

## **RESUME – Xian Lu**

### **PERSONAL DATA**

Assistant Professor  
Department of Physics and Astronomy  
302A Kinard Laboratory  
Clemson University, Clemson, SC 29634  
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### **EDUCATION**

Ph.D., University of Illinois at Urbana-Champaign, 2011, Atmospheric Sciences  
Master, Wuhan University, China, 2006, Space Physics  
B.S., Wuhan University, China, 2003, Electrical Engineering

### **PROFESSIONAL EXPERIENCE**

Clemson University, 2016-, Assistant Professor of Physics and Astronomy  
University of Colorado Boulder, 2012–16, Research Scientist (3yrs) & CIRES Postdoc  
Visiting Fellow (1yr)  
Embry-Riddle Aeronautical University, 2011–12, Postdoctoral Researcher  
University of Illinois at Urbana-Champaign, 2006–11, Graduate Research Assistant,  
High Altitude Observatory (HAO), NCAR, 2010–11, Graduate Student Visitor

### **MEMBERSHIPS**

University Corporation for Atmospheric Research (UCAR) President's Advisory  
Committee on University Relations (PACUR, 2020.8-)  
UCAR member representative (2019.8-)  
Member, American Geophysical Union, AGU, (2007- )

### **PUBLICATIONS**

(\*: Postdocs and Graduate Students Advised)

#### **Refereed Journal Publications**

##### *After Joining Clemson*

- Wu, H.\*, and **X. Lu** (2021), Data Assimilation of High-Latitude Electric Fields: Extension of a Multi-Resolution Gaussian Process Model (Lattice Kriging) to Vector Fields, *Space Weather*, in revision.
- Li, J.\*, and **X. Lu** (2021), Global Responses of Gravity Waves and Zonal Mean Winds to the Madden-Julian Oscillation and the Latitudinal Dependence of Their Relations using MERRA-2, *Geophys. Res. Lett.*, in revision.
- Wang, X.\*, J. Miao, **X. Lu** et al. (2021), The Temporal Relationship of Thermospheric Density with Geomagnetic Activity Indices and Joule Heating and Calibration for NRLMSISE-00 Model During Geomagnetic Storms, *Space Weather*, under review.

- Kumari, K., H. Wu, A. Long, **X. Lu**, and J. Oberheide (2021), Mechanism Studies of Madden-Julian-Oscillation Coupling into the Mesosphere/Lower Thermosphere Tides using SABER, MERRA-2, and SD-WACCMX, *J. Geophys. Res. Space Physics*, doi:10.1029/2021JD034595.
- Li, J.\*, R. L. Collins, **X. Lu**, B. P. Williams (2021), Lidar observations of instability and estimates of vertical eddy diffusivity induced by gravity wave breaking in the Arctic mesosphere, *J. Geophys. Res. Atmos.*, 126, e2020JD033450, doi: 10.1029/2020JD033450.
- Zhou, X.\*, X. Yue, H. Liu, **X. Lu**, et al. (2021), A Comparative Study of Ionospheric Day-to-day Variability over Wuhan based on Ionosonde Measurements and Model Simulations, *J. Geophys. Res. Space Physics*, 126, e2020JA028589, <https://doi.org/10.1029/2020JA028589>.
- Wang, X\*, J. Miao, **X. Lu**, Ercha Aa et al. (2021), Latitudinal Impacts of Joule Heating on the High-Latitude Thermospheric Density Enhancement during Geomagnetic Storms, *J. Geophys. Res. Space Physics*, doi:10.1029/2020JA028747.
- Li, J.\*, and **X. Lu** (2020), SABER Observations of Gravity Wave Responses to the Madden-Julian Oscillation from the Stratosphere to the Lower Thermosphere in Tropics and Extratropics, *Geophys. Res. Lett.*, 47, doi: 10.1029/2020GL091014.
- Wu, H.\*, **X. Lu**, G. Lu, X. Chu, W. Wang, Z. Yu, L. Kilcommons, D. Knipp, B. Wang, Y. Nishimura (2020), Importance of regional-scale auroral precipitation and electrical field variability to the storm-time thermospheric temperature enhancement and inversion layer (TTEIL) in the Antarctic E region, *J. Geophys. Res. Space Physics*, 125, doi: 10.1029/2020JA028224.
- Zhou, X.\*, H. Liu, **X. Lu**, R. Zhang, A. Maute, H. Wu, X. Yue, W. Wan (2020), Quiet-time Day-to-day Variability of Equatorial Vertical  $E \times B$  Drift from Atmosphere Perturbations at Dawn, *J. Geophys. Res. Space Physics.*, 125, doi: 10.1029/2020JA027824.
- Kumari, K., J. Oberheide, X. Lu (2020), The Tidal Response in the Mesosphere/Lower Thermosphere to the Madden-Julian Oscillation Observed by SABER, *Geophys. Res. Lett.*, 47, doi: 10.1029/2020GL089172.
- Li, Z., X. Chu, V. Harvey, J. Jandreau, **X. Lu**, Zhibin Yu, J. Zhao (2020), First Lidar Observations of Quasi-Biennial Oscillation-Induced Interannual Variations of Gravity Wave Potential Energy Density at McMurdo via a Modulation of the Antarctic Polar Vortex, *J. Geophys. Res. Atmos.*, 125, doi: 10.1029/2020JD032866.
- Lu, X.**, H. Wu, X. Chu, J. Oberheide, M. G. Mlynczak, J. M. Russell III (2019), Quasi-biennial oscillation of short-period planetary waves and polar night jet in winter Antarctica observed in SABER and MERRA-2 and mechanism study with a quasi-geostrophic model, *Geophys. Res. Lett.*, 46, doi: 10.1029/2019GL084759.
- Rout, D.\*, K. Pandey, D. Chakrabarty, R. Sekar, **X. Lu** (2019), Significant electric field perturbations in low latitude ionosphere due to the passage of two consecutive ICMEs during 6-8 September 2017, *J. Geophys. Res. Space Physics*, doi: 10.1029/2019JA027133.
- Lu, X.**, H. Wu, J. Oberheide, H. Liu, J. McInerney (2018), Latitudinal Double-Peak Structure of Stationary Planetary Wave 1 in the Austral Winter Middle Atmosphere

and its Possible Generation Mechanism, *J. Geophys. Res. Atmos.*, doi: 10.1029/2018JD029172.

- Chu, X., J. Zhao, **X. Lu**, V. L. Harvey, R. M. Jones, E. Becker, C. Chen, W. Fong, Z. Yu, B. Roberts, A. Dornbrack (2018), Lidar observations of stratospheric gravity waves from 2011 to 2015 at McMurdo, Antarctica: Part II. Potential energy densities, lognormal distributions, and seasonal variations, *J. Geophys. Res. Atmos.*, doi: 10.1029/2017JD027386.
- Dawkins, E., A. Feofilov, L. Rezac, A. Kutepov, Diego Janches, J. Höffner, X. Chu, **X. Lu**, M. Mlynczak, J. Russell (2018), Validation of SABER V2.0 operational temperature data with ground-based lidars in the mesosphere-lower thermosphere region (75-105 km), *J. Geophys. Res. Atmos.*, doi:10.1029/2018JD028742.
- Huang, H.\*, **X. Lu**, L. Liu, Q. Li, W. Wang (2018), Longitudinal and Altitudinal Variations of the Interhemispheric Asymmetry transition of Equatorial Ionization Anomaly, *J. Geophys. Res. Space Physics.*, 123, doi: 10.1029/2018JA026055.
- Lu, X.**, X. Chu, H. Li, C. Chen, J. Smith, S. Vadas (2017), Statistical characterization of high-to-medium frequency mesoscale gravity waves by lidar-measured vertical winds and temperatures in the MLT, *J. Atmos. Solar- Terr. Phys.*, 162,3-15 doi:10.1016/j.jastp.2016.10.009.
- Lu, X.**, X. Chu, C. Chen, V. Nguyen, A. Smith (2017), First observations of short-period eastward propagating planetary waves from the stratosphere to the lower thermosphere (110 km) in winter Antarctica, *Geophys. Res. Lett.*, 44. <https://doi.org/10.1002/2017GL075641>.
- Zhao, J., X. Chu, C. Chen, **X. Lu**, W. Fong, Z. Yu, R. Michael Jones, B. R. Roberts, and A. Dörnbrack (2017), Lidar observations of stratospheric gravity waves from 2011 to 2015 at McMurdo (77.84°S, 166.69°E), Antarctica: 1. Vertical wavelengths, periods, and frequency and vertical wave number spectra, *J. Geophys. Res. Atmos.*, 122, 5041-5062, doi:10.1002/2016JD026368.
- Chen, C., X. Chu, J. Zhao, B. R. Roberts, Z. Yu, W. Fong, **X. Lu**, J. A. Smith (2016), Lidar observations of persistent inertia-gravity waves with periods of 3–10 h in the Antarctic middle and upper atmosphere at McMurdo, *J. Geophys. Res. Space Physics.*, doi:10.1002/2015JA022127.
- Before Joining Clemson*
- Lu, X.**, X. Chu, W. Fong, C. Chen, Z. Yu, B. R. Roberts, and A. J. McDonald (2015a), Vertical evolution of potential energy density and vertical wave number spectrum of Antarctic gravity waves from 35 to 105 km at McMurdo (77.8°S, 166.7°E), *J. Geophys. Res. Atmos.*, 120, 2719–2737. doi: 10.1002/2014JD022751.
- Lu, X.**, C. Chen, W. Huang, J. A. Smith, X. Chu, T. Yuan, P.-D. Pautet, M. J. Taylor, J. Gong, and C. Y. Cullens (2015b), A coordinated study of 1 h mesoscale gravity waves propagating from Logan to Boulder with CRRL Na Doppler lidars and temperature mapper, *J. Geophys. Res. Atmos.*, 120, doi:10.1002/2015JD023604.
- Fong, W., X. Chu, **X. Lu**, C. Chen, T. J. Fuller-Rowell, M. Codrescu, and A. Richmond (2015), Lidar and CTIPE model studies of the fast amplitude growth of the diurnal

temperature ‘tides’ in the Antarctic winter lower thermosphere and relationship with the aurora, *Geophys. Res. Lett.*, doi: 10.1002/2014GL062784.

- Fong, W.\*, **X. Lu**, X. Chu, T. J. Fuller-Rowell, Z. Yu, B. R. Roberts, C. Chen, C. S. Gardner, and A. J. McDonald (2014), Winter temperature tides from 30 to 110 km at McMurdo (77.8°S, 166.7°E), Antarctica: Lidar observations and comparisons with WAM, *J. Geophys. Res. Atmos.*, 119, doi:10.1002/2013JD020784.
- Lu, X.**, X. Chu, T. Fuller-Rowell, L. Chang, W. Fong and Z. Yu (2013), Eastward propagating planetary waves with periods of 1–5 days in the winter Antarctic stratosphere as revealed by MERRA and lidar, *J. Geophys. Res. Atmos.*, 9565–9578, doi:10.1002/jgrd.50717.
- Liu, A. Z., **X. Lu**, and S. J. Franke (2013), Diurnal variation of gravity wave momentum flux and its forcing on the diurnal tide, *J. Geophys. Res. Atmos.*, 118, doi:10.1029/2012JD018653.
- 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 with simultaneous lidar and radar measurements at McMurdo/Scott Base (77.8S, 166.7E), *J. Geophys. Res. Atmos.*, 118, doi:10.1002/jgrd.50318.
- Friedman, J. S., X. Chu, C. Brum and **X. Lu** (2013), Observation of a thermospheric descending layer of neutral K over Arecibo, *J. Atmos. Solar- Terr. Phys.*, 10.1016/j.jastp.2013.03.002.
- Yue, J., J. Xu, L. Chang, Q. Wu, H.-L. Liu, **X. Lu**, J. Russell (2013), Global structure and seasonal variability of the migrating terdiurnal tide in the mesosphere and lower thermosphere, *J. Atmos. Solar- Terr. Phys.*, 105-106, 10.1016/j.jastp.2013.10.010.
- Huang, K. M., A. Z. Liu, **X. Lu**, Z. Li, Q. Gan, Y. Gong, C. M. Huang, F. Yi, and S. D. Zhang (2013), Nonlinear coupling between quasi 2 day wave and tides based on meteor radar observations at Maui, *J. Geophys. Res. Atmos.*, 118, doi:10.1002/jgrd.50872.
- Lu, X.**, H.-L. Liu, A. Z. Liu, J. Yue, J. M. McInerney, and Z. Li (2012), Momentum budget of the migrating diurnal tide in the Whole Atmosphere Community Climate Model at vernal equinox, *J. Geophys. Res. Atmos.*, 117, D07112, doi:10.1029/2011JD017089.
- Li, T., A. Z. Liu, **X. Lu**, Z. Li, S. J. Franke, G. R. Swenson, and X. Dou (2012), Meteor-radar observed mesospheric semi-annual oscillation (SAO) and quasi-biennial oscillation (QBO) over Maui, Hawaii, *J. Geophys. Res. Atmos.*, 117, D05130, doi:10.1029/2011JD016123.
- Lu, X.**, A. Z. Liu, J. Oberheide, Q. Wu, T. Li, Z. H. Li, G. R. Swenson, S. J. Franke (2011), Seasonal variability of the diurnal tide in the mesosphere and lower thermosphere over Maui, HI (20.7° N, 156.3° W), *J. Geophys. Res. Atmos.*, 116, D17103, doi:10.1029/2011JD015599.
- Li, Z., A. Z. Liu, X. Lu, G. R. Swenson, and S. J. Franke (2011), Gravity wave characteristics from OH airglow imager over Maui, *J. Geophys. Res. Atmos.*, 116, D22115, doi:10.1029/2011JD015870.

- Lu, X.**, A. Z. Liu, G. R. Swenson, T. Li, T. Leblanc, and I. S. McDermid (2009), Gravity wave propagation and dissipation from the stratosphere to the lower thermosphere, *J. Geophys. Res. Atmos.*, 114, D11101, doi:10.1029/2008JD010112.
- Lu, X.**, S. D. Zhang, Radiosonde observation of planetary waves in the lower atmosphere over the center China (2005), *Chinese Journal of Space Physics*, 25(6), 529-535.

### **Peer-Reviewed Conference Proceedings**

- Yu, Z., X. Chu, X. Lu, C. Chen, Dynamic drivers of TIFE diurnal cycle in Antarctica, *Proceedings of the 29th International Laser Radar Conference*, July 2020, New York.
- Lu, X.**, C. Chen, W. Huang, J. A. Smith, J. Zhao, X. Chu, T. Yuan, P. D. Pautet, M. J. Taylor, Simultaneous observations of mesoscale gravity waves over the central US with CRRL Na Doppler lidars and USU temperature mapper, *Proceedings of the 27th International Laser Radar Conference*, July 2015, New York.
- Fong, W., X. Chu, **X. Lu**, T. J. Fuller-Rowell, M. Codrescu, A. D. Richmond, Z. Yu, B. Roberts, and C. Chen, Winter temperature and tidal structures from 2011 to 2014 at McMurdo station: Observations from Fe Boltzmann temperature and Rayleigh lidar, *Proceedings of the 27th International Laser Radar Conference*, July 2015, New York.
- Chen, C., X. Chu, W. Fong, **X. Lu**, A. J. McDonald, D. Pautet, and M. J. Taylor, Antarctic wave dynamics mystery discovered by lidar, radar and imager, *Proceedings of the 27th International Laser Radar Conference*, July 2015, New York.
- Chu, X., Z. Yu, W. Fong, C. Chen, J. Zhao, I. F. Barry, J. A. Smith, **X. Lu**, W. Huang, and C. S. Gardner, From Antarctica lidar discoveries to OASIS exploration, *Proceedings of the 27th International Laser Radar Conference*, July 2015, New York.
- Chen, C., X. Chu, Z. Yu, W. Fong, A. J. McDonald, **X. Lu**, and W. Huang, Lidar and radar investigation of inertia gravity wave intrinsic properties at McMurdo, Antarctica, *Proceedings of the 26th International Laser Radar Conference*, June 2012, Greece.

### **Presentations**

- Lu, X.** (2021), Atmospheric Modeling, invited talk, CEDAR Student Workshop, June.
- Lu, X.**, H. Wu, T. Nishimura, S. Kaeppler, J. Meriwether, J. Li, Y. Zhang (2021), An update on 2015 St. Patrick's Day Storm using Assimilated Electric Field, invited talk, CEDAR workshop, June.
- Lu, X.**, H. Wu, J. Li, W. Wang, A. Maute (2021), Tidal and gravity wave impacts on the short-term ionospheric variability using nudged TIEGCM, invited talk, CEDAR workshop, June.

- Lu, X.**, H. Wu, J. Li (2020), Interaction of gravity waves propagating from the lower atmosphere with local Joule heating, AGU, December
- Lu, X.**, H. Wu, G. Lu, X. Chu, T. Nishimura, W. Wang, Z. Yu, L. Kilcommons, D. Knipp, and B. Wang (2020), Observation and simulation of large local neutral disturbances during geomagnetic storm, invited talk, JpGU-AGU Joint Meeting, July.
- Lu, X.**, H. Wu, G. Lu, X. Chu, W. Wang, Z. Yu, L. Kilcommons, D. Knipp, B. Wang, T. Nishimura (2020), Importance of regional auroral, electric field variability, and gravity wave to the storm-time Thermospheric Temperature Enhancement and Inversion Layer (TTEIL) in Antarctic E region, invited talk, CEDAR workshop, June.
- Lu, X.**, H. Wu, T. Nishimura, S. Kaeppler, J. Meriwether, J. Li (2020), Observations and simulation of local ionosphere-thermosphere responses to St. Patrick's day storm using observed aurora and electric field, invited talk, CEDAR workshop, June.
- Lu, X.**, Z. Chen, Z. Li, X. Chu, H. Wu, J. Zhao (2019), Interannual Variations of Polar Gravity Waves and Barotropic/Baroclinic Planetary Waves Possible Link to Quasi-Biennial Oscillation (QBO) and Solar Cycle, invited talk, CEDAR workshop, Santa Fe, June.
- Lu, X.**, et al. (2019), Neutral Temperature Inversion Layer and Unprecedented Enhancement in the Lower Thermosphere during Geomagnetic Storm, invited talk, Solar-Terrestrial Space Environment Workshop, Xining, China, May.
- Lu, X.**, X. Chu (2018), First Lidar Measurement of Heat Fluxes Induced by the Semidiurnal Tide in the Mesosphere and Lower Thermosphere in Boulder (40oN, 105oW), Colorado, AGU meeting, Washington DC, December.
- Lu, X.**, H. Wu, J. Oberheide, H. Liu, J. McInerney (2018), Latitudinal Double-Peak Structure of Stationary Planetary Wave 1 in the Austral Winter Middle Atmosphere & Possible Generation Mechanism, invited talk, CEDAR workshop, Santa Fe, New Mexico, June.
- Lu, X.**, X. Chu (2018), Heat Fluxes induced by 12-h "tidal" waves from the Na Doppler lidar in Boulder, invited talk, CEDAR workshop, Santa Fe, New Mexico, June.
- Lu, X.**, X. Chu, C. Chen, V. Nguyen, A. Smith, J. Oberheide (2017), Observation and Modeling of Eastward Propagating Planetary Waves from the Stratosphere to the Lower Thermosphere (30–110 km) over Winter Antarctica, invited talk, CEDAR workshop, Keystone, Colorado, June.
- Lu, X.** (2017), Neutral dynamics and Magnetosphere-Ionosphere-Thermosphere Coupling over Antarctica, invited talk, the 4<sup>th</sup> International Forum for Interdisciplinary Sciences and Engineering, Wuhan University, May.
- Lu, X.**, L. Hurd, W. Krier, L. Kilcommons, D. Knipp, X. Chu, Tim Fuller-Rowell (2017), Neutral temperature responses to the geomagnetic storms: observations versus modeling, International Meridian Circle Program Workshop, invited talk, Qingdao, China, May.
- Lu, X.**, X. Chu, H. Li, C. Chen, J. A. Smith, S. Vadas, H. Liu (2016), High-to-medium frequency mesoscale gravity waves in vertical winds and temperatures in the MLT &

Comparison with high-resolution WACCM, International Symposium on the Whole Atmosphere, talk, Tokyo, Japan, September.

**Lu, X.**, H. Li, X. Chu, C. Chen, J. A. Smith, S. Vadas, H. Liu (2016), High-to-medium frequency gravity waves in lidar vertical winds and temperatures in the MLT & Comparison with high-resolution WACCM, invited talk, CEDAR workshop, Boulder, CO, June.

**Lu, X.**, C. Chen, X. Chu, V. Nguyen, Planetary Waves from the Stratosphere to the Lower Thermosphere in Antarctica (2016), invited talk, CEDAR Workshop, Boulder, CO, June.

**Lu, X.**, H. Li, X. Chu, C. Chen, J. A. Smith, S. Vadas, H. Liu, Statistical characterization of high-to-medium frequency gravity waves by lidar-measured vertical winds and temperatures in the MLT & Comparison with high-Resolution WACCM (2016), poster, CEDAR Workshop, Boulder, CO, June.

**Lu, X.**, X. Chu, C. Chen, W. Fong, T. Fuller-Rowell, W. Huang, J. A. Smith (2015), talk, Science lecture, McMurdo, Antarctica.

**Lu, X.**, X. Chu, C. Chen, W. Fong, T. Fuller-Rowell, W. Huang, J. A. Smith (2015), talk, Science lecture, McMurdo, Antarctica.

**Lu, X.**, H. Li, C. Chen, W. Huang, J. A. Smith, X. Chu, D. Pautet, T. Yuan, M. Taylor (2015), High to medium frequency mesoscale gravity waves over the central US using CRRL Na lidars and USU AMTM, invited talk, CEDAR, Seattle, WA.

**Lu, X.**, X. Chu, C. Chen, V. Nguyen (2015), Lidar, satellite and modeling studies of the baroclinic planetary waves from the stratosphere to the lower thermosphere in winter Antarctica, poster, CEDAR, Seattle, WA.

**Lu, X.**, C. Chen, W. Huang, J. A. Smith, X. Chu, T. Yuan, D. Pautet, M. Taylor (2015), A coordinated study of 1-h mesoscale gravity waves propagating from Logan to Boulder with CRRL Na Doppler lidars and temperature mapper, poster, CIRES Rendezvous, Boulder, CO.

**Lu, X.**, X. Chu, C. Chen, V. Nguyen (2015), Lidar and satellite studies of the vertical coupling of eastward propagating planetary waves with periods of 1-5 days from the stratosphere to the lower thermosphere in the winter Antarctic, 12<sup>th</sup> LPMR, Boulder, CO

### **HONORS AND AWARDS**

Rising Star in Discovery, College of Science, Clemson University, 2020.

Pilot Program for Faculty Incentive for Global Engagement in SCIENCE, Awardee, Clemson University, 2020

NCAR/HAO Newkirk Fellowship (Graduate Student), HAO/NCAR, 2020.

Junior Researcher of the Year, Nominee, Clemson University, 2019

NSF/CAREER award, 2018

NCAR/Advanced Study Program (ASP) Faculty Fellowship, 2018

CIRES Postdoctoral Visiting Fellowship, University of Colorado at Boulder, 2012–2013

Graduate Student Visiting Fellowship, Advanced Study Program, NCAR, 2010-2011

Second Prize Scholarship & Endorsed Graduate Student, Wuhan University, 2003

Second Prize Scholarship, Wuhan University, 2002  
Third Prize Scholarship, Wuhan University, 2001

## **SPONSORED RESEARCH**

### ***Current***

"CAREER: Integrated Studies of Polar Wave and Magnetosphere-Ionosphere-Thermosphere Couplings from New Observations and Whole Atmosphere Modeling", *NSF, PI, 2018.08–2023.07*.

"Role of lower atmosphere waves in preconditioning the ionosphere-thermosphere response to geomagnetic storms", *NASA/GIGI, PI, 2021.12–2024.12*

"CEDAR: Collaborative Research: Experimental and theoretical investigation of midlatitude ionospheric instability", *NSF/CEDAR, Co-PI, 2020.09–2023.08*.

"Response of the mesosphere/lower thermosphere/ionosphere to tidal variability caused by the Madden-Julian Oscillation", *NASA, Co-I, 2019.02–2022.02*.

"Investigating the Range of Response of Auroral Electron Precipitation in High Latitude Electrodynamic", *AFOSR, Co-I, 2019.01–2021.12*.

"An Investigation of Ion-Neutral Coupling during Active Auroral Conditions", *NASA, Co-I, 2019.04–2022.03*.

### ***Previous***

"Signatures of energy dissipation in the magnetosphere-ionosphere-thermosphere (MIT) Coupled system", *NASA, PI, 2016.09–2019.06*

"CEDAR: Exploration of lower-atmosphere wave forcing, vertical wave coupling and their impacts on the ionosphere and thermosphere variability using WAM, lidar and ISR", *NSF, PI, 2014.03–2019.02*

"Exploring Energy Dissipation in the Magnetosphere-Ionosphere-Thermosphere Coupled System and its Impacts on Space Weather", *PI, NCAR, 2018*.

"Collaborative Research: Antarctic Research: Characterizing Gravity Waves and their Effects on the Antarctic Ozone Layer", *NSF, Co-I, 2016.04–2019.03*

## **OTHER SPONSORED ACTIVITY**

Pilot Program Award for faculty incentive for global engagement in SCIENCE, 2020  
Travel Grant, The 4<sup>th</sup> International Forum for Interdisciplinary Sciences and Engineering, Wuhan University, 2017

Travel Grant, ISWA SCOSTEP/VarSITI by University of Tokyo, 2016

Travel Grant, ANGWIN Workshop by NIPR in Japan, 2013

Travel Grant, AGU Gravity Workshop, 2011