TOMOKO MATSUO'S CURRICULUM VITAE

Associate Professor
Smead Endowed Faculty Fellow
Ann and H.J. Smead Department of Aerospace Engineering Sciences
3775 Discovery Drive, CCAR, Boulder, CO 80303-0429
303-735-7144 | tomoko.matsuo@colorado.edu | https://www.colorado.edu/lab/matsuo/

BIOSKETCH

Dr. Matsuo's research interests include atmospheric sciences and space physics, statistical and machine learning, and remote sensing and modeling of Earth and space environments. As a Principal Investigator (PI), with funding ($6.2M) from the NSF, NASA, European Space Agency (ESA), NOAA, Air Force Office of Scientific Research and Air Force Research Lab, including the NASA Science Mission Directorate Heliophysics Grand Challenges Research award of $1.2M, she has developed original and independent research programs centered on data assimilation of remote sensing data of the Earth's upper atmosphere and near-Earth space. She has received an NSF CAREER award, for her work into the predictability of the atmosphere from the ground to near-Earth space, an Outstanding Junior Faculty award and an Outstanding Undergraduate Teaching & Mentoring award from the Smead Aerospace Engineering Sciences Department, and a Dean's Faculty Fellowship from the College of Engineering and Applied Science. She is named a Smead Endowed Faculty Fellow. She has authored and co-authored over 70 refereed publications. Because of her unique training in space physics, atmospheric sciences, and statistics and the interdisciplinary nature of data assimilation research, she collaborates widely across disciplinary boundaries with space physicists, atmospheric scientists, aerospace engineers, applied mathematicians, and statisticians. She has been actively recruited to give talks and lead sessions at national and international meetings, including 87 invited talks. Dr. Matsuo served on high-level external committees, including the Steering Committee of National Academy of Sciences' Decadal Survey for Solar and Space Physics (Heliophysics) (2022-2023), the ESA-NASA Lower Thermosphere-Ionosphere Science (EN-LoTIS) Working Group (2022-2023), the International Association of Geomagnetism and Aeronomy (IAGA) Geospace Data Assimilation Working Group (GeoDAWG) as Chair (2022-), the NASA Heliophysics Advisory Committee (2017-2022), the NASA Geospace Dynamics Constellation Science and Technology Definition Team (2018-2019), the ESA Daedalus Mission Advisory Group (2018-2021), the NSF Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) Science Steering committee (2012-2015), the NSF Geospace Section Committee of Visitors (2014), the NCAR Computational and Information Systems Laboratory's Science Requirements Advisory Panel for the High-performance Computing System procurement (2019-2020). Since 2023, Dr. Matsuo is serving on the U.S. National Committee for Geodesy and Geophysics. Dr. Matsuo has served on internal committees, including the Advisory Board for the University of Colorado Boulder's Center for Research Data and Digital Scholarship (2017-2021), the University of Colorado Boulder Research and Innovation Office's ad hoc Committee for Research Computing Strategic Visioning (2021), the Department's Graduate Committee, as the Remote Sensing Earth and Space Science (RSESS) Focus Area Lead (2018-2020), Computing Committee as Chair (2019-2022), Inclusive Culture Committee (2020-2022), Undergraduate Committee for Curriculum Development, as the Instrumentation and Avionics Curriculum Group Lead (2022-2023), Performance Evaluation Committee (2022-2023), as well as the Mentoring Committee (2022-). Dr. Matsuo has advised 22 graduate students, including 7 PhD students as a primary academic advisor, 1 PhD student as an academic co-advisor, 8 PhD students as a co-advisor in collaboration with their academic advisors, and 6 MS students as an advisor, on the topics of space physics, atmospheric sciences, and geophysical applications of data assimilation and spatial statistics. Dr. Matsuo has developed and taught two graduate-level courses on Data Assimilation and Inverse Methods for Earth and Geospace Observations (ASEN6055) and Remote Sensing Data Analysis (ASEN6337) and one large undergraduate-level course on Aerospace Computing and Engineering Applications (ASEN1320). She has developed education outreach activities based on ASEN6337 course work and offered three summer camps for first-generation precollegiate high-school students.

EDUCATIONAL BACKGROUND

Hokkaido University, Sapporo, Japan	*Geophysics, B.Sc*. 1995
Nagoya University, Nagoya, Japan	*Physics, M.Sc*. 1998
State University of New York, Stony Brook	*Atmospheric Sciences, M.Sc.* 2000, *Ph.D.* 2003

ACADEMIC EMPLOYMENTS

Ann and H.J. Smead Department of Aerospace Engineering Sciences (AES) 1/2017–Present
Affiliated Faculty with Department of Applied Mathematics (APPM) 1/2018–Present
Assistant Professor (2017-2022) & Associate Professor (2022-)

Authored and co-authored 39 refereed publications. Won 14 grant awards as PI from NSF, NASA, and NOAA and one grant award as Co-PI from ESA, which amounts to the total of $3.8M. Won also awards as Co-I from NASA and the Department of Education (DoEd). Gave 52 invited talks at national and international meetings and departmental seminars. Outcomes from my research group have been reported in 136 oral and poster contributed conference presentations. Developed and taught one new undergraduate core course on Aerospace Computing and Engineering Applications (ASEN1320), and two new graduate courses on Data Assimilation and Inverse Methods for Earth and Geospace Observations (ASEN6055) and Remote Sensing Data Analysis (ASEN6337). Developed and taught a new graduate project on the research payload design for suborbital vehicles (ASEN5018-805). Taught one undergraduate elective course on Aerospace Software (ASEN4057), one graduate core course on Statistical Estimation for Dynamical Systems (ASEN5044), and Remote Sensing Seminar (ASEN5210). Mentored 63 students in total, including 7 PhD students as an advisor, 1 PhD student as a co-advisor, 6 MS students as an advisor, 4 PhD students on PhD research and dissertation in collaboration with their academic advisors, 20 PhD students as a PhD thesis committee member, 2 MS students as a MS thesis committee member, 10 graduate students as a qualifying exam committee member, and 7 graduate and 6 undergraduate students on their internship projects. Developed and offered three summer STEM camps on remote sensing based on ASEN6337 course work for local first-generation precollegiate high-school students. Mentored two high-school students on their independent studies for the Boulder Valley School District Science Fair. Led 32 sessions as a convener or co-convener at the CEDAR, Geospace Environmental Modeling (GEM) and American Geophysical Union (AGU) meetings. Served on external committees, including the U.S. National Committee for Geodesy and Geophysics, the National Academy of Sciences' Decadal Survey for Solar and Space Physics (Heliophysics) Steering Committee, the ESA-NASA Lower Thermosphere-Ionosphere Science (EN-LoTIS) Working Group, the International Association of Geomagnetism and Aeronomy (IAGA) Geospace Data Assimilation Working Group (GeoDAWG) as Chair, the NASA Geospace Dynamics Constellation Science and Technology Definition Team, the NASA Heliophysics Advisory Committee, the AGU Basu United States Early Career Award committee, the ESA Daedalus Mission Advisory Group, the NCAR Computational and Information Systems Laboratory's Science Requirements Advisory Panel for the High-performance Computing System Procurement, International Space Science Institute (ISSI) Science Team for Data Assimilation in the Ionosphere and Thermosphere, and ISSI Science Team for Understanding Interhemispheric Asymmetry in MIT Coupling. Served on internal committees, including the University of Colorado Boulder Research and Innovation Office's ad hoc Committee for Research Computing Strategic Visioning, the Advisory Board for the University of Colorado Boulder's Center for Research Data and Digital Scholarship, the Department's Graduate Committee as Focus Area Lead, the Department's Computing Committee as Chair, the Department's Strategic Vision Committee, the Department's Inclusive Culture Committee, and the Department's Undergraduate Committee for Curriculum Development. Served as an associate editor for AGU Space Weather Special Collection for talks and posters presented the AGU Chapman Conference on Scientific Challenges Pertaining to Space Weather Forecasting Including Extremes, Pasadena, CA, 2019. Provided peer-reviews of 2 journal manuscripts, 1 book chapter, 8 proposals for NASA Heliophysics programs, and 4 proposals for NSF Geospace and Polar programs, and served on a peer-review proposal panel for NASA.

Cooperative Institute for Research in Environmental Sciences (CIRES) 8/2007–12/2016
Space Weather Prediction Center, NOAA
Research Associate & Scientist III (2013-2016) Scientist II (2007-2013)

Led a multi-institutional collaborative project for developing an ensemble forecasting and data assimilation system capable of assimilating observations from the ground to geospace using the National Weather Service (NWS)'s operational ensemble forecasting and data assimilation systems. Won 7 externally funded grants as PI ($2.4M) from the NSF, NASA, AFOSR and AFRL, including the NASA Science Mission Directorate (SMD) Heliophysics Grand Challenges Research award of $1.2M. Gave 29 invited talks at national and international meetings and at research institutions and universities. Served on 5 peer-review proposal panels for the NSF. Lead sessions on data assimilation and related topics as a convener or co-convener at six national and three international meetings. Mentored 8 graduate students on their dissertation research related to data assimilation and spatial statistics. Supervised 2 CIRES research and associate scientists.

Institute for Mathematics Applied to Geosciences, NCAR 6/2003–7/2007
Visiting Scientist

Received post-doctoral training in statistics in NCAR's Geophysical Statistics Program under the guidance of Dr. Doug Nychka. Developed spatial statistical methods and applied them to large geophysical data sets. Applied an ensemble Kalman filter to the mesosphere lower thermosphere. Gave 5 invited talks at national and international meetings on the topic of data assimilation. Served on 2 peer-review proposal panels for NASA. Lead a session on data assimilation as a co-convener at the International Association of Geomagnetism and Aeronomy (IAGA) Scientific Assembly, Toulouse, France in 2005.

High Altitude Observatory, NCAR 9/1999–7/2003
Graduate Research Assistant

Conducted independent graduate research, under the supervision of Dr. Arthur Richmond and Prof. Marvin Geller, as an NCAR Advanced Study Program Graduate Fellow, on the effects of high-latitude ionospheric electric field variability on the estimation of global thermospheric Joule heating. Won 3 student paper awards from AGU and the NSF-CEDAR program. Gave one invited seminar at the NOAA Space Environment Center in 2002. Participated in the NATO Advanced Study Institute on Data Assimilation for the Earth System in Italy in 2002.

Space Environmental Center, NOAA 6/1998–8/1999
Visiting Research Scientist

Conducted a numerical simulation of the neutral density response to two geomagnetic storms using a coupled thermosphere ionosphere model and co-authored one refereed paper.

AWARDS AND HONORS (SINCE 2017)

Smead Endowed Faculty Fellow	2022
CU Smead Aerospace Department Outstanding Undergraduate Teaching & Mentoring Award	2021
CU College of Engineering and Applied Science Dean's Faculty Fellowship	2021
CU Smead Aerospace Department Outstanding Junior Faculty Award	2019
NSF CAREER Award	2019

RESEARCH GRANTS ($6.2M AS PI)

NASA Goddard Space Flight Center - **$162,590** 10/2023–9/2024

Matsuo, T. (PI), Geospace Data Assimilation Capabilities for CCMC III

NSF CEDAR Program - **$407,336 (total)** [$336,336 (PI Matsuo portion)] 9/2023–8/2026

Matsuo, T. (PI), and A. Maute (Co-I), CEDAR: Data-driven Modeling of the Global Equatorial Electrojet Variability

NASA FINESST Program - **$100,000** 9/2023–8/2025

Matsuo, T. (PI), and N. Dietrich (Fellow), Comprehensive Reanalysis of the Thermosphere's Storm-Time Response with Geospace Data Assimilation

NASA Goddard Space Flight Center - **$97,727** 10/2022–9/2023

Matsuo, T. (PI), Geospace Data Assimilation Capabilities for CCMC II

NASA SMD Heliophysics GOLD and ICON Guest Investigator - **$449,997** 10/2021–9/2025

Matsuo, T. (PI), Whole-Atmosphere Satellite Data Assimilation

NOAA NESDIS OPPA - **$218,406 (total)** [$203,062 (PI Matsuo portion)] 10/2021–8/2022

Matsuo, T. (PI), and N. Maruyama (Co-I), Observing System Simulation Experiment (OSSE): Ionospheric Electron Density Profile

NASA Goddard Space Flight Center - **$82,023** 10/2021–9/2022

Matsuo, T. (PI), Geospace Data Assimilation Capabilities for CCMC

NOAA NESDIS OPPA - **$416,846 (total)** [$302,606 (PI Matsuo portion)] 2/2021–8/2022

Matsuo, T. (PI), T. J. Fuller-Rowell, N. Maruyama, and N. Pedatella (Co-Is), Whole Atmosphere-Ionosphere Data Assimilation and Ensemble Forecasting System

ESA Earth Observation Program - **$44,143 (Co-PI Matsuo portion)** 6/2019–6/2020

Malaspina, T. (PI), **T. Matsuo** (Co-PI), Daedalus Science Study

NSF EarthCube Program - **$627,763** 9/2019–8/2023

Matsuo, T. (PI), EarthCube Data Capabilities: Collaborative Proposal: Assimilative Mapping of Geospace Observations

NASA FINESST Program - **$135,000** 9/2019–8/2022

Matsuo, T. (PI), and Clayton Cantrall (Fellow), Airglow Radiance Data Assimilation for Characterizing Vertical Coupling of Atmospheric Layers

NSF CAREER Program - **$713,718 + $16,000 (REU Participant Support)** 3/2019–2/2024

Matsuo, T. (PI), CAREER: Predictability of the Whole Atmosphere from Ground to Geospace

NSF Statistics Program - **$49,998** 9/2018–8/2021

Matsuo, T. (PI), Collaborative Research: Multi-scale Modeling of Non-Gaussian Random Fields on the Sphere

NASA SMD Heliophysics Living With Star Program – [$40,484 (Co-I Matsuo portion)] 10/2017–9/2022

Fang, T. (PI), T. J. Fuller-Rowell, N. Maruyama, **T. Matsuo**, M. Fedrizzi, D. Welling, and G. Toth (Co-Is), Quantifying the Variability of Equatorial Electrodynamics During Disturbed Geomagnetic Conditions Using First-principle Models

NSF CEDAR Program - **$250,000** 8/2017–7/2020

Matsuo, T. (PI), Collaborative Research: CEDAR: Assimilative Analysis of Low- and Mid-latitude Ionospheric Electrodynamics

NSF Polar Program - **$396,547 (total)** [$204,879 (PI Matsuo portion)] 3/2015–2/2019

Matsuo, T. (PI), D. J. Knipp and A. D. Richmond (Co-Is), Assimilative Mapping of Interhemispheric Polar Ionospheric Electrodynamics

NOAA NWS Office of Science and Technology Integration 9/2016–8/2019
– [$24,091 (Co-I Matsuo portion)]

Yudin, V. (PI), **T. Matsuo**, T. J. Fuller-Rowell, and D. Kleist (Co-Is), Data Assimilation in the Vertically Extended Global Atmosphere Models of NEMS

AFOSR Space Science Program - **$80,000 (Institutional PI Matsuo portion)** 8/2015–7/2018

Raeder, J. (PI, UNH PI), **T. Matsuo** (CU PI, Co-I), and J. L. Anderson (NCAR PI, Co-I), Ensemble Kalman filter for OpenGGCM

NSF EarthCube Program - **$100,000** 9/2015–8/2018

Matsuo, T. (PI), EarthCube IA: Collaborative Proposal: Integrated GeoScience Observatory

NASA SMD Heliophysics Grand Challenges Research Program - **$1,162,686 (total)** 4/2014–4/2018
– [$831,882 (PI Matsuo portion)]

Matsuo, T. (PI), T. J. Fuller-Rowell, R. Akmaev, H. Wang, T.-W. Fang, K. Ide, D. Kleist and X. Yue (Co-Is), Predictability and Ensemble Modeling of the Space-Atmosphere Interaction Region

CU-Boulder Innovative Research Program - **$25,000** 2015–2016

Matsuo, T. (PI) and D. Paul (Co-I), Modeling of Scale-dependent Stochastic Magnetosphere-Ionosphere Coupling Processes

AFOSR Science Program - **$159,894** 2013–2016

Matsuo, T. (PI), Thermospheric Data Assimilation

AFRL - **$77,129** 2012–2013

Matsuo, T. (PI) and D. J. Knipp (Co-I), Thermospheric Mass Density Specifications: Synthesis of Observations and Models

Air Force Small Business Technology Transfer Program 2012–2013

Crowley, G. (PI), T. J. Fuller-Rowell, **T. Matsuo**, M. Pilinski, S. Solomon, L. Qian, J. Thayer and M. Codrescu (Co-Is), Satellite Drag Physical Model Module for a Near Real-time Operation Testbed

NSF Space Weather Program - **$385,060** 2010–2016

Matsuo, T. (PI), D. J. Knipp, A. D. Richmond and D. W. Nychka (Co-Is), Assimilative Mapping of Space-based and Extremely Localized Observations of Ionospheric Electrodynamics

NASA SMD Heliophysics LWS Program 2008–2013

Garcia, R. (PI), T. J. Fuller-Rowell, R. Akmaev, M. Codrescu, J. Fontenla, H.-L. Liu, D. Marsh, **T. Matsuo**, C. Randall, A. D. Richmond, S. Solomon and H. Wang (Co-Is), Integrated Modeling of the Atmosphere-Ionosphere System

AFOSR Multidisciplinary University Research Initiative (MURI) Program 2007–2012

Forbes, J. M. (PI), T. J. Fuller-Rowell (Co-PI), R. Akmaev, B. Argrow, G. Born, G. Crowley, D. Falconer, J. Fontenla, D. J. Knipp, **T. Matsuo**, D. Odstrcil, J. Raeder and J. Thayer (Co-Is), Neutral Atmosphere Density Interdisciplinary Research

Air Force Small Business Innovation Research Program 2003–2006

Khattatov, B. (PI), M. Murphy and **T. Matsuo** (Co-Is), Long-term Ionospheric Forecasting System

NSF Space Weather Program 2002–2005

Emery, B. A. (PI), A. D. Richmond, **T. Matsuo** and A. Maute (Co-Is), The Quantification and Validation of Variable Electrodynamic Forcing of the Thermosphere

PEER-REVIEWED PUBLICATIONS (73)

[73] Gilpin*, S., **T. Matsuo**, and S. E. Cohn (2023), A generalized, compactly-supported correlation function for data assimilation applications, Quarterly Journal of the Royal Meteorological Society, 149(754), 1953–1989, https://doi.org/10.1002/qj.4490.

[72] Svaldi*, V., **T. Matsuo**, L. Kilcommons, and B. Gallardo-Lacourt (2023), High Latitude Ionospheric Electrodynamics During STEVE and non-STEVE Substorm Events, J. Geophys. Res. Space Physics, 128, e2022JA030277, https://doi.org/10.1029/2022JA030277.

[71] Sarris, T. E., S. Tourgaidis, P. Pirnaris, D. Baloukidis, K. Papadakis, C. Psychalas, S. C. Buchert, E. Doornbos, M. A. Clilverd, P. T. Verronen, D. Malaspina, N. Ahmadi, I. Dandouras, A. Kotova, W. J. Miloch, D. Knudsen, N. Olsen, O. Marghitu, **T. Matsuo**, G. Lu , A. Marchaudon, A. Hoffmann, D. Lajas, A. Strømme, M. Taylor, A. Aikio, M. Palmroth, R. Heelis, N. Ivchenko, C. Stolle, G. Kervalishvili, T. Moretto-Jørgensen, R. Pfaff, C. Siemes, P. Visser, J. van den Ijssel, H.-L. Liu, I. Sandberg, C. Papadimitriou, J. Vogt, A. Blagau, and N. Stachlys (2023), Daedalus MASE (mission assessment through simulation exercise): A Toolset for Analysis of In-situ Missions and for Processing Global Circulation Model Outputs in the Lower Thermosphere-Ionosphere, Front. Astron. Space Sci., 9:1048318, doi:10.3389/fspas.2022.1048318.

[70] Tang*, T., P. Alken, T. C. M. Lee, **T. Matsuo**, and D. Paul (2023), Modeling Vector Fields On An Annular Shell Using Needlets and Applications to Lithospheric Magnetic Fields, Annals of Applied Statistics, under review.

[69] Bossert, K., L. J. Paxton, **T. Matsuo**, L. Goncharenko, K. Kumari, and M. Conde (2022), Large Scale Travelling Atmospheric and Ionospheric Disturbances observed in GUVI, Geophysical Research Letters, 49, e2022GL099901, doi:10.1029/2022GL099901.

[68] Rajesh, P. K., C. H. Lin, J. T. Lin, C. Y. Lin J. Y. Liu, **T. Matsuo**, C. Y. Huang, M. Y. Chou, J. Yue, H. Jin, J. M. Choi, S. P. Chen, M. Chou, and H. F. Tsai, Extreme poleward expanding super plasma bubbles triggered by Tonga volcano eruption during the recovery phase of a geomagnetic storm, Geophysical Research Letters, 49, e2022GL099798, https://doi.org/10.1029/2022GL099798.

[67] Dietrich*, N., **T. Matsuo**, and C.-H. Hsu (2022), Specifying Satellite Drag Through Coupled Thermosphere-Ionosphere Data Assimilation of Radio Occultation Electron Density Profiles, Space Weather, https://doi.org/10.1029/2022SW003147.

* Papers by students mentored and guided by Dr. Matsuo.

[66] Liu, J. Y., C. H. Lin, C. Y. Lin, I. T. Lee, Y.-Y. Sun, S. P. Chen, F. Y. Chang, P. K. Rajesh, C.-T. Hsu, **T. Matsuo**, C. H. Chen, and H. F. Tsai (2022), Retrospect and Prospect of Ionospheric Weather Observed by FORMOSAT-3/COSMIC and FORMOSAT-7/COSMIC-2, Terrestrial, Atmospheric and Oceanic Sciences, 22 (20), https://doi.org/10.1007/s44195-022-00019-x.

[65] Gilpin[*], S., **T. Matsuo**, and S. E. Cohn (2022), Continuum Covariance Propagation for Understanding Variance Loss in Advective Systems, SIAM / ASA Journal of Uncertainty Quantification, 3(3), 886-914, https://doi.org/10.1137/21M1442449.

[64] Li[*], J., **T. Matsuo**, and L. Kilcommons (2022), Assimilative Mapping of Auroral Electron Energy Flux using SSUSI Lyman-Birge-Hopfield (LBH) Emissions, J. Geophys. Res. Space Physics, 127, e2021JA029739, https://doi.org/10.1029/2021JA029739.

[63] Rajesh, P. K., C. H. Lin, J. T. Lin, C. Y. Lin, J. Yue, **T. Matsuo**, and S. P. Chen (2021), Day-to-day Variability of Ionosphere Electron Density During Solar Minimum Derived from FORMOSAT-7/COSMIC-2 Measurements, Terrestrial, Atmospheric and Oceanic Sciences, doi:10.3319/TAO.2021.08.01.01.

[62] Cantrall[*], C., and **T. Matsuo** (2021), Deriving column-integrated thermospheric temperature with the N2 Lyman-Birge-Hopfield (2,0) band, Atmospheric Measurements Technique, 14, 6917–6928, https://doi.org/10.5194/amt-14-6917-2021.

[61] **Matsuo, T.**, M. Fan, X. Shi, C. Miller, J. M. Ruohoniemi, D. Paul, and T. C. M. Lee (2021), Multiresolution Modeling of high-latitude ionospheric electric field variability and impact on Joule heating using SuperDARN data, J. Geophys. Res. Space Physics, 126, e2021JA029196, https://doi.org/10.1029/2021JA029196.

[60] Palmroth, M., Grandin, M., Sarris, T., Doornbos, E., Tourgaidis, S., Aikio, A., Buchert, S., Clilverd, M. A., Dandouras, I., Heelis, R., Hoffmann, A., Ivchenko, N., Kervalishvili, G., Knudsen, D. J., Kotova, A., Liu, H.-L., Malaspina, D. M., March, G., Marchaudon, A., Marghitu, O., **Matsuo, T.**, Miloch, W. J., Moretto-Jørgensen, T., Mpaloukidis, D., Olsen, N., Papadakis, K., Pfaff, R., Pirnaris, P., Siemes, C., Stolle, C., Suni, J., van den IJssel, J., Verronen, P. T., Visser, P., and Yamauchi, M. (2021): Lower thermosphere – ionosphere (LTI) quantities: Current status of measuring techniques and models, Ann. Geophys., 39, 189-237, https://doi.org/10.5194/angeo-39-189-2021.

[59] **Matsuo, T.**, and C.-H. Hsu (2021), Inference of hidden states by coupled thermosphere-ionosphere data assimilation, In W. Wang and Y. Zhang (Eds.), In Upper Atmosphere Dynamics and Energetics, Geophysical Monograph Series: Space Physics and Aeronomy, 4 (18), 343-363, American Geophysical Union, https://doi.org/10.1002/9781119815631.ch18.

[58] Hsu[**], C.-H., **T. Matsuo**, A. Maute, R. Stoneback, and C.-P. Lien (2021), Data-Driven Ensemble Modeling of Equatorial Ionospheric Electrodynamics: A Case Study During a Minor Storm Period Under Solar Minimum Conditions, J. Geophys. Res. Space Physics, 126, e2020JA028539, https://doi.org/10.1029/2020JA028539.

[57] Lin, J. T., C. H. Lin, P. K. Rajesh, J. Yue, C. Y. Lin, and **T. Matsuo** (2020), Local-Time and Vertical Characteristics of Quasi-6-Day Oscillation in the Ionosphere during the 2019 Antarctic Sudden Stratospheric Warming, Geophysical Research Letters, 47, e2020GL090345, https://doi.org/10.1029/2020GL090345.

[56] Rajesh, P. K., C. H. Lin, C. Y. Lin, C. H. Chen, J. Y. Liu, **T. Matsuo**, S. P. Chen, W. H. Yeh, and C. Y. Huang (2020), Extreme Positive Ionosphere Storm Triggered by a Minor Magnetic Storm in Deep Solar

Minimum Revealed by FORMOSAT-7/COSMIC-2 and GNSS Observations, J. Geophys. Res. Space Physics, 125, e2020JA028261, https://doi.org/10.1029/2020JA028261.

[55] Lin, C. Y., C. H. Lin, J. Y. Liu, P. K. Rajesh, **T. Matsuo**, M. Y. Chou, H. F. Tsai, and W. H. Yeh (2020), The Early Results and Validation of FORMOSAT-7/COSMIC-2 Space Weather Products: Global Ionospheric Specification and Ne-Aided Abel Electron Density Profile, J. Geophys. Res. Space Physics, 125, e2020JA028028, https://doi.org/10.1029/2020JA028028.

[54] Mutschler*, S., P. Axelrad, and **T. Matsuo** (2020), A Partially Orthogonal EnKF Approach to Atmospheric Density Estimation using Orbital Debris, Advances in Space Research, 65, 8,1965-1980, https://doi.org/10.1016/j.asr.2020.01.021.

[53] **Matsuo, T.** (2020), Recent progress on inverse and data assimilation procedure for high-latitude ionospheric electrodynamics, In M. Dunlop and H. Luhr (Eds.) Ionospheric Multi Satellite Analysis Tools: Approaches for Deriving Ionospheric Parameters, ISSI Scientific Report Series, 17, Springer, Cham, https://doi.org/10.1007/978-3-030-26732-2_10.

[52] Shi*, Y., D. J. Knipp, **T. Matsuo**, L. Kilcommons, and B. J. Anderson (2020), Event studies of high-latitude field-aligned currents (FACs) with inverse and assimilative analysis of AMPERE magnetometer data, J. Geophys. Res. Space Physics, 125, e2019JA027266. https://doi.org/10.1029/2019JA027266.

[51] Shi*, Y., D. J. Knipp, **T. Matsuo**, L. Kilcommons, and B. J. Anderson (2020), Modes of field-aligned currents (FACs) variability and their hemispheric asymmetry revealed by inverse and assimilative analysis of Iridium magnetometer data, J. Geophys. Res. Space Physics, 125, e2019JA027265, https://doi.org/10.1029/2019JA027265.

[50] Shi*, Y., D. M. Oliveira, D. J. Knipp, E. Zesta, **T. Matsuo**, and B. J. Anderson (2019), Effects of Nearly Frontal and Highly Inclined Interplanetary Shocks on High-latitude Field-aligned Currents (FACs), Space Weather, 17,1659-1673, https://doi.org/10.1029/2019SW002367.

[49] Cantrall*, C., **T. Matsuo**, and S. Solomon (2019), Upper atmosphere radiance data assimilation: A feasibility study for GOLD far ultraviolet observations, J. Geophys. Res. Space Physics, 124, 8145-8164, https://doi.org/10.1029/2019JA026910.

[48] Lin, J. T., C. H. Lin, C. Y. Lin, N. M. Pedatella, R. K. Rajesh, **T. Matsuo**, and J.-Y. Liu (2019), Revisiting the modulations of ionospheric solar and lunar migrating tides during the 2009 stratospheric sudden warming by using global ionosphere specification, Space Weather, 17, 767-777, https://doi.org/10.1029/2019SW002184.

[47] Chen, C. H., C. H. Lin, and **T. Matsuo** (2019), Ionospheric responses to the 21 August 2017 solar eclipse by using data assimilation approach, Progress in Earth and Planetary Science, 6:13, https://doi.org/10.1186/s40645-019-0263-4.

[46] Hsu*, C.-H., **T. Matsuo**, and J. Y. Liu (2018), Observation impact of the FORMOSAT-3/COSMIC and FORMOSAT-7/COSMIC-2 missions on the mid- and low-latitude ionospheric specification, Earth and Space Science, 5, 875-890, https://doi.org/10.1029/2018EA000447.

[45] Fang, T.-W., T. J. Fuller-Rowell, V. Yudin, **T. Matsuo**, and R. Viereck (2018), Quantifying the sources of ionosphere day-to-day variability, J. Geophys. Res. Space Physics, 123, 9682-9696, https://doi.org/10.1029/2018JA025525.

[44] Flynn*, S., D. J. Knipp, **T. Matsuo,** M. Mlynczak, and L. Hunt (2018), Understanding the global variability in thermospheric nitric oxide flux using empirical orthogonal functions (EOFs), J. Geophys. Res. Space Physics, 123, 4150-4170, https://doi.org/10.1029/2018JA025353.

[43] Hsu*, C.-H., **T. Matsuo**, X. Yue, T.-W. Fang, T. Fuller-Rowell, K. Ide, and J.-Y. Liu, (2018). Assessment of the impact of FORMOSAT-7/COSMIC-2 GNSS RO observations on midlatitude and low-latitude ionosphere specification: Observing system simulation experiments using Ensemble Square Root Filter, J. Geophys. Res. Space Physics, 123, 2296-2314, https://doi.org/10.1002/2017JA025109.

[42] Mlynczak, M. G, D. J. Knipp, L. A. Hunt, J. Gaebler, **T. Matsuo**, L. M. Kilcommons, and C. L. Young (2018), Space-based sentinels for measurement of infrared cooling in the thermosphere for space weather nowcasting and forecasting, Space Weather, 16, 363-375, https://doi.org/10.1002/2017SW001757.

[41] Fan*, M., D. Paul, T. C. M. Lee, and **T. Matsuo** (2018), A multi-resolution model for non-Gaussian random fields on a sphere with application to ionospheric electrostatic potentials, Annals of Applied Statistics, 12, 1, 459-489, https://doi.org/10.1214/17-AOAS1104.

[40] Fan*, M., D. Paul, T. C. M. Lee, and **T. Matsuo** (2018), Modeling tangent vector fields on the sphere, Journal of the American Statistical Association, 113, 1625-1636, doi:10.1080/01621459.2017.1356322.

[39] McGranaghan, R. M., Bhatt, A., **Matsuo, T.**, Mannucci, A. J., Semeter, J. L., and Datta-Barua, S. (2017), Ushering in a new frontier in geospace through data science, J. Geophys. Res. Space Physics, 122, 12,586-12,590, https://doi.org/10.1002/2017JA024835.

[38] Lin*, C.-Y., **T. Matsuo**, J. Y. Liu, C. H. Lin, J. D. Huba, H. F. Tsai, and C. Y. Chen (2017), Data assimilation of ground-based GPS and radio occultation total electron content for global ionospheric specification, J. Geophys. Res. Space Physics, 122, 10,876-10,886, doi:10.1002/ 2017JA024185.

[37] Rajesh, P. K., C. H. Lin, C. H. Chen, J. T. Lin, **T. Matsuo**, M. Y. Chou, W. H. Chen, M. T. Chang, and C. F. You (2017), Equatorial plasma bubble generation/inhibition during 2015 St. Patrick's day storm, Space Weather, 15, 1141-1150, doi:10.1002/2017SW001641.

[36] Smith, A. K., N. M. Pedatella, D. R. Marsh, and **T. Matsuo** (2017), On the dynamical control of the mesosphere-lower thermosphere by the lower and middle atmosphere, Journal of the Atmospheric Sciences, 74, 933-947, doi:10.1175/JAS-D-16-0226.1.

[35] Chen, C. H., C. H. Lin, W. H. Chen, and **T. Matsuo** (2017), Modeling the ionospheric pre-reversal enhancement using coupled thermosphere-ionosphere data assimilation, Geophysical Research Letters, 44, 1652-1659, doi:10.1002/2016GL071812.

[34] Chen, C. H., C. H. Lin, J. Y. Liu, **T. Matsuo**, W. H. Chen (2017), The impact of FORMOSAT-5/AIP on the ionospheric space weather, Terrestrial Atmospheric and Oceanic Sciences Journal, 28, 129-137, doi: 10.3319/TAO.2016.09.30.01(EOF5).

[33] Chen, C. H., C. H. Lin, **T. Matsuo**, W. H. Chen (2016), Ionosphere data assimilation modeling of 2015 St. Patrick's day geomagnetic storm, J. Geophys. Res. Space Physics, J. Geophys. Res. Space Physics, 121, 11,549-11,559, doi:10.1002/2016JA023346.

[32] McGranaghan*, R., D. J. Knipp, and **T. Matsuo** (2016), High-latitude ionospheric conductivity variability in three dimensions, Geophysical Research Letters, 43, 7867-7877, doi:10.1002/2016GL070253.

[31] McGranaghan*, R., D. J. Knipp, **T. Matsuo**, and E. Cousins (2016), Optimal interpolation analysis of high-latitude ionospheric Hall and Pedersen conductivities: Application to assimilative ionospheric electrodynamics reconstruction, J. Geophys. Res. Space Physics, 121, 4898-4923, doi:10.1002/2016JA022486.

[30] Chen, C. H., C. H. Lin, **T. Matsuo**, W. H. Chen, I. T. Lee, J. Y. Liu, J. T. Lin, and C. T. Hsu (2016), Ionospheric data assimilation with thermosphere-ionosphere-electrodynamics general circulation model and GPS-TEC during geomagnetic storm conditions, J. Geophys. Res. Space Physics, 121, 5708-5722, doi:10.1002/2015JA021787.

[29] Chartier**, A., **T. Matsuo**, J. L. Anderson, G. Lu, T. Hoar, N. Collins, A. Coster, C. Mitchell, L. Paxton, G. Bust (2016), Ionospheric data assimilation and forecasting during storms, J. Geophys. Res. Space Physics, 121, 764-778, doi:10.1002/2014JA020799.

[28] McGranaghan*, R., D. J. Knipp, **T. Matsuo**, H. Godinez, R. J. Redmon, S. C. Solomon, and S. K. Morley (2015), Modes of high-latitude auroral conductance variability derived from DMSP energetic electron precipitation observations: Empirical Orthogonal Function (EOF) analysis, J. Geophys. Res. Space Physics, 120, 11,013-11,031, doi:10.1002/2015JA021828.

[27] Cousins**, E. D. P., **T. Matsuo**, and A. D. Richmond (2015), Mapping high-latitude ionospheric electrodynamics with SuperDARN and AMPERE, J. Geophys. Res. Space Physics, 120, 5854-5870, doi:10.1002/2014JA020463.

[26] Cousins**, E. D. P., **T. Matsuo**, A. D. Richmond, and B. J. Anderson (2015), Dominant modes of variability in large-scale Birkeland currents, J. Geophys. Res. Space Physics, 120, 6722-6735, doi:10.1002/2014JA020462.

[25] **Matsuo, T.**, D. J. Knipp, A. D. Richmond, L. Kilcommons, and B. J. Anderson (2015), Inverse procedure for high-latitude ionospheric electrodynamics: Analysis of satellite-borne magnetometer data, J. Geophys. Res. Space Physics, 120, 5241-5251, doi:10.1002/2014JA020565.

[24] Sun*, Y.-Y., **T. Matsuo**, N. Maruyama and J. Y. Liu (2015), Field-aligned neutral wind bias correction scheme for global ionospheric modeling at midlatitudes by assimilating FORMOSAT-3/COSMIC hmF2 data under geomagnetically quiet conditions, J. Geophys. Res. Space Physics, 120, 3130-3149, doi:10.1002/2014JA020768.

[23] Lin*, C.-Y., **T. Matsuo**, J. Y. Liu, C. H. Lin, H. F. Tsai and E. A. Araujo-Pradere (2015), Ionospheric assimilation of radio occultation and ground-based GPS data using non-stationary background model error covariance, Atmospheric Measurement Techniques, 8, 171-182, doi:10.5194/amt-8-171-2015.

[22] Hsu*, C.-H., **T. Matsuo**, W. Wang, and J. Y. Liu (2014), Effects of inferring unobserved thermospheric and ionospheric state variables by using an Ensemble Kalman Filter on global ionospheric specification and forecasting, J. Geophys. Res. Space Physics, 119, 9256-9267, doi:10.1002/2014JA020390.

[21] **Matsuo, T.** (2014), Upper atmosphere data assimilation with an ensemble Kalman filter, in modeling the ionosphere-thermosphere system, Geophys, AGU Monogr. Ser., vol. 201, edited by J. Huba, R. Schunk, and G. Khazanov, pp. 273-282, John Wiley & Sons, Ltd, Chichester, UK, doi:10.1002/9781118704417.

[20] Knipp, D. J., **T. Matsuo**, L. Kilcommons, A. D. Richmond, H. Korth, B. Anderson, N. Parrish, B. Mero, R. Redmon, and F. Rich (2013), Comparison of magnetic perturbation data from LEO satellite constellations: Statistics of DMSP and AMPERE, Space Weather, 12, 2-23, doi:10.1002/2013SW00098.

[19] Cousins[**], E. D. P., **T. Matsuo**, A. D. Richmond (2013), Mesoscale and large-scale variability in high-latitude ionospheric convection: dominant modes and spatial/temporal coherence, J. Geophys. Res. Space Physics, 118, 7895-7904, doi:10.1002/2013JA019319.

[18] Cousins[**], E. D. P., **T. Matsuo**, A. D. Richmond (2013), SuperDARN assimilative mapping, J. Geophys. Res. Space Physics, 118, 7954-7962, doi:10.1002/2013JA019321.

[17] Lee[*], I. T., H. F. Tsai, J. Y. Liu, **Matsuo, T.**, and L. C. Chang (2013), Modeling impact of FORMOSAT-7/COSMIC-2 mission on ionospheric space weather monitoring, J. Geophys. Res. Space Physics, 118, 6518-6523, doi: 10.1002/jgra.50538.

[16] Sun[*], Y.-Y., **T. Matsuo**, E. A. Araujo-Pradere, and J. Y. Liu (2013), Ground-based GPS observation of SED associated irregularities over CONUS, J. Geophys. Res. Space Physics, 118, 2478-2489, doi:10.1029/2012JA018103.

[15] **Matsuo, T.**, I. T. Lee, and J. L. Anderson (2013), Thermospheric mass density specification using an ensemble Kalman filter, J. Geophys. Res. Space Physics, 118, 1339-1350, doi:10.1002/jgra.50162.

[14] Lee[*], I. T., **T. Matsuo**, A. D. Richmond, J. Y. Liu, W. Wang, C. H. Lin, J. L. Anderson, and M. Q. Chen (2012), Assimilation of FORMOSAT-3/COSMIC electron density profiles into thermosphere/ionosphere coupling model by using ensemble Kalman filter, J. Geophys. Res. Space Physics, 117, A10318, doi:10.1029/2012JA017700.

[13] **Matsuo, T.**, M. Fedrizzi, T. J. Fuller-Rowell, and M. V. Codrescu (2012), Data assimilation of thermospheric mass density, Space Weather, 10, S05002, doi:10.1029/2012SW000773.

[12] Lei, J., **T. Matsuo**, X. Dou, E. Sutton, and X. Luan (2012), Annual and semiannual variations of thermospheric density: EOF analysis of CHAMP and GRACE data, J. Geophys. Res. Space Physics, 117, A01310, doi:10.1029/2011JA017324.

[11] Codrescu, M. V., C. Negrea, M. Fedrizzi, T. J. Fuller-Rowell, A. Dobin, N. Jakowsky, H. Khalsa, **T. Matsuo**, and N. Maruyama (2012), A real-time run of the Coupled Thermosphere Ionosphere Plasmasphere Electrodynamics (CTIPe) model, Space Weather, 10, S02001, doi:10.1029/2011SW000736.

[10] **Matsuo, T.**, and E. A. Araujo-Pradere (2011), Role of thermosphere-ionosphere coupling in a global ionospheric specification, Radio Science, 46, RS0D23, doi:10.1029/2010RS004576.

[9] **Matsuo, T.**, D. W. Nychka, and D. Paul (2011), Nonstationary covariance modeling for incomplete data: Monte Carlo EM approach, Computational Statistics and Data Analysis, 55, 2059-2073, doi: 10.1016/j.csda.2010.12.002.

[8] **Matsuo, T.**, and J. Forbes (2010), Principal modes of thermospheric density variability: Empirical orthogonal function analysis of CHAMP 2001-2008 data, J. Geophys. Res. Space Physics, 115, A07309, doi:10.1029/2009JA015109.

[7] Cosgrove, R. B., G. Lu, H. Bahcivan, **T. Matsuo**, C. J. Heinselman, and M. A. McCready (2009), Comparison of AMIE modeled and Sondrestrom measured Joule heating: a study in model resolution and electric field/conductivity correlation, J. Geophys. Res. Space Physics, 114, A04316, doi:10.1029/2008JA013508.

[6] Amm, O., A. Aruliah, S. C. Buchert, R. Fujii, J. W. Gjerloev, A. Ieda, **T. Matsuo**, C. Stolle, H. Vanhamaki, and A. Yoshikawa (2008), Understanding the electrodynamics of the 3-dimensional high-latitude ionosphere: present and future, Ann. Geophys., 26, 3913-3932, doi: 10.5194/angeo-26-3913-2008.

[5] **Matsuo, T.**, and A. D. Richmond (2008), Effects of high-latitude ionospheric electric field variability on global thermospheric Joule heating and mechanical energy transfer rate, J. Geophys. Res. Space Physics, 113, A07309, doi:10.1029/2007JA012993.

[4] **Matsuo, T.**, A. D. Richmond, and G. Lu (2005), Optimal Interpolation analysis of high-latitude Ionospheric electrodynamics using empirical orthogonal functions: Estimation of dominant modes of variability and temporal scales of large-scale electric fields, J. Geophys. Res. Space Physics, 110, A06301, doi:10.1029/2004JA010531.

[3] **Matsuo, T.**, A. D. Richmond, and K. Hensel (2003), High-latitude ionospheric electric field variability and electric potential derived from DE-2 plasma drift measurements: dependence on IMF and dipole tilt, J. Geophys. Res. Space Physics, 108, 1005, doi:10.1029/2002JA009429.

[2] **Matsuo, T.**, A. D. Richmond, and D. W. Nychka (2002), Modes of high-latitude electric field variability derived from DE-2 measurements: Empirical Orthogonal Function (EOF) analysis, Geophysical Research Letters, 29, 1107, doi:10.1029/2001GL014077.

[1] Fuller-Rowell, T. J., **T. Matsuo**, M. V. Codrescu, and F. A. Marcos (1999), Modeling thermospheric neutral density waves and holes in response to high-latitude forcing, Advances in Space Research, 24, 11, 1447-1458, doi:10.1016/S0273-1177(99)00705-X.

INVITED TALKS (87)

[87] **Matsuo, T.** (2023), From Earth to the Edge of Space: How Data Assimilation Advances the Science and Engineering of Forecasting Near Earth Space Environments, *SCOSTEP-Predictability of Variable Solar-Terrestrial Coupling Program Online Seminar*, August 24, Virtual.

[86] **Matsuo, T.** (2023), Ionospheric and Thermospheric Assimilation of RO and Ground-based GNSS data**,** GNSS Remote Sensing Colloquium, June 5-16, Boulder, CO.

[85] **Matsuo, T.**, N. Dietrich, B. Dilorenzo, C.-Y. Lin, C. H. Lin, and T.-W. Fang (2023), Assessing the Impact of RO Constellation Data on Global Ionospheric Monitoring Through Observing System Simulation Experiments, *Space Weather Workshop*, April 17-21, Boulder, CO.

[84] **Matsuo, T.**, W. Mirkovich, A. RatheeshBabu, and J. M. Ruohoniemi (2022), Building a Collaborative Geospace Data Science Community with Assimilative Mapping of Geospace Observations (AMGeO), INV15B-05, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[83] **Matsuo, T.**, W. Mirkovich, A. RatheeshBabu, N. Bartel, V. C. Svaldi, J. M. Ruohoniemi, S.i Chakraborty, B. J. Anderson, S. K. Vines, L. J. Paxton, K. Garcia-Sage, E. MacDonald, R. J. Redmon, A. Bhatt, and C. Stolle (2022), Assimilative Mapping of Geospace Observations (AMGeO): Building a Community for Collaborative Geospace Data Science, INV52B-04, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[82] **Matsuo, T.**, and V. C. Svaldi (2022), Assimilative Mapping of Geospace Observations (AMGeO): Towards Understanding the Global Implications of Regional Phenomenon, *NASA Goddard Space Flight Center Mesoscale Magnetosphere ISFM Group Seminar*, October 28, Virtual.

[81] **Matsuo, T.** (2022), Collaborative Geospace Data Science Enabled by Assimilative Mapping of Geospace Observations (AMGeO), *3rd Center for Geospace Storms DRIVE Science Center Workshop*, November 14-15, Laurel, MD.

[80] **Matsuo, T.**, A. Ratheesh Babu, N. Dietrich, C.-H. Hsu, J. L. Anderson, H. Kerhaw, B. Johnson (2022), Geospace Data Assimilation Capabilities for CCMC, *NASA Community Coordinated Modeling Center (CCMC) Workshop*, June 6-10, College Park, MD.

[79] **Matsuo, T.** (2022), Whole Atmosphere-Ionosphere Data Assimilation and Ensemble Forecasting System, *NOAA Office of Projects, Planning, and Analysis (OPPA) Brown Bag Seminar*, May 19, Virtual.

[78] **Matsuo, T.** (2022), Towards Building Numerical Space Weather Prediction Systems Infrastructure to Unify Observing and Modeling Capabilities, *Data science and analytics: Data fusion and assimilation panel, The National Academies of Sciences, Engineering and Medicine Space Weather Operations and Research Infrastructure Workshop Phase II*, April 11-14, Virtual.

[77] **Matsuo, T.** (2022), The Role of Auroral Imagery in Space Weather Applications of the Assimilative Mapping of Geospace Observations, Panel on Space Weather Applications of Auroral Imager, *18th Conference on Space Weather at 101th AMS Annual Meeting*, January 23-27, Houston, TX.

[76] **Matsuo, T.**, C.-T. Hsu, F. Shen, C. Cantrall, A. Kubaryk, T. J. Fuller-Rowell, N. Maruyama, N. Pedatella, and H. Shao (2021), Whole Atmosphere-Ionosphere Data Assimilation and Ensemble Forecasting System, SA33A-01, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[75] **Matsuo, T.** (2021), Assimilative Mapping of Geospace Observations (AMGeO): Data Science Tools for Collaborative Geospace Systems Science, *GeoDAWG (Geospace Data Assimilation Working Group) Seminar*, October 12, Virtual.

[74] **Matsuo, T.** (2021), NSF EarthCube: Assimilative Mapping of Geospace Observations Project, *GEM Decadal Survey Magnetosphere - Ionosphere Coupling Discussions Session*, July 25-30, Virtual.

[73] **Matsuo, T.** (2021), Opportunities and Challenges of Upper Atmosphere Satellite Data Assimilation: Assimilation of GOLD Disk Emission Data, *NOAA NSDIS Space Weather Observation Requirements Formulation Working Group Meeting*, July 14, Virtual.

[72] **Matsuo, T.**, J. Li, L. Kilcommons, and T. Nishimura (2021), Assimilative Mapping of Auroral Precipitation, *CEDAR Workshop Multi-scale IT System Science Dynamics Session*, June 20-25, Virtual.

[71] **Matsuo, T.** (2021), Data-Driven Ensemble Modeling of the Upper Atmosphere, *CEDAR Workshop Synergy Between First-Principles and Data-Informed Modeling*, June 20-25, Virtual.

[70] **Matsuo, T.** (2021), Assimilative Mapping of Geospace Observations (AMGeO): Building Community for Collaborative CEDAR Data Science, *CEDAR Workshop Plenary Science Highlight*, June 20-25, Virtual Meeting.

[69] **Matsuo, T.** (2021), Towards Ingestion of COSMIC-2 Observations into NOAA's Whole Atmosphere-Ionosphere Data Assimilation System, *NOAA Office of Projects, Planning, and Analysis (OPPA) Staff Meeting*, May 25, Virtual.

[68] **Matsuo, T.** (2021), Predictability of the Space-Atmosphere Interaction Region, *Ionosphere-Thermosphere-Mesosphere Session Facilitator's Scene Setting Talk for Heliophysics 2050 Workshop*, May 3-7, Virtual Meeting.

[67] **Matsuo, T.** (2021), Towards Understanding the Global Implications of Regional Phenomenon by Combining ISR Data With Global Data Sets, *Workshop: A Strategic Vision for Incoherent Scatter Radar*, March 30-April 1, Virtual Meeting.

[66] **Matsuo, T.** (2021), Data-Driven Modeling of Ionospheric Electrodynamics, *Engineering-Physics Space Plasma Seminar*, Dartmouth College, January 19, Hanover, NH.

[65] **Matsuo, T.** (2021), Towards Unified Global and Local Perspectives on High-latitude Ionospheric Electrodynamics, *Mini-GEM 3D Ionospheric Electrodynamics and its Impact on the Magnetosphere-Ionosphere-Thermosphere Coupled System*, January 19, Virtual Meeting.

[64] **Matsuo, T.**, and C.-H. Hsu (2020), Uncertainty Quantification in Data-Driven Ensemble Modeling of the Upper Atmosphere, *AGU Fall meeting*, Virtual Meeting.

[63] **Matsuo, T.** (2020), Data-driven Modeling of High-latitude Electrodynamics, *1st Center for Geospace Storms DRIVE Science Center Workshop*, Virtual Meeting.

[62] **Matsuo, T.**, C.-H. Hsu and N. Dietrich (2020), Inference of Neutral Mass Density From GPSRO by Coupled Thermosphere-Ionosphere Data Assimilation, *5th International Conference on GPS Radio Occultation*, Hsinchu, Taiwan.

[61] **Matsuo, T.**, and C. Cantrall (2020), Opportunities and Challenges of Satellite Data Assimilation: Assimilation of GOLD Disk Emission, *CEDAR Workshop Grand Challenge: Coordinated Ground and Space-based Observations of the Ionosphere-Thermosphere System Session*, Virtual Meeting.

[60] **Matsuo, T.**, and C.-H. Hsu (2020), Inference of Hidden States by Couped Thermosphere-Ionosphere Data Assimilation: Applications to Observability and Predictability of Neutral Mass Density, JpGU-AGU Joint Meeting 2020, Virtual Meeting.

[59] **Matsuo, T.** (2020), Predictability and Observability of the Upper Atmosphere, *17th Conference on Space Weather at 100th AMS Annual Meeting*, Boston, MA.

[58] **Matsuo, T.**, L. M. Kilcommon, J. M. Ruohoniemi, and B. J. Anderson (2019), Assimilative Mapping of Geospace Observations (AMGeO): Data Science Tools for Collaborative Geospace Systems Science, *AGU Fall meeting*, San Francisco, CA.

[57] **Matsuo, T.**, C.-H. Hsu, and S. Shen (2019), Predictability and Observability of the Upper Atmosphere, *AGU Fall meeting*, San Francisco, CA.

[56] **Matsuo, T.** (2019), Manage and Mine Geoscience Data for Your CEDAR Science Breakthroughs, *Student Workshop Plenary Tutorial, CEDAR Workshop*, Santa Fe, NM.

[55] **Matsuo, T.** (2019), Data Assimilation Modeling, *CEDAR Workshop ITM Models: Past, Present, and Future Session,* Santa Fe, NM.

[54] **Matsuo, T.** (2019), What it Takes to Fuse Observations in Geoscience?, *CEDAR Workshop The Challenge, Opportunity, and Art of Data Science For Geospace Session,* Santa Fe, NM.

[53] **Matsuo, T.**, L. M. Kilcommons, D. L. Knipp, and Y. Shi (2019), High-latitude Electrodynamics Responses to Multiple CME Interaction Events on September 7-8 2017, *CEDAR-GEM Joint Workshop Strong-Extreme Events: September 2017 Session,* Santa Fe, NM.

[52] **Matsuo, T.** (2019), Coupled Thermosphere-Ionosphere Data Assimilation, 4th Dynamic Earth SPP Colloquium, *Keynote Lecture,* Bad Aibling, Germany.

[51] **Matsuo, T.** (2019), Numerical Space Weather Forecasting Facilitated by Ensemble Modeling and Data Assimilation, *Taiwan Geosciences Assembly*, Taipei, Taiwan.

[50] **Matsuo, T.** (2019), Coupled Thermosphere-Ionosphere Data Assimilation: An Application to Predictability and Observability of Neutral Mass Density, *Taiwan Geosciences Assembly*, Taipei, Taiwan.

[49] **Matsuo, T.** (2019), A Journey to the Edge of our Planet: How Data Assimilation and Computational Statistics Solve Problems in the Upper Atmosphere, *Plenary Keynote Speaker, Conference of Computational Interdisciplinary Science,* Georgia Institute of Technology, Atlanta, GA.

[48] **Matsuo, T.**, C.-T. Hsu, and C. H. Chen (2018), Coupled Thermosphere-Ionosphere Data Assimilation, *AGU Fall meeting*, Washington, D.C.

[47] **Matsuo, T.** (2018), A Journey to the Edge of our Planet: How Data Assimilation and Computational Statistics Solve Problems in the Upper Atmosphere, *Departmental Seminar,* Department of Mathematics and Statistical Sciences, University of Colorado, Denver, CO.

[46] **Matsuo, T.** (2018), How to Assess Observation Impacts on Mass Density Specification and Forecasting, *CEDAR Workshop Space Weather Observation Network: Thermospheric Expansion Session,* Santa Fe, NM.

[45] **Matsuo, T.** (2018), What Data Assimilative Modeling Advances Are Needs for Prediction and Specification?, *CEDAR Workshop Space Weather Observation Network: Ionospheric Disturbance Session,* Santa Fe, NM.

[44] **Matsuo, T.** (2018), Recent Progress on Inverse and Data Assimilation Procedure for High-Latitude Ionospheric Electrodynamics, *Departmental Seminar,* Institute of Space Science, National Central University, Taiwan.

[43] **Matsuo, T.** (2018), Predictability and Ensemble Modeling of the Space-Atmosphere Interaction Region, *Departmental Seminar,* Institute of Space Science, National Central University, Taiwan.

[42] **Matsuo, T.** (2017), Between Earth and Space: Data Assimilation for High-dimensional Earth and Geospace systems, *Departmental Seminar,* Department of Applied Mathematics, University of Colorado, Boulder, CO.

[41] **Matsuo, T.** (2017), Data Assimilation – How to Combine a Model and Observations Optimally, *National Academies Space Studies Board's Committee on Solar and Space Physics Meeting*, Irvine, CA.

[40] **Matsuo, T.** (2017), Data Assimilation for High-dimensional Earth and Geospace systems, *International Meeting on High-Dimensional Data Driven Science*, Kyoto, Japan.

[39] **Matsuo, T.** (2017), Data Assimilation – How to Combine a Model and Observations Optimally, *Student Workshop Plenary Tutorial, CEDAR Workshop,* Keystone, CO.

[38] **Matsuo, T.** (2017), Space Weather Data Assimilation Requirements, Joint Effort for Data Assimilation Integration (JEDI) Goals and Requirements Planning Meeting, College Park, MD.

[37] **Matsuo, T.** (2017), Numerical Space Weather Forecasting Facilitated by Ensemble Modeling and Data Assimilation, *14th Conference on Space Weather at 97th AMS Annual Meeting*, Seattle, WA.

[36] **Matsuo, T.** (2017), History and recent progress of Assimilative Mapping Ionospheric Electrodynamics (AMIE), *Mini Keynote Speaker, CEDAR Workshop High-Latitude Ionospheric Electrodynamics and Their Impact on the Thermosphere Session,* Keystone, CO.

[35] **Matsuo, T.**, T. J. Fuller-Rowell, T.-W. Fang, V. Yudin, C.-T. Hsu, D. Fuller-Rowel, K. Ide, D. Kleist, and X. Yue (2016), Between Earth and Space: Ensemble Modeling and Data Assimilation of the Space-Atmosphere Interaction Region, *Space Weather Workshop*, Broomfield, CO.

[34] **Matsuo, T.** (2016), Between Earth and Space: Data Assimilation and Predictability of the Aerospace Environment, *Departmental Seminar*, Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO.

[33] **Matsuo, T.**, C.-T. Hsu, and I.-T. Lee (2016), New Era of Upper Atmosphere Forecasting: Roles of RO Data in Coupled Thermosphere-Ionosphere Data Assimilation, *3rd International Conference on GPS Radio Occultation*, Taipei, Taiwan.

[32] **Matsuo, T.** (2016), Between Earth and Space: Data Assimilation and Predictability of the Upper Atmosphere, *Colloquium*, High Altitude Observatory, NCAR, Boulder, CO.

[31] **Matsuo, T.**, C.-T. Hsu, A. T. Chartier, I.-T. Lee, and J. L. Anderson (2014), Coupled Thermosphere-Ionosphere Data Assimilation, *International Radio Occultation Working Group Ionosphere-Atmosphere Coordination Workshop*, Boulder, CO.

[30] **Matsuo, T.**, I.-T. Lee, and J. L. Anderson (2014), Ensemble Data Assimilation for Thermospheric Mass Density Specification and Forecasting, *Japan Geoscience Union Meeting*, Yokohama, Japan.

[29] **Matsuo, T.** (2014), From Earth to Space: Data Assimilation as Engineering Solution for Ozone Monitoring, Satellite and Space Debris Tracking and Beyond, *Departmental Seminar*, Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO.

[28] **Matsuo, T.** (2014), Assimilative Mapping of Ionospheric Electrodynamics, *Departmental Seminar*, Department of Statistics, University of California, Davis, CA.

[27] **Matsuo, T.** (2013), The Role of Data Assimilation in Maximizing the Utility of Geospace Observations, *AGU Fall meeting*, San Francisco, CA.

[26] **Matsuo, T.**, I.-T. Lee, J. L. Anderson (2013), Role of Ionosphere-Thermosphere Coupling in Upper Atmosphere Data Assimilation, *The XIIth IAGA Scientific Assembly*, Merida, Mexico.

[25] **Matsuo, T.**, D. J. Knipp, A. D. Richmond, L. M. Kilcommons, B. J. Anderson, and E. D. P. Cousins (2013), Inverse Procedures for High-latitude Ionospheric Electrodynamics in a New Era of Global Space- and Ground-Based Instrumentation, *The XIIth IAGA Scientific Assembly*, Merida, Mexico.

[24] **Matsuo, T.** (2013), Assimilative Mapping of Apace-based and Extremely Localized Observations of Ionospheric Electrodynamics, *Departmental Seminar*, Institute of Space Science, National Central University, Taiwan.

[23] **Matsuo, T.**, I.-T. Lee, J. L. Anderson (2013), Upper Atmosphere Data Assimilation with Ensemble Kalman Filter, *USNC-URSI National Radio Science Meeting*, Boulder, CO.

[22] **Matsuo, T.**, I.-T. Lee, J. L. Anderson (2012), Upper atmosphere Data Assimilation With Ensemble Kalman Filter, *6th FORMOSAT-3/COSMIC Data Users' Workshop*, Boulder, CO.

[21] **Matsuo, T.** (2012), Data Assimilation for Thermospheric Mass Density Specification, *Seminar*, The National Institute of Information and Communications Technology, Tokyo, Japan.

[20] **Matsuo, T.** (2012), Upper Atmosphere Data Assimilation with Ensemble Kalman Filter, *5th Data Assimilation Workshop*, Institute of Statistical Mathematics, Tokyo, Japan.

[19] **Matsuo, T.** (2012), Understanding Data Assimilation: Applications to Radio Occultation Observations, *Tutorial Lecture, GPS RO Summer School*, National Central University, Taiwan.

[18] **Matsuo, T.**, I.-T. Lee, J. L. Anderson (2012), Upper atmosphere data Assimilation with ensemble Kalman filter, *Departmental Seminar*, Institute of Space Science, National Central University, Taiwan.

[17] **Matsuo, T.** (2012), Data Assimilation for Thermospheric Mass Density Specification, *Seminar*, Los Alamos National Lab, Los Alamos, NM.

[16] **Matsuo, T**., J. L Anderson, I.-T. Lee (2011), Ensemble Kalman Filtering for Assimilation of Mesosphere and Thermosphere Observations, *AGU Fall meeting*, San Francisco, CA.

[15] **Matsuo, T.**, E. A. Araujo-Pradere, and J. L. Anderson (2010), Ensemble Kalman filtering for Assimilation of GPS-based Ionospheric Observations, *Asia-Pacific Radio Science Conference*, Toyama, Japan.

[14] **Matsuo, T.**, E. A. Araujo-Pradere, and J. L. Anderson (2010), Ensemble Kalman filtering for assimilation of GPS-based ionospheric observations, *Beacon Satellite Symposium*, Barcelona, Spain.

[13] **Matsuo, T**. (2008), Effects of High-latitude Ionospheric Electric Field Variability on the Estimation of Global Thermospheric Joule Heating, *Colloquium*, High Altitude Observatory, NCAR, Boulder, CO.

[12] **Matsuo, T**. (2008), Multi-resolution Based Non-stationary Covariance Modeling and Ensemble Kalman Filtering for Assimilation of Mesosphere and Lower Thermosphere Observations, *Data Assimilation Workshop*, Institute of Statistical Mathematics, Tokyo, Japan.

[11] **Matsuo, T**., and J. L. Anderson (2008), Ensemble Kalman Filtering for Assimilation of Mesosphere and Lower thermosphere observations, *Japan Geoscience Union Meeting*, Chiba, Japan.

[10] **Matsuo, T**., J. L. Anderson, D. R. Marsh, and A. K. Smith (2008), Ensemble Kalman Filtering for

Assimilation of Mesosphere and Lower Thermosphere Observations, *European Geosciences Union General Assembly*, Vienna, Austria.

[9] **Matsuo, T.** (2008), Ensemble Kalman Filtering for Assimilation of Mesosphere and Lower Thermosphere Observations, *Departmental Seminar*, Utah State University, Logan, UT.

[8] **Matsuo, T.** (2008), Data Assimilation and its Application to Upper Atmosphere, *Departmental Seminar*, Department of Earth and Planetary Sciences, Kyushu University, Fukuoka, Japan.

[7] **Matsuo, T.** (2008), Assimilative Mapping of Ionospheric Electrodynamics: Present and Future, *Keynote Speaker, Geospace Symposium*, Kyushu University, Fukuoka, Japan.

[6] **Matsuo, T.** (2006), Nonstationary Covariance Modeling for Ionospheric Electrodynamics Data Assimilation, *Colloquium*, High Altitude Observatory, NCAR, Boulder, CO.

[5] **Matsuo, T.** (2005), Understanding Data Assimilation – How Observations and a Model are Weaved into the Analysis via Statistics, *Plenary Tutorial*, CEDAR-GEM Joint Workshop, Santa Fe, NM.

[4] **Matsuo, T.**, and D. W. Nychka (2004), Multi-resolution (wavelet) Based Non-stationary Covariance modeling for Incomplete Data: Expectation Maximization Algorithm, *Graybill Conference on Spatial Statistics*, Fort Collins, CO.

[3] **Matsuo, T.** (2003), Optimal Interpolation (OI) Analysis of High-latitude Ionospheric Electrodynamic Variables Using the Maximum-Likelihood Method for Error Covariance Parameter Estimation, *Seminar*, Colorado State University, Fort Collins, CO.

[2] **Matsuo, T.** (2003), Data Assimilation Problems in the Upper Atmosphere, *Student Workshop Tutorial*, CEDAR Workshop, Longmont, CO.

[1] **Matsuo, T.** (2002), High-latitude Ionospheric Electric Field Variability Derived From DE-2 Measurements, *Seminar*, Space Environment Center, NOAA, Boulder, CO.

CONTRIBUTED ORAL AND POSTER CONFERENCE PRESENTATIONS SINCE 2017 (136)

[136] **Matsuo, T.,** L. P. Goncharenko, O. Verkhoglyadova, J.-H. Yee, L. Paxton, K. Bossert, M. Conde, H. Liu, and J. Oberheide (2023), DYNAMIC – Mission Concept to Reveal Critical Link Between Earth's Atmosphere and Space, *104th AMS Annual Meeting*, January 28 - February 1, Baltimore, MD.

[135] Dietrich[†], N., and **T. Matsuo** (2023), Investigating the Storm-Time Response of Neutral Density Through Ionosphere-Thermosphere Data Assimilation, SA11B-2443, *AGU Fall Meeting*, December 11-15, San Francisco, CA.

[134] Sarris, T. E., J. H. Clemmons, J.-J. Berthelier, N. Ivchenko, D. J. Knudsen, **T. Matsuo**, A. Maute, M. Palmroth, N. Partamies, G. W. Perry, R. F. Pfaff Jr, C. Stolle, J. P. Thayer, S. K. Vines, and ESA-NASA Lower Thermosphere Ionosphere Science (ENLoTIS) Working Group (2023), ENLoTIS: A Science Framework for Improving Understanding of the Lower Thermosphere/Ionosphere Through Systematic In Situ Exploration, SA23A-05, *AGU Fall Meeting*, December 11-15, San Francisco, CA.

[133] Bartel†, N., **T. Matsuo**, S. K. Vines, and B. J. Anderson (2023), Interhemispheric and Seasonal Differences of Field-Aligned Currents Determined by Principal Component and Canonical Correlation Analysis of AMPERE-Iridium NEXT Magnetometer Data, SA31C-2866, *AGU Fall Meeting*, December 11-15, San Francisco, CA.

[132] **Matsuo, T.** (2023), Assimilation of AMPERE and Other Ionospheric Data Sets, *Workshop on machine Learning, data Mining and data Assimilation in Geospace (LMAG)*, August 21-24, Laurel, MD

[131] **Matsuo, T.**, C.-T. Hsu, F. Shen, C. Cantrall, A. Ratheesh Babu, A. Kubaryk, B. Dilorenzo, N. Maruyama, T. Fuller-Rowell, H. Shao, and T.-W. Fang (2023), Whole Atmosphere-Ionosphere Data Assimilation and Ensemble Forecasting System, *The 28th International Union of Geodesy and Geophysics (IUGG) General Assembly*, July 11-20, Berlin, Germany.

[130] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2023), Physics-Based Approach for Neutral Density Specification Through Data Assimilation, *CEDAR Workshop*, June 25-30, San Diego, CA.

[129] Dietrich†, N., and **T. Matsuo** (2023), Investigating the Ionosphere-Thermosphere Storm Response Using Data Assimilation Reanalysis, *CEDAR Workshop*, June 25-30, San Diego, CA.

[128] Dietrich†, N., **T. Matsuo**, B. Dilorenzo, C.-Y. Lin, C. H. Lin, and T.-W. Fang (2023), Evaluating RO Constellation Designs Using Observing System Simulation Experiments: Data Impact of Electron Density Profiles on Ionospheric Specification (poster), *CEDAR Workshop*, June 25-30, San Diego, CA.

[127] Bartel†, N., **T. Matsuo**, B. J. Anderson, and S. K. Vines (2023), Interhemispheric Asymmetry of Field-Aligned Currents Determined by Principal Component Analysis of AMPERE-Iridium NEXT Magnetometer Data (poster), *GEM Workshop*, June 11-16, San Diego, CA.

[126] Bartel†, N., **T. Matsuo**, B. J. Anderson, and S. K. Vines (2023), Interhemispheric Asymmetry of Field-Aligned Currents Determined by Principal Component Analysis of AMPERE-Iridium NEXT Magnetometer Data, *GEM Workshop*, June 11-16, San Diego, CA.

[125] Pickens†, A., M. Suemura, V. Svaldi, **T. Matsuo**, H. T. Smith, and L. Paxton (2023), High-Altitude Atmospheric Observations with the FaLling Aerogel Re-entry Experiment (FLARE), *Next-Generation Suborbital Researchers Conference*, February 27-March 1, Broomfield, CO.

[124] Gilpin†, S., **T. Matsuo**, and S. E. Cohn (2023), A Generalized, Compactly-Supported Correlation Function for Data Assimilation Applications, *103rd AMS Annual Meeting*, January 8-12, Denver, CO.

[123] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2022), Estimating Upper Atmospheric Neutral Density with Ensemble Data Assimilation of Radio Occultation Observations, *103rd AMS Annual Meeting*, January 8-12, Denver, CO.

[122] Astafyeva, E., J. He, X. Yue, E. Doornbos, N. M. Pedatella, B. Maletckii, F. Piout, **T. Matsuo**, C. Siemes, S. Bruinsma, M. Codrescu, M. Fedrizzi, T. J. Fuller-Rowell, and T.-W. Fang (2022), Thermosphere-Ionosphere Conditions During the Moderate Geomagnetic Storm of 3-4 February 2022 That led to the Loss of 40 Starlink Satellites, SA42B-01, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[121] Pedatella, N. M., E. Astafyeva, C. Borries, C.-H. Chen, E. Doornbos, S. Elvidge, J. He, T. Kodikara, J. Lei, C. H. Lin, T. Matsuo, E. K. Sutton, and X. Yue (2022), Validation of Ionosphere Data Assimilation Systems using GNSS Positioning Algorithms, SA32B-01, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[120] **Matsuo, T.**, C.-P. Lien, C.-T. Hsu, and J. L. Anderson (2022), Community Data Assimilation Tools for the GDC mission and Beyond, SA25C-1935, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[119] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2022), Specifying Neutral Density and Satellite Drag Through Coupled Thermosphere-Ionosphere Data Assimilation of Radio Occultation Electron Density Profiles, SA42B-06, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[118] Dietrich†, N., **T. Matsuo**, C.-Y. Lin, C. H. Lin, T.-W. Fang (2022), Evaluating Radio Occultation Constellation Designs using Observing System Simulation Experiments: Data Impact of Electron Density Profiles on Ionospheric Specification, SM25C-1995, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[117] Lien†, C.-P., **T. Matsuo**, C. H. Lin, A. Maute, and C. Stolle (2022), Day-to-day Variability of the Global Equatorial Electrojet Modeled Using Ground- and Space-based Magnetometer Data: March 2009 and December 2019 Case Studies, SA25C-1936, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[116] Bartel†, N., **T. Matsuo**, B. J. Anderson, and S. K. Vines (2022), Interhemispheric Asymmetry of Field-Aligned Currents Determined by Principal Component Analysis of AMPERE-Iridium NEXT Magnetometer Data, SM52C-1423, *AGU Fall Meeting*, December 11-16, Chicago, IL.

[115] Bartel†, N., **T. Matsuo**, B. J. Anderson, and S. K. Vines (2022), Interhemispheric Asymmetry of Field-Aligned Currents Determined by Principal Component Analysis of AMPERE-Iridium NEXT Magnetometer Data, *MiniGEM*, December 10, Chicago, IL.

[114] Svaldi†, V. C., and **T. Matsuo** (2022), Going Beyond Event Studies Using the Assimilative Mapping of Geospace Observations (AMGeO), *MiniGEM*, December 10, Chicago, IL.

[113] Svaldi†, V. C., **T. Matsuo**, and B. Gallardo-Lacourt (2022), High Latitude Ionospheric Electrodynamics during STEVE, 2nd *STEVE Workshop*, October 6-8, Haystack, MA.

[112] **Matsuo, T.** (2022), Understanding Interhemispheric Asymmetry with Assimilative Mapping of Geospace Observations, *International Space Science Institute Science Team Meeting for Understanding Interhemispheric Asymmetry in MIT Coupling*, August 29-September 2, Bern, Switzerland.

[111] Lien†, C.-P., **T. Matsuo**, A. Maute, and C. Stolle (2022), Data-driven Modeling of the Day-to-day variability of the Equatorial Electrojet Using Ground- and Space-based Magnetometer Data, *Asia Oceanic Geosciences Society (AOGS) 19th Annual Meeting*, August 1-5, Virtual.

[110] **Matsuo, T.** (2022), Towards Building Numerical Space Weather Prediction Systems to Unify Observing and Modeling Capabilities: Some Thoughts and Examples, *International Space Science Institute Science Team Meeting for* Data Assimilation in the Ionosphere and Thermosphere, July 4-8, Bern, Switzerland.

[109] Svaldi†, V. C., **T. Matsuo**, and B. Gallardo-Lacourt (2022), High Latitude Ionospheric Electrodynamics during STEVE, *GEM Workshop*, June 19-26, Honolulu, HI.

[108] Svaldi†, V. C., **T. Matsuo**, L. M. Kilcommons, and B. Gallardo-Lacourt (2022), High Latitude Ionospheric Electrodynamics during STEVE and Non-STEVE Substorm Events, *CEDAR Workshop*, June 20-25, Austin, TX.

[107] Dietrich†, N., **T. Matsuo**, C.-Y. Lin, C. H. Lin, T.-W. Fang, Assessing Potential Radio Occultation Constellations for Specifying Neutral Mass Density (poster), *CEDAR Workshop*, June 20-25, Austin, TX.

[106] Lien†, C.-P., **T. Matsuo**, A. Maute, and C. Stolle (2022), Data-driven Modeling of the Global Equatorial Electrojet Variability Using Ground-based Magnetometer Data (poster), *CEDAR Workshop*, June 20-25, Austin, TX.

[105] Mirkovich, W., **Matsuo, T.**, L. M. Kilcommons, Assimilative Mapping of Geospace Observations (AMGeO) 2.0: Crafting an API for Geospace Data Scientists (2022), EarthCube Annual Meeting: Building Beyond, June 14-16, San Diego, CA, https://doi.org/10.5281/zenodo.6780968.

[104] **Matsuo, T.**, L. M. Kilcommons, W. Mirkovich, J. M. Ruohoniemi, S. Chakraborty, B. J. Anderson, S. K. Vines, L. J. Paxton, K. Garcia-Sage, E. MacDonald, R. J. Redmon, A. Bhatt, and C. Stolle (2021), Assimilative Mapping of Geospace Observations (AMGeO): Data Science Tools for Collaborative Geospace Systems Science, SA11A-08, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[103] Lin, C. H., P. K. Rajesh, C.-Y. Lin, J.-T. Lin, and **T. Matsuo** (2021), Investigation of ionosphere variabilities using FORMOSAT-7/COSMIC-2 based global ionosphere specification, SA35E-1943, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[102] Rajesh, P. K., C. H. Lin, C.-Y. Lin, and **T. Matsuo** (2021), Ionospheric response to minor geomagnetic storms in deep solar minimum revealed by Global Ionosphere Specification electron density based on FORMOSAT-7/COSMIC-2 observations, SA35E-1947, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[101] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2021), Specifying Thermospheric Temperature and Composition using Physics-Based Data Assimilation of COSMIC Radio Occultation Data, SA35E-1942, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[100 Lien†, C.-P., **T. Matsuo**, A. Maute, and C. Stolle (2021), Data-driven Modeling of the Day-to-Day Variability of Equatorial Electrojet Using Ground- and Space-Based Magnetometer Data, SA34A-02, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[99] Bartel†, N., **T. Matsuo**, and L. M. Kilcommons (2021), Interhemispheric Asymmetry of Field-Alined Currents Characterized by Principal Component Analysis of Multi-year AMPERE-Iridium Magnetometer Data, SM55B-1778, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[98] Cantrall†, C., T. Matsuo, and A. Kubaryk (2021), Impact of GOLD Radiance Data Assimilation on Global Thermosphere Specification, SA23A-06, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[97] Svaldi†, V. C., **T. Matsuo**, L. M. Kilcommons, and B. Gallardo-Lacourt (2021), High Latitude Ionospheric Electrodynamics during STEVE and Non-STEVE Substorm Events, SM11B-05, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[96] Mirkovich†, W. J., **T. Matsuo**, and V. C. Svaldi (2021), Predictive Models of Ionospheric Convection Patterns During Substorms Related to STEVE, A14G-09, *AGU Fall Meeting*, December 13-17, New Orleans, LA.

[95] **Matsuo, T**., and V. C. Svaldi (2021), Going Beyond Event Studies Using the AMGeO, 1st *STEVE Workshop*, October 20-22, Virtual.

[94] **Matsuo, T**. (2021), A Journey from the Earth to Geospace: Exploring Predictability of Near-Earth Space Environments Through Ensemble-Based Probabilistic Modeling, Data Assimilation, and Observing-System Design, *Departmental Seminar*, Department of Aerospace Engineering Sciences, University of Colorado Boulder, October 5, Boulder, CO.

[93] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2021), Qualifying and Reducing Neutral Density Uncertainty for Precise Orbit Determination using Physics-Based Data Assimilations, *Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference*, September 14-17, Maui, HI.

[92] Gilpin†, S., **T. Matsuo**, and S. E. Cohn (2021), Continuum Covariance Propagation for Understanding Variance Loss in Advective Systems, *World Climate Research Programme (WCRP)-World Weather Research Programme (WWRP) Symposium on Data Assimilation and Reanalysis*, September 13-18, Virtual.

[91] Lien†, C.-P., **T. Matsuo**, A. Maute, and C. Stolle (2021), Assimilative Modeling of the Day-to-Day Variability of Equatorial Electrojet and its Longitudinal Dependence Using Ground- and Space-Based Magnetometer Data, *Joint Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA) and International Association of Seismology and Physics of the Earth's Interior (IASPEI)*, August 22-27, Virtual.

[90] Gilpin†, S., **T. Matsuo**, and S. E. Cohn (2021), Continuum Covariance Propagation for Understanding Variance Loss in Advective Systems, *SIAM Conference on Mathematical and Computational Issues in the Geosciences*, June 21-14, Virtual.

[89] **Matsuo, T.**, L. M. Kilcommons, and W. J. Mirkovich, (2021), EarthCube AMGeO Project Overview, *CEDAR Workshop Accelerating Your Science With Assimilative Mapping of Geospace Observations (AMGeO): Tutorial and Interactive Demos*, June 20-25, Virtual.

[88] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2021), Coupled Thermosphere-Ionosphere Assimilative Modeling of Global Neutral Densities Using COSMIC Radio Occultation Data (iPoster), *CEDAR Workshop*, June 20-25, Virtual.

[87] Lien†, C.-P., **T. Matsuo**, A. Maute, and C. Stolle (2021), Assimilative Modeling of the Day-to-Day Variability of Equatorial Electrojet and its Longitudinal Dependence Using Ground- and Space-Based Magnetometer Data (iPoster), *CEDAR Workshop*, June 20-25, Virtual.

[86] Cantrall†, C., and **T. Matsuo** (2021), Deriving column-integrated thermospheric temperature with the N2 Lyman-Birge-Hopfield (2,0) band (iPoster), *CEDAR Workshop*, June 20-25, Virtual.

[85] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2021), Estimating Localization Parameters for Assimilating COSMIC Radio Occultation Data to Estimate Neutral Density, *The International EnKF Workshop*, June 7-9, Virtual.

[84] Lin, C. Y., C.-H. Lin, J.-Y. Liu, P. K. Rajesh, **T. Matsuo**, M.-Y. Chou, H.-F. Tsai, and W.-H. Yeh (2021), The Early Results and Validation of FORMOSAT-7/COSMIC-2 Space Weather Products: Global Ionospheric Specification and Ne-Aided Abel Electron Density Profile, *Asia Oceanic Geosciences Society (AOGS) 18th Annual Meeting*, August 1-6, Virtual.

† Presentations by students and postdocs mentored and guided by Dr. Matsuo

[83] Rajesh, P. K., C. H. Lin, J. T. Lin, C. Y. Lin, Jia Yue, J. Y. Liu, and **T. Matsuo** (2021), Day-to-day variability of global low-latitude ionospheric electron density observed by FORMOSAT-7/COSMIC-2, *Asia Oceanic Geosciences Society (AOGS) 18th Annual Meeting*, August 1-6, Virtual.

[82] Rajesh, P. K., C. H. Lin, C. Y. Lin, C. H. Chen, Yin-Chen, S. P. Chen, **T. Matsuo**, and J. Y. Liu (2021), Investigation of global ionospheric response during a minor geomagnetic storm under deep solar minimum using FORMOSAT-7/COSMIC-2 observations, *Asia Oceanic Geosciences Society (AOGS) 18th Annual Meeting*, August 1-6, Virtual.

[81] Sarris, T. E., N. Ahmadi, A. T. Aikio, D. Baloukidis, S. C. Buchert, M. A. Clilverd, I. S. Dandouras, E. Doornbos, M. Grandin, R. A. Heelis, A. Hoffmann, N. Ivchenko, T. Moretto Jorgensen, G. Kervalishvili, D. J. Knudsen, A. Kotova, D. Malaspina, A. Marchaudon, O. Marghitu, **T. Matsuo**, W. J. Miloch, N. Olsen, M. Palmroth, R. F. Pfaff, C. Stolle, E. R. Talaat, S. Tourgaidis, P. T. Verronen, J. van den Ijssel, and P. N. Visser (2021), Deadalus: A Mission Concept to Explore the Lower Thermosphere-Ionosphere (iPoster), *Heliophysics 2050 Workshop*, May 3-7, Virtual.

[80] **Matsuo, T.**, L. Goncharenko, L. Paxton, S. Yee, J. Oberheide, and H. Liu (2021), Dynamic – Transforming the Climatological Picture of the Ionosphere and Thermosphere into its Weather and Beyond (iPoster), *Heliophysics 2050 Workshop*, May 3-7, Virtual, https://helio2050.ipostersessions.com/default.aspx?s=DC-8E-21-52-28-EC-C8-1C-F6-A5-24-FE-64-9A-60-0B.

[79] **Matsuo, T.** (2021), Predictability of the Space-Atmosphere Interaction Region (SAIR) (iPoster), *Heliophysics 2050 Workshop*, May 3-7, Virtual, https://helio2050.ipostersessions.com/default.aspx?s=2E-DA-EC-14-7B-14-8F-8B-4B-B9-60-8C-68-14-19-EE.

[78] Gilpin†, S., **T. Matsuo**, and S. E. Cohn (2021), Continuum Covariance Propagation for Understanding Variance Loss in Advective Systems, *The International Symposium on Data Assimilation – Online*, March 12, Virtual.

[77] **Matsuo, T.**, L. M. Kilcommons, Mirkovich, J. M. Ruohoniemi, S. Chakraborty, B. J. Anderson, and S. Vines (2020), Assimilative Mapping of Geospace Observations (AMGeO): Unified Global and Local Perspectives on High-latitude Ionospheric Electrodynamics, *AGU Fall Meeting*, Virtual.

[76] Mirkovich†, W., T. **Matsuo**, and L. M. Kilcommons (2020), Data-Driven Modeling of Polar Ionospheric Electrodynamics Using Convolutional Neural Networks (iPoster), *AGU Fall Meeting*, Virtual.

[75] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2020), Thermospheric Neutral Density Specification and Forecasting via Driver Estimation and Assimilation of COSMIC Radio Occultation Data, *AGU Fall Meeting*, Virtual.

[74] Lien†, C.-P., **T. Matsuo**, A. Maute, C. Stolle, and P. Alken (2020), Modeling Equatorial Magnetic Perturbation Using the 3D Electrodynamo model: A case study in March 2009 (iPoster), *AGU Fall Meeting*, Virtual.

[73] Svaldi†, V. C., **T. Matsuo**, L. M. Kilcommons, B. Gallardo-Lacourt, and E. MacDonald (2020), High-Latitude Ionospheric Electrodynamics during STEVE Events Reported by Citizen Scientists (iPoster), *AGU Fall Meeting*, Virtual.

[72] Li†, J., **T. Matsuo**, and L. M. Kilcommons (2020), Modes of Auroral Precipitation Variability: Empirical Orthogonal Analysis of DMSP SSUSI LBH Emission (iPoster), *AGU Fall Meeting*, Virtual.

[71] Cantrall†, C., and **T. Matsuo** (2020), Sources of Thermospheric Variability During Solar Minimum (iPoster), *AGU Fall Meeting*, Virtual.

[70] Rajesh, P. K., C. H. Lin, J.-T. Lin, C. Y. Lin, J. Yue, J. Y. Liu, and **T. Matsuo** (2020), Global Observations of Day-to-Day Longitudinal Structures of Equatorial Ionization Anomaly by using FORMOSAT-7/COSMIC-2 (iPoster), *AGU Fall Meeting*, Virtual.

[69] Lin, J.-T., C. H. Lin, P. K. Rajesh, J. Yue, C. Y. Lin, and **T. Matsuo** (2020), New Characteristics of Quasi-6-Day Wave Modulations in Ionosphere during the 2019 Antarctic Sudden Stratospheric Warming by Using Global Ionosphere Specification, *AGU Fall Meeting*, Virtual.

[68] Sarris, T. E., A. T. Aikio, S. C. Buchert, M. A. Clilverd, I. S. Dandouras, E. Doornbos, M. Grandin, R. A. Heelis, N. Ivchenko, A. N. Jaynes, T. Moretto, G. Kervalishvili, D. J. Knudsen, A. Kotova, D. Malaspina, N. Ahmadi, A. Marchaudon, O. Marghitu, **T. Matsuo**, W. J. Miloch, N. Olsen, S. Tourgaidis, M. Palmroth, R. F. Pfaff Jr, A. Hoffman, C. Stolle, E. R. Talaa, C. Siemes, P. Pirnaris, P. T. Verronen, D. Mpaloukidis, P. N. Visser, T. Balafoutis and The Daedalus Phase-0 Science Team (2020), Daedalus, a Candidate Mission for the Exploration of the Lower Thermosphere-Ionosphere: Mission Performance Demonstration of Multi-point Sampling Capability, *AGU Fall Meeting*, Virtual.

[67] **Matsuo, T.**, L. M. Kilcommons, J. M. Ruohoniemi, B. J. Anderson, S. Vines, L. Paxton, S. Chakraborty, W. Mirkovich, E. MacDonald, K. Garcia-Sage, R. Redmon, A. Bhatt, and C. Stolle (2020), Assimilative Mapping of Geospace Observations (AMGeO): Data Science Tools for Collaborative Geospace Systems Science, *CEDAR Workshop*, Virtual.

[66] Dietrich†, N., **T. Matsuo**, and C.-T. Hsu (2020), Thermospheric Neutral Density Estimation via Assimilation of COSMIC-2 Radio Occultation Data (Prerecorded Video), *CEDAR Workshop*, Virtual.

[65] Lien†, C.-P., **T. Matsuo**, A. Maute, and C. Stolle (2020), Comparisons of the CHAMP data of equatorial magnetic perturbations with the model results of TIEGCM on March 11-17, 2009: Case Study (Prerecorded Video), *CEDAR Workshop*, Virtual.

[64] **Matsuo, T.**, L. M. Kilcommons, J. M. Ruohoniemi, B. J. Anderson, S. Vines, L. Paxton, S. Chakraborty, W. Mirkovich, E. MacDonald, K. Garcia-Sage, R. Redmon, A. Bhatt, and C. Stolle (2020), Assimilative Mapping of Geospace Observations (AMGeO): Data Science Tools for Collaborative Geospace Systems Science (iPoster), *EarthCube Annual Meeting*, Virtual.

[63] Sarris, T. E., A. T. Aikio, S. C. Buchert, M. A. Clilverd, I. S. Dandouras, E. Doornbos, M. Grandin, R. A. Heelis, N. Ivchenko, T. Moretto, G. Kervalishvili, D. J. Knudsen, A. Kotova, D. Malaspina, A. Marchaudon, O. Marghitu, **T. Matsuo**, W. J. Miloch, N. Olsen, S. Tourgaidis, M. Palmroth, R. F. Pfaff Jr, C. Stolle, E. R. Talaat, P. Verronen, P. Visser, A. Hoffman (2020), Daedalus, a Candidate ESA Earth Explorer Mission for the Exploration of the Lower Thermosphere-Ionosphere, *EGU General Assembly*, Virtual.

[62] Svaldi†, V. C., **T. Matsuo**, L. M. Kilcommons, E. MacDonald, and B. Gallardo-Lacourt (2019), High-Latitude Ionospheric Electrodynamics Characterizing Energy and Momentum Deposition during STEVE Events Reported by Citizen Scientists (Poster), *AGU Fall Meeting*, San Francisco, CA.

[61] Li†, J., **T. Matsuo**, L. M. Kilcommons, and T. Nishimura (2019), Assimilative Mapping of Global Auroral Energy Flux and Conductance (Poster), *AGU Fall Meeting*, San Francisco, CA.

[60] Cantrall†, C., and **T. Matsuo** (2019), Unsupervised Learning on GOLD N_2 Lyman-Birge-Hopfield Measurements to Characterize Thermal Structure Changes in the Thermosphere, *AGU Fall Meeting*, San Francisco, CA.

[59] Hsu†, C.-T., **T. Matsuo**, R. Stoneback, A. I. Maute, L. M. Kilcommons, and C.-P. Lien (2019), Assimilative Analysis of Equatorial Ionospheric Electrodynamics Using a Coupled Thermosphere-Ionosphere Model During a Moderate Storm Period, *AGU Fall Meeting*, San Francisco, CA.

[58] Shi†, Y., D. M. Oliveira, D. J Knipp, **T. Matsuo**, B. J. Anderson, Effects of Nearly Frontal and Highly Inclined Interplanetary Shocks on High-latitude Field-aligned Currents (FACs) (2019), *AGU Fall Meeting*, San Francisco, CA.

[57] Tang†, T., D. Paul, T. C. M. Lee, M. Fan, **T. Matsuo**, and P. Alken (2019), Multi-scale Modeling of Vector Fields on the Sphere With Application to Satellite Based Surveys (Poster), *AGU Fall Meeting*, San Francisco, CA.

[56] Rajesh, P. K., C. H. Lin, C.-Y. Lin, J.-T. Lin, **T. Matsuo** and J. Y. Liu (2019), Global Ionospheric Specification: Ionospheric space weather data product of FORMOSAT-7/COSMIC-2, *AGU Fall Meeting*, San Francisco, CA.

[55] Hsu†, C.-T., **T. Matsuo**, R. Stoneback, A. Maute, and C.-P. Lien (2019), Comparison of TIEGCM and C/NOFS ion velocity using PysatMagVect Preliminary results from a comprehensive analysis of low-latitude ionospheric electrodynamics variability using data assimilation, *CEDAR Workshop Python for Space Science Session*, Santa Fe, NM.

[54] Hsu†, C.-T., **T. Matsuo**, A. Maute, R. Stoneback, and C.-P. Lien (2019), Preliminary Results From a Comprehensive Analysis of Low-latitude Ionospheric Electrodynamics Variability Using Data Assimilation (Poster), *CEDAR Workshop*, Santa Fe, NM.

[53] Cantrall†, C, **T. Matsuo**, and S. Solomon (2019), Upper Atmosphere Radiance Data Assimilation: A Feasibility Study for GOLD Far Ultraviolet Observations (Poster), *CEDAR Workshop*, Santa Fe, NM.

[52] Shi†, Y., D. J. Knipp, **T. Matsuo**, B. J. Anderson (2019), Hemispheric Asymmetries in High-latitude Field-aligned Currents (FACs) Revealed by Inverse and Assimilative Analysis of AMPERE Magnetometer Data (Poster), *CEDAR Workshop*, Santa Fe, NM.

[51] **Matsuo, T**., and L. M. Kilcommons (2019), Assimilative Mapping of Geospace Observations (AMGeO), *Mini-GEM Meeting*, San Francisco, CA.

[50] **Matsuo, T**. (2019), From Earth to the Edge of Space: How Data Assimilation Advances the Science and Engineering of Forecasting Near-Earth Space Environments, *Departmental Seminar*, Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO.

[49] Shi†, Y., D. J Knipp, and **T. Matsuo** (2019), Event study of field-aligned currents (FACs) and their interhemispheric asymmetries revealed by assimilative analysis of AMPERE magnetic perturbation data, *Mini-GEM Meeting*, San Francisco, CA, December 8.

[48] Shi†, Y., D. M. Oliveira, D. J. Knipp, **T. Matsuo**, B. J. Anderson (2019), Effects of Nearly Frontal and Highly Inclined Interplanetary Shocks on High-latitude Field-aligned Currents (Poster), *AGU Chapman*

Conference on Scientific Challenges Pertaining to Space Weather Forecasting Including Extremes, Pasadena, CA.

[47] Hsu†, C.-T., **T. Matsuo**, and J.-Y. Liu (2019), Impact of FORMOSAT-7/COSMIC-2 GNSS RO observations on midlatitude and low-latitude ionosphere specification, *Plenary Early Career Research Highlight, CEDAR Workshop*, Santa Fe, NM, U.S.A.

[46] Mutschler†, S., P. Axelrad, **T. Matsuo**, and E. Sutton (2019), Physics-based Approach to Density Estimation and Prediction using Orbital Debris Tracking Data, *Advanced Maui Optical and Space Surveillance Technologies Conference*, Maui, HI.

[45] Lin, C. H., P. K. Rajesh, C. Y. Lin, C.-H. Chen, J.-T. Lin, **T. Matsuo** and C.-P. Lien (2018), Multi-instrument Satellite-based Observations of Global Low-Latitude Ionosphere: Toward Forecast, *AGU Fall Meeting*, Washington, D.C.

[44] Svaldi†, V. C., **T. Matsuo**, L. M. Kilcommons, and W. Evonosky (2018), Characterizing Energy and Momentum Deposition During Auroral Events Reported by Citizen Scientists (Poster), *AGU Fall Meeting*, Washington, D.C.

[43] Chen, C.-H., C. H. Lin, and **T. Matsuo** (2018), Modeling the Ionospheric Prereversal Enhancement by Using Coupled Thermosphere-Ionosphere Data Assimilation, *AGU Fall Meeting*, Washington, D.C.

[42] **Matsuo, T**., and L. M. Kilcommons (2018), Uncertainty Quantification in Assimilative Mapping of Geospace Observations (Poster), *AGU Fall Meeting*, Washington, D.C.

[41] Chang, Y.-S., C.-H. Chen, C. H. Lin, H.-H. Chu, and **T. Matsuo** (2018), Reconstruction the Ionospheric Responses to the October-November 2003 Halloween Super Storm: A Data Assimilation Approach (Poster), *AGU Fall Meeting*, Washington, D.C.

[40] Lin, J.-T., Ch-Y. Lin, C. H. Lin, N. M. Pedatella, P. K. Rajesh, **T. Matsuo** and J.Y Liu (2018), Revisiting the Modulations of Ionospheric Solar and Lunar Migrating Tides during the 2009 Stratospheric Sudden Warming by using Global Ionosphere Specification (Poster), *AGU Fall Meeting*, Washington, D.C.

[39] Hsu†, C.-T., **T. Matsuo**, X. Yue, T.-W. Fang, T. Fuller-Rowell, K. Ide, and J.-Y. Liu (2018), Assessment of the Impact of FORMOSAT-7/COSMIC-2 GNSS RO Observations on Mid- and Low-latitude Ionospheric Specification and Forecasting Using the GSI Ionosphere Data Assimilation System (Poster), *AGU Fall meeting*, Washington, D.C.

[38] Cantrall†, C, and **T. Matsuo** (2018), Inference of Thermospheric Temperature Profiles From GOLD Disk Images and Applications for Tracking Traveling Atmospheric Disturbances (Poster), *AGU Fall Meeting*, Washington, D.C.

[37] Mutschler†, S., P. Axelrad, and **T. Matsuo** (2018), Harnessing Orbital Debris to Sense the Space Environment, *Advanced Maui Optical and Space Surveillance Technologies Conference*, Maui, HI.

[36] Mlynczak, M., D. L. Knipp, L. A. Hunt, **T. Matsuo**, L. M. Kilcommons, J. Gaebler, D. Weimer, and C. Young (2018), Space-Based Sentinels for Measurement of Infrared Cooling in the Thermosphere for Improved Space Weather Forecasting, *AGU Triennial Earth Sun-Summit-AGU Joint Meeting*, Leesburg VA.

[35] Knipp, D. L., S. Flynn, **T. Matsuo**, M. G. Mlynczak, and L. A. Hunt (2018), Mapping the Global Response and Modes of Variability of Thermospheric Nitric Oxide to Solar and Geomagnetic Forcing, *AGU Triennial Earth Sun-Summit-AGU Joint Meeting*, Leesburg, VA.

[34] Mutschler†, S., P. Axelrad, J. Anderson, and **T. Matsuo** (2018), An Ensemble Kalman Filtering Approach for Atmospheric Density Estimation Using Orbital Debris, *COSPAR Scientific Assembly*, Pasadena, CA.

[33] Fang, T.-W., T. J. Fuller-Rowell, **T. Matsuo**, V. Yudin, and R. Viereck (2018), Quantifying the Sources of Ionospheric Day-to-Day Variability, *COSPAR Scientific Assembly*, Pasadena, CA.

[32] Rajesh, P. K., C.H. Lin, C.-H. Chen and **T. Matsuo** (2018), Estimation of Glonal Plasma Bubble Occurrence Using Data Assimilation, *COSPAR Scientific Assembly*, Pasadena, CA.

[31] Hsu†, C.-T., **T. Matsuo**, and J.-Y. Liu (2018), Weather Revealed by COSMIC missions with the GSI Ionosphere Data Assimilation System, *COSPAR Scientific Assembly*, Pasadena, CA.

[30] Kilcommon, L. M., and **T. Matsuo** (2018), k-fold cross-validation applied to an assimilative mapping analysis of SuperDARN and SuperMag, *CEDAR Workshop Next Generation CEDAR Science: Addressing Geospace System Science in the Age of Data Science Session*, Santa Fe, NM

[29] **Matsuo, T.** (2018), Stochastic Parameterization of Random Electric Fields and its Impact on Joule Heating, *CEDAR Workshop Multi-scale IT System Science Dynamics Session*, Santa Fe, NM.

[28] Cantrall†, C., and **T. Matsuo** (2018), GOLD Radiance Data Assimilation for Global Thermosphere State Inference and Space Weather Forecasting (Poster), *CEDAR Workshop,* Santa Fe, NM

[27] Evonosky†, W., T.-W. Fang, **T. Matsuo**, and A. Chandran (2018), Longitudinal and Temporal Variability of Midnight Temperature Maximum (Poster), *CEDAR Workshop,* Santa Fe, NM.

[26] Hsu†, C.-T., **T. Matsuo**, and J.-Y. Liu (2018), Ionospheric Specification and Forecast by Ensemble Assimilation of FORMOSAT-7/COSMIC-2 Slant Total Electron Content to a Coupled Model of Thermosphere, Ionosphere, and Plasmasphere **(**Poster), *CEDAR Workshop,* Santa Fe, NM.

[25] Shi†, Y., D. J. Knipp, and **T. Matsuo** (2018), Modes of FACs Variability and its Hemispheric Asymmetry Revealed by Inverse and Assimilative Analysis of Iridium Magnetometer Data, *GEM Workshop Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Session*, Santa Fe, NM.

[24] Shi†, Y., **T. Matsuo**, D. L. Knipp, L. M. Kilcommons, and B. J. Anderson (2018). Modes of high-latitude Field-aligned Currents Variability and its Hemispheric Asymmetry Revealed by Inverse and Assimilative Analysis of Iridium Magnetometer Data (Poster), *GEM Workshop*, Santa Fe, NM.

[23] Lin†, C.-Y., **T. Matsuo**, J.-Y. Liu, and C. H. Lin (2018), Data Assimilation of Ground-Based GPS and Radio Occultation Total Electron Content for Global Ionospheric Specification (Poster), *15th Annual Meeting Asia Oceania Geosciences Society*, Honolulu, HI.

[22] **Matsuo**, T. and C. T. Hsu, T. W. Fang, and T. J. Fuller-Rowell (2018), Day-to-Day Variability and Predictability of the Ionosphere, *15th Conference on Space Weather at 98th AMS Annual Meeting*, Austin, TX.

[21] Knipp, D. J., S. Flynn, **T. Matsuo**., M. G. Mlynczak, and L. A. Hunt (2018), Understanding and Forecasting Upper Atmosphere Nitric Oxide Through Data Mining Analysis of TIMED/SABER Data, *15th Conference on Space Weather at 98th AMS Annual Meeting*, Austin, TX.

[20] Hsu†, C.-T., **T. Matsuo**, X. Yue, T.-W. Fang, T. Fuller-Rowell, K. Ide, and J.-Y. Liu (2018), Assessment of the Impact of FORMOSAT-7/COSMIC-2 GNSS RO Observations on Mid- and Low-latitude Ionospheric Specification and Forecasting Using Observing System Simulation Experiments, *USNC-URSI National Radio Science Meeting*, Boulder, CO.

[19] Lin†, C.-Y., **T. Matsuo**, J.-Y. Liu, and C. H. Lin (2018), Data Assimilation of Ground-Based GPS and Radio Occultation Total Electron Content for Global Ionospheric Specification, *USNC-URSI National Radio Science Meeting*, Boulder, CO

[18] Chen, C.-H., C. H. Lin, **T. Matsuo**, J.-Y. Liu (2018), The Ionospheric Forecast System by Assimilation GNSS Observations, *URSI National Radio Science Meeting*, Boulder, CO.

[17] Lin, C. H., C.-H. Chen, P. K. Rajesh, and **T. Matsuo** (2018), Toward Ionosphere Forecast Using COSMIC-2, *USNC-URSI National Radio Science Meeting*, Boulder, CO.

[16] Lin, C. H., C.-H. Chen, and **T. Matsuo** (2017), Ionosphere Data Assimilation Modeling of 2015 St. Patrick's Day Geomagnetic Storm (Poster), *14th Annual Meeting Asia Oceania Geosciences Society*, Singapore.

[15] Lin, C. H., C.-H. Chen, and **T. Matsuo** (2017), Modeling the Ionospheric Electric Fields Using Coupled Thermosphere-ionosphere Data Assimilation, *14th Annual Meeting Asia Oceania Geosciences Society*, Singapore.

[14] Rajesh, P. K., Lin, C. H., C.-H. Chen, and **T. Matsuo** (2017), Modeling Ionospheric Pre-reversal Enhancement and Plasma Bubble Growth Rate Using Data Assimilation, *AGU Fall Meeting*, New Orleans, LA.

[13] Flynn†, S., D. J. Knipp, **T. Matsuo,** M. Mlynczak, and L. Hunt (2017), Understanding and Forecasting Upper Atmosphere Nitric Oxide Through Data Mining Analysis of TIMED/SABER Data (Poster), *AGU Fall Meeting*, New Orleans, LA.

[12] Kilcommons, L. M., and **T. Matsuo** (2017), Assimilative Mapping of Ionospheric Electrodynamics (AMIE) - AMIEPy, *CEDAR Workshop Geospace Science in the Digital Age: New Tools and Methods Session*, Keystone, CO.

[11] Flynn†, S., D. J. Knipp, **T. Matsuo,** M. Mlynczak, and L. Hunt (2017), Empirical Orthogonal Function (EOF) Analysis and Thermospheric Nitric Oxide Flux**,** *CEDAR Workshop: Next Generation Systems Science Session*, Keystone, CO.

[10] Hsu†, C.-T., **T. Matsuo,** X. Yue, T. Fang, T. Fuller-Rowell, and J.-Y. Liu (2017), Assessment of the Impact of FORMOSAT-7/COSMIC-2 GNSS RO Observations on Mid- and Low-latitude Ionosphere Specification and Forecasting Using Observing System Simulation Experiments (OSSEs) (Poster), *CEDAR Workshop,* Keystone, CO.

[9] Flynn†, S., D. J. Knipp, **T. Matsuo,** M. Mlynczak, and L. Hunt (2017), Understanding the Variability in Thermospheric Nitric Oxide Flux Using Empirical Orthogonal Functions (EOFs) (Poster), *CEDAR Workshop*, Keystone, CO.

[8] Shi†, Y., **T. Matsuo**, D. J. Knipp, L. M. Kilcommons, and B. J. Anderson (2017), Determining Optimal Setting for AMIENext Procedure Using Iridium Data (Poster), *CEDAR Workshop*, Keystone, CO.

[7] **Matsuo, T.,** and S, Claudia (2017). Unified Global and Local Perspectives on High-latitude, Ionospheric Electrodynamics, *Forth Swarm Science Meeting*, Banff, Alberta, Canada.

[6] Hsu†, C.-T., **T. Matsuo**, X. Yue, T. Fang, T. Fuller-Rowell, and J.-Y. Liu (2017), Assessment of the Impact of FORMOSAT-7/COSMIC-2 GNSS RO Observations on Ionospheric Specification and Forecasting Using Observing System Simulation Experiments (Poster), *Space Weather Workshop*, Westminster, CO.

[5] Liu, J.-Y., C.-Y. Lin, **T. Matsuo**, C. H. Lin, H.-F. Tsai, and C.-Y. Chen (2017), Global Three-Dimensional Ionospheric Data Assimilation Model Using Ground-based GPS and Radio Occultation Total Electron Content, *European Geosciences Union General Assembly*, Vienna, Austria.

[4] Hsu†, C.-T., **T. Matsuo**, X. Yue, T. Fang, T. Fuller-Rowell, and J.-Y. Liu (2017), Assessment of the Impact of FORMOSAT-7/COSMIC-2 GNSS RO Observations on Ionospheric Specification and Forecasting Using Observing System Simulation Experiments (Poster), *European Geosciences Union General Assembly*, Vienna, Austria.

[3] **Matsuo, T.** (2017), Ionosphere Specification and Forecasting Enabled by Coupled Thermosphere-Ionosphere Data Assimilation, *AFOSR Space Sciences Program Review*, Arlington, VA.

[2] Lin, C. H., C.-H. Chen, and **T. Matsuo** (2017), Development of Ionospheric Data Assimilation Model using GNSS Observations (Poster), *14th Conference on Space Weather at 97th AMS Annual Meeting*, Seattle, WA.

[1] Hsu†, C.-T., **T. Matsuo**, X. Yue, and J.-Y. Liu (2017), Assessment of the Impact of FORMOSAT-7/COSMIC-2 GNSS RO Observations on Mid- and Low-latitude Ionosphere Specification and Forecasting Using Observing System Simulation Experiments (OSSEs), *USNC-URSI National Radio Science Meeting*, Boulder, CO.

OTHER PRODUCTS

Cyberinfrastructure - Assimilative Mapping of Geospace Observations (AMGeO)

Developed and deployed a collaborative data science platform AMGeO (https://amgeo.colorado.edu) for the geospace science community for bringing together a diverse set of heterogeneous geospace observations as part of the NSF-funded EarthCube project. The platform is made of the Python open-source software and web application services that facilitate the data acquisition and pre-processing steps that are otherwise prohibitively labor-intensive and allow the latest data assimilative mapping tools available to the community.

Data Science Lesson Modules for Assimilative Mapping of Geospace Observations (AMGeO)

Developed Jupyter notebook-based data science lesson modules to engage the geospace science community in data science using the AMGeO in collaboration with the EarthCube Office (https://amgeo-collaboration.github.io/Earthcube-Workshop-2022-Intro). The lesson modules include step-by-step exercises for several Python, AMGeO and other data science topics using Jupyter notebooks.

TEACHING – COURSES TAUGHT

ASEN1320 ***Aerospace Computing and Engineering Applications*** Fall 2020, Spring 2022, Spring 2023

Developed and taught a new core undergraduate course on aerospace computing to provide students with little or no prior experience in programming with basics programming concepts and useful tools in C++ and MATLAB for solving problems of interests in engineering with an emphasis on aerospace engineering applications. Lead discussion with the Computer Science (CS) Department to have ASEN 1320 recognized as a prerequisite for CSCI 2270 (Data Structures) which is a pathway to a CS minor. Developed Cloud9 IDE for C++ using the AWS cloud service to enable remote teaching.

ASEN4057 ***Aerospace Software*** Spring 2018, Spring 2019, Spring 2020

Lectured and led computing lab sessions for aerospace software course to provide an overview of prevalent software, hardware, and computing concepts utilized in aerospace academia and industry and to establish the background necessary to tackle programming projects on different computing platforms (e.g., Linux, Unix) with various software tools (e.g., Git, MPI, OpenMP) and programming languages (e.g., Shell, C, MATLAB).

ASEN5044 ***Statistical Estimation for Dynamical Systems*** Spring 2020

Taught a graduate core course on statistical estimation for dynamical systems, introducing theory and methods of statistical estimation for general linear and nonlinear dynamical systems, with emphasis on aerospace engineering applications. Major topics include: review of applied probability and statistics; optimal parameter and dynamical state estimation; theory and design of Kalman filters for linear systems; extended/unscented Kalman filters and general Bayesian filters for non-linear systems.

ASEN6337 ***Remote Sensing Data Analysis*** Fall 2017, Fall 2019

Redeveloped and taught a graduate course on remote sensing data analysis that covers some of the most commonly used machine learning techniques in remote sensing data analysis, specifically for clustering, classification, feature extraction and dimensionality reduction, and inverse methods used to retrieve geophysical information from remote sensing data. Designed hands-on computational homework assignments, and group and individual projects to provide the opportunities to apply the classroom curricula to real remote sensing data.

ASEN6055 ***Data Assimilation & Inverse Methods for Earth & Geospace Observations***
Spring 2017, Fall 2018, Fall 2020

Developed and taught a new graduate course that covers a selection of topics in probability theory, spatial statistics, estimation theory, numeric optimization, and geophysical nonlinear dynamics that form the foundation of commonly used data assimilation and inverse methods in the Earth and space sciences. Designed hands-on computational homework and projects to provide the opportunities to apply the classroom curricula to realistic examples in the context of data assimilation.

ASEN5018 ***Graduate Project*** Fall 2022, Spring 2023

Developed a graduate project on the suborbital research payload design in collaboration with the John Hopkins University Applied Physics Laboratory. Advised a group of students to design and prototype space dropsonde (i.e., GNSS receiver, encapsulated in aerogel spheres) as well as a dispenser system to eject space dropsondes from suborbital vehicles.

ASEN5210 ***Remote Sensing Seminar*** Fall 2019

Lead a remote sensing seminar series that covers subjects pertinent to remote sensing of the Earth and geospace, including oceanography, meteorology, vegetation monitoring, geology, and space science with emphases on techniques for extracting geophysical information from satellite data.

ASEN5335 *Aerospace Environment* 2001

Lectured on thermosphere and ionosphere responses to magnetospheric forcing and developed an interactive web interface for satellite drag estimation as part of teaching practicum requirements.

Oceanography (lower-level undergraduate) 1998

Led recitation sections and graded homework as Teaching Assistant at State University of New York, Stony Brook.

Dynamic Meteorology (upper-level undergraduate) 1997

Led recitation sections and graded homework as Teaching Assistant at State University of New York, Stony Brook.

TEACHING – STUDENT INDIVIDUAL MENTORING

PhD students advised (7)

Mr. Matthew LeDuc, PhD student (APPM), Post Preliminary	2023–present
Ms. Kawther Rouabhi, PhD student (AES), Post Preliminary	2022–present
Mr. Nicholas Bartel, PhD student (AES), Post Preliminary	2021–present
Ms. Skyler Shaver, PhD student (AES), Post Comprehensive	2021–present
Mr. Nicholas Dietrich, PhD student (AES), Post Comprehensive	2019–present
Dr. Shay Gilpin, PhD student (APPM), Graduated in August 2023	2018–2023
Dr. Clayton Cantrall, PhD student (AES), Graduated in May 2022	2017–2022

PhD student co-advised (1)

Dr. Yining Shi, PhD student (AES), Graduated in Dec 2019	2015–2019

PhD students co-advised or mentored in collaboration with their academic advisors (8)

Dr. Tongyi Tang, PhD student (Statistics) at University of California Davis	2018–2021
Dr. Tae Yen (Amy) Kim, PhD student (Statistics) at University of California Davis	2017–2020
Dr. Chih-Ting Hsu, J-1 visiting student from National Central University, Taiwan	2014–2018
Dr. Minjie Fan, PhD student (Statistics) at University of California Davis	2013–2017
Dr. Ryan McGranaghan, PhD student (AES)	2013–2016
Dr. Chi-Yen Lin, J-1 visiting student from National Central University, Taiwan	2011–2015
Dr. Yang-Yi Sun, J-1 visiting student from National Central University, Taiwan	2011–2014
Dr. I-Te Lee, J-1 visiting student from National Central University, Taiwan	2009–2013

MS thesis students advised (3)

Mr. Brandon Dilorenzo, Master student (AES)	2022–current
Mr. Jason Li, Master student (AES)	2018–2021
Ms. Sierra Flynn, Master student (AES)	2017–2017

MS students advised (3)

Mr. Chuan-Ping Lien, Master student (AES)	2019–2023
Dr. Si Shen, Master student (CS)	2018–2019

Mr. Will Evonosky, Master student (AES) 2017–2018

PhD dissertation committee (20)

Ms. Alexandra Wold, PhD student (AES) 2023–present
Mr. Kevin Sacca, PhD student (AES) 2023–present
Ms. Reily Reid, PhD student (AES) 2023–present
Mr. Eduard Heijkoop, PhD student (AES) 2023–present
Dr. Kenichi Sasaki, PhD student (AES) 2021–2023
Dr. Fan Shen, PhD student (CS) 2021–2023
Dr. Bill Goode (AES), PhD student (AES) 2022–2022
Dr. Ramya Rajasekaran, PhD student (AES) 2020–2022
Dr. Shaylah Mutschler, PhD student (AES) 2018–2022
Dr. Vishal Ray‡, PhD student (AES) 2020–2021
Dr. Forest Gasdia, PhD student (AES) 2020–2021
Dr. Andre Lucas‡, PhD student (AES) 2019–2021
Dr. Brian Breitsch‡, PhD student (AES) 2018–2021
Dr. Caleb Miller, PhD student (APPM) 2017–2021
Dr. Paul Diaz, PhD student (AES) 2019–2020
Dr. Viliam Klein, PhD student (AES) 2018–2019
Dr. Gregor Robinson, PhD student (APPM) 2018–2019
Dr. Ryan Hardy, PhD student (AES) 2017–2019
Dr. Michael Croteau, PhD student (AES) 2017–2018
Dr. Matthew Tooth, PhD student (AES) 2017–2018

MS thesis committee (2)

Ms. Yu-Shan Chan, National Cheng Kung University, Taiwan 2020–2020
Mr. Jonathon Nikkel, Master student (AES) 2018–2018

PhD preliminary exam committee‡ (10)

Ms. Kaylee Champion, PhD student (AES) 2022
Ms. Celeste Guiles, PhD student (AES) 2022
Ms. Mozhgan A. Farahani, PhD student (CU Denver) 2021
Ms. Alexandra Wold, PhD student (AES) 2020
Mr. Evan Tucker, PhD student (AES) 2020
Mr. Sergei Bilardi, PhD student (AES) 2020
Dr. Yang Wang, PhD student (AES) 2019
Dr. Ryotaro Sakamoto, PhD student (AES) 2018
Dr. Shota Takahashi, PhD student (AES) 2018
Mr. Alfred Cruz, PhD student (AES) 2017

Graduate student mentoring on independent study (7)

Mr. Sean Svihla, Master student (APPM) 2022-2023
Mr. Lewis Redner, Master student (AES) as a Graduate Research Assistant over the summer 2020
Mr. Tsung-Yu Wu, PhD student from National Central University, Taiwan as a summer visitor 2018
Ms. Gayatri Iyer, Master student from University of Texas Dallas as a summer visitor 2018
Mr. David Gunderman, PhD student (APPM) as a summer intern 2017

‡ Not including 5 PhD advisees and 4 PhD students for whom serving on their PhD dissertation committee

Dr. Xueling Shi, PhD student (EE) from Virginia Tech as a summer visitor 2016
Dr. Zachary Thomas[§*], PhD student (Statistics) from Ohio State University as a summer intern 2014

Undergraduate student mentoring on independent study (7)

Mr. Brandon Dilorenzo, Undergraduate Research Assistant 2022
Mr. Kristian Mrazek[**], REU student from Augustana College, IL 2020
Mr. Willem Mirkovich, Discovery Learning Apprenticeship (CS) 2019–2020
Ms. Sara Reitz, Discovery Learning Apprenticeship (AES) 2018–2019
Ms. Valerie Svaldi[††], Research Assistant from Colorado School of Mines 2018–2023
Ms. Tanya Leung, Undergraduate Research Assistant (CS) 2018
Ms. Suzanne Smith[††], REU student from Lycoming College, PA 2010

EDUCATION GRANTS

DoED Graduate Assistantships in Areas of National Need (GAANN) Program 10/2018–9/2022

Axelrad, P. (PI), A. Anderson, B. Argrow, A. Doostsan, J. Evans, E. Frew, D. Klaus, **T. Matsuo**, J. Morton, S. Palo, H. Schaub, and D. Scheeres (Co-Is), Critical Aerospace Technologies

CU-Boulder Engineering Excellence Fund (EEF) Program 5/2020–4/2021

Henze, D. (Primary Author), K. Graham, **T. Matsuo**, R. Hoenigman, R. Regueiro, and N. Stites (Supporting Authors), Online Mathworks Courses for Enhanced Student Support for MATLAB

EDUCATION OUTREACH ACTIVITIES

Group Mentoring of Early Career Scientists and Graduate Students 2017-current

Served as a moderator for the panel discussion "The Academic Career" at the Women in Aerospace Symposium in 2017, and again as a panelist for the panel discussion "Diverse Academic Perspectives" at the Rising Stars in Aerospace Symposium in 2022. Participated in a mentoring dinner for the CU Women of Aeronautics and Astronautics (WoAA) in 2019. Serve on the Career Panel at the NSF Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) Workshop in 2018 to discuss my non-traditional career path with students.

Boulder Valley School District (BVSD) Science Fair Mentor 11/2020-2/2021, 11/2022-2/2023

Mentored students at the Boulder High School (Ms. Lauren Christiansen; Mr. David LotoAniu) on research involving citizen science auroral sighting data and satellite data for the BVSD Corden Pharma Science Fair (https://www.bvsd.org/parents-students/academics/bvsd-sponsored-events/science-fair)

CU Science Discovery Mountain Research Experience 7/2019

Offered a one-day STEM summer camp program on remote sensing based on ASEN 6037 Remote Sensing Data Analysis coursework for high-school students as part of the CU Science Discovery Mountain Research Experience (https://www.colorado.edu/sciencediscovery/programs/mountain-research-experience).

CU ODECE Pre-Collegiate Bridge Program 6/2018

[***] NCAR's Summer Internships in Parallel Computational Science (https://www2.cisl.ucar.edu/siparcs) program participant.
[**] CU LASP' REU Program in Solar and Space Physics (http://lasp.colorado.edu/home/education/reu)
[††] Started as CU LASP' REU Program in Solar and Space Physics participant from Red Rocks Community College, CO, 2018

Developed an outreach program composed of hands-on activities that traverse the entire arc of remote sensing and in-situ data collection, analysis, and modeling based on ASEN 6037 Remote Sensing Data Analysis coursework, and offered a one-week STEM summer camp for first-generation precollegiate high-school students in collaboration with the CU Science Discovery and Office of Diversity, Equity and Community Engagement (ODECE) (https://www.colorado.edu/odece/what-we-do/pre-college-outreach-engagement).

CU Science Discovery High School STEM Academy 8/2017

Presented a lecture on aerospace environment and organized a NOAA Space Weather Prediction Center forecast office tour as part of the CU Science Discovery High School STEM Academy on Aerospace Engineering (https://www.colorado.edu/sciencediscovery/programs/high-school-stem-academies-cu-boulder).

Earth Explorers 2012, 2014

Participated in Earth Explorers' short-film projects (https://scied.ucar.edu/events/earth-explorers) on NOAA scientists by underrepresented middle-school students.

Expanding Your Horizons 2/2007, 2/2008, 2/2010, 2/2011, 2/2012, 2/2013, 2/2014

Presented hands-on experiment workshops (e.g., liquid nitrogen, electromagnetism experiments) to encourage 6^{th}, 7^{th}, and 8^{th}-grade girls to study math, science, and technology at annual Expanding Your Horizons conferences at the CU Engineering Center (https://eyh.techbridgegirls.org/conferences/Boulder).

SERVICE ACTIVITIES

Session Conveners and Conference Program Committees (42)

[42] AGU Fall Meeting, Machine Learning in Space Weather session, San Francisco, CA, 2023; [41] GeoDAWG Workshop on Current Challenges in Data Assimilation for Geospace Systems, Neustrelitz, Germany, 2023; [40] IUGG General Assembly, Data Assimilation and Statistical Learning in Earth and Space Sciences, Berlin, Germany, 2023; [39] AGU Fall Meeting, Machine Learning in Space Weather session, Chicago, IL, 2022; [38] AGU Fall Meeting, Data-driven Modeling and New Measurements of the Magnetosphere-Ionosphere-Thermosphere (MIT) System, Chicago, IL, 2022; [37] AGU Fall Meeting, Leveraging Multi-point and Multi-source Observations to Advance Frontier ITM Science, Chicago, IL, 2022; [36] Mini-GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Chicago, IL, 2022; [35] CEDAR Workshop, Understanding the Electromagnetic Energy Input to Earth's Atmosphere ground-challenge session, Austin, TX, 2022; [34] GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Honolulu, HI, 2022; [33] AGU Fall Meeting, Machine Learning in Space Weather session, New Orleans, LA, 2021; [32] GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Virtual, 2021; [31] CEDAR Workshop, Accelerating Your Science With Assimilative Mapping of Geospace Observations (AMGeO): Tutorial and Interactive Demos session, Virtual 2021; [30] CEDAR Workshop, Reproducibility in Geospace Science: Best Practices for Data Stewardship session, Virtual 2021; [29] CEDAR Workshop, Understanding the Electromagnetic Energy Input to Earth's Atmosphere ground-challenge session, Virtual, 2021; [28] Mini-GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Virtual, 2021; [27] AGU Fall Meeting, Machine Learning in Space Weather session, Virtual, 2020; [26] CEDAR Workshop, Understanding the Electromagnetic Energy Input to Earth's Atmosphere ground-challenge session, Virtual, 2020; [25] GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Virtual, 2020; [24] AGU Fall Meeting, Machine Learning in Space Weather session, San Francisco, 2019; [23] Mini-GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, San Francisco, 2019; [22] AGU

Chapman Conference on Scientific Challenges Pertaining to Space Weather Forecasting Including Extremes, Pasadena, CA, 2019; [21] GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Santa Fe, NM, 2019; [20] AGU Fall Meeting, Ground-truth Data and Model Validation for Magnetosphere-Ionosphere Coupling Processes session, Washington DC, 2018; [19] AGU Fall Meeting, Geospace Research From Polar Environments session, Washington DC, 2018; [18] Mini-GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Washington DC, 2018; [17] CEDAR Workshop, Next Generation CEDAR Science: Addressing Geospace System Science in the Age of Data Science session, Santa Fe, NM, 2018; [16] GEM Workshop, Inter-hemispheric Approach to Understanding Magnetosphere-Ionosphere Coupling session, Santa Fe, NM, 2018; [15] CEDAR-GEM Joint Workshop, Interhemispheric Processes, Hemispheric Symmetries and Asymmetries panel, Santa Fe, NM, 2018; [14] AGU Fall Meeting, Frontier Solar-terrestrial Science Enabled by the Combination of Data-driven Techniques and Physics-based Understanding session, New Orleans, LA, 2017; [13] CEDAR Workshop, Next Generation Systems Science: Embracing Data Fusion and Data Science Methods to Understand Geospace Complexities session, Keystone, CO, 2017; [12] CEDAR Workshop, Geospace Science in the Digital Age: New Tools and Methods session, Keystone, CO, 2017; [11] CEDAR Workshop, High-Latitude Ionospheric Electrodynamics and Their Impact on the Thermosphere session, Keystone, CO, 2017; [10] CEDAR-GEM Joint Workshop, Making Sense of Geospace Observations session, Santa Fe, NM, 2016; [9] International Union of Geodesy and Geophysics (IUGG) General Assembly, Data Assimilation in Geophysical Sciences session, Prague, Czech Republic, 2015; [8] AGU Fall Meeting, Data Assimilation for Space Physics and Aeronomy session, San Francisco, CA, 2014; [7] CEDAR Workshop, Data Assimilation and Inverse Problems for High-latitude Electrodynamics session, Seattle, WA, 2014; [6] AGU Fall Meeting, Data Assimilation for Space Physics session, San Francisco, CA, 2013; [5] CEDAR Workshop, System-theoretic Approach to CEDAR Science session, Boulder, CO, 2013; [4] CEDAR-GEM Joint Workshop, Tutorial on Data Assimilation session, Santa Fe, NM, 2011; [3] IUGG General Assembly, Data Assimilation and Ensemble Forecasting for Weather and Climate session, Melbourne, Australia, 2011; [2] IUGG General Assembly, Data Assimilation and Space Weather session, Perugia, Italy, 2007; [1] IAGA Scientific Assembly, Data Assimilation Techniques for the Ionosphere-Thermosphere Magnetosphere System session, Toulouse, France, 2005.

External Committees and Panels (15)

[15] U.S. National Committee for Geodesy and Geophysics, 10/2023-current; [14] National Academy of Sciences' Decadal Survey for Solar and Space Physics (Heliophysics) 2024-2033 Steering Committee, 8/2022-5/2023; [13] ESA-NASA Lower Thermosphere-Ionosphere Science (EN-LoTIS) Working Group, 4/2022-9/2023; [12] International Association of Geomagnetism and Aeronomy (IAGA) Geospace Data Assimilation Working Group (GeoDAWG) as Chair, 8/2022-current; [11] International Space Science Institute (ISSI) Science Team for Data Assimilation in the Ionosphere and Thermosphere, 6/2021-present; [10] ISSI Science Team for Understanding Interhemispheric Asymmetry in MIT Coupling, 6/2021-present; [9] NASA Heliophysics Advisory Committee, 9/2017-8/2022; [8] AGU Basu United States Early Career Award committee, 5/2017-1/2022; [7] ESA Daedalus Mission Advisory Group, 1/2018-6/2021; [6] NCAR Computational and Information Systems Laboratory's Science Requirements Advisory Panel for the High-performance Computing System Procurement, 1/2019-7/2020; [5] NASA Geospace Dynamics Constellation Science and Technology Definition Team, 5/2018-10/2019; [4] International Space Science Institute (ISSI) Working Group for Ionospheric Multi-spacecraft Analysis Tools, Bern, Switzerland, 2015-2017; [3] NSF Geospace Section Committee of Visitors, 2014; [2] NSF-CEDAR Science Steering committee, 2012-2015; [1] ISSI Science Team for 3D ionospheric modeling, 2005-2006.

University and Department Committees (12)

[12] Smead Aerospace Engineering Sciences Department's Undergraduate Committee for Curriculum Development, 8/2022-5/2023; [11] Smead Aerospace Engineering Sciences Department's Performance Evaluation Committee, 8/2022-5/2023; [10] Smead Aerospace Engineering Sciences Department's Search Committee for Remote Sensing Technology Faculty Position, 8/2022-5/2023; [9] Smead Aerospace Engineering

Sciences Department's Mentoring Committee, 8/2022-present; [8] Smead Aerospace Engineering Sciences Department's Inclusive Culture Committee, 10/2020-5/2022; [7] Smead Aerospace Engineering Sciences Department's Computing Committee, 8/2019-5/2022; [6] University of Colorado Boulder Research and Innovation Office's ad hoc Committee for Research Computing Strategic Visioning, 1/2021-5/2021; [5] University of Colorado Boulder's Center for Research Data and Digital Scholarship Advisory Board, 1/2017-5/2021; [4] Smead Aerospace Engineering Sciences Department's Strategic Vision Committee, 8/2019-5/2020; [3] Smead Aerospace Engineering Sciences Department's Graduate Committee, 8/2018-5/2020; [2] Smead Aerospace Engineering Sciences Department's RSESS Focus Area Lead, 8/2018-5/2020; [1] University of Colorado Boulder's International Strategy Committee, 8/2017-12/2019.

Proposal Reviews

NASA Heliophysics Research and Analysis Program peer-review panels; NSF Antarctic Aeromony and Astrophysics Program peer-review panels; NSF Coupling, Energetics, and Dynamics of Atmospheric Regions Program peer-review panels; NSF Geospace Environment Modeling Program peer-review panels; AFOSR, NASA, NSF, and DOE mail-in external reviewers.

Paper Reviews

Journal of Geophysical Research; Monthly Weather Review; Geophysical Research Letter; Radio Science; Space Weather; Tellus; Mathematical Geosciences; Annals of the Institute of Statistical Mathematics; AGU Monograph; Elsevier Limited; Space Science Reviews; Springer.