

---

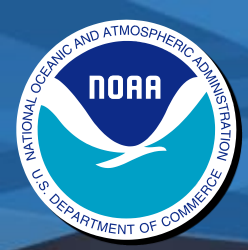
# Space Weather in NextGen: An Update

---

**April 27, 2010**

**Cecilia Miner**

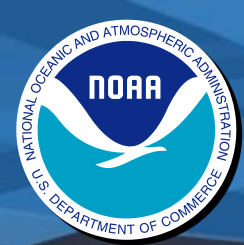
*NOAA/NWS/Aviation Services Branch*



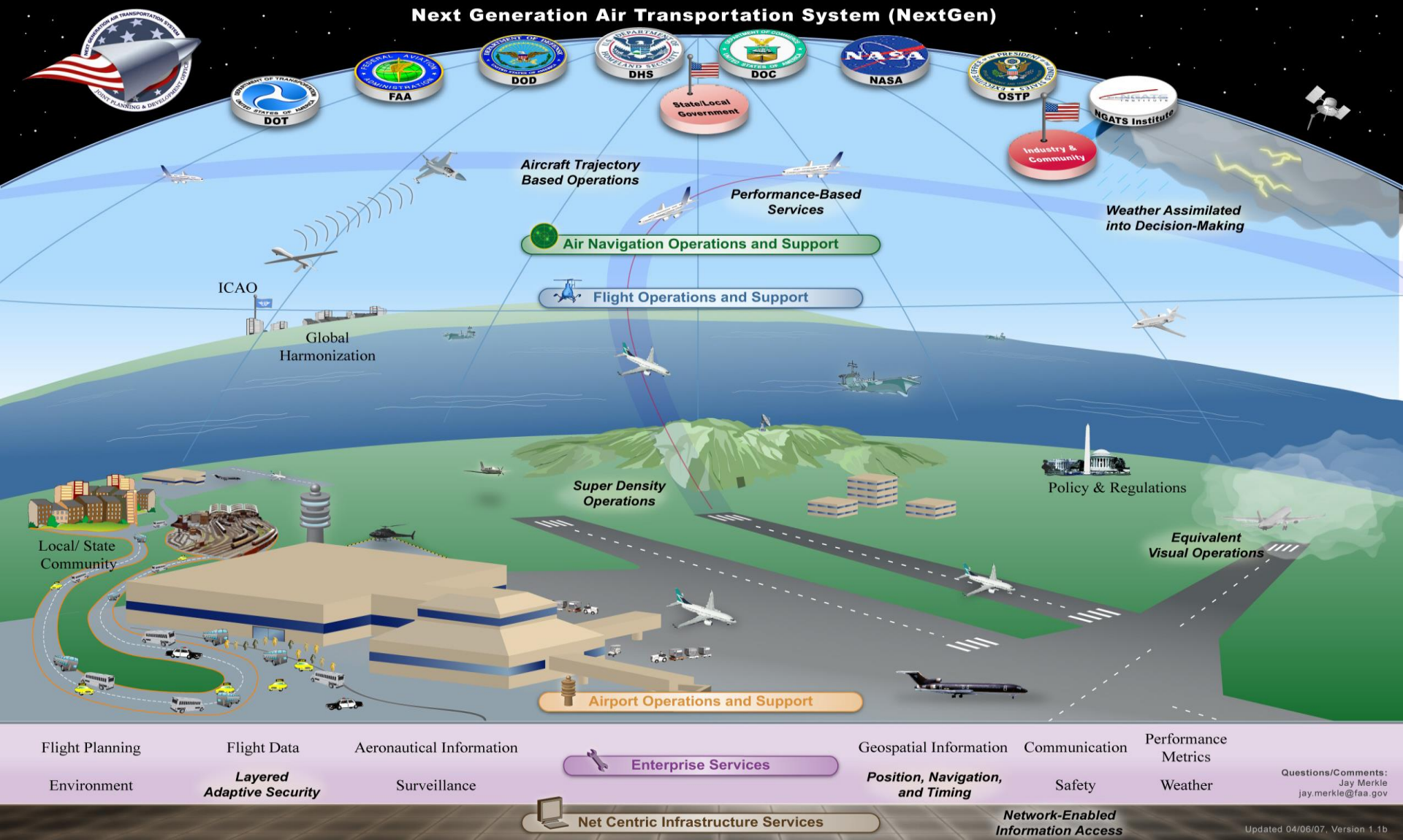
# Overview



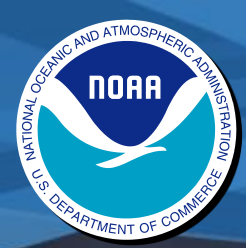
- **NextGen Background**
- **The Current State**
- **Requirements Development**
- **Space Weather Requirements**
- **Demo...the Possibilities**



# NextGen Background



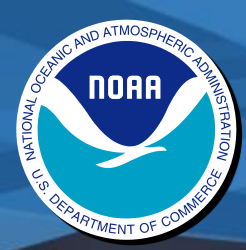




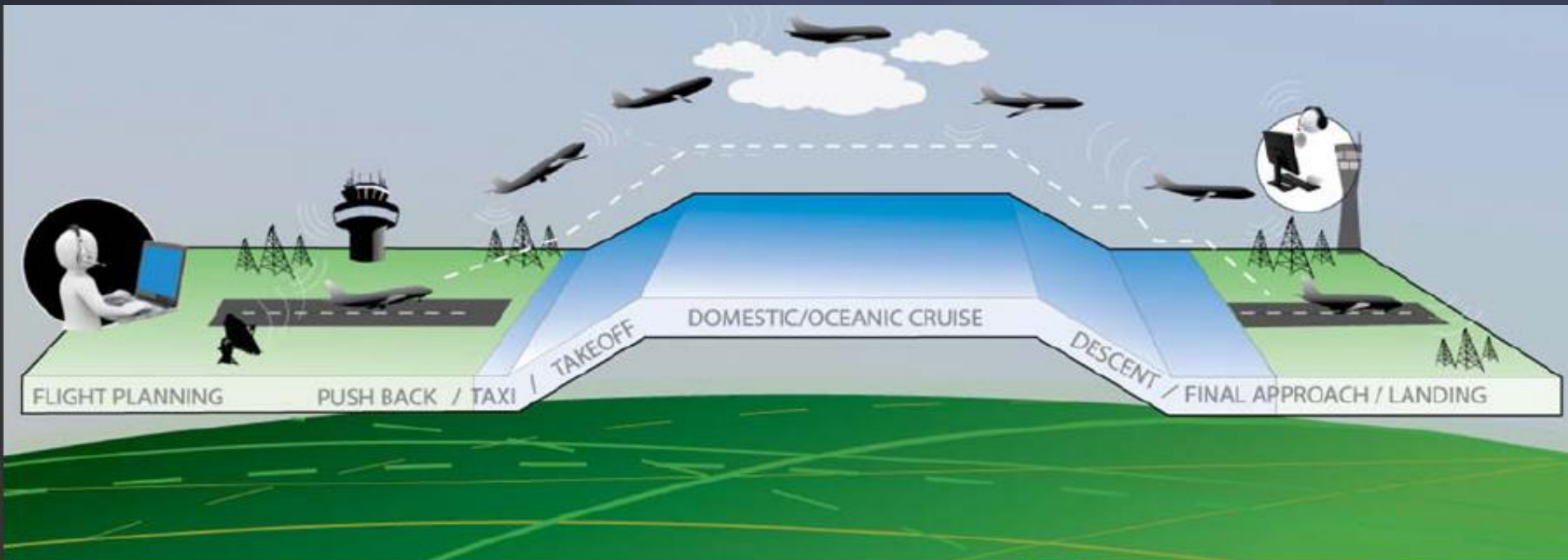
# NextGen Background

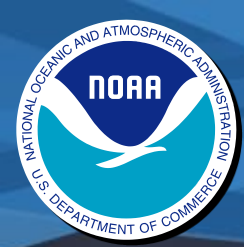


- **Next-Generation Air Traffic Control System (NextGen) is a Congressionally mandated initiative to modernize the U.S. Air Transportation System in order to:**
  - ***Increase capacity and reliability***
  - ***Improve safety and security***
  - ***Minimize the environmental impact of aviation***

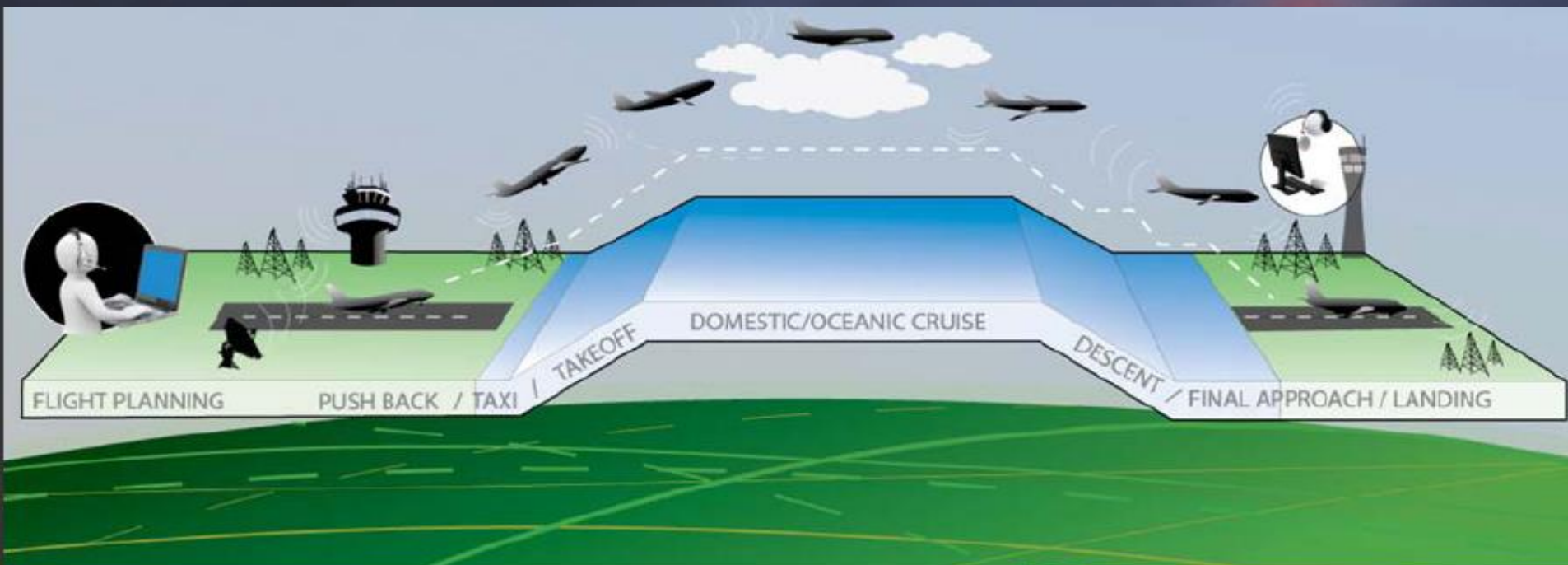


# Current State—FAA





# Current State—NOAA Response



**Terminal Aerodrome  
Forecasts; Airport  
Weather Warnings  
(WFO)**

**Forecasts and weather support by region for  
aircraft after departure and prior to landing  
(CWSU)**

**Terminal Aerodrome  
Forecasts, Airport  
Weather Warnings  
(WFO)**

**Global/National guidance for turbulence, icing, cloud ceiling, visibility,  
thunderstorms, wind, volcanic ash, **space weather**  
(AWC/AAWU/HNL/**SWPC**)**



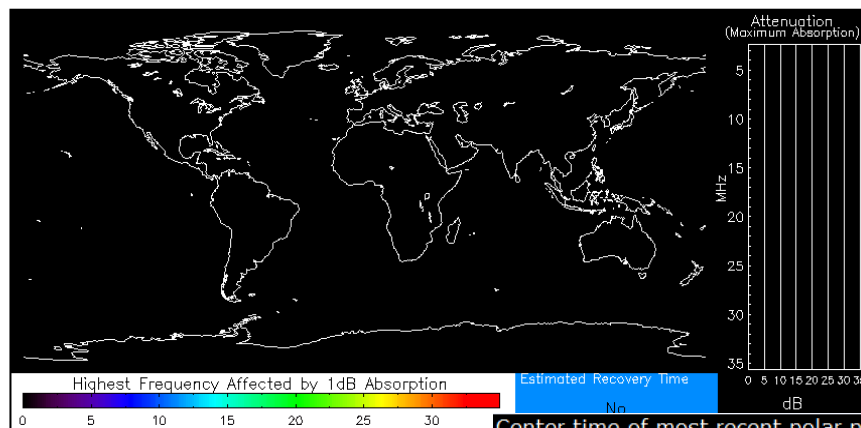


# Current State—SWPC Response



## Space Weather for Aviation Service Providers NOAA National Weather Service Space Weather Prediction Center

### Global D-Region Absorption Prediction



Time of issue: Apr 5, 2010 07:39 EDT

What: Strong Solar Geomagnetic Storm in Progress

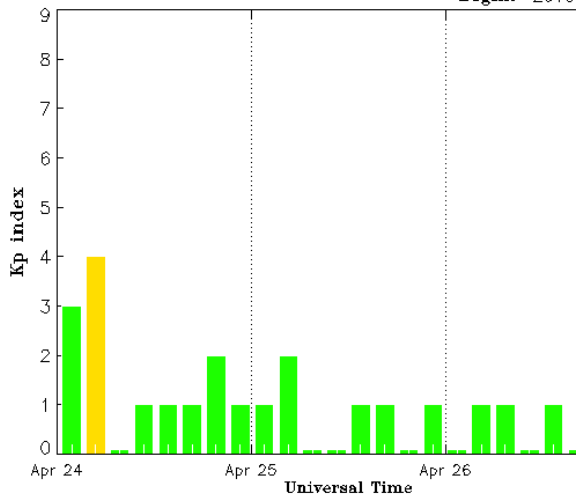
From: Douglas Biesecker

Office: NOAA/NWS/NCEP Space Weather Prediction Center

Event: Heads up - Isolated, Strong Space Weather Storm in Progress

A geomagnetic storm began at 05:55 AM EST (0955 UTC). A weak solar flare occurred in Active Region 1059 on April 3 at 05:54 AM EST (0954 UTC) and produced an Earth-directed coronal mass ejection that resulted in today's geomagnetic storm. Storm levels are currently Strong, reaching G3 on the Geomagnetic Space Weather Scale. Weak storming began at 01:43 EDT (0143 UTC) and has ramped up to reach these strong levels. Other than the flare and CME mentioned previously, Active Region 1059 has remained quiet and not produced any significant activity. Agencies and systems that can be affected by this level of storming include power grid operators, spacecraft operators, GPS users, and High Frequency Radio users.

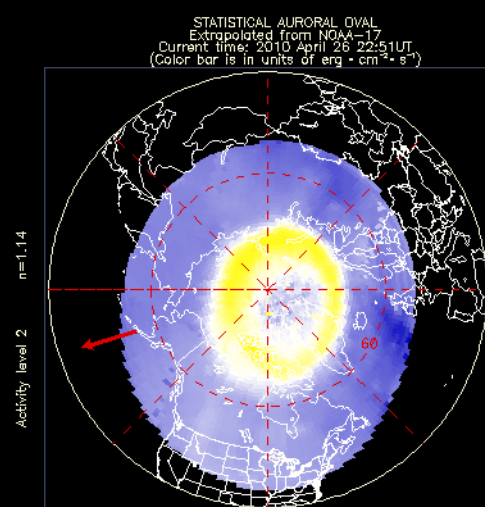
### Estimated Planetary K index (3 hour data) Begin: 2010



Updated 2010 Apr 26 23:10:02 UTC

NOAA/SWPC

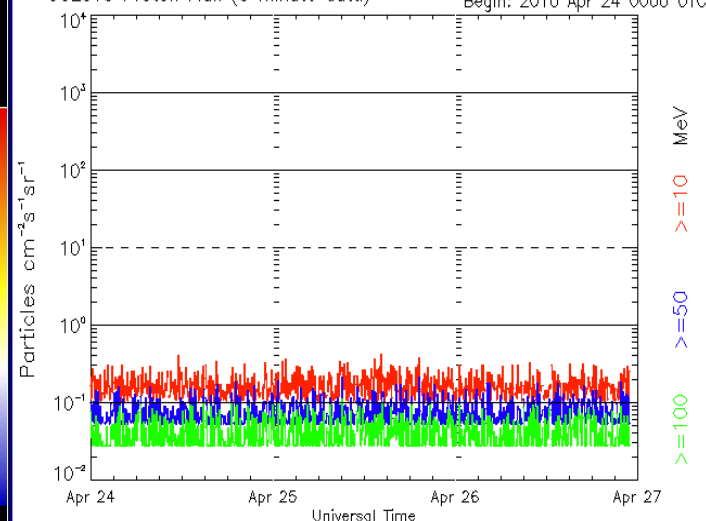
### Center time of most recent polar pass measurement: 2010 n = 1.14



NOAA Space Weather Prediction Center

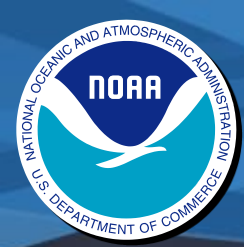
### GOES13 Proton Flux (5 minute data)

Begin: 2010 Apr 24 0000 UTC



Updated 2010 Apr 26 23:11:07 UTC

NOAA/SWPC Boulder, CO USA



# NextGen Now and Future



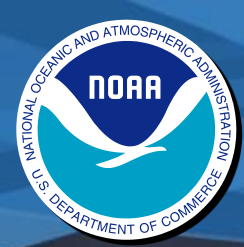
## Today

- Not integrated into aviation decision support systems (DSS)
- Inconsistent/conflicting on a national scale
- Low temporal resolution (for aviation decision making purposes)
- Disseminated in minutes
- Updated by schedule
- Fixed product formats (graphic or text)

## NextGen (new requirements)

- Totally integrated into DSS
- Nationally consistent
- High temporal resolution
- Disseminated in seconds
- Updated by events
- Flexible formats





# Functional Requirements Process



- JPDO chartered a multi-agency team: DOT, DOC, DoD, NASA, Industry
- Functional requirements state “what” needs to be done.
- Examples:
  - *The NextGen shall forecast space conditions (e.g., solar flares, coronal mass ejections)*
  - *The NextGen shall forecast geomagnetic storm activity out through 48 hours*

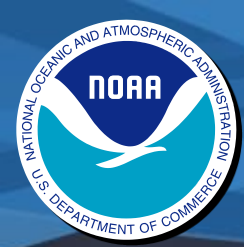
Joint Planning and Development Office



## Four-Dimensional Weather Functional Requirements for NextGen Air Traffic Management

JPDO Weather Functional Requirements Study Team

Version 0.1  
January 18, 2008



# Performance Requirements Process



- Multi-agency team formed by *FAA* with focus on users
- Preliminary ideas used for FAA investment decisions
- Much progress made since then, but performance requirements development continues

Federal Aviation Administration

## Preliminary Performance Requirements (pPR)

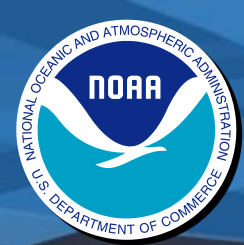


Developed for the Next Generation Air Transportation System (NextGen)

Concept and Requirements Definition (CRD) Phase



NextGen Four-Dimensional Weather  
Single Authoritative Source (4-D Wx SAS)  
Initial Draft - Version 0.1a2c

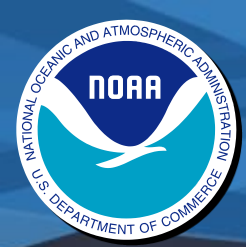


# NextGen Requirements—SWPC Response\*



NextGen Requirement	Current	Near Term	Far Term	Status
1.1.2.5.7.1.1 Determine Magnitude of Solar (X-Ray/EUV) Radiation Impinging on Atmosphere	10	10	10	Based on currently available solar x-ray observations. Measurements will continue on GOES (NOAA)
1.1.2.5.7.1.2 Determine Time of Onset of Solar Radiation (flare) Activity	10	10	10	Based on currently available solar x-ray observations. Measurements will continue on GOES (NOAA)
1.1.2.5.7.1.3 Calculate Duration of Solar Radiation (flare) Activity	10	10	10	Based on currently available solar x-ray observations. Measurements will continue on GOES (NOAA)
1.1.2.5.7.3.1 Determine Location of Geomagnetic Storm Activity	8	8	10	Current specifications based on ground based magnetometers (USGS). Higher spatial resolution (more stations) may be required.
1.1.2.5.7.3.2 Determine Onset of Geomagnetic Storm Activity	10	10	10	Based on currently available observations. Ground magnetometer measurements will continue (USGS)
1.1.2.5.7.3.3 Calculate Duration of Geomagnetic Storm Activity	10	10	10	Specification based on Ground-based magnetometers. (USGS)
1.1.2.5.7.3.1 Determine Onset of Moderate (>10MeV) Energy Solar Radiation (Protons)	10	10	10	Based on currently available observations. Measurements will continue on GOES (NOAA)
1.1.2.5.7.3.2 Calculate Duration of Moderate (>10MeV) Energy Solar Radiation (Protons)	10	10	10	Based on currently available observations. Measurements will continue on GOES (NOAA)
1.1.2.5.7.2.1 Determine Time of Onset of High Energy (>100MeV) Solar Radiation (Protons)	10	10	10	Based on currently available observations. Measurements will continue on GOES (NOAA)
1.1.2.5.7.2.2 Calculate Duration of High Energy (>100MeV) Solar Radiation (Protons)	10	10	10	Based on currently available observations. Measurements will continue on GOES (NOAA)

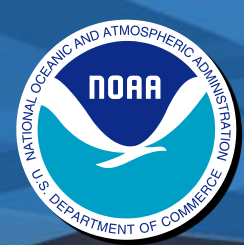




# NextGen Requirements—SWPC Response



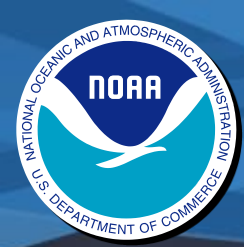
- **Determine time of onset of solar radiation (flare) activity**
  - ▣ *Achievable now through far-term*
  - ▣ *Based on currently available solar x-ray observations; measurements will continue on GOES (NOAA)*
- **Determine location of geomagnetic storm activity**
  - ▣ *80% probability now through mid-term; achievable by end-state*
  - ▣ *Current specifications based on ground-based magnetometers (USGS); higher spatial resolution (more stations) may be required*



# NextGen Requirements—SWPC Response



NextGen Requirement	Current	Near Term	Far Term	Status
5.2.7.1 Forecast Solar Radiation (flare) Activity Affecting Aviation for 12, 24, 36, and 48 hours in Advance	4	5	5	Current forecasts and near term improvements based on empirical relationships (NOAA, NASA). Long term, physics based forecast still a long way away.
5.2.7.4 Forecast Where Solar Activity (flares and geomagnetic) Significantly Degrades HF Communications (WP) 12, 24, and 36 Hours in Advance	4	4	5	Forecasting where the susceptible regions are is not difficult. The accuracy of the forecast (timing, magnitude) is more difficult. Current research (NOAA, NASA, NSF, DOD)
5.2.7.6 Forecast Intensity of Solar Radiation (Flares) 12, 24, and 36 Hours in Advance	4	4	5	Current forecasts provide probabilities of having flares of various magnitudes. Accurate prediction of the magnitude of tomorrow's flare is not yet achievable. Current research (NOAA, NASA, NSF, DOD)
5.2.7.5 Forecast Where Solar Activity (geomagnetic) Will Significantly Degrade Navigation Systems (WP) 12, 24, and 36 Hours in Advance	6	7	8	Forecasting where the degradation will occur difficult. The accuracy of the forecast (timing, magnitude) needs improvement. Ionospheric scintillation remains a major issue. Current research (NOAA, NASA, NSF, DOD)
5.2.7.2 Forecast Regions (e.g., Space, Polar, High-Latitude, and Mid-Latitude) Susceptible to Moderate Energy Level Protons (> 10MeV) of Solar Protons for 12, 24, 36 and 48 Hours in Advance	4	5	6	Forecasting where the susceptible regions are is not difficult. The accuracy of the forecast (timing, magnitude) is more difficult. Current research (NASA, NSF, DOD, DOE)
5.2.7.3 Forecast Regions (e.g., Space, Polar, High-Latitude, and Mid-Latitude) Susceptible to High Energy Levels (> 100 MeV Protons) of Solar Protons for 12, 24, 36 and 48 Hours in Advance	4	5	6	Forecasting where the susceptible regions are is not difficult. The accuracy of the forecast (timing, magnitude) is more difficult. Current research (NASA, NSF, DOD, DOE)
5.2.7.7 Forecast Period of Solar Radiation Maximum Exposure (WP) 12, 24, and 36 hours in Advance	4	5	6	Predicting the period of maximum exposure (with any useful accuracy) is not currently possible. Current research (NASA, DOD, DOE)
5.2.7.8 Forecast Duration of Solar Radiation (WP) 12, 24, and 36 hours in Advance	4	5	6	Predicting the duration of an event is only done with empirical models. Current research (NASA, DOD, DOE)

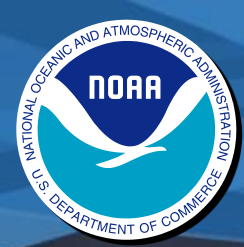


# NextGen Requirements—SWPC Response



- **Forecast intensity of solar radiation (flares) 12, 24, and 36 hours in advance**
  - *50% or less probability of achieving through far-term*
  - *Current forecasts provide probabilities of having flares of various magnitudes. Accurate prediction of the magnitude of tomorrow's flares is not yet achievable. Current research (NOAA, NASA, NSF, DoD)*





# Getting there...demos

*Experimental*  
**@viation digital data Service**

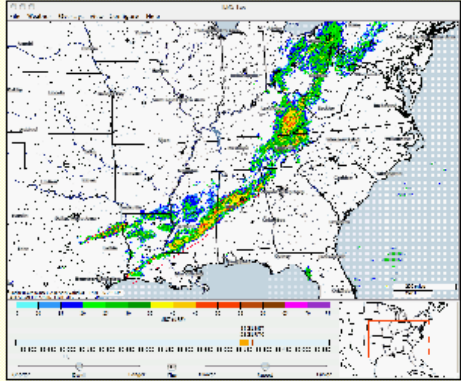
NCEP | NWS | AWC

disclaimer | feedback | FAQ | about ADDS

@dds Home | Dataserver | Turbulence | Icing | Convection | Winds/Temps | Prog Charts | Java Tools  
METARs | TAFs | PIREPs | AIR/SIGMETs | Satellite | Radar | FYI/Help

## NNEW Phase 2 Demo - Sep 2008

The NNEW Phase 2 Demo is a demonstration of standards-based weather data access and cataloguing. It includes data made available from NOAA Global Systems Division, NCAR Research Applications Lab, and MIT Lincoln Labs through open standards. The services and the standards are the core of the demonstration, this application is an example of one that may be written to access them. Further information on the data products that are available and the means to access them may be found [here](#).



**Launch the NNEW Phase 2 Demo**

The following standards are a part of this demonstration:

- [OGC Web Coverage Service 1.0/1.1](#)
- [OGC Web Feature Service 1.0/1.1](#)
- [OGC Geography Markup Language \(GML\)](#)
- [NETCDF 3 and 4](#) file format using the [CF \(Climate and Forecast\) Convention](#)
- [EbXML/EbRIM](#)

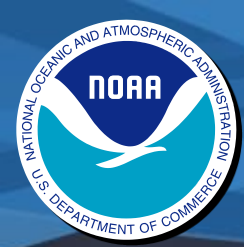
Faster internet connections (cable/DSL or better) are highly recommended for this phase of the demonstration. The NNEW Demo application may take some time to download initially, but it is a one time download and will remain cached on your local system for fast startups in the future.

[Click here](#) for first time installation instructions

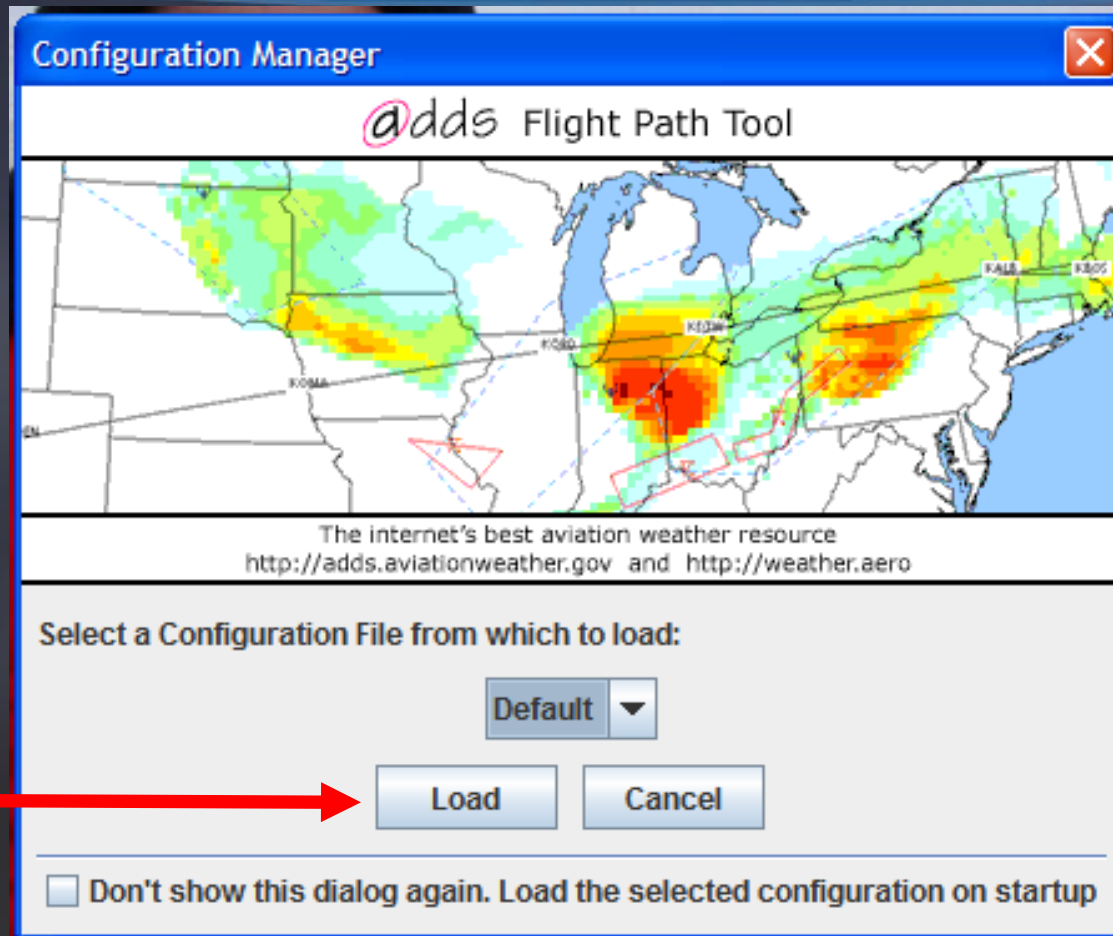
Having any trouble? Check out our [Frequently Asked Questions](#).

Please ensure you have the latest security patches for your OS and the most recent [Java Runtime Environment](#) (look for a button labelled "Java Software Download").

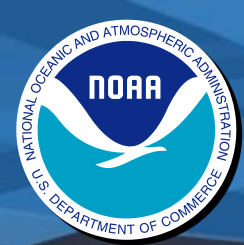
**<http://weather.aero/nnew/phase2b/>**



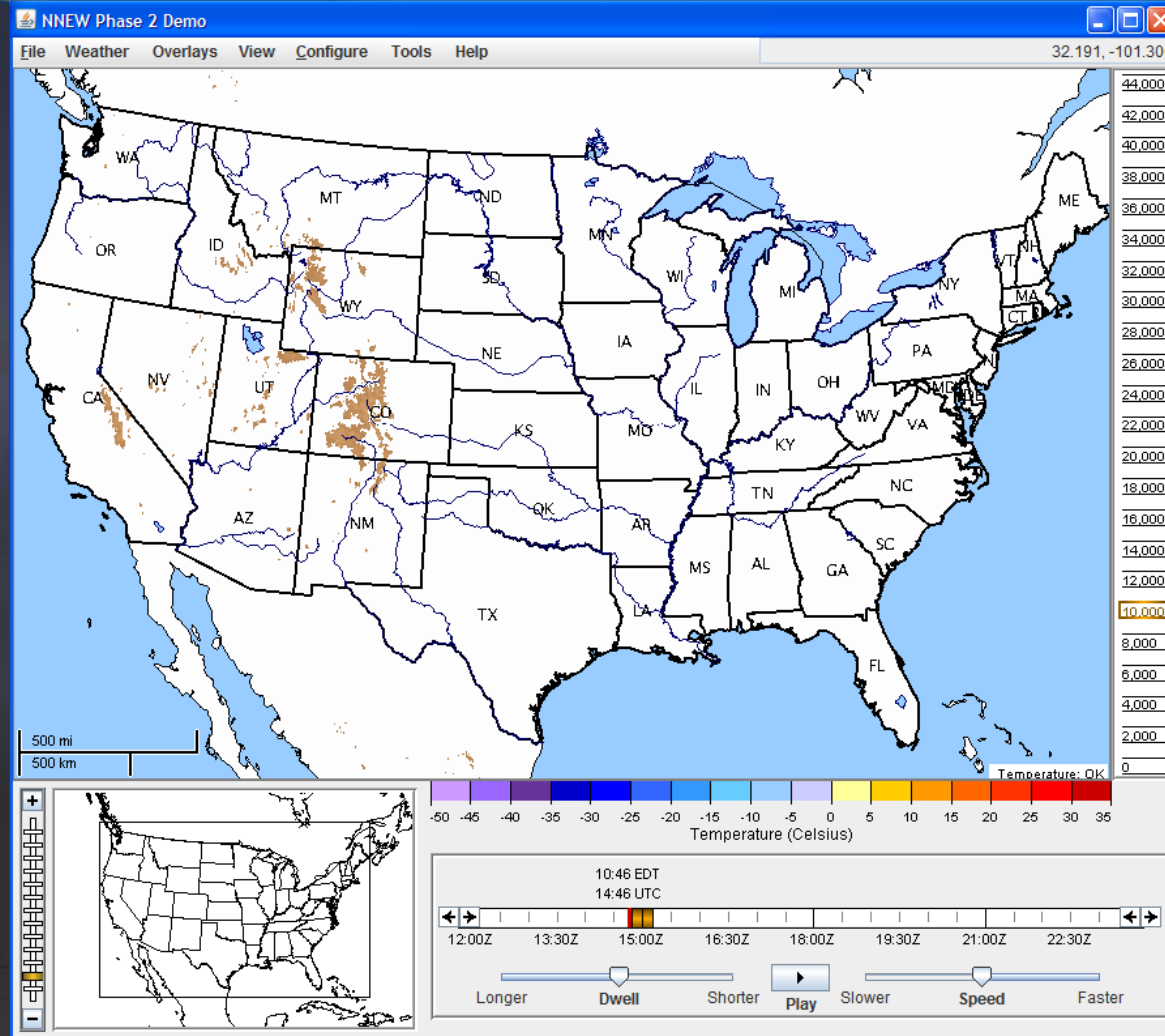
# Getting there...demos



<http://weather.aero/nnew/phase2b/>

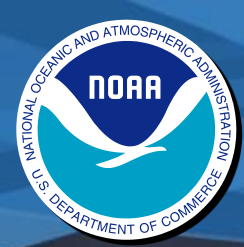


# Getting there...demos

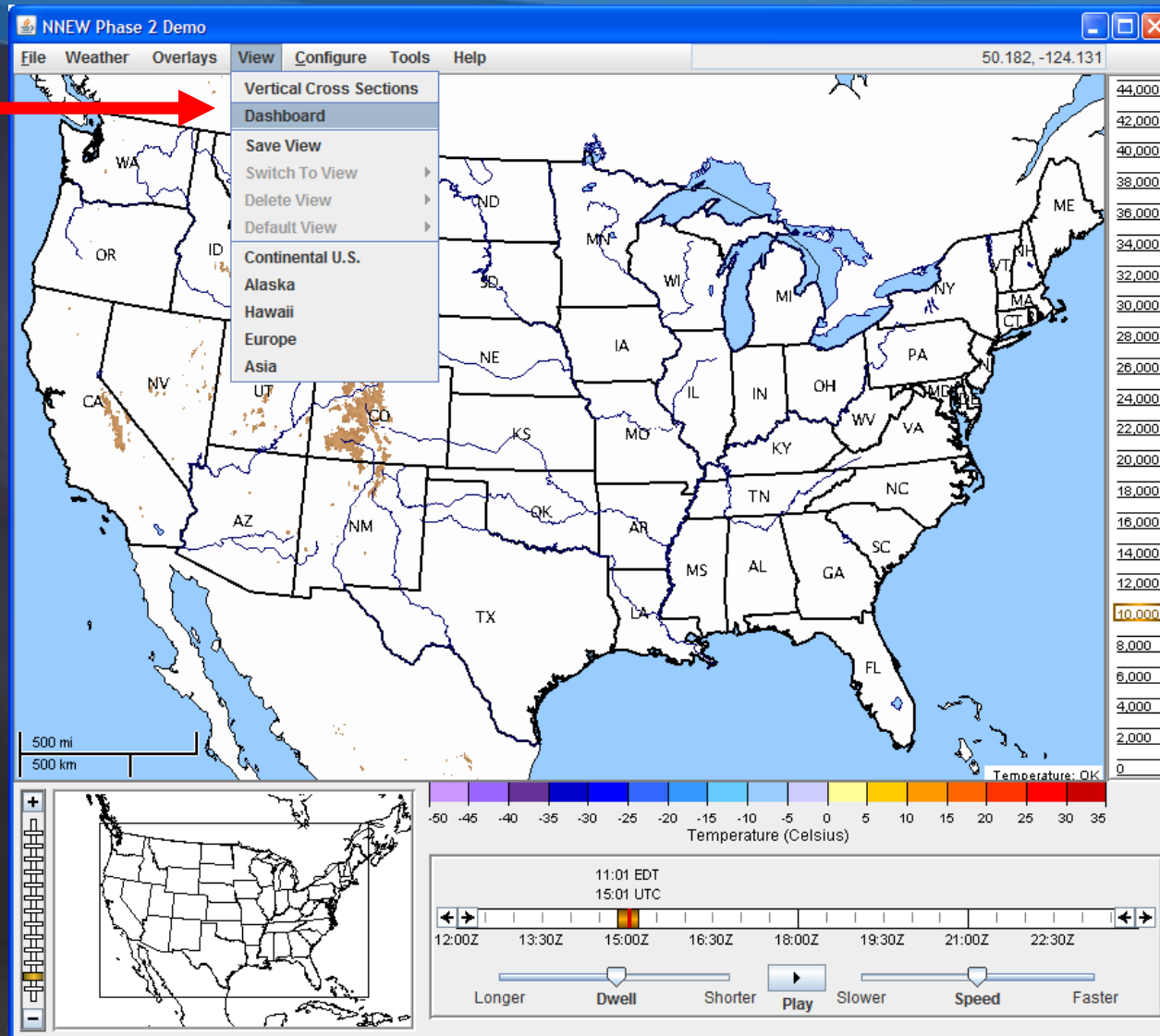


<http://weather.aero/nnew/phase2b/>

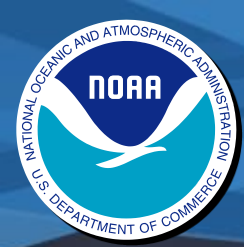




# Getting there...demos



<http://weather.aero/nnew/phase2b/>



# Getting there...demos

**Dashboard**

**NNEW Demo Application Layers**

- WFS-LIGHTNING( LL )
- WFS-TAF( RAL )
- WFS-AIR/SIGMET( RAL )
- WFS-PIREP( ESRL )
- WFS-PIREP( RAL )
- WFS-METAR( ESRL )
- WFS-METAR( RAL )
- RTMA Surface Wind Barbs
- Rapid Refresh Wind Barbs
- Wind Barbs
- Temperature
- Relative Humidity
- Wind Speed
- Turbulence
- Icing
- Icing Severity
- Rapid Refresh Temperature
- Rapid Refresh Wind Speed
- RTMA Surface Temperature
- RTMA Surface Wind Speed
- CIWS VIL
- CIWS Echo Tops
- Radar Base Ref
- Radar Composite Ref
- GOES Visible
- GOES Infrared
- GOES Water Vapor

**4D Weather Data Cube**

**Registries**

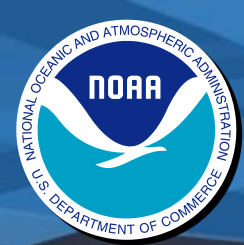
<http://ngenwww2.ll.mit.edu/omar-server-4.1>

<http://esrl.noaa.gov/> (Under Development)

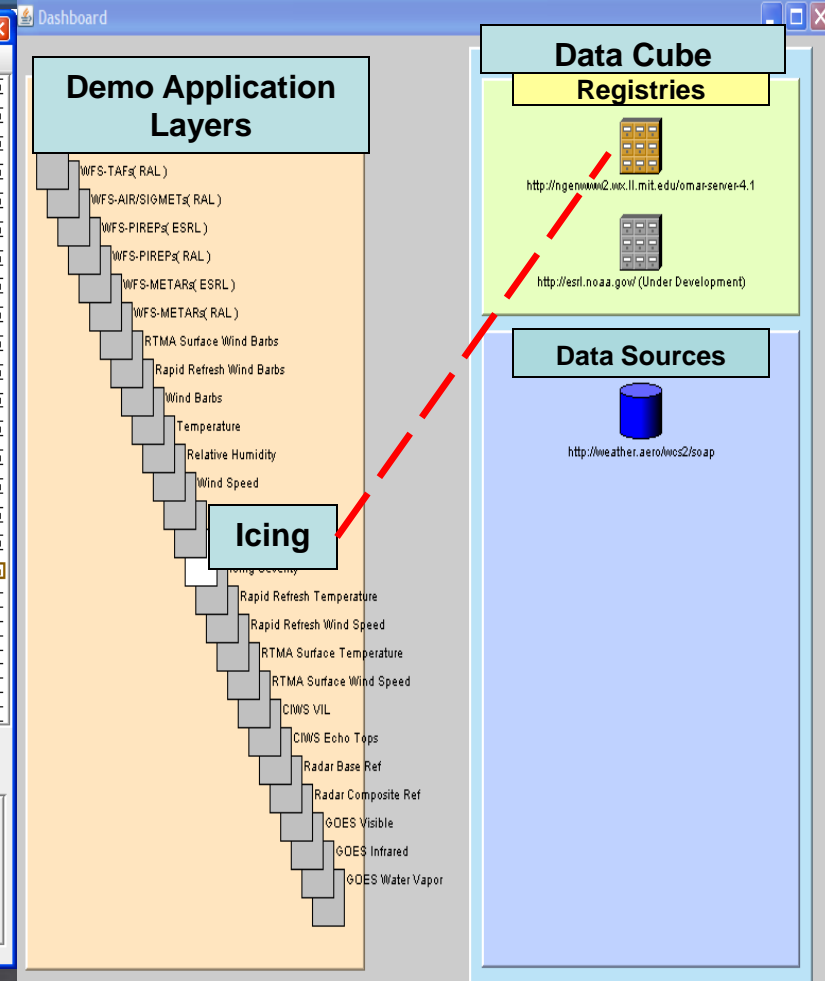
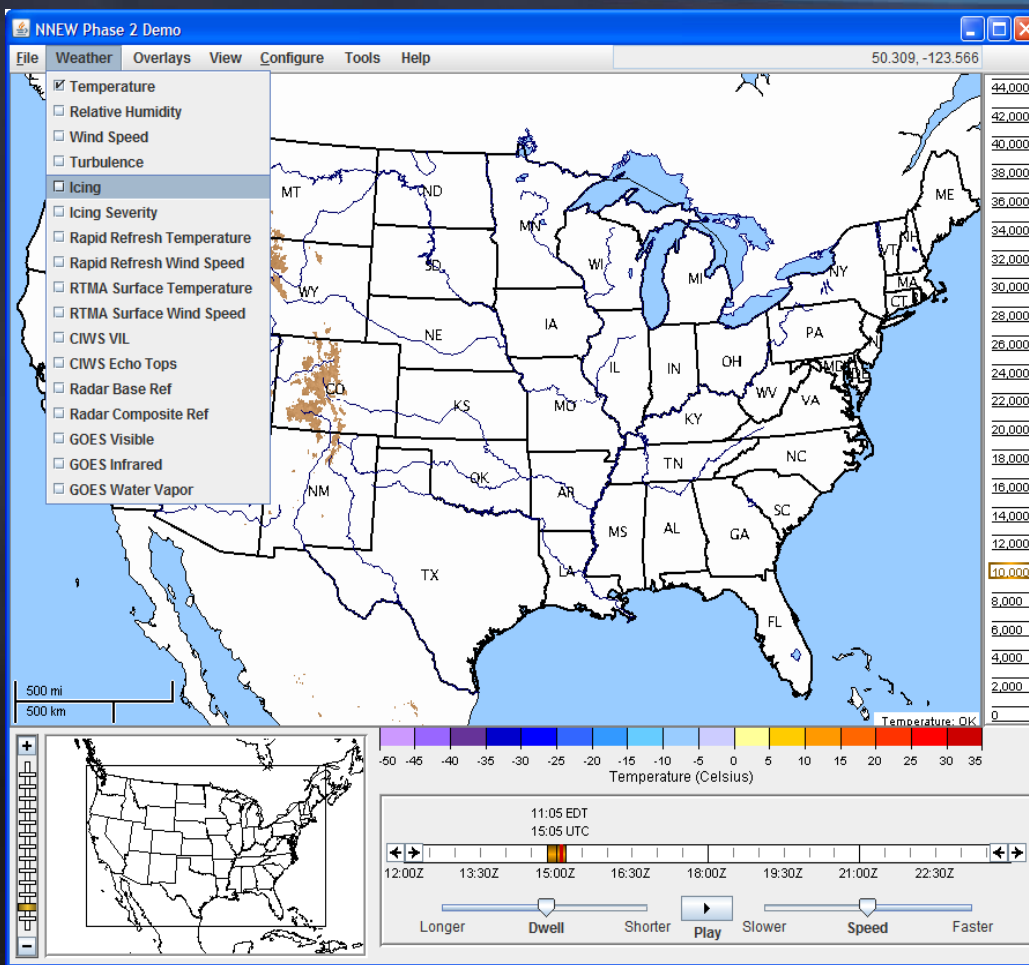
**Data Sources**

**Could show one or more data sources here**

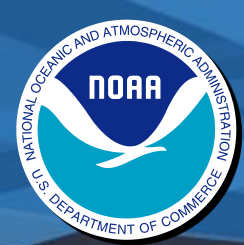
<http://weather.aero/nnew/phase2b/>



# Getting There...Demos



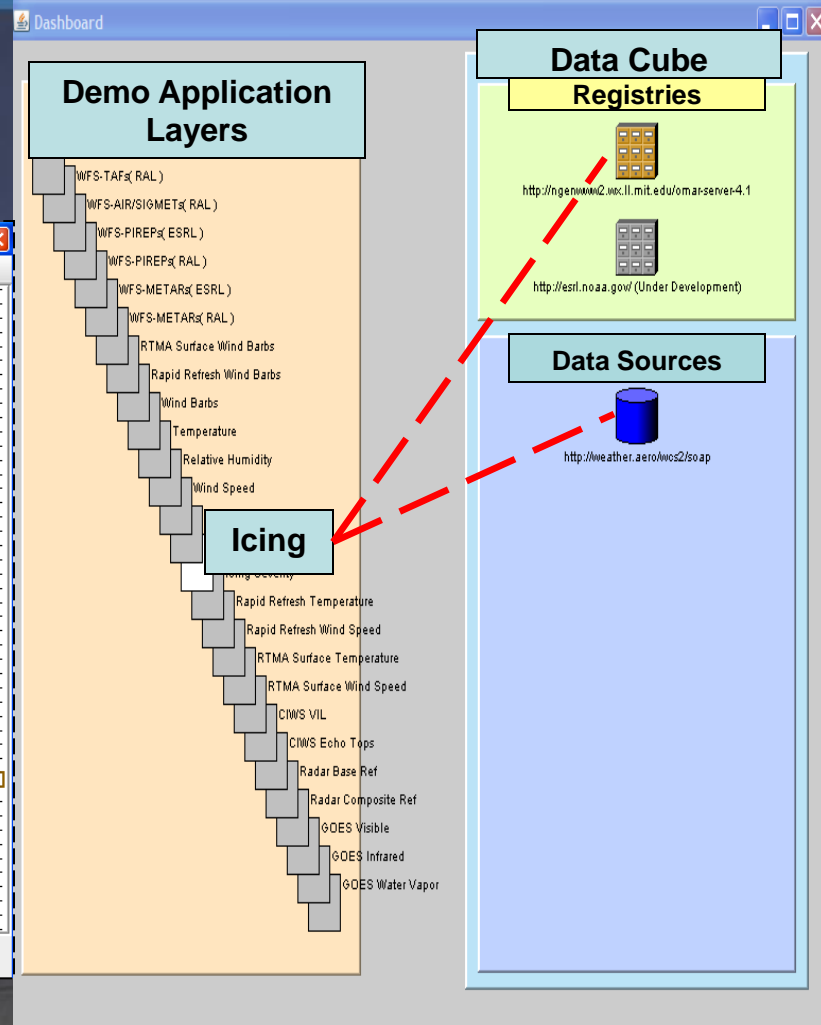
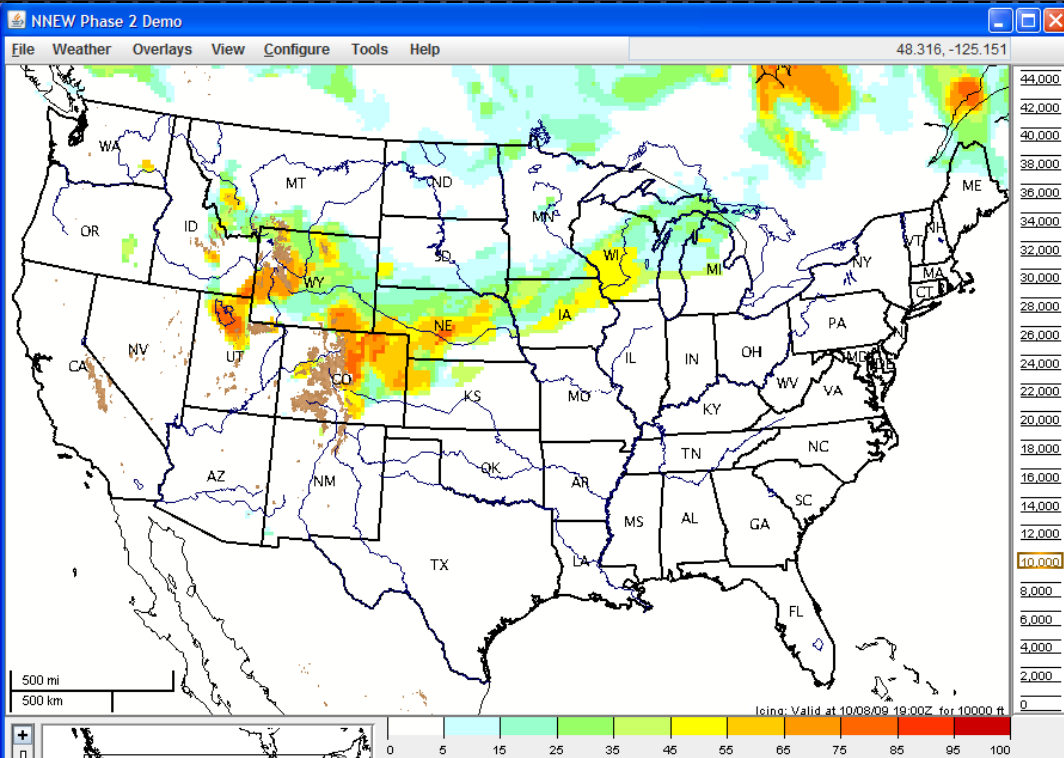


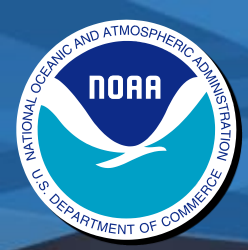


# Getting There...Demos

<https://wiki.ucar.edu/display/NNEWD>

<http://weather.aero/nnew/phase2/>





# Questions?