

Sun-Solar System Connection Roadmap

Knowledge for Exploration

Explore the Sun-Earth system to understand the

- Sun and its effects on Earth,*
- The solar system,*
- the space environmental conditions that will be experienced by human explorers, and*
- Demonstrate technologies that can improve future operational systems*

S3C Research Focus Area Missions

SOLAR IRRADIANCE:

- ACRIMSAT
- ERBS
- SORCE
- UARS

SOLAR:

- RHESSI
- SDO
- SOHO
- Solar-B
- STEREO
- TRACE

MAGNETOSPHERIC / IONOSPHERIC/ THERMOSPHERIC

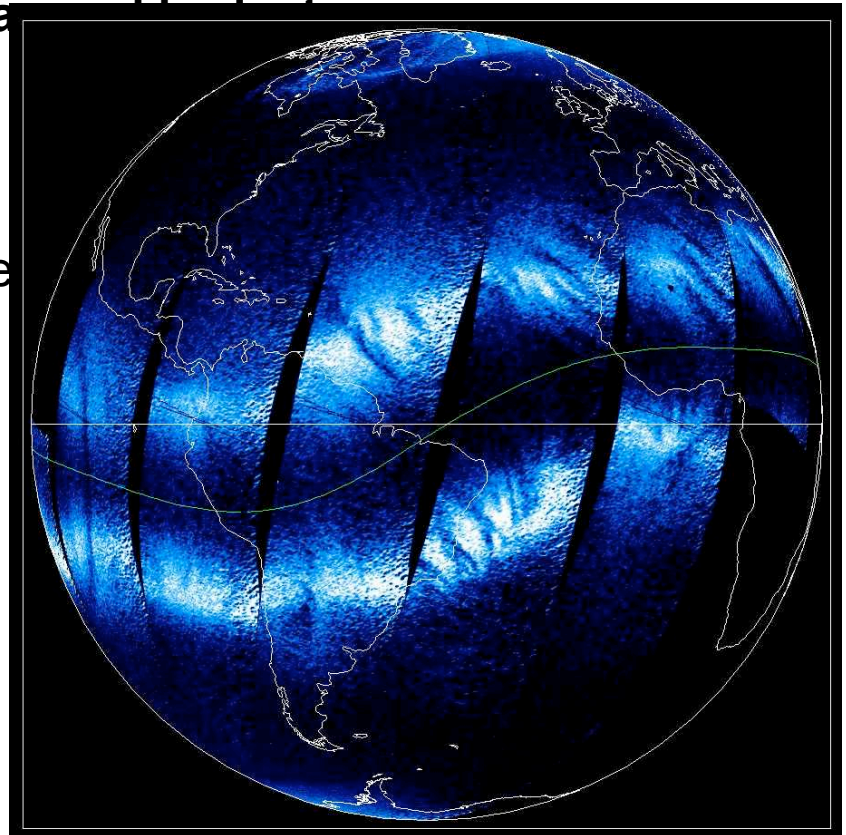
- AIM
- CINDI
- Cluster
- FAST
- Genesis
- Geotail
- IMAGE
- Polar
- THEMIS
- TIMED
- TWINS

HELIOSPHERIC:

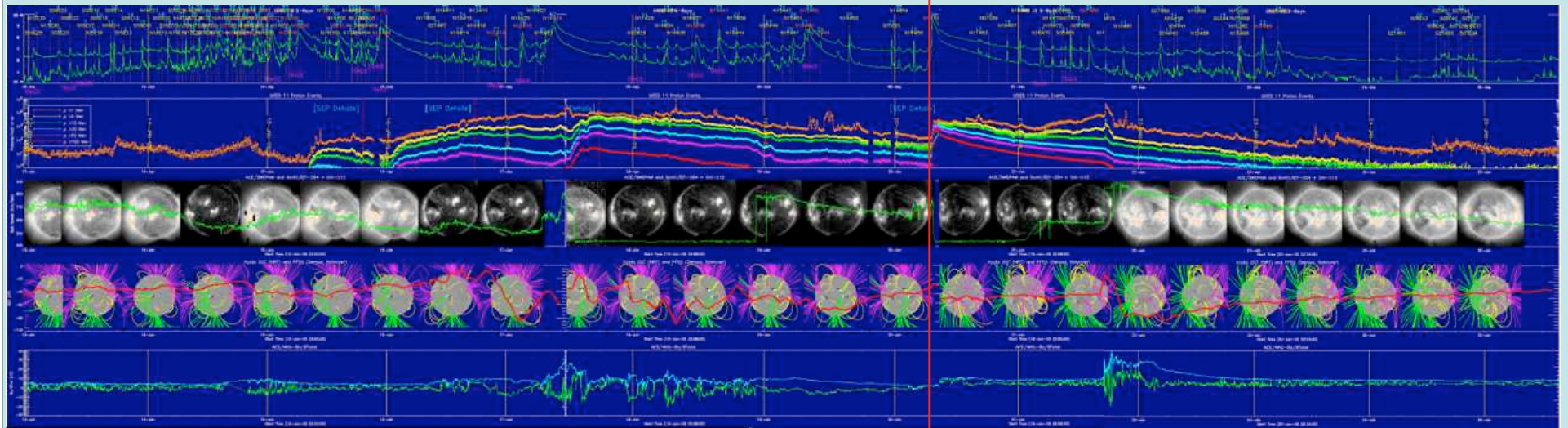
- ACE
- Ulysses
- Wind
- Voyager 1 & 2
- IBEX

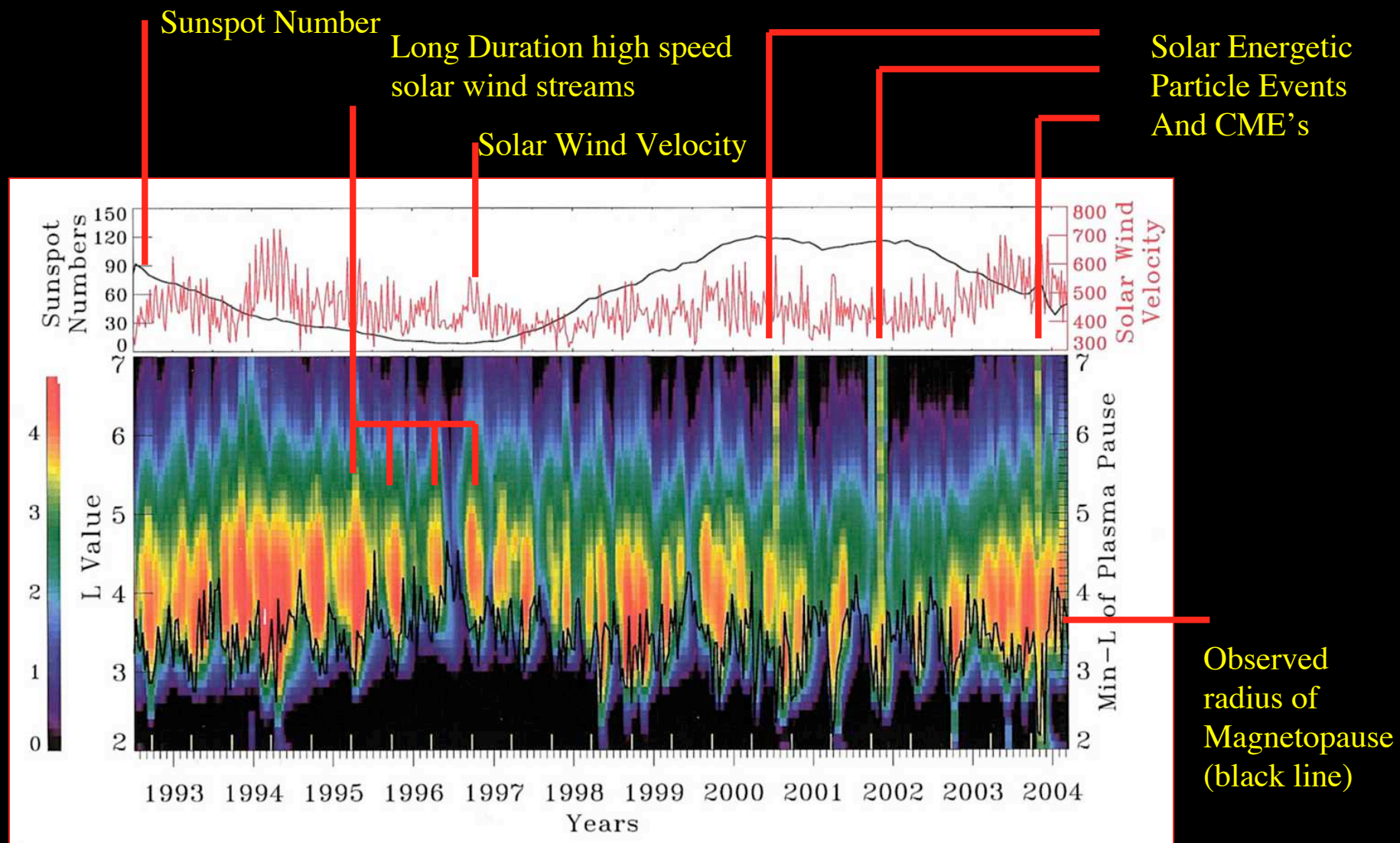
The 5th Great Observatory

- **The “5th Great Observatory”**
 - **World’s largest and most expensive plasma physics laboratory**
 - **Enabled investigation of the Sun-Solar System “system of systems”**
 - **~ \$5B investment; ~ \$100M/yr a**
 - 13 magnetometers
 - 9 E-field analyzers
 - 15 plasma analyzers
 - 31 energetic particle spectrometers
 - 4 neutral particle imagers
 - 9 RF spectrometers
 - 3 visible imagers
 - 3 doppler interferometers
 - 8 UV and x-ray imagers
 - 6 UV and x-ray spectrometers
 - 1 IR radiometer
 - 4 gamma ray spectrometers



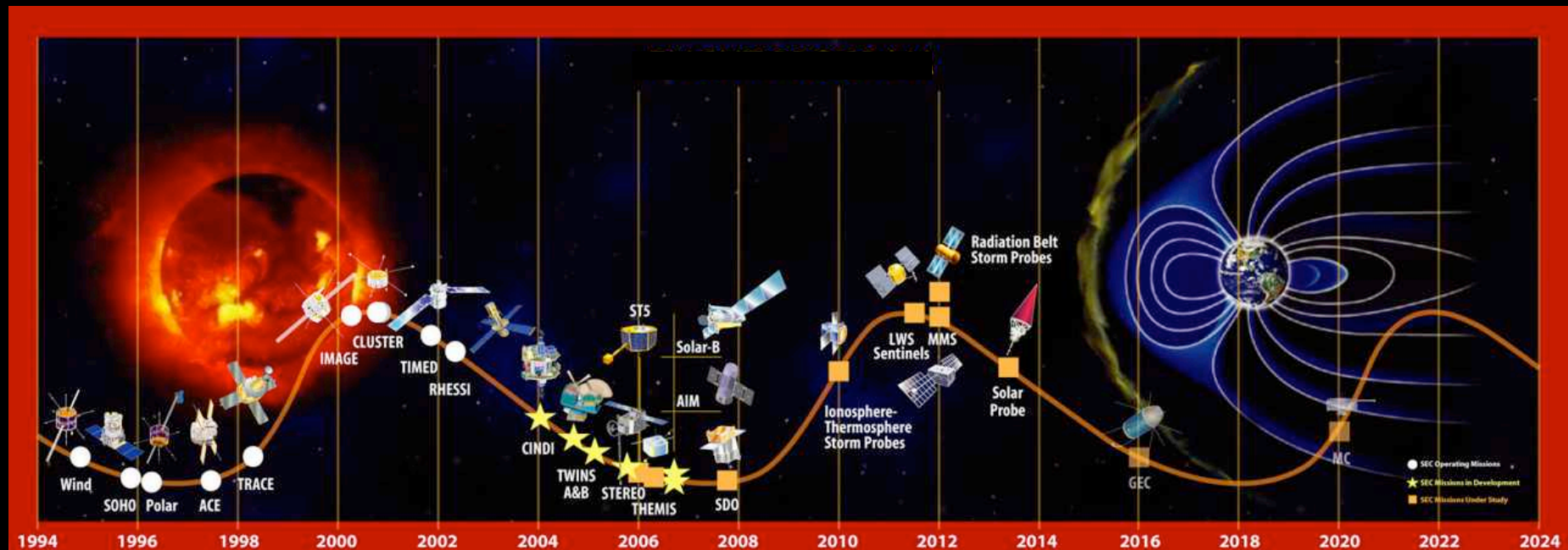
MLK Ground Level Neutron Event 2005





Radiation Belt Density vs Time (SAMPEX 1992-2004)

Sun-Earth Connections Missions Supporting Future Exploration (Circa Dec 2003)



STP Program

Solar -B (with Japan)

STEREO Nominal mission

LWS Program

SDO Nominal mission + 5 yr Extended mission

Radiation Belt Storm Probe mission

Heliospheric Sentinel Mission

Solar Probe Mission (Augmentation under study)

Development
Formulation
Under Study

S3C Mission Planning : Research and Utility

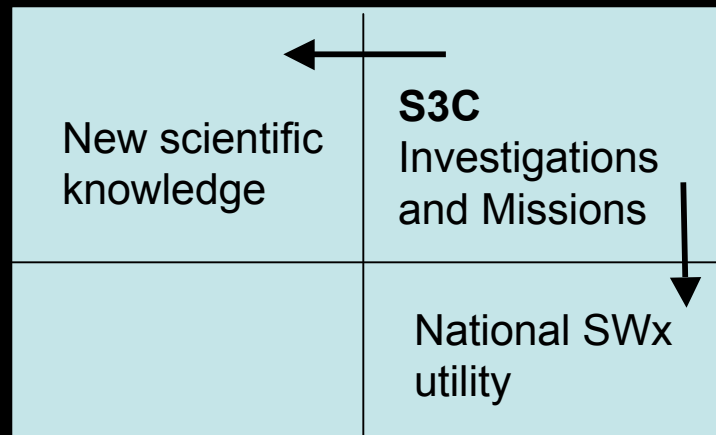


“Pasteur’s Quadrant”

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Hi



Hi

Utility for Exploration Missions
and SWx sensitive systems


SEC strategic missions are high national priority Space investigations with significant value of direct support for Exploration Missions and other national space activities.

Real-time solar, heliospheric, and planetary electro-magnetic radiation, charged particle, and magnetic field conditions-present and future.



The Vision for Space Exploration: Moon, Mars and Beyond...

- Implement a sustained and affordable human and robotic program to explore the solar system and beyond
- Extend human presence across the solar system, starting with human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations
- Develop the innovative technologies, knowledge, and infrastructure both to explore and support decisions about the destinations for human exploration
- Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests



Elements of S3C Strategy 2005-2010

Classic Strategy

- Vital Goal
- Available Resource
- Political Will

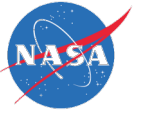
S3C Strategic Element

- SECAS Roadmap
- Decadal Study
- Code S Strategic Plan (Winter 2003)
- The New Age Of Exploration (February 2005)
- STP Mission Line,
- LWS Program Mission Line, Explorer Program (including MOOs),
- ESSD Research Budget (FY06 -10)
- Vision for Space Exploration (2004), Scientific Community, Agency, Executive Branch, and Congress



Scientific Landscape for the Roadmap

- S3C Science identified as necessary meet National and agency needs
- Identification and prioritization of missions will be achieved by agency Roadmap processes
- Resources are available to apply to the development of flight missions and production of new scientific knowledge
- Clear statement of National Political Will to achieve goals (Vision for Space Exploration)
- Possibility exists that in so doing these tasks a new scientific discipline will emerge via a conciliant process creating a scientific revolution.



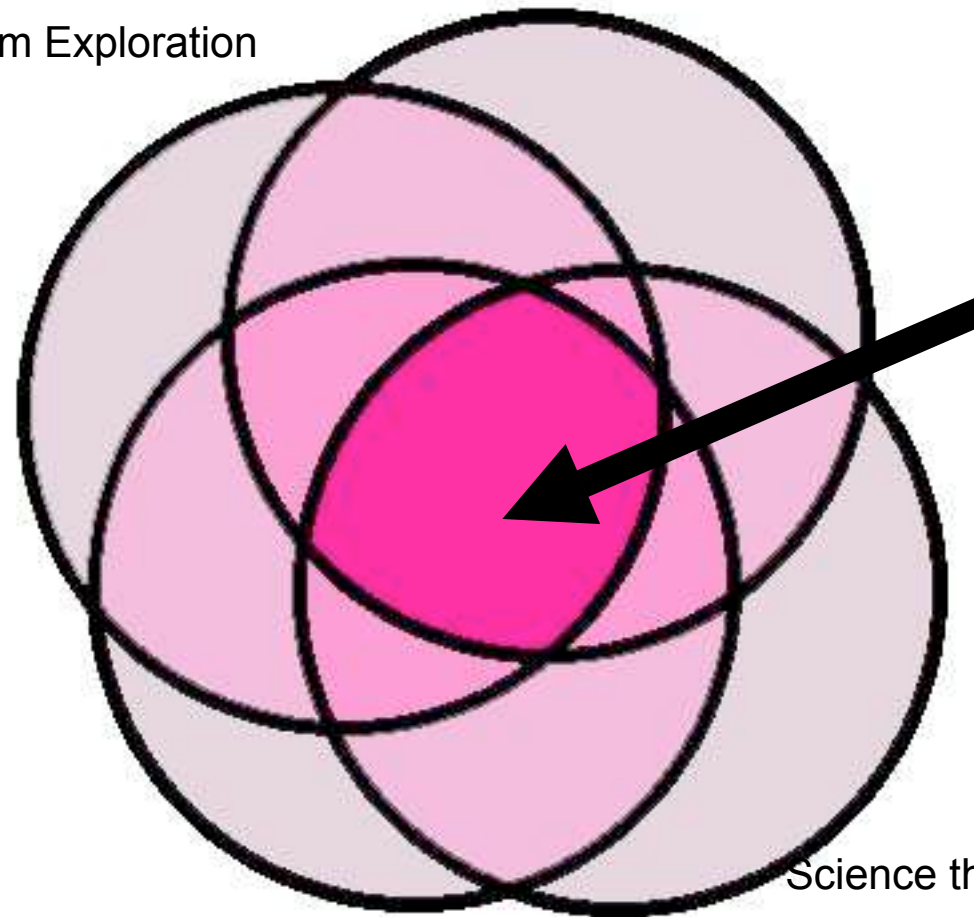
Science for the Vision for Space Exploration

- Science that Flows from Exploration
- Science that Enables Exploration
- Science that Transforms the Knowledge Base
- Science that Addresses National Objectives



Science that Addresses National Objectives

Science that Flows from Exploration



Science that is:
Vital,
Compelling,
and Urgent

Science that Enables Exploration

Science that Transforms the Knowledge Base

Structures and Processes

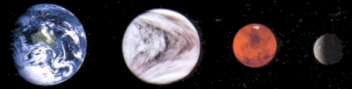


Gravitationally
Driven

Galaxies



Nebulae



Planetary
Bodies



Structures and Processes

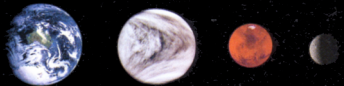
Gravitationally
Driven



Galaxies

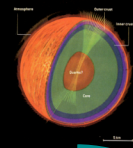


Nebulae

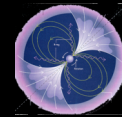


Planetary
Bodies

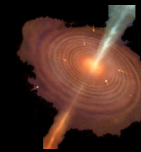
Magnetically
Driven



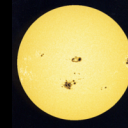
Magnetars



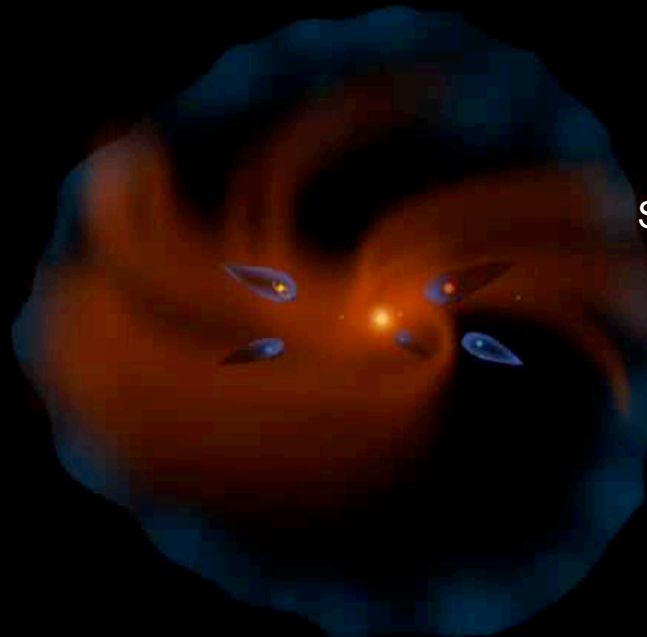
Pulsars



Stellar
Magnetism

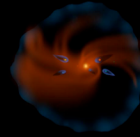


Solar Variability



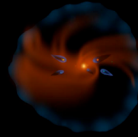
Stellar Heliospheres, CRs

Magnetically Driven and Gravitationally Driven : S3C Science



Heliospheric Structure and Dynamics, And CRs

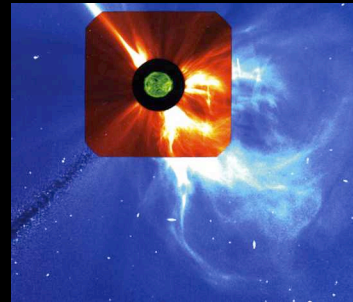
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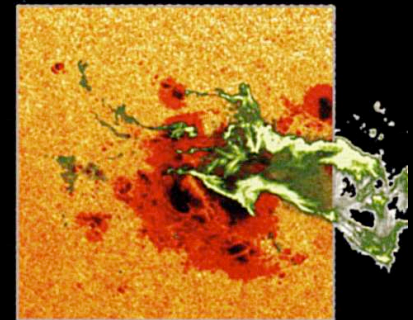
Stellar Heliospheres And CRs



Radiation Environment and SWx

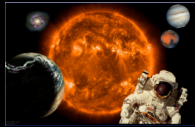


CMEs

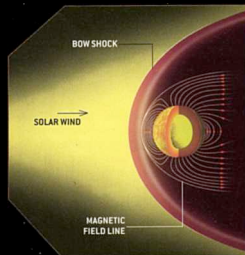
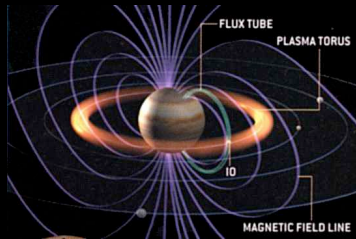


Flares

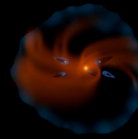
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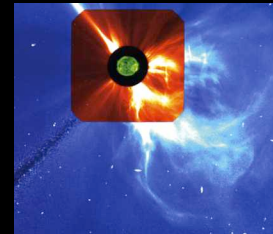
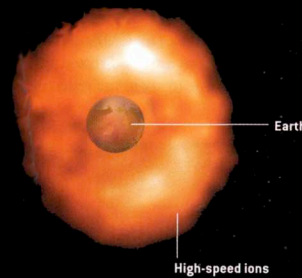
Radiation Environment and SWx



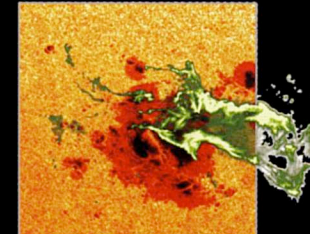
Planetary Magnetospheres



Stellar Heliospheres And CRs

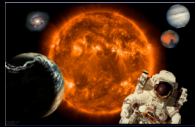


CMEs

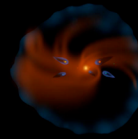
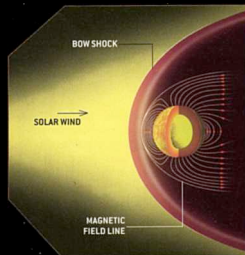
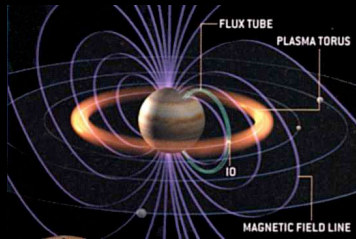


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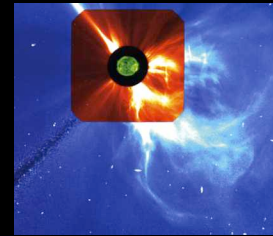
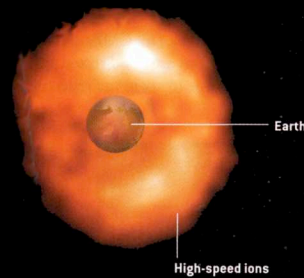
Magnetically Driven and Gravitationally Driven : S3C Science



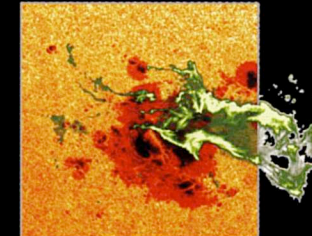
Radiation Environment and SWx



Stellar Heliospheres And CRs

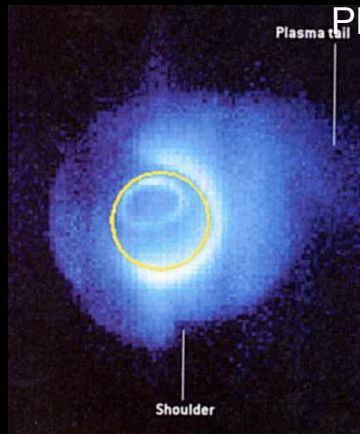


CMEs

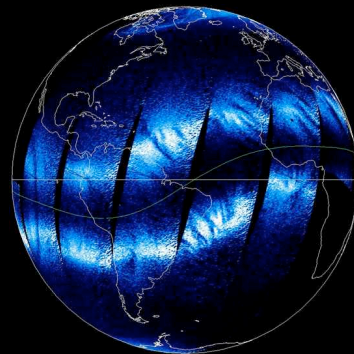


Flares

Planetary Magnetosph

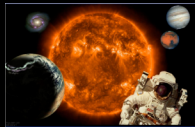


Aurorae

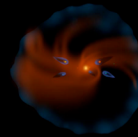


Ionospheres

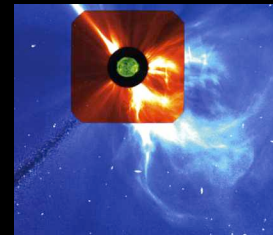
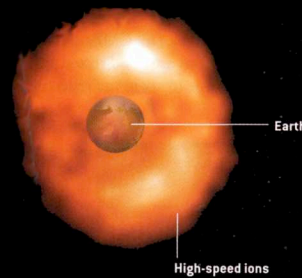
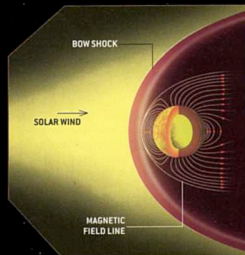
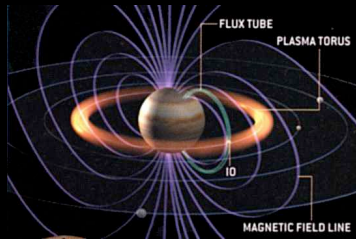
Magnetically Driven and Gravitationally Driven : S3C Science



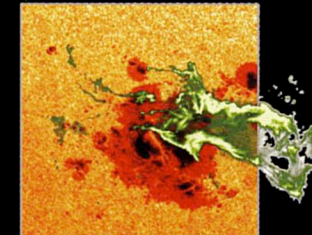
Radiation Environment and SWx



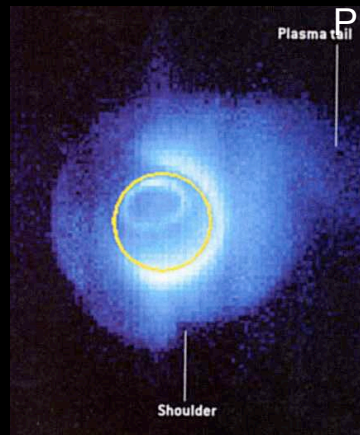
Stellar Heliospheres And CRs



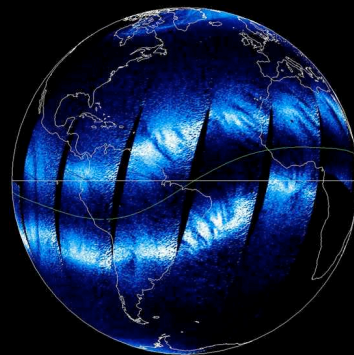
CMEs



Flares

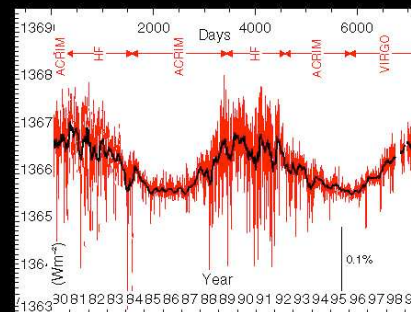


Planetary Magnetosph



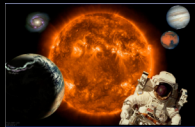
Aurorae

Ionospheres

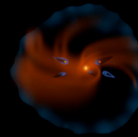
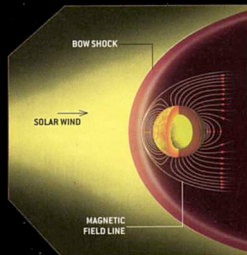
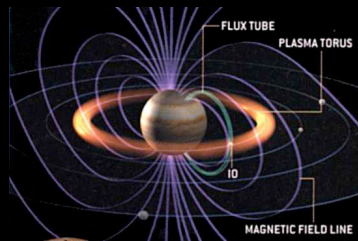


Total Solar Irradiance/Climate

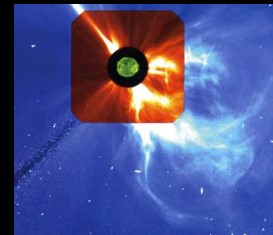
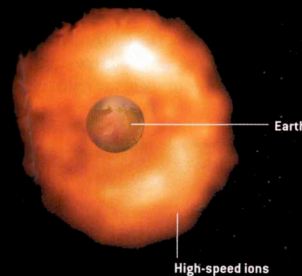
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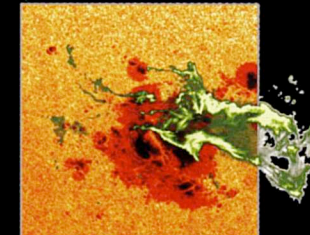
Radiation Environment and SWx



Stellar Heliospheres And CRs

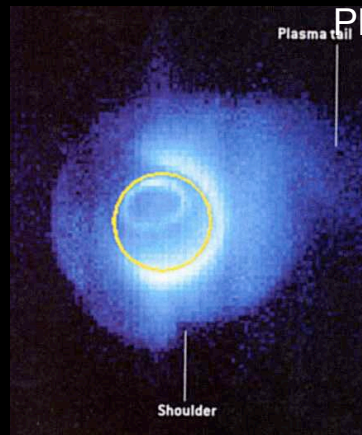


CMEs

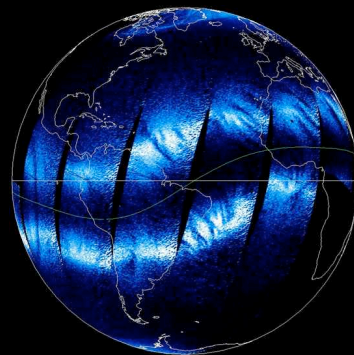


Flares

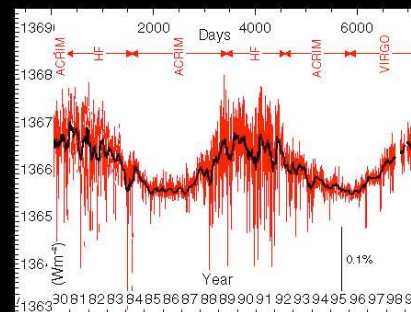
Planetary Magnetospheres



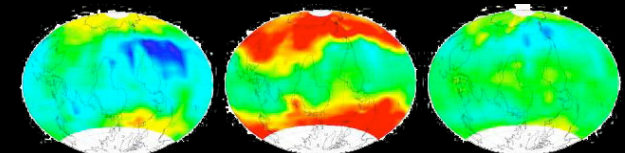
Aurorae



Ionospheres



Total Solar Irradiance/Climate



Upper Atmospheric Chemistry and Dynamics

Structures and Processes

Gravitationally
Driven

Magnetically
Driven

Galaxies

Nebulae

Planetary
Bodies

Magnetars

Pulsars

Stellar
Magnetism

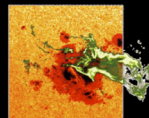
Stellar
Heliospheres
And CRs

Solar Variability

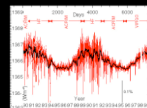
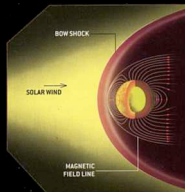
Radiation Environment and SWx



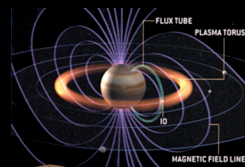
CMEs



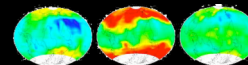
Flares



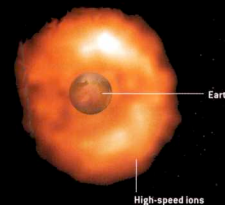
Total Solar Irradiance/Climate



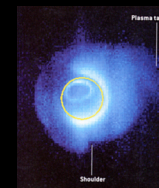
Planetary
Magnetospheres



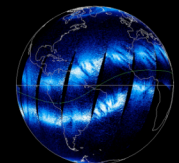
Atmospheric Chemistry



Aurorae



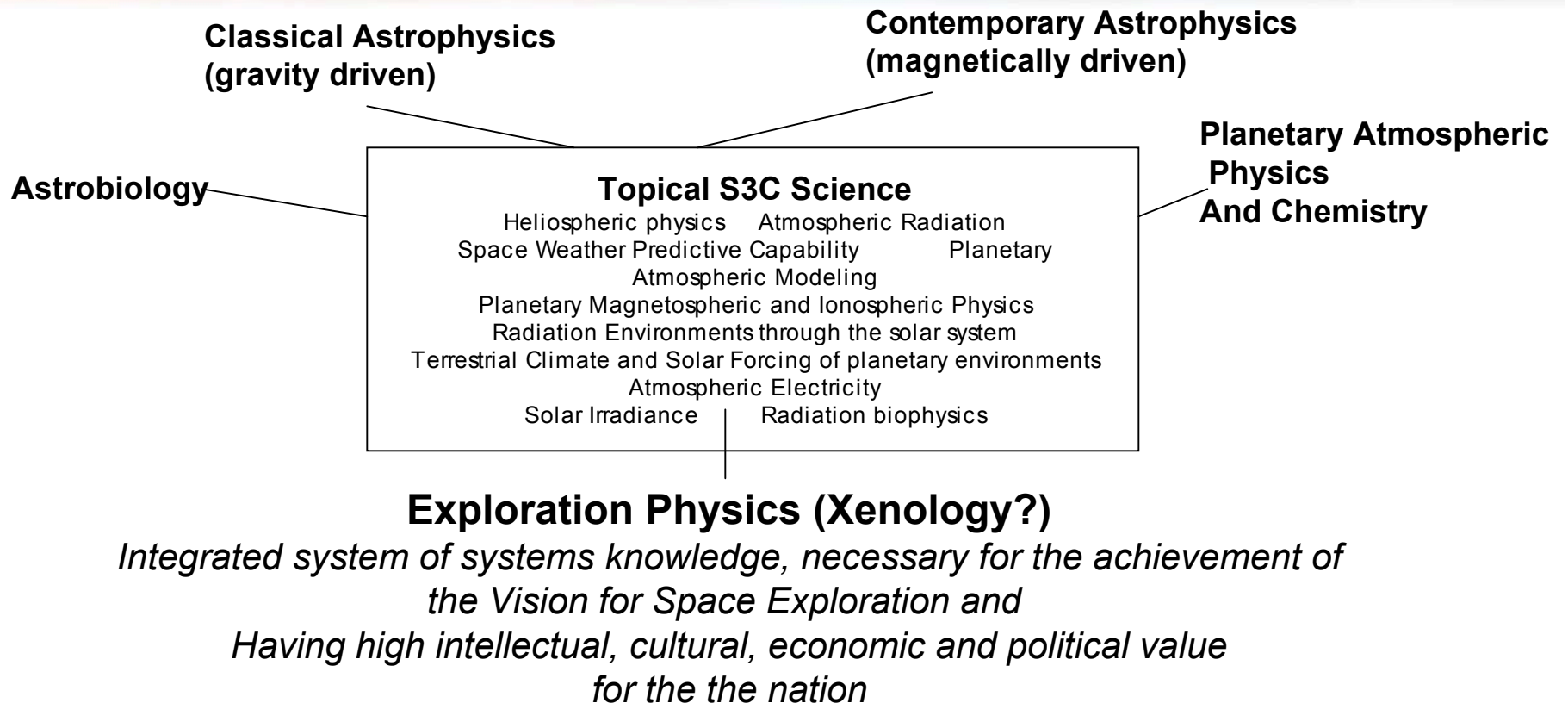
Ionospheres





The Concept of Consilience

E O Wilson (1998)



The result of comprehensive, wide-ranging investigations is **Consilience** (the word means "a jumping together," in this case many branches of human knowledge), producing a broad study that encourages researchers to bridge the gaps that yawn between and within the cultures of science. No such gaps should exist, Prof. Wilson maintains, for the sciences, humanities, and arts have a common goal: to give understanding a purpose, to lend to "a conviction, far deeper than a mere working proposition, that the world is orderly and can be explained by natural laws."



Can predictive or warning capability be developed before Lunar landing or Mars landing?

- **Assumptions**

- Lunar landing 2020, Mars landing 2032
- Each mission consists of 1 yr planning/selection, 4-yr development, 2-yr MO&DA
- An operational system is deployed prior to landing
- Several concepts need to be tried to select operational system

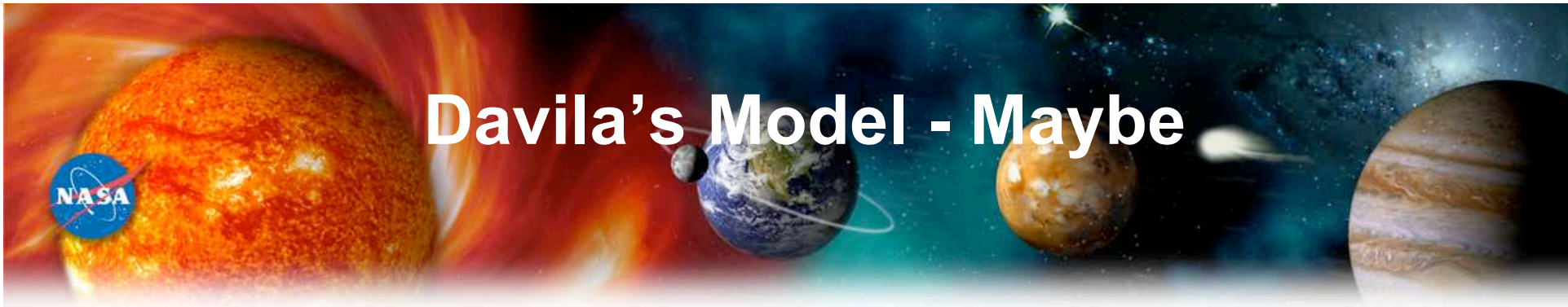
- **Results)**

- Only 1 mission can be built and flown prior to Lunar Operational System deployment
- 2 missions (scheduled end-to-end) can be built flown and data analyzed prior to deployment of the Mars Operational System.
- Parallel sets of end-to-end missions can be implemented to develop a set of alternatives for Mars Operational System

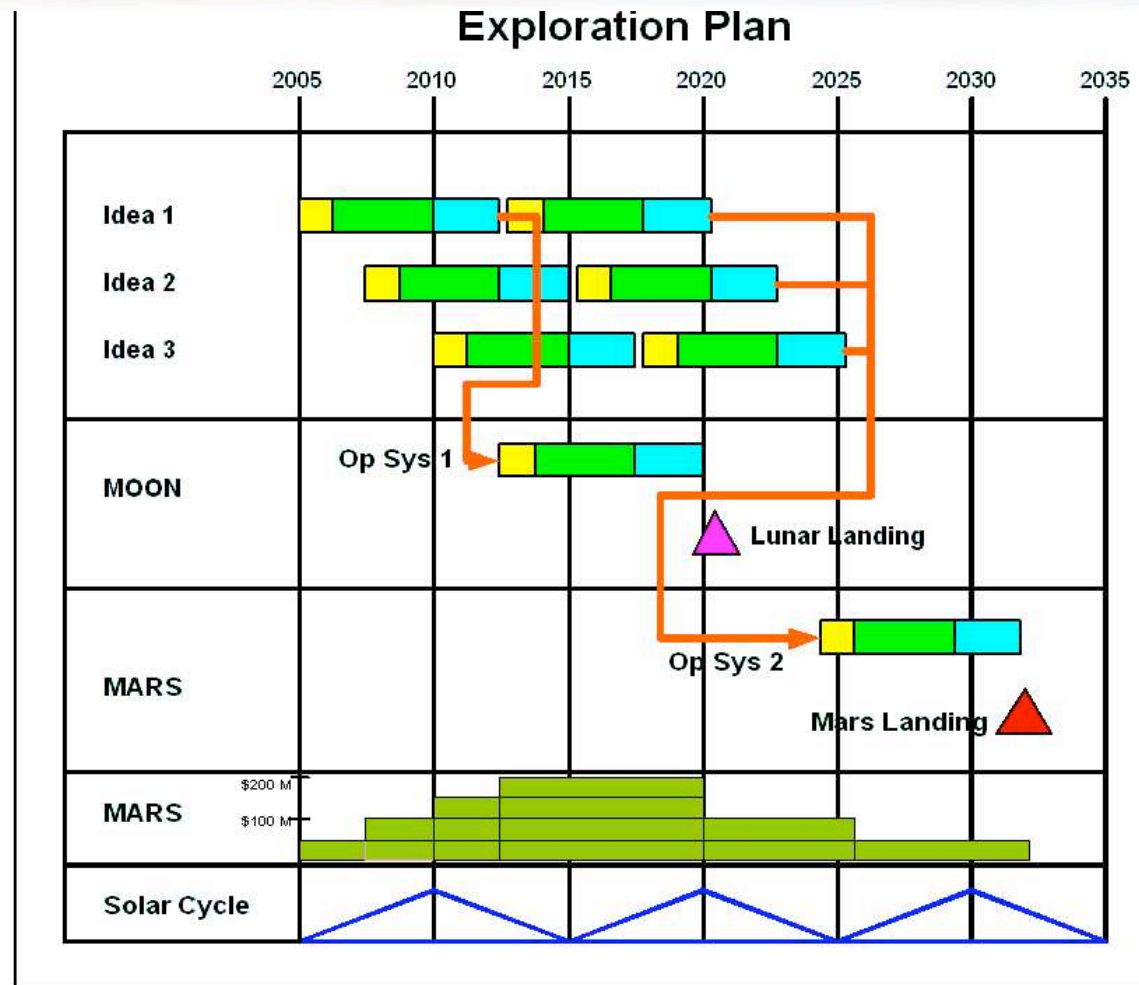
- **Conclusions**

- Developing predictive capability for Lunar landing is challenging but possible
- Perhaps a warning system with some limited prediction capability can be developed to support Mars landing

Joseph M Davila, SSSC Roadmap Input
(fisher edit- Jan 2005)



Davila's Model - Maybe





Challenge of the Roadmap

Take this unique confluence of events and conditions to:

Design the roadmap such that the resulting missions, required theory and modeling, and new data sets ensure the achievement of the Vision for Space Exploration.

In so doing, bare in mind the possibility of enabling the emergence of a new scientific discipline (yet unnamed) that describes and predicts the function of a solar system - a true system of systems. A science akin to Geology (1808), Meteorology (1869), and Oceanography (1882) - the sciences that enabled Exploration of the Earth.



A Few Words of Inspiration

From this day to the ending of the world,
But we in it shall be remembered-
We few, we happy few, we band of comrads;
For those to-day that sheds their (intellectual) blood with me
Shall be like kin; be they ne'er so vile,
This day shall gentle their condition;
*Make them member of the Exploration gentry, even if they be
common science folk-*
And gentlepersons in our land now-a-bed
Shall think themselves accurs'd they were not here,
And hold their values cheap whiles any speaks
That sat with us upon this Roadmap day.

Henry V,
before the Battle of Agincourt, (sort of)
25 October 1415



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