Noah Eudy And Max Cannon
Faculty Advisor
Dr. Janet Tinoco

Simulation and Modeling of Space Operations in the NAS: Analysis of Impacts to the Aviation Industry and Finding Solutions

EMBRY-RIDDLE
Aeronautical University
DAVID B. O'MALEY COLLEGE OF BUSINESS
The Business of Flight®

Issue

This research effort examines airline impacts due to Falcon 9 launches and the horizontal landings (shuttle) at the Kennedy Space Center. Using the NASA FACET simulation software, we developed the baseline model with historical records from previous launches, landings and airspace traffic provided by NASA for March 30, 2016 (a non-launch date). Scenarios developed and simulations run, with varying airspace closures, based on input from literature reviews, the FAA, and NASA to ensure applicability.

Research Questions

- What are the most common airspace closures?
- What times are they closed?
- What number of planes fly through this airspace?
- What are the rerouting options?
- What type (commercial, domestic/international, GA) of flight?

Method

- Using the FAA Historical NOTAM Database for the last 9 SpaceX launches and 7 shuttle landings, we analyzed airspace closure, time of day and duration to compose an understanding of the number of flights and type of flights affected.
- Our simulated closures used the worst-case situation for duration and size, using 30 March 2016 data ("no launch" date)

Launch/ Landing	Times closed (Zulu)	Area Closed	# of Planes
Launch	00:30-04:52	R2933, R2934, W497a, W137f, W137g	23 commercial
Landing	03:25-07:45	R2932, R2933, R2934, R2935, W158a, W158c, Arc	8 commercial & 4 GA
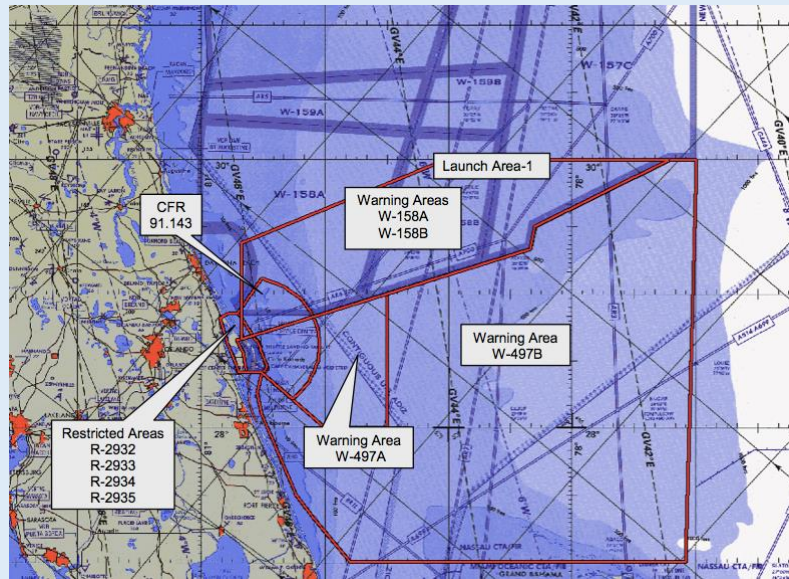
Map of Cape Canaveral SUA's and Arc

Key Findings

- Majority of planes interacting with the closures are commercial aircraft as shown in the table. Several flights were international carriers. Some GA flights impacted.
- Air traffic was more congested between 10:50-19:10 Zulu; least busy was between 00:30-07:45 Zulu
- Airspace closures should become smaller with advanced rockets and more historical data.
- Visual observation revealed some flights were not greatly impacted; others may have more severe impacts.

Possible Solutions to Reduce Airspace Impact

- Close airspace dynamically
- Treat horizontal launch vehicles as aircraft, limiting closures
- Alter launch and landing to nighttime or less busy air traffic times
- Reduce size of closures
- Reduce amount time airspace closure is active

Limitations

- Limitations of NASA FACET were not fully understood; large learning curve.
- User defined SUAs, reroute, and fuel emission applications could not be implemented as part of our research as originally thought.
- NASA FACET license expired which limited simulation efforts.
- New license received in early March was ITAR-controlled and could only be used on-campus. After we got the new software license, we started to setup and run our closures based off our research to figure out key numbers like how much the airlines spend rerouting around space related NAS closures. Unfortunately, we did not get very far into this part of the research due to the impact of the COVID-19 virus that closed our University.
- Extension of research effort into 2020-2021 will allow remainder of planned simulations to move forward.

Acknowledgments

References

- Colvin, T.J. and Alonso, J.J. (2015), 'Near-Elimination of Airspace Disruption from Commercial Space Traffic Using Compact Envelopes', AIAA Space Forum, Pasadena, California, August 31- September 2, 2015
- Future Air Traffic Management Concepts Evaluation Tool (FACET) version 19.0 with NAS (National Airspace System) Constraint Evaluation and Notification Tool (NASCENT) version 19.03
- Tinoco, J., Yu, C., Firmo, R., Moallemi, M., Castro, C., & Babb, R. (Publication pending), The impact of commercial space transportation on the United States National Airspace System (NAS) and airlines: A simulation model. *Journal of Space Safety Engineering*
- https://notams.aim.faa.gov/notamSearch/nsapp.html#/