Outreach Committee

Lunar Science Workshop

Tempe, AZ

Feb. 27-March 2, 2007

Members of the Outreach Committee

Name	Location	NASA Area
Allen, Jaclyn	NASA-JSC	Planetary Protection
Collins, Eileen	Astronaut-JSC	Earth Sciences
Fortson, Lucy	Adler Planetarium	Astrophysics
Hauck, Rick	Astronaut-USN (Ret.)	Earth Sciences
Hynek, Brian	Univ. Colorado	Planetary Sciences
Klug, Sherri	Arizona State Univ.	Planetary Sciences
Kulcinski, Gerald	Univ. Wisconsin	Heliophysics
Milgram, Jim	Stanford Univ.	Astrophysics
Shipp, Stephanie	LPI	Planetary Sciences
Slavin, Jim	NASA-GSFC	Heliophysics

Format for Outreach Committee Report

- 1) Top 3 messages from the Workshop to the general public and scientific community.
- 2) Top 3 messages to the general public for each of the 5 thrust areas.
- 3) Top 3 messages to the scientific community for each of the 5 thrust areas.

Overall Messages to Scientific Community and the Public From the Lunar Science Workshop

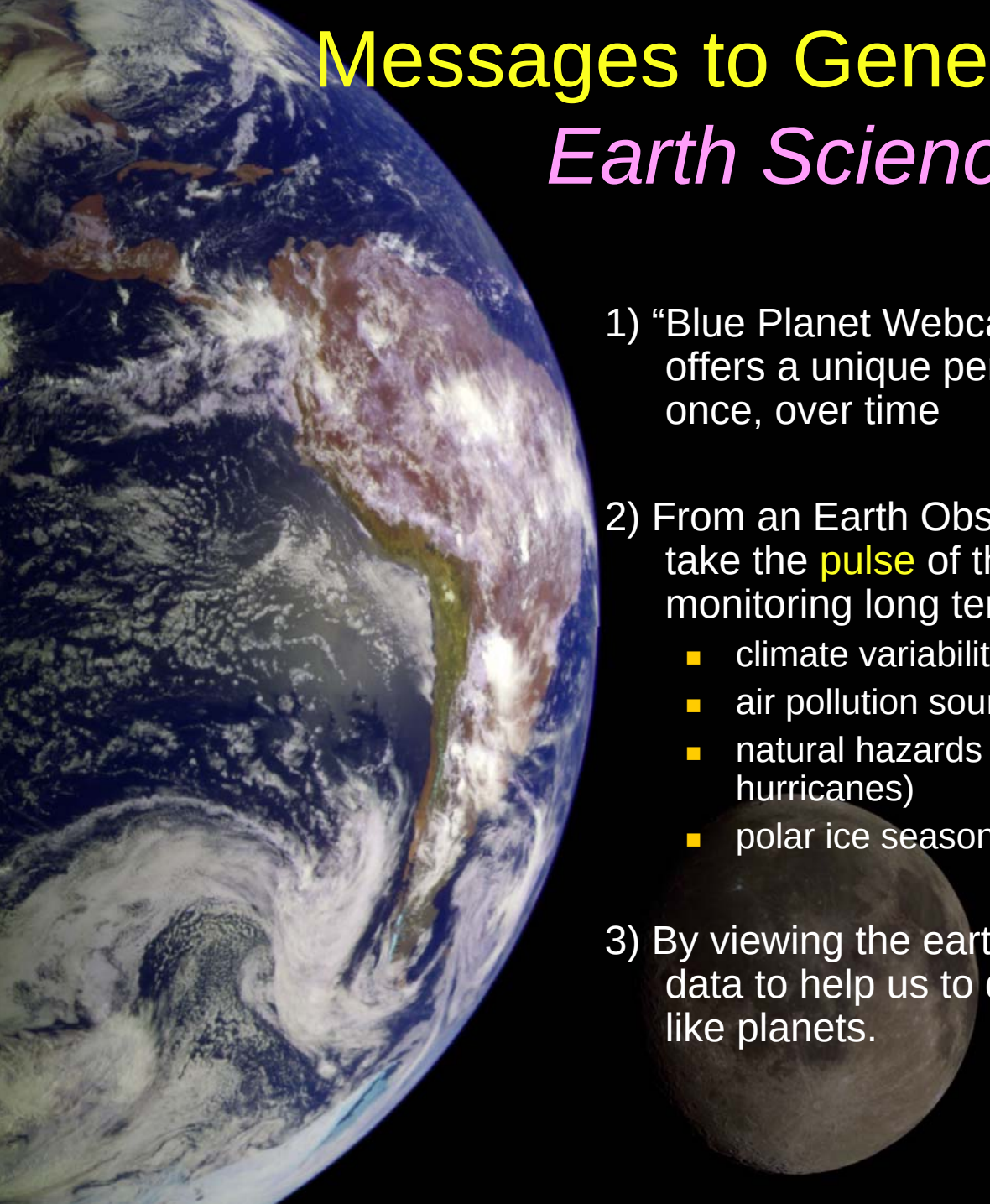
1) The Moon is witness to 4.5 billion years of Solar System history-*human exploration of the Moon will contribute greatly to discovering the origins of the Earth and ourselves.*

2) The Moon is a unique location from which to observe and analyze the ever changing nature of the Earth, Sun, and Universe.

3) The Moon is a fundamental stepping stone to the human exploration of Mars and the rest of the Solar System.

Messages to General Public

Earth Sciences



1) “Blue Planet Webcam”: The view from the Moon offers a unique perspective of the full earth, all at once, over time

2) From an Earth Observatory on the Moon, we can take the pulse of the Earth from the Moon by monitoring long term Earth events such as,
   - climate variability
   - air pollution sources and transport
   - natural hazards (extreme weather, volcanic plumes, hurricanes)
   - polar ice seasonal and long term variations

3) By viewing the earth from a distance we can collect data to help us to detect and study far away earth-like planets.

Messages to Scientific Community

Earth Sciences

1) A lunar observatory provides a unique, stable, serviceable platform for global, continuous full-spectrum view of the Earth to address a range of Earth science issues over the long-term

2) Synergy of current (LEO, GEO, GPS) assets with lunar instrumentation will insure the collection of the widest array of information from a lunar base

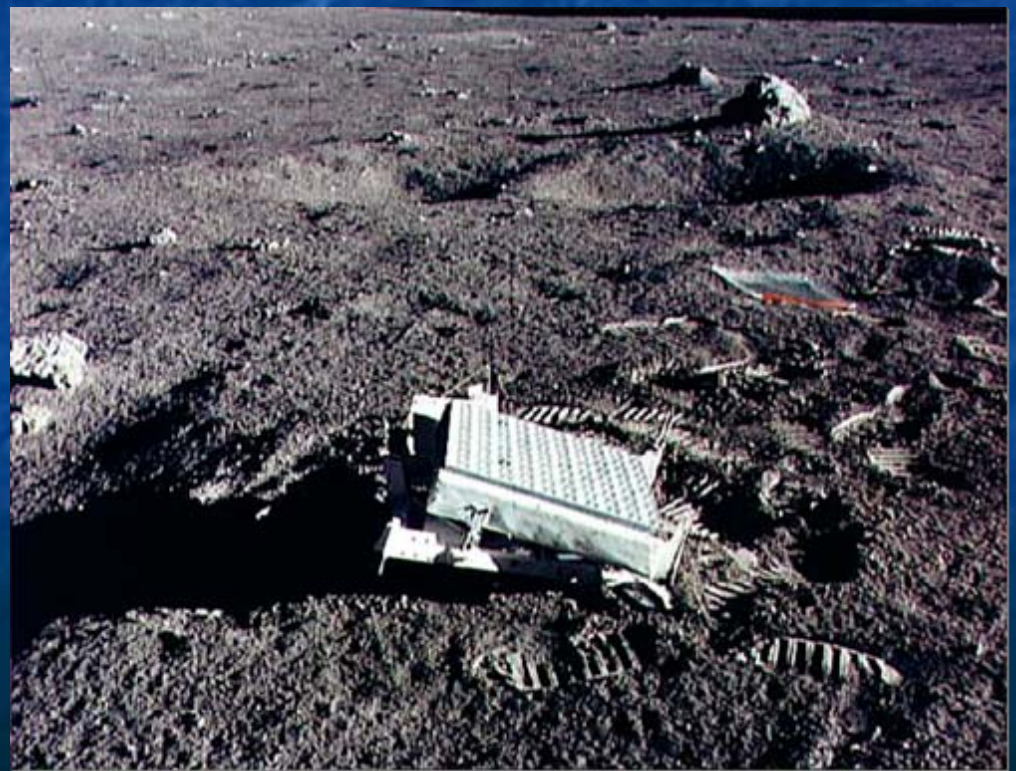
3) There are numerous atmospheric profiling opportunities from visible (stars) to microwave (GPS) to VHF (communications)

Key Astrophysics Messages for Public

- 1. The far-side of the moon provides a radio quiet zone that enables astronomers to look back in time and find out when the first stars were born.

Key Astrophysics Messages for Public

- 2. Astronauts can carry relatively small astronomy experiments with them to the moon. These packages can accomplish a wide range of science from understanding how gravity really works to using the full view of our own Earth in understanding how to search for signs of life on other worlds.



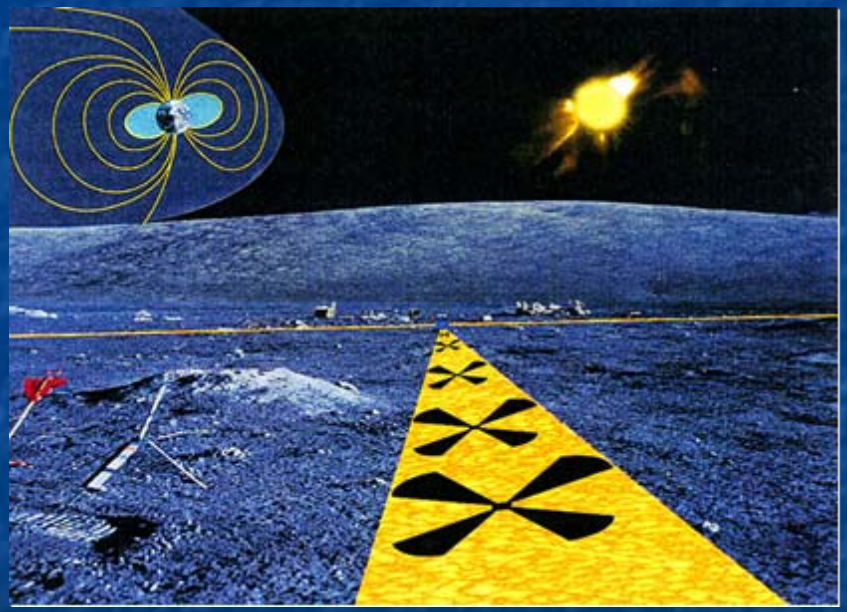
Key Astrophysics Messages for Public

- 3. The rockets that will take us back to the moon give astronomers the heavy lifting they need to put bigger and better telescopes in space. Among other things, these telescopes will look for earth-like planets beyond our solar system, investigate the environment around black holes, and probe the dark energy that makes up most of our Universe.

Key Astrophysics Messages to Scientists

1. The return to the Moon will enable progress in astrophysics through the associated infrastructure. Some important astrophysical observations, as well as a few smaller experiments, can be uniquely carried out from the lunar surface and in lunar orbit.

- **Long-wavelength radio observations from the far-side of the moon**
- **Lunar laser ranging observations for fundamental physics**
- **Characterization of Earth and dust in the solar system as they apply to extra-solar planet research**

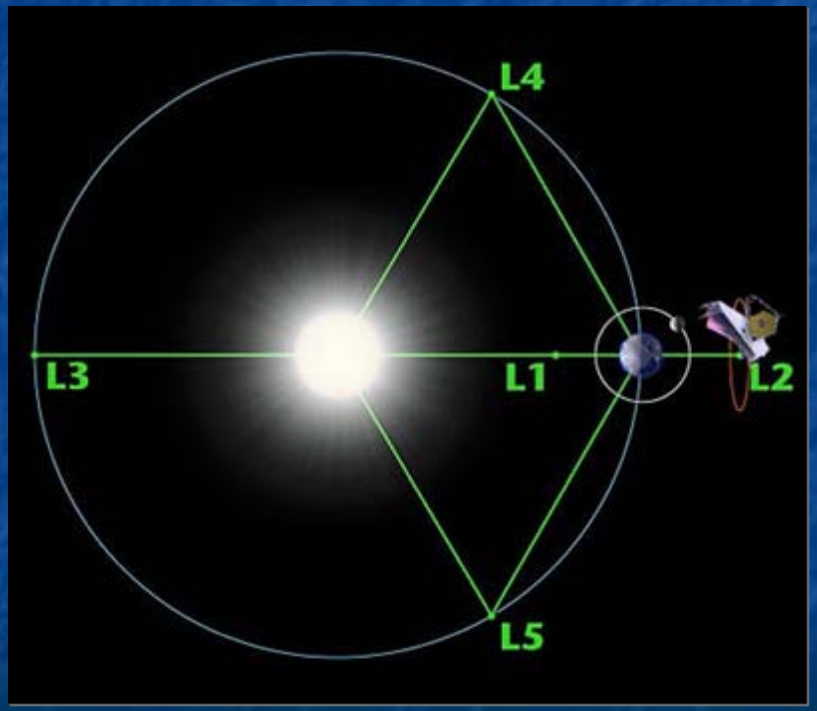


- **Other "science of opportunity" missions competitively selected**

Key Astrophysics Messages to Scientists

- 2. Observations from free space (in particular Lagrange points) enabled by the lunar architecture offer the most promise for broad areas of astrophysics.

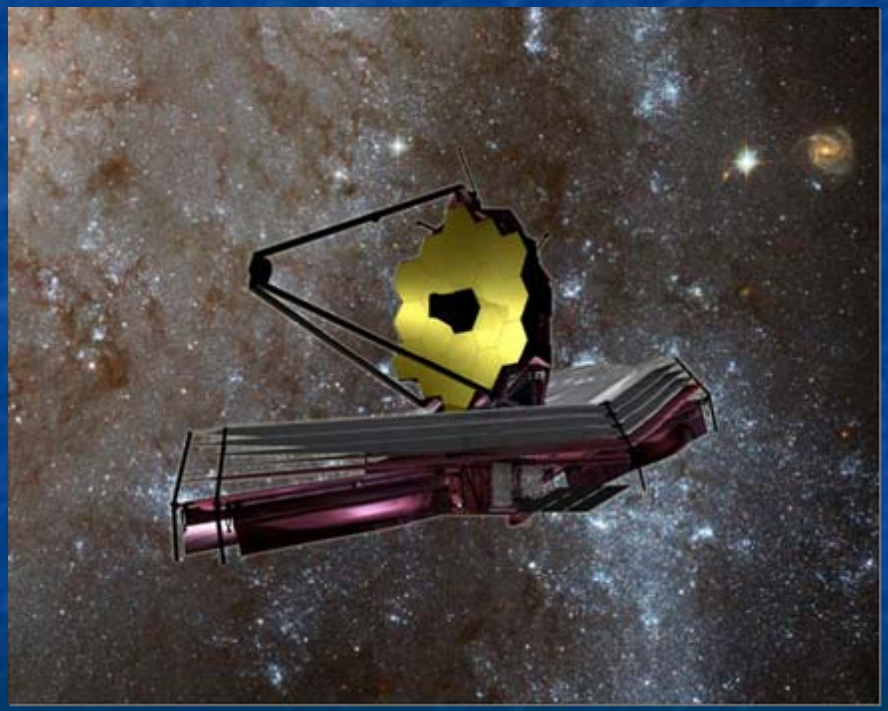
- **High-sensitivity energetic particle observations including a gamma-ray imager**
- **Single-Aperture Far-InfraRed Observatory (SAFIR)**
- **Exo-planet detection observatories**
- **Other "Great Observatory" class missions**



Sun-Earth Lagrange points (not to scale)

Key Astrophysics Messages to Scientists

- 3. The Vision for Space Exploration should be planned so as not to preclude — and to the extent possible to include — capabilities that will enable astrophysics from free space.



- Capabilities of great interest include:
- Large fairings
- Advanced telerobotics
- EVA capabilities
- High-bandwidth communication
- A low-cost transportation system (e.g. between Lagrange points)

Messages to the General Public
Planetary Protection

1) Based on international treaties, policies, and decades of research experience on protecting planetary bodies during exploration, lunar missions *will not* require special planetary protection controls.

2) Lunar exploration provides a good opportunity for testing technologies and methods to understand and control mission-associated contamination on long-duration expeditions

3) Lessons learned on the Moon will provide essential information to ensure protection of planetary environments and humans as we explore Mars and other destinations.

Messages to the Scientific Community

Planetary Protection

Preamble:

Planetary Protection is an important on-going focus of both science research and mission planning to safeguard planetary environments and exploration throughout the solar system.

Messages to Scientific Community
Planetary Protection

• Based on the Outer Space Treaty, international policies, and decades of research and experience on protecting planetary bodies during exploration, lunar missions *will not* require special planetary protection controls.

•Lunar exploration provides the opportunity for an integrated test bed of sophisticated technologies and methods needed to understand and control mission-associated contamination on long-duration expeditions.

• Lessons learned on the Moon will provide essential, enabling, and comparative information to ensure protection of planetary environments and humans as we explore Mars and other destinations. (e.g., understanding background and mission-associated organic and inorganic contaminants, dusts, and microbes from the outpost).

Messages to General Public

Planetary Science

1) The Moon has a record of the early history of terrestrial planetary formation and change that is absent on other planets because they have active resurfacing processes like weathering and plate tectonics.

2) We are in a position to build on four decades of lunar science. There is much more new information to learn about our Moon and - from the Moon - about our Earth. For example, the Moon maintains a cratering history and may inform our understanding of the evolution of life on Earth and potentially elsewhere in the Solar System.

3) The lunar outpost will serve as a test-bed for science and exploration of the Moon, Mars and beyond (camp first in your own back yard!).

Messages to Scientific Community

Planetary Science

1) The Moon is critical for accessing the early formation, differentiation, and impact history of the terrestrial planets – and biotic evolution of Earth and Mars.

2) Additional data are needed:

-Geophysical and geochemical data to determine the composition, structure, condition, and evolution of the lunar interior

-Data from the lunar surface to understand the processes that have occurred during its evolution, such as the history of impact cratering and formation of regolith, and the distribution of resources

-Data to inform us more about the lunar environment (conditions in cold traps, atmosphere, volatiles).

3) These new data will enable us to validate lunar science process models, understand the early history and evolution of Earth and other terrestrial planets, and prepare for human habitation of the Moon and beyond.

Messages to Scientific Community

Planetary Science Access

1) The architecture as presented (South Pole Aitkin Basin access) will enable long-term lunar science in a region of high interest and will address several scientific questions (e.g., crust to upper mantle access, impact processes).

2) The scientific goals will have to be prioritized in a cohesive vision across a timeline. This long-term planning will need to encompass:

- Robotic and robotic/human sorties to acquire distributed samples and establish the geophysical network necessary to prepare for a lunar outpost, as well as to address the fundamental science questions.
- Samples from diverse locations on the lunar surface and subsurface to address fundamental science questions. In-situ science will optimize science output / return.

3) The community needs to actively participate in the development of human capital to fuel the pipeline of scientists and engineers.

Heliophysics Science at the Moon

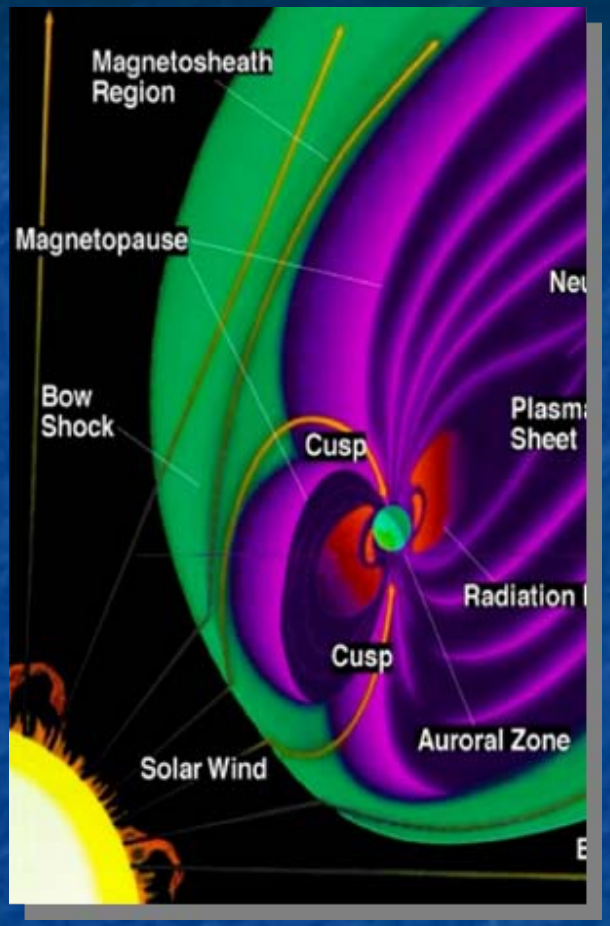
Top 3 messages for both the general public and scientists:

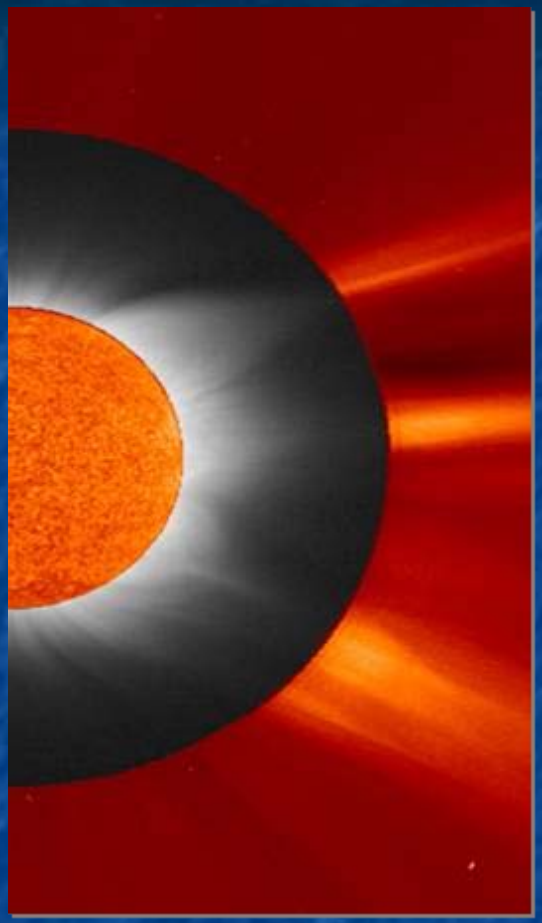
1) Understanding our space environment is the first step to "Safeguarding the Journey".

2) The Moon can be used as an unique vantage point to better understand the Sun-Earth space environment – our "Home in Space".

3) The analysis of lunar regolith will provide a history of the Sun's brightness and radiation output and reveal how the Sun – Earth connection has changed through the ages.

Space Weather: Safeguarding the Journey



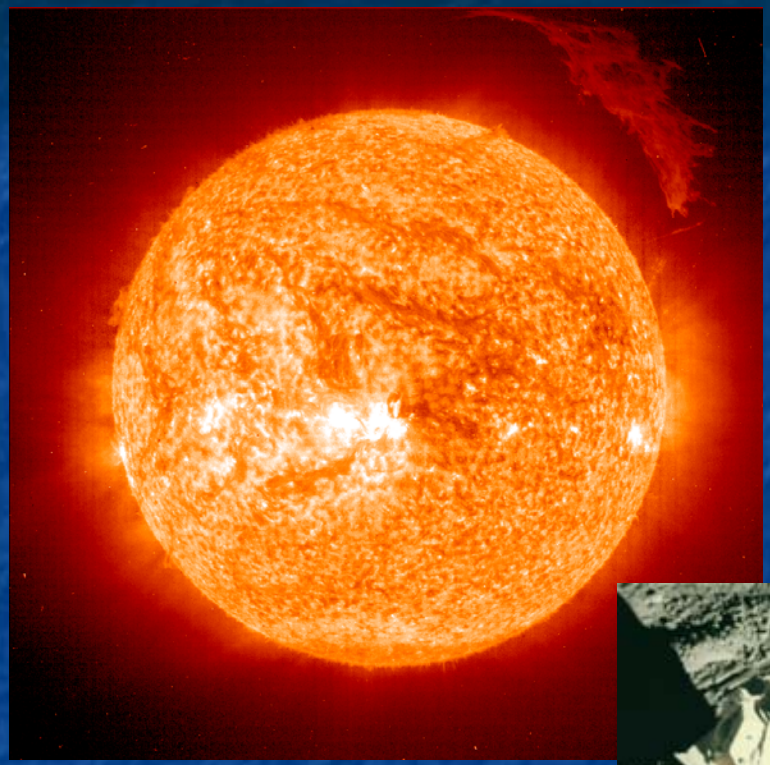


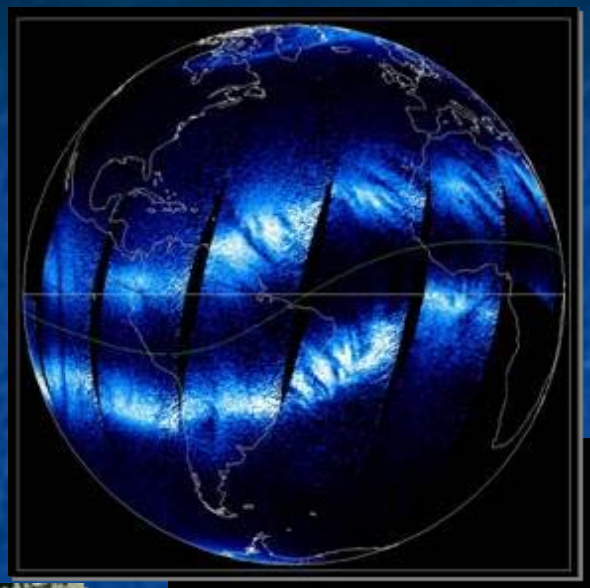
Outer space is a perilous ocean through which we must pass to reach the dusty shores of the Moon, then Mars

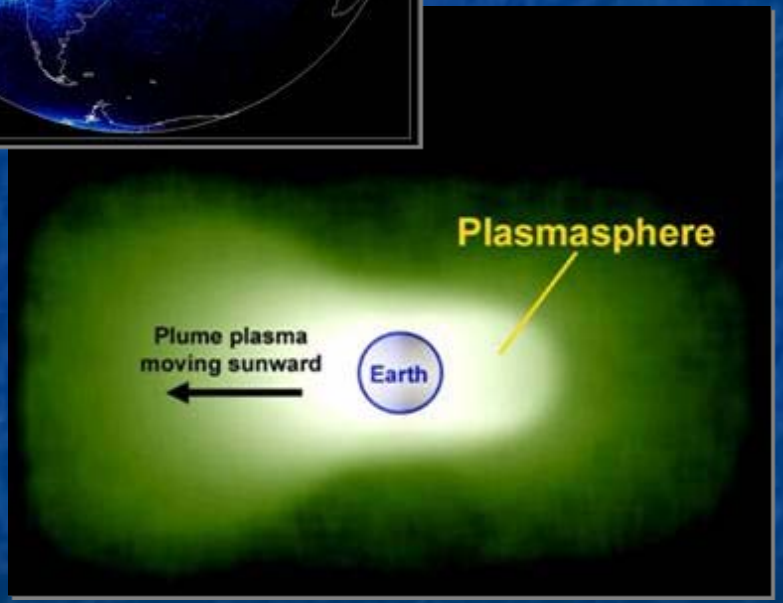
This ocean is permeated with charged particles, electromagnetic fields and blasts of radiation from the sun.

We seek to enhance astronaut and robot productivity by forecasting and learning to mitigate resulting space weather and charged dust impacts.

Bases on the Moon Help Us Understand our Home in Space





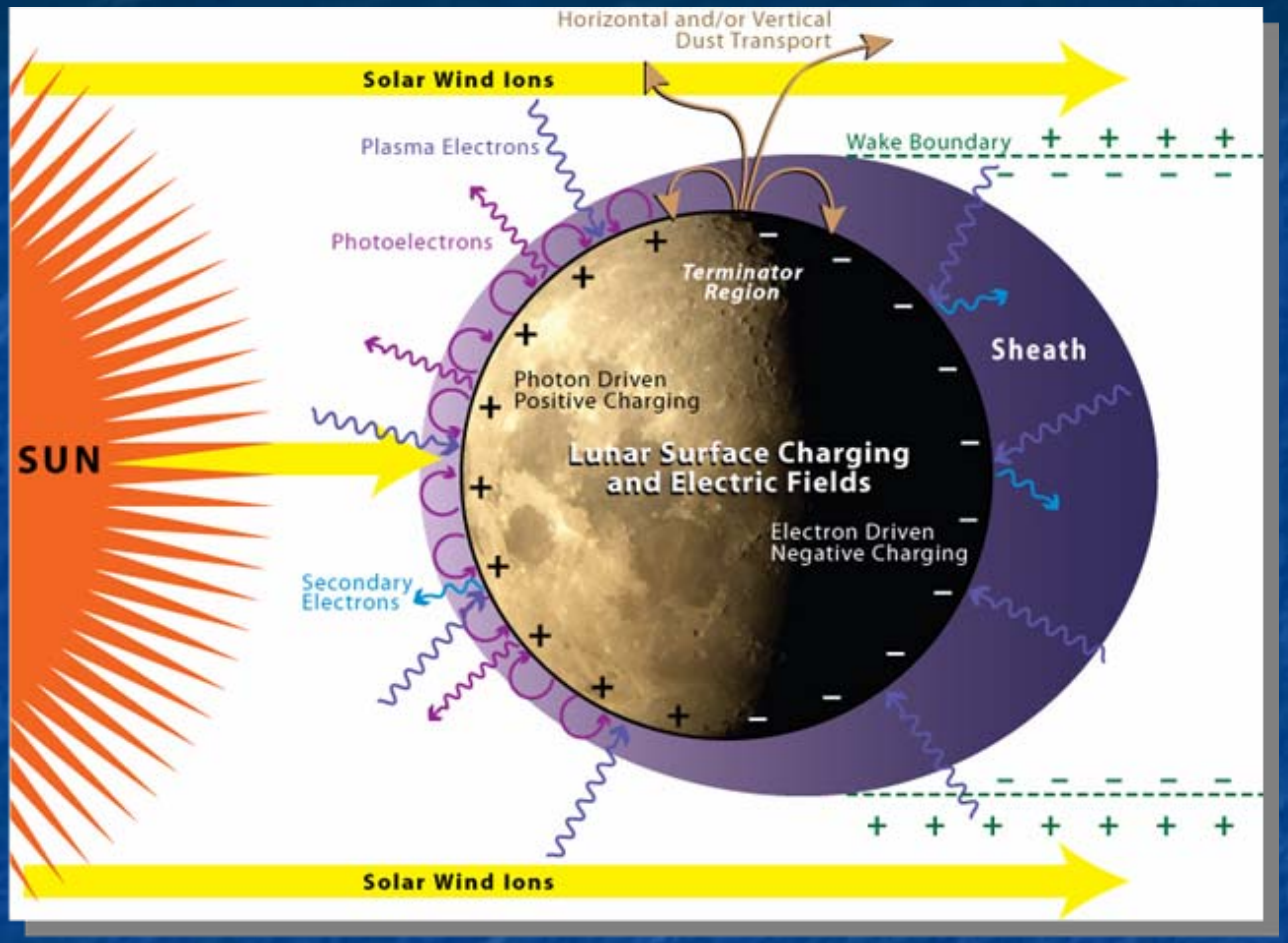


How and why does the Sun vary?

How do Earth and other planetary systems respond?

What are the effects on Humanity?

The Moon is a Natural Laboratory for Space Physics



Electromagnetic interactions with the solar wind and Earth's magnetotail

Lunar magnetic and electric fields

Plasma and dust environment at lunar surface