User Community and Operations: Space Weather Operations Panel

Key Questions:

- 1) What new observations, models or other assets are needed to supply high-quality services?
- 2) How do we educate the user community to be able to demand new services making use of novel observations and models?
- 3) Where are the competence gaps in the community?

Moderator: Delores Knipp, Committee

Hazel Bain,	CIRES/SWPC	Research Scientist, Space Weather Prediction Center (SWPC)
Michele Cash,	SWPC/NOAA	Research Section Lead, NOAA SWPC
Mark Olson,	NERC	Sr Engr & Mngr, North American Electric Reliability Corp.
Michael Stills,	Retired UAL	Former Dir. Flight Dispatch, Ntwk Ops Cntl Ctr United Airlines
Scott Leonard,	OSC NOAA	Technical Director, Office of Space Commerce NOAA NESDIS

Space Weather Operations and Research Infrastructure Workshop: Phase II, Monday April 11, 2022, 1345 ET

Space Weather Operations and Research Infrastructure Workshop: Phase II

Space Weather Operations Panel

Hazel M Bain
CIRES University of Colorado, Boulder
NOAA Space Weather Prediction Center

hazel.bain@noaa.gov









Robust validation of models and observations

Benchmark operational performance metrics and forecast skill

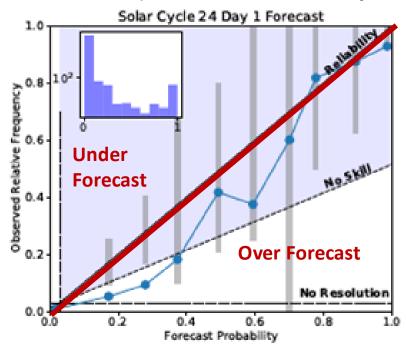
- operational models
- forecast products

Validation of model/observational capabilities against operational benchmarks to determine value added.

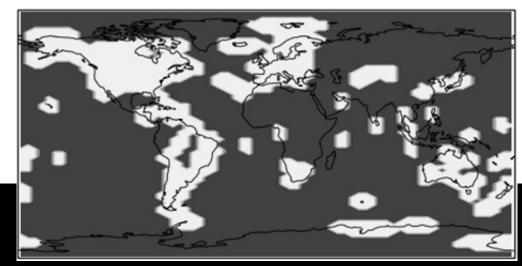
Sophisticated validation methodology

- e.g. NCARs METplus validation tools developed for the terrestrial weather community

SWPC proton forecast reliability



GloTEC model validation with/without RO data Ground-based Data Location Validation Mask





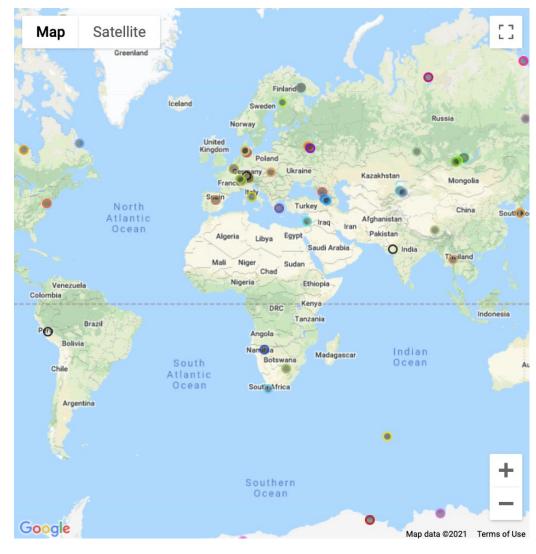
Securing proven scientific observations for space weather operations

Example: global neutron monitor network

- Observes secondary neutrons generated in atmospheric particle showers from incoming GCR and solar energetic particles.
- Characterizes high energy component of incident particle spectrum for modeling radiation environment at aviation flight levels.

Historically funded by agencies/institutes for fundamental science but to support forecasts the network needs to be operationally supported.

- Dense coverage/ideally located
- Real time data stream
- Operational robustness
- International cooperation







Space Weather Operations and Research Infrastructure Workshop: Phase II



Michele Cash

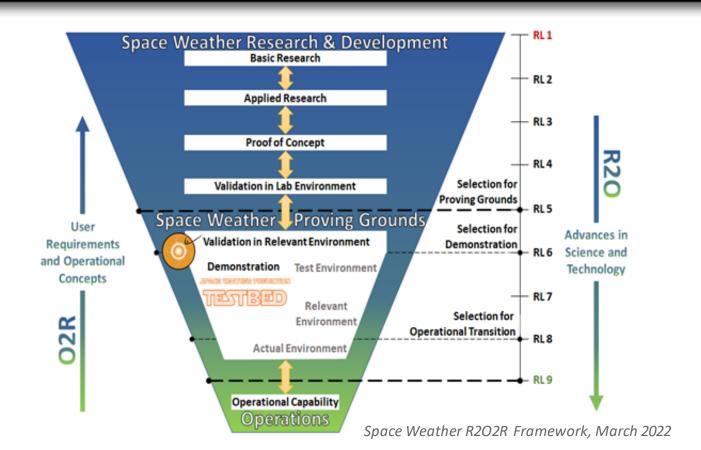
Research Section Lead Space Weather Prediction Center National Weather Service National Oceanic and Atmospheric Administration

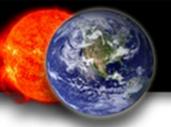
Space Weather Operations Panel 11 April 2022





Space Weather R2O2R Process Funnel

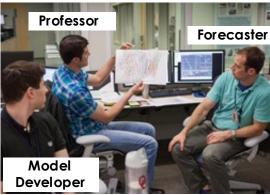




NOAA Testbed Experiments

- Bring together forecasters, customers, regulators, internal and external research and development staff, and federal partners for a testbed experiment to explore the current capabilities, needs, and gaps of current space weather services.
- Emerging concepts and new technologies for improving space weather prediction are tested to accelerate R2O and to inform O2R







NOAA Hazardous Weather Testbed Spring Forecasting Experiment



Space Weather Operations Panel

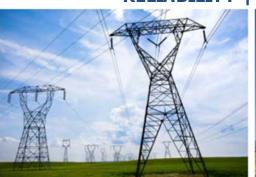
Reducing Risk to the North American Electric Grid

Mark Olson, Manager, Reliability Assessments
Space Weather Operations and Research Infrastructure Workshop: Phase II
April 11, 2022

RELIABILITY | RESILIENCE | SECURITY











Observations and models for maintaining effective GMD reliability standards

Mandatory GMD standards for North American Bulk Power System

GMD Operating Procedures

Grid operators must have procedures to mitigate impacts during GMD events

GMD Vulnerability Assessment

Grid planners and asset owners must assess and design the system to mitigate a 100-year event

Industry priorities for new space weather information and services

- Granularity in storm intensity scales (G)
- Geographic description of impacts (continue SWPC geoelectric field product)
- Impact confidence improvements and uncertainty estimation
- Earlier lead times

- Geoelectric field spatial and temporal granularity
- Latitude behavior of severe GMD event (auroral boundary)
- Earth conductivity mapping for geoelectric field models
- Support for GIC estimation in complex areas (Piedmont, New England)



Collaboration between electric industry and space weather community

Partnerships between the electric industry and the space weather community help to define and meet end-user needs

- NERC engages in open and collaborative efforts with stakeholders throughout North America to reduce GMD risks
 - Department of Energy and U.S. National Labs
 - Electric Power Research Institute (EPRI)
 - North American Transmission Forum (NATF)
 - NASA, Canadian Space Agency
 - U.S. Geological Survey (USGS) and Natural Resources Canada
 - U.S. Space Weather Prediction Center (SWPC)
 - Utilities from all regions in North America



GMD event data for improving assessment accuracy

- NERC GMD Data Collection program will support GIC model validation
 - Using GIC measurements with estimates will ensure GMD assessment accuracy
- GIC estimate accuracy affected by:
 - Power system configuration
 - Power equipment modeling details
 - Accuracy of system design data
 - Earth conductivity model
- NERC will launch its public portal for downloading GIC data in mid-2022

GMD Data Collection Program

- Collecting GIC and magnetic field data from monitors owned by utilities
- 10-second sampled data
- Covers all G3 and stronger events from May 2013
- Annual collection period (not realtime)



Space Weather Operations Panel

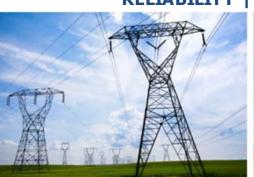
Reducing Risk to the North American Electric Grid

Mark Olson, Manager, Reliability Assessments contact: mark.olson@nerc.net

RELIABILITY | RESILIENCE | SECURITY









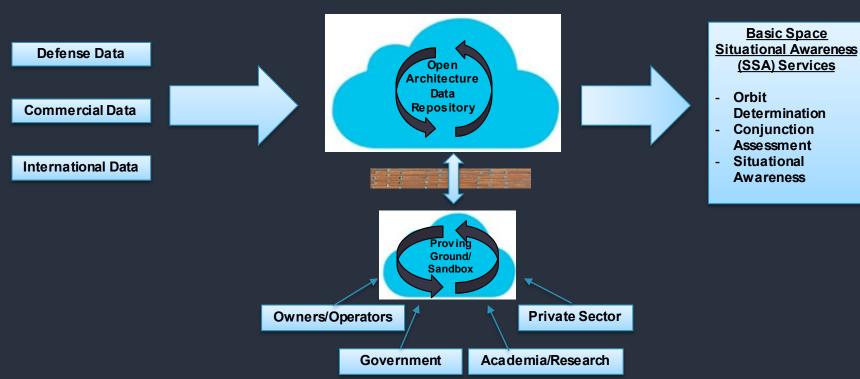


Maneuvering into the Future: Open-Architecture Data Repository Demonstration

by NOAA's Office of Space Commerce

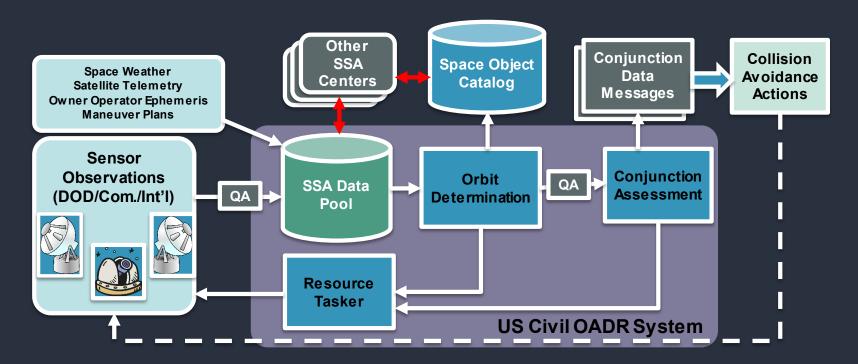
National Environmental Satellite, Data, and Information Service April 2022

OADR Prototype Overview





Notional SSA Safety Process

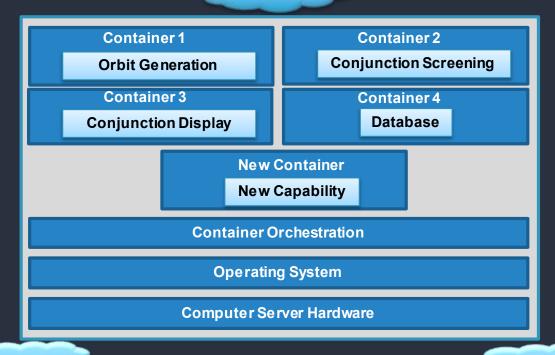




OADR Cloud Software Architecture

Containerized services





Reliable

Flexible

Scale out to more data, capabilities and users by adding servers and containers

Advantages of a Containerized Microservice Architecture

Containers package software with libraries and operating system required to execute

- Portable to any computer
- Efficient
- Allow developers to create and deploy software applications faster
- More secure and reliable
- Avoid cloud vendor lock-in

Microservices break a complex software application into small, specialized services that communicate over a common interface

- Can update one part of software without affecting the whole application
- More reliable
- Faster development, testing and deployment



This is the industry standard way to develop modern data systems in the cloud.

OADR Prototype Data System



Data **Scientist**

Analyze / process data at scale



Set up and manage data workflows, templates, and triggers

Integrated CI/CD

pipelines

Batch Analytic Environment User Applications Data Visualization W arehouse **Batch Jobs** (Druid.Hive) Tools (Yarn, Argo (2D/3D, ...) Data Ingest W orkflows) Search Tools Ingest Data Storage Orchestration (ElasticSearch (HDFS, S3, (Argo Solr, ...) Ceph) Workflows) Ingest Triggers (Argo Events) Streaming Analytic Environment Interactive Workflow Analytics (Zeppelin, Templates Streaming Jobs Messaging Jupyter) (Spark/Tez) (Kafka) \$ \$ \$ Analytic Applications Analytic Microservices (C2, Mission Planning, ... Monitoring FLAME-MP Code Generation DevOps Service Discovery Container Dashboard (Grafana) Toolchain Services (Swagger) Services Orchestration

Consume data products

Mission User(s)

Engineer

DevOps

Can be deployed to any cloud provider or on-prem

Develop and deploy apps / analytics



Analytic Developer

National Environmental Satellite, Data, and Information Service



