

NextGen Weather: Network-Enabled Verification Service

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Overview

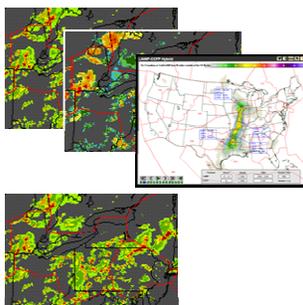
- Motivation for NEVS
- NWS Plans and Requirements for NEVS
- NEVS OSIP and Implementation Schedules
- Evolution of Verification
- Current RTVS Capabilities
- NEVS Solution
- NEVS Techniques
- NEVS Prototype 2010
- Summary



Network-Enabled Verification Service (NEVS) Overview

Data Input to NEVS

- Forecasts
- Observations
- Aviation ops criteria, decision thresholds, and governance criteria

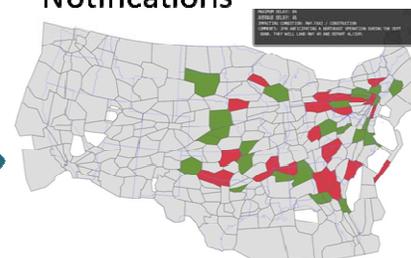


- Verification Mechanics
- Performance Metrics
- Integration of data and decision criteria

Data Output from NEVS

▪ Performance Information in *Operational Context*:

- Graphics
- Plots
- Tabular Data
- Notifications





Motivation for NEVS

- Support the Federal Aviation Administration (FAA) goals for the Next Generation Air Transportation System (NextGen)
- Provide NWS forecasters real-time feedback on the quality of their official products
- Provide users of the NextGen 4-Dimensional Weather Data Cube (Cube) information about quality and uncertainty of the data and products they access
- Need to establish quality baselines for NextGen Program Performance Management



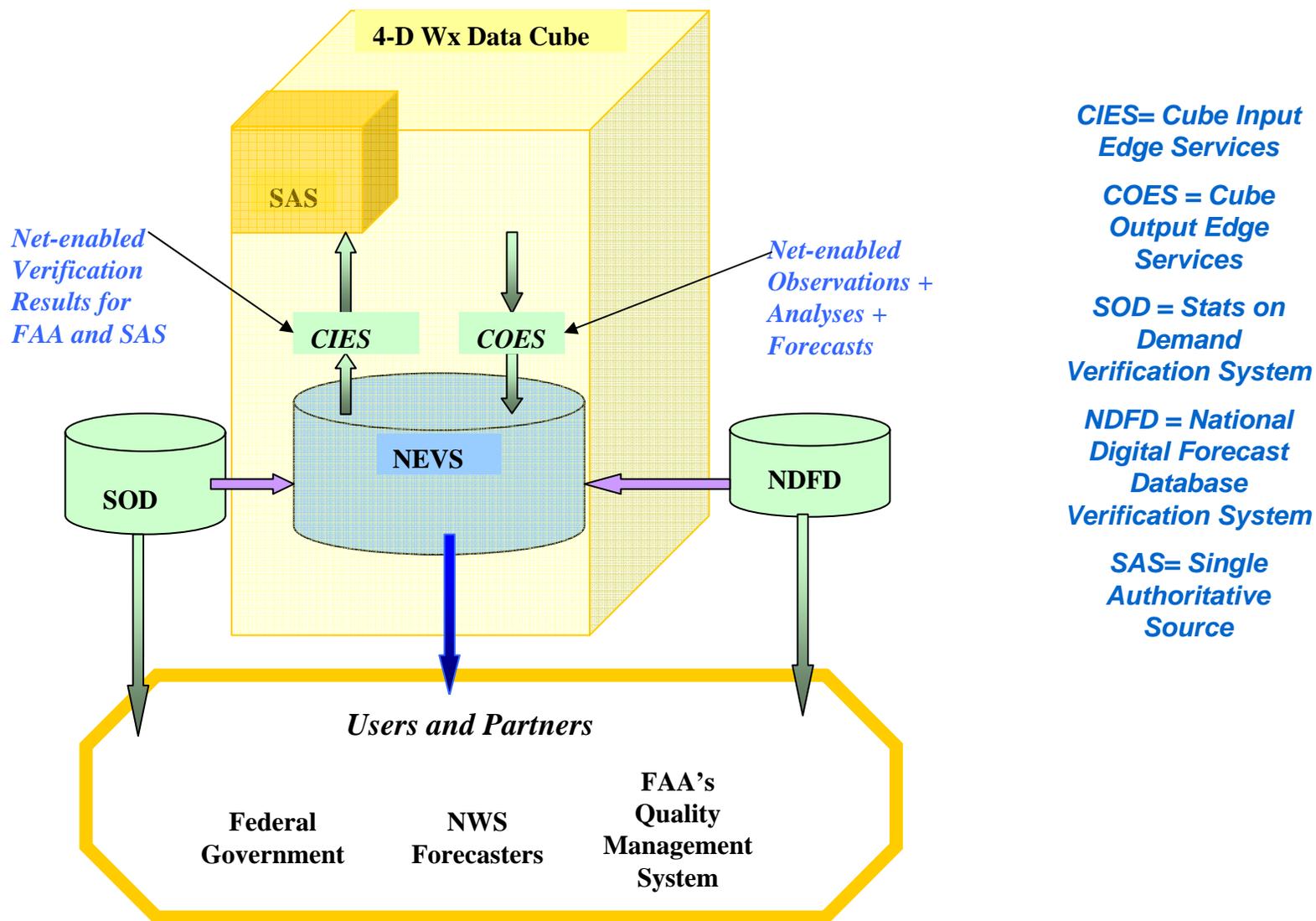
Key NWS NEVS Requirements

- Forecaster Perspective
 - Real-time feedback to forecasters
 - User relevant verification metrics and displays
 - Web-based graphical interfaces
 - Augment existing NWS capabilities in Stats on Demand (SOD) and National Digital Forecast Database (NDFD) verification systems
- System Perspective
 - NextGen Net-centric Standards
 - Service Oriented Architecture (SOA)
 - Open Geospatial Consortium (OGC) Web Services
 - Inter-operability among all Cube system components
- User Perspective
 - NEVS will be a consumer of and publisher of verification results to NextGen Cube
 - Objective data to use for Single Authoritative Source for FAA





NEVS Notional Architecture





NOAA NextGen Plans for NEVS

- NWS plans to transition NEVS to operations to replace Real-Time Verification System (RTVS) by 2013
- NEVS capabilities will continue to evolve incrementally until NextGen Final Operational Capability (FOC) in 2022
- *NEVS at NWS will have five primary roles:*
 - Verification of Aviation Services products
 - Verification of 4-D Weather Data Cube elements
 - Support development of performance measures
 - Support FAA's Quality Management System (QMS) verification reporting requirements
 - Provide objective information for NextGen Single Authoritative Source (SAS) contents decision-making



NEVS OSIP Milestones

- Gate 1 - *Completed June 2009*
- Gate 2 - *Completed April 2010*
- Gate 3A - *Completed September 2010*
- Gate 3B - *April 2011*
- Gate 4 - *April 2012*
- NEVS Deployment at NWS - *Fall 2013*



Schedule for NEVS Implementation at NWS

- NOAA NextGen Weather Program planned funding:
 - *2010-13*
 - Prototype NEVS verification web services capabilities as a consumer of NextGen Cube
 - Develop NEVS Architecture
 - Implement RTVS functionality in NEVS
 - *2011-13*
 - Prototype NEVS verification results as web services provider to AWIPS II via Data Delivery and to the NextGen Cube
 - *2013*
 - Integrate NEVS with NextGen Cube infrastructure
 - Deploy NEVS in NWS operations





Evolution of Verification

	1990's	~2003	2013
Verification Drivers	<ul style="list-style-type: none"> • Meteorological quality assessment feedback to algorithm developers 	<ul style="list-style-type: none"> • Support for the Aviation Weather Technology Transition (AWTT) process • Historical aviation forecast performance record for FAA Managers • Meteorological quality assessment feedback to forecast producers • Meteorological feedback to algorithm developers 	<ul style="list-style-type: none"> • NextGen: Forecast performance in the context of FAA operations and decision criteria • Support for Research Transition process (formerly AWTT) • Historical aviation forecast performance record for FAA and NWS Managers • Meteorological quality assessment feedback to forecast producers • Meteorological feedback to algorithm developers
Performance Metric and Verification Techniques	Standard meteorological skill scores for State of the Atmosphere variables	Modified verification techniques and scores for aviation weather products, historical performance	User-specific verification techniques and new performance metrics to provide performance in the context of how the forecast is used
Engineering Requirements	Tools for users	Database storage and web access to results	Real-time feedback for operational decision support, and real-time machine to machine delivery of data



Demands of a NextGen Verification Service

- Network-enabled communication for data access and distribution
- Forecast quality in the context of its use
- Agility and adaptability to add new datasets and methodologies
- Meets security and safety requirements of the NextGen architecture



Current Verification - RTVS

ESRL RTVS Real-Time Verification System



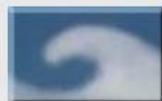
Convection



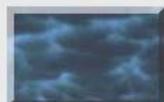
Ceiling and Visibility



Icing



Turbulence



NCEP Models

Developed by the Forecast Impact and Quality Assessment Section within the Aviation, Computing, and Evaluation Branch of the Global Systems Division at NOAA's Earth System Research Laboratory.
Funded by the FAA AWRP

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RTVS Has Served Us Well, but...

- Lack of modularity
 - Invasive changes needed to add new products
 - Requires duplication across verification domains to incorporate new methodologies
- Data ingest and output lack ability to support NNEW protocols
- Security and maintenance do not meet operational requirements
- More cost-effective to re-engineer ... resulting in NEVS



The NEVS Solution

- New infrastructure
 - Modular decomposition allows for the efficient addition of new data products and verification methods
 - “Integration” layer supports the joining of verification data with air traffic information
 - Support of NNEW communication protocols
- New verification techniques
 - Incorporate user-based criteria
 - Methodologies represent the use of the forecast in aviation decisions



NEVS Infrastructure

Production	Integration	Presentation
<ul style="list-style-type: none">• Data ingest and management• Import of verification results from other systems• Verification modules	<ul style="list-style-type: none">• Storage of verification information• Storage of air traffic information• Strategies to allow joining of air traffic and verification information	<ul style="list-style-type: none">• Web user interface providing variety of graphical results• Web services for machine-to-machine communication



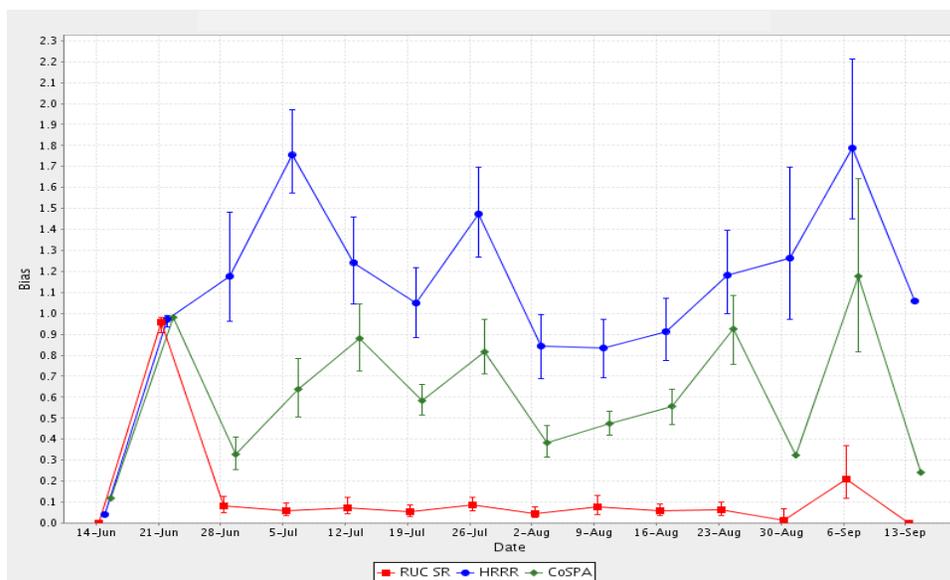
Verification Techniques

- Traditional
 - Pixel-to-pixel
 - POD, FAR, CSI
 - Stratifications such as forecast issuance, lead, altitudes
- Future
 - User-based
 - Object-oriented
 - Operational stratifications such as telecon time, planning period



Traditional Metrics

- Can provide a first-order indicator of skill
- User-agnostic
- May even be misleading, particularly for high-resolution models





Future – Incorporation of the User's Perspective

- Methodologies incorporate use of the forecast in a decision-making context
- Example: Context of operational ATM planning:
 - Strategic decision points are incorporated into statistical measures
 - Operational spatial domains are included in assessment mechanics
 - ARTCC boundaries
 - High altitude sectors
 - Metrics link forecast quality to operational constraints such as air space capacity

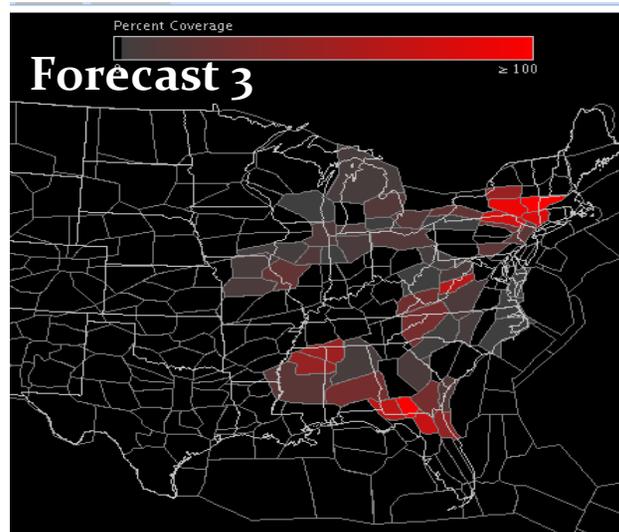
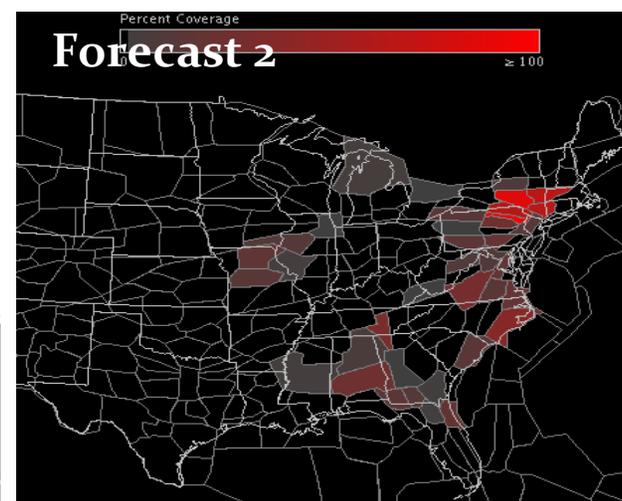
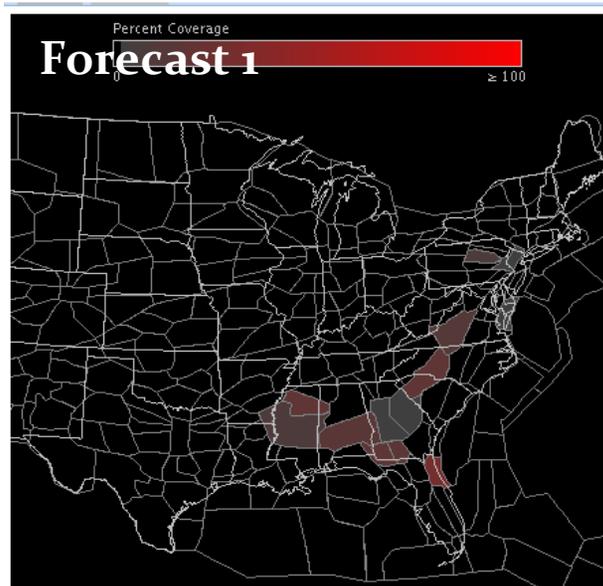
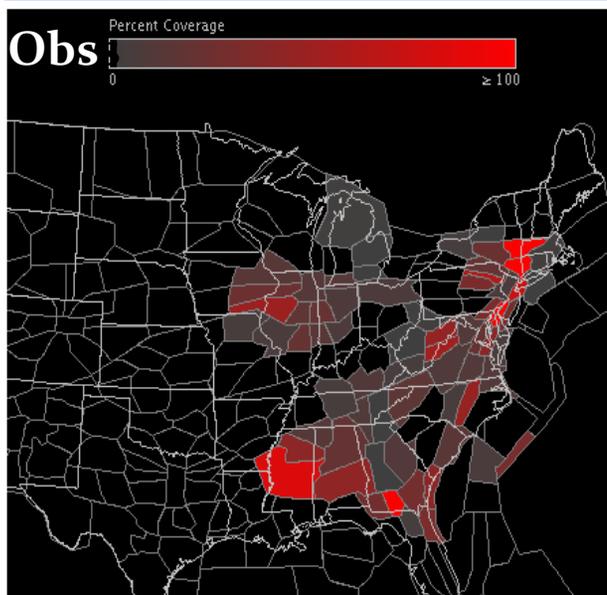


User-based Techniques

- Forecasts and observations are translated into estimates of sector capacity (or capacity reduction), due to presence of convective weather
 - Techniques such as Mincut Bottleneck
- Resulting output is at the spatial granularity of high altitude sectors
- Verification skill scores are applied to translated forecast and observations, thus measuring performance in context operational parameters (such as airspace capacity)



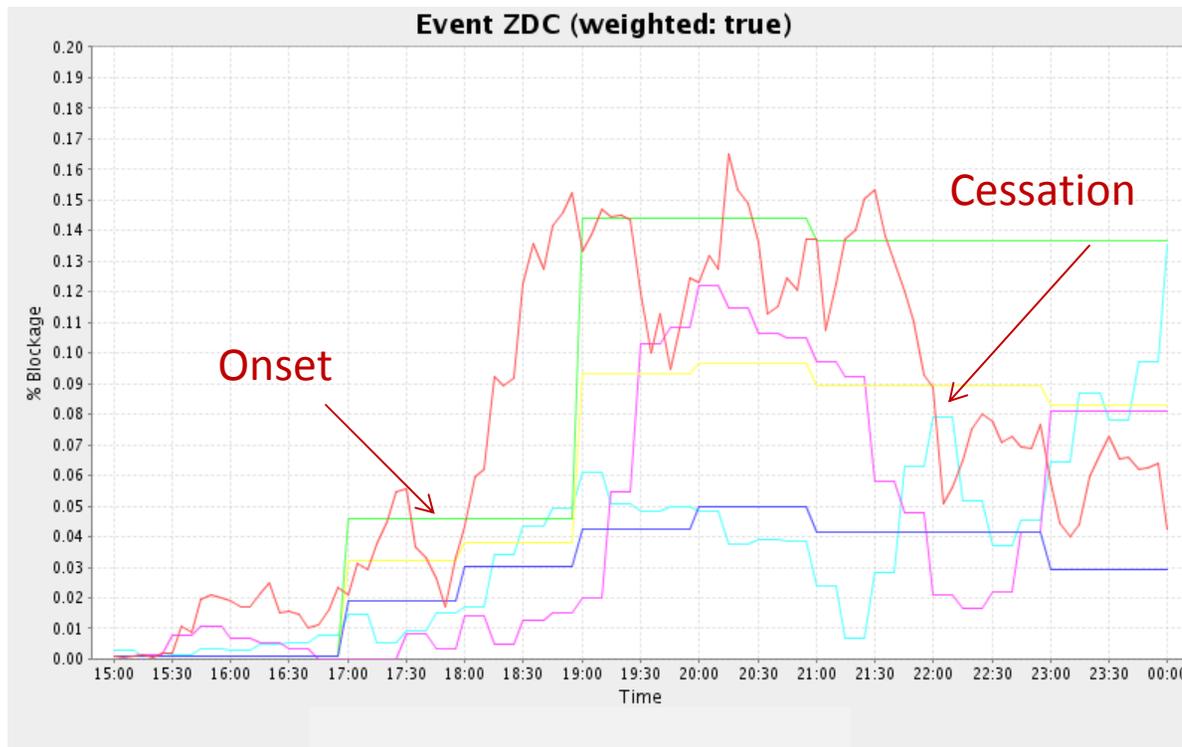
NEVS Graphical Mincut Bottleneck Output





Planning Point Capacity Plot

% Blockage as derived from
Mincut Bottleneck Technique





NEVS Prototype 2010

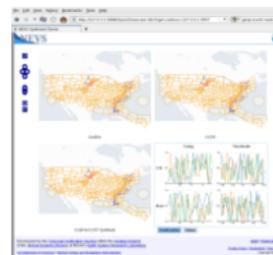
NEVS Network Enabled Verification Service



Integration Examples

Weather Translation Support Example

The availability of detailed, sophisticated quality information will provide value to the ATM enterprise in both the short, mid and long term time frames. NEVS is designed to support the integration of weather into the decision-making process, by providing performance information for weather data to users as well as input to the weather translation process. The following is an example of how verification data from NEVS could be used to optimize the blending of forecasts into a common weather picture, which could ultimately be used to generate a weather-related aviation constraint.



[Go to demo...](#)

Services



VxQuery

NEVS supports weather, translation and ATM decision-making by providing a broad set of scenario-specific verification measures via NextGen service interfaces.



VxAlert

NEVS also provides proactive support by alerting users or systems of specific weather, translation or verification events for which alerting criteria have been registered.

Core



VxEngine

The NEVS verification engine manages the creation of verification measures and is designed for future extensibility.



VxConnect

NEVS has been designed to be compatible with the NextGen infrastructure, enabling connections to WCS, WFS and WMS services as well as Pub/Sub and Reg/Rep.

Developed by the [Forecast Verification Section](#) within the [Aviation Branch](#) of the [Global Systems Division](#) at NOAA's [Earth System Research Laboratory](#)

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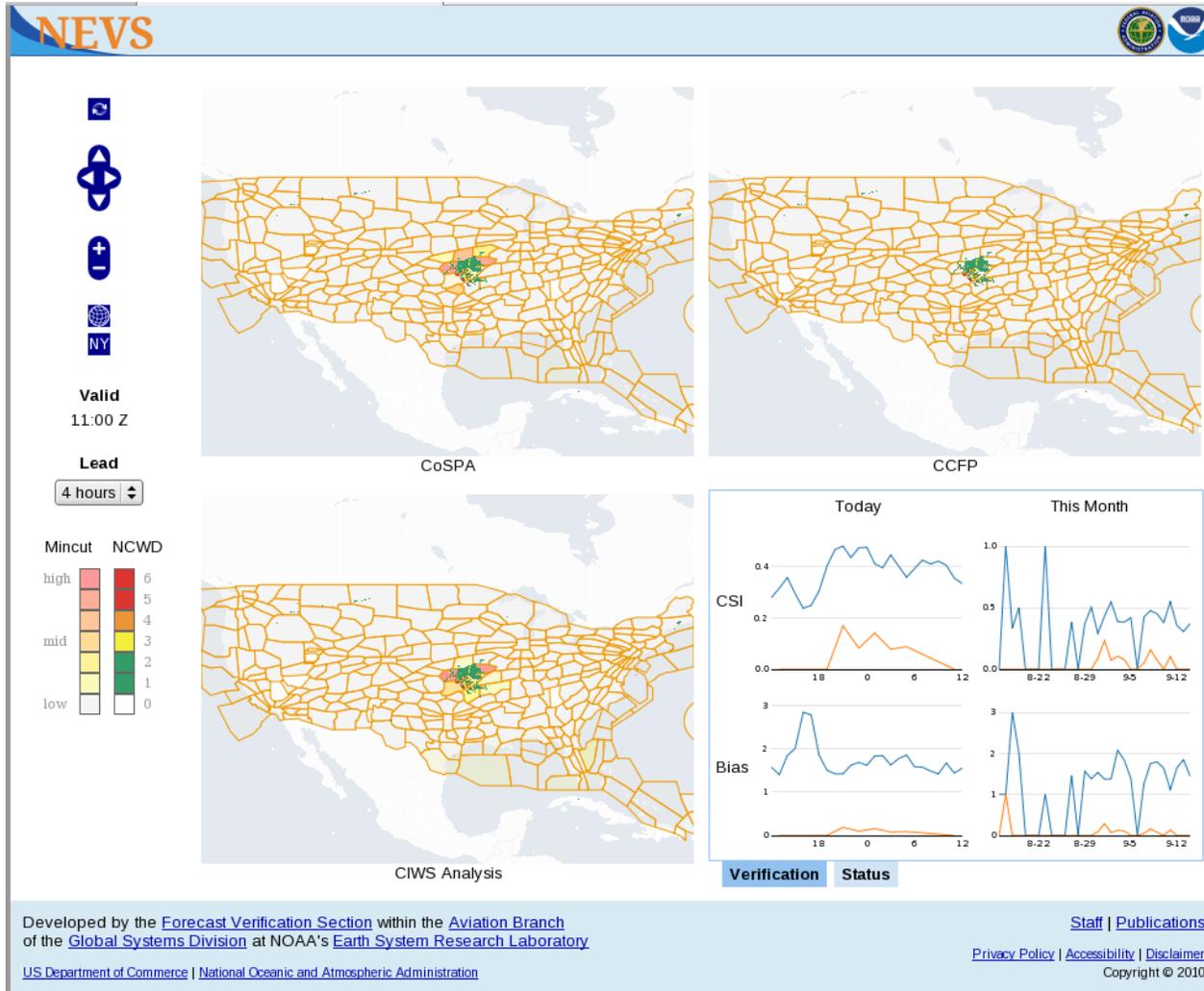
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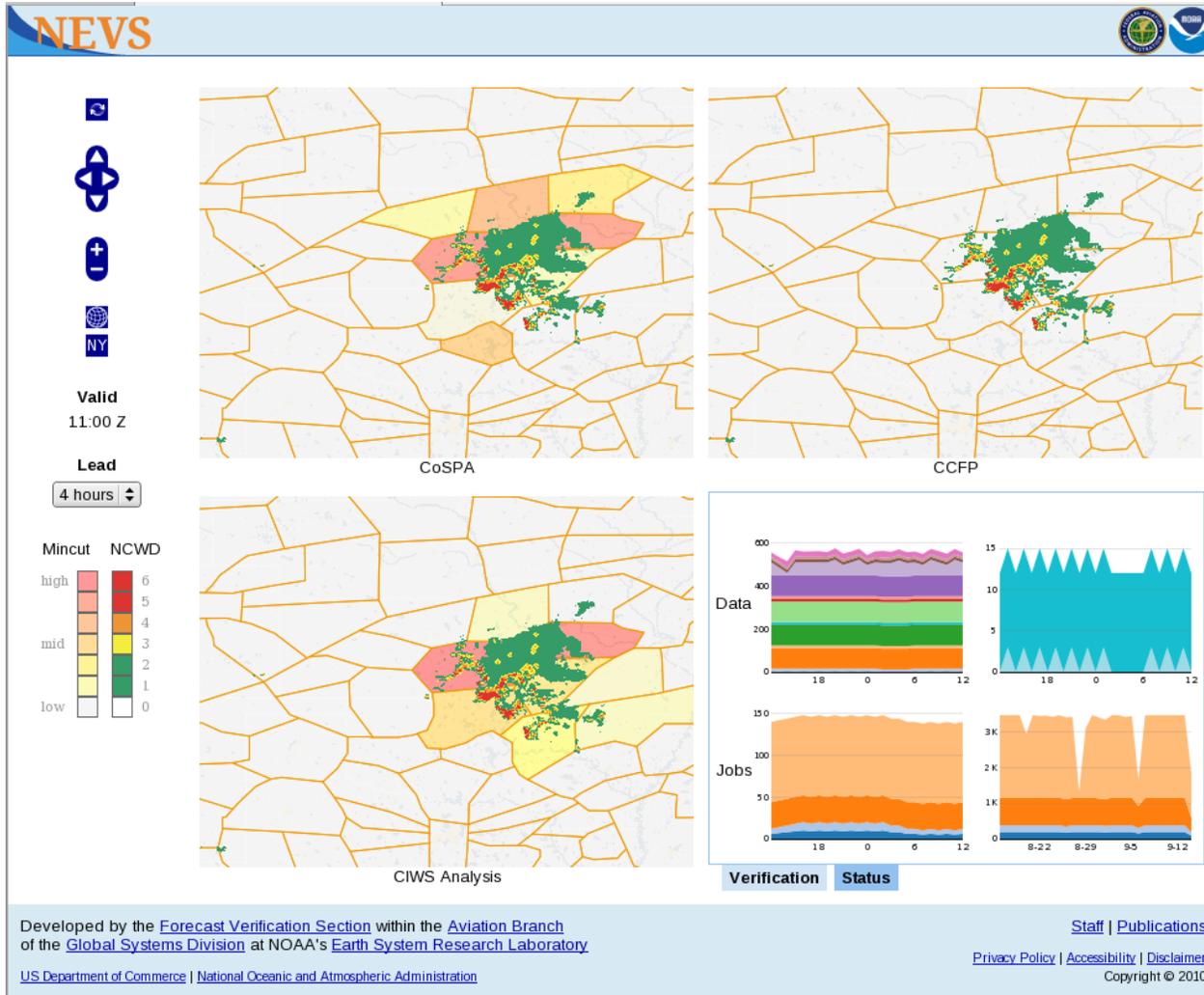


NEVS Prototype 2010





NEVS Prototype 2010





Summary

- NEVS verification capabilities will enable NWS, FAA and users to understand quality of Aviation Products and data provided in NextGen Cube

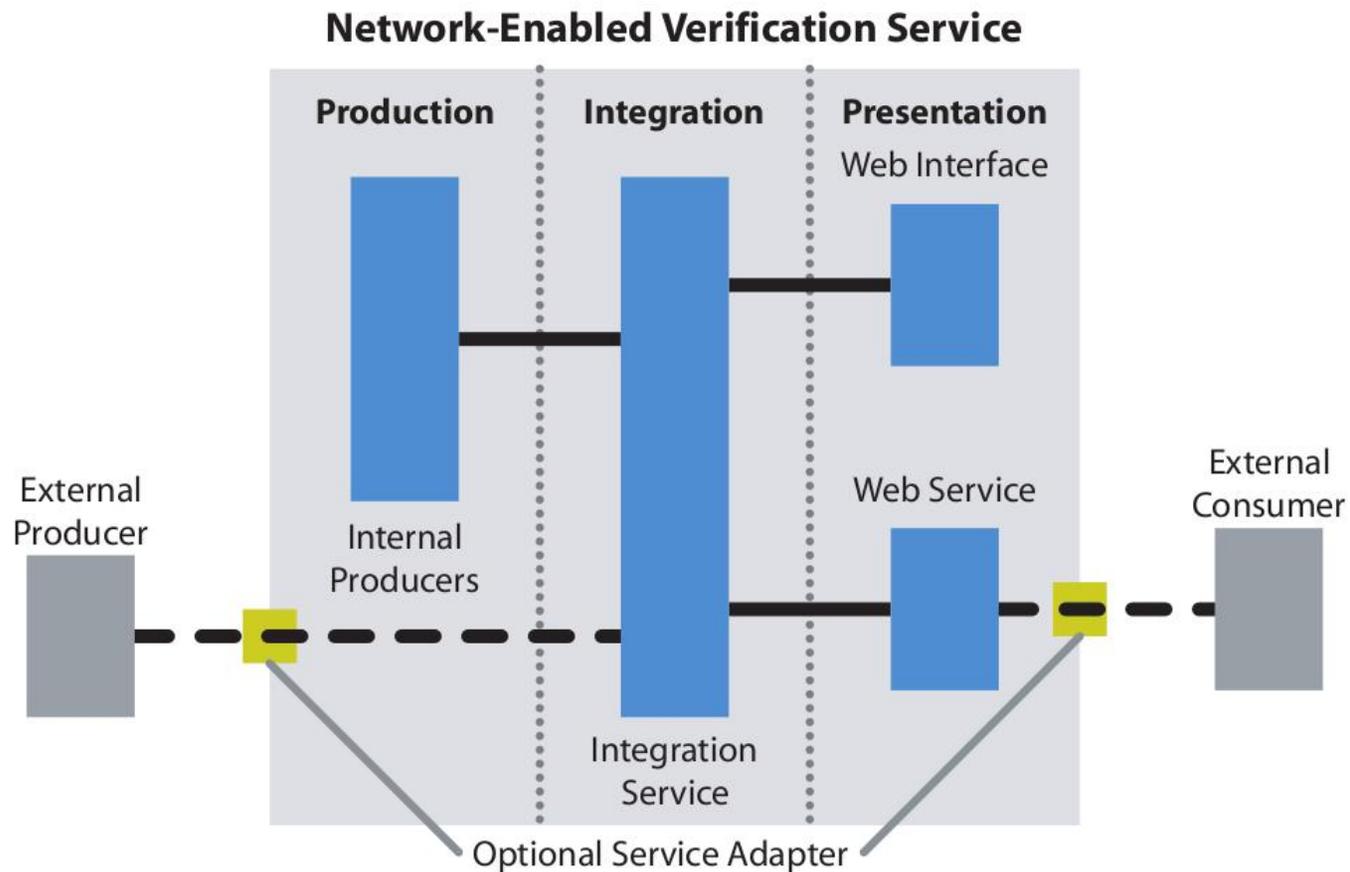


Backup Slides





NEVS Architecture





Jetway

Mincut Bottleneck Technique

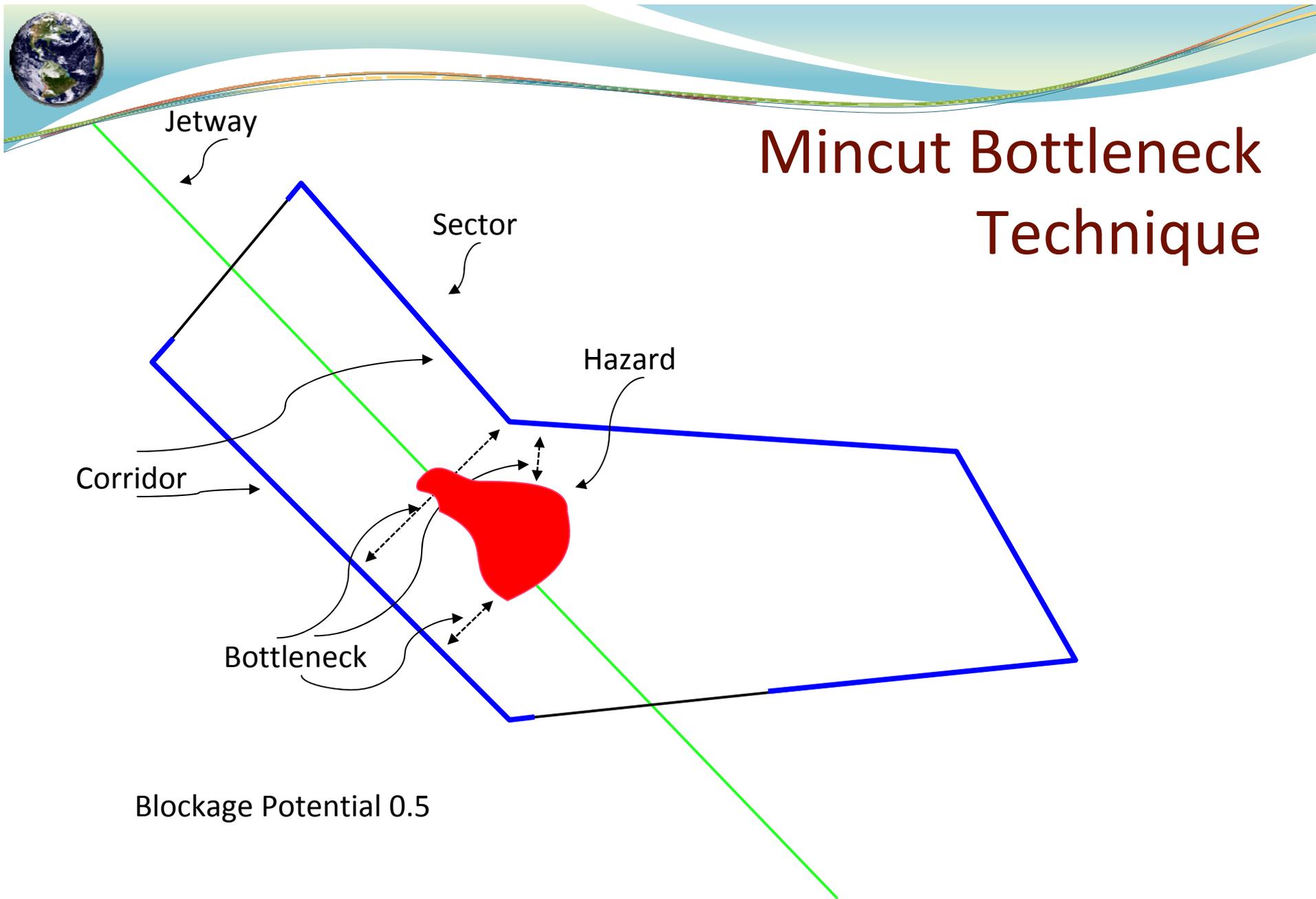
Sector

Hazard

Corridor

Bottleneck

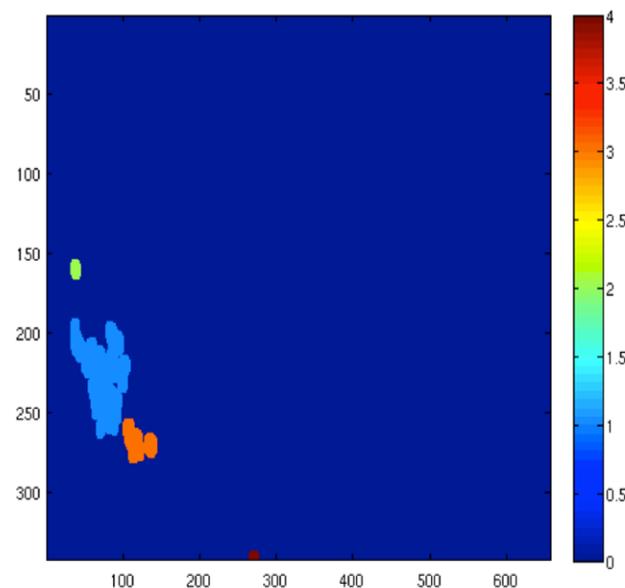
Blockage Potential 0.5





Object-oriented Techniques

- Attempt to capture how the user perceives the matching of objects in the forecast field to the observed field
- Differentiators between techniques are
 - What defines an object
 - How objects (between forecast and obs) are matched





Procrustes Methodology

- Identify forecast and observation objects (cells)
- Fit forecast cells to truth cells by shifting location, resizing the object, and rotating them if necessary
- If there is not a perfect fit, there will be a resultant residual error term
- Works with gridded data of any dimensions for spatial objects
- References
 - Micheas et al. 2007, Cell identification and verification of QPF ensembles using shape analysis techniques. J. of Hydro., 363, 105-116.
 - Lack et al., 2010: An Object-Oriented Multiscale Verification Scheme. Weather and Forecasting, 25, 79-92