Living With a Star

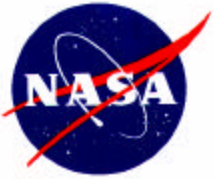## A Systems Approach to Sun-Earth Science

O. C. St. Cyr

LWS Senior Project Scientist

NASA-GSFC Solar Physics Branch (Code 682)
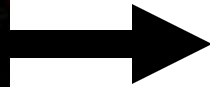
301-286-2575 (Chris.StCyr @nasa.gov)

lws.gsfc.nasa.gov

The Sun-Earth Connected System

Magnetically-Variable Star

Varying

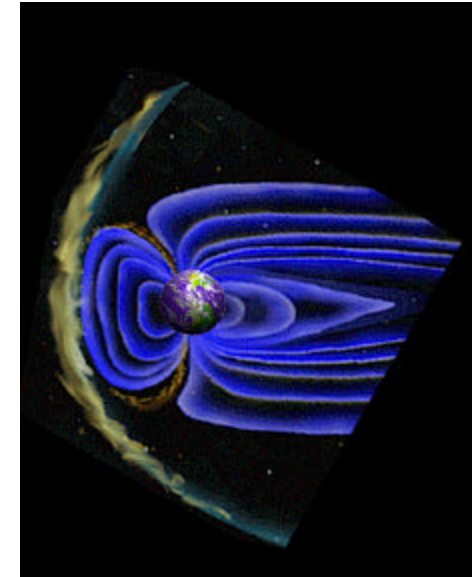- Radiation
- Solar Wind
- Energetic Particles

Interacting

- Solar Wind
- Energetic Particles

Interacting
- Magnetic Fields
- Plasmas
- Energetic Particles
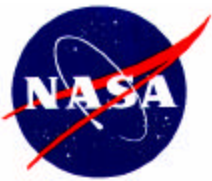
Magnetic Planet

Interacting
- Magnetic Fields
- Atmosphere
- Plasma
- Energetic Particles

Questions:

- *How and why does the Sun vary?*

- *How does Earth respond?*

- *What are the impacts on humanity?*

LWS MOWG June 2003

Why Do We Care

- **Solar Variability Affects Human Technology, Humans in Space and Terrestrial Climate.**
- **The Sphere of the Human Environment Continues to Expand Above and Beyond Our Planet.**
  - Increasing dependence on space-based systems
  - Permanent presence of humans in Earth orbit and beyond
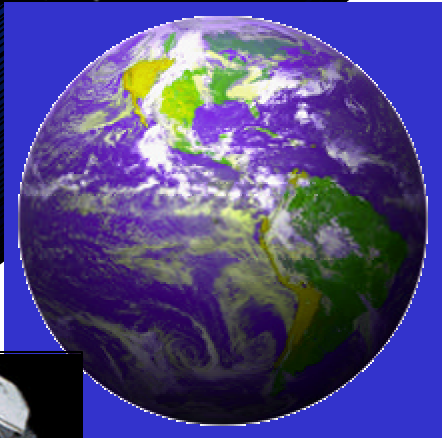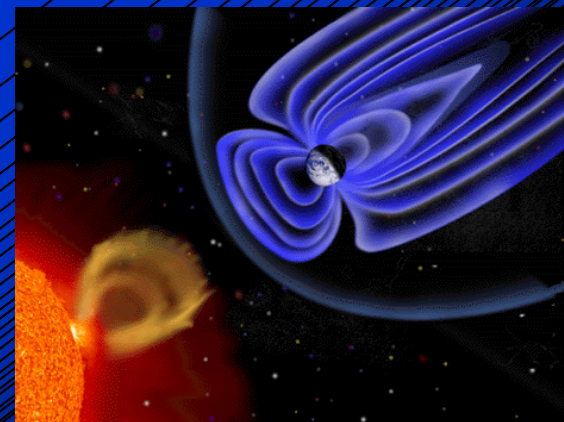
Science Application as the Focus

The primary goal of the LWS Program is to develop the understanding necessary to enable the U.S. to effectively address those aspects of the Connected Sun-Earth system that directly affect life and society.

- **Space Weather**

- **Sun-Climate Connection**
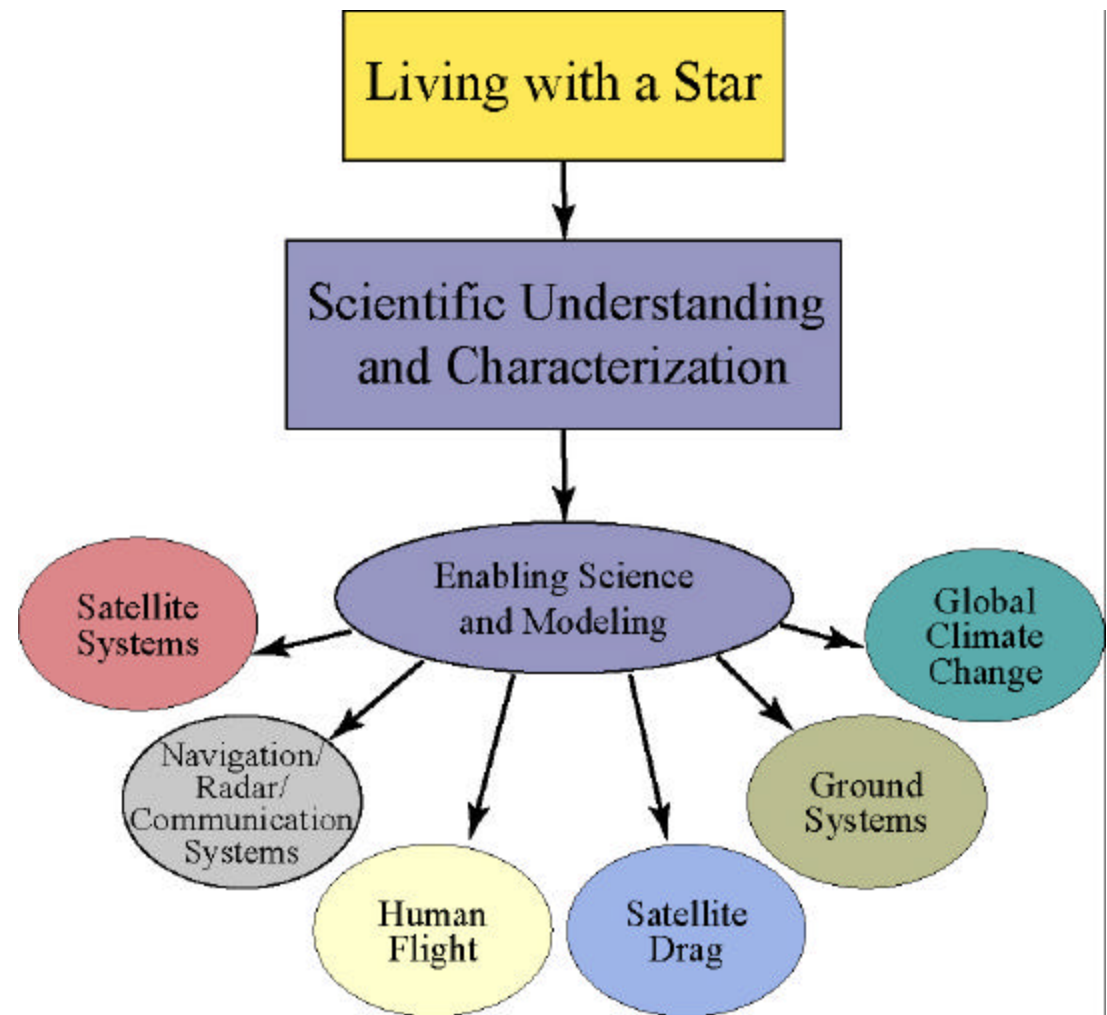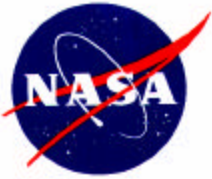
LWS is a Systems Approach

LWS focuses not on any one region of space, but rather on our Sun Earth Region as one system.
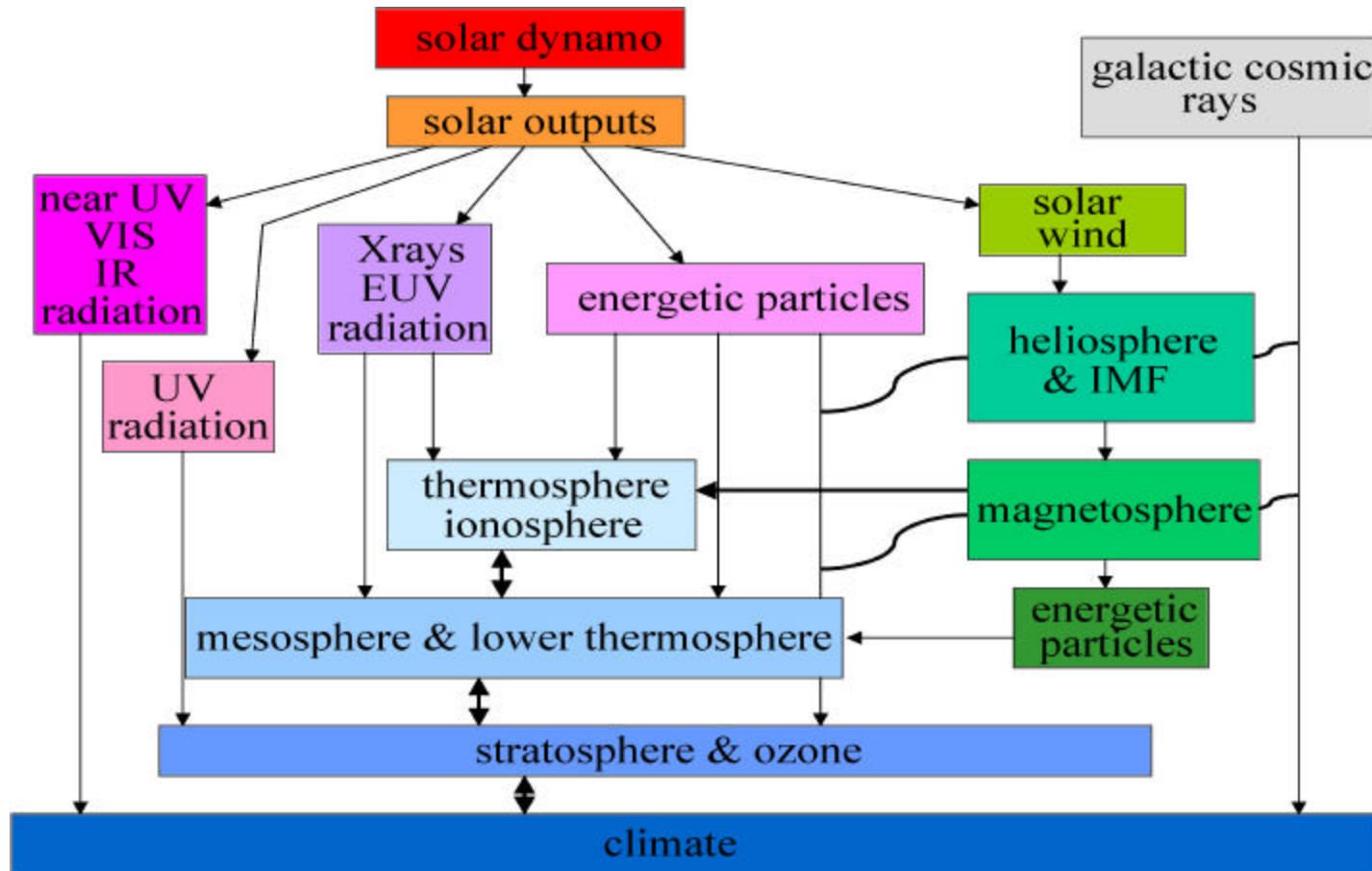
A very important part is the study of the connection between the regions and how one drives a response in another.

LWS Program History

- Spring 1999 - George Withbroe, SEC Theme Director began investigating the idea of a new initiative on Space Weather

- Spring 2000 - GSFC scientists organized a community meeting to gather input for LWS program

- Based on preliminary GSFC work, a new start was approved and moved up to 2001

- LWS program became a partnership between GSFC and APL

- 2000-2001 - GSFC and APL scientists defined the program with the scientific community (Science Architect Team)

- 2001-2002 - GSFC scientists led science definition teams to prepare the SDO SDT report and the Geospace MDT report

- 2002-2003 – GSFC and APL scientists participated in TR&T SDT
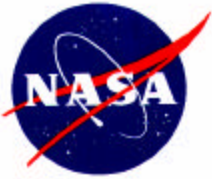
GSFC & APL LWS Science Team

J. Barth	GSFC	SET Project Scientist
N. Fox	JHU/APL	
B. Giles	GSFC	Geospace Project Scientist
N. Gopalswamy	GSFC	CDAW/Workshop Coordinator
J. Grebowski	GSFC	Deputy Geospace Project Scientist
D. Haggerty	JHU/APL	Heliospheric Sentinels Project Scientist
M. Hesse	GSFC	TR&T Study Scientist -- CCMC Director
C. Jackman	GSFC	Sun-Climate Liaison
T. Kucera	GSFC	Data Environment Project Scientist
B. LaBonte	JHU/APL	Data Environment Project Scientist
B. Mauk	JHU/APL	Geospace Project Scientist
D. Pesnell	GSFC-Nomad	SDO Assistant Project Scientist
R. Pfaff	GSFC	C/NOFS Liaison
D. Rabin	GSFC	
D. Rust	JHU/APL	
D. Sibeck	GSFC	ILWS Executive Secretary
J. Slavin	GSFC	
C. St. Cyr	GSFC	LWS Senior Project Scientist
A. Szabo	GSFC	Heliospheric Sentinels Project Scientist
B. Thompson	GSFC	SDO Project Scientist
R. Vondrak	GSFC	
S. Yee	JHU/APL	
L. Zanetti	JHU/APL	LWS Senior Project Scientist
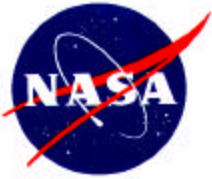
LWS Management Organization

JHU/APL

NASA HQ

NASA GSFC

SEC Program Director
R.R. Fisher

LWS Program Executive
Dana Brewer

LWS Program Scientist
M. Guhathakurta

SEC Program Manager
Gil Colon

LWS Senior PS
Larry Zanetti

LWS Program Manager
Ken Potocki

LWS Program Manager
Nick Chrissotimos

LWS Senior PS
O.C. St. Cyr

Geospace PS
Barry Mauk

Geospace PM
Peter Bedini

APL Project Managers
for APL Missions

SDO PM
Ken Schwerr

SDO PS
Barbara Thompson

Geospace PM
Bob Lebair

Geospace PS
Barbara Giles

SET PM
Bert Dixon

SET PS
Janet Barth

GSFC Project Managers
for GSFC Missions

LWS MOWG June 2003

LWS Program Components

- **Science Missions**
  - Solar Dynamics Observatory (SDO)
  - Geospace (I-T, RB, FUV)
  - Heliospheric Sentinels

- **Engineering Missions**
  - Space Environment Testbeds (SET)

- **Targeted Research and Technology (TR&T)**
  - Theory, Modeling, Data Analysis
  - Data Environment Development
  - Instrumentation Development
  - Sun-Climate Task Group

TR&T Organization

SEC Program Director

LWS Program Scientist

NASA-HQ

LWS Community

TR&T SDT
LWS MOWG

TR&T
Steering
Committee

NASA-GSFC

LWS TR&T Public Web Site
Abstracts
Reports
Tools & Products

TR&T Project Scientist | Admin/RA/Web

NASA-HQ selected
LWS TR&T
Proposals

TMDA Project Scientist

Data Environment Scientists

SET Project Scientist

Campaign/Workshop Coordination

Other LWS Scientists
(as needed)

Goddard
Procurement
Offices

LWS Components Status

LWS Science Architecture Team

Chair: G. Mason

Generated program-level science requirements

SDO SDT

Chair: D. Hathaway

→ Pre-formulation → AO → Payload Selection → Formulation

Geospace MDT

Chair: P. Kinter

→ I-TSP / FUV / RBSP → Pre-formulation → AO

TR&T SDT

Chair: J. Gosling

→ Target Areas → Annual ROSS NRA

Sentinels Strategy Panel

Study Scientist: A. Szabo

Sun-Climate Task Group

Leader: J. Eddy
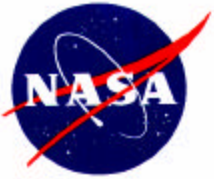
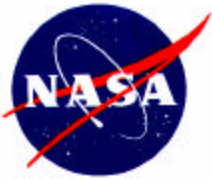# Science Community Involvement

LWS Science Workshops

- May 2000 in Greenbelt

- Nov 2002 at JHU/APL

- Winter 2004 (SDO-focus workshop in discussion)

- Fall 2004 (MSFC modelling workshop in discussion)

•LWS MOWG

E/PO

- E/PO efforts of Missions and Investigators are coordinated at the SEC Program Office at Goddard (both LWS and STP)

- LWS/STP Education focus has been K-12

- LWS/STP Public Outreach plan is being formulated

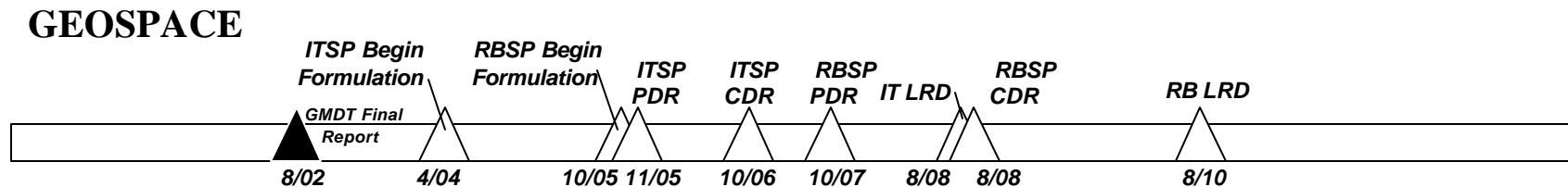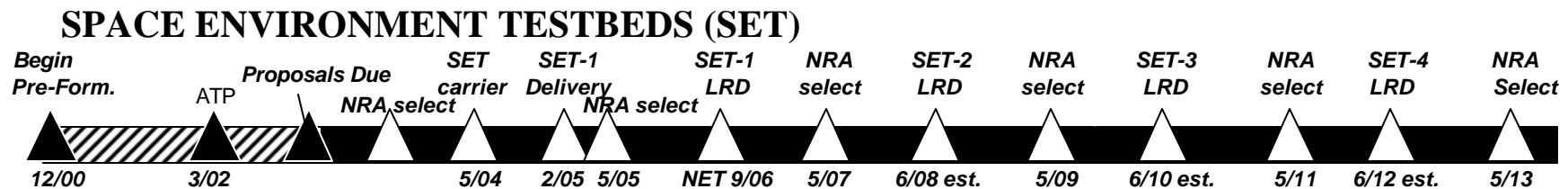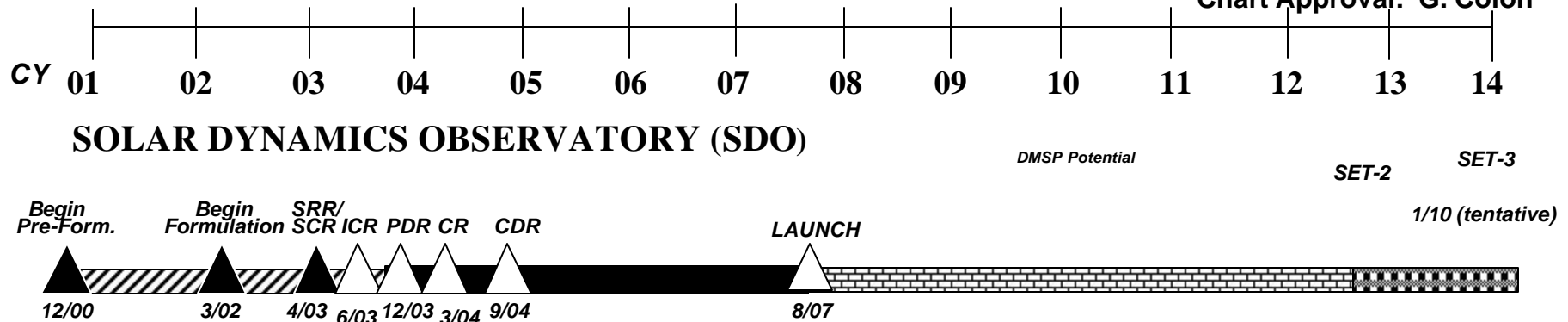 - Steele Hill, Art Poland, Isabel Hawkins

Living With A Star Program

CY **01 02 03 04 05 06 07 08 09 10 11 12 13 14**

SOLAR DYNAMICS OBSERVATORY (SDO)

DMSP Potential

SET-2

SET-3

Begin Pre-Form. **Begin Formulation** **SRR/ SCR** **ICR** **PDR** **CR** **CDR** **LAUNCH**

1/10 (tentative)

12/00 3/02 4/03 6/03 12/03 3/04 9/04 8/07

SPACE ENVIRONMENT TESTBEDS (SET)

Begin Pre-Form. **ATP** **Proposals Due** **NRA select** **SET carrier** **SET-1 Delivery** **NRA select** **SET-1 LRD** **NRA select** **SET-2 LRD** **NRA select** **SET-3 LRD** **NRA select** **SET-4 LRD** **NRA Select**

12/00 3/02 5/04 2/05 5/05 NET 9/06 5/07 6/08 est. 5/09 6/10 est. 5/11 6/12 est. 5/13

GEOSPACE

ITSP Begin Formulation **RBSP Begin Formulation** **ITSP PDR** **ITSP CDR** **RBSP PDR** **IT LRD** **RBSP CDR** **RB LRD**

GMDT Final Report

8/02 4/04 10/05 11/05 10/06 10/07 8/08 8/08 8/10

SOLAR SENTINELS

(*MISSION ARCHITECTURE UNDER STUDY*)

| //// Formulation	☐ Study	▦ Extended Mission
■ Development	▦ Prime Mission	⌐ ¬ Subject to revision during Phase A

Status As Of: 05/02/03
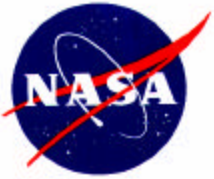
Sun-Climate Connection

- Task Group Chaired by Jack Eddy met in June 2003
  - Charter is to develop a comprehensive intellectual foundation for the scientific investigation of the influence of solar variability on climate, and through this process, to help refine the focus and definition of the Sun-Climate component of the NASA LWS Program
- Goals
  - to assess the current state of Sun-Climate science and associated uncertainties
  - to identify high priority questions for future research
  - to identify opportunities for progress in the next five years and the next decade
  - to outline the essentials of a viable Sun-Climate research effort
- Report will be generated based on meeting discussions presenting a well-reasoned foundation and priority goals for the study of possible solar influences on climate
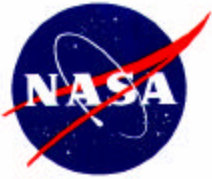
Sun-Climate Connection

- **Task Group Members**

•Gerard Bond	Lamont Doherty Geophysical Observatory
•Jack Eddy, Chair	National Solar Observatory
•Len Fisk	University of Michigan
•Rolando Garcia	National Center for Atmospheric Research
•Charles Jackman	NASA GSFC
•Judith Lean	Naval Research Laboratory
•Michael Prather	Univ. of California at Irvine
•George Reid	University of Colorado
•David Rind	NASA GISS
•Michael Schlesinger	University of Illinois
•George Withbroe	George Mason University

- **EX OFFICIO:**

•Don Anderson	NASA HQ Code Y
•Richard Fisher	NASA HQ Code S
•Lika Guhathakurta	NASA HQ Code S
•Chris St. Cyr	NASA GSFC

Summary

- **Science Missions**
  - Solar Dynamics Observatory (SDO)
    - Instruments selected; Completing Phase A
  - Geospace (I-T, RB, FUV)
    - AO for instruments in preparation
  - Heliospheric Sentinels
    - Strategy panel – leverage through International partners

- **Engineering Missions**
  - Space Environment Testbeds (SET)
    - Initial flight experiments selected; DMSP opportunity in 2006

- **Targeted Research and Technology (TR&T)**
  - Third round of NRA awards announced; SDT completing report
  - Sun-Climate Task Group; Initial meeting June 2003