FORECAST IMPACT FIQAS QUALITY ASSESSMENT

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

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Motivation

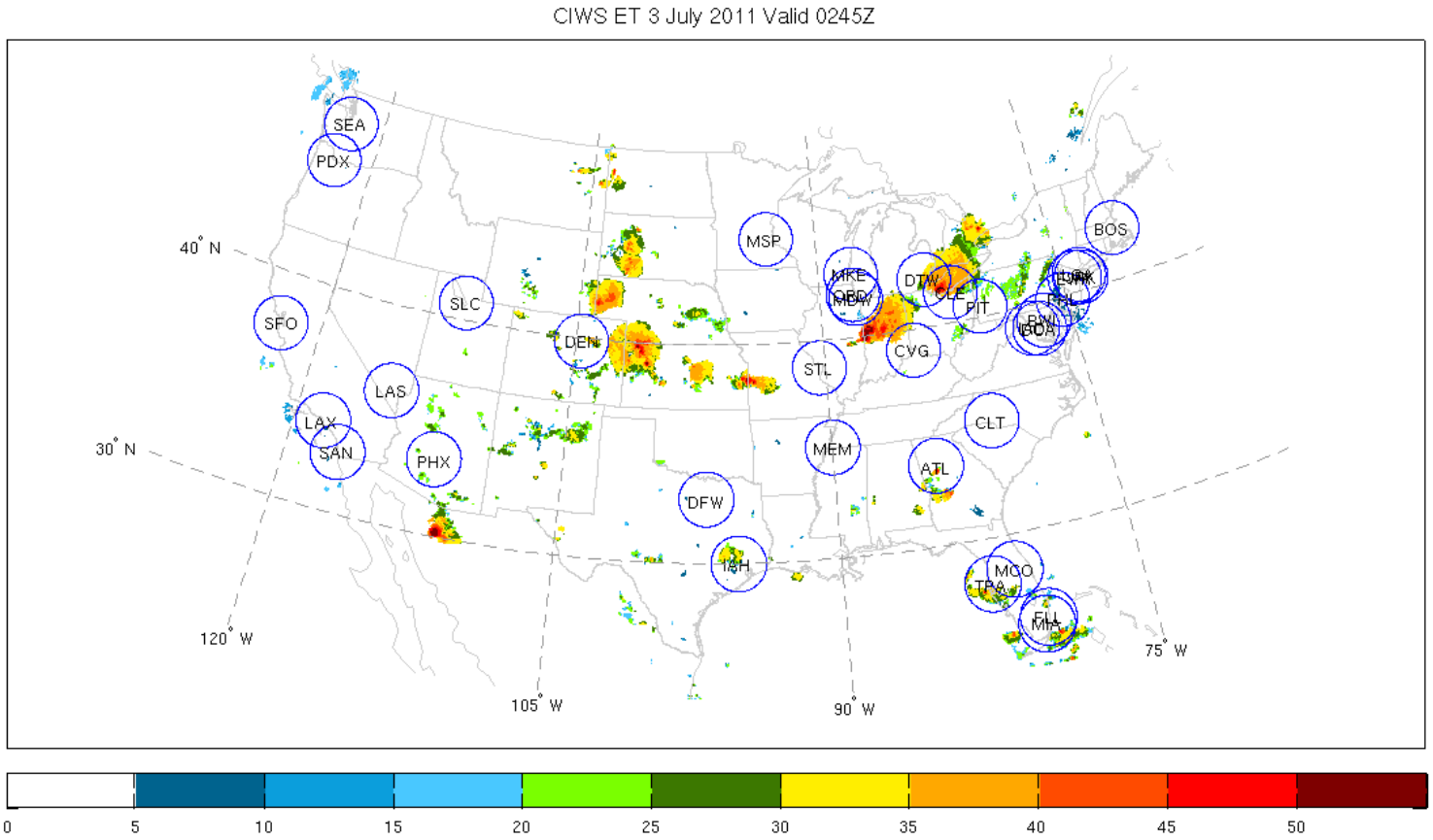
- Assess the quality of weather forecasts used for Traffic Flow Planning
- Support the requirements provided by the FAA and tracked by NWS
- Terminal and En-route domains


TERMINAL

Verification Objective Terminal

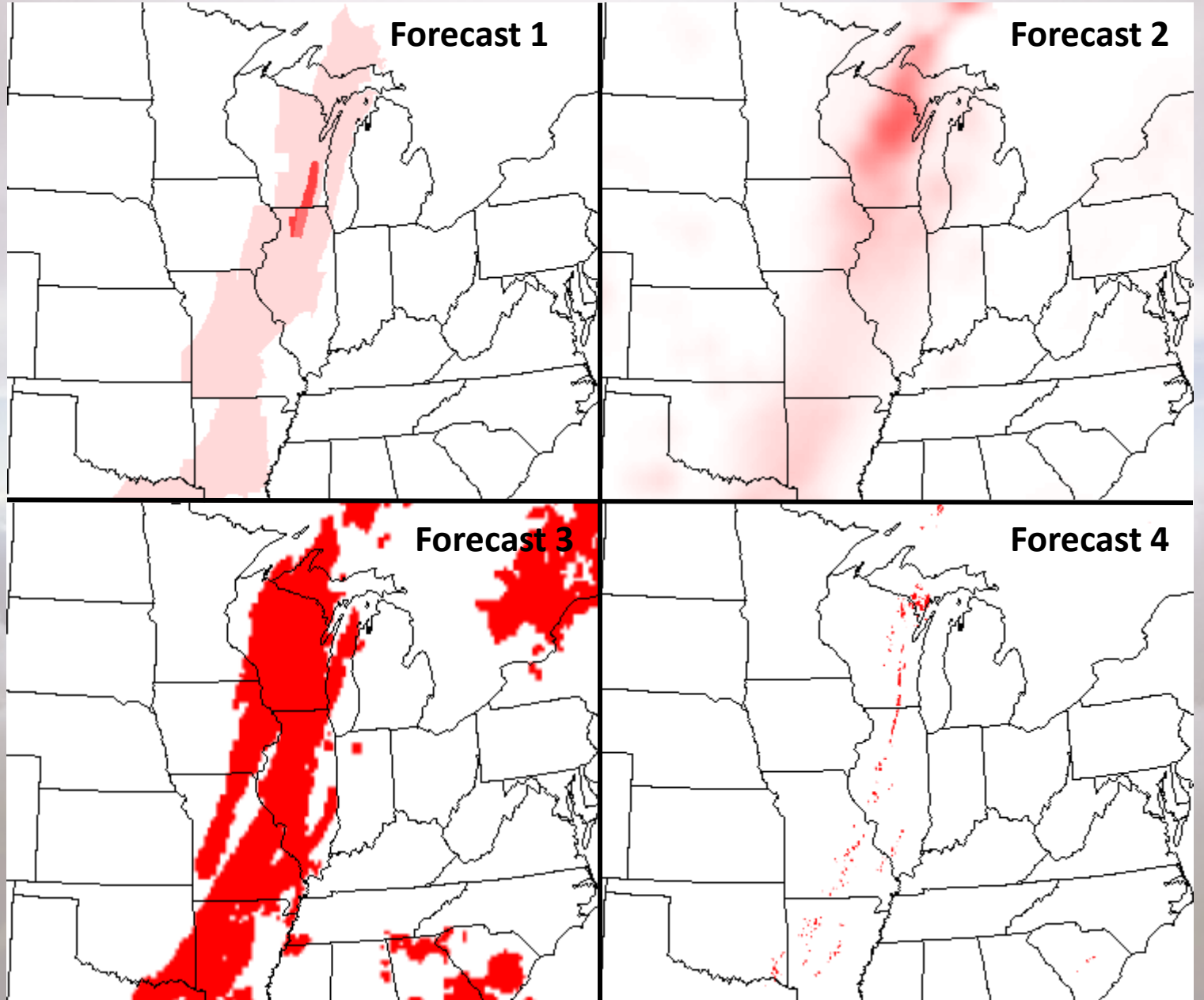
- Operational need
  - Impact of weather on ground delays/ground stops for the 30 core airports
- Impactful weather
  - Thunderstorms with a probability equal to or greater than 50% within 75 nmi of an airport
- Measures
  - Lead-time, timing error, and displacement for onset and cessation of the weather

30 Core Airports



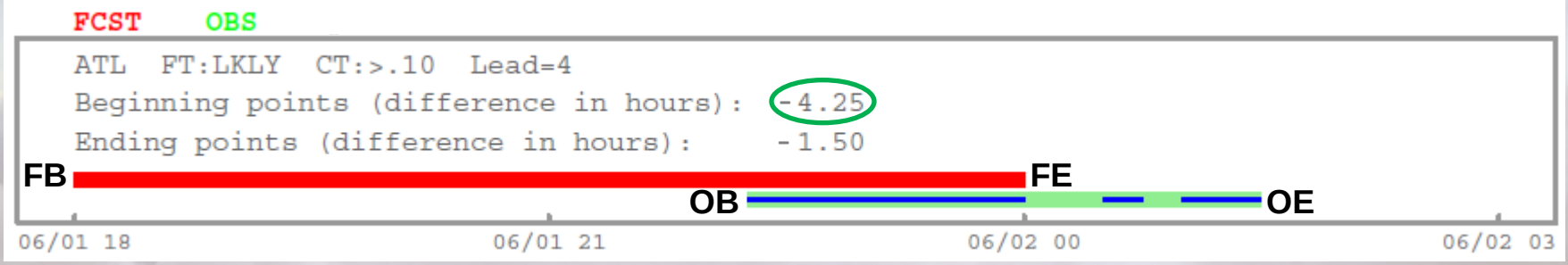
Circles are 75 nmi of 30-core airports. Color are observations

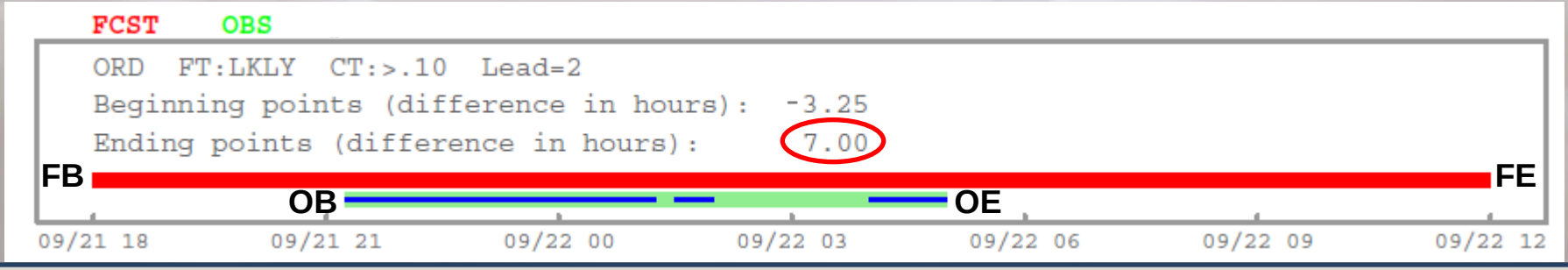
Forecasts Available for TFM Decisions



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)

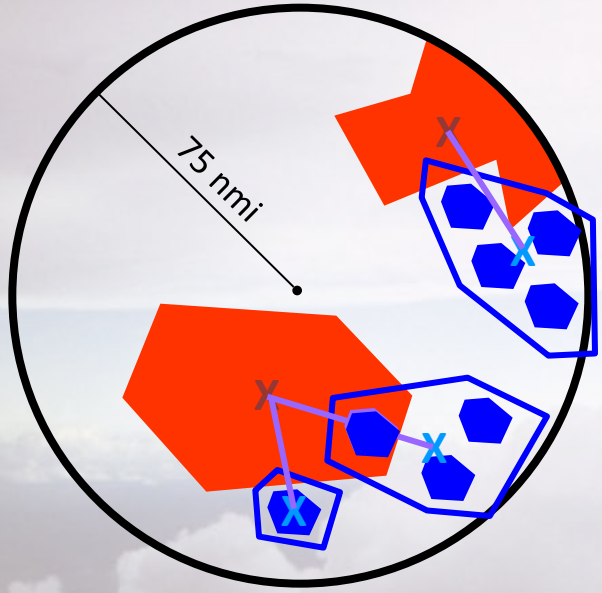




Event Displacement

- 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

Terminal airspace object matching

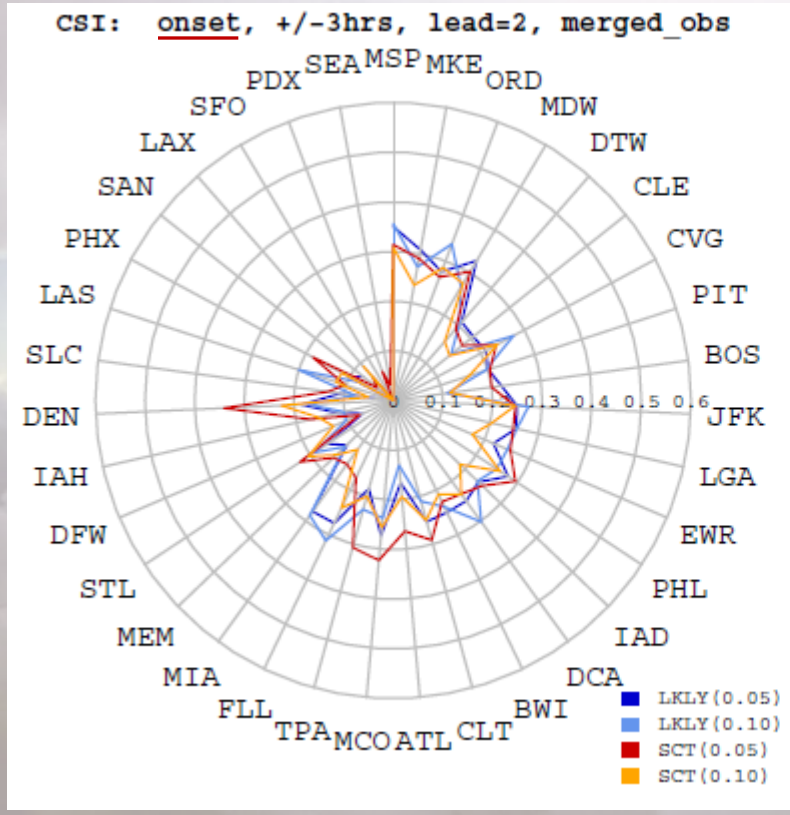


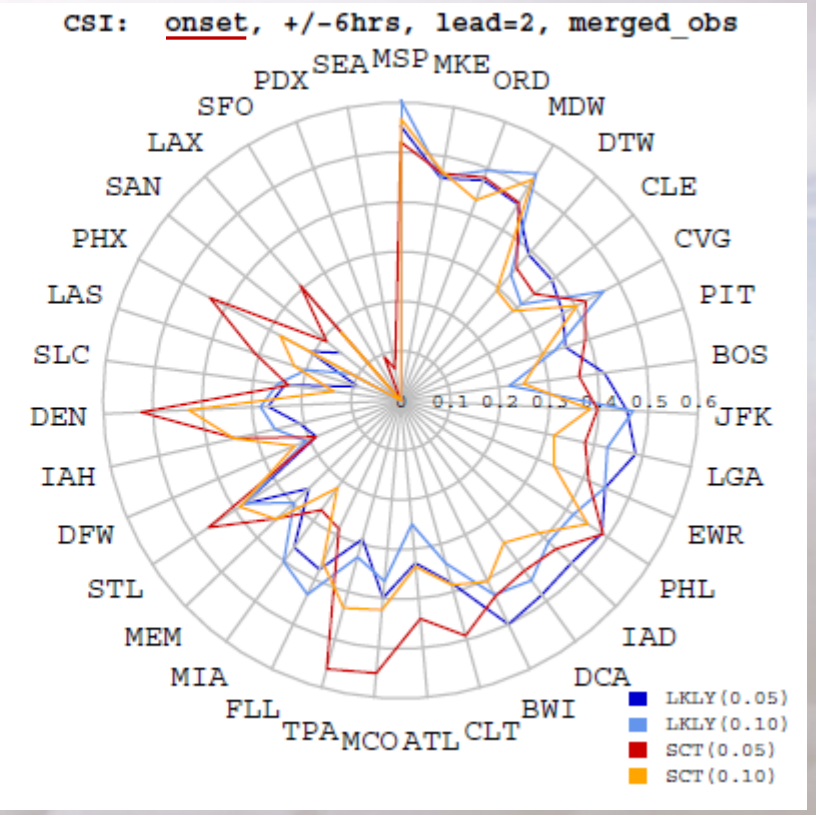
Forecast
CIWS observation
X = Center of mass (CM)
Distance between CMs

Measure Performance

CSI with ±3 and ±6 hour temporal precision*

FCST Lead = 2h





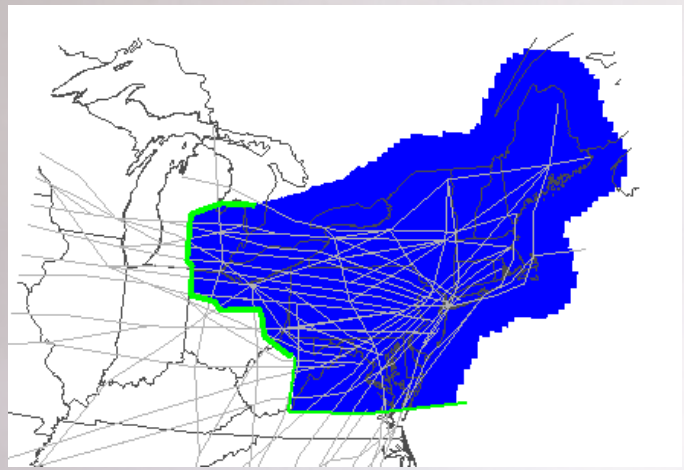
Layne et al. 2013

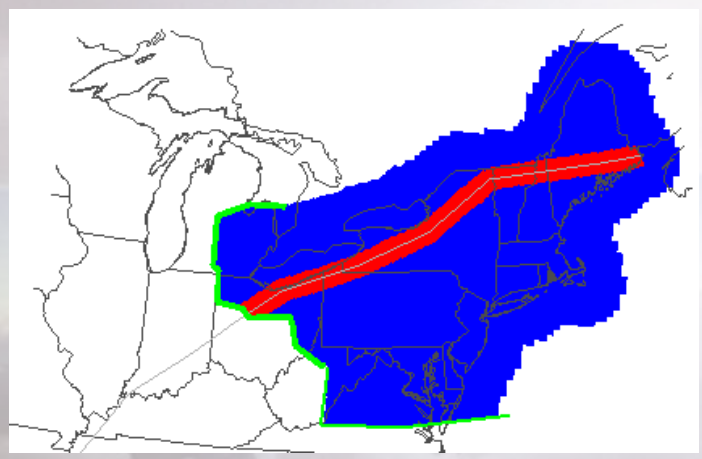
*Critical Success Index

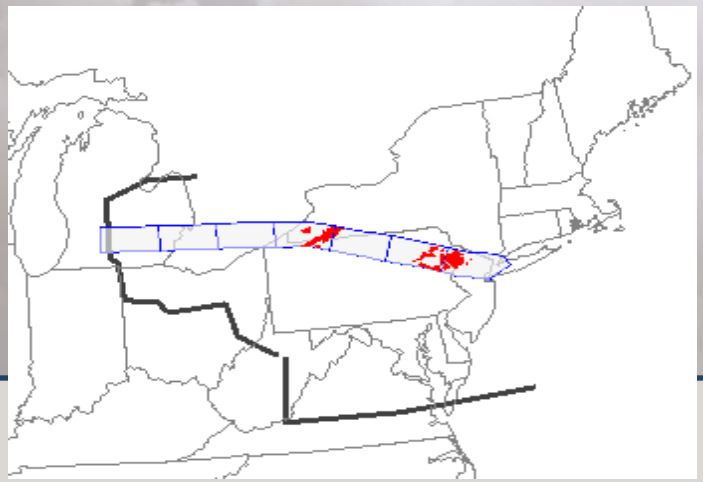
EN-ROUTE

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



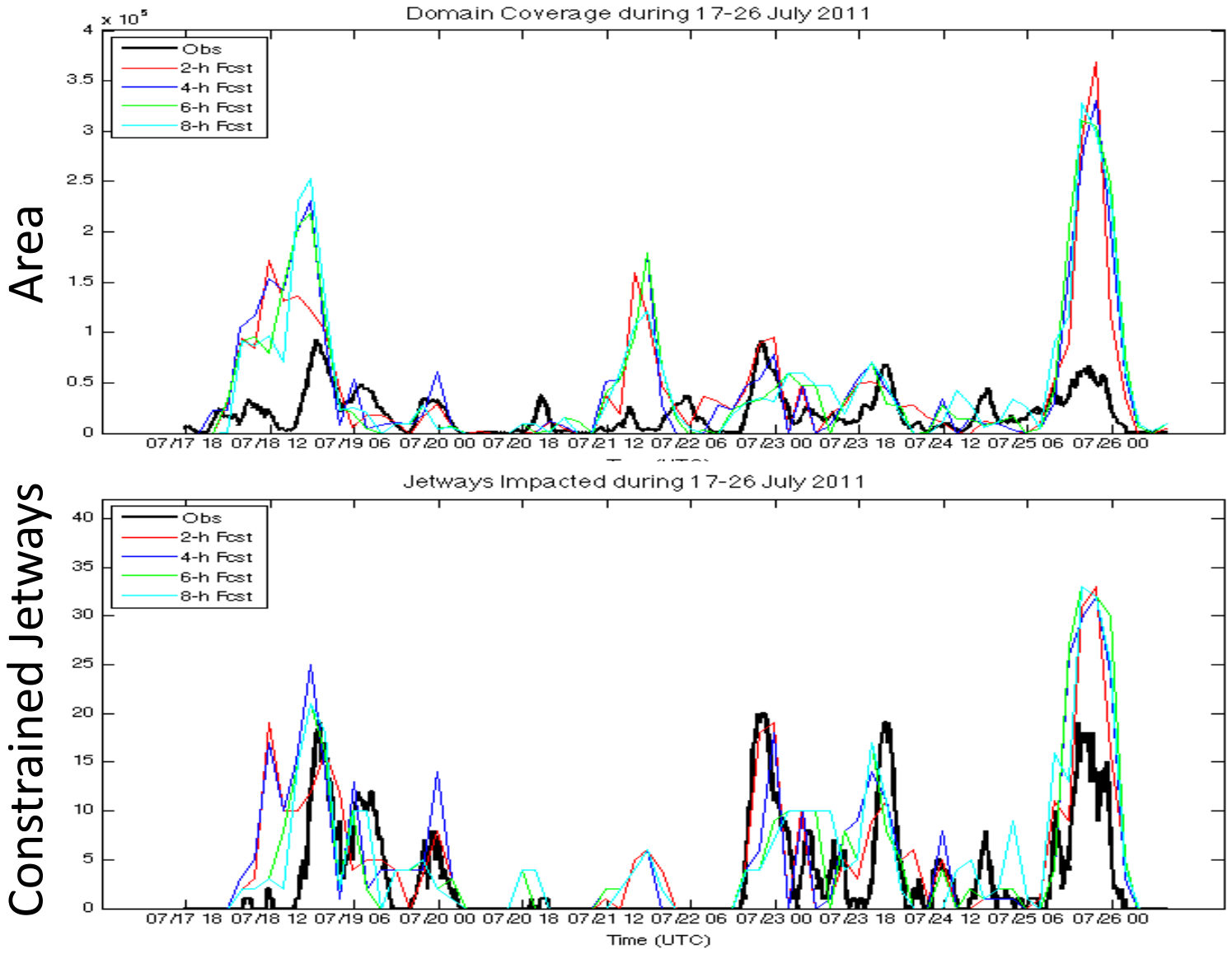




Set Up

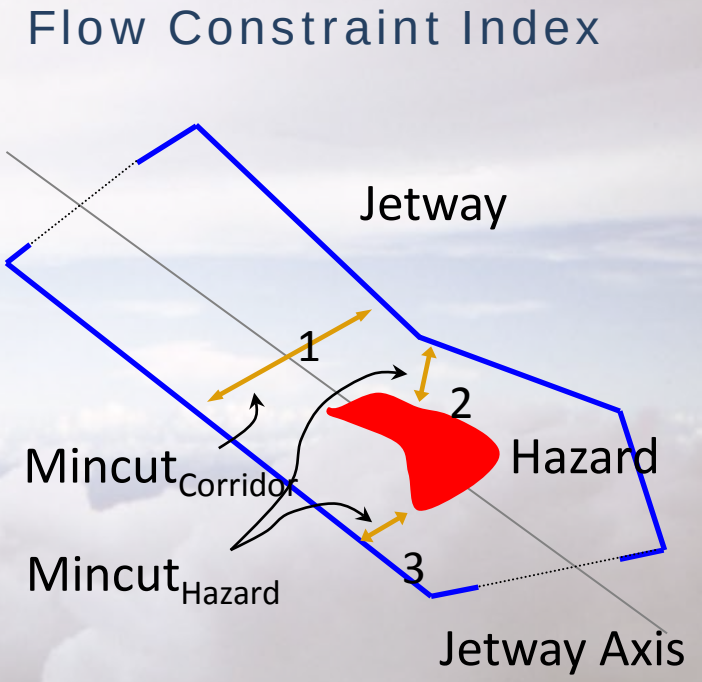
- Jetways in the northeast oriented N-S and E-W
- Apply 20 nmi buffer around jetway for calculation
- Identify thunderstorms echo tops (30,000 ft or greater) that are at least 20 nmi in size that intersect the jetway
- Apply the Flow Constraint Index

Convection and Constrained Jetways

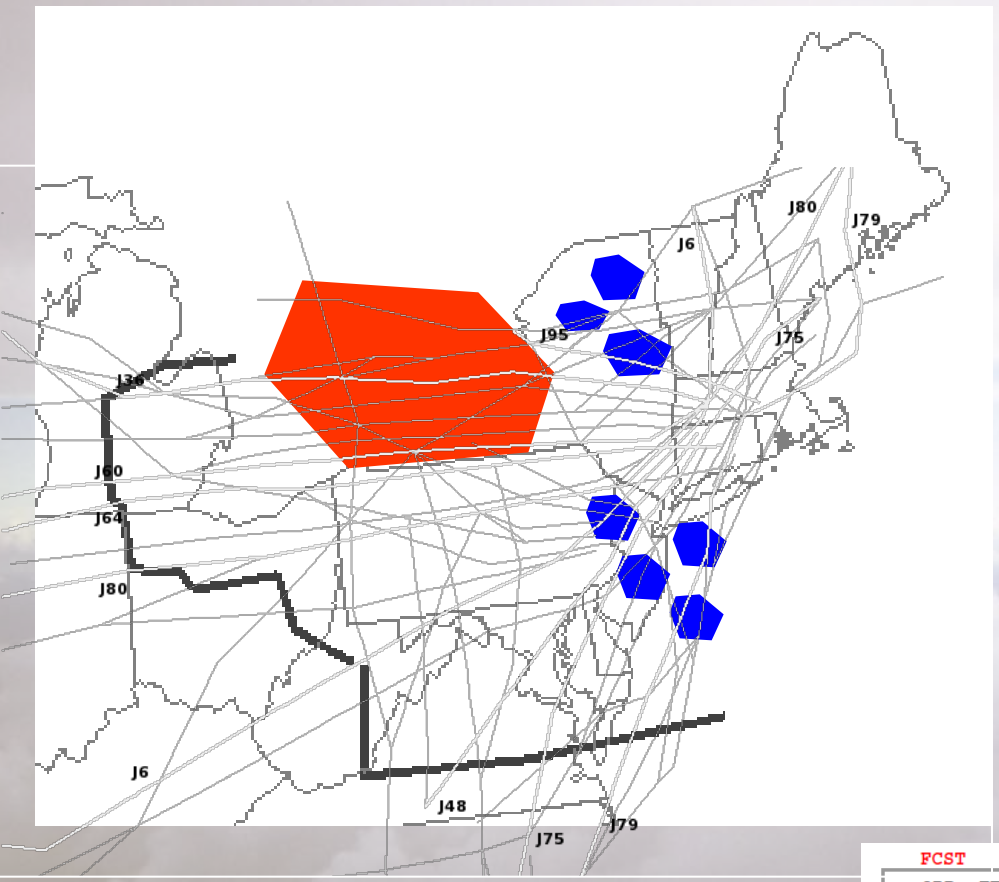


En-route Procedures

- 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

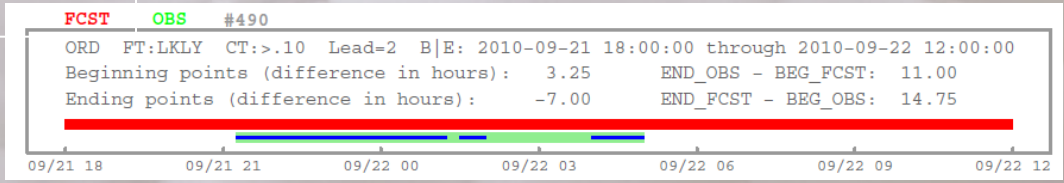


Lead Time

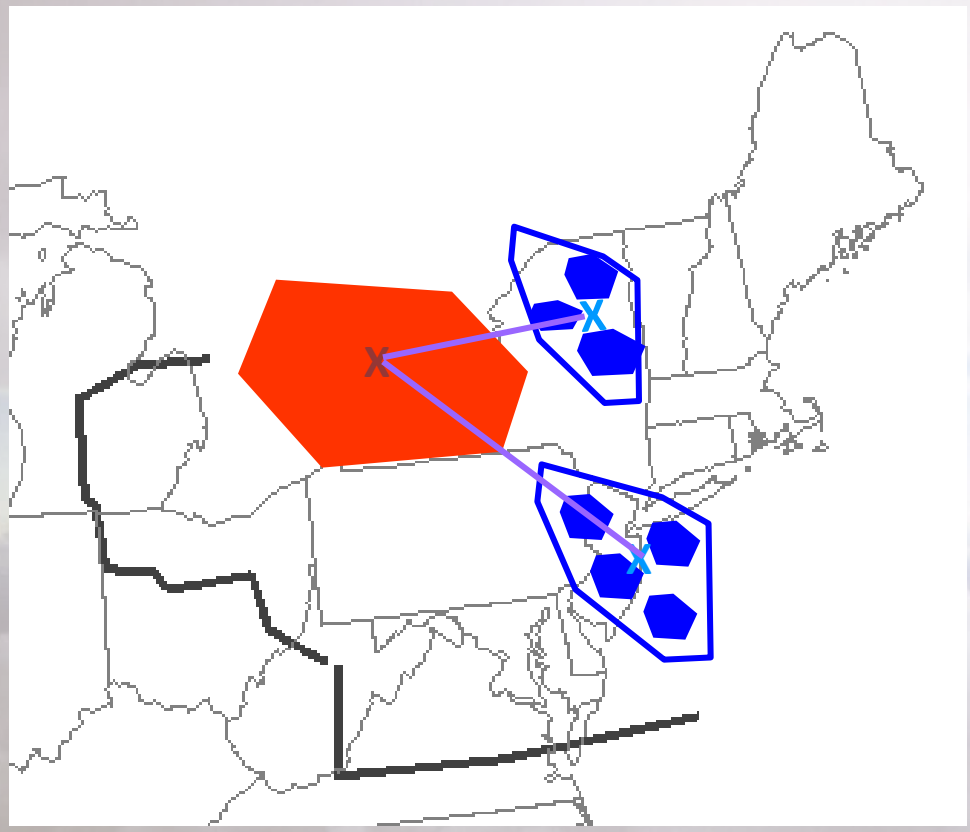


- Difference between time of observed event onset (cessation) and the forecast event onset (cessation)
  - Event defined as NE with 10% of jetways constrained

Blue – Observed convection
Red – Forecast convection



Displacement



Blue – Observed convection
Red – Forecast convection

- 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

Forecast Skill

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

			POD		FARatio		Timing (min)		Location (nmi)	
			NDFD	MOC	NDFD	MOC	NDFD	MOC	NDFD	MOC
Thunderstorms for Core Airports with: Probability ≥ LKLY Area Diameter ≤ 150 nmi	Time of Onset	2-h	*0.34*	≥ .85	*0.61*	≤ .15	*88.80*	± 10 min	*34.16*	≤ 3 nmi
		4-h	*0.30*	≥ .80	*0.65*	≤ .20	*87.60*	± 20 min	*34.98*	≤ 3 nmi
		6-h	*0.28*	≥ .75	*0.65*	≤ .25	*86.40*	± 30 min	*35.43*	≤ 3 nmi
		8-h	*0.26*	≥ .75	*0.66*	≤ .30	*83.40*	± 45 min	*36.45*	≤ 3 nmi
			POD		FARatio		Timing (min)		Location (nmi)	
			NDFD	MOC	NDFD	MOC	NDFD	MOC	NDFD	MOC
	Time of Cessation	2-h	*0.30*	≥ .85	*0.66*	≤ .15	*92.40*	± 10 min	*42.54*	≤ 3 nmi
		4-h	*0.27*	≥ .80	*0.68*	≤ .20	*91.80*	± 20 min	*44.06*	≤ 3 nmi
		6-h	*0.24*	≥ .75	*0.70*	≤ .25	*85.80*	± 30 min	*44.23*	≤ 3 nmi
		8-h	*0.22*	≥ .75	*0.70*	≤ .30	*81.00*	± 45 min	*44.42*	≤ 3 nmi

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

			POD		FARatio		Timing (min)		Location (nmi)	
			NDFD	MOC	NDFD	MOC	NDFD	MOC	NDFD	MOC
Thunderstorms for Core Airports with: Probability ≥ LKLY Area Diameter ≤ 150 nmi	Time of Onset	2-h	*0.13*	≥ .85	*0.85*	≤ .15	*277.20*	± 10 min	*39.63*	≤ 3 nmi
		4-h	*0.12*	≥ .80	*0.86*	≤ .20	*302.40*	± 20 min	*40.06*	≤ 3 nmi
		6-h	*0.12*	≥ .75	*0.86*	≤ .25	*308.40*	± 30 min	*41.32*	≤ 3 nmi
		8-h	*0.11*	≥ .75	*0.85*	≤ .30	*313.80*	± 45 min	*41.37*	≤ 3 nmi
			POD		FARatio		Timing (min)		Location (nmi)	
			NDFD	MOC	NDFD	MOC	NDFD	MOC	NDFD	MOC
	Time of Cessation	2-h	*0.11*	≥ .85	*0.87*	≤ .15	*335.40*	± 10 min	*42.10*	≤ 3 nmi
		4-h	*0.11*	≥ .80	*0.88*	≤ .20	*354.60*	± 20 min	*43.74*	≤ 3 nmi
		6-h	*0.11*	≥ .75	*0.87*	≤ .25	*378.60*	± 30 min	*44.35*	≤ 3 nmi
		8-h	*0.10*	≥ .75	*0.86*	≤ .30	*379.80*	± 45 min	*45.34*	≤ 3 nmi

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