

Michael R. Craymer, B.Sc., M.A.Sc., Ph.D.

Coordinator, Reference Frames & Earth Dynamics
 Geodetic Survey Division, Natural Resources Canada
 615 Booth Street, Ottawa, Ontario, Canada K1A 0E9
 Tel. (613) 947-1829, Fax. (613) 995-3215
 Email: craymer@nrcan.gc.ca

Relevant Accomplishments

- 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.
- Coordinated and implemented international effort under the auspices of the International Association of Geodesy (IAG) to densify of the International Terrestrial Reference Frame (ITRF) in North America using permanent, continuously operating GPS stations (Secretary, IAG Commission 1, Chair, IAG Sub-Commission SC1.3c, and Chair, IAG Working Group SC1.3c-WG1).
- Redefined, coordinated and implemented standardization and maintenance of the NAD83 reference frame in the U.S. and Canada and its relationship to the ITRF reference frame. Received Intermap Award from the Canadian Institute of Geomatics for best paper on NAD83 in *Geomatica*, 2006. (Chair, IAG Working Group SC1.3c-WG3).
- Co-developed robustness analysis technique, an extension of modern reliability theory using strain analysis for the assessment of biases and systematic errors in geodetic networks.
- Developed theoretical foundation and algorithm for the statistical adjustment of individually processed GPS baselines that is mathematically equivalent to rigorous session processing which accounts for all mathematical correlations. Received best paper award at Institute of Navigation GPS-93. Algorithm incorporated by various GPS receiver manufacturers in their GPS post-processing software.
- Developed an inverse least squares transform and its application to the determination of autocorrelation functions for unevenly spaced data series. Results featured prominently in the Wikipedia entry on Least Squares Spectral Analysis.
- Developed various software packages, including the Geodetic Toolbox for Matlab. A suite of functions for solving general problems in geodesy. Consistently the top weekly download in Earth Sciences on the Matlab web site since submission over two years ago.

Education

- B.Sc. U. Toronto, Survey Science, 1979. AOLS John E. Jackson Scholarship & AOLS Scholarships (2). Graduated with distinction.
- M.A.Sc. U. Toronto, Dept. Civil Engineering (Survey Science), 1984. J.E.R. Ross Graduate Scholarship.
- Ph.D. U. Toronto, Dept. Civil Engineering (Survey Science), 1998.

Employment History

- 1996-Present Head, Reference Frames & Geodynamics, Geodetic Survey Division, Geomatics Canada, Natural Resource Canada.
- 1992-1996 Senior Geodetic Engineer, Geodetic Survey Division, Geomatics Canada, Natural Resource Canada.
- 1989-1992 Vice-President, General Manager, Geodetic Research Services Ltd., Fredericton, N.B.

- 1989 Lecturer, Dept. Surveying Engineering, University of New Brunswick.
 1986-1991 Research Associate, Geodetic Research Laboratory, Dept. Surveying Engineering, University of New Brunswick.
 1986 Lecturer (Survey Analysis II), Survey Science, University of Toronto.
 1984-1992 Geodetic & photogrammetric consultant to various companies.

Awards

- 2007 Fellow of the International Association of Geodesy
 2006 Intermap Award (best paper in Geomatica), Canadian Institute of Geomatics
 1999 Earth Sciences Sector Merit Award, Natural Resources Canada
 1998 Earth Sciences Sector Merit Award, Natural Resources Canada
 1996 Geodetic Survey Division Merit Award, Natural Resources Canada
 1993 Institute of Navigation GPS'93 Best Paper Award
 1982 J.E.R. Ross Graduate Scholarship, University of Toronto
 1978 AOLS Scholarship, University of Toronto
 1977 AOLS Scholarship, University of Toronto
 1976 AOLS John E. Jackson Scholarship, University of Toronto

Recent Professional Activities

- 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.
 2007-Present Vice-President, Commission 1 (Reference Frames), International Association of Geodesy.
 2007-Present Member, Working Group, SC1.3-WG1 (Regional Dense Velocity Fields), Sub-Commission 1.3 (Regional Reference Frames), International Association of Geodesy.
 2004-2007 Chair, Working Group SC1.3-WG1 (Inter-regional Technical), Sub-Commission 1.3 (Regional Reference Frames), International Association of Geodesy.
 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), Regional Sub-Commission 1.3c (Regional Reference Frames for North America), International Association of Geodesy.
 2003-Present 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.
 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.
 2003-Present Member, Commission 1.3 (Regional Reference Frames), International Association of Geodesy.
 2000-Present Contributing Editor, GPS Solutions, Springer-Verlag, New York.
 1998-Present Contributing Editor, Surveying and Land Information Systems, American Congress on Surveying and Mapping, Falls Church, VA.

Relevant Publications

Full publication list available at <<http://www.craymer.com/geodesy/craymer-pubs.html>>.

- 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.
- 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.
- 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. *GSA 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.
- 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 P. Vanicek. 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.
- 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., R. Ferland and R. Snay. Realization and Unification of NAD83 in Canada and the U.S. 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, Vol. 120, Springer, Berlin, 2000.
- 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. Integration of local surveys in to the Canadian Spatial Reference System. Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, February 20, 1998.
- Craymer, M.R. and L. Hennessey. Analysis of Calgary Monument Stability Test Site: Epochs 1 to 7. Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, 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, Natural Resources Canada, Ottawa, 1997.
- Craymer, M.R. Recommended Procedure for the Adjustment of Individual GPS Baseline Solutions. Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, March 1995,

- Revised November 1996.
- Vaniček, P., P. Ong, E.J. Krakiwsky, and M.R. Craymer. Application of robustness analysis to large geodetic networks. Contract Report 96-001, Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, February 1996.
- Krakiwsky, E.J., D.J. Szabo, P. Vaniček and M.R. Craymer. Development of in-context confidence regions for geodetic survey networks. Contract Report 99-001, Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, April 1994, Revised February 1999.
- Craymer, M.R., P. Vaniček 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., P. Vaniček, E.J. Krakiwsky and D. Szabo. Robustness analysis: A new method of assessing the strength of geodetic networks. Proceedings of the Surveying and Mapping Conference, Toronto, June 8-11, 1993.
- Craymer, M.R. and N. Beck. Session Versus Baseline GPS Processing. Proceedings of the 5th International Technical Meeting of the Institute of Navigation, ION GPS-92, Albuquerque, NM, 16-18 September 1992. Received Best Paper award.
- Carrera, G., P. Vaniček and M.R. Craymer. The Compilation of a Map of Recent Vertical Crustal Movements in Canada. Contract Report 91-001, Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, 1991, or Dept. of Surveying Engineering Technical Report No. 153, University of New Brunswick, N.B. May 1991.
- Craymer, M.R., D.E. Wells, P. Vaniček and R. Devlin. Specifications for Urban GPS Surveys. *Surveying and Land Information Systems*, Vol. 50, No. 4, pp. 251-259, 1990.
- 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. Vaniček 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. Vaniček. 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.
- Wells, D.E., M.R. Craymer and S.H. Quek. High Latitude Positioning. Contract report for the Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth, N.S. Dept. of Surveying Engineering, Univ. of New Brunswick, Fredericton, N.B., March 1987.
- Craymer, M.R. and P. Vaniček. 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.
- Vaniček, P. and M.R. Craymer. Autocorrelation functions in the search for systematic errors in levelling. *Manuscripta Geodaetica*, Vol. 8, pp. 321-341, 1983.
- Vaniček, 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.