Applying FAA Aviation Weather Metrics Program Research to Operational Benefits Evaluations

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Challenges to Quantifying Operational Benefits Attributed to Enhanced Weather Forecasts

- Normalizing for similar weather events
- Normalizing for similar operations
- Defining pertinent baselines; How much of impact was “unavoidable”
- Attributing improved decisions to (a) improved forecasts, (b) USE of improved forecasts
- Providing objective, data-driven, quantified benefits estimates

“Of course delays were down this July compared to last…..there was 60% less convection!”

“Of course delays are down, ORD demand was down 20%!”

“What do you mean you have no way to apply this new forecast?”
(Said during solid ME to Gulf line)

“Weren’t those delay improvements Associated with that new procedure / TMI?

you say delays were saved during all 200 days of convection in ZMA Center….how often were improved decisions derived from this new forecast?

“We are in a tight fiscal environment…. I am not going to just take your word that this new forecast increases operational efficiency!”

FAA ANG-C6 Aviation Weather Metrics Program

Weather Metrics Development Program				
WITI/WITI-FA Enhancements 1. Add Echo Tops 2. TRACON 3. Adaptive Airport WITI 4. Metroplex Airport WITI 5. Alternate Truth 6. VFR Traffic 7. Daily WITI 8. O-D Pair WITI	**WX Impact Mitigation Opportunities Assessment** ***("Unavoidable" Delay)*** 1. Terminal 2. En Route	**"Similar Day" Analysis** ***WX-Event Normalization*** 1. Similar Weather 2. Similar Impact - For an Airport - For the NAS	**DART & WAVE** ***WX-AWARE Air Traffic Modeling, Simulation, & Visualization / Data-Mining***	**NAS Response to Weather (Best Practices)** Response variability by forecast performance

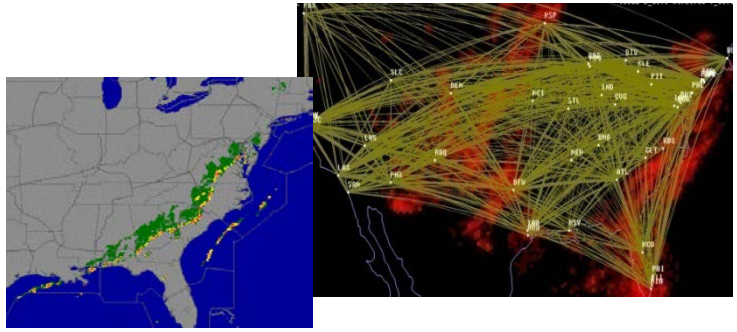
Emphasis on:

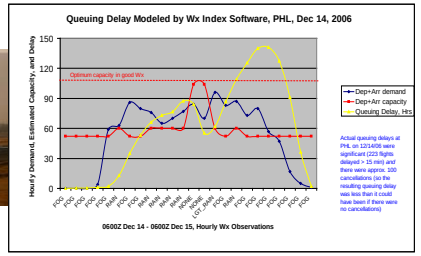
- **Weather impacts in context of operations (specifically, operational decision-making)**
- **Weather event normalization and baselining**
- **Objective, relational data analysis (and simulation support)**

Weather Impact Traffic Index (WITI)
Weather Weighted by Traffic

WITI is a weighted sum of three components:

- **<u>En-route Component:</u>** hourly frequency on major flows ***X*** amount of convective Wx that these flows cross
- **<u>Terminal Component</u>**
  - **<u>Linear part:</u>** capacity degradation due to terminal weather impact, proportional to number of ops
  - **<u>Non-linear (Queuing Delay) part</u>** reflecting excess traffic demand vs. capacity

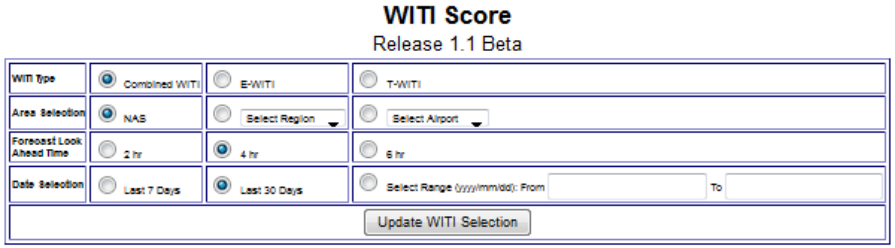


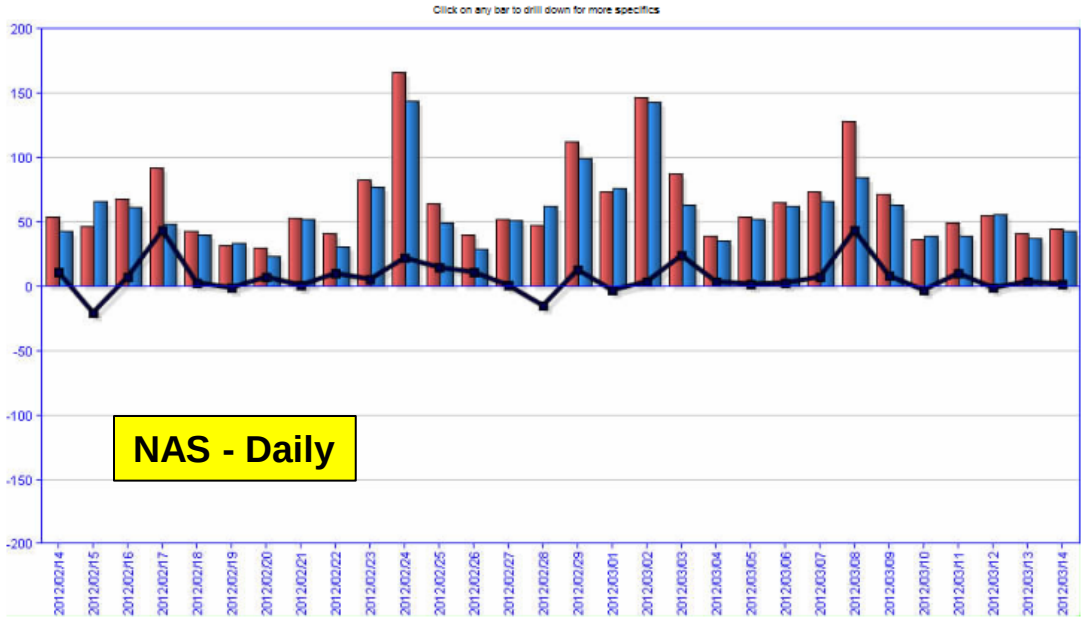


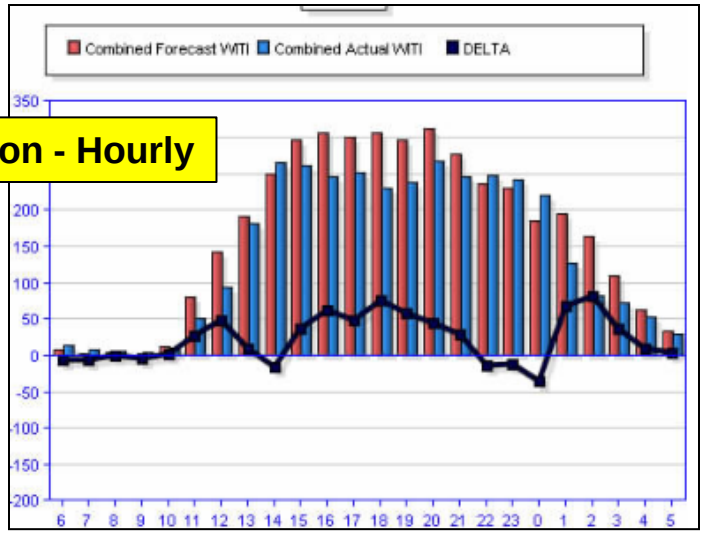
Used by the FAA and NWS on a regular basis:

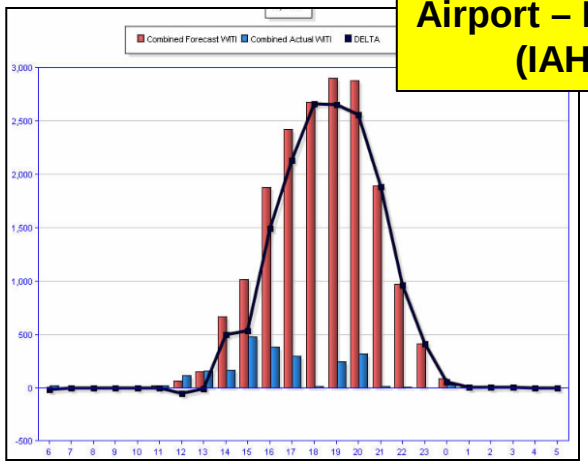
- Macroscopic system performance measure in an objective manner – weekly reports
- Compare different seasons' Wx/traffic impact with outcomes (e.g. delays)

Historical Scalable Record of WITI / WITI – Forecast Accuracy (FA)

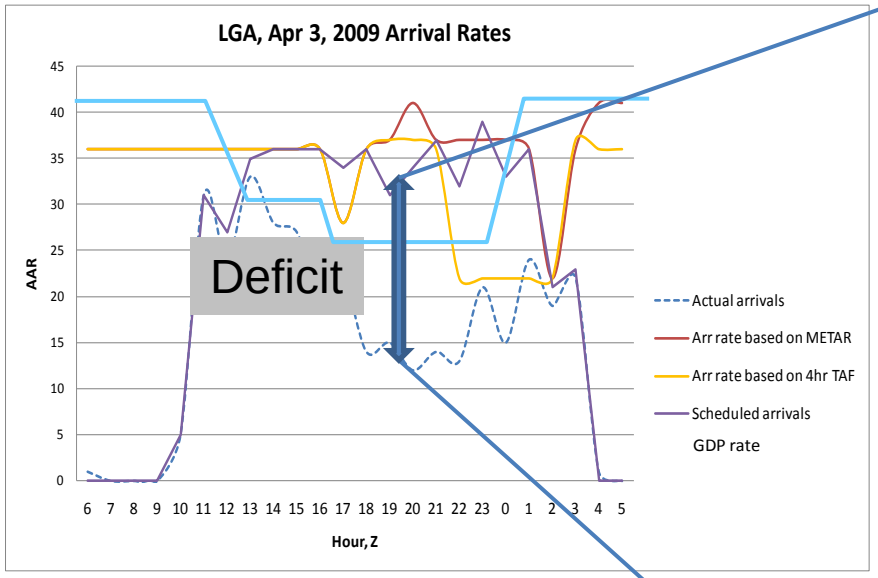


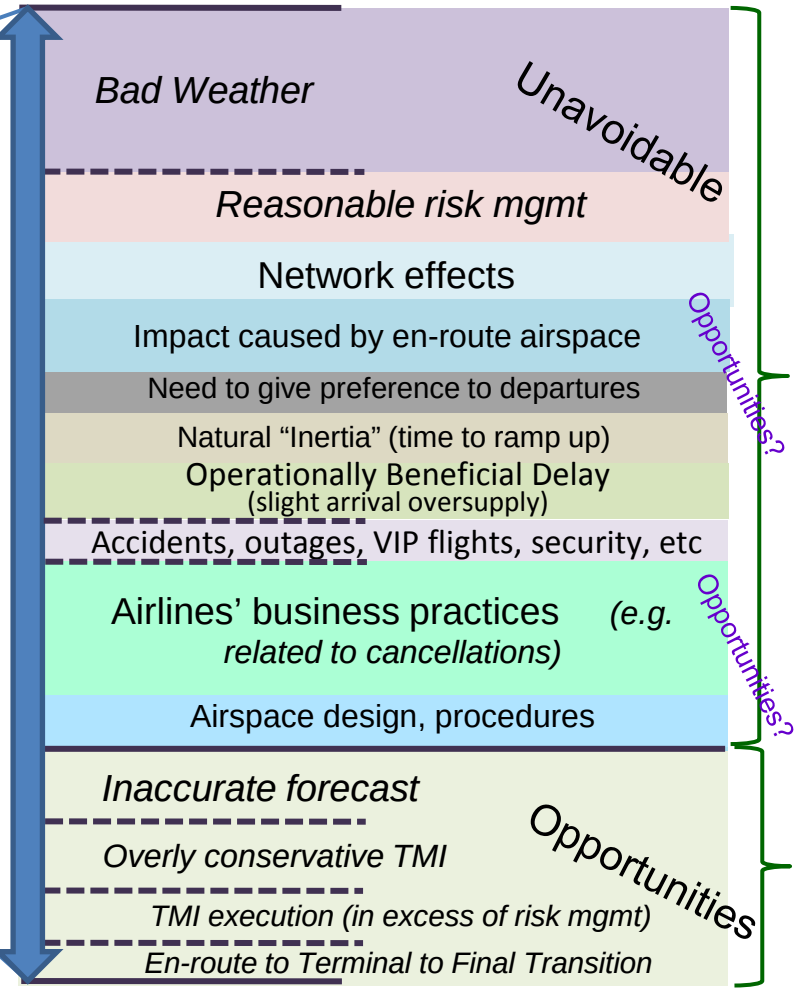




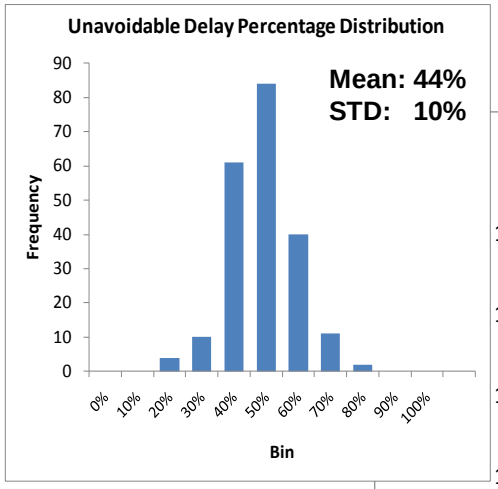


Assessing Components of Unavoidable Weather Impacts

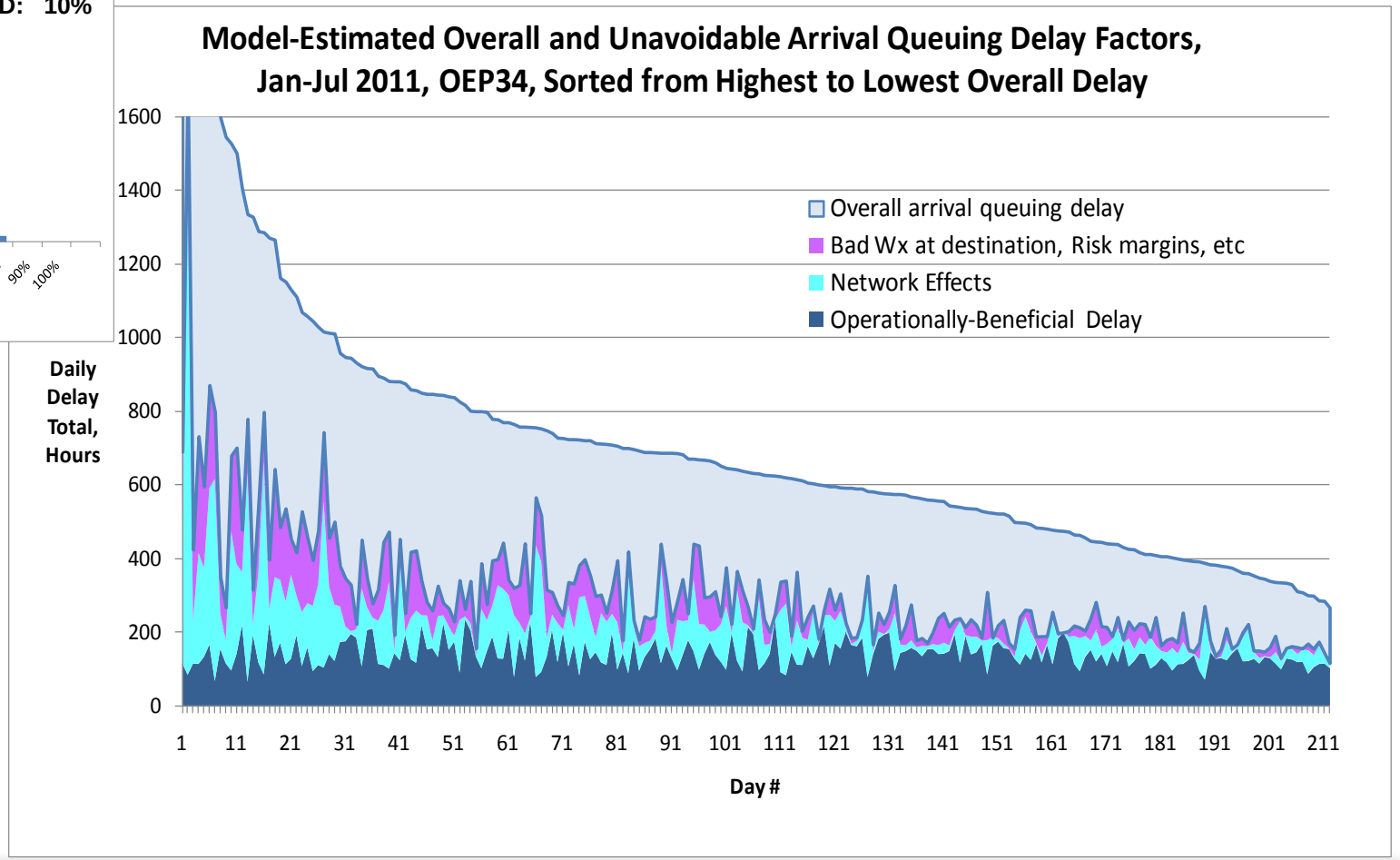




Estimating Unavoidable Arrival Delay

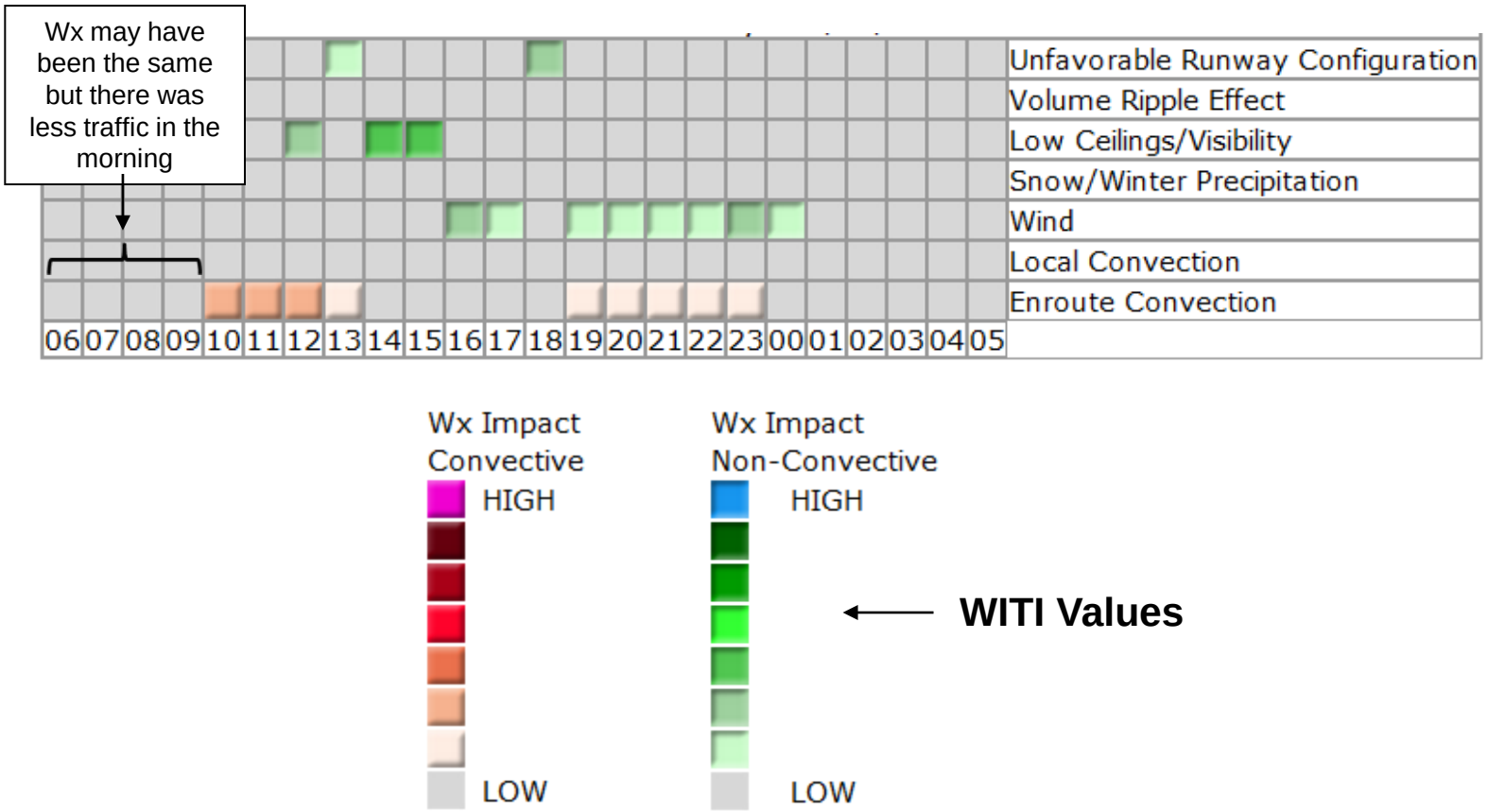


- Modeled estimated unavoidable arrival delay 40-55% of overall delay
- Results similar to independent estimates of unavoidable delay (e.g., REDAC report)



Similar Weather Impact Events (WX & Demand)

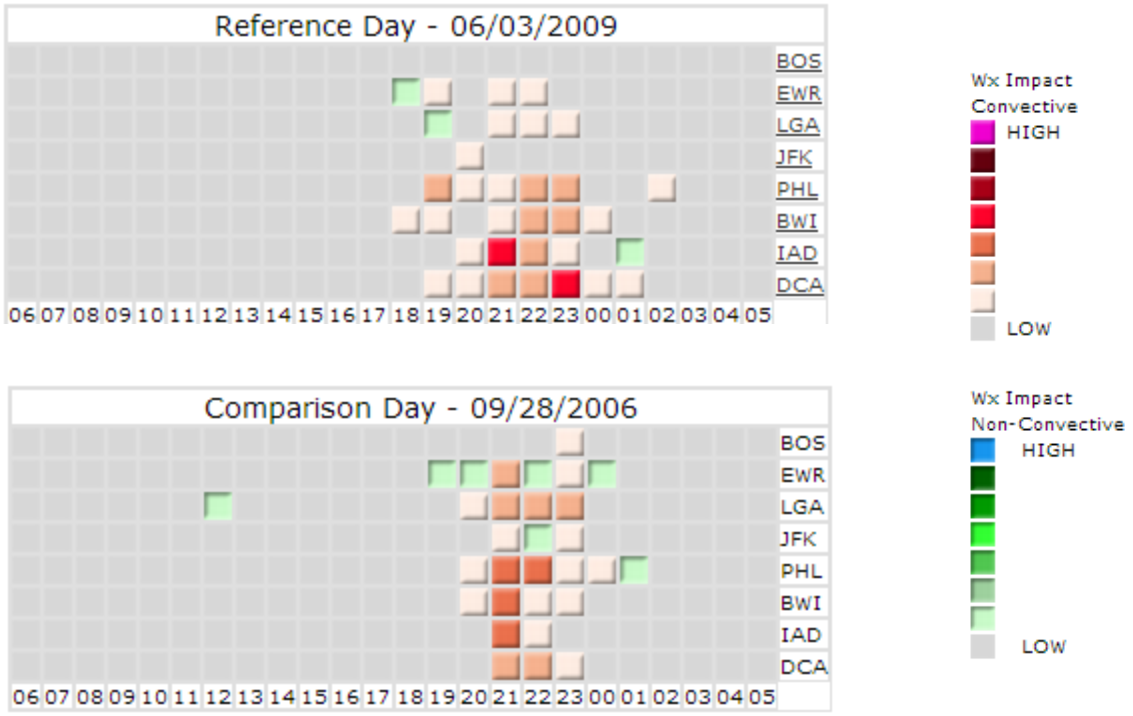
Example: ORD – Varying impacts throughout the day, both convective and non-convective



Finding Similar Weather Impact Days

Similar Weather Event/Impact Evaluation Portal (SWEEP)

- Identify, rank, and inspect similar REGIONAL wx-impact days



Dynamic Airspace Routing Tool

Air Traffic Analysis, Inc

What is DART?

Weather-Aware Superfast-Time NAS/ATM Simulation Model

- Full ETMS flight plans
- Terminal Wx (convective and non-convective), TRACON and En-route convective Wx: actual and forecasts; permeability
- Airport RWY configurations and capacity (may be Wx-degraded) but no physical RWYs
- Airspace (sector, Center) capacity (may be Wx-degraded)
- TMIs (Playbook, GDP, GS, AFP, MIT)
  - Can blend historically enforced TMIs and simulated TMIs
- Reroutes, delays, Cnx, simulated airborne holding & diversions
- User-definable rules, risk factors, equipage profiles, etc
- Randomized Wx, airport/airspace capacity, Wx forecast, traffic

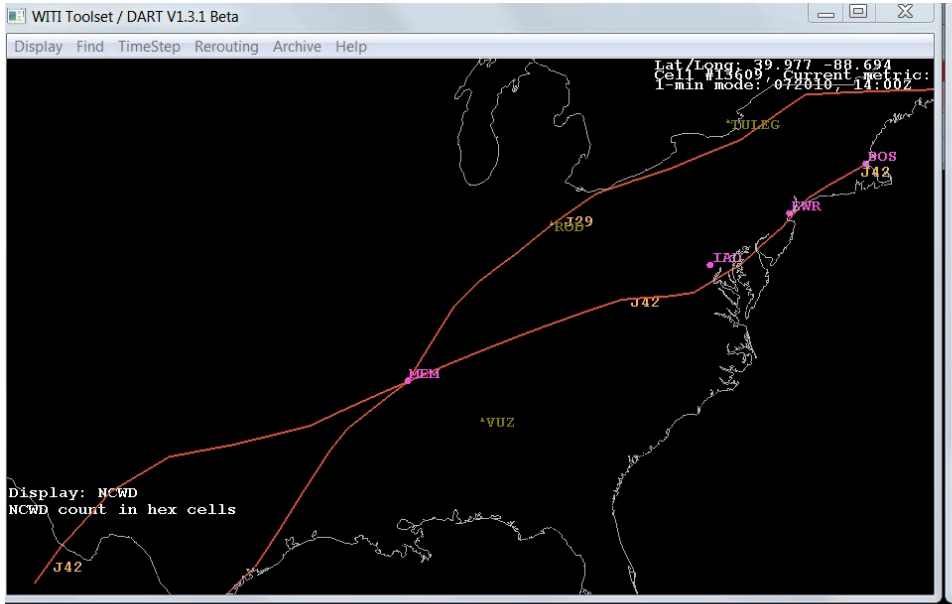
A “superfast-time” NAS simulation tool

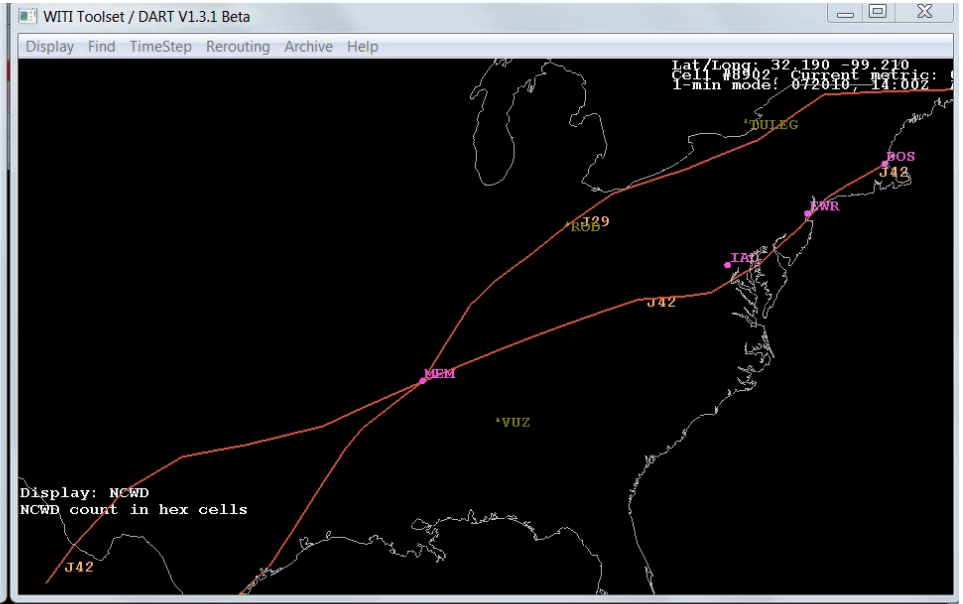
- Day-in-the-NAS (50,000+ flights and all the above detail) in 2-3 min

Abundant output on various aspects of NAS operations

- Impact (cost) metrics include delay (airborne, ground, etc.) AND cancellations and diversions
- Validation of DART includes all three primary impact metrics

Examining Alternative TMIs via DART Simulations





Optimized solution: Airway J29 open to relieve traffic on VUZ playbook reroute; reduced MIT, less delay

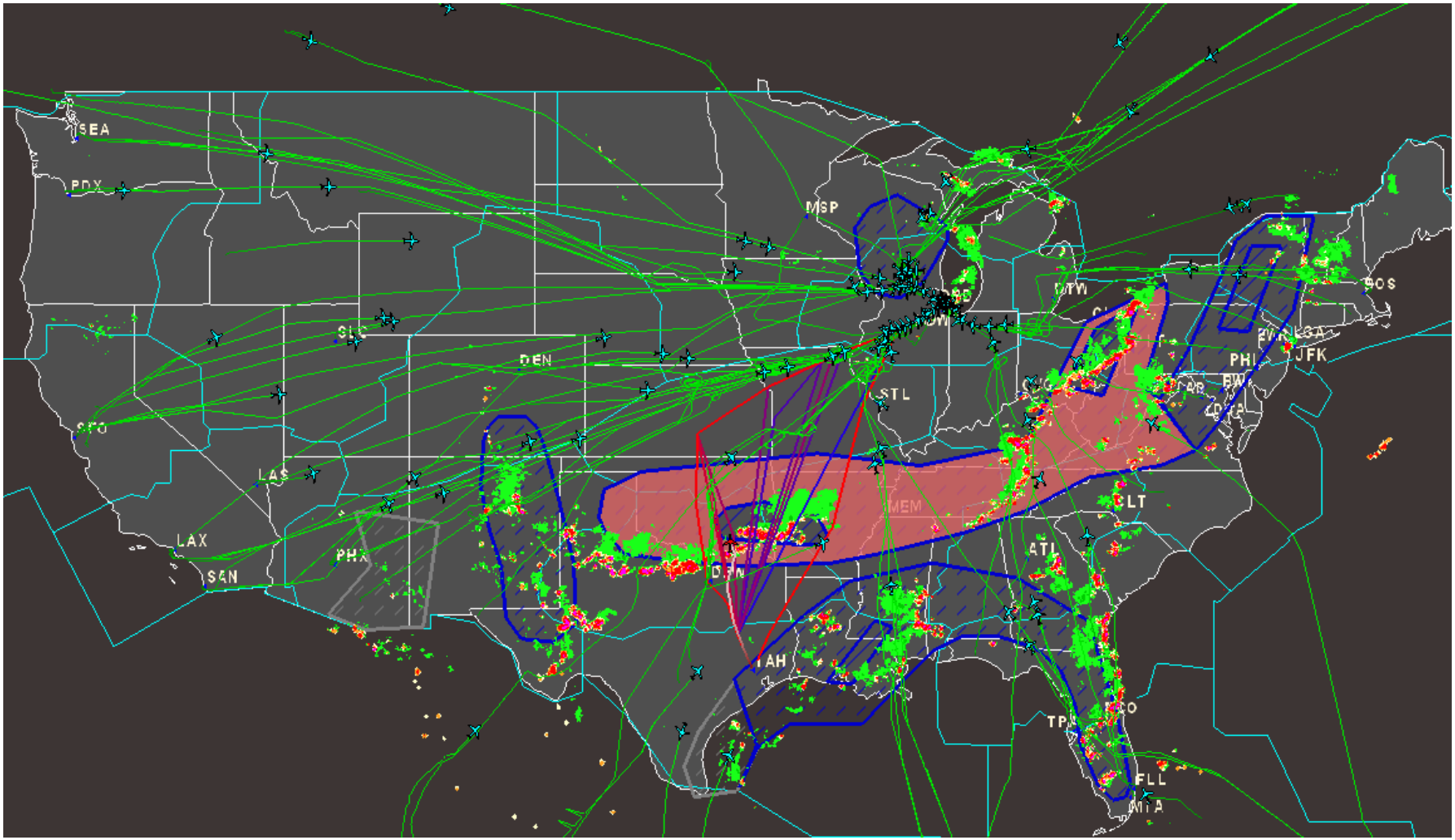
Non-optimal solution: VUZ playbook reroute traffic uses standard route; J29 closed; heavier MIT, longer delays

Only the traffic using NAS Playbook reroutes is shown; Color-coding by delay: 0-15, 15-20, 30-60, 60-120, >120 min arrival delay

Weather-ATM Analysis and Visualization Environment (WAVE)

- “Weather-Centric” air traffic / ATM analysis tool and research platform
- Utilizes 1-min ETMS traffic data (flight information, flight plans, amendments, lat/lon/altitude positioning)
- Can ingest and display any gridded or polygon-based weather product (diagnostic or forecast)
- Engine for extensive analysis, utilizing multiple data types; output results in CSV format
- Generate standard output reports, targeted for specific performance assessments accounting for weather / forecasts

WAVE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