

NASA Research to Support the Airlines

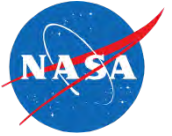
Cody Evans

Airline Operations Research Laboratory

NASA Ames Research Center

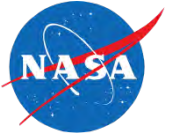
April 20, 2017



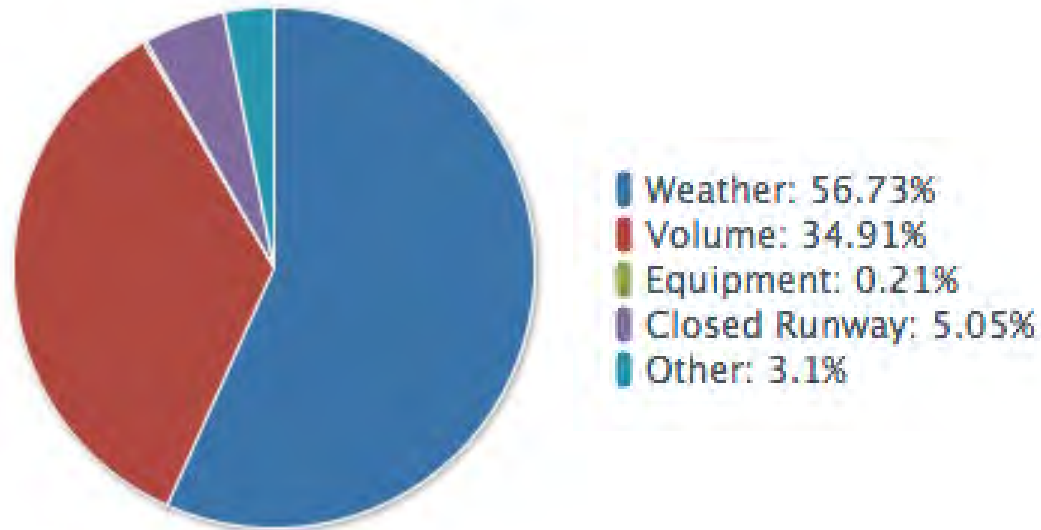


Let's Talk About Disruption Management

Disruption Management



- Weather is the primary disruptive element in the National Airspace System
- Must detect, analyze, coordinate, and take action



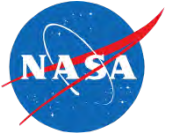
Causes of National Aviation System Delays
(January - September, 2016)

Disruption Management

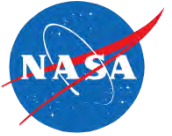


- Detection
 - Forecasting and detection tools for convective weather and winter storms are fairly mature
- Analysis
 - Analysis and prediction of effects are often subjective and inaccurate
- Coordination/collaboration
 - There are few ways that dispatcher, pilot, controller, and airport personnel can interact to devise a mutually beneficial plan
- Action
 - Communication of actions is dispatcher-to-pilot-to-controller or controller-to-pilot
 - Some key personnel only see the indirect effects of decisions regarding weather

Disruption Management



- Detection
 - Develop NASA tools for detection of clear air turbulence
- Analysis
 - Continue to work on NASA concepts such as Dynamic Weather Routes, Traffic Aware Strategic Aircrew Requests, and the Flight Awareness Collaboration Tool
 - Create new tools requested by the airline industry
- Coordination/collaboration
 - Using high-bandwidth data exchange, improve the communication between dispatcher, pilot, controller, and airport staff
- Action
 - Improve the sharing of and review of decisions by using enhanced data communications between dispatcher, pilot, controller, and airport staff



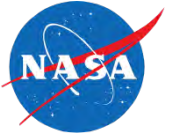
Dispatcher Workload Study

Richard Mogford, Pam Munro

NASA Ames/Feiji

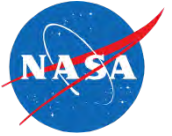
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Dispatcher Workload Study

- Suggestions for a human factors study of dispatcher tasks after the Airline Operations Workshop at NASA Ames in August 2016
- Partnered with Alaska Airlines and Delta Airlines
- Will visit airline operations control centers to shadow dispatchers during various shifts across several days
- Trying to better understand the conditions for dispatchers across shifts in various configurations
 - Extended operations flights
 - Transcontinental flights
 - Weather events
 - Hubs/regional
- Will allow for innovation and research by leveraging current technology used by the dispatcher
- Study will take place starting in the Spring of 2017 at Delta



Flight Awareness Collaboration Tool

Richard Mogford, Cody Evans

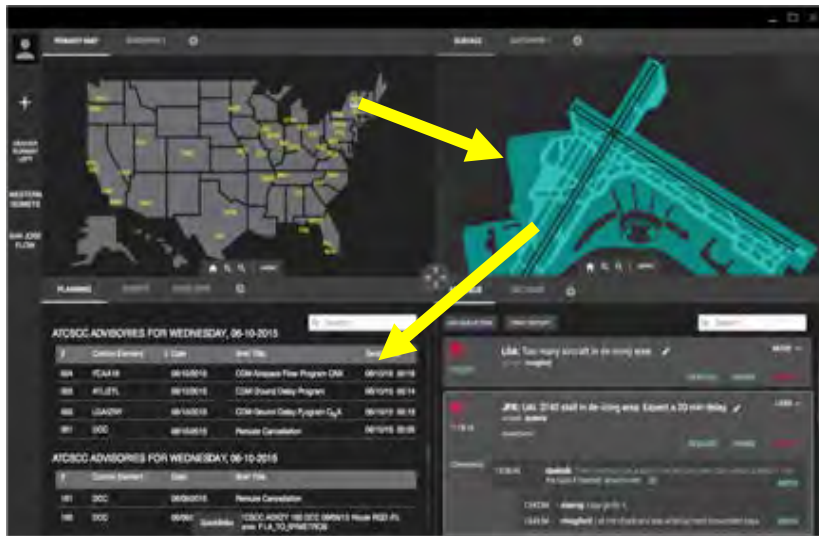
NASA Ames/SJSURF

richard.mogford@nasa.gov

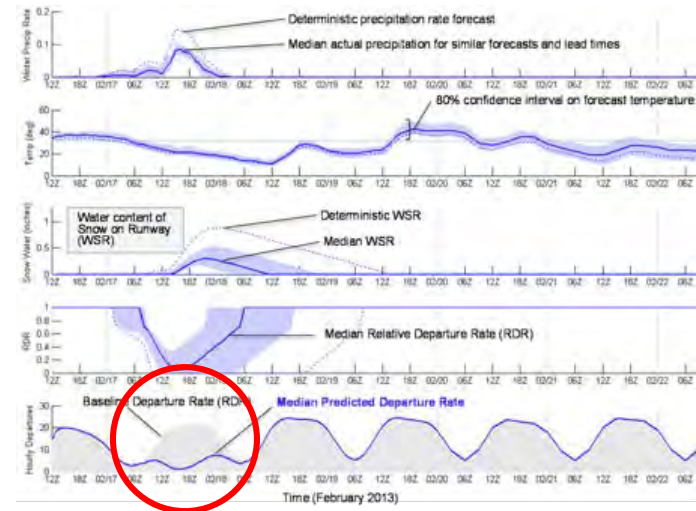
cody.a.evans@nasa.gov

Flight Awareness Collaboration Tool

- Developing the “Flight Awareness Collaboration Tool” (FACT)
- Concentrates information about winter weather events on one display
- Includes predictive tools
- Supports collaboration between airline operations center, air traffic control, airport authority, and de-icing operators

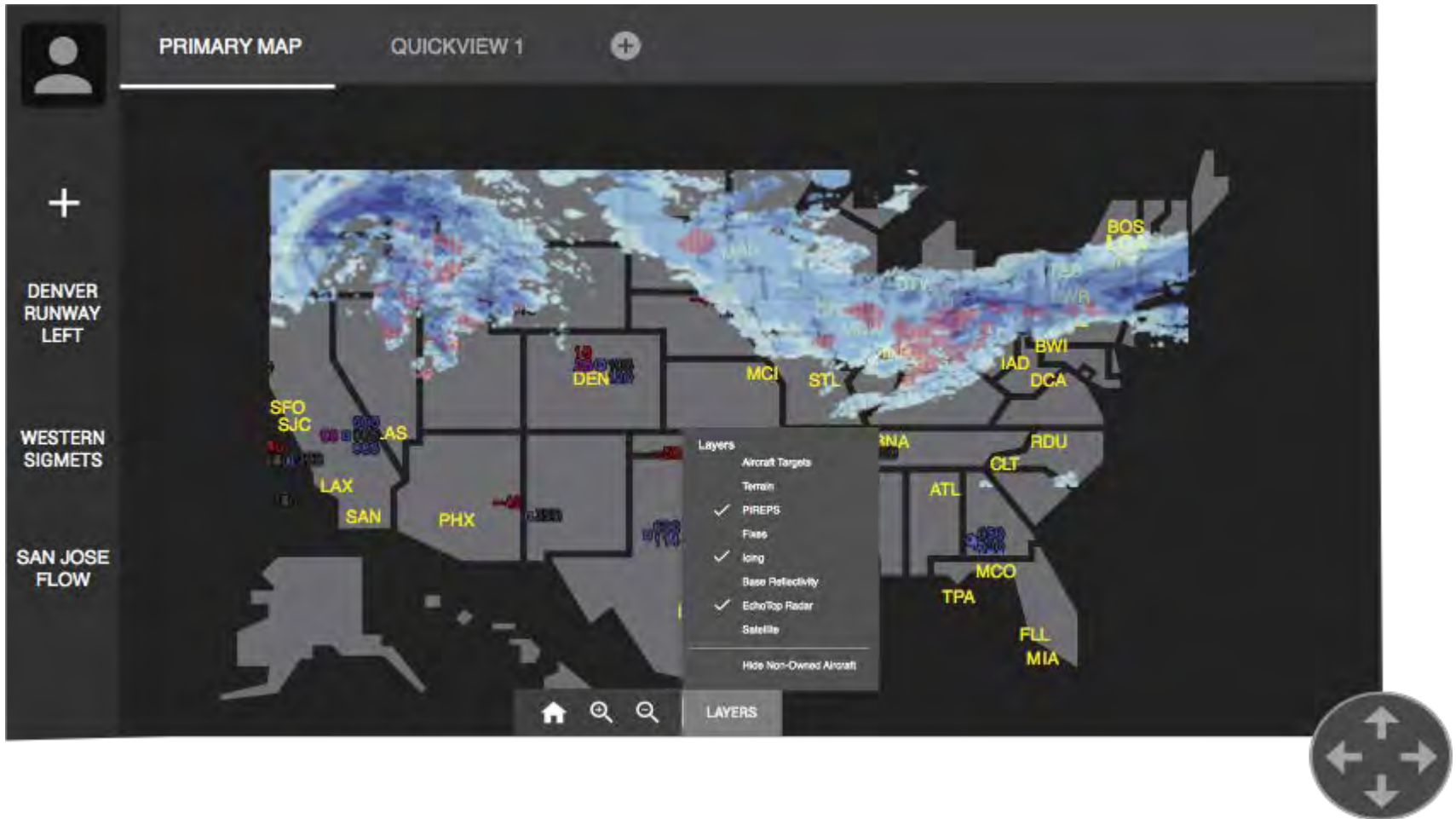
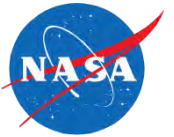


FACT Screen



Winter Weather Airport Capacity Model

FACT Primary Map View



FACT Surface Map View



FACT Information View



PLANNING CHARTS QUICKVIEW 1 +

Search

ATCSCC ADVISORIES FOR WEDNESDAY, 06-10-2015

#	Control Element	↓ Date	Brief Title	Send Time
004	FCAA16	06/10/2015	CDM Airspace Flow Program CNX	06/10/15 00:18
003	ATL/ZTL	06/10/2015	CDM Ground Delay Program	06/10/15 00:14
002	LGA/ZNY	06/10/2015	CDM Airspace Flow Program CNX	06/10/15 00:13
001	DCC	06/10/2015		06/10/15 00:05

ATCSCC ADVISORIES FOR WEDNESDAY, 06-10-2015

#	Control Element	Date	Brief Title
161	DCC	06/10/2015	
160	DCC	06/10/2015	DCC 06/09/15 Route RQD /FL

Quicklinks

- FAA OIS
- ✓ Aviation Weather Center
- FAA NOTAMs
- WWACM

Quicklinks

Name: FLA_TO_NYMETROS
Constrained area: ZJX/ZMA

FACT Communication View (MyQueue)



MY QUEUE FACT CHAT +

ADD QUEUE ITEM PRINT REPORT Search

LGA: Too many aircraft in de-icing area. ✎ MORE ▾
AUTHOR: **rmogford**
15:30:02 RESOLVE SHARE DELETE

JFK: UAL 3740 stall in de-icing area. Expect a 20 min delay. ✎ LESS ▲
AUTHOR: **dpeknik**
11:18:16 SHARED WITH: RESOLVE SHARE DELETE

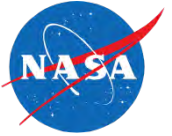
Comments:

13:30:45 **dpeknik:** Not sure how to deal with this one, any suggestions?
Here's the procedure. [attachment](#) 📎 REPLY

13:42:34 **eleong:** That's an old document I believe,

13:42:34 **rmogford:** I'll update and send a new document to the team. REPLY

FACT Communication View (Chat)



MY QUEUE **FACT CHAT** 6

41 users online

- TMC Group
- 2 LGA Dispatchers
- GMTO
- AFP Position Managers
- 4 Information Team
- LGA Controllers
- JFK Controllers

Hello there..
Richard Mogford 8:56:14 AM

Hello there...
Richard Mogford 8:56:14 AM

It seems like we're getting a lot of warnings about ice and heavy freezing rain.
Richard Mogford 8:56:14 AM

The group is tracking and shows an hour or more...
Richard Mogford 8:56:14 AM

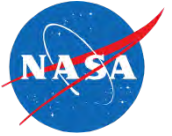
Thanks for the update, have a good one.
Before I forget, there's another front coming in, so stay tuned for additional info.
Richard Mogford 8:56:14 AM

Type your message here & press Enter or the send icon to submit... ➤

Flight Awareness Collaboration Tool Status



- User interface designed completed and web-based prototype under development
- Winter Weather Airport Capacity Model being evaluated at several facilities
- Plan to begin showing FACT to the airlines in July 2017 to request feedback on functionality and user interface design
- Will visit Southwest Airlines in June to review FACT and other research issues
- Creating a forum for NASA/industry discussion of operational and research needs



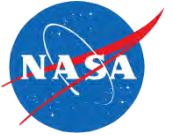
Human-autonomy Teaming with the Dispatcher

Summer Brandt, Joel Lachter

SJSURF/NASA Ames

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Problems with Automation

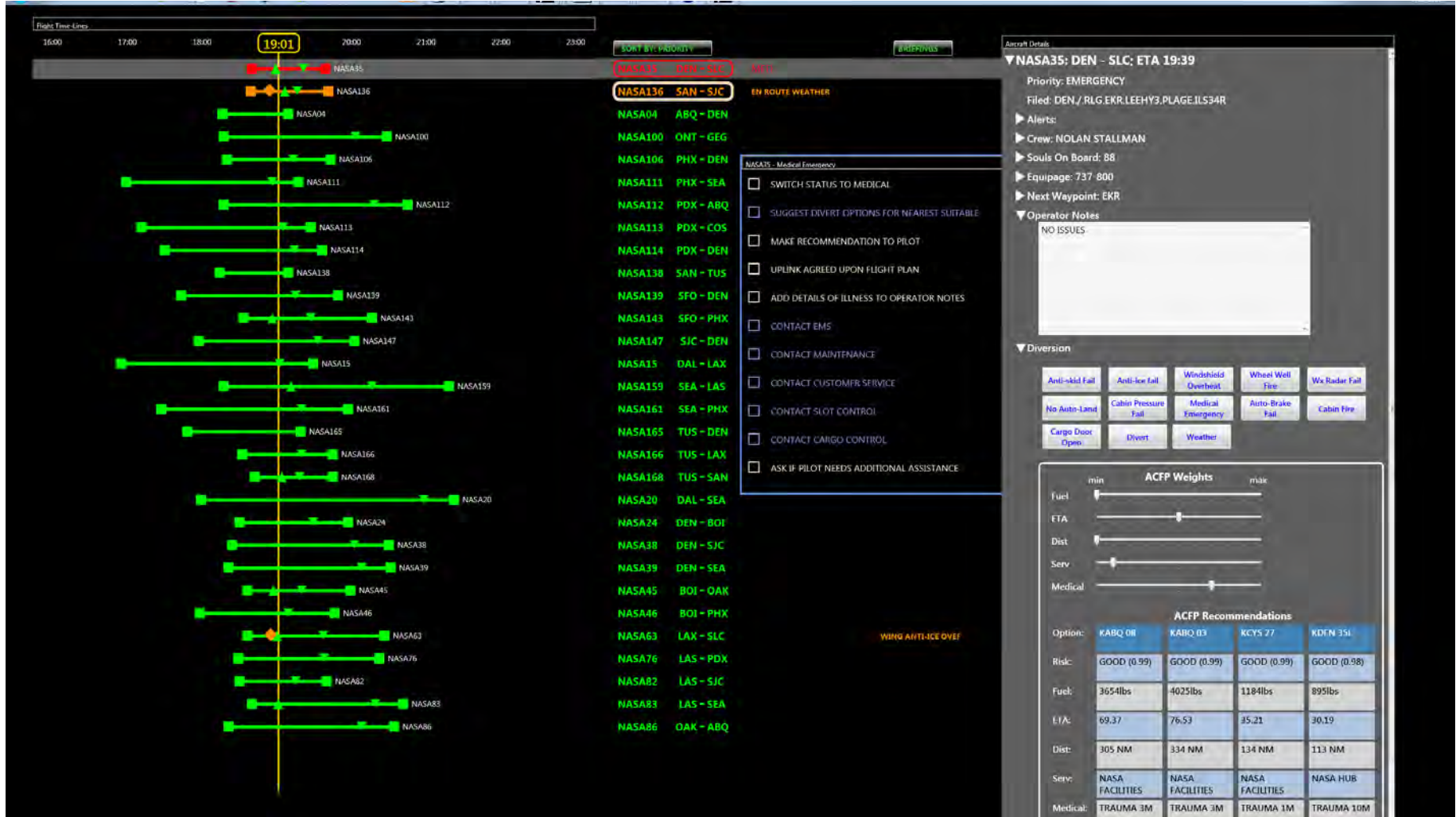
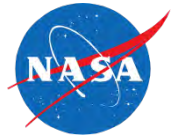
- Brittle
 - Automation often operates well for a range of situations but requires human intervention to handle boundary conditions
- Opaque
 - Automation interfaces often do not facilitate understanding or tracking of the system
- Miscalibrated trust
 - Disuse and misuse of automation have lead to real-world mishaps and tragedies
- Out-of-the-loop loss of situation awareness
 - Trade-off: automation helps manual performance and workload but recovering from automation failure is often worse

Human-autonomy Teaming with the Dispatcher



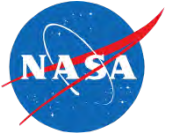
- Brittle
 - Negotiated decisions puts a layer of human flexibility into system behavior
- Opaque
 - Requires that systems be designed to be transparent and present rationales and confidence in solutions
 - Communication should be in terms the operator can easily understand (shared language)
- Miscalibrated trust
 - Automation display of rationale helps human operator know when to trust it
- Out-of-the-loop loss of situation awareness
 - Keep operator in control: adaptable, not adaptive automation
 - Greater interaction (e.g., negotiation) with automation reduces likelihood of being out of the loop

Human-autonomy Teaming and the Dispatcher

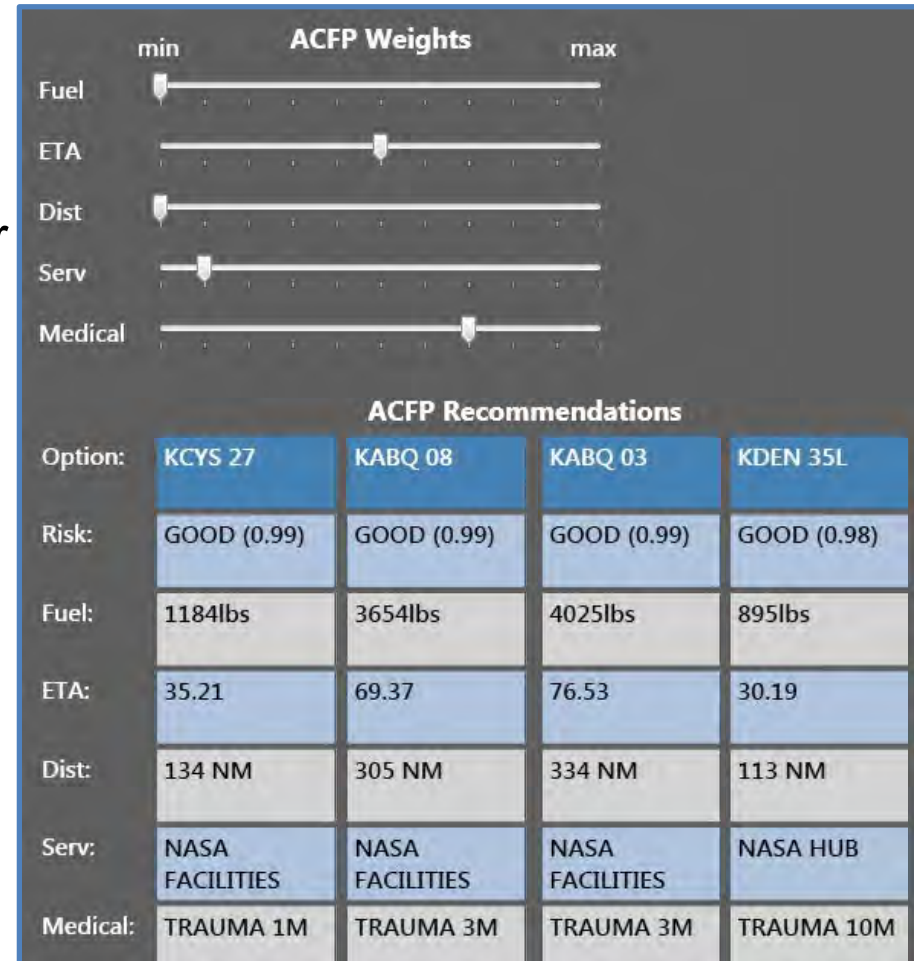


Flight list with Autonomous Constrained Flight Planner

Human-autonomy Teaming and the Dispatcher

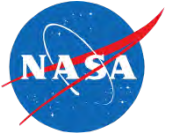


- Transparency: Divert reasoning and factor weights are displayed
- Negotiation/dialog: Operators can change factor weights to match their priorities
- Shared language/communication: Numeric output from the Autonomous Constrained Flight Planner was found to be misleading by pilots
- Display now uses English categorical descriptions



Autonomous Constrained Flight Planner

Human-autonomy Teaming and the Dispatcher

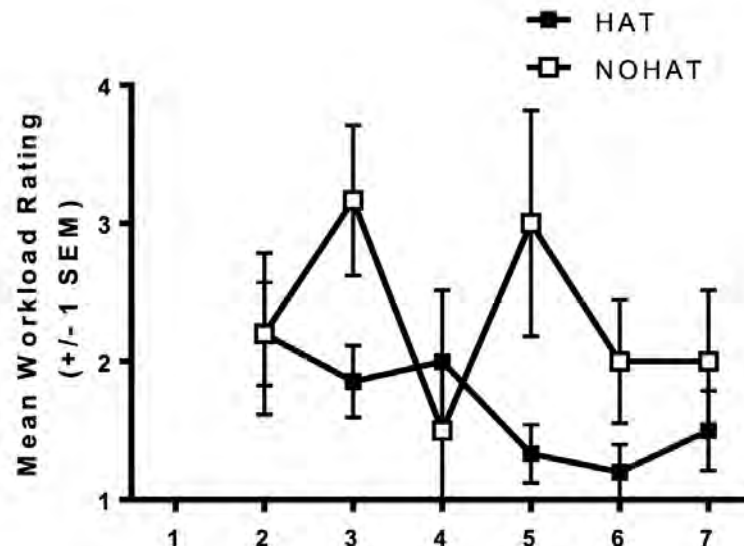


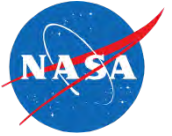
- Participants, with the help of automation, monitored 30 aircraft
- Alerted pilots when
 - Aircraft was off path or pilot failed to comply with clearances
 - Significant weather events affect aircraft trajectory
 - Pilot failed to act on EICAS alerts
- Rerouted aircraft when
 - Weather impacted the route
 - System failures or medical events force diversions
- Ran with and without human-autonomy teaming (HAT) tools

Human Autonomy Teaming and the Dispatcher



- Participants preferred the HAT condition overall (rated 8.5 out of 9)
- HAT displays and automation preferred for keeping up with operationally important issues (rated 8.7 out of 9)
- HAT displays and automation provided enough situational awareness to complete the task (rated 8.7 out of 9)
- HAT displays and automation reduced the workload relative to no HAT (rated 8.3 out of 9)





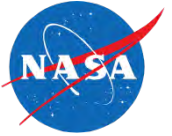
Infrasound Turbulence Detection

Qamar Shams

NASA Langley

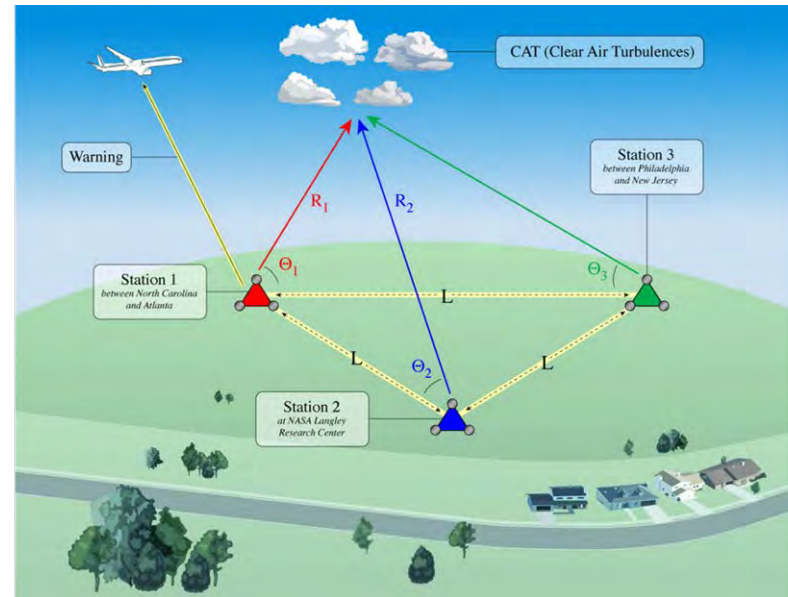
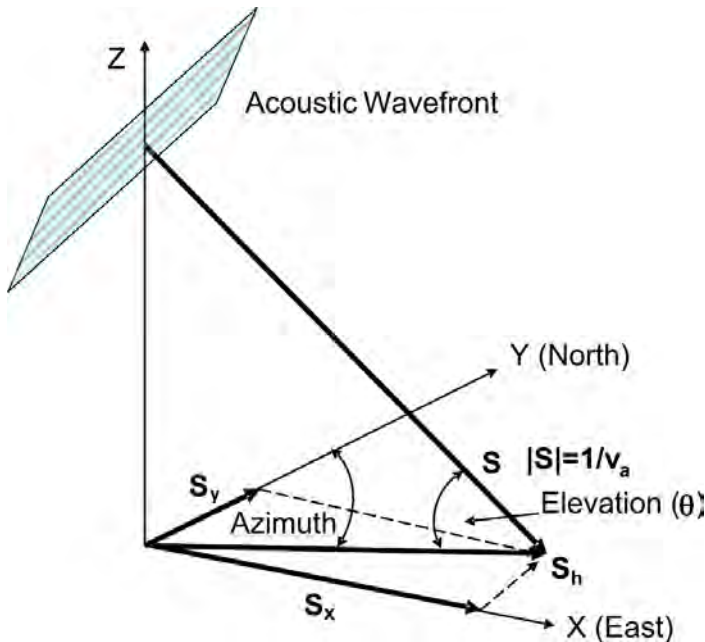
qamar.a.shams@nasa.gov

Infrasound Turbulence Detection Feasibility Study



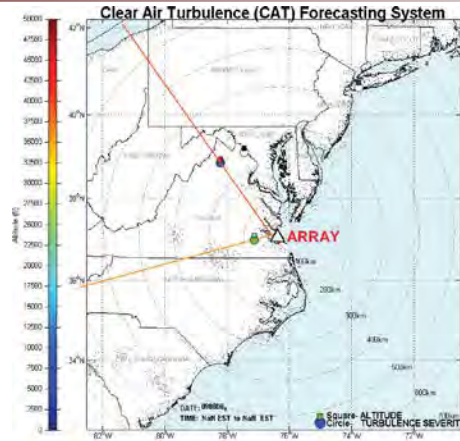
- Partnering with University Corporation for Atmospheric Research to determine if clear air turbulence detection by infrasonic microphone arrays is feasible
- Dr. Qamar Shams at NASA Langley has an array set up but additional arrays will increase accuracy
- Study objectives:
 - What are the spectral characteristics of the acoustic energy?
 - How are the spectral characteristics of the acoustic energy related to turbulence intensity metrics (e.g., energy dissipation rate), that in turn can be related to aircraft response?
 - What are the transmission properties of the acoustic signal, i.e., attenuation, refraction, and diffraction, as the acoustic waves propagate from the source to the receivers?
 - Given proposed geometries of a receiver array, what are the temporal and spatial accuracies that can be achieved?
 - What are the appropriate signal processing methods to ensure adequate detection and minimal false alarms?

Infrasound Clear Air Turbulence Detection Feasibility

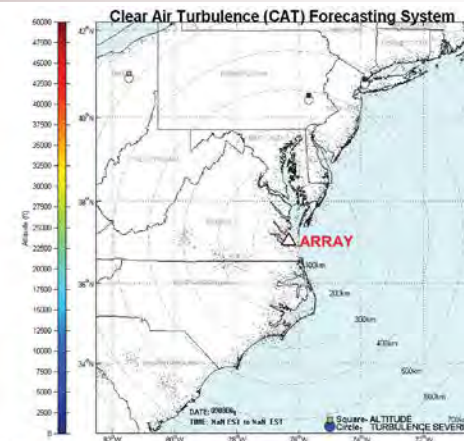


Microphone Array and Detection Example

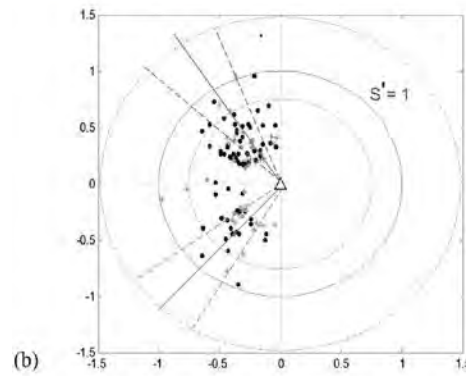
Infrasound Turbulence Detection



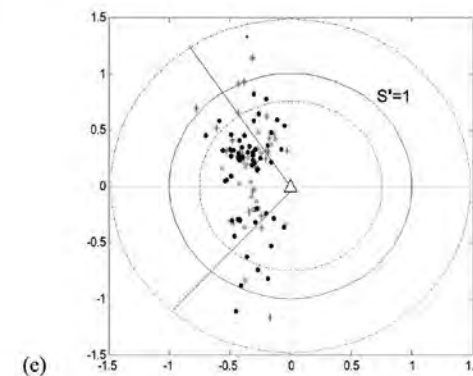
(a)



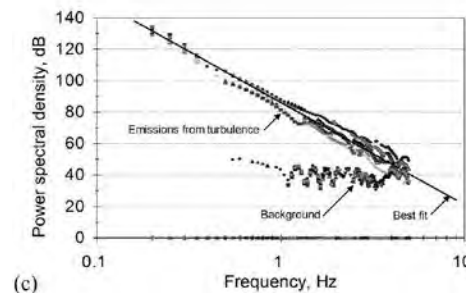
(d)



(b)

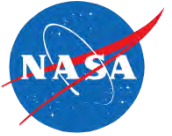


(e)



(c)

Clear Air Turbulence Detection Event

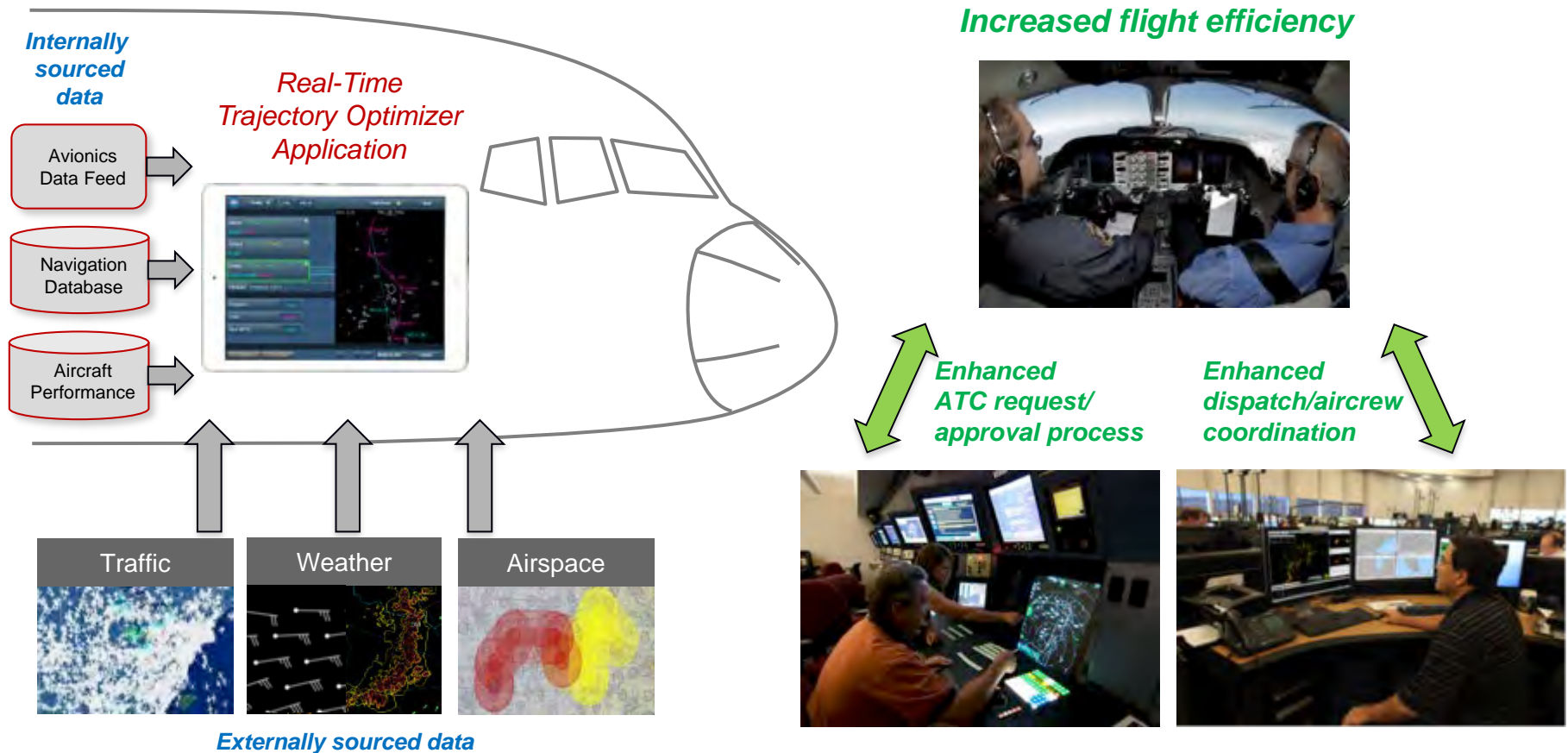


Traffic Aware Strategic Aircrew Requests

David Wing
NASA Langley
david.wing@nasa.gov

Traffic Aware Strategic Aircrew Requests

Enhanced User Request Process leveraging **Cockpit Automation** and **Networked Connectivity** to real-time operational data to optimize an aircraft's trajectory en route



Traffic Aware Strategic Aircrew Requests



The interface displays flight parameters and a path visualization. On the left, a sidebar shows various flight metrics and objectives. The main area on the right shows a path with waypoints and a highlighted 'Combo' section.

Flight Parameters:

- Cruise: (green indicator)
- FL300
- M0.76
- Data Feeds: (yellow indicator)
- Auto: (dropdown)

Path Visualization:

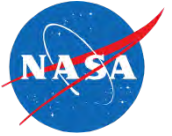
- RNG: 1120
- TRK: 283
- MAG
- Waypoints: NASSH, MEVDY, JUBDI, AHYOB, DOGGS, ODLOE
- Highlighted Combo: FL340 / PROTN NASSH
- ALT FL340

Objective and Limit Settings:

- Objective: Fuel
- Limit: NASSH
- Max WPTS: Two

Message: Processing...(60%)

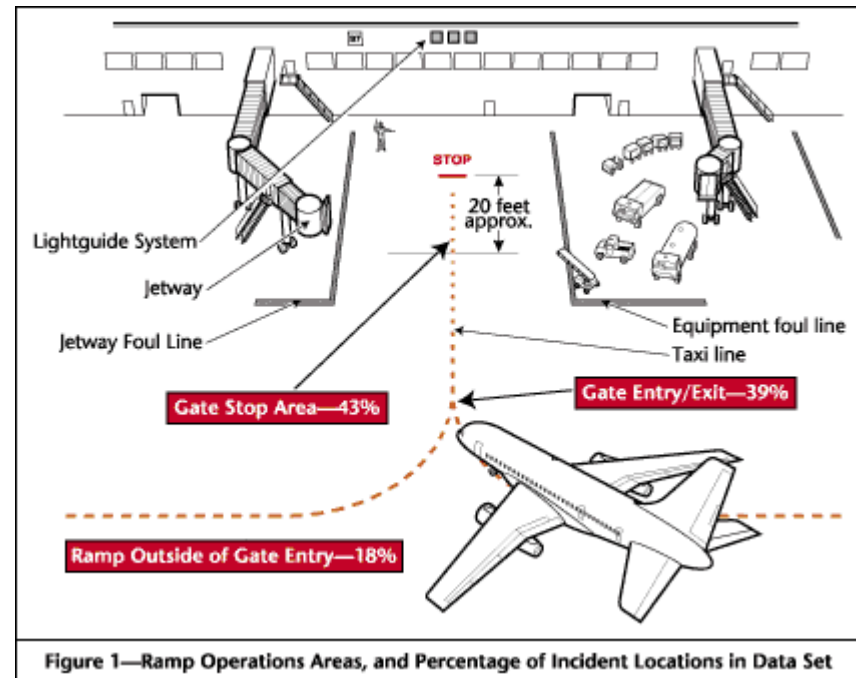
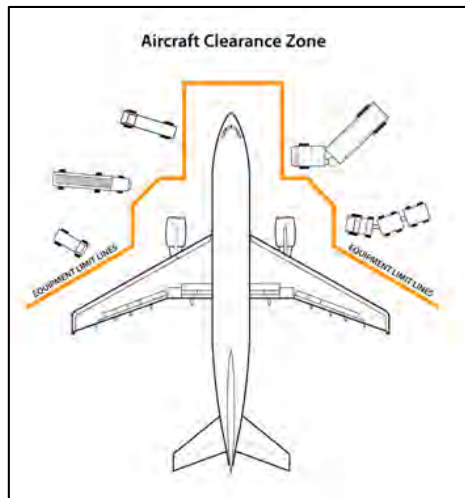
Buttons: ATC Approved, ATC Denied, Winds FL 300, Layers



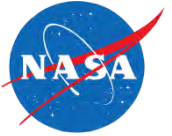
Visual Detection in Aircraft Safety Zone

Visual Detection in Aircraft Safety Zone

- Develop approaches to reducing ground vehicle incidents
 - Will analyze ramp area video recordings provided by Southwest Airlines
 - Determine if ground vehicle incursion into aircraft safety zone can be detected or prevented



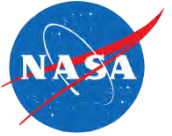
Accident Percentages in Aircraft Clearance Zones



Questions?

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Work With Us!

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- FACT
 - richard.mogford@nasa.gov
- UAS/Ground Station Research
 - summer.l.brandt@nasa.gov
- Clear Air Turbulence Detection Research
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