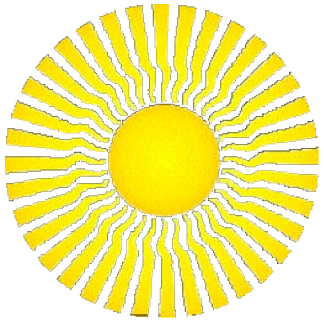
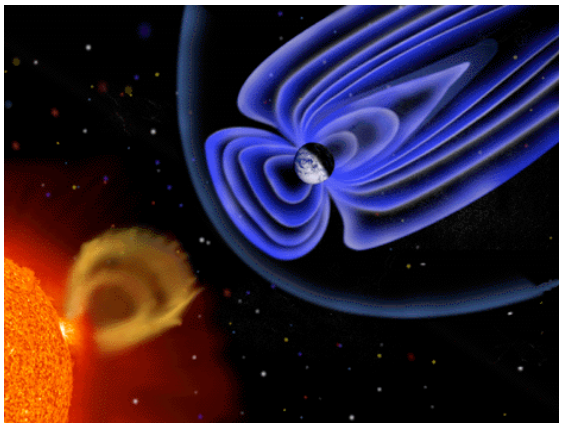


Solar Dynamics Observatory: Understanding Our Dynamic Star



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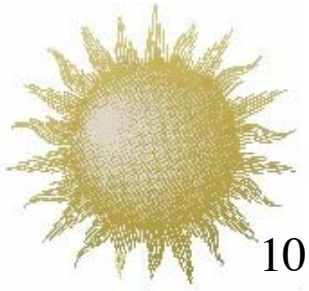
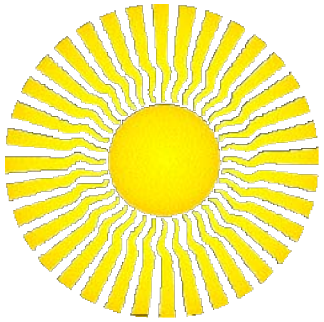
NASA Goddard Space Flight Center

Alan Title

Paul Caruso

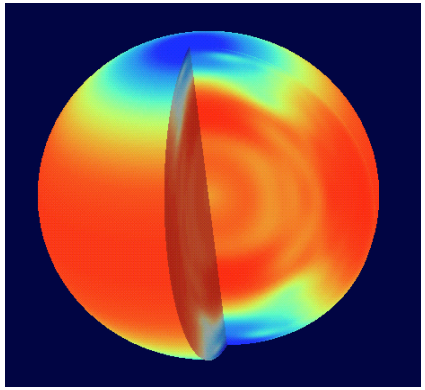
Gerry Daelemans

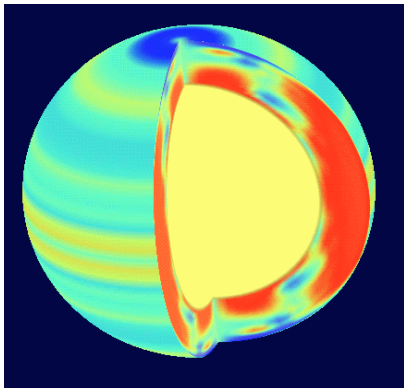


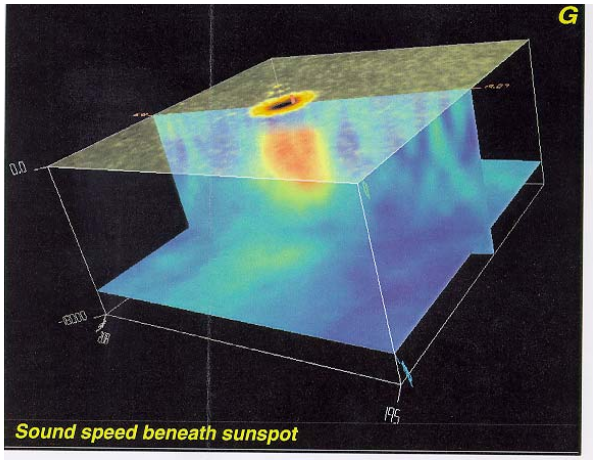


Solar Dynamics Observatory: Second Generation SOHO

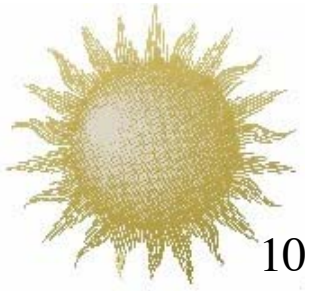
Goal: To determine, observe and understand the dynamic state of the Sun on the multiple temporal and spatial scales which influence life and technology on Earth.







Sunspot data from MDI High Resolution, 18 June 1998



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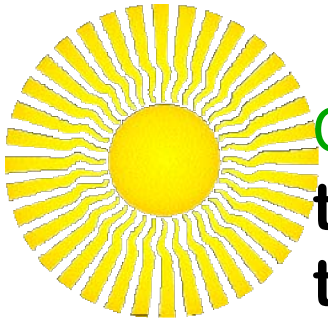
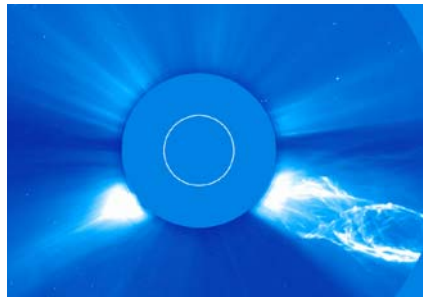
Solar Dynamics Observatory

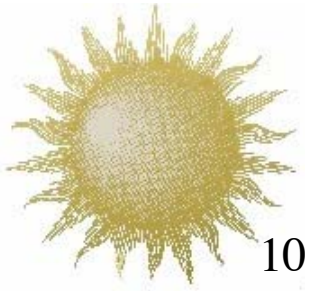


Goal: **To determine, observe and understand the dynamic state of the Sun on the multiple temporal and spatial scales which influence life and technology on Earth.**

This includes:

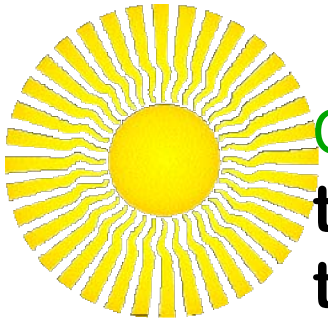
- developing an understanding of how relevant phenomena develop and behave
- driving towards a predictive capacity
- understanding the secondary processes which allow solar phenomena to influence Earth





10 May 2000 *Barbara J. Thompson barbara.thompson@gsfc.nasa.gov*

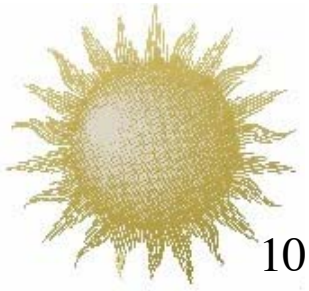
Solar Dynamics Observatory



Goal: **To determine, observe and understand the dynamic state of the Sun on the multiple temporal and spatial scales which influence life and technology on Earth.**

The phenomena which influence Earth include:

- Solar irradiance
- Transient events (coronal mass ejections, flares)
- The Sun's evolving structure
- The extension of the Sun's atmosphere to Earth: the Solar Wind
- The ultimate source and driver of these phenomena: the Sun's Interior



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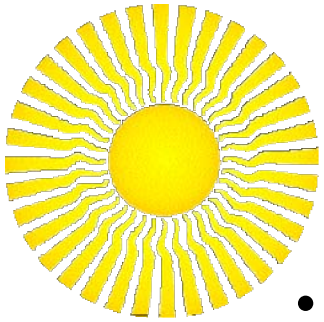
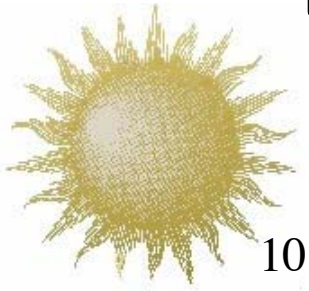


History - Programmatics

- Billed as “Second Generation SOHO”
- Currently “SONAR” (Solar Near-surface Active Region Rendering) on the SEC Roadmap
- Endorsed and highly prioritized in the Astronomy and Astrophysics Decadal Survey Report
- Preliminary Mission Definition Team met January 24, 2000 at GSFC to begin preliminary mission design process
- Integrated Mission Design Center (IMDC) conference February 16-23, 2000: initial mission design concept
- April - May 2000: Costing estimates and implementation plan finalization



Solar Dynamics Observatory

Preliminary Mission Definition Team

Tom Bogdan - High Altitude Observatory/NCAR
Leon Golub - Smithsonian Astrophysical Observatory/CFA
Russell Howard - Naval Research Laboratory
Steve Kahler - Air Force Research Laboratory
Dana Longcope - Montana State University
Victor Pizzo - NOAA/SEC
David Rust - Applied Physics Laboratory
Phil Scherrer - Stanford University
Lt. Col. Michael Bonadonna - US Air Force, Pentagon
Michael Golightly - Johnson Space Center
Lt. Col. Erwin Williams - Department of Defense
Lt. Col. Stephen Carr - Air Force Space Command
Capt. Riley D. Jay - Air Force Space Command
Major Peter Engelmann - Air Force Space Command

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History - Motivation

- **Continuous observations**
  (*e.g. SOHO* SOI)
- **High data rate and resolution**
  (*e.g. TRACE, SOHO* MDI)
- **Continuous contact**
  (*e.g. SOHO* LASCO/EIT, *WIND, ACE*)

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Mission Design Drivers

- Continuous (primarily) observations: L1 orbit or high-inc Earth orbit
- High data rate and resolution: near-Earth orbit
- Continuous contact: Single dedicated ground station or continous DSN schedule

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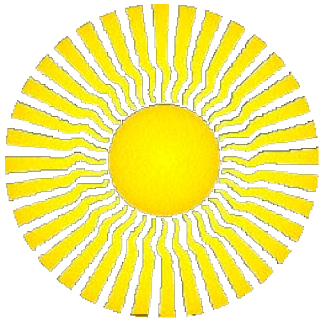
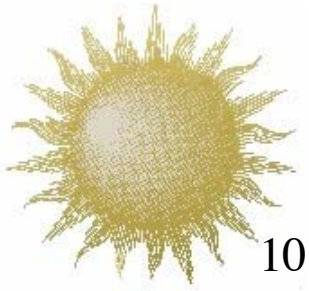


SDO Mission Features

- Observe the Sun continuously with a well-defined unchanging set of measurements
- Five year baseline - possibility of collecting data over an entire solar cycle
- Data analysis tool development
- Operations: single observing mode, streamlined observation plans



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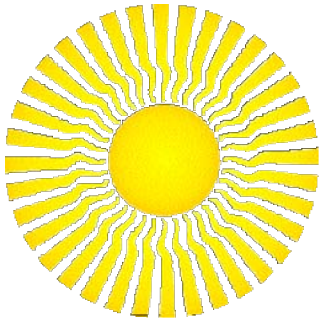
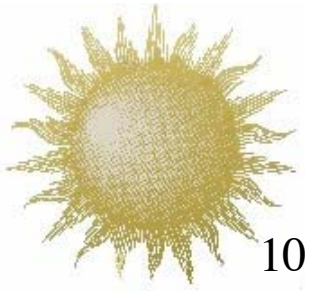


SDO Current Baseline Capabilities

- 10 arcsec accuracy and low jitter
- 120 Mbps data rate
- Continuous observations interrupted by brief eclipse periods
- Available instrument mass depends on spacecraft bus selection - ~ 250 kg



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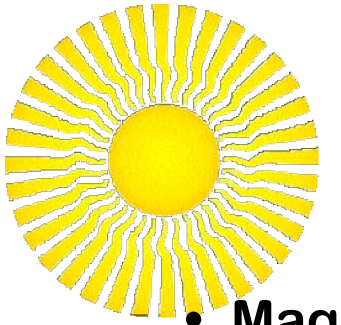
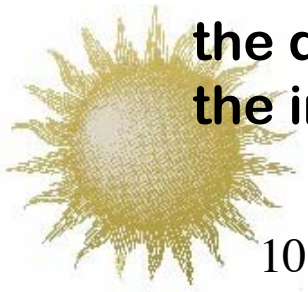


SDO Potential Instrument Complement

- Magnetograph / Helioseismograph capable of delivering a magnetic data product every 20 seconds, a vector magnetogram every 5 minutes, and a complete helioseismology data set every 45 seconds
- A suite of EUV/UV/Visible Telescopes to image the Sun simultaneously every 10 seconds, 4096x4096 CCD (.5 arcsec pixels)
- Coronagraphs capable of making polarization measurements from <1.2 to 18 Solar radii every 30 seconds, 4096x4096 CCD
- A complement of irradiance instruments to study the drivers of irradiance variations and the impact on climate and geospace



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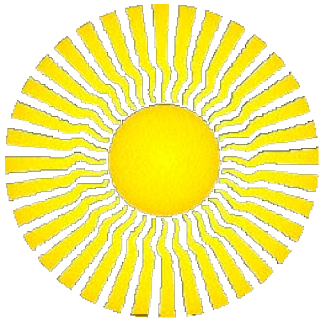
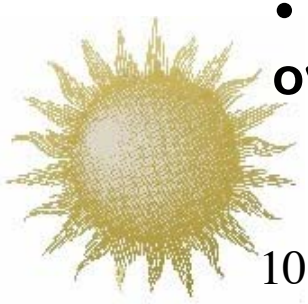


SDO Potential Science Questions

- Why are there sunspots and solar active regions?
- How do magnetic regions emerge, evolve and decay?
- How do the active-region fields interact with the small-scale fields?
- Do local dynamo processes occur?
- What can we learn about the origin of the solar wind, which serves as a continuous energy input to geospace?
- How does the large amount of magnetic energy that is created at small scales dissipate?
- Can we assess the variation of the solar interior over an entire solar cycle?



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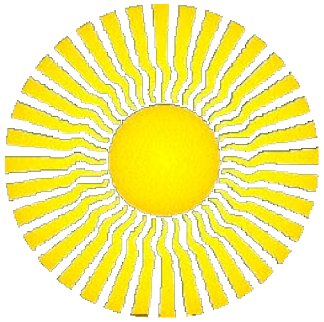
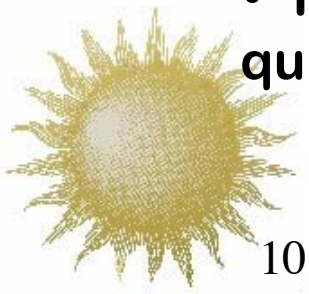


SDO Potential Science Questions

- What are the surface and subsurface configurations that lead to CME's and flares?
- How important are cascading processes of flux emergence to large-scale flux evolution and expulsion?
- To what extent are CME's and flares predictable?
- How do active regions and the magnetic carpet affect solar convection and irradiance?
- Can we understand the large-scale structure of the corona?
- How are the dynamics of the interior and the quiet and active solar corona linked?



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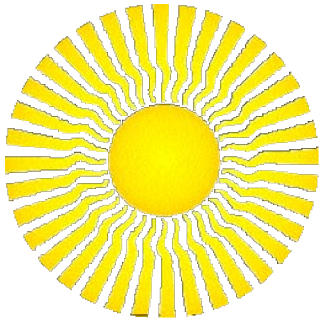
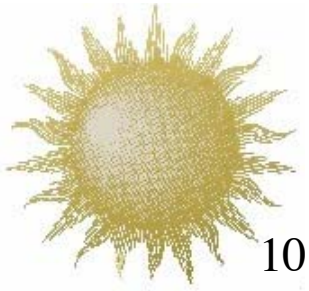


SDO Potential Science Questions

- What aspects of solar irradiance influences different regimes of geospace? Earth's climate?
- What are the processes contributing to the variations in irradiance?
- What can we learn about subsurface structures before they reach the photosphere?
- Can we further develop time-distance and other helioseismological techniques to assist in gauging the overall dynamic state of the Sun?



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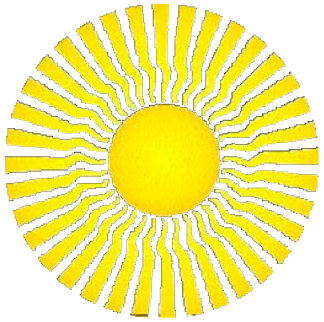
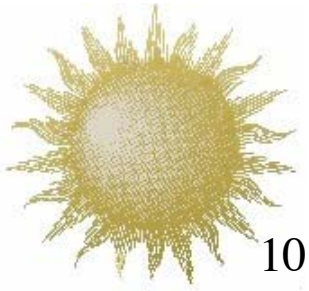


SDO Cost Drivers

- Continuous Contact -> Launch vehicle, ground station
- Instrument Complement (number of instruments, type of instruments, heritage)
- Reliability - 5-year mission baseline



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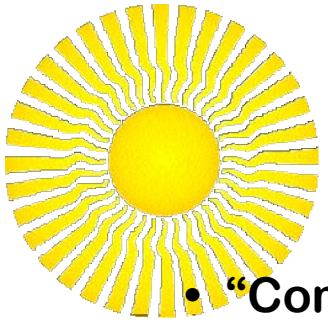
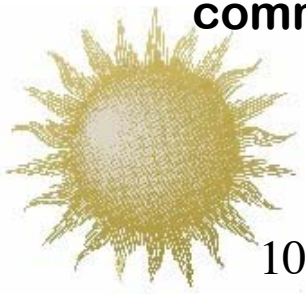


Future Challenges and Considerations

- "Complete" development of scientific priorities independent of mission design requires:
  - Complete assessment of all other instruments and initiatives which are complementary to LWS
  - Determination of supplemental measurements and science which will not be performed by SDO or any other planned missions which are essential to the success of LWS
  - Enabling of investigations which cut across traditional boundaries: decouple research from particular missions and instruments
- Continuity and stability: suborbital program?
- Integration with and responsiveness to the user community



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