Aircraft Operations Environmental Assessment: Cruise Altitude and Speed Optimization

ASCENT Project 15

Project Status
September 27, 2017

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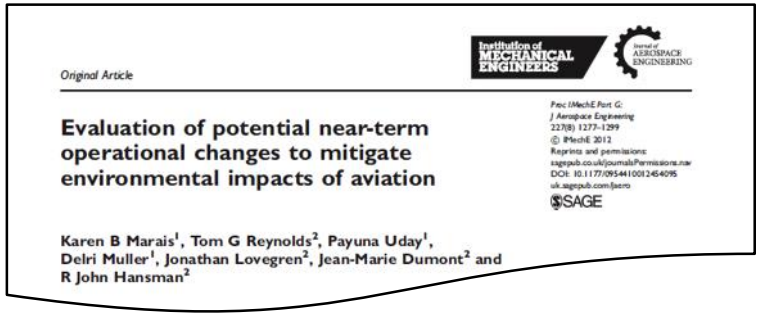
This work is funded by the US Federal Aviation Administration (FAA) Office of Environment and Energy as a part of ASCENT Project 15. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA or other ASCENT Sponsors.

Project Overview

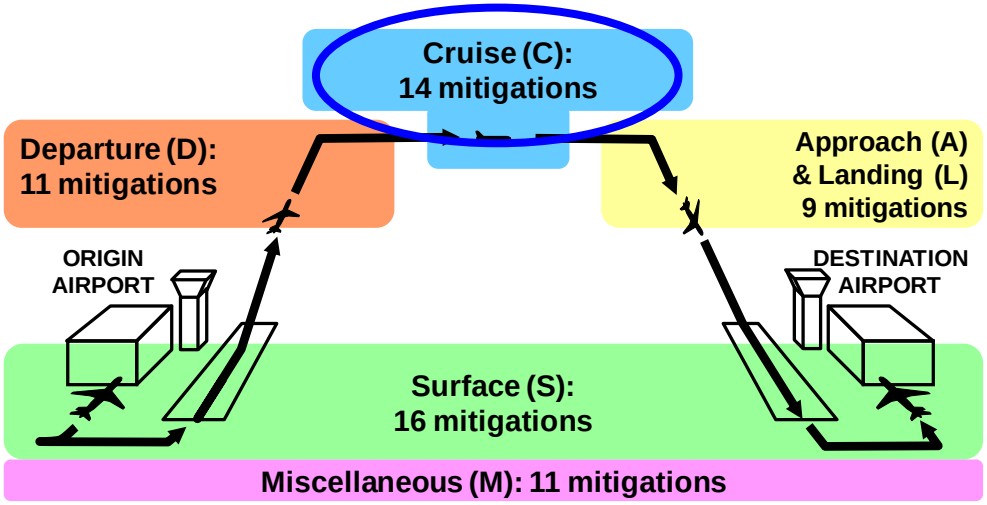
- Funding: FAA Office of Environment & Energy (FAA/AEE)
- High-Level objective: Identify & evaluate operational mitigations to reduce environmental impacts of aviation in the near/mid-term with minimal implementation barriers
- Prior work: Identified/evaluated over 60 mitigations
- Current research focus:
  - Quantify benefits and barriers to implementation of Cruise Altitude and Speed Optimization (CASO)
  - Prototype a CASO decision support tool and engage with operators



Original Article

Evaluation of potential near-term operational changes to mitigate environmental impacts of aviation

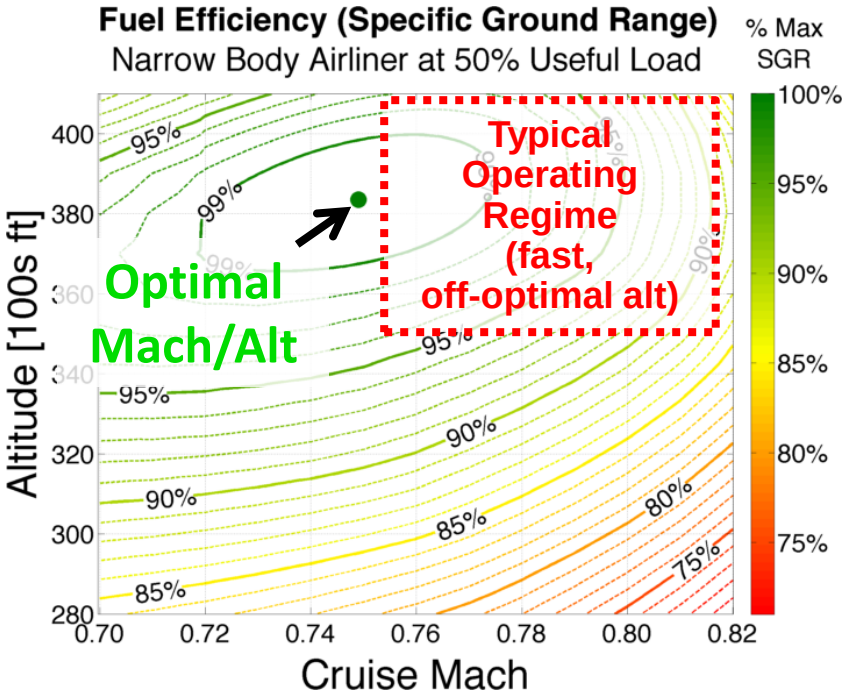
Karen B Marais[1], Tom G Reynolds[2], Payuna Uday[1], Delri Muller[1], Jonathan Lovegren[2], Jean-Marie Dumont[2] and R John Hansman[2]



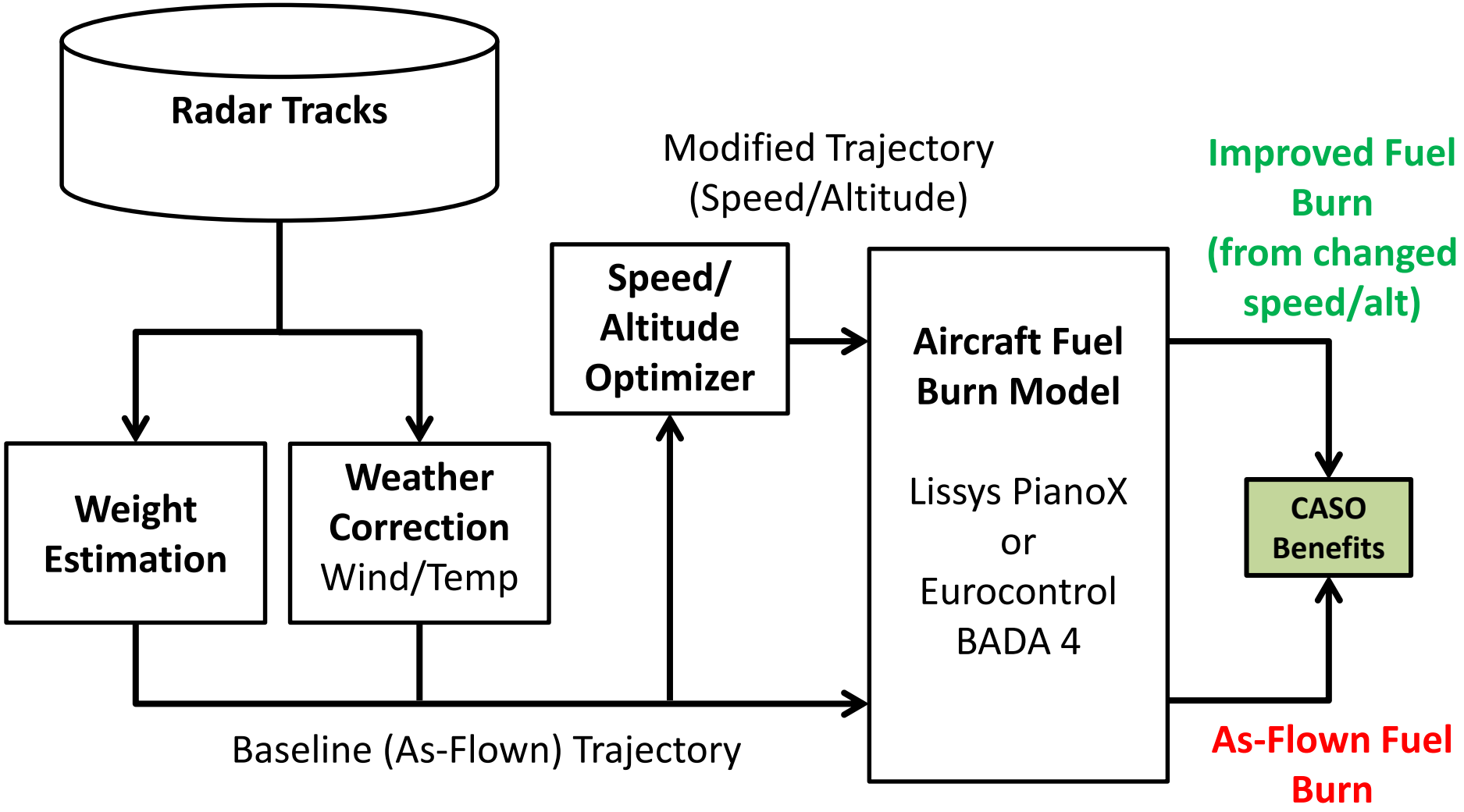
Cruise Altitude and Speed Optimization: Overview

- **Fuel burn reduction important for airlines, regulators, and society**
  - Economic impact
  - Environmental impact
- **2012 Radar analysis shows 56% of domestic flight time spent in high-altitude cruise**
- **Efficiency Metric: "Specific Ground Range"**
  - Maximizes ground distance per unit of fuel consumption
  - Accounts for wind and temperature
- **Typical airliner cruise conditions are not fuel-optimal with respect to speed and altitude**
  - Opportunities in flight planning, dispatch, and cockpit procedures
  - Potential applications in the NextGen ATM framework

Typical Narrow Body Jet Efficiency Contours



CASO High-Level Approach

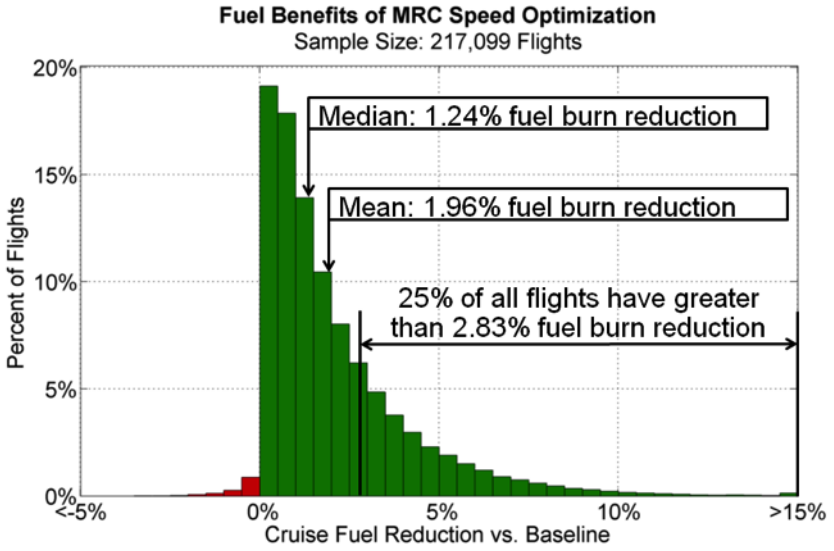


Aggregate Speed Results

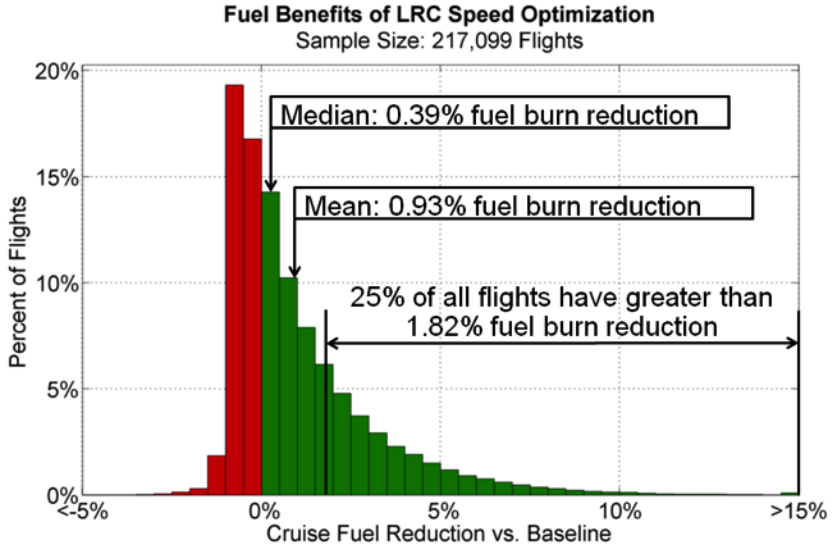
18 days in 2012

217,099 Flights

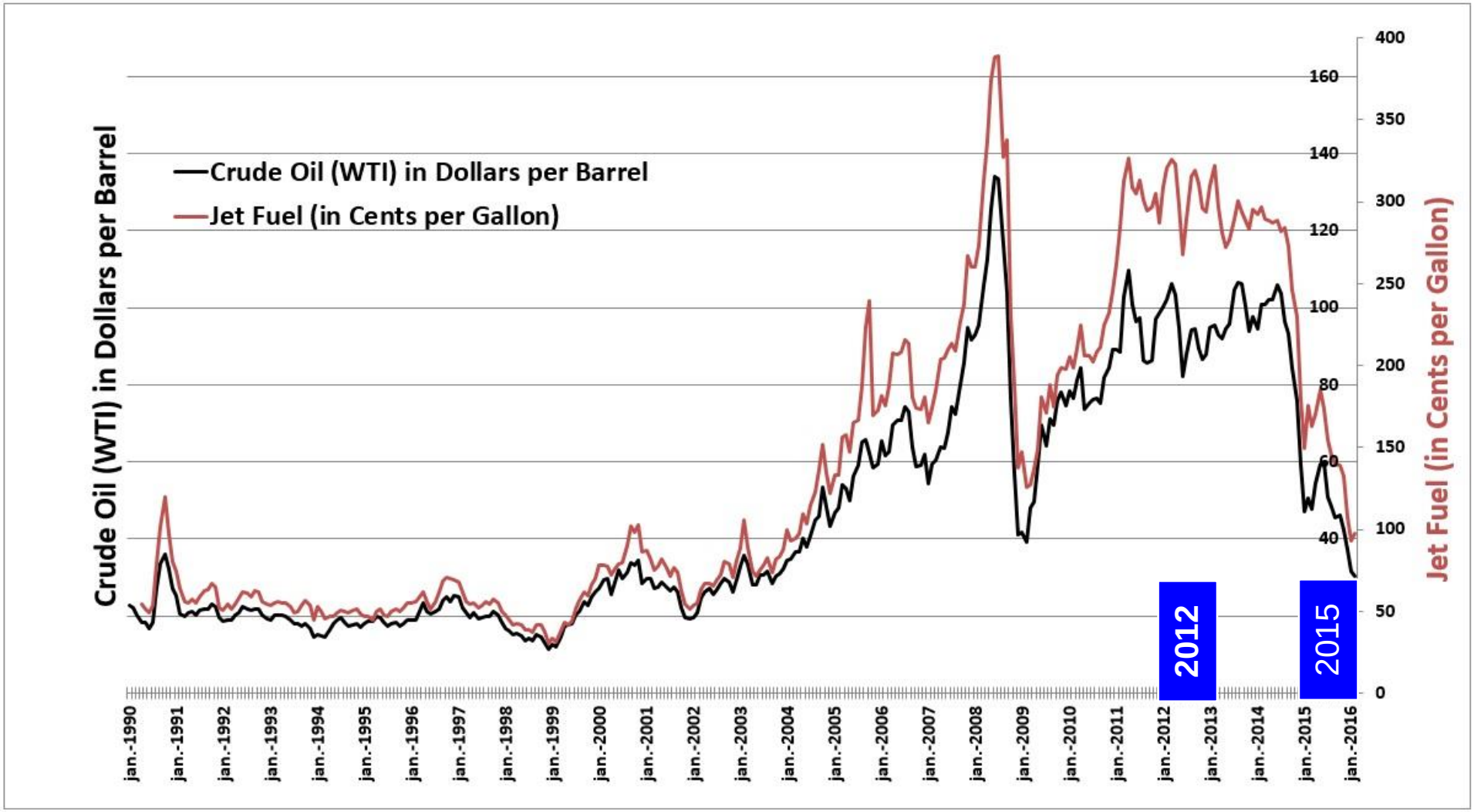
Max Range Cruise (MRC):
Fuel-optimal speed



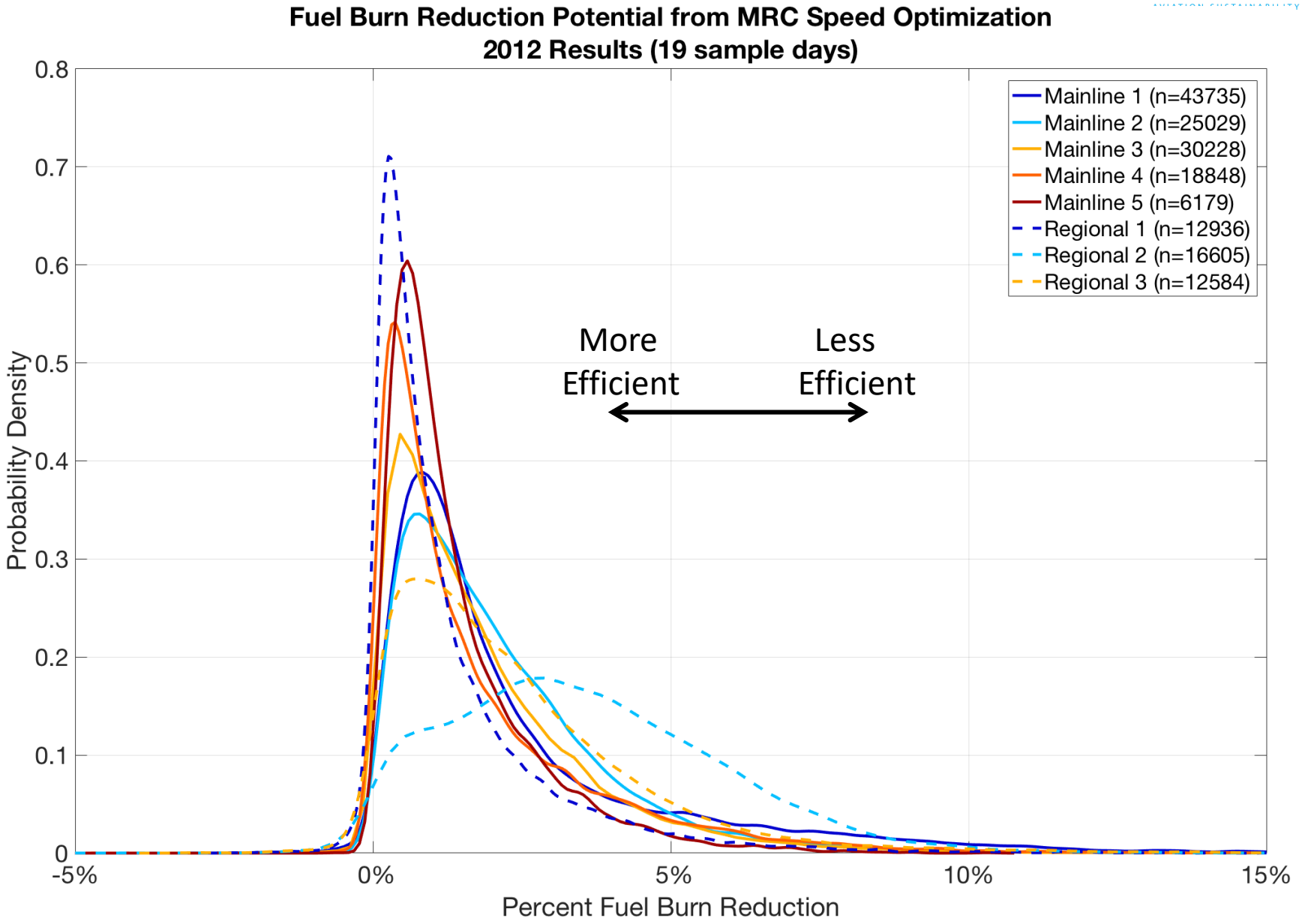
Long Range Cruise (LRC):
99% Efficiency Speed



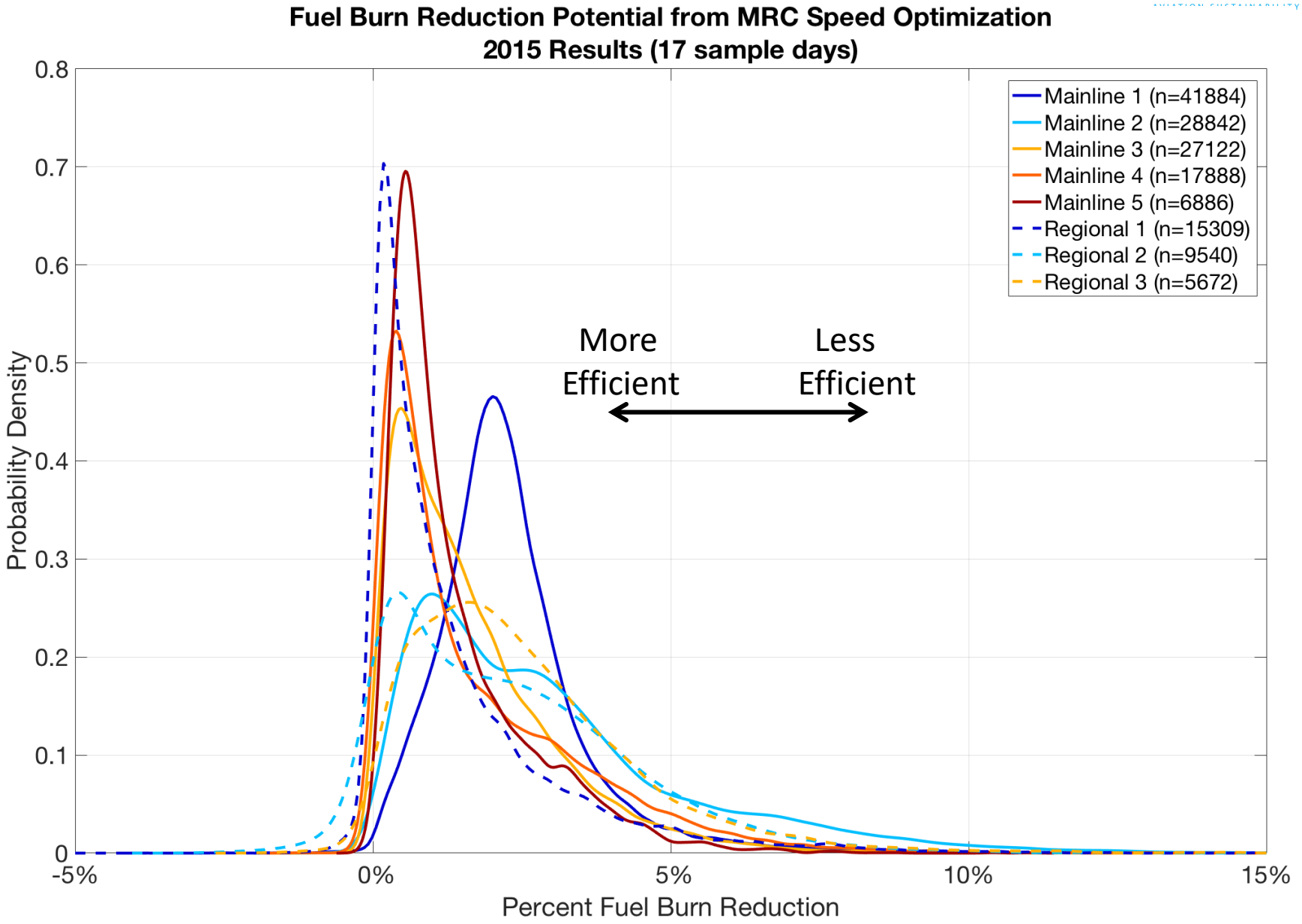
Crude Oil and Jet Fuel Price Trends



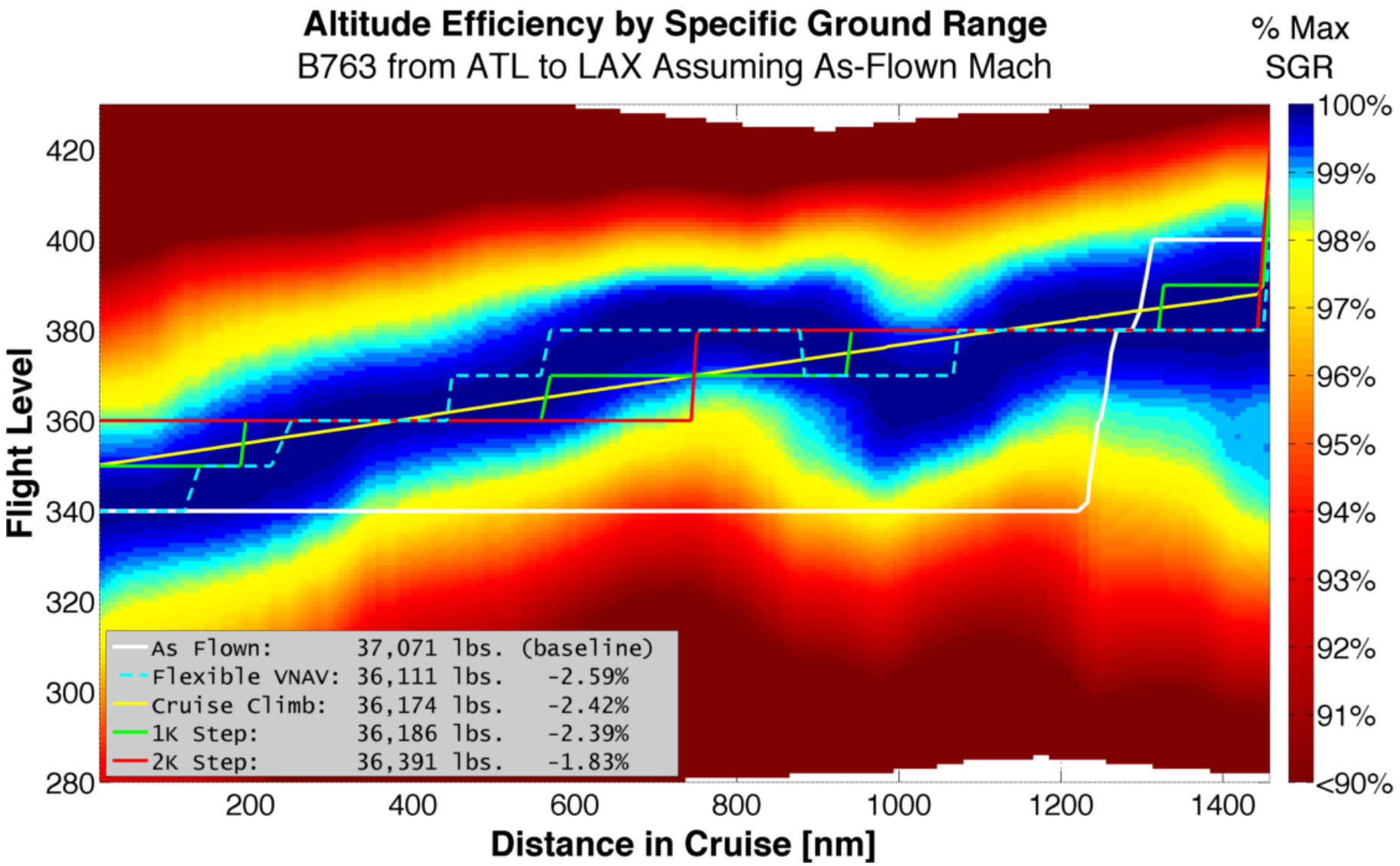
Aggregate Speed Efficiency: 2012 Data



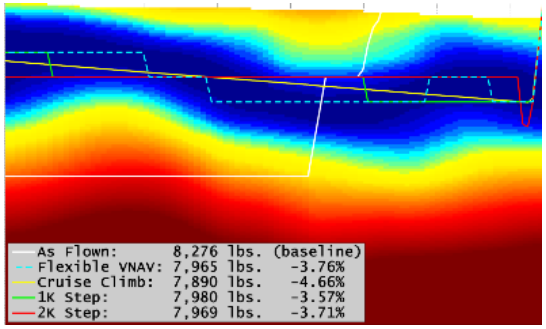
Aggregate Speed Efficiency: 2015 Data

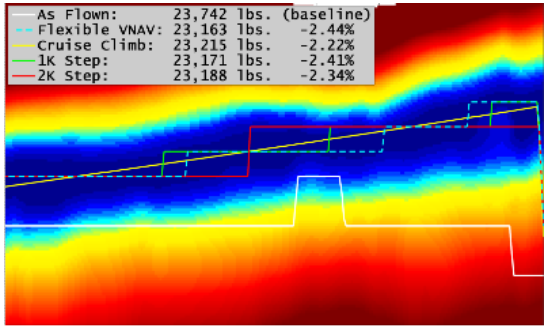


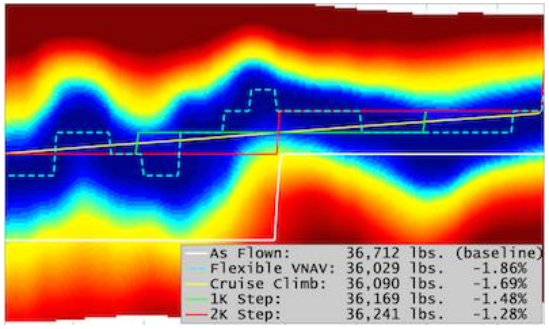
Altitude Optimization

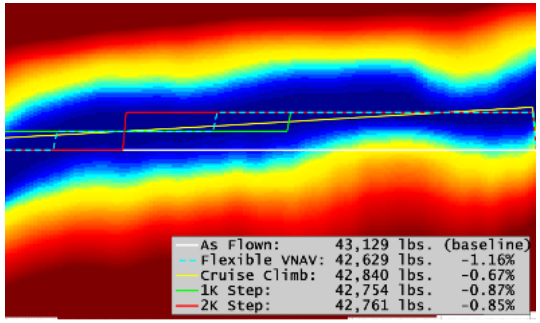


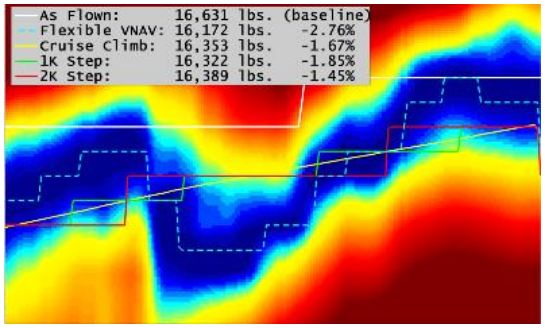
Sample Altitude Efficiency Tunnels

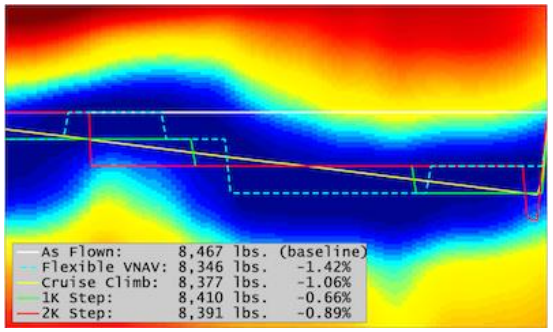


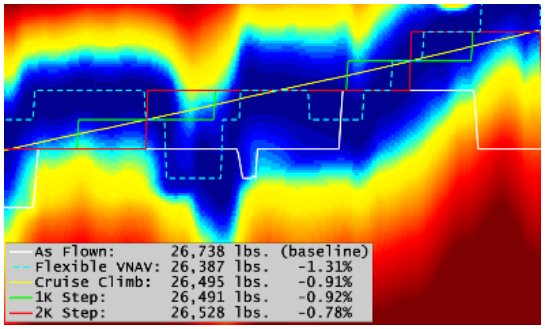


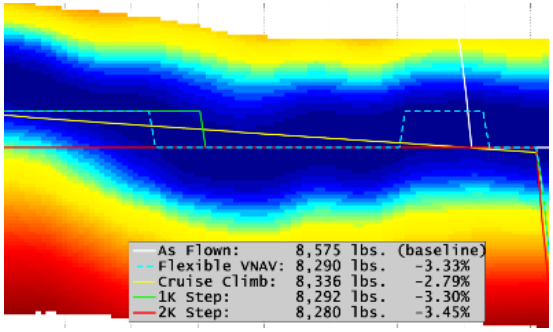


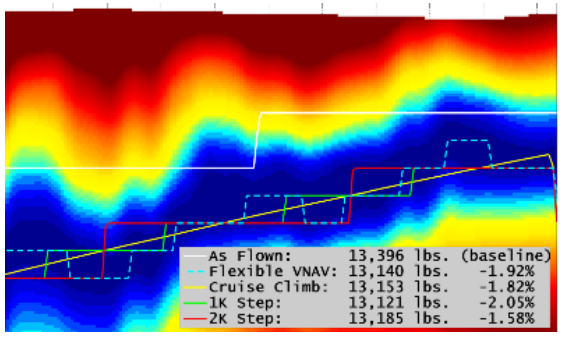




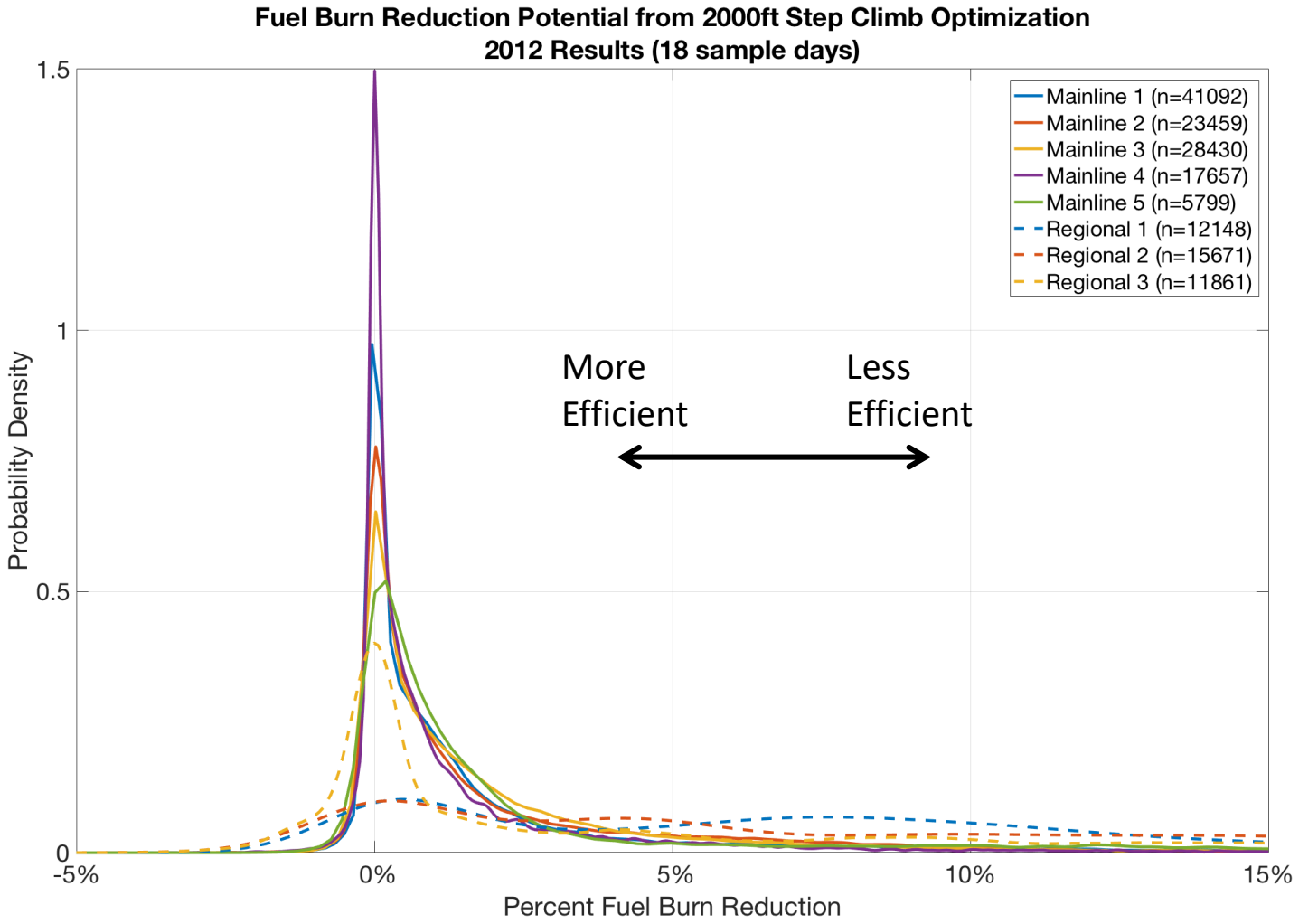




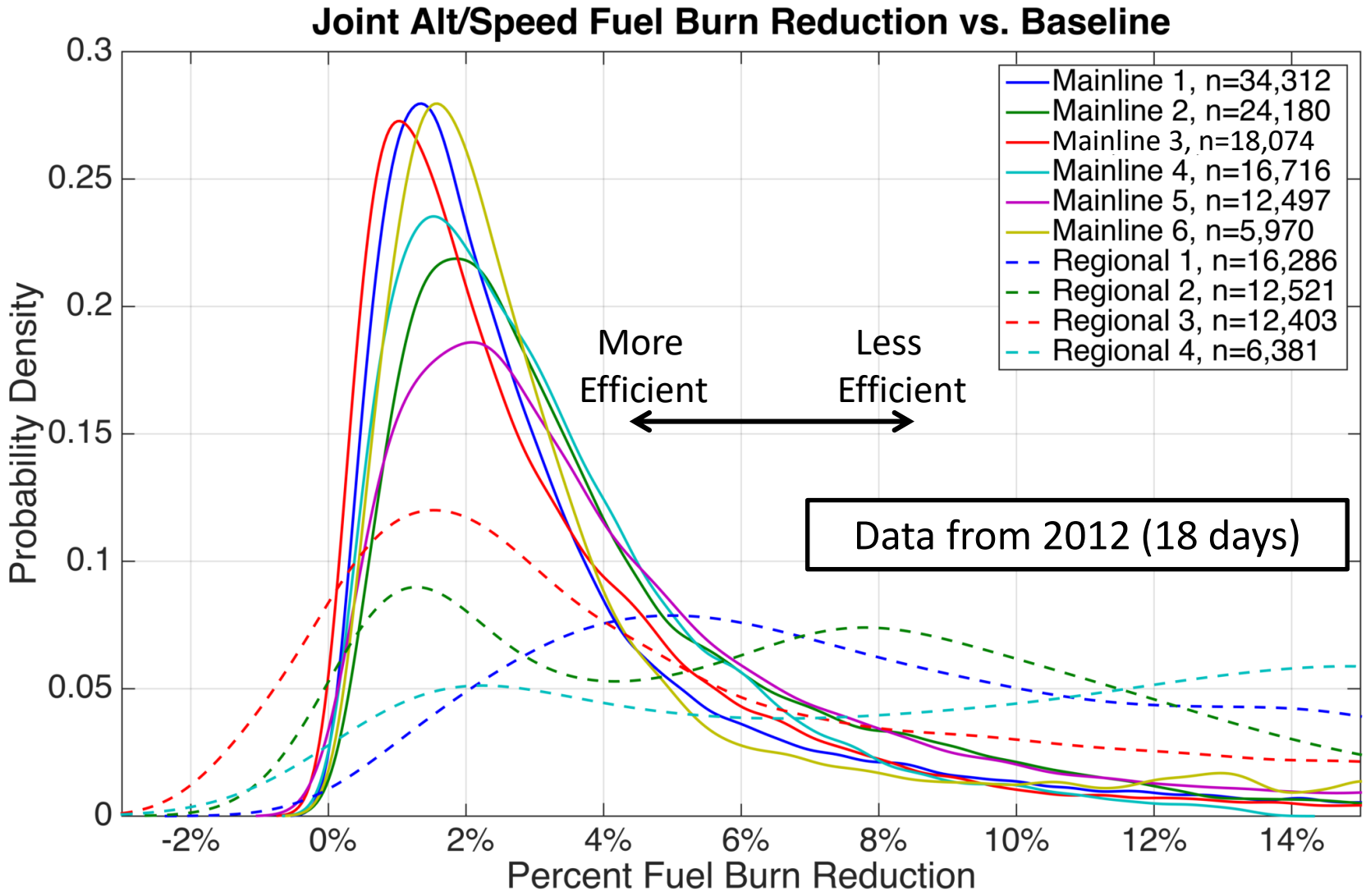




Altitude Efficiency
Aggregate 2012 Data (2000 ft Step Climbs)



Joint Altitude and Speed Optimization for 2012 Data By Airline

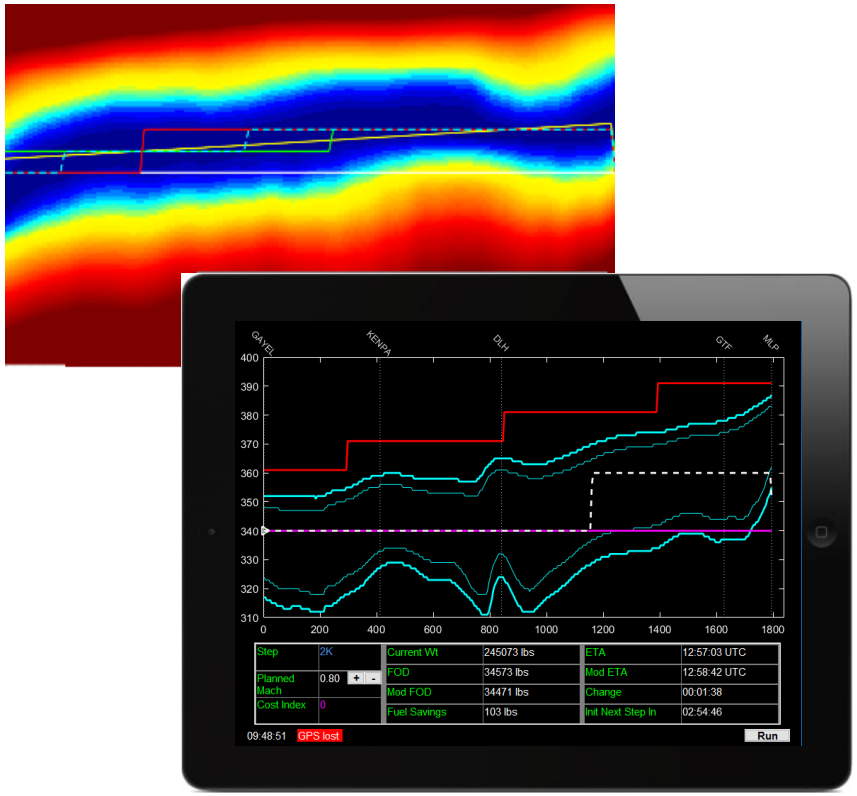


Potential Barriers to Optimal Cruise Altitude and Speed

- Internal factors
  - Airline
    - Dispatcher Flight Planning Tools
    - Flight Crew Awareness/Workload
  - Air Traffic Control
    - Controller Workload (Tactical)
    - Policies and Regulations (Strategic)
- External factors
  - Weather Conditions
    - Turbulence
    - Icing
- Business Drivers
  - Schedule (Cost Index)
  - Delays and schedule reliability
  - Non-Fuel Cost Drivers

Cruise Optimization DST

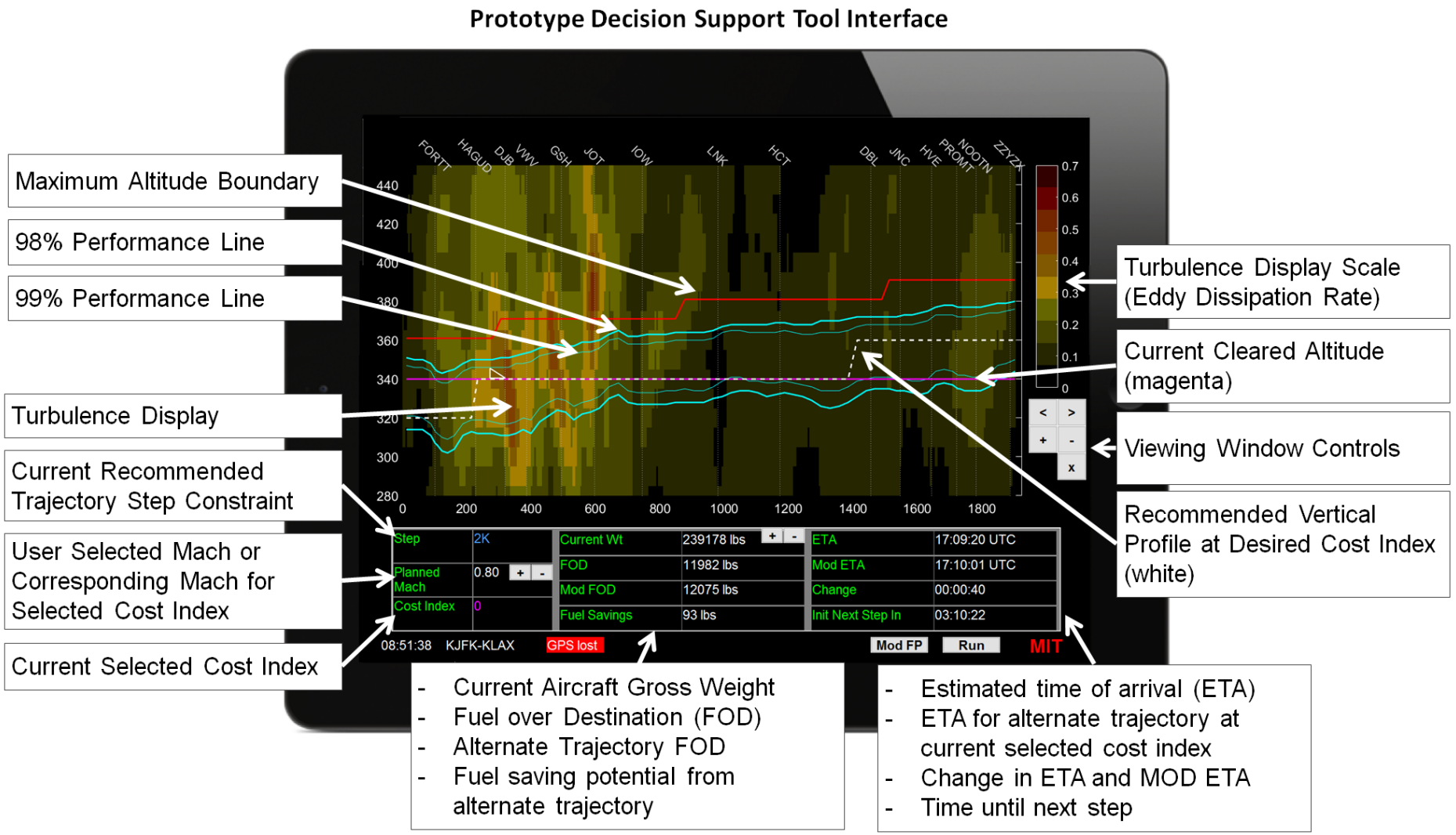
A prototype tablet-based Decision Support Tool (DST) using the underlying optimization approach was developed to provide better information by leveraging existing capabilities and emerging airline trends in connectivity



Objective: To identify opportunities, limitations, and practical considerations for altitude optimization in airline operations

Prototype currently running on a Microsoft Surface

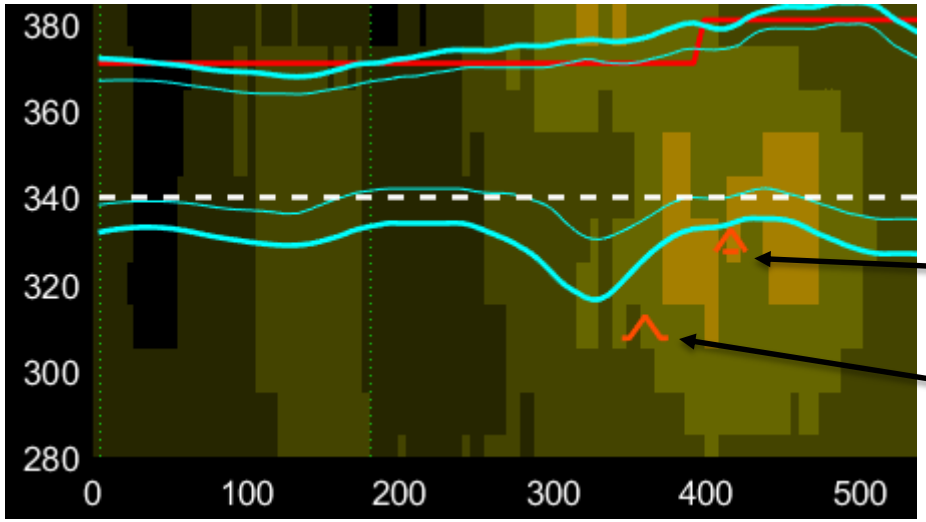
Prototype Decision Support Tool Features



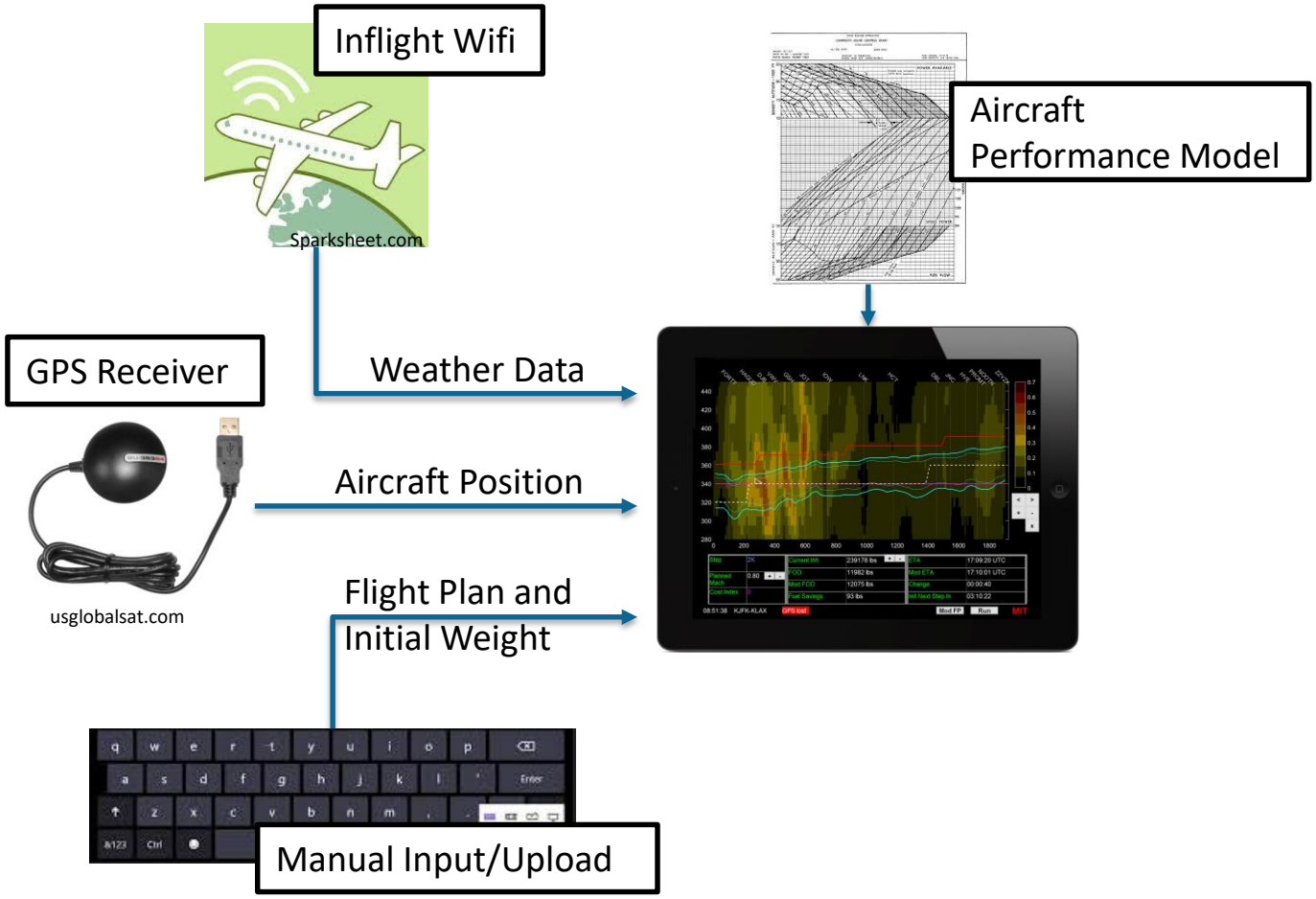
Turbulence Information: Graphical Turbulence Guidance and PIREPs

- Graphical Turbulence Guidance 3.0 (GTG) from NOAA
  - Eddy dissipation rates (EDR) as metric

- Pilot Reports (PIREPs)
  - Ride report, location, time, aircraft type

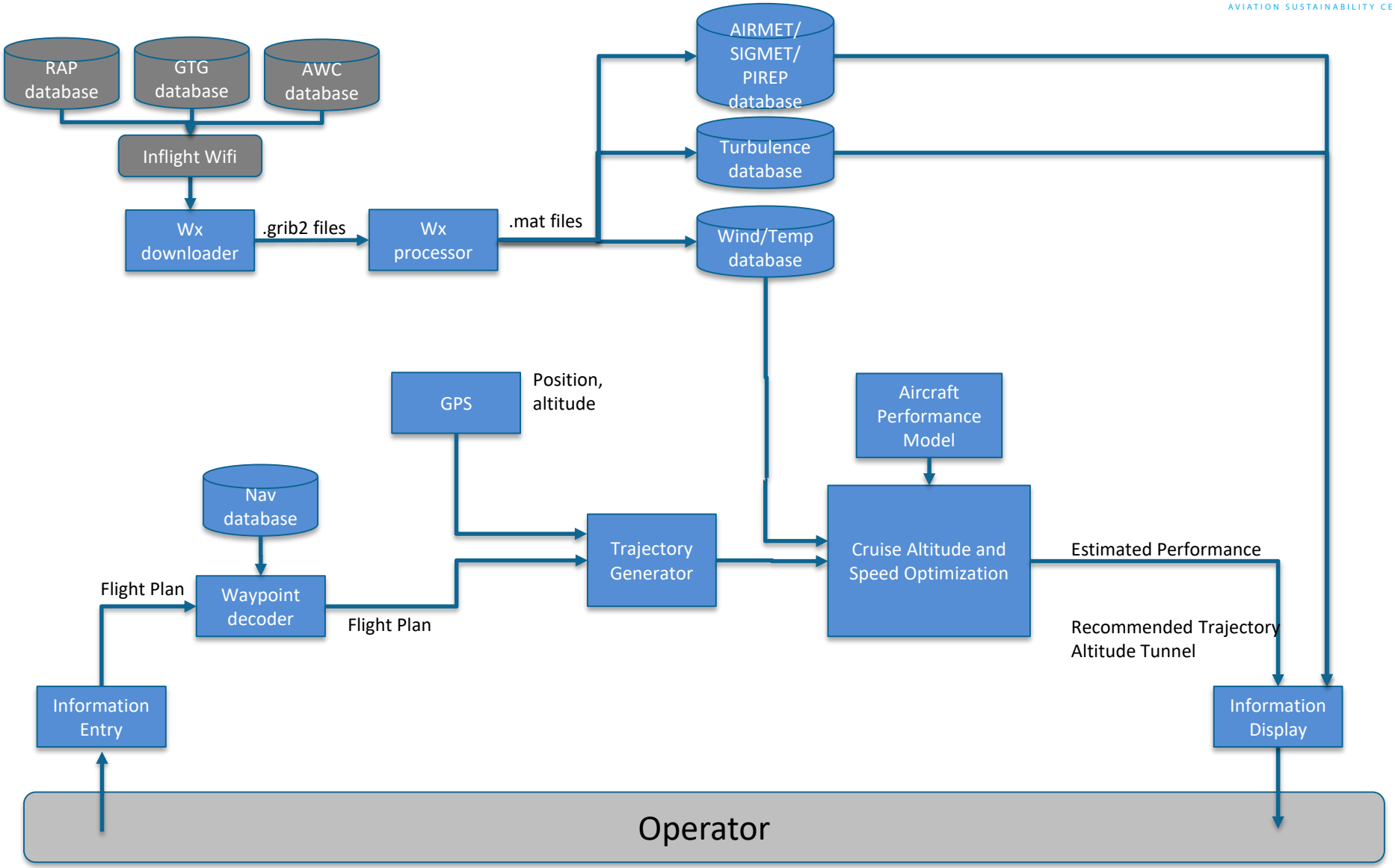


Prototype System

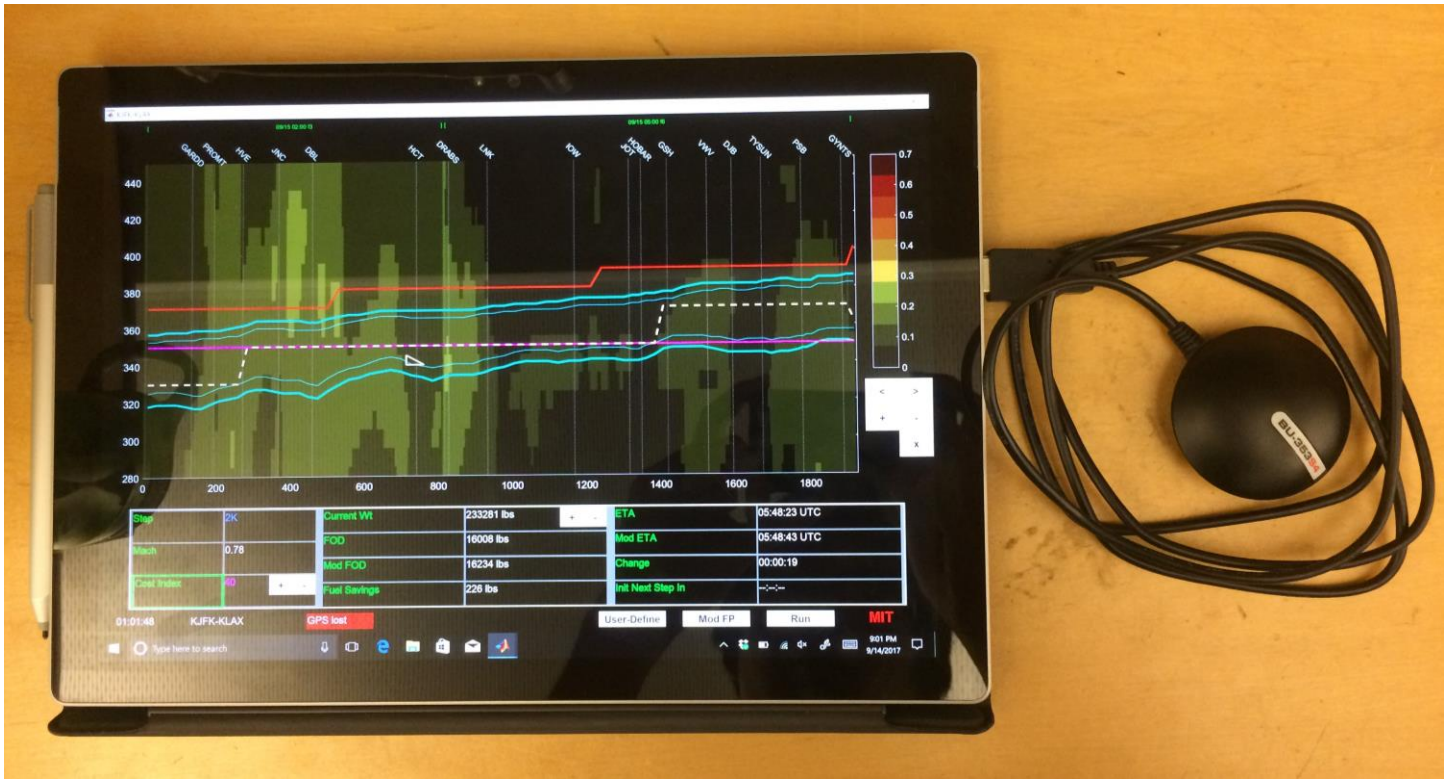


Standalone setup independent of aircraft systems developed for testing, but future integration with aircraft systems envisioned

Architecture (Prototype Test System)



Prototype System



- Prototype developed and running on Surface tablet
- Preliminary functionality testing conducted on GPS receiver and cabin Wifi download speeds

Next Steps

- NDA has been signed with a major carrier to compare flight plans
- Compare optimal trajectories and performance estimates from DST with trajectories from airline dispatch tools
- Test GPS reception in the cockpit
- Obtain feedback from pilots on usability and utility of the DST