Status of NSF Space Physics

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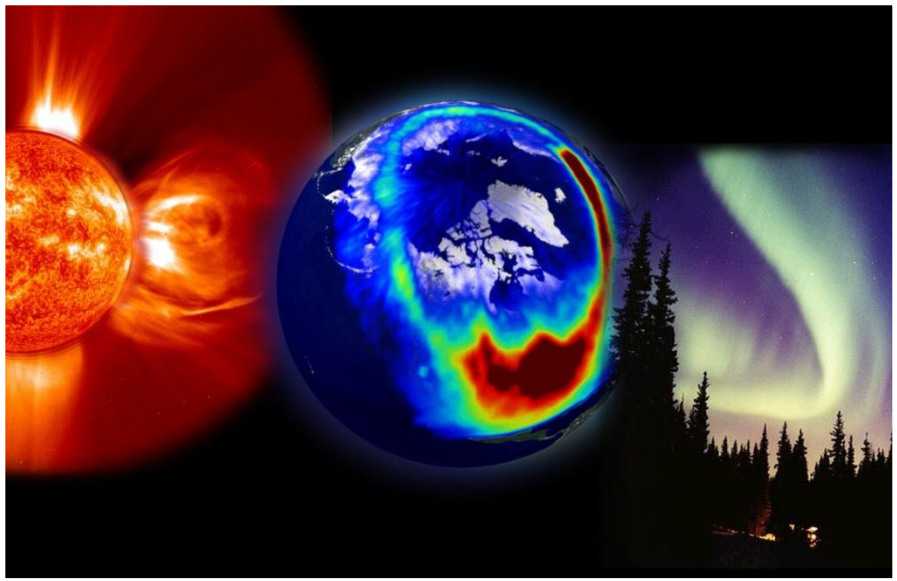
Therese Moretto, Bob Robinson, Anja Stromme, and Ray Walker

National Academy – March 7,2013

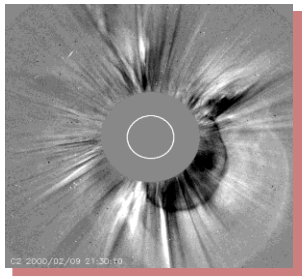
- Status and Updates

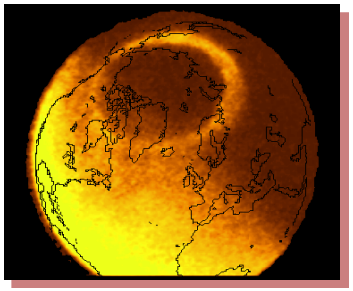
- NSF Response to the Academy's "Solar and Space Physics: A Science for a Technological Society



The Five Geospace Programs

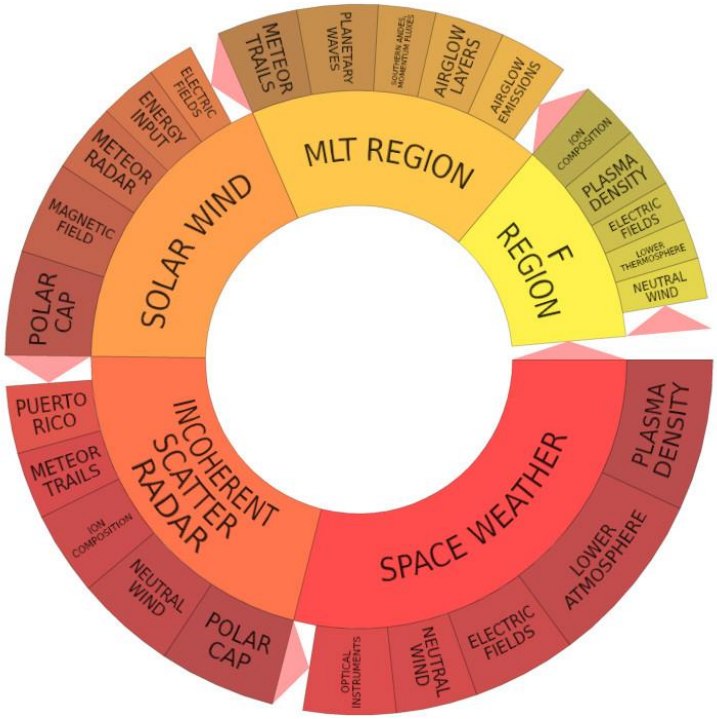
- Solar Physics -- *Paul Bellaire has retired, new PD has been selected – but not signed.*
- Magnetospheric Physics – *Ray Walker*
- Aeronomy – *Anja Stromme*
- Geospace Facilities – *Bob Robinson*
- Space Weather and Instrumentation -- *Therese Moretto*





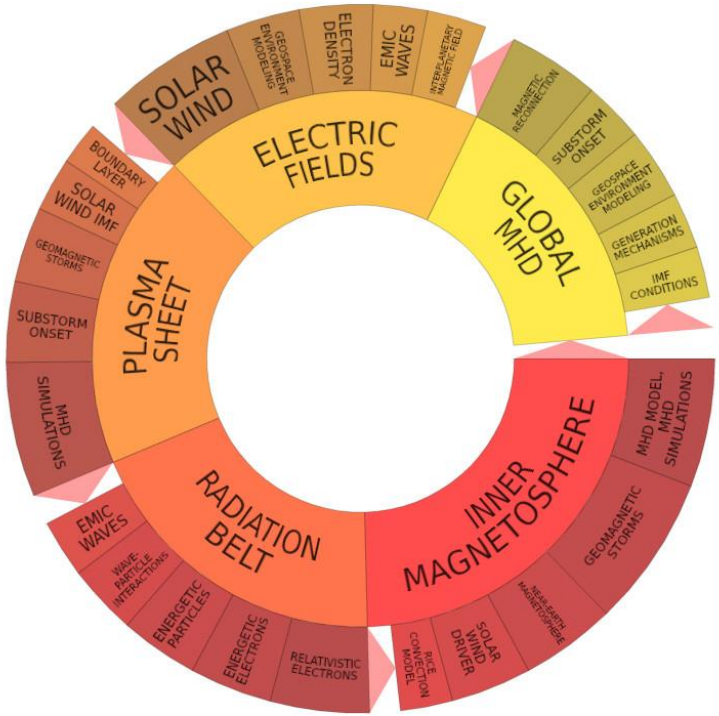
Aeronomy (AER)

- Typically around 95 proposals per year, about 1/3 funded. Budget is about $11M
- Home of CEDAR
- Program Director --Anja Stromme (SRII)



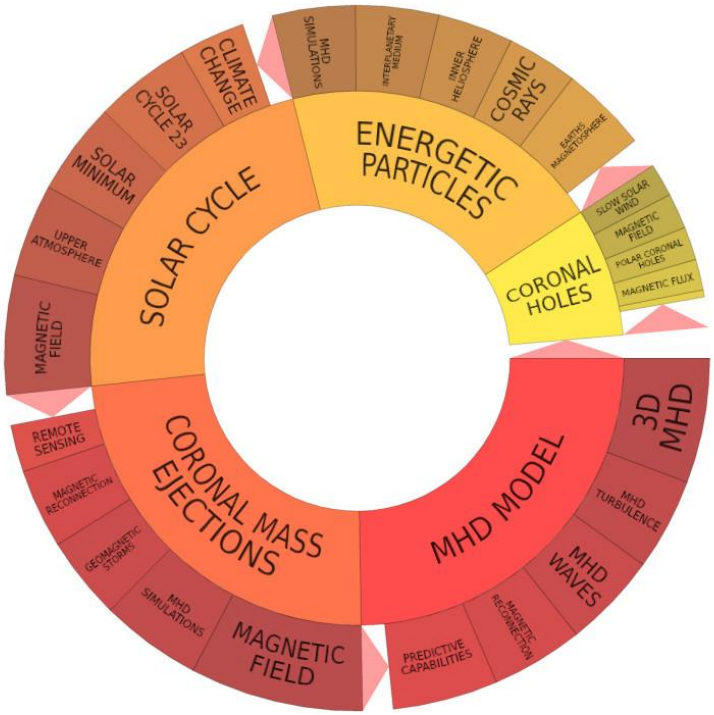
Magnetospheric Physics (MAG)

- typically around 90 proposals per year, 1/3 funded. Budget is about $8.5M.
- Home of GEM
- Program Director – Ray Walker (UCLA)



Solar Physics Program (STR)

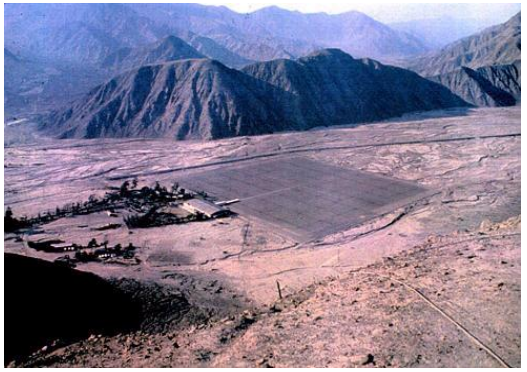
- Typically around 80 proposals per year, 1/3 funded. Budget is about $8.5M
- Home of SHINE
- Program Director – Paul Bellaire/TBA



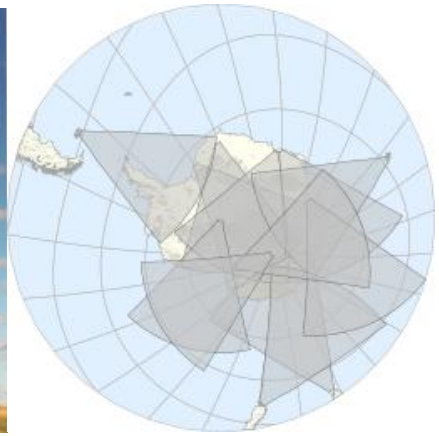
The Geospace Facilities Program (GS)

Program Director – Bob Robinson

- Six incoherent scatter radar sites (five awards:~$12M)
- Lidar Consortium (six institutions: ~$1M)
- Miscellaneous facility-related awards (facility supplements, CAREER, REU, Workshops, schools: ~1M)



SuperDARN is being expanded



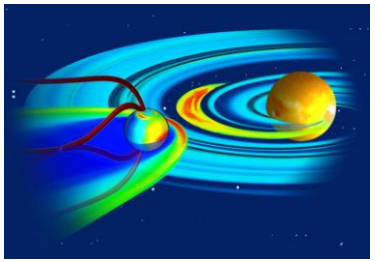
- The Mid-latitude SuperDARN Array (AGS's first midscale project): New SuperDARN radars have been constructed and are operational at: Fort Hays, Kansas; Christmas Valley, Oregon; and Adak, Alaska
- Negotiations are underway with Portuguese officials in the Azores for the fourth and final element of the array. Expected completion at end of summer 2013.

Recent Geospace Major Research Instrumentation (MRI) successes

- Completion of the Low Latitude Ionospheric Scintillation Network (LISN)
- Development and Deployment of an Iron-Boltzmann lidar at McMurdo (Boston College)
- Acquisition of a new lidar and development of a photonics laboratory at the Arecibo Observatory (Universidad Metropolitana)
- Acquisition of a small AMISR phased-array radar for deployment in Argentina (Universidad Metropolitana)
- Construction of the Owens Valley Solar Radio Array (NJIT)
- Recent award for the development of a Radio Array of Portable Interferometric Detectors (RAPID) for ionospheric research and radio astronomy (MIT Haystack Observatory)

Space Weather Research and Instrumentation

New GS program for FY13 (~$6M)
Program Director – Therese Moretto



NASA/NSF Partnership:

Collaborative Space Weather Modeling ($1.5M/y)

- Proposal deadline March 15, 2012; awards in process
- 51 proposals; 8 awards (totaling $4M/y for 5 years)

Community Coordinated Modeling Center, Goddard (~$450k/y)

- Funded and managed jointly with NASA

Faculty Development in the Space Sciences (up to $1.5M/y)

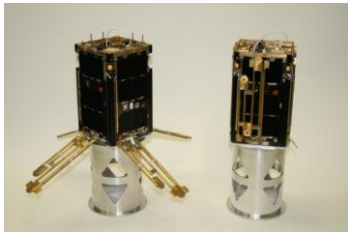
- New annual solicitation soon; Deadline ~May 2013
- 1 new award/year (~$300k/year for 5 years)

AMPERE, SuperDARN and SuperMAG (~$1.7M/year)

- Global networks of space weather relevant observations
- Exploring real-time capabilities

Cubesat program (~$1.5M/y)

- 8 current projects funded; 4 in orbit; 2 launching in 2013
- Proposal deadline was May 7, 2012
- 23 projects; Selection pending; 1-2 awards



NASA-NSF Partnership for Collaborative Space Weather Modeling -- 2012

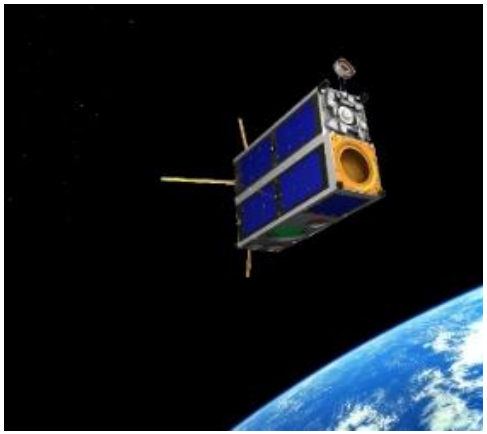
- The Coronal Global Evolutionary Model (CGEM)
  - Lead: George Fisher, UC Berkeley
- A Modular Capability for Community Modeling of Flares, CMEs and their Interplanetary Impacts
  - Lead: Spiro Antiochos, NASA GSFC)
- Integration of Extended MHD and Kinetic Effects in Global Magnetosphere Models
  - Lead: Amitava Bhattacharjee, Princeton U.
- Integrated Global-Sun Model of Magnetic Flux Emergence and Transport
  - Lead: Dusan Odstrcil, George Mason U.
- Integrated Real-Time Modeling System for Heliospheric Space Weather Forecasting
  - Lead: Nagi Mansour, NASA ARC
- Medium Range Thermosphere Ionosphere Storm Forecasts
  - Lead: Anthony Mannucci, NASA JPL
- A First-Principles-Based Data Assimilation System for the Global Ionosphere-Thermosphere-Electrodynamics
  - Lead: Robert Schunk, Utah State U
- Coronal-Solar Wind Energetic Particle Acceleration (C-SWEPA) Modules
  - Lead: Nathan Schwadron, U of New Hampshire

CubeSat Status

- CubeSats: 4 Cubesat missions currently operating in orbit - making science measurements and sending down data.
- RAX-2 and DICE were launched on Oct 28, 2011 so exceed 1 year in orbit - major accomplishment!
- Colorado Student Space Weather Explorer (CSSWE) and CINEMA were launched Sep 13, 2012 and both taking science measurements.
- Firefly scheduled for launch August 2013, and the follow on Firestation (same instruments) will be delivered to the ISS in July 2013.
- Firebird scheduled for launch October 2013; CADRE is also being considered for launch in 2013. EXOCUBE in line for launch by NASA, likely to be in 2014.

The Latest NSF CubeSat Selection

- LAICE --A team led by Professor Gregory Earle is developing two 3U payloads for a 6U nano-satellite project to be launched in late 2015. The satellite will fly in low Earth orbit, and will focus on the detection of gravity waves.
- Virginia Tech is the lead institution on the project, with collaborators from the University of Illinois, The Aerospace Corporation, and Colorado Research Associates.



CubeSats

-- mentioned in over 140 Project Summaries since 2008!

CEDAR/GEM/SHINE Competitions

CEDAR FY 12

- 32 proposals (26 separate projects) submitted
- 10 funded – funding about $1.2M

GEM FY 2012

- 44 proposals (38 separate projects) submitted
- 8 funded – funding about $.9M

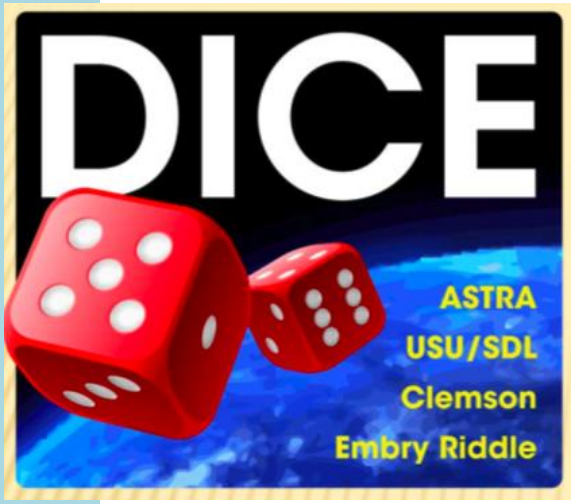
SHINE FY 2012

- 41 proposals (36 separate projects) submitted
- 10 funded – funding about $1.1M

Transitions

- Retirements – Paul Bellaire (Solar Research Program) (end of December 2012)
- Departures
  - Farzad Kamalabadi (U of Illinois)
  - Kile Baker
- Arrivals
  - Ray Walker (MAG) from UCLA
  - Anja Stromme (SRII)
- Solar Research Program Search Completed
  - Negotiations in progress
- Pending Search
  - Program Director for Aeronomy (sometime in early to mid 2013)

- ✓SRI International & U. Michigan
- ✓Radar receiver, ionospheric irregularities
  - ➢3U CubeSat
- ✓RAX-1 Launched Nov 2010
  - ✓A few experiments; Premature power system failure
- ✓RAX-2
  - ✓Launched Oct 2011



- ✔ ASTRA & Utah St. U.
- ✔ Ionospheric storm gradients; E-fields and electron densities
- ✔ Multi-spacecraft mission
  - ➢ 2 identical 1.5U CubeSats
- ✔ Launched Oct 2011

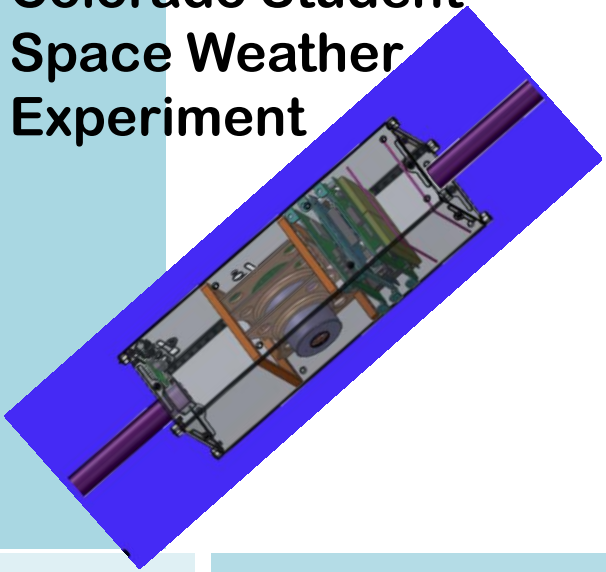
CubeSat for Ions Neutrals Electrons and MAgnetic fields

trio cinema

Space Sciences Laboratory, UC Berkeley
Kyung Hee University of South Korea
Imperial College London

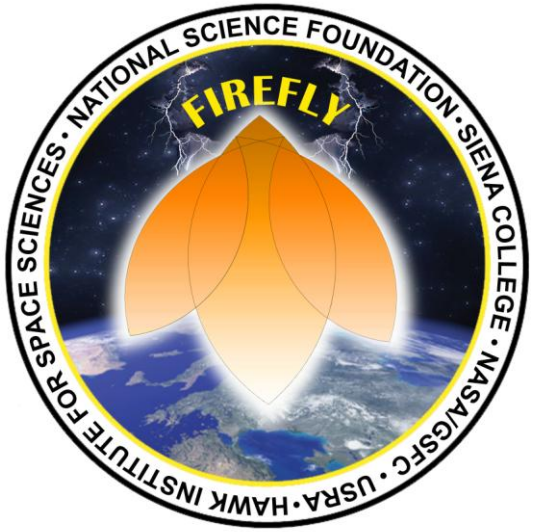
- ✓UC Berkeley with international partners
- ✓Ring current dynamics and auroral particles
  - ➢3U CubeSat
  - ➢Neutral imaging; ions and electrons, magnetic field
- ✓Manifested for launch Aug 2012
  - ➢through NASA, ELANA/ DOD NRO

Colorado Student Space Weather Experiment

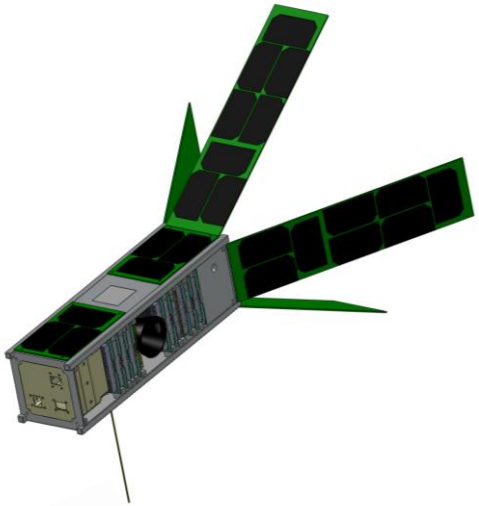


- ✓ U. Colorado, Boulder
- ✓ Solar Proton Events, CMEs, and radiation belt dynamics
  - ➢ 3U CubeSat
  - ➢ Energetic electrons and protons
- ✓ Manifested for launch Aug 2012
  - ➢ through NASA, ELANA/ DOD NRO

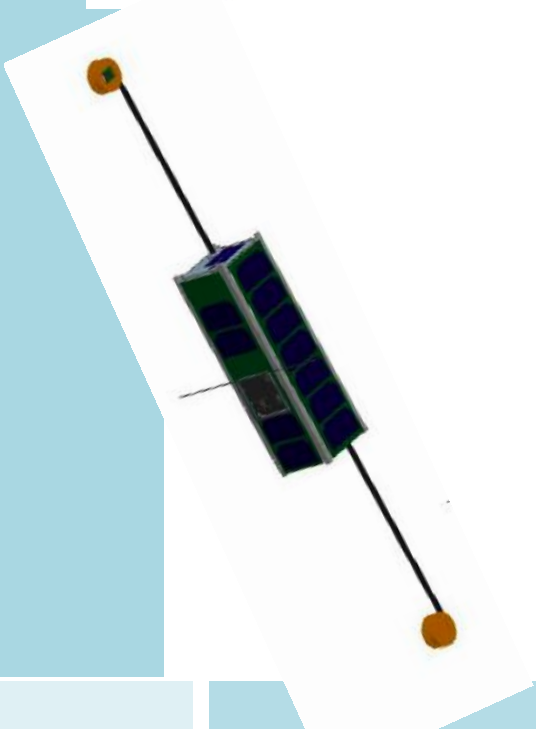
- ✔ U. New Hampshire & Montana St. U.
- ✔ Relativistic electron microbursts in the Van Allen belts
  - ✗ High time-resolution energetic electrons
- ✔ Multi-spacecraft mission
  - ✗ 2 identical 1.5U CubeSats
- ✔ Manifested for launch 2013
  - ✗ through NASA, ELANA



- ✔ NASA GSFC & Siena College
- ✔ Lightning and Terrestrial Gamma Ray Flashes
  - ✗ 3U CubeSat
- ✔ Not yet manifested on a launch
  - ✗ Firestation on ISS; ELaNA, NRO



- ✔ CADRE
- ✔ U. Michigan
- ✔ Thermospheric dynamics during ionospheric storms
  - ✗ 3U CubeSat
  - ✗ Wind Ion Neutral Composition Suite
- ✔ Project Started Oct 2011



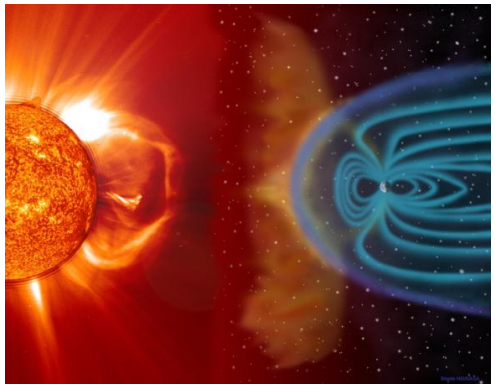
- ✔ EXOCUBE
- ✔ Scientific Solutions, Inc, U. Wisconsin & Cal Poly
- ✔ Composition of the upper atmosphere
  - ✗ 3U CubeSat
  - ✗ Densities of 4 ion and neutral species
- ✔ Project Started Oct 2011

Response to the Decadal Survey….

- First, THANK YOU to the community for doing this.
- Our commitment is to listen to the community, to engage the community, to be part of the community.
- We like ALL of the recommendations and are working -- and will continue to work– to make them reality.

The Four Scientific Goals of the Decadal Survey

- Establish the origins of the Sun's activity and predict the variations of the space environment.
  - ~ $9M (mostly from Solar)
- Determine the dynamics and coupling of the Magnetosphere, Ionosphere, and atmosphere and the response to solar and terrestrial inputs.
  - ~ $20.5M
- Understand the interaction of the Sun with the solar system and interstellar medium.
  - ~ .5M
- Discover and characterize fundamental processes that occur within the heliosphere.
  - ~ $9M (all Programs)



For NSF, the Decadal Survey Recommends:

- Complete the on-going program
  - Finish and adequately fund the Advanced Solar Telescope
- Implement DRIVE
  - Diversify
  - Realize
  - Integrate
  - Venture
  - Educate

Diversify: Diversify Observing Platforms

- ***NSF Geospace addresses the "Diversify" mandate of the Decadal Survey through its broad approach to enabling geospace research.***
- Expansion of observing facilities
  - six incoherent scatter radars, networks
  - SuperDARN
  - Consortium for Resonance and Rayleigh Lidars
  - Low-Latitude Ionospheric Sensor Network
  - Space-based capabilities (AMPERE and the Cubesat missions)

- Improved databases -- CEDAR database continues to be a repository of measurements
- Community-driven modelling efforts
- On-going efforts to fund mid-scale projects such as FASR and COSMO.
- The next decade will see new observations from AMISR sites constructed at or moved to new locations to meet emerging scientific priorities.
- Increase our efforts toward distributed sensor networks.

Realize

- ***Recommendation**: Complete the Advanced Technology Solar Telescope (ATST) and provide sufficient funding for efficient and scientifically productive operation.*
- We are in on-going discussions with the Astronomy Division to transfer the ATST to our Division.

Integrate: Integrate Observing Platforms and Strengthen Ties Between Agencies

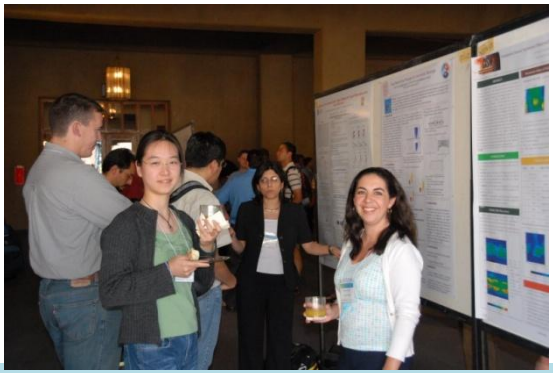
- ***Recommendation: NSF should ensure that funding is available for basic research in subjects that fall between sections, divisions, and directorates, such as planetary magnetospheres and ionospheres, the Sun as a star, and the outer heliosphere.***
- The Geospace section is involved in joint programs that cross disciplinary lines with NASA, AFOSR and DOE and within the NSF.
- We are working with the NASA Heliophysics Division to jointly develop strategic capabilities for the National Space Weather Program.
- Within NSF we are working with Plasma Physics as part of the NSF/DOE Partnership for Basic Plasma Science and Engineering
- Our Section Strategic Plan explicitly calls for participation in new Directorate and NSF-wide initiatives that cross disciplines and support investigation of the entire Sun-Earth system.
- Comparative studies of planetary magnetospheres and ionospheres are important for understand the magnetosphere and ionosphere system at the Earth and are supported under the base program

Venture: Venture Forward with Science Centers and Instrument and Technology Development

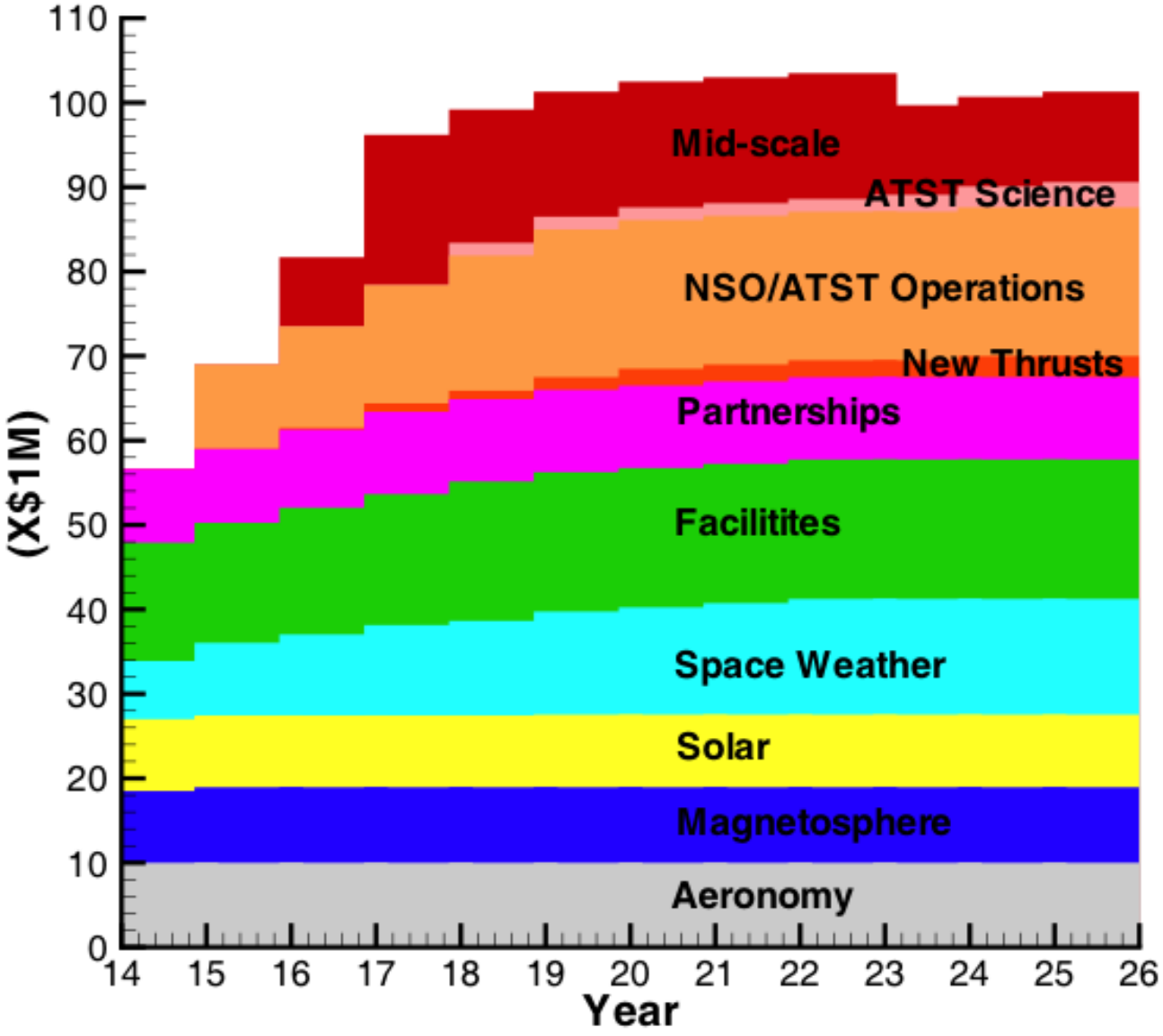
- NSF support for larger collaborative research projects, at the level recommended, on critical space science and space weather topics is currently provided through Directorate and NSF-wide initiatives, such as Frontier in Earth System Dynamics (FESD) and Hazard SEES and possibly INSPIRE.
- We will continue to pursue and inter-agency collaborations with NASA, AFOSR, DOE, and other partners to fund a new generation of coupled space weather models.
- We recognize the need to develop and exploit new technologies over a broad spectrum of instrumentation, including AMISR radar technology, CubeSats, and distributed sensor networks.
- New instrument development line?

Educate

- Continue efforts to train the next generation of space scientist through proactive efforts within the GEM, CEDAR, and SHINE Programs.
- Continue to encourage Research Experiences for Undergraduates through both formal and informal programs at universities, laboratories, centers, and facilties.
- The Cubesat program is highly successful in attracting students – Of course!
- The NSF Geospace Section supports early career scientists through the NSF CAREER program.
- Academic positions has been provided through the Faculty Development in Space Science
- A variety of informal education and outreach programs ioncluding continued support for AGU's Space Weather Journal, and sponsorship of workshops, such as Space Weather Week and the Space Weather Enterprise Forum.



The Long Term Plan for Geospace at NSF



Geospace is alive and well

- We have plans and there are LOTS of opportunities!
- Our priorities are stress creativity in research; provide the needed facilities; partner more effectively with other agencies; and educate the next generation of space scientists, and
- Benefit society through our scientific advances.