

Launch Vehicle/Reentry Vehicle (LV/RV) National Airspace System (NAS) Effect Assessment

**Center of Excellence for
Commercial Space Transportation**

**5th Annual Technical Meeting
October 26-28, 2015**

Background

Demand for space access for commercial, civilian and military use has been rising rapidly.

FAA accommodates space launches often by blocking large volumes of airspace from traditional National Airspace System (NAS) usage. This results in flights routing around blocked airspace resulting in extra flying distance and delays.

FAA has asked for insights into the effects of upcoming launches on the NAS to balance competing demands in a safe and efficient manner

What is the Effect of A Proposed Future LVRV Operation on the Other NAS Users?

Example of Flight Rerouting During Actual Launch

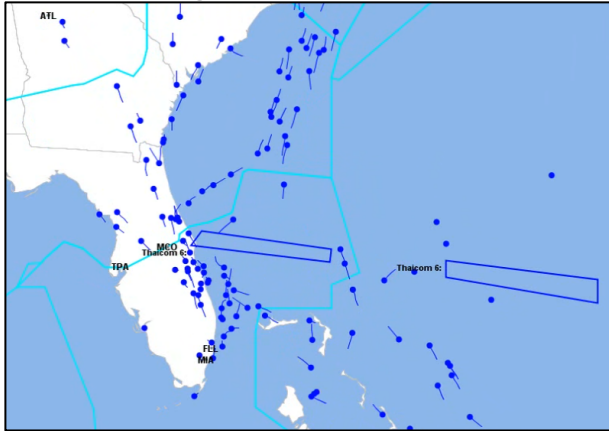


Image source: All NAS Display, MITRE Corporation

Current FAA Practice:

- Use manual analysis of Traffic Situation Display (TSD) replays for a few sample days to estimate impact of proposed operation on future day in terms of flight counts
- This analysis is input to decision making process and in any negotiations between the FAA and the space operator

MITRE recommended to the FAA the following improvements:

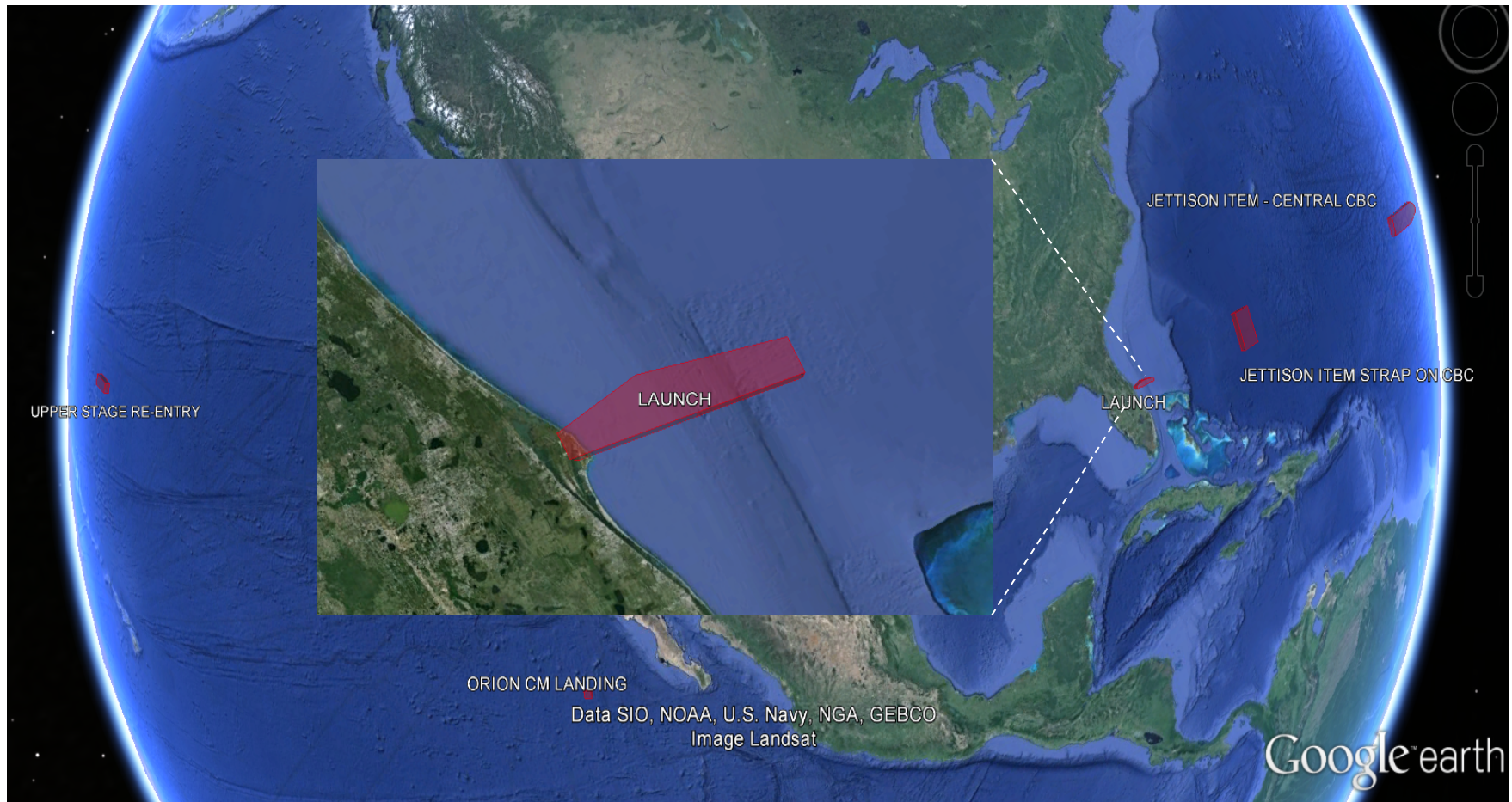
- Use objective, repeatable, model-based approach to look at the distribution of likely impacts over a large sample of historical dates similar to the proposed date
- Consider number of impacted flights, expected increase in flying time, or possible ground delay, and the likely range for these values
- Include ability to perform detailed time period and sensitivity analysis
- FAA accepted these recommendations

Technical Approach

- **Historical Date Selection for Input to Simulation Model**
 - Pick sample of 30 historical days most similar to the proposed launch date
- **Simulating Effect of the Launch on Other NAS Users Over the Selected Dates**
 - Avoid active Aircraft Hazard Area (AHA) by ground delay, or by routing around them
 - Reroute using minimum deviation around AHAs
 - Impact metrics
 - Number of affected flights
 - Extra distance travelled
 - Delay experienced
- For each metric
 - The average value
 - Likely range of the average
 - The likely maximum value
- Model Performance
 - Completes on “standard PC” in 1-2 hours or less
 - Preprocessing to speed-up run time
- Based on Alternative TFM Actions Model (ATAM) software
 - Developed previously for AJR
 - Extensively revised for LVRV application

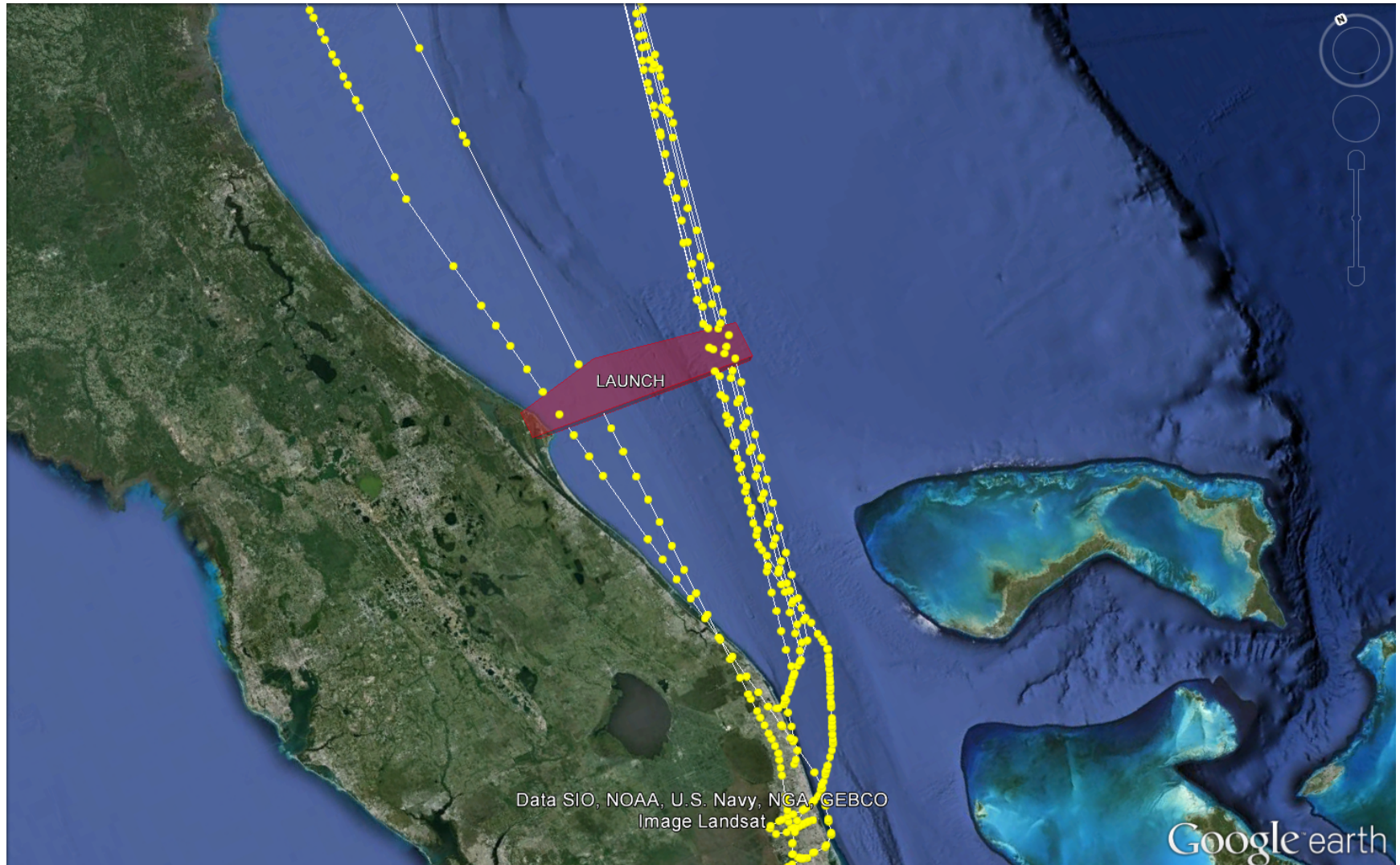
Example: NASA ORION Launch

(Launched from Cape Canaveral on 5th December, 2014)



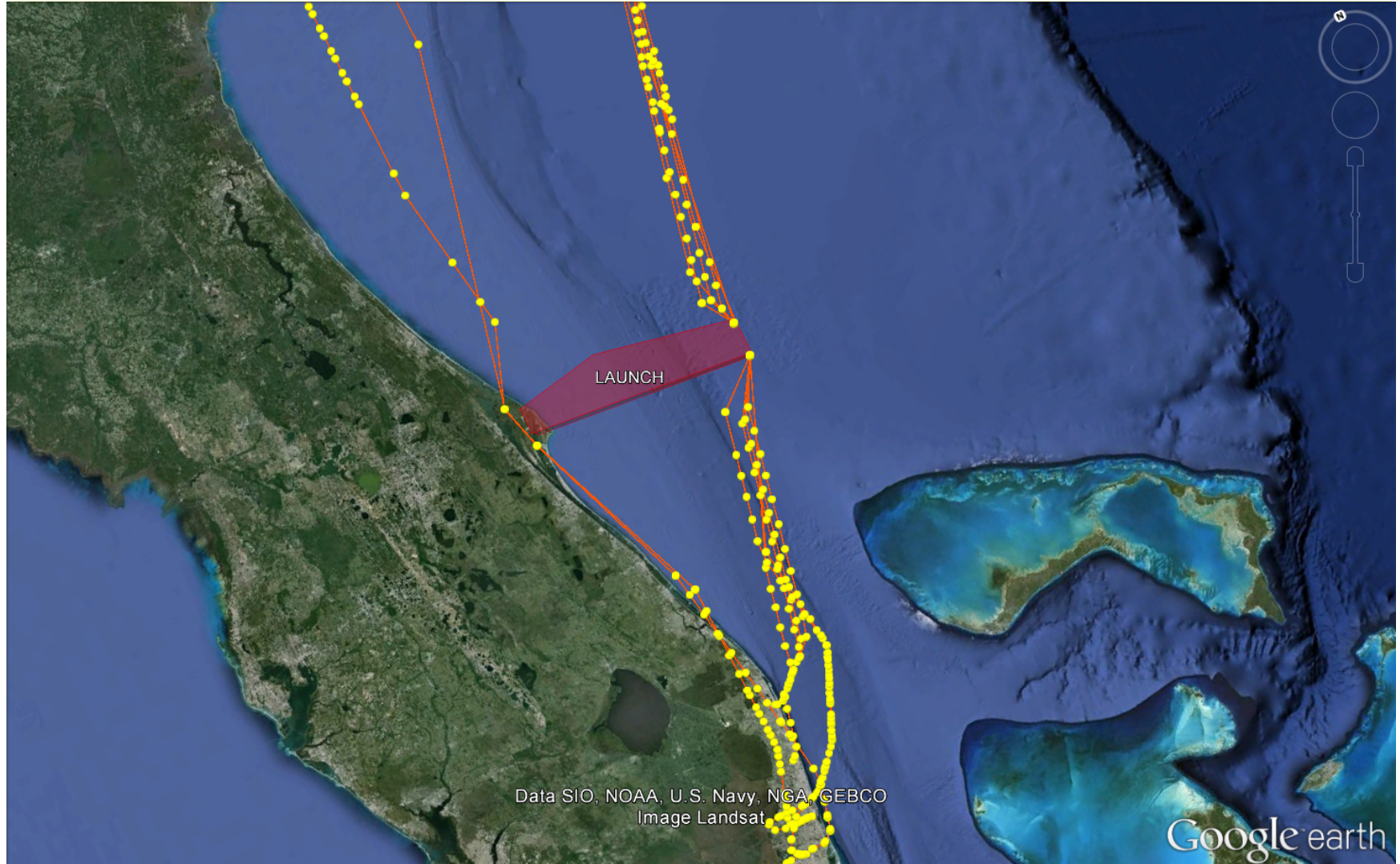
Background Image source: Google Earth, product of Google Inc.

Example: Actual Flights Intersecting Launch AHA on Historical Date



Background Image source: Google Earth, product of Google Inc.

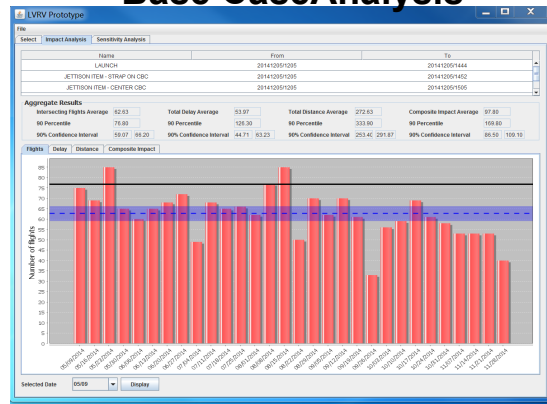
Example: Flights Rerouted Around Launch AHA and SUAs



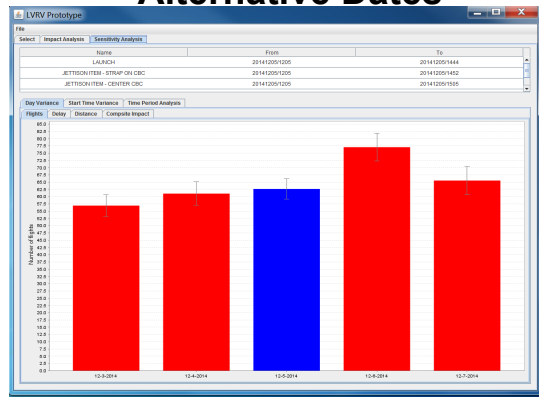
Background Image source: Google Earth, product of Google Inc.

What Happens if the Launch Or Recovery Time Window is Changed?

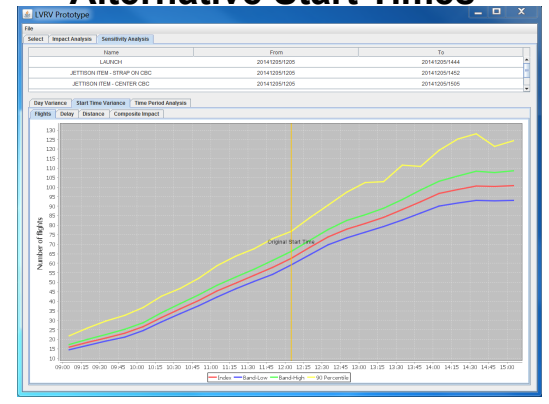
Base Case Analysis



Alternative Dates

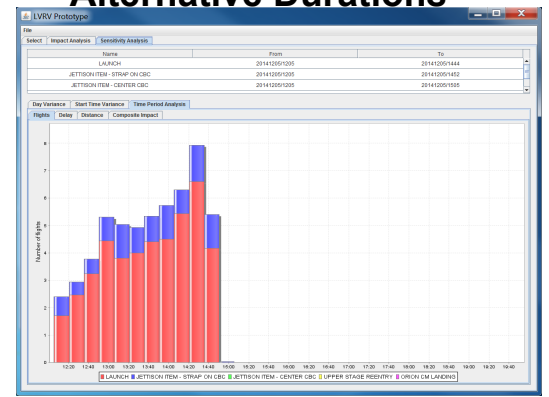


Alternative Start Times



- *Base Analysis: Impact on 30 similar historical dates*
- *Alternative Dates?: Look at likely back-up dates*
- *Alternative Start Times?: Change time by +/- 3 hours*
- *Time Period Analysis?*
 - Look at effect by 15-minute interval in within base case time window
 - See impact of each AHA separately
- *Data to answer all these questions is pre-generated during the simulation run*

Alternative Durations



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