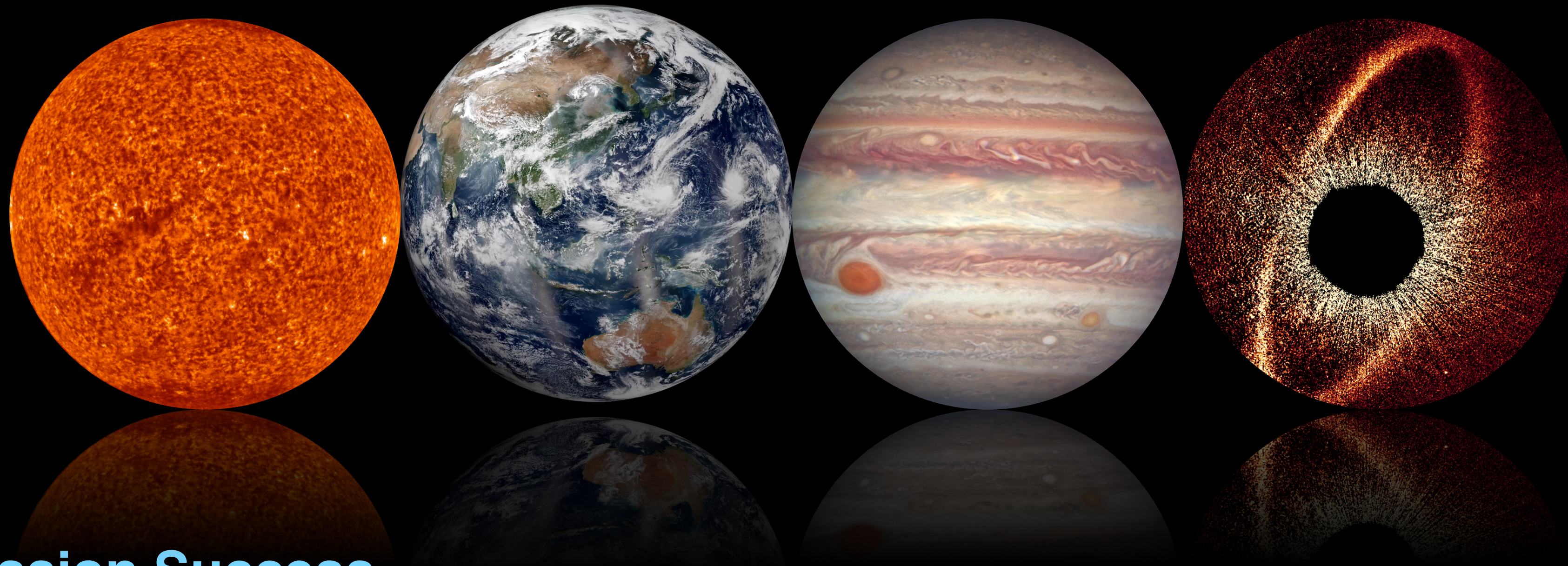


# Science at GSFC



**Road to Mission Success**

**Dr. Mark Clampin**

**Director**

**Sciences & Exploration Directorate**

**Goddard Space Flight Center**

# Goddard Space Flight Center

**Greenbelt  
Main Campus  
1,270 Acres**

**Wallops Flight Facility  
6,188 Acres**

**Goddard Institute for Space  
Studies**

**Independent Validation &  
Verification Facility**

**White Sands Complex**

**Columbia  
Scientific Balloon  
Facility**

**Executing NASA's most complex  
science missions**

Est. 1959



**MARYLAND**

**Launching Payloads for NASA &  
the Nation**

Est. 1945



**VIRGINIA**

**Understanding our Planet**

Est. 1961



**NEW YORK**

**Providing Software Assurance**

Est. 1993



**WEST VIRGINIA**

**Communicating with Assets in  
Earth's Orbit**

Est. 1963



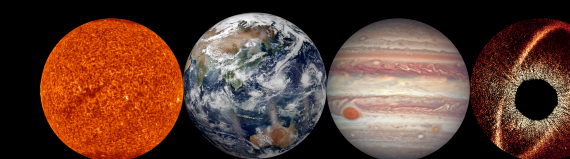
**NEW MEXICO**

**Directing High Altitude  
Investigations**

Est. 1982



**TEXAS**



# Sciences and Exploration Directorate

- Largest Earth and Space Science Research organization in the world
- Three locations:

**Greenbelt**



**Wallops Flight Facility**



**Goddard Inst. for Space Studies**



543 Civil servants including ~400 Scientists  
~600 Co-located Post-Docs and University Scientists  
~1,500 Support Contractors, Visitors, Students, Emeritus, etc.

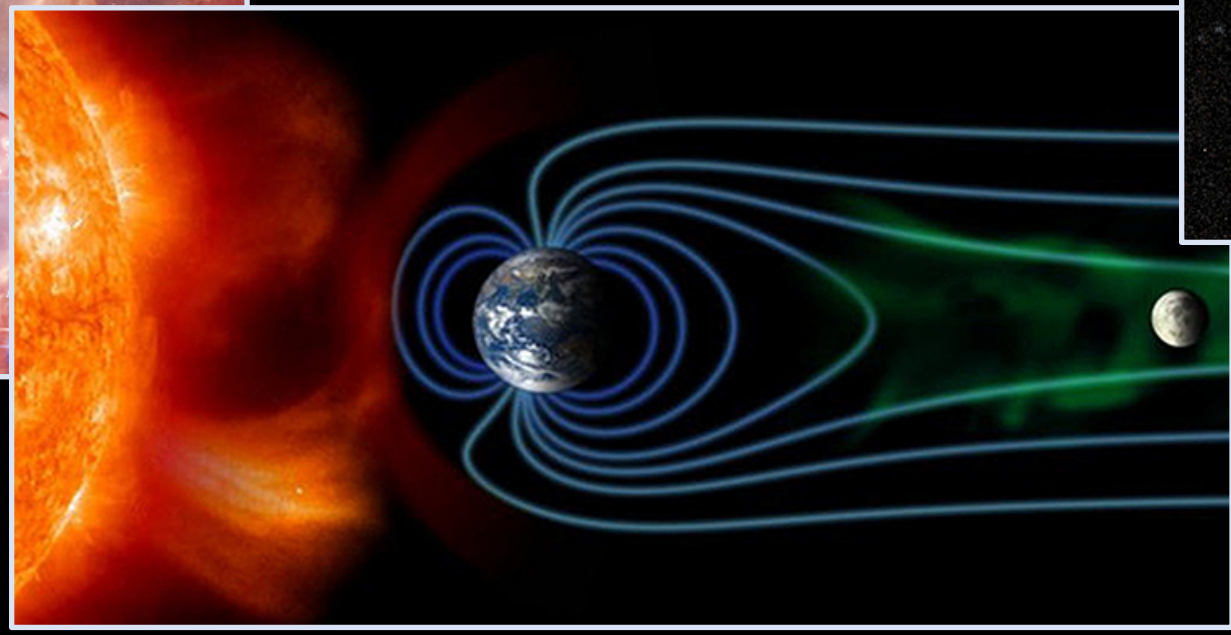


# Goddard Space Flight Center

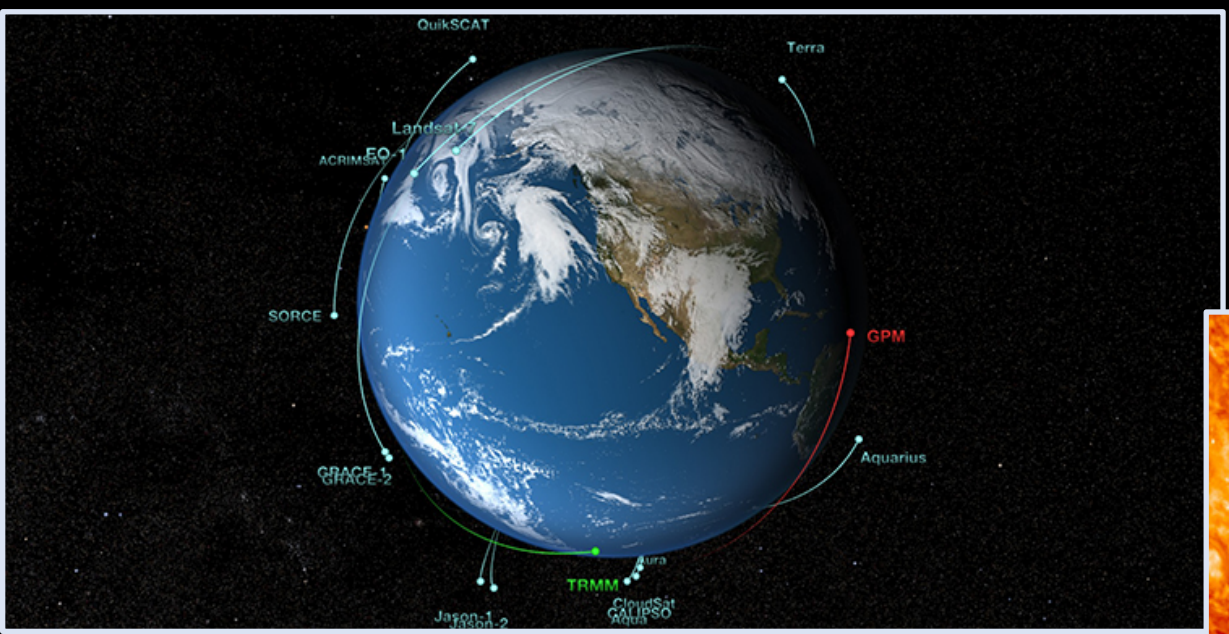
## Astrophysics



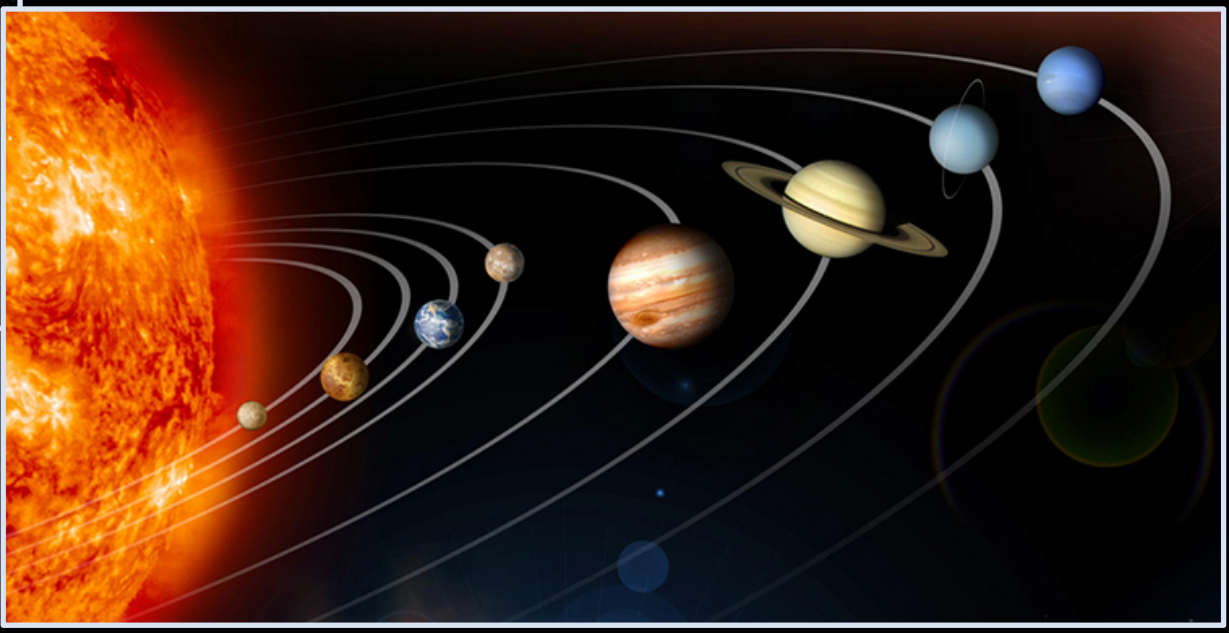
## Heliophysics



## Earth Science



## Planetary & Lunar Science



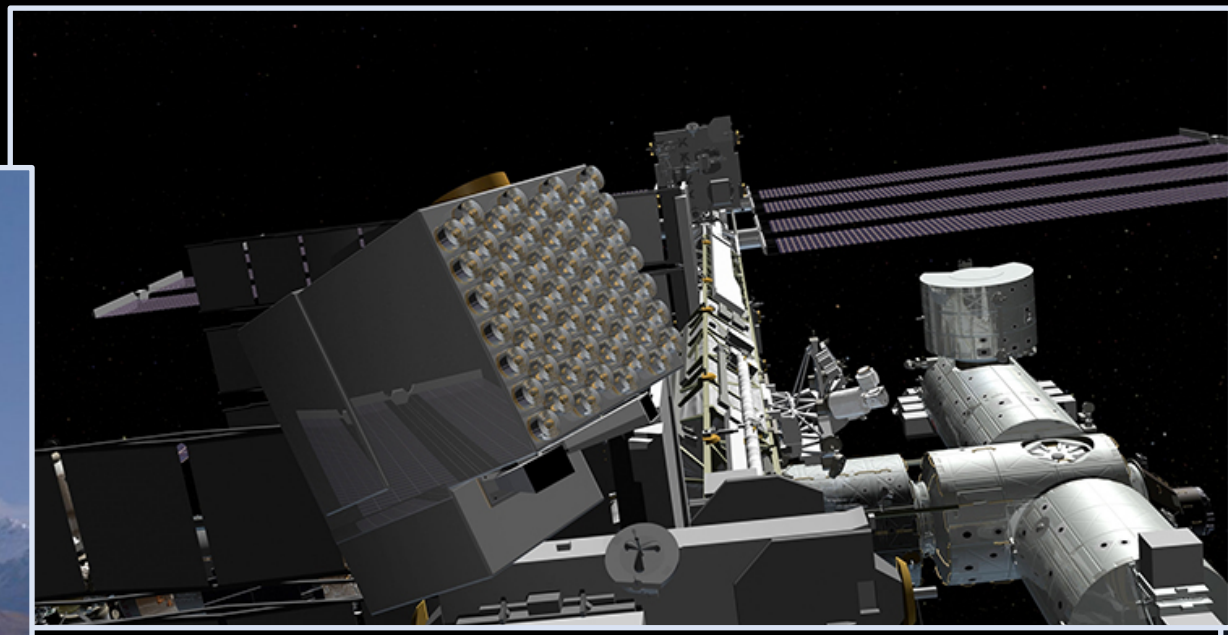
## Human Exploration & Operations



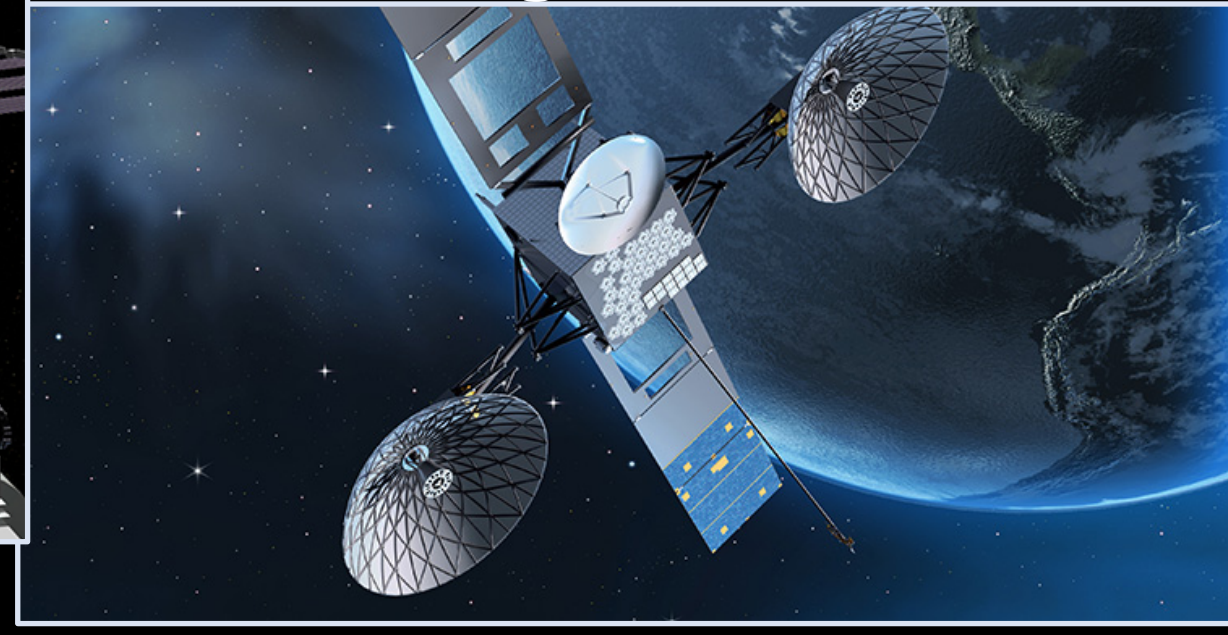
## Suborbital Platforms



## Cross Cutting Technology And Capabilities



## Communications & Navigation



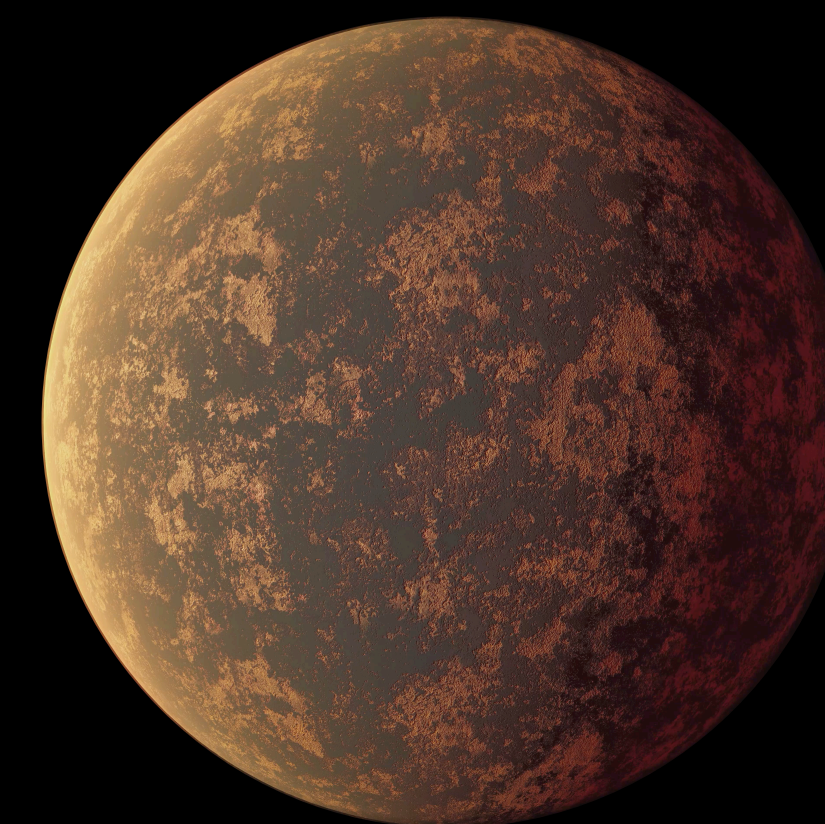
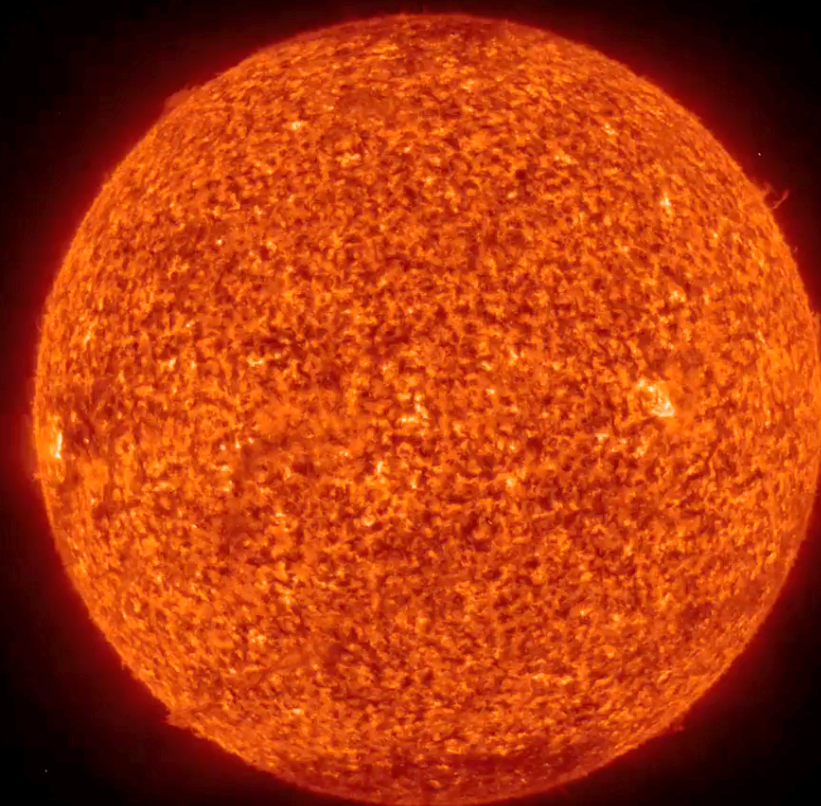
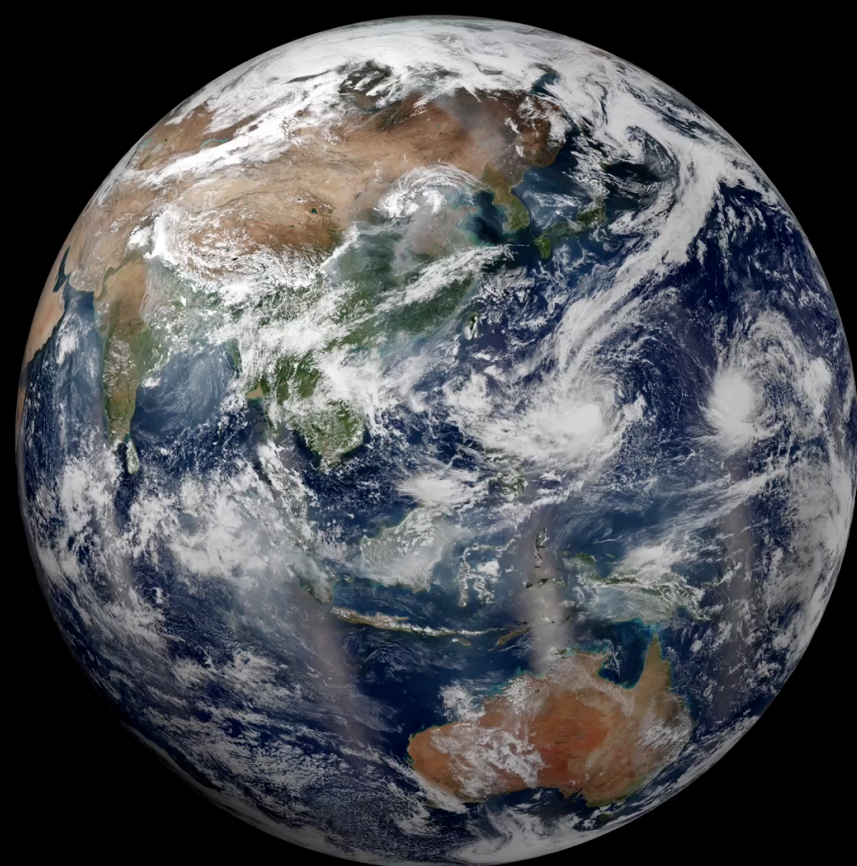
# NASA SMD/SED Crosscutting Science Themes

EXPLORE EARTH

EXPLORE HELIOPHYSICS

EXPLORE SOLAR SYSTEM

EXPLORE ASTROPHYSICS



---

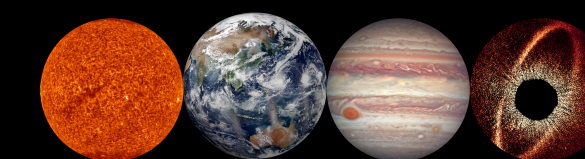
**Safeguarding and Improving  
Life on Earth**

---

**Searching for Life  
Elsewhere**

---

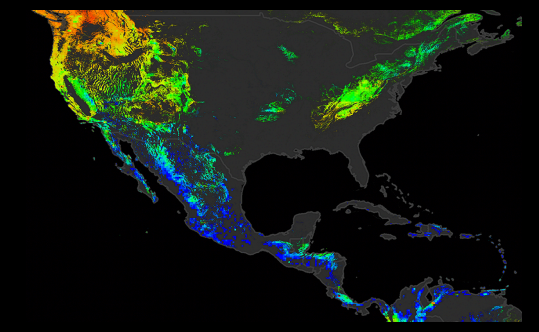
**Expanding our  
Knowledge**



# Earth Science Applications



From Space to Society:  
**Applied Sciences at NASA Goddard**



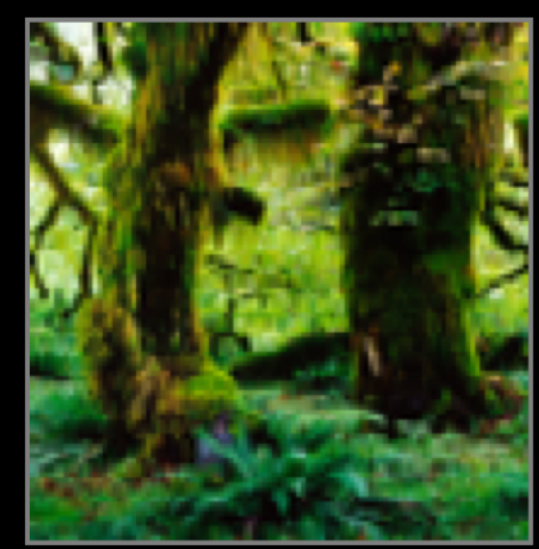
## Current focus areas and programs



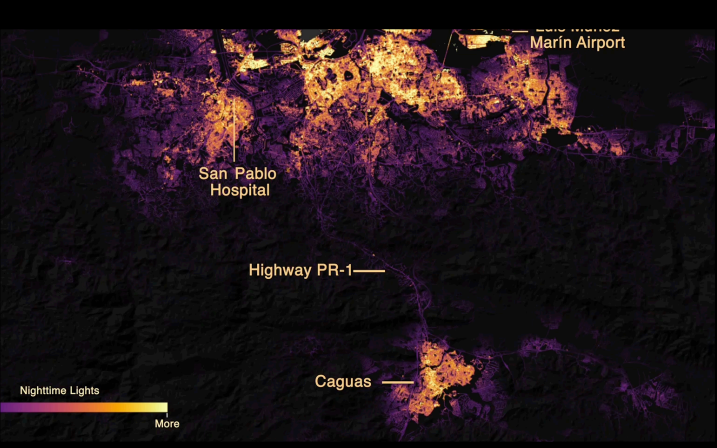
**Health &  
Air Quality**



**Water  
Resources**



**Ecological  
Forecasting**

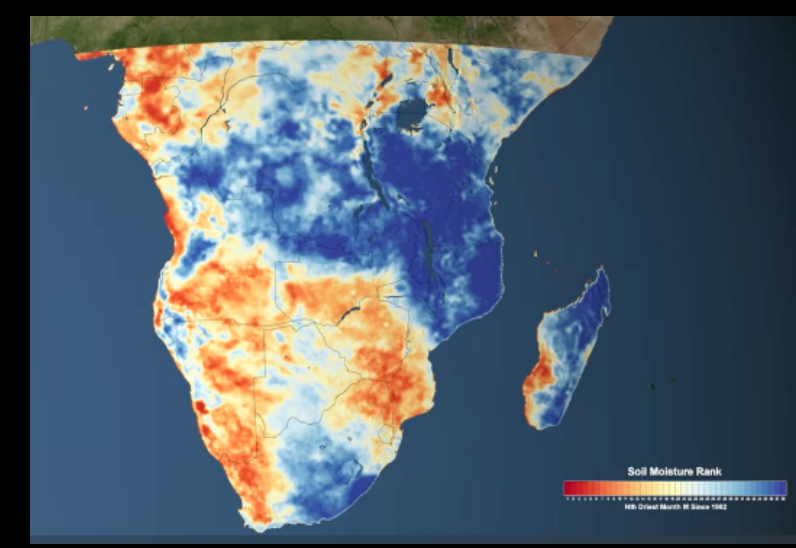


**Disasters**



**Capacity Building**

## Multidisciplinary areas



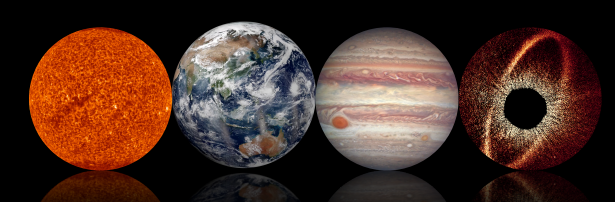
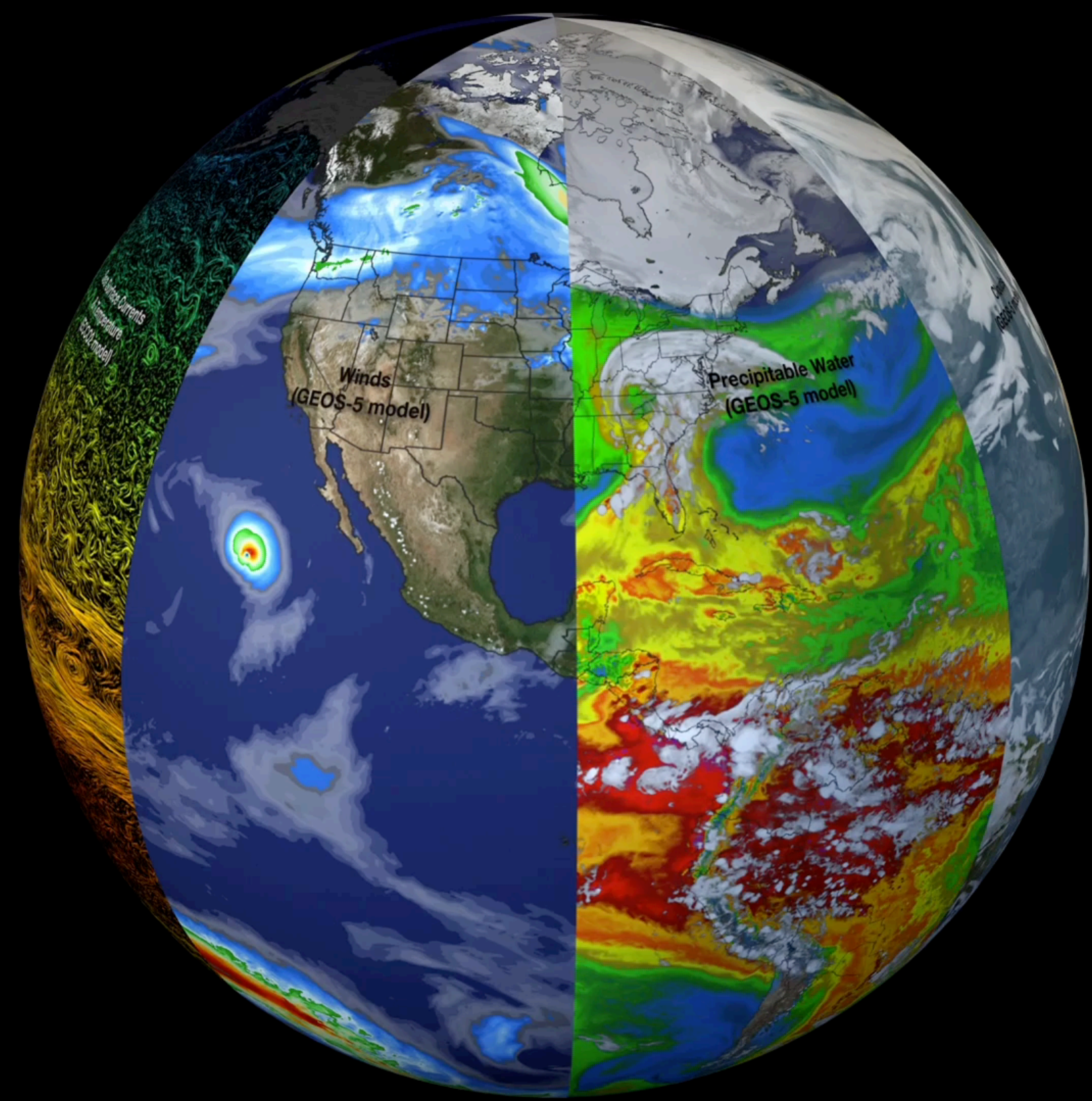
**Agriculture / Food Security**



**Energy**



**Transportation**



# Decadal Survey Process

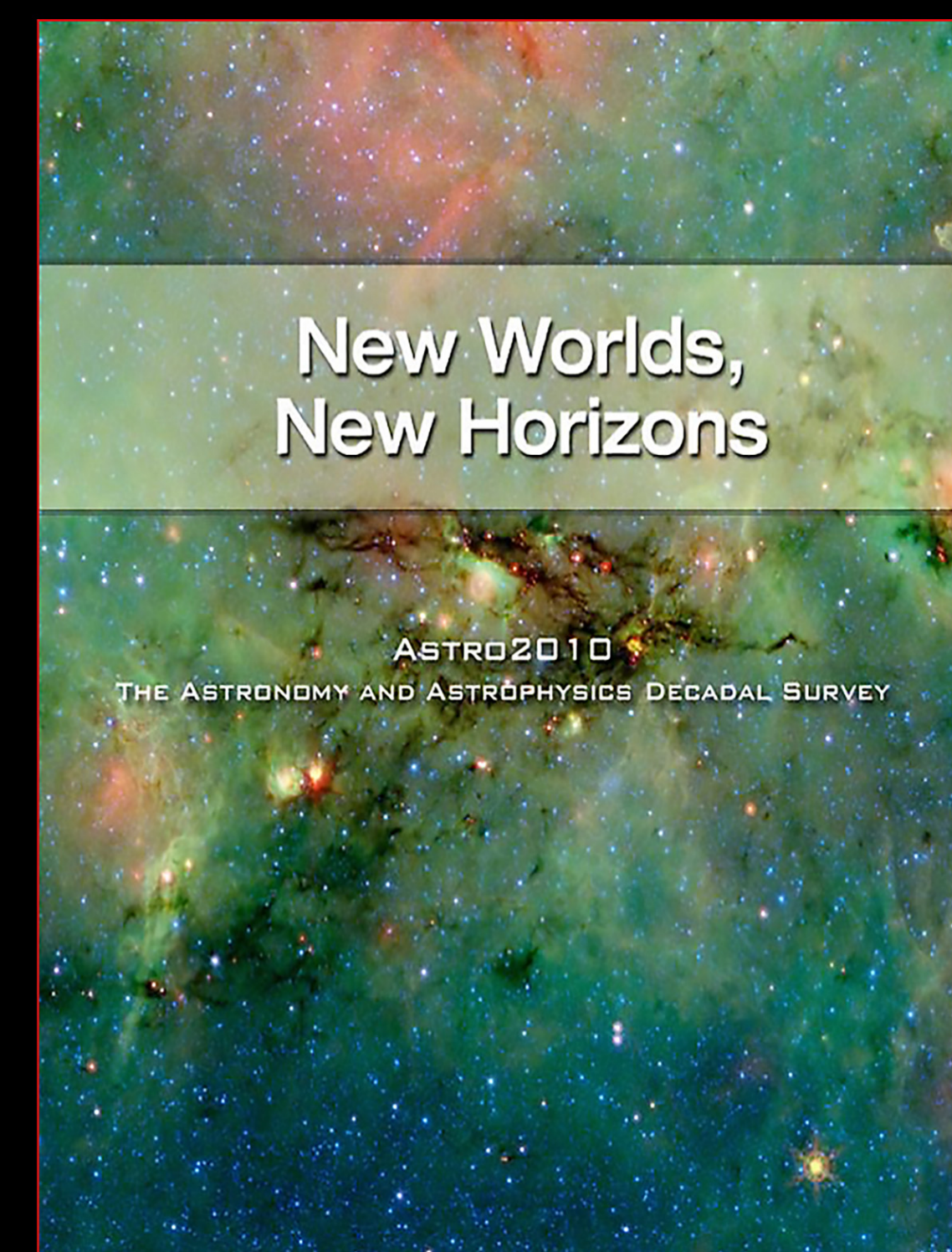
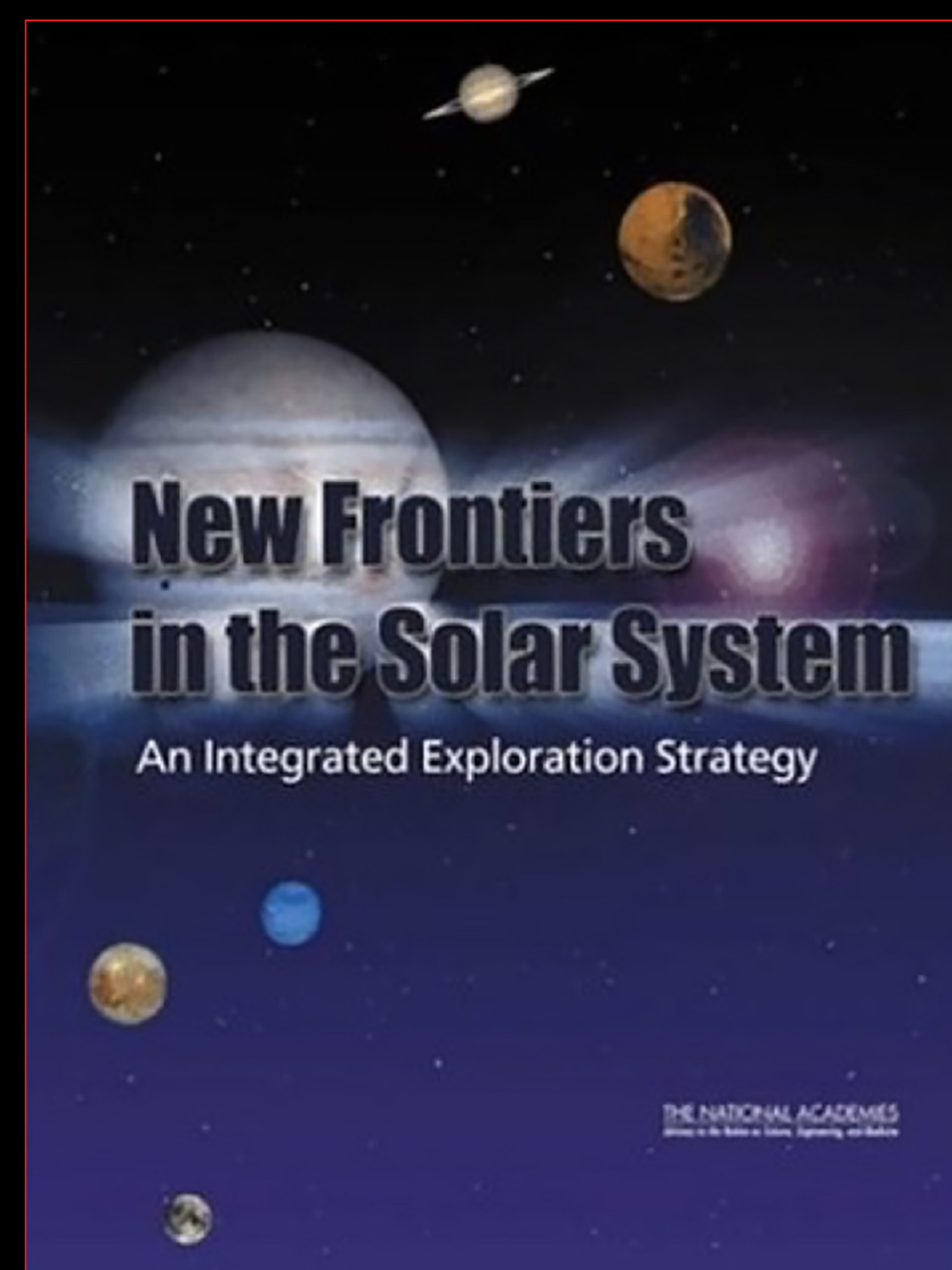
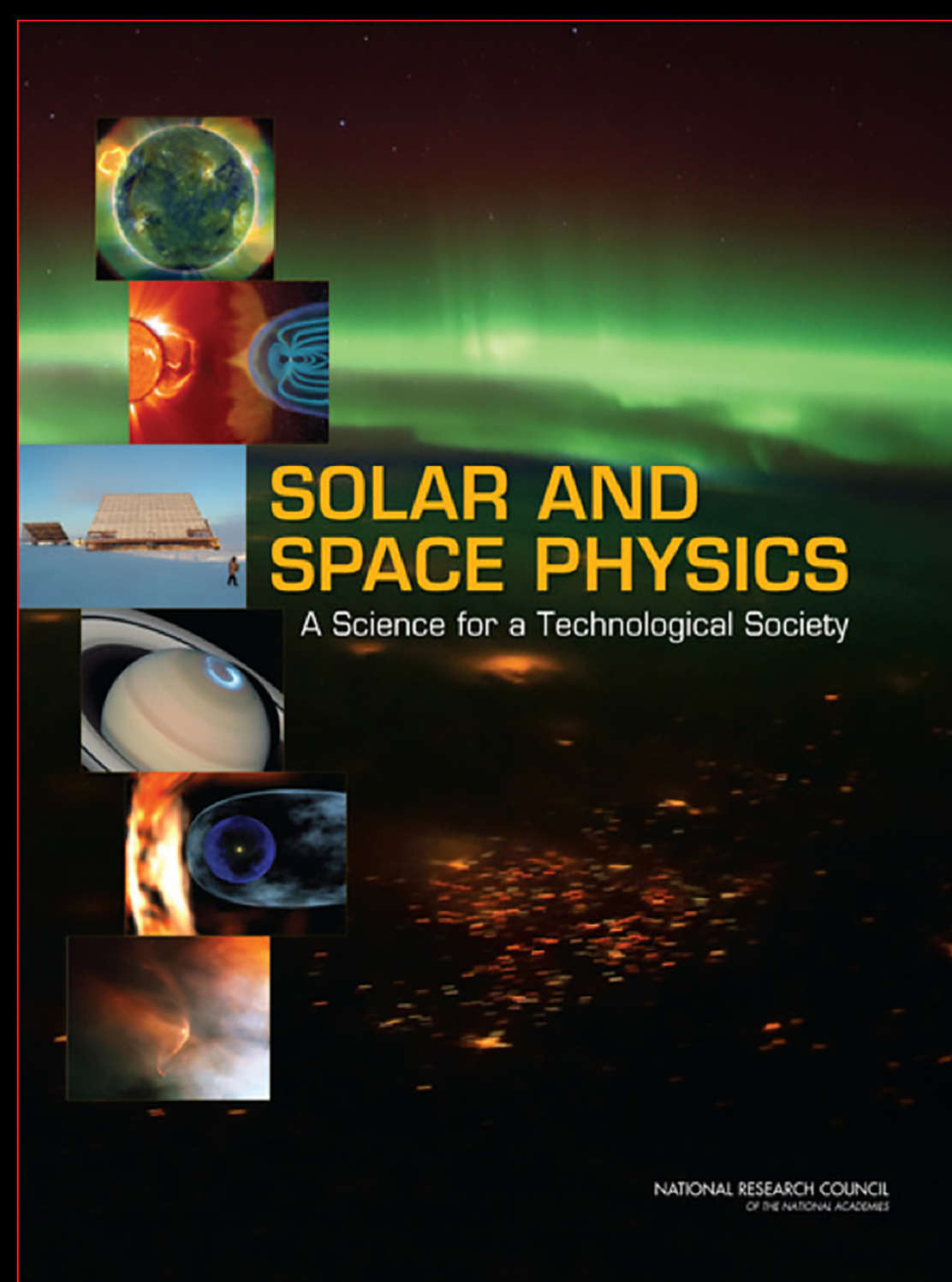
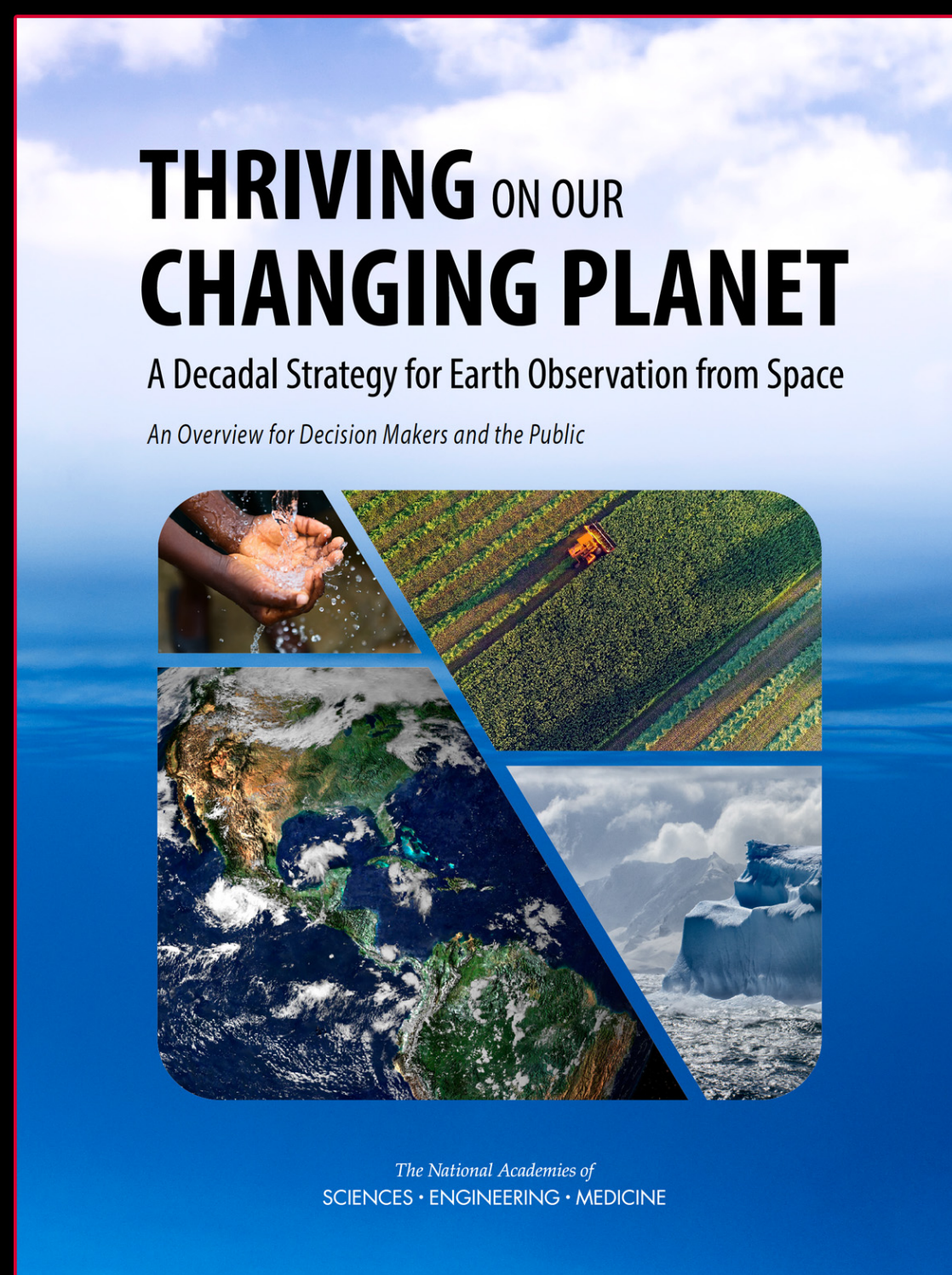
EARTH SCIENCE

HELIOPHYSICS

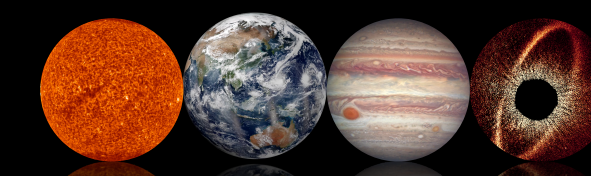
SOLAR SYSTEM

ASTROPHYSICS

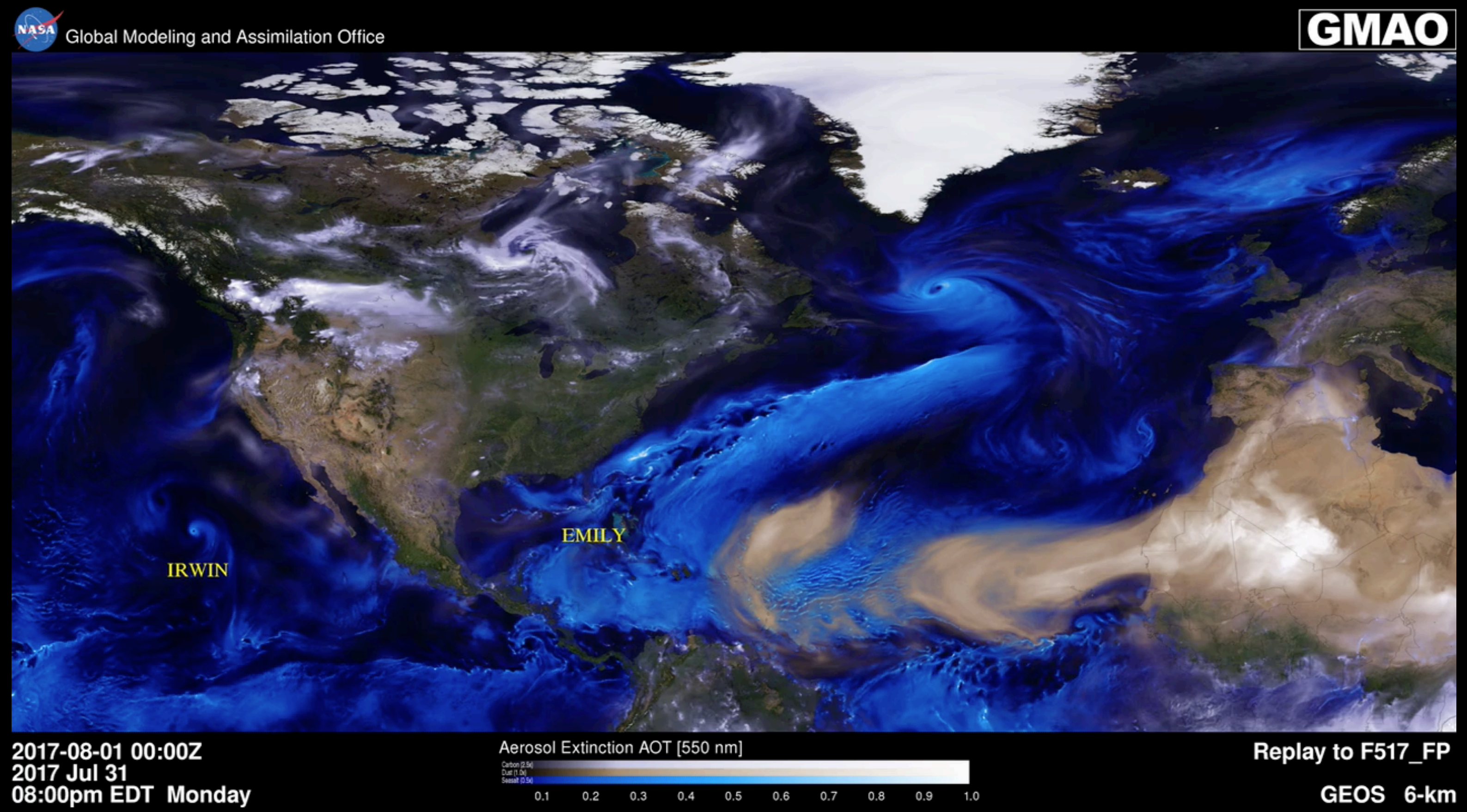
Strategic science is prioritized by the National Academies every 10 years through a Decadal Survey process.



- Strategic science is prioritized by the National Academies



# Earth Science



How does the Earth work? Atmosphere, ice, oceans, land, humans....

How do we humans impact the climate?

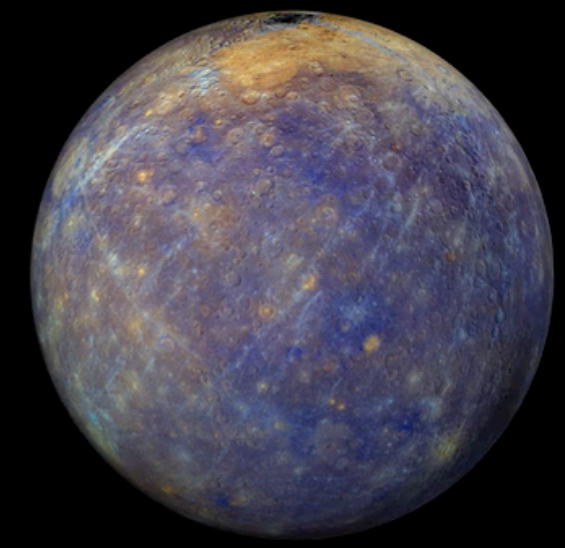
How will the Earth's climate evolve in the future?





# Planetary Science

**Mercury**  
Messenger  
2011



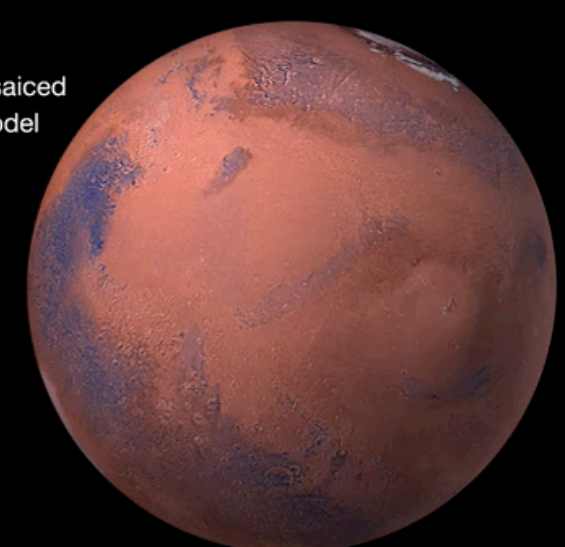
**Venus**  
Magellan  
1990-1992



**Earth**  
S-NPP VIIRS  
2015



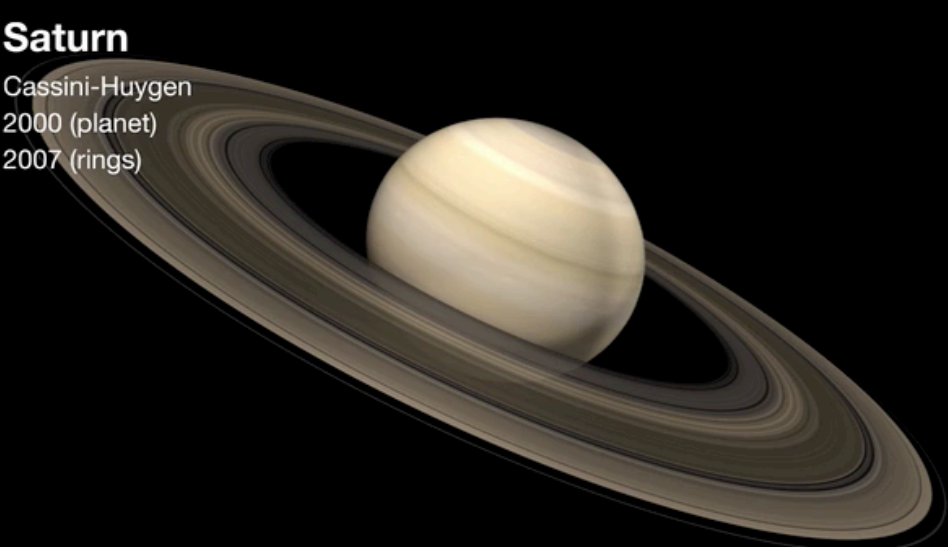
**Mars**  
Viking/Mars Mosaiced  
Digital Image Model  
(MDIM)  
1975/2014



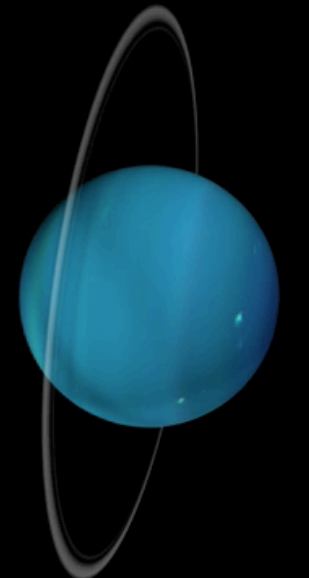
**Jupiter**  
Hubble Space  
Telescope  
2015



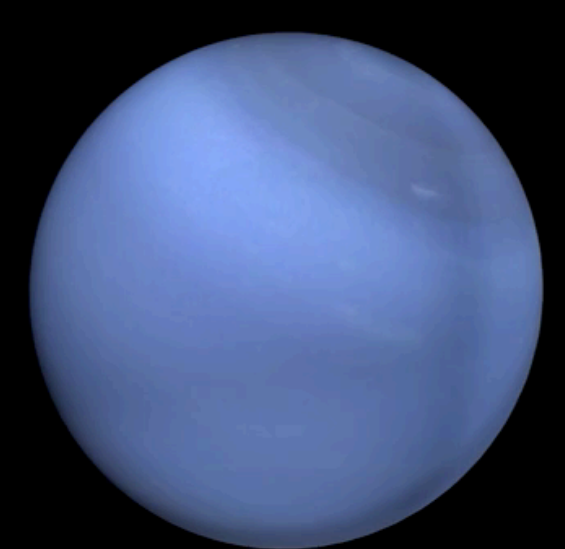
**Saturn**  
Cassini-Huygen  
2000 (planet)  
2007 (rings)



**Uranus**  
W.M. Keck Observatory  
2004



**Neptune**  
Voyager  
1989



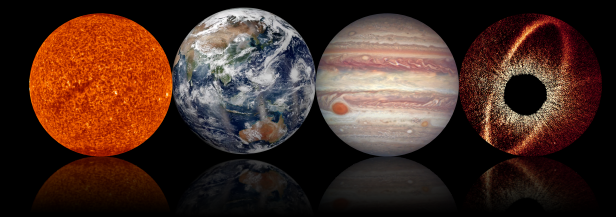
**Pluto**  
New Horizons  
2015

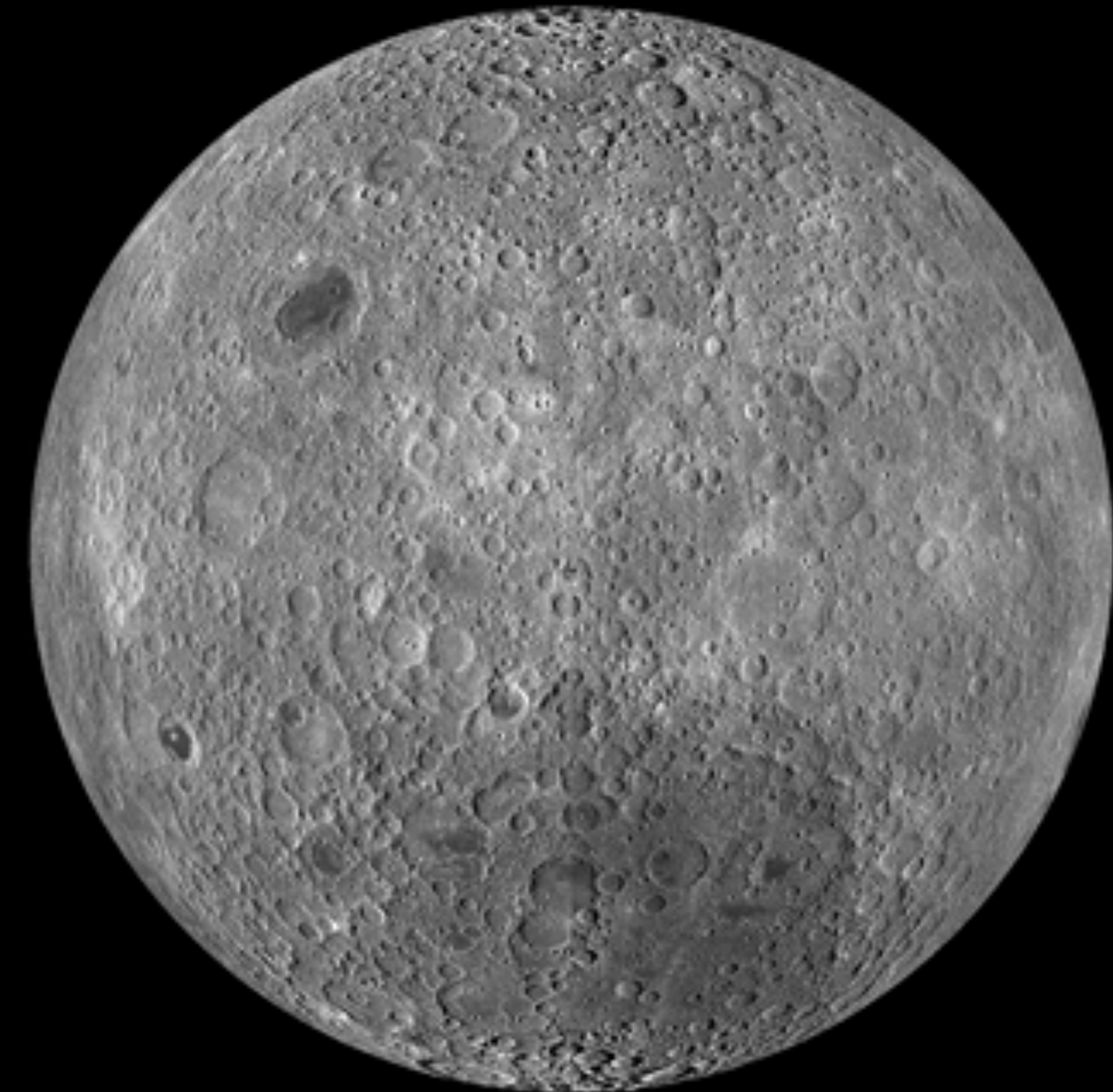


How did our solar system form and evolve?

Can we find evidence of life elsewhere in the solar system?

What are the different environments and processes in our solar system?





## Lunar studies relevant to future human exploration

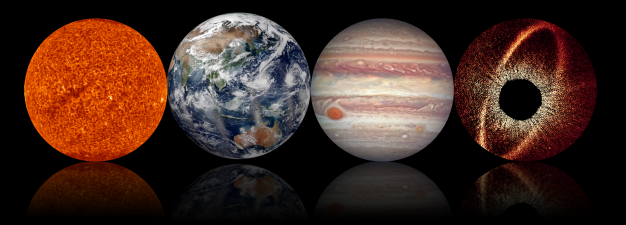
- Lunar Reconnaissance Orbiter Data Characterizing Past and Future Landing Sites (Petro)
- Space plasma-surface interactions at the Moon and other airless bodies (Farrell and the SSERVI DREAM team)
- Astronaut training in collaboration with JSC (Bleacher, Young)
- Meteor impacts from LADEE NMS (Benna)

# Astrophysics

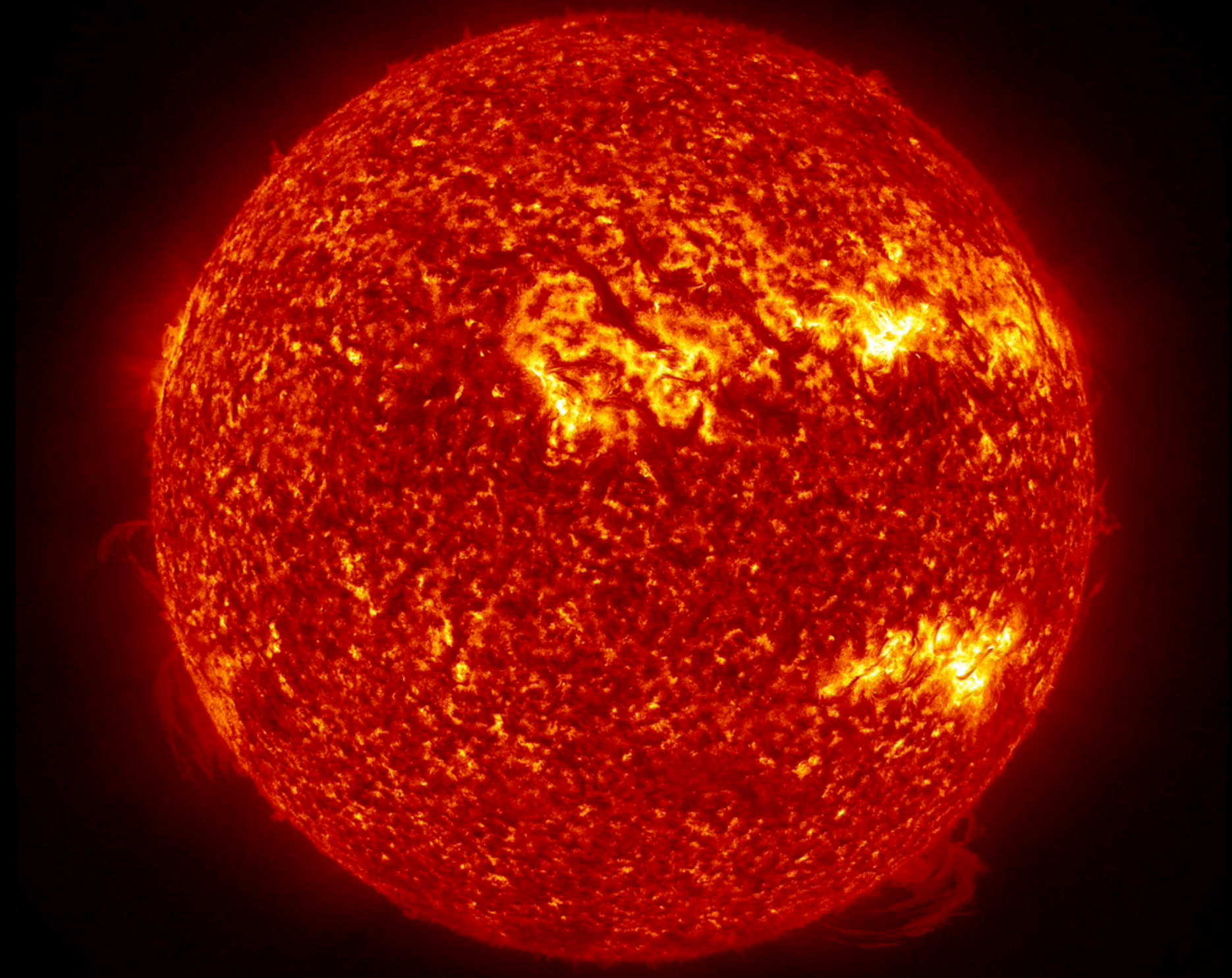
**How does the universe work?**

**Where did we come from?**

**Are we alone?**



# Heliophysics

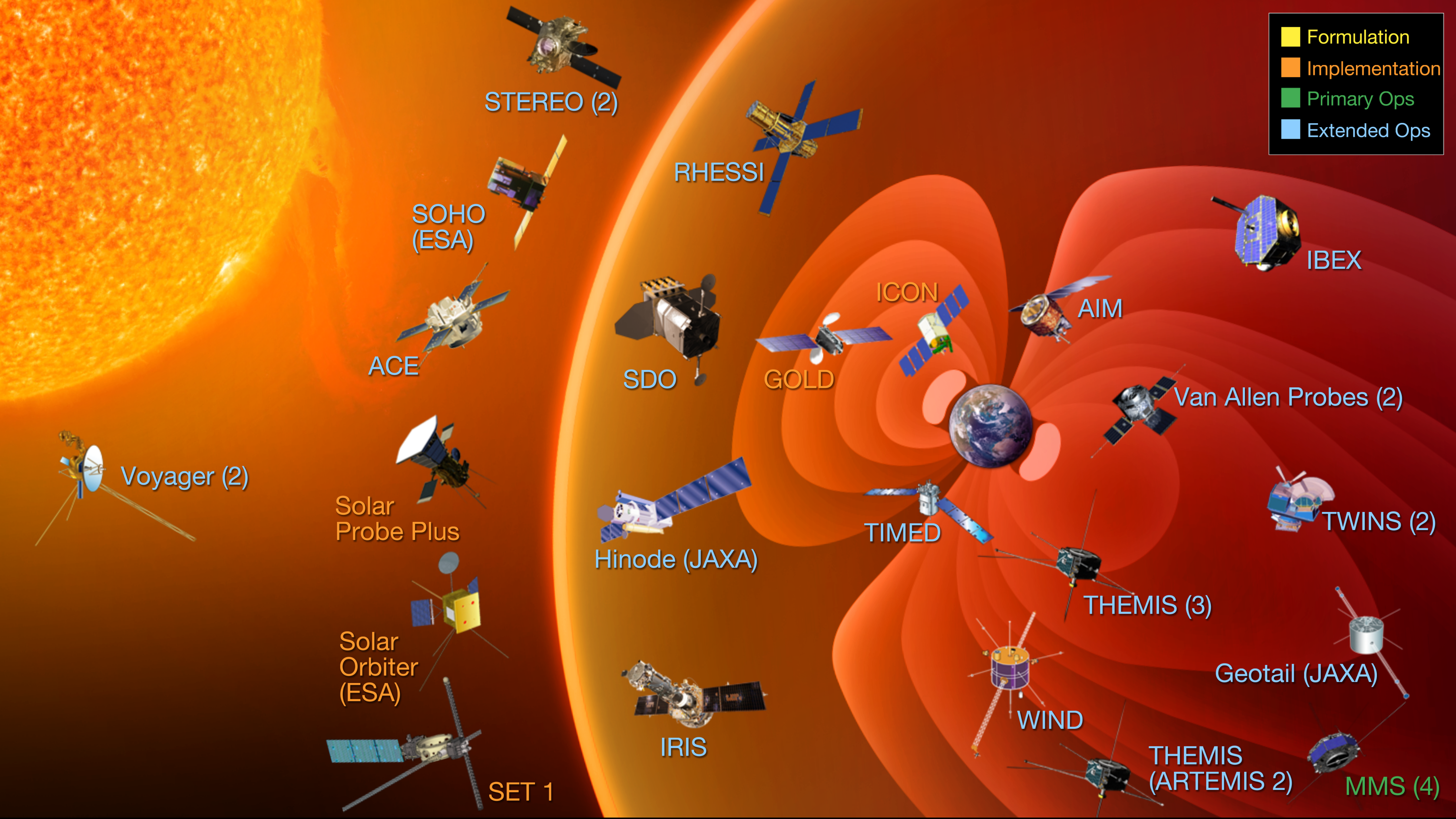


How does the sun work?

When does space harm us?

How to live within a star's atmosphere?





- Formulation
- Implementation
- Primary Ops
- Extended Ops

STEREO (2)

RHESSI

SOHO (ESA)

ACE

SDO

GOLD

ICON

AIM

IBEX

Voyager (2)

Solar Probe Plus

Hinode (JAXA)

TIMED

Van Allen Probes (2)

TWINS (2)

Solar Orbiter (ESA)

THEMIS (3)

Geotail (JAXA)

IRIS

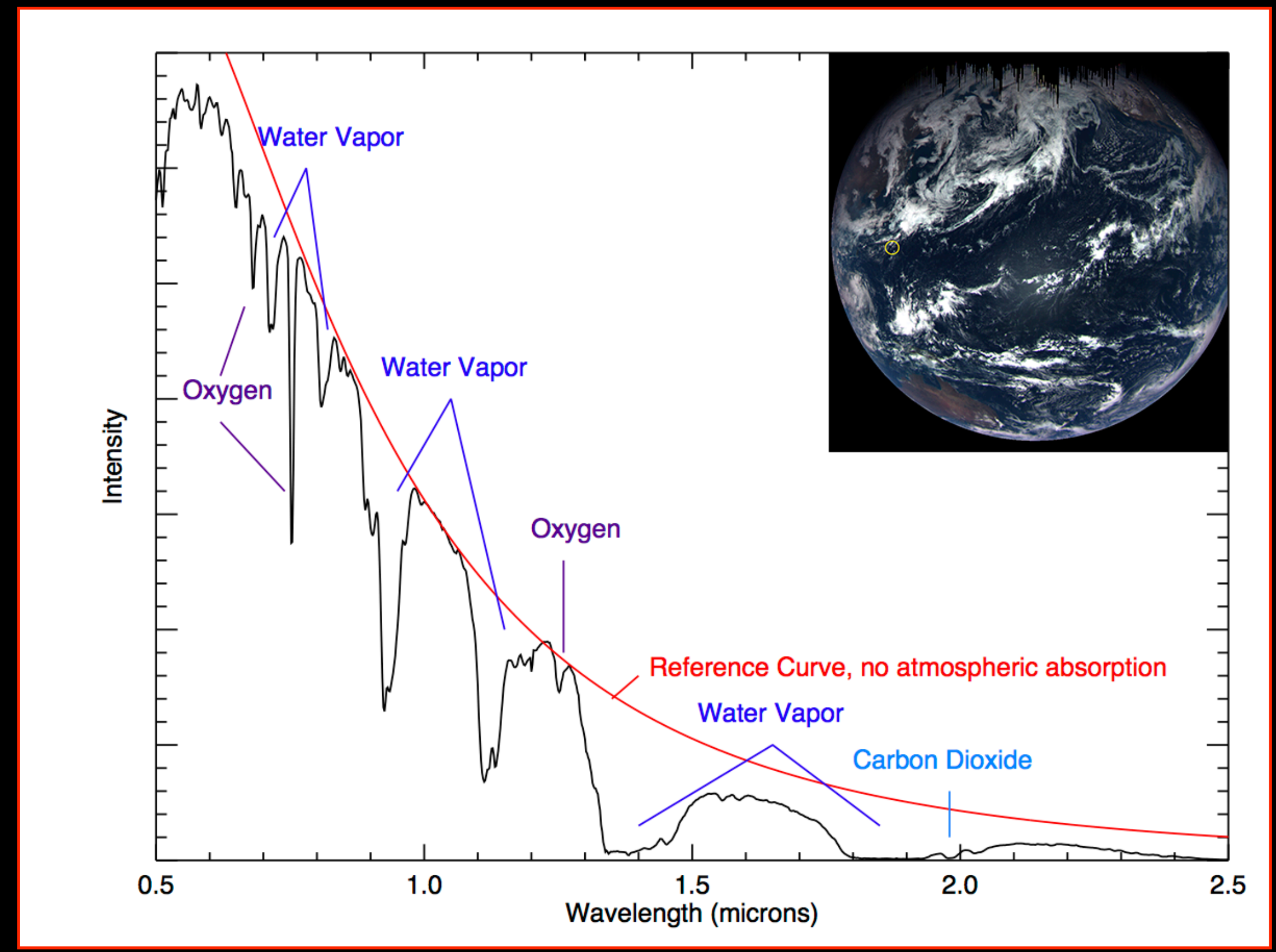
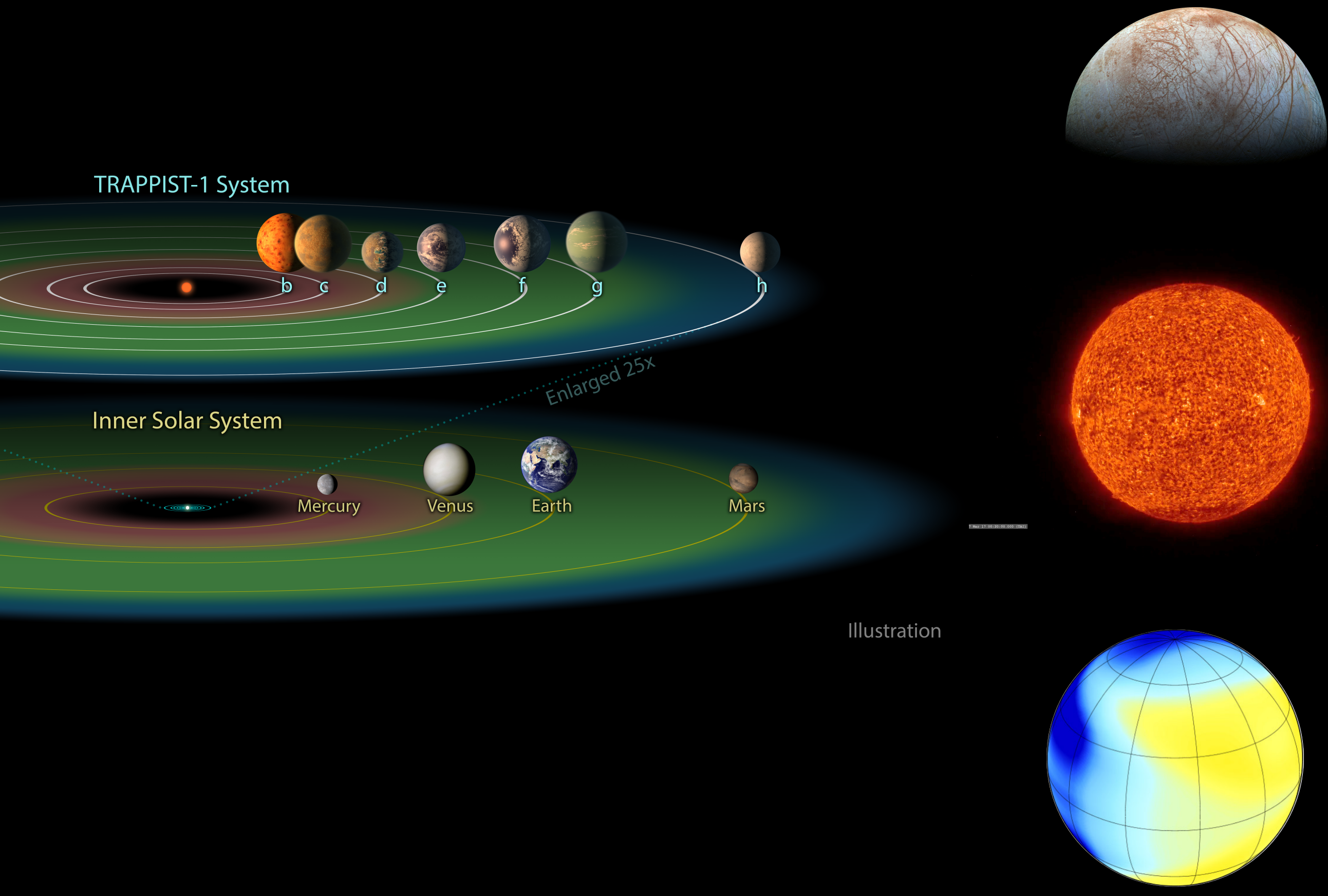
WIND

THEMIS (ARTEMIS 2)

MMS (4)

SET 1

# Interdisciplinary Science



Habitability of exoplanets

**nature**  
THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

**JUPITER REVISITED**  
Juno mission offers a fresh perspective on the gas giant  
PAGES 168, 216, 220, 223 & 227

**OUTLOOK**  
The coming month

**FEATURE**  
FLOOD WARNING  
Rising sea levels raise risk of extreme events  
PAGE 116

**PEER REVIEW**  
The reputational judgments that drive evolution  
PAGE 119 & 122

**FLYING HIGH**  
How mountain shape and diversity  
PAGE 117 & 120

**NATURE.COM/NEWS**  
8 March 2018  
ISSN 1472-0025

**Science**  
26 MAY 2017  
sciencemag.org

**UNCOVERING JUPITER**  
Juno sees the gas giant from new angles  
pp. 822 & 831

**OUTLOOK**  
The coming month

**FEATURE**  
FLOOD WARNING  
Rising sea levels raise risk of extreme events  
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**NATURE.COM/NEWS**  
8 March 2018  
ISSN 1472-0025

**Geophysical Research Letters**  
AN AGU JOURNAL

Volume 44, Issue 4, 28 March 2017, Pages 2151-2166

**AGU PUBLICATIONS** **WILEY**

ISSN 1531-1074  
Volume 16, Number 11 November 2016

**Astrobiology**

Mary Ann Liebert, Inc., publishers  
www.liebertpub.com/ast

**JOURNAL OF GEOPHYSICAL RESEARCH**  
**Space Physics**  
AN AGU JOURNAL

Volume 121, Issue 11, November 2016, Pages 10,661-11,584

**JGR**

STEREO-A COR1  
2008-06-02-00:00:5.18UT  
ARMS  
t = 174 hrs

**AGU PUBLICATIONS** **WILEY**

ISSN 1364-502X | Volume 374 | Issue 2005 | 13 April 2016

**PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A**  
MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES

Adaptive data analysis: theory and applications  
Theme issue compiled and edited by Norden E. Huang, Ingrid Daubechies and Thomas Y. Hou

**THE ROYAL SOCIETY PUBLISHING**

**JOURNAL OF VOLCANOLOGY AND GEOTHERMAL RESEARCH**

Special Issue  
Patterns in Process: Remotely Sensed Observations of Volcanic Deposits and Their Implications for Surface Processes  
Loren Wilson (Overseas Editor)  
Shankar Prasad, Laura Kerber and Patrick Shelley (Guest Editors)

AN INTERNATIONAL RESEARCH JOURNAL WITH FOCUS ON VOLCANIC AND GEOTHERMAL PROCESSES AND THEIR IMPACT ON THE ENVIRONMENT AND SOCIETY

**ELSEVIER**

**nature**  
THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

**JUPITER REVISITED**  
Juno mission offers a fresh perspective on the gas giant  
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PAGE 117 & 120

**NATURE.COM/NEWS**  
8 March 2018  
ISSN 1472-0025

特別寄稿 宇宙の誕生の謎に迫る  
\*高エネルギー宇宙線コンドミニアムの発見とマルチメッセジャー宇宙粒子物理学への展望  
\*ランダムネスが誘発するフラストレーション電子の量子スピン液体

NO. 7  
2017 Vol. 72

**BUTSURI 日本物理学会誌**

The Quiescent Intracluster Medium in the Core of the Perseus Cluster Observed with Hitomi

**Water Resources Research**  
AN AGU JOURNAL

Volume 53, Issue 11, November 2017, Pages 8649-10002

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Making climate science more policy-relevant

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sciencemag.org

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How this crater got its rings  
pp. 438 & 447

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The world's best-selling astronomy magazine

**VENUS REVISITED**  
New missions set to untangle old mysteries  
p. 24

The hunt for stars' hidden fingerprints

**AND MORE!**  
100 brightest galaxies observed  
Astronomy's 7th annual Star Products  
Bob Berman on celestial dangers

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The European Physical Journal  
**EPJ C**  
Recognized by European Physical Society

volume 76, number 3, march, 2016

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**Springer**

Can tailored T cells kill solid tumors?  
Paradoxical refuge politics  
How dogs process human language

**Science**  
2 SEPTEMBER 2016  
sciencemag.org

**DAWN EXPLORES CERES**  
A dwarf planet made of rock and ice  
pp. 1003-1020

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MEET THE NEXT GENERATION SPACE TELESCOPE

**Astronomy**  
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**Gravitational waves breakthrough**  
A wrinkle in space-time confirms Einstein's theory

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35 favorite double stars  
How to view Mercury's rare transit  
10 tempting spring bino targets

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A PUBLICATION OF THE IEEE GEOSCIENCE AND REMOTE SENSING SOCIETY

SEPTEMBER 2016 VOLUME 54 NUMBER 9 IGRS02 (ISSN 0196-2892)

**IEEE**

**Astronomy**  
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**TOP 10 SPACE STORIES OF THE YEAR**

- New Horizons reveals Pluto close-up
- Rosetta zooms in on comet
- Youngest cluster of galaxies imaged
- A watery moon of Saturn exposed
- Closing in on dark matter

**AND MORE!**

A stellar gift-giver's guide  
Bob Berman on marketing the cosmos

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JANUARY 2017 VOLUME 55 NUMBER 1 IGRS02 (ISSN 0196-2892)

**IEEE**

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Earth & Space Science News

Radiation Belts in a Waning Solar Cycle

Urban Seismic Networks  
Fungal Burrows in Rocks  
Triggers of Geyser Eruptions

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Vol. 2, No. 4 | October-December 2016  
ISSN 2151-9124

**Journal of Astronomical Telescopes, Instruments, and Systems**

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**SPIE**

STALKING THE EBOLA VIRUS  
GANDHI'S LIVING LEGACY  
JULY 2016

**NATIONAL GEOGRAPHIC**

DESTINATION PLUTO  
FIRST LOOK AT THE DWARF PLANET

**TIME**

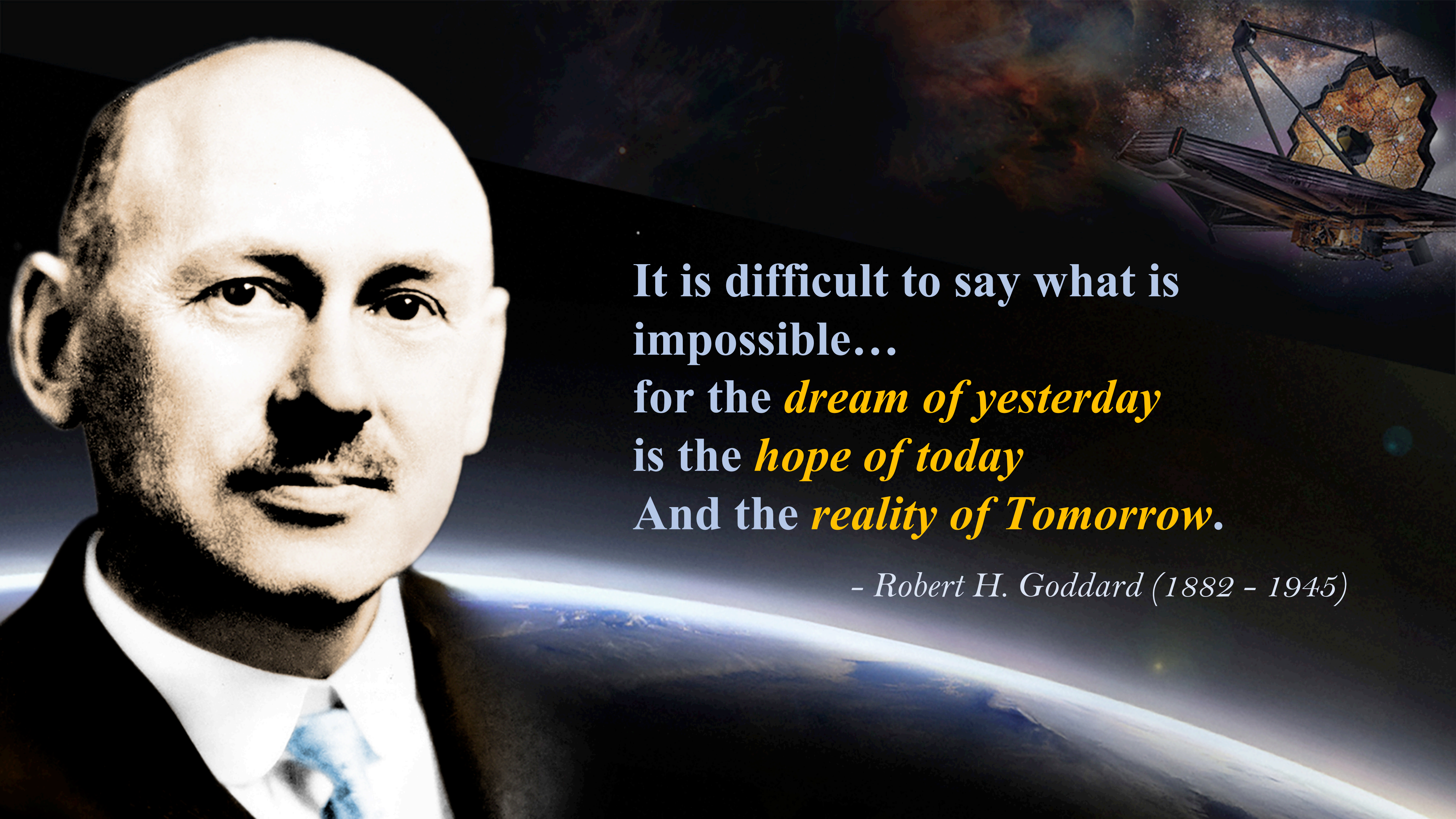
**Big Thaw**  
ANTARCTICA AND THE RAVAGES OF CLIMATE CHANGE  
Photographs by Paolo Pellegrin

A fertility company that defies the textbooks  
Multigenerational effects on development  
Microbial ecology and evolution

**Science**  
510 NOVEMBER 2015  
sciencemag.org

**MAVEN at Mars**  
Probing a dynamic upper atmosphere  
p. 643

**AGU**



It is difficult to say what is  
impossible...  
for the *dream of yesterday*  
is the *hope of today*  
And the *reality of Tomorrow.*

- Robert H. Goddard (1882 - 1945)