*Fast*TIMES

EEGS Student Chapters:

Charles University

Clemson University

Kutztown University

Memorial University

Rutgers University

New Technology:

Spatiotemporal Characterization of Soil Moisture Fields in the Near Surface Using Cosmic-Ray Neutron Probes

December 2014

Volume 19, Number 4

This special issue of *Fast*TIMES, is focused on EEGS Student Chapters. Also included in this issue is a new technology feature article on the use of cosmic-ray neutron probes to measure soil moisture in agricultural fields.

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New Technology:

*Fast*TIMES

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ABOUT EEGS

The Environmental and Engineering Geophysical Society (EEGS) is an applied scientific organization founded in 1992. Our mission:

"To promote the science of geophysics especially as it is applied to environmental and engineering problems; to foster common scientific interests of geophysicists and their colleagues in other related sciences and engineering; to maintain a high professional standing among its members; and to promote fellowship and cooperation among persons interested in the science."

We strive to accomplish our mission in many ways, including (1) holding the annual Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP); (2) publishing the Journal of Environmental & Engineering Geophysics (JEEG), a peer-reviewed journal devoted to near-surface geophysics; (3) publishing *Fast*TIMES, a magazine for the near-surface community, and (4) maintaining relationships with other professional societies relevant to near-surface geophysics.

JOINING EEGS

EEGS welcomes membership applications from individuals (including students) and businesses. Annual dues are $90 for an individual membership, $50 for introductory membership, $50 for a retired member, $50 developing world membership, complimentary corporate sponsored student membership - if available, and $300 to $4000 for various levels of corporate membership. All membership categories include free online access to JEEG. The membership application is available at the back of this issue, or online at www.eegs.org.

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To advertise in FastTIMES, contact:

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*Fast*TIMES is published electronically four times a year. Please send articles to any member of the editorial team by March 1, 2015. Advertisements are due to Jackie Jacoby by March 1, 2015.

CALENDAR

2015

February 15 - 18	Australian Society of Exploration Geophysics and Petroleum Exploration Society of Australia - 24th International Geophysics Conference and Exhibition Perth, Australia http://www.conference.aseg.org.au (Note: See page 56 for additional information.)
February 19 - 20 March 31 - April 1	Multichannel Analysis of Surface Wave (MASW) Workshop Lawrence, Kansas, USA http://www.kgs.ku.edu/software/surfseis/workshops.html
March 22 - 26	Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP) Austin, Texas, USA http://www.eegs.org/sageep-2015 (Note: See page 54 for additional information.)
May 19 - 22	NovCare 2015 "Novel Methods for Subsurface Characterization and Monitoring: From Theory to Practice" Lawrence, Kansas, USA http://www.ufz.de/novcare/ (Note: See page 55 for additional information.)
June 22 - July 2	26th General Assembly of the International Union of Geodesy & Geophysics (IUGG) Prague, Czech Republic http://www.iugg2015prague.com
October 5 - 9	14th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst Rochester, Minnesota, USA http://www.sinkholeconference.com/
October 26 - 31	Society of Exploration Geophysicists International Exposition and 85th Annual Meeting New Orleans, Louisiana USA http://www.seg.org

Please send event listings, corrections or omitted events to any member of the *Fast*TIMES editorial team.

NOTES FROM EEGS

PRESIDENT'S MESSAGE

Moe Momayez, President
(mmomayez@email.arizona.edu)

STRONGER TOGETHER

In this issue, I'd like to speak to the entire near-surface community and not only the EEGS membership. As you may already be aware, there is much discussion going on within geophysical societies about the future of our community - specifically, what can be done to bridge the gap between groups that have differing aspirations and focus, and bring us closer together.

Although it may appear that the near-surface community is seriously fractured, the good news is that it is *not* in crisis. The pace of innovation, development of new technologies and applications in the earth sciences and engineering domains is faster than ever before in this growing field. As the economy evolves and corporations, large and small, adopt new ways of conducting business, we are presented with new opportunities at the professional, commercial and academic levels. I think we the near-surface community are currently in the process of reexamining and redefining our profession and its place in the society.

While for most of us, this is a period of contemplation and introspection, it would be valuable to come together on a regular basis to share and discuss our aspirations, and if feasible, chart a common path into the future. I believe there is a renewed enthusiasm to organize a large spring meeting in the near future. I invite all of you, to join forces with EEGS and make the next spring conference a meeting for the entire near-surface community. I believe we can create a new conference that appeals to both academics and professionals alike, which can only boost the popularity of this already great event.

EEGS is an innovative and inclusive professional society that promotes partnership with other societies. EEGS also values the contribution of the next generation of near-surface geophysicists and geoscientists. The focus of this particular issue of FastTIMES is on our student chapters. I am pleased that we are featuring five universities with a strong geophysics program; inside, you will find information about their club activities and student interests. I strongly urge our student readership to join their local chapters and if there is none, consider working with a faculty or academic advisor to establish your own EEGS student chapter.

On the SAGEEP 2015 front, 225 abstracts for oral and poster presentations have been accepted. Abstract revisions and the optional extended abstracts are due January 19, 2015. The technical program has turned out to be one of the strongest we've had in many years, under the leadership of Brad Carr. General Chair Jeff Paine, and his team of local organizers have planned several extracurricular events to introduce you to some the unforgettable experiences to be had in Austin. Please consult the EEGS website for all the information and latest updates on workshops, the technical program, and special events. I look forward to seeing you all in Austin.

Moe Momayez, EEGS President

EEGS Foundation makes great strides in its first years.

Since the launch of the EEGS Foundation, there are numerous accomplishments for which we can all be proud: Establishing and organizing a structure that serves the needs of EEGS; underwriting the legal process, achieving tax-exempt status; and soliciting and receiving support for SAGEEP. In addition, the Foundation helped underwrite the SAGEEP conference held this spring in Keystone.

These are only a few of the tangible results your donations to the Foundation have enabled. We would therefore like to recognize and gratefully thank the following individuals and companies for their generous contributions:

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NOTES FROM EEGS

Renew your EEGS Membership for 2015

Be sure to renew your EEGS membership for 2015! In addition to the more tangible member benefits (including the option of receiving a print or electronic subscription to JEEG, *Fast*TIMES delivered to your email box quarterly, discounts on EEGS publications and SAGEEP registration, and benefits from associated societies), your dues help support EEGS's major initiatives such as producing our annual meeting (SAGEEP), publishing JEEG, making our publications available electronically, expanding the awareness of near-surface geophysics outside our discipline, and enhancing our web site to enable desired capabilities such as membership services, publication ordering, and search and delivery of SAGEEP papers. You will also have the opportunity to donate to the EEGS Foundation during the renewal process. Members can renew by mail, fax, or online at www.eegs.org.

Sponsorship Opportunities

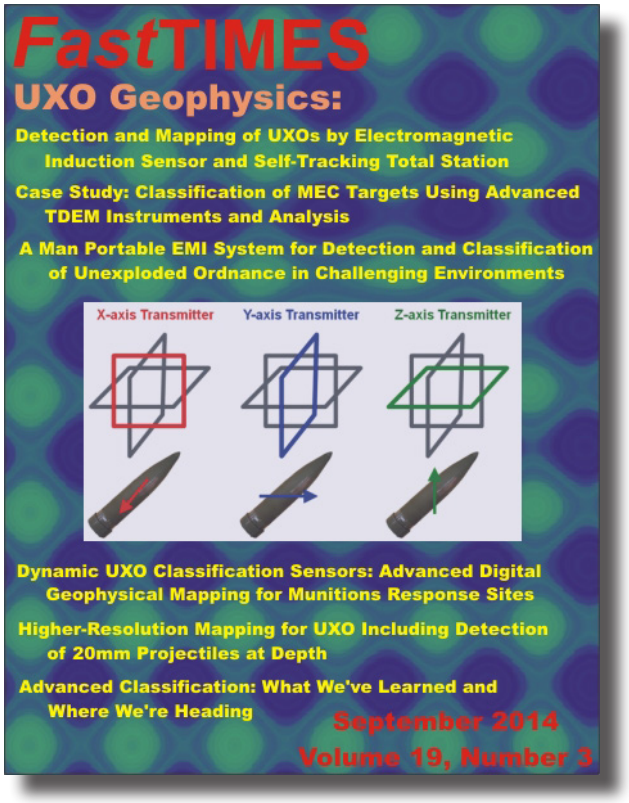
There are always sponsorship opportunities available for government agencies, corporations, and individuals who wish to help support EEGS's activities. Specific opportunities include development and maintenance of an online system for accessing SAGEEP papers from the EEGS web site and support for our next SAGEEP. Make this the year your company gets involved! Contact Moe Momayez (mmomayez@email.arizona.edu) for more information.

From the *Fast*TIMES Editorial Team

*Fast*TIMES is distributed as an electronic document (pdf) to all EEGS members, sent by web link to several related professional societies, and is available to all for downloading from the EEGS *Fast*TIMES web site (http://www.eegs.org/fasttimes). Past issues of *Fast*TIMES continually rank among the top downloads from the EEGS web site. Your articles, advertisements, and announcements receive a wide audience, both within and outside the geophysics community.

To keep the content of *Fast*TIMES fresh, the editorial team strongly encourages submissions from researchers, instrument makers, software designers, practitioners, researchers, and consumers of geophysics—in short, everyone with an interest in near-surface geophysics, whether you are an EEGS member or not. We welcome short research articles or descriptions of geophysical successes and challenges, summaries of recent conferences, notices of upcoming events, descriptions of new hardware or software developments, professional opportunities, problems needing solutions, and advertisements for hardware, software, or staff positions.

The *Fast*TIMES presence on the EEGS web site has been redesigned. At http://www.eegs.org/fasttimes you'll now find calls for articles, author guidelines, current and past issues, and advertising information.

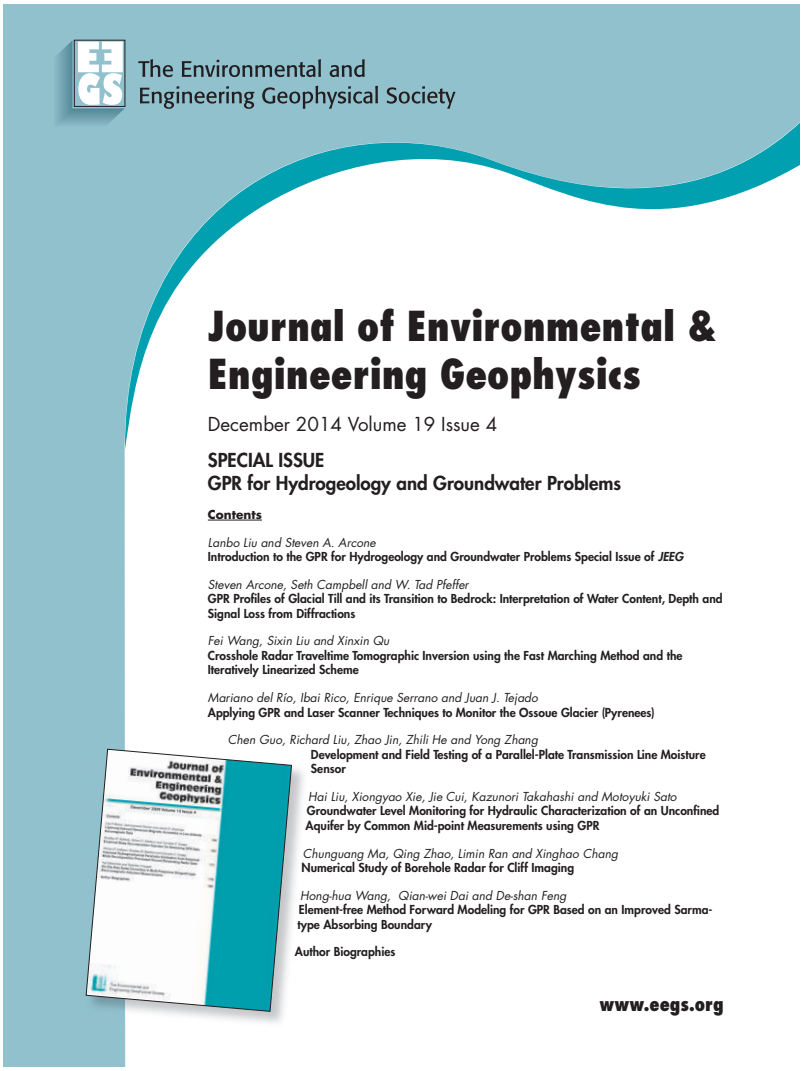


Submissions

The *Fast*TIMES editorial team welcomes contributions of any subject touching upon geophysics. *Fast*TIMES also accepts photographs and brief non-commercial descriptions of new instruments with possible environmental or engineering applications, news from geophysical or earth-science societies, conference notices, and brief reports from recent conferences. Please submit your items to a member of the *Fast*TIMES editorial team by March 1, 2015 to ensure inclusion in the next issue. We look forward to seeing your work in our pages. Note: *Fast*TIMES is also looking for guest editors who are interested in organizing a *Fast*TIMES issue around a special topic within the guest editor's area of expertise. For more information, please contact Barry Allred (Barry.Allred@ars.usda.gov), if you would like to serve as a *Fast*TIMES guest editor.

JEEG NEWS AND INFO

The Journal of Environmental & Engineering Geophysics (JEEG), published four times each year, is the EEGS peer-reviewed and Science Citation Index (SCI®)-listed journal dedicated to near-surface geophysics. It is available in print by subscription, and is one of a select group of journals available through GeoScienceWorld (www.geoscienceworld.org). JEEG is one of the major benefits of an EEGS membership. Information regarding preparing and submitting JEEG articles is available at http://jeeg.allentrack.net.



December 2014 Volume 19 Issue 4

Special Issue
GPR for Hydrogeology and Groundwater Problems

Introduction to the GPR for Hydrogeology and Groundwater Problems Special Issue of JEEG
Lanbo Liu and Steven A. Arcone

GPR Profiles of Glacial Till and its Transition to Bedrock: Interpretation of Water Content, Depth and Signal Loss from Diffractions
Steven Arcone, Seth Campbell, and W. Tad Pfeffer

Crosshole Radar Traveltime Tomographic Inversion using the Fast Marching Method and the Iteratively Linearized Scheme
Fei Wang, Sixin Liu, and Xinxin Qu

Applying GPR and Laser Scanner Techniques to Monitor the Ossoue Glacier (Pyrenees)
Mariano del Río, Ibai Rico, Enrique Serrano, and Juan J. Tejado

Development and Field Testing of a Parallel-Plate Transmission Line Moisture Sensor
Chen Guo, Richard Liu, Zhao Jin, Zhili He, and Yong Zhang

Groundwater Level Monitoring for Hydraulic Characterization of an Unconfined Aquifer by Common Mid-point Measurements using GPR
Hai Liu, Xiongyao Xie, Jie Cui, Kazunori Takahashi, and Motoyuki Sato

Numerical Study of Borehole Radar for Cliff Imaging
Hong-hua Wang, Qian-wei Dai and De-shan Feng
Element-free Method Forward Modeling for GPR Based on an Improved Sarma-type Absorbing Boundary
Chunguang Ma, Qing Zhao, Limin Ran, and Xinghao Chang

Editor's Note

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The Journal of Environmental and Engineering Geophysics (JEEG) is the flagship publication of the Environmental and Engineering Geophysical Society (EEGS). All topics related to geophysics are viable candidates for publication in JEEG, although its primary emphasis is on the theory and application of geophysical techniques for environmental, engineering, and mining applications. There is no page limit, and no page charges for the first ten journal pages of an article. The review process is relatively quick; articles are often published within a year of submission. Articles published in JEEG are available electronically through GeoScienceWorld and the SEG's Digital Library in the EEGS Research Collection. Manuscripts can be submitted online at http://www.eegs.org/jeeg.

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SUCCESS WITH GEOPHYSICS

*Fast*TIMES welcomes short articles on applications of geophysics to the near surface in many disciplines, including engineering and environmental problems, geology, hydrology, agriculture, archaeology, and astronomy. This special issue of *Fast*TIMES, is focused on EEGS Student Chapters. If you would like information on forming an EEGS Student Chapter, please contact Laura Sherrod (sherrod@kutztown.edu). Also included in this issue is a new technology feature article on the use of cosmic-ray neutron probes to measure soil moisture in agricultural fields.

CHARLES UNIVERSITY IN PRAGUE DEPT. OF APPLIED GEOPHYSICS PRAGUE, CZECH REPUBLIC

Our EEGS Student Chapter currently consists of seven members – all of them are PhD or MSc students in applied geophysics in the Faculty of Science. Our faculty advisor, Dr. Petr Taborik, is a geophysicist in the Department of Applied Geophysics, and his specialty is ERT and GPR used for morphological issues. Research for most of our department´s students involve engineering or environmental issues. In recent years some seismological or oil and gas topics have been addressed as well.

Fieldwork and Social Activities

Geophysical Excursion – Vienna Basin

Between 2/27 – 28/2014 we organized an excursion for twelve participants to the southeastern part of our country, an area containing significant oil and gas resources. The excursion showed students aspects of oil exploration using 3D seismic reflection. The excursion included field seismic measurements obtained by DMT (Figure 1). Furthermore, we toured the data processing and interpretation center of the MND Company, and also their laboratories, and one of the underground gas storage facilities.

Figure 1: DMT vibrator truck employed for seismic survey in Vienna Basin.

Geophysical Field Course – Cheb Basin and Jeseniky Mountains

Once per year a field course for MSc students is organized at our alma mater. It gives an opportunity for students to get experience with most of the main geophysical methods, while solving geological problems. This year, the course took place at two locations; the Jeseniky Mountains (gravimetry, radiometry, and magnetometry) and the Cheb Basin (seismic reflection and refraction - Figure 2, ERT, and well logging). For the latter location, we collaborated with Jena University from Germany. The collaboration aims to identify deep tectonic structure (and migration of CO_2 from underground) within the Cheb Basin in Western Bohemia.

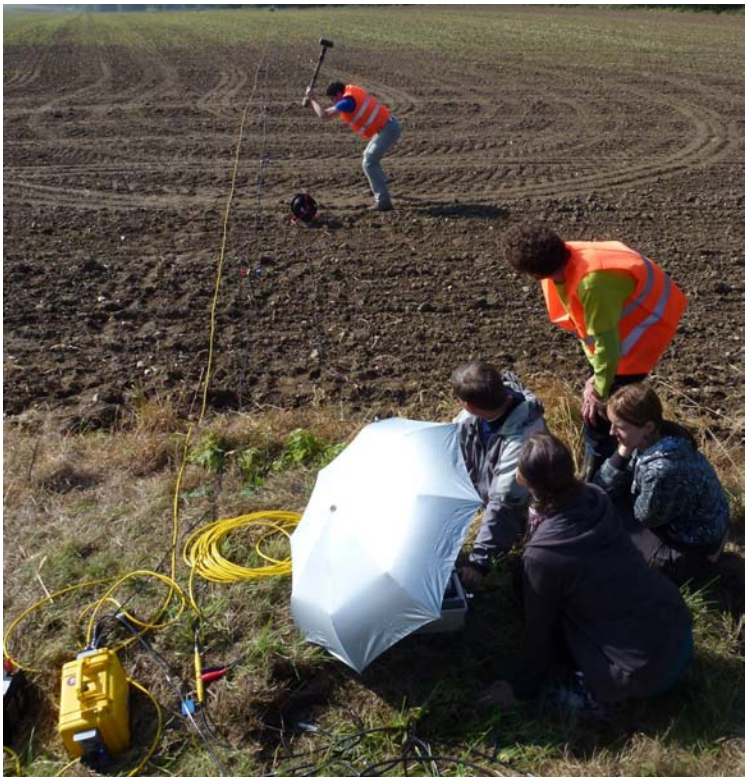

Figure 2: Seismic refraction survey in Cheb Basin.

Geophysical Weekends Events

We usually organize this informal event twice per year, to help build a friendly collective of students. We spend one weekend in nature around the Czech Republic, typically hiking (or skiing, biking – depends on weather and season) in a geologically interesting place.

Geophysical Coffee Meetings

Once per month, students and professors discuss progress in their research or news that might be interesting to others. Everybody gets important feedback on his work from those present; what should be done, where they see problems, or ideas of how to make progress. Attendees consist of mostly PhD students and professors, also some MSc students.

Outreach Activities

Seminars for High Schools Students

During last few years, our school identified a negative trend in the number of students going into geological majors. We were asked by the head of our faculty to work with potential future

students at high schools. To do so, we prepare lecture material for high-school students, where we pick the most interesting topics being solved at our department.

Open House Days

This event is typically organized in the beginning of each year and aims to recruit new students. During the day we do excursions, which give an introduction to our department, available equipment/facilities, and a basic overview of geophysics to our potential students.

Individual Research

Jaroslav Jirku - MSc.

Our research is based on observing time-lapse changes of the physical parameters (conductivity, IP or elastic parameters) of joints systems (mostly in crystalline massifs). The primary aim is to develop a monitoring system mostly for the needs of deep repositories of nuclear waste. Geophysical research of such repositories has so far dealt only with one-time research (no temporal monitoring) of potential host rock´s properties. Contrary to this, our developed system and methodology is unique in continuously measuring the physical properties of the rock massif. This system will be permanently fixed in the field, and by observing changes in measured data reports, determine if any remarkable occurrence in the EDZ zone is or was happening (for example, opening or closing of the joints or micro-fractures).

In our research, we are trying to get complex insight in the time-lapse behavior of granite massif (our field base is at the Bedrichov gallery in Jizera Mountains). We collected very dense ERT data, which was continuously measured during two months, every six hours (Figure 3). We have found very interesting short and long-term changes in measured resisitivites. Right now we are trying to nail down the particular geological phenomena connected with these changes and narrow our interpretation. We did our laboratory measurement (resistivity dependence on the water saturation and sample´s disruption) and are comparing our results with dilatometers and 3D geophones placed close to our field base.

Figure 3: ERT time-lapse measurement in the Bedrichov gallery.

Petr Taborik, Ph.D. - RNDr.

Our research is focused on application of a complex geophysical survey for the investigation of various geological and geomorphological problems (structural geology, tectonics, slope processes, fluvial geomorphology, etc.). A multidisciplinary geophysical survey provides much more information on subsurface structures in comparison with a single geophysical technique. The complex measurements and "joint-interpretations“ not only provides geological data, but also valuable information on applicability of individual methods within such combinations. With this complex survey we employ DC geoeletrical methods (multi-electrode resistivity tomography, ERT), electromagnetic surveys (dipole electromagnetic survey, DEMP; ground penetrating radar, GPR), shallow seismic refraction (SSR), and in special cases, microgravimetry (Figure 4).

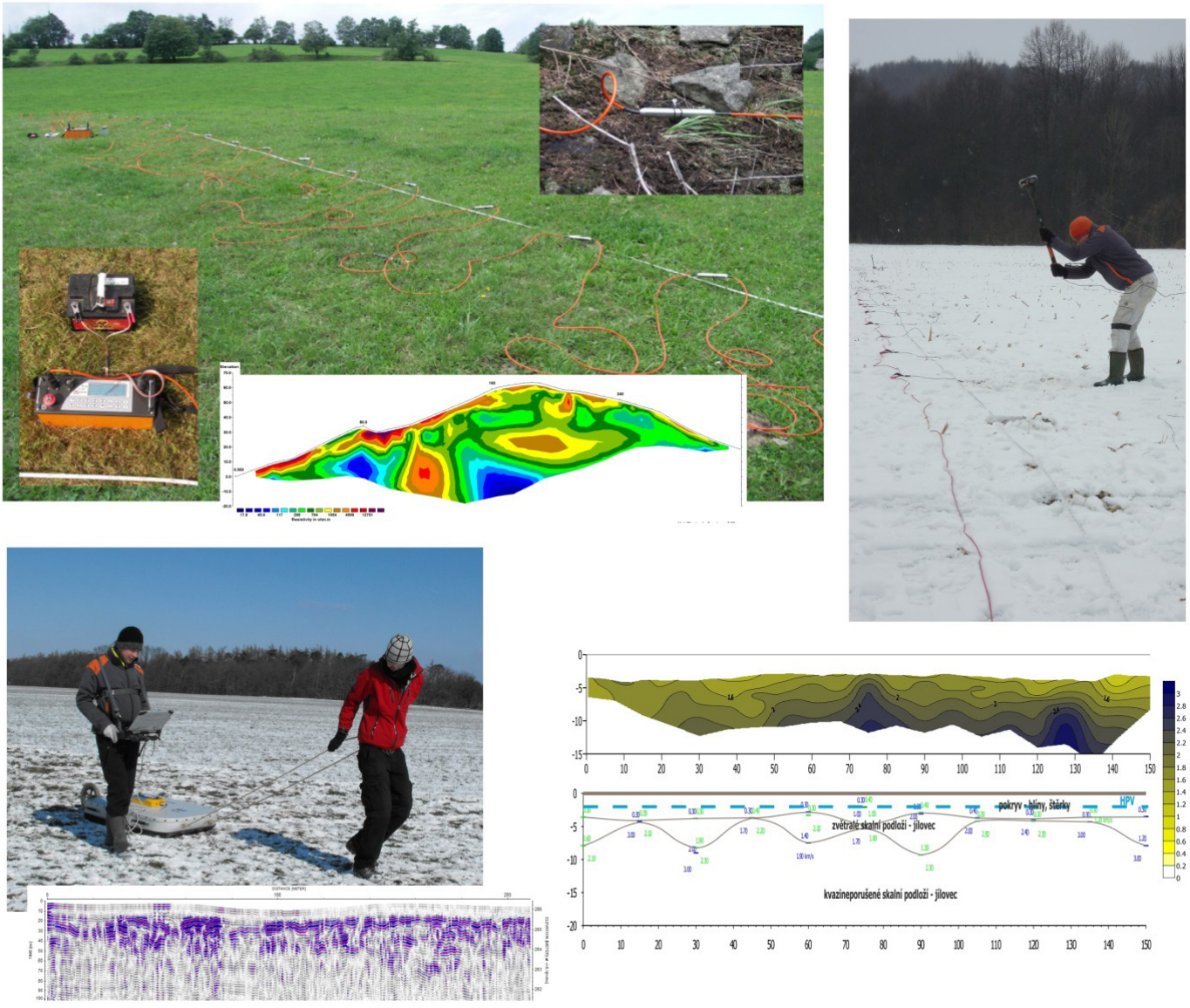

Figure 4: Complex geophysical survey for the investigation of geomorphological problems.

Ondrej Salek - MSc.

On 10/3/2014 well-logging measurement was done in the 1H031b well in Nebanice, a region of Karlovy Vary. The well is 28.2 m deep. During measurement, the ground-water level was at a depth of 2.7 m. The well is equipped with plastic casing of 125 mm diameter. Between 0 – 18 m, the well is cemented, and gravel packed below 18 m. The casing is perforated between 20.06 – 28.00 m.

The emission of CO_2 was monitored in this well. The purpose of the well-logging measurements (Figure 5) was to test the reaction of physical parameters to the presence of the gas in the well shaft. We used photometry, resistivity logging, thermometry, gamma logging and laterolog. The presence of CO_2 bubbles could be detected with photometry and resistivity logging (in the form of scattered signal between 0 – 20 m). Beneath this, the well response curve was smooth and constant. We believe that the gas flows in the well around the top edge of the perforated section.

Figure 5: Well-logging in Cheb Basin of a CO_2 monitoring well.

CLEMSON UNIVERSITY DEPT. OF ENVIRONMENTAL ENGINEERING AND EARTH SCIENCES CLEMSON, SOUTH CAROLINA

The Clemson University Student Chapter of the Environmental and Engineering Geophysical Society (CUEEGS) was recognized by EEGS in May of 2013. Our active members are highly focused on their own research projects, but remain motivated to expand CUEEGS through community outreach. Recently, three of our members became alumni, and are continuing geophysical research at other research institutions. Each member of CUEEGS has prepared a brief statement concerning their background, research interests and contributions to the geophysical community.

Blake Lytle

Blake Lytle (Figure 1) is a Master's student studying hydrogeology at Clemson University. He hails from Michigan and did his undergraduate studies in geological engineering at Michigan Technological University. For his master's degree, Blake is studying how geophysical measurements and methods can be used to investigate and characterize hydrologic systems. Specifically, he is actively researching the use of ground penetrating radar (GPR) to monitor unsaturated flow processes. Blake is projected to graduate from Clemson in the August of 2015 and plans to enter the work force at an environmental engineering firm.

Figure 1: Blake Lytle, M.Sc. student at Clemson University.

Alex Hannah

Alex Hanna (Figure 2) grew up in Southern California, where he received his B.Sc. in Geophysics from California State University - Northridge. As an undergraduate researcher, he helped deploy a network of seafloor seismometers in the Pacific Ocean. Additionally, Alex has published a study using seismic tomography to investigate the tectonic structure of the western Himalayas (Hanna

and Weeraratne, 2013). He is currently pursuing a M.Sc. in Hydrogeology and plans to continue his studies and pursue a PhD in Environmental Engineering at Clemson University. His research focuses on developing stochastic inverse methods that use geomechanical signals to characterize geologic formations undergoing carbon sequestration. Additionally, he is helping to develop a web-based video game that uses surface hydrology and groundwater flow models to teach students about interactions between agriculture, economics and groundwater contamination. Upon his graduation in 2018, Alex plans on continuing his role in academia as an assistant professor.

Figure 2: Alex Hannah, M.Sc. student at Clemson University.

Na Hao

Na Hao (Figure 3) is a Ph.D candidate studying the changes in the induced polarization (IP) response of porous media undergoing biochemical processes that alter the surface area of individual grains. She is originally from China where she earned her B.S. at Sichuan University in Environmental Engineering and her M.S. at Beijing Normal University in Environmental Engineering. Her general research interests are monitoring the contaminant fate and transport in the subsurface and the use of geophysical methods to monitor geochemical processes between solid-liquid-microbe interfaces. Upon her graduation in May of 2015, she would like to continue her research as a post doc before starting a career in academia as a professor at a research university. She thinks the EEGS community is a very good communication stage for people to network and share information in this research area.

Figure 3: Na Hao, Ph.D. student at Clemson University.

Adam R. Mangel

Adam Mangel (Figure 4) is a Ph.D. candidate studying hydrologic events with time-lapse ground-penetrating radar. Adam is originally from Buffalo, NY where he earned his B.S. in Geology at SUNY Buffalo. He came to Clemson University in 2009 and defended his M.S. in Hydrogeology in December of 2011. Recently Adam has published a paper detailing the hydrogeophysical response of a soil during infiltration (Mangel et al., 2012). He continues to focus his research in this area and plans to graduate in May of 2016. His research interests include statistical methods for coupled inversion of geophysical and hydrologic data sets, pattern recognition, computer programming, and automation of data collection. Upon graduation, he plans to establish himself as an assistant professor at a research university.

Figure 4: Adam Mangel, Ph.D. student at Clemson University.

Savannah Miller

Savannah Miller (Figure 5) is originally from Taylors, South Carolina and graduated from Clemson University in August of 2014 with her B.S. Degree in Geology. She was accepted into an MS program at the Colorado School of Mines in the Hydrologic Science and Engineering program. As a first year MS student, she is taking a lot of classes. However, her current research interests are in comparing nonlocal transport of solutes at various scales to the classical advection dispersion equation. Savannah has no concrete plans for the future at this time but would like to work in environmental consulting and/or water resource management after her graduation in May 2017.

Figure 5: Savannah Miller, graduated with B.S. Degree in Geology from Clemson University, now an M.Sc. student at Colorado School of Mines.

Erasmus Oware

Erasmus Oware (Figure 6) is a recent graduate of Clemson University from Ghana. He earned his B.S. at Kwame Nkrumah University of Science and Technology in Geological Engineering and his M.S. from Illinois State in Hydrogeology. Recently, he successfully defended his dissertation and is currently employed as an Assistant Professor at SUNY Buffalo. His research focuses on the application of geophysics to investigate near-surface environmental and water related objectives. He uses research methodology that fundamentally entails the use of geostatistics to generate site-specific geological or hydrological features to constrain geophysical inversion algorithms.

Figure 6: Erasmus Oware, recent Ph.D graduate from Clemson University, now an Assistant Professor at SUNY Buffalo.

Andrea Creighton

Andrea Creighton (Figure 7) is originally from Silverdale, Washington. She obtained a B.S. in Geology from Clemson University in August 2014 and is now a first year PhD student at the University of Wyoming working with surface magnetic resonance to study the hydrology of thermokarst lakes in Alaska. Andrea participated in the Summer of Applied Geophysical Experience (SAGE) in the summer of 2013 working with transient electromagnetics to determine the geothermal potential of a local aquifer. She plans to stay in academia either as a professor at a major research university or at a national lab.

Figure 7: Andrea Creighton, graduated with B.S. Degree in Geology from Clemson University, now a Ph.D. student at University of Wyoming.

Chapter Publications

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Mangel, A.R., S.M.J. Moysey, J.C. Ryan, J.A. Tarbutton, 2012, "Multi-offset ground-penetrating radar imaging of a lab-scale infiltration test", Hydrology and Earth Systems Science, vol. 16, pp. 4009-4022, doi:10.5194/hess-16-4009-2012.

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KUTZTOWN UNIVERSITY PHYSICAL SCIENCES DEPT. KUTZTOWN, PENNSYLVANIA

Description of Chapter

The EEGS Student Chapter at Kutztown University consists of four undergraduate students majoring in geology or physics. Dr. Laura Sherrod, the hydrogeologist and geophysicist of the Department of Physical Sciences, is the faculty adviser of this group. The department has no graduate program, but focuses heavily on undergraduate research. Students in this chapter apply geophysics to local archaeological projects in eastern Pennsylvania, watershed issues in the anthracite region of Pennsylvania, and geologic mapping in New York and Pennsylvania.

Group Activities

During the summer of 2014, the EEGS Student Chapter at Kutztown University worked on abandoned mine drainage issues in the Schuylkill watershed under a state-funded Growing Greener Plus grant in collaboration with the USGS, the Schuylkill Conservation District, and the Schuylkill Headwaters Association. This grant is part of an ongoing project to decrease the impact of mining in the Schuylkill region of Pennsylvania.

Individual Research

Emily Snyder

Emily Snyder has surveyed 18th century cemeteries near Kutztown University to locate the limits of burial sites and identify unmarked graves through the use of GPR (Figure 1), magnetometry, and EM methods. There was interest from a local historian in finding the burial site of a local patriarch whose gravesite had been lost. Likewise, during the depression, some family cemeteries were opened to less fortunate neighbors who had no money to bury their dead at the church cemetery, leaving many unmarked burials outside the walls of the main cemetery. Emily's collaboration with local historians has provided a more complete view of the past at these sites.

Figure 1: Emily Snyder, GPR surveys at local cemeteries.

Alex Spielman

Alex Spielman is working on a project in collaboration with the Schuylkill Headwaters Association, the Schuylkill Conservation District, and the USGS to develop a strategy for restoration and retention of streamflow in West Creek, which is underlain by abandoned anthracite mines in the headwaters of the upper Schuylkill River. This stream experiences intermittent, complete flow losses by streambed leakage from West Creek to the Oak Hill mine complex that extends beneath the surface water divide to an adjacent watershed. If the streamflow losses from West Creek can be prevented, aquatic habitat in West Creek can be maintained and the total volume of abandoned mine drainage (AMD) entering the Schuylkill River may be decreased. Combining water-quality and aquatic ecological surveys, streamflow and electrical resistivity surveys (Figure 2), and hydrology modeling of West Creek will produce a phased restoration strategy for the region.

Figure 2: Alex Spielman, resistivity surveys in West Creek.

Sebastien Treciak - Recent Graduate

Sebastien Treciak participated in multiple projects while at Kutztown University, including mapping glacial deposits in the Montezuma Wetland Complex (Figure 3), surveying local cemeteries, and identifying zones of flow loss in West Creek. He is now a student in the graduate program at Shippensburg University of Pennsylvania where he is working on his masters' degree in geoenvironmental studies within the Geography and Earth Science Department. He is excited to learn even more while he is there and continue doing geophysical research in his spare time.

Figure 3: Sebastien Treciak, resistivity survey in Montezuma Wetland Complex.

Dea Musa - Recent Graduate

Dea Musa worked as an undergraduate student in a collaborative project with the New York State Museum to map glacial sediments in the Montezuma Wetlands Complex of New York, an important hydrological and ecological setting. Resistivity (Figure 4) and GPR were used to identify zones of brine springs within the wetland and to map subsurface glacial drainage patterns in the land around the wetland. Her work over the past two years was used to produce a chapter in a field trip guide book of the area. She graduated in May 2014 and is now working as an intern at Los Alamos National Laboratory in New Mexico where she is once again working in wetlands, studying the geochemistry, investigating attenuation of contaminants, and developing new methods of water collection.

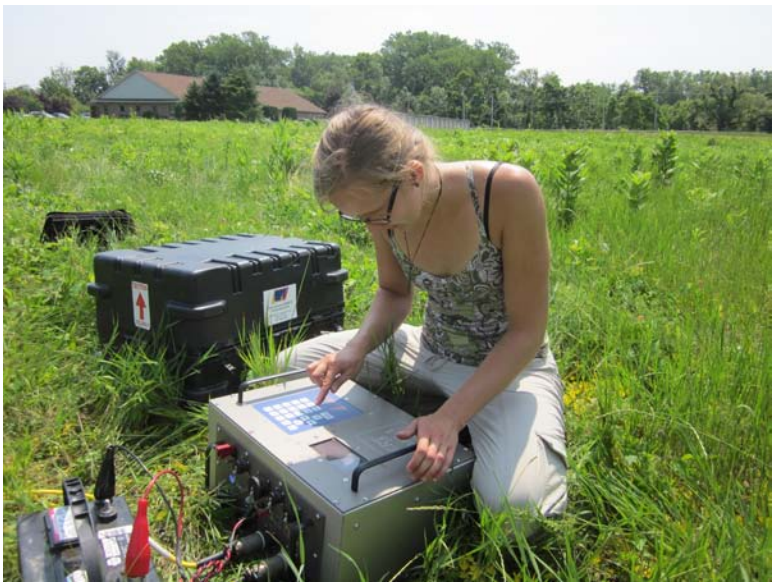

Figure 4: Dea Musa, resistivity survey in Lyons, NY glacial deposits.

MEMORIAL UNIVERSITY DEPT. OF PROCESS ENGINEERING AND DEPT. OF EARTH SCIENCES ST. JOHN'S, NEWFOUNDLAND AND LABRADOR, CANADA

Chapter Formation

The EEGS Student Chapter at Memorial University formally came into is existence on August 2014. Since it has been formed very recently, the approved EEGS Student Chapter at Memorial University only meets the minimum membership requirement. That is to say there are just two members at present comprising this chapter (i.e. the president and the executive member, both of whom are graduate students). Because most collaborations and initiatives of intensive research are vested with national and international graduate students, the chapter initially strives to improve graduate student membership. Upon the advice of the EEGS Student Chapter Committee, this chapter plans to invite memberships from a few other universities in the Atlantic region to form a joint chapter. The chapter is endorsed formally by Dr. Stephen Butt, as an advisor, at the Faculty of Engineering and Applied Science, with the informal support of Dr. Charles Hurich from the Department of Earth Sciences.

Recent Activities

Our Memorial University EEGS Student Chapter members include Bilal Hassan, a Ph. D. Candidate at Memorial University, and Yashodha Marambage, an M.Eng. candidate at the same institution. Bilal Hassan has presented/participated twice at SAGEEP meetings, which helped identify consistent ideas and issues to present elsewhere. Other events attended were SGI-SIMP 2014 in Milan Italy and EAGE Near Surface in Athens, Greece. This report highlights a mix of academic, professional, and cultural experience attained through these activities. Specifically, this report will focus on: (1) research presented at SGI-SIMP in Milan, Italy at the University of Milan; (2) research presented at EAGE Near Surface 2014 in Athens, Greece at the Hotel Divani Caravel; (3) a photographic description of a formal field trip at the historical mining site of Lavrion and Cape Sounion, both near Athens, with a personal trip to the historical site of the Acropolis.

Research Presentations

Global urbanization has had geo-environmentally hazardous impacts in the Mediterranean, and Italy in particular, due to release of non-aqueous toxins into the near surface. Consequently, there is a need to locate, characterize/monitor, and contain these non-aqueous toxins to protect ground water aquifers, the sea, and/or enhance remedial measures. Seismic surveys focused on S-wave attributes can provide insight on this problem by providing geotechnical and geohydrological characterization of the near surface. These ideas were highlighted with an abstract and presentation at SGI-SIMP 2014 in Milan Italy. The presentation was given in a conference session that was well attended, with an audience that had broad range of experience in geology and near surface geophysics. A reference for the abstract submitted to this conference is listed as follows.

Hassan, B., Butt, S. and Hurich, C. (2014) . An assessment of S-waves potential for integrated geotechnical and geohydrological characterization and monitoring of near surface unconsolidated sediments for hazard prevention, Società Geologica Italiana, Roma 2014 Rend. Online Soc. Geol. It., Suppl. n. 1 al Vol. 31, p.662.

A poster presentation based on an extended abstract was given at EAGE Near Surface in Athens, Greece (Figure 1). This presentation focused on acoustic attenuation characteristics examined with a statistically benchmarked time-lapse type workflow. This method provides greater sensitivity to subsurface fluids and offers reliability in such situations where velocity information alone, used for near surface acoustic monitoring of fluid fronts and interfaces from non-aqueous spills in unconsolidated sediments, appears inadequate. The method resolves oil from brine and the interfacial mixing and evolution in time, thereby providing insights on frequency dependent effects related to fluid density, viscosity and flow rate. A reference for the extended abstract submitted to this conference is listed as follows.

Hassan, B., Butt, S. and Hurich, C. (2014). Evaluation of time lapse acoustic monitoring of immiscible fluid flows in near surface by attenuation examination method, Near Surface Geoscience 2014 - 20th European Meeting of Environmental and Engineering Geophysics. DOI: 10.3997/2214-4609.20142005

Figure 1: Bilal Hassan, with other presenters/delegates during the poster session (left), and during the EAGE dinner with some distinguished delegates.

Field Trips

Official field trip related activities were too numerous to provide a detailed account. However, a few photographs are shown (Figures 2, 3, and 4) that capture participation in the main activities.

Figure 2: Cross-section of EAGE members during the Lavrion Mine Field trip, after the meeting at the office of mining /processing facility (left), and inside, inspecting the tunnel (right).

Figure 3: A Spanish designed process/storage facility heritage site (left) that was viewed with other such sites before settling in for a very elaborate traditional Greek lunch in town (right).

Figure 4: An official archaeological/historical site under simultaneous excavation and restoration at Cape Sounion (left) and the famous Odeon of Herodes Atticus (right).

RUTGERS UNIVERSITY DEPT. OF EARTH AND ENVIRONMENTAL SCIENCES NEWARK, NEW JERSEY

At Rutgers-Newark, we have begun a tradition of conducting a diverse range of geophysical measurements over the course of a couple of days in the spring at the Christina River Basin Critical Zone Observatory in southeastern Pennsylvania. Known as the Rutgers Hydrogeophysics Workshop, it is largely spearheaded by graduate students with support from faculty and researchers at Rutgers and other participating institutions. The workshop was originally envisioned as an educational workshop for undergraduate and graduate students but over the course of three years, it has been used to springboard Ph.D. research projects and as a foundation for research collaborations between numerous institutions. We will seek to continue and expand this tradition to benefit future generations of Rutgers near-surface geophysics students. (This chapter update was provided by Gordon Osterman, Jonathan Algeo, and Ashley Samuel.)

Education: Understanding Our Role in Hydrogeological Studies

Applying what we have learned from our classes and our research to real-world problems is what makes the workshop stand out for many participants. While we have numerous geophysical tools at our disposal, we do not get a chance to use all of them in our research. The workshop presents a great opportunity for students to use and understand the near-surface geophysical instruments used for research in our department in the context of a real-world research. Over the years, these geophysical methods have included DC resistivity (Figure 1), ground penetrating radar (Figure 2), frequency-domain EM, surface nuclear magnetic resonance, and shallow seismic reflection. The diversity of methods teaches students the steps involved in planning and executing a near-surface geophysical survey. The knowledge of the practices and pitfalls of running geophysical surveys is invaluable to any near-surface geophysics researcher, whether they do laboratory, field, or computational work. Additionally, our collaboration with other researchers and students allows us to learn from their work and understand how various hydrogeological disciplines are related.

Figure 1: University of Minnesota graduate student Beth Wenell lays out cable for the DC resistivity survey. (photo credit unknown)

Figure 2: Rutgers professor Dr. Lee Slater (left) and graduate student Neil Terry conduct a common offset ground penetrating radar survey. (photo credit: Beth Wenell)

Research: A Deeper Understanding

The Christina River Basin CZO is ideal for our research purposes due to the wealth of hydrogeological information available at the site. The Stroud Water Research Center conducts the majority of the research at the site and has has been our partner and host for each workshop. Along with their researchers, we have embarked on research projects that transcend the narrow focus of the workshop itself.

Ph.D. candidate Jon Algeo has begun a project centered on characterizing the hydrostratigraphy of a catchment at the CZO. Resistivity and GPR lines on the scale of hundreds of meters were collected to identify deep structure in the catchment, with targeted, smaller scale measurements in areas of interest, such as near soil pits currently being installed by the CZO. From one of our long GPR lines (Figure 3), a series of beds sloping towards the top of the catchment were identified, which could have a significant effect on the path that infiltrating water takes through the catchment.

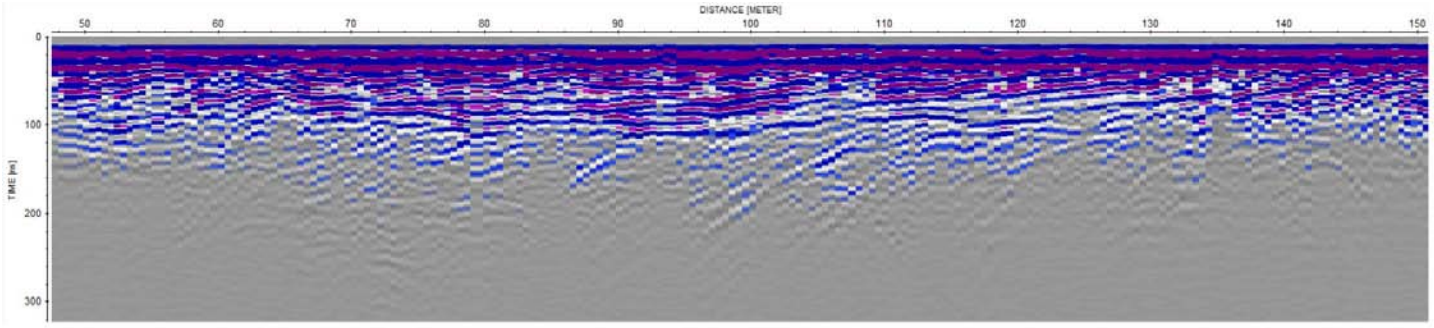

Figure 3: Dipping reflectors, potentially representing bedding, captured by a GPR reflection survey.

The soil pits in the catchment are the primary focus of Jon Algeo's Ph.D. work. The faces of 3 soil pits have been instrumented with 25-electrode resistivity arrays, as well as with numerous other probes to measure important hydrogeological parameters such as water chemistry and temperature (Figure 4). The pits are scheduled to be backfilled late in the fall of 2014, at which point the electrical resistivity arrays will monitor the subsurface remotely. When precipitation events are expected, the array will take measurements of the shallow subsurface before, during, and after the rainfall. Hopefully, the arrays will be able to capture a clear, three-dimensional picture of how water is infiltrating at different locations through the basin.

Figure 4: Jon Algeo instrumenting a soil pit with resistivity electrodes at the Laurel's Preserve in the Christina River Basin. (photo credit: Neil Terry)

Collaboration: Outreach and Connections

The collaborations we have started as a result of the workshop are as valuable as the research we do. In the past three years, we have worked with students and researchers from Temple University (Figure 5), the University of Delaware, University of Minnesota, Bucknell University in Pennsylvania, and the City University of New York in addition to the researchers from Stroud. The multidisciplinary research center provides fertile ground for hydrogeophysical collaborations, which have already taken the form of two PhD projects at the CZO. In addition to the research led by Jon Algeo discussed previously, a future project to explore the hydraulic conductivity spatial variability at the site using novel petrophysical models is in the works. As the workshop continues into the future, we hope to develop the connections we have already made and establish new connections with researchers from numerous hydrogeological fields in order to expand and grow the workshop.

Figure 5: Temple University professor Dr. Jonathan Nyquist (seated, front) instructs his graduate geophysics class in how to conduct a near-surface seismic survey (photo credit: Beth Wenell).

NEW TECHNOLOGY:

SPATIOTEMPORAL CHARACTERIZATION OF SOIL MOISTURE FIELDS IN THE NEAR SURFACE USING COSMIC-RAY NEUTRON PROBES

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Introduction and Background

The accurate measurement of soil moisture fields in space and time is critical to a wide variety of disciplines given the direct relationship between soil moisture, soil matrix potential, and water flux in the unsaturated zone (Brooks and Corey, 1964; Richards, 1931; Vangenuchten, 1980). Furthermore, soil moisture is a key regulator of evapotranspiration and thus the surface energy balance (Santanello et al., 2011). Despite its critical importance, accurate soil moisture observations have been largely limited to (Robinson et al., 2008): 1) the point scale from a variety of technologies (i.e. TDR, TDT, capacitance, resistance of a granular matrix, etc.), 2) large scales from passive and active microwave, and 3) "soft" data from direct current and electromagnetic methods, thus leaving critical gaps in our ability to quantify soil moisture fields across scales (Figure 1). With the recent advance of the cosmic-ray neutron probe, CRNP (Zreda et al., 2012), we now have the ability to continuously measure soil moisture accurately over a 0.28 km^2 area (Desilets and Zreda, 2013), and down to ~15-40 cm in the vertical depending on water content (Franz et al., 2012) (Figure 2). In addition, the proximal non-invasive probe can be used on a mobile platform (Chrisman and Zreda, 2013; Dong et al., 2014; Ochsner et al., 2013), further expanding the spatial scales of observations and connecting the point scale observations with remote sensing products.

In this work, we will first summarize the cosmic-ray neutron method for measuring soil moisture in the near surface. Next, we will present a case study comparing the continuous measurements from a stationary probe in southern Arizona versus a distributed TDT network. Finally, we will discuss some recent work where we combine stationary and mobile mapping of soil moisture in the agriculturally intense areas of eastern Nebraska.

Keywords: Soil Moisture, Cosmic-Ray Neutron Probe (CRNP), Near Surface.

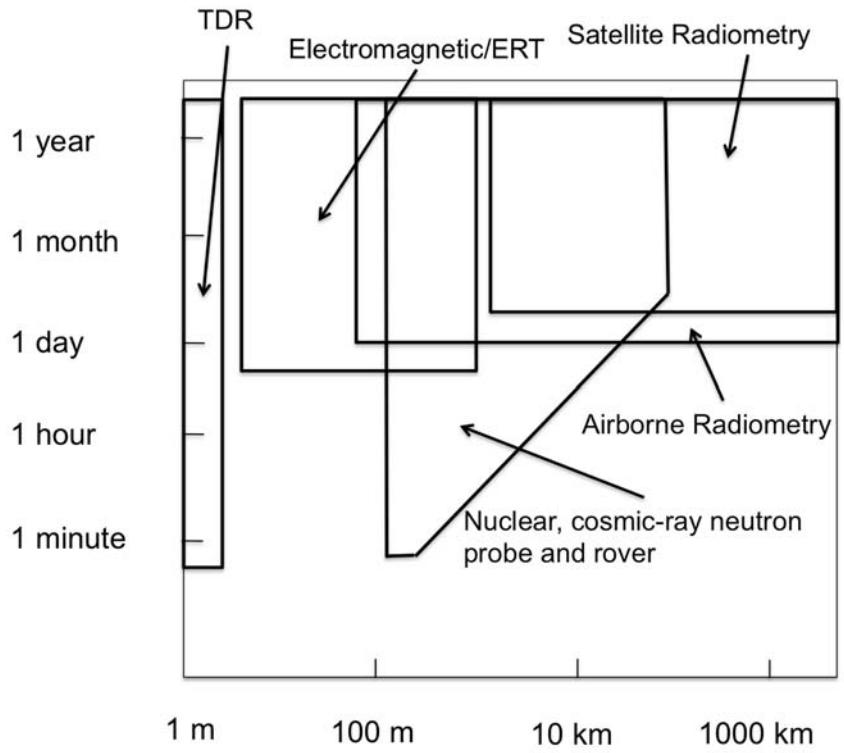

Figure 1: Space-time diagram of measurement scale for various indirect soil moisture methods (Adapted from Robinson et al. 2008). The cosmic-ray neutron method fills in a critical missing piece at intermediate spatial scales.

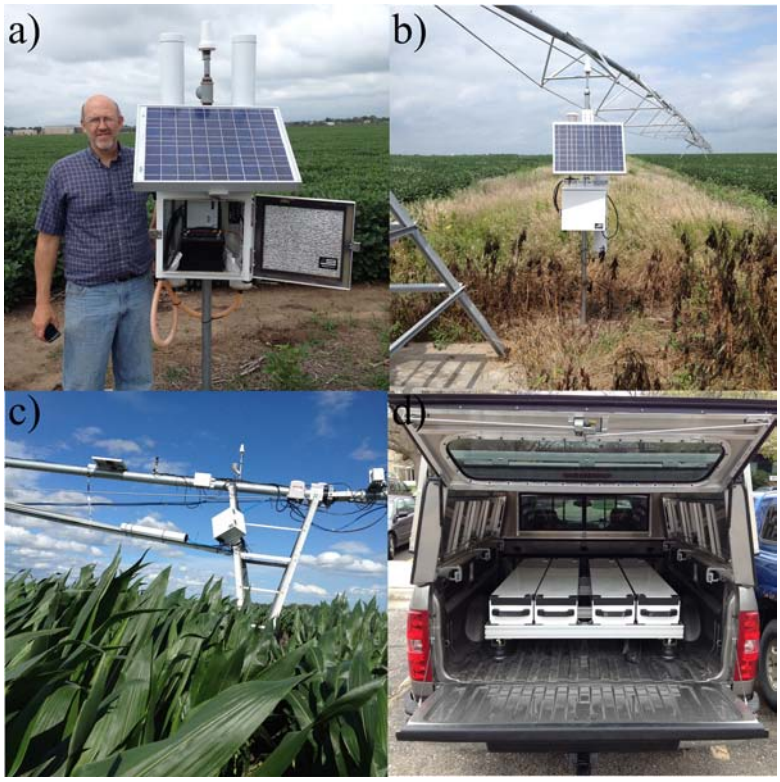

Figure 2: Cosmic-ray neutron probes located: **a**) in a soybean field near Mead, NE, **b**) beneath a center-pivot sprinkler pivot near Waco, NE, **c**) mounted on a center-pivot sprinkler near Mead, NE, and **d**) in the back of a vehicle for mobile mapping.

Methods

General Description

The cosmic-ray neutron method for estimating area-average soil moisture is becoming an established hydrogeophysical method for accurately quantifying soil moisture (RMSE < ~0.02 m^3/m^3) in a wide-variety of ecosystems from the semi-arid shrubland of southern Arizona (Franz et al., 2012) to the humid forests of Germany (Bogena et al., 2013). Moreover, the establishment and continuing expansion of national networks in the USA (Zreda et al., 2012), Australia (Hawdon et al., 2014), UK, Germany (Bogena et al., 2013), and South Africa, further bolsters the wide-spread adoption of the method (Figure 3).

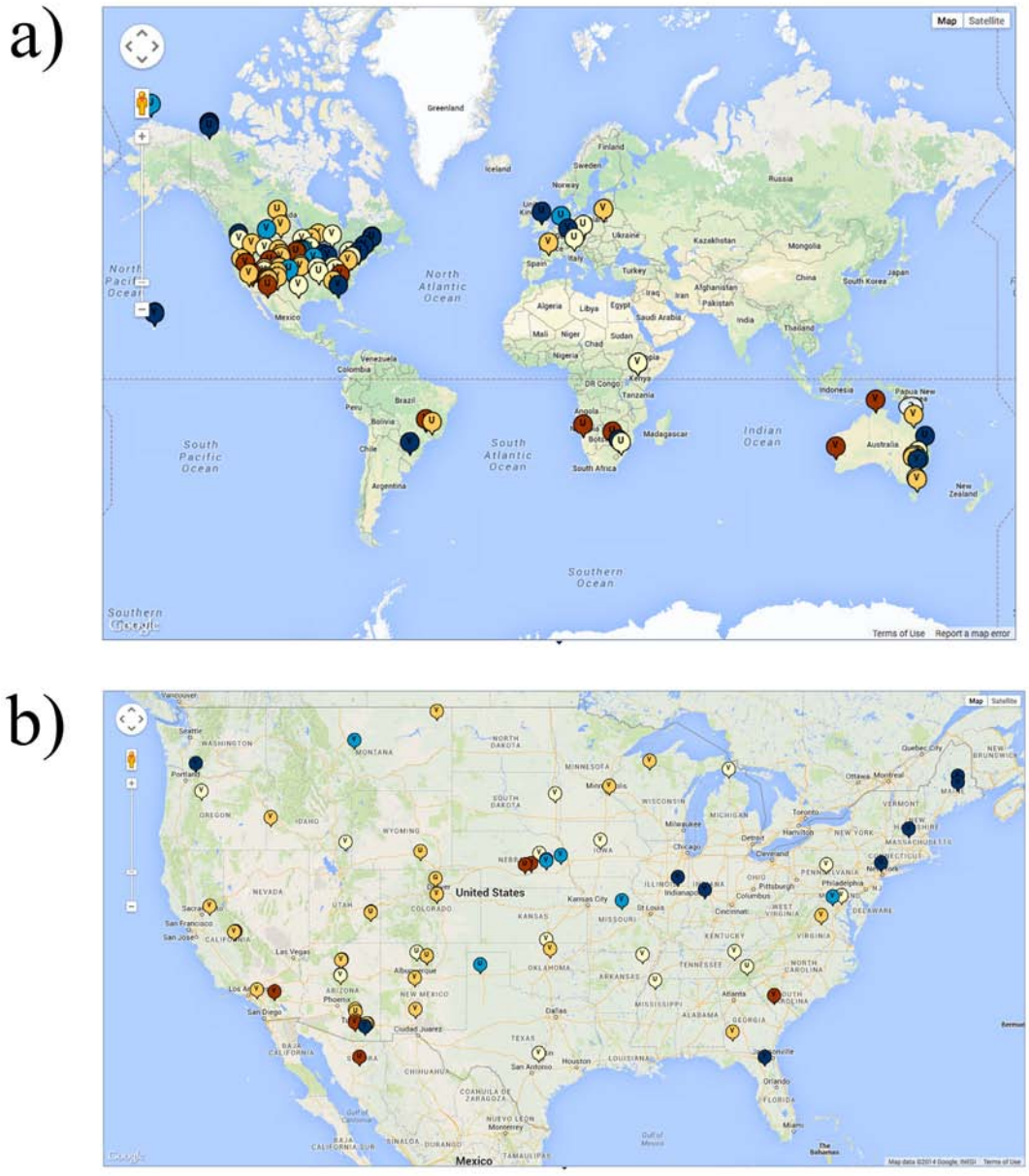

Figure 3: **a**) Global and **b**) Continental United States locations of cosmic-ray neutron probes reporting to the COSMOS data portal (http://cosmos.hwr.arizona.edu/Probes/probemap.php) as of 29 October 2014. Neutron data will be corrected for variations in location, pressure, high-energy intensity. Offline corrections for changes in atmospheric humidity are still currently required because of the need for local air temperature and relative humidity data.

The principles of neutron detection with proportional counters are well-established (Knoll, 2000). Here we use the moderated or fast neutron detector implemented in the COsmic-ray Soil Moisture Observing System, COSMOS (Zreda et al., 2012). The fast neutron detector is shielded by 2.5 cm of plastic making it most sensitive to neutrons between ~1 eV and 1000 eV (Desilets, 2011). We note from neutron transport modeling that the relationship between average hydrogen content and neutron flux is nearly identical over these energy ranges. The fast detector measures the intensity of low-energy cosmic-ray neutrons where the intensity depends on the chemical composition of the material, in particular the medium's hydrogen content due to its high moderation power (as summarized with references in Zreda et al., 2012). Fast neutrons (~1 MeV), a tertiary cosmic ray flux created by high-energy secondary cosmic-ray neutrons, exist in a well-mixed reservoir comprising soil and air (Zreda et al., 2012). During the moderation process, fast neutrons can mix at the scale of hundreds of meters in air and tens of centimeters in soil (Desilets and Zreda, 2013). Finally, we note that the technique relies on many of the same physical principles underlying the long established "active" neutron method used in agronomy since the late 1940s (Gardner and Kirkham, 1952), but applied to a larger spatial scale. The key differences are the natural source of neutrons from cosmic-ray interactions, which provide a lower neutron counting rate, and the measurement of fast neutrons in the air as opposed to slow neutrons in the soil. The spatially distributed nature of the natural neutron source combined with the long scattering length for neutrons in air give the CRNP its large footprint.

Neutron Correction Factors and the Calibration Function

In order to convert moderated neutron counts into volumetric soil moisture we first correct the neutron counts for variations in location, incoming high-energy particles, atmospheric pressure, and absolute humidity following established protocols (Zreda et al., 2012). The corrected neutron counts are then converted to volumetric pore water content using the calibration function originally proposed by (Desilets et al., 2010) and further modified by (Bogena et al., 2013). The calibration function is given by:

$$\left(\theta_p + \theta_{LW} + \theta_{SOC_{eq}}\right)\rho_{bd} = \frac{0.0808}{\frac{N}{N_0\left(BWE\right)} - 0.372} - 0.115 \quad , \qquad (1)$$

where θ_P is pore water content (g/g), θ_{LW} is lattice water content (g/g), θ_{SOCeq} is soil organic carbon water content equivalent (g/g), ρ_{bd} is dry soil bulk density (g/cm^3), N is the corrected neutron counts per time interval (cph or cpm), N_0 is an instrument specific calibrated parameter that represents the count rate over dry silica soils (cph or cpm), and BWE is the biomass water equivalent (mm). We note that volumetric water content equals $\theta_P * \rho_{bd}$ (cm^3/cm^3). Soil organic carbon water content equivalent is estimated from on-site soil chemistry sampling as:

$$\theta_{SOC_{eq}} = \left(TC - \frac{12}{44}CO_2\right)0.5556 \quad , \qquad (2)$$

where TC is the soil total carbon (g/g), CO_2 is the soil CO_2 (g/g), $12/44$ is the stoichiometric ratio of carbon to CO_2, and 0.5556 is the stoichiometric ratio of H_2O to organic carbon (assuming organic carbon is cellulose $C_6H_{10}O_5$).

We found that a linear function can be used to describe the dependence growing biomass on the parameter. We suggest establishing the linear function parameters by local sampling in order to remove any sensor bias that may exist. The BWE can be found from biomass sampling as:

$$BWE = SWB * (1 - BWC) * 0.5556 + SWB * BWC \quad , \qquad (3)$$

where ***SWB*** is the standing wet biomass per unit area (kg/m^2 ~ mm of water/m^2), ***BWC*** is the biomass water content (g/g) found by oven drying samples at 70°C for 5 days ((Wet-Dry)/Wet), and ***0.5556*** is the stoichiometric ratio of H_2O to dry biomass (assuming dry biomass is cellulose $C_6H_{10}O_5$).

Field Calibration

The distribution of pore water is highly variable, thus requiring a large number of samples to get a spatially representative value with low standard error. For the calibration procedure, we typically use a split tube sampler with six 5 cm rings covering a depth of 30 cm in the vertical. We have found that collecting samples at 18 locations and 6 depths (108 total) provides a good estimate of the mean volumetric water content with low standard error (< 0.007 m^3/m^3). The sample locations are every 60 degrees (0, 60, 120, 180, 240, 300) and radii of 25, 75, and 200 m. This pattern was chosen such that each sample location (and representative area) is given equal weight in the cosmic-ray neutron probe sensitivity (sensitivity dies off exponentially from sensor). We note that these points don't need to be exact (within several meters is sufficient), but most importantly they should be representative of the whole sampling quadrant. From a known volume sample, the soil bulk density and volumetric water content can be estimated by gravimetric methods. The standard gravimetric method is to obtain the wet soil weight and dry soil weight following oven drying at 105°C for 24 to 48 hours.

Lattice water is the amount of water contained in the structure of clay minerals. Soil organic carbon water equivalence is the amount of water contained in the organic carbon compounds. This analysis must be performed in a laboratory. We typically use Actlabs Inc. of Ontario Canada, with codes 4E-exploration, 4F-CO2, 4F-C, 4F-H2O+/-, and 4F-C Organic to estimate the basic soil chemical elements. We know that lattice water varies significantly around the continental US and is a function of both the soil formation, and is highly correlated with clay content and soil provenance (mature volcanic soils have among the highest lattice water contents) . But the distribution of lattice water is not known a priori at most sites.. We are currently in the process of compiling a global database and using remote sensing information to help approximate values where local sampling is challenging. Fortunately we have found lattice water does not vary greatly within a CRNP footprint. We recommend collecting one site-representative composite sample for lattice water determination. Following oven drying and weighing of the pore water samples, we typically take ~1 g from each sample to use as a representative sample.

Results

Santa Rita Experimental Range, Tucson, AZ

The cosmic-ray neutron probe soil moisture values has been validated at the Santa Rita Experimental Range (SRER, Figure 4a) near Tucson, AZ using volumetric samples and continuously recording Time-Domain Transmission (TDT) probes (Franz et al., 2012). The SRER receives an average of ~400 mm of rainfall per year, with 50% occurring between July and September and 30% between December and March. Daytime temperatures often exceed 35°C in the summer months and 15°C in the winter months. The study site has ~24% vegetation cover, which is primarily composed of creosotebush (~14%), Larrea tridentate, with the remaining vegetation (~10%) composed of grasses, forbes, catci, and mesquite. The soil is an Agustin sandy loam with 5 to 15% gravel in the top meter, with a caliche layer below one meter. The land surface slopes shallowly (2°) to the northwest.

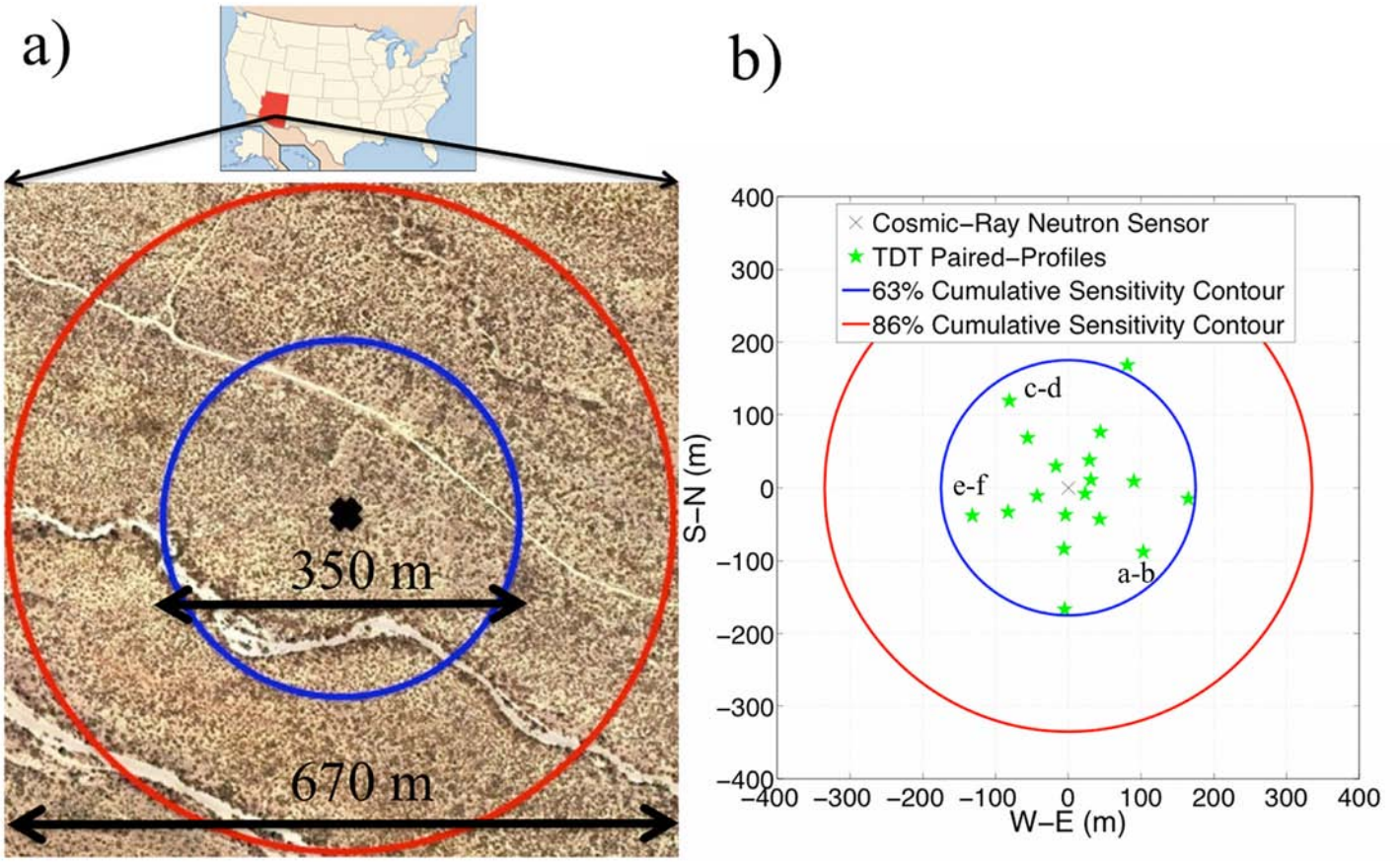

Figure 4: **a**) Location and two radial cumulative sensitivity contours of the cosmic-ray neutron probe at Santa Rita Experimental Range in Southern Arizona (31.9085°N 110.8394°W, elevation 989 m). **b**) Location of eighteen paired soil moisture profiles in open areas and below the canopy where TDT probes were inserted horizontally at 10, 20, 30, 50, and 70 cm depths. Letters a-f are keyed to profiles illustrated in Figure 5. Satellite image is from Google Earth. Figure adapted from Franz et al. (2012).

Five volumetric sampling campaigns were conducted at the site between 2010 and 2012, with an average deviation of less than 0.02 m^3 m^{-3} from the CRNP value, as summarized in Table 1. In the same general spatial distribution of the volumetric calibration datasets, profiles of time-domain transmission probes (TDT) (Model ACC-SEN-TDT from Acclima Inc., Meridian, ID, USA) were installed between 15 and 26 June 2011 (Figure 4b). At each site, probes were placed horizontally at 10, 20, 30, 50, and 70 cm both in open areas and beneath a creosotebush within 3 meters of each other for a paired study. Following excavation of a 1 m^3 soil pit, a chisel of the same dimensions as the TDT probe was used to excavate a cavity in the upslope soil face. The TDT probe was then placed in the cavity using the excavated soil to backfill the remaining void space. After all five probes were in place; we repacked the excavated soil pit using the soil from the same depth location. The half hourly time series of the paired TDT profiles indicates a significant amount of soil moisture variability in the top 30 cm around the footprint (Figure 5). The paired profiles illustrate that soil moisture dynamics can be nearly identical (Figure 5a versus 5b), similar (Figure 5c versus 5d), or different (Figure 5e versus 5f) from the CRNP over different time periods. We found that peak soil moisture following precipitation events was slightly higher on average in canopy profiles compared to open profiles (~0.02 m^3 m^{-3}). We also found that no wetting fronts reached the 50 cm probes during the summer monsoons. However, rainfall events in the winter season (see Figure 6b), when evapotranspiration is lower, led to deep percolation as indicated by both the individual profiles (Figure 5, particularly 5a and 5d) and the spatially averaged TDT profiles at 50 and 70 cm (Figure 6a), which is consistent with previous work. The spatial average of the TDT probes results in a standard error of the mean of less than 0.01 m^3 m^{-3} for all depth profiles (Figure 6a).

Table 1: Summary of Volumetric Calibration Datasets and Uncertainty Between Various Datasets. Adapted from Franz et al. (2012).

Calibration Sample Date	10/10/2010	1/6/2011	9/11/2011	12/15/2011	2/18/2012	All Five Calibration Datasets
Depth Weighted Soil Moisture ($m^3\ m^{-3}$)	0.0517	0.0682	0.1046	0.1420	0.0810	-
Computed N_0 (counts hr^{-1})	3311.9	3291.7	3116.2	3172.6	3228.9	3187.0
Matrix of Soil Moisture Deviation Between Calibration Datasets ($m^3\ m^{-3}$)						
10/10/2010	-	0.0018	0.0166	0.0120	0.0072	0.0108
1/6/2011	-0.0021	-	0.0172	0.0118	0.0063	0.0104
9/11/2011	-0.0295	-0.0263	-	-0.0081	-0.0165	-0.0102
12/15/2011	-0.0259	-0.0220	0.0097	-	-0.0101	-0.0025
2/18/2012	-0.0098	-0.0074	0.0126	0.0064	-	0.0048
Computed Uncertainty of Calibration Datasets						
Average Absolute Deviation Between Calibration Datasets ($m^3\ m^{-3}$)	0.0168	0.0144	0.0140	0.0096	0.0101	0.0097
Percent Error of Observed Soil Moisture	32.5	21.0	13.4	6.7	12.4	19.4% at 0.05 $m^3\ m^{-3}$ and 6.5% at 0.15 $m^3\ m^{-3}$

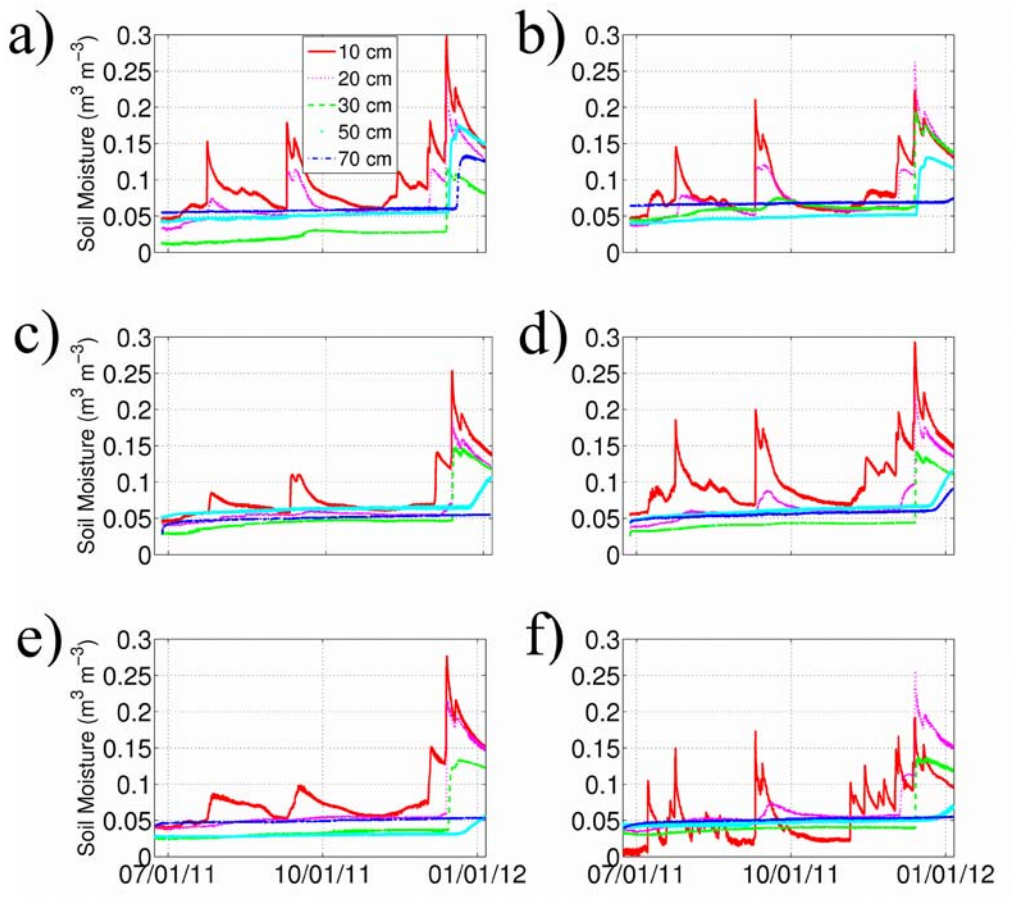

Figure 5: Time series of three paired TDT profiles (**a-b**, **c-d**, **e-f**) at different locations (shown in Fig. 4b) within the cosmic-ray footprint. Left column: profiles in open areas, right column: profiles under canopy. Figure adapted from Franz et al. (2012).

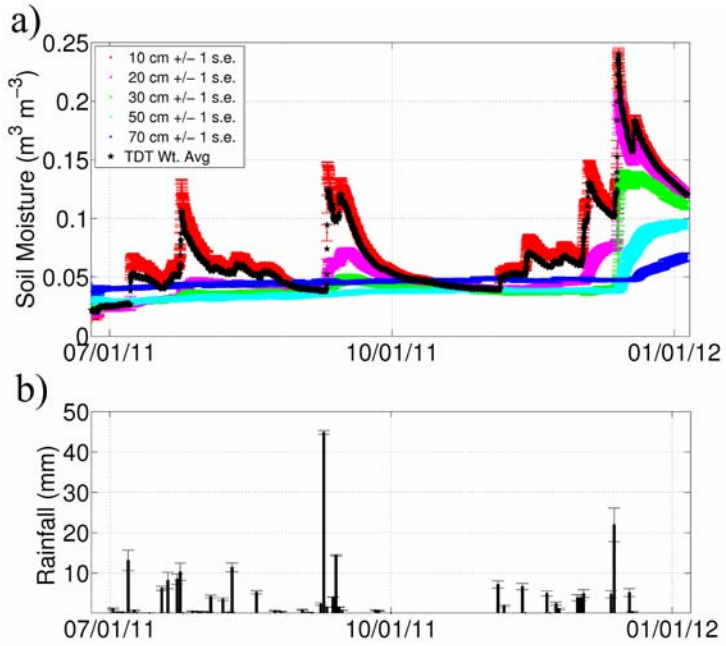

Figure 6: **a**) Time series of spatially averaged TDT water content by depth and weighted average from eighteen paired profiles. **b**) Time series of daily rainfall from twelve rain gauges within footprint. Error bars are 1 standard error of the mean. Figure adapted from Franz et al. (2012).

Using the best fit N_0 from the volumetric calibration datasets, Figure 7 illustrates the relationships between the derived calibration function, equation (1) with N_0 = 3187 counts hr^{-1}, the five volumetric calibration datasets and the continuous TDT validation datasets over the study period. Using the derived calibration function, we find the TDT validation datasets have an R^2 = 0.822, RMSE = 0.0165 m^3 m^{-3} and $p < 0.001$ over the 6-month study period. The remaining 18.8% of variation in the signal could be due to a variety of reasons including: neutron count uncertainty, sampling uncertainty and spatial variability, slight hysteresis in neutron counts during wetting and drying fronts, and changes in background hydrogen pools other than those considered in the analysis. Overall the RMSE of 0.0165 m^3 m^{-3} is small, and well within the uncertainty reported in the TDT and TDR literature (Blonquist et al., 2005; Topp et al., 1980).

We used the neutron particle transport model MCNPx to compute the average water content that the cosmic-ray sensor would see given the distribution of pore water from the observed TDT profiles. The comparison between the computed TDT weighted average value and MCNPx modeled value (Figure 8a) shows an RMSE of 0.0044 m^3 m^{-3}, with maximum deviations of 0.01 to 0.02 m^3 m^{-3} during high near-surface soil moisture due to the existence of sharp wetting fronts in the profile. Using the calibration function estimated in Figure 7, we can compare the CRNP soil moisture data with the TDT weighted averaged values (Figure 8b). We find a RMSE of 0.0108 m^3 m^{-3}, and maximum deviation of 0.03 to 0.04 m^3 m^{-3} during high near-surface soil moisture periods. In addition, we find that the cosmic-ray soil moisture time series decays faster during dry-down periods and is more responsive to small rain events (< 5 mm), which is due to the shallowest TDT probe located at 10 cm depth.

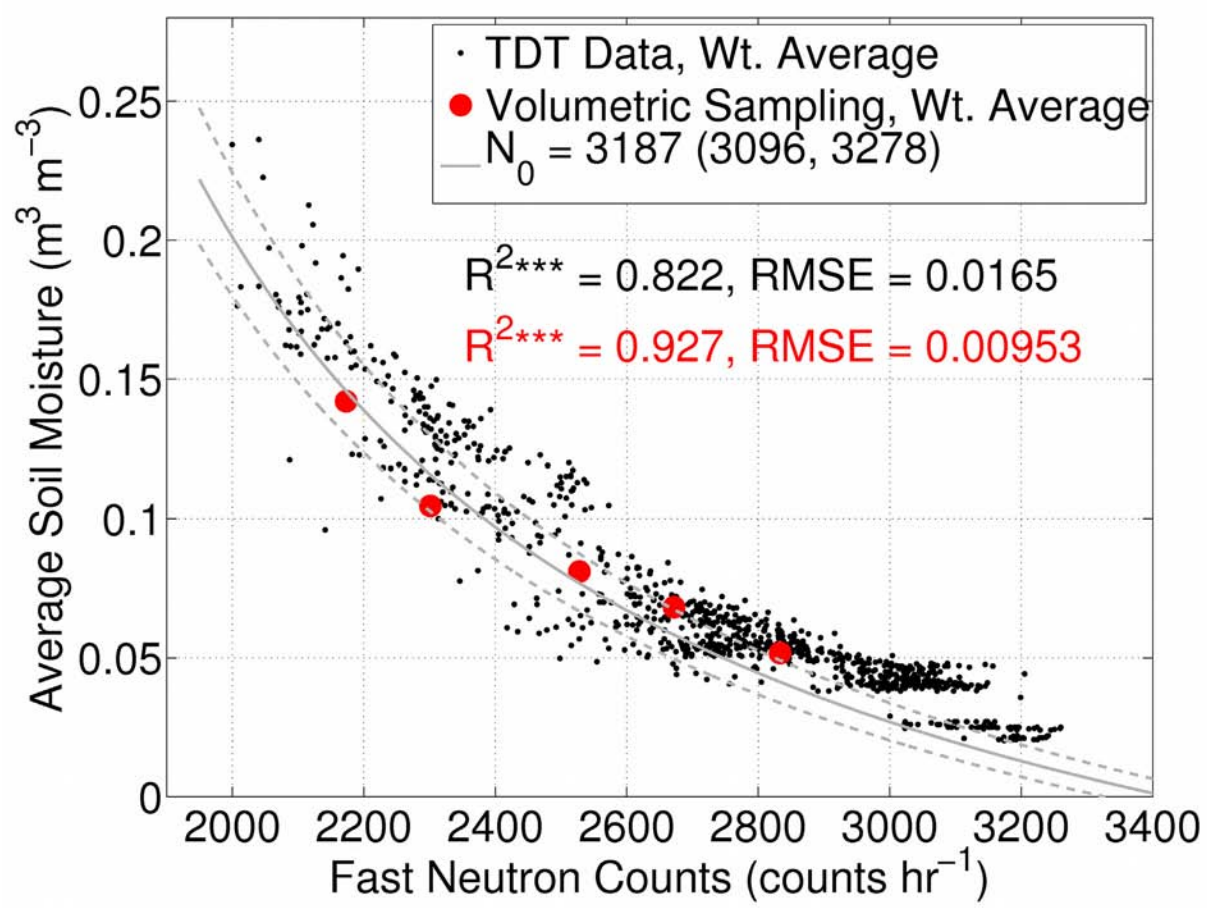

Figure 7: Relationship between observed fast neutron counts and five different volumetric calibration datasets and continuous TDT validation datasets. Data points are averaged over 6 hours periods. Fitted curves are significant at $p < 0.001$ level. Figure adapted from Franz et al. (2012).

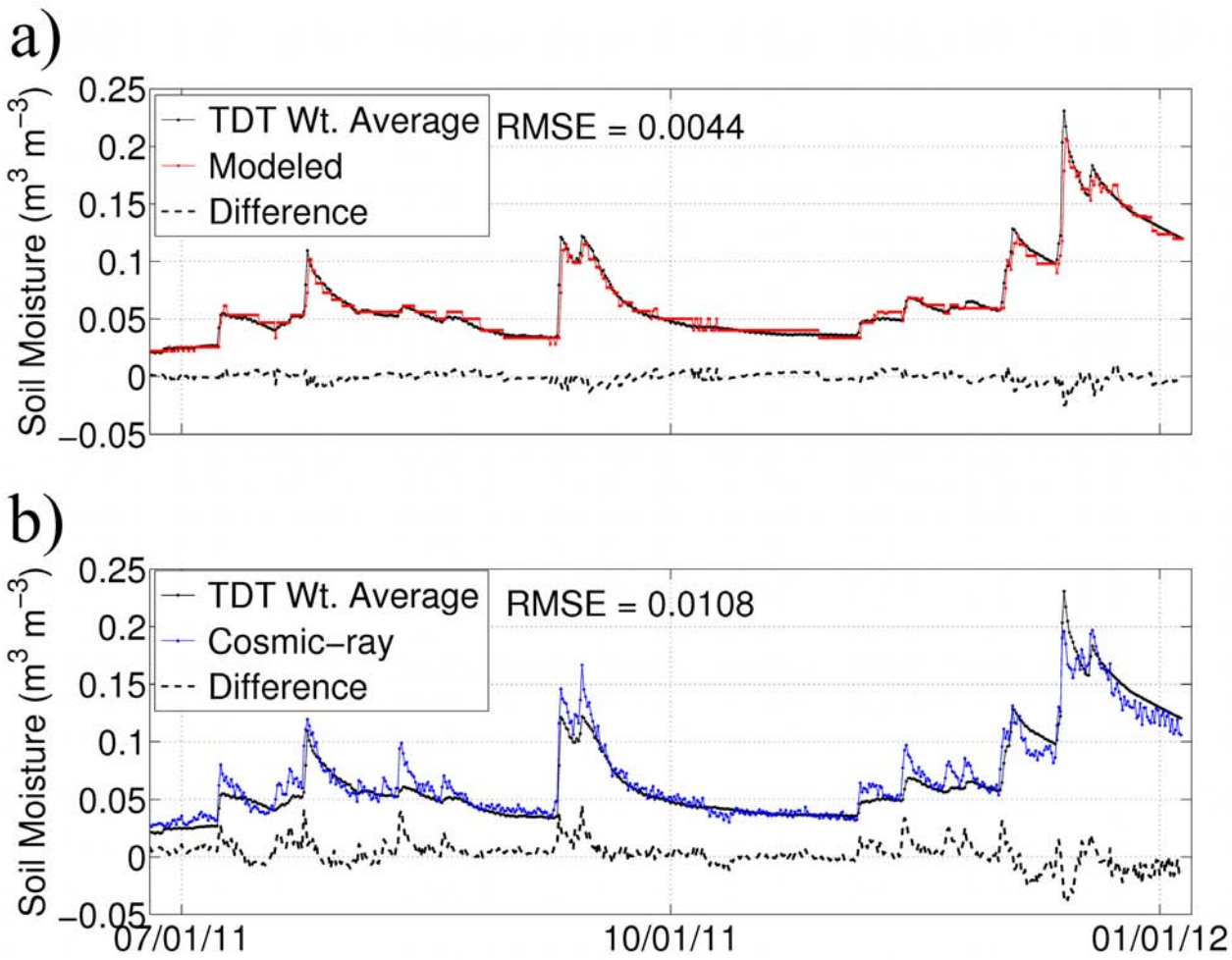

Figure 8: **a**) Comparison between TDT weighted average water content and MCNPx modeled water content using observed spatially averaged profiles from 10, 20, 30, 50, and 70 cm. **b**) Comparison between TDT weighted average water content and observed water content from cosmic-ray sensor. Data points are averaged over 8 hours. Figure adapted from Franz et al. (2012).

Mixed Irrigated Agriculture, Waco, NE

A soil moisture monitoring network consisting of three stationary CRNP and multiple rover surveys was setup in 2014 over a 12 km by 12 km area around Waco, NE, USA (center of study area 40.8976°N, 97.4604°W, Figure 9a) (Franz et al. 2014, In review). Because of the intense agricultural production the study area contains a square lattice of paved and gravel roads at 1.6 km spacing (Figure 9b), making the location an ideal setting for a roving CRNP. The study area comprises a mixture of built up urban areas (1.26%), natural wetlands (8.03%), and predominantly irrigated maize (51.82%) and soybean (38.89%) partitioned by quarter section areas or smaller (Figure 9b). The dominant form of irrigation is with center-pivot sprinklers. Given the available growing season rainfall in the study area, seasonal irrigation is often supplemental with the heaviest periods beginning in early July and continuing through August. The 2014 growing season (May to September) was an above average year (data available from the High Plaines Regional Climate Center) with widespread irrigation only occurring between late July and mid August with a total applied irrigation depth around 90 mm (Pers. Comm. with Romper Farms, 16 October 2014).

Three stationary CRNP (model CRS 2000/B from Hydroinnova LLC, Albuequerque, NM USA) were setup in late April 2014 at an irrigated maize field (40.9482°N, 97.4875°W), an irrigated soybean field (40.9338°N, 97.4587°W), and a rainfed mixed maize and soybean field (40.8899°N, 97.4586°W) within the study area, Figure 9a. At each site, hourly values of moderated neutron

counts, air pressure, air temperature, and relative humidity were recorded for processing (Zreda et al., 2012). Over the course of the growing season, 11 calibration datasets (5 at each of the two irrigated sites and 1 at the rainfed site) were collected for variables of area average gravimetric water content, soil bulk density, soil lattice water, soil organic carbon, wet above ground biomass, and dry above ground biomass following established protocols (Zreda et al., 2012), see Figure 10. Calibration datasets took between 2 and 4 hours to complete on each sampling day.

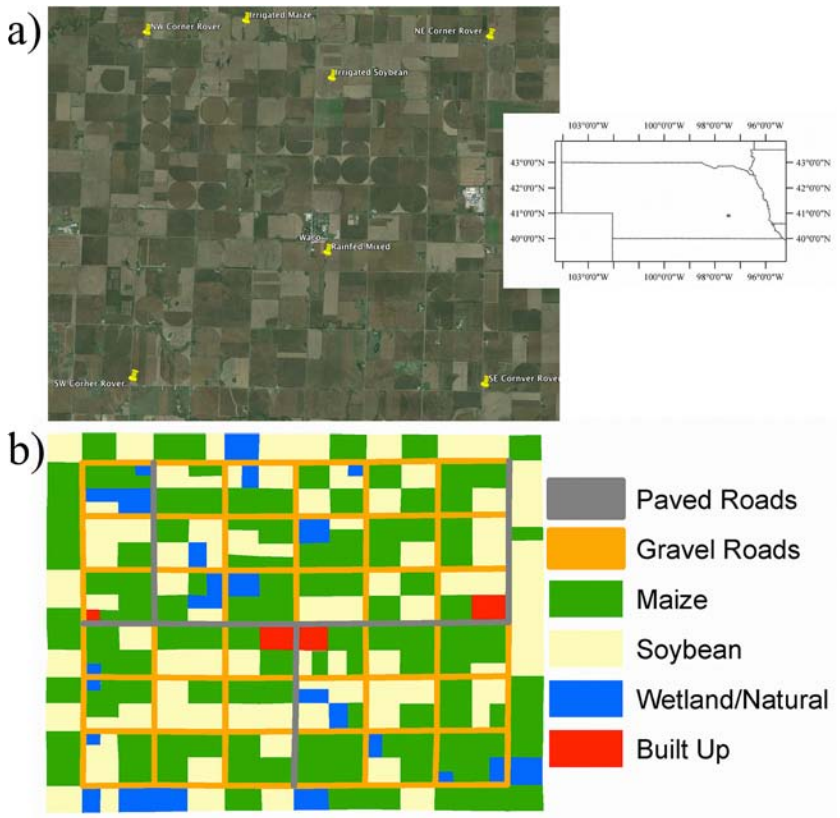

Figure 9: **a**) Location of the 12 km by 12 km study area in eastern Nebraska (gray box in inset) and location of rover survey boundaries and three stationary CRNP in irrigated maize, irrigated soybean and rainfed mixed. **b**) 2014 land cover map classifying the study area into four categories and illustrating the 1.6 km network of gravel and paved roadways. Adapted from Franz et al. (2014 in review).

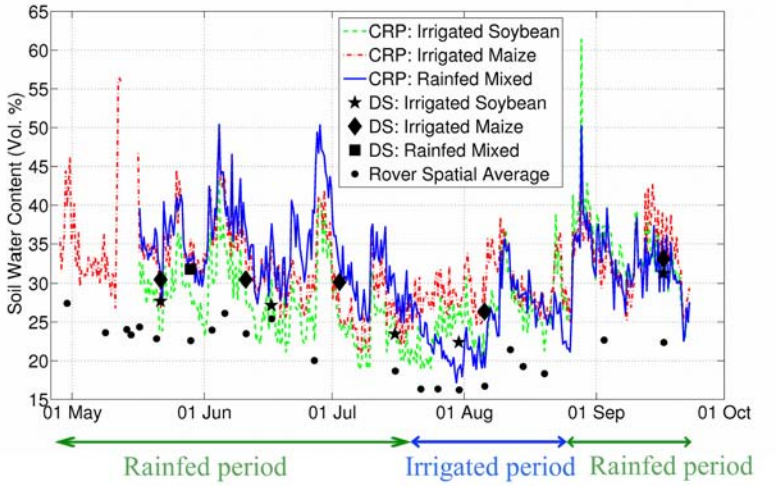

Figure 10: Comparison of soil water content from the three stationary CRNP (green, red, and blue lines) and average from the twenty-two CRNP rover surveys (black dots) between May and September 2014. Gravimetric estimates from calibration datasets are also shown (black diamonds, black stars, and black square). Adapted from Franz et al. (2014 in review).

Between 29 April and 16 September 2014, twenty-two mobile CRNP surveys were collected across the study site. The cosmic-ray rover (Hydroinnova LLC, Albuequerque, NM USA) is composed of eight specially designed extra long (~1.8 m as compared to ~0.9 m) CRS 2000/B tube capsules and has counting rates are approximately 15 times greater than the CRS 2000/B model, allowing for 1-minute level measurements with sufficiently low uncertainty (~350 counts per minute with an uncertainty of ~ 5%). The eight capsules are mounted on a custom frame with shock mounts, which is bolted to the bed of a vehicle (Figure 2d). Air temperature, air pressure, relative humidity, and location were also recorded at 1-minute intervals. During a rover survey, the vehicle was driven at a maximum speed of 0.8 km per minute, first in a North-South boustrophedonic pattern, then followed by an East-West survey, see Figure 11 for example survey points and spatially interpolated neutron count and soil moisture fields. Given the use of heavy equipment and routine maintenance of gravel roads, closures occurred often, requiring the vehicle to double-back and/or periodically skip certain sections. In general, rover surveys took between 4 and 6 hours to complete resulting in between 240 and 360 neutron count observation points. Start times of the surveys varied between 9AM and noon local time. Because of the required time to collect a rover survey and calibration dataset, all data processing was done with a time resolution of 8 hours. Future work may be able to further reduce the temporal resolution of the observations. Figure 10 illustrates the mean values of all rover surveys showing the consistent temporal behavior with the stationary probe values but with consistently lower absolute values. The difference in the absolute values are due to the fact that the rover surveys were all collected from the single-lane gravel and paved roadways. During calibration sampling the rover was driven to within 5 m of the stationary probe and showed consistent behavior indicating the influence of the dry roadways on the rover surveys.

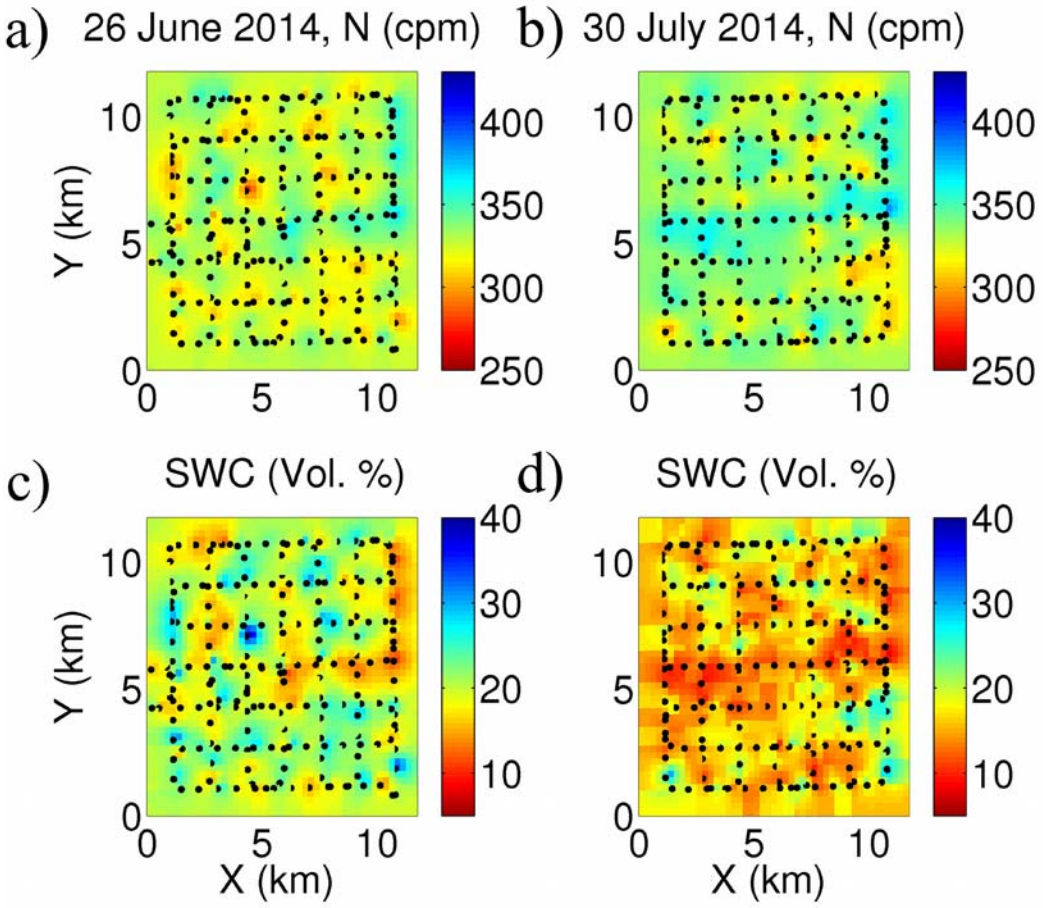

Figure 11: **a** and **b**) Neutron count field and corresponding **c** and **d**) soil water content for **a** and **c**) a rainfed and **b** and **d**) irrigated period. Black dots correspond to measurement locations. Adapted from Franz et al. (2014 in review).

Summary and Future Work

In this article we describe the rapidly evolving cosmic-ray neutron method for estimating area-average soil moisture over an area of 0.28 km^2 and depths down to 10-40 cm. We provide basic procedures for correcting raw neutron counts, converting corrected counts into volumetric water content, and performing instrument calibration. In addition we summarize results from two CRNP studies that have extensive independent soil moisture data. The first was in a shrubland in southern Arizona where we compared the mean values from a distributed network of TDT probes versus the CRNP values showing excellent agreement (RMSE < 0.02 m^3/m^3). The second and on-going study used a combination of stationary CRNP and mobile CRNP surveys to characterize the spatiotemporal patterns of soil moisture fields over a 12 km by 12 km area in an intense agricultural setting in eastern Nebraska. Given the CRNP measurement volume we are encouraged for using these techniques in a variety of ways in agricultural settings, from monitoring individual fields with a stationary CRNP, to monitoring thousands of fields by combing data from a few stationary CRNP with spatial data from mobile CRNP surveys with data fusion techniques.

On-going research is investigating the practicality of scheduling irrigation with CRNP directly or complementing the CRNP data with existing irrigation scheduling practices like those used by the 1350+ producers in the Nebraska Agricultural Water Management Demonstration Network (NAWMDN) (Irmak et al., 2010). Preliminary results indicate the usefulness of using CRNP to help cross-calibrate and validate the inexpensive point sensors used by NAWMDN. With the rising demand for food and water resources, solutions that seek to ensure food security without devastating ecosystem services (Scott et al., 2014) will need to be provided at integrative scales and involve multiple stakeholders. The effective integration of key water resource components from remote sensing products (Brena-Naranjo et al., 2014), on-site local networks (Irmak et al., 2010), and land surface modeling (Santanello et al., 2011) will be essential for ensuring the future water resources provided by aquifers around the globe. The CRNP and network design strategies presented here fills an important observational gap as it provides a methodology to connect local soil moisture conditions of an individual field to larger scales where remote sensing products and land surface modeling can be utilized.

Acknowledgments

This research is supported by the Daugherty Water for Food Institute at the University of Nebraska, NSF EPSCoR FIRST Award, and Cold Regions Research Engineering Laboratory. We would also like to thank Chase Johnson and Romher Farms for providing access to field sites near Waco, NE, the Santa Rita Experimental Range for providing field sites near Tucson, AZ, and Gary Womack for support with the rover.

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INDUSTRY NEWS

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Dualem Inc. has developed new six-array EM instruments to complement the DUALEM-421 and DUALEM-642 (pictured), which were introduced respectively in 2008 and 2012. As shown in the literature, six-array instruments can enable meaningful analysis of conductive layering to, and occasionally beyond, their nominal depth of exploration. The DUALEM-21H has dual arrays of 2-, 1- and half-meter length, with nominal 3-m depth of exploration. The DUALEM-842 has dual arrays of 8-, 4- and 2-m length, with nominal 13-m depth of exploration. For longer instruments and/or higher conductivities, interpretational tools such as EMTOMO and Aarhus Workbench can provide a fuller analysis of layering by considering both in-phase and quadrature amplitudes of each array. For more information, go to http://www.dualem.com/.

INDUSTRY NEWS

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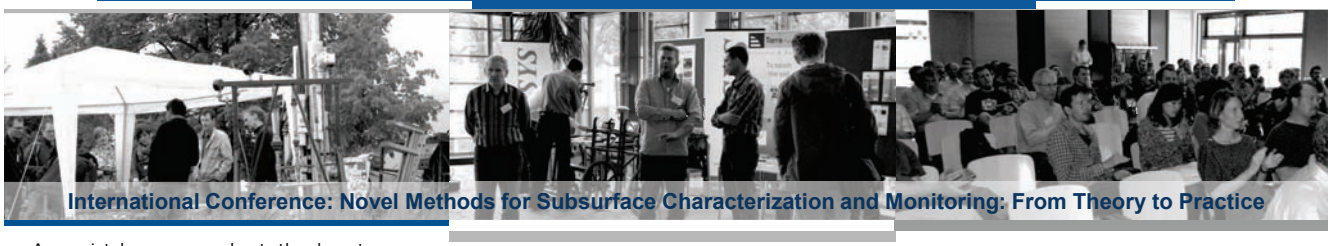

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As societal concerns about the long-term sustainability of groundwater supplies mount, there is a pressing need to improve our understanding of the subsurface and to better monitor and characterize natural and anthropogenic-influenced systems.

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The 4th NovCare Conference in 2015 will showcase newly developed and refined methods, novel applications of existing methods, and new concepts for subsurface characterization and monitoring. NovCare 2015 will again provide an outstanding platform for researchers and practitioners from all over the world to share research on innovative methods for characterization and monitoring of aquifers, soils, and watersheds. Selected papers of NovCare 2015 will be published in a special issue of the ISI journal *Environmental Earth Science*.

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Agricultural Geophysics Webinar Series

Videos of the presentations and panel discussions for the first two agricultural geophysics webinars in 2014 can be accessed at http://www.ag-geophysics.org. The title of the first webinar was "*Application of Geophysics to Agriculture: Methods Employed*", and title of the second webinar was "*Using Ground Penetrating Radar in Agriculture*". This is an ongoing series, with the next webinar scheduled for April 2015. The next webinar will focus on agricultural applications of geophysical methods used to measure soil electrical conductivity. Information and registration (no cost) for the next webinar will be available through http://www.ag-geophysics.org in February 2015.

COMING EVENTS AND ANNOUNCEMENTS

FUNDING AVAILABLE FOR ENVIRONMENTAL TECHNOLOGY DEMONSTRATIONS

ALEXANDRIA, VA, January 8, 2015—The Department of Defense (DoD), through the **Environmental Security Technology Certification Program** (ESTCP), supports the demonstration of technologies that address priority DoD environmental requirements. The goal of ESTCP is to promote the transfer of innovative environmental technologies through demonstrations that collect the data needed for regulatory and DoD end-user acceptance. Projects conduct formal demonstrations at DoD facilities and sites in operational settings to document and validate improved performance and cost savings.

ESTCP is seeking proposals for innovative environmental technology demonstrations as candidates for funding beginning in FY2016. This solicitation requests pre-proposals via Calls for Proposals to Federal organizations and via a Broad Agency Announcement (BAA) for Private Sector organizations. **PRE-PROPOSALS ARE DUE BY MARCH 12, 2015.**

Detailed instructions are on the ESTCP website: https://serdp-estcp.org/Funding-Opportunities/ ESTCP-Solicitations/Environmental-Technologies-Solicitation.

DoD organizations (Service and Defense Agencies) may submit pre-proposals for demonstrations of innovative environmental technologies in the following topic areas**:**

- Environmental Restoration - Technologies to address the reduction of the Department's current and future liabilities through cost-effective management and remediation of contaminants in soil, sediments, and water, as well as the treatment of wastewater on fixed installations.
- Munitions Response in Underwater Environments — Technologies to address the reduction of the Department's current liabilities due to unexploded ordnance and discarded military munitions at underwater sites.
- Resource Conservation — Technologies to support the sustainability of installations and training and testing areas.
- Weapons Systems and Platforms — Technologies to reduce, control, or eliminate the sources of wastes and emissions in the manufacturing, maintenance, and use of weapons systems and platforms.

The Broad Agency Announcement (BAA) and Call for Proposals (CFP) from Federal Organizations Outside DoD are seeking pre-proposals for environmental technologies in the following topic areas**:**

- Management of Contaminated Groundwater
- Detection, Classification, and Remediation of Military Munitions in Underwater Environments

WEBINAR – JANUARY 16: ESTCP Director Dr. Anne Andrews and Deputy Director Dr. Andrea Leeson will conduct an online seminar "***ESTCP Funding Opportunities***" on **January 16, 2015**, from **1:00-2:00 p.m. Eastern Time**. This briefing will offer valuable information for those interested in new ESTCP funding opportunities. During the online seminar, participants may ask questions about the funding process, the current ESTCP solicitation, and the proposal submission process. **Pre-registration for this webinar is required**. To register, visit https://cc.readytalk.com/r/bjmshmowuzug&eom. If you have difficulty registering, please contact the ESTCP Support Office at partners@hgl.com or 703-736-4547.

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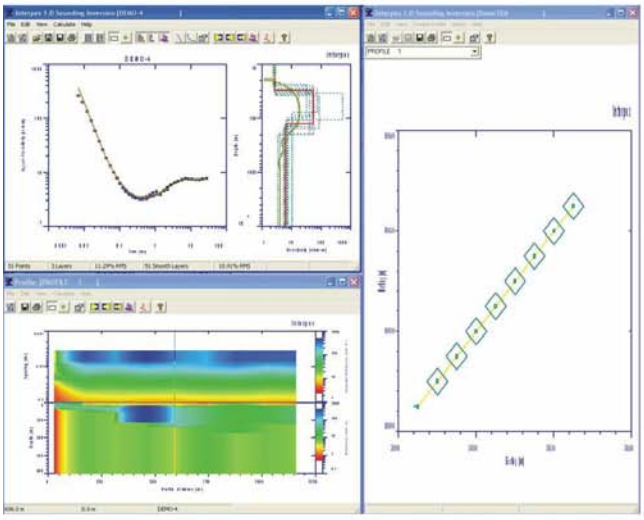

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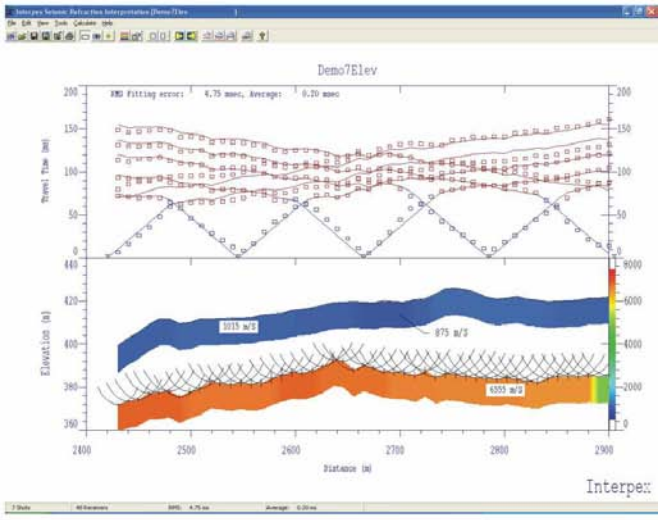

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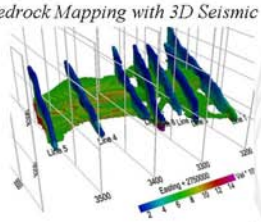
Bedrock Mapping with 3D Seismic



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- *Sinkholes and Cavity Detection*
- *Landslide Delineation*
- *Soil & Rock Characterization*
- *Aquifer Characterization*
- *Structure Mapping*
- *Groundwater Basin Mapping*
- *Archeological Investigations*
- *Contaminant Tracking*
- *Time-lapse Monitoring*
- *UXO/MEC Detection*

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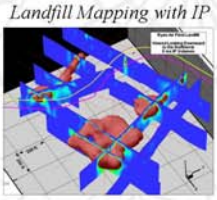

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- Resistivity, IP, CR
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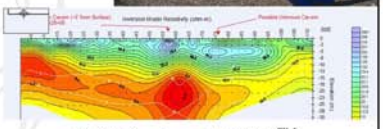

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zonge@zongenev.com

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720.962.4444
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Soldotna, AK 99669
907.262.5072
zonge@alaska.net

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4700 West 77th Street
Minneapolis, MN 55435
952.832.2616
zongeminn@zonge.com

Environmental and Engineering Geophysical Society

2015 Individual Membership Application

Renew or Join Online at www.EEGS.org

Individual Membership Categories

EEGS is the premier organization for geophysics applied to engineering and environmental problems. Our multi-disciplinary blend of professionals from the private sector, academia, and government offers a unique opportunity to network with researchers, practitioners, and users of near-surface geophysical methods.

Memberships include access to the *Journal of Environmental & Engineering Geophysics (JEEG)*, proceedings archives of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), and our quarterly electronic newsletter, *FastTIMES*. Members also enjoy complimentary access to SEG's technical program expanded abstracts, discounted SAGEEP registration fees, books and other educational publications. EEGS offers a variety of membership categories tailored to fit your needs. Please select (circle) your membership category and indicate your willingness to support student members below:

☐ **Yes, I wish to sponsor _____ student(s) @ $20 each to be included in my membership payment.**

Individual Members **New this year: Individual members are invited to sponsor student members. Simply indicate the number of students you'd like to support (at $20 each) to encourage growth in this important segment of EEGS' membership.**

Category	Electronic *JEEG* Available Online	Printed *JEEG* Mailed to You
Individual	$90	$110

Retired Members **Your opportunity to stay connected and support the only membership organization focusing on near surface geophysics. New this year: Retired members are invited to sponsor student members. Simply indicate the number of students you'd like to support (at $20 each) to encourage growth in this important segment of EEGS' membership.**

Category	Electronic *JEEG* Available Online	Printed *JEEG* Mailed to You
Retired ***Must be Approved by EEGS Board of Directors***	$50	$110

Introductory Members **If you have not been a member of EEGS before, Welcome! We offer a reduced rate for new members to enjoy all the benefits of individual membership (except vote or hold office) for one year.**

Category	Electronic *JEEG* Available Online	Printed *JEEG* Mailed to You
Introductory	$50	$110

Developing World Members **Those wishing to join this category of EEGS membership are invited to check the list of countries to determine qualification.**

Category	Electronic *JEEG* Available Online	Printed *JEEG* Mailed to You
Developing World ***(List of qualifying countries next page)***	$50	$110

Student Members **Students represent EEGS' future and we offer complimentary membership subsidized by Corporate Student Sponsor Members and Individual members who choose to sponsor students. Student members enjoy all the benefits of individual membership (except to vote or hold office). Available for all students in an accredited university up to one year post-graduation. Please submit a copy of your student ID and indicate your projected date of graduation: ___ /____ (Month/Year).**

Category	Electronic *JEEG* Available Online	Printed *JEEG* Mailed to You
Student	No Cost (Students sponsored by Corporate Student Sponsor Members and participating Individual Members)	$70

Membership Renewal
Developing World Category Qualification

If you reside in one of the countries listed below, you are eligible for EEGS's Developing World membership category rate of $50.00 (or $100.00 if you would like the printed, quarterly *Journal of Environmental & Engineering Geophysics* (*JEEG*) mailed to you). To receive a printed *JEEG* as a benefit of membership, select the Developing World Printed membership category on the membership application form.

Afghanistan
Albania
Algeria
Angola
Armenia
Azerbaijan
Bangladesh
Belize
Benin
Bhutan
Bolivia
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Comoros
Congo, Dem. Rep.
Congo, Rep.
Djibouti
Ecuador
Egypt
El Salvador
Eritrea
Ethiopia
Gambia
Georgia
Ghana
Guatemala
Guinea-Bissau
GuyanaHaiti
Honduras
India
Indonesia
Iran
Iraq
Ivory Coast
Jordan
Kenya
Kiribati
Kosovo
Kyrgyz Republic
Lao PDR
Lesotho
Liberia
Madagascar
Malawi
Maldives
Mali
Marshall Islands
Mauritania
Micronesia
Moldova
Mongolia
Morocco
Mozambique
Myanmar
Nepal
Nicaragua
Niger
Nigeria
North Korea
Pakistan
Papua New Guinea
Paraguay
Philippines
Rwanda
Samoa
Sao Tome and Principe
Senegal
Sierra Leone
Solomon Islands
Somalia
Sri Lanka
Sudan
Suriname
Swaziland
Syria
Taiwan
Tajikistan
Tanzania
Thailand
Timor-Leste
Togo
Tonga
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Uganda
Ukraine
Uzbekistan
Vanuatu
Vietnam
West Bank and Gaza
Yemen
Zambia
Zimbabwe

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Environmental and Engineering Geophysical Society

2015 Corporate Membership Application

Renew or Join Online at www.EEGS.org

EEGS is the premier organization for geophysics applied to engineering and environmental problems. Our multi-disciplinary blend of professionals from the private sector, academia, and government offers a unique opportunity to network with researchers, practitioners, and users of near-surface geophysical methods.

Memberships include access to the *Journal of Environmental & Engineering Geophysics (JEEG)*, proceedings archives of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), and our quarterly electronic newsletter *FastTIMES*. Members also enjoy complimentary access to SEG's technical program expanded abstracts, discounted SAGEEP registration fees, books and other educational publications. EEGS offers a variety of membership categories tailored to fit your needs. We've added value to all the Corporate Membership categories and added two new Website Advertising opportunities. We've packaged the two for an even greater value! Please select (circle) your membership category and rate. EEGS is also offering an opportunity for all EEGS members to help support student(s) at $20 each. Please indicate your willingness to contribute to support of student members below:

☐ **Yes, I wish to support ____ student(s) at $20 each to be included in my membership payment.**

Category	2015 Electronic JEEG	2015 Basic Rate	2015 Basic + Web Ad Package
Corporate Student Sponsor *Includes one (1) individual membership, a company profile and linked logo on the EEGS Corporate Members web page, a company profile in FastTIMES and the SAGEEP program, recognition at SAGEEP and a 10% discount on advertising in JEEG and FastTIMES and Sponsorship of 10 student memberships*	$310	$320	$820 a $1515 value!
Corporate Donor *Includes one (1) individual EEGS membership, one (1) full conference registration to SAGEEP, a company profile and linked logo on the EEGS Corporate Members web page, a company profile in FastTIMES and the SAGEEP program, recognition at SAGEEP and a 10% discount on advertising in JEEG and FastTIMES*	$660	$670	$1170 a $2005 value!
Corporate Associate *Includes two (2) individual EEGS memberships, an exhibit booth and registration at SAGEEP, the ability to insert marketing materials in the SAGEEP delegate packets, a company profile and linked logo on the EEGS Corporate Members web page, a company profile in FastTIMES and the SAGEEP program, recognition at SAGEEP and a 10% discount on advertising in JEEG and FastTIMES*	$2410	$2420	$2920 a $4290 value!
Corporate Benefactor *Includes two (2) individual memberships to EEGS, two (2) exhibit booths and registration at SAGEEP, the ability to insert marketing materials in the SAGEEP delegate packets, a company profile and linked logo on the EEGS Corporate Members web page, a company profile in FastTIMES and the SAGEEP program, recognition at SAGEEP and a 10% discount on advertising in JEEG and FastTIMES*	$4010	$4020	$4520 a $6705 value!
NEW! **Website Advertising**	Purchase Separately		
One (1) Pop-Under, scrolling marquee style ad with tagline on Home page, logo linked to Company web site	$600/yr.	$600/yr.	Package Rates include both website ad locations
One (1) Button sized ad, linked logo, right rail on each web page	$250/yr.	$250/yr.	

Environmental and Engineering Geophysical Society

2015 EEGS Membership Application

Renew or Join Online at www.EEGS.org

CONTACT INFORMATION

Salutation | First Name | Middle Initial | Last Name

Company/Organization | Title

Street Address | City | State/Province | Zip Code | Country

Direct Phone | Mobile Phone | Fax

Email | Website

ABOUT ME: INTERESTS & EXPERTISE

In order to identify your areas of specific interests and expertise, please check all that apply:

Role	Interest or Focus	Geophysical Expertise	Professional/ Scientific Societies	Willing to Serve on a Committee?
☐ Consultant	☐ Archaeology	☐ Borehole Geophysical Logging	☐ AAPG	☐ Publications
☐ User of Geophysical Svcs.	☐ Engineering	☐ Electrical Methods	☐ AEG	☐ Web Site
☐ Student	☐ Environmental	☐ Electromagnetics	☐ ASCE	☐ Membership
☐ Geophysical Contractor	☐ Geotechnical	☐ Gravity	☐ AWWA	☐ Student
☐ Equipment Manufacturer	☐ Geo. Infrastructure	☐ Ground Penetrating Radar	☐ AGU	
☐ Software Manufacturer	☐ Groundwater	☐ Magnetics	☐ EAGE	
☐ Research/Academia	☐ Hazardous Waste	☐ Marine Geophysics	☐ EERI	
☐ Government Agency	☐ Humanitarian Geo.	☐ Remote Sensing	☐ GeoInstitute	
☐ Other	☐ Mining	☐ Seismic	☐ GSA	
	☐ Shallow Oil & Gas	☐ Other	☐ NGWA	
	☐ UXO		☐ NSG	
	☐ Aerial Geophysics		☐ SEG	
	☐ Other		☐ SSA	
			☐ SPWLA	

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(p) 001.1.303.531.7517 | (f) 000.1.303.820.3844 | staff@eegs.org | www.eegs.org

Environmental and Engineering Geophysical Society

2015 EEGS Membership Application

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FOUNDATION CONTRIBUTIONS

FOUNDERS FUND

The Founders Fund has been established to support costs associated with the establishment and maintenance of the EEGS Foundation as we solicit support from larger sponsors. These will support business office expenses, necessary travel, and similar expenses. It is expected that the operating capital for the foundation will eventually be derived from outside sources, but the Founder's Fund will provide an operation budget to "jump start" the work. Donations of $50.00 or more are greatly appreciated. For additional information about the EEGS Foundation (an IRS status 501(c)(3) tax exempt public charity), visit the website at http://www.EEGSFoundation.org.

Foundation Fund Total: $ _____

STUDENT SUPPORT ENDOWMENT

This Endowed Fund will be used to support travel and reduced membership fees so that we can attract greater involvement from our student members. Student members are the lifeblood of our society, and our support can lead to a lifetime of involvement and leadership in the near-surface geophysics community. Donations of $50.00 or more are greatly appreciated. For additional information about the EEGS Foundation (a tax exempt public charity), visit the website at http://www.EEGSFoundation.org.

Student Support Endowment Total: $ _____

CORPORATE CONTRIBUTIONS

The EEGS Foundation is designed to solicit support from individuals and corporate entities that are not currently corporate members (as listed above). We recognize that most of our corporate members are small businesses with limited resources, and that their contributions to professional societies are distributed among several organizations. The Corporate Founder's Fund has been developed to allow our corporate members to support the establishment of the Foundation as we solicit support from new contributors.

Corporate Contribution Total: $ _____

Foundation Total: $ _____

PAYMENT INFORMATION

☐ Check/Money Order ☐ VISA ☐ MasterCard

☐ AmEx ☐ Discover

Subtotals

Membership: $ _____

Student Sponsorship: $ _____

Foundation Contributions: $ _____

Grand Total: $ _____

Card Number **Exp. Date**

Name on Card

Signature

Make your check or money order in US dollars payable to: EEGS. Checks from Canadian bank accounts must be drawn on banks with US affiliations (example: checks from Canadian Credit Suisse banks are payable through Credit Suisse New York, USA). Checks must be drawn on US banks.

Payments are not tax deductible as charitable contributions although they may be deductible as a business expense. Consult your tax advisor.

Return this form with payment to: EEGS, 1720 South Bellaire Street, Suite 110, Denver, CO 80222 USA

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Corporate dues payments, once paid, are non-refundable. Individual dues are non-refundable except in cases of extreme hardship and will be considered on a case-by-case basis by the EEGS Board of Directors. Requests for refunds must be submitted in writing to the EEGS business office.

QUESTIONS? CALL 001.1.303.531.7517

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Geonics Ltd.
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Geophysical Survey Systems, Inc.
www.geophysical.com

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Zonge international, Inc
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Northwest Geophysics
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Spotlight Geophysical Services
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Spotlight Geophysical Services
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EEGS STORE

Environmental and Engineering Geophysical Society

2015 Publications Order Form

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Company: _____

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Country: _____ Phone: _____

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SAGEEP PROCEEDINGS

			Member	Non-Member
	0036	2014 (CD-ROM)	$75	$100
	0034	2013 (CD-ROM)	$75	$100
	0033	2012 (CD-ROM)	$75	$100
	0030	2011 (CD-ROM)	$75	$100
	0029	2010 (CD-ROM)	$75	$100
	0026	2009 (CD-ROM)	$75	$100
	0025	2008 (CD-ROM)	$75	$100
	0023	2007 (CD-ROM)	$75	$100

			Member	Non-Member
	0020	2006 (CD-ROM)	$75	$100
	0018	2005 (CD-ROM)	$75	$100
	0016	2004 (CD-ROM)	$75	$100
	0015	2003 (CD-ROM)	$75	$100
	0014	2002 (CD-ROM)	$75	$100
	0013	2001 (CD-ROM)	$75	$100
	0012	1988-2000 (CD-ROM)	$150	$225
		SUBTOTAL—PROCEEDINGS ORDERED:		

SAGEEP Short Course Handbooks

	0039	2013 Agricultural Geophysics: Methods Employed and Recent Applications - Barry Allred, Bruce Smith, et al.	$35	$45
	0038	2010 Processing Seismic Refraction Tomography Data (including CD-ROM) - William Doll	$35	$45
	0037	2011 Application of Time Domain Electromagnetics to Ground-water Studies – David V. Fitterman	$20	$30
	0032	2010 Application of Time Domain Electromagnetics to Ground-water Studies – David V. Fitterman	$20	$30
	0027	2010 Principles and Applications of Seismic Refraction Tomography (Printed Course Notes & CD-ROM) - William Doll	$70	$90
	0028	2009 Principles and Applications of Seismic Refraction Tomography (CD-ROM w/ PDF format Course Notes) - William Doll	$70	$90
	0007	2002 - UXO 101 - An Introduction to Unexploded Ordnance - (Dwain Butler, Roger Young, William Veith)	$15	$25
	0009	2001 - Applications of Geophysics in Geotechnical and Environmental Engineering (HANDBOOK ONLY) - John Greenhouse	$25	$35
	0011	2001 - Applications of Geophysics in Environmental Investigations (CD-ROM ONLY) - John Greenhouse	$80	$105
	0010	2001- Applications of Geophysics in Geotechnical and Environmental Engineering (HANDBOOK) & Applications of Geophysics in Environmental Investigations (CD-ROM) - John Greenhouse	$100	$125
	0004	1998 - Global Positioning System (GPS): Theory and Practice - John D. Bossler & Dorota A. Brzezinska	$10	$15
	0003	1998 - Introduction to Environmental & Engineering Geophysics - Roelof Versteeg	$10	$15
	0002	1998 - Near Surface Seismology - Don Steeples	$10	$15
	0001	1998 - Nondestructive Testing (NDT) - Larry Olson	$10	$15
	0005	1997 - An Introduction to Near-Surface and Environmental Geophysical Methods and Applications - Roelof Versteeg	$10	$15
	0006	1996 - Introduction to Geophysical Techniques and their Applications for Engineers and Project Managers - Richard Benson & Lynn Yuhr	$10	$15

Miscellaneous Items

	0031	***New Pricing!!*** Advances in Near-surface Seismology and Ground Penetrating Radar—R. Miller, J.Bradford, K.Holliger Special Pricing Available for Limited Time—through March 25, 2015—end of SAGEEP 2015!	$79	$99
	0021	Geophysics Applied to Contaminant Studies: Papers Presented at SAGEEP from 1988-2006 (CD-ROM)	$50	$75
	0022	Application of Geophysical Methods to Engineering and Environmental Problems - Produced by SEGJ	$35	$45
	0019	Near Surface Geophysics - 2005 Dwain K. Butler, Ed.; Hardcover Special student rate - $71.20	$89	$139
	0035	Einstein Redux: A Humorous & Refreshing New Chapter in the Einstein Saga—D.Butler	$20	$25

MISCELLANEOUS ITEMS CONTINUED ON NEXT PAGE...

EEGS STORE

Publications Order Form (Page Two)

		EEGS T-shirt (X-Large) Please circle: white/gray	$10	$10
		EEGS Lapel Pin	$3	$3
		SUBTOTAL—SHORT COURSE/MISC. ORDERED ITEMS:		

Journal of Environmental and Engineering Geophysics **(JEEG) Back Issue Order Information:**
Member Rate: $15 | Non-Member Rate: $25

Qt.	Year	Issue
	1995	JEEG 0/1 - July
		JEEG 0/2 - January
	1996	JEEG 1/1 - April
		JEEG 1/2 - August
		JEEG 1/3 - December
	1998	JEEG 3/2 - June
		JEEG 3/3 - September
		JEEG 3/4 - December
	1999	JEEG 4/1 – March
		JEEG 4/2 - June
		JEEG 4/3 - September
		JEEG 4/4 - December
	2000	JEEG 5/3 - September
		JEEG 5/4 - December
	2001	JEEG 6/1 - March
		JEEG 6/3 - September
		JEEG 6/4 - December
	2003	JEEG 8/1- March
		JEEG 8/2 - June
		JEEG 8/3 - September
		JEEG 8/4 - December

Qt.	Year	Issue
	2004	JEEG 9/1- March
		JEEG 9/2 - June
		JEEG 9/3 - September
		JEEG 9/4 - December
	2005	JEEG 10/1 - March
		JEEG 10/2 - June
		JEEG 10/3 - September
		JEEG 10/4 - December
	2006	JEEG 11/1 - March
		JEEG 11/2 - June
		JEEG 11/3 - September
		JEEG 11/4 - December
	2007	JEEG 12/1 - March
		JEEG 12/2 - June
		JEEG 12/3 - September
		JEEG 12/4 - December
	2008	JEEG 13/1 - March
		JEEG 13/2 - June
		JEEG 13/3 - September
		JEEG 13/4 - December

Qt.	Year	Issue
	2009	JEEG 14/1 - March
		JEEG 14/2 - June
		JEEG 14/3 - September
		JEEG 14/4 - December
	2010	JEEG 15/1 - March
		JEEG 15/2 - June
		JEEG 15/3 - September
		JEEG 15/4 - December
	2011	JEEG 16/1 - March
		JEEG 16/2 - June
		JEEG 16/3 - September
		JEEG 16/4 - December
	2012	JEEG 17/1 - March
		JEEG 17/2 - June
		JEEG 17/3 - September
		JEEG 17/4 - December
	2013	JEEG 18/1 - March
		JEEG 18/2 - June
		JEEG 18/3 - September
		JEEG 18/4 - December
	2014	JEEG 19/1 - March
		JEEG 19/2 - June
		SUBTOTAL—JEEG ISSUES ORDERED

SUBTOTAL - SAGEEP PROCEEDINGS ORDERED	
SUBTOTAL - SHORT COURSE / MISCELLANEOUS ITEMS ORDERED	
SUBTOTAL - JEEG ISSUES ORDERED	
CITY & STATE SALES TAX (If order will be delivered in the Denver, Colorado—add an additional 7.62%)	
SHIPPING & HANDLING (US—$10; Canada/Mexico—$20; All other countries: $45)	
GRAND TOTAL:	

Order Return Policy: Returns for credit must be accompanied by invoice or invoice information (invoice number, date, and purchase price). Materials must be in saleable condition. Out-of-print titles are not accepted 180 days after order. No returns will be accepted for credit that were not purchased directly from EEGS. Return shipment costs will be borne by the shipper. Returned orders carry a 10% restocking fee to cover administrative costs unless waived by EEGS.

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Cardholder Name (Print) _____
Signature: _____

EEGS STORE

Environmental and Engineering Geophysical Society

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2015 Merchandise Order Form

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Name: _____
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Address: _____
City/State/Zip: _____
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E-mail: _____ Fax: _____

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Company: _____
Address: _____
City/State/Zip: _____
Country: _____ Phone: _____
E-mail: _____ Fax: _____

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Merchandise Order Information:

ITEM DESCRIPTION	QTY	EEGS T-SHIRT COLOR WHITE OR GRAY	MEMBER RATE	NON-MEMBER RATE	TOTAL
EEGS Mug			$10	$10	
SAGEEP 2015 T-shirt (Small)			$18	$18	
SAGEEP 2015 T-shirt (Medium)			$18	$18	
SAGEEP 2015 T-shirt (Large)			$18	$18	
SAGEEP 2015 T-shirt (XLarge)			$18	$18	
SAGEEP 2015 T-shirt (XXLarge)			$18	$18	
EEGS T-shirt (XLarge)			$10	$10	
EEGS Lapel Pin			$3	$3	
SUBTOTAL – MERCHANDISE ORDERED:					

TOTAL ORDER:

SUBTOTAL – Merchandise Ordered:	
STATE SALES TAX: (If order will be delivered in Colorado – add 3.7000%):	
CITY SALES TAX: (If order will be delivered in the City of Denver – add an additional 3.5000%):	
SHIPPING AND HANDLING (US - $7; Canada/Mexico - $15; All other countries - $40):	
GRAND TOTAL:	

Payment Information:

☐ Check #: _____ (Payable to EEGS)

☐ Purchase Order: _____
(Shipment will be made upon receipt of payment.)

☐ Visa ☐ MasterCard ☐ AMEX ☐ Discover

Card Number: _____CVV# ____ Cardholder Name (Print): _____

Exp. Date: _____ Signature: _____

Three easy ways to order:
Fax to: 303.820.3844
Internet: www.eegs.org
Mail to: EEGS
1720 S. Bellaire St., #110
Denver, CO 80222-4303

THANK YOU FOR YOUR ORDER!

Order Return Policy: Returns for credit must be accompanied by invoice or invoice information (invoice number, date, and purchase price). Materials must be in saleable condition. Out-of-print titles are not accepted 180 days after order. No returns for credit will be accepted which were not purchased directly from EEGS. Return shipment costs will be borne by the shipper. Returned orders carry a 10% restocking fee to cover administrative costs unless waived by EEGS.

EEGS STORE

Environmental and Engineering Geophysical Society

1720 S. Bellaire Street, Suite 110
Denver, CO 80222-4303
Phone: 303.531.7517
Fax: 303.820.3844
E-mail: staff@eegs.org
Web Site: www.eegs.org

2015 SAGEEP T-SHIRTS Order Form

ALL ORDERS ARE PREPAY

Sold To:

Name: _____
Company: _____
Address: _____
City/State/Zip: _____
Country: _____ Phone: _____
E-mail: _____ Fax: _____

Ship To (If different from "Sold To"):

Name: _____
Company: _____
Address: _____
City/State/Zip: _____
Country: _____ Phone: _____
E-mail: _____ Fax: _____

Instructions:
T-Shirts can be picked up at SAGEEP 2015! Please complete this order form and fax or mail to the EEGS office listed above. Payment must accompany the form or materials will not be shipped. If you wish to pick your order up on site in Austin, TX, mark your form with a check in the space below. **If you will be picking up your T-Shirt(s) at SAGEEP, do not include tax or shipping and handling** – listed prices are inclusive of all fees. Faxing a copy of a check does not constitute payment and the order will be held until payment is received. Purchase orders will be held until payment is received. If you have questions regarding any of the items, please contact the EEGS Office. Thank you for your order!

SAGEEP 2015 T-Shirt Order Information:

ITEM DESCRIPTION	QTY	ONE COLOR/ BLUE	MEMBER NON-MEMBER RATE	PICK UP AT SAGEEP (CHECK)	TOTAL
SAGEEP 2015 T-Shirts – Sizing Chart Available online (http://www.eegs.org/program)					
SAGEEP 2015 T-Shirt (Small)			$18		
SAGEEP 2015 T-Shirt (Medium)			$18		
SAGEEP 2015 T-Shirt (Large)			$18		
SAGEEP 2015 T-Shirt (X-Large)			$18		
SAGEEP 2015 T-Shirt (XX-Large)			$18		
SUBTOTAL –					

TOTAL ORDER:

SUBTOTAL – Merchandise Ordered:	
STATE SALES TAX: (If order will be delivered in Colorado – add 3.7000%):	
CITY SALES TAX: (If order will be delivered in the City of Denver – add an additional 3.5000%):	
SHIPPING AND HANDLING (US - $7; Canada/Mexico - $15; All other countries - $40):	
GRAND TOTAL:	

Payment Information:

☐ Check #: _____ (Payable to EEGS)
☐ Purchase Order: _____
(Shipment will be made upon receipt of payment.)

☐ Visa ☐ MasterCard ☐ AMEX ☐ Discover

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