

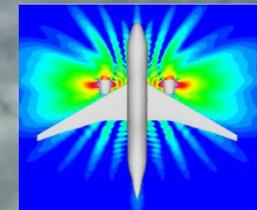
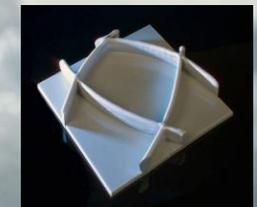
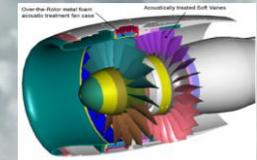
National Aeronautics and Space  
Administration

# Subsonic Fixed Wing Project Alternative Fuels Research

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Dan Bulzan,  
Associate Principal Investigator

Green Aviation Summit  
September 8-9, 2010



# NASA FAP Alternative Fuels Research Effort

## National Plan Goals...

**Energy and Environment Goal 1:** Enable new aviation fuels derived from diverse and domestic resources to improve fuel supply security and price stability.

**Energy and Environment Goal 3:** Advance development of technologies and operational procedures to decrease the significant environmental impacts of the aviation system.

## FA/FSW Technical Challenge (draft):

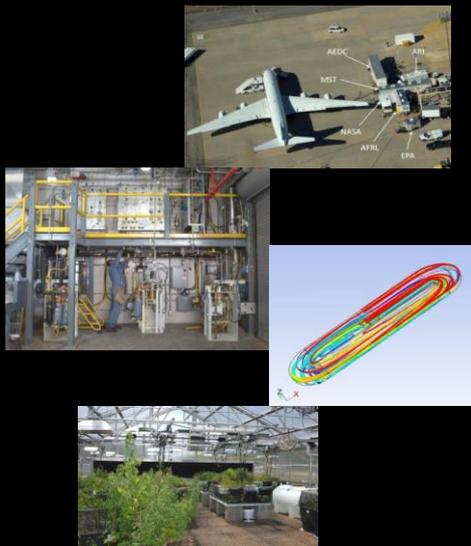
Reduced Emission Aircraft - Enabling concepts and technologies to dramatically reduce or eliminate harmful emissions affecting local air quality/health and global climate change attributable to aircraft energy consumption.

## Alternative Fuels Research

Alternative Fuels Analysis & F-T Reaction Kinetics

Combustion Performance & Emission Evaluation

Biomass Production & System Modeling



# NASA Alternative Fuels Effort

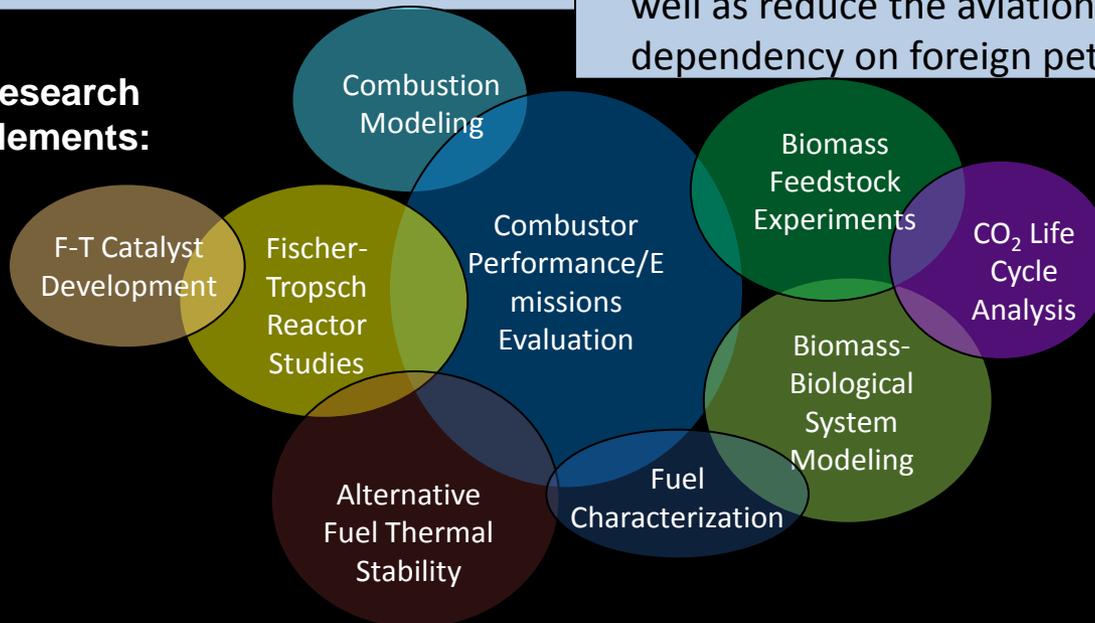
What are we trying to do?

- Develop technology and knowledge base that helps enable, improve, and sustain alternative fuels for the aviation industry.

Why?

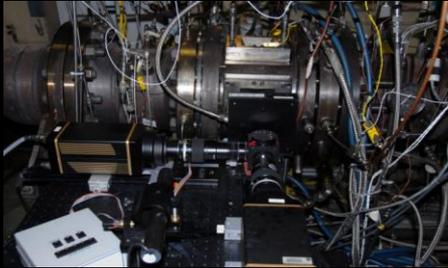
- Alternative fuels have the potential for reducing the gaseous and particulate emissions of aircraft as well as reduce the aviation dependency on foreign petroleum

**Research Elements:**

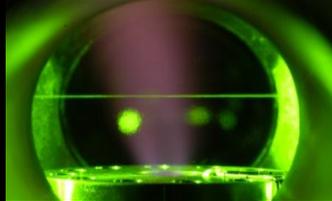


# NASA Alternative Fuel Research Facilities

## Combustion Testing



## Validation Experiments

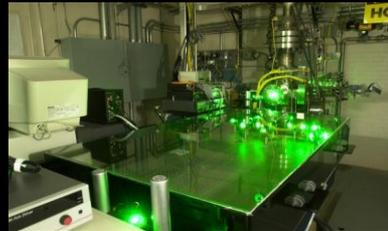


## Exhaust Plume Contrail Experiments

SE-11



## CE-5 High Pressure Flametube



## SE-5 High-Pressure Laboratory Scale Burner



## Chemical Kinetics

CE-24 Well Stirred Reactor

# NASA Alternative Fuels Research Facilities



Alternative Fuels Laboratory

Fischer-Tropsch Reactors  
Fuel Thermal Stability



Greenlab

Fundamental Biomass  
Experiments/Model  
validation

# Alternative Aviation Fuel Experiment - AAFEX

**Location:** NASA Dryden Aircraft Operation Facility

**Dates:** January 20 – February 3, 2009

**Sponsors:** NASA, Air Force, EPA, FAA

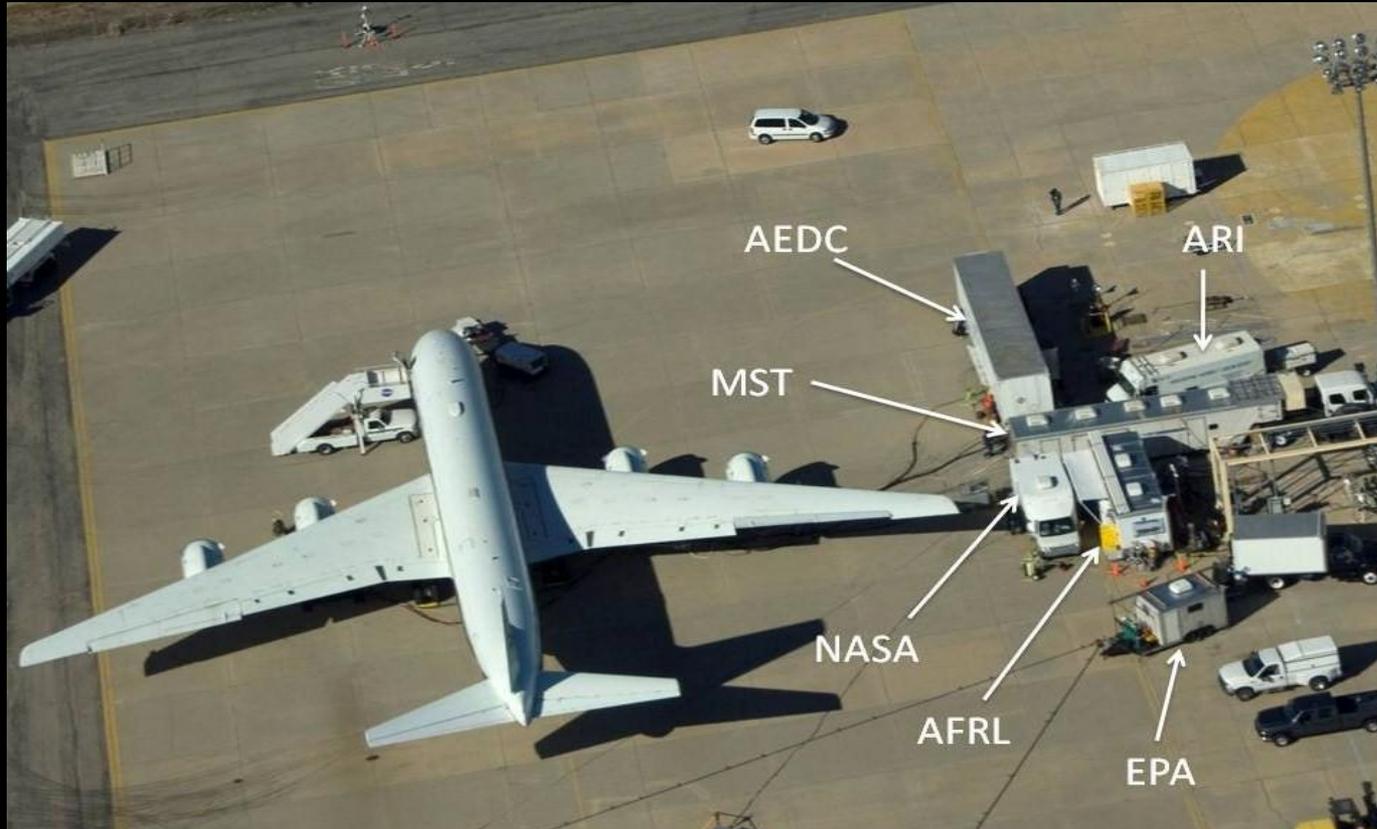
**Aircraft:** DC-8 with CFM56-2 engines

**Fuels:**

- 1--Standard JP-8
- 2-- Fischer-Tropsch Fuel from Natural Gas (FT1)
- 3--50/50 JP-8/FT1 blend
- 4-- Fischer-Tropsch fuel from Coal (FT2)
- 5--50/50 JP-8/FT2 blend

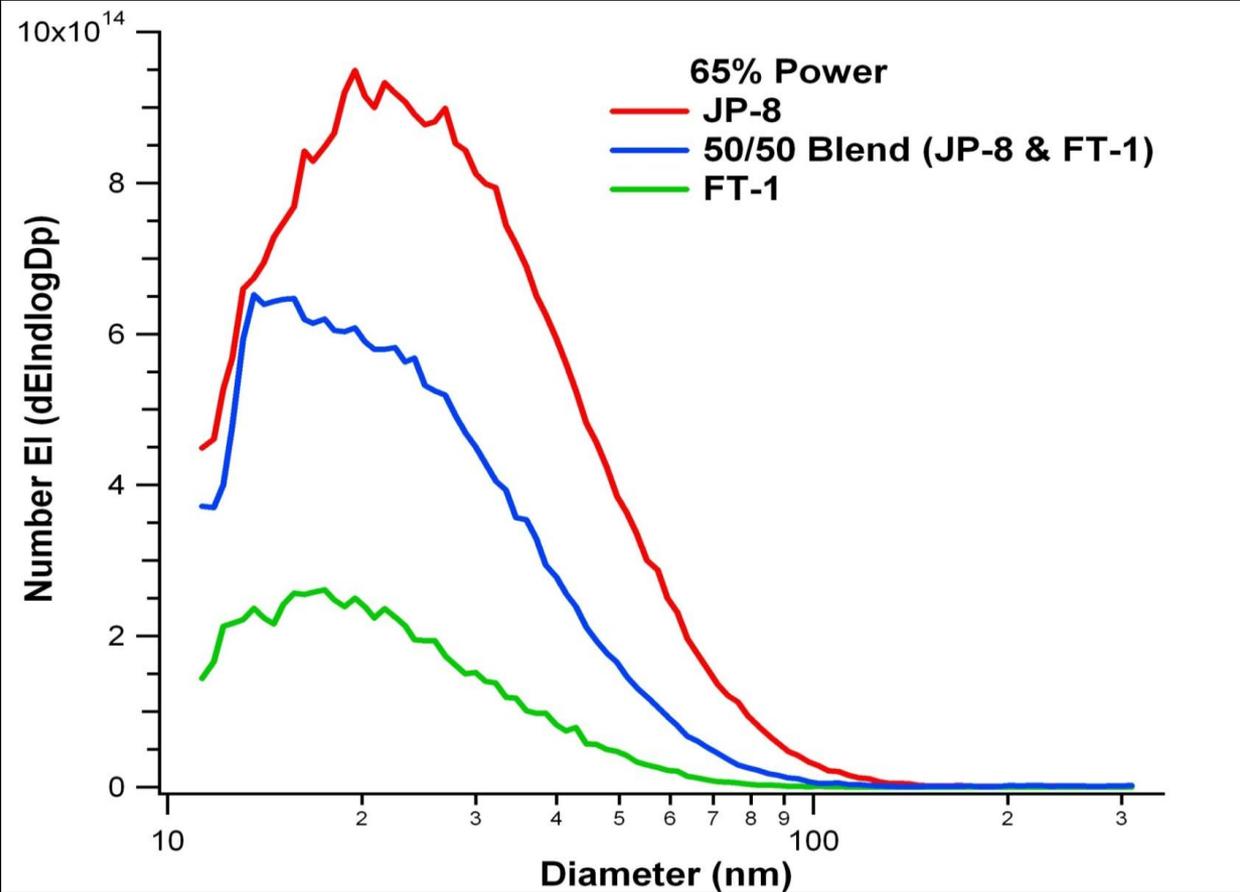
**Runtime:** ~35 hours total

# AAFEX Test Site Arrangement



Boeing, GE, Pratt and Whitney, CMU, Harvard, MSU, UCSD, and UTRC also participated

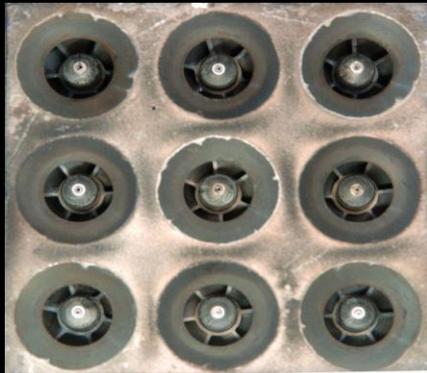
# AAFEX Results



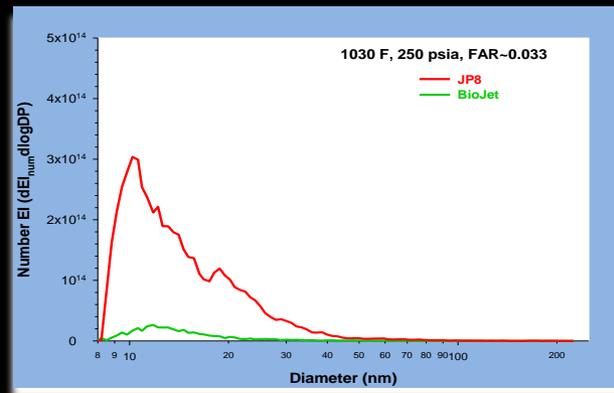
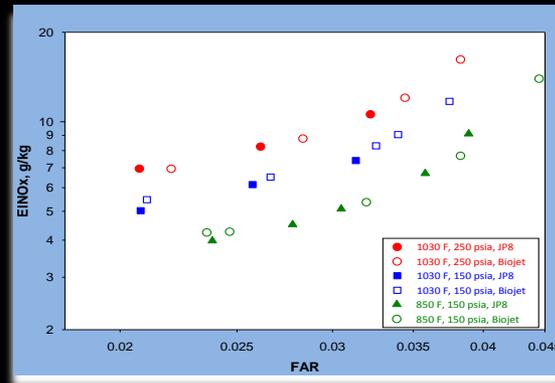
Particles Greatly Reduced with F-T Fuel

# Advanced Low Emissions Combustor Concept Testing with Biojet Fuel in NASA CE-5 Flametube Facility

## 9-Point LDI

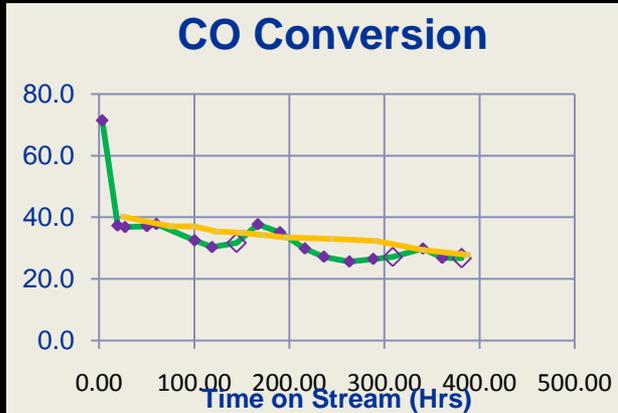


## NOx Emissions



## Particulate Emissions

# Alternative Fuels Research Laboratory



- Hot Liquid Process Simulator for fuel thermal stability studies
- Three 1-L Fischer-Tropsch Reactors to study F-T reaction process in order to increase jet fuel yield and reduce energy consumption
- Advanced catalysts will be developed and tested



F-T Reactor Product Samples

# Biomass Research

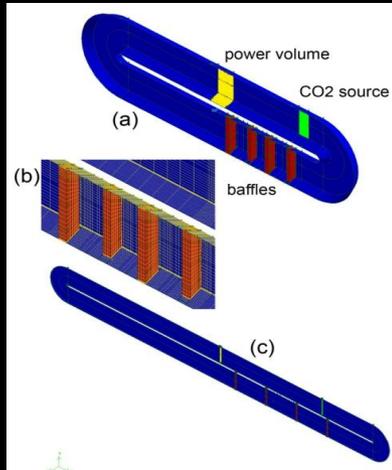


**Salicornia europaea**



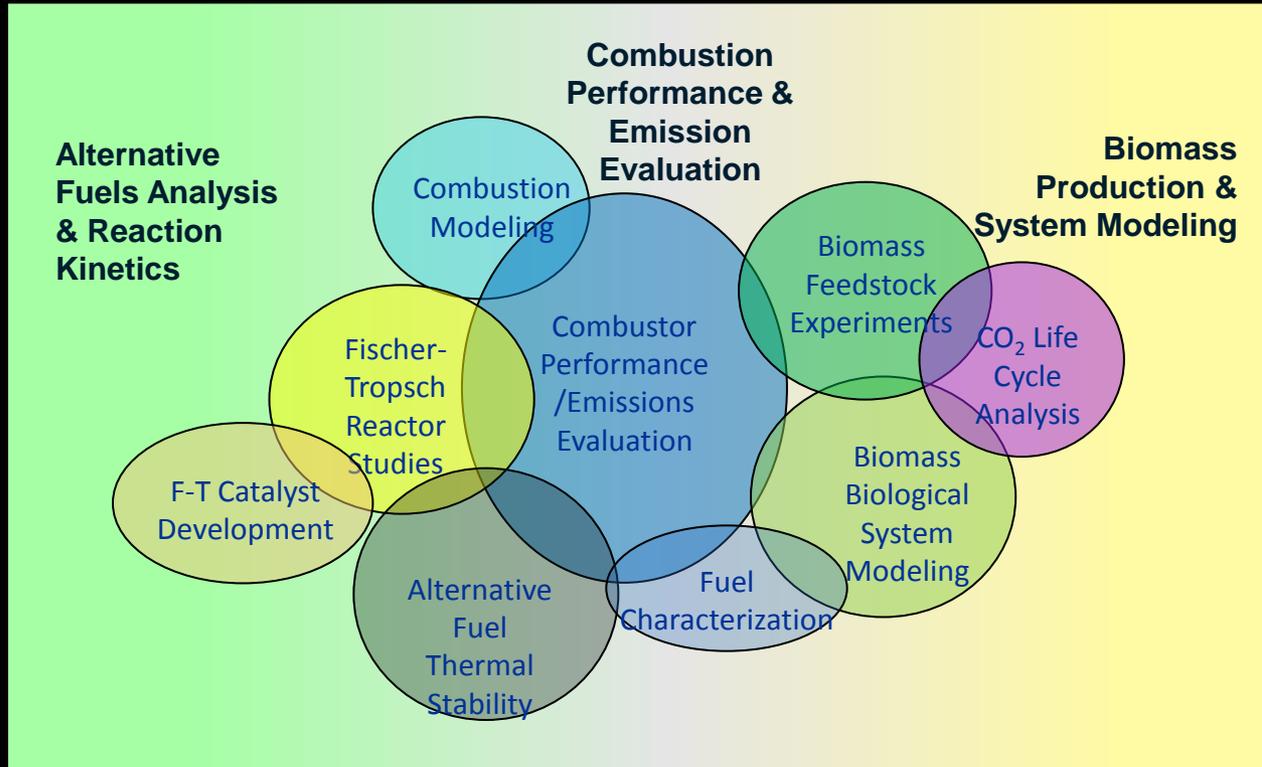
**Salicornia virginica**

Collaboration with DOE NETL to investigate lipid extraction and analysis from several Salicornia species



Algae Open Pond Modeling Interdisciplinary approach combining biology-transport physics to optimize overall open pond algae process  
Collaboration with Seambiotics, Phycal LLC

# Summary



Broad Range of Research Activities are being conducted on Alternative Fuels