Proposed
Performance Metrics
Block Time & Predictability

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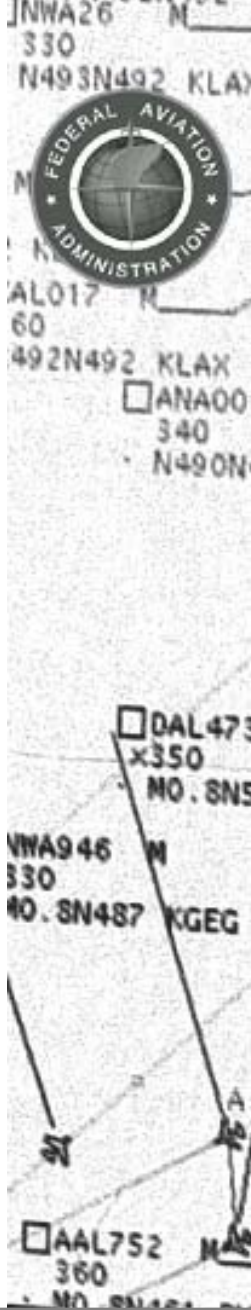
Objective

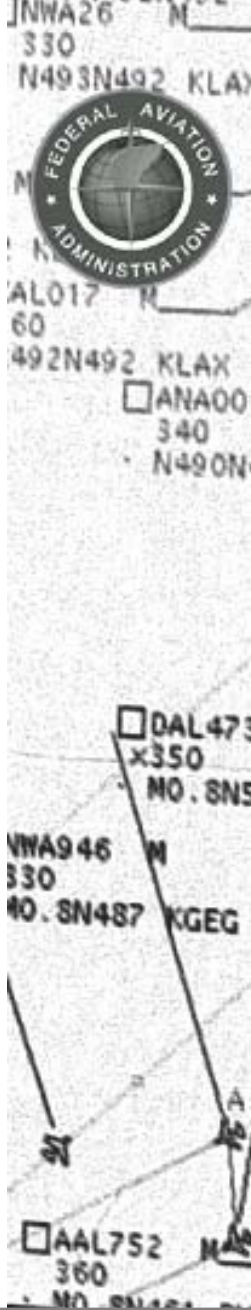
- An evaluation of two specific metrics: Scheduled Block Time and Predictability
- A general discussion of types of metrics

- This work has been sponsored by two ATO Planning offices:
  1) The Office of Strategy
  2) The Office of Performance Analysis



Three Primary Types of Metrics

- System Activity or Workload
  - Number of flights per month, overall average block time
  - Provides an estimate of workload, generally NOT performance
  - Impacted by non-performance based changes
    - Avg Flight length - more longer flights, not performance related
- Performance
  - Generally a system activity metric in constrained times
  - Normalized block time, arrival delay (sometimes)
- Diagnostic
  - Needed to understand changes in performance



Three Primary Types of Metrics

ALL metrics have flaws/limitations:

Identification of these limitations is vital to understanding and proper usage

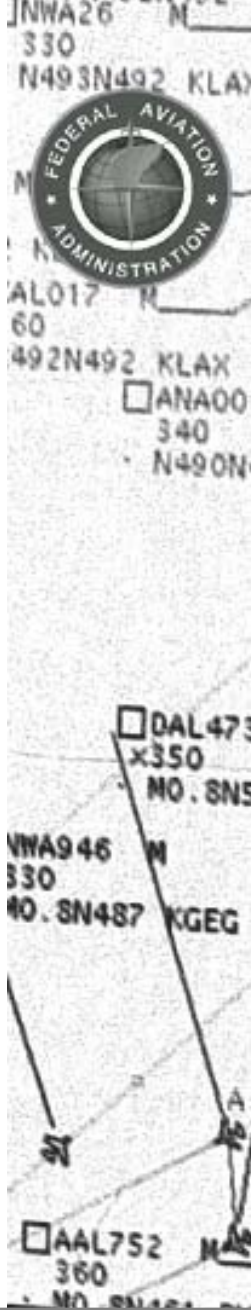
Data and Definition

- Data Sources
  - Airline Service Quality Performance (ASQP)
    - Data available from 1/1995 to 12/2005
  - Aviation System Performance Metrics (ASPM)
    - Data available from 1/2000 to 12/2005
  - Official Airline Guide (OAG)
    - Data available from 1/1982 to 9/2005
- Definition:
  - Block Time: Airborne+Taxi-Out+Taxi-In (Gate-Out to Gate-in)
  - Total Flight Time: Block Time + Departure Delay
    - Or: Actual arrival (in) - Scheduled Departure
  - Scheduled: Airline published departure/arrival times
    - Based on OAG or ASPM data (pre departure)
  - Actual: departure/arrival times as flown (post departure)
    - Based on ASQP or ASPM data

Scheduled Block Time

- A *Performance* Metric (a lagging indicator)
- Metric based on OEP to OEP flights
  - A current FAA Executive Council decision
- Considered the “NAS Level” (All* flights) and the OEP-OEP level (only flights to/from an OEP 35 airport)
- Used ASPM data, limited to those flights that have OAG data
  - OAG=“Y” flag
  - Does not include cancelled flights
- Two metrics proposed
  1) “Normalized” average block time
     - Normalization consists of identical set of O-D pairs weighted using the average number of flights/month across all datasets
  2) Delta metric - A relative change from the overall average

*Not truly ALL flights – as will be seen in the development



Normalization of Block Time Mathematical Details

Two intermediate values are calculated

1) the mean time μ
2) the average number of flights $\hat{n}_{ij}$

$$\mu_{ijk} = \frac{\sum_{l} x_{ijkl}}{n_{ijk}}$$

Where x is the block time for flight l for O-D pair ij within month k and n is the number of flights for O-D pair Within all (majority*) of data sets

$$\hat{n}_{ij} = \frac{\sum_{k=1}^{N} n_{ijk}}{N}$$

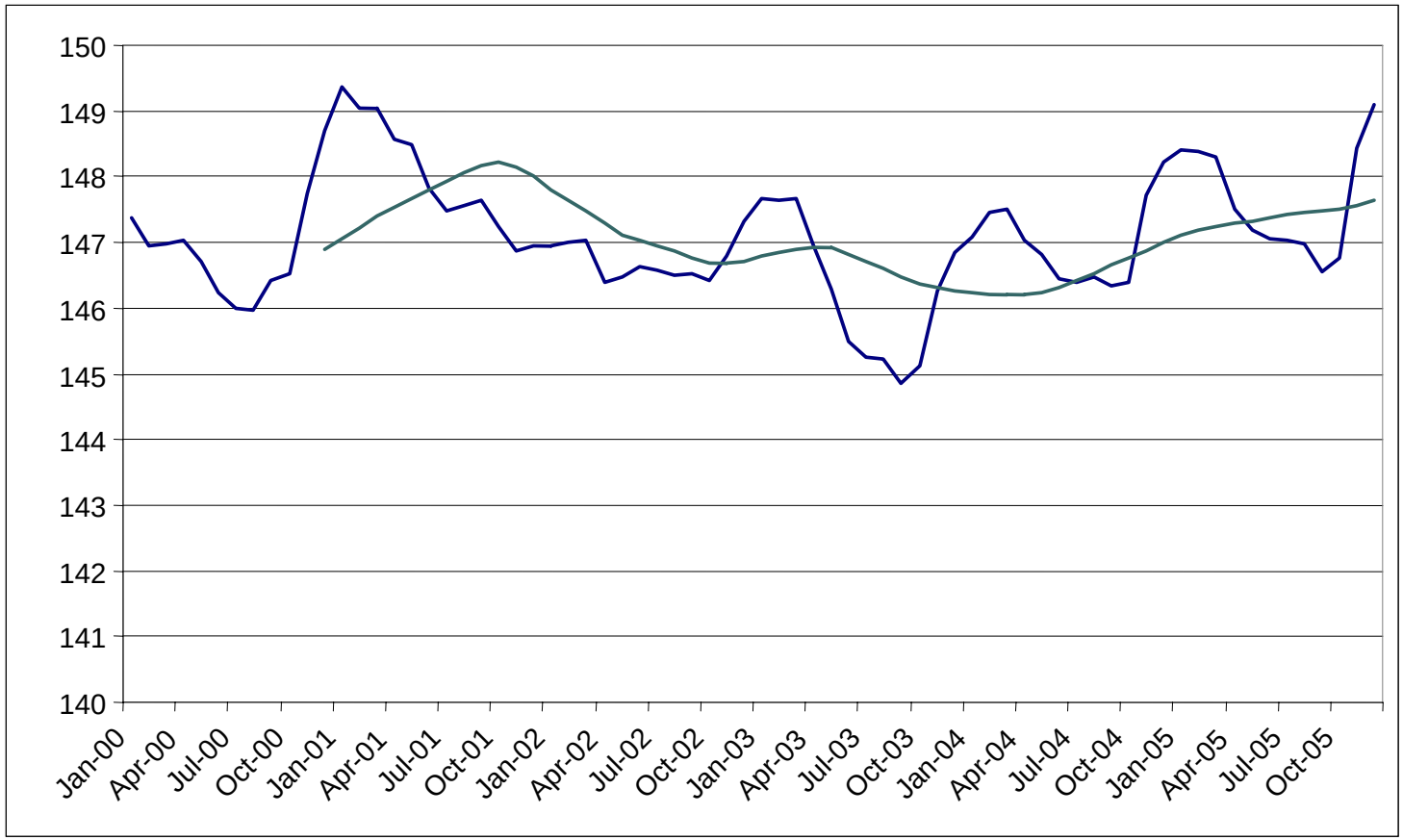
Where N is the number of months of data

Combining into a normalized NAS level "Performance" measure:

$$\mu_k = \frac{\sum_{i,j} \mu_{ijk} \hat{n}_{ij}}{\sum_{i,j} \hat{n}_{ij}}$$

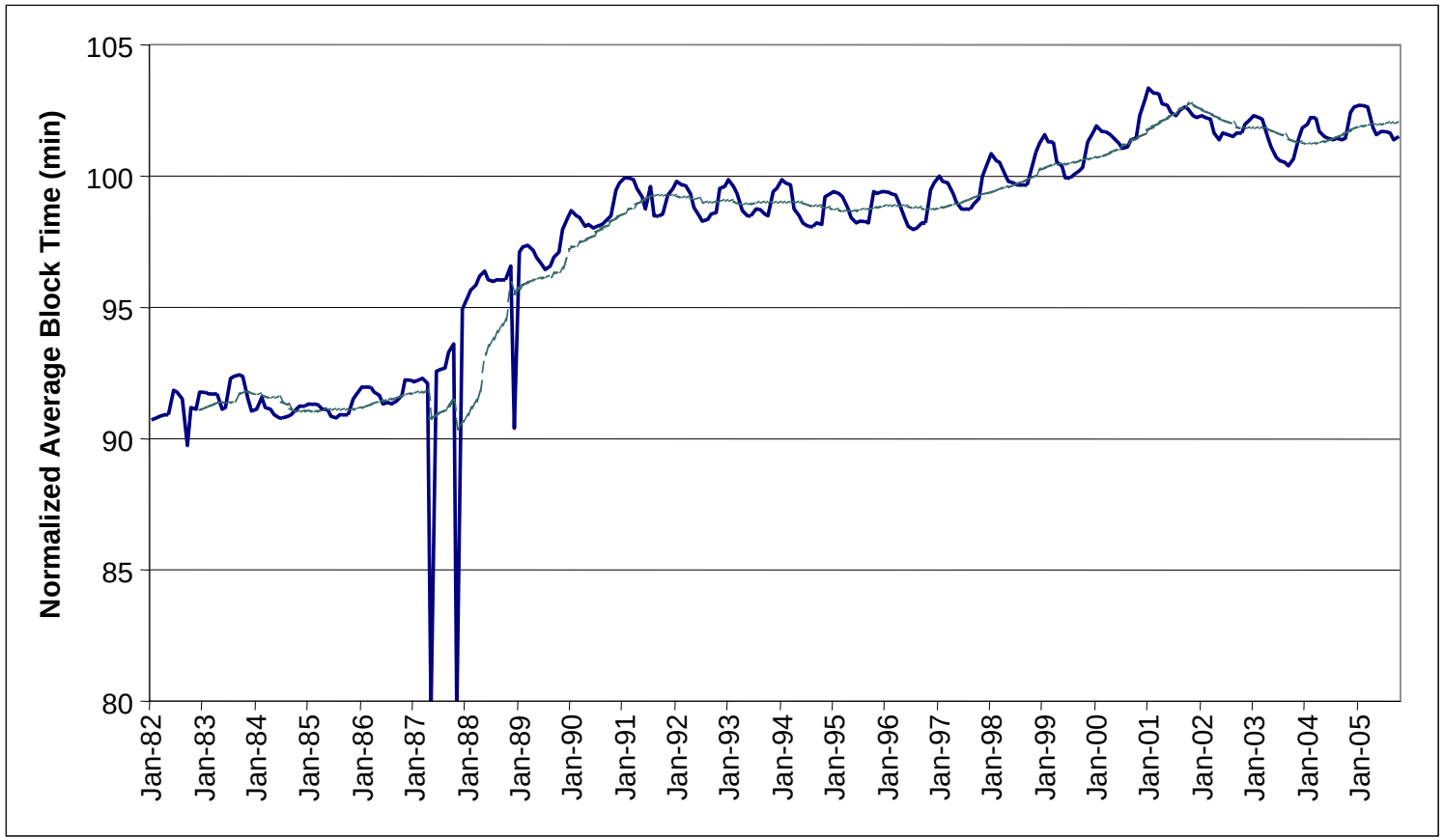
Where ij is an O-D pair, and k is month/year

Normalized Scheduled Block Time (OEP to OEP)



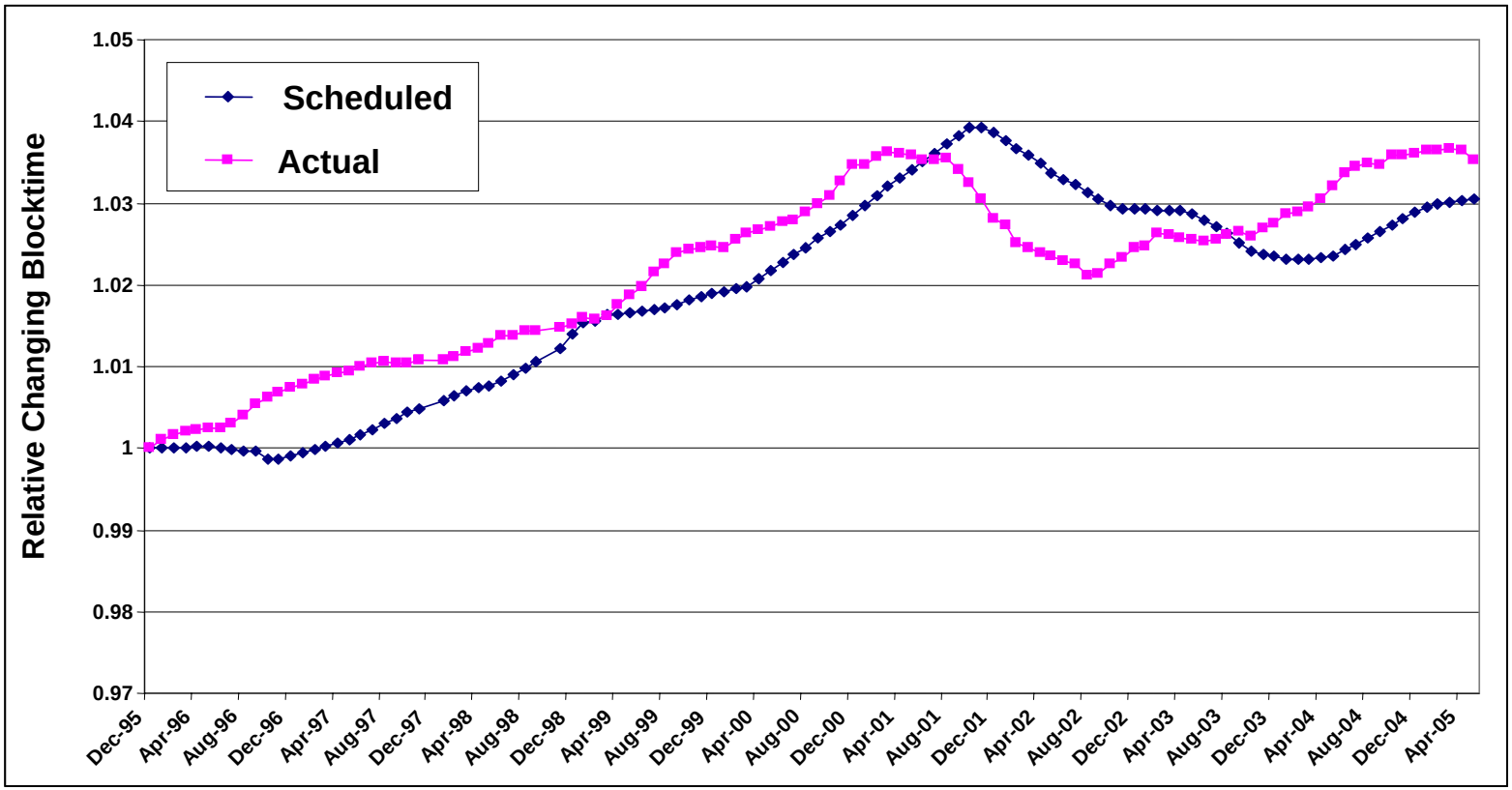
Source: ASPM

Normalized Scheduled Block Time (NAS Level)



Source: OAG

Scheduled Block Times A Lagging Metric



Source: ASPM, OAG and ASQP

Delta Metric – Another Approach

$$\mu_{ijk} = \frac{\sum_{l=1}^{n_{ijk}} x_{ijkl}}{n_{ijk}}$$

Where x is the block time for flight l and O-D pair ij within month k and n is the number of flights

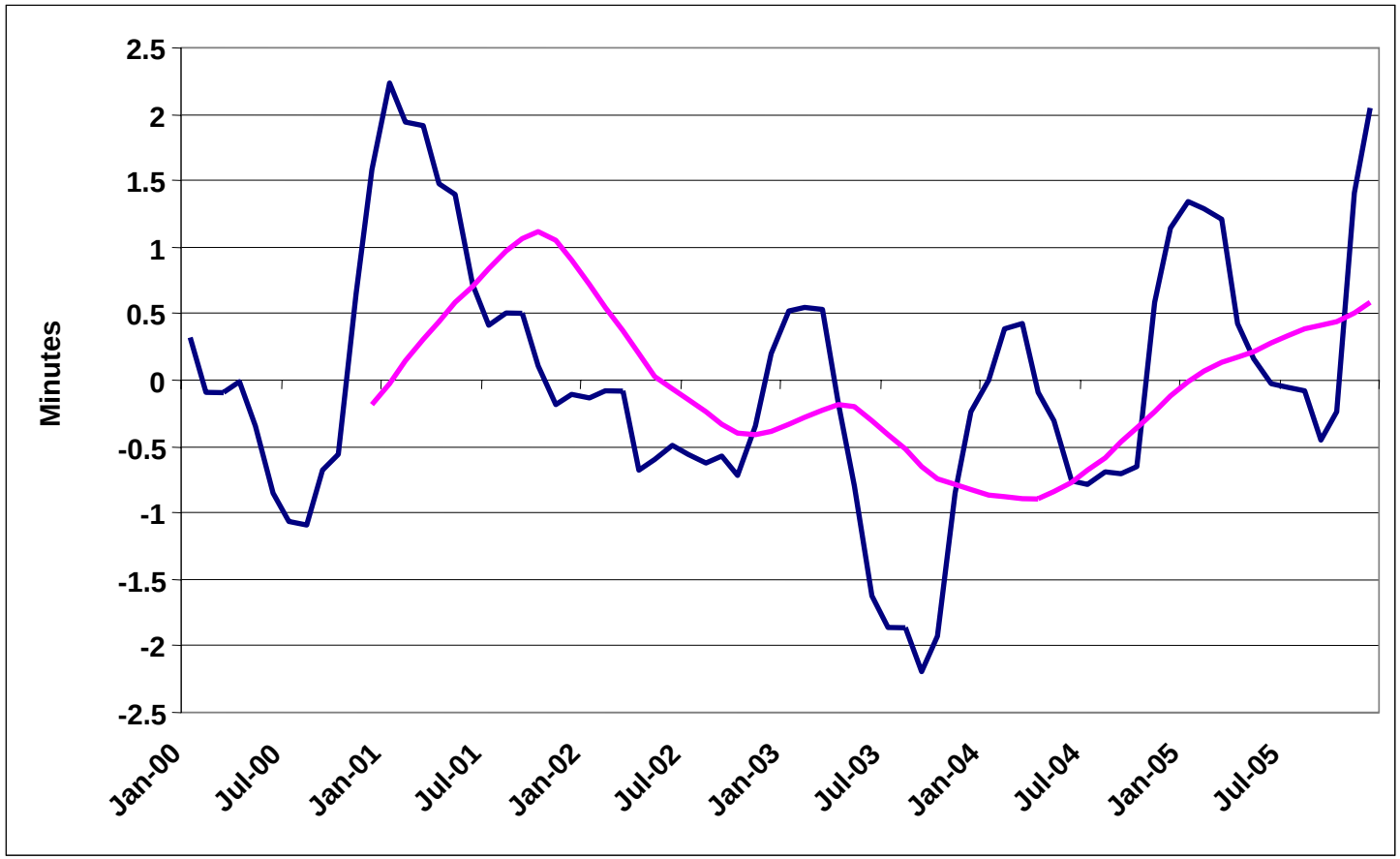
$$\hat{\mu}_{ij} = \frac{\sum_{k=1}^{N} \mu_{ijk} n_{ijk}}{\sum_{k} n_{ijk}}$$

A multi-month average block time

$$\delta_k = \frac{\sum_{ij} (\mu_{ijk-} \hat{\mu}_{ij}) n_{ijk}}{\sum_{ij} n_{ijk}}$$

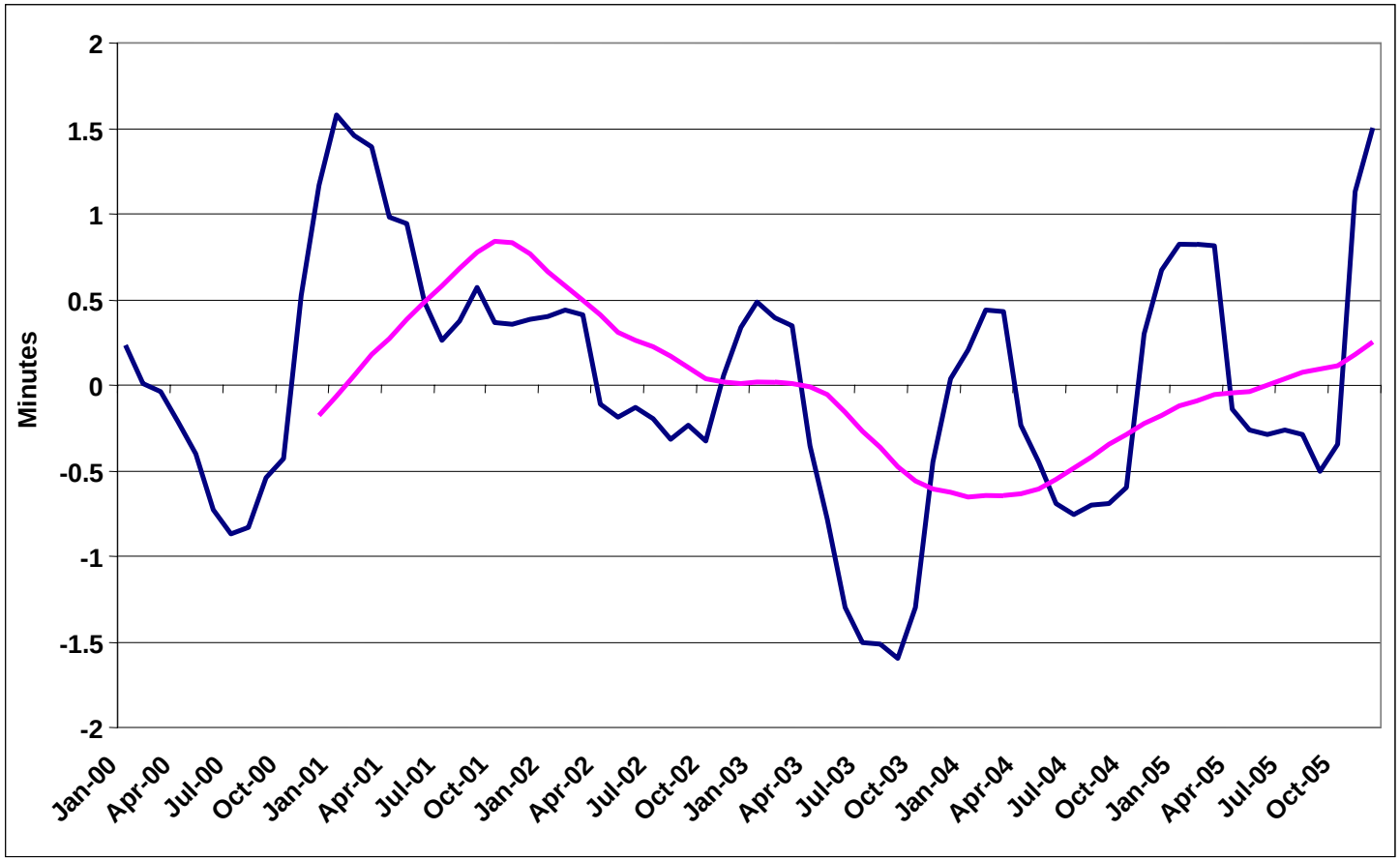
Which is a relative performance metric for the block time that includes ALL flights

Scheduled Block Time Delta Metric (OEP-OEP)



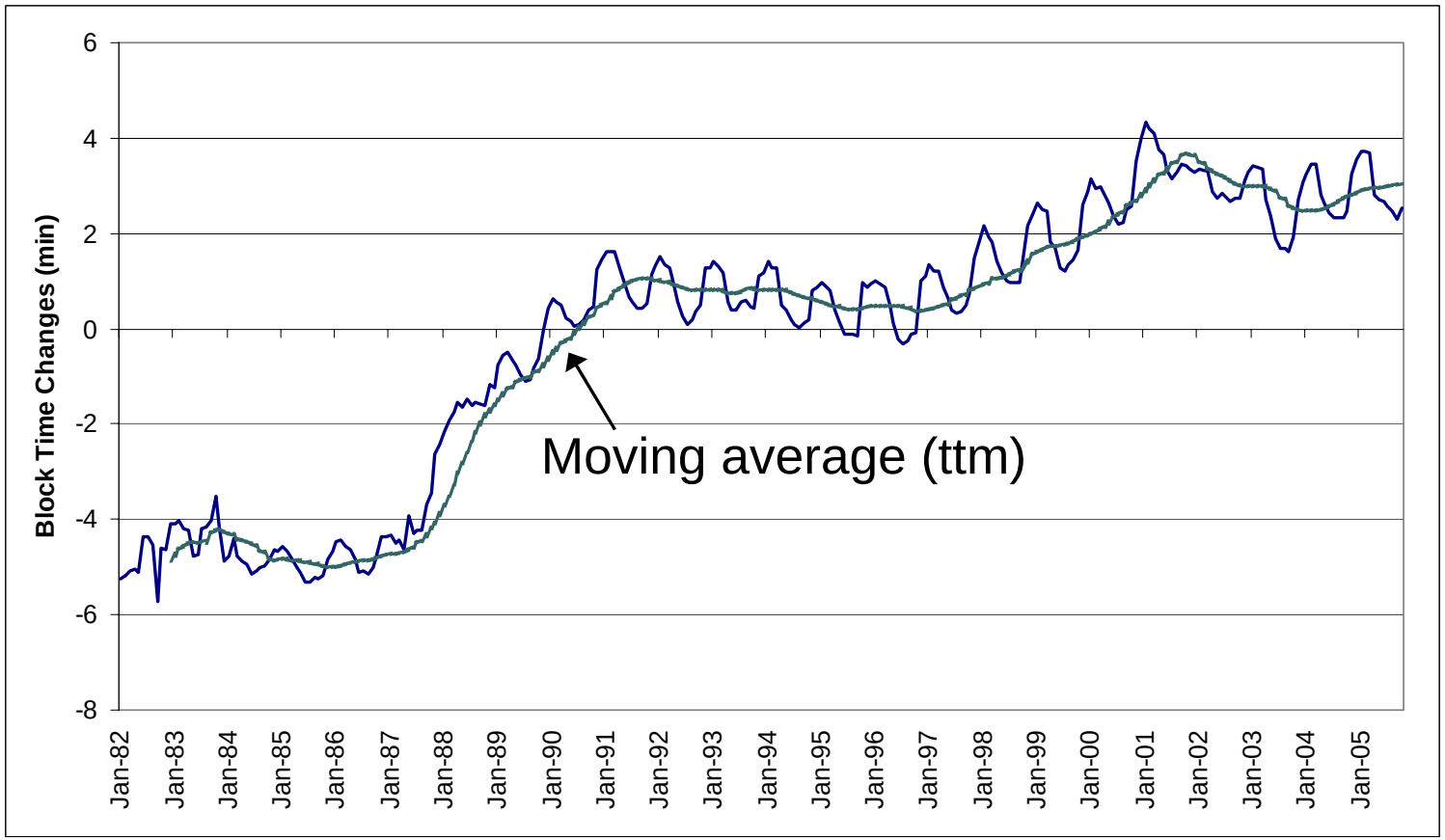
Data Source: ASPM

Scheduled Block Time Delta Metric (NAS Level)



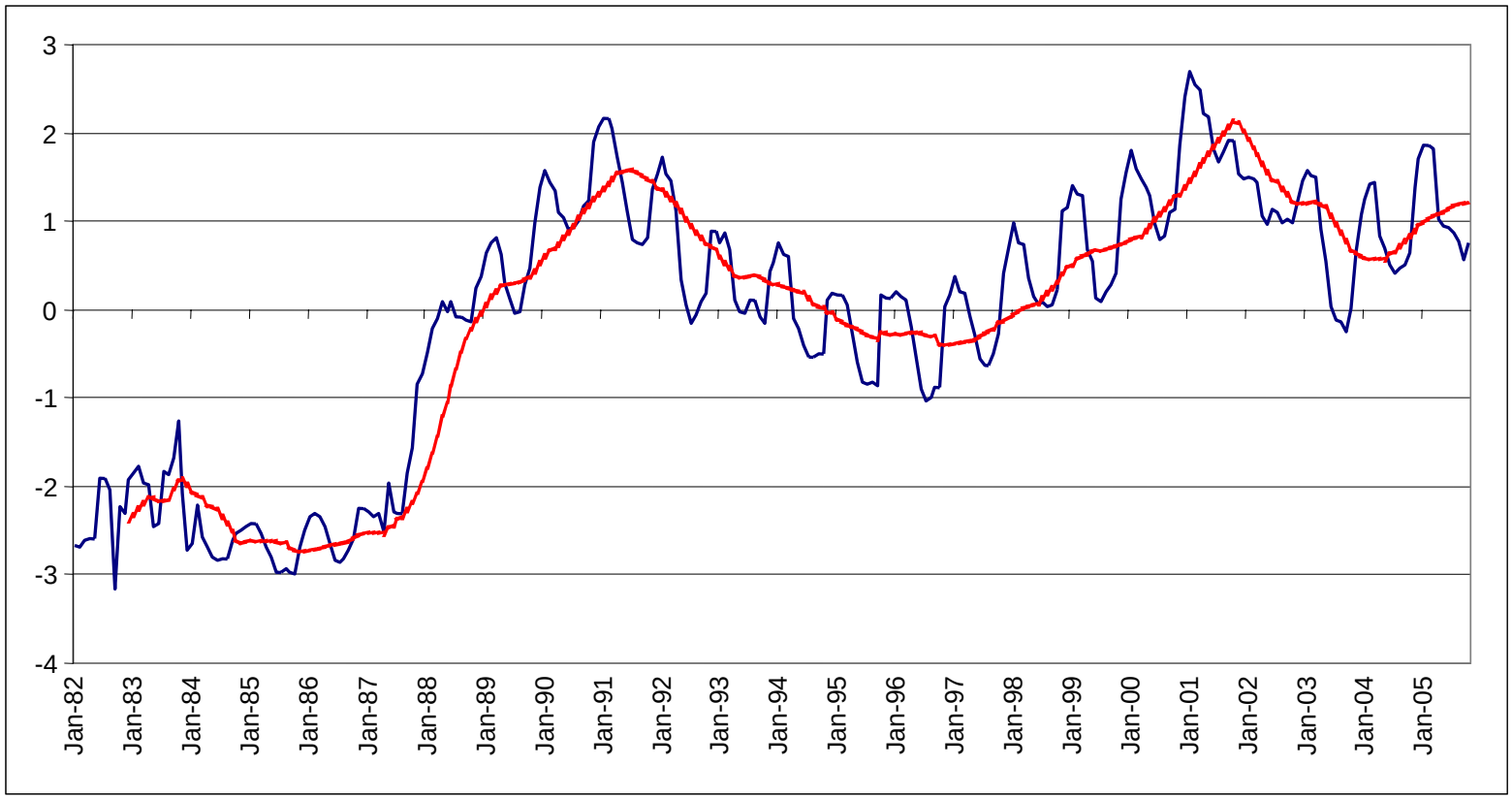
Data Source: ASPM

Historical Scheduled Block Time Delta Metric (NAS Level)



Data Source: OAG

Scheduled Block Time Changes Accounting for Aircraft Type



Data Source: OAG

Total Flight Time Variability a Predictability Metric?

Percentiles as a Predictability Metric

- Start at origin-destination level:
  - How does measured block time of airport-pair (O-D) differ from average time

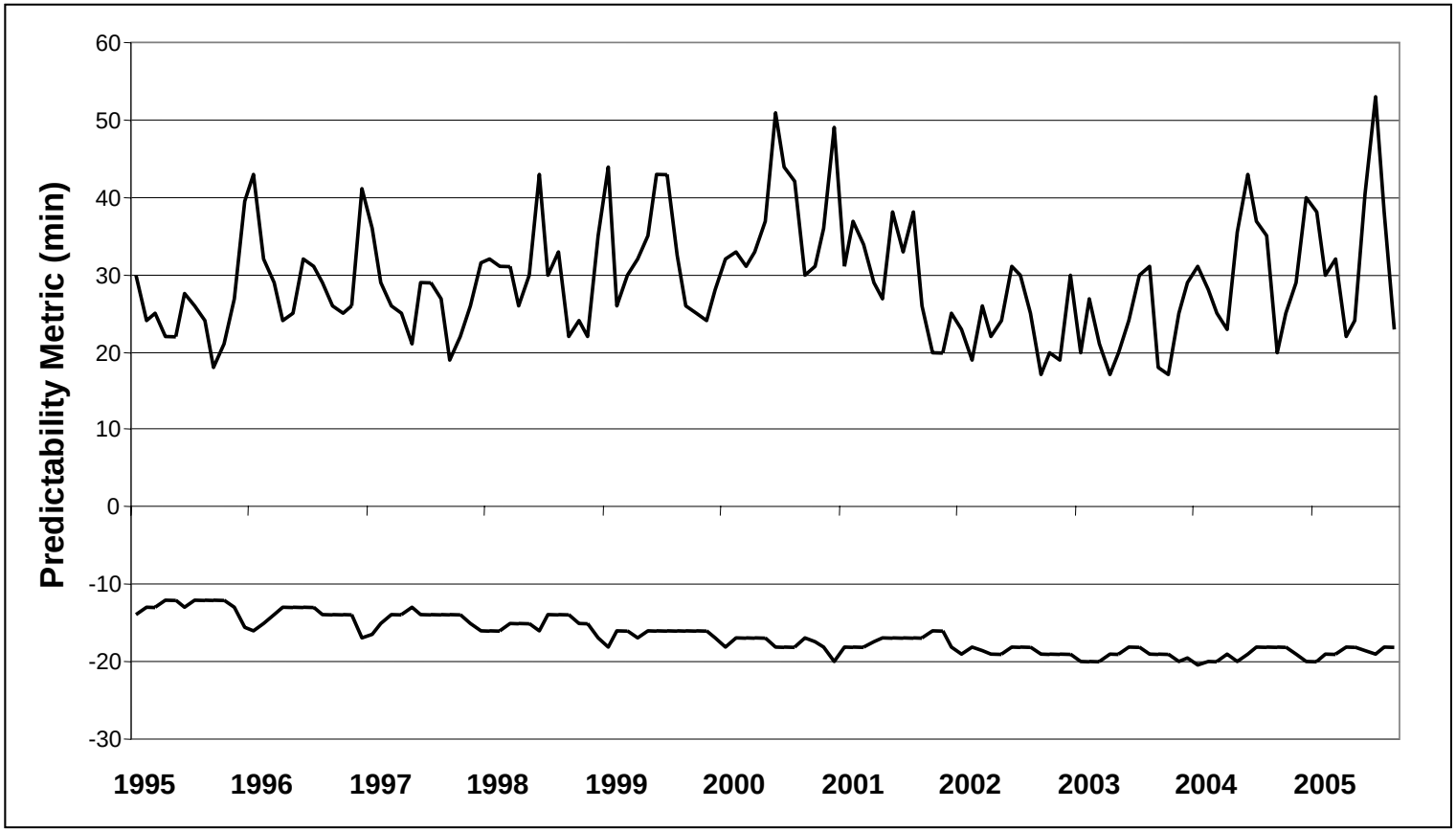
where: $$M_k = x_{ij} - \mu_{ij}$$

x_{ij} is measured time for O-D pair (i, j)

μ_{ij} is mean time for O-D pair (i, j)

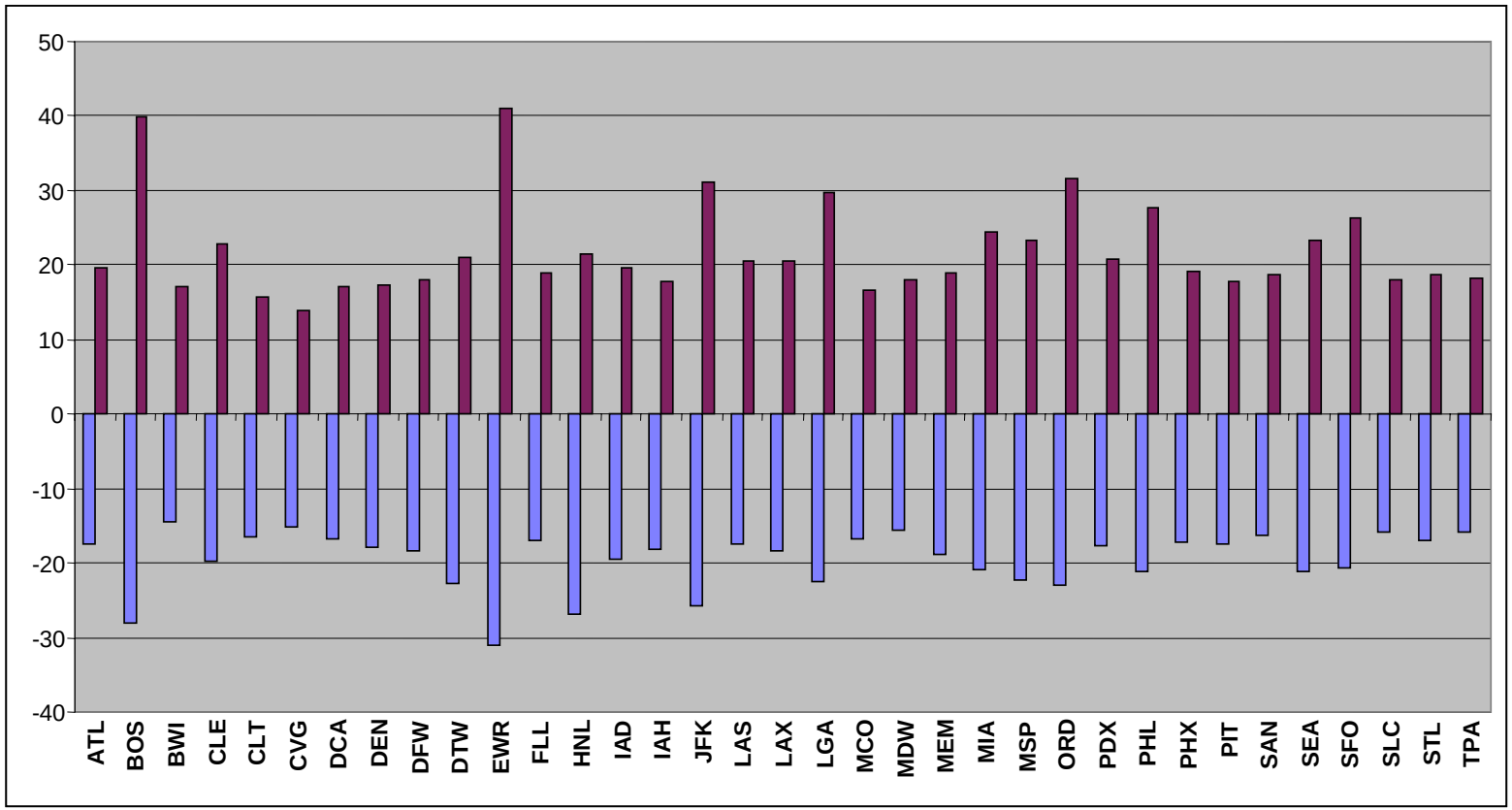
- Flight-level M_k is generated for all flights and the Selected percentiles are output as a NAS level metric

NAS Predictability Performance Metric
(Total Flight Time – includes gate delay)



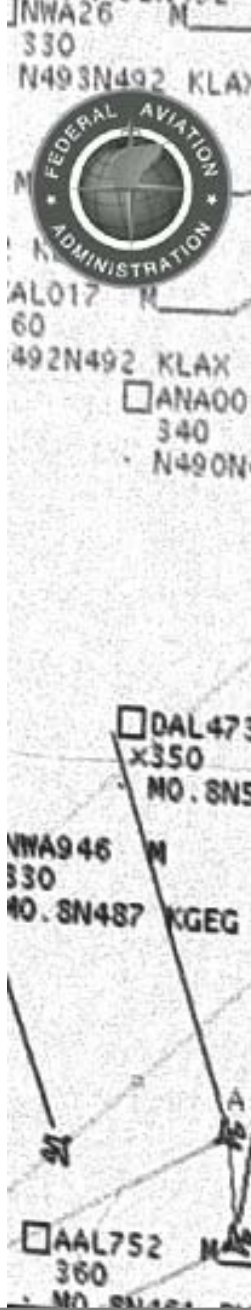
Source: ASQP

Predictability Metric
OEP Arrival Airports – Sep/2005



Observations

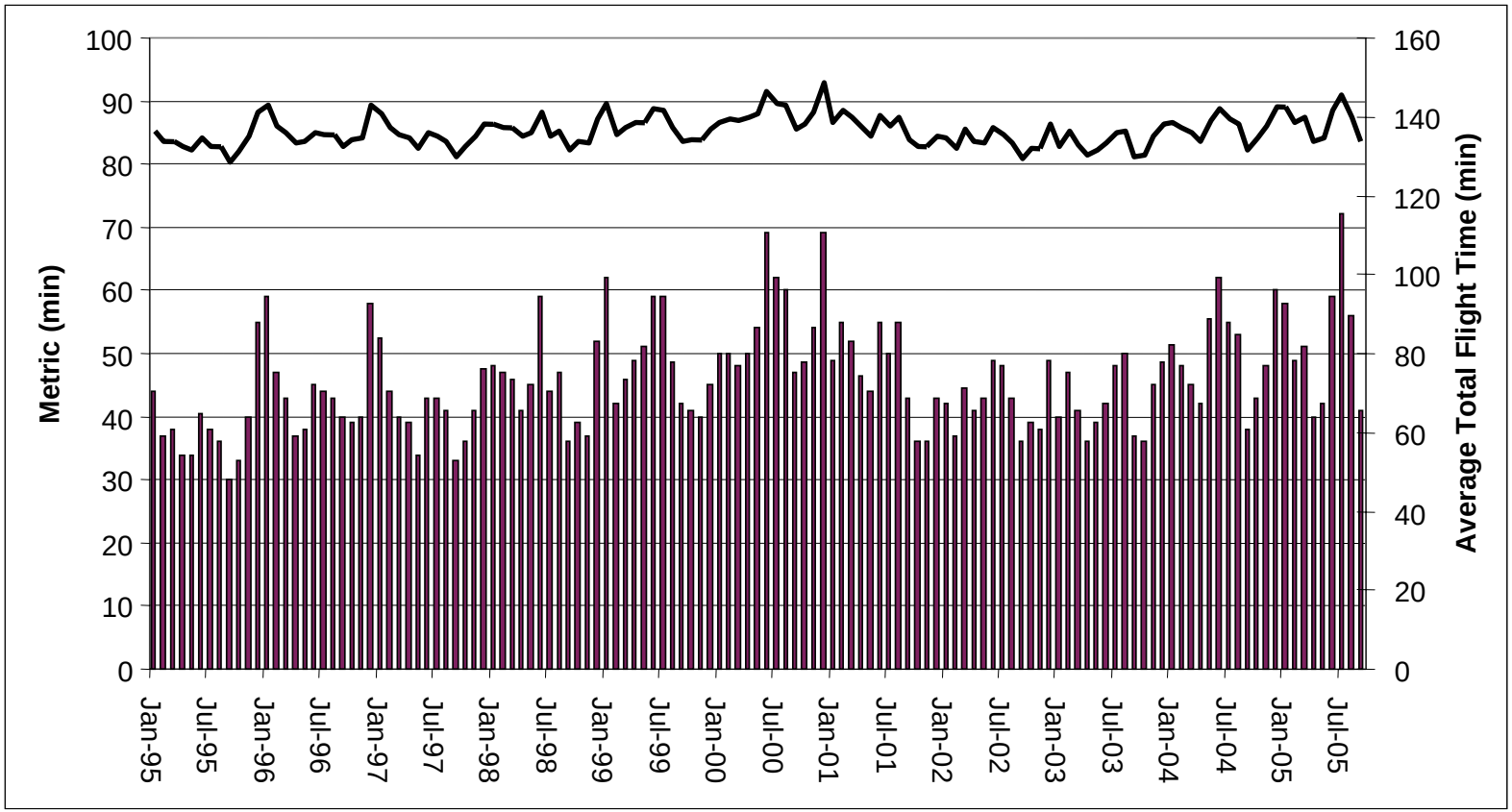
- **Using 10th, 90th percentiles**
  - –Eliminate significant outliers
  - –Analysis shows distribution right-skewed.
    - •Average closer to lower bound than upper bound.
  - –Metric defined as difference between lower, upper percentiles.
    - •Can be calculated with one month of data.
      - –Does not require historical data.
- **Seasonality**
  - –This Metric partially accounts for known seasonality (e.g., winter headwinds) by using current months averages rather than historical



Backup

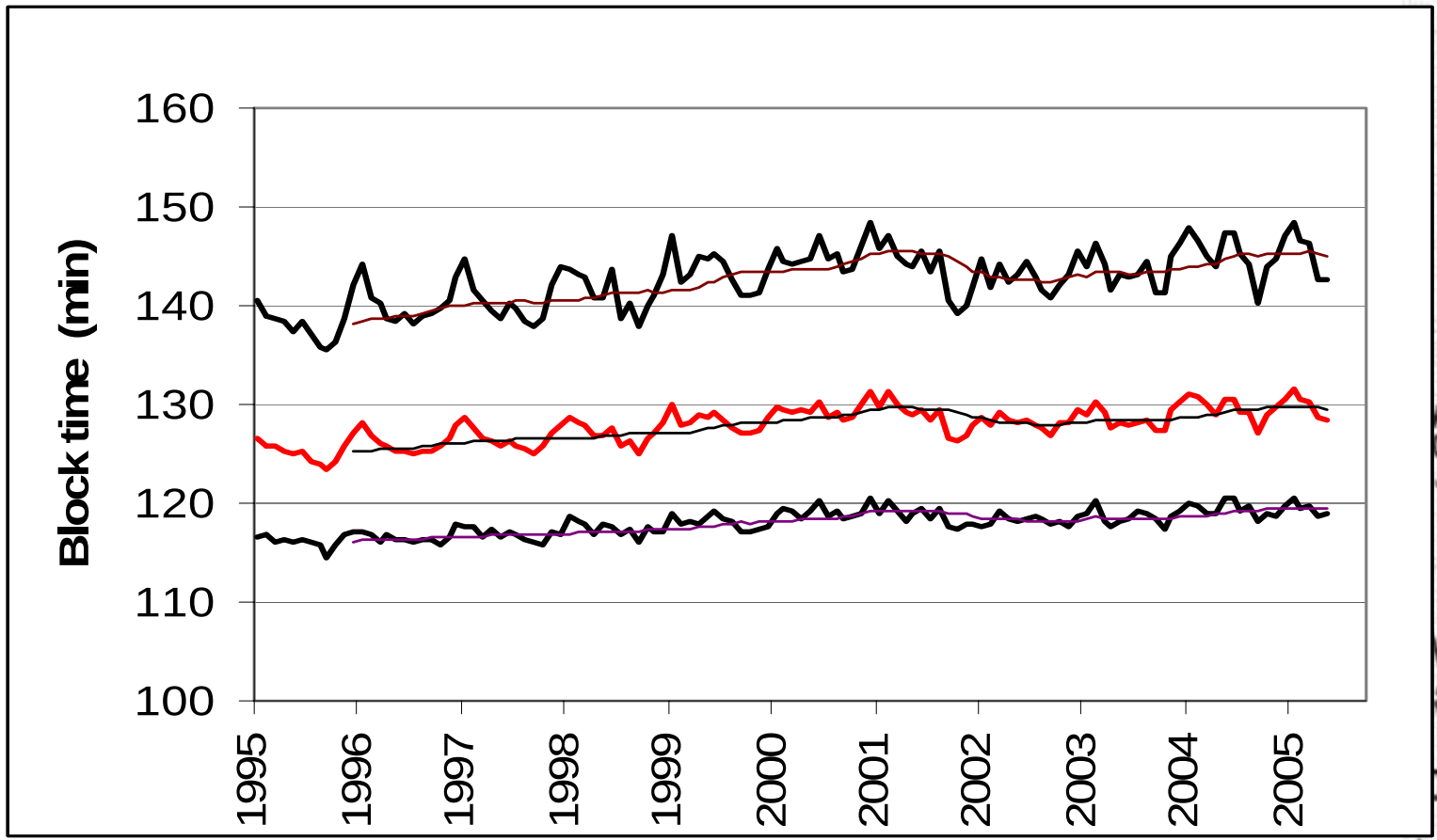

NWA26
330
N493N492 KLAX
AL017
60
492N492 KLAX
ANA00
340
N490N
DAL473
x350
MO.SN5
NWA946
330
40.SN487 KGEG
AAL752
360

Metric with Normalized Average Flight Time



Actual Block Time Variability: Percentiles and Weighted Average

(10th and 90th percentiles)



Predictability Metric Calculation - Example

Origin	Destination	Flight Time	Avg Flt tm	Delta	Sorted Delta
A	B	90	98.0	-8.0	-29.9
A	B	110	98.0	12.0	-14.9
A	B	92	98.0	-6.0	**-14.8**
A	B	100	98.0	2.0	-9.8
C	D	97	81.8	15.2	-8.0
C	D	67	81.8	-14.8	-7.9
C	D	72	81.8	-9.8	-7.8
C	D	101	81.8	19.2	-6.0
C	D	80	81.8	-1.8	-4.9
C	D	74	81.8	-7.8	-1.8
E	F	200	174.9	25.1	2.0
E	F	202	174.9	27.1	5.1
E	F	160	174.9	-14.9	12.0
E	F	145	174.9	-29.9	15.2
E	F	170	174.9	-4.9	**19.2**
E	F	180	174.9	5.1	25.1
E	F	167	174.9	-7.9	27.1

Metric = -14.8 to +21.5