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May 8, 2019

*Via Electronic Mail*
David Carlon, Chairman
Massport Community Advisory Committee
dcarlonmcac@gmail.com

RE: *MIT RNAV Study Presentation Deck from April General Meeting*

Dear Chairman Carlon;

The attached presentation deck provided by MIT (Massport and the FAA's lead technical consultant) is from the April 23rd Massport CAC General Meeting. Much of the content included illustrates the ongoing work product including notional ideals. Additionally, considerable verbal context regarding the work product was provided during the presentation and the attached visual component alone serves only to augment, not take place of, that evening's presentation.

We strongly urge the Massport CAC and its members to avoid drawing any specific conclusions from this material alone. We look forward to the Massport CAC providing Massport with feedback following the technical team's presentation of the Block 2 work.

Sincerely,

Anthony J. Gallagher
Massport Community Relations

Cc:
(Via Electronic Mail)

Alaina Coppola, Director
Community Relations & Government Affairs
Massachusetts Port Authority
acoppola@massport.com

Matthew Romero, Executive Director
Massport Community Advisory Committee
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MIT International Center for Air Transportation

# Procedure Design Concepts for Logan Airport Community Noise Reduction

R. John Hansman

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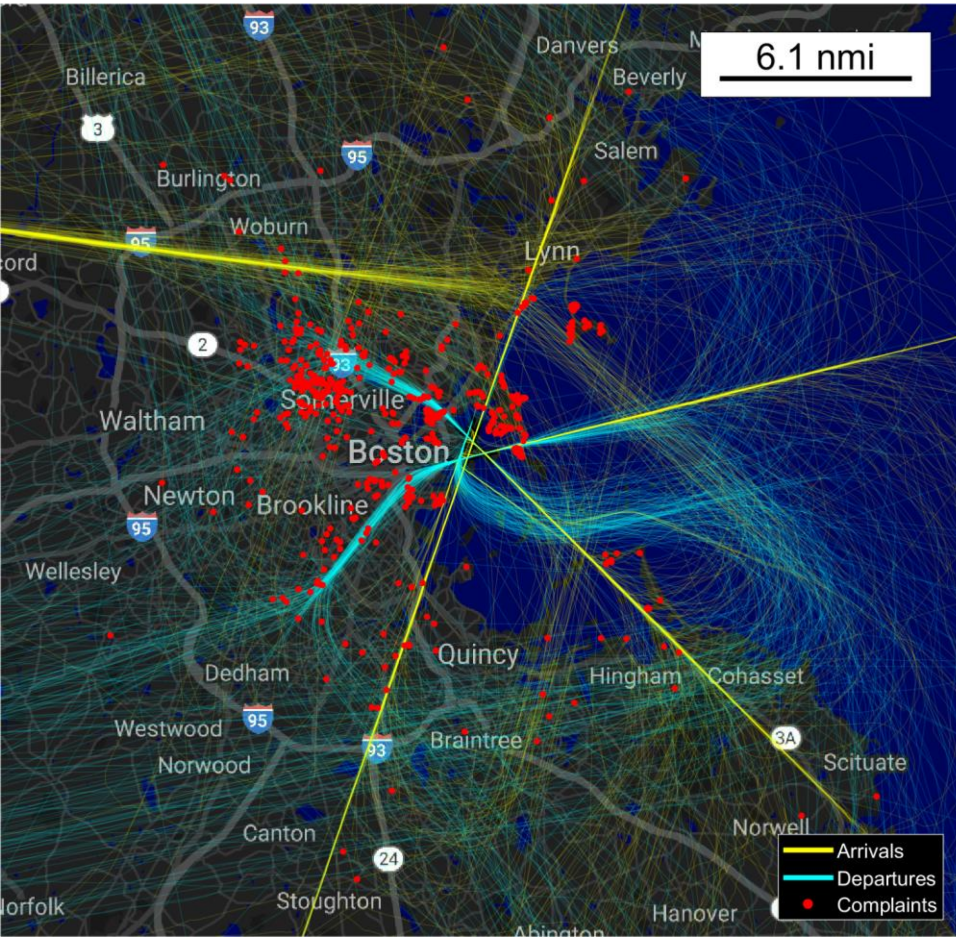
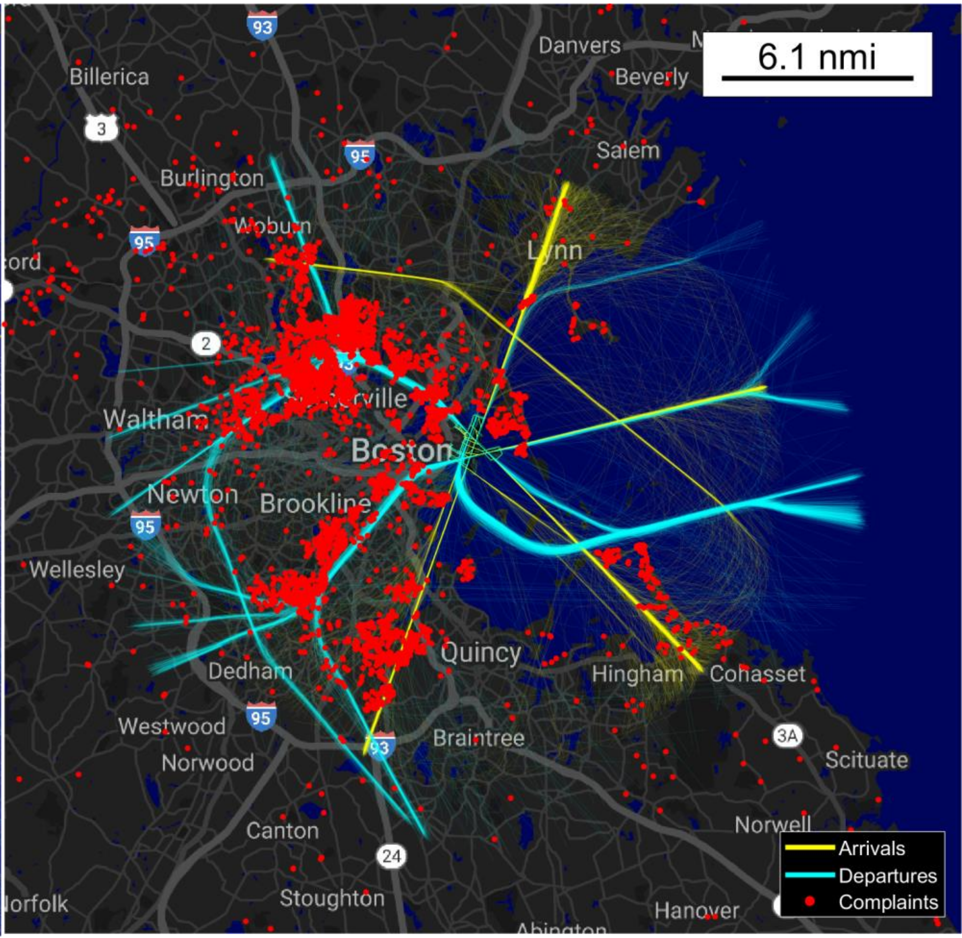
Technical support from MIT ICAT students, HMMH, and Massport

# RNAV Track Concentration

2010




2017



# Technical Approach

- Collect Data and Evaluate Baseline Conditions
  - Pre and Post RNAV
  - Community Input (Meetings and MCAC)
- Identify Candidate Procedure Modifications
  - Block 1
    - Clear noise benefit, no equity issues, limited operational/technical barriers
  - Block 2
    - More complex due to potential operational/technical barriers or equity issues
- Model Noise Impact
  - Standard and Supplemental Metrics
- Evaluate Implementation Barriers
  - Aircraft Performance
  - Navigation and Flight Management (FMS)
  - Flight Crew Workload
  - Safety
  - Procedure Design
  - Air Traffic Control Workload
- Recommend Procedural Modifications to Massport and FAA
- Repeat for Block 2

MIT ICAT

# Block 1 Final Recommendations

| Proc. ID<br>D = Dep.<br>A = Arr. | Procedure | Primary Benefits |
|---|---|---|
| 1-D1 | Restrict target climb speed for jet departures from Runways 33L and 27 to 220 knots or minimum safe airspeed in clean configuration, whichever is higher. | Reduced airframe and total noise during climb below 10,000 ft (beyond immediate airport vicinity) |
| 1-D2 | Modify RNAV SID from Runway 15R to move tracks further to the north away from populated areas. | Departure flight paths moved north away from Hull |
| 1-D3 | Modify RNAV SID from Runway 22L and 22R to initiate turns sooner after takeoff and move tracks further to the north away from populated areas. | Departure flight paths moved north away from Hull and South Boston |
| 1-D3a | *Option A*: Climb to intercept course (VI-CF) procedure | |
| 1-D3b | *Option B*: Climb to altitude, then direct (VA-DF) procedure | |
| 1-D3c | *Option C*: Heading-based procedure | |
| 1-A1 | Implement an overwater RNAV approach procedure with RNP overlay to Runway 33L that follows the ground track of the jetBlue RNAV Visual procedure as closely as possible. | Arrival flight paths moved overwater instead of over the Hull peninsula and points further south |
| 1-A1a | *Option A*: Published instrument approach procedure | |
| 1-A1b | *Option B*: Public distribution of RNAV Visual procedure | |

**"Block 1 Procedure Recommendations for Logan Airport Community Noise Reduction"**

Available at: [http://hdl.handle.net/1721.1/114038](http://hdl.handle.net/1721.1/114038)

# FAA 7100.41 Working Group

- Performance Based Navigation Implementation Process
- Purpose: To vet procedures with industry and facilities including airlines, ATC, and FAA
- Following FAA 7100.41 working group, procedures will be reviewed by flight standards

Lessons learned:

- Stakeholders may have flyability concerns despite a procedure design being within TERPS criteria
  - RNP SIDS are being further analyzed for situations where RNAV SIDS do not meet the desired objectives
- Designing RNAV and RNP procedures that are similar enough to be used simultaneously relieves ATC of workload burdens and allows for slight additional noise benefits in the RNP procedure

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

**ORDER 7100.41**

**Effective Date:**
April 3, 2014

SUBJ: Performance Based Navigation Implementation Process

This order provides a standardized five-phase implementation process related to Performance-Based Navigation (PBN) routes and procedures, referred to as the "Performance Based Navigation Implementation Process," which has been deemed compliant by the Office of Safety and meets the requirements set forth by the Federal Aviation Administration (FAA) Air Traffic Organization's (ATO) Safety Management System (SMS).

This order applies to the development and implementation of PBN procedures and routes; specifically, Area Navigation (RNAV)/Required Navigation Performance (RNP) Standard Instrument Departures (SID), RNAV/RNP Standard Terminal Arrivals (STAR), and RNP Authorization Required (AR) Standard Instrument Approach Procedures (SIAP), Q, Tango or "T," and TK (helicopter) Routes, and RNAV/RNP transitions to SIAPs.

Development and implementation of RNAV (GPS, GLS, LPV, etc.) and conventional (ILS, VOR, NDB, etc.) SIAPs, routes, position, and airspace modifications are not covered by this order. This order does not eliminate the SMS process required to decommission existing navigation stations.

This order is to be used in conjunction with and does not supersede other FAA orders and directives related to procedure development and implementation.

Elizabeth L. Ray
Vice President, Mission Support Services

2/7/14
Date Signed

https://www.faa.gov/documentLibrary/media/Order/FAA_JO_7100.41_Performance_Based_Navigation_Implementation_Process.pdf

# Block 1 Final Recommendations

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**Pending resolution of NASA modeling issues and national implementation**

**Technically infeasible**

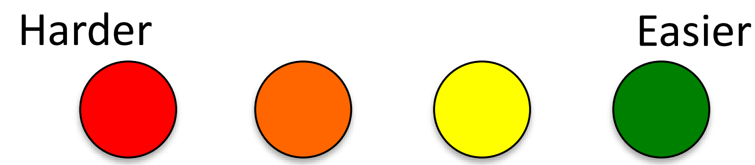
**Re-recommended in Block 2**

**"Block 1 Procedure Recommendations for Logan Airport Community Noise Reduction"**

Available at: http://hdl.handle.net/1721.1/114038

**Advanced by .41 group**

**Ease of Implementation Scale***

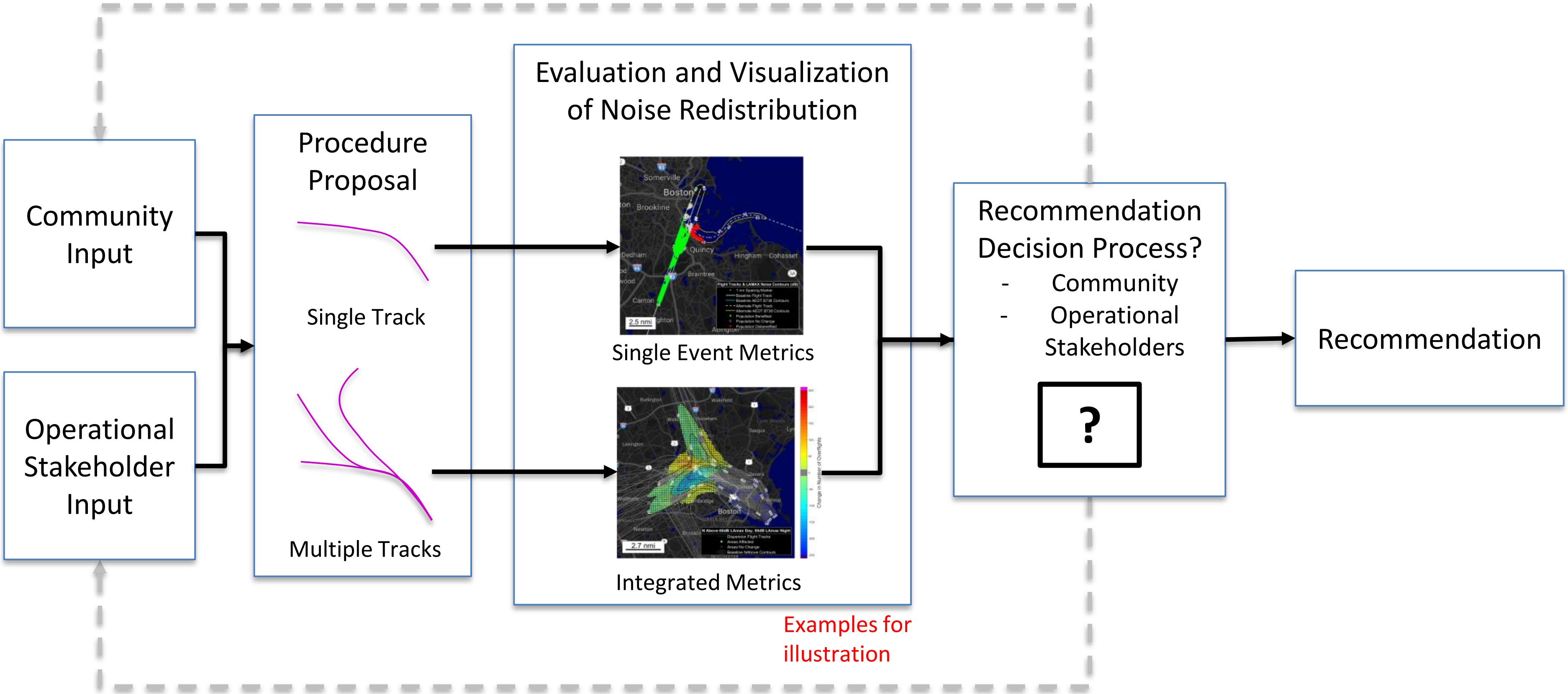



*All Block 2 procedures will be difficult to implement; the color scale only indicates *relative* ease of implementation

# Block 2

More complex due to potential operational/technical barriers or equity issues

# Need for Community Decision Process for Procedures with Noise Redistribution




*Analysis Thresholds*

Single event metrics: $L_{A,max}$ = 60dB during the day, 50dB during the night

Integrated metrics: $N_{60}$ greater than 50 events per peak day

MIT ICAT

# Block 2 Procedures

## Block 2 Arrival Mods

### Lateral Path Changes

- RNAV approach with RNP overlay
  - Runway 22L
  - Runway 4R
- RNP approach
  - Runway 4R

### Vertical Path Changes

- Delayed Deceleration Approach
  - All approach runways
- Continuous Descent RNAV Profiles
  - Runway 4R Arrivals from South
  - Runway 4R Arrivals from North

## Block 2 Departure Mods

### Lateral Path Changes

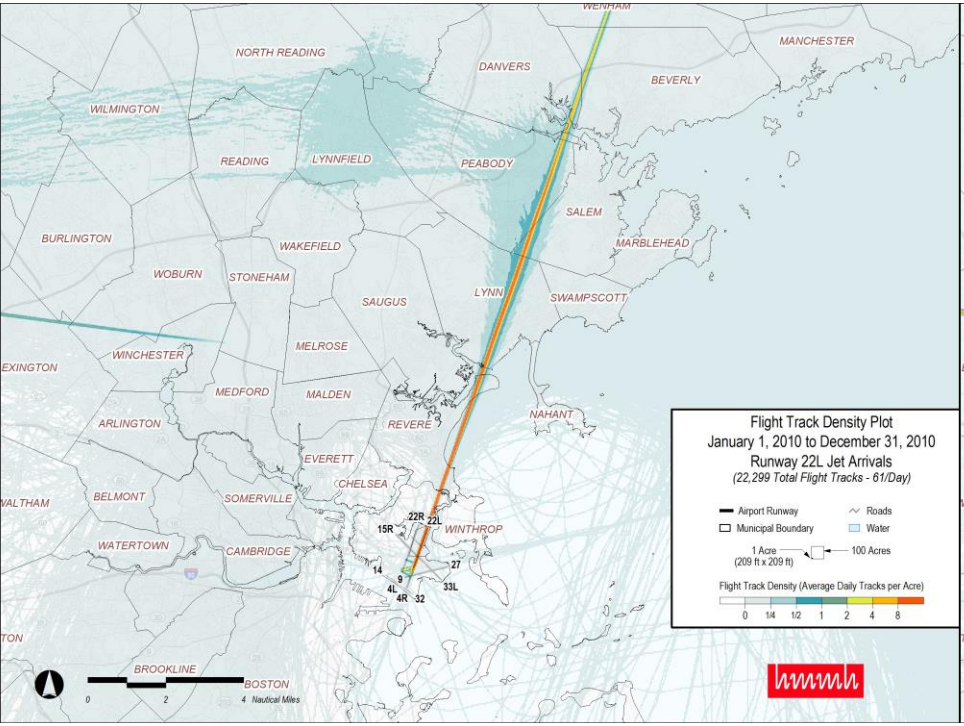
- Heading-based departure
  - Runway 22: Re-recommend 1-D3c. When runway 27 not in use, heading-based departure then re-join RNAV SID
- Dispersion

  Runways 33L and 27
  - Altitude-based dispersion
    - 3000ft
    - 4000ft
  - Controller-based dispersion
  - Divergent heading dispersion
  - RNAV SID Waypoint Relocation

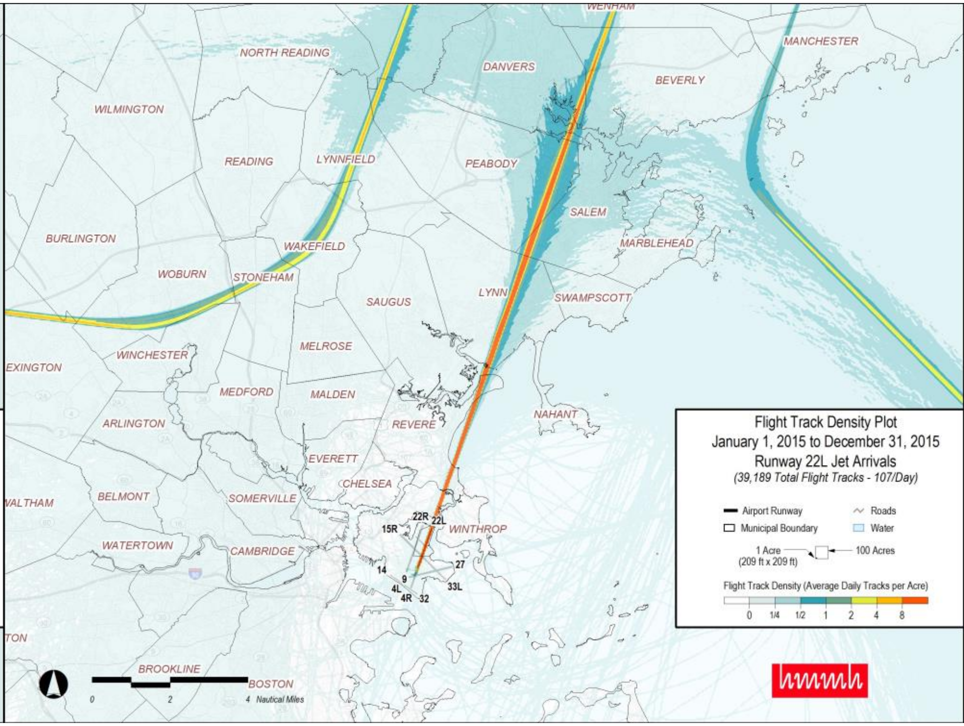
# RNAV/RNP Lateral Modifications to 22L Approach Procedure

# Runway 22L Arrivals: 2010-2015

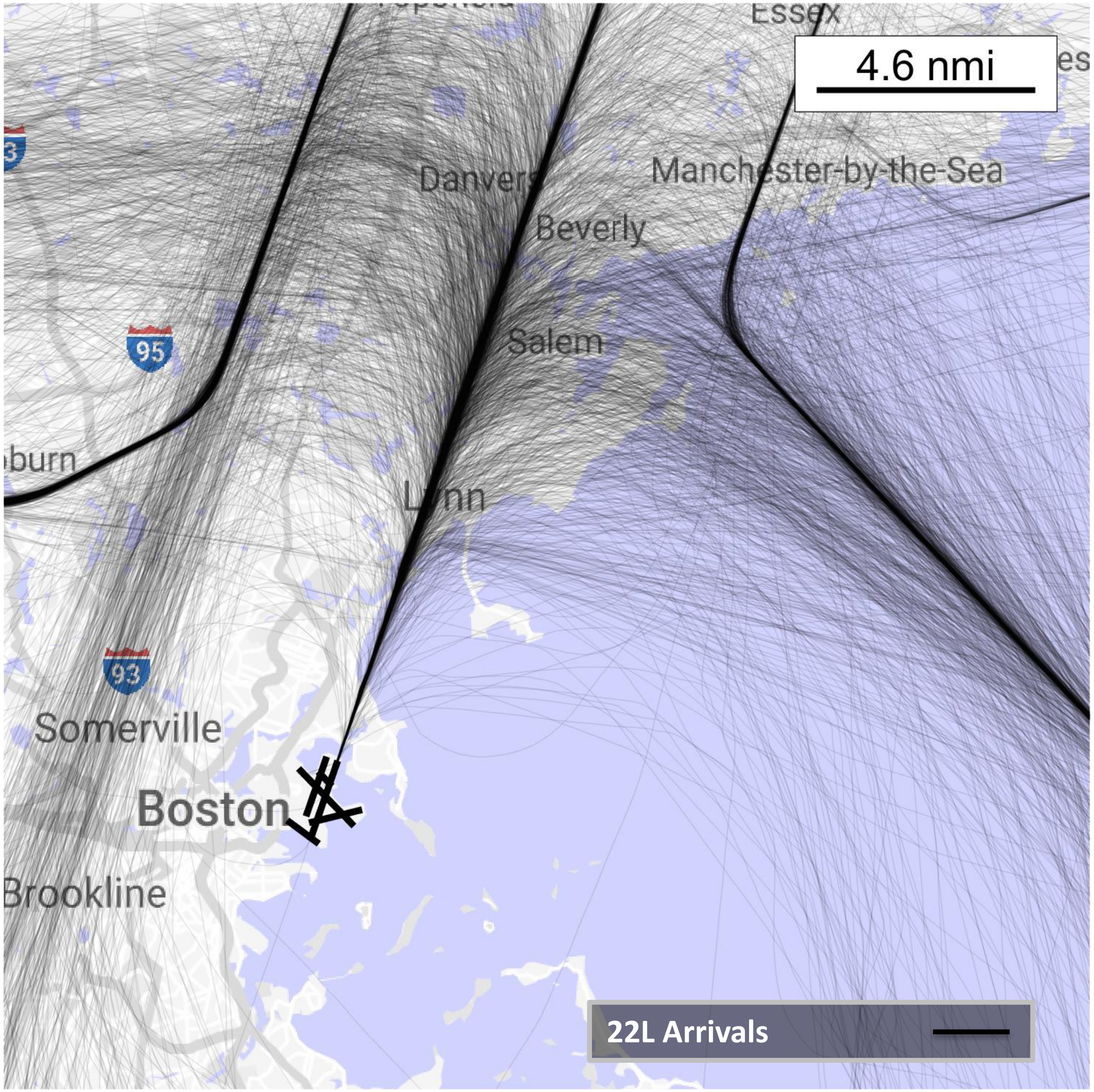
2010




2015



# Baseline: 2017 Arrivals to Runway 22L




**Notes:**

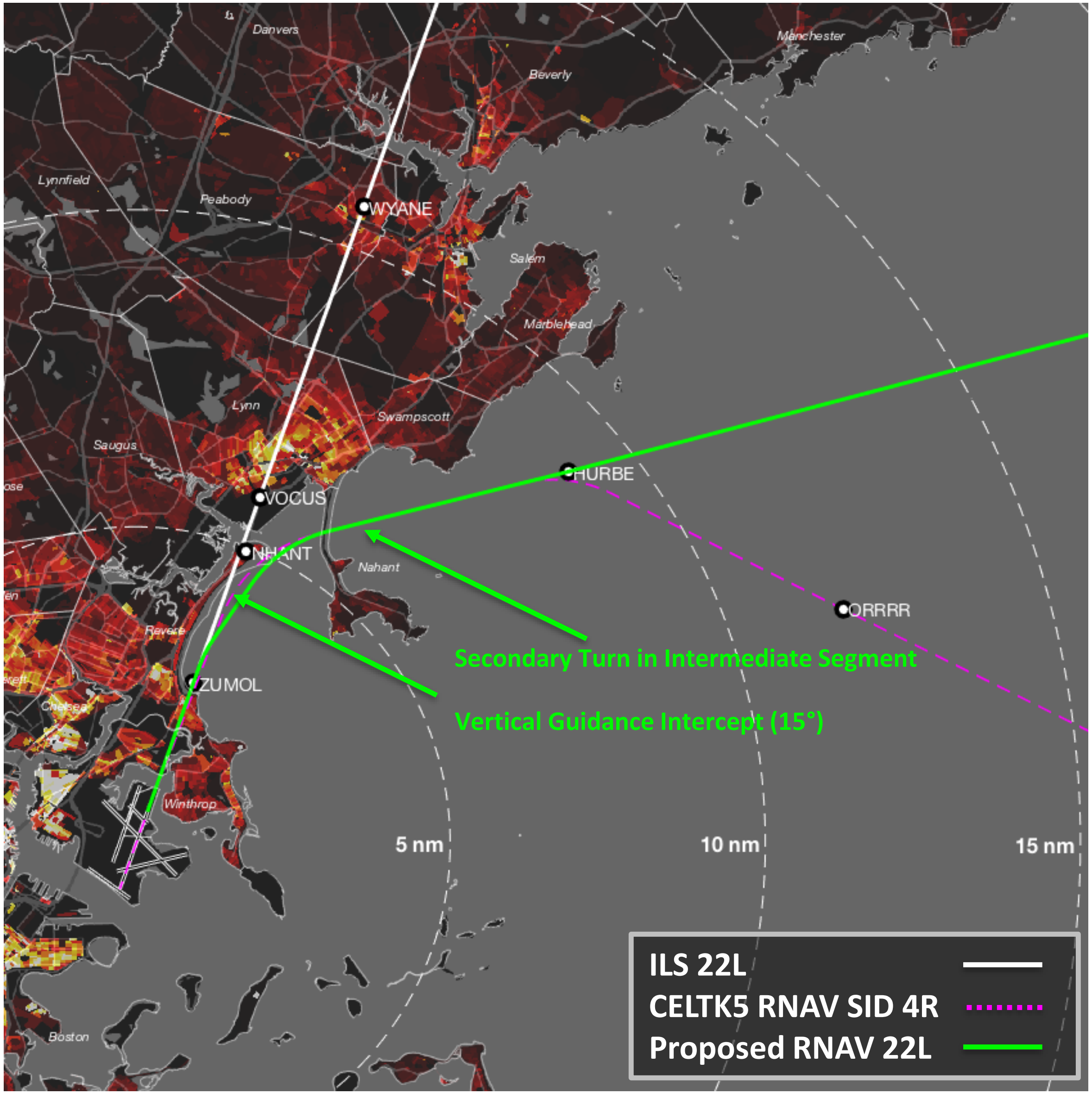
- 46,187 Arrivals to Rwy 22L in 2017 (jet & prop):
- Figure shows 10% of all 2017 arrivals selected at random
- Data Source: Flight Tracks, Massport Noise and Operations Management System (NOMS)

# 22L Low-Noise Offset RNAV Approach with RNP Overlay

Overlaying arrival corridor from east on existing 4R RNAV SID for 22L arrivals

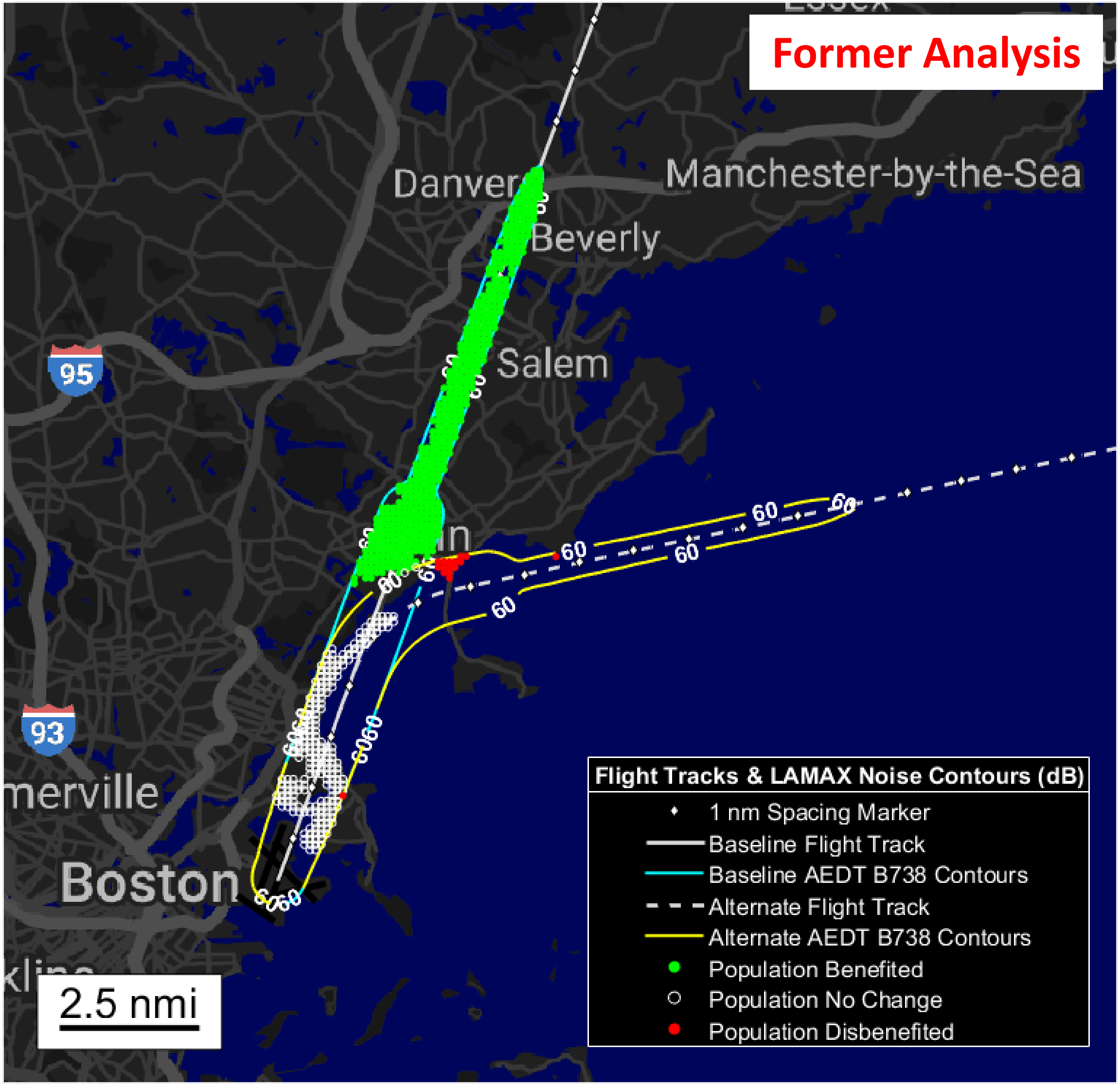
Notes:

- Intended to comply with design criteria for vertical-guidance RNAV
- Overflies midpoint of Nahant causeway at same location as 4R SID departure crossings



# 22L Arrival RNAV with RNP Overlay vs Straight In
# B738 AEDT Profile 60dB $L_{A,max}$ Noise Exposure
## Former Analysis

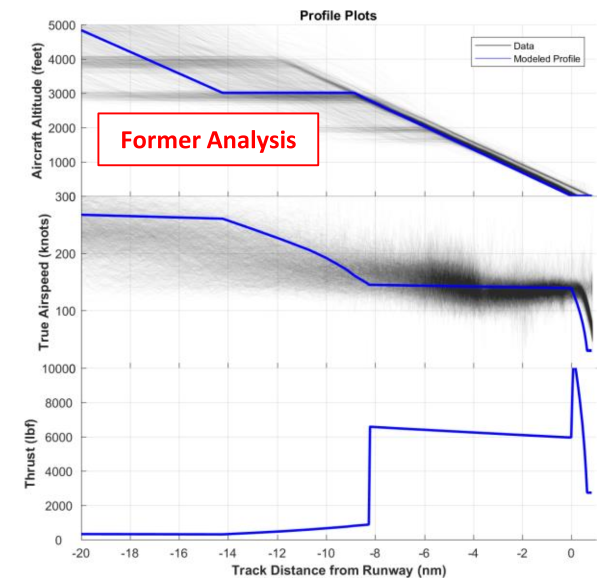
### B737-800 60dB $L_{A,max}$ Noise Exposure




**B737-800 Population Exposure ($L_{A,MAX}$)**

15% of aircraft fleet

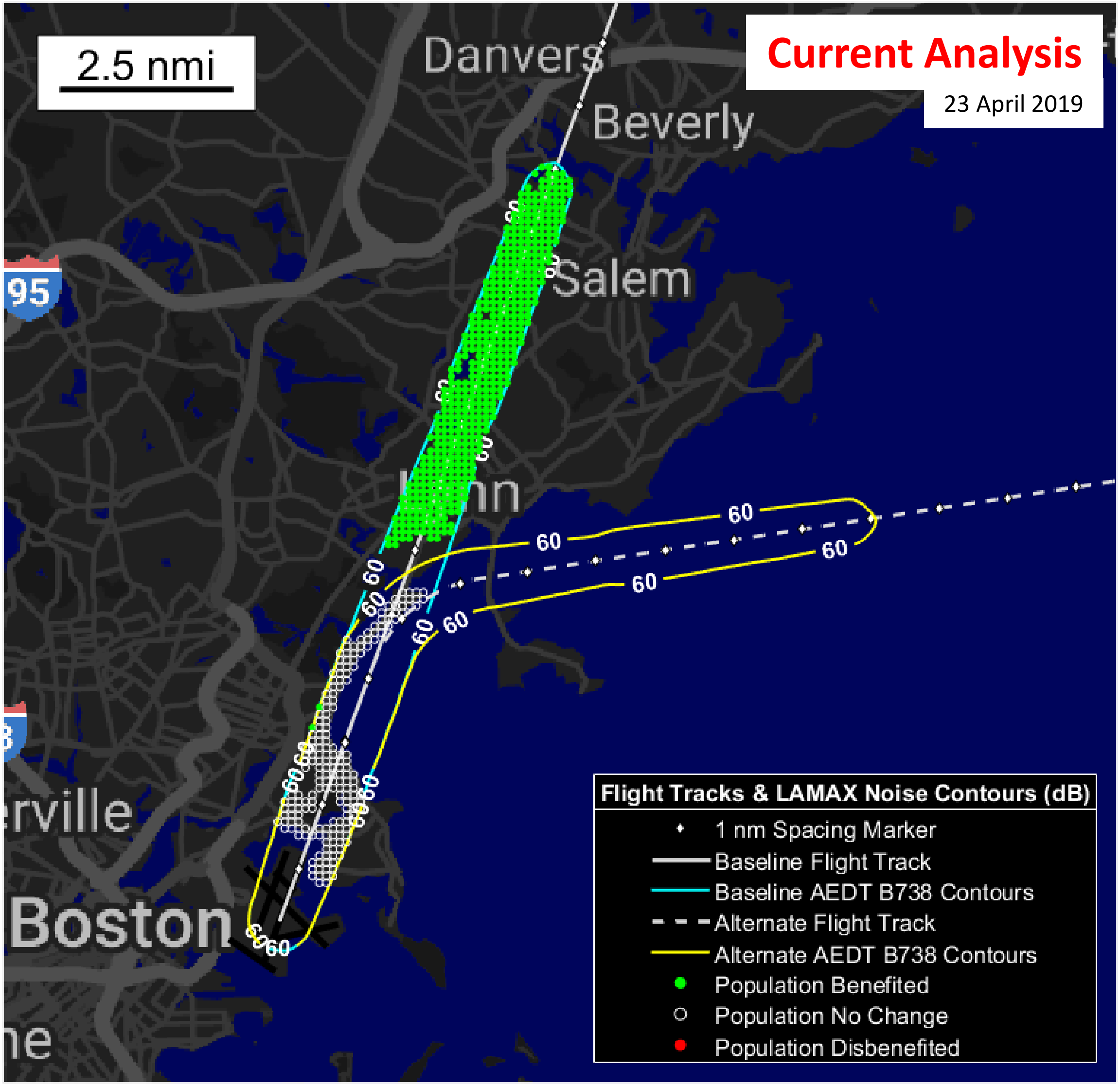
| | 60dB |
|---|---|
| Straight In | 82,162 |
| RNP | 29,561 |
| Difference (Straight In – RNP) | 52,601 |




Standard AEDT flight profile is not representative of altitude, speed, and thrust flight profile data at Boston

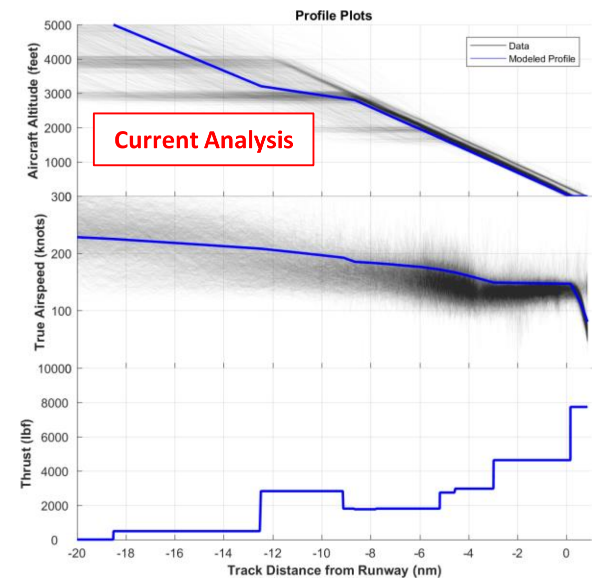
# 22L Arrival RNAV with RNP Overlay vs Straight In
# B738 Profile Generator 60dB $L_{A,max}$ Noise Exposure
## Current Analysis

### B737-800 60dB $L_{A,max}$ Noise Exposure




### B737-800 Population Exposure ($L_{A,MAX}$)
**15% of aircraft fleet**

| | 60dB |
|---|---|
| Straight In | 77,418 |
| RNP | 24,272 |
| Difference (Straight In – RNP) | 53,146 |

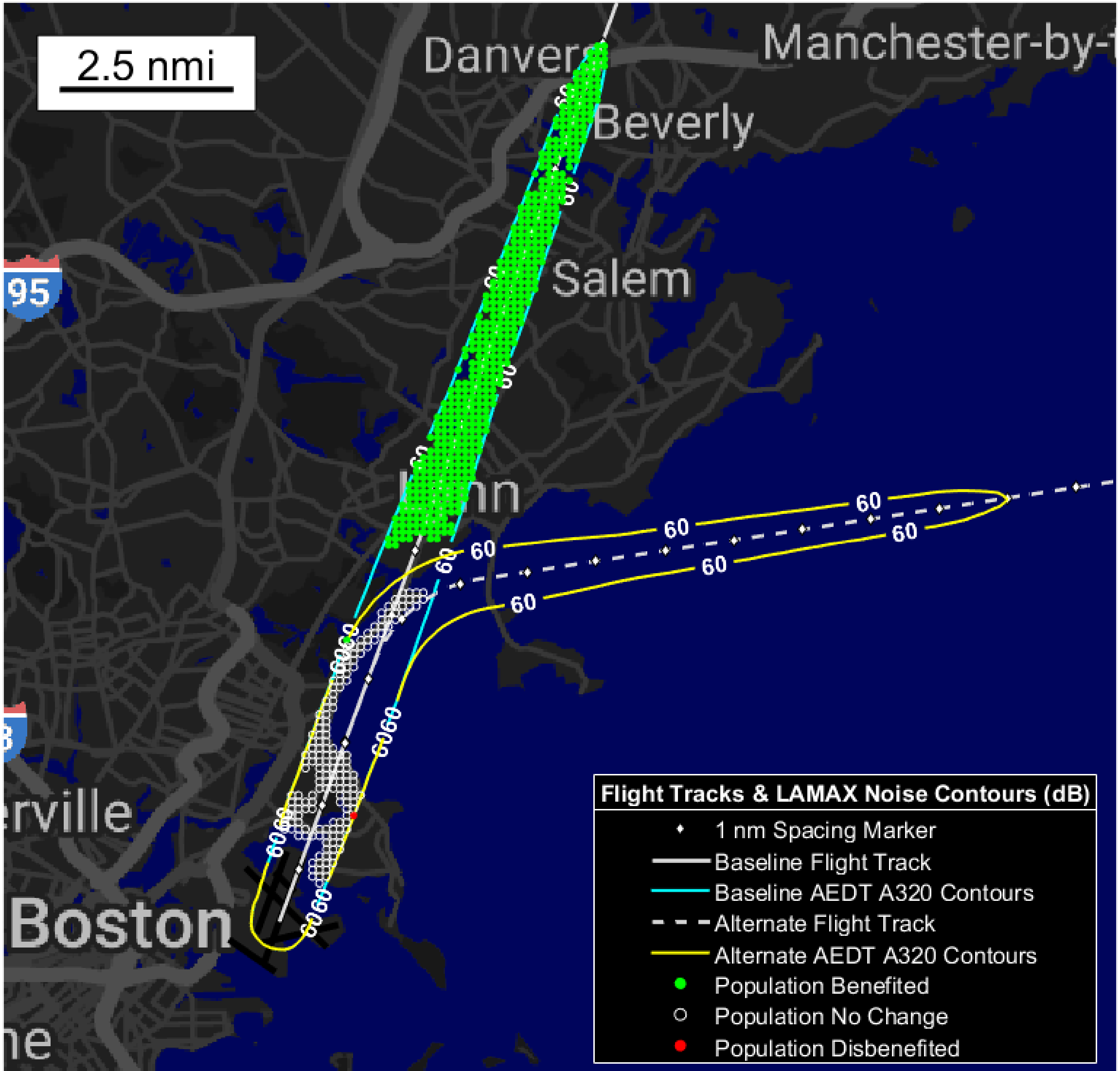



Altitude, speed, and thrust profiles are based on flight profile data from Boston. Slightly adjusted inbound heading

- Procedure within RNAV criteria. Initial .41 review found no major obstacles

# 22L Arrival RNAV with RNP Overlay vs Straight In
# A320 Profile Generator 60dB $L_{A,max}$ Noise Exposure

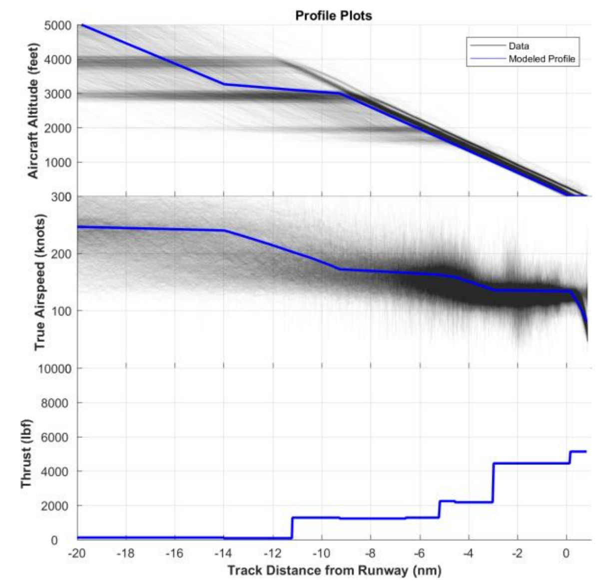
## A320 60dB $L_{A,max}$ Noise Exposure




**A320 Population Exposure ($L_{A,MAX}$)**

**27% of aircraft fleet**

| | 60dB |
|---|---|
| Straight In | 73,173 |
| RNP | 22,003 |
| Difference (Straight In – RNP) | 51,170 |

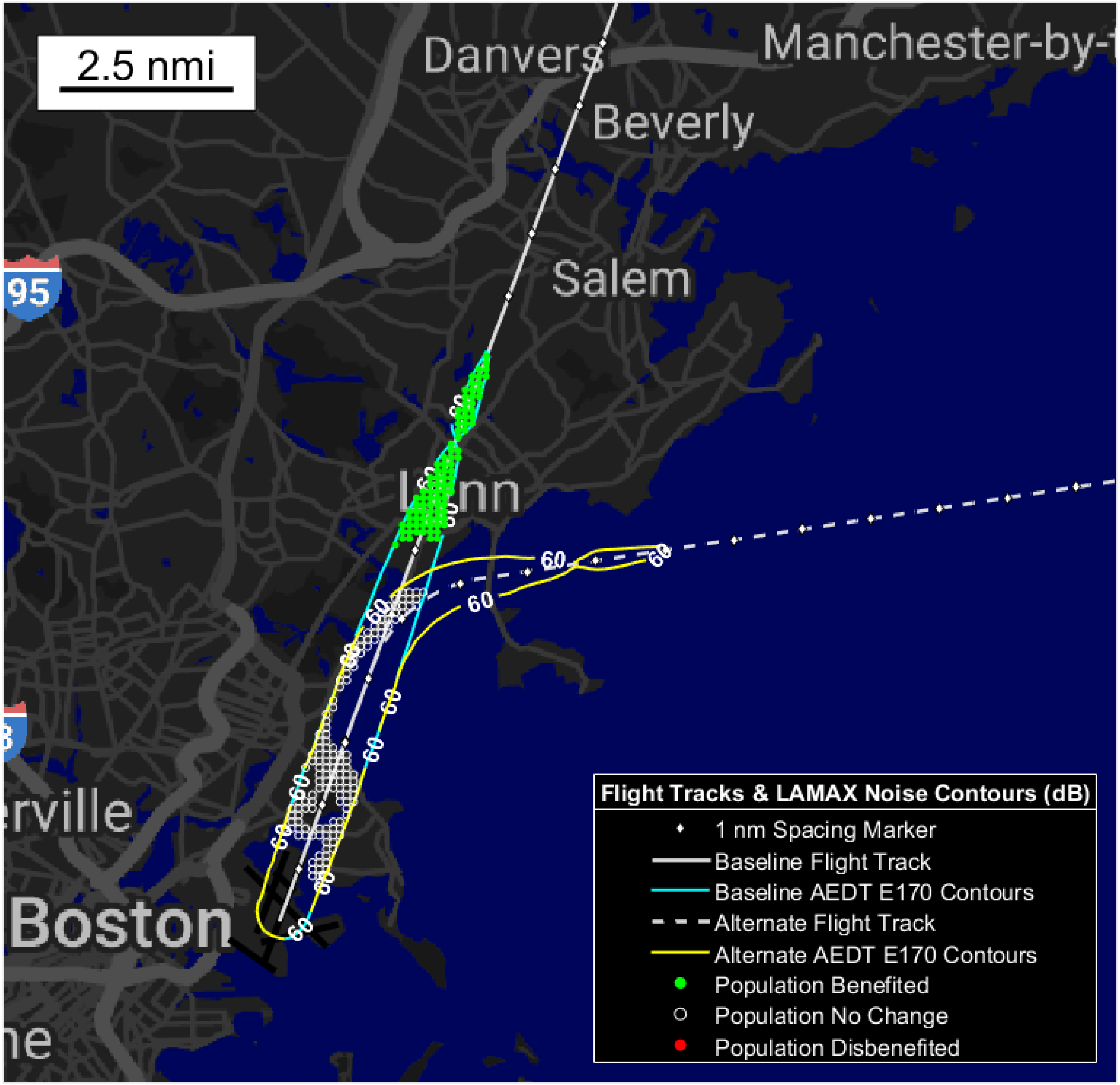



Altitude, speed, and thrust profiles are based on flight profile data from Boston. Slightly adjusted inbound heading

- Procedure within RNAV criteria. Initial .41 review found no major obstacles

# 22L Arrival RNAV with RNP Overlay vs Straight In
# E190 Profile Generator 60dB $L_{A,max}$ Noise Exposure

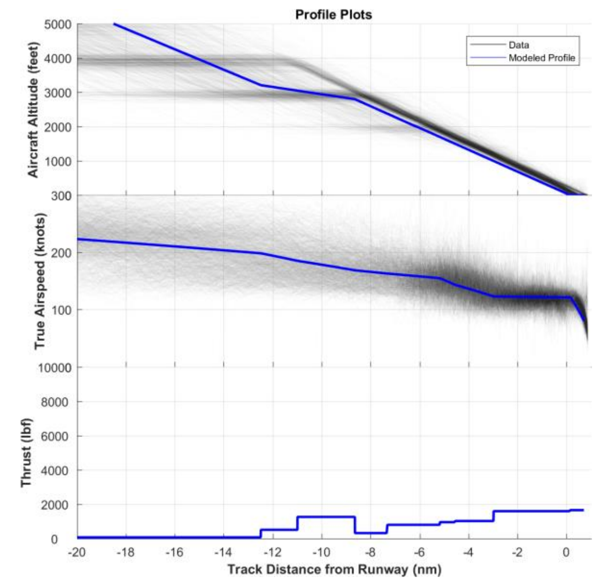
## E190 60dB $L_{A,max}$ Noise Exposure




**E190 Population Exposure ($L_{A,MAX}$)**

**24% of aircraft fleet**

| | 60dB |
|---|---|
| Straight In | 36,581 |
| RNP | 16,972 |
| Difference (Straight In – RNP) | 19,609 |




Altitude, speed, and thrust profiles are based on flight profile data from Boston. Slightly adjusted inbound heading

- Procedure within RNAV criteria. Initial .41 review found no major obstacles

# 22L Arrival RNAV with RNP Overlay vs Straight In
# B773 Profile Generator 60dB $L_{A,max}$ Noise Exposure

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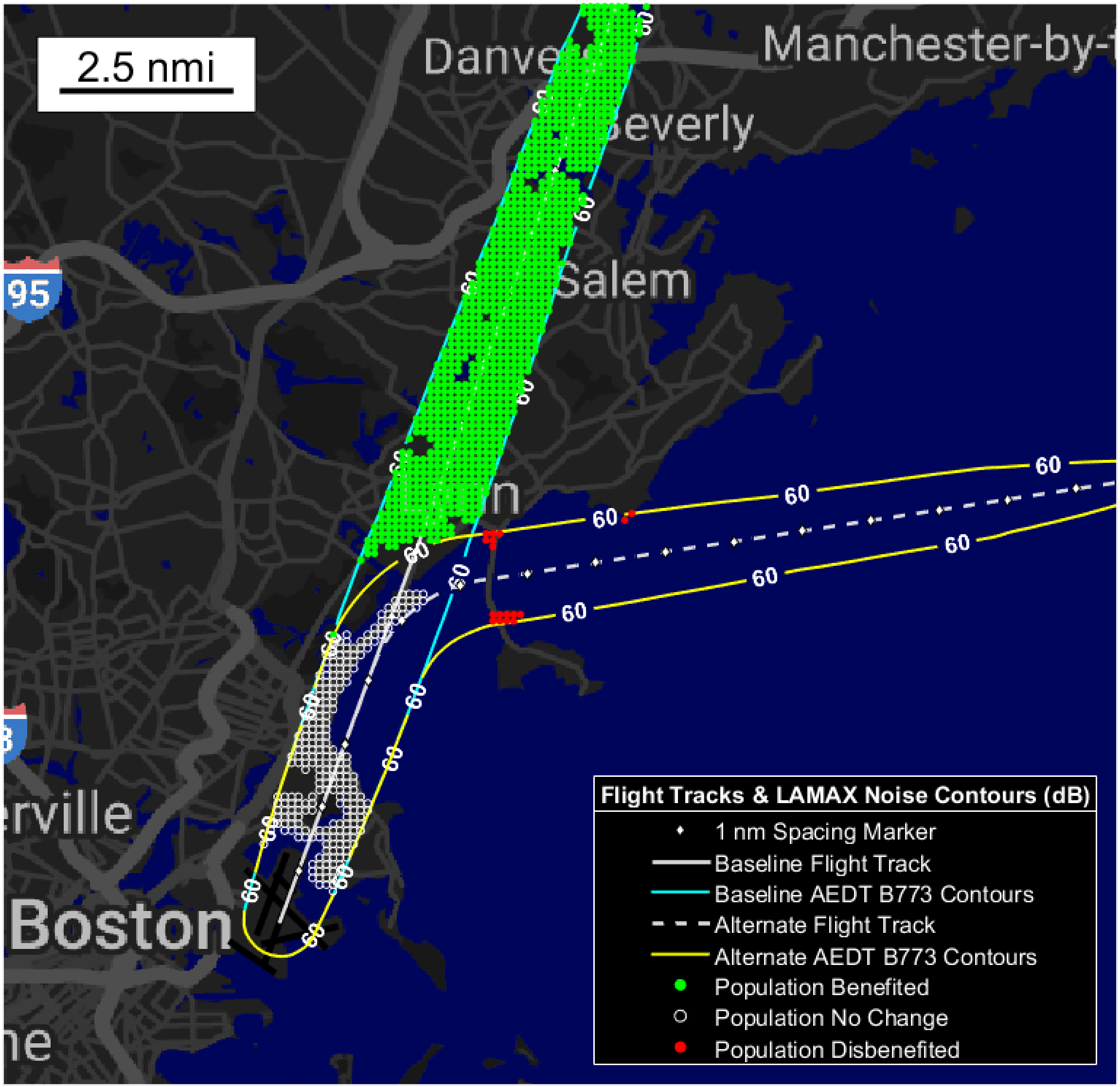
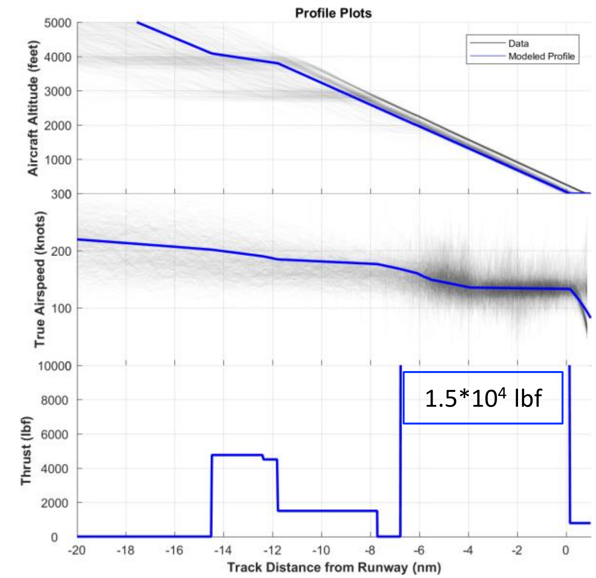
## B777-300 60dB $L_{A,max}$ Noise Exposure




**B777-300 Population Exposure ($L_{A,MAX}$)**

**6% of aircraft fleet**

| | 60dB |
|---|---|
| Straight In | 119,392 |
| RNP | 33,145 |
| Difference (Straight In – RNP) | 86,247 |



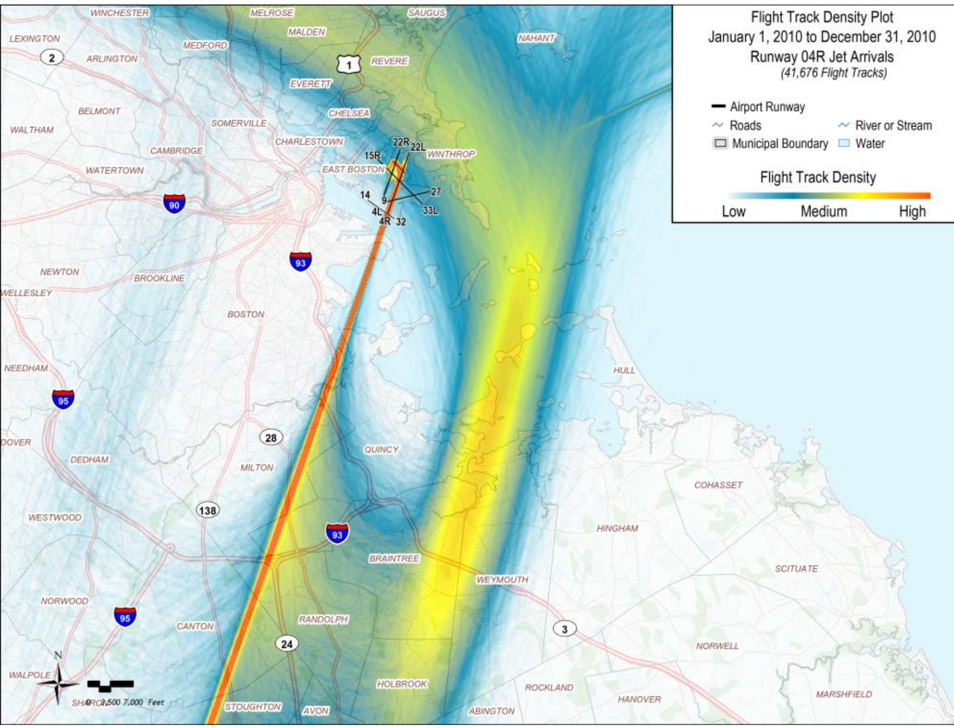

Altitude, speed, and thrust profiles are based on flight profile data from Boston. Slightly adjusted inbound heading

- Procedure within RNAV criteria. Initial .41 review found no major obstacles

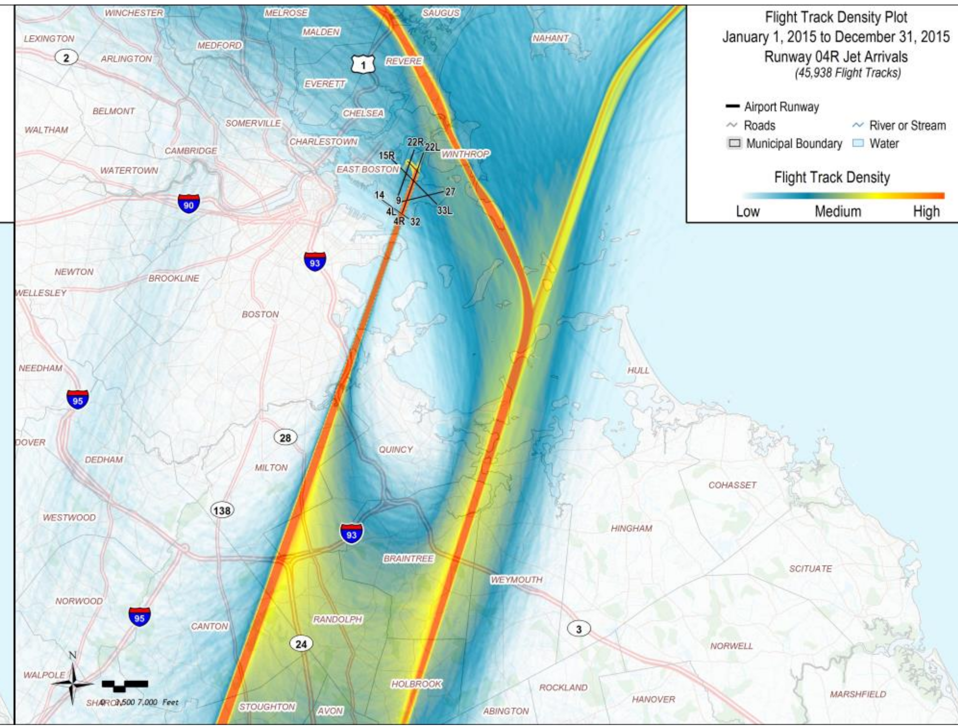
# RNAV/RNP Lateral Modifications to 4R Approach Procedure

# Runway 4R Arrivals: 2010-2015

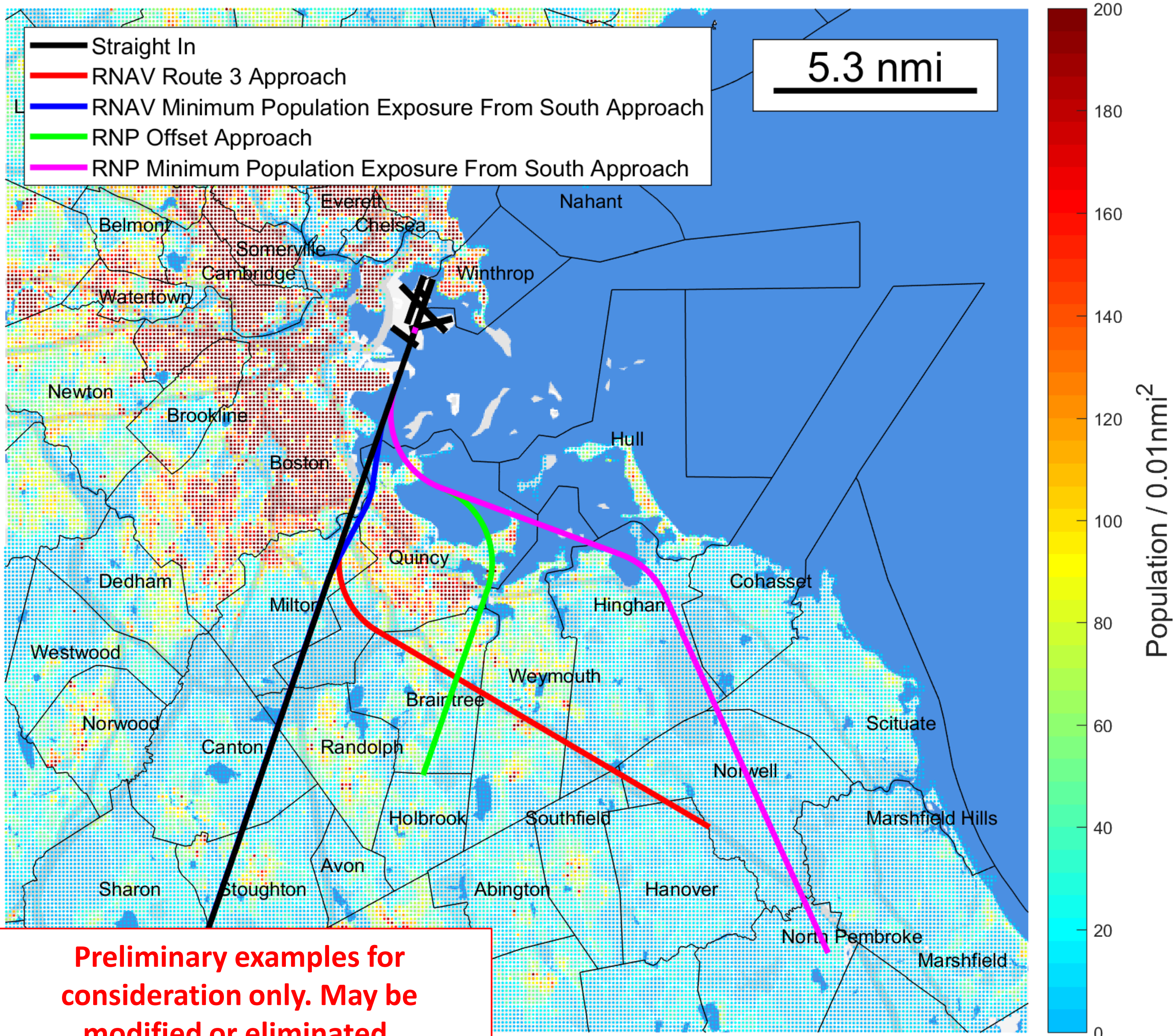
2010




2015



# Example 4R RNAV and RNP Approaches

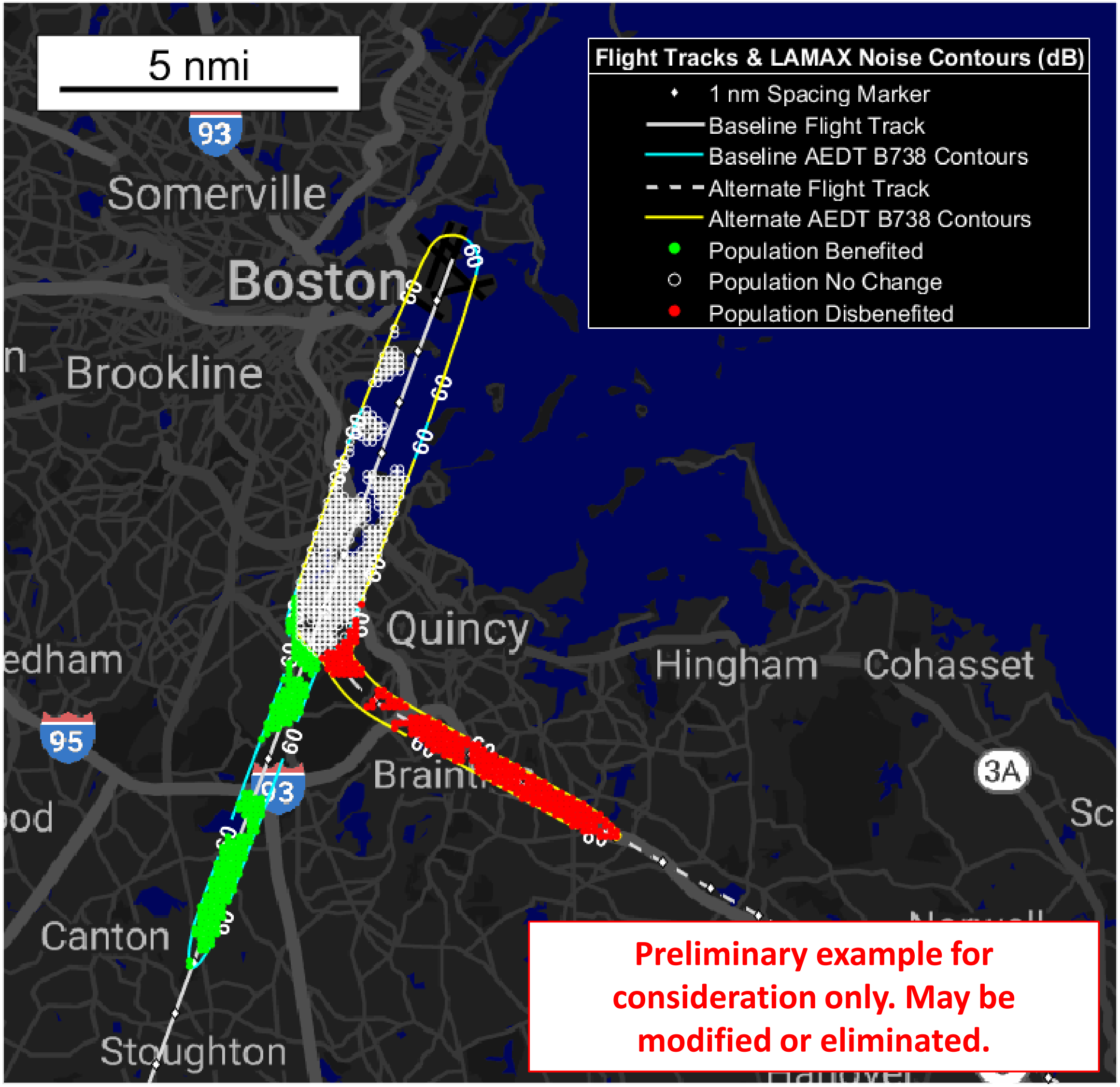



**Preliminary examples for consideration only. May be modified or eliminated.**

- Several approaches to 4R shown as examples
- RNP technology allows approach to be kept overwater near final approach

# 4R RNAV Approach – Route 3 Initial

B737-800 60dB $L_{A,max}$ Noise Exposure




**B737-800**
**Population Exposure ($L_{A,MAX}$)**

| | 60dB |
|---|---|
| Straight In | 32,232 |
| RNP | 38,353 |
| Difference (Straight In – RNP) | -6,121 |

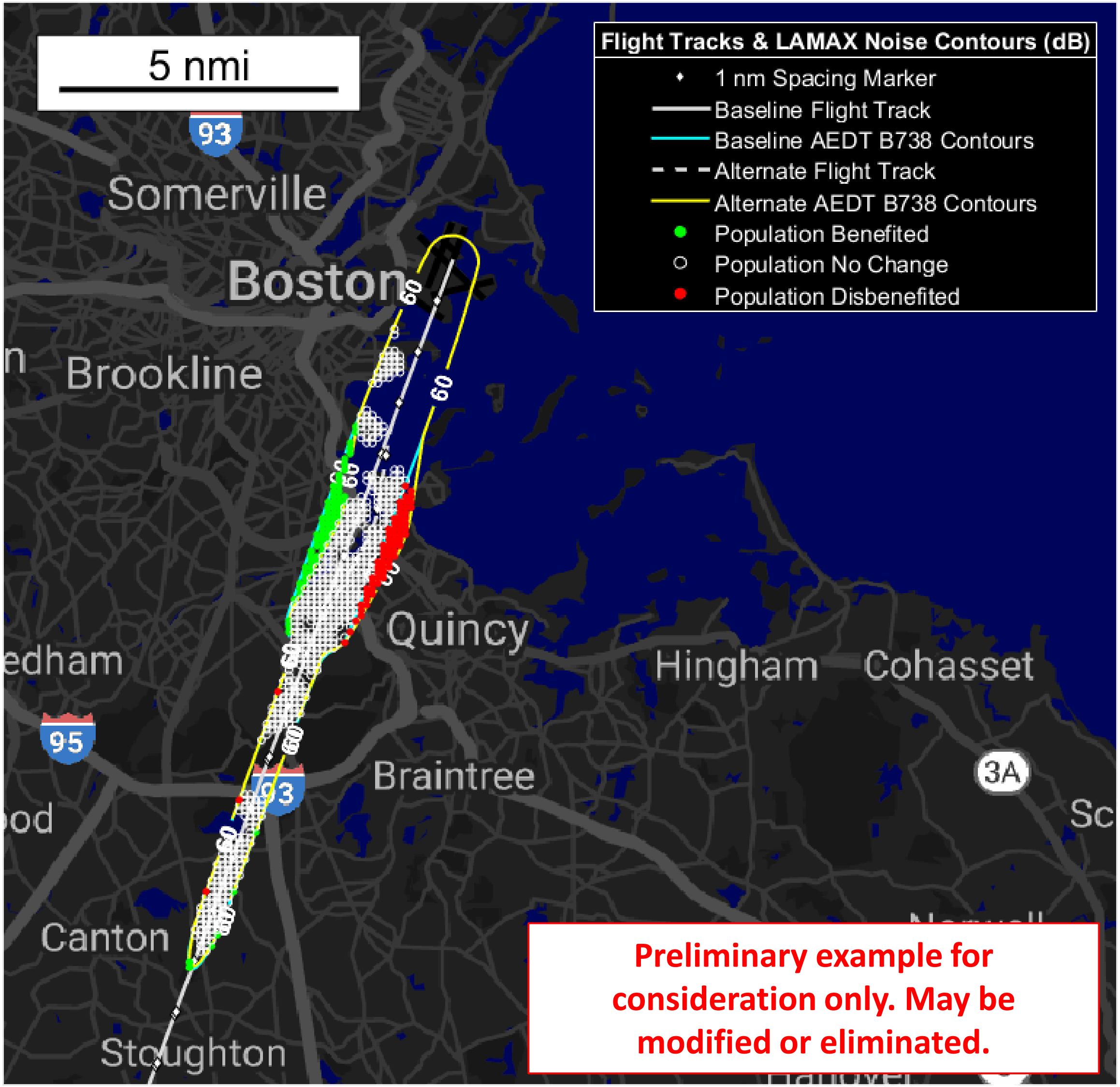
5.5nmi final segment
80$^{o}$ 2nmi radius-to-fix turn

Population exposure calculations do not take advantage of noise masking

- Procedure within RNAV criteria.
- Air traffic control concerns with merging with straight-in flight track.
- Community support unclear.

# 4R RNAV Approach – Minimum Population Exposure From South

B737-800 60dB $L_{A,max}$ Noise Exposure



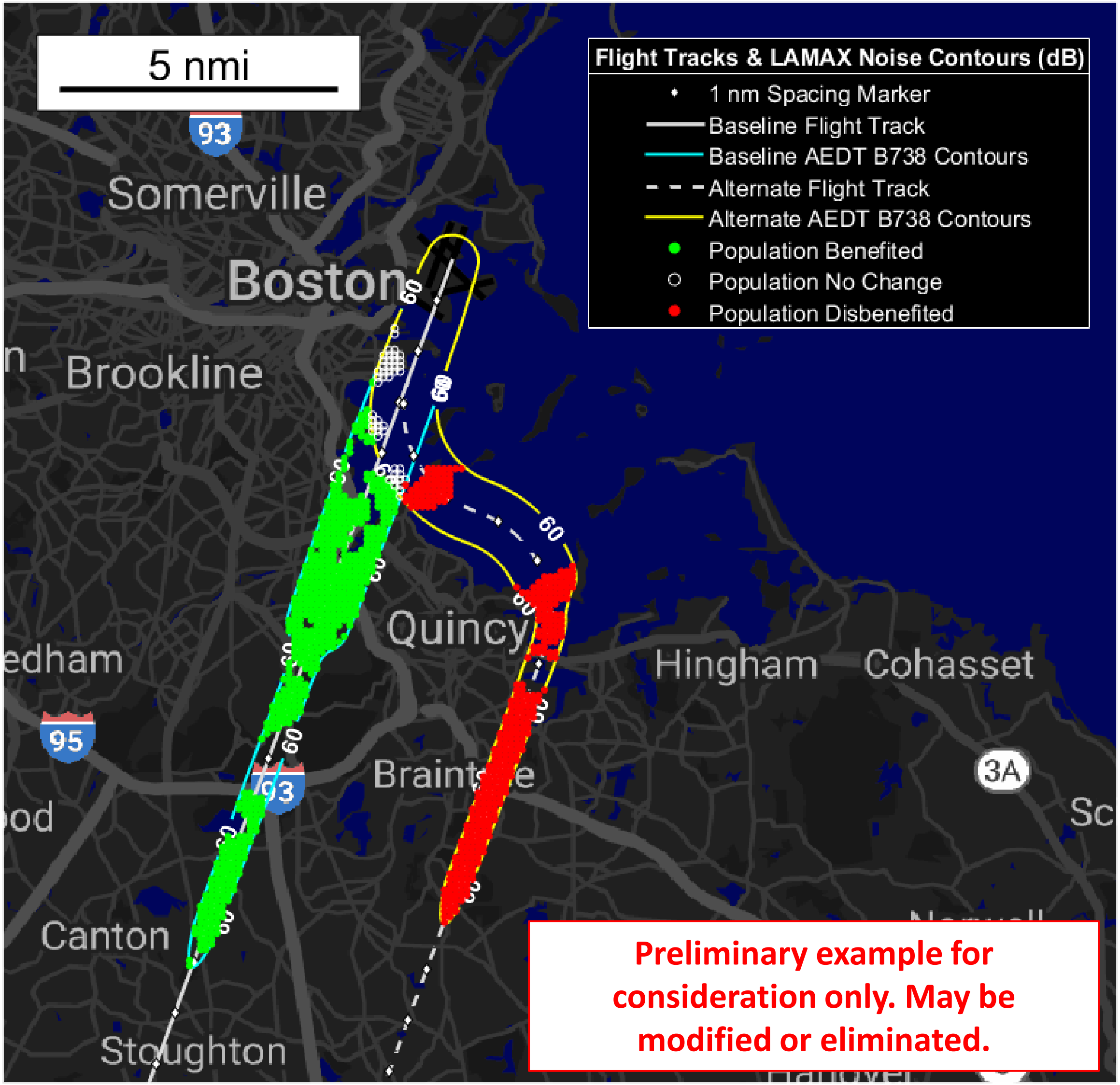

**B737-800**
**Population Exposure ($L_{A,MAX}$)**

| | 60dB |
|---|---|
| Straight In | 32,232 |
| RNP | 32,018 |
| Difference (Straight In – RNP) | 214 |

- Procedure within RNAV criteria.
- Community support unclear.

# 4R RNP Approach – Offset Initial

B737-800 60dB $L_{A,max}$ Noise Exposure




**Preliminary example for consideration only. May be modified or eliminated.**

**B737-800**
**Population Exposure ($L_{A,MAX}$)**

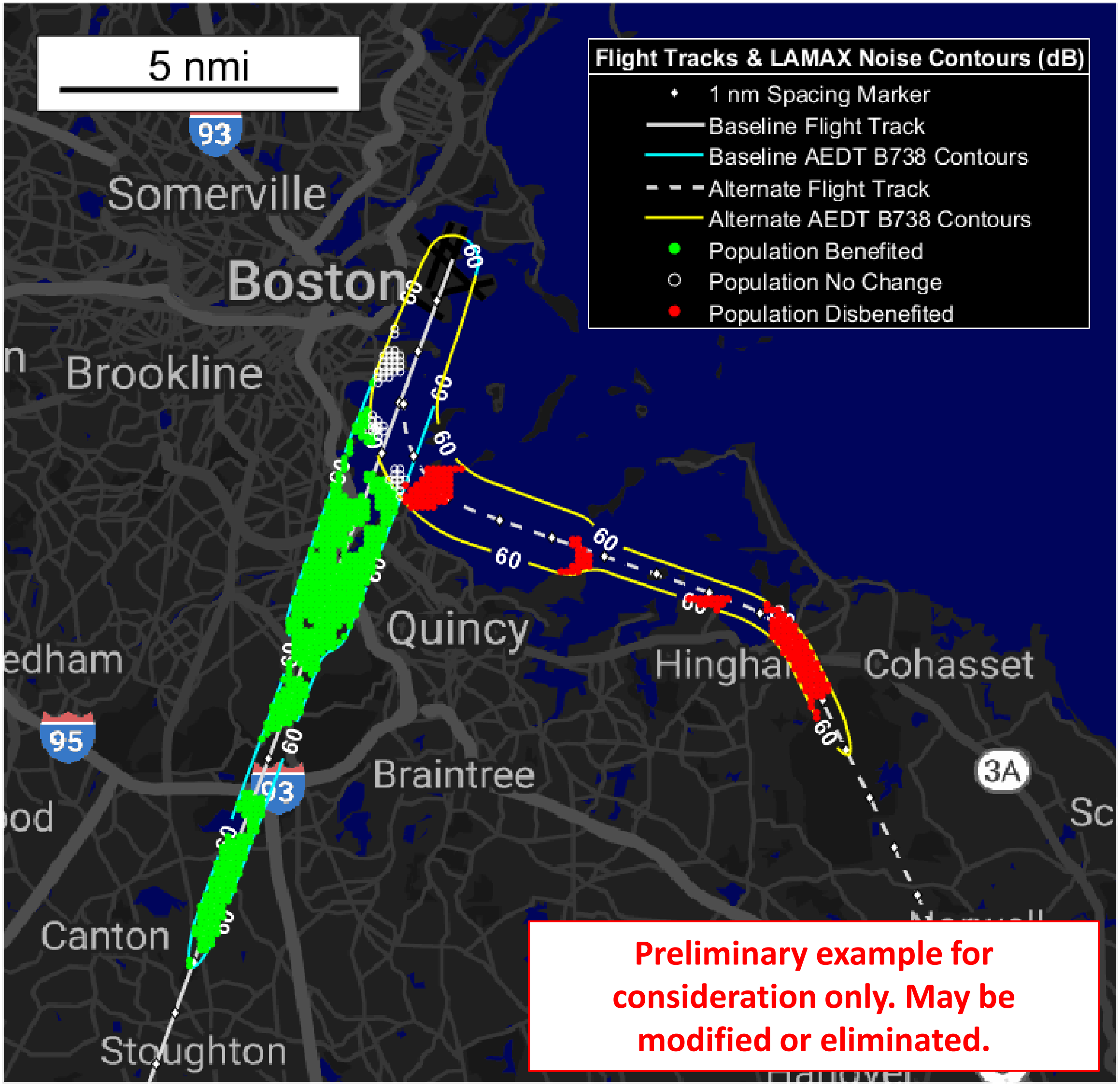
| | 60dB |
|---|---|
| Straight In | 32,232 |
| RNP | 25,106 |
| Difference (Straight In – RNP) | 7,126 |

1.5nmi final segment
90° 2nmi radius-to-fix turn
90° 2nmi radius-to-fix turn

- Procedure within RNP criteria.
- Community support unclear.

# 4R RNP Approach – Min Population Exposure from South

B737-800 60dB $L_{A,max}$ Noise Exposure




**B737-800**
**Population Exposure ($L_{A,MAX}$)**

| | 60dB |
|---|---|
| Straight In | 32,232 |
| RNP | 11,682 |
| Difference (Straight In – RNP) | 20,550 |

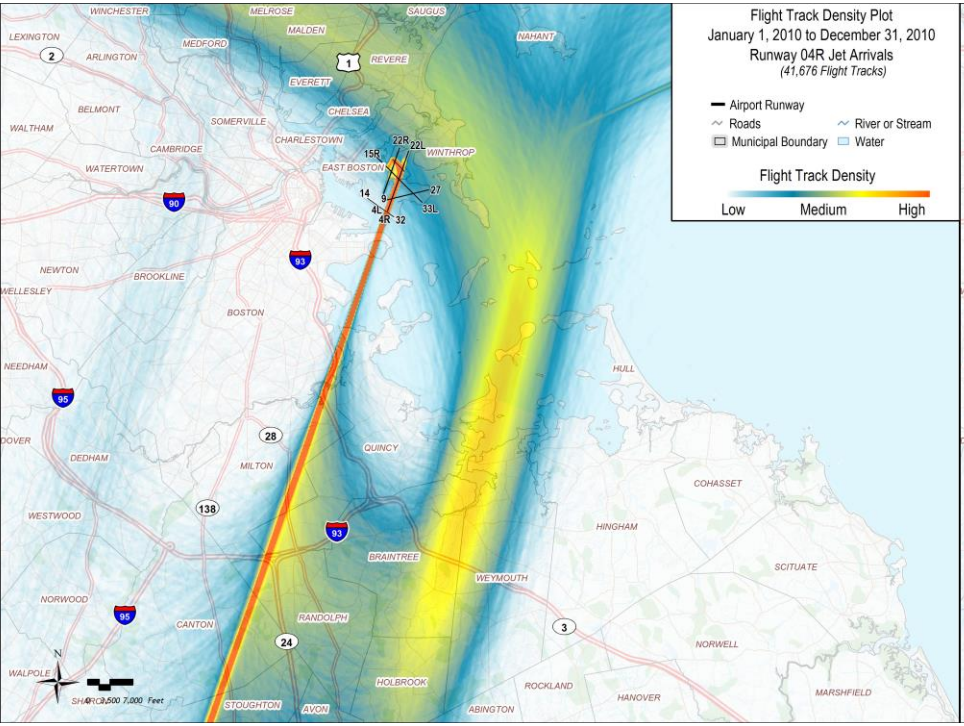
1.5nmi final segment
90° 2nmi radius-to-fix turn
5nmi straight segment
45° 2nmi radius-to-fix turn

- Procedure within RNP criteria.
- Community support unclear.
- Possible flyability issues need to be tested.
- Air traffic merging concern with straight-in traffic.

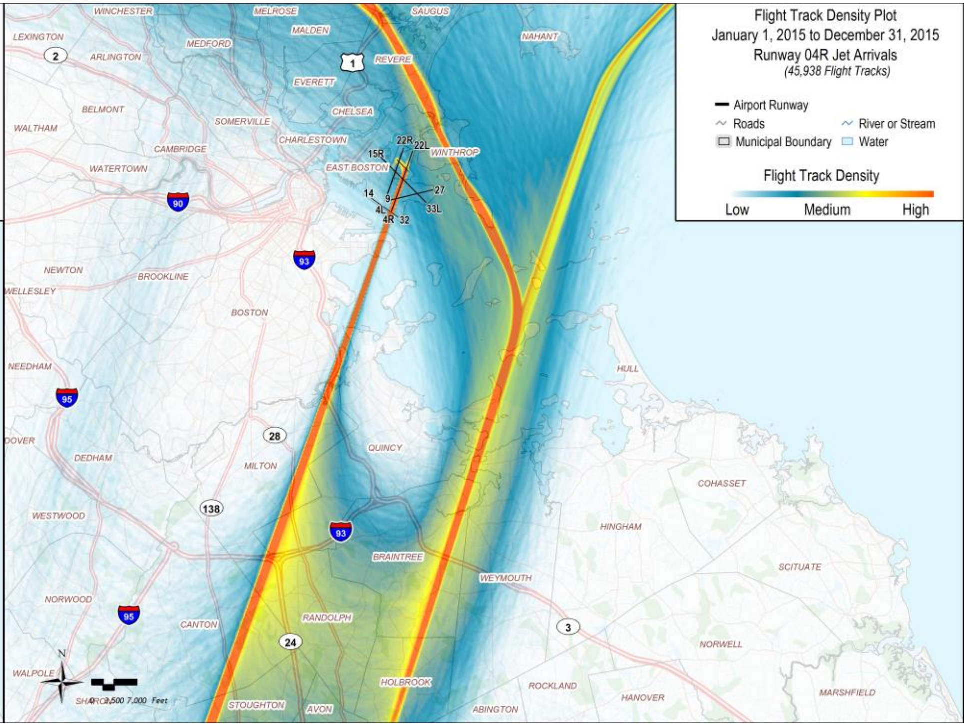
# Delayed Deceleration Approaches

# Runway 4R Arrivals: 2010-2015

2010

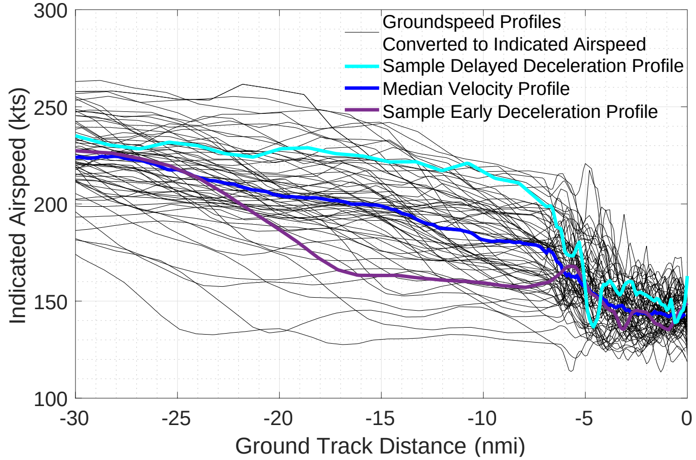



2015

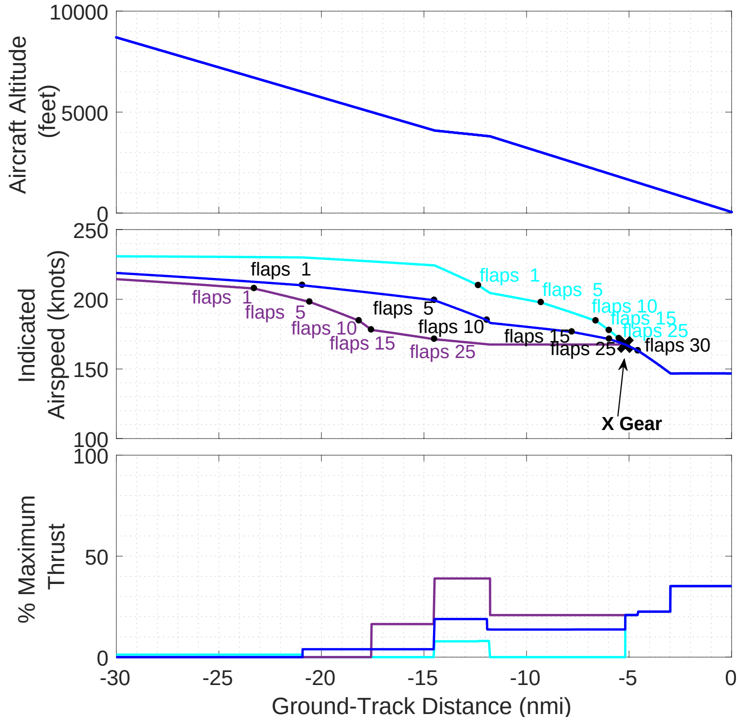


# Delayed Deceleration Approaches

Velocity Radar Data for B737-800 4000ft Level Offs into 4R

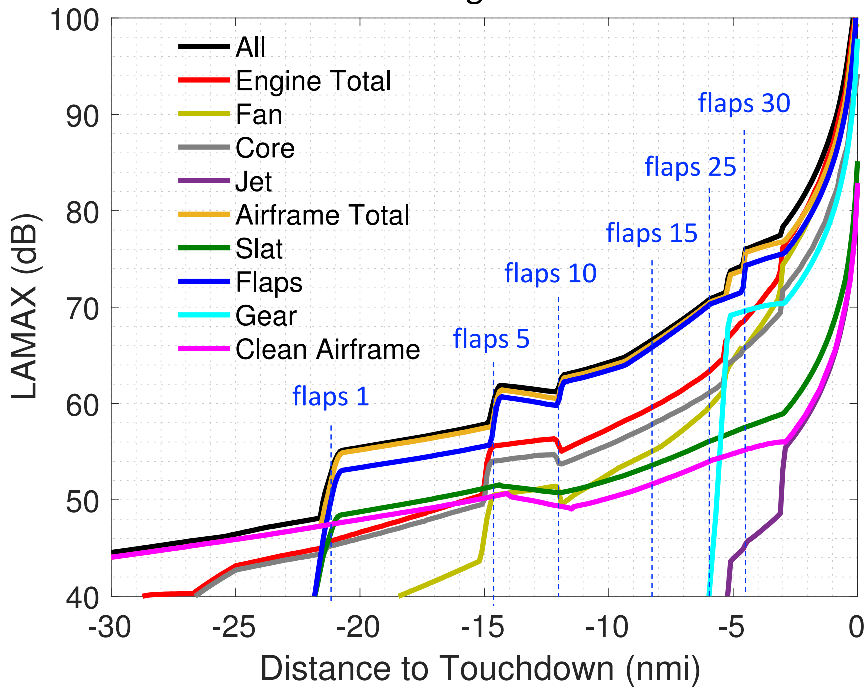



Modeled Profiles

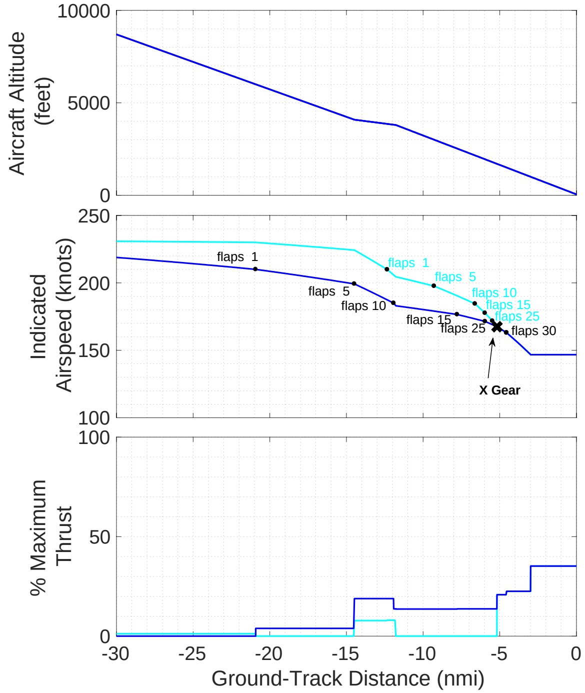



- Reduce noise by delaying extension of flaps
- Potential concerns from ATC and pilots regarding different deceleration rates and managing traffic
- Must decelerate early enough to assure stable approach criteria

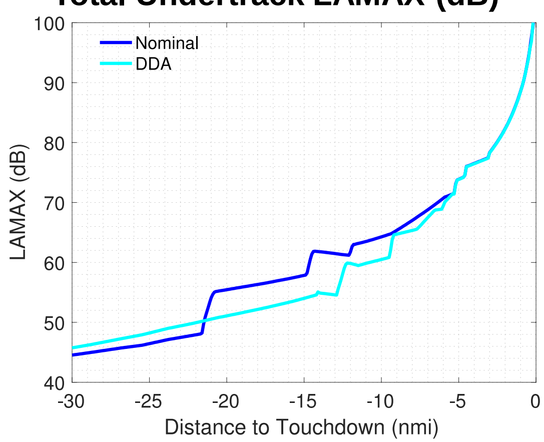
Example Noise Component Breakdown Under the Flight Track



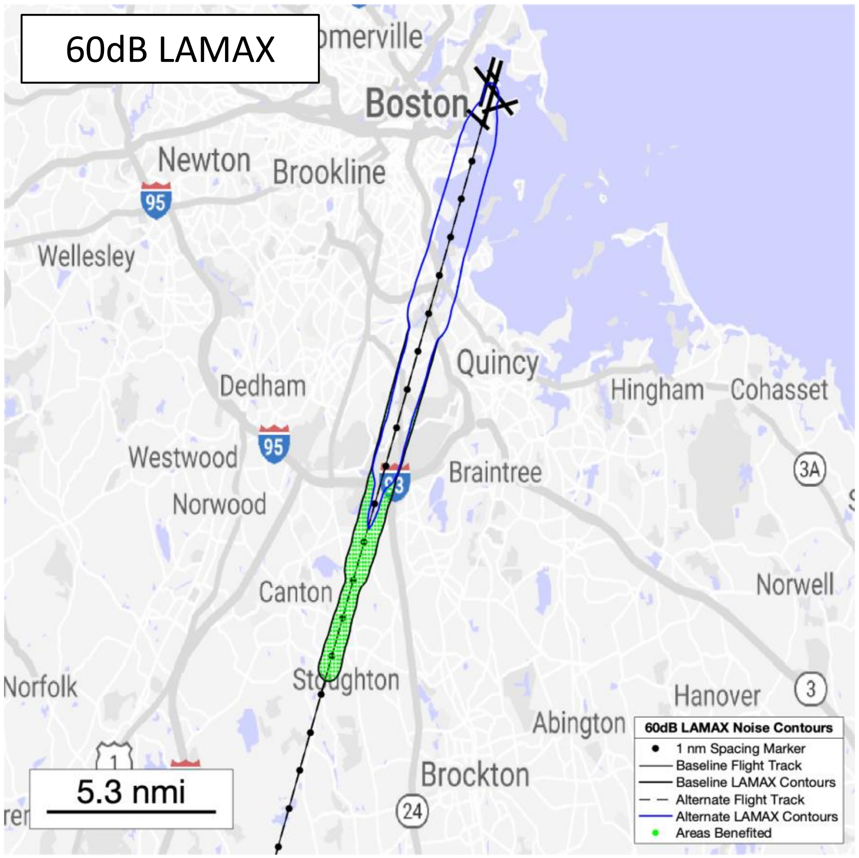
# DDA vs Nominal Approach from South with 4000 ft Level Off, B737-800




## Total Undertrack LAMAX (dB)




## 60 dB Contour Comparison

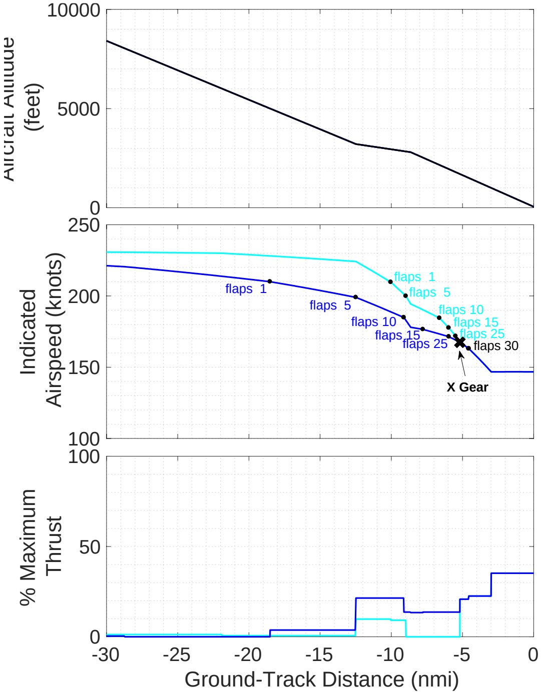



## Population Exposure

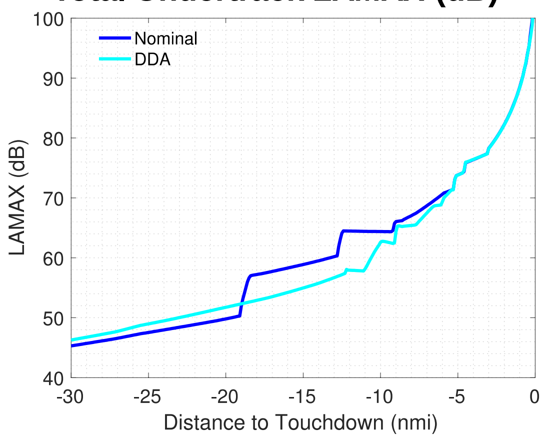
| $L_{A,max}$ | 60 dB | 65 dB | 70 dB |
|---|---|---|---|
| Nominal | 37,621 | 14,912 | 4,936 |
| DDA | 31,835 | 13,927 | 4,784 |
| Difference | 5,786 | 985 | 152 |

Preliminary example for consideration only. May be modified or eliminated.

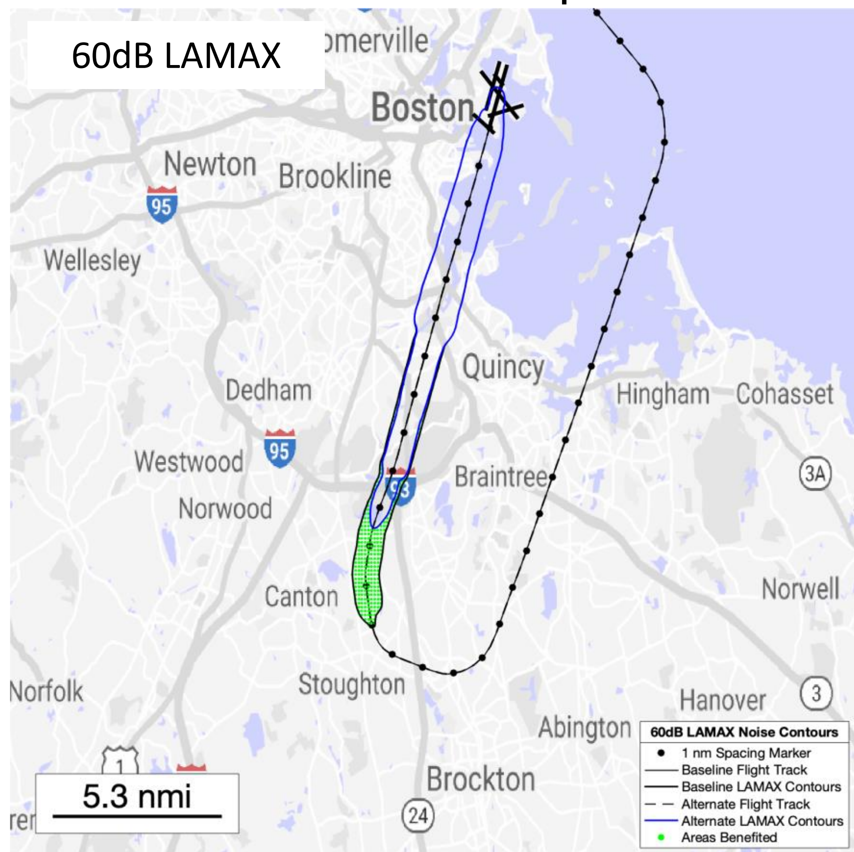
# DDA vs Nominal Approach from North with 3000 ft Level Off, B737-800




## Total Undertrack LAMAX (dB)




## 60 dB Contour Comparison




## Population Exposure

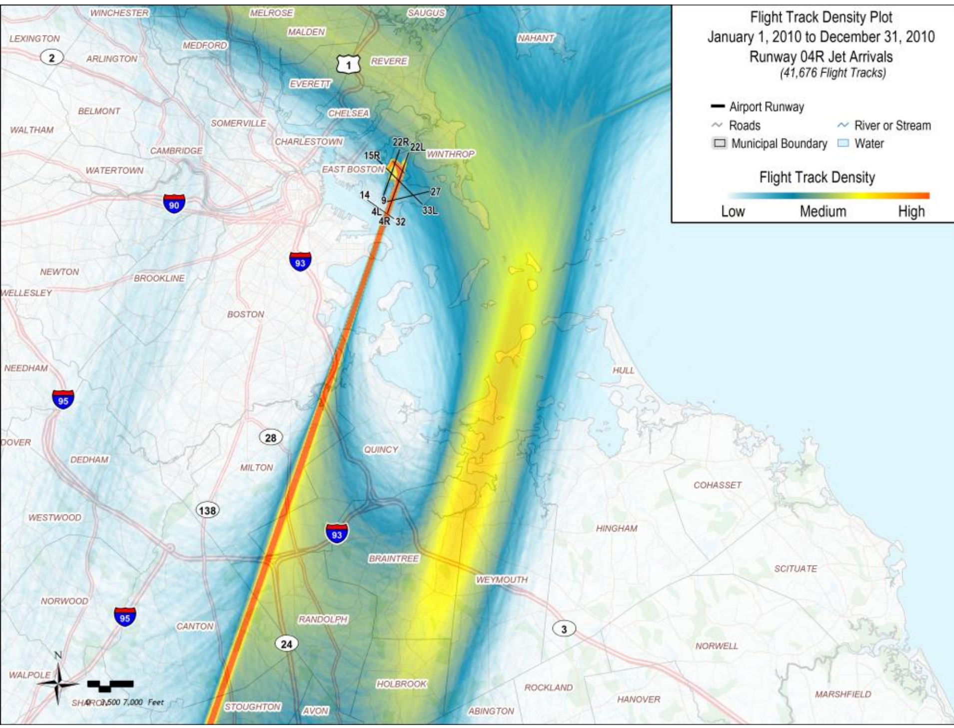
| $L_{A,max}$ | 60 dB | 65 dB | 70 dB |
|---|---|---|---|
| Nominal | 33,227 | 14,448 | 3,969 |
| DDA | 30.925 | 13,687 | 3,741 |
| Difference | 2,302 | 761 | 228 |

Preliminary example for consideration only. May be modified or eliminated.

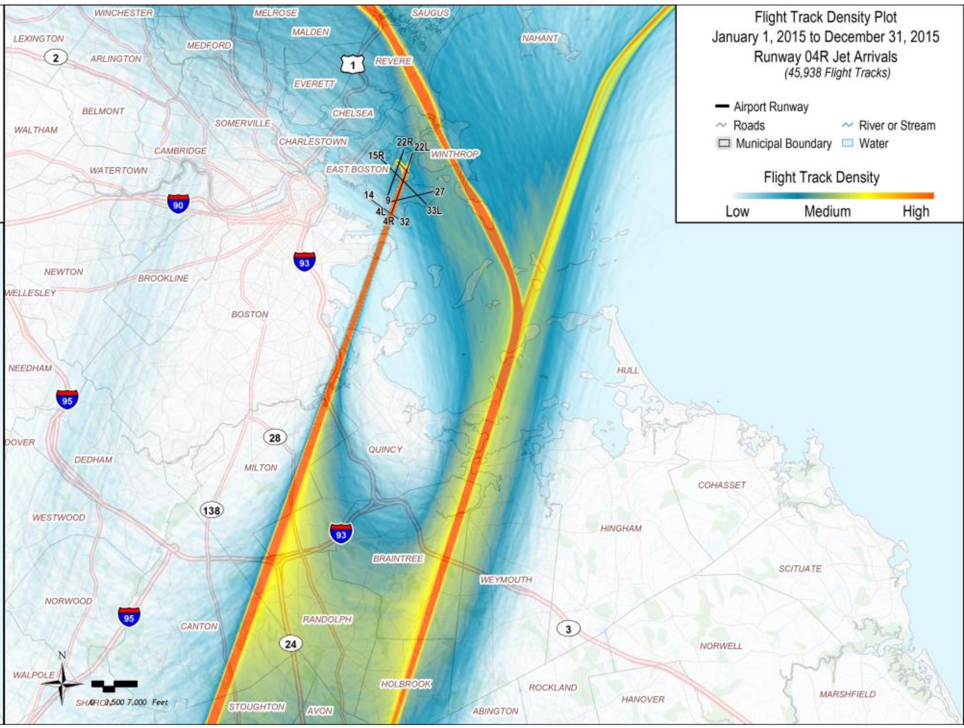
# Continuous Descent Approaches

# Runway 4R Arrivals: 2010-2015

2010



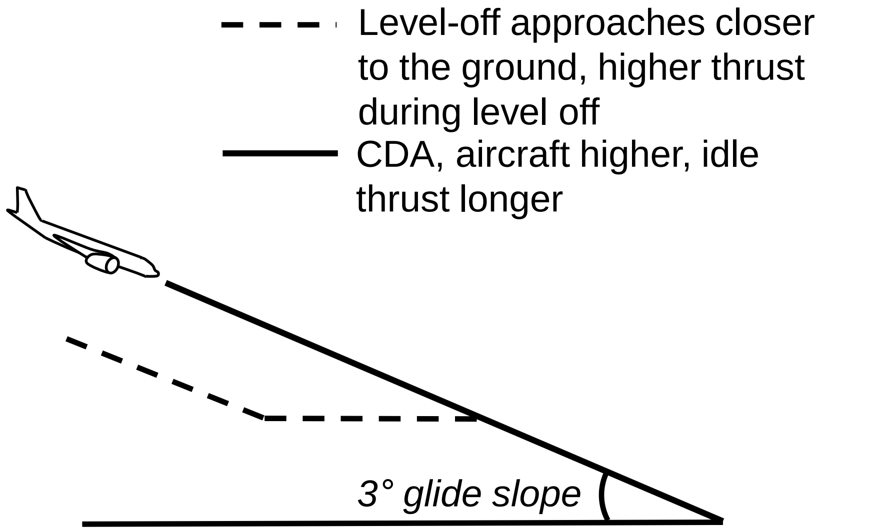

2015



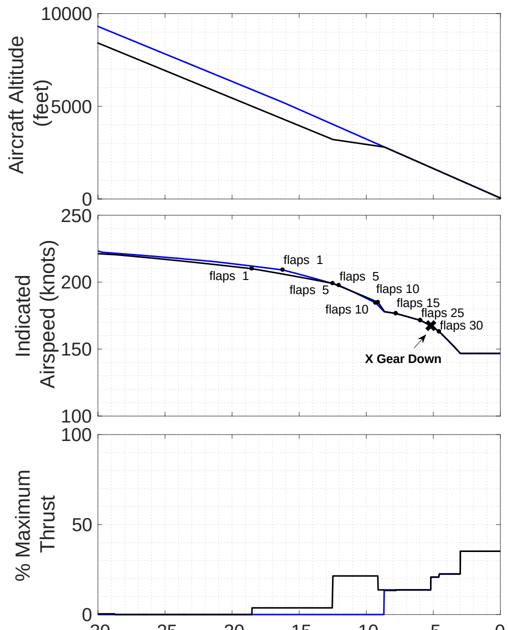
# Continuous Descent Approaches

- Reduce noise by removing level-off segment
  - Reduces thrust
  - Aircraft at a higher altitude for more of the procedure
- Continuous descent approaches could be achieved through RNAV procedures or RNP procedures

## Continuous Descent Approaches (CDA)



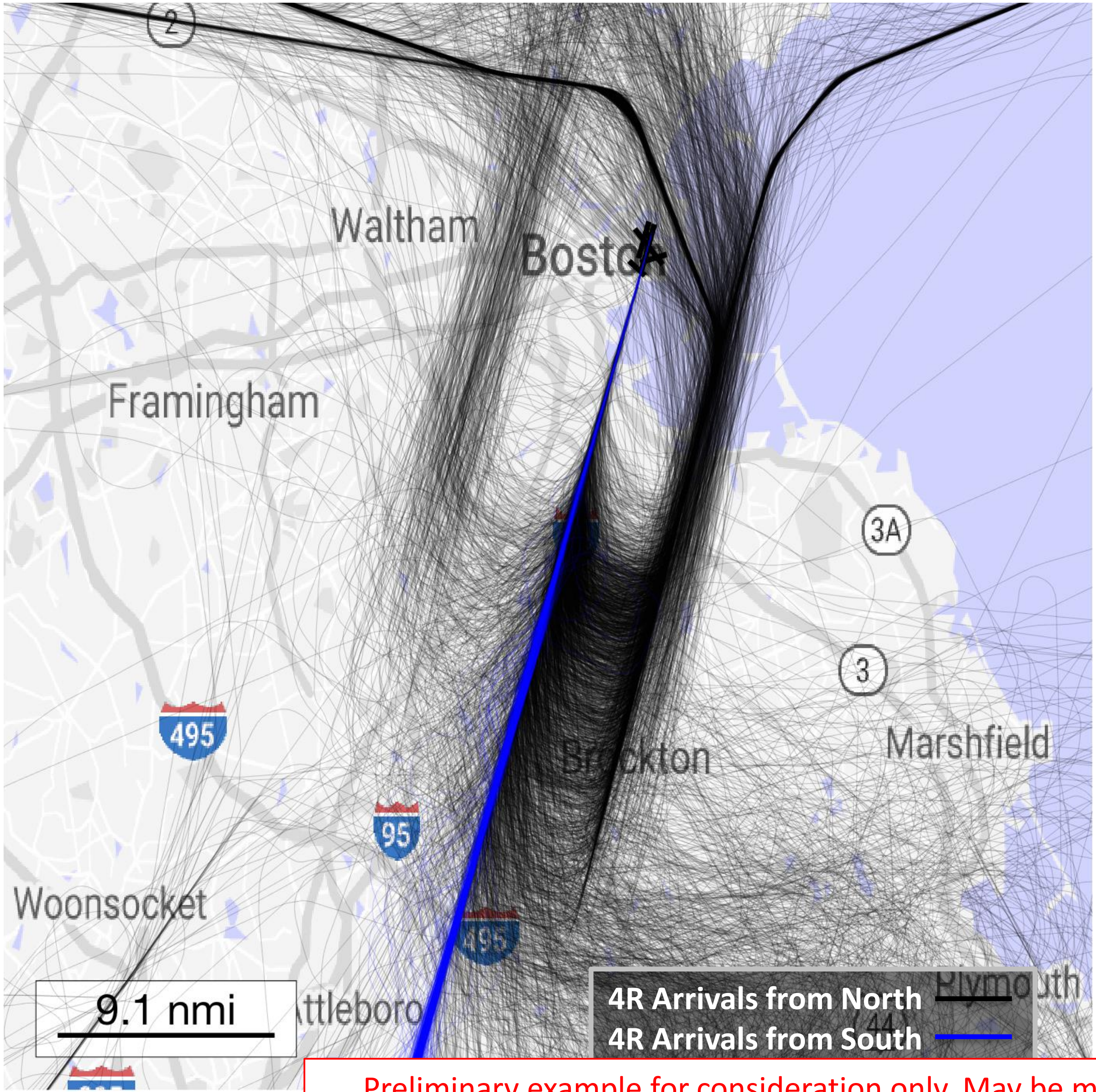

Modeled Profiles




- Difficult for vectored procedures where distance to go is ambiguous e.g. trombone downwind.
- Potential ATC workload for merging procedures

Preliminary example for consideration only. May be modified or eliminated.

# Baseline: 2017 Arrivals to Runway 4R




**Notes:**

- 39,615 Arrivals to Rwy 4R in 2017 (jet & prop):
- Figure shows 10% of all 2017 arrivals selected at random
- Data Source: Flight Tracks, Massport Noise and Operations Management System (NOMS)

- **51%** of Rwy4R arrivals came from south on a 2017 peak day

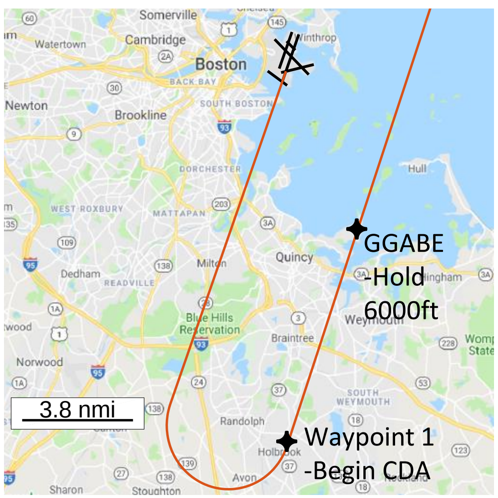
| Altitude Profiles | Arrivals from South | Arrivals from North |
|---|---|---|
| % Continuous Descent Profiles | 38 | 6 |
| % Non-Continuous Descent (level-off) Profiles | 62 | 94 |
| Median level-off altitude (Non-Continuous Descent Profiles) | 4,000 ft | 3,000 ft |

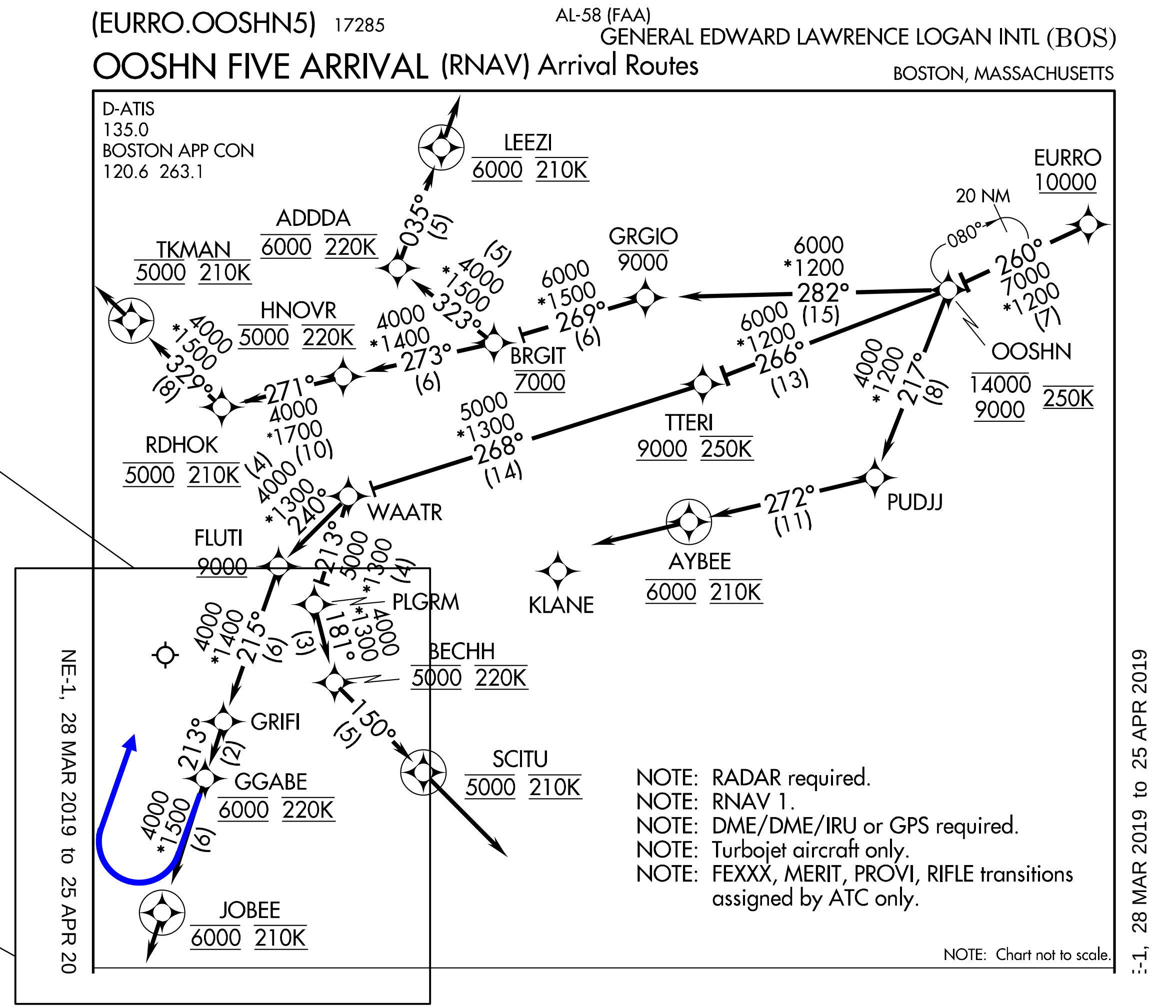
Preliminary example for consideration only. May be modified or eliminated.

# Continuous Descent Approaches (CDAs)

- 4R RNAV CDA from the north

Note: Defined track necessary for CDA from north would increase concentration under track

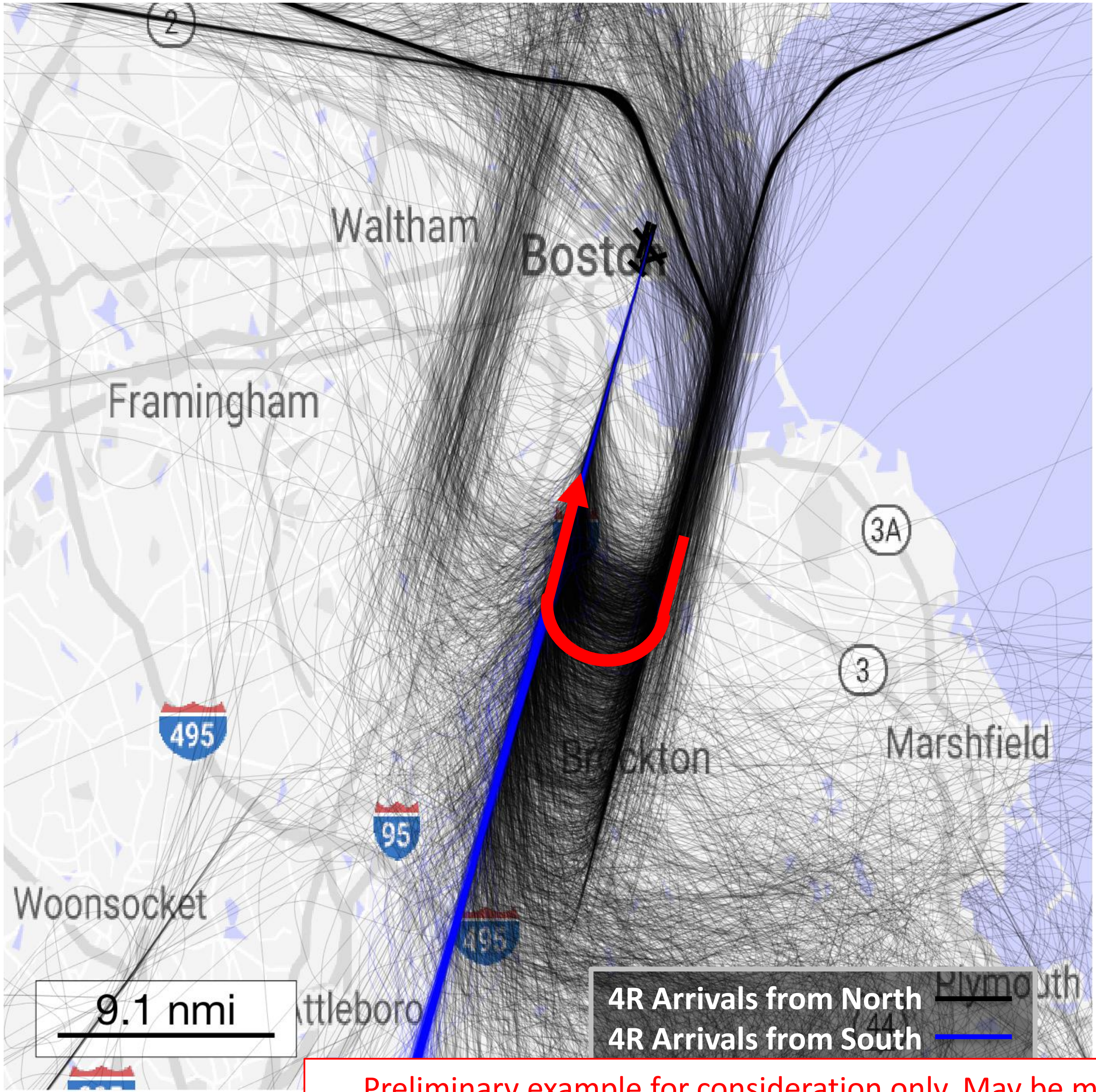



- Possible increase in ATC workload to merge traffic

Preliminary example for consideration only. May be modified or eliminated.

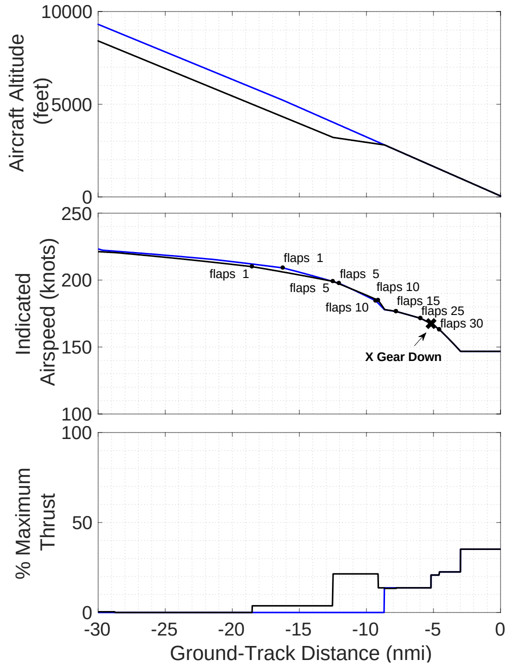
# Example Track (Approximate)

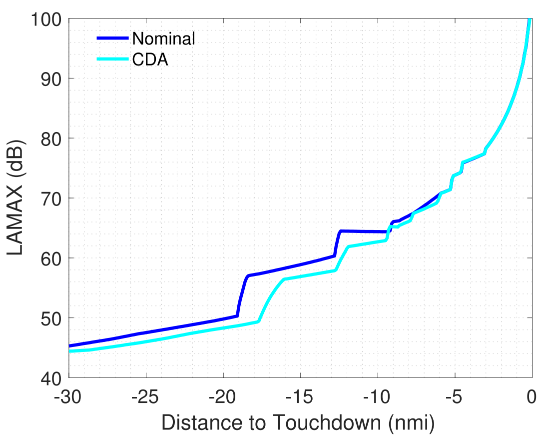


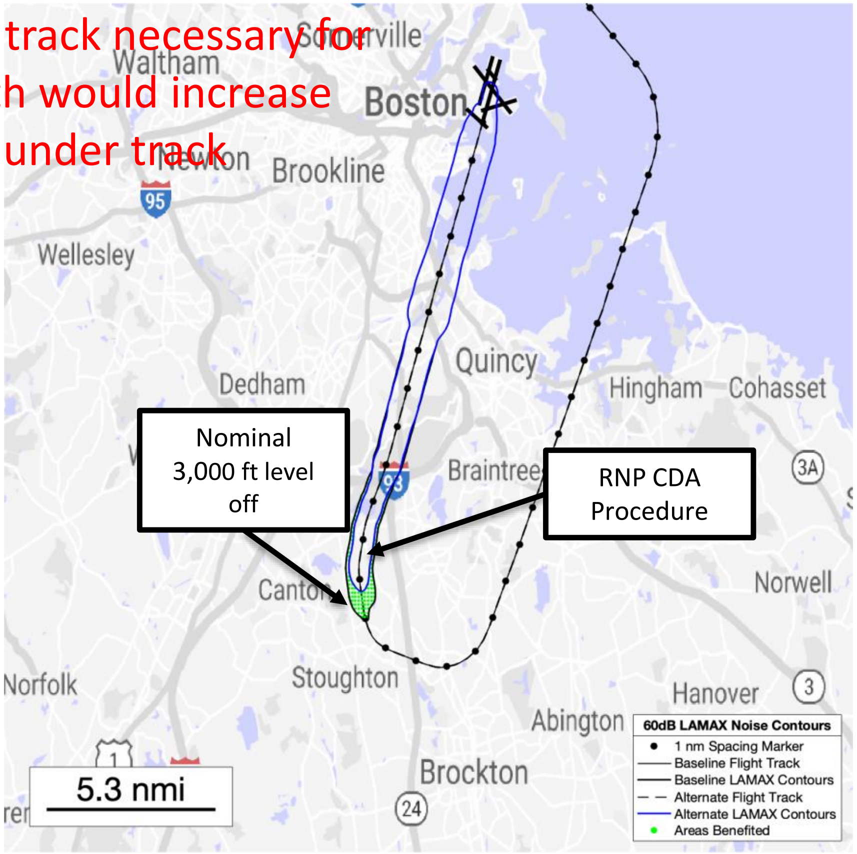

Preliminary example for consideration only. May be modified or eliminated.

# Continuous Descent Approaches (CDAs) from the North

Note: Defined track necessary for CDA from north would increase concentration under track



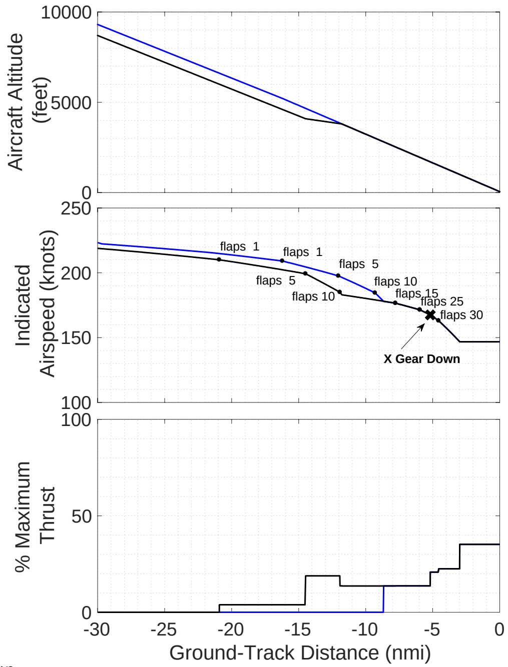



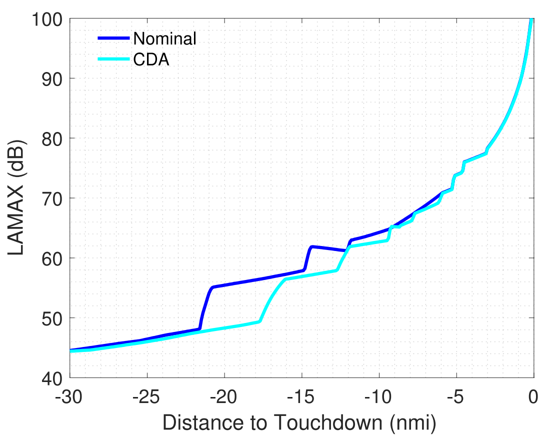

**Population Exposure**

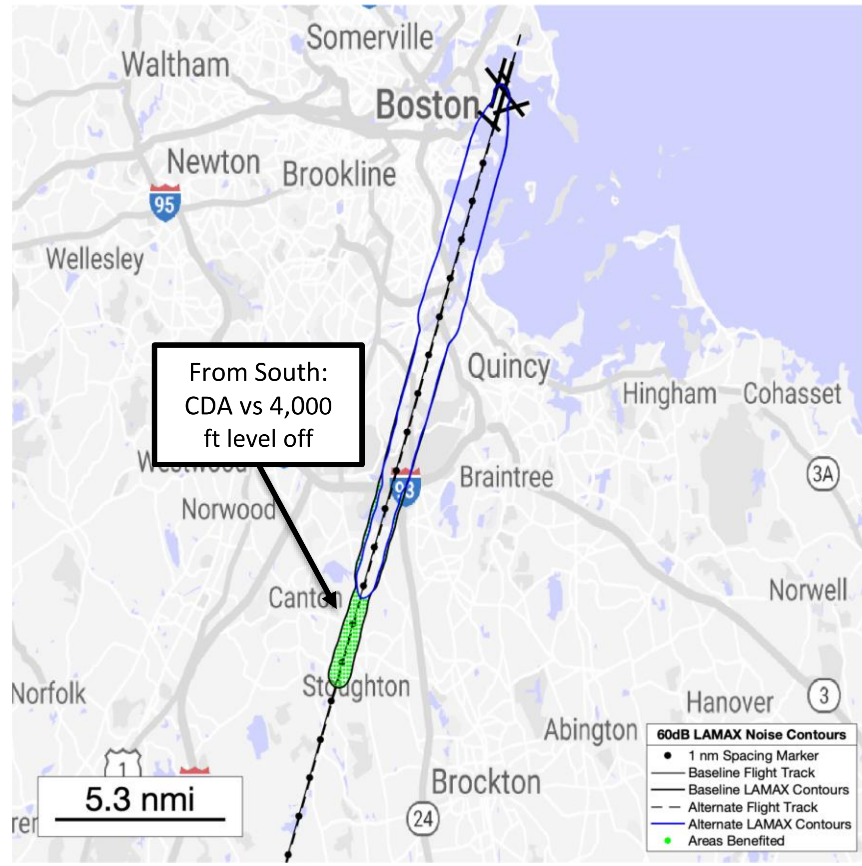
| $L_{A,max}$ | 60 dB | 65 dB | 70 dB |
|---|---|---|---|
| Nominal | 33,227 | 14,448 | 3,969 |
| DDA | 32,231 | 14,233 | 3,912 |
| Difference | 996 | 215 | 57 |

Preliminary example for consideration only. May be modified or eliminated.

# Continuous Descent Approaches (CDAs) from the South




**Population Exposure**

| $L_{A,max}$ | 60 dB | 65 dB | 70 dB |
|---|---|---|---|
| Nominal | 37,621 | 14,912 | 4,936 |
| CDA | 34,099 | 14,628 | 4,936 |
| Difference | 3,522 | 284 | 0 |

Preliminary example for consideration only. May be modified or eliminated.

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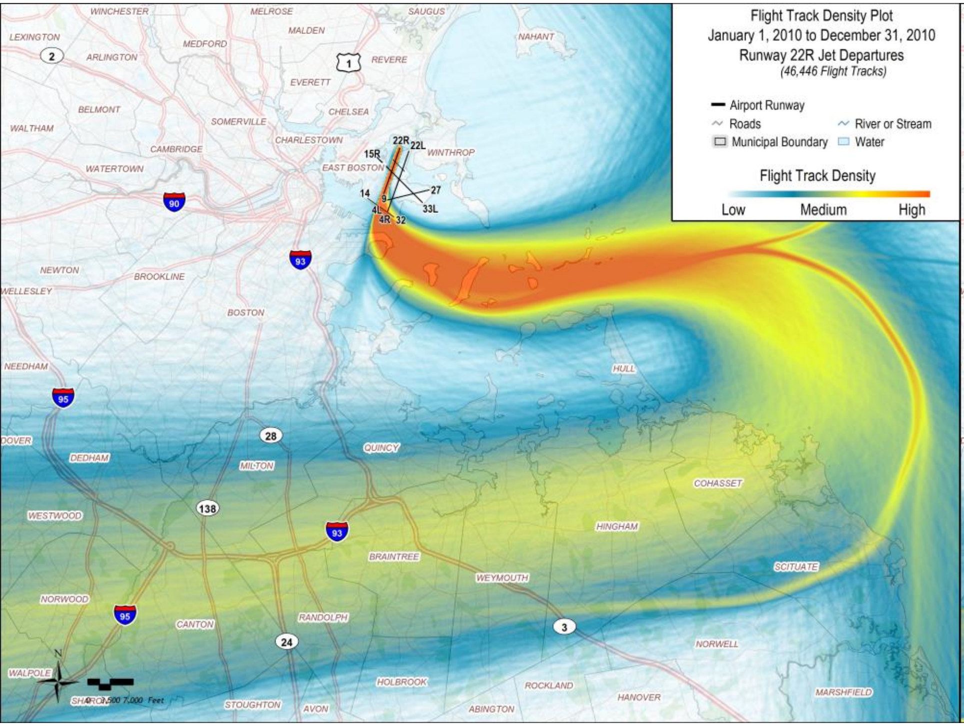
Air Transportation

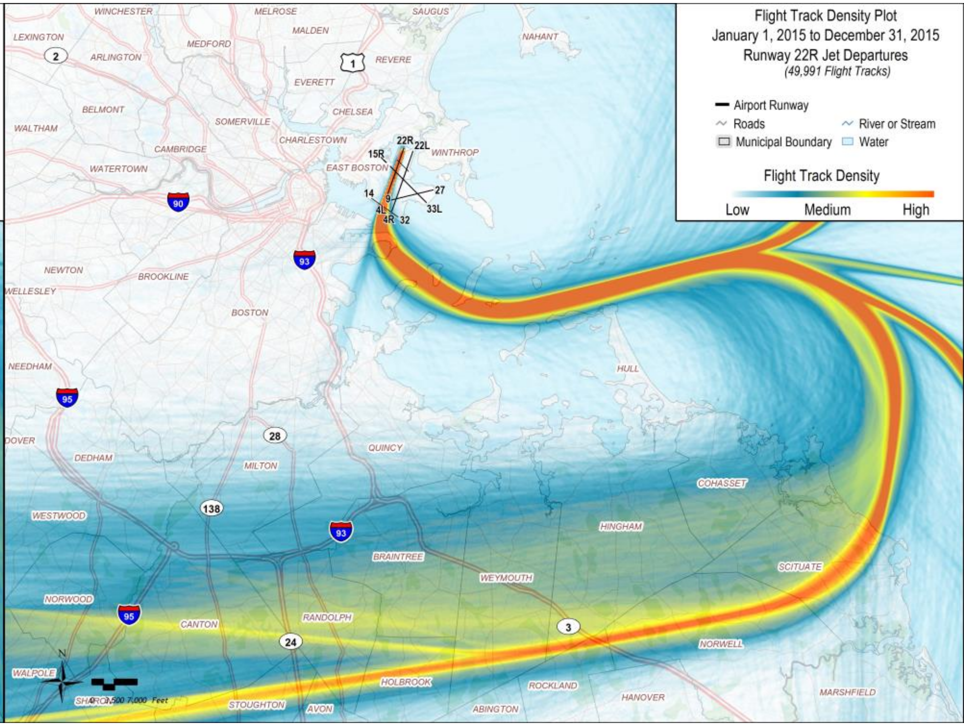
# Continued Support for 1-D3c 22 Heading-Based Departures

# Runway 22R Departures: 2010-2015

2010

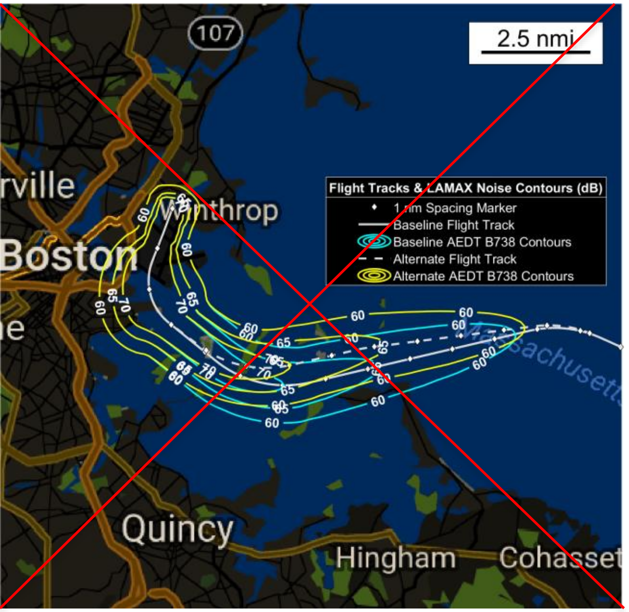
2015

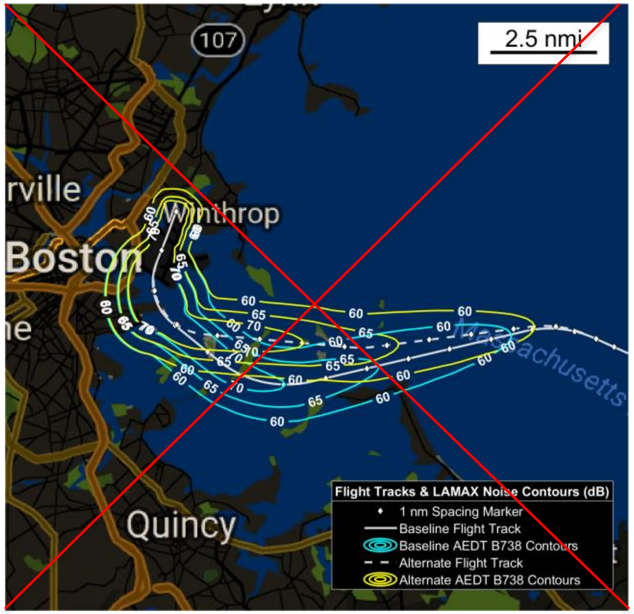


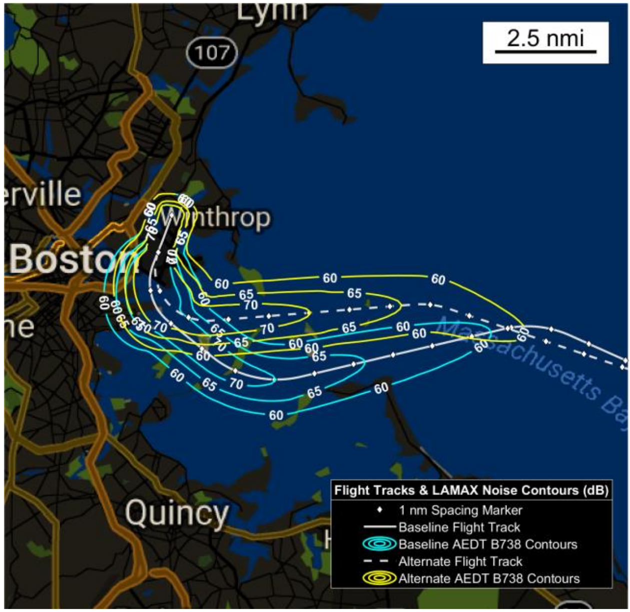



# 1-D3 Runway 22R SID Modification

Pending




Option A – RNAV Climb to Intercept Course

Technically infeasible to modify current RNAV procedure due to previous flyability issues with winds despite being within TERPS procedure design criteria

Option B – RNAV Climb to Altitude then Direct

Technically infeasible to modify current RNAV procedure due to previous flyability issues with winds despite being within TERPS procedure design criteria

Option C – Heading-Based Departure

Airline concerns with dispatch

Controller concerns with workload and communication load

# FAA 7100.41 Working Group Concerns on 1-D3c

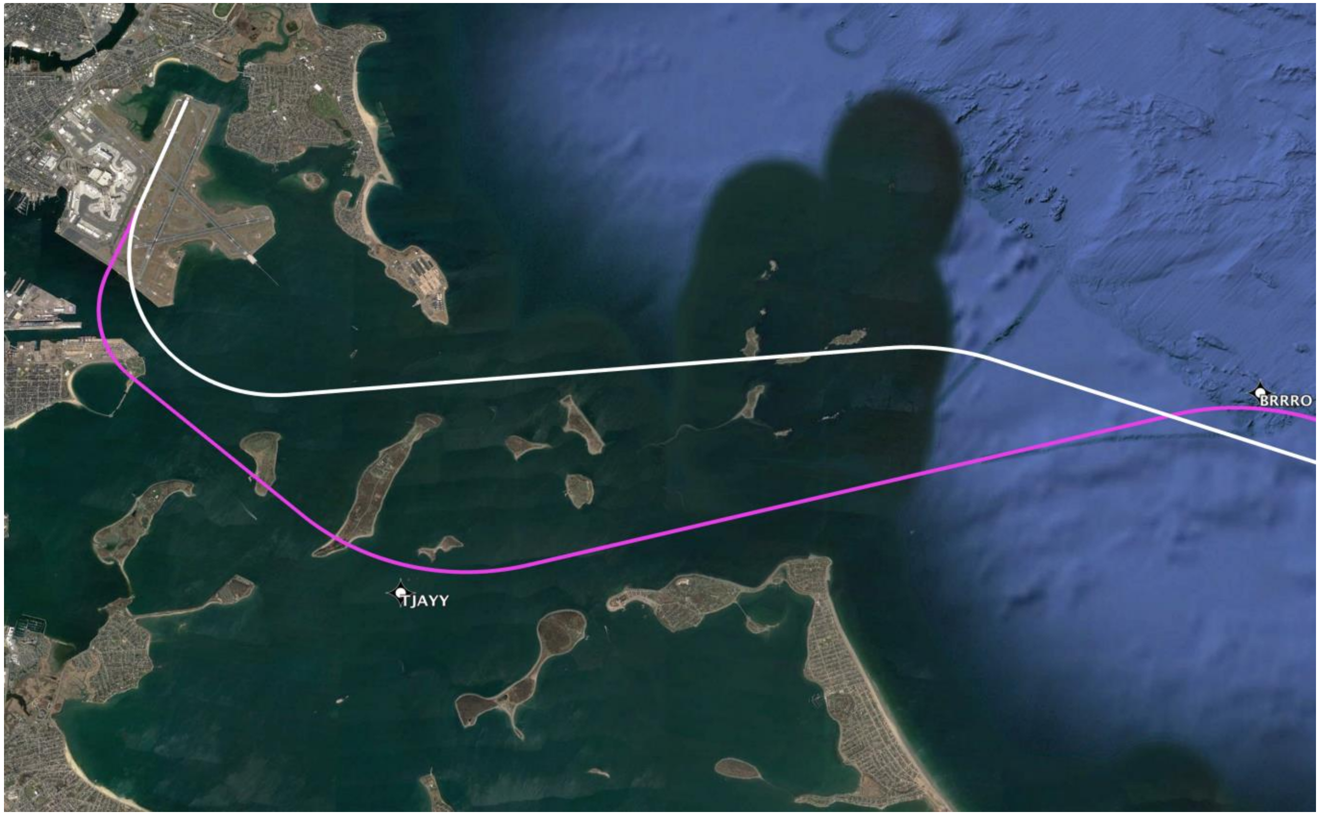
## (1-D3c)
### *Option C: Heading-based procedure*

- **Increases verbiage between Local Control, Departure Control and pilots**
- **Increases probability of readback/hearback errors, a safety issue**
- **Shortening departure paths cause conflicts with ROBUC STAR, particularly with heavy/low performing aircraft**
- **Current procedures from 4R, 9, 15R, 22R/22L provided noise benefits to shoreline communities**
- **Logan CAC requested RNAV SID departures in lieu of vector based procedures**

  * Vector based procedures are in direct conflict with BLANS (BLANS Table 3-2)

# Option C: Heading-based departure (1-D3c) Definition

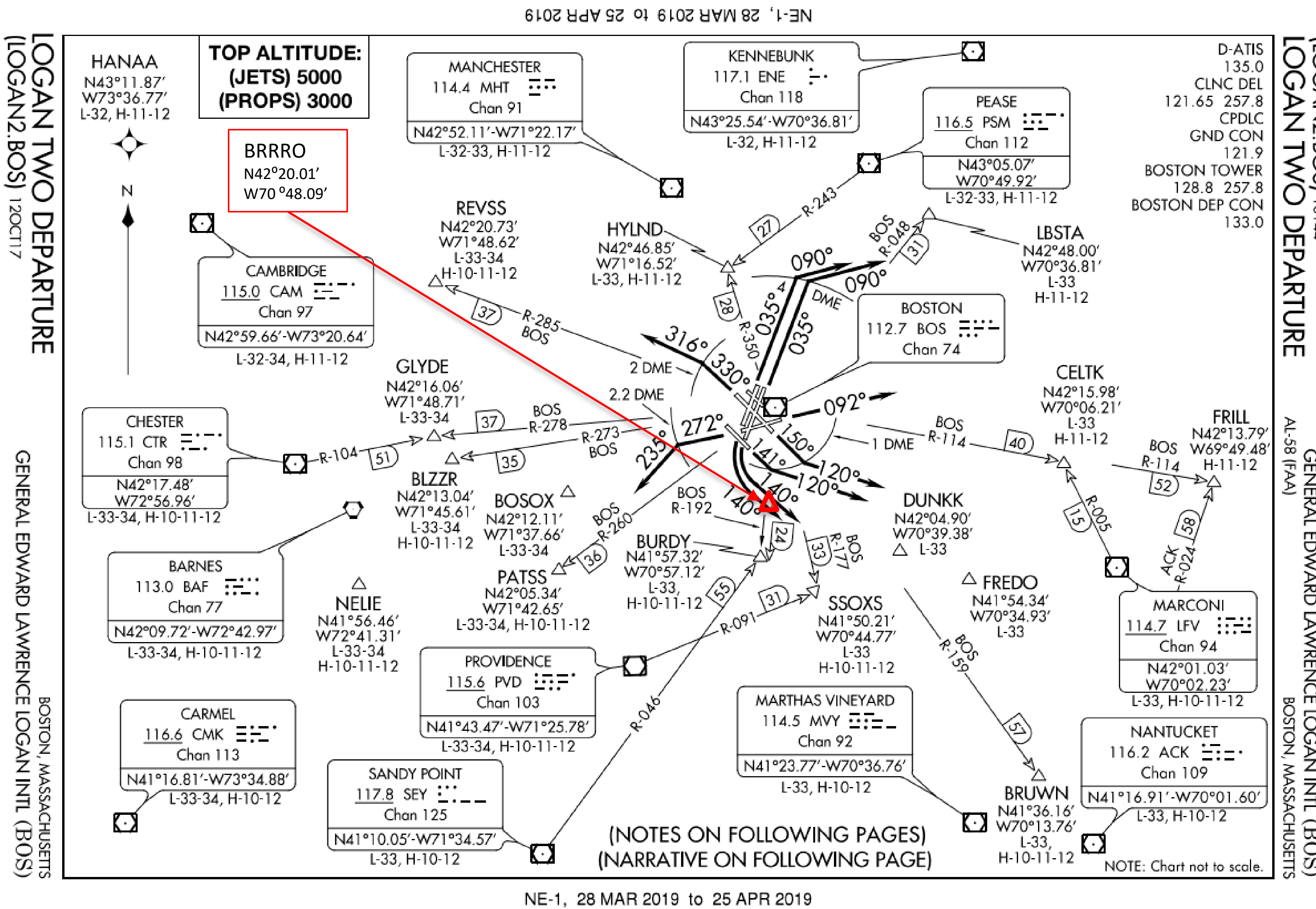
- **Concept**: During periods where runway 27 not in use for arrivals, issue takeoff clearance with heading *then rejoin RNAV SID at Waypoint BRRRO*




- Resistance from FAA and ATC towards heading-based departures

# LOGAN TWO

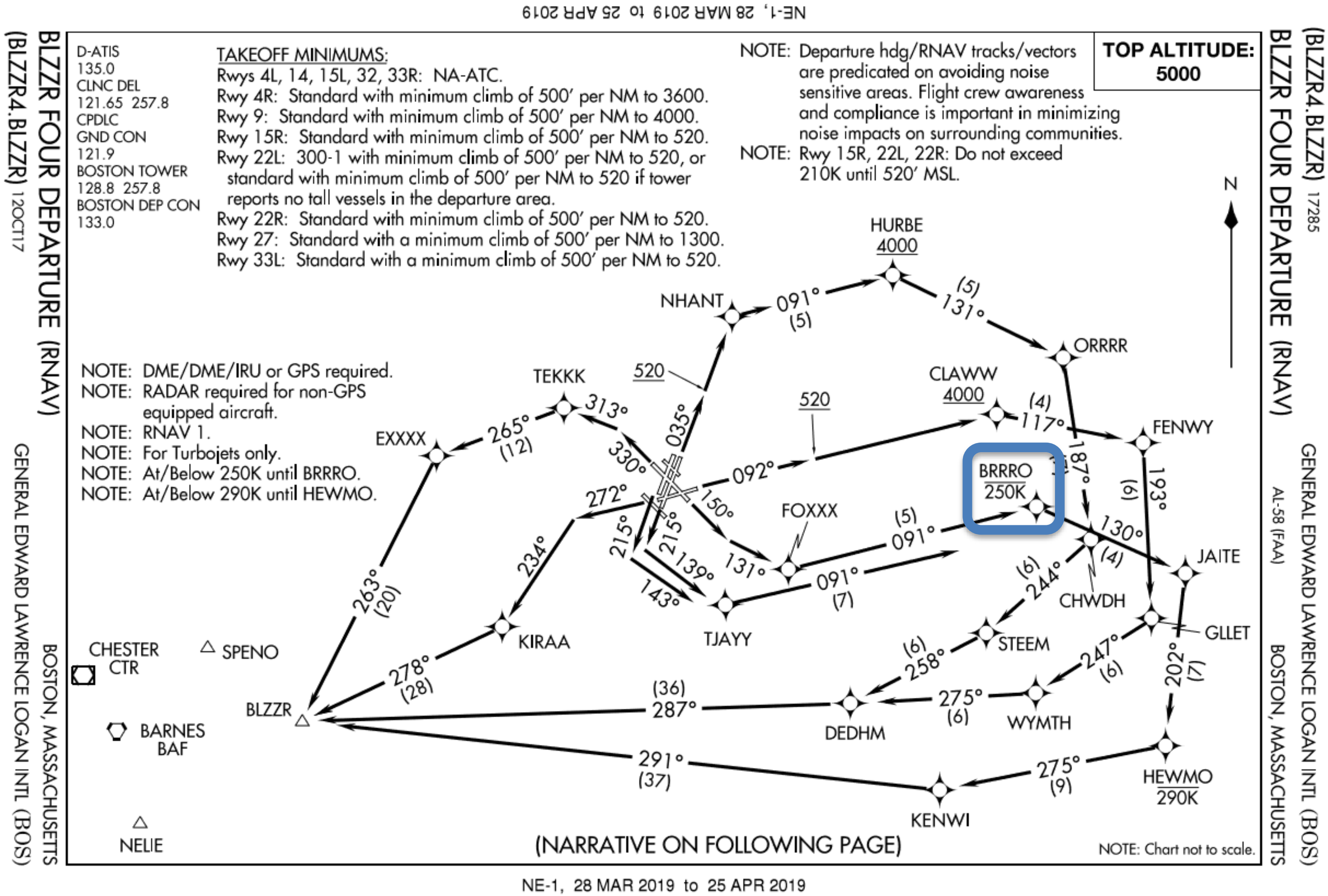
## Current Heading Based Departure




https://flightaware.com/resources/airport/BOS/DP/LOGAN+TWO/pdf

# Heading-based Departure then Re-join RNAV SID

Re-join RNAV SID at Waypoint BRRRO

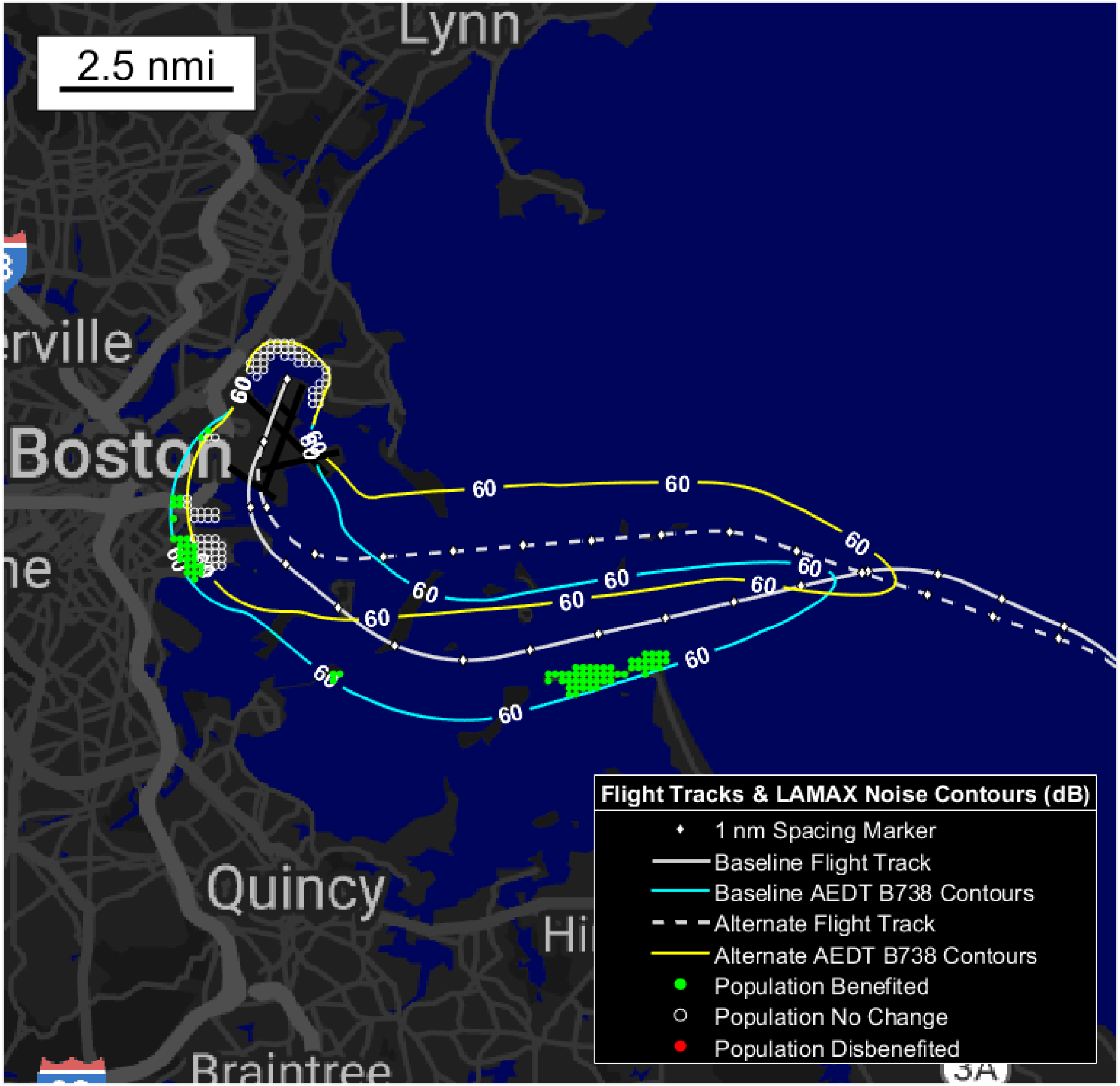


# Option C - Heading-based departure (1-D3c): B738 Noise Impact

| | |
|---|---|
| **Aircraft** | B737-800 |
| **Metric** | $L_{A,MAX}$ |
| **Noise Model** | AEDT |
| **Notes** | Vertical departure profile derived from median or historical radar data |

**B737-800**
**Population Exposure ($L_{A,MAX}$)**

| | 60dB |
|---|---|
| Baseline RNAV SID | 17,630 |
| Modified Procedure | 9,668 |
| Reduction | 7,962 |

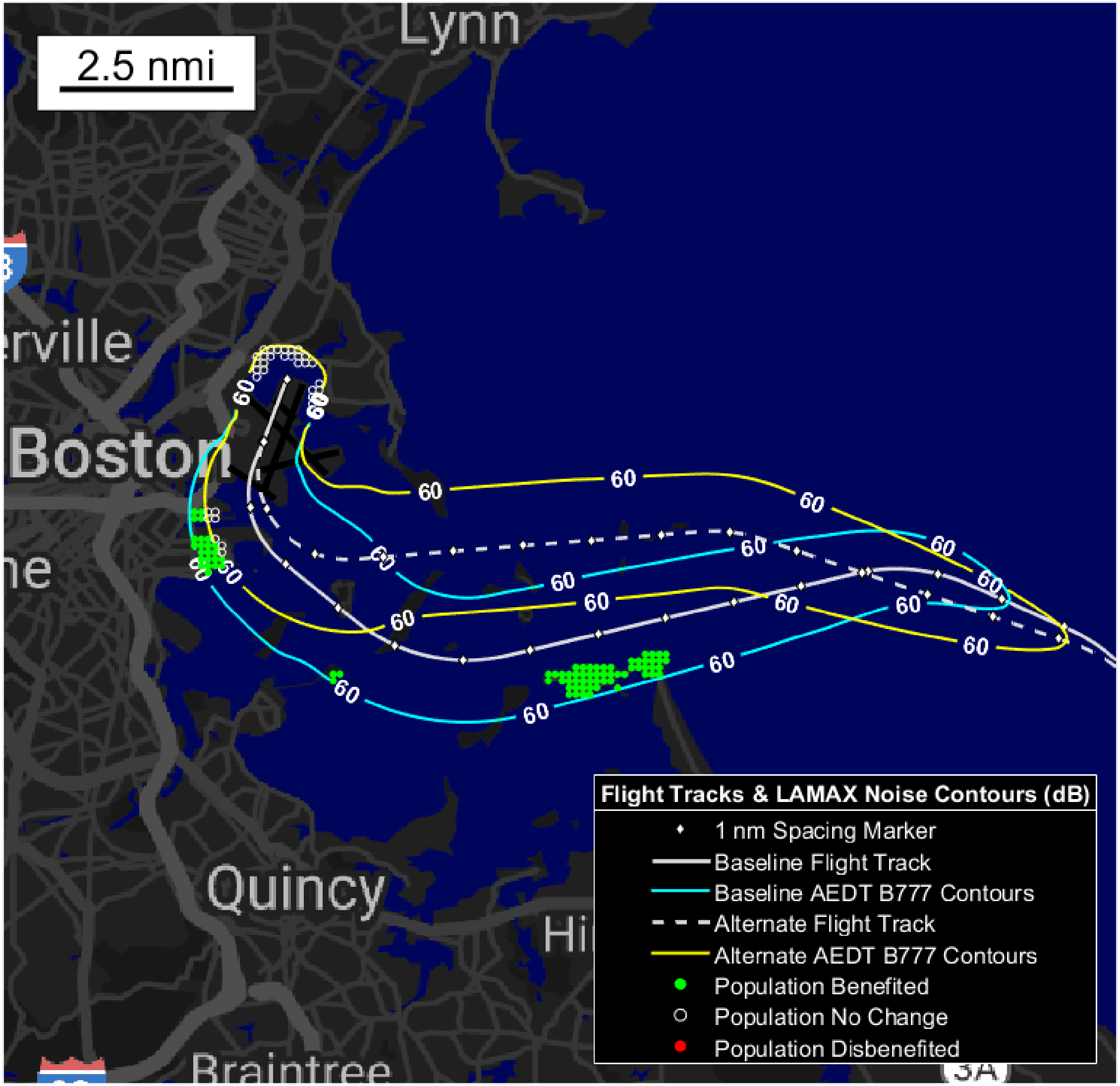


# Option C - Heading-based departure (1-D3c): B777 Noise Impact

| | |
|---|---|
| **Aircraft** | B777-300 |
| **Metric** | $L_{A,MAX}$ |
| **Noise Model** | AEDT |
| **Notes** | Vertical departure profile derived from median or historical radar data |

**B777-300**
**Population Exposure ($L_{A,MAX}$)**

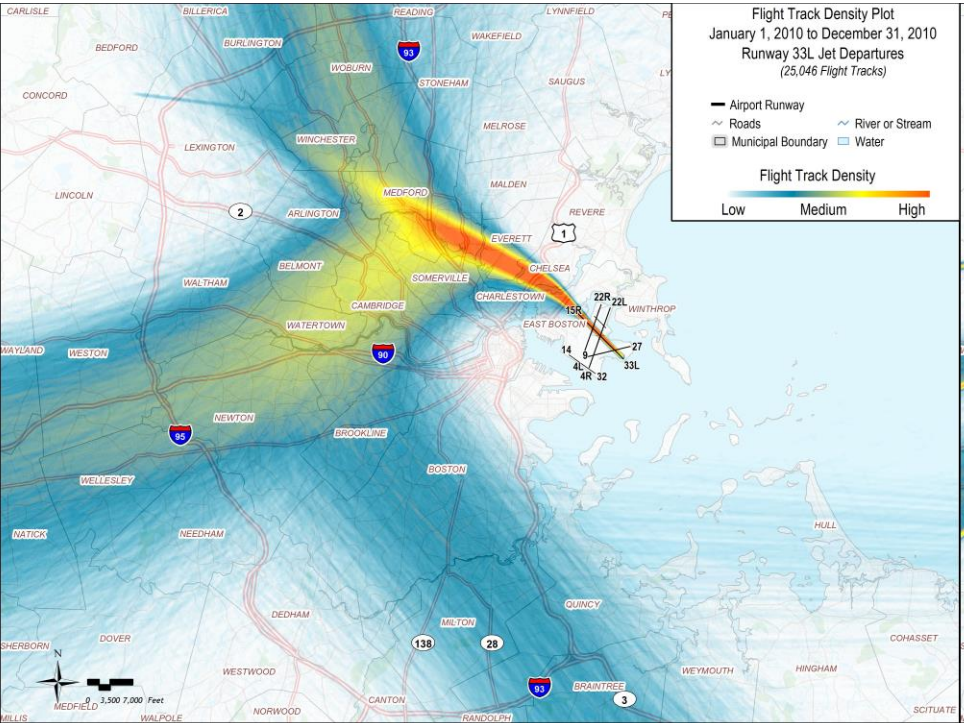
| | 60dB |
|---|---|
| Baseline RNAV SID | 10,071 |
| Modified Procedure | 3,573 |
| Reduction | 6,487 |



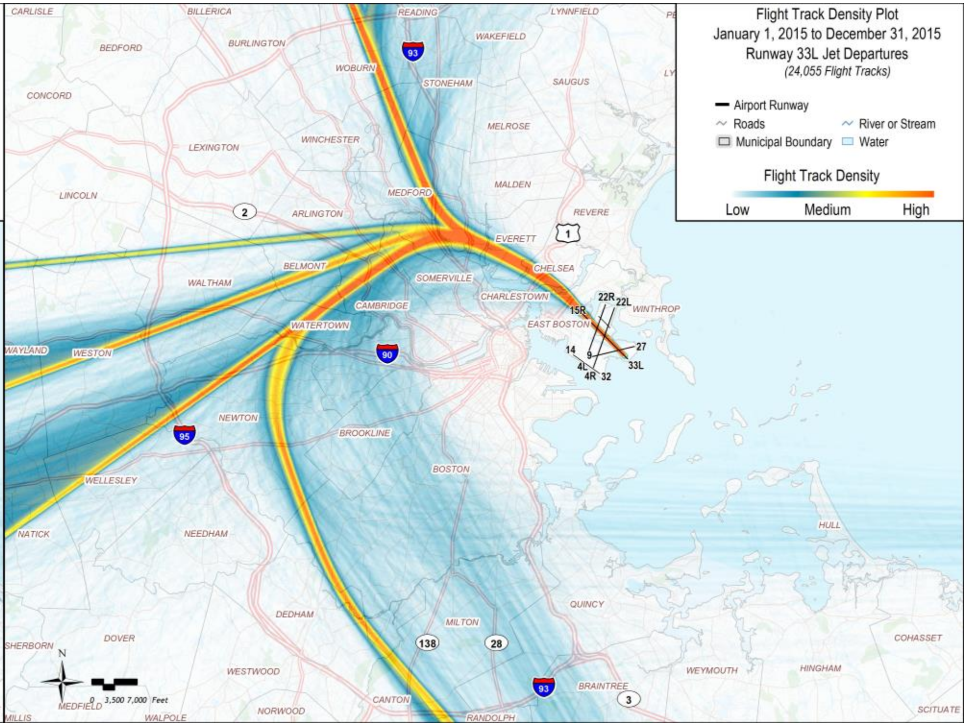
# Departure Dispersion: Runway 33L and 27

# Runway 33L Departures: 2010-2015

## 2010



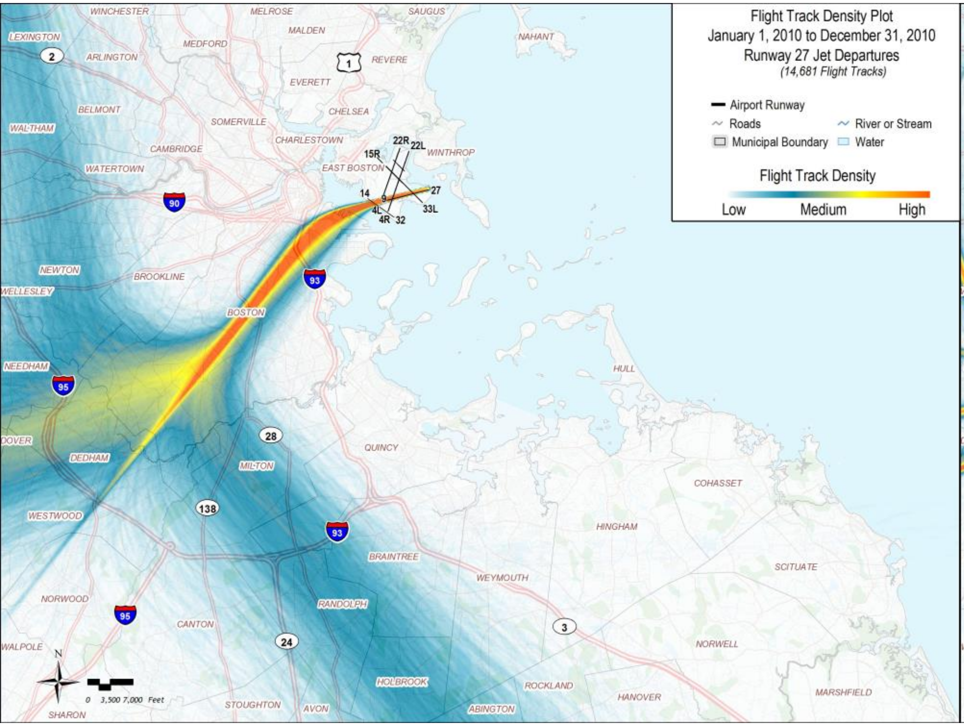

## 2015



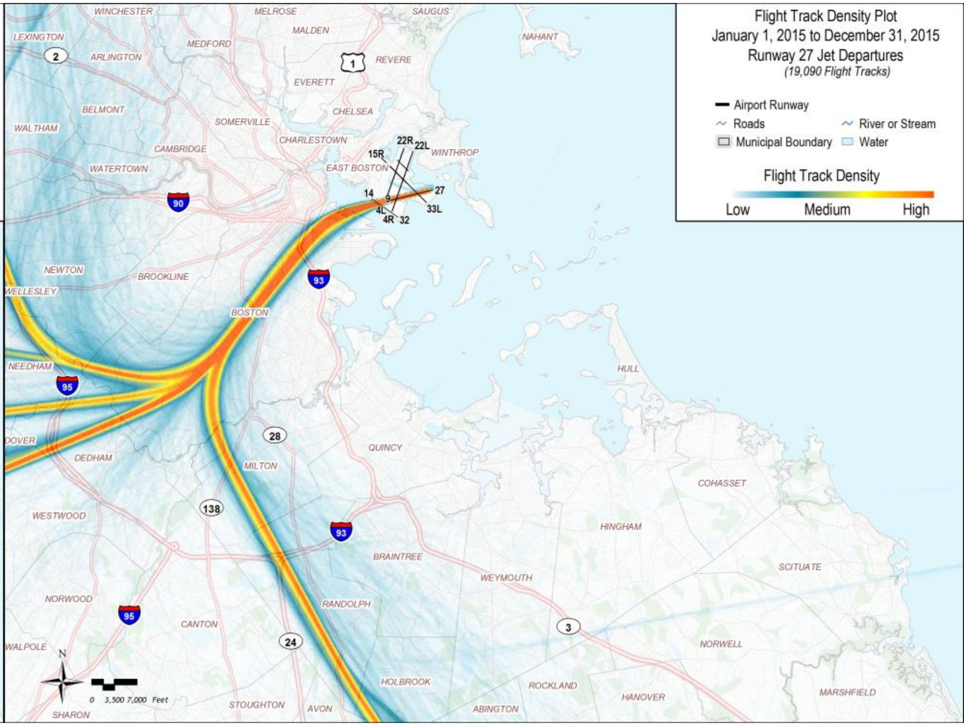
MIT ICAT

# Runway 27 Departures: 2010-2015

2010



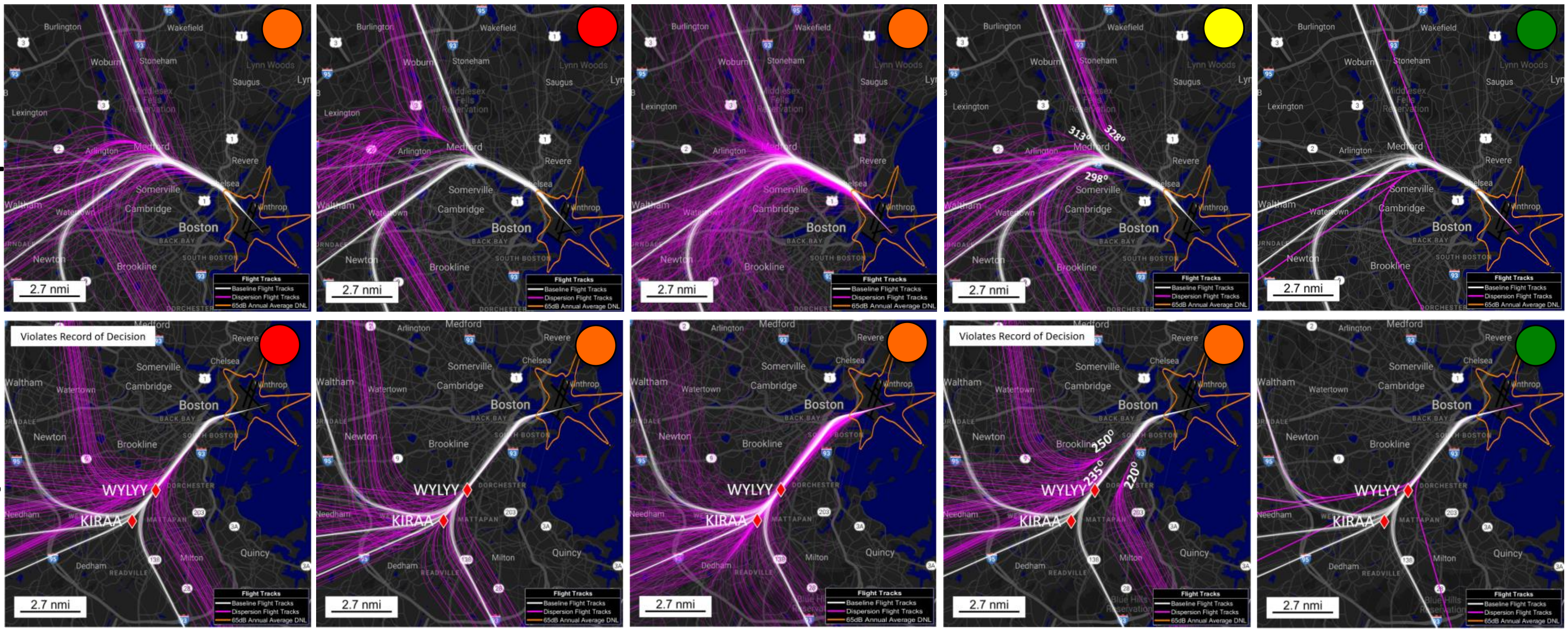

2015



# Dispersion Concepts

33L Departures

27 Departures

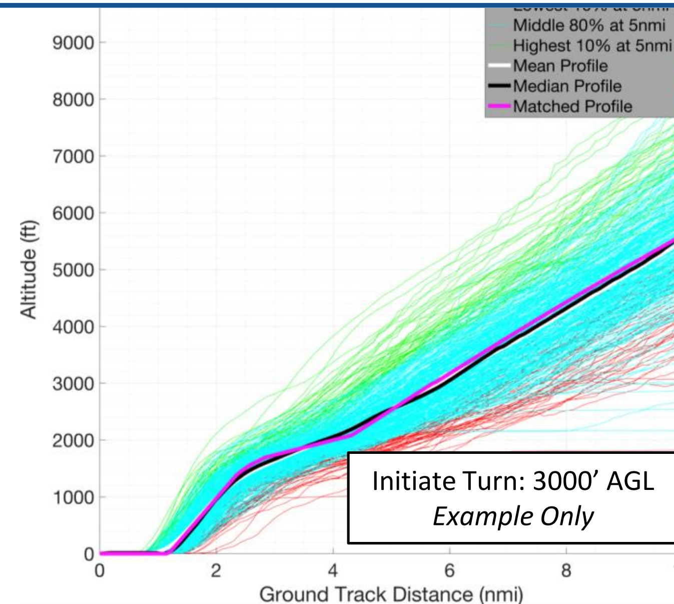



| Altitude-Based 3000ft | Altitude-Based 4000ft | Controller-Based | Divergent Headings | RNAV Waypoint Relocation |
|---|---|---|---|---|

Preliminary examples for consideration only. May be modified or eliminated.

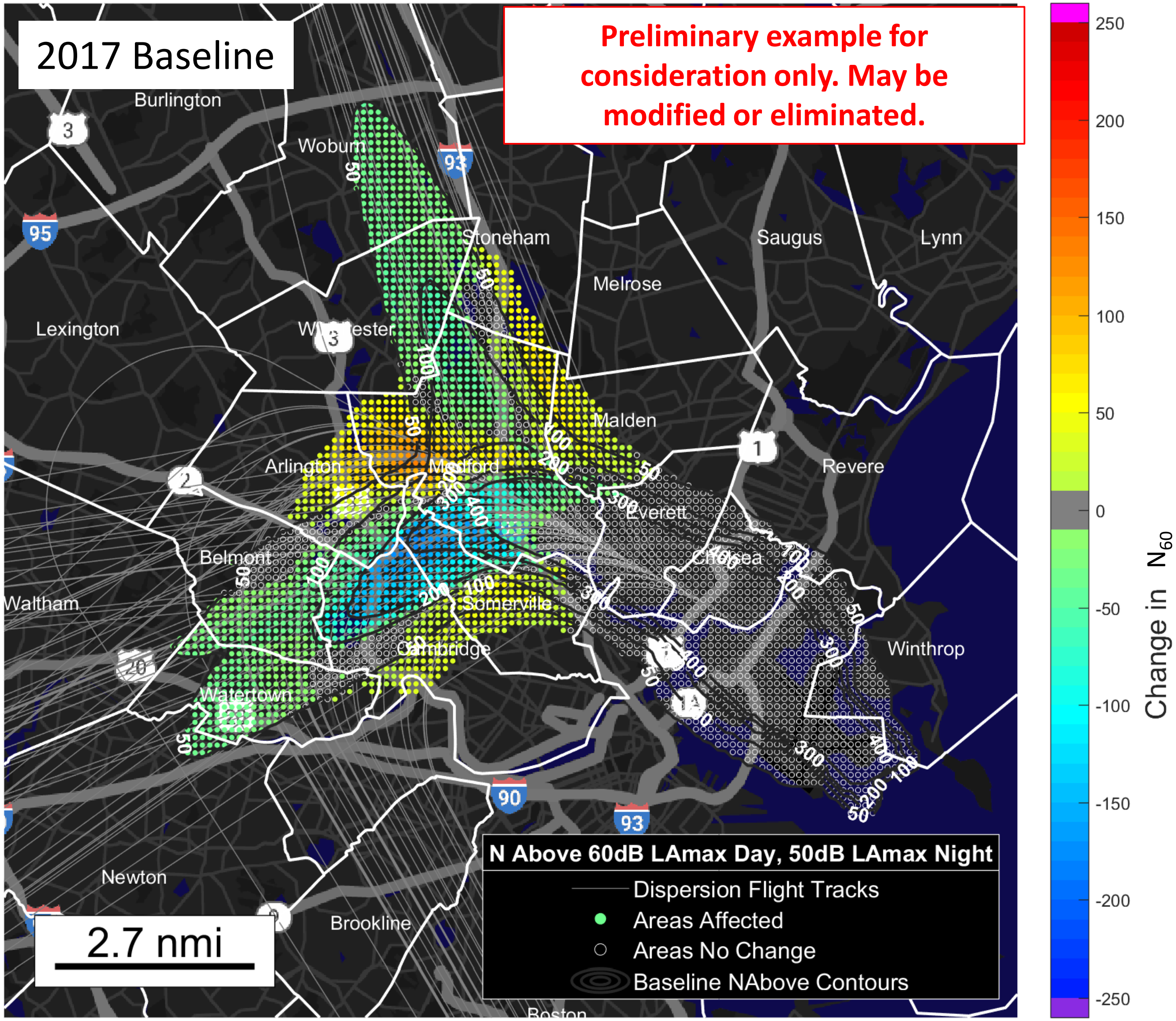
# Dispersion Concepts

- Altitude-based dispersion
  - Direct routing to transition waypoint upon reaching specific altitude
- Controller-based dispersion
  - Dispersion arising from radar vectoring
  - 2010 flight track data normalized for comparison with 2017 data
  - Comparison between pre-RNAV and RNAV flight tracks
- Divergent heading dispersion
  - 15º divergent headings then direct routing to transition waypoint upon reaching 3000ft
- RNAV Waypoint Relocation
  - Moving the waypoint at which the RNAV tracks branch off could allow for population exposure reduction




# 33L Departures Dispersion Analysis

# 33L Departures Altitude-Based Dispersion at 3000ft Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 342,387 |
| Baseline - Dispersion | -5,744 |

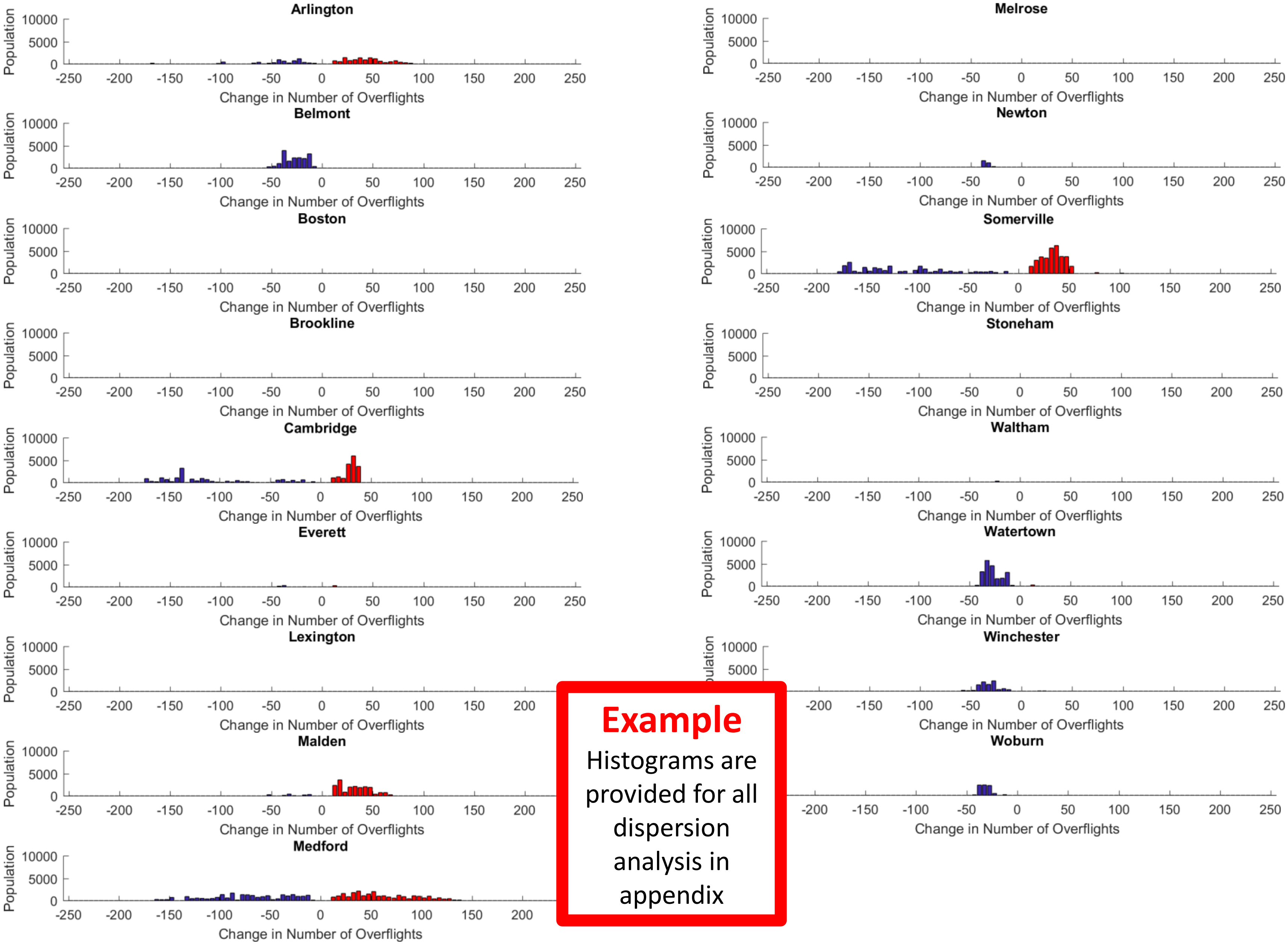
Analysis updated Dec 4 2018 to correct for discretization differences

- Controller concerns about variability in flight path length

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

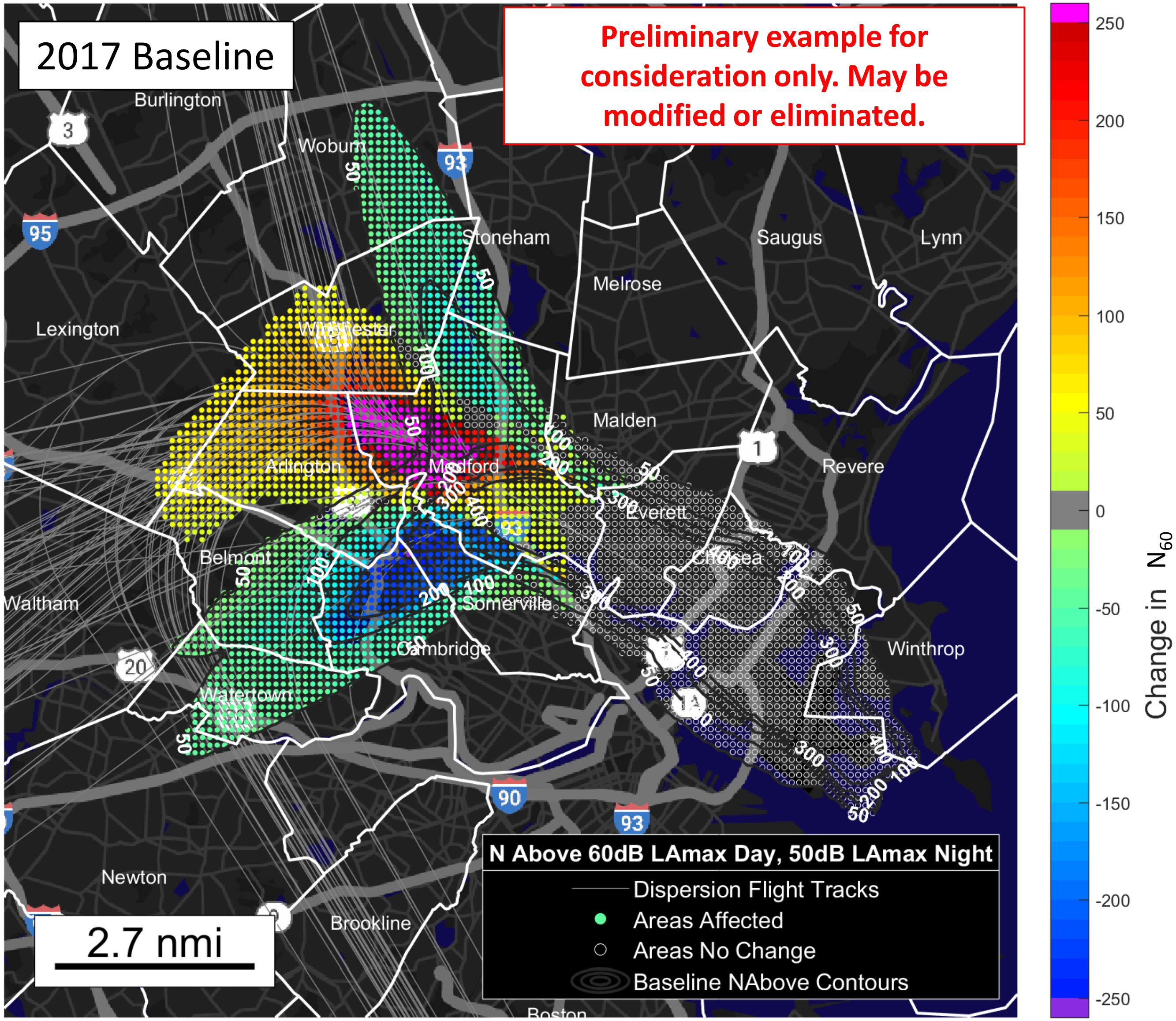
# 33L Departures Altitude-Based Dispersion at 3000ft Change in $N_{60}$ Compared to 2017




**Example**

Histograms are provided for all dispersion analysis in appendix

# 33L Departures Altitude-Based Dispersion at 4000ft Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 273,878 |
| Baseline - Dispersion | 62,765 |

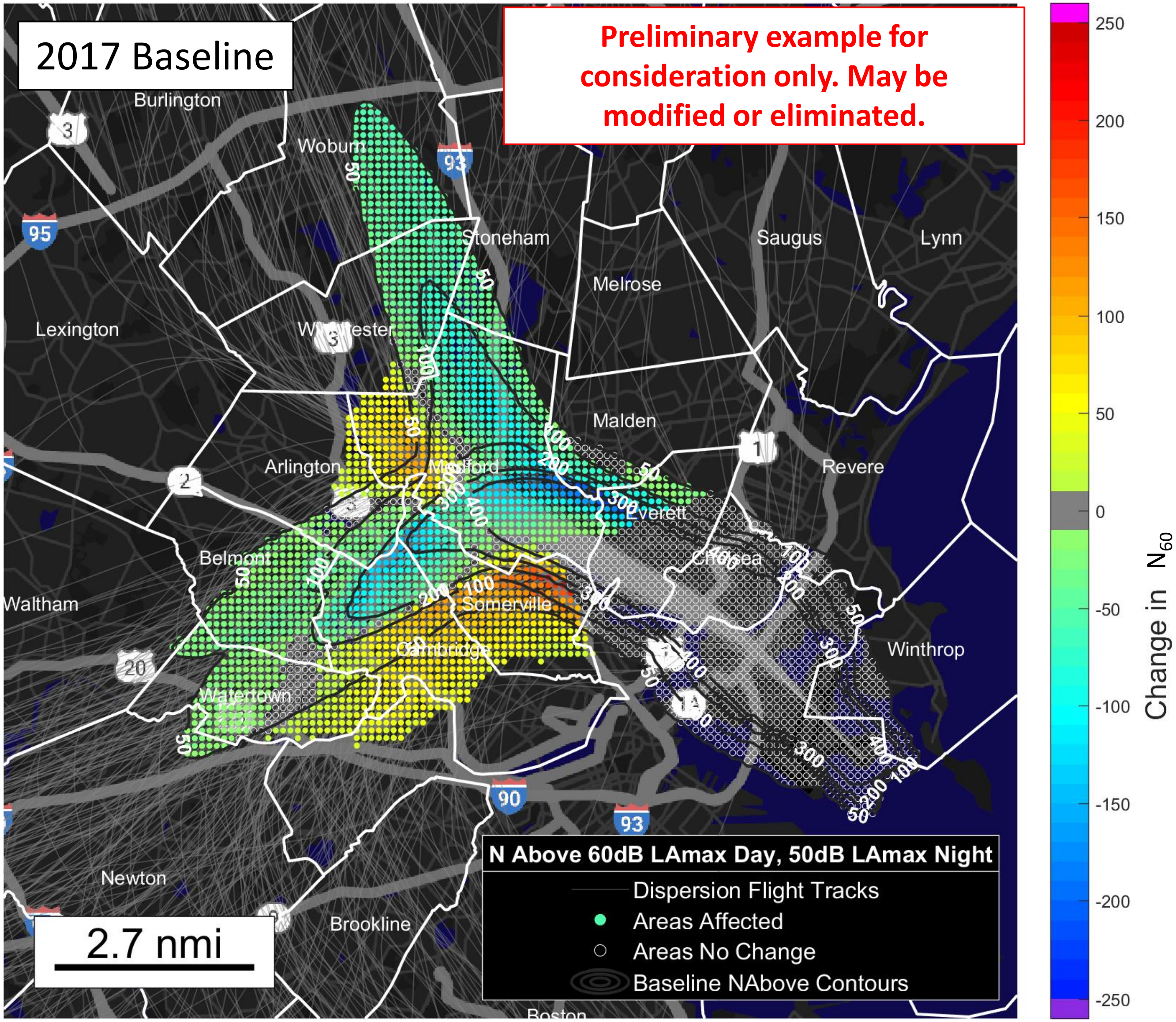
Analysis updated Dec 4 2018 to correct for discretization differences

- Controller concerns about variability in flight path length
- Conflicts with airspace at Hanscom Airport

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 33L Departures Controller-Based Dispersion Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 349,359 |
| Baseline - Dispersion | -12,716 |

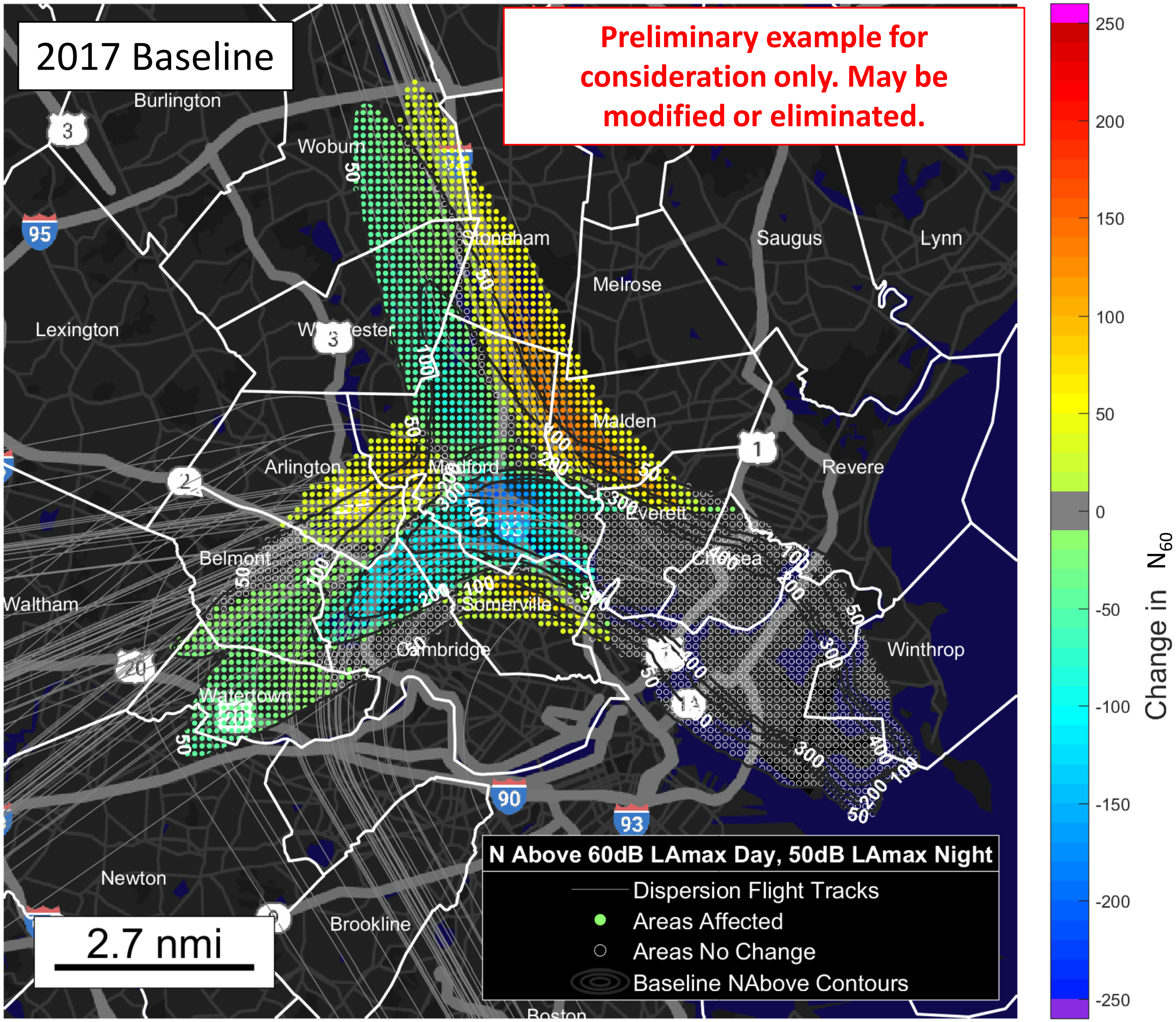
Analysis updated Dec 4 2018 to correct for discretization differences

- Controller concerns about variability in flight path length

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 33L Departures Divergent Headings Dispersion Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 334,305 |
| Baseline - Dispersion | 2,338 |

Analysis updated Dec 4 2018 to correct for discretization differences

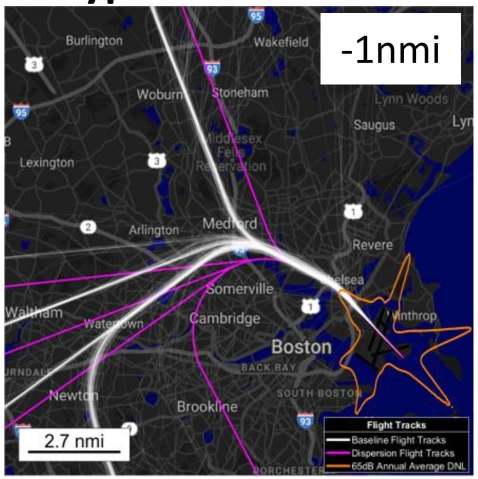
- Divergent headings help to maintain aircraft separation criteria

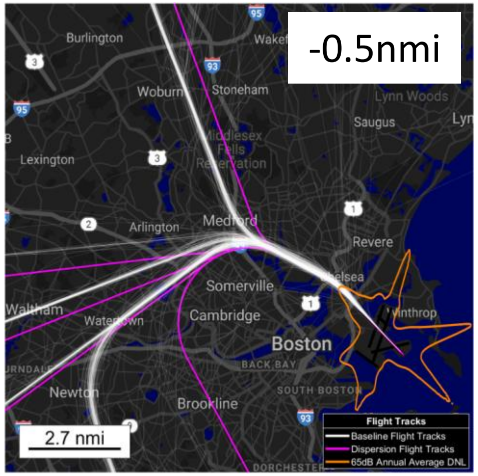
Analysis based on peak day operations; only includes 33L departures

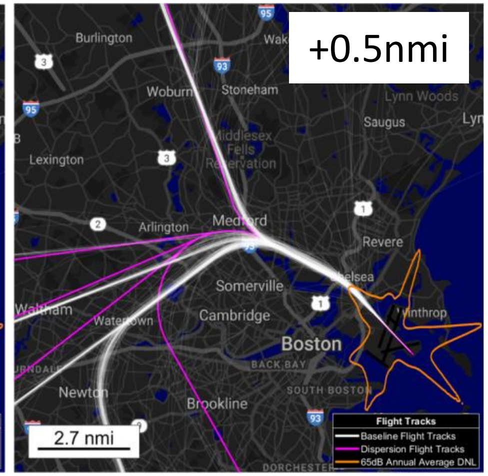
$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

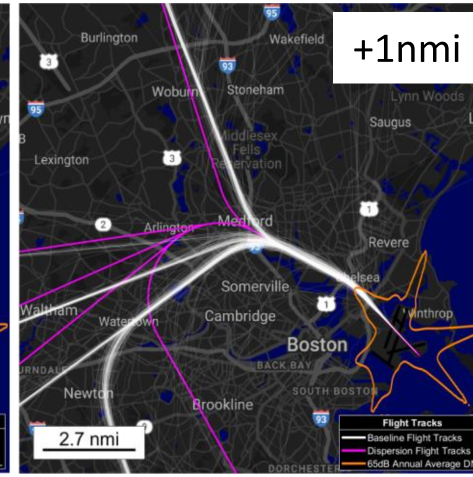
# 33L Departures RNAV Waypoint Relocation

**Waypoint moved:**



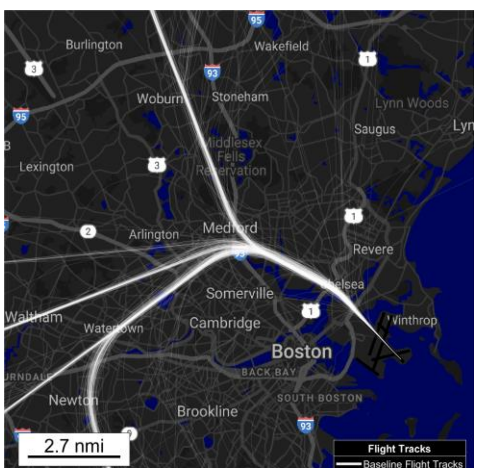




**50 $N_{60}$ Population Exposure Change (Baseline – Alternate):**

| -1nmi | -0.5nmi | +0.5nmi | +1nmi |
|---|---|---|---|
| -43,835 | -1,576 | 36,006 | 42,659 |

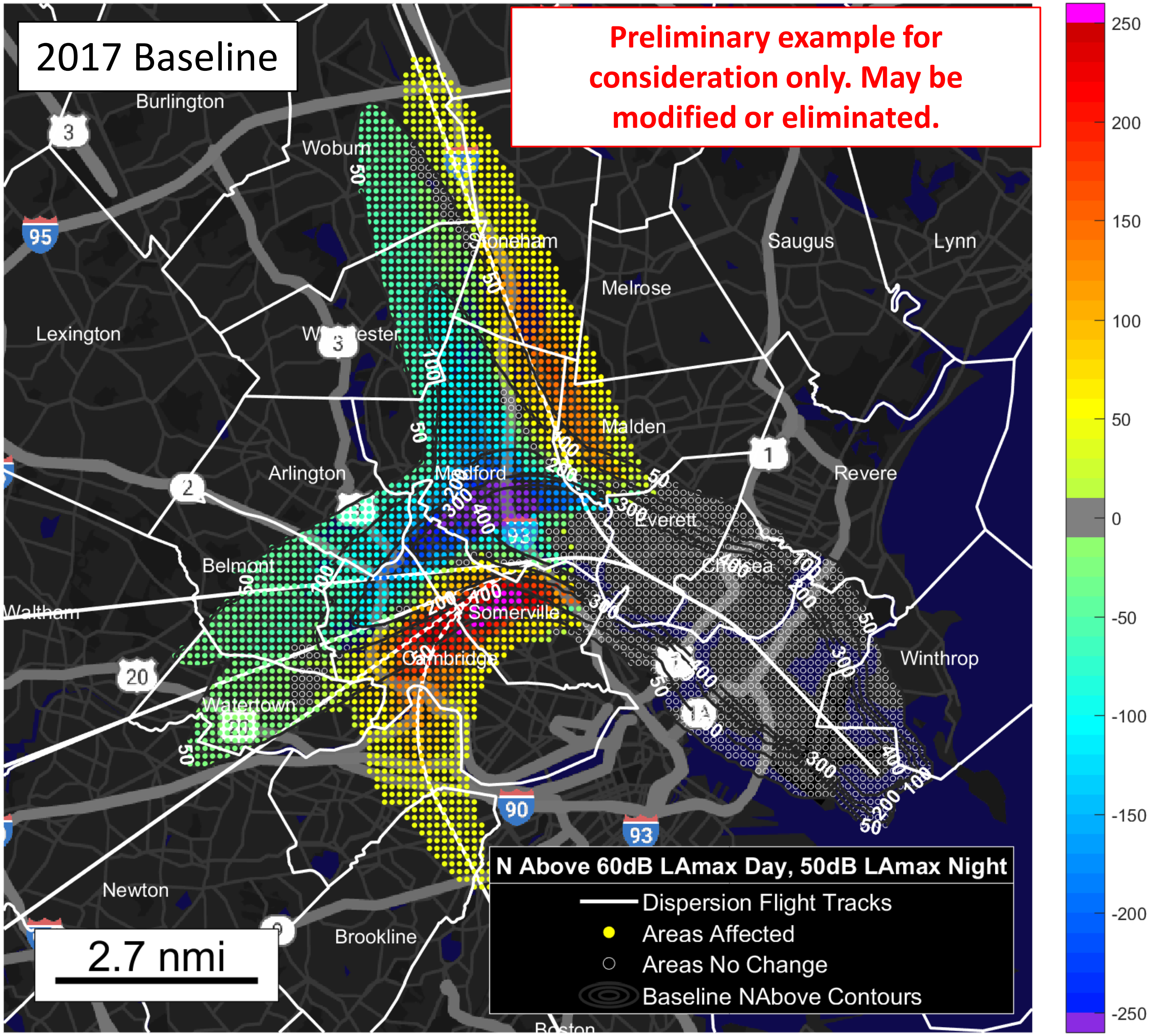



**RNAV $N_{60}$ Population Exposure:**
336,643

Modification to existing RNAV procedure

Preliminary example for consideration only. May be modified or eliminated.

# 33L Departures RNAV Waypoint Relocation -1nmi
# Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 380,478 |
| Baseline - Dispersion | -43,835 |

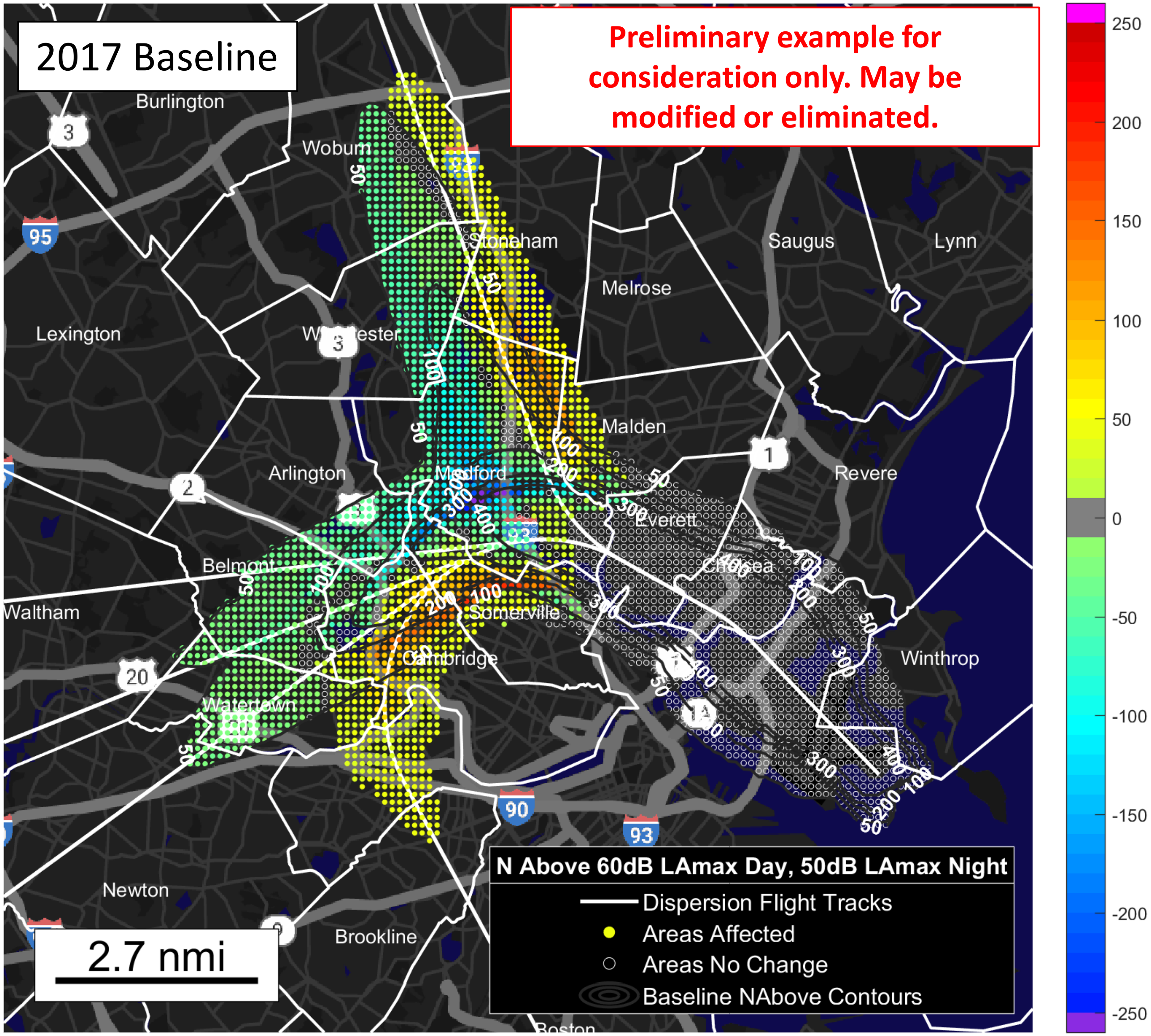
Analysis updated Dec 4 2018 to correct for discretization differences

● Modification to existing RNAV procedure

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 33L Departures RNAV Waypoint Relocation -0.5nmi Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 338,219 |
| Baseline - Dispersion | -1,576 |

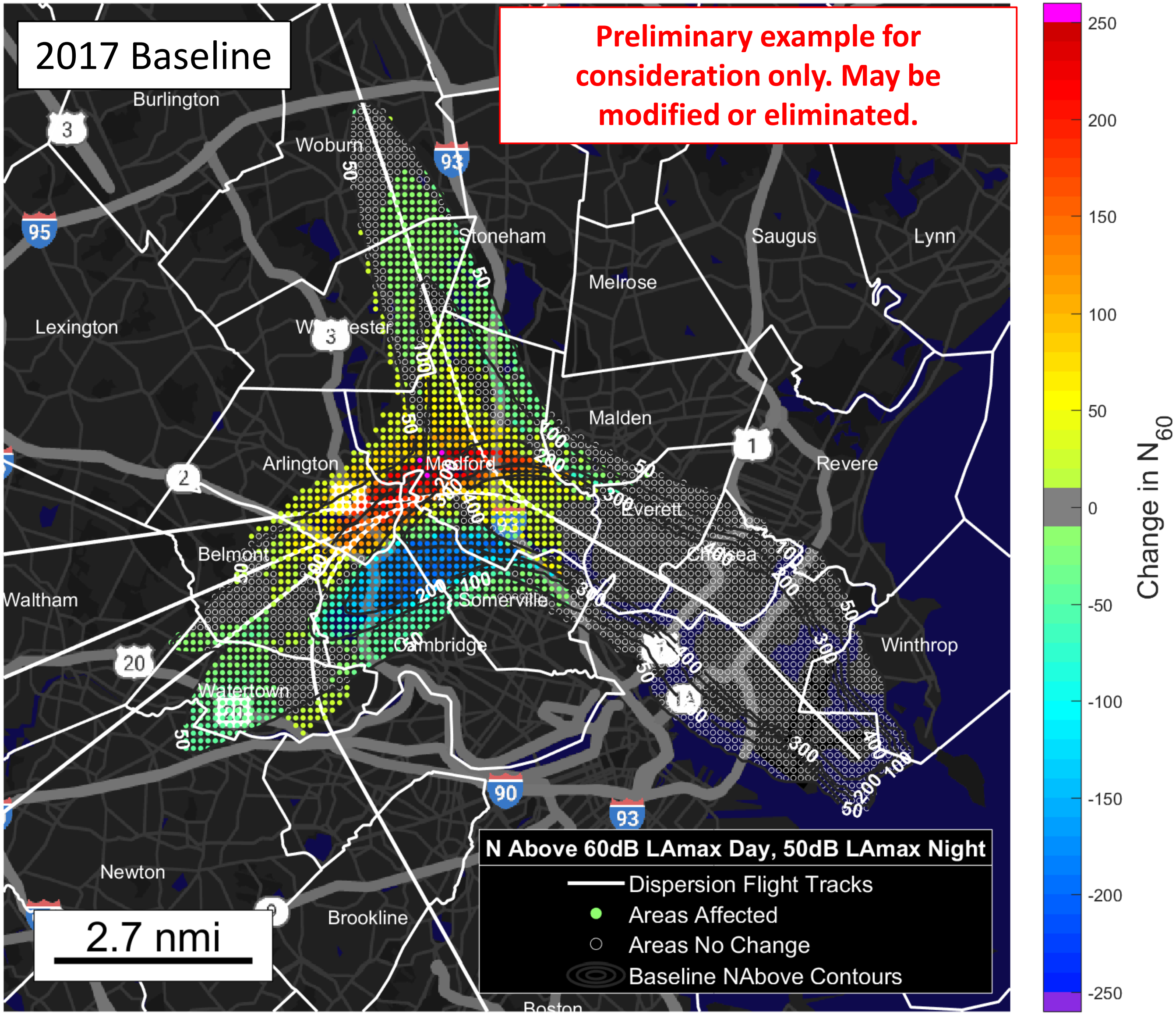
Analysis updated Dec 4 2018 to correct for discretization differences

Modification to existing RNAV procedure

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 33L Departures RNAV Waypoint Relocation +0.5nmi Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 300,637 |
| Baseline - Dispersion | 36,006 |

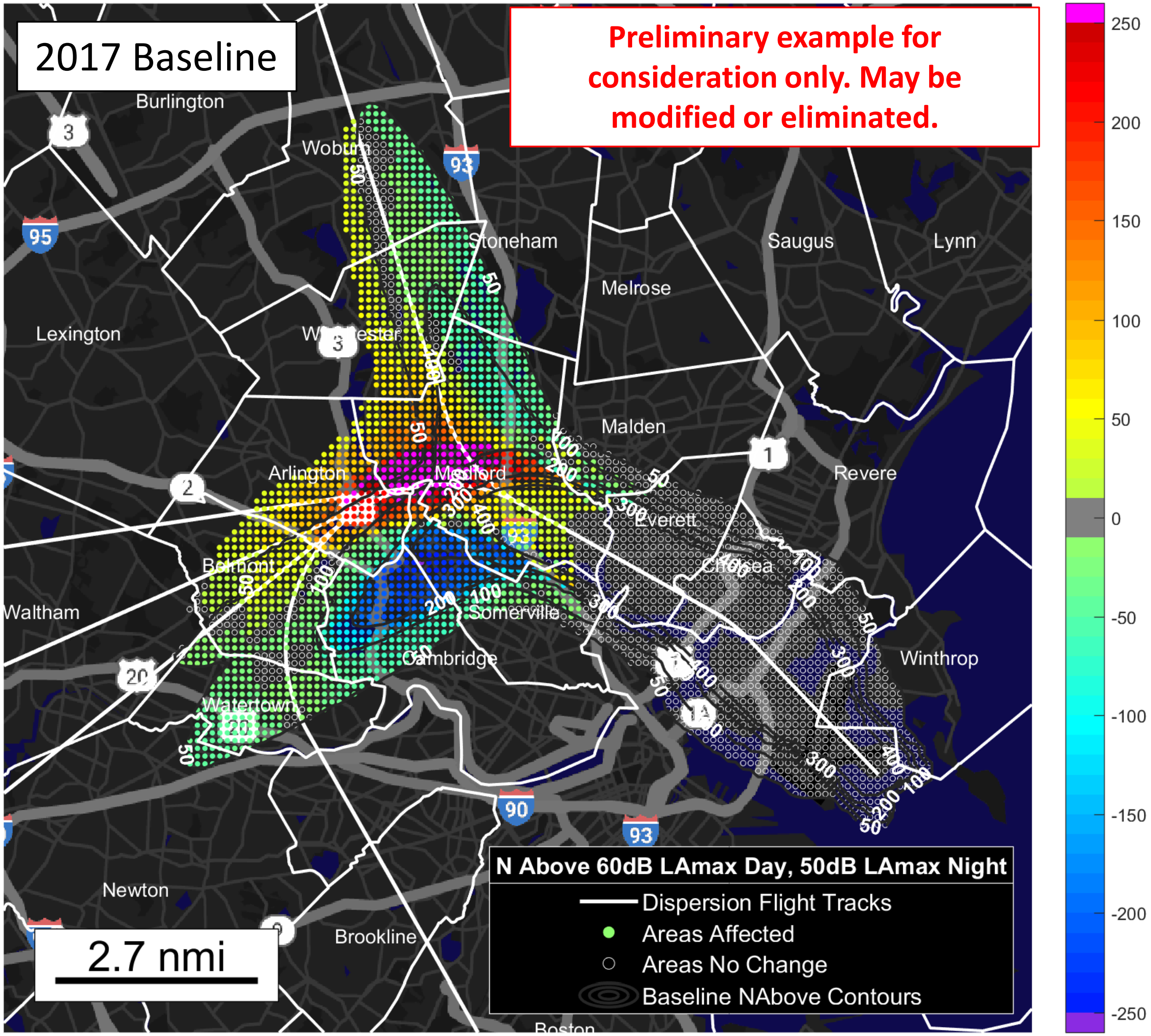
Analysis updated Dec 4 2018 to correct for discretization differences

Modification to existing RNAV procedure

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 33L Departures RNAV Waypoint Relocation +1nmi Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 336,643 |
| Dispersion | 293,984 |
| Baseline - Dispersion | 42,659 |

Analysis updated Dec 4 2018 to correct for discretization differences

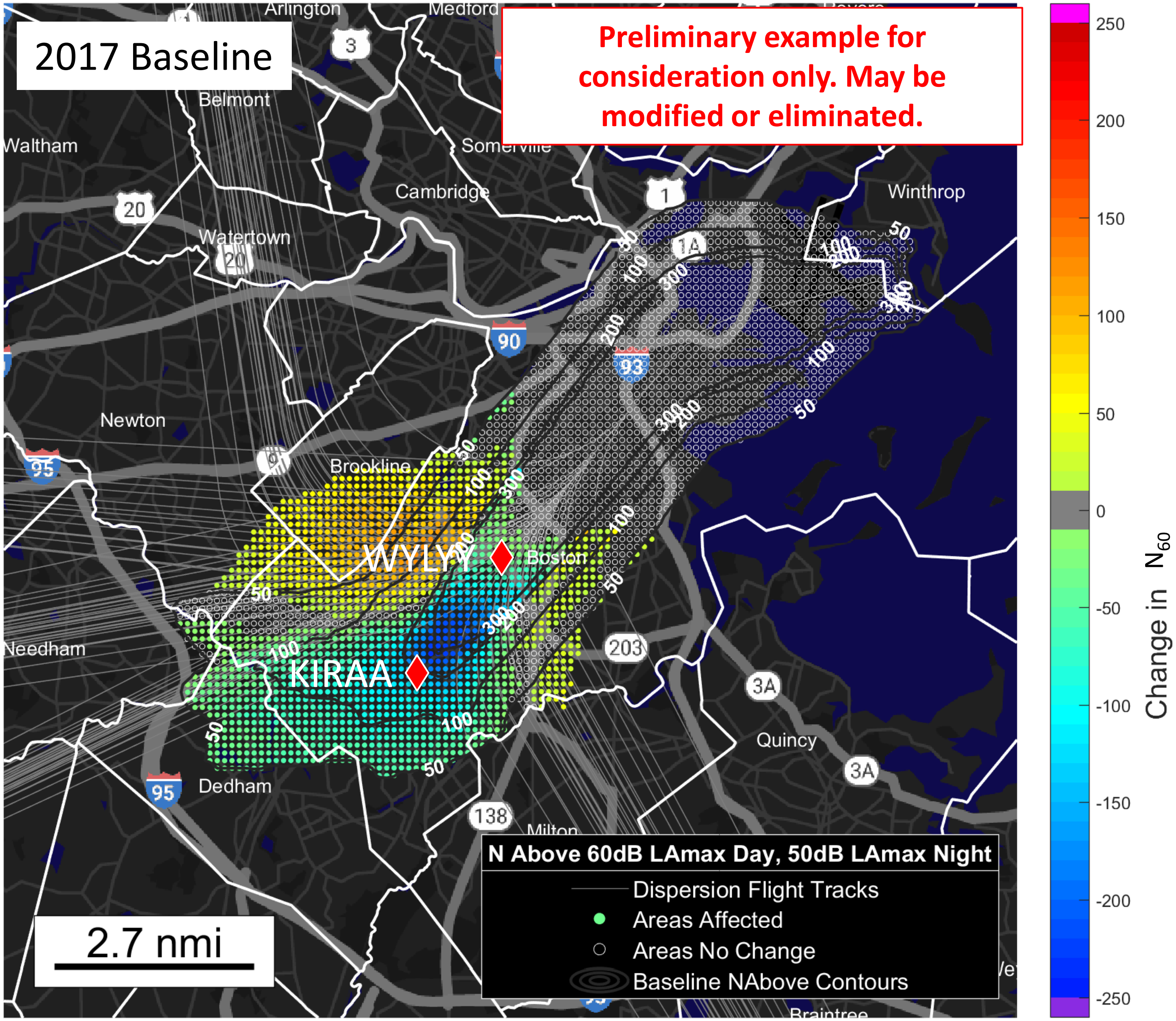
Modification to existing RNAV procedure

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 27 Departures Dispersion Analysis

# 27 Departures Altitude-Based Dispersion at 3000ft Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 407,357 |
| Dispersion | 384,114 |
| Baseline - Dispersion | 23,243 |

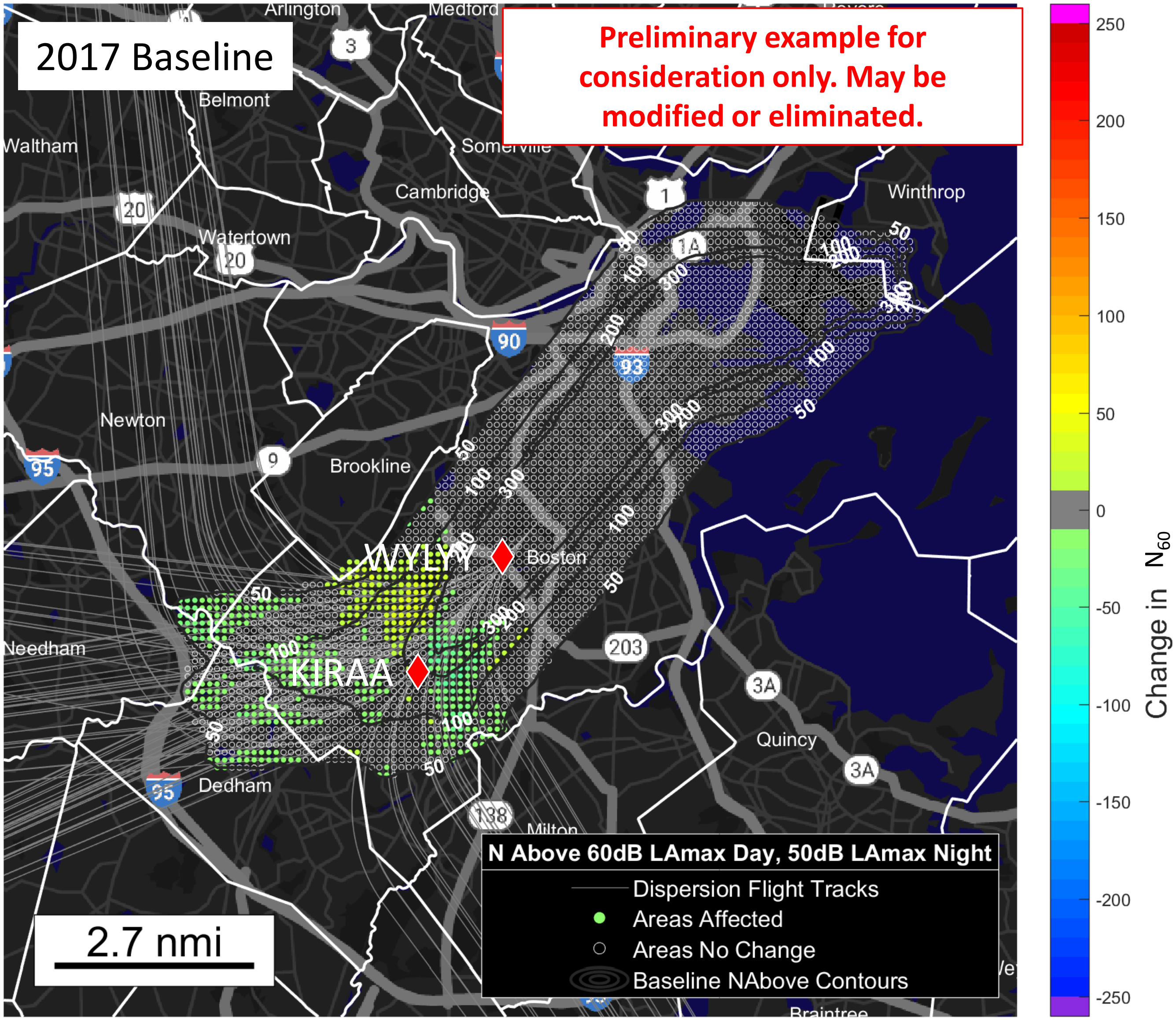
Analysis updated Dec 4 2018 to correct for discretization differences

🔴 Controller concerns about variability in flight path length Violates Record of Decision

Analysis based on peak day operations; only includes 27 departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 27 Departures Altitude-Based Dispersion at 4000ft Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 407,357 |
| Dispersion | 405,385 |
| Baseline - Dispersion | 1,972 |

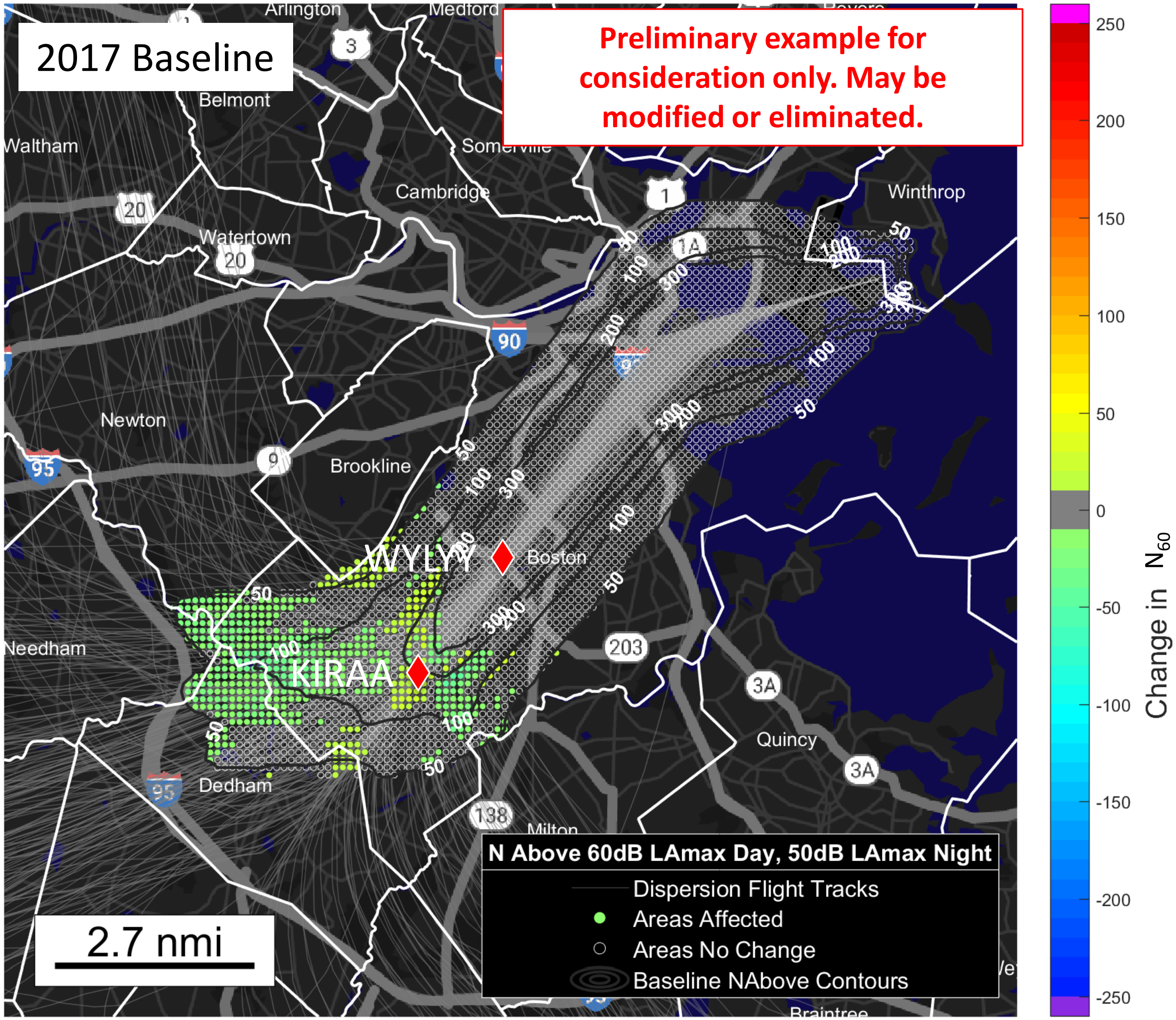
Analysis updated Dec 4 2018 to correct for discretization differences

- Controller concerns about variability in flight path length

Analysis based on peak day operations; only includes 27 departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 27 Departures Controller-Based Dispersion Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 407,357 |
| Dispersion | 407,001 |
| Baseline - Dispersion | 356 |

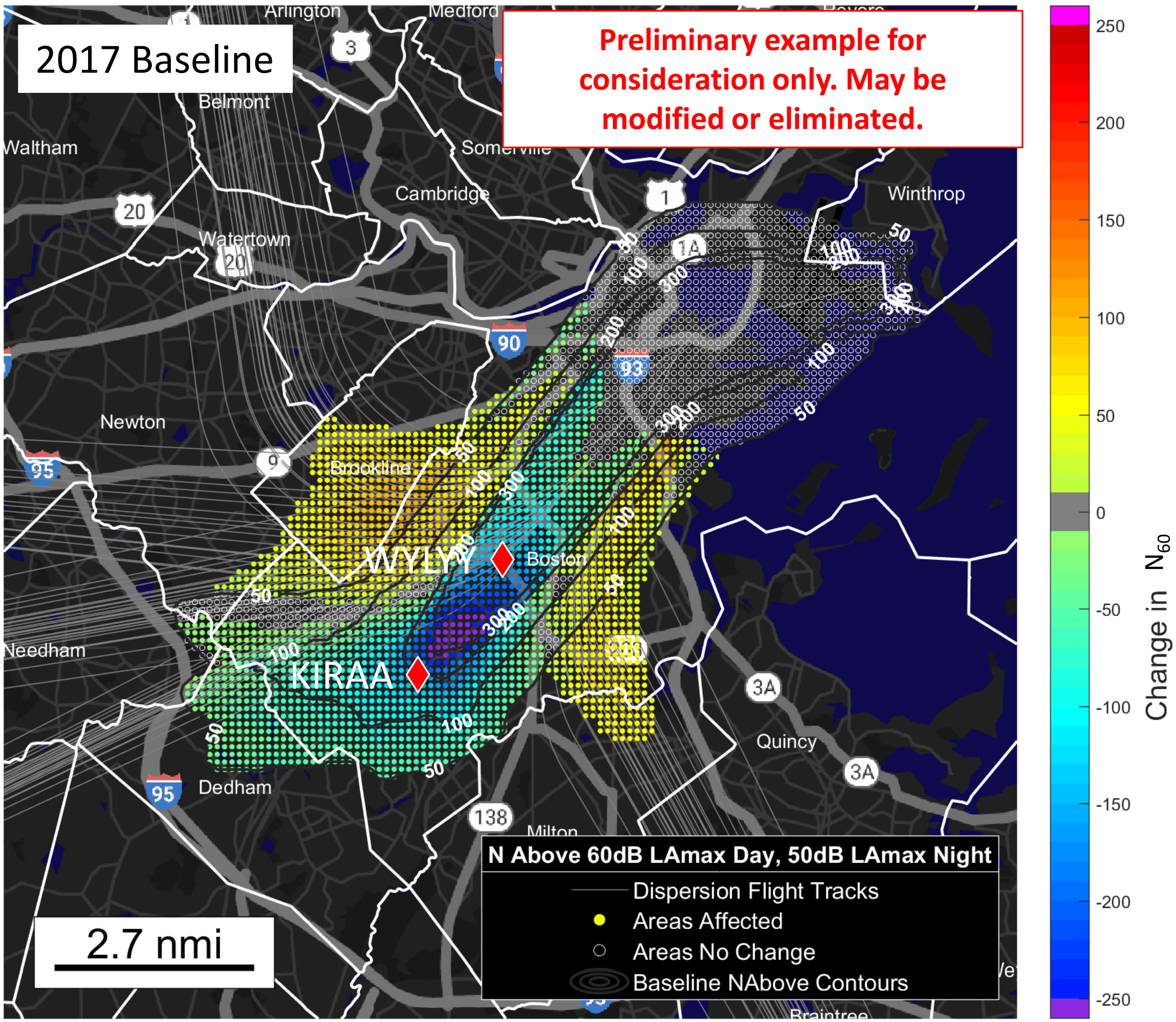
Analysis updated Dec 4 2018 to correct for discretization differences

- Controller concerns about variability in flight path length

Analysis based on peak day operations; only includes 27 departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 27 Departures Divergent Headings Dispersion Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 407,357 |
| Dispersion | 399,883 |
| Baseline - Dispersion | 7,474 |

Analysis updated Dec 4 2018 to correct for discretization differences

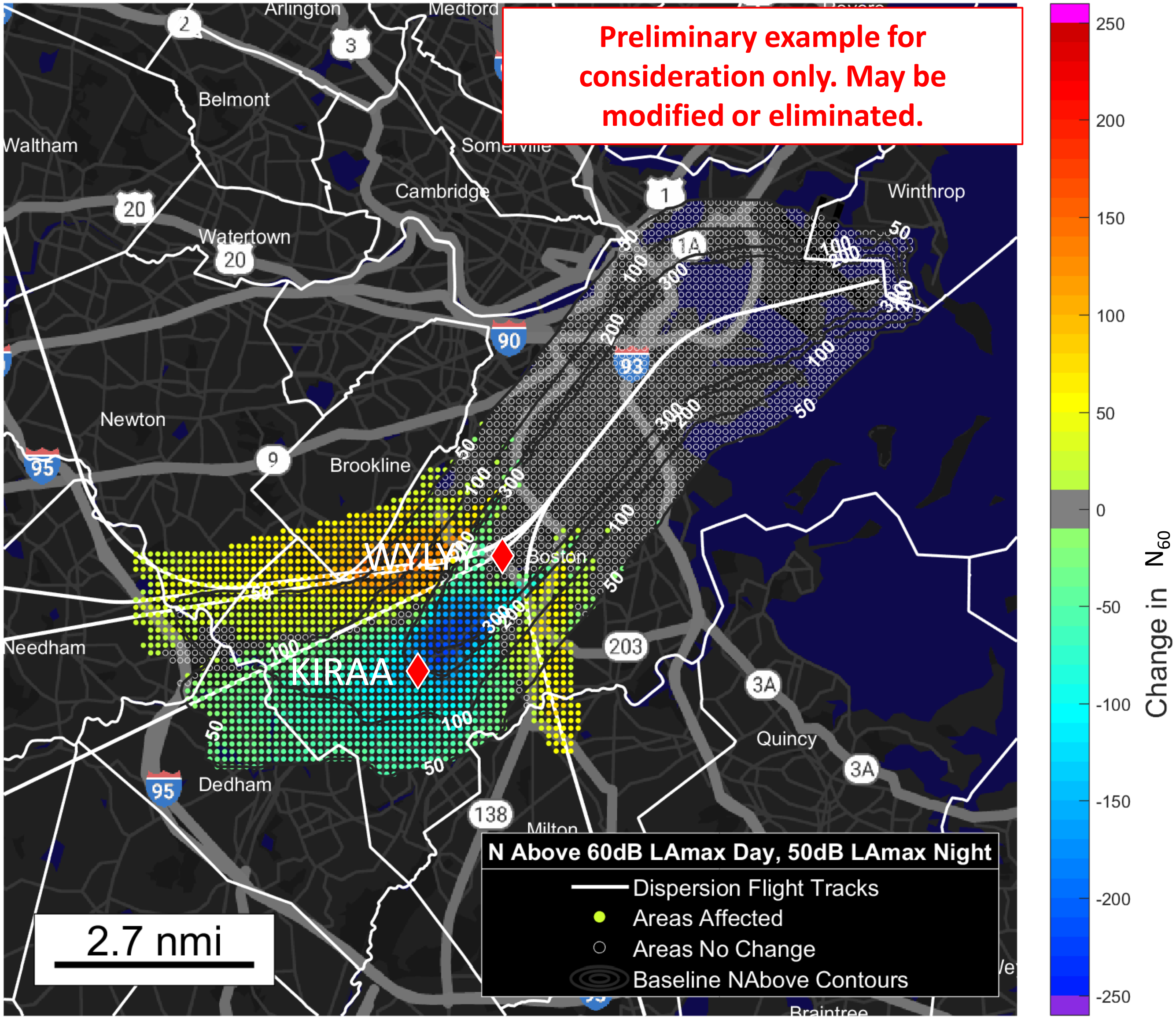
🔴 Violates Record of Decision

Analysis based on peak day operations; only includes 27 departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# 27 Departures RNAV Waypoint Relocation

## Change in $N_{60}$ Compared to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Baseline 2017 | 407,357 |
| Dispersion | 388,449 |
| Baseline - Dispersion | 18,908 |

Analysis updated Dec 4 2018 to correct for discretization differences

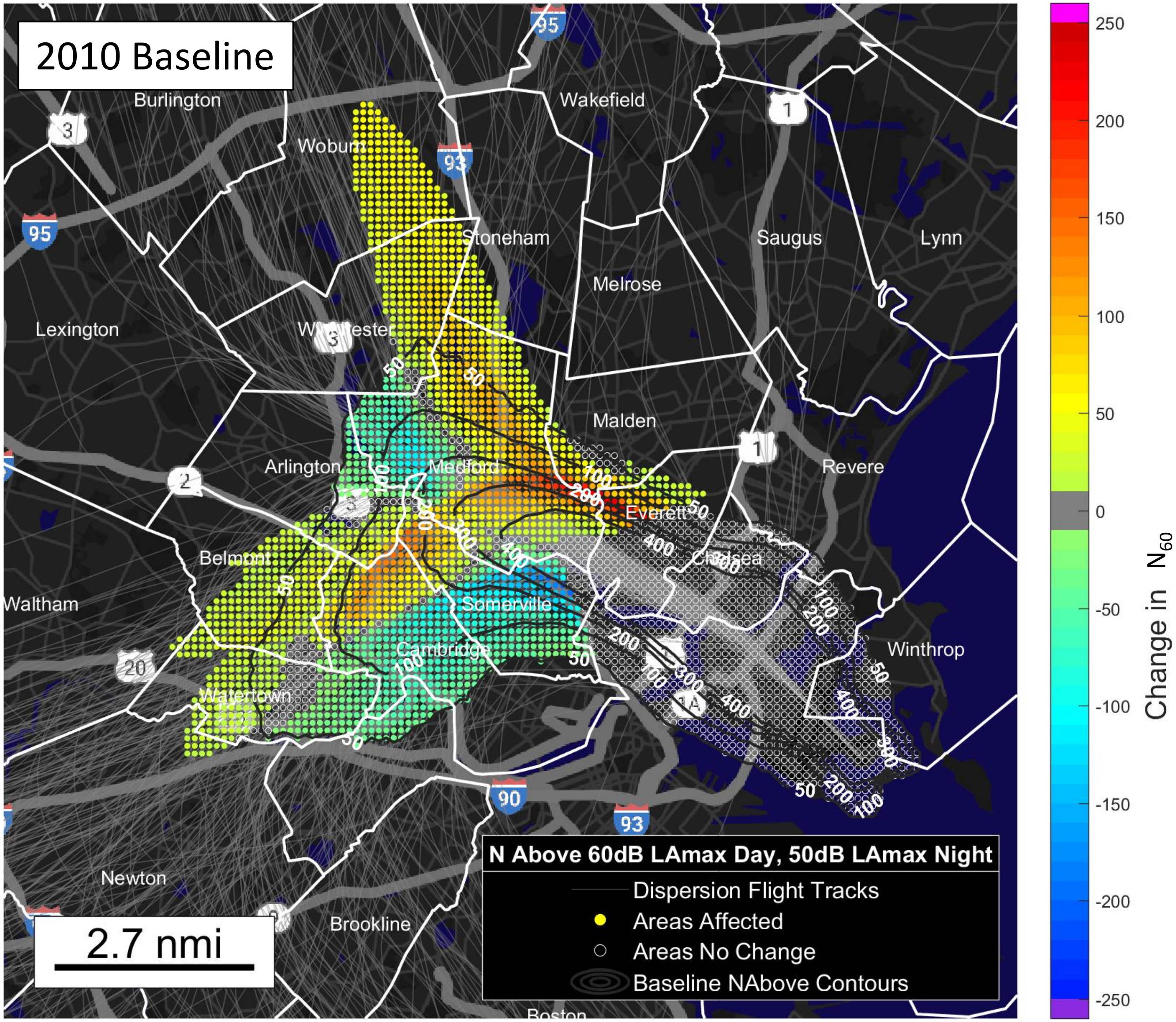
Modification to existing RNAV procedure

Analysis based on peak day operations; only includes 27 departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# Comparison between 2010 and 2017 for Reference per Community Request

# Effect of RNAV Concentration on 33L Departures
## 2010 to 2017




**Population Exposure**

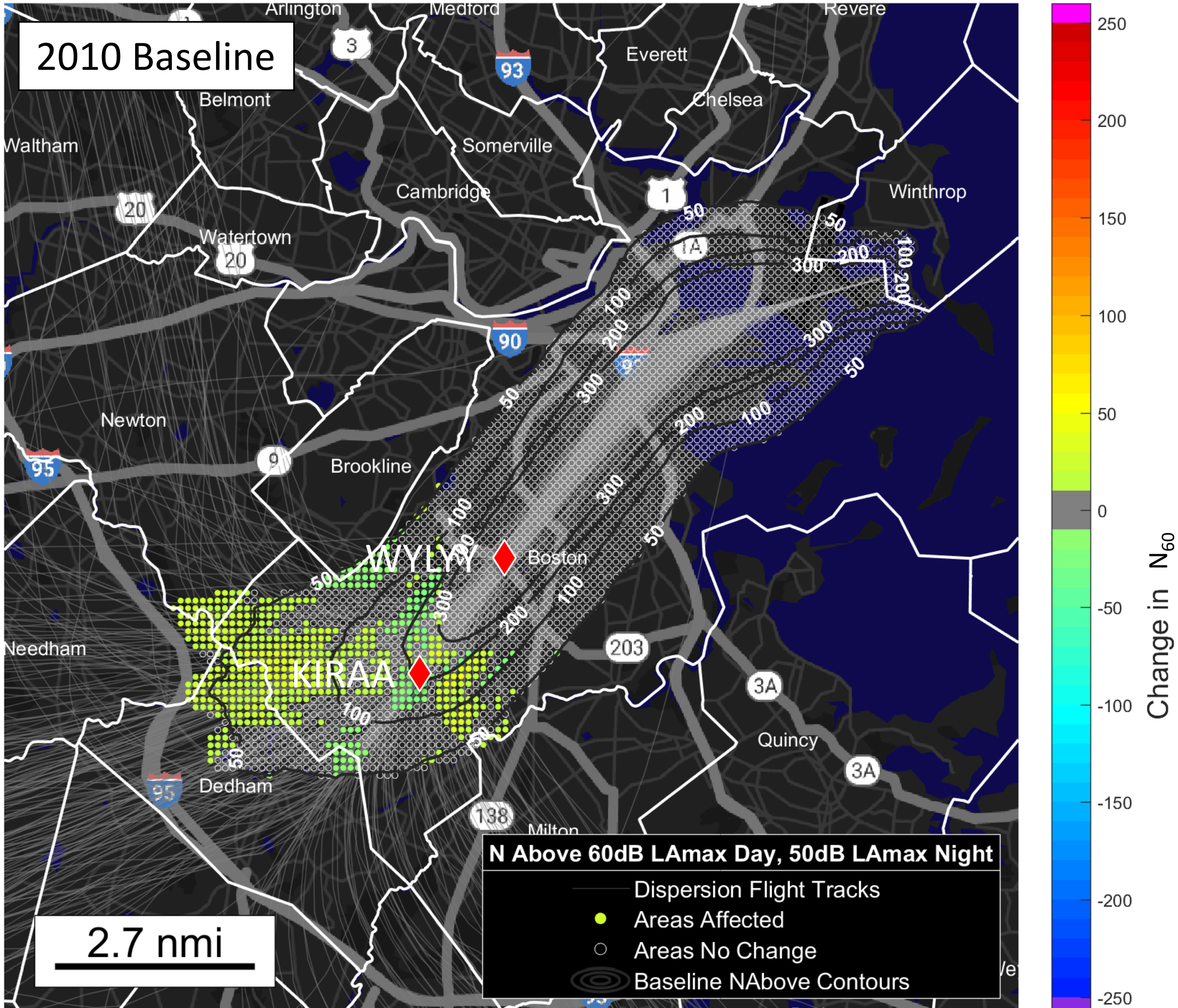
| $N_{60}$ | 50x |
|---|---|
| Dispersion | 356,960 |
| RNAV | 344,244 |
| RNAV Benefit | 12,716 |

Analysis updated Dec 4 2018 to correct for discretization differences

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# Effect of RNAV Concentration on 27 Departures
## 2010 to 2017




**Population Exposure**

| $N_{60}$ | 50x |
|---|---|
| Dispersion | 407,001 |
| RNAV | 407,357 |
| RNAV Benefit | -356 |

Analysis updated Dec 4 2018 to correct for discretization differences

Analysis based on peak day operations; only includes 33L departures

$N_{60}$ Thresholds:
60dB $L_{A,max}$ Day, 50dB $L_{A,max}$ Night

# Concepts Tabled

| Concept | Reason Tabled |
|---|---|
| 1. Maximum performance climb | Significant adverse impact to communities close to airport |
| 2. Steep approach | Limited noise benefit at maximum allowable angle of 3.2 deg and safety concerns raised by operators and pilots from high energy procedures |
| 3. Delayed landing gear approach | Significant resistance from pilot groups due to current use of landing gear for speed management on approach |
| 4. 4R max overwater approach (Canarsie-like) | ATC and flyability concerns as well as limited community support. Adds path length to procedure |

# Response to MCAC Comments

- The presentation and report should include a “general ledger” listing meaningful and realistic requests and options that had previously been reviewed and clearly state if they were viable or not.

  *Included in presentation*
- Model dispersion methods. Ideally both 3000’ AGL and ATC control.

  *Included in presentation*
- Compare “impact” to both current conditions and pre-RNAV conditions (see how closely new dispersion method mimics prior).

  *Prior baselines are provided in the 2010-2017 comparison analysis in both map graphic format and dispersion histograms for each city impacted by dispersion*
- Check conformity to NEPA thresholds for both methods. Include tabular statistics for change in DNL and alternative metrics for all communities with overflights from new dispersion methods up to 10,000’ AGL.

  *Out of scope. NEPA analysis will be done for implemented procedures*
- Provide flight track data files for modeled dispersion methods (KML ideally).

  *Tracks not available in KML format. Significant effort to regenerate*
- Presentation of options at meeting with 33L Municipal Working Group of elected officials and public at a location in a 33L Community.

  *Open to this pending schedule*
- Why is some of his analysis performed using the N(Above) metric while other analysis is performed using the L(A)(max) metric? Similarly for the same runway, analysis for arrivals were done with one metric while departures were done with using another metric. It appears as if two separate persons were running their analysis without coordinating with one another.

  *For procedure changes which involve a single track that all aircraft would follow we use the L(A)(max) metric which shows where the 60dB and 50dB contours would change. For procedures, such as dispersion, where different aircraft would follow different tracks we need to integrate the impacts over all the flights. In these cases we use the N60 which is the N(Above) at a 60dB Lmax level in the day and a 50dB Lmax level at night for the peak day or runway use during 2017.*

# Response to MCAC Comments

- I ask that all the analysis be performed using both N(Above) and L(A)(max) in each scenario for comparison purposes.

  *This would require some effort and an estimate of how many aircraft would fly the new procedures on a peak day. It is not that useful for identification of the noise benefit but could be done with effort.*
- Why was analysis done using a B737-800 and not another type of aircraft?

  *This is one of the 2 most common aircraft flown from BOS and we have the highest confidence in the noise models. We model other aircraft when it looks like the size or aircraft performance may have a significant impact.*
- Add distances on the map to identify proximity of flight path.

  *This is included and one mile tic marks are included in the trajectories.*
- Provide census block information for population impacts for Swampscott and Lynn.

  *Analysis done at a higher resolution then census block. Would require effort to convert back to census. It would require effort but could evaluate each .1 mile analysis block for census.*
- 22L arrival design RNP only – design arrival perpendicular to 22L, bringing arrival path farther from Swampscott.

  *Arrival re-analyzed with more accurate power settings and impact at Swampscott mitigated.*
- Provide operation use data – volume/frequency (day and hour) of operation for both RNP and RNAV.

  *RNAV equipage estimated at 98% from FAA sources. RNP(AR) more limited and varies by carrier. Jet Blue and SWA have high equipage levels but other carriers do not use RNP(AR).*
- Move the transition way point back from KIRAA to WYLYY.

  *This is considered in the 27 waypoint relocation option*.
- As has been discussed a few times at meetings, we are waiting for all realistic alternatives to be submitted with data, at least on the census block level, showing the before and after impacts of changes of the RNAV for 33L, as well as data on what changes are anticipated for different dispersion alternatives. It would be helpful if data were presented in ways that the public could interpret, and graphics were larger, and with more clear features so they can be understood as well.

  *Included town boundaries on map graphics and included dispersion histograms by town.*

# Response to MCAC Comments

- I am concerned that Runway 9 was not considered particularly, since proposals to Runway 33 may add further departures from Runway 9.

  *Because the Runway 9 departures are over water shortly after departure there were no procedure changes we could identify which would have a significant benefit to the communities near the departure end. We did look at high power departure procedures to get more altitude quickly but this ended increasing the population exposed to noise.*
- Provide a high level overview of U.S. air space management and specifically the complexities of the eastern seaboard airspace.

  *Beyond scope*
- Provide projections of impacts of Wake Recategorization (Wake Recat) as part of the NextGen implementation process.

  *Beyond scope*
- Review Air Traffic Controller procedures and governance for switching evening flight configuration to overnight preferred configuration.

  *Beyond scope*
- Given the continuing narrative from member communities regarding RNAV impacts, provide detailed facts and data for pre- and post-RNAV implementation operations by hour.

  *Beyond scope*
- Runway 15R Implementation status update.

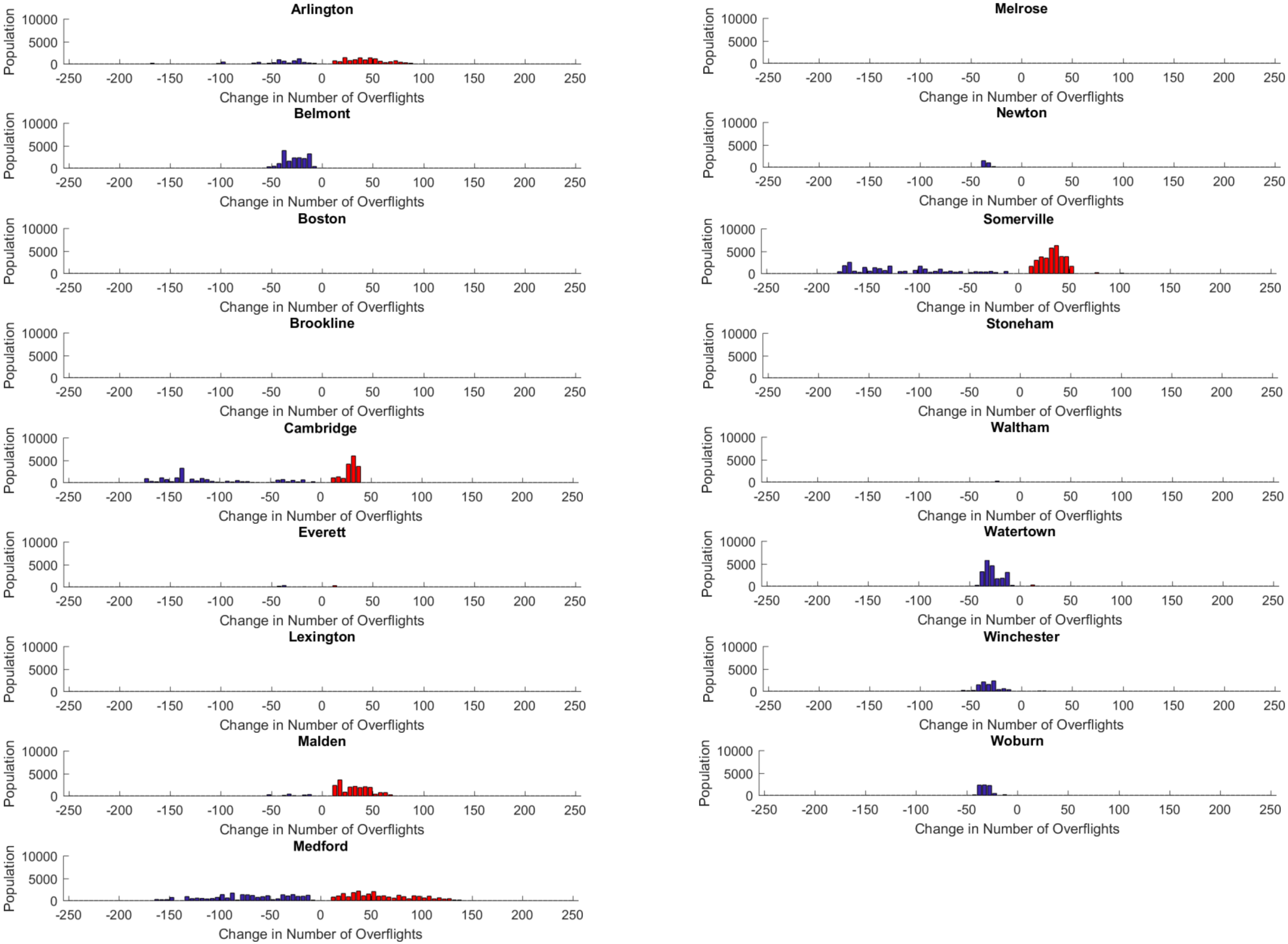
  *Recommended by .41 process. In FAA implementation.*
- Runway 33L Boston Light arrivals – status update on RNAV modification request to move the path farther away from Hull.

  *Recommended by .41 process. In FAA implementation.*

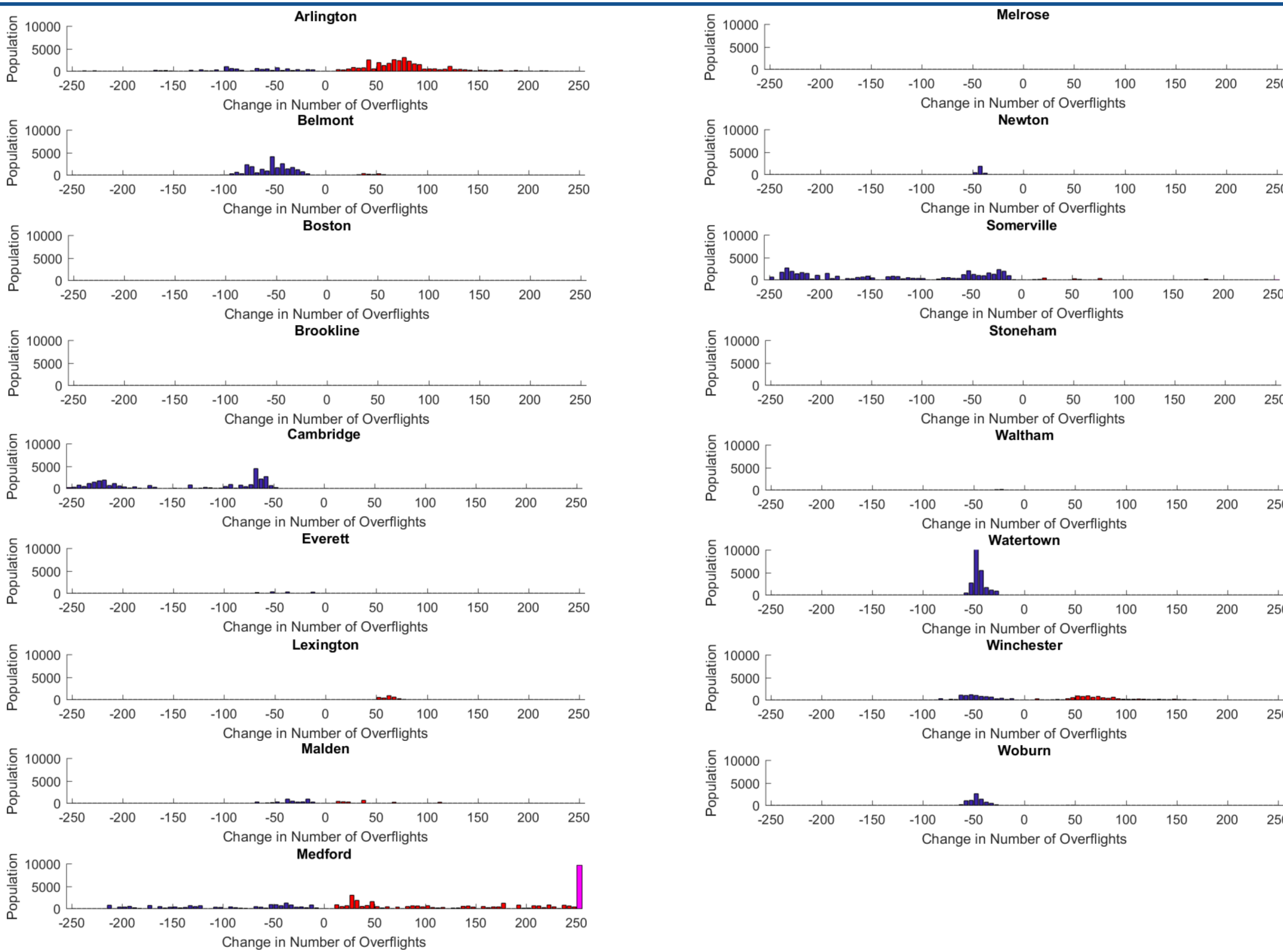
# Discussion

# Appendix:
# Dispersion Histograms

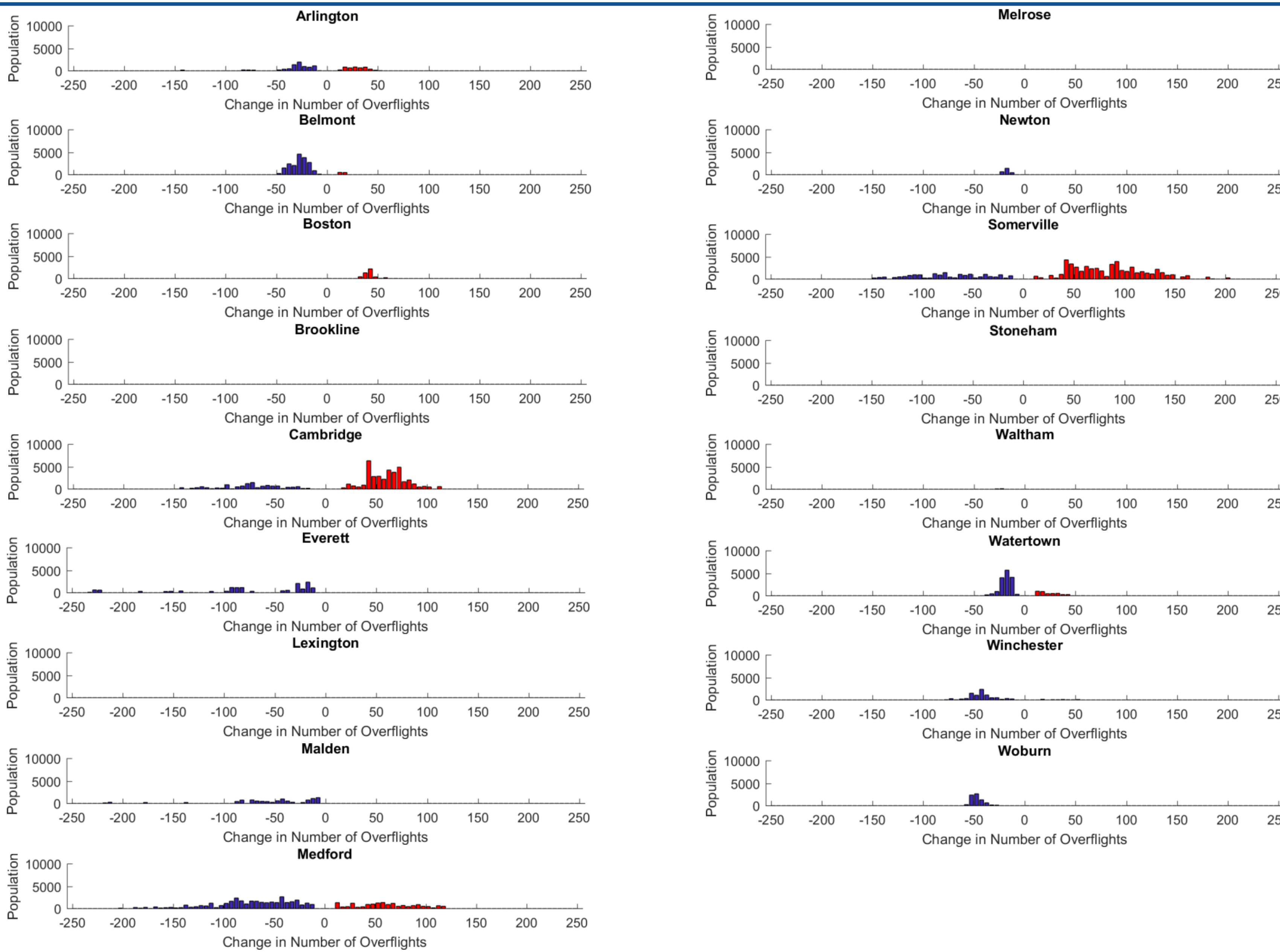
# 33L Departures Altitude-Based Dispersion at 3000ft Change in $N_{60}$ Compared to 2017



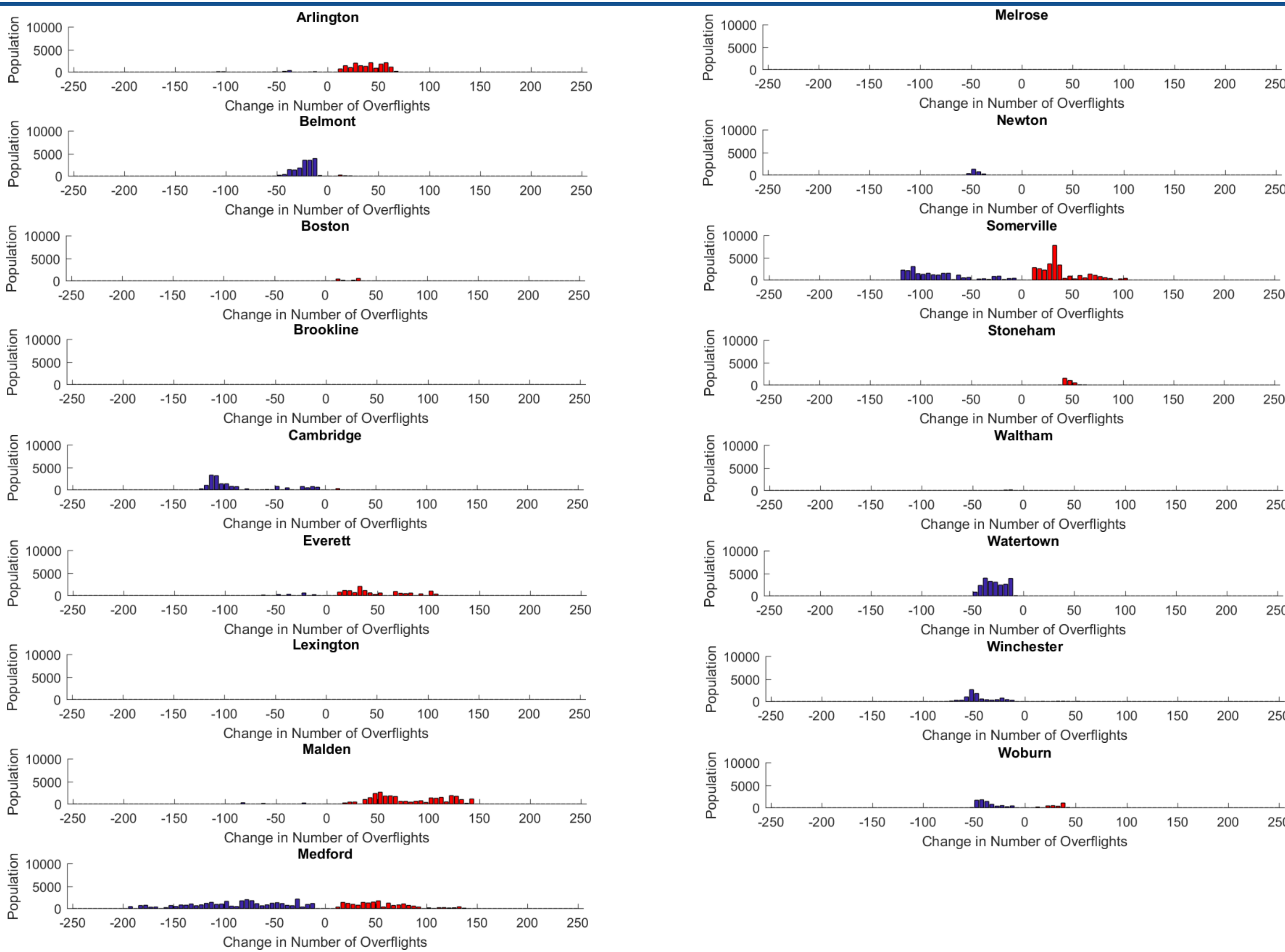
# 33L Departures Altitude-Based Dispersion at 4000ft Change in $N_{60}$ Compared to 2017



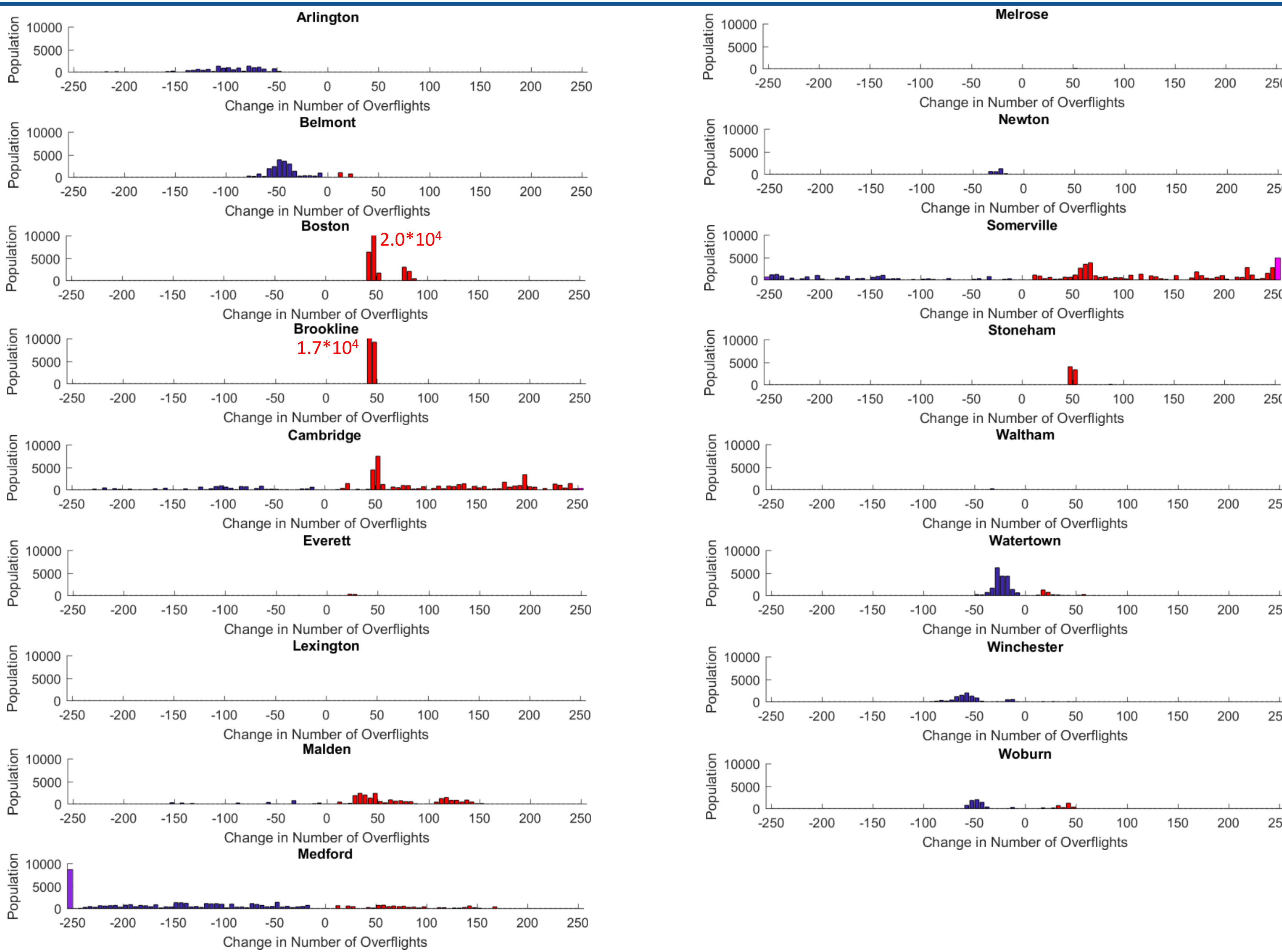
# 33L Departures Controller-Based Dispersion Change in $N_{60}$ Compared to 2017



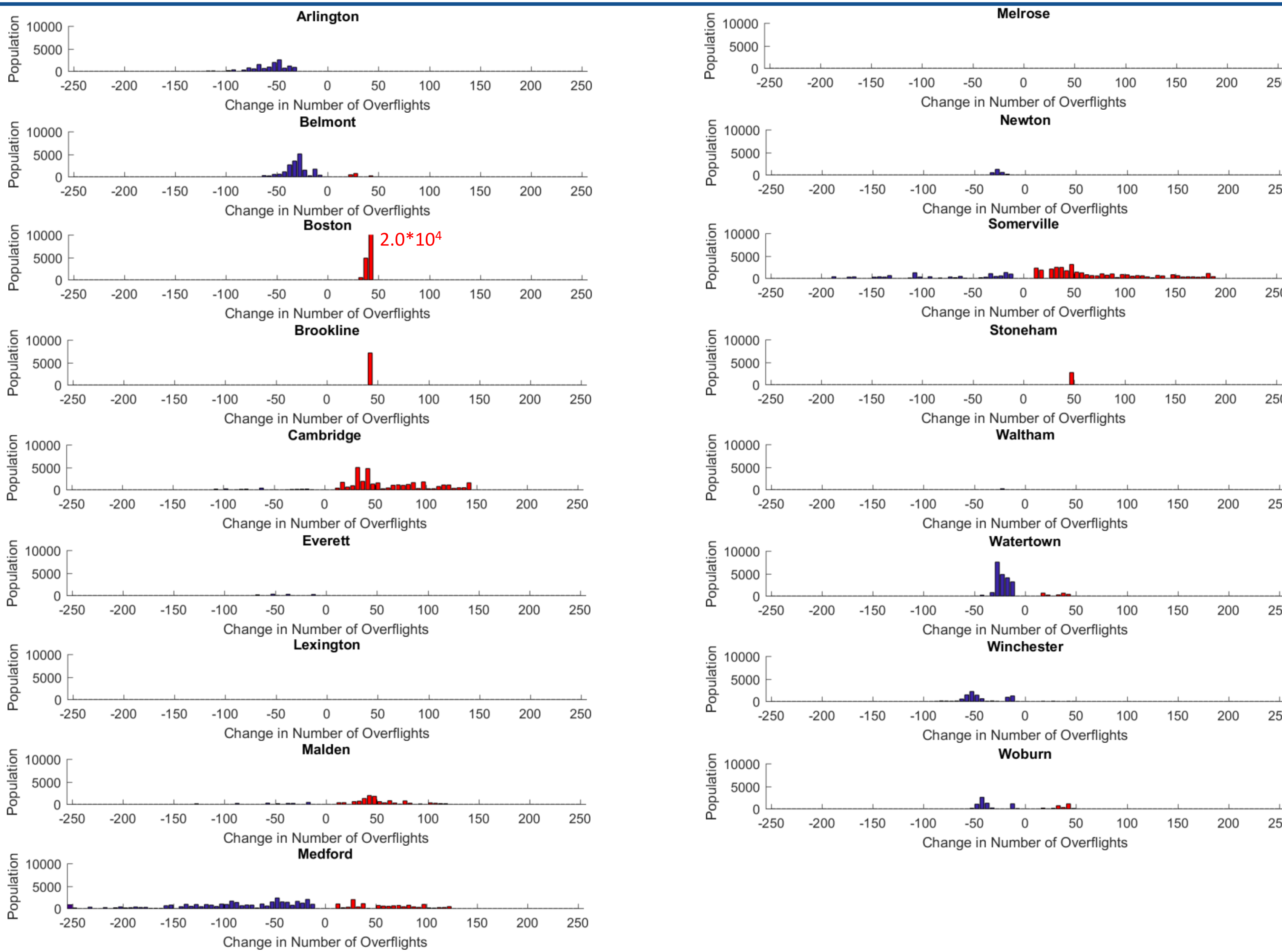
# 33L Departures Divergent Headings Dispersion Change in $N_{60}$ Compared to 2017



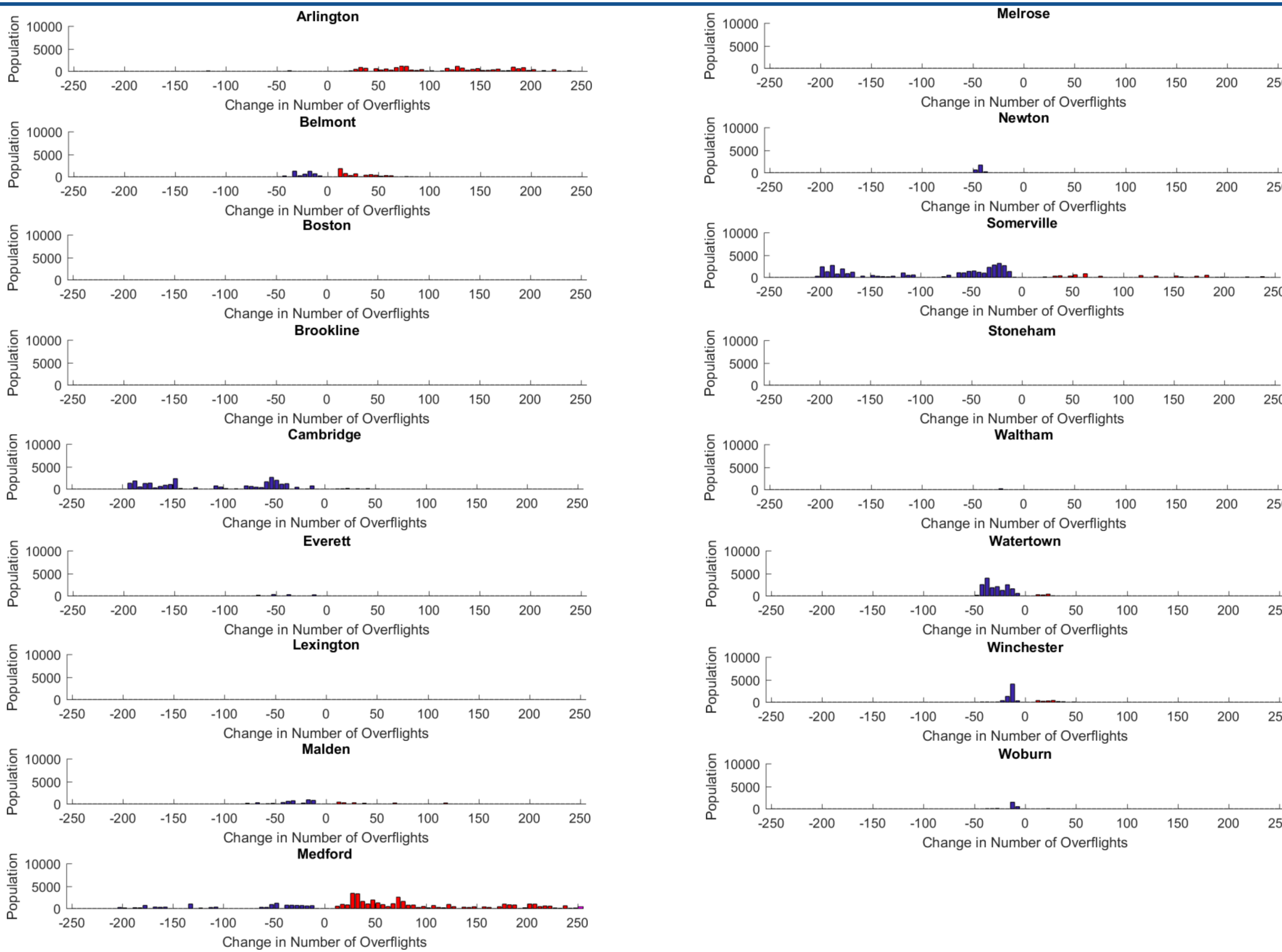
# 33L Departures RNAV Waypoint Relocation -1nmi Change in $N_{60}$ Compared to 2017



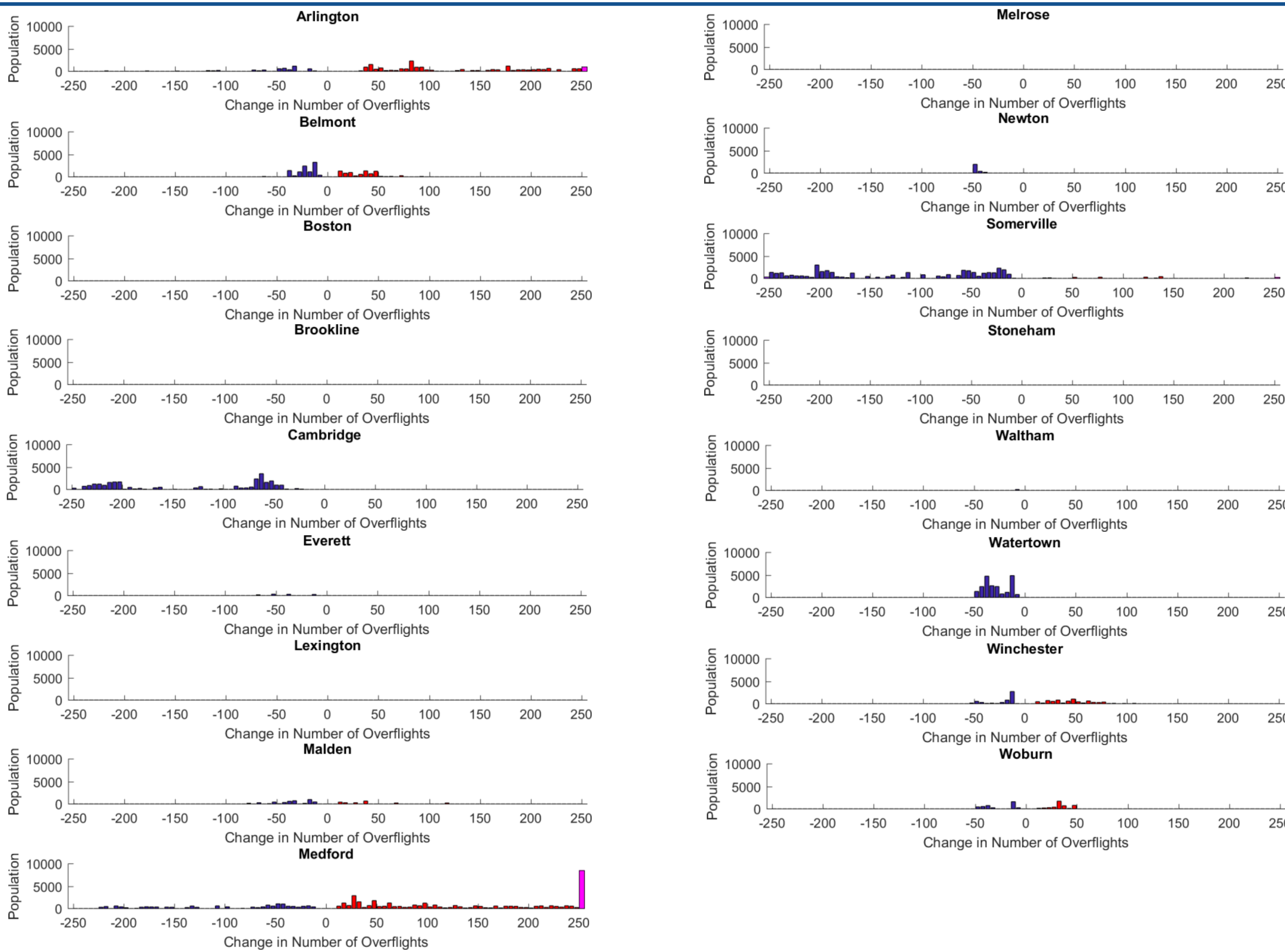
# 33L Departures RNAV Waypoint Relocation -0.5nmi Change in $N_{60}$ Compared to 2017



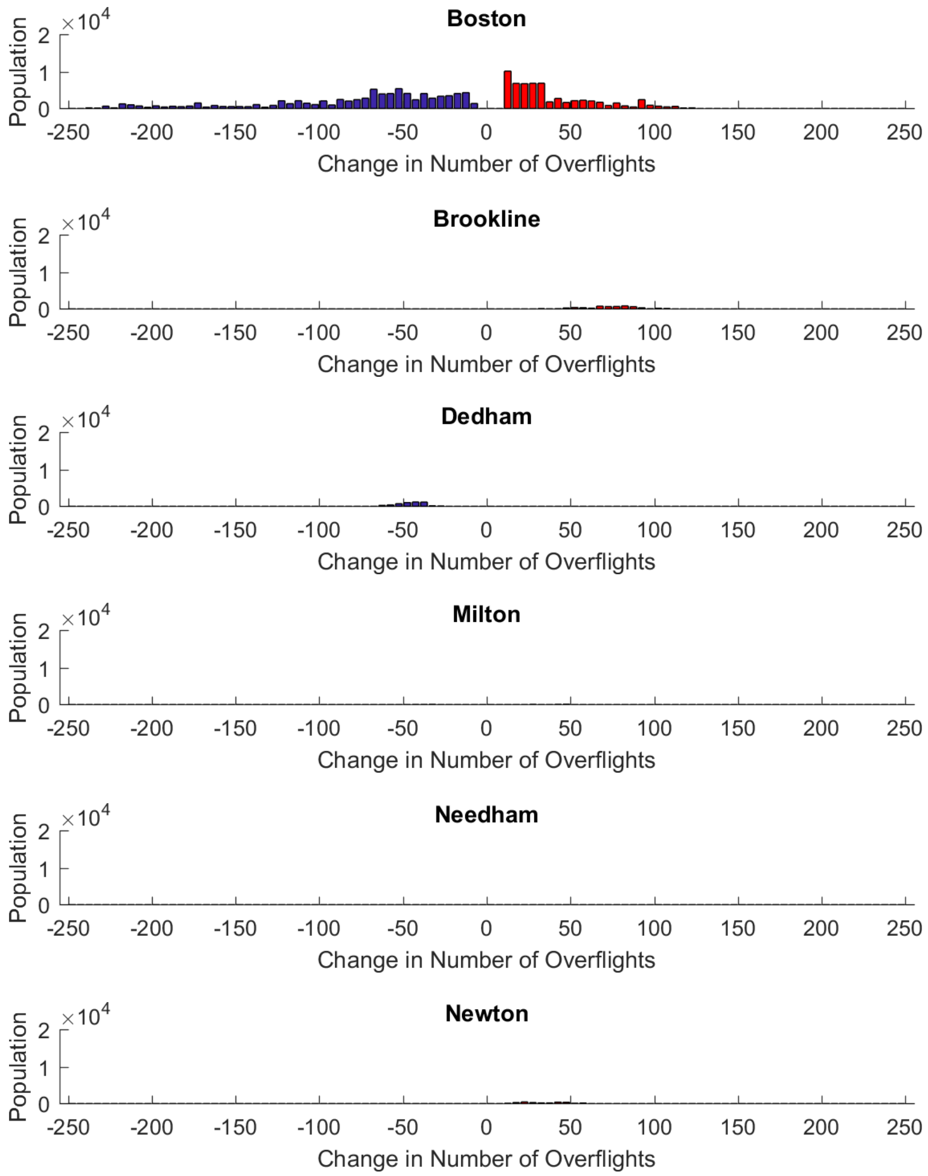
# 33L Departures RNAV Waypoint Relocation +0.5nmi Change in $N_{60}$ Compared to 2017



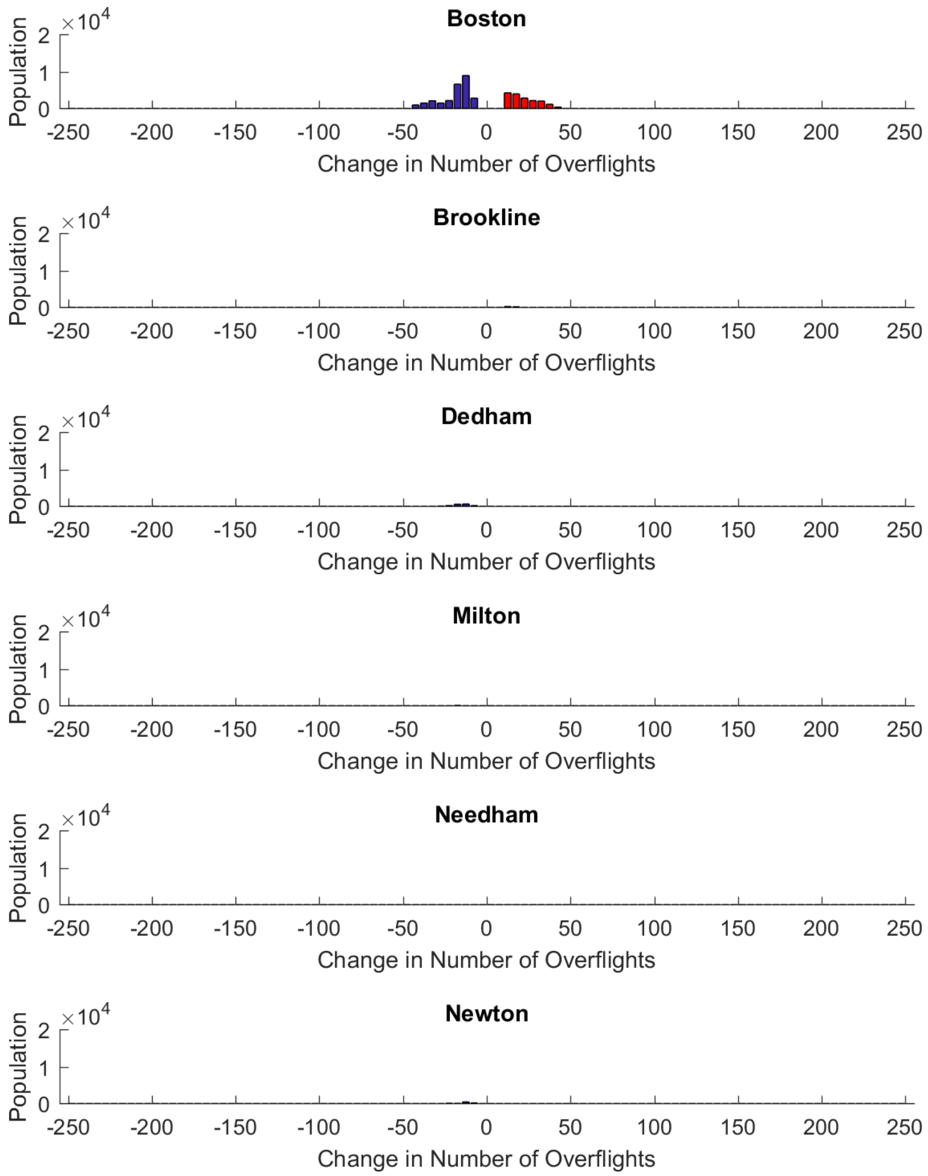
# 33L Departures RNAV Waypoint Relocation +1nmi Change in $N_{60}$ Compared to 2017



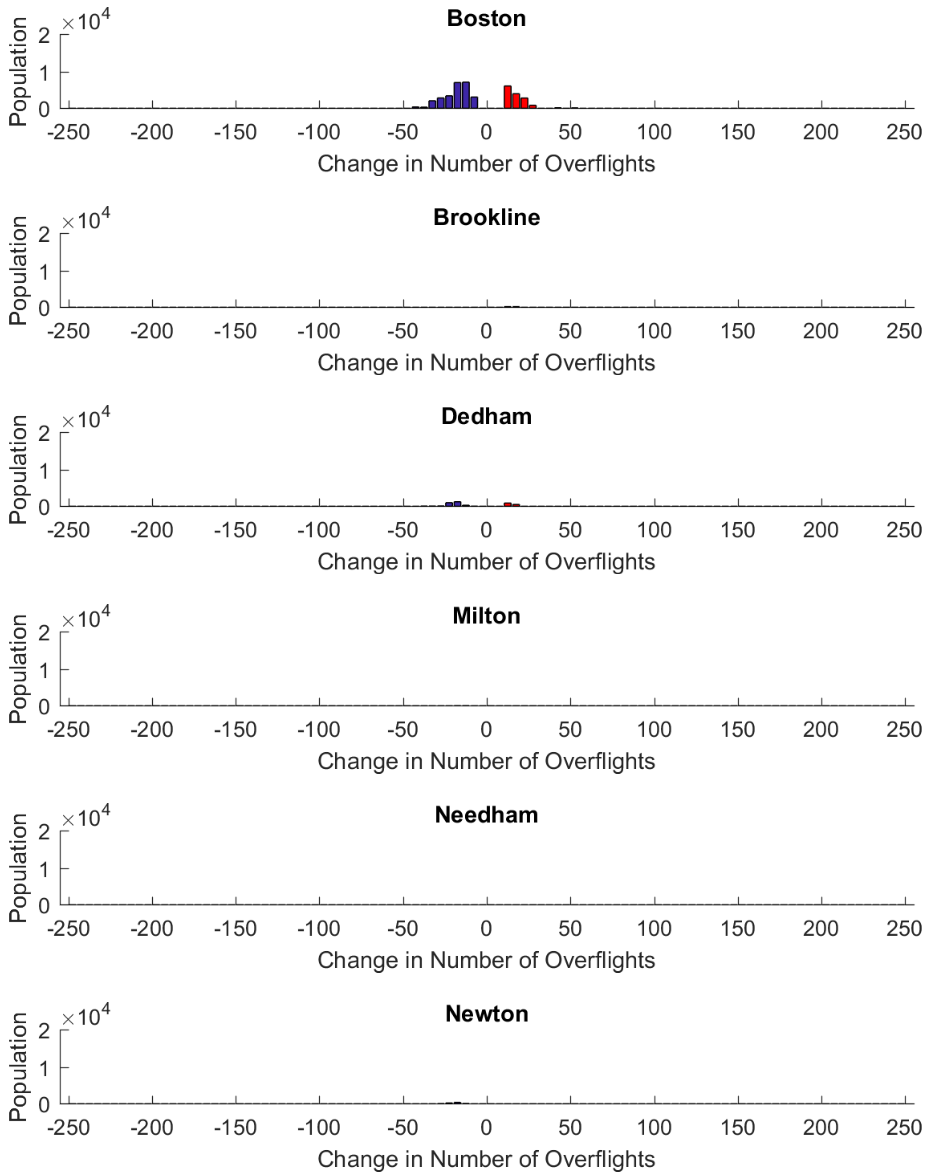
# 27 Departures Altitude-Based Dispersion at 3000ft Change in $N_{60}$ Compared to 2017



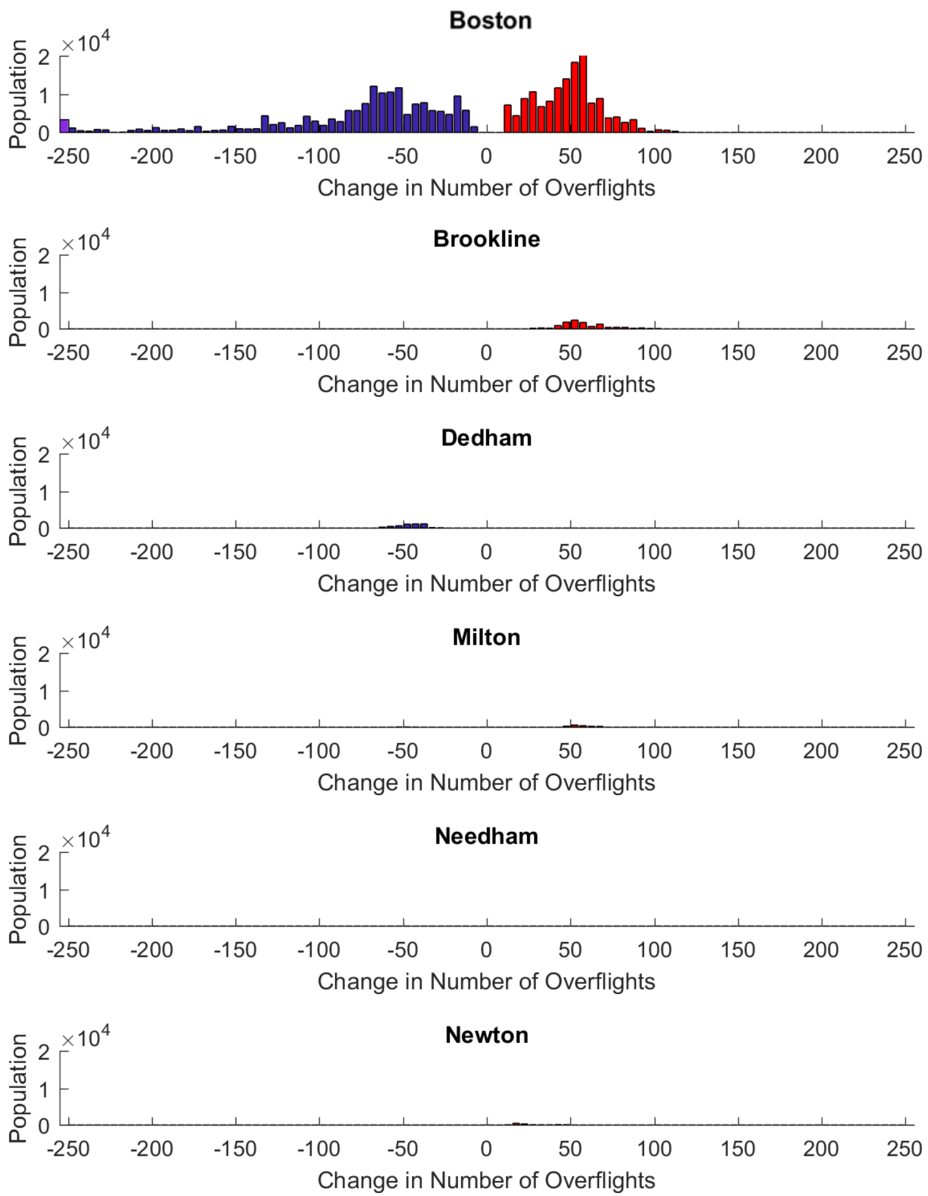
# 27 Departures Altitude-Based Dispersion at 4000ft Change in $N_{60}$ Compared to 2017



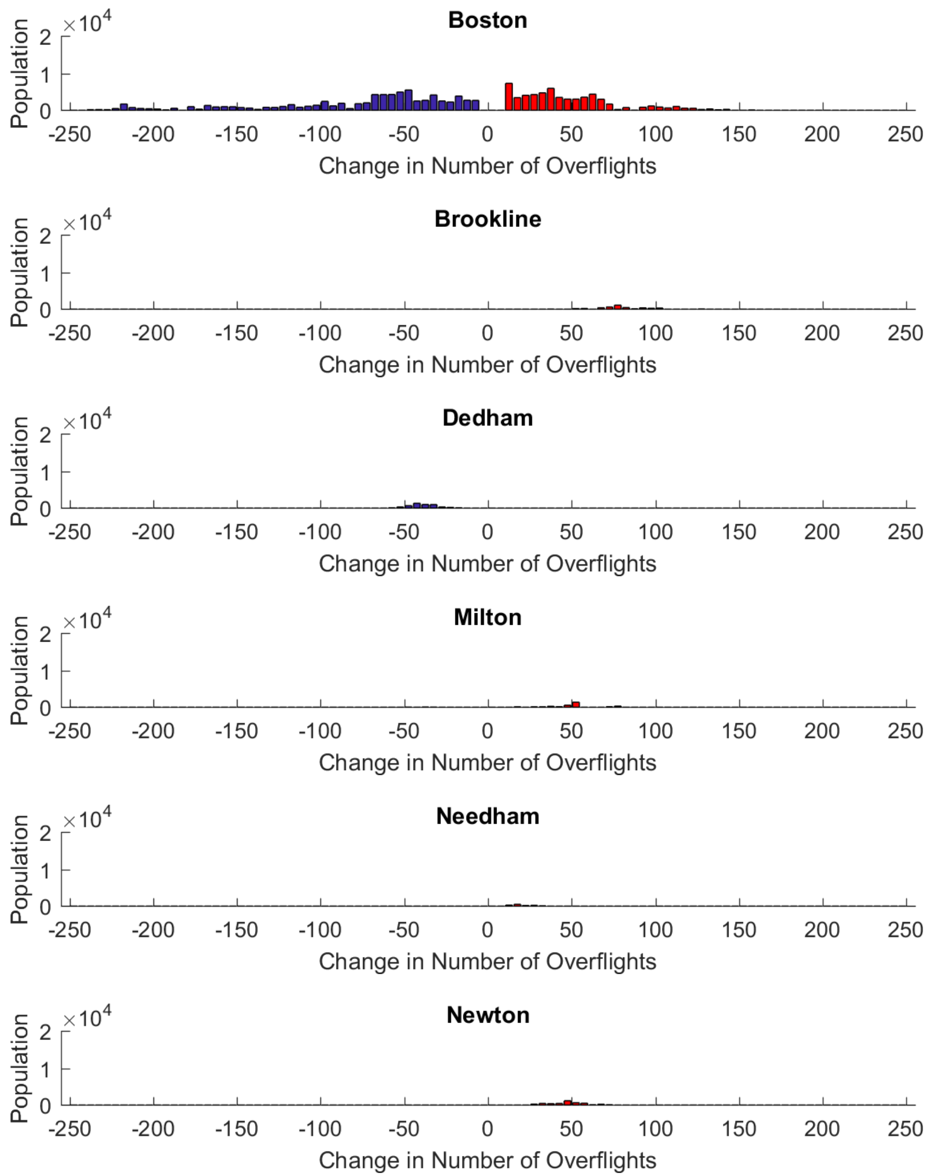
# 27 Departures Controller-Based Dispersion Change in $N_{60}$ Compared to 2017



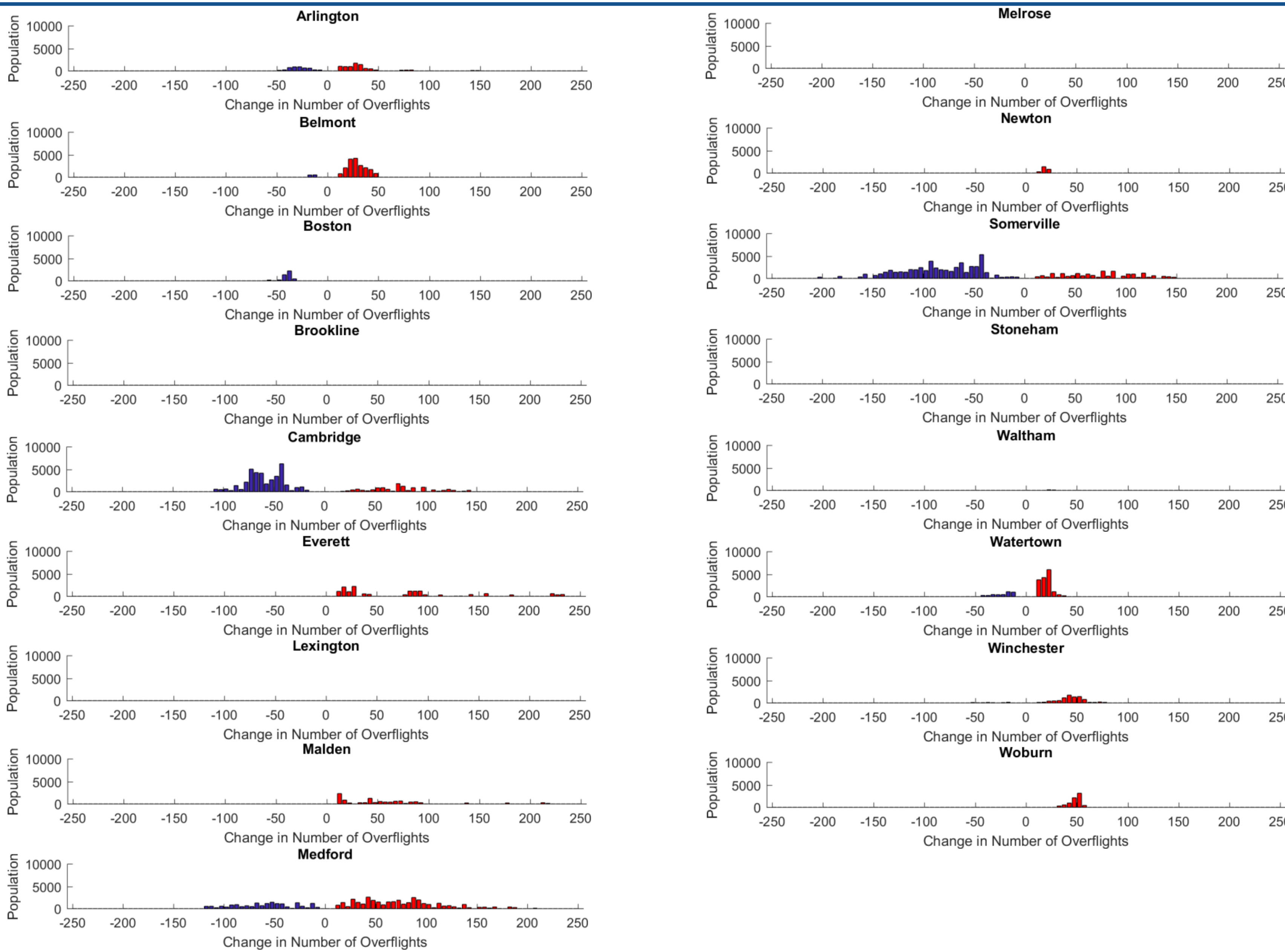
# 27 Departures Divergent Headings Dispersion Change in $N_{60}$ Compared to 2017



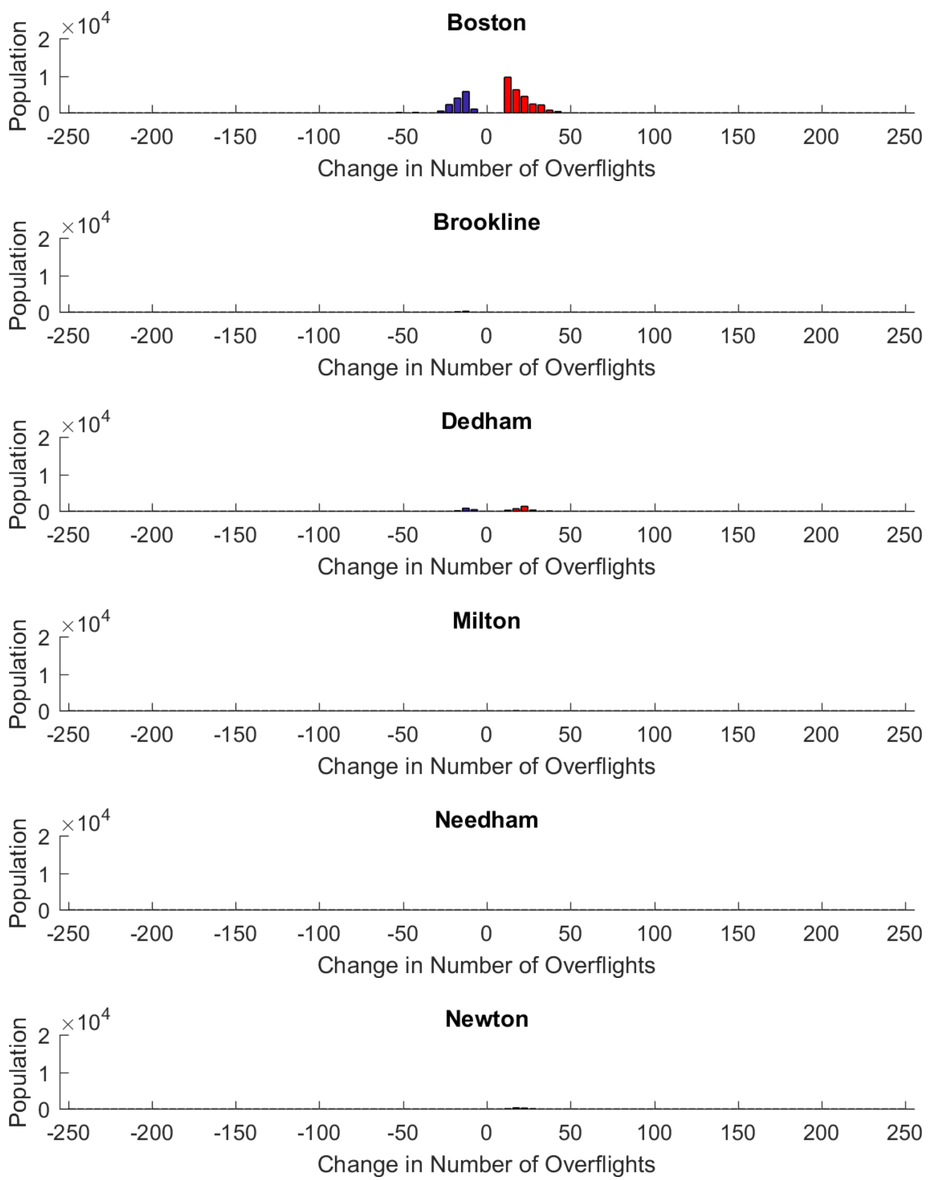
# 27 Departures RNAV Waypoint Relocation
## Change in $N_{60}$ Compared to 2017



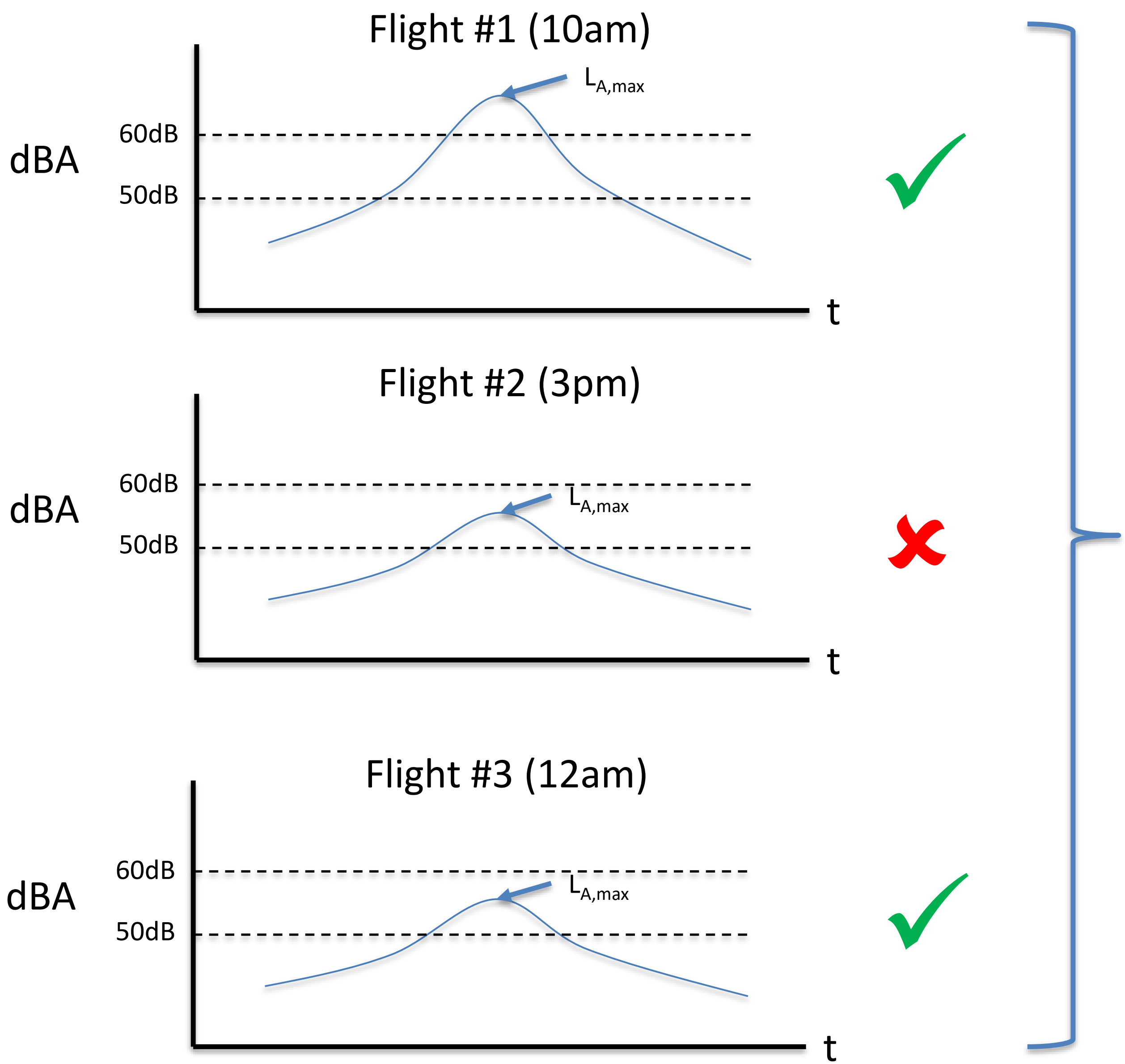
# Effect of RNAV Concentration on 33L Departures
## 2010 to 2017



# Effect of RNAV Concentration on 27 Departures
## 2010 to 2017



# $N_{60}$ Explanation




= 2 $N_{60}$

(60dB $L_{A,max}$ Day
50dB $L_{A,max}$ Night)