319 Benton Hall
UF P.O. Box 116200
Gainesville, FL 32611
352-392-1605

# ROBERT C. MOORE

email: moore@ece.ufl.edu
website: www.vlf.ece.ufl.edu

Permanent Address:
1025 NW 101st Drive
Gainesville, FL 32606
352-871-5107

## EDUCATION:

**STANFORD UNIVERSITY**, Stanford, California.

**Ph.D. Electrical Engineering**, Electromagnetic Waves concentration, April 2007.
Dissertation: ELF/VLF Waves Generated by Modulated HF Heating of the Auroral Electrojet.

M.S.E. Electrical Engineering, Wireless Communications concentration, January 2001.

B.S.E. Electrical Engineering, Computer Software concentration, June 1999.
Hettinger Scholarship recipient, 1998, 1999.

Wellesley High School, Wellesley, Massachusetts, June 1995.
Valedictorian (1/191), Senior Cup Recipient (elected by senior class).

## WORK & RESEARCH EXPERIENCE:

May 2007-Present — **Assistant Professor,** ECE Department, University of Florida, Gainesville, Florida.
Workload includes teaching courses in electromagnetics and conducting ionospheric research using remote sensing methods developed for very low frequency (3-30 kHz) waves.

June 1999-March 2007 — **Research Assistant**, EE Department, Stanford University, Stanford, California.

- Conducted active experiments investigating the properties of ELF/VLF waves generated via ionospheric HF heating by the HAARP facility in Gakona, AK.
  - Experimentally identified and quantified the deviation of the observed ELF/VLF amplitude from a power-law dependence on HF power level.
  - Associated the observed ELF/VLF amplitude 'saturation' effect with the nonlinear dependence of the ionospheric electron temperature on the energy losses due to the excitation of vibrational modes in molecular oxygen.
  - Demonstrated the ability to remote-sense spatial variations within the ELF/VLF source region using observations of amplitude saturation as a function of HF beam direction.
  - Identified and quantified an optimal HF power level maximizing ELF/VLF wave amplitude observed at ground-based receivers for modulation depths < 100%.
  - Reported the detection of ELF waves generated by modulated HF heating at a ground distance of ~4400 km, the largest distance to date.
- Quantitatively connected ionospheric disturbances associated with sprite halos to early/fast VLF events, a specific type of perturbation of the amplitude and phase of VLF signals propagating in the Earth-ionosphere waveguide.
- Developed a new MSK demodulation algorithm for accurate calculation of the propagation phase of MSK-modulated VLF signals at high time resolution.
- Designed and implemented a real-time narrowband (200 Hz) and broadband (100 kHz) data acquisition software package that operates 24/365 at more than 20 locations worldwide.
- Antarctic Research: upgraded hardware at Palmer, McMurdo, and South Pole Stations.
- Other Remote Field Site Installations: Alaska, Hawaii, Greenland, Kwajalein Atoll.

Summer 1998 — **Research Intern**, Aero/Astro Department, Stanford University, Stanford, California.
Developed a data-transfer mechanism for GPS pseudolites used in mining car automation.

Summer 1997 — **Quality Assurance Engineer**, Baan USA, Inc., Santa Clara, California.
Designed and implemented automated test suites for the Baan V Internet application.

Autumn 1996-Spring 1997 — **Teaching Assistant**, CS Department, Stanford University, Stanford, California.
Led a section of ~10 students in the Introduction to Computer Science course (C and Java).

Summer 1996 — **Computer Analyst**, Fidelity Investments, Inc., Boston, Massachusetts.
Developed test tools for a newly developed order entry system.

1994-1995 **Computer Analyst**, Talmadge Solutions, Inc., Wellesley, Massachusetts.
Designed and implemented software solutions for a financial-projections consulting company.

## PROFESSIONAL ORGANIZATIONS:

- American Geophysical Union (AGU) – Member, 2000-present
- Institute of Electrical and Electronics Engineers (IEEE) – Member, 2007-present
- International Union of Radio Science (URSI), Commission H – Member, 2007-present

The goals of URSI Commission H are: (a) To study waves in plasmas in the broadest sense, and in particular: (i) the generation (i.e. plasma instabilities) and propagation of waves in plasmas (ii) the interaction between these waves, and wave-particle interactions (iii) plasma turbulence and chaos (iv) spacecraft-plasma interaction; and (b) to encourage the application of these studies, particularly to solar/planetary plasma interactions, space weather, and the exploitation of space as a research laboratory.

## RESEARCH INTERESTS:

- Non-linear, energetic interactions in the ionosphere.
- Remote-sensing applications of ELF/VLF wave propagation in the Earth-ionosphere waveguide.
- Both the direct and the indirect effects of electromagnetic radiation emanating from lightning on the lower ionosphere/upper thermosphere, with particular emphasis on measurements in the ELF/VLF frequency range.

## INVITED CONFERENCE PRESENTATIONS:

6. Moore, R. C. (2008), ELF wave generation, Polar Aeronomy and Radio Science Summer School, ONR/AFRL/NSF/IHY, Fairbanks, AK, July 19-31.
5. Moore, R. C. (2008), Observations of HAARP-generated ELF/VLF waves as a function of HF power, 37th Committee on Space Research (COSPAR) Scientific Assembly, CSA/NRC/COSPAR, Montreal, Canada, July 13-20.
4. Moore, R. C. (2008), Characterization of the *D*-region ionosphere using ELF/VLF wave generation experiments: An interpretation and review of experimental facts, International Union of Radio Science, USNC/URSI, Boulder, CO, January 3-6.
3. Moore, R. C., and U. S. Inan (2007), ELF/VLF amplitude saturation as a function of HF frequency, The VII International URSI Suzdal Symposium on "Modification of Ionosphere by Powerful Radio Waves", URSI/IZMIRAN/Russian Academy of Sciences, Troitsk, Moscow Region, Russia, October 16-18.
2. Moore, R. C. (2007), HF heating of the ionosphere and ELF wave generation, Polar Aeronomy and Radio Science Summer School, ONR/AFRL/NSF/IHY, Fairbanks, AK, July 23 - August 3.
1. Moore, R. C. (2007), ELF/VLF waves generated by modulated HF heating of the auroral electrojet, RF Ionospheric Interactions Workshop, NSF, Santa Fe, NM, April 22-25.

## CONFERENCE PRESENTATIONS:

20. Moore R. C., Dual-beam ELF/VLF wave generation experiments at HAARP (POSTER), Presented at the RF Ionospheric Interactions Workshop, NSF, Boulder, CO, 2008.
19. Zhang, X. and R. C. Moore, ELF/VLF wave generation at HAARP as a function of HF power, HF polarization, and modulation frequency (POSTER), Presented at the RF Ionospheric Interactions Workshop, NSF, Boulder, CO, 2008.
18. Moore, R. C., Observations of ELF/VLF waves produced using the HAARP HF transmitter in dual-beam configuration, International Union of Radio Science, USNC/URSI, Boulder, CO, 2008.
17. Moore, R. C., Dual-frequency amplitude and phase measurements by blind demodulation of MSK-modulated VLF signals, URSI, USNC/URSI, Boulder, CO, 2008.
16. Moore, R. C., A lack of electron density production during long-pulse ionospheric HF heating experiments (POSTER SA11A-0293), American Geophysical Union, AGU, San Francisco, CA, 2007.
15. Moore, R. C., ELF/VLF wave generation by modulated HF heating of the auroral electrojet, Ph.D. Oral Defense, Stanford University, Stanford, CA, 2007.
14. Moore, R. C., U. S. Inan, and T. F. Bell, Long-distance detection of ELF waves generated via modulated heating of the auroral electrojet, International Union of Radio Science, USNC/URSI, Boulder, CO, 2006.

13. Moore, R. C., U. S. Inan, and T. F. Bell, Long-distance detection of ELF/VLF waves generated via modulated HF heating of the auroral electrojet (POSTER), Presented at the RF Ionospheric Interactions Workshop, NSF, Santa Fe, NM, 2005.
12. Moore, R. C., U. S. Inan, T. F. Bell, E. J. Kennedy, and P. A. Kossey, ELF/VLF waves generated by modulated heating of the auroral electrojet with the HAARP HF transmitter, International Union of Radio Science, USNC/URSI, Boulder, CO, 2005.
11. Moore, R. C. and U. S. Inan, Blind demodulation of continuous-phase minimum-shift-keyed signals in the very low frequency (3-30 kHz) band, URSI, USNC/URSI, Boulder, CO, 2005.
10. Golkowski, M., U. S. Inan, R. C. Moore, D. L. Carpenter, and T. F. Bell, Investigation and statistical survey of ducted whistler mode wave injection by the HAARP HF heater, International Union of Radio Science, USNC/URSI, Boulder, CO, 2005.
9. Inan, U. S., M. Golkowski, D. L. Carpenter, N. Reddell, R. C. Moore, and T. F. Bell, Multi-hop whistler-mode ELF/VLF signals and triggered emissions excited by the HAARP HF heater, International Union of Radio Science, USNC/URSI, Boulder, CO, 2005.
8. Moore, R. C., U. S. Inan, and T. F. Bell, ELF/VLF waves generated by an artificially-modulated auroral electrojet above the HAARP HF transmitter (POSTER SA21C-0377), American Geophysical Union, AGU, San Francisco, CA, 2004.
7. Moore, R. C., U. S. Inan, and T. F. Bell, Properties of HAARP-induced ELF/VLF waves observed during the March 2002 and November 2002 HAARP campaigns (POSTER), Presented at the RF Ionospheric Interactions Workshop, NSF, Santa Fe, NM, 2004.
6. Moore, R. C. and U. S. Inan, Direction-finding of scattered fields produced during non-ducted LEP events as measured at Palmer Station, Antarctica (POSTER), Presented at the Coupling, Energetics, and Dynamics of Atmospheric Regions Workshop, CEDAR, Longmont, CO, 2003.
5. Moore, R. C., C. P. Barrington-Leigh , and U. S. Inan, Early/fast disturbances of the lower ionosphere, International Union of Radio Science, USNC/URSI, Boulder, CO, 2002.
4. Moore, R. C., VLF *D*-region diagnostics, RF Ionospheric Interactions Workshop, NSF, Santa Fe, NM, 2001.
3. Inan, U. S., R. C. Moore, B. R. Decker, Holographic imaging of lightning-induced disturbances in the lower ionosphere (A11E-02), American Geophysical Union, AGU, San Francisco, CA, 2000.
2. Inan, U. S., T. F. Bell, M. W. Chevalier, and R. C. Moore, VLF remote sensing of relativistic electron precipitation events and the auroral electrojet (SM22A-06), American Geophysical Union, AGU, Washington, DC, 2000.
1. Inan, U. S., T. F. Bell, M. W. Chevalier, R. C. Moore, Very low frequency remote sensing of relativistic electron precipitation and the position and intensity of the auroral electrojet, Chapman Conference on Space Weather: Progress and Challenges in Research and Applications, NSF/NASA/IAGA/NOAA/ COSPAR, Clearwater, FL, 2000.

## REFEREED JOURNAL PUBLICATIONS:

6. Moore, R. C., U. S. Inan, T. F. Bell, and E. J. Kennedy (2007), ELF waves generated by modulated HF heating of the auroral electrojet and observed at a ground distance of ~4400 km, *J. Geophys. Res.*, *112*, A05309, doi:10.1029/2006JA012063.
5. Inan, U. S., N. G. Lehtinen, R. C. Moore, K. Hurley, S. Boggs, D. M. Smith, and G. J. Fishman (2007), Massive disturbance of the daytime lower ionosphere by the giant γ–ray flare from magnetar SGR 1806-20, *Geophys. Res. Lett.*, *34*, L08103, doi:10.1029/2006GL029145.
4. Inan, U. S., M. Golkowski, M. K. Casey, R. C. Moore, W. Peter, P. Kulkarni, P. Kossey, E. Kennedy, S. Meth, and P. Smit (2007), Subionospheric VLF observations of transmitter-induced precipitation of inner radiation belt electrons, *Geophys. Res. Lett.*, *34*, L02106, doi:10.1029/2006GL028494.
3. Moore, R. C., U. S. Inan, and T. F. Bell (2006), Observations of amplitude saturation in ELF/VLF wave generation by modulated HF heating of the auroral electrojet, *Geophys. Res. Lett.*, *33*, L12106, doi:10.1029/2006GL025934.
2. Inan, U. S., M. Golkowski, D. L. Carpenter, N. Reddell, R. C. Moore, T. F. Bell, E. Paschal, P. Kossey, E. Kennedy, and S. Z. Meth (2004), Multihop Whistler-mode ELF/VLF signals and triggered emissions excited by the HAARP HF heater, *Geophys. Res. Lett.*, *31*, L24805, doi:10.1029/2004GL021647.
1. Moore, R. C., C. P. Barrington-Leigh, U. S. Inan, and T. F. Bell (2003), Early/fast VLF events produced by electron density changes associated with sprite halos, *J. Geophys. Res.*, *108*(A10), 1363, doi:10.1029/2002JA009816.

## AWARDS AND HONORS:

3. Young Scientist Award for XXIXth URSI General Assembly, Chicago, Illinois, USA, 2008.
2. Recipient: National Science Foundation Antarctic Service Medal, 2006.
1. Hewlett Packard Project Award for Analog Design, Stanford University, 1998.