



Aviation Wind Research Overview

3 August 2016

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integration

training

engineering

consulting



Sponsored by FAA ANG-C6

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AvMet Wind Research

Winds can impact all phases of flight

Need to understand frequency, impact, and challenges related to adverse wind conditions



Wind Compression

The diagram shows wind vectors at different altitudes, with a vertical axis labeled **Altitude**. To the right is a map of the New York area with flight paths and the **EWR** airport marked.

Transient Wind Shifts

Three radar-like maps show wind shifts around airports. Below are satellite images of airports with arrows indicating wind directions: **22L, 32L**; **4L, 32R**; and a question mark **?**.

Runway Crosswinds

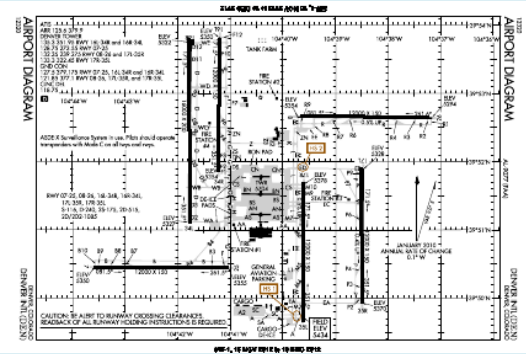
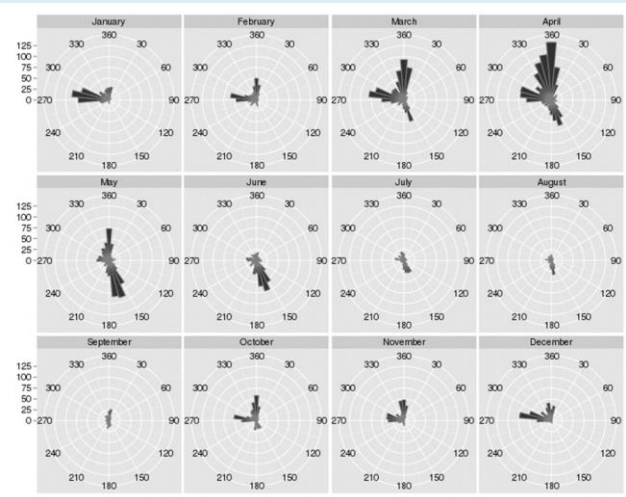
A photograph shows an aircraft on a runway. Below it is a technical diagram of a runway layout with wind vectors.



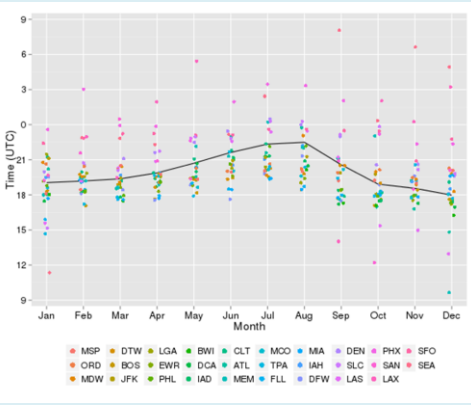
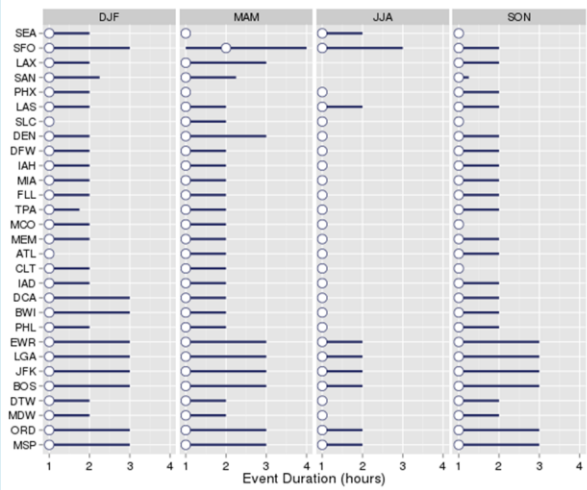
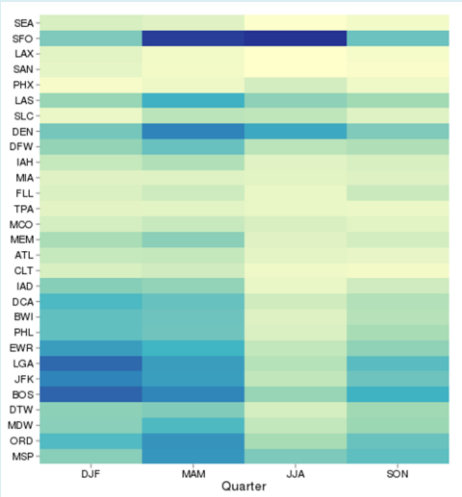
Runway Crosswinds



Assessed Historical Surface Winds Relative to Runway Configurations



Evaluated Variability in Potential Crosswind Events



- Crosswinds possible at all Core airports
- Spring, fall most favored seasons
- Most events short-lived (< 2 hrs)
- Events typically begin in afternoon



Wind Research

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Wind Compression

The diagram illustrates wind compression where wind vectors are forced into a narrower path, increasing their density. The inset map shows flight paths near Newark Liberty International Airport (EWR).



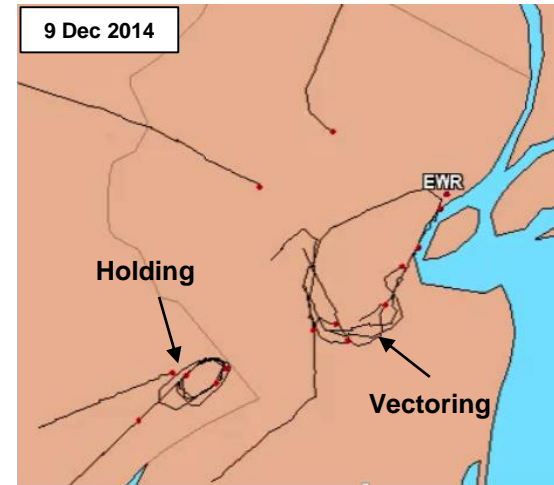
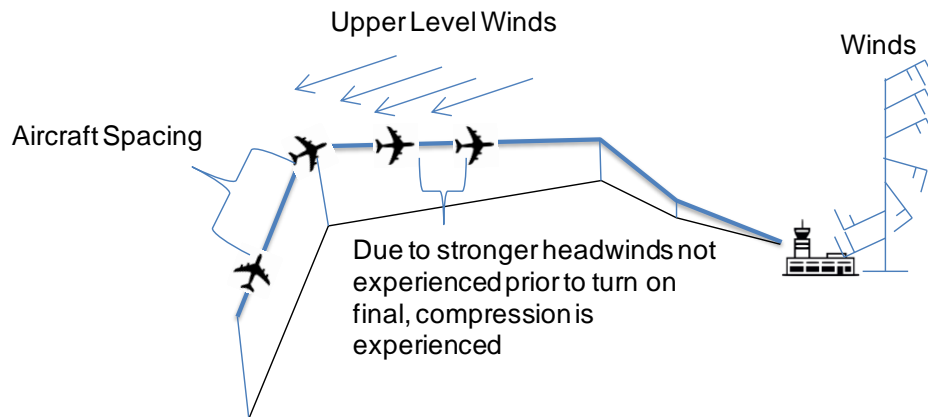
Transient Wind Shifts

Runway Crosswinds



Wind Compression – Problem Definition

- Path-based wind shear present during sufficient arrival demand can create challenging wind compression situation in attempt to maintain spacing
 - Requires *both* sufficiently high air traffic volume and variability in winds by altitude
 - Results in adjustments to aircraft approach profile and operational impacts

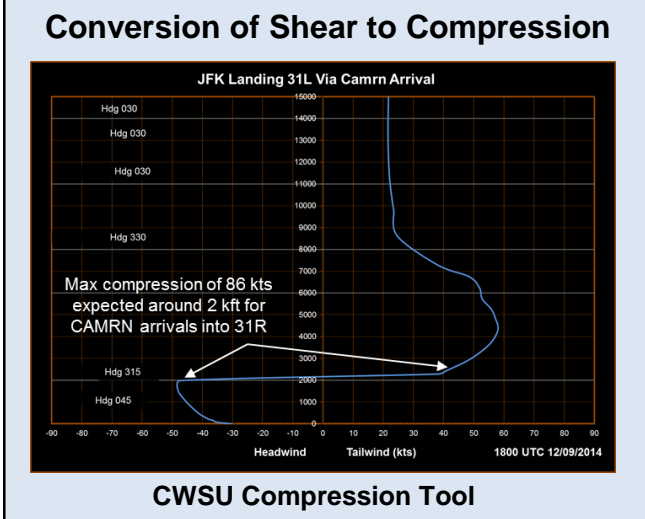
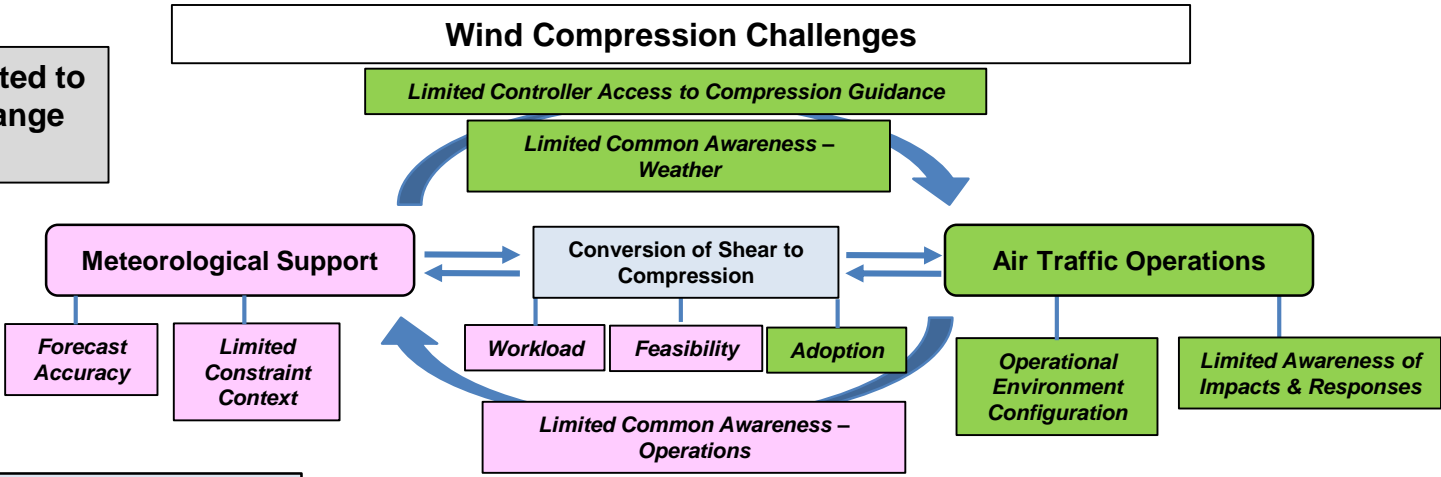


135 min GS
26 rate GDP
31 Cancellations
1 Diversion

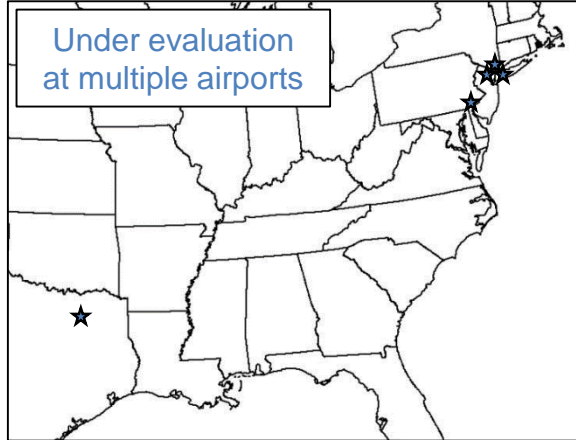
Wind Compression Challenges

- Identified and catalogued wind compression challenges through stakeholder feedback

Many challenges related to information interchange and conversion



Developed to convert wind shear information to path-specific potential compression



Forecast Accuracy Shortfall Scenarios

- Evaluated forecast accuracy to identify environments with limited performance, or shortfall scenarios
 - At least one accuracy shortfall scenario at each focus airport

ATL		Operational Environment Combination of: Traffic Demand Significant Terminal Area Wx Landing Direction	
		Nom IFR East	
Wind Shear	High		
	Typical		
	Low		

DFW		Operational Environment Combination of: Traffic Demand Significant Terminal Area Wx Landing Direction	
		Nom None South	High None South
Wind Shear	High		
	Typical		
	Low		

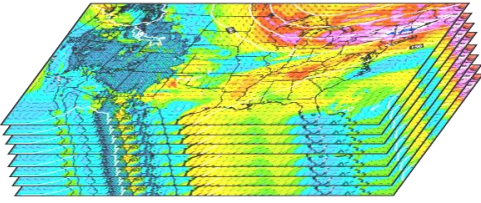
ORD		Operational Environment Combination of: Traffic Demand Significant Terminal Area Wx Landing Direction			
		Nom None West	Nom None East	Nom Frz+IFR East	Nom Frz+IFR North/East
Wind Shear	High				
	Typical				
	Low				

EWR		Operational Environment Combination of: Traffic Demand Significant Terminal Area Wx Landing Direction		
		Nom None South	Nom None North	Nom IFR North
Wind Shear	High			
	Typical			
	Low			

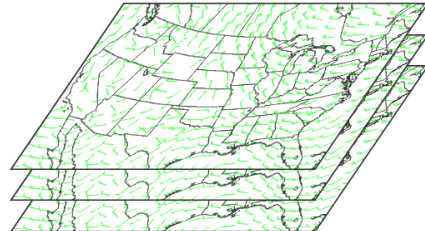
LGA		Operational Environment Combination of: Traffic Demand Significant Terminal Area Wx Landing Direction				
		Nom None South	Nom None North	Nom IFR South	Nom IFR North	High None South
Wind Shear	High					
	Typical					
	Low					

JFK		Operational Environment Combination of: Traffic Demand Significant Terminal Area Wx Landing Direction				
		Nom None South	Nom None North	Nom IFR North	Nom IFR+Wind North	High Wind North
Wind Shear	High					
	Typical					
	Low					

High Resolution Rapid Refresh (HRRR) 3D Wind Forecast



Short Range Ensemble Forecast (SREF) 3D Wind Forecast

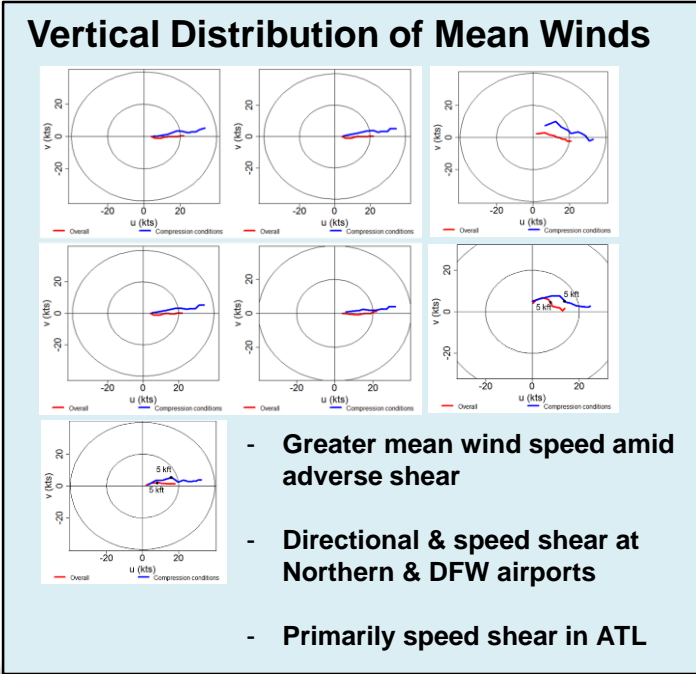
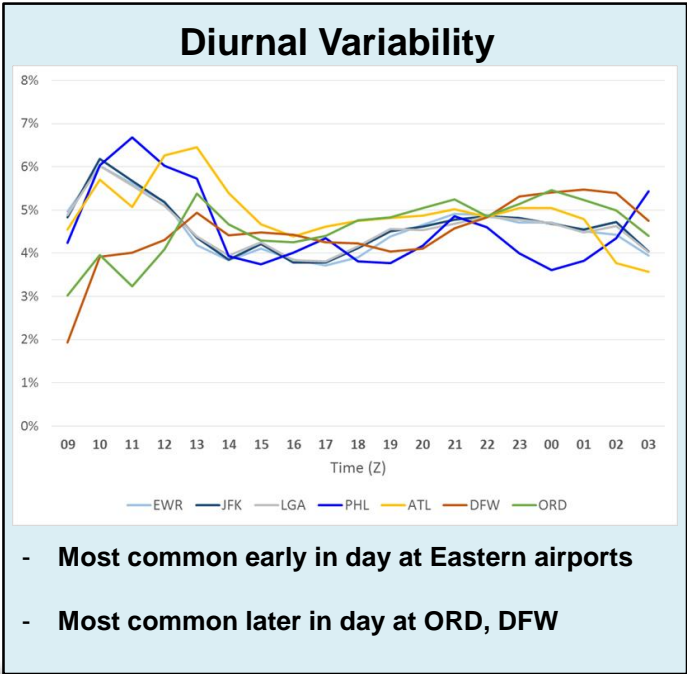
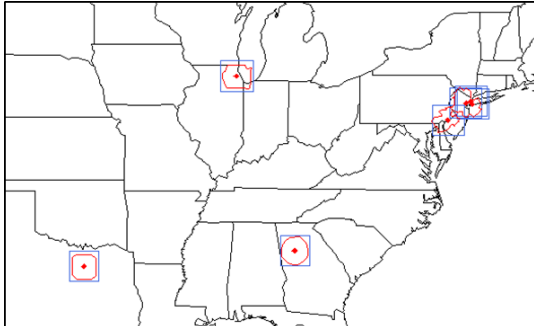


- Onset Timing Accuracy Shortfall Scenario
- Shear Magnitude Accuracy Shortfall Scenario
- Both Shear Magnitude and Timing Offset Accuracy Shortfall Scenario
- Good Forecast Performance Overall
- Data Limitation Prohibited Evaluation of One or Both Characteristics



Wind Compression Contributing Climatology

- Characterized winds during adverse shear / potential wind compression periods and variation from overall “background” climatology
 - Leveraged ACARS airborne wind observations
 - Focus on altitudes most sensitive to wind compression (0-10 kft)



At what altitudes was adverse shear observed?

Was shear due to directional or speed shear?

How different were winds than in overall climatology?



Wind Compression Needs Assessment

- Assess needs to address wind compression guidance usage and adoption challenges
 - How do controllers and planners use and would like to use wind compression guidance?
 - Conduct operational observations and interviews (fall/winter 2016-2017)
 - Evaluate accuracy of automated vertical headwind profile Compression Tool guidance

