Heliophysics Science Enabled By the Return to the Moon

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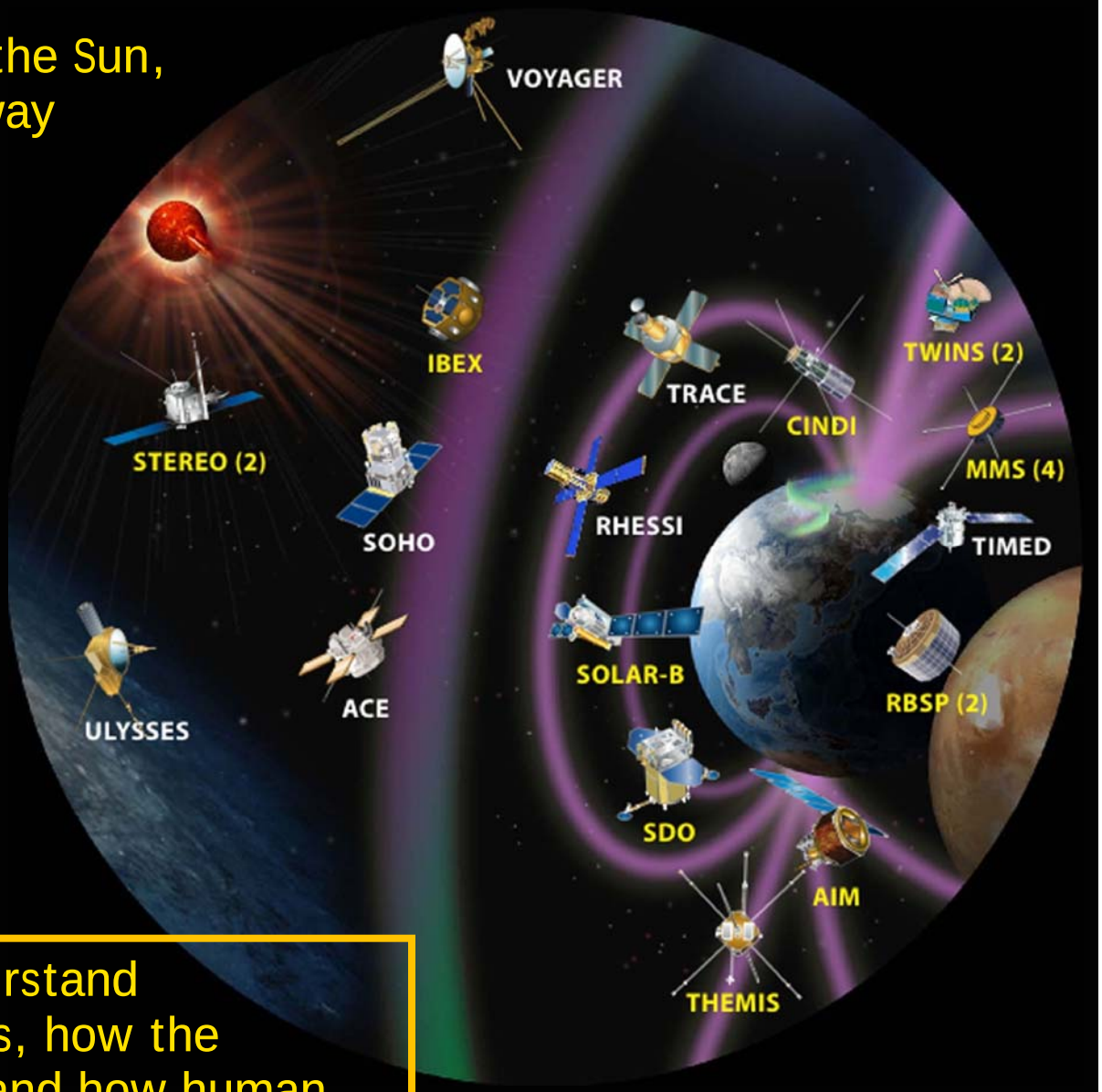
What is "Heliophysics"? *(in the context of VSE)*

The realm of **heliophysics** is the perilous ocean through which explorers, both robotic and human, must journey to reach the dusty shores of the Moon, then Mars.

Our Moon is influenced by the Sun, a main-sequence star midway through its stellar life.

The Sun's influence is wielded through radiation, the solar wind, and magnetic fields.

Through the eyes of multiple spacecraft, we see the Sun, Earth, and Moon as a single, interconnected system moving through interstellar space.



Heliophysics seeks to understand how and why the Sun varies, how the Earth and Moon responds, and how human activities in these environments are affected.

- The Heliophysics community has been investigating the region of space in which the Moon resides since the inception of NASA
- It is well qualified to address compelling science problems enabled by the return to the Moon

Heliophysics Science and the Moon

- NASA asked the NASA Advisory Council – the NAC – to provide scientific and technical recommendations relevant to planning the Science Architecture and Activities associated with Lunar Exploration within the framework of the Vision for Space Exploration.

- The Heliophysics Subcommittee of the NAC, is supporting this effort by defining, for heliophysics science, potential activities and objectives of science associated with, or enabled by lunar exploration

Heliophysics Science and the Moon

The Heliophysics Subcommittee approached this task by forming a subpanel. Starting in July '06, the subpanel solicited input from the science community; this report is the work of that subpanel.

Heliophysics Science and the Moon Subpanel Members:

James Spann (lead)	NASA Marshall Space Flight Center
Gordon Emslie	Oklahoma State University
Harlan Spence	Boston University
Phil Goode	New Jersey Institute of Technology
Tim Stubbs	Univ. of Maryland
Michael Kaiser	NASA Goddard Space Flight Center
Andy Christensen	Northrup Grumman
Pontus C-Brandt	JHU/APL
Lynn Kistler	Univ. of New Hampshire

plus participating members of the Heliophysics Subcommittee

Heliophysics Science at the Moon

- The Moon and orbits about the Moon offer useful platforms for a renewed emphasis on in-situ measurements and imaging of important space plasma phenomena from the Sun to the edge of the heliosphere.

- While no lunar-based measurements were recommended in the 2003 Solar and Space Physics decadal survey, several high-priority science objectives of the survey can be addressed with lunar-based measurements.

Heliophysics Science at the Moon

- Measurements of phenomena such as lunar crustal magnetic fields, dust-plasma interactions, and interactions of plasmas and energetic particles with the lunar regolith, while of secondary importance to heliophysics, nevertheless would provide important and even crucial information for lunar surface exploration missions.

- Opportunities identified by the heliophysics community are described in this presentation.

Heliophysics Science at the Moon

Science community efforts to explore the range of priority potential Heliophysics science topics have defined four themes:

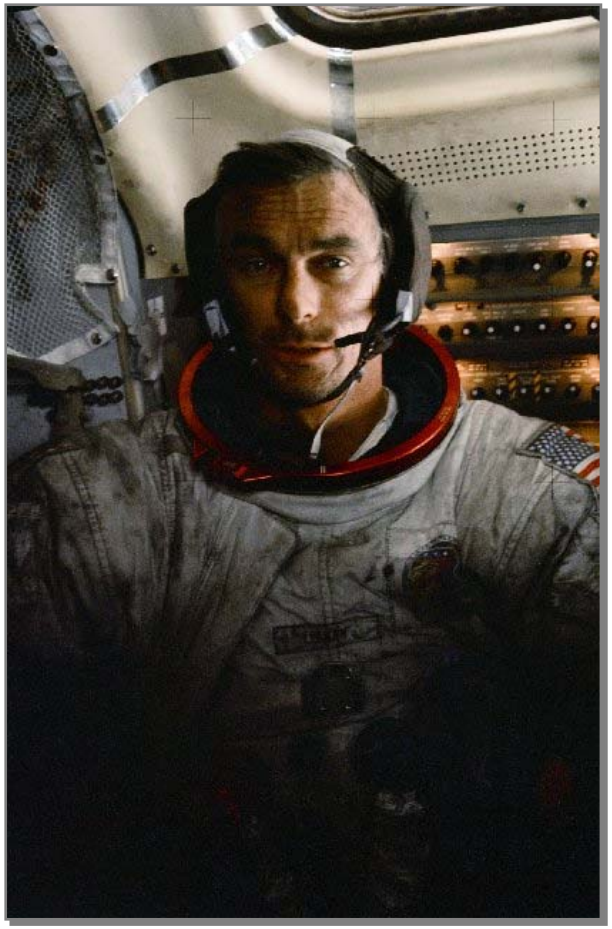
1) Space Weather, Safeguarding the Journey

2) Heliophysics Science *of* the Moon

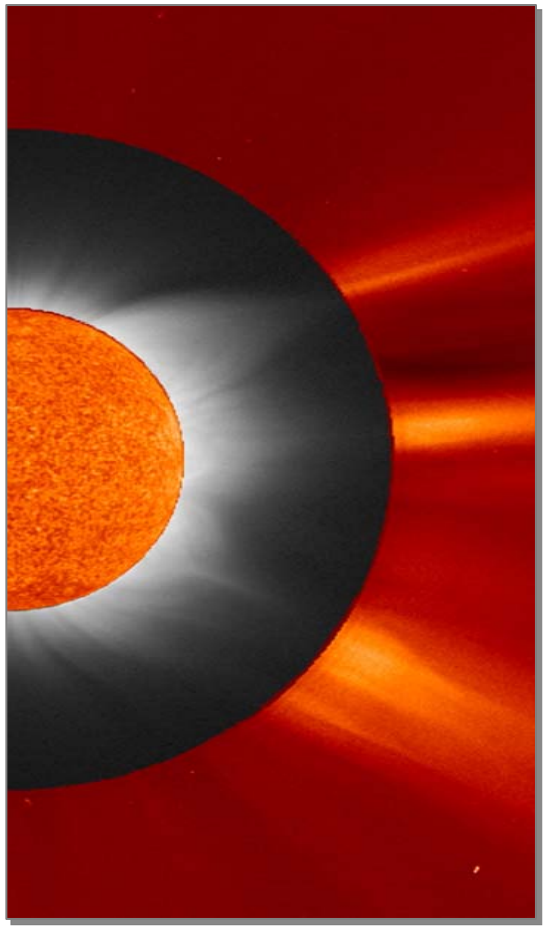
3) The Moon as a Historical Record

4) The Moon as a Heliophysics Science Platform

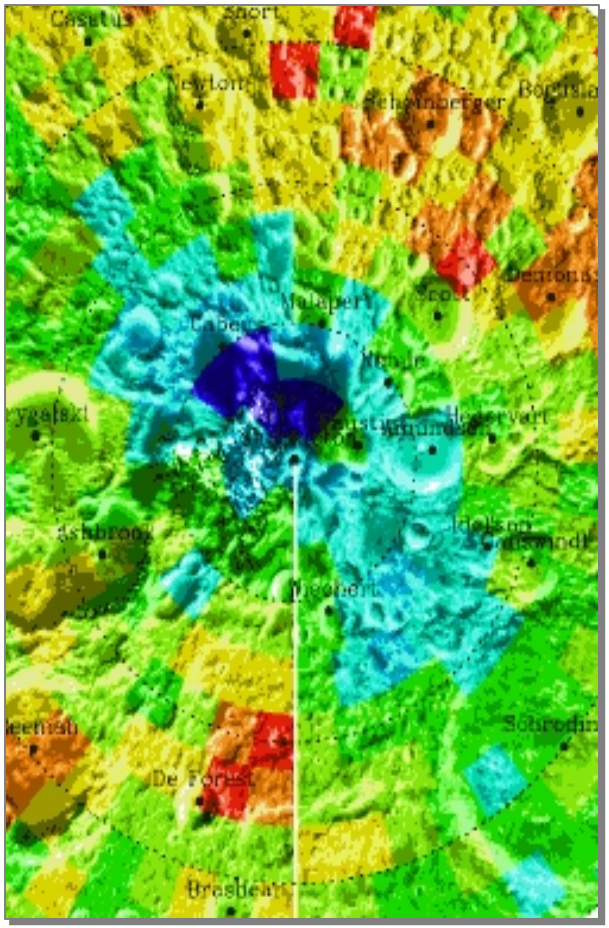
Space Weather, Safeguarding the Journey



Interaction of dust and plasma on the surface of the Moon and in the exosphere

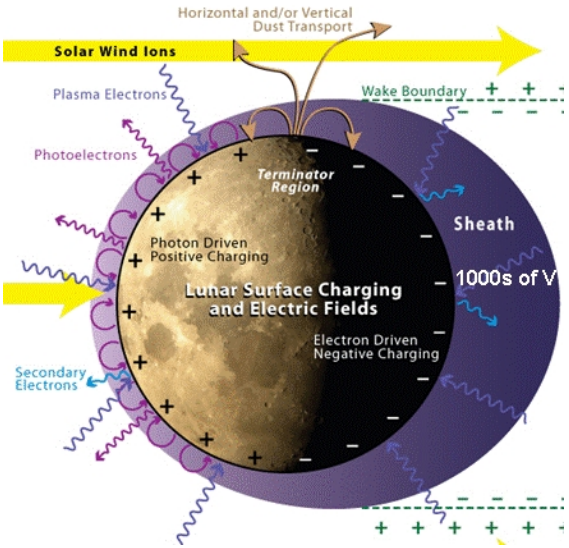


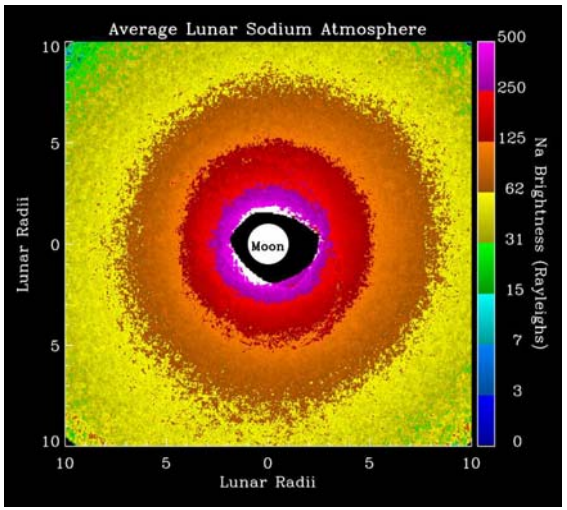
Space weather impacts on robotic and human productivity



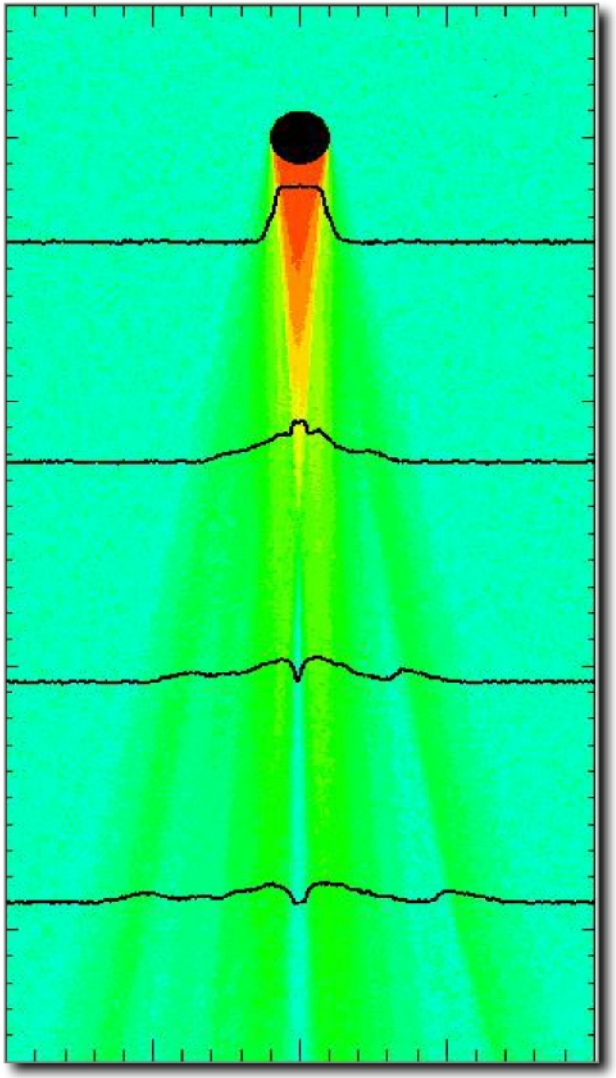
Radiation bombardment on the lunar surface and subsurface

Heliophysics Science of the Moon

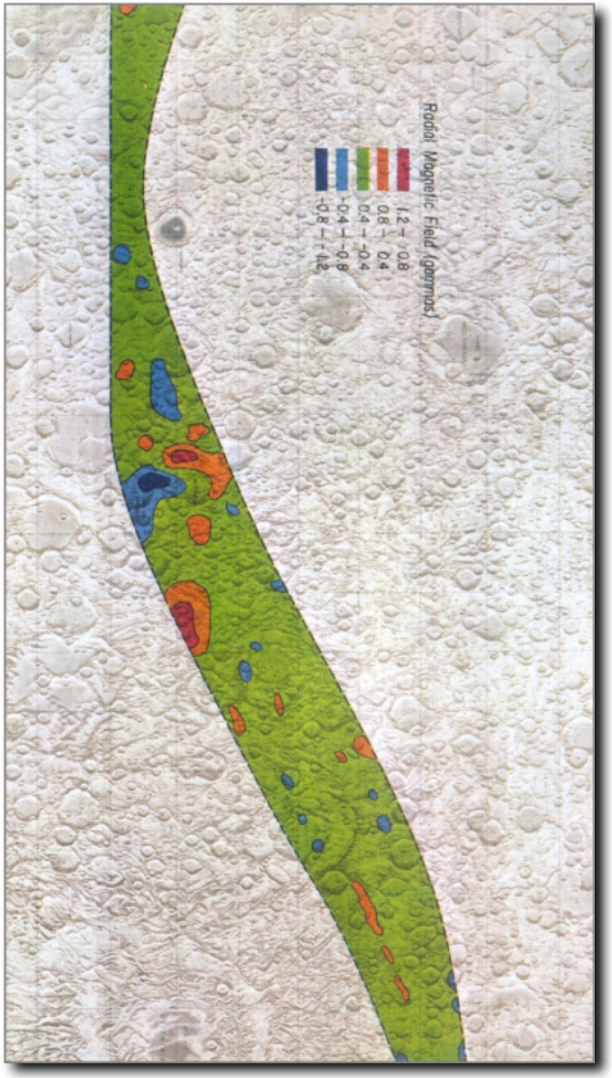




Plasma and neutral environments

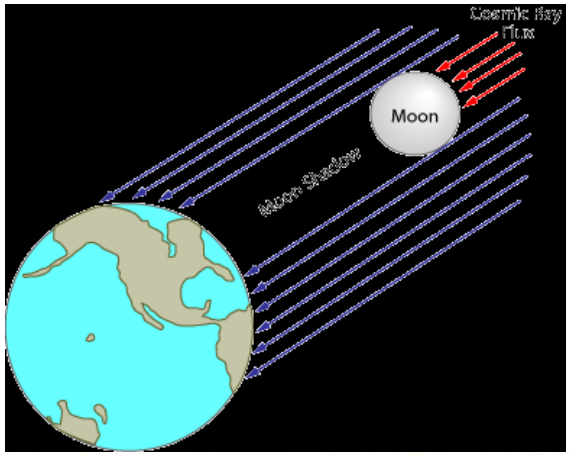


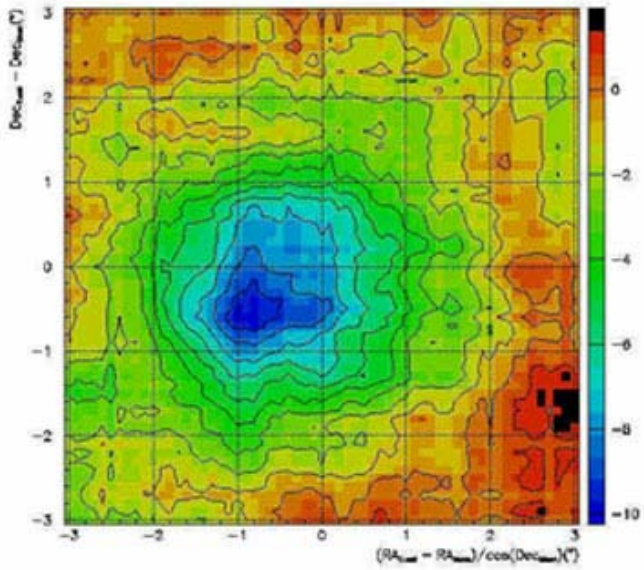
Magnetotail dynamics at lunar orbit



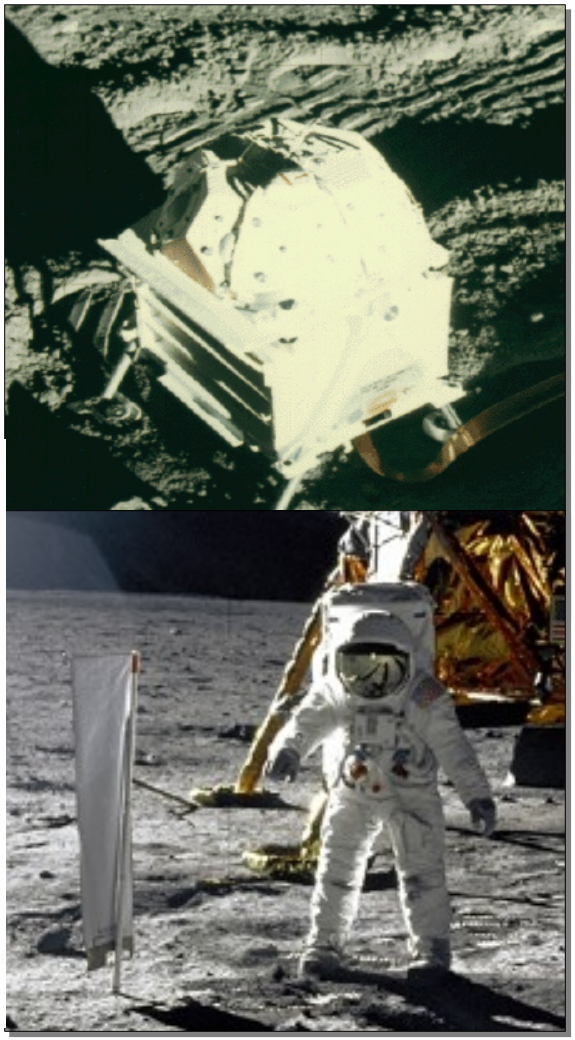
Lunar crustal magnetic fields and their origin

The Moon as an Historical Record

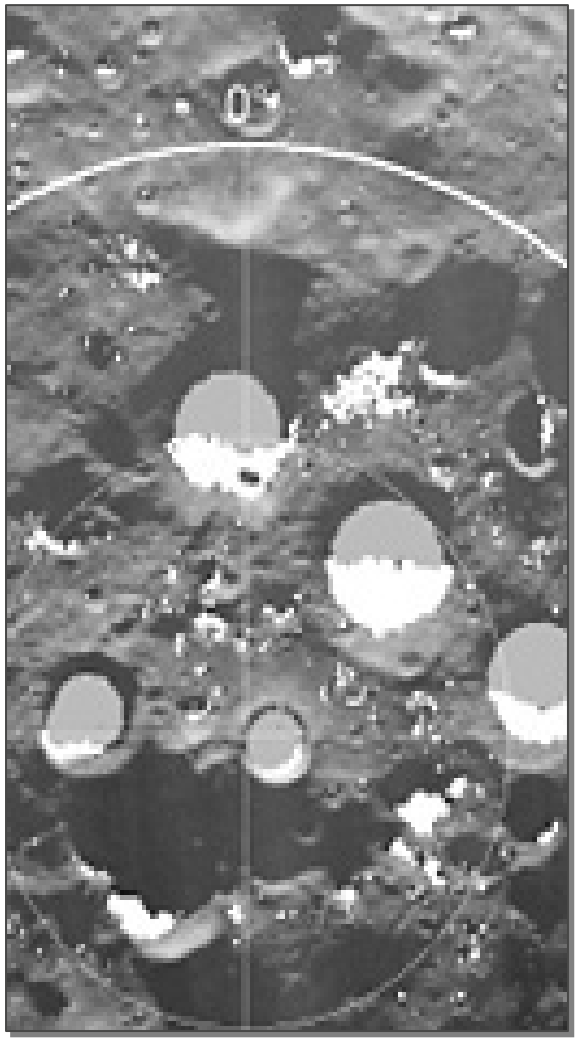




History of the Sun, cosmic radiation, and local interstellar medium



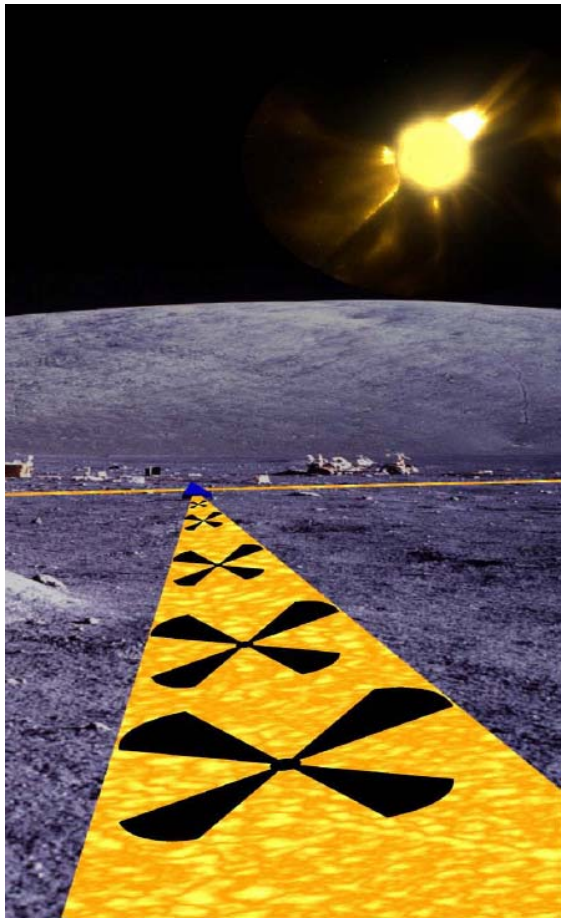
Composition of the solar wind



History of the Inner Solar System According to Lunar Cold Traps

Moon as a Heliophysics Science Platform

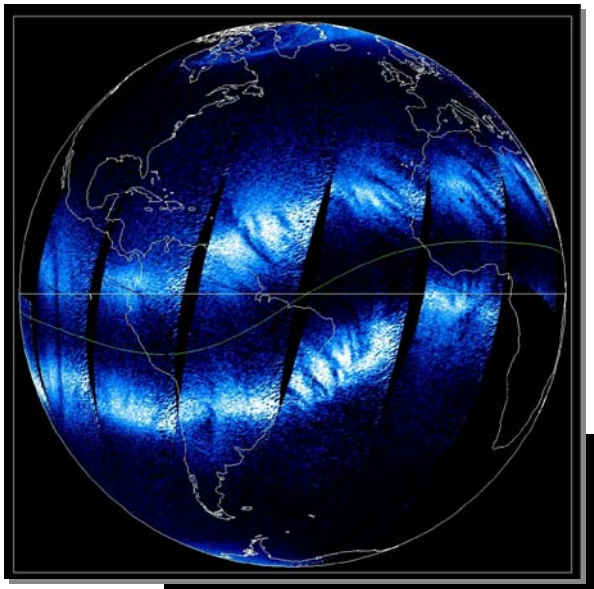
Imaging of the Heliospheric Boundary

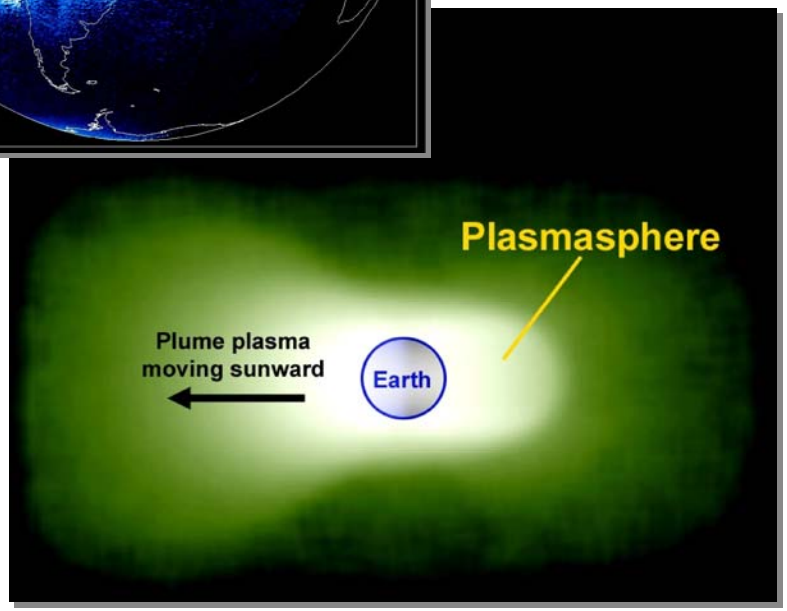


Low-frequency radio observations

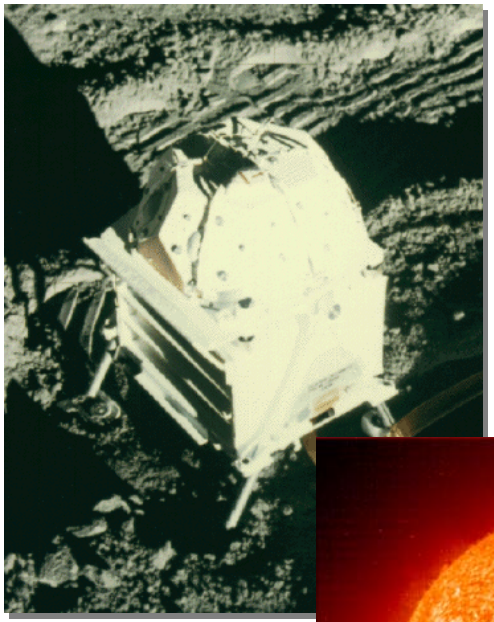
Sun's Role in Climate Change

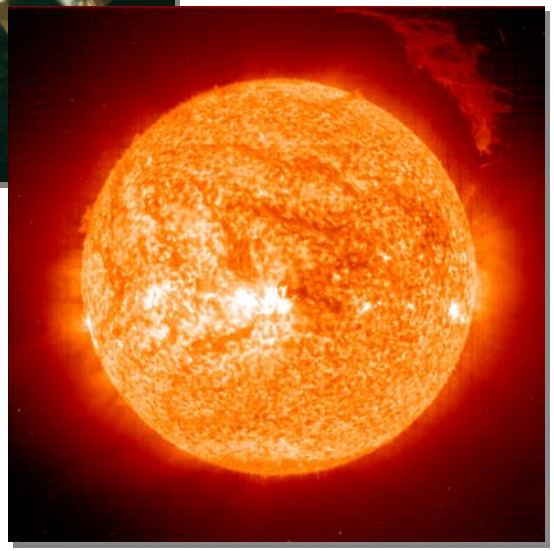
Moon as a Heliophysics Science Platform





Ionosphere/Magnetosphere Imaging





High-Energy Solar Observatory and an Optical Solar Observatory

Solar and Space Physics at the Moon: Summary

- The lunar surface and lunar orbits provide excellent vantage points for **investigating the lunar environment**, particularly crustal magnetization and dust-plasma interactions.
- Excavation of the lunar regolith could provide unique and unprecedented data on the particle and irradiance **history of the Sun**.
- The lunar surface and lunar orbits offer excellent **vantage points for imaging** of the Sun, Earth and planetary magnetospheres and ionospheres, and the outer boundaries of the heliosphere.
- Lunar-based instrumentation would allow measurements of plasma transport in the magnetotail and would provide important **space weather** monitoring capabilities in support of exploration missions.

Thank you!

The realm of heliophysics is the perilous ocean through which explorers, both robotic and human, must journey to reach the dusty shores of the Moon, then Mars.