Nicola Fox, Heliophysics Division Director

Nicola Fox is the Heliophysics Division Director in the Science Mission Directorate at NASA Headquarters in Washington, DC. Until August 2018, Fox worked at the Applied Physics Lab at the Johns Hopkins University in Laurel, Maryland, where she was the chief scientist for Heliophysics and the project scientist for NASA's Parker Solar Probe – humanity's first mission to a star. She previously served as the deputy project scientist for the Van Allen Probes, and the operations scientist for the International Solar Terrestrial Physics program. Fox was born in Hitchin, Hertfordshire in England. She graduated from The Imperial College of Science, Technology and Medicine in London with a BS in Physics. She received an MS in Telematics and Satellite Communications from the University of Surrey. She then returned to Imperial College to complete a PhD in Space and Atmospheric Physics.

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Statement of
Nicola Fox, PhD
Director, Heliophysics Division
Science Mission Directorate, NASA
before the
Subcommittee on the Environment and the
Subcommittee on Space and Aeronautics,
Committee on Science Space and Technology,
United States House of Representatives

Chairwomen Horn and Fletcher, Ranking Members Babin and Marshall, and members of the Subcommittees, I am honored to appear before these Subcommittees to discuss NASA's contributions to understanding space weather and its impacts on our society.

Space weather is the result of complex interactions between the Sun, solar wind, Earth's magnetic field, and Earth's atmosphere. Our ability to understand and predict space weather is of growing importance to our nation's economy, national security, and even NASA Astronauts.

Through its Artemis program, NASA is accelerating its exploration plans and working to land the first woman and next man on the surface of the Moon by 2024. To meet these objectives, we continue to accelerate development of the systems required to ensure success. The Artemis missions will send humans beyond the protection of Earth's magnetic field for the first time since Apollo, and expose our astronauts and the systems upon which they will depend to a unique, and potentially hazardous space weather environment. NASA's Heliophysics division is working closely with the Artemis Program to support the human exploration of deep space, and on potential approaches to measure the radiation environment on and around the Moon. These measurements would aid in the prediction and validation of the radiation environment to which our astronauts will be subjected. Looking further in the future to journeys to Mars, NASA astronauts will need the capability to autonomously generate their own space weather data and predictions. To this end, the Heliophysics Division is working with the Space Radiation Analysis Group (SRAG) at the Johnson Space Center on possible experiments in cislunar space to develop the science and technology needed for such predictions.

Artemis holds important potential as a platform for scientific research. There is intense interest in what we can discover at the Moon. The lunar samples returned during the Apollo Program dramatically changed our view of the solar system, and scientists continue to unlock new secrets from the samples. We know the Moon can tell us more about our own planet, and even our Sun. Artemis missions may include installation of space weather instruments on the Moon, and studies of the lunar surface could yield significant insights into the space weather over long time scales. There is so much more to learn – knowledge we can acquire with a sustained human and robotic presence on the Moon. NASA will conduct many more science investigations and technology demonstrations on the Moon ahead of a human return through its Commercial Lunar Payload

Services (CLPS) initiative. Several payloads among those already selected through this program earlier this year will provide data of interest to solar and space physicists, and future payloads could include dedicated space weather instruments. The Artemis Program seeks to establish a sustainable architecture with our commercial and international partners on the Moon by 2028 and this architecture will support a future of scientific research.

NASA already addresses space weather impacts on astronauts and spacecraft while maintaining the International Space Station (ISS) and protecting the astronauts living there. The Community Coordinated Modeling Center (CCMC) team at the Goddard Space Flight Center works with NOAA's Space Weather Prediction Center (SWPC) to provide data and forecasts to the SRAG, who can then assess risks to the ISS. This experience will help NASA as it considers how best to protect Artemis astronauts from space weather impacts.

Space weather events are not only a concern for our astronauts and spacecraft; airline travel, communications and precision navigation and timing systems like the global positioning system (GPS), and the electrical power grid, on which we depend each day, can all be impacted by space weather. The NASA Heliophysics Division continues to study the Sun, how it influences the very nature of space, the atmospheres of planets and in the case of Earth, the technology that exists in low earth orbit and on the surface.

The extensive, dynamic solar atmosphere surrounds the Sun, Earth, and planets and extends far out into the solar system. Mapping out this interconnected system requires a holistic study of the Sun's influence. NASA has a fleet of spacecraft strategically placed throughout our heliosphere -- from Parker Solar Probe nearest the Sun, observing the very start of the solar wind, to satellites around Earth, to the farthest human-made object, Voyager, which is sending back observations on interstellar space. Each mission is positioned at a critical, well-thought out vantage point to observe and understand the flow of energy and particles throughout the solar system.

Several key missions are particularly focused on improving our understanding of space weather. The Parker Solar Probe, a first-of-its-kind mission, will visit the Sun's atmosphere, or corona, and provide information about coronal heating and the source of the solar wind. The Advanced Composition Explorer along with NOAA's Deep Space Climate Observatory observe the solar wind as it travels away from the Sun toward Earth and the other planets. The Solar Dynamics Observatory, the Solar and Terrestrial Relations Observatory, and the joint ESA/NASA Solar and Heliospheric Observatory all observe solar eruptions on the Sun. And finally, the Global-scale Observations of the Limb and Disk (GOLD) mission and the Ionospheric Connection (ICON) mission, launched earlier this month, will improve our understanding of what is happening in the ionosphere. Each of these missions provide a different view of the complex system that leads to the space weather we experience.

NASA Heliophysics works as the research arm of the nation's space weather effort, coordinating with NOAA, the National Science Foundation (NSF) and the U.S. Geological Survey, and Department of Defense (DoD). NASA is also a member of the Space Weather Operations, Research, and Mitigation (SWORM) Interagency Working Group run by the National Science and Technology Council, which coordinates interagency efforts to carry out the actions and meet the objectives identified in the National Space Weather Strategy and Action Plan. In addition to research missions, NASA supports improvements in space weather prediction models, such as those used by NOAA SWPC, the U.S. government's official source for space weather forecasts.

The NASA CCMC plays a key role in supporting our sister agencies by transitioning space research models to space weather operations.

NASA's Space Weather Science and Applications (SWxSA) project works to effectively support the transition of heliophysics science results to applications that enhance the user communities' ability to address impacts caused by the dynamic space environment. This activity supports interagency space weather efforts and is consistent with the recommendations of the 2013 Decadal Survey for Solar and Space Physics. Under SWxSA, NASA plans to competitively fund ideas and products, leverage existing agency capabilities, collaborate with other agencies, and partner with user communities. NASA established SWxSA in collaboration with sister federal agencies, academia and industry. Recent achievements include the award of grants that target research efforts to advance science priorities identified by our operational agency partner, investments in high end computing and the community coordinated modeling center.

Furthermore, in coordination with NOAA, we have initiated a pilot program to expand the interagency capability and improve space weather products and services for Research to Operations and Operations to Research (R2O2R). We are meeting regularly with NOAA to develop a shared framework for research to operations, and once we have established an effective and efficient process, we will further integrate NSF, DoD, academia and private industry into the framework.

NASA appreciates the continued support from these committees, which ensures that the United States maintains a superior position in understanding space weather and is prepared to respond to space weather events. We look forward to continued collaboration with our sister agencies, international partners, academia, and industry.

Thank you for the invitation to be here with you today, and I am happy to answer any questions you may have.

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Columbia, MD 21045 United States
Mobile: 240-475-2353
Email: nicola.j.fox@nasa.gov

Work Experience:
NASA Headquarters
300 E St SW
Washington DC, DC 20546 United States

09/2018 - Present

Heliophysics Division Director
Duties, Accomplishments and Related Skills:
As the Director of the Heliophysics Division, I report directly to the Science Mission Directorate Associate Administrator (AA) and support him in determining and presenting the Heliophysics Program to NASA senior management, the Office of Management and Budget, and Congress. In partnership with other SMD Directors, I support the AA in providing the overall guidance, strategy, focus advocacy, and budget for NASA's Science Program. I direct, plan and implement the Heliophysics program to reflect the priorities of the scientific community and maintain a balanced program. I implement and manage a portfolio of scientific flight investigations and plan and formulate recommendations for future flight programs for Heliophysics, in concert with overall SMD strategic planning. I oversee an effective program of research and analysis of Heliophysics science data and ensure the dissemination of results of the studies to the public and to the scientific community. I establish policy and objectives as a basis for the planning and formulation of a national program in Heliophysics science. I develop budgets, policies and priorities for programs, including providing scientific and technical leadership to guide implementation of relevant programs at NASA centers, Government research laboratories, academia and private industry.

Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723 United States

02/2015 - 08/2018
Chief Scientist, Heliophysics
Duties, Accomplishments and Related Skills:
As the chief scientist for Heliophysics I provided strategic leadership for all aspects of the heliophysics work conducted in the Space Research branch of the Space Exploration Sector, including DoD and civil space activities, including budget formulation, execution and defense, identifying new business opportunities, recommending which mission and instrument proposals are supported, and leading the review process as the proposals are matured prior to submission. I worked with leaders in the Heliophysics discipline in various agencies and fostered

collaborative relationships within the community in general. I was the sector lead for Space Weather, working with Congressional and community leaders, as well as decision makers to raise the profile of space weather and to generate revenue streams to support the Space Weather Action Plan.

Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723 United States

03/2011 - 08/2018
Mission Project Scientist
Duties, Accomplishments and Related Skills:
Parker Solar Probe Project Scientist. Leading the science teams in development, review and integration of mission science requirements both internally at APL and at the NASA project/program level, including the Mission Level 1 requirements document and the science for the Mission Requirements Document. I led a number of project initiatives, including strategic Phase E budget evaluation for SMD management. I conducted the mission telemetry rate study, and science planning. As chair of the Science Working Group, I led the Principal Investigators and science teams. This included developing strategic science direction in coordination with NASA HQ and the GSFC Program Office. I led the development of mission science budgets, schedules and deliverables, internally to APL and externally for instrument teams. I defended science budgets and requirements to all levels of NASA/HQ and GSFC LWS Program managers, including discipline scientists, Program Executives and the Heliophysics leadership. I have given TV interviews and talks on behalf of the PSP mission and have supported the Communications and Public Engagement initiative for the program, including the Eclipse 2017 events and the 2018 launch campaign.

Project Scientist for the Princeton-APL IMAP mission team. Duties included proposal production, day to day management of the APL science team, support for the PI at Princeton and organization and running of the full science team meeting.

Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723 United States

09/2001 - 06/2016
Deputy Project Scientist
Duties, Accomplishments and Related Skills:
Van Allen Probes Deputy Project Scientist. I led the science teams in development, review and integration of mission science requirements both internally at APL and at the NASA project/program level, including the Mission Level 1 requirements document and the science for the Mission Requirements Document. I led a number of project initiatives, including mission telemetry rate study, space weather, eclipse operations, and creation of materials to support the mission in general. The Space Weather initiative included negotiating with foreign partners

for use of ground stations and working with civilian and military organizations to determine customer needs. I led the Principal Investigators and science teams, and the Science Working Group (SWG) activities for Van Allen Probes. This included assigning science tasks, coordinating document reviews, running telecoms and organizing team meetings. I was involved with assessing adequacy of mission science budgets, schedules and deliverables, internally to APL and externally for instrument teams. I actively managed relationships and worked closely with the NASA/HQ and GSFC LWS project personnel, including discipline scientists, Program Executives and when necessary the Heliophysics Director. I have given TV interviews and talks on behalf of the Van Allen Probes mission and have supported the E/PO initiative for the program. Following the launch of Van Allen Probes, I supported the HQ discipline scientist in the evaluation of mission data products and closure of level 1 science goals, and I edited the RBSP book.

Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723 United States

06/2014 - 01/2015
Acting Deputy Managing Executive
Duties, Accomplishments and Related Skills:
6-month rotational position to gain experience and insight into the management of the Space Sector. Responsibilities included standing in for the Managing Executive (ME) at various meetings including the APL Management Forum and the Space Sector Executive Leadership Team meetings, and running the weekly branch supervisor meetings in her absence. I also gave an overview of the Space Sector briefing to the JHU Community Affairs group, and was a member of the interview panel for the several branch supervisor positions. I attended a number of Maryland Space Business Roundtable lunches and represented the ME at their steering committee meeting.

Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723 United States

10/2008 - 05/2014
Assistant Group Supervisor
Duties, Accomplishments and Related Skills:
Assistant Group Supervisor of the Space Research Planetary Magnetospheres (SRP) Group responsible for employee performance evaluations, day to day tasking, Group strategic planning and administrative tasks such as security reviews, staffing plans and problem resolution. As Assistant Group Supervisor, I supported the Group Supervisor in mentoring and developing staff at all levels, and advancing the coordination between staff for research, project, proposal, and scientific engagement activities. I helped to manage a wide variety of grants within the research group, and evaluate proposals to be submitted. I also conducted Performance Management Process actions and annual performance reviews of Section

Supervisors and staff. I identified staffing, facility, and equipment needs of the SRP Group, helped evaluate task loading, drafted personnel requisitions, interviewed new candidates, and provided input for hiring decisions. I assisted with the development of new business, managed projects, and interacted with sponsors and peers in other organizations on a regular basis. I produced the strategic plan for the APL Heliophysics discipline, establishing the science goals, mission and instrument development, and planning the near-term science activities

Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723 United States

09/1998 - 10/2004
Senior Professional Staff
Duties, Accomplishments and Related Skills:
As a research scientist, I studied various aspects of the geospace impact of coronal mass ejection events from the Sun, supported by a NASA Guest Investigator Program grant, including or the interaction of the magnetospheric system with particles and fields emanating from the sun. A second research grant focused on the efficiency of energy transfer from the solar wind, storage in the magnetosphere and release into the ionized upper layers of the atmosphere of the Earth, supported by a NASA Targeted Research and Technology (TR&T) Program Award. I was invited to give many talks at science meetings and pubic events on the subject of Sun-Earth connections. I supported the Education and Public Outreach (E/PO) efforts for a number of mission proposals from the Space Department, including leading the effort for the New Horizons mission.

Raytheon ITSS
10210 Greenbelt Road
Glenarden, MD 20706 United States

09/1997 - 09/1998
Research/Payload Scientist
Duties, Accomplishments and Related Skills:
Payload Scientist for the NASA Polar Mission including mission operations planning, weekly operations meetings, maneuver planning, anomaly resolution and recovery, monthly newsletters, education and public outreach, representing the GSFC Project Scientist, and performing scientific research.

USA National Research Council
NASA/Goddard Space Flight Center
Greenbelt Road
Greenbelt, MD 20771 United States

09/1995 - 09/1997
Resident Research Fellowship

Duties, Accomplishments and Related Skills:
Research work in the field of Solar System Plasma Physics, with particular emphasis on data analysis. First studied various aspects of the Earth's geomagnetic cusp region using data from the second Dynamics Explorer (DE2) mission. A second research project was on the comparison of cusp currents detected by the Polar spacecraft and the SuperDARN ground-based radar.

Education:
Imperial College, London, United Kingdom
Doctorate 06/1995

Major: Space Plasma Physics
Relevant Coursework, Licenses and Certifications:
PhD in Space Plasma Physics - Thesis "Ionospheric Convection during Substorms"

University of Surrey, Guildford, United Kingdom
Master's Degree 09/1991

Major: Telematics
Relevant Coursework, Licenses and Certifications:
Telecommunications, Satellite Communications, Computer Engineering
Master Thesis on the use of Broadband Communications for General Motors

Imperial College, London, United Kingdom
Bachelor's Degree 06/1990

Major: Physics
Relevant Coursework, Licenses and Certifications:
3 year, full time degree in Physics including course and laboratory work

Job Related Training:
Course: SES Orientation Briefing 3/13/2019 - 3/14/2019
Course: APL Coaching Seminar: April 2013
Course: APL Supervisor Training: 2012
Course: APL Leadership Training: October 2010

Extensive strategic budget development and execution skills, science and organizational leadership skills. 15 years of successful supervisory experience. Extensive background in applied and theoretical physics and mathematics applied to a variety of NASA mission and instrument development projects. Extensive background in physics and mathematics.

Affiliations:
American Geophysical Union - Member - formerly member of SPA Executive Committee
Royal Astronomical Society - Member

Institute of Physics - Chartered Physicist
American Meteorological Society - Member

Professional Publications:

More than 80 significant communications . A partial list of journal articles follows:

Fox, N.J., Velli, M.C., Bale, S.D. et al., The Solar Probe Plus Mission: Humanity's First Visit to Our Star. Space Sci Rev (2016) 204: 7. doi:10.1007/s11214-015-0211-6

Fox, N. J., and D. J. McComas. Editorial: Topical Volume on Developing the Solar Probe Plus Mission, Space Science Reviews, Journal, DOI: 10.1007/s11214-016-0323-7, 2016

Bale, S.D., Goetz, K., Harvey, P.R. et al., The FIELDS Instrument Suite for Solar Probe Plus. Space Sci Rev (2016) 204: 49. doi:10.1007/s11214-016-0244-5

Kasper, J.C., Abiad, R., Austin, G. et al., Solar Wind Electrons Alphas and Protons (SWEAP) Investigation: Design of the Solar Wind and Coronal Plasma Instrument Suite for Solar Probe Plus, Space Sci Rev (2016) 204: 131. doi:10.1007/s11214-015-0206-3

McComas, D.J., Alexander, N., Angold, N. et al., Integrated Science Investigation of the Sun (ISIS): Design of the Energetic Particle Investigation. Space Sci Rev (2016) 204: 187. doi:10.1007/s11214-014-0059-1

Fox, N. J., and J. L. Burch. Preface to the Van Allen Probes Mission book, Space Science Reviews, Journal, DOI 10.1007/s11214-013-9997-2, 2013

D. Turney, A. Matiella Novak, K. Beisser, N.J. Fox, Radiation Belt Storm Probes (RBSP) Education and Public Outreach Program, Space Science Reviews Journal, DOI 10.1007/s11214-012-9945-6, 2013

Mauk, B.H., N.J. Fox, S.G. Kanekal, R.L. Kessel, D.G. Sibeck, A. Ukhorskiy, Science Objectives andRationale for the Radiation Belt Storm Probes Mission, Space Science Reviews Journal, DOI 10.1007/s11214-012-9908-y, 2012

R.L. Kessel, N.J. Fox, M. Weiss, The Radiation Belt Storm Probes (RBSP) and Space Weather, Space Science Reviews Journal, DOI 10.1007/s11214-012-9953-6, 2012

Mauk, B.H., and N.J. Fox. Electron radiation belts of the solar system, J. Geophys. Res., 115 (A12), doi:10.1029/2010JA015660 2010

Fox N. J., B. H. Mauk, J. B. Blake, Role of non-adiabatic processes in the creation of the outer radiation belts, Geophys. Res. Lett., 33, L18108, doi:10.1029/2006GL026598, 2006

Fox N.J., S.W.H. Cowley, J.A. Davies, R.A. Greenwald, M. Lester, M. Lockwood, H. Lühr. Observations of an expanding auroral bulge and current system far poleward of the main substorm electrojet, J. Geophys. Res., 106, 12845, 2001.

Brittnacher, M., J. Kang, G. Parks, R. Elsen, G. Germany, J. Spann, N. Fox, R. C. Puetter, and A. Yahil, Far-Ultraviolet Observations of the Neutral Comae of Comet Hale-Bopp (C/1995 01) Near Perihelion, Geophys. Res. Lett., 28(13), 2561–2564, 2001

Fox, N.J., M. Lockwood, S.W.H. Cowley, G. Enno, E. Friis-Christensen, R.A. Greenwald, M.R. Hairston, M. Lester, D.K. Milling, J.S. Murphree, M. Pinnock, and G.D. Reeves. A multipoint study of a substorm occurring on 7 December and its theoretical implications, Ann. Geophysicae, 17, 1369, 1999.

Fox, N.J., M. Peredo, and B.J. Thompson, Cradle to grave tracking of the January 6-11, 1997 Sun-Earth connections event, Geophys. Res. Lett., 25, 2461, 1998.

Peredo, M., Fox, N. J., and Thompson, B. J., Scientists track solar event all the way to Earth, EOS

Transactions of the American Geophysical Union, 78, 447, 1997
Fox N.J., M. Lockwood, S.W.H. Cowley, M.P. Freeman, E. Friis-Christensen, D.K. Milling, M. Pinnock, and G.D. Reeves. EISCAT observations of unusual flows in the morning sector associated with weak substorm activity, Ann. Geophys., 12, 541, 1994.

Additional Information:
AWARDS/FELLOWSHIPS
National Aeronautics and Space Administration (NASA), Silver Medal Team Award, 2019 Parker Solar Probe
National Aeronautics and Space Administration (NASA), Group Achievement Award, 2014 Van Allen Probes Mission
National Aeronautics and Space Administration (NASA), Group Achievement Award, 2004 Sun-Earth Day
National Aeronautics and Space Administration (NASA), Group Achievement Award, 1998
International Solar Terrestrial Physics Mission Johns Hopkins Applied Physics Laboratory, Publication Award, 2017 - Outstanding Special Publications: The Solar Probe Plus Mission: Humanity's First Visit to Our Star.
Johns Hopkins Applied Physics Laboratory, Publication Award 2017 - Walter G. Berl Award: Van Allen Probes Mission Overview and Discoveries to Date
Johns Hopkins Applied Physics Laboratory, Publication Award, 2014 - Outstanding Special Publications: "The Van Allen Probes Mission"
USA National Research Council, Resident Research Fellow, 1995
Research fellowship at NASA/Goddard Space Flight Center
European Geophysical Society, Outstanding Young Scientist Award, 1995
European Geophysical Society, Outstanding Young Scientist Award, 1993

HONORS
ISTP Outstanding Performance Award, 1997
Associate Editor for Geophysical Research Letters, 1997–2004
Associate Editor for Journal of Atmospheric & Solar Terrestrial Physics, 2000–2005
Member of the AGU SPA Education committee, 2001-2003
Communicator Award, 2006
Associate Editor for EOS, 2010-2018
Member of the AGU SPA Executive Committee, 2010-2018
Editor for the Van Allen Probes Mission Book, 2012-2013
Editor for the Solar Probe Plus Mission Book, 2015-2016

Selected Invited Presentations:
"The Sun in the 21st Century": NASA evening for VIP guests at the National Air and Space Museum, hosted by Dr. Daniel Goldin (NASA Administrator 1992-2001), September 5, 2001
"Science for Alaska: Sun Earth Connections": public lectures in Anchorage and Fairbanks with Shannon Lucid (astronaut and NASA Chief Scientist 2002-2003), February 2003
"A Solar Cycle in Solar-Terrestrial Relations": A symposium to mark the retirement of the director of Space Sciences at NASA/GSFC, July 7, 2004

Radiation Belt Storm Probes: launch events at NASA/KSC, August 2012
TEDx presentation, Johns Hopkins University, March 2017
Parker Solar Probe renaming ceremony, May 2017
Maryland Space Business Roundtable luncheon keynote speaker, September 2017, May 2019
“Parker Solar Probe: A NASA mission to touch the Sun”, SXSW (South by South West), Spring 2018
Parker Solar Probe: Launch events at NASA/KSC, July-August 2018
Rice University Public Lecture, March 2019
Amazon MARS keynote speaker, March 2019
Space Weather Workshop dinner speaker, April 2019
Pass the Torch lecture at US Space & Rocket Center, Huntsville, September 2019
USA-Canada Space Day, Calgary, October 2019

Selected TV appearances:
"Equinox: Sun Storms" (1997) on Channel 4 (UK) and Discovery Channel (USA),
Cosmic Storms (for National Geographic, 1997),
Live from the Sun 1-3 (1999-2000) and Live from the Aurora (2003),
NASA Connect 'Dancing in the Night Sky' (2003),
SciFiles 'The Case of the Technical Knockout' Episode 504 (2005),
“The Sun in 3-D” IMAX (2007),
NIA VODcast “Space Weather'” (2008),
Naked Science (2008),
“Data Into Dance - Dance of the Auroras - Fire in the Sky” (2008/9)
NASA Sun Earth Day webcast and podcast interviews (2010)
National Geographic at 125 (2013)
Discovery Channel: Dark Side of the Sun (2017)
Eclipse across America: NASA TV (2017)
National Geographic: “Mission to the Sun” (2019)