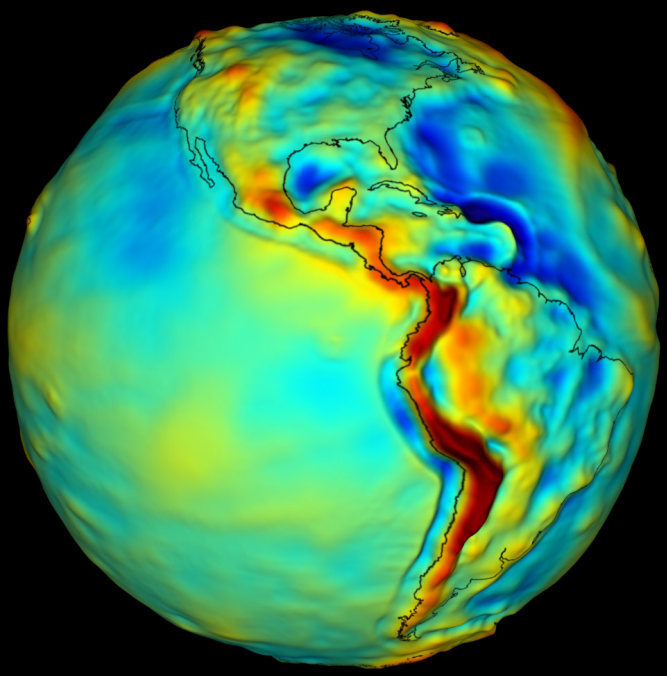
The National Academies of
SCIENCES • ENGINEERING • MEDICINE

COMMITTEE ON SOLID EARTH GEOPHYSICS

NOVEL GEOPHYSICAL DATASETS FOR ENVIRONMENTAL APPLICATIONS:

MOVING FROM DISCOVERING SIGNALS TO SOCIETAL BENEFITS



MARCH 23, 2021

AGENDA BOOKLET

Open Session Agenda

March 23, 2021

Novel Geophysical Datasets for Environmental Applications: Moving from Discovering Signals to Societal Benefits

Environmental seismology, geodesy, and geoelectrics are growing fields that use geophysical sensors in novel ways—beyond traditional applications—to learn about environmental conditions including hurricanes, coastal erosion, river discharge, seasonal snowpack, ocean hum, vegetation and permafrost change, subsurface temperatures, and hydrology, as well as space weather impacts on the electricity grid, pipelines, and submarine cabled arrays. Environmental seismology, geodesy, and geoelectrics extend the well-established discipline of environmental geophysics by using large sensor networks, continuous timeseries, and high performance computing to develop new ways of looking at conventional data (for instance, finding a useful signal in someone else's noise). Some links among disciplines have been underway for several years (e.g., hydrogeodesy), but how can the solid Earth geophysics community nurture these nascent interdisciplinary fields? How do we engage new potential users of geophysical datasets from oceanography, hydrology, atmospheric sciences, and geomorphology and ensure that we are addressing the most pressing questions in these fields? Do existing instruments or networks need to be modified to maximize their utility for environmental seismology, geoelectrics, and geodesy? Are new facilities needed to encourage data sharing and discoverability to new communities of users? How will research in these interdisciplinary fields be funded? Finally, how will discoveries of environmental geophysics be translated into routine use for societal benefit?

Register Here

TUESDAY, MARCH 23, 2021
(all times are EST)

Open Session	
12:00 PM	**Introduction to and Goals for the Session** *Matthew Pritchard, COSEG Member*
Panel 1: Overviews *Moderator: Matthew Pritchard, COSEG Member*	
12:05 PM	**Making An Impact On Environmental Sciences With Non-Traditional Applications Of GPS Measurements: Some Things I Learned While Developing Hydrogeodesy** *Kristine Larson, University of Colorado*
12:30 PM	**Advances and Applications in Near-Surface Geophysical Imaging** *Sarah Kruse, University of South Florida*
12:55 PM	**Discussion and Q&A**

1:15 PM	**Break**
Panel 2: Latest Developments *Moderator: Jessica Warren, COSEG Member*	
1:30 PM	**The Language of Water: New Insights Into River Processes From Seismic Signals** *Danica Roth, Colorado School of Mines*
1:42 PM	**Shaking Shores: Progress in Seismic Monitoring of Rocky Coasts** *Claire Masteller, Washington University in St. Louis*
1:54 PM	**Groundwater Monitoring Using Ambient Noise Seismology** *Marine Denolle, University of Washington*
2:06 PM	**Submarine Environmental Sensing Over Telecommunication Fiber Optic Cables** *Zhongwen Zhan, California Institute of Technology*
2:18 PM	**Abundant Spontaneous and Dynamically Triggered Submarine Landslides in The Gulf of Mexico** *Wenyuan Fan, Scripps Institution of Oceanography, UC San Diego*
2:30 PM	**Discussion and Questions**
3:00 PM	**Break**
Panel 3: Satellite Gravimetry and Hydrological Applications: Examples *Moderator: Steve Nerem, COSEG Member*	
3:15 PM	**Application of Satellite Gravimetry for Water Resources Monitoring** *Matt Rodell, NASA*
3:35 PM	**Comparison of GRACE Satellite Data with Modeling and Monitoring Data** *Bridget Scanlon, University of Texas at Austin*
3:55 PM	**Discussion and Questions**
4:15 PM	**Wrap-up** *Matthew Pritchard, COSEG Member*

4:30 PM – Meeting Adjourns

COMMITTEE

IN THIS SECTION

Committee on SOLID EARTH GEOPHYSICS

Statement of Task

The Committee on Solid Earth Geophysics (COSEG) provides independent advice to all levels of government and society on scientific, technical, and policy matters related to seismology, geodesy, and geodynamics.

Members are drawn from the public, academic, and private sectors and have a broad range of expertise and experience. The mission of the committee is as follows:

- To foster and encourage understanding of the structure, dynamics, and evolution of the Earth.
- To review and define basic and applied research activities in seismology, geodesy and geodynamics that contribute to federal agency missions.
- To address the transfer of seismological and geody¬namics knowledge to areas of public welfare and national need including topics such as earthquake science; geological hazards; energy, mineral, and water resources; national security, global climate change; land-use planning; and public education.
- To foster long-term national efforts to collect, store and openly disseminate seismological, geodetic, and geodynamical data of all types.
- To foster long-term national efforts to monitor geodynamical events as well as nuclear testing treaties using geophysical technologies.
- To serve as the U.S. member of the International Lithosphere Program.

COSEG, formerly the Committee on Seismology and Geodynamics (name changed June 2020), was formed in 2001 as a standing committee of the Board on Earth Sciences and Resources. This committee succeeded three former entities: the Committee on Seismology, the U.S. Geodynamics Committee, and the Committee on Geodesy.

Committee Biographies

THORSTEN W. BECKER, Chair, is the Shell Distinguished Chair in Geophysics at the Institute for Geophysics and the Department of Geological Sciences, Jackson School of Geosciences, at the University of Texas at Austin. His main research interests are in geodynamics and seismology with a focus on interactions between mantle convection and surface tectonics—studying the inner workings of terrestrial planets and how their mantle and surface systems have co-evolved over time. He combines field, laboratory, and numerical approaches into dynamical models, focusing on the physics of plate tectonics from grain-scale deformation to plate-scale flow. Recent research projects include work on seismic anisotropy, mantle heat transport and the mechanics of plate tectonics, subduction dynamics, and fault system mechanics. He has co-authored more than 110 publications and was named an AGU Fellow in 2015. Dr. Becker holds an M.Sc. in physics from J. W. Goethe University, a Ph.D. in geophysics from Harvard University, and was a postdoctoral scholar at the Scripps Institution of Oceanography at the University of California, San Diego.

MARK D. BEHN is an associate professor in the Morrissey College of Arts and Sciences at Boston College. Dr. Behn's research investigates the dynamics of Earth deformation in glacial, marine, and terrestrial environments through the use of a wide range of geophysical techniques. These techniques include the development of geodynamic models that relate laboratory-based rheologic and petrologic models to the large-scale behavior of the Earth, which are then applied to a spectrum of problems from basic science to societally-relevant issues. His research interests include dynamics of faulting, magmatism, and surface processes at mid-ocean ridges and continental rifts; seismic anisotropy and imaging of sub-asthenospheric mantle flow; evolution of the continental crust; and ice-sheet dynamics. He is the co-chair of the Geodynamics Focus Research Group for the Community Surface Dynamics Modeling System, was active in the MARGINS/GeoPRISMS program, and is a former fellow of the WHOI Deep Ocean Exploration Institute. Dr. Behn received his B.S. in geology from Bates College and a Ph.D. in marine geophysics from the Massachusetts Institute of Technology/WHOI Joint Program.

JEFFREY T. FREYMUELLER is the Thomas A. Vogel Endowed Chair for Geology of the Solid Earth in the Department of Earth and Environmental Sciences at Michigan State University. Dr. Freymueller is an internationally recognized leader in the field of geodesy and utilizes satellites from the Global Positioning System (GPS) to make highly precise measurements of movement on the Earth's surface. In his far-reaching research activities, he has made discoveries in a wide range of topics including plate tectonics and plate boundary zones, faults dynamics, the continuing rebound of the Earth's surface from the melting of ice-age glaciers, inflation and deflation of volcanoes, and interpreting how changing water and ice levels deform the Earth. He is particularly well-cited for his work on using GPS to understand the crustal deformation in China related to the formation of the Himalayas and the Tibetan Plateau. In addition to his research, Dr. Freymueller is the director of the EarthScope National Office. EarthScope is a long-term, large-scale program funded by the National Science Foundation to study the structure and evolution of North America and associated hazards through the deployment of thousands of geophysical instruments throughout the country. Dr. Freymueller also has served the scientific community as the U.S. National Correspondent to the International Association of Geodesy and its representative to the International Union of Geodesy and Geophysics, has served terms as an associate editor for the Journal of Geophysical Research and the Journal of Geodesy, and is currently Editor in Chief of the International Association of Geodesy Symposia Series. Dr. Freymueller received his M.S. and Ph.D. in geophysics from the University of South Carolina.

RENGIN GOK is a research seismologist at the Lawrence Livermore National Laboratory where she manages the Seismic Cooperation Program for the DOE/NNSA Office of Nuclear Verification. She is an expert in the development and improvement of seismic monitoring in international communities. Her interests include: seismic source behavior, Comprehensive Nuclear-Test-Ban Treaty verification technologies, velocity and attenuation structure of the Earth, and seismic hazard assessment and its engineering applications. She has published more than 35 peer-reviewed scientific papers. Dr. Gok earned her B.Sc. in geophysical engineering from Istanbul Technical University, and her M.Sc. and Ph.D. in geophysics from Bogazici University in Istanbul, Turkey.

DIEGO MELGAR is an assistant professor of geophysics in the Department of Earth Sciences at the University of Oregon where his research focuses on large earthquakes. He works on the physics of the rupture process and how to best image it by using many diverse kinds of on-shore and off-shore geophysical data. He also researches the hazards associated with

these large events, working on tsunami modeling and coastal impacts, as well as studying how strong shaking is generated. Prior to joining the University of Oregon, Diego researched the role of global navigation satellite systems (GNSS) in seismology. He also spent three years at the University of California Berkeley's SeismoLab working on early warning systems. He continues to work on early warning systems to abate the societal impact of these hazards. Diego earned his B.Eng. in geophysics from the Universidad Nacional Autónoma de México and his M.S. and Ph.D. in geophysics from the Scripps Institution of Oceanography.

R. STEVEN NEREM is a professor in the Department of Aerospace Engineering Sciences and associate director of the Colorado Center for Astrodynamics Research at the University of Colorado at Boulder. Dr. Nerem's research interests include sea-level change, satellite altimetry, Earth's gravity field, planetary geodesy, precision orbit determination, and astrodynamics. He has served on two previous committees for the National Academies of Sciences, Engineering, and Medicine - the Committee on Earth Science and Applications from Space and the Committee on Evolving the Geodetic Infrastructure to Meet New Scientific Needs. Dr. Nerem is the recipient of numerous awards including the American Astronautical Society's Earth Science and Applications Award and the American Geophysical Union's (AGU) Geodesy Section Award. He is a fellow of the AGU. Dr. Nerem earned a B.S. in geology from Colorado State University and an M.S. and Ph.D. in aerospace engineering from the University of Texas, Austin.

MATTHEW PRITCHARD is a professor of geophysics at Cornell University. He is interested in how the Earth's surface deforms in response to earthquakes, magma movements, glacier dynamics, and human manipulation of subsurface fluids (e.g., carbon sequestration, hydrocarbon withdrawal). Dr. Pritchard uses a variety of tools including Interferometric Synthetic Aperture Radar (INSAR), GPS, and laser scanning to study deformation. He is a member of the American Geophysical Union, Geological Society of America, and the International Association for Volcanology and Chemistry of the Earth's Interior. He received the 2015 Geodesy Section Award from the AGU. He served on the UNAVCO Board of Directors from 2009 to 2012 and currently serves on the advisory board of the Carl Sagen Institute and the U.S. National Committee for Geodesy and Geophysics. He earned a B.S. in physics from the University of Chicago and an M.S. and Ph.D. in geophysics from the California Institute of Technology.

DONNA J. SHILLINGTON is an associate professor in the School of Earth and Sustainability at Northern Arizona University. Her research focuses on deformation, magmatism, and sedimentation at plate tectonic boundaries and in other interesting geological settings, which she studies using active-source seismology together with other geophysical, geological, and geochemical approaches. An important component of her research is the acquisition and analysis of novel geophysical data on land and at sea; she has sailed on 18 research cruises around the world and also led major seismic data collection efforts on land. Her prior community service and leadership includes serving on the IRIS Board of Directors, the steering committees of GeoPRISMS and EarthScope and the Marine Seismic Research Oversight Committee; she currently serves on the steering committee of the SZ4D Research Coordination Network. Prior to joining Northern Arizona University, she was a research scientist and professor at Lamont-Doherty Earth Observatory of Columbia University and a postdoctoral research scientist and lecturer at the National Oceanography Centre in Southampton, UK. Dr. Shillington earned her B.S. in geology and A.B.J. in journalism from the University of Georgia and her Ph.D. in geophysics from the University of Wyoming.

JESSICA M. WARREN is an associate professor in the Department of Earth Sciences at the University of Delaware. Dr. Warren's research focuses on the rheology and geochemistry of the Earth's upper mantle. She has worked extensively on the localization of deformation at plate boundaries with a focus on the transform faults that offset the global mid-ocean ridge system. She has also worked on the constraints provided by naturally deformed samples for interpreting seismic anisotropy. Dr. Warren has participated in 14 field expeditions including on-land expeditions to the western United States and Oman Ophiolite and seagoing expeditions in the Pacific, Atlantic, and Indian Oceans. In 2019, she served as chief scientist on the R/V Atlantis for a large ocean bottom seismometer (OBS) and dredging campaign on Gofar transform fault. Dr. Warren serves on the GeoPRISMS steering committee, the In-Situ Rock Deformation Research Coordination Network (RCN) steering committee, and previously on the Physical Properties of Earth Materials steering committee. Outreach by Dr. Warren includes work to improve the quality and accessibility of Earth Science education with a focus on field learning and the graduate experience. Dr. Warren is a recipient of a NSF CAREER award, Stanford Terman Fellowship, and Carnegie Postdoctoral Fellowship. She holds a B.A. First Class, M.A., and M.Sci. in natural sciences from the University of Cambridge and a Ph.D. in geochemistry and geophysics from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program.

Speaker Biographies

Kristine M. Larson is a geodesist known for developing innovative ways to use GPS signals to study the Earth. She was a professor at the University of Colorado from 1990-2018. In 2014, her research group was awarded the Prince Sultan Bin Abdulaziz International Water Prize for Creativity. Larson received the European Geosciences Union's Huygens Medal in 2015, an honorary doctorate from Chalmers University in 2017, and the American Geophysical Union's Whitten Medal in 2020. She received a B.A. in engineering sciences from Harvard University and a Ph.D. in geophysics from Scripps Institution of Oceanography, UC San Diego. She is a member of the National Academy of Sciences.

Sarah Kruse is a professor at the University of South Florida She is a near-surface geophysicist whose recent work focuses on planetary, volcanological, and sinkhole hazard applications of ground penetrating radar (GPR). Current projects address resolution of lava tubes and other voids, full-waveform inversion of GPR data, and the development of geophysics teaching materials to reach diverse audiences. She received her Ph.D. from the Massachusetts Institute of Technology.

Danica Roth is an assistant professor in the Department of Geology and Geological Engineering at the Colorado School of Mines. Previously, she was an NSF Postdoctoral Fellow at the University of Oregon. Danica's primary research interests center on understanding the coupling of surface processes with regional variables such as climate, biology, and anthropogenic influences in order to better relate process mechanics to landscape form and evolution across scales. Common themes in her work include examining feedbacks and morphodynamics in complex Earth surface systems, linking empirical observations, experiments, and analytical and geophysical techniques to the development of physically-based theory, and looking for signals in the noise of geomorphic data. She holds B.A. degrees in physics and astrophysics from the University of California, Berkeley and a Ph.D. in Earth science from the University of California, Santa Cruz.

Wenyuan Fan is an assistant professor of geophysics at Scripps Institution of Oceanography, University of California San Diego (UC San Diego). He is an observational seismologist and uses seismic records that are collected both onshore and offshore to study the Earth, earthquakes, and environmental processes, including hurricanes, landslides, and turbulent subglacial rivers. Before coming to Scripps in his current position in July 2020, Wenyuan was an assistant professor of geophysics at Florida State University from January 2019 to June 2020. He obtained his B.S. and M.S. (geophysics) from Peking University. He obtained his Ph.D. from the Scripps Institution of Oceanography at the UC San Diego. He was a postdoctoral scholar at Woods Hole Oceanographic Institution.

Claire Masteller is an assistant professor of earth and planetary sciences at Washington University in St. Louis. She is broadly interested in sediment transport and erosion mechanics and their role in driving landscape evolution. She uses interdisciplinary methods to address research questions across a wide range of spatial and temporal scales. Masteller received her undergraduate degree in earth and environmental science from the University of Pennsylvania. She then pursued a Ph.D. in the Earth and Planetary Sciences Department at the University of California, Santa Cruz. Following her Ph.D. research, Masteller moved to Germany to undertake training in environmental seismology, active source geophysics, and their application to rocky coast geomorphology. She worked as a postdoctoral researcher and Alexander von Humboldt Fellow at the Helmholtz Center, German Research Center for Geoscience from 2017-2019.

SPEAKER BIOGRAPHIES

Zhongwen Zhan is an assistant professor of geophysics at the California Institute of Technology. His research lies in the broad area of seismology and recently focuses on the application of fiber optic sensing over telecommunication cables. He is mostly interested in seismic imaging of the earth's structure using dense arrays, rupture processes of shallow and deep earthquakes, and the intersections of seismology and environmental science. He received his B.S. and M.S. degrees from the University of Science and Technology of China and his Ph.D. from the California Institute of Technology, all in geophysics and seismology.

Marine Denolle is an assistant professor in the Department of Earth and Space Sciences at the College of the Environment, University of Washington. Her research aims at predicting the dynamics of earthquakes and their ground motions in a changing Earth. She captures their seismic signatures and characterizes the physical processes that control them. She received her Ph.D. at Stanford, completed a 2-year Green postdoctoral scholarship at Scripps Institution of Oceanography (UC San Diego), spent 5 years as an assistant professor at Harvard University, and just joined The University of Washington.

Matthew Rodell is the Associate (and now Acting) Deputy Director of Earth Sciences for Hydrosphere, Biosphere, and Geophysics at NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. From 2012 to 2019, Dr. Rodell was chief of the Hydrological Sciences Laboratory. He is a member of the science team for NASA's Gravity Recovery and Climate Experiment Follow On mission and is co-lead of the Mass Change Designated Observable Study's Research and Application Team. He leads the Global Land Data Assimilation System and projects focused on monitoring groundwater storage changes, mapping and forecasting drought/wetness, and detecting climate related variations in the water cycle. Dr. Rodell is a past associate editor for the Journal of Hydrology and a current Editor for the Journal of Hydrometeorology. He has also chaired the Hydrology Program for the American Geophysical Union Fall Meeting (2009-2011) and led various national and international scientific working groups. He received a Presidential Early Career Award for Scientists and Engineers in 2006, a NASA/GSFC Earth Science Achievement Award in 2007, a Robert H. Goddard Award for Exceptional Achievement in Science in 2011, and an Arthur S. Flemming Award for outstanding federal service in the area of basic science in 2015. Dr. Rodell has more than 120 peer-reviewed publications and appears on Clarivate Web of Science's 2018, 2019, and 2020 lists of Highly Cited Researchers. He holds a B.S. in environmental science from the College of William and Mary and a Ph.D. in geological sciences from the University of Texas at Austin.

Bridget Scanlon is a senior research scientist in the Bureau of Economic Geology at The University of Texas at Austin. Her research focuses on the impacts of climate variability/change on precipitation (El Niño-Southern Oscillation, Pacific Decadal Oscillation, etc.) and water resources; the assessment of paleoclimate impacts on groundwater recharge in semiarid and arid regions; evaluation of land-use change impacts on groundwater resources; quantification of groundwater recharge using soil physics, environmental tracers, and numerical simulations; evaluation of arsenic contamination related to anthropogenic and geogenic sources; unsaturated zone nitrate profiling to link land surface processes with groundwater contamination; and monitoring and modeling analyses of evapotranspiration covers for waste containment. She received her B.S. in geology from Trinity College, her M.S. in geology from the University of Alabama, and her Ph.D. in geology from the University of Kentucky.