

Curriculum Vita for Sharon L. Vadas

ADDRESS: NorthWest Research Associates/Colorado Research Associates
3380 Mitchell Lane, Boulder, CO 80301

Education:

B.A. Physics & Chemistry	Univ. of Rochester	1987
M.A. Physics	Univ. of Chicago	1990
Ph.D. Physics	Univ. of Chicago	1993

Experience:

2010-present	Senior Research Scientist	NWRA/CoRA office
1997-2010	Research Scientist	NWRA/CoRA office
1995-1997	Postdoctoral Fellow	LASP, Univ of Colorado, Boulder
1993-1995	President's Postdoctoral Fellow	Univ. of California, Berkeley
1993	Guest Scientist	Fermi National Accelerator Lab
1987-1993	Graduate student	University of Chicago
1983-1987	Undergraduate student	University of Rochester

Honors:

2008-CEDAR Prize Lecture, "The coupling of the lower atmosphere to the thermosphere via gravity wave excitation, propagation and dissipation" CEDAR workshop, Utah, June
Reviewer for JGR Space Physics and Atmospheres, GRL, JASTP, JAS, and AG.
Associate Editor, JGR Space Physics---January 2010—December 2014.
CSSC (Cedar Steering Committee) Member, 2011-2014
NASA panel review member
NSF proposal reviewer

Papers in Preparation:

Vadas, S.L. and G. Crowley, "Neutral wind and density perturbations in the thermosphere created by gravity waves observed by the TIDDBIT sounder", to be submitted to *J. Geophys. Res. Space Physics* December, 2016.

G. Crowley, S. Vadas and I. Azeem,, "Impact of Hurricane Noel on TID Characteristics Measured from Wallops Island by a TIDDBIT sounder", to be submitted to *J. Geophys. Res. Space Physics* December, 2016.

Papers Submitted for Publication (peer-reviewed):

Azeem, I., S.L. Vadas, G. Crowley, and J.J. Makela, "Traveling Ionospheric Disturbances (TIDs) over the United States Induced by Gravity Waves from the 2011 Tohoku Tsunami and Comparison with Gravity Wave Dissipative Theory", submitted to *J. Geophys. Res. Space Physics* November, 2016.

Becker, E. and S.L. Vadas, "Secondary gravity waves in the winter mesosphere: Results from a high-resolution, gravity-wave resolving global circulation model", submitted to *J. Geophys. Res. Atmos.*, November, 2016.

Papers In Press (peer-reviewed):

Lu, X., X. Chu, H. Li, C. Chen, J. A. Smith, and S. L. Vadas, 2016, Statistical characterization of high-to-medium frequency mesoscale gravity waves by lidar-measured vertical winds and temperatures in the MLT, submitted to *J. Atmos. Solar Terres. Phys.*, in press

Peer-reviewed Publications:

Paulino, I., A. F. Medeiros, S. L. Vadas, C. M. Wrasse, H. Takahashi, R. A. Buriti, D. Leite, S. Filgueira, J. V. Bageston, J. H. A. Sobral, and D. Gobbi, 2016, "Periodic waves in the lower thermosphere observed by OI630 nm airglow images", *Ann. Geophys.*, **34**, 293-301, doi:10.5194/angeo-34-293-2016.

Vadas, S. L., J. J. Makela, M. J. Nicolls, and R. F. Milliff, 2015, "Excitation of gravity waves by ocean surface wave packets: Upward propagation and reconstruction of the thermospheric gravity wave field", *J. Geophys. Res. Space Physics*, **120**, doi:10.1002/2015JA021430.

J. Westerhoff, G. Earle, R. Bishop, G. R. Swenson, S. Vadas, J. Clemmons, R. Davidson, L. Fanelli, C. Fish, V. Garg, A. Ghosh, B. B. Jagannatha, E. Kroeker, P. Marquis, D. Martin, S. Noel, C. Orr, R. Robertson, 2015, "LAICE CubeSat mission for gravity wave studies", *Advances in Space Research*, **56** (7), 1413—1427.

Vadas, S.L., H.-L. Liu, and R.S. Lieberman, 2014, "Numerical modeling of the global changes to the thermosphere and ionosphere from the dissipation of gravity waves from deep convection", *J. Geophys. Res. Space Physics*, **119**, doi:10.1002/2014JA020280.

Vadas, S. L., H. Suzuki, M.J. Nicolls, T. Nakamura and R.O. Harmon, 2014, "Atmospheric gravity waves excited by a fireball meteor: Observations and modeling", *J. Geophys. Res.*, **119**, doi:10.1002/2014JD021664.

Nicolls, M.J., S.L. Vadas, N. Aponte and M. P. Sulzer, 2014, "Horizontal Wave Parameters of Daytime Thermospheric Gravity Waves and E-Region Neutral Winds over Puerto Rico", *J. Geophys. Res. Space Physics*, **119**, doi:10.1002/2013JA018988.

Suzuki, S., S.L. Vadas, K. Shiokawa, and Y. Otsuka, S. Kawamura, and Y. Murayama, 2013, "Typhoon-induced concentric airglow structures in the mesopause region", *Geophys. Res. Lett.*, **40**, 1–5, doi:10.1002/2013GL058087.

Vadas, S.L. and D.C. Fritts, 2013, "Corrigendum" to "Gravity wave radiation and mean responses to local body forces in the atmosphere", *Jour. Atmos. Sci.*, **70**, 2680.

Liu, H.-L. and S.L. Vadas, 2013: "Large-scale ionospheric disturbances due to the dissipation of convectively-generated gravity waves over Brazil", *J. Geophys. Res. Space Physics*, **118**, 2419–2427, doi:10.1002/jgra.50244.

Vadas, S. L., and H.-L. Liu, 2013, Numerical modeling of the large-scale neutral and plasma responses to the body forces created by the dissipation of gravity waves from 6 h of deep convection in Brazil, *J. Geophys. Res. Space Physics*, **118**, 2593–2617, doi:10.1002/jgra.50249

Suzuki, H., T. Nakamura, S.L. Vadas, M. Tsutsumi, M. Taguchi and Y. Fujiwara, 2013, "Inertia-gravity wave in the polar mesopause region inferred from successive images of a meteor train", *J. Geophys. Res.*, **118**, doi:10.1029/2012JD018928.

Vadas, S. L., 2013, Compressible f-plane solutions to body forces, heatings, and coolings, and application to the primary and secondary gravity waves generated by a deep convective plume, *J. Geophys. Res.*, **118**, 2377–2397, doi:10.1002/jgra.50163.

Smith, S.M., S.L. Vadas, W.J. Baggaley, G. Hernandez, and J. Baumgardner, 2013, "Gravity Wave Coupling Between the Mesosphere and Thermosphere Over New Zealand", *J. Geophys. Res.*, **118**, doi:10.1002/jgra.50263.

Chen, C., X. Chu, A. J. McDonald, S.L. Vadas, Z. Yu, W. Fong and X. Lu, 2013, "Inertia-gravity waves in Antarctica: A case study using simultaneous lidar and radar measurements at McMurdo/Scott Base (77.8° S, 166.7° E)", *JGR*, **118**, 1–15, doi:10.1002/jgrd.50318.

Liu, X., J. Xu, J. Yue and S. L. Vadas, 2013, "Numerical modeling study of the momentum deposition of small amplitude gravity waves in the thermosphere", *Ann. Geophys.*, **31**, 1–14.

Paulino, I., H. Takahashi, S.L. Vadas, C.M. Wrasse, J.H.A. Sobral, A.F. Medeiros, R.A. Buriti, D. Gobbi, 2012, "Forward ray tracing for medium-scale gravity waves observed during the COPEX campaign", *J. Atmos. Solar Terres. Phys.*, 90–91, 117–123.

Vadas, S. L. and M. J. Nicolls, 2012, "The Phases and Amplitudes of Gravity Waves Propagating and Dissipating in the Thermosphere: Theory", *J. Geophys. Res.*, **117**, A05322, doi:10.1029/2011JA017426.

Nicolls, M. J., S. L. Vadas, J. W. Meriwether, M. G. Conde, and D. Hampton, 2012, "The Phases and Amplitudes of Gravity Waves Propagating and Dissipating in the Thermosphere: Application to Measurements over Alaska", *J. Geophys. Res.*, **117**, A05323, doi:10.1029/2012JA017542.

Vadas, S.L., J. Yue, and T. Nakamura, 2012, "Mesospheric concentric gravity waves generated by multiple convection storms over the North America Great Plain", *J. Geophys. Res.*, **117**, D7, doi:10.1029/2011JD017025.

Earle, G.D. P. Bhaneja, P.A. Roddy, C.M. Swenson, A. Barjatya, R.L. Bishop, T.W. Bullett, G. Crowley, R. Redmon, K. Groves, R. Cosgrove, and S.L. Vadas, 2010. "A comprehensive rocket and radar study of midlatitude spread F", *J. Geophys. Res.*, **115**, A12339, doi:10.1029/2010JA015503.

Makela, J.J., S.L. Vadas, R. Muryanto, T. Duly, and G. Crowley, 2010: "Periodic spacing between consecutive equatorial plasma bubbles", *Geophys. Res. Lett.*, **37**, L14103, doi:10.1029/2010GL043968.

Nicolls, M. J., R. H. Varney, S. L. Vadas, P.A. Stamus, C. J. Heinselman, R. B. Cosgrove, and M. C. Kelley, 2010: "Influence of an inertia-gravity wave on mesospheric dynamics: A case study with the Poker Flat Incoherent Scatter Radar", *J. Geophys. Res.*, **115**, D00N02, doi:10.1029/2010JD014042.

Vadas, S.L and G. Crowley, 2010: "Sources of the traveling ionospheric disturbances observed by the ionospheric TIDDBIT sounder near Wallops Island on October 30, 2007", *J. Geophys. Res. Space Physics*, **115**, A07324, doi:10.1029/2009JA015053.

Vadas, S.L. and M.J. Keskinen, 2010: "Correction to "Three-dimensional nonlinear evolution of equatorial ionospheric bubbles with gravity wave seeding and tidal wind effects", *Geophys. Res. Lett.*, **37**, L03101, doi:10.1029/2009GL041216.

Keskinen, M.J. and S.L. Vadas, 2009: "Three-dimensional nonlinear evolution of equatorial ionospheric bubbles with gravity wave seeding and tidal wind effects", *Geophys. Res. Lett.*, **36**, L12102, doi:10.1029/2009GL037892.

Vadas, S.L. and H.-L. Liu, 2009, "The generation of large-scale gravity waves and neutral winds in the thermosphere from the dissipation of convectively-generated gravity waves, *J. Geophys. Res.*, **114**, A10310, doi:10.1029/2009JA014108.

Vadas, S. L., and D.C Fritts, 2009: "Reconstruction of the gravity wave field from convective plumes via ray tracing", *Ann. Geophys.*, **27**, 147-177.

Vadas, S. L., and M. J. Nicolls, 2009: "Temporal evolution of neutral, thermospheric winds and plasma response using PFISR measurements of gravity waves", *J. Atmos. Solar Terres. Phys.*, **71**, 740-770.

Vadas, S.L., J. Yue, C.-Y. She, P.A. Stamus, and A.Z. Liu, 2009: "A model study of the effects of winds on concentric rings of gravity waves from a convective plume near Fort Collins on 11 May 2004", *J. Geoph. Res.*, **114**, D06103, doi:10.1029/2008JD010753.

Yue, J., S.L. Vadas, C.-Y. She, T. Nakamura, S. Reising, H.-Li Liu, P. Stamus, D. Krueger, W. Lyons, T. Li, 2009: "Concentric gravity waves in the mesosphere generated by convective plumes in the lower atmosphere near Fort Collins, Colorado", *J. Geoph. Res.*, **114**, D06104, doi:10.1029/2008JD011244.

Vadas, S.L., M.J. Taylor, P.-D. Pautet, P. A. Stamus, D.C. Fritts, H.-L. Liu, F.T. Sao Sabbas, V.T. Rampinelli, P. Batista and H. Takahashi, 2009: "Convection: the likely source of medium-scale gravity waves observed in the OH airglow layer near Brasilia, Brazil, during the SpreadFEx Campaign", *Ann. Geophys*, **27**, 231-259.

Takahashi, H., M. J. Taylor, P.-D. Pautet, A. F. Medeiros, D. Gobbi, C. M. Wrasse, J. Fachine, M. A. Abdu, I. S. Batista, E. Paula, J.H.A. Sobral, D. Arruda, S. L. Vadas, F. S. Sabbas and D. C. Fritts, 2009, "Simultaneous observation of ionospheric plasma bubbles and mesospheric gravity waves during the SpreadFEx Campaign", *Annals Geoph.*, **27**, 1477-1487.

Taylor, M.J., P.-D. Pautet, A.F. Medeiros, R. Buriti, J. Fachine, D.C. Fritts, S.L. Vadas, H. Takahashi, and F.T. Sao Sabbas, 2009: "Characteristics of mesospheric gravity waves near the magnetic equator, Brazil during the SpreadFEx campaign", **27**, 461-472.

Fritts, D. C., Abdu, M. A., Batista, B. R., Batista, I. S., Batista, P. P., Buriti, R., Clemesha, B. R., Dautermann, T., de Paula, E., Fachine, B. J., Fejer, B., D.Gobbi, Haase, J., Kamalabadi, F., Laughman, B., Lima, P. P., Liu, H., Medeiros, A., Pautet, D., Riggin, D.M., Sao Sabbas, F. S., Sobral, J. H., Stamus, P., Takahashi, H., Taylor, M. J., Vadas, S. L., and Wrasse, C., 2009: "The Spread F Experiment (SpreadFEx): Program overview and first results", *Earth, Planets and Space*, **61**, 411-430.

Fritts, D.C., M. A. Abdu, B. R. Batista, I. S. Batista, P. P. Batista, R. Buriti, B. R. Clemesha, T. Dautermann, E.R. de Paula, B. J. Fachine, B.G. Fejer, D. Gobbi, J. Haase, F. Kamalabadi, E. A. Kherani, B. Laughman, P. P. Lima, H.-L. Liu, A. Medeiros, P.-D. Pautet, D. M. Riggin, F. S. Rodrigues, F.T. Sao Sabbas, J. H. A. Sobral, P. Stamus, H. Takahashi, M. J. Taylor, S. L. Vadas, F. Vargas, C.M. Wrasse, 2009: "Overview and Summary of the Spread F Experiment (SpreadFEx)", *Annals Geoph.*, **27**, 1-15.

Sao Sabbas, F.T., V. T. Rampinelli, J. Santiago, P. Stamus, S.L. Vadas, D.C. Fritts, M.J. Taylor, P.-D. Pautet, G. Dolif Neto, and O. Pinto, 2009: "Characteristics of sprite and gravity wave convective sources present in satellite IR images during the SpreadFEx 2005 in Brazil", *Annals Geoph.*, **27**, 1279-1293.

Fritts, D.C. and S.L. Vadas, 2008: "Gravity wave penetration into the thermosphere: Sensitivity to solar cycle variations and mean winds", *Ann. Geophys*, **26**, 3841-3861.

Fritts, D.C., S.L. Vadas, D.M. Riggin, M.A. Abdu, I.S. Batista, H. Takahashi, A. Medeiros, F. Kamalabadi, H.-L. Liu, B. J. Fejer, and M.J. Taylor, 2008: "Gravity wave and tidal influences on equatorial spread F based on observations during the spread F experiment (SpreadFEx)", *Annals Geoph.*, **26**, 3235-3252.

Vadas, S. L., and M. J. Nicolls, 2008: "Using PFISR measurements and gravity wave dissipative theory to determine the neutral, background thermospheric winds", *Geophys. Res. Lett.*, **35**, L02105, doi:10.1029/2007GL031522.

Earle, G.D., A. Mwene-Musumba, and S.L. Vadas, 2008: "Satellite-Based measurements of gravity wave-induced Mid-latitude plasma density perturbations", *J. Geoph. Res.*, **113**, A03303, doi:10.1029/2007JA012766.

Vadas, S.L., 2007: "Horizontal and vertical propagation and dissipation of gravity waves in the thermosphere from lower atmospheric and thermospheric sources", *J. Geoph. Res.*, **112**, A06305, doi:10.1029/2006JA011845.

Vadas, S.L. and D.C. Fritts, 2006: "The influence of solar variability on gravity wave structure and dissipation in the thermosphere from tropospheric convection" *J. Geoph. Res.*, **111**; A10S12, doi:10.1029/2005JA011510.

Vadas, S.L. and D.C. Fritts, 2005: "Thermospheric responses to gravity waves: Influences of increasing viscosity and thermal diffusivity" *J. Geoph. Res.*, **110**, D15103; doi:10.1029/2004JD005574.

Fritts, D. C., S. L. Vadas, K. Wan, and J. A. Werne, 2006: Mean and variable forcing of the middle atmosphere by gravity waves, *J. Atmos. Solar-Terres. Phys.*, **68**, 247-265.

Vadas, S.L. and D.C. Fritts, 2004: "Thermospheric responses to gravity waves arising from mesoscale convective complexes", *J. Atmos. Solar Terres. Phys.*, **66**, 781–804.

Vadas, S.L., D.C. Fritts, and M.J. Alexander, 2003: "Mechanism for the generation of secondary waves in wave breaking regions", *J. Atmos. Sci.*, **60**, 194–214.

Vadas, S.L. and D.C. Fritts, 2002: "The Importance of spatial variability in the generation of secondary gravity waves from local body forces", *Geophys. Res. Lett.*, **29**(20) 10.1029/2002GL015574.

Fritts, D.C., S.L. Vadas, and Y. Yamada, 2002: "An estimate of strong local bod forcing and gravity wave radiation based on OH airglow and meteor radar observations", *Geophy. Res. Lett.*, **29** (10) 10.1029/2001GL013753.

Balsley, B., D.C. Fritts, R. Frehlich, M. Jones, S.L. Vadas, R. Coulter, 2002, "Up-gully flow in the great plains region: a mechanism for perturbing the nighttime lower atmosphere", *Geophys. Res. Lett.*, **29**(19) 10.1029/2002GL015435.

Vadas, S.L. and D.C. Fritts, 2001: “Gravity wave radiation and mean responses to local body forces in the atmosphere” *J. Atmos. Sci.*, **58**, 2249–2279.

Fritts, D.C., S.L. Vadas and O. Andreassen, 1998, “Gravity wave excitation and momentum transport in the solar interior: Implications for a residual circulation and lithium depletion”, *Astron & Astroph.*, **333**, 343–361.

Vadas, S.L., 1998, “The Signatures of Voids I. Numerical Model”, *Monthly Not. Royal Astron. Soc.*, **299**, 277-284.

Vadas, S.L., 1998, “The Signatures of Voids II. In Front of the Last Scattering Surface”, *Monthly Not. Royal Astron. Soc.*, **299**, 285-298.

Vadas, S.L., 1998, 1994, “Collapse of a superhorizon-sized void in the early Universe”, *Phys. Rev D*, **50**, 7179-7201.

Kolb, E.W. and S.L. Vadas, 1994, “Relating spectral indices to tensor and scalar amplitudes in inflation”, *Phys. Rev D*, **50**, 2479-2487.

Vadas, S.L., 1993, “Numerical Evolution of General Relativistic Voids”, *Phys. Rev D*, **48**, 4562-4594 [PhD thesis].

Holman, R., E.W. Kolb, S.L. Vadas, Y. Wang, 1991, “Plausible Double Inflation”, *Phys. Lett.*, **269B**, 252-256.

Holman, R., E.W. Kolb, S.L. Vadas, Y. Wang, 1991, “Scale-Invariant Extended Inflation”, *Phys. Rev D*, **43**, 3833-3845.

Holman, R., E.W. Kolb, S.L. Vadas, Y. Wang, 1991, “Extended Inflation From Higher Dimensional Theories”, *Phys. Rev D*, **43**, 995-1004.

Holman, R., E.W. Kolb, S.L. Vadas, Y. Wang, 1990, “False-Vacuum Decay in Generalized Extended Inflation”, *Phys. Lett.*, **250B**, 24-28.

Holman, R., E.W. Kolb, S.L. Vadas, Y. Wang, E. Weinberg, 1990, “False Vacuum Decay in Jordan-Brans-Dicke Cosmologies”, *Phys. Lett.*, **237B**, 37-42.

Takagi, K., B.R. Suddaby, S.L. Vadas, C.A. Backer and D.G. Whitten, 1986, “Topological Control of Reactivity by Interfacial Orientation: Excimer Fluorescence and Photodimerization of 4-Stillbazolium Cations in Aerosol OT Reversed Micelles”, *Jour.Am.Chem.Soc*, **108**, 7865-7867.

Keynote Lectures:

SCOSTEP, 12th Solar-Terrestrial Symposium, “Thermospheric response to gravity wave coupling from below”, Berlin, Germany, July, 2010

Invited Conference Talks:

COSPAR (C2.2), “Ray Tracing Modeling of Gravity Wave Propagation and Dissipation”, in Wave Coupling Processes in the Whole Atmosphere, Russia, August, 2014

COSPAR (C1.1), “Model study of the effects of gravity wave dissipation on the thermosphere and ionosphere from deep convection worldwide”, in Recent Advances in Equatorial, Low- and Mid-latitude Mesosphere, Thermosphere and Ionosphere Studies, Russia, August, 2014

COSPAR (C1.1), “Effects of gravity wave dissipation on the thermosphere and ionosphere from deep convection: Excitation of secondary gravity waves, and large-scale changes to the background neutral wind and temperature”, in Recent Advances in Equatorial, Low- and Mid-latitude Mesosphere, Thermosphere and Ionosphere Studies, India, July, 2012

CEDAR-GEM Workshop, 2011, “Differences in propagation and dissipation of gravity waves during SC24”, High speed streams workshop, 30 June, 2011

CEDAR-GEM workshop, 2011, “The phases and amplitudes of gravity waves propagating and dissipating in the thermosphere, and its application to Fabry Perot and PFISR observations on 9-10 January 2010 in Alaska”, Thermospheric Winds workshop, 28 June, 2011

AGU (SA09): “The excitation, propagation and dissipation of secondary gravity waves excited by mountain wave breaking” , SA21B-05, 14 December, 2010

COSPAR (C1.1) “Secondary gravity waves near the mesopause: fingerprints of thermospheric dynamics” in Recent Advances in Equatorial, Low- and Mid-latitude Mesosphere, Thermosphere and Ionosphere Studies, Bremen, Germany, July, 2010

COSPAR (C2.2) “Gravity Wave Propagation into the Thermosphere from Deep Convection” in Troposphere to Ionosphere Multi-Scale Wave Coupling Processes, Bremen, Germany, July, 2010

IAGA, ICDC Symposium, (DC.01), “The Response of the Thermosphere and Ionosphere to the Dissipation of Gravity Waves Generated from Deep Convection” in Atmospheric coupling processes in the equatorial region, Sopron, Hungary, August, 2009

2009 Joint Assembly: “Convective Coupling Between the Lower Atmosphere and the Thermosphere/Ionosphere” in Coupling Between the Lower and Upper Atmosphere, Toronto, May 26, 2009

ISEA-12, Session S8 : Coupling processes at low- and mid-latitudes, Crete, May 22, 2008.

International CAWSES Symposium, Kyoto, Japan, 2007 (*did not attend*).

IUGG, IAGA/ICMA JAS007 Symposium, Response of the Atmosphere/Ionosphere Coupling System to Forcing from the Sun and the Lower Atmosphere, “Response of the atmosphere/ionosphere coupling system to forcing from the sun and the lower atmosphere”, Perugia, Italy, 2007.

36 th COSPAR Scientific Assembly, C2.2 , Tides, Waves and Coupling Processes from Troposphere to Ionosphere?, “Coupling of the lower atmosphere to the thermosphere via gravity waves”, Beijing, China, 2006.

34 th COSPAR Scientific Assembly, C2.1, Middle Atmosphere Structure and Dynamics, “Body Forcing as a Source of Gravity Waves”, Houston, Texas, October, 2002.

The 17th Texas Symposium for Relativistic Astrophysics, “The Signatures of Voids and the CMBR”, Munich, Germany, December 1994.

Numerical Simulations in Astrophysics, “The Evolution of Superhorizon-sized Voids in the Early Universe”, Mexico City, July 1993.

Invited Colloquium/Talks:

University of Colorado, Physics Dept. colloquium, Fort Collins, CO, November 10, 2008.

Clemson University, Physics Dept. colloquium, Clemson, SC, 2007.

University of Colorado, 2007.

High Altitude Observatory, NCAR, Boulder, CO, 1996.

University of California at San Diego, San Diego, CA, 1994.

University of California at Santa Barbara, Santa Barbara, CA, 1995.

Tufts University, Physics Dept., 1993.

University of Pennsylvania, Physics Dept., Philadelphia, PA, 1993.

Conference Proceedings (non peer-reviewed papers):

Vadas, S. L. and H.-L. Liu, 2011, “Neutral winds and densities at the bottomside of the F layer from primary and secondary gravity waves from deep convection”, *Aeronomy of the Earth's atmosphere and ionosphere*, Springer.

Thesis Advisor: Edward W. Kolb, University of Chicago, Dept. of Astronomy and Astrophysics