Verification for Terminal and En-route Weather Forecasts and TFM Decisions

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Motivation

• Assess the quality of weather forecasts used for Traffic Flow Planning
• Support the requirements provided by the FAA and tracked by NWS
• Terminal and En-route domains
TERMINAL
Verification Objective Terminal

• Operational need
  – Impact of weather on ground delays/ground stops for the 30 core airports

• Impactful weather
  – Thunderstorms with a probability equal to or greater than 50% within 75 nmi of an airport

• Measures
  – Lead-time, timing error, and displacement for onset and cessation of the weather
Circles are 75 nmi of 30-core airports. Color are observations.
Forecasts Available for TFM Decisions
Event Onset and Cessation

• Using the thunderstorm coverage within 75 nmi of airport, translate the forecasts and observations to ‘events’

• Compare forecast and observed event onset and cessation (does not take in account storm proximity)
Event Displacement

- Define forecast event objects
- Group observed objects that are in close proximity
- Compute center of mass of each object grouping
- Match observed and forecast objects
- Compute distance between center of mass for observed and forecast objects
Measure Performance

CSI* with ±3 and ±6 hour temporal precision

FCST Lead = 2h

Layne et al. 2013

*Critical Success Index
EN-ROUTE
Verification Objective

En-route

• Operational need
  – Support issuance of airspace flow programs in the northeast

• Impactful weather
  – Thunderstorms with tops greater than 30,000 ft and with probability greater than 50% of occurrence

• Measures
  – Lead-time, timing error, and displacement for onset and cessation of the weather
Set Up

- Jetways in the northeast oriented N-S and E-W
- Apply 20 nmi buffer around jetway for calculation
- Identify thunderstorms echo tops (30,000 ft or greater) that are at least 20 nmi in size that intersect the jetway
- Apply the Flow Constraint Index
Convection and Constrained Jetways

Domain Coverage during 17-26 July 2011

Jetways Impacted during 17-26 July 2011

Constrained Jetways
En-route Procedures

- Compute thunderstorm constraint within tangentially-aligned jetway
- Define event as 10% of the selected jetways in the NE constrained at any one time
  - Stratify by all, east/west and north/south routes
Lead Time

- Difference between time of observed event onset (cessation) and the forecast event onset (cessation)
  - Event defined as NE with 10% of jetways constrained

Blue – Observed convection
Red – Forecast convection
Displacement

- Group thunderstorms with 30,000 ft tops and 20 nmi in size
- Measure distance at the granularity of thunderstorm groupings.
- Measures placement of convection within NE domain

Blue – Observed convection
Red – Forecast convection
# Forecast Skill

## Skill with 10% coverage threshold and ±3hr temporal precision; Timing and Location Error (±3hr)

<table>
<thead>
<tr>
<th>Time of Onset</th>
<th>POD</th>
<th>FARatio</th>
<th>Timing (min)</th>
<th>Location (nmi)</th>
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<td>MOC</td>
<td>NDFD</td>
<td>MOC</td>
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<tr>
<td>2-h</td>
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<td>≤ .15</td>
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<tr>
<td>4-h</td>
<td>0.30</td>
<td>≥ .80</td>
<td>0.65</td>
<td>≤ .20</td>
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<tr>
<td>6-h</td>
<td>0.28</td>
<td>≥ .75</td>
<td>0.65</td>
<td>≤ .25</td>
</tr>
<tr>
<td>8-h</td>
<td>0.26</td>
<td>≥ .75</td>
<td>0.66</td>
<td>≤ .30</td>
</tr>
</tbody>
</table>

## Skill with 10% coverage threshold and ±1hr temporal precision; Timing and Location error (any association)

<table>
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<td>8-h</td>
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<td>≤ .30</td>
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</tbody>
</table>

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1 November 2012

Friends and Partners of Aviation Weather
Highlights

• Measure performance for FAA/NWS requirements using *lead-time* to onset and cessation and *displacement* for terminal and en-route operations

• New user-specific techniques are developed to measure the performance – Flow Constraint Index
  – Onset/cessation of ‘events’
  – Displacement of ‘event’
  – Blockages to jetways

• Continuous measurements are recorded and provided to FAA/NWS
Future Efforts

• Extend the jetway mechanics to include:
  – Weighting with respect to operational importance
  – Standardize routes in and out of congested terminal space
    • Standard terminal arrival (STAR)
    • Standard Instrument Departure (SID)

• Deliver an automated web-based tool for tracking the quality of forecasts in the terminal and en-route space
QUESTIONS