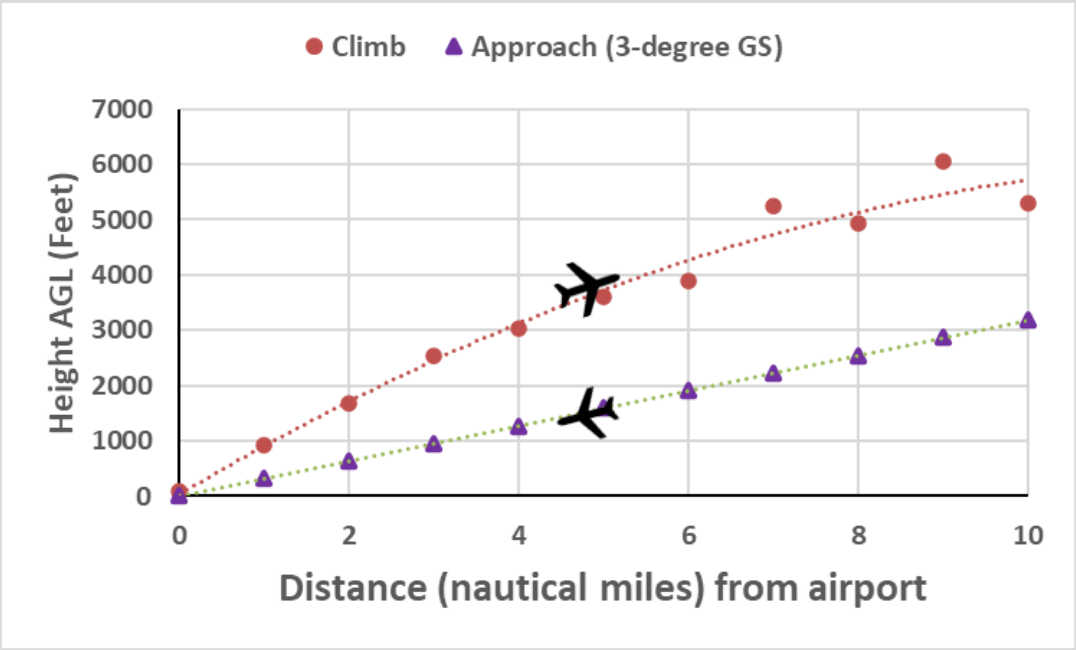
Height and speed equations for bird strikes in relation to distance from airport: potential uses to mitigate risk



Bird Strike Committee-USA, August 19, 2021

Richard A. Dolbeer, Science Adviser, Airport Wildlife Hazards Program

Acknowledgements

U.S. Department of Agriculture, Wildlife Services

U.S. Federal Aviation Administration

Findings and recommendations expressed in this presentation do not necessarily represent the position of the U.S. Federal Aviation Administration

15 January 2009, Airbus 320, New York
Miracle on The Hudson

- Migrant Canada geese into both engines
- 2900 feet AGL during climb from LGA
- 5 miles from airport

15 August 2019, Airbus 331, Russia

"Miracle in the Cornfield"

- Gulls ingested in both engines
- 0 feet AGL during T/O run
- Zhukovsky Airport (Moscow)
- Local gulls attracted to uncovered garbage

"Miracle on the Hudson" and "Miracle in the Cornfield"

A study in similarities and contrasts

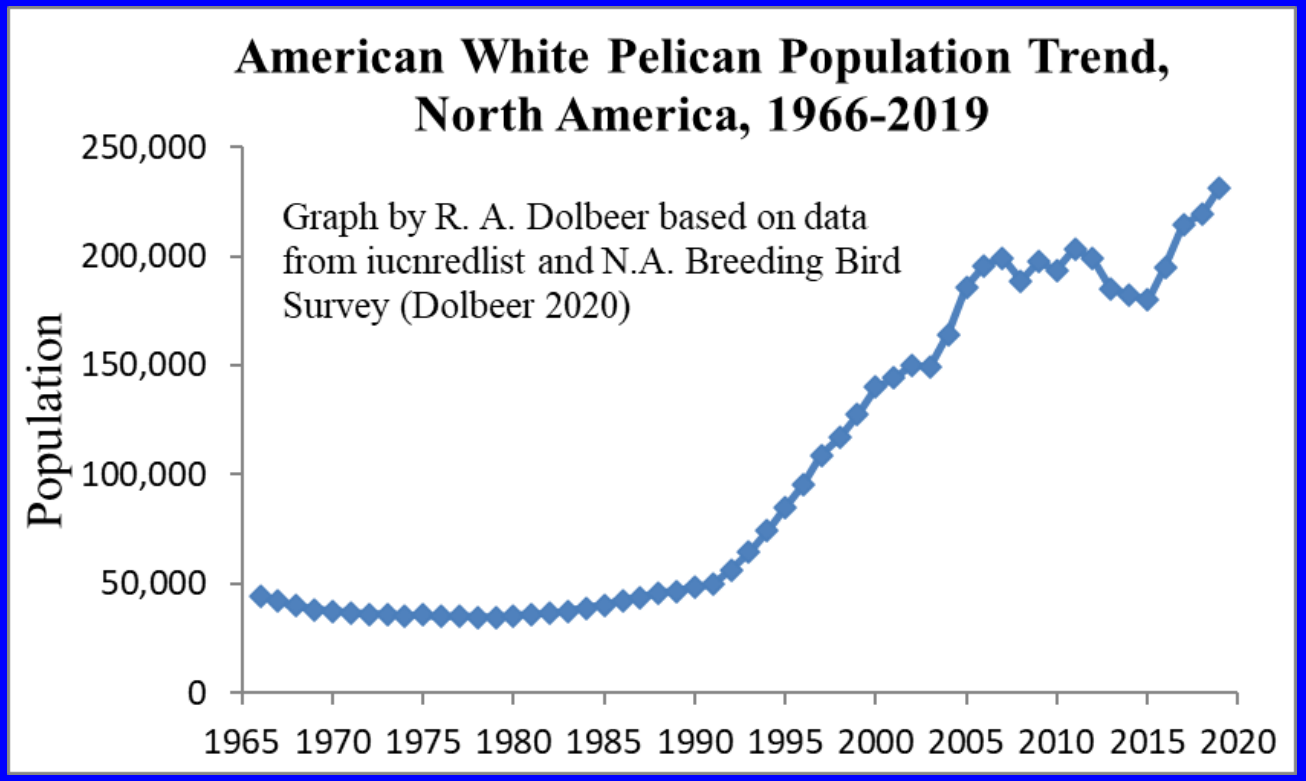
Characteristics of event	Miracle on Hudson	Miracle in Cornfield
Aircraft	A320 (2 engines)	A331 (2 engines)
Status of aircraft	Climb, 2900 ft AGL	Take-off run, 0 ft AGL
Status of birds	Migrating, 2900 ft	On runway
Bird struck	Multiple Canada geese	Multiple Gulls
Parts struck/damaged	Both engines	Both engines
Methods available to mitigate risk	None	Garbage control/ harassment/ lethal control

"Miracle on the Hudson" and "Close Call in Utah"

A study in similarities

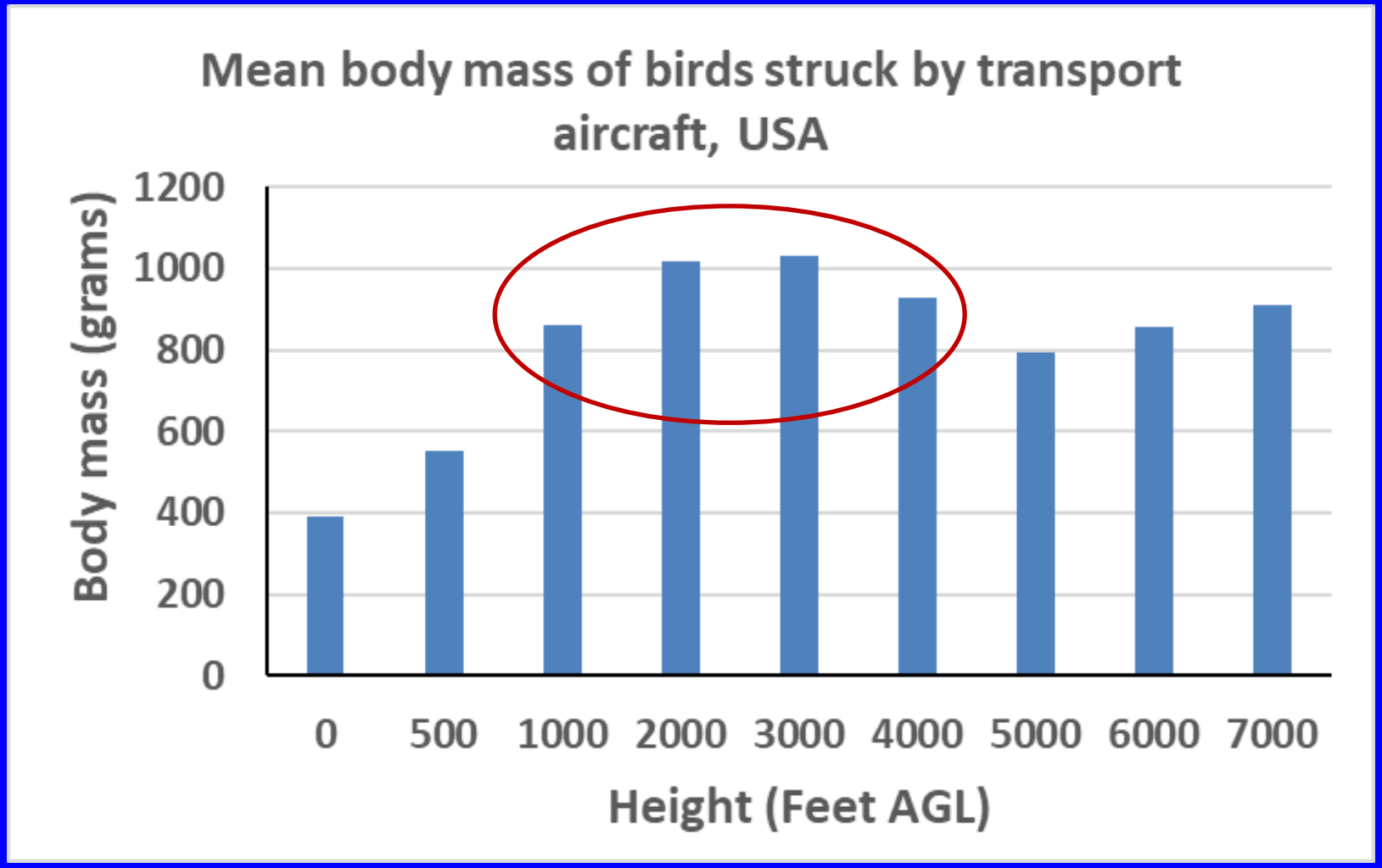
Characteristics of event	Miracle on Hudson	Close call in Utah
Aircraft	A320 (2 engines)	B757 (2 engines)
Status aircraft	Climb, 2900 ft AGL	Climb, 4000 ft AGL
Status of birds	Migrating, 2900 ft AGL	Migrating, 4000 ft AGL
Birds struck	Multiple Canada geese	Multiple white pelicans
Parts struck/damaged	Both engines	One engine; radome
Methods available to mitigate risk	None	None

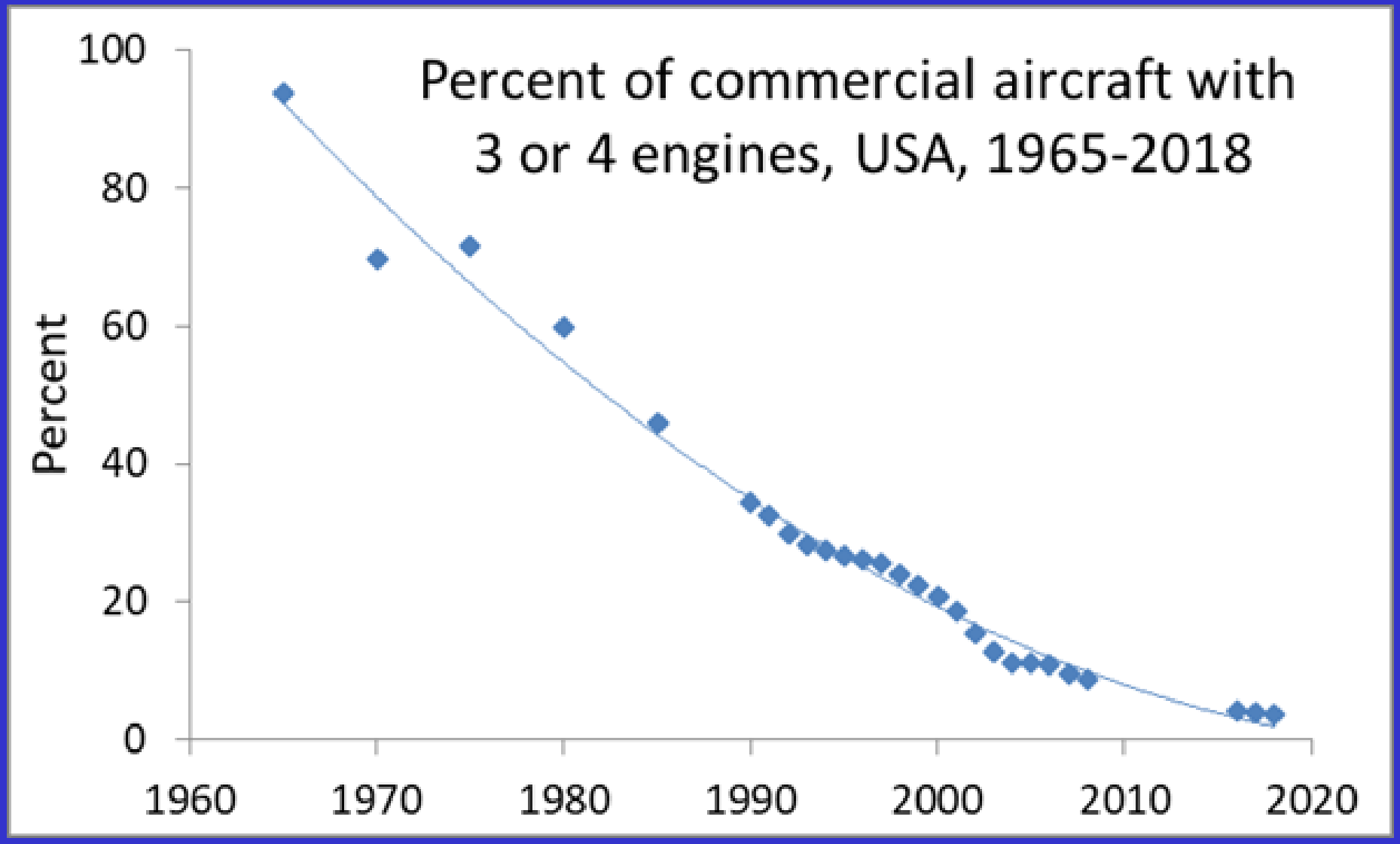
Almost all large, flocking bird species in North America have significant population increases since 1990*

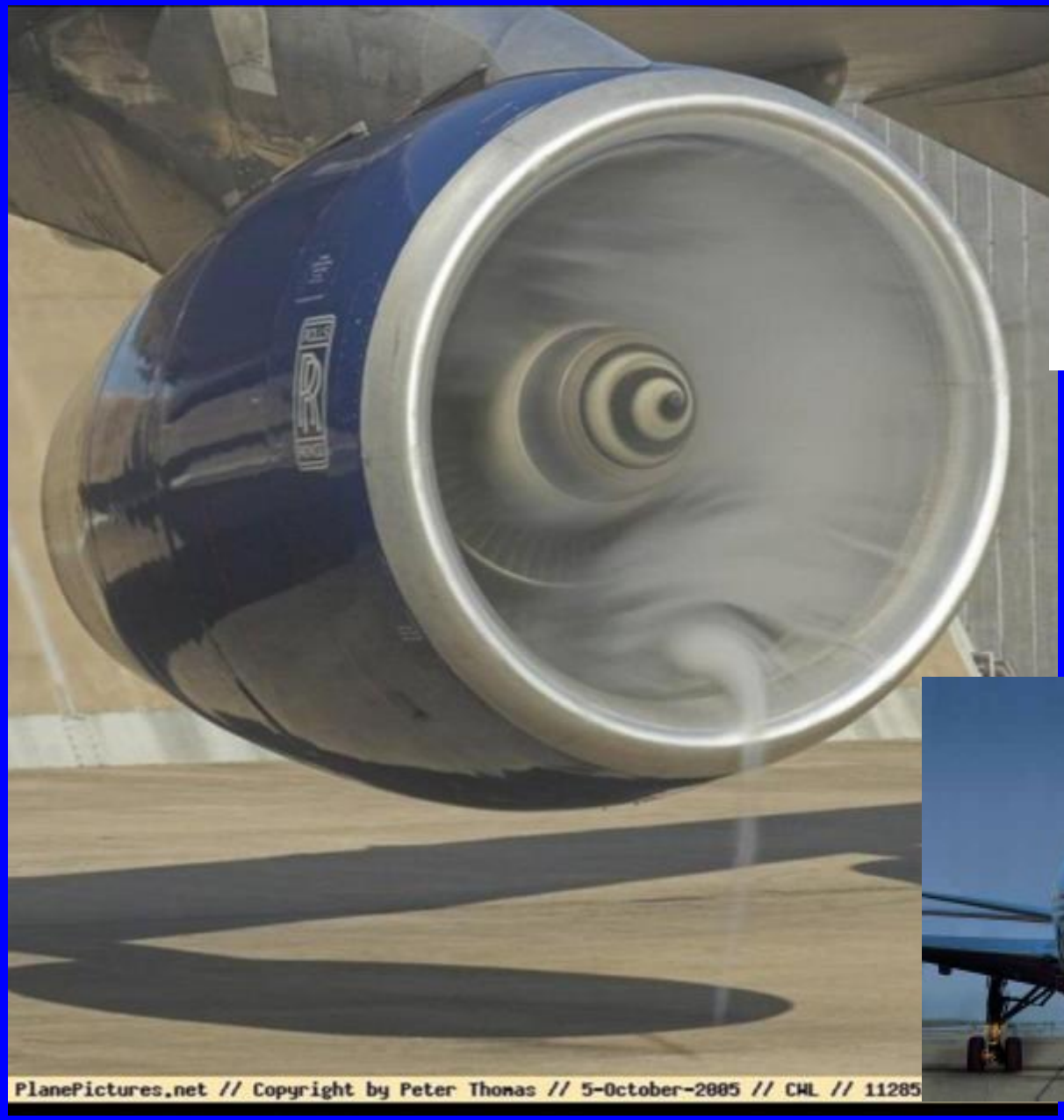


*Dolbeer, R. A. 2020. Population increases of large bird species in North America pose challenges for aviation safety. Human Wildlife Interactions 14 (3):345–357.

The mean body mass of birds struck at 2000-4000 feet AGL is twice that of birds struck at <500 feet!




Percent of commercial aircraft with 3 or 4 engines, USA, 1965-2018
Percent
100
80
60
40
20
0
1960
1970
1980
1990
2000
2010
2020

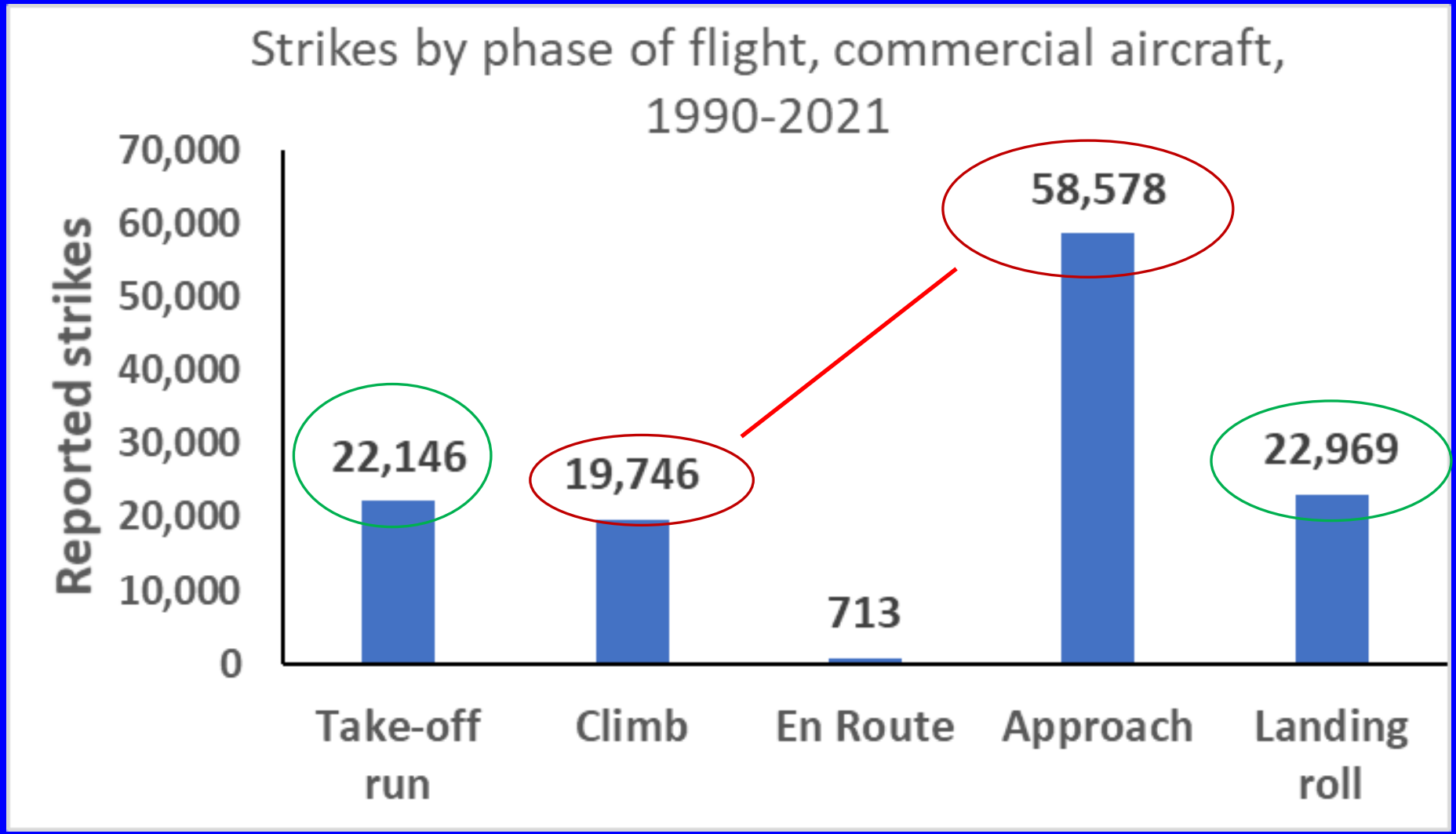


Modern turbofan engines have larger diameters, tremendous suction power

Also quieter!

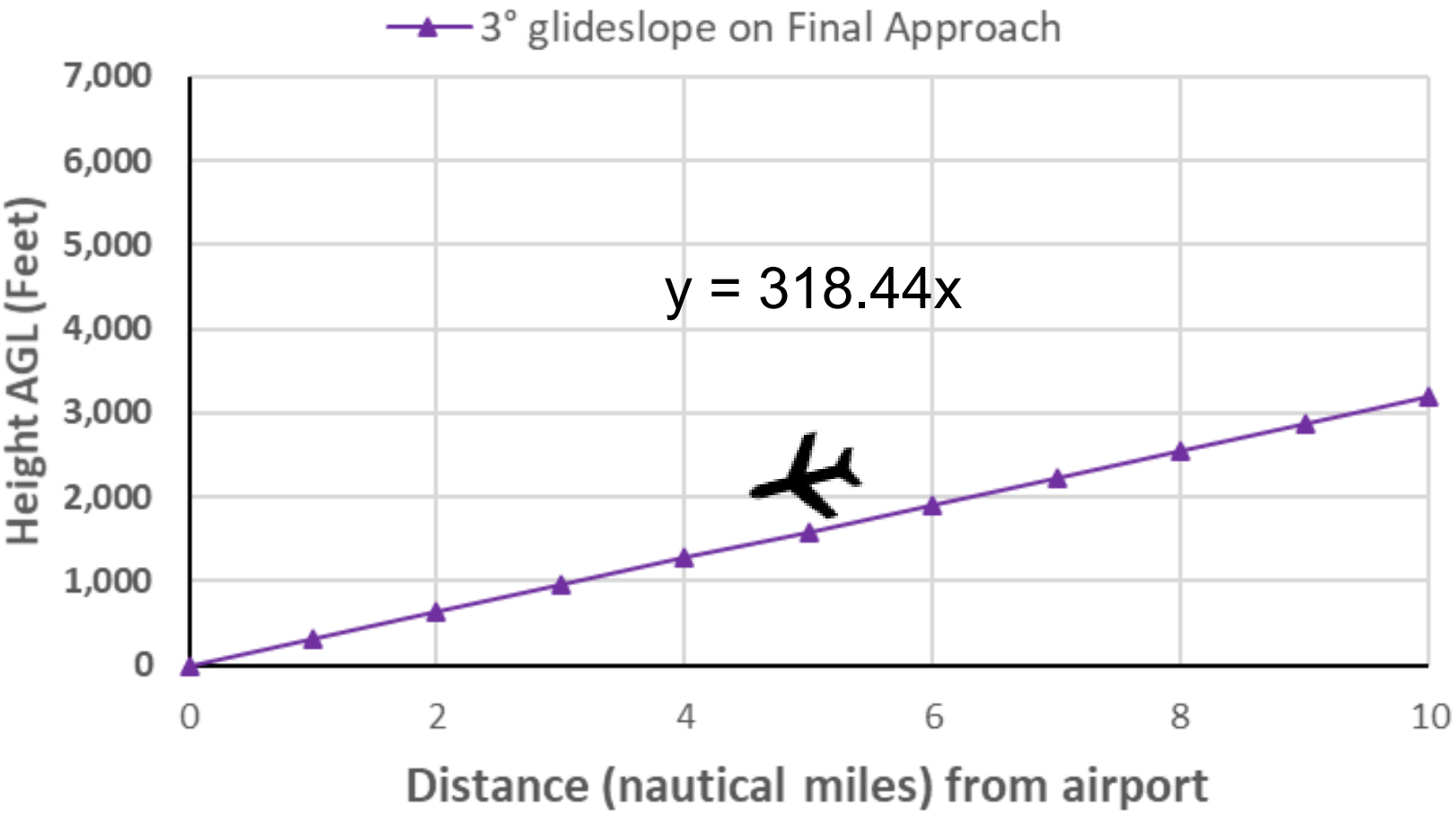
- **Since the Miracle on the Hudson (2009), we have nothing in place to prevent this type of event from occurring again!**
- **Populations of large, flocking bird species continue to increase.**
- **The most promising solution is Bird Detecting Radar in real-time mode*.**
- **My objective: to analyze flight profiles for transport aircraft on approach and climb to see if BDR could be focused on the predicted 3-D airspace where birds and aircraft are likely to intersect to provide warnings of large birds during these critical phases of flight.**

*** Radar systems to give real-time warnings for windshear, in place since the 1990s, have effectively mitigated this threat at over 100 USA airports.**

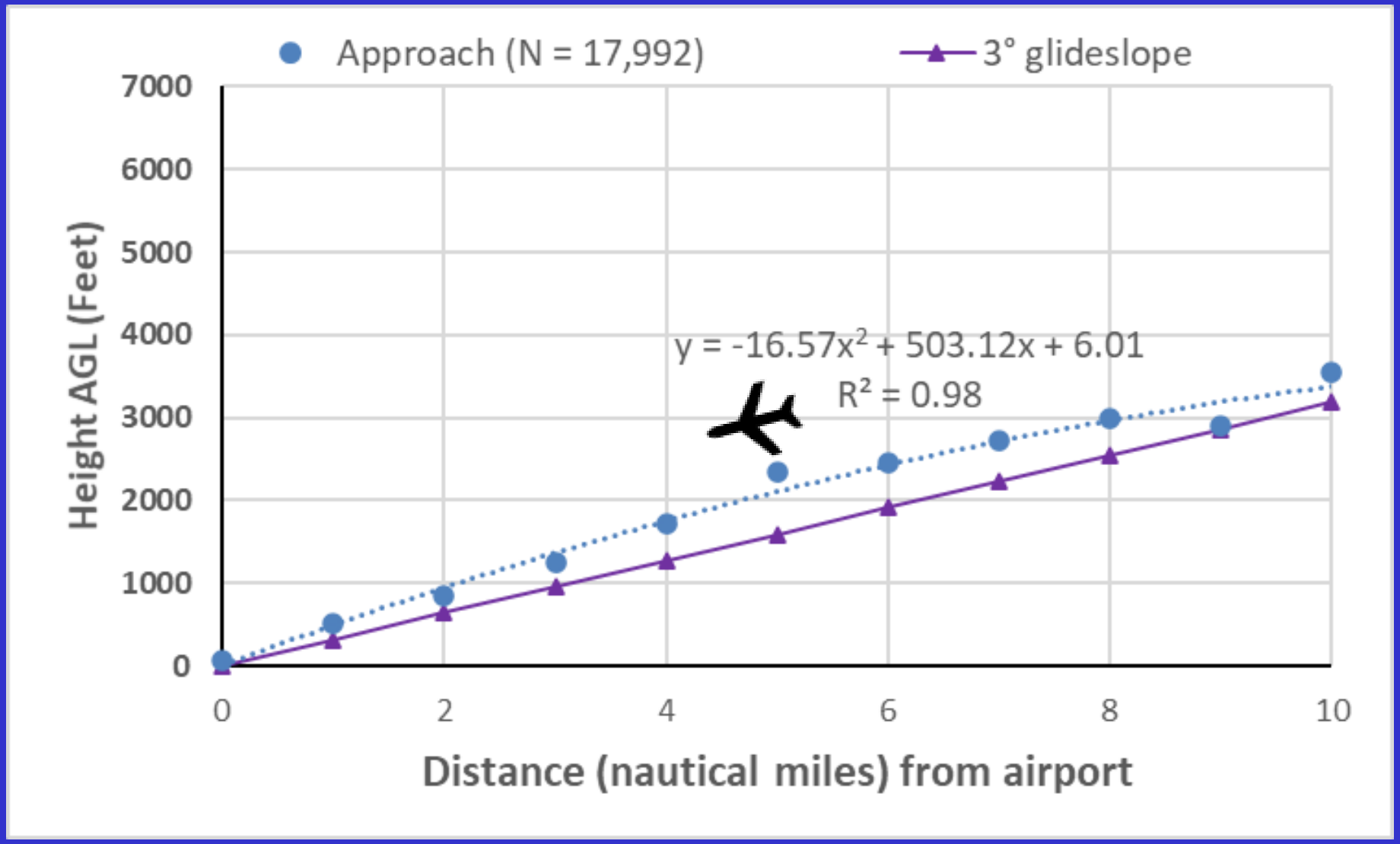


Same number of strikes on T/O-off run and Landing roll!

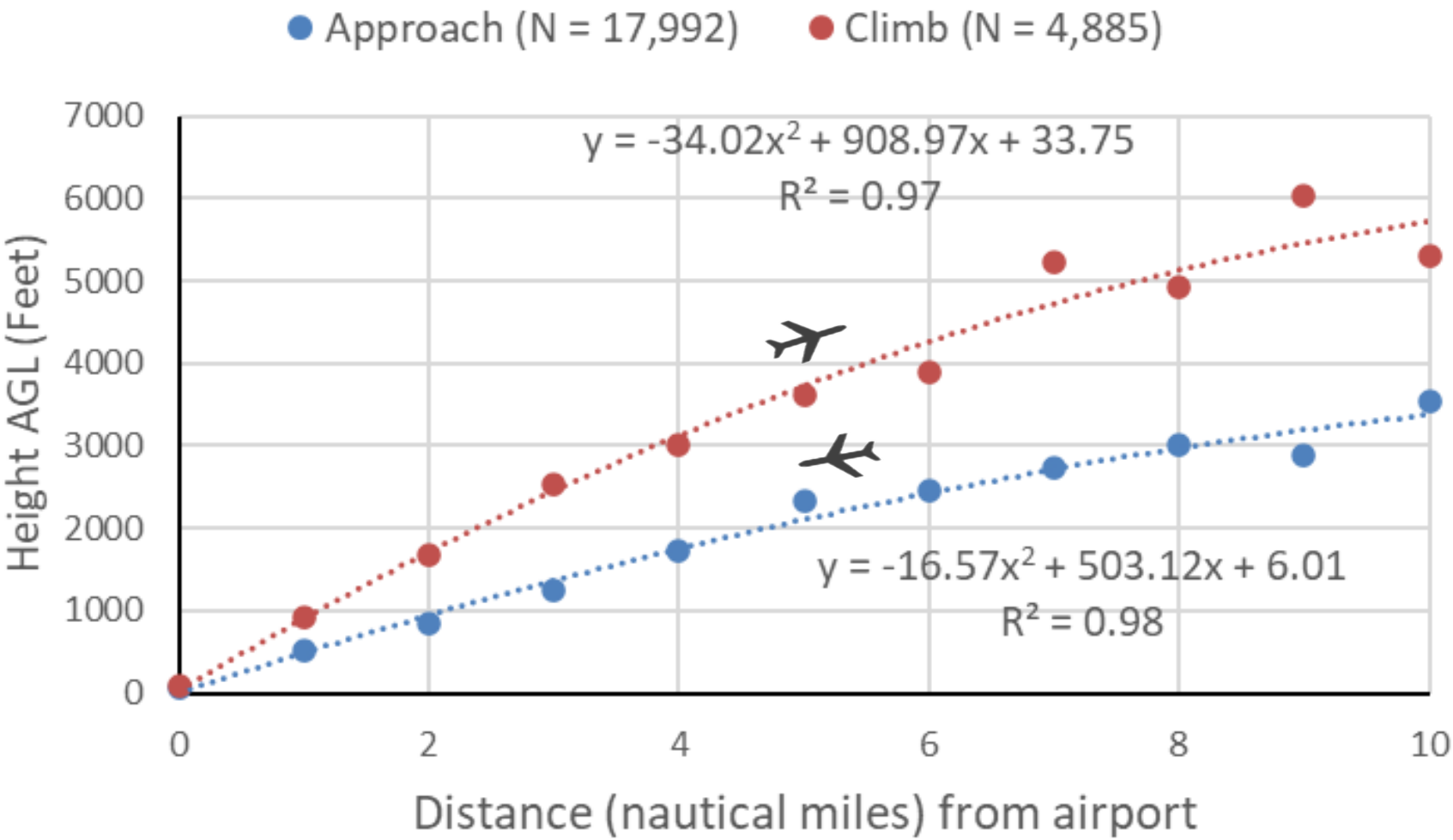
Why 3x more strikes on Approach vs Climb?



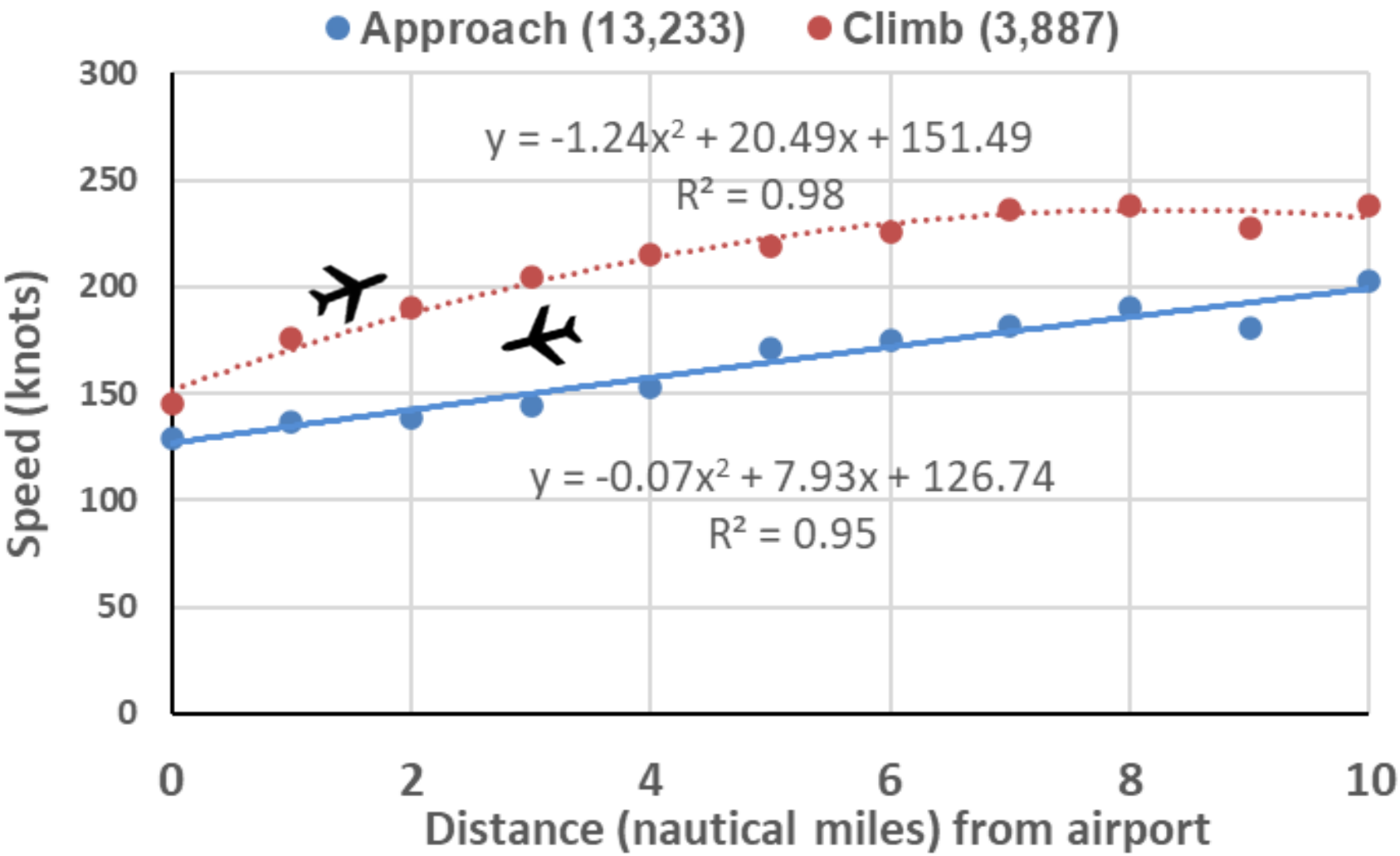
Height AGL = Tangent (3 degrees) *Distance

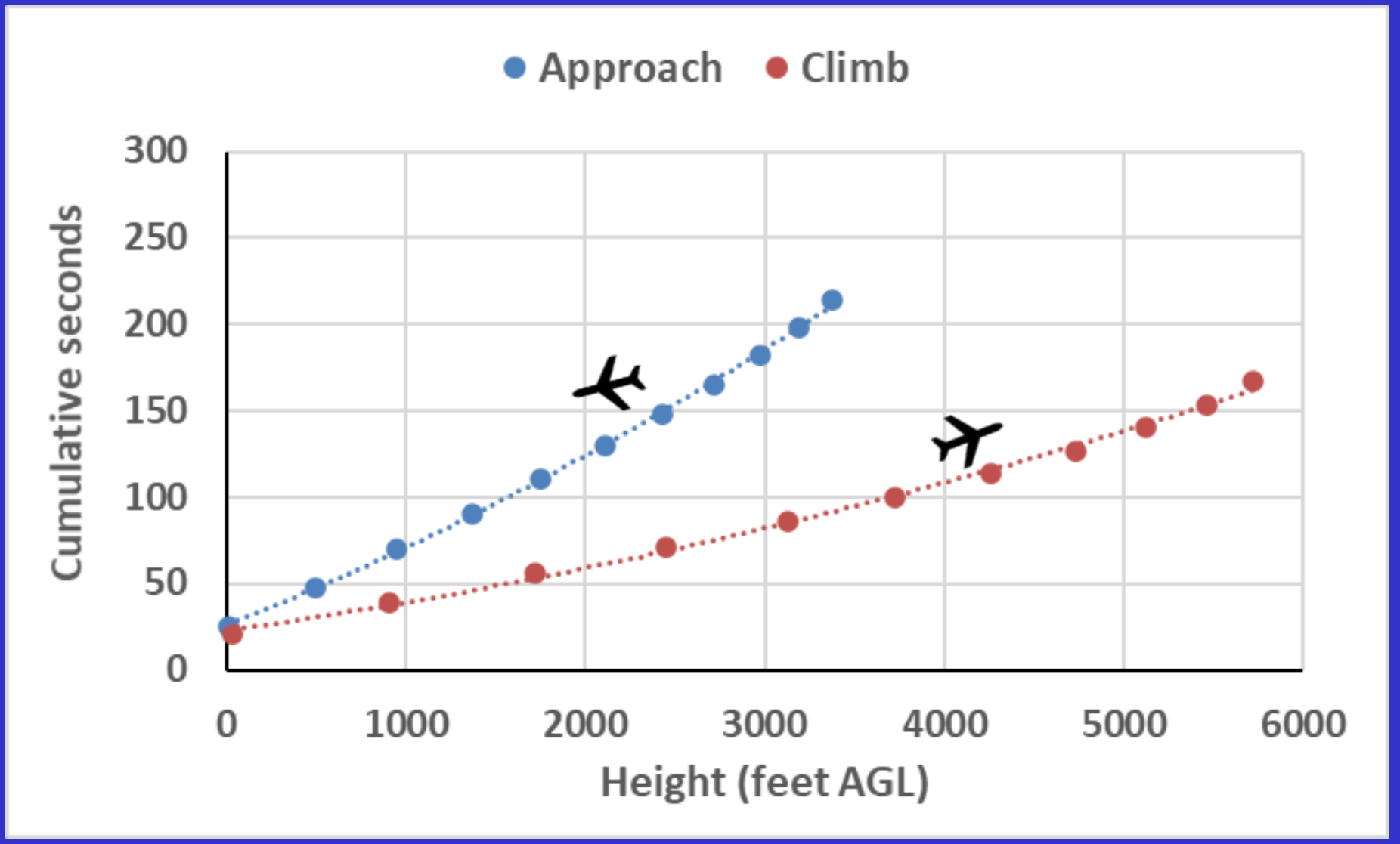

Approach (N = 17,992)
3° glideslope
7000
6000
5000
4000
3000
2000
1000
0
Height AGL (Feet)
y = -16.57x² + 503.12x + 6.01
R² = 0.98
0
2
4
6
8
10
Distance (nautical miles) from airport

Distance vs Height profiles during Approach and Climb.



Distance vs Speed profiles during Approach and Climb

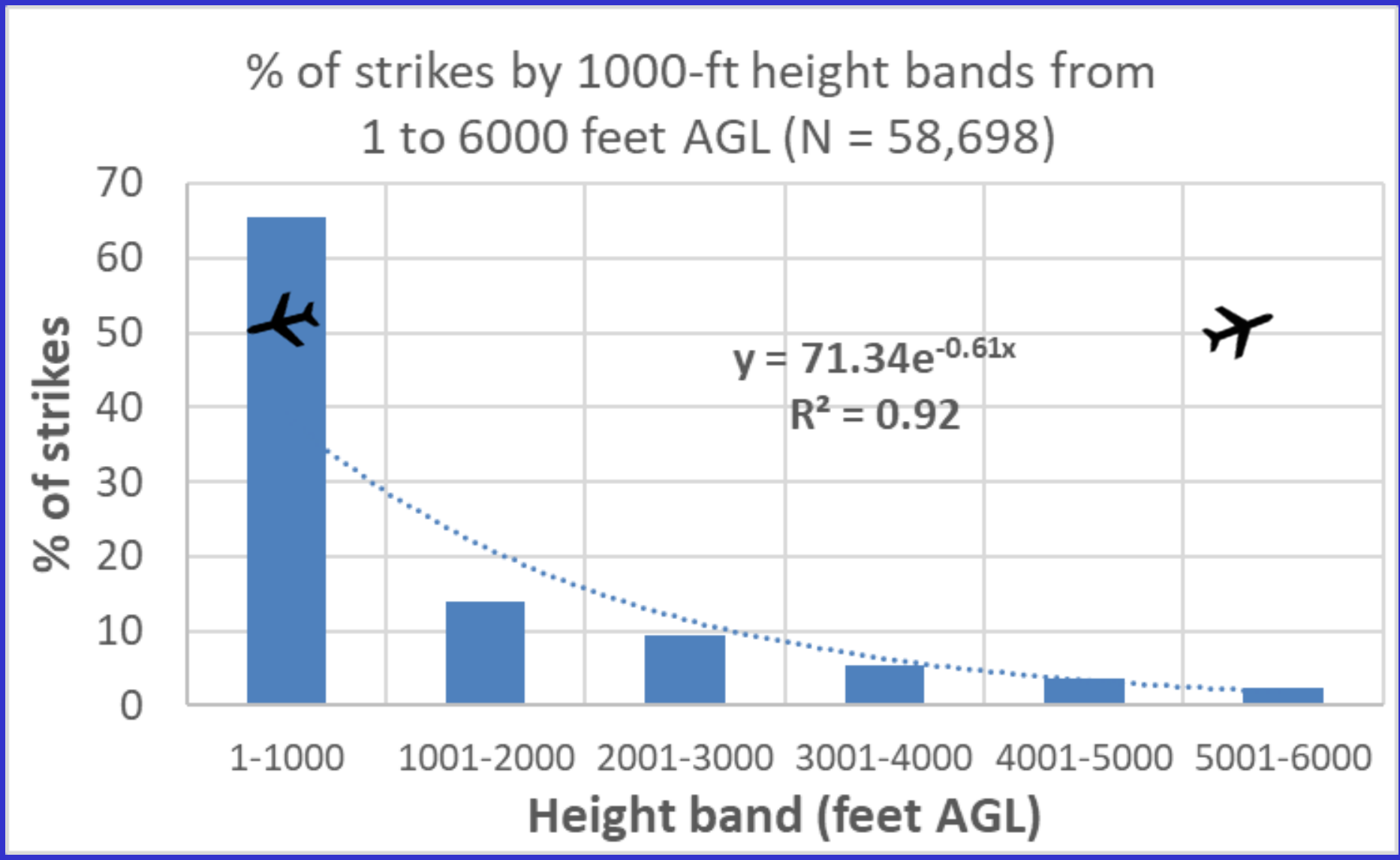



Approach
Climb
Cumulative seconds
300
250
200
150
100
50
0
0
1000
2000
3000
4000
5000
6000
Height (feet AGL)

Cumulative time (seconds) elapsed by commercial aircraft during departure and arrival, based on height and speed reported for bird strikes in NWSD, 1990-2021

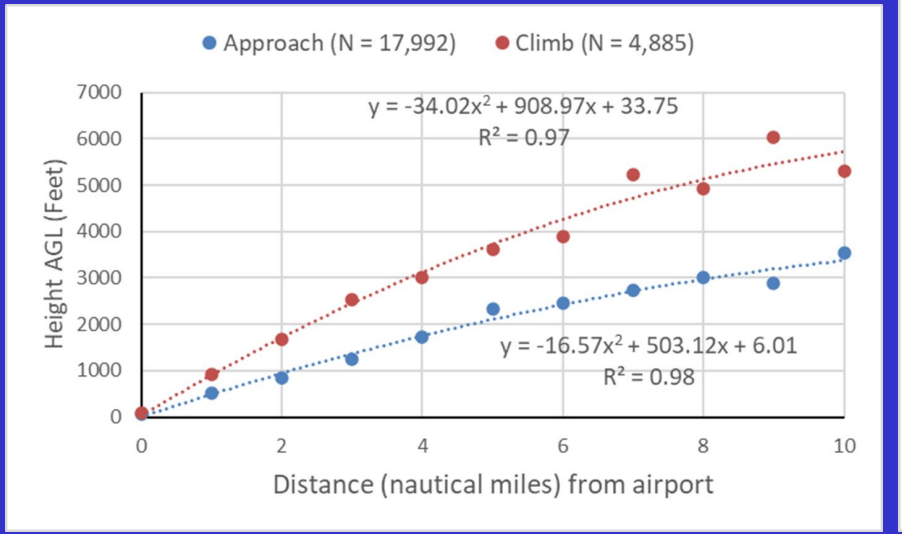
Height zone (feet AGL)	Cumulative time (sec) spent below various heights		Difference (seconds)
	Departure	Arrival	
1-1000	37	69	32
1-2000	56	121	65
1-3000	79	182	103
1-4000	105	251	146
1-5000	135	329	194
1-6000	168	415	247

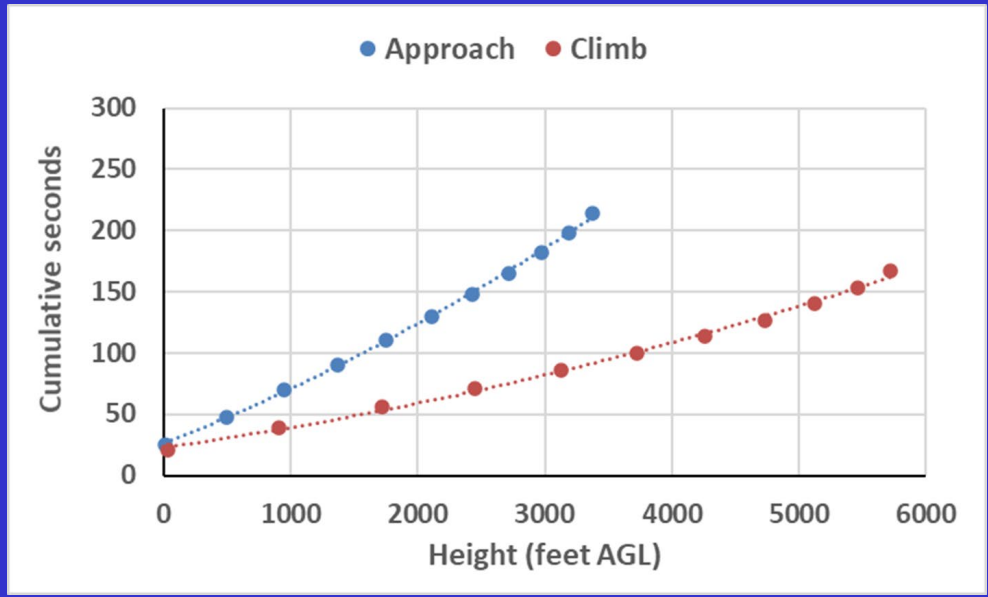
Bird strikes decline exponentially as height AGL increases



Conclusions

- **Transport aircraft have very different flight profiles (height and speed) during approach and climb, empirically demonstrated by height, distance and speed data in the NWSD.**
- **These differences explain the 3X greater number of strikes during approach than departure.**





Recommendations/ Management Implications

- **Since the Miracle on the Hudson (2009), we have nothing in place to prevent this type of event from occurring again (off airport strikes during approach or climb)!**
- **Populations of large, flocking bird species continue to increase.**
- **The most promising solution is Bird Detecting Radar in real-time mode.**
- **I propose that flight profile equations developed empirically from the NWSD for bird strikes with aircraft on approach and climb can be integrated with BDR.**
- **This integration can focus radar on the predicted 3-D airspace where birds and aircraft are likely to intersect, providing real-time warnings to pilots for avoiding off-airport strikes, especially with large flocking birds.**

USDA/Sandusky, OH