

# Annual Report for Research Centers and Institutes Reporting Period 1998 and 1999

Centre for Earth Observation Science (CEOS)  
Level 1 Centre of the Faculty of Arts  
Department of Geography, University of Manitoba

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## **Personnel**

### **Faculty**

Barber, D.G., Professor of Geography (50 percent)  
Benbow, M. Assistant Professor of Geography (10 percent)  
Burke, A. Associate Professor of Archeology (5 percent)  
Gardner, J. Professor of Geography ( 5 percent)  
Kenkel, N, Professor of Botany (10 percent)  
Papakyriakou, T, Assistant Professor of Geography (10 percent)  
Stene.L, Associate Professor of Geography (10 percent)  
Smith, G. Professor of Geography (10 percent)  
Valeo, C. Assistant Professor of Civil Engineering (5 percent)

### **Research Associates and Post Docs**

Iacoza, J. full time appointment to CEOS  
Papakyriakou, T. full time in 1998/99 to CEOS now a faculty member in Geography.  
Saczuk, E. part time RA for CEOS (30 percent)  
Chan.W. part time RA for CEOS (20 percent)

### **Support Staff**

Roberecki, Aggie, Administrative support for CEOS, particularly budget control and reporting (50 percent)

Mossdrop, David R., Operations Manager of CEOS. Support for hardware, software, field equipment management, planning and organization of research projects (50 percent)

### Students (Ph.D. and Masters)

The following students are being supported (financially and/or logistically) over the reporting period.

Name	Years Supervised	Degree (date)	Research Topic
Mkanda, F.	1997-2002	Ph.D. (2002)	Soil erosion modeling within a geographical information system.
McCullough, G.	1998-2002	Ph.D. (2002)	River Sediment loading studies in Lake Malawi.
Hanesiak, J	1996-2001	Ph.D. (2001)	Integration of remote sensing data within numerical models of ocean-sea ice-atmosphere processes.
Cooley, P.	1996-2001	Ph.D. (2001)	Development of a GIS based biodiversity atlas for Lake Malawi, Africa.
Hochheim, K.	1995-2000	Ph.D. (2000)	Microwave and optical remote sensing of agricultural surfaces.
Yackel, J.	1995-2000	Ph.D. (2000)	Estimation of ice breaker navigability based on the time series microwave scattering coefficient ( $\sigma^{\circ}$ ).
Nichols, T.	1994-1997	MA (1997)	Development of a ringed seal habitat suitability index based on synthetic aperture radar images of sea ice.
McCullough, G.	1996-1998	MA (1998)	Estimating suspended sediment concentrations using optical scattering and transmission.
Brook, R	1996-1998	MA (2000)	Digital Elevation Modelling from RadarSAT Interferometry and stereo projection.
Mundy, C.J.	1997-1999	MA (1999)	Ecological implications of snow thickness distributions on sea ice.
Pegado, A	1997-2000	MA (2000)	Effects of sedimentation of Fish Diversity in Lake Malawi, Africa.
O. Banais	1997-98	Honours	Statistical Characterization of melt ponds on sea ice.
C. Parslow	1998-99	MA	GIS and Archeology
Walker, D.	1995-2000	PhD (2000)	Riding Mountain National Park study
Quiring, S.	1999-2001	MA (2001)	Prairie climate change study
Silvestrie, G.	1996-2001	PhD (2001)	Decision making of the Elderly
Vander Kruys, J.	1999-2001	MA (2001)	Cryosphere-climate interactions
Harouche, I.	1999-2001	MA (2001)	Sea Ice Remote Sensing
Thorgillson, W.	1998-2000	MA (2000)	Precision Agriculture
Saczuk, E.	1999-2002	PhD (2002)	Mass Wasting in the Himalaya
Hempel, R.	1998-2000	MA (2000)	Forrest Management in Indonesia
McPherson-Scott, C.	1998-2000	MA (2000)	Geography of the Elderly

## Academic Contributions

### **Primary Publications**

Barber, D.G., and A. Thomas. 1998. The Influence of Cloud on the Radiation Balance, Physical Properties and Microwave Scattering of First Year and Multi-Year Sea Ice *IEEE Transactions on Geoscience and Remote Sensing*. 36(1): 38-50.

Thomas, A. and D.G. Barber. 1998. On the use of Multi-year ERS-1  $\sigma^{\circ}$  as a Proxy Indicator of Melt Period Sea Ice Albedo. *International Journal of Remote Sensing*. 19(14): 2807-2821.

Barber, D.G. and Yackel, J. 1999. The physical, radiative and microwave scattering characteristics of melt ponds on sea ice. *International Journal of Remote Sensing*. In Press (July, 1998)

Drobot, S. and D.G. Barber. 1998. Towards development of a snow water equivalence (SWE) algorithm using microwave radiometry over snow covered first-year sea ice. *Photogrammetric Engineering and Remote Sensing*. 64(5):415-423

Hochheim, P. and D.G. Barber. 1998. Spring Wheat Yield Estimation for Western Canada using NOAA NDVI data. *Canadian Journal of Remote Sensing*. 24(1):18-27

Barber, D.G., J. Yackel, R. Wolfe, and W. Lumsden. 1998. Estimating the thermodynamic state of snow covered sea ice using time series synthetic aperture radar (SAR) data. *Proceedings of the Eighth International Offshore and Polar Engineering Conference, Montreal Canada, May, 1998*. International Society of Offshore and Polar Engineers. Vol III: 50-54.

Jezek, K.C., D. Perovich, K.M. Golden, C. Luther, D.G. Barber, P. Gogineni, T. Grenfell, A. Jordan, C. Mobley, S. Nghiem, and R. Onstott. 1998 A broad Spectral, Interdisciplinary Investigation of the Electromagnetic Properties of Sea Ice. *IEEE Transactions on Geoscience and Remote Sensing*. ONR ARI special issue. 36(5):1633-1641.

Barber, D.G., A.K. Fung, T.C. Grenfell, S.V. Nghiem, R.G. Onstott, V. Lytle, D.K. Perovich and A.J. Gow. 1998. The Role of Snow on Microwave Emission and Scattering over First-Year Sea Ice. *IEEE Transactions on Geoscience and Remote Sensing*. ONR ARI special issue. 36(5):1750-1763.

- Grenfell, T.C., D.G. Barber, A.K. Fung, A.J. Gow, K.C. Jezek, E.J., Knapp, S.V. Nghiem, R.G. Onstott, D.K. Perovich, C.S. Roesler, C.T. Swift, and F. Tanis. 1998. Evolution of Electromagnetic-Signatures of Sea Ice From Initial Formation Through the Establishment of Thick First-Year Ice. *IEEE Transactions on Geoscience and Remote Sensing*. ONR ARI special issue. 36(5):1642-1654.
- Kwok, R., S.V. Nghiem, S. Martin, D.P. Winebrenner, A.J. Gow, D.K. Perovich, C.T. Swift, D.G., Barber, K.M. Golden, and E. Knapp. 1998 Laboratory Measurements of sea ice: connections to microwave remote sensing. *IEEE Transactions on Geoscience and Remote Sensing*. ONR ARI special issue. 36(5):1716-1730.
- Perovich, D.K. D. Barber, G. Cota, A.J. Gow, T.C. Grenfell, A.J. Hunt, R.A. Maffione, C.D. Mobley, R.O. Onstott, W.W. Pegau, and C.S. Roesler. Field Observations of the electromagnetic properties of first-year sea ice. *IEEE Transactions on Geoscience and Remote Sensing*. ONR ARI special issue. 36(5):1705-1715.
- Barber, D.G., and S.V. Nghiem. 1999. The role of snow on the thermal dependence of backscatter over sea ice. *Journal of Geophysical Research (Oceans)*. In Press (July'98).
- Hanesiak, J.M., D.G. Barber and G.M. Flato. The Role of Diurnal Processes in the Seasonal Evolution of Sea Ice and its Snow Cover. *Journal of Geophysical Research (Oceans)*. , 104(C6),13593-13604.
- Iacoza, J. and D.G. Barber. Modelling the Distribution of Snow on Sea Ice Using Variograms *Atmosphere-Oceans*. In Press (Sept'98)
- Yackel, J. and D. G. Barber. An Examination of the Morphological, Climatological and Microwave Scattering Characteristics of Melt Ponds on Landfast First-Year Sea Ice using RADARSAT-1. *Journal of Geophysical Research-Oceans* (March'99).
- Barber, D.G., J. Yackel and J. Hanesiak.1999. Perspectives on Sea Ice, RadarSat-1, and Arctic Climate Change. *ADRO special issue, Canadian Journal of Remote Sensing*. In Review (April'99)
- Hanesiak, J.M, D. G., Barber, R. De Abreu and J.J. Yackel. An Examination of the Role of Melt Pond Broadband and spectral Albedo in Sea Ice Ablation. *Journal of Geophysical Research-Oceans*. (June'99).
- Barber, D.G., A. Thomas and T. Papakyriakou. 1998 The role of synthetic aperture radar (SAR) in surface energy flux measurements over sea ice. Invited

- Chapter #3 in Tsatsoulis, C. and R. Kwok. Synthetic Aperture Radar Remote Sensing of Sea ice. John Wiley and Sons. pp 35-67.
- Smith, G.C., "Geographic Separation and Patterns of Social Interaction Between Residents of Senior Citizen Apartment Buildings and Their Adult Children," *The Canadian Geographer*, Vol.42, No.2 (1998), 145-58.
- Smith, G.C., "Residential Separation and Patterns of Interaction Between Elderly Parents and Their Adult Children," *Progress in Human Geography*, Vol.22, No.3 (1998), 368-84.
- Smith, G.C., "Change in Elderly Residential Segregation in Canadian Metropolitan Areas, 1981-91" *Canadian Journal on Aging*, Vol.17, No.1 (1998), 59-82.
- Smith, G.C. and Ford, R.G., "Geographical Change in the Provision of Residential Care Resources for the Elderly in England, 1988-93," *Health and Place*, Vol.4, No.1 (1998), 15-31.
- Macey, S.M., Smith, G.C. and Watkins, J.F., "Aging and the Aged," In Gaile, G.L. and Willmott, C.J. (eds.), *Geography in America at the Dawn of the 21st Century*, New York: Oxford University Press, in press.
- Ingram, G, D.G. Barber and J.M. Hanesiak, 1999: The North Water Polynya: An Overview. *Atmos.-Ocean* (in review).
- Yackel, J.J., D.G. Barber and J.M. Hanesiak, 1999: An examination of the morphological, climatological and microwave scattering characteristics of melt ponds on landfast first-year sea ice using Radarsat-1, *J. Geophys Res.* (in review).
- Hanesiak, J.M., T.N. Papakyriakou and D.G. Barber, 1999: Parameterization schemes of incident radiation in the North Water. (to be submitted to *Atmos.-Ocean NOW* special issue).
- Szeto, K.K., Halvey, I., J.M. Hanesiak, R.W. Crawford, R.E. Stewart and G.W.K. Moore, 1999: The Beaufort mesoscale vortex: Its structure, evolution and occurrence. *Atmos.-Ocean*, in press
- Szeto, K.K., R.E. Stewart and J.M. Hanesiak, 1997: High-latitude cold season frontal cloud systems and their precipitation efficiency. *Tellus*, 49A, 439-454.
- Hanesiak, J. M., R. E. Stewart, K. K. Szeto, D. R. Hudak and H. Leighton, 1996: The Structure, Water Budget and Radiational Features of a High Latitude Warm Front. *J. Atmos. Sci.*, 54, 1553-1573.
- Hanesiak, J. M. and R. E. Stewart, 1995: Mesoscale and Microscale Structure of a Severe Ice Pellet Storm. *Mon. Wea. Rev.*, 123, 3144-3162.

Raddatz, R. L. and J. M. Hanesiak, 1991: Climatology of Tornado Days 1960-1989 for Manitoba and Saskatchewan. *Climatological Bul.*, 25, 47-59.

Hanesiak, J.M. and D.G. Barber, 1998: Integration of Remote Sensing and Numerical Process/Prediction Models: CEOS Technical Report 98-1, Geography Department, University of Manitoba, Winnipeg.

### **Conference Papers**

Barber, D. 1999. "Geomatics" Presented at the first annual GIS Modelling Workshop, co-sponsored by the Departments of Geography, Botany and Civil and Geological Engineering, University of Manitoba, June 24-25<sup>th</sup>, 1999

Barber, D. 1999. Snow on Sea Ice. Eastern Snow Conference. IAHS meeting. Fredericton, NB. May'99.

Barber, D. 1999. Response of Sea Ice to Climate Change. Arctic Climate Change Workshop. Victoria B.C. February, 1999.

Kenkel, N. 1999. "Spatial Statistical Analysis in GIS" Presented at the first annual GIS Modelling Workshop, co-sponsored by the Departments of Geography, Botany and Civil and Geological Engineering, University of Manitoba, June 24-25<sup>th</sup>, 1999

Valeo, C. 1999. "Hydrological Modelling and GIS". Presented at the first annual GIS Modelling Workshop, co-sponsored by the Departments of Geography, Botany and Civil and Geological Engineering, University of Manitoba, June 24-25<sup>th</sup>, 1999.

Yackel, J.J., 1999. An evaluation RADARSAT-1 for geophysical inversion of melt pond characteristics over sea ice. The 1999 Prairie Division of the Canadian Association of Geographers Annual Meeting, Winnipeg, Manitoba, 24-26 September (oral presentation given)

Yackel, J.J., D.G. Barber and J.M. Hanesiak., 1999. An Examination of the Morphological, Climatological and Microwave Scattering Characteristics of Melt Ponds on Landfast First-Year Sea Ice using Airborne Videography and RADARSAT-1. Proceedings, Fourth International Airborne Remote Sensing Conference and Exhibition/21st Canadian Symposium on Remote Sensing, Ottawa, Ontario, 21-24 June (interactive presentation given).

Yackel, J.J., 1999. Microwave Scattering Characteristics of Melt Ponds on Landfast First-Year Sea Ice using RADARSAT-1. GIS Workshop: From Theory to Application, 24-25 June (oral presentation given).

Yackel, J.J., D.G. Barber and J.M. Hanesiak., 1999. Microwave Scattering Characteristics of Melt Ponds on Landfast First-Year Sea Ice using

RADARSAT-1. Proceedings, The Canadian Association of Geographers 1999 Annual Meeting, Lethbridge, Alberta, 1-5 June (oral presentation given)

Yackel, J.J. and D.G. Barber., 1998. Estimating IceBreaker Navigability over Landfast First Year Sea Ice using Synthetic Aperture Radar (SAR) Time Series Scattering Coefficients, Proceedings, ADRO Final Symposium, Oct 13-15, Montreal, Quebec, (oral presentation given).

Yackel, J.J. and D.G. Barber., 1998. Measuring the thermodynamic state of sea ice using Synthetic Aperture Radar (SAR) time series data, Proceedings, IGARSS'98, June 12-15, Seattle, WA.

Hanesiak, J.M., D.G. Barber and G.M. Flato, 1998: The role of diurnal processes in the seasonal evolution of sea ice and its snow cover, IGARSS'98, July 6-10, Seattle, Washington.

Hanesiak, J.M., D.G. Barber and G.M. Flato, 1997: The use of remote sensing in a one-dimensional thermodynamic sea ice model. Geomatics in the Era of RADARSAT (GER'97), May 27-31, Ottawa, Ontario.

Hanesiak, J.M., V.R. Kezys, S. Haykin and R.E. Stewart, 1996: Cloud layering observations in southern Ontario. WCRP report on the GEWEX Cloud System Study workshop, WMO.

Szeto, K.K., J.M. Hanesiak and R.E. Stewart, 1996: Moist simulation of a high latitude warm frontal system. WCRP report on the GEWEX Cloud System Study workshop, WMO.

Smith, G.C. and Sylvestre, G.M., "Locational Aspects of Government-Subsidized Senior Citizen Apartment Buildings in Winnipeg," Annual Spring Symposium, Centre on Aging, University of Manitoba, Winnipeg, Manitoba, May, 1999.

Sylvestre, G.M. and Smith, G.C., "Locational Aspects of Low-Rent Senior Citizen Apartment Buildings in Winnipeg," Annual Meeting, The Canadian Association of Geographers, Lethbridge, Alberta, June, 1999.

### **Workshops/Meetings**

Yackel, J.J. attended the annual Cryospheric System (CRYSYS) meeting at the University of Waterloo, February 25-27, 1998. Oral presentation on behalf of Mr. John

Hanesiak, (Ph.D. Student). Interactive presentation of cryospheric research being conducted within the Centre for Earth Observation Science, University of Manitoba.

Yackel, J.J. attended the RADARSAT Antarctic Mapping Project (RAMP) meeting at Ohio State University in Columbus, Ohio (November 25-27, 1997). I was one of only four Canadians present at the meeting which discussed strategies for effectively utilizing the first ever complete SAR dataset of the Antarctic continent.

Yackel, J.J. conducted a week long research investigation of Sea Ice Decay at the Canadian Ice Service, Ottawa, Ontario, 13-21 June, 1999.

Yackel, J.J. talked on Arctic Climate Change: A Sea Ice Perspective. Issues in the North Seminar Series, Department of Native Studies, 29 September, 1999.

### **Thesis completed**

Nichols. T., Ringed Seal Habitat Suitability from SAR. MA. 1999.

McCullough.G. AVHRR assessment for total suspended solids in Lake Erie. MA. 1999.

Saczuk, E., Mapping Debris Flow Mapping in GIS, MA. 1998

Banias O. Melt ponds on sea ice. Honours (Geography) 1998.

## **Activities and Research Projects**

CEOS participated in several working meetings relating to climate change. We also supported several working group meetings and conferences. Selected activities are highlighted below:

DICE proposal – CEOS led the development of the CFI proposal for the Disaster Information Centre (DICE). The proposal was very well received by provincial and federal partners, both in the private and public sectors. We organized a team of some 30 researchers from 10 different agencies. The Canadian Space Agency agreed to contribute over 4 million dollars. Other partnership contributions brought the total committed to over 11 million. The CFI review committee decided not to fund the centre. The reasons provided were a contradiction to the phase I review and a blatant statement of small political decision making. An adequate explanation has still not been provided to the U of M for this decision.

CEOS is an active partner in the High Performance Computing Initiative being developed by Computer Science for submission to CFI in the near future.

ONR ARI- CEOS participated in an American lead project to study the electromagnetic properties of sea ice. The project spanned the period 1993 to 1998. A special issue of the Transactions on Geoscience and Remote Sensing resulted from this collaborative research project.

North Water Polynya Project – D. Barber was selected (through a national competition) as the Principle Investigator for the Sea ice-climate dynamics subgroup of this Arctic climate change project. The field component of the project was conducted in the NOW region in the spring and summer of 1998. We are currently working towards a special issue of the journal, Atmosphere-Ocean as a contribution from our group to the national NOW initiative. NSERC funded national network program (5 million in NSERC support and 11 million from international partners)

GlobeSAR projects- CEOS is partnered with the University of Pariaba and the University of Beunos Airies on two Radarsat related projected relating to climate change impacts in South America. The Space Agency provides funds for academics from the South American Universities to come up to the U of M and for us to travel to their labs.

CEOS is a founding member of the Lake Winnipeg Research Consortium. This group of more than 15 agencies meets at DFO (FWI) to develop the research partnerships necessary to forward the study of Lake Winnipeg. These studies are multidisciplinary in nature. Other partners include Fisheries and Oceans, Manitoba Hydro and the Province of Manitoba.

High latitude climate change research – CEOS continues to lead a longitudinal climate change research programme in the high arctic. We conducted field projects there in the

spring of 1998 and 1999. These projects are part of a 10 year dataset on the processes of arctic climate change. Partners in this work are Environment Canada, AES, DFO, CCRS, CSA and NASA.

Measuring tundra productivity and vegetation structure from cloud-free weather satellite (geocomp-n) data is a new project of a research partnership between the Parks Canada Agency and the University of Manitoba. The aim of the present partnership between Parks Canada and CEOS is to improve the interpretation of the GEOCOMP-n satellite data that Parks Canada is currently using as a monitoring tool in its northern parks.

Dr. Barber will lead a research program using archived Landsat MSS data to map the magnitude and interannual evolution of total suspended solids (TSS) within regions affected by the Lake Winnipeg-Churchill-Nelson regulation.

GIS workshop – CEOS coordinated a professional development workshop at the University of Manitoba on GIS – from theory to applications. The two day workshop was attended by about 195 people from public, private and academic sectors. The workshop was very well received and it is hoped that it will become an annual event hosted by CEOS.

ESRI software consortium is a group representing 6 post-secondary educational institutions in Manitoba (UofM, U of W, Brandon U, Red River College, Assiniboine College, Keewatin College) which came together in 1998 to negotiate a provincial wide software deal with ESRI for the use of GIS software in teaching and research. The software deal enters the second year after having contributed greatly to the teaching and research programs of all partners. CEOS played a major role in the development of this deal and in it's continuation.

Invited speakers – CEOS sponsored a presentation by Dr. Lawrence Mysak at the U of M. Dr. Mysak is the president of the Royal Society and spoke on decadal oscillations in the atmosphere-ocean system in high latitudes.

## Sources of Funding

CEOS receives an annual operating grant from the Faculty of Arts. The Department of Geography and CEOS also collaborate on providing teaching and research facilities within the Department. Currently we have one undergraduate lab, and two graduate research labs. The following research grants were obtained within the reporting period.

<b>Principal Investigator</b>	<b>Grant Description</b>
Barber, D.G.	Support from the Department of Fisheries and Oceans for training of two graduate students (1 PhD and 1 masters) as part of the Lake Malawi Biodiversity Conservation Program
Barber, D.G.	Sea Ice/Climate Dynamics subgroup of the North Water Polynya Study (NOW). Research grant from NSERC for a National Network.
Barber, D.G.	Sea Ice/Climate Dynamics subgroup of the North Water Polynya Study (NOW). Research grant from NSERC for a National Network.
Barber, D.G.	Canadian Climate Centre, Atmospheric Environment Service. Research Grant to develop a technique for estimation SWE over snow covered sea ice.
Barber, D.G.	Canadian Climate Centre, Atmospheric Environment Service. Research Grant to investigate approaches available for linking remote sensing data within numerical climate process models
Barber, D.G.	Canadian Ice Services, Environment Canada, Research Grant to support analysis of C-ICE'97 radiometer data
Barber, D.G.	Canadian Ice Services, Environment Canada, Support in Kind for the NOW polynya study
Barber, D.G.	Canadian Ice Services, Environment Canada, Research Grant to support the NOW polynya study
Barber, D.G.	Arctic Ice Regime Shipping System research project supported by Transport

Canada and Canadian Ice Services

- Barber, D.G. National Ice Services, Washington, DC. Research Grant to support the NOW polynya study
- Barber, D.G. Arctic Ice Regime Shipping System research project supported by Canadian Ice Services
- Barber, D.G. Development of the Disaster Information Research Centre (DIRC). Canadian Space Agency and the Government of Manitoba
- Barber, D.G. Support for the CFI proposal for DIRC (part of the DICE Proposal) from the Western Economic Diversification fund.
- Barber, D.G. Northern Studies Training Program to support the C-ICE'98/NOW experiment
- Barber, D.G. Arctic Ice Regime Shipping System (Phase 2 and 3) research project supported by Transport Canada and Canadian Ice Services
- Barber, D.G. NSERC Operating Grant - This is a four year grant for general research support from the Natural Sciences and Engineering Research Council.
- Barber, D.G. NSERC Equipment Grant – This is an equipment grant to purchase an Analytical Spectral Devises (ASD) spectrometer.
- Barber, D.G. NOW sea ice collaborative research with the Canadian Ice Services
- Barber, D.G. Joint Ocean-Ice Study (JOIS'98). Support from the Canadian Coast Guard and the Department of Fisheries and Oceans for the Canadian Ice Breaker Louis St. Laurant and helicopter support for the Fall C-ICE'98 experiment.
- Barber, D.G. Purchase of a ceilometer for climate change research from the Faculty of Arts and Research Administration.
- Barber, D.G. Globesar projects for collaborative research work in Argentina, Brazil and Peru. Funds are provided by CCRS for travel between labs, per diem support and collaboration on field research.
- Barber, D.G. Support for microwave radiometry project as part of C-ICE'98 from the Canadian Ice

Services

Barber, D.G.	Support for thermodynamic-microwave scattering research into ice decay from the Canadian Ice Services
Barber, D.G.	Sponsorship from the Gordon Research Conference on Polar Marine Science to participate as an invited speaker and to support the travel of one graduate student and post doctoral fellow from my lab.
Barber, D.G.	Northern Studies Training Program to support the C-ICE'99 experiment
Smith, G.	SSHRC research grant (1998-2001). Effects of Local Environments upon the Adjustments of Movers to Senior Citizen Housing.
Valeo, C.	NSERC Operating Grant to develop variable source area models in mixed land use.
Valeo, C.	Manitoba Hydro Grant to develop a GIS-assisted distributed hydrological model for remote regions of Manitoba.
Valeo, C.	NSERC CRD Grant to provide hardware and student support for distributed hydrological modelling in remote regions of Manitoba
Barber, D.G.	Collaborative research grant from the Centre for International Forest Research (CIFOR) in Indonesia

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**subtotal**

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The centre has a reasonably good financial status. We find that the special academic funds which go to the Department of Geography are totally inadequate. Most of the CEOS research support money goes to student stipends and equipment. The operating grant from the Faculty of Arts will have to be increased in the near future if we are to maintain the level of research and funding activity currently enjoyed by CEOS.

## **Infrastructure**

### **New equipment purchases:**

Second NVIR spectrometer  
2 hand held GPS units  
climate field equipment

### **Research Facilities**

Technologically, CEOS considers remote sensing, geographic information systems, image analysis systems, global positioning systems, computer modeling and analytical methods as an integrated set of 'Geomatics' tools.

- Computer Hardware/software:

State-of-the-art network computer facility with modern industry standard software. CEOS through the University of Manitoba is part of a GIS consortium, which has entered into a province wide licensing agreement with ERSI to provide industry standard GIS software to students regardless of which institute they are attending.

- Field equipment:

two vis/NIR spectrometers, differential GPS base station and rover units, surface energy balance and cloud physics instrumentation (radiometers, psychrometers, ceilometers, and an all sky cameras)

### Data:

- MOUs between CEOS and the Province of Manitoba (Land Information Branch), NASA, CSA, NASDA, and ESA for access rights to data - with the qualification that these data must be used for research.
- The University of Manitoba Libraries has entered into a licensing agreement with Linnet Geomatics to make the Land Information Navigator data available on campus. CEOS is the repository of one of four University held sets of these data.

## **Web Address**

To be kept up-to-date with the variety of CEOS activities and to be informed of upcoming events, check our World Wide Web page regularly. You can find us at:

[www.umanitoba.ca/ceos](http://www.umanitoba.ca/ceos)

[www.umanitoba.ca/geography](http://www.umanitoba.ca/geography)

emails: David Barber – [dbarber@ms.umanitoba.ca](mailto:dbarber@ms.umanitoba.ca)

David Mosscrop – [David\\_Mosscrop@Umanitoba.ca](mailto:David_Mosscrop@Umanitoba.ca)