Flexibility and Predictability in Management of Convective Weather Impacts on the NAS

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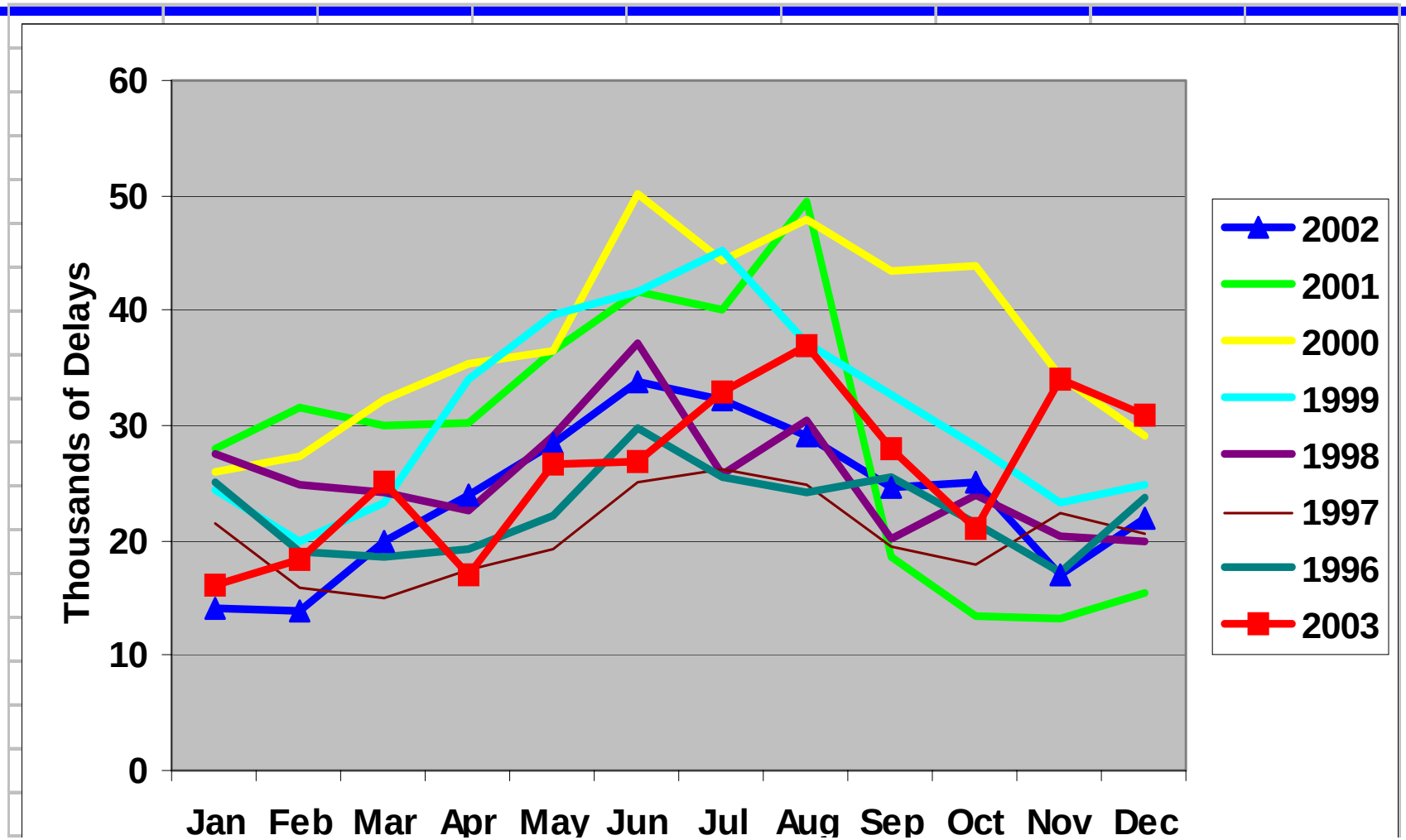
Outline

- Why do we care?
  - Delays
  - Metrics implications
- Overall FAA/airline weather impact mitigation process
  - Ability to predict weather impact with sufficient lead time is poor
- Insights from the CIWS benefits assessment
- How can we achieve a higher degree of predictability through increasing flexibility in ATM during adverse weather
- Metrics and system design implications

Why of Interest and Concern

- Airlines seek to reliably and economically deliver the desired product
  - Predictability is essential to airline network design and operation
  - Want flexibility to make adjustments to address problems and handle flight specific issues (e.g., high value connections)
  - Use of off ATC-preferred routes as a key flexibility index
- Initiatives underway to improve information transfer and navigation capability seek to provide a more predictable system for scheduling and increase flexibility
  - But predictability and flexibility are very hard to achieve when major capacity losses occur “randomly”
- Need to improve system design and develop better metrics capabilities

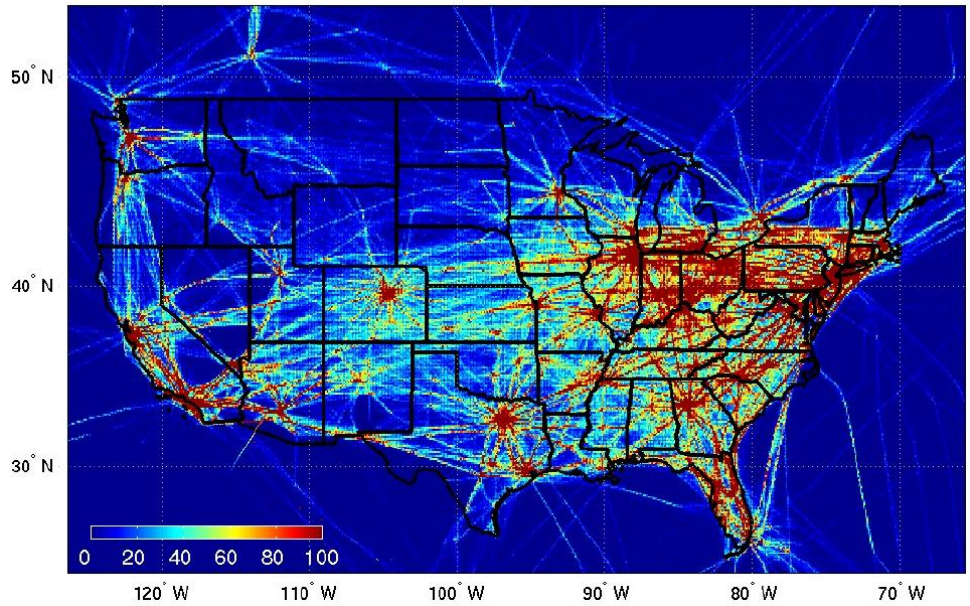
Trends in Aviation Delays



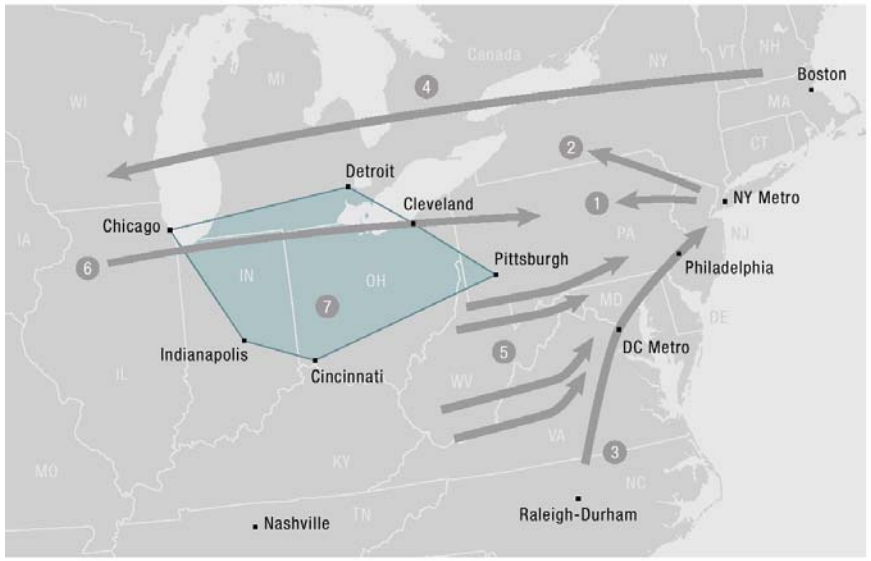
- **Peak delays** – summer thunderstorms → Delay reduction as metric

Air Traffic Congestion

Air Traffic 09/12/02 1000 UTC – 09/13/02 1000 UTC



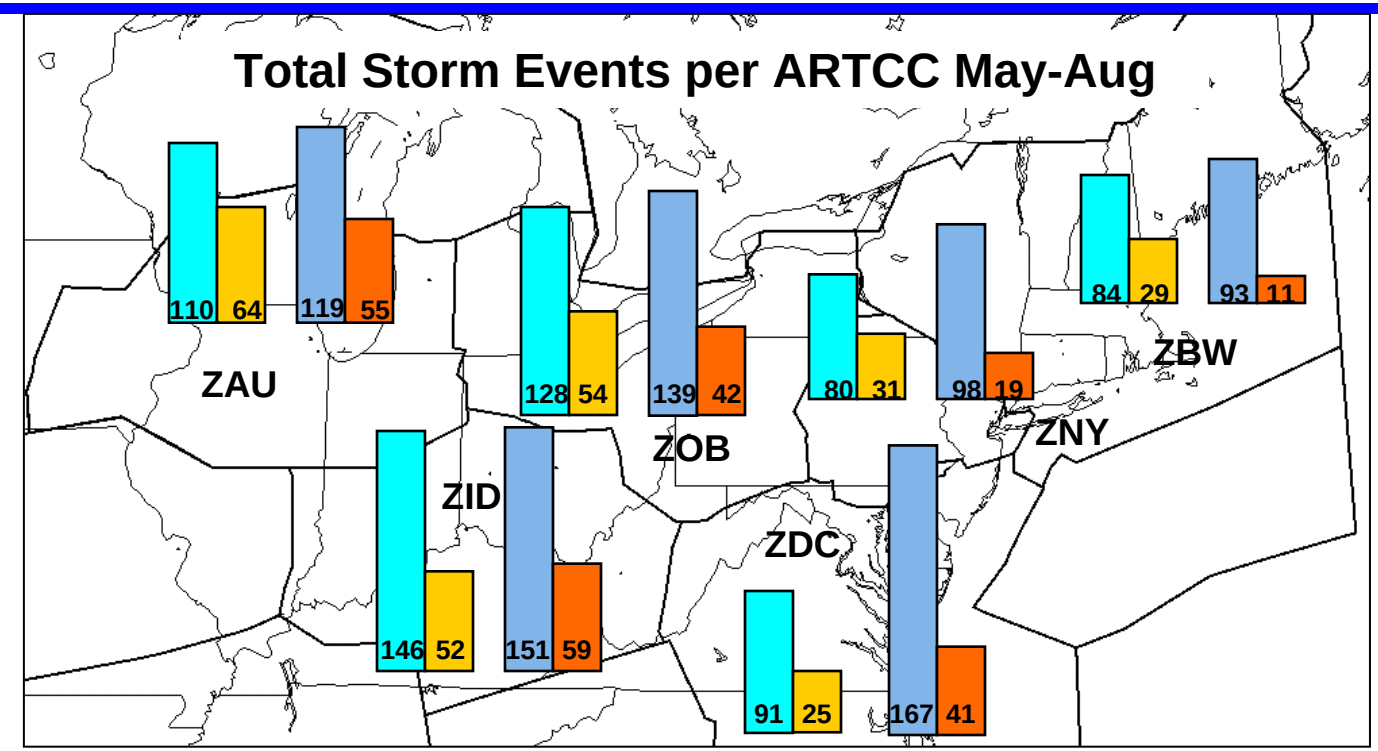
ATC chokepoints



[from FAA 2002 Airport Capacity Enhancement (ACE) Plan]

Increased use of point-to-point flights (versus hubs) and use of alternative airports increases en route congestion and hence, difficulty in providing flexibility and predictability when adverse weather occurs

Frequency of Convective Storm Impacts

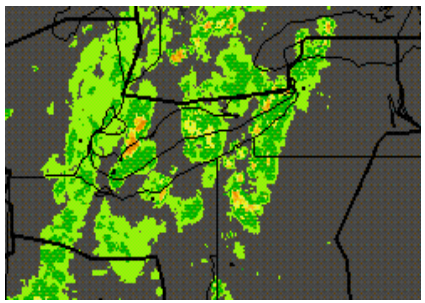
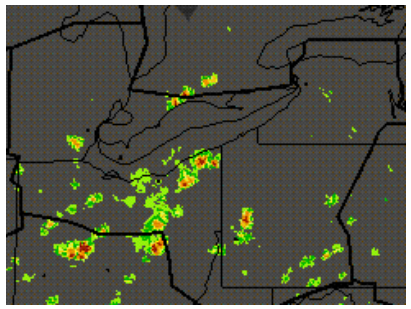
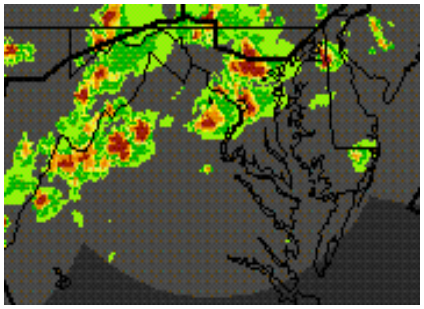
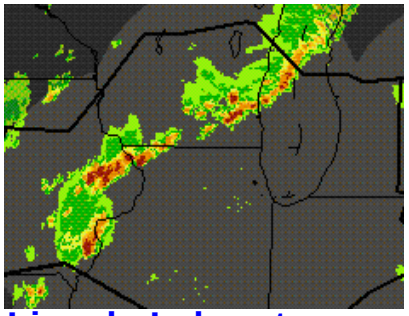


Unorganized Convective Events *2002*

Unorganized Convective Events *2003*

Organized Convective Events *2002*

Organized Convective Events *2003*

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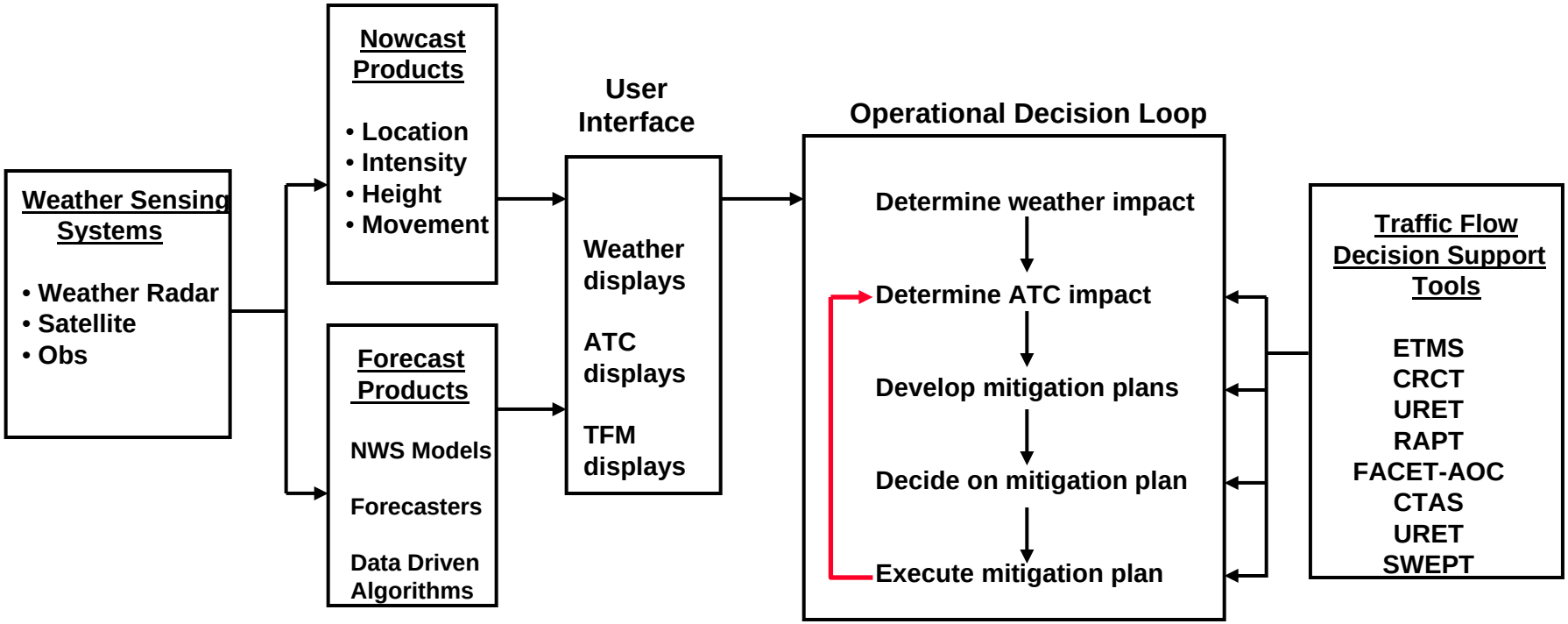
Weather Impact Mitigation Paradigm

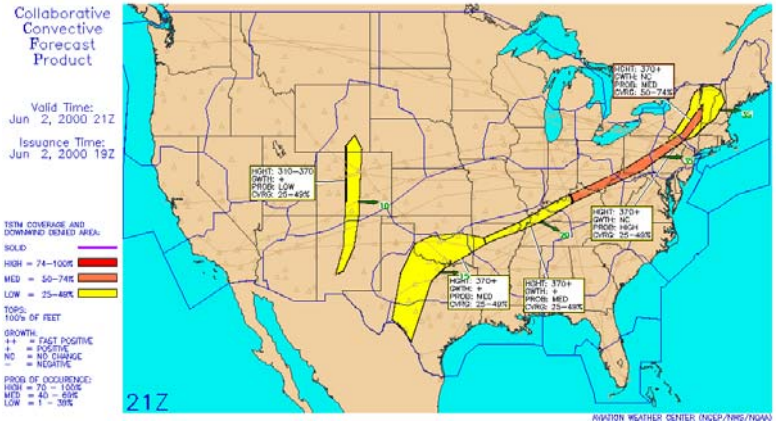


"Success" in FAA/airline context = executed an appropriate weather impact mitigation plan

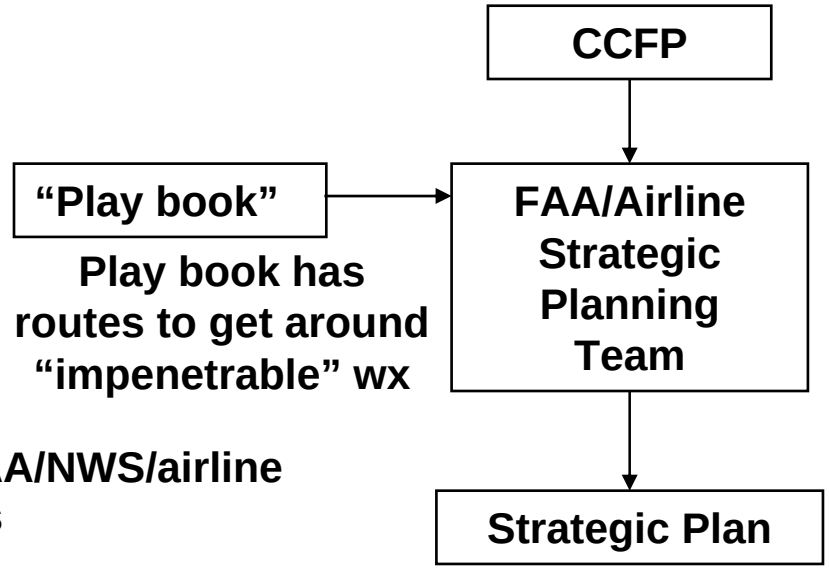
Must execute the decision loop on a time scale compatible with lead time for accurate forecasts

FAA/Airline "Spring 2K" Planning

Collaborative Convective Forecast Product (CCFP)



Strategic Planning



Play book has routes to get around "impenetrable" wx

Teleconference Every 2 hours

2, 4 and 6 hour predictions generated by FAA/NWS/airline meteorologist collaboration every 2-4 hours

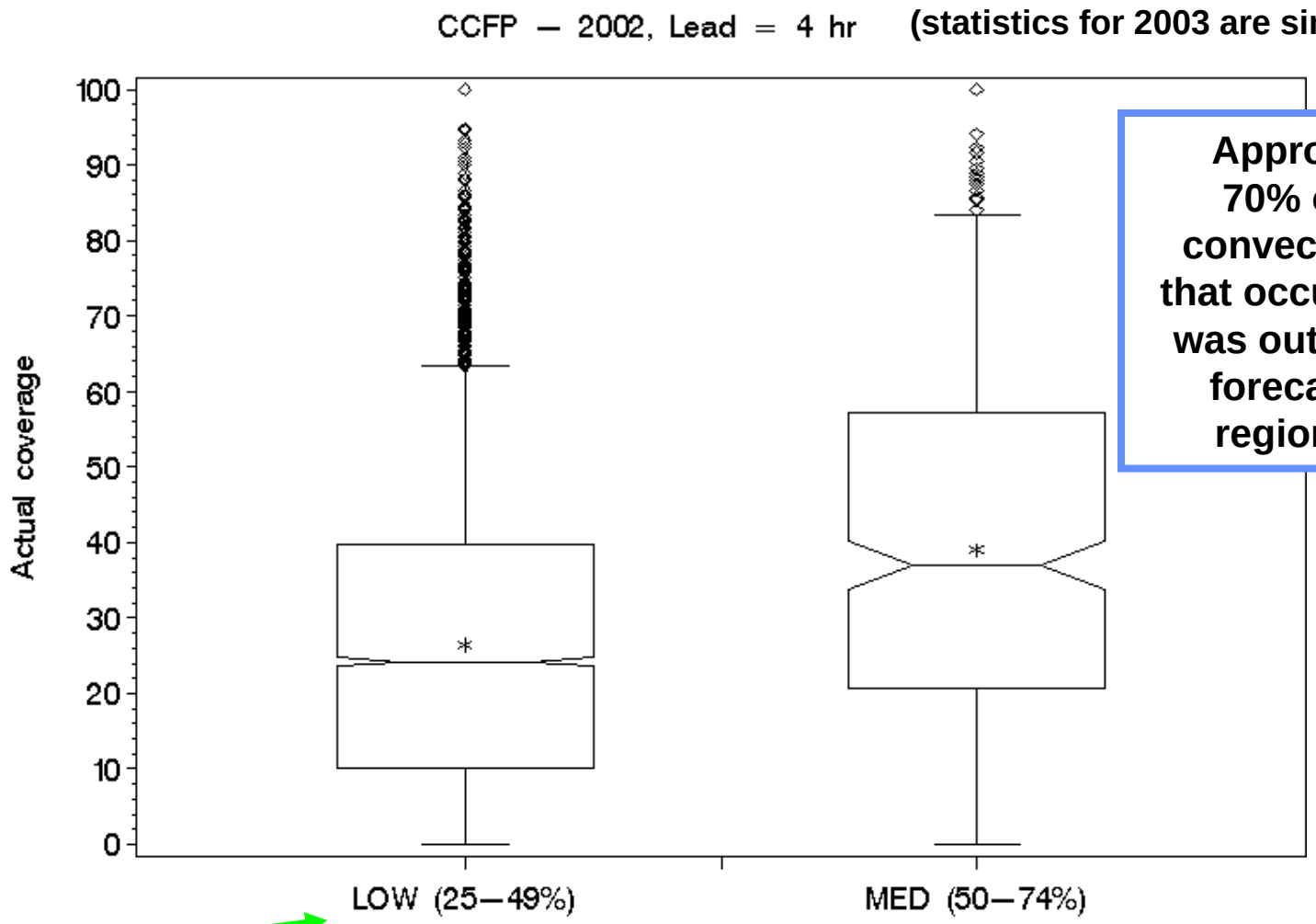
Each region of predicted convective activity has estimates of:

- **Thunderstorm coverage – three* intervals (e.g., 25-49%)**
- **Confidence in forecast= low, medium, high**

*** To become two intervals**

Delays that occur reflect forecasts plus plans plus actual wx

CCFP Coverage vs Actual Coverage



(statistics for 2003 are similar)

Approx. 70% of convection that occurred was outside forecast regions

95% of forecasts issued

Forecast Coverage

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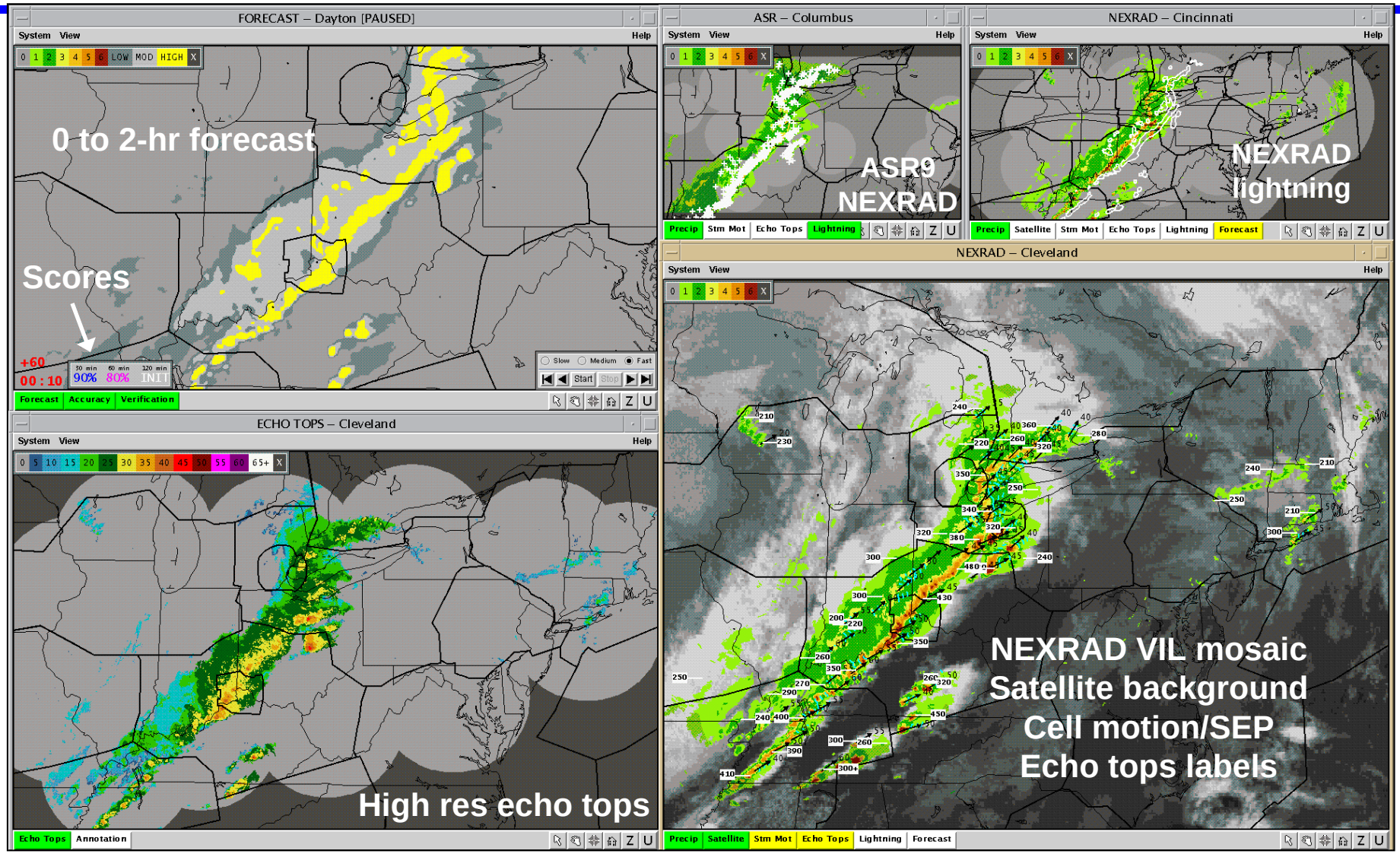
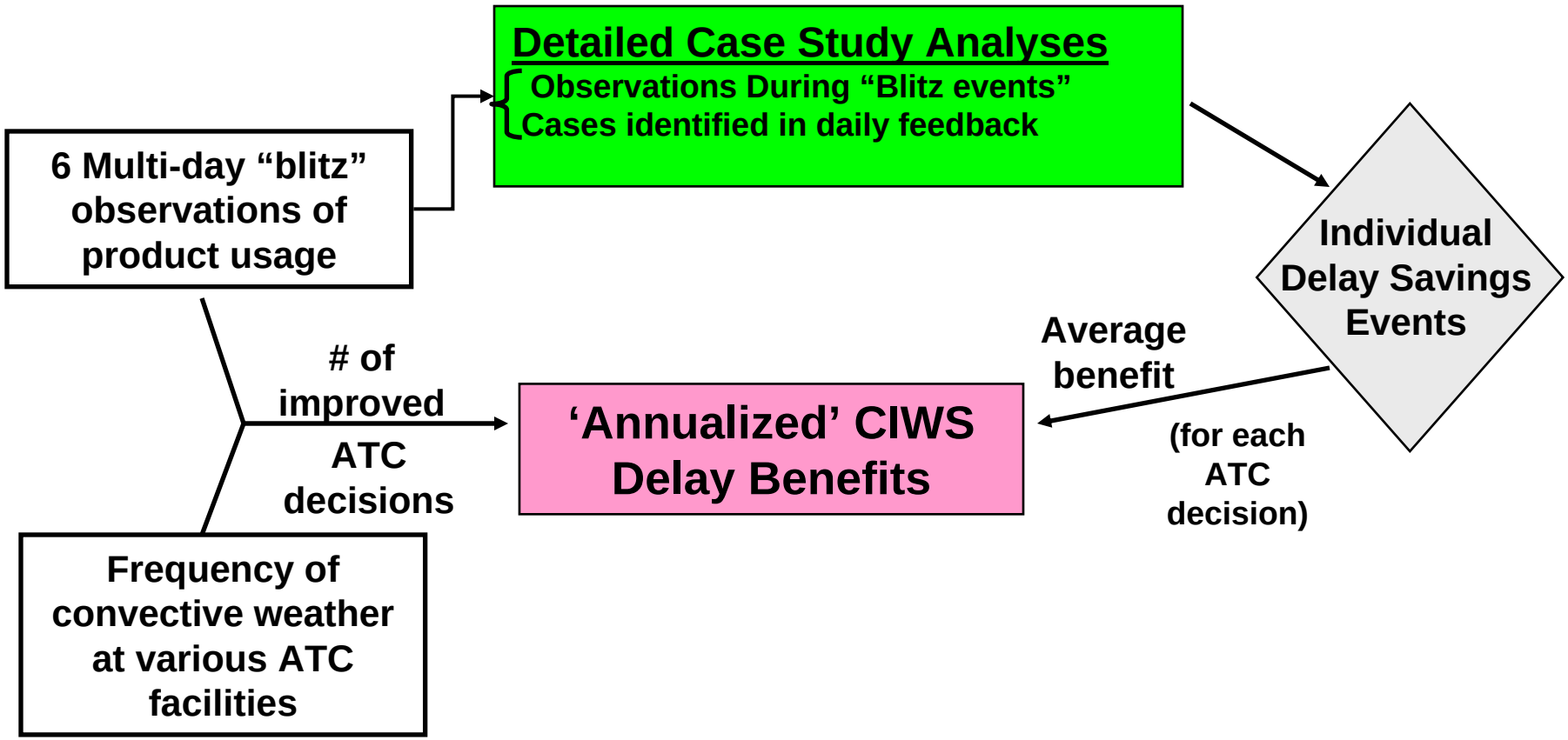
Corridor Integrated Weather System (CIWS) Products



CIWS Benefits Assessment



CIWS 2003 Operational Benefits

Route Impacts / Traffic Flow Management

CIWS Benefit	Times/year
•Jet routes kept open or reopened earlier	699
• Proactive, efficient reroutes	501
• Directing pathfinders	300
• Identifying opportunities to fly over storms	109

Delay savings > $ 110 M per year

Other uses being quantified:

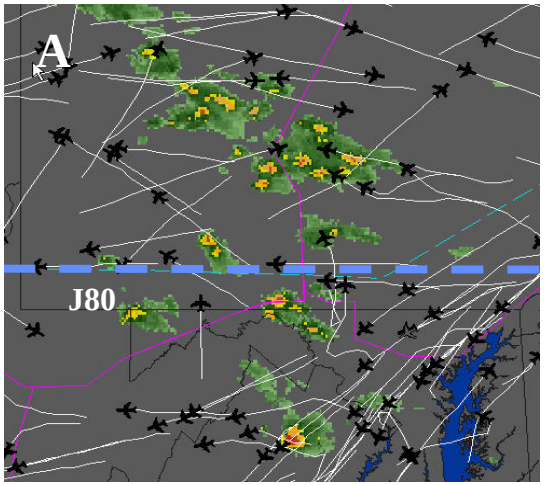
- Better use of delay programs
- More departures during severe wx
- Reduced MIT restrictions

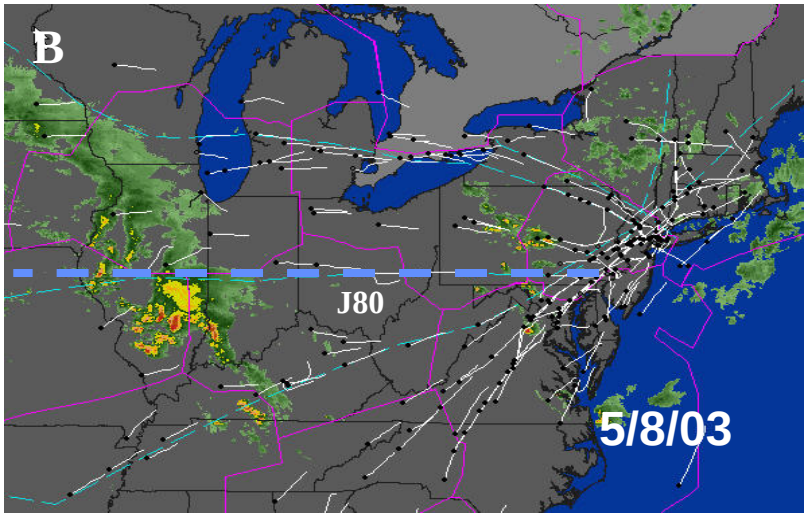
Benefits from Randomly Chosen Instances of Routes Kept Open

Facility	Dates	Direct Delay (Hrs)
ZAU	4/30 6/26	14 106
ZID	6/10 7/10 7/23	1 70 5
ZOB	5/8 7/6 8/3	4 18 189
ZDC	7/22 7/23 9/3	8 3 29
ZBW	6/11 8/5	3 7
ZNY	6/12 8/5	2 49

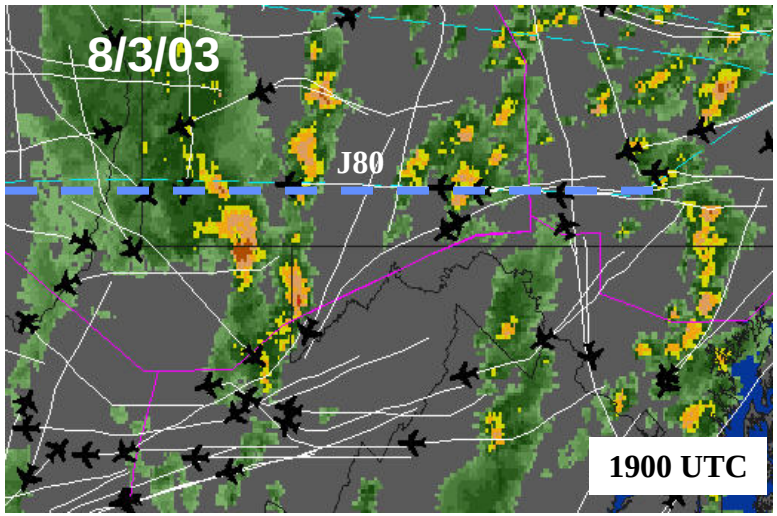
Annual benefit using above instances to estimate mean benefits:
42,457 hours
~ $ 178 M (including passenger time)

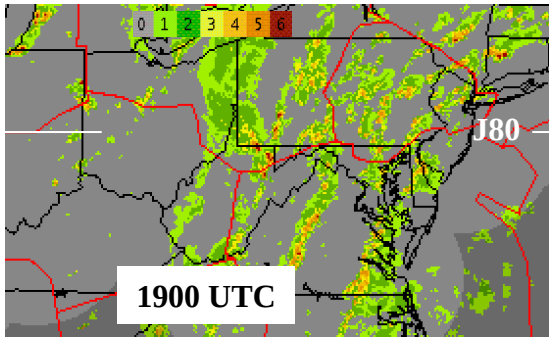
Examples of Different Cases





Low benefit – J80 blocked in IL





High benefit: few other usable E-W routes

Understandings from CIWS Study

- **Delays and benefits varied greatly for nominally similar "local" convective situations due to queues and overall network context**
  - **Queue delay is very sensitive to demand, fair and bad weather capacity, and time duration of bad weather**
  - **Need a very detailed knowledge of weather locations and 3D structure to accurately assess impact of weather**
- **System design implications**
  - **Predictions of ATC impact of storms hours in advance are likely to have a very wide range of possibilities for ATC impact**
  - **Need to focus on options for maximizing flexibility to respond to rapidly changing situations**
- **Metrics implication: will be very hard to normalize for weather effects of different weather (and forecasts) in delay comparison**

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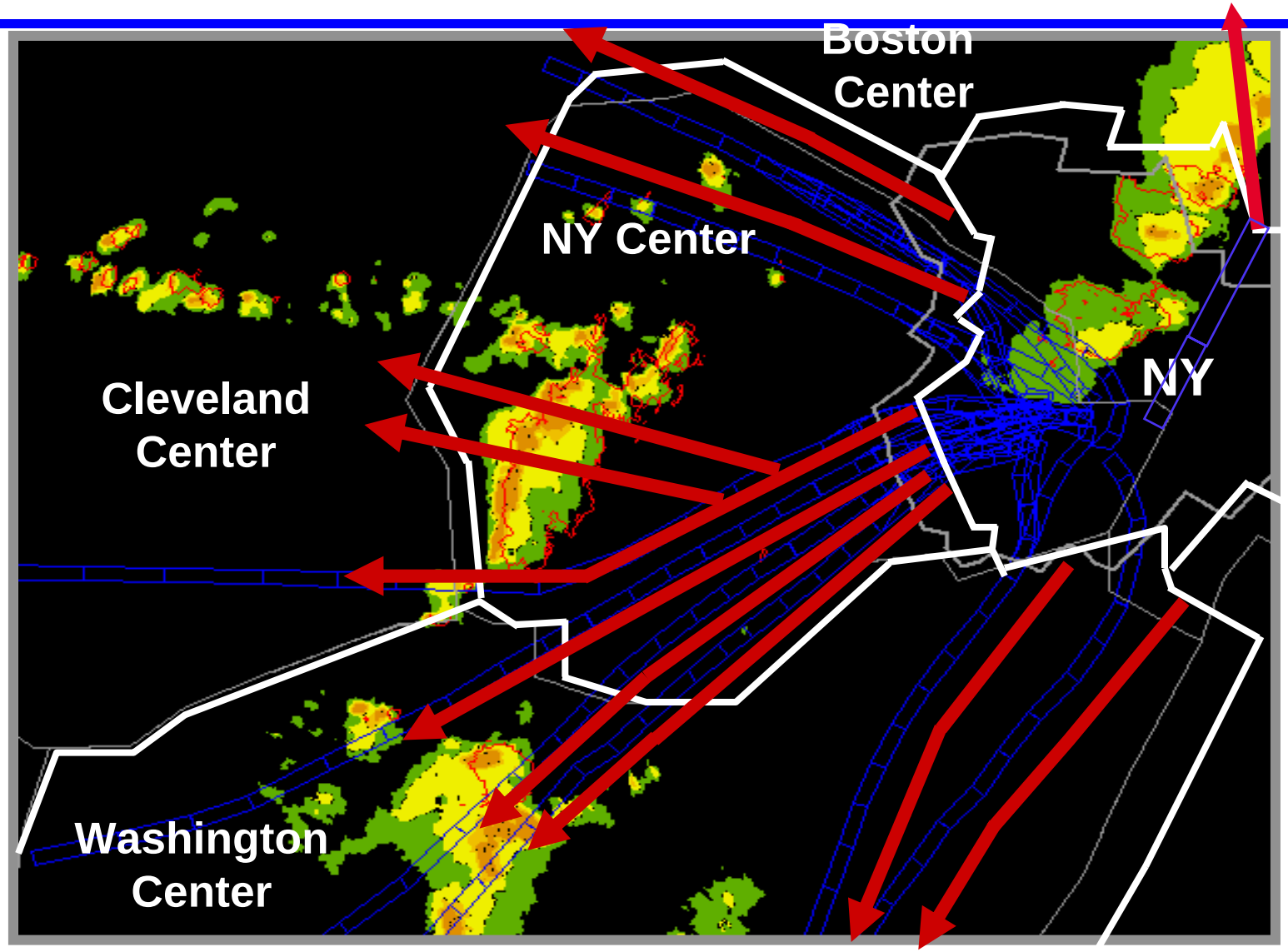
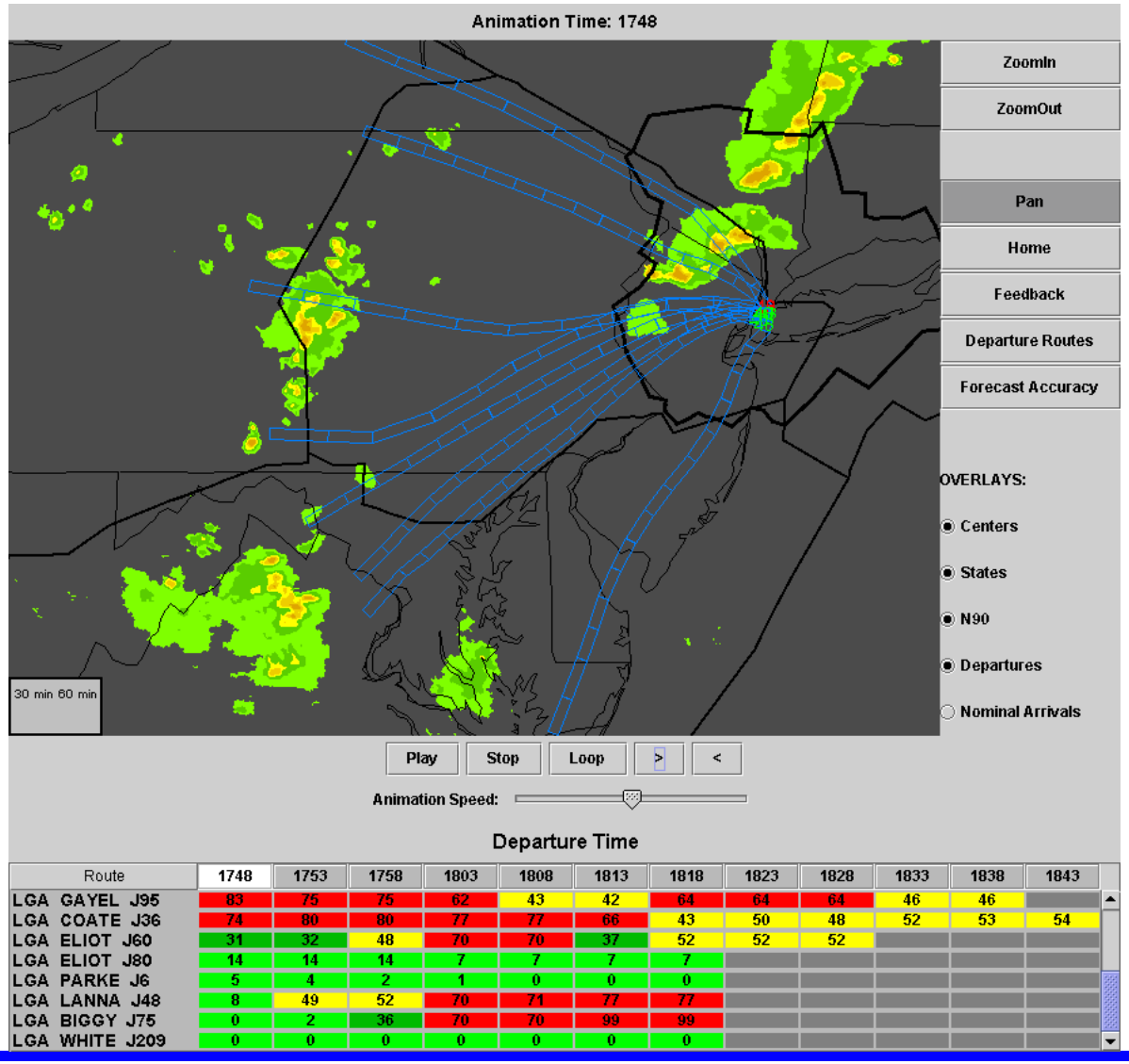
Flexibility in Transcon Routing

Proposal By UA at Dec 03 CDM mtg

Multi-facility Coordination for Departures



Route Availability Planning Tool (RAPT)



Route	1748	1753	1758	1803	1808	1813	1818	1823	1828	1833	1838	1843
LGA GAYEL J95	83	75	75	62	43	42	64	64	64	46	46	
LGA COATE J36	74	80	80	77	77	66	43	50	48	52	53	54
LGA ELIOT J60	31	32	48	70	70	37	52	52	52			
LGA ELIOT J80	14	14	14	7	7	7	7					
LGA PARKE J6	5	4	2	1	0	0	0					
LGA LANNA J48	8	49	52	70	71	77	77					
LGA BIGGY J75	0	2	36	70	70	99	99					
LGA WHITE J209	0	0	0	0	0	0	0					

Takes advantage of short lived opportunities for departures

<u>To be added</u>:

- **Aircraft specific 3D guidance**
- **Better support for assessing alternative routes if filed route is blocked**
- **Pilot/dispatch CDM**

Summary

- Convective weather impacts on congested airspace will continue to be a major problem for the NAS
  - Capacity impacts cannot be accurately predicted with the desired lead time
  - Classic “free flight” flexibility and predictability objectives will be hard to achieve
- Will need to consider developing a flexible, agile system that facilitates coping with rapidly changing problems
- Metrics implications
  - Reassessing system operations effectiveness metrics in context of flexible response to changing conditions
  - Normalization for weather and forecast differences between different time periods will require very detailed analysis + new tools