Space Weather Technology, Research, and Education

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Problem Statement(s)

1. Space weather (SWx) forecasting is not accurate, reliable, or timely enough to allow mitigating actions by users of the information.
   - 24-hour solar forecasting is barely better than climatology (average rate forecast).
   - Radiation events remain a mystery: some very large eruptions cause events, some don’t.
   - Current error in geomagnetic storm forecasts = ±6—12 hours.

2. Transition of new research models, mission data, and tools to operational forecasting is inefficient. “R2O problem”
   - Full-physics satellite drag models + vehicle gas dynamics simulations.
   - Van Allen Probes radiation belt data.
   - Application of artificial intelligence to space weather prediction.

3. Researchers are unaware of the requirements (and shortcomings) of operational models and tools and cannot help. “O2R problem”
Addressing the R2O and O2R Problems

Current State of Scientific Understanding

Research Observations
Missions/Instruments / Facilities

Fundamental, Supporting Research

Targeted Sensor Capability Research and Development

Targeted Modeling Research and Development

Operational Models

Operational Observations

Nowcasting/Forecasting Capabilities
First Principles, Assimilative, Empirical

Dedicated R2O-O2R Centers

Addressing the R2O and O2R Problems

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CSSP Meeting 30-March-2016
Space Weather Testbeds
Enabling SWx O2R

Operational Model Copies

NRT Operational Data

SWx Data Portal and Archive

Data Improvements

Model Improvements

Tool Innovations

Operationally Validated Result
Required Education Program

- Undergraduate, Graduate, & Professional Curricula
- Focused SWx Science Topic Workshops
- SWx Summer School Contributions
- Academic SmallSat Programs
- Operational Forecasting Focused Workshops
- Infrastructure & Policy Makers Communications Programs

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Space, still the final frontier

It has been 50 years since the launch of Sputnik, the first artificial satellite, which marked the beginning of the space age. Since then, space exploration has taken on new dimensions, with a growing number of private companies, universities, and government agencies involved in research and development. The International Space Station (ISS) has become a symbol of international cooperation, with astronauts from around the world living and working there.

The future of space exploration is not just about reaching further into our solar system, but also about finding new ways to use space for the benefit of humanity. From satellite communications to climate monitoring, space technology has the potential to solve some of the world's most pressing problems.

One of the most exciting areas of space exploration is the search for extraterrestrial life. Scientists are using telescopes and spacecraft to look for signs of life in our solar system and beyond, and the data they are collecting is helping to inform our understanding of the universe.

As we continue to explore space, it is important to remember the importance of international cooperation and collaboration. The ISS is a testament to this, with scientists from different countries working together to achieve a common goal.

The future of space exploration is bright, and there is no doubt that we will continue to make amazing discoveries in the years to come.
We can do much better.