Climatological Analysis of Helium Bulges in Mars's Upper Atmosphere using MAVEN and EMM observations and MPCM Simulations. Neha Gupta[1], Bhaskar Sharma[3], Shaikha Aldhaheri[1,2], Claus Gebhardt[1,2], Bijay Kumar Guha[1], Luca Montabone[4,5], Piyush Sharma[6,] and Roland Young[7], [1]National Space Science and Technology Centre, United Arab Emirates University, Al Ain, United Arab Emirates (g.neha@uaeu.ac.ae), [2]College of Science, Department of Physics, United Arab Emirates University, Al Ain, United Arab Emirates, [3]VIT Bhopal University, India, [4] Centre for Mars Meteorology Monitoring, Paneureka, Le Bourget-du-Lac, France. Laboratoire de Météorologie Dynamique, IPSL/CNRS/Sorbonne Université, Paris, France. [5]Space Science Institute, Boulder, CO, USA, [6]Physical Research Laboratory, Department of Space, Ahmedabad, India, and [7]Department of Physics, SUPA, University of Aberdeen, King's College, Aberdeen, UK.

Introduction: Light atmospheric species like helium and oxygen trace global circulation in Mars' upper atmosphere. Formation of Helium bulges [1], their seasonal variations [3], and their response to the 2018 Planetary Encircling Dust Storm [2] demonstrate the sensitivity of helium, due to its light mass and large-scale height, to the global circulation in the Martian upper atmosphere. NASA's Mars Atmosphere and Volatile Evolution (MAVEN) Mission began its science operations in December 2014. Since then, it is continuously providing invaluable data from the upper atmosphere of Mars. This long-term data, spanning Mars Years (MY) 32–37 (Earth years 2014–2023) from the Neutral Gas Ion Mass Spectrometer (NGIMS) onboard MAVEN, offers not only global coverage but also a unique opportunity to investigate the long-term climatology of helium in the Martian upper atmosphere. Our analysis reveals that the seasonal and local time variations are consistent with the previous studies [1,2,3]. Additionally, we present the first-time observation of the Helium-bulge-like formation during the early morning (0–7 hr) and night-time (17–24 hr) hours over mid to high latitudes (40–80°S) around northern spring (solar longitude (Ls) = 300–360°). We observe that Helium densities during the high dust loading season (Ls = 140–360°) [4] are generally lower than those in the low dust loading seasons (Ls = 10 – 140°). During the high dust loading season, He density decreases around Ls = 180–260° and Ls =300–360°, particularly when the Column Dust Optical Depth (CDOD) exceeds one. However, such changes are not evident for CDOD<1. Furthermore, we compare the helium observations with the model output from the Mars Planetary Climate Model (MPCM) upper atmospheric simulations. We observe that the MPCM outputs are in general consistent with the Helium observations, with a few noted discrepancies. Finally, we investigate the changes in the Helium bulge driven by a particular dust storm observed by the Emirates eXploration Imager and Emirates Mars Infrared Spectrometer onboard the Emirates Mars Mission during Ls =105–120° in MY 37.

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