Data-driven evaluation of a flight re-route air traffic management decision-support tool*

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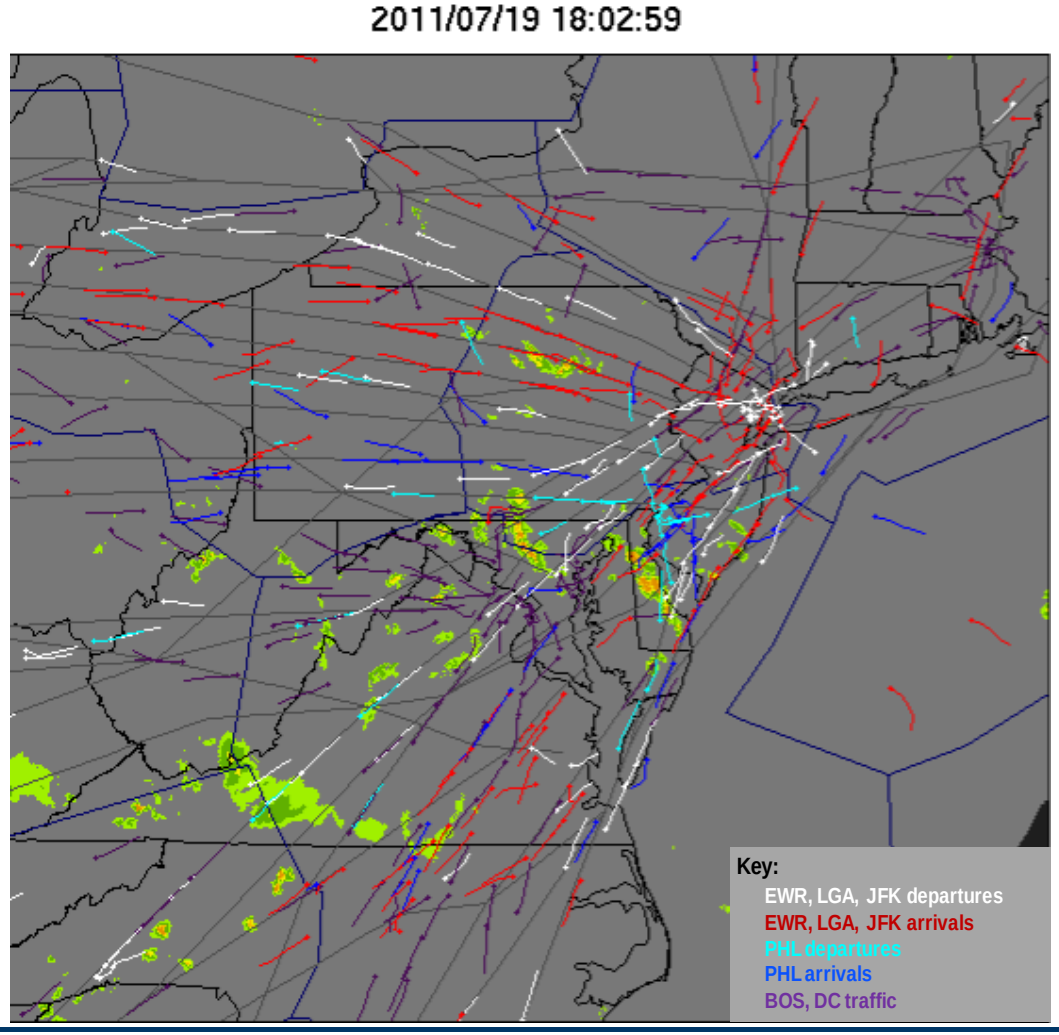
Departure re-route reasons

New York City area air traffic

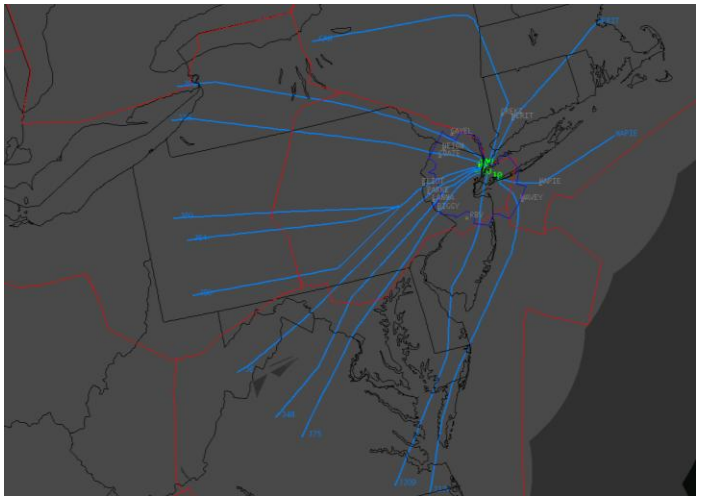


NYC-area airspace

- Complex, multiple airports
- Congested, causes ¾ of U.S. air traffic delays

Weather

- 70% of delays due to weather, often with thunderstorms
- Thunderstorms are unpredictable and have recently increased



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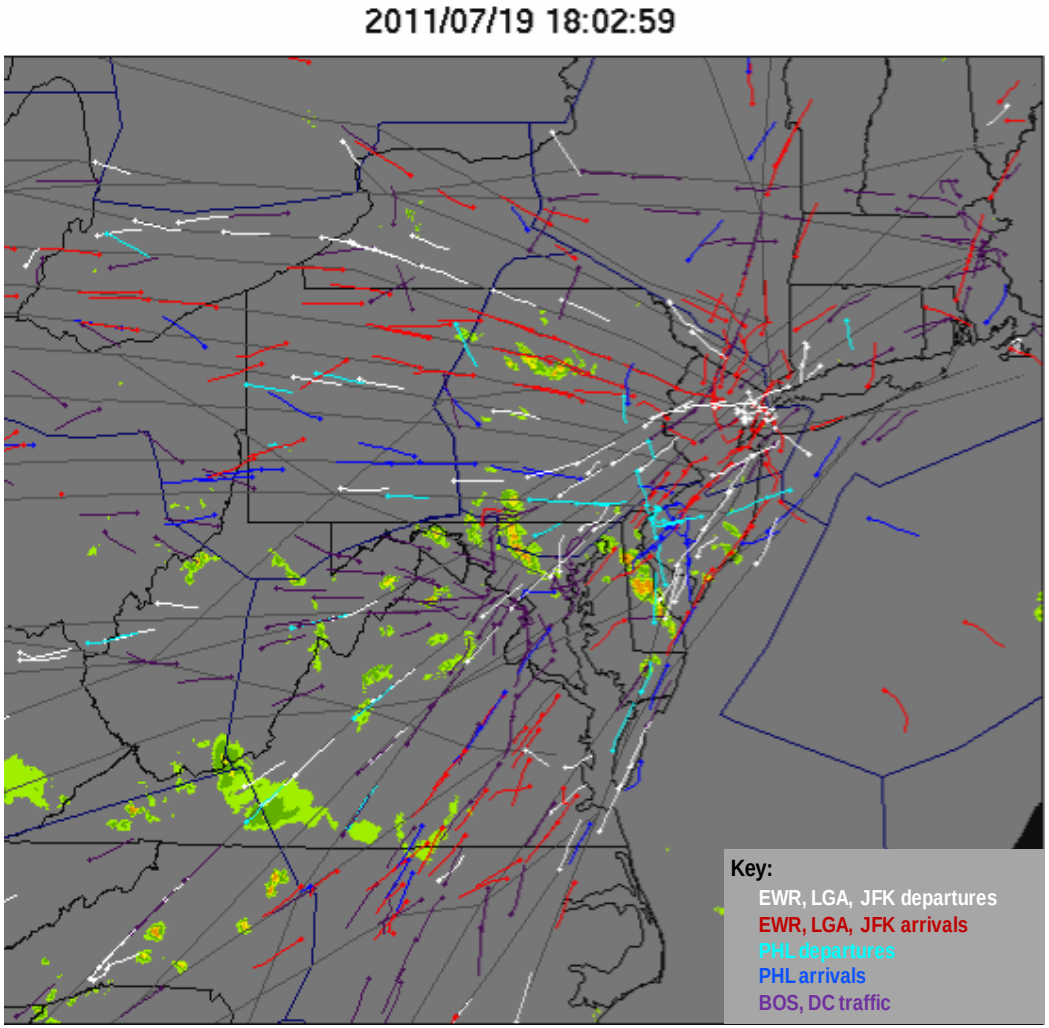

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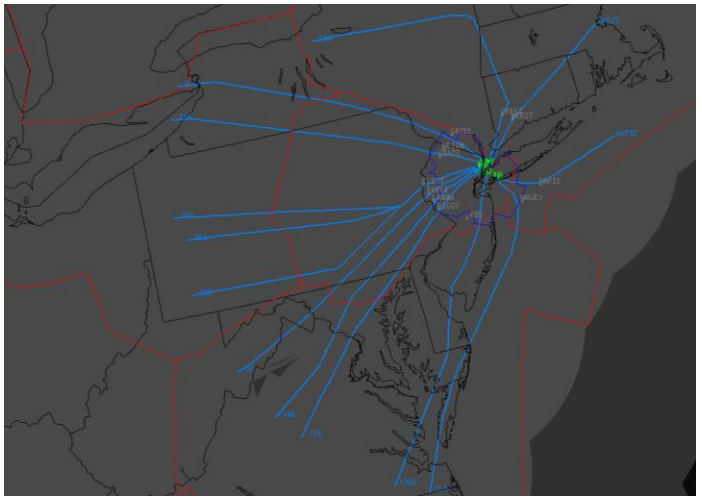
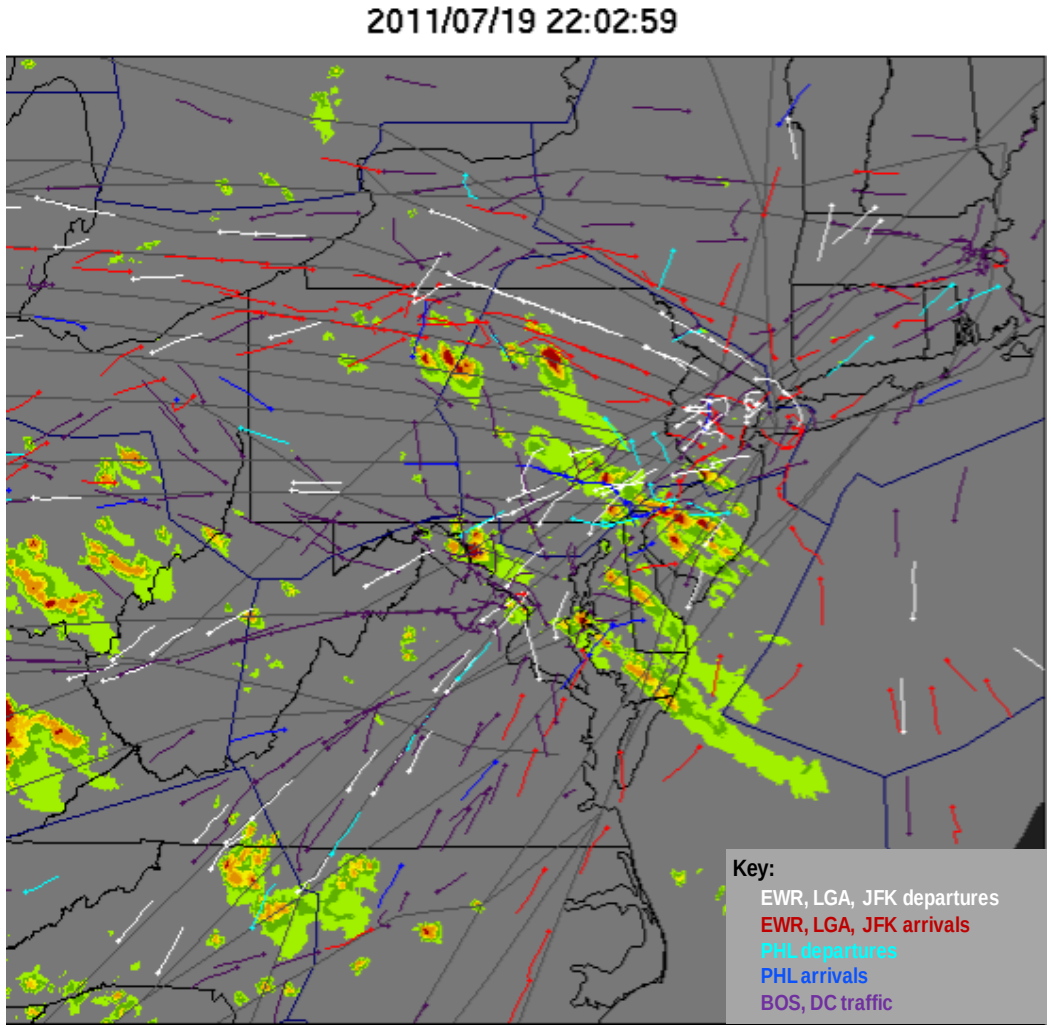


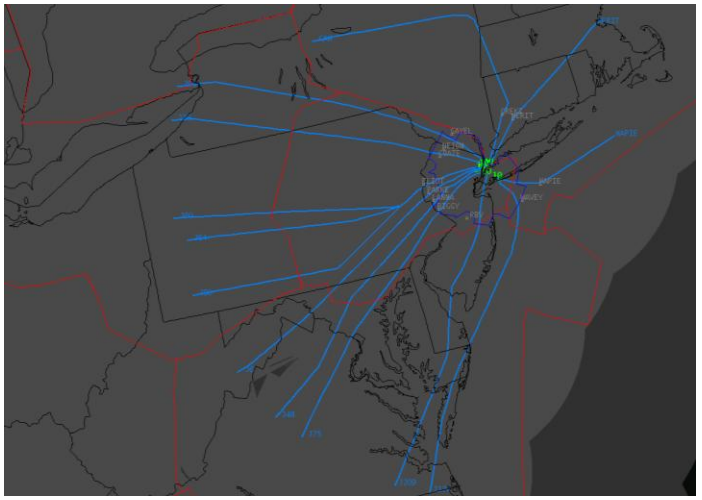
Departure re-route considerations

New York City area air traffic



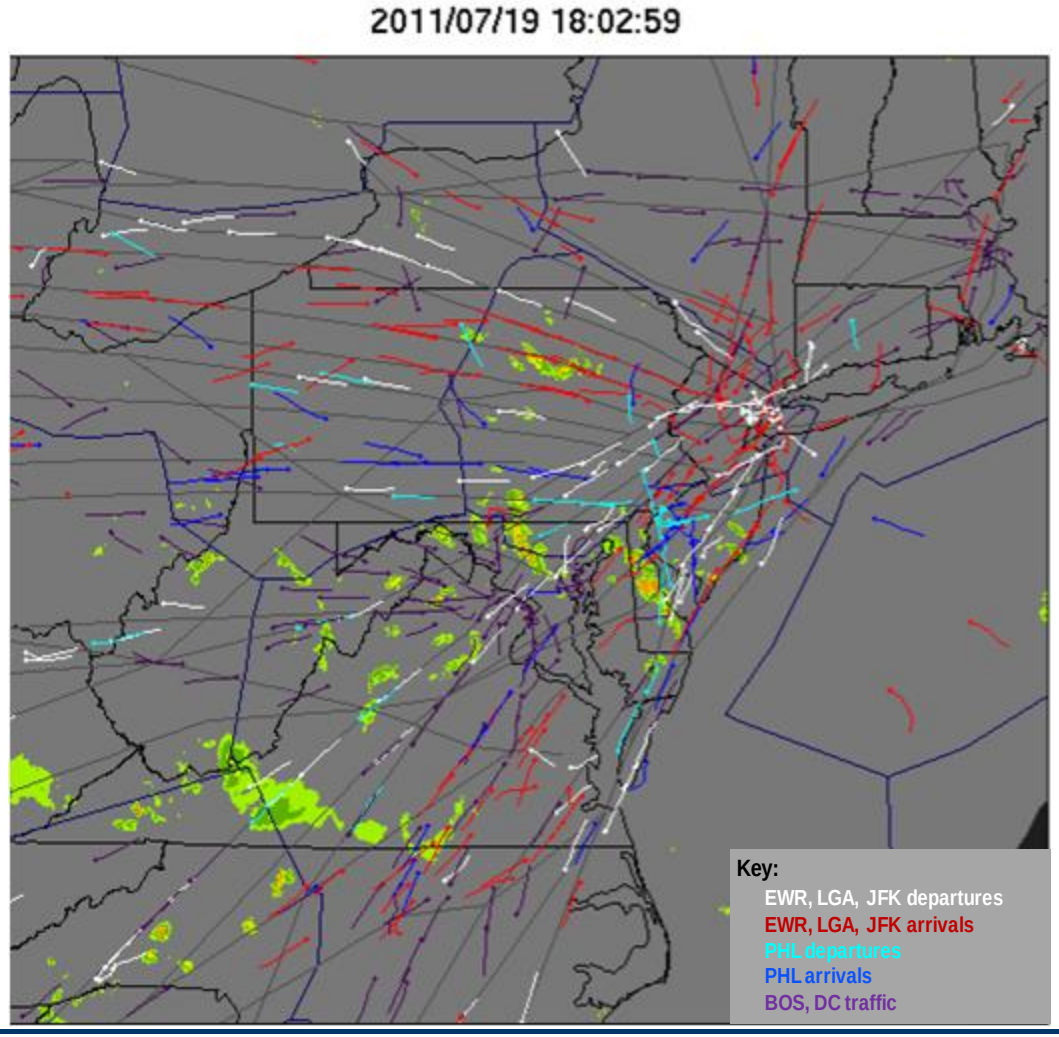
Decisions include

- Demand vs. capacity
- Forecast weather locations and impacts
- Coordination of flight changes



Underlying decision support tools

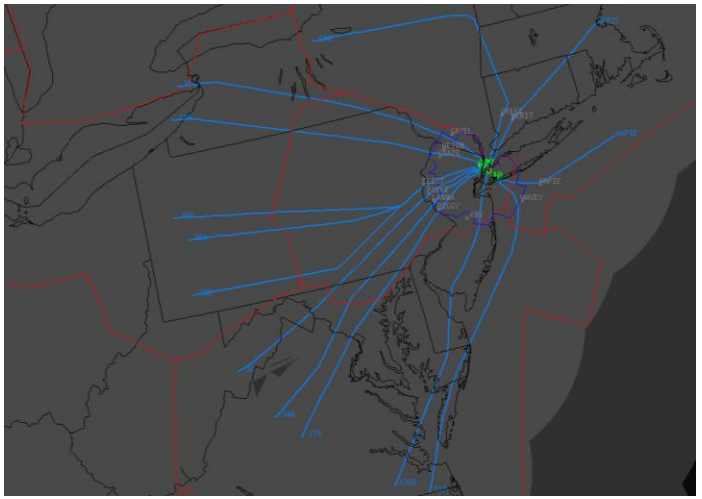
New York City area air traffic



Weather forecast tools

- Geospatial forecast (CIWS*)
- Departure routes (RAPT**)
  - 30-minute forecast, 5-minute bins

Route	Trend	PIG	1730	1735	1740	1745	1750	1755	1800
N90 HAPIE	—								
N90 MERIT	—								
N90 GREKI CAM	—								
N90 GAYEL J95	—								
N90 COATE J36	—								
N90 PARKE J6	—								
N90 LANNA J48	—								
N90 BIGGY J75	—								
N90 WHITE J209	—								
N90 WAVEY J174	—								



*CIWS = Corridor Integrated Weather System
**RAPT = Route Availability Planning Tool

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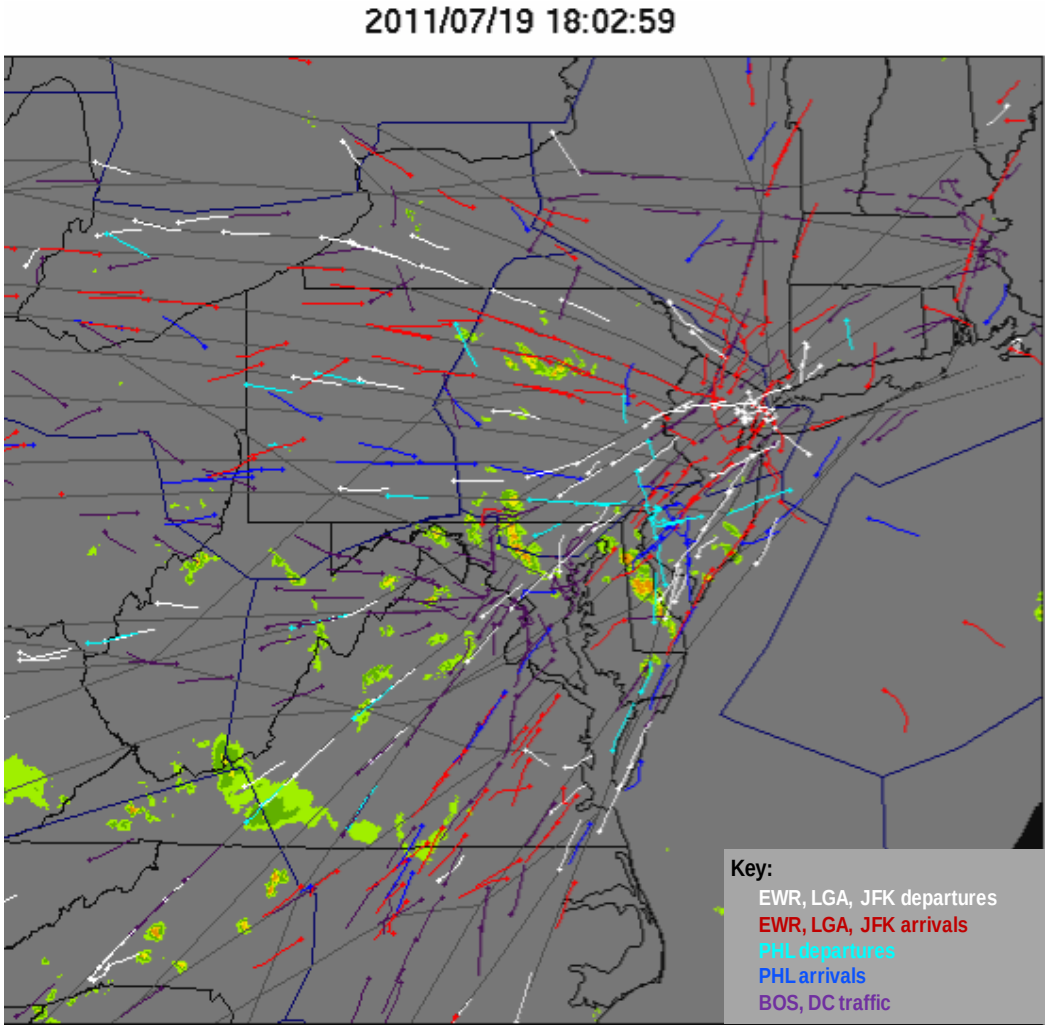

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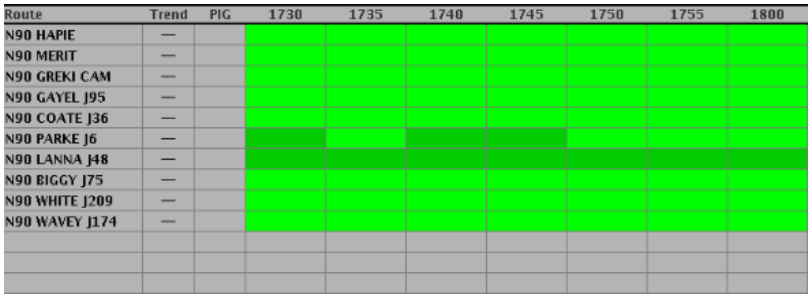

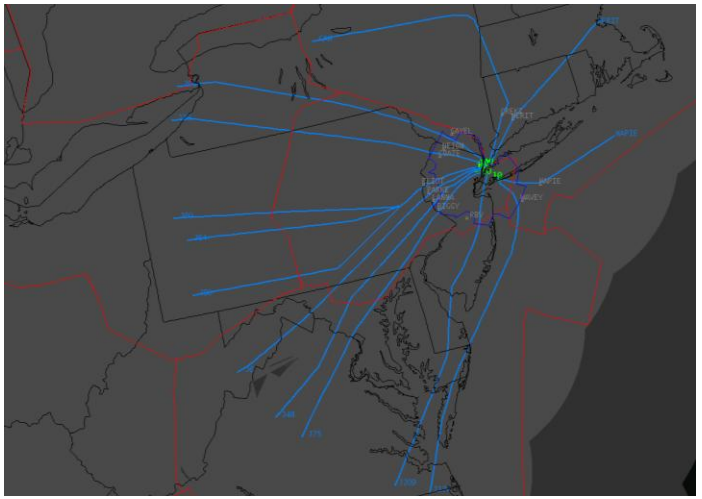

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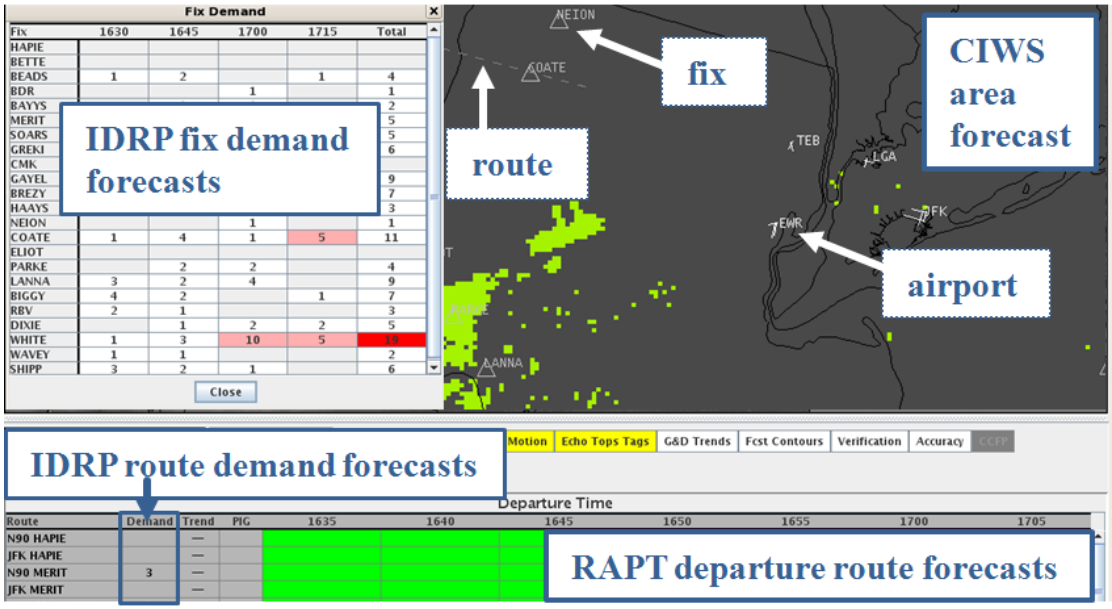
Departure re-route decision-support tools

Integrated Departure Route Planning (IDRP) Tool



Capabilities

1. Integrated with CIWS and RAPT.
2. 30-minute demand forecast per departure route
3. 60-minute demand forecasts and congestion alerts per departure fix, in 15-minute bins

Not shown: flight list and re-route alternatives list.

Prototype jointly developed by MIT Lincoln Laboratory and MITRE.

Forecast calculations updated every minute. Wheels-off predictions use filed flight plans (ASPM) and radar-based surface (ASDE-X) locations.

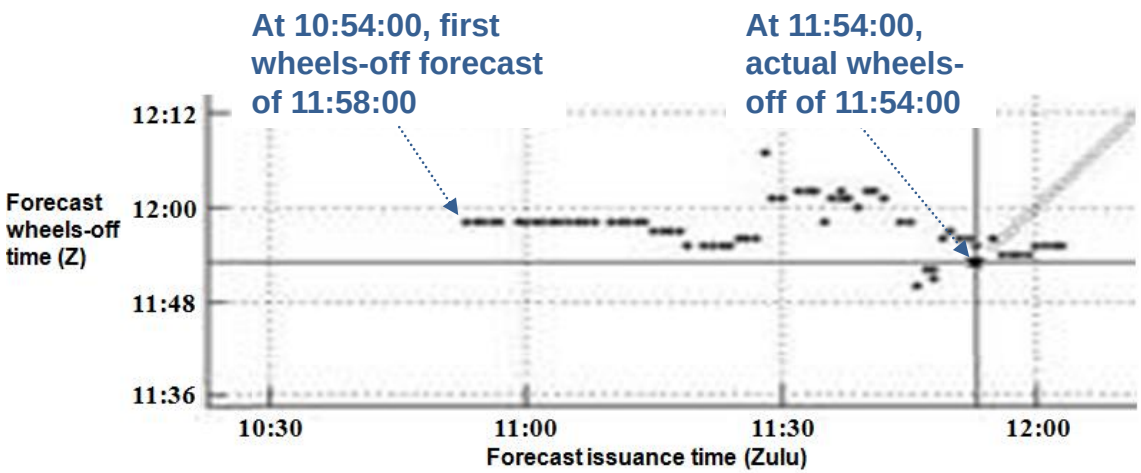
ASPM = Aviation System Performance Metrics
ASDE-X= Airport Surveillance Detection Equipment, Model X

Tool evaluation plan

- **Summer 2011, deployed to 12 locations involved in NYC-area air traffic**
- **Data analyses for 2 fair and 10 convective weather days at 5 high-volume NYC-area airports:**

  Newark, LaGuardia, JFK, Teterboro, White Plains
- **Data mined from IDRP (predictions), ASPM* (actual departure times)**

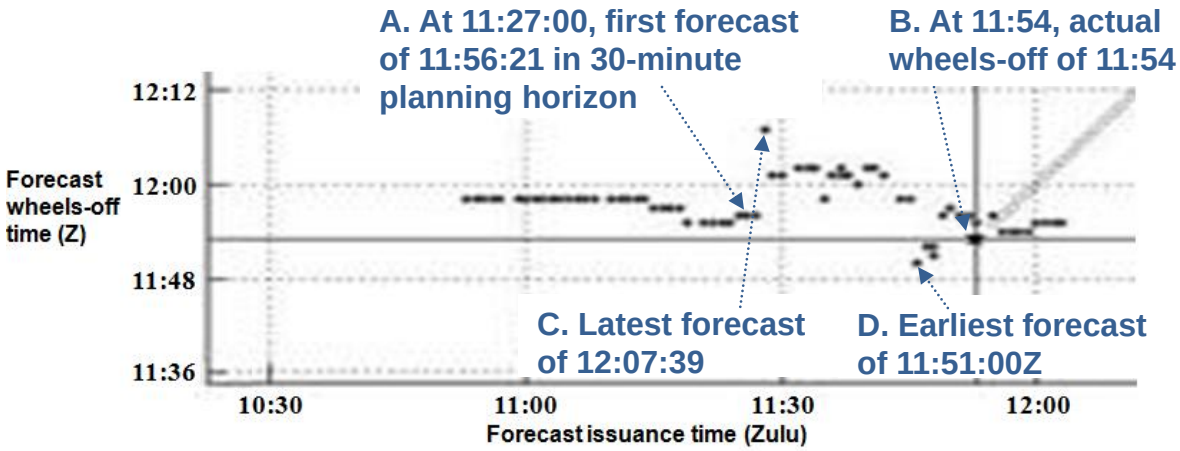
Example flight forecast issuances



*ASPM = Aviation System Performance Metrics

Tool evaluation – 3 system metrics

Predicted wheels-off forecasts* within 30-minute planning horizon



Predicted wheels-off error (accuracy)

Metric 1. error = actual wheels-off time (B) – predicted wheels-off time (A)

Predicted wheels-off spread (reliability)

Metric 2. spread = latest pred. wheels-off time (C) – earliest pred. wheels-off time (D)

Hourly predicted fix demand spread (24 fixes, in 15-minute bins)

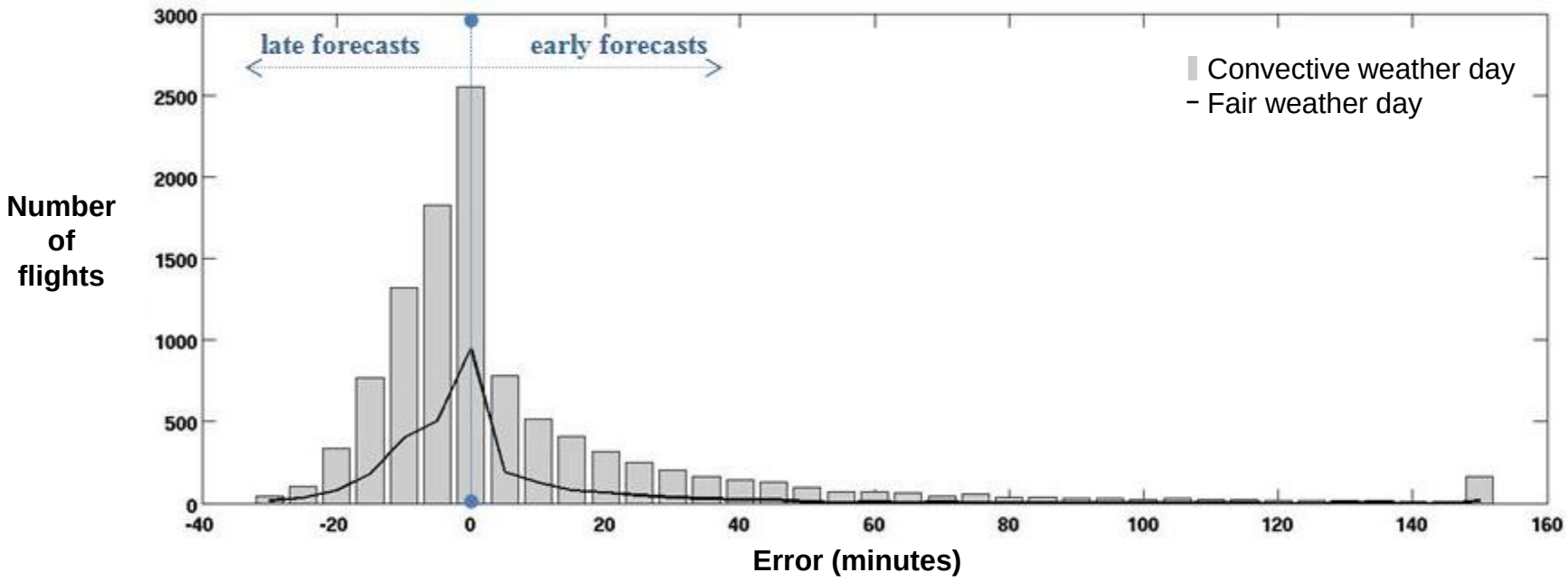
Metric 3. fix spread = largest – smallest total hourly fix demand

* Flights must have ASPM and must not have been rerouted

Results – Predicted wheels-off error

Over 15,000 departure flights included:

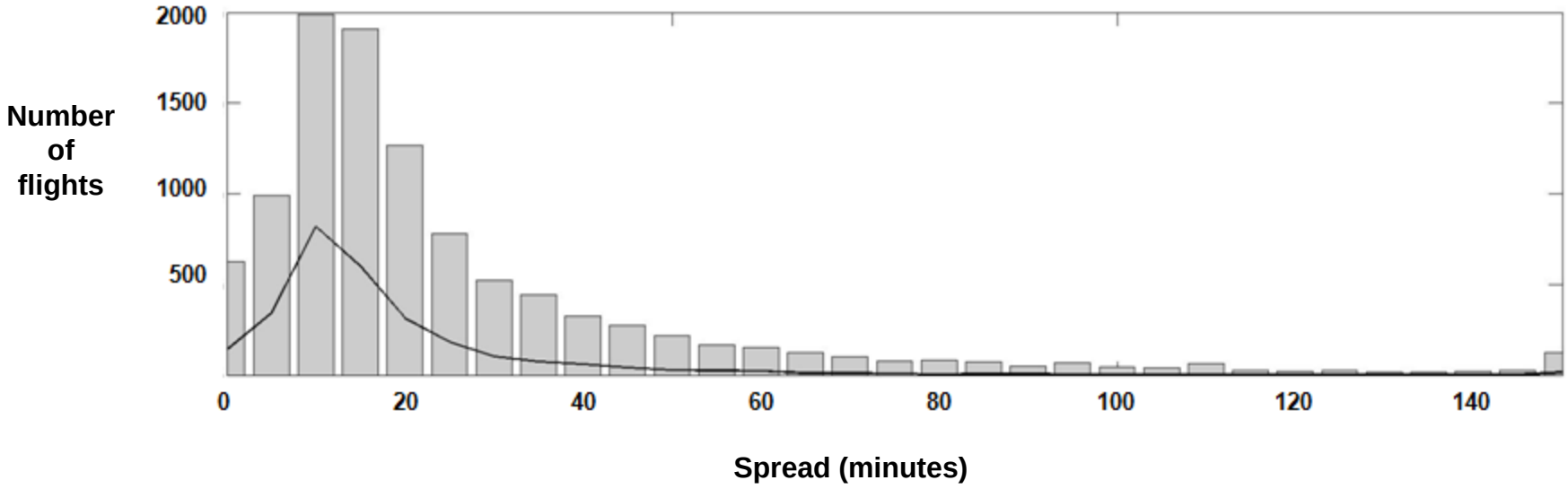
- Median error was near zero minutes for fair and convective weather days.
- Half of prediction errors fell within -10 to 12 minutes for convective days*, and -10 to 5 minutes for fair days.
- Highest 10% of prediction errors ranged from 30 to 50 minutes on convective days** and 15 to 18 minutes on fair days.



*Except for August 25, when the upper bound reached 20 minutes.
**Except for August 25, when the upper bound reached 70 minutes.

Results – predicted wheels-off spread

- Forecast spread 20 minutes or less for most flights on fair and convective days.
- Convective days have a long tail to the distribution and some flights with spreads in excess of 30 minutes.
- Highest 10% of forecast spreads ranged from 50 to 70 minutes on convective days* and 34 to 38 minutes on fair days.

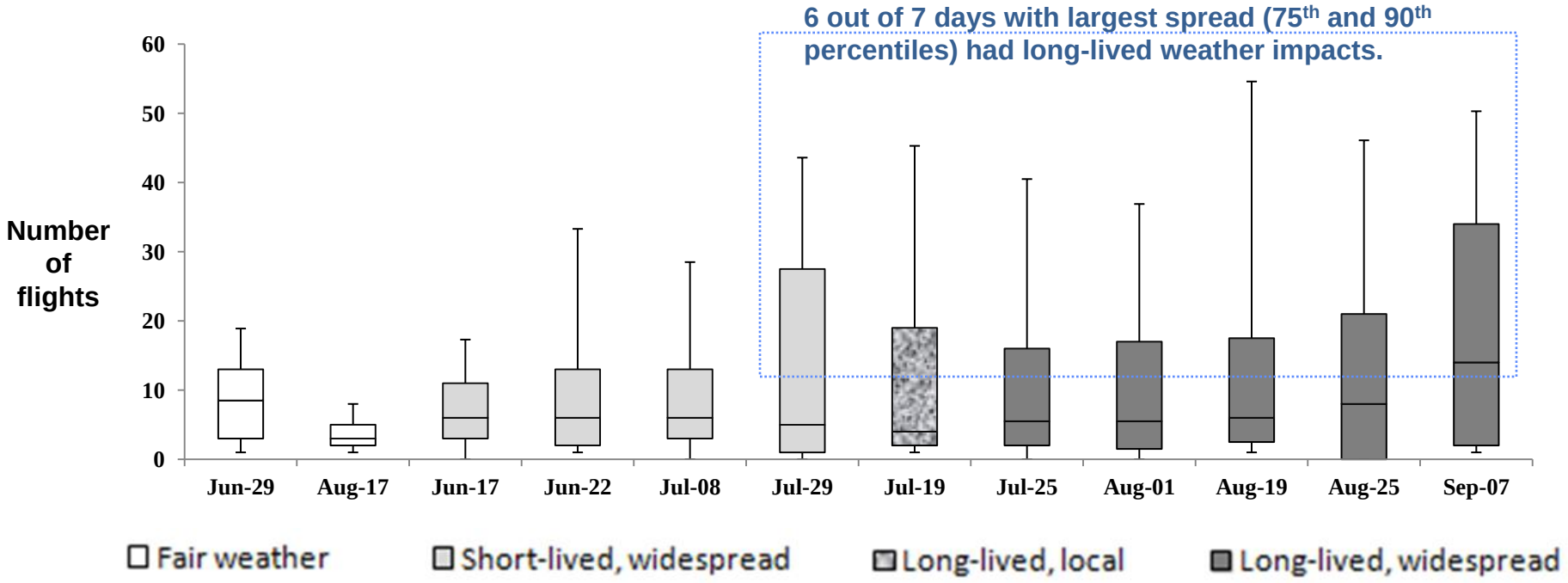


*Except for August 25, when the upper bound reached 90 minutes.

Results – predicted hourly fix demand

Hourly fix demand spread by day, grouped by weather:

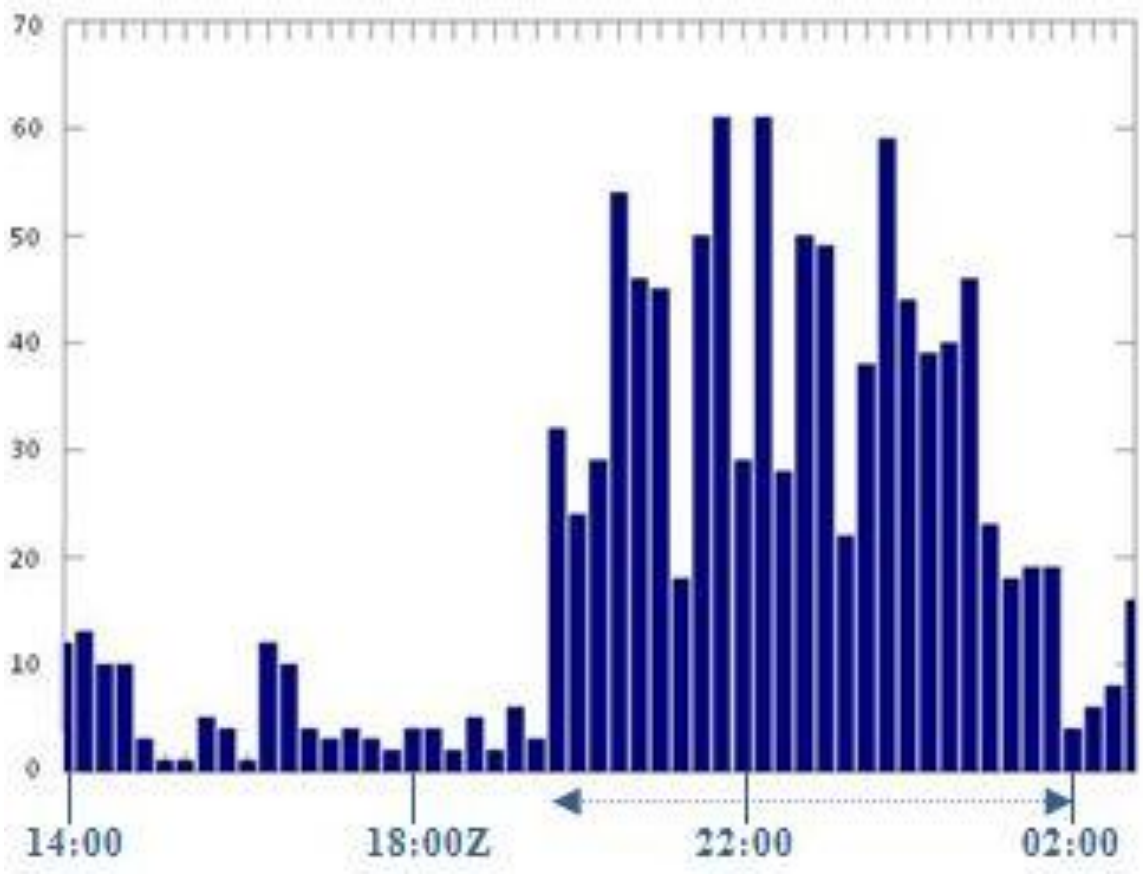
- Predicted fix demand spread was 9 flights or less for half the flights*.
- The spread was 19 flights or less for 75% of departures on convective days**.
- Highest 10% spread ranged from 17 to 55 flights on convective days, and 8 to 19 flights on fair days.



*Except for September 7, when the spread reached 14 flights.
**Except for July 29 and September 7, each having 28 and 34 flights.

Results – fix demand example day

July 19th, long-lived, local weather impacts, forecast demand spread in 15-minute bins.



Discussion/Conclusions

1. **Forecasts were overall less accurate and reliable on convective weather days:**
   a. **Wheels-off error had late predictions for over 25% of flights**
   b. **Wheels-off spread was 30+ minutes, which is greater than the planning horizon**
   c. **Hourly fix demand spread was highest on days with long-lived weather impacts**

2. **Forecast uncertainty may influence tool usage and air traffic management decisions**
   a. **Possible disuse (under utilization), or misuse (overreliance) of tool**
   b. **System may cause over-control, paralysis, or poor decisions**

3. **Predicted wheels off calculations need improvements to reduce error and volatility**

Thank you

Questions?