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Space Weather Data for Disaster Response

A Global Earth Observations System-of-Systems Approach

Space Weather Workshop
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The Challenge: Connect Users to Environmental Data Providers for Disaster Response

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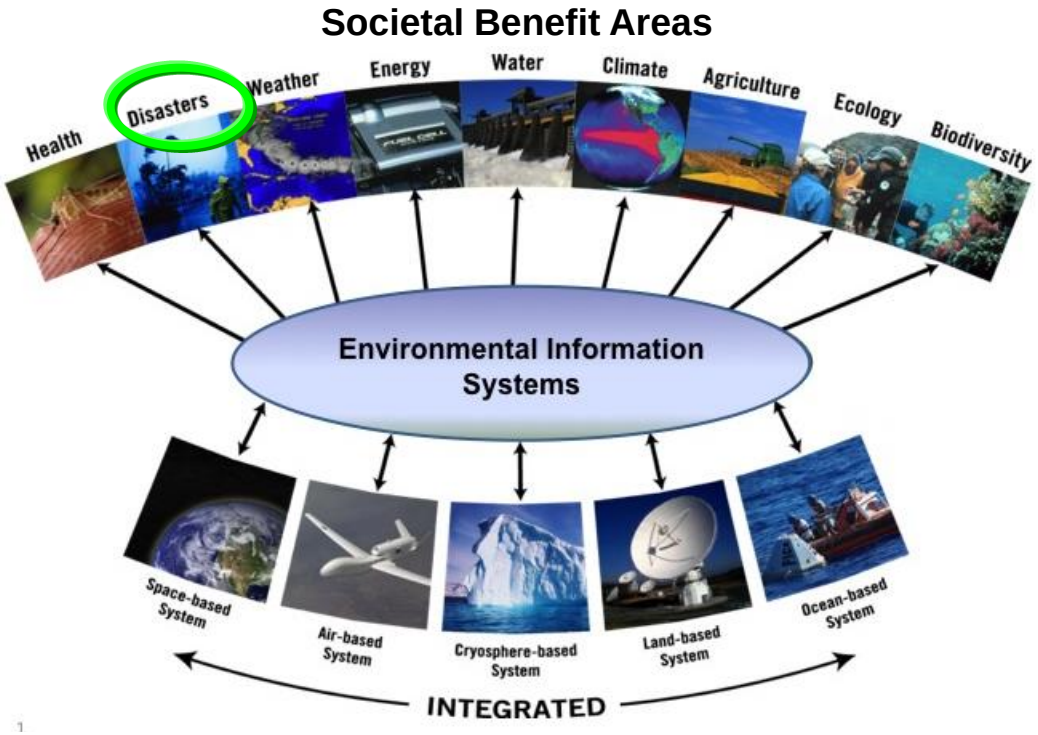
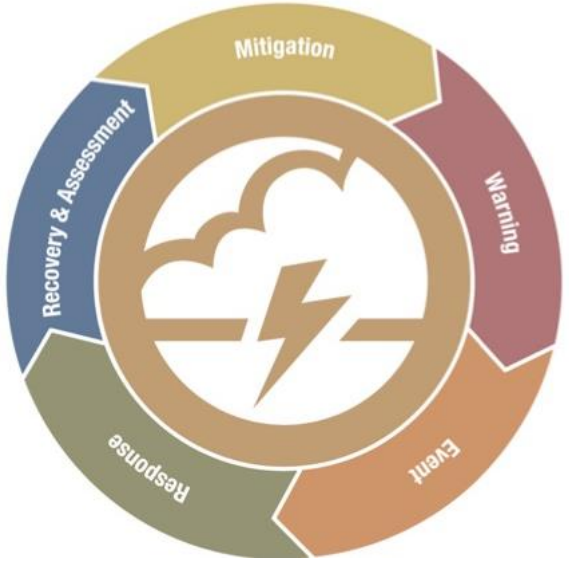


- Global Earth Observation System of System (GEOSS) Implementation Plan has identified nine different user communities, called "Societal Benefit Areas" (SBA), that are responding to the challenges posed by climate and technology change.
- Each SBA has unique needs and capabilities and shares common services and approaches through a network of community portals.
- Our focus is on disaster response and management

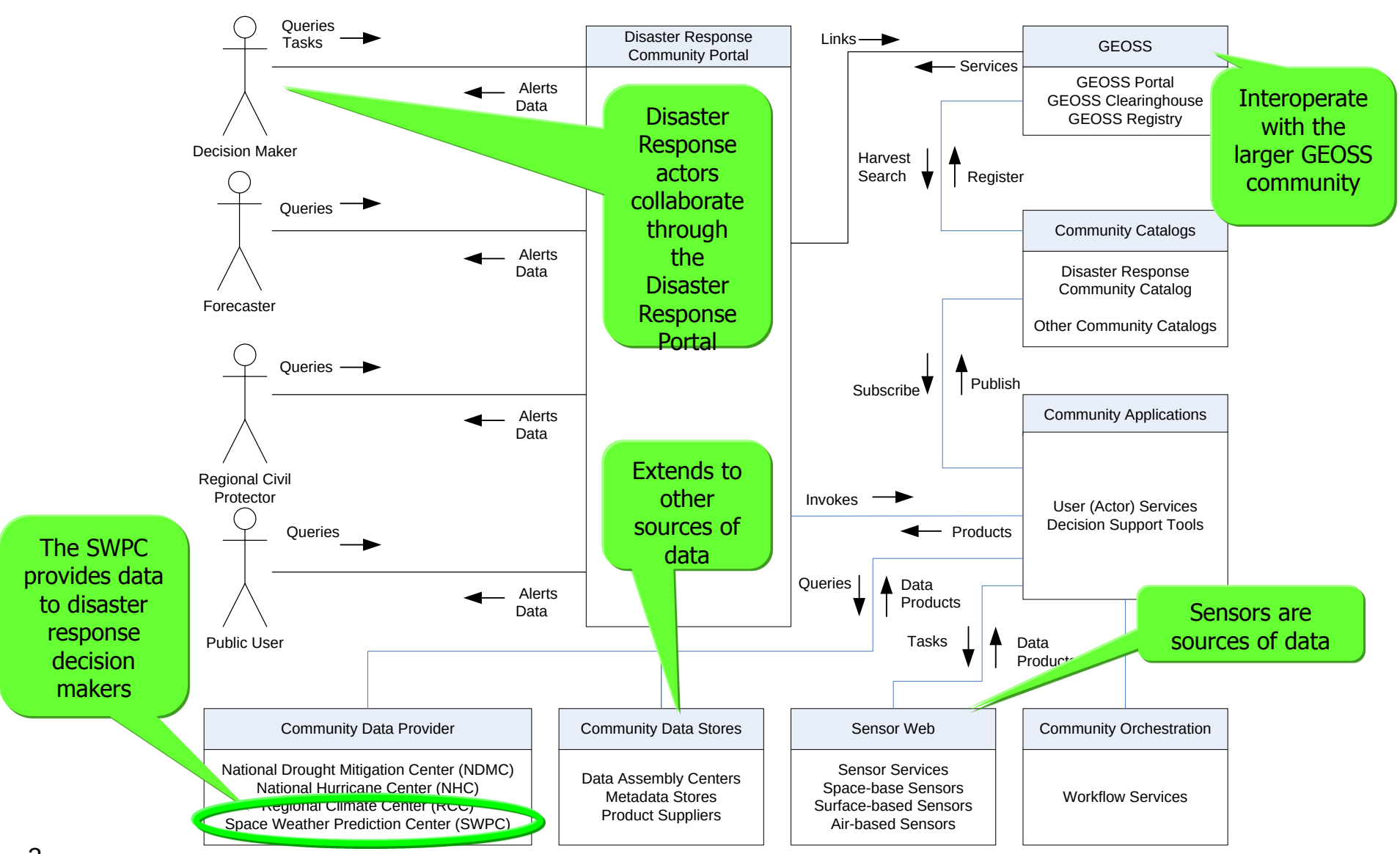
Figures: Group on Earth Observations, "Architecture Implementation Pilot (AIP) Phase 2: IOC Augmentation Call for Participation (CFP), Annex B – Architecture", June 2008

- Environmental sensor systems and their ground segments are not currently integrated
- The system must appear as an integrated enterprise
- The Disaster Cycle is the workflow for hurricane and flooding disaster response

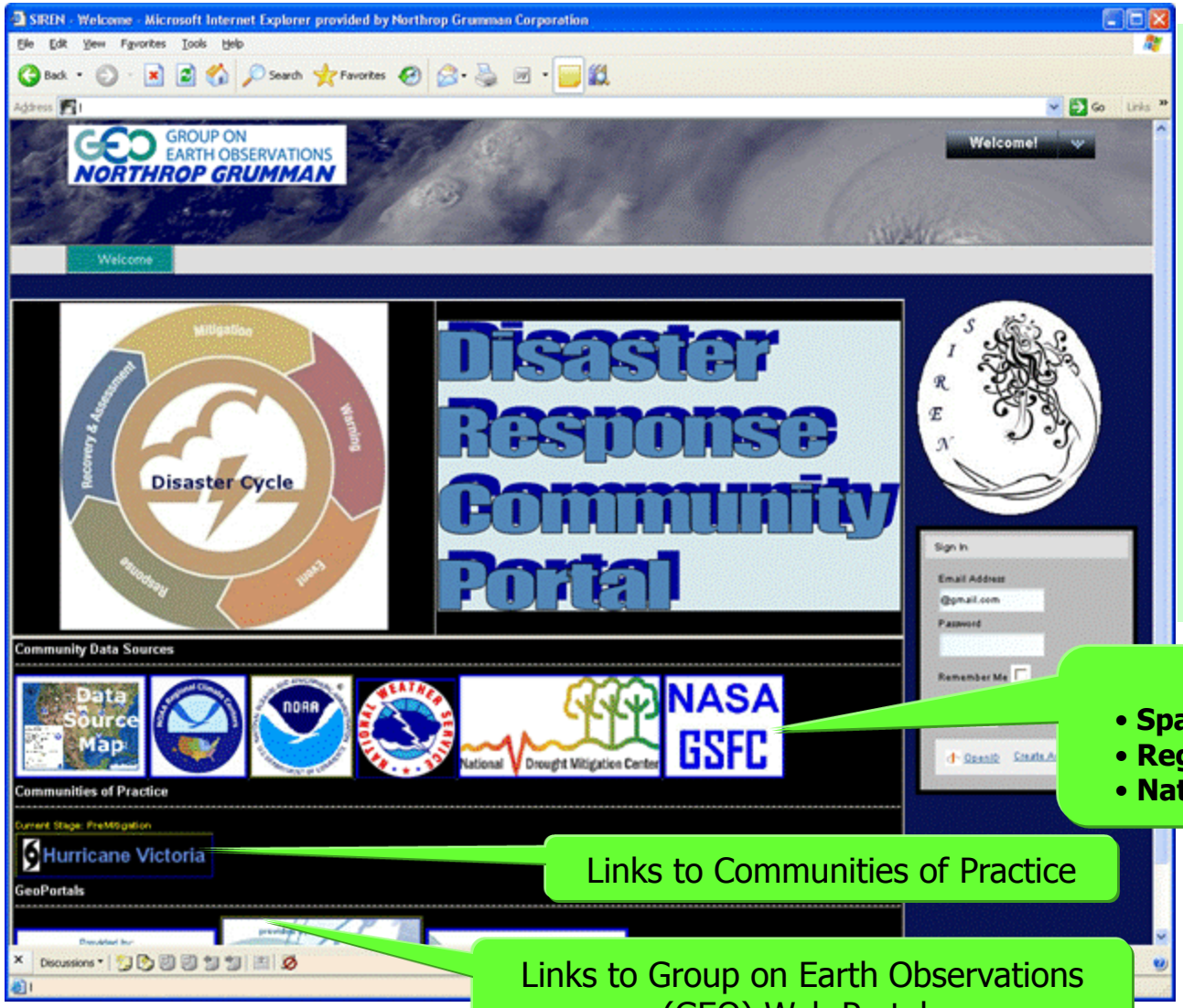


Disaster Cycle

The Disaster Response Community Portal is Central for Collaborative Disaster Response and Planning



The Community Portal is the Gateway to Disaster Response Activities



- Disaster Response Community Portal "virtually integrates" an earth environmental system-of-systems using data, services, components.
- Developed using open source and Open Geospatial Consortium (OGC) standards
- Updated as new storms (disasters) are identified

- **Disaster Cycle Figure: Group on Earth Observations, "Architecture Implementation Pilot (AIP) Phase 2: IOC Augmentation Call for Participation (CFP), Annex B – Architecture", June 2008**
- **National Oceanic and Atmospheric Administration (NOAA) images and text are used by courtesy**
- **Images and text of the GEO and GEOSS are used by courtesy**

Our Disaster Response Scenario Steps Through All Activities of the Disaster Cycle

Activity	*Scenario Step*	*User (Primary)*	*Storyline*	*Proposed Data and Source(s)*	*Proposed Service(s)*
	Community Data Providers investigate and monitor area drought, flooding, and	▪ Forecaster	▪ Forecasters at … the foundati… of hurrican…		
Warning	Forecaster begins tracking storm and posts projected track, watches, and warnings		▪ The Forecas… used is IR and … example, we show GOES-East imag… Certainly, a variety of sources are… …y, we can use NOAAPort but certain… …-E data that will be available on GEO… …uture.		
Event: Tasking	Storm gathers strength resulting in an upgrade of storm to a CAT I storm	▪ Forecast…	▪ The Forecaster upgrades th… …T 1 hurricane and issues an alert that alerts… …nd the Public that Hurricane Victoria is on a path t… …along the TX, LA Gulf coast.	▪ NHC – Hurricane Alert	▪ RSS
Event: Tracking & Response Preparation	Decision Maker at Regional Decision Support Center (RDSC) engages the Response Team COP including Regional Civil	▪ Decision Mak… ▪ Civil Protector	The Decision Maker… …g the Disaster Response Community Portal to share an i… …e path of the storm. He is shown using the Portal's chat cap… …y to communicate with the Response Team… Decision Mak… Regional Civil Protector chec… space weather to determine any impacts to em…	▪ Community Portal	▪ WMS ▪ WCS ▪ CAP
			…otection takes the upper hand du… …otector has access to high re… …g in oil refinery and stor…		
Recovery & Assessment	as it passes over… slowing slightly upo… landfall before it heads northward with torrential rains falling in river basins that flow toward the coast		…er track… …heavy rainfall might still be falling. This greatly affects flo… …g patterns in the area. The Forecaster keeps monitoring the bayou… …n the Houston area for signs of cresting. There is a USGS sensor on the Buffalo Bayou that runs through downtown Houston. USGS sensor data is shared with the National Weather Service.	▪ RCC ▪ NHC ▪ WGRFC – Flood data	▪ WMS, WCS
Mitigation	Post-event analysis of data and products by Community Data Providers	▪ Civil Protector	…storm and aftermath events have passed. We are now back in the …gation activity of the Disaster Cycle. The Civil Protector will be re… …ing the timeline of events, forecasts, types and timeliness of warning… issuance and obeyance of evacuation orders, etc. to glean lessons learned. Here we see the Civil Protector looking at the timeline of events on the Community Portal.	▪ Community Portal	▪ Timeline ▪ AVI of storm and flooding

Decision Maker and Regional Civil Protector monitor current and predicted space weather to determine any impacts to emergency response.

May include
- ✓ **Monitoring emergency frequencies 245 MHz, 410 MHz, and 1.4 GHz frequency which lies between GPS L1 (~1.575 GHz) and L2 (~1.227 Ghz)**
- ✓ **Monitoring USTEC for GPS error on the ground**
- ✓ **Monitor radio black-out, geomagnetic storm, solar storm**
- ✓ **D-Region Absorption Region (DRAP) impact to HF communications**
- ✓ **GOES proton flux for aviation and health**

Mitigation events after the disaster focus on critical reviews to improved future responses (e.g., timeliness of space weather warnings)

Decision Maker alerts COP of space weather detection of a solar flare--prediction of wide-area blackouts of HF radio communications

Space Weather Events May Impact Disaster Response

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- Communications
  - Geomagnetic storms may disrupt the ionosphere effecting HF (3 – 30 MHz) and VHF (30 – 300 MHz) communications
  - X-ray flux variations may disrupt the ionosphere and cause scintillation effecting HF and VHF communications as well as UHF SATCOM (300 – 3000MHz)
  - Solar radio bursts can cause background noise on emergency responder radio frequencies
- Navigation (GPS)
  - Solar radio bursts can cause background noise disruption to GPS (≈1.4 GHz) signals
  - Geomagnetic storms may disrupt the ionosphere affecting GPS signals
  - X-ray flux variations may disrupt the ionosphere and cause scintillation affecting GPS signals
- Power Systems
  - Geomagnetic storms may affect power systems
  - Higher latitudes are more susceptible
    - "Power systems in areas of igneous rock are most vulnerable to the effects of intense geomagnetic activity." [SWPC]
- Aviation
  - Proton flux poses biological hazard to astronauts and passengers/crew in high latitudes
    - Air traffic rerouted to avoid polar region

Disaster Cycle Workflow Embedded in Community of Practice Portal

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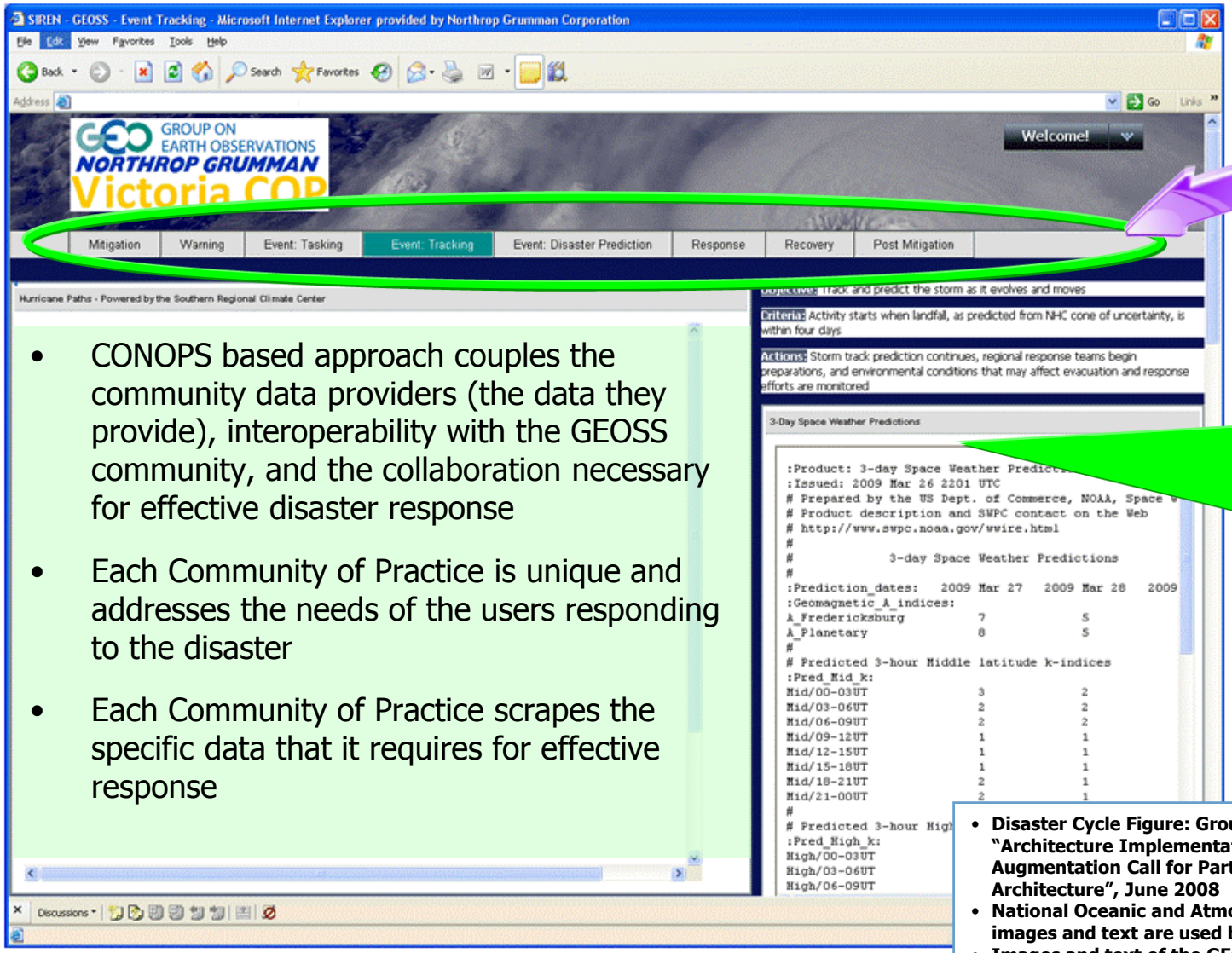
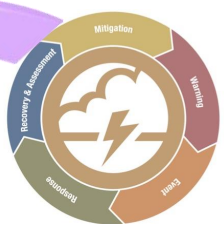


- CONOPS based approach couples the community data providers (the data they provide), interoperability with the GEOSS community, and the collaboration necessary for effective disaster response
- Each Community of Practice is unique and addresses the needs of the users responding to the disaster
- Each Community of Practice scrapes the specific data that it requires for effective response



Space weather forecasting to assess impact on disaster response operations

- **Disaster Cycle Figure: Group on Earth Observations, "Architecture Implementation Pilot (AIP) Phase 2: IOC Augmentation Call for Participation (CFP), Annex B – Architecture", June 2008**
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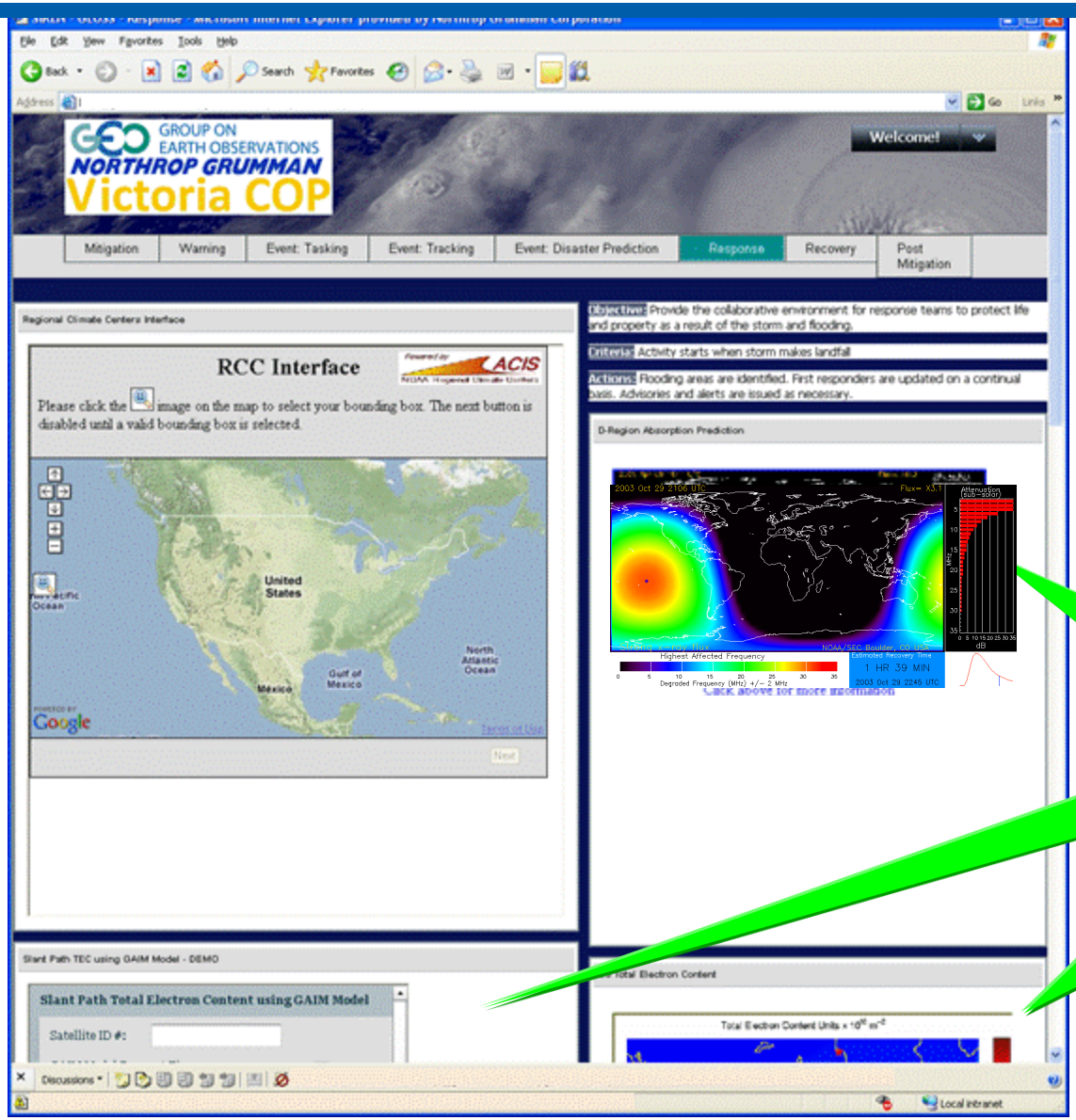
Space Weather Portlets Keep Disaster Responders Informed



Space weather monitoring during Disaster Response

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Current Space Weather Portal: Initial Approach

SpaceWx

NOAA

NATIONAL WEATHER SERVICE

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SWx Home

Space Weather Now
- Alerts/Warnings
- TBD

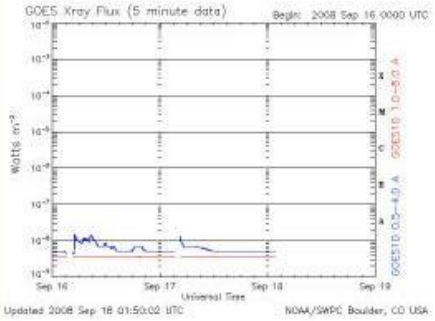
Next
- Three Day Forecast

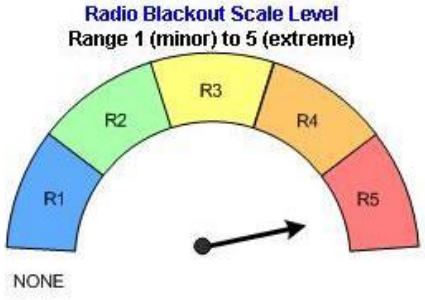
Links
- SWPC Home Page
- RCC Home Page
- NDMC Home Page
- Aviation Space Weather (ADDS)
- Disaster Response
- Community Portal
- GEOSS Portals
  - ESRI
  - ESA
  - Compusalt

Contact SWPC
- Contact SWPC

Current Space Weather Conditions

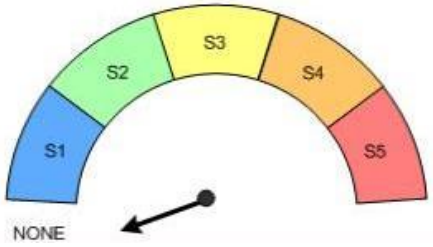
GOES X-ray Flux

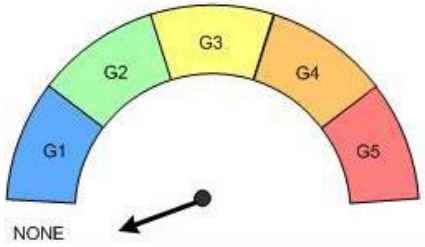




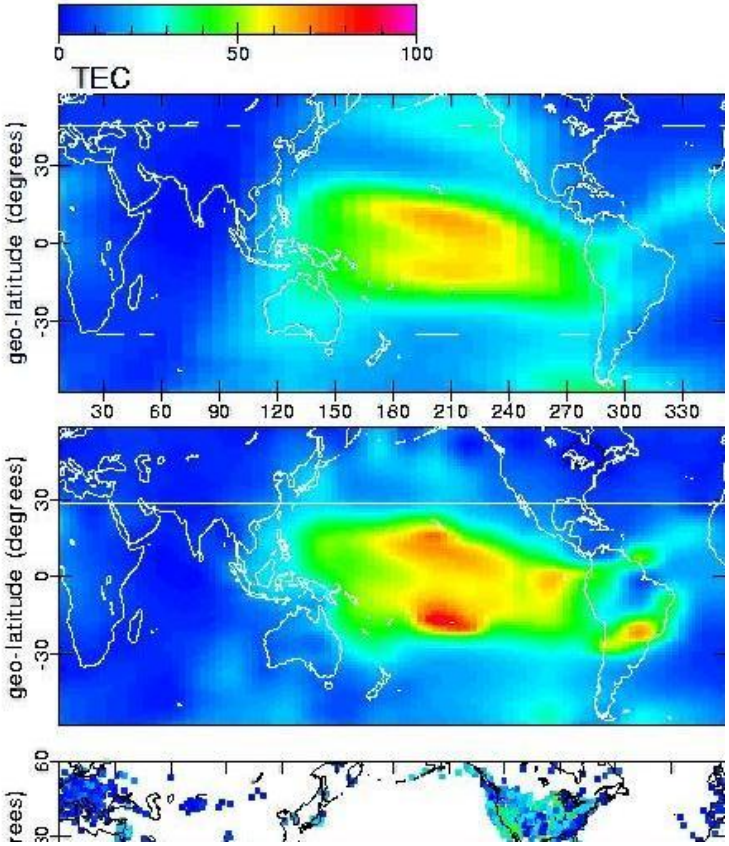
Space Weather Radiation Activity Scales

Range 1 (minor) to 5 (extreme)

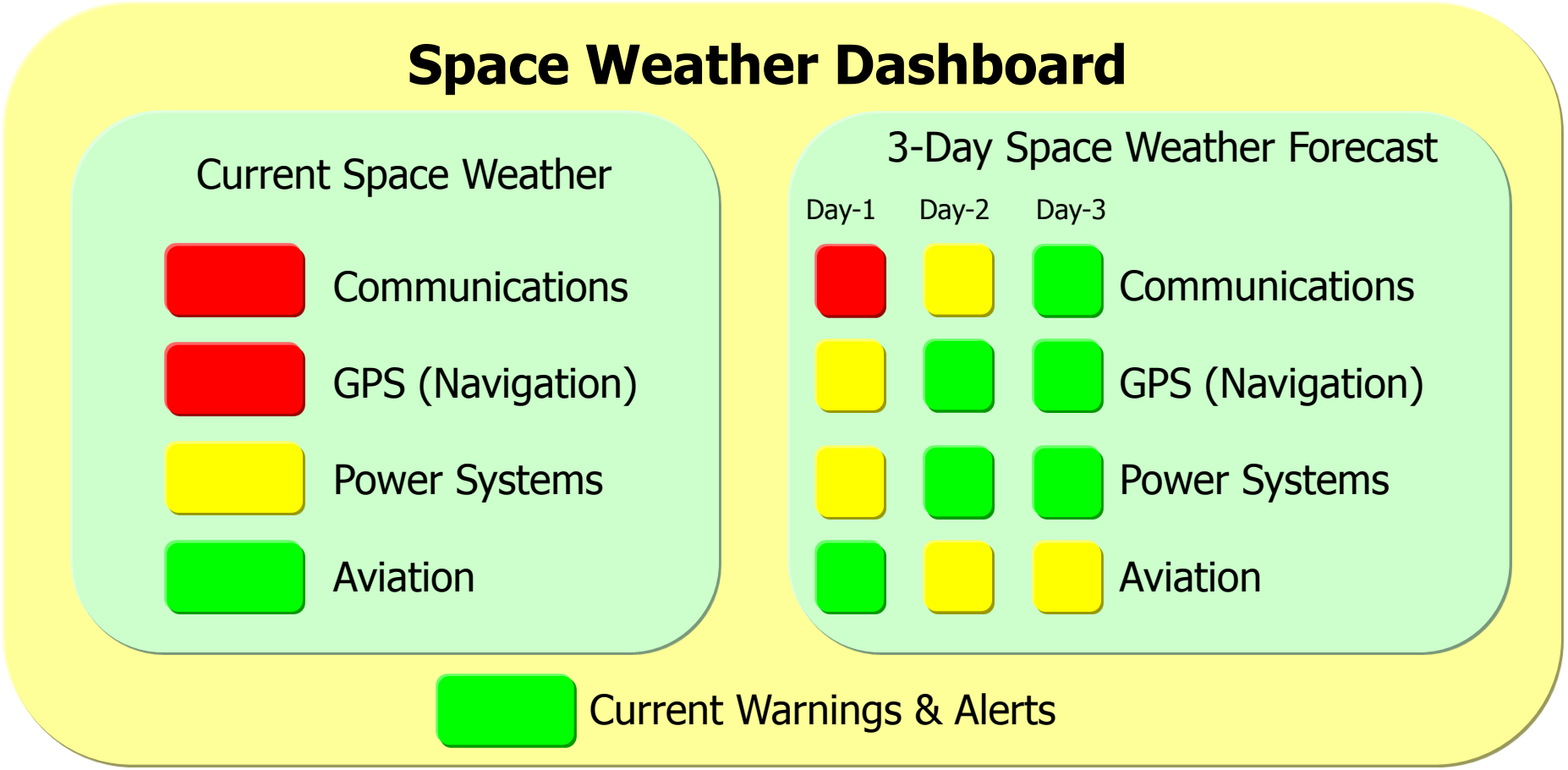




Current TEC Conditions



Future: Evolving to Dashboard for Unified View

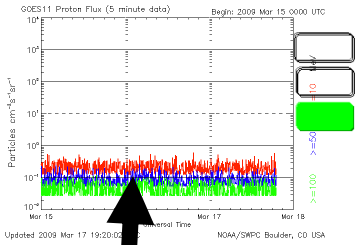


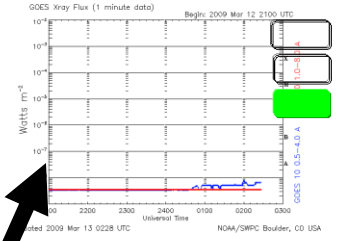
- One space weather situational view for non-experts
- Drill down for expert analysis

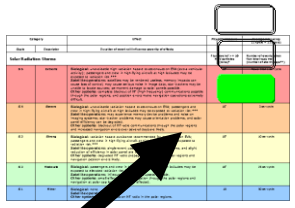
Future: Drilling Down for Clarity

Current Space Weather

- Communications
- GPS (Navigation)
- Power Systems
- Aviation







Space Weather Effects on Aviation

- Proton Flux (Primary)
- X-ray Flux Status
- Solar Radiation Storm Scale

Aviation Mitigation Steps for Disaster Management

- Notify COP of potential radiation health concerns to high latitude aviation traffic with observed flux of 10MeV protons of 1 or more and/or forecast flux of 10^3 or greater
- Monitor 3-Day forecasts for trends
- Review SWPC warnings and alerts
- Take no action

Summary

- The Community-of-Practice is user driven, each is as unique as the disaster response it services
- User needs are matched with environmental data providers—environmental data providers are motivated to be matched with users—a marketplace for information sharing
- Information sharing is transparent to the internal operations of the environmental or community data provider
- Workflow must be embedded into the design of the Community of Practice Portal to organize disaster response
- Open source and standards based approaches are meeting the needs of the environmental community
- Space weather situational awareness is a key component for a comprehensive disaster response strategy

Thank You

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