

NOAA SWPC / NASA CCMC PARTNERSHIP

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NOAA Space Weather Prediction Center

Outline:

- SWPC Mission
- Motivation and Policy
- Connections to CCMC
 - Past, Present and Future
- Conclusions

9th CCMC Community Workshop
College Park, Md.
April 23, 2018

Acknowledgments: Adamson, Balch, Cash,
Murtagh, Onsager, Rutledge, Steenburgh,
Viereck



Space Weather Prediction Center

Established 1946 as part of Central Radio Propagation Laboratory

Operations – Space Weather Forecast Office



Daily forecast since 1965.

Specifications; Current conditions

Forecast; Conditions tomorrow

Watches; Conditions are favorable for storm

Warnings; Storm is imminent with high probability

Alerts; observed conditions meeting or exceeding storm thresholds

R & D – Space Weather Prediction Testbed Transitioning models & data into operations

R2O

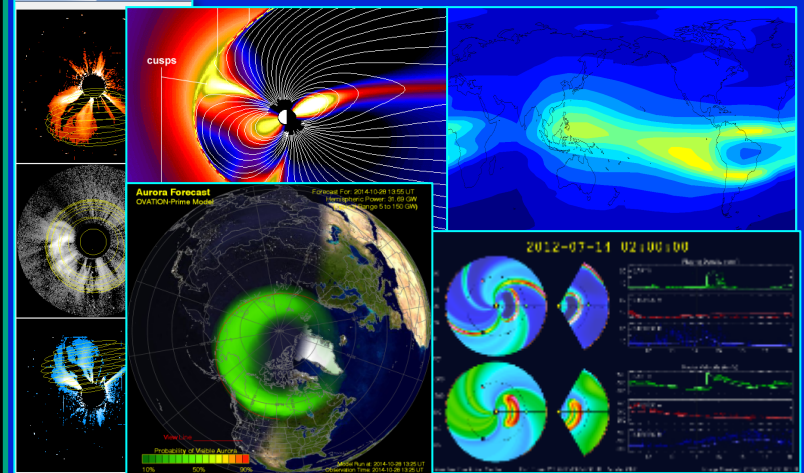
Research-to-Operations

- Applied Research
- Model Development
- Model Test/Evaluation
- Model Transition
- Operations Support

Operations-to-Research

- Customer Requirements
- Observation Requirements
- Research Requirements

O2R



Space Weather Prediction Center

CCMC Connections

CCMC

- **Multi-agency partnership** for next-generation space science and space weather models
- **Services include:** test and evaluate models in support of the needs of science users and space weather forecasters; **support Space Weather forecasters through transitioning of research models to operations,** through model evaluations, and through the provisions of forecasting tools



R & D –

Space Weather Prediction Testbed

Transitioning models & data into operations

R2O

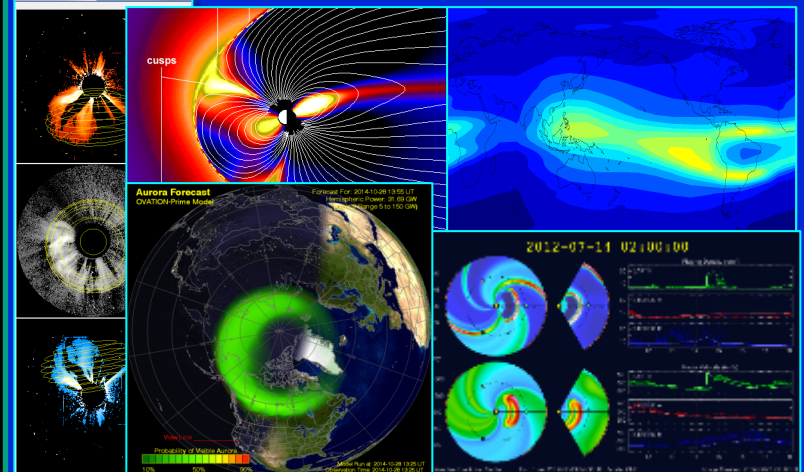
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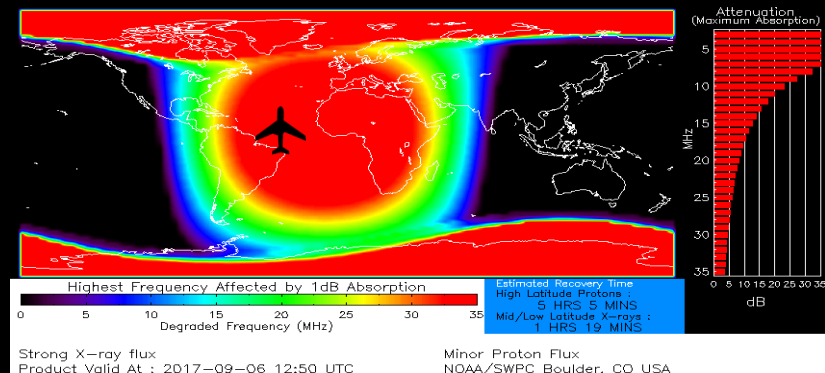
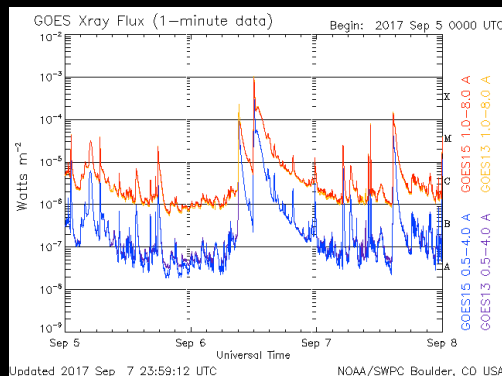
Operations-to-Research

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Customer Impact Example--September Storms Solar Flares, Solar Particle Events and Geomagnetic Storms



September 6, 2017 X-class Flare

French Civil Aviation authorities reported that HF radio contact was lost with one non-Controller Pilot Data Link Communications (CPDLC) equipped aircraft off the coasts of Brazil and French Guyana for approximately 90 minutes, triggering an alert phase until a position report was received by New York radio.

September 6, 2017 D-Region Absorption Prediction due to Solar flare (sub-solar) and solar protons (polar)

Approximate area (black disc) where HF communication was lost with a non-CPDLC equipped aircraft on September 6 at about 12:00 UTC.

Space Weather Policy Administration Priorities for Federal Research and Development – FY19 Budget

**Improving Preparedness for and Response to
Natural Disasters:**

“The Budget also continues to support space weather-related R&D, since space weather can affect not just the Nation’s satellites and space explorers, but can potentially cause significant damage to our electrical grid and electronic systems.”

Space Weather Policy Administration Priorities for Federal Research and Development – FY18 Budget

Space weather research. Senate report language also specifies that **NASA dedicate \$10 million to a space weather research program**. It further directs, ***“NASA should coordinate with NOAA and the Department of Defense to ensure that NASA is focused on research and technology that enables other agencies to dramatically improve their operational space weather assets and the forecasts they generate using data from those assets including current and future ground-based telescopes and instruments that are expected to come on line, such as [the National Science Foundation’s] Daniel K. Inouye Solar Telescope.”***

Geospace Models: Transition to Operations

- **Goal:** Evaluate Geospace models (MHD and empirical) to determine which model(s) are ready for transition to operations
- **Focus:** Regional K and dB/dt (important to electric utilities)
- **Partnership:** Evaluation at NASA/Goddard CCMC working with SWPC, modelers and science community

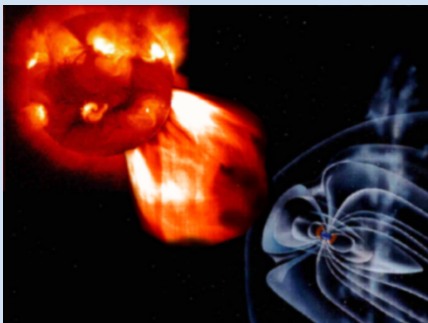
Select Models and Events

Establish Metrics

Model-Data Comparisons

CCMC Reports to SWPC

SWPC Selection FY 14: U. Of Michigan (MHD); VT (Weimer Empirical)
based on CCMC reports, internal and external advice, and following considerations:

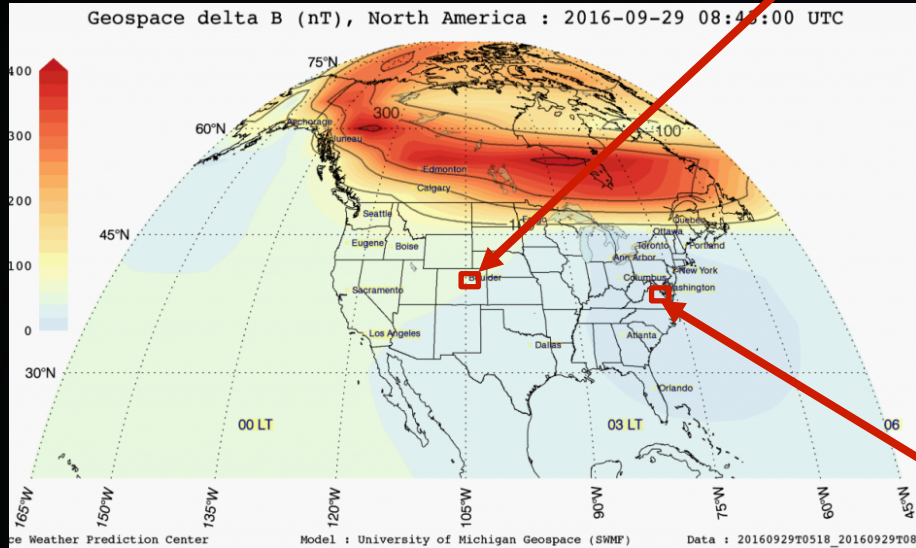


Solar Influences on Geospace Predicted with Geospace Models using Solar Wind Input

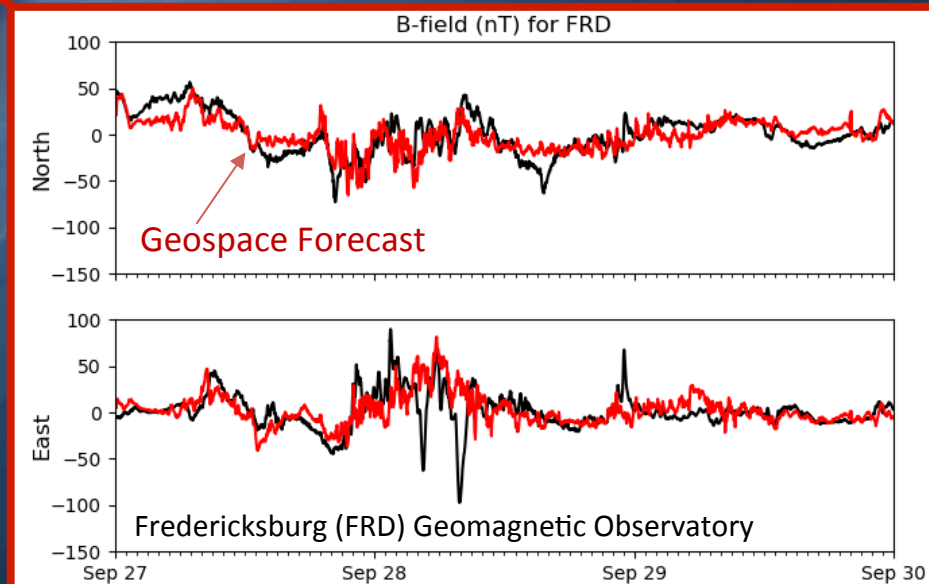
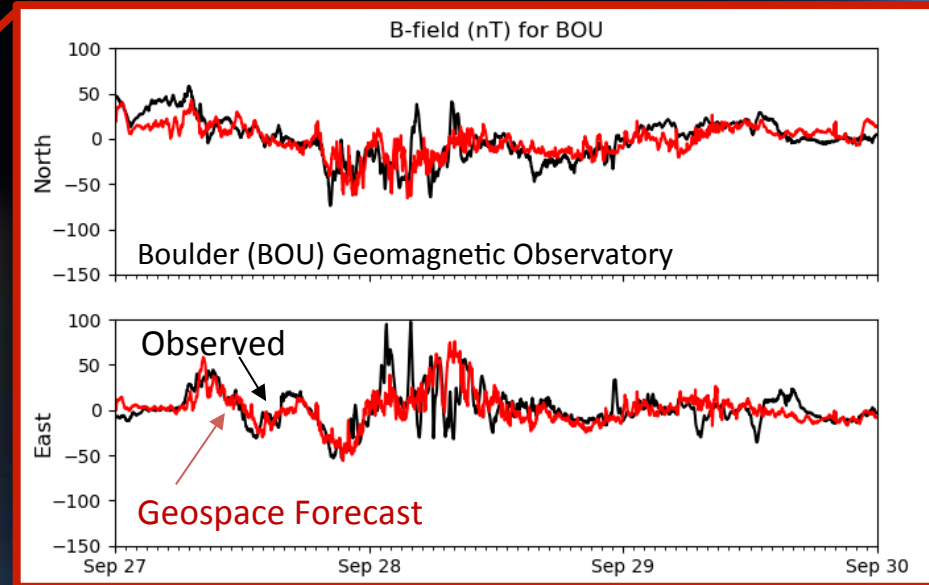
- Strategic Importance
- Operational Significance
- Implementation Readiness
- Cost to Operate, Maintain, and Improve

Geospace Model – Operational Oct 2016

Current Focus on Regional Validation



- Captures activity well at mid-latitudes during active periods
- Substorms challenging
- More validation is needed to provide confidence levels
- Provides regional geomagnetic storm predictions supporting space weather forecasters and electric power industry



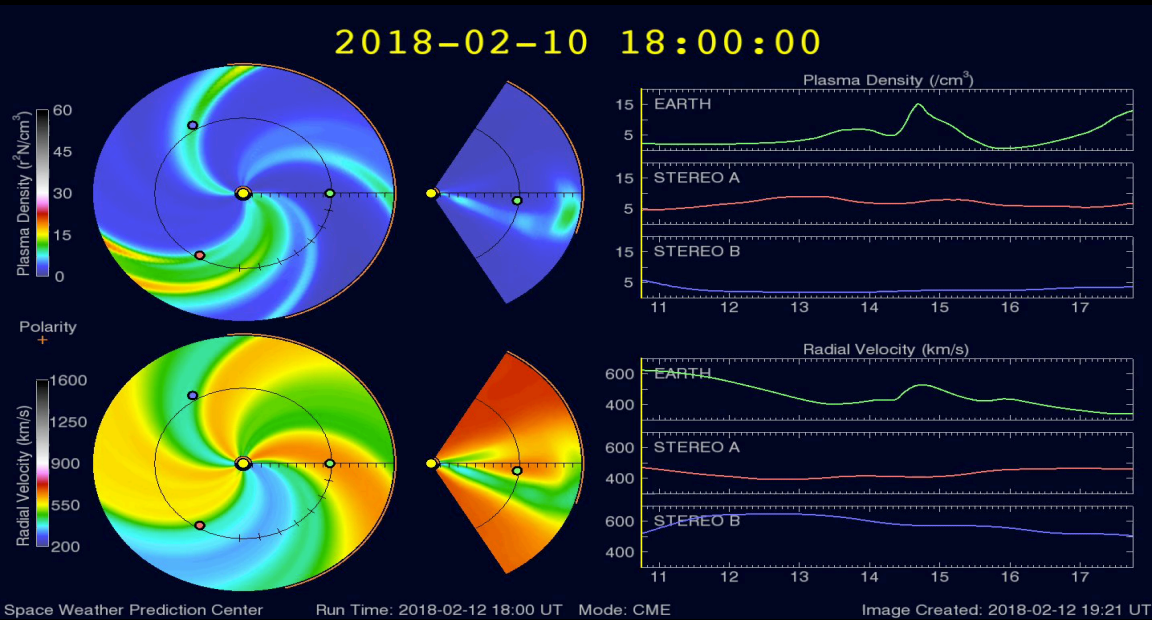
Geospace Model Prediction September 7-10, 2017



NOAA NASA MOU

- *MOU signed in 2016 between NOAA and NASA
Our two centers are working closely with each other on an evaluation of the Air Force Data Assimilation Flux Transport Model (ADAPT) for inclusion in the SWPC operational WSA-Enlil model*
- *Next topic of mutual interest being explored*

WSA-Enlil Heliospheric Model



Models ambient background solar wind and CME propagation - informs forecasts of timing, and to some extent, magnitude of Geomagnetic disturbances

Major model upgrades scheduled for 2018

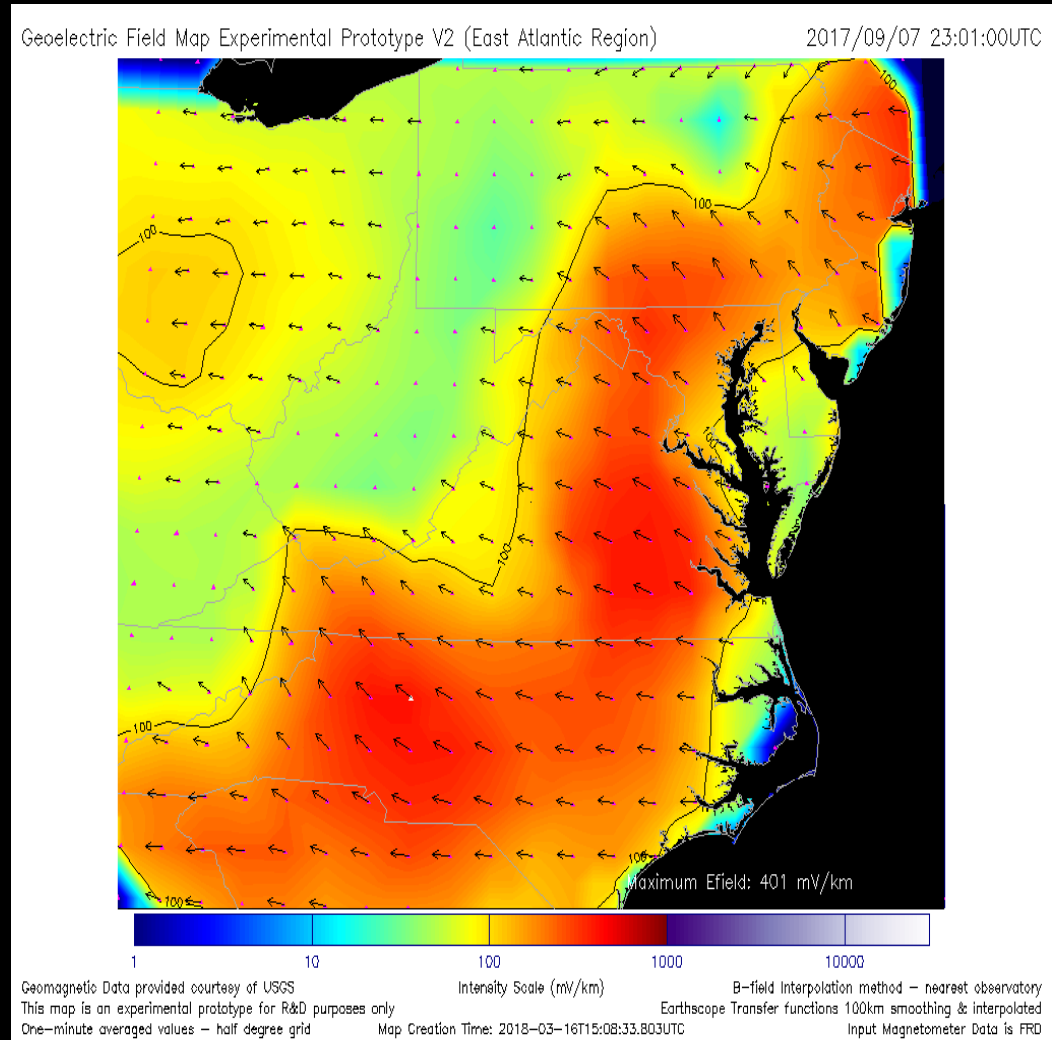
- Improved model inputs through enhanced processing of solar photosphere observations
- Increased operational robustness
- ADAPT compatible - enabling more accurate and time-dep. driving

Collaborative effort underway with NASA's CCMC to validate and quantify advancements in space weather prediction afforded by impending upgrades + ADAPT

See E. Adamson Presentation on Thursday

Geoelectric Field

- Computed from ground-based magnetometer data and ground-conductivity maps
- Upgrade for map products in progress
- Grid resolution increase from 2 degree to $\frac{1}{2}$ degree
- Conductivity models improve from 1D (Fernberg) to 3D based (Earthscope) – in regions where surveys have been completed
- Validation work with user community is underway

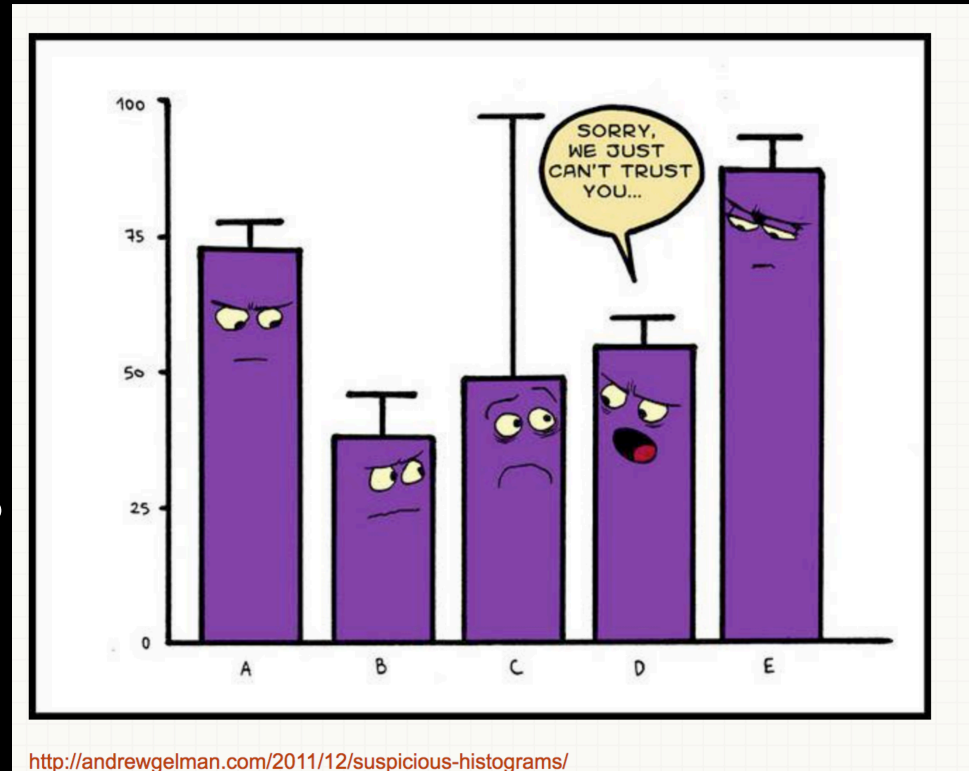


Eastern Seaboard 9/7/2017
Max E field = 0.4 V/km

**Collaborators: USGS, NASA,
NRCAN, NSF-Earthscope Project**

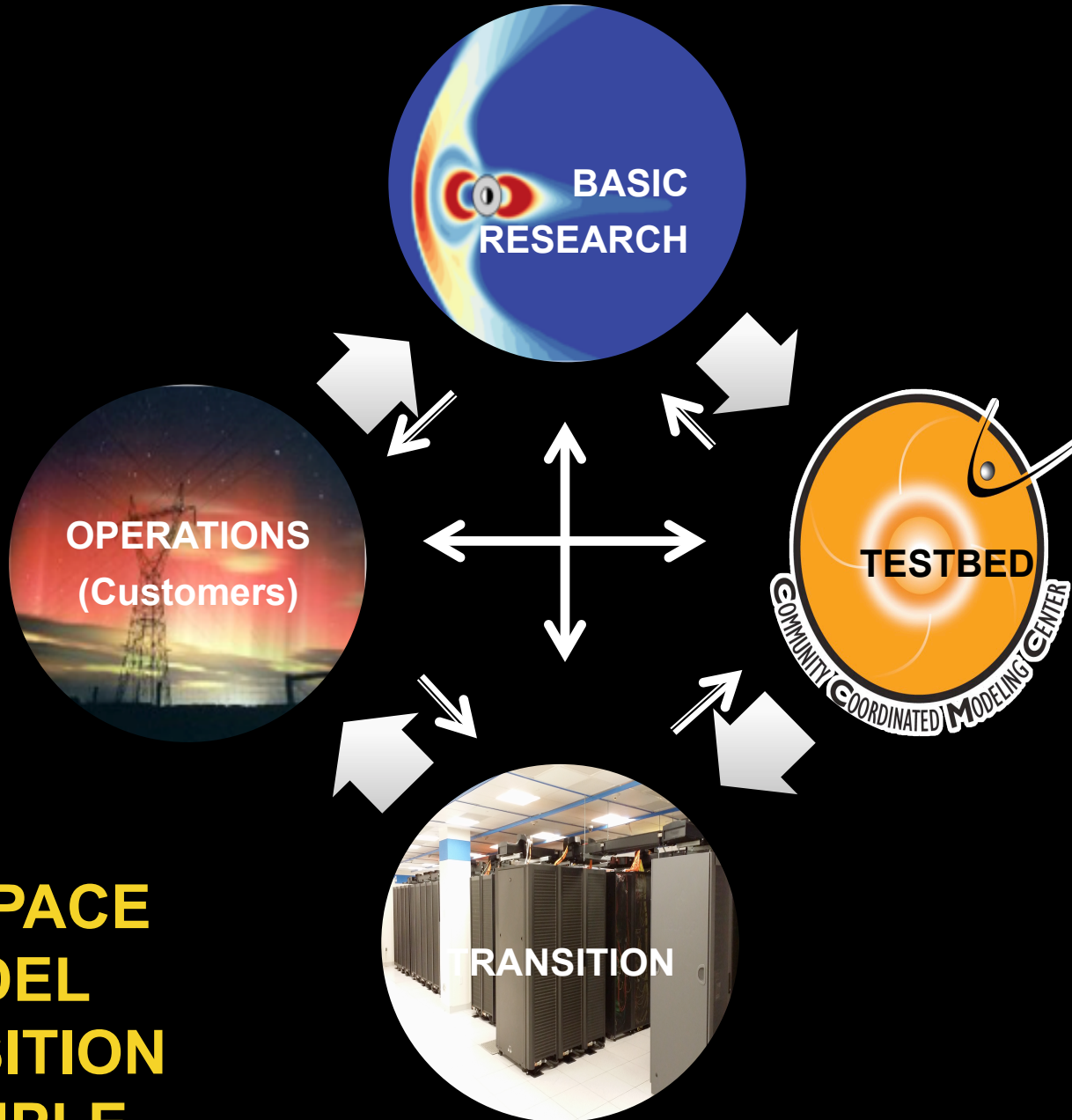
Validation is Essential

- An on-going process
- In SWAP
- Enables establishment of confidence levels on products and services
- Requires thoughtful metric selection
- Required for new model selection and on-going use
- Provides guidance for model improvements



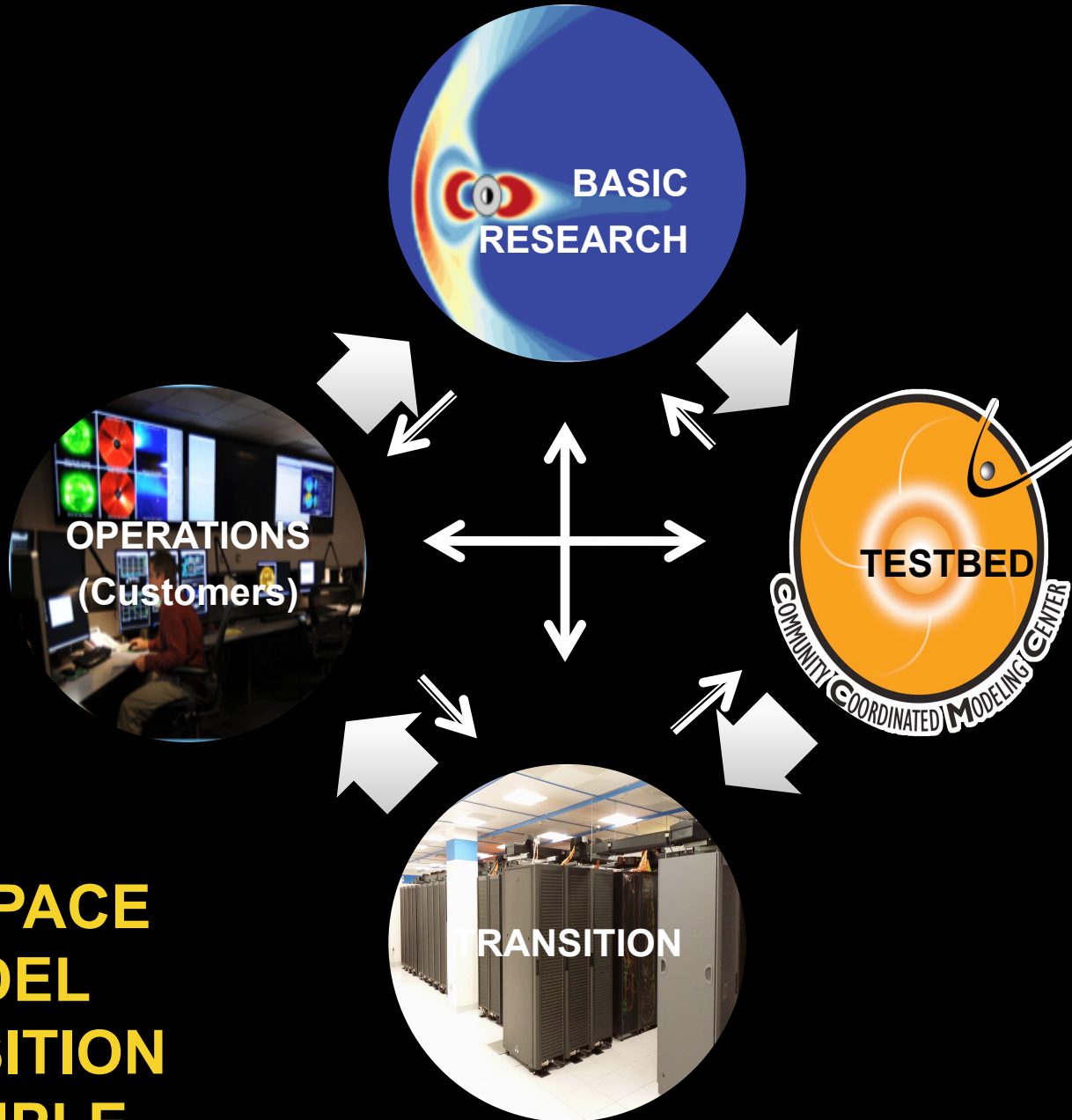
**CCMC has a major role
in model validation**

RESEARCH TO OPERATIONS TO RESEARCH CYCLE



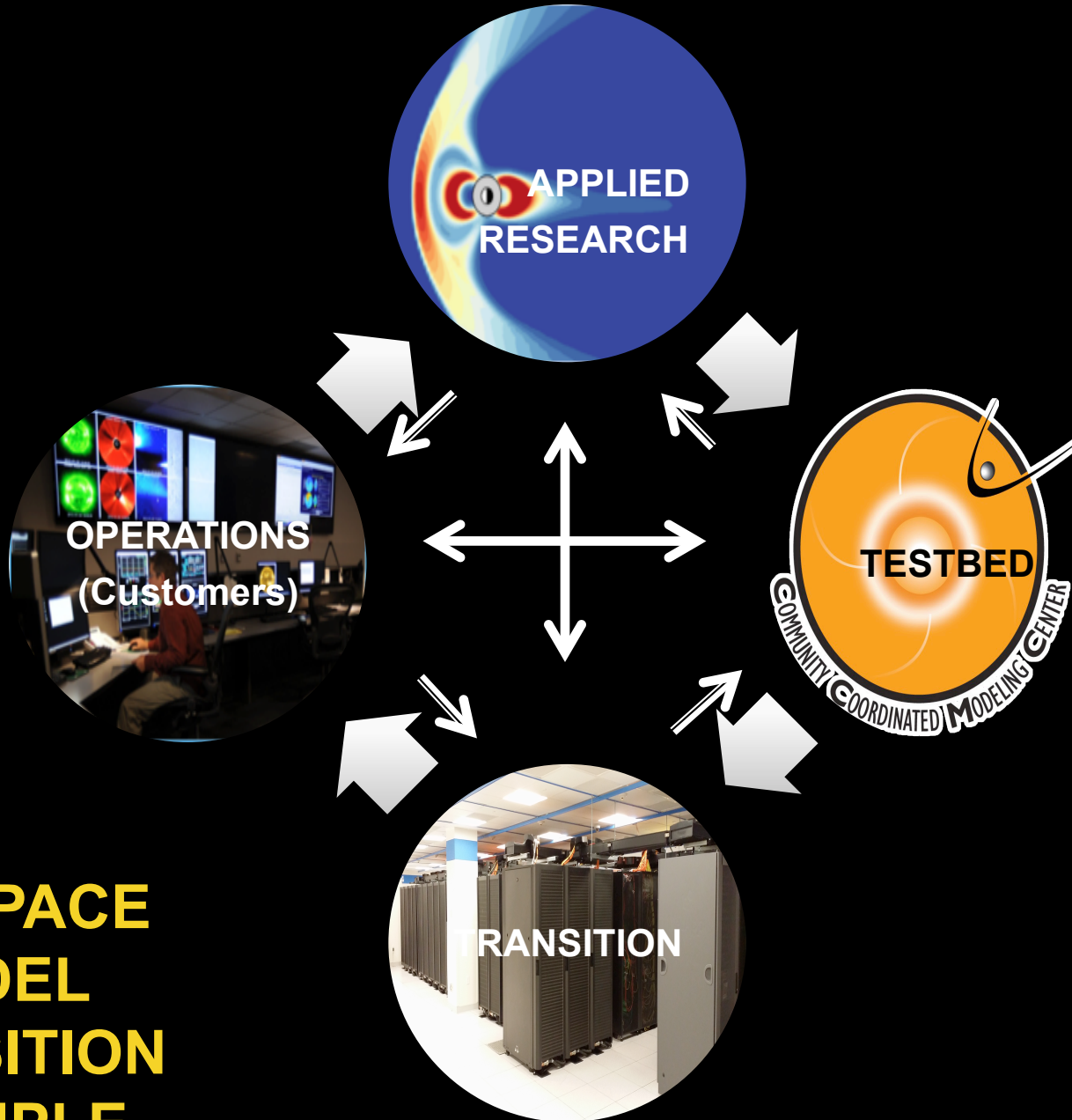
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MODEL
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Conclusions

Forecasting Space Weather will advance, in part, through a successful SWPC-CCMC partnership

- Broad range of CCMC activities benefit SWPC**
- Geospace model transition – a success story**
- MOU leading to WSA-Enlil-ADAPT model evaluation showing excellent progress**
- Model validation for potential future transition is useful for both science and operations**
- SWAP R2O-O2R -- an expanding opportunity**

These actions, along with an understanding of user needs, will enable SWPC to serve customers with consistent, accurate, and actionable information.