CURRICULUM VITAE

MICHAEL R. CRAYMER

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EDUCATION

B.Sc. (1979) 1975-1976, Queen's University, Faculty of Applied Science.
1976-1979, University of Toronto, Survey Science, Graduated with distinction.

M.A.Sc. (1984) 1982-1984, University of Toronto, Dept. of Civil Engineering (Survey Science). Area of concentration: geodesy and statistics. Thesis: "Data series analysis and systematic effects in levelling." Supervisor: Prof. Petr Vaníček.

Ph.D. (1998) 1984-1998 (part time), University of Toronto, Dept. of Civil Engineering (Survey Science). Area of concentration: geodesy and statistics. Thesis: "The least squares spectrum, its inverse transform and autocorrelation function: Theory and some applications in geodesy." Supervisor: Prof. Petr Vaníček.

SCHOLARSHIPS AND AWARDS

2013 Earth Sciences Sector Merit Award, Natural Resources Canada (A Crustal Velocity Field for Canada)
2007 Fellow of the International Association of Geodesy.
2007 Canadian Institute of Geomatics Intermap Award (best paper of 2006 in the journal Geomatica).
1999 Earth Sciences Sector Merit Award, Natural Resources Canada (Canadian Base Network).
1998 Earth Sciences Sector Merit Award, Natural Resources Canada (GPS Height Transformation).
1996 Geodetic Survey Division Merit Award, Natural Resources Canada.
1992 Best Paper Award at the 5th International Technical Meeting of the Institute of Navigation, ION GPS-92., Albuquerque, NM, September 16-18.
1982 J.E.R. Ross Graduate Scholarship in Survey Science, University of Toronto.
1978 Association of Ontario Land Surveyors Scholarship, University of Toronto.
1977 Association of Ontario Land Surveyors John E. Jackson Scholarship, University of Toronto.
1974 Province of Ontario Scholarship, Bracebridge and Muskoka Lakes Secondary School, Bracebridge, Ontario.

MEMBERSHIP IN SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Geophysical Union
Canadian Geophysical Union

Canadian Institute of Geomatics
International Association of Geodesy
University NAVSTAR Consortium (UNAVCO)

EMPLOYMENT HISTORY

1992-present Senior Geodetic Engineer and Coordinator, Reference Frames & Earth Dynamics, Canadian Geodetic Survey, Natural Resources Canada, Ottawa, Ontario. Responsible for establishing and maintain spatial reference systems for Canada, conducting research and development on a variety of geodetic problems, providing advice on geodetic and statistical matters and acting as scientific authority for external contracts. Recent projects: development of a national crustal velocity model, analysis and adjustment of the Canadian Base Network, development of a method of estimating rod scale errors in historic leveling, development of a method for the optimal adjustment of individually processed GPS baselines, development of software for the analysis of EDM baselines, and continued development of robustness analysis of geodetic networks.

1990-1991 Vice-President/General Manager/Joint-Owner of Geodetic Research Services Limited, Fredericton, N.B. Responsibilities: Administration and management of entire company operations including consulting, software development/support and day-to-day operations. Recent projects: Development and marketing of geodetic software for a variety of land survey problems including GPS positioning, network analysis, geoid height determination, astronomic azimuth; development of procedures and specifications for urban GPS surveys; adjustment and analysis of networks for establishment of shore-based microwave hydrographic positioning system; development of an attitude determination system using GPS; GPS surveying and training.

1986-1991 Research Assistant in the Geodetic Research Laboratory, Dept. of Surveying Engineering, University of New Brunswick, Fredericton, N.B. Supervisor: Prof. Petr Vaníč ek. Responsibilities: Conducting research in satellite and terrestrial positioning and navigation, and in solid earth, ocean and atmospheric dynamics. Supervision of graduate and undergraduate research assistants. Typically involves development of mathematical models, their implementation in software and their testing. Recent projects: Development of robustness analysis of geodetic networks using reliability theory and strain techniques; statistical analysis and estimation of rod scale errors in geodetic levelling;

1990 Lecturer in Advanced Adjustments (SE 3122). Dept. of Surveying Engineering, University of New Brunswick, Fredericton, N.B.

1988-1992 Geodetic consultant to Geodetic Research Services Limited, Fredericton, N.B. Recent projects: Development and support of commercial, geodetic software products for geodetic network analysis (NETVAL), GPS positioning (DIPOP), satellite tracking (MacGEPSAL, MacSat), geoid height estimation (CndGeoid) and astronomic azimuth determination (SPADE); development of procedures and specifications for urban GPS surveys.

1986 Lecturer in Survey Analysis II (SUR 312). Survey Science, University of Toronto, Erindale Campus, Mississauga, Ontario.

1984-1986 Photogrammetric consultant to George Kelk Ltd., Don Mills, Ontario. Topic: Development of close-range photogrammetric algorithms and real-time computer programs for automated calibration, space resection and space intersection using digital scanners in steel mills.

1983-1988 Geodetic consultant to Marshall Macklin Monaghan Ltd., Don Mills, Ontario. Topic: Development of algorithms and an interactive graphics computer program for strain and strength analysis of two- and three-dimensional geodetic networks (Canadian Geodetic Survey contract).

1983-1985 Teaching assistant in Survey Analysis II (SUR 312). Survey Science, University of Toronto,

Erindale Campus, Mississauga, Ontario. Supervisor: Prof. R.C. Gunn.

1982-1985 Research assistant in geodesy. Survey Science, University of Toronto, Erindale Campus, Mississauga, Ontario. Topic: Systematic errors in levelling (including administration and coordination of government research contracts). Supervisor: Prof. Petr Vaníč ek.

1981-1983 Teaching assistant in Advanced Land Surveying (SUR 230). Survey Science, University of Toronto, Erindale Campus, Mississauga, Ontario. Supervisor: Prof. R.C. Gunn.

1979-1981 Articling Ontario Land Surveyor. Maurice W. Fitzmaurice Ltd., Bracebridge, Ontario. Supervisor: Maurice W. Fitzmaurice, O.L.S. (ret.). Duties included all facets of operating a land surveying business including consultation with clients, title searching, job cost estimation and planning, management of field crews and office personnel.

1978-1979 Teaching assistant in Geodesy (SUR 303). Survey Science, University of Toronto, Erindale Campus, Mississauga, Ontario. Supervisor: Prof. Louis A. Gale.

1978 (summer) Surveyor, Northern Yukon Research Project. Coordinated by Prof. Irving, Dept. of Anthropology, University of Toronto, Toronto, Ontario. Duties included archeological site surveying and topographic mapping, establishment of regional vertical control using barometric levelling and consulting on general surveying matters.

1960s & 1970s Surveyor's assistant with various Ontario land surveying firms including: Maurice W. Fitzmaurice Ltd., Bracebridge, Ontario; Norman P. Lyndon, O.L.S., Bracebridge, Ontario; Bart Tompsett, O.L.S., Gravenhurst, Ontario; District of Muskoka, Engineering Division, Bracebridge, Ontario. Duties ranged from chainman to draftsman to party chief.

PROFESSIONAL ACTIVITIES

2011-Present Member, Working Group, SC1.3-WG1 (Integration of Dense Velocity Fields in the ITRF), Sub-Commission 1.3 (Regional Reference Frames), International Association of Geodesy.

2008-Present Chair, International Registry of Geodetic Codes and Parameters Control Body for the ISO Geodetic Registry Network, International Standards Organization Technical Control Committee 211.

2006-Present Associate Member, UNAVCO, Inc. (University NAVSTAR Consortium). NRCan representative.

2003-Present Co-Chair, Sub-commission 1.3c (Regional Reference Frames for North America), Commission 1 (Reference Frames), International Association of Geodesy.

2003-Present Chair, Working Group SC1.3c-WG1 (North American Reference Frame Densification), Regional Sub-Commission 1.3c (Regional Reference Frames for North America), International Association of Geodesy.

2003-Present Chair, Working Group SC1.3c-WG3 (Reference Frame Transformations), Regional Sub-Commission 1.3c (Regional Reference Frames for North America), International Association of Geodesy.

2007-2011 Vice-President, Commission 1 (Reference Frames), International Association of Geodesy.

2007-2011 Member, Working Group, SC1.3-WG1 (Regional Dense Velocity Fields), Sub-Commission 1.3 (Regional Reference Frames), International Association of Geodesy.

2004-2007 Chair, Inter-regional Technical Working Group SC1.3-WG1, Sub-Commission 1.3 (Regional

Reference Frames), International Association of Geodesy.

2003-2011 Member, Working Group SC1.3c-WG2 (Stable North American Reference Frame), joint with Regional Sub-Commission 1.3c (Regional Reference Frames for North America), International Association of Geodesy, and UNAVCO, Inc.

1999-2003 Co-Chair, Regional Reference Frames Sub-commission for North America, Commission X (Reference Frames), International Association of Geodesy.

1999-2003 Chair, North American Reference Frame (NAREF) Working Group, Regional Sub-Commission for North America, Commission X (Reference Frames), International Association of Geodesy.

1999-2003 Chair, Reference Frame Transformations Working Group, Regional Sub-Commission for North America, Commission X (Reference Frames), International Association of Geodesy.

1996 Chairman, Gravity and Geodesy Session, Annual General Meeting of the Canadian Geophysical Union, Banff, Alberta, 5-9 May 1996.

1995-Present Canadian Representative, Commission X (Global and Regional Geodetic Networks), International Association of Geodesy.

1992-1995 Member, Special Commission I: Mathematical and Physical Foundations of Geodesy, Subcommission I: Statistics, International Association of Geodesy.

2006-Present Reviewer, *Journal of Geophysics (Solid Earth)*, American Geophysical Union, Washington, DC.

2000-Present Contributing Editor, GPS Solutions, Springer-Verlag, New York.

1998-2010 Contributing Editor, Surveying and Land Information Systems, American Congress on Surveying and Mapping, Falls Church, VA.

1986-Present Reviewer, *Surveying and Land Information Systems* (formerly *Surveying and Mapping*), American Congress on Surveying and Mapping, Falls Church, VA.

1987-Present Reviewer, *Geomatica,* Canadian Institute of Geomatics, Ottawa, Ontario.

1987-Present Reviewer, *Journal of Geodesy* (formerly *Manuscripta Geodaetica*), Springer-Verlag, New York.

1987-1993 Member, International Association of Geodesy Section IV: Theory and Methodology, Special Study Group 4.117: Optimization of Modern Positioning Techniques.

1987-1995 Member, Geodesy Committee, Canadian Institute of Geomatics.

COMPUTER KNOWLEDGE

Operating Systems	DOS, Windows 3.1/95/98/NT/2000 Mac OS X Linux HP-UX DEC VAX VMS IBM MVS/VSPC, CMS CDC NOS/BE
Languages	APL BASIC

C/C++
FORTRAN 77/95/etc.
MATLAB
Pascal
Perl
Unix Shell

MAJOR ACCOMPLISHMENTS

National 3D NAD83 Velocity Model for Canada
Developed a national crustal velocity grid using on a velocity field based on a combined GPS velocity solution for the NAREF and CBN networks in the NAD83(CSRS) reference frame. The velocity field can be used to propagate NAD83 coordinates from one epoch to another, reconcile different realizations of NAD83(CSRS) at different epochs, and transform PPP results from the epoch of observation to the epoch of any particular realization of NAD83(CSRS) in Canada. Received an Earth Sciences Merit Award from Natural Resources Canada.

North American Reference Frame Densification
As Chair of the North American Regional Sub-Commission 1.3c under the auspices of IAG Commission 1 (Reference Frames) and the International GNSS Service (IGS), established and managed the densification of the IGS and ITRF global geodetic networks within North America, which evolved from a network of a few hundred stations in 1999 to 900 stations in 2007 and includes the production of weekly coordinate time series for all stations and annual velocity solutions that contributed to both the ITRF2005 densification effort and the development of the new Stable North American Reference Frame.

Canadian Base Network Adjustments
Developed, supervised and managed the GPS data processing, network adjustment, analysis and integration into NAD83(CSRS) of the Canadian Base Network survey campaigns from 1994 to date, including the development of optimal processing, adjustment and data weighting methodologies.

Redefinition of the North American Datum of 1983
Defined a more stable and consistent realization of the North American Datum of 1983 (NAD83) based on a fourteen parameter transformation from the International Terrestrial Reference Frame (ITRF). Received Intermap Award from the Canadian Institute of Geomatics for best paper in Geomatica.

Equivalence of Session and Baseline GPS Processing
Developed theoretical foundation and algorithm for the adjustment of individually processed GPS baselines that is mathematically equivalent to the rigorous session processing accounting for all mathematical correlations. Received best paper award at Institute of Navigation GPS-93. Algorithm incorporated by various receiver manufacturers in their GPS post-processing software.

Autocorrelation Function for Unevenly Spaced Data
Developed an inverse least squares transform and its application to the determination of a rigorous autocorrelation function for unevenly spaced data series. All other methods require evenly spaced data or try to interpolate an evenly spaced data series from the original unevenly spaced one. The method based on the inverse least squares transform provides a rigorous solution. Results are featured prominently in the Wikipedia entry on Least Squares Spectral Analysis.

Software Development

ACP Software	A suite of programs for the automated control of a prototype GPS active control point that downloads and preprocesses data from a TI 4100 GPS receiver and environmental sensing unit and uploads the data to a master control station. Part of a team of 3 programmers. Developed at the University of New Brunswick under contract to the Geodetic Survey Division, NRCan. Language: Fortran. System: VAX/VMS
CndGeoid	A program for estimating geoid heights using the UNB'86 geoid. Developed for and marketed

	by Geodetic Research Services Ltd. Language: Fortran. Systems: DOS, Mac OS 9.
DIPOP 2.1	A suite of programs for differential positioning using GPS carrier phase observations. Converted entire package to IBM PC and developed utility programs for data plotting and data conversion from various GPS receiver types. Developed at University of New Brunswick and Geodetic Research Services Ltd. Language: Fortran. Systems: DOS, Mac OS 9.
Geodetic Toolbox	A collection of geodetic functions for MATLAB that solve a variety of problems in geodesy, including angle conversions, coordinate conversions, coordinate transformations, date conversions, 3D direct and inverse problems, error ellipses, and more. Supports a wide range of common and user-defined reference ellipsoids. Ranked as top weekly downloaded software on the MATLAB web site every week since submission. Developed and distributed personally. Language: MATLAB. Systems: Linux/Unix, Mac OS X, Windows.
GHOST	A suite of programs for the analysis and adjustment of very large geodetic networks. Developed numerous support programs and routines and provided general maintenance and support. Developed at and distributed by the Geodetic Survey Division, NRCan. Language: Fortran. Systems: Linux/Unix, Windows, Mac OS X.
NET	National Epoch Transformation, the definitive program to propagate NAD83(CSRS) coordinates from one epoch to another using the national velocity model for Canada. Accepts both GHOST and GeoLab data files. Developed at and distributed by the Geodetic Survey Division, NRCan. On-line version implemented at NRCan. Language: Fortran. Systems: Linux/Unix, Mac OS X, MS Windows.
NETAN	A program for the interactive analysis of geodetic networks using statistical, geometrical strength, strain and robustness techniques. Originally developed at the University of New Brunswick for Marshall, Macklin and Monaghan Ltd. under contract to the Geodetic Survey Division, NRCan. Currently developed at and distributed by the Geodetic Survey Division. Language: Fortran. Systems: VAX/VMS, Linux/Unix
NETVAL	A suite of programs for the validation of GPS networks using statistical analysis, strain analysis and similarity transformations. Originally developed for and marketed by Geodetic Research Services Ltd. Currently developed and distributed personally. Language: Fortran. System: DOS, Mac OS X, Unix.
SPADE	A program for the determination of astronomic azimuths without the use of ephemeris tables. Developed and distributed personally. Languages: Turbo Pascal, Fortran, C. Systems: DOS, Linux/Unix, Mac OS X.
TRNOBS	The definitive program that implements the adopted transformation between NAD83 and ITRF reference frames in Canada and the US. Accepts both GHOST and GeoLab data files. Developed at and distributed by the Geodetic Survey Division, NRCan. On-line version implemented at NRCan. Language: Fortran. Systems: Linux/Unix, Mac OS X, MS Windows.

PUBLICATIONS

Copies of publications available at <http://www.craymer.com/geodesy/craymer-pubs.html>.

Refereed Publications

Chaves, J.C., M.C. Santos, F.G. Nievinski and M.R. Craymer . Sources of distortions in the Brazilian Geodetic Network. *Boletim de Ciências Geodésicas*, Vol. 14, No. 2, pp. 186-199, 2008.

Sella, G.F., S. Stein, T.H. Dixon, M. Craymer, T.S. James, S. Mazzotti, R.K. Dokka. Observation of glacial isostatic adjustment in "stable" North America with GPS. *Geophysical Research Letters*, Vol. 34, No. 2, L02306, 2007.

Craymer, M.R.. The Evolution of NAD83 in Canada: Addendum. *Geomatica*, Vol. 60, No. 4, pp. 433, 2006.

Craymer, M.R.. The Evolution of NAD83 in Canada. *Geomatica*, Vol. 60, No. 2, pp. 151-164, 2006. Received Intermap Award for best paper of 2006.

Henton, J., M. Craymer, R. Ferland, H. Dragert, S. Mazzotti, D. Forbes. Crustal Motion and Deformation Monitoring of the Canadian Landmass. *Geomatica*, Vol. 60, No. 2, pp. 151-164, 2006.

Mainville, A. and M.R. Craymer. Present-day tilting of the Great Lakes region based on water level gauges. *Geological Society of America Bulletin*, Vol. 117, No. 7/8, pp. 1070-1080, 2005.

Mazzotti, S., H. Dragert, J. Henton, M. Schmidt, R. Hyndman, T. James, Y. Lu, M. Craymer. Current tectonics of northern Cascadia from a decade of GPS measurements. *Journal of Geophysical Research*, Vol. 108, No. B12, p. 2554, 2003.

Vaníček, P., P. Novak, M. Craymer and S. Pagiatakis. On the Correct Determination of Transformation Parameters of a Horizontal Geodetic Datum. Geomatica, Vol. 56, No. 4, 2002.

Craymer, M.R. and P. Vaníček. Correction to "Robustness Analysis of Geodetic Horizontal Networks". *Journal of Geodesy*, Vol. 76, No. 8, p. 476, 2002.

Vaníček, P., M.R. Craymer and E.J. Krakiwsky. Robustness Analysis of Geodetic Horizontal Networks. *Journal of Geodesy*, Vol. 75, No. 4, pp. 199-209, 2001.

Najafi, M., P. Vaníček and M.R. Craymer. Accuracy of a regional geoid. *Geomatica*, Vol.53, No.3, 1999.

Craymer, M.R. The least squares spectrum, its inverse transform and autocorrelation function: theory and some applications in geodesy. Ph.D. dissertation, Department of Civil Engineering, University of Toronto, 1998.

Craymer, M.R., P. Vaníček and R.O. Castle. Estimation of rod scale errors in geodetic levelling. *Journal of Geophysical Research*, Vol. 100, No. B8, pp. 15129-15146, August 10, 1995.

Craymer, M.R., D.E. Wells, P. Vaníček and R. Devlin. Specifications for Urban GPS Surveys. *Surveying and Land Information Systems,* Vol. 50, No. 4, pp. 251-259, 1990.

Craymer, M.R. and P. Vaníček Comment on "Saugus-Palmdale, California, field test for refraction error in historical levelling surveys" by R.S. Stein, C.T. Whalen, S.R. Holdahl, W.E. Strange and W. Thatcher and reply to "Comment on 'Further analysis of the 1981 southern California field test for levelling refraction' by M.R. Craymer and P. Vaníč ek" by R.S. Stein, C.T. Whalen, S.R. Holdahl, W.E. Strange and W. Thatcher". *Journal of Geophysical Research,* Vol. 94, No. B6, pp. 7667-7672, June 10, 1989.

Quek, S.H., M.R. Craymer, R.B. Langley, D. Parkhill, B. Arseneau, D. McArthur and K. Lochhead. Development of a GPS Active Control Point station. *Journal of Surveying Engineering,* Vol. 115, No. 1, pp. 46-55, February, 1989.

Craymer, M.R., P. Vaníč ek and A. Tarvydas. NETAN — A computer program for the interactive analysis of geodetic networks. *CISM Journal,* Vol. 43, No. 1, pp. 25-37, Spring, 1989.

Craymer, M.R. and P. Vaníček. Further analysis of the 1981 southern California field test for levelling refraction. *Journal of Geophysical Research,* Vol. 91, No. B9, pp. 9045-9055, August 10, 1986.

Craymer, M.R. and R.C. Gunn. Astronomical coordinates without the use of tables. *The Ontario Land Surveyor,* Summer, 1984.

Vaníček, P. and M.R. Craymer. Autocorrelation functions in the search for systematic errors in levelling. *Manuscripta Geodaetica,* Vol. 8, pp. 321-341, 1983.

Chapters in Books

Craymer, M.R., R. Ferland, R. Snay. Realization and Unification of NAD83 in Canada and the US via the ITRF. In R. Rummel, H. Drewes, W. Bosch, H. Hornik (eds.), *Towards an Integrated Global Geodetic Observing System*

(IGGOS), IAG Section II Symposium, Munich, October 5-9, 1998. International Association of Geodesy Symposia, Volume 120, Springer-Verlag, Berlin, 2000. Revised March 11, 1999.

Craymer, M.R. Geodesy. In *Canadian Geophysical Bulletin,* Ed. B. Robertson, Volume 42, December 1989. Canadian National Committee for the International Union of Geodesy and Geophysics of the National Research Council of Canada, Minister of Supplies and Services Canada, Ottawa, 1990.

Craymer, M.R. and P. Vaníček. Sequential adjustment methods for the maintenance of geodetic networks. In *Papers prepared for the CISM Seminars on the NAD '83 Redefinition in Canada and the Impact on Users*. Canadian Institute of Surveying and Mapping, Ottawa, Ontario, pp. 242-262, 1988.

Gunn, R.C. and M.R. Craymer. An algorithm for the azimuth of Polaris. In *Association of Ontario Land Surveyors Professional Practice Manual,* Association of Ontario Land Surveyors, September 1985.

Vaníček, P. and M.R. Craymer. Autocorrelation functions as a diagnostic tool in levelling. In H. Pelzer and W. Niemeier (editors), *Precise Levelling,* Dummler Verlag, Bonn, pp. 327-341, 1983.

Non-Refereed Publications

Samsonov, S., D. White, M. Craymer. Aquistore project: ground deformation retrieved by InSAR during May 2012 - May 2013. Proceedings of MultiTemp 2013: 7th International Workshop on the Analysis of Multi-temporal Remote Sensing Images. The Banff Centre, Banff, AB, Canada, June 25-27, 2013.

Craymer, M.R., J. Henton, M. Piraszewski, E. Lapelle. An updated GPS velocity field for Canada. Eos Transactions, AGU, 92(51), Meeting Supplement, Abstract G21A-0793, 2011.

Craymer, M.R., J. Henton, E. Lapelle, M. Piraszewski. Preliminary results of an updated North American GPS velocity field. Eos Transactions, AGU, 91(51), Meeting Supplement, Abstract G23B-0825, 2010.

Mtamakaya, J.D., M.C. Santos, M.R. Craymer. In search of periodic signatures in IGS REPRO1 solution. Eos Transactions, AGU, 91(51), Fall Meeting Supplement, Abstract G51B-0665, 2010.

Craymer, M.R., J.A. Henton, M. Piraszewski. Transforming PPP results to different realizations of the NAD83 reference frame in Canada. Eos Transactions, AGU, 90(52), Fall Meeting Supplement, Abstract G11C-0659, 2009.

Mtamakaya, J., M.C. Santos, M. Craymer. Harmonic analysis of IGS stations time series. Eos Transactions, AGU, 90(52), Fall Meeting Supplement, Abstract G11B-0634, 2009.

Craymer, M.R., J.A. Henton, M. Piraszewski. Predicting Present-Day Rates of Glacial Isostatic Adjustment Using a Smoothed GPS-Based Velocity Field for the Reconciliation of NAD83 Reference Frames in Canada. Eos Transactions, AGU, 89(53), Fall Meeting Supplement, Abstract G31A-0638, 2008.

Bruyninx, C., Z. Altamimi, M. Becker, M. Craymer, L. Combrinck, A. Combrink, R. Fernandes, R. Govind, T. Herring, A. Kenyeres, B. King, C. Kreemer, D. Lavallee, J. Legrand, M. Moore, L. Sanchez, G. Sella, G. Woppelmann. IGS [IAG] Working Group "Regional Dense Velocity Fields": Objectives and Work Plan. Eos Transactions, AGU, 89(53), Fall Meeting Supplement, Abstract G33B-0689, 2008.

Herring, T., M. Craymer, G. Sella, R. Snay, G. Blewitt, D. Argus, Y. Bock, E. Calais, J. Davis, M. Tamisiea. SNARF 2.0: A Regional Reference Frame for North America. Eos Transactions, AGU, 89(23), Joint Assembly Supplement, Abstract G31B-01, 2008.

Henton, J., M. Craymer, E. Lapelle, M. Piraszewski. Contributions of the North American Reference Frame Working Group to the next realization of the Stable North American Reference Frame (SNARF). Eos Transactions, AGU, 88(52), Fall Meeting Supplement, Abstract G21B-0498, 2007.

Forbes, D.L., M. Craymer, J. Henton, T. Herron, S. Kokelj, E. Lapelle, G.K. Manson, P. Marsh, S. Mazzotti, M. Piraszewski, S.M. Solomon, D. Whalen. Combining Geological, Geodetic, and Tide-Gauge Data to Estimate Coastal Subsidence and Flooding Hazards in the Mackenzie Delta, Western Arctic Canada. Eos Transactions, AGU, 88(52), Fall Meeting Supplement, Abstract G51A-0136, 2007.

Craymer, M.R., M. Piraszewski, J.A. Henton. The North American Reference Frame (NAREF) project to densify the ITRF in North America. Proceedings of ION GNSS 2007, Fort Worth, Texas, September 25-28, 2007.

Craymer, M., G. Sella. Making Sense of Evolving Reference Frames for North America. Eos Transactions, AGU, 88(23), Joint Assembly Supplement, Abstract G32A-01 Invited, 2007.

Craymer, M., J. Henton, M. Piraszewski. Sea Level Change and Vertical Crustal Motion in the Canadian Arctic Using GPS and Tide Gauges: Challenges and Preliminary Results. Eos Transactions, AGU, 87(52), Fall Meeting Supplement, Abstract G23B-1288, 2006.

Craymer, M., D.L. Forbes, J. Henton, E. Lapelle, M. Piraszewski, S.M. Solomon. Determining Sea Level Rise and Coastal Subsidence in the Canadian Arctic Using a Dense GPS Velocity Field for North America. Eos Transactions, AGU, 86(52), Fall Meeting Supplement, Abstract G11B-1203, 2005.

Henton, J., M. Craymer, J. Liard, R. Duval, C. Klatt. Integration of the Canadian Gravity Standardization Network with the Canadian Spatial Reference System: Challenges and Opportunities. Eos Transactions, AGU, 86(52), Fall Meeting Supplement, Abstract G41B-0362, 2005.

Sella, G., S. Stein, T. Dixon, M. Craymer, T. James, S. Mazzotti. Constraints on Glacial Isostatic Adjustment (GIA) Motion in North American Using GPS. Eos Transactions, AGU, 86(52), Fall Meeting Supplement, Abstract G24A-07, 2005.

Craymer, M.R., R. Snay, P. Knudsen. Report on IAG Sub-Commission 1.3 Regional Reference Frames July 2003-April 2005: 1.3C Regional Sub-Commission for North America (NAREF). Report to IAG/IAPSO/IABO Joint Assembly, Cairns, Australia, August 22-26, 2005.

Craymer, M.R., R. Snay, P. Knudsen. Report on IAG Sub-Commission 1.3 Regional Reference Frames July 2003-April 2004: 1.3C Regional Sub-Commission for North America (NAREF). Report to EGU General Assembly, April 24-29, 2005.

Craymer, M.R., D. Milbert, P. Knudsen. Report of the Sub-Commission for North America, IAG Commission X (Global and Regional Geodetic Networks), 1999 to 2003. Report to the XXIII General Assembly of IUGG, Sapporo, Japan, June 30 - July 11, 2003.

Ferland R., Z. Altamimi, C. Bruyninx, M. Craymer, H. Habrich and J. Kouba. Regional Networks Densification. Proceedings of the IGS Network, Data and Analysis Center Workshop, Ottawa, April 8-11, 2002.

Craymer, M.R. and M. Piraszewski. The North American Reference Frame (NAREF): An Initiative to Densify the ITRF in North America. Proceedings of KIS 2001: International Symposium on Kinematic Systems in Geodesy, Geomatics and Navigation, Banff, Canada, June 5-8, 2001. Revised July 13, 2001.

Craymer, M.R. and M. Piraszewski. The NAREF Initiative to Densify the ITRF in North America. Proceedings of the EUREF Permanent Network Third Local Analysis Centres Workshop, Warsaw University of Technology, Warsaw, Poland, May 31 - June 1, 2001.

Krakiwsky, E.J., D.J. Szabo, P. Vaníček and M.R. Craymer. Development and Testing of In-Context Confidence Regions for Geodetic Survey Networks. Contract Report 99-001, Geodetic Survey Division, Geomatics Canada, February 1999.

Craymer, M.R., R. Ferland and R. Snay. Realization and Unification of NAD83 in Canada and the U.S. via the ITRF. Proceedings of the International Symposium of the International Association of Geodesy, Section II,

"Towards an Integrated Geodetic Observing System (IGGOS)", Munich, October 5-9, 1998. Revised 11 March 1999.

Craymer, M.R. Integration of local surveys in to the Canadian Spatial Reference System. Geodetic Survey Division, Geomatics Canada, February 20, 1998. Revised May 24, 1998.

Craymer, M.R. and L. Hennessey. Analysis of Calgary Monument Stability Test Site: Epochs 1 to 7. Geodetic Survey Division, Geomatics Canada, December 2, 1997.

Mainville, A., M.R. Craymer and S. Blackie. The GPS Height Transformation of 1997: An ellipsoidal-orthometric height transformation for use with GPS in Canada. Geodetic Survey Division, Geomatics Canada, 1997.

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