

## WaiChing Sun, PhD

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Assistant Professor  
Civil Engineering and  
Engineering Mechanics Department  
Columbia University  
610 SW Mudd, Mail Code:4709  
New York, NY 10027  
Web page: <http://civil.columbia.edu/steve-waiching-sun>

Office Phone: (212) 851-4371  
Cell Phone: (925) 960-5601  
Fax: (212)854-6267  
Email: [wsun@columbia.edu](mailto:wsun@columbia.edu)  
Researcher ID: A-2638-2009

### Education

**PhD.** Theoretical and Applied Mechanics, Northwestern University, 09/2008-06/2011

**M.A.** Civil Engineering, Princeton University <sup>1</sup>, 06/2007-05/2008

**M.S.** Civil Engineering (Geomechanics), Stanford University, 09/2005-06/2007

**B.S.** Civil Engineering, University of California, Davis, 09/2002-06/2005

### Research Statement

My research focuses on the development of theoretical and computational models for multiscale, multiphysics problems with special emphasis on poromechanics and geomechanics applications, such as geological carbon sequestration, hydraulic fracture, soil liquefaction, faulting and geotechnical earthquake engineering. My research group develops both mathematical theories and numerical algorithms to predict how multiphase solids react to diverse influences such as stress, deformation, heat source, presence of chemical species and fluid flows, and how material instabilities such as strain localization, liquefaction and fractures propagate across different spatial and temporal scales. The research team acts as a bridge between mathematical science and engineering industry. As a result, we emphasize on both the mathematical foundations and the practicality when deriving models for specific engineering problems.

### Specialties

computational mechanics, multi-scale modeling, geomechanics, poromechanics, geotechnical earthquake engineering, hybrid finite element/lattice Boltzmann analysis, micro-mechanics, discrete element method, computational plasticity and inverse problems, application of graph theory on granular system.

### Honors and Awards

#### Individual Award received by the PI

- **Dresden Fellowship**, Technische Universität Dresden, Germany, 2016.
- **ARO Young Investigator Award**, Army Research Office, 2015.
- **DURIP Award**, United States Department of Defense and Army Research Office, 2015.
- **Claude R. Hocott Lectureship**, Department of Petroleum and Geosystem Engineering, the University of Texas at Austin, 2015.
- **Provost Diversity Award**, Provost's Office, Columbia University, 2015.
- **Visiting Professorship**, Technische Universität Dresden, Germany, 2015.
- **Visiting Professorship**, University of Perugia, Italy, 2015.
- **Caterpillar Best Paper Prize**, selected among all journal articles published in *Acta Geotechnica* in 2013, Springer-Verlag Berlin Heidelberg, 2014.

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<sup>1</sup>Transferred to Northwestern due to my advisor's departure from Princeton.

- **IUTAM Travel Fellowship**, selected as one of the six young investigators to present at IUTAM symposium on "Connecting Multiscale Mechanics to Complex Material Design", International Union of Theoretical and Applied Mechanics, 2014.
- **USNCTAM Travel Fellowship**, 16th US National Congress of Theoretical & Applied Mechanics, 2010
- **USACM Travel Fellowship**, 9th World Congress of Computational Mechanics, 2010
- **NSF Travel Fellowship**, International Workshop on Multiscale and Multiphysics Processes in Geomechanics, 2010
- **Tuition Scholarship**, Summer School on Accelerators for Science and Engineering, National Science Foundation, 2008
- **Graduate Fellowship**, Northwestern University, 2008
- **Graduate Fellowship**, Princeton University, 2007
- **Graduate Fellowship**, Stanford University, 2005
- **John W. and Ernestine L. Heinrich Scholarship**, University of California, Davis, 2004
- **American Public Works Associations Scholarship**, American Public Works Associations, 2004
- **PEER Scholarship**, Pacific Earthquake Engineering Research Center, 2004
- **MORE Undergraduate Research Fellowship**, University of California, Davis, 2004

#### Awards received by PI's student and group Members

- **Best Poster Presentation Award** (Yang Liu), USNCCM San Diego, 2015.
- **Travel Scholarship** (Kun Wang), Society of Engineering Science Meeting at Texas A&M University, 2015.
- **Travel Scholarship** (Yang Liu), USNCCM San Diego, 2015.
- **Travel Scholarship** (SeonHong Na), EMI Stanford, 2015.
- **Travel Scholarship** (SeonHong Na), deal.ii Workshop, Texas A&M University, 2015.

#### Work Experience

**Assistant Professor** 2014-current  
 Civil Engineering and Engineering Mechanics Columbia University, New York, NY  
 -Conduct research aligned with strategic goals of department and school  
 -Supervise, collaborate and mentor undergraduate and graduate students, and postdoctoral scholars.  
 -Develop long-term research directions for the research group  
 -Teach courses at both undergraduate (soil mechanics) and graduate levels.  
 -Serve in external and internal committees for Columbia and professional society communities.  
 -Serve as an academic adviser to professional master students.  
 -Seek and manage funding support to sustain a research group consisting of 3-8 group members.  
 -Collaborate and interact with international scientific communities.

**Sr. Member of Technical Staff** (2013-2014) 2011-2014  
**Postdoctoral Fellow** (2011-2012)  
 Mechanics of Materials Department Sandia National Laboratories, Livermore, CA  
 Research Topic: Multiscale modeling of material failures  
 - Develop and implement an internal variable mapping scheme through Lie algebra.  
 - Derive and implement stabilized mixed finite element methods for poromechanics problems.  
 - Derive inf-sup tests to ensure stability of three-field formulation.  
 - Derive and implement an asynchronous domain coupling method for solid mechanics problem.  
 - Review, derive and implement variational localization finite element for grain boundary diffusions.  
 - Extend a variational localization element formulation to model strain localization in porous media.

**Research Assistant** 2008-2011  
Advisors: José E. Andrade & John W. Rudnicki Northwestern University, Evanston, IL  
Research Topic: Multi-scale predictions and simulations of localization banding in granular media  
- Design algorithms to couple continuum and discrete element models for granular media.  
- Develop and implement a multi-scale Lattice Boltzmann/Finite element code.  
- Develop finite element code for 3D consolidating bi-phase porous media.  
- Incorporate an semi-implicit level set scheme to conduct micro-mechanical medial axis analysis.  
- Incorporate the graph theory to analyze micro-structures of porous media.  
- Analyze micro-structural attributes of compaction bands found in Aztec Sandstone.  
- Implement the Manzari-Dafalias sand model for modeling soil liquefaction in sand.

**Research Assistant** 2007-2008  
Advisors: Yin Lu Young & Jean H. Prevost Princeton University, Princeton, NJ  
Research Topic: Influence of soil heterogeneity on sedimentation-consolidation phenomena  
- Develop and implement finite difference code to simulate sedimentation-consolidation phenomena.  
- Implement fast Fourier transform method to generate realizations for Monte-Carlos simulation.  
- Analyze sensitivity of mechanical behaviors of particle-fluid suspension.

**Research Assistant** 2005-2007  
Advisor: Ronaldo I. Borja Stanford University, Stanford, CA  
Research Topic: Co-seismic inelastic sediment deformation of Loma Prieta Earthquake  
- Study dynamic local site responses of layered sediment deposits subjected to seismic excitation.  
- Adopt a combined deterministic-stochastic approach to estimate co-seismic sediment deformation.  
- Perform finite element simulations to estimate displacement of soil columns.  
- Perform Monte-Carlos simulations to quantify sensitivity of seismic responses.  
- Analyze the noise of accelerogram data and its influence on deformation estimation.

**Summer Research Intern** 2004  
Advisor: Kincho Law Stanford University, Stanford, CA  
Research Topic: Internet-enabled software framework to facilitate the collaborative development and usage of engineering programs  
- Develop a pre- and post- process toolbox for an Internet-enabled software framework.  
- Develop a MATLAB program to create input files for various finite element codes.  
- Develop and implement a MATLAB program to interpret and visualize finite element solutions.

**Undergraduate Research Assistant** 2003-2005  
Advisor: Boris Jeremic University of California, Davis, CA  
Research Topic: Development of Open Simulation Earthquake Engineering System on Domain Reduction Method and its Simulation Tools  
-Develop a graphical user interface for dynamics finite element simulations via OpenSees.  
-Review the plastic blow method for large scale earthquake simulations.

### Referred Journal Articles

1. R.I. Borja and **W.C. Sun**, Estimating inelastic sediment deformation from local site response simulations, *Acta Geotechnica*, 2(3):183-195, 2007 [URL].
2. R.I. Borja and **W.C. Sun**, Co-seismic sediment deformation during the 1989 Loma Prieta Earthquake, *Journal of Geophysical Research*, Vol.113, B08314, doi:10.1029/2007JB005265, 2008 [URL].
3. **W.C. Sun**, J.E. Andrade, J.W. Rudnicki, A multiscale method for characterization of porous microstructures and their impact on macroscopic effective permeability, *International Journal for Numerical Methods in Engineering*, 88(12), 1260-1279, doi:10.1002/nme.3220, 2011 [URL].
4. **W.C. Sun**, J.E. Andrade, J.W. Rudnicki and P. Eichhubl, Connecting microstructural attributes and permeability from 3-D tomographic images of in situ compaction bands using multi-scale com-

- putation, *Geophysical Research Letter*, doi:10.1029/2011GL047683, 2011 (featured in EARTH magazine September 2011 issue [[LINK](#)] [[URL](#)]).
5. **W.C. Sun**, An unified method to predict diffuse and localized instabilities in sands, *Geomechanics and Geoengineering*, 8(2):65-75 doi:10.1080/17486025.2012.695403, 2013 [[URL](#)].
  6. **W.C. Sun**, J.T. Ostien and A.G. Salinger, A stabilized assumed deformation gradient finite element formulation for strongly coupled poromechanical simulations at finite strain, 37(6):2755-2788, doi:10.1002/nag.2161, *International Journal for Numerical and Analytical Methods in Geomechanics*, 2013. [[URL](#)].
  7. **W.C. Sun**, M.R. Kuhn and J.W. Rudnicki, A multiscale DEM-LBM analysis on permeability evolutions inside a dilatant shear band, *Acta Geotechnica*, 8(5):465-480 doi:10.1007/s11440-013-0210-2, 2013 [[URL](#)] (Caterpillar Best Paper Prize in the year of 2013).
  8. A. Mota, **W.C. Sun**, J.T. Ostien, J.W. Foulk III and K.N. Long, Lie-Group interpolation and variational recovery for internal variables, *Computational Mechanics*, 52(6):1281-1299, 2013. [[URL](#)].
  9. **W.C. Sun**, Q. Chen and J.T. Ostien, Modeling hydro-mechanical responses of strip and circular footings on saturated collapsible geomaterials, *Acta Geotechnica*, 9(5):903-934, 2014. [[URL](#)].
  10. **W.C. Sun** and A. Mota, A large deformation multiscale overlapped coupling formulation for strain localization, *Computational Mechanics*, 54(3):803-820, doi:10.1007/s00466-014-1034-0, 2014. [[URL](#)].
  11. **W.C. Sun**, A stabilized finite element formulation for monolithic thermo-hydro-mechanical simulations at finite strain, *International Journal for Numerical Methods in Engineering*, 103(11):798-839, doi:10.1002/nme.4910, 2015 [[URL](#)].
  12. M.R. Kuhn, **W.C. Sun**, Q. Wang, Stress-induced anisotropy in granular materials, fabric, stiffness and permeability, doi:10.1007/s11440-015-0397-5, *Acta Geotechnica*, 2015 [[URL](#)].
  13. K. Wang and **W.C. Sun**, Anisotropy of a tensorial Bishop coefficient under suction-controlled triaxial loadings, doi:10.1061/(ASCE)EM.1943-7889.0001005, *ASCE Journal of Engineering Mechanics*, 2015. [[URL](#)].
  14. Y. Liu, **W.C. Sun**, J. Fish, Parameter identification for critical state plasticity models based on multilevel extended digital database, 83(1), 011003, *Journal of Applied Mechanics*, 2015. [[URL](#)].
  15. Y. Liu, **W.C. Sun**, Z. Yuan, J. Fish, A nonlocal multiscale discrete-continuum model for predicting mechanical behavior of granular materials, doi:10.1002/nme.5139, *International Journal for Numerical Methods in Engineering*, 2015 (Student won 2015 poster competition at USNCCM San Diego). [[URL](#)].
  16. N. Guo, J. Zhao, **W.C. Sun**, Multiscale analysis of shear failure of thick-walled hollow cylinder in dry sand, in press, *Geotechnique Letters*, 2015.
  17. S. Na, **W.C. Sun**, Thermo-hydro-mechanical coupling effects on dynamic wave propagation in a fully saturated softening porous medium, in press, *International Journal for Numerical and Analytical Methods in Geomechanics*, 2016.
  18. Z. Zheng, **W.C. Sun**, J. Fish, Micropolar effect on the cataclastic flow and brittle-ductile transition in cohesive-frictional materials, submitted to *Journal of Geophysical Research*, 2015.
  19. K. Wang, **W.C. Sun**, A semi-implicit discrete-continuum coupling method for porous media based on the effective stress principle at finite strain, submitted to *Computer Methods in Applied Mechanics and Engineering*, 2015.
  20. G. Liu, **W.C. Sun**, S.M. Lowinger, Modeling crack coalescence in brittle rock with a coupled network DEM model, submitted to *International Journal of Rock Mechanics and Mining Science*, 2015.

21. A.G. Salinger, R.P. Pawlowski, Eric T. Phipps, R.A. Bartlett, G.A. Hansen, I. Kalashnikova, J.T. Ostien, **W.C. Sun**, Q. Chen, A. Mota, R.A. Muller, E. Nielsen, X. Gao. Albany: A component-based partial differential equation code build on Trilinos, submitted to *International Journal for Multiscale Computational Engineering*, 2015.
22. **W.C. Sun**, Z. Cai, Mixed Arlequin method for multiscale poromechanics problems: theory, implementation and verification, submitted to *International Journal for Numerical Methods in Engineering*, 2015.

### Journal Articles in Preparation

23. **W.C. Sun**, K. Wang, S. Salanger, S. Na, G. Khaddour, Identifying micropolar material parameters via micro-CT images, in preparation.
24. K. Wang, **W.C. Sun**, Micropolar discrete-continuum method for granular materials, in preparation.
25. S. Na, **W.C. Sun**, Computational thermo-hydro-mechanics for freezing soils, in preparation.
26. X. Zhang, **W.C. Sun**, Modeling propagation and coalescence of pure compaction band, in preparation.
27. J.W. Foulk, **W.C. Sun**, G.J. Wagner, J.T. Ostien and A. Mota, finite-deformation diffusion of hydrogen in stainless steel alloys, in preparation.
28. **W.C. Sun**, S. Salanger, K. Wang, G. Khaddour, S. Na, Micro-CT-based multiscale calibration, verification and validation for discrete-continuum coupling poromechanics model at finite deformation range, in preparation.
29. T-F. Wong and **W.C. Sun**, Prediction of hydraulic and electrical transport properties of sandstone with multiscale lattice Boltzmann/finite element simulation on microtomographic images, in preparation.
30. Z. Zheng, **W.C. Sun**, J. Fish, Modeling scale-dependent fracture processes with lattice-beam models of Euler-Bernoulli and Timoshenko types, in preparation.

### Peer Reviewed Conference Proceedings and Book Chapters

31. J. Zhao, N. Guo, **W.C. Sun**, A multiscale study of inherent anisotropy and strain localization in granular soils, 15th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, Japan, 2015.
32. **W.C. Sun**, Stabilized mixed finite element modeling of unsaturated flow barrier and fractured porous media at finite strain, 17th US National Congress on Theoretical and Applied Mechanics, Michigan State University, 2014.
33. **W.C. Sun**, M.R. Kuhn and J.W. Rudnicki, A micromechanical analysis on permeability evolution of a dilatant shear band, ARMA 14-7626, 40th US Rock Mechanics and Geomechanics Symposium, Minneapolis, MN, USA, 2014.
34. Q. Chen, **W.C. Sun** and J.T. Ostien, Finite element analysis of hydro-mechanical coupling of fully saturated collapsible geomaterials, Proceedings of GeoShanghai 2014 Conference, Shanghai, China, 2014.
35. **W.C. Sun**, J.E. Andrade, Diffuse bifurcations of porous media under partially drained conditions, *Springer Series in Geomechanics and Geoengineering*, 2:61-64, doi:10.1007/978-3-642-19630-0\_16, 2011[URL].
36. **W.C. Sun**, J.E. Andrade, Capturing the effective permeability of field compaction band using hybrid lattice Boltzmann/Finite element simulations, Proceedings of 9th World Congress of Computational Mechanics/APCOM 2010, Sydney, Australia, doi:10.1088/1757-899X/10/1/012077, 2010[URL].

37. **W.C. Sun** and J.E. Andrade, Surface slumping of submarine slope and its relation to material instability, Proceedings of 16th US National Congress on Theoretical and Applied Mechanics, University Park, Pennsylvania, 2010.
38. N. Lenoir, J.E. Andrade, **W.C. Sun** and J.W. Rudnicki, In situ permeability measurement inside compaction bands using X-ray CT and lattice Boltzmann calculations, Proceedings of 3th International Workshop on X-ray CT for geomaterials, New Orleans, Louisiana, 2010.
39. J.E. Andrade, and **W.C. Sun**, Predictive framework for simulation of instabilities in sands, Jornadas Geotecnicas Colombianas, Bogotá, Colombia, 2009.

### Technical Reports

40. **W.C. Sun**, A multi-scale framework for modeling instabilities in fluid-infiltrated porous solids, PhD dissertation, Northwestern University, 2011.
41. B. Jeremic, C. Zhao, M. Preisig, K. Sett, **W.C. Sun**, Geomechanics Simulation Tools for PBEE, PEER Year 8 Progress Report, Vol. II, pp. B150-B155, Pacific Earthquake Engineering Research Center, UC Berkeley, 2005.
42. B. Jeremic, J. Putnam, Z. Yang, K. Sett, C. Zhao, J. Liao, G. Jie, **W.C. Sun**, Earthquake Response of Bridge Abutment Backfill Constructed with Tire Shreds, Department of Civil and Environmental Engineering, UC Davis, 2004.

### Keynote Lectures, Invited Talks and Other Presentations

43. **W.C. Sun**, Modeling and validating a micropolar multiscale model for wetted granular matters, keynote Lecture, the International Symposium on Plasticity and Its Current Applications, Keauhou Bay, Hawaii, 2016.
44. K. Wang, **W.C. Sun**, Micro-polar Discrete-continuum coupling method for fluid-infiltrating porous media, Engineering Mechanics Institute Conference, Vanderbilt University, 2016.
45. S. Na, **W.C. Sun**, Computational cryo-mechanics for frozen soil, Engineering Mechanics Institute Conference, Vanderbilt University, 2016.
46. **W.C. Sun**, Z. Cai, Staggered schemes for multiscale Arlequin poromechanics problems, Engineering Mechanics Institute Conference, Vanderbilt University, 2016.
47. **W.C. Sun**, C. Tamagnini, Modeling thermal softening effects in coupled THM problems at finite strain, Engineering Mechanics Institute Conference, Vanderbilt University, 2016.
48. **W.C. Sun**, Computational Thermoporomechanics, University of Perugia, Perugia, Italy, 2015.
49. **W.C. Sun**, Multiscale coupling method for fluid-infiltrating porous media at the finite deformation range, Technical University of Dresden, Dresden, Germany, 2015.
50. **W.C. Sun**, Multiscale hydro-mechanical responses of geological materials, Sandia National Laboratories, Albuquerque, New Mexico, 2015.
51. **W.C. Sun**, Validation and Verification of Discrete-continuum coupling modeling of granular materials, 3D Printing and Digital Rock Physics Workshop, Santa Fe, New Mexico, 2015. Albuquerque, New Mexico, 2015.
52. **W.C. Sun**, Coupling dissimilar hydromechanical models for fluid-saturated porous media from grain to field scales, Los Alamos National Laboratory, Los Alamos, New Mexico, 2015.
53. **W.C. Sun**, Multiscale Modeling for fluid-infiltrating fractured porous media, Claude R. Hocott Lecture, Department of Petroleum and Geosystems Engineering, the University of Texas at Austin, Austin, Texas, 2015.
54. O.I. Ulven, **W.C. Sun**, Fluid transport in reaction-induced fractures, European Geophysical Union General Assembly, Vienna, Austria, 2015.

55. S. Na, **W.C. Sun**, Thermo-hydro-mechanical coupling effects on wave propagation and strain localization in a softening porous medium, Engineering Mechanics Institute Conference, Stanford, California, 2015.
56. **W.C. Sun**, Z. Cai, Modeling the hydromechanical coupling process of fluid-infiltrating solids via the monolithic and operator-splitting Arlequin method, Engineering Mechanics Institute Conference, Stanford, California, 2015.
57. **W.C. Sun**, Teng-fong Wong, SeonHong Na, Kun Wang, Imer Jasiel del Cid, Mechanical, hydraulic and electrical transport properties of sandstone with multiscale lattice Boltzmann/finite element simulations on micro-tomographic and DEM-simulated images, Engineering Mechanics Institute Conference, Stanford, California, 2015.
58. **W.C. Sun**, S. Na, A finite strain thermo-hydro-mechanical model for thermal softening geomaterials, the United State National Congress on Computational Mechanics, San Diego, 2015.
59. **W.C. Sun**, K. Wang, A discrete-continuum coupling approach for predicting anisotropic damages in water-saturated brittle rocks, 2015, the United State National Congress on Computational Mechanics, San Diego, 2015.
60. **W.C. sun**, Concurrent and Hierarchical Multiscale Modeling for Strain Localization in Fluid-infiltrating Porous Solids, Department of Mechanical engineering, Columbia University, 2015.
61. **W.C. Sun**, Multiscale modeling of strong and weak discontinuities in porous media, University of Hong Kong, Hong Kong, 2015.
62. **W.C. Sun**, Concurrent and hierarchical multiscale modeling of fluid-infiltrating solids, Department Seminar, Department of Civil and Environmental Engineering, the Hong Kong University of Science and Technology, Hong Kong, 2015.
63. Y. Liu, **W.C. Sun**, K. Wang, Z. Yuan, J. Fish, A nonlocal multiscale discrete-continuum model for dynamics shear band propagations and ruptures in granular materials, Engineering Mechanics Institute International Conference, Hong Kong Polytechnic University, Hong Kong, 2015.
64. **W.C. Sun**, C. Tamagnini, Modeling deformation bands in thermal softening and fluid infiltrating porous solids at finite strain, John Rudnicki Symposium, SES Meeting, Purdue University, 2014.
65. Y. Liu, **W.C. Sun**, Predicting possible leakage due to dynamics strain localization in granular materials with a coupled continuum-discrete coupling model, SES Meeting, Purdue University, 2014.
66. **W.C. Sun**, A DEM-LBM-FEM model for the formation of a dilatant shear band, 12th Annual Northwestern Granular Materials Workshop, Brown University, 2014.
67. **W.C. Sun**, Modeling multi-physical responses of deformation bands in porous media across length scales, Itasca Consulting Group, Minneapolis, MN, USA, 2014.
68. **W.C. Sun**, M.R. Kuhn, J.W. Rudnicki, A micromechanical analysis on permeability evolution of a dilatant shear band, ARMA 14-7626, Minneapolis, MN, 2014.
69. **W.C. Sun**, Modeling the multiscale deformation-diffusion process of fluid-infiltrating solids via the Arlequin method, IUTAM symposium, Evanston, IL, 2014.
70. **W.C. Sun**, Concurrent and hierarchical multiscale modeling of shear bands in fluid infiltrating solids multiscale modeling of deformation bands, Civil and Material Engineering Seminar, University of Illinois at Chicago, 2014.
71. **W.C. Sun**, Two-scale modeling of shear bands in fluid infiltrating solids, Joint Materials/Solid Mechanics Seminar Series, Brown University, 2014.
72. **W.C. Sun**, Modeling Thermo-hydro-mechanics at finite strain, UC Davis Geotechnical Seminar Series, University of California, Davis, 2013.
73. **W.C. Sun**, Modeling multiphysical coupling effects of deformation bands across length scales, Lawrence Livermore National Laboratory, Livermore, California, 2013.

74. **W.C. Sun**, J.T. Ostien, J.W. Foulk III, a stabilized finite element formulation for monolithic thermo-hydro-mechanical simulations at finite strain, Engineering Mechanics Institute Conference, Evanston, Illinois , 2013.
75. **W.C. Sun** Computational poromechanics across temporal and spatial scales, Department of Civil Engineering and Engineering Mechanics, Columbia University, New York, New York, 2013.
76. **W.C. Sun**, Multiscale modeling of thermo-hydro-mechanical coupling effects in deformation band, Department of Civil and Environmental Engineering, Carnegie Mellon university, Pittsburgh, Pennsylvania, 2013.
77. A. Mota, **W.C. Sun**, J.T. Ostien, J.W. Foulk III, K.N. Long, Lie-group interpolation and variational recovery for internal variables, the Third International Conference on Computational Modeling of Fracture and Failure of Materials and Structure, Prague, Czech Republic, 2013.
78. **W.C. Sun**, Modeling fully coupled hydromechanical process in porous media across different length scales, invited seminar, department of civil and environmental engineering, the Hong Kong Polytechnic University, Hong Kong, China, 2013.
79. **W.C. Sun**, J.T. Ostien, J.W. Foulk III, Modeling fluid flow in deformation bands with stabilized localization mixed finite elements, AGU Fall Meeting, San Francisco, 2012.
80. T-F. Wong, **W.C. Sun**, Prediction of hydraulic and electrical transport properties of sandstone with multiscale lattice Boltzmann/finite element simulation on microtomographic images, AGU Fall Meeting, San Francisco, 2012.
81. **W.C. Sun**, Modeling fully coupled hydromechanical process in porous media across different length scales, Shell Westhollow Technology Center, November 28th, Houston, Texas, 2012.
82. **W.C. Sun**, Computational poromechanics across different length scales, Engineering Science Center, Sandia National Laboratories, Albuquerque, New Mexico, 2012.
83. J W. Foulk III, **W.C. Sun**, C. San Marchi, B. Somerday, D. Balch, Coupled hydrogen transport and deformation of 21Cr-6Ni-9Mn austenitic stainless steel, 2012 International Hydrogen Conference, Grand Teton National Park, Jackson Lake Lodge, Wyoming, USA, 2012.
84. **W.C. Sun**, Connections between microstructural attributes and macroscopic mechanical and hydraulic responses of deformation bands in idealized and real porous media, Center for Frontiers of Subsurface Energy Security, Sandia National Laboratories, May, 8th, Albuquerque, NM, 2012.
85. T-F. Wong, **W.C. Sun**, Y. Ji, P. Baud, MicroCT imaging of porous sandstone and limestone: Implication on permeability evolution and mechanics damage, DOE basic science workshop, April 4th-5th, Gaithersburg, MD, 2012.
86. **W.C. Sun**, J.E. Andrade, J.W. Rudnicki, P. Eichhubl, Connecting microstructural attributes and macroscopic permeability of a natural shear-enhanced compaction band using multiscale computations, American Geophysical Union Fall Meeting, San Francisco, CA, 2011.
87. **W.C. Sun**, J.E. Andrade, J.W. Rudnicki, Capturing micro-structural attributes and macroscopic fluid transport properties of two-phase porous media with multi-scale framework, 11th US National Congress on Computational Mechanics, July 25-29, Minneapolis, MN, 2011.
88. **W.C. Sun**, Analyzing interplays between microstructures and macroscopic transport properties of shear-enhanced bands with a multi-scale framework, Army Research Laboratory, Aberdeen Proving Ground, Maryland, 2011.
89. **W.C. Sun**, A multiscale analysis on porous microstructures of deformation bands and their implications on macroscopic transport of pore-fluid, Los Alamos National Laboratory, New Mexico, 2011.
90. **W.C. Sun**, A multiscale analysis of strain localizations in fully saturated porous media, Naval Research Laboratory, John C. Stennis Space Center, Mississippi, 2011.



91. **W.C. Sun**, Connecting micro-structural attributes and macroscopic fluid transport properties of two-phase porous media with a multi-scale framework, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 2011.
92. **W.C. Sun** and J.E. Andrade, Capturing the effective permeability of field compaction bands with hybrid lattice Boltzmann/finite element, World Congress of Computational Mechanics, Sydney, Australia, 2010.
93. **W.C. Sun** and J.E. Andrade, Surface Slumping of Submarine Slope And Its Relation To Material Instability, 16th US National Congress on Theoretical and Applied Mechanics, University Park, Pennsylvania, 2010.
94. **W.C. Sun** and J.E. Andrade, Diffuse bifurcations of porous media under partially drained conditions, International Workshop on Multiscale and Multiphysics Processes in Geomechanics, Stanford, California, 2010.
95. **W.C. Sun** and J.E. Andrade, Capturing material instability in saturated porous media, US Congress on Computational Mechanics, Columbus, Ohio, 2009.
96. J.E. Andrade, N. Lenoir, **W.C. Sun**, J.W. Rudnicki, X-ray aided permeability computations inside compaction bands in sandstones, American Geophysical Union, Fall Meeting, 2009.
97. B. Jeremic, M. Preisig and **W.C. Sun**, Seismic soil-foundation interaction: numerical modeling issues, 2005 Structures Congress, Structural Engineering Institute, New York, 2005.
98. **W.C. Sun**, OpenSees simulation tools for geotechnical earthquake engineering, PEER Annual Meeting, Menlo Creek, 2005.
99. **W.C. Sun**, OpenSees pre- and post- Processing, 2005 EERI Annual Meeting, Mexico, 2005.
100. **W.C. Sun**, OpenSees pre- and post- Processing with Application to OpenGL and FLTK, Undergraduate Research Conference, University of California, Davis, 2004.
101. M. Preisig and **W.C. Sun**, I-880 test bed simulation, 2004 PEER Annual Meeting, Palm Springs Riviera Resort, 2004.

### Teaching Experience

1. **Instructor**, Finite Element in Geotechnical Engineering, Columbia University, CIEN 4195, Fall 2015.
2. **Instructor**, Computational Poromechanics, ENME6320, Columbia University, Fall 2014.
3. **Instructor**, Soil Mechanics CIEN 3141, Columbia University, Spring 2014, 2015.
4. **Instructor**, Civil Engineering Research, CIEN9101, Columbia University, Fall 2014, Spring 2015.
5. **Instructor**, Individual Studies for Civil Engineering Senior, CIEN, 3304, Columbia University, Fall 2014.
6. **Teaching Assistant**, Computational Poromechanics CIVENG 495, Northwestern University, Winter 2009, responsibilities include leading TA session, preparing lecture notes, grading and preparing solutions for homework and exams.
7. **Teaching Assistant**, Modeling of Models in Geotechnical Engineering CEE296, Stanford University, Winter 2006 and Winter 2007, responsibilities include giving brief instructions, demonstrating and leading experiments.
8. **Teaching Assistant**, Geotechnical Engineering CEE101C, Stanford University, Fall 2005 and Fall 2006, responsibilities include giving lectures, leading experiments and grading homework.

## Grants and Contracts

Professor Sun's research group is currently supported by Army Research Office, Air Force Office of Scientific Research, National Science Foundation (CMMI and EAR divisions), Department of Defense, Sandia National Laboratories and Columbia University. He received the Young Investigator Award from Army Research Office in 2015.

### As the Principal Investigator in Funded Single-PI Projects

1. Title: Young Investigator Award: Understanding hydro-mechanical coupling mechanism of wetted granular matters beyond the pendular regime  
Funding Agency: Army Research Office  
Duration: 9/1/2015-8/31/2018  
Amount: \$347,000  
PI: **W.C. Sun**
2. Title: A phase field Arlequin model for resolving non-local hydromechanical effects of porous media across time and spatial Scales  
Funding Agency: National Science Foundation  
Duration: 8/1/2015-7/31/2018  
Amount: \$300,000  
PI: **W.C. Sun**
3. Title: Cryo-mechanics of unsaturated frozen soils during freeze-thaw cycle  
Funding Agency: Army Research Office, Department of Defense  
Duration: 9/1/2015-9/1/2015  
Amount: \$108,889  
PI: **W.C. Sun**
4. Title: A multiscale analysis on the moisture effect of dynamics responses of granular matters  
Funding Agency: Army Research Office  
Duration: 1/1/2015-9/1/2015  
Amount: \$50,000  
PI: **W.C. Sun**
5. Title: Modeling chemical driven fractured rocks by integrating 3D printing digenesis and multiscale computations  
Funding Agency: Columbia University Provost's Grants Program  
Duration: 1/1/2015-12/31/2015  
Amount: \$25,000  
PI: **W.C. Sun**
6. Title: A discrete-continuum coupling method for environmental-driven fracture in rock  
Funding Agency: Sandia National Laboratories  
Duration: 6/1/2015-12/31/2015 Amount: \$15,000  
PI: **W.C. Sun**
7. Title: Phase field modeling of anisotropic damages in orthotropic material  
Funding Agency: Sandia National Laboratories  
Duration: 1/1/2016-12/31/2016 Amount: \$15,000  
PI: **W.C. Sun**
8. Title: Adaptive phase field modeling of crack and anticrack  
Funding Agency: Extreme Science and Engineering Discovery Environment (XSEDE)  
Duration: 9/1/2015-8/31/2016 Amount: 50,000 Service Unit (roughly equivalent to \$50,000)  
PI: **W.C. Sun**

### As Co-Principal Investigator in Funded Multiple-PI Projects

9. Title: A Combined experimental and theoretical investigation of reactive flow in brittle media with applications to solid earth geodynamics  
Funding Agency: National Science Foundation  
Duration: 8/1/2015-7/31/2018  
Amount: \$409,036 (Sun's activities: \$34,298)  
PI: M. Spiegelman , co-PI: **W.C. Sun**, H. Savage, P. Kelemen
10. Title: STTR: Particulate Composite Mixing Processes  
Funding Agency: Air Force Office of Scientific Research  
Duration: 2/1/2016-1/31/2018 Amount: \$414,000 (Sun's activities: \$182,896)  
PI: H. Yin, co-PI: **W.C. Sun**
11. Title: Collaborative Research: Alteration of mantle peridotite: Geochemical fluxes and dynamics of far from equilibrium transport  
Funding Agency: National Science Foundation  
Duration: 8/1/2015-7/31/2018  
Amount: \$1,968,362 (Sun's activities: \$68,589)  
PI: P. Kelemen, co-PI: **W.C. Sun**, H. Savage, M. Stute, M. Spiegelman
12. Title: Experimental and digital rock physics in relation to hydraulic and electrical transport properties of porous sandstone  
Funding Agency: Hong Kong Research Council  
Duration: 6/1/2015-12/31/2015 Amount: \$160,530 (Sun's activities: \$20,000)  
PI: T.F. Wong, co-PI: **W.C. Sun**

### Service to University and Scientific Community

#### Technical Committee and Editorial Board Membership

- ASCE Engineering Mechanics Technical Committee (Computational Mechanics, Granular Mechanics)
- International Journal for Multiscale Computational Engineering

#### Reviewer of the following peer-reviewed journal articles

- ASCE Journal of Geotechnical and Geoenvironmental Engineering
- International Journal for Numerical and Analytical Methods in Geomechanics
- International Journal for Numerical Methods in Engineering
- International Journal of Solids and Structures
- the Geological Society of America Bulletin
- Acta Geotechnica
- Finite Element Analysis and Design
- Soil Dynamics and Earthquake Engineering
- International Journal of Plasticity
- International Journal of Fracture
- International Journal of Solids and Structures
- ASCE Journal of Engineering Mechanics
- Journal of Geophysical Research (Solid Earth)
- Computer Methods in Applied Mechanics and Engineering
- International Journal for Multiscale Computational Engineering
- Granular Matters

- Computer and Geotechnics

Reviewer for the conferences and professional meeting

- Engineering Mechanics Institute International Conference, Hong Kong, 2015
- Engineering Mechanics Institute Conference, Stanford, California, 2015.
- ASCE GeoFlorida 2010: Advances in Analysis, Modeling and Design, Florida, 2010.

Reviewer of grant proposals for the following government agencies

- Army Corps of Engineers
- Army Research Laboratories
- National Science Foundation

Organizer of domestic and international conferences and professional meetings

- Failure and instabilities in soft materials and geomaterials Mini-symposium at the 7th International Conference on Computational Methods, Berkeley (2016).
- Computational Geomechanics Mini-symposium at Engineering Mechanics Institute Conference, Vanderbilt University, Nashville (2016).
- Digital Rock and Granular Physics, Engineering Mechanics Institute Conference, Stanford University (2015).
- Digital Rock Physics, 3D printing and More, Mineral and Rock Physics Sessions, AGU 2014 Fall Meeting, San Francisco (2014).
- Computational Geomechanics Mini-symposium at United States National Congress of Theoretical and Applied Mechanics at Michigan State University (2014).
- Digital Rock and Granular Physics, EMI Stanford (2015).
- Multiscale Modeling of Granular Materials, 13th US National Congress on Computational Mechanics, San Diego (2015).
- Multiphysical Modeling of Geomaterials, 13th US National Congress on Computational Mechanics, San Diego (2015).
- International scientific committee member of the Engineering Mechanics Institute International Conference at Hong Kong Polytechnic University (2015).

Thesis Defense and Examination Committees

- PhD graduate candidate at Columbia University (as primary advisor)
  - \* Yang Liu, Civil Engineering and Engineering Mechanics, August 2015.
- PhD graduate candidate at Columbia University (not primary advisor)
  - \* Daniel Marasco, Civil Engineering and Engineering Mechanics, May 2014.
  - \* Abdulhamit Sarac, Mechanical Engineering, May 2014.
  - \* Lingqi Yang, Civil Engineering and Engineering Mechanics, December 2014.
  - \* Shuoshuo Han, Earth and Environmental Science, January, 2015.
  - \* Raha Hakimdavar, Civil Engineering and Engineering Mechanics, January 2016.
  - \* Zifeng Yuan, Civil Engineering and Engineering Mechanics, January 2016.

## Professional and Honor Society Membership

Member, Engineering Mechanics Institute, 2014-current  
Member, American Society of Civil Engineers, 2014-current  
Member, American Society of Mechanical Engineers, 2014-current  
Member, International Society of Porous Media, 2014-current  
Member, Sigma Xi the scientific research society, 2013-current  
Member, American Geophysical Union, 2010-current  
Member, UC Davis Chapter, the Honor Society of Phi Kappa Phi, since 2003  
Member, California Lambda Chapter, Tau Beta Pi Engineering Honor Society, since 2003  
Member, UCAD Chapter, Golden Key International Honor Society, since 2003

## Technical Skills

Programming language: Proficient in C++, FORTRAN, MATLAB and Python.  
Operation system: UNIX, Red Hat Enterprise, Fedora, Windows and Macintosh.  
Software: ABAQUS, ANSYS, ImageJ, OpenSees, SHAKE and MATLAB.  
Language: Chinese and American English.  
Code development experience: mixed finite element method, constitutive modeling of geomaterials, lattice Boltzmann simulation, discrete element method and multiscale modeling, written in C, C++ and FORTRAN.

## Collaborators and other affiliations

**Collaborators:** Jose E. Andrade (Caltech), Joe E. Bishop (Sandia National Laboratories), Ronaldo I. Borja (Stanford), Qiushi Chen (Clemson University), George Deodatis (Columbia University), Thomas Dewers (Sandia National Laboratories), Peter Eichhubl (UT Austin), James W. Foulk (Sandia National Laboratories), Jacob Fish (Columbia University), Craig Foster (University of Illinois at Chicago), Boris Jeremic (UC Davis), Peter Kelemen (Columbia University), Matthew Kuhn (University of Portland), Hoe I. Ling (Columbia), Moo Lee (Sandia National Laboratories), Nicolas Lenoir (Université Paris-Est, France), Kevin N. Long (Sandia National Laboratories), Kincho Law (Stanford), Mario J. Martinez (Sandia National Laboratories), Alejandro Mota (Sandia National Laboratories), Jakob T. Ostien (Sandia National Laboratories), Roger Buck (Columbia University), John W. Rudnicki (Northwestern), Simon Salager (Université de Joseph Fourier), Andrew G. Salinger (Sandia National Laboratories), Marcelo Sanchez (Texas A&M University), Heather Savage (Columbia), Marc Spiegelman (Columbia), Claudio Tamagnini (University of Perugia, Italy), Cian Wilson (Columbia), Teng-fong Wong (Chinese University of Hong Kong, Hong Kong), Honghku, Yoon (Sandia National Laboratories), Huiming Yin (Columbia University), Yin Lu Young (University of Michigan, Ann Arbor). Jidong Zhao (Hong Kong University of Science & Technology).

## Student Research Advising

### Graduate Students

- Yang Liu, PhD (now postdoctoral scholar at MIT), *Modeling shear bands with multiscale DEM-FEM coupling method in loose and dense grain assemblies*. Spring 2014-Summer 2015.
- Qi Wang, Master student, *Microstructural attributes and effective conductivity of Fontainebleau sandstone*. Spring 2014-Spring 2015 (now structural engineer at Patuxent Engineering Group).
- SeonHong Na, PhD student, *Stabilized finite element method for phase-transition porous media*. Fall 2014-current.
- Zhijun Cai, PhD student, *Adaptive Arlequin Mechanics*. Fall 2014-current.
- Kun Wang, PhD student, *Discrete-continuum poromechanics*. Spring 2015-current.

- Xian Zhang, MS/PhD student, *Multi-phase field method for fluid-driven fractures*. Fall 2015-current.
- Francisco J. Contreras, MS student, *Fluid-infiltrating porous meta-materials*. Fall 2015-current.

#### Undergraduate Researchers

- Imer Jasiel del Cid, Undergraduate research student, *Micro-structural attributes of sandstone with low porosity*. Fall 2014-Spring 2015 (now engineer at Boeing).
- Efram J. Stone, Undergraduate research student, *Micro-structural attributes of sandstone with low porosity*. Summer 2014 (now master student at University of Southern California).
- Steven M. Lowinger, Undergraduate research student, *Application of graph theory for double-porosity system*, Fall 2015-current.

#### Short Term Visiting Students (from other universities)

- Federica Ronchi (University of Perugia, Italy), Visiting Student, *Thermo-hydro-mechanical coupling effect of thermal hardening/softening of soil*, 2/2015-5/31/2015.
- Guang Liu (Wuhan University), Visiting Student, *Discrete Element Modeling of Hydraulic Fracture*, 9/2014-8/2015.
- Zhilin Liu, Nanjing University of Science and Technology, 9/2015-9/2016.
- Ning Liu, BeiHang University, 9/2015-10/2016.
- Fadi Abdeljawad (Princeton University), Summer Internship at Sandia National Laboratories (co-advised with Dr. James W Foulk, III), *Localized diffusion in hydrogen embrittled steel*. Summer 2012.