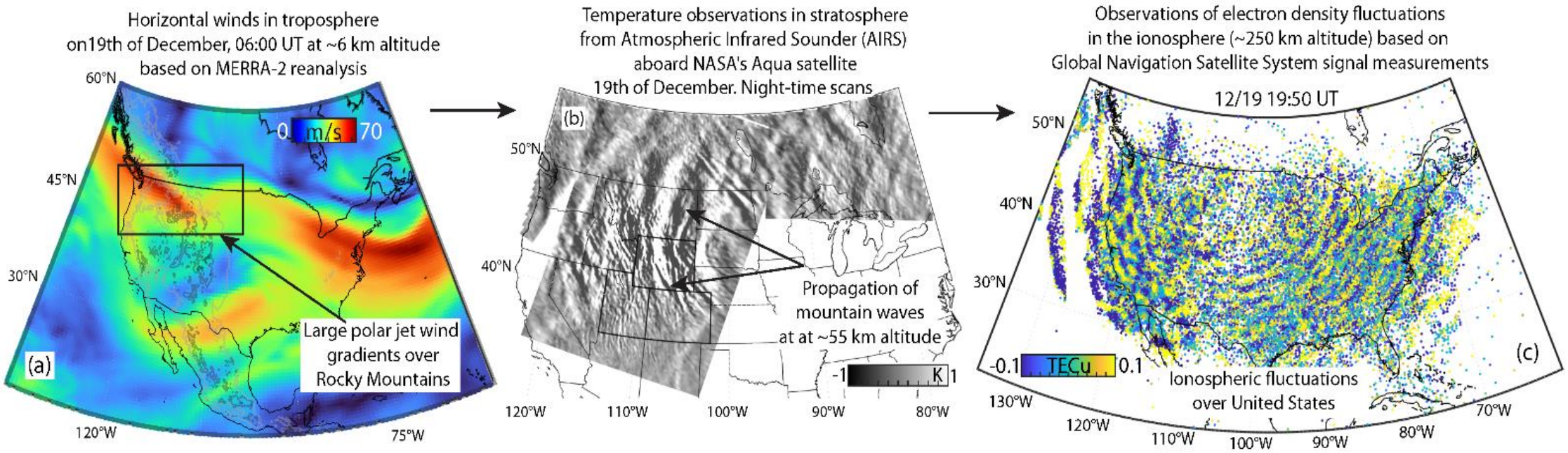
Grand Challenge Report: Impact of Terrestrial Weather on the Space Weather of the Ionosphere-Thermosphere-Mesosphere

MERRA-2
troposphere

AIRS
stratosphere

GNSS
ionosphere

Inchin et al., 2024JA032485



The North American winter storm event in December 2022 excited a wide spectrum of acoustic and gravity waves that made their way up to the ionosphere

Conveners: J. Oberheide, S. Debchoudhury, L. Goncharenko, G. Liu, S. McDonald, F. Sassi, J. Zhang, D. Aggarwal, B. Bergsson, M. Jones, Z. Qiao

What is the GC Workshop about?

Advance the understanding of whole atmosphere interconnections between terrestrial and space weather through combined modeling and observations across different spatial and temporal scales

2024

- Observational baseline data and state of models, 16 talks, 90+ attendance

2025

- Adding data-model comparisons and impact of data assimilation

2026

- Focus on physical mechanisms

Some of the Data/Models from Year 1 (2024)

Feature	Parameters	Models	Datasets
Global/Regional Ionosphere	TEC, NmF2 (or fof2), hmF2, NmE (or foE), MUF(3000)F2	SAMI3/WACCM-X WACCM-X TIEGCM Empirical models	Ionosondes ISRs Jason-2/3 GPS receivers GOLD ICON
Global/ Regional Thermosphere	Zonal winds (U), Meridional winds (V), neutral temperature (T), tidal amplitudes, composition, total mass density	WACCM-X TIEGCM WAM-GEOS Empirical models	ICON Meteor radars TIDI SABER GOLD FPIs AWE
Traveling Atmospheric and Ionospheric Disturbances (TADs and TIDs)	periods, wavelengths, speeds, amplitudes, directions of propagation	MAGIC-GEMINI	GNSS TEC, Ionosondes, FPIs, HF/LF, airglow imagers, LIDARs, ISS-based instruments among them
Acoustic shock N-waves in sTEC signals	Time of flight (onset of disturbance), the duration of N-pulse, amplitudes of pulse, Pearson correlation coefficient (r)	MAGIC-GEMINI	sTEC along temporally and spatially varying line-of-sight between a GNSS satellite and a receiver

Subset of workshop results turned into review article in Surveys in Geophysics:

Oberheide, J., D. Aggarwal, B. Bergsson, S. Chakraborty, S. Debchoudhury, M. Dhadly, F. Gasperini, L. Goncharenko, V. L. Harvey, C. Heale, P. Inchin, J. Li, G. Liu, H.-L. Liu, X. Lu, S. McDonald, M. Neogi, N. Pedatella, F. Sassi, D. Singh, R. Volz, V. Yudin, M. Zettergren, and S.-R. Zhang
Impact of Terrestrial Weather on the Space Weather of the Ionosphere-Thermosphere: Initial Results from a NASA Living With a Star Focused Science Topic
Surveys in Geophysics, accepted, 2025

Grand Challenge: Impact of Terrestrial Weather on the Space Weather of the Ionosphere-Thermosphere-Mesosphere

Friday 1:30 – 3:30

E. Yiğit – IT effects of Hurricanes

J. Guerrero – GW imaging over CONUS

H. Liu – GWs from high-res WACCM-X

J. Pettit – Extending GEOS into thermosph.

X. Lu – Modeling IT variability driven by obs.

B. Bergsson – AGW-driven TID modeling

F. Gasperini – Impact of resolved GWs on global-scale wave variability

Discussion

Friday 4 – 6

N. Pedatella – PW-driven plasma bubbles

S. Derghazarian – Polar vortex and MSTID

S. Kumar – Artic sea-ice loss and MLT response

Z. Qiao – Interhemispheric coupling during SSW

J. Zhang – SSW impacts on O/N2

M. Neogi – Tidal heating in thermosphere

J. Wu – Tracking Q6DW using MIGHTI

Y. Chen – TINa observations from lidar

Zoom info on agenda