NASA Space Weather Challenges

Dr. Michael Ryschkewitsch

NASA Chief Engineer

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Architecture Studies

- **Building up to the architectures, we**
  - Identified NASA Mission Directorate's strategic and mission requirements
  - Described current state of space weather/climatology architecture (sensors, models, simulation facilities, and forecasting capability)
  - Documented current trends and challenges in operational space weather
- **We considered three notional architectures**
  - "Status quo" (extending today's capability into the future)
  - "Improved" (implementing current state of the art)
  - "Ideal" (what might be deployed incorporating expected findings from planned missions but within budget realism)

This study facilitated and encouraged substantial communication and coordination across NASA and the space weather community

Space Weather Activities and NASA Operations

Solar Imager(s)

Heliosphere Monitor(s)

Magnetosphere Monitor(s)

Particle Environment Monitor(s)

Dosimeter data

Outlook/ Warning/ Alert

Impact/ Options

Instructions, Commands

Space Weather Forecast Center

Mission Support

Mission Operations

Models and Analysis Input

Climatology
Nowcast
Forecast

Limits
Environment
Transport Code

Flight Plan
Flight Rules

Human Missions

Crew Vehicle

Shielding

Dose/Dose Rate Monitors

Communications

Habitat

Rover

Suit

Concept of Surface Operations

Robotic Missions

- Total dose estimates for mission design
- Operations support
- Anomaly resolution

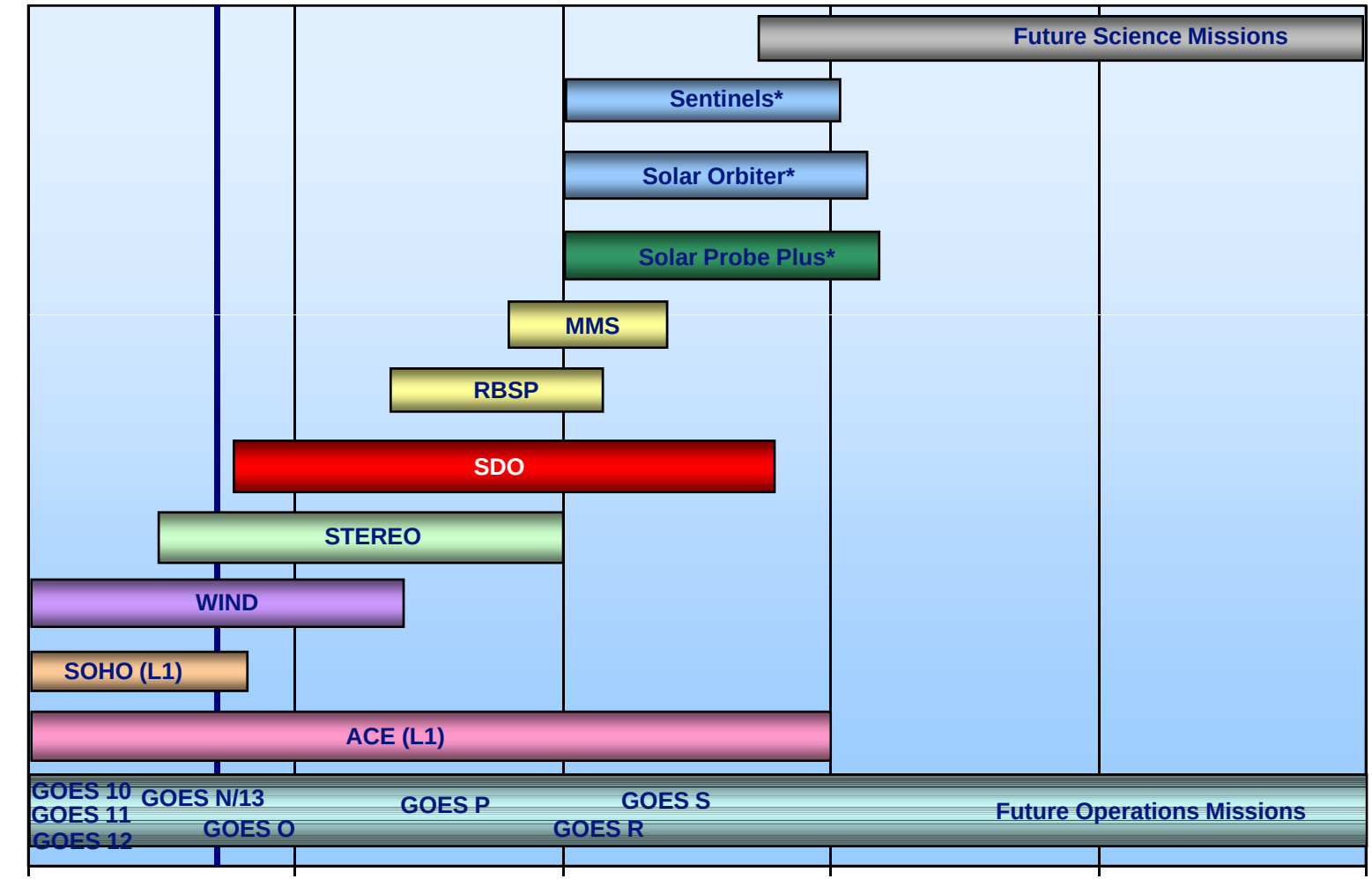
Launch Operations

- Risk to Avionics
- Anomaly resolution

Aeronautics

- Risk to Avionics
- Human exposure

Key Heliophysics and Space Weather Mission Timelines



* Sentinel, Solar Orbiter and Solar Probe Plus Not Earlier than 2015

Next Steps

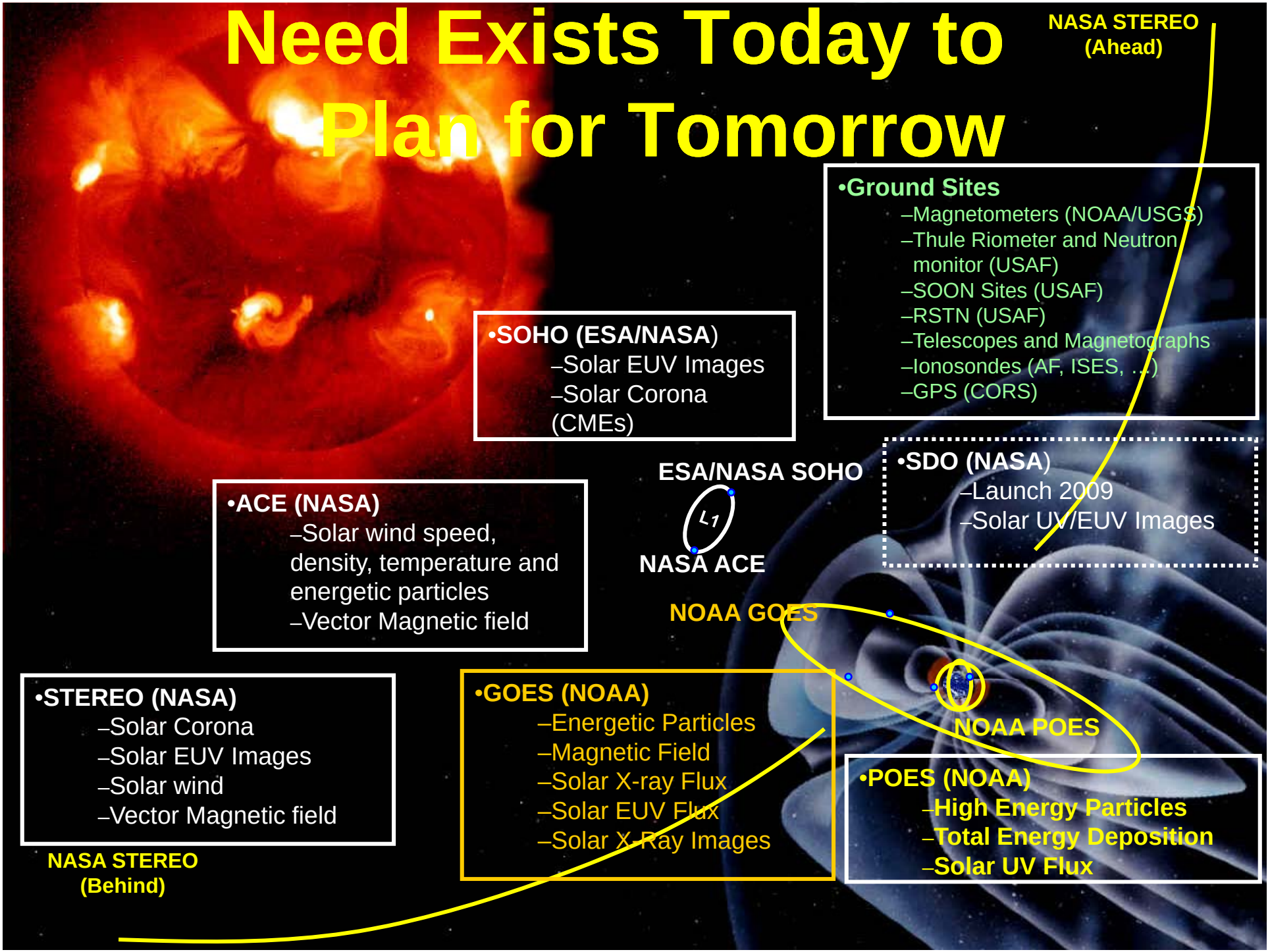
- A series of initiatives will be developed to support the implementation of report recommendations
- The initiatives will be presented to the NASA Technical Investment Steering Committee (pre-brief in June/July, Implementation in September)
- Selected initiatives will begin implementation as soon as practical and will be phased to support critical timelines for decision makers
  - Formulation over spring/summer of 2009
  - Approval for implementation in time for FY 10 Kick-off

Needed: an approach which continues to build on momentum and cooperation/collaboration

Focus: preserve efforts to understand fundamental physics of the space environment, compile operationally effective space weather observations, produce appropriate operational models, and maintain associated communications to support NASA missions throughout the solar system through 2028 and beyond

Backup

Need Exists Today to Plan for Tomorrow



Space Weather Challenges to NASA Operational Mission Support

- **Ensure the health and performance of crews living and working beyond the protection of the Earth's atmosphere and magnetic field**
- **Improve our understanding of the consequences of space radiation exposure to astronauts, with emphasis on reducing the uncertainty to 50 percent**
- **Ensure appropriate observations for space weather forecasts are available to meet NASA-specific requirements for use in the 2015-2020 timeframe**
- **Predict the onset and evolution of SPEs within the first hours of an event, with emphasis on the ability to forecast 6 to 12 hour "All Clear" periods**
- **Develop spacecraft subsystems, including life support systems, for optimum mission performance in the space environment**
- **Provide efficient and effective space weather operational support to robotic missions**
- **Develop climatological and dynamic models of the space environment for design and operation of optimal space systems**
- **Minimize time-lag between development of research models of space weather and their application in user-friendly tools for mission operations**
- **Develop and implement standards and guidelines for space system radiation hardness and space environment risk mitigation**
- **Improve Intra- and Inter-agency communication and cooperation in space weather related activities**

Human Radiation Research	Operational Space Weather	Programmatic/Policy