

Ed Cloutis – Recent Publications

a) Journal Articles:

- Lyder, D., J. Feng, B. Ribard, A. Gallie, and **E. Cloutis** (2010) Remote bitumen content estimation of Athabasca oil sand from hyperspectral infrared reflectance spectra using Gaussian singlets and derivative of Gaussian wavelets. *Fuel*, 89, 760-767.
- Cloutis, E.A.**, P. Hudon, C.S. Romanek, V. Reddy, M.J. Gaffey, and P.S. Hardersen (2009) Spectral reflectance properties of ureilites. *Meteoritics and Planetary Science*, in press.
- Cloutis, E.A.**, R.L. Klima, L. Kaletzke, A. Coradini, L.F. Golubeva, L.A. McFadden, D.I. Shestopalov, and F. Vilas (2010) The 506 nm absorption feature in pyroxene spectra: nature and implications for spectroscopy-based studies of pyroxene-bearing targets. *Icarus*, in press; doi: 10.1016/j.icarus.2009.11.025.
- Palomba, E., A. Zinzi, **E.A. Cloutis**, M. D'Amore, D. Grassi, and A. Maturilli (2009) Evidence for Mg-rich carbonates on Mars from a 3.9 μm absorption band. *Icarus*, 203, 58-65.
- Cloutis, E.A.**, P.S. Hardersen, D.L. Bish, D.T. Bailey, M.J. Gaffey, and M.A. Craig (2009) Reflectance spectra of iron meteorites: Implications for spectral identification of their parent bodies. *Meteoritics and Planetary Science*, in press.
- Cloutis, E.A.**, S.E. Grasby, W.M. Last, R. Leveille, G.R. Osinski, and B.L. Sherriff (2009) Spectral reflectance properties of carbonates from terrestrial analogue environments: Implications for Mars. *Planetary and Space Science*, in press; doi:10.106/j.pss.2009.09.002.
- Goltz, D., M. Attas, **E. Cloutis**, G. Young, and P. Begin (2009) Visible (420-720 nm) hyperspectral imaging techniques to assess inks in historical documents. *Restaurator*, 2009, 199-221.
- Rice, M.S., J.F. Bell III, **E.A. Cloutis**, A. Wang, S.W. Ruff, M.A. Craig, D.T. Bailey, J.R. Johnson, P.A. de Souza Jr., and W.H. Farrand (2009) Silica-rich deposits and hydrated minerals at Gusev crater, Mars: Vis-NIR spectral characterization and regional mapping. *Icarus*, in press; doi: 10.1016/j.icarus.2009.03.035.
- Clark, B.E., M.E. Ockert-Bell, **E.A. Cloutis**, D. Nesvorny, T. Mothe-Diniz, and S.J. Bus (2009) Spectroscopy of K-complex asteroids: Parent bodies of carbonaceous meteorites?. *Icarus*, 202, 119-133.
- Pompilio, L., G. Pedrazzi, M. Sgavetti, **E.A. Cloutis**, M.A. Craig, and T.L. Roush (2009) Exponential Gaussian approach for spectral modeling: The EGO algorithm, I. Band saturation. *Icarus*, 201, 781-794.
- Horgan, B.H., J.F. Bell III, E.Z. Noe Dobrea, **E.A. Cloutis**, D.T. Bailey, M.A. Craig, L.H. Roach, and J.F. Mustard (2009) The distribution of hydrated minerals in the north polar

regions of Mars. *Journal of Geophysical Research - Planets*, 114, E01, E01005
doi:10.1029/2008JE003187.

Küppers, M., H.U. Keller, E. Kührt, M.F. A. Hearn, K. Altwegg, R. Bertrand, H. Busemann, M.T. Capria, L. Colangeli, B. Davidsson, P. Ehrenfreund, J. Knollenberg, S. Mottola, A. Rathke, P. Weiss, M. Zolensky, E. Akim, A. Basilevsky, E. Galimov, M. Gerasimov, O. Korablev, I. Lomakin, M. Marov, M. Martynov, M. Nazarov, A. Zakharov, L. Zelenyi, A. Aronica, A.J. Ball, C. Barbieri, A. Bar-Nun, J. Benkhoff, J. Biele, N. Biver, J. Blum, D. Bockelée-Morvan, O. Botta, J.-H. Bredehöft, F. Cappaccioni, S. Charnley, **E. Cloutis**, H. Cottin, G. Cremonese, J. Crovisier, S.A. Crowther, E.M. Epifani, F. Esposito, A.C. Ferrari, F. Ferri, M. Fulle, J. Gilmour, F. Goesmann, N. Gortsas, S.F. Green, O. Groussin, E. Grün, P.J. Gutiérrez, P. Hartogh, T. Henkel, M. Hilchenbach, T.-M. Ho, G. Horneck, S.F. Hviid, W.-H. Ip, A. Jäckel, E. Jessberger, R. Kallenbach, G. Kargl, N.I. Kömle, A. Korth, K. Kossacki, C. Krause, H. Krüger, Z.-Y. Li, J. Licandro, J.J. Lopez-Moreno, S.C. Lowry, I. Lyon, G. Magni, U. Mall, I. Mann, W. Markiewicz, Z. Martins, M. Murette, U. Meierhenrich, V. Mennella, T.C. Ng, L.R. Nittler, P. Palumbo, M. Pätzold, D. Prialnik, M. Rengel, H. Rickman, J. Rodriguez, R. Roll, D. Rost, A. Rotundi, S. Sandford, M. Schönbachler, H. Sierks, R. Srama, R.M. Stroud, S. Szutowicz, C. Tornow, S. Ulamec, M. Wallis, W. Waniak, P. Weissman, R. Wieler, P. Wurz, K.L. Yung, and J.C. Zarnecki (2009) Triple F - A comet nucleus sample return mission. *Experimental Astronomy*, 23 (3), 809-847; doi:10.1007/s10686-008-9115-8.

Wang, A., J.F. Bell III, R. Li, J.R. Johnson, W.H. Farrand, **E.A. Cloutis**, R.E. Arvidson, L. Crumpler, S.W. Squyres, S.M. McLennan, K.E. Herkenhoff, S.W. Ruff, A.T. Knudson, W. Chen, R. Greenberger, and the Athena Science Team (2008) Light-toned salty soils and coexisting Si-rich species discovered by the Mars Exploration Rover Spirit in Columbia Hills. *Journal of Geophysical Research - Planets*, 113, E12, CiteID: E12S40
doi:10.1029/2008JE003126, 35 pp.

Gallie, E.A., D.A. Lyder, B. Rivard, and **E.A. Cloutis** (2008) Equivalence of modified Gaussian model in wavenumber and Gaussian in wavelength for deconvolution of hyperspectral reflectance spectra. *International Journal of Remote Sensing* 29 (14), 4089-4096.

Cloutis, E.A., K.A. McCormack, J.F. Bell III, A.R. Hendrix, D.T. Bailey, M.A. Craig, S.A. Mertzman, M.S. Robinson, and M.A. Riner (2008) Ultraviolet spectral reflectance properties of common planetary materials. *Icarus*, 197, 321-347. doi: 10.1016/j.icarus.2008.04.018.

Cloutis, E.A., M.A. Craig, R.V. Kruzelecky, W.R. Jamroz, A. Scott, F.C. Hawthorne, and S.A. Mertzman (2008) Spectral reflectance properties of minerals exposed to simulated Mars surface conditions. *Icarus*, 195, 140-168. doi: 10.1016/j.icarus.2007.10.028.

Cloutis, E.A., M.A. Craig, J.F. Mustard, R.V. Kruzelecky, W.R. Jamroz, A. Scott, D.L. Bish, F. Poulet, J.-P. Bibring, and P.L. King (2007) Stability of hydrated minerals on Mars. *Geophysical Research Letters*, 34, L20202, doi:10.1029/2007GL031267.

Johnson, J.R., J.F. Bell III, **E. Cloutis**, M. Staid, W.H. Farrand, T. McCoy, M. Rice, A.

Wang, and A. Yen (2007) Mineralogic constraints on sulfur-rich soils from Pancam spectra at Gusev crater, Mars. *Geophysical Research Letters*, 34, L13202, doi:10.1029/2007GL029894.

Goltz, D.M., **E. Cloutis**, L. Norman, and M. Attas (2007) Enhancement of faint text using visible (420-720 nm) multispectral imaging. *Restaurator*, 2007, 11-28.

Goltz, D.M., K. Charleton, **E. Cloutis**, P. Grinberg, and C. Collins (2007) Identification of darkened pigments in cultural objects by graphite furnace atomic absorption spectroscopy and inductively coupled plasma-mass spectrometry. *Journal of Analytical Atomic Spectroscopy*, 22, 140-146.

b) Proceedings of Meetings:

Cloutis, E., B. Vila, A. Bell, and M. Lamothe (2009) Hyperspectral And Luminescence Observer (HALO) Mars mission concept - Innovative data triage, compression, processing and analysis for the hyperspectral imager. *Proceedings of the IEEE GRSS Workshop on Hyperspectral Image and Signal Processing Evolution in Remote Sensing (WHISPERS'09)*, paper #31, 4pp.

Feng, J., B. Rivard, A. Gallie, and **E. Cloutis** (2009) Feature selection and broad band bitumen content estimation of Athabasca oil sands from infrared reflectance spectra. *Proceedings of the IEEE GRSS Workshop on Hyperspectral Image and Signal Processing Evolution in Remote Sensing (WHISPERS'09)*, paper #13, 4 pp.

Kruzelecky, R.V., B. Wong, J. Zou, E. Haddad, W. Jamroz, **E. Cloutis**, N. Ghafoor, S. Jessen, and G. Ravindran (2009) In situ planetary resource exploration using miniature robotic subsurface sample analysis. *Proceedings of ICES 39: International Conference on Environmental Systems*; July 12-16, Savannah, GA, USA; paper 2009-01-2528.

Kruzelecky, R.V., B. Wong, E. Haddad, W. Jamroz, **E. Cloutis**, N. Ghafoor, and S. Jessen (2007) Inukshuk landed robotic Canadian mission to Mars using a miniature sample analysis lab for planetary mineralogy and microbiology. *Proceedings of ICES 37: International Conference on Environmental Systems*; July 9-12, 2007, Chicago, IL, USA; paper 07ICES23-324 (CD ROM).

c) Journal Abstracts and Conference Presentations:

Kruzelecky, R.V., B. Wong, J. Zou, E. Haddad, W. Jamroz, **E. Cloutis**, A. Ellery, K. Strong, N. Ghafoor, S. Jessen, and G. Ravindran (2010) LORE: Lunar Origins and Resource Exploration science/payload. *Canadian Aeronautics and Space Institute ASTRO2010 Conference*; May 24-26, 2010, Toronto, ON, Canada.

Cloutis, E.A. (2010) Basalt-ilmenite mixtures: Spectral reflectance changes as a function of grain size and ilmenite abundance. *Lunar and Planetary Science Conference 41*, abstract #1139.

- Rice, M.S., **E.A. Cloutis**, and J.K. Crowley (2010) Spectral reflectance changes accompanying long-duration exposure of silica sinter and Fe-sulfates to simulated Mars surface conditions. *Lunar and Planetary Science Conference 41*, abstract #2576.
- Craig, M.A., R.L. Flemming, G.R. Osinski, and **E.A. Cloutis** (2010) UV-VIS-NIR reflectance spectra of intimate mixtures of synthetic CaCO₃ and amorphous SiO₂: 0.35-2.5 μm; implications for the spectral identification of shocked assemblages on Mars. *Lunar and Planetary Science Conference 41*, abstract #2110.
- Reddy, V., **E.A. Cloutis**, M.J. Gaffey, A. Galád, P. Pravec, A.W. Harris, A. Nathues, and J.A. Sanchez (2010) Compositional investigation of (5404) Uemura: The largest fast-rotating monolith. *Lunar and Planetary Science Conference 41*, abstract #1227.
- Osinski, G.R., L. Whyte, N. Banerjee, **E. Cloutis**, J. Nadeua, W. Pollard, R. Pudritz, B. Sherwood Lollar, G. Slater, H. Vali, and B. Wing (2010) The Canadian Astrobiology Training Program: A new driving force for astrobiology in Canada. *Astrobiology Science Conference 2010*; April 26-29, 2010; League City, TX, USA.
- Rice, M.S., J.F. Bell III, and **E.A. Cloutis** (2009) Reflectance spectra of hydrated silica-rich materials: Sensitivity to the form of water and implications for Mars. *Geological Society of America Annual Meeting*; October 18-21, 2009; Portland, OR, USA; paper No. 97-7.
- Cloutis, E.A.**, and M.J. Gaffey (2009) Searching for the 506-nm pyroxene absorption band in meteorite spectra. *72nd Meeting of the Meteoritical Society (MetSoc 2009)*; July 13-18, 2009; Nancy, France, abstract #5078.
- Cloutis, E.**, and L. Norman (2009) Reflectance spectroscopy of single mineral grains: Implications for lunar remote sensing. *Lunar Reconnaissance Orbiter Science Targeting Meeting*; June 9-11, 2009; Tempe, AZ, USA, abstract #6020.
- Cloutis, E.A.**, M.S. Rice, J.F. Bell III, S.A. Mertzman, D.L. Bish, and R. Renaut (2009) Spectral reflectance diversity of silica-rich materials: Insights into structure and petrogenesis and implications for Mars. *Workshop on Modeling Martian Hydrous Environments*; June 1-3, 2009; Houston, TX, USA, abstract #4002.
- Cloutis, E.**, B. Vila, A. Bell, and M. Lamothe (2009) Hyperspectral And Luminescence Observer (HALO) Mars mission concept - Innovative data triage, compression, processing and analysis for the hyperspectral imager. *IEEE WHISPERS Conference*; August 26-28, 2009; Grenoble, France.
- Feng, J., B. Rivard, A. Gallie, and **E. Cloutis** (2009) Feature selection and broad band bitumen content estimation of Athabasca oil sand from infrared reflectance spectra. *IEEE WHISPERS Conference*; August 26-28, 2009; Grenoble, France.
- Cloutis, E.A.** (2009) Reflectance spectra of low atomic weight (■APXS-blind) Na-bearing minerals: Nitrates, nitrites, borates, hydroxides, and peroxides. *Lunar and Planetary Science Conference, 40*, abstract #1176 [CD ROM].

- Cloutis, E.A.**, P.S. Hardersen, V. Reddy, M.J. Gaffey, D.T. Bailey, and M.A. Craig (2009) Metal-orthopyroxene and metal-olivine mixtures: Spectral reflectance properties and implications for asteroid spectroscopy. *Lunar and Planetary Science Conference, 40*, abstract #1332 [CD ROM].
- McFadden, L.A., E. Ammonito, **E.A. Cloutis**, A. Coradini, M.C. deSanctis, M. Fulchignoni, E. Hadamcik, T. Hiroi, L. Kolokolova, A.C. Levasseur-Regourd, V. Psarev, and J.-B. Renard (2009) Coordinated laboratory studies of meteorites supporting Rosetta mission's asteroid flyby target: 2867 Steins. *Lunar and Planetary Science Conference, 40*, abstract #2287 [CD ROM].
- Rice, M.S., J.F. Bell III, **E.A. Cloutis**, A. Wang, S.W. Ruff, M.A. Craig, D.T. Bailey, J.R. Johnson, P.A. de Souza Jr., and W.H. Farrand (2009) Silica-rich deposits and hydrated minerals at Gusev Crater, Mars. *Lunar and Planetary Science Conference, 40*, abstract #2134 [CD ROM].
- Craig, M.A., G.R. Osinski, R.L. Fleming, and **E.A. Cloutis** (2009) UV-VIS-NIR reflectance spectra of shocked carbonates from the Haughton impact structure, Devon Island, Canada: 0.35-2.5 μm ; implications for carbonate identification on Mars. *Lunar and Planetary Science Conference, 40*, abstract #1643 [CD ROM].
- McFadden, L.A., M.F. A'Hearn, E. Ammonito, **E. Cloutis**, A. Coradini, M.C. de Sanctis, L.M. Feaga, M. Fulchignoni, E. Hadamcik, T. Hiroi, L. Kolokolova, A.-C. Levasseur-Regourd, A.A. Ovcharenko, W.J. Parker, V. Psarev, and J.-B. Renard (2009) Coordinated international laboratory studies of meteorites supporting Rosetta mission's asteroid flybys. *2009 AGU-GAC-MAC Joint Assembly; May 24-27, 2009; Toronto, ON, Canada*.
- Cloutis, E.A., and G.R. Osinski (2009) Spectral reflectance properties of carbonates from diverse environments and related phases: Implications for Mars. *2009 AGU-GAC-MAC Joint Assembly; May 24-27, 2009; Toronto, ON, Canada (paper #1773)*.
- Palomba, E., A. Zinzi, and E. Cloutis (2009) Widespread occurrence of carbonates on Mars: Implications for atmospheric evolution. *European Space Agency International Conference on Comparative Planetology: Venus - Earth - Mars; May 11-15, 2009; Noordwijk, The Netherlands*.
- Goltz, D.M., S. Tse, S. Guild, G. Young, P. Begin, M. Attas, M. Richardson, **E. Cloutis**, and M. Trojan-Bedynski (2009) Visible and near infrared hyperspectral imaging of historical documents. *American Institute for Conservation of Historic and Artistic Works (AIC) 37th Annual Meeting; May 19-22, 2009, Los Angeles, CA, USA*.
- McFadden, L.A., M.F. A'Hearn, E. Ammonito, T. Burbine, **E. Cloutis**, A. Coradini, M.C. De Sanctis, L.M. Feaga, S. Fornasier, M. Fulchignoni, E. Hadamcik, T. Hiroi, L. Kolokolova, J.-Y. Li, A.C. Levasseur-Regourd, A.A. Ovcharenko, W.J. Parker, V. Psarev, J.-B. Renard, G. Strazzulla, and P. Vernazza (2009) Coordinated laboratory studies of meteorites supporting Rosetta asteroid flybys: Status report. *Rosetta Scientific Workshop; February 27, 2009, Berlin, Germany*.

- McFadden, L., E. Ammanito, T. Burbine, **E. Cloutis**, A. Coradini, M. De Sanctis, S. Fornasier, M. Fulchignoni, E. Hadamchik, T. Hiroi, L. Kolokolova, J.-Y. Li, A.-C. Levasseur-Regourd, A.A. Ovcharenki, J. Parker, V. Psarev, J.-P. Renard, G. Strazzulla, and P. Vernazza (2008) Laboratory work with meteoritic analogues supporting Rosetta asteroid flyby targets. *3rd Annual Meeting of the U.S. Rosetta Project*; December 14, 2008, San Francisco, CA, USA.
- Bell, D.A., **E. Cloutis**, M. Lamothe, and M.B. Vila (2008) HALO - Hyperspectral And Luminescence Observer for Mars surface geological exploration. *6th Canadian Space Exploration Workshop (CSEW6)*; December 1-3, 2008, St. Hubert, QC, Canada; abstract #CSEW6044.
- Kruzelecky, R.V., B. Wong, J. Zou, W. Jamroz, **E. Cloutis**, K. Strong, N. Ghafoor, and S. Jessen (2008) Miniature robotic sample analysis lab for planetary *in situ* mineralogy and microbiology. *6th Canadian Space Exploration Workshop (CSEW6)*; December 1-3, 2008, St. Hubert, QC, Canada.
- Cloutis, E.A.** (2008) Planetary research at the University of Winnipeg: Facilities and projects. *6th Canadian Space Exploration Workshop (CSEW6)*; December 1-3, 2008, St. Hubert, QC, Canada; abstract #CSEW6002.
- Southam, G., **E. Cloutis**, C. Herd, L. Lau, G. Osinski, R. Patel, W. Pollard, W. Srinivasan, P. Sylvester, and L. Whyte (2008) The Canadian Astromaterials Facility - A CFI NIF application. *6th Canadian Space Exploration Workshop (CSEW6)*; December 1-3, 2008, St. Hubert, QC, Canada; abstract #CSEW6004.
- Cloutis, E.A.** (2008) Spectroscopy-based analysis of astromaterials. *Planetary Science Research Symposium 2008*; October 17, 2008, Edmonton, AB, Canada.
- Rice, M.S., J.F. Bell III, A. Wang, and **E.A. Cloutis** (2008) High-silica rocks and soils at Gusev crater, Mars: Distribution, spectra, and implications for past hydrothermal activity. *American Geophysical Union Fall 2008 Meeting*; December 15-19, 2008, San Francisco, CA, USA.
- Kruzelecky, R.V., B. Wong, J. Zou, W. Jamroz, J. Sloan, and **E. Cloutis** (2008) Guided-wave high-performance spectrometers for the MEOS Miniature Earth Observing Satellite. *International Conference on Space Optics (ICSO) 2008*; October 14-17, 2008, Toulouse, France.
- Kruzelecky, R.V., B. Wong, J. Zou, W. Jamroz, **E. Cloutis**, N. Ghafoor, and S. Jessen (2008) Miniature instrument suite with robotic mole drill for planetary *in situ* mineralogy and microbiology. *Planetary and Terrestrial Mining Sciences Symposium (PTMSS) 2008*; June 8-11, 2008, Montreal, QC, Canada.
- Cloutis, E.A.**, D.T. Bailey, M.A. Craig, and P.S. Hardersen (2008) Reflectance spectra of iron meteorite powders. *Lunar and Planetary Science Conference, 39*, abstract #1082 [CD ROM].

- Craig, M.A., **E.A. Cloutis**, V. Reddy, D.T. Bailey, and M.J. Gaffey (2008) The effects of grain size, <10 μm - 4.75 mm, on the reflectance spectrum of planetary analogs from 0.35-2.5 μm . *Lunar and Planetary Science Conference, 39*, abstract #2082 [CD ROM].
- Horgan, B.H.N., J.F. Bell III, E.Z. Noe Dobrea, **E.A. Cloutis**, D.T. Bailey, M.A. Craig, and L. Stewart (2008) Hydrated units in the martian north polar region. *Lunar and Planetary Science Conference, 39*, abstract #2122 [CD ROM].
- Pompilio, L., G. Pedrazzi, M.A. Craig, M. Sgavetti, and **E.A. Cloutis** (2008) Spectral modeling of planetary analogues, preliminary results. *Lunar and Planetary Science Conference, 39*, abstract #1550 [CD ROM].
- Reddy, V., **E.A. Cloutis**, M.A. Craig, and M.J. Gaffey (2008) Spectral calibration of orthopyroxene-type A clinopyroxene mixtures: Implications for interpreting asteroid spectra. *Lunar and Planetary Science Conference, 39*, abstract #2007 [CD ROM].
- Rice, M.S., J.F. Bell III, A. Wang, and **E.A. Cloutis** (2008) VIS-NIR spectral characterization of Si-rich deposits at Gusev crater, Mars. *Lunar and Planetary Science Conference, 39*, abstract #2138 [CD ROM].
- Wang, A., J.F. Bell III, M. Rice, and **E.A. Cloutis** (2008) Coexistence of Si-rich and S-rich materials at Gusev crater, Columbia Hills. *Lunar and Planetary Science Conference, 39*, abstract #2186 [CD ROM].
- Cloutis, E.A.** (2008) Astromaterials and small bodies research at the University of Winnipeg Planetary Spectrophotometer Facility. *Journal of the Royal Astronomical Society, 102*, 58.
- Rice, M.S., J.F. Bell III, A. Wang, and **E.A. Cloutis** (2008) The regional distribution and spectral character of high-silica material at Gusev crater, Mars: Emerging evidence for a hydrothermal system. *IAVCEI (International Association of Volcanology and Chemistry of the Earth & Interior) 2008 General Assembly*; August 17-22, 2008; Reykjavik, Iceland.
- Cloutis, E.A.**, R.J. Leveille, D.T. Bailey, L. Stewart, M.A. Craig, K. McCormack, and L. Kaltefleiter (2008) Mineral suites in carbonate- and sulfate-rich environments: Implications for remote sensing of Mars. *Quebec 2008: Joint Annual Meeting of GAC-MAC-SEG-SGA*; May 26-28, 2008, Quebec City, QC, Canada.
- Cloutis, E.A.**, G.R. Osinski, and C. Marion (2008) Applications of reflectance spectroscopy to cratering studies. *Quebec 2008: Joint Annual Meeting of GAC-MAC-SEG-SGA*; May 26-28, 2008, Quebec City, QC, Canada.
- Kruzelecky, R.V., B. Wong, E. Haddad, W. Jamroz, **E. Cloutis**, K. Strong, N. Ghafoor, and S. Jessen (2008) Miniature robotic sample analysis lab for planetary in situ mineralogy and microbiology. *37th Committee on Space Research (COSPAR) Scientific Assembly*; July 13-20, 2008, Montreal, QC, Canada.

Kruzelecky, R.V., E. Haddad, W. Jamroz, J. Sloan, A. Trishchenko, S. Wang, L. Garand, K. Strong, D. Jones, **E. Cloutis**, K. Chance, and T. Kurosu (2008) MEOS microsatellite earth observation using miniature integrated optic IR spectrometers. *37th Committee on Space Research (COSPAR) Scientific Assembly*; July 13-20, 2008, Montreal, QC, Canada.