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# **An Evaluation of Future Routing Initiatives**

## **Case Study: Southern Region**

Presented to

Free Flight Modeling Workshop

Douglas Baart  
[douglas.baart@faa.gov](mailto:douglas.baart@faa.gov)



# Objectives



- To provide summary metrics that identify differences in a range of potential future routing scenarios  
Metrics include:
  - Fuelburn
  - Flight distance
  - Flight time
  - Proximity alerts (conflicts)
  - Operational delay
- To apply a framework that measures the potential “pool of benefits” of increased utilization expected from planned en route NAS initiatives
- To assess some of the *flight efficiency* initiatives in the Operational Evolution Plan (OEP) and NAS Architecture
  - Initiatives impact WAAS (satellite navigation), URET (conflict probe), data link (reduced frequency congestion), NRP and RNAV (direct routing) benefits
- To apply multiple sets of data sets, tools, and models to a practical “real-world” problem



# Methodology

## Overview of Primary Tools and Models

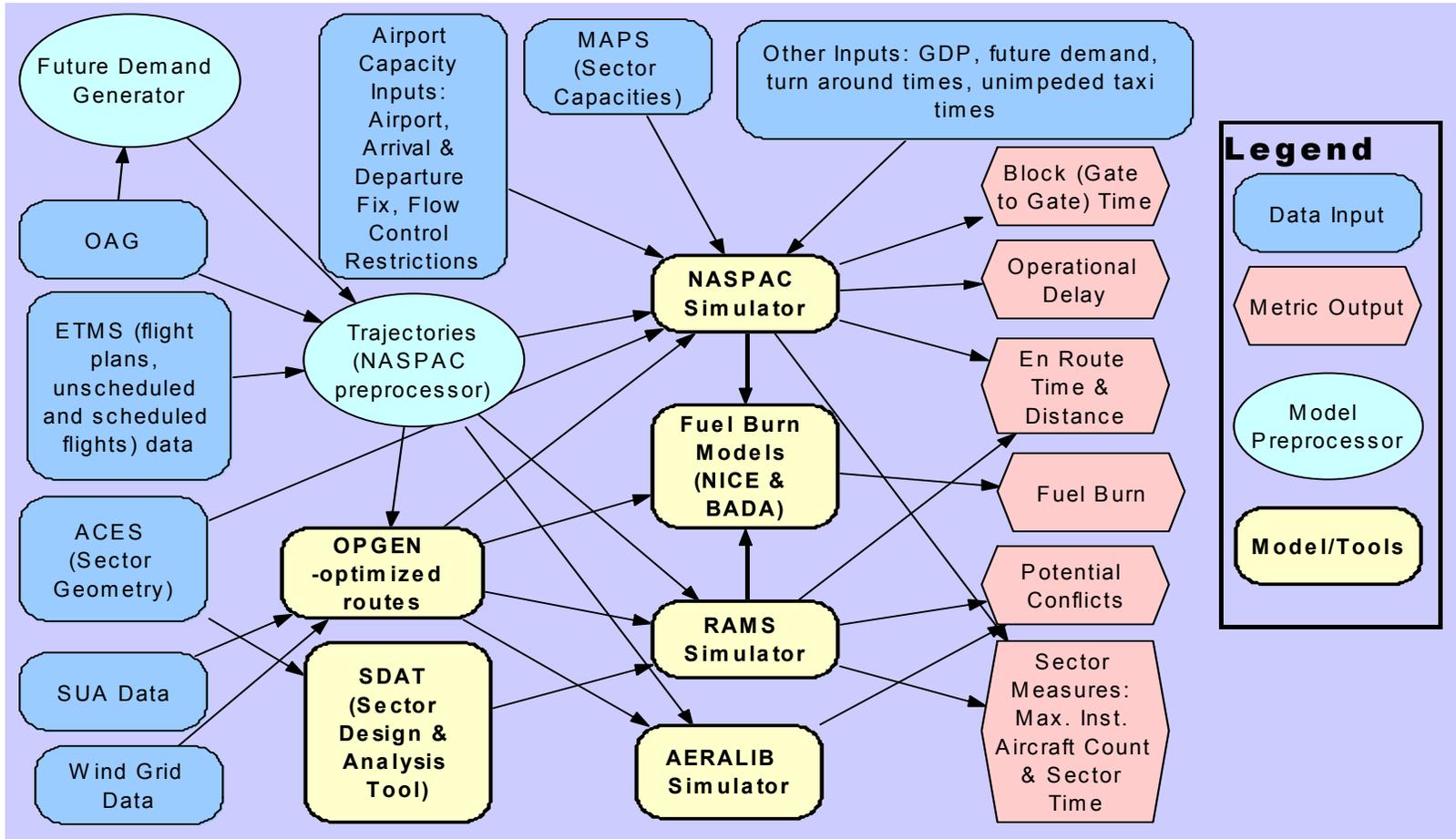


Tools and Models	Description
<b>Reorganized Air Traffic Mathematical Simulator (RAMS)</b>	A discrete-event simulation model developed by Eurocontrol. It is used for the study of airspace design, ATC systems, and future ATC concepts. It is typically used for <i>regional analysis</i> .
<b>NAS Performance Analysis Capability (NASPAC)</b>	A discrete-event simulation model that tracks aircraft as they progress through the NAS. It measures system performance based on demand placed on the airspace and airports. It is typically used for <i>national analysis</i> .
<b>Sector Design &amp; Analysis Tool (SDAT)</b>	A decision support tool that provides <i>NAS sector geometries</i> that are input into RAMS
<b>Optimal Trajectory Generator (OPGEN) Model</b>	A model that attempts to fly an <i>optimum trajectory</i> using wind-optimized routes from both the original flight plan and other flight plan variations, e.g., future demand, given a set of pre-established criteria
<b>The North Atlantic Systems Implementation Group Cost Effectiveness Programme (NICE) Fuelburn Model</b>	An ICAO-endorsed model that provides <i>fuel consumption</i> rates for specified aircraft type by speed, altitude (climb, cruise, and descent), and weight of aircraft. The information is provided by Lufthansa Airlines.
<b>Aircraft Performance Summary Tables for Base of Aircraft Data (BADA)</b>	Provides performance tables of <i>fuel consumption</i> based on a total-energy model and performance coefficients for 67 aircraft types. The information is provided by Eurocontrol.



# Methodology (Cont'd)

## Interrelationships between Tools and Models





# Methodology (Cont'd)

## Overview of Cases



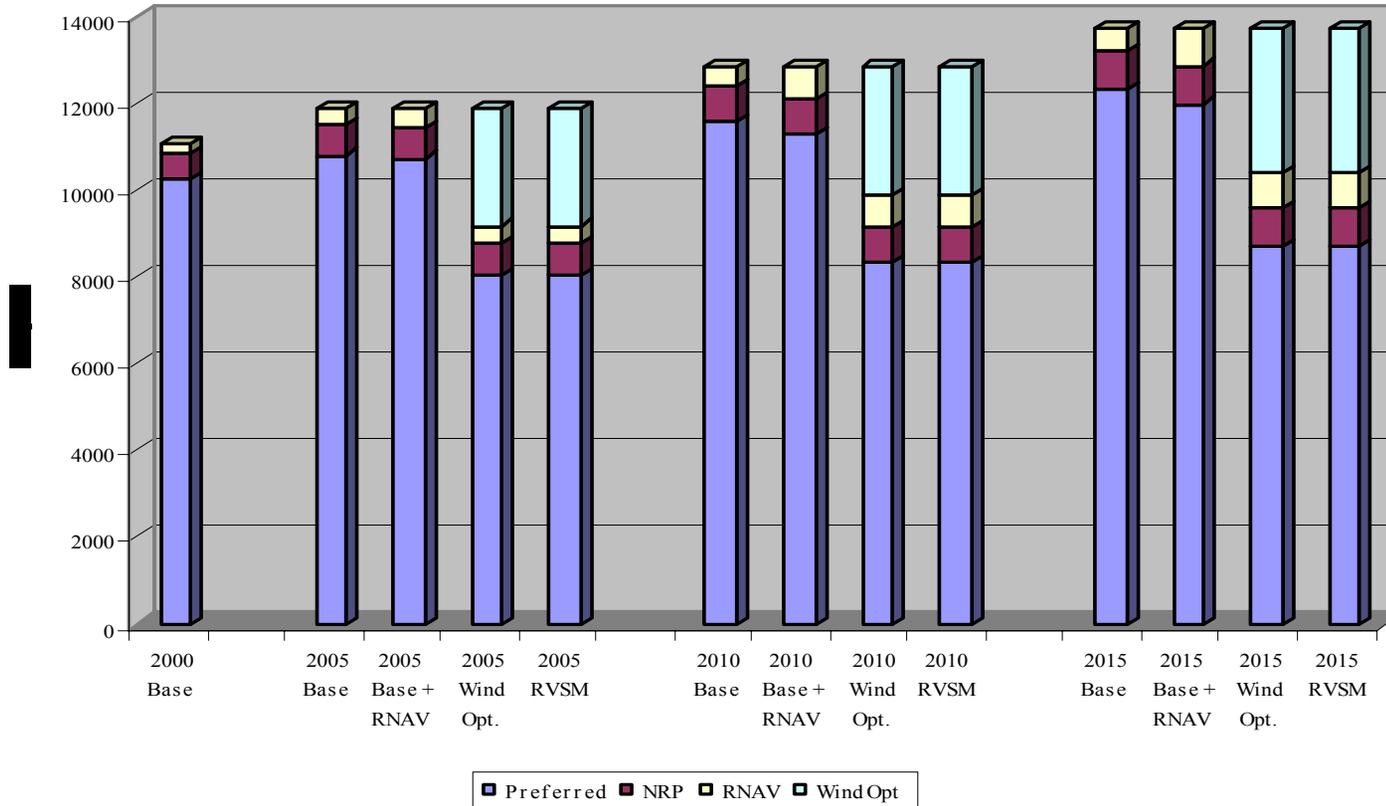
Case*	2000	2005	2010	2015	Key Elements
<b>Case 1:</b> Baseline	X				Current NRP and Southern Region RNAV routes
<b>Case 2:</b> Baseline + <i>Increased RNAV Routes</i>		X	X	X	Projected growth in Southern Region RNAV routes
<b>Case 3:</b> Baseline + Increased RNAV Routes + <i>Increased Wind Optimized Routes</i>		X	X	X	Additional wind optimized routes for FL290 and above and stage length $\geq 750$ nmi
<b>Case 4:</b> Baseline + Increased RNAV Routes + Increased Wind Optimized Routes + <i>Domestic RVSM</i>		X	X	X	Reduction in vertical separation from 2000' to 1000' from FL290 to FL390

\* Each case is additive and reflects enhanced capabilities



# Methodology (Cont'd)

## Distribution of Flights through Southern Region

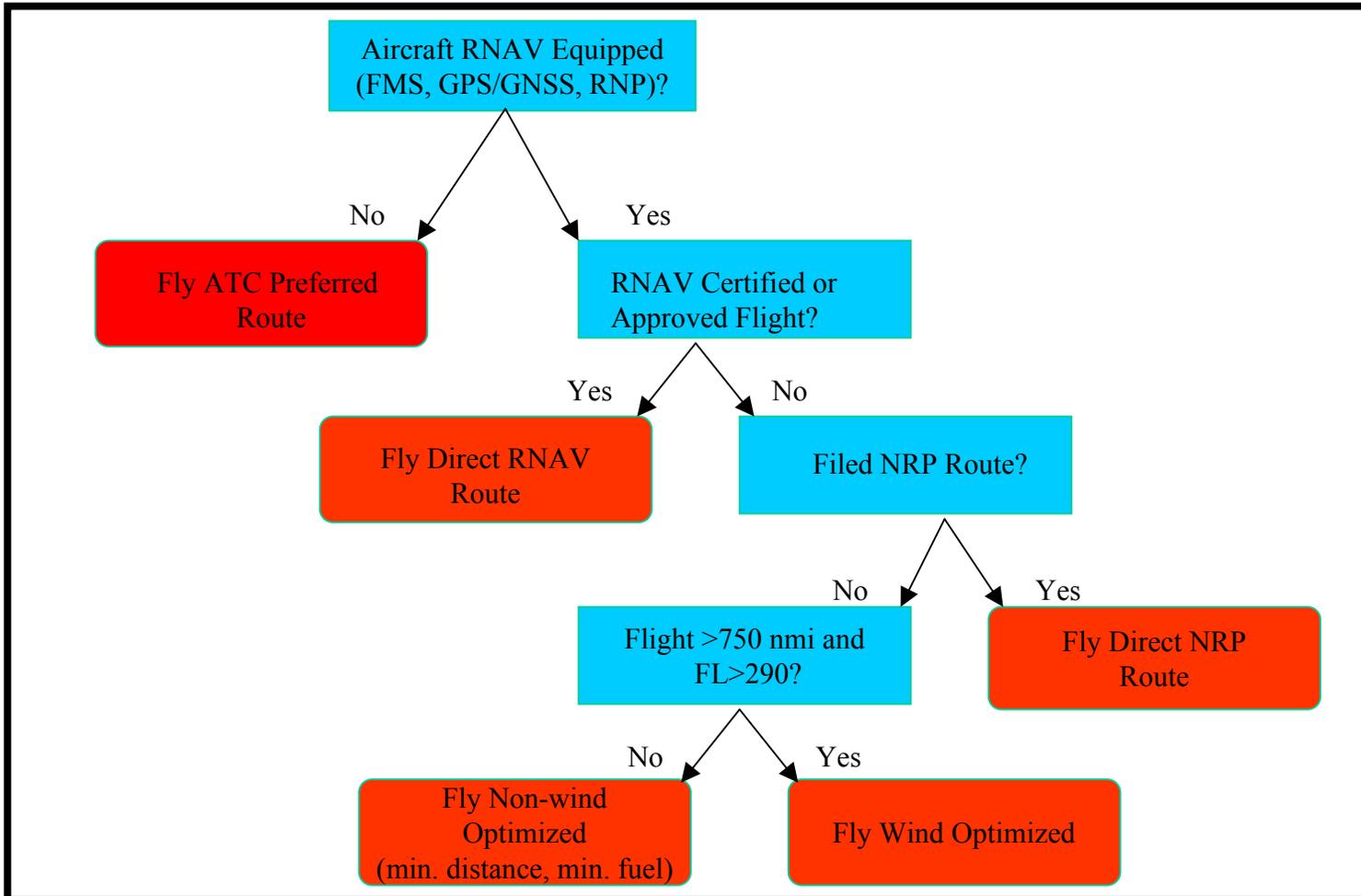


*In 2005, there were 5359 flights that were simulated in the Southern Region which were candidates for RVSM. Percentage of ATC Pref Routes decrease in future years*



# Methodology (Cont'd)

## Route Selection Process



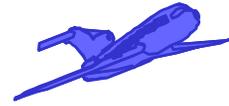


# Methodology (Cont'd)

## Domestic RVSM (Case 4)



- Assumption that domestic RVSM will be completed by 2005 for FL290-FL410
  - Vertical separation is currently 2000 feet; horizontal separation minima is 5 nautical miles.
  - RVSM will provide vertical separation down to 1000 feet at or above FL290
  - Upper altitude is the first priority when changing flight level, i.e., when an aircraft is at FL350 it will attempt to fly at FL360 before FL340
- 0-179 degree heading gives odd cardinal flight level of FL290, 330, and 370
- 180-359 degree heading gives odd cardinal flight level of FL310, 350, and 390
- Current and future RVSM equipage by carrier/aircraft type provided by FAA's Flight Standards Division

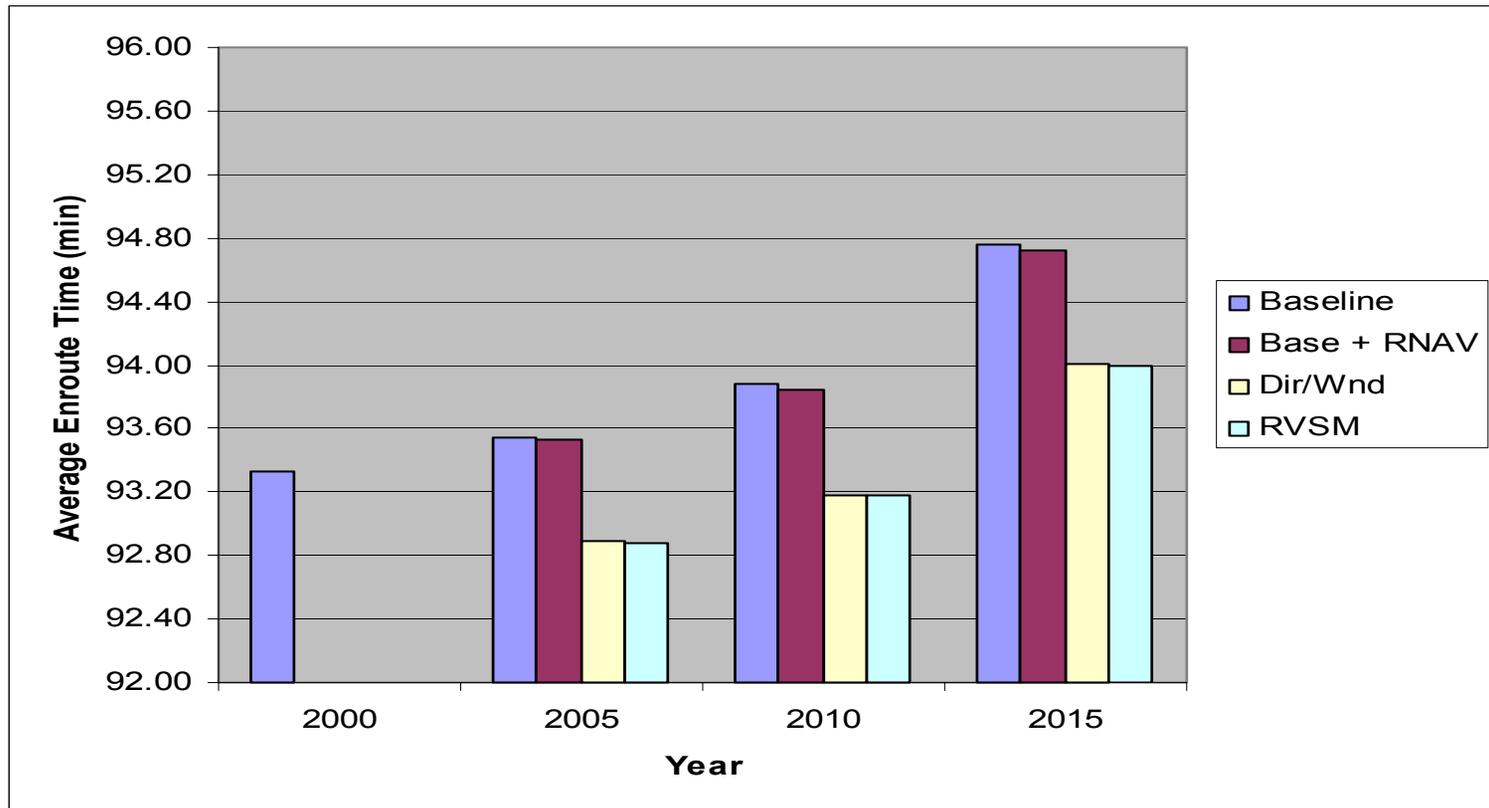


# Results



# Results: Scenario Analysis

## Average Airborne Time per Flight

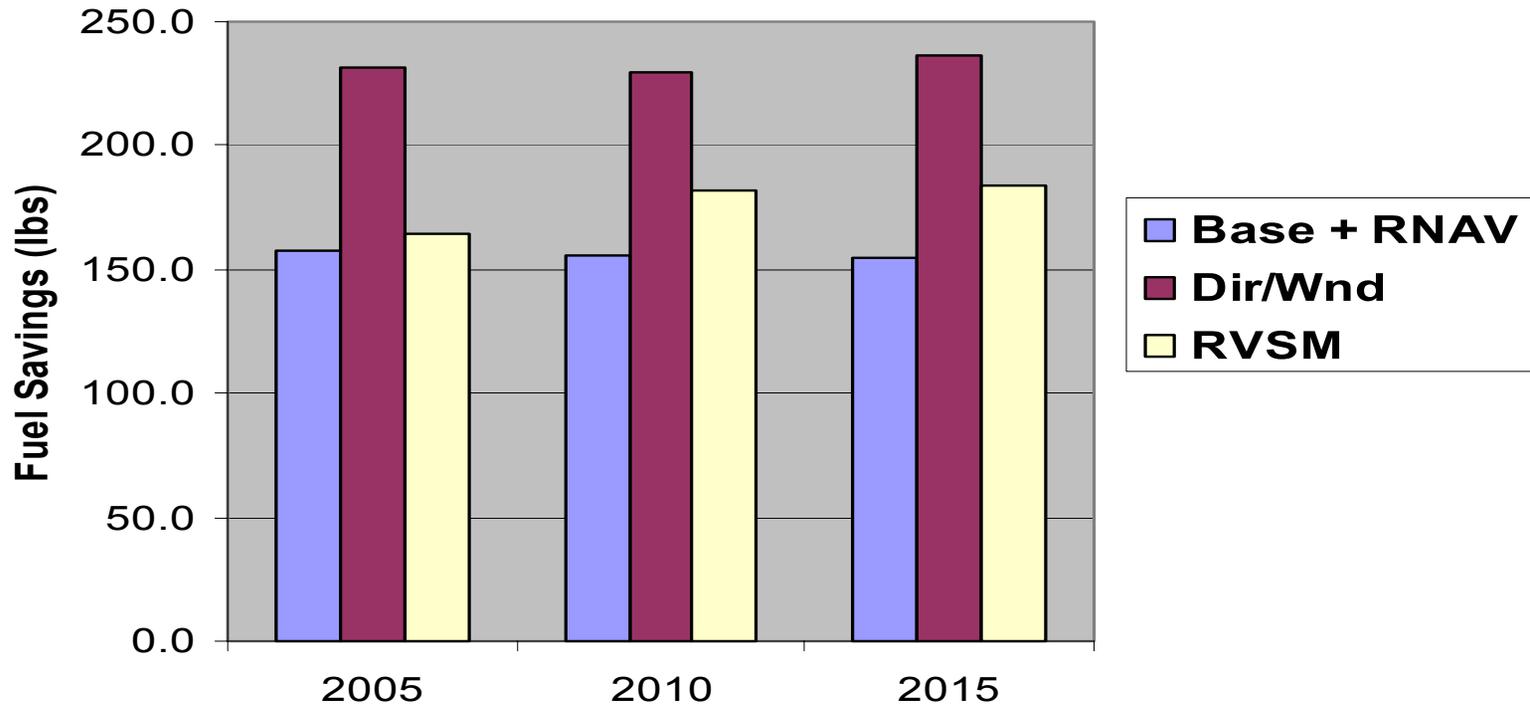


*The airborne times in the Southern Region are slightly less than the rest of the NAS. The average airborne time for these flights in 2000 was 94.2 minutes; NAS-wide it was 101 minutes.*



# Results: Marginal Metrics per Flight

## Marginal Airborne Fuel Savings per Flight by Routing Type





# Results: Optimized Flights Analysis

## Marginal Savings Metrics per Marginal Flight



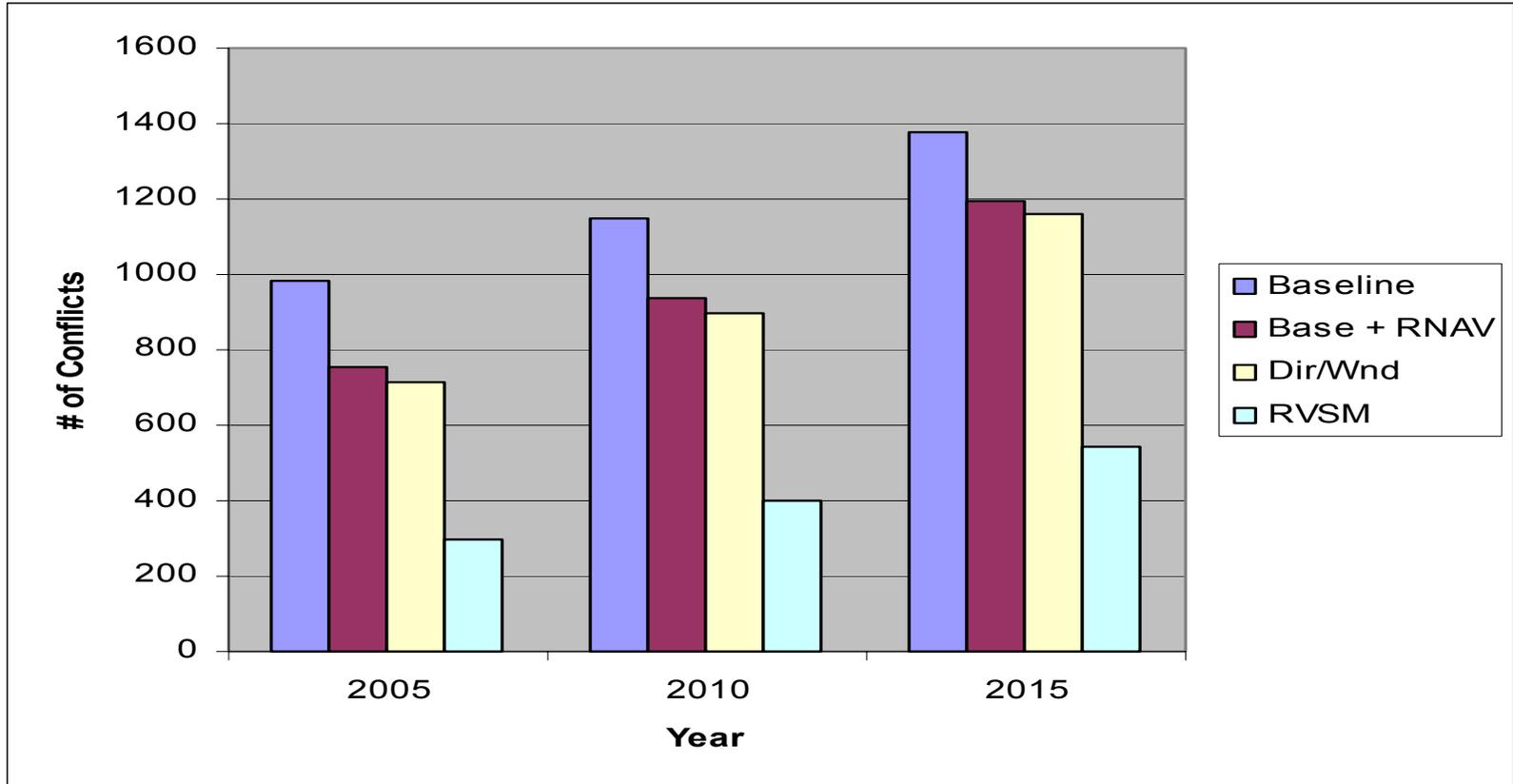
Metrics Savings per Flight from the Optimized Flights in the Dir/Wnd Case				
	2005	2010	2015	
<b>Direct Routes</b>				
Fuel (lbs)	150.00	143.73	150.50	
Distance (nmi)	14.58	15.26	16.06	
Time (minutes)	3.83	3.96	4.08	
<b>Wind Routes</b>				
Fuel (lbs)	323.48	325.00	330.02	
Distance (nmi)	1.46	1.49	1.56	
Time (minutes)	1.71	1.70	1.74	



# Results (Cont'd)

## Number of Conflicts

(Flights FL290 or above through Southern Region)



*Conflict is defined as a violation within 1000 feet vertically for RVSM case between FL290 and FL410 or 2000 feet vertically for non-RVSM case and a violation of 5 mile horizontal separation.*

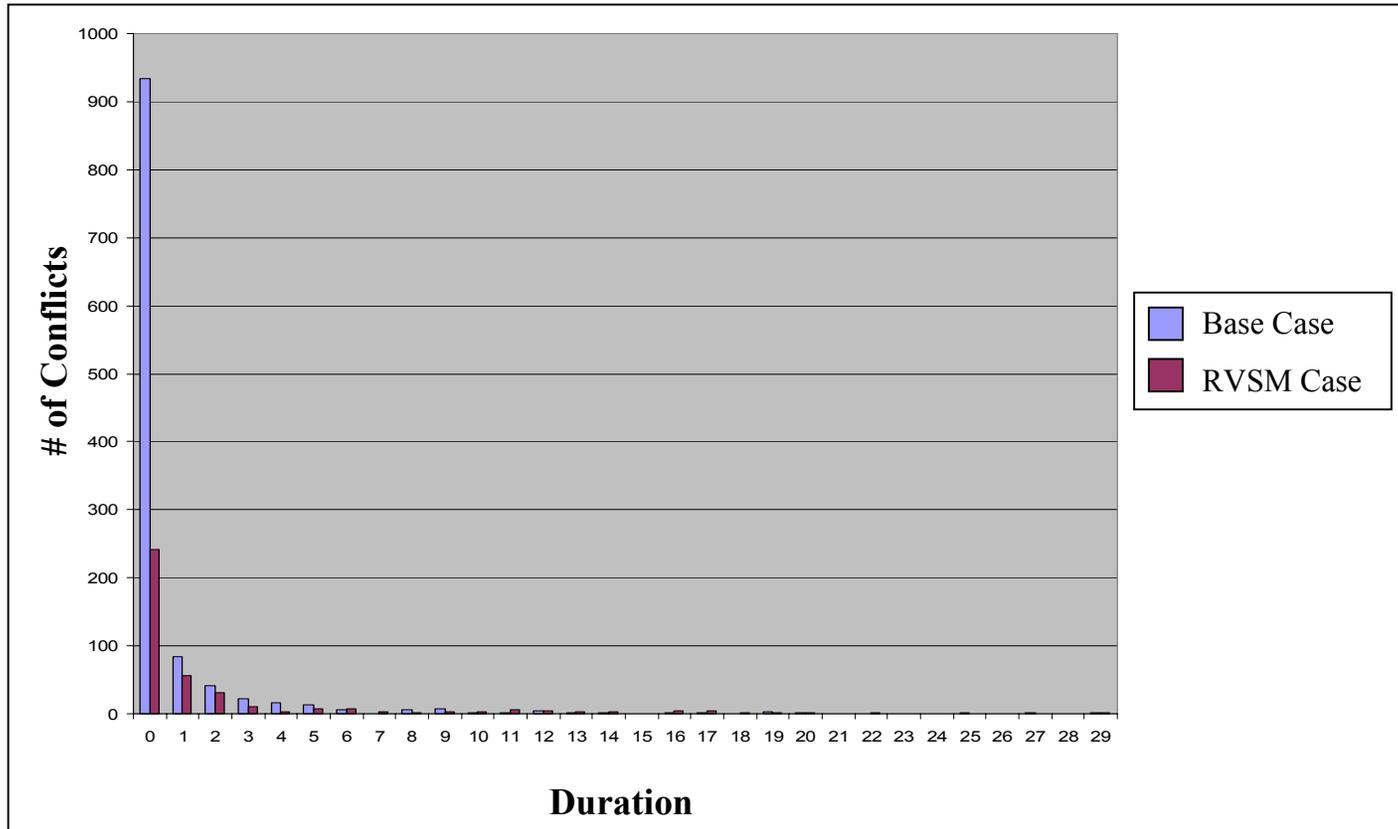
There were 5612 flights that flew at FL290 or above in 2005; 6058 flights in 2010



# Conflicts

## Distribution by Time

(Base Case 2010 vs. RVSM Case 2010)



*Given a flight has a conflict, 81 percent of the 2010 base case have conflicts of <1 minute; 60 percent of the 2010 RVSM case have conflicts of <1 minute. This is a reduction from 950 conflicts to 250 conflicts.*



# Future Model Improvements



- More Robust NAS-Wide Simulation Engine
- Separation Based instead of Discrete Event
  - Dynamic Reroute of Traffic
  - Dynamic Resectorization Capability
  - Conflict Resolution Capability
    - Support for Investment Analysis Benefits
    - Assist in support of ranges of FFP2 scenarios
- Currently Evaluating Aerospace Industries “AWSIM” En Route Software