ato
AIR TRAFFIC ORGANIZATION

NAS Weather Index

[Previously Weather Impact Traffic Index (WITI)]

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November 2006

** Graphics throughout courtesy CSSI/Air Traffic Analysis

Content

- WITI Components
  - Enroute
  - Terminal
- System Performance
- Sample Analyses
- Future Plan

WITI Background/Purpose

Need/Objective:

- Compare NAS performance over differing time intervals with differing weather and demand

Intent:

- Engage operational service units and customers in dialogue focused on overall system performance to gain consensus on “good” vs. “bad” days, weeks, seasons.
  - The outcome of the discussions aimed at developing specific plans to identify, analyze and take action to elevate system performance at the best investment level.

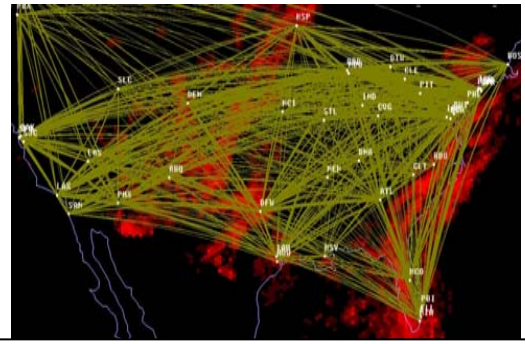
Strategy:

- Develop a suite of measures that reflect macro-level:
  - Weather [en route & terminal, including convective and airport specific]
  - Forecast Accuracy
  - Operational Impacts/Constraints [e.g.; interdependent operations, etc]
  - Operational Response – impacts imposed on customers in response to the above elements

Weather / Traffic Impact Metric: Q-WITI

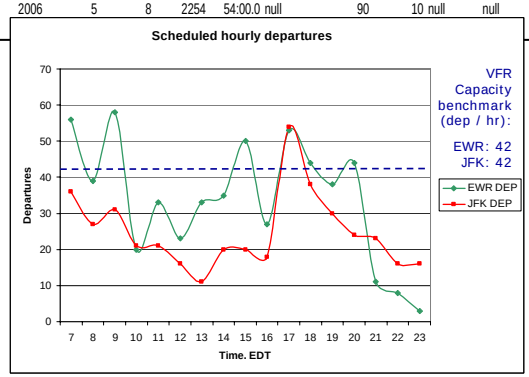
Weighted sum of 3 components:

- **<u>En-route WITI</u>** reflecting impact of convective weather on major airports e.g OEP35
  - Linear impact (more Wx, more traffic = proportionally higher impact)
- **<u>Terminal WITI</u>** for same airports: local Wx impact
  - Linear impact
- **<u>Queuing Delay</u>** for same airports reflecting excess traffic demand vs. capacity
  - May be exacerbated by reduced capacity due to local Wx and en-route Wx
  - <u>Non-linear</u> (exponential) impact



KPHL	2006	5	8	1654	54:00.0	null	75	10	null	null	10	17	1	null	8	14	34	70	15
KPHL	2006	5	8	1754	54:00.0	null	100	10	null	null	10	17	1	null	8	14	34	80	14
KPHL	2006	5	8	1754	54:00.0	null	100	10	null	null	10	17	1	null	8	14	34	80	14
KPHL	2006	5	8	1854	54:00.0	null	80	10	null	null	10	17	1	null	8	14	34	80	13
KPHL	2006	5	8	1954	54:00.0	null	80	10	null	null	10	16	1	null	7	13	36	60	10
KPHL	2006	5	8	2054	54:00.0	null	85	10	null	null	10	16	-1	null	7	13	31	60	10
KPHL	2006	5	8	2054	54:00.0	null	85	10	null	null	10	16	-1	null	7	13	31	60	10
KPHL	2006	5	8	2154	54:00.0	null	85	10	null	null	10	16	-2	null	7	13	29	60	10
KPHL	2006	5	8	2254	54:00.0	null	90	10	null	null	10	14	-3	9	5	12	31	70	9
KPHL	2006	5	8	2254	54:00.0	null	90	10	null	null	10	14	-3	9	5	12	31	70	9
KPHL											10	14	-3	8	5	12	31	80	11

METAR

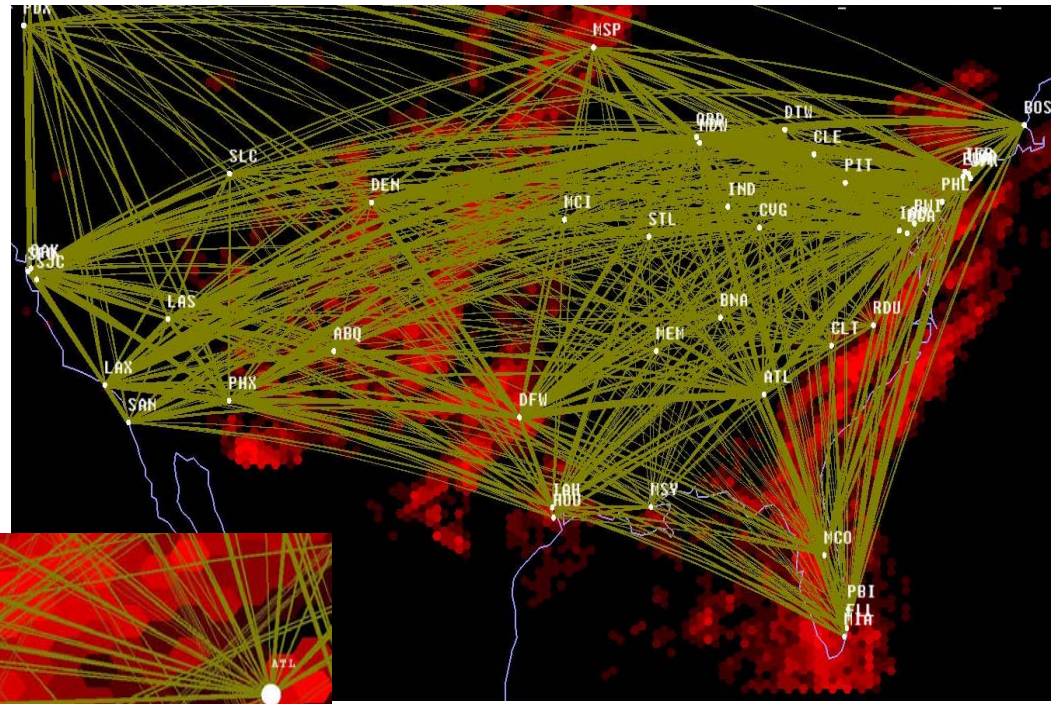


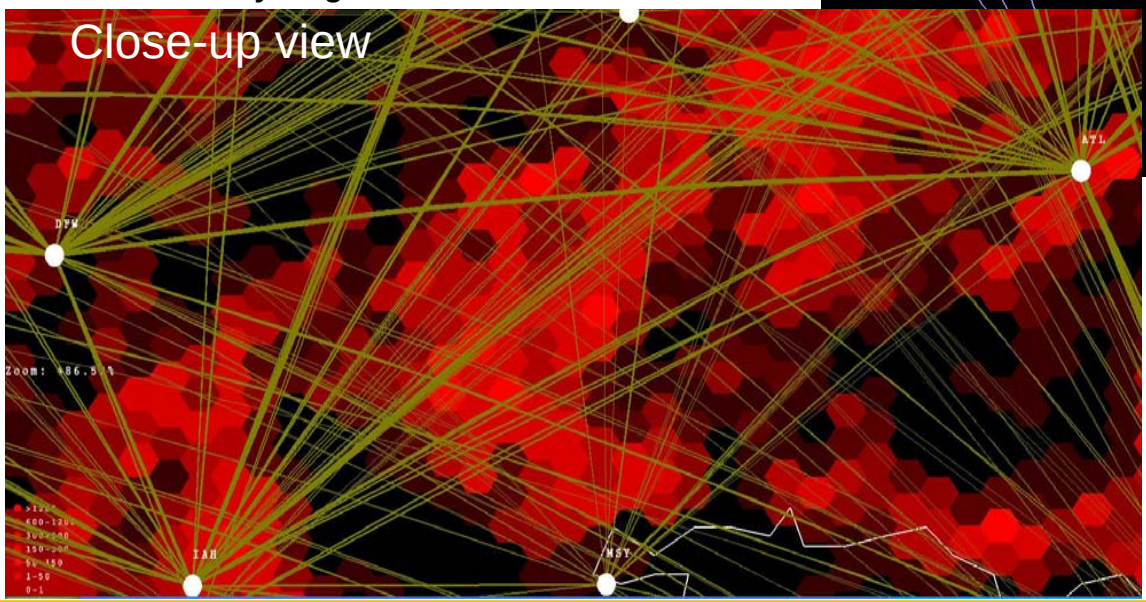
Traffic Component and En-Route Wx

Using “Flows” (Great Circle tracks between OEP35, OpsNet45 or ASPM75 airports)

E-WITI Calculation:

- Find intersections of each flow (GC track) with convective Wx
- Multiply number of convective reports in grid cells by # of hourly flights for each flow





En-Route Wx: NCWD

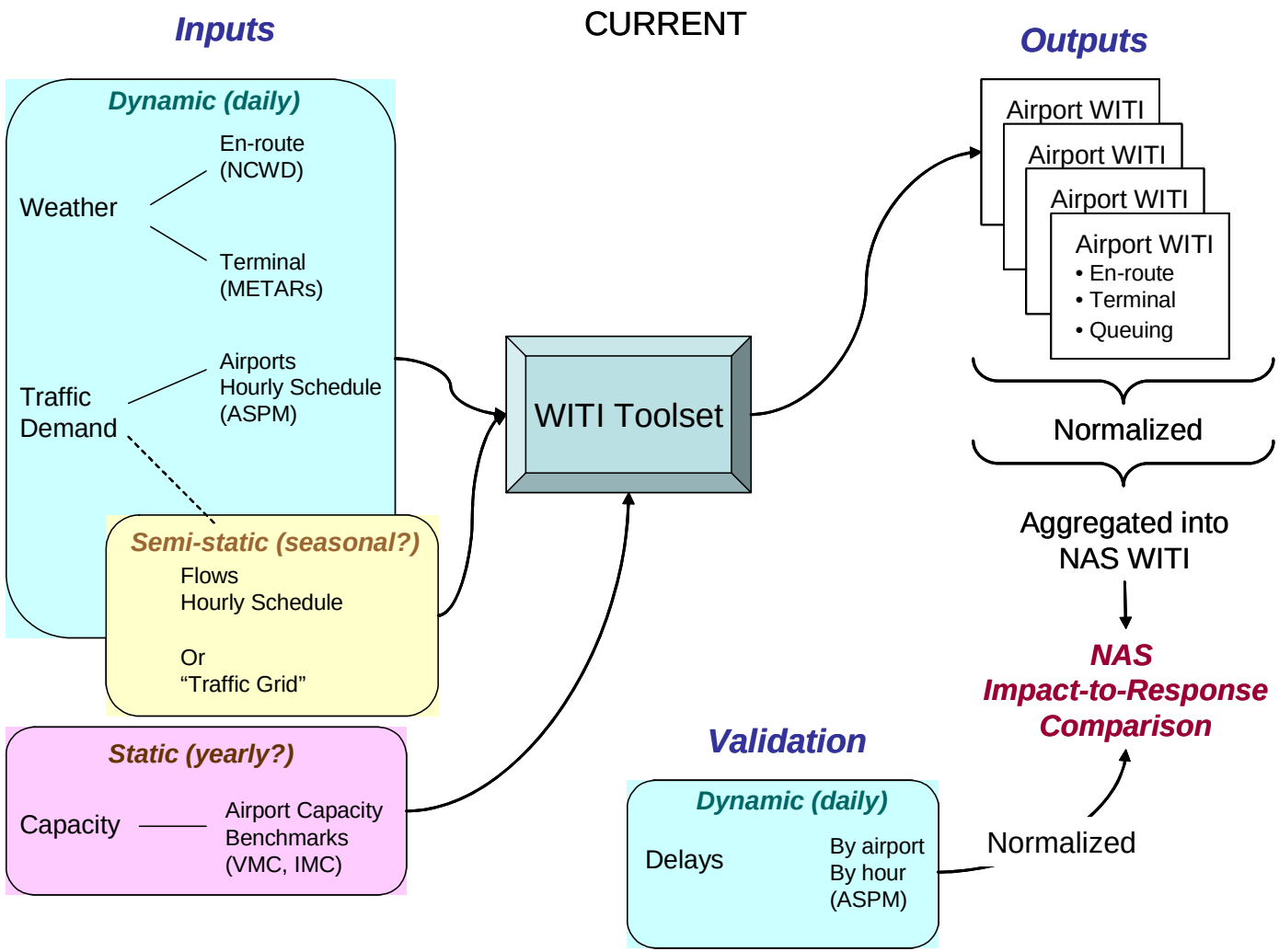
Traffic:

- ETMS for Flows
- ASPM for Airport Demand

Terminal Weather Component

- For each of N major airports (e.g. OEP-35), use hourly METAR data on:
  - Type of precipitation (e.g. heavy snow, thunderstorm, drizzle, freezing rain)
  - Wind
  - Visibility and cloud ceilings
- For weather that induces IMC (CIGS/VSB/RAIN/SNOW/etc):
  - Use FAA data on capacity degradation % (varies by airport)
- For other Wx types, define "% capacity degradation":
  - Major degradation: local thunderstorm, high winds, heavy snow
  - Significant degradation: heavy rain, snow, freezing rain, strong wind etc
  - Some degradation: e.g. moderate wind
- Then, for each airport, every hour:
  - Multiply total hourly operations by % capacity degradation
  - Result is Terminal WITI
- Can be aggregated for all airports (to get a NAS value)

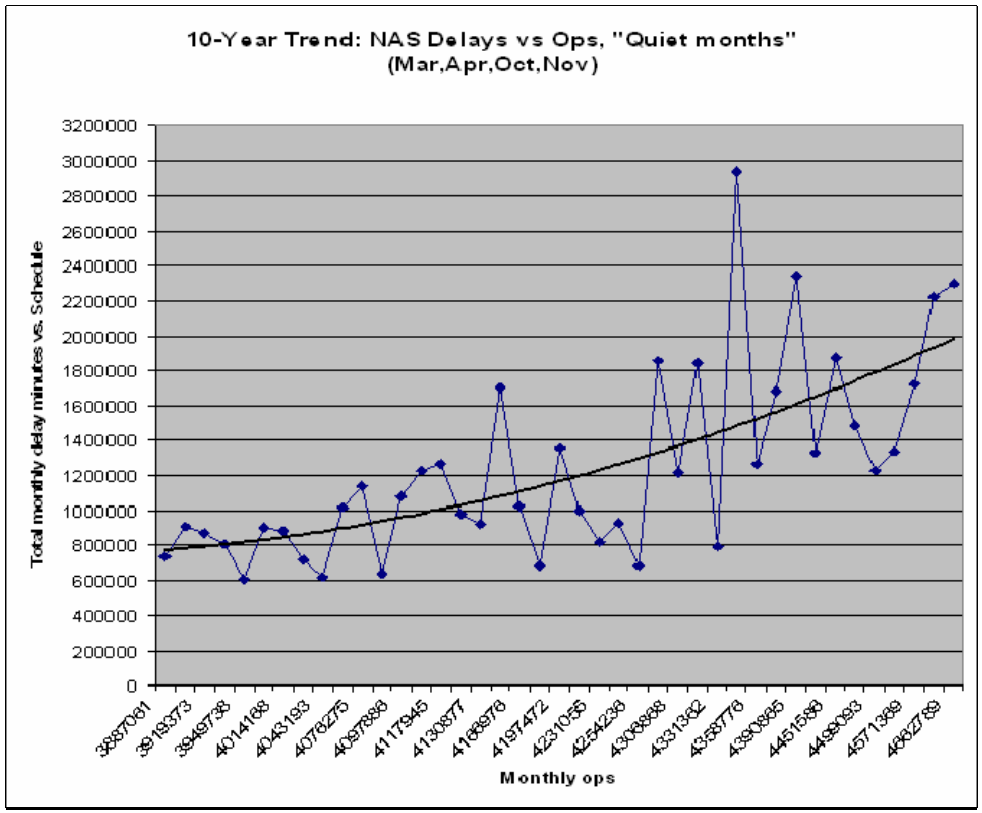
Q-WITI Data Flows -Sketch

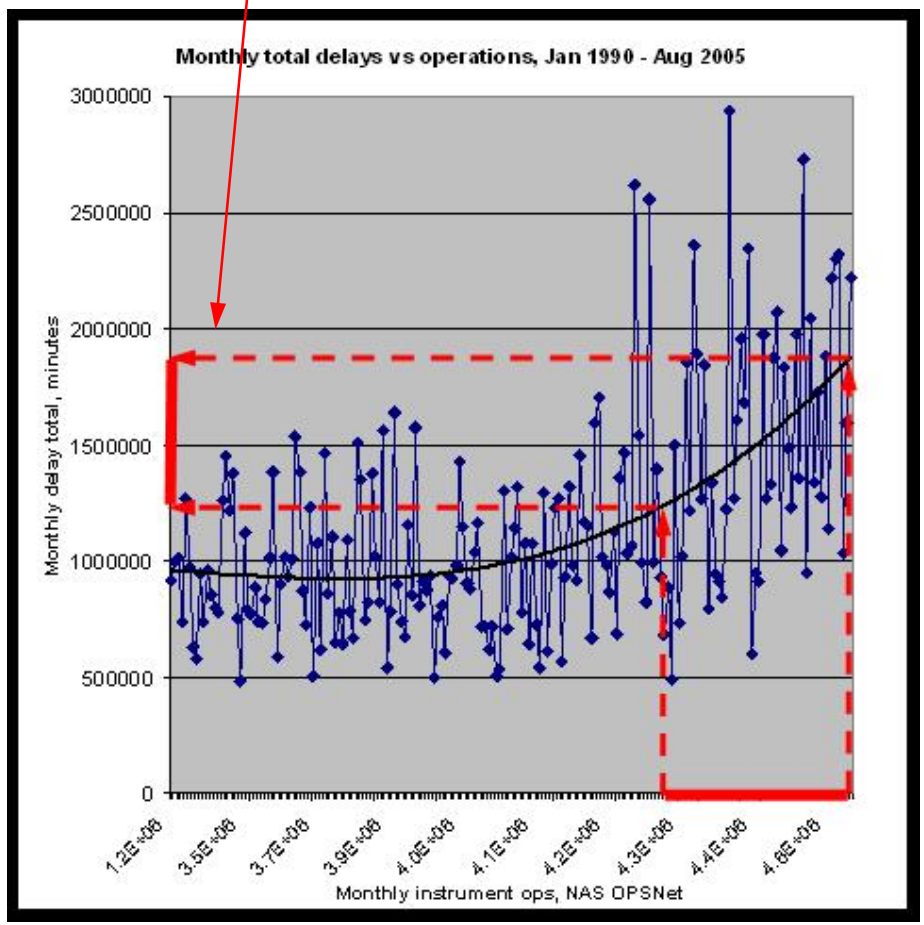


Demand/Delay Trend

10% increase in traffic (from 4.3M to 4.7M ops) could lead to a 45% increase in delays (from 1.25M to 1.8M minutes

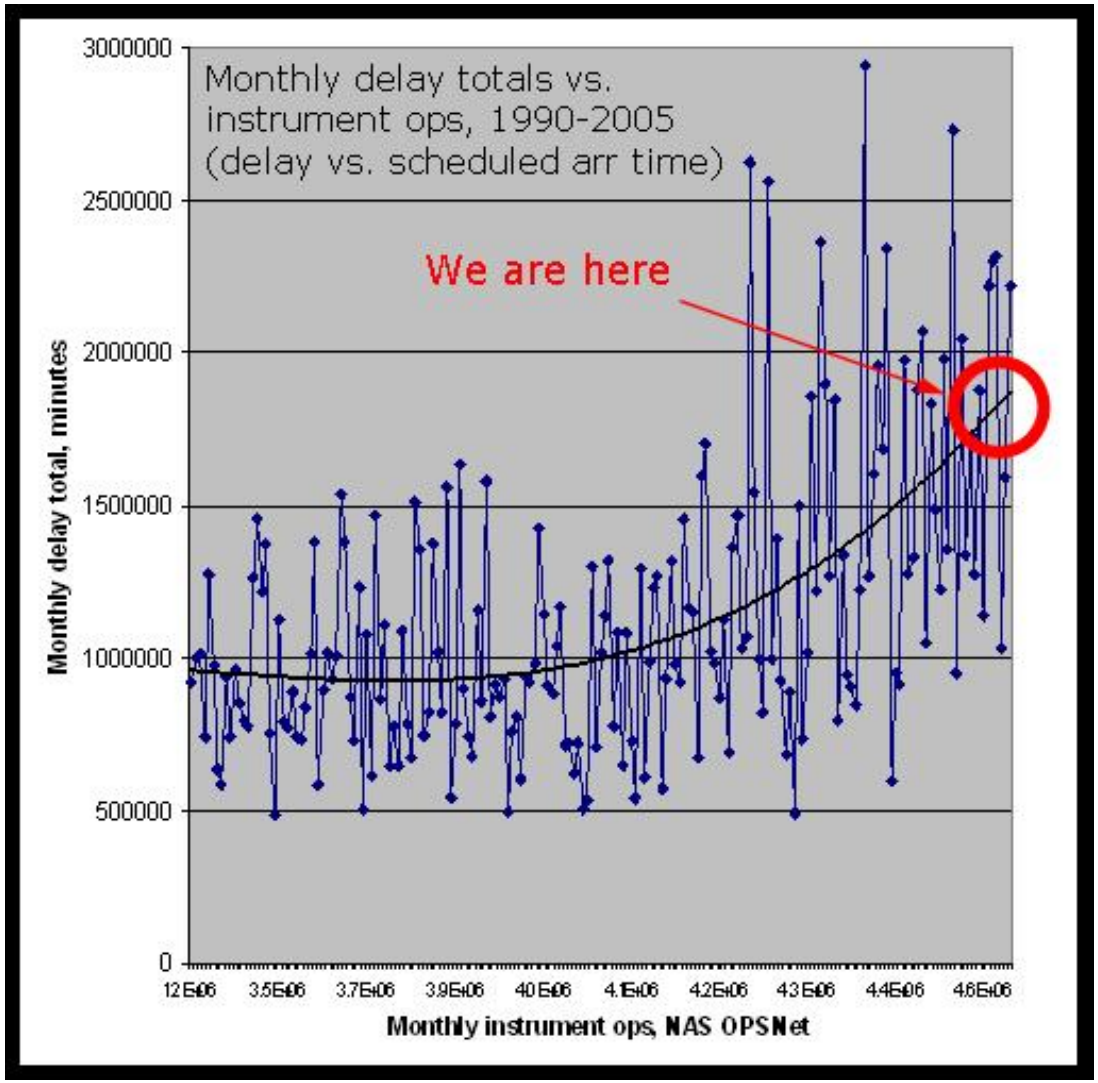
1995-2005 Historical Monthly Delay Averages with "no" WX





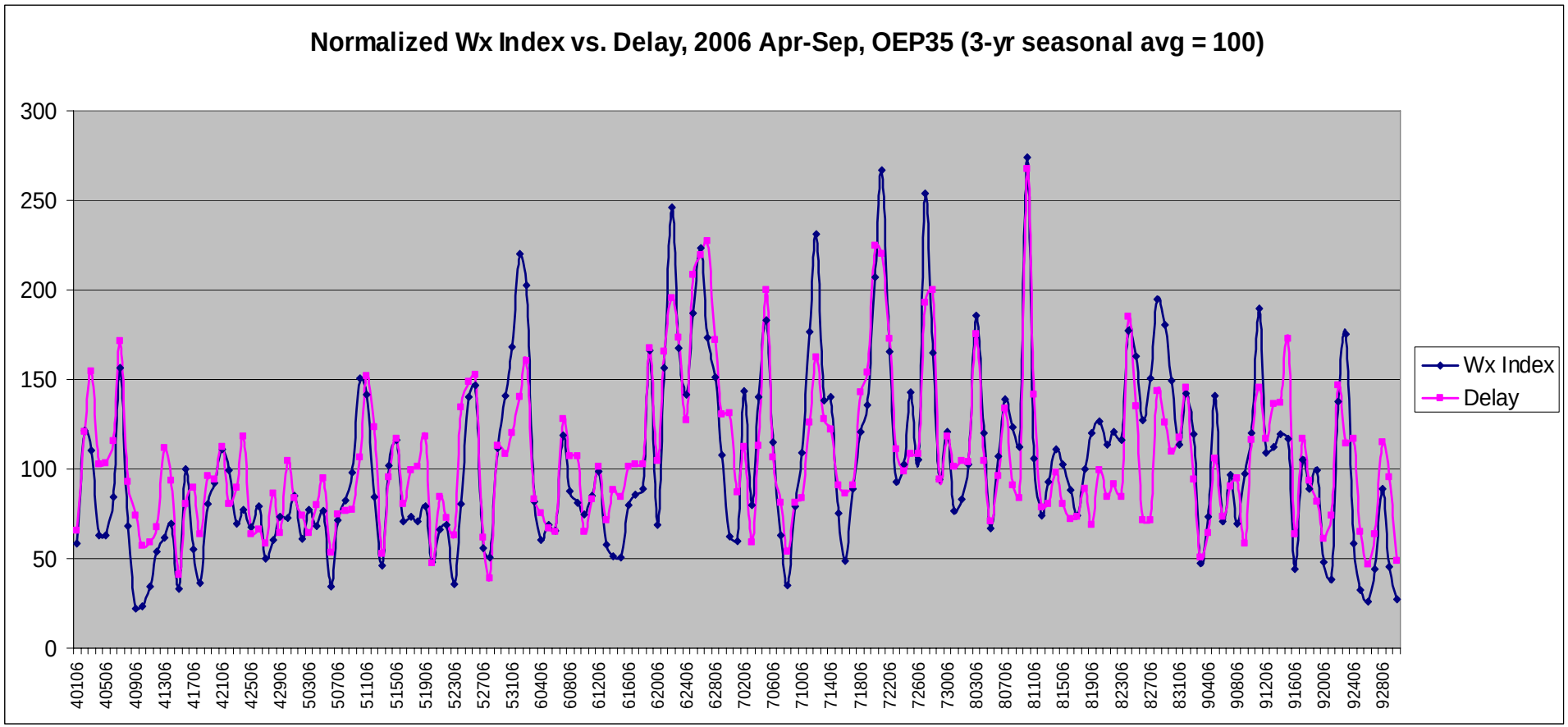
Normalization of Demand Impacts

- As demand grows, delays increase exponentially… regardless of Wx
- When comparing system performance from different periods, need to account for this dynamic to segregate the costs imposed by ATM actions and those imposed as a consequence of the increased demand itself.
  - The intent is to measure "service" performance within the limits of the system – not the impacts of queuing theory
  - That is, what was the result of what "ATM" did given the weather conditions – good or bad (compared to like weather impacts).



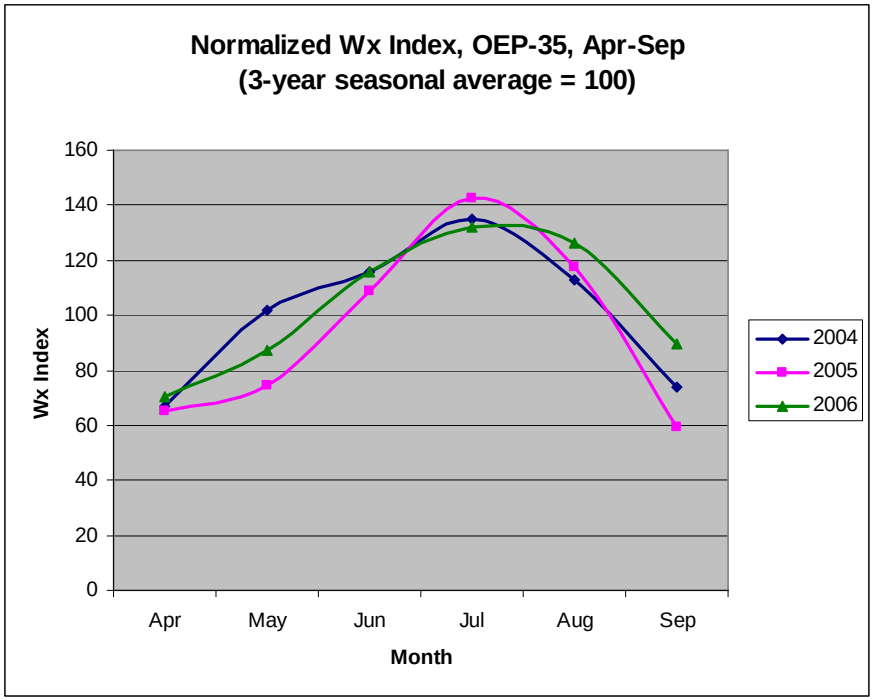
Normalized Q-WITI vs. Delay: Example

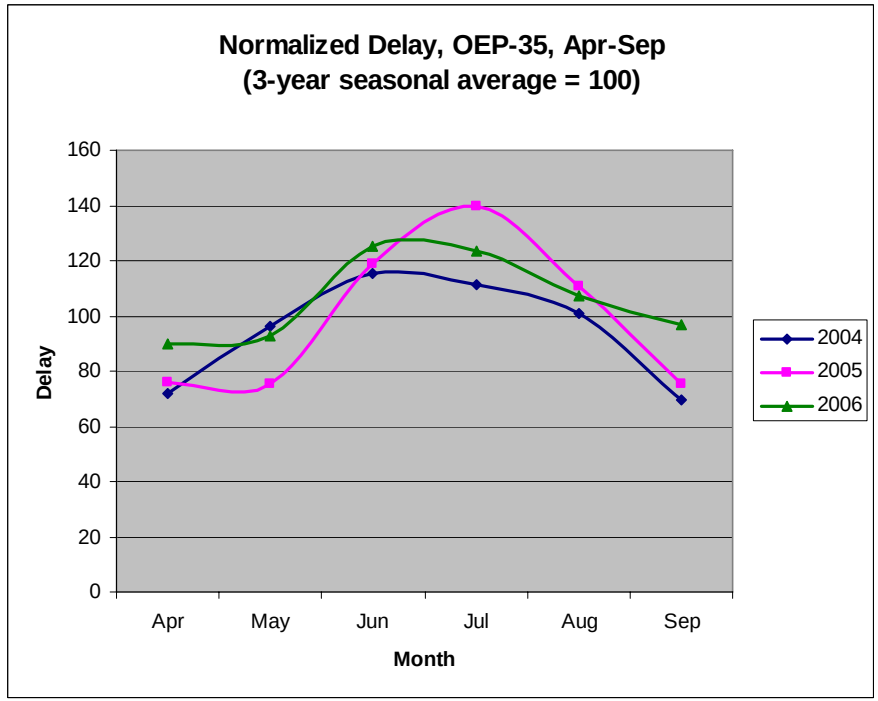
2006 Convective Season



Correlation coefficient: 0.85

WX Index and Delay Comparison, 2004-2006





WX Index FY06 = 14% > FY05

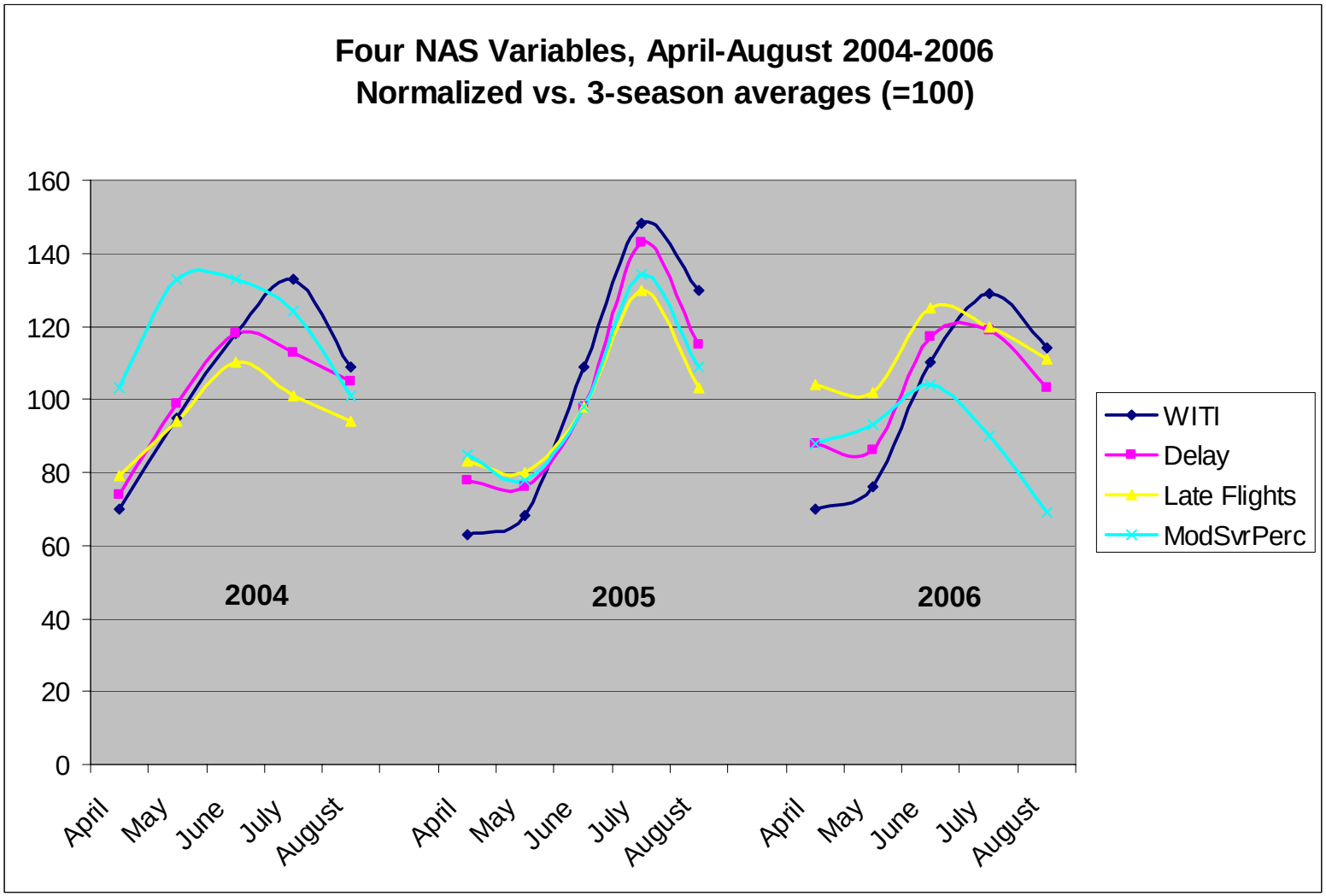
Delays FY06 = 10% > FY05

Monthly Averages (normalized vs. 3-year seasonal average)

	Wx Index				Delay		
	2004	*2005*	*2006*		*2004*	*2005*	*2006*
Apr	67	65	70	Apr	72	76	90
May	102	75	87	May	97	75	93
Jun	116	109	116	Jun	115	119	125
Jul	135	143	132	Jul	111	140	124
Aug	113	117	126	Aug	101	111	108
Sep	74	59	89	Sep	70	75	97
Season's average (3-year avg = 100)	***101.3***	***95.0***	***103.8***		***94.5***	***99.5***	***106.0***

Comparing NAS Performance Metrics

2004-06, Monthly Averages



"R-OTP" = "Reverse on-time performance" (100-OTP), same as "Late flights"

Next Steps, Opportunities & Issues

Next Steps:

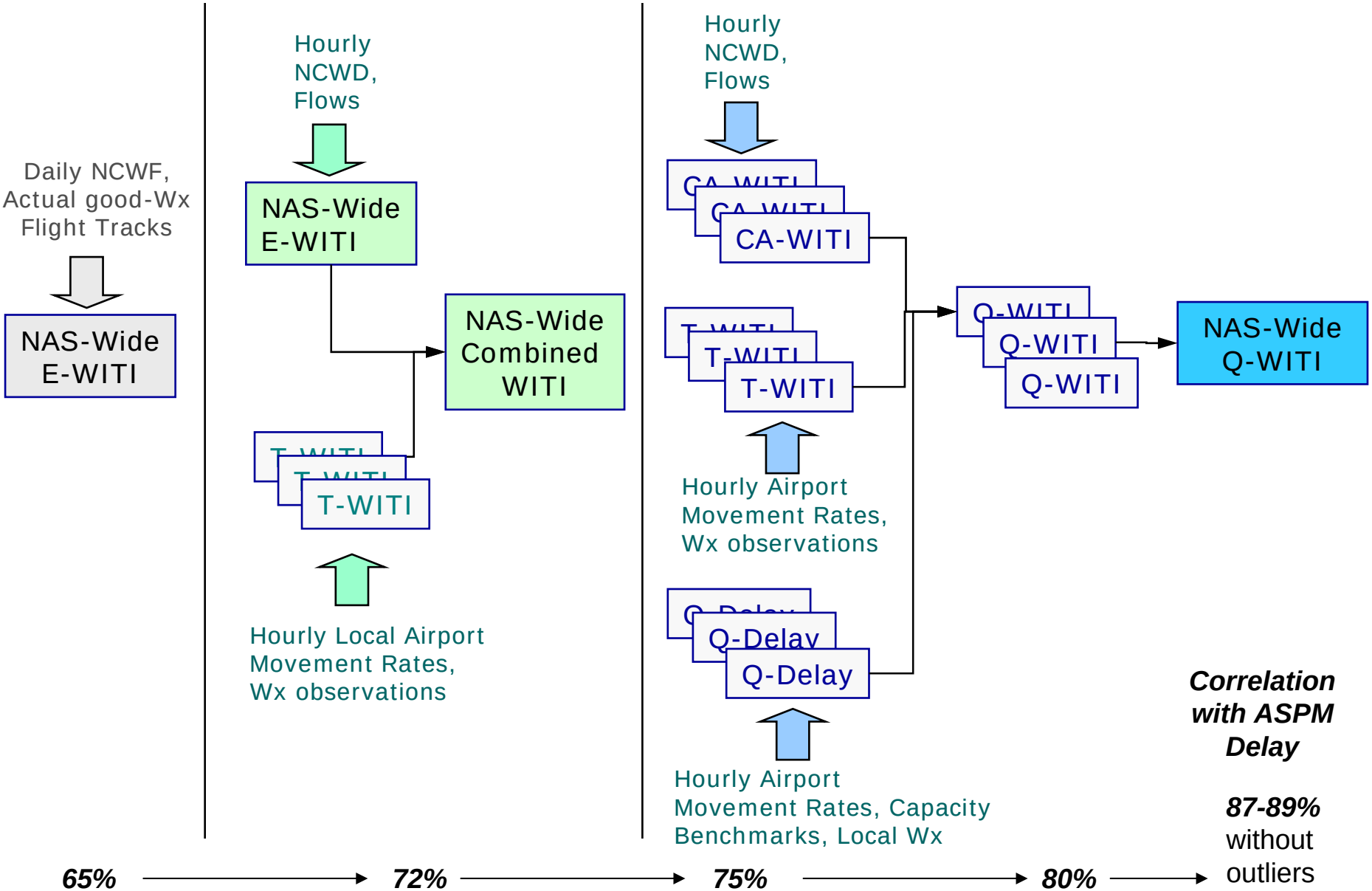
- Baseline WITI 1.0
  - Cross ATO agreement on methodology, data sources and algorithms [meetings planned for Sept]. Production to follow [Funding and contracts already in place with CSSI/ATA]
- Work with NOAA/NWS to develop initial WITI-FA for next severe WX season
- Extend WITI (1.5) to account for: tops, airport specific WX [marginal VMC impact – visuals]
- Continue analysis on possible modifications to improve correlation across the range of ATM performance expectations [on-time, delay, predictability, flexibility, access & equity, etc]

Opportunities:

- Probabilistic TFM
- Drill down performance to specific locations (ATC Daily) as complement to TAER/SAER [ATL-haze example]
- Future demand and NGATS environment projections (Comparison between Future-NAS scenarios)

Backup Details

The Evolution of WITI



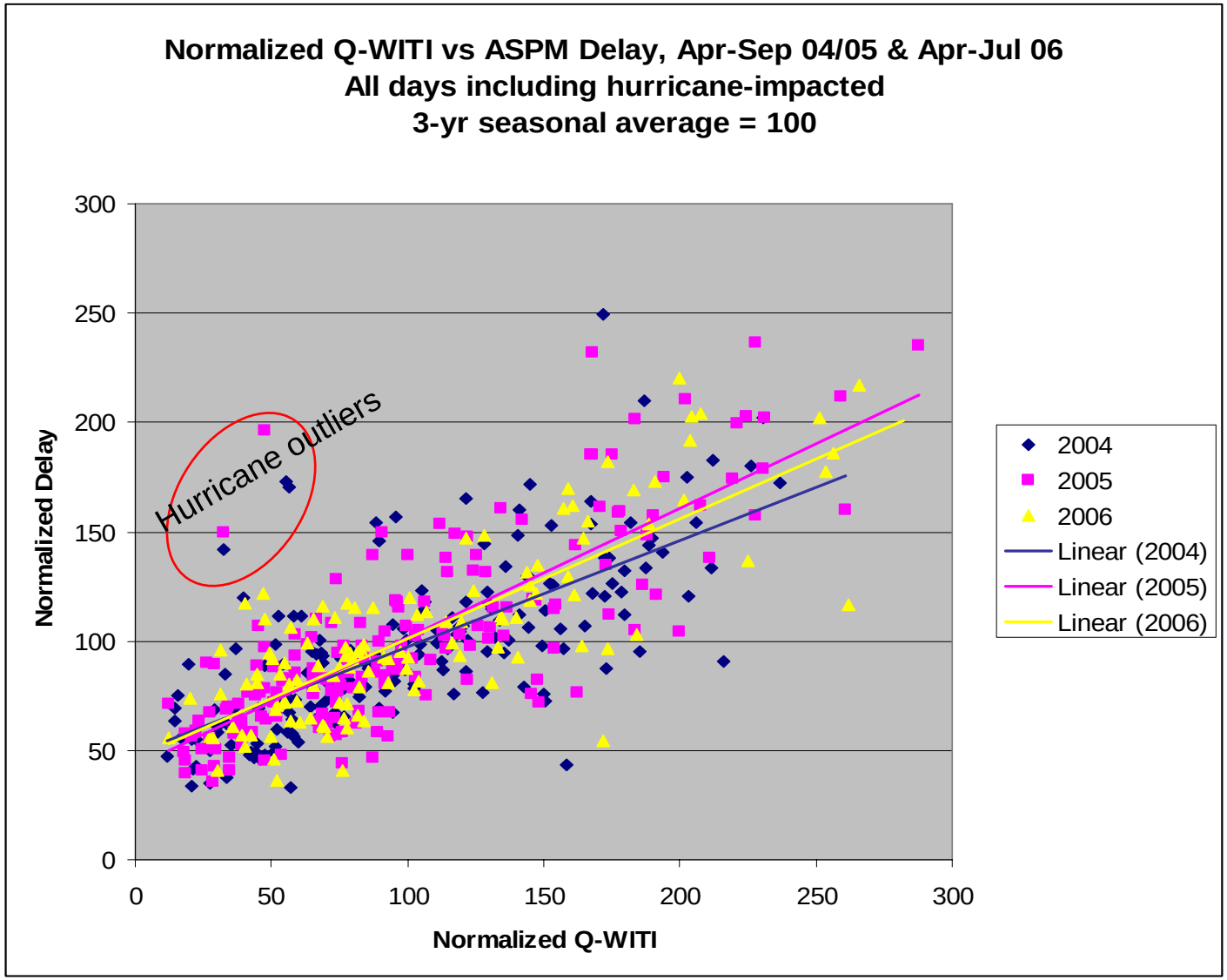
Conceptual Components in the "Suite"

- **Weather Index (WITI)** –
  - Initially comprised of the available, baselined elements to establish an index of the weather's impact on the ATM system:
    - Traffic Component – weighting of cells across NAS to represent relative "value" of each
    - Weather Component –
      - En Route – allocation of weather to each of the cells calculating the "scores"
      - Terminal – weather (IMC, surface conditions, winds, etc) at specific locations
    - Normalization of Demand Impact – predicated on documented queuing theory analysis applied to NAS.
  - Extend initial WITI to include additional weather items such as tops and more detailed, airport specific data. [Impacts of winds for compression on final, loss of visuals below certain thresholds while still marginal VMC, haze and impacts on the high-speeds, etc]
- **Performance Component** – based on aggregation of elements that serve as a proxy to reflect operational responses to NAS conditions. (delays [minutes & miles], cancellations and diversions, etc)
  - Index against which the WITI elements are mapped to determine if the ATM System is improving [realizing gains based on investments]
- **WITI – FA** (Forecast Accuracy) – Index, based on the WITI operational weighting method/criteria, that reflects the accuracy of the forecast to which ATM responded
  - Component to reflect what environment the ATM System was preparing to respond to vice what eventually materialized

Use Case: Historical Analysis

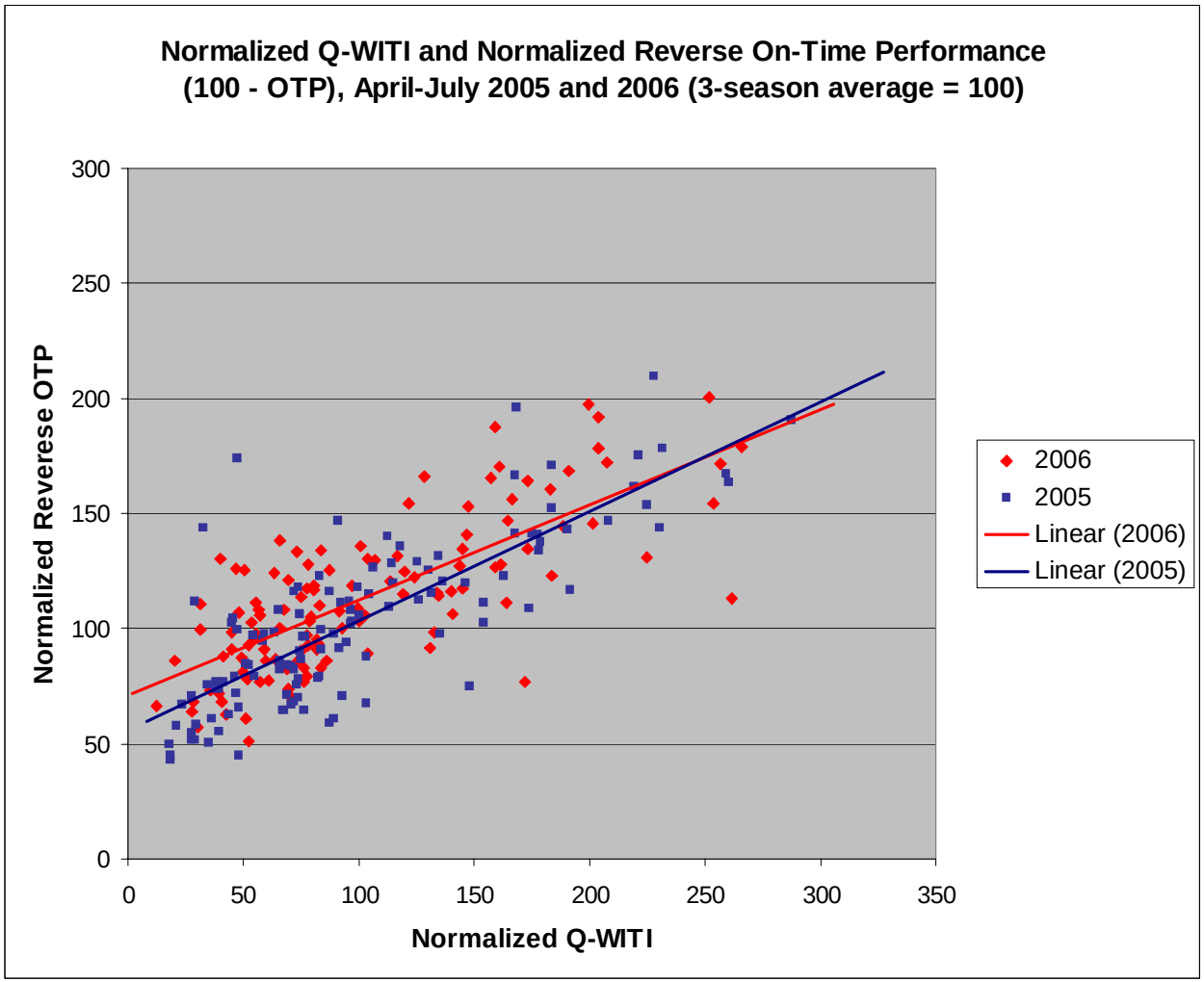
Use: Results for 2004, 2005 and 2006

(2004, 2005: Apr-Sep; 2006: Apr-Jul)



Q-WITI & Reverse OTP, 2005/2006

(Normalized vs. 2004-06 seasonal averages)

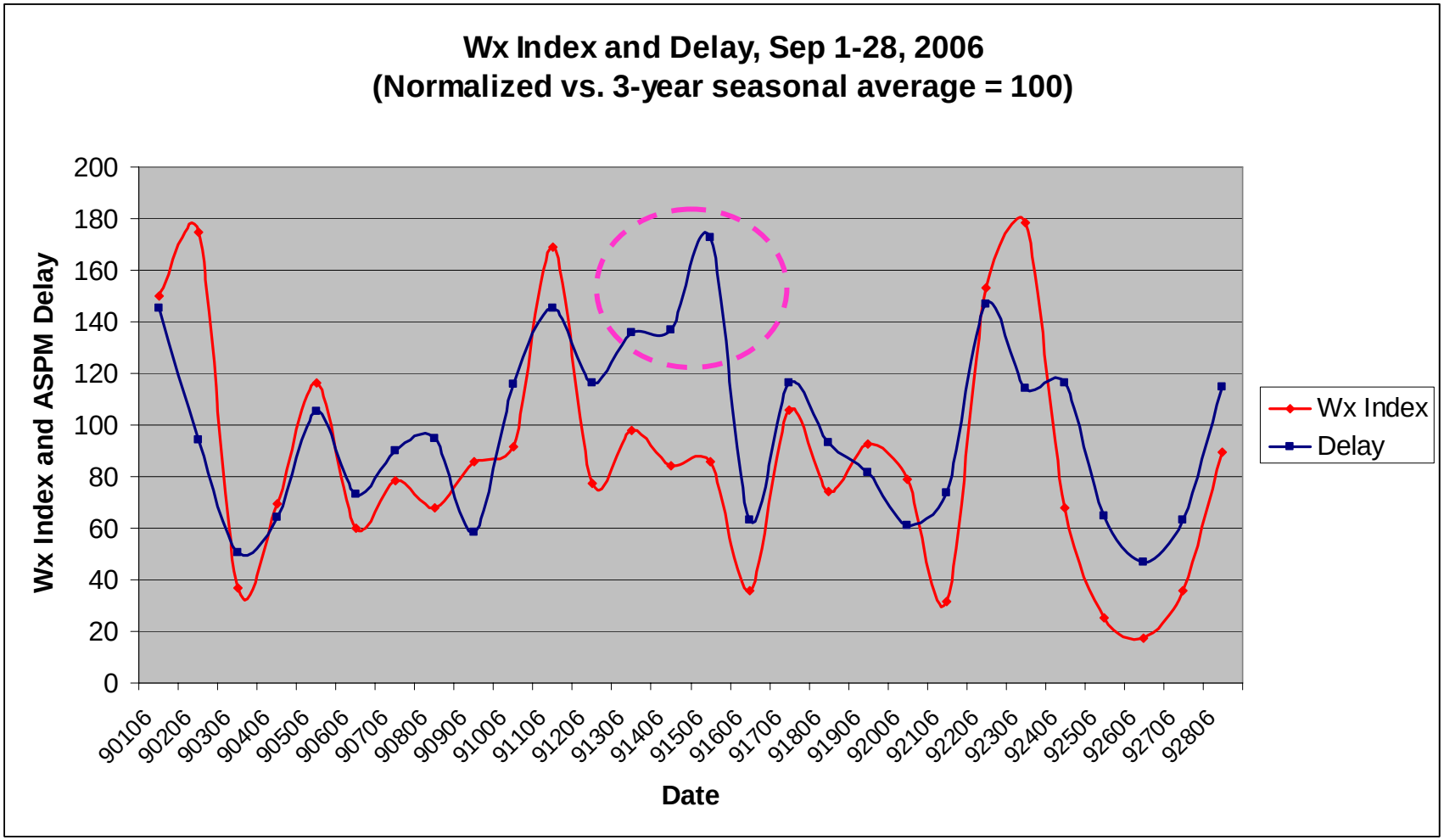


2006 appears to be slightly better (trend line slope lower)

Use Case: Potential Future Analysis

[Segregate individual elements impacting performance that are interdependent with WX]

WX vs. Delay, September 1-28



ATC Daily Reports, 9/13- 9/15, 2006

ATC Daily Report For Wednesday, September 13, 2006
Total Delays 2285

Fac	GDP	Times	Reason	OPSNET Data						Arr/ Dep Canc	Arr/Dep			Terminal Arrival Efficiency Rate (TAER)			SAER	Airport Daily Capacity (ADC)		
				Ops	Total Dlys	Seas-onal Avg	Arr Dlys	Dep Dlys	TMS Dlys		Txo ≥90 And <120 Mins	Txo ≥120 And <180 Mins	Txo ≥180 Mins	TAER	FYTD TAER	TAER VAR		ADC	FYTD ADC Avg	ADC VAR
ATL	72-84	1200-0140	Rwy Const	2570	821	191	47	259	515	77 / 80	0 / 0	1 / 1	0 / 0	92.92	94.64	(1.72)	91.69	3846	4565	(719)
ORD	76-100	1300-0125	Rwy Const	2680	552	193	2	0	550	79 / 72	17 / 2	5 / 0	0 / 0	87.79	94.29	(6.5)	87.77	4226	4464	(238)
LGA			Term Vol	1214	174	71	1	169	4	13 / 17	0 / 4	0 / 2	0 / 0	94.83	94.00	0.83	92.17	1906	1811	95
DTW			Tstms	1302	91	6	9	59	23	24 / 24	2 / 10	5 / 3	0 / 0	75.50	87.54	(12.04)	79.93	3048	3740	(692)
C90			Tstms	4030	88	NA	0	0	88	0 / 0										
TEB			Term Vol	787	83	17	0	7												
JFK			Term Vol	1172	76	59	0	7												
EWR			Term Vol	1314	48	122	5	3												
CLT			Low Cigs	1439	46	15	0	3												
PHL			Term Vol	1538	44	71	0	3												
LAS			Rwy Const	1765	38	37	0	3												
BOS			Wind	1327	27	56	0	2												

ATC Daily Report For Thursday, September 14, 2006
Total Delays 2618

Fac	GDP	Times	Reason	OPSNET Data						Arr/ Dep Canc	Arr/Dep			Terminal Arrival Efficiency Rate (TAER)			SAER	Airport Daily Capacity (ADC)		
				Ops	Total Dlys	Seas-onal Avg	Arr Dlys	Dep Dlys	TMS Dlys		Txo ≥90 And <120 Mins	Txo ≥120 And <180 Mins	Txo ≥180 Mins	TAER	FYTD TAER	TAER VAR		ADC	FYTD ADC Avg	ADC VAR
ATL			Rwy Const	2886	443	191	18	344	81	35 / 34	8 / 0	0 / 1	0 / 0	94.34	94.64	(0.3)	92.88	4207	4564	(357)
ZNY			Tstms	6851	380	NA	1	0	379	0 / 0										
PHL	36-50	1001-0154	Low Cigs	1407	360	71	0	98	262	34 / 43	3 / 2	1 / 0	0 / 0	91.38	93.07	(1.69)	86.32	2177	2385	(208)
EWR	34-36	1500-0345	Low Cigs	1215	220	122	15	8	197	32 / 25	5 / 4	3 / 3	0 / 0	88.92	90.73	(1.81)	87.81	1944	2118	(174)
LGA	34	1130-0359	Low Cigs	1140	207	71	4	0	203	23 / 29	2 / 5	0 / 7	0 / 0	95.75	94.00	1.75	87.89	1832	1811	21
N90			Tstms	0	175	NA	0	0	175	0 / 0										
LAS			Tstms	1815	138	37	0	130	8	3 / 4	0 / 0	0 / 0	0 / 0	97.01	96.23	0.78	91.71	2438	2529	(91)

ATC Daily Report For Friday, September 15, 2006
Total Delays 3085

Fac	GDP	Times	Reason	OPSNET Data						Arr/ Dep Canc	Arr/Dep			Terminal Arrival Efficiency Rate (TAER)			SAER	Airport Daily Capacity (ADC)		
				Ops	Total Dlys	Seas-onal Avg	Arr Dlys	Dep Dlys	TMS Dlys		Txo ≥90 And <120 Mins	Txo ≥120 And <180 Mins	Txo ≥180 Mins	TAER	FYTD TAER	TAER VAR		ADC	FYTD ADC Avg	ADC VAR
ZNY			Tstms	8298	1083	NA	5	0	1078	0 / 0										
EWR	32-36	1715-0355	Low Cigs	1217	412	122	60	159	193	71 / 44	5 / 16	5 / 0	1 / 0	85.86	90.72	(4.86)	85.71	1892	2117	(225)
PHL	38-48	1200-0054	Low Cigs	1370	354	71	12	98	244	98 / 80	3 / 20	2 / 12	0 / 1	91.57	93.06	(1.49)	87.92	1944	2384	(440)
LGA	14-34	1300-0359	Low Cigs	1124	218	71	17	0	201	75 / 88	6 / 15	5 / 9	0 / 1	91.73	94.00	(2.27)	82.84	1893	1811	82
ATL			Const	2885	170	191	1	157	12	25 / 26	5 / 2	4 / 0	0 / 0	93.55	94.64	(1.09)	97.00	4440	4563	(123)
LAS			Const	1681	143	37	0	141	2	9 / 5	3 / 2	1 / 0	0 / 0	94.80	96.23	(1.43)	95.26	2480	2529	(49)
SLC	36	2245-0303	Tstms	1077	123	3	54	14	55	18 / 16	2 / 0	0 / 0	0 / 0	84.46	92.39	(7.93)	88.41	2684	3297	(613)
JFK	30-40	1800-0155	Low Cigs	1065	118	59	4	0	114	39 / 46	3 / 37	1 / 6	0 / 0	93.63	91.29	2.34	86.65	1553	1794	(241)
ORD			Const	2778	53	103	3	37	13	24 / 27	3 / 5	4 / 3	0 / 0	93.50	94.29	(0.79)	97.47	4576	4465	111
IAH			Tstms	1724	49	28	8	21	20	6 / 2	2 / 0	0 / 0	0 / 0	81.76	92.10	(10.34)	92.31	3919	3610	309
PHX			Volume	1550	32	39	0	30	2	4 / 7	0 / 0	0 / 0	0 / 0	97.01	96.10	0.91	98.02	3250	3213	37