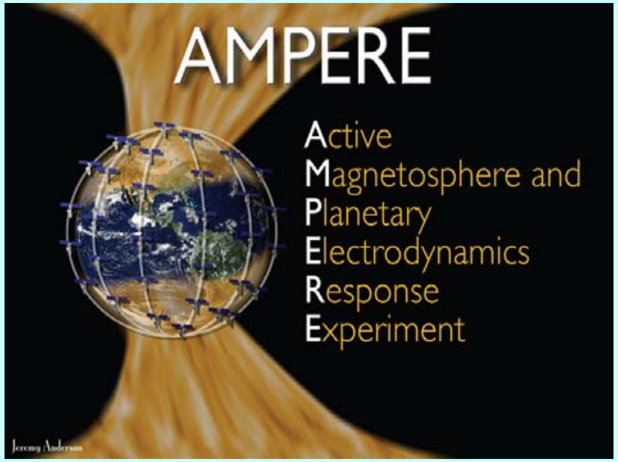
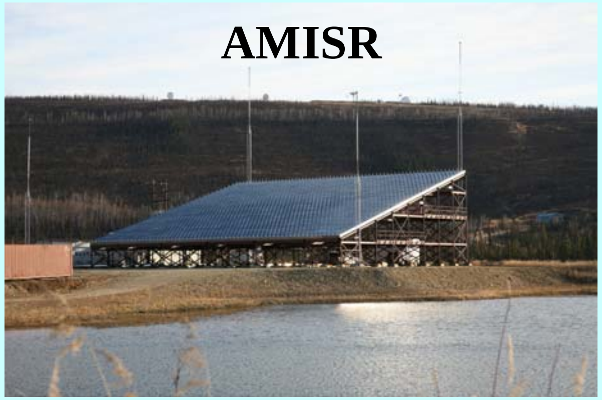
NSF Contributions to Space Research



Community
Coordinated
Modeling
Center

CISM

Center for Integrated Space Weather Modeling

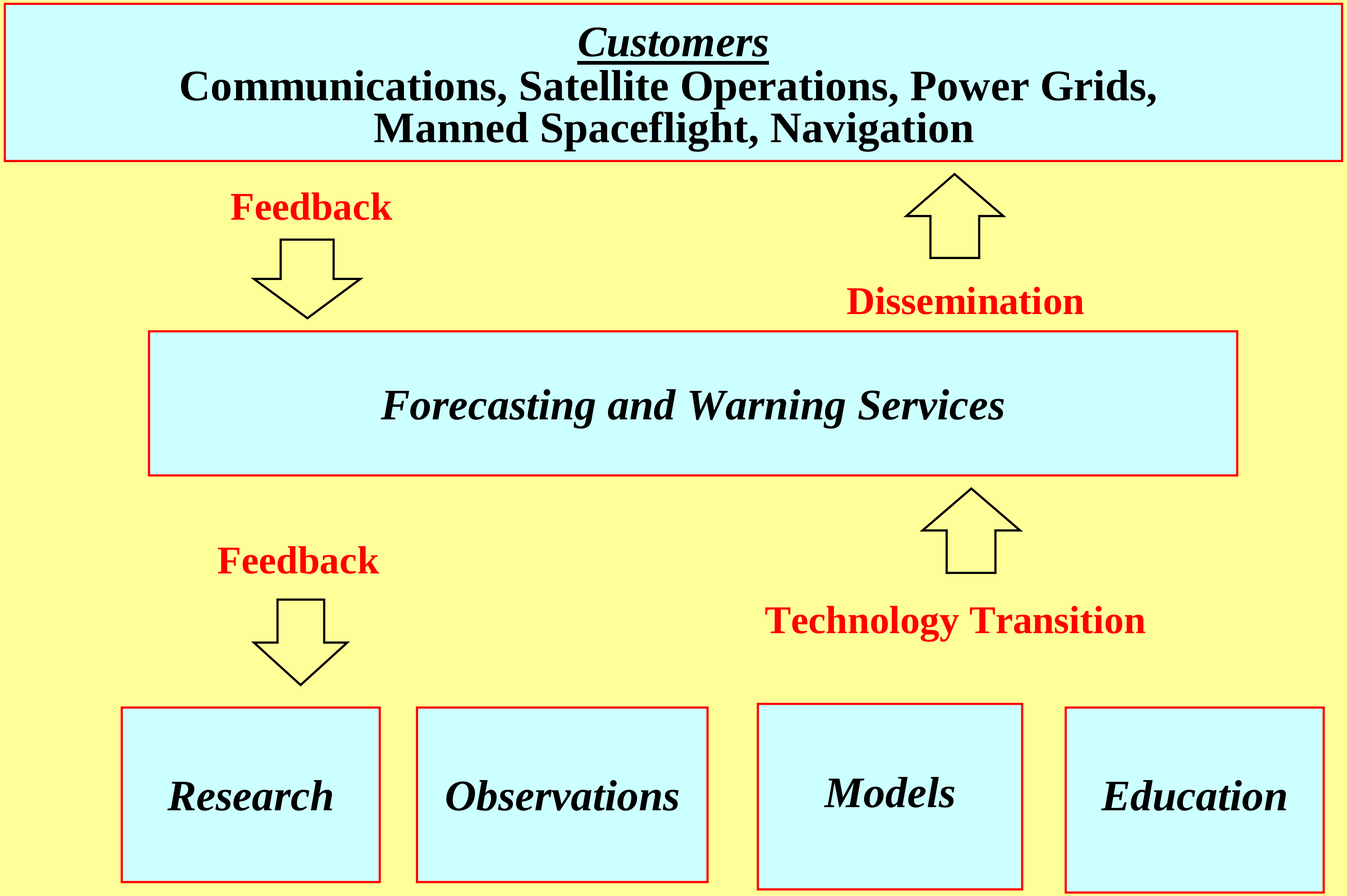


Farzad Kamalabadi

NSF

National Space Weather Program

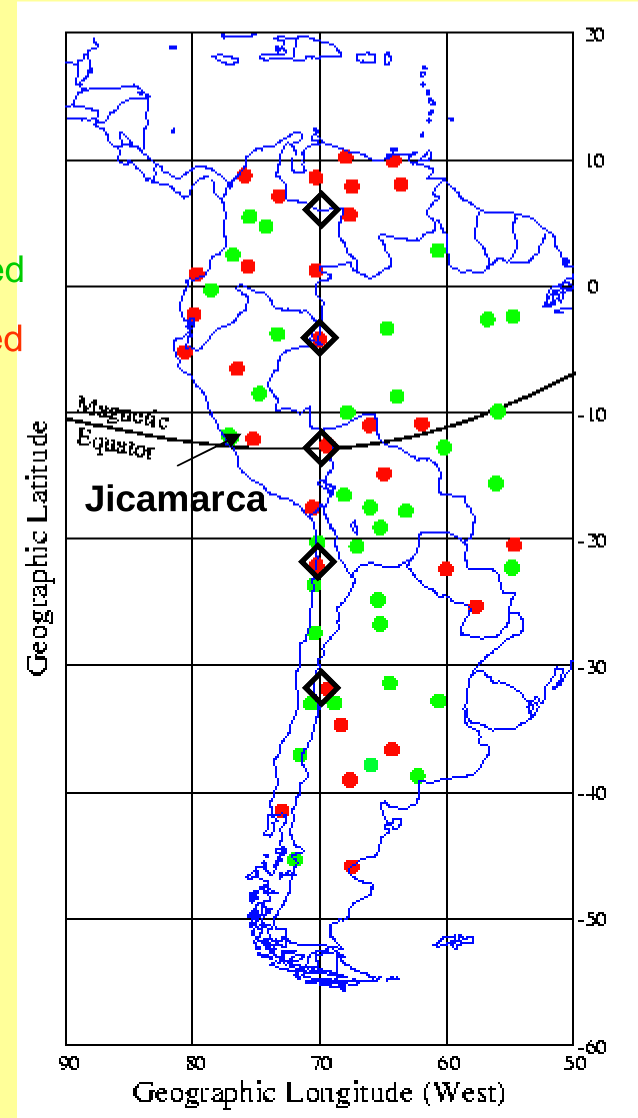
Strategic Elements



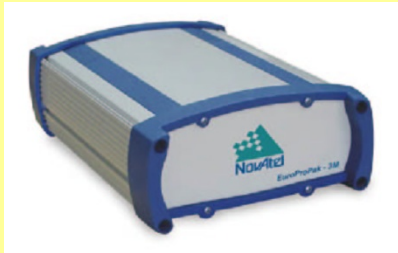
The Low Latitude Ionospheric Sensor Network (LISN)

● Installed

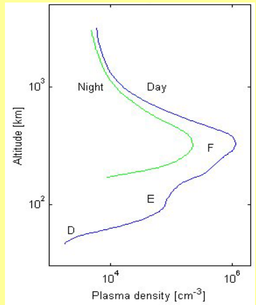
● Planned



- To address key questions about the physics of the equatorial ionosphere
- Develop nowcast/forecasts capabilities on the onset of Spread F

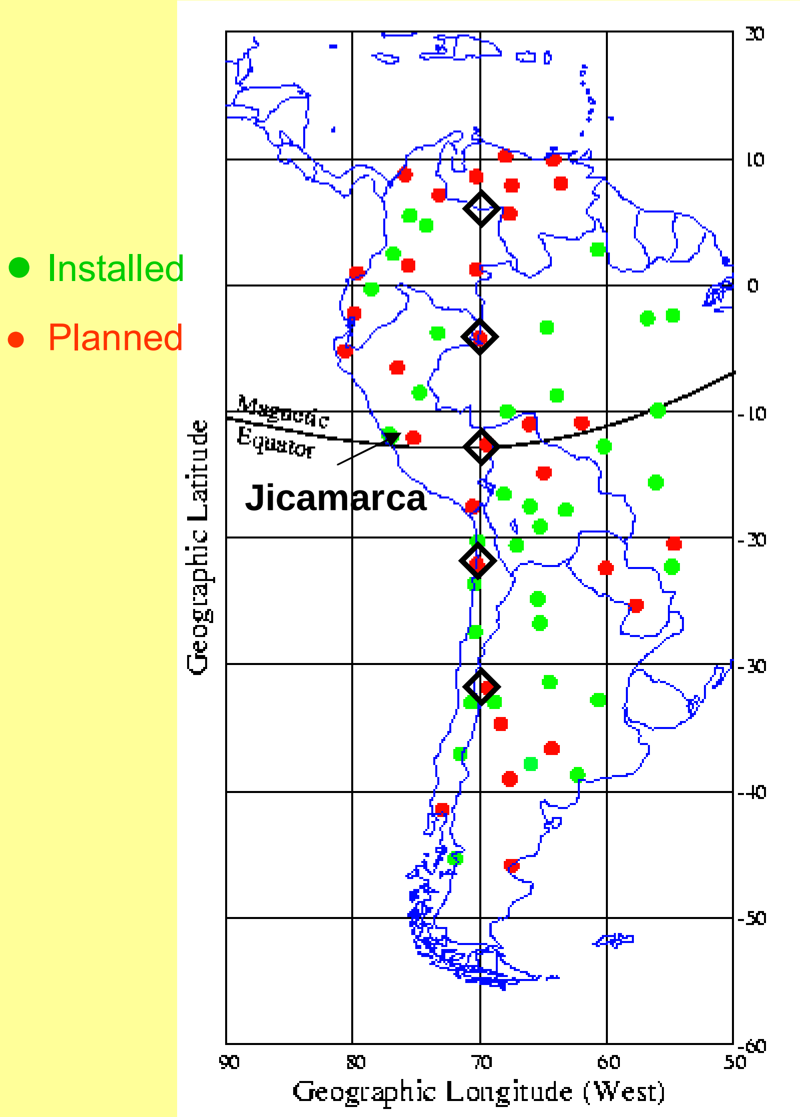


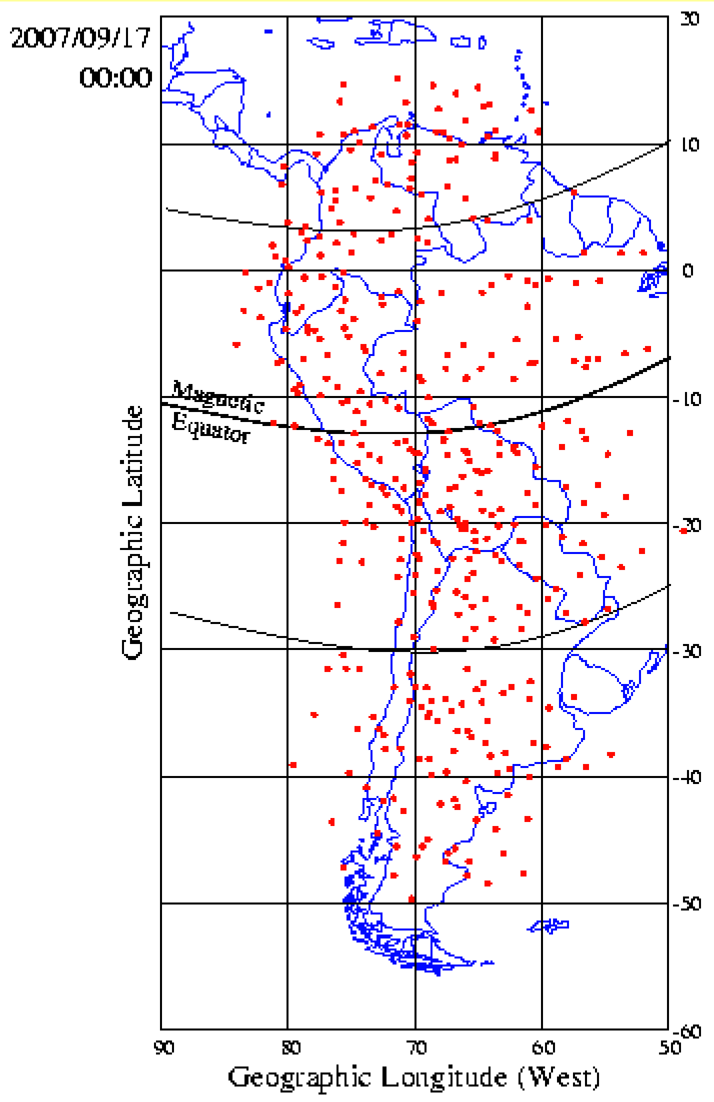
- **70 GPS Receivers**
  - TEC, TIDs
  - Scintillation
- **5 Ionosondes**
  - Virtual height
  - Bottomside density profiles
  - Meridional winds
  - Nighttime capability



- **5 Magnetometers**
  - Monitor ionospheric currents
  - Measure Vertical plasma drifts

The Low Latitude Ionospheric Sensor Network (LISN)





IPPs after all 70 receivers are integrated

Objectives of the LISN Observatory

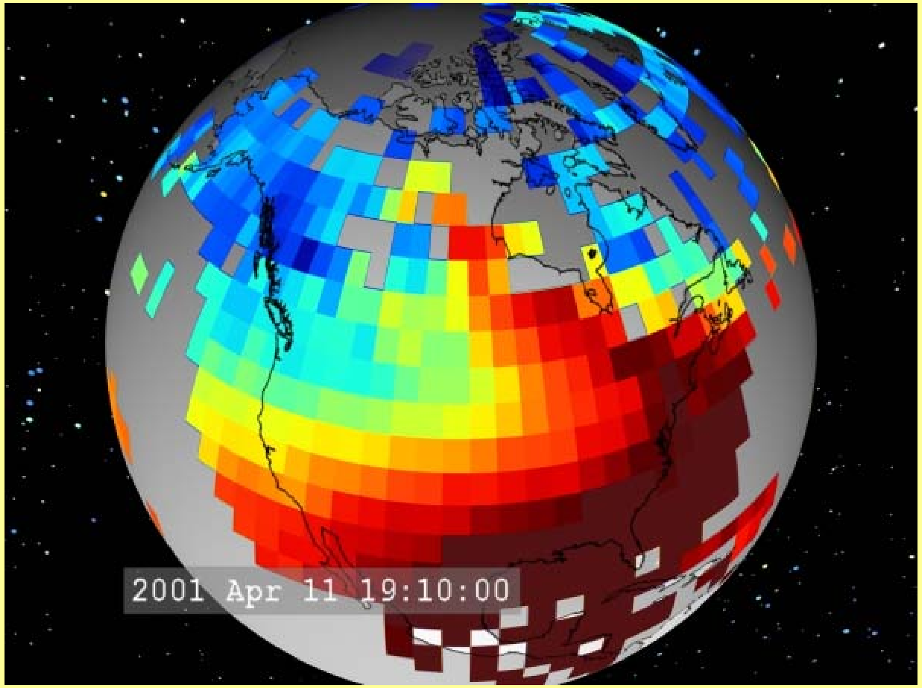
- **To install the first Distributed Observatory in South America**

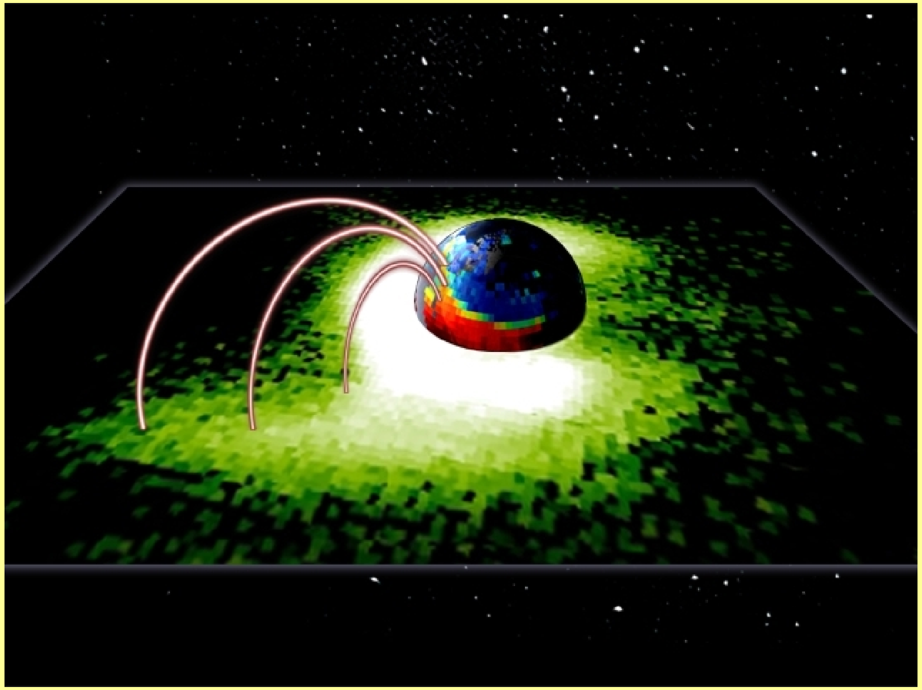
- **To nowcast the state of the low-latitude ionosphere in terms of TEC, scintillations, TEC depletions, bottomside E- and F- region densities**

- **To address key questions about the low-latitude ionosphere**
  - **drivers of the low-latitude ionosphere**
  - **the effect of E and Es layers on inhibiting ESF**
  - **the role of Gravity Waves on seeding plasma bubbles**
  - **alternative theories for ESF**
  - **longitudinal variability of the low-latitude ionosphere**

- **To initiate collaboration with South American scientists working on Space Weather problems. Motivate researchers and students in South America by providing science projects in space physics and creating programs for instrument development.**

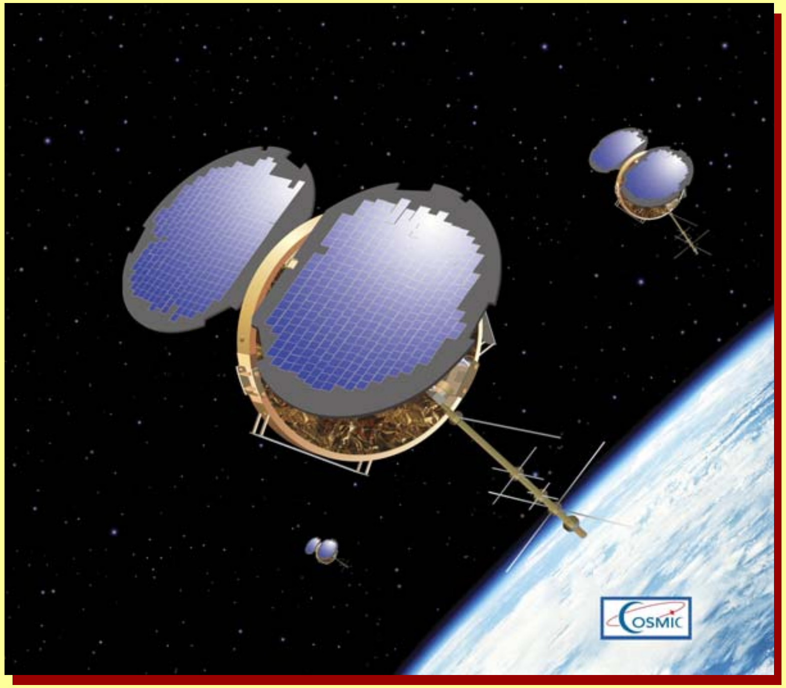
Coupling between the Ionosphere and the Plasmasphere (Foster et al.)

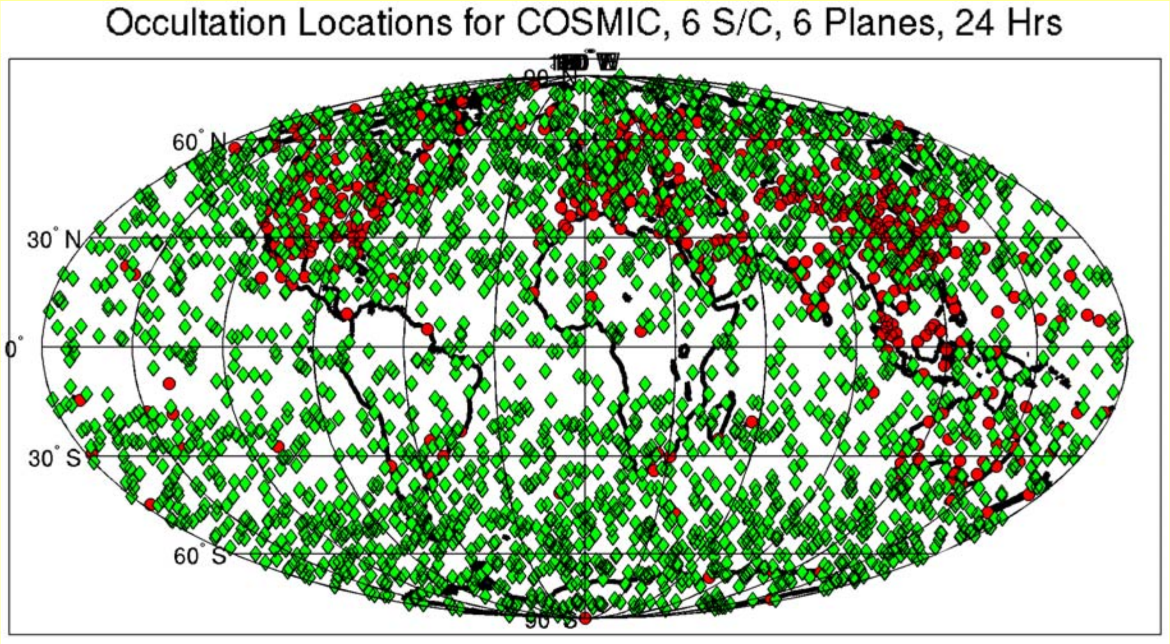


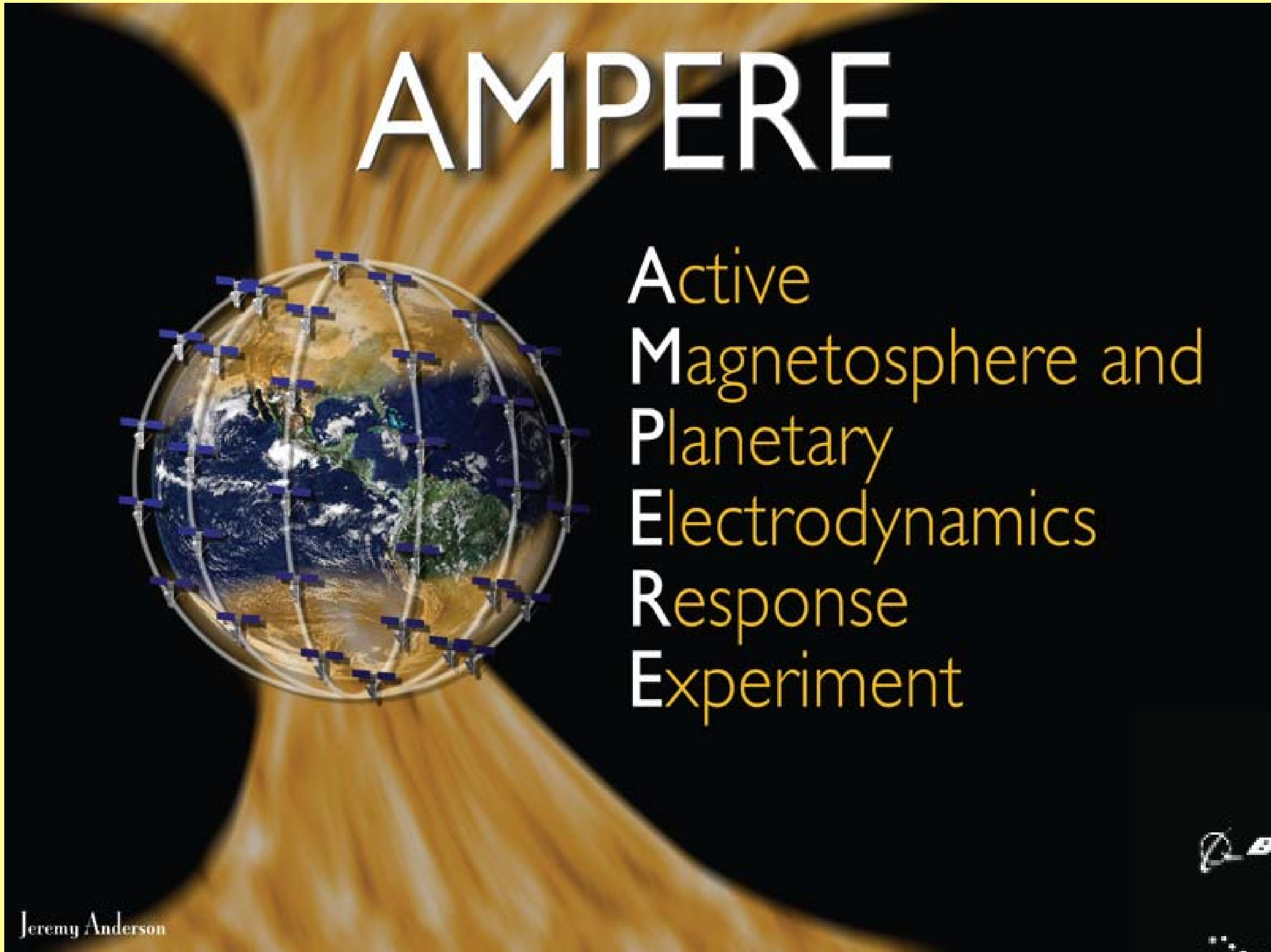


COSMIC

- **Taiwan-US Collaboration**
- **Six satellites record weather, climate, and space weather data**
- **NSF lead agency for science activities**







- Upgrade to Iridium magnetometer data
- Global, 24/7, real-time, field-aligned-currents
- 9 minute cadence
- Commercial data-buy from Boeing & Iridium

Sponsor
National Science Foundation

Data provider
Boeing Service Company

Data source
Iridium Satellite LLC

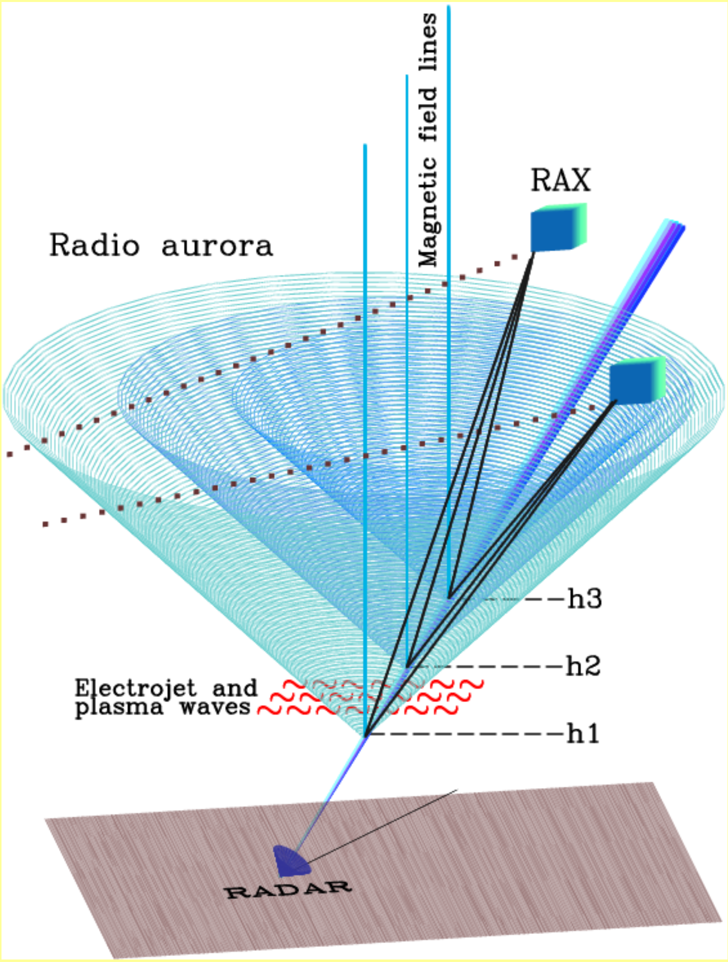
PI Institution, Science Data Center
The Johns Hopkins University
Applied Physics Laboratory

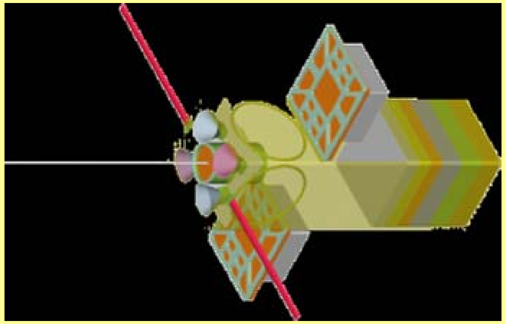
Data acquisition start	Q1 2010
First data product releases	Q1 2011
First real-time products	Q1 2012
Final product release	Q2 2013
Potential continuing ops.	2014 & beyond

Project started August 2008, being led by

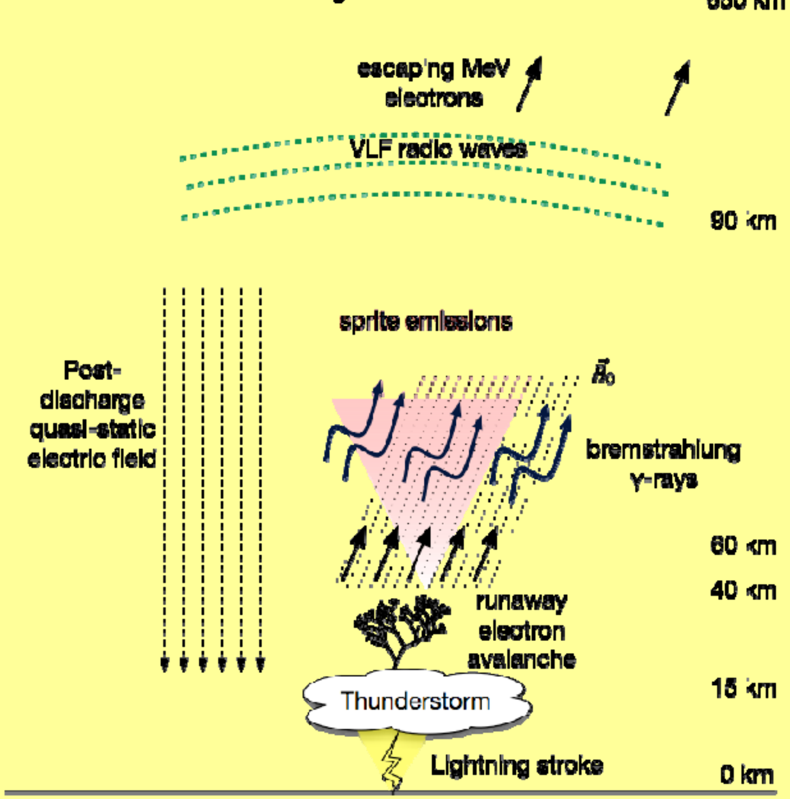
Brian Anderson, JHU/APL

Two NSF Cubesat Missions





Firefly detects radio and optical signatures of lightning as well as the gamma-rays and energetic electrons.

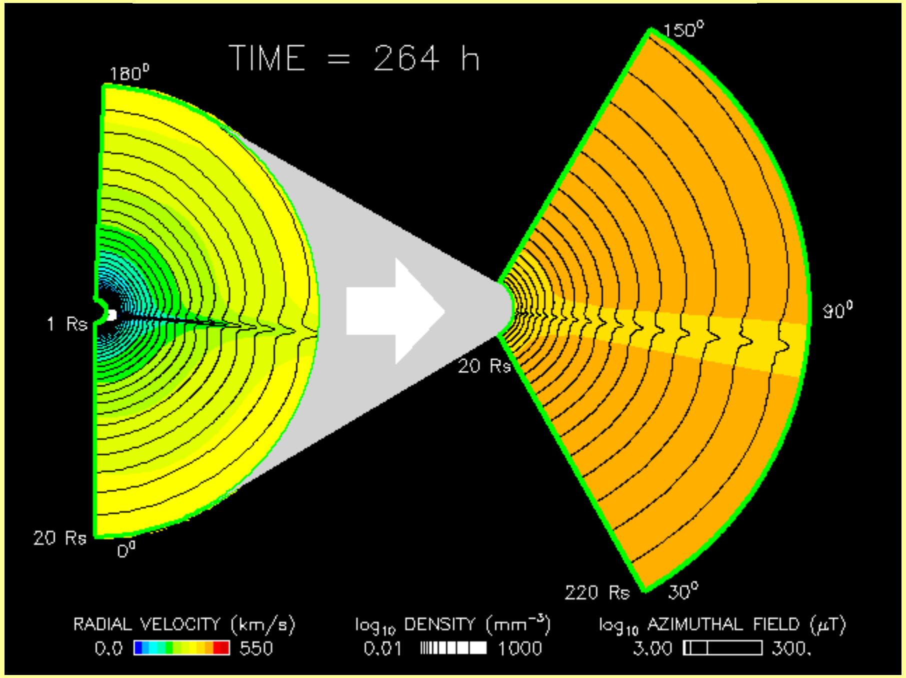


CISM

CENTER FOR INTEGRATED SPACE WEATHER MODELLING

Education and Diversity

Space Weather Research and Model Development

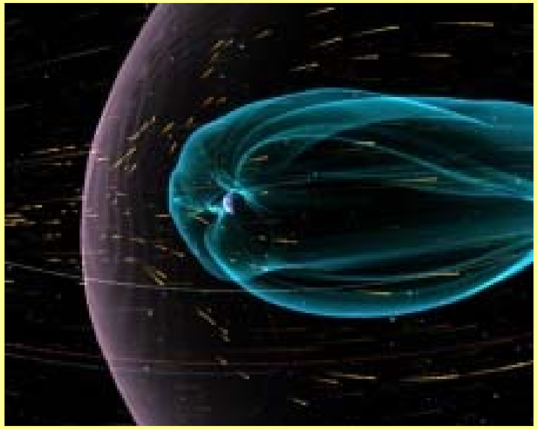


Knowledge Transfer

Education, Outreach, Diversity

Space Weather Weekend at Alabama A&M

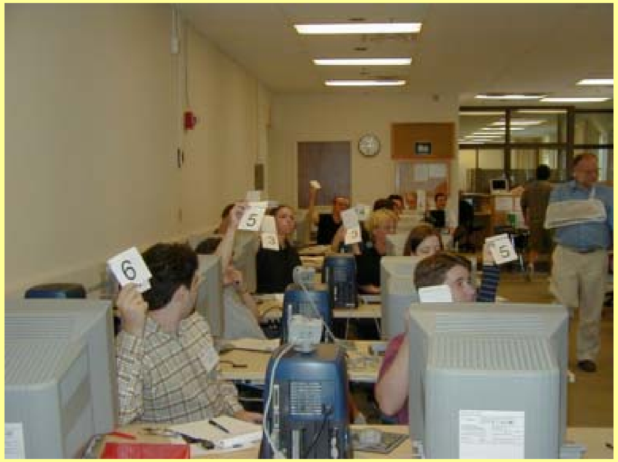
CISM Space Weather simulation used at Hayden Planetarium



First Alabama A&M Physics graduates with a concentration in space physics

CISM Graduate Student Retreat

CISM Summer School



The Poker Flat Incoherent Scatter Radar (PFISR) by day

The Poker Flat Incoherent Scatter Radar (PFISR) by night

The Resolute Incoherent Scatter Radar (RISR)
First Light: April 23, 2009

Advanced Technology Solar Telescope

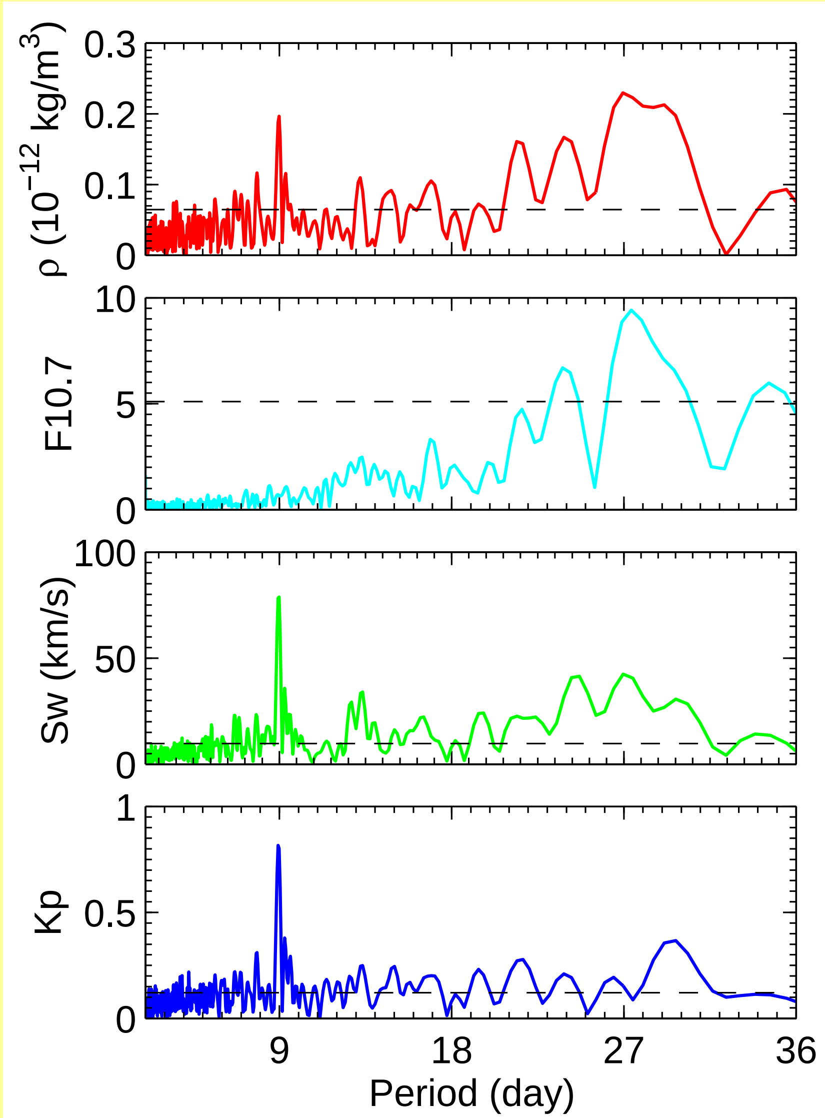
Coupling between the ionosphere and the solar wind (Thayer et al.)

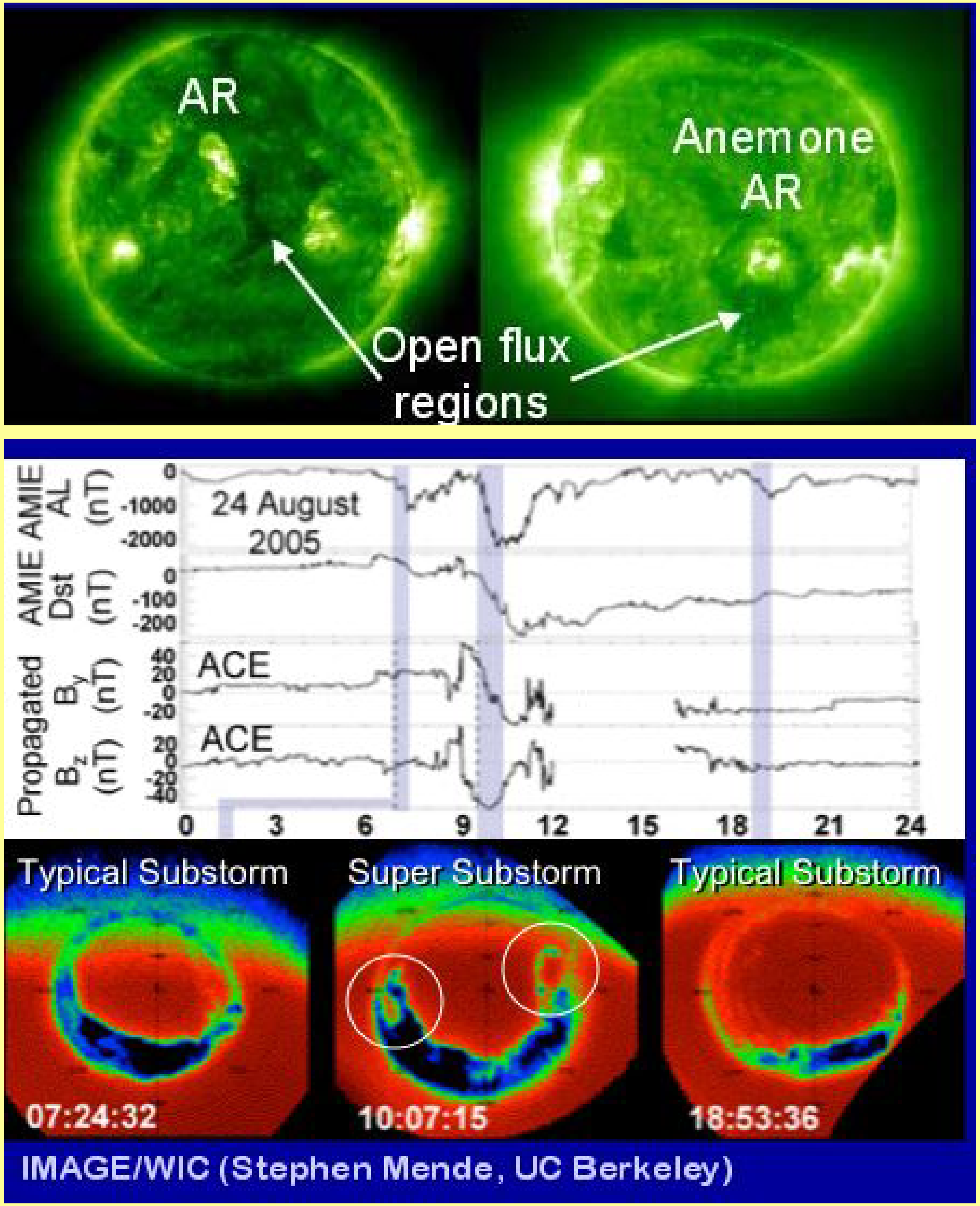
Density - 400km altitude

Solar EUV flux index

Solar wind speed

Geomagnetic Activity Index



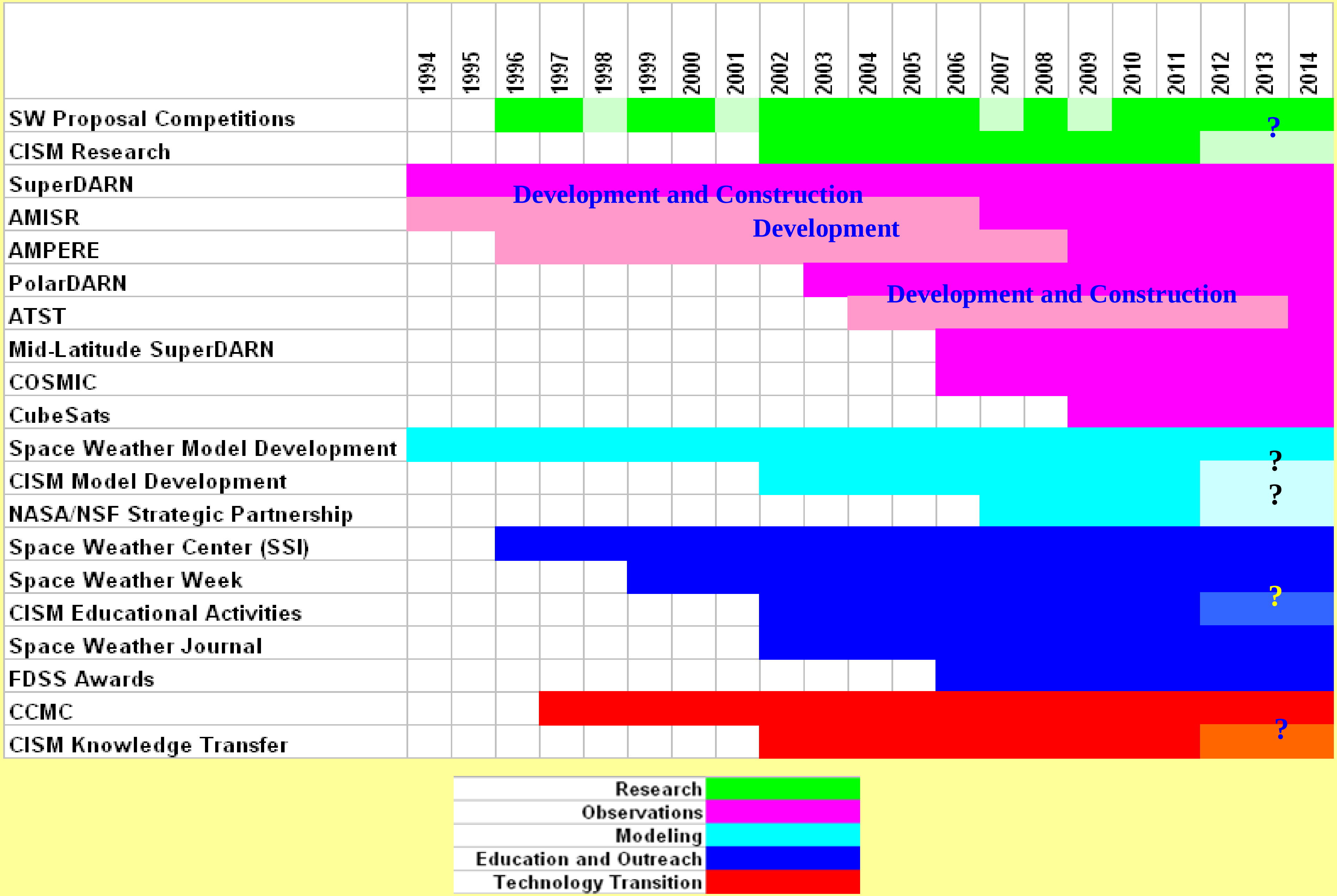


Coupling between the ionosphere and the Sun (Kozyra et al.)

Ionospheric features uniquely linked to solar active regions

Active regions that give rise to distinctive features in the auroral ionosphere

Timeline of NSF-supported Space Weather Activities



Space Weather in the Future

- **Space weather researchers will make fundamental breakthroughs in core disciplinary areas required to better understand the past, current and future behavior of the Sun-Earth system.**
- **The 21st century will see many exciting discoveries in space sciences, many of which will involve the identification of unanticipated linkages among phenomena seemingly disconnected spatially, temporally, and phenomenologically.**
- **Advanced models will accurately simulate the individual elements of the Sun-Earth system, as well as the linkages between the physical phenomena and the societal impacts.**
- **Space scientists of the future will exploit advanced cyberinfrastructure to run end-to-end models, making use of ensemble modeling techniques and numerical experimentation to provide reliable, quantitative information.**
- **New and upgraded facilities will provide space scientists critical data on scientifically and strategically important aspects of the Sun-Earth system.**
- **Global networks of interactive, autonomous, and smart sensors will provide space scientists the critical long-term data bases necessary to understand the whole Sun-Earth system and how it changes through time.**
- **Advanced cyberinfrastructure will help scientists assimilate, explore, and understand observations obtained from disparate databases.**
- **A burgeoning space weather industry will provide tailored products to space weather stakeholders to more effectively address the ever increasing breadth of customer-driven requirements.**
- **The importance and excitement of future space weather research will motivate and inspire new generations of young scientists who are trained to better appreciate and understand the linkages that make the Sun-Earth system both unique and fascinating.**
- **Space scientists, as well as the public at large, will have a finger on the heartbeat of the Sun-Earth system, with the tools and understanding to better meet and overcome the challenges the future will bring.**