

Curriculum Vita - **Curtis E. Woodcock** (May, 2017)

Professor

Department of Earth and Environment, Boston University

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**Education:** B.A. (1977), M.A. (1982), Ph.D. (1985) in Geography, U.C. Santa Barbara

**Areas of Specialization:** *Remote sensing*, particularly of forests and natural vegetation, environmental monitoring, change detection and time series analysis; *Land Cover and Land Use Change*; *Terrestrial Carbon Dynamics*; *Spatial modeling and analysis*; *Digital image processing*.

### **Professional Activities/Service (Current)**

Member, NASA Senior Review 2017

Member, MODIS Science Team (2015-present)

Chief Scientist, USGS Land Change Monitoring, Assessment and Projection

Science Team Leader, USGS/NASA Landsat Science Team (1/1/07-present)

NASA Land Cover and Land Use Change, Science Team Member (1/05 - present)

GOFC/GOLD Land Cover Implementation Team (team member 2/2002-present and Co-Chair 1/1/07- present)

### **Employment and Appointments**

Chair, Department of Earth and Environment, 7/12-6/15.

Professor, Department of Earth and Environment, 7/12-present.

Chair, Department of Geography, Boston University, 9/01-6/03.

Professor, Department of Geography and Environment, Boston University, 9/98-6/12.

Research Fellow, Department of Cognitive and Neural Systems, Boston University, 2/97-present

Chair, Department of Geography, Boston University, 7/91-9/98.

Associate Professor, Department of Geography, Boston University, 9/90-9/98.

Director of Geographic Applications, Center for Remote Sensing, Boston University, 6/86-present.

Acting Director, Center for Remote Sensing, Boston University, 9/85-6/86.

Assistant Professor, Department of Geography, Boston University, 9/84-8/90.

Research Associate, Department of Geology and Geography, Hunter College, City University of New York, 9/82-9/84.

Staff Research Associate, Geography Remote Sensing Unit, University of California, Santa Barbara, 3/79-9/82

### **Honors and Awards**

*NASA Graduate Researchers Program* (Johnson Space Center) 1980-1983.

*1995 ERDAS Award for Best Science Paper in Remote Sensing*, (With Sucharita Gopal) from the American Society of Photogrammetry and Remote Sensing, for the paper:

- Gopal, S., and C.E. Woodcock, 1994. Theory and Methods for Accuracy Assessment of Thematic Maps Using Fuzzy Sets, *Photogrammetric Engineering and Remote Sensing*, 60(2):181-188.
- 1996 *ERDAS Award for Best Science Paper in Remote Sensing* (Third Prize), (With Soren Ryherd) from the American Society of Photogrammetry and Remote Sensing, for the paper: Ryherd, S., and C.E. Woodcock, 1996. Combining spectral and texture data in the segmentation of remotely sensed images, *Photogrammetric Engineering and Remote Sensing*, 62(2):181-194.
- 2000 *Autometric Award for the Best Paper in Photogrammetric Interpretation*, (With John Collins) from the American Society of Photogrammetry and Remote Sensing, for the paper: Collins, J.B., and C.E. Woodcock, 1999. Geostatistical estimation of resolution-dependent variance in remotely sensed images, *Photogrammetric Engineering and Remote Sensing*, 65(1):41-50.
- 2003 *Leica Geosystems Award for the Best Scientific Paper in Remote Sensing* (Second Prize) with A. Schneider, M. Friedl and D.K. McIver, from the American Society of Photogrammetry and Remote Sensing, for the paper: Schneider, A., Friedl, M.A., McIver, D.K., and C.E. Woodcock, 2003. Mapping Urban Areas by Fusing Multiple Sources of Coarse Resolution Remotely Sensed Data, *Photogrammetric Engineering and Remote Sensing*, 69(12):1377-1386.
- 2008 *John I. Davidson President's Award for Best Practical Paper*, from the American Society of Photogrammetry and Remote Sensing, (with A. Baccini, M. Friedl and J. Zhu), for the paper: Baccini, A., Friedl, M.A., Woodcock, C.E., and J. Zhu, 2007. Scaling Field Data to Calibrate and Validate Moderate Spatial Resolution Remote Sensing Models, *Photogrammetric Engineering and Remote Sensing*, 73(8):945-954.
- 2008 *Leica Geosystems Award for Best Scientific Paper* (Third Prize), from the American Society of Photogrammetry and Remote Sensing, (with A. Baccini, M. Friedl and J. Zhu), for the paper: Baccini, A., Friedl, M.A., Woodcock, C.E., and J. Zhu, 2007. Scaling Field Data to Calibrate and Validate Moderate Spatial Resolution Remote Sensing Models, *Photogrammetric Engineering and Remote Sensing*, 73(8):945-954.
- Erasmus Mundus Visiting Scholar*, 9/2005-12/2005, University of Southampton.
- 2010 *Outstanding Contributions Award*, Remote Sensing Specialty Group of the Association of American Geographers.
- 2012 *Boeing Award for Best Paper in Image Analysis and Interpretation* from the American Society of Photogrammetry and Remote Sensing (with Joe Fortier, John Rogan and Daniel Miller Runfola) for the paper: Fortier, J., Rogan, J., Woodcock, C.E., and D.M. Runfola, 2011. Utilizing Temporally Invariant Calibration Sites to Classify Multiple Dates and Types of Satellite Imagery, *PE&RS*, 77(2):181-189.
- 2016 *William T. Pecora Award* from NASA and the Department of the Interior. Lifetime achievement award for "outstanding contributions toward understanding the Earth by means of remote sensing".

## Media

*Earth's Forests from Space*, 2010, Interview on EarthSky: available at <http://earthsky.org/earth/curtis-woodcock-earths-forests-from-space>

*Ten Thousand Shovels: Rapid Urban Growth in China*, 2006, Karen Seto, Producer, Curtis E. Woodcock, Associate Producer.

*An idea that Worked*, 2007, comments on the vision of Stuart Udall and Landsat.

## Publications: Journals

Woodcock, C.E., Franklin, J., and A.H. Strahler, 1982. The role of remote sensing in land management and planning, *Environmental Management*, 7(3):223-238.

Franklin, J., Logan, T.L., Woodcock, C.E., and A.H. Strahler, 1986. Coniferous forest classification and inventory using Landsat and digital terrain data, *IEEE Transactions on Geoscience and Remote Sensing*, GE-24(1):139-149.

Strahler, A.H., Woodcock, C.E., and J.A. Smith, 1986. On the nature of models in remote sensing, *Remote Sensing of Environment*, (20):121-139.

Woodcock, C.E., and A.H. Strahler, 1987. The factor of scale in remote sensing, *Remote Sensing of Environment*, (21):311-332.

Jupp, D.L.B., Strahler, A.H., and C.E. Woodcock, 1988. Autocorrelation and regularization in digital images I: Basic theory, *IEEE Transactions on Geoscience and Remote Sensing*, 26(4):463-473.

Woodcock, C.E., Strahler, A.H., and D.L.B. Jupp, 1988. The use of variograms in remote sensing: I. Scene models and simulated images, *Remote Sensing of Environment*, 25:323-348.

Woodcock, C.E., Strahler, A.H., and D.L.B. Jupp, 1988. The use of variograms in remote sensing: II. Real digital images, *Remote Sensing of Environment*, 25:349-379.

Jupp, D.L.B., Strahler, A.H., and C.E. Woodcock, 1989. Autocorrelation and regularization in digital images II, Simple image models, *IEEE Transactions on Geoscience and Remote Sensing*, 27(3):247-258.

Woodcock, C.E., Sham, C.H., and B.J. Shaw, 1990. Comments on selecting a geographic information system for resource management, *Environmental Management*, 14(3):307-315.

Woodcock, C.E., and V.J. Harward, 1992. Nested-hierarchical scene models and image segmentation, *International Journal of Remote Sensing*, 13(16):3167-3187.

Chen, R., Woodcock, C.E., Strahler, A.H., and D.L.B. Jupp, 1993. Nonlinear estimation of scene parameters from digital images using zero-hit run-length statistics, *IEEE Transactions on Geoscience and Remote Sensing*, 31(3):735-746.

Gopal, S., and C.E. Woodcock, 1994. Theory and methods for accuracy assessment of thematic maps using fuzzy sets, *Photogrammetric Engineering and Remote Sensing*, 60(2):181-188.

Moody, A., and C.E. Woodcock, 1994. Scale-dependent errors in the estimation of land-cover proportions--implications for global land-cover datasets, *Photogrammetric Engineering and Remote Sensing*, 60(5):585-594.

Woodcock, C.E., Collins, J.B., Gopal, S., Jakabhazy, V.D., Li, X., Macomber, S.,

- Ryherd, S., Wu, Y., Harward, V.J., Levitan, J., and R. Warbington, 1994. Mapping forest vegetation using Landsat TM imagery and a canopy reflectance model, *Remote Sensing of Environment*, 50:240-254.
- Macomber, S., and C.E. Woodcock, 1994. Mapping and monitoring conifer mortality using remote sensing in the Lake Tahoe Basin, *Remote Sensing of Environment*, 50:255-266.
- Collins, J.B., and C.E. Woodcock, 1994. Change detection using the Gramm-Schmidt transformation applied to mapping forest mortality, *Remote Sensing of Environment*, 50:267- 279.
- Li, X., C.E. Woodcock, and R. Davis, 1994. A hybrid geometric optical and radiative transfer approach for modeling pyranometer measurements under a Jack Pine forest, *Geographic Information Science*, 1(1):27-33.
- Li, X., Strahler, A.H., and C.E. Woodcock, 1995. A hybrid geometric optical-radiative transfer approach for modeling albedo and directional reflectance of discontinuous canopies, *IEEE Transactions on Geoscience and Remote Sensing*, 33(2):466-480.
- Moody, A. and C.E. Woodcock, 1995. The influence of scale and the spatial characteristics of landscapes on land-cover mapping using remote sensing, *Landscape Ecology*, 10(6):363-379.
- Ryherd, S., and C.E. Woodcock, 1996. Combining spectral and texture data in the segmentation of remotely sensed images, *Photogrammetric Engineering and Remote Sensing*, 62(2):181-194.
- Woodcock, C.E., Gopal, S., and W. Albert, 1996. Evaluation of the potential for providing secondary labels in vegetation maps, *Photogrammetric Engineering and Remote Sensing*, 62(4):393-399.
- Gopal, S., and C.E. Woodcock, 1996. Remote sensing of forest change using artificial neural networks, *IEEE Transactions on Geoscience and Remote Sensing*, 34(2):398-404.
- Pax Lenney, M., Woodcock, C.E., Collins, J.C., and H. Hamdi, 1996. The status of agricultural lands in Egypt: The use of multitemporal NDVI features derived from Landsat TM, *Remote Sensing of Environment*, 56(1):8-20.
- Collins, J.B., and C.E. Woodcock, 1996. An assessment of several linear change detection techniques for mapping forest mortality using multitemporal Landsat TM data, *Remote Sensing of Environment*, 56(1):66-77.
- Gopal, S., C.E. Woodcock, and G. Unis, 1996. Labeling map polygons using remote sensing: Calibrating decision rules, *Geographical Systems*, 3:243-258.
- Moody, A., and C.E. Woodcock, 1996. Calibration-based models for correction of area estimates derived from coarse resolution imagery, *Remote Sensing of Environment*, 58(3):225-241.
- Ni, W., Li, X., Woodcock, C.E. and A.H. Strahler, 1997. Parameterization of spectral component signatures for geometric optical canopy reflectance modeling, *Journal of Remote Sensing (China)*, 1:102-108 (in English).
- Woodcock, C.E., Collins, J., Jakabhazy, V.D., Li, X., Macomber, S.A., and Y. Wu, 1997. Inversion of the Li-Strahler canopy reflectance model for mapping forest structure, *IEEE Transactions on Geoscience and Remote Sensing*, 35(2):405-414.
- Carpenter, G.A., Gjaja, M.N., Gopal, S., and C.E. Woodcock, 1997. ART neural networks for remote sensing: vegetation classification from Landsat TM and

- Terrain Data, *IEEE Transactions on Geoscience and Remote Sensing*, 35(2):308-325.
- Pax Lenney, M., and C.E. Woodcock, 1997. Monitoring agricultural lands with multitemporal Landsat TM imagery: How many images are needed?, *Remote Sensing of Environment*, 59(3):522-529.
- Pax Lenney, M., and C.E. Woodcock, 1997. The effect of spatial resolution on monitoring the status of agricultural lands, *Remote Sensing of Environment*, 61(2):210-220.
- Ni, W., Li, X., Woodcock, C.E., Roujean, J.L., Davis, R.E., 1997. Transmission of solar radiation in boreal conifer forests: modeling and measurements, *Journal of Geophysical Research*, 102(D24):29,555-29,566.
- Hardy, J.P., Davis, R.E., Jordan, R., Li, X., Woodcock, C.E., Ni, W., and J.C. MacKenzie, 1997. Snow ablation modeling at the stand scale in a boreal Jack Pine forest, *Journal of Geophysical Research*, (102)D24:29,397-29,405.
- Davis, R.E., J.P. Hardy, W. Ni, C. Woodcock, J.C. McKenzie, R. Jordan, and X. Li, 1997. Variation of snow cover ablation in the boreal forest: a sensitivity study on the effects of conifer canopy, *Journal of Geophysical Research*, 102(D24):29,389-29,396.
- Hardy, J.P., Davis, R.E., Jordan, R., Woodcock, C.E., and W. Ni, 1998. Snow ablation modelling in a mature aspen stand of the boreal forest, *Hydrologic Processes*, 12:1763-2778.
- Collins, J.B., and C.E. Woodcock, 1999. Geostatistical estimation of resolution-dependent variance in remotely sensed images, *Photogrammetric Engineering and Remote Sensing*, 65(1):41-50.
- Gopal, S., Woodcock, C.E., and A.H. Strahler, 1999. Fuzzy neural network classification of global land cover from a 1-degree AVHRR data set, *Remote Sensing of Environment*, 67(2):230-243.
- Ni, W., Li, X., Woodcock, C.E., Caetano, M.R., and A.H. Strahler, 1999. An analytical hybrid GORT model for bidirectional reflectance over discontinuous plant canopies, *IEEE Transactions on Geoscience and Remote Sensing*, 37(2):987-999.
- Ni, W., Woodcock, C.E., and D.L.B. Jupp, 1999. Variance in Bidirectional Reflectance over Discontinuous Plant Canopies, *Remote Sensing of Environment*, 69(1):1-15.
- Carpenter, G.A., Gopal, S., Martens, S., and C.E. Woodcock, 1999. A neural network method for mixture estimation for vegetation mapping, *Remote Sensing of Environment*, 70(2):138-152.
- Abuelgasim, A.A., Ross, W.D., Gopal, S., and C.E. Woodcock, 1999. Change detection using adaptive fuzzy neural networks: Environmental damage assessment after the Gulf War, *Remote Sensing of Environment*, 70(2):208-223.
- Carpenter, G.A., Gopal, S., Macomber, S., Martens, S., Woodcock, C.E., and J. Franklin, 1999. A neural network method for efficient vegetation mapping, *Remote Sensing of Environment*, 70(3):326-338.
- Woodcock, C.E., and S. Gopal, 2000. Fuzzy set theory and thematic maps: Accuracy assessment and area estimation, *International Journal of GIS*, 14(2):153-172.
- Collins, J.B., and C.E. Woodcock, 2000. Combining Geostatistical Methods and Hierarchical Scene Models for Analysis of Multiscale Variation in Spatial Data, *Geographical Analysis*, 32(1):50- 63.

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- Franklin, J., Woodcock, C.E., and R. Warbington, 2000. Multi-Attribute Vegetation Maps of Forest Service Lands in California Supporting Resource Management Decisions, *Photogrammetric Engineering and Remote Sensing*, 66(10):1209-1217.
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- Song, C., Woodcock, C.E., and X. Li, 2002. The spectral/temporal manifestation of forest succession in optical imagery: The Potential of Multitemporal Imagery, *Remote Sensing of Environment*, 82(2-3):285-302.
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- Tian, Y., Woodcock, C.E., Wang, Y., Privette, J.L., Shabanov, N.V., Zhou, L., Zhang, Y., Buermann, W., Dong, J., Veikkanen, B., Hame, T., Andersson, K., Ozdogan, M., Knyazikhin, Y., and R.B. Myneni, 2002. Multiscale Analysis and Validation of the MODIS LAI Product: I. Uncertainty Analysis, *Remote Sensing of Environment*, 83:414-430.

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- Song, C., and C.E. Woodcock, 2003. A regional forest ecosystem carbon budget model: impacts of forest age structure and land use history, *Ecological Modelling*, 164(1):33-47.
- Song, C., and C.E. Woodcock, 2003. Estimating Tree Crown Size from Multiresolution Remotely Sensed Imagery, *Photogrammetric Engineering and Remote Sensing*, 69(11):1263-1270.
- Song, C., and C.E. Woodcock, 2003. Monitoring forest succession with multitemporal Landsat images: Factors of uncertainty. *IEEE Transactions on Geoscience and Remote Sensing*, 41(11):2557-2568.
- Schneider, A., Friedl, M.A., McIver, D.K., and C.E. Woodcock, 2003. Mapping Urban Areas by Fusing Multiple Sources of Coarse Resolution Remotely Sensed Data, *Photogrammetric Engineering and Remote Sensing*, 69(12):1377-1386.
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- Liu, W.G., Gopal, S., and C.E. Woodcock, 2004. Uncertainty and confidence in land cover classification using a hybrid classifier approach, *Remote Sensing of Environment*, 70(8):963- 971.
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- irrigated crop area and water use in Southeastern Turkey from 1993-2002: Implications for current and future water resources, *Water Resources Management*, 20(3):467-488.
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### **Funding from Boston University**

- "Initiation and Development of the Center for Remote Sensing" C.E. Woodcock, Project Director, January, 1985, \$300,000.

### **Extramurally Sponsored Research**

- "Labeling Manually Delineated Timber Stands Using a Landsat-Based Stratification", U.S. Forest Service Region 5. A.H. Strahler, Principal Investigator, C.E. Woodcock, Co-Principal Investigator. \$25,771, 5/1/80 - 6/30/81.
- "Eldorado National Forest Stratification and Inventory", U.S. Forest Service Region 5. A.H. Strahler, Principal Investigator, C.E. Woodcock, Co-Principal Investigator. \$91,631, 7/1/81 - 6/30/82.
- "Image Segmentation for Forest Stand Delineation", NASA Graduate Researchers Program, NASA Headquarters, Washington D.C., A.H. Strahler, Principal Investigator (for participant C.E. Woodcock). \$31,000, 9/1/80 - 8/31/83.
- "Multilayer Database Segmentation", NASA Jet Propulsion Laboratory. C.E. Woodcock and A.H. Strahler, Principal Investigators. \$15,000, 9/23/82 - 9/22/83.
- "Preliminary Evaluation of the Airborne Imaging Spectrometer for Vegetation Analysis, Phases I and II", A.H. Strahler, Principal Investigator, C.E. Woodcock, Co-Investigator, Phase I, \$9,342, 5/16/83 - 5/15/83, Phase II, \$9,813, 8/16/83 - 10/15/83.
- "Improving Spatial Modeling in Remote Sensing, Year II", NASA Fundamental Research Program. A.H. Strahler, Principal Investigator, C.E. Woodcock, Co-Investigator, \$69,156, 7/16/83 - 7/15/84.
- "The Center for Remote Sensing at Boston University", The W.M. Keck Foundation, J.R. Wiseman, Project Director, C.E. Woodcock, Collaborator, \$320,000, 1/1/86 - 12/31/86.
- "The Use of Spatial Features in Image Segmentation", NASA Goddard Space Flight Center, C.E. Woodcock, Principal Investigator, \$14,608, 4/15/87 - 4/14/88.
- "Remote Sensing of Natural Plant Communities", NASA Graduate Researchers Program, NASA Headquarters, Washington D.C., C.E. Woodcock, Principal Investigator

- (for participant C. Brown), \$18,000, 9/1/87 - 8/31/88.
- "The Center for Remote Sensing at Boston University: Year II", The W.M. Keck Foundation, J.R. Wiseman, Project Director, C.E. Woodcock, Collaborator, \$410,000, 1/1/87 - 12/31/87.
- "Development of a Prototype Geographic Information System Design for North Atlantic Regional Parks", North Atlantic Region of the National Park Service, C.H. Sham, Principal Investigator, C.E. Woodcock, Co-Investigator, \$29,755, 5/1/87 - 4/31/88.
- "Development, Application, and Operational Implementation of a Forest Inventory System Using Satellite Remote Sensing", Region 5, US Forest Service, C.E. Woodcock, Principal Investigator, A.H. Strahler, Co-Investigator, \$657,736, 7/18/88-12/31/91.
- "GIS Technology in the Cape Cod National Seashore", North Atlantic Region of the National Park Service, C.H. Sham, Principal Investigator, C.E. Woodcock, Co-Investigator, \$54,000, 9/1/88- 8/30/89.
- "Remote Sensing for Resource Management" (Training Course), Government of Jordan, F. El-Baz and C.E. Woodcock, Principal Investigators, \$30,000, August, 1988.
- "Equipment and Program Support for the Center for Remote Sensing", The W.M. Keck Foundation, J.R. Wiseman, Project Director, C.E. Woodcock, Collaborator, \$600,000, 1/1/89- 7/1/90.
- "Evaluation of the use of Canopy Models for Mapping Old Growth", US Forest Service, C.E. Woodcock, Principal Investigator, A.H. Strahler, Co-Investigator, \$191,916, 2/1/89-1/31/90.
- "Analysis of the Spatial and Temporal Variability of Primary Production in the Boston Harbor and Massachusetts Bay", Massachusetts Water Resources Authority, C. Yentsch, Principal Investigator, C. Woodcock, Co-Investigator, \$40,000, 10/1/89-9/30/90.
- "Development of a Beach Community Habitat Model for Cape Cod National Seashore", C.E. Woodcock, Principal Investigator, North Atlantic Region of the National Park Service, \$7,544, 9/30/91-12/31/91.
- "Forest Mapping and Accuracy Assessment", US Forest Service, C.E. Woodcock, Principal Investigator, \$270,096, 10/1/91-5/31/93.
- "Evaluation of the Utility of Satellite Remote Sensing for Detecting Conifer Mortality", US Forest Service, C.E. Woodcock, Principal Investigator, \$91,957, 10/1/91-5/31/93.
- "Desertification of Agricultural Lands in Egypt by Remote Sensing", Egyptian Ministry of Agriculture and Land Reclamation and the US Department of Agriculture, C.E. Woodcock, Principal Investigator, \$280,666, 10/1/92-9/31/94.
- "Forest Influences on the Shortwave Radiation Regime over Snow Surfaces", U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Geophysical Sciences Branch, C.E. Woodcock, Principal Investigator, A.H. Strahler and X. Li, Co-Investigators, \$230,000, started 10/1/93-10/31/2000.
- "Mapping Existing Vegetation Using Landsat TM Imagery and Digital Terrain Data for Four National Forests in the Southern Region of California," J. Franklin, Principal Investigator, C.E. Woodcock, Co-Investigator, \$764,143, 10/1/93-9/30/96 (funded through San Diego State University).

- "Monitoring Conifer Mortality," Pest Management, Region 5, U.S. Forest Service, *C.E. Woodcock, PI*, J. Collins, Co-Investigator, 8/1/94-7/31/95, \$50,261.
- "Resolving Map and Tree Size Accuracy and Modifications to Cover Estimates," C. E. Woodcock, US Forest Service, Region 5 Remote Sensing Laboratory, 6/1/95-5/30/96, \$22,000 (funded through San Diego State University).
- "Providing Secondary Labels for Map Polygons in the Plumas National Forest," *C. E. Woodcock Principal Investigator*, US Forest Service, Region 5 Remote Sensing Laboratory, 9/15/95-3/15/96, \$24,750 (funded through San Diego State University).
- "Assessment of Landuse and Landcover Change Using Remote Sensing and Artificial Neural Networks," S. Gopal, Principal Investigator, and C.E. Woodcock, Co-Investigator, NSF, 8/1/96-7/31/99, \$190,000.
- "Monitoring Change in Temperate Coniferous Forest Ecosystems," NASA - Landsat Science Team, *C.E. Woodcock, PI*, 10/1/96-6/30/01, \$915,000.
- "Modeling and Forecasting Effects of Land Use Change in China Based on Socioeconomic Drivers," R. Kaufmann, Principal Investigator, D. Dye, K. Seto and C.E. Woodcock, Co- Investigators, NASA Land Use and Land-Cover Change Program, 6/1/97-5/30/01, \$295,000.
- "Center for Excellence in Remote Sensing at Boston University," *C.E. Woodcock, PI*, F. El-Baz, C. Cleveland, M. Friedl, S. Gopal, R. Kaufmann, J. Key, D. Dye, R. Myneni, G. Salvucci, A. Strahler, Co-Is. NASA, \$380,000, 10/1/97-9/30/98.
- "Algorithm Development for NPOESS," C.L.B. Schaaf, PI, M. Friedl, J. Key, A.H. Strahler, and C.E. Woodcock, Co-Is, AER Inc., \$606,450, 1/1/97-12/31/99.
- "An Ultra-Compact, High-Definition Hyperspectral Imaging System," A.H. Strahler, PI, C.E. Woodcock, Co-I, in conjunction with Flight Landata, Inc, NASA STTR, 9/1/00-8/31/01, BU portion, \$23,369.
- "Urbanization as a Component of Global Change," *C.E. Woodcock, PI*, for student Annemarie Schneider, NASA Earth System Science Fellowship, \$66K, 9/1/01-8/31/03.
- "The Effects of Agricultural Expansion on Regional Hydrology in Southeastern Turkey", Principal Investigator: Guido Salvucci, Co-Is, M.K. Friedl, B. Anderson, and C.E. Woodcock, NASA Land Cover and Land Use Change Program, \$541,982, 6/1/01-5/31/04.
- "Developing Next-Generation Tools for Remote Sensing in Support of LANDFIRE", Mark Friedl, Principal Investigator, C.E. Woodcock and A. Baccini, Co-Is, \$164,693, 7/15/02-7/14/05, United States Geological Survey.
- "Field site improvement at Sargent Center for education and research activities," N. Phillips, Principal Investigator, T.H. Kunz, C.E. Woodcock, R. Rubendal, Co-Is, NSF, \$116,304, 1/1/2002-6/30/2002.
- "Vegetation Mapping in Support of Conservation Planning", *C.E. Woodcock, PI*, Manomet Foundation, \$26,995, 1/1/02-8/31/02.
- "Scattering of Light by Vegetation Canopies: Theory and Applications of a Discrete Object Approach", A.H. Strahler, PI, C.E. Woodcock and X. Li, Co-Is. NSF International Program, \$34,480, 9/01/02-8/31/03.
- "The effect of forest canopies on the remote sensing of the land surface," *C.E. Woodcock, PI.*, Cold Regions Research and Engineering Laboratory, Army Corps of

- Engineers, 11/01/02- present, \$359,465.
- "Quantifying the Effects of Land Use Change on the Carbon Budgets of the Black Sea Region," *C.E. Woodcock, PI.*, R.A. Houghton and M. Ozdogan, Co-Is, NASA LCLUC Program, 2/1/05-1/31/08, \$642,320.
- "The Use of Variograms to Characterize Errors in Gap Filling in the Landsat SLC-Off Era", *C.E. Woodcock, PI*, NASA Goddard Space Flight Center, 10/1/05-9/30/06, \$18,000.
- "NELDA: Monitoring and Validating the Distribution and Change in Land Cover across Northern Eurasia", O. Krankina, PI., includes many others, including M.A. Friedl and C.E. Woodcock from Boston University, NASA Land Cover and Land Use Change Program, 1/1/06-12/31/08, (BU portion \$198K).
- "Retrieval of Vegetation Structure and Carbon Balance Parameters Using Ground-Based Lidar and Scaling to Airborne and Spaceborne Lidar Sensors", NASA, A. H. Strahler, PI, C. E. Woodcock, C. Schaaf, and W. Ni, Co-Is, 1/1/06-12/30/08, \$458,592.
- "Toward Operational Global Monitoring of Landcover Change", *C.E. Woodcock, PI*, USGS/NASA Landsat Science Team (Leader), USGS, 10/1/06-9/30/11, \$700,000.
- "Accuracy Assessment of Global Land Cover Products and Production of a 'Best Available' Land Cover Map: a GOF-C-GOLD Initiative, NASA Land Cover and Land Use Change Program, *C.E. Woodcock, PI*, Steve Stehman, Co-I, 6/1/08-5/31/10, \$390,000.
- "Quantifying the accuracy and uncertainty in remote sensing products of land use changing implications for carbon monitoring", NASA, *C.E. Woodcock, PI*, 6/1/11-12/1/12, \$74,966.00.
- "Research and Training in support of SilvaCarbon", USGS, *C.E. Woodcock, PI*, (IPA for Woodcock, summer 2011), \$64,828, 6/1/11-8/31/11.
- "Research and Training in support of SilvaCarbon", USGS, *C.E. Woodcock, PI*, (IPA for Pontus Olofsson, \$105,535, 8/1/11-7/31/12.
- "Support for Silvacarbon, GEO FCT and GFOI", IPA with USGS for *C.E. Woodcock*, 12/10/12-12/9/13, \$58,468.
- "Enhancing Compatibility of Sentinel 2 and Landsat products for improved monitoring of the Earth System", NASA, Earth Science US Participating Investigator Program, *PI, C.E. Woodcock*, Co-I, Eric Vermote, 1/1/2011-12/31/2014, \$725K (extended to 12/31/15).
- "Synthesis of Studies on Institutional Change and LCLUC Effects on Carbon, Biodiversity, and Agriculture After the Collapse of the Soviet Union.", V. Radeloff, PI, *C.E. Woodcock, PI* of BU portion \$77,520. 1/1/12-12/31/14.
- "Development of a Dual-Wavelength, Ground-Based, Echidna® Lidar (DWEL) for Structural Characterization and Virtual Reconstruction of Forest Canopies", NSF MRI Program, A.H. Strahler, PI, C.E. Woodcock, S. Chakrabarti, T. Cook, and C. Schaaf, Co-Is, \$1,662,384.
- "Towards a Land Cover Climate Data Record from VIIRS", NASA, M.A. Fried, PI, C.E. Woodcock, Co-I, 6/1/11-5/30/14, \$628,995.
- "Using MODIS to Monitor Dynamics in Land Cover and Phenology at Seasonal to Decadal Time Scales", NASA, M.A. Fried, PI, C.E. Woodcock, Co-I, 6/1/11-5/30/14, \$588,725.00.

- “4-D Modeling of the Regional Carbon Cycle in and Around Urban Environments: An Interdisciplinary Study to Advance Observational and Modeling Foundations,” M.A. Friedl, PI, C.E. Woodcock, L. Hutya, S. Wofsy, A. Dunn and K. Chance, Co-Is, NASA Interdisciplinary Science Program, 8/12-7/15, \$1,282,141.
- “Making better use of Landsat images: Time series algorithms to screen clouds, shadows and snow as well as find deforestation and land cover change.” *Woodcock, C.E. Principal Investigator*, Google, \$41,567, 12/12-6/13.
- “Support for LCMAP”, IPA from USGS for *C.E. Woodcock*, 8/1/15-7/31/16, \$101,689.

### **Current Projects:**

- “Better Use of the Landsat Temporal Domain: Monitoring Land Cover Type, Condition and Change”, *C.E. Woodcock, PI*, M.A. Friedl and P. Olofsson, Co-Is, USGS Landsat Science Team, \$1,000,000, 10/12-9/17.
- “Time Series Fusion of Optical and Radar Imagery for Improved Monitoring of Activity Data, and Uncertainty Analysis of Emission Factors for Estimation of Forest Carbon Flux”, Josef Kelldorfer, PI, C.E. Woodcock, R. Houghton, P. Olofsson, Co-Is, NASA Carbon Monitoring System, 8/1/13-7/31/16, \$894,735 (BU portion \$317,054).
- “Landsat Time Series Analysis for LCMS”, USDA Forest Service, *C.E. Woodcock, PI*, 8/31/13-8/30/15, \$73,251.
- “Using Three Decades of Landsat Data to Characterize Changes and Vulnerability of Temperate and Boreal Forest Phenology to Climate Change”, Mark Friedl, Principal Investigator, Curtis Woodcock and Eli Melaas, co-Investigators, \$680,450 for period 1/1/14-12/31/16, National Aeronautics and Space Administration.
- “Near real-time monitoring of land cover disturbance by fusion of MODIS and Landsat data,” NASA (Science of Terra and Aqua), *C.E. Woodcock, PI*, P. Olofsson, Co-I, 6/1/14-5/31/17, \$689,833.
- “Creating Synthetic Images for the Carbon Monitoring System”, *C.E. Woodcock, PI*, USDA Forest Service, 7/1/14-6/30/17, \$75,000.
- “Direct Measurement of Aboveground Carbon Dynamics in Support of Large Area CMS Development”, W. Walker (Woods Hole Research Center), PI, M. Carvalho and C.E. Woodcock, Co-I, \$186,232 (BU Portion), 1/1/15-12/31/17, NASA Carbon Monitoring System.
- “Landscape-Scale Histories and Active Monitoring of Disturbance, Seasonality and Greenness Trends for ABoVE from Landsat”, C.E. Woodcock, PI, M.A. Friedl, Co-I, \$300,000, 8/24/15-8/23/18, NASA Terrestrial Ecology.
- “Improved Activity Data for Carbon Emissions from Forest Degradation Through Multi-Sensor Time Series Analysis in Southeast Asia”, *C.E. Woodcock, PI* for participant Eric Bullock, NASA Earth System Science Fellowship, 9/1/16-8/31/17,
- “Improving the Sentinel 2 cloud, cloud shadow, and snow detection algorithm,” NASA Landsat Program, C.E. Woodcock, PI, 10/1/16-10/1/17, \$48,871.