Issues on Network and Airspace Capacity

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CEE 5614 - Analysis of Air Transportation Systems

Spring 2020

Organization of the Presentation

- Recent FAA directives that affect airport capacity (Converging runway operations)
- Airport system capacity
  - Tactical ve Strategic responses to capacity
  - Tactical - Ground Delay programs
  - Strategic - Airport and NextGen improvements
- Airway and airspace issues

Recent FAA Directives that Affect Runway Capacity

- Converging Runway Operations (CRO)
- Following four incidents at Las Vegas (Nevada), the FAA developed more conservative guidelines for operations on converging runways

NOTICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization Policy

N JO 7210.860

Effective Date:
January 15, 2014

Cancellation Date:
January 14, 2015

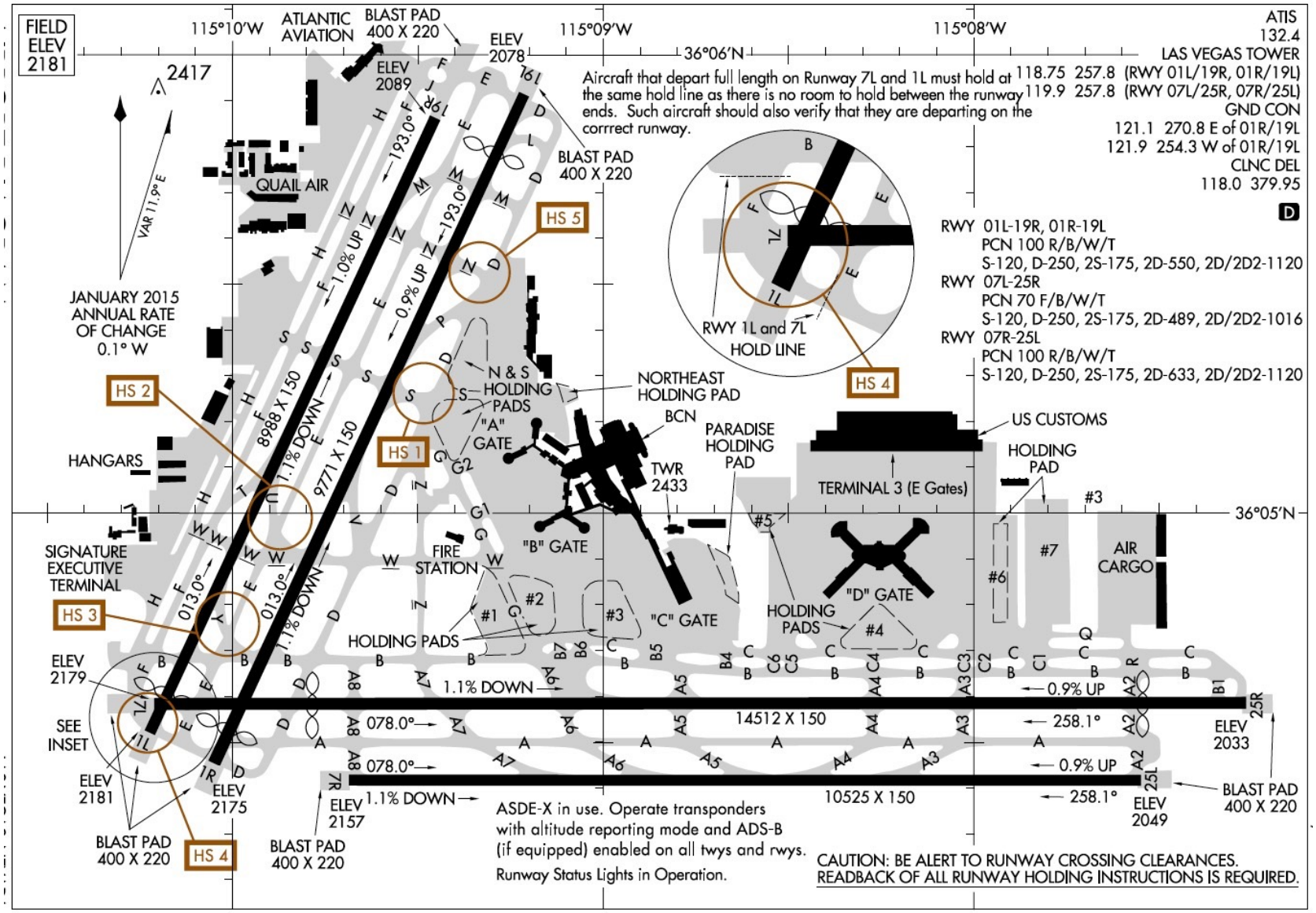
SUBJ: Converging Runway Operations

1. Purpose of This Notice. This notice amends Federal Aviation Administration (FAA) Order JO 7210.3, Facility Operation and Administration, paragraphs 3-7-3, Display Map Data, and paragraph 10-3-14, Go-Around/Missed Approach.

This notice incorporates changes that will be applied at LAS, CLT, JFK, IAD, IAH, ORD, and BOS beginning January 15, 2014. Secondly, this change will apply to DFW, MSP, DEN, BWI, HNL, MEM, MIA, PHL, SLC, and TPA beginning April 2, 2014. Lastly, this change will apply to all additional affected airports beginning July 9, 2014.

Information of N JO 7210.860 is now part of the FAA Task Order 7110.65 (ATC Handbook)

Las Vegas International Airport



NTSB Reports that Prompted CRO

NTSB Identification: OPS13IA071

Incident occurred Thursday, July 04, 2013 in Las Vegas, NV
Probable Cause Approval Date: 03/10/2015
Aircraft: GULFSTREAM GIV - UNDESIGNAT, registration:
Injuries: Unavailable

"A Boeing 737 (737) executing a go-around from runway 25L and a Gulfstream 4 that had just departed from runway 19R experienced an airborne conflict. When passing over runway 25L, the 737 pilot announced his intention to go around because the airplane was encountering a 20-knot tailwind.

The tower controller responsible for runway 25L acknowledged the report, immediately advised the pilot of traffic "just lifting off" from runway 19R, and instructed the pilot to report the traffic in sight. The tower controller then instructed the pilot to fly the runway heading and climb to 7,000 ft. The pilot read back the clearance and reported the traffic in sight. The controller told the pilot to maintain visual separation from the traffic. The 737 subsequently completed another approach and landed."

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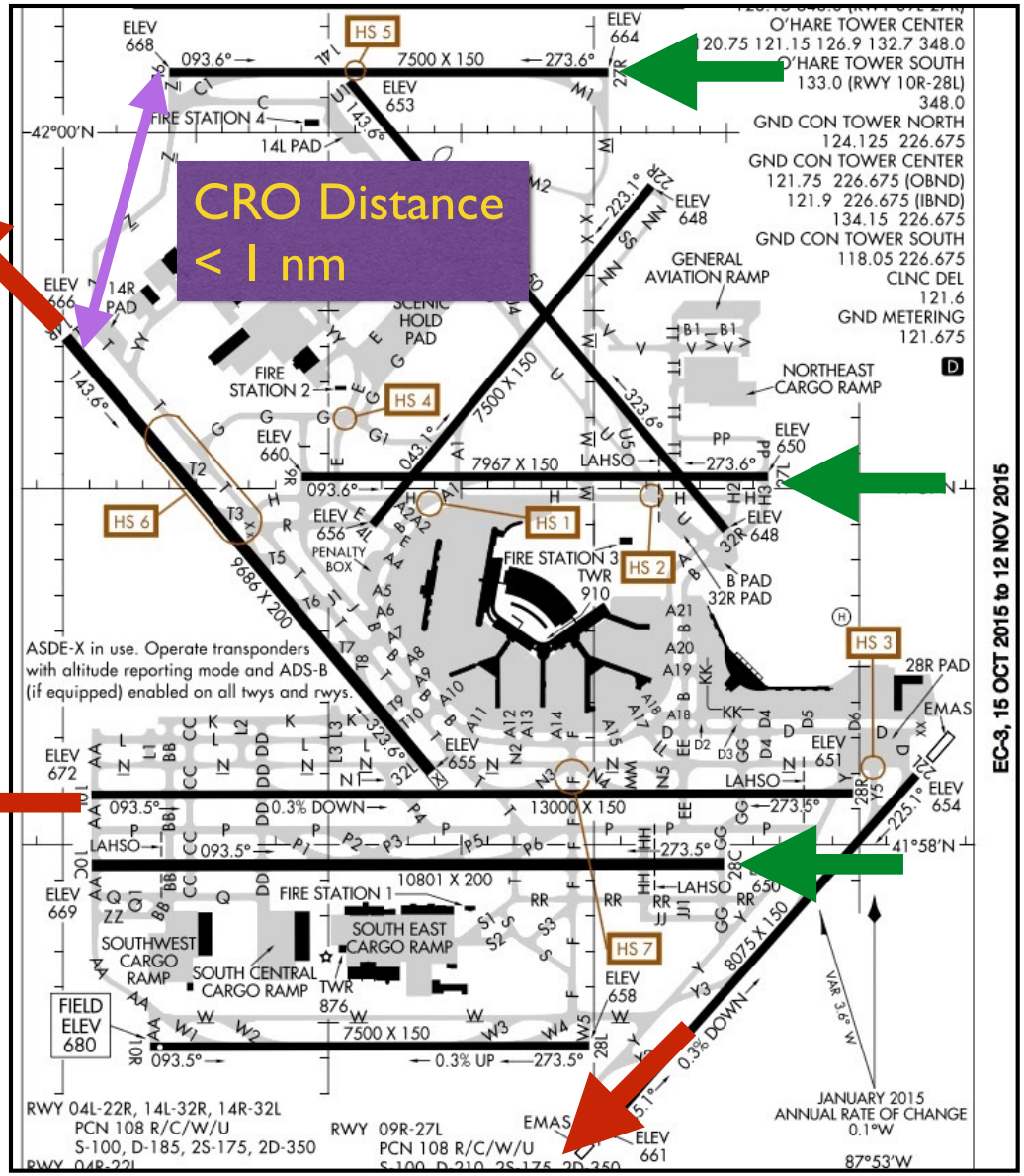
"At the time of the incident, the FAA did not have procedures requiring specific separation between aircraft operating on nonintersecting runways where flightpaths may intersect despite the occurrence of several previous similar incidents.

Following this incident and another similar incident, the FAA amended FAA Notice 7110.65, "Air Traffic Control," by adding paragraph 3-9-9, "Non-Intersecting Converging Runway Operations," which directed changes in converging runway operations to prevent similar reoccurrences."

Example of CRO Effect (ORD Airport)

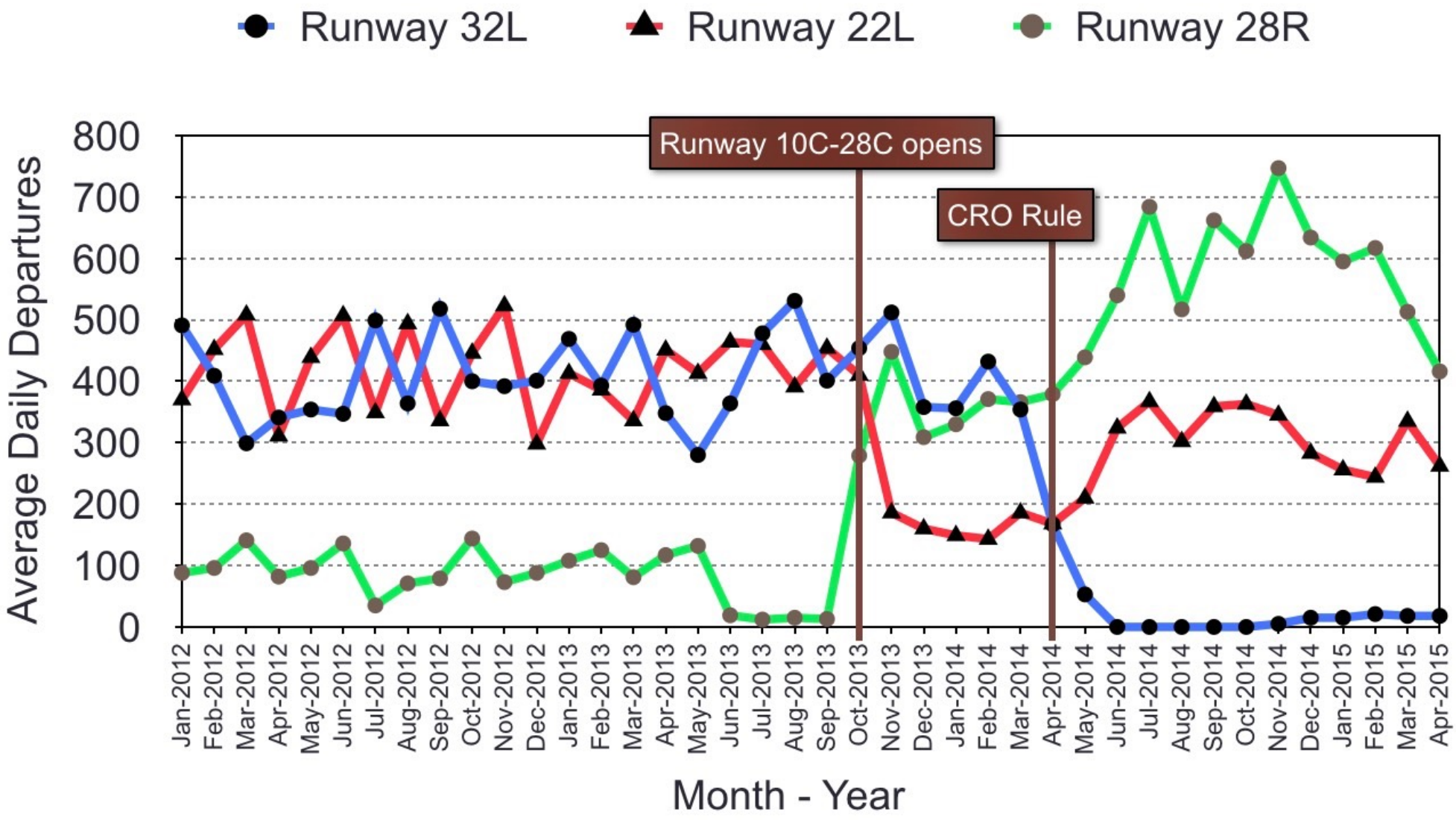
- In the summer 2014, ORD lost 1/3 of its departure capacity for one of the most heavily used configurations
- Runway 32L become almost unusable during daytime hours



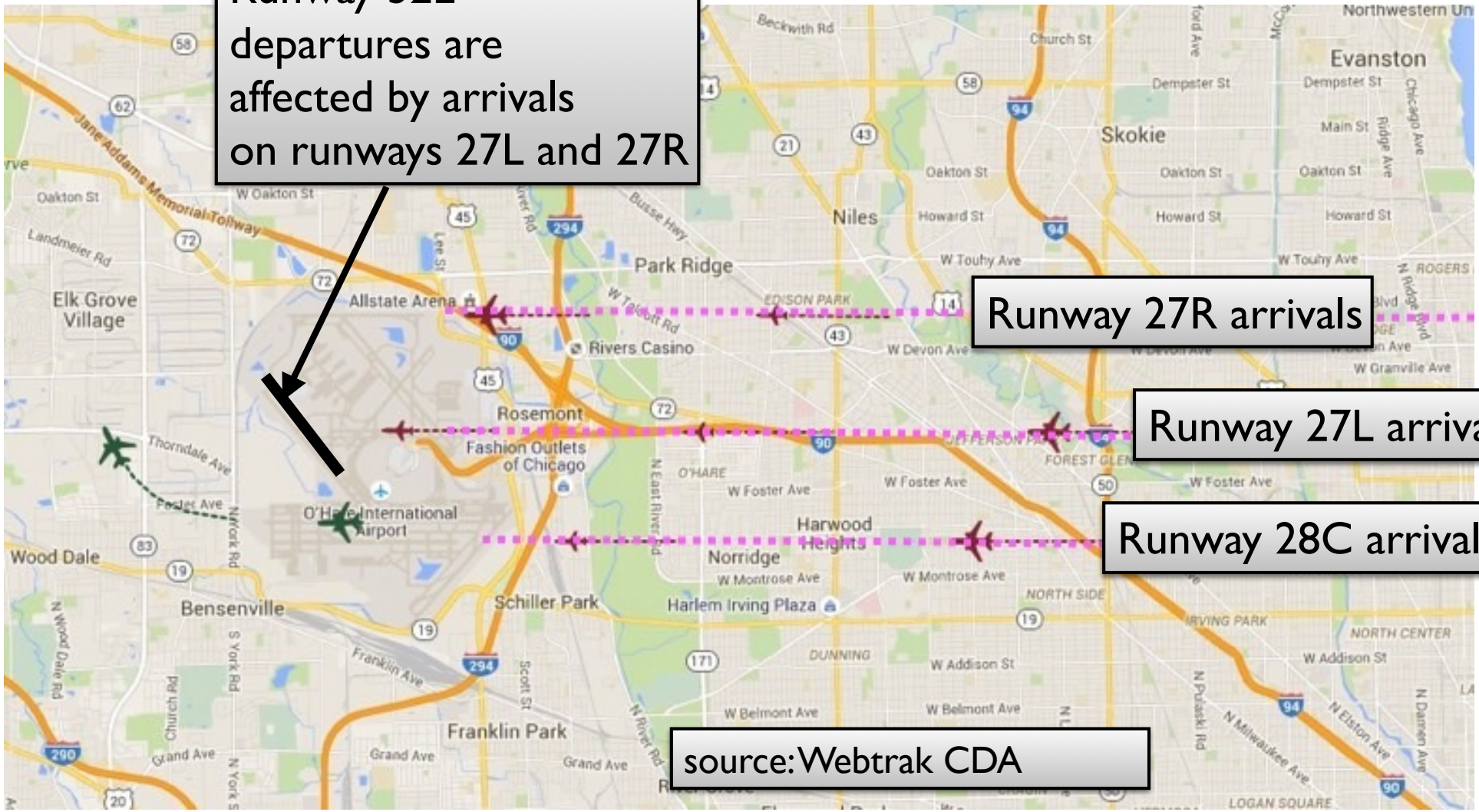
Arrival runways (west flow)

Departure runways (west flow)

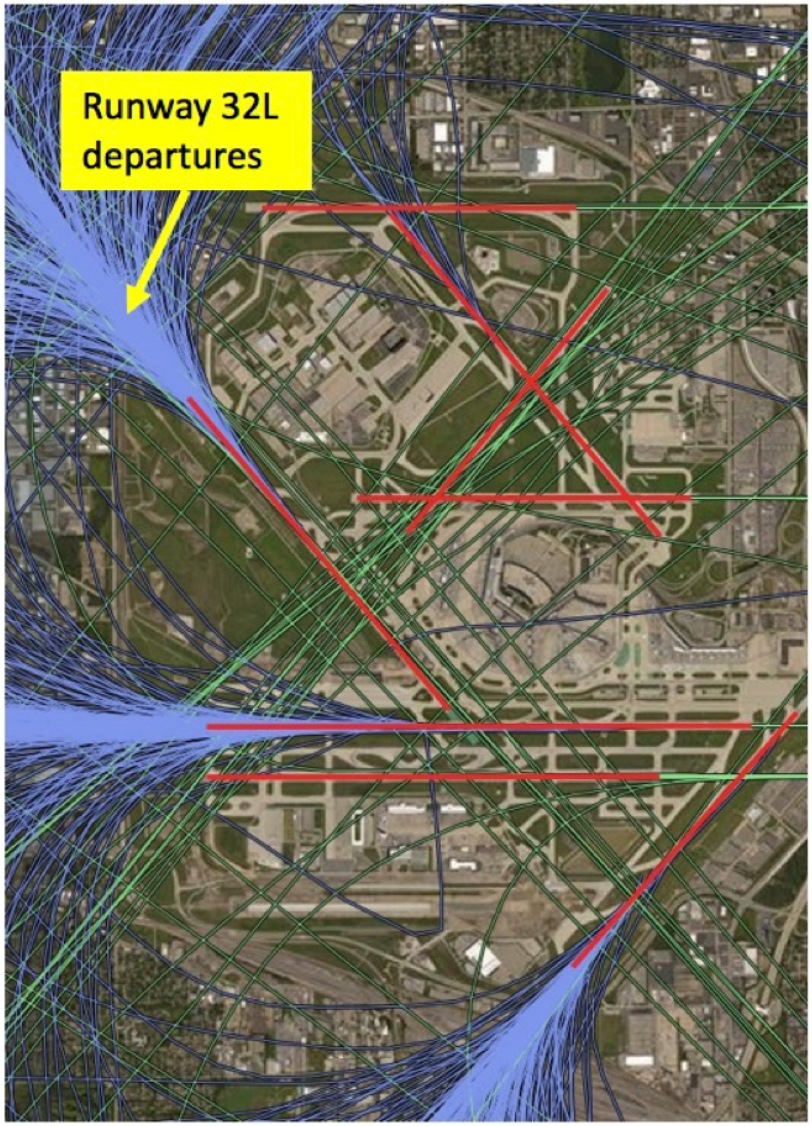
Example of CRO Effect (ORD Airport)



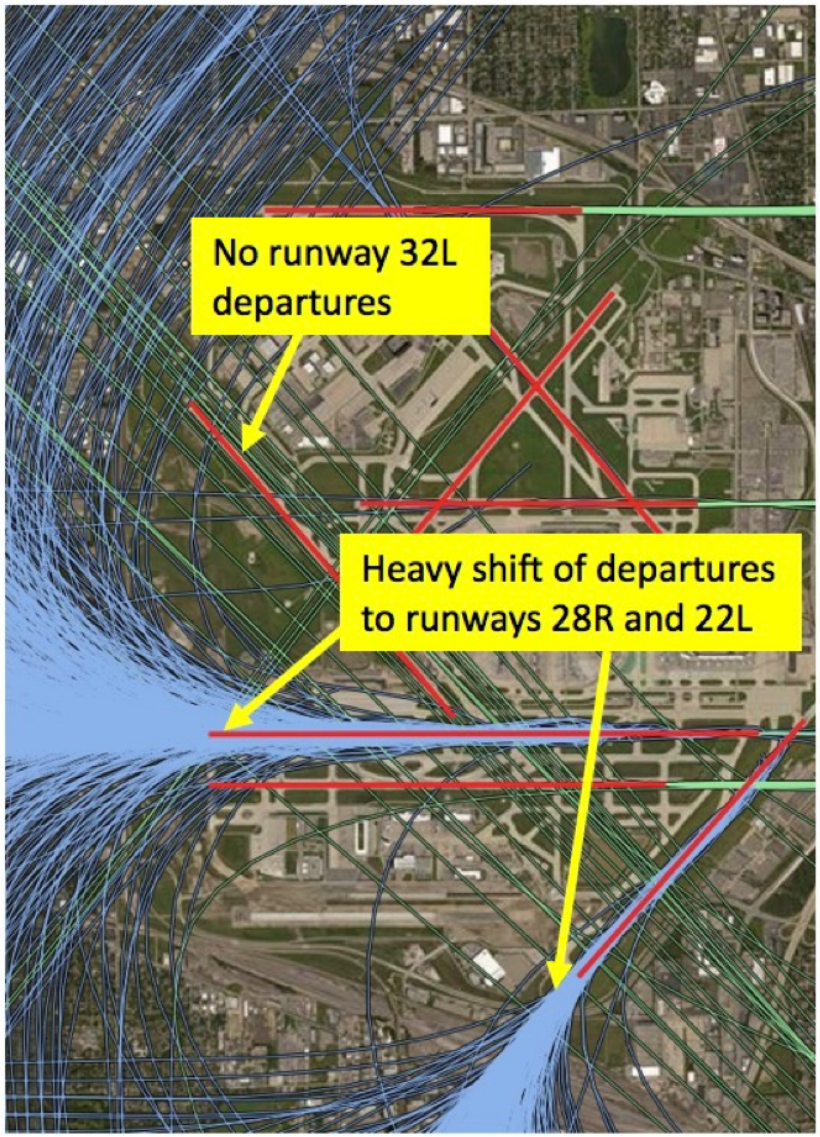
Example of CRO Effect



CRO Rule at Chicago O'Hare Intl. Airport



Before CRO Rule



After CRO Rule

Airspace Capacity

- Airspace constraints need to be considered when planning air transport operations
- Issues:
  - Airport proximity (New York)
  - Lack of airways (China)
  - Geographical boundaries (Florida)

Example of Airspace Capacity Constraints

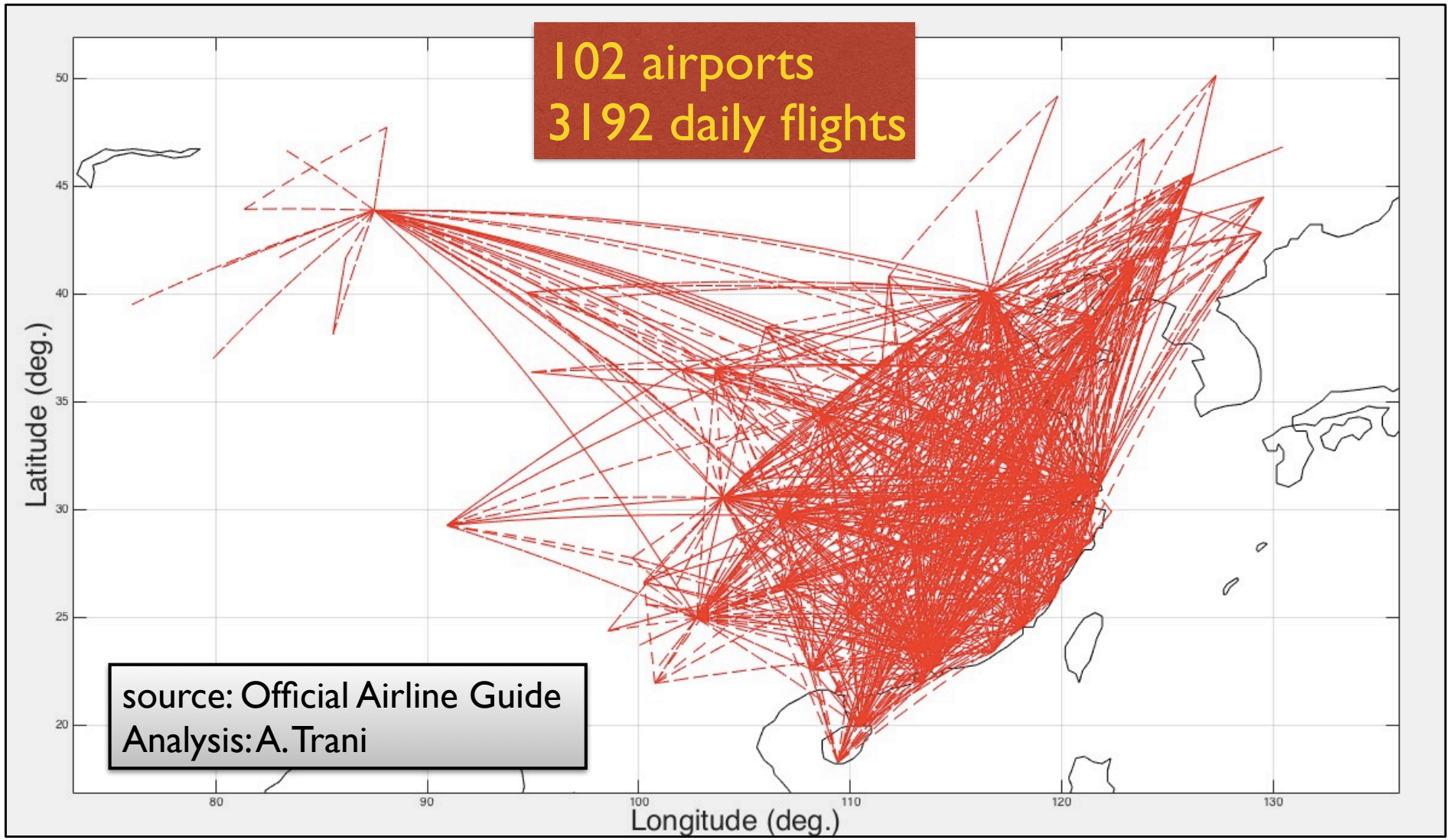
- China's air transportation operations have kept pace with GDP

- China's Gross Domestic Product increased at 9-10% in recent years

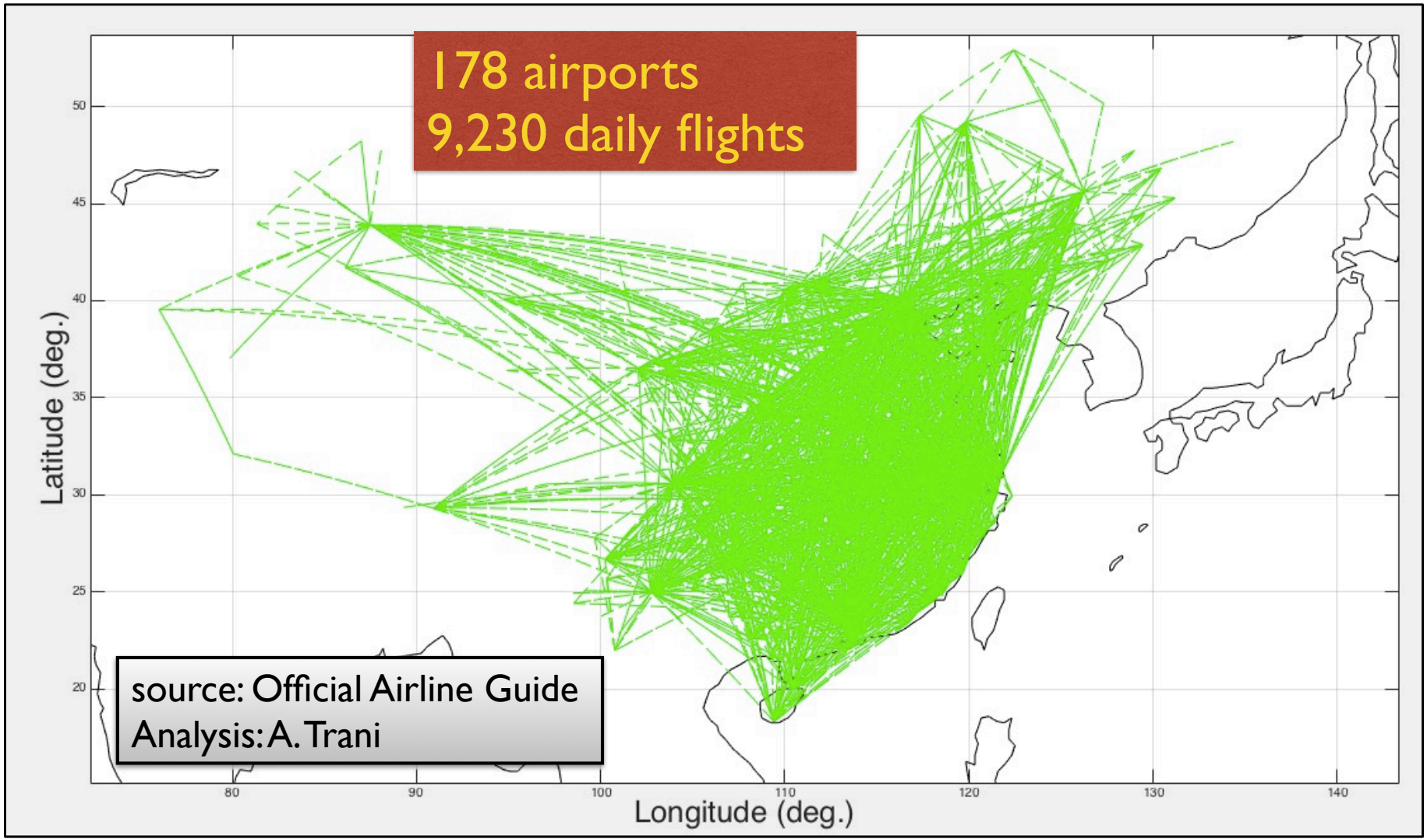
- For years 2016-2017 the World Bank predicts 6.9%

source: www.chinatourmap.com

China's Domestic Commercial Air Transport Network (2004)

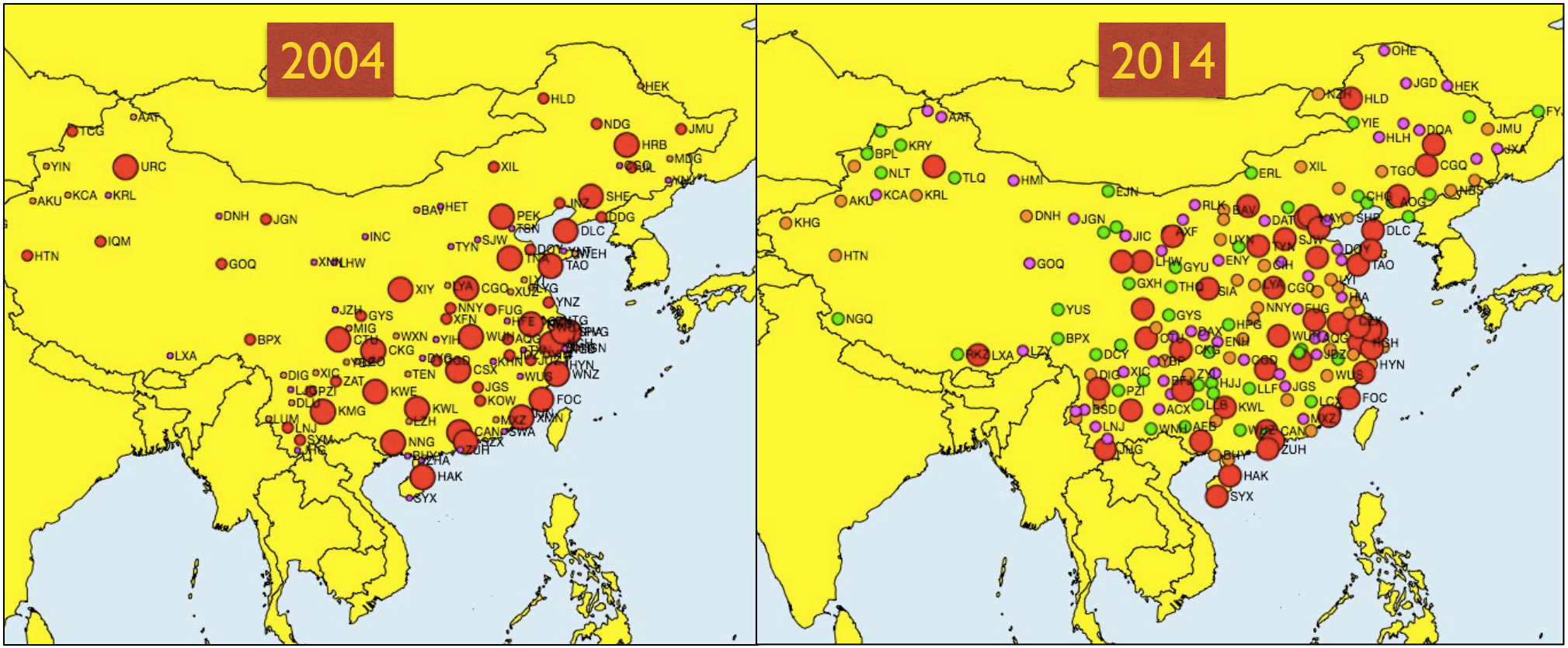


China's Domestic Commercial Air Transport Network (2014)



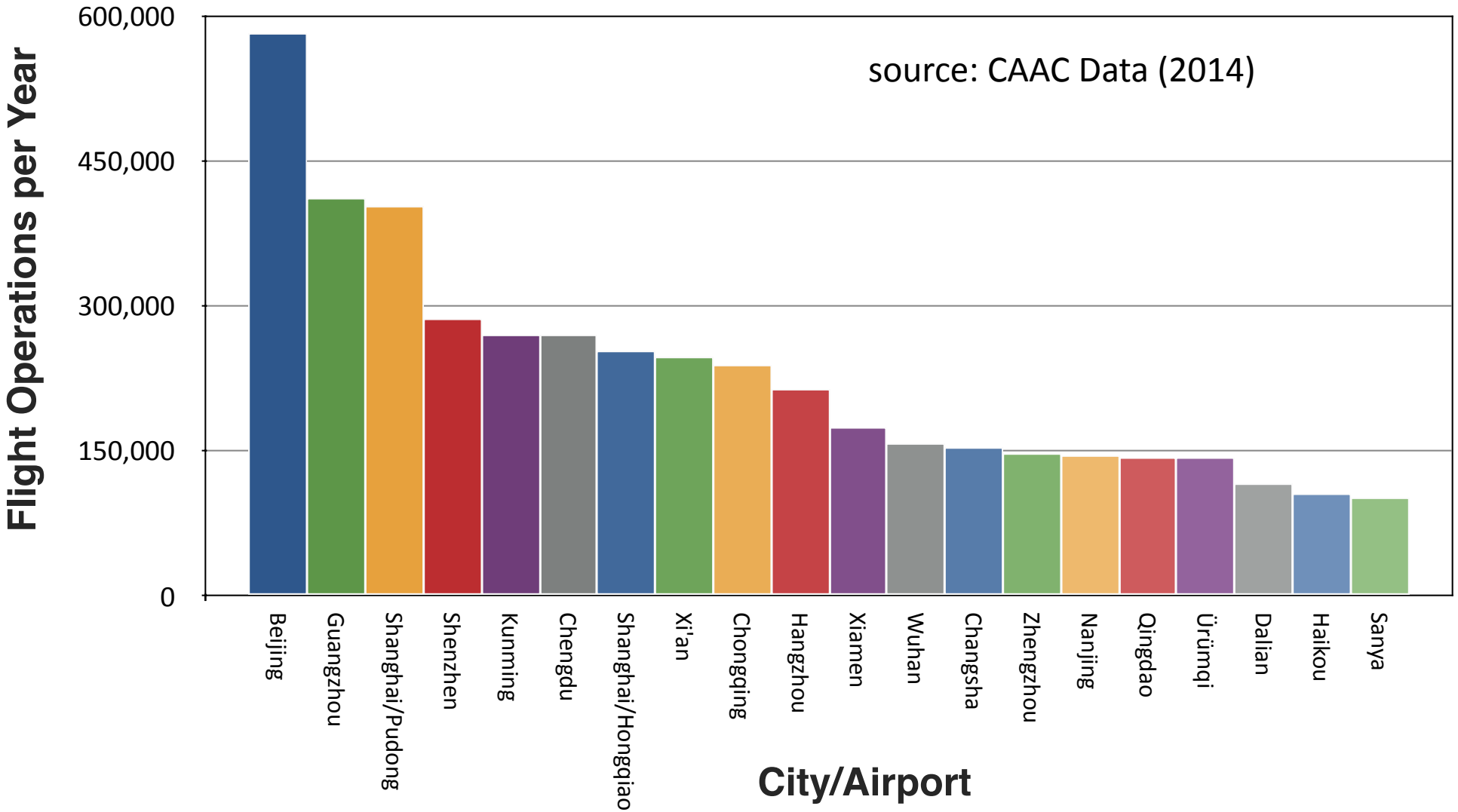
Growth in Air China's Transportation Demand

- 74 airports with added commercial service in the year 2014 (compared to the year 2004)
- Daily airport movements grew by almost three fold

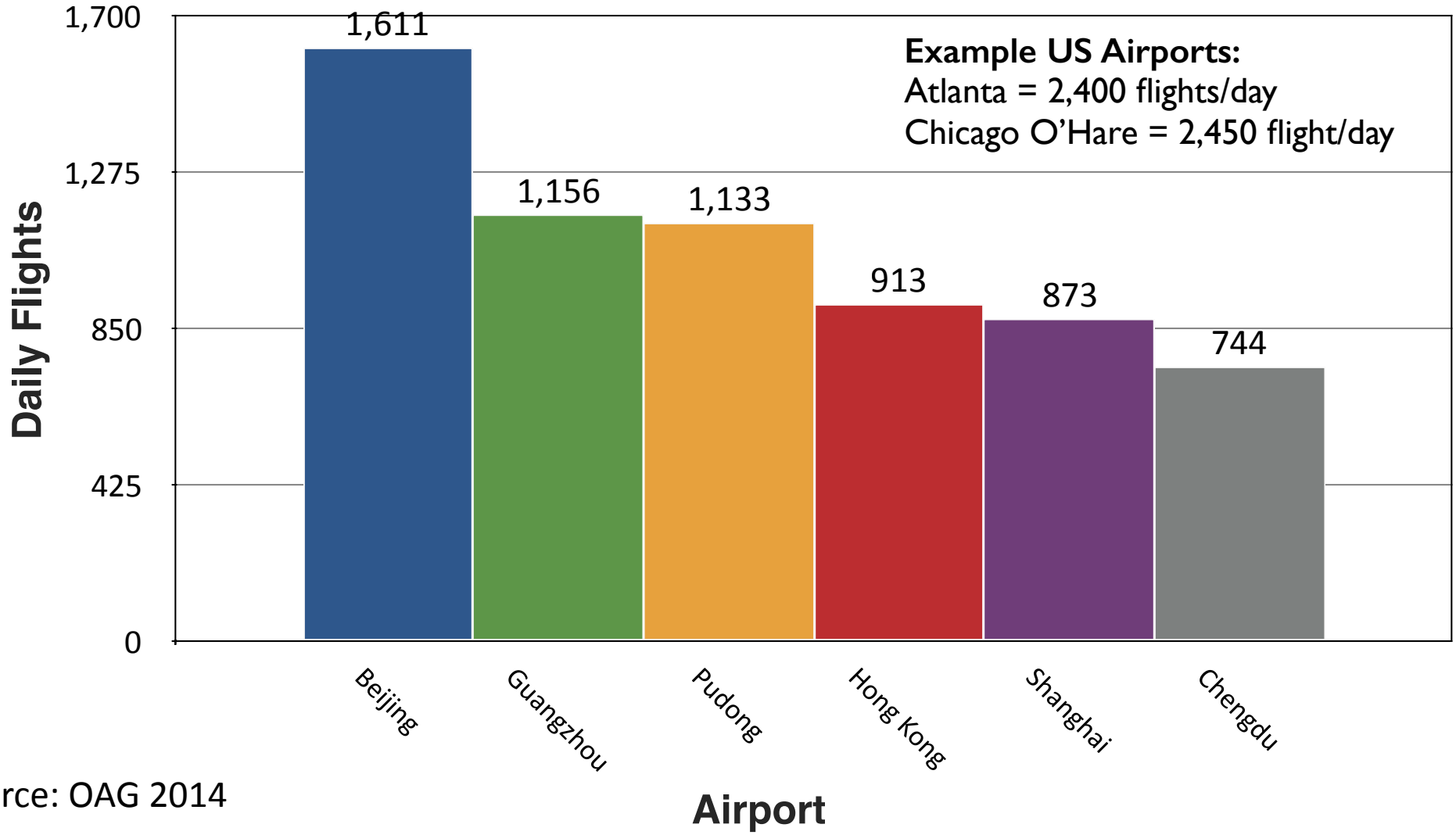


Flight Operations at the Top 20 Airports in China

- 51% of the passengers handled at the top 10 airports in China

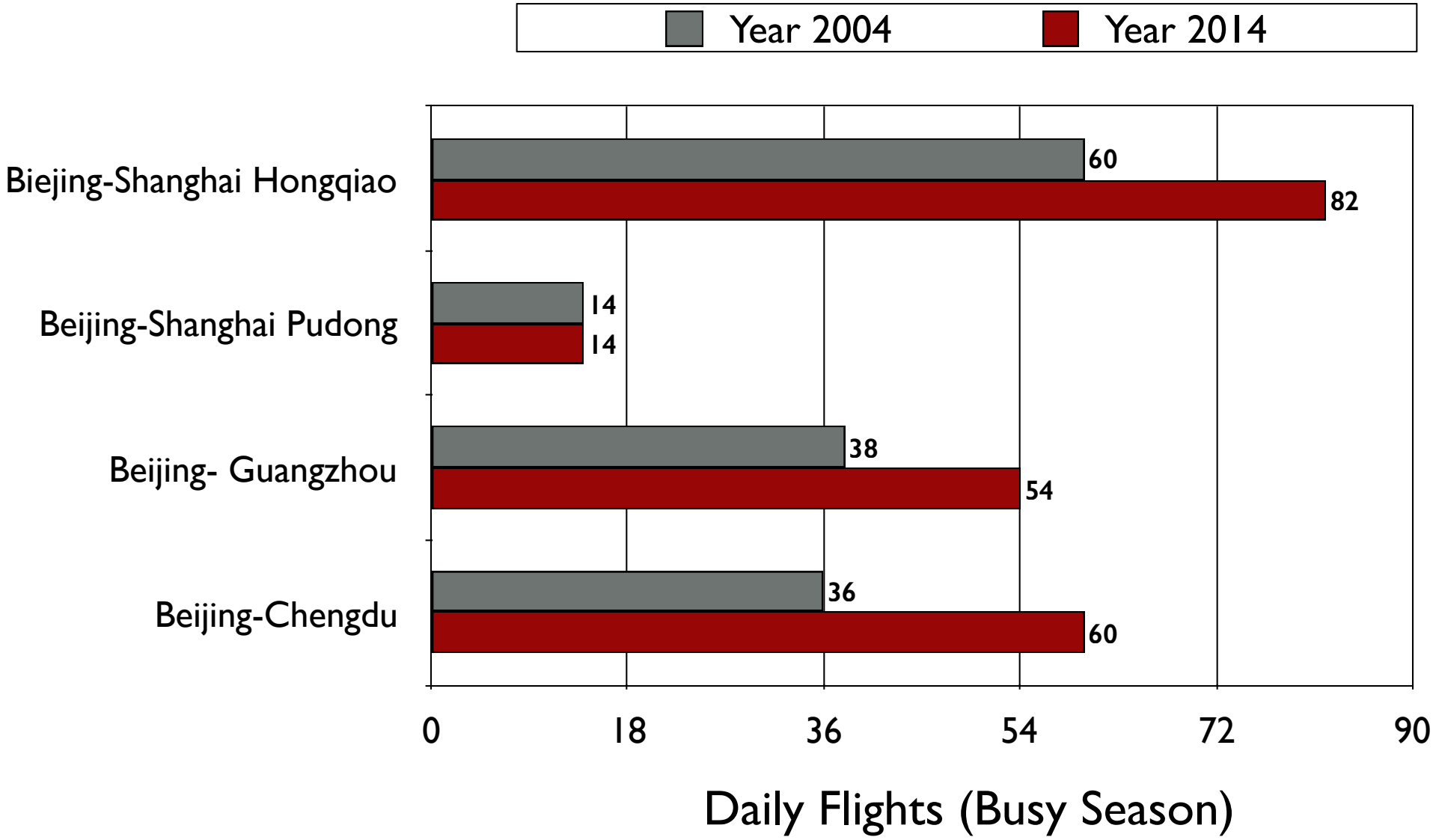


Daily Operations During Busy Month of July at Key Airports in China



source: OAG 2014

Some Busy Air Corridors in China



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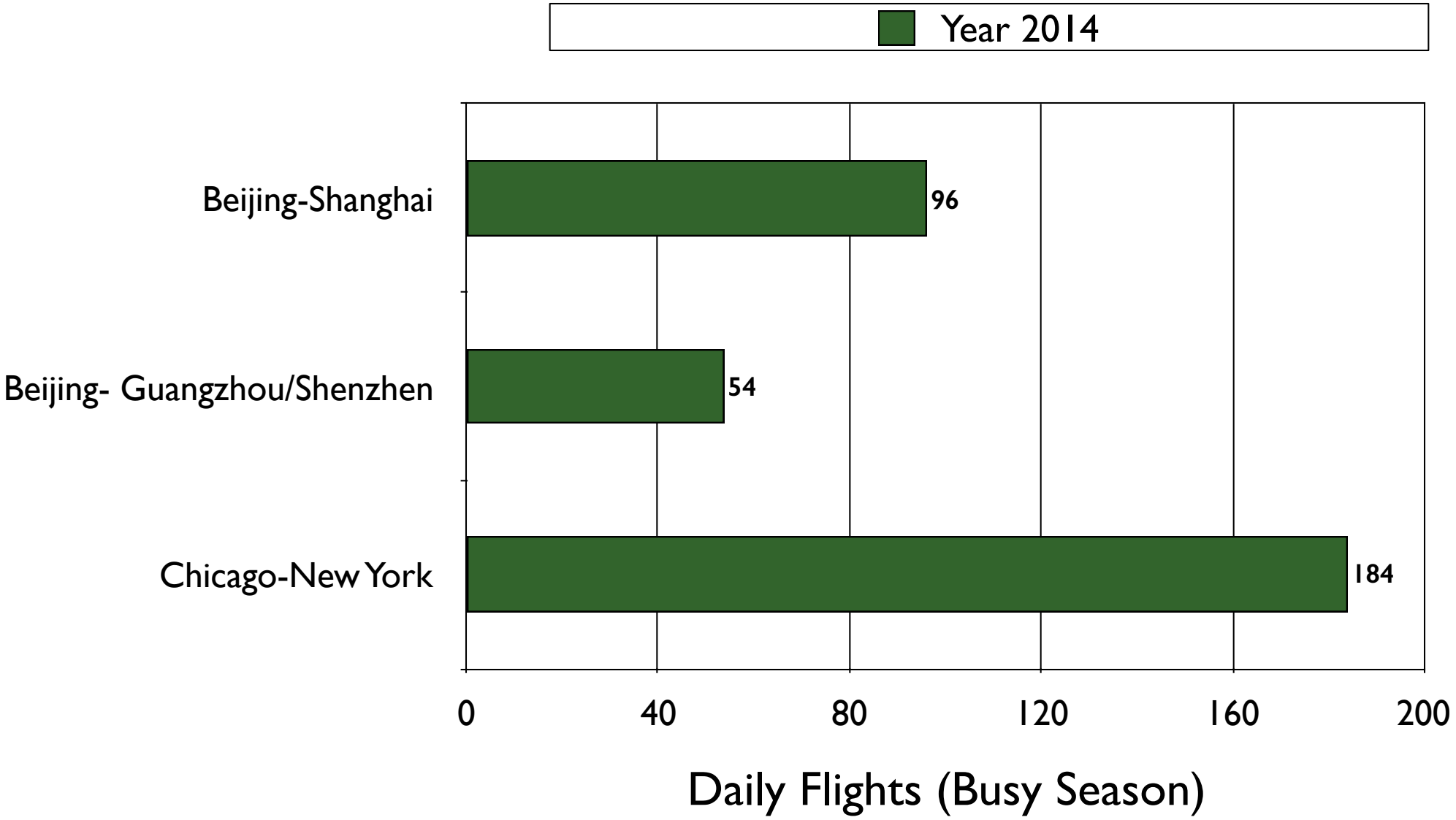
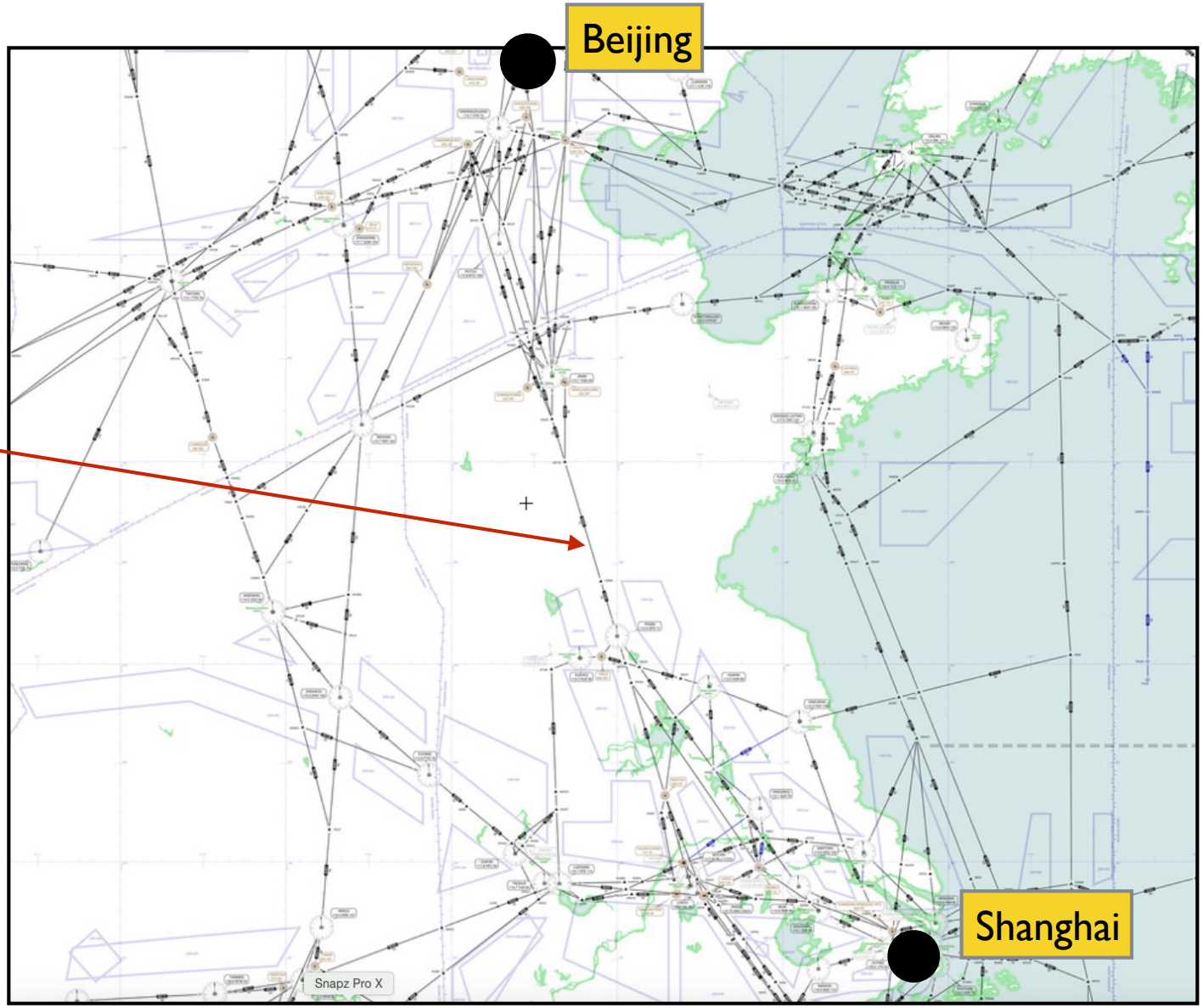


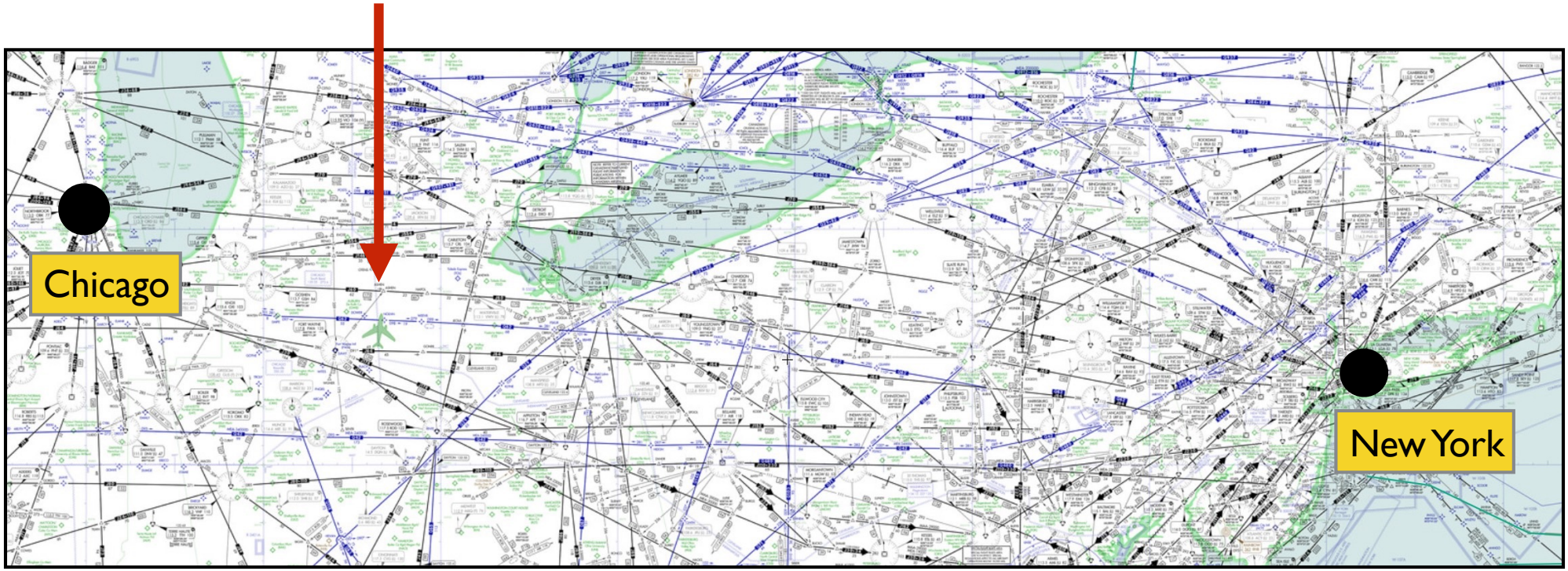
Airspace Capacity Issues

- Corridor between Beijing-Shanghai has a single airway
- This becomes a bottleneck

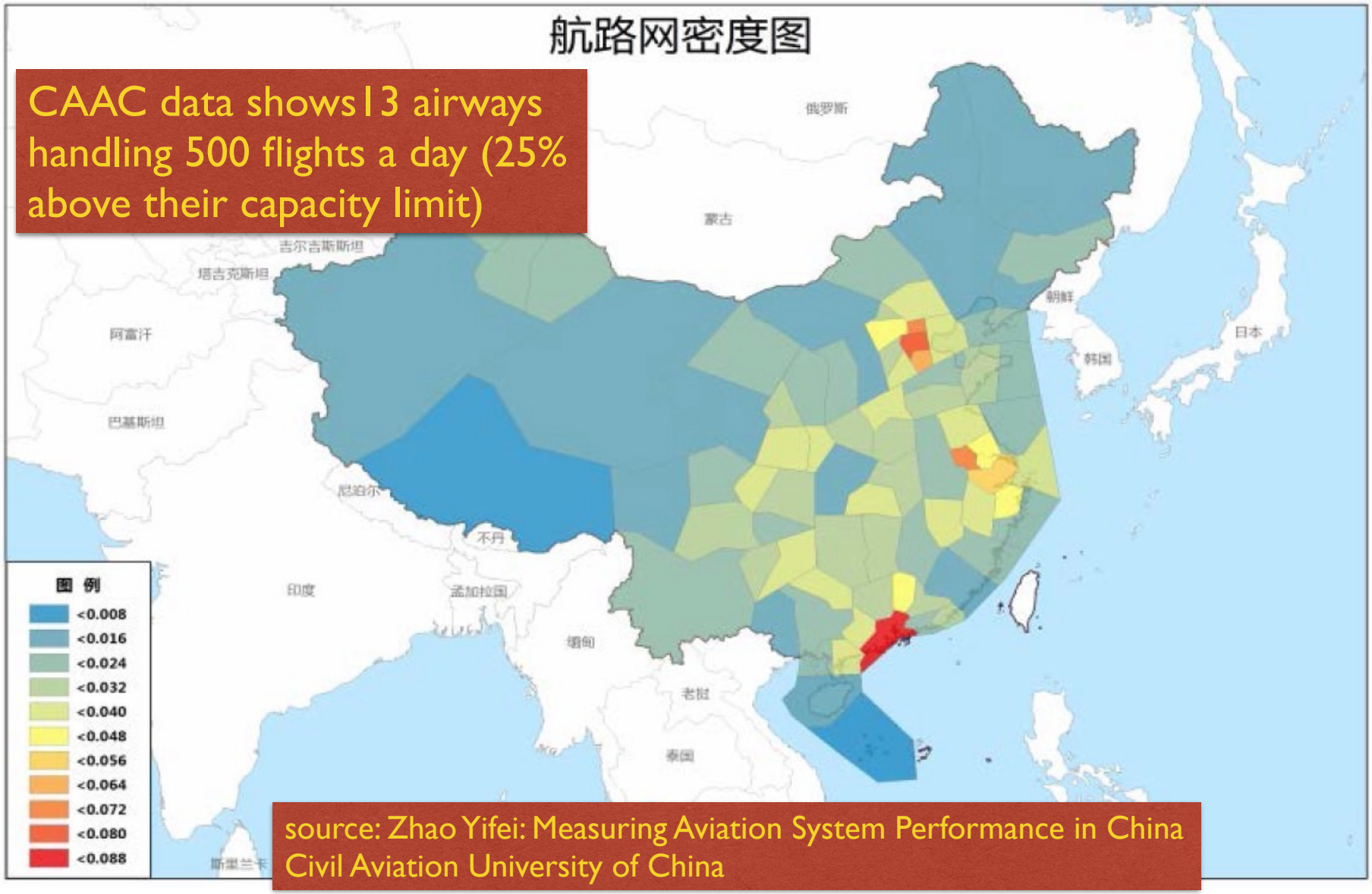


Airspace Capacity Issues

- US corridor between Chicago and New York
- Plenty of airways and connections to handle traffic
- During bad weather these routes can be closed due to weather



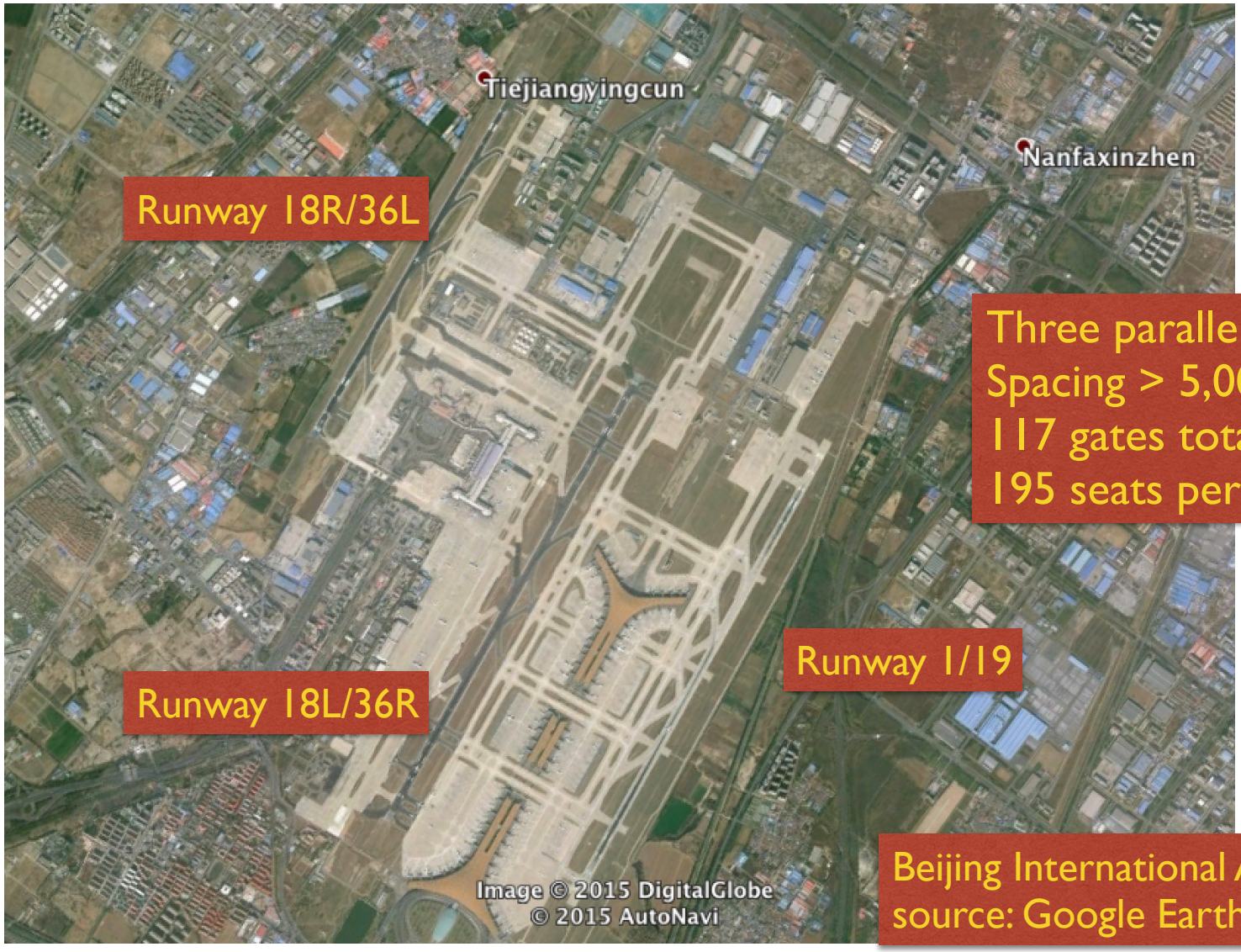
Air Traffic Sector Densities



Air Transportation Capacity Issues

- Based on our observations of some data reported in the literature, China ATC employs very conservative aircraft separation rules
- We do not believe the separations are conservative to avoid restricted use airspace or if they are driven by runway/gate capacity alone
- Conservative separation rules reduce the capacity of any airport
- An example for Beijing airport is provided
- According to the CAAC:
- *"At Beijing, Shanghai Hongqiao, Guangzhou, Shenzhen, Chengdu and Chongqing, average hourly aircraft movements are exceeding the capacity set by the CAAC. Every day the airport and traffic control organizations are operating under overload conditions".*

Airport Capacity Constraints



Three parallel runways
Spacing > 5,000 feet
117 gates total
195 seats per flight departure

Beijing International Airport
source: Google Earth

Example of Limited Airport Capacity

- Beijing International Airport is currently limited to 90 operations per hour
- Operations seem to be very conservative

graphic: Aviation Week and Space Technology (2015)

Delays and Percent of Flights on Time

- Lack of airport capacity translates into delays and poor on-time performance records
- The trend of on-time performance record in China is the result of multiple of reasons:
  - Lack of airport capacity
  - Lack of airspace capacity
  - Aggressive airline scheduling practices
  - Conservative ATC separation rules

Percent of Flights on Time in China

source: Zhao Yifei: Measuring Aviation System Performance in China
Civil Aviation University of China

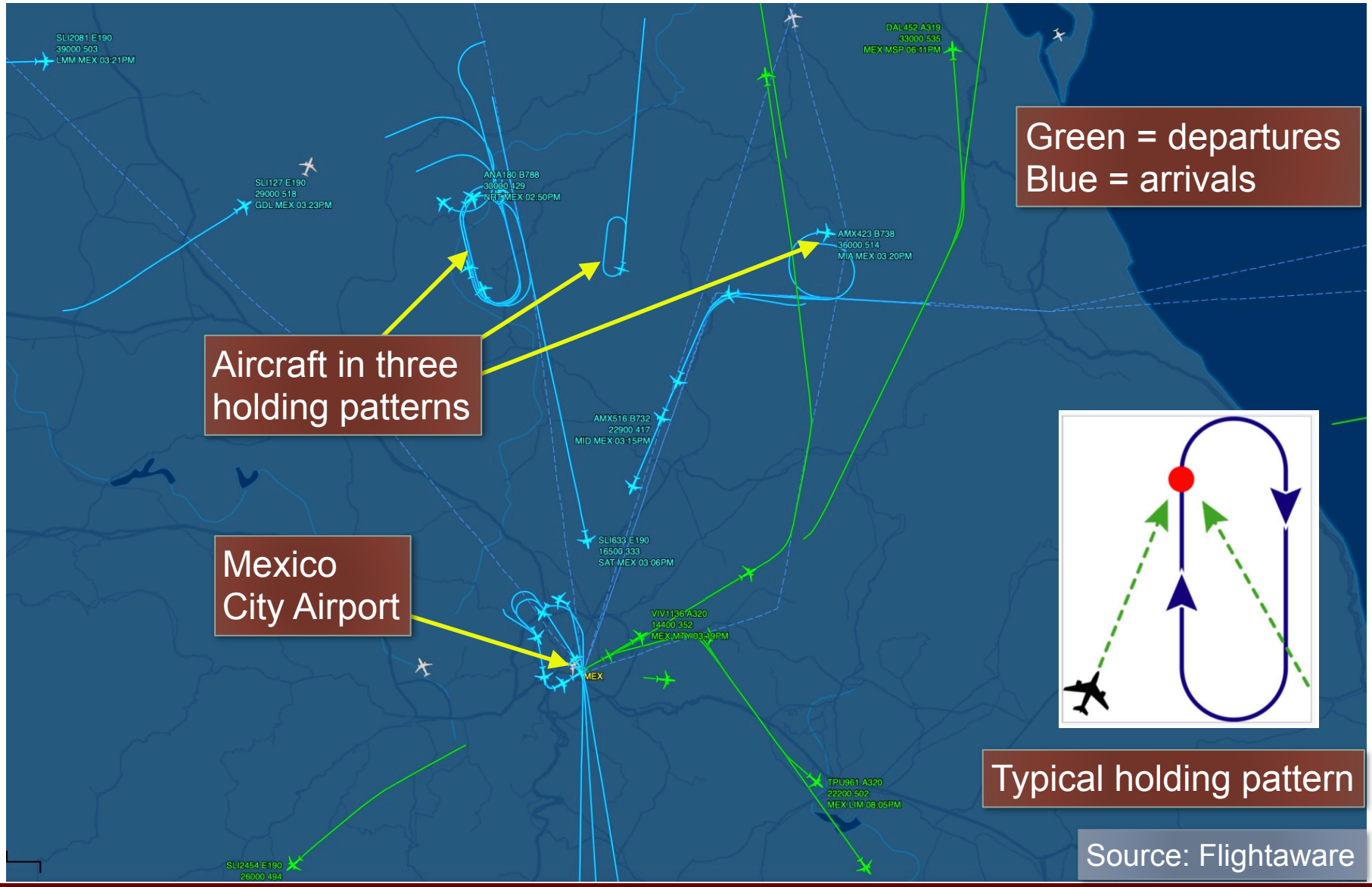
- Last year (2014) the on-time performance was **68.4%**
- This indicates a serious deficiency in airport/airspace capacity
- Beijing airport had on-time performance of 69.7%,
- Shanghai Pudong International had on-time performance of 56.3%

Managing Limited Airport/Airspace Capacity in Air Traffic Control

- To manage airport and airspace capacity (not all aircraft can land at their desired times)
- To manage air traffic due to weather conditions

- **Possible strategies:**
  - **Implement holding patterns near destination airport**
  - Hold aircraft on the ground at the departure airport
  - Reduce speed enroute to add travel time to the destination assuming capacity will be available when aircraft arrives
  - **Assign less than ideal cruise flight levels when capacity of optimal altitudes are taken by other aircraft**
  - **Develop new advanced airspace procedures that allow reduced separation in the airspace**

Managing Air Traffic - Arrivals to México City



Air Traffic Situation (Holding Patterns)

Boeing 787-8

ATR-72 turboprop

Boeing 787-8
Fuel burn ~ 90 kg
per minute at FL 240

Smaller aircraft
fly shorter holding
paterns

Holding pattern
is flown with one
minute “legs”

ATR-72 turboprop

AMX423 B738
28400 487
MIA MEX 03:20PM

Value of Holding at High Altitude

- Perform holding at higher speeds (save time to destination when cleared to continue)
- Saves fuel because holding at low altitudes, requires slower speeds (recall 250 knot limit blow 10,000 feet)
- More comfortable to passengers (less turbulence at higher altitudes)

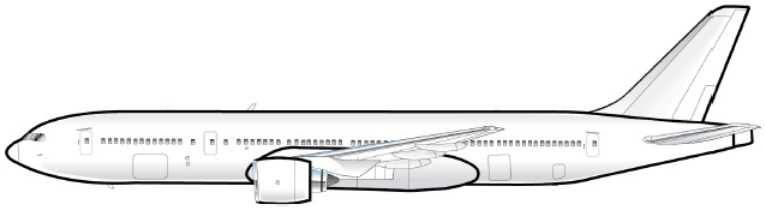
Limited Airspace Capacity Example: North Atlantic Organized Track System

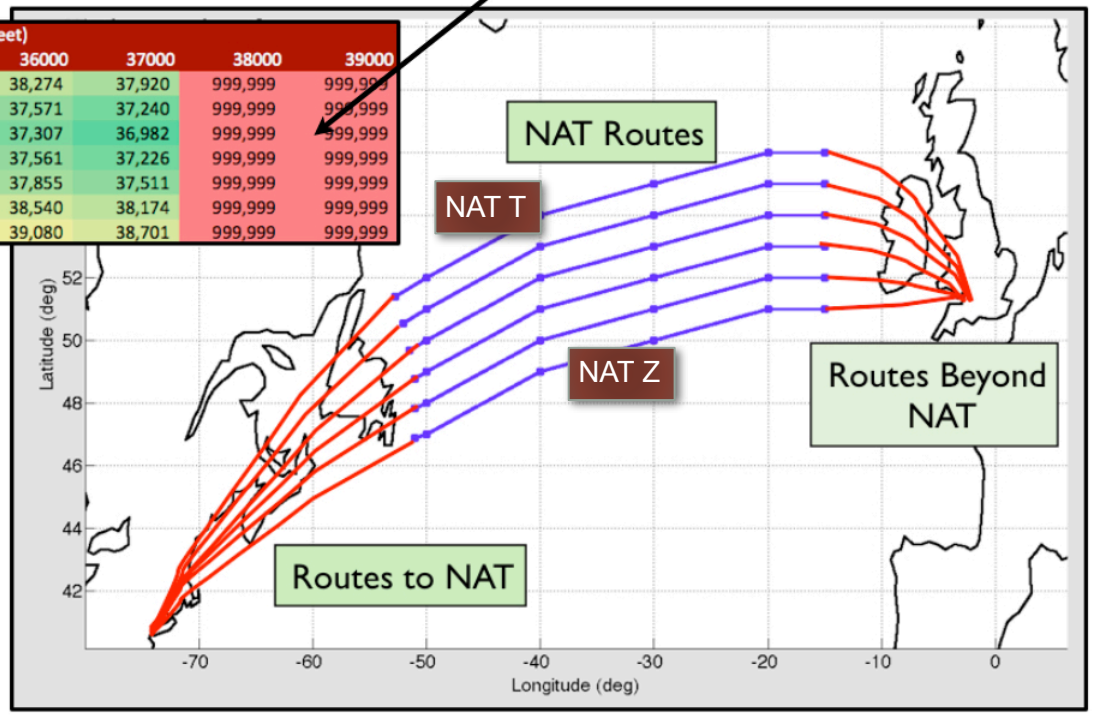
Unfeasible cruise flight levels

Sample Eastbound Tracks

Track	Cruise Altitude (feet)								
	31000	32000	33000	34000	35000	36000	37000	38000	39000
NATT	40,912	40,246	39,625	39,053	38,644	38,274	37,920	999,999	999,999
NATU	40,264	39,563	38,910	38,307	37,919	37,571	37,240	999,999	999,999
NATV	40,041	39,321	38,650	38,030	37,648	37,307	36,982	999,999	999,999
NATW	40,325	39,602	38,928	38,306	37,913	37,561	37,226	999,999	999,999
NATX	40,662	39,931	39,249	38,620	38,217	37,855	37,511	999,999	999,999
NATY	41,384	40,655	39,976	39,350	38,923	38,540	38,174	999,999	999,999
NATZ	41,984	41,243	40,553	39,916	39,476	39,080	38,701	999,999	999,999

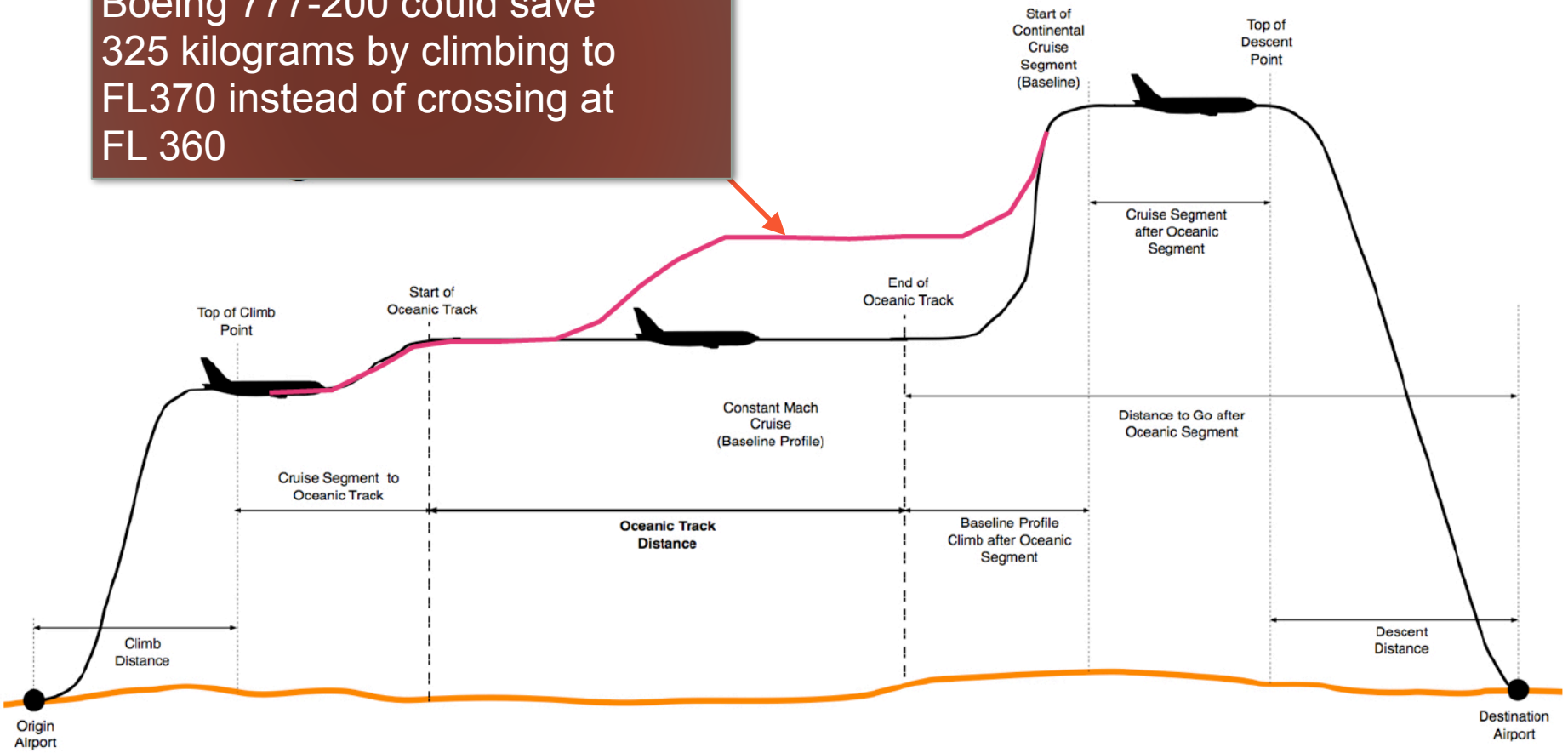
Fuel cost matrix (kilograms)
Boeing 777-200





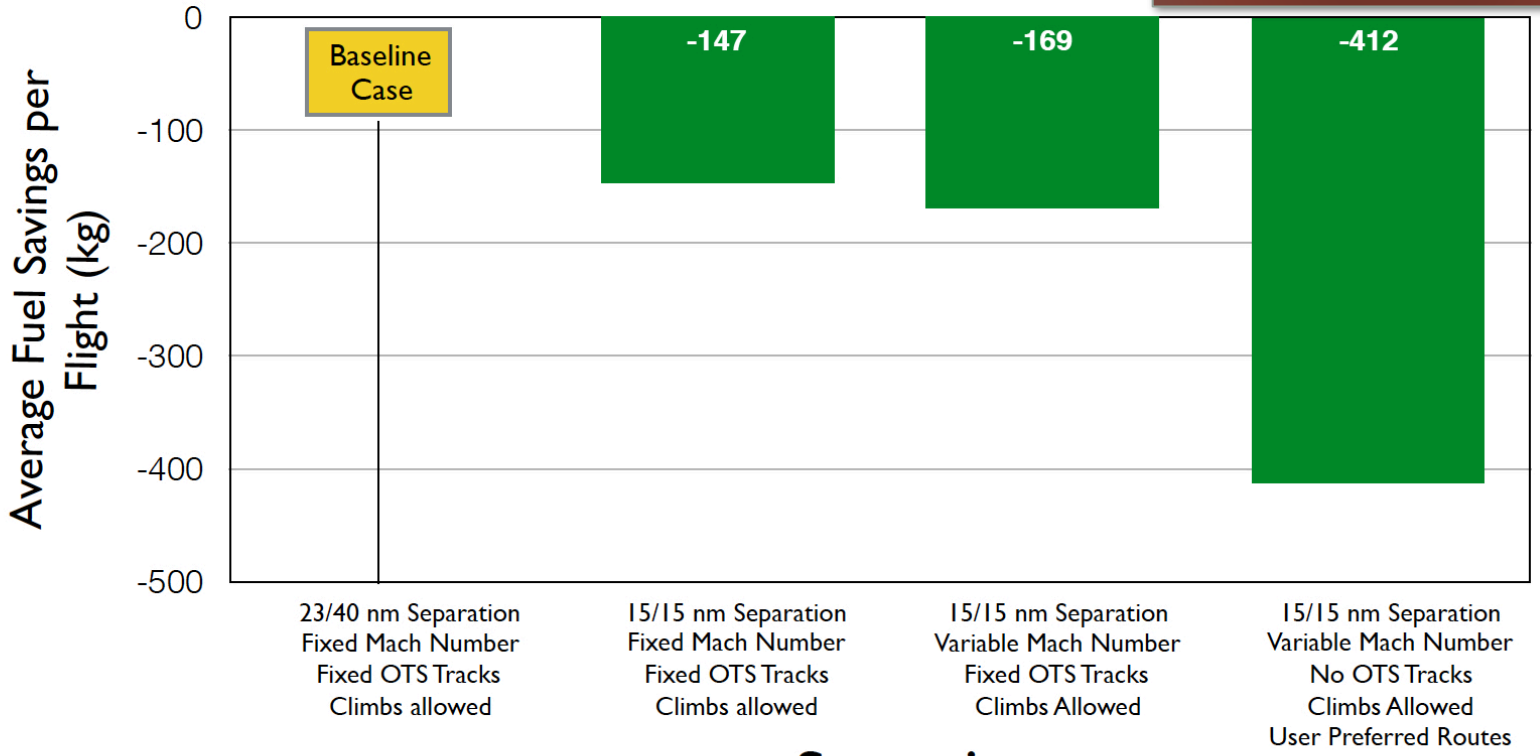
Allowing Earlier Climbs in the North Atlantic Organized Track System can Save Fuel

Boeing 777-200 could save 325 kilograms by climbing to FL370 instead of crossing at FL 360



North Atlantic Fuel Benefits of Various Concepts of Operation

Global Oceanic Model
VT/FAA model results

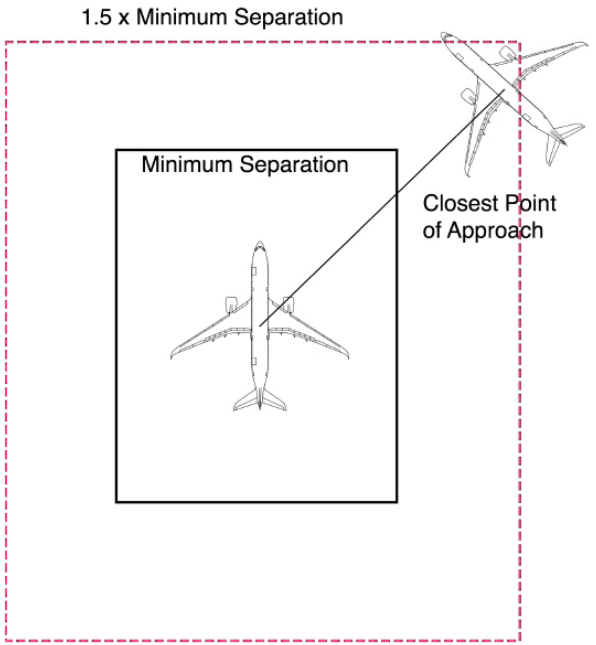


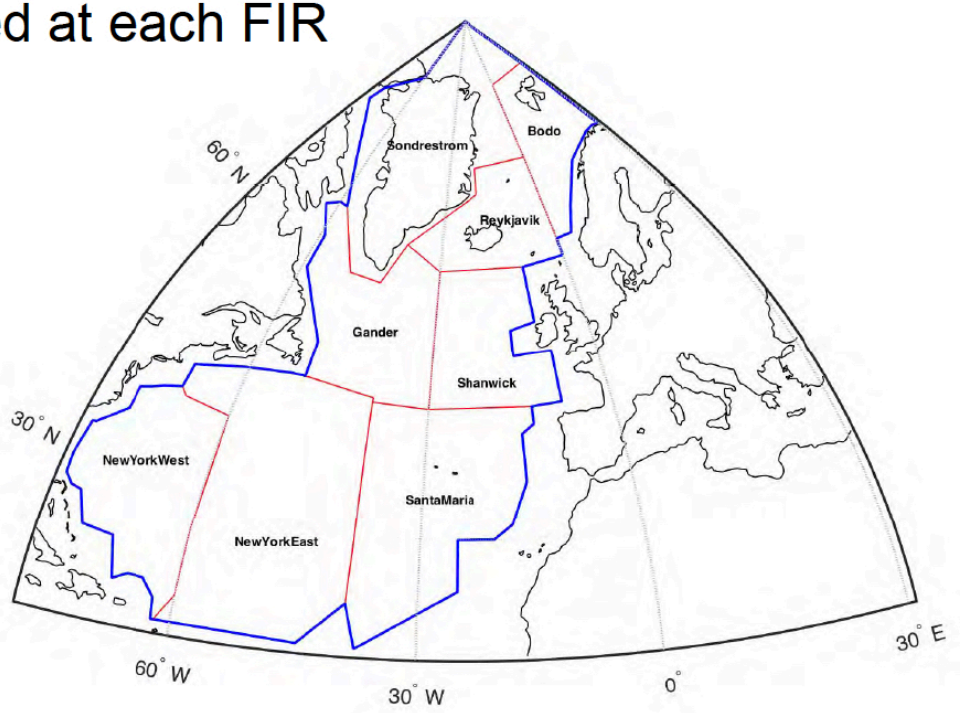
Notes:
a) **Includes All Atlantic traffic above 20 degrees North**
b) All 2220 flights typical (in 24 hour period)
c) Projected year 2020 traffic
d) Aircraft enter HLA at optimal Mach Numbers
e) All flight plans designed using wind-optimal trajectories

- **Contribution of Variable Mach Number to fuel benefit is 22 kilograms per flight**
- **OTS flights save on average 184 kilograms of fuel per flight**

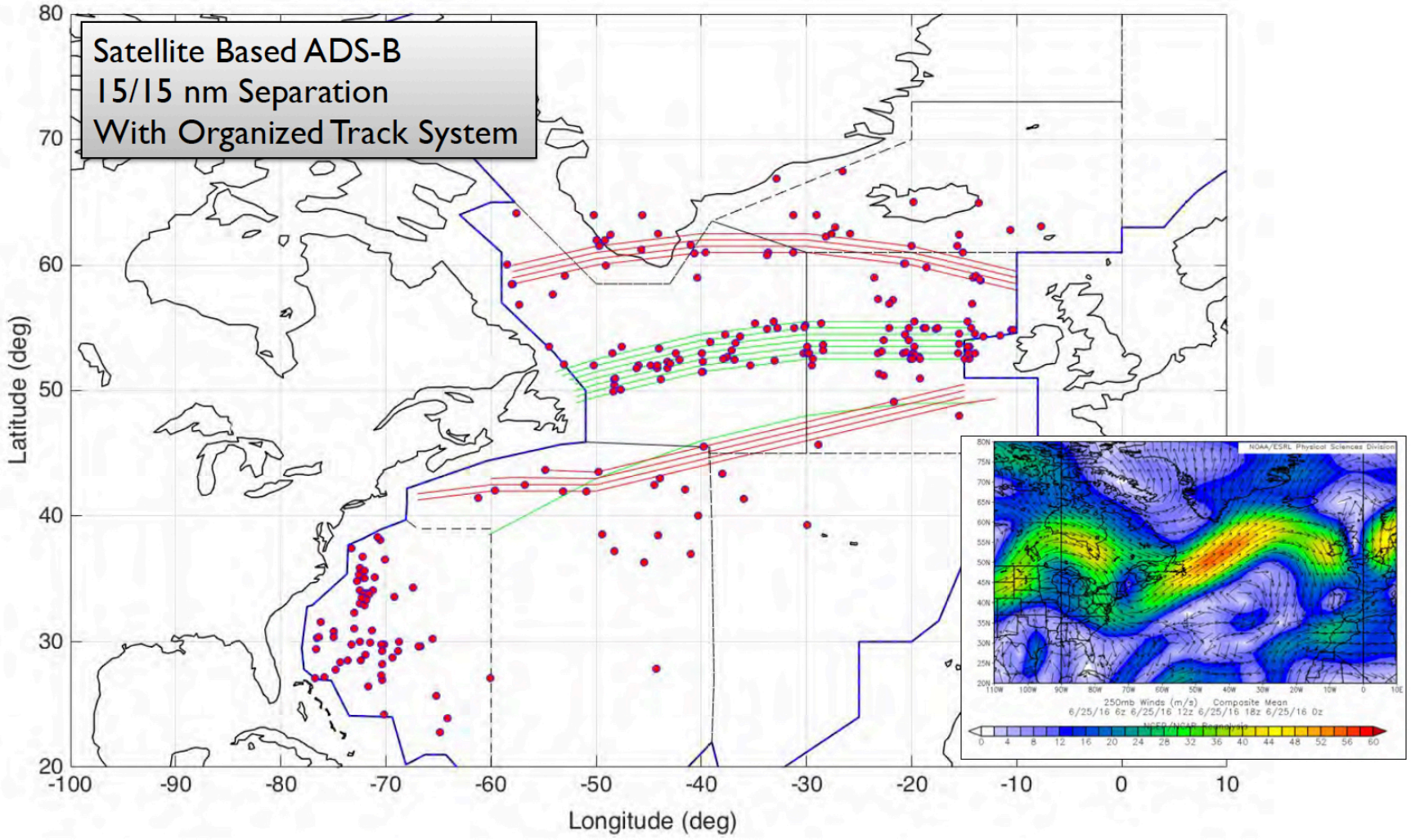
Analysis of Potential Workload Issues in Advanced Oceanic Scenarios

- The simulation results provide insight on the distribution of potential aircraft conflict events that may require close ATC monitoring
- We compared the number and spatial distribution of potential conflicts events detected at each FIR

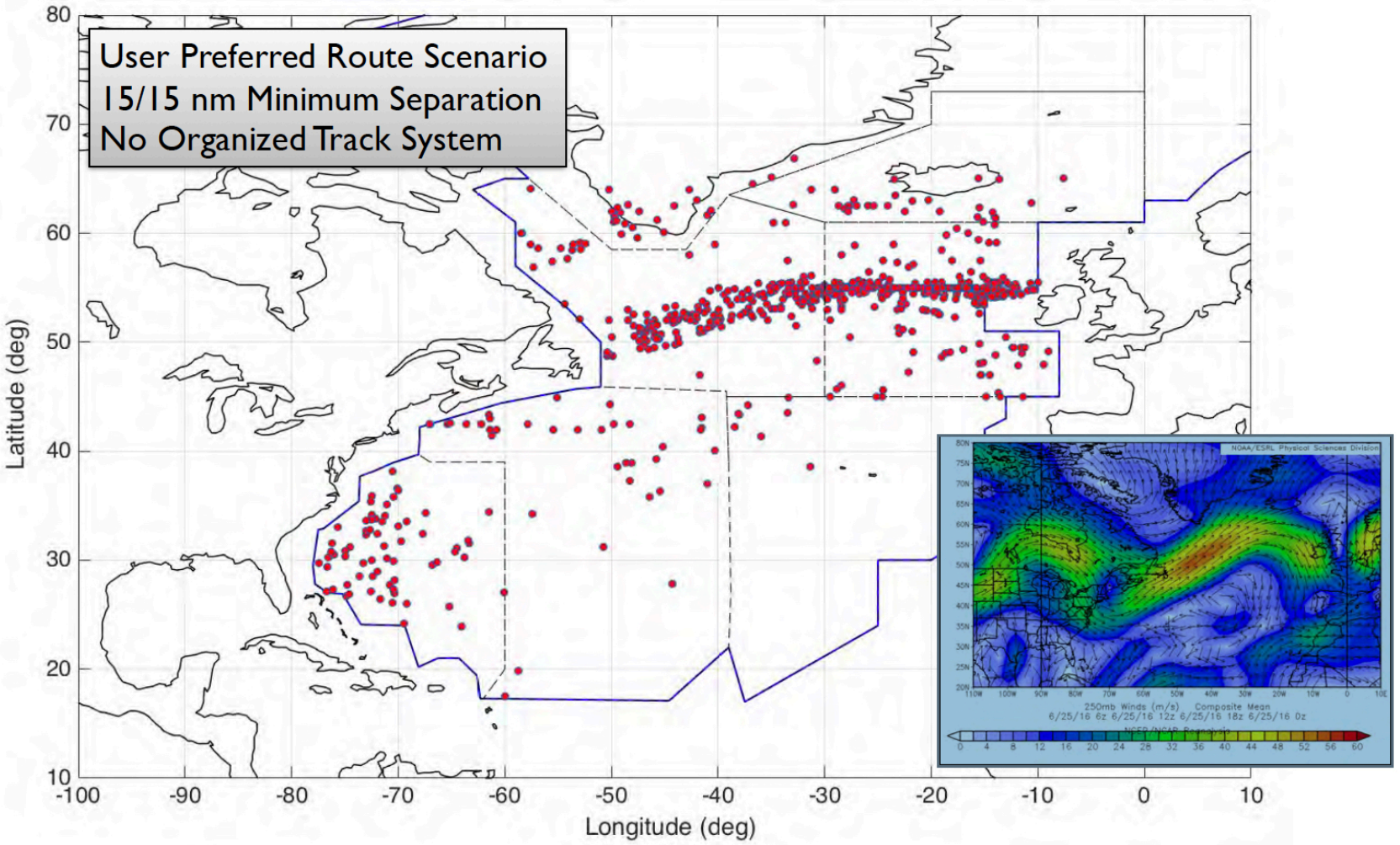




Potential Conflict Events with Closest Point of Approach 150% or less than the Minimum Separation



Potential Conflict Events Requiring ATC Monitoring Could Increase Dramatically in Gander and Shanwick



Conclusions

- Advanced airspace procedures that reduced aircraft separation can save fuel
  - Example 1: Satellite ADS-B over the ocean
  - Example 2: reduced in-trail longitudinal separation near runways
- Air traffic control workload benefits/dis-benefits needs to be considered in the analysis

Ground Delay Programs (GDPs)

- Provide a rational mechanism to accommodate reduced number of flights at one or more airports
- GDPs are initiated by the FAA Air Traffic Systems Command Center
- FAA coordinates with airlines and general aviation users (hourly conference calls)

AIRPORT STATUS INFORMATION
provided by the FAA's Air Traffic Control System Command Center

Minneapolis-St Paul International/Wold-Chamberlain Airport (MSP) Real-time Status
The status information provided on this site indicates general airport conditions; it is not flight-specific. Check with your airline to determine if your flight is affected.
Due to **WEATHER / WIND**, there is a Traffic Management Program in effect for traffic arriving **Minneapolis-St Paul International/Wold-Chamberlain Airport, Minneapolis, MN (MSP)**. This is causing some arriving flights to be delayed an average of **21 minutes**. To see if you may be affected, select your departure airport and check "Delays by Destination".
Delays by Destination: No destination-specific delays are being reported.
General Departure Delays: Because a traffic management program is delaying some arriving flights, departing flight schedules may be affected. Check with your airline to determine if your flight is affected.
General Arrival Delays: Arrival traffic is experiencing airborne delays of 15 minutes or less.

Ground Delay Programs (GDPs) in the US

- *"Ground Delay Programs are implemented to control air traffic volume to airports where the projected traffic demand is expected to exceed the airport's acceptance rate for a lengthy period of time. The most common reason for a reduction in acceptance rate is adverse weather such as low ceilings and visibility."*
- ***How it works:***
- *"Flights that are destined to the affected airport are issued Expected Departure Clearance Times (EDCT) at their point of departure.*
- *These ECDTs are calculated in such a way as to meter the rate that traffic arrives at the affected airport; ensuring that demand is equal to acceptance rate that result from the implementation of a Ground Delay Program"*

source: FAA, 2015

References

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