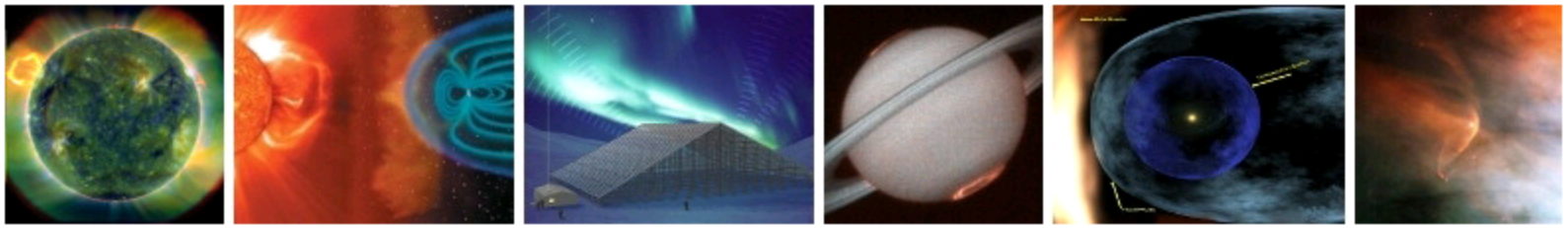
Space Weather and the 2013-2022 NRC Decadal Survey in Solar and Space Physics (Heliophysics)



Art Charo
Senior Program Officer
Space Studies Board
National Research Council

SWEF-Session 4
June 5, 2012

WHY UNDERTAKE A "DECADAL SURVEY"

- Take a long-term look at the field and recommend top priority scientific goals and directions for the future;
- Direct recommendations to the principal agencies that support facilities and research in the relevant fields;
- Provide recommendations for programmatic directions and explicit priorities for government investment in research facilities, including space flight missions; and
- Address issues of advanced technology, infrastructure, interagency coordination, education, and international cooperation.

Facilitates Planning, Coordination, Advocacy, and Outreach

Context

- *The Sun to the Earth—and Beyond: A Decadal Research Strategy in Solar and Space Physics*
  - Summary Report (2002)
  - Compendium of 5 Study Panel Reports (2003)
- The 2003 Survey was the first NRC decadal survey in Solar and Space Physics:
  - Community-led
  - Integrated plan for the field
  - Prioritized recommendations
  - Sponsors: NASA (SMD), NSF (GEO), NOAA (NESDIS), DoD (AFOSR and ONR).

Task Statement for the 2013-2022 Decadal Survey

- Provide an overview of the science and a broad survey of the current state of knowledge in the field, including a discussion of the relationship between space- and ground-based science research and its connection to other scientific areas;
- Identify the most compelling science challenges that have arisen from recent advances and accomplishments;
- Identify—having considered scientific value, urgency, cost category and risk, and technical readiness—the highest priority scientific targets for the interval 2013-2022, recommending science objectives and measurement requirements for each target rather than specific mission or project design/implementation concepts; and
- Develop an integrated research strategy that will present means to address these targets.

Note: In the 2013-2022 Survey, there is much greater emphasis on evaluating the technical maturity and probable costs of candidate "reference missions."

Survey Organization

- Steering Committee: 19 members
  - Chair, D.N. Baker; Vice-Chair, T. Zurbuchen
  - Representatives from across the community; including a member from each interdisciplinary study panel.
- Interdisciplinary Study Panels (~12 members for each panel)
  - Atmosphere-Ionosphere-Magnetosphere Interactions
  - Solar Wind-Magnetosphere Interactions
  - Solar and Heliospheric Physics
- "National Capabilities" Working Groups: Theory/Modeling, Technology; Platforms; R2O/O2R; Education and Society
- Focused Workshops: R2O/O2R; SP+

SpaceWx in the 2003 Survey

- Challenge 5: Developing a near real-time predictive capability for understanding and quantifying the impact on human activities of dynamical processes at the Sun, in the interplanetary medium, and in Earth's magnetosphere and ionosphere. What is the probability that specific types of space weather phenomena will occur over periods from hours to days?
  - Recommendations to NASA, NOAA, and NSF regarding missions, facilities, and policies towards meeting the challenge.

Since 2003:

- Progress: Solar EUV operational on GOES; WSA-Enlil model operational and improving forecasts for CME arrivals; funding in place for L1 monitor. Exciting new capabilities from NASA and NSF successes.
- Disappointments: Impact of NPOESS restructuring on space environment monitoring.
- Concerns: Agencies still operating largely ad hoc vis-à-vis SpaceWx R2O; Available resources will not meet future needs.

SpaceWx Needs and Capabilities

- **Real-time upstream measurements of solar wind parameters and solar energetic particle intensities**:
  - Currently relying on instruments on ACE (launched in 1997); DSCOVR may provide a follow-on; but no plans beyond and no plans to develop enhanced operational capabilities for continuous monitoring from L1.
- **Real-time detection of Coronal Mass Ejections (CMEs):**
  - Coronagraphs observe CMEs and they are able to indicate halo CMEs, which, when Earth-directed, may produce strong geomagnetic disturbances, however:
    - SOHO/LASCO (launch Dec. 1995): extended mission phase ends 12/31/12. SDO (Feb. 2010) does not have a coronagraph
    - STEREO (launched Oct. 2006): 2-year mission; 5-year goal and no follow-on
    - Coronagraph no longer planned for DSCOVR.

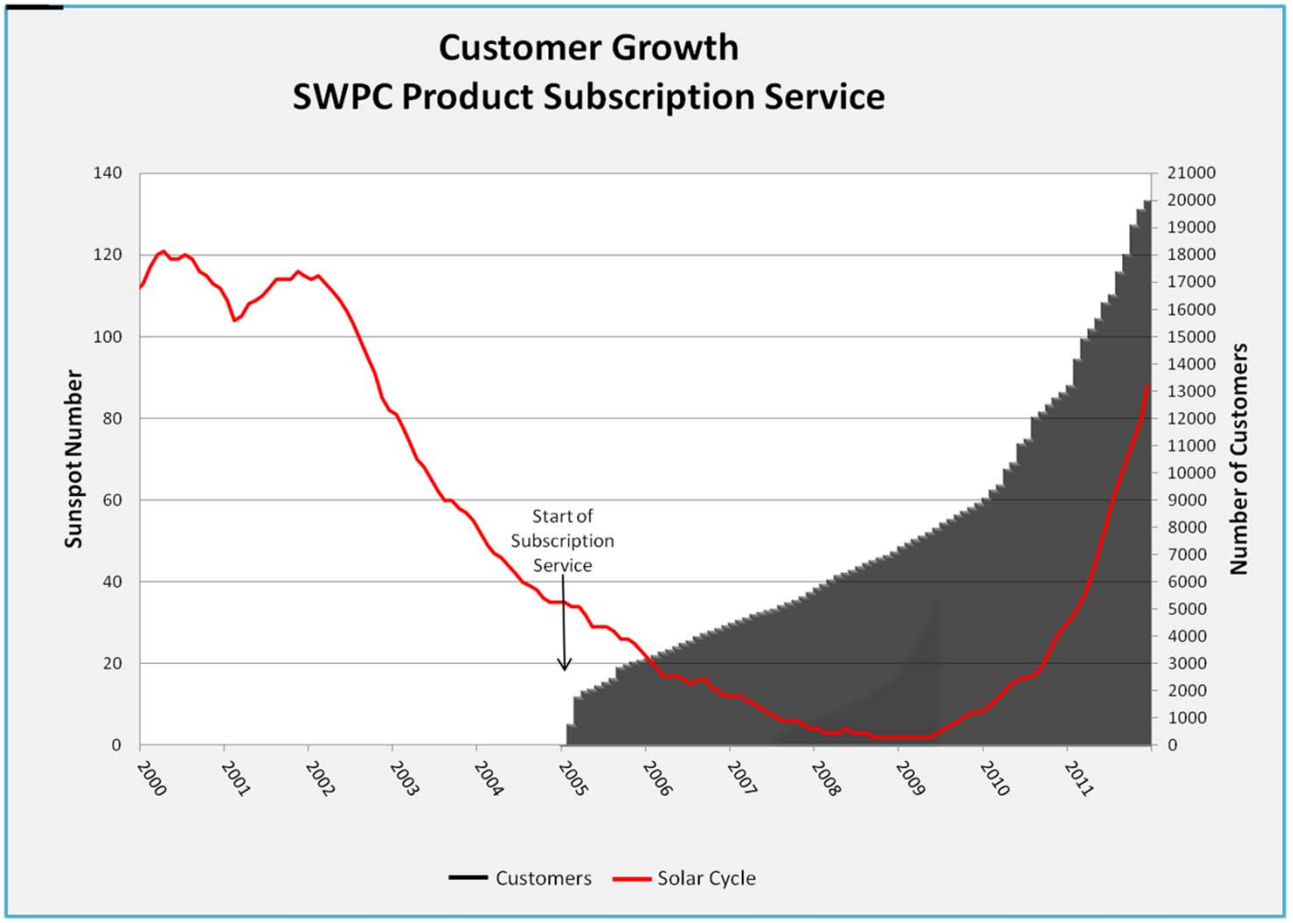
SOHO, STEREO, SDO, and RBSP are NASA research missions that are, or will be, used for operations, but they are not operational.

SpaceWx-Related Documents that Informed the Current Decadal Survey

- White Papers: ~ 300; some focused on SpaceWx; for example, observations at L1 and L5
- Previous NRC Studies:
  - *Space Radiation Hazards and the Vision for Space Exploration: Report of a Workshop*, 2006
  - *Severe Space Weather: Understanding Societal and Economic Impacts*, 2009
- Agency Planning Documents:
  - NASA 2009 Roadmap for Heliophysics
- NSWP Strategic Plan, 2010:
  - Establish a NSWP focal point in the Executive Office of the President
  - Ensure continuity of critical data sources

Increasing Need for SpaceWx Information

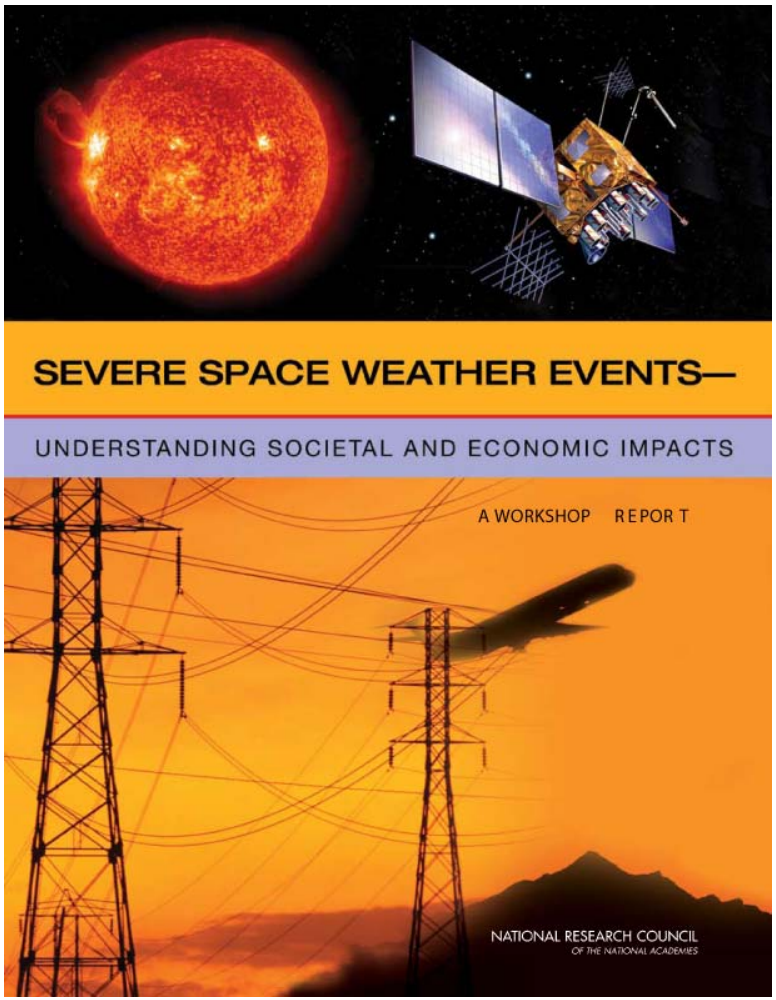
- Previous NRC reports and the Interagency NWSP Strategic Plan (2010) document the United States' need for increased capability to specify and predict the weather and climate of the space environment. This need seen at NOAA SWPC.



The Societal and Economic Impacts of Severe Space Weather Events: A Workshop

Workshop details

- May 22-23, 2008 in DC
- Approximately 80 attendees from academia, industry, government, and industry associations
  - Association reps aggregated data and helped avoid concerns about proprietary or competition-sensitive data
- Analyses in specific areas; e.g., GPS, power industry, aviation, military systems, human and robotic exploration beyond low-Earth orbit
- Econometric analysis of value of improved SpaceWx forecasts



[http://www.nap.edu/catalog.php?record_id=12507]

NASA→NOAA Handoffs – Not Just a SpaceWx Problem

- JPSS (replaces NPOESS) continues to dominate NOAA's budget and program focus. JPSS received its full budget request in FY12 to mitigate the potential gap between NPP and JPSS-1 (early 2017); however, many other programs remain underfunded:
  - Ocean Surface Vector Winds: NOAA had proposed to place a dual-frequency scatterometer on Japan's GCOM-W2. The appropriated budget does not support this plan and NOAA has asked NASA to undertake the mission.
  - Total Solar Irradiance: TSI measurements, a critical time series unbroken since 1978, are now in danger (loss of GLORY means relying on SORCE, which is already well beyond its design lifetime).
  - Sea-Surface Height: Jason-3 is follow-on in the altimetry series of Topex/Poseidon, Jason-I, and Jason-II/OSTM. Launch is now April 2014, but additional delays due to budget shortfalls and/or LV issues (Taurus XL had been planned) are concern for the partnership with EUMESAT and CNES.
  - **GPS Radio Occultation/COSMIC-2: NOAA did not receive the requested funding. Fortunately, the AF is funding the first six of the planned 12-satellite constellation.**
  - **Solar-wind monitor at L1: relying on ACE, good interagency progress on DSCOVR, Afterwards?**
  - **Coronagraph: SOHO near end of mission life; no follow-on to STEREO**

Doing More With Less

- Maximizing Resources:
  - International partnerships—COSMIC-2
  - Hosted Payloads—AMPERE; GeoScan?
  - Missions of Opportunity
  - Data buys?
  - New architectures? New observing locations and/or platforms.
- Elevate the problem:
  - Focal point for SpaceWx in the Executive Office of the President
  - Develop national strategy that would align agency roles with responsibilities: needed for Earth science- and SpaceWx-related measurements
    - Lessons from the Operational Satellite Improvement Program?
- Congress is considering the transfer of weather satellite acquisition from NOAA to NASA in FY13. Implications for R2O and SpaceWx are unclear; cost savings?

R2O and Continuity in the 2007 Earth Science Decadal

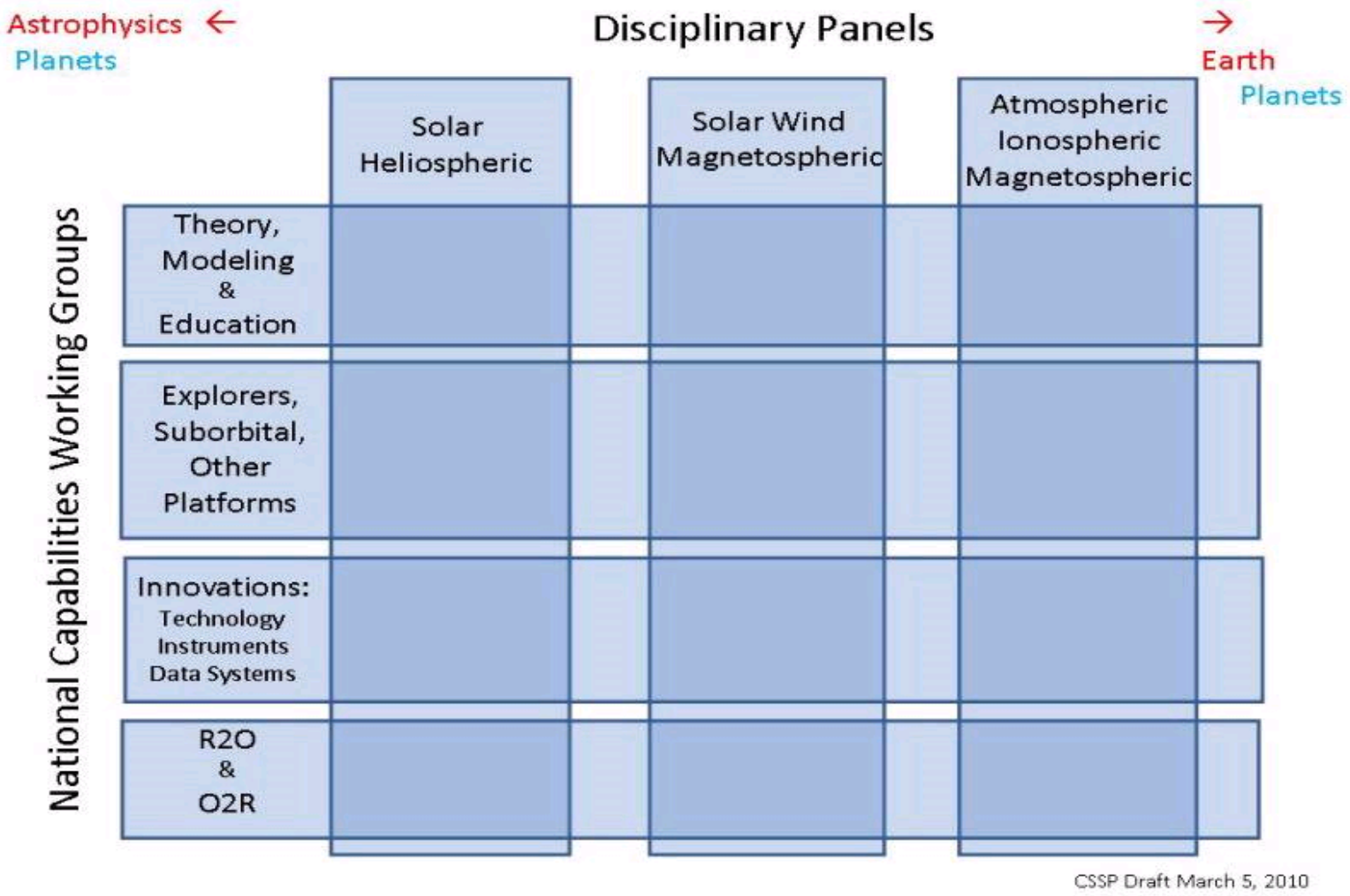
- "There is a lack of clear agency responsibility for sustained research programs and the transitioning of proof-of-concept measurements into sustained measurement…"
- "Institutions have responsibilities that are in many cases mismatched with their authorities and resources: institutional mandates are inconsistent with agency charters, budgets are not well matched to emerging needs, and shared responsibilities are supported inconsistently by mechanisms for cooperation."
- **Recommendation: The Office of Science and Technology Policy, in collaboration with the relevant agencies and in consultation with the scientific community, should develop and implement a plan for achieving and sustaining global Earth observations.** This plan should recognize the complexity of differing agency roles, responsibilities, and capabilities as well as the lessons from implementation of the Landsat, EOS, and NPOESS programs.

The World According To Art

...and why it may be time for action versus more studies.

BACKUP SLIDES

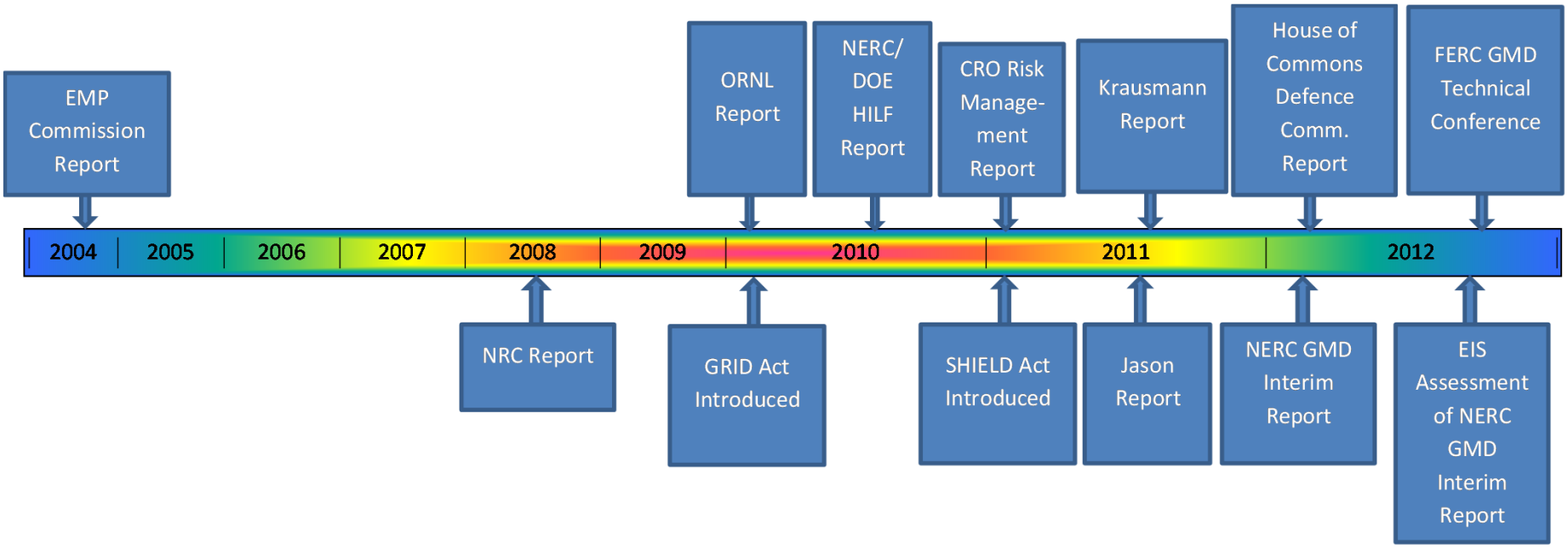
Panel and Working Group Organization



From *Ensuring the Climate Record from the NPOESS and GOES-R Spacecraft*, 2008

- While the current NASA-NOAA transition pathways have included successful examples, transitions have been ad hoc and often complex and unstructured.
- No organizational mechanism exists to ensure efficient and effective transitions.
- A structured, consistent, and well-defined organizational approach to transitioning is needed to:
  - Help to improve communication and coordination between parties
  - Help identify and evaluate missions for potential transitions
  - Create opportunities to infuse new technologies

Timeline of GMD Grid Protection Publications and Events



Future Needs Identified by NOAA SWPC (from NRC, 2009: *Severe Space Weather Events*)

- Secure an operational L1 solar wind monitor.
- Transition a numerical coronal mass ejection/solar wind model into operations.
- Secure backup capability for GOES-10 XRS (X Ray Spectrometer) data stream.
- Transition the whole-atmosphere model into operations.
- Develop forecast capabilities based on STEREO data streams.
- Revamp the concept of operations of the Space Weather Forecast Office.
- Transition a coupled magnetosphere/whole-atmosphere model into operations.
- Develop precision Global Positioning System forecast and correction tools.
- Develop operational radiation environment models.