COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science

Faculty Personnel Record

WaiChing Sun

Assistant Professor

Department: Civil Engineering and Engineering Mechanics

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Date: 7/1/2019

Education:

School	Degree		Date
University of California, Davis	Civil Engineering	B.S.	2005
Stanford University	Civil Engineering	M.S.	2007
Princeton University	Civil Engineering	M.A.	2008
Northwestern University	Applied Mechanics	PhD.	2011
Sandia National Laboratories	Mechanics of Materials	Post-doc	2013

Title of Ph.D. Thesis:

A multi-scale framework for modeling instabilities in fluid-infiltrating porous solids, PhD Dissertation, Northwestern University, June 2011.

Principal Fields of Interest:

Geomechanics, Computational Mechanics, Porous Media, Geomaterials, Granular materials, Multiscale Modeling, Computational Plasticity and Fractures, Data-driven modeling, Nuclear waste disposal

Career History: (list in reverse chronological order)

Employer	Position	Beginning	Ending
Columbia University	Assistant Professor	2014	Current Position
Sandia National Laboratories	Sr Member of Technical Staff	2013	2014
Sandia National Laboratories	Postdoctoral Appointee	2011	2013
Caltech	Visiting Scholar	2010	2011

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Awards/Honors Received:

Internal (Department, School, University):

- **Provost's Diversity Award**, Columbia University, 2015.

External:

Selected individual awards received by the PI

- **NSF CAREER Award**, National Science Foundation (Mechanics of Materials and Structures Program, Civil, Mechanics and Manufacturing Innovation Division), 2019. The NSF's most prestigious award in support of junior faculty who exemplifies the role of teacher-scholar through outstanding research and excellent education.
- **EMI Leonardo Da Vinci Award**, the Engineering Mechanics Institute of American Society of Civil Engineers, 2018. The purpose of the award is to recognize outstanding young in- vestigators early in their careers for promising ground-breaking developments in the field of Engineering Mechanics and Mechanical Sciences as relevant to Civil Engineering, understood in the broadest sense. The award is given annually to a young investigator, generally under 35 years of age or have worked no more than 7 years since receiving their doctoral degree, and whose contributions have the promise to define new directions in theory and application of Engineering Mechanics, in the vein of Leonardo da Vinci (1452-1519), a man of unquench- able curiosity and feverishly inventive imagination. The EMI of ASCE selected the PI "*for his fundamental contributions to computational multiscale poromechanics*".
- **Zienkiewicz Numerical Methods in Engineering Prize**, Institution of Civil Engineers (ICE) and John Wiley & Sons, 2017. Instituted following a donation by John Wiley & Sons Ltd to commemorate the work of Professor Olgierd Cecil Zienkiewicz CBE. DSc FRS FREng of the Institute for Numerical Methods in Engineering, University of Wales, Swansea. The medal is awarded biennially by the Institution of Civil Engineers (ICE) to a researcher under 40 for the paper which contributes most to research in numerical methods in engineering, among 8 prime peer-reviewed journals published by ICE or Wiley, i.e., Géothechnique, Géothechnique Letters, International Journal for Numerical Methods in Engineering, International Journal for Numerical Methods in Biomedical Engineering, International Journal for Numerical Methods in Fluids, International Journal for Numerical and Analytical Methods in Geomechanics, International Journal of Numerical Modelling: Electronic Networks, Devices and Fields, and ICE Proceedings.

- **AFOSR Young Investigator Program Award**, Air Force Office of Scientific Research, US Air Force, 2017. The Air Force's Young Investigator Program (YIP) award is one of the most prestigious honors bestowed by the US Air Force to outstanding scientists beginning their independent careers. The program is designed to identify and support talented scientists and engineers who show exceptional promise for doing creative research in order to encourage their teaching and research careers.
- **ARO Young Investigator Program Award**, Army Research Office, US Army, 2015. The Army's Young Investigator Program (YIP) award is one of the most prestigious honors be- stowed by the US Army to outstanding scientists beginning their independent careers. The program is designed to identify and support talented scientists and engineers who show excep- tional promise for doing creative research in order to encourage their teaching and research careers.

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- **Caterpillar Best Paper Prize**, Springer-Verlag Berlin Heidelberg, 2013. Selected annually among all journal articles published in *Acta Geotechnica* in 2013. Previous awardees include Yannis Dafalias (2014) and Franz-Josef Ulm (2012).

Other individual awards received by the PI

- **Dresden Fellowship,** Technische Universität Dresden, 2016.
- **Recognition Award,** for original work and authorship of Albany, Sandia National Laboratories, Department of Energy, 2016.
- **DURIP award**, Army Research Office and Department of Defense, 2015.
- **IUTAM Travel Fellowship**, 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, Princeton University, 2007, 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 students and group Members since joining research group

- **Mindlin award** (Kun Wang), Department of Civil Engineering and Engineering Mechanics, Columbia University, 2019
- **Finalist of the Director's Postdoctoral Fellowship** (Kun Wang), Los Alamos National Laboratory, Department of Energy, 2019.
- Travel Scholarship (Kun Wang), 20th International Conference on Finite Elements in Flow Problems, Northwestern University, Evanston, 2019.
- Travel Scholarship (Kun Wang and Chuanqi Liu), Workshop on Meshfree and Particle Mechanics: Application and Theory, Santa Fe, 2018.
- **Mindlin award** (SeonHong Na), Department of Civil Engineering and Engineering Mechanics, Columbia University, 2018
- Travel Scholarship (Eric Bryant), 3rd Biennial CO2 for EOR as CCUS conference, Petroleum Research School of Norway, 2017.
- **Dongju Lee Memorial Award** (SeonHong Na), Department of Civil Engineering and Engineering Mechanics, Columbia University, 2017.

- 2nd Place in Best Paper Student Competition (SeonHong Na), Engineering Mechanics Institute, Modeling Inelasticity and Multiscale Behavior Committee, EMI 2016 & PMC 2016, Vanderbilt University, Nashville, TN, 2016.
- Best Poster Presentation Award (Yang Liu, now assistant professor at Northeastern), USNCCM San Diego, San Diego, CA, 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.

Publications

(underlines indicate students, * indicates postdocs, † indicates visiting scholars.)

Papers in Refereed Journals: (List in Chronological Order)

2012 and earlier

J1. R.I. Borja, **W.C. Sun**, Estimating inelastic sediment deformation from local site response simulations, *Acta Geotechnica*, 2(3):183-195, doi: 10.10072Fs11440-007-0044-x, 2007. [PDF]

J2. R.I. Borja, **W.C. Sun**, Co-seismic sediment deformation during the 1989 Loma Prieta Earthquake, *Journal of Geophysical Research: Solid Earth*, Vol.113, B08314, doi:10.1029/2007JB005265, 2008. [PDF]

J3. **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. [PDF]

J4. **W.C. Sun**, J.E. Andrade, J.W. Rudnicki, P. Eichhubl, Connecting microstructural attributes and permeability from 3-D tomographic images of in situ compaction bands using multi-scale computation, *Geophysical Research Letter*, 38(10), L1032, doi:10.1029/2011GL047683, 2011 (featured in **EARTH magazine** September 2011 issue). [PDF]

2013

J5. **W.C. Sun**, An unified method to predict diffuse and localized instabilities in sands, *Geomechanics and Geoengineering*, 8(22):65-75, doi:10.1080/17486025.2012.695403, 2013. [PDF]

J6. A. Mota, **W.C. Sun**, J.T.Ostein, J.W. Foulk III, K.N. Long, Lie-Group interpolation and variational recovery for internal variables, *Computational Mechanics*, 52:1281-1299, doi:10.1007/s00466-013-0876-1, 2013. [PDF]

J7. **W.C. Sun**, J.T. Ostien, A.G. Salinger, A stabilized assumed deformation gradient finite element formulation for strongly coupled poromechanical simulations at finite strain, *International Journal for Numerical and Analytical Methods in Geomechanics*, 37(16):2755-2788, doi:10.1002/nag.2161, 2013. [PDF]

J8. **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. (The authors received the **Caterpillar Best paper prize** in the year of 2013) [PDF]

2014

J9. **W.C. Sun**, Q. Chen, J.T. Ostien, Modeling hydro-mechanical responses of strip and circular footings on saturated collapsible geomaterials, *Acta Geotechnica,* 9(5):903-934, doi:10.1007/s11440-013-0276-x, 2014. [PDF]

J10. **W.C. Sun**, A. Mota, A multiscale overlapped coupling formulation for large deformation strain localization, *Computational Mechanics*, 54(3):803-820, doi: 10.1007/s00466-014-1034-0, 2014. [PDF] [Bibtex] [Erratum]

2015

J11. **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. [PDF]

J12. M.R. Kuhn, **W.C. Sun**, Q. Wang, Stress-induced anisotropy in granular materials: fabric, stiffness, and permeability, *Acta Geotechnica*, 10(4)399-419, doi:10.1007/s11440-015-0397-5, 2015. [PDF]

J13. K. Wang, **W.C. Sun**, Anisotropy of a tensorial Bishop's coefficient for wetted granular materials, *Journal of Engineering Mechanics*, 143(3), B4015004, doi:10.1061/(ASCE)EM.1943-7889.0001005, 2015. [DRAFT]

J14. Y. Liu, **W.C. Sun**, J. Fish, Determining material parameters for critical state plasticity models based on multilevel extended digital database, *Journal of Applied Mechanics*, 88(1), 011003, doi: 10.1115/1.4031619, 2015. [PDF]

J15. Y. Liu, **W.C. Sun**, Z-F. Yuan, J. Fish, A nonlocal multiscale discrete-continuum model for predicting mechanical behavior of granular materials, *International Journal for Numerical Methods in Engineering*, 106(2):129-160, doi: 10.1002/nme.5139, 2015. [PDF]

2016

J16. N. Guo, J. Zhao, **W.C. Sun**, Multiscale analysis of shear failure of thick-walled hollow cylinder in dry sand, *Géotechnique Letters*, 6(1), 77-82, doi:10.1680/jgele.15.00149, 2016. [PDF]

J17. S. Na, **W.C. Sun**, Wave propagation and strain localization in a fully saturated softening porous medium under the non-isothermal conditions, *International Journal for Numerical and Analytical Methods in Geomechanics*, 40(10):1485-1510, doi:10.1002/nag.2505, 2016. [PDF]

J18. Z. Zheng,†, **W.C. Sun**, J. Fish, Micropolar effect on the cataclastic flow and brittle-ductile transition in high-porosity rocks, *Journal of Geophysical Research*, doi:10.1002/2015JB012179, 2016.

J19. K. Wang, **W.C. Sun**, A semi-implicit discrete-continuum coupling method for porous media based on the effective stress principle at finite strain, *Computer Methods in Applied Mechanics and Engineering*, 304(1):546-583, doi:10.1016/j.cma.2016.02.020, 2016. [PDF]

J20. K. Wang, **W.C. Sun**, S. Salager, S. Na, G. Khaddour, Identifying material parameters for a micro-polar plasticity model via X-ray micro-CT images: lessons learned from the curve-fitting exercises, *International Journal of Multiscale Computational Engineering*, 14(4):389-413, doi:10.1615/IntJMultCompEng.2016016841, 2016. [PDF][Bibtex]

J21. 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, *International Journal of Multiscale Computational Engineering*, 14(4):415-438, doi:10.1615/IntJMultCompEng.2016017040, 2016. [PDF][Bibtex]

J22. **W.C. Sun**, Foreword: computational poromechanics, *International Journal of Multiscale Computational Engineering*, doi:10.1615/IntJMultCompEng.2016018596, 2016. [PDF][Bibtex]

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2017

J23. K. Wang, **W.C. Sun**, A unified variational eigen-erosion framework for interacting fractures and compaction bands in brittle porous media, *Computer Methods in Applied Mechanics and Engineering*, 318:1-32 doi:10.1016/j.cma.2017.01.017, 2017. [PDF][Bibtex]

J24. S. Na, **W.C. Sun**, Computational thermo-hydro-mechanics for multiphase freezing and thawing porous media in the finite deformation range, *Computer Methods in Applied Mechanics and Engineering*, 318:667-700, doi:10.1016/j.cma.2017.01.028, 2017. (PhD Student SeonHong Na selected as runner-up for the 2017 best paper competition at EMI Nashville) [PDF]

J25. **W.C. Sun**, Z. Cai, J. Choo*, Mixed Arlequin method for multiscale poromechanics problems, *International Journal for Numerical Methods in Engineering*, 111:624-659, doi:10.1002/nme.5476, 2017. [PDF]

J26. I. Wollny, **W.C. Sun**, M. Kaliske, A hierarchical sequential ALE poromechanics model for tire-water-road interaction on fluid-infiltrating roads, *International Journal for Numerical Methods in Engineering*, 112(8):909-938, doi:10.1002/nme.5537, 2017. [PDF]

J27. S. Na, **W.C. Sun**, H. Yoon, M. Ingraham, Effects of elastic heterogeneity on the fracture pattern and macroscopic effective toughness of Mancos Shale in Brazilian tests, *Journal of Geophysical Research: Solid Earth*, B013374, 122(8):6202-6230, doi:10.1002/2016JB013374, 2017. [URL]

J28. H. Xin†, **W.C. Sun**, J. Fish, a surrogate modeling approach for additive-manufactured materials, *International Journal of Multiscale Computational Engineering*, 15:525-543, doi: 10.1615/IntJMultCompEng.2017024632, 2017.

J29. H. Xin†, **W.C. Sun**, J. Fish, Thermo-mechanical discrete element simulations on Powder- Bed Sintering-based Additive Manufacturing, *International Journal of Mechanical Sciences*, 149:373-392, doi:10.1016/j.ijmecsci.2017.11.028, 2018. [URL]

J30. O.I. Ulven†, **W.C. Sun**, Capturing the two-way hydro-mechanical coupling effect on fluid-driven fracture in a dual-graph lattice beam model, *International Journal for Numerical and Analytical Methods in Geomechanics*, 42(5):736-767, doi:10.1002/nag.2763, 2017. [URL]

2018

J31. K. Wang, **W.C. Sun**, A multiscale multi-permeability poroplasticity model linked by recursive homoge- nizations and deep learning, *Computer Methods in Applied Mechanics and Engineering*, 334(1):337-379, doi.org/10.1016/j.cma.2018.01.036, 2018. [URL]

J32. S. Na, **W.C. Sun**, Computational thermomerchanics of crystalline rock salt Part I: a combined phase field/crystal plasticity approach for single grain simulations, *Computer Methods in Applied Mechanics and Engineering*, doi:10.1016/j.cma.2017.12.022, 2018. [URL]

J33. J. Choo*, **W.C. Sun**, Coupled phase-field and plasticity modeling of geological materials: from brit- tle fracture to ductile flow, *Computer Methods in Applied Mechanics and Engineering*, 330:1-32, doi:10.1016/j.cma.2017.10.009, 2018. [URL]

J34. J. Choo*, **W.C. Sun**, Cracking and damage from crystallization in pores: Coupled chemo-poro-mechanics and phase-field modeling, *Computer Methods in Applied Mechanics and Engineering*, 335:347-379, doi:10.1016/j.cma.2018.01.044, 2018. [URL]

J35. **W.C. Sun**, T-F. Wong, Prediction of permeability and formation factors of sandstone with multiscale lattice Boltzmann/finite element simulation on microtomographic images, *International Journal of Rock Mechanics and Mining Sciences*, 106:269-277, doi:10.1016/j.ijrmms.2018.04.020, 2018.

J36. R. Gupta, S. Salager, **W.C. Sun**, K. Wang, Open-source support toward validating and falsifying discrete mechanics models using synthetic granular materials Part I: Experimental tests with particles manufactured by a 3D printer, *Acta Geotechnica*, doi:10.1007/s11440-018-0703-0, 2018. [URL]

J37. E. C.Bryant, **W.C. Sun**, Mixed-mode phase field fracture for secondary cracks in anisotropic brittle rocks with consistent kinematics, *Computer Methods in Applied Mechanics and Engineering*, 342:561-584, doi:10.1016/j.cma.2018.08.008, 2018. [URL]

J38. X. Zhong† , **W.C. Sun**, An adaptive reduced-dimensional discrete element model for dynamic responses of granular materials with high-frequency noises, *International Journal of Multiscale Computational Engineering*, 16(4):345-366, doi:10.1615/IntJMultCompEng.2018026895, 2018. [URL]

J39. L. Mishnaevsky, C. Linder, **W.C. Sun**, Preface: Multiscale computational analysis of complex materials, *International Journal of Multiscale Computational Engineering*, doi:10.1615/IntJMultCompEng.2018027912, 2018.

2019

J40. G. Liu†, **W.C. Sun**, S. M. Lowinger, Z Zheng, M Huang, J. Peng, Coupled flow network and discrete element modeling of injection-induced crack propagation and coalescence in brittle rock, *Acta Geotechnica*, 14(3):843-868, doi:10.1007/s11440-018-0682-1, 2019. [URL]

J41. K. Wang, **W.C. Sun**, An updated Lagrangian LBM-DEM-FEM coupling model for dual-permeability porous media with embedded discontinuities, *Computer Methods in Applied Mechanics and Engineering*, 334:276-305, doi:10.1016/j.cma.2018.09.034, 2019. [URL]

J42. K Wang, **W.C. Sun**, Meta-modeling game for deriving theory-consistent, micro-structure-based tractionseparation laws via deep reinforcement learning, *Computer Methods in Applied Mechanics and Engineering*, 346:216-241, doi:10.1016/j.cma.2018.11.026, 2019. [URL]

J43. A. Qinami† , E. C. Bryant, **W.C. Sun**, M. Kaliske, Circumventing mesh bias by r- and h-adpative techniques for variational eigen-fracture, *International Journal of Fracture*, doi:10.1007/s10704-019-00349-x, 2019. [URL]

J44. C. Liu, **W.C. Sun**, Shift domain material point method for solids in the finite deformation range, *Computational Particle Mechanics, special thematic issue for Meshfree and Particle Methods for Modeling Extreme Loadings*, doi:10.1007/s40571-019-00239-y, 2019. [PDF]

J45. K. Kang, **W.C. Sun**, Q. Du, A cooperative two-player game for automated generations of elastoplasticity theories and models with AI-guided experimentation, *Computational Mechanics, special issue for Data-Driven Modeling and Simulations: Theory, Methods and Applications*, doi:10.1007/s00466-019-01723-1, 2019. [PDF]

J46. E. C. Bryant, **W.C. Sun**, A micromorphic-regularized anisotropic Cam-clay for capturing size-dependent anisotropy of geomaterials, *Computer Methods in Applied Mechanics and Engineering*, 354:56-95, doi:10.1016/j.cma.2019.05.003, 2019. [PDF]

J47. S. Na, E.C. Bryant, **W.C. Sun**, A configurational force for adaptive re-meshing of gradient-enhanced poromechanics problems with history-dependent variables, *Computer Methods in Applied Mechanics and Engineering*, accepted, 2019.

J48. R. Ma", W.C. Sun, FFT-based solver for higher-order and multi-phase-field fracture models applied to strongly anisotropic brittle materials and poly-crystals, *Computer Methods in Applied Mechanics and Engineering*, tentatively accepted, 2019.

J49. Y. Heider*, **W.C. Sun**, Phase field modeling of capillary-induced fracture in unsaturated porous media: drying-induced vs. hydraulic-driven cracking, submitted to *Computer Methods in Applied Mechanics and Engineering*, 2019.

J50. X. Zhong*, **W.C. Sun**, Y. Dai, A reduced-dimensional explicit discrete element solver for simulating granular mixing problems, submitted to *Granular Matter*, 2019.

J51. Y. Heider", K. Wang, **W.C. Sun**, SO(3)-invariance of graph-based deep neural network for anisotropic elastoplastic materials, submitted to *Computer Methods in Applied Mechanics and Engineering*, 2019.

Proceedings of Refereed Conferences: (List in Chronological Order)

C1. **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. [PDF].

C2. **W.C. Sun**, 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. [PDF]

C3. **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. [PDF]

C4. **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. [PDF]

C5. **W.C. Sun**, M.R. Kuhn, J.W. Rudnicki, A micromechanical analysis on permeability evolutions of a dilatant shear band, Proceedings of the 48th American Rock Mechanics Association Symposium, University of Minnesota, 2014. [PDF]

C6. Q. Chen**, W.C. Sun,** J.T. Ostien**,** Finite element analysis of hydro-mechanical coupling effects on shear failures of fully saturated collapsible geomaterials, Soil Behavior and Geomechanics GSP 236, GeoShanghai, Shanghai, China, 2014 [PDF]

C7. 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.

C8. O.I. Ulven*, **W.C. Sun**, A. Malthe-Sørenssen, Fluid transport in reaction induced fractures, European Geophysical Union General Assembly, Vienna, Austria, 2015. [PDF]

C9. K. Wang, **W.C. Sun**, A semi-implicit micropolar discrete-to-continuum method for granular materials, VII European Congress on Computational Methods in Applied Science and Engineering, Crete Island, Greece, 2016. [PDF]

C10. K. Wang, **W.C. Sun**, Data-driven Discrete-continuum Method for Partially Saturated Micro-polar Porous Media, 6th Biot Conference on Poromechanics - A tribute to Olivier Coussy, Paris, France, 2017.

C11. S. Na, **W.C. Sun**, A multi-phase-field anisotropic damage-plasticity model for crystalline rocks, China-Europe Conference on Geotechnical Engineering, 2018.

C12. S. Na, **W.C. Sun**, A multi-phase-field/polycrystal plasticity for rock salt: micromorphic regularized grain- boundary slip, 5th US Rock Mechanics/Geomechanics Symposium, American Rock Mechanics Association, New York, 2019.

C13. E.C. Bryant, **W.C. Sun**, A micromorphic regularized anisotropic Cam-clay model for capturing the anisotropic size effect of shale, clay and mudstone, 5th US Rock Mechanics/Geomechanics Symposium, American Rock Mechanics Association, New York, 2019.

Books and Chapters in Books: (List in Chronological Order)

B1. N. Lenoir, J.E. Andrade, **W.C. Sun,** 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. [PDF]

Other Major Publications:

MP1. B. Jeremic, J. Putnam, Z. Yang, K. Sett, Z. Cheng, J. Liao, G. Jie, **W.C. Sun**, Final Report: Earthquake Response of Bridge Abutment Backfills Constructed with Tire Shreds, University of California Davis, 2005. [PDF]

MP2. 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. [PDF]

MP3. **W.C. Sun**, A multi-scale framework for modeling instabilities in fluid-infilrating porous solids, PhD Dissertation, Northwestern University, June 2011. [PDF]

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MP4. **W.C. Sun**, Final Report: Cryo-mechanics of unsaturated frozen soils during freeze-thaw cycles, US Army Research Office, Contract Number No. W911BF15-1-0442, 2017. [PDF]

MP5. **W.C. Sun**, Final Report: A multiscale analysis on the moisture effect of dynamics responses of granular matters, US Army Research Office, Contract No. W911NF-14-1-0658, 2016. [PDF]

MP6. R. Gupta, E. Ando, S. Salager, K. Wang, **W.C. Sun**, Open source database for validating and falsifying discrete mechanics models using synthetic granular materials Part I: Experimental tests with particles manufactured by a 3D printer, *Mendeley Data*, doi:10.17632/n6t49stxrh.1, 2018. (Supplement data for verification, validation and falsification of published work Gupta et al. Acta Geotechnica [PDF])

MP7. K. Wang, **W.C. Sun**, Discrete element traction-separation data for meta-modeling, Mendeley Data, doi:10.17632/n5v7hyny8n.1, 2019. (Supplement data for meta-modeling games published in Computer Methods in Applied Mechanics and Engineering [PDF]).

Memoranda and Reports (from Committee Work):

Internal (Department, School, University): N/A

External:

The Minerals, Metals & Materials Society (TMS), Verification & Validation of Computational Models Associated with the Mechanics of Materials (Pittsburgh, PA: TMS, 2019). Electronic copies available at www.tms.org/verificationandvalidation. [URL]

Patents: N/A

Major New Products, Processes, Designs, or Systems:

- **Albany/LCM**: The PI implemented the finite and small strain poromechanics and thermohydromechanics finite element capabilities in Albany. The PIs of this project was Andrew W. Salinger and Alejandro Mota.
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- **Deal.ii/Geocentric**: The PI and his students have formulated, implemented, verified and validated a frozen soil model and a finite strain thermo-hydro-mechanics model for frozen soil with unfrozen flow inside. Further a phase field model for anti-crack has implemented by the Columbia research team to study the propagation of compaction band.

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- **DPS Deep learning poromechanics simulator**: The PI and his students have formulated, implemented, verified and validated a DEM-FEM model for dry, unsaturated and saturated porous media. In the proposed model, the flow can be modeled via network or via Lattice Boltzmann model. Recurrent neural networks trained via dataset fusion from experimental data and RVE sub-scale simulations are used as placeholders

Research Funding History

(List in Chronological Order, If co-PI list your amount or portion of the award):

The research group is currently supported by Department of Energy, 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. The PI received the Young Investigator Program Award from the Army Research Office in 2015, another Young Investigator Program Award from the Air Force Office of Scientific Research in 2017 and the NSF CAREER award from the Mechanics of Materials and Structures Program of National Science Foundation in 2019. **Since joining Columbia in 2014, the PI has been awarded more than 4.9 million US dollars for his own research expense** (more than half from single-PI projects, the rest from MURI and other projects) The team also joins force in collaboration projects within the department, school, university and with external collaborators on various other projects with total support **over 8.0 million dollars**. The PI has so far secured at least two single-PI or MURI grants with more than $600K through open competitions from the following federal agencies: NSF, ARO, AFOSR and DOE.

As the Principal Investigator in Funded Single-PI Projects (in chronological order)

1. 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 in total (not including cost sharing from Dean's office for reduced overhead)
    - PI: **W.C. Sun**

2. 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 in total, $25,000 per year
    - PI: **W.C. Sun**

WaiChing Sun

3. Title: A discrete-continuum coupling method for environmental-driven fracture in rock Funding Agency: Sandia National Laboratories

    - Duration: 6/1/2015-12/31/2017.
    - Amount: $30,000 in total, $15,000 per year
    - PI: **W.C. Sun**

4. 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 in total, $100,000 per year
    - PI: **W.C. Sun**

5. 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**

6. **Young Investigator Program 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: $150,000 in total from ARO ($347,000 including cost sharing), $50,000 per year from ARO.
    - PI: **W.C. Sun**

7. Cryo-mechanics of unsaturated frozen soils during freeze-thaw cycle

    - Funding Agency: Army Research Office, Department of Defense
    - Duration: 9/1/2015-9/1/2017.
    - Amount: $108,889 in total, one-time expense for equipment.
    - PI: **W.C. Sun**

WaiChing Sun

8. Computational Modeling of hydraulic fracture

    - Funding Agency: Sandia National Laboratories.
    - Duration: 5/25/2016-8/31/2016
    - Amount: $20,000 in total (cost sharing from Dean's office $3,478)
    - PI: **W.C. Sun**

9. Phase field modeling of anisotropic damages in orthotropic materials

    - Funding Agency: Sandia National Laboratories
    - Duration: 1/1/2016-7/31/2017.
    - Amount: $30,000 in total, $10,000 per half year
    - PI: **W.C. Sun**

10. **DOE NEUP:** An integrated multiscale experimental-numerical analysis on reconsolidation of salt-clay mixture for disposal of heat-generating waste

    - Funding Agency: Department of Energy, Nuclear Energy University Program
    - Duration: 10/1/2016-9/31/2019.
    - Amount: $800,000 in total, $266,666 per year
    - PI: **W.C. Sun**

11. **Young Investigator Program Award**: Modeling the High-rate Responses of Wetted Granular Materials Across Scales and the Third-party Replicable Validation Exercises Utilizing 3D Printers

    - Funding Agency: Air Force Office of Scientific Research
    - Duration: 3/1/2017-2/28/2020.
    - Amount: $360,000 in total, $120,000 per year
    - PI: **W.C. Sun**

12. Broaden undergraduate and high school student participation for cold-region computational geomechanics

    - Funding Agency: Army Research Office
    - Duration: 6/1/2018-5/31/2019
    - Amount: $13,206 in total, $13,206 per year
    - PI: **W.C. Sun**

WaiChing Sun

13. Phase field modeling of ice-segregation induced fracture and thawing plasticity in frozen geomaterials with unfrozen water
    - Funding Agency: Army Research Office
    - Duration: 6/1/2018-5/31/2021
    - Amount: $360,000 in total, $120,000 per year
    - PI: **W.C. Sun**

14. INTERN: Adaptive phase field Arlequin models for material failures
    - Funding Agency: National Science Foundation
    - Duration: 1/1/2019-12/31/2019
    - Amount: $50,000, in total $50,000 per year
    - PI: **W.C. Sun**

15. **NSF Early CAREER Development Award**: Computational failure mechanics across multiple scales with deep reinforcement learning
    - Funding Agency: National Science Foundation
    - Duration: 1/1/2019-12/31/2023
    - Amount: $500,000 in total, $100,000 per year
    - PI: **W.C. Sun**

16. Broaden undergraduate and high school student participation for cold-region soil mechanics
    - Funding Agency: Army Research Office
    - Duration: 6/1/2019-5/31/2020
    - Amount: $10,000 in total, $10,000 per year
    - PI: **W.C. Sun**

17. **NSF Early CAREER Development Award Supplement**: A TPU-enhanced deep reinforcement learning approach for data-driven computational mechanics
    - Funding Agency: National Science Foundation
    - Duration: 1/1/2019-12/31/2023
    - Amount: $94,156 in total, $94,156 per year
    - PI: **W.C. Sun**

As Co-Principal Investigator in Funded Multiple-PI Projects (in chronological order)

18. 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 in total)
    - PI: T.F. Wong, co-PI: **W.C. Sun**

19. 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 in total (Sun's activities: $68,589 in total).
    - PI: P. Kelemen, co-PI: W.C. Sun, H. Savage, M. Stute, M. Spiegelman

20. STTR: Particulate Composite Mixing Processes
    - Funding Agency: Air Force Office of Scientific Research.
    - Duration: 2/1/2016-1/31/2018
    - Amount: $414,000 in total (Sun's activities: $182,896 in total, $91,448 per year).
    - PI: H. Yin, co-PI: **W.C. Sun**

21. GPU-accelerated computing for CUIT Habanero Cluster

    - Funding Agency: Columbia University
    - Duration: One-time equipment grant, 9/1/2018
    - Amount: $39,000 (with $39,000 matching fund), one-time expense.
    - PI: P. Gentine, co-PI: D. Blei, S. Agrawal, **W.C. Sun**, H. Waisman

22. Graduate Fellowship for 13th World Congress in Computational Mechanics

    - Funding Agency: National Science Foundation
    - Duration: 1/1/2018-8/31/2018
    - Amount: $50, 000 in total, one-time expense.
    - PI: **W.C. Sun**, co-PI: J. Fish, H. Waisman

23. 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 in total (Sun's activities: $34,298 in total).
    - PI: M. Spiegelman, co-PI: **W.C. Sun**, H. Savage, P. Kelemen

24. Purdue Workshop on Damage Mechanics Challenge
    - Funding Agency: Purdue University
    - Duration: One-time grant for workshop expense, April 2019
    - Amount: $25,000 in total.
    - PI: L. Pyrak-Nolte (Purdue), co-PI: H. Yoon (Sandia), A. Bobet (Purdue), W.C. Sun.

25. Data-driven multiscale poromechanics – bridging scales and physics through graph-based machine learning with uncertainty quantification.
    - Funding Agency: Columbia University
    - Duration: 1/2/2017-12/31/2019
    - Amount: $140, 000 in total (Sun's activities: $70,000)
    - PI: **W.C. Sun**, co-PI: Q. Du

26. **AFOSR MURI:** Integrating Multiscale Modeling and Experiments to Develop a Meso-Informed Predictive Capability for Explosives Safety and Performance

    - Funding Agency: Air Force Office of Scientific Research
    - Duration: 6/1/2019-5/31/2024
    - Amount: $7,500,000 in total (Sun's activities: $ 861,250 in total, $172,250 per year)
    - PI: T. Sewell (University of Missouri-Columbia) , co-PI: H.S. Udaykumar (University of Iowa), D. Dlott (University of Illinois at Urbana-Champaign), C. Picu (Rennselaer Polytechnic Institute), S. Chauhuri (University of Illinois at Chicago), W.C. Sun (Columbia), S Baek (University of Iowa)

27. Collaborative Research: I-AIM: Interpretable Augmented Intelligence for Multiscale Material Discovery
    - Funding Agency: National Science Foundation
    - Duration: 9/1/2019-8/31/2021
    - Amount: $2,000,000 in total (Sun's activities: $ 418,000 in total, $209,000 per year)
    - PI: **W.C. Sun** (Columbia), Wei Chen (Illinois Institute of Technology) , Hendrik Heinz (University of Colorado), Yusu Wang (Ohio State University), Yanxin Xu (Johns Hopkins University)

WaiChing Sun

Invited Lectures

(List in Chronological Order) – Plenary Lectures; Keynote Lectures; Invited Seminars at Universities, Companies, Agencies:

2013

I1. **W.C. Sun**, Modeling Thermo-hydro-mechanics at finite strain, UC Davis Geotechnical Seminar Series, University of California, Davis, 2013.
I2. **W.C. Sun**, Modeling multiphysical coupling effects of deformation bands across length scales, ***invited seminar***, Lawrence Livermore National Laboratory, Livermore, California, 2013.
I3. **W.C. Sun**, Multiscale modeling of thermo-hydro-mechaical coupling effects in deformation band, Department of Civil and Environmental Engineering, ***invited seminar***, Carnegie Mellon University, Pittsburgh, Pennsylvania, 2013.
I4. **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.

2014

I5. **W.C. Sun**, permeability evolutions in shear band, Northeastern Granular Materials Workshop, ***keynote lecture***, Brown University, 2014.
I6. **W.C. Sun**, Modeling multi-physical responses of deformation bands in porous media across length scales, ***invited seminar,*** Itasca Consulting Group, Minneapolis, MN, USA, 2014.
I7. **W.C. Sun**, Modeling the multiscale deformation-diffusion process of fluid-infiltrating solids via the Arlequin method, ***invited seminar***, IUTAM symposium, Evanston, 2014.
I8. **W.C. Sun**, Arlequin multiscale modeling of deformation bands, Civil Engineering Seminar, University of Illinois at Chicago, 2014.
I9. **W.C. Sun**, Two-scale modeling of shear bands in fluid infiltrating solids, Joint Materials/Solid Mechanics Seminar Series, Brown University, 2014.

2015

I10. **W.C. sun**, Computational Thermoporomechanics, ***invited seminar***, University of Perugia, Perugia, Italy, 2015.
I11. **W.C. sun**, Multiscale coupling method for fluid-infiltrating porous media at the finite deformation range, ***invited seminar***, Technical University of Dresden, Dresden, Germany, 2015.
I12. **W.C. sun**, Multiscale hydro-mechanical responses of geological materials, ***invited seminar***, Sandia National Laboratories, Albuquerque, New Mexico, 2015.
I13.

2016

I14. **W.C. sun**, Coupling dissimilar hydromechanical models for fluid-saturated porous media from grain to field scales, ***invited seminar***, Los Alamos National Laboratory, Los Alamos, New Mexico, 2015.
I15. **W.C. Sun**, Multiscale modeling for fluid-infiltrating fractured porous media, the 2015 Claude R. Hocott Lecture, ***invited seminar***, Department of Petroleum and Geosystems Engineering, the University of Texas at Austin, Austin, Texas, 2015.
I16. **W.C. sun**, Concurrent and hierarchical multiscale modeling for strain localization in fluid-infiltrating porous solids, ***invited seminar,*** Department of Mechanical engineering, Columbia University, 2015.
I17. **W.C. Sun**, Multiscale modeling of strong and weak discontinuities in porous media, ***invited seminar***, Department of Civil and Environmental Engineering, University of Hong Kong, Hong Kong, 2015.
I18. **W.C. Sun**, Concurrent and hierarchical multiscale modeling of fluid-infiltrating solids, ***invited seminar***, Department of Civil and Environmental Engineering, the Hong Kong University of Science and Technology, Hong Kong, 2015.
I19. Perugia, Perugia, Italy, 2015.
I20. **W.C. sun**, Multiscale coupling method for fluid-infiltrating porous media at the finite deformation range, ***invited seminar***, Technical University of Dresden, Dresden, Germany, 2015.
I21. **W.C. sun**, Multiscale hydro-mechanical responses of geological materials, ***invited seminar***, Sandia National Laboratories, Albuquerque, New Mexico, 2015.
I22. **W.C. sun**, Coupling dissimilar hydromechanical models for fluid-saturated porous media from grain to field scales, ***invited seminar***, Los Alamos National Laboratory, Los Alamos, New Mexico, 2015.
I23. **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.
I24. **W.C. Sun**, Data-driven multiscale poromechanics for cold region applications, ***invited seminar,*** Cold Regions Research and Engineering Laboratory, US Army Corps of Engineers, Hanover, New Hampshire, 2016.
I25. **W.C. Sun**, A variational eigen-deformation model for simulating compaction band and fracture propagation in fluid-infiltrating porous media, ***invited seminar,*** Jointed Department Seminar, Department of Civil and Environmental Engineering, Department of Mechanical Engineering, Northwestern University, 2016.
I26. **W.C. Sun**, Multiscale discrete-continuum modeling of fluid-infiltrating, partially-frozen and quasi-brittle porous media, ***invited seminar,*** Lawrence Livermore National Laboratory, Livermore, California, 2016.
I27. **W.C.Sun**, Modeling fluid-infiltrating, partially-frozenandquasi brittle porous media with nonlocal discrete-continuum techniques, ***invited seminar,*** Lecture Series on Interaction Modeling in Mechanized Tunneling, Ruhn-University Bochum, Germany, 2016.

I28. **W.C. Sun**, Computational mechanics for porous media in extreme environments, ***invited seminar,*** Technical University of Dresden, Germany, 2016.

I29. **W.C. Sun**, Computational geomechanics for fluid-infiltrating, thermal-sensitive and partially frozen granular materials, ***keynote lecture***, Machine-ground Interaction Consortium Workshop: Next Generation Mobility Modeling and Simulation, the Suburban Collection Showplace, 46100 Grand River Avenue, Novi, Michigan, 2016.

I30. **W.C. sun**, Some remarks on modeling fluid-infiltrating, thermal-sensitive, and partially-frozen porous media across length scales, **invited *seminar,*** Applied Mechanics Colloquia, John A. Paulson School of Engineering and Applied Sciences, Harvard University, 2016.

I31. **W.C. sun**, A multiscale eigenerosion method for propagating fractures in fluid-infilrating porous media, ***invited lecture***, the 4th International Workshop on Modern Trends in Geomechanics, Assisi, Italy, 2016.

2017

I32. **W.C. Sun**, Data-driven computational geomechanics, Department of Civil Engineering, ***invited seminar,*** the University of Hong Kong, 2017.

I33. **W.C. Sun**, Accelerating multiscale discrete-continuum modeling of fluid-infiltrating geomaterials with deep learning, ***invited seminar,*** Department of Civil and Environmental Engineering, Hong Kong University of Science and Technology, 2017.

I34. **W.C. Sun**, Hybrid data-driven multiscale modeling of brittle and ductile responses of fluid-infiltrating geomaterials, ***invited seminar,*** 2017 AFOSR Young Investigator Research Program Meeting, Basic Research Innovation and Collaboration Center (BRICC), Arlington, 2017.

I35. **W.C. Sun**, A multiscale damage-plasticity model for compaction band and fractures in anisotropic fluid-infiltrating porous media, ***invited seminar,*** Department of Earth Science and Engineering, Imperial College London, the United Kingdom, 2017.

I36. **W.C. Sun**, Data-driven multiscale modeling of fractured porous media with cross-validations, ***invited seminar,*** Lund University, Lund, Sweden, 2017.

I37. **W.C. Sun**, Data-driven multiscale geomechanics, Geomechanics Department, ***invited seminar,*** Sandia National Laboratories, 2017.

I38. **W.C. Sun**, A discrete-continuum coupling model for fractured porous media with embedded branched- discontinuities in the finite deformation range, Department of Civil and Environmental Engineering, ***invited seminar,*** Princeton University, 2017.

I39. **W.C. Sun**, A critical comparison of variational phase field and eigen-erosion modeling of fractures in fluid- infiltrating porous media: from brittle faulting to cataclastic flow, ***invited seminar,*** Department of Civil and Environmental Engineering, Georgia Institute of Technology, 2017.

I40. **W.C. Sun**, Data-driven computational poromechanics across length scales, ***invited seminar,*** Henry L. Pierce Laboratory Seminar Series, Massachusetts Institute of Technology, 2017.

I41. **W.C. Sun**, Multiscale discrete-continuum modeling of porous media in extreme environments, Department Seminar, ***invited seminar,*** Department of Civil and Environmental Engineering, New Jersey Institute of Technology, 2017.

2018

I42. **W.C. Sun**, A triple-scale discrete-continuum coupling method for path-dependent porous media enhanced by recurrent and recursive deep learning, ***thematic plenary lecture***, 9th International Conference on Computational Methods, Rome, Italy, 2018.
I43. **W.C. Sun**, K-fold validation for hybridized theory-based/data-driven anisotropic path-dependent constitutive models for geological materials and beyond, ***invited seminar,*** Naval Research Laboratory, 2018.
I44. **W.C. Sun**, A multiscale damage-plasticity model for anisotropic fluid-infiltrating crystalline rock salt, Department of Civil and Environmental Engineering, ***invited seminar,*** the George Washington University, 2018.
I45. **W.C. Sun**, Computational poromechanics for civil engineering at Columbia University, Research Training Group, Mineral-bonded composites for enhanced structural impact safety (GRK 2050), ***invited seminar,*** Technical University of Dresden and German Science Foundation, Germany, 2018.
I46. **W.C. Sun**, A meta-modeling game for deriving theory-consistent microstructure-based constitutive laws for poromechanics problems, ***invited seminar,*** Department of Civil and Environmental Engineering, Pennsylvania State University, 2018.
I47. **W.C. Sun**, An adaptive micromorphic-regularized Cam-clay-type model for fluid-infiltrating geological materials, ***invited seminar,*** Cold Regions Research and Engineering Laboratory, US Army Corps of Engineers, Hanover, New Hampshire.
I48. **W.C. Sun**, A cooperative two-player game for automated generations of elasto-plasticity theories and models with AI-guided experimentation, the 3rd Mesoscale Modeling of Explosive Initiation Workshop, ***invited seminar,*** Fort Walton Beach, Florida, 2018.
I49. **W.C. Sun**, Meta-modeling of geological materials: generating mathematical models by hybridizing theory and data, ***invited seminar,*** Los Alamos National Laboratory, 2018.
I50. **W.C. Sun**, Meta-modeling of porous media with strain localization and embedded strong discontinuities, ***invited seminar,*** Sandia National Laboratories, 2018.
I51. **W.C. Sun**, A multiscale damage-plasticity model for capturing brittle-ductile transition in anisotropic fluid-infiltrating porous rock, ***invited seminar,*** Department of Mechanical, Aerospace, and Nuclear Engineering, Rensselaer Polytechnic Institute, 2018
I52. **W.C. Sun**, A reinforcement learning approach for modeling the brittle-ductile transition in geological materials, ***invited seminar,*** ExxonMobil Research and Engineering Company, 2018.
I53. **W.C. Sun**, Deep-learning enabled multiscale poromechanics: from brittle fracture to ductile flow, ***invited seminar,*** Department of Civil and Environmental Engineering, Duke University, 2018.

2019

I54. **W.C. Sun**, Computational soil mechanics beyond critical state plasticity, ***invited seminar,*** Winter Workshop on Mineral-bonded Composite for Enhanced Structural Impact Safety, Technische Universität Dresden, Germany, 2019.

I55. **W.C. Sun**, Phase field damage-plasticity frameworks for fluid-infiltrating geomaterials with size-dependent anisotropy for geological disposals, ***invited seminar,*** Department of Civil and Environmental Engineering, Stanford University, 2019.

I56. **W.C. Sun**, A cooperative multi-agent game for automated physical model generations with AI-guided experimentation, ***invited seminar,*** Mesh-free Methods and Advances in Computational Mechanics Workshop, Pleasanton, California, 2019.

I57. **W.C. Sun**, A cooperative multi-agent game for self-generating/improved physics-constrained constitutive laws with AI-guided experimentations, ***invited seminar,*** Workshop on Computational Data Science Approaches for Materials, Los Alamos National Laboratory and Institute of Material Science, Los Alamos New Mexico, 2019.

I58. **W.C. Sun**, A micromorphic phase field framework for geomaterials with size-dependent strong anisotropy***, invited seminar,*** Lawrence Livermore National Laboratory, Livermore, California (tentatively scheduled in June, 2019).

I59. **W.C. Sun**, A cooperative/competitive game approach for automated derivation and validation multiscale predictive material modeling, ***Institute of Material Science Distinguished Lecture Series***, Los Alamos National Laboratory and Institute of Material Science, Los Alamos, New Mexico 2019.

I60. **W.C. Sun,** AFOSR YIP: A non-cooperative game approach for robust multiscale material modeling of wetted micropolar granular materials, Advanced Energetic Materials Tri-Service Program Review, ***invited talk***, Department of Defense, Arlington, Washington DC, 2019.

I61. **W.C. Sun**, A machine-learning meta-modeling game for generating traction-separation law for frictional interfaces across length scale, ***invited talk,*** Mechanics & Geophysics Symposium, the University of California, San Diego, California, 2019.

I62. **W.C. Sun**, Title to be determined, ***invited seminar,*** Mechanical and Aerospace Engineering colloquium, Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, New York, 2019.

I63. **W.C. Sun**, Short course on meta-modeling of complex materials (with approval from the Columbia SEAS Dean's office), University of Nottingham, the United Kingdom, W.C. Sun, (scheduled 12-13th December, 2019).

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Service:

Department Level

Activity	Beginning	Ending
Member of Graduate Admission Committee, CEEM	2016	Current
Member of Faculty Search Committee, CEEM	2016	2016
Academic Advisor for Master Students	2014	Current
Examiner for PhD screening Exam	2014	2016
Guest Lecturer, Inside Engineering Lab visit	2017	2017

School Level

Reviewer of the SEAS SIR seed fund program	2018	2019

University Level

Reviewer of the RISE program	2018	2019

Professional Services:

(Proposal Reviewing; Editorial Work; National Committee Work; Conference organization, etc)

Proposal Reviewer and Panelist for the following government agencies:

- Army Corps of Engineers
- Army Research Laboratories
- Army Research Office
- Columbia University
- Department of Energy (Nuclear University Program, Scientific Discovery through Advanced Computing)
- European Union Liaison Office (Cellule Europe)
- Germany Research Foundation (Deutsche Forschungsgemeinschaft)
- Hong Kong Research Council
- National Science Foundation ((Division of Civil, Mechanical and Manufacturing Innovation, Division of Earth Sciences, Computational and Data-enabled Science and Engineering Programs)
- Sandia National Laboratories

Editorial Work

- Associate Editor, Computer Modeling in Engineering and Sciences, 2018-current.
- Editorial Broad Member, International Journal for Multiscale Computational Engineering, 2016-current
- Guest Editor, Special issue for computational Poromechanics, International Journal for Multiscale Computational Engineering, 2016

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- Guest Co-editor, with Gregory Wagner (Northwestern)and Miugel Bessa (TU Delft), Data-driven computational Modeling and simulations, Computer Modeling in Engineering and Sciences, 2018.
- Guest Co-editor, with Christian Linder (Stanford) and Leon Mishnaevsky (TU Denmark), Multiscale Multiphysics modeling of materials, International Journal for Multiscale Computational Engineering, 2018.

National Committee Work

- Co-chair & member of Local Organizing Committee, ASCE Engineering Mechanics Conference New York City, 2020.
- Member, International Advisory Board, 2nd International Conference on Energy Geotechnics, La Jolla, CA, 2020.
- Committee Member, Organizing Committee, 5th Rock Mechanics/Geomechanics Symposium, New York City, 2019.
- Committee Member, Organizing Committee, Engineering Mechanics Conference, Caltech, 2019.
- Committee Member, Organizing Committee, the United State Congress of Computational Mechanics, Austin, Texas, 2019.
- Committee Member, Organizing Committee, 5th International Workshop on Rock Physics, Hong Kong, 2019.
- Co-chair, Geomechanics and Geomaterials Track, ASCE Engineering Mechanics Institute Conference, Caltech, 2019.
- Chair, Planning Team, Workshop on Verification and Validation of Computational Models Associated with the Mechanics of Materials, the Minerals, Metals and Materials Society, 2018.
- Committee Member, Computational Mechanics Committee, ASCE Engineering Mechanics Institute, since 2017.
- Committee Member, Granular Mechanics Committee, ASCE Engineering Mechanics Institute, since 2017.
- Committee Member, Elasticity Committee, ASCE Engineering Mechanics Institute, since 2017.
- Committee Member, Poromechanics Committee, ASCE Engineering Mechanics Institute
- Committee Member, Computational Geotechnics Committee, ASCE Geo-Institute, since 2017.
- Committee Member, International scientific committee member of the Engineering Mechanics Institute International Conference at Hong Kong Polytechnic University (2015).
- Committee Member, Digital Rock and Granular Physics, EMI Stanford (2015).
- Committee Member, Multiscale Modeling of Granular Materials, 13th US National Congress on Computational Mechanics, San Diego (2015).

- Committee Member, Multiphysical Modeling of Geomaterials, 13th US National Congress on Computational Mechanics, San Diego (2015).

Organizer of domestic and international conferences and professional meetings:

- Lead organizer, Mini-symposium on Computational Geomechanics, 15th US National Congress on Computational Mechanics, Austin, Texas (2019).
- Co-organizer, Mini-symposium on Crystalline and Anisotropic Rock Mechanics, Engineering Mechanics Institute Conference, Caltech, Pasadena (2019).
- Co-organizer, Mini-symposium on Computational Geomechanics, Engineering Mechanics Institute Conference, Caltech, Pasadena (2019).
- Co-organizer, Mini-symposium on Additive Manufacturing and Digital Rock Physics for Granular and Fractured Materials, 20th International Conference on Fluid Flow Problems (FEF-2019), Northwestern University, Evanston (2019).
- Lead organizer, Mini-symposium on Computational Geomechanics, Computational Geomechanics Mini-symposium at Engineering Mechanics Institute Conference, Boston (2018).
- Lead organizer, Computational Geomechanics Mini-symposium at 18th US National Congress of Theoretical and Applied Mechanics, Northwestern University (2018).
- Co-organizer, International Symposium on Multiscale Computational Analysis of Complex Materials, Copenhagen/Lyngby, Denmark (2017).
- Local organization committee of World Congress of Computational Mechanics New York (2018).
- Primary convener, Data-driven and theoretical approaches for modeling, prediction, analysis of thermo- hydro-mechanical behaviors of frozen soil and rocks, AGU Fall Meeting 2017 (2017).
- Computational Geomechanics Mini-symposium at 14th US National Congress on Computational Mechanics, Montreal, Canada (2017).
- Computational Geomechanics Mini-symposium at Engineering Mechanics Institute Conference, San Diego (2017).
- Mini-symposium on Fluid- and chemical-driven fractures of porous media, AGU Fall Meeting, San Francisco (2016).
- Failure and instabilities in soft materials and geomaterials Mini-symposium at the 7th International Conference on Computational Methods, Berkeley (2016).
- Mini-symposium on Multiscale multiphysical process in fractured rock and modeling of coupled trans- port phenomena in fracture networks, AGU Fall Meeting, San Francisco (2016).
- Symposium on Computational Mechanics of Materials and Structures, University of Maryland, College Part Marriott Hotel and Conference Center (2016).
- Mini-symposium on computational geomechanics, Engineering Mechanics Institute, ASCE, Nashville (2016).

- Symposium on computational mechanics of materials and structures, SES Meeting, University of Maryland, College Park (2016).
- Failure and Instabilities in soft materials and geomaterials, The 7th International Conference on Computational Methods, Berkeley, CA (2016).
- Digital Rock Physics, 3D printing and More, Mineral and Rock Physics Sessions, AGU 2014 Fall Meeting, San Francisco (2015).
- Computational Geomechanics Symposium at the United States National Congress of Theoretical and Applied Mechanics at Michigan State University (2014).

Reviewer of the following peer-reviewed journal articles:

- Acta Geotechnica
- ASCE Journal of Geotechnical and Geoenvironmental Engineering
- ASCE Journal of Engineering Mechanics
- Computer Methods in Applied Mechanics and Engineering
- Computer and Geotechnics
- Computational Particle Mechanics
- Computational Mechanics
- European Journal of Mechanics A/Solids
- European Journal of Civil Engineering
- Finite Element Analysis and Design
- Granular Matters
- Géotechnqiue
- Géotechnqiue Letters
- International Journal of Fracture
- International Journal for Multiscale Computational Engineering
- International Journal for Numerical and Analytical Methods in Geomechanics
- International Journal for Numerical Methods in Engineering
- International Journal of Solids and Structures
- International Journal of Plasticity
- Journal of Geophysical Research (Solid Earth)
- Journal of Fluid Mechanics
- Journal of the Mechanics and Physics of Solids
- Meccanica
- Mechanics Research Communication
- Nature Scientific Reports
- Soil Dynamics and Earthquake Engineering
- the Geological Society of America Bulletin

Reviewer for the conferences and professional meeting:

- Engineering Mechanics Institute Conference, Caltech, California, 2019.
- 51th US Rock Mechanics/Geomechanics Symposium, San Francisco, 2017.
- Engineering Mechanics Institute International Conference, Hong Kong, 2015

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

Current Professional Organization Membership:

- Member, GAMM Gesellschaft für Angewandte Mathematik und Mechanik, 2016-current
- 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, since 2003
- Member, UCAD Chapter, Golden Key International Honor Society, since 2003

Consulting Record:

N/A

Professional Registration:

N/A

Theses Supervised

It is the goal of this research group to have at least one PhD student graduated per year. Since 2014, the research group has three former group members (2 PhD students and 1 postdoc) who successfully obtain tenure-track positions. PhD graduates Yang Liu and SeonHong Na are now assistant professors at **Northeastern University** (USA) and **McMaster University** (Canada) in January 2019. Meanwhile, PhD candidate Kun Wang will join the Theoretical Division of **Los Alamos National Laboratory** as postdoctoral research scientist. Another former postdoc research scientist Jinhyun Choo has joined the **University of Hong Kong** as assistant professor of Civil and Environmental Engineering since January 2018.

	Total	Completed	In Progress
B.S.	N/A		
M.S.	N/A		
As Supervisor	N/A		

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Doctoral

As Supervisor:	6	3	4
As Reader:	19	19	0

B.S. Theses

N/A

M.S. Theses

N/A

Doctoral Theses, Supervisor

1. Yang Liu, *Modeling shear bands with multiscale DEM-FEM coupling method in loose and dense grain assemblies*. Spring 2014- Spring 2016 (co-advised with Jacob Fish). *Now assistant professor at Department of Mechanical and Industrial Engineering, Northeastern University.*

2. SeonHong Na, *Multiscale modeling of thermo-hydro-mechanical-chemical (THMC) coupling effects in fluid-infiltrating dual-porosity crystalline rock* (proposal defended 9/27/2017), Fall 2014-Fall 2018. Now *assistant professor of Civil and Environmental Engineering.*

3. Kun Wang, *From multiscale modeling to meta-modeling of poromechanics problems*. (proposal defended 10/22/2018), Spring 2015 to Spring 2019. Will join Theoretical Division of Los Alamos National Laboratory as postdoctoral research scientist in September 15th, 2019.

Doctoral Theses, As Reader (On Thesis Committee):

1. Daniel Marasco, PhD, CEEM, successfully defined in May 2014.
2. Abdulhamit Sarac, PhD, ME, successfully defined in May 2014.
3. Lingqi Yang, PhD, successfully defended in January 2015.
4. Shuoshuo Han, Earth Science, successfully defended in January, 2015.
5. Luc Berger-Vergiat, PhD, CEEM, successfully defended in July 2015.
6. Raha Hakimdavar, PhD, CEEM, successfully defended in January 2016.

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7. Zifeng Yuan, PhD, CEEM, successfully defended in January 2016.
8. Po-Chieh Liu, PhD, CEEM, successfully defined in May 2016.
9. Nan Hu, PhD, CEEM, successfully defined in August, 2016.
10. Mofstafa Mobasher, PhD, CEEM, passed qualification exam in December 2016.
11. Dimitrios Fafalis, PhD, CEEM, passed qualification exam in March 2017.
12. Lei Xu, PhD, Civil Engineering and Engineering Mechanics, November 2017.
13. Nandan H. Shetty, PhD, Civil Engineering and Engineering Mechanics, November 2017.
14. Yang Jiao, PhD, Civil Engineering and Engineering Mechanics, January 2018.
15. Ines Wollny, PhD, Technical University of Dresden, Germany, January 2018.
16. Breannan Smith, PhD. Computer Science, February 2018.
17. Yunzhe Tao, PhD, Applied Mathematics, November 2018.
18. Peter Yichen Chen, Computer Science, July 2019.
19. Raymond Yun Fei, Computer Science, July 2019.

Current Research Group (students and postdoctoral associates who are in progress):

Associate Research Scientist

1. Yousef Heider, PhD (Institute of Continuum Mechanics, University of Stuttgart, Germany), *High-strain-rate responses of geomaterials*, Fall 2018-current.

Postdoctoral Research Scientist

2. Ran Ma, PhD (University of Tennessee), *Fast Fourier Transform Solver for polycrystal plasticity and fractures of reconsolidated salt*, Spring 2019-current.

3. Chuanqi Liu, PhD (Tsinghua University), *Shift domain material point method for crystal plasticity of reconsolidated salt*, Fall 2018-current.

4. SeonHong Na, PhD (Columbia University), joined McMaster University as an assistant professor in January 2019), *Phase field modeling of frozen soil in the changing climate*. Fall 2018.

PhD Students

5. Kun Wang, PhD student, *From multiscale modeling to meta-modeling of fluid-infiltrating porous media*. Spring 2015-Spring 2019. (Position held: GRA, 2014-2015; GRA, 2015-2016; GRA, 2016-2017; GRA, 2017-2018; GRA, 2018-2019).

6. Eric C. Bryant, PhD student, *Mechanics of hydraulic fracture across length scales*, Fall 2016-current. (Position held: Presidential Fellowship, 2016-2017; Guggenheim Fellowship (6 months) and GRA (6 months), 2017-2018; GRA, 2018-2019, GRA 2019-2020).

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7. Nikolaos N. Vlassis, PhD student, *Computational crystal plasticity of geological materials*, Summer 2017-current (Position held: TA, 2017-2018; GRA (6 months) + TA (6 months), 2018-2019; GRA, 2019-2020).

8. Hyoung Suk Suh, PhD student *Image-based multiscale computational poromechanics,* Summer 2018- current. (Position held: Presidential Fellow, 2018-2019; GRA, 2019-2020).

9. Bahador Bahmani, PhD student *Applications of combinatorics on data-driven computational mechanics*, Fall 2019-current. (Position held: GRA, 2019-2020).

Undergraduate Researchers

10. Tracy Paltoo (Columbia), Undergraduate research student, *wettability of porous media*. Fall 2018.

11. Elizabeth Rossi (George Washington University), Undergraduate research student, machine learning of granular responses, Summer 2019

High School Summer Interns

12. Brooke Lauren (Mother Seton Regional High School), co-advised with PhD student Eric Bryant, *Army Educational Outreach Program*, Summer 2018.

13. Anish Avasthi (Woodlands High School),co-advised with PhD student Eric Bryant, *Army Educational Outreach Program*, Summer 2018.

14. Sophia Wong (Brooklyn Amity School), *Army Educational Outreach Program*, Summer 2019.

Short-Term Visiting Students (from other universities)

15. Alessandro Milleri (University of Perugia, Italy),Visiting student, *Undrained stress path of frozen sand*, 10/2018-03/2019.

16. Nico De Marchi (University of Padova, Italy), Visiting student, *Shear wave splitting in anisotropic rock*, 09/2018-02/2019.

17. Feng Du, (China University of Mining and Technology-Beijing, China), Visiting Student, *Digial rock physics for dual-porosity media*, 09/2018-09/2019.

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Teaching Experience

Term	Subject Number	Title	Role (Lecturer, Laboratory, Recitation)
Spring 2014	CIENE3141	Soil Mechanics	Lecturer
Fall 2014	ENMEE6320	Computational Poromechanics	Lecturer
Spring 2015	CIENE3141	Soil Mechanics	Lecturer
Fall 2015	CIENE4253	Finite Elements for Geotechnical Eng.	Lecturer
Spring 2016	CIEN3141	Soil Mechanics	Lecturer
Fall 2016	ENMEE6320	Computational Poromechanics	Lecturer
Spring 2017	CIEN3141	Soil Mechanics	Lecturer
Fall 2017	CIENE4253	Finite Elements for Geotechnical Eng.	Lecturer
Spring 2018	CIEN3141	Soil Mechanics	Lecturer
Fall 2018	ENMEE6320	Computational Poromechanics	Lecturer
Spring 2019	CIEN3141	Soil Mechanics	Lecturer

Teaching Innovations

Indicate any teaching innovations if applicable such as architecting and offering a new course; new teaching methods for a course; new laboratory elements; new on-line elements

Introduction of a new PhD level graduate course titled Computational Poromechanics. Course description. The course description is as followed. A fluid infiltrating porous solid is a multiphase material whose mechanical behavior is significantly influenced by the pore fluid. In particular, the diffusion, advection, capillarity, heating, cooling and freezing of pore fluid, the build-up of pore pressure and the mass exchanges among the solid and fluid constituents may all influence the stability and integrity of the solid skeleton, cause shrinkage, swelling, fracture or liquefaction. These coupling phenomena are important for numerous disciplines, including but not limited to geophysics, biomechanics, and material sciences. The objective of this course is to present the fundamental principles of poromechanics that are essential for engineering practice and to prepare students for more advanced study on porous media. We will cover a selected number of topics, including but not limited to balance principles, Biot's poroelasticity, mixture theory, constitutive modeling of path independent and dependent multiphase materials, numerical methods for parabolic and hyperbolic systems, inf-sup conditions and common stabilization procedures for mixed finite element models, explicit and implicit time integrators, and operator splitting techniques for poromechanics problems.

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Teaching Evaluations
(Include Term, number of students, course evaluation score, and instructor evaluation score)

A. Courses taught in 2013-2014 (include enrollments and evaluations of courses and instructor)
Fall 2013: Employment not yet started.
Spring 2014: CIENE3141 Soil Mechanics (enrollments = 47, overall (mean) evaluation of course and instructor= (3.29, 3.12), response rate: 36%))

B. Courses taught in 2014-2015 (include enrollments and evaluations of courses and instructor)
Fall 2014: ENMEE6320 Computational Poromechanics (enrollment = 12, evaluation of course and instructor = (3.40, 3.85))
Spring 2015: CIENE3141 Soil Mechanics (enrollments = 42, overall evaluations of course and instructor = (3.33, 3.33), response rate: 28%))

C. Courses taught in 2015-2016
Fall 2015: CIENE4253 Finite Elements for Geotechnical Engineering (enrollments = 6, evaluations of course and instructor = (4.37, 4.62)),
Spring 2016: CIENE3141 Soil Mechanics (enrollment = 28, overall evaluation of course and instruction = (2.45, 2.55), response rate: 27%)

D. Courses taught in 2016-2017
Fall 2016: ENMEE6320 Computational Poromechanics (enrollment = 7, evaluation of course and instructor= (4.75, 5.00))
Spring 2017: CIENE3141 Soil Mechanics (enrollment = 27, overall evaluation of course and instruction= (3.11, 3.33), response rate: 33%))

E. Courses taught in 2017-2018
Fall 2016: CIENE4253 Finite Elements for Geotechnical Engineering (enrollment = 5, evaluation of course and instructor= (4.75, 5.00))
Spring 2018: CIENE3141 Soil Mechanics (enrollment = 22, overall evaluation of course and instruction= (2.50, 2.17), response rate: 27%)

F. Courses taught in 2018-2019
Fall 2018: ENMEE6320 Computational Poromechanics (enrollment = 3, evaluation of course and instructor= (4.75, 5.00))
Spring 2019: CIENE3141 Soil Mechanics (enrollment = 28, overall evaluation of course and instruction= (3.2, 2.9, response rate: 36%).

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Outreach Efforts
(General Public, Media, K-12, Under-Represented Groups)

General Public, K-12

- The research group has participated in Inside Engineering Lab Visits and hosted Academy of the Holy Angels from New Jersey for a site visit and guest lecture.

- The research group has secured grant from Army Research Office to host high school student for summer research in Summer 2018 and summer 2019.

Under-Represented Groups

- Currently mentoring and supervising one undergraduate students from an under-represented group to conduct research and providing career advice to them.

- Graduated one PhD student (Yang Liu) from minority group (gender) who then landed a postdoc position at MIT, followed by a tenure-track position at Northeastern.

- Graduated two MS research students (Francisco Contreras and Xian Zhang) from underrepresented group.

- The research group has mentored undergraduate research students (Imer Jasiel del Cid) from minority groups who successfully provided research results in the form of a manuscript and found engineer positions at Boeing.

- The research group has regularly secured supports from Army Research Office to support students from underrepresented group to conduct research with the PI for two consecutive year.