur de pseudoditance observée, corrigée des erreurs "modélisables", la valeur calculée de la distance récepteur-satellite, et ceci entre la station mobile (W) et la station de référence ($W_{réf}$):

$$\Delta W = W - W réf$$

En mode cinématique, la valeur approchée de la position est obtenue en additionnant, à la position compensée de l'époque précédente, le déplacement entre les 2 époques estimé à l'aide du vecteur vitesse du mobile. La vitesse du mobile est obtenue à l'aide des mesures de fréquence Doppler instantanée. Des itérations sont effectuées jusqu'à ce que les valeurs absolues des termes correctifs deviennent inférieures au critère de convergence.

La matrice de poids des observations de pseudodistance $P_{\Delta p}$ est une matrice diagonale. Chacun des éléments de la diagonale est composé de l'inverse de la variance associée à chaque mesure de pseudodistance (brute, filtrée ou lissée).

Tous ces algorithmes ont été programmés dans le logiciel POSICIEL (logiciEL de POSItionnement CInématique) développé au Centre de Recherche en Géomatique. Rappelons que le traitement des observations est effectué en mode différence simple. La prochaine section présente et analyse les résultats obtenus avec POSICIEL.

Présentation et analyse de résultats

Un moyen simple et efficace de valider les résultats obtenus du traitement d'observations GPS est de comparer les coordonnées calculées avec celles de points géodésiques provenant d'un traitement GPS en mode statique classique. Avec cette dernière méthode, les coordonnées sont habituellement connues à une précision de quelques centimètres (ou mieux). Au tableau 1 sont présentées les erreurs associées aux différences de coordonnées, i.e., les différences entre les coordonnées calculées par POSICIEL et les coordonnées "connues" de points géodésiques. Les différences de coordonnées sont exprimées selon les composantes horizontales (ΔN: en direction nord et ΔE: en direction Est) et la composante verticale (Δh: altitude). Ici, l'"écart type" des différences entre les positions calculées et celles connues des points géodésiques est calculé par rapport à 0 et non pas par rapport à la moyenne des différences de coordonnées. Dans la littérature anglaise, cette mesure de précision est appelée le "root sum square error" ou "rss". De plus, rappelons qu'à cette mesure de précision est associée un niveau de probabilité de 68%.

Le tableau 1 contient les résultats du traitement des mesures de pseudodistance brutes (B), filtrées avant (F) et lissées (L) de 10 sessions d'observations. Les observations proviennent de récepteurs NovAtel, Ashtech et Trimble recueillies sur des vecteurs de 0, 0.5, 14, 23, 50, 54, 81, 101, 128 et 175 km. Les longueurs des vecteurs, les récepteurs employés, les taux d'échantillonnage

Traitement			Fichier Complet				100 Époques			
			rss				rss			
Distance (km)	Récepteur Intervalle	Code	ΔN (cm)	ΔE (cm)	Δh (cm)	Époques Durée	ΔN (cm)	ΔE (cm)	Δh (cm)	Époques Durée
0.0	NovAtel	C/A - B	7	4	13	667	9	3	16	100
	3 sec	C/A - F	3	2	4	0:33	3	2	3	0:05
		C/A - L	1	1	3		2	0	3	
0.5	Ashtech	Y1 - B	33	19	49	667	9	17	40	100
	2 sec	Y1 - F	19	12	29	0:22	12	8	32	0:03
		Y1 - L	7	7	19		5	14	37	
14	Ashtech	Y1 - B	21	10	27	354	13	7	27	100
	20 sec	Y1 - F	13	9	23	1:58	5	4	17	0:33
		Y1 - L	9	7	17		4	8	16	
23	Trimble	Y1 - B	62	49	141	646	65	70	145	100
	15 sec	Y1 - F	28	26	46	2:44	25	35	62	0:25
		Y1 - L	24	20	39		20	35	49	
50	Ashtech	Y1 - B	28	23	44	356	20	17	51	100
	20 sec	Y1 - F	30	17	44	1:58	17	15	40	0:33
		Y1 - L	21	11	34		16	9	20	
54	Trimble	P1 - B	45	32	67	524	36	37	54	100
	15 sec	P1 - F	13	8	13	2:11	9	18	9	0:25
		P1 - L	9	7	9		4	18	8	
81	Trimble	P1 - B	53	38	91	486	74	52	116	100
	15 sec	P1 - F	16	8	24	2:02	34	13	36	0:25
		P1 - L	9	11	20		18	21	26	
101	Trimble	P1 - B	65	49	112	485	41	33	94	100
	15 sec	P1 - F	19	11	24	2:01	16	13	52	0:25
		P1 - L	14	7	23		5	4	14	
128	Trimble	Y1 - B	50	37	82	765	36	26	50	100
	15 sec	Y1 - F	13	12	18	3:11	19	11	16	0:25
		Y1 - L	10	7	16		15	4	16	
175	Trimble	Y1 - B	75	59	138	604	51	51	125	100
	15 sec	Y1 - F	56	29	54	2:31	14	11	20	0:25
		Y1 - L	44	21	38		14	5	13	

B : Brut F : Filtré avant L : Lissé

Tableau 1: Comparaison des résultats du positionnement avec des mesures de pseudodistance brutes, filtrées et lissées.

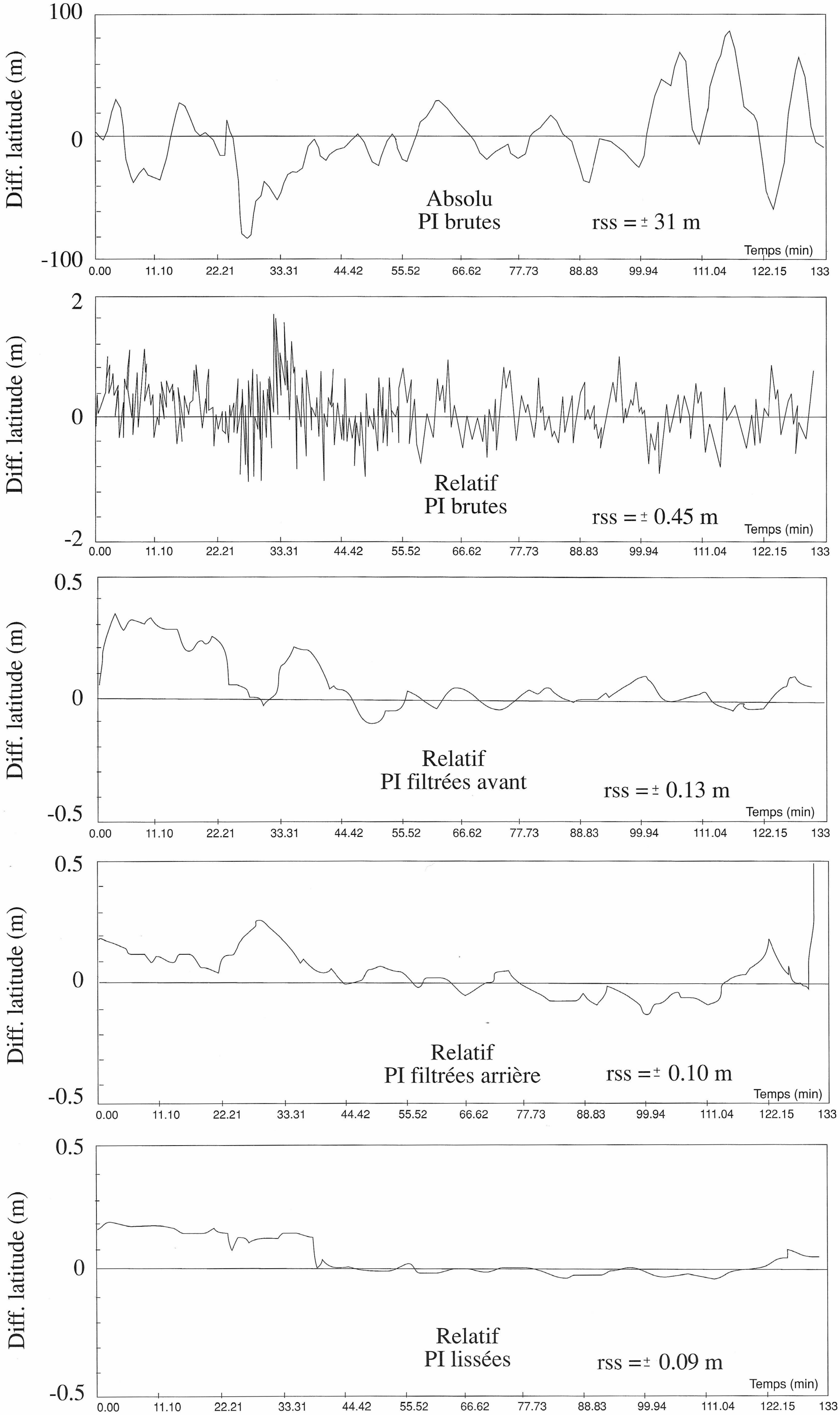


Figure 2: Comparaison des latitudes (vecteur de 54 km) calculées pour différents modes de traitement des mesures de pseudodistance.

(intervalle) ainsi que les codes traités sont indiqués pour chacun des 10 vecteurs. Dans la colonne "Code", la lettre Y indique que le code Y était utilisé parce que le dispositif d'anti-leurrage (A-S: Anti-Spoofing) était activé donc que le code P n'était pas disponible. Dans un premier temps, les fichiers des 10 vecteurs ont été traités au complet; le nombre d'époques et la durée des sessions d'observations y sont indiqués. Dans un deuxième temps, 100 époques extraites des fichiers complets ont été retraitées. La durée de ces sous-sessions correspondant aux 100 époques est également indiquée dans la dernière colonne du tableau 1.

L'analyse de ces résultats permet de tirer quelques règles générales: Les résultats du lissage sont meilleurs que ceux du filtrage. Quant aux résultats du filtrage, ils donnaient déjà de plus petites erreurs que celles associées au traitement des mesures de pseudodistance brutes. Dans la plupart des cas, les erreurs associées aux altitudes sont, en général, environ 2 fois plus élevées que celles des composantes horizontales. Le gain de précision du lissage par rapport au filtrage est aussi perceptible même lorsque seulement 100 époques d'observations sont traitées.

Plus en détails, l'analyse des résultats du lissage des mesures de pseudodistance démontre les faits suivants. Les résultats obtenus sur le vecteur de longueur nulle montrent des erreurs de quelques centimètres. Ce qui permet de confirmer la rigueur des algorithmes et la qualité de la programmation informatique. Pour les autres vecteurs, les erreurs associées aux composantes horizontales se situent majoritairement entre ±10 et ±20 cm. Les erreurs des altitudes varient entre ±20 et ±30 cm. Par exemple, pour un vecteur de 175 km, une erreur de ±44 cm représente une erreur relative d'à peine ±3 ppm. Encore une fois, mentionnons que ces erreurs représentent les écarts avec les coordonnées obtenues du traitement d'observations GPS en mode statique classique. Ces coordonnées de comparaison ne doivent pas être confondues avec les "vraies" coordonnées des points géodésiques qui elles sont inconnues. Cependant, cette comparaison demeure tout à fait valide pour apprécier le gain de précision entre les traitements des mesures de pseudodistance brutes, filtrées et lissées.

La figure 2 présente les différences de latitude obtenues de différents modes de traitement des observations du vecteur de 54 km. Sous forme de graphiques, les performances du filtrage et du lissage sont plus faciles à apprécier. Les modes de traitement sont: le positionnement absolu, le postionnement relatif avec les mesures de pseudodistance brutes, filtrées avant, filtrées arrière et lissées. Tout d'abord, on remarque que l'échelle verticale du graphique du mode absolu est de ±100 m, celle associée au mode relatif avec les pseudodistances brutes est de ±2 m comparativement à ±0.5 m pour les autres traitements. Plus précisément, les erreurs (rss) sont de ±31 m, ±0.45 m, ±0.13 m, ±0.10 m et ±0.09 m, respectivement. Il est intéressant de remarquer que les pics du début du traitement "P1 filtrées avant" se retrouvent dans le traitement "P1 brutes" et que les pics s'amenuisent au fur et à mesure que le traitement du filtrage avant progresse dans le temps. De façon similaire les pics de la fin du traitement "P1 brutes" sont apparents au début de la séquence du traitement du filtrage arrière (qui en fait débute par la fin du fichier). Les pics s'amenuisant au fur et à mesure que le filtre arrière progresse, i.e., lorsque le traitement se dirige vers le début du fichier. Puisque les résultats du lissage proviennent de la moyenne pondérée entre les observations filtrées avant et filtrées arrière, il est normal de retrouver en fin de traitement "P1 lissées" les résultats obtenus à la fin du traitement "P1 filtrées avant". De façon semblable, en début de traitement "P1 lissées" on retrouve les résultats de la fin du traitement "P1 filtrées arrière" (qui correspond au début du fichier d'observations). En bref, les pics distinctement apparents dans le traitement des pseudodistances brutes n'apparaissent plus, ni en début et ni en fin de session d'observations, lorsque les pseudodistances sont lissées avec les mesures de phase.

Les derniers résultats, présentés dans cet article, ont été obtenus en mode cinématique sur le boulevard Champlain à Québec. Le parcours entre les stations 4 et 5 (voir figure 3) a été effectué à 3 reprises avec arrêts d'une minute sur ces 2 stations. Les stations 4 et 5 sont matérialisées par le centre de grille d'égoût pluvial dont les coordonnées ont été déterminées par la méthode GPS statique rapide. La précision de la position de ces stations est estimée à ±3 cm. Le véhicule se déplaçait à une vitesse d'environ 90 km/h entre les 2 stations et le taux d'échantillonnage était de 2 secondes. Le trajet du véhicule est représenté, sur la figure 3, par la série de points le long du boulevard Champlain. À cette échelle, il est difficile de distinguer les trajets calculés avec les traitements des pseudodistances brutes, filtrées (avant) et lissées. Pour ce faire, un agrandissement sur la station 4 est reproduit à la figure 4. Les trois passages sur la station 4 sont représentés par des symboles différents, et ce, pour les 3 types de traitement. Les lettres "d" et "f" indique le début et la fin de l'arrêt du véhicule sur la station 4. Le centre des cercles de rayon de 1 m et de 2 m coïncide avec la position connue de la station 4. On remarque une meilleure consistance des fixes instantanés entre eux, ainsi qu'un rapprochement des positions calculées par rapport à la position connue de la station, dès que l'on passe du traitement des pseudodistances brutes au filtrage. Cette constatation est encore plus probante lorsque l'on passe du filtrage au lissage des mesures de pseudodistance. Toutes les positions calculées avec les algorithmes de lissage demeurent à l'intérieur d'un rayon de 0.9 m, lors du premier passage à la station 4; lors des passages 2 et 3, les positions sont regroupées à l'intérieur d'un rayon d'environ 0.5 m. Des résultats semblables ont été obtenus à la station 5.

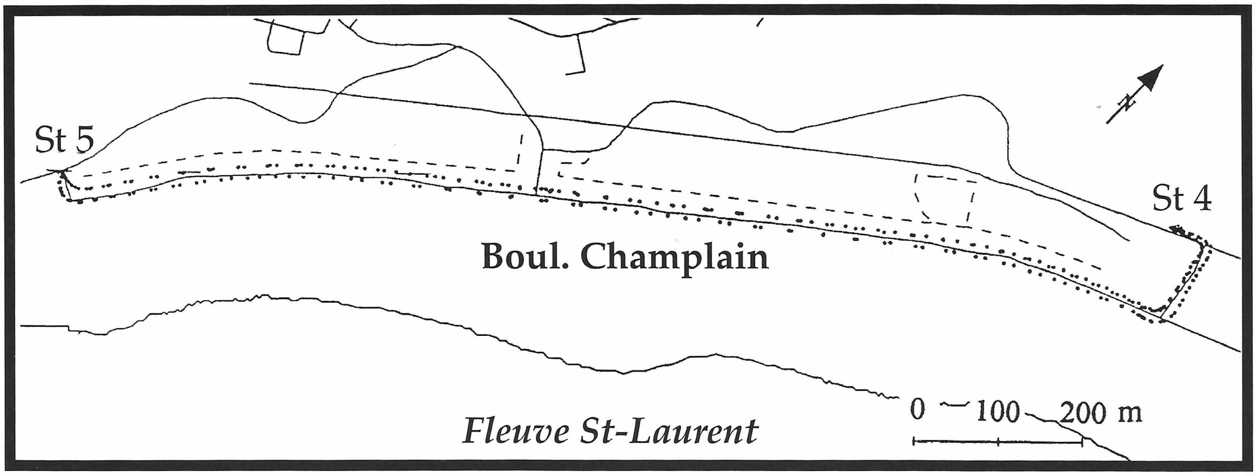


Figure 3: Parcours cinématique GPS le long du boulevard Champlain.

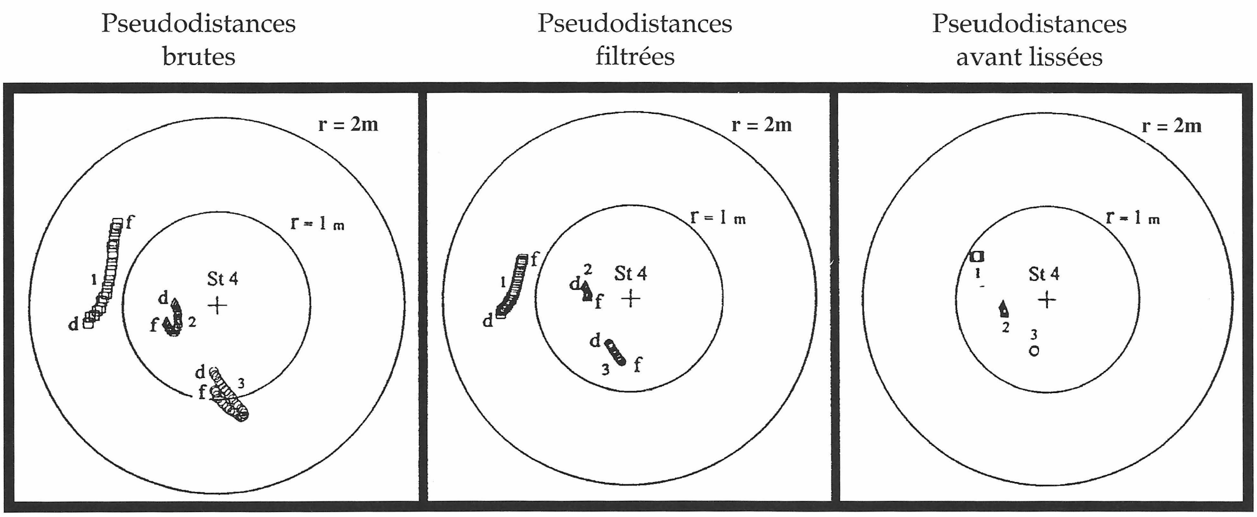


Figure 4: Répartition des positions horizontales calculées avec des pseudodistances brutes, filtrées avant et lissées (station 4 du parcours cinématique GPS).

Conclusions

La distinction entre les techniques de filtrage et de lissage des mesures de pseudodistance avec les mesures de phase a été établie. Les algorithmes ont été décrits et les résultats obtenus de ces 2 techniques ont été comparés à ceux du traitement des pseudodistances brutes. Les résultats du filtrage donnent définitivement de plus petites erreurs que celles associées au traitement des mesures de pseudodistance brutes. Le lissage améliore substantiellement les résultats du positionnement comparativement aux résultats du filtrage. Même si les algorithmes de lissage ne peuvent être utilisés qu'en post-traitement, les efforts supplémentaires en traitement peuvent devenir justifiés pour certaines applications nécessitant une plus grande précision.

En général, les résultats du lissage des mesures de pseudodistance ont donné des erreurs associées aux composantes horizontales se situant entre ±10 et ±20 cm (avec un niveau de probabilité de 68%). Les erreurs sur les altitudes, qu'en à eux, varient entre ±20 et ±30 cm.

Pour de nombreuses applications, les précisions obtenues du lissage (ou même du filtrage) des pseudodistances avec les mesures de phase sont tout à fait satisfaisantes. Pour obtenir de meilleures précisions, que celles présentées dans cet article, la résolution des ambiguïtés de phase est essentielle. Dans ce cas, les algorithmes de filtrage et mieux encore, de lissage deviennent la première étape essentielle afin de restreindre la recherche d'ambiguïtés. Le filtrage et à plus forte raison, le lissage joue un rôle fondamental dans les techniques de résolution d'ambiguïtés en mouvement (communément appelé On The Fly ambiguity resolution, dans la littérature anglaise). En effet, la connaissance à quelques décimètres près de la position "vraie" permet de lever presqu'instantanément les ambiguïtées de phase.

Remerciements

Nous tenons à remercier le Fonds de Développement Technologique du Ministère de l'Enseignement Supérieur et de la Science du Québec pour la subvention de recherche au projet PREDIR (Programme de Recherche sur l'Exploitation des Données Image Radar) du programme Synergie. L'aide de M. Sylvain Babineau dans le traitement et la présentation des résultats a été fortement appréciée. Finalement, nous voulons souligner l'aimable collaboration de la Division des Levés géodésiques du Canada pour nous avoir donné accès à des observations GPS recueillies par des récepteurs Trimble.

Références

1. Abidin, H.Z., "Computational and geometrical aspects of On-The-Fly ambiguity resolution", Ph.D. dissertation, Department of Surveying Engineering Technical Report No. 164, University of New Brunswick, Fredericton, Canada, 314 p., 1993.

2. Hatch, R., "The synergism of GPS code and carrier measurements", Proceedings of the Third International Geodetic Symposiun on Satellite Doppler Positioning, Las Cruces, USA, 8-12 February, pp. 1213-1231, 1982.

3. Santerre, R., Parrot, D. et Roy, E., "Positionnement cinématique GPS à l'aide des mesures de pseudodistance lissées", Rapport scientifique du Module Télédétection-GPS, Projet PREDIR, mars, 109 p., 1994.

À propos des auteurs / About The Authors

Rock Santerre *est membre du Centre de Recherche en Géomatique et professeur au Département des sciences géomatiques et de l'Université Laval. Ses enseignements et recherches portent sur les applications du GPS à la géomatique. Il compte plus de dix années d'expérience dans le domaine du positionnement spatial. M. Santerre détient un doctorat en géodésie de l'Université du Nouveau-Brunswick et est auteur et co-auteur d'une quarantaine de publications scientifiques.*

Édith Roy *est professionnelle de recherche au Centre de Recherche en Géomatique de l'Université Laval et travaille en étroite collaboration avec VIASAT Géo-Technologie. Ses activités portent sur le développement de logiciels reliés au domaine du positionnement par satellite. Mme Roy détient un baccalauréat en géomatique (option génie) de l'Université Laval depuis 1992.*

Denis Parrot *est associé chez VIASAT Géo-Technologie, une entreprise privée spécialisée en positionnement GPS et en télédétection. Il compte huit années d'expérience dans le domaine du GPS. De plus, il cumule une douzaine d'années d'expérience en géomatique par des travaux exécutés autant au Québec qu'à l'étranger. M. Parrot est bachelier en géodésie de l'Université Laval et détient une maîtrise en géodésie de l'Université du Nouveau-Brunswick.*

For more information please contact:
Rock Santerre,Ph.D,a.g.
Pavillon Louis-Jacques-Casault
Université Laval
Québec, Que., Canada
G1K 7P4

Upgrading Nautical Charts in Canada's Arctic Using Landsat Thematic Mapper (TM)

G. Tomlins, P. Wainwright and
M. Woods

Introduction
Mariners navigating the Northwest Passage using Global Positioning Systems (GPS) are finding that the GPS position fixes do not plot properly on many nautical charts. In September 1993, the Canadian Hydrographic Service (CHS) received a Marine Information Report from Captain N. Thomas, master CCGS *Arctic Ivik*: "*It has been noted that the latitude and longitude of the southern coastline of King William Island are not synchronous on Charts 7760 and 7733. On 18 Sept. 93 using a Global Positioning System (GPS) receiver aboard a Coast Guard helicopter, we tried to determine some of the discrepancies. The helicopter was flown to various identifiable locations, and positions were relayed back to the vessel for plotting on charts.*" The results of this effort show that the coastline of chart 7733 is as much as a mile in error in the Simpson Strait area. This is just one example of the problems associated with charts of Arctic regions.

For years mariners have complained that radar fixes are inconsistent if one fix is taken off the north shore and the next off the south shore of many passages. They also complain of problems associated with transferring fixes from one chart to the next. CHS cartographers have had difficulty updating charts because the modern surveys do not match the existing coastline. These problems must be rectified before mariners can safely use GPS and Electronic Chart technology in Arctic waters. If charts are not corrected there is an increased probability of marine casualties and the cost of maintaining navigation aids in the restricted passages remains high. Each year the Coast Guard must visit such locations before the first ships of the season, and deploy many buoys and service many lights and beacons. If all charts were drawn correctly on North American Datum (NAD 83), the need for annual navigation aids servicing could be greatly reduced through use of GPS and Electronic Chart technology at a great savings to Canada.

There are several reasons for the poor horizontal positioning of existing Arctic coastlines. Existing charts are compiled from many different sources. Most of the charts' shorelines are drawn from existing topographic maps that were based on aerial photography from the 1950's and 1960's, controlled by SHORAN aerotriangulation (which lacks the density and accuracy for precise geodetic control). Some surveys were done on a local datum with an astronomic observation for a baseline. Lastly, the NAD 27 geodetic network contains local distortion errors which may compound the problem.

To re-map poorly charted areas of the Arctic by conventional methods would be extremely expensive.

Objectives
To investigate the potential use of Landsat imagery to correct Arctic coastlines a research project was developed involving Chart 7083, Cambridge Bay to Shepherd Bay, at 1:500 000 scale (Figure 1). This chart was constructed prior to 1955 and is based on astronomic observations. The coastline has known errors, relative to NAD 83, up to four miles in the M'Clintock Channel area, up to three miles near Cape Felix, and up to two miles in the southern Northwest Passage (Simpson Strait - Queen Maud Gulf).

Data Acquisition and Rectification
Selection of Imagery:
A review of available satellite sensors was conducted [Tomlins *et al.* 1995]. Given the scale of this chart (1:500 000) Landsat-5 TM was the obvious choice of sensor. Each full scene covers 184 by 176 km, with a pixel resolution of about 30 metres square (0.06 mm at scale). Other satellite sensors are potentially suitable with the selection of the most appropriate sensor involving considerations of cost, spatial resolution, ability to discriminate shallow-water hazards and the coastline, and influence of the presence of ice. For example, SPOT imagery was rejected as unsuitable because 50 scenes would be required to cover the area.

For this study there was not sufficient time to consider acquisition of new imagery. Therefore, criteria for selection of Landsat data from the archive of existing data were the following:

- cloud-free conditions over coastline and water
- maximum open-water
- maximum scene coverage
- minimum scene count
- availability of full 7-band TM data

The Landsat fiche library at Radarsat International Inc. (RSI) was searched to assess area coverage and cloud/snow/ice conditions for both Landsat-4 and Landsat-5. Summer images, July through October (break-up to freeze-up), were examined either on microfiche (1984-1990 images), or using the colour video fiche system (1991-1993 images). Six scenes were selected which cover Chart 7083 (Table 1).

Table 1. Landsat Data for Chart 7083

Scene Centre	Date	Image Size	Area Covered	Comments
44-11	30 July 93	Full	Albert Edward Bay	ice breaking up
44-12	30 July 93	Full	W. Cambridge Bay	ice breaking up
41-11	5 Aug 91	Full	Victoria Strait	sea-ice/open-water
41-12	5 Aug 91	Full	Queen Maud Gulf	open-water
38-11	21 Aug 93	Full	James Ross Strait	open-water
38-12	21 Aug 93	Full	Rasmussen Basin	open-water, minor cloud

Geometric Control and Rectification:

Available geometric control consisted of 1:250 000 and 1:50 000 scale National Topographic Series (NTS) maps, geodetic control points provided by the Canadian Hydrographic Service, and 1:25 000 scale coastlines produced by recent LIDAR surveys (provided by CHS).

After preliminary investigation, the 1:250 000 scale NTS maps were discarded. Lacking good targets for control, such as road intersections, this scale was too coarse for accurate matching of map features against features in the Landsat imagery. Also, the 1:250 000 scale NTS data was used for some Arctic chart coastlines and therefore suffers from some of the same control problems.

The coastlines from the 1:25 000 scale surveys were the best source of control in the areas for which they were available. Coastline features on small islands were easily matched against the Landsat imagery with high precision. Because of the limited coverage of these surveys, most control points were taken from 1:50 000 scale NTS maps. Very small shoreline features and tips of small and narrow islands provided unambiguous control at precision of one pixel (30 m) in the image, and 0.5 mm (25 m) in the map. Control points that could not be positioned within 30 m precision were discarded.

NTS coverage of the study area at 1:50 000 scale is incomplete. No coverage was available for the northwestern corner of the study area (Collinson Peninsula, Admiralty and Taylor Islands), nor for the northern half of King William Island. In those areas, geodetic control points and CHS photogrammetric base plots were used for control.

It was very difficult to position geodetic control points accurately in the Landsat imagery. Air photos were often unavailable and site descriptions were too detailed for use with satellite imagery. For example, a position described relative to a 2 m wide trench or 5 m wide pond refers to a feature that is not discernible in 30 m resolution satellite imagery. Even when air photos were available, large differences in scale and resolution between the photos and imagery often limited use of the control point.

Each image was rectified separately using a first order affine transformation and cubic convolution resampling output at 50 m by 50 m resolution. After all scenes were rectified, each was compared with its neighbours for good fit in the areas of overlap. Table 2 summarizes the registration results. Overall root mean square (RMS) errors were 17 m East/West, and 18 m North/South. Maximum errors were less than 50 m in both directions (less than 1 pixel).

Table 2. Registration Results

WRS Scene I.D.	44-11	44-12	41-11	41-12	38-11	38-12	ALL
Number of GCPS	38	24	20	20	31	31	164
Maximum error - X(m)	34	47	37	37	24	30	47
Maximum error - Y (m)	47	41	35	34	23	31	47
RMS error - X (m)	14	23	19	20	14	16	17
RMS error - Y (m)	21	23	19	23	13	12	18

Investigation of Classification Methods

To determine which Landsat spectral bands would be best for delineation of the coastline (especially in areas where sea ice cluttered the images) one full 7-band scene, 41-11, was initially purchased.

A feature set analysis was performed on this scene which concluded that the best combination of bands for shoreline determination would be bands 1, 2, 4 and 7. The remaining five scenes were then purchased with these four bands only.

The CHS provided a 1:25 000 scale coastline of Admiralty Island for accuracy assessment of the test area (scene 41-11). However, when the digital CHS coastline was overlaid on the satellite image a poor fit was observed between the vector and image coastline. On further investigation the CHS coastline was found to be derived from 1960's black-and-white photography. Because of the age difference between the two data sets and considering the dynamic nature of the shoreline in the test area, an alternate test area (Jenny Lind Island, which had been surveyed in 1992) was selected for classification analysis.

Jenny Lind Island is imaged on Landsat scene 41-12, which is immediately south of scene 41-11 (Admiralty Island). An image acquired on 5 August 1991 was purchased. When Terra Surveys' digital coastline for Jenny Lind Island was overlaid on the satellite image the apparent fit was excellent. Coastlines for Jenny Lind Island were then derived from the Landsat data using two methods: supervised classification and single-band thresholding.

<u>Supervised classification of TM Bands 1, 2, 4 and 7:</u>
Homogeneous areas of water and ice were identified and used as "training sites", spatially-referenced areas of homogeneous cover. Spectral signatures derived from the training sites were used as input for a Maximum Likelihood Classifier algorithm. The resulting classes were compared with Terra Surveys' data. Twelve of fourteen classes, when combined, appeared to fit the

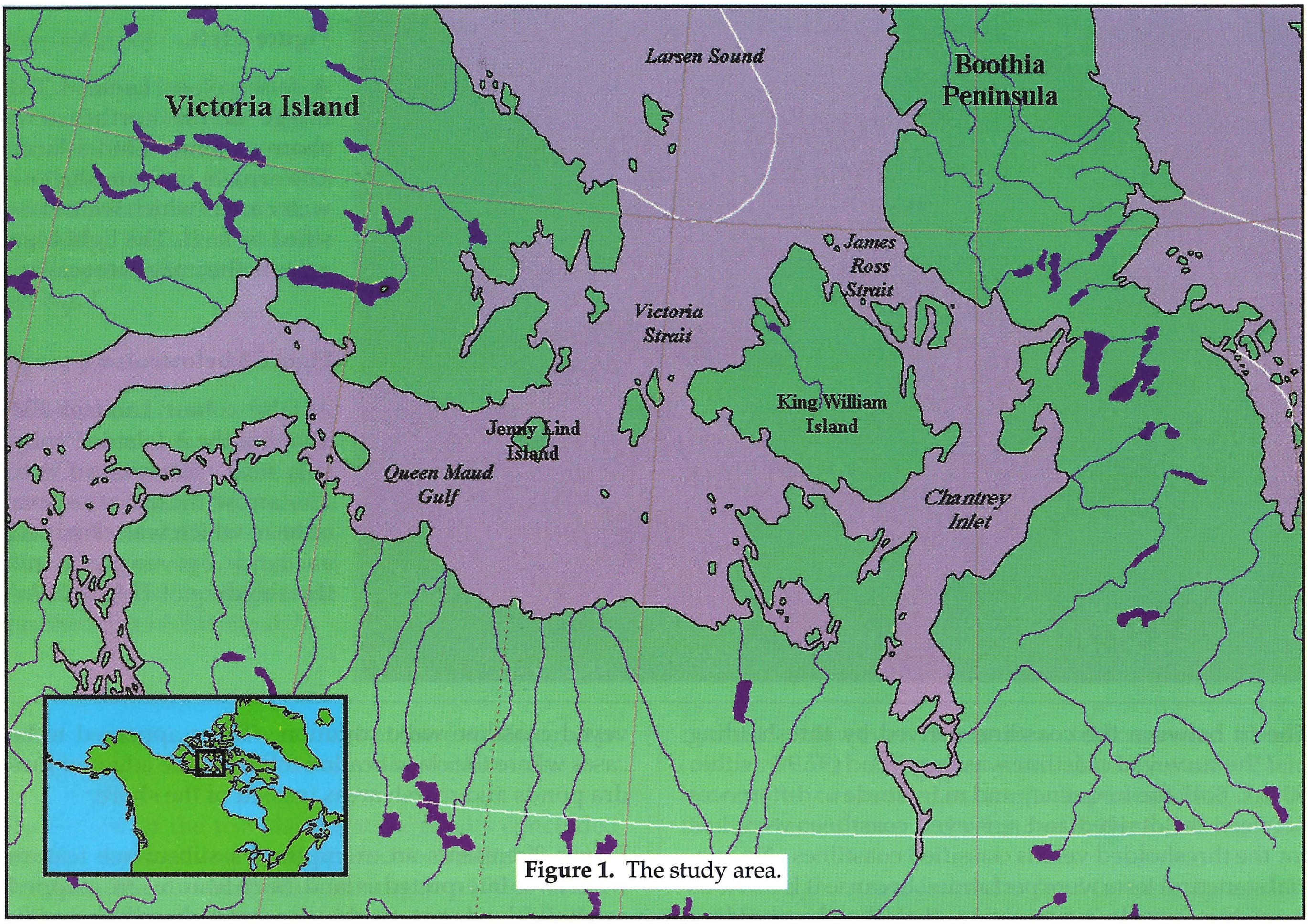


Figure 1. The study area.

marine area seaward of the low-water linework. An additional class gave the best visual agreement with the area between the low-water and high-water linework.

Single-band Thresholding of TM Band 7:

The feature set analysis concluded that TM Band 7 imagery alone could separate sea-ice and open-water from land. Sea-ice and open-water are both highly absorbent (very dark) at TM7 wavelengths whereas land is highly reflective. With the TM7 image of Jenny Lind Island and Terra Surveys' linework displayed on the monitor, the lowest gray level values were incrementally reset to zero until the threshold border approximated that of Terra Surveys' coastline. This method proved superior to the supervised classification, both in processing effort and quality of derived shoreline.

Accuracy of Landsat-derived Coastlines:

To test the accuracy of the Landsat-derived coastlines, 1:25 000 scale digital data of Jenny Lind Island prepared by Terra Surveys Ltd. were compared with the Landsat-derived coastline. The Terra Surveys' data are digitized vectors, whereas the Landsat-derived data are "square" vectors produced from raster-to-vector conversion where the size of the "steps" is determined by the pixel dimensions. To convert the data to a common standard the Terra Surveys' data were first converted to raster data with the same pixel dimensions as the Landsat data and then converted back to vectors by raster-to-vector conversion. In this manner, differences in resolution between the data sets were eliminated.

The next step was to examine the differences between the two data sets. The approach used was to create a series of concentric buffers at 25 metre intervals to a distance of 200 m from the Terra Surveys' coastline. The Landsat-derived coastlines were then intersected with the concentric buffers and the total length of coastline within each buffer was computed (see Table 3).

Table 3. Comparison of Surveyed and Remote Sensing-Derived Coastlines

Buffer Distance (m)	Classification Bands 1,2,4,7*	Thresholding Band 7*
0-25	57.7	79.5
25-50	16.5	18.4
50-75	4.8	1.6
75-100	3.7	0.2
100-125	2.5	0
125-150	1.5	0
150-175	1.3	0
175-200	1.1	0
>200	11.0	0.3

* Percentage of total length of coastline within buffer

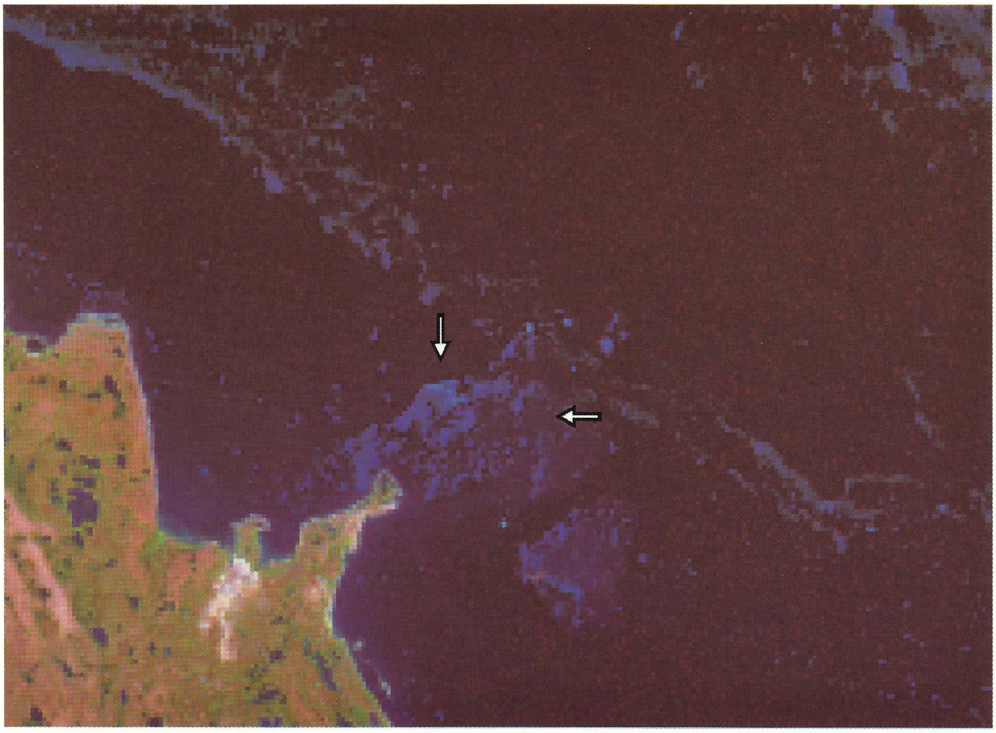


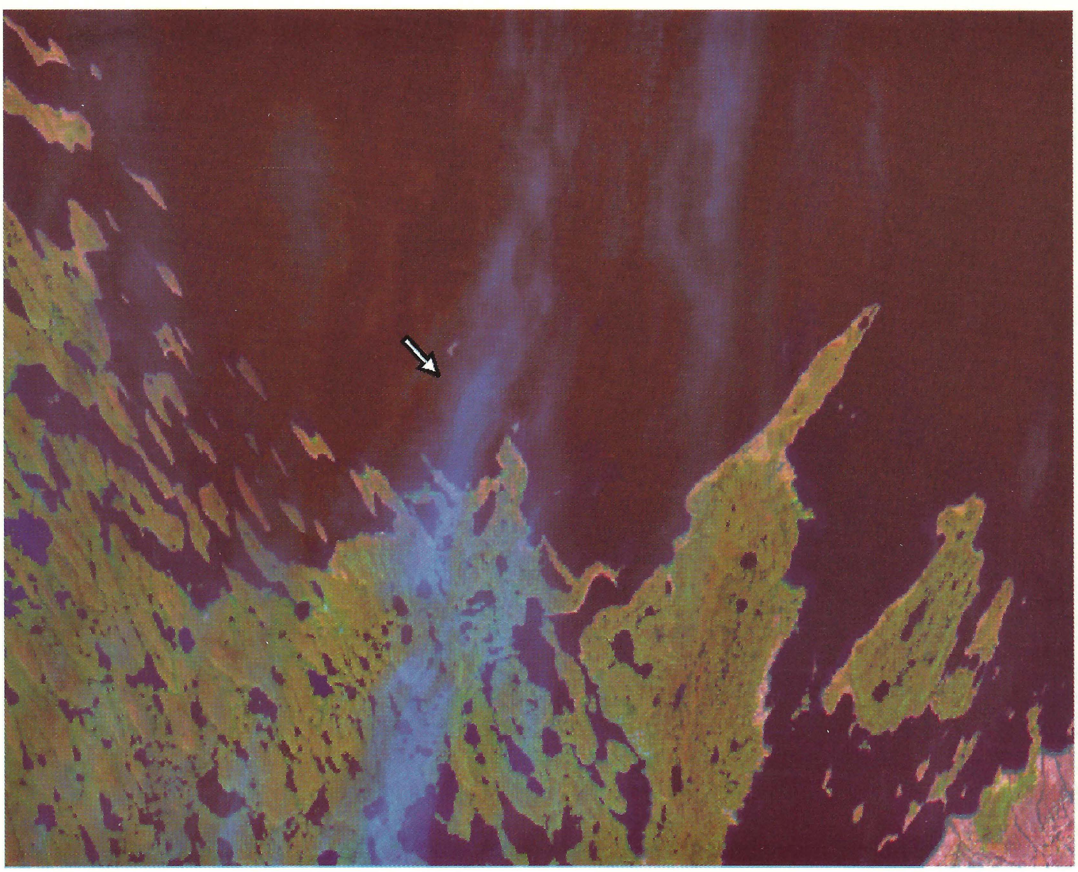
Figure 2 left.

A false colour Landsat TM image of the northeastern shore of Jenny Lind Island. The arrows indicate shallow water areas which were classified as land. The light blue areas in the image are sea-ice.

Figure 3 below.

A false colour Landsat TM image of the Adelaide Peninsula near Starvation Cove. The arrow indicates an area of haze which was classified as land by single band thresholding of TM Band 7.

The fit between the coastline derived by thresholding and the surveyed coastline was very good (97.9% within 50 m). Both the frequency and magnitude of differences between the derived and surveyed coastlines were less for the thresholded versus classified coastlines. No special statistical tests were performed because it is obvious from this simple examination that the thresholding method produced a superior result.



Sections of the derived coastline which differed by more than 50 m from the surveyed coast were examined visually. It appears that both methods identified some subsurface features which were interpreted as land. The information available does not allow confirmation of these subsurface features or consideration of their nature.

In many cases the coastline derived by the classification method generally parallels the surveyed coastline and is within the foreshore. However, instances where the derived coastline was inland of the surveyed coastline were common. These appeared to be cases where the classification followed the edges of tundra ponds and marsh areas instead of the shore.

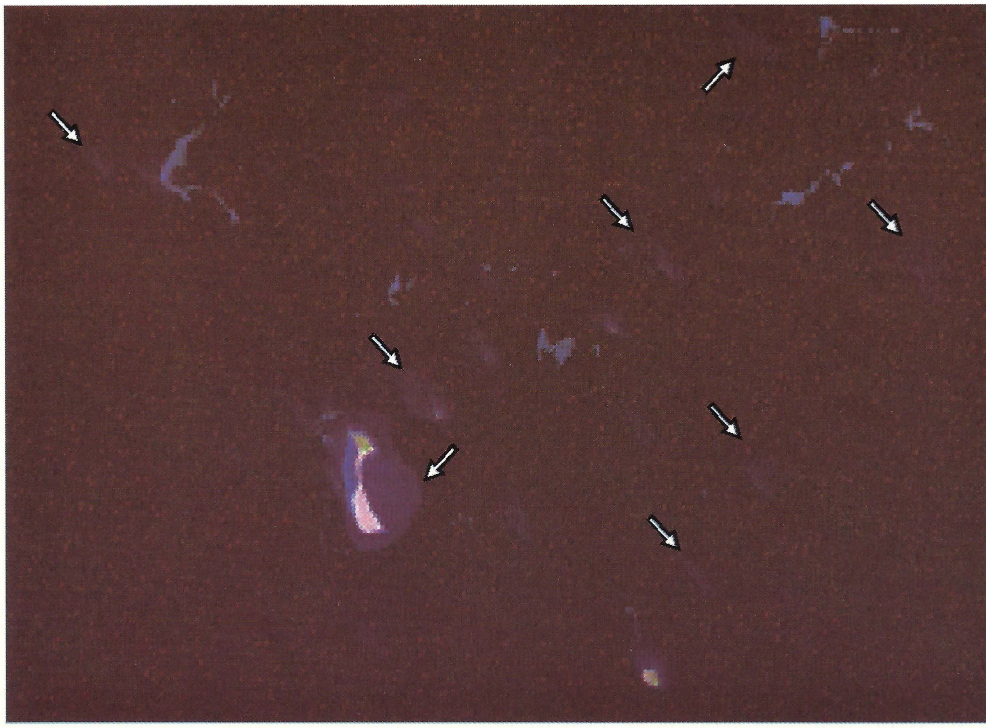
Figure 2 presents an example of a subsurface feature which was interpreted as land. Such features are mapped as small islands not previously reported and are readily identified during chart compilation. The number of such

Figure 4 right.

A false colour Landsat TM image of the waters near Guard Island and the eastern entrance of Palander Strait. The arrows indicate a series of known shallow water hazards which are visible primarily in the infrared band.

Figure 5 below.

A false colour Landsat TM image of the mouth of the Back River in Chantrey Inlet. The arrows indicate foreshore (pinkish) and shallow subtidal (blue-green) areas which were classified as land by single band thresholding of TM Band 7.

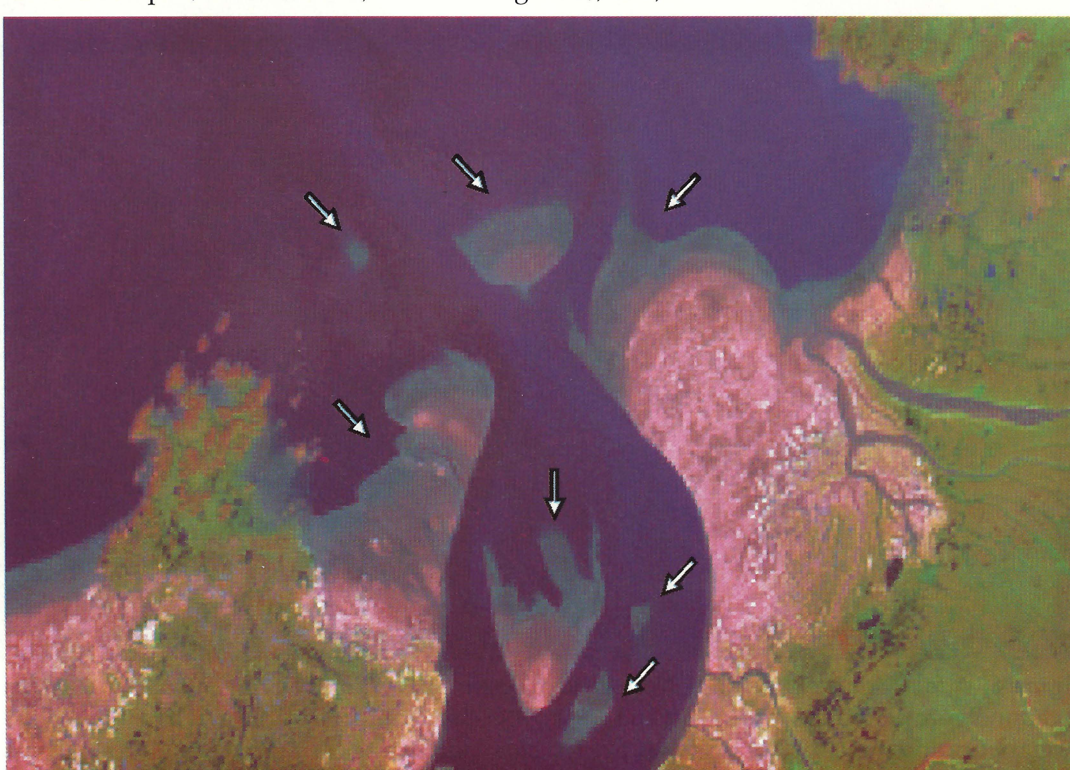


features in the test area was low, but there was interest in these features as potential shallow-water hazards.

The review of the test classification results concluded that the thresholding method produced suitable coastline data. Maximum errors were less than 100 m excepting some subsurface features. Most errors were less than 50 m. It is appropriate that methodology-related errors be small in relation to the scale of mapping. An appropriate acceptance criterion would be less than 0.1 mm at scale (*i.e.*, less than the width of a thin pen). On this basis, the coastline derived by thresholding is more than adequate for scales less than 1:100 000.

Landsat-derived Coastline for Chart 7083:
Following rectification, each Landsat scene was processed to derive a coastline by single-band thresholding of TM band 7. The resulting vector coastline was then inspected against the current chart, field sheets, NTS mapping and survey records. It was expected that differences in position of features would be observed, presumably resulting from poor control. However, some new features and some conformational differences were also observed. Each instance was examined in detail. It was concluded that the differences observed were due to the following:

- cloud or haze classified as land (see example, Figure 3);
- shallow subsurface features classified as land (see example, Figure 4);
- foreshore areas classified as land (see example, Figure 5); and,



- coastal river - lagoon systems which had gazetted names and were therefore included on previous charts, but were not significant in the classification (see example, Figure 6).

In each case the operator had no difficulty correctly interpreting the imagery. Visual scrutiny was necessary to identify and correct these "errors". The derived vector coastline was edited on-screen with the satellite image as a backdrop. This allowed the operator to inspect the derived coastline relative to the image and to correct the vectors as appropriate by following features in the image.

Review by CHS

Comparison to Existing Charts and Topographic Maps: Following delivery of the final vector coastline, CHS staff made an exhaustive comparison of the results with existing charts and NTS topographic maps. When questions arose, image processing software was used to inspect the imagery.

A few previously unreported islands appeared in obviously deep water as well as several in shallow water which could not be attributed to errors in the satellite data. Also, a few charted islands (one is shown in Figure 7) do not appear in the imagery. Some of these appear on both topographic maps and CHS charts. Others appear only on one or the other. Knowing that many air photos used to produce these maps were taken during ice cover, it is possible that the photo interpretation is in error.

The fact that the existing chart is off datum by varying amounts made it difficult to determine how well the satellite derived coastline matched the existing chart coastline, or whether one source was correct and the other wrong. In Chantrey Inlet, for example, when the satellite shoreline was overlaid on the chart and aligned using the general trend of the shoreline, some islands would not align. The charted shoal in Figure 7 is a good example of a small island that is badly plotted on the chart. It should coincide with the island found in the imagery. On older topographic maps small islands were shown by a cross and it is likely that some crosses on the chart are really small islands. Nonetheless there are several cases where it appears that the identification of a new feature or failure to identify a charted feature cannot be interpreted as being due to position differences.

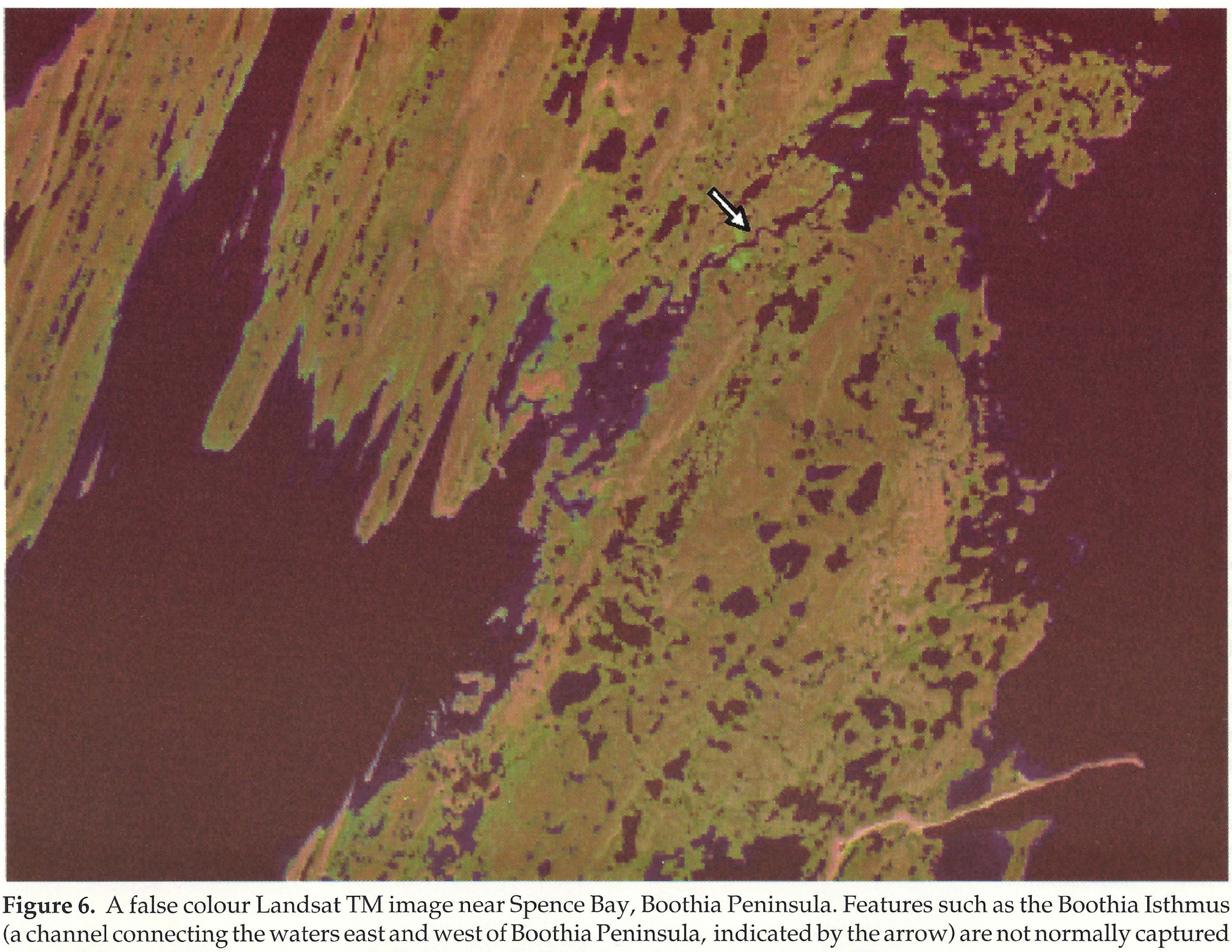


Figure 6. A false colour Landsat TM image near Spence Bay, Boothia Peninsula. Features such as the Boothia Isthmus (a channel connecting the waters east and west of Boothia Peninsula, indicated by the arrow) are not normally captured by classification methods because they are too small relative to the output scale. Nonetheless, gazetted features such as this are of interest to cartographers.

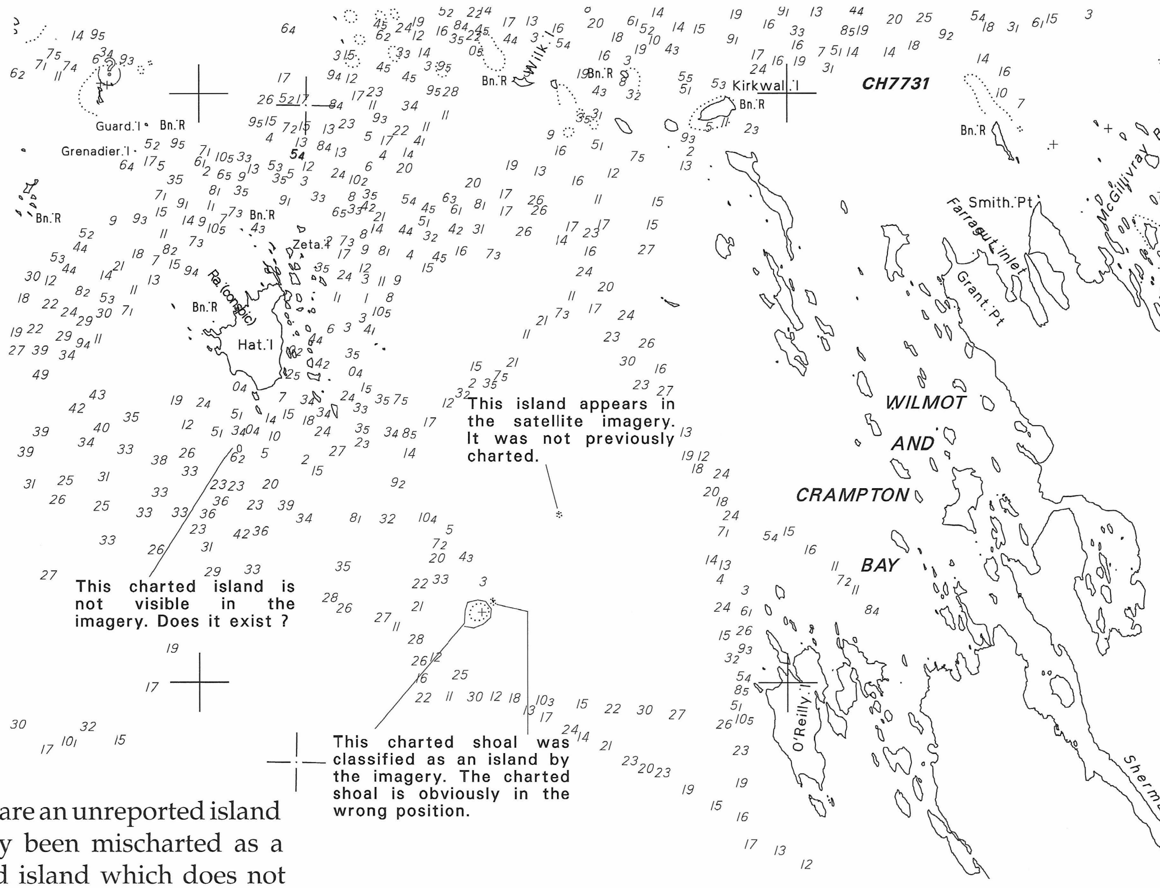


Figure 7. A composite of the existing Chart 7083 and the coastline derived from satellite data showing the area near Wilmot and Crampton Bay. A previously unreported island is shown in the figure centre. Also shown are an unreported island which has probably been mischarted as a shoal and a charted island which does not exist in the satellite imagery.

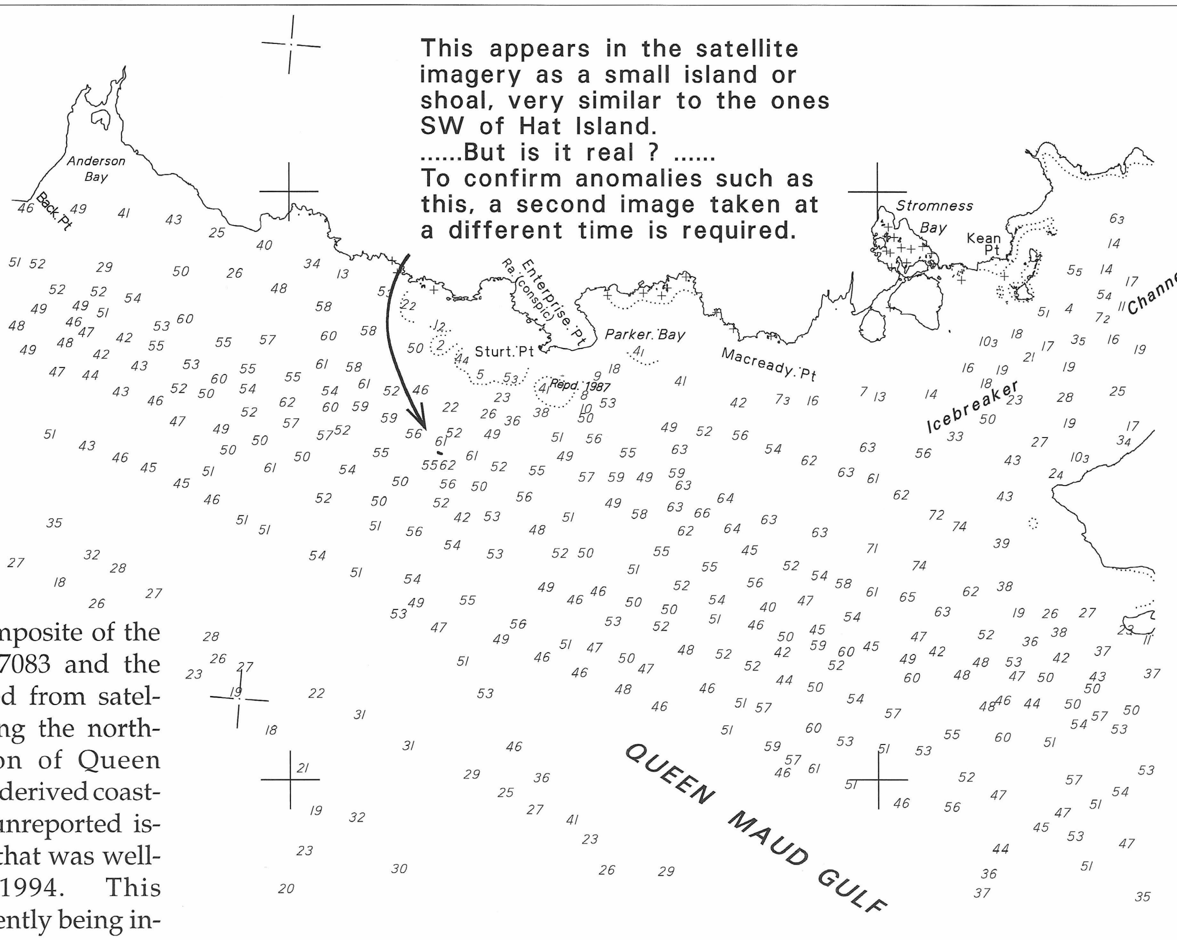


Figure 8. A composite of the existing Chart 7083 and the coastline derived from satellite data showing the northwestern portion of Queen Maud Gulf. The derived coastline shows an unreported island in an area that was well-surveyed in 1994. This anomaly is currently being investigated.

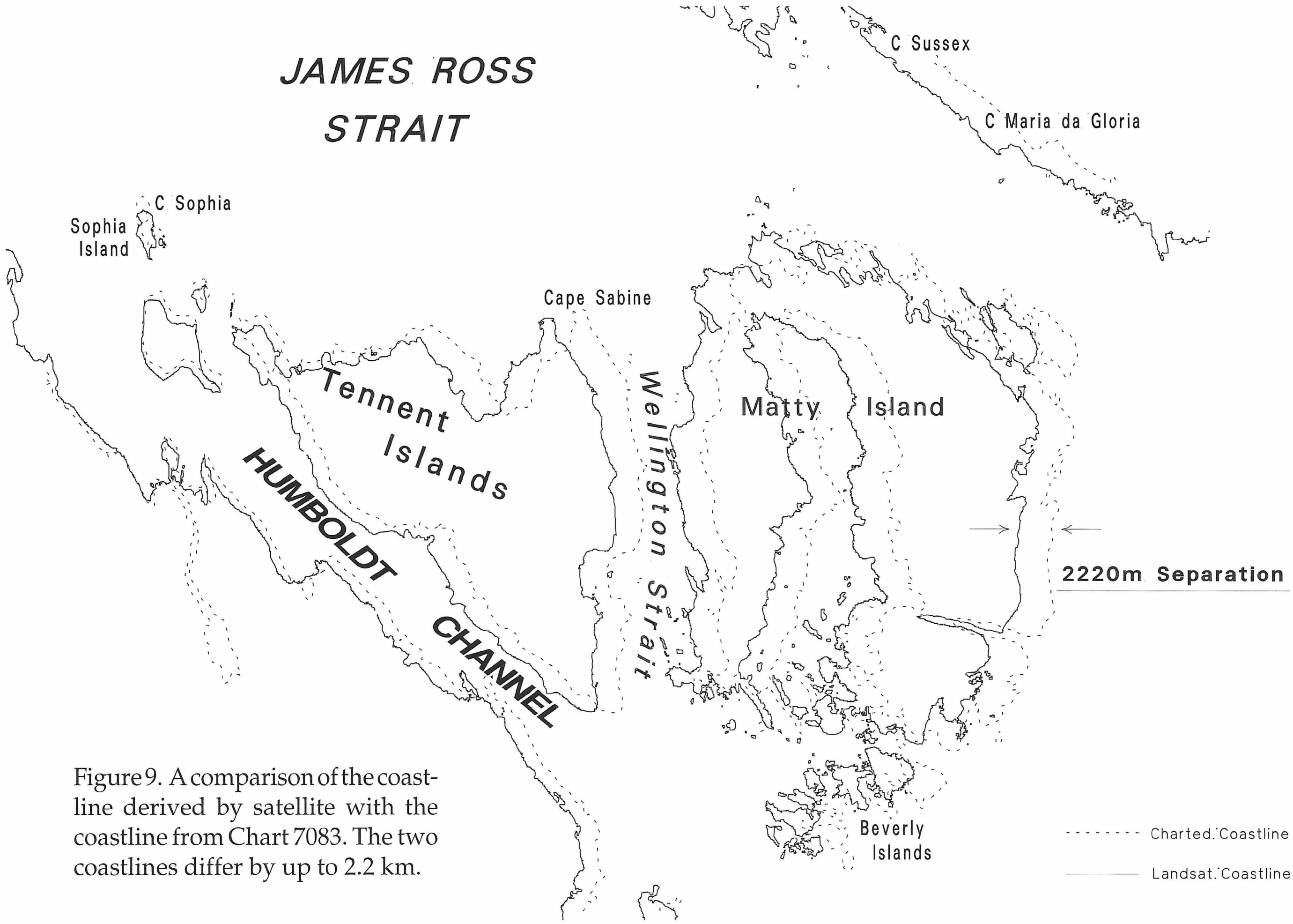


Figure 9. A comparison of the coastline derived by satellite with the coastline from Chart 7083. The two coastlines differ by up to 2.2 km.

Careful scrutiny was given to several instances where an island was reported by one source and not the others, particularly island features observed only in the imagery which were located well removed from land. For all of these the Landsat data give the same spectral signature as other confirmed island features. An example is shown in Figure 7. In this case, the intensity of the visible infrared suggests the likelihood of vegetation. However, one "island" in Queen Maud Gulf (Figure 8) remains a mystery. It is known from 1994 surveys that the island is not present and that the waters are 100 metres deep. Perhaps this is some dirty ice or ice-rafted vegetation. There is no signature in the thermal infrared, making it unlikely to be a vessel.

In the past two field seasons, survey parties in Victoria Strait and Queen Maud Gulf were able to perform GPS checks of the satellite-derived shoreline. Where fixes on the old chart plot up to 2 miles or more in error, there is no plotable error on the new product. These checks are not rigorous enough to determine an absolute accuracy figure, but it is expected from the statistical analysis of the methodology and from the comparison to large scale survey data that most positional errors are within 50 - 100 metres. The differences observed between the two coastlines were frequently large (Figure 9).

As previously mentioned, the derivation of the shoreline in some places (*e.g.*, river deltas, lagoons) is not straightforward. However, for navigation purposes, at scales such as this chart, such details are irrelevant and could be added by digitizing from an existing map.

Perhaps the best approach to resolve queries and anomalies as described above would be to examine other imagery for confirmation. For now, islands that are charted but do not show up in the imagery are probably best left on the chart, but marked "ED" (Existence Doubtful), and other anomalies may have to be labelled as "Rep 1994" (Reported in 1994), or "PA" (Position Approximate). The island feature shown in Figure 8 is currently being so investigated.

Rubber Sheeting the Bathymetry to Fit the New Coastline:

Given the large differences observed between the satellite-derived coastline and the current chart and that the satellite-derived coastline appears to be correct, it became necessary to consider how to adjust the existing bathymetry information to fit the new coastline. Rubber sheeting appeared to be the most cost-effective approach. The assumption was made that all of the old survey data was positioned relative to the land, mainly from radar, sextant, microwave, or Decca positioning. The rubber sheeting simply needed to be done so that the soundings would be moved to maintain their relationship to the land. Because distortions in the chart were not consistent, it was necessary to break the chart into a series of tiles and to rubber sheet each separately. Using a DEC Alpha system and new CARIS software, it was possible to rubber sheet the bathymetry successfully. The best results were produced with a spline transformation and at least 20 control points. The result is a NAD 83 chart which can be used for navigating the main passages with confidence.

Conclusion

The new NAD 83 chart is clearly much more accurate than the existing charts. It will easily satisfy mariners navigating with GPS and this approach is very cost-effective relative to previous methods for updating charts. The cost using this approach was estimated as $465 per 1 000 km¨ [Tomlins *et al.* 1995].

The success of this project prompted CHS to use the imagery and other data on hand to attempt rectification of four other larger scale (1:75 000 to 1:150 000) charts (7725, 7731, 7733, 7760) that are badly off-datum and fall within the bounds of chart 7083. These have recently been delivered by the contractors and are undergoing checking. To assist with the Quality Control, CHS Pacific has purchased PCI's Image Works software which will allow the overlay of the vector coastline on the imagery to resolve queries.

Acknowledgements

The assistance of many individuals is gratefully acknowledged. Jim Vosburg and Rick Quinn of Terra Surveys Ltd. provided information from recent surveys of Admiralty and Jenny Lind Islands. Bob Donegani and André Gagnon of Natural Resources Canada provided geodetic control information. Dave Thornhill of CHS and co-op student Jennifer Naylor assisted in the detailed examination of the derived coastline. Dr. Jim Gower and John Wallace of the Ocean Sciences Remote Sensing Group provided access to equipment and assisted in the examination of the imagery to address specific queries. Co-op student Jeff Duy investigated and resolved problems with topology. Doug Cartwright of CHS performed the rubber sheeting of the bathymetry. Terry Curran provided valuable administrative support and editorial comments. Funding for the work was provided by the Panel on Energy Research and Development (PERD).

Reference

Tomlins, G., Wainwright, P. and Woods, M., 1995, "Investigation of the Use of Satellite Remote Sensing for Charting Poorly Controlled Areas", Unpublished report by LGL Limited for the Canadian Hydrographic Service, P.O. Box 6000, Sidney, B.C., Canada, V8L 4B2.

About The Authors / À propos des auteurs

Mike Woods *joined the Canadian Hydrographic Service as an Hydrographer in 1970. He has worked on various assignments and is presently with the Geomatics Section, Pacific Region. Mike was the Scientific Authority for this project.*

Peter Wainwright *is a GIS and Database Specialist with LGL Limited, an environmental consulting firm located in Sidney, B.C. He has worked on GIS and database projects and research for 10 years. In his recent projects, remote sensing has played a major role in quality assurance and as a means of updating existing GIS data.*

Dr. Geoff Tomlins *is the president of Pacific Geomatics Ltd., a consulting firm located in Surrey, B.C. Since 1979, Dr. Tomlins has specialized in extracting valuable information from earth observation satellite data. Recently he has promoted the role of satellite image mosaics for large area mapping applications as well as the fusion of satellite imagery and elevation models.*

For more information please contact:

Mike Woods
Canadian Hydrographic Service,
P.O. Box 6000,
Sidney, B.C.,
V8L 4B2

Une mission au large de Boston (Massachusetts Bay), un exemple de partenariat international

R. Sanfaçon, a.f.

Introduction
Le mandat du Service hydrographique du Canada (SHC) est bien défini et l'autorise à oeuvrer au sein d'organismes internationaux. Ses politiques de travail en partenariat sont clairement énoncées et de plus en plus mises en pratique par la réalisation de projets conjoints. Pour le SHC, l'année 1994 a vu se concrétiser un des plus importants projets de relevés bathymétriques en terme de partenariat avec l'entreprise privée, le secteur universitaire et un gouvernement étranger. Il s'agit du projet de la Baie Massachusetts au large de Boston. Le projet représentait un défi de taille pour le SHC soucieux de ne pas rater son entrée sur la scène internationale dans le domaine du sondage multifaisceaux. L'enjeu, crucial pour toutes les parties impliquées bien qu'à différents niveaux, était pressenti comme lourd de conséquences.

Contexte
Constitué en 1883, le SHC cartographie les eaux canadiennes et internationales adjacentes par le biais de levés hydrographiques, de collectes de données sur les marées, de courants et niveaux d'eau et il publie l'information relative à la navigation (cartes, atlas de courants, tables des marées et données numériques). Membre de l'Organisation hydrographique internationale (OHI), il est représenté à l'Organisation maritime internationale (OMI) et maintient des liens avec les services hydrographiques de divers pays à travers le monde. La Commission hydrographique US/Canada est un organisme qui permet de faciliter ces liens avec nos voisins du sud.

Dans son désir de travailler avec des partenaires, le SHC est prêt à aider des universités et le secteur privé à avoir une visibilité internationale et démontre une ferme volonté de bâtir des partenariats internationaux menant à la recherche et au développement avancé de technologies et de services reliés à son domaine. De cette façon, le SHC bénéficie également de l'avancement technologique et d'une meilleure connaissance du fond marin.

Ainsi, informés de la volonté du SHC, en février 1994, le Dr. Larry Mayer et le Dr. John Hughes Clark, du Groupe de cartographie des océans (ou *Ocean Mapping Group-OMG*), de l'Université du Nouveau-Brunswick (UNB) rencontrent au *Woods Hole Oceanographic Institution* des confrères géologues des Services géologiques des États-Unis (USGS) et leur mentionnent les grandes possibilités qu'offre le navire F.G. CREED dont la base d'opération est à l'Institut Maurice-Lamontagne. Ils décrivent également les performances du système d'acquisition installé à bord, dont le sondeur multifaisceaux EM1000 permettant d'acquérir simultanément les profondeurs et l'imagerie sonore. Les géologues américains sont vite convaincus et se montrent très intéressés à utiliser le navire pour quelques semaines en 1994. Si cela fonctionne bien, ils espèrent créer un précédent chez eux, lequel pourrait tracer la voie à suivre en terme d'outils à utiliser pour des levés futurs. Les spécialistes de l'UNB, très enthousiastes à la perspective de ce projet, s'adressent ensuite au SHC afin d'initier une alliance stratégique bénéfique pour toutes les parties.

Préparatifs
Le SHC répond positivement à ce projet. Une telle initiative semble à première vue survenir à un moment opportun; elle présente de plus une occasion très appropriée de faire bénéficier le ministère Pêches et Océans (MPO) d'un enrichissement significatif en termes de connaissances de l'intégration de toutes les composantes et concepts pour développer une approche géomatique de gestion de la zone côtière (sous-sol, fond marin, colonne d'eau, gestion des pêches et des ressources marines). Plusieurs démarches administratives entre les bureaux du SHC impliqués (Ottawa, Halifax et Mont-Joli) sont alors initiées.

Le ministère des Affaires extérieures en est également informé, et il obtient des autorités américaines la permission pour le SHC d'effectuer des sondages marins aux États-Unis. Des contacts sont rapidement établis au niveau des responsables des navires de l'IML et de l'USGS. Puis, des formalités et des arrangements sont conclus avec la Garde côtière américaine (USCG) et des fournisseurs américains. La date de la mission est fixée du 2 novembre au 7 décembre 1994.

Pendant ce temps, le chef de mission nouvellement formé à l'opération du système à bord du F.G. CREED établit les contacts avec ses clients [USGS, *National Oceanic & Atmospheric Administration (NOAA)* et UNB]. Dans la course aux préparatifs, se trouve également un partenaire de l'entreprise privée canadienne, *Applied Analytics Corporation*, qui est à mettre au point un senseur de mouvement pour le F.G. CREED. Ce *motion sensor* canadien, à la fine pointe de la technologie, fonctionne sur le navire en parallèle avec un autre senseur, de conception britannique, durant l'été et l'automne; les deux technologies sont évaluées et comparées bien que l'appareil britannique soit considéré le plus performant du genre à ce jour. L'appareil canadien, lorsque mis au point, devait être de beaucoup supérieur et permettre une plus grande productivité. Le but visé par la compagnie *Applied Analytics Corporation* est de procéder à des ajustements nécessaires avant le départ de la mission, afin que son appareil soit utilisé pendant cette importante mission fortement médiatisée. Dans l'hypothèse d'une mission réussie, le projet de la Baie Massachusetts pouvait alors constituer une merveilleuse rampe de lancement pour ce produit canadien.

Au fur et à mesure que novembre approche, la tension augmente chez les participants de la mission. Certains problèmes avec le sondeur multifaisceaux sont éliminés et, à la mi-octobre, le senseur de mouvement ne fonctionne toujours pas aussi bien que prévu. La pression atteint son paroxysme à la fin octobre lorsque le F.G. CREED s'échoue lors de sa dernière mission dans la Baie des Chaleurs. Tous craignent que le transducteur du sondeur ait été touché. Pendant un certain temps, la mission est compromise. C'est le branle-bas de combat. Le navire est mis en cale sèche et réparé. Le sondeur n'a pas été endommagé, seul un couvercle de protection a cédé. C'est à l'Institut océanographique de Bedford (BIO) que les derniers tests sont faits à la suite de l'échouage. En mode opératoire, on constate un problème avec les données et le senseur n'est pas encore tout à fait au point. Il reste deux jours avant le départ pour Boston prévu alors pour le 7 novembre. Grâce à l'effort de tous, les problèmes sont éliminés et la plate-forme réparée devient complètement opérationnelle. Qui plus est, en route vers Boston, on constate, que les dernières modifications ont permis la mise au point finale du senseur canadien. C'est ce senseur qui sera utilisé pour la mission.

La mission américaine

Les zones à cartographier se trouvent dans la Baie Massachusetts (voir carte jointe). La première zone est le site de l'aboutissement du nouvel émissaire d'eaux usées en construction sous le fond de la baie. Cette surface est à environ 10 milles marins au large du port de Boston. En deux jours et demi, nous avons parcouru 554 kilomètres et couvert 81 kilomètres carrés. Les Américains sont impressionnés car ce travail leur aurait normalement pris de 2 à 3 semaines. De plus, les données obtenues avec notre outillage sont de qualité supérieure. La deuxième zone est le Banc Stellwagen, au nord de Provincetown sur Cape Cod. Cet endroit a été désigné parc marin et couvre 638 milles marins carrés. Il est prévu de couvrir la totalité de la surface en trois étapes d'environ 1 mois chacune. Lors de notre mission -qui a duré un mois-, nous avons parcouru 5 126 kilomètres de sondage et couvert 976 kilomètres carrés (environ 280 milles marins carrés) soit environ 44 % de la zone. Le SHC était responsable de l'acquisition des données et l'*Ocean Mapping Group* de l'Université du Nouveau-Brunswick assurait le traitement des données. Le produit est essentiellement constitué des données de bathymétrie et d'imagerie sonore pour tous les secteurs sondés. La mission fut un très grand succès. Notre partenaire américain a maintes fois exprimé sa très grande satisfaction et veut obtenir nos services pour 1995.

La compagnie canadienne, *Applied Analytics Corporation*, est extrêmement heureuse du dénouement. Fière des résultats obtenus, elle a déjà entrepris de vendre son produit sur les marchés européens.

Pour l'UNB, l'expérience fut très bénéfique. En effet, la réussite de ce projet a permis de faire connaître davantage son institution et son groupe sélect de recherche en cartographie des océans, en plus de mettre en valeur les logiciels de visualisation du fond en temps réel que l'UNB a développés et qui comptent parmi les plus performants au monde.

Conclusion

Comme nous pouvons le constater, ce projet comptait plusieurs enjeux stratégiques. Le succès de la mission a généré des bénéfices immédiats extrêmement positifs pour les partenaires de cette aventure. L'expertise et la technologie canadiennes ont réussi une percée remarquée chez nos voisins. Nous pouvons maintenant affirmer que l'expertise du SHC dépasse largement l'hydrographie. Récemment reconnu pour son parrainage de projets de recherche et développement (Système d'information sur les niveaux d'eau, Carte électronique, etc.), le SHC est aujourd'hui en train de se tailler une réputation de partenaire économique, de facilitateur et de gestionnaire de projet à grande échelle au niveau international. Celui de la Baie Massachusetts en constitue certainement un très bel exemple.

À propos de l'auteur / About the Author

Richard Sanfaçon, a.f., *Chargé de projet*
Division de l'Acquisition de données hydrographiques, Service hydrographique du Canada

For more information please contact:
Richard Sanfaçon
Service hydrographique du Canada
C.P. 1000, 850, Rue de la Mer
Mont Joli, Québec,
G5H 3Z4

Lighthouse Puzzler
Casse-tête du Lighthouse

by Beth Weller

Lighthouse Puzzler # 13

A hydrographer is retiring in March and three others are changing jobs. From several items you happened to see on the boss's desk the other day, can you figure out who is doing what?

The clues:

1. Carol and Corkum will not be working with CHS.
2. Jane Anderson is not changing regions within the CHS, but will not move east of Winnipeg.
3. Phil was not the one in touch with Offshore Surveyors.
4. Neil, who is not O'Connor, has left Quebec Region of CHS, but is not retiring.
5. The hydrographer from Offshore will be joining CHS.
6. O'Connor is looking forward to getting his 45 year pin from CHS, but is not retiring yet.

	Rogers	Anderson	O'Connor	Corkum	To retire	To Nautical Data Inc.	To CHS Pacific Region	To CHS Atlantic Region	From Offshore	From Universal	From CHS Quebec	From CHS Central
Carol												
Jane												
Phil												
Neil												
From Offshore												
From Universal												
From CHS Quebec												
From CHS Central												
To retire												
To Nautical Data Inc.												
To CHS Pacific Region												
To CHS Atlantic Region												

Solution to Spring Puzzler (#12)

Jane and Larry are at Norfolk (Clue 4) and are not with the lighthouse, the guide books or the marina (Clues 2, 3 & 4) so they must be at the weather station. Adam is in Victoria (Clue 1) and is not with the guide books or the marina (Clues 3 & 4) so he must be the lighthouse; he is not with Carol or Marg (Clues 2 & 5) or Jane so he must be with Judith.

Marg is in Scotland (Clue 5) and, by elimination, must be with Bob working on the guide books, and Carol is with Rob at the marina in Newfoundland.

Book Review / Critique de livres

The Admiralty Chart

R.W. (Sandy) Sandilands

Rear Admiral G.S. Ritchie. *The Admiralty Chart (A New Edition)* Durham: The Pentland Press Ltd., 1995. xiv + 444 pp., 12 maps, 7 illustration, 4 photographs, bibliography, index. U.K. £19.50, casebound; ISBN 1-85821-234-0.

For those who missed the first edition of this excellent history of The Admiralty Chart, first published in 1967, Admiral Ritchie has written an updated edition with some corrections that have been brought to his attention by further research, mainly by Lieutenant Commander Andrew David R.N. who spent many years in the Sailing Directions Division of the Hydrographic Office in Taunton and who is well known as an hydrographic historian.

This edition is timely, coinciding with the 200th anniversary of the establishment of the Hydrographic Office of the Royal Navy. The book covers the leadership of the Hydrographers of the Navy from Dalrymple, appointed in 1795 and the only civilian to hold the position, through to Wharton, who retired in 1904.

The period was the golden years of hydrographic surveying where the "greats" sailed from England to survey the unknown or largely unknown continents of the world. Cook is acknowledged to be the father of British scientific hydrography and he founded a school of surveyors among his junior officers, such as Vancouver and Bligh, who in time became leaders of expeditions and passed their acquired and refined methods of surveying to officers such as Mudge, Broughton, Flinders and others and on throughout the century.

The great continental surveys and their hydrographers are dealt with in individual chapters, each chapter illustrated with a map showing their progress and places of significance in the toponymy of the period.

Of specific Canadian interest are the chapters on Vancouver, the Northwest Passage and part of the Arctic and Antarctic.

Methods of hydrographic surveying during the period are initially covered by descriptions in an early chapter which admirably covers the early rivalry to produce a shipborne timepiece or chronometer, it having been early recognized that the solution to the longitude problem was the observation of the sun's meridian compared to that of the Greenwich Observatory by the accurate carrying of time from there. The irascible Belcher, Canadian born, added much theoretical but often impracticable treatises on beacon surveying offshore, and probably the use of lime – whitewash – in marking shore stations can be attributed to him! Today's environmentalists would not approve of the way we old-timers used to splash it around our coasts. Mention is also made of surveying practices in the general chapters.

The sad story of Flinders who was imprisoned by the French at Île de France (Mauritius) on his passage home from the long and arduous survey of Australia is particularly poignant. He had left his newly married wife and his return was delayed six and half years during diplomatic discussions between Paris, London and Île de France. In all he was ten years out of England and died three years after his return.

A fellow prisoner of Flinders was W.F.W. Owen who surveyed our Great Lakes and recruited Bayfield who carried on the surveys. Owen was given the task of surveying the coast of Africa. Scurvy had long been the decimator of naval crews but malaria killed his crews at a tragic rate. Ritchie notes that "New-found features ashore or under the sea were easy to name for the men who continued to die aboard, and each was made immortal – in fact there is not a remarkable spot between English River and Morley's Bank that does not record the fate of our departed shipmates."

An interesting personal note is brought to mind by one of Ritchie's delightful asides, namely, the practice of naming sounding boats after earlier surveying ships. Owen's ships on the African expedition were the ship–sloop *Leven* and the brig *Barracouta*. Over forty years ago while serving on board the H.M.S. *Owen*, I spent many long days sounding in the launch *Barracouta*. These asides show Ritchie's great knowledge of the minutia and add greatly to the reader's pleasure without disturbing the thread of his story.

Whilst the continental hydrographers are familiar names, those who surveyed the home waters of Britain are not so well known. It was not until Beaufort assumed the office of Hydrographer that a concerted effort was made to chart them. Thomas Snr. and Jnr., Bullock, Sheringham, Denham, Hewett, Beechey, Otter, Mudge, Frazer, Robinson, White, Williams and Slater are recognized in this "Grand Survey of the British Isles". It too had its human cost, the Fairy being lost with all hands off

Orfordness and Slater falling to his death off a cliff whilst ashore observing.

It was largely due to Denham's activities on the Mersey that a permanent hydrographic service was established for Liverpool and this was followed by several other of the large ports in the U.K.

War with Russia in 1854 – 56 brought new challenges to hydrographers as their skills were brought into play in surveying approaches to ports and finding suitable landing beaches, as Cook had done in the St. Lawrence and unheralded hydrographers did in W.W. II.

George H. Richards, a name well known to Canadian west coasters, became Hydrographer in 1863 and the Hydrographic Office showed marked expansion in his term of office. It also marked a more official approach to oceanography, physical charts of the oceans being produced to assist in planning the voyages of the world's commercial sailing fleets showing as they did prevailing winds, currents and other meteorological data. His successor, Evans, continued this trend initiating charts showing curves of equal magnetic variation.

Wharton is the last hydrographer in the period covered by the book. As a young Lieutenant he had surveyed in the Bay of Fundy and had impressed his seniors in the difficult task, well known to east coast hydrographers, of coping with forty plus foot tides. His period of office was marked by a further increase in scientific surveying and he left the legacy of his Manual of Hydrographic Surveying. This was an up-to-date successor to Belcher's work and was a hydrographer's Bible well into the 20th century.

Canadian hydrographers of the 70's and 80's will remember efforts to evaluate production in the field and there was an attempt by Wharton to effect this, known as the "acreage report", as a method of evaluating hydrographers for promotion. However, as it must always be, accuracy was giving way to acreage and other methods of evaluation were found. But the pressures were there on the surveying captains and Ritchie gives several excerpts from a book called The Bogus Surveyor by Whitewash – the Surveyor's Friend – a nom de plume of a Lieutenant C.H.A. Gleig. Last listed in the Navy List as an assistant under Vereker in Rambler, his name vanishes from the hydrographic specialists at the time the book was published! The excerpts are cynically amusing and copies of the book were much sought after. In the days before photocopying I was loaned a typewritten copy and spent many off duty hours hunting and pecking on a portable typewriter making my own copy, sadly mislaid over the years.

Not in the original edition, there is an excellent introductory essay by Andrew David on a few of the relatively unknown hydrographers whose exploits and surveys played an important part in the development of the Hydrographic Office.

During the period covered by the book, the Admiralty produced a world wide folio of over 2,500 charts, all copper plate engraved, and these charts gained a reputation for accuracy not equaled by any other nation.

In addition to the maps mentioned, the book is illustrated with a suitable selection of etchings, reproductions of paintings and photographs of the period.

The bibliography, as one would expect, is extensive and is referenced by chapter and I found the index to be excellent.

The dustcover cites the following reviews of the "First Edition". "An expert exploration of most of the world's coastlines under the pressures of trade, politics, war and sheer adventure", The Time's Literary Supplement, and "This is a book to be read by all who love the sea." The New Scientist.

What more need be said.

R.W. (Sandy) Sandilands

Footnote:

Readers who prefer their history of Flinders in the form of a novel should try to obtain the Australian Classics Series My Love Must Wait by Ernestine Hill, pub. 1941, reprint 1971 by Lloyd O'Neil, Victoria, Australia. A Harlequin romance title but historically correct and the only novel I have found with a hydrographic theme.

About the Author / À propos de l'auteur

R. W. "Sandy" Sandilands was born and educated in Edinburgh, Scotland, and joined the Royal Navy in 1942, becoming a hydrography (H) specialist after the war. In 1954 he resigned his commission and came to Canada, serving with the Canadian Hydrographic Service until his retirement in 1989, by which time he had reached the position of Assistant Director, Hydrography, in Pacific Region. He and his wife June are now enjoying retirement in Victoria B.C.

Ends of the Earth
Au bout du monde

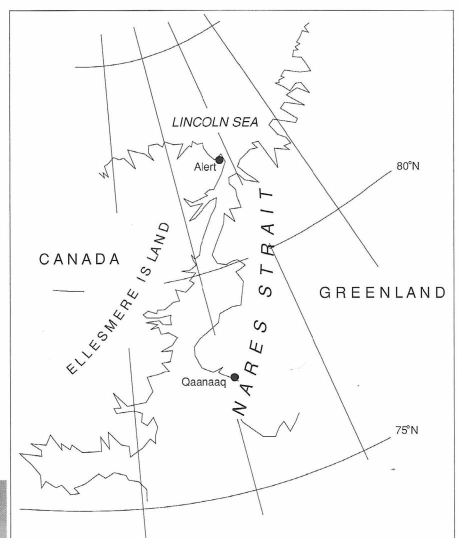
by Andrew Leyzack

A New Lighthouse feature ***Ends of the Earth*** *describes the activities of hydrographers and those practising related disciplines afield. We encourage readers everywhere to send accounts of their own work.*

The Nares Strait separates Canada's Ellesmere Island and Greenland (Denmark) by a mere 12 nautical miles at its narrowest point. Throughout the strait, during clear conditions, one may observe both countries at a glance; the majestic peaks which rise above the Canadian coastline and the palisade cliffs which mark the edges of the Greenland ice cap. This is where icebergs begin, calved from ancient glacial structures such as Greenland's Humboldt Glacier, the largest glacier in the world.

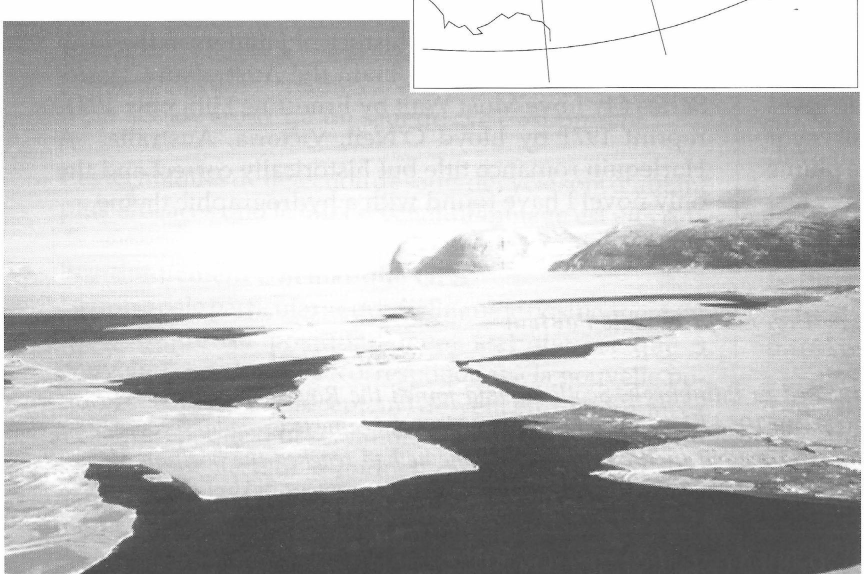
Ellesmere Island and Nares Strait comprise one of the last major voids in Canada's Gravity Data Base. Bathymetry in the Strait is also very limited. A complete gravity survey of the Strait was undertaken to resolve discrepancies in plate tectonics reconstruction as a method of determining past movements between continents.

The Nares Strait gravity survey was part of a co-operative effort between the Canadian Hydrographic Service, Geological Survey of Canada (GSC), the Defence Mapping Agency (DMA), and the National Survey and Cadastre of Denmark (KMS). Roy Cooper (GSC) was party chief for the survey, which ran from May 8 to 25th, 1995, beginning at Qaanaaq, Greenland and ending at CFS Alert. The hydrographic staff included Rudy Cutillo (Engineering and Technical Services), Ken Dexel and myself (Field Surveys).



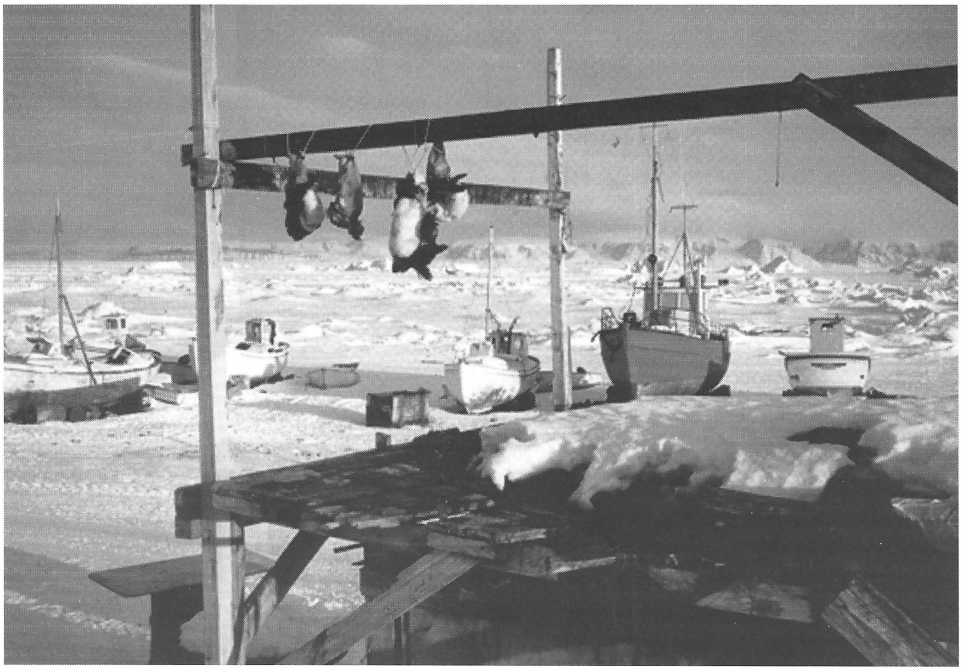
Upon our arrival in Greenland, it was discovered that most of the Kane Basin and Smith Sound were free of ice. Remaining shore fast ice permitted us to acquire 195 soundings/gravity stations at 12 km spacing in the areas of Alexandra Fjord, Peabody Bay, Kennedy Channel, Hall Basin and north through Robeson Channel. Some of the larger free-floating ice pans proved adequate platforms for spot sounding, but were too unstable to obtain even dampened gravimetry readings.

The diversity of the topography of this region was matched by its weather conditions. While the skies over our base camp may have promised a good day's work, a half hour flight out to the Strait would find us in the midst of snow squalls and fog. Air support was provided by two Canadian Helicopters' Bell 206 Long Rangers on contract from the Polar Continental Shelf Project. The helicopters were equipped with Ashtech Z12 (12 channel, P code) GPS receivers, and Knudsen 320A, arctic echo sounders. GPS positions were post-processed differentially using Ashtech's 'Prism' software. Frans Rubek, student geodesist and our liaison with the KMS, headed up a one day survey expedition to collect gravimetry by dogsled. One of the team's sleds was retrofitted with an echo sounder, and a hand-held GPS receiver for navigation and positioning. The native drivers were thrilled to see the GPS, 'speed over ground' display, as they mushed their teams enthusiastically over the ice.



Nares Strait looking north, Greenland to the right.

The early spring break-up which hampered our survey operations was a welcome sight to the Thule who were preparing for the spring Narwhal hunt. Qaanaaq, home of the Thule people is situated on the north side of Murchison Sound at the mouth of Inglefield Bay, latitude 77° 30′ N. Fresh water from several glaciers flows into Inglefield Bay. The brackish waters at the head of the bay are a natural mating ground for the Narwhal and for generations of Thule, the chosen hunting ground. Unlike their Canadian counterparts, the Thule are not restricted to a quota system, but must achieve their kills by traditional methods. The use of kayaks for whaling and dogsled for hunting seal and bear is supposed to give the animal a fair chance of survival, while fostering the old ways. There are no snowmobiles in Qaanaaq, and sled dogs outnumber humans by four to one.



Fishing fleet at Qaanaaq.

During the seventies, as a means of resolving a boundary dispute between Denmark and Canada, the CHS participated in control surveys throughout the Strait. Hans Island, a disputed possession, located mid channel, was eventually designated as Canadian by the International Boundary Commission. When hydrographer Ken Dexel landed at Hans Island to occupy some of the old stations he found signs of Danish occupation. There were the remains of a Danish Flag hoisted atop a rickety flag pole and a letter written by some visiting Danish soldiers. In the name of sovereignty, we decided to revisit Hans Island with the Maple Leaf. Unfortunately, weather was not on our side by this time and the flag donated by the good folks at CFS Alert never fulfilled its calling. The survey is scheduled to return April/May 1997 with hopes of better ice conditions. The flag will be onboard.

Left to right: Roy Cooper, Rudy Cutillo, Ken Dexel and Andrew Leyzack.

Coming Events
Événements à venir

Geomatics 1996
8th International Conference on Geomatics
May 28 - 30, 1996
Ottawa Congress Centre, Ottawa Canada

The theme of Geomatics 1996 is: "The Business of Geomatics: Real Solutions for Real Problems". Decision-makers are turning to Geomatics to solve problems of business location and management, resource allocation, community growth, government information requirements, environmental management, client needs as well as workforce downsizing and budget cuts. It is increasingly critical for those in business to know the who, what, where and why of business to remain profitable in today's market. Individuals who know how to use the building blocks of Geomatics gain that competitive advantage.

With its broad base of support and interest, the Conference deals with an ever increasing area of daily life - the use of spatial data.

The technical program will be structured around the following topics:

• **Products:** Real Time Applications, Shipping, Monitoring and Tracking, Map Updates, the GPS Business, Exploitation Monitoring and Mapping, and Environmental Information.

• **Services:** Cadastral Reform, Shipping and Routing, Banking, Real Estate, Property Assessment, Insurance, Risk Analysis, Site Location, Demographics and Geographics, and Market Research and Strategies.

• **Technology Transfer:** Human Resources Development, Training Requirements, International Opportunities and Consulting, Distance Education/Learning, Geomatics Standards, Applications Developments, GPS and DGPS, Remote Sensing Information Extraction, Data Fusion Methodologies, RS/GIS/GPS, Planning and Monitoring Requirements, Municipal Applications, and Socio-Economics.

• **Infrastructure Technology and Information Access:** GPS, GIS, End to End Systems, and Systems for Information Access and Distribution.

For Information Contact:
Dr. M. D'Iorio, Chairman, Technical Program,
Geomatics 1996
615 Booth Street, Room 220
Ottawa, Ontario, Canada K1A 0E9
Tel. (613) 996-2817 Fax. (902) 947-7059

Canadian Hydrographic Conference '96
Conférence hydrographique canadienne '96
June / juin 3-5, 1996
Halifax, Nova Scotia / Nouvelle-Écosse

Announcement

The theme of CHC'96, "Hydrography and Marine Navigation: Defining the Future Direction", responds to the dynamic changes that have been taking place during the past several years in Differential Global Positioning System, Mult-Beam Acoustic Survey Systems and Electronic Chart Display and Information System.

Each day of this three-day conference will have a dedicated topic: DGPS on day one, Multi-Beam Survey Systems on day two and ECDIS on day three. Also, a significant amount of time has been scheduled for demonstrations on two ships, the CSS *Matthew* and the CSS *Frederick G. Creed*, plus four survey launches in Halifax Harbour.

Annonce

Le thème de CHC'96, "L'hydrographie et la navigation maritime : Définir l'orientation future", reflète les changements dynamiques survenus ces dernières années dans les domaines de positionnement, levés hydrographiques numeriques, et navigation maritime.

Chacun des trois jours de la conférence sera consacré à un sujet: le SPGD le premier jour, les systèmes de levés multifaisceaux le deuxième et le SEVCM le troisième. On a aussi alloué suffisamment de temps pour des démonstrations à bord de deux navires, le NSC *Matthew* et le NSC *Frederick G. Creed*, ainsi qu'à bord de quatre vedettes hydrographiques dans le port de Halifax.

Questions and enquiries should be directed to:
Les questions et des demandes des renseignements devrais être envoyés à:

Canadian Hydrographic Conference '96
Conférence hydrographique canadienne '96
Canadian Hydrographic Service
Department of Fisheries and Oceans
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia
Canada B2Y 4A2
Tel. (902) 426-3624 Fax. (902) 426-1893
email: CHC96@bionet.bio.ns.ca

Coastal Zone Canada '96

This International Conference is the second in the continuing inter–disciplinary series begun in 1994 in Halifax, Nova Scotia. We invite you to participate in **Coastal Zone Canada '96** (CZC '96) to be held in Rimouski, Québec, Canada, on 12–17 August 1996. The theme of the conference is 'Integrated Management and Sustainable Development in Coastal Zones'.

One of the most important lessons that has been learned during the 1990's is that there must be integrated management and sustainable development of coastal areas, including Exclusive Economic Zones. Continuing the tradition of the United Nations Conference on the Environment and Development in 1992 (UNCED '92 and Agenda 21), the World Coasts Conference in 1993 and the Coastal Zone Canada (CZC) Conference have been designed to advance the integrated planning and management of our coastal areas.

Papers and Case Study Presentations are invited from national and international coastal zone stakeholders, community–based organizations, scientists and engineers, governments and primary resource users, industry and business. This international conference will feature oral and poster presentations, plenary panel sessions and round–table discussions in the following subject areas:

- Scientific Tools for Monitoring, Classification, Surveillance and Management of Coastal Environments.
- Environmental Quality, Pollution Impacts and Coastal Oceanography
- Climate Change, Sea Level Rise and Natural Disaster Impacts
- Cultural–Socio–economic and Political Considerations in Coastal Development
- Legal Issues and Problem Solving in a Multi–use Environment
- Conservation and Protection of the Coastal Zone
- Survival and Development of Coastal Communities
- Public and Formal Education in Coastal Zone Management
- Promotion of Environmentally Sound Technology
- Management and Development of Coastal Zone Resources
- Coastal Zone Policy and Institutional Arrangements
- Regional and International Issues
- Agenda 21: A Vehicle for Action?

Other coastal subjects are encouraged. Proposals for round–table sessions are also invited. Individuals wishing to submit a paper or poster for CZC '96 should send an abstract of no more than 300 words in either English or French to the Chair of the Scientific Committee, no later than 1 February 1996. Please ensure that your complete address, telephone and fax numbers are included. A diskette copy (Word Perfect, World or ASCII format) of the abstract would be much appreciated. Notification of acceptance will be sent in February – March 1996.

A Major Trade Show and Exhibition is planned to allow private companies and public organizations involved in coastal/marine activities to meet with attendees and discuss innovative technologies, approaches and business opportunities. Write to the **Coastal Zone Canada '96 Secretariat** for details.

General Information. The CZC '96 Conference will be held at the Université du Québec à Rimouski Campus. Rimouski is well known for its coastal and marine sciences research and famous for its hospitality. The Conference is organized by the Groupe de Recherché en Environment Côtier (GREC), Université du Québec, jointly with the Coastal Zone Canada Association.

For more information or in order to receive the second announcement, please write to:

Professor Mohammed El-Sabh,Coordinator
Coastal Zone Canada '96 International Conference,
Groupe de recherché en environnement côtier,
(GREC), Université du Québec,
310, allée des Ursulines,
Rimouski, Quebec, Canada G5L 3Al.

HYDRO 96

The Hydrographic Society's tenth international biennial symposium will be held at the De Doelen Congress and Exhibition Centre, Rotterdam, from September 24-26, 1996.

Organised by The Society's Benelux Branch and expected to attract worldwide participation, Symposium topics will be wide-ranging and addressed to key hydrographic issues affecting port and other applications. They include: Port and Coastal Surveys, Port and Coast Geodesy and Navigation, Dredging Surveys, Mapping, and Water Management.

Proceedings will be supported by an exhibition of equipment and services at which the Port of Rotterdam will be a major participant.

Prospective speakers and organisations wishing to participate should contact:

Mrs. P.Y. van den Berg
Hydro 96 Organising Committee
Oceangraphic Company of the Netherlands
P.O. Box 7429
2701AK oetermeer,
The Netherlands
Tel: 01419 835381 Fax: 01491 826344
(Tel: +31 7942 8316, Fax: +31 7941 5084)

Sustaining Members
Membres de soutien

Sustaining membership allows companies closely linked with the hydrographic field to become more involved with the activities of the CHA and to maintain closer contact with users of their products. Through LIGHTHOUSE these Sustaining Members are also able to reach a world-wide hydrographic audience. The benefits of Sustaining Membership include:

- a certificate suitable for framing;
- three copies of each issue of Lighthouse;
- copies of the local Branch newsletters, where available;
- an invitation to participate in CHA seminars;
- an annual listing in Lighthouse;
- an annual 250 word description in Lighthouse; and
- discounted advertising rates in Lighthouse.

Annual dues for CHA Sustaining Membership are $150.00 (Canadian).
Current Sustaining Members are listed below.

Aanderaa Instruments Ltd.
100 - 4243 Glanford Avenue
Victoria, British Columbia
Canada V8Z 4B9 Fax: (604) 479-6588
contact: Gail Gabel *(affiliation - CHA Pacific Branch)*

Cansel Survey Equipment
3751 Napier Street
Burnaby, British Columbia
Canada V5C 3E4 Fax: (604) 299-1998
contact: Bo Skapski *(affiliation - CHA Captain Vancouver Branch)*

Garde côtière canadienne
104 rue Dalhousie, Suite 311
Québec, Québec
Canada G1K 4B8 Téléc: (418) 648-4236
contact: Claude Duval *(affiliation - ACH Section du Québec)*

l'Institut maritime du Québec
53 St-Germain Ouest
Rimouski, Québec
Canada G5L 4B4 Téléc: (418) 724-0606
contact: Claude Jean *(affiliation - ACH Section du Québec)*

Quester Tangent Corporation
9865 West Saanich Road
Sidney, British Columbia
Canada V8L 3S3 Fax: (604) 655-4696
contact: John Watt *(affiliation - CHA Pacific Branch)*

Simrad Mesotech Systems Ltd.
202 Brownlow Avenue
Dartmouth, Nova Scotia
Canada B3B 1T5 Fax: (902) 468-2217
contact: John Gillis *(affiliation - CHA Central Branch)*

terra surveys ltd.
1962 Mills Road,
Sidney, British Columbia
Canada V8L 3S1 Fax: (604) 656-4604
contact: Rick Quinn *(affiliation - CHA Pacific Branch)*

Institut maritime du Québec

À la demande du Service hydrographique du Canada, l'Institut maritime du Québec (IMQ) dispense actuellement une formation théorique et pratique en navigation, matelotage, mécanique de marine et en électronique maritime à des Égyptiens qui assureront un soutien technique aux équipes d'hydrographes qui réaliseront, au cours des prochaines années, des levés hydrographiques sur plus de 1000 km sur le Nil, en Égypte.

Du 11 au 22 juin dernier, en Égypte, M. Philippe Canniccioni, professeur de navigation à l'Institut maritime du Québec, a assuré la formation en navigation et en matelotage d'une quinzaine de personnes qui opéreront les petits bateaux qui serviront à réaliser les levés hydrographiques. Par ailleurs, depuis le 19 juin et jusqu'au 12 août prochain, MM. Gratien Lebrun et Raymond Tardif, respectivement professeur d'électronique maritime à l'IMQ à Rimouski et de mécanique marine au centre de formation continue de l'IMQ à Montréal, et M. Éric D'Amours, professeur de mécanique marine au Centre spécialisé des pêches de Grande–Rivière, en Gaspésie, offriront une formation théorique et pratique sur l'installation et l'entretien de petits moteurs marins diesels et de moteurs de hors–bord ainsi que sur l'utilisation et l'entretien d'appareils d'aide électronique à la navigation et pour les levés hydrographiques à MM. Gamal Abdel Aziz Khaled El–Sabbagh, en stage au siège social de l'Institut à Rimouski.

Ce projet, parrainé par l'A.C.D.I. et réalisé par le Service hydrographique du Canada en collaboration avec S.N.C. Lavallin et le Centre national de recherche sur les eaux du Nil, vise le développement et la protection du Nil, le fleuve le plus long du monde. La coordination de ce projet à l'IMQ, a été confiée à M. Léo Morissette, responsable du Centre de formation continue de l'IMQ à Rimouski.

Terra Surveys Ltd.

Earlier this year, Terra participated in a search for marine placer diamond deposits aboard a Russian marine geophysical vessel off the coast of Sierra Leone. The project involved DGPS, high resolution seismic reflection and vibro-core drilling. Needless to say it was a project with an element of adventure, but proved to be quite successful.

Terra has been busy with several jobs, such as the B.C. Ferries Sea Trials for the newly refitted Queen of New Westminster. They have also collected data for a side scan/bathymetry project off of the United States coast for Oregon Fish and Wildlife. A recently completed air-gun geophysical exploration job for Syncrude on the Athabasca Riover went well.

Remote Sensing

Terra's most recent lidar bathymetry job was flown for Mobil Oil off of Sable Island, Nova Scotia in late September. X, Y, Z data and video mapped shoreline is being quickly processed for delivery by mid-October.

Terra Survey's video mapping system was busy in the summer flying for West Kootenay Power.

Upcoming Projects

The next survey to be performed is a sidescan job for B.C. Hydro in Georgia Strait in October. More video mapping is also in the works in eastern Canada.

Quester Tangent Corporation (QTC)

Quester Tangent continues to expand and diversify its markets with our people becoming more mobile than ever. Hold onto your hats and passports as we follow "two months in the travel life of Quester Tangent." Sean Duffey is now in Goa, India delivering a month-long training course. Prior to this, he had completed six weeks of installation, commissioning and training exercises in Egypt. Sean's itinerary also included the Indian cities of Bombay, Cochin, Visag, Dehradun and Delhi. John Watt is also currently in India and will be visiting Delhi, Bombay, Goa, Calcutta and Vishakaputnam. He then travels to Singapore and Johor Baru before returning to Bombay.

Meanwhile, Paul LaCroix, Dan Young and Andre Sodermans are in Quebec City for a few weeks of system commissioning. Graham Rankine will join them later this month. In November, Paul will meet John Watt and Sean Duffey in Bombay for a series of equipment trials.

Brad Prager is in Newfoundland doing further QTC VIEW operations. Previously he was attending QTC VIEW trials in Baton Rouge, Louisiana. Fraser Rea and Henrik Christensen attended design reviews with Bombardier in Kingston and then travelled to the Baton Rouge demonstrations. Fraser is currently in San Diego with Rob Inkster attending Oceans '95; the QTC VIEW is the highlight of our booth. During the conference, Rob will present "Bottom Classification: Operational Results from QTC VIEW." Following the conference, Fraser is off to the United Kingdom and France.

Application for Membership
Formule d'adhésion

I hereby make application for membership in the Canadian Hydrographic Association and if accepted agree to abide by the constitution and by-laws of the association.

Je désire devenir membre de l'Association canadienne d'hydrographie en tant que et si ma demande est acceptée je m'engage à respecter la constitution et les règlements de cette association.

☐ Member / membre
$30.00
(for most branches/pour la plupart des sections)

☐ Sustaining Member / membre de soutien
$150.00

☐ International Member / membre international
$30.00

Name/Nom ____________________

Address / Adresse ____________________

____

Telephone / Téléphone ____________________ (Home / Résidence) ____________________ (Business / Bureau)

Employed by / Employeur ____________________ Present Position / Post Occupé ____________________

Citizenship / Citoyenneté ____________________ Date ____________________

Canadian Hydrographic Association
Association canadienne d'hydrographie

The **Canadian Hydrographic Association (CHA)** is a non-profit, scientific and technical group of about 500 members with the objectives of:

- advancing the development of hydrography, marine cartography and associated activities in Canada;
- furthering the knowledge and professional development of its members;
- enhancing and demonstrating the public need for hydrography;
- assisting in the development of hydrographic sciences in developing countries.

It is the only national hydrographic organization in Canada. It embraces the disciplines of:

- hydrographic surveying;
- marine cartography;
- marine geodesy;
- offshore exploration;
- tidal and tidal current studies.

The Canadian Hydrographic Association is formally affiliated with the Canadian Institute of Geomatics. It is informally associated with the Hydrographic Society.

<u>What the CHA Can Do For You</u>

- advance your knowledge of hydrography, cartography and associated disciplines, and keep you abreast of the latest development in these disciplines;

- enable you to develop and maintain contacts with others involved with hydrography, nationally and internationally.

These benefits are provided through the publication of LIGHTHOUSE (one of only three journals in the world devoted exclusively to hydrography), through the sponsorship of seminars, colloquiums, training programs, national conferences, and branch and national meetings.

<u>Lighthouse</u>
The journal of the Canadian Hydrographic Association, LIGHTHOUSE, is published twice yearly and distributed free to its members. Timely scientific, technical and non-technical papers and articles appear in the journal, with authors from national and international academia, industry and government. Present circulation of LIGHTHOUSE is approximately 700.

<u>Membership</u>
Membership is open to all hydrographers, those working in associated disciplines, and those interested in hydrography and marine cartography.

<u>Branch & Regional Activities</u>
The Canadian Hydrographic Association has seven (7) branches located across Canada. National headquarters is located in Ottawa.

For further information write to:

National President
Canadian Hydrographic Association
P.O. Box 5378, Station F
Ottawa, Ontario
Canada
K2C 3J1

L'Association canadienne d'hydrographie (ACH) est un organisme sans but lucratif réunissant un groupe scientifique et technique de plus de 500 membres ayant des objectifs communs, comme:

- faire progresser le développement de l'hydrographie, de la cartographie marine et de leurs sphères d'activités au Canada
- permettre les échanges d'idées et le développement professionel de ses membres
- rehausser et démontrer l'importance de l'hydrographie auprès de public
- assister au développement des sciences de l'hydrographie dans les pays en voie de développement

Au Canada, l'Association est la seule organisation hydrographique qui embrasse les disciplines suivantes:

- levé hydrographique
- cartographie marine
- géodésie marine
- exploration extra-côtière
- étude des marées et courants

L'Association canadienne d'hydrographie est affiliée à l'Association canadienne des sciences géomatiques, et non-officiellement liée à la Hydrographic Society.

<u>Ce qu'elle peut faire pour vous</u>
<u>L'ACH vous offre des avantages tels que</u>:

- parfaire vos connaissances de l'hydrographie, de la cartographies et des disciplines connexes, tout en vous tenant au courant des nouvelles techniques et des derniers développements réalisés dans ces domaines;

- établir et maintenir des contacts avec ceux qui oeuvrent en hydrographie, au niveau national et international.

Ces avantages sont transmis par l'entremise de LIGHTHOUSE (une des trois revues au monde traitant exclusivement d'hydrographie) et par la tenue de séminaires, de colloques, de programmes de formation et d'assemblées régionales et nationales.

<u>Lighthouse</u>
La revue de l'Association canadienne d'hydrographie, LIGHTHOUSE, est publiée deux fois l'an et distribuée gratuitement aux membres. Des articles scientifiques, techniques et non techniques, provenant du milieu de l'industrie ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 700 copies.

<u>Comment devenir membre</u>
Le statut de membre est offert aux hydrographes et à tout ceux oeuvrant ou ayant un intérêt dans des disciplines associées à hydrographie ou à la cartographie marine.

<u>Sections et activités régionales</u>
L'Association canadienne d'hydrographie possède sept (7) sections à travers le Canada. L'administration central se trouve à Ottawa.

Pour plus d'informations, s'adresser au:

Président national
Association canadienne d'hydrographie
C.P. 5378, station F
Ottawa, Ontario
Canada
K2C 3J1

The Canadian Hydrographic Association
L'Association canadienne d'hydrographie
Academic Award / Bourse d'étude

(established / constituée en 1992)

Rules for eligibility:

1. The applicant must be a full-time student registered in an accredited program related to Hydrography (these programs include, Geomatics, Geography, Cartography or Survey Sciences) in a university or technological college in Canada. The CHA Academic Award administrators reserve the right to determine applicability of the program.
2. The award will be available only to students who have completed at least one year of instruction in the program.
3. The applicant will be required to write a 500 word paper on the relationship of their academic work to hydrography.
4. The applicant will be required to write a short paragraph explaining how this financial award will assist them in their academic career.
5. The awards applications must be submitted to the CHA Academic Awards Manager by the end of June of the applicable year. The award will be given by September 15th of the same year. All officials from the academic institutes of students submitting applications will be notified by mail of the results.
6. The value of the award will be $ 2000.00.
7. The successful candidate will receive a special Canadian Hydrographic Association certificate.
8. The successful candidate will be requested to write a letter of appreciation to the CHA for publication in "Lighthouse".
9. The award will be presented to an individual only once.
10. At the time of application, the applicant will be required to submit an official transcript from their academic institute indicating their previous year grades.
11. The applicant must submit one letter of reference from an official of the university or college at which the applicant spent the previous year. The letter of reference must include the address and phone number of the official.
12. Applications must be made on forms supplied by, and submitted to:

    Barry Lusk,
    Academic Awards Manager,
    CHA Academic Awards Program,
    4719 Amblewood Dr.,
    Victoria, B.C.
    V8Y 2S2

Critères d'admissibilité:

1. Le postulant doit être un étudiant à plein temps, inscrit à un programme reconnu dans le domaine de l'hydrographie (comme géomatiques, géographie, cartographie ou sciences des levés) à responsables de la bourse d'étude seréservent le droit de décider si le programme est conforme.
2. La bourse ne sera disponible qu'aux étudiants ayant complété au moins une année de formation dans un programme avec diplôme ou licence relié à l'hydrographie.
3. Le candidat devra présenter un travail de 500 mots portant sur la relation entre sa formation scolaire et l'hydrographie.
4. Le candidat devra présenter un court paragraphe expliquant comment cette bourse aidera à son état d'étudiant.
5. Les formulaires d'inscription pour une bourse doivent être soumis au directeur aux bourses d'études de l'ACH d'ici la fin juin de l'année concernée. La bourse sera versée avant le 15 septembre de la même année. Les responsables du corps enseignant d'un établissement dont des membres ont postulés recevront les résultats par la poste.
6. Le montant de la bourse est de 2000 dollars.
7. Le candidat sélectionné recevra un certificat spécial de l'ACH.
8. L'étudiant qui reçoit la bourse devra remercier l'ACH par lettre, lettre qui sera publiée dans «Lighthouse», revue de l'ACH.
9. La bourse n'est remise qu'une seule fois à une personne.
10. Le postulant devra fournir au moment de la demande, une copie officielle provenant de l'établissement d'enseignement des notes obtenues lors des années précédentes.
11. Le postulant doit présenter une lettre de référence d'un représentant de l'université ou du collège où il a passé la dernière année. Cette lettre doit porter l'adresse et le numéro de téléphone du représentant.
12. On doit utiliser les formulaires fournis et les faire parvenir à:

    Barry Lusk,
    Directeur aux bourses d'études,
    Programme de bourses d'étude de l'ACH,
    4719 Amblewood Dr.,
    Victoria (C.-B.)
    V8Y 2S2

News From Industry
Nouvelles d l'industrie

• Sirius Solutions Limited •

Sirius Solutions Limited, Dartmouth, Canada has recently sold a multiple site installation of SEE~BED(tm) to the Swedish Maritime Administration. Sirius will provide user and system administrator training and multi-year application support. Also, Sirius will provide additional services in order to fully integrate SEE~BED(tm) into the Swedish hydrographic data processing system.

The Canadian Hydrographic Service has contracted with Sirius to provide 2 licenses of SEE~BED(tm) which will operate on Silicon Graphics workstations in the Atlantic Region. The work will involve porting the application to other Unix platforms.

SEE~BED(tm), is a hydrographic data cleaning and visualization software application. Release 3.2 features enhanced options in data selection and visualization modes. SEE~BED(tm) is a sonar independent application which allows data to be cleaned and visualized at the same time. It can also be used for data validation and provide visual interface to hydrographic databases.

• SeaBeam Instruments Inc •

SeaBeam Instruments Inc. of East Walpole, MA, USA, is involved in the development of multibeam survey systems. Their survey systems include sophisticated presentation software and interaction tools. John Chance and Associates Inc. of Lafayette, LA, USA will be deploying this technology in the Gulf of Mexico for oil exploration purposes.

• Klein Associates Inc •

Klein Associates Inc of Salem, NH, USA, has recently supplied the US National Oceanic and Atmospheric Administration with a number of high speed, high resolution, multibeam side scan sonar systems. The sonar system creates five beams per side, port and starboard, with each beam bring focused and steered to produce a 20 cm footprint of the bottom. At a sonar operating range of 150 metres per side (300 metre swath), the sonar system can be operated at speeds up to 10 knots with 100 percent bottom coverage.

• McQuest Marine Sciences •

McQuest Marine Sciences of Burlington, Ontario, Canada, has announced the addition of Romor Equipment to its corporate structure. Romor has over the past 18 years provided a full complement of marine connectors, cables, survey accessories and instruments to government and private industry users across Canada.

• Laser Technology •

Laser Technology of Englewood Colorado, USA, specializing in pulsed laser measurement instruments, introduces its Internet connection. Access the LTI site at http://www.lasertech.com.

• NOTRA BV •

NOTRA BV, an offshoot of Plessey Nederland BV are representatives of Chelsea Instruments Ltd. in The Netherlands, this relationship has now been extended to cover Belgium.

• Racal Survey Ltd •

Racal Survey Ltd. of New Malden, Surrey, U.K., is continuing expansion of its ROV (Remotely Operated Vehicle) and survey services after winning a substantial multi-well agreement from BHP Petroleum in Australia. Australian Underwater Contractors in Perth, Australia, is the newest division of Racal Survey Australia.

• The Hydrographic Society •

The Hydrographic Society has elected Ross Douglas in succession to Commodore Folke Hallbjorner as the President of the Hydrographic Society.

Ross Douglas was the Dominion Hydrographer of Canada from 1987-94 and Special Advisor to the Canadian Assistant Deputy Minister of Science until retirement from public service last May.

Until his retirement as its Director-General and Dominion Hydrographer, Mr. Douglas had been associated with the Canadian Hydrographic Service for 35 years, having at one time been Regional Director of its Central Region with responsibility for hydrographic activities in the Great Lakes, St. Lawrence Seaway, Hudson Bay and the high Arctic. Also responsible during the 1970's for charting all navigable waters along the eastern Canadian seaboard, he additionally acted as Director of the CHS's Atlantic Region as well as becoming Acting Director-General of its Bayfield Laboratory.

A former member of the Great Lakes Charting Advisors and Commissioner of the US-Canada Hydrographic Commission, he was President of the Canadian Institute of Surveying and Mapping in 1991 in addition to chairing its Hydrographic Committee for a number of years. A member of the Canadian Hydrographic Association and an adjunct professor of survey science at the University of Toronto, Ross Douglas was Director of the Canadian Marine Club from 1982-85.

Ottawa

Check out the CHS Headquarters web site at www.chshq.dfo.ca. This site is continually being updated, so check out what's new!

CHS Headquarters is pleased to welcome Dr. Lee Alexander to Ottawa. Lee, a research scientist with the US Coast Guard at Groton, Connecticut, is on an extended assignment with the CHS. He is dividing his time between CHS Headquarters and the Marine Communications Centre in St. John's.

Rick Mehlman spent the summer on board CCGS *Sir John Franklin* in the Arctic doing survey work on an opportunity basis in Alexandra Fiord, Broughton Island, Allen Bay and Hoare Bay. He was assisted by Terese Herron and Tony Natolino, from Central and Arctic Region.

In September Dick MacDougall attended the International Map Trade Association conference in Dublin, Ireland as well as a G7 Maritime Information Society meeting in Brussels and a meeting with the UK Hydrographic Office to discuss marketing.

Peter Richards sailed down the Mackenzie to the Arctic Ocean on the CCGS *Nahidik* to update sailing directions.

The summer of 1995 marked the establishment of a Chart Distributor in Winnipeg. The Manitoba Land Information Office took over the administration of the CHS dealers in Manitoba, Northwestern Ontario, North Dakota, South Dakota, Minnesota, and parts of Michigan and Wisconsin and added 90 of their existing dealers to the CHS network. Because the Land Information Office is also a distributor of topographic maps for Natural Resources Canada as well as the distributor of Manitoba mapping products, these dealers can offer a wider range of products to clients.

Rene Lepage has just returned from a two-week assignment in Cairo, where he provided CARIS training to participants in the River Nile Protection and Development Project. This a joint project of the Egyptian and Canadian governments to protect and develop the Nile River System.

The CHS Service Standards were released in September. This document outlines to all clients the major services provided by CHS and the level of service which the CHS strives to provide.

Jerzy Czartoryski, Geomatics Research Unit participated in the 18th Baltic Sea Ice Meeting in Gdynia, Poland and in the DIGEST Catalogue Sub-Group Harmonization Meeting in Brest, France. The Baltic Sea Ice Group, a Sub-Group of the International Sea Ice Commission, represents countries interested in the improvement and the coordination of services to winter navigation on the Baltic Sea and in the approaches. While in Poland, Jerzy also visited the Polish Navy Hydrographic Office and C-Map of Poland. The objective of the Brest DIGEST meeting was to resolve problems and harmonize conversion of S57 Catalogue version 2 to FACC/DIGEST system. A list of recommendations for modifications or changes to the S57 Catalogue was prepared and later submitted at the October Ottawa S57 Catalogue Workshop for consideration.

Electronic Charting

The Electronic Charting division in Ottawa is currently focusing on a number of aspects of ECDIS and other activities related to GIS. A major on-going activity is the checking of NTX ENCs against CHS Digital Chart File Standards, performing data conversion tasks, coordinating the release process, and delivering ENCs to Nautical Data International for dissemination to CHS clients.

At the same time, work is underway towards building an infrastructure for producing ENCs in the International Hydrographic Organization (IHO) standard S-57 format. This work involves producing test DX-90 data for CHS partners to evaluate, testing and evaluating new CARIS software, developing quality control tools, addressing issues related to product specifications, software installation and training, and contributing to the establishment of an ECDIS updating mechanism.

The division is also working on digital production of the CHS chart catalogues, and in digital bathymetric map production including the pending release of a new map of the Great Lakes basin at a scale of 1:1 500 000. A contribution is also being made to the implementation of ChartNet for the management and dissemination of CHS digital products.

Paul Holroyd chaired the "Workshop to Develop a Canadian S-57 ENC Product Specification" in St. John's in October.

Personal Notes

A number of headquarters staff received long-term service awards from Dr. Scott Parsons at a reception in

October. George Medynski and Boyd Thorson (who came out of retirement to attend) received their 35-year medallions. The following were presented with their 25-year plaques: Mike Casey, Vionnie Adjadu-Amponsah, Bob Farmer, Dave Monahan, Jeep Seguin, Dick MacDougall, Michel Turgeon, Ralph Renaud, Russ McColl and Léo Lanthier.

Congratulations to Vicki Smith. Vicki received a Deputy Minister's Merit Award in recognition of her outstanding achievements as a chart corrector for the past five years.

There have been two more retirements at CHS headquarters. Ron Lamirande and George Medynski both retired on November 15. Ron had spent 37 years with the CHS and George was with us for 35 years. We congratulate them both on their successful careers and wish them well as they pursue this new phase of their lives.

Richard Dumais left his position with the Chart Distribution Office to pursue a career in construction.

Lise Lague has just returned from a month-long vacation in China; she has promised to give a presentation on her trip in the new year.

Obituary

Jim Larose passed away in Ottawa on November 30. Jim started his career with the CHS as a cartographer here at Headquarters. In the late seventies Jim moved to Scotia-Fundy Region. After he retired a few years ago Jim returned to Ottawa. We extend our condolences to Jim's family.

Pacific Region

Hydrographic Surveys

Mike Woodward and his crew spent three weeks in April on the CSS *John P. Tully*. Despite the rain, wind and broken steering gear, 14 current meters were deployed, drifters were tracked and 220 conductivity, temperature and depth (CTD) casts were completed. Mike, Neil Sutherland and others made another trip, this time on the CCGS *Narwal* in August. Pete Richards and Marilyn van Dusen from Ottawa visited Institute of Ocean Sciences (IOS) to arrange for the testing of software to be used in the production of current tables.

Ernie Sargent and Denny Sinnott were busy processing both analogue and digital gauge data and report that all 16 gauges in the permanent/temporary network are functioning well. Conversion from analogue to digital equipment is progressing. The joint CHS/CCG/ British Columbia Hydro, backwater flow project has drawn to a conclusion with the removal of gauges at Courtenay and Campbell River. The Tsunami warning equipment in Tofino was serviced with a new orifice.

Kal Czotter lead a field party on the CSS *R.B.Young* to examine the misfit of our charts on NAD83 and carry out revisory surveys. Kal focused primarily on the area between Campbell River and Port Hardy where few off-datum problems were identified. Differential Global Positioning System (DGPS) and an Offshore Systems Limited (OSL) ECPINS were of some assistance in this exercise. The CSS *R.B. Young* steamed down the west coast of Vancouver Island, stopping near Kyuquot to cast Sev Crowther's ashes to the seas, before returning to IOS on June 16th.

Peter Milner was in charge of the second portion of this project. The focus was on the North Coast ENCs with most of the time being devoted to DGPS position comparisons with features on the digital chart files. Horizontal control was re-established in the Higgins Passage area.

Alex Raymond returned from his work in the western arctic aboard the CCGS *Nahidik*. Doug Popejoy and Al Thomson traveled to Hay River to deliver a truck load of freight needed for the survey and install transducers before *Nahidik's* voyage down the Mackenzie River. Doug Cartwright used GPS techniques to position arctic fixed aids. Doug accompanied the CCGS *Arctic Ivik* on her visits to these lights and beacons for their annual servicing.

Training retained a high profile during this quarter. Some staff attended welding, climbing, confined space awareness, CPR, UNIX and office automation courses. Jim Galloway from Client Liaison and Services and George Eaton attended a very good two week multibeam sounder course in St. Andrews, N.B. during the last half of June.

Nautical Publications

The first quarter of this fiscal year saw the end of an era in Pacific Region. Ken Holman, A/Manager Nautical Publications retired after 33 years with the CHS. A "roast", attended by 120 of Ken's family and friends, was held July 8 at IOS. Shirley Demeriez of the Chart Amendments Unit retired after 8 years with the CHS.

Production highlights during the quarter included chart releases for 2 New Charts, 7 New Editions, 7 Reprints, 5 Reruns, 1 Overprint and 1 Patch. Chart 3313 will be shipped to headquarters for printing by the end of August. ENC activities included the completion of 1 ENC with 9 others nearing completion. Eight were also updated through NTM's. NDI requirements for scanning positives included 18 sets for a total of 123 positives. Terra Surveys and Eastcan Group were successful bidders to digitize five charts to level 3 ENC.

The Sailing Directions Unit conducted a three day field review of sailing directions information for New Charts 3488 and 3489. A reprinting of B.C. Sailing Directions Vol. 2 and Supplement were released.

Geomatics Engineering

Hydrographic Data Centre

The Source Directory System (SDS) was implemented and became operational in May. Communications problems inhibited its use but confidence in the system is increasing as user's comments are dealt with. SDS loading will continue with the assistance of a student for the rest of the year. Two people have been assigned to HDC on a full-time basis.

Computer Systems Support

Two thirds of the group's resources were devoted entirely to work on current surveys and the current table editing routines for the new Tide and Current Table software. P. Richards (Nautical Publications, Ottawa) visited the region in June and confirmed the quality of the work done. A highly effective graphic time series editor has been developed.

Source Data

Work based on satellite derived coastline for charts 7083, 7731, 7733 and 7760 is ready for checking. Work has started on Beaufort Sea coastline data that was obtained from recent photography. A comparison will be made between the photo mapping and charted coastlines around Pullen Island where there is active erosion/deposition. Storage of field survey data has been improved so that in addition to formal field sheet files, coastline, revisory survey and miscellaneous files are now archived and available to users. Hypercard benchmark and rockpost descriptions are now available to Mac users. Mr. Woods continued work on digital field sheet file standards.

Product Data

Subsequent to scanning, vectorizing and conversion to NTX format the following digital chart files are being prepared for quality control: 3668, 3604, 3605, 3475, 3892, 3893 and 3895. The following chart files have been digitized by contractors and will be submitted to quality control if priorities require: 3000, 3001, 3002, 3536, 3559, 3647, 3477 and 3927.

Client Liaison and Support

Sonar Systems Group

In May, Jim Galloway attended an In-season Stock Size Estimation and Risk Assessment workshop at the UBC Fisheries Centre. A major point of discussion was the soundness of the statistical approach used to conduct in-season stock estimates. There seems to be little consistency in the approach by mangers in deriving the real time estimates, and Walters attempted to coordinate the approaches to an optimum Baysean method.

Dave Gartley assisted QT with their work to reduce data latency in ISAH. The accurate 1-PPS signal from the MX4200 receivers is being used, as well as software changes in the ISAH DAS and processing software to achieve these results. Substantial reduction were made to the data latency problems we've previously experienced using ISAH. The internal ISAH clock is now synchronized to GPS time and the input records are time tagged on the first character not last as was previously the case.

Gordon Worthing performed a quick evaluation on the 10-channel carrier phase Magellan Pro Mark X-CP GPS receiver purchased by Hydrography. It appears to work well and is quite versatile considering it size and price. Bruce Johnson investigated and recommended the purchase of two ruggedized PCs with DC supplies for field use and a Xerox network Colour Laser Printer. Larry Dorosh and Bill Hinds evaluated a 600 watt pure sine wave DC-to-AC converter purchased with year end money from Analytic Systems. Bill Hinds described the faults found and suggested recommendations. Analytic replaced the original converter with a new unit which incorporated all of our suggestions.

Hydraulics Research

Bill Crawford set up a program to transmit Argos data to the MEDOC centre for inclusion in their surface temperature analyses, and to prepare weekly charts of drifter tracks, which are faxed to fisheries scientists for predictions of northern diversion of Fraser River salmon. Bill took delivery of a PC-based program to compute and display crab larvae drift tracks in Dixon Entrance, British Columbia. Bill also provided advice to the Pacific Biological Station on Northern Diversion of salmon and to the Science Council of British Columbia on research proposals for fisheries science.

Central And Arctic Region

Hydrographic Survey of Nottawasaga Bay uses CCGS *Griffon*

At the south end of Georgian Bay, the CHS conducted a hydrographic survey of Nottawasaga Bay. The survey was based on board the Canadian Coast Guard Ship *Griffon* and ran from mid-May to mid-June. Survey staff in the EN-SUR, EG and EL categories requested to work a variable work week. Staff worked 12 hour days, seven days a week for two (or four) weeks, and then took two (or four) weeks off (depending on the contract). As a result, overtime was limited to nine hours a week. The survey operation was extremely efficient. Productivity increased by 20% per day worked, compared to working a regular work week. This was largely a result of the fact that survey launches could remain in the survey area longer each day, so there was less transit time during the survey. The seven day operation further increased productivity by as much as 30% over the survey duration. Murray Calder, the local Federal Member of Parliament, along with representatives of the ports of Collingwood and Thornbury, local chart dealers and the media, toured the Nottawasaga Bay survey on May 23.

Nares Strait Gravity and Bathymetry Survey Completed

The United States Defence Mapping Agency and the National Survey and Cadastre of Denmark initiated a survey program in Nares Strait, in cooperation with the Department of National Defense, and Natural Resources Canada. The Canadian Hydrographic Service was asked to collect gravity and bathymetry in the area covered by water. The gravity/bathymetry survey began at Qaanaaq, Greenland on May 8 and moved to Alert, NWT at mid month. Most of Kane Basin and Smith Sound were free of ice and it was not possible to obtain data. Where shore fast ice remained, 195 soundings/gravity stations were acquired at 12 kilometre spacing, in Alexandra Fjord, Peabody Bay, Kennedy Channel, Hall Basin and north through Robeson Channel. The survey employed two Bell 206 Long Rangers, on contract from Canadian Helicopters. Aircraft were equipped with Ashtech Z12 (12 channel, P code) GPS receivers for positioning and Knudsen 320A sounders to obtain spot depths. GPS positions were post processed differentially using Ashtech's "Prism" software. The survey was completed on May 25.

Visit from Great Lakes Pilotage Authority

Central and Arctic region had a visit in May from the Great Lakes Pilotage Authority Committee on Training. Their main interest was to discuss ECDIS and to see what processes we use to produce ENCs. After showing the video "ECDIS - A View from the Bridge", the Regional Electronic Chart Program was described, stressing that the core interest of the CHS was data, not hardware or systems. The questions asked and the discussion which was generated showed that the Pilots were thinking about how this technology might be used by Great Lakes Pilots, in particular how they might take their own portable ECDIS aboard a ship and plugging into the ship's system.

ISAH and Knudsen Sounder Training Courses for Seasonal Staff

Personnel reductions have made it necessary to look at innovative ways to continue staffing surveys and also meet other charting requirements. This year, many seasonal ships crew were used as acting hydrographers, in charge of survey launches in the Great Lakes and Hudson Bay. These staff participated in training courses to become familiar with ISAH and Knudsen 320M sounder operations. Many of these staff have remained on strength this winter to help process data and produce charts.

Visit From Georgian Bay Sailing Association

Several members of the Georgian Bay Sailing Association visited the Region on May 9. The new Electronic Chart video "ECDIS - A View from the Bridge" was shown, followed by a tour of Regional offices.

Petro Canada Wharf Surveyed

At the request of Robin Maritime Inc. of Montreal, the area adjacent to Petro Canada wharf at Clarkson was surveyed on May 31. The wharf had not been surveyed since 1987. New data was used to help ships load at the facility. The survey was funded by Robin Maritime.

Lac du Bonnet Chart Completed

Less than a year after the completion of the 1994 Lac du Bonnet survey, a copy of the completed chart was presented to Mayor Glen Hirst, Village of Lac du Bonnet and Reeve David Marion, Regional Municipality of Lac du Bonnet. Also on hand at the Winnipeg River Water Weekend on July 15 in Lac du Bonnet were Mr. David Iftody, M.P. Provencher, Manitoba; David Studham, Chairman Board of Directors, Winnipeg River Brokenhead Community Futures Development Corporation; representatives of the CHS Chart Distributor at Manitoba Natural Resources; Sharon Leonhard, DFO Communications, Winnipeg; Judy Fredette, DFO Winnipeg; and Paul Davies, CHS, Burlington. Paul presented a CHS crest to Winnipeg River Brokenhead Community Futures Development Corporation in recognition of their support for the field survey.

Discussions with the public after the presentations, indicated a large amount of interest in the chart. A few individuals said that, although they had been navigating the waterway for many years, they had been very cautious because they did not know where the hazards were located. Dealers in the area were already taking orders for the new chart, before it was officially released.

The event was arranged by Pierre Paquette, DFO Communications, Burlington. It proved to be an excellent way to involve the community and made many levels of government aware of CHS activities. In this case, since the community was involved throughout the project, it was a fitting conclusion.

Lake Huron Survey Completed

In 1991 the CHS began a program to survey the west side of the Bruce Peninsula from Cape Hurd to Point Clark. The project started with a LIDAR (airborne laser bathymetry) survey, and was followed up by launch surveys to examine shoals and to collect data in deeper water. This year the survey was based in Kincardine, to complete shoal exams at the south end of the survey area and to collect large scale data for insets and A2 charts. The data will be used to produce new charts which will resolve unknown datum problems with two existing Lake Huron charts.

Reception in Rankin Inlet hosted by CSS *Hudson* and GNWT Minister of Transportation

On August 28 the Honourable John Todd, Minister of Transportation for the Government of the Northwest Territories (GNWT), hosted a reception for officials from the town of Rankin Inlet, on board the CSS *Hudson*. The GNWT is funding a hydrographic survey and the production of new charts, to ensure safe navigation into Rankin Inlet. The existing hydrographic charts are not adequate for deep draft tankers, since there is no bathymetric data east of Marble Island, and there is some uncertainty of the position of dangers to navigation along the shipping route. Since the critical offshore surveys will extend 120 kilometres from Rankin Inlet, the CSS *Hudson*, a DFO vessel based in Dartmouth, was assigned to the survey. The three year project will collect preliminary bathymetry and calibration data in 1995, use a multibeam system for 100% bottom coverage in the shipping corridor in 1996, and produce new navigation charts in 1997.

Rankin Inlet Survey Successful

On September 26 the Director, Hydrography, the Dominion Hydrographer, the Regional Director General and the GNWT Deputy Minister, Transportation visited the Rankin Inlet survey to review progress and discuss future cooperative survey opportunities. The CSS *Hudson* departed Rankin Inlet on September 28, after a successful season. Some staff flew home the same day; others remained on board to dismantle and pack equipment during the trip to Dartmouth, where the ship arrived on October 5. The survey collected 7186 line kilometres of sounding and examined 1209 shoals during the 42 days on site. 10 days were lost to weather.

Participation in International Cartographic Conference

The Manager, Nautical Publications Division, participated in the International Cartographic Conference in Barcelona, from September 3 to 9. Canada will be organising the 1999 Conference, to be held in Ottawa.

Portable Hydrographic Data Acquisition System

Central and Arctic Region has developed a portable hydrographic data acquisition system. The HYPACK program from Coastal Oceanographics Inc., which has become an industry standard, uses Microsoft Windows based software modules that allow hydrographers to: plan the survey; acquire and validate the data; and present the data prior to leaving the survey site. The hardware is housed in portable containers that will allow a hydrographer to quickly deploy to a remote location, collect data from a vessel of opportunity and then return to Burlington with validated data. The sensors that are being used with the first system are the Knudsen 320M digital echo sounder, the Sercel DGPS positioning system and a Zenith PC notebook computer for computation and navigation.

North Channel Marine Tourism Council Annual Meeting

The Manager of Nautical Publications Division provided an update on CHS activities to the North Channel Marine Tourism Council Annual Meeting in Blind River on October 20. This involved a discussion and display, indicating our progress to date on North Channel charting, and a viewing of the video "ECDIS - A View from the Bridge".

CHS Displays At Regional Boat Shows and Meetings

The CHS display at the Goderich Marine Festival from July 21 to 23, included a survey launch outfitted with data logging equipment.

The CHS staffed a chart exhibit at the Wooden Boat Festival at the Port of Newcastle from July 28 to 30. The exhibit was organised in conjunction with a retail display by our official Chart Dealer, Dean Marine of Cobourg, Ontario. It concentrated on local charts and a selection of different chart formats. The show was very well attended and comments were mainly centred around chart production plans.

The Orillia Centre of Power In-Water Boat Show was sponsored by the Orillia and District Chamber of Commerce and was held at the Port of Orillia. CHS set up and staffed an exhibit, which concentrated on the area charts and the new Harbour Charts in southern Georgian Bay.

The Port Credit Boat Show, held August 25 to 28, was sponsored by the CHS official Chart Dealer, Mason's Chandlery. The CHS exhibit featured the local charts and an electronic chart demonstration.

The Prince Edward Boat Show, held October 7 and 8 in Picton, Ontario was sponsored by the Prince Edward Yacht Club. The CHS exhibit emphasized local charts, the new St. Lawrence River charts and the electronic charts.

CHS organised and manned an electronic charting display for the Company of Master Mariners Annual General Meeting in Toronto on October 28.

CHS and NDI participated in a Canadian Power and Sail Squadron conference in Toronto at the beginning of November.

French Language Training

Dennis St. Jacques has returned to his position as the Manager, Development Division after successfully completing nine months of french language training.

1995 CHA Annual General Meeting
Réunion générale annuelle de l'ACH

Conducted by Teleconference
October 4, 1995

Attendance: as per the site registers:

1. **Welcome**
   Dave Pugh called the meeting to order (11:00 EDT) and thanked those present for their participation.

2. **Agenda**
   Motion to accept the agenda as circulated.
   Carried

3. **1994 Annual General Minutes**
   Motion to accept the minutes as circulated.

   Discussion:
   As Mr. Raymond was not present to provide his action item report on Life Members he will be requested to provide a report or withdraw this action item which has been ongoing for two years.
   Carried

4. **Receiving reports of the Directors**
   The following branch reports were presented:
   Pacific Branch - Rob Hare
   Captain Vancouver Branch - Paul Sawyer
   Prairie Schooner Branch - Bruce Calderbank
   Ottawa Branch - Dave Pugh for Ilona Monahan
   Central Branch - Terese Herron
   Quebec Branch - Bernard Labreque
   Newfoundland Branch - Frank Hall

5. **Financial statement and auditor's report**
   Motion to accept the financial statement and auditor's report as presented.

   Discussion:
   In response to a question concerning the 1994 auditors, the President responded that as the auditors appointed in the 1994 minutes were unable to perform that duty, the appointed auditors for 1993 were requested to perform the audit function for 1994, which they graciously did.

   It was requested that the financial statement reflect the calendar year. This will be provided to the Directors for circulation.
   Action: National Treasurer
   Carried

6. **Auditors for 1995**
   The proposed auditors for 1995 are Sheila Acheson and Jake Kean.
   Motion to accept the auditors for 1995.
   Hinds/Calderbank

   Discussion:
   It was requested that the Directors review the role of the auditor to determine if a professional accountant is required to perform this duty. The President reported that this was reviewed four years ago and at that time an accountant's review was not required.
   Action: Directors
   Carried

7. **Other Business**
   a) Lighthouse
   It was requested that the Editor ensure that confirmation be forwarded to authors when material has been received and that correspondence as appropriate be continued with the authors. It was also suggested that an author's guideline page be developed and included in Lighthouse.
   Action: Editor Lighthouse

   b) Carnet de Bord
   In response to a question concerning the potential of liability resulting from the publishing of Carnet de Bord, it was reiterated that the Carnet de Bord is a logbook and not a navigation product; therefore liability is not an issue.

   c) General Liability Insurance
   The Directors were requested to solicit quotes when the Association's General Liability Insurance policy is due for renewal. The existing policy is being carried over from the CIDA/CHA Malaysia training project.
   Action: Directors

8. **Lighthouse awards for 1994:**

   Best Technical Paper:
   "Captain Vancouver's Assessment of Kendall's Chronometer K3 1791/1792" by N.A. Doe.
   Fall 1994 Edition

   Best Non-Technical Paper:
   "Royal Navy Hydrographers Honoured" by R. W. Sandilands of Pacific Branch
   Spring 1994 Edition

   Lighthouse will be forwarding $100 cheques to each of the authors and appreciation was expressed for all the excellent articles submitted to Lighthouse.

9. **Adjournment**
   Motion to adjourn. (12:35)
   Carried

1995 Directors' Meeting
Réunion des directeurs de l'ACH

Location:
2919 Richardson Side Soad,
West Carleton, Ontario
Saturday May 27, 1995

MINUTES (abridged)

Directors present: Dave Pugh, Rob Hare, Ilona Monahan, Paul Sawyer, Bernard Labrecque.

Regrets: Bruce Calderbank, Terese Herron and Frank Hall.

1. **Agenda**
   Motion to accept the agenda as circulated.
   Carried

2. **Receiving minutes of 1994 Director's meeting and conference call**
   Motion to accept the minutes with minor amendments.
   Carried

3. **Report on Action items:**
   a) from 1993 Director's meeting
   Item 3.3 a) CHA/CIG Journal exchange - No issues of Geomatica have been received by the CHA Directors present at the meeting.
   Action: Pugh
   Item 3.3 b) Association bylaws - CHA bylaws have been received by branches.

   Item 3.3 c) Membership lists - Lists are to be submitted to the national president by February 15th each year, along with the branch report, financial statement, proposed budget for the coming year and planned activities.
   Action: Directors
   Rob Hare proposed to use Microsoft Access as the database software. Rob Hare will work with Dave Pugh, Sharon Thomson, Tony O'Connor (CIG President) and Mary-Beth Bérubé to fine tune the selection of database fields.
   Action: Hare/Pugh
   Dave Pugh, Paul Sawyer and Ilona Monahan will work to create a database questionnaire suitable for attachment to the 1996 renewal notices. This questionnaire will also be published in the Spring 1996 edition of Lighthouse.
   Action: Pugh/Monahan/Sawyer
   Bernard Labrecque will have the questionnaire translated into French.
   Action: Labrecque
   Item 3.14) Insurance coverage - Indemnification for Directors is not considered to be required. General Liability insurance (at $891 per year) is considered to be required to cover CHA sponsored events. Dave Pugh will discuss the need for a rider on the policy to cover the Heritage Launch insurance costs with Sean Hinds.
   Action: Pugh
   Item 9) CHA student award - A letter from Barry Lusk (Student Award Manager) was tabled by Rob Hare as Barry was unable to attend the meeting. The status of the award was discussed. A new bilingual poster will be printed in 1996. Money from HydroComm '95 will be used to "top up" the CHA award endowment if necessary so that enough interest is generated to provide for the $2000.00 award and its administration.
   Action: Pugh

   b) from 1994 Director's meeting
   Item 6) Lighthouse - discussion deferred to item 5 on 1995 Director's meeting agenda.
   Item 9) Editorship of Lighthouse - discussion deferred to item 8 on 1995 Director's meeting agenda.
   Item 10) CHA award - discussed under item 9 from 1993 Director's meeting.
   Item 12) Memberships - discussed membership lists under item 3.3 c from 1993 Director's meeting. Alex Raymond has an action item regarding life memberships under item 6 of the AGM minutes for 1994. Action for Alex Raymond continues for 1995 AGM. He will be required to present what he has been tasked with, or to drop the motion.
   Item 13) Proposed budget for 1995 and list of activities - All branches are to submit a proposed budget and list of activities for the coming year to the National President by February 15th each year.
   Action: Directors
   Item 14 - 1) Central mailing for Lighthouse - discussion deferred to item 8 on the 1995 Director's meeting agenda.
   Item 14 - 3) Position of past national president - The Directors felt that the immediate past president should act as a non-voting advisor to the board of Directors for a period of one year following the close of his or her term of office, for the purposes of continuity of office.

4. **Auditor's report on 1994 National Account**
   The national treasurer's statements were presented and Dave Pugh elaborated on each item. The audited report will be tabled at the AGM.

5. **Lighthouse report for 1994**
   A brief report was submitted by Bruce Richards, who was not present at the meeting. Bruce has stepped down and Terese Herron is now acting as interim editor of the journal. The new Editor has plans to change the look and feel of Lighthouse as a move is made to lower production costs and increase advertising revenues. Special feature issues

will be prepared, based on a request for papers on a particular hydrographic theme made a year in advance of the issue.

6. **Lighthouse financial statement for 1994**
The Lighthouse financial statement for 1994, prepared by J.H. (Sam) Weller, was presented. Dave Pugh will ask Sam for clarification on the capital equipment depreciation line items.
Action: Pugh

7. **Lighthouse proposed budget for 1995**
The 1995 Lighthouse proposed budget was presented, which shows a zero balance at the end of 1996. Revenue needs to be increased and production costs need to be reduced.
Action: Directors/
Herron (Editor of Lighthouse)

8. **Editorship of Lighthouse**
Terese Herron has been acting as interim editor of Lighthouse since Bruce Richards stepped down. The efforts of Bruce Richards over the past ten issues of Lighthouse are to be commended.

9. **CHA award**
This item was discussed under item 3, Report on action items.

10. **CIDA projects**
Tom McCulloch was not present at the meeting. Dave Pugh gave a report on the status of the training project in Malaysia. The training project is in its final phase. University Technology Malaysia (UTM) has achieved IHO/FIG category B certification and will make an IHO/FIG category A submission in June of 1996 at UNB. The CHA involvement is expected to end in March of 1997. Tom McCulloch is project manager, Barry Lusk is financial manager and Dave Pugh is technical manager. No new projects are scheduled.

11. **Memberships**
Discussion centered around whether a membership drive is needed or not. Student memberships at a reduced rate were discussed as a way to increase the new blood and ensure the future health of the organisation. The Directors will look to the branch membership for volunteers to help draft a letter soliciting student membership at the campuses where the CHA award is offered. The letter will then be circulated among the Directors for review and comment.
Action: Directors

12. **Atlantic Branch**
Approximately $1000 still remains in the Atlantic Branch account, which is looked after by Mike Lamplugh.

13. **Correspondence**
A letter was received from Barry Lusk with a number of concerns about the organisation. Each of his concerns were addressed in turn and were discussed at length among the Directors. Dave Pugh will draft a letter to Barry which summarizes how the Directors have addressed each item on his list.
Action: Pugh

14. **HydroComm '95**
Dave Pugh thanked all those members who participated and helped to make this first-of-its-kind conference take place. He noted a letter from Adam Kerr of the IHB to the Hydrographic Journal which praises the Canadians for this initiative. The conference made a profit which the Directors felt could be put to good use to assist Lighthouse as required and topping up the CHA award endowment. The money will be put into short-term GICs which can be cashed quickly when these needs, or others deemed worthy, arise.

15. **1995 AGM**
A conference call is scheduled for October 4th, 1995 at 0800 Pacific time. Directors should have all branch reports and financial statements to Dave Pugh by July 15th. Sites and phone numbers are to be confirmed by August 1st.
Action: Directors

16. **Other Business**
i) CHA membership database - The database was discussed under item 3 - Report on action items.
ii) Length of term of Branch executive - An extension to the length of term for Branch Vice-president and Secretary-Treasurer was discussed and rejected by the Directors.
iii) National President - Ken McMillan has been nominated and has accepted his nomination. As Ken will become the first national president (by acclamation) who is not a CHS employee, the Directors discussed what additional support might be required from the national account. Some funds from the HydroComm '95 profit may be used for this purpose as required.
iv) Captain Vancouver Branch - Paul Sawyer felt that the members of his branch were losing interest and that the branch needed to be stimulated in some way. Rob Hare suggested that a combined event with Pacific Branch be planned in order to get the Captain Vancouver Branch members more involved in CHA. Holding joint meeting with the Vancouver Branch of CIG was also suggested. These meetings could also be held at BCIT, which may foster some student memberships in both organisations.
Action: Sawyer/Hare
v) Heritage Launch - A report prepared by Sean Hinds was tabled.

17. **CHA National dues for 1996**
The national dues will remain at $15.00 for 1996.

18. **Proposed National budget for 1995**
A budget with a slight surplus was presented. Dave Pugh will check with Central Branch to see if they still require the $5.00 per International member subsidy for Lighthouse to assist with mailing costs.
Action: Pugh
Motion that the budget be accepted as amended
Carried

Adjournment
Motion to adjourn. (16:12)
Carried

Section du Québec
Le 20 avril 1995, la Section du Québec tenait son assemblée générale des membres. Cela a été une bonne occasion de discuter des orientations prises par la Section. Il en est ressorti qu'il devient important pour la Section de trouver d'autres activités pour susciter le recrutement et l'intérêt des membres. De plus, les programmes d'aide offerts par les gouvernements fédéral et provincial sont de plus en plus restrictifs. La Section devra donc trouver d'autres avenues afin de subventionner l'embauche d'employés pour son magasin, son Carnet de Bord et sa publicité en commun. Aucun conseil d'administration n'a été élu cette année, faute de candidature, il ne reste que Bernard Labrecque en temps que vice-président ex-officio.

Encore une fois, la Section du Québec était exposant à l'Expo-Nature de Rimouski du 27 au 30 avril 1995. Cela nous a permis de constater que le public en général connaît de plus en plus l'Association. Je tiens à remercier notre employée Linda Grégoire pour son dévouement ainsi que Robert Dorais, Normand Doucet, Pierre Pagé, Denis Proulx, Jean Proteau et Bernard Tessier pour leur participation bénévole à cet événement. Pour la première fois, la Section du Québec a participé, le 10 juin 1995, au bazar nautique organisé par le Club nautique de Rimouski.

En début d'été, la Section du Québec a fait l'installation d'un marégraphe analogique OTTBORO sur "l'île des Débrouillards" (îlet Canuel) en face de Rimouski. Le marégraphe a été prêté par le Service hydrographique du Canada au Conseil des loisirs scientifiques de l'Est du Québec. Ces derniers ont rendu possible l'exploration de l'îlet aux jeunes et moins jeunes en y installant neuf stations d'interprétation sur différents sujets, dont un portant sur l'hydrographie. L'île est accessible à pied à marée basse mais pour ajouter à l'aventure, un véhicule amphibie a été utilisé. Le 14 juin 1995, la Section du Québec a participé aussi à l'ouverture officielle de l'île des Débrouillards qui a été des plus réussie.

Sur l'invitation du Conseil des loisirs scientifiques de l'Est du Québec, Bernard Labrecque et Normand Doucet ont fait une présentation sur l'hydrographie en général à "l'île des Débrouillards" (îlet Canuel) le 9 juillet 1995. Considérant la proximité de la défunte station marégraphique de Pointe-au-Père (10 km) et de celle de Rimouski (5 km) qui la remplace, on a discuté du phénomène de la marée et démontré l'importance de la région pour l'établissement et le maintien du réseau de repères de nivellement pour le contrôle altimétrique du Canada et de l'Amérique du Nord. On y a aussi traité de l'évolution des techniques de sondage depuis le début du siècle jusqu'à aujourd'hui et de ce qui s'en vient dans un proche avenir. Des cartes marines, des tables des marées, des instructions nautiques et d'autres documents connexés étaient affichés et mis à la disposition des participants pour entretenir la discussion.

Ottawa Branch
Social Activities
The Branch again held its annual CHA Picnic on June 29th 1995 in Vincent Massey Park. The weather was terrific, approximately 50 people showed up to eat, drink and be merry. There was a softball game, but no one knows who won, so a great time was had by all.

On Thursday September 21, 1995, the annual CHA Golf Tournament was held at the Casselview Golf and Country Club. Luckily the rainy weather held off long enough to let all our teams get their 18 holes of golf in. Twenty-nine hardy players showed up to play golf and enjoy a roast beef dinner afterwards. Thanks to our wonderful sponsors G.E. Hamilton, NDI, Canada Post, Alberta Distilleries, CHA National, CHA Ottawa Branch and the Casselview Golf and Country Club for all the terrific prizes. The BEST PUTT trophies were won by Elaine Killeen and Andy Seguin this year.

Plans are well underway for our CHA Christmas luncheon at the R.A. Centre on Wednesday December 20th, 1995. Any out of town members visiting Ottawa around that time are cordially invited to join us for the festivities.

Lunch Time Seminars
The branch sponsored one presentation on June 28, 1995. "SEE~BED, a visualization and Editing Software for Hydrographic Data" was presented by Sirius Solutions Limited.

Meetings
Our Branch Annual General Meeting will be held in January this year. Hopefully ideas on how to promote more activities and increase membership will be brought forward.

General
Congratulations go to Vicki Smith who has worked diligently at CHS headquarters for the past 16 years, and this past June 26, 1995, received the Deputy Minister's Merit award for outstanding performance.

Several more Ottawa Branch members have retired in the last couple of months. Fond farewells were bid to Ken Peskett, George Medynski and Ron Lamirande. Hopefully we will continue to see them at all our social events.

Central Branch
Summer BBQ
There was a record turn out at this year's summer BBQ held at the home of Lucy Krucko and Chris Gorski. Almost 60 people (including 20 children) enjoyed this annual social event. The marvellous deck made it an ideal party spot. The food, as always, was great. The pot luck table of salads and desserts was a feast in itself and once again Brian Power and Sean Hinds were masters of the grill. Thanks to Lucy and Chris, their daughter Olivia and their tolerant cats for their excellent hospitality.

General
One-time member and V-P of Central Branch, Ed Thompson, retired from the CHS in October and has moved east, with his wife Terry, to the Annapolis Valley to enjoy a life of leisure.

CHA members Bill Warrender, Andrew Leyzack, and John Dixon are embarking on another wooden boat building project as they take positions on the executive of the 1812 Ship's Company, that is endeavouring to construct a reproduction of The HMS *Wolfe*, a nineteenth century warship. This is a long-term project arranged around recreating an 1812 era shipyard and developing a wooden boat building school in the Hamilton area.

Mike Crutchlow is temporarily relocated to the CHS Scotia-Fundy Region as he is heading up a project team to implement the SIMRAD multibeam technology on a national basis.

Mike Bennett and Ken Hipkin have been attending a number of boat shows and special events (Master Mariners Annual General Meeting) promoting CHS products.

Long-time member Bruce Wright who retired from the CHS in '94 has returned and is working on a short-term project applying his expertise in assessing the status of Arctic charts and surveys for Central and Arctic Region.

Most of our Branch Members have hung up the survey equipment for the year. Out-house members such as Ron Dreyer of MDA Engineering, Ken Richmond of Kev-Tech and Jim Berry of Metro Toronto Conservation Authority have been sounding or doing waterfront work in and near Toronto. John Halsall of Halsall Hydrographic Surveys has ventured farther to the south and is promoting his talents in areas such as the Gulf of Mexico. Ken McMillan is busy as always on the greater expanses of the Great Lakes. All the CHS field survey personnel are home from places as far away as Rankin Inlet, NWT, (Paul Davies, George Fenn, Ken Dexel, Paola Travaglini, Tim Janzen) and the CCGS *Sir John Franklin* was doing harbour surveys in Canada's Arctic (Terese Herron). Closer to home, the surveys were on Georgian Bay (Al Koudys, Terese Herron, Ray Treciokas, Andrew Leyzack and Fred Oliff) and Lake Huron (John Medendorp and Raj Beri).

International Members
At Central Branch we are very fortunate to have a direct tie to our International Members as they are administered from this Branch. This link (thanks in some respects to the Internet) has provided some entertaining and informative correspondence of late. Commander Larry Robbins, RNZN; Nick Emerson, Hydrographer with the Hong Kong Marine Department; Gary Chisholm, Trimble Navigation, NZ; and Nick Doe, with CANAC Microtel in BC are a few members reachable on the NET. Their columns published in our Branch Newsletter (thanks to Sam, Editor) are great reading as they bring close to home those with a common interest in a not-so-common field.

Meetings
There have been two general meetings this fall. One, held at the home of Anna and Brian Power, featured a great talk by our Out-house CHA member Bill Thuma. Bill spoke of his involvement since 1985 in the recovery of a WWII squadron of P-38 Fighter/Bombers and their B-17 escorts on the Greenland Icecap. This was a stimulating talk covering the history of the aircraft to the present. Our second meeting was hosted from our Out-House ranks in the home of Leigh Morrison and Heimo Duller. This meeting was highlighted by a talk from Heather Fitzsimons, the District Commander of the Canadian Power and Sail Squadron, Guelph Branch. Heather outlined the history and roles of the Canadian Power Squadron and spoke of the cooperative efforts between their organisation and the Canadian Coast Guard with respect to training and seamanship. The fall events concluded with the Annual General Meeting and Dinner held on December 7 at the Mimico Cruising Club.

Surveyor
The Heritage Launch *Surveyor* is tucked away after another busy season that saw her in both fresh and salt water. After the adventure to Louisbourg the *Surveyor* and crew were involved in a twenty mile row down the Nottawasaga River to the historical site on Nancy Island at the shores of Georgian Bay. The next event was staged at the Christie Conservation area where a number of our members setup a period camp while the rest returned to the comforts of a warm home. The weekend was spent demonstrating heritage hydrographic techniques and talking to interested parties about various aspect of early Canadian history.

Prairie Schooner Branch
The members of the Prairie Schooner Branch have been carrying on as reported in the Spring 1995 Edition.

Andrew Brebner has continued to manage his company's office in Yellowknife and has been involved in mineral claims, subdivisions and a GPS control project in the Territories.

John Brigden has been working overseas.

Bruce Calderbank has been working in Vietnam, the North Sea and Malaysia.

Elizabeth Cannon and Gerard Lachapelle have continued to lecture and provide geomatics research at the University of Calgary. Elizabeth has just completed her stint as the Technical Chairperson for the Institute of Navigation GPS95 Conference. Gerard is now the Department Head of Geomatics.

Mike Chorney has continued to work in the Netherlands supervising ocean bottom and land seismic surveys. He has been enjoying the numerous celebrations in Holland with and on behalf of the Canadian veterans, for the 50th anniversary of the end of the Second World War.

Frank Colton has now joined a seismic processing company.

Glen Harvey has continued to carry out GIS and mapping surveys in northwest British Columbia.

Lorraine Hortness has continued to provide office support and technical expertise for her company. She had a great holiday in Costa Rica in January and met up unexpectedly with a bunch of people from Calgary.

Hal Janes has continued to manage his company's Edmonton office, and has been involved extensively in native land claims in the Territories.

David Thomson has continued to manage his company's Calgary office, which provides survey services in Canada, Kenya and Thailand.

Pacific Branch
Member activities

Beer is on the minds of many members these days. They can be found making beer at The Brew Works microbrewery.

Janet Lawson is still doing hydrographic surveys on the West Coast when she's not on her motorbike. Pete Wills of CHS-Central and Arctic Region was on a work exchange to our region till the end of September.

Brian Watt is back to work after suffering a serious bike accident. Glad to see you're back to work and recovering, Brian! A word of advice to Tony O'Connor: **Never** lift a refrigerator by yourself! Tony is also **back** to work and recovering after a brief stint in the hospital. Good to hear you are OK!

Kal Czotter returned from a six-week trip on the CSS *R.B. Young* to find himself on a six month (or so) vacation. When they say use your annual leave or lose it, they mean it! Kal is enjoying puttering around the house, but can't wait to get back to the office (?). Sherman Oraas spent some time stargazing in Hawaii. George Schlagintweit is off once again to Klemtu to assist with the setup for a Bottom Classification Survey sponsored by the Kitasoo Band Council. George Eaton & Jim Galloway are on their way to Biloxi, Mississippi, for FEMME 95 (a forum for SIMRAD multibeam echosounder users).

Alex Raymond and his Arctic wanderers are back from the CCGS *Nahidik*-based surveys near Cambridge Bay. The sounding for the **main** shipping corridor from Coppermine to Larsen Sound is now complete. Additional work included ground-truthing LIDAR soundings from 1985 in Simpson Strait, tidal & current surveys, and positioning navigation aids with GPS. Doug Cartwright is sorting through his many Arctic pictures taken while on the CCGS *Arctic Ivik* this summer. Al Thomson is a new man after his Arctic experience. Al installed the DGPS telemetry antenna on the old LORAN-A tower in Cambridge Bay (for the *Nahidik* survey). You say the tower is how high, Al?

Neil Sutherland is spelunking (caving) on the job these days out at the Tofino Tide Gauge. He is the resident Confined Workspace Climber for the maintenance work at that gauge. Neil Sutherland and James Wilcox will be up-island (Campbell River and points North) for the Fall Tide Gauge maintenance trip.

Everyone has pets. Ken Halcro & Carol Nowak have two kittens. Ken is trying to get them to bark and make rude noises. They have also inherited a teenager (Carol's niece) for a few years, while she completes her high school science classes. Did someone say grad school? Carol Nowak is overseeing the raster to vector conversion contract of a number of CHS charts.

Ken Holman and Shirley Demeriez have retired. Congratulations on your retirement and good luck in your future. We hope to see you at CHA social events and seminars.

Barry Lusk continues to provide material for the Pacific Branch Newsletter, *Sounding Board*. He also contributes regularly to the *Times-Colonist* (Victoria newspaper).

Seminars

Quester Tangent presented a seminar on QTC-View, Acoustic Bottom Classification System. It took place Thurs., October 5th in the IOS Auditorium at 1200. An Arctic slide show of the NW Passage Hydrographic Surveys' project will be present during lunch-hour sometime in November. Jim Galloway will give a presentation on Fish Stock Assessment in the new year. A presentation on ENC Ground-truthing occurred in December.

Other news

The Photo Contest was on again for the fourth straight year. This year, the closing date was Monday, November 6. The categories were people, wildlife, and places. For further information, please contact one of the executive members.

We've had colour transparencies made of the World's largest sextant. The necessary paperwork has been sent to the Guinness Book of Records people. We look forward to seeing it in the next edition (possibly on CD-ROM).

Fall 1995

Lighthouse

Journal of the Canadian Hydrographic Association
Revue de l'Association canadienne d'hydrographie

LIGHTHOUSE originally began as an internal newsletter of the Canadian Hydrographers' Association (CHA) in the winter of 1969. It was conceived as a means of stimulating discussion between the branches of CHA. Over the years, **LIGHTHOUSE** has become Canada's national hydrographic journal. It still remains faithful to the original goal of providing a mix of technical, historical and social information of interest to those associated with hydrography in Canada. But its circulation has expanded to include over 700 individuals, companies and hydrographic organisations in Canada and around the world!

Automne 1995

Lighthouse

Revue de l'Association canadienne d'hydrographie
Journal of the Canadian Hydrographic Association

Originalement à l'hiver 1969, **LIGHTHOUSE** était le journal de l'Association canadienne des hydrographes (ACH). Il représentait un moyen pour stimuler les discussions entre les Sections de l'ACH. De par les années, **LIGHTHOUSE** est devenue la revue hydrographique nationale du Canada. Elle reste fidèle à son but original de fournir une source d'information technique, historique et sociale à ceux qui s'intéressent à l'hydrographie au Canada. Son tirage a augmenté pour inclure au-delà de 700 membres, compagnies et organisations hydrographiques au Canada et dans le monde entier.

Tarifs publicitaires 1996

EMPLACEMENTS

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur. Cependant, toute demande d'emplacement spécifique sera considérée si une prime de 25 $ est ajoutée à la demande de parution.

EXIGENCES MÉCANIQUES

L'annonce publicitaire doit être un prêt à photographier ou sur film négatif (les couleurs supplémentaires doivent être sur film négatif) et être fournie aux dates de tombée. La préparation de copie couleur, à fond perdu et de photos, sera chargée au tarif de l'imprimeur plus 10 %. Les épreuves devraient être fournies avec tous les suppléments.

Les insertions d'une page seront chargées au tarif d'une pleine page. Le matériel devra être fourni par le client.

DIMENSIONS DE LA PUBLICITÉ

	(Hauteur)		(Largeur)
Dimension de la revue:	8.5"	x	11.0"
Encart libre:	7.0"	x	10.0"
Publicité à fond perdu:	8.75"	x	11.25"
Insertion d'une page:	8.25"	x	10.75"

Grandeurs standards des suppléments:

Pleine page:	7.0"	x	10.0"
Demie-page:	6.875"	x	4.75"
ou:	3.375"	x	9.75"

DATE DE TOMBÉE

LIGHTHOUSE est publiée deux fois par année, au printemps et à l'automne. Les dates de tombée sont **le 15 mars** et **le 15 octobre** respectivement.

IMPRESSION

Internégatif tramé à 133 lignes au pouce.

TARIFS

Tous les tarifs sont en devises canadiennes. Les membres de soutien ont droit à un rabais de 10 %.

	N & B	Couleur	
		Une*	Quatre
Couverture arrière	SO	SO	1025 $
Couverture intérieure	300 $	400 $	825 $
Pleine page	275 $	375 $	675 $
Demie-page	200 $	300 $	675 $
Insertion d'une page	275 $	375 $	675 $
Carte d'affaire	125 $	225 $	SO $

*Une couleur (orange, rouge ou bleu)

Les tarifs sont assurés aux termes des contrats publicitaires jusqu'à concurrence d'un an. Les annulations ne sont pas acceptées après la date de tombée.

Tout le matériel publicitaire doit être acheminé à:

Monsieur K. Weaver, Directeur de la publicité
LIGHTHOUSE
P.O. Box 5050
867 Lakeshore Road
Burlington, Ontario
CANADA L7R 4A6
Téléphone: (905) 336-4538
Télécopieur: (905) 336-8916

Canadian Hydrographic Conference

Conférence hydrographique canadienne

CHC 96

Hydrography and Marine Navigation: Defining the Future Direction

Hydrographie et Navigation: définir l'avenir

For information:

P.O. Box 1006
Dartmouth, N.S.
B2Y 4A2

Pour information:

C.P. 1006
Dartmouth, N.-É.
B2Y 4A2

(902) 426-3624
(902) 426-1893 FAX
chc96@bionet.bio.ns.ca

Halifax, Nova Scotia
June 3 – 5, 1996

Halifax, Nouvelle-Écosse
Juin 3 – 5, 1996