



 *Air Traffic Analysis, Inc*

Airspace Capacity Estimation Using WITI

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Project Objectives and Scope

Objectives:

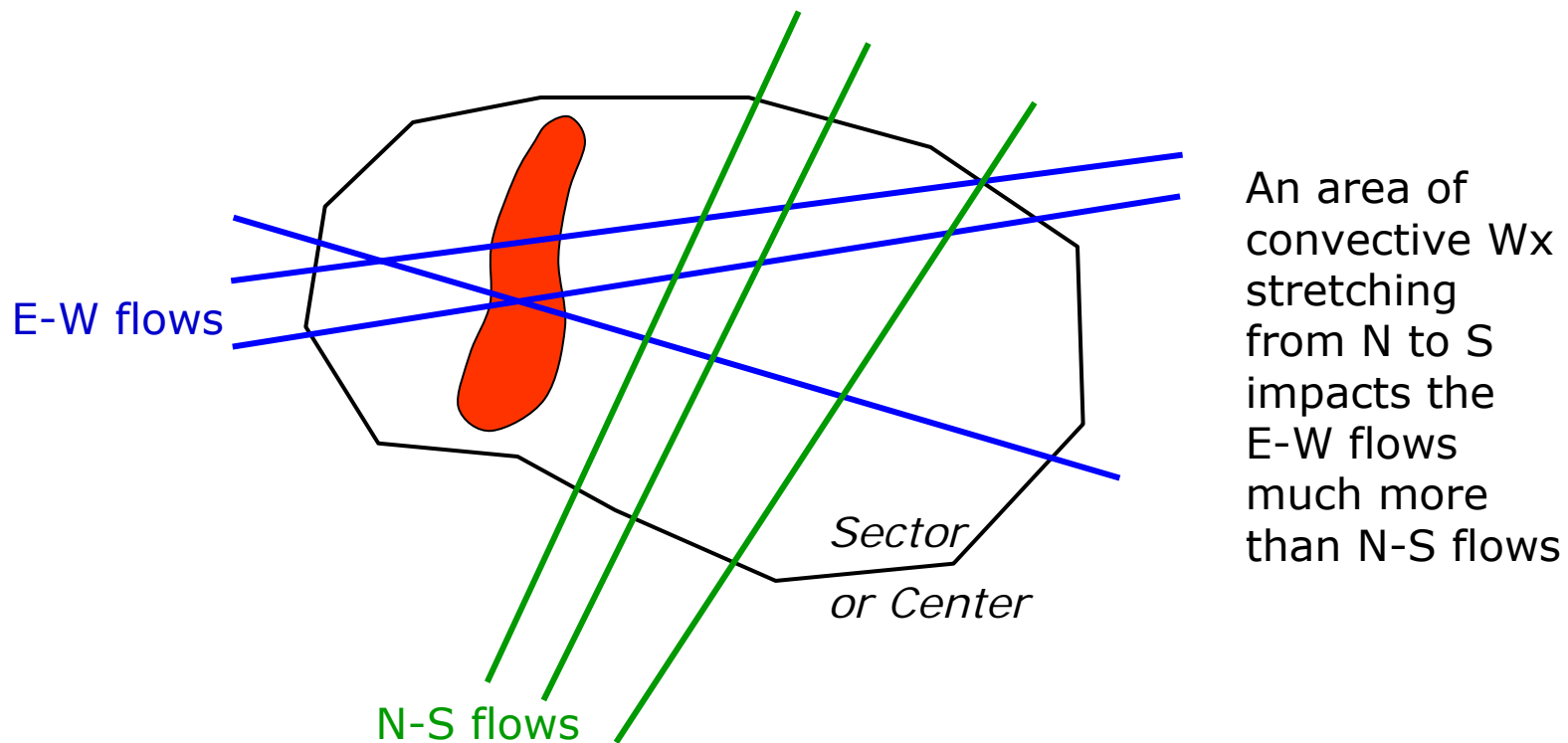
- Translate weather information into appropriate TFM constraint
 - Actual or forecast weather
- Validate
- Provide input for a range of air traffic simulation models

A Note on Scope:

- We are not developing a deployable TFM decision support system. We are merely exploring methods for better estimation of en-route airspace capacity for strategic TFM

Airspace Capacity Is Flow Dependent

- Airspace capacity (constrained by convective weather) is flow dependent. Example:



En-Route Weather Impacted Traffic Index (WITI)

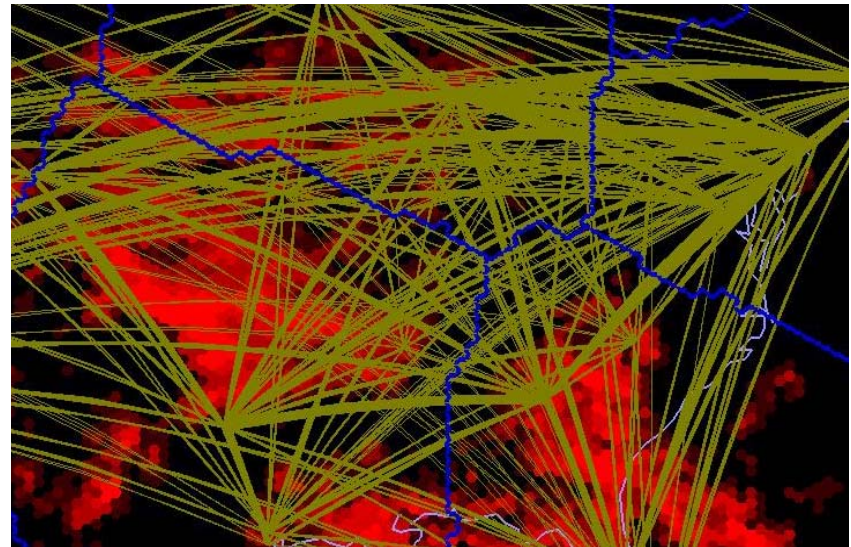
"E_WITI_A" Computation as Used in NAS WITI Today

Use hexagonal grid and 'Flows'

Convective product: NCWD

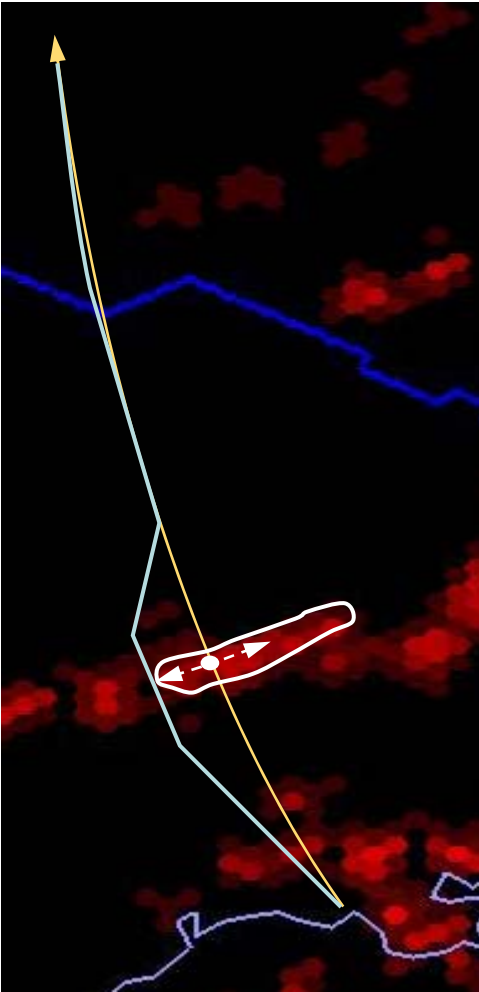
For each Flow:

- Find intersections with hex cells where severe Wx was reported
- Multiply by hex cell's hourly NCWD count
- Multiply by number of hourly flights on this flow
- Result is E_WITI_A
- Reflects impact of Wx on planned flights



Expanding E_WITI to Account for Lines of Wx

Result is "E_WITI_B"



Accounting for Contiguous Wx Clusters

For each flow, find hex cells it crosses that contain Wx

For each hex cell, find neighbors in both directions *perpendicular* to the flow

If they contain Wx for *same* time period, include them in cluster

Expand while cluster remains contiguous (or cut off at e.g. 100 NM from Flow)

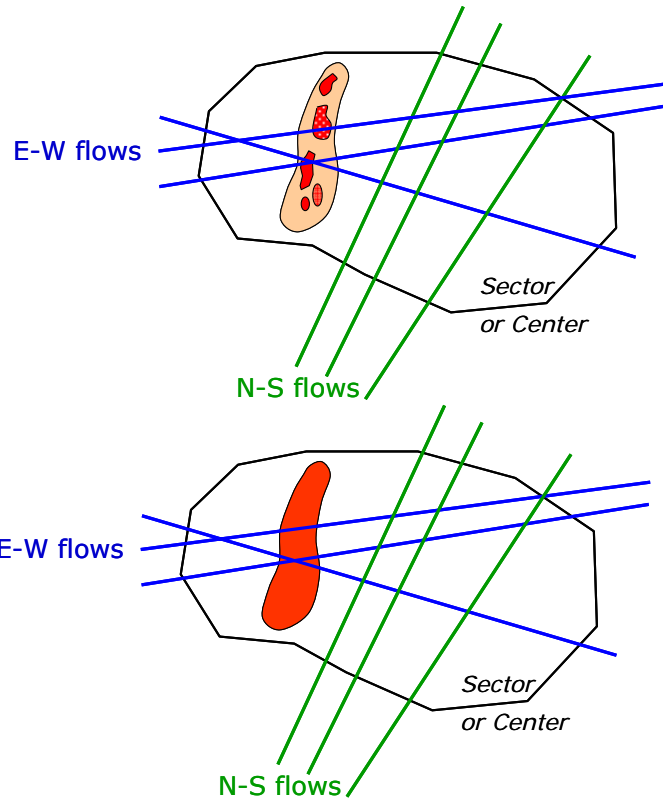
Add all Wx reports in the *cluster* and multiply by flow's frequency

Result = E_WITI_B for the flow

Computing Convective Impact on Airspace Unit

Computing Convective Impact on a Center:

- Compute *two* E_WITI_B values:



First, compute *actual* WITI_B for each flow [i] that crosses the Center:

$$E_WITI_B_i$$

Then, compute *maximum* WITI_B for each flow [i] that crosses the Center

(flow being completely blocked by Wx)

$$\text{Max_E_WITI_B}_i$$

Computing Convective Impact on Airspace Unit (continued)

The measure of convective impact on a Sector or Center is:

$$I_C = \frac{\sum_{i=0}^N \min\left(\frac{E_WITI_B_i}{\text{Max_E_WITI_B}_i}, 1\right)}{N}$$

where
N is the number of flows that cross the Sector

E_WITI_B / Max_E_WITI_B ratios are truncated at 1.0

- Once computed, relate these I_C scores to sector capacity
 - I_C score close to 0 means full capacity (E_WITI_B very low vs. Max)
 - I_C score close to 1 means zero capacity (E_WITI_B near Max)
- Sector or Center capacity % available in any given hour:

$$C = (1 - I_C) * 100$$

Validation

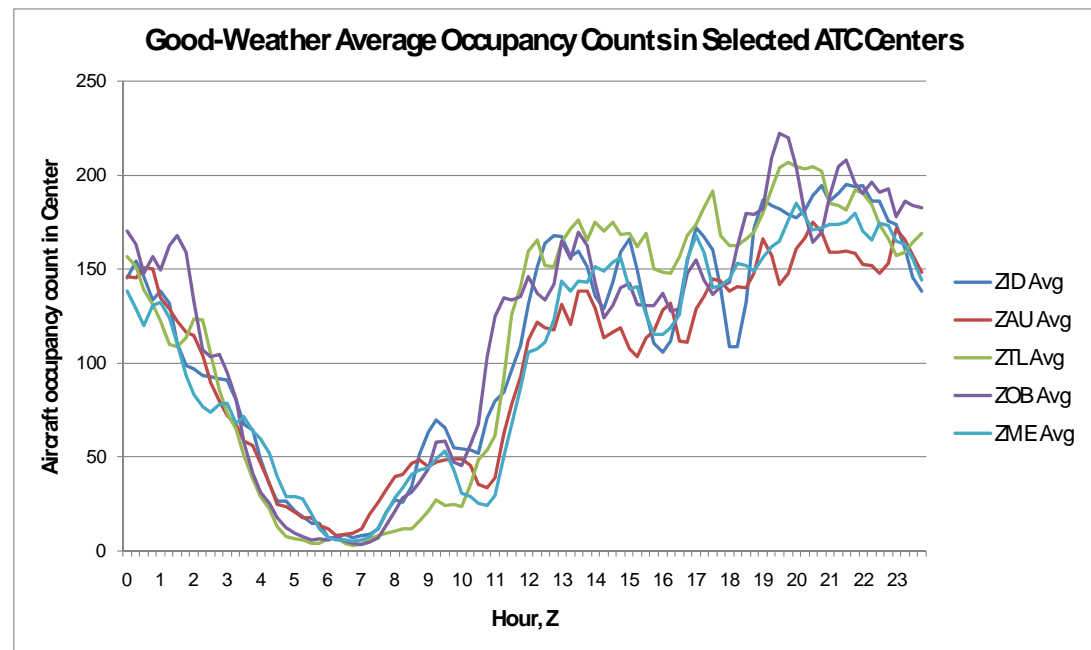
On Wx impacted days:

- Compare predicted reduction in airspace capacity with actual traffic in impacted Centers
- Estimated capacity = Occupancy count as % of averaged traffic on good-Wx days

Currently the only method where actual data can be used

Occupancy counts in selected Centers

Averaged over 5 good-Wx weekdays in summer 2007



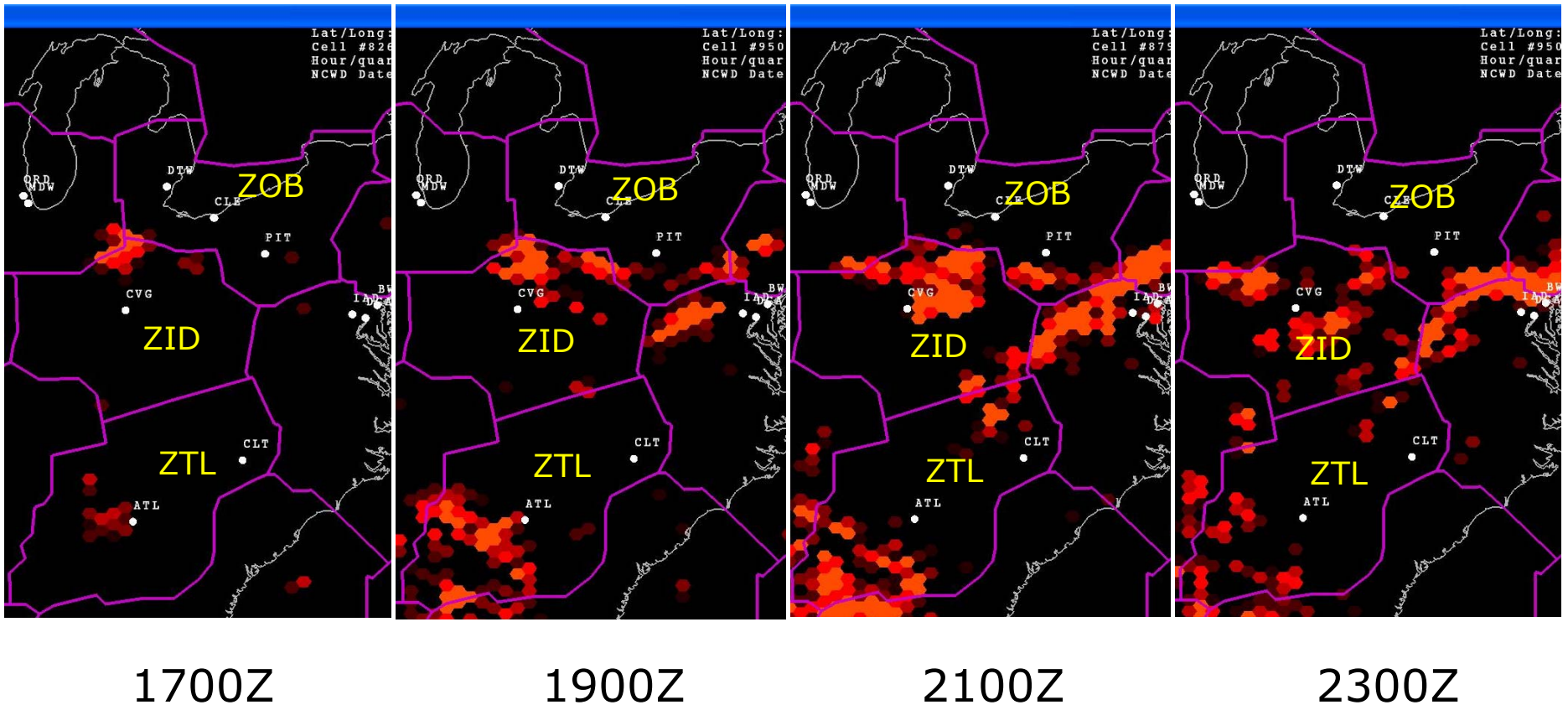
Limitations and Caveats

- 1) Lower traffic demand
- 2) ATM over-reaction (heavier TMIs imposed in anticipation of Wx)
- 3) Interdependencies between Centers
- 4) We use intended flows; potential reroutes not fully taken into account
- 5) Actual TMIs use combination of forecast and actual weather

Airspace Capacity Loss Estimation

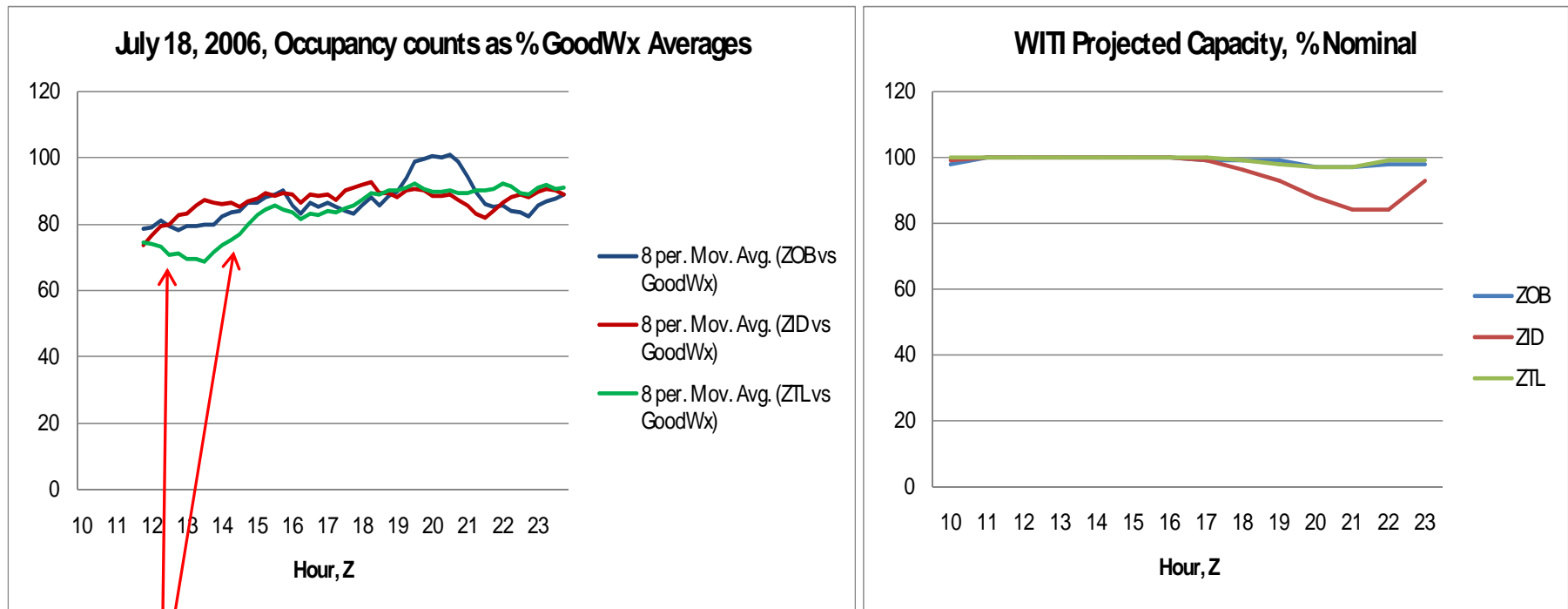
July 18, 2006: Minor Wx Impact

Convective situation at the start of the hour



Airspace Capacity Loss Estimation

July 18, 2006: Minor Wx Impact



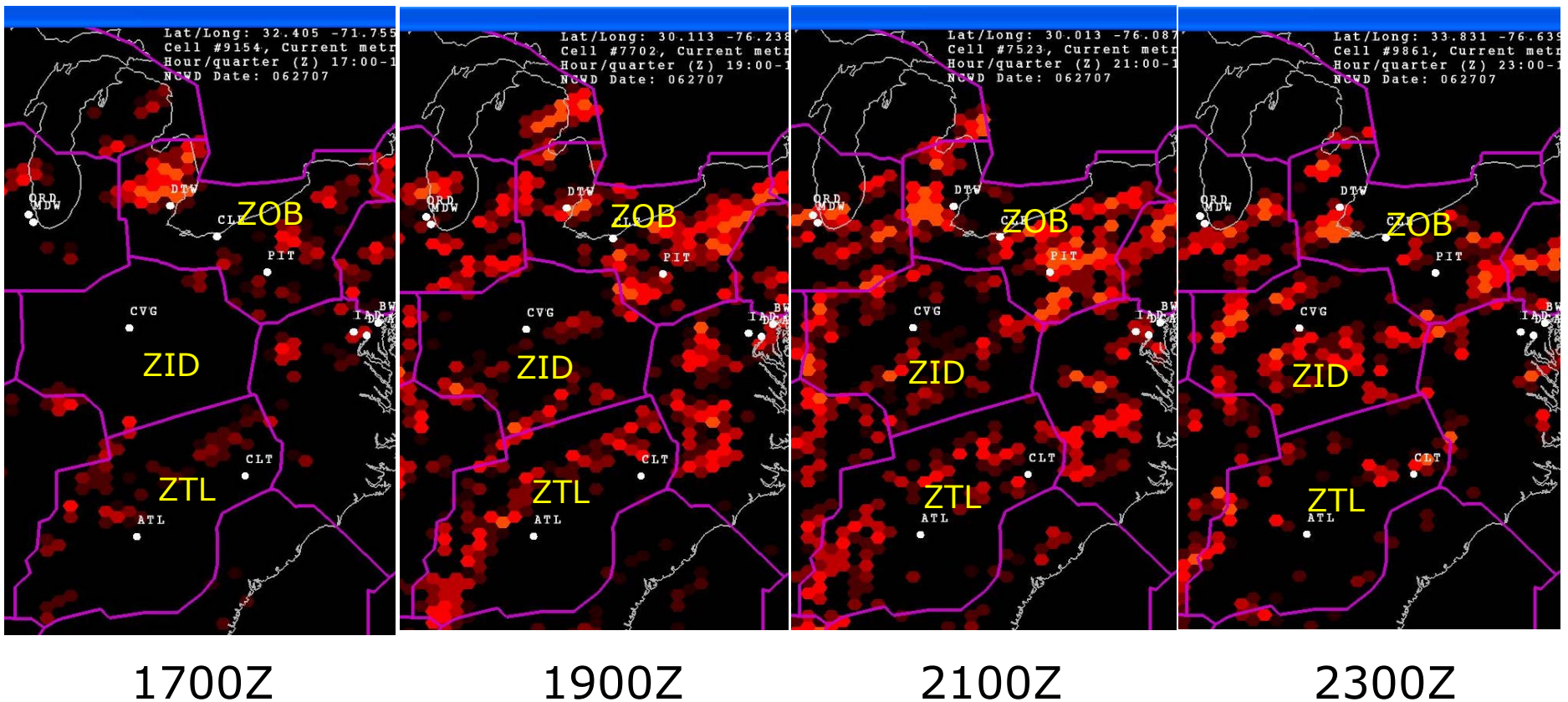
Lower traffic counts in ZOB, ZID and ZTL during 1200-1600Z are due to less traffic observed in these Centers as weather impact at that time was low. Prediction of ZID, ZTL capacity loss is otherwise reasonable.

TMIs: EWR GDP, 7 GS, and 1 FCAA05 AFP issued at 15:38 to start at 21:00.

Airspace Capacity Loss Estimation

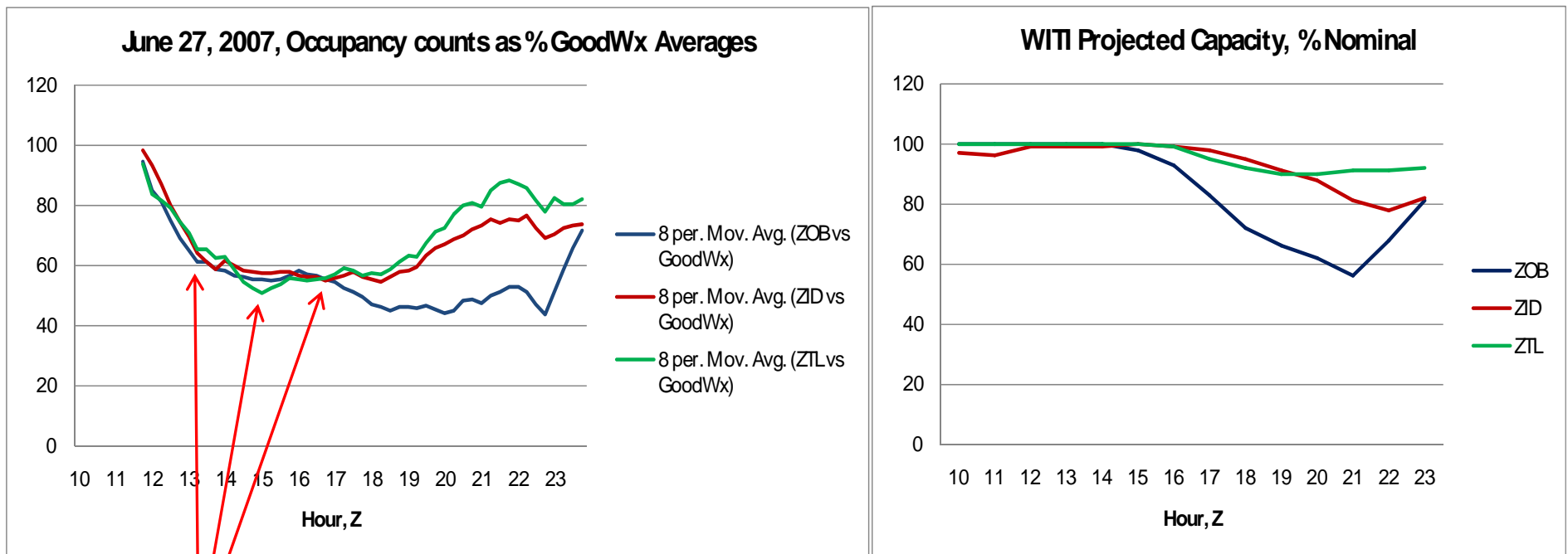
June 27, 2007: Significant Wx Impact

Convective situation at the start of the hour



Airspace Capacity Loss Estimation

June 27, 2007: Impact on ZOB, ZID and ZTL



Lower traffic counts in ZOB, ZID and ZTL during 1200-1700Z may be due to less traffic observed in these Centers.

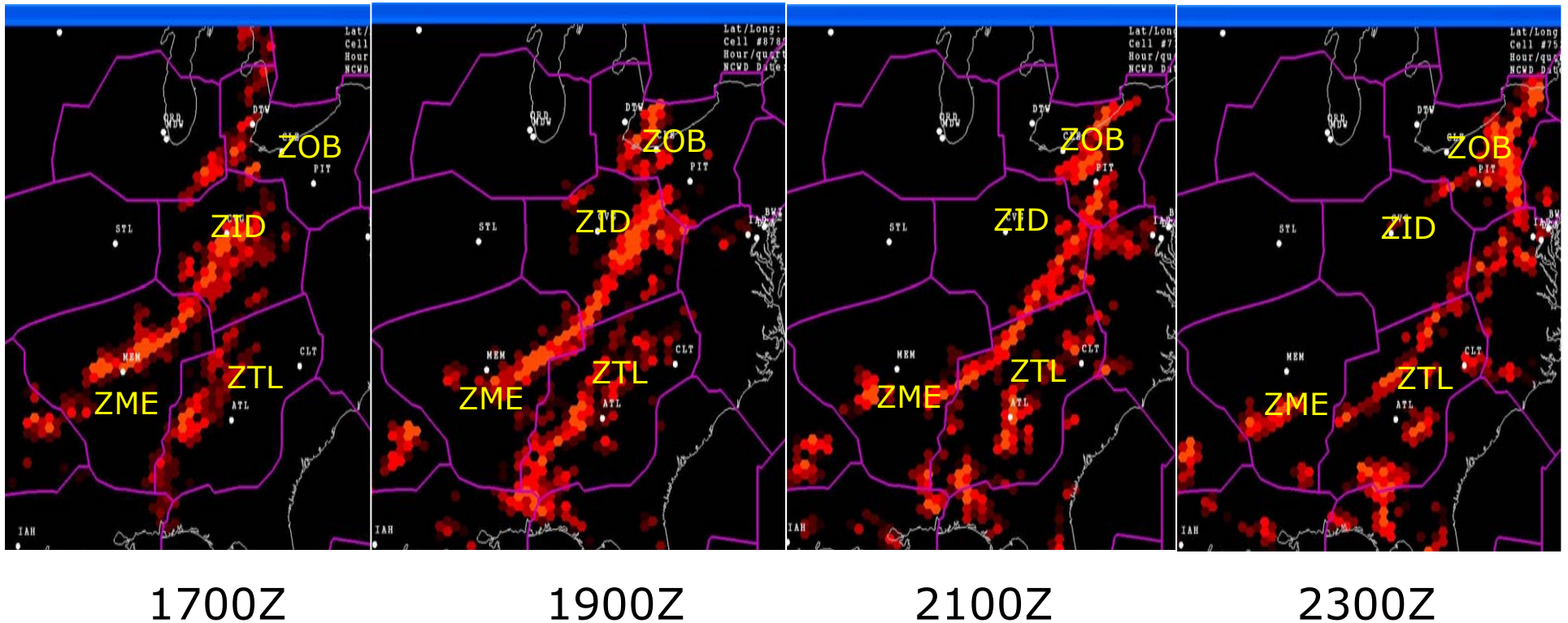
TMIs may have been imposed too early.

Capacity prediction is otherwise reasonable.

Airspace Capacity Loss Estimation

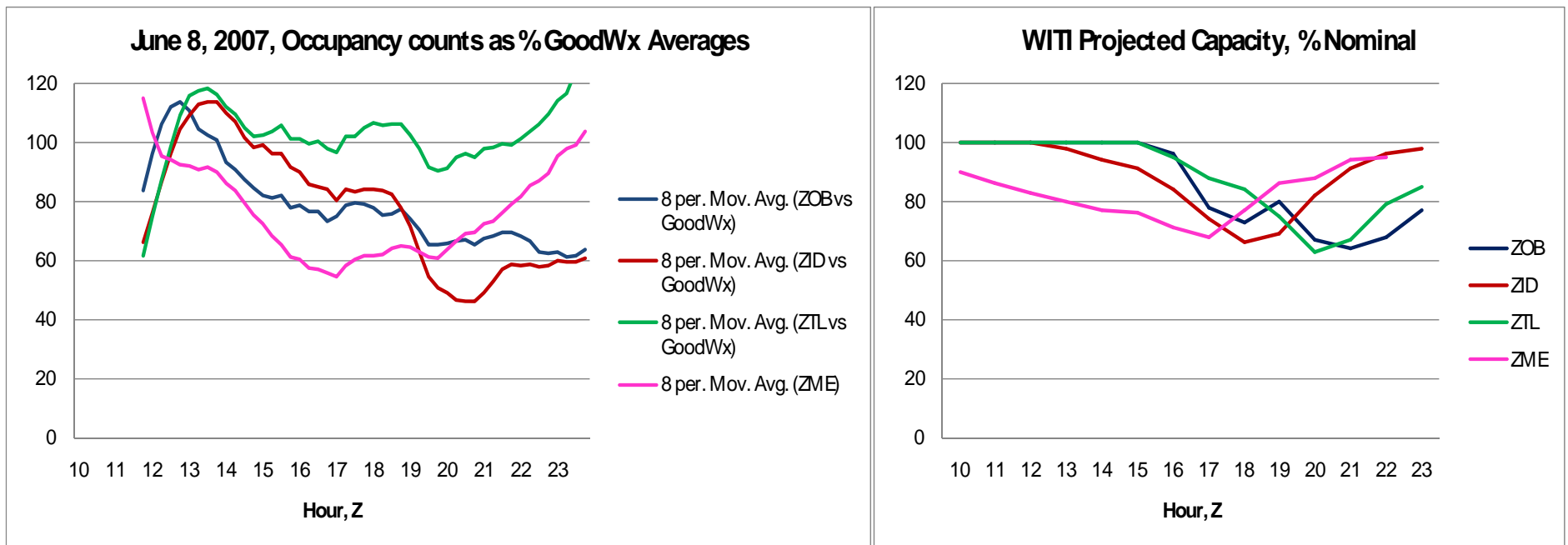
June 8, 2007: Solid Line of Wx, Heavy Impact

Convective situation at the start of the hour



Airspace Capacity Loss Estimation

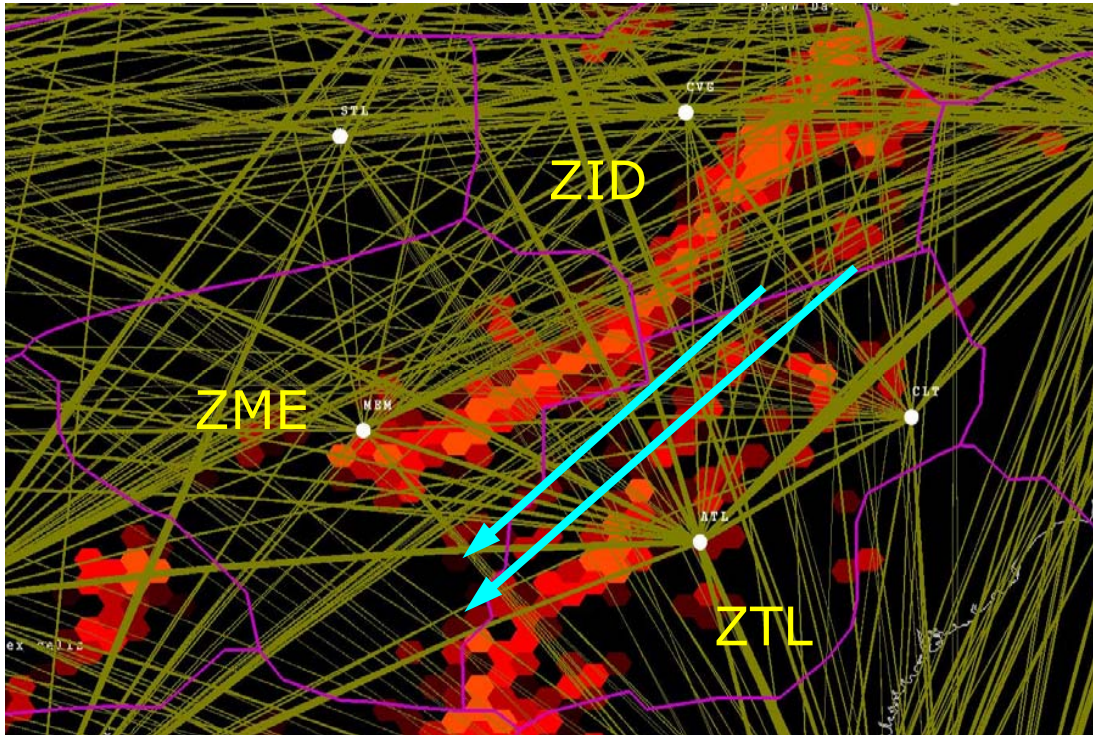
June 8, 2007, Heavy Impact



ZOB, ZID and ZME capacity prediction is reasonable (although ZOB recovery took place later than predicted).
ZTL capacity prediction is incorrect (actual occupancy counts are higher).

Airspace Capacity Loss Estimation

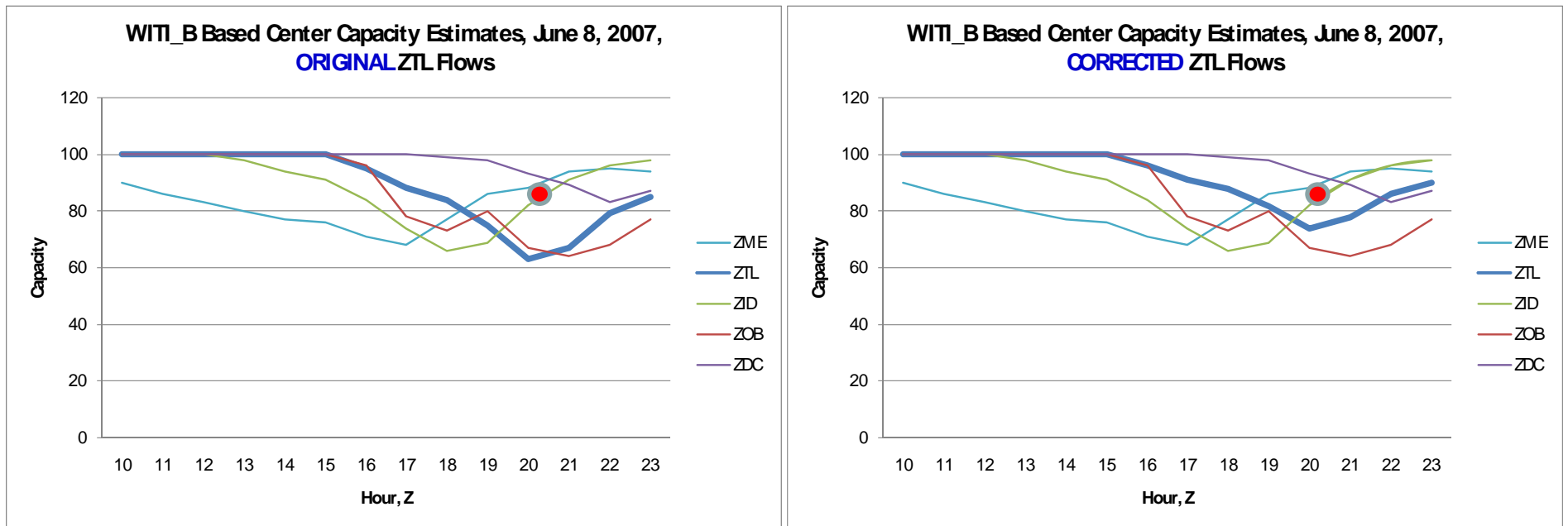
June 8, 2007: ZTL Capacity Prediction



Potential reroute (Playbook) flows added to reflect ZTL airspace availability

Airspace Capacity Loss Estimation

June 8, 2007: Corrected ZTL Flows

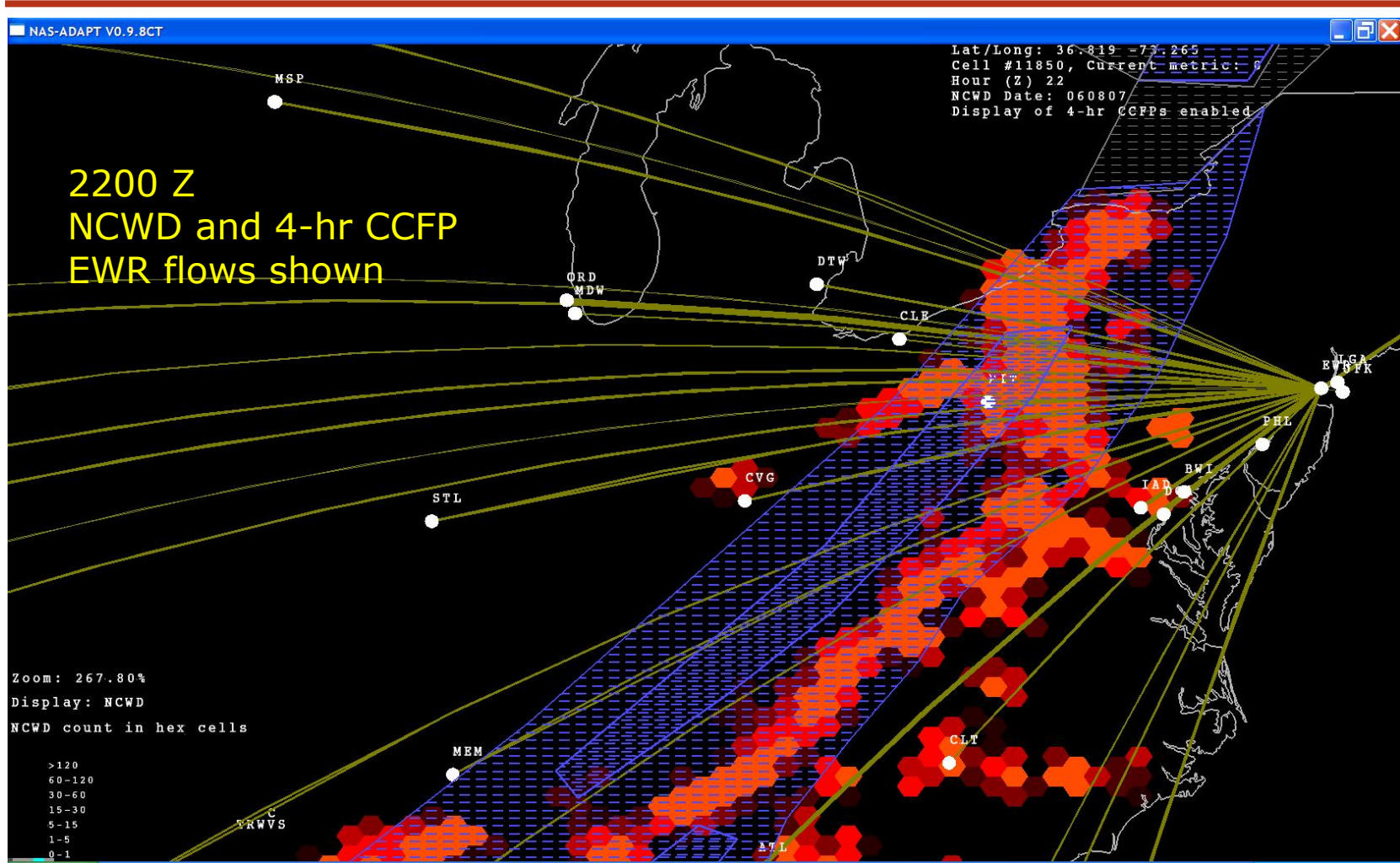


Adding several "reroute" flows improves ZTL capacity loss estimate (thick blue line, left chart)

● indicates lowest actual traffic count % in ZTL vs. good-Wx average

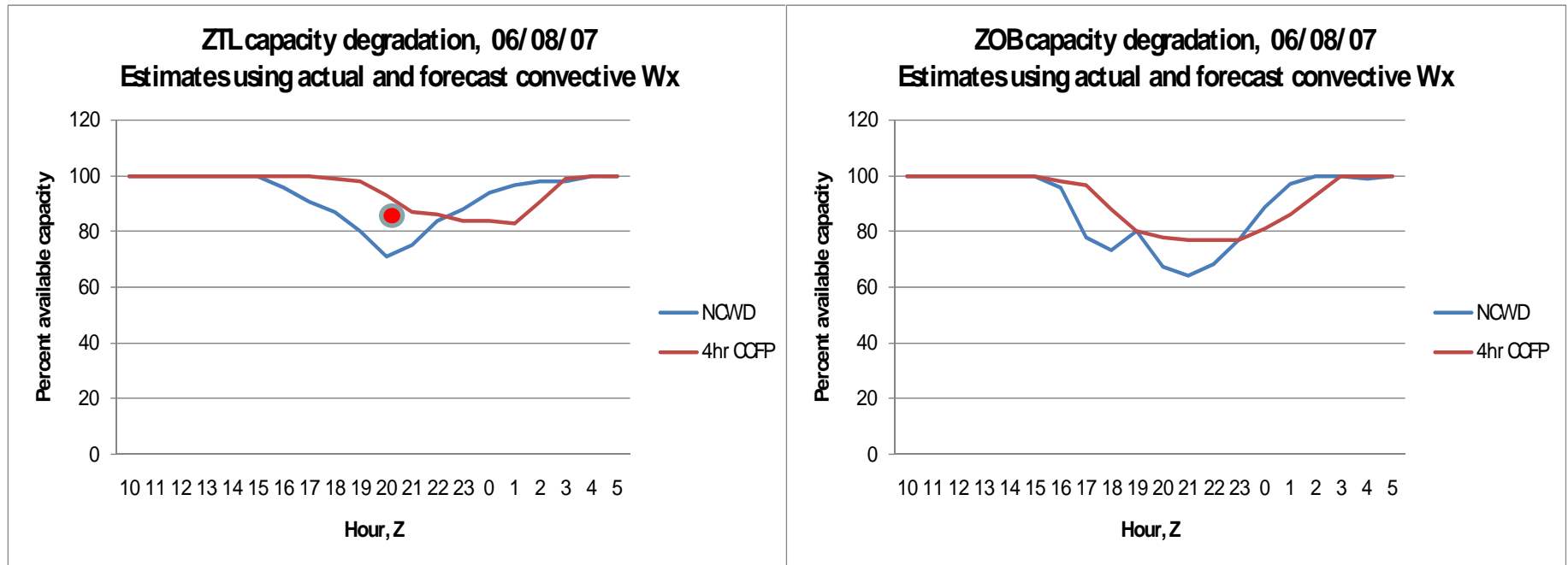
Airspace Capacity Loss Prediction

June 8, 2007: Using CCFP



Airspace Capacity Loss Prediction

June 8, 2007: NCWD vs CCFP sourced



For CCFP, “quasi-NCWD score” is computed for each hexagonal cell.

● indicates lowest actual traffic count % in ZTL vs. good-Wx average

Discussion

En-route WITI (E_WITI_B) method produces reasonable airspace capacity estimates for Centers

Validation by comparing to actual occupancy counts: caveats

Both actual and Convective Forecast Wx products can be used

- CCFP, NCWF-6, CIWS, other forecast products currently being analyzed

Currently researching this and alternative methods

- "Scanning algorithm" to be presented at DASC