Geospace Sciences at the National Science Foundation

Vladimir Papitashvili
Acting Head, Geospace Section (also with Antarctic Astrophysics & Geospace Sciences Program)

Kile Baker, Janet Kozyra, Therese Moretto Jørgensen, Ilia Roussev, and Anne-Marie Schmoltner
Geospace Program Directors

NSF Directorate for Geosciences

Earth Sciences

Ocean Sciences

Polar Programs
Antarctic Geospace ($3M)

Paul Shepson

Division of Atmospheric and Geospace Sciences

Atmosphere Section

NCAR and Facilities Section
High Altitude Observatory ($5.5M)

Geospace Section (GS)

Programs:
- Aeronomy
- Geospace Facilities
- Magnetospheric Physics
- Solar–Terrestrial Research
- Space Weather Research

AGS Budget: about $250M

GS Budget: ~$43.5M in FY 2015

GS Staff Changes

Departures: Rich Behnke & Bob Robinson have recently retired

New arrivals:

Geospace Facilities
Kile Baker (expert)

Magnetospheric Physics
Janet Kozyra

Aeronomy

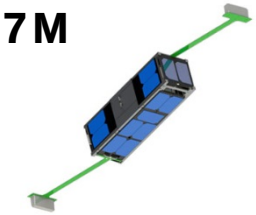
Anne-Marie Schmoltner

Space Weather Research
Therese Moretto Jørgensen

Solar-Terrestrial Research
Ilia Roussev

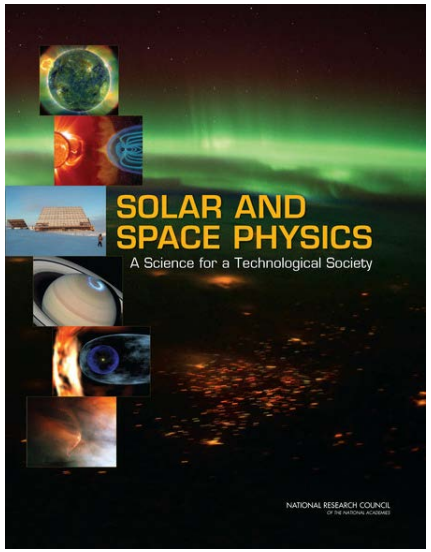
GS Research Programs ($43.5M)

- **Aeronomy (AER)** **Budget: $9.2M**
  - Program Director – **Anne-Marie Schmoltner**
  - About 100 proposals per year
  - Home for **CEDAR**
- **Magnetospheric Physics (MAG)** **Budget: $6.8M**
  - Program Director – **Janet Kozyra**
  - Around 70 proposals per year
  - Home for **GEM**
- **Solar Physics (STR)** **Budget: $7.3M**
  - Program Director – **Ilia Roussev**
  - Around 80 proposals per year
  - Home for **SHINE**
- **Space Weather Research (SWR)** **Budget: $5.7M**
  - Program Director – **Therese Moretto Jørgensen**
  - Every other year: ~20 CubeSat proposals, 2-3 funded
  - Faculty Development in Space Science program
  - AMPERE-II, SuperMAG, SuperDARN, and CCMC (total ~$4.0M)
- **Geospace Facilities (GSF)** **Budget: $14.1M**
  - Program Director – **Kile Baker** (including Arecibo $4.1M)
  - AMISR, Arecibo, Jicamarca, Millstone Hill, Sondrestrom, Lidars



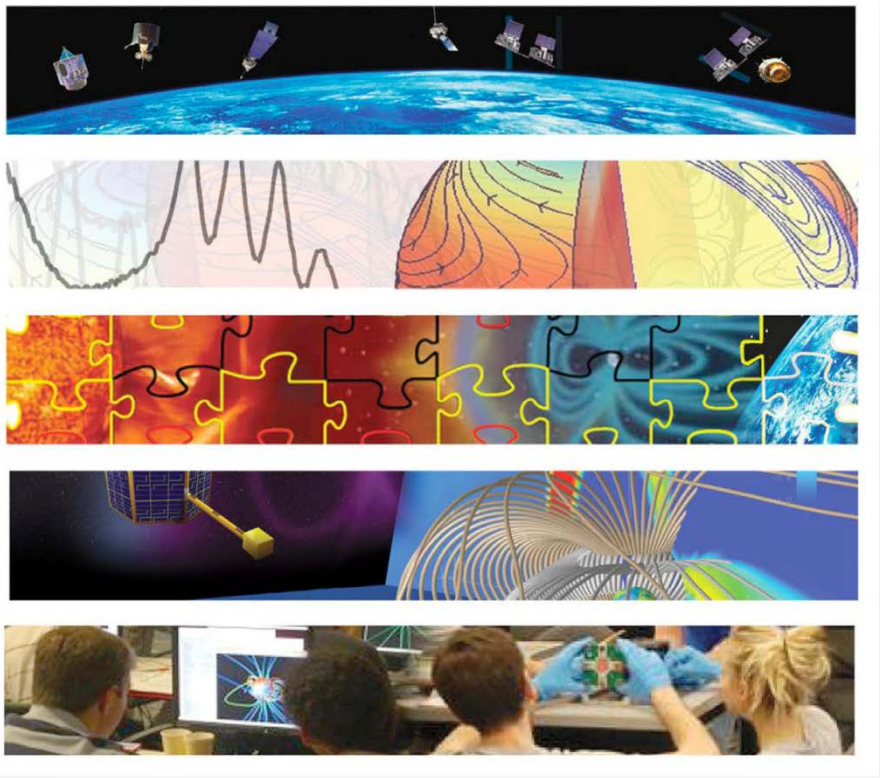
All GS Facilities: ~42% of the total GS annual budget of $43.5M

2013 Decadal Strategy for Solar & Space Physics



- DRIVE would provide high leverage to current and future space science research investments.
- ***Five DRIVE components are "basic building blocks" in which NSF/Geospace Section already invests… and will continue to invest!***

D
R
I
V
E



- **D**iversify observing platforms with microsatellites and midscale ground-based assets.
- **R**ealize scientific potential by sufficiently funding operations and data analysis.
- **I**ntegrate observing platforms and strengthen ties between agency disciplines.
- **V**enture forward with science centers and instrument and technology development.
- **E**ducate, empower, and inspire the next generation of space researchers.

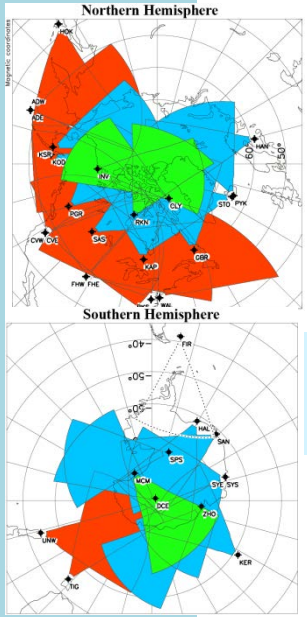
Diversify observing platforms with microsatellites and midscale ground-based assets

CubeSat Program

- Two new Cubesat projects are at work: QBUS and ELFIN (NASA with NSF's participation)
- NSF's Cubesats: ExoCube and Firebird-II were launched January 31, 2015; CADRE is scheduled for launch in 2015

Realize scientific potential by sufficiently funding operations and data analysis

- Six incoherent scatter radar sites, Lidar Consortium
- New Ionospheric Heater at Arecibo Observatory



Integrate observing platforms and strengthen ties between agency disciplines

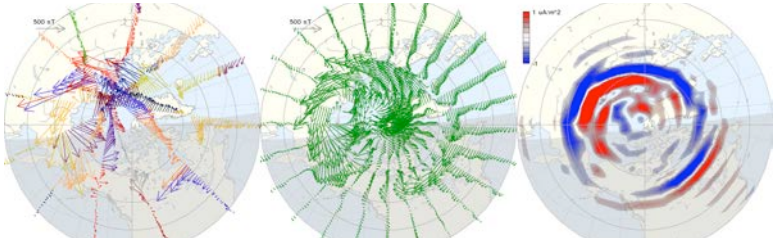
- SuperDARN is a worldwide collaboration of 34 radars funded by 11 different countries!
- SuperMAG – global geomagnetic database & service

SuperMAG

Venture forward with science centers and instrument and technology development

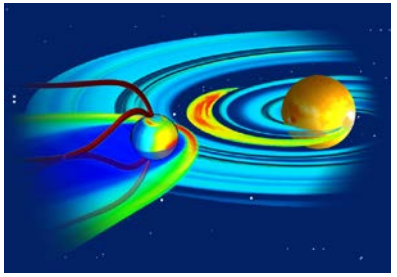
- AMPERE- II at Iridium NEXT

Global Space Weather Research Facility



~10-min FAC snapshots of both polar regions

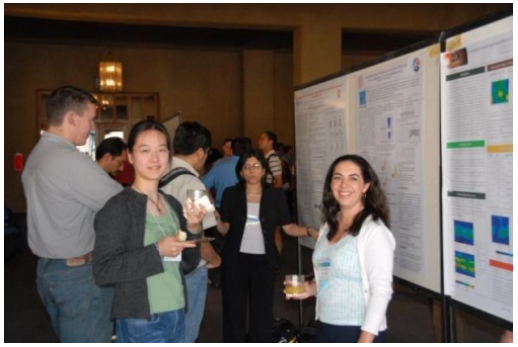
Educate, empower, and inspire the next generation of space researchers



- **Faculty Development in Space Sciences:** Biennial (or so) Solicitation
- Two awards in 2015 (Univ. of Minnesota and Univ. of Illinois at Urbana Champaign

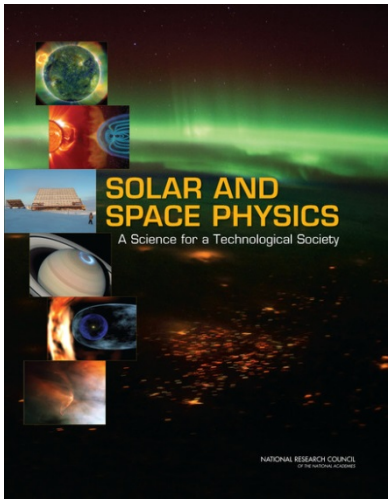
- **Continue efforts to train the next generation of space scientists** through proactive efforts within the GEM, CEDAR, and SHINE Programs
- **Continue to support Research Experiences for Undergraduates programs and sites** through both the formal and informal programs at the universities, laboratories, centers, and facilities

- **Support early career scientists** through the NSF CAREER Awards program

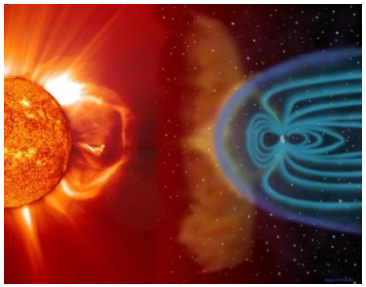


- **Sponsor Geospace workshops and conference,** such as CEDAR, GEM, SHINE, Space Weather Week, Space Weather Enterprise Forum, TESS-2015, MSSP-2015, etc.

Key Science Goals of the Decadal Survey



1. **Determine the origins of the Sun's activity and predict the variations in the space environment.**
   NSF/Geospace Section: ~$7.5M/year
2. **Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.**
   NSF/Geospace Section: ~$25M/year
3. **Determine the interaction of the Sun with the solar system and the interstellar medium.**
   NSF/Geospace Section: ~$0.5M/year
4. **Discover and characterize fundamental processes that occur both within the heliosphere and throughout the Universe.**
   NSF/Geospace Section: ~$10.5M/year



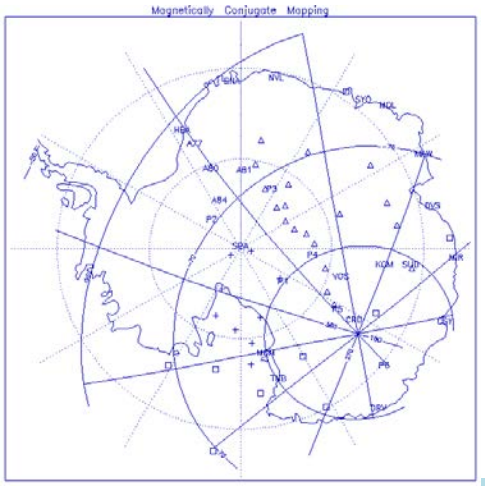
NCAR/High Altitude Observatory:

Mauna Loa Solar Observatory

Community Spectropolarimetric Analysis Center

Thermosphere Ionosphere Global Circulation Models

~$5.5M/year Geospace Research & Facilities



NSF Antarctic Astrophysics & Geospace Sciences

~$3M/year Geospace Research & Instrumentation

GS Space Weather Research

NASA / NSF Collaborative Space Weather Modeling

2013: 51 proposals ➔ 8 awards ($4.3M per year for 5 years)

Community Coordinated Modeling Center (CCMC) at NASA / GSFC

Renewal is due in FY 2015 - Funded and managed jointly by NSF ($500K/yr) and NASA ($2M/yr)

AMPERE, SuperDARN and SuperMAG

(renewed in FY 2014 and 2015)

Global networks of “space weather” observations

Exploring near real-time capabilities

CubeSat program

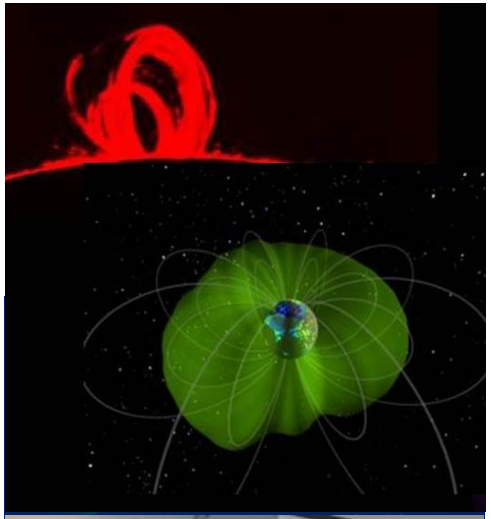
12 current projects funded; 8 satellites are in orbit

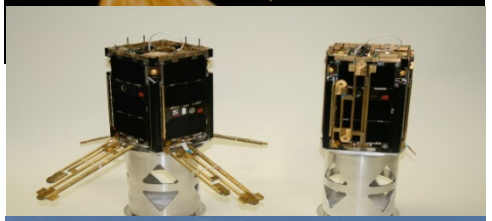
2014: 21 proposals ➔ 2 awards pending

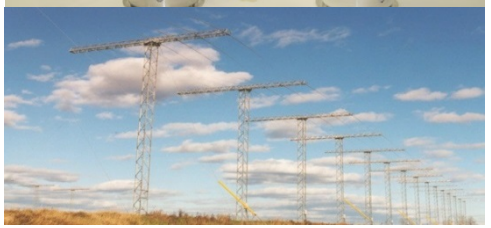
Core Space Weather Research

2015: *What is the Science of Space Weather?*

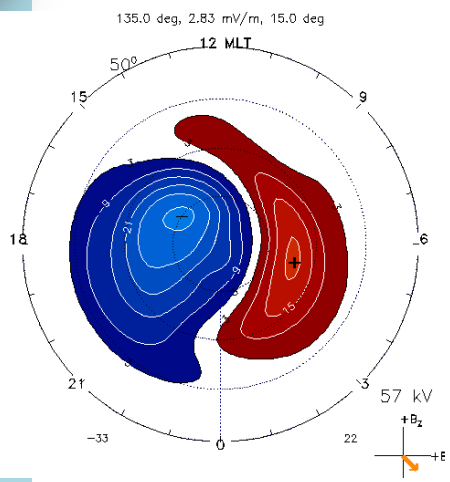
Respond to recommendations of National Space Weather Strategy!

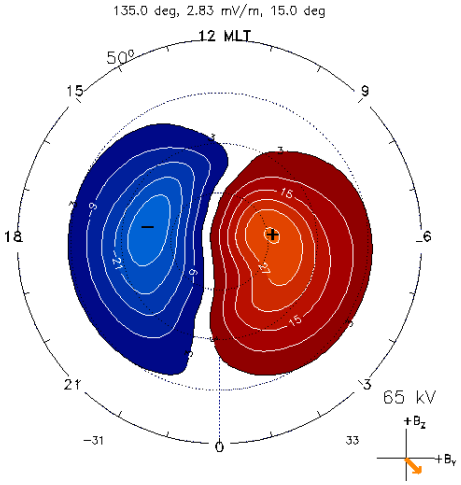


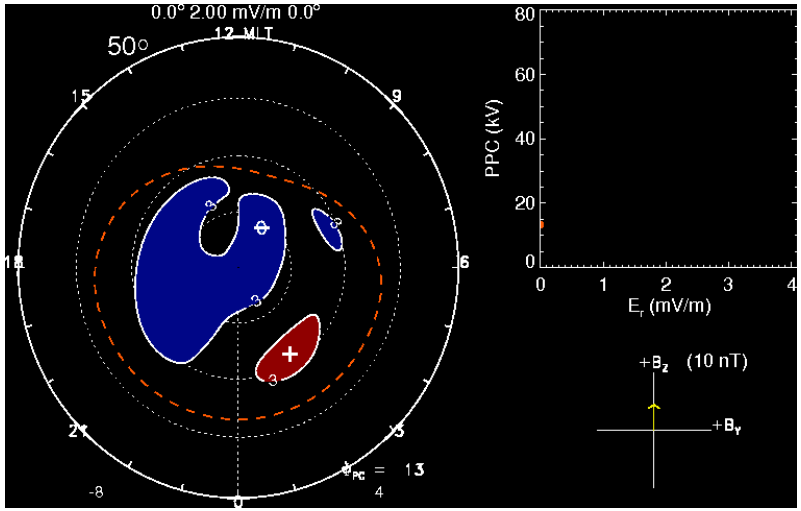




SuperDARN: Hemispheric Convection Models







- Climatological convection patterns derived from the Northern and Southern hemispheres
- SuperDARN data reveal interhemispheric asymmetries and a strong dipole tilt factor (left two panels)
- Results have been coded into a new dynamical convection model (right panel)
- Dominant modes of variability have been related to the IMF components through the Empirical Orthogonal Functions (EOF) analysis

Pettigrew et al, JGR, 2010

RESEARCH HIGHLIGHTS

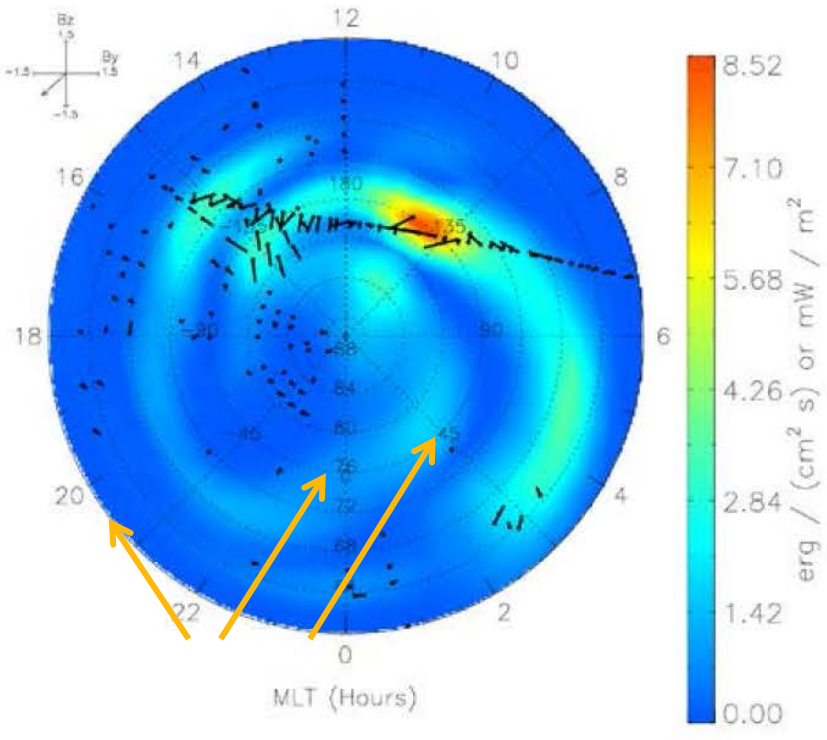
Ionospheric Electrodynamics

Ionospheric Integrated **Joule Heating** from NCAR-AMIE
00:30-00:40 UT 5 April 2010

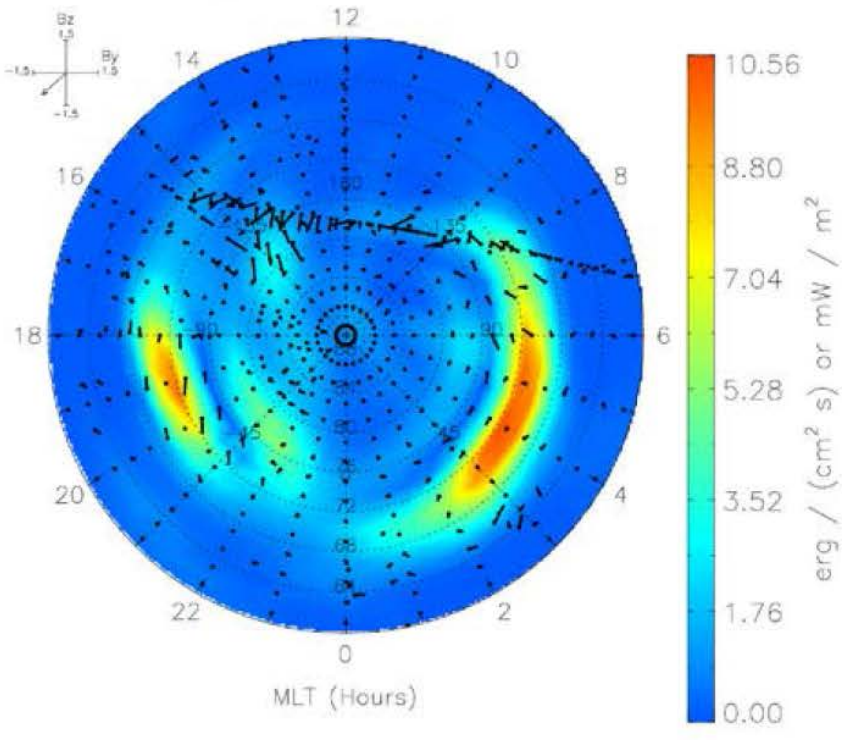
Wilder et al., JGR, 2012

RESARCH HIGHLIGHTS

Ground magnetometers,
DMSP E-field, SuperDARN



AMPERE Data Included



Broad regions without data can be filled in with AMPERE

AMPERE Yields a Dramatic Change in Heating Distribution and Intensity

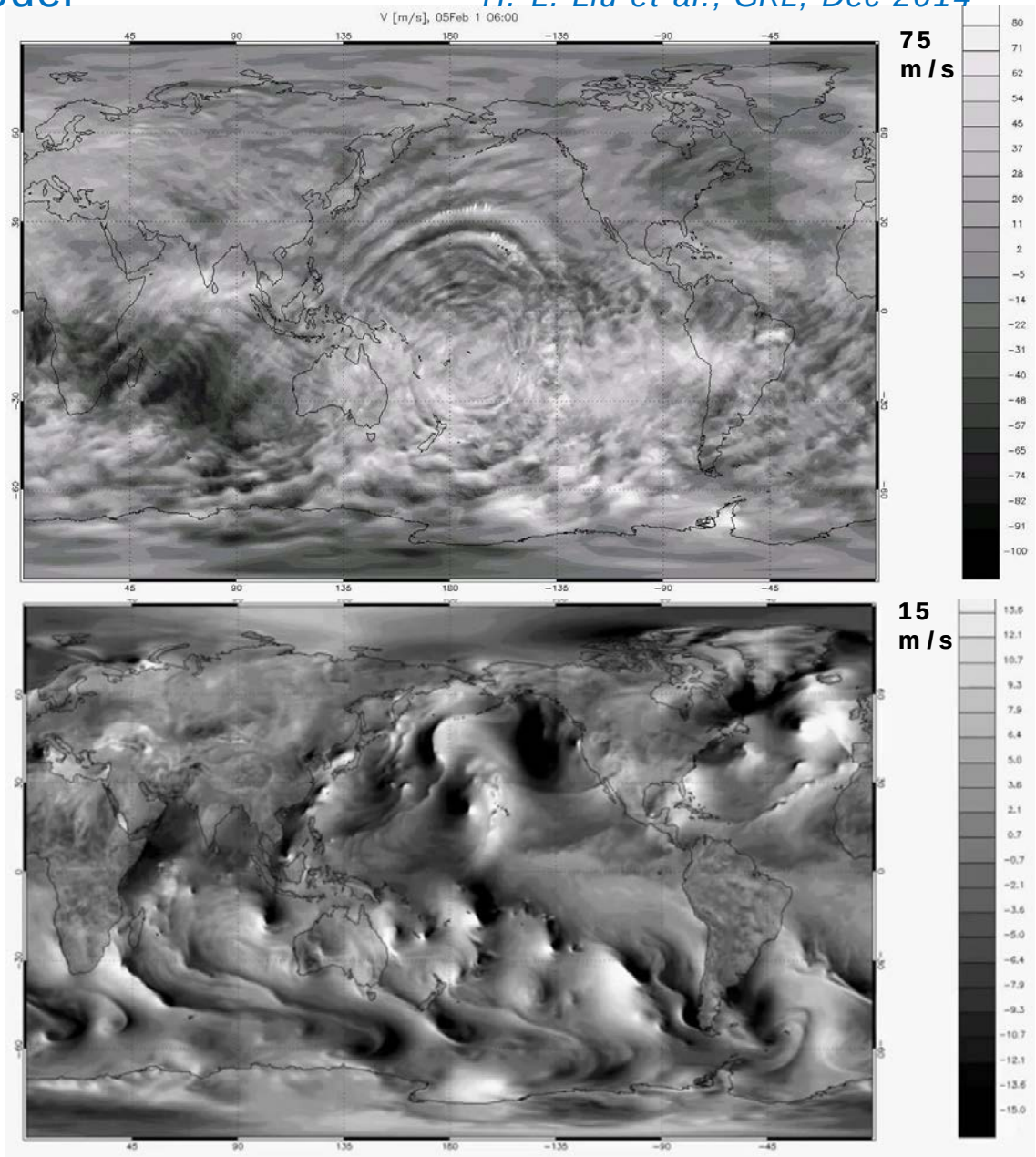
Gravity waves simulated by high-resolution Whole Atmosphere Community Climate Model

H.-L. Liu et al., GRL, Dec 2014

RESEARCH HIGHLIGHTS

Global atmospheric perturbations at 115 km

- The ripples [*at high altitude*] are caused mainly by three factors: the jet stream, wind moving over mountains, and tropical storms.
- Concentric rings undulating in the South Pacific [*in the video*] were caused by a giant cyclone simulated off the coast of Australia.
- *"**A key point we try to make is to demonstrate that the weather of the near space environment can be strongly affected by the terrestrial weather**"* said Han-Li Liu, a fluid dynamics researcher at the National Center for Atmospheric Research



Global surface weather patterns

http://www.wired.com/2015/01/science-graphic-week-weather-edge-space-ripples-like-pond/

NSF Geospace Research - Portfolio Review

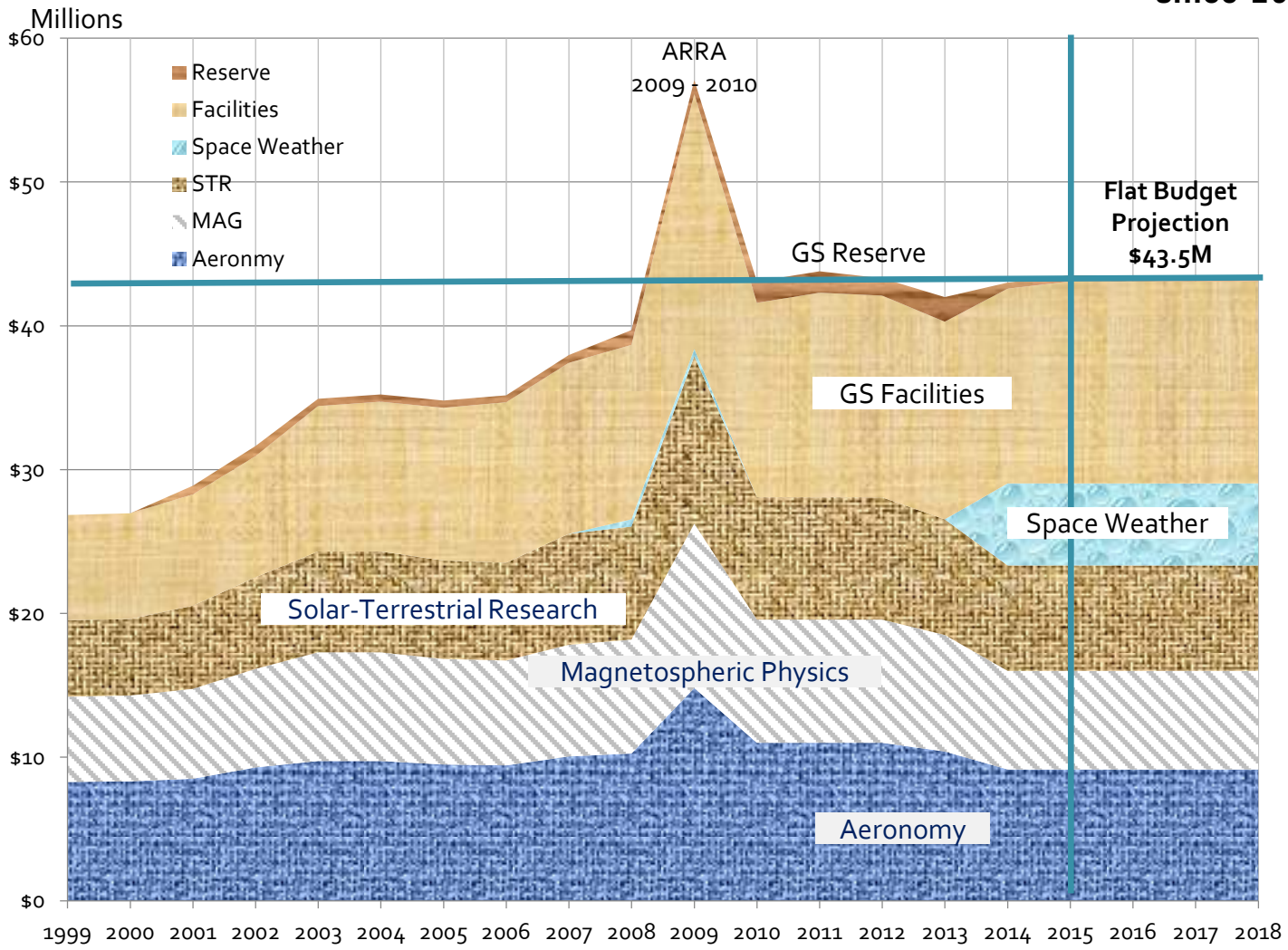
- ***This review is motivated in part by priorities highlighted*** for the Geospace scientific community in the National Research Council's ***Decadal Survey: Solar and Space Physics*** – *A Science for a Technological Society* (2013) ***and by the current challenging outlook for the U.S. Federal budget***.
- ***Examine the balance across the entire portfolio of activities*** supported by NSF's Geospace Section (GS) within the Division of Atmospheric and Geospace Sciences (AGS).
- ***Ensure that GS investments are guided by and aligned with the above-cited Survey recommendations.*** These recommendations should encompass not only observational capabilities, but also theoretical, computational, and laboratory capabilities, as well as capabilities in research support, workforce, and education.
- ***The Portfolio Review will consider not only what new activities need to be introduced or accomplished, but also what activities and capabilities will be potentially lost in enabling these new activities and discontinuing current activities.***

Geospace Section Budget Profile 1999-2015

U.S. Bureau of Labor Statistics' Inflation (http://data.bls.gov/cgi-bin/cpicalc.pl)

$1.00 in 1999 equates to $1.41 in 2015

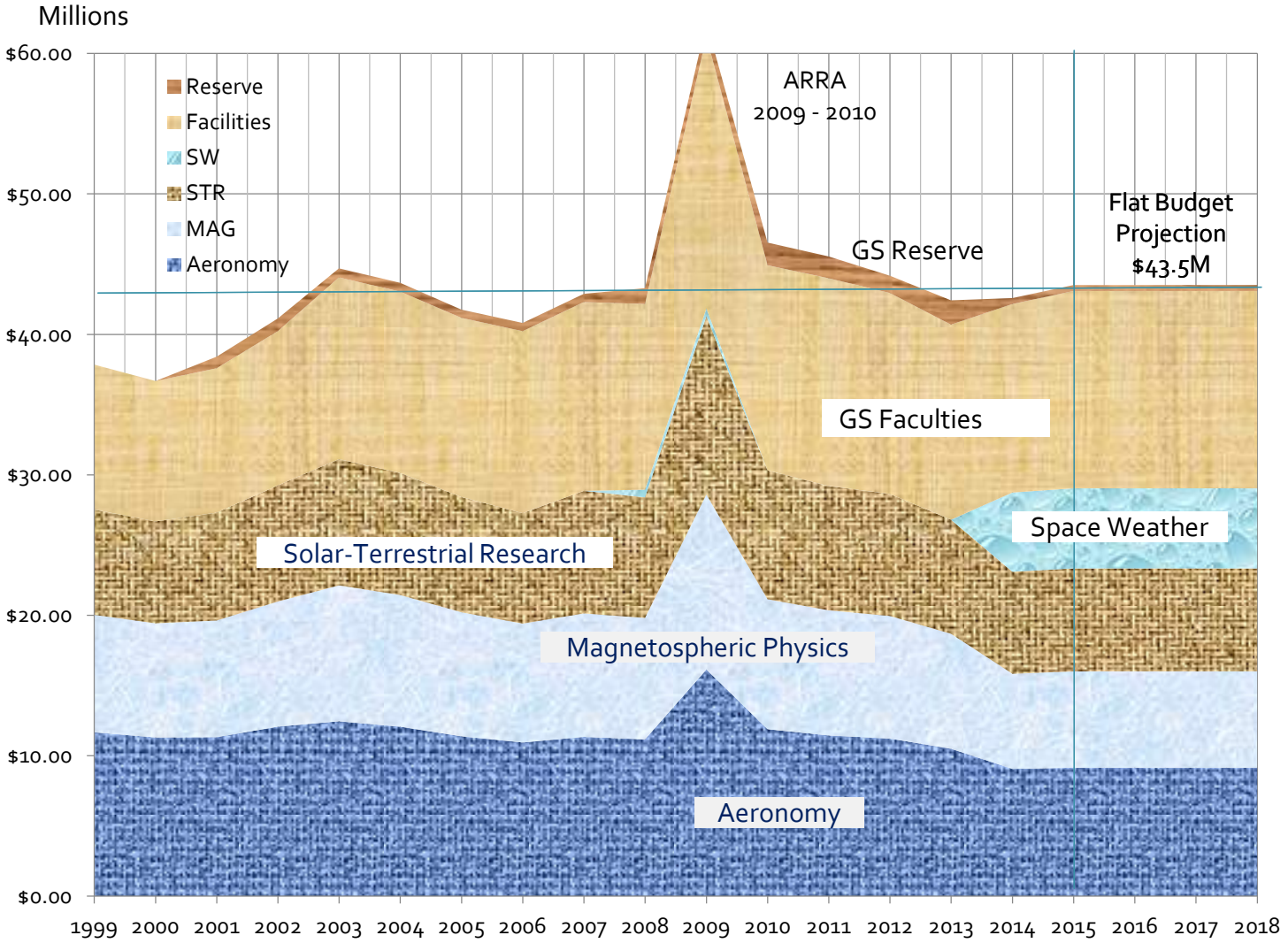
Budget Growth since 1999: ~60%



Geospace Section Budget Profile 1999-2015

Adjusted by inflation to 2015 dollars

No Real Budget Growth since ~2003 (with exception of ARRA funds in 2009-2010)



Geospace Portfolio Review Committee

William Lotko (Chair)
Dartmouth College
(Magnetospheric Physics, Education & Outreach)

Joshua Semeter (GEO/AC Liaison)
Boston University (Aeronomy)

Daniel N. Baker (Magnetospheric Physics)
University of Colorado – Boulder

William Bristow (Aeronomy)
University of Alaska – Fairbanks

Jorge Chau (Geospace Facilities)
Leibniz-Institute of Atmospheric Physics (Germany)

Christina Cohen (Solar Physics)
California Institute of Technology

Sarah Gibson (Solar-Terrestrial Research)
National Center for Atmospheric Research

Mona Kessel (Magnetospheric Physics)
NASA/HQ & Goddard Space Flight Center

Delores Knipp (Space Weather Research)
University of Colorado – Boulder

Louis Lanzerotti (Geospace Facilities)
New Jersey Institute of Technology

Patricia Reiff (Education & Outreach)
Rice University

Alan Rodger (Geospace Facilities)
University of Cambridge (UK)

Howard Singer (Space Weather Research)
NOAA/Space Weather Prediction Center

Geospace Portfolio Review Timeline

- ***PR Committee membership (13 members; January 2015)***
- ***Criteria and strategy (January-February 2015)***
- ***PR Committee Charge and Formation (February 2015)***
- ***PR Five Teleconferences (March - May, 2015):*** collecting and assessing GS data
- **First PR Committee in-person meeting at NSF (April 6-7, 2015)**

  Very productive and successful meeting, full GS review and plans developed for report construction. The **PR Fact Sheet** is developed and will be placed to the PR **Public Web site**: **http://www.nsf.gov/geo/ags/geospace-portfolio-review-2015**
- **Community input:** via geoagsgsportfolio@nsf.gov (Apr–May 2015) and workshops
- PR Committee drafts their report (June – August, 2015)
- Second PR Committee in-person meeting at NSF (August 12-14, 2015)
- GS Portfolio Review Report to GEO/Advisory Committee (September 2015)

  Pursuing option to have this draft reviewed by the NRC/CSSP Committee
- GEO/Advisory Committee reviews the GS/PR Report (October 2015)
- GS programs response to the PR Committee Report (November 2015)
- Final (revised if necessary) GS/PR Report released (December 2015)

Questions?

Thank you!