INSITE – AN IDSS TOOL FOR AVIATION

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VLab Forum

17 February 2016
Forecast Impact and Quality Assessment Section

- Mission: Advance the understanding and use of weather information through impact-based assessments and targeted information delivery to benefit decision making in response to high-impact weather events

- Sponsors
  - NWS: NextGen Program and Aviation and Space Weather Services Branch
  - FAA: Aviation Weather Research Program (QA PDT)

- Activities
  - Independent quality assessments
  - Verification in operational context
  - Technologies
INSITE

- Development sponsored by NWS NextGen Program
  - Aligned with NWS Weather Ready Nation initiative of Impact-based Decision Support Services

Key Forecaster Responsibilities

- Maintain continuous awareness of meteorological conditions as they pertain to aviation decisions
- Determine accuracy and confidence in existing weather predictions as they pertain to aviation decisions
- Update forecast as needed to support aviation decisions
Impact-based Decision Support

A weather decision service for common situational awareness and forecast preparation

INSITE: INtegrated Support for Impacted air Traffic Environments
INSITE Features

- Features support forecaster identification of convective weather potentially impactful to air traffic
- Several convective forecast products, plus observations
- Overlays of routes and Control Centers (ARTCCs)
- Airspace constraint fields (Flow Constraint Index) derived from blend of weather and traffic data
- Confidence information for forecast constraint
- Displays of both raw weather and constraint fields
- ‘Synthesis’ product, where different forecast products are blended into a single forecast of constraint using performance information
- Summary constraint information for regions of interest (default ARTCCs or user-drawn)
  - Drill-down capabilities to identify potential impacts to related routes or ARTCCs
- Historical playback feature to review past events
INSITE – Main Page
Raw weather with core airport overlays
INSITE

- Raw weather graphics and route overlays indicate this line of convection could be impactful to East-West traffic
- INSITE provides a metric that is a quantitative measure of how much impact is likely
Flow Constraint Index (FCI)

- Blue lines: Corridor boundaries.
- Red area: Area of hazardous weather.
- Arrow A: Distance across corridor in absence of hazards.
- Arrows B and C: Distance across the available airspace around a hazard.
- Flow constraint is $1 - \left( \frac{\text{MinCut}_{\text{Hazard}}}{\text{MinCut}_{\text{Corridor}}} \right)$
- Apply weighting scheme (traffic density)
- FCI of 1.0 corresponds to most constrained, 0.0 corresponds to none.
- Can compute FCI for any type of forecast (probabilistic, deterministic)
FCI Hexagonal Grid
FCI Example in INSITE

CONVECTION FORECAST

TRAFFIC FORECAST

AIR TRAFFIC FLOW CONSTRAINED BY WEATHER
FCI Traffic Weighting – Historic Data

- ASDI Data from 2014 convective season (May-Sept)
- Flights corresponding to major carriers, operating at OEP 35 airports
- Data representing ‘ideal scenario’ for standard routes
  - Clear air days
  - First flight plan
- Traffic density stratified by day of week and hour of day
FCI Traffic Weighting – Current Data

- Ingest real-time air traffic from the ASDI data set
- Determine the set of most recent flight plans, planned aircraft locations
- Incorporate ‘planned’ traffic density into the FCI

A FACET snapshot of air traffic over the United States on July 10, 2006, at 2:45 p.m. EST. Image Credit: NASA Ames Research Center
INSITE

- Raw weather graphics and route overlays indicate this line of convection could be impactful
- INSITE provides a metric that is a quantitative measure of how much impact is likely
FCI in INSITE – Our Case

- FCI is depicted via ‘heat map’
- For this case, FCI indicates a large area of constraint as forecast by the NSSL WRF
FCI in INSITE – Our Case

- Users can click on the ‘up arrow’ button on to view FCI computed with current traffic.
- ‘Current traffic’ view indicates that planned routes are still impacted by the convection depicted by the NSSL WRF.
FCI in INSITE – Areas of Interest

Users can draw their own polygons for more detailed interrogation of a specific region.
FCI – Summary Information

- Bar charts on far left are time series of constraint as identified by FCI
- Each bar corresponds to a polygon drawn on the geographical map
Constraint and Confidence Bars (CC-Bars)

- Now (Reference Time)
- Past Valid Times
- Future Valid Times

My polygon
Constraint and Confidence Bars (CC-Bars)

- Polygon text: Click to rename polygon
- Top bar: Forecast constraint
- Bottom bar: Constraint derived from observations
- Black horizontal line: Forecast confidence level between 0 and 100
- Click to delete polygon
- Click to navigate to constraint details for polygon
- Severity Categories:
  - None
  - Low
  - Med
  - High
  - Severe
Constraint and Confidence bars

Constraint and Confidence (or Consistency) bars (CC bars) are provided on the left side.

**Confidence Information**
- Confidence is based on long-term historical performance of the forecast products, and also includes a prolonged forecast latency penalty.
Products Featured in INSITE

- INSITE products:
  - HRRR
  - NSSL WRF
  - SREF
  - LAMP
  - CCFP
  - CIWS
- Raw product or derived constraint (FCI)
Synthesis Product

- The synthesis is a blend of the individual FCI’ed products
  - All
  - High-res only
- Product weights based on historical performance, inter-model consistency
Synthesis

CCFP

HRRR

LAMP

SREF

NSSL WRF

Synth Hi-res

Synth All
Constraint and Confidence bars (CC bars) are provided on the left side.

**Confidence Information**

- Confidence is based on long-term historical performance of the forecast products, and also includes a prolonged forecast latency penalty.
- For synthesis product, horizontal line is grey and indicates level of consistency between constituent forecasts.
Further Regional Interrogation

- Clicking on the ‘green arrow’ icon above the CC-bar navigates the user to more detailed information about the corresponding polygon.
NAS Elements Within a Polygon/Area

- CC-bars correspond to high altitude routes that pass through the selected polygon area
NAS Elements Within a Polygon/Area

- Routes are listed by rank, with the most impacted at the top of the list, the least impacted at the bottom of the list.
- Impact, as used to rank the routes, is for future times only.
- Intersecting ARTCCs are also viewable, using the gear symbol.
NAS elements within a polygon/area

- Hovering over one of the CC-bars highlights the route associated with that CC-bar on the FCI image.
NAS elements within a polygon/area

- Clicking on one of the CC-bars brings up a time series of the FCI values from all products for the time period from 4 hours before to 12 hours after the reference time.
NAS elements within a polygon/area

- Hovering over a product name causes that product’s time series to become bold (in this case, the dark blue NSSL WRF)
## Use Case

### INSITE Operational Scenario Steps

<table>
<thead>
<tr>
<th>Step Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify potential areas of air-traffic constraints in area of responsibility</td>
<td></td>
</tr>
<tr>
<td>Compare potential areas of air-traffic constraints with other model guidance</td>
<td></td>
</tr>
<tr>
<td>Narrow down area of interest using polygon drawing tool</td>
<td></td>
</tr>
<tr>
<td>Identify geographic areas with constraints above moderate severity threshold</td>
<td></td>
</tr>
<tr>
<td>Identify potential time of onset and cessation</td>
<td></td>
</tr>
<tr>
<td>Adjust forecast based upon model trends using confidence in CC bars</td>
<td></td>
</tr>
<tr>
<td>Adjust forecast based upon model consistency in CC bars</td>
<td></td>
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<tr>
<td>Use these areas of constraints as first guess impact areas in CAWS</td>
<td></td>
</tr>
</tbody>
</table>
Collaborative Aviation Weather Statement (CAWS)

Collaborative Aviation Weather Statement 003
NWS Aviation Weather Center Kansas City MO
1450 UTC Mon 06 Jul 2015

Weather: Thunderstorms
Valid: 1800-2200Z

ARTCCs affected: ZFW, ZKC, ZMP
Terminals affected:

CCFP: 15Z - Coverage too low

SUMMARY: Thunderstorms expected to develop across ZKC by 18Z and intensify into a line by 20-22Z.

DISCUSSION: Current storms across N KS/SE Neb will intensify after 18Z and form a broken line by 20Z and a significant solid line by 22Z with tops FL400+. Further south across the panhandle TX and W OK a broken line should begin to form around 22Z.

An additional CAWS may be needed as the storms pushes eastward.
INSITE v4

• Funding organization: NWS NextGen Program
• INSITE 4 to be released late May 2016, available for OB/CAWS activities
  • Addition of MRMS analyses
  • Switch from AWC SREF product to NCEP/NCO SREF product
  • Numerous UI updates (such as black background, improved product navigation, more help info)
  • New “Alert” feature – system identification of areas that are in excess of a given FCI value
When user clicks specific valid time, the alert polygons and heat map for that valid time will be displayed.
Transition to NWS Operations

- Operational host: IDP
- IOC
  - INSITE v4
    - Switch to all operational NWS products (replace CIWS with MRMS, NSSL-WRF with HiRes NMM/ARW runs)
    - May 2017
- Where in the process?
  - Have begun the necessary coordination with IDP
  - Initial design review
  - Technical documentation
Contacts

• Feedback and questions on INSITE and its use are welcomed

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