Proposal #10

Identifying sources of N_2O production in agroecosystems: A step towards more effective mitigation

Texas A&M AgriLife Research Air Quality Research Program
FY 2014-2015

Principal Investigator: Jason West[1], Assistant Professor
Co-Principal Investigator: Thomas Boutton[1], Regents Professor
Collaborator(s): Frank Hons[2], Professor; Jed Sparks[3], Associate Professor
Amount Requested per year: $150,201 **FY 2014**; $49,260 **FY 2015**
[1]Department of Ecosystem Science and Management, Texas A&M University; [2]Department of Soil and Crop Sciences, Texas A&M University; [3]Department of Ecology & Evolutionary Biology, Cornell University

Executive Summary

Identified need. Nitrous oxide (N_2O) is among the most powerful greenhouse gases, with a heat-holding capacity that is 300 times greater than CO_2 on a per molecule basis, and an atmospheric residence time of over 100 years. Its concentration is now increasing exponentially due to human industrial and agricultural activities. In agricultural lands, such as croplands and rangelands, N_2O is produced by soil microorganisms during the processes of nitrification and denitrification. Because the conditions and management activities that favor nitrification versus denitrification are significantly different and quite complex, it is necessary to be able to quantify and distinguish these two N_2O sources in order to develop more effective strategies to mitigate the production rates associated with each source. Although croplands and rangelands strongly dominate the land cover of Texas, our understanding of both the identity and rates of the soil processes that produce N_2O in these systems remains limited.

Research approach. We propose to employ a powerful new methodology that allows the separation of specific soil microbial processes (nitrification vs. denitrification) responsible for N_2O production in two important agricultural systems in Texas. The unique approach relies on the fact that N_2O produced by nitrification has a significantly different intramolecular arrangement of natural N and O isotopes compared to N_2O derived from denitrification. Thus, N_2O derived from each source has a unique isotopic “fingerprint.” This approach has been validated in a small number of laboratories worldwide and has already yielded novel insights regarding the processes responsible for N_2O production. We have the expertise and capacity to develop this method and are requesting funds to integrate the necessary instrumentation and sample preparation tools in our stable isotope facility and to then produce an initial assessment of N_2O sources in: (a) a long-term (> 30 year) agricultural experiment studying crop rotation, tillage and fertilizer effects on soil processes, and (b) a rangeland system with well-described changes in N cycling caused by an important vegetation change (woody encroachment).

Expected deliverables. Two key deliverables are expected. First, we will establish the tools and procedures at our isotope laboratory (http://sibs.tamu.edu) to allow the separation of microbial processes responsible for N_2O fluxes from soils. This will provide exciting new avenues for collaboration across Texas A&M AgriLife Research and with other entities. Second, we will utilize this new capacity to: (a) provide an assessment of tillage and fertilizer effects on N_2O production, (b) the effects of woody encroachment on N_2O in a rangeland system, and (c)

develop proposals to pursue research in both areas based on these findings. Both assessments will be conducted in well-studied systems where the N cycle has been thoroughly documented.

Proposal Narrative

Goals and objectives. Several emerging air quality issues present challenges and potential opportunities for agriculture in Texas. In particular, the role of agricultural land management activities in mitigating or contributing to the flux of recognized greenhouse gases (GHG; e.g., CO_2, N_2O) is increasingly discussed. A key question in any assessment of a change in policy or management activity related to GHG is to what extent will a particular agricultural practice or land use affect the targeted emission? In many cases, the expected outcome is difficult to predict in a quantitative sense, given uncertainties associated with the underlying processes and mechanisms that yield GHG fluxes. In some cases, simply quantifying the process itself presents significant technical challenges. With nearly 300 times the global warming potential of CO_2 over an atmospheric lifetime of approximately a century, N_2O represents an important greenhouse gas. It is also recognized as perhaps the most important greenhouse gas in agricultural systems [1]. Global estimates indicate that fertilized agriculture (crops and animal production systems) contributes approximately 24% of total annual N_2O emissions and that the emissions from lands that are not actively cultivated contribute approximately 55% of total emissions [2]. It is important, therefore, to understand the processes that generate N_2O if viable management strategies are to be developed that reduce its flux to the atmosphere. While its importance to atmospheric chemistry is relatively well understood, the spatial and temporal variation in N_2O fluxes at regional scales remain poorly constrained. The potential impacts of various management activities are similarly uncertain, although some linkages are clear [e.g., with nitrate fertilizers; 3]. This uncertainty is in part because N_2O is produced by a wide range of microbially-mediated processes in soils, including intermediate steps of both autotrophic nitrification and heterotrophic denitrification. The uncertainties are particularly acute for more extensively managed lands, particularly livestock production systems on rangelands. While the flux rates per unit area on rangelands may not be as high as in fertilized agricultural land, their extensive area (>50% of Texas) makes them an important component of the total trace gas flux inventory of the state. In addition, the impacts of large-scale land cover/land use changes on N_2O fluxes are not known. New and better tools are therefore needed to study how land uses including dryland farming, livestock production, various cropping systems, and management changes that target such goals as carbon sequestration or water yield impact the flux of important GHGs like N_2O. ***We propose to assess the microbial sources of N_2O in intensively and extensively managed agricultural soils using a unique and powerful stable isotope technique and leverage this to expanded future research efforts.*** The availability of the proposed technique (described below) would dramatically enhance our ability to assess the underlying mechanisms of observed variation in N_2O fluxes and *would yield a stronger platform for future competitive proposals across Texas AgriLife Research*. We will apply this approach here to a long-term agricultural experiment (>30 years) designed to study the effects of a no-till cropping system and to a well-described rangeland system that has exhibited important N cycle changes in response to significant vegetation change. The primary objectives are to: (1) develop this unique capacity at our existing stable isotope facility at Texas A&M University, (2) provide a preliminary assessment of two key agricultural systems that encompass the wide spectrum of agricultural land in Texas, and then (3) leverage this and other key linkages for competitive proposals following the second project year. We believe the proposed work is responsive to two of the three scientific priority areas identified in the Air Quality Research Initiative, specifically *the development of tools that improve measurement accuracy*, and the *causative or corrective factors responsible for emissions* of recognized greenhouse gases.

Strategies. Our strategy will follow three phases: (1) Implementation and assessment of the N_2O isotopomer technique, (2) Preliminary quantification of underlying mechanisms (nitrification versus denitrification) in intensive and extensive agricultural systems in Texas, and (3) Publication of initial results and development of proposals that integrate this new capacity into larger efforts to understand the impacts of agricultural activities on N trace gas fluxes.

Methodology. *Isotopomer capacity development at SIBS Laboratory (http://sibs.tamu.edu).* The N_2O molecule has a linear structure of the form $N_\beta{=}N_\alpha{=}O$ which also equilibrates with $N_\beta{\equiv}N_\alpha$-O. The basis for the proposed research rests on the fact that microbially-mediated reactions involved in denitrification result in ^{15}N enrichment at the central N_α relative to the terminal N_β, while reactions during nitrification result in smaller ^{15}N discrimination between the central N_α and the terminal N_β. Thus, by determining the intramolecular isotopic composition of N_2O, the relative contributions of nitrification vs. denitrification to the soil N_2O flux can be quantified [4-6]. The proposed effort would include the installation and calibration of the necessary peripherals for N_2O isotopomer analysis in our existing stable isotope facility. This includes the components described below interfaced to an existing isotope ratio mass spectrometer (IRMS). Bulk isotope ratio analysis of N_2O ($\delta^{15}N_{bulk}$, $\delta^{18}O_{bulk}$) will be conducted with a traditional GasBench (Thermo Scientific, Waltham, MA) configuration that utilizes a cryofocusing peripheral (PreCon) and gas chromatography (GC) prior to gas introduction to the IRMS (Delta V, Thermo Scientific, Waltham, MA) to allow the analysis of trace gases in atmospheric samples. In addition, position-dependent ^{15}N abundance of N_2O ($^{15}N^{14}N^{16}O$ versus $^{14}N^{15}N^{16}O$) will be quantified using a similar PreCon/GasBench configuration. The N_2O gas sample must be analyzed twice under different IRMS configurations and will follow modifications of previously published approaches [7]. Briefly, the Precon/GC arrangement allows CO_2 and water to be initially "scrubbed" from the gas stream and then the N_2O to be separated from any remaining CO_2 and water and cryofocused prior to introduction into the mass spectrometer to yield isotope ratios for each N position. A first run is conducted monitoring ions at m/z 44, 45, and 46 and a second to monitor the NO^+ fragment ion (m/z 30 and 31). This analysis yields bulk nitrogen and oxygen isotope ratios and isotope ratios of the central position N with the fragment analysis. Calculation of ^{15}N site preference will follow Toyoda et al. [8].

Measurement suite for all sites. For all experimental units (treatment combination, landscape element, etc.) we will establish 5 replicates of a suite of measurements that will allow an assessment of the isotopomer approach and initial estimates of key microbial processes causing variation in N_2O fluxes. **Net nitrogen fluxes**: Net nitrogen mineralization, nitrification, and NH_4^+ and NO_3^- pool sizes will be assessed quarterly over a period of one year using the resin core soil incubation method as an index of integrated inorganic N availability [9], **Soil nitrogen trace gas measurements**: Soil measurement collars are constructed of polyvinyl chloride (PVC) pipe. The collars are 24 cm in diameter and 18 cm in height and they are inserted to a depth of 9 cm in the soil. To determine fluxes of N_2O from the soil, the collars are fitted with vented, static collar tops. The headspace volume is vented through a 0.5 m coil of 1/8" stainless steel tubing. This length eliminates any pressure differential within the collar and for any measurement sequence shorter than three hours no N_2O will diffuse through the coil. After placing the static chamber top, three 25 ml gas samples will be sequentially taken through a septum port over a two-hour period and injected into previously evacuated gas-tight vials. The vials will then be transported back to our collaborating laboratory at Cornell University and analyzed for N_2O concentration on a gas chromatograph with an electron capture detector (Shimadzu Model 14A). Fluxes of N_2O will then be calculated as the slope of the line describing the concentrations over time. **N_2O isotopomer analysis**: Three gas samples for isotopomer analysis will be collected as above, parallel to those necessary for the flux measurements. These gas samples will be analyzed for $\delta^{15}N_{bulk}$, $\delta^{18}O_{bulk}$ followed by isotopomer analysis and determination of ^{15}N site preference as described above.

Tillage effects on soil organic matter. A long-term experiment was set up at the Texas A&M University Research Farm near College Station, TX in 1982 by project collaborator Hons. The experiment is ongoing and is designed to quantify the effects of converting from a conventional tillage (CT) to a no tillage (NT) approach. Soil at the site has been characterized as a fine silty, mixed, thermic Fluventic Ustochrep and is in the Brazos River floodplain. Treatments include two cropping systems (continuous wheat and a sorghum-wheat-soybean rotation), CT and NT, and were replicated four times (sixteen total plots). Several papers have been published on various aspects of this study [e.g., 10] and it represents an ideal test case for studying changes to the N cycle following increased C sequestration caused by removing tillage from the cropping system. Recent work shows changes to the soil microbial community as well [11], allowing a potential link between microbial community composition and microbially-mediated N_2O production to be assessed with the proposed N_2O isotopomer approach.

Mesquite encroachment of grasslands. Woody plant expansion into formerly grass-dominated rangelands is among the most important land cover changes of the past 100-200 years. It has been documented in rangelands worldwide and has had a significant impact on ranching operations in Texas where the dominant woody invader is *Prosopis glandulosa* or mesquite [12]. Significant impacts on N cycling have been clearly demonstrated. In particular, soil C and N pools tend to increase, along with internal cycling rates [13]. However, the effects of this vegetation change on N trace gas emissions are poorly constrained. Our recent observations (Figure 1) suggest that woody encroachment may increase N_2O fluxes. Research for this component will be conducted at the Texas A&M AgriLife La Copita Research Area located near Ben Bolt, TX. Upland soils are sandy loams (Typic Argiustolls) with a laterally continuous subsurface (Bt) horizon with non-argillic inclusions and are characterized by a two-phase vegetation pattern consisting of clusters of woody vegetation embedded within a matrix of

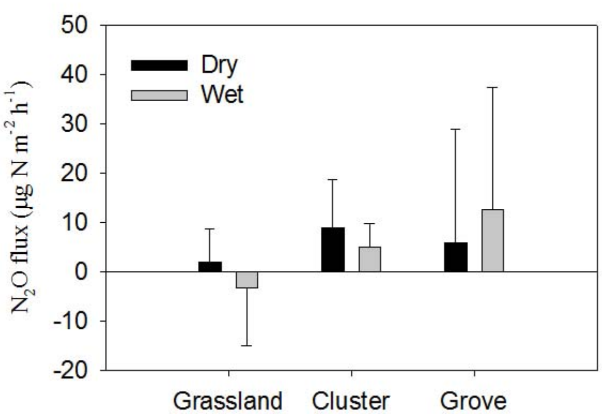

Figure 1. N_2O fluxes from the La Copita site (Sparks, unpublished) from June 2011. Measurements were conducted at ambient soil moisture and 24 hours following a simulated precipitation event.

remnant C_4 grasses. Where the argillic horizon is absent, clusters expand laterally and fuse to form larger groves of woody vegetation. This grassland-to-woodland conversion has resulted in increases in primary productivity in woodlands relative to remnant grasslands. This also increased N-inputs from symbiotic N-fixation by mesquite and caused numerous changes to N cycling [e.g., 14, 15, 16]. The three discrete landscape elements (grassland, cluster, grove) will be sampled as above and will coincide with ongoing measurements of trace gas fluxes (NH_3, NO_y, NO) and other N cycle components currently being conducted in collaboration with our collaborator at Cornell University (Sparks).

Deliverables & Timeline

See Table 1 for major project activity timelines and expected milestones. Key deliverables include: a previously unavailable method for studying N_2O production in agricultural soils, an assessment of the underlying causes of N_2O production in two well-studied agricultural systems, and the development of at least two competitive proposals for external funding.

Table 1. Timeline for major project activities by quarter.

	2013	2014				2015		
Major activity	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
GasBench/Precon installation	■	■	■					
Isotopomer methodology development	■	■	■					
Field collar installation			■					
Field N mineralization			■	■	■			
N_2O gas sampling				■	■			
N_2O isotopomer analysis				■	■	■		
Data analysis						■	■	
Manuscript and proposal development							■	■

Individual responsibilities

West will serve as project lead and work with the Co-PI (Boutton), project collaborators (Hons and Sparks), and the project technician to complete all proposed activities. Both project investigators have had significant prior success in obtaining competitive funds from several sources (see CV's). We have ongoing relationships with project collaborators and shared interest in the project research questions and strongly believe that the development of the proposed capacity and preliminary fundamental insights will lead to enhanced competitiveness in future proposal efforts. *Neither PI has previously received State Air Quality Initiative funds*. Future funding sources that will be targeted include the United States Department of Agriculture (USDA) AFRI Competitive Grants Program, the Department of Energy Office of Biological and Environmental Research Terrestrial Ecosystem Science Program, and relevant programs at the National Science Foundation (Environmental Biology and Geosciences). These are extremely competitive programs and the requested funding would represent a key development that would set our group apart from others in a range of proposals designed to address land use change, agriculture, and climate change adaptation and mitigation.

References

1. Robertson, G.P., E.A. Paul, and R.R. Harwood, *Greenhouse gases in intensive agriculture: Contributions of individual gases to the radiative forcing of the atmosphere.* Science, 2000. **289**(5486): p. 1922-1925.
2. Kim, D.-G., D. Giltrap, and G. Hernandez-Ramirez, *Background nitrous oxide emissions in agricultural and natural lands: a meta-analysis.* Plant and Soil, 2013: p. 1-14.
3. Snyder, C.S., et al., *Review of greenhouse gas emissions from crop production systems and fertilizer management effects.* Agriculture Ecosystems & Environment, 2009. **133**(3-4): p. 247-266.
4. Park, S., et al., *Can N2O stable isotopes and isotopomers be useful tools to characterize sources and microbial pathways of N2O production and consumption in tropical soils?* Global Biogeochemical Cycles, 2011. **25**.
5. Opdyke, M.R., N.E. Ostrom, and P.H. Ostrom, *Evidence for the predominance of denitrification as a source of N2O in temperate agricultural soils based on isotopologue measurements.* Global Biogeochemical Cycles, 2009. **23**.
6. Ostrom, N.E., et al., *Isotopologue data reveal bacterial denitrification as the primary source of N2O during a high flux event following cultivation of a native temperate grassland.* Soil Biology & Biochemistry, 2010. **42**(3): p. 499-506.
7. Rockmann, T., et al., *Gas chromatography/isotope-ratio mass spectrometry method for high-precision position-dependent N-15 and O-18 measurements of atmospheric nitrous oxide.* Rapid Communications in Mass Spectrometry, 2003. **17**(16): p. 1897-1908.
8. Toyoda, S., et al., *Characterization and production and consumption processes of N2O emitted from temperate agricultural soils determined via isotopomer ratio analysis.* Global Biogeochemical Cycles, 2011. **25**.
9. Brye, K.R., et al., *Refinements to an in-situ soil core technique for measuring net nitrogen mineralization in moist, fertilized agricultural soil.* Agronomy Journal, 2002. **94**: p. 864-869.
10. Wright, A.L., F. Dou, and F.M. Hons, *Soil organic C and N distribution for wheat cropping systems after 20 years of conservation tillage in central Texas.* Agriculture Ecosystems & Environment, 2007. **121**(4): p. 376-382.
11. González-Chávez, M.d.C.A., et al., *Soil microbial community, C, N, and P responses to long-term tillage and crop rotation.* Soil and Tillage Research, 2010. **106**(2): p. 285-293.
12. Van Auken, O.W., *Causes and consequences of woody plant encroachment into western North American grasslands.* Journal of Environmental Management, 2009. **90**(10): p. 2931-2942.
13. Boutton, T.W. and J.D. Liao, *Changes in soil nitrogen storage and delta N-15 with woody plant encroachment in a subtropical savanna parkland landscape.* Journal of Geophysical Research-Biogeosciences, 2010. **115**: p. G03019 10.1029/2009jg001184.
14. Hibbard, K.A., et al., *Biogeochemical changes accompanying woody plant encroachment in a subtropical savanna.* Ecology, 2001. **82**: p. 1999-2011.
15. McCulley, R.L., et al., *Soil respiration and nutrient cycling in wooded communities developing in grassland.* Ecology, 2004. **85**(10): p. 2804-2817.
16. Creamer, C.A., et al., *Changes to soil organic N dynamics with leguminous woody plant encroachment into grasslands.* Biogeochemistry, in press.

BUDGET

	FY14	FY15	TOTAL
Senior personnel	*No funds requested*		
Other personnel			
Postdoctoral scholar	$40,000	$41,200	$81,200
Undergraduate workers	$2,000	$2,060	$4,060
Travel	$2,000	$2,000	$4,000
Sampling and laboratory consumables	$4,000	$4,000	$8,000
Capital Equipment			
GasBench II (Thermo)	$65,088		$65,088
PreCon device (Thermo)	$30,960		$30,960
Connection accessories (Thermo)	$5,653		$5,653
Freight & insurance	$500		$500
TOTAL	$150,201	$49,260	**$199,461**

Allocation. All funds will be allocated in equal share to the PI's (50% to West, 50% to Boutton), with the recognition that the capital equipment funds will be used as described above and the equipment will be installed for use in the shared stable isotope facility (http://sibs.tamu.edu).

Capital Equipment. Funds are requested for the purchase of the necessary peripherals that would be interfaced to our existing isotope ratio mass spectrometer to allow the measurement of N_2O isotopomers. The costs are based on a recent (May 13, 2013) quote provided by Thermo Electron North America that would permit the purchase of the "GasBench II" and the "PreCon device" as well as additional funds for necessary accessories such as the sample tray, GC column, and connection supplies. The GasBench II allows the sampling of gases from sample vials and "cleanup" of atmospheric samples for introduction to the mass spectrometer. The PreCon device provides the capacity to concentrate trace gas samples (e.g., with automated cold traps). This is necessary for such trace gases as N_2O that exist in atmospheric samples in the parts per billion range. The equipment is necessary and sufficient for the proposed isotopomer analysis.

Other. Funds are requested to cover the salary of a postdoctoral scholar who will be charged with installation and testing of the listed equipment, field sampling, laboratory sample preparation, and gas isotope ratio analysis. The postdoctoral scholar will operate under the guidance of project PI's and will work closely with the current manager of the stable isotope facility (Dr. Ayumi Hyodo). In addition, summer part-time undergraduate workers will assist the technician with routine laboratory procedures, including collar construction and deployment, field sampling, mineralization incubations and other tasks as appropriate. Funds are requested to cover travel to and from the La Copita field site in south Texas in FY14 and FY15. The amount is estimated based on actual costs of travel in prior years of work at this site. Funds are also requested to cover sampling and laboratory consumables associated with the net N mineralization incubations, collar installation, N_2O gas sampling and transport to the laboratory, and isotopomer analysis.

BIOGRAPHICAL SKETCH

JASON B. WEST

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A. General Research Focus

Dr. West directs a research group focused on improving scientific understanding of terrestrial ecosystem function, with an emphasis on water, nutrient, and carbon cycling processes. Of particular interest are the interactions between vegetation and the abiotic environment, and the influence of humans on biospheric processes. The research is conducted at many spatial and temporal scales, in a variety of ecosystems, and across a wide range of human influence on ecosystem structure and function. Dr. West is also co-director of the Stable Isotopes for Biosphere Science Laboratory at Texas A&M University.

B. Professional Preparation

Utah State University	Range Science	BS, 1996
University of Georgia	Plant Ecophysiology	PhD, 2002
University of Minnesota	Ecosystem Ecology/Biogeochemistry	2002-2004
University of Utah	Isotope Ecology/Geochemistry/Forensics	2004-2008

C. Appointments

2008 – present: Assistant Professor, Texas A&M University
2006 – 2008: Research Assistant Professor, University of Utah
2004 – 2005: Research Associate, University of Utah
2002 – 2004: Postdoctoral Fellow, University of Minnesota

D. Products

Five relevant products (of 27 total peer-reviewed papers)

1. Espeleta, JF, JB West, LA Donovan. 2009. Tree species fine-root demography parallels habitat specialization across a sandhill soil resource gradient. Ecology 90(7):1773-1787
2. Dijkstra, FA, JB West, SE Hobbie, PB Reich. 2009. Antagonistic effects of species on decomposition and net N mineralization in soils from mixed coniferous plantations. Forest Ecology and Management 257:1112-1118
3. West, JB, SE Hobbie, PB Reich. 2006. Effects of plant species diversity, atmospheric [CO_2], and N addition on gross rates of inorganic N release from soil organic matter. Global Change Biology 12:1400-1408
4. Espeleta, JF, JB West, and LA Donovan. 2004. Species-specific patterns of hydraulic lift in co-occurring adult trees and grasses in a sandhill community. Oecologia 138(3):341-349
5. West, JB, J HilleRisLambers, TD Lee, SE Hobbie, PB Reich. 2005. Legume species identity and soil nitrogen supply determine symbiotic nitrogen-fixation responses to elevated atmospheric [CO_2]. New Phytologist 167:523-530

*Five Other Products (*denotes student paper)*

1. *Colón-Rivera, RJ, RA Feagin, JB West, KM Yeager. 2012. Salt marsh connectivity and freshwater versus saltwater inflow: Multiple methods including tidal gauges, water isotopes, and LIDAR elevation models. Canadian Journal of Fisheries and Aquatic Sciences 69:1420-1432.
2. Kahmen, A, B Hoffmann, E Schefuss, SK Arndt, LA Cernusak, JB West, D Sachse. *in press (available online 2012)*. Leaf water enrichment in deuterium shapes leaf wax n-alkane δD values of terrestrial plants II: Observational evidence and global implications. Geochimica et Cosmochimica Acta.
3. Hultine, KR, J Belnap, C van Riper III, JR Ehleringer, PE Dennison, ME Lee, PL Nagler, KA Snyder, SM Uselman, JB West. 2010. Tamarisk biocontrol in the western United States: ecological and societal implications. Frontiers in Ecology and the Environment 8:467-474
4. West, JB, GJ Bowen, TE Cerling, JR Ehleringer. 2006. Stable isotopes as one of nature's ecological recorders. Trends in Ecology and Evolution 21(7):408-4142
5. Reich, PB, SE Hobbie, T Lee, D Ellsworth, JB West, D Tilman, J Knops, S Naeem, J Trost. 2006. Nitrogen limitation constrains sustainability of ecosystem response to CO_2. Nature 440:922-925

E. Synergistic Activities

1. Instructor for the short course "*Isotopes in Spatial Ecology and Biology*" to be held at the University of Utah in June 2013. The course is broadly multi-disciplinary and is in part funded by the National Science Foundation (https://itce.utah.edu/spatial.html).
2. Guest editor for a special issue in the new online-only journal from the Ecological Society of America, Ecosphere: "*Isoscapes in ecology: integrating across scales with the isotopic record*" a cross-disciplinary Special Feature that demonstrates the depth and breadth of work in this rapidly growing area.
3. Co-organizer of an international multi-disciplinary meeting "Isoscapes 2011" (http://wateriso.eas.purdue.edu/isoscapes2011/index_new.html). This meeting was funded primarily by the National Science Foundation (DBI grant #0743543) and served as a follow-up to Isoscapes 2008, as well as a workshop for the project web portal and modeling platform IsoMAP (http://isomap.org).
4. Co-organizer of a special session in The 6th International Conference on Applications of Stable Isotope Techniques to Ecological Studies (ISOECOL) on Isotope Mapping to Address Ecological Questions; August 25-29, 2008
5. Co-organizer of American Geophysical Union organized session Insights on Human Impacts on the Environment from Spatial Variation in Stable Isotope Ratios, 2006, with support from the Biogeosphere-Atmosphere Stable Isotope Network (BASIN; NSF Research Coordination Network)

BIOGRAPHICAL SKETCH

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A. Expertise Related to Proposed Research

For the past 25 yrs, my research group has focused on understanding the biogeochemical consequences of land cover/land use changes and their implications for the climate system. Our work has been aimed primarily at understanding how ecosystem C, N, and P storage and dynamics are altered during grassland to woodland transitions. I also serve as co-director of the Stable Isotopes for Biosphere Sciences Lab, which is a comprehensive facility for biogeochemical and isotopic analyses of the plant-soil-water-atmosphere system.

B. Professional Preparation

B.A.	Biology, St. Louis University, June 1973
M.S.	Biology, University of Houston, June 1976
Ph.D.	Botany, Brigham Young University, December 1979

C. Appointments

2011-now	Associate Department Head for Graduate Programs, Dept. Ecosystem Science & Management
2010-now	Senior Faculty Fellow, Texas A&M AgriLife Research, Texas A&M University System
2006-now	Regents Professor, Dept. Ecosystem Science & Management, Texas A&M University
2006-2009	Affiliate Faculty Member, Dept. Crop & Soil Science, Oregon State University
2006-2007	Visiting Scholar, Dept. Earth and Atmospheric Sciences, Purdue University
1994-now	Professor, Dept. Ecosystem Science & Management, Texas A&M University
1987-1994	Associate Professor, Dept. Rangeland Ecology & Management, Texas A&M University
1985-1987	Assistant Professor, Dept. Pediatrics, Baylor College of Medicine, Houston, TX
1983-1985	Instructor, Dept. Pediatrics, Baylor College of Medicine, Houston, TX
1982-1983	Postdoctoral Fellow, Dept. Pediatrics, Baylor College of Medicine, Houston, TX
1980-1982	Postdoctoral Fellow, Dept. Biology, Augustana College, Sioux Falls, SD

D. Recent Publications (* denotes grad student, postdoc, or undergrad student)

Creamer CA*, Filley TR, Olk DC, Stott DE, Boutton TW, Dooling V. 2013. Changes to soil organic N dynamics with leguminous woody plant encroachment into grasslands. ***Biogeochemistry*** doi 10.1007/s10533-012-9757-5 (in press).

Bai E*, Boutton TW, Liu F*, Wu XB, Archer SR. 2013. ^{15}N isoscapes in a subtropical savanna parkland: Spatial-temporal perspectives. ***Ecosphere*** 4(1): 4. http://dx.doi.org/10.1890 /ES12-00187.1

Creamer CA*, Filley TR, Boutton TW. 2013. Long-term incubations of size-separated soil fractions to inform soil organic carbon decay dynamics. ***Soil Biology and Biochemistry*** 57: 496-503.

Creamer CA*, Filley TR, Olk DC, Plante AF, Peltre C, Top SM, Boutton TW. 2012. Degree of woody plant encroachment into grasslands controls soil carbohydrate and amino compound changes during long-term laboratory incubation. ***Organic Geochemistry*** 52: 23-31.

Hall SA, Boutton TW, Lintz CR, Baugh TG. 2012. New correlation of stable carbon isotopes with changing late-Holocene fluvial environments in the Trinity River basin of Texas, USA. ***The Holocene*** 22: 541-549.

Bai E*, Boutton TW, Liu F*, Wu XB, Archer SR, Hallmark CT. 2012. Spatial variation of soil δ^{13}C and its relation to carbon input and soil texture in a subtropical lowland woodland. ***Soil Biology and Biochemistry*** 44: 102-112.

Bai E*, Boutton TW, Liu F*, Wu XB, Archer SR. 2012. Spatial patterns of soil δ^{13}C reveal grassland-to-woodland successional processes. ***Organic Geochemistry*** 42: 1512-1518.

Liu F*, Wu XB, Bai E*, Boutton TW, Archer SR. 2011. Quantifying soil organic carbon in complex landscapes. ***Global Change Biology*** 17: 1119-1129.
Creamer CA*, Filley TR, Boutton TW, Oleynik S, Kantola IB*. 2011. Controls on soil carbon accumulation during woody plant encroachment into grasslands: Evidence from physical fractionation, soil respiration, and the isotopic composition of respired CO_2. ***Soil Biology and Biochemistry*** 43: 1678-1687.
Boutton TW, Liao JD*. 2010. Changes in soil nitrogen storage and $\delta^{15}N$ with woody plant encroachment in a subtropical savanna parkland landscape. ***Journal of Geophysical Research*** 115: G03019, doi:10.1029/2009 JG 001184, 2010.
Liu F*, Wu XB, Bai E*, Boutton TW, Archer SR. 2010. Spatial scaling of ecosystem C and N in a subtropical savanna landscape. ***Global Change Biology*** 16: 2213-2223.
Biederman L*, Boutton TW. 2010. Spatial variation in biodiversity and trophic structure of soil nematode communities in a subtropical savanna parkland: responses to woody plant encroachment. ***Applied Soil Ecology*** 46: 168-176.
Hollister EB*, Schadt CW, Palumbo AV, Ansley RJ, Boutton TW. 2010. Structural and functional diversity of soil bacterial and fungal communities following woody plant encroachment in the southern Great Plains. ***Soil Biology and Biochemistry*** 42: 1816-1824.
Ansley RJ, Boutton TW, Mirik M, Kramp BA, Castellano MJ*. 2010. Seasonal fire effects on herbaceous composition in a C_3/C_4 grassland invaded by *Prosopis*, a fire-resistant shrub. ***Applied Vegetation Science*** 13: 520-530.
Kovda I, Morgun E, Boutton TW. 2010. Vertic processes and specificity of organic matter properties and distribution in vertisols. ***Eurasian Soil Science*** 43: 1467-1476.
Morgun EG, Boutton TW, Jessup KD*. 2010. Assessment of the mobility and time of renewal of the densimetric fractions of organic matter in chestnut soils from the ratio of stable carbon isotopes. ***Eurasian Soil Science*** 43: 533-540.

E. Current Grant Funding

Ahmed, I, Boutton TW, Strom KB. 2011-2014. Hydrologic influences on soil organic carbon loss monitoring using stable isotopes. ***USDA/NIFA-CBG Program*** (2011-38821-30970) ($499,999).
Hewitt DG, Fulbright TE, Boutton TW, Gann K, Hines S, Ortega-Santos A, DeYoung R. 2013-2015. Dietary overlap between wildlife and livestock assessed with stable isotopes. ***East Wildlife Foundation*** ($361,934).
Scanlon B, DeLaune P, Boutton T, Schwartz R, Haney R. 2010-2013. Groundwater nitrogen source identification and remediation in the Texas High Plains and Rolling Plains Regions. ***Texas State Soil and Water Conservation Board*** (TSSWCB 09-03) ($487,064).
Boutton TW, Scott A. 2010-2013. Soil carbon storage and dynamics in the western Gulf Coastal Plain as impacted by forest management. ***U.S. Forest Service Cooperative Agreement*** (l0-CA-11330124-093) ($25,000).

F. Synergistic Activities

Co-Director: Stable Isotopes for Biosphere Science Laboratory, Department of Ecosystem Science and Management, Texas A&M University, 1987-present. Lab consists of two isotope ratio mass spectrometers, 3 elemental analyzers, a discrete chemistry analyzer, DOC/DON analyzer, a gas chromatograph, and sample preparation equipment. This lab has supported the research of approximately 120 faculty, postdocs, and graduate students from TAMU and other universities.
Session Co-Organizer and Co-Chair: "Global Change and the Biogeochemistry of Dryland Ecosystems," annual meeting of the American Geophysical Union, 2012.
Advisory Panel Member: US Department of Energy, Terrestrial Ecology Program, 2011-present.
Advisory Panel Member: National Science Foundation, 2008-2011.
Committee Member: NEON Domain Science and Education Coordination Committee, Southeastern Region, 2009-present.
Advisory Board and Faculty Mentor: Sloan Foundation Minority Ph.D. Fellowship Program, and Texas A&M Hispanic Leadership Program in Agriculture and Natural Resources, 2007-present.

CURRICULUM VITAE

NAME: Frank M. Hons

CURRENT TITLE: Professor and Texas A&M AgriLife Research Faculty Fellow
Department of Soil and Crop Sciences
Texas A&M University
College Station, TX 77843-2474

EDUCATION:

B.A. Chemistry	1972	University of Dallas
M.S. Soil Chemistry	1974	Texas A&M University
Ph.D. Soil Science	1978	Texas A&M University

PROFESSIONAL AND ACADEMIC APPOINTMENTS:

1972-1975	Graduate Research Assistant, Department of Soil and Crop Sciences, Texas A&M University, College Station, TX
1975-1978	Graduate Research Fellow, Department of Soil & Crop Sciences, Texas A&M University, College Station, TX
1978-1981	Assistant Professor, Department of Plant & Soil Science, Texas Tech University
1981-1986	Assistant Professor, Department of Soil & Crop Sciences, Texas A&M University
1986-1991	Associate Professor, Department of Soil & Crop Sciences, Texas A&M University
1991-2005	Professor, Department of Soil & Crop Sciences, Texas A&M University
2005-present	Professor and Texas A&M AgriLife Research Faculty Fellow, Department of Soil & Crop Sciences, Texas A&M University

PROFESSIONAL ACTIVITIES AND RECOGNITION:

Board member, Vice-President, President of Texas Chapter of American Society of Agronomy, 1980-83
Associate Editor (soils) for *Agronomy Journal*, 1985-1988
Member, Audio-Visual Aids Committee - American Society of Agronomy, 1985-1988
Member, National Student Manuscript Contest Committee - American Society of Agronomy, 1985-1988, 1993-1995
Member, Program Committee of the Texas Chapter of the Soil Conservation Society of America, 1987
Member, Program Planning Committee for the 1987 Southern Region No-Till Conference
Member, Southern Regional Project S-9, 1990-2000
Member, planning committee for SCS Conservation Research Workshop, 1991
Board member, Vice-President, President-Texas Plant Protection Association, 1996-1998
Soil Science Institute Instructor at TAMU, February, 1984, 1986, 1992, 1993, 1998, 1999
Associate Editor: *Soil Science Society of America Journal* (Divs. S-4, S-8), 1997-2001
Soil Science Section Coordinator: External review of Departmental doctoral programs, 2001
Member, Program Planning Committee of Southern Region No-Till Conference, 2003
Ad hoc reviewer for USDA-ARS National CRIS Research Project Plans, 2003
Program Reviewer: USDA-ARS, 2003
USAID- and Fulbright-Sponsored Activities: Mali Africa, Egypt, Mexico, 1998-present
Department of Soil and Crop Sciences Superior Achievement Award for Teaching, 1984
Invited Participant- Alpbach European Forum, 1985
Distinguished Teaching Award - College Level - Association of Former Students, 1988
TAMU Ag Program Award in Excellence for Team Research, 1988
Invited Lecturer, University of Agriculture, Nitra, Czechoslovakia, 1991
Fellow of the American Society of Agronomy, 1997
Fellow of the Soil Science Society of America, 1998
Binational Fulbright Participant, Assiut University, Egypt, 1999-2000
Department of Soil and Crop Sciences Special Achievement Award for Research, 2003
Texas A&M AgriLife Research Fellow, 2005
Texas A&M AgriLife Extension Team Award for Superior Service, 2012

SELECTED RELEVANT PUBLICATIONS:

Hons, F.M., R.F. Moresco, R.P. Wiedenfeld, and J.T. Cothren. 1986. Applied N and P effects on yield and nutrient uptake by high-energy sorghum produced for grain and biomass. Agron. J. 78:1069-1078.
Locke, M.A. and F.M. Hons. 1988. Tillage effect on seasonal accumulation of labeled fertilizer N in sorghum. Crop Sci. 28:694-700.

Powell, J.M., F.M. Hons, and G.G. McBee. 1991. Nutrient and carbohydrate partitioning in sorghum stover. Agron. J. 83:933-937.
Powell, J.M. and F.M. Hons. 1991. Sorghum stover removal effects on soil organic matter content, extractable nutrients, and crop yield. J. Sustainable Agric. 2:25-39.
Powell, J.M. and F.M. Hons. 1992. Fertilizer N and stover removal effects on sorghum yields and nutrient uptake and partitioning. Agric. Ecosystems. Environ. 39:197-211.
Hons, F.M., J.T. Cothren, J.C. Vincent and N.L. Erickson. 1993. Land application of sludge generated by the anaerobic fermentation of biomass to methane. Biomass Bioenergy 5:289-300.
Franzluebbers, A.J., F.M. Hons, and D.A. Zuberer. 1995. Soil organic C, microbial biomass, and mineralizable C in sorghum management systems. Soil Sci. Soc. Am. J. 59:460-466.
Franzluebbers, A.J., F.M. Hons, and D.A. Zuberer. 1995. Tillage and crop effects on seasonal soil carbon and nitrogen dynamics. Soil Sci. Soc. Am. J. 59:1618-1624.
Mjelde, J.W., T.N. Thompson, F.M. Hons, J.T. Cothren, and C.G. Coffman. 1996. Using southern oscillation forecasts for determining corn and sorghum profit - maximizing nitrogen levels in central Texas. J. Prod. Agric. 10:168-175.
Salinas-Garcia, J.R., F.M. Hons, and J.E. Matocha. 1997. Long-term effects of tillage and fertilization on soil organic matter dynamics. Soil Sci. Soc. Am. J. 61:152-159.
Sanderson, M.A., R.L. Reed, W.R. Ocumpaugh, M.A. Hussey, G. van Esbroeck, J.C. Read, C.R. Tischler, and F.M. Hons. 1999. Switchgrass cultivars and germplasm for biomass feedstock production in Texas. Bioresource Tech. 67:209-219.
Franzluebbers, A.J., R.L. Haney, C.W. Honeycutt, M.A. Arshad, H.H. Schomberg, and F.M. Hons. 2001. Climatic influences on active fractions of soil organic matter. Soil Biol. Biochem. 33:1103-1111.
Ribera, L.A., F.M. Hons, and J.W. Richardson. 2004. An economic comparison between conventional and no-tillage farming systems in Burleson County, Texas. Agron. J. 96:415-424.
Hons, F.M., M.L. McFarland, R.G. Lemon, R.L. Nichols, V.A. Saladino, F.J. Mazac Jr., R. Jahn, and J. Stapper. 2004. Improving nitrogen management in cotton production systems. Texas Cooperative Extension/Cotton Incorporated Bulletin L-5458.
Wright, A.L., and F.M. Hons. 2005. Carbon and nitrogen sequestration and soil aggregation under sorghum cropping sequences. Biol. Fert. Soils 41:95-100.
Wright, A.L., F. Dou, and F.M. Hons. 2007. Crop species and tillage effects on carbon sequestration in subsurface soil. Soil Sci. 172:124-131.
Wright, A.L., F.M. Hons, R.G. Lemon, M.L. McFarland, and R.L. Nichols. 2008. Microbial activity and soil C sequestration for reduced and conventional tillage cotton. Appl. Soil Ecol. 38:168-173.
Dou, F., A.L. Wright, and F.M. Hons. 2008. Dissolved and soil organic C after long-term conventional and no-till sorghum cropping. Commun. Soil Sci. Plant Anal. 39:667-679.
Wiedenfeld, R.P., B.W. Wallace, and F.M. Hons. 2009. Foliar application of urea and triazone nitrogen to cotton. J. Plant Nutrition 32:274-286.
González-Chávez, M.C., J. A. Aitkenhead-Peterson, T.J. Gentry, D. Zuberer, F. Hons, R. Loeppert. 2010. Soil microbial community, C, N, and P responses to long-term tillage and crop rotation. Soil Till. Res. 106:285-293.
Shahandeh, H., C.-Y. Chou, F.M. Hons, and M.A. Hussey. 2010. Nutrient partitioning and carbon and nitrogen mineralization of switchgrass plant parts. Comm. Soil Sci. Plant Anal. 42:599-615.
Wight, J.P., F.M. Hons, J.O. Storlien, T.L. Provin, H. Shahandeh, and R.P. Wiedenfeld. 2012. Management effects on bioenergy sorghum growth, yield, and nutrient uptake. Biomass Bioenergy 46:593-604.
R. Carrillo-Gonzalez, M.C.A. González-Chávez, J.A. Aitkenhead-Peterson, F.M. Hons, and R.H. Loeppert. 2013. Extractable DOC and DON from a dry-land long-term rotation and cropping system in Texas, USA. Geoderma 198:79-86.
Dou, F. and F.M. Hons. 2013. Soil organic carbon pools under switchgrass grown as a bioenergy crop compared to other conventional crops. Pedosphere (In Press).

PUBLICATION AND PRESENTATION SUMMARY:

(a)	books written:	1 (1st edition 1981, revised editions 1983, 1996, 2005)
(b)	books or other publications edited:	1
(c)	chapters of books written:	3
(d)	technical papers, refereed:	115
(e)	technical papers, nonrefereed:	57
(f)	nontechnical papers:	2
(g)	invited lectures, seminars, or symposia presentations:	252
(h)	other related oral, written, visual presentations, or products:	378

BIOGRAPHICAL SKETCH

JED P. SPARKS

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A. Expertise Related to Proposed Research

The Sparks laboratory has considerable expertise in terrestrial nitrogen biogeochemistry, the quantification of soil trace gases, and the application of stable isotopes to questions in ecosystem ecology. All three of these areas of expertise will be utilized in the proposed research.

B. Professional Preparation

University of Colorado/ National Center for Atmospheric Research	Biosphere fluxes	Postdoc	1998-2001
Washington State University	Botany	Ph.D.	1998
University of Utah	Biology	B.S.	1994

C. Appointments

2010-present	Director, Office of Undergraduate Biology, Cornell University
2007-present	Associate Professor, Ecology and Evolutionary Biology, Cornell University
2003-present	Director, Cornell Stable Isotope Laboratory, Cornell University
2002-2007	Assistant Professor, Ecology and Evolutionary Biology, Cornell University
2001-2002	Research Associate, NOAA
1998-2002	Postdoctoral Research Associate, University of Colorado
1998-2001	Visiting Scientist, National Center for Atmospheric Research
1994-1998	Pre-doctoral Research Associate, Washington State University

D. Products

(i) Five most closely related products (*denotes graduate student, post doc, or undergraduate)

S. C. Reed, K. K. Coe*, J. P. Sparks, D. C. Housman, T. J. Zelikova, and J. Belnap. 2012. Increased precipitation causes rapid moss mortality and altered fertility in an arid ecosystem. *Nature-Climate Change*. 2:752–755.

K. K. Coe*, J. Belnap, and J. P. Sparks. 2012. Precipitation-driven carbon balance controls survivorship in the desert biocrust moss *Syntrichia caninervis*. *Ecology*. 93(7): 1626-1636.

McCalley C.K.*, B. D. Strahm*, K. L. Sparks*, A. S.D. Eller*, and J. P. Sparks. 2011. The effect of long-term exposure to elevated CO_2 on nitrogen gas emissions from Mojave Desert soils. *JGR-Biogeosciences*. 116: G03022, doi:10.1029/2011JG001667.

McCalley, C. K.* and J. P. Sparks. 2009. Abiotic gas formation drives nitrogen loss from a desert ecosystem. *Science*. 326(5954):837-840.

Sparks, J. P. 2009. Foliar incorporation of reactive nitrogen: an important ecological process? *Oecologia* 159(1):1-13.

(ii) Five Other Significant Publications

L.E. Nave, C.M. Gough, K. Maurer, G. Bohrer, B.S. Hardiman, J. Le Moine, A.B. Munoz, K.J. Nadelhoffer, J. P. Sparks, B.D.Strahm*, C.S. Vogel, and P.S. Curtis. 2011. Disturbance, decoupling and resilience of carbon and nitrogen cycles in a northern temperate forest: initial results from the

Forest Accelerated Succession ExperimenT (FASET). *JGR-Biogeosciences*. 116: G04016, doi:10.1029/2011JG001758.

Sparks, J. P., S. Chandra, L. A. Derry, M. V. Parthasarathy, C. S. Daugherty, and R. Griffin*. 2011. The distribution of silicon and germanium in tissues of annual blue grass (*Poa annua* L.): Evidence for differential and active transport from SIMS ion microscopy. Biogeochemistry. 104: 237-249

Eller, A. S. D.*, K. L. McGuire and J. P. Sparks. 2011. Responses of sugar maple and hemlock seedlings to elevated carbon dioxide under altered above- and belowground nitrogen sources. *Tree Physiology*. 31: 391-401

E. E. Grote, J. Belnap, D. Hausman, and J. P. Sparks. 2011. Carbon exchange in biological soil crust communities under differential temperatures and soil water contents: implications for global change. *Global Climate Change*. 16: 2763–2774

McCalley, C. K.* and J. P. Sparks. 2008. Controls over NO and NH_3 emissions from Mojave Desert soils. *Oecologia*. 156:871-881.

E. Synergistic Activities

Senior Scientist for the Kohala Center. (2006-present). The Kohala Center is a not-for-profit organization in Hawaii for the promotion of environmental stewardship and the preservation of native Hawaiin cultural heritage.

Mentor Faculty for the Biogeochemistry and Environmental Biocomplexity Research Training Program (BEB-IGERT) and the Cross-Scale Biogeochemistry and Climate Research Training Program (CSBC-IGERT). (2003-present). We have been fortunate enough to have continuous support for graduate students in biogeochemistry at Cornell through multiple NSF supported IGERT programs. During this time I have filled several roles including director, instructor, and mentor.

Faculty Fellow, Atkinson Center for a Sustainable Future (2007-present). The Atkinson Center for a Sustainable Future (ACSF) is an independent center housed at Cornell University that brings to together Engineers, environmental researchers and energy experts to develop sustainable solutions for providing energy in an environmental sustainable manner. I have been a Faculty Fellow and led the center's effort exploring aspects of methane and the sustainability of the hydrofracturing of shale.

Visiting Research Fellow, National Center for Atmospheric Research – Atmospheric Chemistry Division (2002-present). Over the past decade I have worked closely with NCAR including having my student utilize the modeling infrastructure.

Faculty director for the Cornell CIRTL program (2010-present). The Center for the Integration of Research, Teaching and Learning (CIRTL) is a consortium of twenty-five universities aimed at enhancing excellence in undergraduate education through the development of a national faculty committed to implementing and advancing effective teaching. I am one of two faculty directors of this program at Cornell where we are developing multiple programs to develop the teaching skills of our graduate students and post-docs.