

Seattle-Tacoma International Airport



# Aircraft Arrival Altitude Analysis



May 23, 2018

# Presentation Overview

- Topics discussed at the January 24<sup>th</sup> meeting
- Relationship between aircraft altitude and aircraft noise exposure
- Purpose of the Altitude Analysis
- Have there been notable changes in arrival altitudes between 2013, 2015, and 2017?
- Summary
- Questions

## Topics discussed at the January 24<sup>th</sup> meeting

- Questions answered during the January 24<sup>th</sup> Meeting –
  - Since 2013 there has been an increase in the number of arrivals to SEA.
  - There was no notable change in traffic flow (north flow, south flow) between 2013, 2015, and 2017.
  - There was a notable difference in arrival runway use between 2013, 2015, and 2017 with traffic shifting from the center runways to the right and left runways.
  - Both the narrow body and wide body fleet mix serving SEA changed between 2013 and 2017 in so much as there has been an increase in use of some aircraft types and a decrease in use of others.

# Relationship between aircraft altitude and aircraft noise exposure

- Aircraft noise heard on the ground is a function of the:
  - Distance from the aircraft to the listener,
  - Aircraft thrust settings,
  - Aircraft configuration (i.e., is the aircraft “clean” or “dirty”?), and
  - Meteorological conditions (e.g., wind, humidity, inversions, etc.)
- On arrival, aircraft are:
  - Following vertical and horizontal guidance to the runway,
  - Using approach thrust settings and adjusting them as necessary to maintain a stabilized approach, and
  - Configured for landing with flaps, slats, and landing gear extended (i.e., the aircraft is “dirty”)



## Definition of a Stabilized Approach

*“A stabilized approach is one in which the pilot establishes and maintains a constant angle glide path towards a predetermined point on the landing runway.”*

Source: Federal Aviation Administration, [Airplane Flying Handbook](#), 2016.

- Published instrument approaches standardize the approach process making stabilized approaches routine
- Instrument Landing Systems (ILS) at the airport and Flight Management Systems (FMS) in the cockpit utilize precision guidance to keep aircraft on the desired approach course and glide slope

**SEATTLE, WASHINGTON**

LOC/DME I-C/L 110.75 Chan 44 (V)	APP CRS 184°	Rwy Idg TDZE Rwy Elev 3500 415	AL-52 (FAA)
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**ILS or LOC Rwy 16R**  
SEATTLE-TACOMA INTL (SEA) A

**MISSED APPROACH:** Climb to 900 then climb on heading 195° and on SEA VORTAC R-210 to cross TECCE/SEA 3 DME/RADAR at or below 2000 then climb to 5000 on SEA VORTAC R-210 to ZERU INT/SEA 1.5 DME/RADAR and hold, continue climb-in-hold to 5000.

D-ATIS	SEATTLE APP CON	SEATTLE TOWER	GND CON	CINC DEL	CPDCL
118.0	133.65 273.45	119.9 239.3 [Rwys 16L, 16C, 34C, 34R] 120.95 239.3 [Rwys 16R, 34L]	121.7	128.0	

**DME or RADAR REQUIRED**

**ALTERNATE MISSED APCH FIX**

**MISSED APCH FIX**

**ZERU INT**

**TECCE SEA**

**LOCIZER**

**CELAK**

**BUGNE**

**BOEING FIELD/KING COUNTY INT**

**SEATTLE**

**ELEV 433**

**TDZE 415**

**VGS and ILS glideslope not coincident (VGS Angle 3.00/TCH 69)**

**GS 3.00° TCH 55**

**Category A**

**S-LOC 16R**

**S-LOC 16L**

**CIRCLING**

**SEATTLE, WASHINGTON**

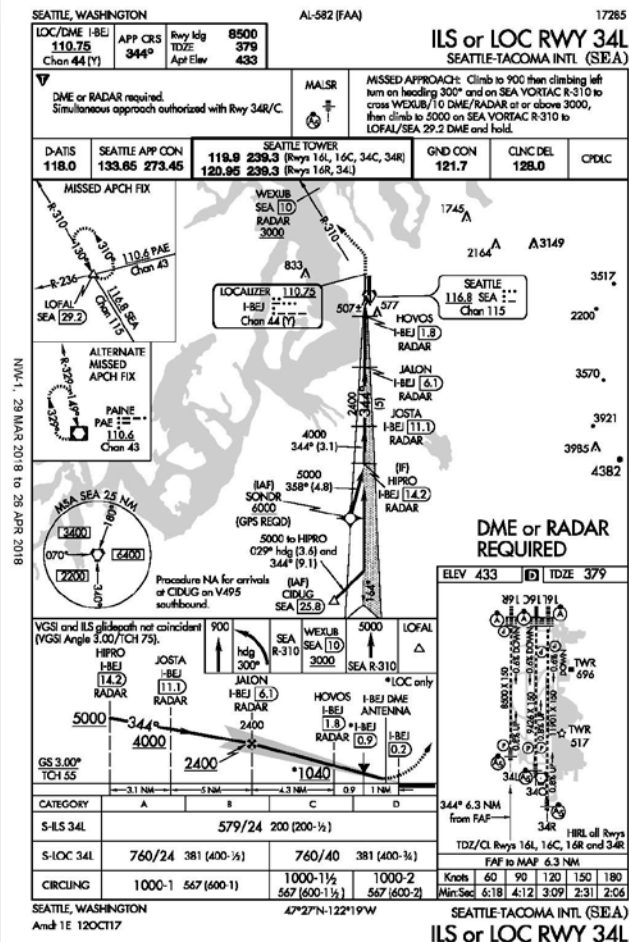
**Amch 4A 120CT17**

**47°27'N-122°19'W**

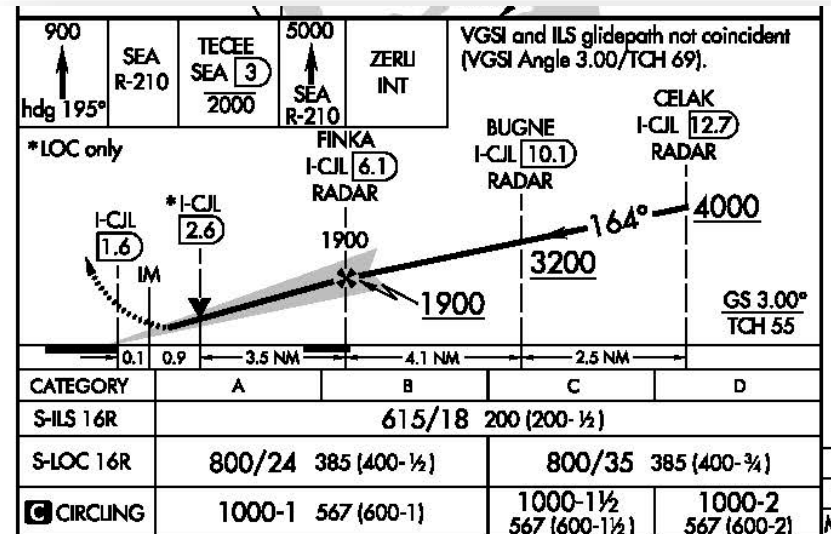
**ILS or LOC Rwy 16R**

esassoc.com

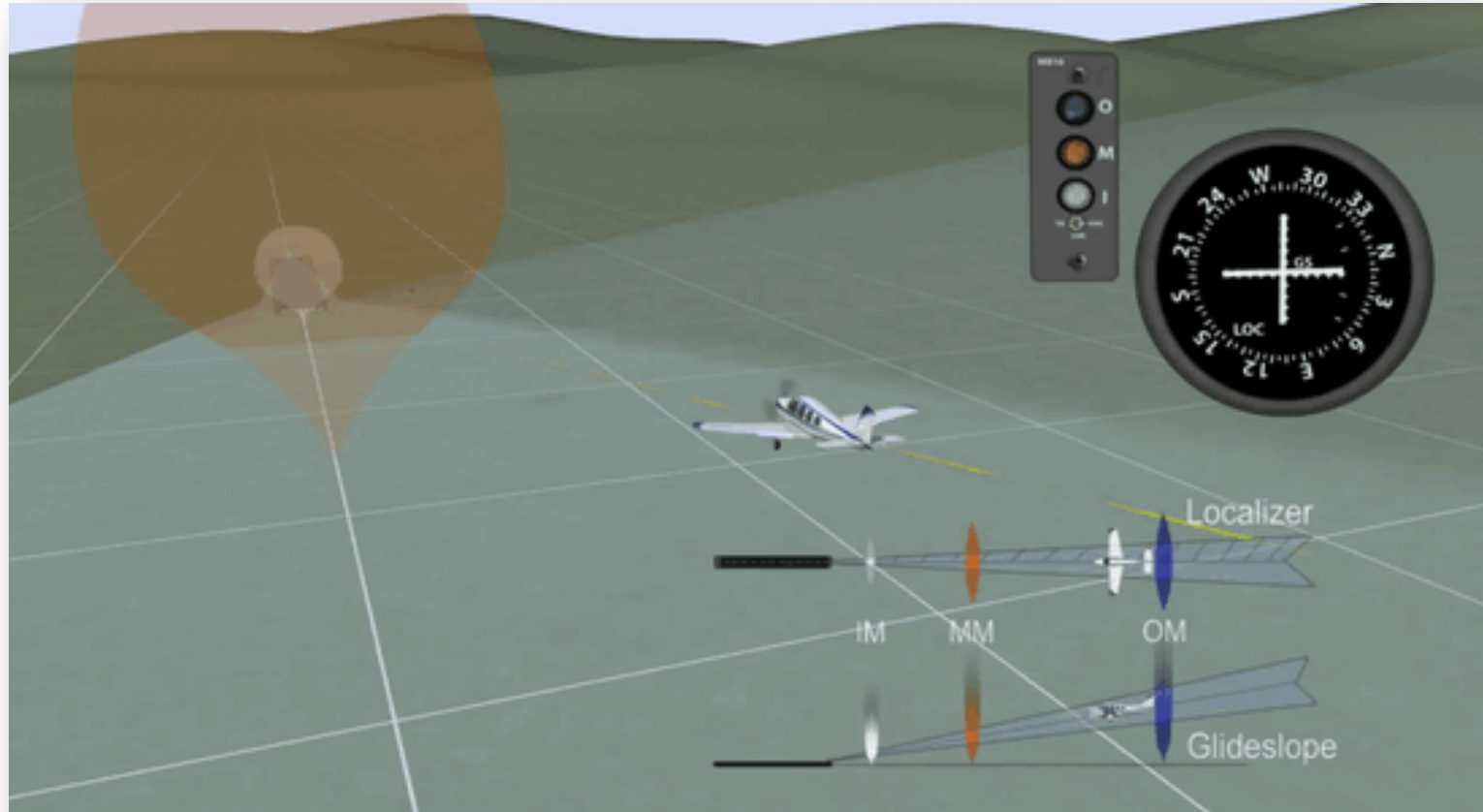
Source: Federal Aviation Administration



- Approach plate data in each aircraft's FMS includes:
  - Course guidance (heading)
  - Minimum altitudes at points (fixes) along the approach course
- Pilots are required to follow the approach plate guidance



# ILS Provides Vertical and Horizontal Guidance



Source: RBRN.com

# Depiction of Aircraft Noise Propagation

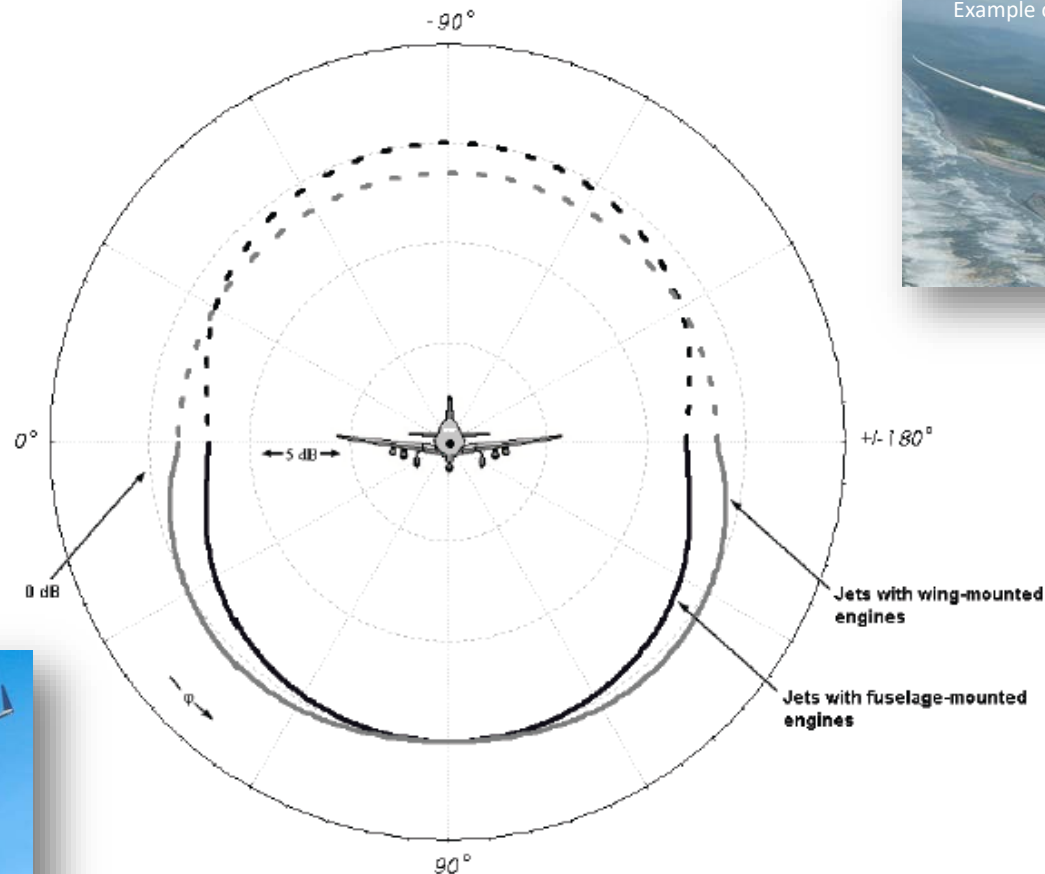


Image Credit: Bombardier



Photo Credit: Boeing

Source: Federal Aviation Administration, Aviation Environmental Design Tool 2d Technical Manual, September 2017.

DRAFT – For Deliberative Purposes Only

# Depiction of Aircraft Noise Propagation

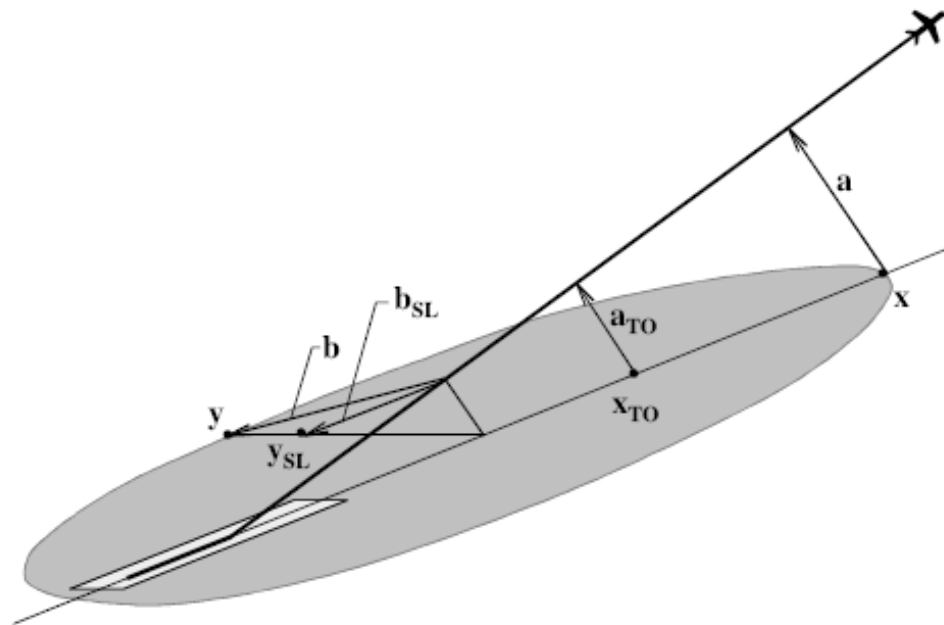
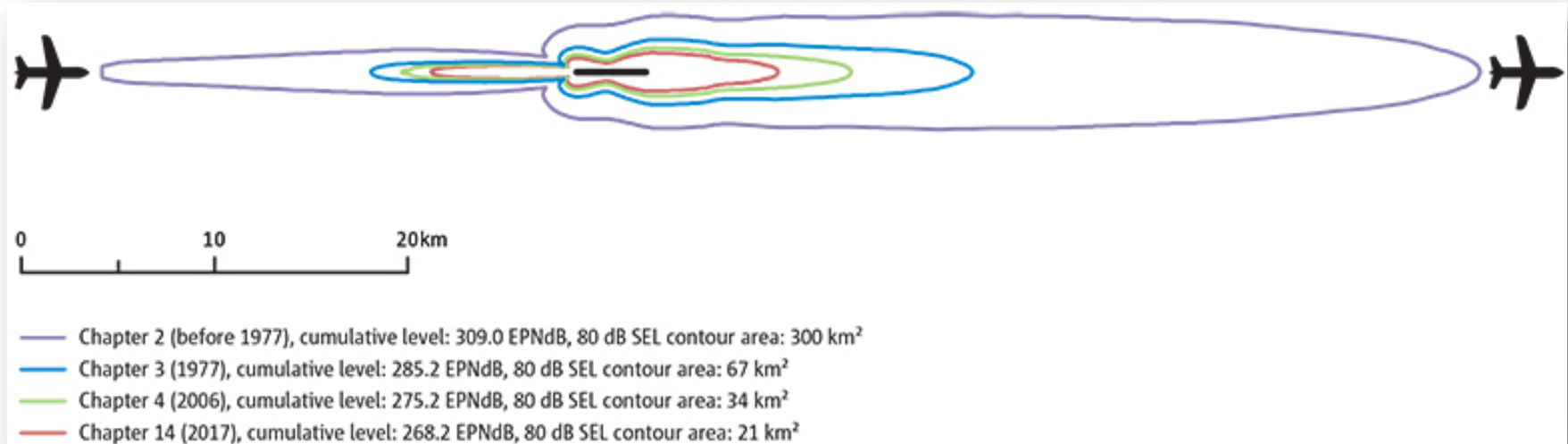


Figure 1. Generalized departure noise contour and geometric relationships to noise certification measurement locations

Source: NASA, Relationship between Aircraft Noise Contour Area and Noise Levels at Certification Points, September 2003.



## Example Sound Exposure Level Contours



*“Figure 2.2 shows the effect of the difference between the noise certification limits of the various chapters. It illustrates the areas that are exposed to noise levels greater than 80 dB during one landing and take-off for aircraft that just meet the various Chapter limits.”*

Source: European Aviation Safety Agency, the European Environment Agency and EUROCONTROL, Figure 2.2, European Aviation Environmental Report, 2016.



## Purpose of the Altitude Analysis

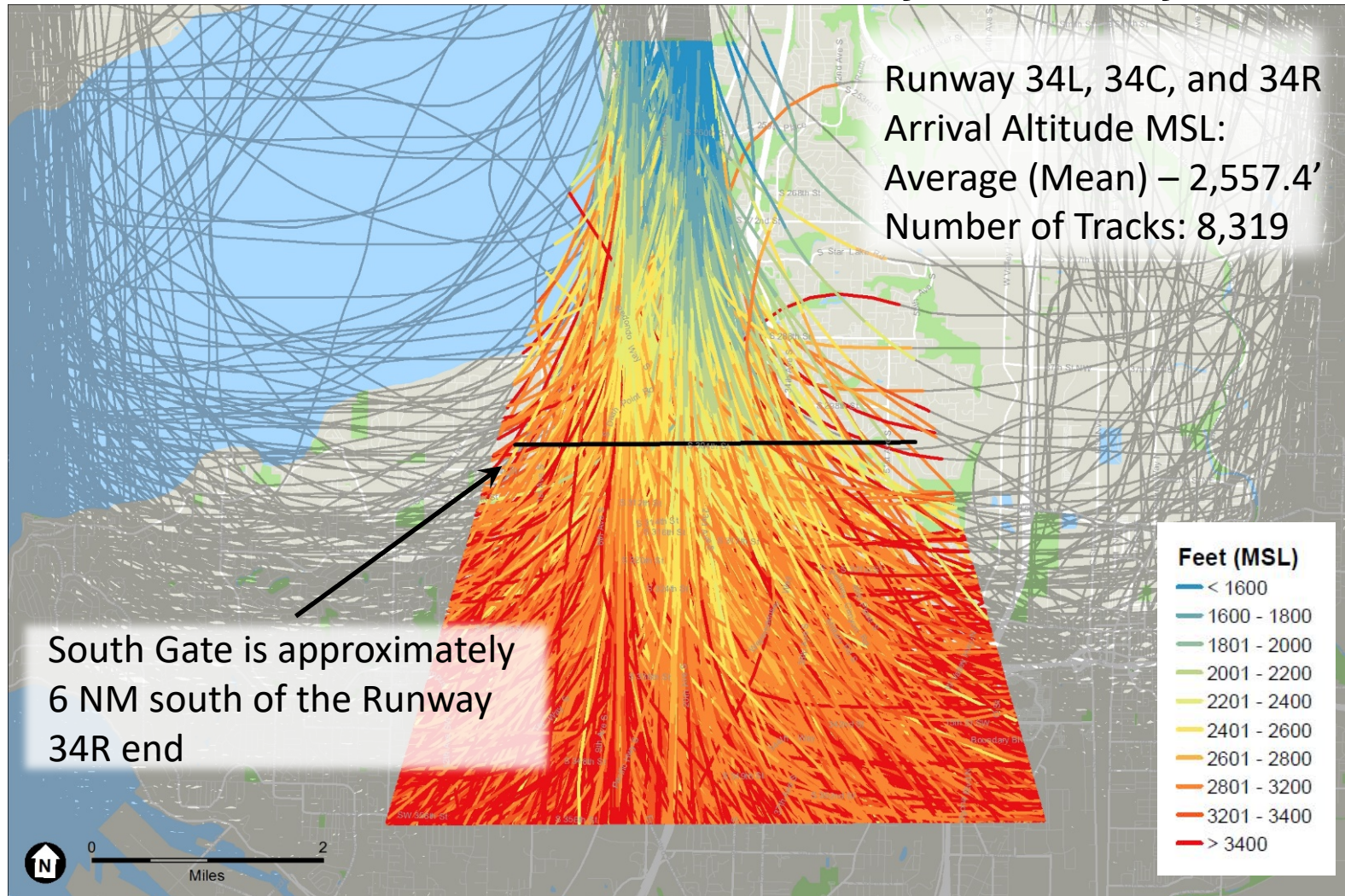
- To determine whether changes to aircraft arrival altitudes have occurred over the last five years
- Basis of the analysis –
  - Radar flight track data sets for the months of July and December 2013, 2015, and 2017
  - Apples-to-apples comparison of aircraft arrivals to SEA for these time periods
- Analysis details –
  - Radar flight tracks were analyzed to evaluate average aircraft altitudes at six nautical miles from SEA in both North and South Flow

## Have there been notable changes in arrival altitudes between 2013, 2015, and 2017?

- Answer - No.
  - Aircraft altitudes on arrival from both the north and the south have remained very consistent year over year
    - For example, between 2013 and 2017, the difference in average altitude for north flow arrivals 6 NM from the Runway 34R end was approximately 55 feet. In comparison, the tail of a 747-800 is approximately 64 feet in height. The difference in altitude is less than the height of a common wide body aircraft.
  - Aircraft are following the glideslopes in the published approach procedures

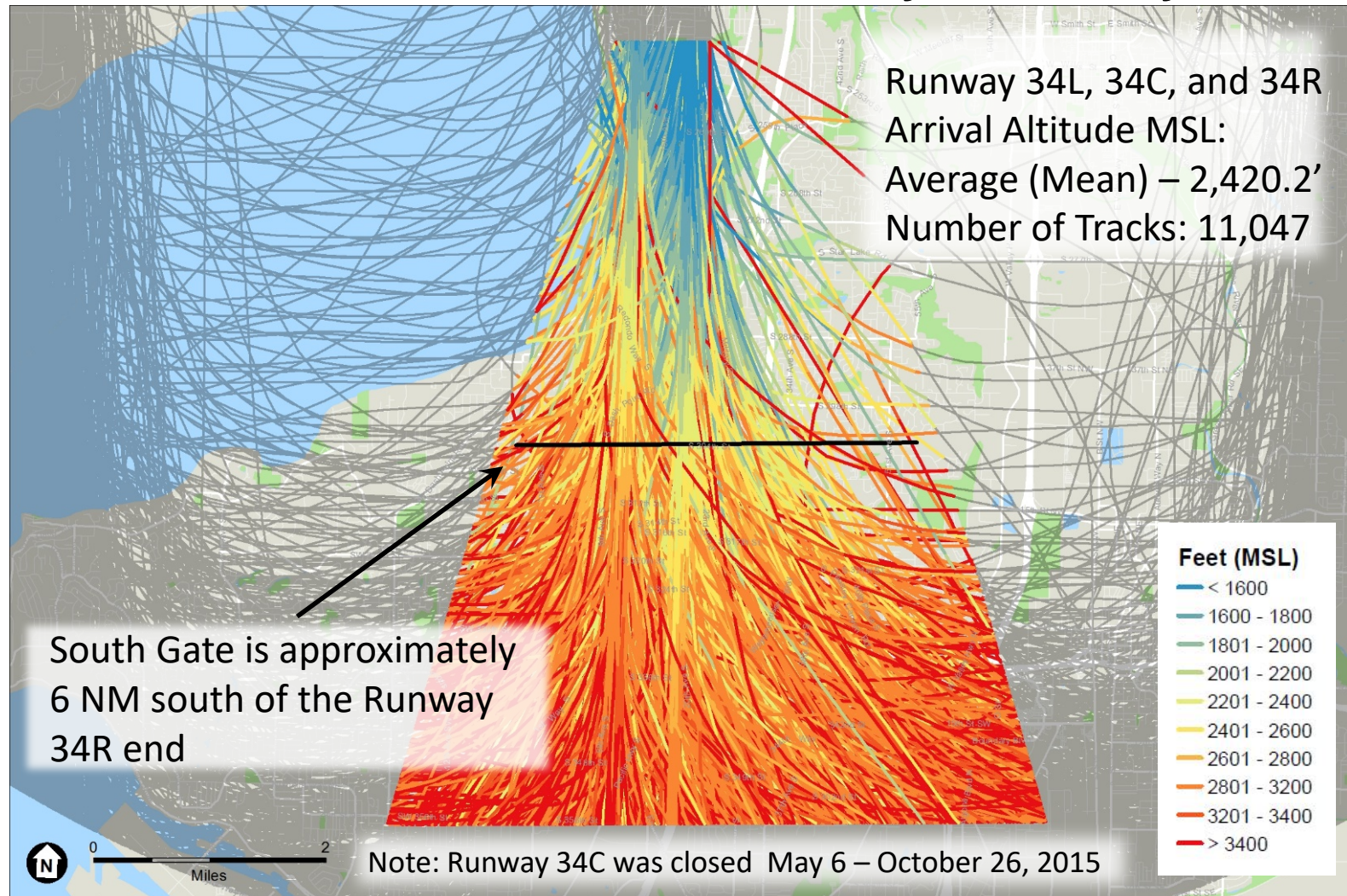
# Summer Flight Tracks

# North Flow Arrivals Over Federal Way, WA – July 2013



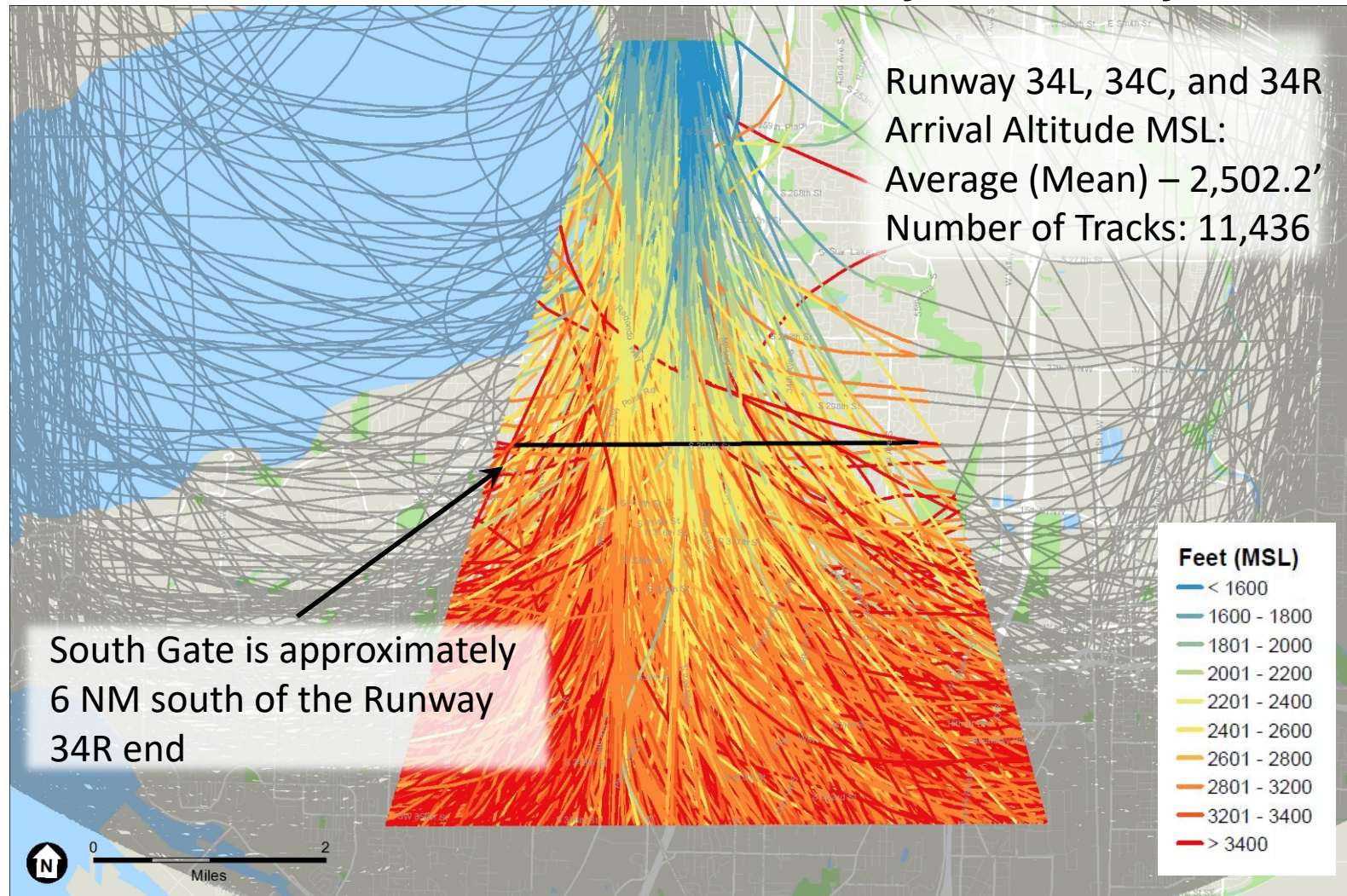


# North Flow Arrivals Over Federal Way, WA – July 2015

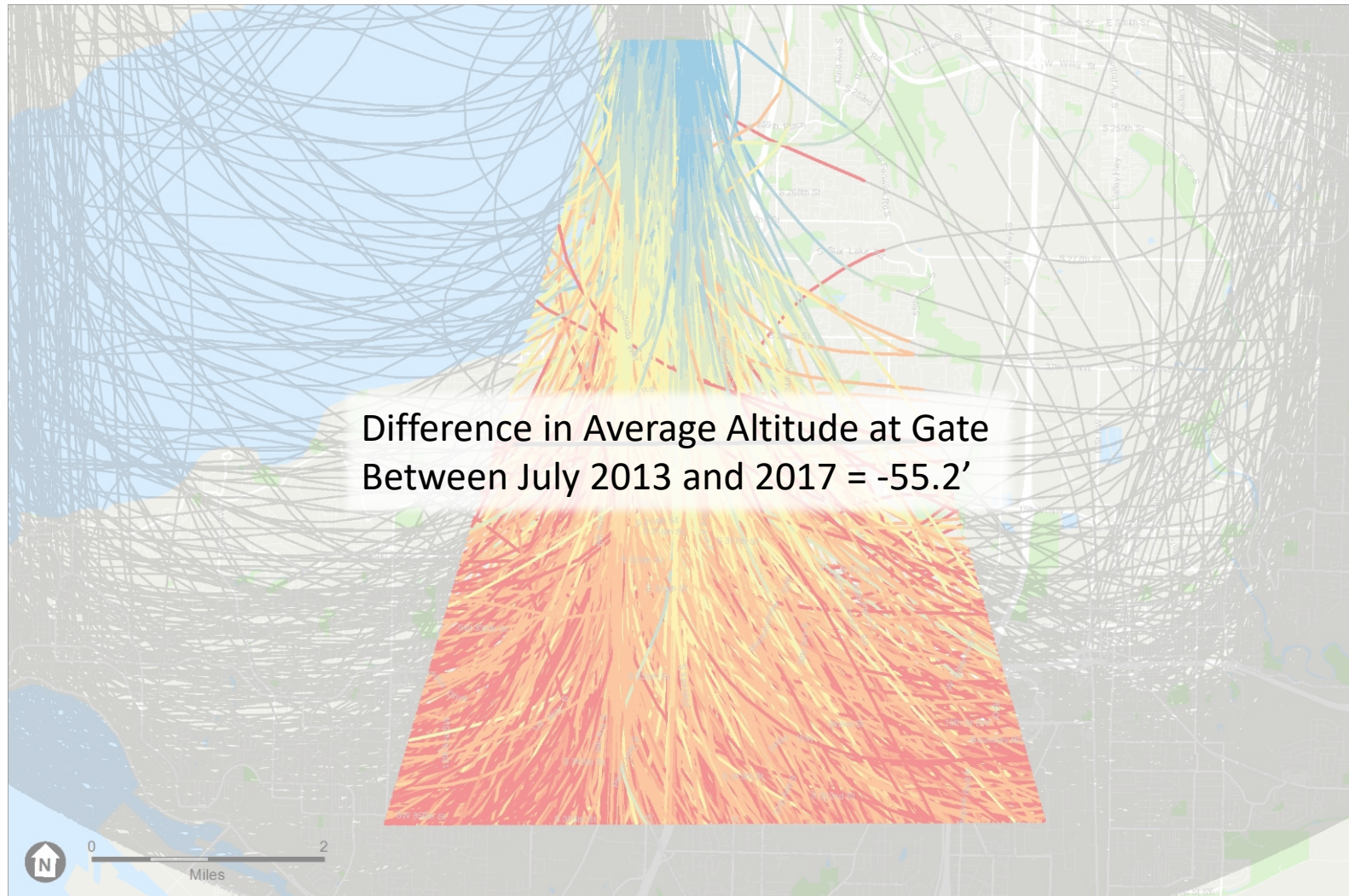




# North Flow Arrivals Over Federal Way, WA – July 2017

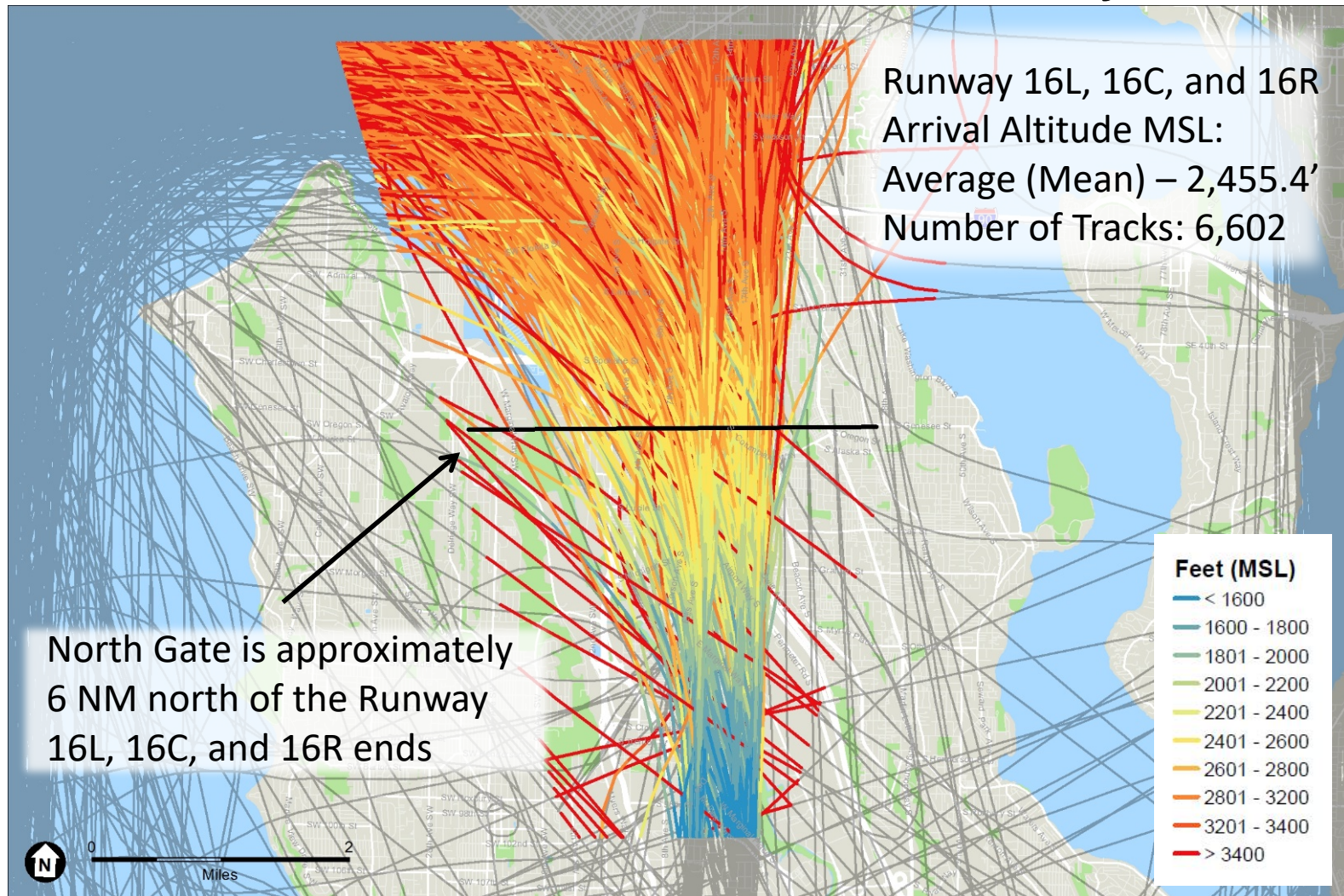






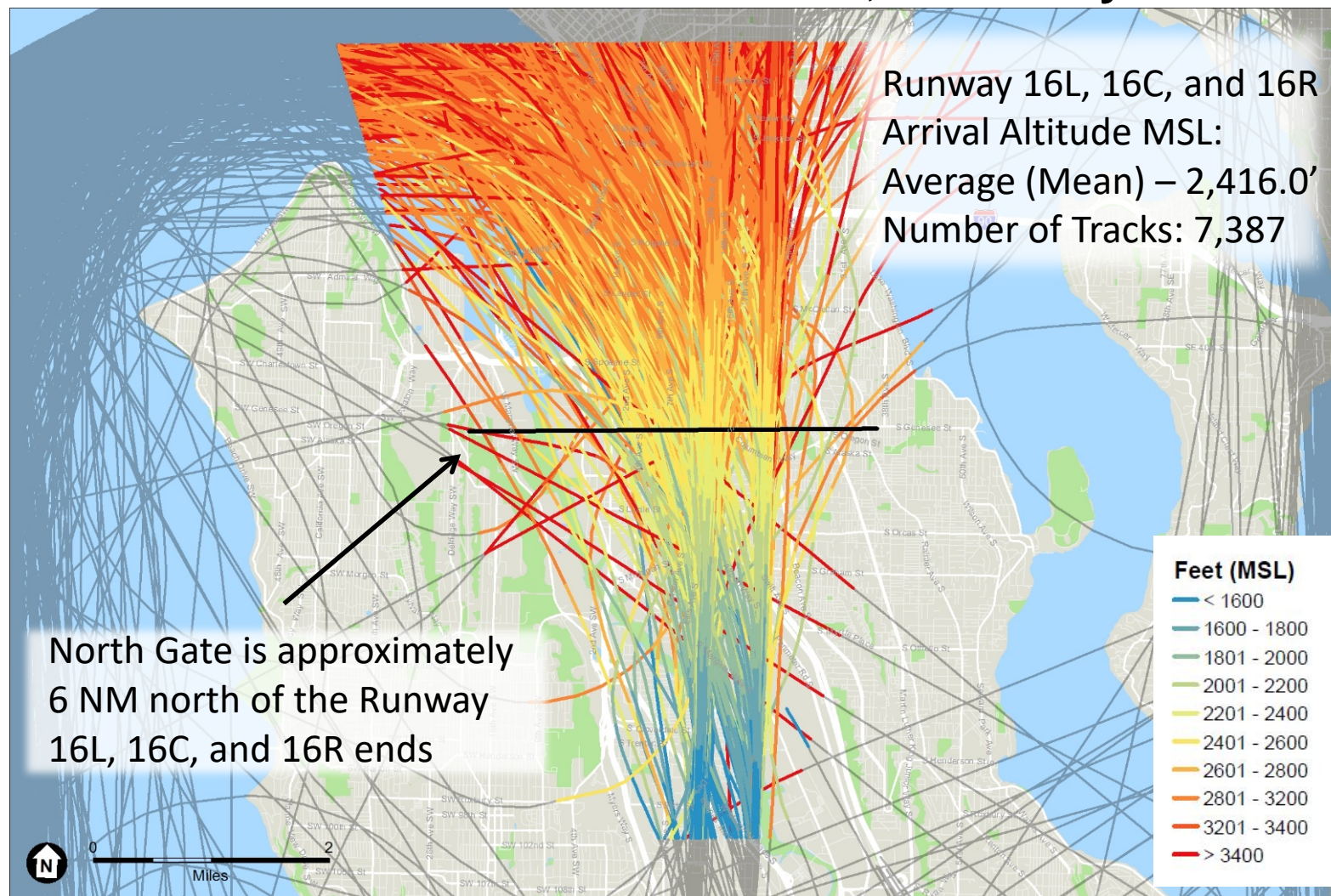


## South Flow Arrivals Over Seattle, WA – July 2013



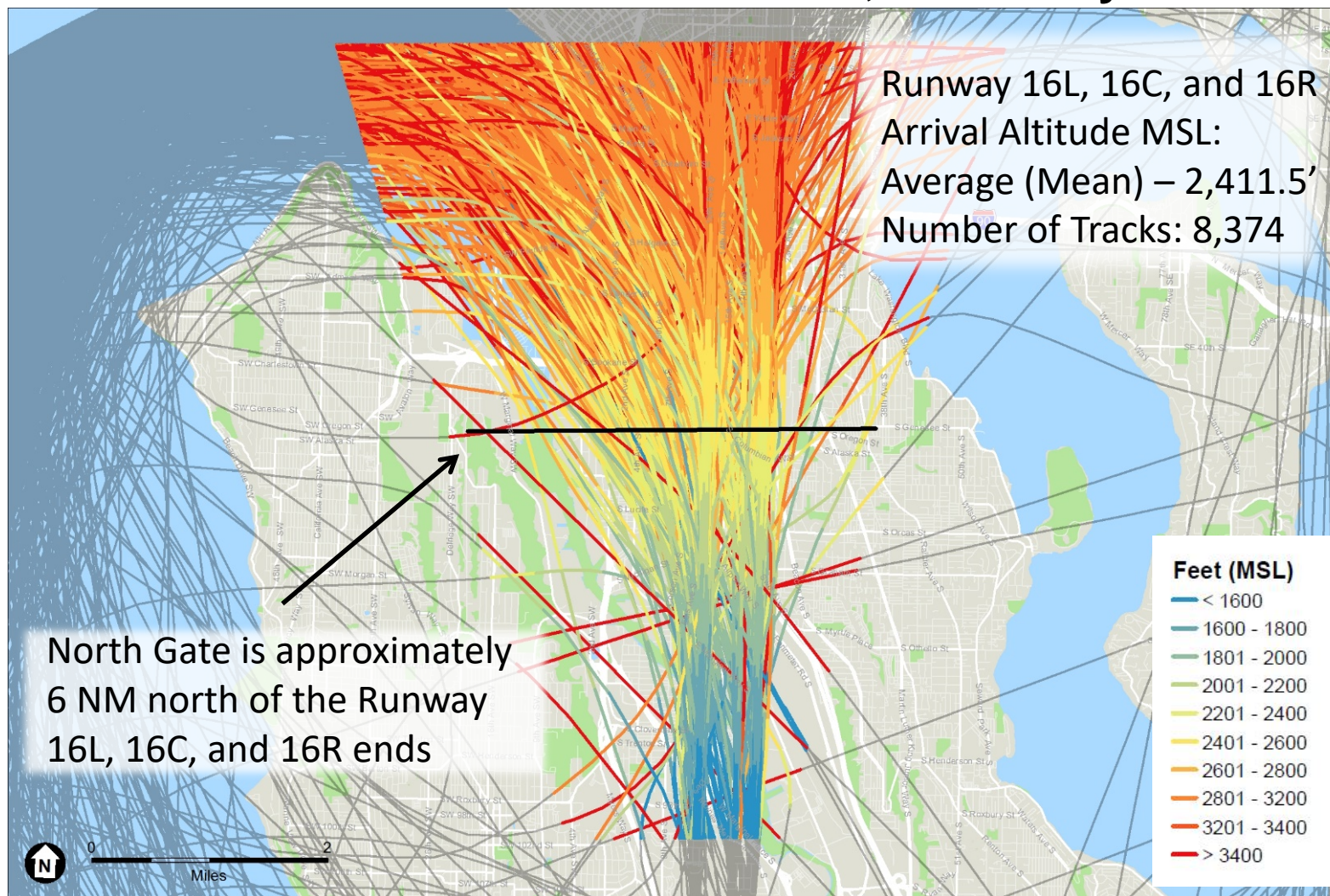


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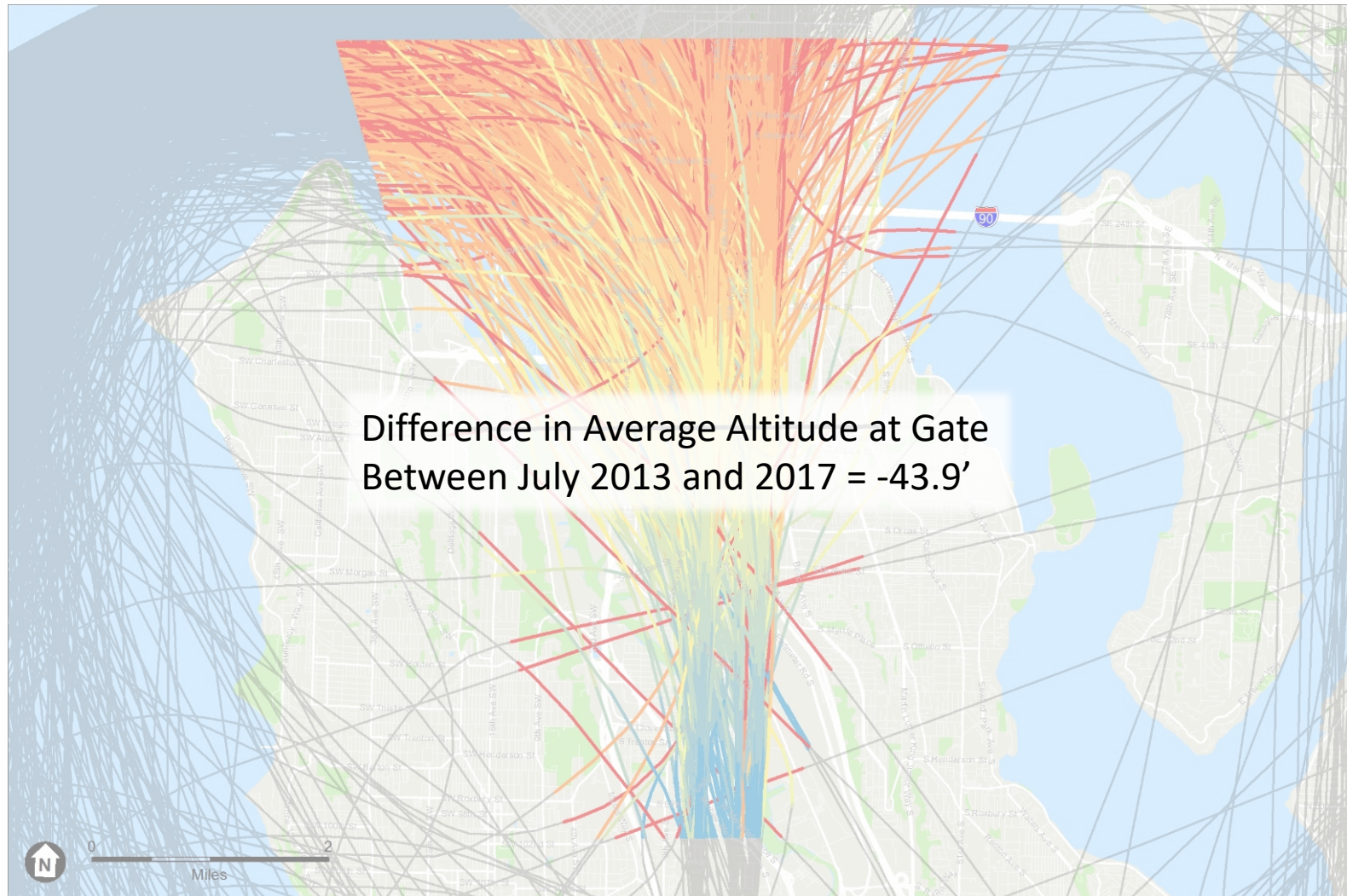




## South Flow Arrivals Over Seattle, WA – July 2017



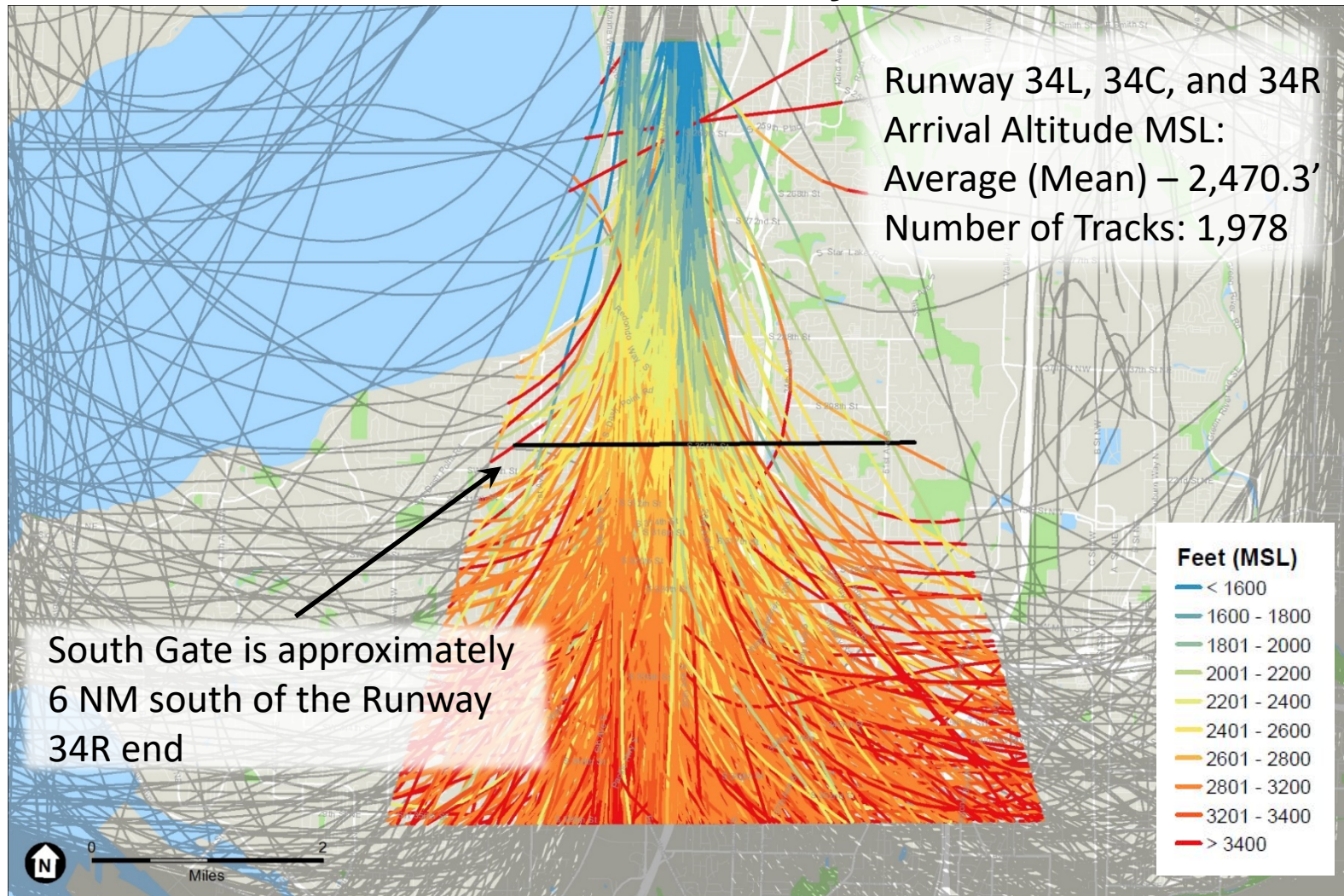




# Winter Flight Tracks

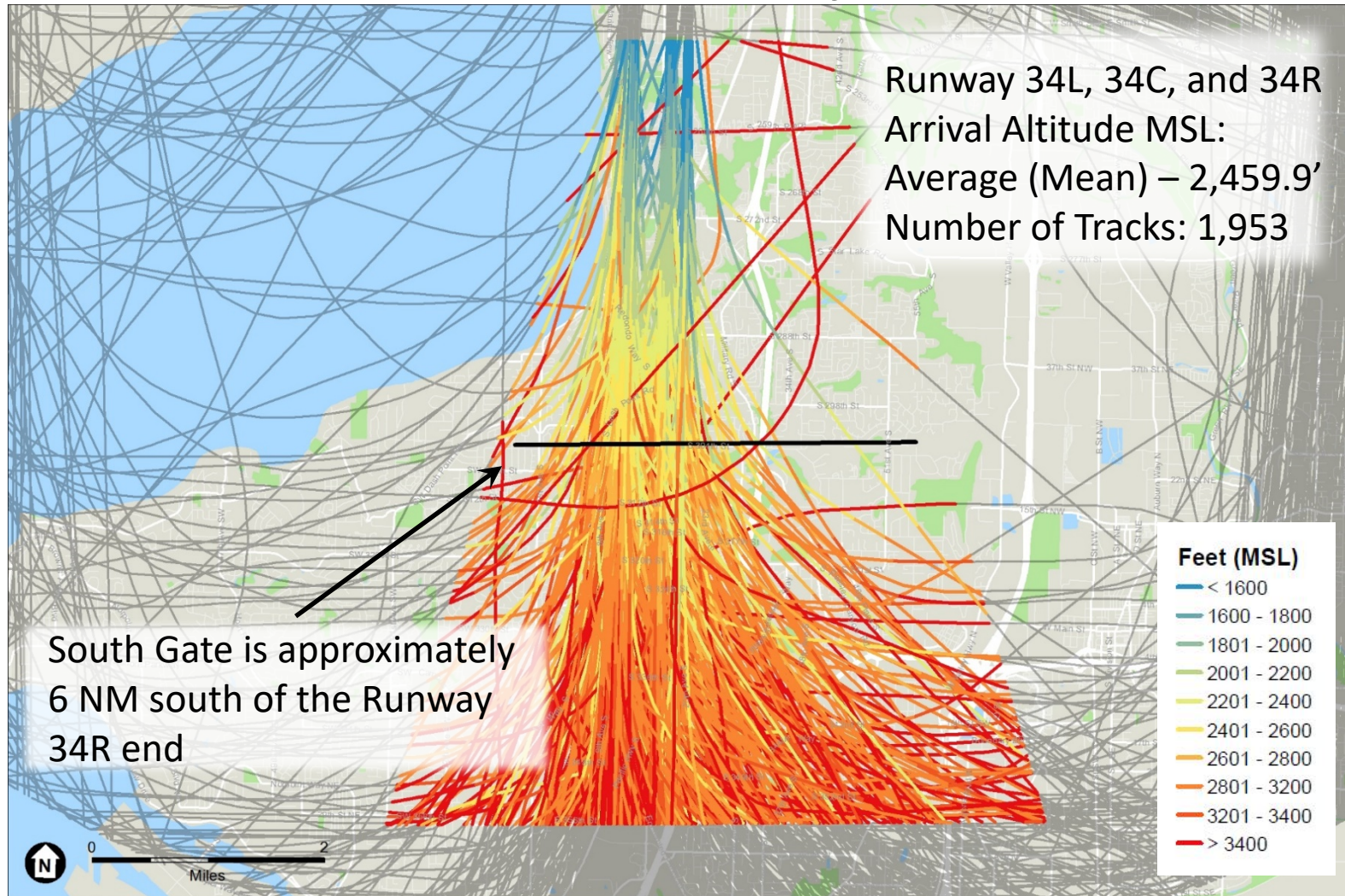


# North Flow Arrivals Over Federal Way, WA – December 2013



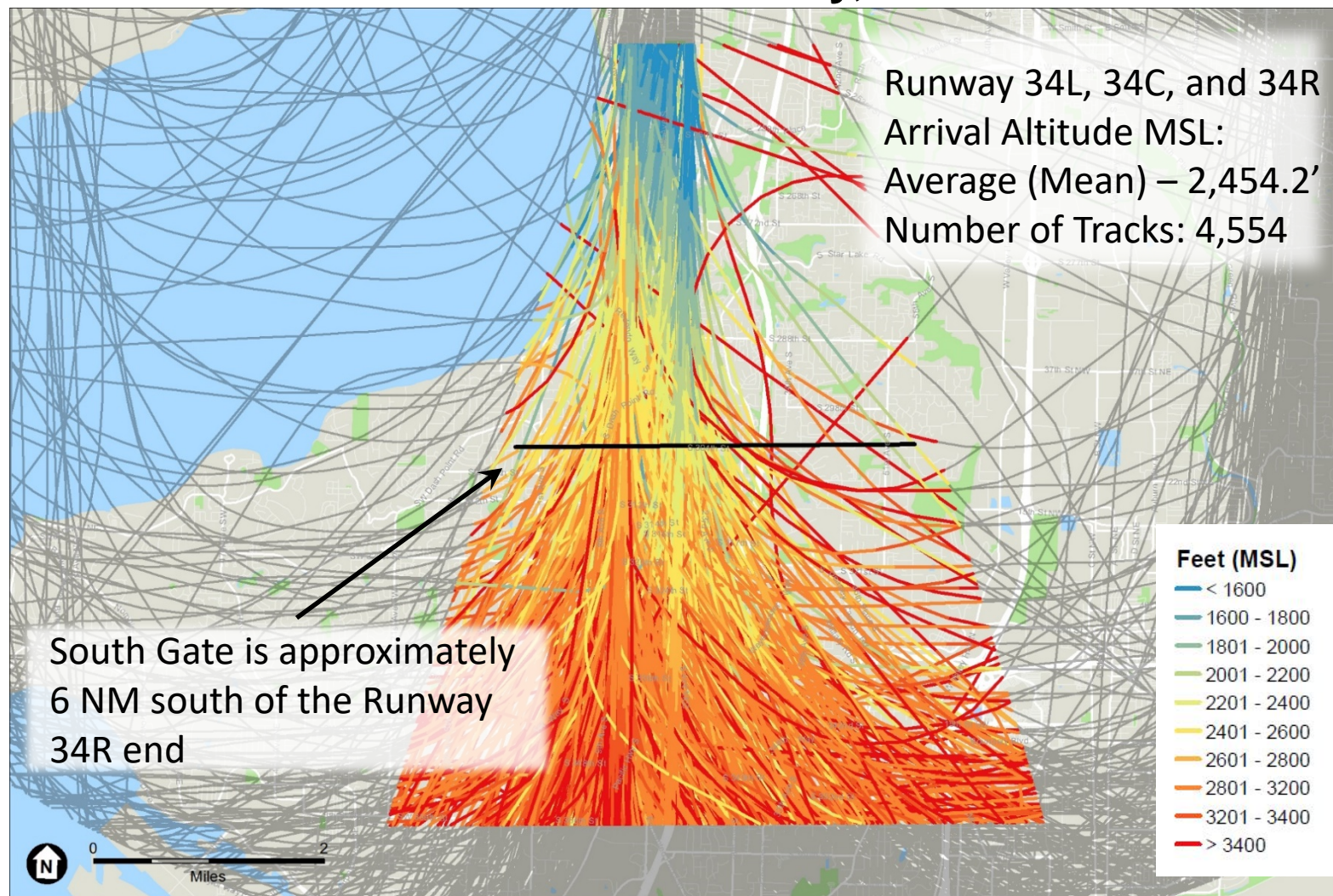


# North Flow Arrivals Over Federal Way, WA – December 2015

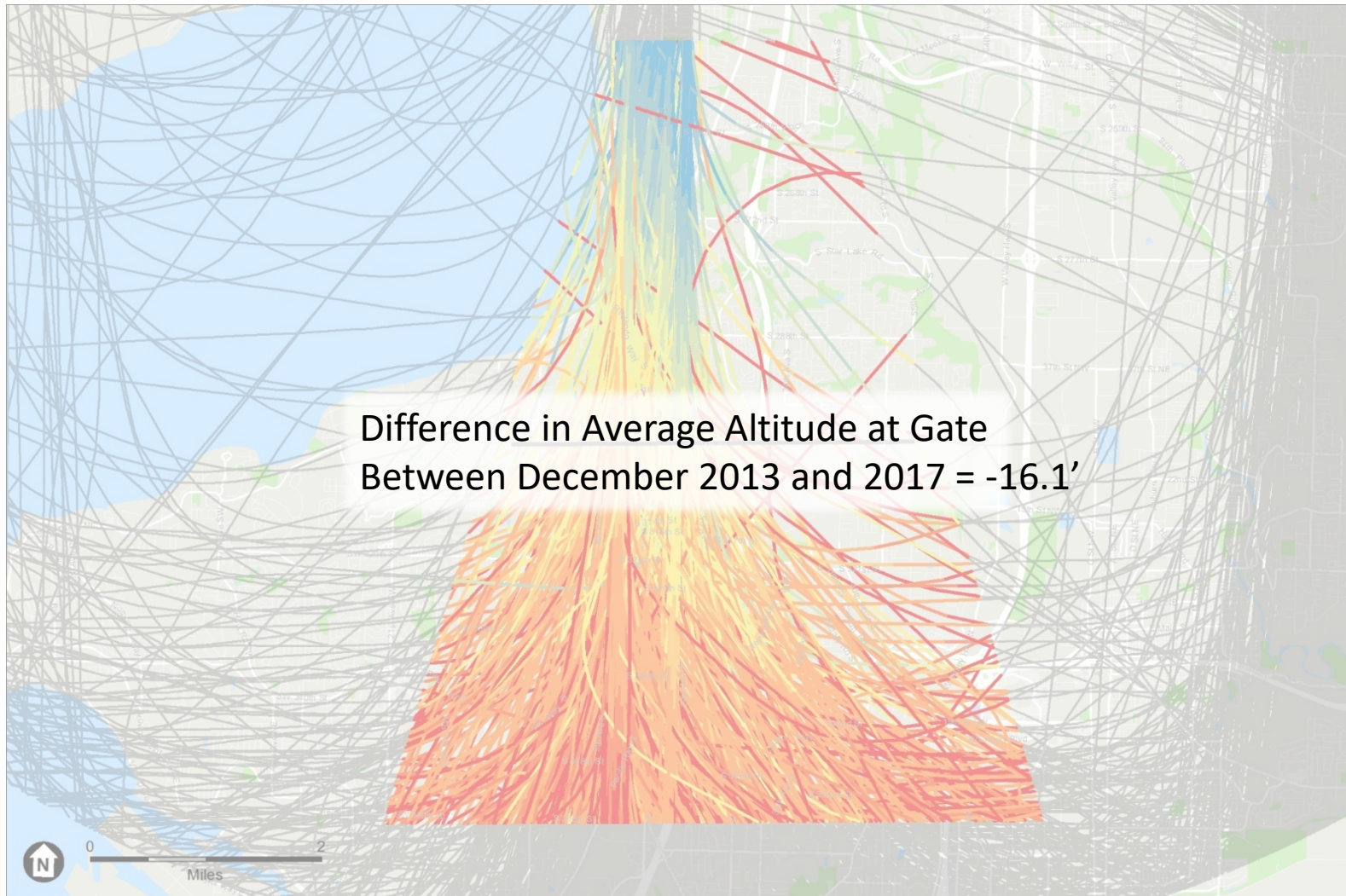




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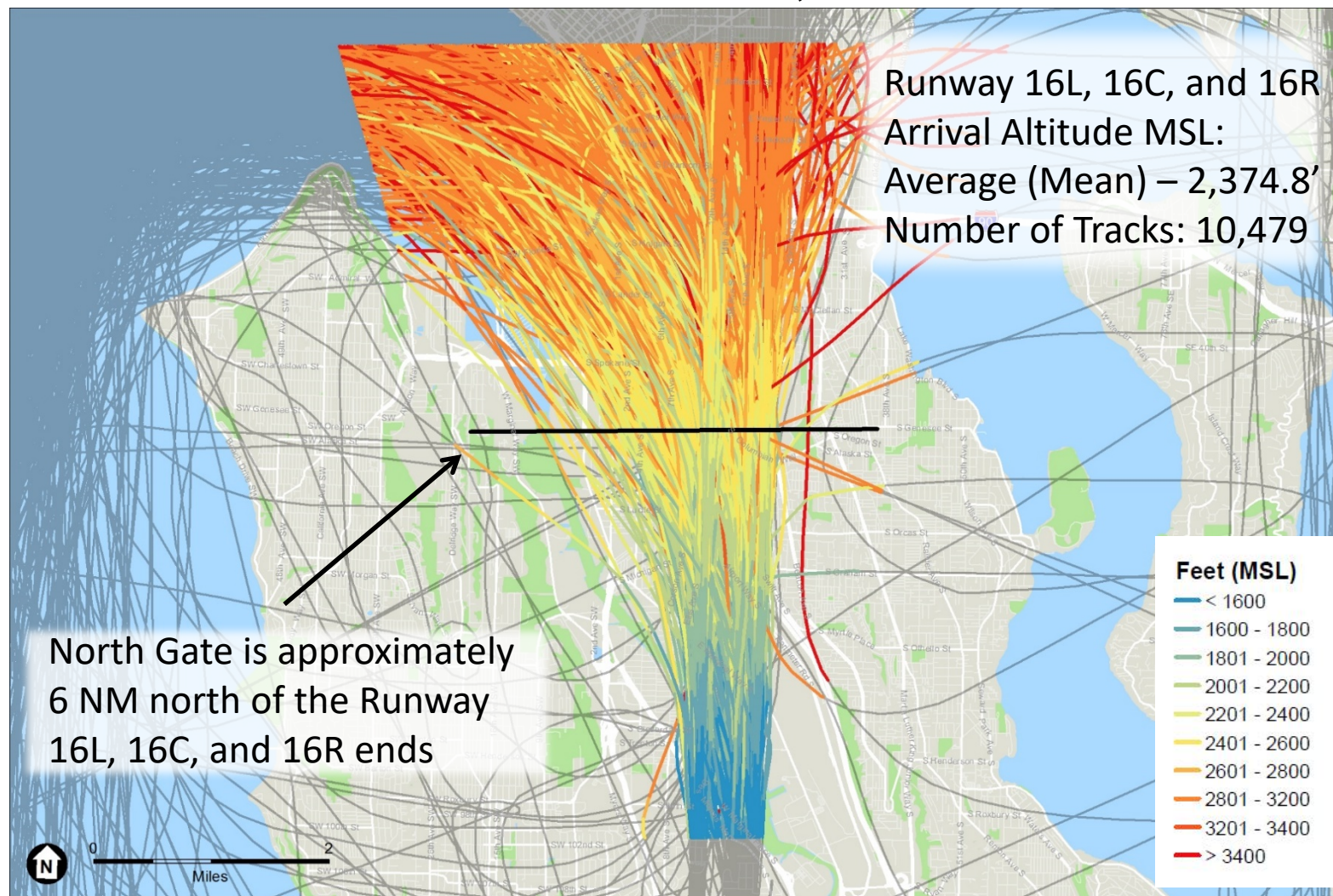






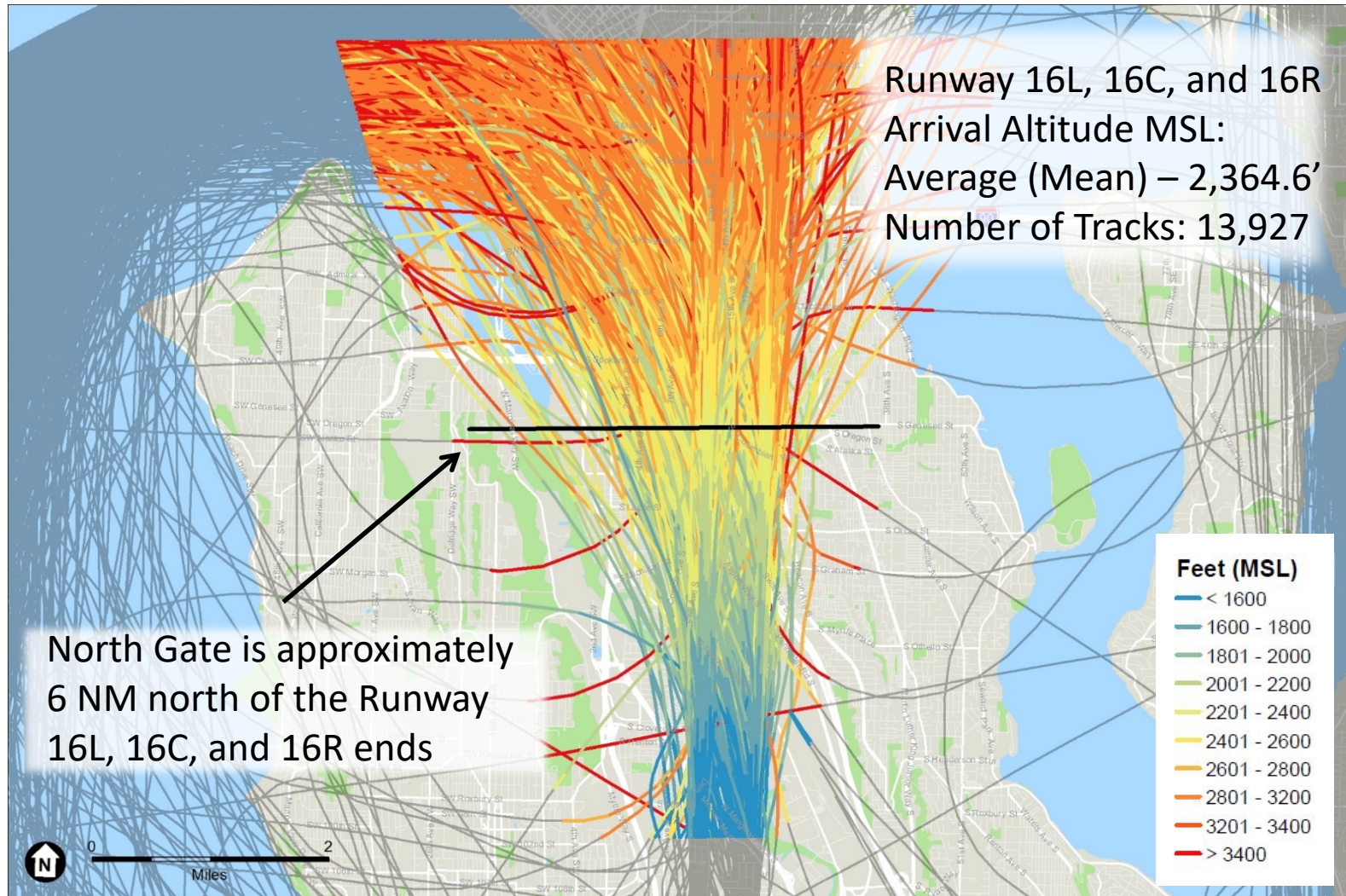


# South Flow Arrivals Over Seattle, WA – December 2013



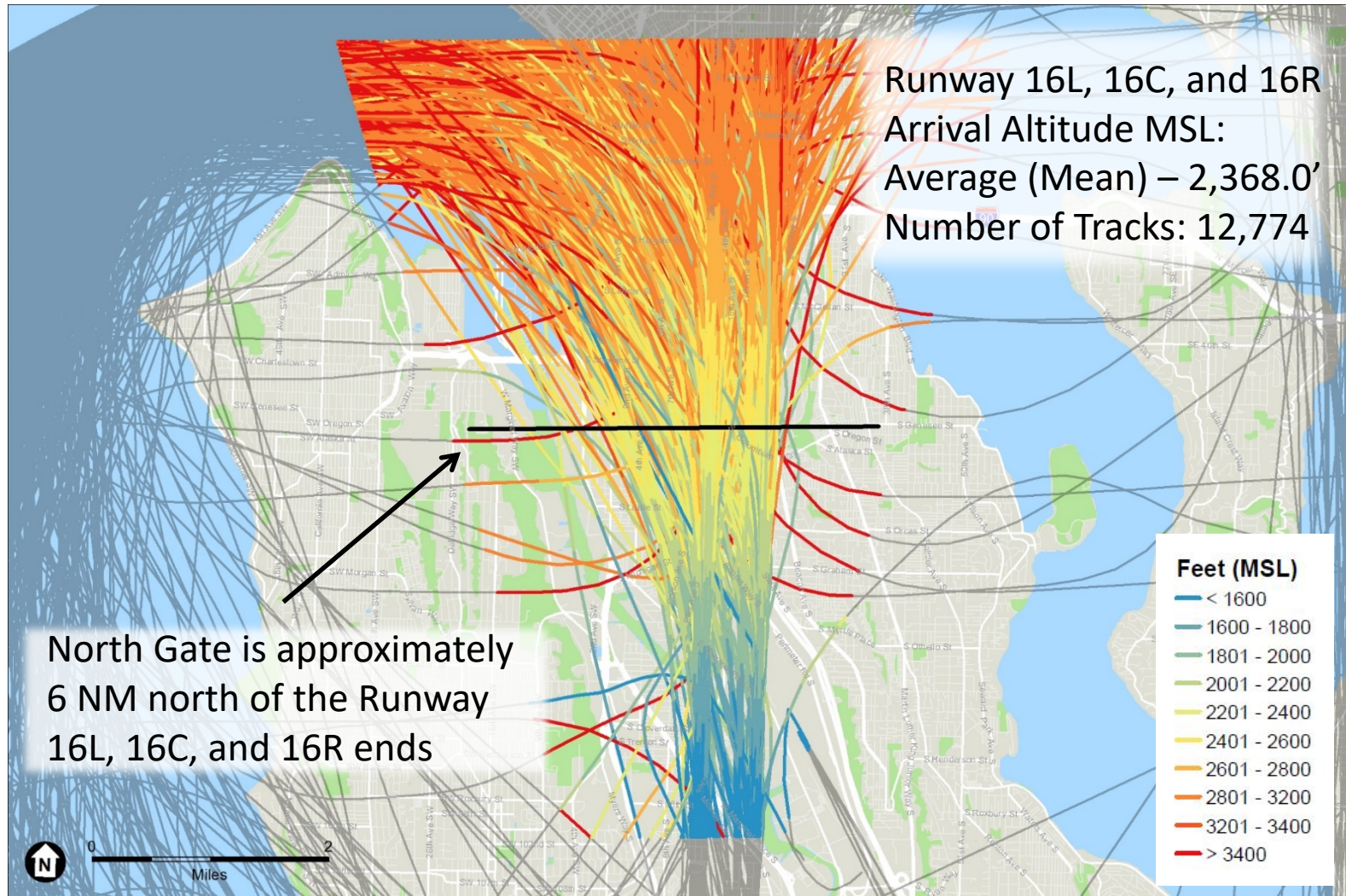


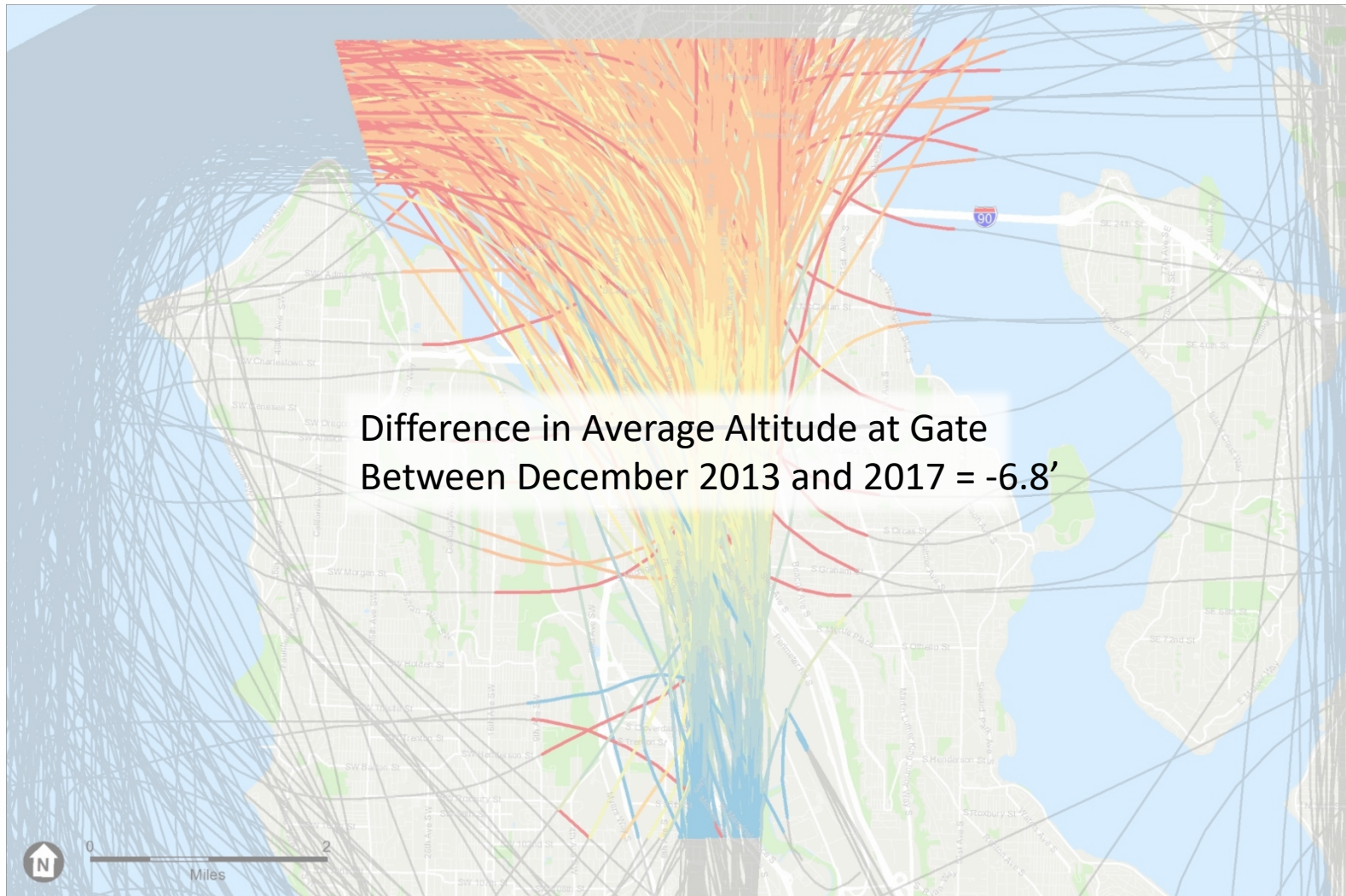
# South Flow Arrivals Over Seattle, WA – December 2015





# South Flow Arrivals Over Seattle, WA – December 2017



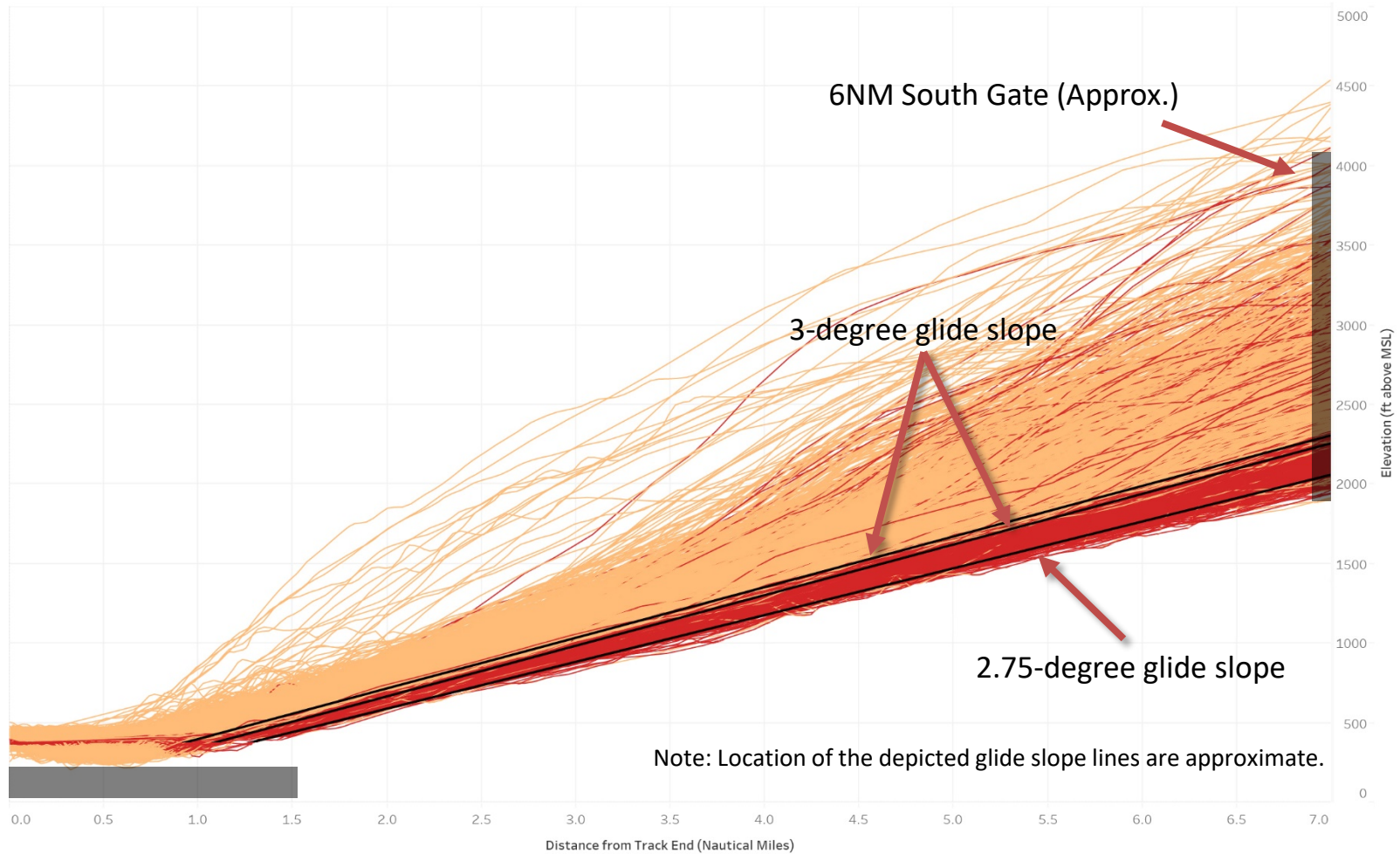


**Difference in Average Altitude at Gate  
Between December 2013 and 2017 = -6.8'**

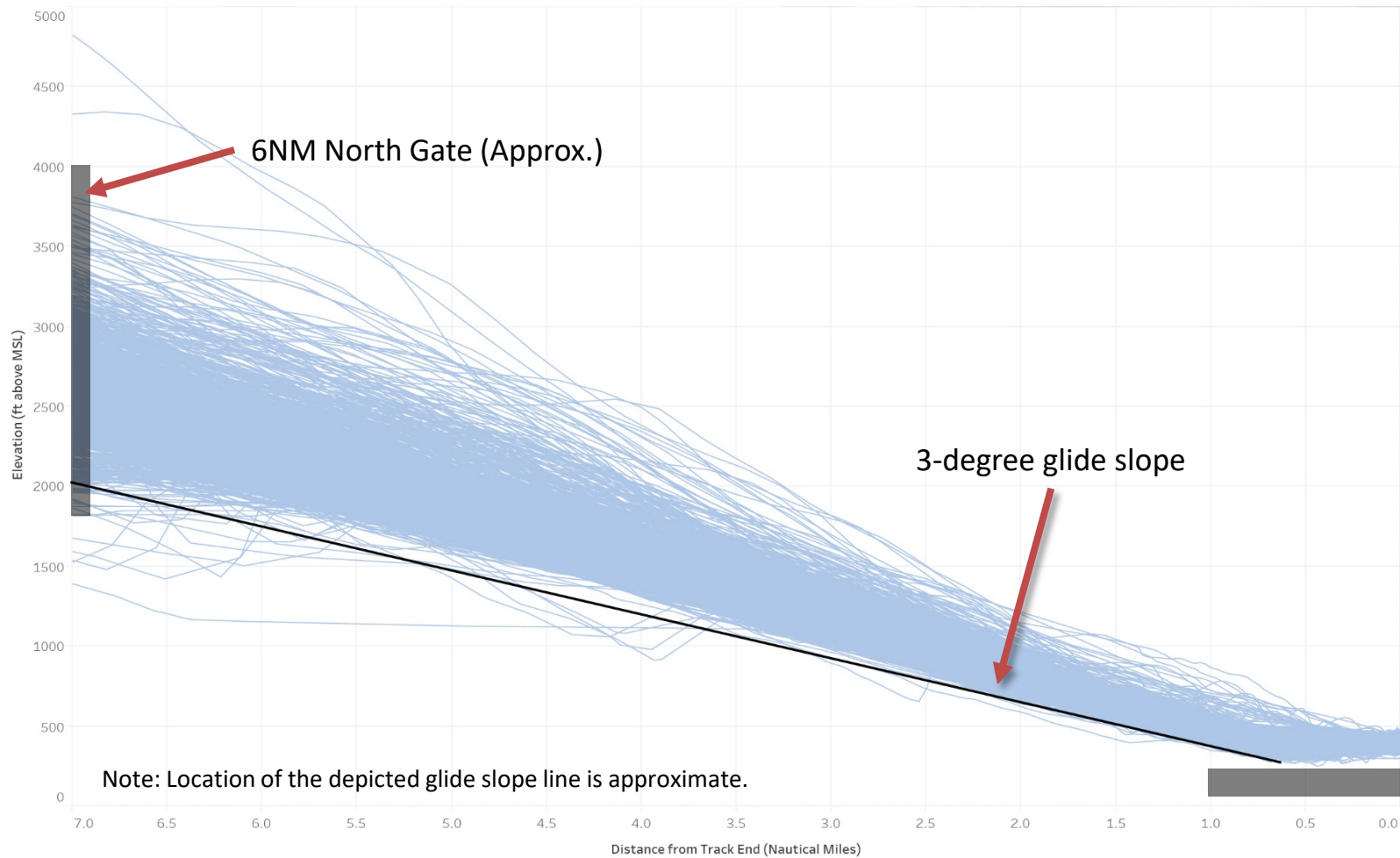
# Examples of Vertical Profiles



# North Flow Arrivals to Runway 34 L/C/R Ends - July 2017



# South Flow Arrivals to Runway 16 L/C/R Ends - July 2017



## Comparison of a Boeing 737-900 and Boeing 787-900 at an altitude of 2,500' MSL



Source: Environmental Science Associates

## Summary

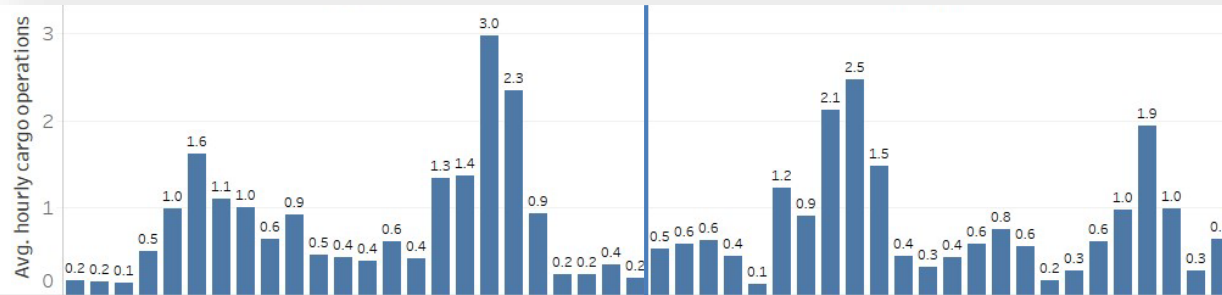
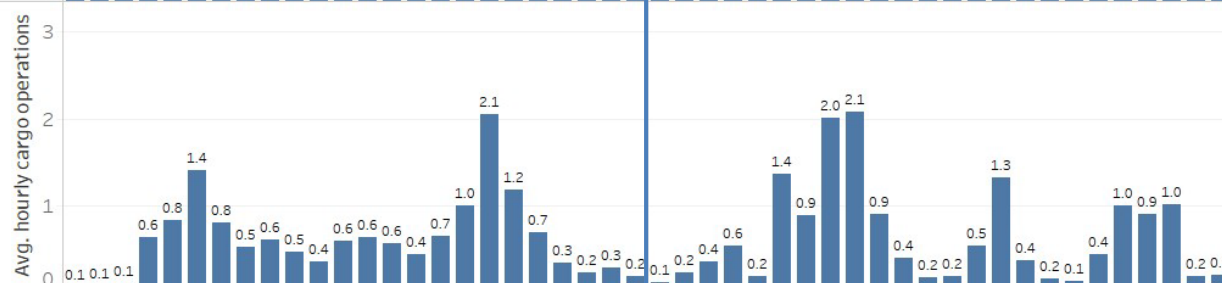
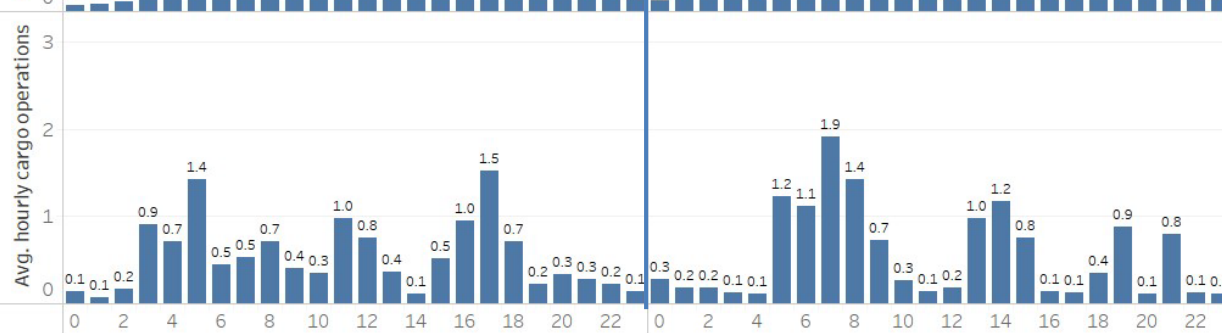
- Aircraft altitudes on arrival from both the north and the south have remained very consistent year over year
- Aircraft are following the glideslopes in the published approach procedures

There have been no notable changes in aircraft arrival altitudes between 2013, 2015, and 2017

# Historic Hourly Air Cargo Operations at SEA

## Arrivals

## Departures

**2017****2016****2015**

# Questions from the Forum Members