

# **Brief Review on Weather Related NAS Delays in the Context of NAS Performance Metrics for the Last Decade**

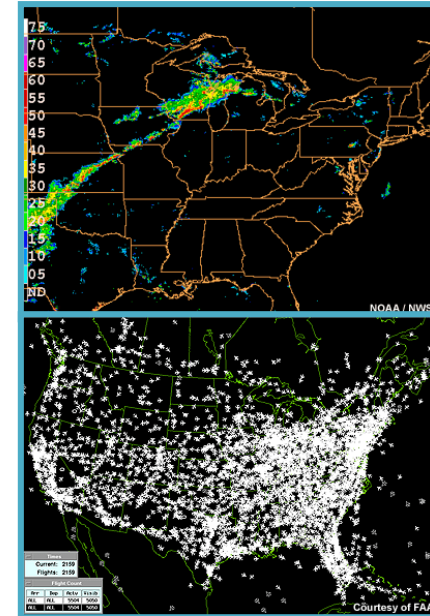
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(August 2, 2016)

# Background

## In U.S.

- Over 60% flight delays relates to weather (TS, VIS, Ceiling, Wind, Turbulence, Snow, Freezing Rain, Icing) ; 80% of the NAS delays occurred at 8 major airports
- Improve NAS performance by reducing "Avoidable Delays"
- NextGen Air Transportation System will further increase flight volume, requiring aviation weather to be more timely and accurate.



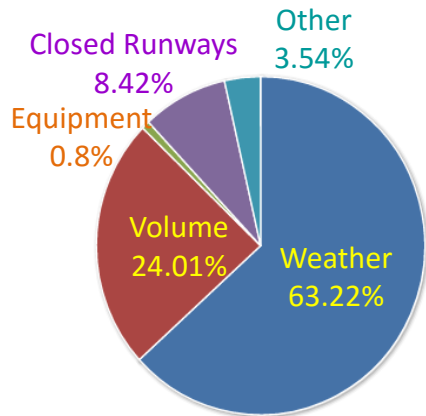
**Causes of National Aviation System Delays  
National (January, 2004 - December, 2015)**

Most Recent Month    Year to Date

[View Individual Months](#)    [View Tabular Version](#)

### More Topics:

- On-Time Arrival Performance
- Flight Delays by Cause
- Weather's Share of Delayed Flights
- Weather's Share of National Aviation System (NAS) Delays

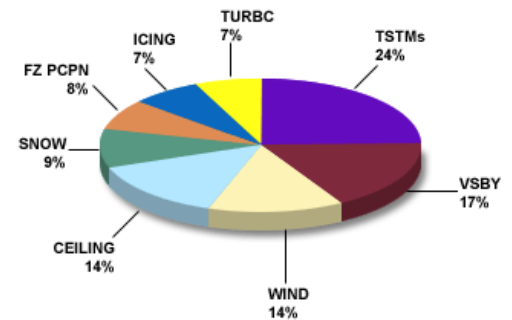


(Source: U.S. DOT/Bureau of Transportation Statistics:  
[http://www.transtats.bts.gov/OT\\_Delay/OT\\_DelayCause1.asp?pn=1](http://www.transtats.bts.gov/OT_Delay/OT_DelayCause1.asp?pn=1))

- Weather: 63.22%
- Volume: 24.01%
- Equipment: 0.8%
- Closed Runway: 8.42%
- Other: 3.54%

Additional Reading: <http://www.faa.gov/nextgen/programs/weather/faq/>

**Rankings of Impact to the NAS by Significant Weather Elements**



NOAA / NWS

## □ Background (Cont'd)

- *2007 – FAA Weather ATM Integration Working Group (WAIWG) Report:* 60~70% delays & diversions are weather-related, among which 2/3 are avoidable ... ..
- **Assumptions:**
  - *65% delays & diversions are weather-related;*
  - *2/3<sup>rd</sup> (or 66.7%) of these are avoidable by improved weather forecast and more effective use of weather information;*
  - *Other factors for delays & diversions stay unchanged*
- **How does this translate to the total potential expected percentage of NAS delays & diversions?**

- *Potentially, Expected Delays (ED) Weather Related:*

$$ED_{weather\_related} = \frac{65\% - 0.667 \times 65\%}{100\% - 0.667 \times 65\%} = 38.2\%$$

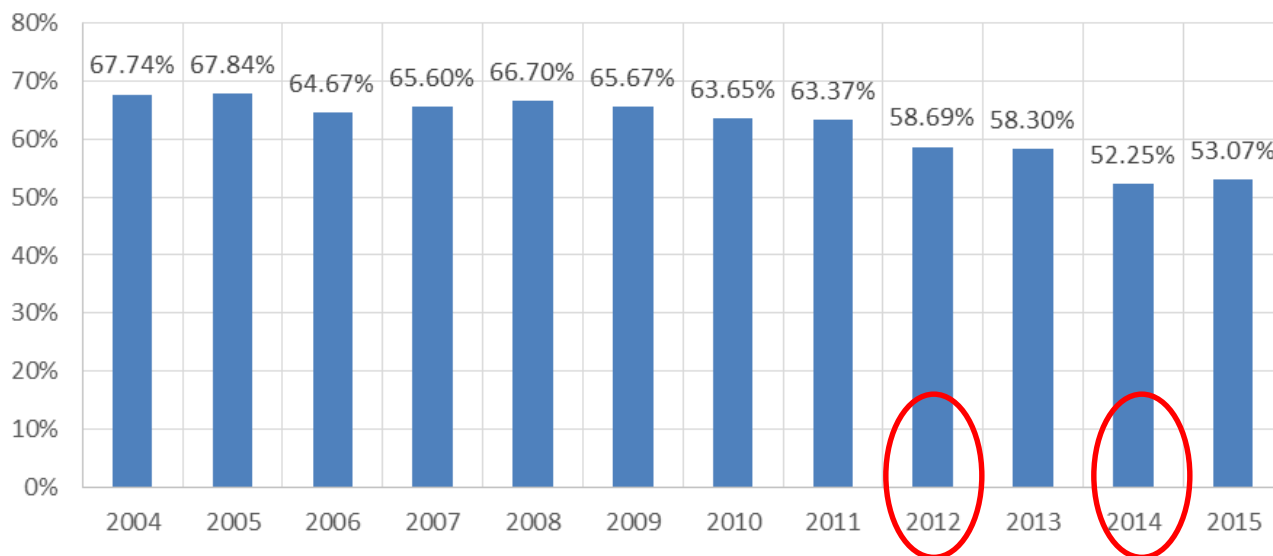
- *In other words, if we do things correctly, NAS Weather Related Delays could be reduced from 65% (in 2007) to 38% (in future).*

- Following Analysis is based on data published by DOT Bureau of Transportation Statistics <http://www.transtats.bts.gov/>

## □ Analysis in the Context of National Aviation System (NAS)

- **Question #1: Has weather related NAS delays percentage been reduced over the last decade?**

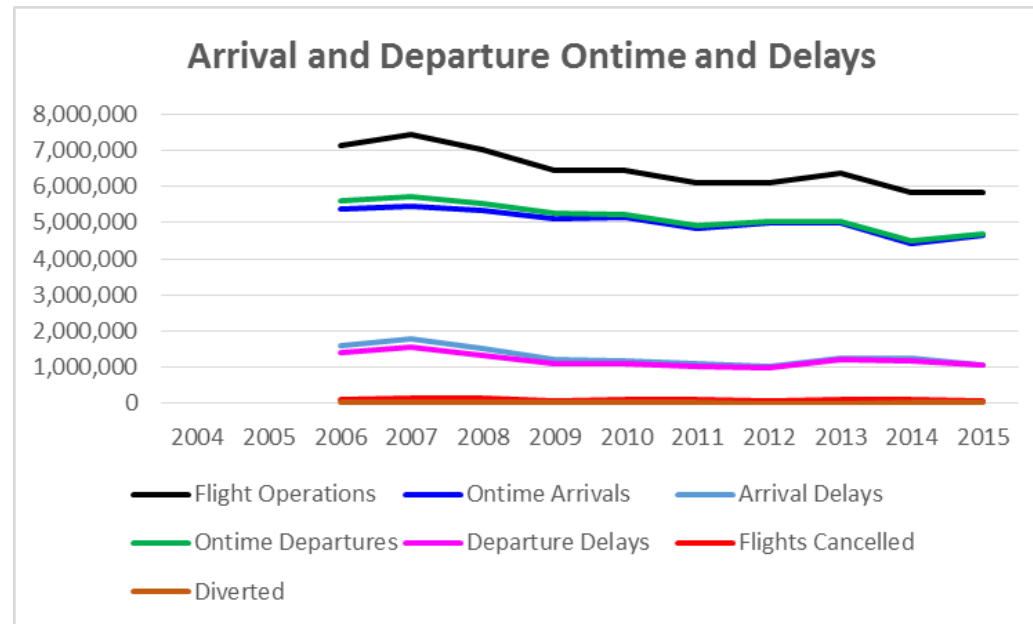
Weather's Share of NAS Delays (2004~2015)



**Answer:** Yes. Lowest (Weather Related Delays)% was 52.25%, in 2014 – but *still have room to improve to get to 38%*.

**Implications:** a) Improved weather forecast available at ATM decision making scales; b) Better use of weather forecast in strategic planning operations (or CDM) appear to be effective; c) Addition of National Aviation Meteorologists (NAMs) in 2012, and increase of NAM positions in 2014 at FAA ATCSCC may have contributed to the significant reductions of Weather Share of NAS Delays one starting 2012 and the other starting 2014

- **Question #2: However, is it (i.e. weather related NAS delays reduction) because of the overall air traffic volume reduction over the last decade?**



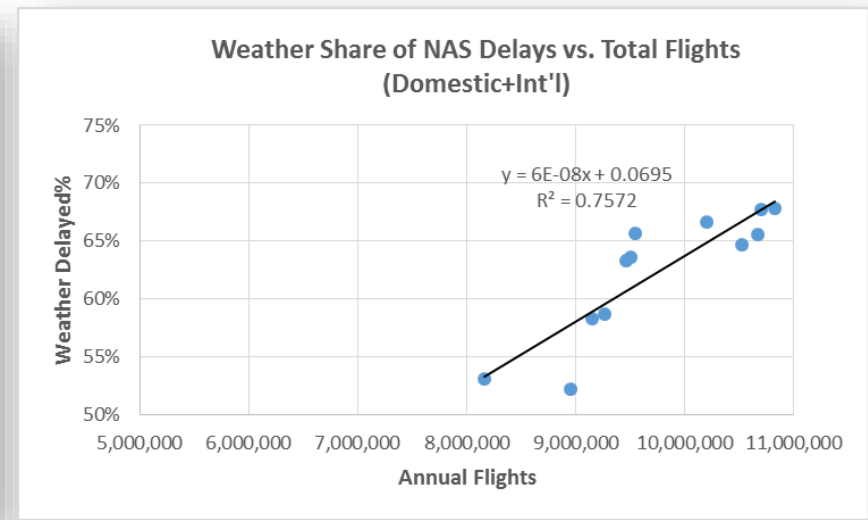
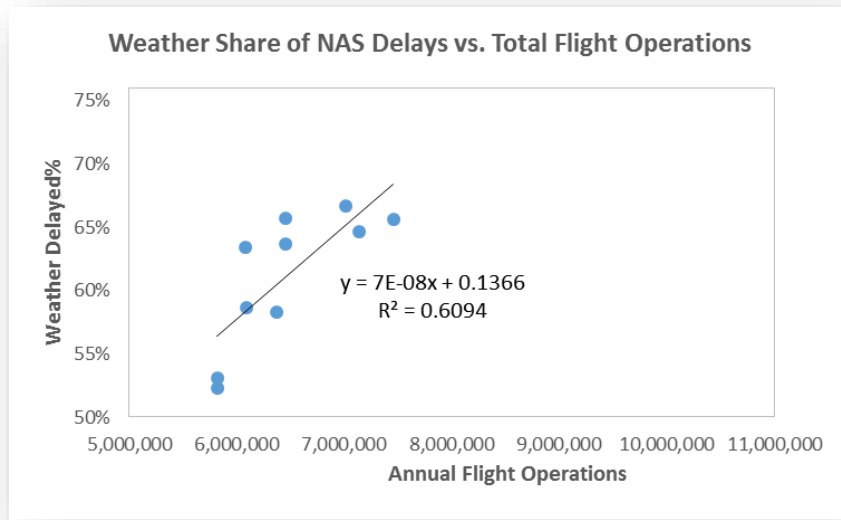
**Answer:** well ..., ...

**Note:** Flight Operations from 7,141,922 (2006) to 5,819,079 (2015) – **an 18.5% reduction!** In the meantime, Weather Share of NAS Delays from 64.67% (2006) to 53.07% (2015) – a **17.9% reduction.**

**Implications:**

- The reduction in Weather Share of NAS Delays may just be a result of the overall reduced flight volume.
- Benefit of improving weather forecast to the volume-reduced NAS is clouded?
- Benefits from NextGen Aviation Weather maybe hampered if other NAS components stay the same ...

- Question #3: Does Weather Share of NAS Delays directly linked to Total Flight Operations?**

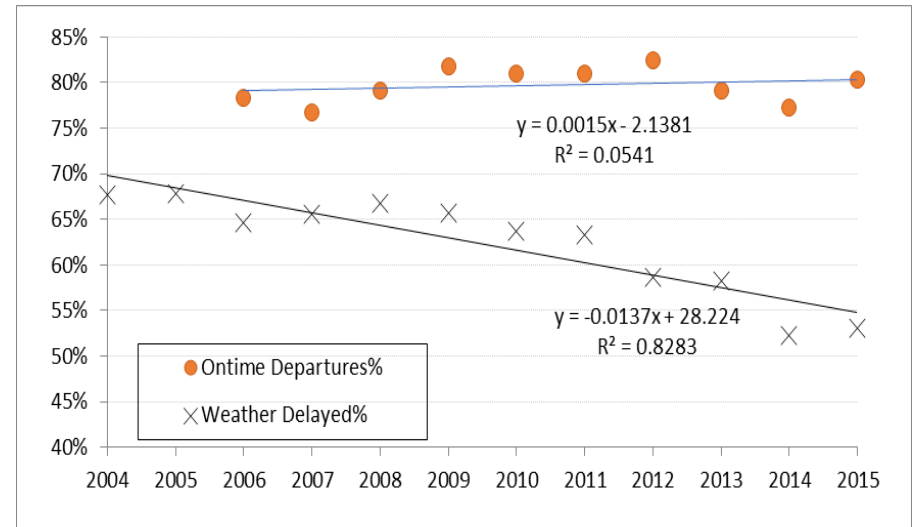
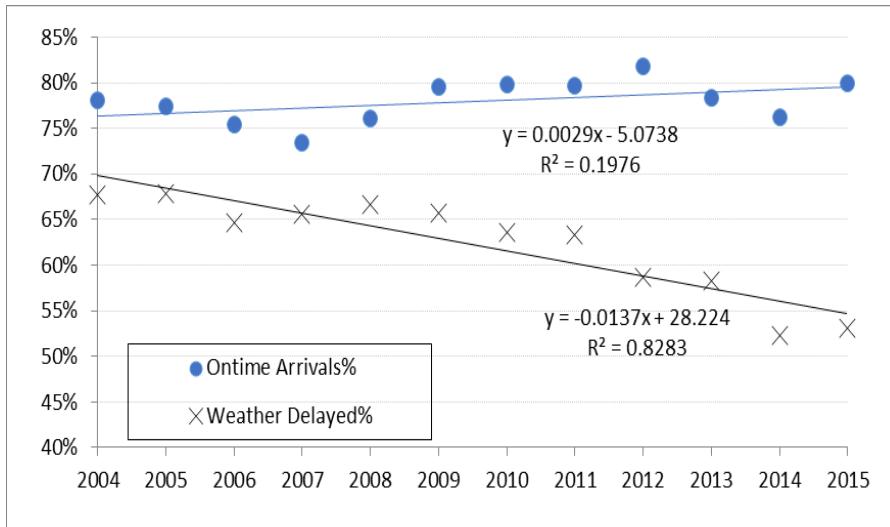


**Answer:** Appears to be so. (In other words, the more the air traffic volume, the more important to address the weather related delay issue).

**Implications:**

- The benefit of weather improvement is complicated by this – meaning 64.67% weather related delays in 2006 vs. 53.07% weather related delays in 2015 – an 11.6% improvement: *is it really because of we did much better in 2015, or just a consequence of 18.5% reduction (or 1.32 million) in total flight operations?*
- Should we normalize to the same basis, before statistical metric can meaningfully reveal what happened?

- **Question #4: Would significant reduction in (Weather Related Delays)% lead to significant improvement in the overall NAS performance?**

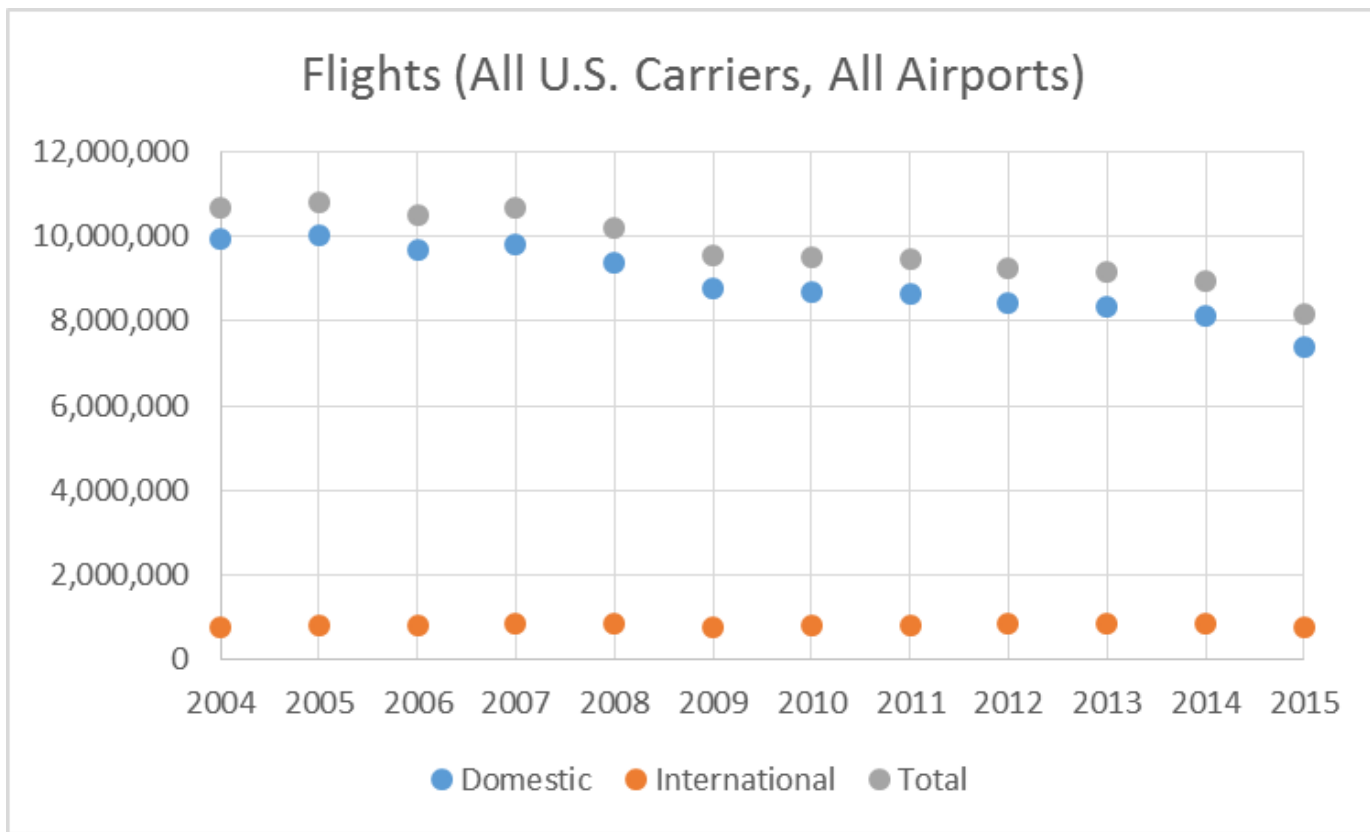


**Answer:** Yes, to some degree (overall) or not necessarily so (year to year). (Weather Related Delays)% dropped from mid-60's% to lower-50's% from 2004 to 2015, however, the (Overtime Arrivals)% improved much slower around upper-70's%, and (Overtime Departures)% improved much slower around 80%. Overall trend (derived from linear fits) – 0.0137:0.0029 or **4.7:1 (for Arrivals)** and 0.0137:0.0015 or **9.13:1 (for Departures)**

### Implications:

- There are other aspects in the NAS and ATM that have hampered the benefits of weather improvement

- **Annual Total Flights**



**Conclusion:** Total domestic flight volume descending, while international flights stay steady.

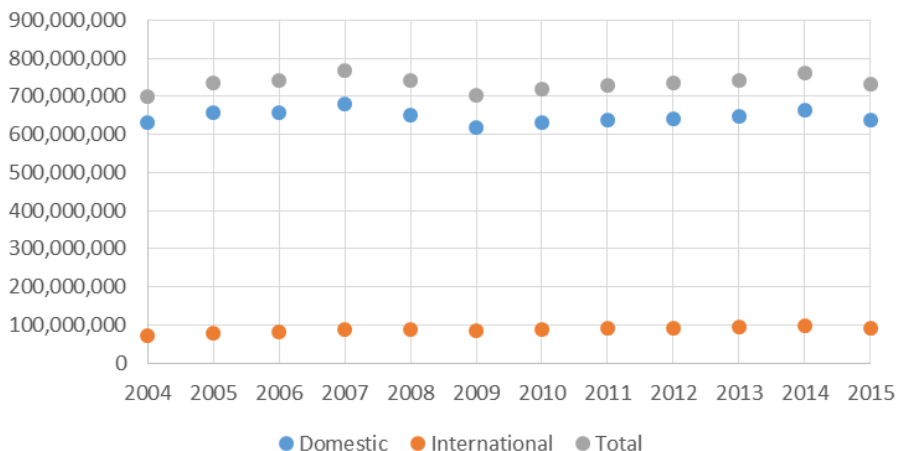
**Implications:**

- The business case on the international side of civil aviation ...

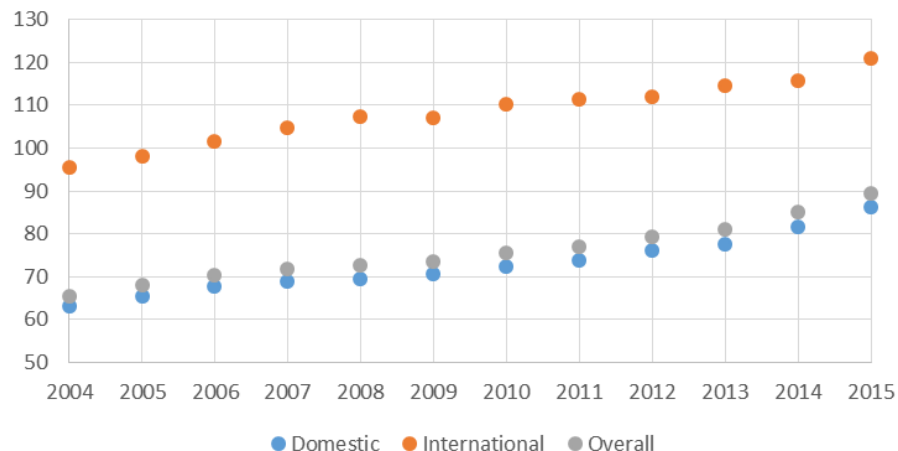


- **How about Passengers, and Passengers per Flight?**

Passengers (All U.S. Carriers)



Average Passengers per Flight



### Conclusion:

- Total domestic passengers declined after 2007 then recovered slowly after 2009, International passengers less so – staying more stable
- Average passengers per flight steady increase both domestic and international, meaning more efficiency (cost-effectiveness) gained.

### Implications:

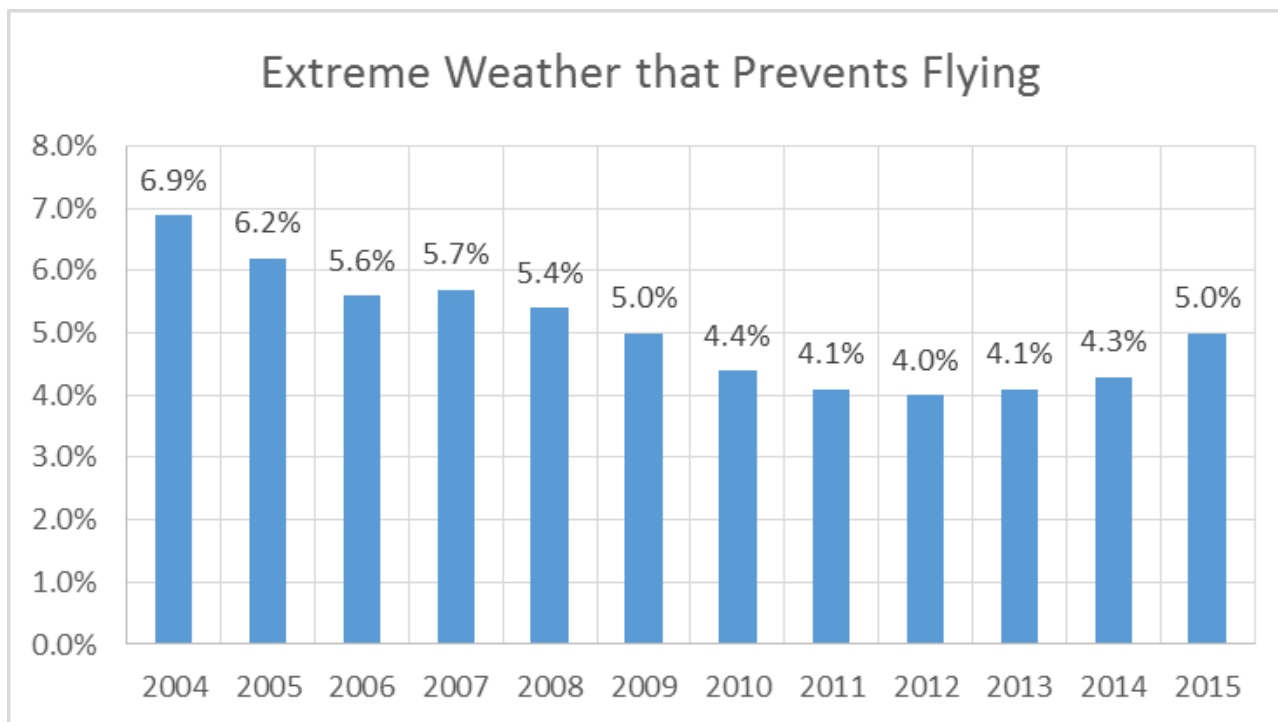
- Better utilization of civil aviation capacity: Airlines become more profitable by operating smaller number of flights with each flight carry more passengers.
- **With overall less flights after 2007, shall we get more significant improvement in On-Time rates (see slide #6)?**

## ❑ Conclusions (Preliminary)

- (Weather Related Delays)% has been significantly reduced over the past decade.
- The reason for such performance improvement may be **convoluted**, with the overall NAS traffic volume reduction percentage almost the same as the (Weather Related Delay)% reduction percentage (from 2006 to 2015)
- Overall NAS On-Time Arrival and Departure Rates improve as Weather Related Delays reduces, however, the rates of (On-Time Arrivals/Departures)% improvement were much slower than the rate of (Weather Related Delays)% reduction.
- Some other factors in the NAS need to be further analyzed to understand and **quantify** the full benefits of aviation weather capability improvement.

# Backup Slides

- **Extreme Weather that Prevents Flights**



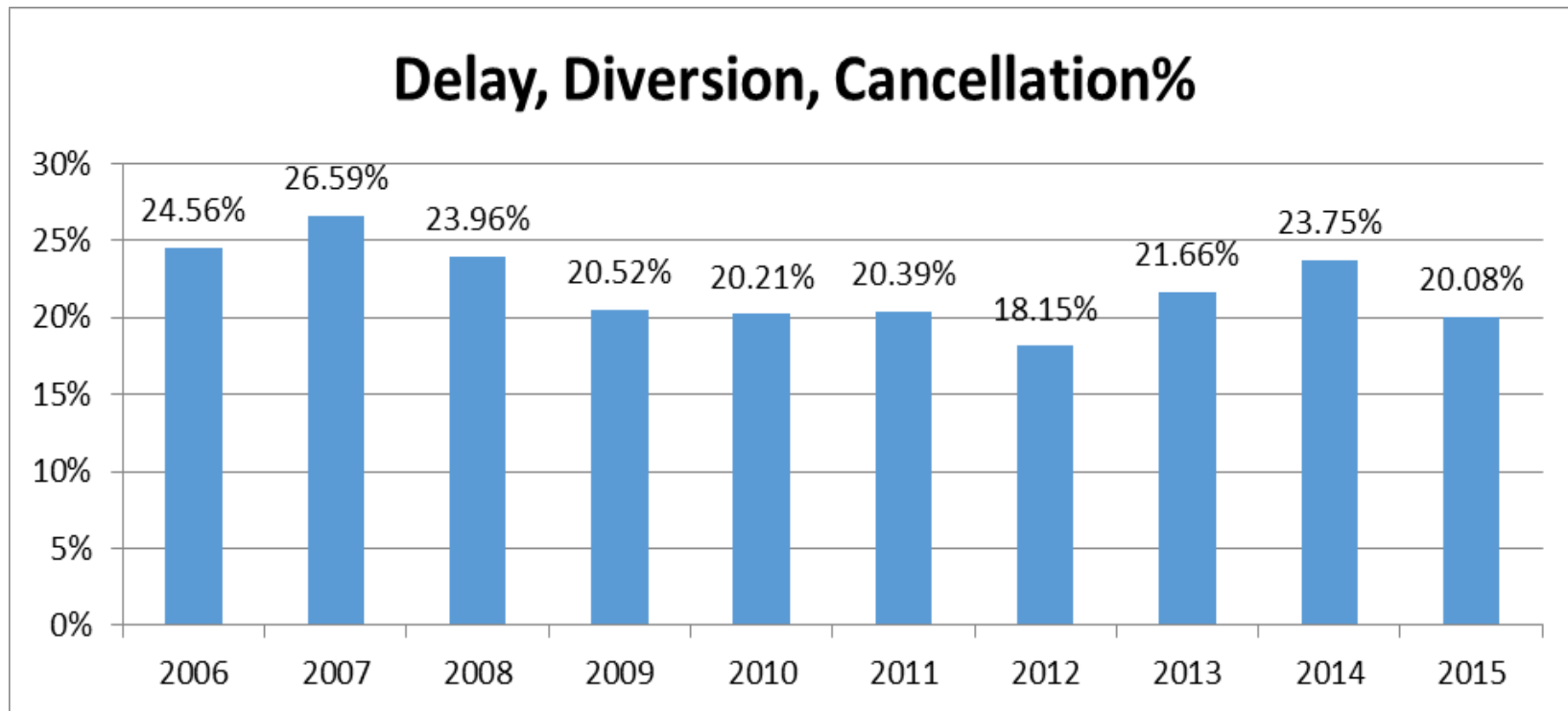
**Notes:**

- Each year, there is a small percentage of flight cancellations due to extreme weather that prevents flying

**Implications:**

- “Irreducible” percentage of cancellations appears to be around 4%

- **Arrival Delays, Diversion, and Cancellation%**



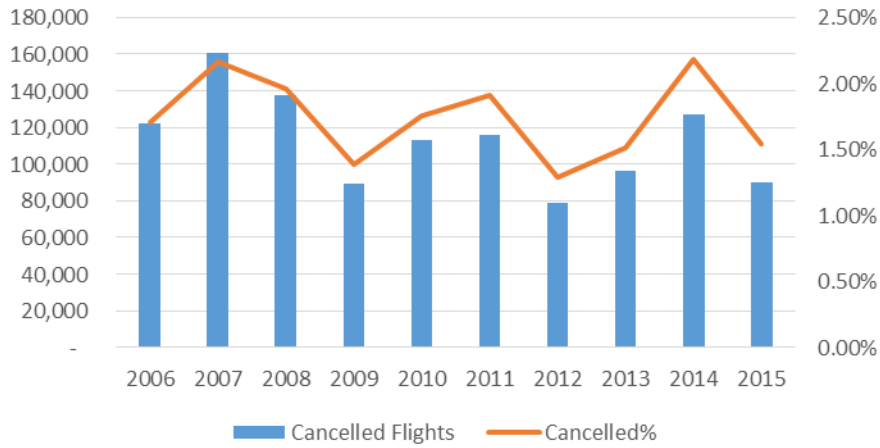
**Notes:**

- Derived from (1.0 – Ontime Arrivals%);
- Winter of 2012 was warm, so there were less weather related delays & cancellation.

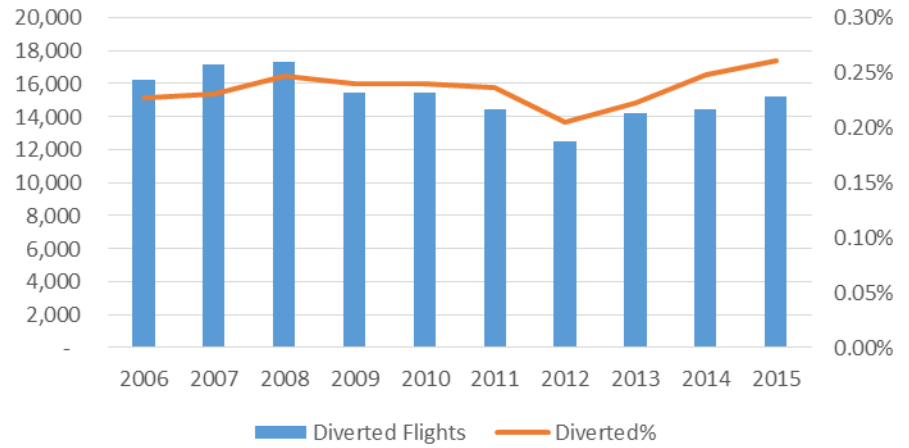
**Implications:**

- 2013, 2014 seem to indicate some problem in overall ATM ...

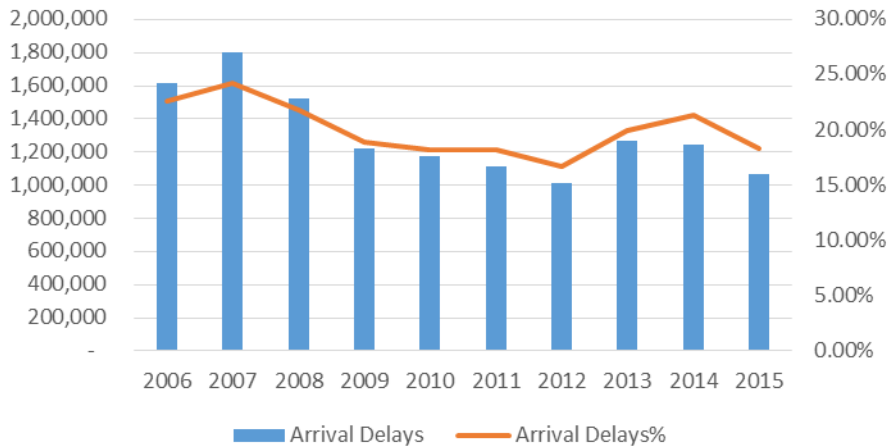
### Cancelled



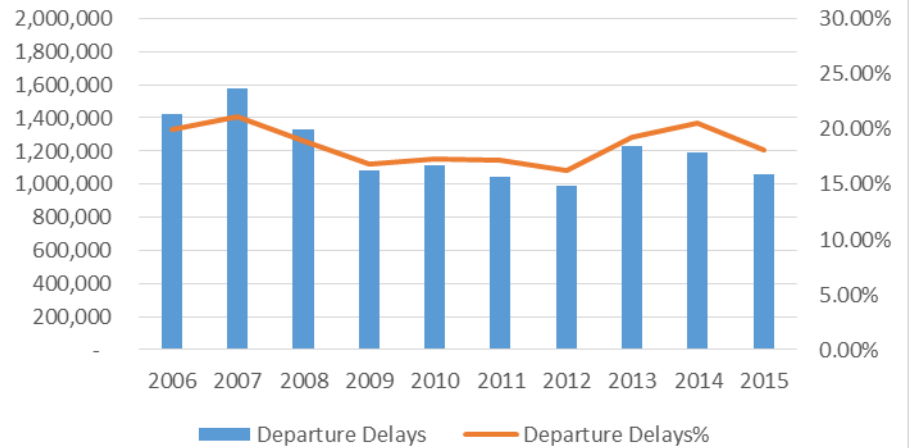
### Diverted



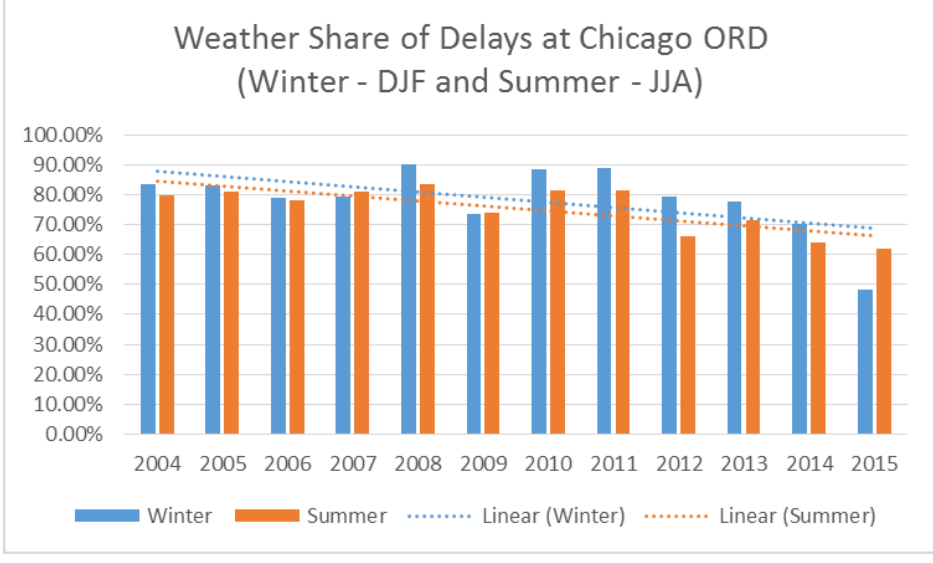
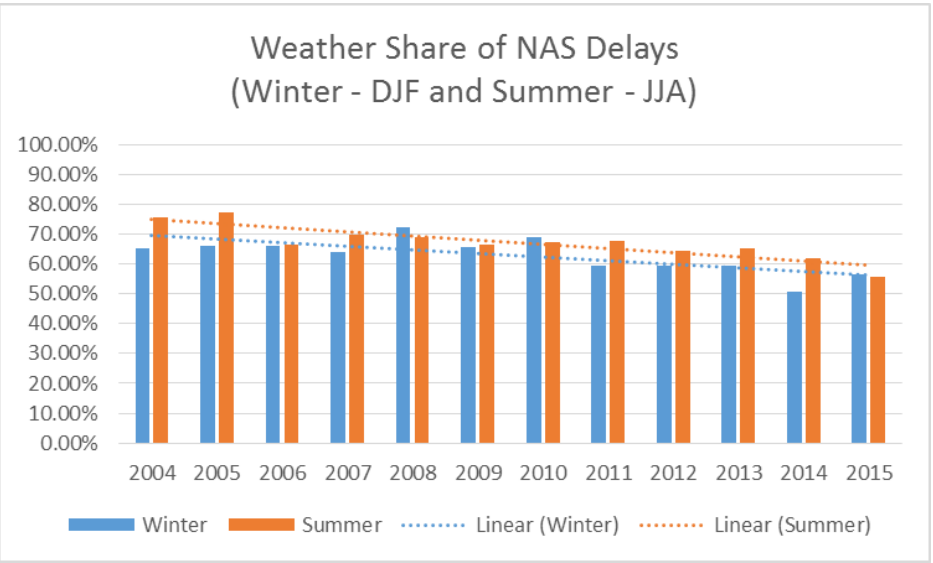
### Arrival Delays



### Departure Delays



- **Weather Share of NAS Delays: Winter – Dec (previous year), Jan, Feb, and Summer – Jun, Jul, Aug**
- **Weather Share of Delays at Chicago O’Hare Airport (ORD) in Winter and in Summer**



**Conclusion:**

- **Weather Share of Delays was higher at ORD than that of the overall NAS, both in Winter and Summer.**
- **Overall descending trend of weather share of delays, but varies year to year.**

**Implications:**

- **There are other factors in the ATM-ATC system that should be looked in further depth.**