Nicholas G. Heavens, Ph.D., FRAS, FGS

EDUCATION

CALIFORNIA INSTITUTE OF TECHNOLOGY (PASADENA, CA, USA)
Ph.D. in Planetary Science, 2010
Thesis: "The Impact of Mesoscale Processes on the Atmospheric Circulation of Mars"

M.S. in Planetary Science, 2007.
[Supervisors: Mark I. Richardson (2005–2009), Yuk L. Yung (2009–2010)]

THE UNIVERSITY OF CHICAGO (CHICAGO, IL, USA)
S.B. in Geophysical Sciences (Earth Science and Atmosphere/Ocean Science Emphases) with Honors and General Distinction in the College, 2005.
Thesis: "Climatology of Heat and Moisture Transport in the Lower Troposphere of the Red Sea"
[Supervisor: Gidon Eshel]

AWARDS

2011: NASA Group Achievement Award for the Mars Climate Sounder Team
2010: NASA Group Achievement Award for the Mars Climate Sounder Team
2010: First Prize, American Meteorological Society Applied Meteorology and Climatology Student Presentation Competition
2005–2006: Institute Fellowship, Caltech
2005: Elected as an Associate Member of Sigma Xi (University of Chicago)
2005: Elected to Phi Beta Kappa (University of Chicago)
2004: Student Marshal (University of Chicago)
2001–2005: University Scholarship (University of Chicago)
2001–2005: Knight Ridder National Merit Scholarship

FUNDING

2015–2020: W. Moore et al., The Living, Breathing Planet, NASA Exoplanet Systems Science (as Co-I and Atmospheric Transport Technical Lead), NNX15AE05G, 03/01/2015–02/28/2020: ~$3,800,000.

2015–2018: **N.G. Heavens**, C.E. Newman, M.L. Witek, and R.J. Wilson, Modeling Dust Injection and Vertical Mixing for the Next Generation of Martian Exploration (as PI), NASA Solar System Workings 2014, NNX15AI33G, 08/01/2015–07/31/2018: $431,179.

2014–2018: W. Moore, J. McNabb, K.M. Sayanagi, **N.G. Heavens**, and S. Providence, HBCU-RISE Hampton University: Advanced Physical Modeling and Simulation for 21st Century Scientists, US National Science Foundation HBCU-RISE (as Co-PI), HRD-1345209, 03/01/2014–02/28/2019(?): $999,950.

2014–2018: **N.G. Heavens**, S.V. Kireev, and A.M. Zalucha, The Structural and Dynamical Role of Deep Convection in Martian Dust Storms, NASA Mars Data Analysis Program 2013 (as PI), NNX14AM32G, 07/02/2014–07/01/2018: $500,262.

2013–2017**:** G.S. Soreghan, **N.G. Heavens**, L. Hinnov, S. Aciego, and C. Simpson, ELT COLLABORATIVE RESEARCH: Investigating the Biotic and Paleoclimatic Consequences of Dust in the Late Paleozoic, US National Science Foundation Sedimentary Geology and Paleobiology (Earth-Life Transitions track) (as Non-Lead PI), EAR-1337463, 09/01/2013–08/31/2019: $174,641.

2012–2015**: N.G. Heavens**, Dust in the Year Before Curiosity, JPL Subcontract through the Mars Climate Sounder Science Operation Team (as Principal Investigator), 1471216, 12/03/2012–09/30/2015: $61,401.

RESEARCH EXPERIENCE

2018–present: SPACE SCIENCE INSTITUTE (BOULDER, CO)
Affiliate Research Scientist in Earth Science

2012–present: HAMPTON UNIVERSITY (HAMPTON, VA, USA)
Research Assistant Professor of Planetary Science
Department of Atmospheric and Planetary Sciences

Duties: Studied and obtained external support for studies of Martian weather, late Paleozoic climate, and planetary atmospheric escape/evolution. Performed beta-plane simulations of giant planet dynamics for Dr. Kunio M. Sayanagi in the EPIC Model.

2010–**2012**: CORNELL UNIVERSITY (ITHACA, NY, USA)
Postdoctoral Associate
Department of Earth and Atmospheric Sciences

Duties: Studied the dust cycle of the late Paleozoic under the supervision of Natalie M. Mahowald and in collaboration with Gerilyn S. Soreghan, including modeling with CCSM3. Provided occasional support on technical issues relating to dust cycle modeling by Mahowald's research group using CESM1. Wrote NSF collaborative research proposal on late Paleozoic wildfire.

2005–**2010**: CALIFORNIA INSTITUTE OF TECHNOLOGY (PASADENA, CA, USA),
Graduate Research Assistant
Division of the Geological and Planetary Sciences

Duties: Validated and enhanced the Planetary Weather Research and Forecasting model for Mark I. Richardson. Served as data analyst and consultant on atmospheric dynamics/interaction with modelers to Mars Climate Sounder science

operations team. Studied low-frequency variability in the Earth's oceans for Yuk L. Yung.

2004–2005: THE UNIVERSITY OF CHICAGO (CHICAGO, IL, USA)
Undergraduate volunteer
Department of Geophysical Sciences
Duties: Studied land-sea interactions in the Red Sea for Gidon Eshel.

2004: THE LUNAR AND PLANETARY INSTITUTE (PASADENA, TX, USA)
Lunar and Planetary Institute Summer Intern
Duties: Studied Mars analog mineralogical remote sensing with Laurel Kirkland.

TEACHING EXPERIENCE

2012–present: HAMPTON UNIVERSITY (HAMPTON, VA)

Postgraduate Supervisor
Alima Diawara (Ph.D. student), 2015–2017 (awarded Ph.D. in Bioresources Sciences from Mie University, 2017, now at NOAA Climate Prediction Center).

Summer Undergraduate Student Supervisor
Morgan S. Johnson (undergraduate at Rochester Institute of Technology), 2013.

Marcell Fischler (undergraduate at Ithaca College), 2014.

Substitute Lecturer
Course: Introductory Astronomy, 2013 and 2014.

2007–2010: CALIFORNIA INSTITUTE OF TECHNOLOGY (PASADENA, CA),
Graduate Teaching Assistant in the Division of the Geological and Planetary Sciences

Courses: Introduction to the Solar System (A.P. Ingersoll); Atmospheric Radiation (Y.L. Yung); Fundamentals of Planetary Surfaces (O. Aharonson). Substitute lecturer for Introduction to the Solar System, Atmospheric Radiation, and Introduction to Planetary Atmospheres.

See Invited Talks for informal teaching and outreach

RELEVANT ADMINISTRATIVE EXPERIENCE

2014–2016: Member of the Board of Directors and Committee Member for Cyberinfrastructure, STEPPE (Sedimentary Geology, Time, Environment, Paleontology,

Paleoclimate, and Energy: an international consortium focused on incubating grand challenge projects in Earth deep time research).

2012–present: Voting Member of the Departmental Faculty, Department of Atmospheric and Planetary Sciences, Hampton University, 2012–present. (Faculty members collectively consider graduate admissions and a variety of other matters.)

2012–present: Seminar and Presentations Committee, Department of Atmospheric and Planetary Sciences, Hampton University

2007–2008: Co-Chair, Kliegel Lectures in Planetary Science, California Institute of Technology.

2006–2010: Coffee and Cookies Coordinator, Planetary Science, California Institute of Technology

2004–2005: Co-President, University of Chicago Geounion

2003–2005: Publisher, *Aubade* (literary magazine), University of Chicago

OTHER SERVICE TO THE PROFESSION

Professional Memberships

American Meteorological Society
American Geophysical Union
Division for Planetary Sciences, American Astronomical Society
Royal Astronomical Society
Geological Society of London

Science Team Memberships

Mars Climate Sounder/Mars Reconnaissance Orbiter, 2007–present

Journal Reviewer Service

Science, Geology, *Geophysical Research Letters*, *Earth and Space Science, Journal of the Atmospheric Sciences, Journal of Geophysical Research—Planets, Journal of Geophysical Research—Space Physics, Icarus*, *Climate of the Past*, *Space Science Reviews, Aeolian Research, Global and Planetary Change, Research in Astronomy and Astrophysics*, *Astrophysics and Space Science, Progress in Earth and Planetary Science*.

Program Reviewer Service

Multiple NASA Planetary Science Division programs, US NSF, Deutsche Forschungsgemeinschaft, Swedish National Space Board; York University (Canada) Research Chairs Program.

Conference Organizing

Co-Convener, "Current Processes in the Atmosphere of Mars", AGU Fall Meeting 2014–2017; Co-Convener, "Dynamic Processes in Mars's Atmosphere", AGU Fall Meeting 2013; Co-Convener, "Milankovitch Forcing and Biochemical Cycling, Paleozoic to Paleogene: Staying Ahead of the Curve", AGU Fall Meeting 2012; Co-Convener, "Global Freezes and Thaws Prior to the Cenozoic," AGU Fall Meeting 2011.

Outstanding Student Presentation Coordinator, Planetary Sciences Section, American Geophysical Union, 2018-2019.

Miscellaneous Service

Representative of STEPPE and Sedimentary Geology End User Community to EarthCube End User Communities and Professional Societies Workshop, Washington, DC, 18-–20 March 2014.

Rapporteur, Drill Core Records of Re-Organization of the Atmosphere, Scientific Drilling and the Evolution of the Earth System: Climate, Biota, Biogeochemistry, and Extreme Events, Norman, OK, 17–19 May 2013.

PUBLICATIONS

Refereed Articles

[35] **Heavens, N.G.,** A. Kleinböhl, M.S. Chaffin, J.S. Halekas, D.M. Kass, P.O. Hayne, D.J. McCleese, S. Piqueux, J.H. Shirley, and J.T. Schofield, 2018, Hydrogen escape from Mars enhanced by deep convection in dust storms, *Nature Astron*, **2**, 126–132, doi: 10.1038/s41550-017-0353-4.

[34] **Heavens**, **N.G.,** 2017b, The Reflectivity of Mars at 1064 nm: Derivation from Mars Orbiter Laser Altimeter Data and Application to Climatology and Meteorology, *Icarus*, **289**, 1–21, doi: 10.1016/j.icarus.2017.01.032.

[33] **Heavens**, **N.G.,** 2017a, Textured Dust Storm Activity in Northeast Amazonis–Southwest Arcadia, Mars: Phenomenology and Dynamical Interpretation, *J. Atmos. Sci.*, **74** (4), 1011–1037, doi:10.1175/JAS-D-16-0.211.1.

[32] Piqueux, S., A. Kleinböhl, P.O. Hayne, **N.G. Heavens**, D.M. Kass, D.J. McCleese, J.T. Schofield, and J.H. Shirley, 2016, Discovery of a widespread low-latitude diurnal CO_2 frost cycle on Mars, *J. Geophys. Res. Planets*, **121**, 1174–1189, 10.1002/2016JE005034.

(Press Coverage: Shultz, D. (2016), Carbon dioxide frost may keep Martian soil dusty, *Eos*, **97**, doi:10.1029/2016EO055597).

[31] Marshall, C., D.J. Large, and **N.G. Heavens**, 2016, Coal derived rates of atmospheric dust deposition during the Permian, *Gondwana Research*, **31**, 20–29, doi:10.1016/j.gr.2015.10.002.

[30] **Heavens, N.G.**, 2015, Injecting Climate Modeling Into Deep Time Studies: Ideas for Nearly Every Project, *The Sedimentary Record*, **13**(4), 4–10, doi:10.2110/sedred.2015.4.

[29] Sur, S., J.D. Owens, G.S. Soreghan, T.W. Lyons, R. Raiswell, **N.G. Heavens**, and N.M. Mahowald, 2015, Extreme eolian delivery of reactive iron to late Paleozoic icehouse seas, *Geology*, **43**, 1099–1102, doi:10.1130/G37226.1.

[28] Soreghan, G.S., **N.G. Heavens**, L.A. Hinnov, S.M. Aciego, and C. Simpson, 2015, Reconstructing the dust cycle in deep time: The case of the Late Paleozoic Icehouse in: D. Polly, J.J. Head, and D.L Fox, eds., Earth-Life Transitions: Paleobiology in the Context of Earth System Evolution: The Paleontology Short Course October 31, 2015., *Paleo. Soc. Spec. Pap*., **21**, 83–120, doi:10.1017/S1089332600002977.

[27] Daerden, F., J. Whiteway, L. Neary, L. Komguem, M.T. Lemmon, **N. Heavens**, B. Cantor, E. Hébrard, and M. Smith, 2015, A Solar Escalator on Mars: Self-Lifting of Dust Layers by Radiative Heating, *Geophys Res. Lett.*, **42**, 7319–7326, doi:10.1002/ 2015GL064892.

[26] Albani, S., N. M. Mahowald, G. Winckler, R. F. Anderson, L. I. Bradtmiller, B. Delmonte, R. François, M. Goman, **N. G. Heavens**, P. P. Hesse, S. A. Hovan, K. E. Kohfeld, H. Lu, V. Maggi, J. A. Mason, P. A. Mayewski, D. McGee, X. Miao, B. L. Otto-Bliesner, A. T. Perry, A. Pourmand, H. M. Roberts, N. Rosenbloom, T. Stevens, and J. Sun, 2015, Twelve thousand years of dust: the Holocene global dust cycle constrained by natural archives, Clim. Past., **11**, 869–903, doi:10.5194/cp-11-869-2015.

[25] **Heavens, N.G.**, B.A. Cantor, P.O. Hayne, D.M. Kass, A. Kleinböhl, D.J. McCleese, S. Piqueux, J.T. Schofield, and J.H. Shirley, 2015b, Extreme Detached Dust Layers near Martian Volcanoes: Evidence for Dust Transport by Mesoscale Circulations Forced by High Topography, *Geophys. Res. Lett.*, **42**, 3730–3738, doi: 10.1002/2015GL064004.

(Press Coverage: J. Aron, Mars volcanoes launch dust storms like a skate ramp, New Scientist, 12 May 2015, http://www.newscientist.com/article/dn27502-mars-volcanoes-launch-dust-storms-like-a-skate-ramp.html).

[24] **Heavens, N.G.,** N.M. Mahowald, G.S. Soreghan, M.J. Soreghan, C.A. Shields, 2015a, A model-based evaluation of tropical climate in Pangaea during the late Palaeozoic Icehouse, *Palaeogeogr. Palaeoclimatol., Palaeoecol*., **425**, 109–127, doi:10.1016/j.palaeo.2015.02.024.

[23] **Heavens, N.G.,** M.S. Johnson, D.M. Kass, A. Kleinböhl, D.J. McCleese, J. Shirley, R.J. Wilson, and W.A. Abdou, 2014, Seasonal and Diurnal Variability of Detached Dust Layers in the Tropical Martian Atmosphere, *J. Geophys. Res.*, **119**, 1748–1774, doi:10.1002/2014JE004619.

[22] Shirley, J.H., T.H. McConnochie, D.M. Kass, A. Kleinböhl, J.T. Schofield, **N.G. Heavens,** D.J. McCleese, J. Benson, D.P. Hinson, and J.L. Bandfield, 2015, Temperatures and aerosol opacities of the Mars atmosphere at aphelion: Validation and inter-comparison of limb sounding profiles from MRO/MCS and MGS/TES, *Icarus*, **251**, 26–49, doi: 10.1016/j.icarus.2014.05.011.

[21] Albani, S., N.M. Mahowald, A. Perry, R. Scanza, C. Zender, **N.G. Heavens**, V. Maggi, J. Kok, and B. Otto-Bliesner, 2014, Improved Dust Representation in the Community Atmosphere Model, *J. Adv. Mod. Earth. Sys*., **6** (3), 541–570, doi: 10.1002/2013MS000279.

[20] Edmonds, R., J. Murphy, J.T. Schofield, and **N.G. Heavens**, 2014, Convective Instabilities During Mars Climate Sounder's Limb Staring Mode Were Overestimated, *Icarus*, **237**, 415–418, doi:10.1016/j.icarus.2014.04.034.

[19] Soreghan, G.S., D.E. Sweet, and **N. Heavens**, 2014, Upland Glaciation in Tropical Pangaea: Geologic Evidence, and Implications for Late Paleozoic Climate Modeling, *Journal of Geology*, **122**, 137–163, doi:10.1086/675255.

[18] Hayne, P.O., D.A. Paige, **N.G. Heavens,** and the Mars Climate Sounder Science Team, 2014, The role of snowfall in forming the seasonal ice caps of Mars: models and constraints from the Mars Climate Sounder, *Icarus*, **231**, 122–130, doi: 10.1016/j.icarus.2013.10.020.

[17] Soreghan, M.J., **N. Heavens,** G.S. Soreghan, P.K. Link, and M.A. Hamilton, 2014, Abrupt and high-magnitude changes in atmospheric circulation recorded in the Permian Maroon Formation, tropical Pangaea, *Geological Society of America Bulletin*, doi: 10.1130/B30840.1.

[16] **Heavens**, **N.G.,** D.S. Ward, and N.M. Mahowald, 2013, Studying and Projecting Global Change with Earth System Models, *Nature Education Knowledge*, **4**(5), 4.

[15**] Heavens**, **N.G.,** C.A. Shields, and N.M. Mahowald, 2012, A paleogeographic approach to aerosol prescription in simulations of deep time climate, *J. Adv. Model. Earth Syst.*, **4**, M11002, doi:10.1029/2012MS000166.

[14] Hayne, P., D.A. Paige, J.T. Schofield, D.M. Kass, A. Kleinböhl, **N.G. Heavens,** and D.J. McCleese, 2012, Carbon dioxide snow clouds on Mars: south polar winter observations by the Mars Climate Sounder*, J. Geophys. Res.,* **117**, E08014, doi:10.1029/2011JE004040.

[13] Clancy, R.T., B.J. Sandor, M.J. Wolff, M.D. Smith, F. Lefèvre, J.-B. Madeleine, F. Forget, S.L. Murchie, F.P. Seelos, K.D. Seelos, H.A. Nair, A.D. Toigo, D. Humm, D.M.

Kass, A. Kleinböhl, and **N.G. Heavens,** 2012, Extensive MRO CRISM Observations of 1.27 μm O_2 Airglow In Mars Polar Night and Their Comparison to MRO MCS Temperature Profiles and LMD GCM Simulations, *J. Geophys. Res*., **117**, E00J10, doi:10.1029/2011JE004018.

Correction: Clancy, R.T., B.J. Sandor, M.J. Wolff, M.D. Smith, F. Lefèvre, J.-B. Madeleine, F. Forget, S.L. Murchie, F.P. Seelos, K.D. Seelos, H.A. Nair, A.D. Toigo, D. Humm, D.M. Kass, A. Kleinböhl, and **N.G. Heavens,** 2013, Correction to "Extensive MRO CRISM Observations of 1.27 μm O_2 Airglow In Mars Polar Night and Their Comparison to MRO MCS Temperature Profiles and LMD GCM Simulations", 2012, *J. Geophys. Res*. *Planets*, **118**, 1148–1154, doi:10.1002/jgre.20073.

[12] Mahowald, N.M., D.S. Ward, S. Kloster, M.G. Flanner, C.L. Heald, **N.G. Heavens**, P.G. Hess, J.-F. Lamarque, and P.Y. Chuang, 2011, Aerosol impacts on climate and biogeochemistry, *Annual Reviews of Environment and Resources*, **36**, 45–74.

[11] **Heavens**, **N.G.** M.I. Richardson, A. Kleinböhl, D.M. Kass, D.J. McCleese, W.A. Abdou, J.L. Benson, J.T. Schofield, J.H. Shirley, and P.M. Wolkenberg, 2011c, The vertical distribution of dust in the martian atmosphere during northern spring and summer: Observations by the Mars Climate Sounder and analysis of zonal average vertical dust profiles, *J. Geophys. Res.,* **116**, E04003, doi: 10.1029/2010JE003691.

[10] **Heavens, N.G.,** D.J. McCleese, M.I. Richardson, D.M. Kass, A. Kleinböhl, and J.T. Schofield, 2011b, The Structure and Dynamics of the Martian Lower and Middle Atmosphere as Observed by the Mars Climate Sounder: 2. Implications of the Zonal Average Thermal Structure and Aerosol Distributions for the Mean Meridional Circulation, *J. Geophys. Res.,* **116**, E01010, doi: 10.1029/2010JE003713.

[9] **Heavens, N.G.,** M.I. Richardson, A. Kleinböhl, D.M. Kass, D.J. McCleese, W.A. Abdou, J.L. Benson, J.T. Schofield, J.H. Shirley, and P.M. Wolkenberg, 2011a, Vertical distribution of dust in the martian atmosphere during northern spring and summer: High altitude tropical dust maximum at northern summer solstice, *J. Geophys. Res,* **116**, E01007, doi: 10.1029/2010JE003692.

[8] McCleese, D.J., **N.G. Heavens**, J.T. Schofield, W.A. Abdou, J.L. Bandfield, S.B. Calcutt, P.G.J. Irwin, D.M. Kass, A. Kleinboehl, C.B. Leovy, S.R. Lewis, D.A. Paige, P.L. Read, M.I. Richardson, J.H. Shirley, F.W. Taylor, N. Teanby, and R.W. Zurek, 2010, The Structure and Dynamics of the Martian Lower and Middle Atmosphere as Observed by the Mars Climate Sounder: 1. Seasonal variations in zonal mean temperature, dust and water ice aerosols, *J. Geophys. Res.* **115**, E12016, doi: 10.1029/2010JE003677.

[7] **Heavens**, **N.G.,** J.L. Benson, D.M. Kass, A. Kleinböhl, W.A. Abdou, D.J. McCleese, M.I. Richardson, J.T. Schofield, J.H. Shirley, and P.M. Wolkenberg, 2010b, Water ice clouds over the Martian tropics during northern summer, *Geophys. Res. Lett*, **37**, L18202, doi:10.1029/2010GL044610.

(*Featured in "Our choice from the recent literature*", *Nature Geoscience*, *3(10), 976*.)

[6] **Heavens, N.G.,** M.I. Richardson, W.G. Lawson, C. Lee, D.J. McCleese, D.M. Kass, A. Kleinböhl, J.T. Schofield, W.A. Abdou, and J.H. Shirley, 2010a, Convective instability in the martian middle atmosphere, *Icarus*, **208**, 574–589, doi:10.1016/j.icarus.2010.03.023.

[5] Lee, C. W.G. Lawson, M.I. Richardson, **N.G. Heavens**, A. Kleinboehl, D. Banfield, D.J. McCleese, R. Zurek, D. Kass, J.T. Schofield, C.B. Leovy, F.W. Taylor, and A.D. Toigo, 2009, Thermal tides in the Martian Middle Atmosphere as Seen by the Mars Climate Sounder**,** *J. Geophys. Res.,* **114**, E03005, doi:10.1029/2008JE003285.

[4] McCleese, D.J., J.T. Schofield, F.W. Taylor, W.A. Abdou, O. Aharonson, D. Banfield, S.B. Calcutt, **N.G. Heavens,** P.G.J. Irwin, D.M. Kass, A. Kleinböhl, W.G. Lawson, C.B. Leovy, S.R. Lewis, D.A. Paige, P.L. Read, M.I. Richardson, N. Teanby, and R.W. Zurek, 2008, Intense Polar Temperature Inversion in the Middle Atmosphere on Mars, *Nature Geosci*.,**1**, 745–749, doi:10.1038/ngeo332.

[3] **Heavens**, **N.G.**, M.I. Richardson, and A.D. Toigo, 2008, Two Aerodynamic Roughness Maps Derived from MOLA Data and Their Effects on Boundary Layer Properties in a Mars GCM, *J. Geophys. Res*., **113,** E02014, doi:10.1029/2007JE002991.

[2] Eshel, G. and **Heavens**, **N.** 2007, Climatological evaporation seasonality in the Northern Red Sea, *Paleoceanography*, **22**, PA4201, doi:10.1029/2006PA001365.

[1] **Heavens, N.G.,** 2004, Empire of the Air: Meteorological Intellectual Property in the United States, 1850-2003, accepted by *Chicago Scholarly Review* (journal became defunct before publication)

Non-refereed publications

Heavens, **N.G.,** 2017, Of kangaroo rats and gypsum gravel: Probing the extremes of aeolian transport in the present and the past, *Geology*, **45**(5), 479–480, doi: 10.1130/focus052017.1.

Heavens, N.G., N.M. Mahowald, G.S. Soreghan, M.J. Soreghan, C.A. Shields, 2012, Glacial-Interglacial Variability in Tropical Pangaean Precipitation during the Late Paleozoic Ice Age: Simulations with the Community Climate System Model, *Climate of the Past Discussions*, **8,** 19151972.

Heavens, **N.G.,** 2011, Sunshine on a Cloudy Forecast (Perspective), *Science*, **333**, 1832-1833.

Heavens, **N.G.,** 2005, *Mind over Magma* by Davis A. Young, *J. Geology*, **113**, 237 (book review).

Conference Presentations (as first author)

N.G. Heavens, Thermal infrared sounding observations of lower atmospheric variances at Mars and their implications for gravity wave activity: a preliminary examination, AGU

Fall Meeting 2017, P23D-2766 (poster).

N.G. Heavens, Bridging the Scales: What Local Dust Storms can tell us about Regional and Global Dust Events and vice versa, Sixth international workshop on the Mars atmosphere: Modelling and observations, Granada, Spain, 17–20 January 2017 (oral).

N.G. Heavens, M.L. Witek, and C.E. Newman, Eddy Diffusivity Mass Flux Parameterization for Non-Dusty Martian Boundary Layers: A Progress Report, Sixth international workshop on the Mars atmosphere: Modelling and observations, Granada, Spain, 17–20 January 2017 (poster).

N.G. Heavens, A Peek into a Cul-De-Sac and Mews of Martian Dust Storm Activity: Western Hellas and Syria-Claritas Fossae During Mars Year 29, AGU Fall Meeting 2016, P21B-2104 (poster).

N.G. Heavens, Unraveling Local Dust Storm Structure on Mars: The Case of Northern Amazonis During Mars Year 24, AGU Fall Meeting 2015, P23B-2131 (poster).

N.G. Heavens and G.S. Soreghan, Volcanic Winter and Cold Tropical Uplands in Late Paleozoic Pangaea: A Thought Experiment, AGU Fall Meeting 2014, PP13A-1406 (poster).

N.G. Heavens, Seasonal and Diurnal Variability of Detached Dust Layers in the Tropical Martian Atmosphere, Mars Climate Sounder Extended Science Team Meeting, Pasadena, CA, 12 December 2014 (oral)

N.G. Heavens, Detached Dust Layers in Regional and Global Dust Events on Mars, DPS AAS Annual Meeting 2014, 300.09 (oral).

N.G. Heavens, The Meteorology of Dust and Water on Mars: Insights from the Recent Past and New Challenges, 8th International Conference on Mars, Pasadena, CA, 14-18 July 2014 (invited talk), 1072.

N.G. Heavens, G.S. Soreghan, S.M. Aciego, L.A. Hinnov, and C. Simpson, Investigating the Biotic and Paleoclimatic Consequences of Dust during Late Paleozoic Time, Third International Conference of Geobiology, Wuhan, China, 16-18 June 2014 (invited talk).

N.G. Heavens and M.S. Johnson, Diurnal Variability in the Martian Atmosphere Inferred from Nearly Coincident Profiles at Semidiurnal Separation, AGU Fall Meeting 2013, P41A-1917 (poster).

N.G. Heavens, Seasonal and Diurnal Variability of Detached Dust Layers in the Tropical Martian Atmosphere, Mars Climate Sounder Extended Science Team Meeting, Pasadena, CA, 5-6 December 2013 (oral).

N.G. Heavens and K.M. Sayanagi, Modeling the Transition From Jets to Polar Turbulence in Giant Planet Atmospheres, DPS AAS Annual Meeting 2013, 509.02 (oral).

N.G. Heavens, N.M Mahowald, G.S. Soreghan, M.J. Soreghan, C.A. Shields, and S. Albani, Simulating Dust Cycling during the Late Paleozoic Ice Age, AGU Fall Meeting 2012, PP11C-2030 (poster).

N.G. Heavens, Detached Dust Layers (High Altitude Maxima) in the Atmosphere of Mars, Mars Climate Sounder Extended Science Team Meeting, Pasadena, CA, 29-30 November 2012 (oral).

N.G. Heavens, N.M. Mahowald, G.S. Soreghan, and M. Soreghan, Fundamentals of Glacial-Interglacial Variability in Tropical Pangaean Aridity during the Late Paleozoic, AGU Fall Meeting 2011, PP13D-1860. (poster)

N.G. Heavens, N.M. Mahowald, and G.S. Soreghan, Data Analysis, Modeling, and Interpretation of Low Latitude Dust Deposits from the Late Paleozoic, Dust Workshop 2011: Processes and Quaternary History of Dust Dynamics, 31 October-3 November 2011, Bremen, Germany (invited talk).

N.G. Heavens, M.I. Richardson, A. Kleinböhl, D.M. Kass, D.J. McCleese, W. Abdou, W., J.L. Benson, J.T. Schofield, J.H. Shirley, and P.M. Wolkenberg, The Vertical Distribution of Dust in the Martian Atmosphere as Observed by the Mars Climate Sounder, Fourth International Workshop on the Mars Atmosphere, 8-11 February 2011, Paris, France (poster).

N.G. Heavens, M.I. Richardson, A. Kleinboehl, D. Kass, and D.J. McCleese, The Vertical Distribution of Dust in the Martian Atmosphere: The Haze in the Clear Season and the Haze After the Storm, AGU Fall Meeting 2010, P52A-06 (oral).

N.G. Heavens, The Vertical Distribution of Dust in the Atmosphere, Mars Engineering Dust Workshop, NASA Jet Propulsion Laboratory, Pasadena and Arcadia, CA, 18-19 March 2010, 5e (invited talk).

N.G. Heavens, Richardson, M.I., I.J. McEwan, I.J., and M.W. Busch, Martian dust storm hazards: Improving characterization and forecasting, 18th Conference on Applied Meteorology and Climatology, 90th AMS Annual Meeting, J8.6. (oral)

(*Won First Prize, American Meteorological Society Applied Meteorology and Climatology Student Presentation Competition*)

N.G. Heavens, M.-C., L. Lin, K.-F. Li, K.K. Tung, and Y.L. Yung, Assessing Low Frequency Variability in North Atlantic Ocean Sea Surface Temperatures in Global Climate Models, AGU Fall Meeting 2009, GC32A-08 (oral).

N. G. **Heavens**, M.I. Richardson, D.M. Kass, A. Kleinböhl, D.J. McCleese, The Vertical Distribution of Dust in Mars' Atmosphere during Northern Spring and Summer: The Perspective from the Mars Climate Sounder, Mars Dust Cycle Workshop, NASA Ames Research Center, 15-17 September 2009 (oral).

N. G. Heavens, M.I. Richardson, A. Kleinböhl, D.J. McCleese, and the Mars Climate Sounder Science Team, Martian Airborne Dust during the Clear Season, AGU Fall

Meeting 2008, P41B-1380 (poster).

N. G. Heavens, M.I. Richardson, and D.J. McCleese, and the MCS Science Team, A New Perspective on the Vertical Distribution of Dust in the Martian Atmosphere During Northern Summer from Mars Climate Sounder: Elevated Maxima over the Tropics, Third International Workshop on the Mars Atmosphere, Williamsburg, VA, 10-13 November 2008, 9066 (poster).

N. G. **Heavens**, M.I. Richardson, D.J. McCleese, A. Kleinböhl, and the Mars Climate Sounder Science Team, A New Perspective on the Vertical Distribution of Dust in the Martian Atmosphere During Northern Summer from Mars Climate Sounder: Zonally-averaged profiles, Third International Workshop on the Mars Atmosphere, Williamsburg, VA, 10-13 November 2008, 9065 (oral, invited).

N. Heavens, I.J. McEwan, M.W. Busch, C.E. Newman, and M.I. Richardson, Modeling and Implications of Exotic Martian Radio Emission, 39th Annual Meeting of Division for Planetary Sciences of the American Astronomical Society, 17.05 (oral).

N.G. Heavens, M.I. Richardson, and C.E. Newman, 2007, Using Mars Orbital Camera Dust Devil Observations to Develop Schemes for Representing Dust Devils in Mars General Circulation Models, 7th International Mars Conference, 3218 (poster).

N.G. Heavens, M.I. Richardson, and A.D. Toigo, 2007, Two Aerodynamic Roughness Maps Derived from MOLA Data and Their Effects on Boundary Layer Properties in a Mars GCM, 7th International Mars Conference, 3208 (poster).

N.G. Heavens and Y.L. Yung, 2006, Regime Change in the Pacific Ocean and the Relative Intensities of Multi-Decadal and Quasi-Centennial Variability, AGU Fall Meeting 2006, Eos Trans. AGU Fall Meeting 2006, PP51C-1146 (poster).

N.G. Heavens, M.I. Richardson, and C.E. Newman, 2006, Forecasting Martian Dust Devils, 60.04, 2006 DPS Meeting, Pasadena, CA (poster).

N.G. Heavens, L.E. Kirkland, and P.M. Adams, 2005, Mars Analog Field Infrared Spectroscopy at Alunite, Clark County, NV: Comparison with EDXS, LPSC XXXVI, 1936 (poster).

N.G. Heavens and L.E. Kirkland, 2004, Field Experience for Mars via Infrared Spectrometers, Lunar and Planetary Science Institute Summer Intern Conference XX (oral).

SEMINARS/OUTREACH

Invited Talks

Data sharing, CESM Paleoclimate Working Group Winter 2018, College Station, TX, 28 February 2018 (remote/discussion starter).

Deep convection in dust storms enhances hydrogen escape from Mars, Laboratoire de Météorologie Dynamique du CNRS (Paris, France), 26 September 2017.

Vanishing Airs, Freezing Waters, and Dusty Places: Present and Past Martian Climate, Department of Earth Science and Engineering, Imperial College (London, UK), 20 March 2017 (guest lecture for ESE-UG 5.26: Geomorphology: an undergraduate geomorphology class).

The Search for the Third Pole in Late Paleozoic Time: A Progress Report, Department of Geological Sciences, University of Delaware (Newark, DE, USA), 23 February 2017.

And Now Here's the Weather on Mars, Evangel University (Springfield, MO, USA), 4 February 2017 (talk to undergraduate physics students)

Dusty Mars: An Adventure in Limited Visibility, Skateboard Ramps, and Static Cling, American Chemical Society Hampton Roads Chapter, Old Dominion University (Norfolk, VA, USA), 28 March 2016.

Textured Dust Storm Activity in Northern Amazonis, Mars, Laboratoire de Météorologie Dynamique du CNRS (Paris, France), 11 February 2016.

Northern Amazonis: A Natural Laboratory for Investigating Martian Dust Storm Structure, Department of Physical Sciences, Open University (Milton Keynes, UK), 10 December 2015.

And Now Here's the Weather on Mars, Evangel University (Springfield, MO, USA), 2 October 2015 (two guest lectures for general chemistry and engineering physics students)

Mars's Extreme Detached Dust Layers: Surprises From Inside and Outside the Storm, Special Space Science and Astrobiology Division Seminar, NASA Ames Research Center (Mountain View, CA, USA), 31 March 2015.

And Now Here's the Weather on Mars: Rowan University Department of Physics and Astronomy Colloquium (Glassboro, NJ, USA), 26 September 2014 (talk aimed at juniors and seniors)

And Now the Weather on Mars!, James Madison University Space Camp and National Institute of Aerospace (Harrisonburg, VA, USA/Hampton, VA, USA), 22 July 2014 (outreach talk to middle schoolers and in-service teachers)

Weather Observation for Mars Exploration, NOAA CREST at City College of New York (New York, NY, USA), 30 May 2014.

What Every Telescopic Observer Should Know About the Weather On Mars, Back Bay Astronomers (Chesapeake, VA, USA) (outreach talk to amateur astronomers), 1 May 2014.

The Late Paleozoic Icehouse Controversy: What It Is, Why It Matters, And What We're Going To Do About It, Commonwealth Center for Coastal Physical Oceanography, Old Dominion University (Norfolk, VA, USA), 17 February 2014.

Dust-Driven Convection on Mars: Problems, Progress, and Promise, MIT Skolkovo Initiative (Cambridge, MA, USA), 29 August 2013.

Dust-Driven Convection on Mars: Problems, Progress, and Promise, Chemistry and Dynamics Branch, Science Mission Directorate, NASA Langley Research Center (Hampton, VA, USA), 26 August 2013.

The Vertical Distribution of Dust in the Martian Atmosphere, Department of Physics and Astronomy, the College of Charleston (Charleston, SC, USA), 29 March 2012.

Dust on Mars: An Adventure in Static Cling, Limited Visibility, and Cyclostratigraphy, Shell Colloquium, ConocoPhillips School of Geology and Geophysics, the University of Oklahoma (Norman, OK, USA), 1 March 2012.

Glacial-Interglacial Variability in Precipitation and Dust Deposition in Tropical Pangaea, Planetary Lunch Seminar, Department of Astronomy, Cornell University (Ithaca, NY, USA), 28 November 2011.

Searching for the Meteorology of Mars in a Hazy Limb, Department of Atmospheric and Planetary Science, Hampton University (Hampton, VA, USA), 21 June 2011.

Out on a Limb: Some Recent Results from the Mars Climate Sounder, Planetary Lunch Seminar, Department of Astronomy, Cornell University (Ithaca, NY, USA), 29 November 2010.

The Fish Turn Off and On: Decadal to Century-Scale Ocean Variability and Its Effects on Climate Above and Below the Ocean Surface, JPL Climate Discussion Group (Pasadena, CA, USA), 18 August 2006.

Television/Radio Interviews

Up All Night, BBC Radio 5, 17 February 2015, ~ 1:25 AM Greenwich Mean Time (Unusual Martian limb plume).

Miscellaneous Outreach

Technical Advisor, *Pioneer One* (web series), 2012.

Tweeted on group Twitter account @astrotweeps from 13–19 July 2014, 4–10 January 2016.

A short piece on Martian gravity waves on the blog of Planet Four: a citizen science project that studies features on Mars's surface connected with carbon dioxide outbursts: http://blog.planetfour.org/2015/07/31/gravity-waves-in-mars-atmosphere/

Ambassador (What's My Line), London Space Expo, National Space Academy, 19 July 2017. (Helped Year 8 and 9 students try to guess what I do for a living.)

Ark Globe Academy 6th Form Networking Evening (Southwark, London), 29 November 2017 (Talked to Year 12 and 13s about planetary science, careers etc.)