



 *Air Traffic Analysis, Inc*

Predicting Weather Impact on Air Traffic

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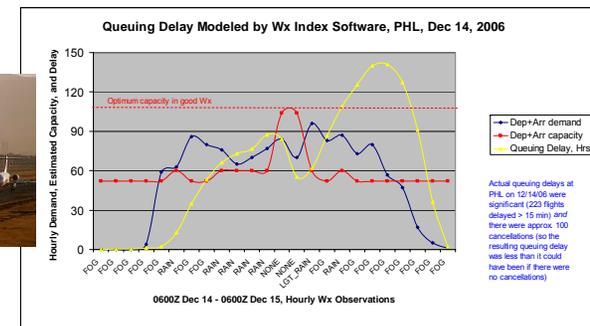
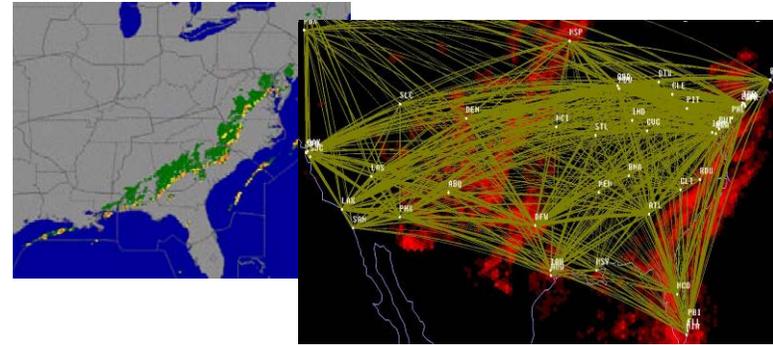
Weather / Traffic Impact Metric: *NAS Weather Index (NWX) including E-WITI*

NWX is a weighted sum of three components:

- **En-route Component (E-WITI)** reflecting impact of convective weather on major airports e.g. OEP-35 airports

- **Terminal Component (T-WITI)** for same airports: local weather impact

- **Queuing Delay Component** for same airports reflecting excess traffic demand vs. capacity



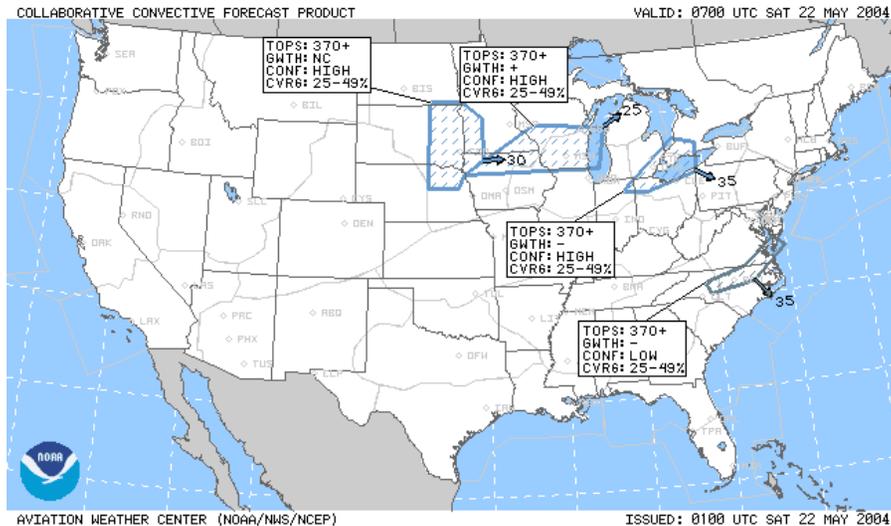
WITI-FA Project

Funded by NOAA/NWS, Coordinated with FAA

- Compare forecast and actual weather impacts on air traffic (*not just weather coverage!*) - “Deltas”
- Extend WITI methodologies to generate Forecast WITI using current convective weather forecast products
 - Start with CCFP
 - Expand to other products
 - “WITI-FA” (“Forecast Accuracy”)
- Conduct various analyses to assess the effectiveness of convective products and metrics

CCFP Background

CCFP Background



Embraced by the FAA and airlines as the cornerstone of severe weather planning for US Airspace operations

Creates common situational awareness

- Strategic planning tool for the 2 - 6 hour time frame
- Available March 1 through October 31
- A package of 3 forecast maps (sets of Areas) with lead times of 2, 4 and 6 hours
 - CCFP areas can have Low (25-49%) & High (50-100%) confidence
 - Sparse (25-49%), Medium (50-74%) & Solid (75-100%) coverage

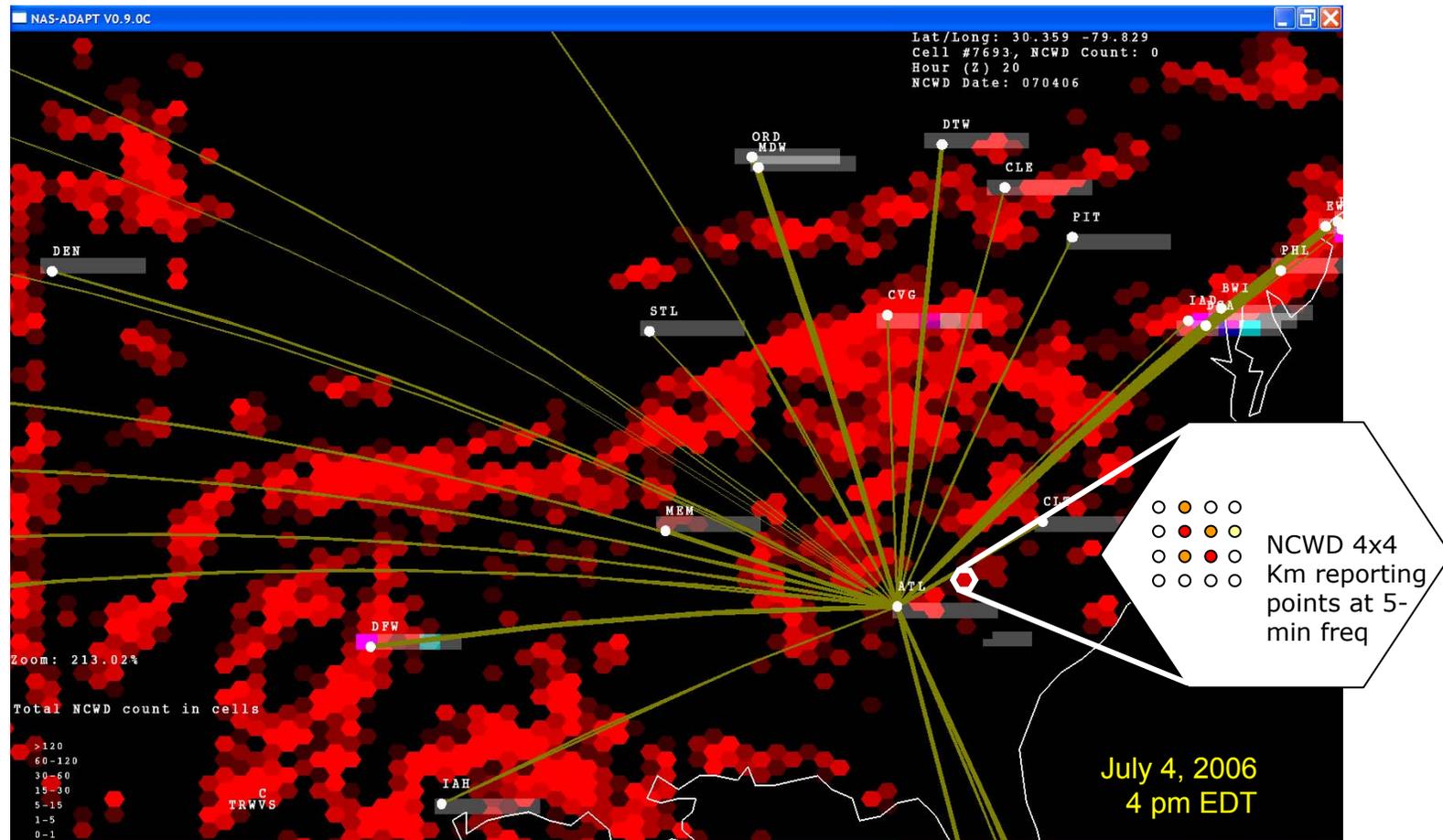
Focus on E-WITI (Convective Wx Impact)

Traffic Component and En-Route Weather

Hexagonal grid over a finer-grain NCWD mesh for Wx quantification

"Flows" for capturing en-route traffic

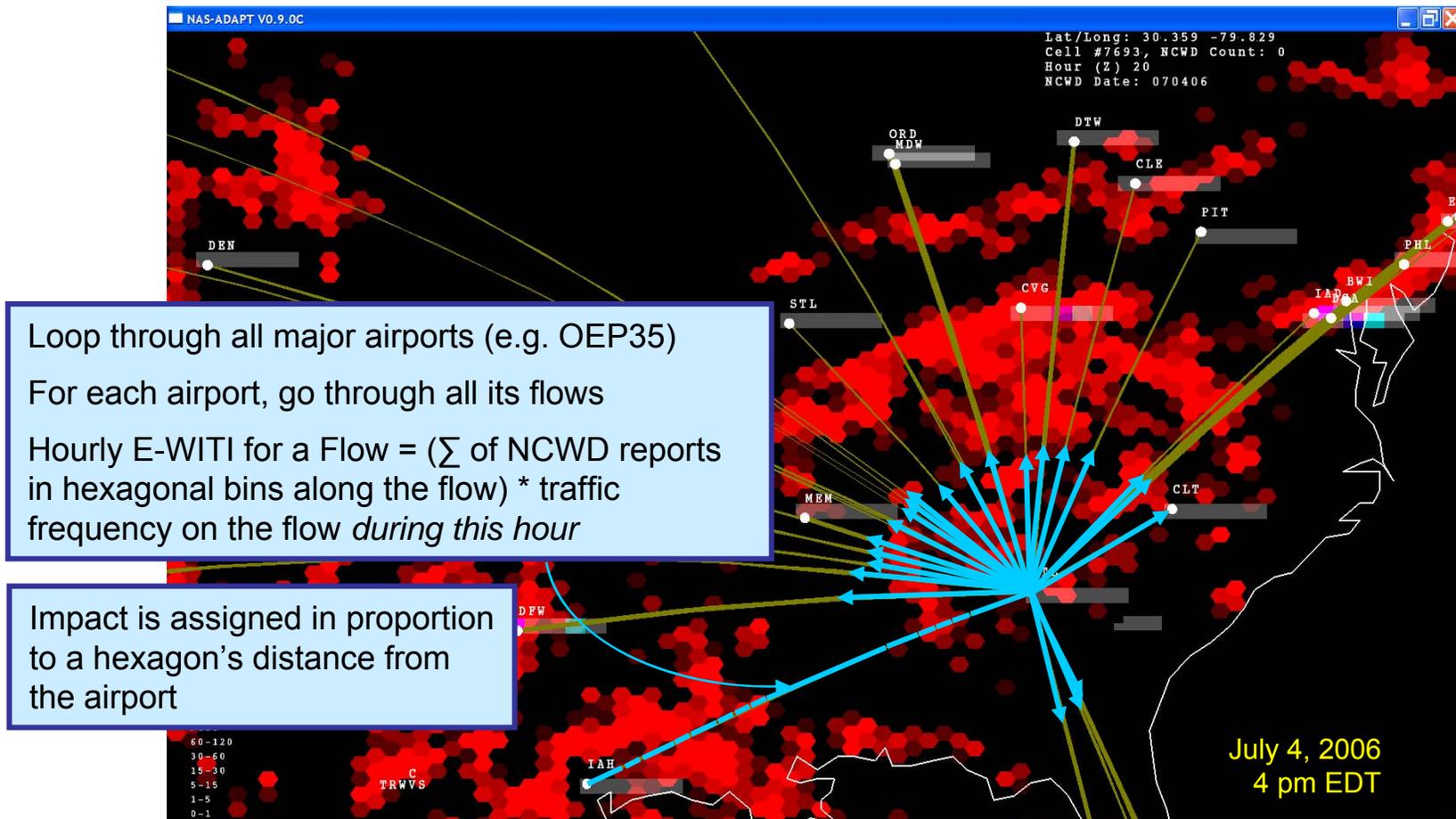
E-WITI = Scheduled flight frequency on flows X amount of convective Wx



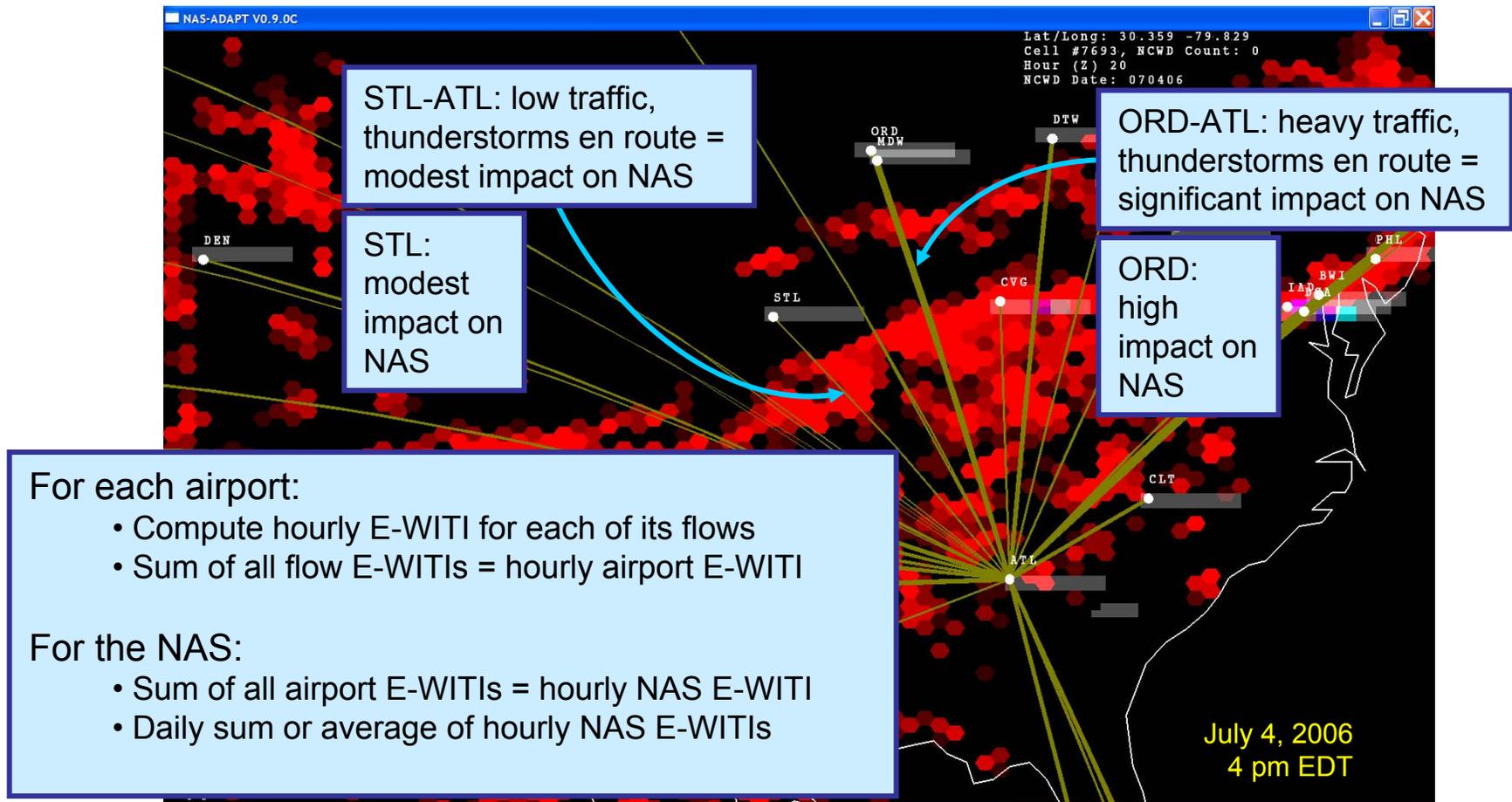
Airport E-WITI

Pushing WITI to Airports

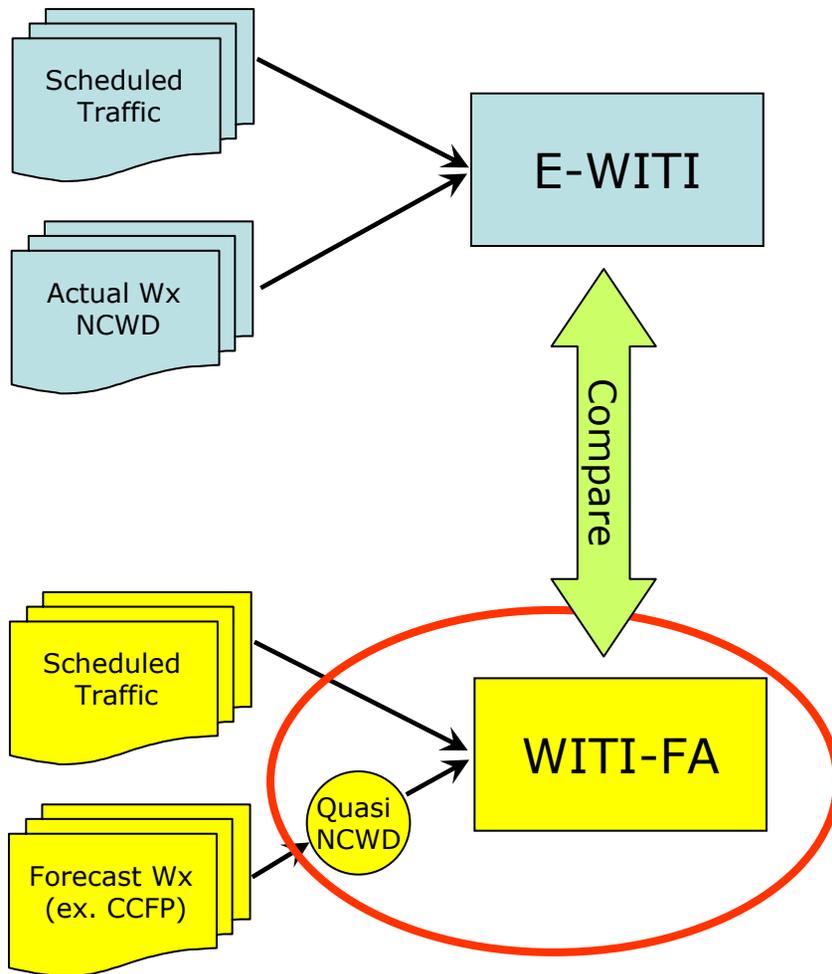
Just like delays originate and eventuate at airports



From Airport to NAS E-WITI



E-WITI vs. WITI-FA



We need to develop a Quasi-NCWD based on forecast weather, e.g. CCFP

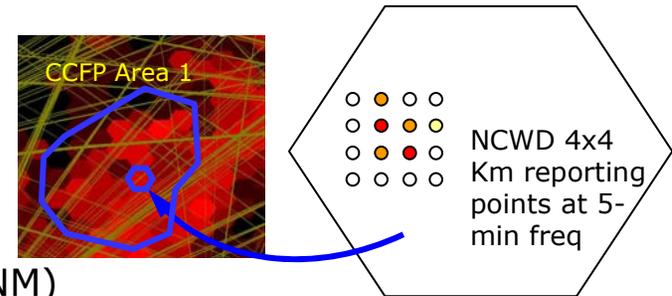
Then we can compare E-WITI with WITI-FA

Converting CCFP to Quasi-NCWD and Computing WITI-FA

Converting CCFP into Quasi-NCWD

Methodology (Slide 1 of 2)

- For each hexagonal cell inside a CCFP area:
 - Pre-compute how many 4x4 Km NCWD reporting points are in a hexagonal cell
 - Imagine that the CCFP area had 100% confidence and 100% coverage:
 - Each 4x4 Km reporting point inside this hexagon would be reporting convective Wx for the whole hour, every 5 min
 - For this hexagonal cell (diameter about 20 NM) the hourly “quasi-NCWD” score would be:



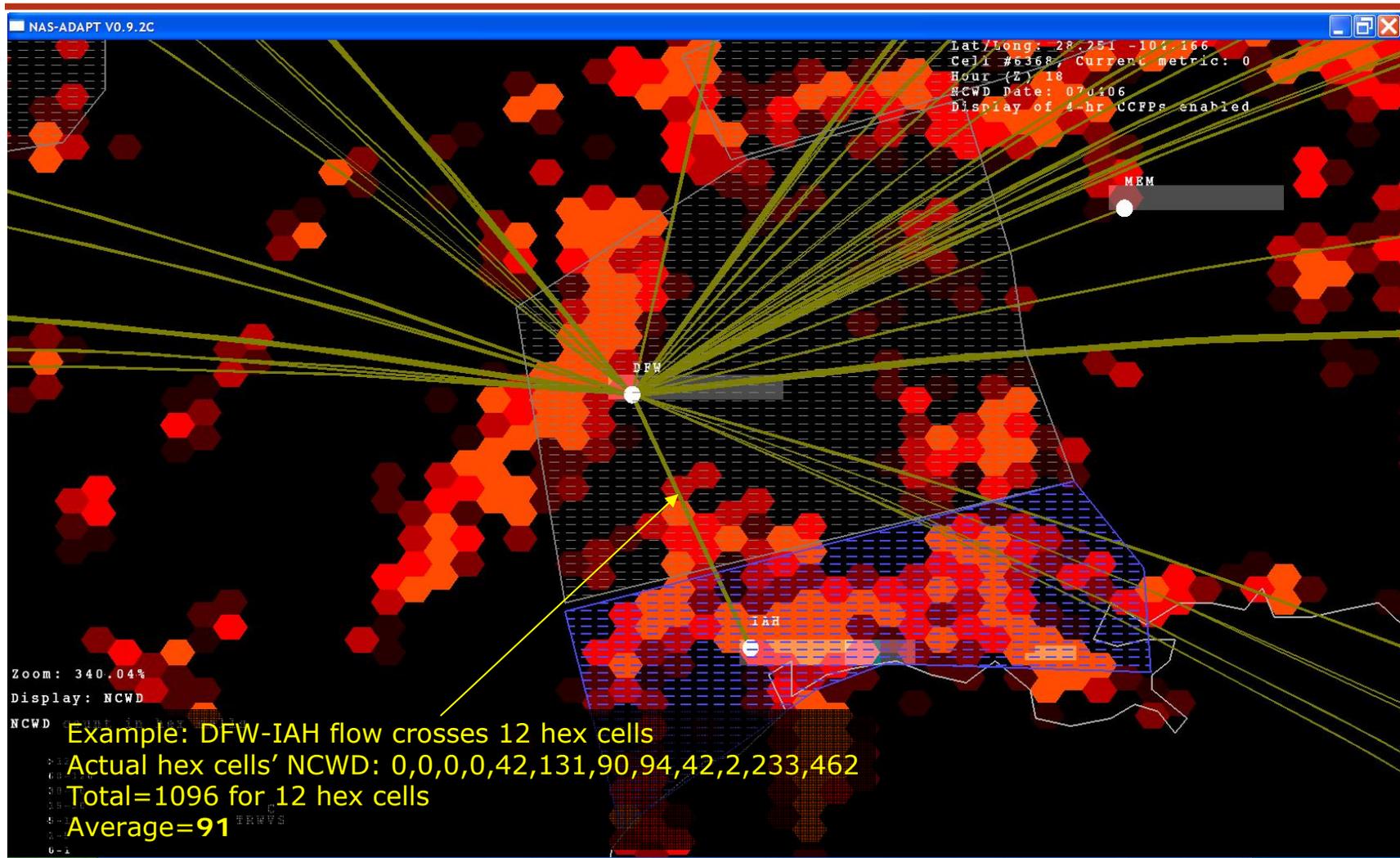
$$\text{hourly_quasi_NCWD_score_for_a_hex_cell_in_100\%_CCFP_area} = \text{num_5_min_reports_in_1_hr} * \text{num_4x4_Km_points_in_hex_cell}$$

- But our CCFP has a confidence level < 100% and coverage < 100%
- So:

$$\text{hourly_quasi_NCWD_score_for_a_hex_cell_in_actual_CCFP_area} = \text{num_5_min_reports_in_1_hr} * \text{num_4x4_Km_points_in_hex_cell} * \text{confidence_coef} * \text{coverage_coef}$$

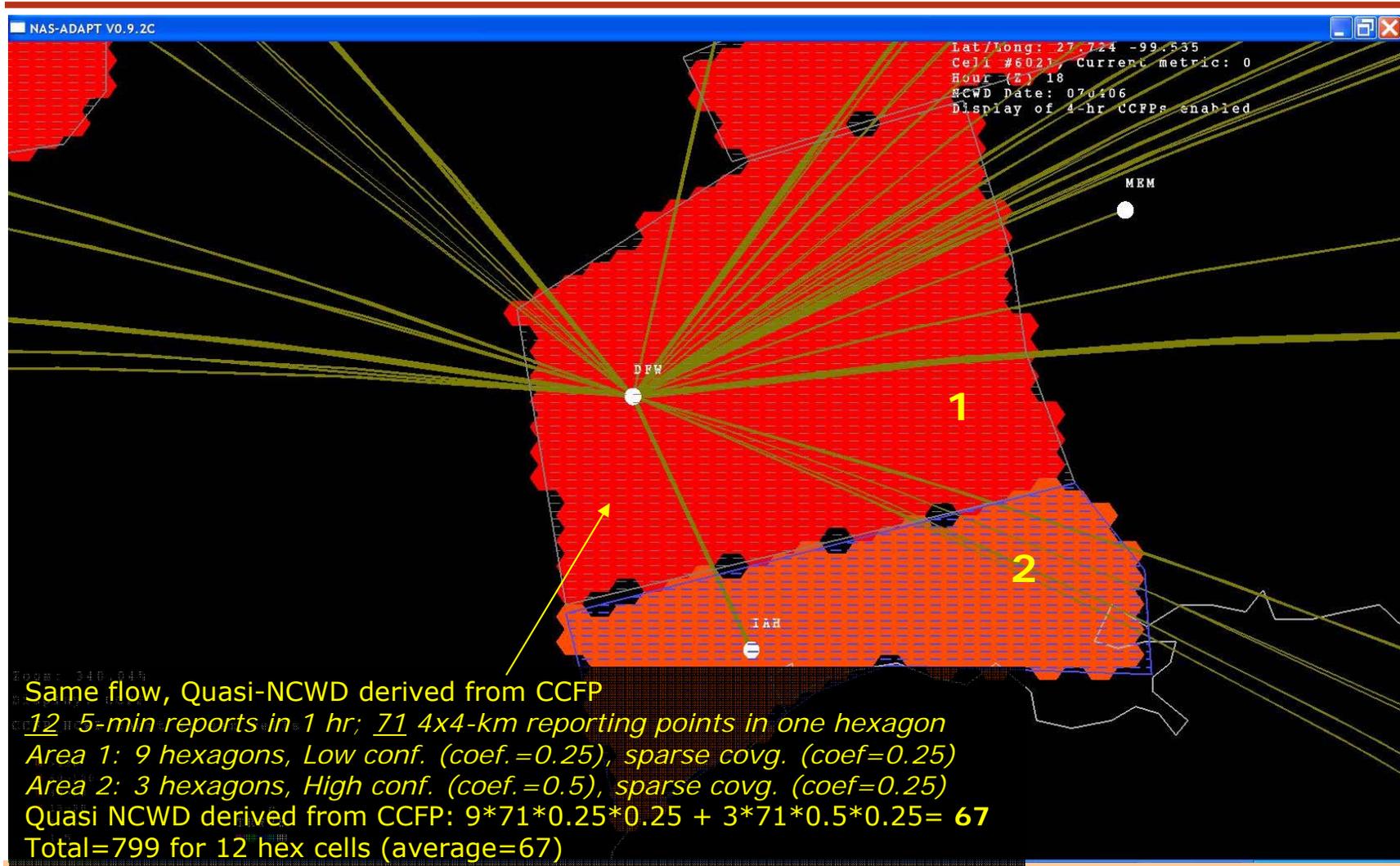
Computing E-WITI from Actual NCWD

Only DFW flows shown for clarity (2100z)



Computing WITI-FA from 2-hr CCFP

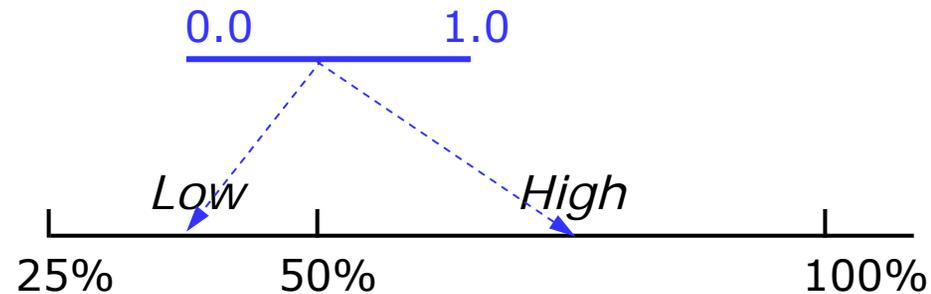
Same method as for "normal" E-WITI



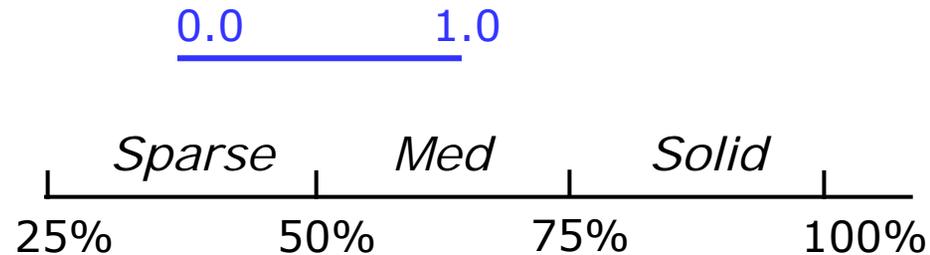
Converting CCFP into Quasi-NCWD

Coefficients ("Sliders")

Confidence
Slider



Coverage
Slider

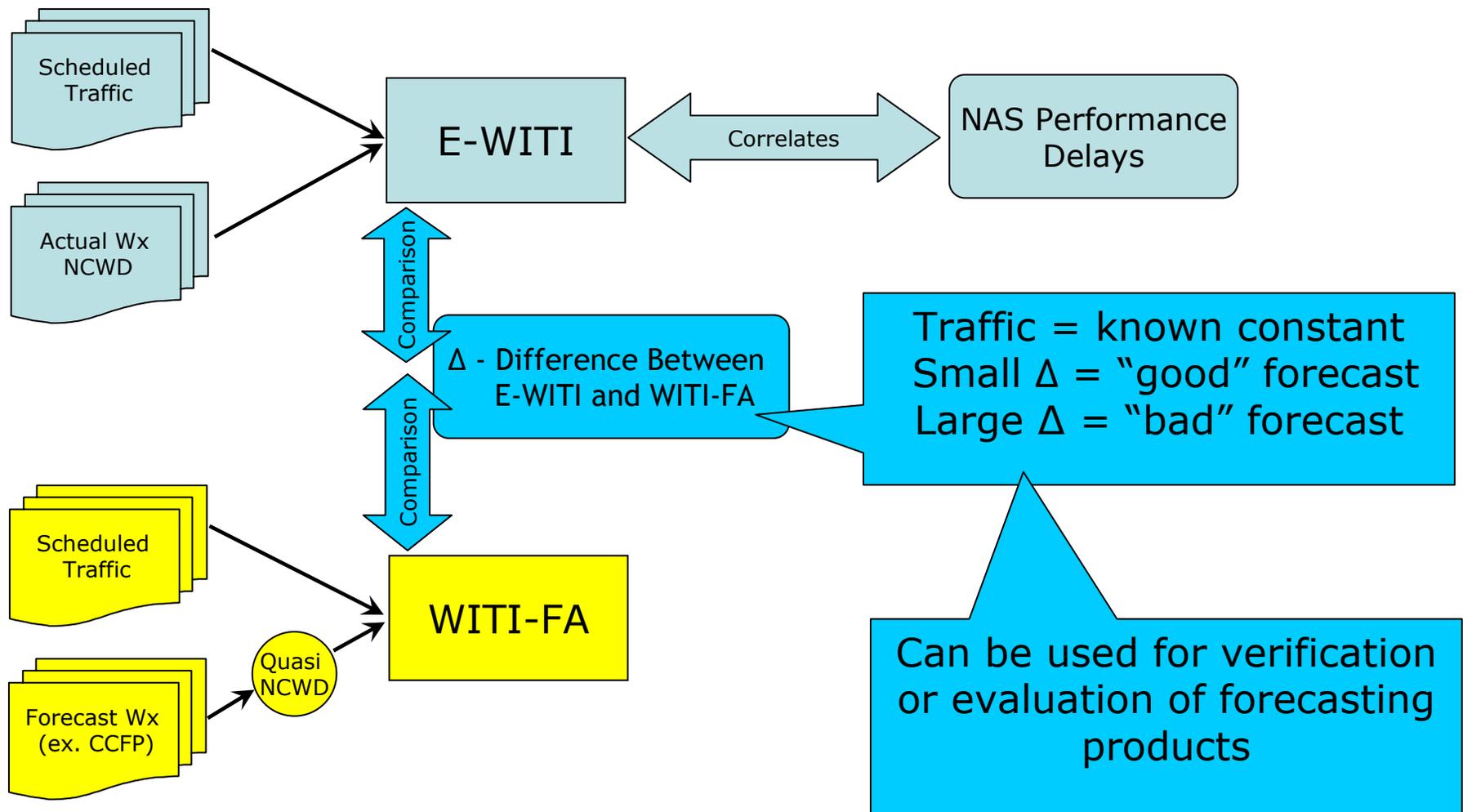


$\text{confidence_coef} = \text{CONF_LOW_START} + \text{ccfp_conf_adj_slider} * (\text{CONF_LOW_END} - \text{CONF_LOW_START});$

Conf and Covg sliders:

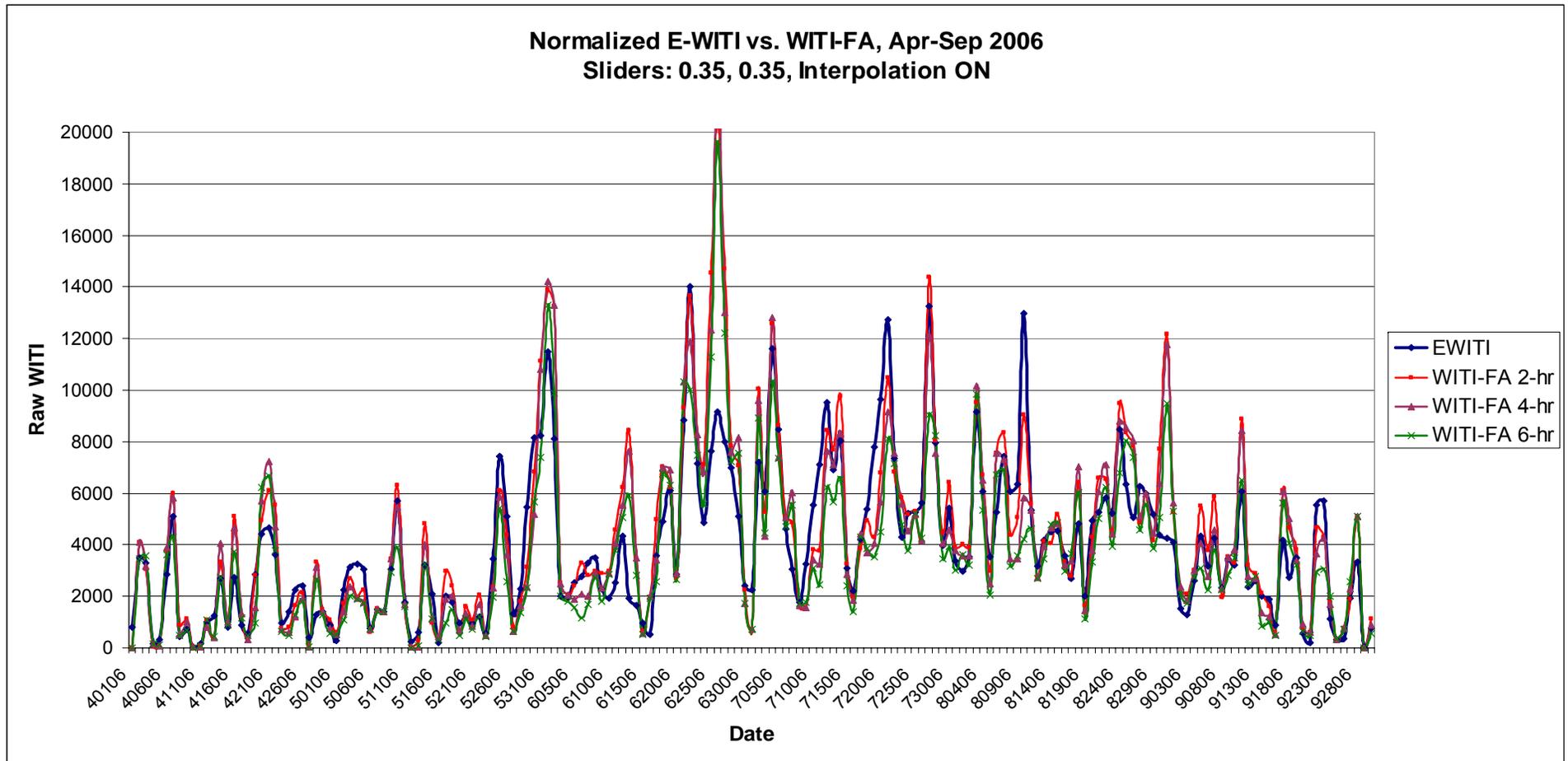
- user-definable
- generally vary between 0 (Lowest end) and 1 (Highest) but can be set to < 0 or > 1 if desired

E-WITI vs. WITI-FA



2006 E-WITI vs. WITI-FAs

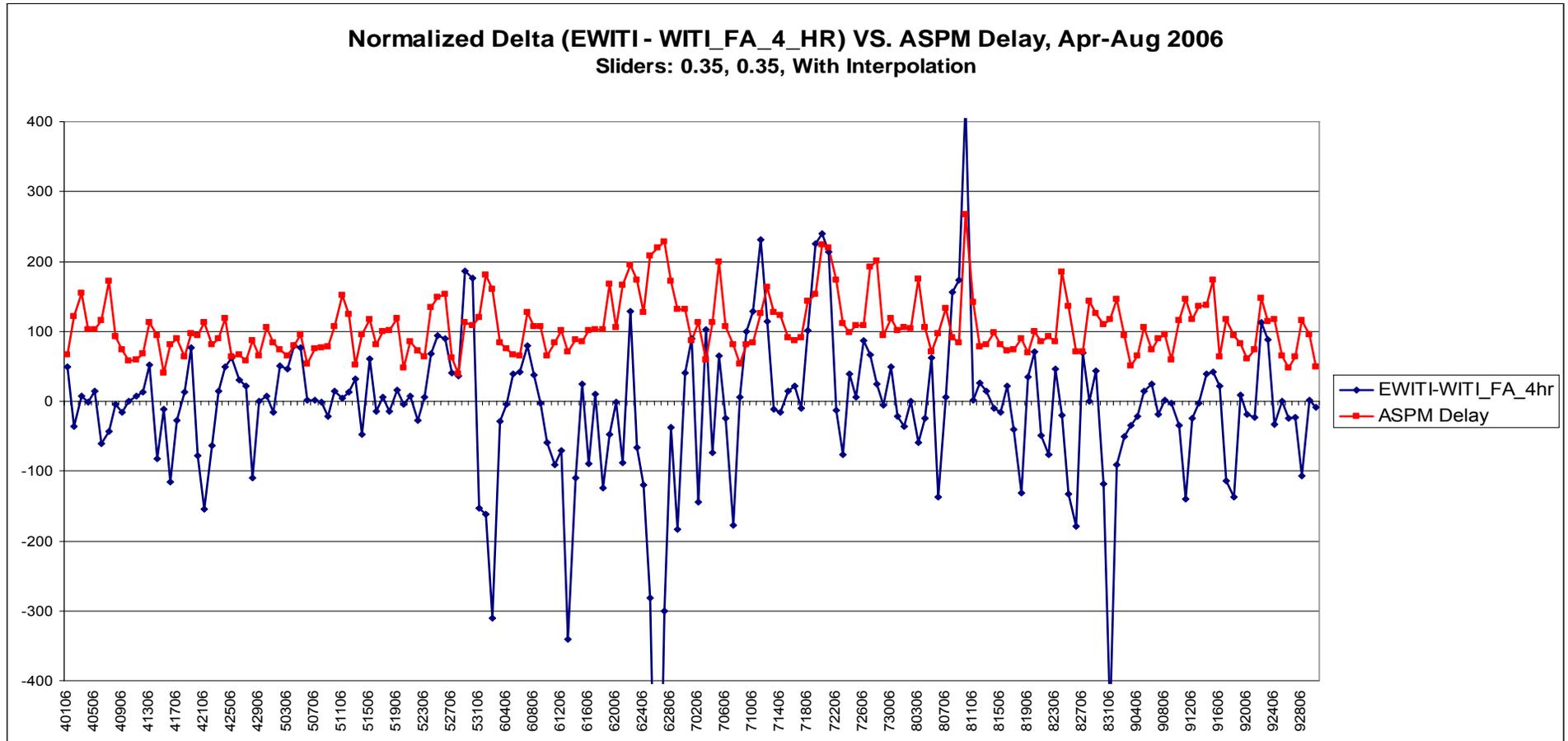
Correlation



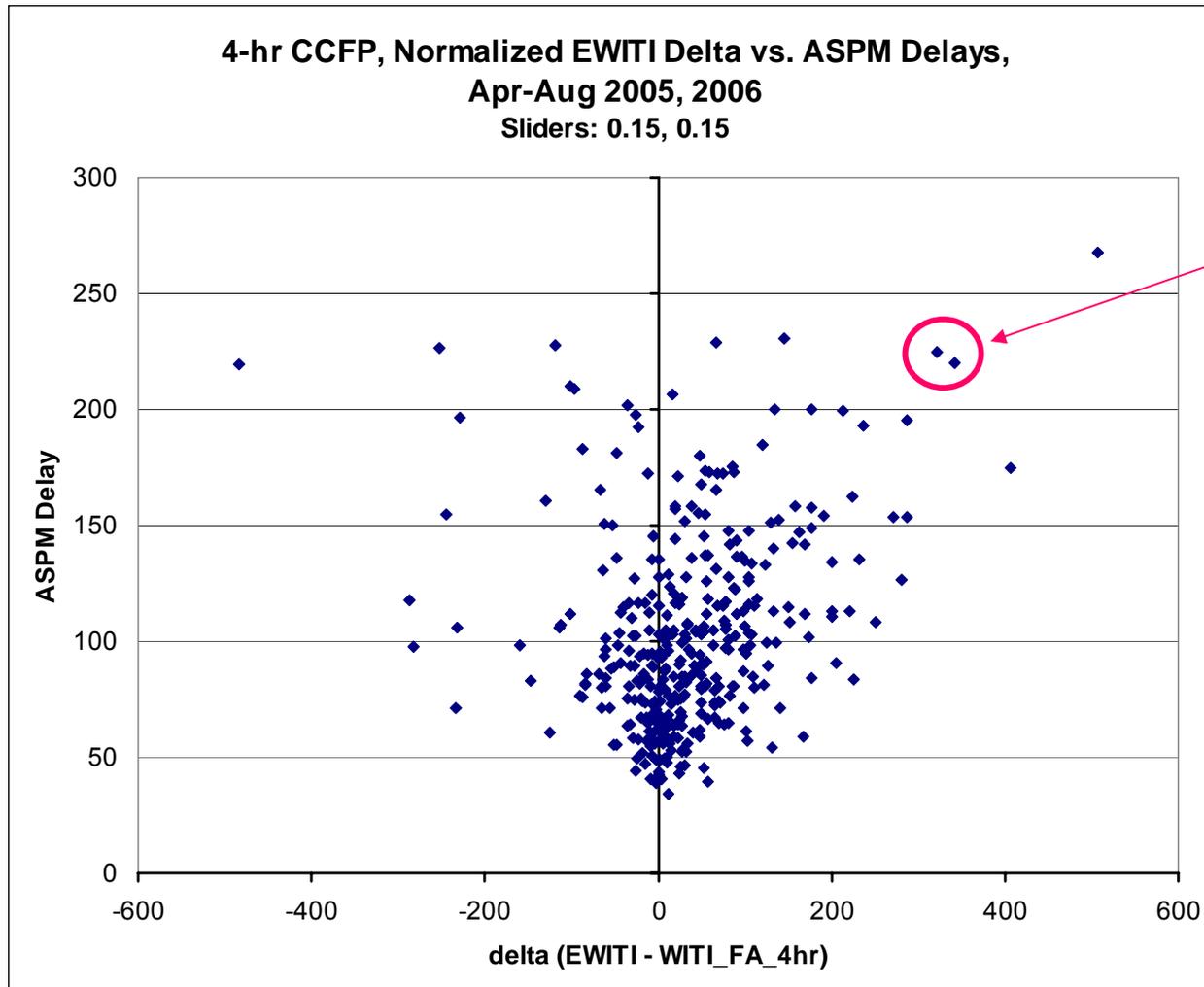
Initial Analysis of WITI “Delta” vs. NAS Delay

2006 Delta WITI vs. ASPM Delay

E-WITI - WITI-FA (4-hr CCFP)



2005 and 2006 Delta WITI vs. Delay Based on 4-hr CCFPs

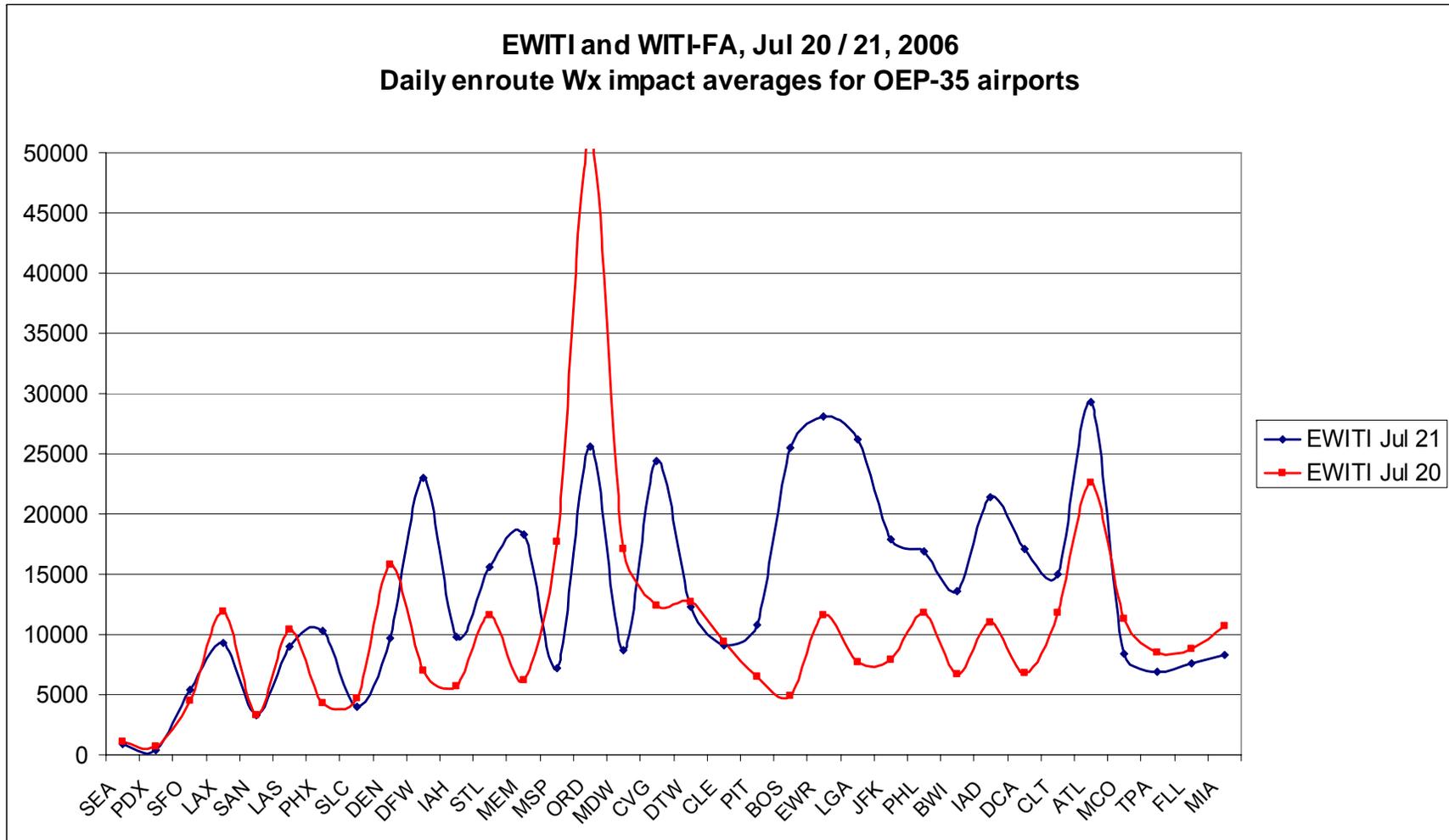


These are two consecutive days: July 20 and 21, 2006

Similar Delta, similar delay: are these two days similar?

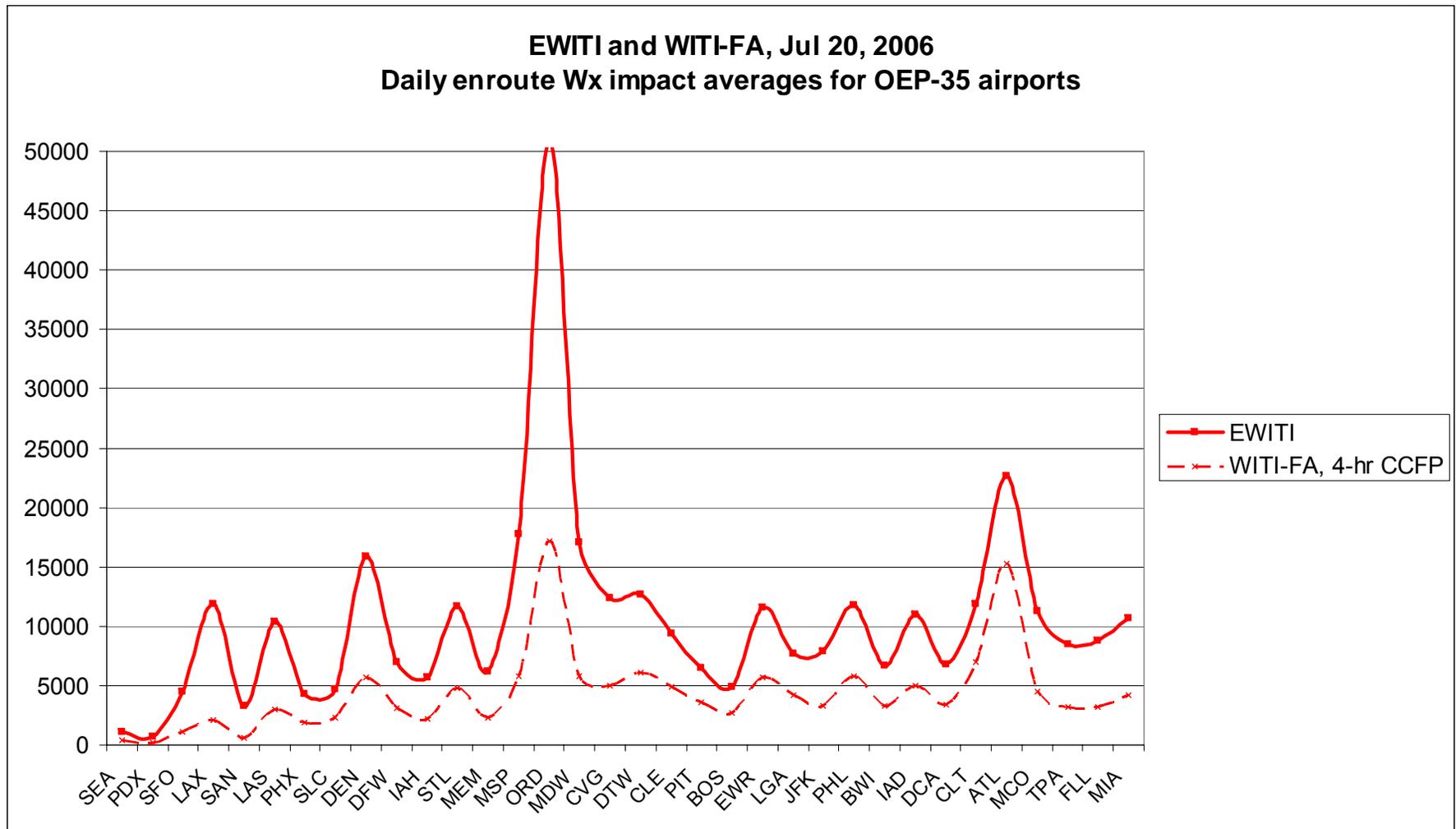
2006 July 20, 21

EWITI Shows Impact on Different Areas of NAS (Daily Averages for OEP-35 Airports)



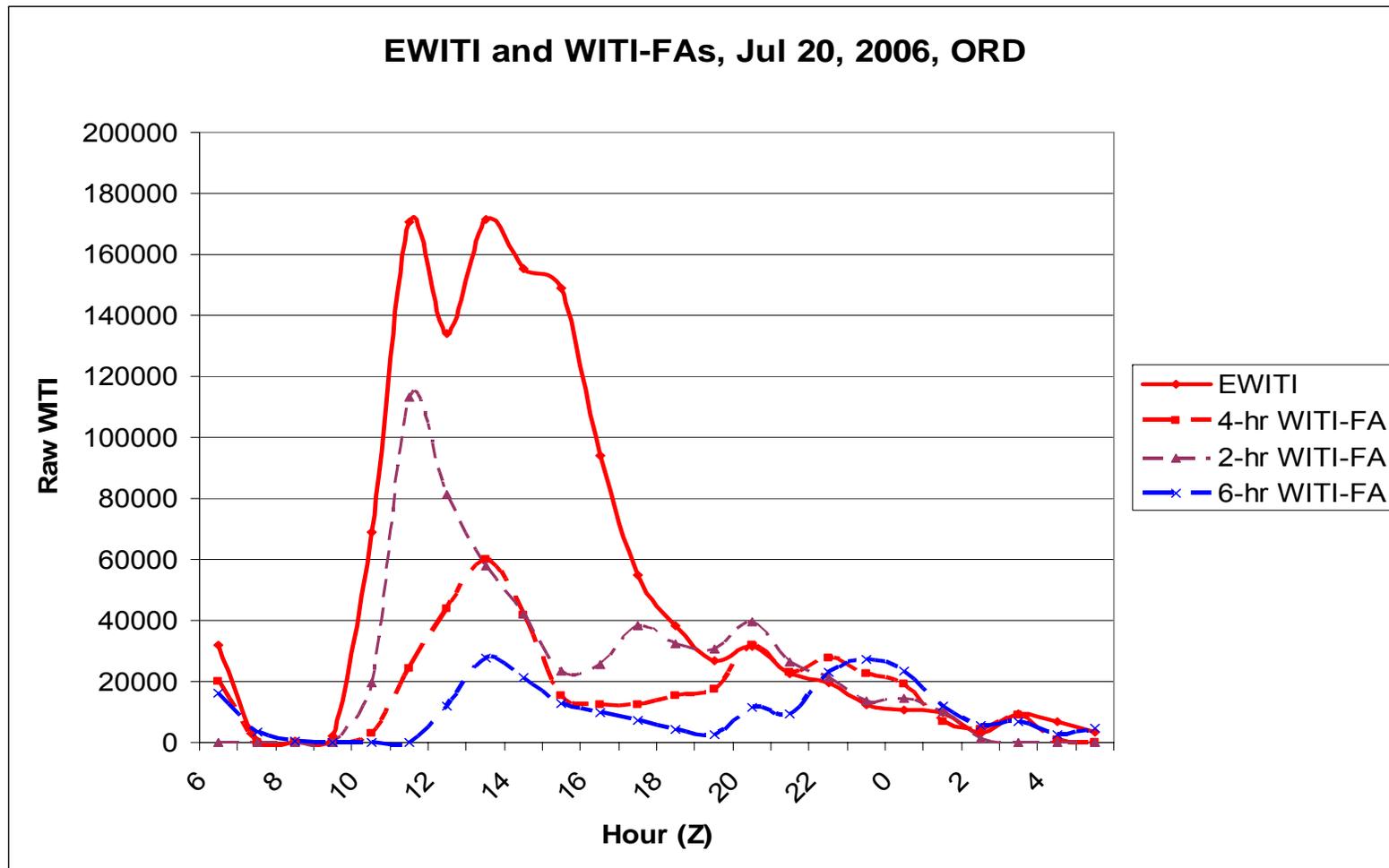
2006 July 20

EWITI vs WITI-FA (4-hr CCFP) Airport Averages



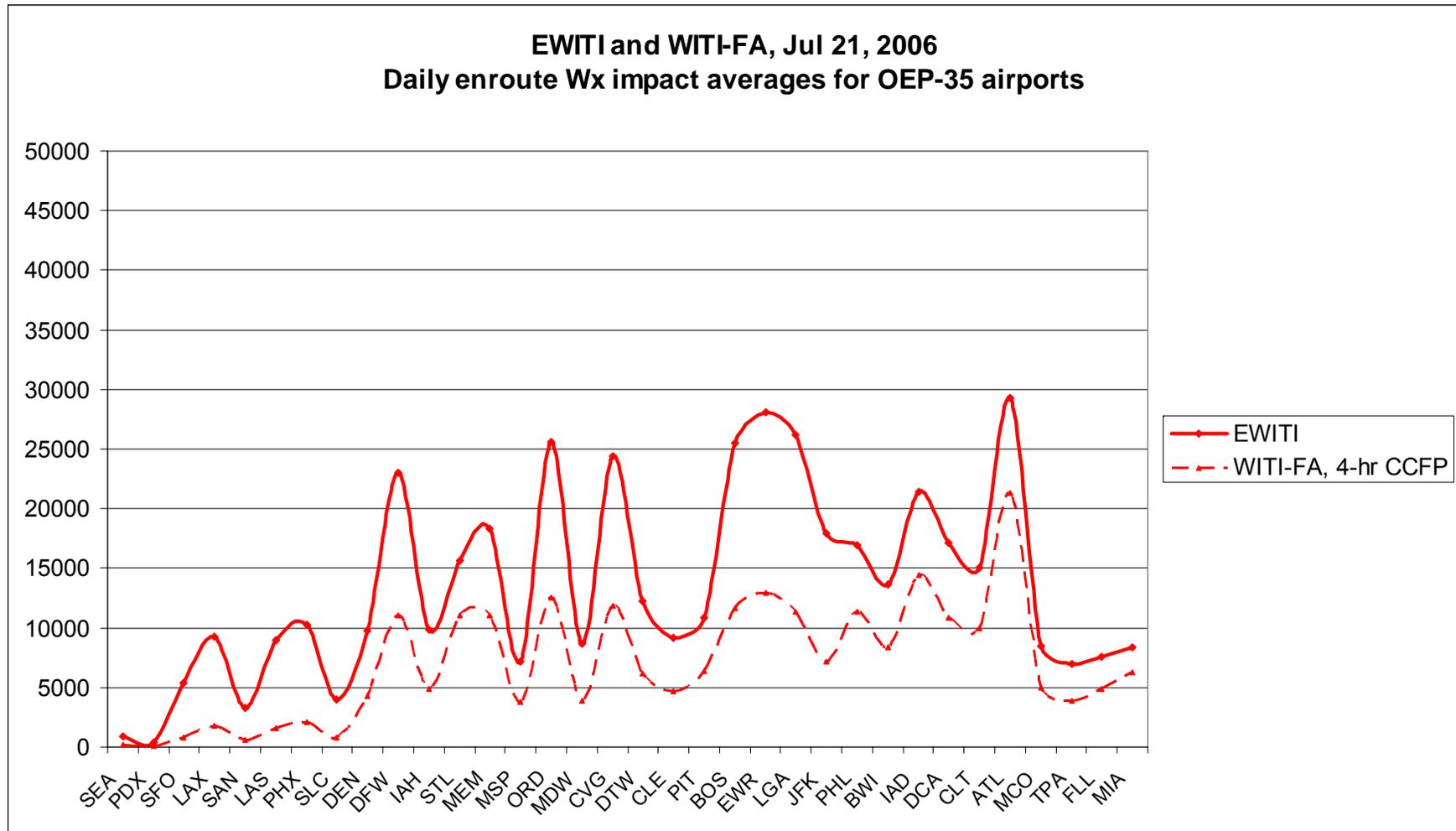
2006 July 20

Hourly WITI vs. WITI-FA (2,4,6-hr CCFP) at ORD



2006 July 21

EWITI vs. WITI-FA (4-hr CCFP) Airport Averages



Back-up Slides

1-hr "Interim" CCFP Estimation

No Interpolation / With Interpolation

CCFP is provided in 2-hr chunks

NCWD-based E-WITI is computed in 1-hr chunks

Need to fill these 1-hr gaps which would allow for smoother computation and comparison of "apples to apples"

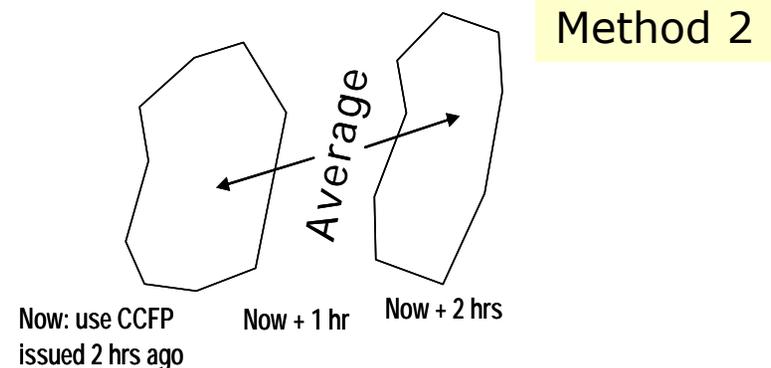
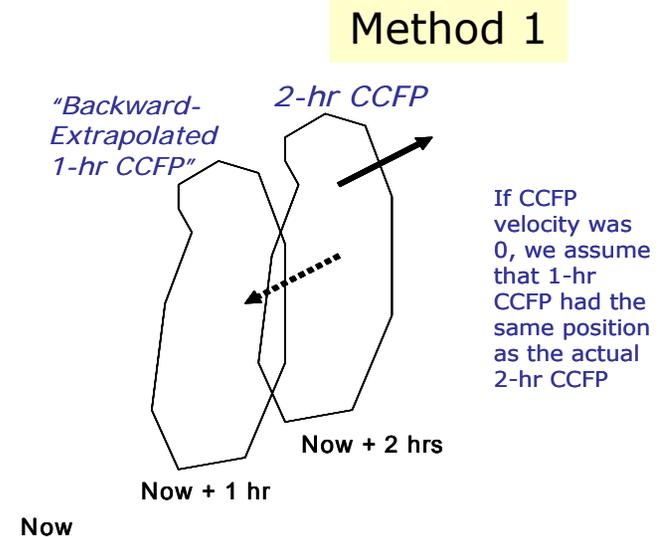
Two Quasi-NCWD calculation methods:

1) No interpolation, use CCFP velocity vectors

Extrapolate backward from current 2-hr forecast using CCFP velocity vector (if no vector, 1-hr interim position is considered same as 2-hr)

2) With interpolation

Use the average between two consecutive 2-hr CCFP predicted positions to estimate 1-hr "interim" positions



Assigning En-Route Wx Impact to Airports

Assigning impact in proportion to distance from airport to Wx

Calculation:

- Severe Wx along each route between airports A & B impacts them *both*
- The further the Wx is from airport, the less the impact
- We use a cut-off distance

